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7. Abstract

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1.0 INTRODUCTION

Recent modifications to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) require the U.S. Department of Energy (DOE) to implement the *Hanford Past-Practice Strategy* (DOE-RL 1991). The first step in the implementation of this strategy is the 200 Aggregate Area Management Study (200 AAMS) (TPA milestone M-27-00). The purpose of the 200 AAMS will be to compile all environmental data and evaluate the usefulness of the data, identify contaminants of concern and applicable remedial actions, focus future site characterization activities, and provide defensible conceptual models. The 200 Areas has been divided into eight source aggregate areas and two groundwater aggregate areas. The source aggregate areas are based on major facility groups and the associated waste disposal operations (U Plant, T Plant, etc.). Two groundwater aggregate areas have been identified that encompass groundwater contamination underlying or originating from the 200 West Area and the 200 East Area, respectively.

This document is a topical report which provides a compilation and evaluation of available hydrogeologic and hydrochemical data collected in and surrounding the 200 West Area. This data compilation and evaluation effort has been conducted in support of the 200 West Groundwater Aggregate Area Management Study. Information and conclusions found in this topical report will be incorporated into the 200 West Groundwater Aggregate Area Management Study report where appropriate.

This document provides a comprehensive overview of groundwater flow characteristics in the 200 West Area and identify the extent and nature of groundwater contamination associated with current and historical liquid waste management operations in the 200 West Area. An emphasis has been placed on integrating the available data so that an aggregate area-scale hydrogeologic conceptual model can be constructed.

Objectives of the document are as follows.

- Compile and analyze all existing hydrogeologic and hydrochemical data collected from within and surrounding the 200 West Area.
- Develop an area-wide conceptualization of groundwater flow for both the unsaturated and saturated zones.
- Develop a comprehensive hydrogeologic model for the 200 West groundwater aggregate area.
- Identify and describe the nature and extent of groundwater contamination associated with 200 West Area waste management operations.

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2.0 GEOLOGY

The geology of the 200 West Area has been presented in detail by Lindsey et al. (1991) and Bjornstad (1990). The following geologic description of the 200 West Area is a summarization of the geologic and stratigraphic relationships as described by Lindsey et al. (1991). (For an in-depth description of the geology and stratigraphy of the 200 West Area, refer to Lindsey et al. [1991] and Bjornstad [1990].) Additional information on the Hanford Site geology is provided by Delaney et al. (1991).

The uppermost basalt beneath the 200 West Area is the Elephant Mountain Member of the Saddle Mountains Basalt. The Elephant Mountain Member is overlain by the Ringold Formation which in this area consists of gravel unit A, the lower mud sequence, gravel unit E, and the upper unit (Figure 2-1). Fluvial sequences B, C, and D are not present in the 200 West Area. The Ringold Formation in this area is overlain by the Plio-Pleistocene unit, early "Palouse" soil, and Hanford formation (Figure 2-1) (DOE 1988, Last et al. 1989). A discontinuous veneer of Holocene eolian deposits overlies the Hanford formation.

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2.1 BASALT GEOLOGY AND STRUCTURE

The 200 West Area is situated on the generally southward dipping north limb of the Cold Creek syncline, 1 to 5 km north of the syncline axis (Figure 2-2). The Gable Mountain-Gable Butte segment of the Umtanum Ridge anticline lies approximately 4 km north of the 200 West Area. The axes of the anticline and syncline are separated by a distance of 9 to 10 km, and the crest of the anticline (as now exposed) is over 200 m higher than the uppermost basalt layer in the syncline axis. As a result, the basalts and overlying sediments dip to the south and southwest beneath the 200 West Area.

The Elephant Mountain Member of the Saddle Mountains Basalt is the uppermost basalt unit beneath the 200 West Area and it is continuous beneath the entire area. The top of the Elephant Mountain Member, as portrayed in Figure 2-2, dips to the southwest and south into the Cold Creek syncline, reflecting the structure of the area. There is little evidence for significant erosion into the top of the Elephant Mountain Member and no indication of erosional "windows" through the basalt into the underlying Rattlesnake Ridge interbed.

2.2 RINGOLD FORMATION

The Ringold Formation in the 200 West Area is divided, from the bottom to the top of the section, into the fluvial gravels of unit A, the paleosol and lacustrine muds of the lower mud sequence, the fluvial gravels of unit E, and the sands and lesser muds of the upper unit. Fluvial gravel units B, C, and D are not found in the immediate vicinity of the 200 West Area.

The two lowest Ringold units in the 200 West Area, the fluvial gravels of unit A and the lower mud sequence, display similar trends. The fluvial gravels and intercalated sands of unit A thicken and dip to the south and southwest towards the axis of the Cold Creek syncline (Figures 2-3 and 2-4).

The top of the unit is relatively flat, dipping to the west and southwest. Intercalated lenticular sand and silt is most common in unit A in the western and southern part of the area. The overlying overbank and lacustrine deposits of the lower mud sequence also thicken and dip to the south and southwest. However, unlike unit A, the top of the lower mud sequence is irregular and the interval pinches out in the northeastern corner of the 200 West Area (Figures 2-5 and 2-6).

Isopach and structure contour maps of fluvial gravel unit E (Figures 2-7 and 2-8) show trends not seen in the underlying strata of unit A and the lower mud sequence. The gravels of unit E generally thin from the north-northwest to the east-southeast. The unit is recognized by: (1) coarse texture; (2) high proportion of quartzite and granitic clasts; (3) relatively low calcium carbonate content; (4) partial consolidation; and (5) relatively low natural-gamma response. This unit is present throughout the 200 West Area ranging in total thickness from __ to ___ m (Figure 2-7). The top of the unit is irregular, displaying several highs in the northern and southern parts of the area and several lows in the central part of the area. The top of unit E generally dips to the southeast and climbs to the northeast. Intercalated lenticular beds of sand and silt probably occur throughout the 200 West Area, although predicting where they will occur is very difficult.

The upper unit is very discontinuous across the area because of post-Ringold erosion. The upper unit in the 200 West Area consists of silty overbank deposits and fluvial sands. It represents a transition to a lower energy fluvial environment than that of Ringold FSE. The contact between the upper Ringold and Ringold FSE is gradational, and is defined by the transition where light-colored arkosic sand exceeds the amount of gravel. This unit is recognized by: (1) abundance of well-sorted sand; (2) light color, caused by abundance of quartz and feldspar material over mafic material; and (3) variable natural-gamma response (Bjornstad 1990). It only is found in the west, north, and central parts of the 200 West Area. In these areas, the top of the unit generally is dipping to the south-southwest (Figures 2-9 and 2-10).

2.3 PLIO-PLEISTOCENE UNIT

Plio-Pleistocene unit is largely restricted to the vicinity of 200 West Area, pinching out near the northern, eastern, and southern boundaries of the area (Figures 2-11 and 2-12). It represents an highly weathered surface that developed atop of the Ringold Formation (Brown 1959, 1960) and has two distinct facies: pedogenic calcrete and basaltic detritus (DOE 1991). One or both facies may be present. However, the pedogenic calcrete dominates in the 200 West Area. The calcrete layer generally consists of carbonate-rich silt and sand interfingered with carbonate-poor silts and sands. It is locally referred to as the "caliche layer". This caliche layer is moderately to highly fractured (Lindsey et al. 1991). The differentiating features of this unit are (1) high degree of cementation, (2) presence of root traces and animal burrows in cores, and (3) white color (Bjornstad 1990). The amount of calcium carbonate is variable; zones containing between 5 and 10% calcium carbonate are referred to as calcic soil, while zones containing >10% are usually very cemented and are referred to as calcrete (Machette 1985). Boreholes located adjacent to Yakima Ridge indicate the unit extends into the area west of the 200 West Area. The thickness of the unit is very irregular. It is thickest in the southeast, southwest, and north-central parts of the

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area, while it thins in the south-central and central parts of the area. Although no direct evidence exists indicating that erosional windows through the unit are present, the isopach map (Figure 2-11) indicates that the unit thins considerably in several areas. Within these areas, there is a good possibility that erosional windows exist. Interbedded calcium carbonate-poor lithologies are found at many locations and in general calcium carbonate content decreases to the south while the abundance of basaltic clasts increases. The top of the unit generally dips to the south and southwest although irregularities occur, especially in the center of the 200 West Area.

2.4 EARLY PALOUSE SOIL

Like the Plio-Pleistocene unit the early Palouse soil (Figures 2-13 and 2-14) is largely restricted to the vicinity of the 200 West Area. The unit is differentiated from the overlying Hanford slackwater deposits by: (1) greater calcium carbonate content; (2) cohesive structure in core samples; (3) uniform fine-grained texture; and (4) high natural gamma response in geophysical logs (Bjornstad 1984). The upper contact is poorly defined grading into the lower part of the Hanford formation. The early Palouse soils are unconsolidated and less calcareous than the underlying Plio-Pleistocene and are distinguished from it by a high natural gamma response and lower calcium carbonate content. Although carbonate is present in the unit, no obvious pedogenic calcium carbonate concentrations like those seen in the underlying Plio-Pleistocene unit are found. The loess-like sediments of the early Palouse soil are uncemented. In the 200 West Area, the unit pinches out near the southern, eastern, and northern boundaries. Boreholes located west of the 200 West Area encounter the unit. The thickness of the unit varies irregularly. It is thickest in the southwest, southeast, and central parts of the area. Generally, the top of the unit dips to the south, although it becomes fairly irregular in the southern half of the area.

2.5 HANFORD FORMATION

Hanford formation is divided into three facies: gravel-dominated, sand-dominated, and slackwater. Studying the distribution of these facies types and identifying similarities in lithologic succession from borehole to borehole across the 200 West Area indicates the Hanford formation can be divided into at least two stratigraphic sequences. Typical lithologic successions used in defining the two Hanford formation sequences consist of fining upwards packages, major fine-grained intervals, and laterally persistent coarse-grained sequences. Mineralogic and geochemical data were not used in differentiating sequences because of the lack of a comprehensive mineralogic and geochemical data set. The two sequences into which the Hanford formation is divided, coarse-grained and fine-grained, are essentially the same units as defined by Last et al. (1989). The coarse- and fine-grained sequences correspond to the coarse-grained and basal slackwater sequences, respectively, of Last et al. (1989). Neither of these sequences is continuous across the entire 200 West Area, they both display marked changes in thickness and continuity, and are texturally very heterogeneous.

The fine-grained sequence of the Hanford formation in the 200 West Area is thick, but locally discontinuous (Figures 2-15 and 2-16). The sequence is

0 to 32 m thick and consists dominantly of silt, silty sand, and sand typical of the slackwater facies interbedded with coarser sands like those comprising the sand-dominated facies. Thin (<3-m) intervals dominated by the gravel facies are found locally. The sand and silt consists of fine- to coarse-grained plane to cross-bedded sand and silt that commonly display normally graded rhythmites a few centimeters to several tens of centimeters thick in outcrop (Myers and Price 1979, DOE 1988). These sediments were deposited in transitional areas adjacent to main flood channels and in slackwater conditions and backflood areas (DOE 1988). They are locally referred to as the "Basal Slackwater Sequence". The distribution of facies within the sequence is variable, although the fine-grained sequence generally fines to the south where the slackwater facies becomes more common. The fine-grained sequence is not found in the northern part of the area, and it generally thickens to the south. An erosional scour through the sequence is present in the central part of the 200 West Area. This scour is elongated in a north-south direction.

The coarse-grained sequence of the Hanford formation consists of interstratified gravel, sand, and lesser silt. Gravel-dominated deposits typical of the gravel facies generally dominate the sequence. However, at some localities, deposits typical of the sand-dominated facies dominate the coarse-grained sequence. The coarse-grained facies is distinguished by a coarse-grained sand to a boulder gravel that display massive bedding, plane to low angle bedding, and large scale cross bedding in outcrop. The matrix is commonly lacking in gravels, giving them an open framework appearance. Minor, laterally discontinuous silty deposits like those that form the slackwater facies are found locally. The thickness and distribution of individual facies within the coarse-grained sequence is variable. Fining upwards sequences, going from coarser to finer gravel, and gravel, sand, and/or silt are present at some locations. The coarse-grained sequence is up to 45 m thick and laterally discontinuous, being found in the northern, east-central, and eastern parts of the area (Figures 2-17). The base of the sequence is incised into underlying strata of the fine-grained sequence and, where that unit is absent, the coarse-grained sequence fills an erosional scour. The contact between the coarse-grained sequence and underlying strata is generally sharp, consisting of gravel facies strata overlying the fines of the fine-grained sequence, the early Palouse soil, and the Plio-Pleistocene unit.

2.6 HOLOCENE SURFICIAL DEPOSITS

Holocene-aged deposits in the 200 West Area are dominated by eolian sheet sands. These sands tend to consist of very fine- to medium-grained, occasionally silty sands. The eolian deposits have been removed from much of the area by construction activities. Where the eolian sands are found, they tend to be deposited in thin (<3-m) sheets. Dunes are not generally well developed within the 200 West Area.

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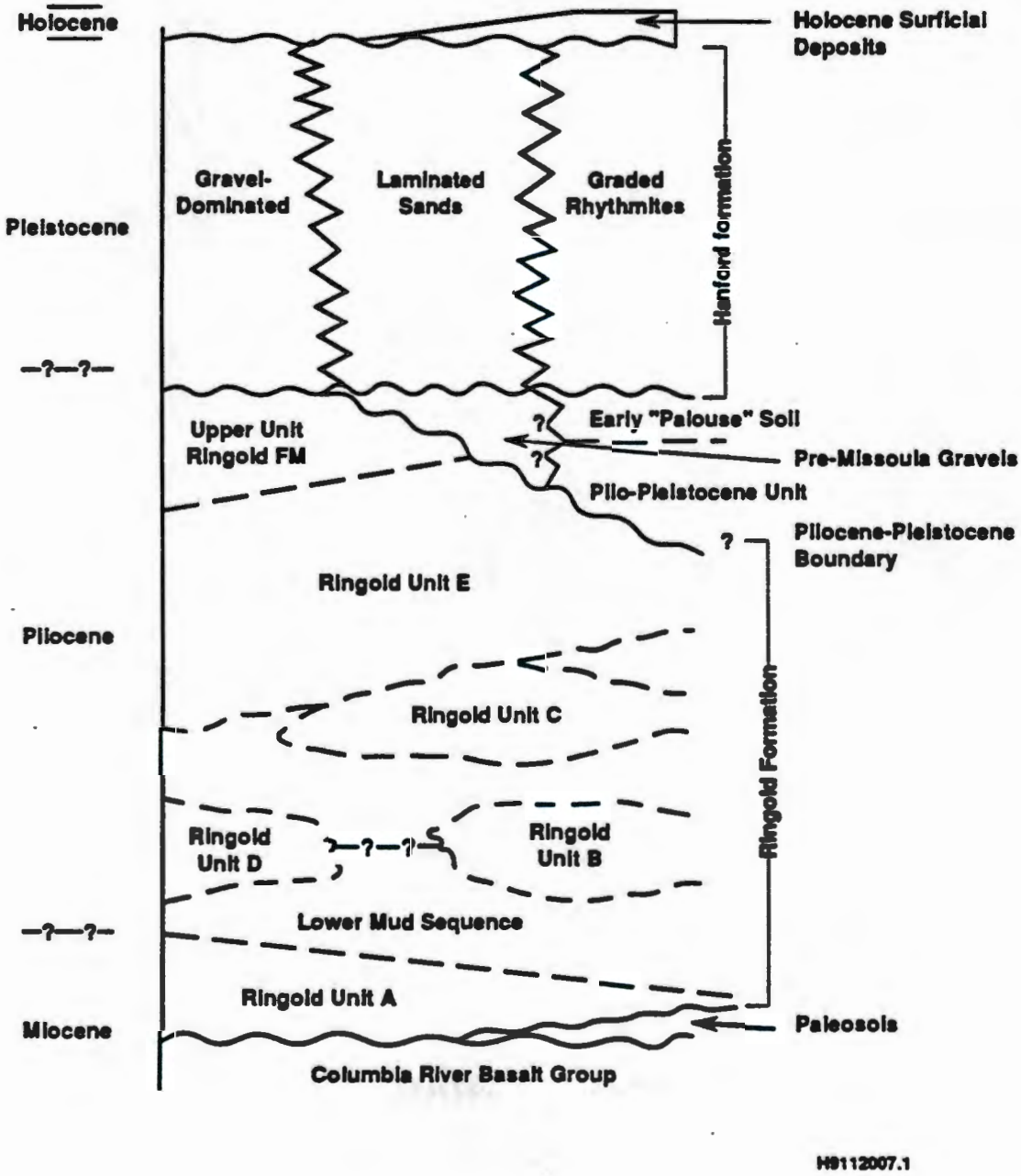
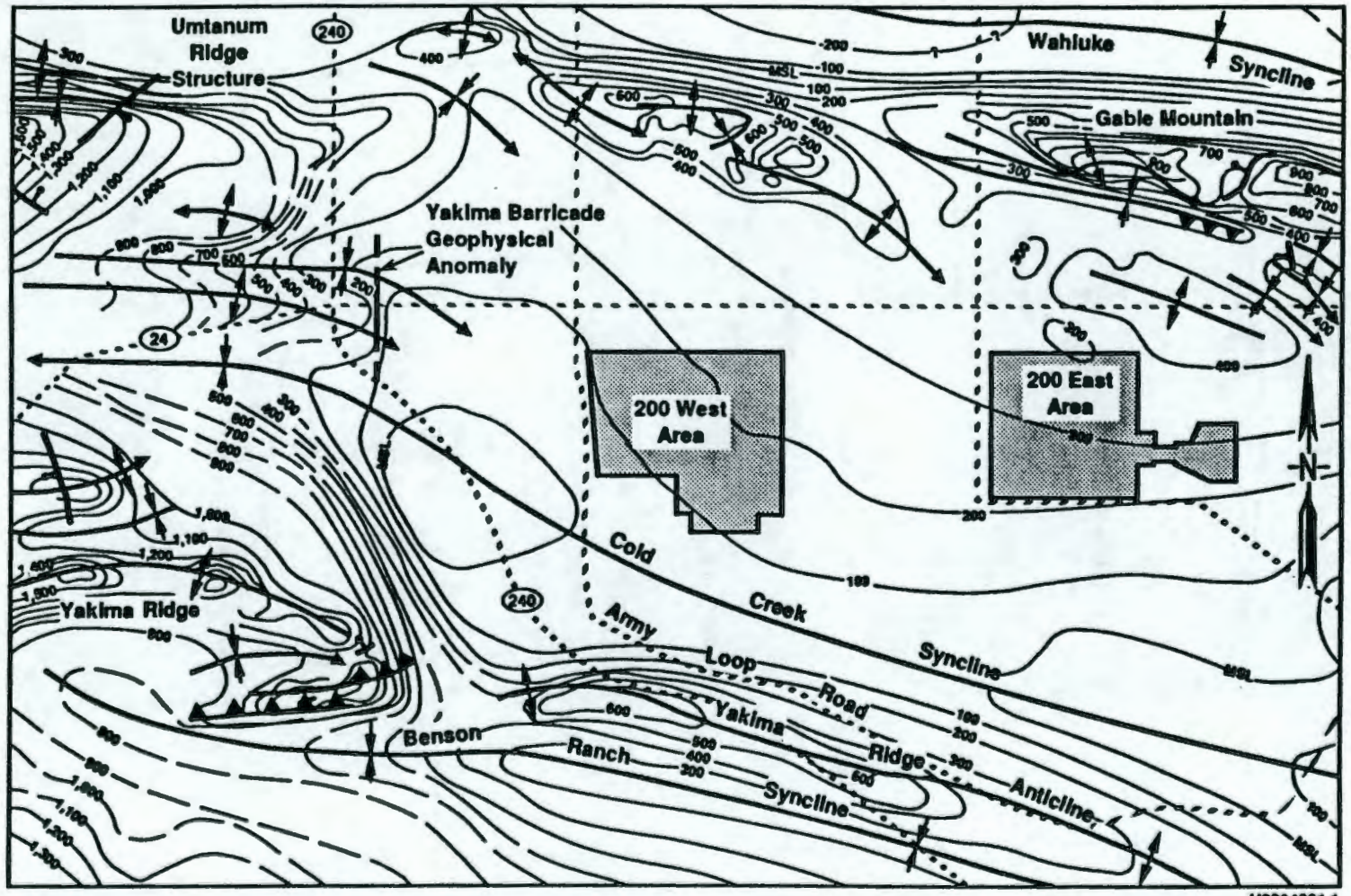


Figure 2-1: Generalized stratigraphy of suprabasalt sediments beneath the Hanford Site.



Anticline
Syncline
Thrust Fault
Normal Fault
MSL = Mean Sea Level
Contour Interval = 100 ft

0 — 5 Miles
0 — 5 Kilometers

To convert to meters multiply by 0.3048.

Figure 2-2: Uppermost basal structure-contour map illustrating significant structural features.

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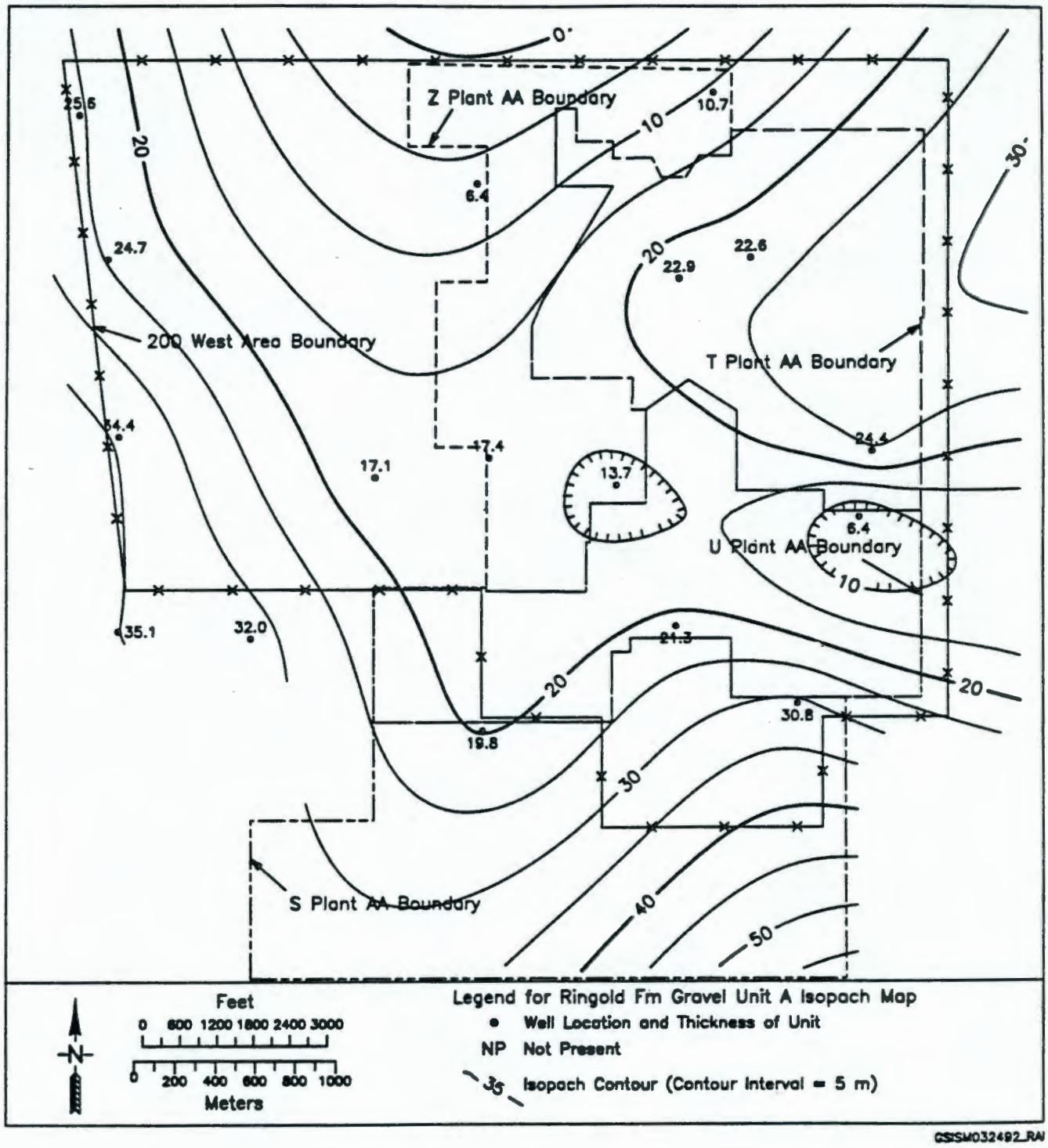

Figure 2-3: Isopach map of the Ringold Gravel Unit A.

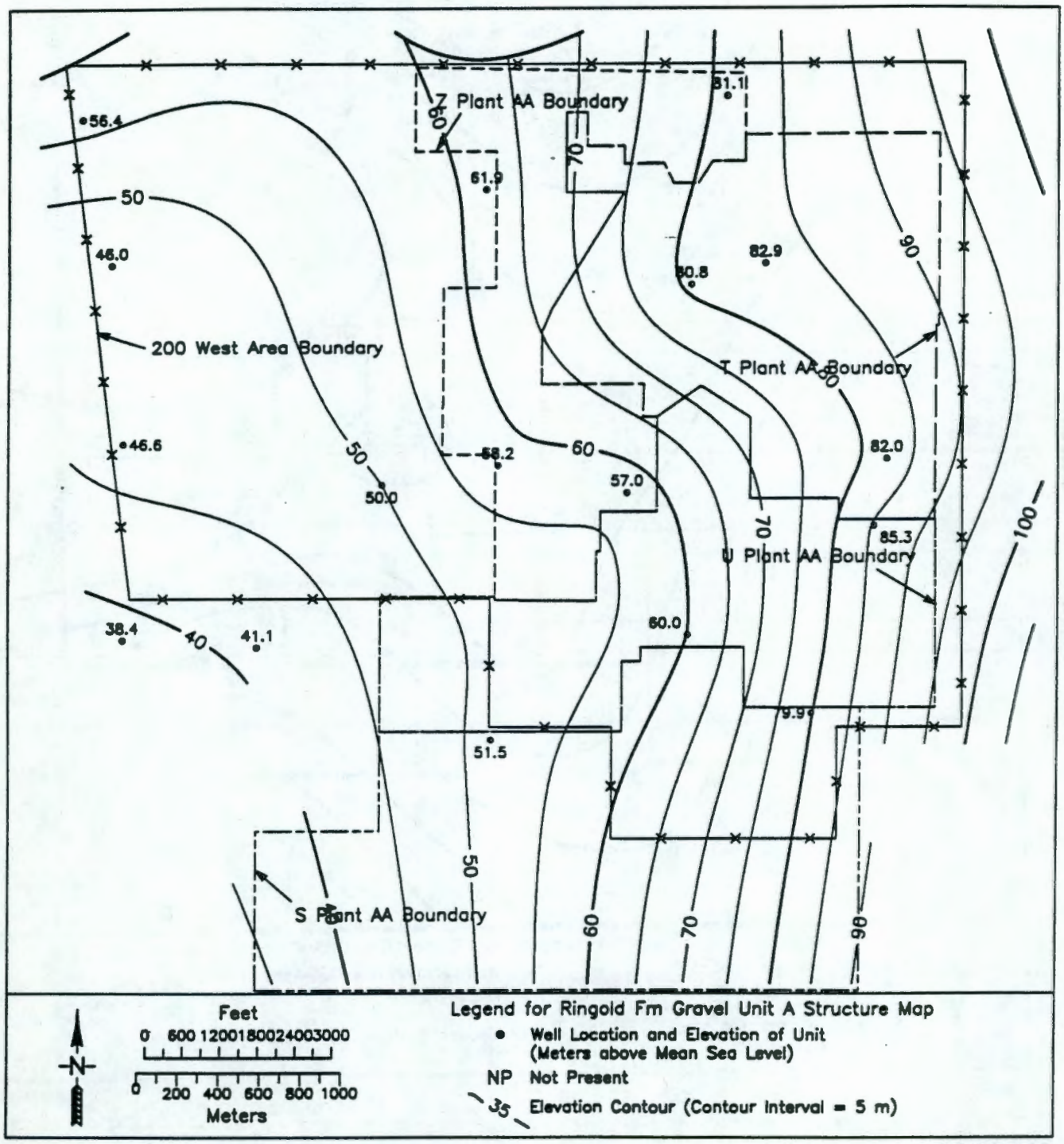

Figure 2-4: Structure-contour (top of) map of the Ringold Gravel Unit A.

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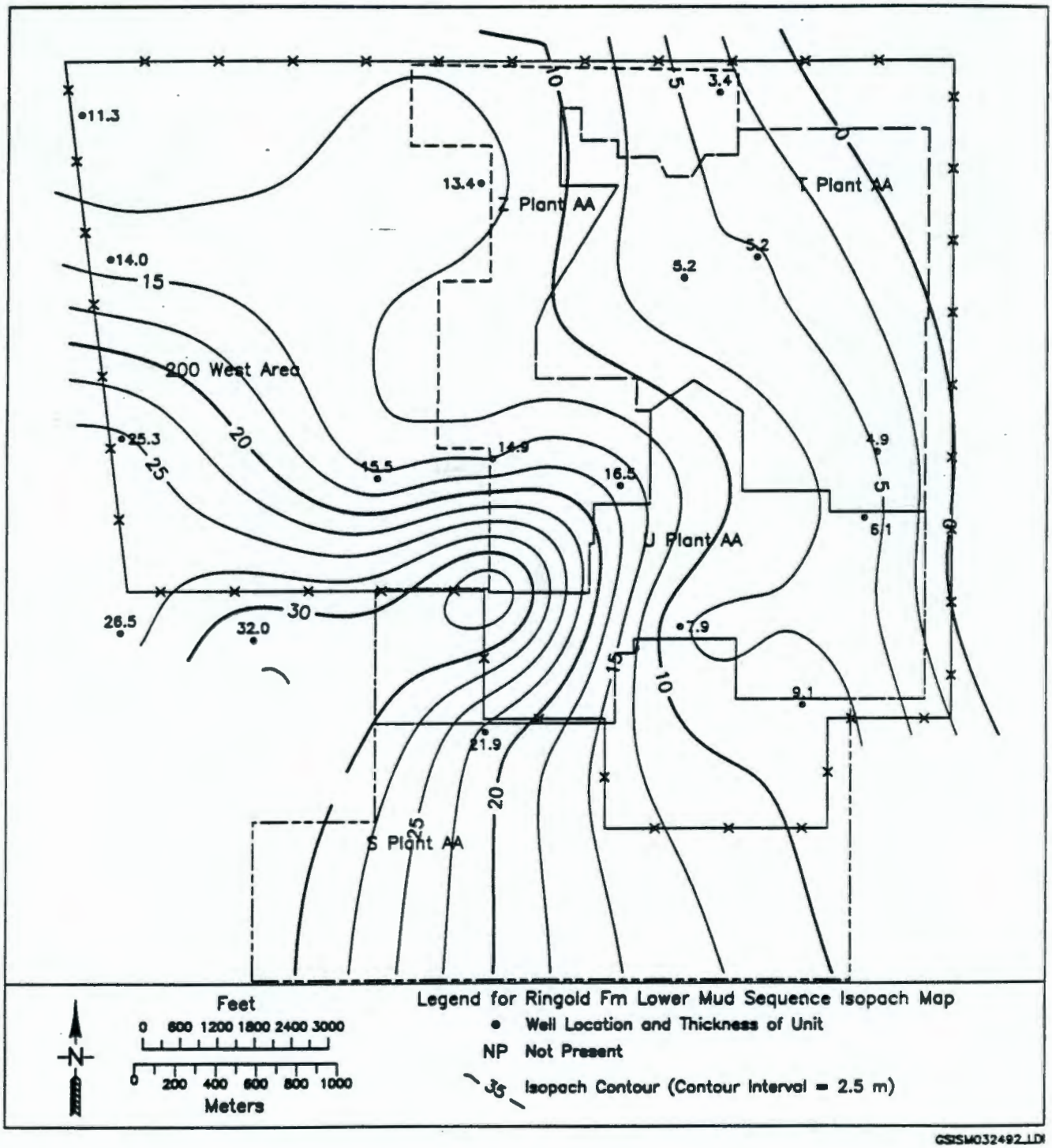

Figure 2-5: Isopach map of the Ringold Lower Mud Sequence.

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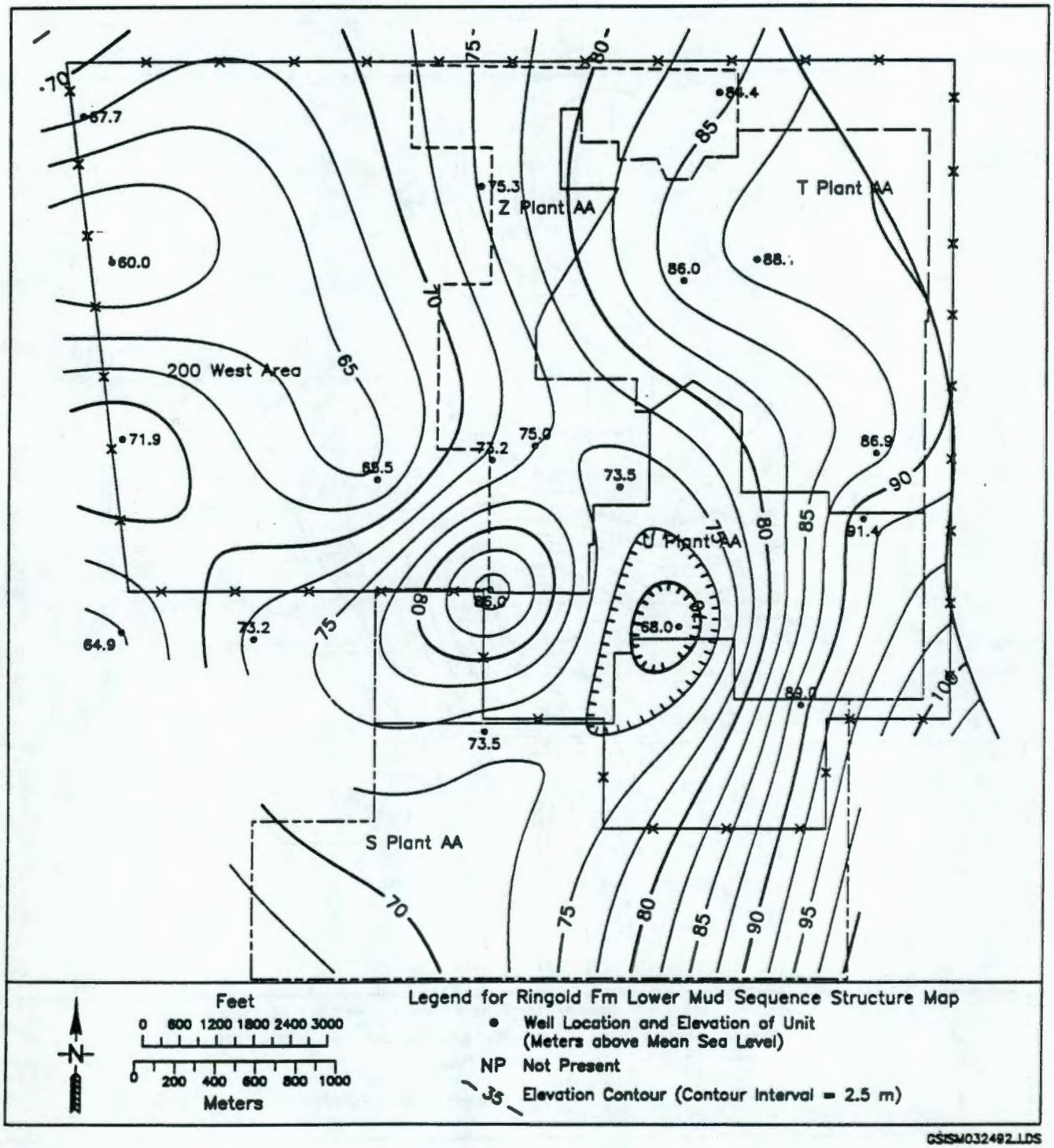

Figure 2-6: Structure-contour (top of) map of the Ringold Lower Mud Sequence.

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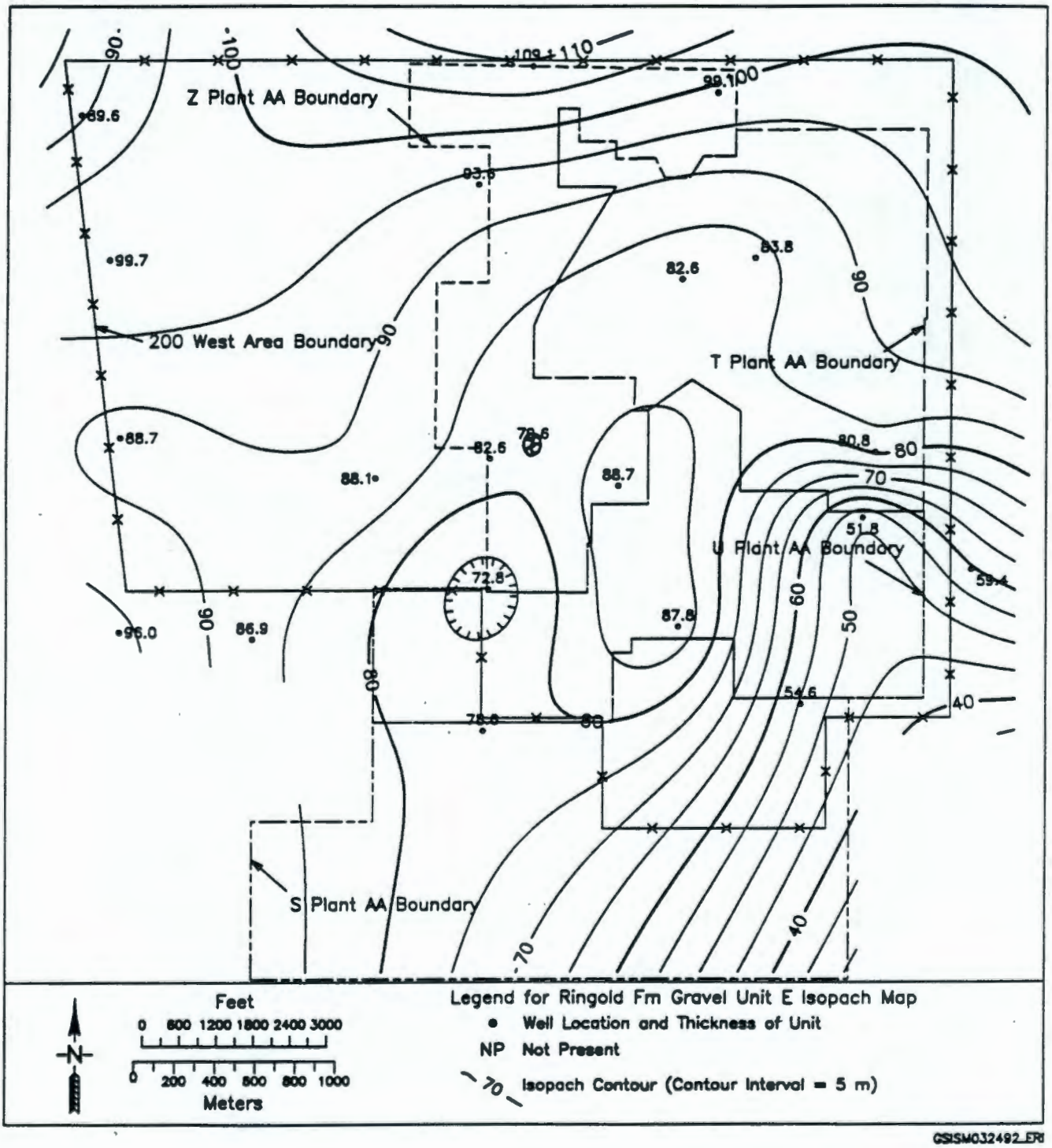

Figure 2-7: Isopach map of the Ringold Gravel Unit E.

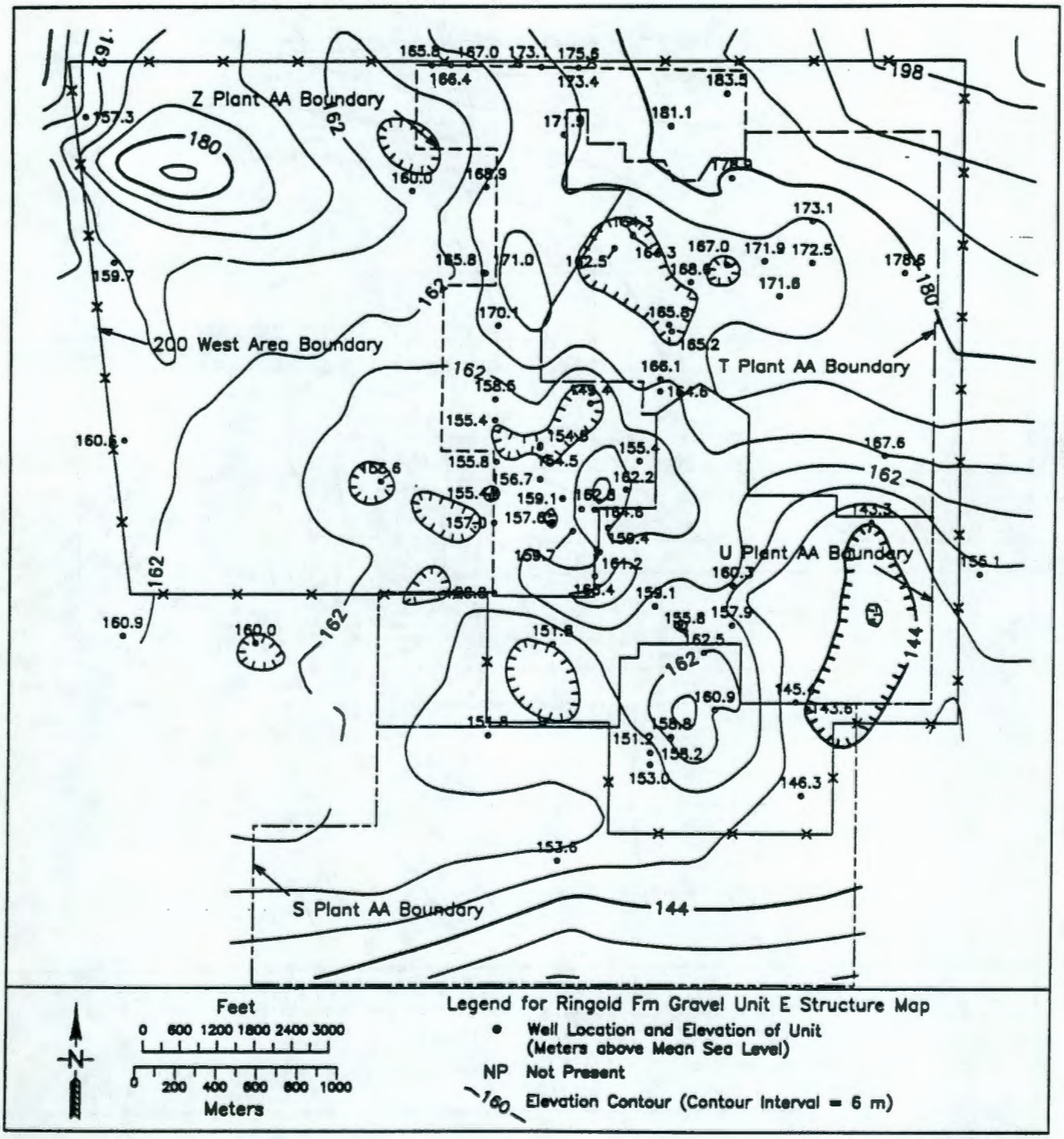

Figure 2-8: Structure-contour (top of) map of the Ringold Gravel Unit E.

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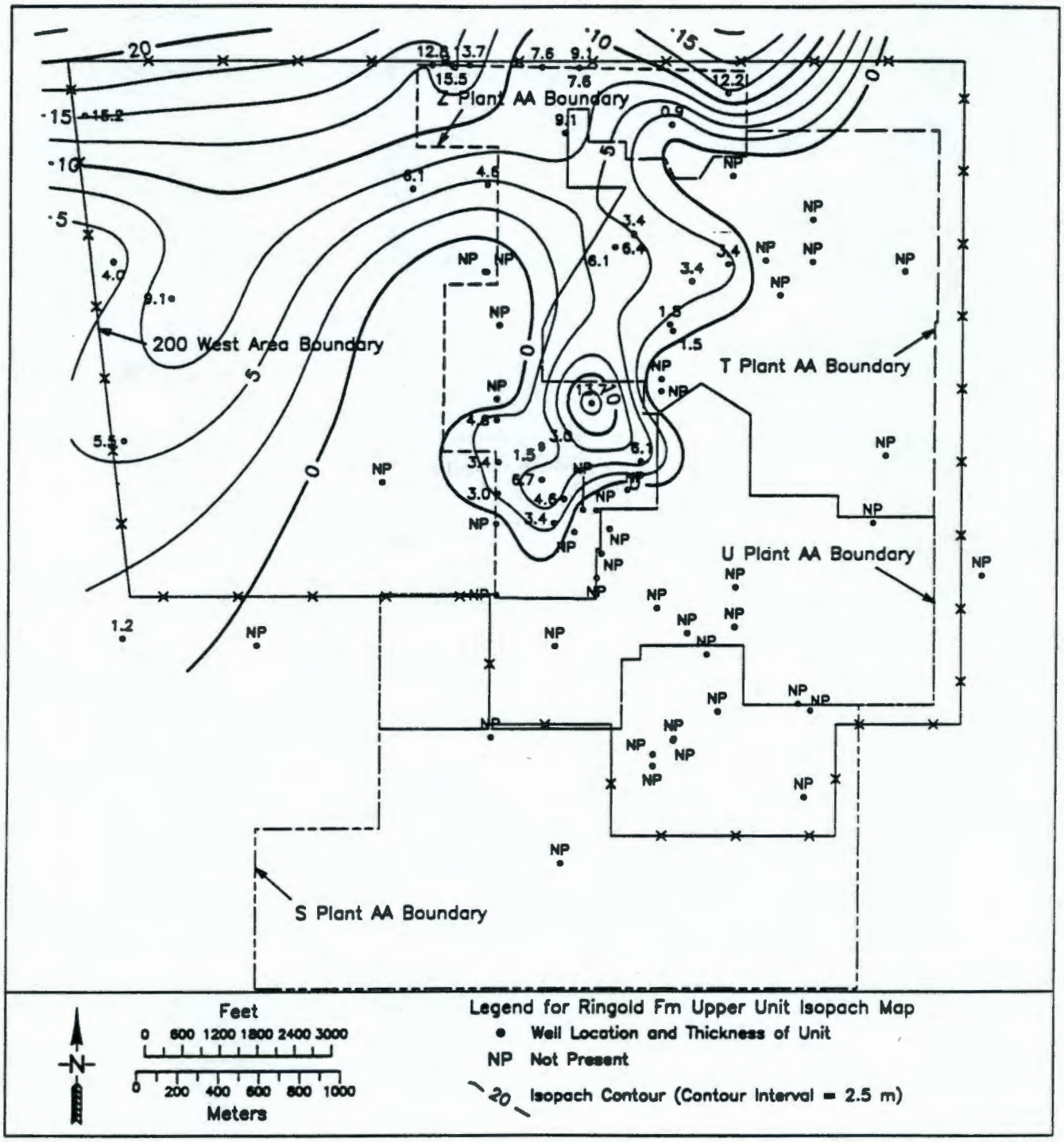

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Figure 2-9: Isopach map of the Upper Ringold.

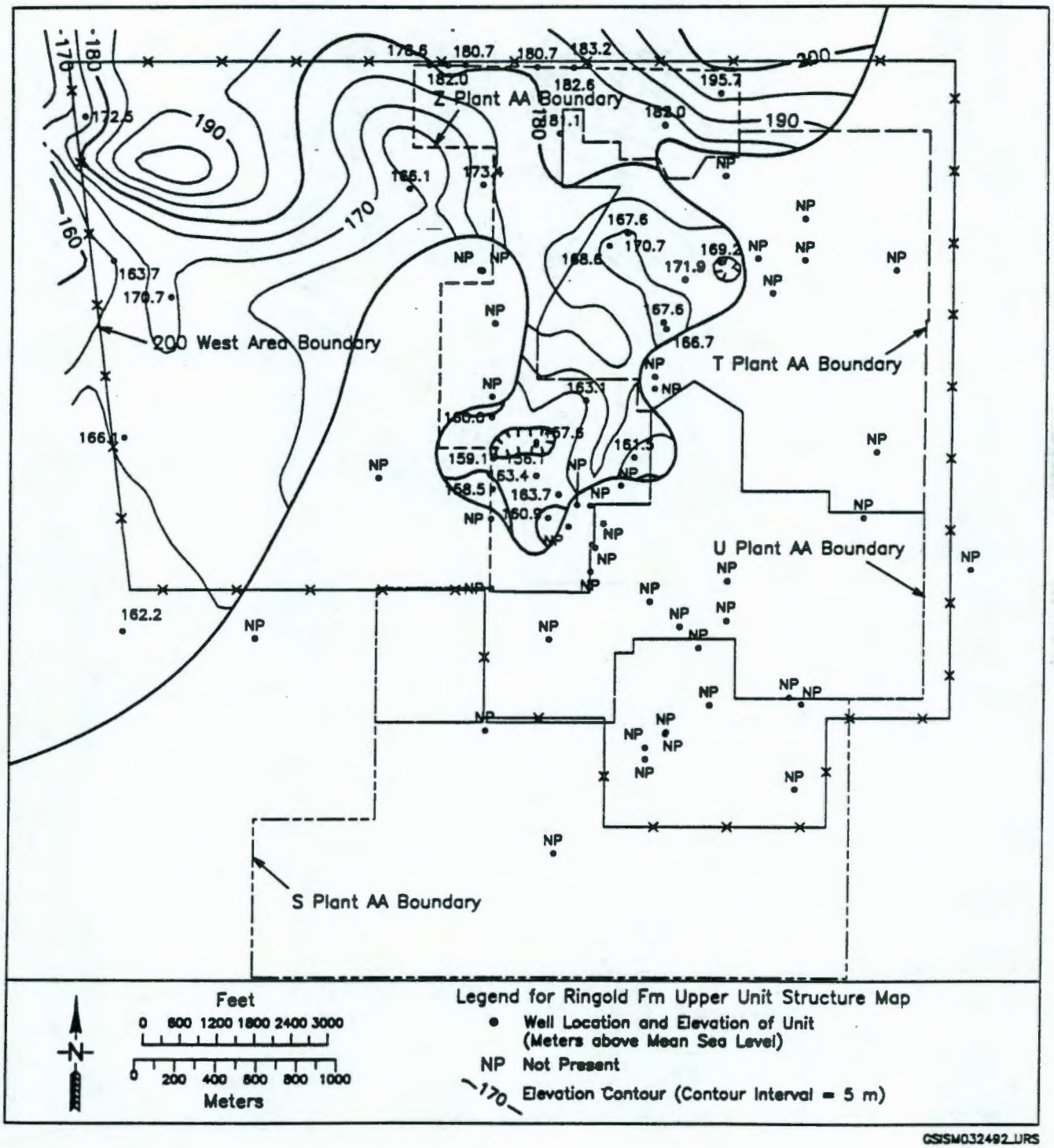

Figure 2-10: Structure-contour (top of) map of the Upper Ringold.

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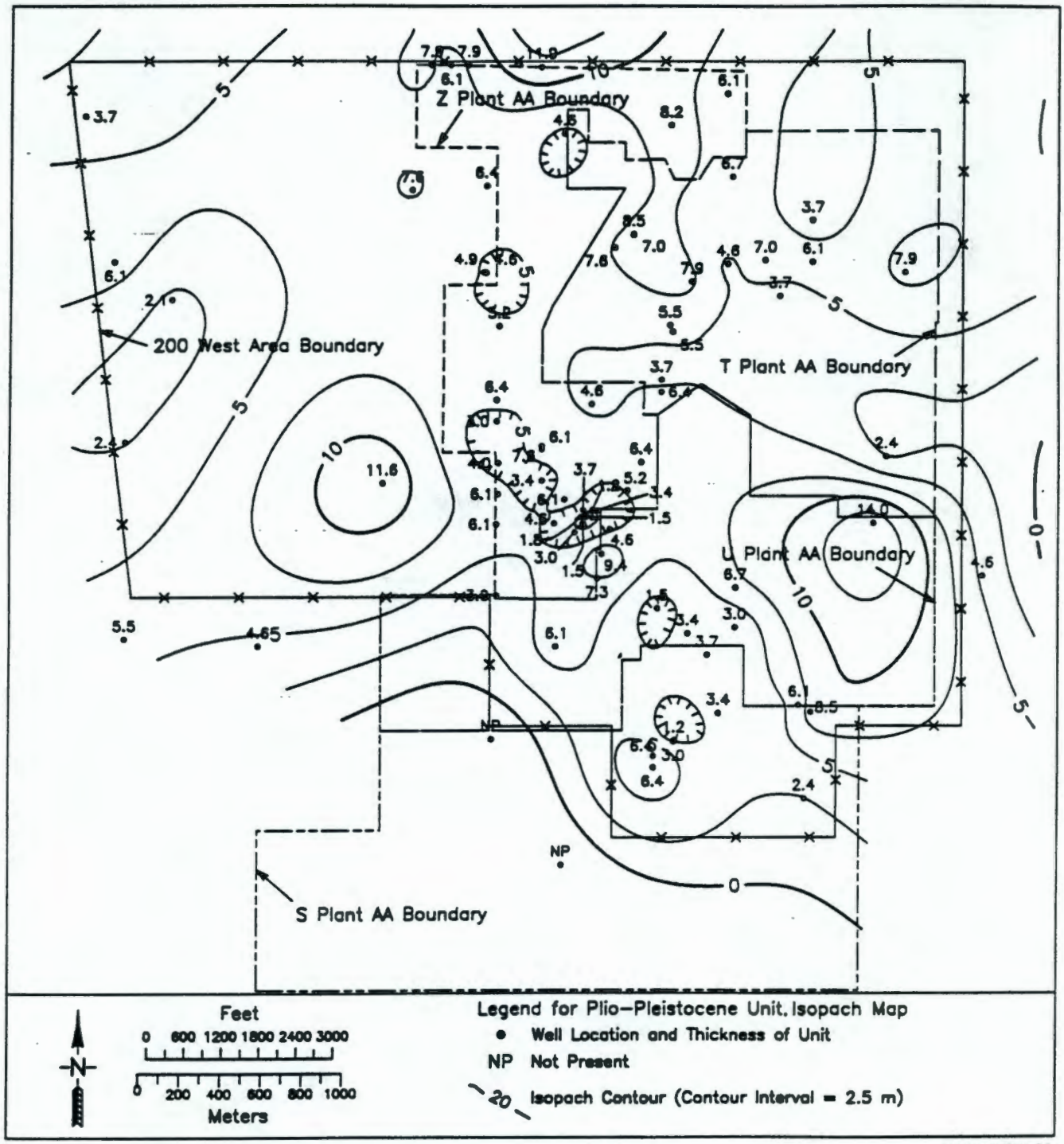

Figure 2-11: Isopach map of the Plio-Pleistocene.

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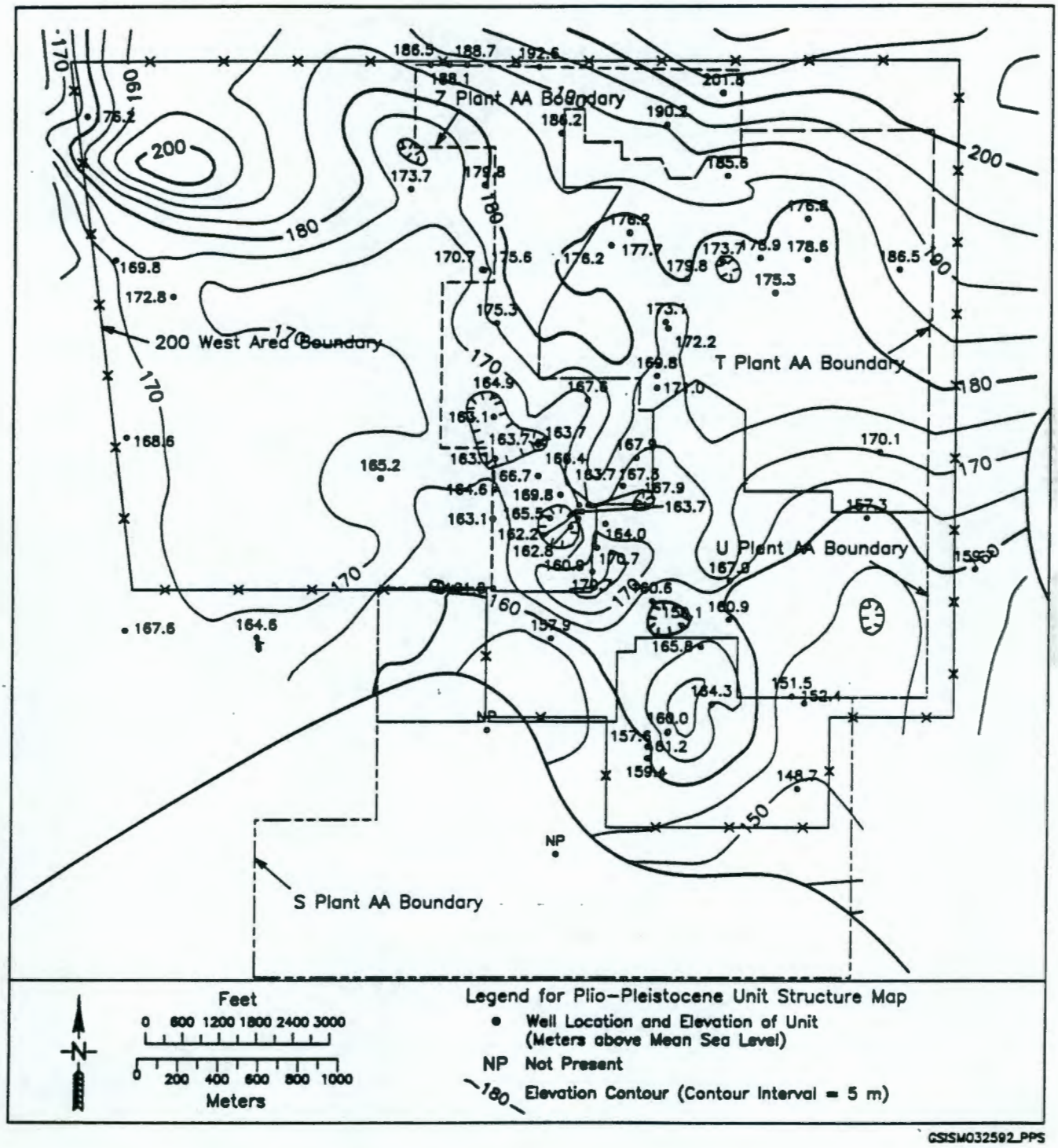

Figure 2-12: Structure-contour (top of) map of the Plio-Pleistocene.

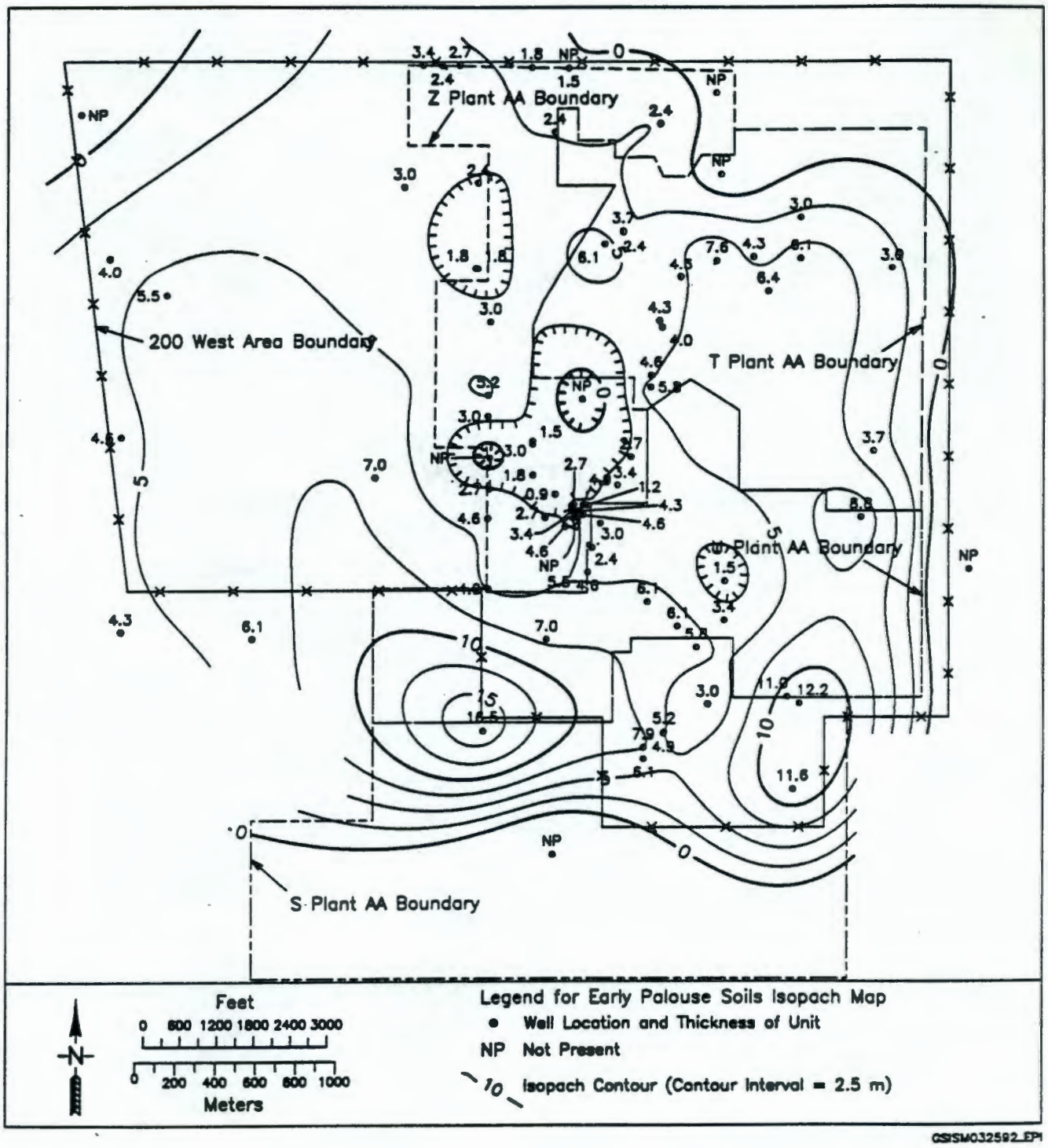

Figure 2-13: Isopach map of the Early Palouse Soils.

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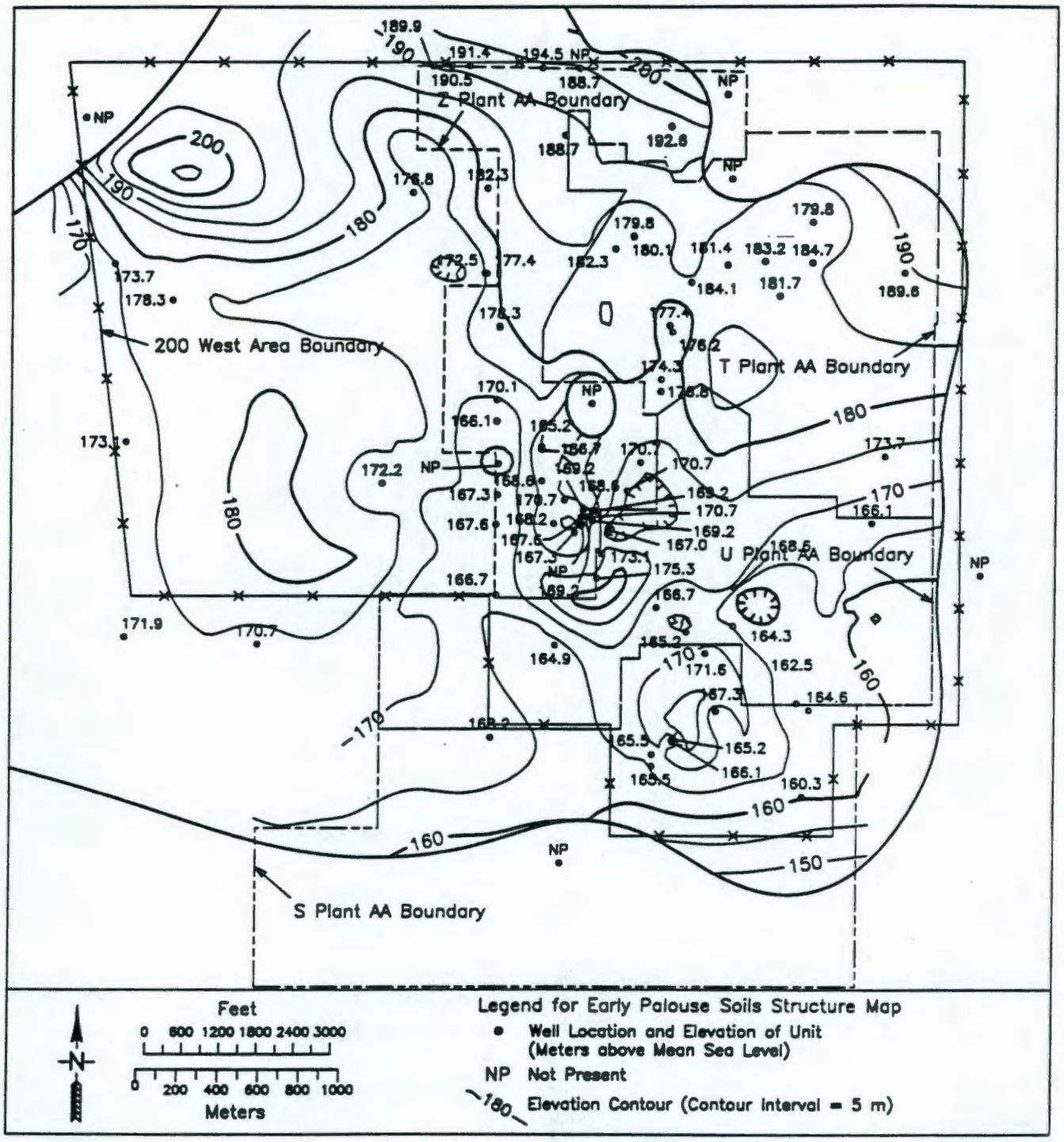

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Figure 2-14: Structure-contour (top of) map of the Early Palouse Soils.

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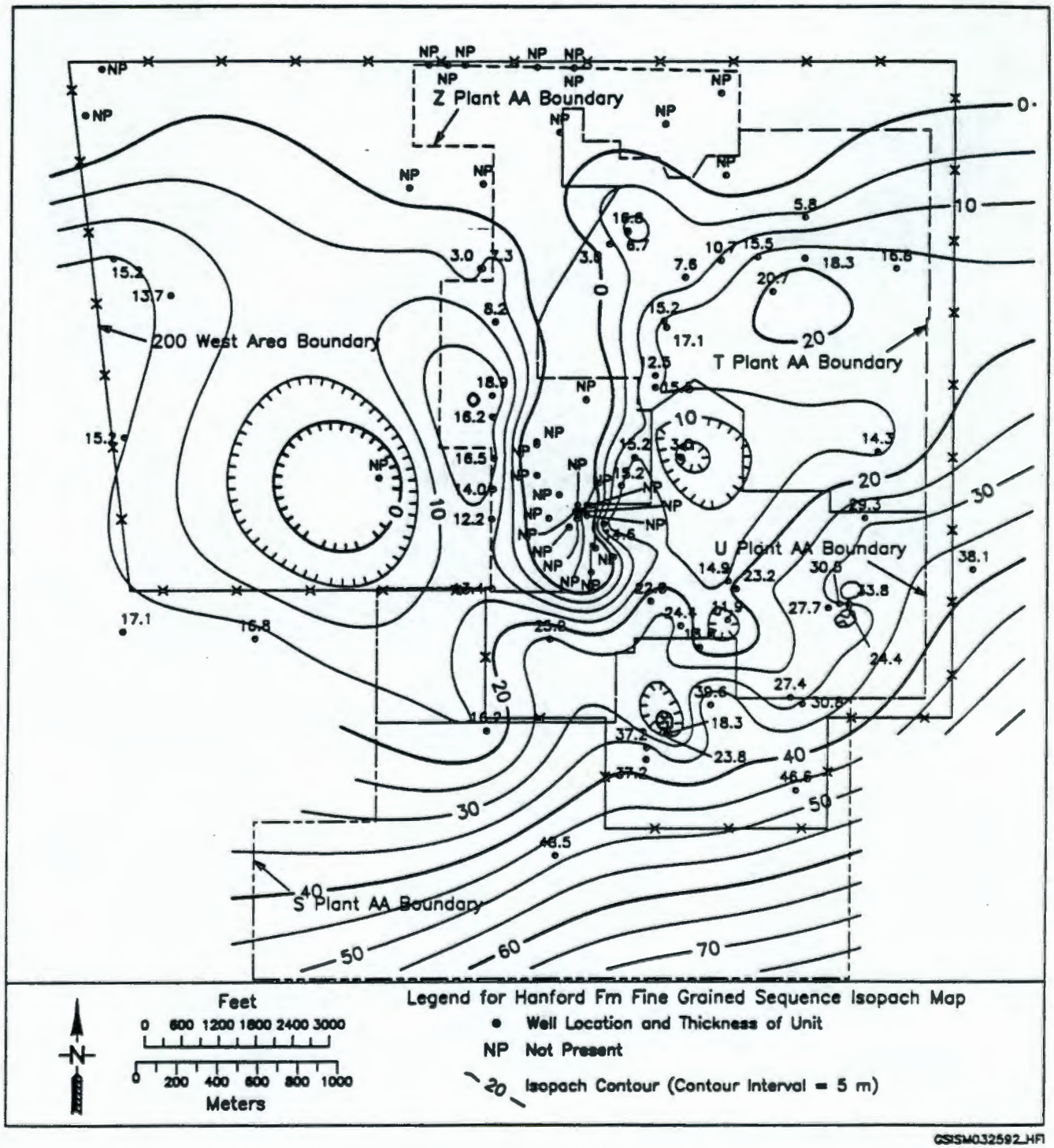

Figure 2-15: Isopach map of the fine-grained Hanford Sequence.

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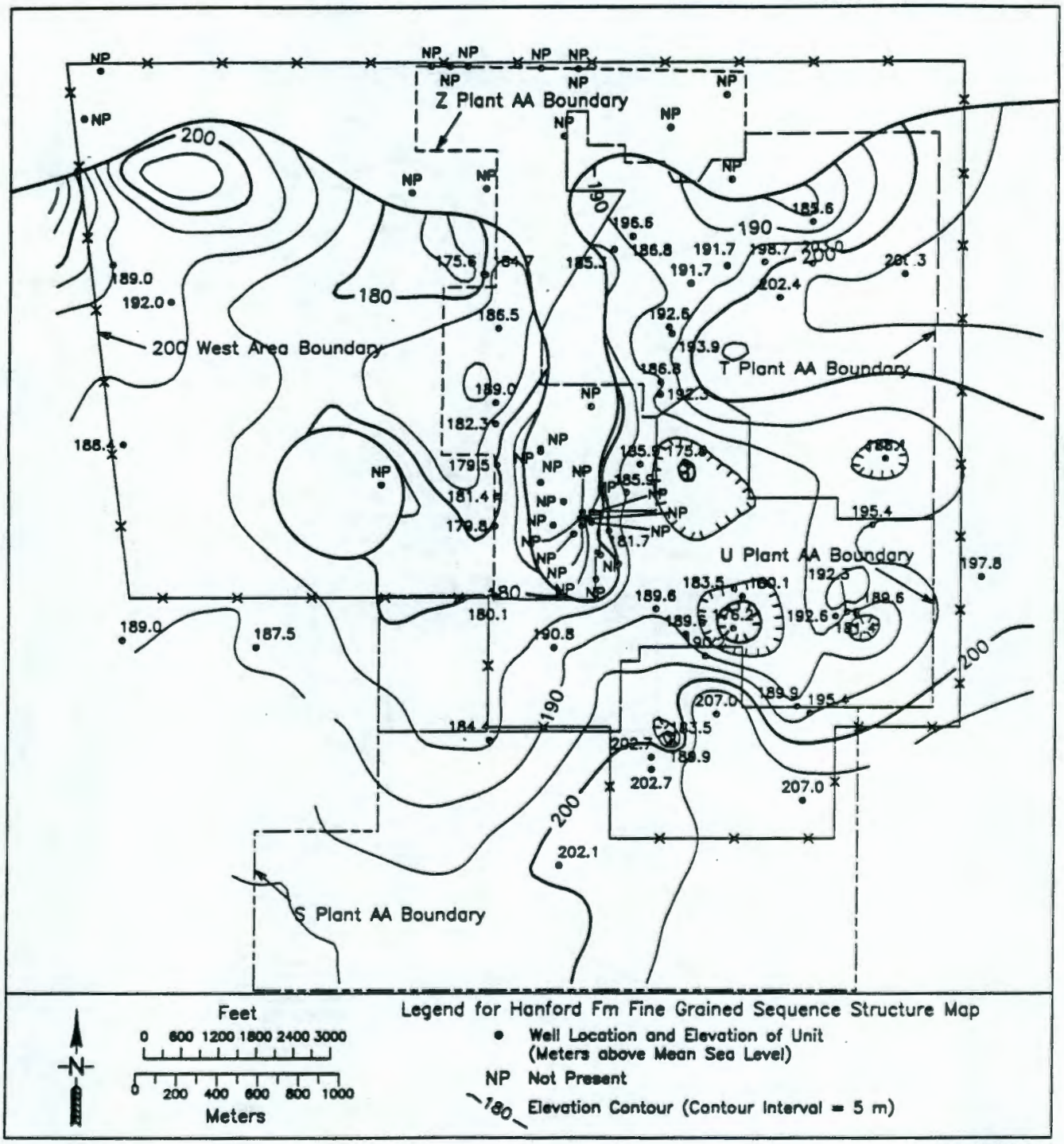

Figure 2-16: Structure-contour (top of) map of the fine-grained Hanford Sequence

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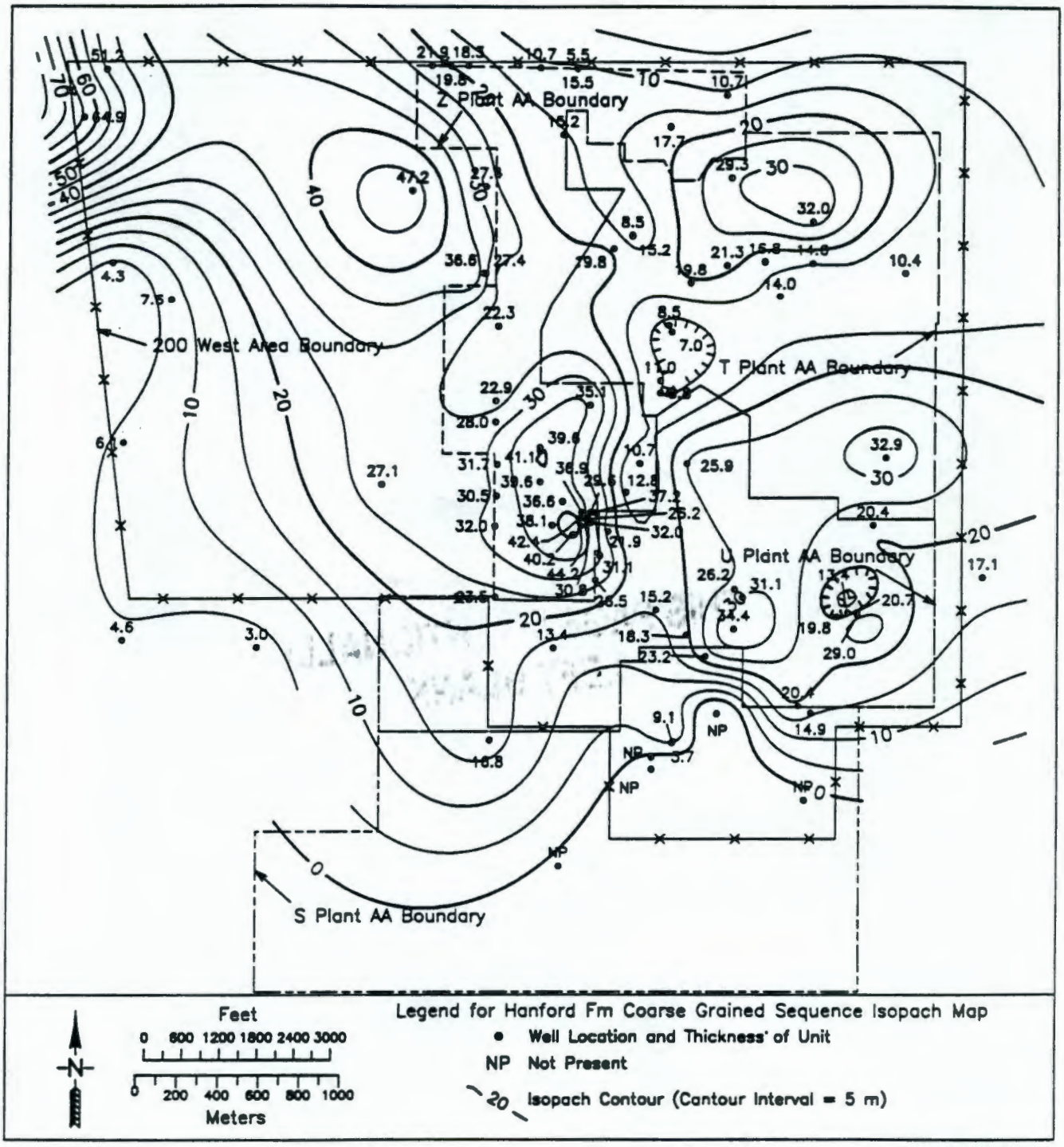

Figure 2-17: Isopach map of the coarse-grained Hanford Sequence.

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3.0 HYDRAULIC PROPERTIES OF PARTIALLY SATURATED ZONE, UNCONFINED AND CONFINED AQUIFERS

In evaluating the health and environmental risks associated with a waste disposal site at the surface, an understanding of how water migrates through the different lithologic layers is essential. Of critical importance is the determination of each layer's hydraulic properties. This discussion focuses on the measurement of the hydraulic properties, where these properties were measured, and their application to the stratigraphic units described by Lindsey (1991).

3.1 PARTIALLY SATURATED ZONE

The partially saturated zone or vadose zone is the region above the water table in which the pore spaces of the sediments are usually only partially filled with water. This zone in the 200 West Area encompasses, in ascending order, the following major lithologic units (Lindsey et al. 1991): Ringold fluvial gravel unit E, upper Ringold unit, Plio-Pleistocene, early Palouse soils, Hanford fine-grained sequence, and Hanford coarse-grained sequence. A generalized description of each of these units is provided in Chapter 2. Figure 3-1 is a fence diagram showing the thickness and distribution of these units within the partially saturated zone in the 200 West Area. Movement of water through these sediments to the water table is controlled by the following factors: (1) depth to the water table (Figure 3-2); (2) amount of both natural and artificial recharge; (3) thickness, location, and dip of the underlying sediments; and (4) the hydraulic properties and moisture content of these sediments.

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3.1.1 Measurement of Unsaturated Hydraulic Conductivity

Although a variety of methods has been developed to measure the soils hydraulic functions (Klute 1986), these are often costly and difficult to implement, especially for unsaturated hydraulic conductivity. An alternative to direct measurement of unsaturated hydraulic conductivity is to use theoretical methods that predict the conductivity from measured soil water retention data (van Genuchten 1991). Rockhold et al. (1988) compared direct measurement of unsaturated hydraulic conductivities to those predicted from measured water retention data for three sites at Hanford. They found that each method produced results different from other methods and recommend that several methods should be used to determine unsaturated hydraulic conductivities. Although only water retention data have been reported for the sediments in the 200 West Area, there is an ongoing effort to directly measure the unsaturated hydraulic conductivity. Once that data become available, a comparison will be made between directly measured unsaturated hydraulic and that predicted by measured soil water retention data.

Thirty-five samples from the 200 West Area have had water retention data measured. These samples collected from the wells shown in Figure 3-3. Eleven of these measurements were reported by Bjornstad (1990). The remaining 24 samples were analyzed as part of the ongoing performance assessment of the low level burial grounds. When possible, both the wetting (w) and drying (d) curves are given. For each of these samples, a laboratory measured, saturated

hydraulic conductivity is also given (Appendix A). van Genuchten's computer program RETC (1978) uses a nonlinear, least-squares curve fitting routine to match the measured soil water retention data to the following equation:

$$\theta = \theta_r + \frac{(\theta_s - \theta_r)}{[1+(\alpha\varphi)^n]^m} \tag{1}$$

where:

- θ = volumetric moisture content
- θ_s = saturated moisture content
- θ_r = residual moisture content
- α = van Genuchten curve fitting parameter (1/cm)
- φ = matric potential (suction head (-cm))
- n = van Genuchten curve fitting parameter
- m = 1 - 1/n.

Using Mualem's (1976) general model (equation 2) to predict the hydraulic conductivity from soil retention data,

$$K(S_e) = K_s S_e^{\ell}\left[\frac{f(S_e)}{f(1)}\right]^2 \tag{2}$$

$$\text{where} \quad f(S_e) = \int_0^{S_e} \frac{1}{\varphi(x)}\,dx$$

where $S_e = (\theta - \theta_r)/(\theta_s - \theta_r)$, ℓ is a pore-connectivity parameter estimated by Mualem (1976) to be about 0.5 as an average for many soils. Equations 2 and 3 are from van Genuchten (1991, p13).

van Genuchten (1978) derived a closed form analytic solution to equation 1 to predict the relative hydraulic conductivity (K_r) by assuming m = 1-1/n at a specified volumetric moisture content. This solution is given in equation 3.

$$K_r = \left[\frac{(\theta-\theta_r)}{(\theta_s-\theta_r)}\right]^{1/2}\left\{1-\left[1-\left(\frac{(\theta-\theta_r)}{(\theta_s-\theta_r)}\right)^{1/m}\right]^m\right\}^2 \tag{3}$$

The unsaturated hydraulic conductivity at a specified moisture content is:

$$K(\theta) = K_{(sat)} * K_r \tag{4}$$

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Saturated hydraulic conductivities for each of the samples were measured in the laboratory using a permeameter. Drying curve parameters were obtained by setting θ_s at total porosity. The values of θ_r, α_d, and n were then fitted to the drainage data. The wetting curve was then scaled by fixing the values for θ_r and n equal to those determined by the drainage data and θ_s and α_w were fitted using RETC (1978). The value for the saturated hydraulic conductivity for the wetting curve (K_{sw}) was obtained using:

$$K_{rw} = \left(\frac{(\theta_{sw}-\theta_r)}{(\theta_{sd}-\theta_r)}\right)^{1/2} \left(1-\left[\frac{(\theta_{sd}-\theta_{sw})}{(\theta_{sd}-\theta_r)}\right]\right)^2 \tag{5}$$

$$K_{sw} = K_{rw} * K_{sd} \tag{6}$$

from Lenhard and Parker (1987). The added subscript (w) and (d) refer to wetting and drying curves. The results of the linear regression analyses for the sediment samples from the 200 West Area are given in Appendix A.

3.1.1.1 Ringold Fluvial Gravel Unit E. Although this unit is present throughout the 200 West Area, the unsaturated portion of this unit varies in thickness from 0 m in the south to 64 m in the north (Figure 3-4). Two drainage water retention curves (Bjornstad 1990) have been measured for the two sediment samples from this unit as shown in Appendix A, Figures A-10 and A-11. For comparison in this hydrostratigraphic unit, the hydraulic conductivity curves for these samples have been combined in Figure 3-5. The samples were taken from well 299-W7-2 on the northern edge of the 200 West Area at depths of 47.1 and 67.1 m. As can be seen in Figure 3-5, there is a considerable difference between the two curves. Bjornstad (1990) explains the sample taken at 67.1 m may be significantly compacted or cemented judged by it's relatively low saturated volumetric moisture content. However, there are too few samples for comparison. Since this unit is widespread across the 200 West Area, more water retention curves, both wetting and drying along with a sieve analyses, need to be measured for this unit.

3.1.1.2 Upper Ringold. A total of 11 drainage and 10 imbibition curves were measured (Figures 3-6, 3-7, and Appendix A, Figures A-12 through A-28). All but one were measured as part of the ongoing performance assessment for the low level burial grounds. These samples, except for W7-2, came from sampling interval 29.9- to 43.3-m in well 299-W7-9. Data from well W7-2 were reported by Bjornstad (1990) and were taken at a depth of 30 m. The range in laboratory-measured saturated hydraulic conductivity is from 0.000165 to 0.0011 cm/s for the samples from well 299-W7-9. The sample from well 299-W7-2 has a saturated hydraulic conductivity of 0.037 cm/s, which is 30 times higher than the highest one measured in well 299-W7-9. To account for this difference, an inspection of the well log from 299-W7-2 indicates that this sample was taken very close to the contact with Ringold gravel unit E and may be part of the transition between these two units.

Although the shape of the unsaturated hydraulic conductivity curves for all of the samples from well 299-W7-9 are similar (Figure 3-6), a close examination at a moisture content 0.20 reveals two orders of magnitude difference

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between the minimum (sample at 34.1 m) and maximum (sample at 40.2 m) values for unsaturated hydraulic conductivity. However, at saturation, the hydraulic conductivity for sample at 34.1 m is higher by a factor of 4 than the sample at 40.2 m. This difference is most likely due to slight changes in clay, silt, and sand content.

3.1.1.3 Plio-Pleistocene. This unit is hydrologically important because the highly cemented zones within it could cause laterally spreading and perched water table development from downward percolating water. Five drainage and four imbibition water retention curves have been measured for this formation (Figures 3-8, 3-9, and Appendix A, Figures A-29 through A-37). These curves show a high degree of variability for both saturated hydraulic conductivities (1.3E-06 to 1.3E-04 cm/s for the samples from well 299-W7-9 [calcrete] and 7.6E-2 cm/s for the sample from well 299-W7-2 [calcic soil]) and saturated water content (0.33 to 0.52). The variation between the moisture characteristic curves taken from well 299-W7-9 is due to differences in grain size and degree of cementation and compaction. Because there is such a large variation for these curves, more moisture characteristic curves should be measured for this unit.

3.1.1.4 Early Palouse Soils. As part of the performance assessment of the low level waste burial grounds, two water retention curves (Figures 3-10, 3-11, and Appendix A, Figures A-38 through A-41) were measured in the early Palouse soils. These samples were taken at depths of 21.0 and 21.6 m from well 299-W7-9. Sieve analysis (Appendix A, Figures A-37 and A-39) indicate that both are very fine-grained samples composed of mostly fine sand and silt with little variability between the samples. However, two samples from the same well are not enough to show any variability and more moisture retention curves should be measured for this unit.

3.1.1.5 Hanford Formation. As described in Chapter 2 in the 200 West Area, the Hanford formation has been divided into two sequences: a fined-grained sandy and silty sequence overlain by a coarse-grained gravel sequence. Of particular importance is the presence of flood channel of coarse-grained gravel sequence running north-south under Z Plant toward U Pond and bisecting 200 West Area. The location of this flood channel is defined by the absence of the fine-grained sequence in the center of 200 West Area (Figure 2-16).

Thirteen drying and six wetting water retention curves (Figures 3-12, 2-13, and Appendix A, Figures A-42 through A-60) for the Hanford formation were measured on samples taken from wells 299-W7-5, 299-W7-9, 299-W10-13, 299-W15-2, 299-W15-16, and 299-W18-21. Samples from well 299-W7-5, 299-W10-13 (13.7 and 24.4 m), 299-W15-16, and 299-W18-21 were reported by Bjornstad (1990). The other samples were measured as part of the performance assessment effort on the low level waste burial grounds. The sample taken from well 299-W15-2 at 30.5 m was measured in the fine-grained sequence. The rest of these samples were measured in the coarse-grained facies. The saturated hydraulic conductivity for these samples varies widely, ranging from 7.0E-6 to 5.5E-2 cm/s. Particle size analysis (Appendix A, Figures A-38, A-40, and A-42) indicates that samples taken from wells 299-W7-9 (19.8 m) and 299-W10-13 (12.2 and 18.3 m) are sand and silt rather than gravels. If these samples are eliminated, the range of saturated hydraulic conductivity for the gravel facies is 0.011 - 0.055 cm/s. However, calculated unsaturated conductivities range several orders of magnitude at lower moisture contents.

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3.1.2 Summary of Unsaturated Zone Hydrologic Parameters

The functional relationship between unsaturated hydraulic conductivity, matric potential, and moisture content has been calculated for a number of samples in the sediments underlying the 200 West Area. The curve fitting parameters for all of the samples measured are given in Table 3-1. It is evident from these samples that both saturated and unsaturated hydraulic conductivity can vary by several orders of magnitude within a lithologic unit. This illustrates the need for evaluating sample location and textural description when selecting moisture characteristic curves. Typically, the choice of a water retention curve is made by examining water retention curves (Appendix A) along with the particle size analyses (Appendix A) to distinguish lithologies with significantly different soil textures and hydraulic conductivities.

3.2 SATURATED ZONE

The saturated zone within the 200 West Area consists of the unconfined aquifer within gravel unit E of the Ringold Formation, the confined aquifer, gravel unit A of the Ringold Formation beneath the lower mud unit and the confined aquifers within the basalt.

3.2.1 Unconfined Aquifer

The water table underlying the 200 West Groundwater aggregate area is contained within the Ringold Formation gravel unit E (Lindsey, et al 1991). This unit is generally described in Chapter 2. Gravel unit E is a clast-supported granule to cobble gravel with a sandy matrix. Intercalated sands and muds also are found (Lindsey et al. 1991). The bottom of the unconfined aquifer may either be the lower mud sequence of the Ringold Formation or the basalt where the mud sequence is absent. The lower mud unit of the Ringold Formation thins in the north and east part of the 200 West Area (Lindsey et al. 1991).

3.2.1.1 Hydraulic Properties. Hydraulic properties of transmissivity and/or hydraulic conductivity have been determined for some of the wells in the 200 West Area. The properties were determined from the results of aquifer tests, either constant discharge-recovery tests or instantaneous slug tests. The majority of the constant discharge-recovery pumping tests were single well tests of partially penetrating wells and, therefore, there is little information on storage properties for the unconfined aquifer. Some of the shortcomings that have to be accounted for with single well pump tests are pump influences and well losses. The majority of the constant discharge-recovery tests were analyzed with the Cooper-Jacob straight line method (_____ 19__). The major shortcoming to analyzing the results of slug tests are the limited areal influence of the test, the potential sandpack influences, the limited stress applied to the aquifer, and the relatively low values of transmissivity for which the tests are interpretable. The majority of the slug tests were analyzed using the updated Bouwer and Rice method (19__). Table 3-2 lists the transmissivity (T) and hydraulic conductivity (K) values of the upper unconfined aquifer known for wells in the 200 West Area. Compilation of test data are provided (Appendix B) and Newcomer et al. (1992).

A map of the T values (Figure 3-14) was constructed from the results of the aquifer tests. The map indicates that there are two relatively higher zones of T, one located at the south end of the area with a T value of about 50,000 ft^2/d (to convert ft^2 to m^2 multiply by 0.093) (near well W18-22) and the other just north of the center of the area with a T value of about 5,000 ft^2/d (near well W10-14). Between the two zones of high T is a relatively low T zone with values ranging from 20 to 1,000 ft^2/d. The map of T values resembles the water table map (Figure 3-15). The higher T values are associated with the groundwater mounds present underneath the area. A map of K (Figure 3-16) will not be influenced by the thickness of the saturated zone. The K values used to configure the map are determined directly with the use of the Bouwer-Rice method (19__) slug test analysis or indirectly determined from the T values resulting from constant discharge-recovery tests. The K values were determined for this report using the thickness of the stressed interval (since the stressed interval and not the total thickness was tested). Since the aquifer is over 61 m thick, using the thickness of the aquifer to determine K values may lead to an underestimate if the entire thickness of the aquifer was not stressed during the test. The map of K shows similar trends as the map of T. There is a high K area in the center of the map and to the north of the center, which correspond to the high T areas. The maps of K and T are preliminary because of the varying methods used to determine these properties, and the lack of information in some areas.

3.2.1.2 Groundwater Flow Directions. The elevation of the water table ranges between 143 and 137 m (Figure 3-15). The higher elevations are near the groundwater mound beneath the presently dry U Pond wastewater facilities. The groundwater flow is dominated by the existing mounds. The flow directions are to the east at the south end of the 200 West Area, to the north and northeast at the north end of the 200 West Area. Artificial recharge at U Pond system raised the level of the water table about 26 m since the mid-1940s (Newcomer 1990). The groundwater mound is dissipating since the decommissioning of U Pond in 1984. The mound has declined approximately 3 m during the late 1980s. A detailed discussion of the changes in the configuration of the water table for period of 1980-1990 is provided by Newcomer (1990).

The flow directions in the unconfined aquifer are likely to change directions as the groundwater mound dissipates. The direction of groundwater flow after the mound dissipates will likely be similar to the flow directions prior to the construction of U Pond. Figure 3-17 shows estimated 1944 water table map for the 200 Areas. Wastewater facilities were not present in 1944.

3.2.1.3 Vertical Gradients. Wells monitoring the upper unconfined aquifer have a higher head than adjacent wells monitoring the lower unconfined aquifer above the lower mud sequence. This head difference indicates a downward gradient exists. Plots of the water level in wells 2-W18-21, 2-W18-22 (deep well), 2-W7-2, and 2-W7-3 (deep well) are shown in Figures 3-18 and 3-19. The water level in the wells monitoring the upper unconfined will decline with the decline in the groundwater mounds.

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3.2.2 Confined Aquifer

The uppermost confined aquifer is contained either within gravel unit A of the Ringold Formation, or the basalts and interbeds of the Columbia River Basalt Group. Few wells penetrate the confined aquifer in the 200 West Area, and therefore little information regarding the hydrogeology exists.

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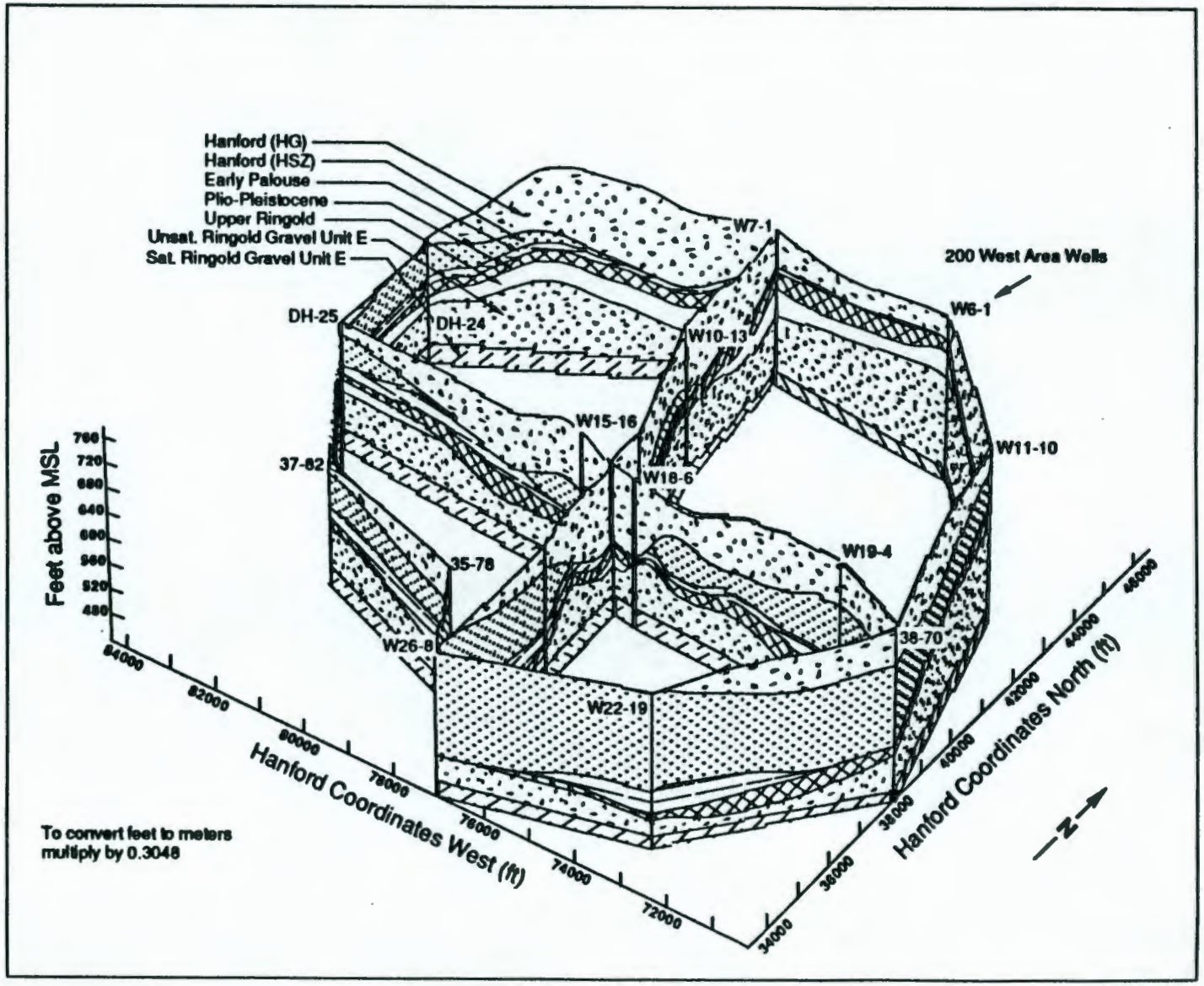

Figure 3-1: Generalized stratigraphy of partially saturated sediments beneath the 200 West Area.

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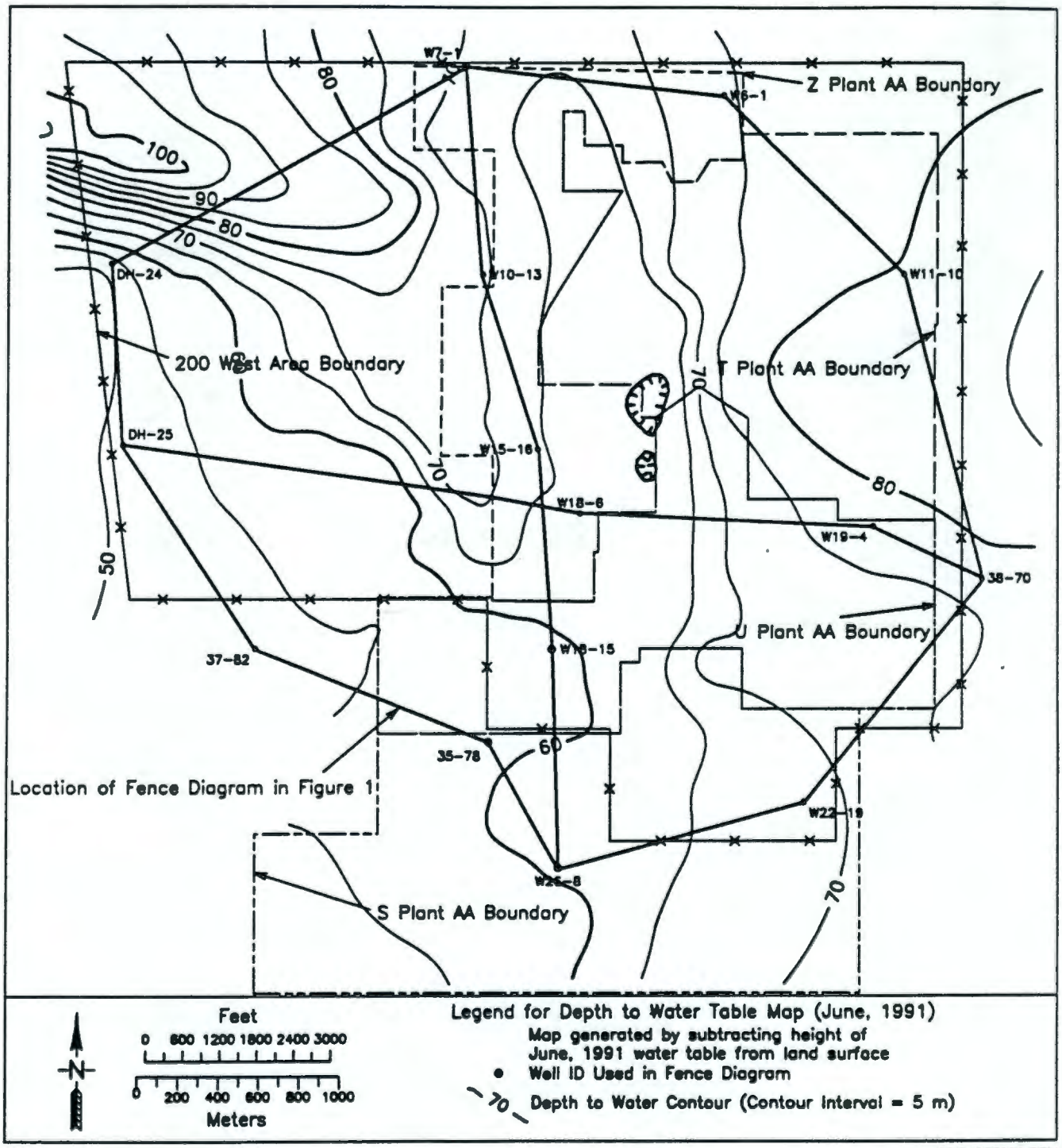

Figure 3-2: Depth to water table in June, 1991.

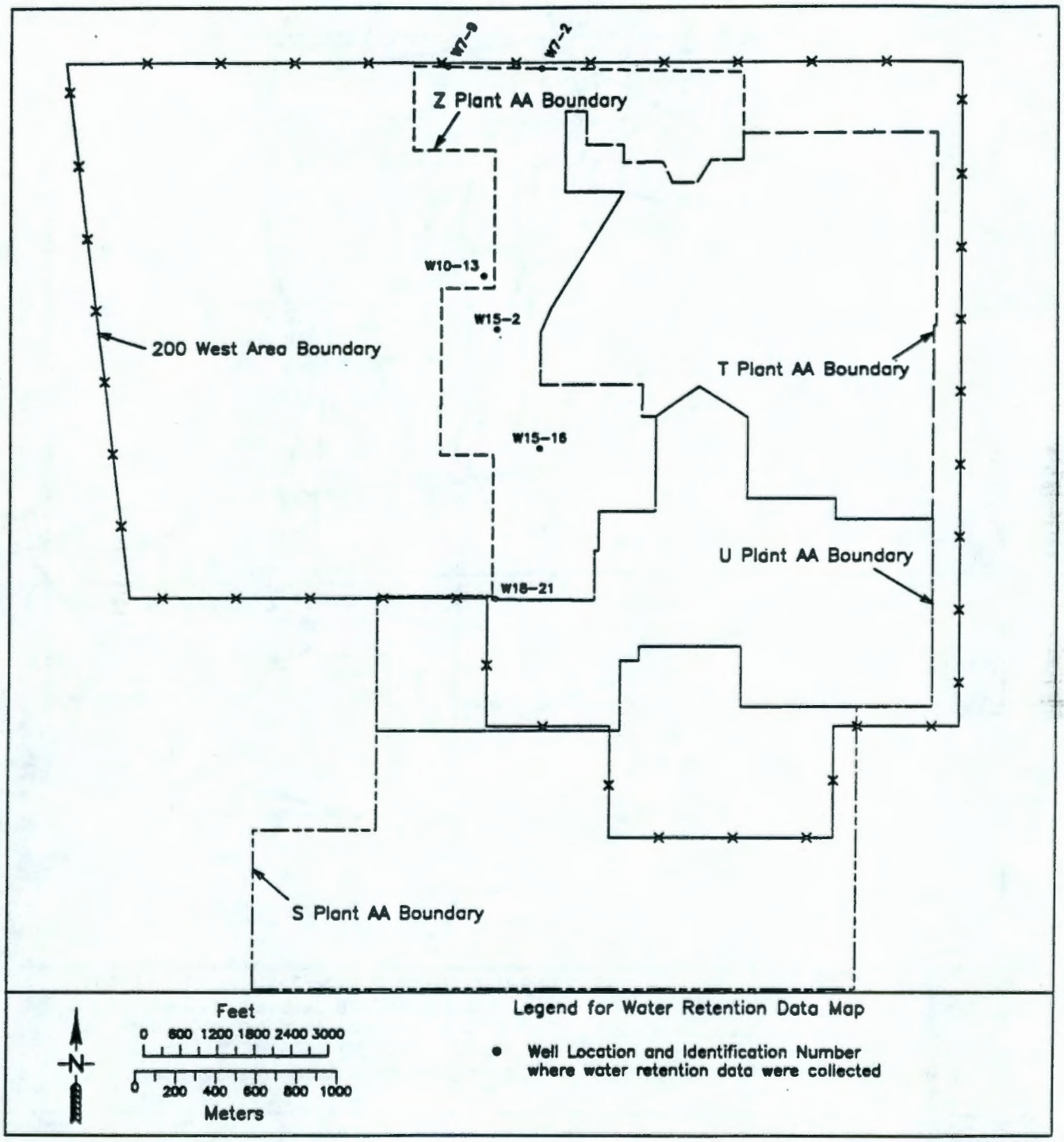

Figure 3-3: Map showing the location of wells where water retention data were collected.

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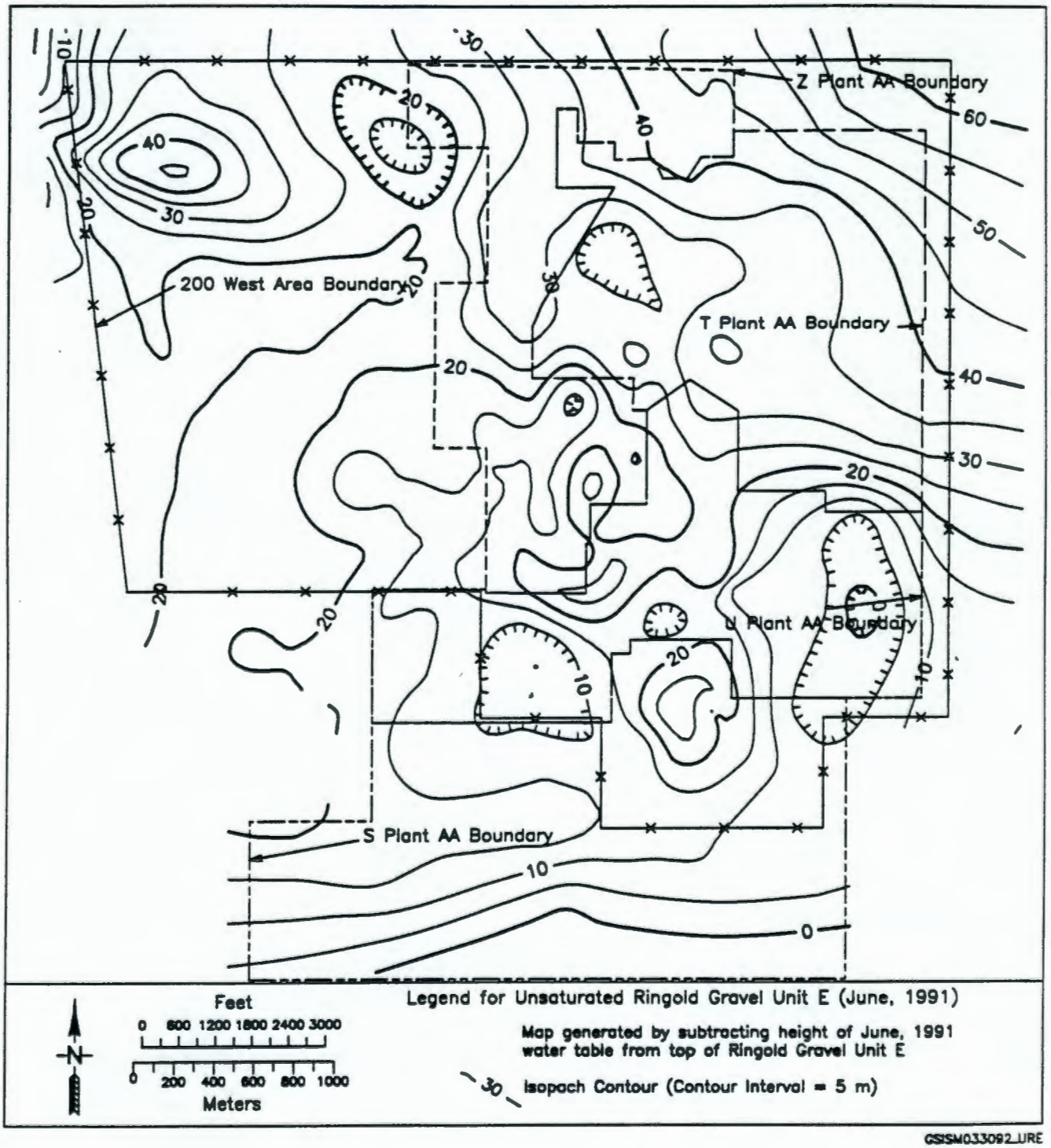

Figure 3-4: Isopach map of the unsaturated Ringold Gravel Unit E.

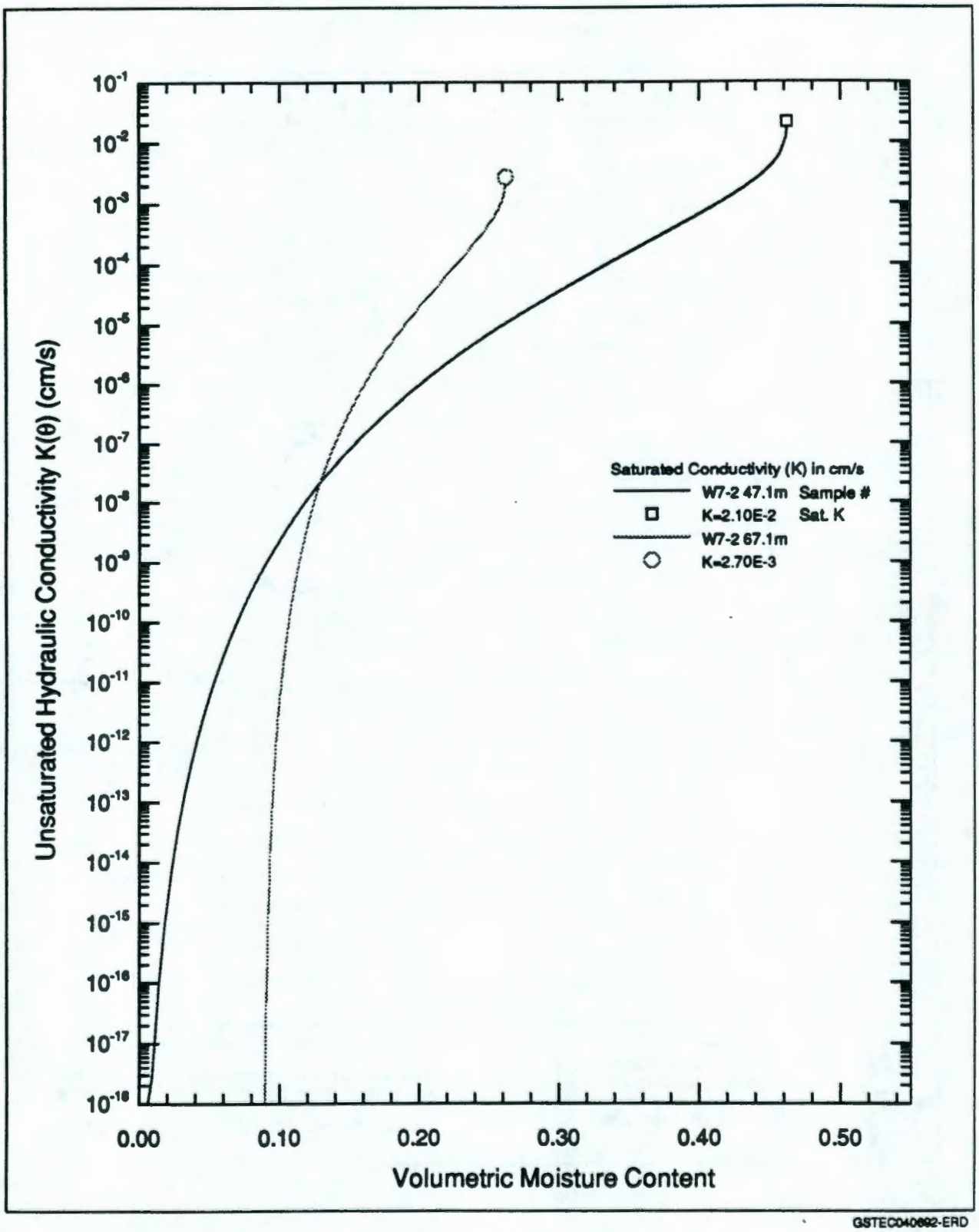

Figure 3-5: Hydraulic conductivity as a function of volumetric moisture content for Ringold Gravel Unit E (Drainage Data).

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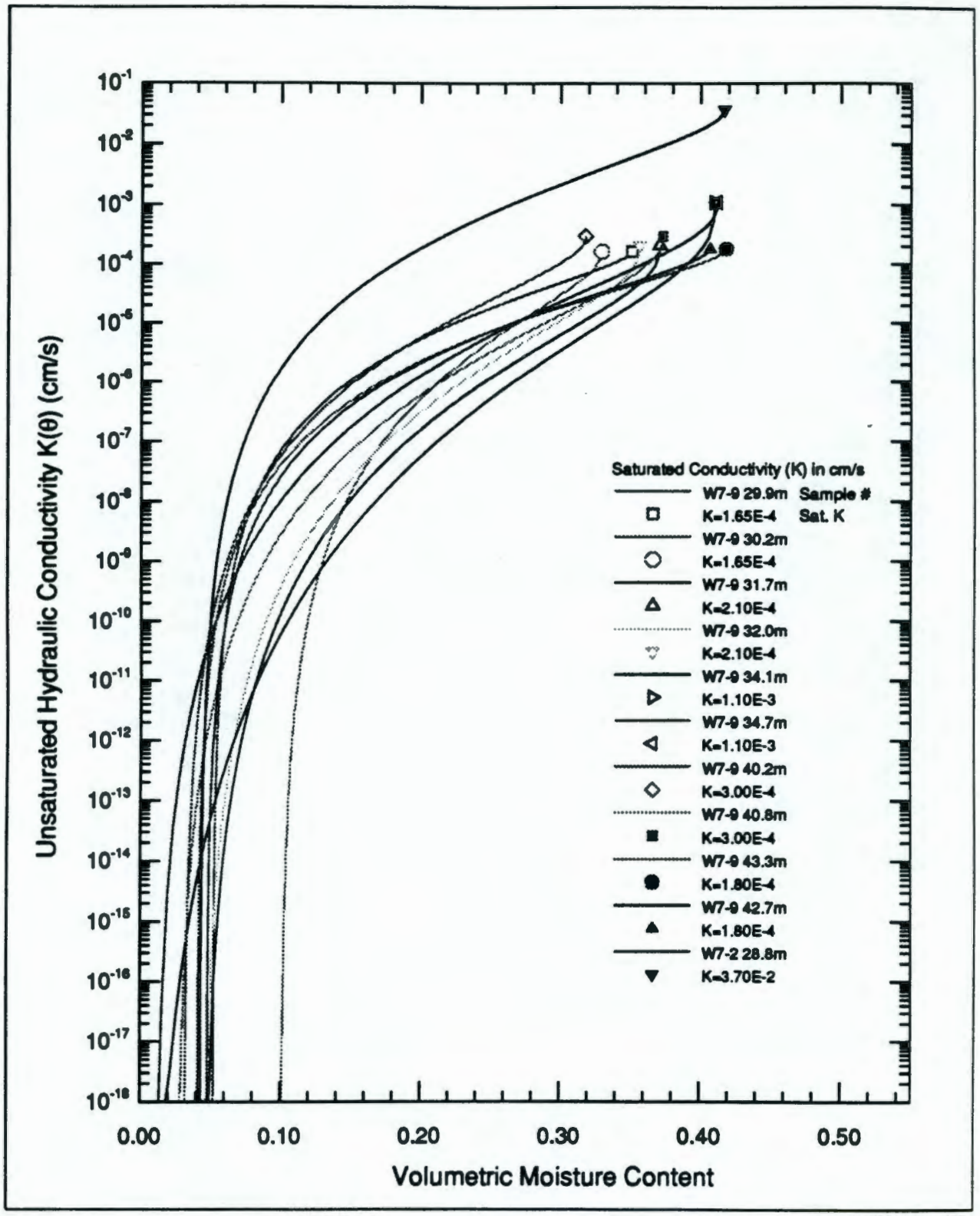

Figure 3-6: Hydraulic conductivity as a function of volumetric moisture content for upper Ringold (Drainage Data).

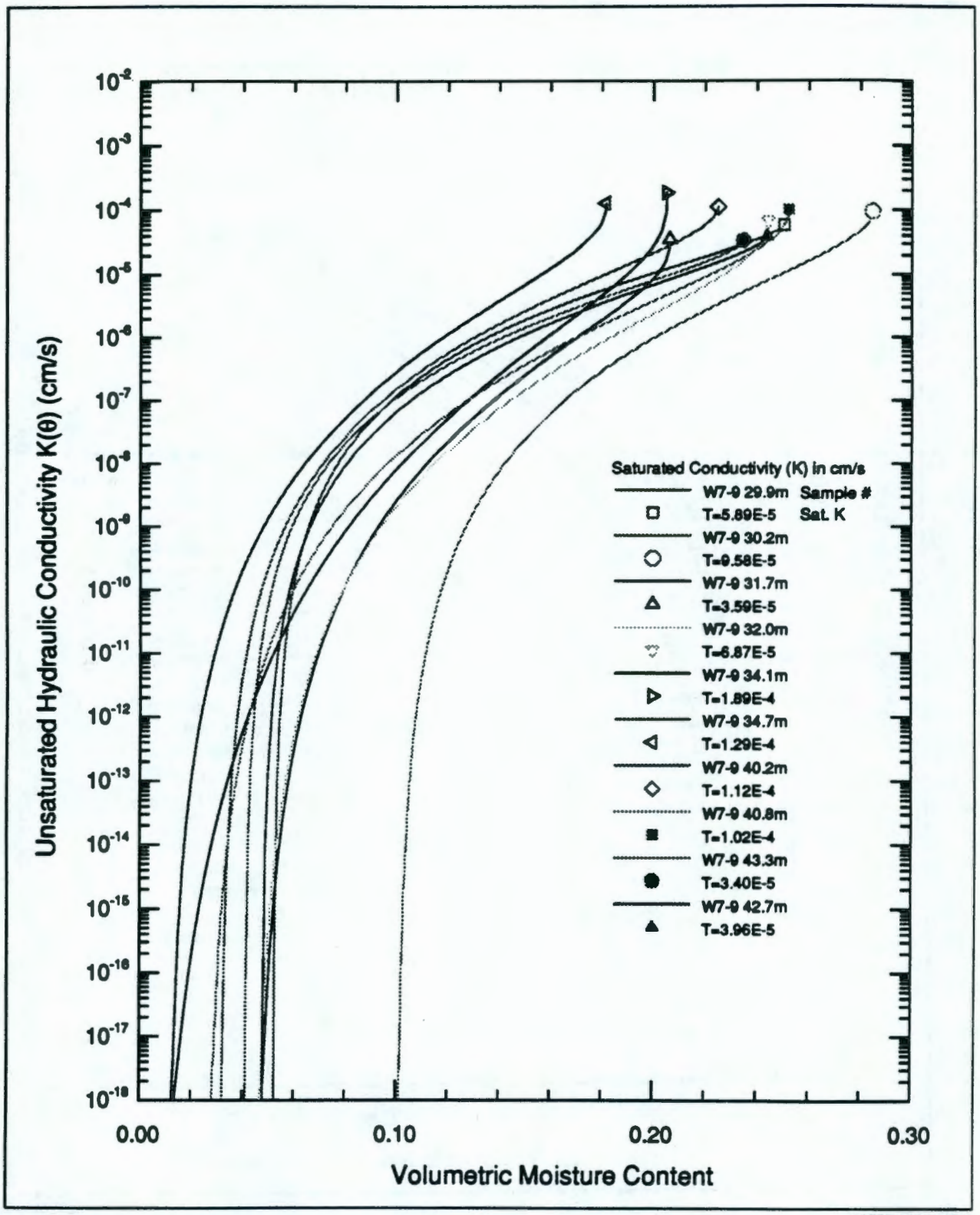

Figure 3-7: Hydraulic conductivity as a function of volumetric moisture content for upper Ringold (Imbibition Data).

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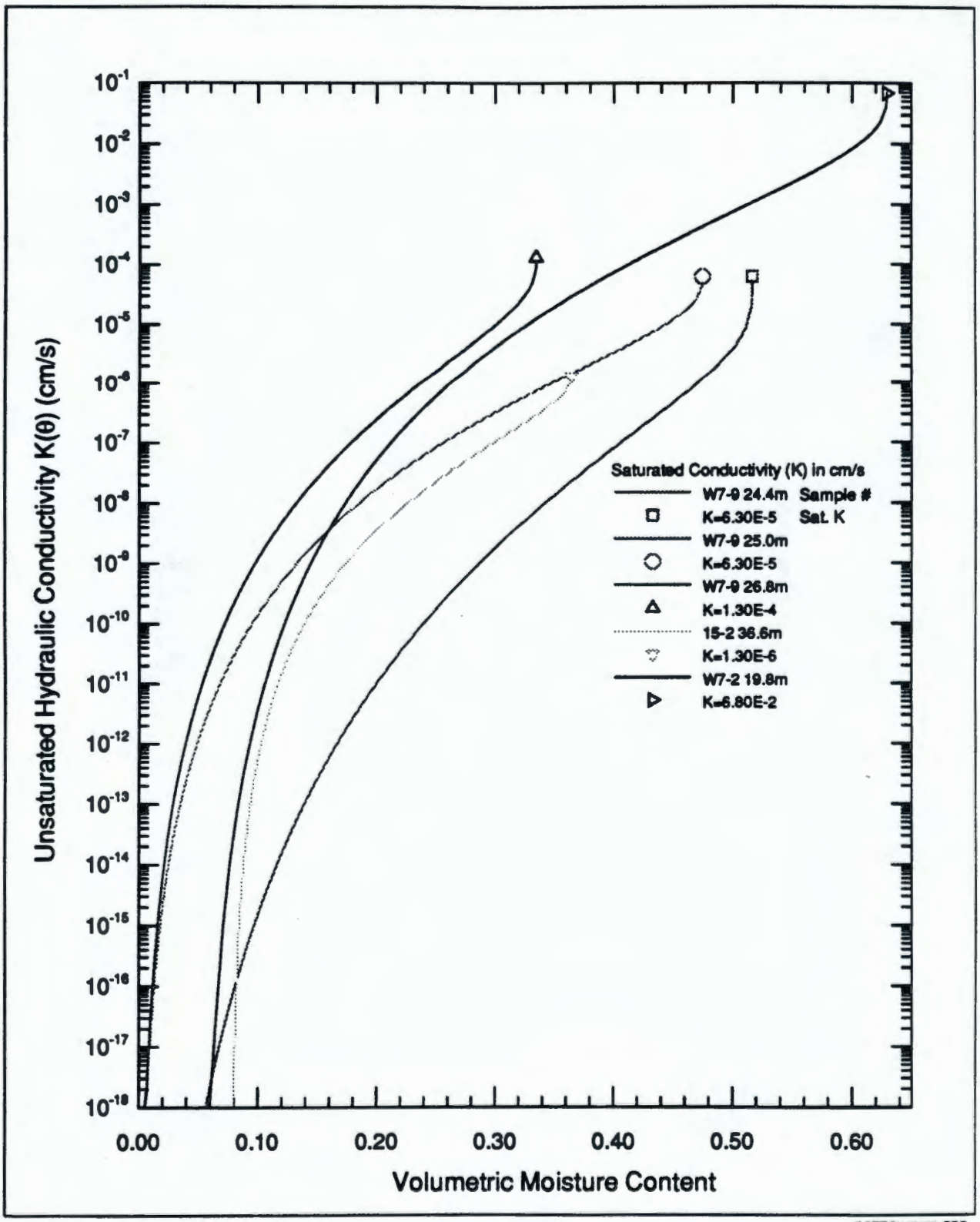

Figure 3-8: Hydraulic conductivity as a function of volumetric moisture content for the Plio-Pleistocene (Drainage Data).

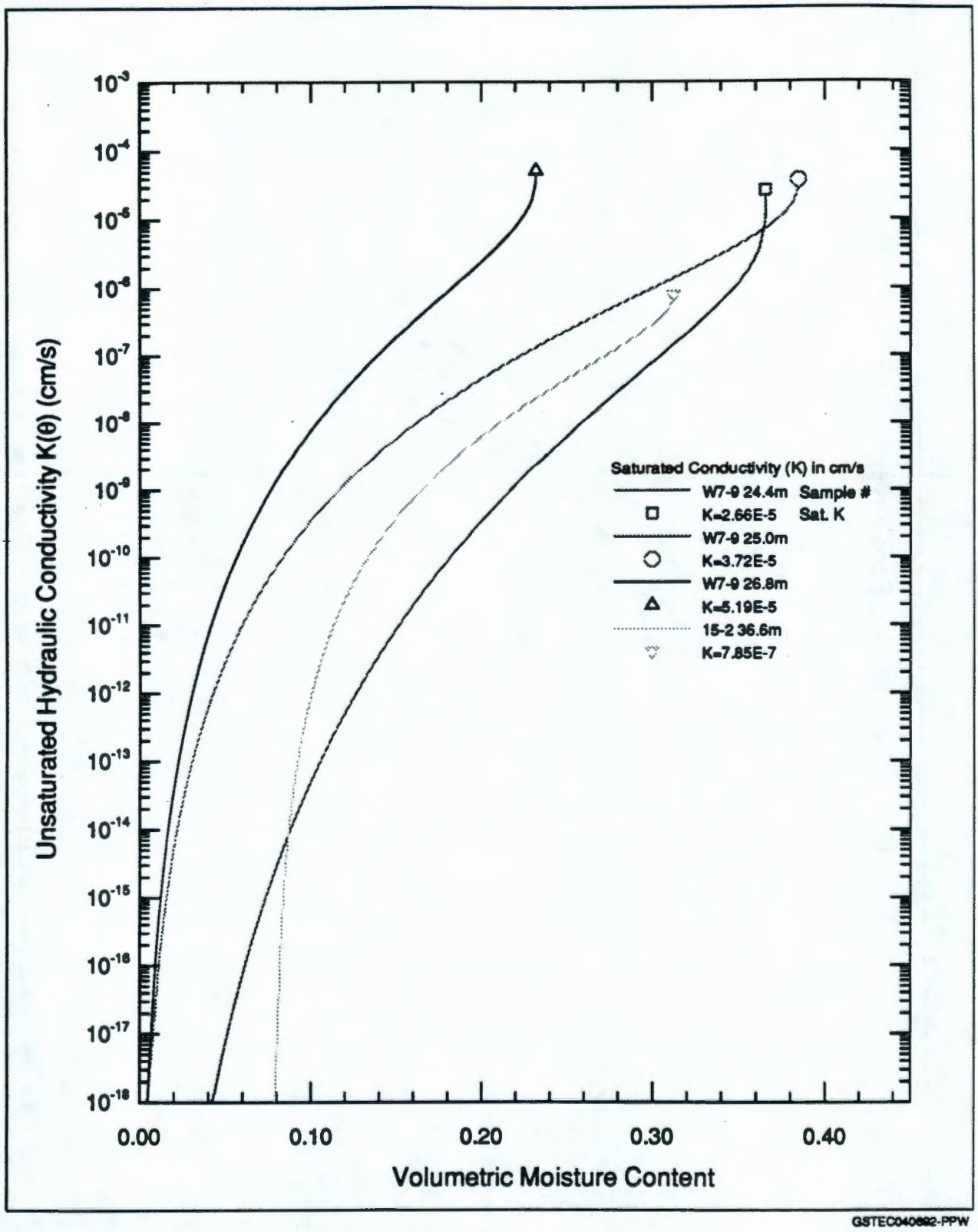

Figure 3-9: Hydraulic conductivity as a function of volumetric moisture content for the Plio-Pleistocene (Imbibition Data).

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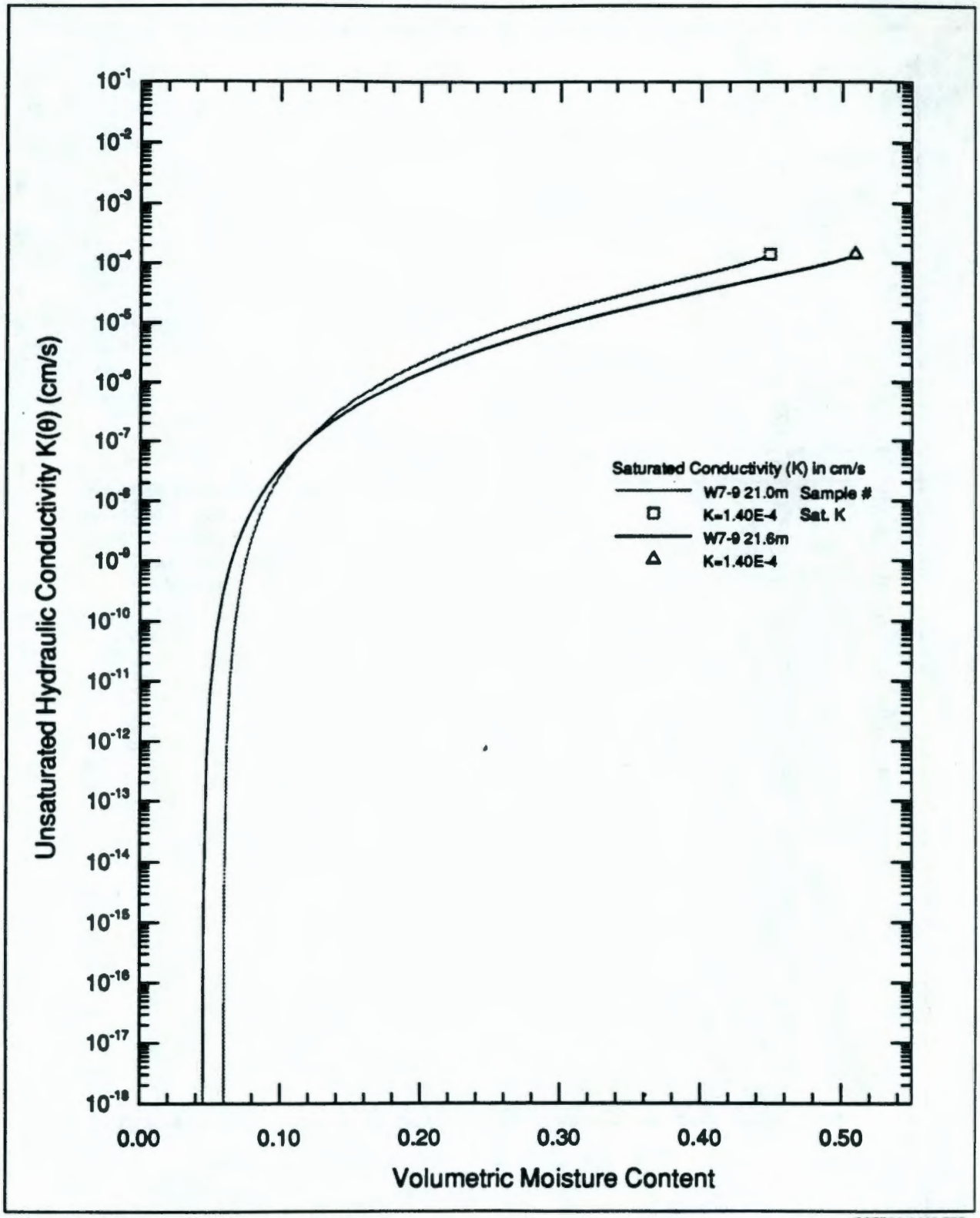

Figure 3-10: Hydraulic conductivity as a function of volumetric moisture content for the Early Palouse Soils (Drainage Data).

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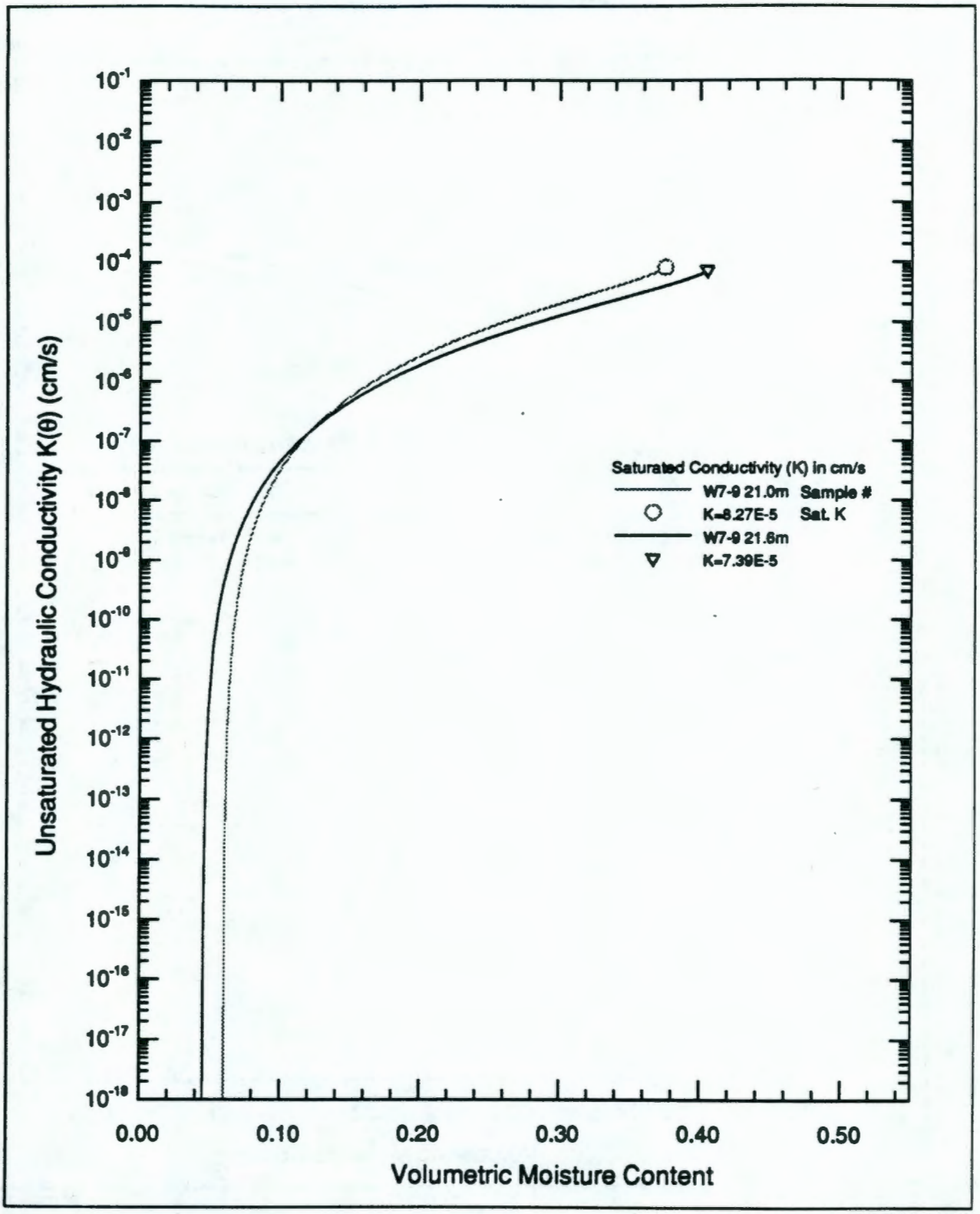

Figure 3-11: Hydraulic conductivity as a function of volumetric moisture content for the Early Palouse Soils (Imbibition Data).

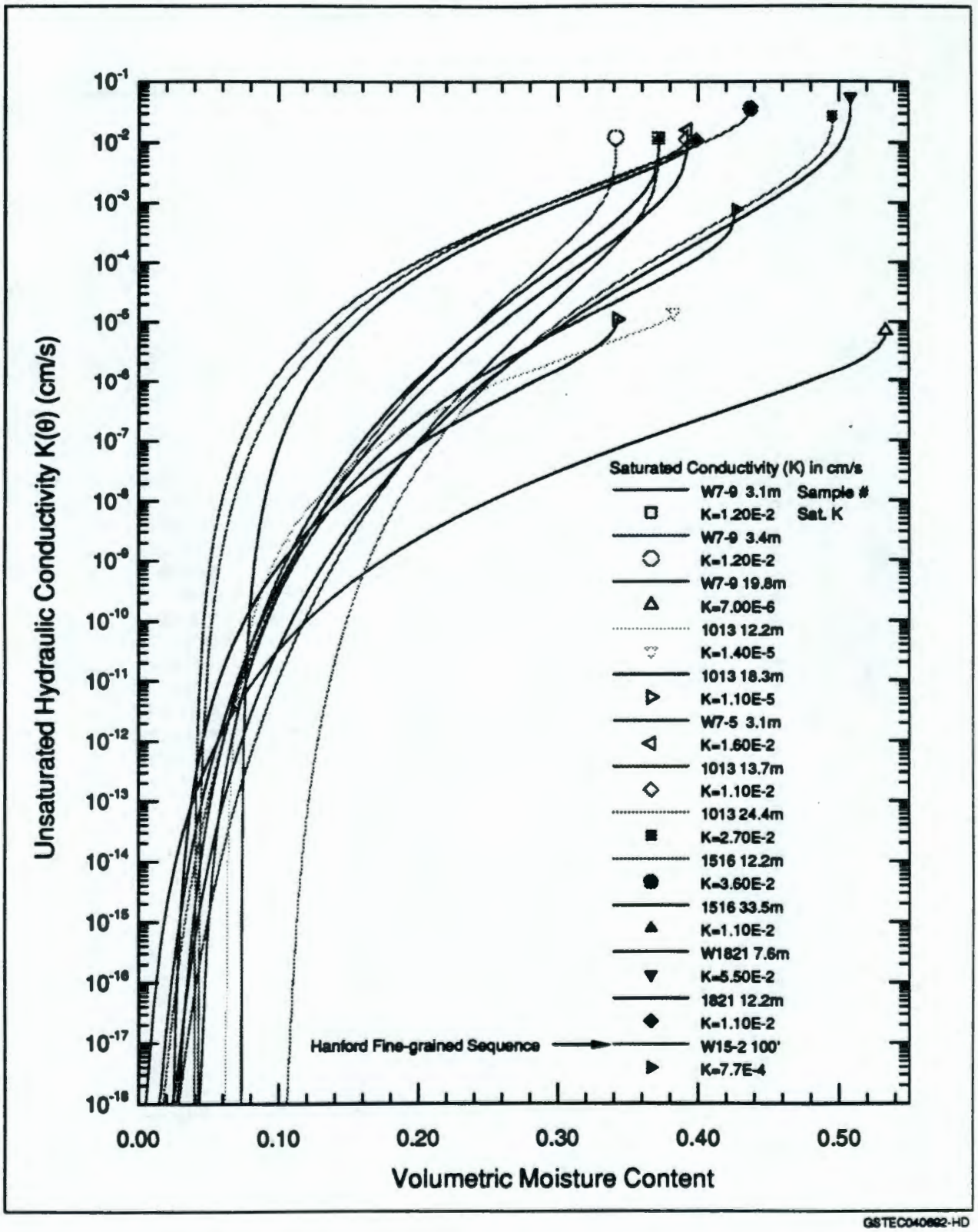

Figure 3-12: Hydraulic conductivity as a function of volumetric moisture content for the Hanford fm (Drainage Data).

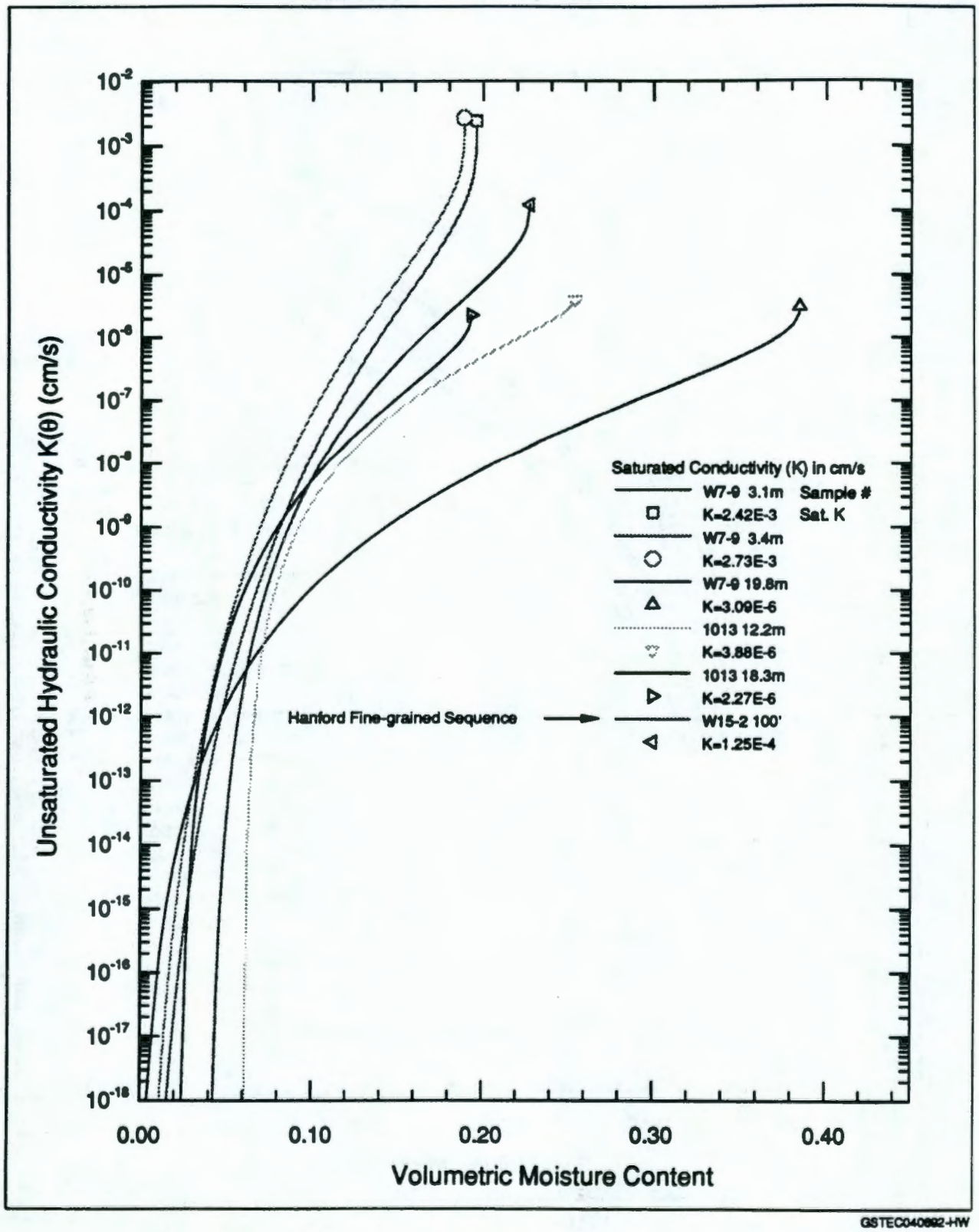

Figure 3-13: Hydraulic conductivity as a function of volumetric moisture content for the Hanford fm (Imbibition Data).

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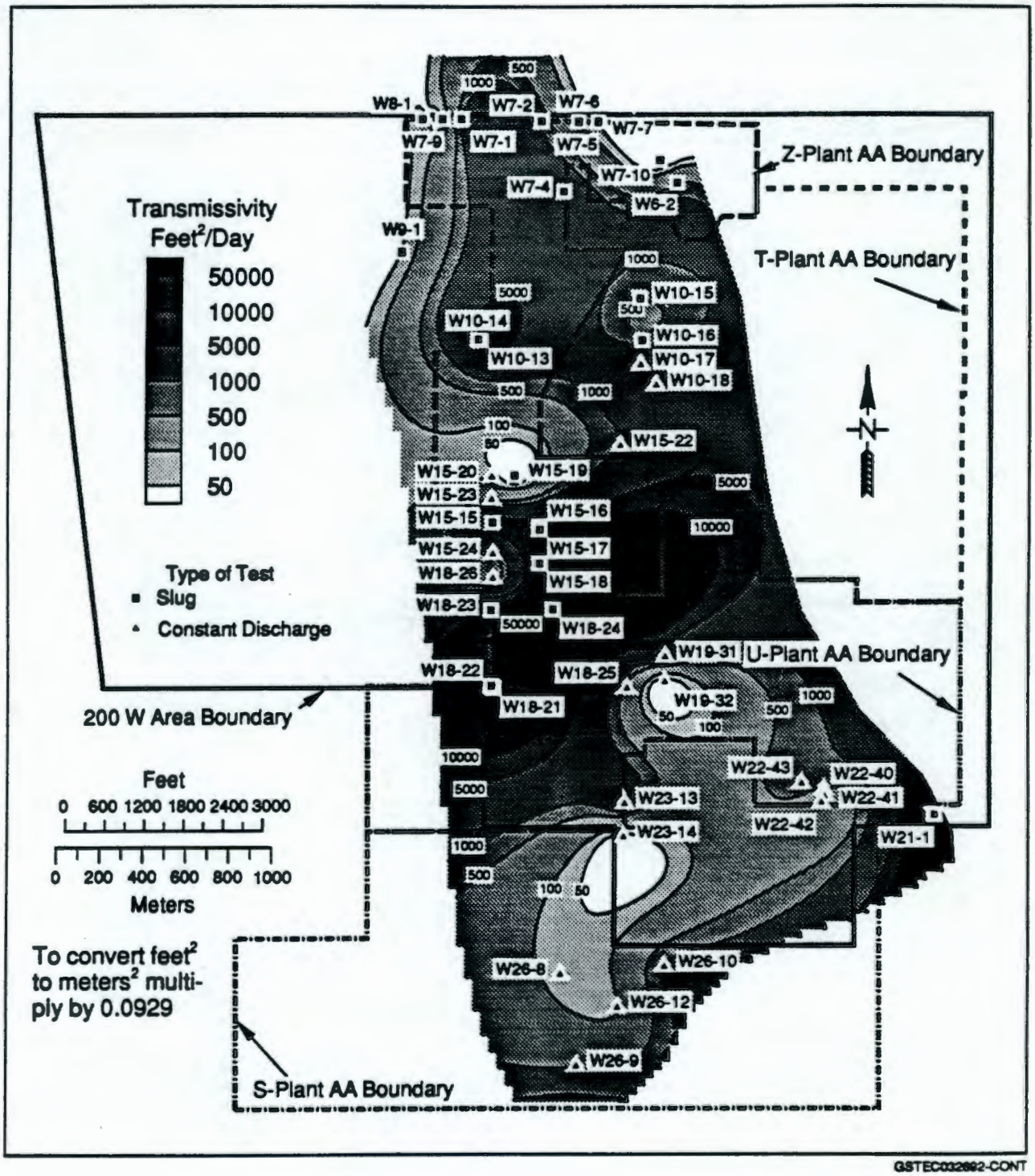

Figure 3-14: Transmissivity Map of the 200 West Area.

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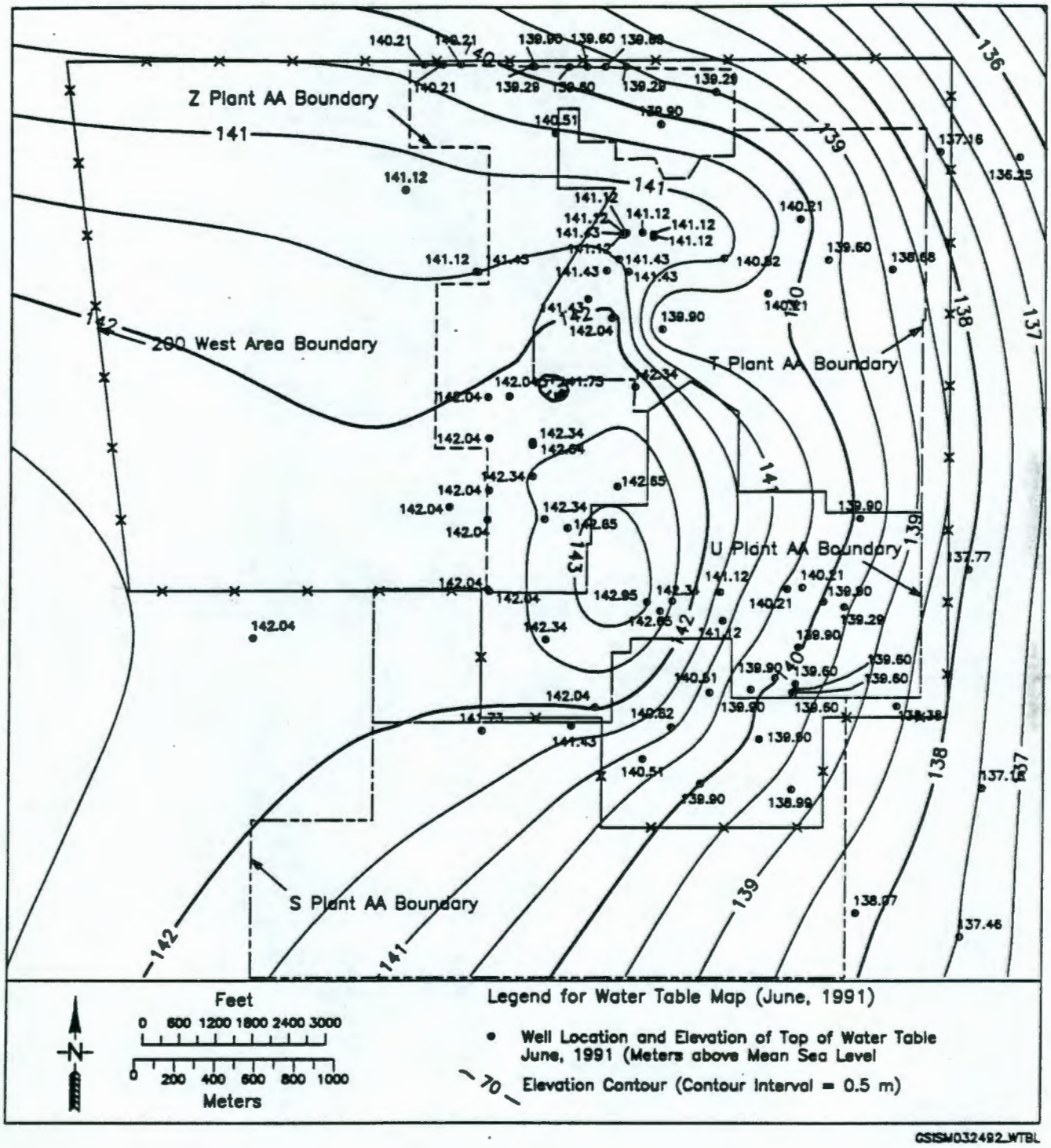

Figure 3-15: June, 1991 Water Table Map for the 200 West Area.

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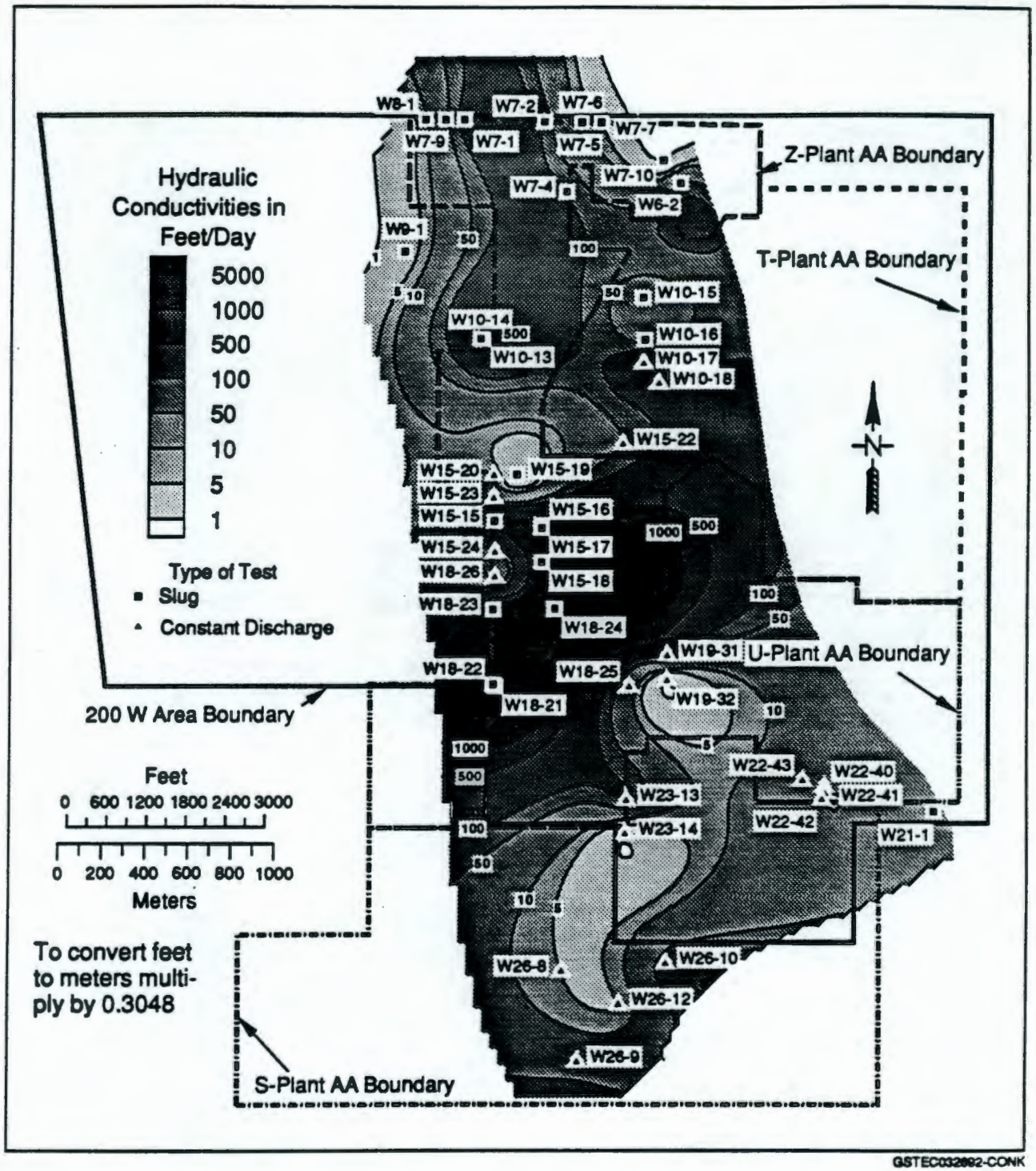

Figure 3-16: Hydraulic Conductivity Map for the 200 West Area

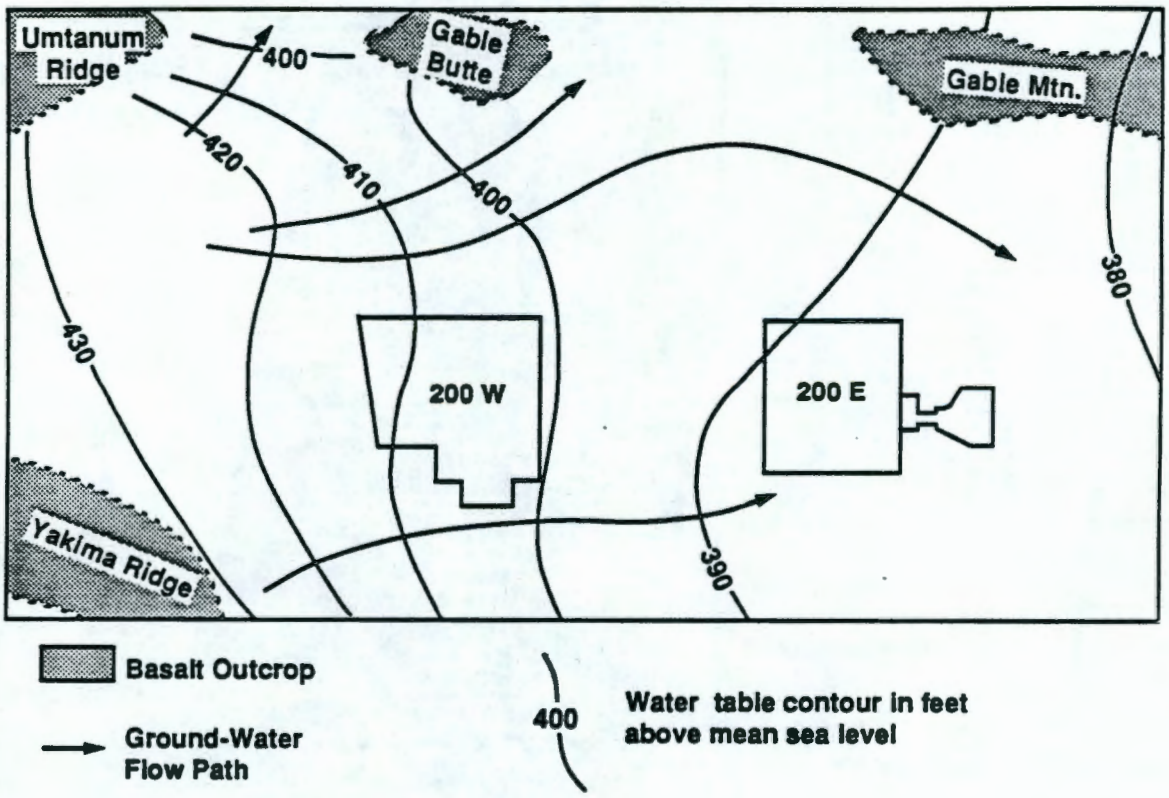

Figure 3-17: Estimated Water Table Map for the 200 Areas prior to 1944.

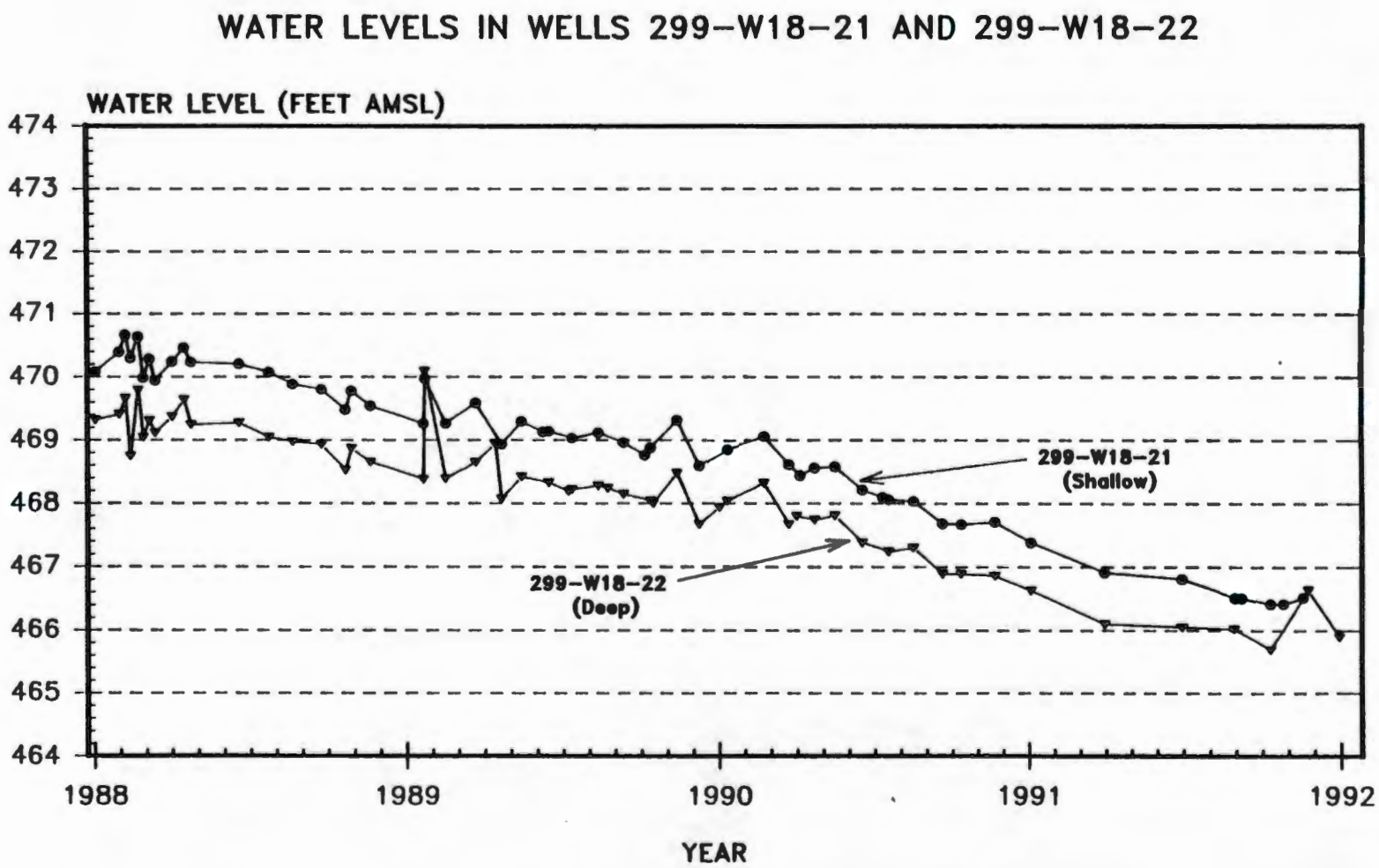

Figure 3-18: Hydrograph of wells 299-W18-21 and 299-W18-22.

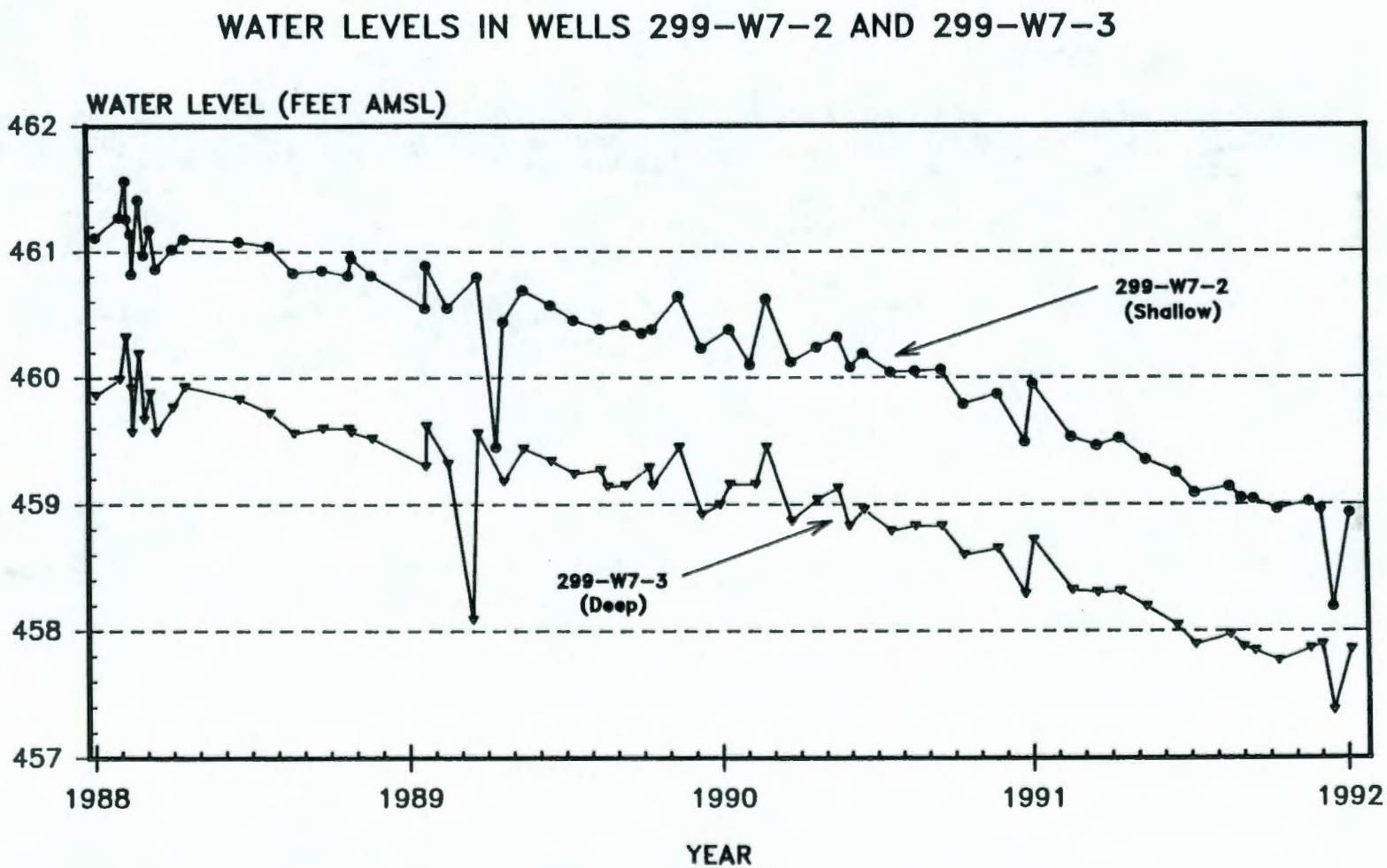

Figure 3-19: Hydrograph of wells 299-W7-2 and 299-W7-3.

Table 3-1. Summary of van Genuchten Curve Fitting Parameters for the Major Lithologic Units.

Sample	Residual Volumetric Content	Saturated Volumetric Content	Alpha 1/cm	n	Saturated Hydraulic Conductivity cm/s
Ringold Gravel Unit E (Drainage)					
2-W7-2 (47.1 m)	0.0000	0.4617	0.1254	1.3260	2.10E-02
2-W7-2 (67.1 m)	0.0880	0.2621	0.1045	1.4913	2.70E-03
Upper Ringold (Drainage)					
2-W7-9 (29.9 m)	0.0523	0.3513	0.0190	2.6425	1.65E-04
2-W7-9 (30.2 m)	0.1010	0.3293	0.0115	1.7886	1.65E-4*
2-W7-9 (31.7 m)	0.0460	0.3710	0.4714	1.4763	2.10E-04
2-W7-9 (32.0 m)	0.0451	0.3566	0.1991	1.5410	2.10E-4*
2-W7-9 (34.1 m)	0.0054	0.4096	1.1499	1.2873	1.10E-03
2-W7-9 (34.7 m)	0.0116	0.4121	0.2886	1.5303	1.10E-3*
2-W7-9 (40.2 m)	0.0319	0.3182	0.0944	1.8400	3.00E-04
2-W7-9 (40.8 m)	0.0268	0.3734	0.1292	1.5518	3.00E-4*
2-W7-9 (43.3 m)	0.0411	0.4183	0.0773	2.3868	1.80E-04
2-W7-9 (42.7 m)	0.0478	0.4068	0.0658	2.3266	1.80E-4*
2-W7-2 (28.8 m)	0.0430	0.4169	0.0557	1.9675	3.70E-02
Upper Ringold (Imbibition)					
2-W7-9 (29.9 m)	0.0532	0.2503	0.0213	2.6425	5.89E-05
2-W7-9 (30.2 m)	0.1010	0.2847	0.0131	1.7886	9.58E-05
2-W7-9 (31.7 m)	0.0460	0.2063	0.1555	1.4763	3.59E-05
2-W7-9 (32.0 m)	0.0451	0.2443	0.1659	1.5140	6.87E-05
2-W7-9 (34.1 m)	0.0054	0.2051	0.1607	1.2873	1.89E-04
2-W7-9 (34.7 m)	0.0116	0.1815	0.1389	1.5303	1.29E-04
2-W7-9 (40.2 m)	0.0319	0.2249	0.0961	1.8400	1.12E-04
2-W7-9 (40.8 m)	0.0268	0.2520	0.0975	1.5518	1.02E-04
2-W7-9 (43.3 m)	0.0411	0.2348	0.0883	2.3868	3.40E-05
2-W7-9 (42.7 m)	0.0478	0.2437	0.0752	2.3266	3.96E-05
Plio-Pleistocene (Drainage)					
2-W7-9 (24.4 m)	0.0000	0.5163	0.0622	1.1961	6.30E-05
2-W7-9 (25.0 m)	0.0000	0.4747	0.0123	1.4571	6.30E-5*
2-W7-9 (26.8 m)	0.0000	0.3348	0.0243	1.3972	1.30E-04
2-W15-2 (36.6 m)	0.0779	0.3645	0.0051	1.7721	1.30E-06
2-W7-2 (19.8 m)	0.0054	0.6292	0.3603	1.3444	6.80E-02
Plio-Pleistocene (Imbibition)					
2-W7-9 (24.4 m)	0.0000	0.3656	0.0147	1.1961	6.30E-05
2-W7-9 (25.0 m)	0.0000	0.3847	0.0108	1.457	3.73E-05
2-W7-9 (26.8 m)	0.0000	0.2319	0.0147	1.3972	5.19E-05
2-W15-2 (36.6 m)	0.0779	0.3121	0.0049	1.7721	7.85E-07
Early Palouse Soils (Drainage)					
2-W7-9 (21.0 m)	0.0600	0.4489	0.0043	3.1449	1.40E-04
2-W7-9 (21.6 m)	0.0452	0.5094	0.0069	2.9810	1.40E-4*
Early Palouse Soils (Imbibition)					
2-W7-9 (21.0 m)	0.0600	0.3751	0.0058	3.1449	8.27E-05
2-W7-9 (21.6 m)	0.0452	0.4048	0.0140	2.9810	7.39E-05
Hanford Formation (Fine-grained Sequence) (Drainage) 2-W15-2 (30.5 m)	0.0407	0.4272	0.1071	1.4734	7.70E-04
Hanford Formation (Fine-grained Sequence) (Imbibition) 2-W15-2 (30.5 m)	0.0407	0.2274	0.1060	1.4734	1.25E-04

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Sample	Residual Volumetric Content	Saturated Volumetric Content	Alpha 1/cm	n	Saturated Hydraulic Conductivity cm/s
Hanford Formation (Coarse-grained Sequence) (Drainage)	0.0000	0.3717	0.2698	1.1893	1.20E-02
2-W7-9 (3.1 m)	0.0000	0.3414	0.1902	1.2234	1.20E-2*
2-W7-9 (3.4 m)	0.0000	0.5336	0.0181	1.5550	7.00E-06
2-W7-9 (19.8 m)	0.0620	0.3827	0.0663	2.4706	1.40E-05
2-W10-13 (12.2 m)	0.0230	0.3424	0.1137	1.6829	1.10E-05
2-W10-13 (18.3 m)	0.0000	0.3924	0.1570	1.2507	1.60E-02
2-W7-5 (3.1 m)	0.0400	0.3915	0.0408	2.0672	1.10E-02
2-W10-13 (13.7 m)	0.1020	0.4955	0.2785	1.3713	2.70E-02
2-W10-13 (24.4 m)	0.0420	0.4375	0.0736	1.8185	3.60E-02
2-W15-16 (12.2 m)	0.0190	0.3719	0.1368	1.2885	1.10E-02
2-W15-16 (33.5 m)	0.0080	0.5083	1.8666	1.2474	5.50E-02
2-W18-21 (7.6 m)	0.0730	0.3988	0.0289	2.1349	1.10E-02
2-W18-21 (12.2 m)					
Hanford Formation (Coarse-grained Sequence) (Imbibition)	0.0000	0.1960	0.0232	1.1893	2.42E-03
2-W7-9 (3.1 m)	0.0000	0.1889	0.0259	1.2234	2.73E-03
2-W7-9 (3.4 m)	0.0000	0.3845	0.0159	1.5550	3.09E-06
2-W7-9 (19.8 m)	0.0621	0.2530	0.0772	2.4706	3.88E-06
2-W10-13 (12.2 m)	0.0233	0.1931	0.0777	1.6829	2.27E-06
2-W10-13 (18.3)					

*Saturated hydraulic conductivity is the second of a paired samples.

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Table 3-2. Transmissivity and Hydraulic Conductivity Values for the Unconfined Aquifer.

Well Number	Hanford coordinates west	Hanford coordinates north	T ft2/day	K ft/day	distance from water level to bottom of screen
W6-2	75302	45571	500	50	12
W7-1	78601	46551	1400	140	13
W7-2	77385	46519	740	74	5
W7-4	77040	45435	2800	95	2
W7-5	76816	46509	170	8.5	2
					14
W7-6	76816	46509	40	4	9
W7-7	76519	46509	45	5	17
W7-9	78889	46549	26		9
W7-10	75564	45921	18	1	10
W8-1	79200	46551	80	8	15
W9-1	79507	44508	50	2.5	11
W10-13	78297	43137	7000	700	12
W10-14	78330	43143	3500	350	5
W10-14[a]	78330	43143	900		20
W10-15	75858	43791	540	33	10
W10-16	75825	43130	540	33	10
W10-17	75844	42751	5000	260	19
W10-18	75610	42439	2500	140	18
W15-15	78103	40330	10000	1000	22
W15-16	77387	40269	12000	1200	20
W15-17	77387	40221	12000	1200	
W15-18	77383	39705	14000	1400	10
W15-19	77772	41041	20	1	10
W15-20	78120	41028	75	10	9
W15-22	76150	41504	1000	50	20
W15-23	78119	40680	300	20	6
W15-24	78096	39851	600	40	8
W18-21	78080	37794	51000	5100	10
W18-22[b]	78109	37831	420	42	10
W18-23	78120	38987	23000	2300	21
W18-24	77180	38998	44000	4400	10
W18-25	76034	37786	400	20	20
W18-26	78097	39477	200	10	11
W19-31	75457	38275	2400	120	20
W19-32	75459	37887	20	1	20
W21-1	71382	35868	29000		9
W22-40	73041.7	36242.3	600	20	10
W22-41	73033.8	36242.1	140	8	12
W22-42	73079.6	36052.7	190	12	10
W22-43	73376.5	36339.1	790	20	12
W23-13	76067	36040	1800	90	20
W23-14	76082	35529	27	1.4	19
W26-8	77049	33441	80	5	16
W26-9	76801.1	32048.7	480	30	16
W26-10	75456	33557	1125	75	15
W26-11[c]	75793	33526		.006	15
W26-12	76172	32933	90	5	18

[a]At time of test well was completed in the bottom of the unconfined aquifer, values not used in maps.

[b]Well monitors the bottom of the unconfined, values not used in maps.

[c]Well monitors a perched zone, values not used in maps to convert from ft^2 to $meters^2$ multiply by 0.0930 to convert from ft to meters multiply by 0.3048.

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4.0 HYDROCHEMISTRY

This section describes contaminant plume distributions beneath the 200 West Area. The plume geometries were developed from a review of published contaminant plume studies and compilation of information from the Hanford Environmental Information System (HEIS) database. This section does not contain a discussion of the source units that contributed to the groundwater contamination in this area. That information is contained in the technical baseline reports and AAMS source reports for U Plant, Z Plant, S Plant, and T Plant (DOE-RL 1992a-d).

As part of the 200 AAMS program, limited groundwater sampling is being conducted to help refine the list of contaminants of concern and contaminant plume geometries. The goal is to supplement existing information to more accurately assess contaminant plume distributions. The analytical results are added to the database as it is received from the laboratories and used to modify the plume geometries.

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4.1 EXISTING CONTAMINANT PLUME INFORMATION

Groundwater contaminant plume mapping in the 200 West Area has been conducted on selected constituents since the 1940s. In support of the current 200 AAMS program, the most recent information regarding plume distributions in the area has been reviewed. Four studies have been identified that contain contaminant plume maps and/or information on contaminant detections in the 200 West Area (Evans et al. 1990, Jaquish and Bryce 1990, Serkowski and Jordan 1989, and DOE 1991). Published data more recent than June 1990 (except for the 200 West Area carbon tetrachloride investigation), have not been available primarily due to an interruption of laboratory services during the period from June 1990 until May 1991, during which time no sampling for hazardous chemistry constituents was conducted. Samples for radioactive constituents were collected from select wells and archived for later analysis. Those samples are being analyzed in conjunction with normally scheduled samples. Therefore, the most recent published information is based on groundwater samples collected in 1989 and/or the first half of 1990. The one report that contains more recent information is the *Expedited Response Action Proposal (EE/CA & EA) for 200 West Area Carbon Tetrachloride Plume* (DOE-RL 1991b) This study was primarily directed toward understanding the distribution of only one constituent (carbon tetrachloride) although other volatile organics were sampled and analyzed.

4.2 CONTAMINANT PLUME MAPPING

The Hanford Site Groundwater Database was queried for all contaminants that have been detected in both 200 West and 200 East groundwater samples analyzed since January 1, 1988. The term "contaminants" refers to any chemical or constituent that is listed in:

- 40 CFR 141 and 143, Primary and Secondary Drinking Water Regulations
- FR 54 22062, Proposed Drinking Water MCL

- 40 CFR 264, Appendix IV, the RCRA "Long List"
- WAC 173-200-040, Model Toxics Control Act
- DOE Order 5400.5. Derived Concentration Guides (DCG) for Radionuclides.

The contaminants that exceeded a standard were then compiled and the results are presented in Table 4-1. The information from the most recent published studies has been integrated with the contaminant detection determinations to develop plume distribution maps for the constituents identified in Table 4-1. Maps were developed from average concentration values of constituents from samplings which were reported in the groundwater database from the period 1/1/88 to 12/15/91. This approach was chosen to provide a gross indication of the extent of contamination of each constituent as well as sufficient data for contouring. The average values for each well (by constituent) used in developing the plume maps are contained in Appendix C.

The maps can be categorized into four groupings based on areal extent of contamination (widespread, intermediate, localized, and indeterminate). A summary of these categorizations (by contaminant) is contained Table 4-2. These plume maps accompany brief discussions of each contaminant found in the groundwater beneath the 200 West Area.

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4.2.1 Arsenic

At least three separate areas of arsenic contamination potentially exist in 200 West Area groundwater as illustrated in Figure 4-1. A problem exists in the interpretation of the analytical data because the analytical detection limit (5 ppb) exceeds the most stringent regulatory limit (Washington Water Quality Standard [WWQS] = 0.05 ppb). Illustrated in Figure 4-1 are those areas that exceed the detection limit.

4.2.2 Chromium

Two areas of chromium contamination appear to exist as shown in Figure 4-2. All three of the applicable regulatory standards for this constituent (WWQS, Drinking Water Standard [DWS], and Maximum Concentration Limit [MCL]) are equivalent (50 ppb) and exceed the detection limit (10 ppb). The area of contamination located in the southeast corner of the 200 West Area is defined by only one point. It appears to be a persistent contaminant and other detection level exceedences are present in the area and to the east.

4.2.3 Fluoride

Two minor areas of fluoride contamination potentially exist which exceed the DWS and MCL standard of 4 ppm. The plume map for this constituent is presented in Figure 4-3.

4.2.4 Carbon Tetrachloride

The distribution of this constituent is described in detail by DOE-RL (1991b) and the contaminant plume map for that study is reproduced in this document as Figure 4-4. The data are from groundwater sampling conducted from January 1988 until April 1991. The most stringent limit for this constituent is 0.3 ppb (WWQS) which is well below the 5-ppb detection limit. This contaminant has the largest extent of contamination beneath the 200 West Area.

4.2.5 Chloroform

The chloroform contaminant plumes illustrated in Figure 4-5 has its centers of mass close to those of the carbon tetrachloride plumes. The main plume roughly mimics the shape of the distribution of the much larger carbon tetrachloride contamination illustrated in Figure 4-4. A potential process which may account for a large portion of this distribution may be the biodegradation of the carbon tetrachloride, although the addition of chloroform to the groundwater system by other processes may have occurred (e.g., byproduct of process water chlorination or direct disposal). The most stringent applicable standard for this contaminant is 7 ppb (WWQS), much higher than the carbon tetrachloride standard.

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4.2.6 Trichloroethylene

This is the third volatile organic contaminant found in highest concentration in the central portion of 200 West (Figure 4-6). As with chloroform, the two plumes of contamination appear to roughly mimic the carbon tetrachloride distribution. In the case of trichloroethylene, the detection limit (5 ppb) exceeds the most stringent standard (WWQS = 3 ppb). Therefore, the limits of the plume may be even larger than what is illustrated in the figure.

4.2.7 Nitrate

Figure 4-7 illustrates the nitrate plume distribution. The DWS and MCL standard for nitrate is 45 ppm. These areas of contamination can be seen to exist beneath the central portion of the 200 West Area and extending well to the east.

4.2.8 Gross Alpha and Gross Beta

By and large the distribution of the radionuclide contamination beneath the 200 West Area is confined to the southern and northeastern portion of the area. This distribution is well illustrated in the gross alpha and gross beta plume maps (Figures 4-8 and 4-9). This pattern of contamination is distinct from that of the volatile organics in that very little radionuclide contamination is present beneath the central portion of the area. The applicable standards are 15 pCi/L (WWQS, DWS) for gross alpha, and 50 pCi/L (WWQS, DWS) for gross beta. The detection limit for each gross indicator constituent is well below the applicable standard.

4.2.9 Iodine-129

The detection limit for iodine-129 is equivalent to the DWS and MCL standard of 1 pCi/L. Two distinct plumes beneath the 200 West Area are illustrated in Figure 4-10. The plumes coincide with the general radionuclide distribution discussed in Section 4.2.8, but also extend well to the southeast of the 200 West Area.

4.2.10 Plutonium-239/240

A single well contained plutonium-239/240 contamination that exceeded the DWS standard of 1 pCi/L. The area of contamination is illustrated in Figure 4-11.

4.2.11 Technetium-99

The contaminant plume distribution for technetium-99 (Figure 4-12) is very similar to that of the southern plume for iodine-129 (Figure 4-10) although somewhat more restricted. The DWS and MCL for this constituent is 900 pCi/L. The area of contamination extends to the east of the 200 West Area boundary.

4.2.12 Tritium

Tritium is a contaminant that has been sampled for and analyzed extensively due to its mobility and suitability for use as a contamination indicator species. The distribution of this constituent beneath the 200 West Area is presented in Figure 4-13. The general radionuclide contamination pattern beneath the 200 West Area is mimicked by this constituent with the modification of a more extensive eastward spread of contamination. The detection limit (0.5 nCi/L) is well below the most stringent regulatory standards (DWS, WWQS, MCL = 20 nCi/L).

4.2.13 Uranium

Uranium contamination appears in two areas beneath the 200 West Area as illustrated in Figure 4-14. The areas of contamination are of limited extent, but contain contamination well in excess of the 40-pCi/L DWS and MCL limit.

4.2.14 Composite Plume Maps

Composite plume maps of the areas of radioactive and hazardous contamination for the constituents discussed above are contained in Figures 4-15 and 4-16. These figures illustrate the areas of contamination that must be addressed when considering all contamination that exceed regulatory standards.

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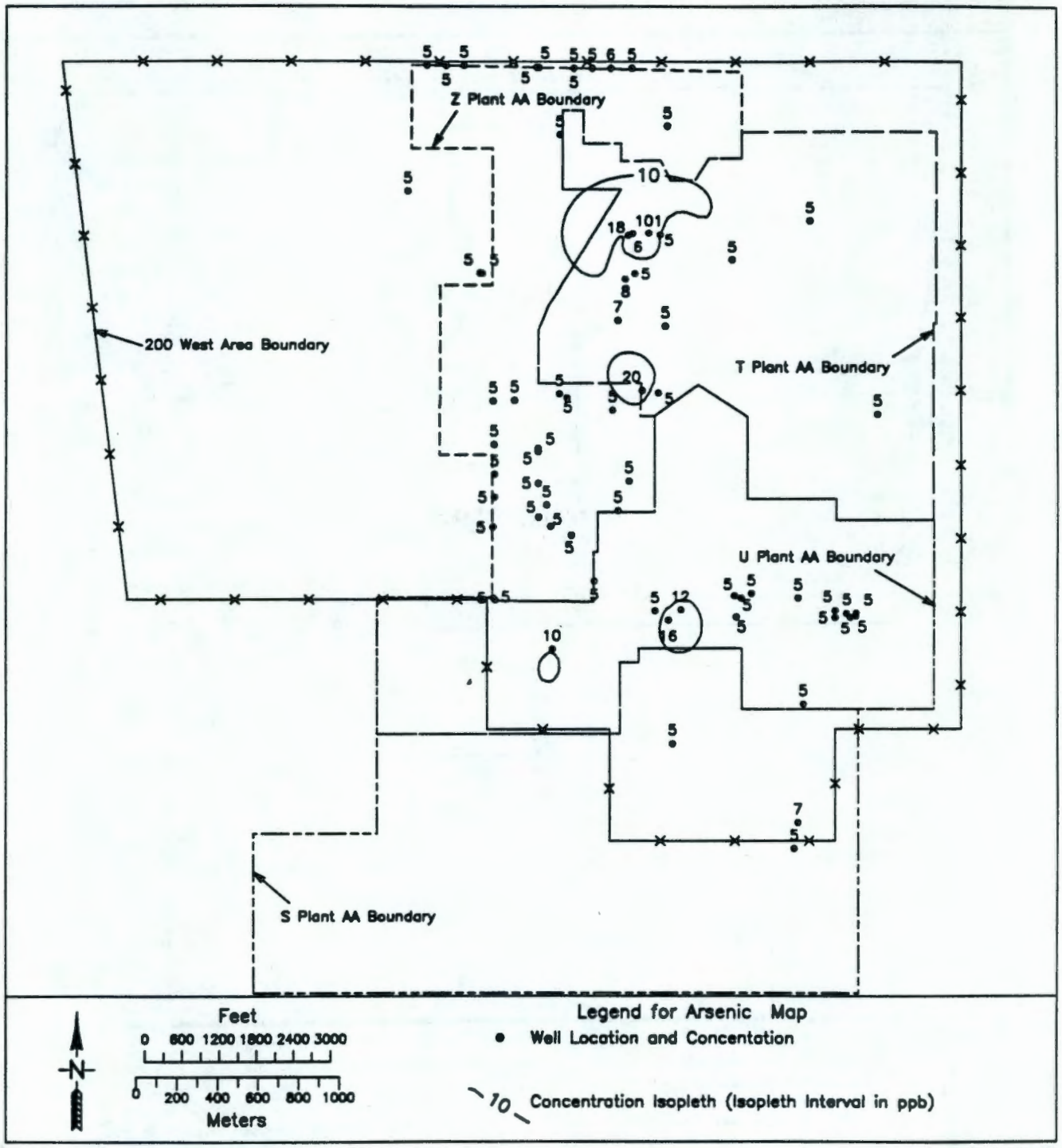

Figure 4-1: Arsenic Plume Map

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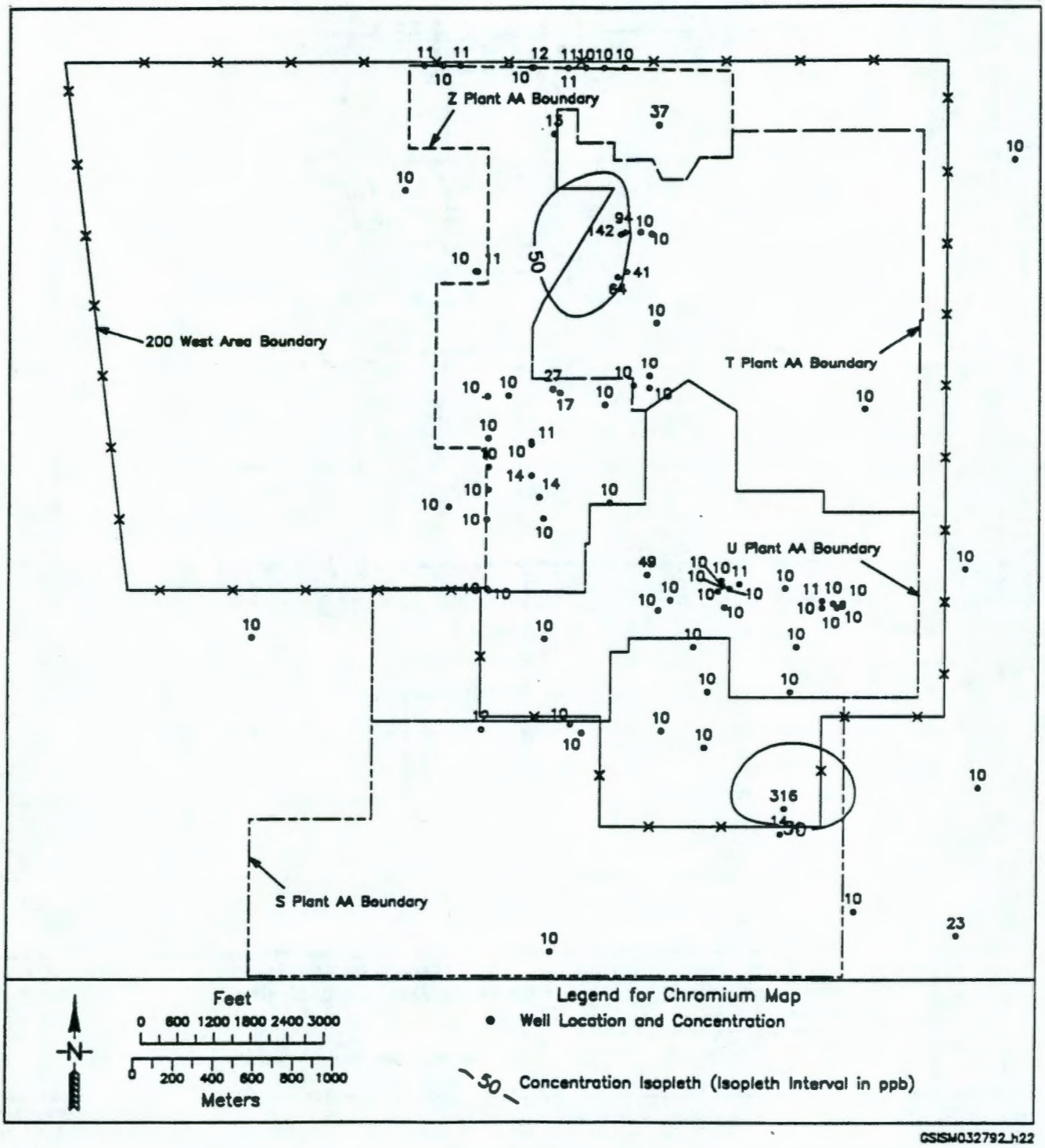

Figure 4-2: Chromium Plume Map

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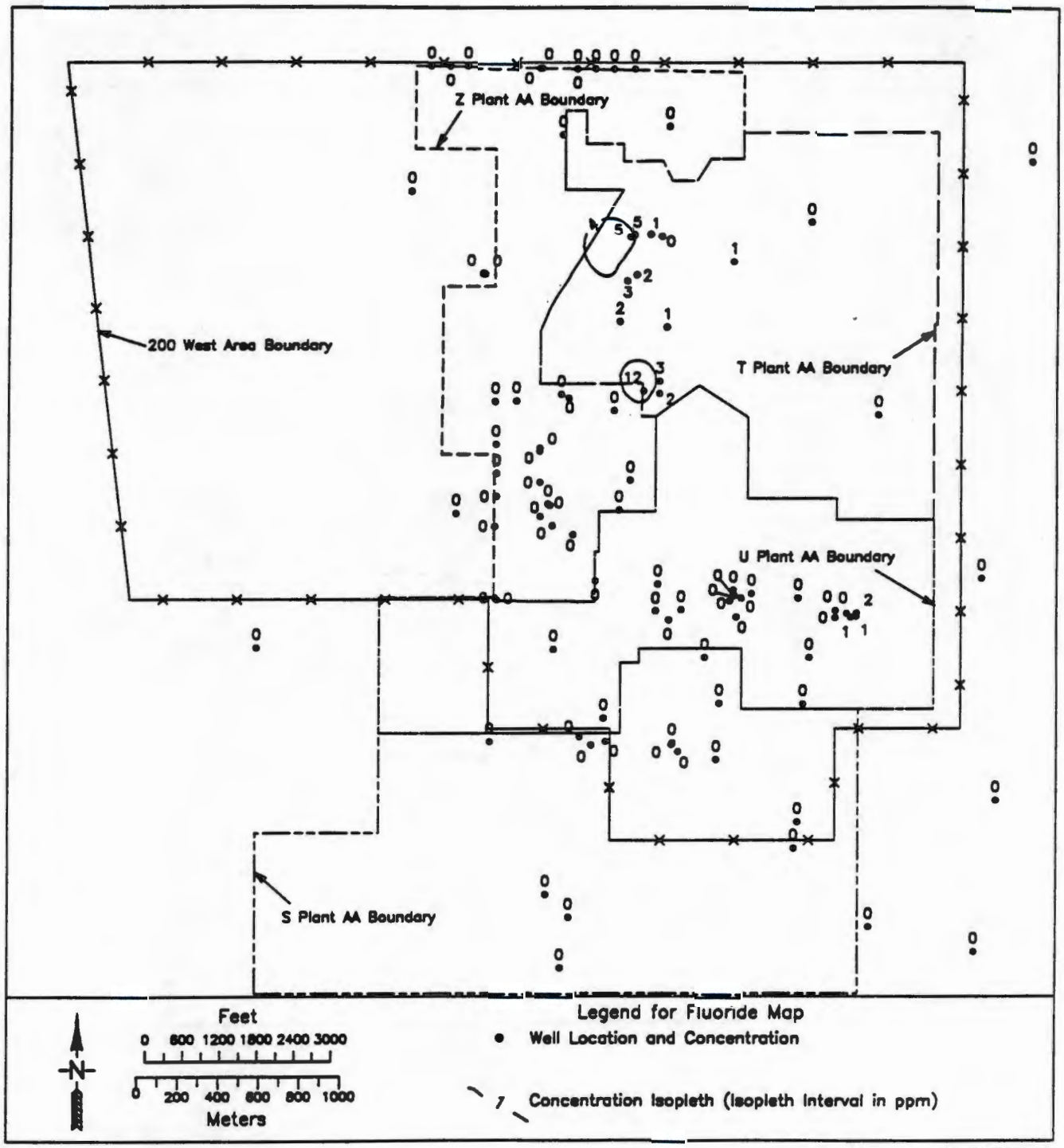

Figure 4-3: Fluoride Plume Map

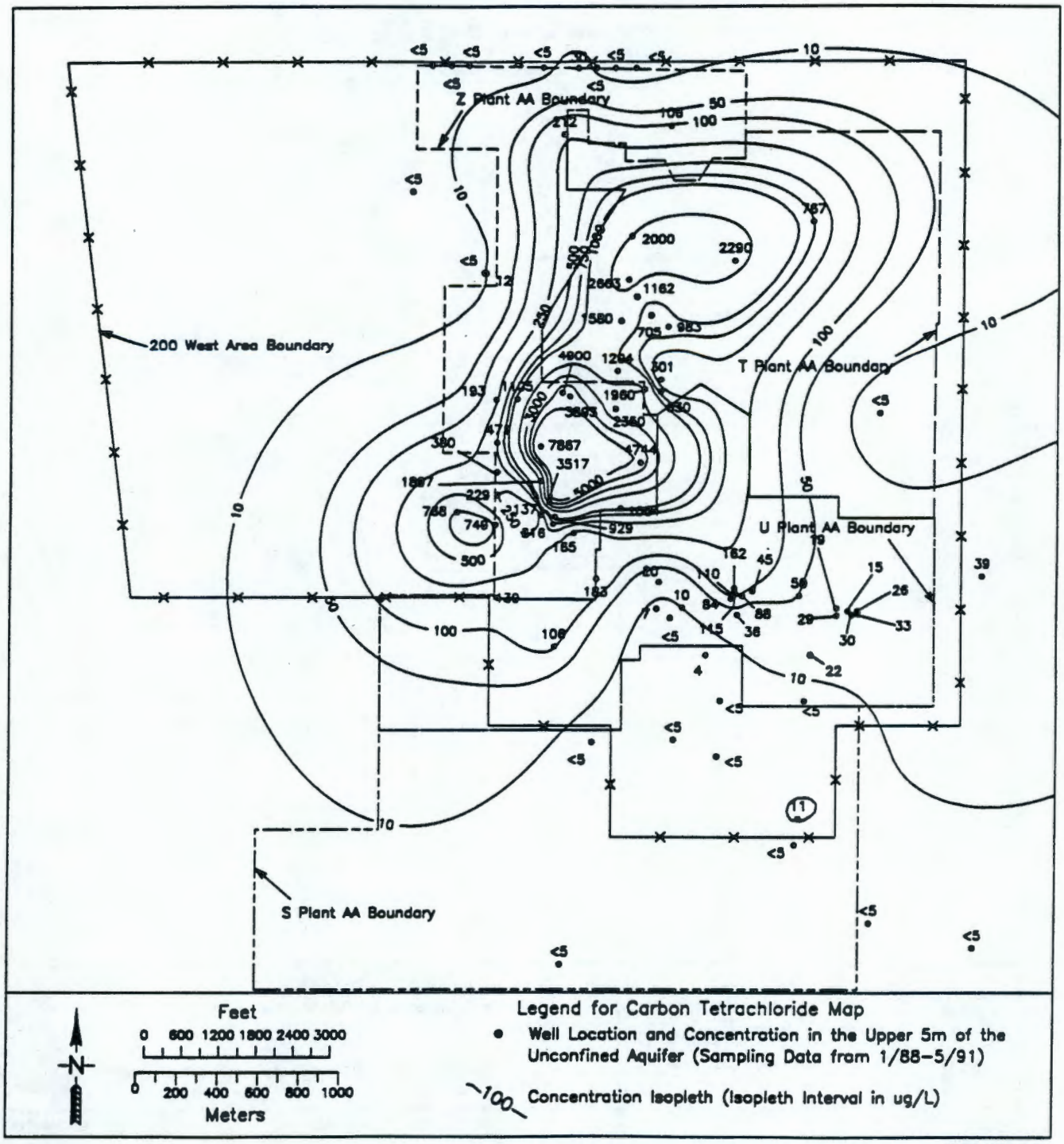

Figure 4-4: Carbon Tetrachloride Plume Map

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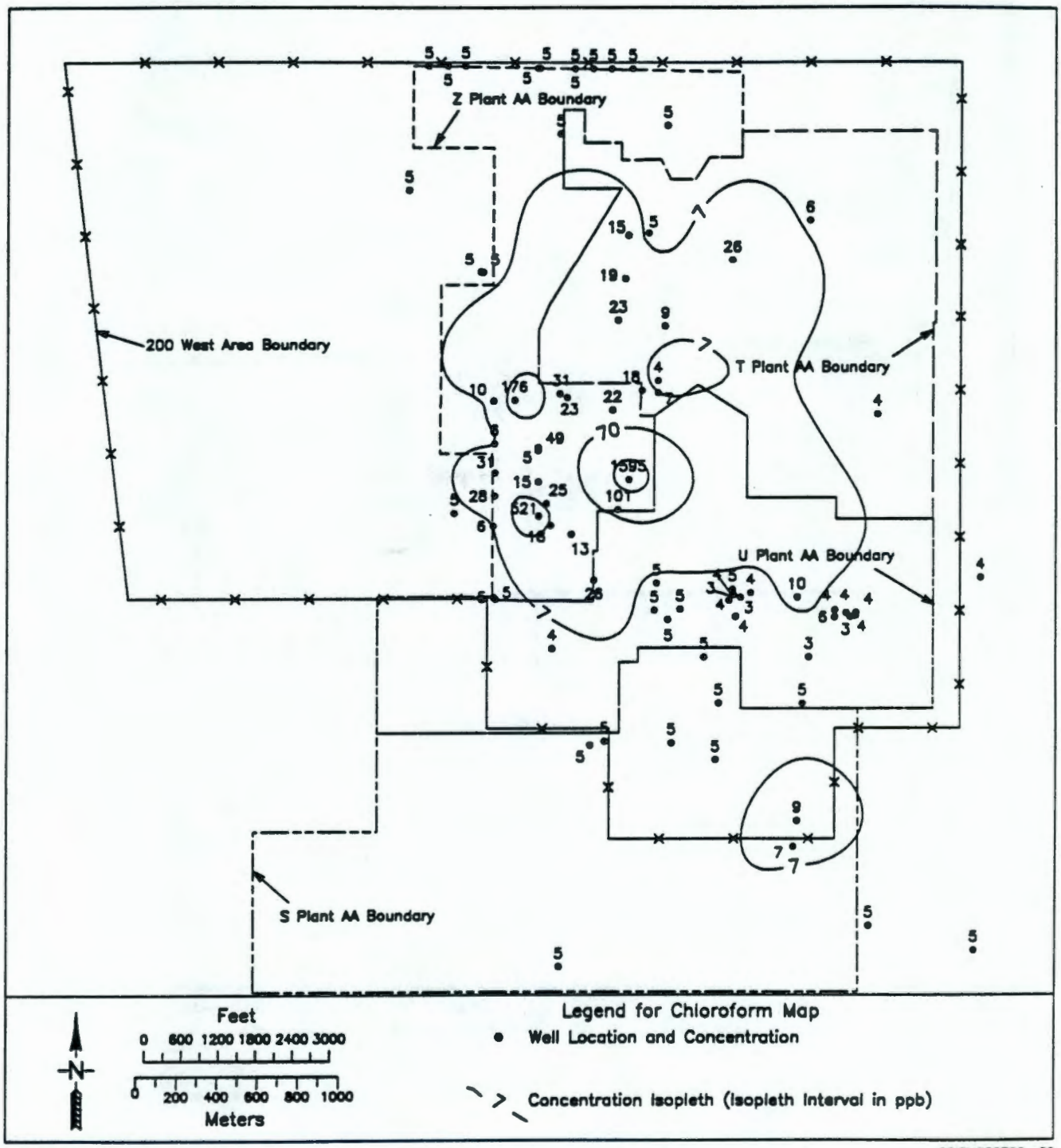

Figure 4-5: Chloroform Plume Map

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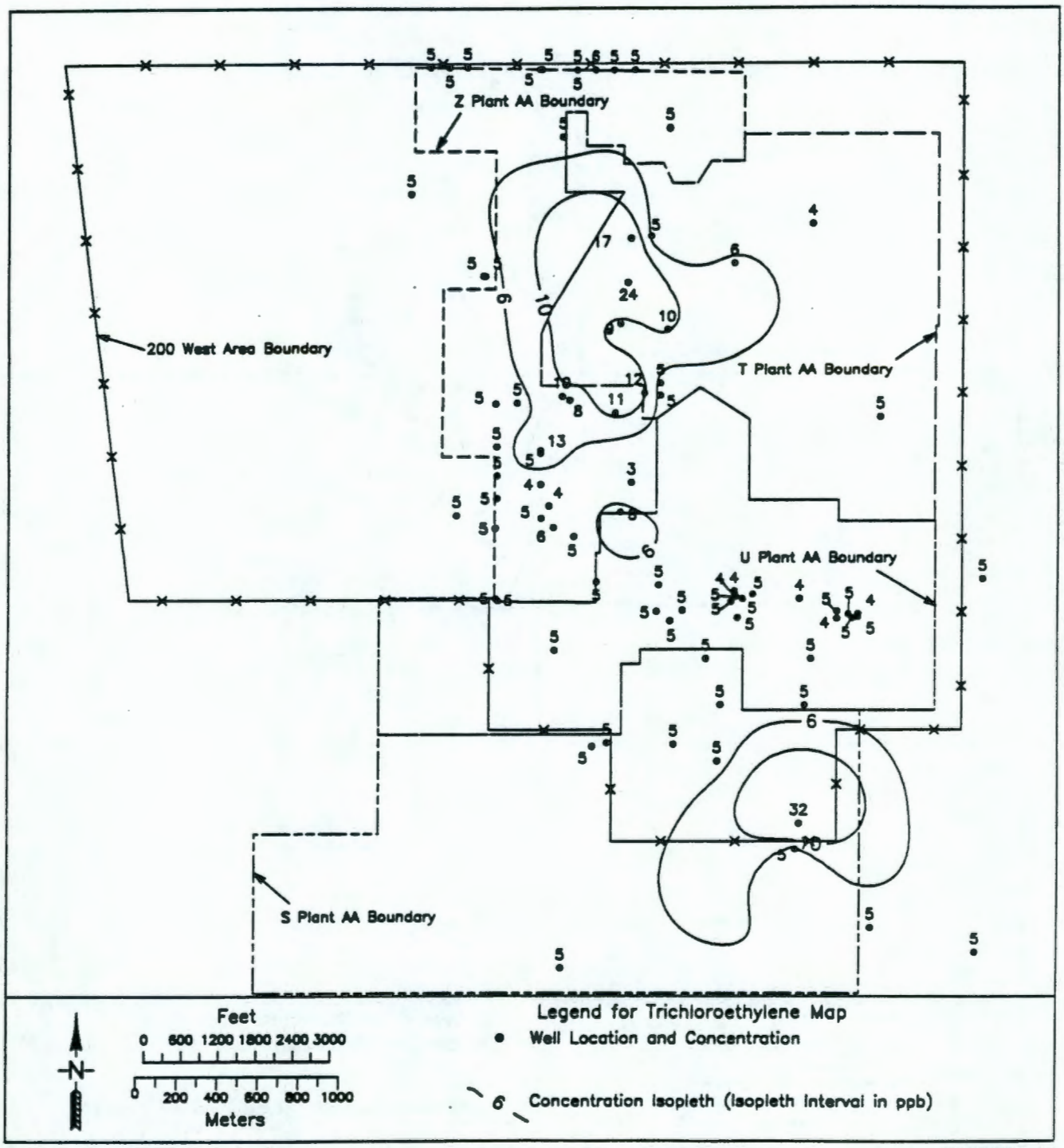

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Figure 4-6: Trichloroethylene Plume Map

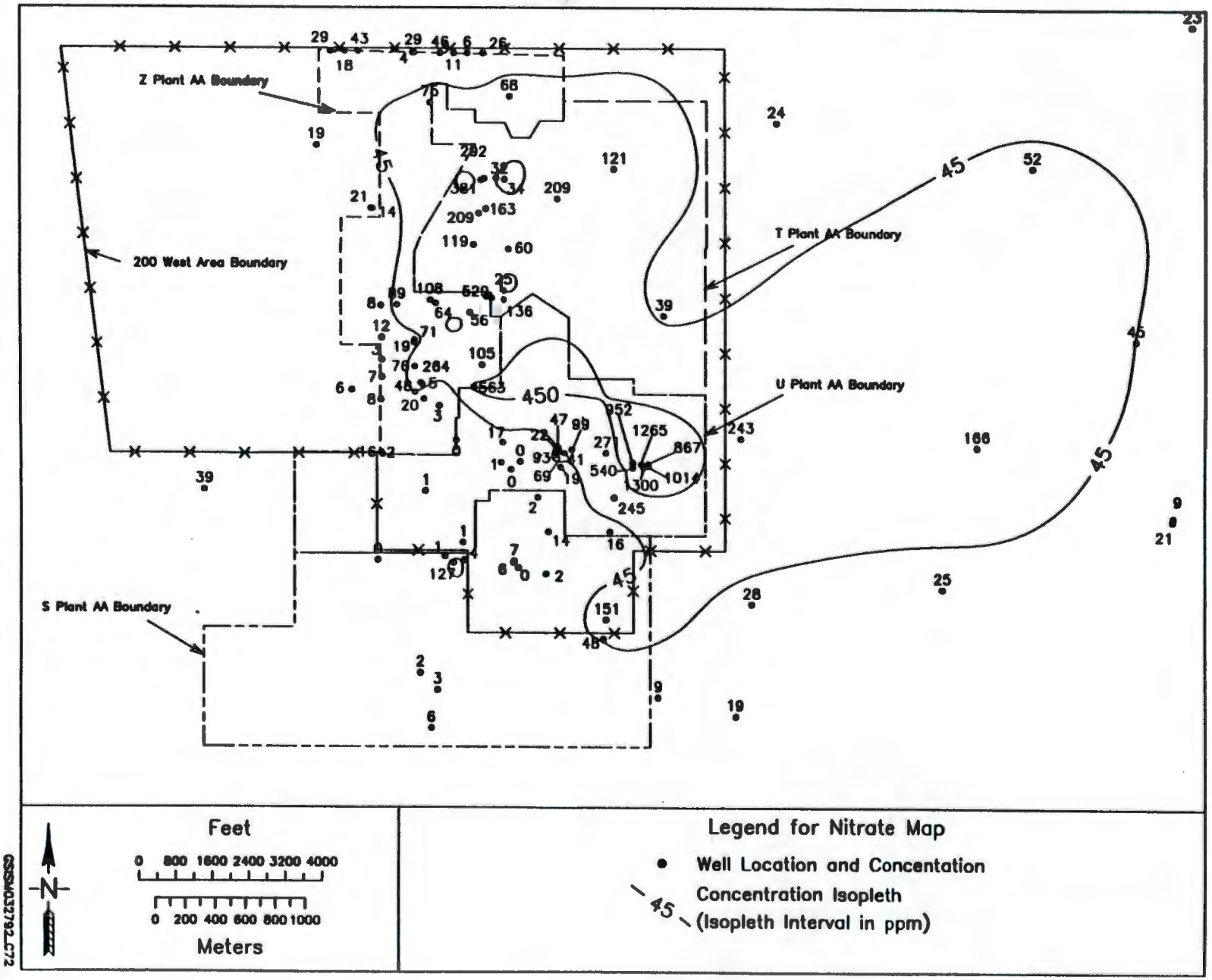

Figure 4-7: Nitrate Plume Map

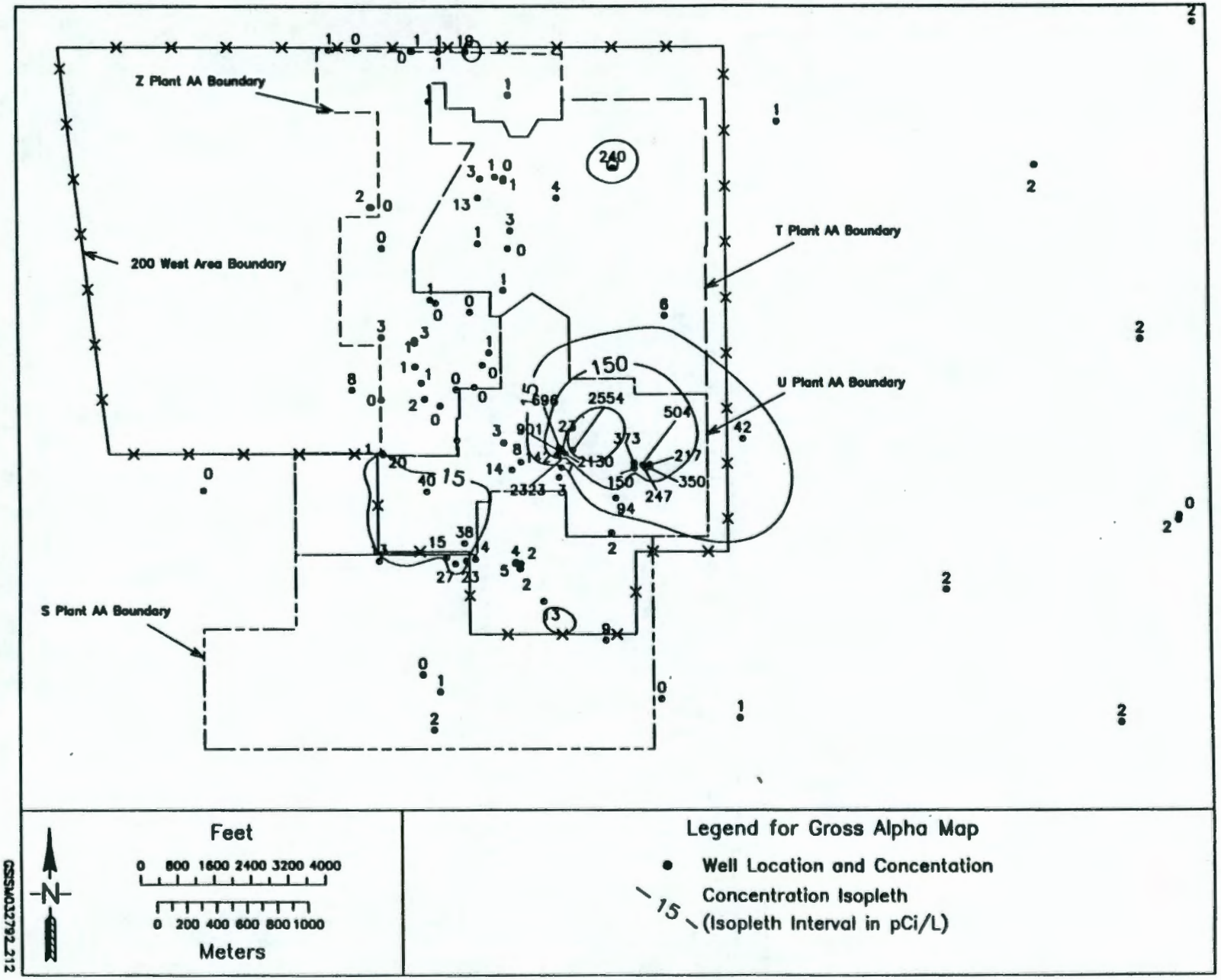

Figure 4-8: Gross Alpha Plume Map

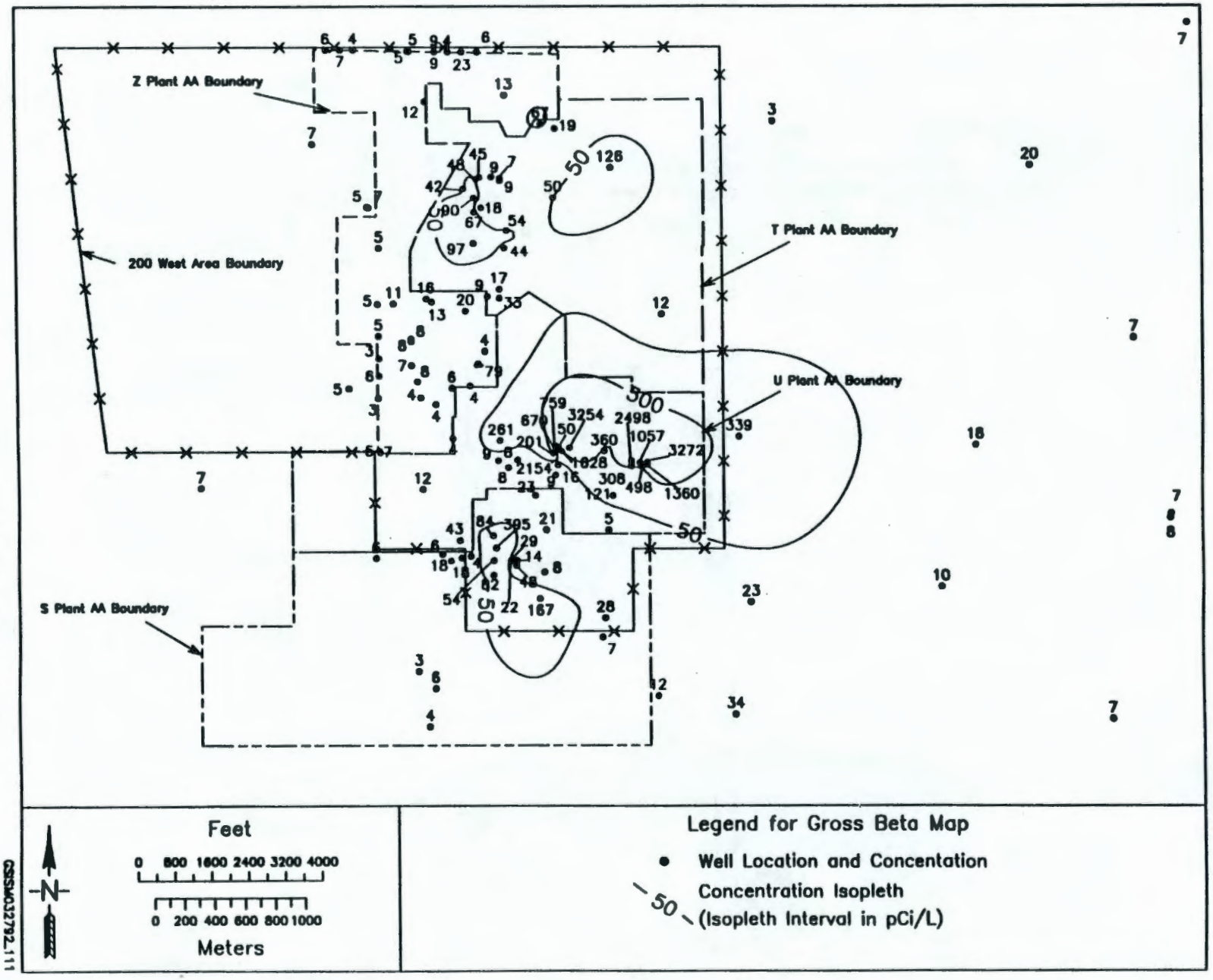

Figure 4-9: Gross Beta Plume Map

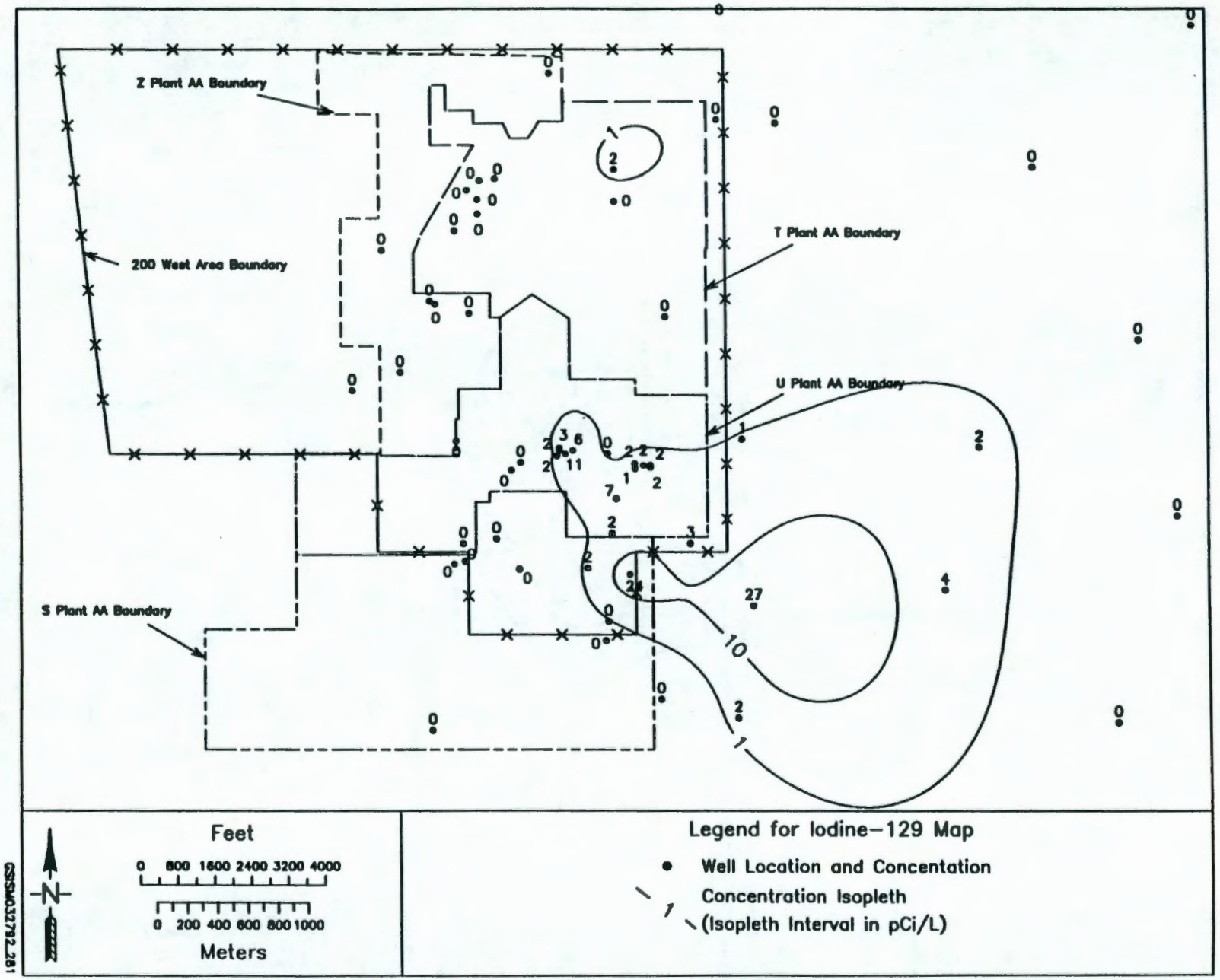

Figure 4-10: Iodine-129 Plume Map

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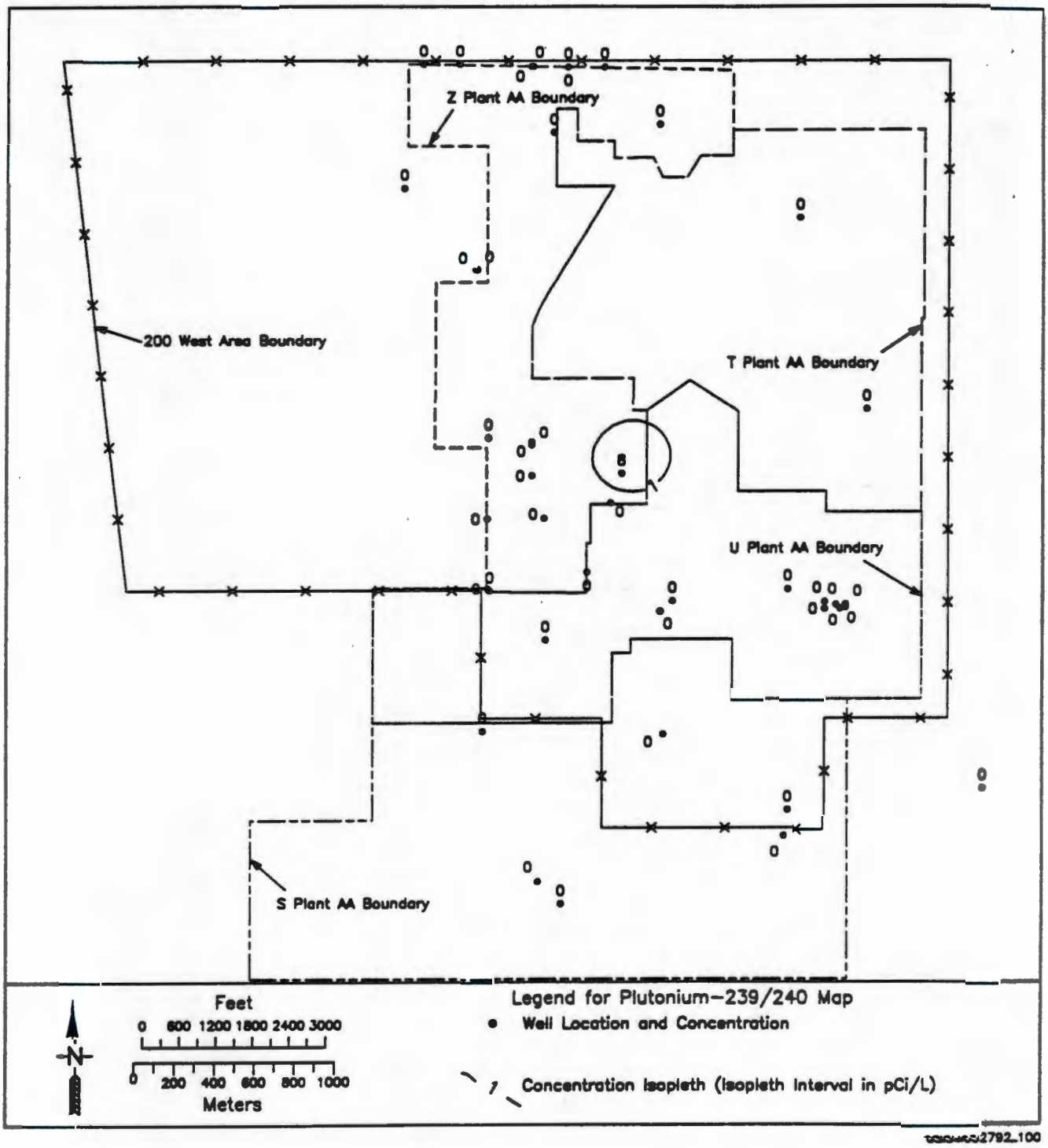

Figure 4-11: Plutonium-239/240 Plume Map

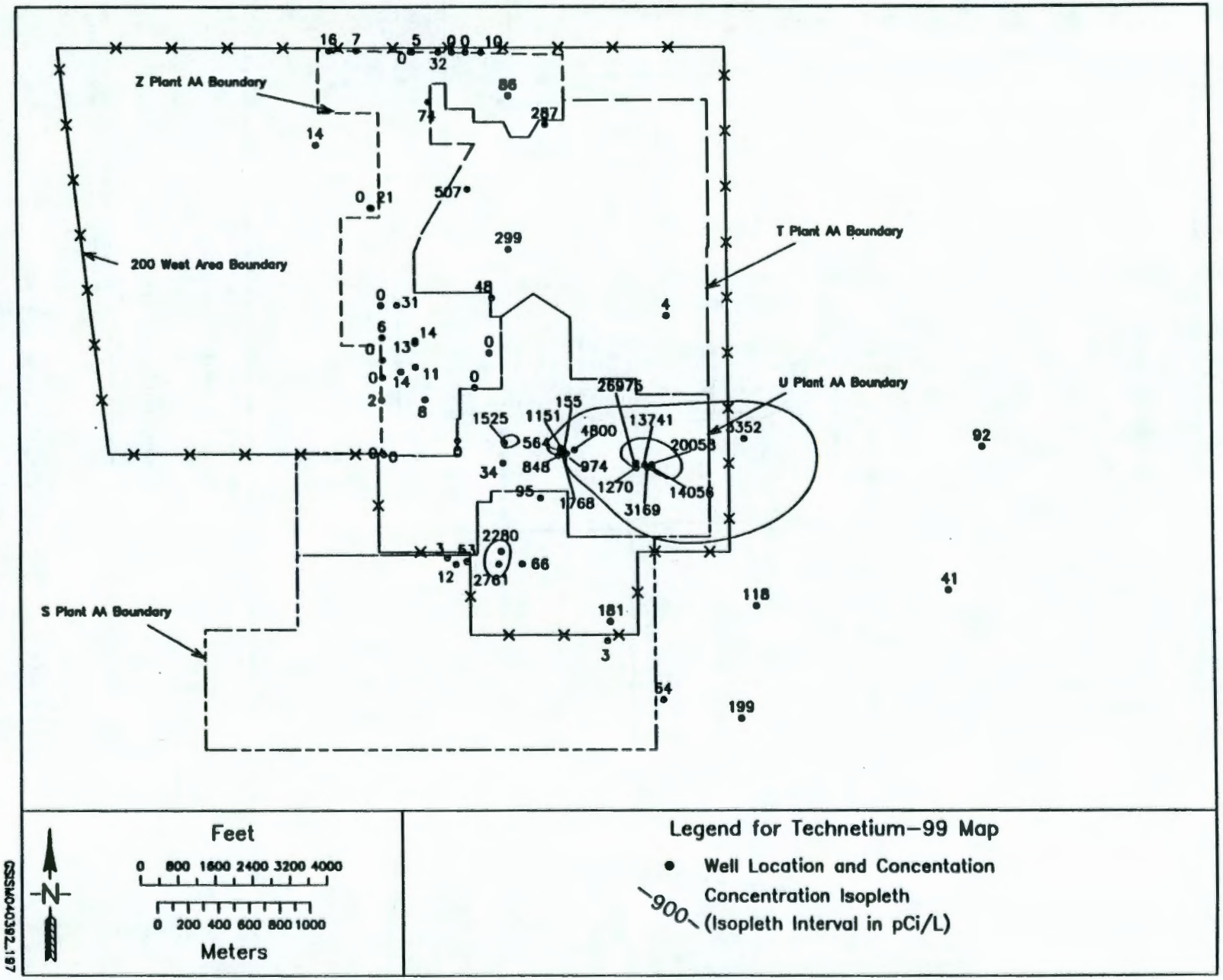

Figure 4-12: Technetium-99 Plume Map

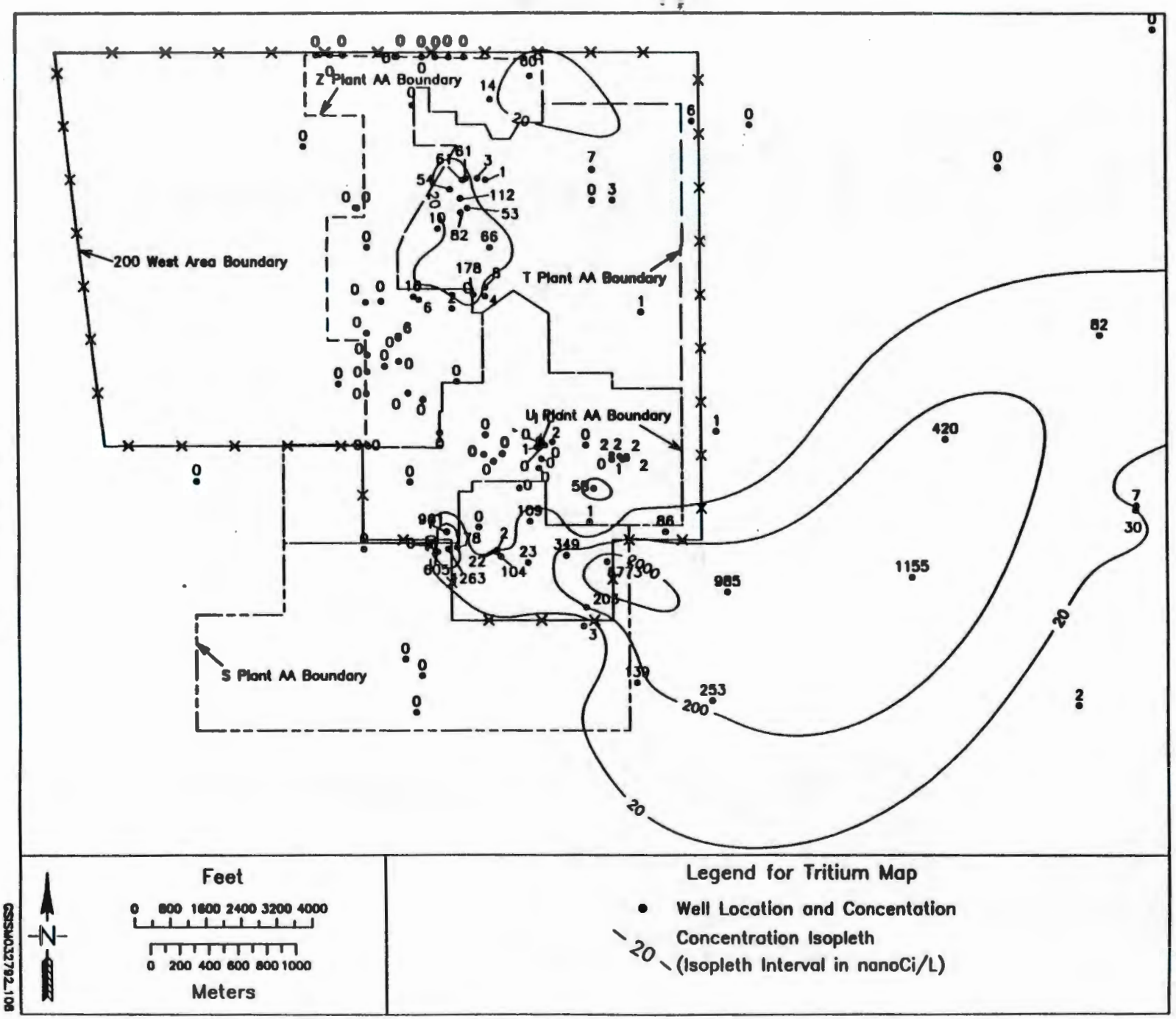

Figure 4-13: Tritium Plume Map

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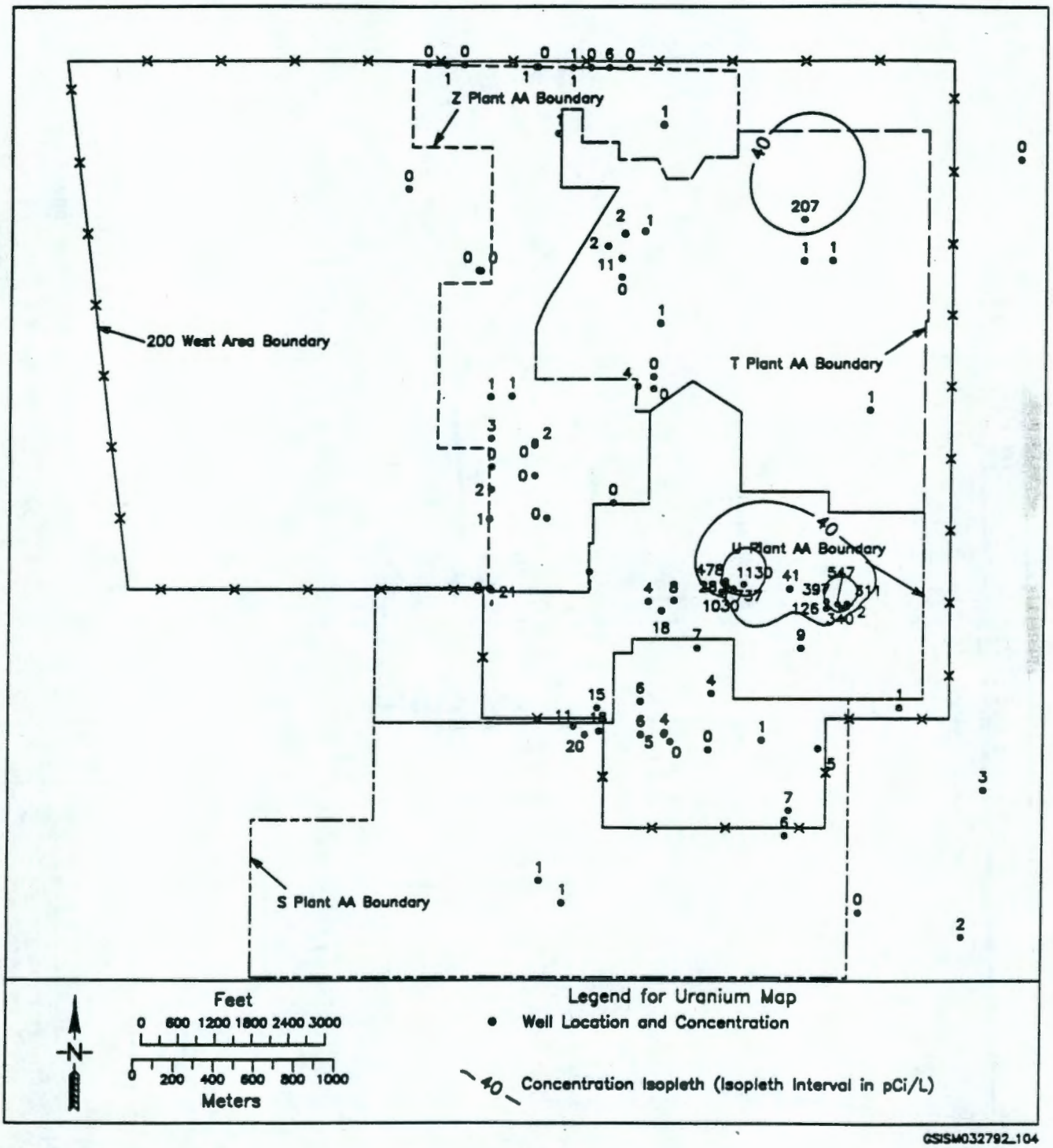

Figure 4-14: Uranium Plume Map

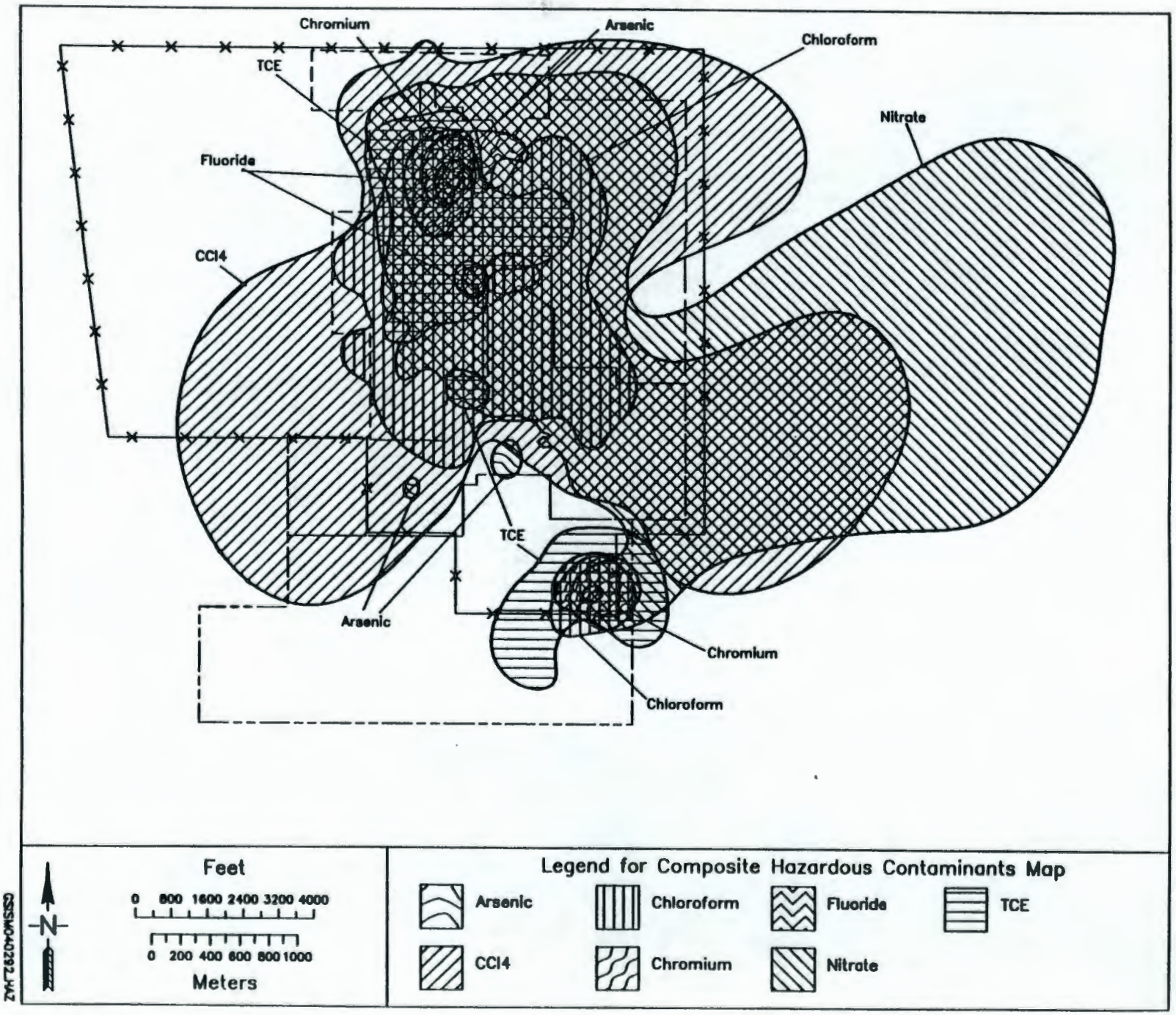

Figure 4-15: Composite Hazardous Contaminant Plume Map

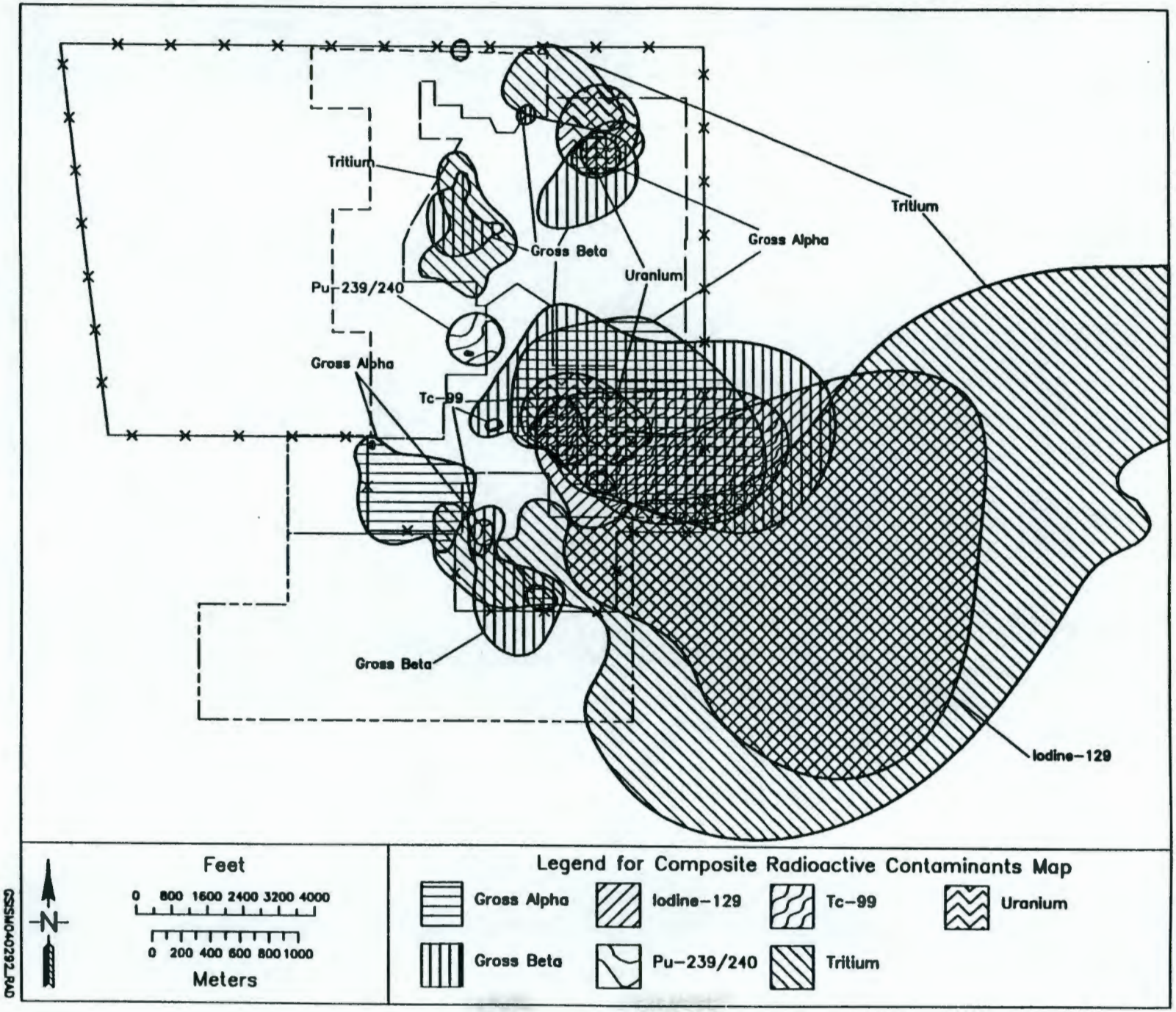

Figure 4-16: Composite Radioactive Contaminant Plume Map

5.0 GEOHYDROLOGIC MODEL FOR THE 200 WEST AREA GROUNDWATER AAMS

The shape and extent of contaminant plumes within the study area are controlled by the source terms and hydraulic properties of the underlying lithologic units. The purpose of this study was to provide and interpret measured hydrologic parameters for each of the different layers to develop a geohydrologic model. This model can be divided into two general sections: (1) movement of water through the unsaturated zone, and (2) movement of water through the unconfined and confined aquifers.

5.1 PARTIALLY SATURATED ZONE

To help understand the movement of water through the unsaturated zone, Figures 5-1 through 5-6 show the distribution and thickness of the sediments comprising the unsaturated zone in a three dimensional perspective. In each successive figure, the overlying formations have been removed from the field of view. Important features of the unsaturated zone in the 200 West Area are the lack of Hanford fine-grained sequence in the central and northern portions of the area (Figure 5-2), the presence of early Palouse and Plio-Pleistocene (Figures 5-3 and 5-4) throughout most of the area, and the presence of upper Ringold in the northern and central portions of the area (Figure 5-5). All of these sediments are fine-grained with a different moisture retention curve and a lower saturated hydraulic conductivity than the Hanford coarse-grained sequence and the Ringold gravel unit E. Water movement through all these sediments will be controlled by the amount of recharge at the surface for a steady state condition, and the moisture content, recharge, hysteresis, and unsaturated hydraulic conductivity for a transient condition.

Water movement through partially saturated sediments can be described Richard's (1931) extension to Darcy's law, which added the provision that conductivity is now a function of saturation [i.e., $K = K(\theta)$]:

$$q = K(\theta)\,\nabla H \tag{7}$$

where:

- q = Darcy flux (cm/s)
- K = hydraulic conductivity (cm/s)
- θ = volumetric moisture content
- ∇ = vector differential operator, representing the three-dimensional operator in space [in this case the spatial gradient of hydraulic head (cm)]
- H = hydraulic head (cm).

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For a steady state, one-dimensional, and vertically aligned unsaturated soil column, equation (1) becomes:

$$q = K(\theta)\,[1 + \frac{\partial \varphi}{\partial z}(\theta)] \tag{8}$$

where:

φ = matric potential [suction head (cm)]
z = vertical cartesian coordinate (cm)
∂ = differential.

Under the unit gradient assumption, only the force of gravity is considered and all other forces are consider negligible. Therefore, the hydraulic gradient under steady state assumption becomes one,

$$[1 + \frac{\partial \varphi}{\partial Z}(\theta)] = 1 \quad \textit{because} \quad 1 > \frac{\partial \varphi}{\partial Z}(\theta) \tag{9}$$

and the hydraulic conductivity at a specified moisture content is equal to the Darcy flux:

$$q = K(\theta)\,. \tag{10}$$

Once the relationship between unsaturated hydraulic conductivity and moisture content for a particular sediment is known (given in Chapter 3), the unit gradient assumption can be used to (1) estimate initial conditions for multi-dimensional, transient numerical models, and (2) estimate a travel time through the vadose zone for a one-dimensional wetting front. The initial conditions for a numerical model can be estimated from the moisture characteristic curves by setting the Darcy flux equal to the recharge across the top boundary. This assumes uniform recharge across that boundary. Travel time through the vadose zone can be estimated using the following approach. The velocity of groundwater water for saturated conditions is:

$$v = 1\frac{q}{n_{effective}} \tag{11}$$

where:

$n_{effective}$ = effective porosity.

For unsaturated conditions, $n_{effective}$ in equation 5 is replaced by θ (volumetric moisture content at a specific recharge). The travel time (t) through each soil layer of thickness L is:

$$t = \frac{(L * \theta)}{q} \tag{12}$$

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The total travel time (T) through the unsaturated zone is:

$$T = \sum_{i}^{N} \frac{L_i \, \theta_i}{q} \tag{13}$$

where:

N = number of layers
i = index of the soil layer.

Travel time to the water table has been calculated for the lithologies observed in the 200 West Area. Only the major lithologic unit was considered and facies changes within each of these units were ignored. This example is given only to illustrate the following: (1) the unit gradient condition for calculating travel times through the vadose zone; (2) differences between travel times calculated with drainage and imbibition curves; (3) differences between different recharge rates; and (4) differences between different moisture characteristic curves for the same lithologic unit.

Examples 1 and 2 in Table 5-1 have a recharge rate equal to 0.5 cm/y, while examples 3 and 4 have a recharge rate equal to 5 cm/yr. For these examples, increasing the recharge rate by a factor of 10 has resulted in an eightfold decrease in travel time. The use of different moisture characteristic curves for the same lithologic rock type can produce large differences (2,311 yr for example 1, and 1,376 yr for example 2) in travel time through the vadose zone. The use of both drainage and imbibition curves is to provide a bounding calculation, since the unsaturated hydraulic conductivity is also dependent on the hysteritic path. Further, the examples given in Table 5-1 illustrate the need to collect site-specific information on the physical properties of the partially saturated zone.

The unit gradient approach is a only first approximation for travel time. It does not take into account multidimensional flow or a source term that changes over time. Under transient conditions, the unit gradient approach will not work because the unsaturated hydraulic conductivity within in a single unit is dependent on the wetting and drying paths within the hysteresis cycle, moisture content, and the amount of recharge. Additionally, with interbedded coarse and fine-grained sediments, a capillary barrier can form at the top of coarse grained sediments. This capillary barrier forms when unsaturated hydraulic conductivity of the coarse grained sediments is lower than the overlying finer grained sediments. The approximate travel time may be calculated for the transient case by applying a numerical model.

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5.2 SATURATED ZONE CONCEPTUAL MODEL SUMMARY

Movement of water within the saturated zone occurs within the unconfined aquifer. The unconfined aquifer in the area of study is within the Ringold Formation stratigraphic unit. The unconfined aquifer consists of gravel unit E in all but the northeast section of the study area where the aquifer also consists of gravel unit A. Figure 5-7, which shows the surface of saturated gravel unit E and the formations beneath, conceptualizes the unconfined aquifer in three dimensions for the area of study. Figure 5-8 shows the extent of the lower mud unit and Figure 5-9 shows the surface of gravel unit A.

The upper boundary of the unconfined aquifer is the water table (Figure 5-7). The water table within the area of study has a high of over 143 m above mean sea level (June 1991) and a low of <137 m above mean sea level (June 1991). The water table is mound shaped, with the center of the mound approximately located beneath the dry 216-U-10 Pond which was deactivated in 1984.

The bottom boundary of the unconfined aquifer is the lower mud unit of the Ringold Formation in all but the northeast portion of the study area. Figure 5-8 shows the extent of the lower mud unit within the study area. The Elephant mountain basalt is the base of the unconfined aquifer (Figure 5-10) where the lower mud unit is not present.

Hydraulic properties of the upper unconfined aquifer within the study area can be loosely classified into three zones; northern, central, and southern. The northern zone has high hydraulic conductivity values (>100 ft/d) trending north-south. The central zone has high hydraulic conductivity values (>1,000 ft/d) trending southwest-northeast. Low hydraulic conductivity values (<10 ft/d) separate the northern from the central zone. The southern zone has low hydraulic conductivity values (<10 ft/d) trending southwest-northeast.

Contaminant movement within the upper unconfined aquifer is illustrated with streamlines in Figure 5-11. This figure shows a map of hydraulic conductivity of the upper unconfined aquifer, water table elevations, and streamlines with time markers emanating from selected points. The rate of fluid movement will differ between the hydraulic conductivity zones. The time markers shown on Figure 5-11 illustrate the rate differences between zones. For a contaminant to travel 610 m under present conditions, it will take 3 yr in the northern zone, <1 yr in the central zone, and 10 to 20 yr in the southern zone.

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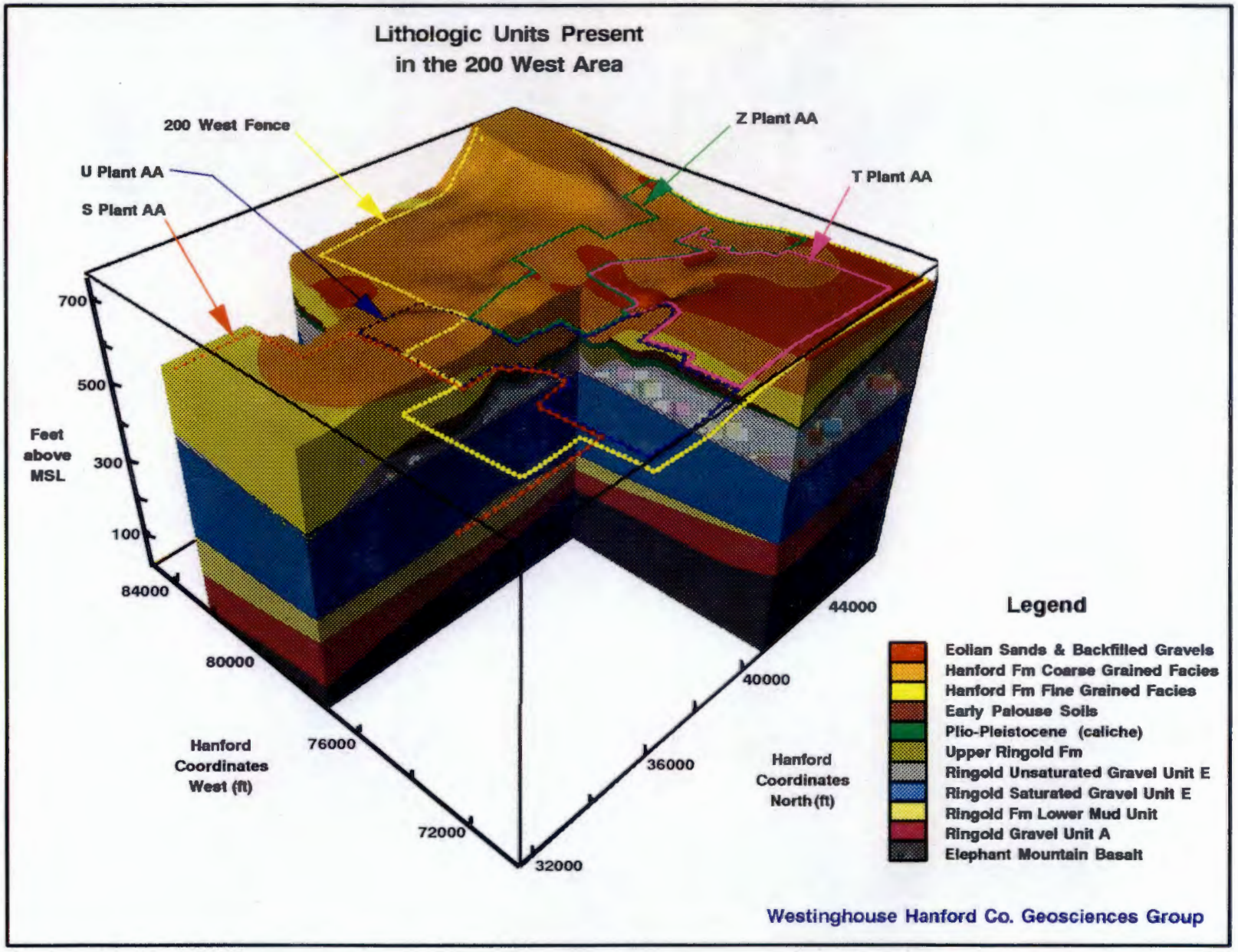

Figure 5-1. Elephant Mountain Basalt to Hanford Coarse-Grained Sequence.

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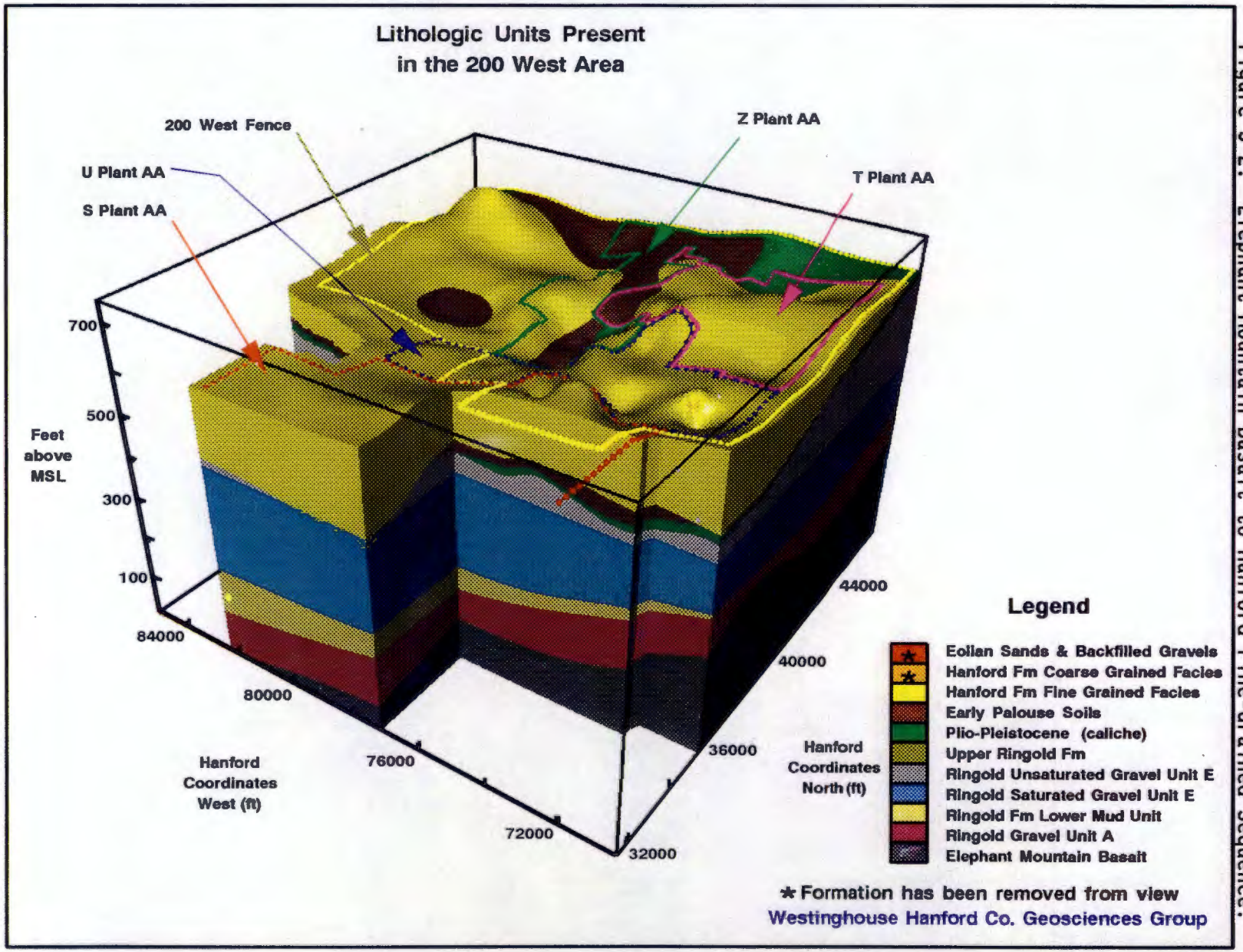

Figure 5-2. Elephant Mountain Basalt to Hanford Fine-Grained Sequence.

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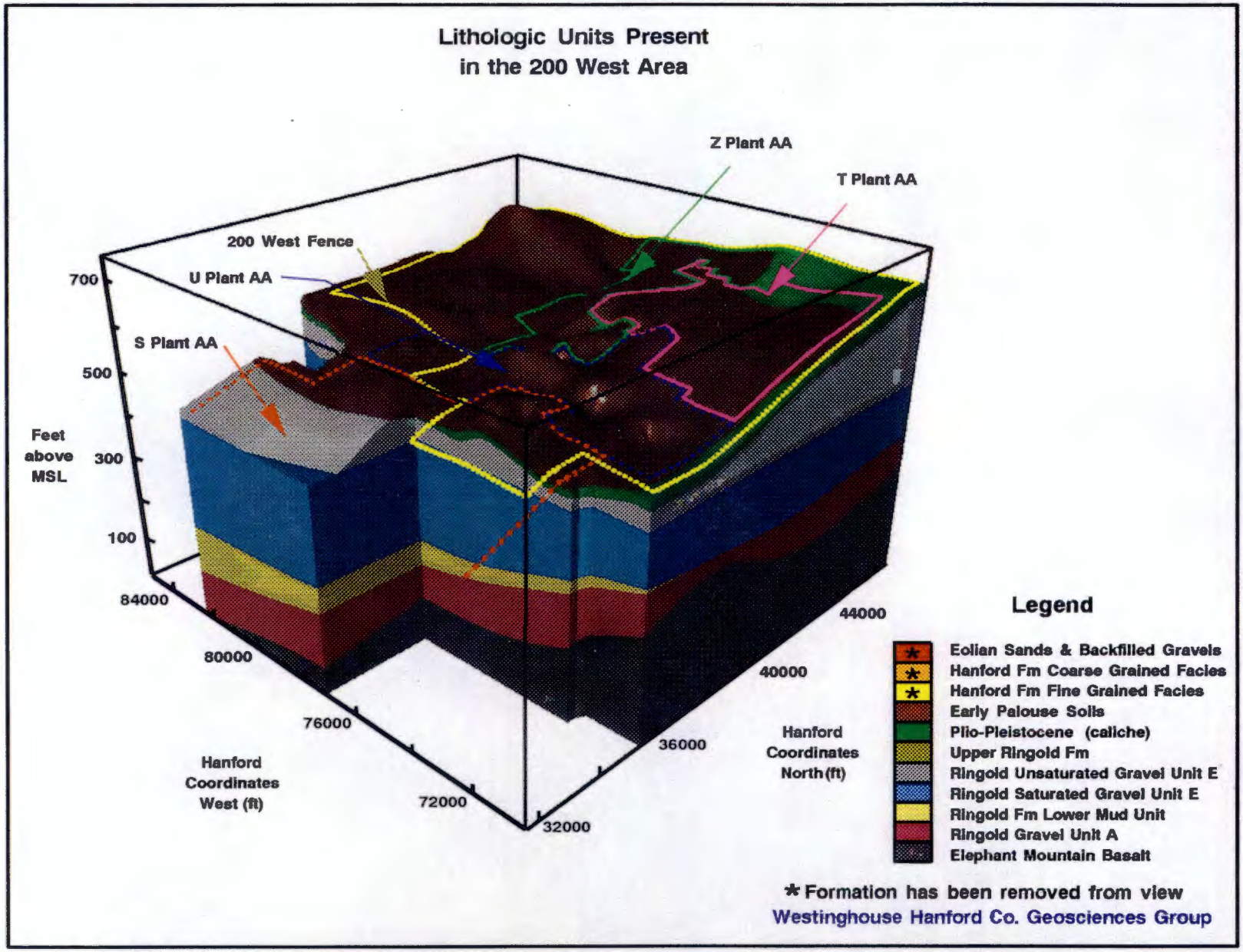
Figure 5-3. Elephant Mountain Basalt to Early Palouse Soils.



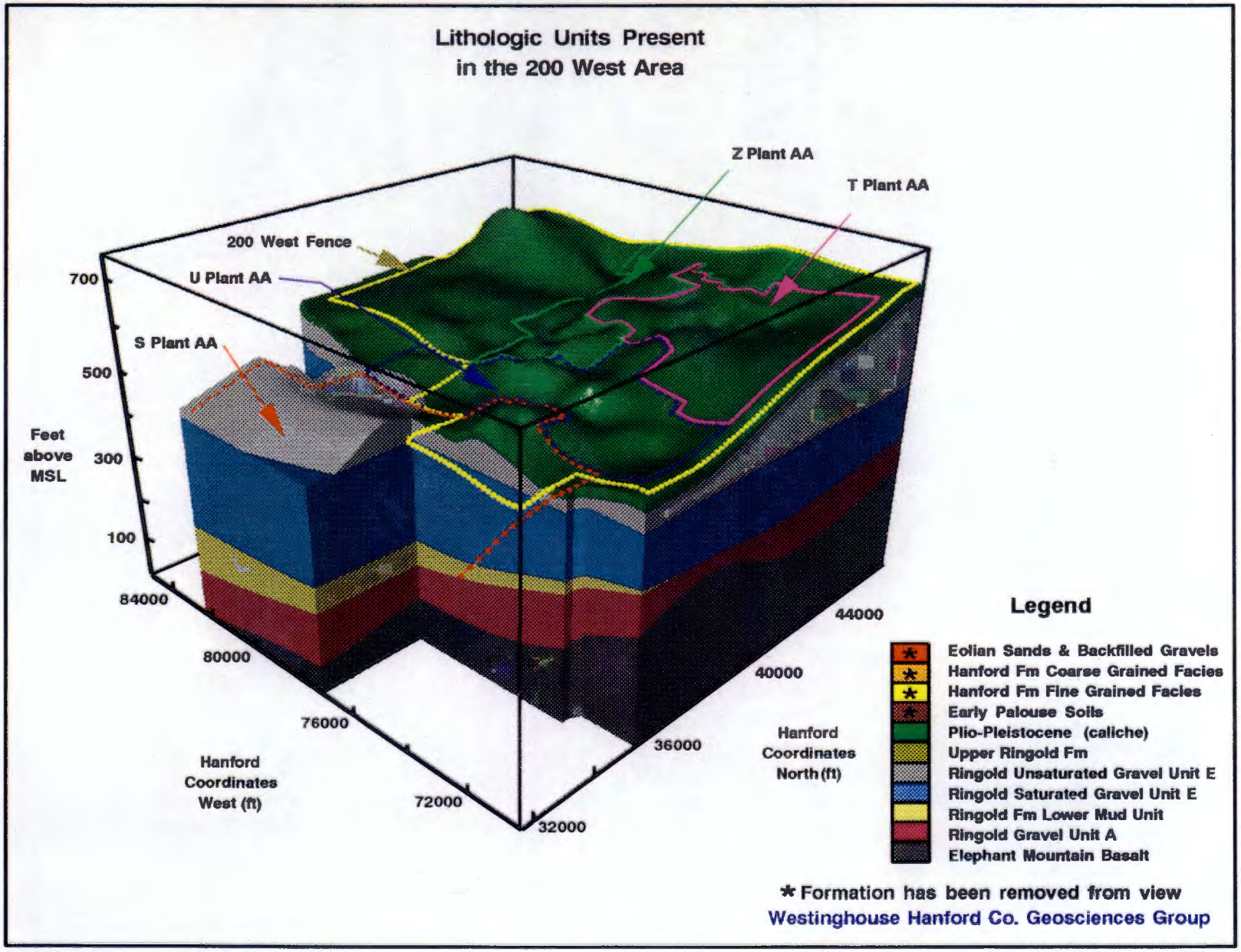


Figure 5-4. Elephant Mountain Basalt to Plio-Pleistocene.

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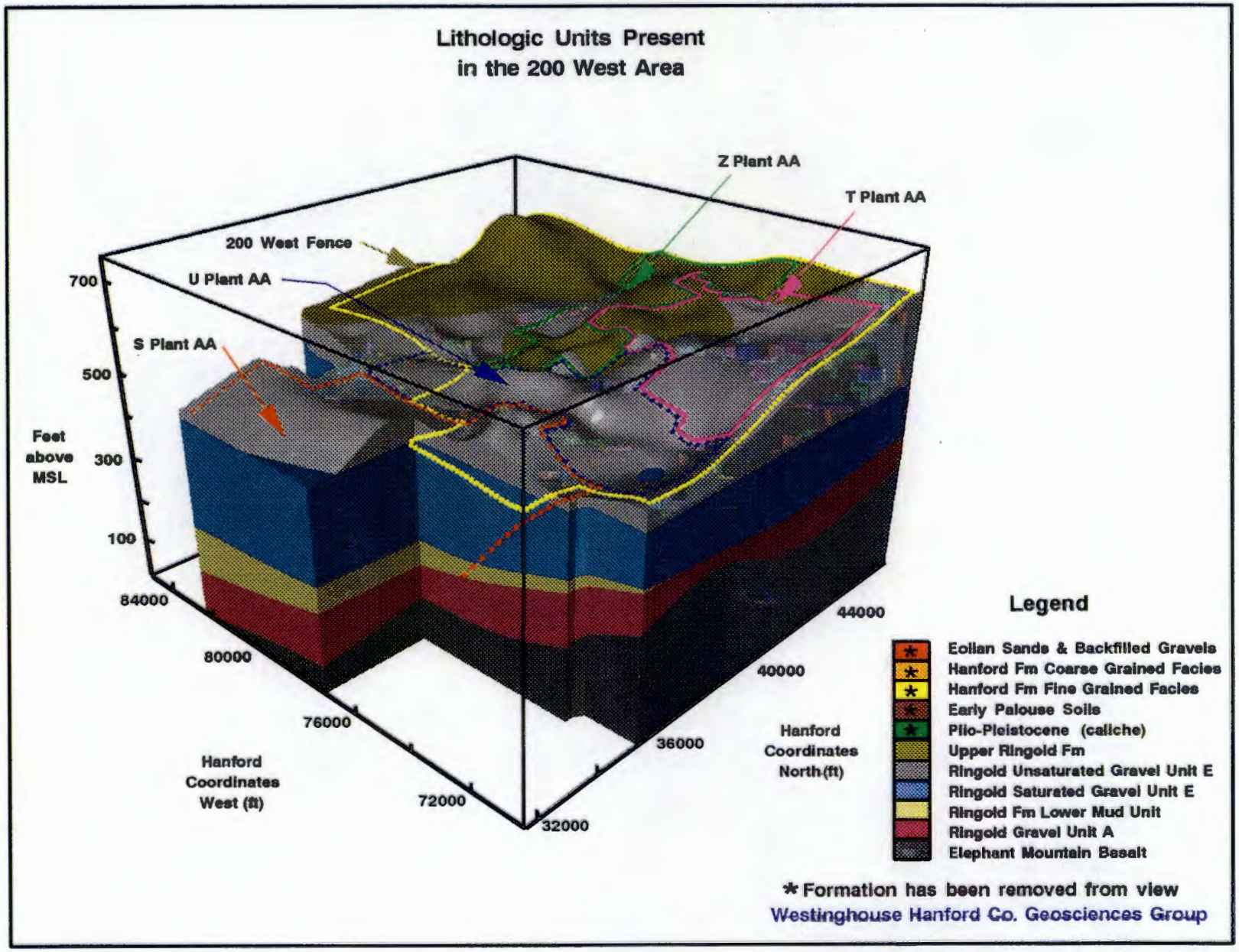


Figure 5-5. Elephant Mountain Basalt to Upper Ringold.

Figure 5-6. Elephant Mountain Basalt to Unsaturated Ringold Gravel Unit E.

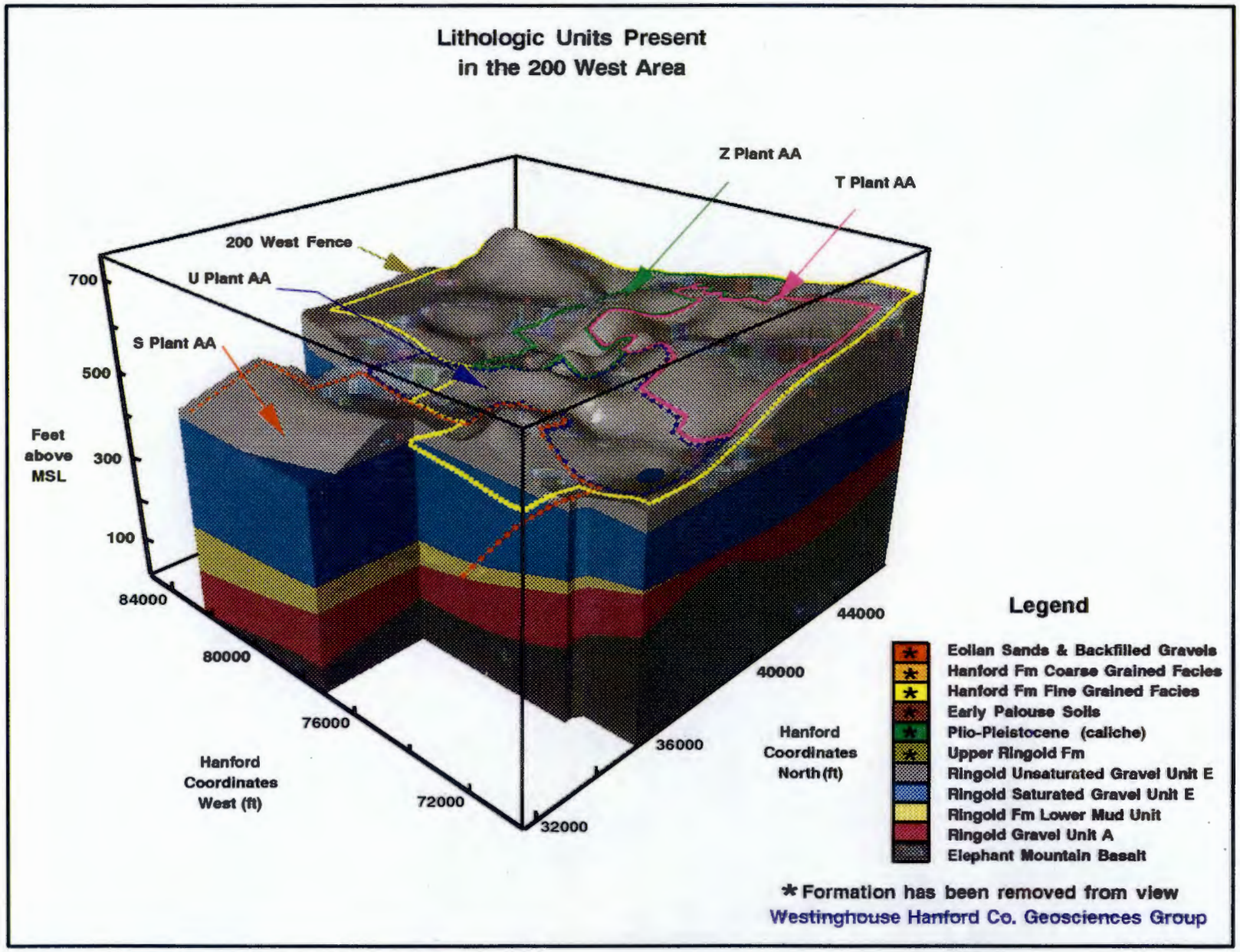
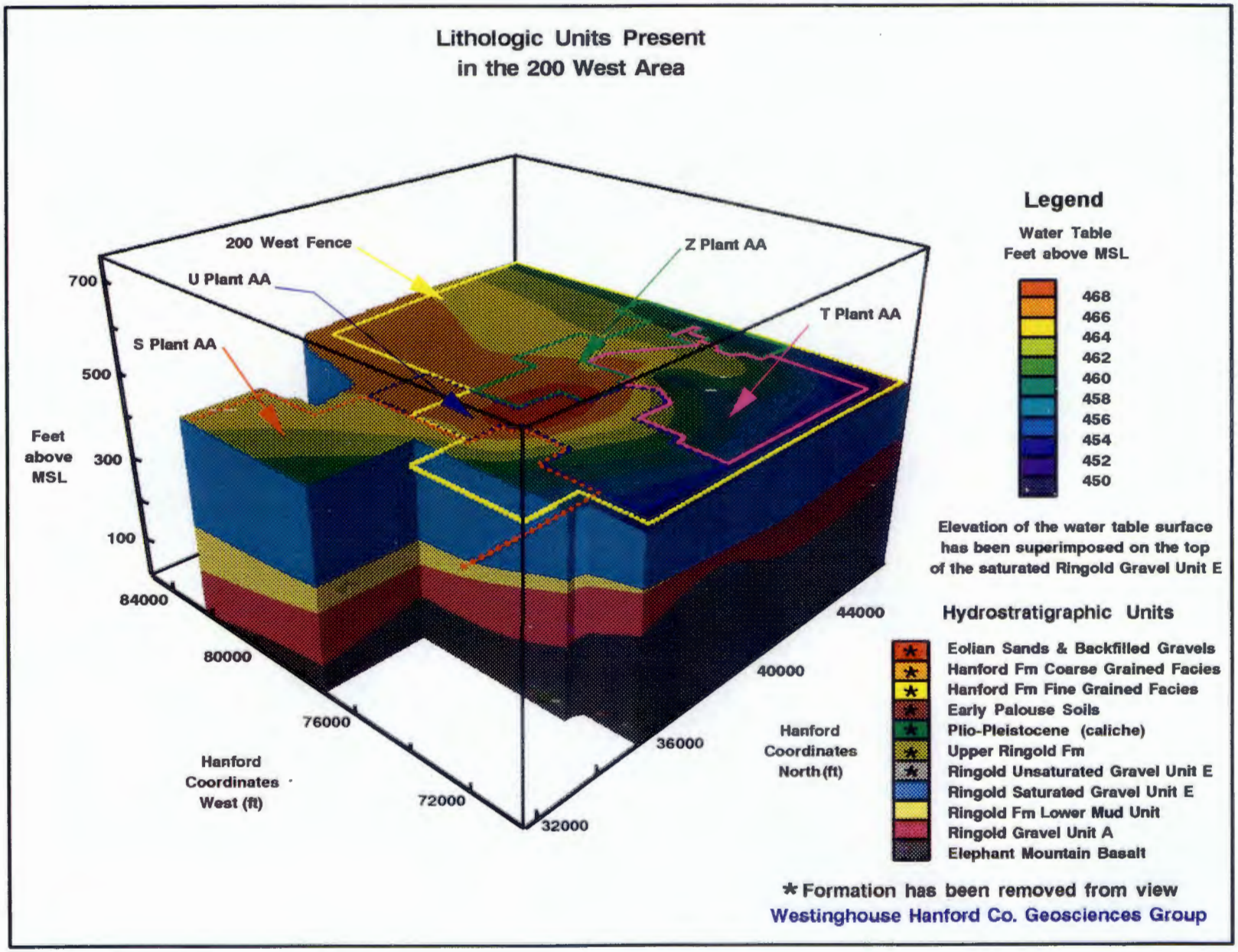


Figure 5-7. Elephant Mountain Basalt to Saturated Ringold Gravel Unit E.



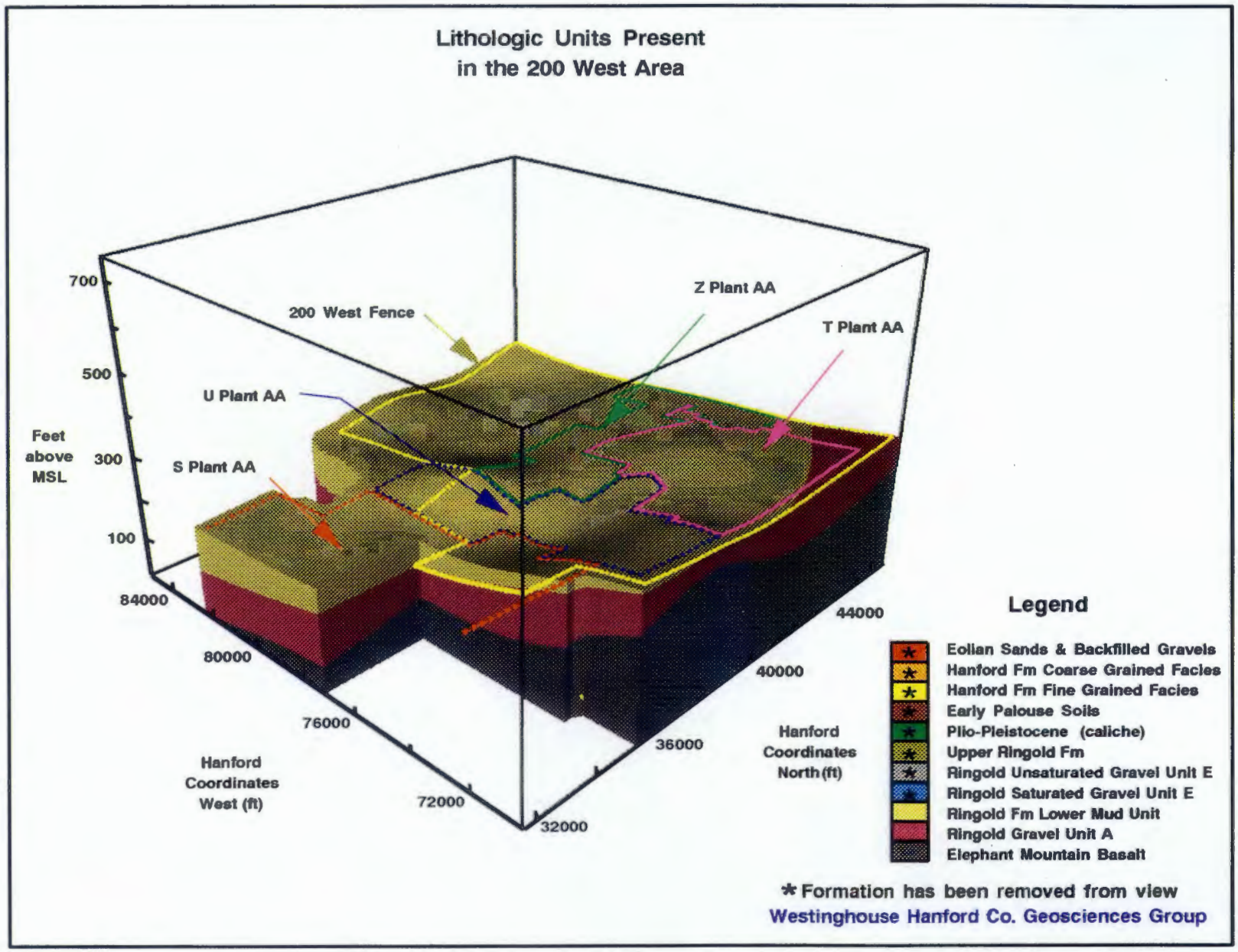


Figure 5-8. Elephant Mountain Basalt to Ringold Lower Mud Unit.

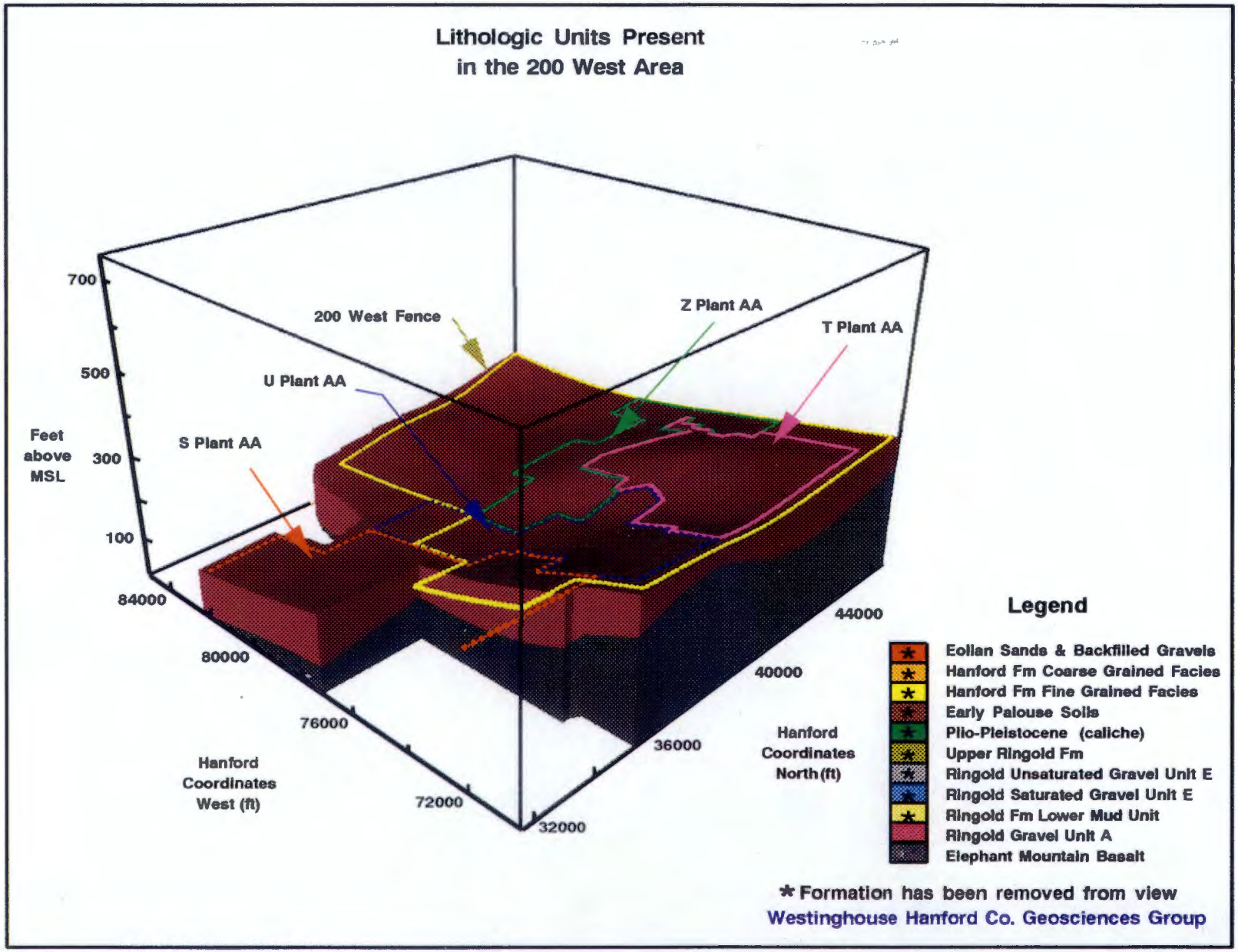


Figure 5-9. Elephant Mountain Basalt to Ringold Gravel Unit A.

Figure 5-10. Elephant Mountain Basalt with the Wells Used to Create Three-Dimensional Perspective.

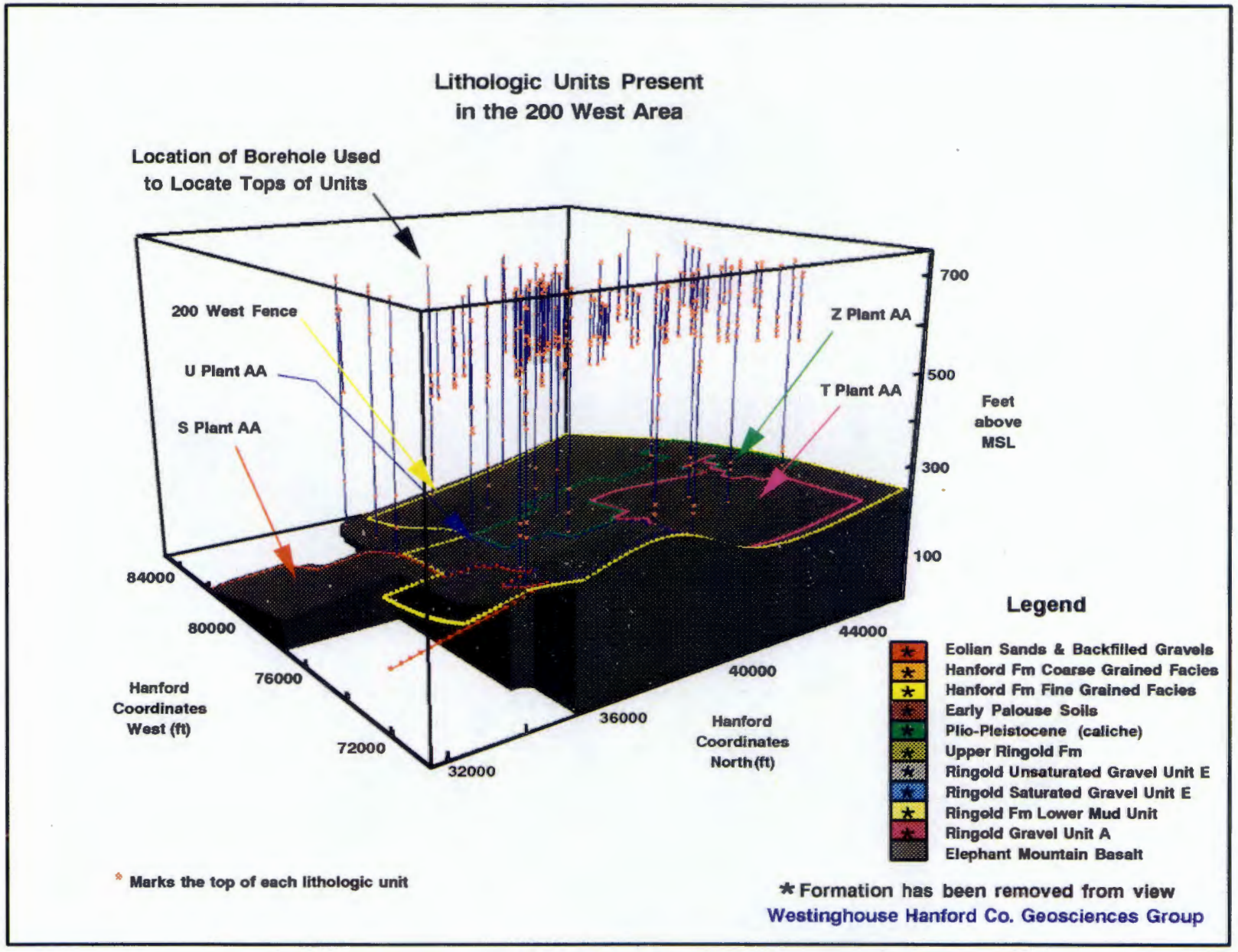


Figure 5-11. Water Table Elevations and Streamlines with Time Markers Overlain on the Hydraulic Conductivities for the 200 West Area.

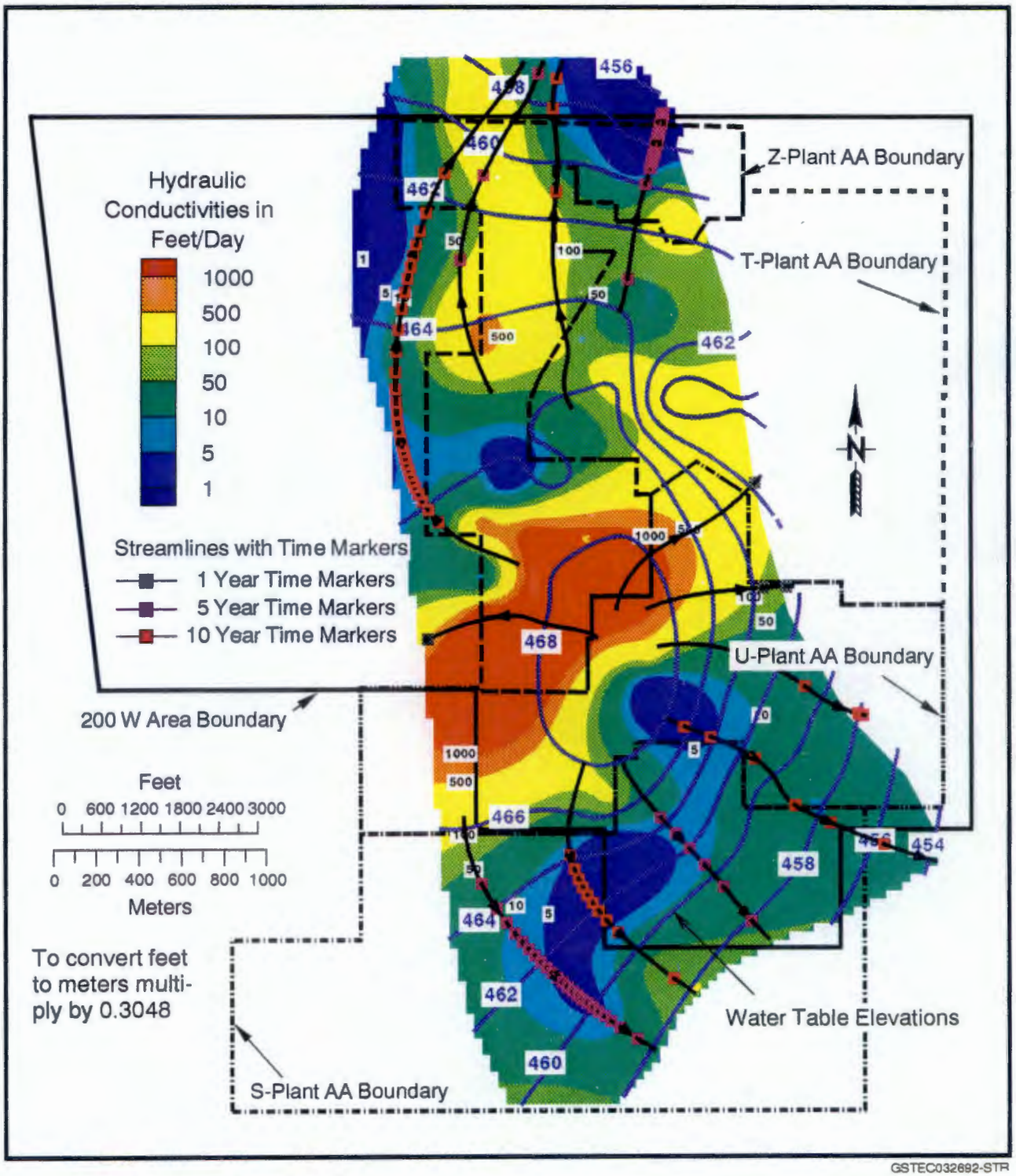


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Table 5-1. Travel Time Calculations for Several Samples from the Partially Saturated Zone.

			Drainage Curves			Imbibition Curves		
Unit	Sample No.	Thickness (cm)	Curve	Moisture Content	Calculated Travel Time	Curve	Moisture Content	Calculated Travel Time
Example 1								
Hanford (Coarse)	W7-9 3.1m	2804.16	D	0.175	981.5	I	0.118	661.8
Hanford (Fine)**	W15-2 30.5m	1615.44	D	0.149	481.4	I	0.109	352.2
Early Palouse	W7-9 21.6m	304.8	D	0.095	57.9	I	0.093	56.7
Plio-Pleistocene	W15-2 36.6m	304.8	D	0.24	146.3	I	0.213	129.8
Upper Ringold	W7-9 34.1m	457.2	D	0.177	161.8	I	0.107	97.8
Ringold Unit E	W7-2 47.1m	1341.12	D	0.18	482.7	D*	0.18	482.7
Total Travel Time in Years					2311.6			1781.0
Natural Recharge (flux in cm/yr) = 0.5								
Example 2								
Hanford (Coarse)	W10-13 13.7m	2804.16	D*	0.06	336.5	D*	0.06	336.5
Hanford (Fine)**	W15-2 30.5m	1615.44	D	0.149	481.4	I	0.109	352.2
Early Palouse	W7-9 21.6m	304.8	D	0.09	54.9	I	0.087	53
Plio-Pleistocene	W7-9 26.8m	304.8	D	0.14	85.3	I	0.11	67.1
Upper Ringold	W7-9 40.2m	457.2	D	0.085	77.7	I	0.075	68.6
Ringold Gravel E	W7-2 67.1m	1341.12	D*	0.127	340.6	D*	0.127	340.6
Total Travel Time in Years					1376.4			1218.0
Natural Recharge (flux in cm/yr) = 0.5								
Example 3								
Hanford (Coarse)	W7-9 3.1m	2804.16	D	0.208	116.7	I	0.12	67.3
Hanford (Fine)**	W15-2 30.5m	1615.44	D	0.193	62.4	I	0.136	43.9
Early Palouse	W7-9 21.0m	304.8	D	0.127	7.7	I	0.123	7.5
Plio-Pleistocene	W15-2 36.6m	304.8	D	0.315	19.2	I	0.285	17.4
Upper Ringold	W7-9 34.1m	457.2	D	0.222	20.3	I	0.132	12.1
Ringold Unit E	W7-2 47.1m	1341.12	D	0.133	59.3	D*	0.133	59.3
Total Travel Time in Years					285.6			207.5
Natural Recharge (flux in cm/yr) = 5.0								
Example 4								
Hanford (Coarse)	W10-13 13.7m	2804.16	D*	0.074	41.5	D*	0.074	41.5
Hanford (Fine)**	W15-2 30.5m	1615.44	D	0.193	62.4	I	0.136	43.9
Early Palouse	W7-9 21.6m	304.8	D	0.13	7.9	I	0.123	7.5
Plio-Pleistocene	W7-9 26.8m	304.8	D	0.19	11.6	I	0.148	9
Upper Ringold	W7-9 40.2m	457.2	D	0.115	10.5	I	0.1	9.1
Ringold Gravel E	W7-2 67.1m	1341.12	D*	0.143	38.3	D*	0.143	38.3
Total Travel Time in Years					172.2			149.3
Natural Recharge (flux in cm/yr) = 5.0								

Sample number follows the following format Well Identification Number followed by the depth (m) of sample
Curve Type D = Drainage, I = Imbibition
*No imbibition curves measured for this sample
**Only one sample was measured for this unit

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APPENDIX A

SUMMARY OF MOISTURE RETENTION DATA FOR THE WELLS IN 200 WEST AREA

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Ringold Gravel Unit E	Well 299-W7-2, 47.1 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.414	0.382	0.343	0.312	0.281	0.263	0.253	0.233	0.116	0.103	0.054
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.4617 Alpha = 0.1254/cm | N = 1.326 | K(sat) = 2.10E-02 cm/s										

Ringold Gravel Unit E	Well 299-W7-2, 67.1 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.239	0.231	0.219	0.201	0.175	0.166	0.157	0.15	0.124	0.122	0.08
van Genuchten Parameters	Resdual Moisture Content = 0.088 | Saturated Moisture Content = 0.262 | Alpha = 0.1045/cm | N = 1.4913 | K(sat) = 2.70E-03 cm										

Upper Ringold Fm	Well 299-W7-9, 29.9 m Depth, Sample 0-098 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2000	3000
Volumetric Water Content	0.351	0.35	0.349	0.348	0.234	0.161	0.147	0.112	0.094	0.072	0.057	0.053	0.044	0.054	0.053
van Genuchten Parameters	Resdual Moisture Content = 0.052 | Saturated Moisture Content = 0.351 | Alpha = 0.019/cm | N = 2.642 | K(sat) = 1.65E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 29.9 m Depth, Sample 0-098 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2000	3000
Volumetric Water Content	0.268	0.248	0.226	0.206	0.167	0.142	0.116	0.089	0.076	0.062	0.053	0.052	0.044	0.054	0.053
van Genuchten Parameters	Resdual Moisture Content = 0.052 | Saturated Moisture Content = 0.250 | Alpha = 0.021/cm | N = 2.642 | K(sat) = 5.89E-05 cm/s														

Upper Ringold Fm	Well 299-W7-9, 30.2 m Depth, Sample 0-099 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2000	5000
Volumetric Water Content	0.329	0.33	0.329	0.326	0.315	0.267	0.258	0.222	0.208	0.176	0.163	0.156	0.141	0.115	0.104
van Genuchten Parameters	Resdual Moisture Content = 0.101 | Saturated Moisture Content = 0.329 | Alpha = 0.012/cm | N = 1.789 | K(sat) = 1.65E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 30.2 m Depth, Sample 0-099 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2000	5000
Volumetric Water Content	0.29	0.284	0.276	0.271	0.254	0.234	0.212	0.194	0.182	0.164	0.15	0.149	0.141	0.115	0.104
van Genuchten Parameters	Resdual Moisture Content = 0.101 | Saturated Moisture Content = 0.285 | Alpha = 0.013/cm | N = 1.789 | K(sat) = 9.58E-05 cm/s														

Upper Ringold Fm	Well 299-W7-9, 31.7 m Depth, Sample 0-101 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2000	3000
Volumetric Water Content	0.371	0.192	0.153	0.14	0.125	0.11	0.102	0.09	0.082	0.068	0.059	0.056	0.05	0.075	0.069
van Genuchten Parameters	Resdual Moisture Content = 0.046 | Saturated Moisture Content = 0.371 | Alpha = 0.471/cm | N = 1.476 | K(sat) = 2.10E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 31.7 m Depth, Sample 0-101 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2000	3000
Volumetric Water Content	0.206	0.153	0.138	0.125	0.108	0.099	0.088	0.076	0.069	0.06	0.054	0.052	0.05	0.075	0.069
van Genuchten Parameters	Resdual Moisture Content = 0.046 | Saturated Moisture Content = 0.206 | Alpha = 0.155/cm | N = 1.476 | K(sat) = 3.59E-05 cm/s														

Upper Ringold Fm	Well 299-W7-9, 32.0 m Depth, Sample 0-102 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2000	3000
Volumetric Water Content	0.357	0.244	0.179	0.165	0.146	0.13	0.122	0.1	0.09	0.078	0.065	0.061	0.054	0.07	0.069
van Genuchten Parameters	Resdual Moisture Content = 0.045 | Saturated Moisture Content = 0.357 | Alpha = 0.199/cm | N = 1.514 | K(sat) = 2.10E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 32.0 m Depth, Sample 0-102 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2000	3000
Volumetric Water Content	0.245	0.163	0.147	0.134	0.114	0.104	0.096	0.084	0.075	0.065	0.059	0.057	0.054	0.07	0.069
van Genuchten Parameters	Resdual Moisture Content = 0.045 | Saturated Moisture Content = 0.244 | Alpha = 0.166/cm | N = 1.514 | K(sat) = 6.87E-05 cm/s														

Upper Ringold Fm	Well 299-W7-9, 34.1 m Depth, Sample 0-104 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2000	3000
Volumetric Water Content	0.41	0.218	0.156	0.14	0.126	0.115	0.111	0.097	0.091	0.085	0.079	0.078	0.073	0.032	0.034
van Genuchten Parameters	Resdual Moisture Content = 0.005 | Saturated Moisture Content = 0.410 | Alpha = 1.150/cm | N = 1.287 | K(sat) = 1.10E-03 cm/s														

Upper Ringold Fm	Well 299-W7-9, 34.1 m Depth, Sample 0-104 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2000	3000
Volumetric Water Content	0.21	0.146	0.13	0.119	0.109	0.103	0.097	0.091	0.088	0.078	0.077	0.075	0.073	0.032	0.034
van Genuchten Parameters	Resdual Moisture Content = 0.005 | Saturated Moisture Content = 0.205 | Alpha = 0.161/cm | N = 1.287 | K(sat) = 1.89E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 34.7 m Depth, Sample 0-105 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2000	3000
Volumetric Water Content	0.412	0.228	0.157	0.134	0.112	0.098	0.074	0.072	0.068	0.043	0.024	0.032	0.032	0.029	0.029
van Genuchten Parameters	Resdual Moisture Content = 0.012 | Saturated Moisture Content = 0.412 | Alpha = 0.289/cm | N = 1.530 | K(sat) = 1.10E-03 cm/s														

Upper Ringold Fm	Well 299-W7-9, 34.7 m Depth, Sample 0-105 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2000	3000
Volumetric Water Content	0.183	0.118	0.1	0.088	0.074	0.064	0.05	0.048	0.044	0.036	0.031	0.028	0.032	0.029	0.029
van Genuchten Parameters	Resdual Moisture Content = 0.012 | Saturated Moisture Content = 0.181 | Alpha = 0.139/cm | N = 1.530 | K(sat) = 1.29E-03 cm/s														

Upper Ringold Fm	Well 299-W7-9, 40.2 m Depth, Sample 0-107 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2100	3000
Volumetric Water Content	0.318	0.246	0.177	0.141	0.108	0.086	0.075	0.065	0.058	0.054	0.04	0.038	0.033	0.04	0.033
van Genuchten Parameters	Resdual Moisture Content = 0.032 | Saturated Moisture Content = 0.318 | Alpha = 0.094/cm | N = 1.840 | K(sat) = 3.00E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 40.2 m Depth, Sample 0-107 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2100	3000
Volumetric Water Content	0.226	0.16	0.128	0.105	0.086	0.072	0.062	0.052	0.047	0.04	0.036	0.036	0.033	0.04	0.033
van Genuchten Parameters	Resdual Moisture Content = 0.032 | Saturated Moisture Content = 0.225 | Alpha = 0.096/cm | N = 1.840 | K(sat) = 1.12E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 40.8 m Depth, Sample 0-108 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2100	3000
Volumetric Water Content	0.373	0.28	0.209	0.182	0.152	0.125	0.107	0.095	0.088	0.077	0.057	0.054	0.048	0.045	0.04
van Genuchten Parameters	Resdual Moisture Content = 0.027 | Saturated Moisture Content = 0.373 | Alpha = 0.129/cm | N = 1.552 | K(sat) = 3.00E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 40.8 m Depth, Sample 0-108 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2100	3000
Volumetric Water Content	0.252	0.192	0.168	0.146	0.119	0.101	0.087	0.074	0.067	0.058	0.052	0.051	0.048	0.045	0.04
van Genuchten Parameters	Resdual Moisture Content = 0.027 | Saturated Moisture Content = 0.252 | Alpha = 0.097/cm | N = 1.552 | K(sat) = 1.02E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 43.8 m Depth, Sample 0-113 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2100	3000
Volumetric Water Content	0.418	0.36	0.177	0.14	0.113	0.083	0.073	0.065	0.06	0.055	0.038	0.036	0.028	0.034	0.03
van Genuchten Parameters	Resdual Moisture Content = 0.041 | Saturated Moisture Content = 0.418 | Alpha = 0.077/cm | N = 2.387 | K(sat) = 1.80E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 43.8 m Depth, Sample 0-113 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2100	3000
Volumetric Water Content	0.239	0.151	0.114	0.097	0.078	0.066	0.06	0.051	0.045	0.038	0.031	0.031	0.028	0.034	0.03
van Genuchten Parameters	Resdual Moisture Content = 0.041 | Saturated Moisture Content = 0.235 | Alpha = 0.068/cm | N = 2.387 | K(sat) = 3.40E-05 cm/s														

Upper Ringold Fm	Well 299-W7-9, 42.7 m Depth, Sample 0-114 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	2100	5000
Volumetric Water Content	0.407	0.395	0.202	0.158	0.127	0.109	0.094	0.085	0.074	0.064	0.044	0.039	0.029	0.043	0.031
van Genuchten Parameters	Resdual Moisture Content = 0.048 | Saturated Moisture Content = 0.407 | Alpha = 0.066/cm | N = 2.327 | K(sat) = 1.80E-04 cm/s														

Upper Ringold Fm	Well 299-W7-9, 42.7 m Depth, Sample 0-114 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	2100	5000
Volumetric Water Content	0.25	0.171	0.141	0.114	0.091	0.078	0.072	0.055	0.05	0.043	0.036	0.035	0.029	0.043	0.031
van Genuchten Parameters	Resdual Moisture Content = 0.048 | Saturated Moisture Content = 0.244 | Alpha = 0.075/cm | N = 2.327 | K(sat) = 3.96E-04 cm/s														

Upper Ringold	Well 299-W7-2, 28.8 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.401	0.367	0.34	0.298	0.224	0.199	0.184	0.129	0.064	0.06	0.032
van Genuchten Parameters	Resdual Moisture Content = 0.043 | Saturated Moisture Content = 0.417 | Alpha = 0.056/cm | N = 1.968 | K(sat) = 3.70E-02 cm/s										

Plio-Pleistocene (caliche)	Well 299-W7-9, 24.4 m Depth, Sample 0-082 Drainage Data														
Matric Potential (-cm)	0	10	20	30	51	71	100	150	195	300	400	540	700	840	990
Volumetric Water Content	0.516	0.469	0.447	0.431	0.397	0.389	0.363	0.322	0.307	0.284	0.273	0.26	0.25	0.239	0.229
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.516 | Alpha = 0.062/cm | N = 1.196 | K(sat) = 6.30E-05 cm/s														

Plio-Pleistocene (caliche) Well 299-W7-9, 24.4 m Depth, Sample 0-082 Imbibition Data															
Matric Potential (-cm)	0	10	20	30	51	72	100	160	200	300	400	540	700	850	990
Volumetric Water Content	0.38	0.364	0.35	0.343	0.329	0.317	0.302	0.287	0.275	0.261	0.252	0.245	0.24	0.236	0.229
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.366 | Alpha = 0.015/cm | N = 1.196 | K(sat) = 2.66E-05 cm/s														

Plio-Pleistocene (caliche) Well 299-W7-9, 25.0 m Depth, Sample 0-083 Drainage Data															
Matric Potential (-cm)	0	10	20	30	51	71	100	150	195	300	400	540	700	840	990
Volumetric Water Content	0.475	0.456	0.428	0.415	0.403	0.392	0.386	0.339	0.311	0.243	0.211	0.186	0.171	0.16	0.156
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.475 | Alpha = 0.012/cm | N = 1.457 | K(sat) = 6.30E-05 cm/s														

Plio-Pleistocene (caliche) Well 299-W7-9, 25.0 m Depth, Sample 0-083 Imbibition Data															
Matric Potential (-cm)	0	10	20	30	51	72	100	160	200	300	400	540	700	850	990
Volumetric Water Content	0.39	0.38	0.37	0.363	0.347	0.332	0.297	0.257	0.233	0.2	0.182	0.172	0.163	0.158	0.156
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.385 | Alpha = 0.011/cm | N = 1.457 | K(sat) = 3.72E-05 cm/s														

Plio-Pleistocene (caliche) Well 299-W7-9, 26.8 m Depth, Sample 0-085 Drainage Data															
Matric Potential (-cm)	0	10	20	30	51	71	100	150	195	300	400	540	700	840	990
Volumetric Water Content	0.335	0.29	0.274	0.274	0.273	0.244	0.238	0.206	0.188	0.152	0.129	0.113	0.102	0.089	0.086
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.335 | Alpha = 0.024/cm | N = 1.397 | K(sat) = 1.30E-04 cm/s														

Plio-Pleistocene (caliche) Well 299-W7-9, 26.8 m Depth, Sample 0-085 Imbibition Data															
Matric Potential (-cm)	0	10	20	30	51	72	100	160	200	300	400	540	700	850	990
Volumetric Water Content	0.233	0.225	0.219	0.213	0.204	0.194	0.174	0.153	0.14	0.12	0.107	0.099	0.092	0.088	0.086
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.232 | Alpha = 0.015/cm | N = 1.397 | K(sat) = 5.19E-05 cm/s														

Plio-Pleistocene Well 299-W15-2, 36.6m Depth, Sample 0-171 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	9900
Volumetric Water Content	0.365	0.364	0.365	0.364	0.362	0.365	0.337	0.299	0.272	0.247	0.214	0.203	0.145	0.091
van Genuchten Parameters	Resdual Moisture Content = 0.078 | Saturated Moisture Content = 0.365 | Alpha = 0.005/cm | N = 1.772 | K(sat) = 1.3E-06 cm/s													

Plio-Pleistocene Well 299-W15-2, 36.6 m Depth, Sample 0-171 Imbibition Data														
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000	9900
Volumetric Water Content	0.327	0.323	0.312	0.308	0.303	0.296	0.272	0.249	0.235	0.225	0.199	0.193	0.145	0.09
van Genuchten Parameters	Resdual Moisture Content = 0.078 | Saturated Moisture Content = 0.312 | Alpha = 0.005/cm | N = 1.772 | K(sat) = 7.85E-07 cm/s													

Plio-Pleistocene Well 299-W7-2, 19.8 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	50	75	501	1020	3060
Volumetric Water Content	0.478	0.415	0.377	0.329	0.297	0.265	0.241	0.15	0.139	0.097
van Genuchten Parameters	Resdual Moisture Content = 0.054 | Saturated Moisture Content = 0.6292 | Alpha = 0.36/cm | N = 1.3444 | K(sat) = 6.80E-02 cm/s									

Early Palouse Soils	Well 299-W7-9, 21.0 m Depth, Sample 0-079 Drainage Data													
Matric Potential (-cm)	0	10	20	30	51	71	100	150	195	300	540	700	840	990
Volumetric Water Content	0.449	0.45	0.449	0.445	0.442	0.438	0.43	0.414	0.357	0.21	0.128	0.11	0.092	0.088
van Genuchten Parameters	Resdual Moisture Content = 0.060 | Saturated Moisture Content = 0.449 | Alpha = 0.004/cm | N = 3.145 | K(sat) = 1.40E-04 cm/s													

Early Palouse Soils	Well 299-W7-9, 21.0 m Depth, Sample 0-079 Imbibition Data														
Matric Potential (-cm)	0	10	20	30	51	72	100	160	200	300	400	540	700	850	990
Volumetric Water Content	0.397	0.382	0.377	0.372	0.364	0.355	0.328	0.264	0.221	0.153	0.124	0.106	0.096	0.089	0.088
van Genuchten Parameters	Resdual Moisture Content = 0.060 | Saturated Moisture Content = 0.375 | Alpha = 0.006/cm | N = 3.145 | K(sat) = 8.27E-05 cm/s														

Early Palouse Soils	Well 299-W7-9, 21.6 m Depth, Sample 0-080 Drainage Data														
Matric Potential (-cm)	0	10	20	30	51	71	100	150	195	300	400	540	700	840	990
Volumetric Water Content	0.509	0.494	0.456	0.455	0.453	0.453	0.452	0.342	0.246	0.124	0.102	0.088	0.078	0.055	0.054
van Genuchten Parameters	Resdual Moisture Content = 0.045 | Saturated Moisture Content = 0.509 | Alpha = 0.007/cm | N = 2.981 | K(sat) = 1.40E-04 cm/s														

Early Palouse Soils	Well 299-W7-9, 21.6 m Depth, Sample 0-080 Imbibition Data														
Matric Potential (-cm)	0	10	20	30	51	72	100	160	200	300	400	540	700	850	990
Volumetric Water Content	0.417	0.406	0.395	0.386	0.371	0.345	0.249	0.157	0.127	0.086	0.07	0.061	0.056	0.054	0.054
van Genuchten Parameters	Resdual Moisture Content = 0.045 | Saturated Moisture Content = 0.405 | Alpha = 0.010/cm | N = 2.981 | K(sat) = 7.39E-05 cm/s														

Hanford formation (fine)	Well 299-W15-2, 30.5 m Depth, Sample 0-170 Drainage Data												
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000
Volumetric Water Content	0.427	0.403	0.264	0.22	0.189	0.173	0.165	0.159	0.15	0.116	0.113	0.109	0.072
van Genuchten Parameters	Resdual Moisture Content = 0.041 | Saturated Moisture Content = 0.427 | Alpha = 0.107/cm | N = 1.473 | K(sat) = 7.70E-04 cm/s												

Hanford formation (fine)	Well 299-W15-2, 30.5 m Depth, Sample 0-170 Imbibition Data												
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000
Volumetric Water Content	0.23	0.176	0.152	0.136	0.123	0.113	0.103	0.095	0.089	0.084	0.075	0.075	0.072
van Genuchten Parameters	Resdual Moisture Content = 0.041 | Saturated Moisture Content = 0.227 | Alpha = 0.106/cm | N = 1.473 | K(sat) = 1.25E-04 cm/s												

Hanford formation (coarse)	Well 299-W7-9, 3.1 m Depth, Sample 0-069 Drainage Data														
Matric Potential (-cm)	0	10	20	30	51	71	100	150	195	300	400	540	700	840	990
Volumetric Water Content	0.372	0.278	0.25	0.239	0.234	0.228	0.229	0.193	0.183	0.169	0.157	0.146	0.128	0.113	0.104
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.372 | Alpha = 0.270/cm | N = 1.189 | K(sat) = 1.20E-02 cm/s														

Hanford formation (coarse)	Well 299-W7-9, 3.1 m Depth, Sample 0-069 Imbibition Data														
Matric Potential (-cm)	0	10	20	30	51	72	100	160	200	300	400	540	700	850	990
Volumetric Water Content	0.198	0.189	0.184	0.179	0.177	0.162	0.155	0.149	0.141	0.134	0.124	0.119	0.112	0.107	0.104
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.197 | Alpha = 0.026/cm | N = 1.189 | K(sat) = 2.45E-03 cm/s														

Hanford formation (coarse)	Well 299-W7-9, 3.4 m Depth, Sample 0-070-4 Drainage Data														
Matric Potential (-cm)	0	10	20	30	51	71	100	150	195	300	400	540	700	840	990
Volumetric Water Content	0.341	0.263	0.228	0.221	0.213	0.203	0.201	0.172	0.161	0.142	0.129	0.116	0.105	0.093	0.091
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.341 | Alpha = 0.190/cm | N = 1.223 | K(sat) = 1.20E-02 cm/s														

Hanford formation (coarse)	Well 299-W7-9, 3.4 m Depth, Sample 0-070-4 Imbibition Data														
Matric Potential (-cm)	0	10	20	30	51	72	100	160	200	300	400	540	700	850	990
Volumetric Water Content	0.193	0.162	0.175	0.166	0.16	0.155	0.146	0.137	0.13	0.119	0.109	0.104	0.097	0.093	0.091
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.189 | Alpha = 0.026/cm | N = 1.223 | K(sat) = 2.73E-03 cm/s														

Hanford formation (coarse)	Well 299-W7-9, 19.8 m Depth, Sample 0-072 Drainage Data														
Matric Potential (-cm)	0	10	20	30	51	71	100	150	195	300	400	540	700	840	990
Volumetric Water Content	0.534	0.471	0.428	0.426	0.417	0.416	0.416	0.287	0.244	0.187	0.165	0.142	0.124	0.108	0.103
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.534 | Alpha = 0.018/cm | N = 1.555 | K(sat) = 7.00E-06 cm/s														

Hanford formation (coarse)	Well 299-W7-9, 19.8 m Depth, Sample 0-072 Imbibition Data														
Matric Potential (-cm)	0	10	20	30	51	72	100	160	200	300	400	540	700	850	990
Volumetric Water Content	0.384	0.373	0.36	0.349	0.331	0.301	0.249	0.202	0.178	0.147	0.13	0.118	0.11	0.104	0.103
van Genuchten Parameters	Resdual Moisture Content = 0.000 | Saturated Moisture Content = 0.385 | Alpha = 0.016/cm | N = 1.555 | K(sat) = 3.09E-06 cm/s														

Hanford formation (coarse)	Well 299-W10-13, 12.2 m Depth, Sample 0-168 Drainage Data												
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000
Volumetric Water Content	0.383	0.364	0.203	0.166	0.131	0.107	0.092	0.083	0.073	0.066	0.057	0.055	0.051
van Genuchten Parameters	Resdual Moisture Content = 0.062 | Saturated Moisture Content = 0.3827 Alpha = 0.0633/cm | N = 2.4706 | K(sat) = 1.40E-05 cm												

Hanford formation (coarse)	Well 299-W10-13, 12.2 m Depth, Sample 0-168 Imbibition Data												
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000
Volumetric Water Content	0.261	0.177	0.148	0.125	0.106	0.093	0.078	0.069	0.065	0.062	0.054	0.057	0.051
van Genuchten Parameters	Resdual Moisture Content = 0.062 | Saturated Moisture Content = 0.2529 Alpha = 0.0747/cm | N = 2.4706 | K(sat) = 3.83E-06 cm												

Hanford formation (coarse)	Well 299-W10-13, 18.3 m Depth, Sample 0-169 Drainage Data														
Matric Potential (-cm)	0	10	21	31	48	74	103	154	203	300	500	650	1000	4900	9900
Volumetric Water Content	0.342	0.237	0.19	0.165	0.136	0.093	0.077	0.063	0.055	0.046	0.038	0.035	0.031	0.038	0.037
van Genuchten Parameters	Resdual Moisture Content = 0.023 | Saturated Moisture Content = 0.342 | Alpha = 0.114/cm | N = 1.683 | K(sat) = 1.10E-05 cm/s														

Hanford formation (coarse)	Well 299-W10-13, 18.3 m Depth, Sample 0-169 Imbibition Data												
Matric Potential (-cm)	0	12	21	31	49	73	100	150	200	300	500	700	1000
Volumetric Water Content	0.194	0.151	0.126	0.112	0.095	0.08	0.061	0.05	0.046	0.043	0.032	0.032	0.031
van Genuchten Parameters	Resdual Moisture Content = 0.023 | Saturated Moisture Content = 0.193 | Alpha = 0.078/cm | N = 1.683 | K(sat) = 2.27E-5 cm/s												

Hanford fm (coarse)	Well 299-W7-9, 3.1 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.352	0.322	0.299	0.274	0.254	0.244	0.236	0.221	0.116	0.114	0.087
van Genuchten Parameters	Resdual Moisture Content = 0.00 | Saturated Moisture Content = 0.3924 | Alpha = 0.157/cm | N = 1.251 | K(sat) = 1.60E-02 cm/s										

Hanford formation (coarse)	Well 299-W10-13, 13.7 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.378	0.374	0.347	0.302	0.256	0.218	0.19	0.142	0.052	0.049	0.04
van Genuchten Parameters	Resdual Moisture Content = 0.040 | Saturated Moisture Content = 0.392 | Alpha = 0.041/cm | N = 2.167 | K(sat) = 1.10E-02 cm/s										

Hanford formation (coarse)	Well 299-W10-13, 24.4 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.404	0.363	0.328	0.301	0.272	0.258	0.249	0.233	0.165	0.159	0.127
van Genuchten Parameters	Resdual Moisture Content = 0.102 | Saturated Moisture Content = 0.496 | Alpha = 0.279/cm | N = 1.371 | K(sat) = 2.70E-02 cm/s										

Hanford fm (coarse)	Well 299-W15-16, 12.2 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.405	0.372	0.33	0.281	0.217	0.187	0.169	0.158	0.064	0.056	0.04
van Genuchten Parameters	Resdual Moisture Content = 0.042 | Saturated Moisture Content = 0.438 | Alpha = 0.074/cm | N = 1.819 | K(sat) = 3.60E-02 cm/s										

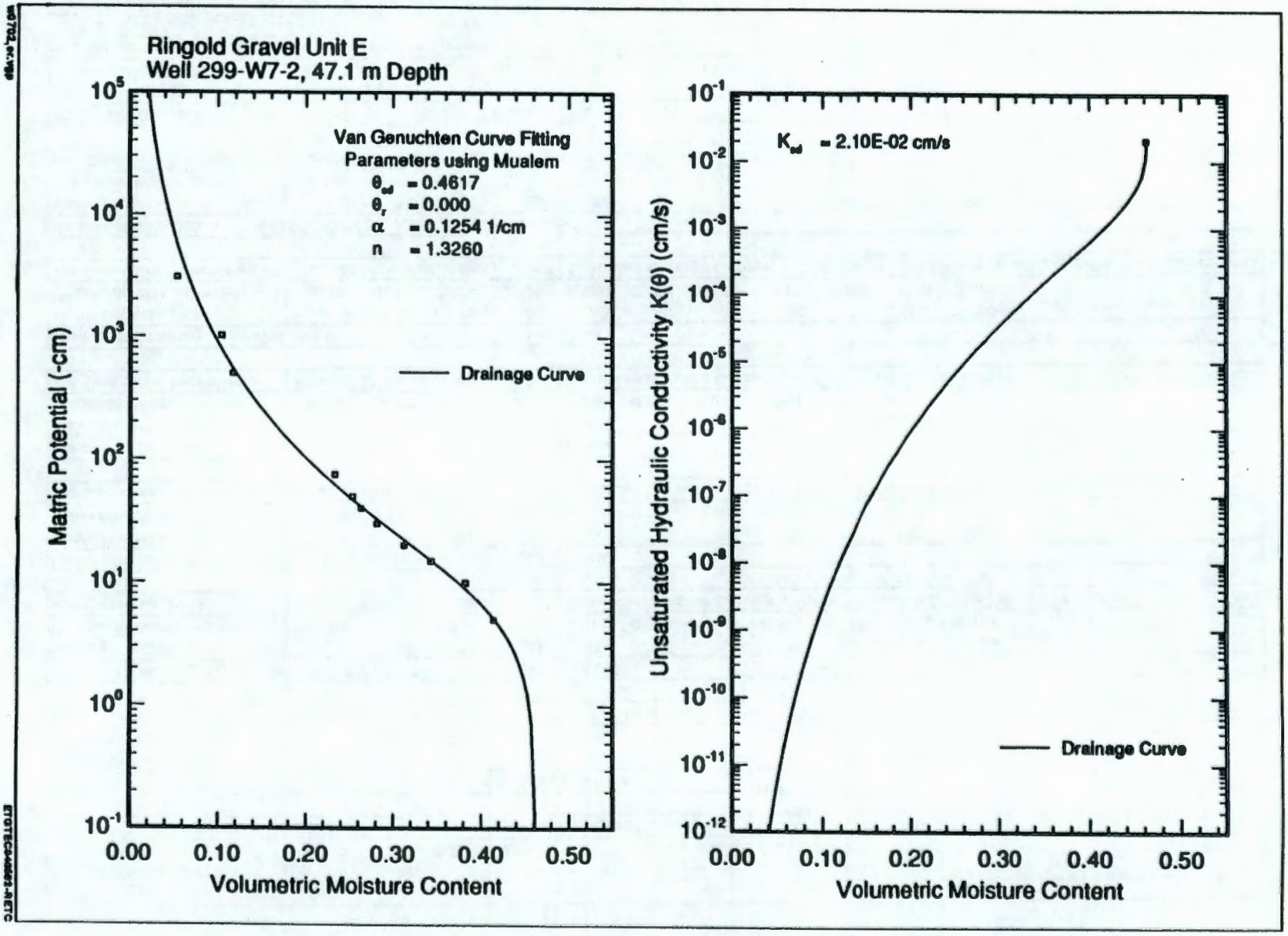
Hanford fm (coarse)	Well 299-W15-16, 33.5 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.334	0.31	0.287	0.271	0.239	0.225	0.219	0.204	0.117	0.111	0.078
van Genuchten Parameters	Resdual Moisture Content = 0.019 | Saturated Moisture Content = 0.3719 Alpha = 0.1368/cm | N = 1.289 | K(sat) = 1.10E-02 cm/s										

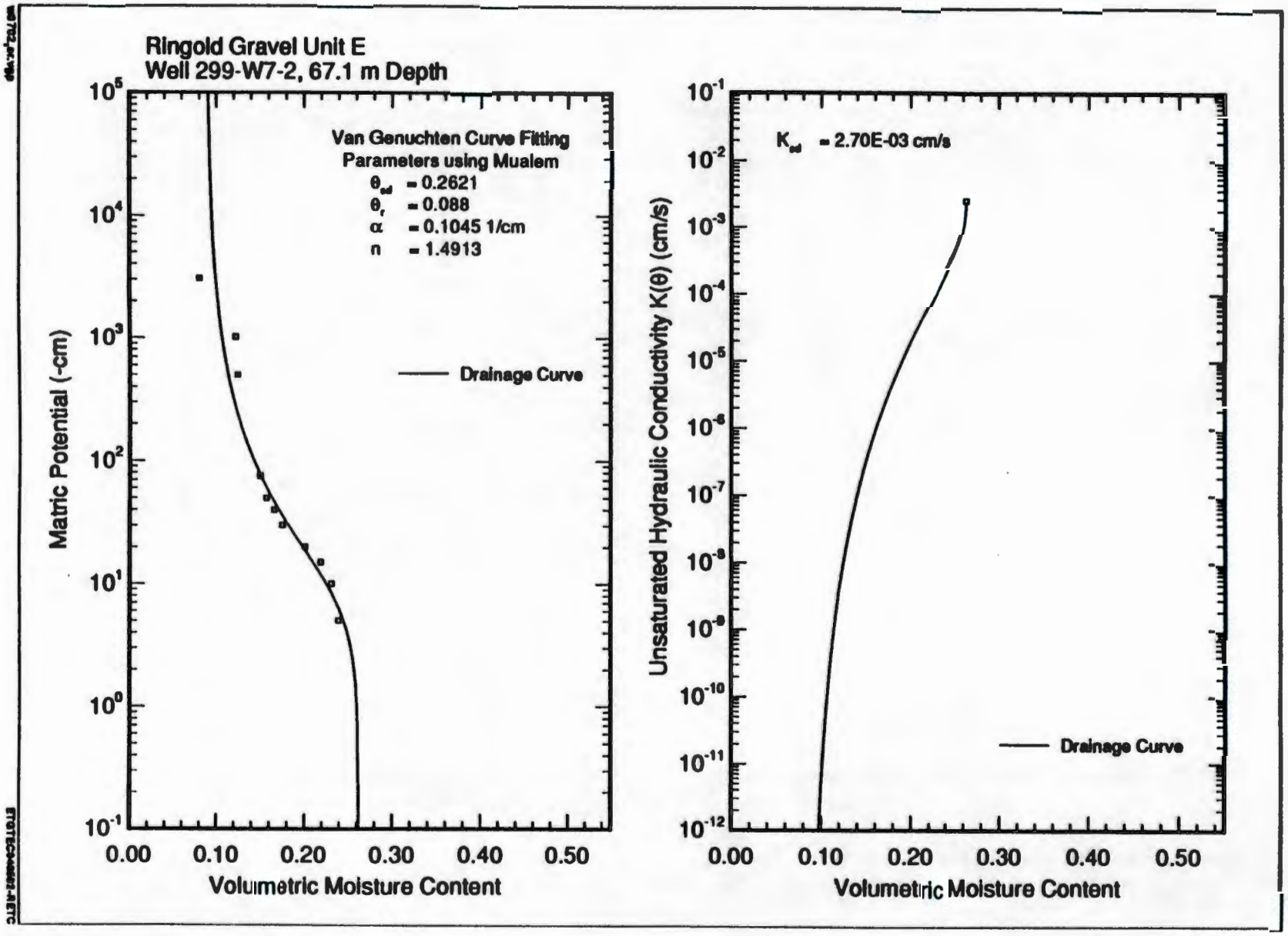
Hanford fm (coarse)	Well 299-W18-21, 7.6 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.293	0.251	0.224	0.206	0.188	0.183	0.174	0.17	0.086	0.08	0.076
van Genuchten Parameters	Resdual Moisture Content = 0.008 | Saturated Moisture Content = 0.5083 Alpha = 1.866/cm | N = 1.247 | K(sat) = 5.50E-02 cm/s										

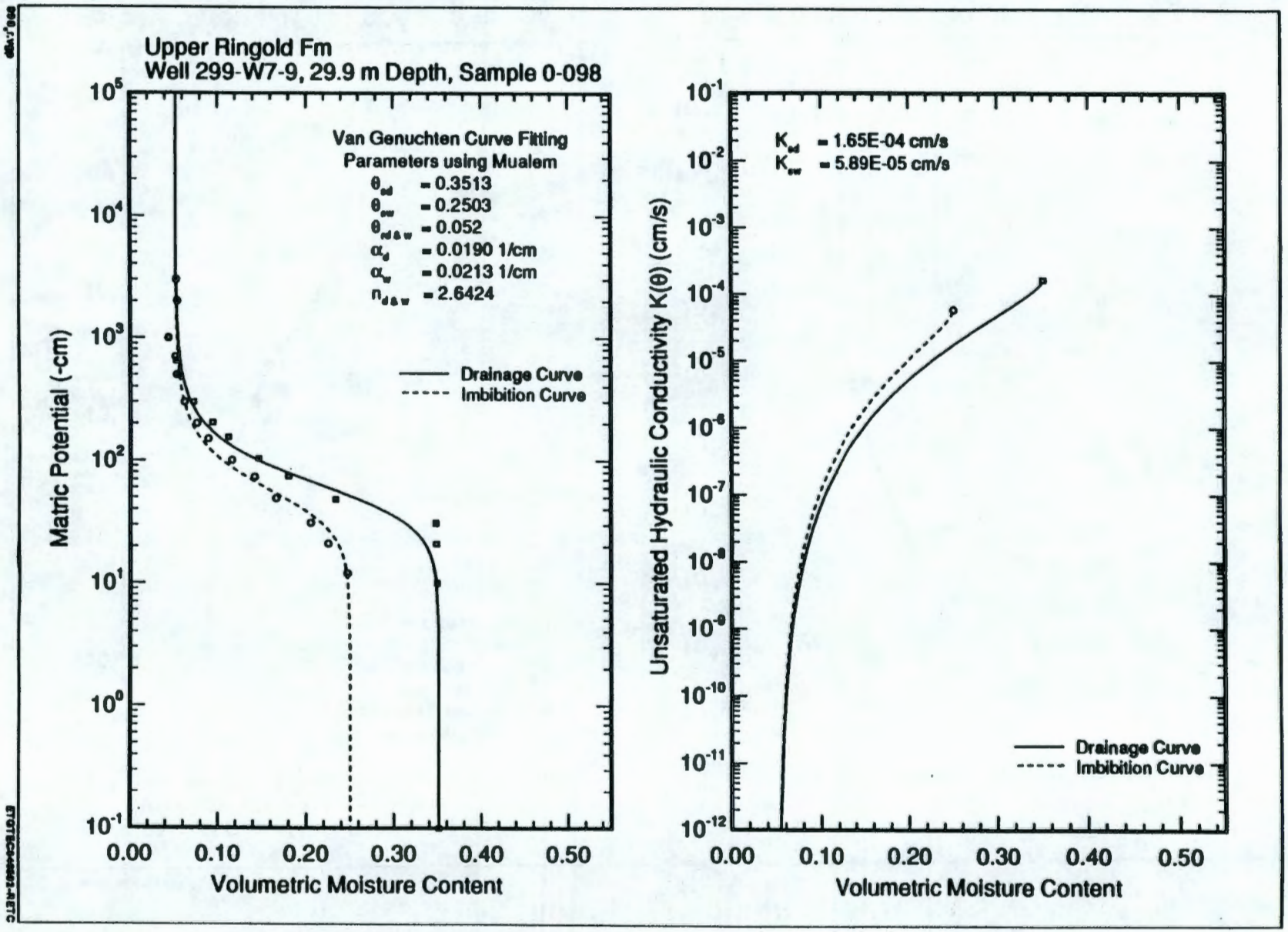
Hanford fm (coarse)	Well 299-W18-21, 12.2 m Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.405	0.382	0.374	0.347	0.31	0.273	0.288	0.169	0.092	0.09	0.067
van Genuchten Parameters	Resdual Moisture Content = 0.073 | Saturated Moisture Content = 0.399 | Alpha = 0.029/cm | N = 2.135 | K(sat) = 1.10E-02 cm/s										

Hanford fm (coarse)	Well 299-W18-21, 25 ft Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.293	0.251	0.224	0.206	0.188	0.183	0.174	0.17	0.086	0.08	0.076
van Genuchten Parameters	Resdual Moisture Content = 0.051 | Saturated Moisture Content = 0.293 | Alpha = 0.093/cm | N = 1.438 | K(sat) = 5.50E-02 cm/s										

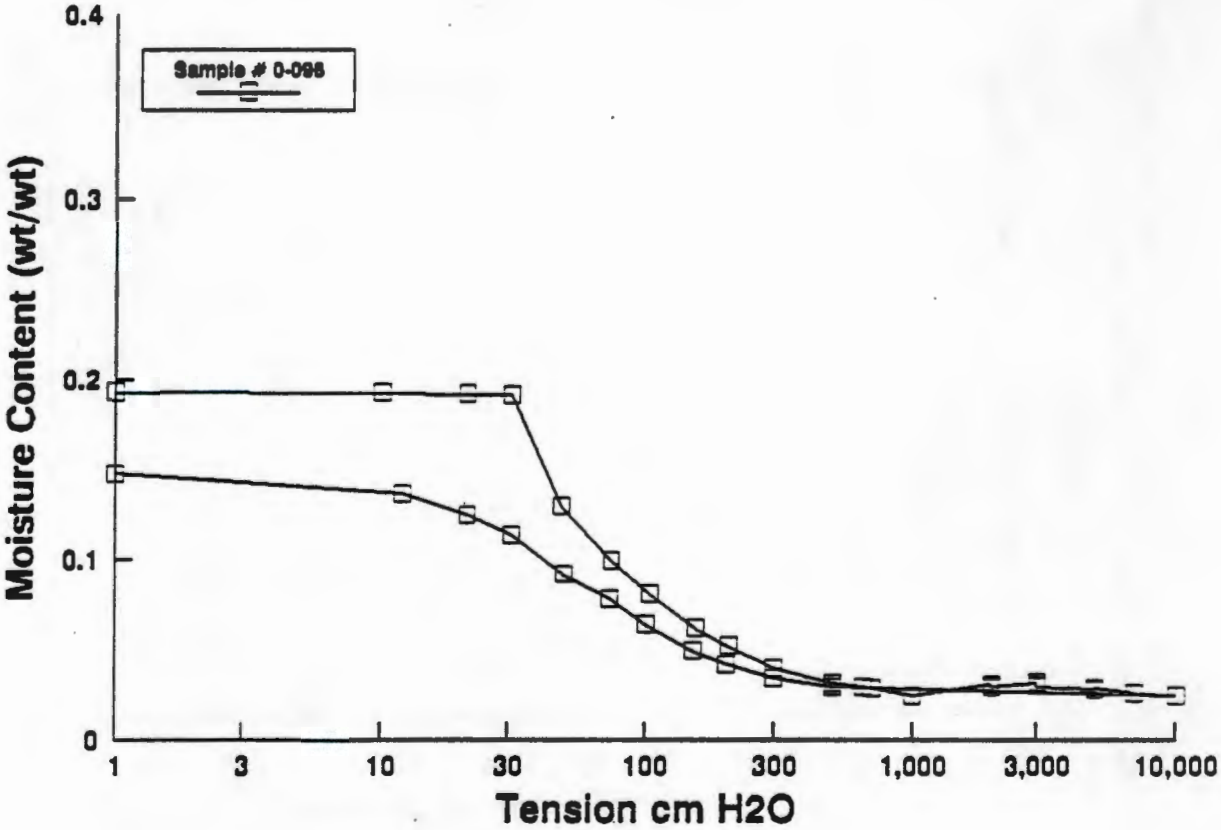
Hanford fm (coarse)	Well 299-W18-21, 40 ft Depth Drainage Data										
Matric Potential (-cm)	5	10	15	20	30	40	50	75	501	1020	3060
Volumetric Water Content	0.405	0.382	0.374	0.347	0.31	0.273	0.288	0.169	0.092	0.09	0.067
van Genuchten Parameters	Resdual Moisture Content = 0.040 | Saturated Moisture Content = 0.405 | Alpha = 0.035/cm | N = 1.701 | K(sat) = 1.10E-02 cm/s										


Ringold Gravel Unit E
Well 299-W7-2, 47.1 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsat = 0.4617
θr = 0.000
α = 0.1254 1/cm
n = 1.3260
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksat = 2.10E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content


Ringold Gravel Unit E
Well 299-W7-2, 67.1 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsat = 0.2621
θr = 0.088
α = 0.1045 1/cm
n = 1.4913
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksat = 2.70E-03 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content

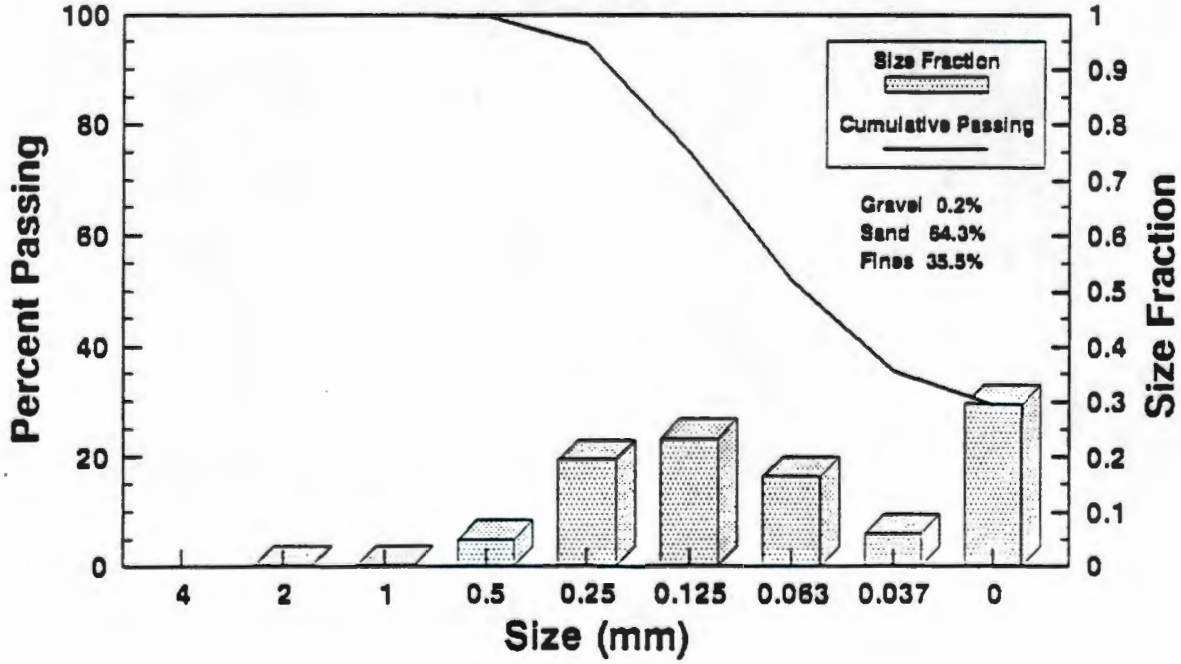

Upper Ringold Fm
Well 299-W7-9, 29.9 m Depth, Sample 0-098
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3513
θsw = 0.2503
θrd&w = 0.052
αd = 0.0190 1/cm
αw = 0.0213 1/cm
nd&w = 2.6424
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.65E-04 cm/s
Ksw = 5.89E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

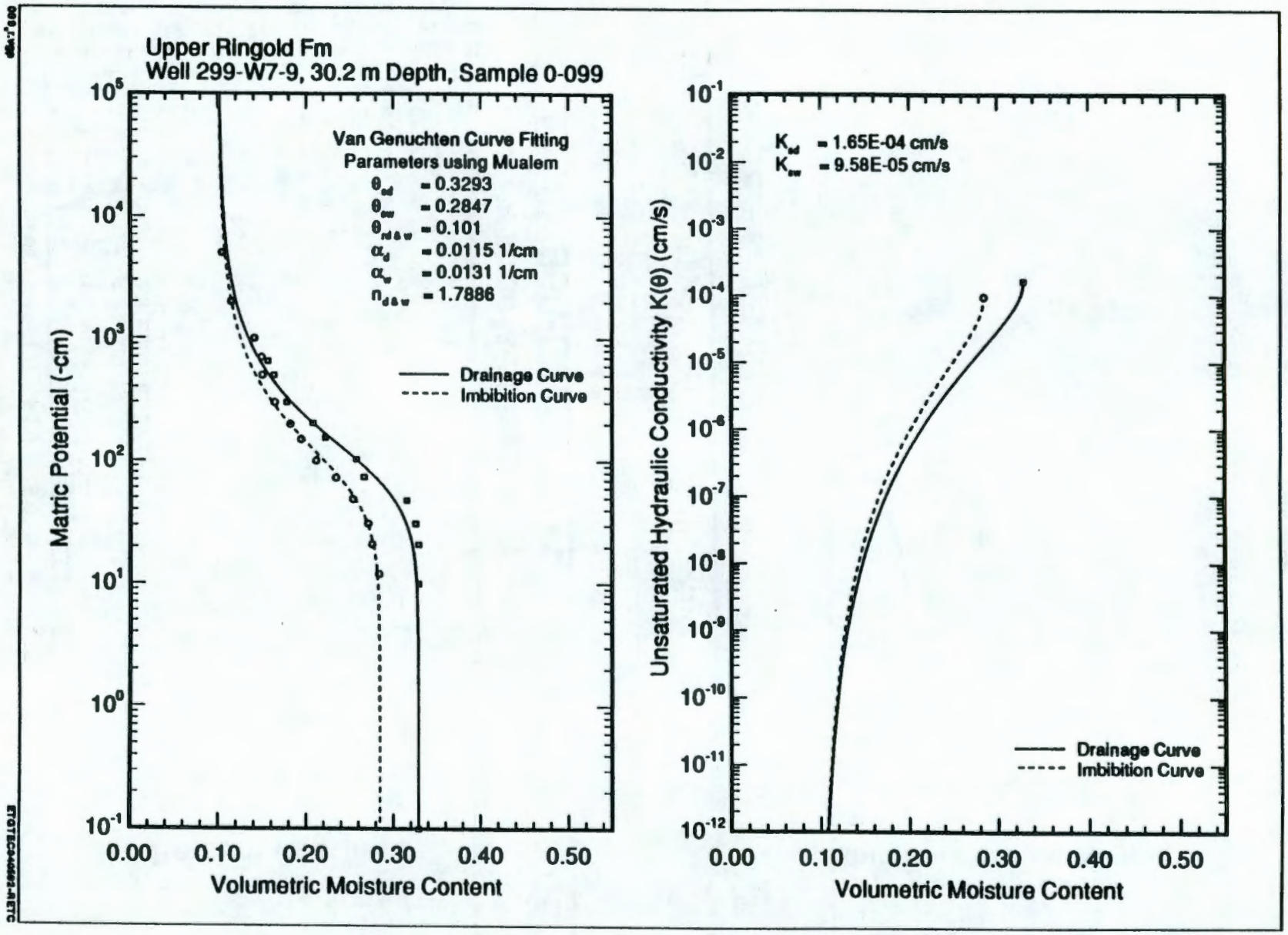
9413136.1955

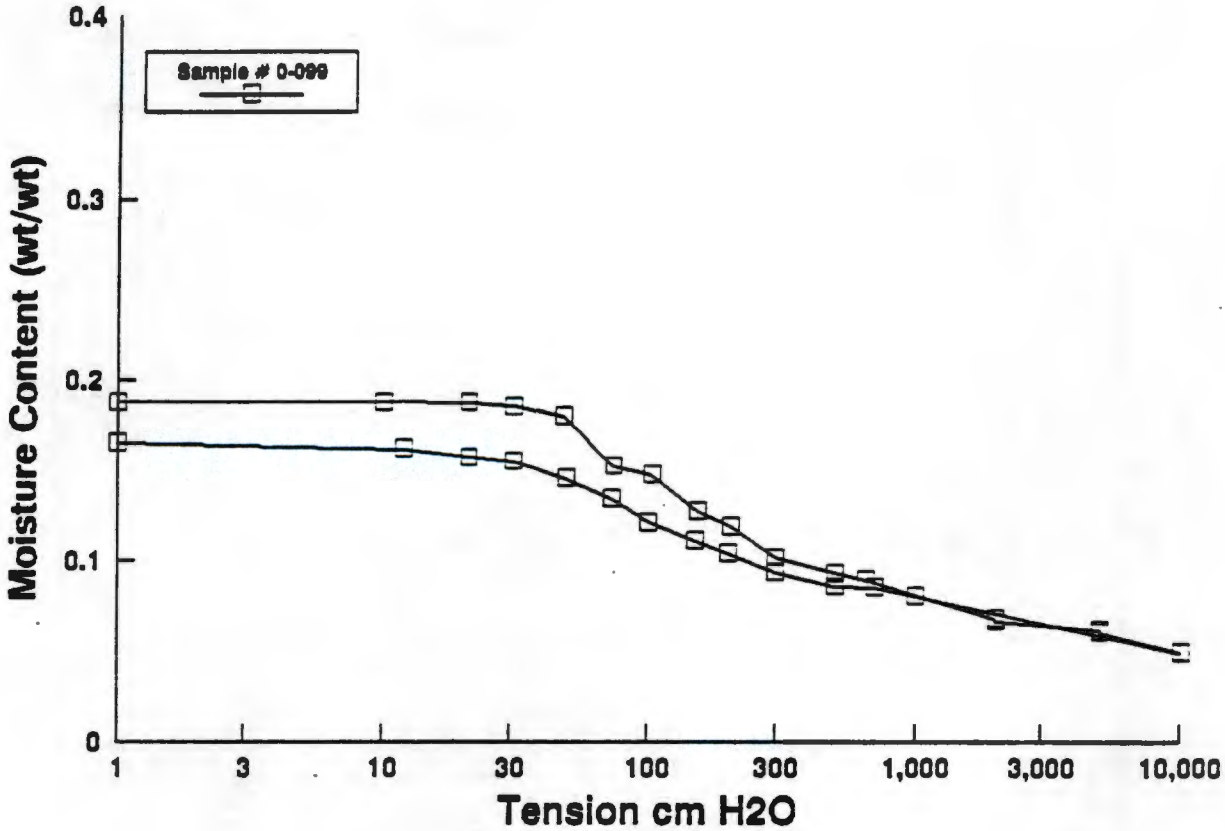


ETAL NO. 0-098

WELL NO. 299-W7-9; 98.25 ft.

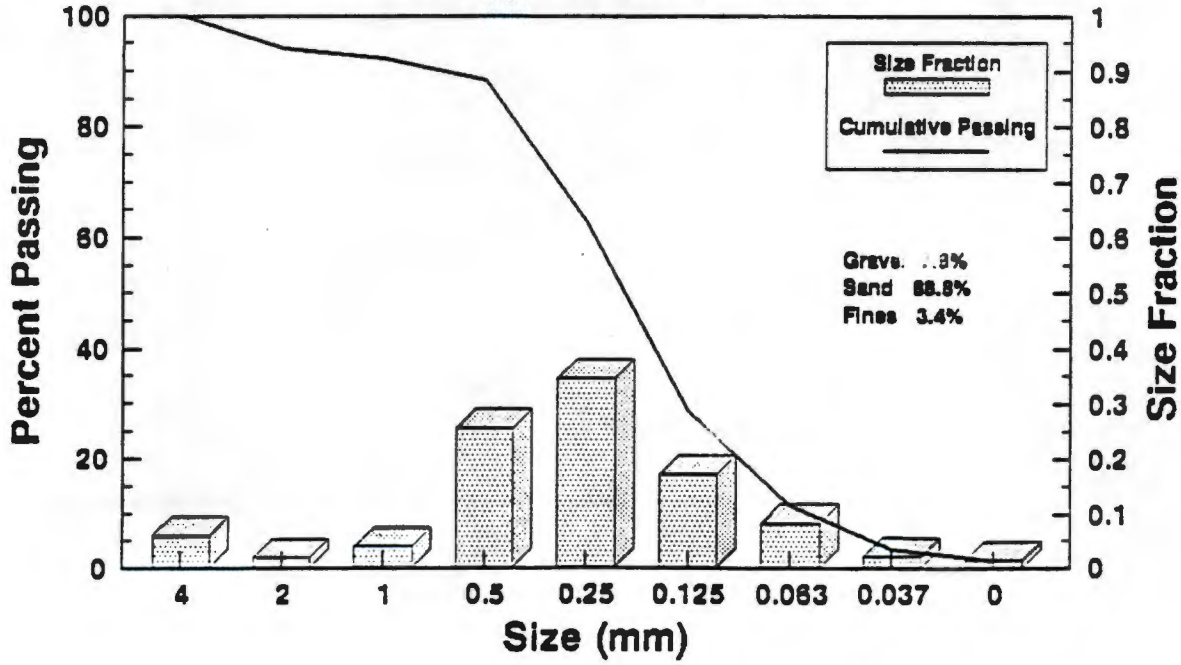



Upper Ringold Fm
Well 299-W7-9, 30.2 m Depth, Sample 0-099
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3293
θsw = 0.2847
θrd&w = 0.101
αd = 0.0115 1/cm
αw = 0.0131 1/cm
nd&w = 1.7886
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.65E-04 cm/s
Ksw = 9.58E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content



ETAL NO. 0-099

WELL NO. 299-W7-9; 99.25 ft.



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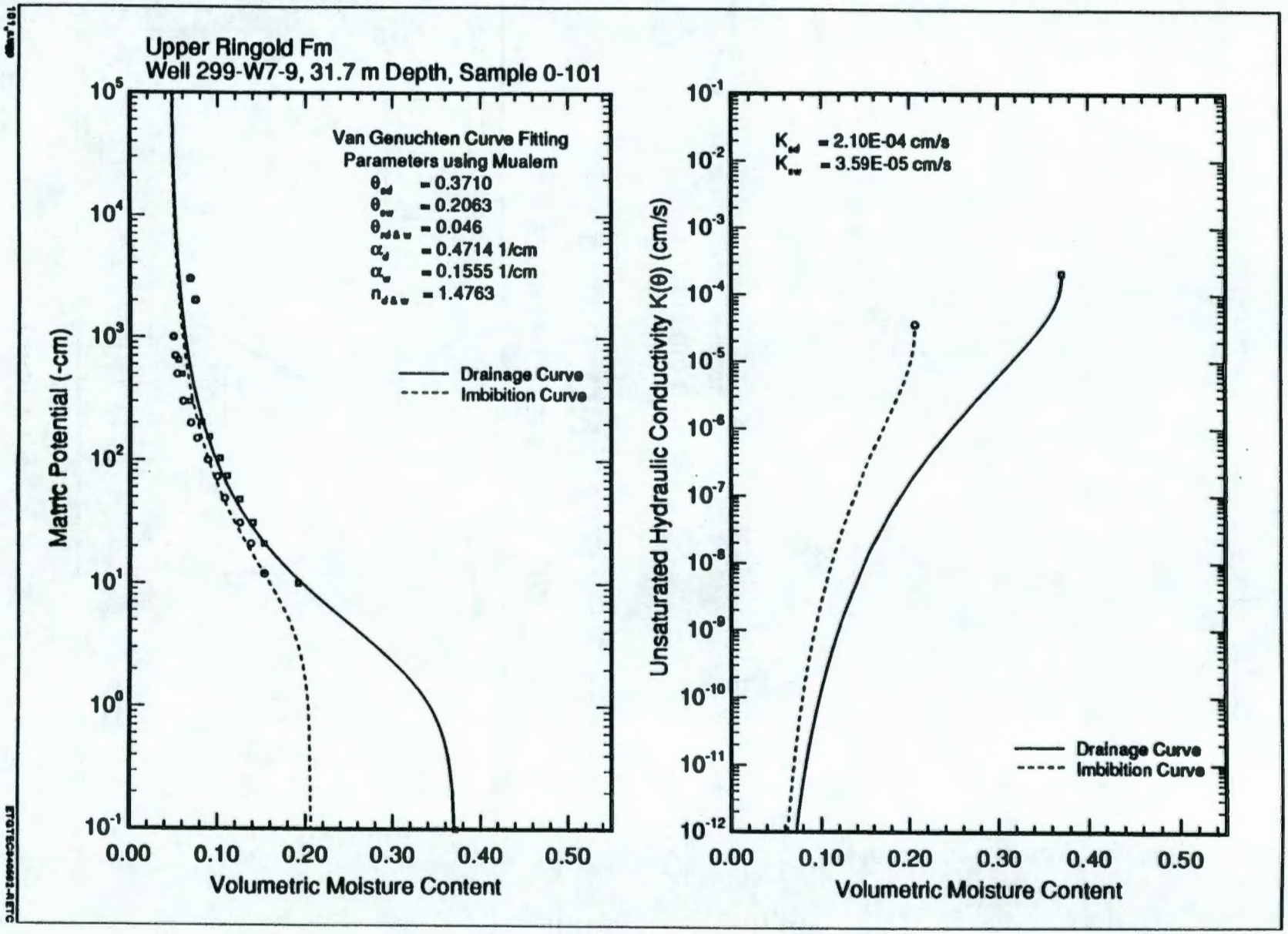
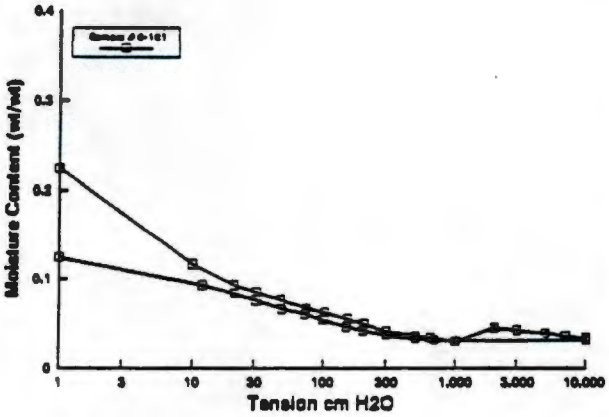
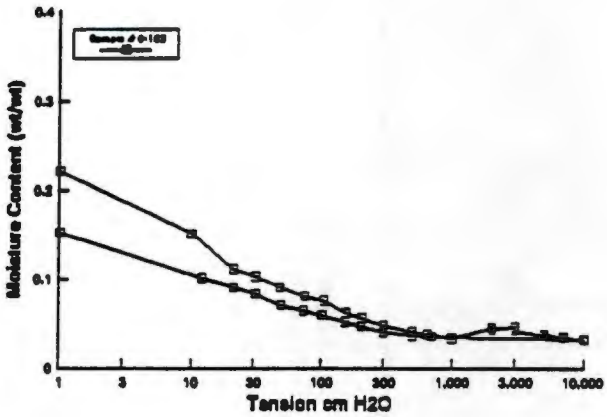
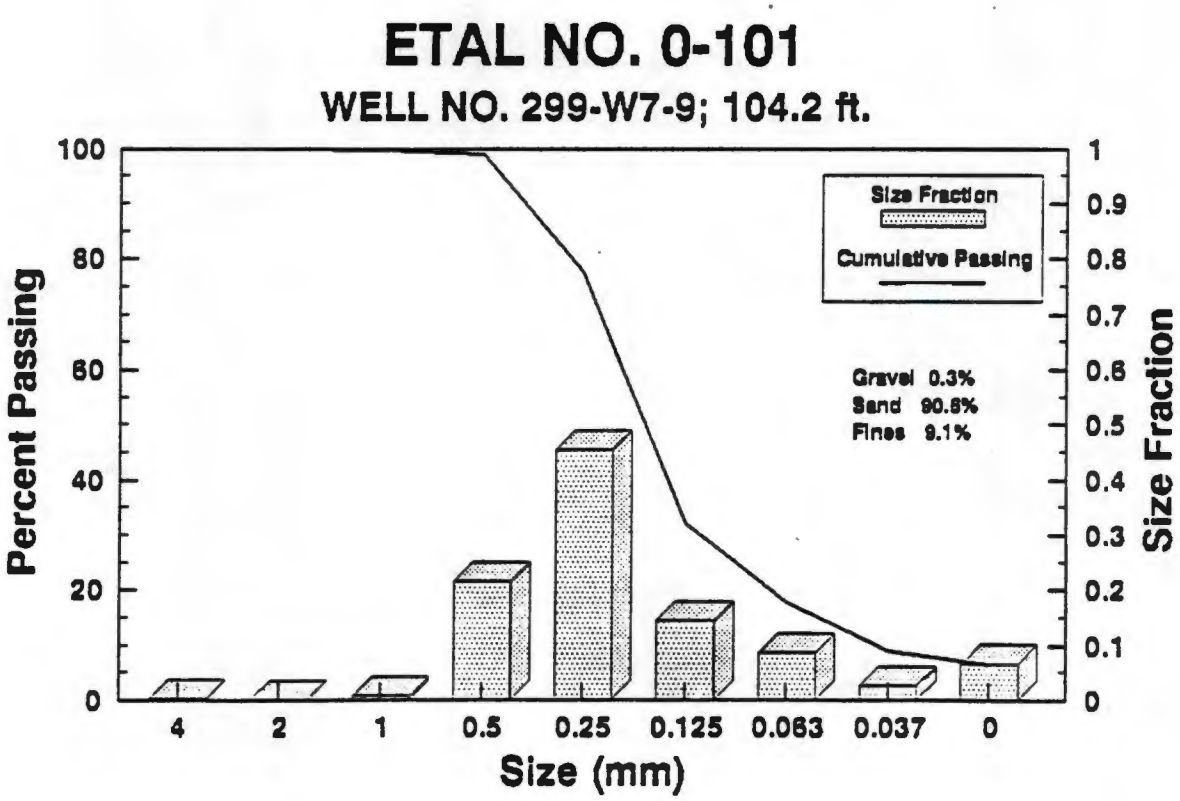
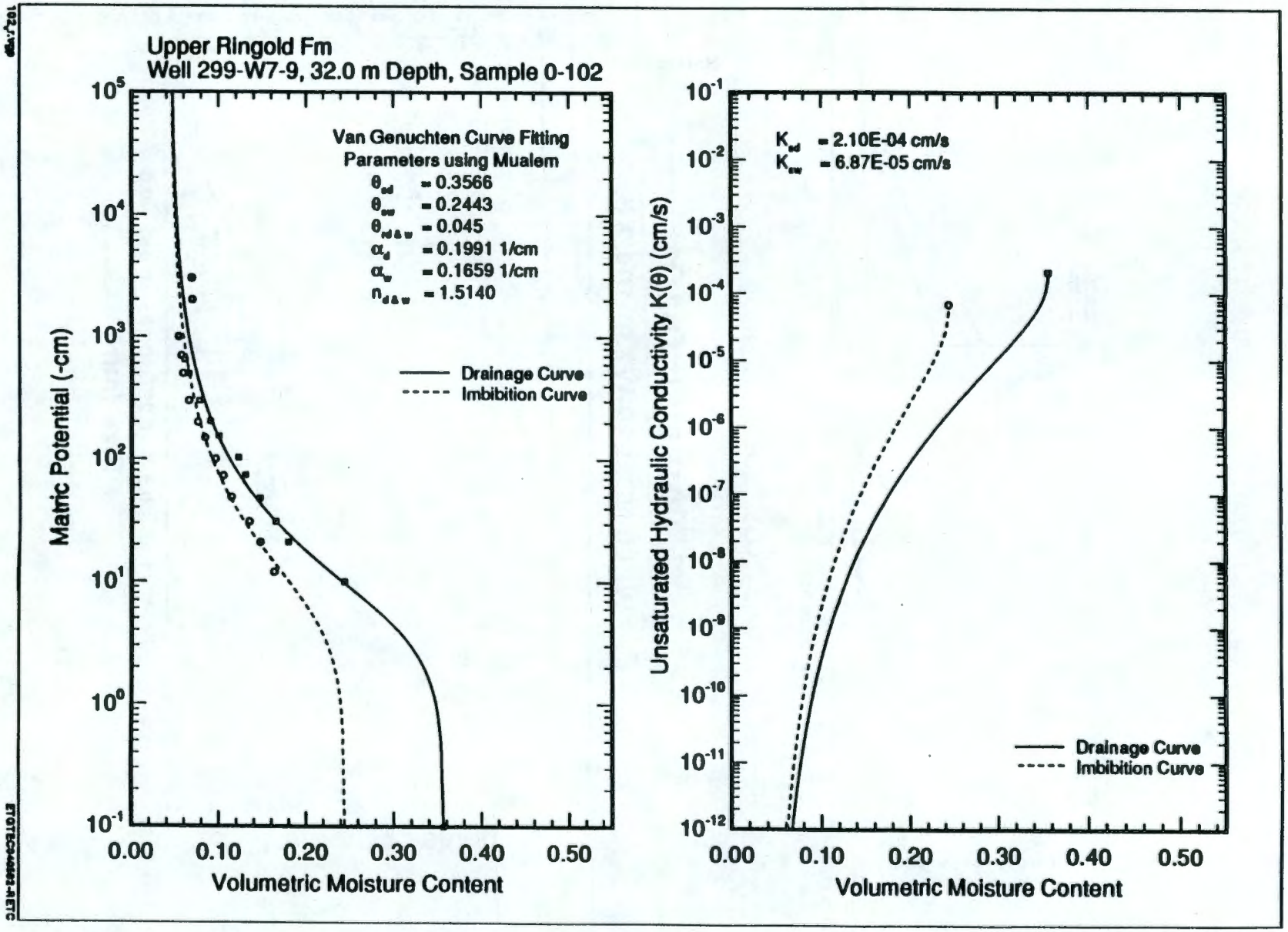

Upper Ringold Fm
Well 299-W7-9, 31.7 m Depth, Sample 0-101
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3710
θsw = 0.2063
θrd&w = 0.046
αd = 0.4714 1/cm
αw = 0.1555 1/cm
nd&w = 1.4763
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 2.10E-04 cm/s
Ksw = 3.59E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

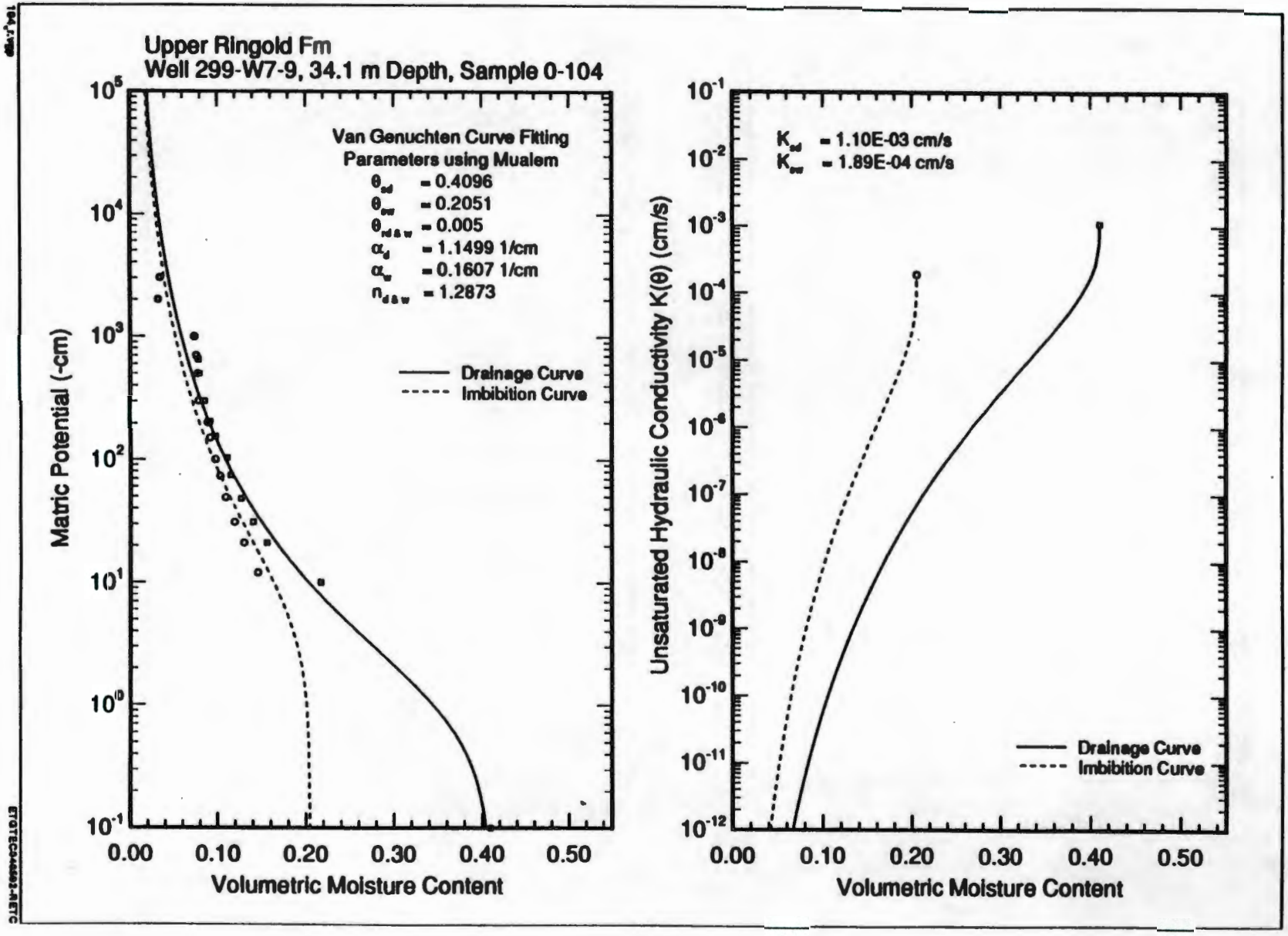
9413136.1959

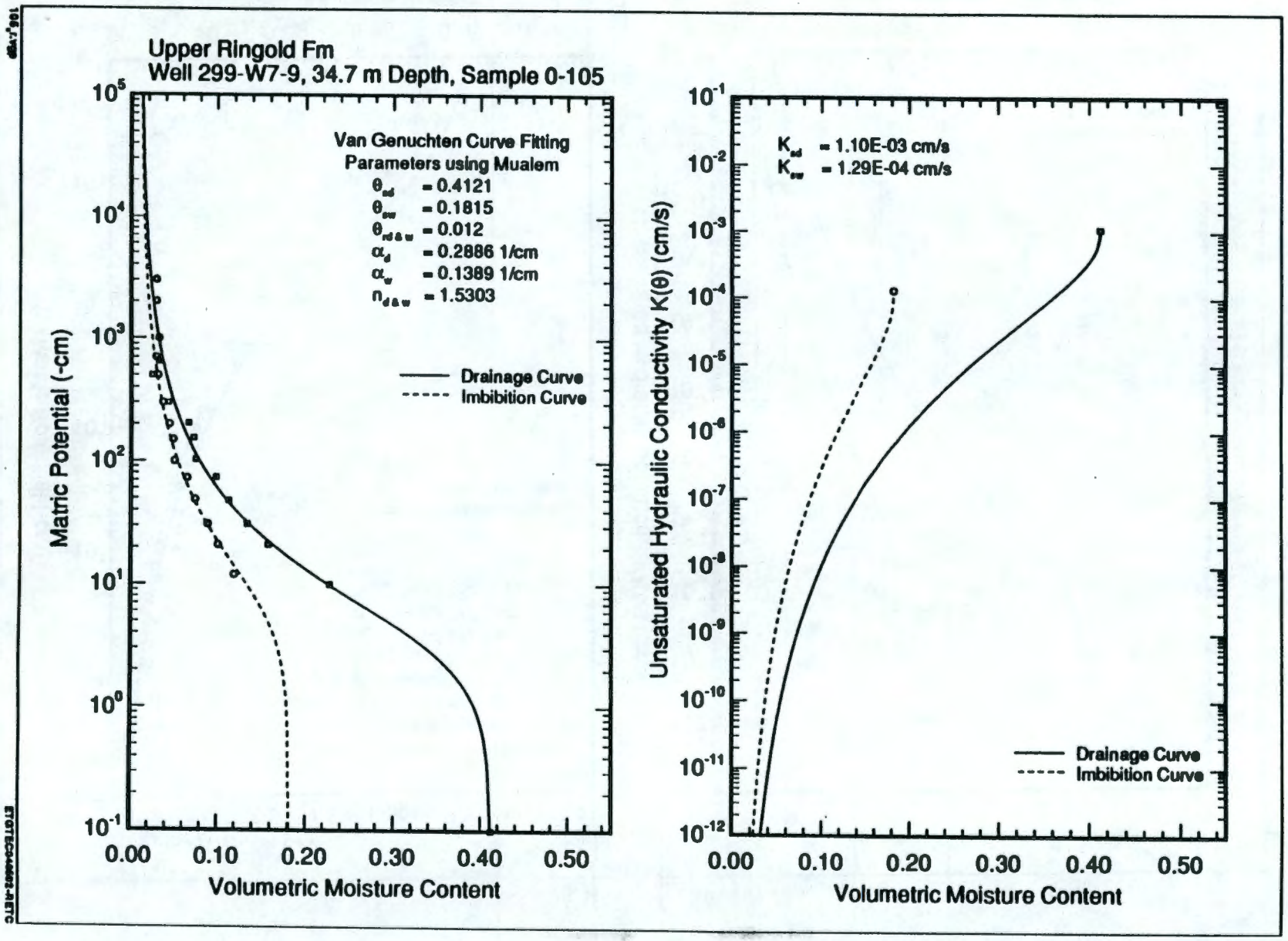


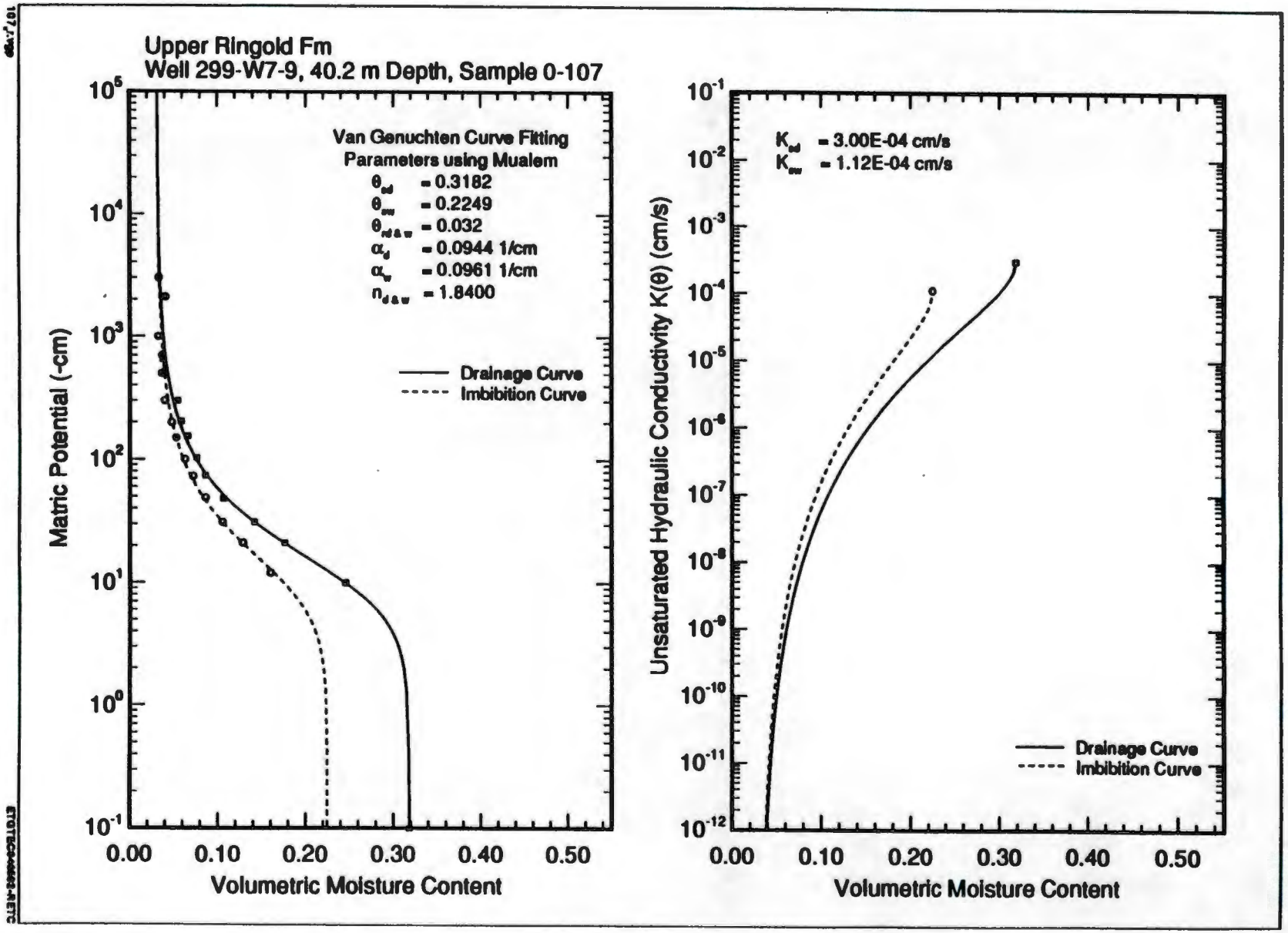


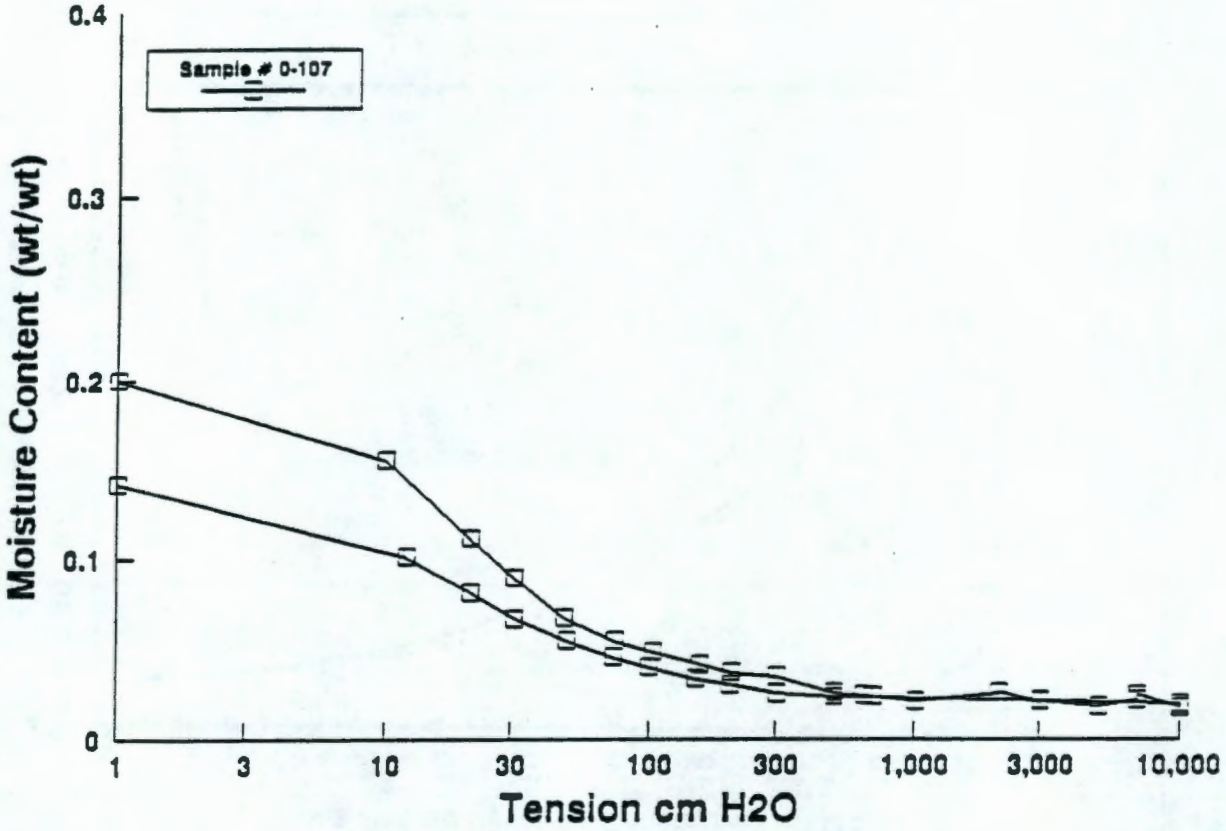



Upper Ringold Fm
Well 299-W7-9, 32.0 m Depth, Sample 0-102
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.3566
θ_{sw} = 0.2443
$\theta_{rd\&w}$ = 0.045
α_d = 0.1991 1/cm
α_w = 0.1659 1/cm
$n_{d\&w}$ = 1.5140
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 2.10E-04 cm/s
K_{sw} = 6.87E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content


Upper Ringold Fm
Well 299-W7-9, 34.1 m Depth, Sample 0-104
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.4096
θ_{sw} = 0.2051
$\theta_{rd\&w}$ = 0.005
α_d = 1.1499 1/cm
α_w = 0.1607 1/cm
$n_{d\&w}$ = 1.2873
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 1.10E-03 cm/s
K_{sw} = 1.89E-04 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

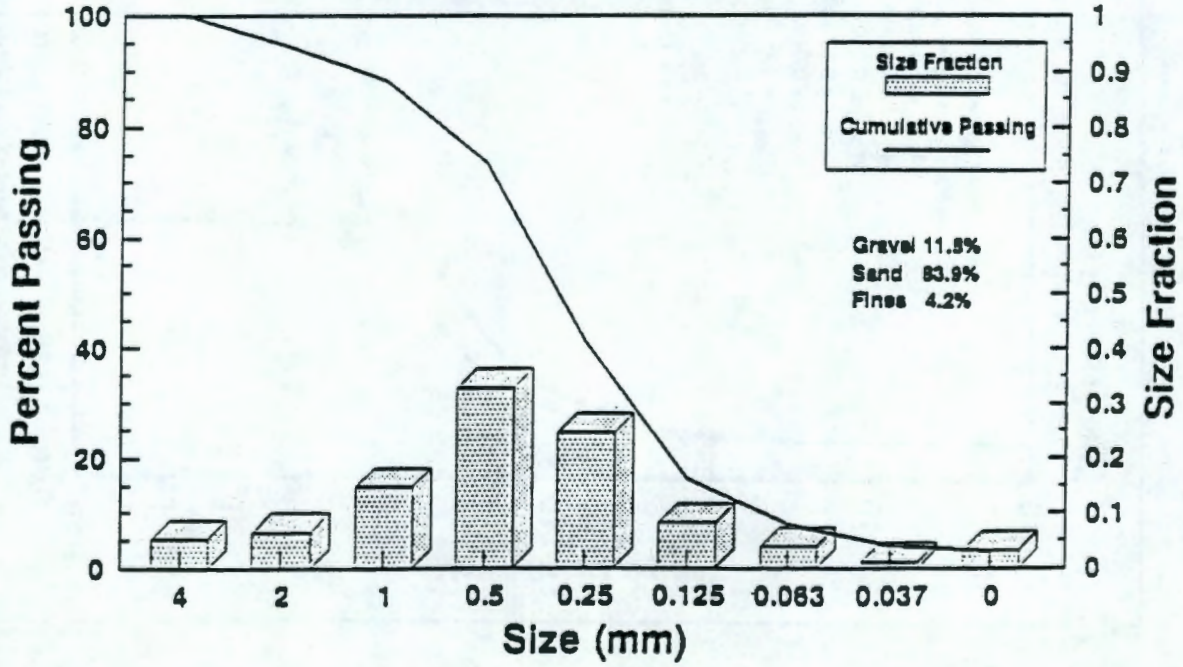

Upper Ringold Fm
Well 299-W7-9, 34.7 m Depth, Sample 0-105
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.4121
θsw = 0.1815
θrd&w = 0.012
αd = 0.2886 1/cm
αw = 0.1389 1/cm
nd&w = 1.5303
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.10E-03 cm/s
Ksw = 1.29E-04 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

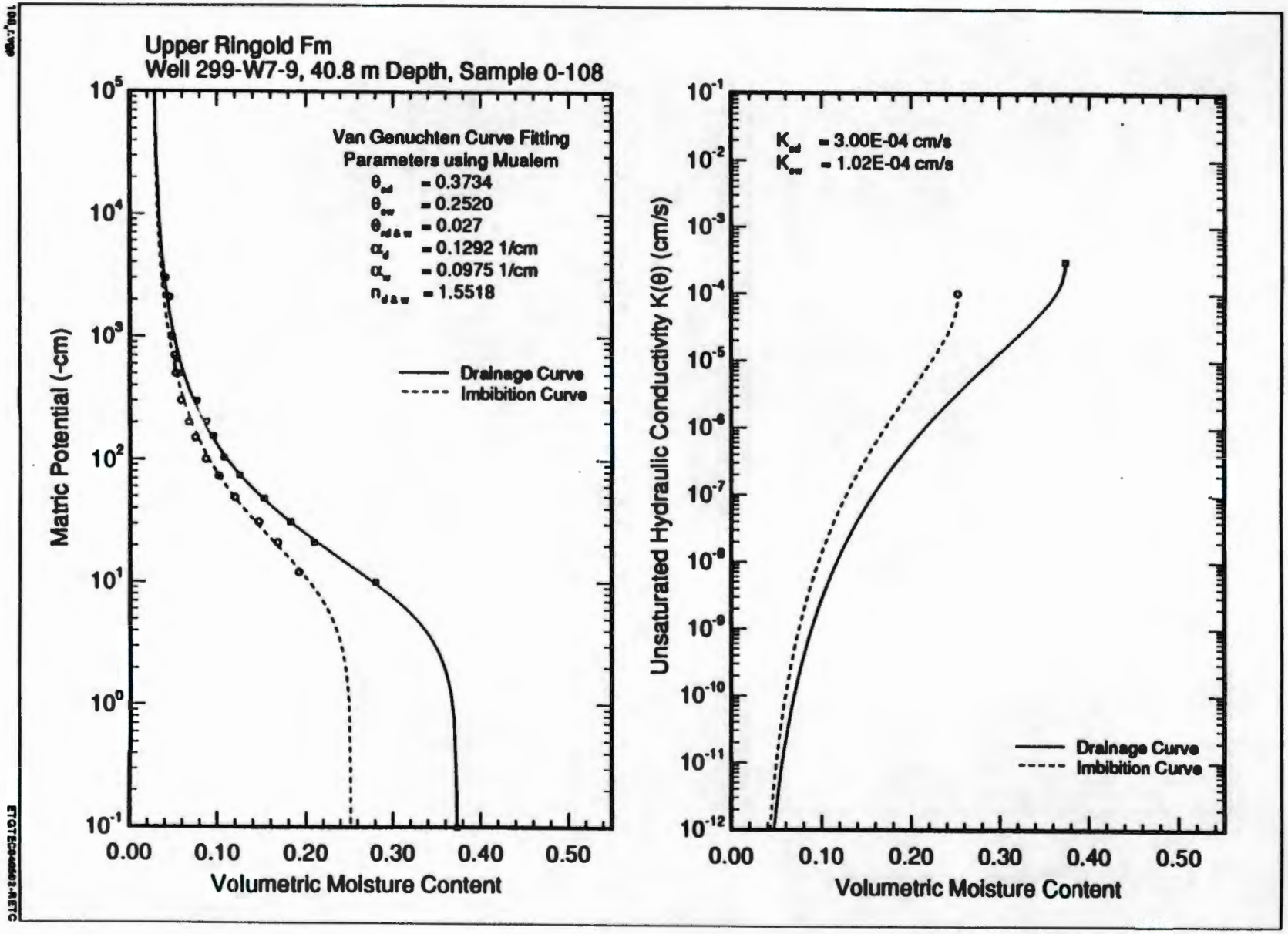

Upper Ringold Fm
Well 299-W7-9, 40.2 m Depth, Sample 0-107
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.3182
θ_{sw} = 0.2249
$\theta_{rd\&w}$ = 0.032
α_d = 0.0944 1/cm
α_w = 0.0961 1/cm
$n_{d\&w}$ = 1.8400
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 3.00E-04 cm/s
K_{sw} = 1.12E-04 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

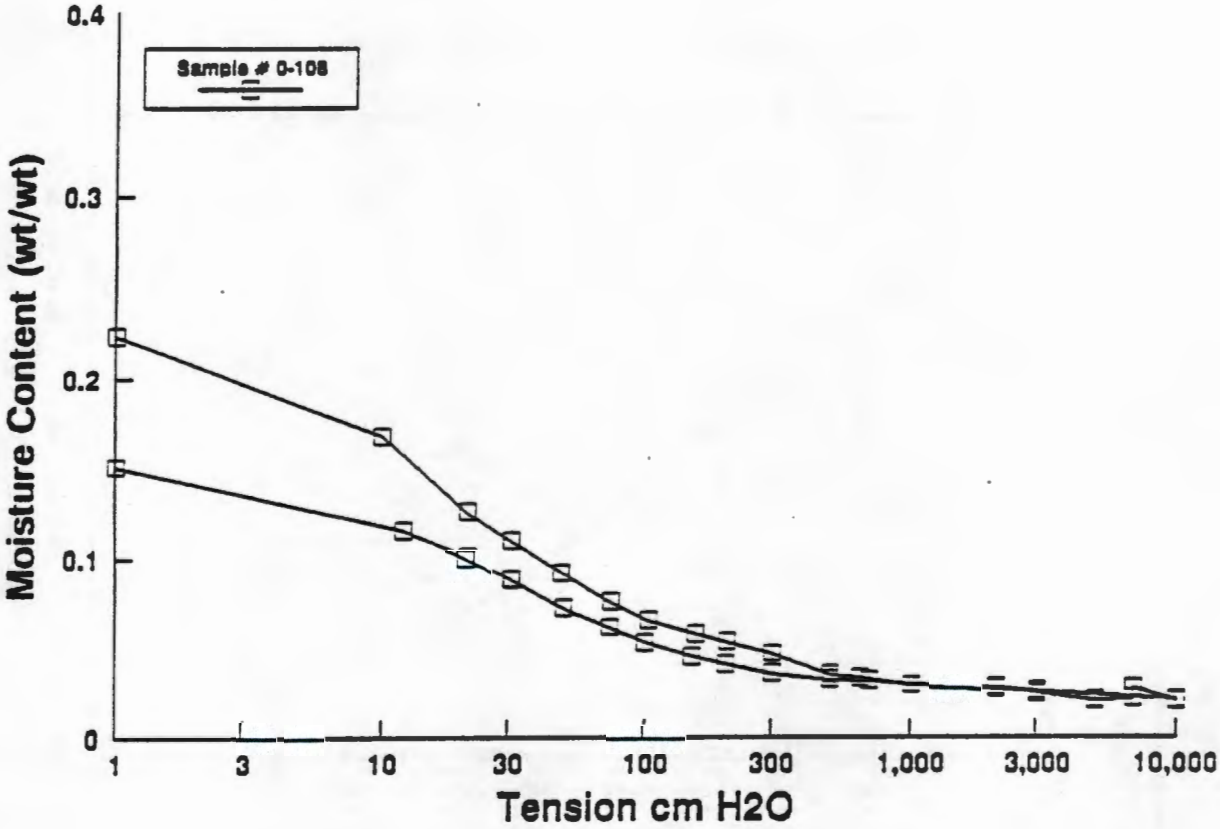


ETAL NO. 0-107

WELL NO. 299-W7-9; 132.5 ft.

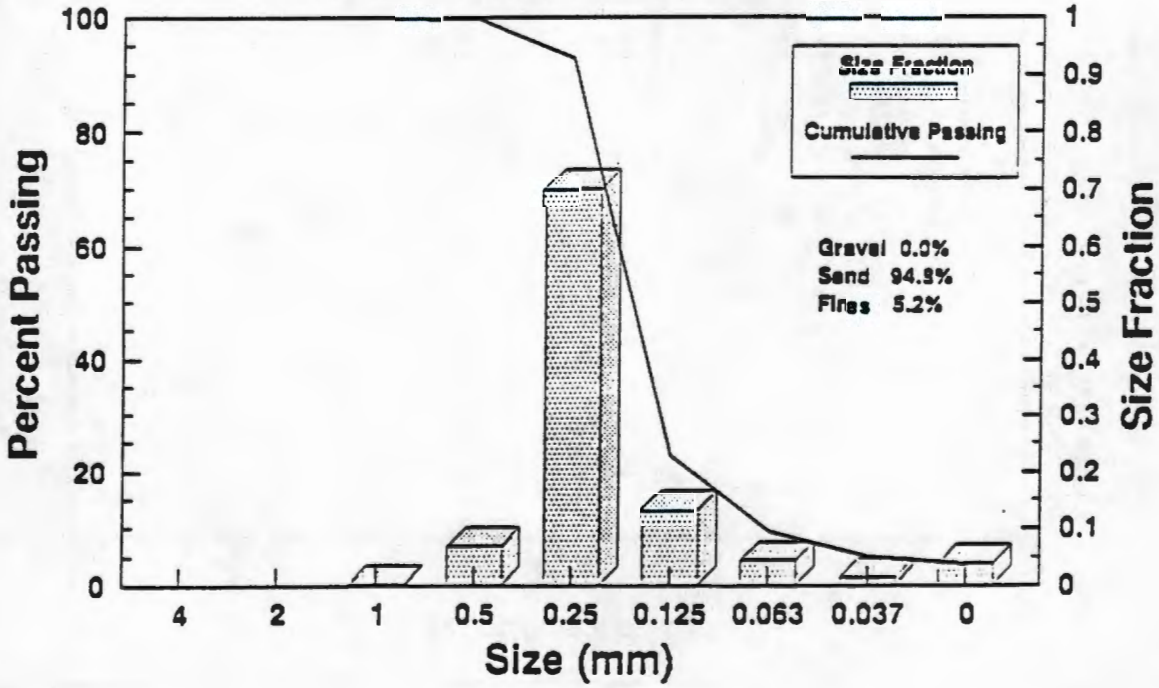


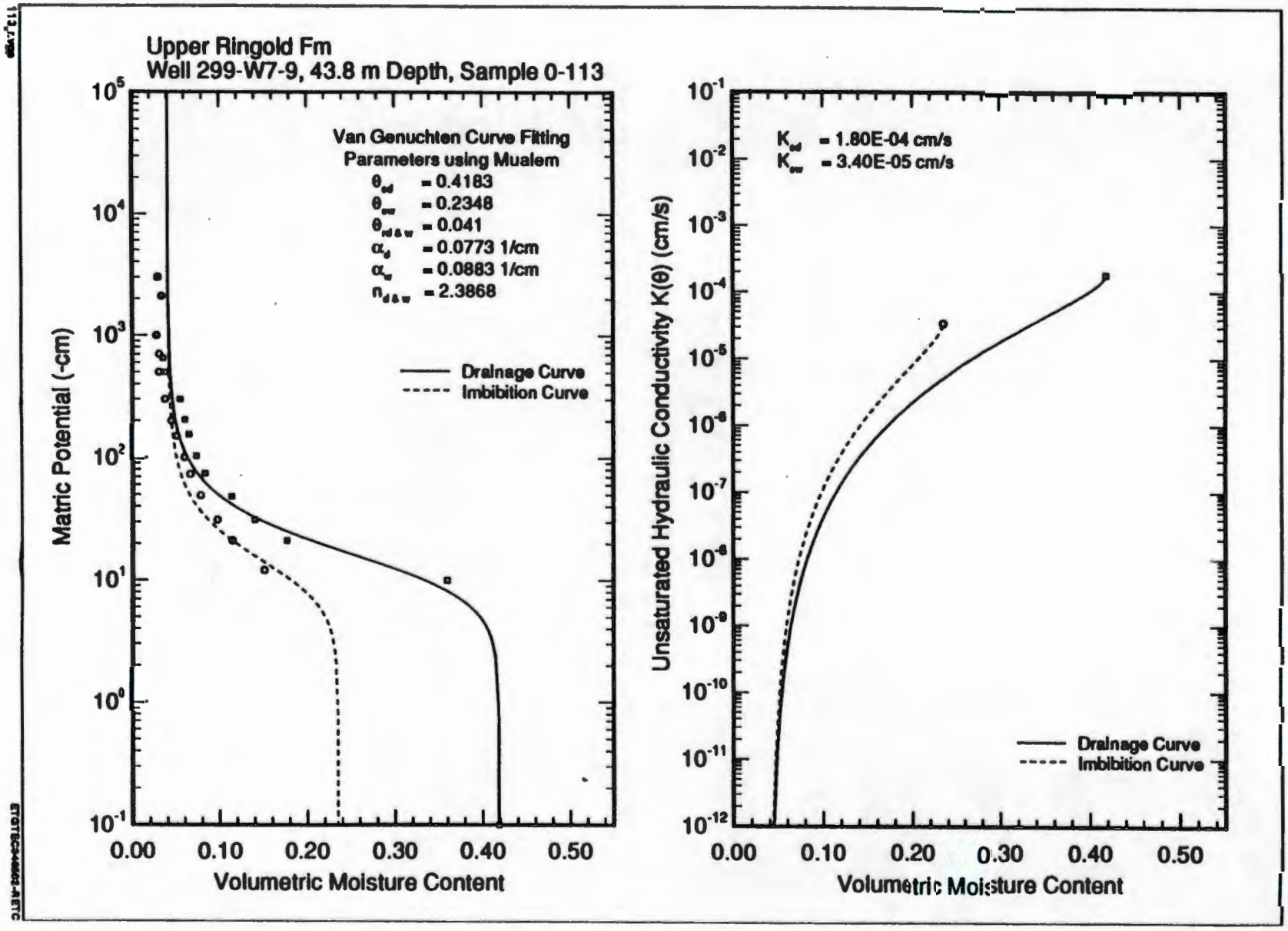

Upper Ringold Fm
Well 299-W7-9, 40.8 m Depth, Sample 0-108
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3734
θsw = 0.2520
θrd&w = 0.027
αd = 0.1292 1/cm
αw = 0.0975 1/cm
nd&w = 1.5518
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 3.00E-04 cm/s
Ksw = 1.02E-04 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

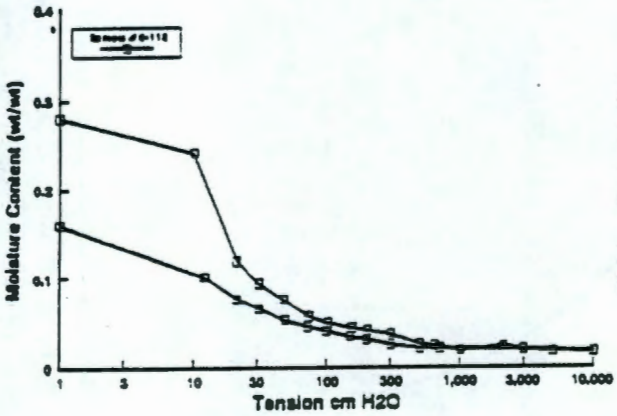


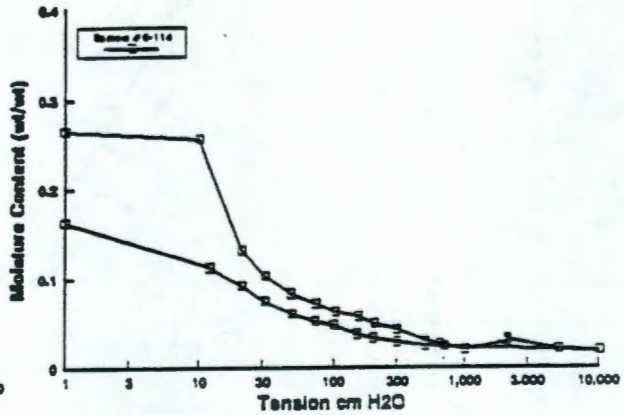
ETAL NO. 0-108

WELL NO. 299-W7-9; 133.75 ft.



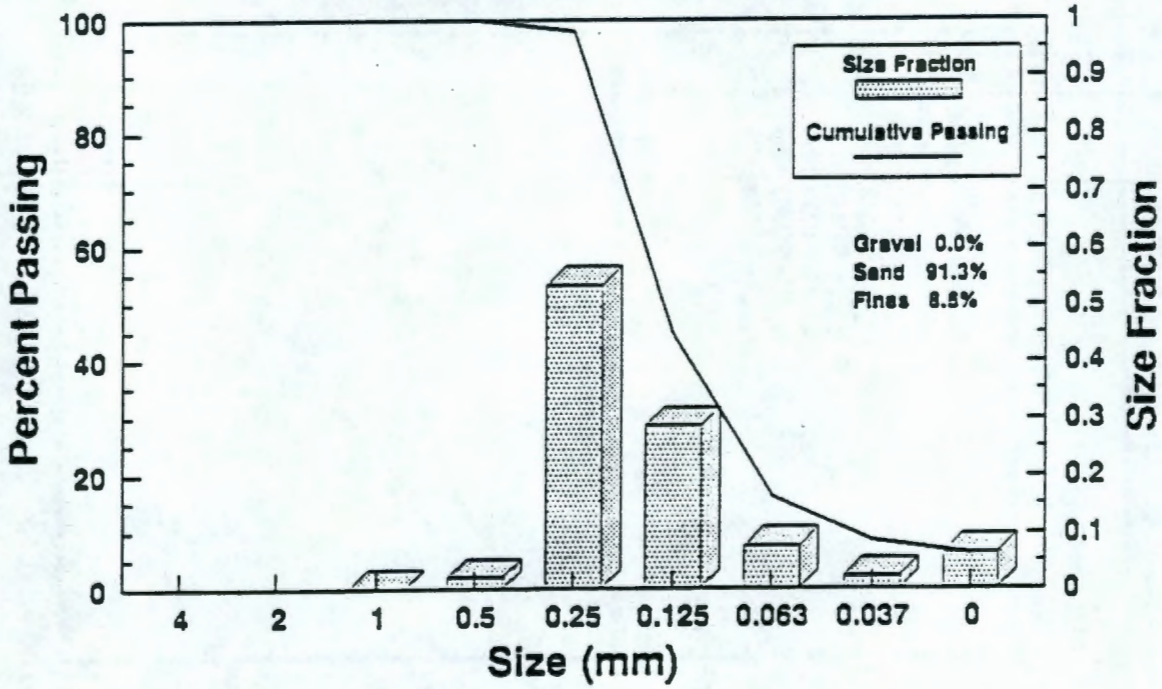

Upper Ringold Fm
Well 299-W7-9, 43.8 m Depth, Sample 0-113
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.4183
θsw = 0.2348
θrd&w = 0.041
αd = 0.0773 1/cm
αw = 0.0883 1/cm
nd&w = 2.3868
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.80E-04 cm/s
Ksw = 3.40E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

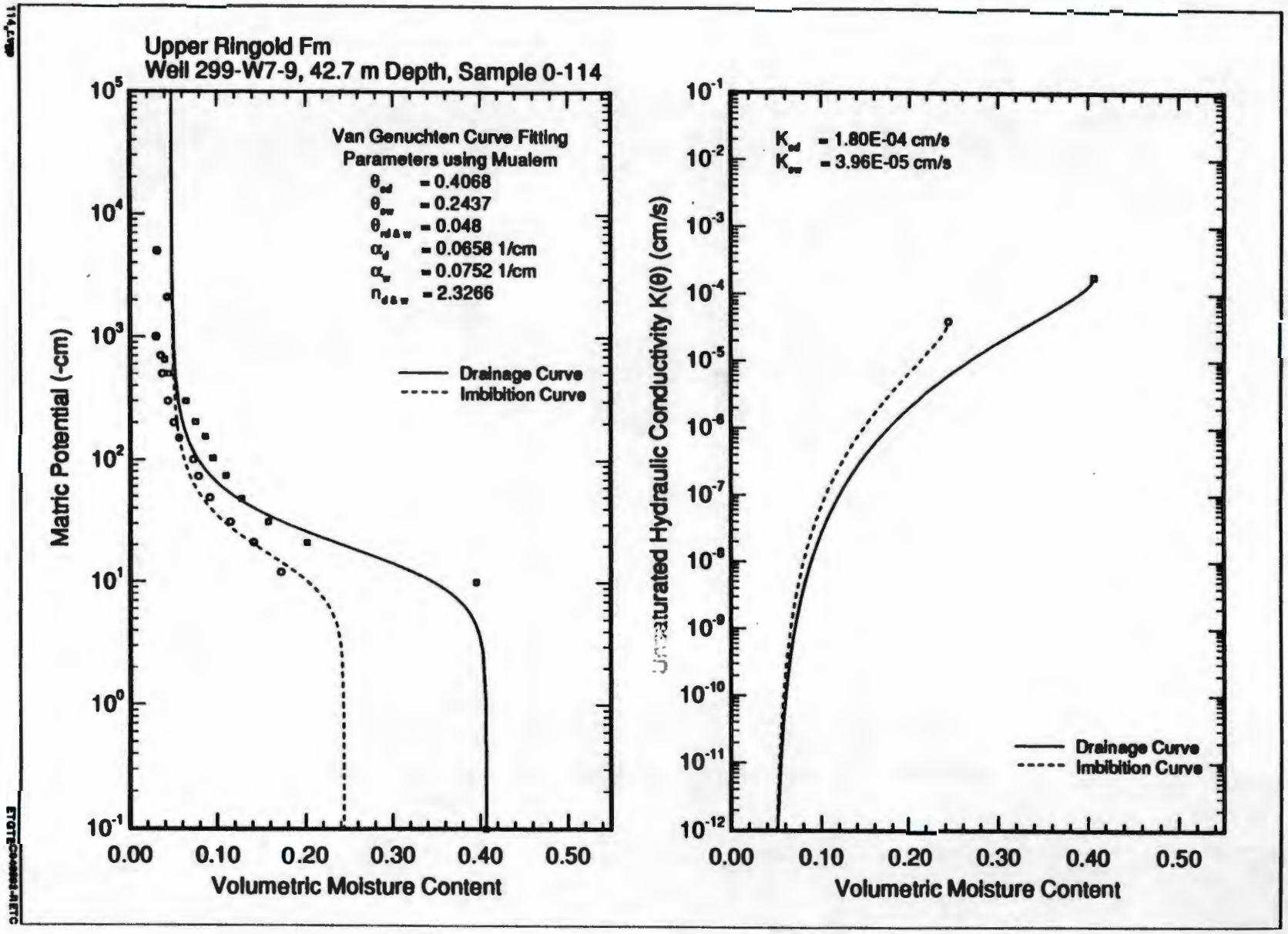


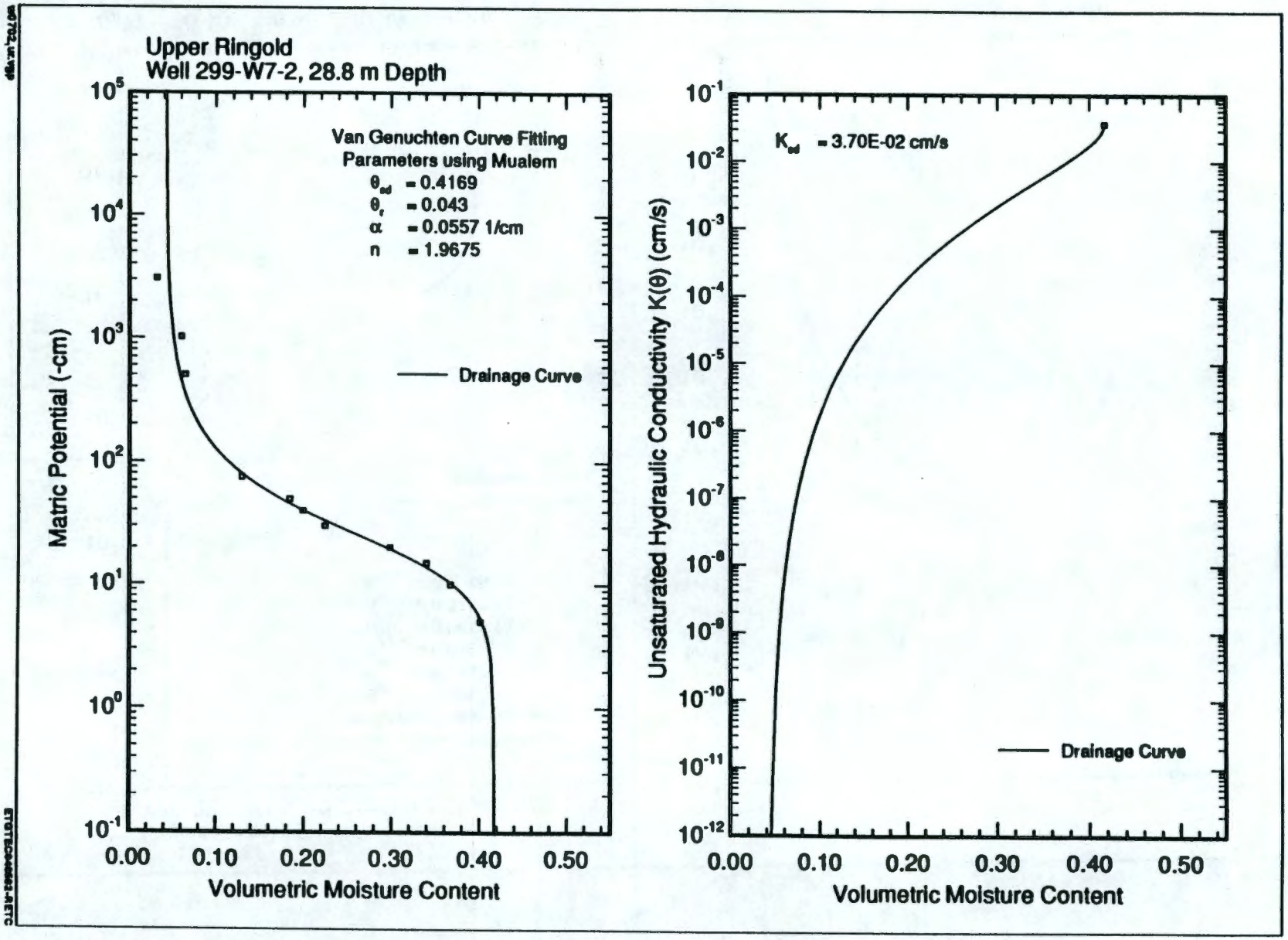


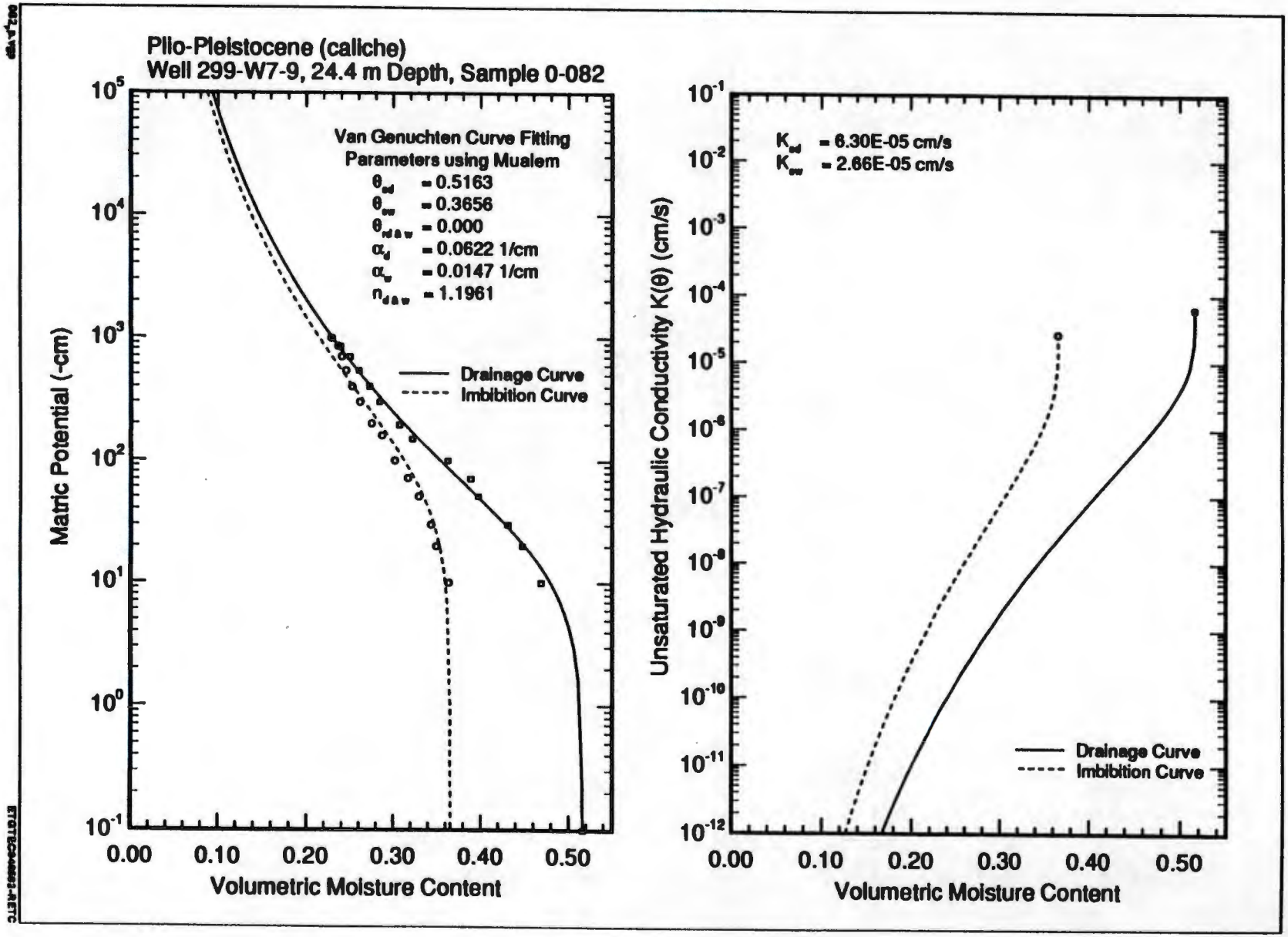
ETAL NO. 0-113

WELL NO. 299-W7-9; 141.75 ft.

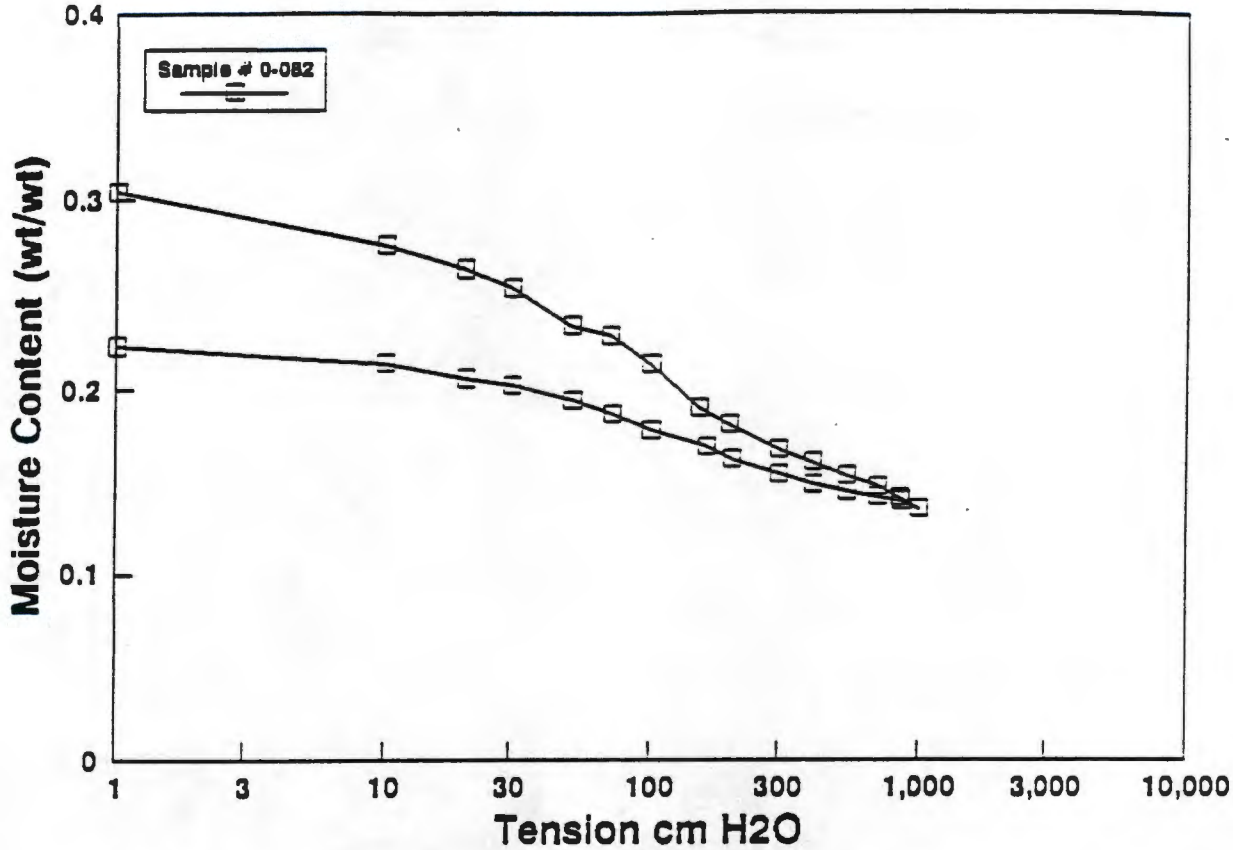


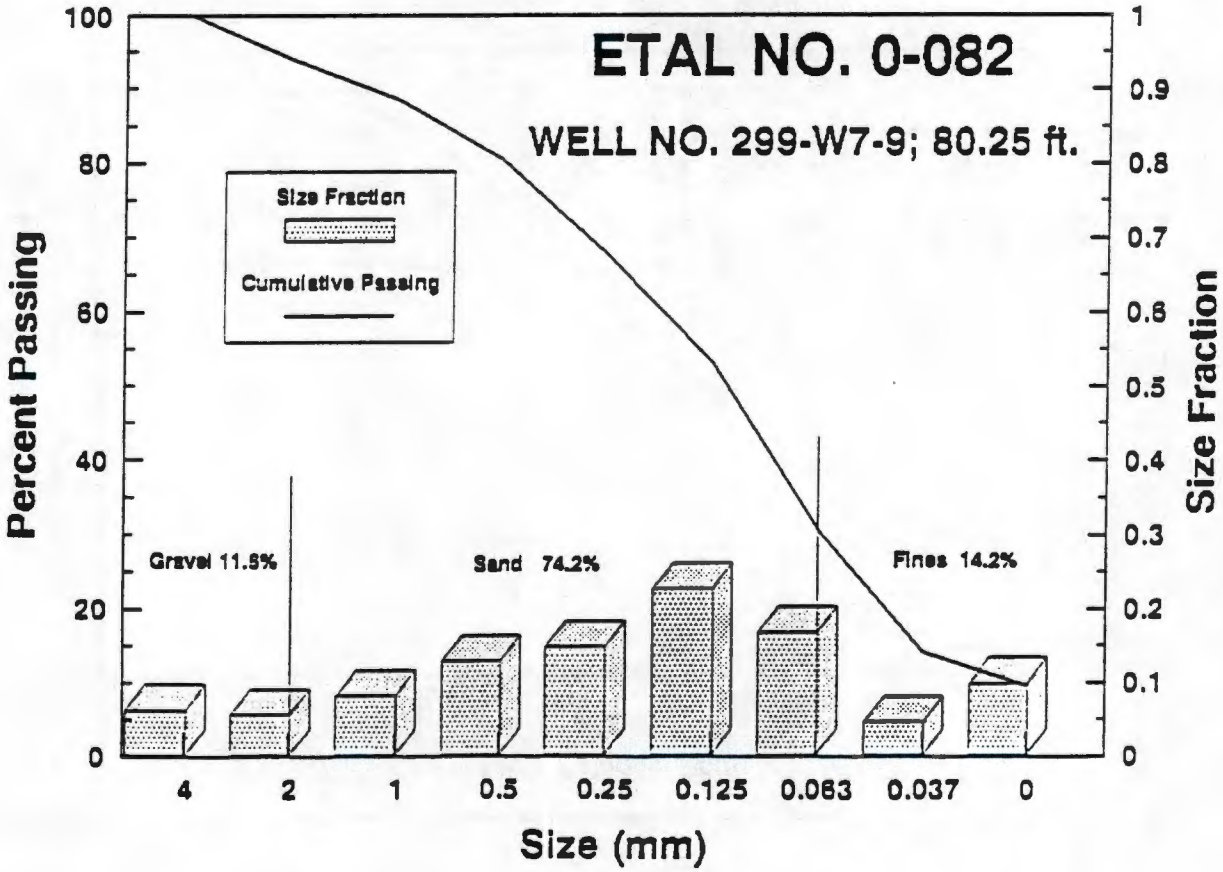

Upper Ringold Fm
Well 299-W7-9, 42.7 m Depth, Sample 0-114
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.4068
θsw = 0.2437
θrd&w = 0.048
αd = 0.0658 1/cm
αw = 0.0752 1/cm
nd&w = 2.3266
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.80E-04 cm/s
Ksw = 3.96E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

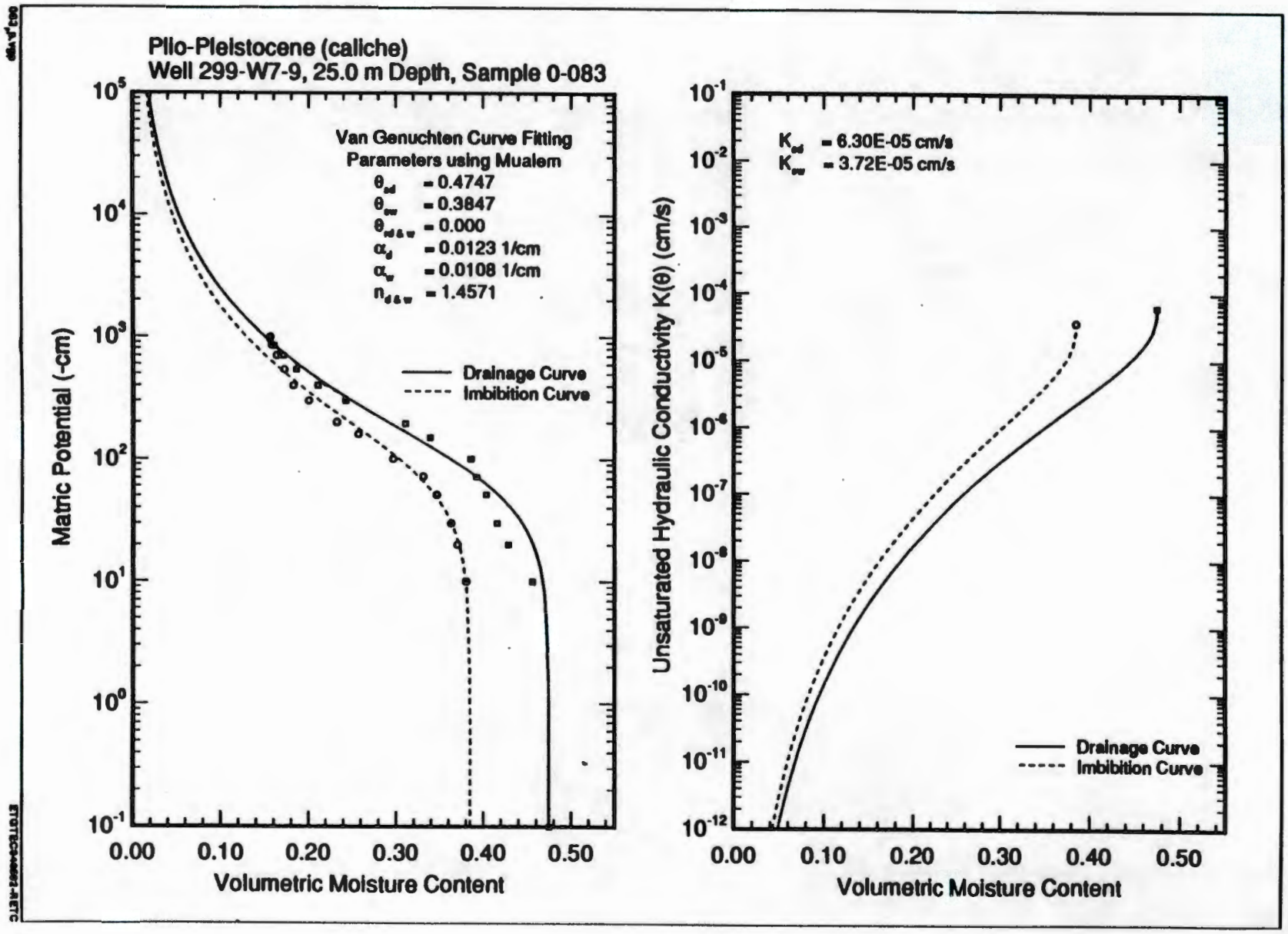

Upper Ringold
Well 299-W7-2, 28.8 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.4169
θr = 0.043
α = 0.0557 1/cm
n = 1.9675
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 3.70E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content

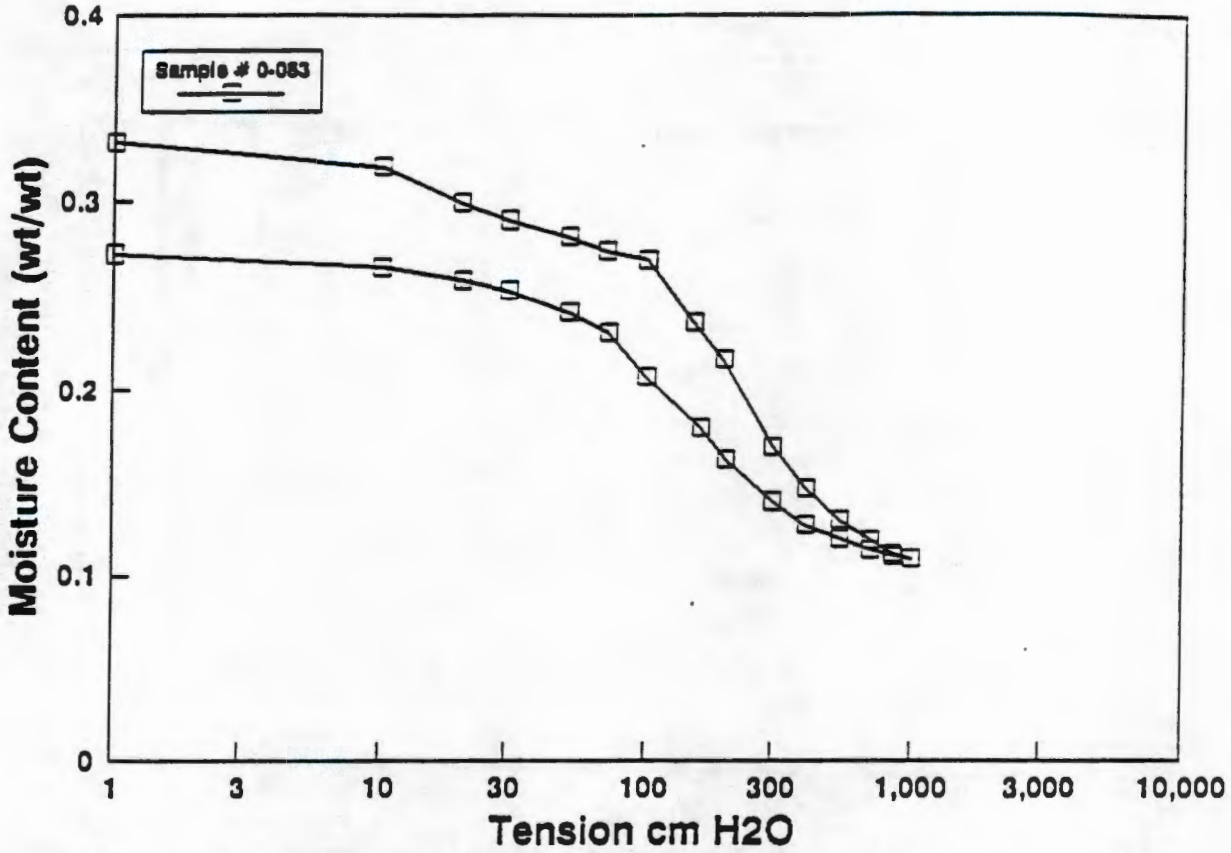

Plio-Pleistocene (caliche)
Well 299-W7-9, 24.4 m Depth, Sample 0-082
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.5163
θ_{sw} = 0.3656
θ_{rdsw} = 0.000
α_d = 0.0622 1/cm
α_w = 0.0147 1/cm
n_{dsw} = 1.1961
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 6.30E-05 cm/s
K_{sw} = 2.66E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

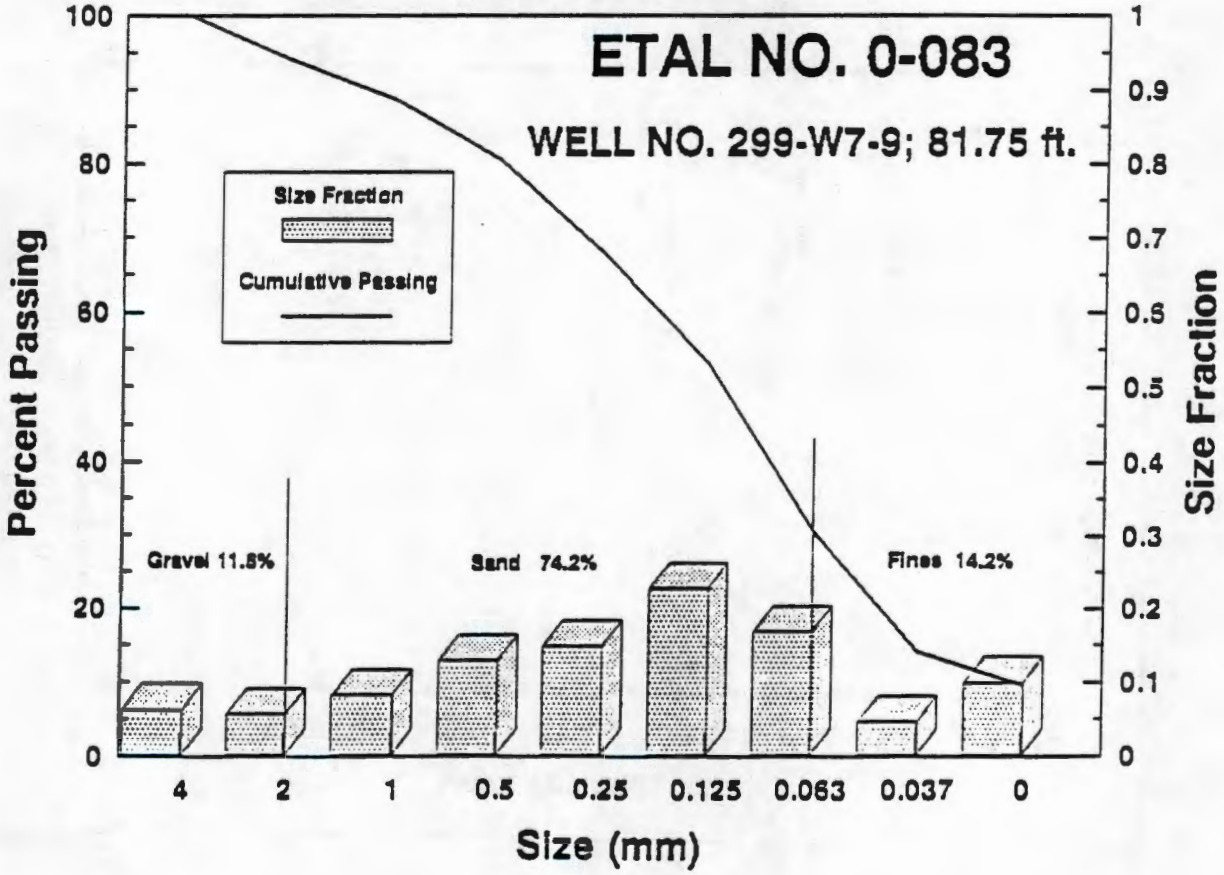
9413136.1972

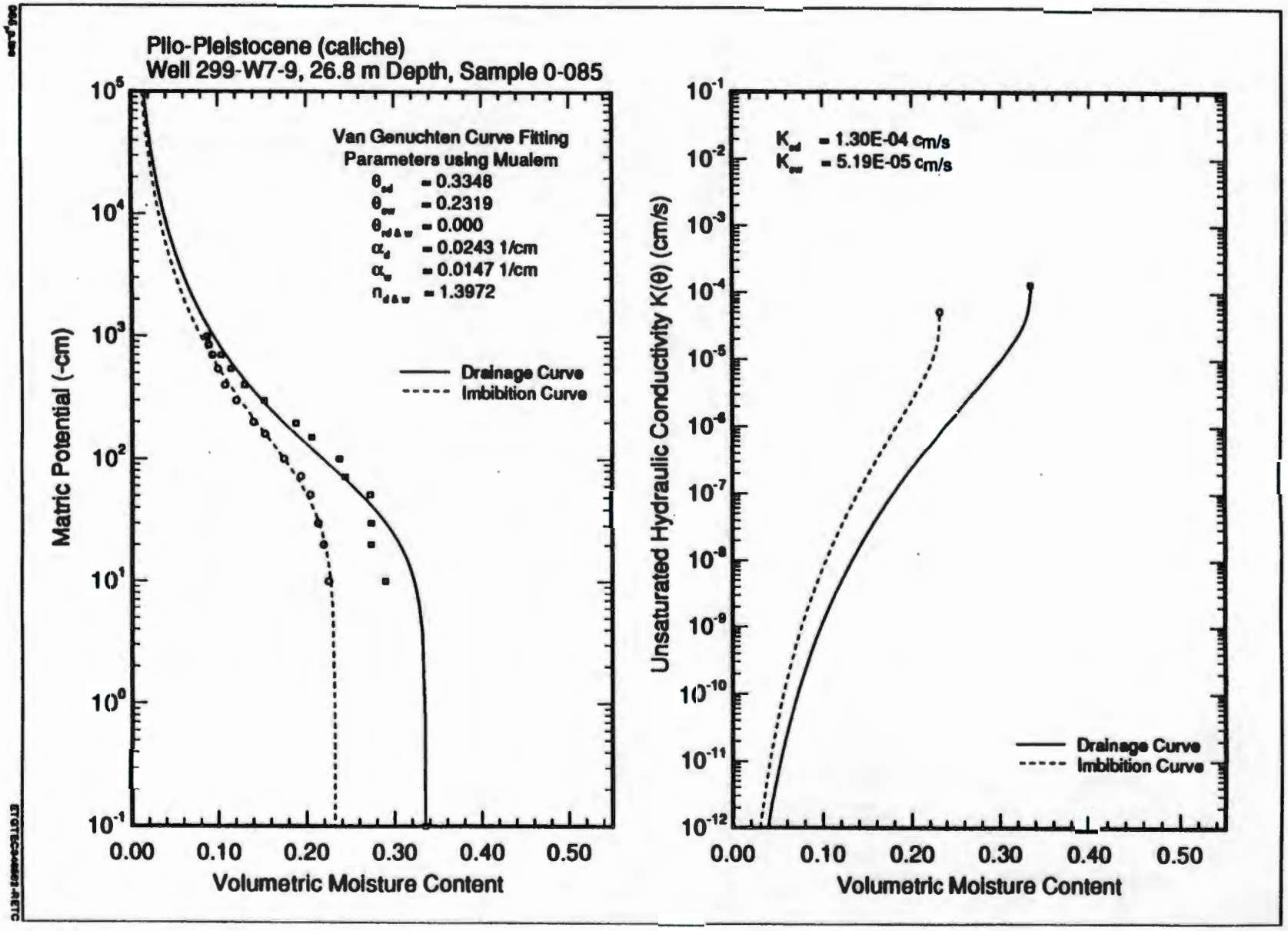


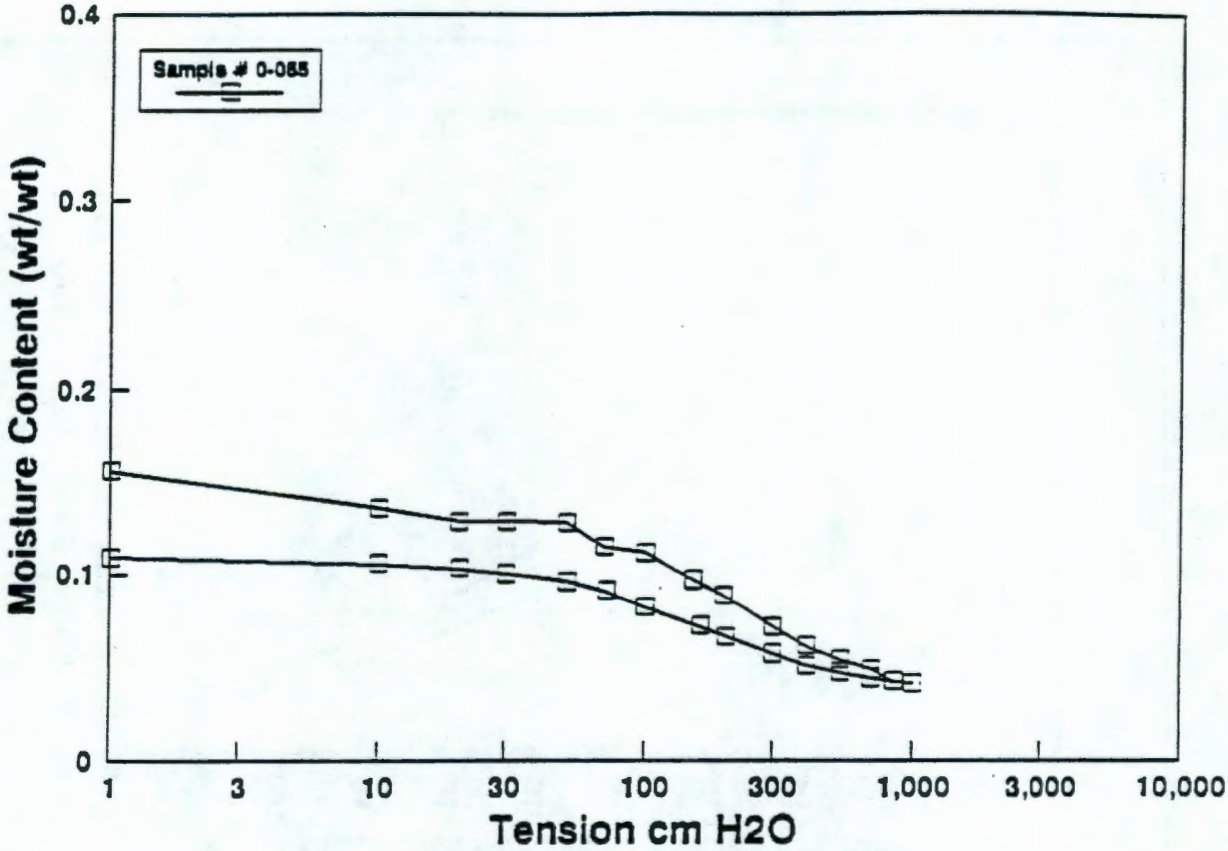


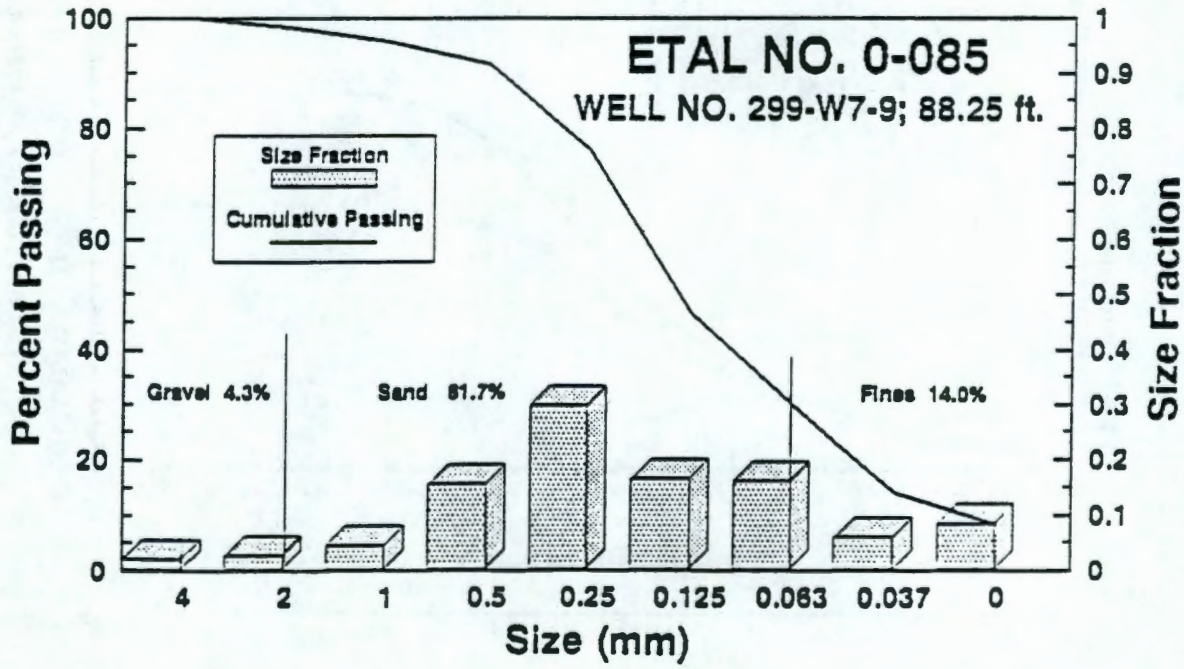

Plio-Pleistocene (caliche)
Well 299-W7-9, 25.0 m Depth, Sample 0-083
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.4747
θsw = 0.3847
θsd&w = 0.000
αd = 0.0123 1/cm
αw = 0.0108 1/cm
nd&w = 1.4571
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 6.30E-05 cm/s
Ksw = 3.72E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

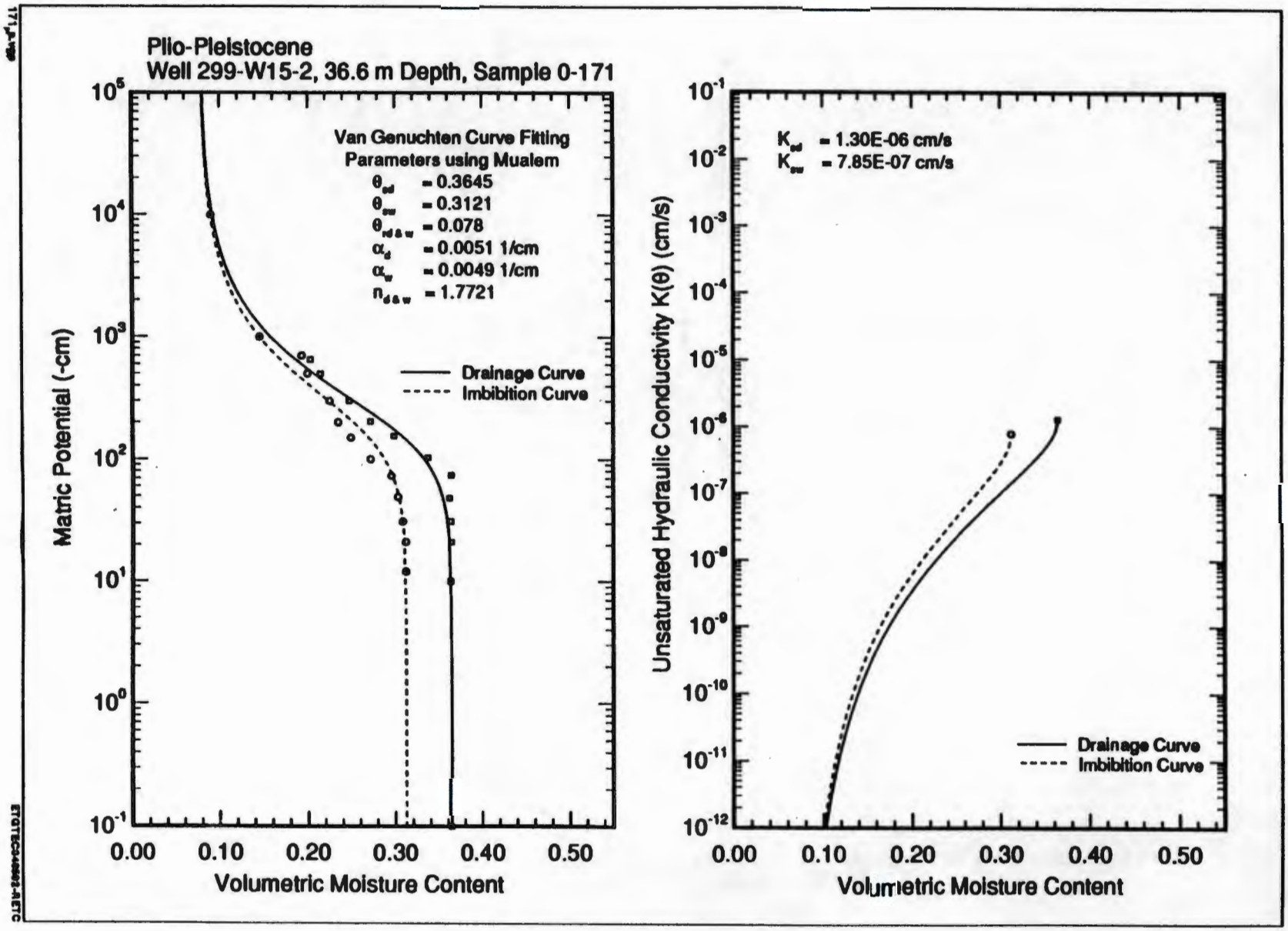

Sample # 0-083
Moisture Content (wt/wt)
0.4
0.3
0.2
0.1
0
1
3
10
30
100
300
1,000
3,000
10,000
Tension cm H2O


ETAL NO. 0-083
WELL NO. 299-W7-9; 81.75 ft.
Size Fraction
Cumulative Passing
Gravel 11.8%
Sand 74.2%
Fines 14.2%
Percent Passing
Size Fraction
100
80
60
40
20
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4
2
1
0.5
0.25
0.125
0.063
0.037
0
Size (mm)

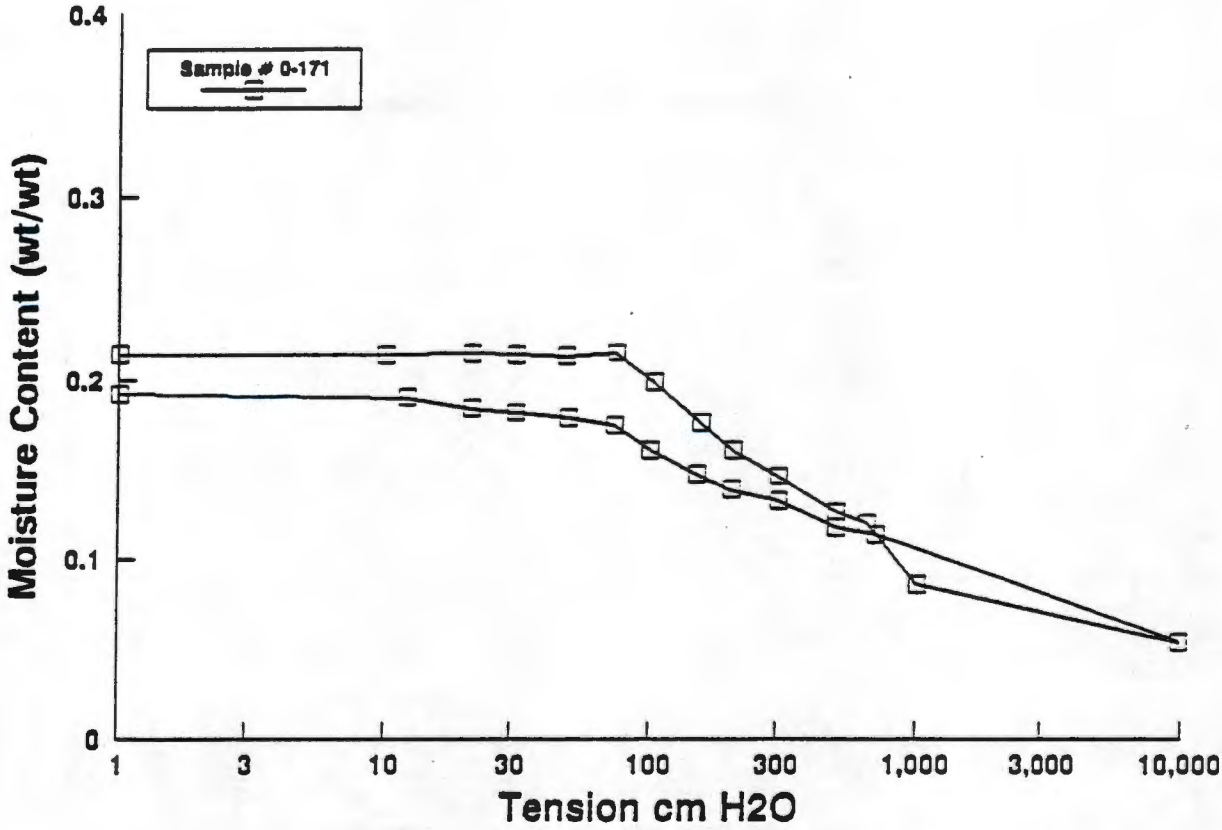

Plio-Pleistocene (caliche)
Well 299-W7-9, 26.8 m Depth, Sample 0-085
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3348
θsw = 0.2319
θrd&w = 0.000
αd = 0.0243 1/cm
αw = 0.0147 1/cm
nd&w = 1.3972
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.30E-04 cm/s
Ksw = 5.19E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content


Sample # 0-085
Moisture Content (wt/wt)
0.4
0.3
0.2
0.1
0
1
3
10
30
100
300
1,000
3,000
10,000
Tension cm H2O


ETAL NO. 0-085
WELL NO. 299-W7-9; 88.25 ft.
Size Fraction
Cumulative Passing
Gravel 4.3%
Sand 81.7%
Fines 14.0%
Percent Passing
Size Fraction
100
80
60
40
20
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4
2
1
0.5
0.25
0.125
0.063
0.037
0
Size (mm)

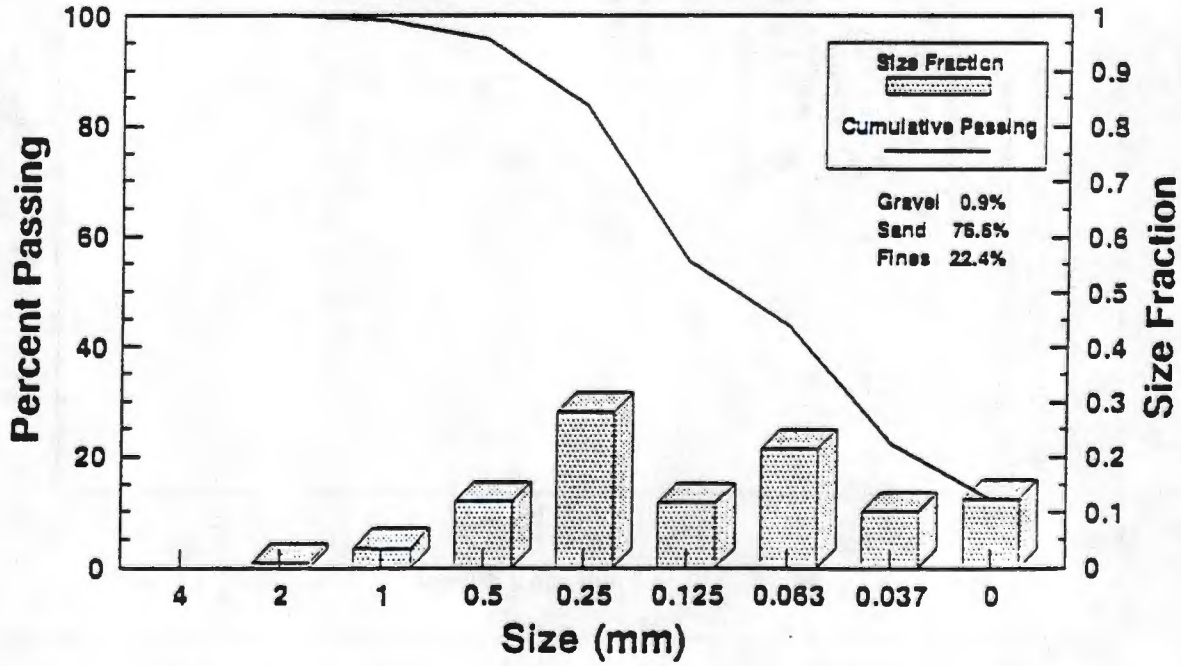

Plio-Pleistocene
Well 299-W15-2, 36.6 m Depth, Sample 0-171
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.3645
θ_{sw} = 0.3121
$\theta_{rd\&w}$ = 0.078
α_d = 0.0051 1/cm
α_w = 0.0049 1/cm
$n_{d\&w}$ = 1.7721
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 1.30E-06 cm/s
K_{sw} = 7.85E-07 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

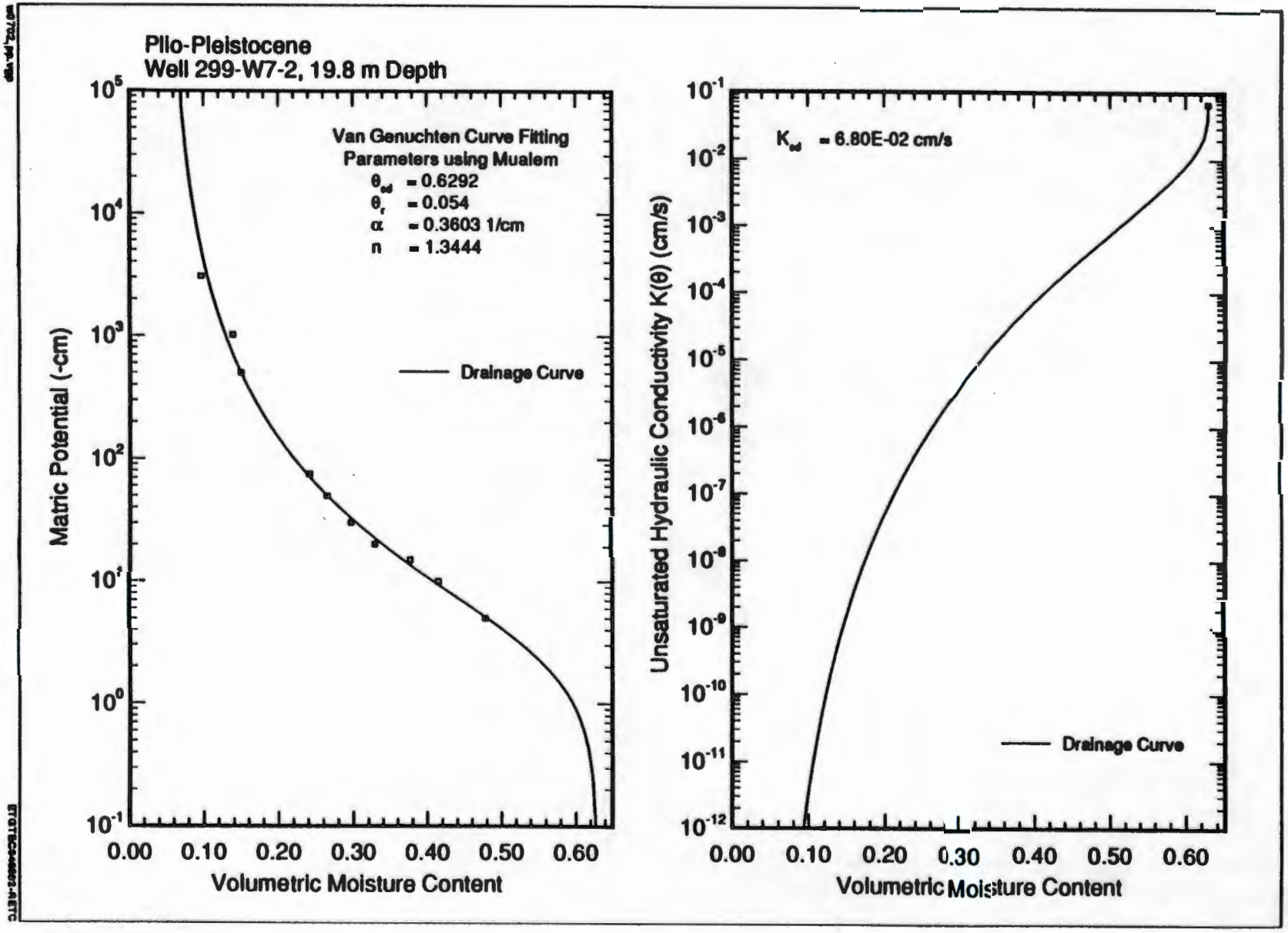
9413136.1978

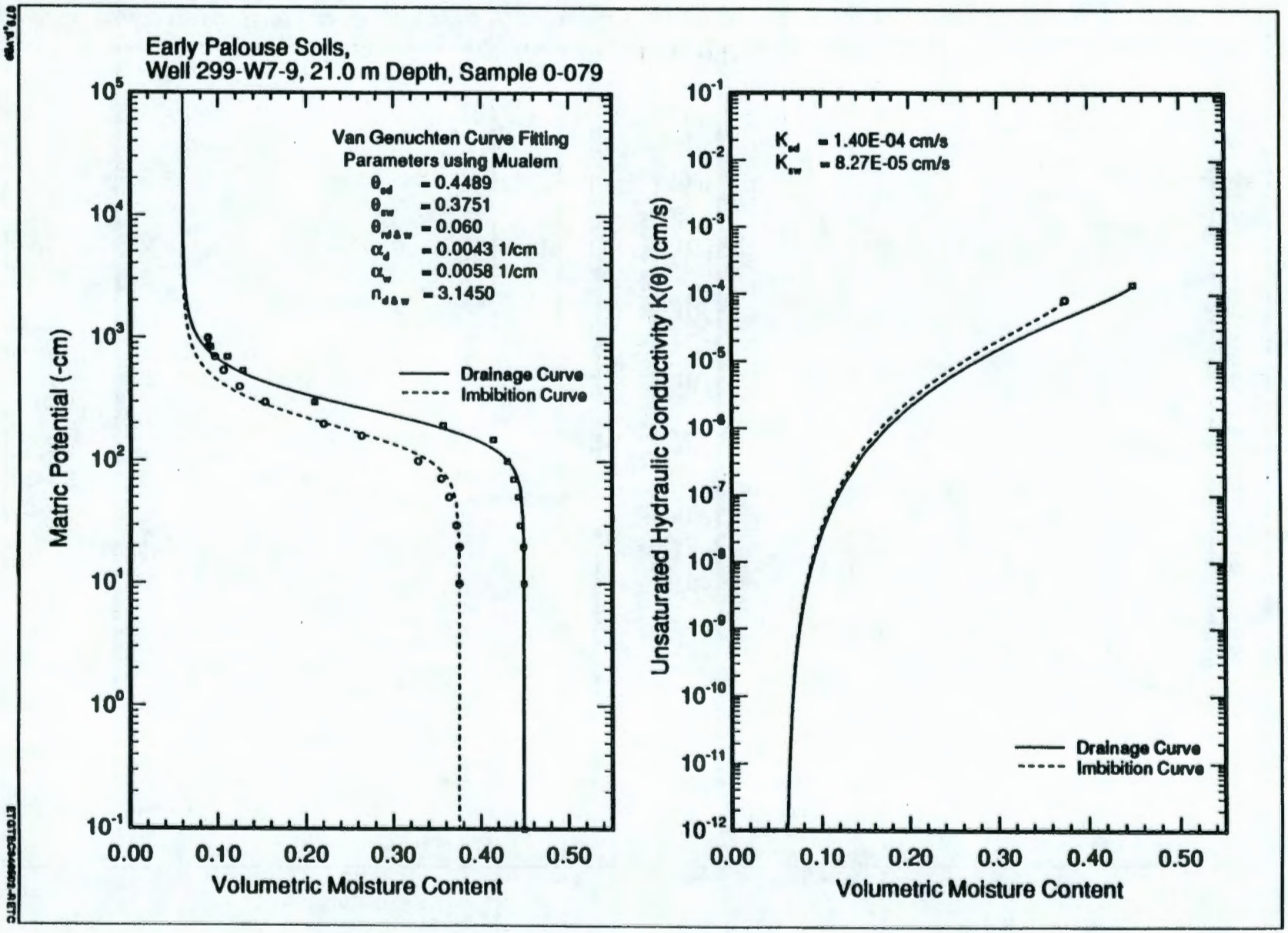


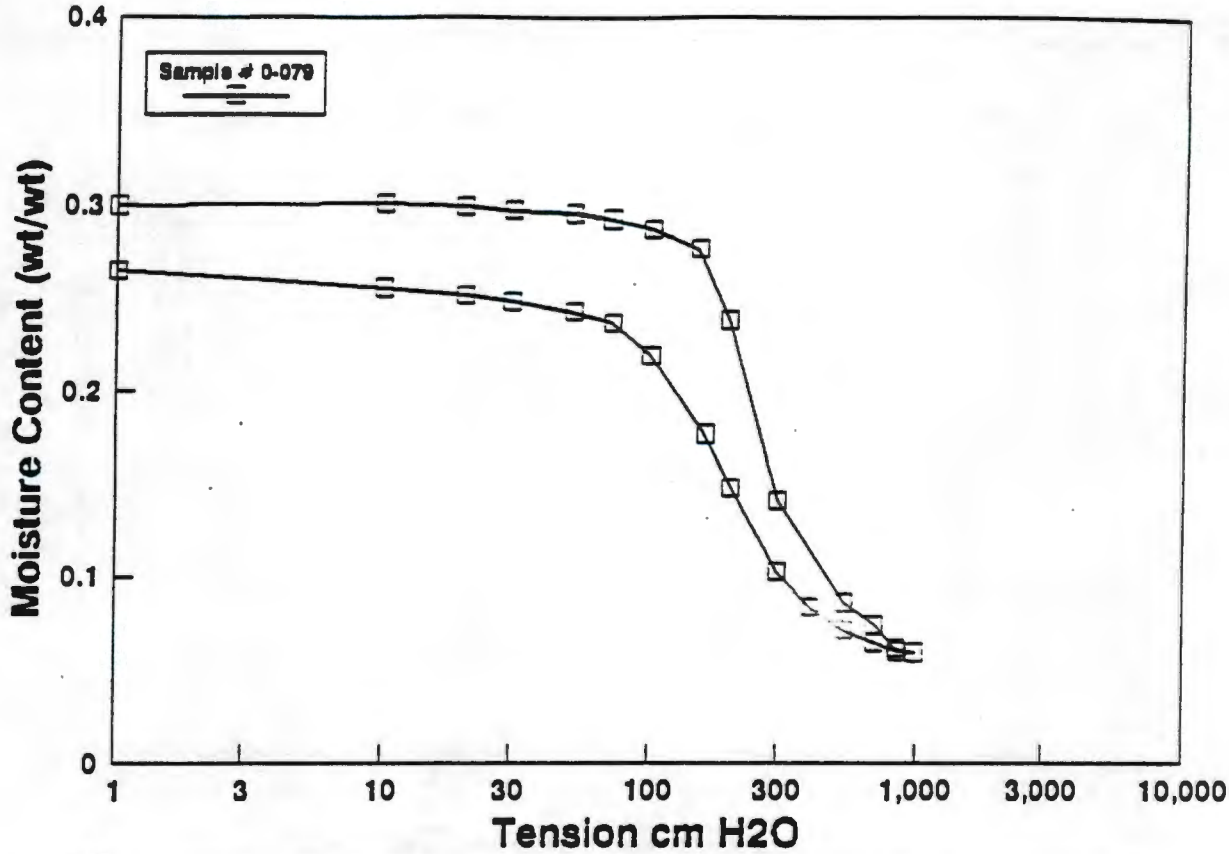
ETAL NO. 0-171

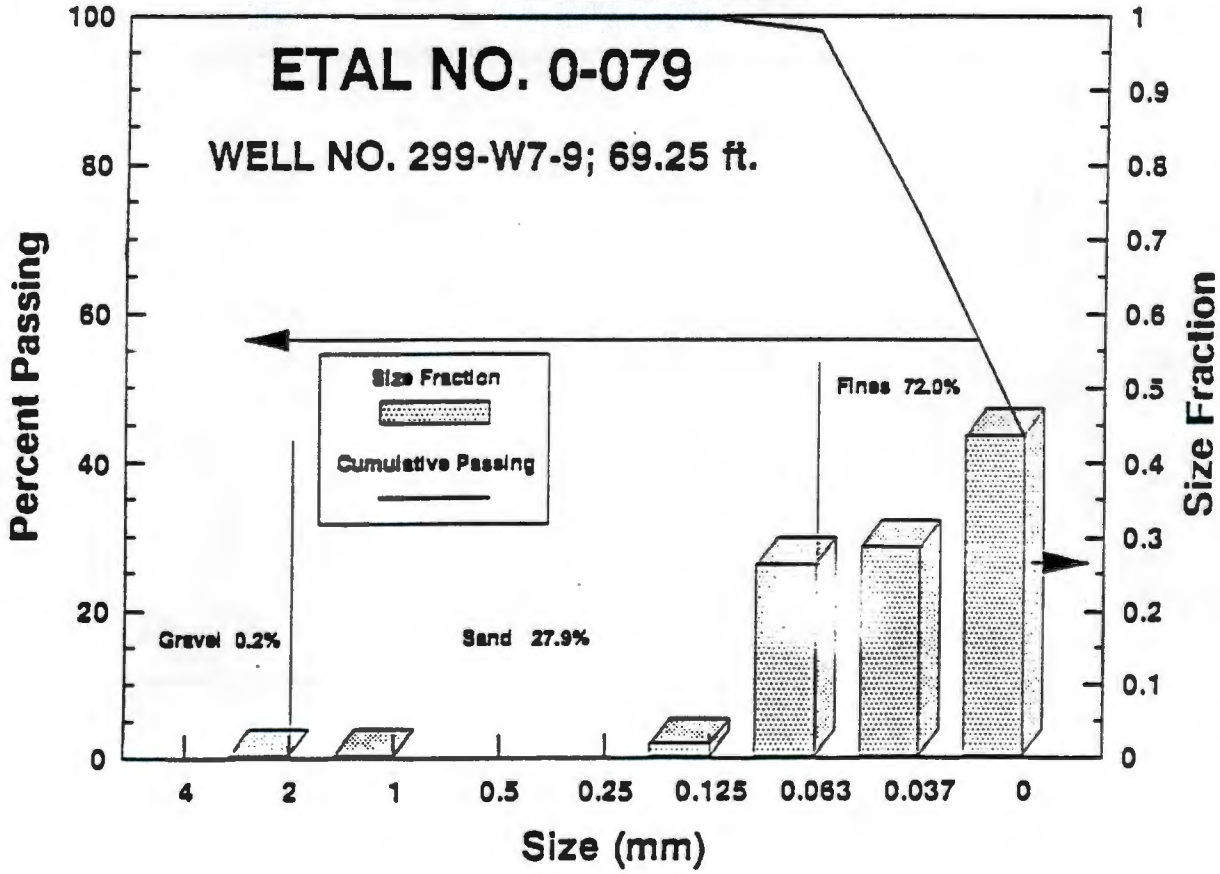
WELL NO. 299-W15-2; 120 ft.



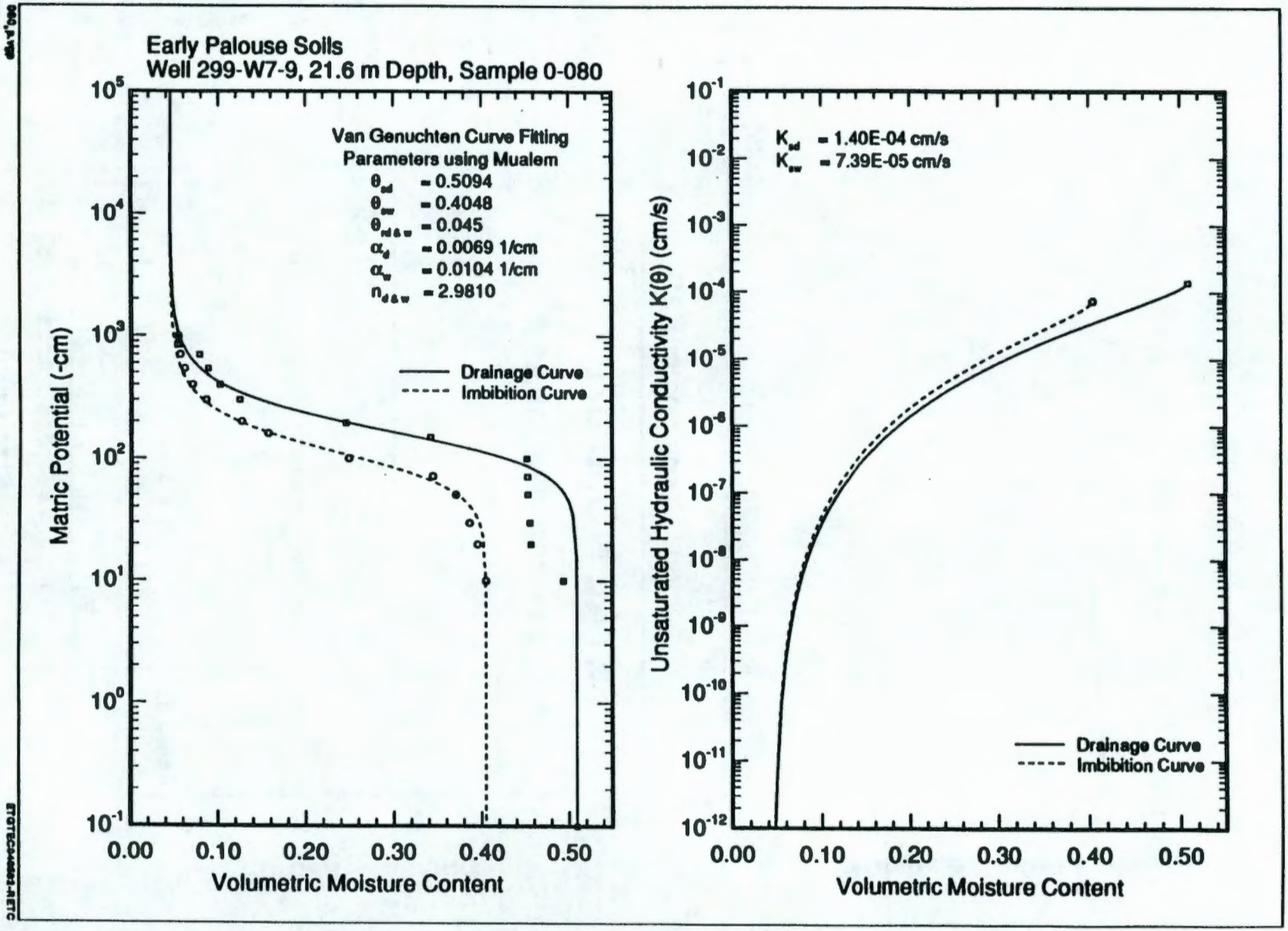

Plio-Pleistocene
Well 299-W7-2, 19.8 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.6292
θ_r = 0.054
α = 0.3603 1/cm
n = 1.3444
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 6.80E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content

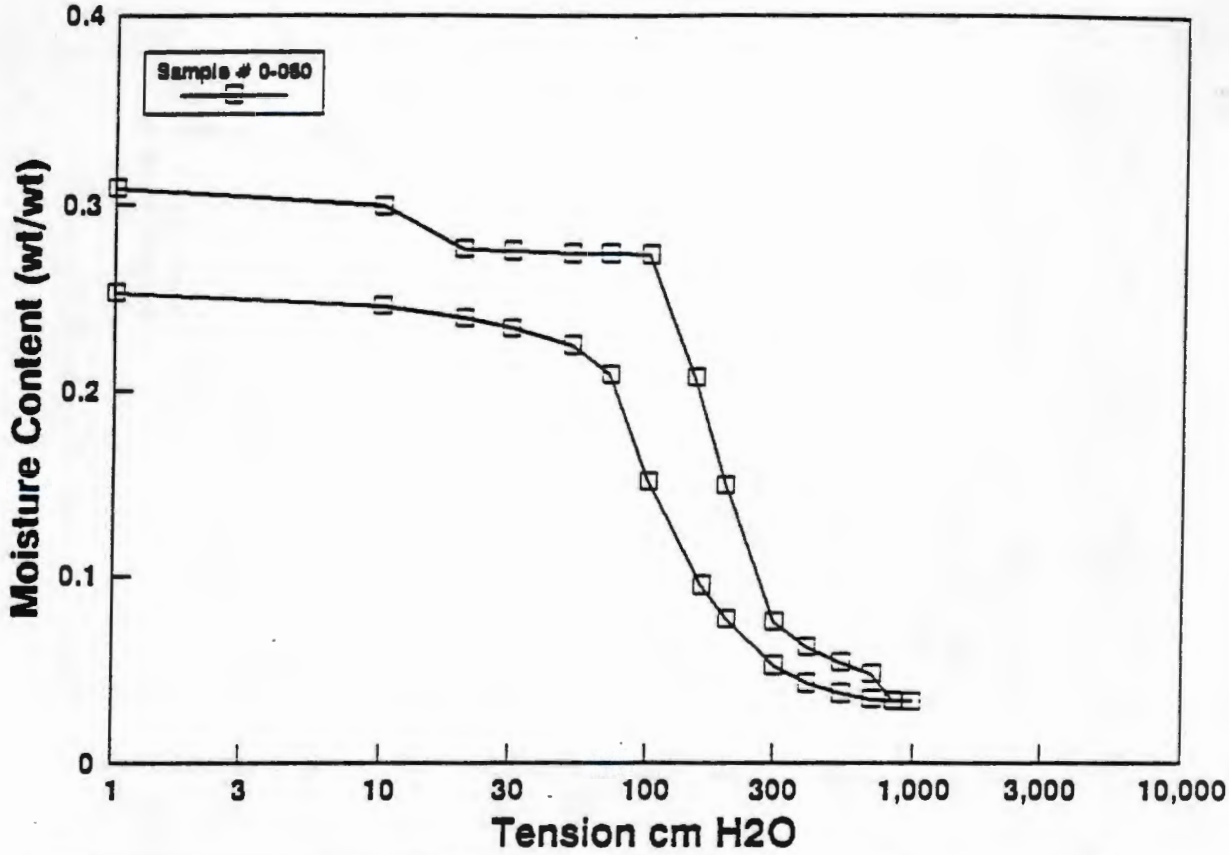

Early Palouse Soils,
Well 299-W7-9, 21.0 m Depth, Sample 0-079
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.4489
θ_{sw} = 0.3751
$\theta_{rd\&w}$ = 0.060
α_d = 0.0043 1/cm
α_w = 0.0058 1/cm
$n_{d\&w}$ = 3.1450
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 1.40E-04 cm/s
K_{sw} = 8.27E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

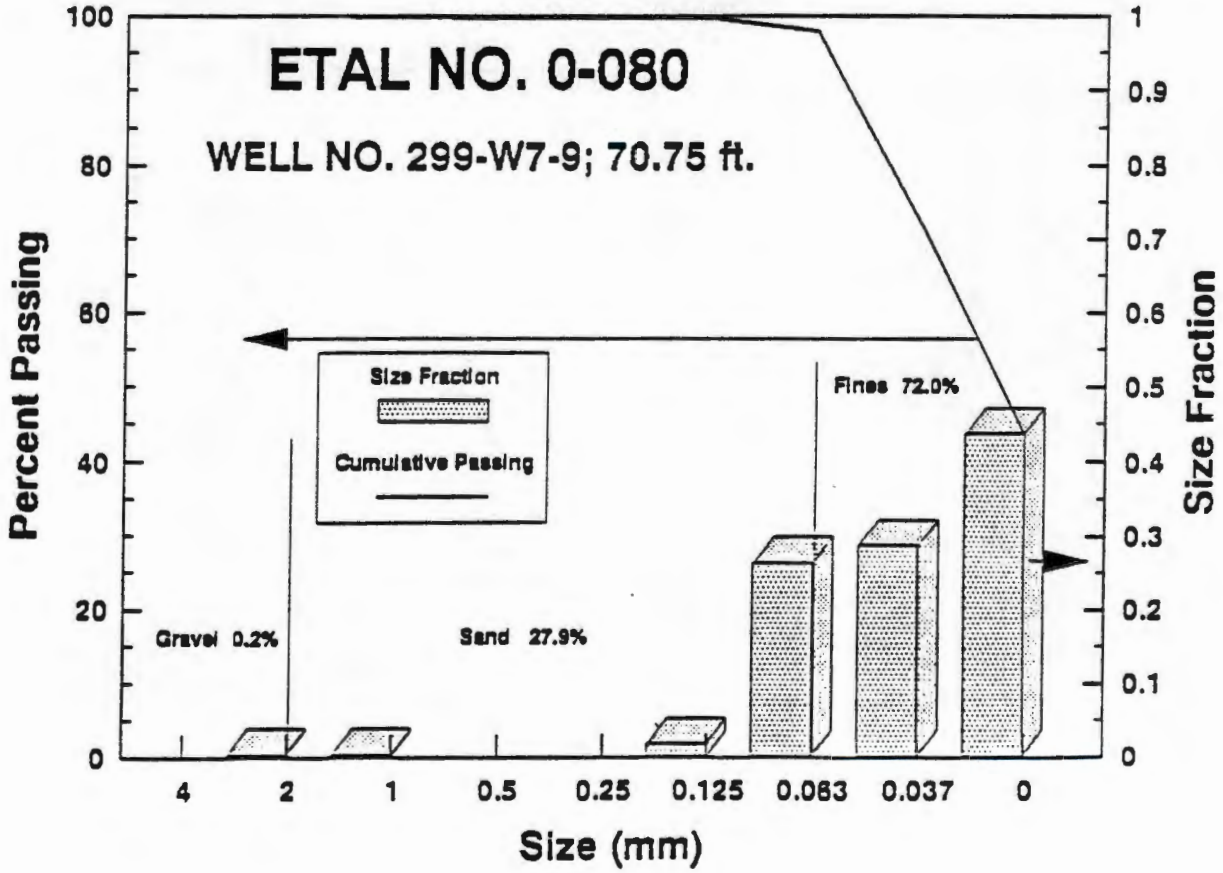




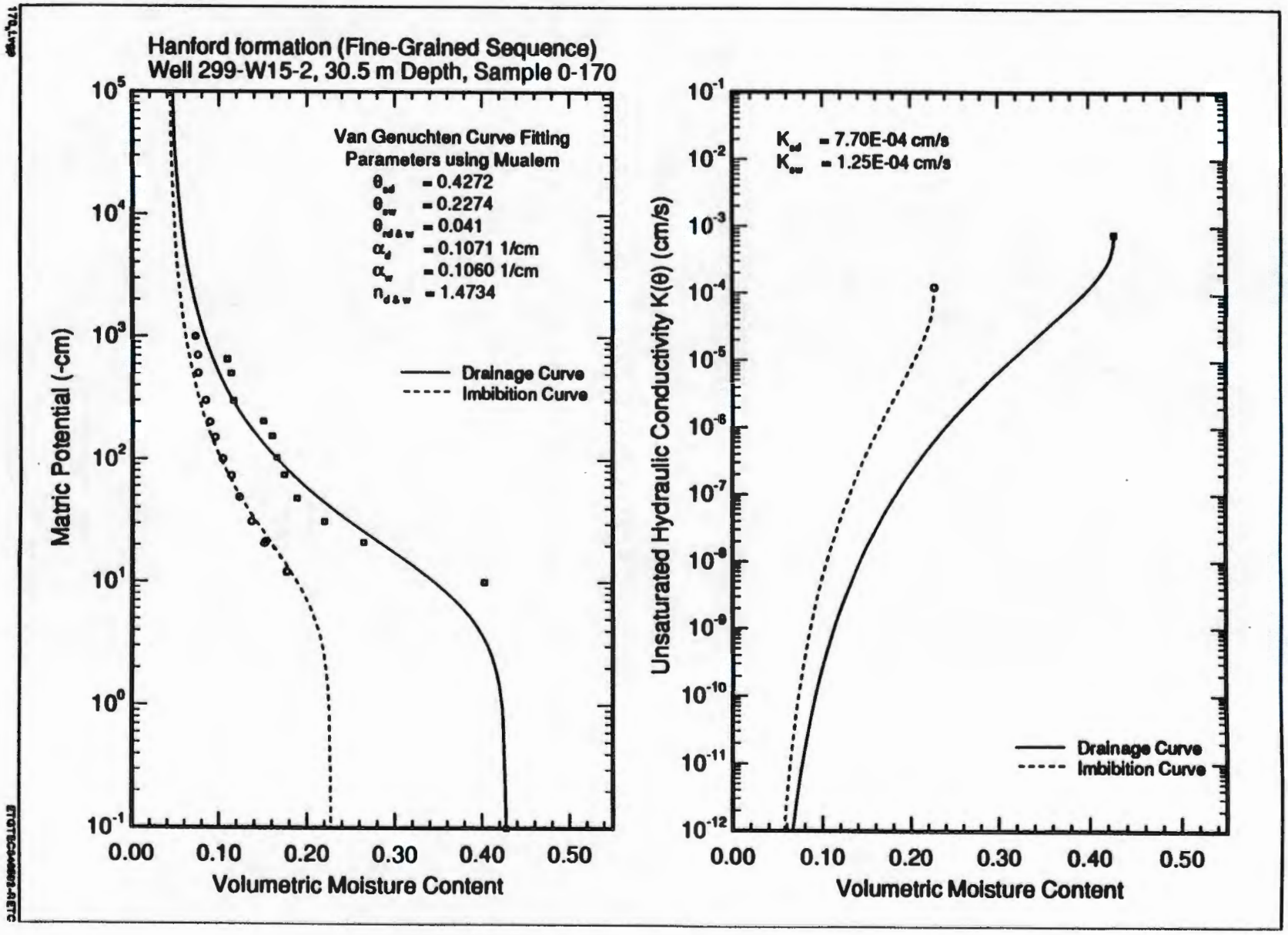
9413136.1981

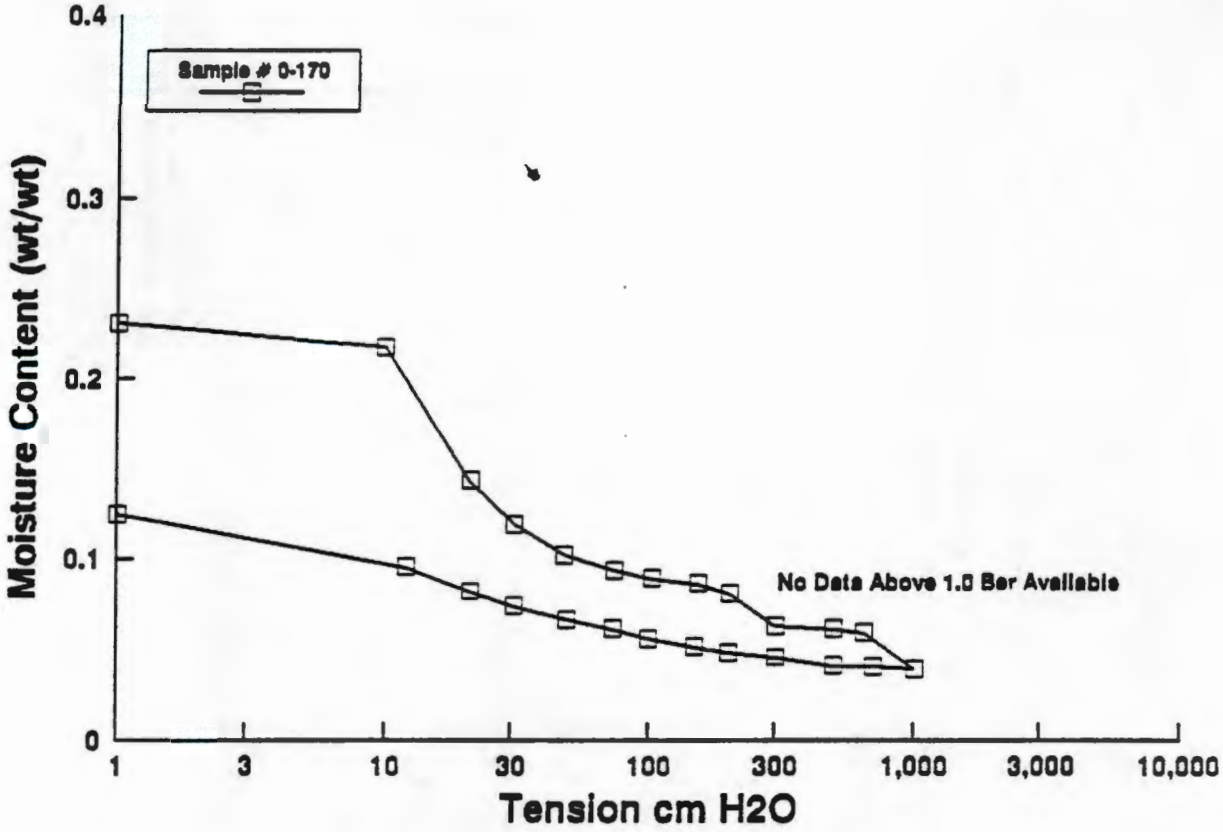

Early Palouse Soils
Well 299-W7-9, 21.6 m Depth, Sample 0-080
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.5094
θsw = 0.4048
θrd&w = 0.045
αd = 0.0069 1/cm
αw = 0.0104 1/cm
nd&w = 2.9810
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.40E-04 cm/s
Ksw = 7.39E-05 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content





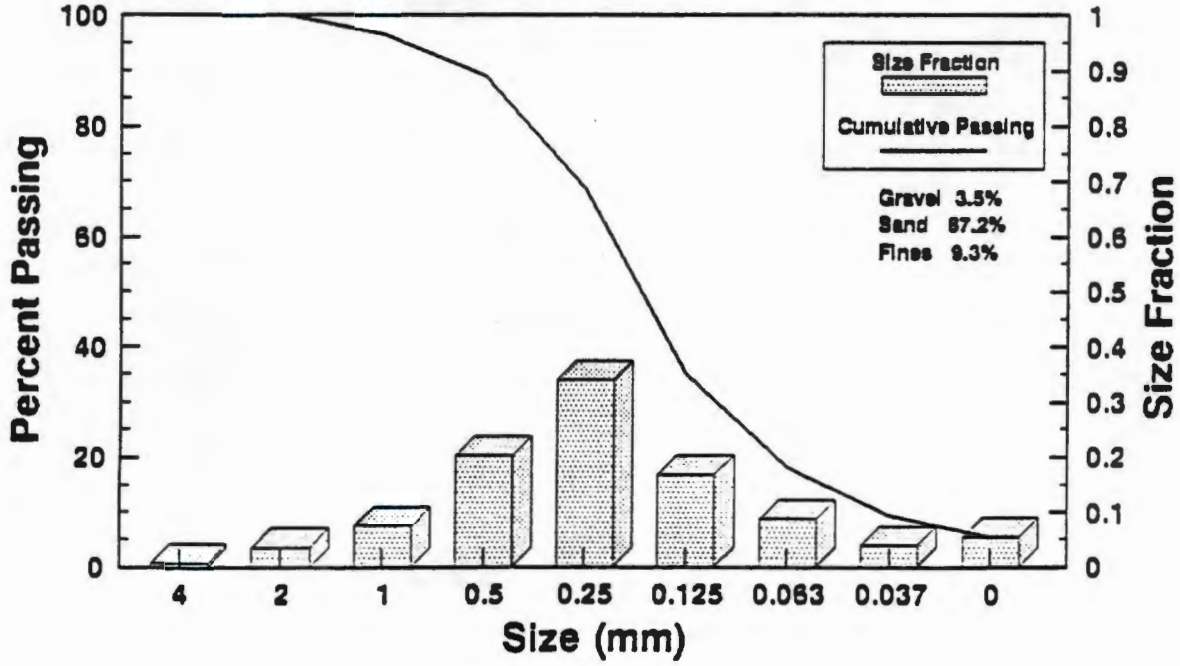
9413136.1983

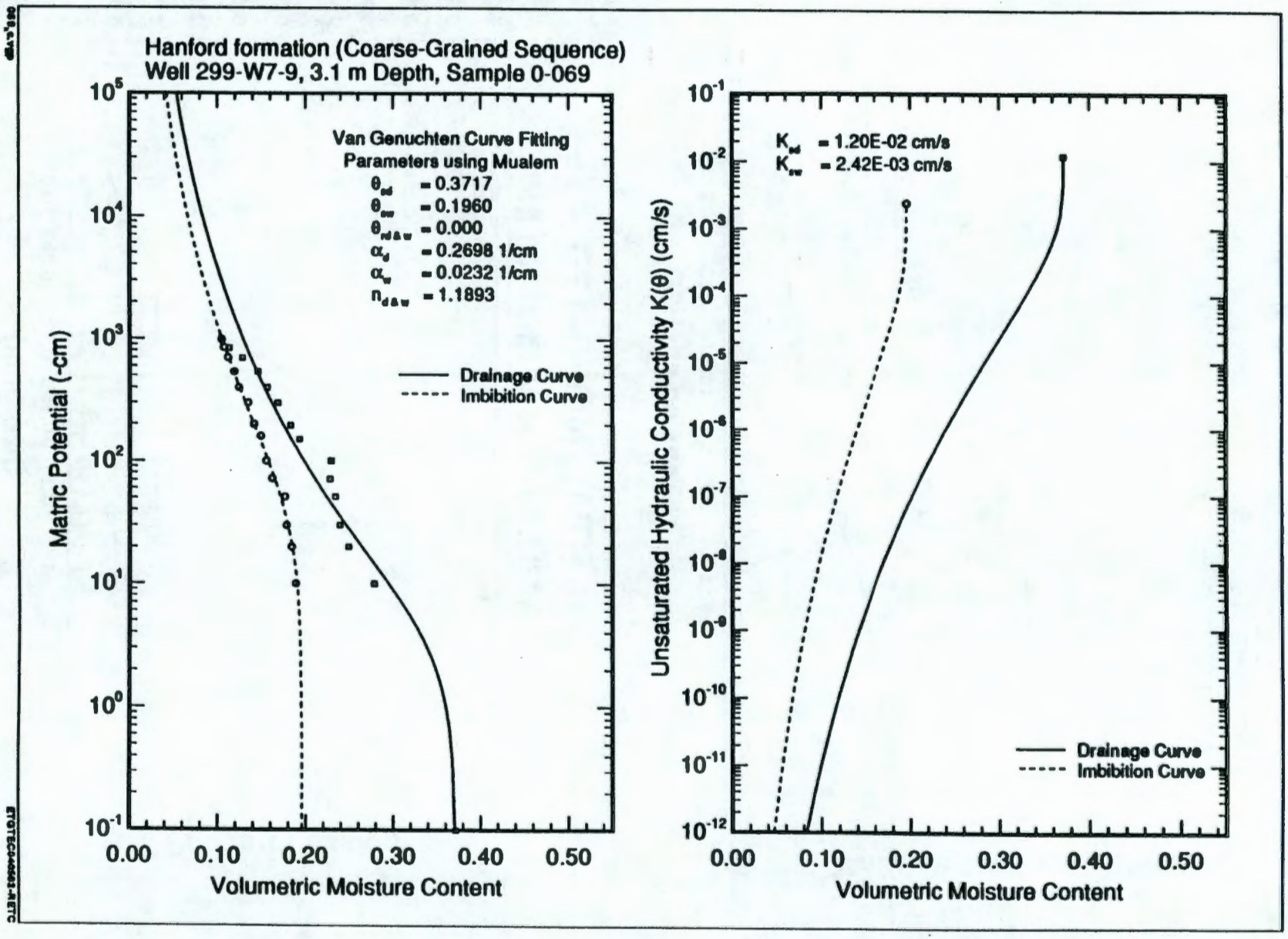

Hanford formation (Fine-Grained Sequence)
Well 299-W15-2, 30.5 m Depth, Sample 0-170
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.4272
θ_{sw} = 0.2274
$\theta_{rd\&w}$ = 0.041
α_d = 0.1071 1/cm
α_w = 0.1060 1/cm
$n_{d\&w}$ = 1.4734
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 7.70E-04 cm/s
K_{sw} = 1.25E-04 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content



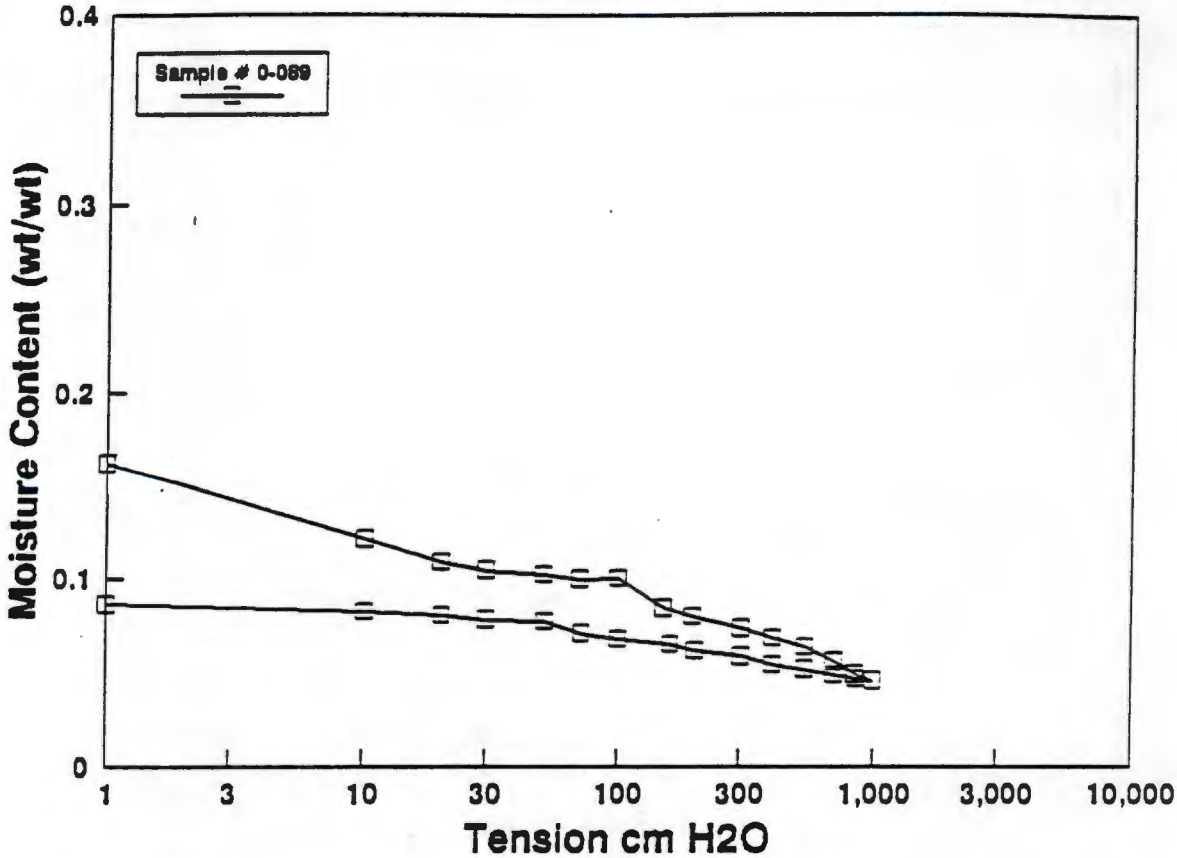
ETAL NO. 0-170

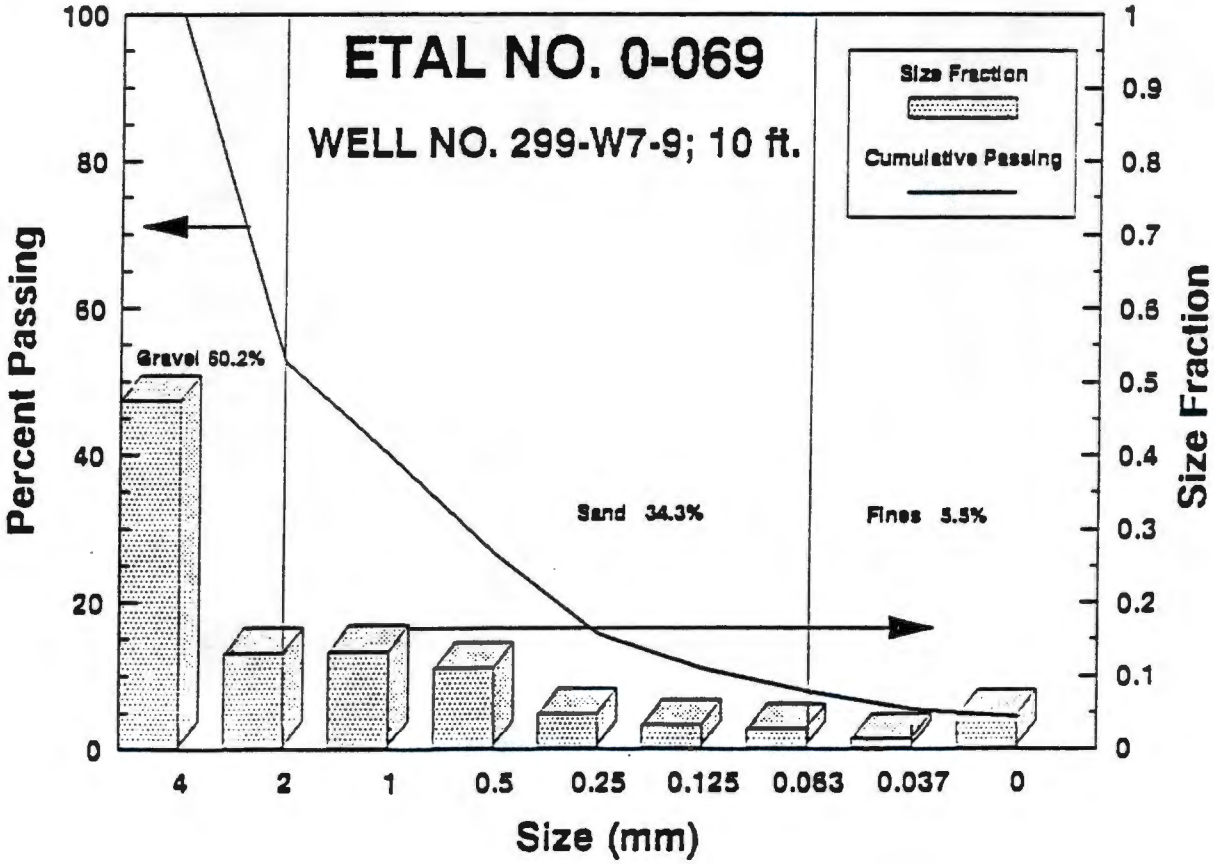
WELL NO. 299-W15-2; 100 ft.

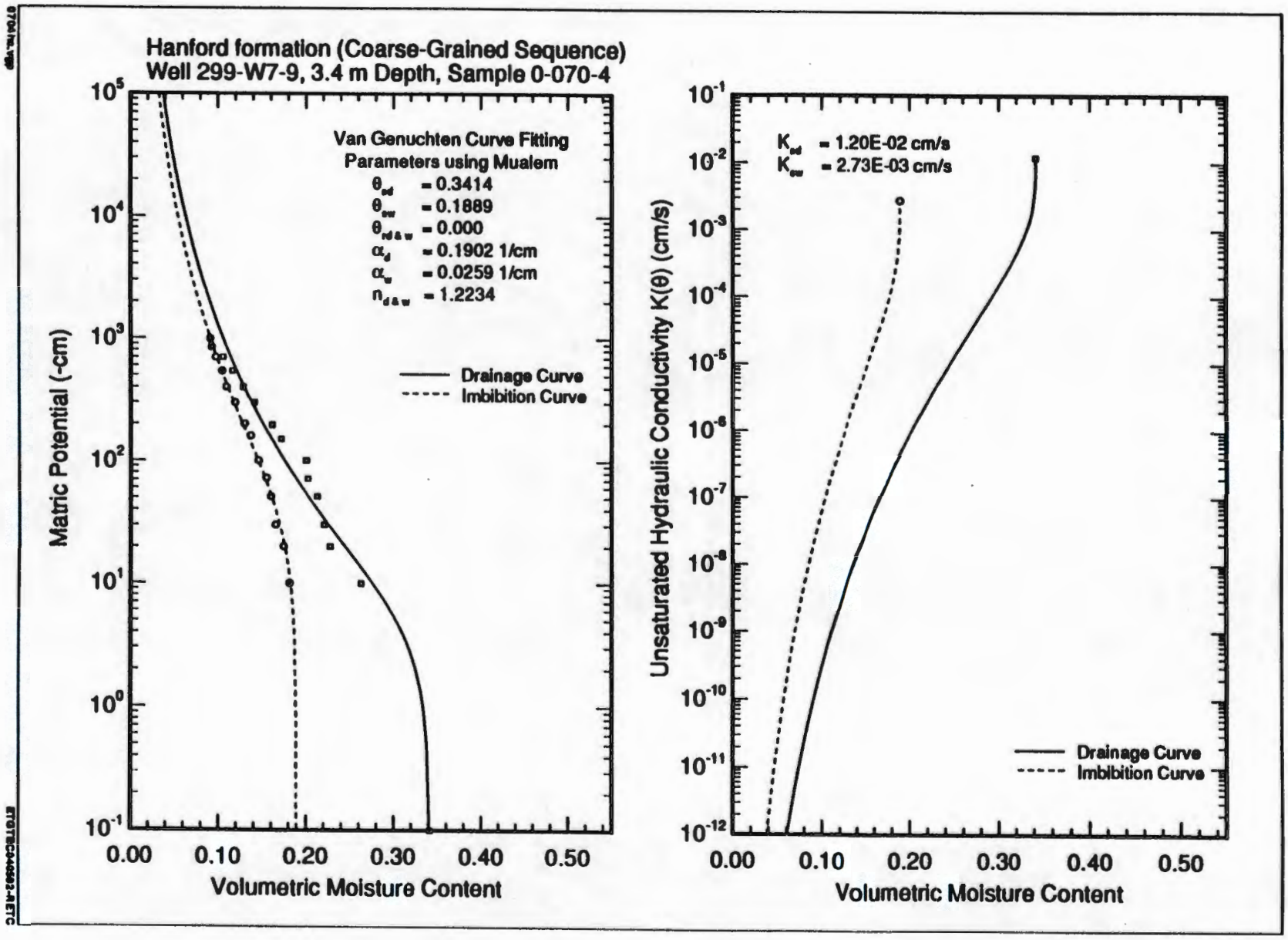



Hanford formation (Coarse-Grained Sequence)
Well 299-W7-9, 3.1 m Depth, Sample 0-069
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3717
θsw = 0.1960
θrd&w = 0.000
αd = 0.2698 1/cm
αw = 0.0232 1/cm
nd&w = 1.1893
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.20E-02 cm/s
Ksw = 2.42E-03 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

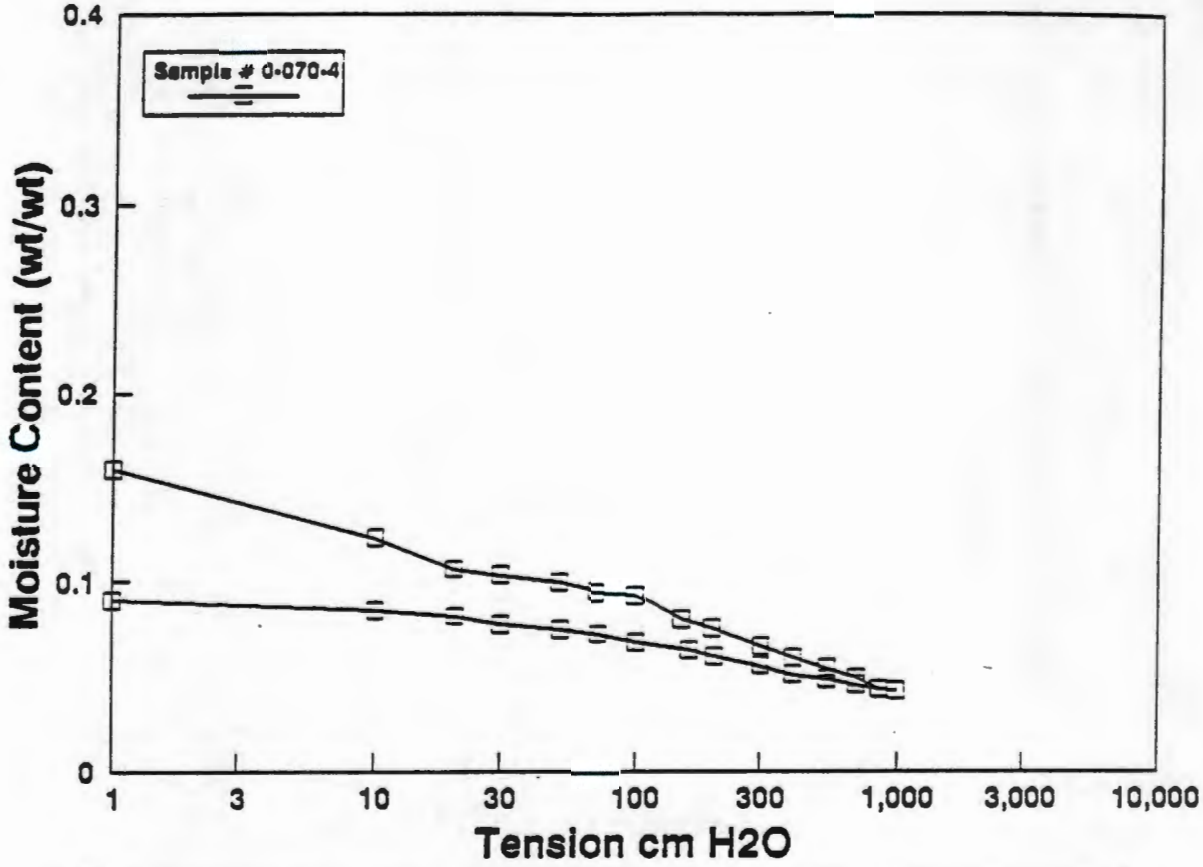
9413136.1987

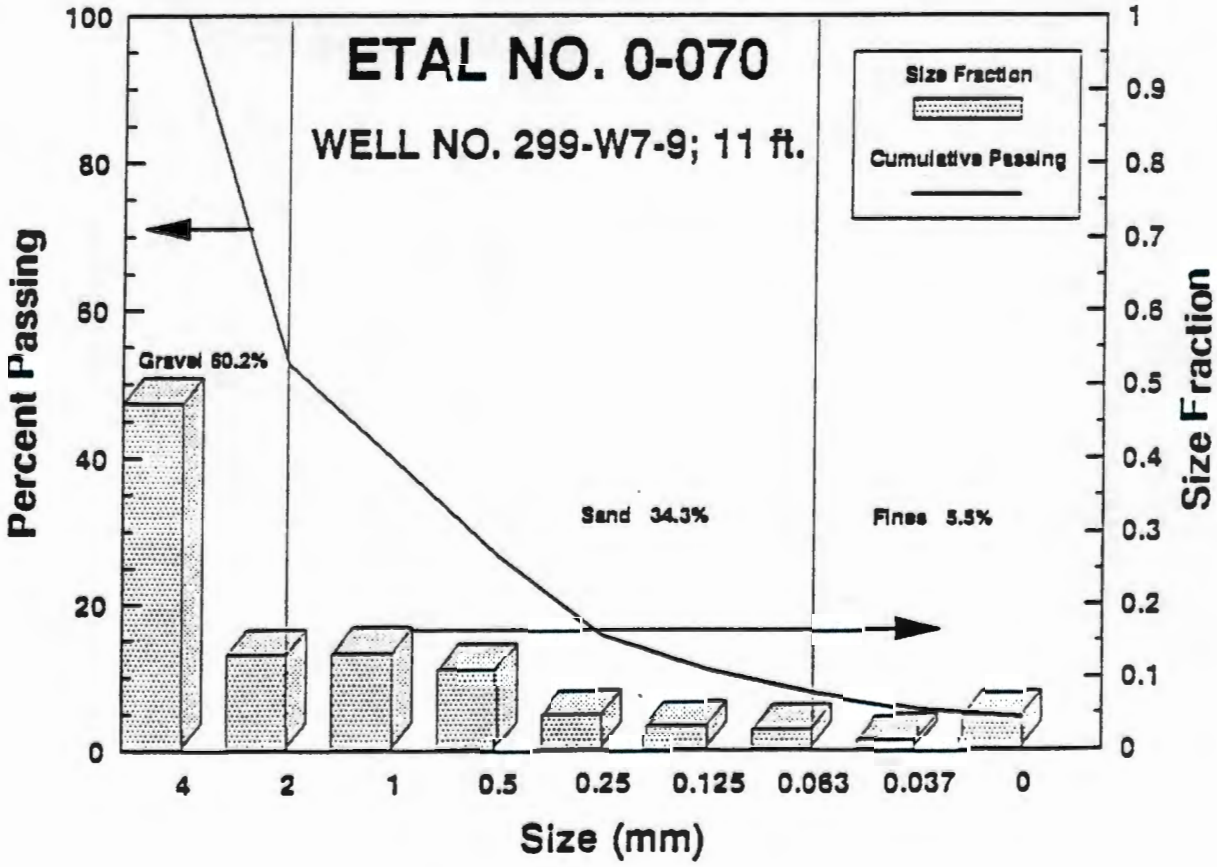


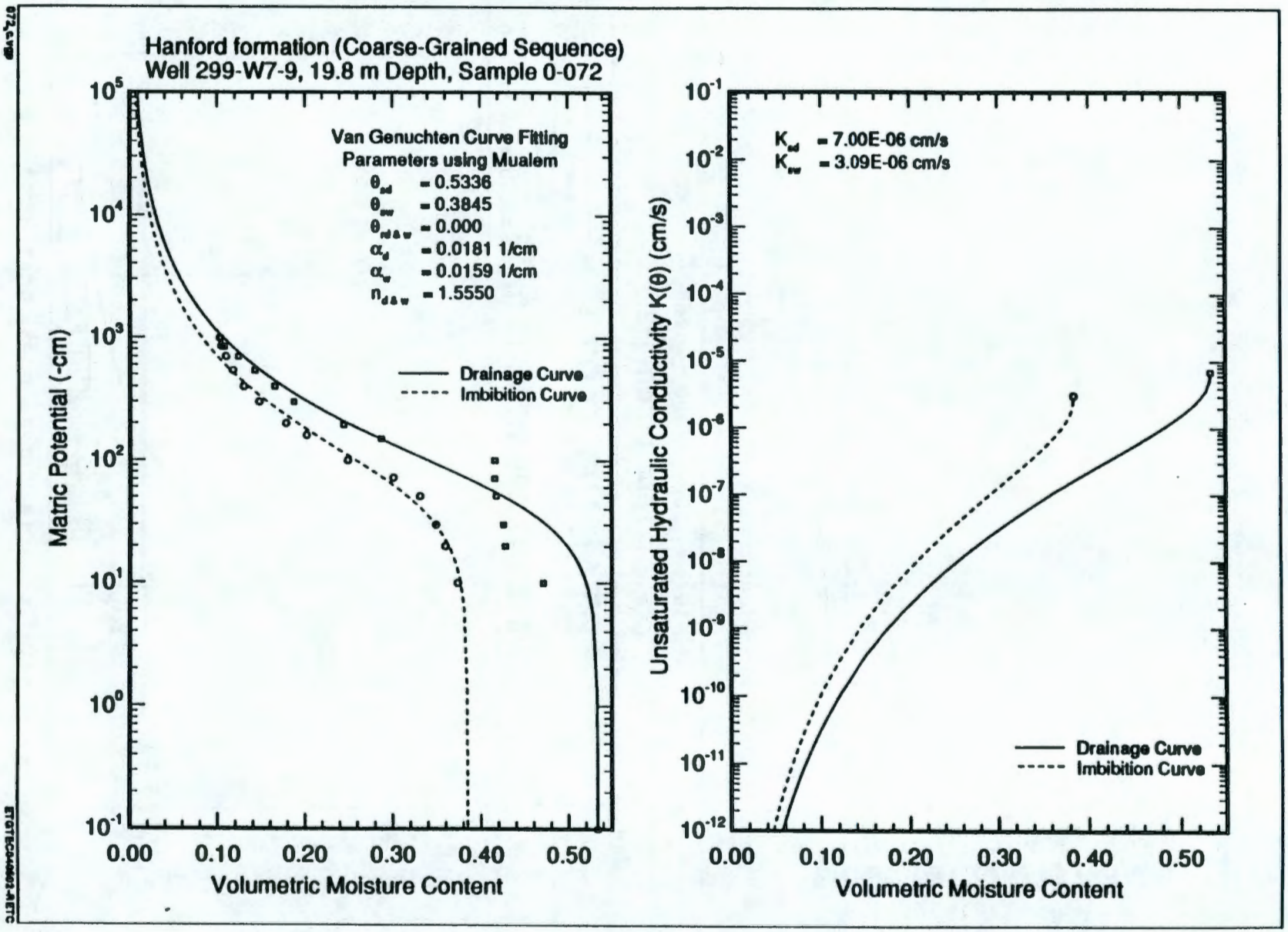


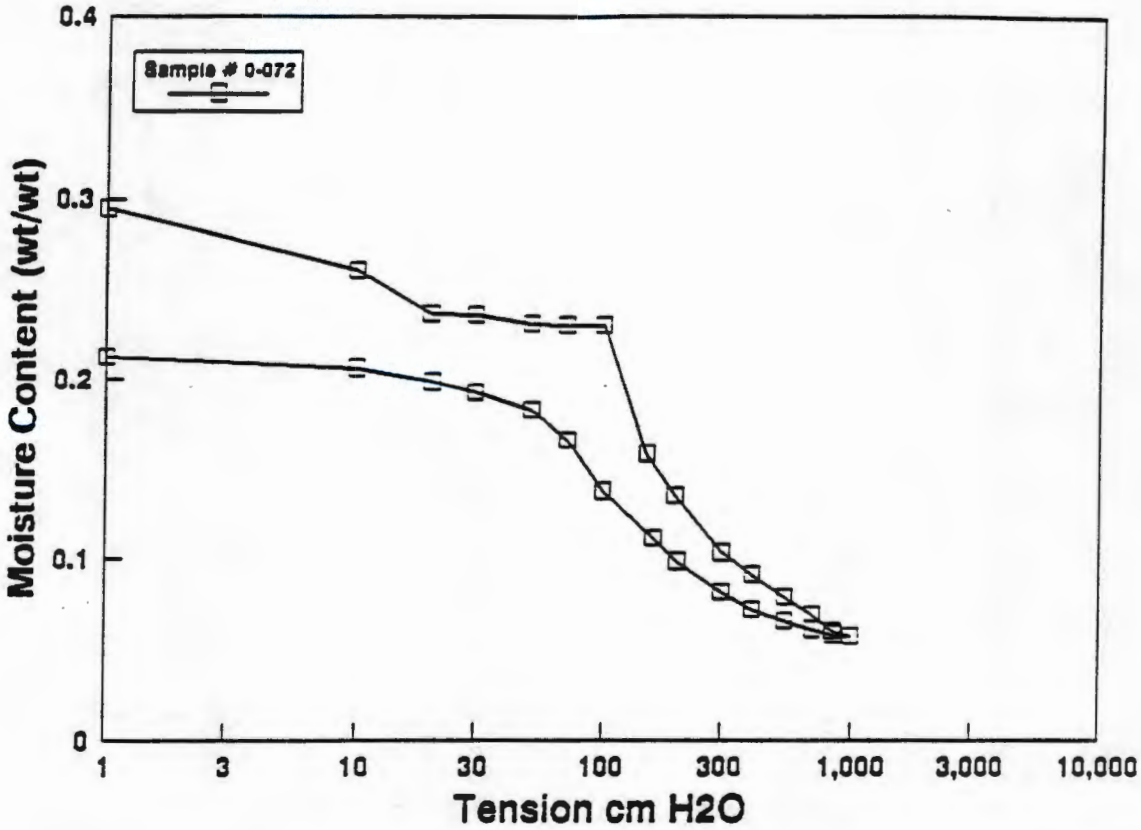

Hanford formation (Coarse-Grained Sequence)
Well 299-W7-9, 3.4 m Depth, Sample 0-070-4
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3414
θsw = 0.1889
θrd&w = 0.000
αd = 0.1902 1/cm
αw = 0.0259 1/cm
nd&w = 1.2234
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.20E-02 cm/s
Ksw = 2.73E-03 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

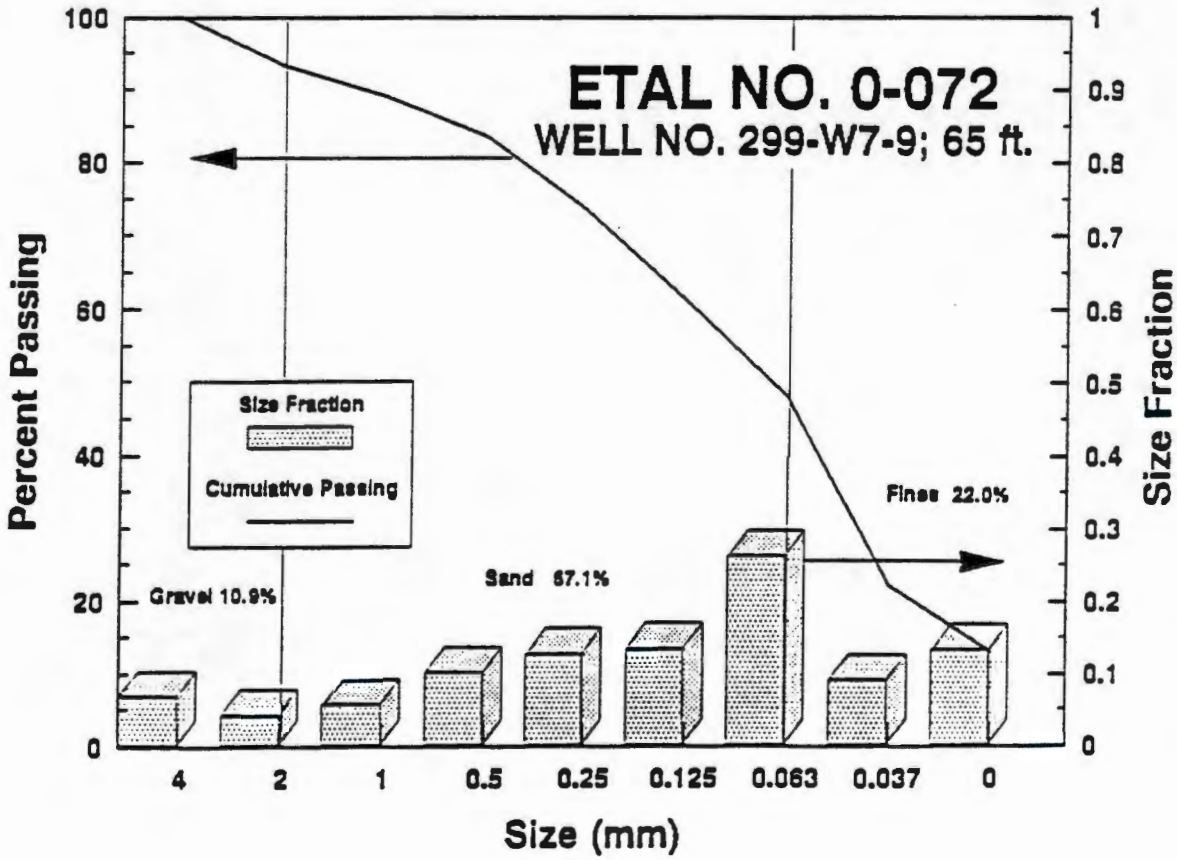
9413136.1989

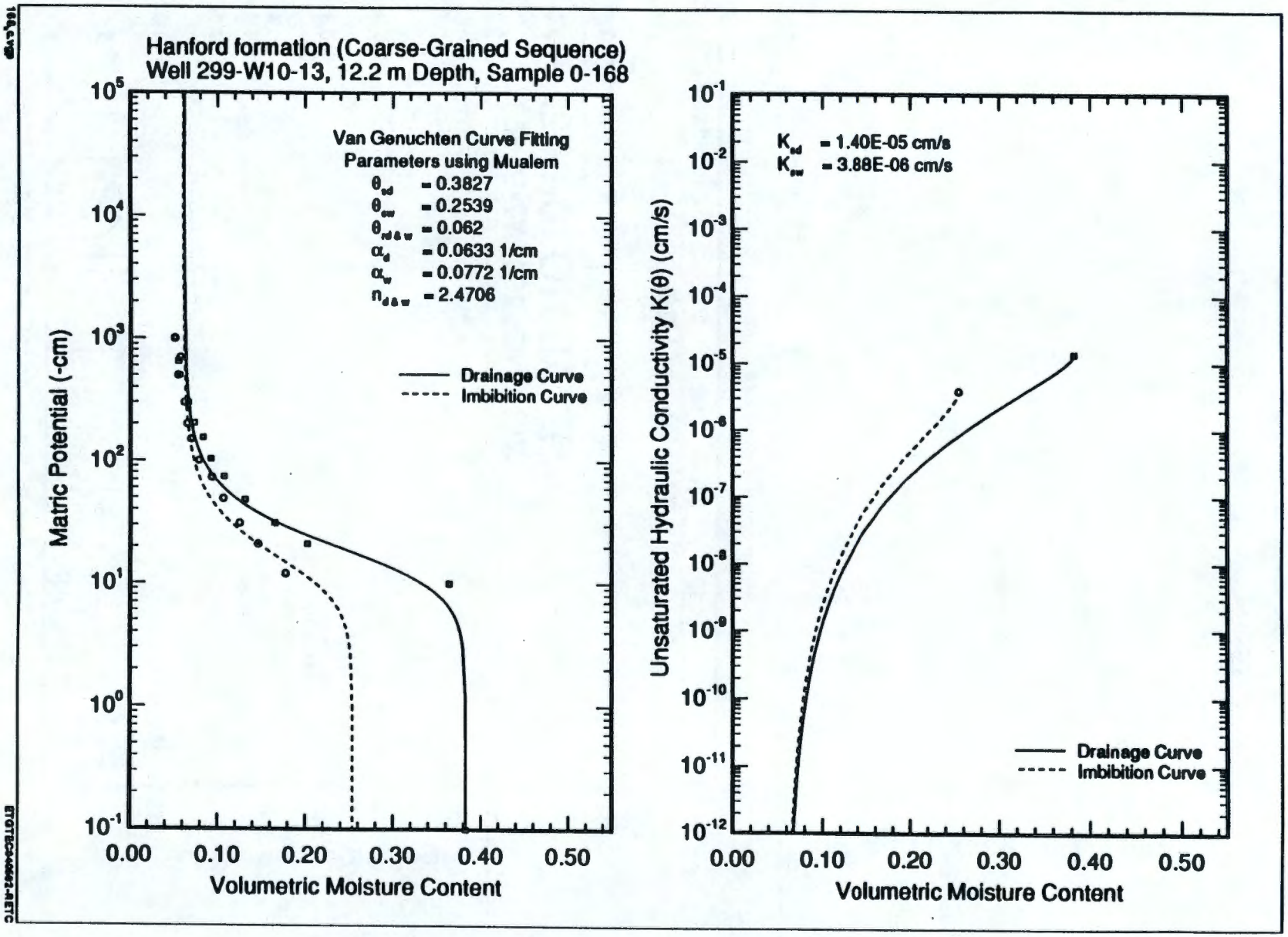




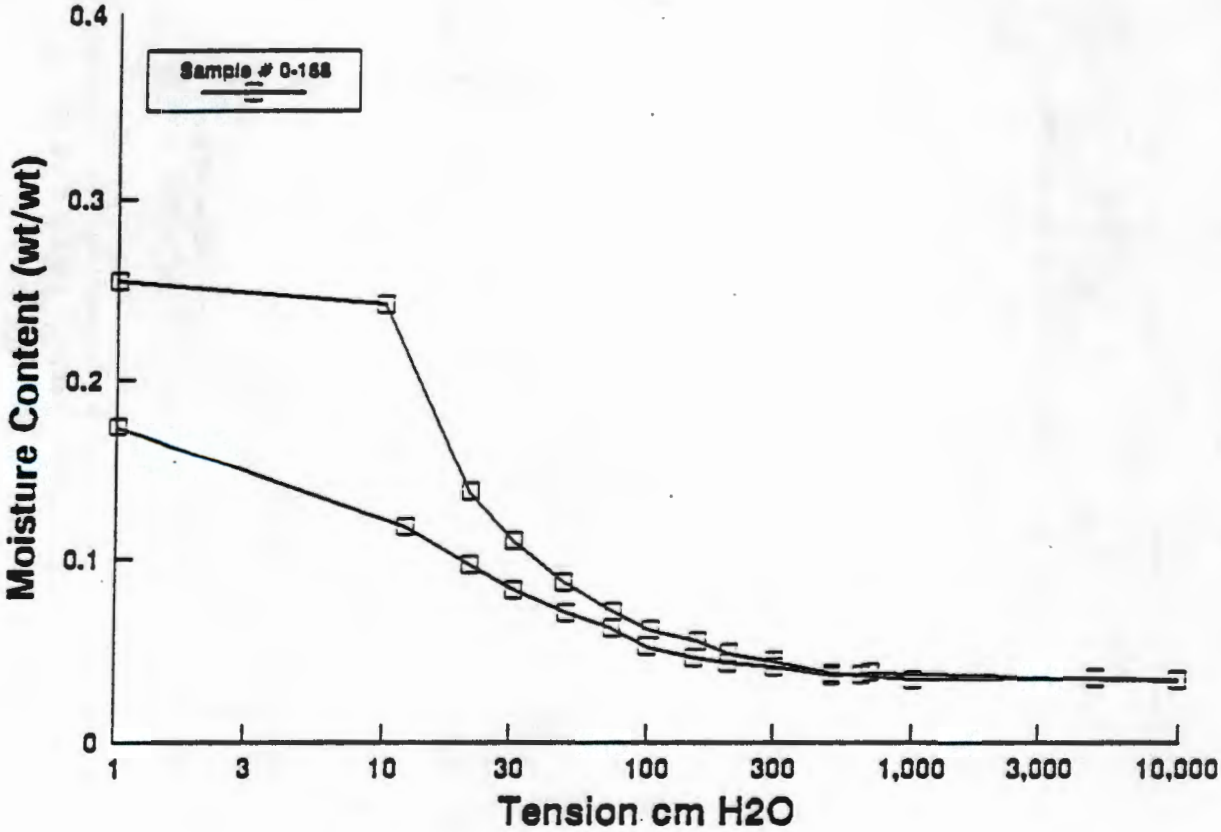

Hanford formation (Coarse-Grained Sequence)
Well 299-W7-9, 19.8 m Depth, Sample 0-072
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.5336
θ_{sw} = 0.3845
$\theta_{rd\&w}$ = 0.000
α_d = 0.0181 1/cm
α_w = 0.0159 1/cm
$n_{d\&w}$ = 1.5550
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 7.00E-06 cm/s
K_{sw} = 3.09E-06 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content


Sample # 0-072
Moisture Content (wt/wt)
0.4
0.3
0.2
0.1
0
1
3
10
30
100
300
1,000
3,000
10,000
Tension cm H2O


ETAL NO. 0-072
WELL NO. 299-W7-9; 65 ft.
Percent Passing
Size Fraction
Size Fraction
Cumulative Passing
Gravel 10.9%
Sand 67.1%
Fines 22.0%
100
80
60
40
20
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4
2
1
0.5
0.25
0.125
0.063
0.037
0
Size (mm)

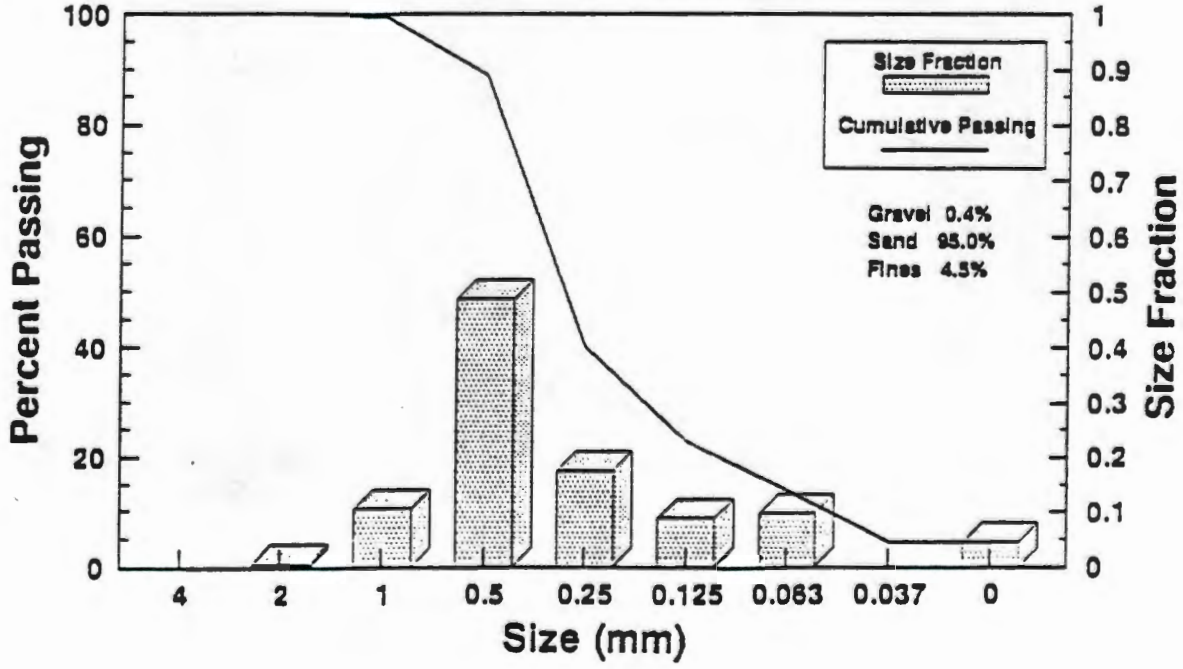

Hanford formation (Coarse-Grained Sequence)
Well 299-W10-13, 12.2 m Depth, Sample 0-168
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.3827
θ_{sw} = 0.2539
$\theta_{rd\&w}$ = 0.062
α_d = 0.0633 1/cm
α_w = 0.0772 1/cm
$n_{d\&w}$ = 2.4706
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 1.40E-05 cm/s
K_{sw} = 3.88E-06 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

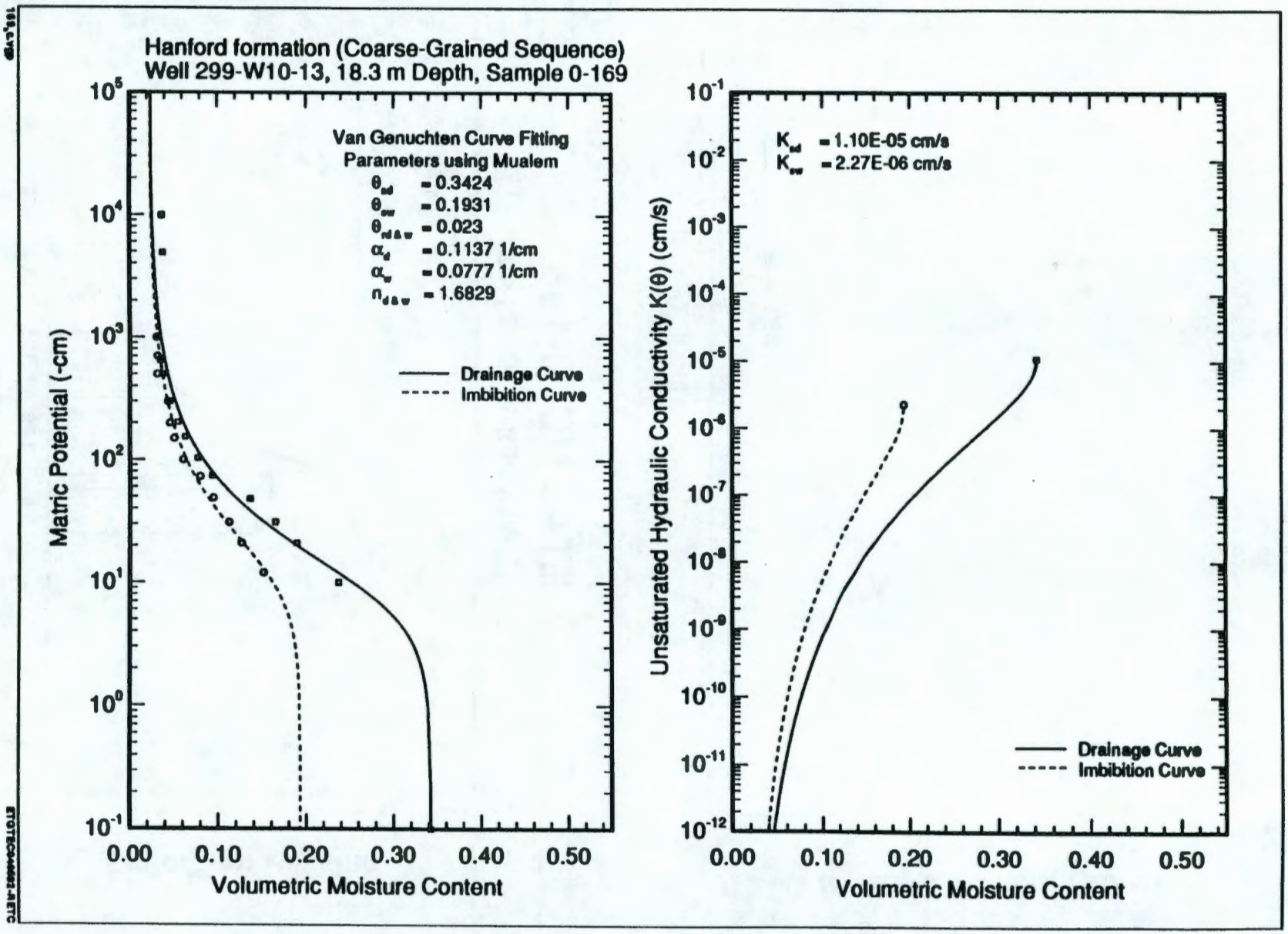
9413136.1993



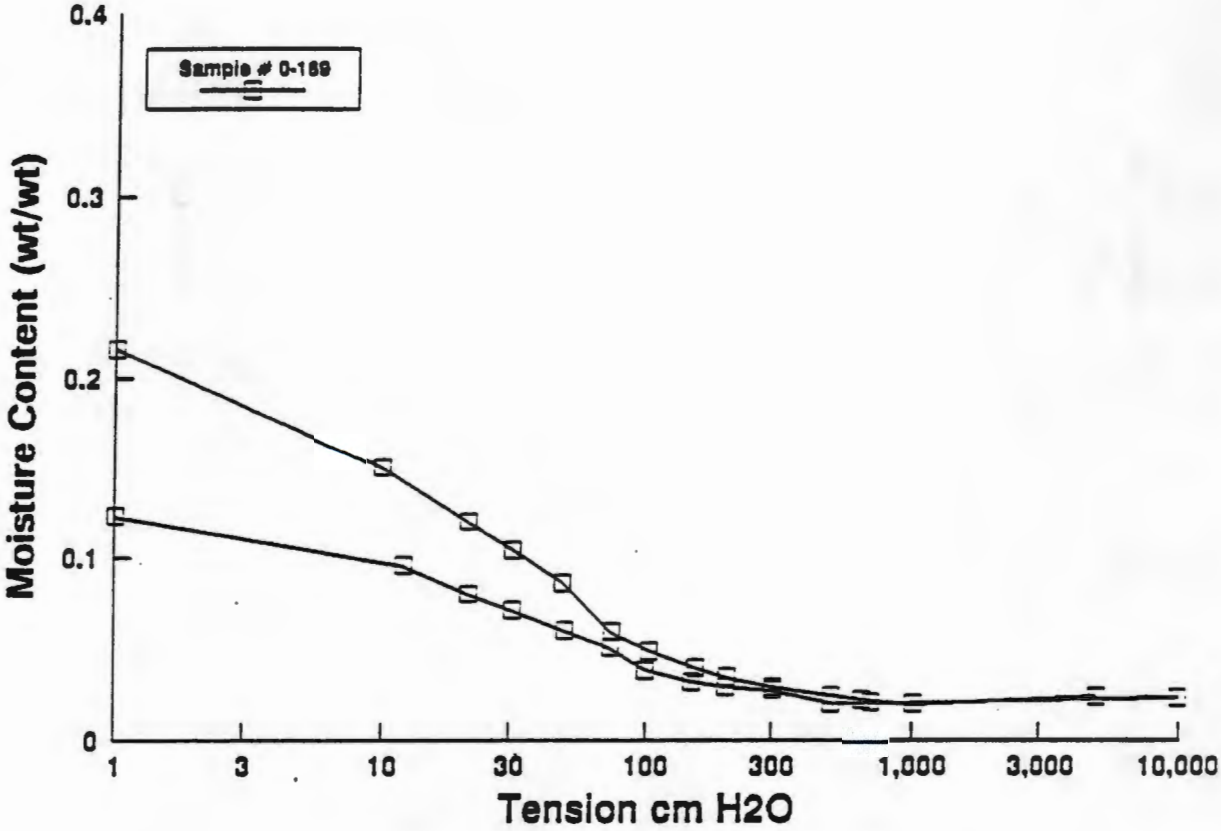
ETAL NO. 0-168

WELL NO. 299-W10-13; 40 ft.



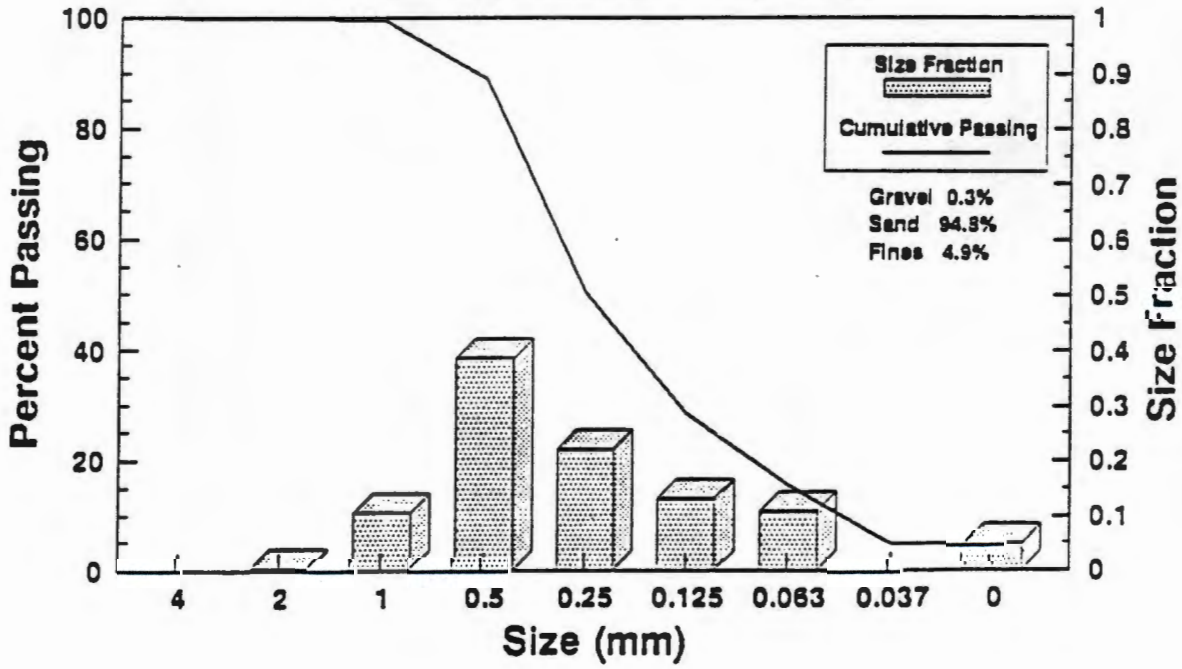

Hanford formation (Coarse-Grained Sequence)
Well 299-W10-13, 18.3 m Depth, Sample 0-169
Van Genuchten Curve Fitting
Parameters using Mualem
θ_{sd} = 0.3424
θ_{sw} = 0.1931
$\theta_{rd\&w}$ = 0.023
α_d = 0.1137 1/cm
α_w = 0.0777 1/cm
$n_{d\&w}$ = 1.6829
Drainage Curve
Imbibition Curve
Matric Potential (-cm)
Volumetric Moisture Content
K_{sd} = 1.10E-05 cm/s
K_{sw} = 2.27E-06 cm/s
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Drainage Curve
Imbibition Curve
Volumetric Moisture Content

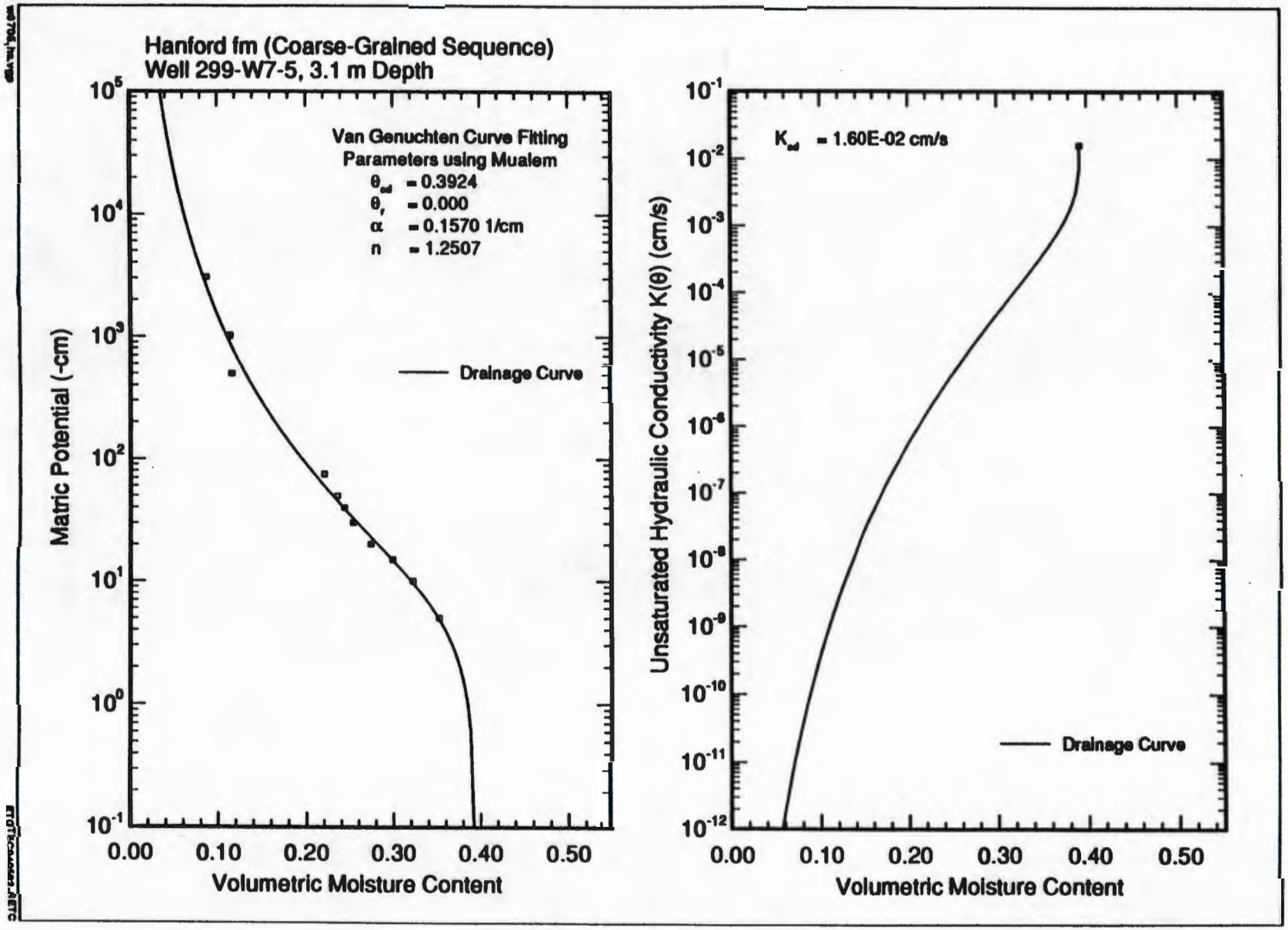
9413136.1995

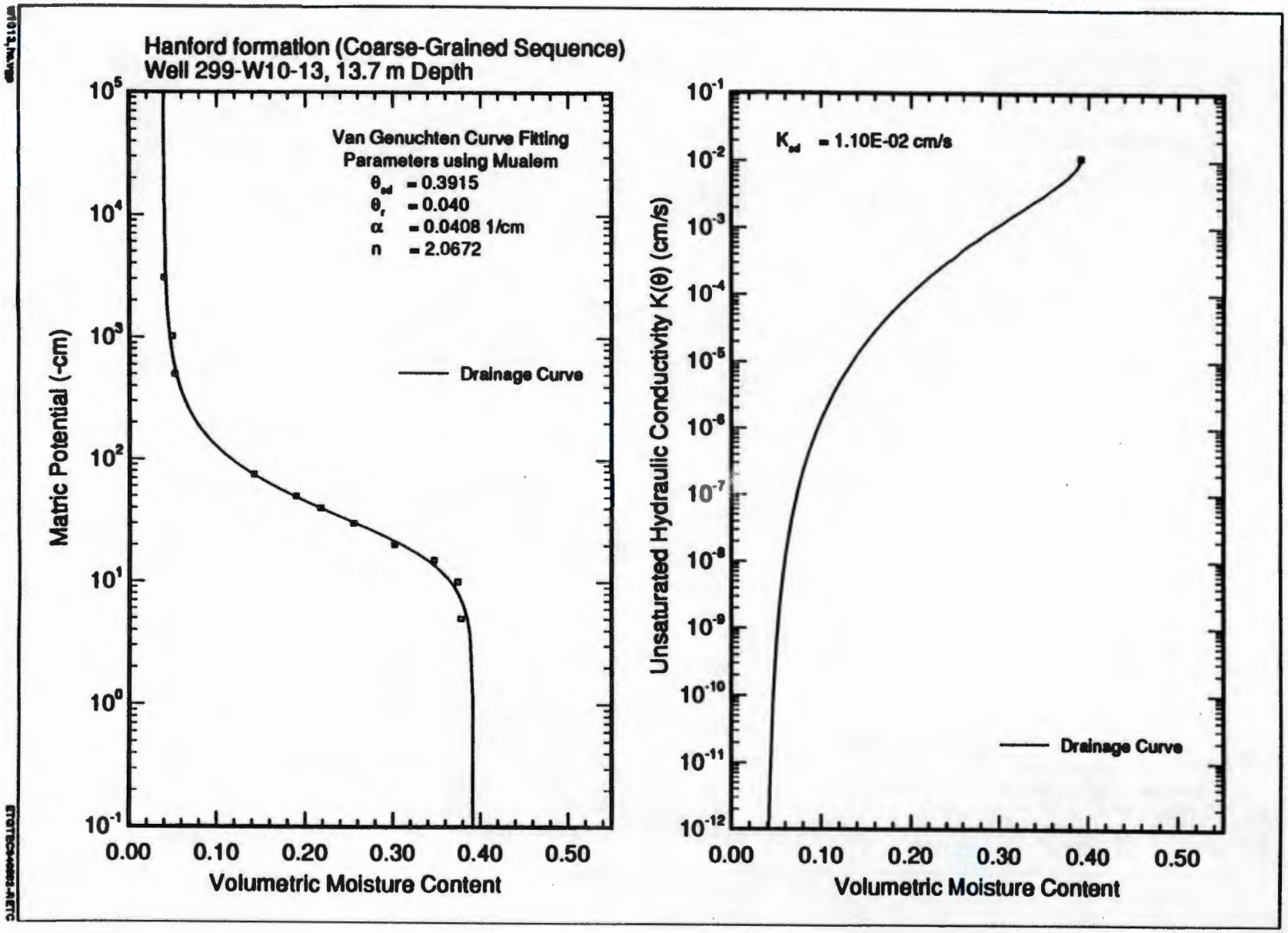


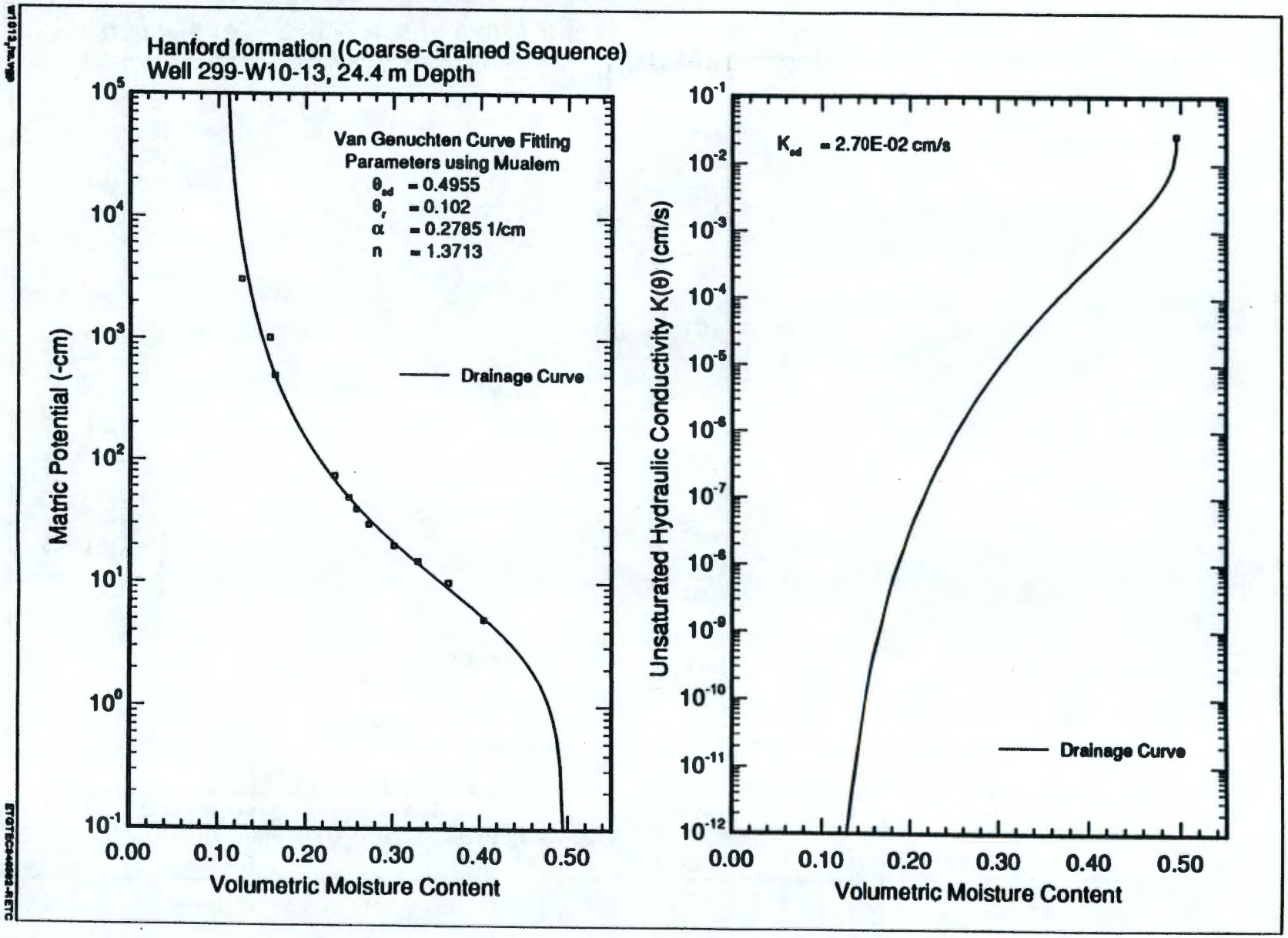
ETAL NO. 0-169

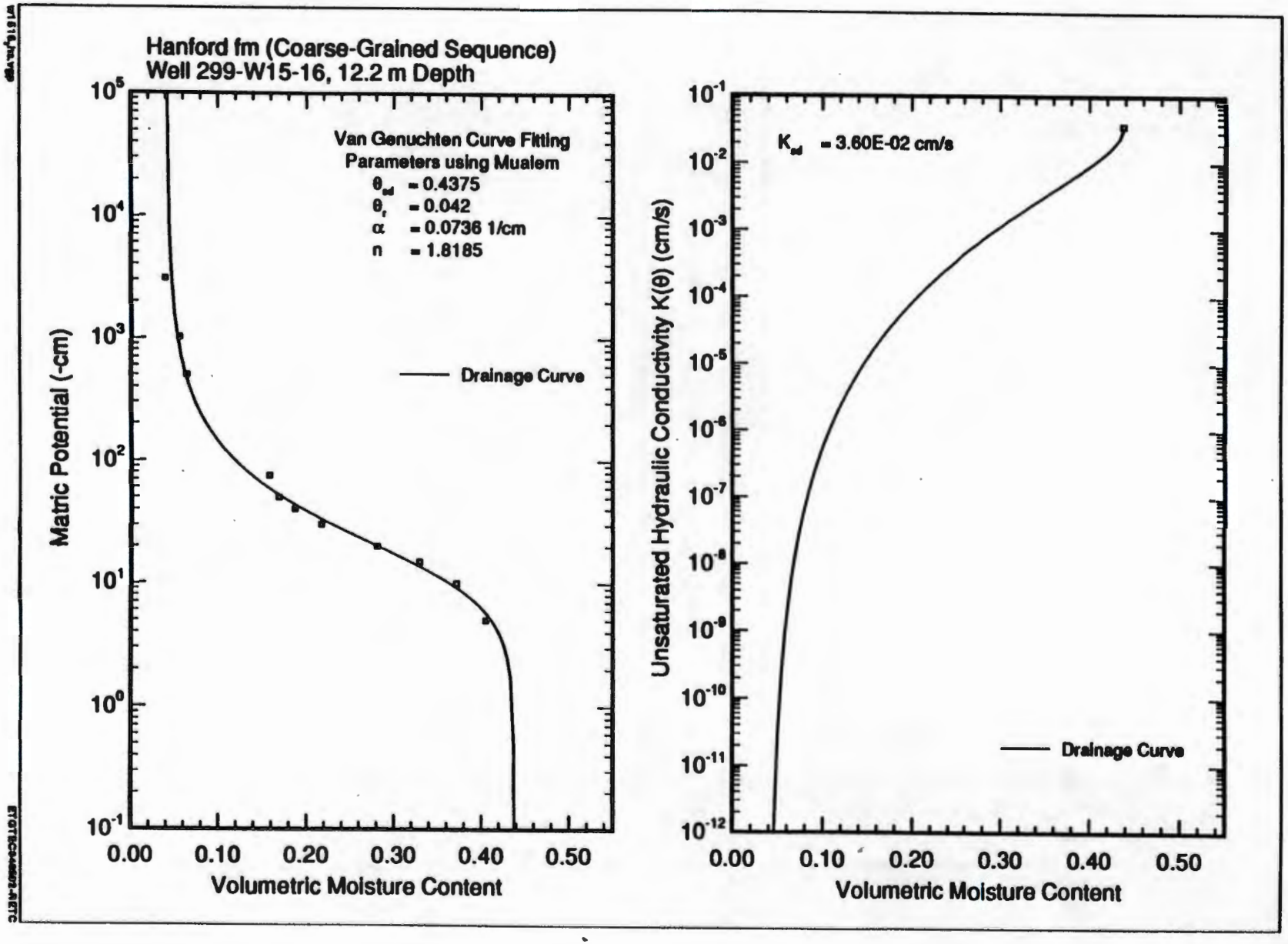
WELL NO. 299-W10-13; 60 ft.

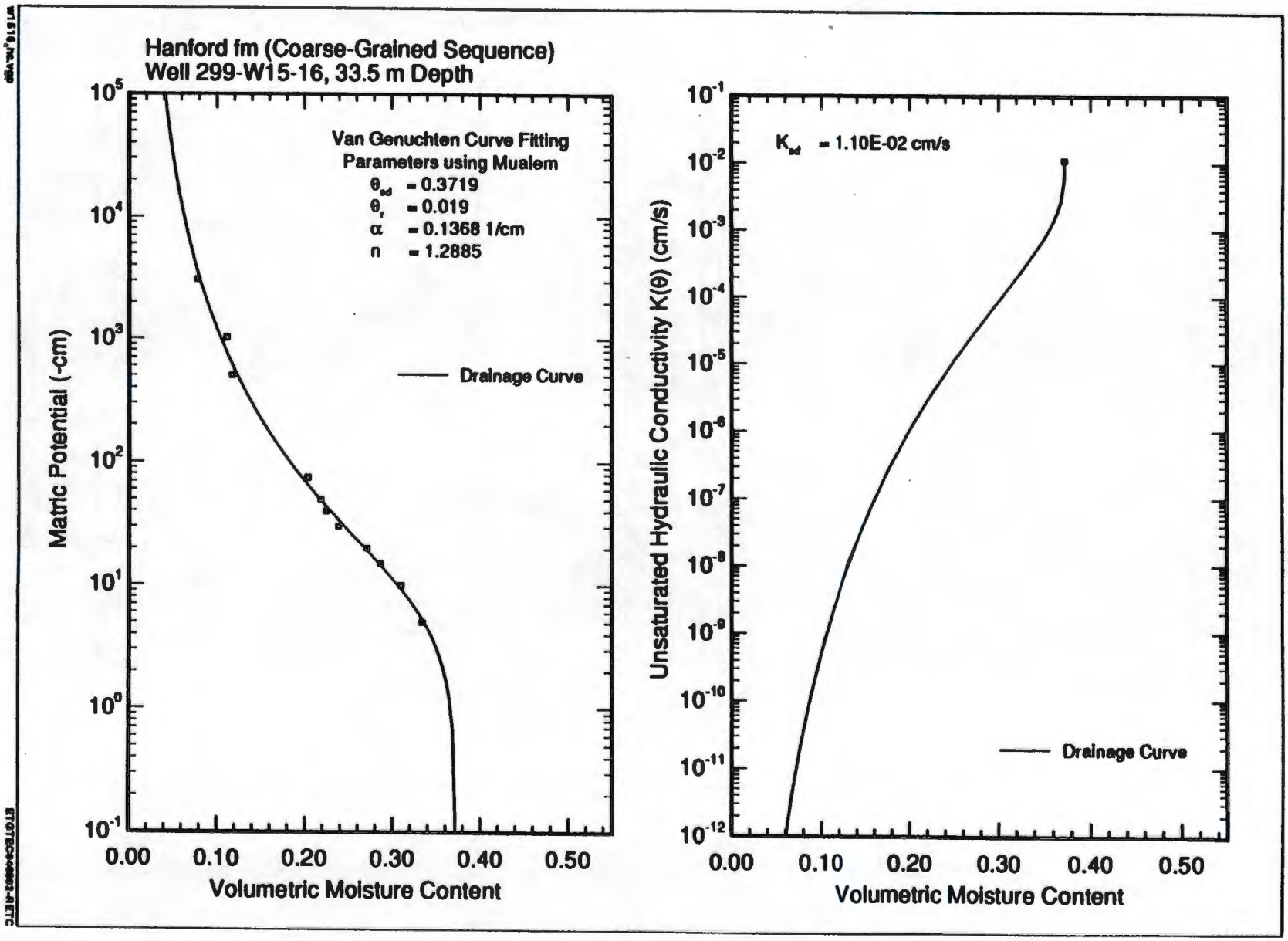


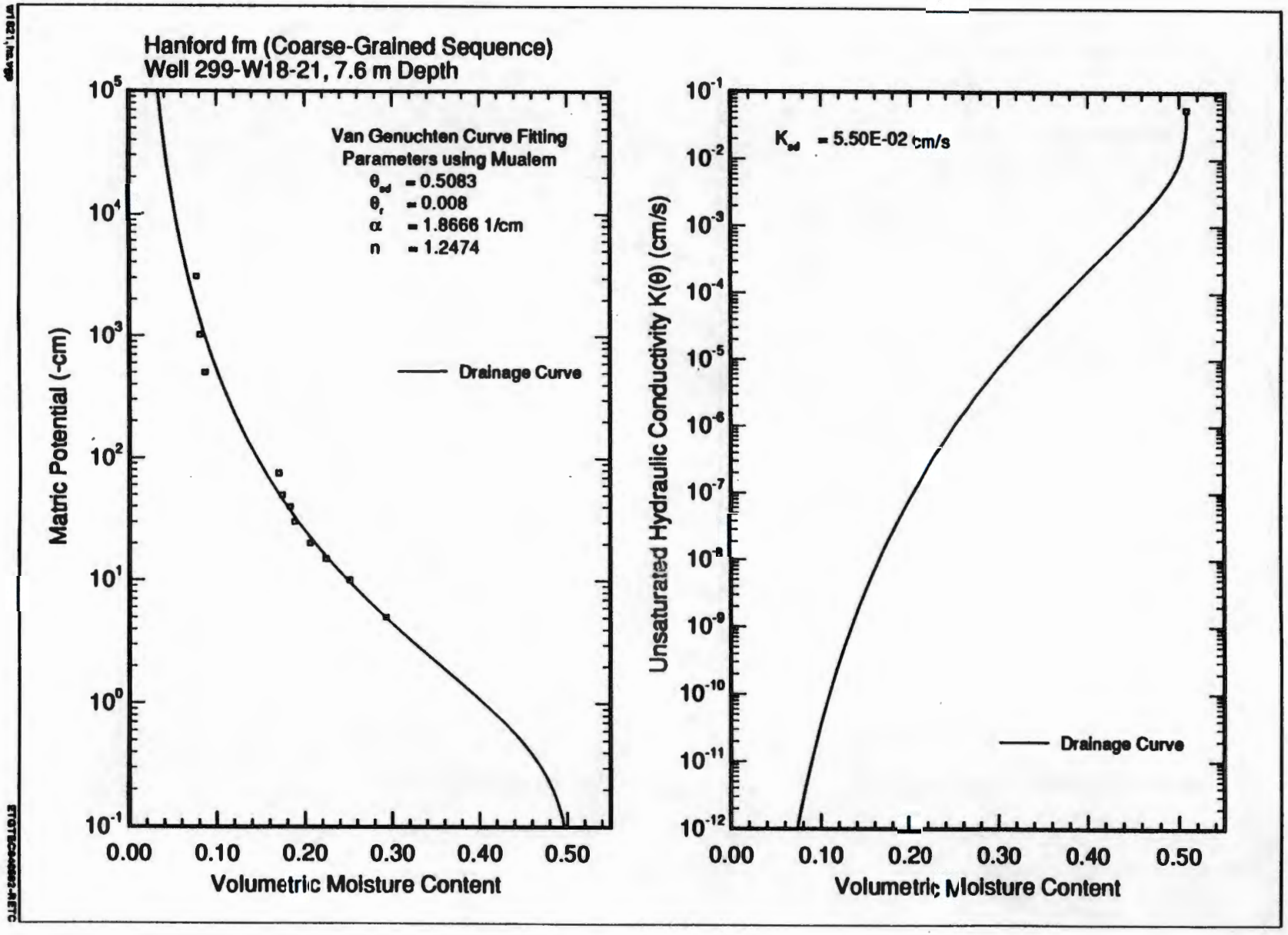

Hanford fm (Coarse-Grained Sequence)
Well 299-W7-5, 3.1 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsat = 0.3924
θr = 0.000
α = 0.1570 1/cm
n = 1.2507
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksat = 1.60E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content

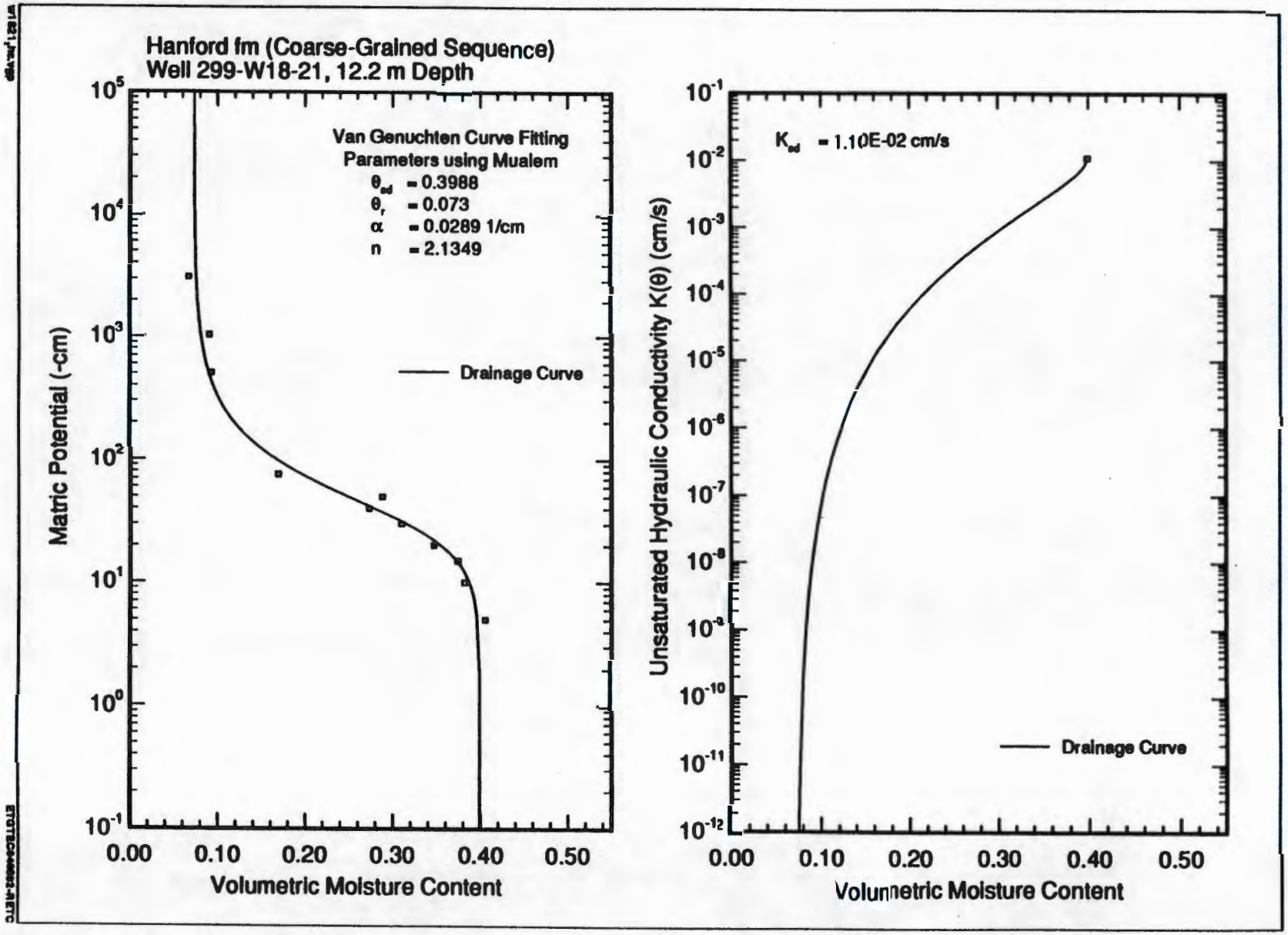

Hanford formation (Coarse-Grained Sequence)
Well 299-W10-13, 13.7 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3915
θr = 0.040
α = 0.0408 1/cm
n = 2.0672
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.10E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content


Hanford formation (Coarse-Grained Sequence)
Well 299-W10-13, 24.4 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsat = 0.4955
θr = 0.102
α = 0.2785 1/cm
n = 1.3713
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksat = 2.70E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content


Hanford fm (Coarse-Grained Sequence)
Well 299-W15-16, 12.2 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsat = 0.4375
θr = 0.042
α = 0.0736 1/cm
n = 1.8185
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksat = 3.60E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content


Hanford fm (Coarse-Grained Sequence)
Well 299-W15-16, 33.5 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3719
θr = 0.019
α = 0.1368 1/cm
n = 1.2885
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.10E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content


Hanford fm (Coarse-Grained Sequence)
Well 299-W18-21, 7.6 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.5083
θr = 0.008
α = 1.8666 1/cm
n = 1.2474
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 5.50E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content


Hanford fm (Coarse-Grained Sequence)
Well 299-W18-21, 12.2 m Depth
Van Genuchten Curve Fitting
Parameters using Mualem
θsd = 0.3988
θr = 0.073
α = 0.0289 1/cm
n = 2.1349
Drainage Curve
Matric Potential (-cm)
Volumetric Moisture Content
Ksd = 1.10E-02 cm/s
Drainage Curve
Unsaturated Hydraulic Conductivity K(θ) (cm/s)
Volumetric Moisture Content

APPENDIX B

SUMMARY OF AQUIFER TESTING DATA FOR THE WELLS IN 200 WEST AREA

9413136.2002

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Summary of Aquifer Testing S-10 Facility

Six wells were drilled for RCRA monitoring of the 216-S-10 Facility. Aquifer tests were conducted in these wells to determine aquifer properties of hydraulic conductivity (K) and transmissivity (T). The following table list some of the test information.

Well Number	Type of Test	Date of Test	Depth from land surface of Tested Interval	Developed?	K ft^2/day
299-W26-7	slug	5/7/91	186.26-205.5	yes	data not in computer
	development	5/7/91	186.26-205.5	in process	--[a]
299-W26-8	slug withdrawal	5/31/90	200-216	no	5
299-W26-9	slug withdrawal	5/31/90	189-205	no	30
299-W26-10	slug withdrawal	5/3/91	206.54-221.69	yes	75
	slug injection	5/3/91	206.54-221.69	yes	--
299-W26-11[b]	slug immersion[c]	5/31/90	122-136	no	.006
	slug withdrawal	5/31/90-6/1/90	122-136	no	.00004[d]
299-W26-12	slug withdrawal	5/10/91	228.24-210.22	yes	5
	slug injection	5/10/91	228.24-210.22	yes	16[e]

a - non-unique match to type curve
b - well is completed in a perched water zone
c - data is from immersion of slugging rod, automatic recording of water level was initiated some time after rod was immersed.
d - water level was not at a static level prior to slugging rod withdrawal
e - value suspect, limited data to determine straight line on semilog plot

Pertinent Notes:

- The "The Bouwer and Rice Slug Test - An Update" was used to determine K. ref; Bouwer, 1989: Ground Water vol 27, no.3.
- Tests were conducted in completed wells.
- All of the above wells except 299-W26-11 are screened in the upper unconfined aquifer which is in the Ringold Formation in this area. Well 299-W26-11 is completed in a perched water zone.
- Wells tested in 1990 were tested by PNL. Wells tested in 1991 were tested by WHC.
- Test analyses were not reviewed.
- Because of less water level fluctuation in the withdrawal tests than injection tests, values determined from withdrawal test are probably more representative of aquifer properties.
- In many of the tests the initiation of data recording occurred after slugging rod was withdrawn or injected. Because of this the exact t=0 is unknown, which may result in a shift of the data. The shift of the data will yield different values of Yo and Tc (for the same Yt) and therefore a different K. Small shifts will yield very little change in K.

Jane V. Borghese

9413136.2005

Well Number: 299-W26-7

Dimensions in ft unless otherwise specified

Project: RCRA S-10 Facility

Date of Test: May 7, 1991

Type of Test: Well development

Slugging Rod Dimensions, L:

D: NA

Theorectical head displacement in 4 inch casing:

Location of Field Records and Data: RCRA Records file

Rod within screened interval: NA

Depth below land surface of tested zone: 186.26 - 205.4

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: NA

Length of saturated screen interval, Le: NA

Thickness of aquifer, H: 200 (Last 1989)

Estimated Porosity of Sand Pack: NA

For Bouwer and Rice Analysis

Time correction applied to data (min):

Intial Head change, Yo: NA

Arbitrary time value on straight line, Tc (min):

Head at Tc, Yt:

Comments: Soft copy of slug test data was not stored. Used ISOAQX v2.72 to analyze drawdown data from well development. Q = 11.5 gpm Limited data to match type curve used ISOAQX Theissian water table partial penetration parameter verification method. I have little faith in ISOAQX's resulting T values.

WL on 5/7/91 190.21' from top of 6", second int. 209.33 - 188.32 from 6"

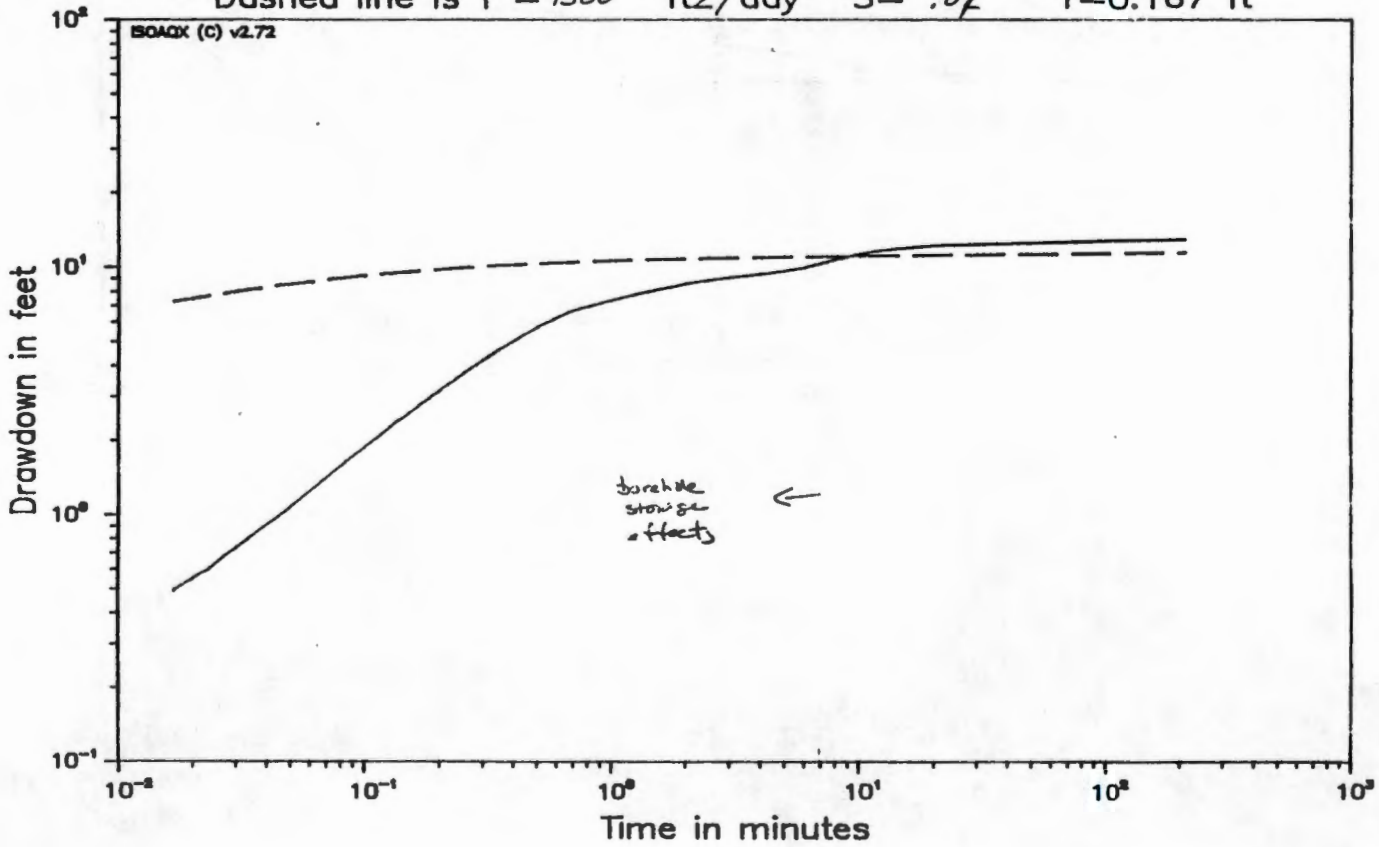
Note: Soft copy did not match hard copy from files.

Name (print): JV Borghese Signature: JV Borghese Date: 11/19/91

9413136.2006

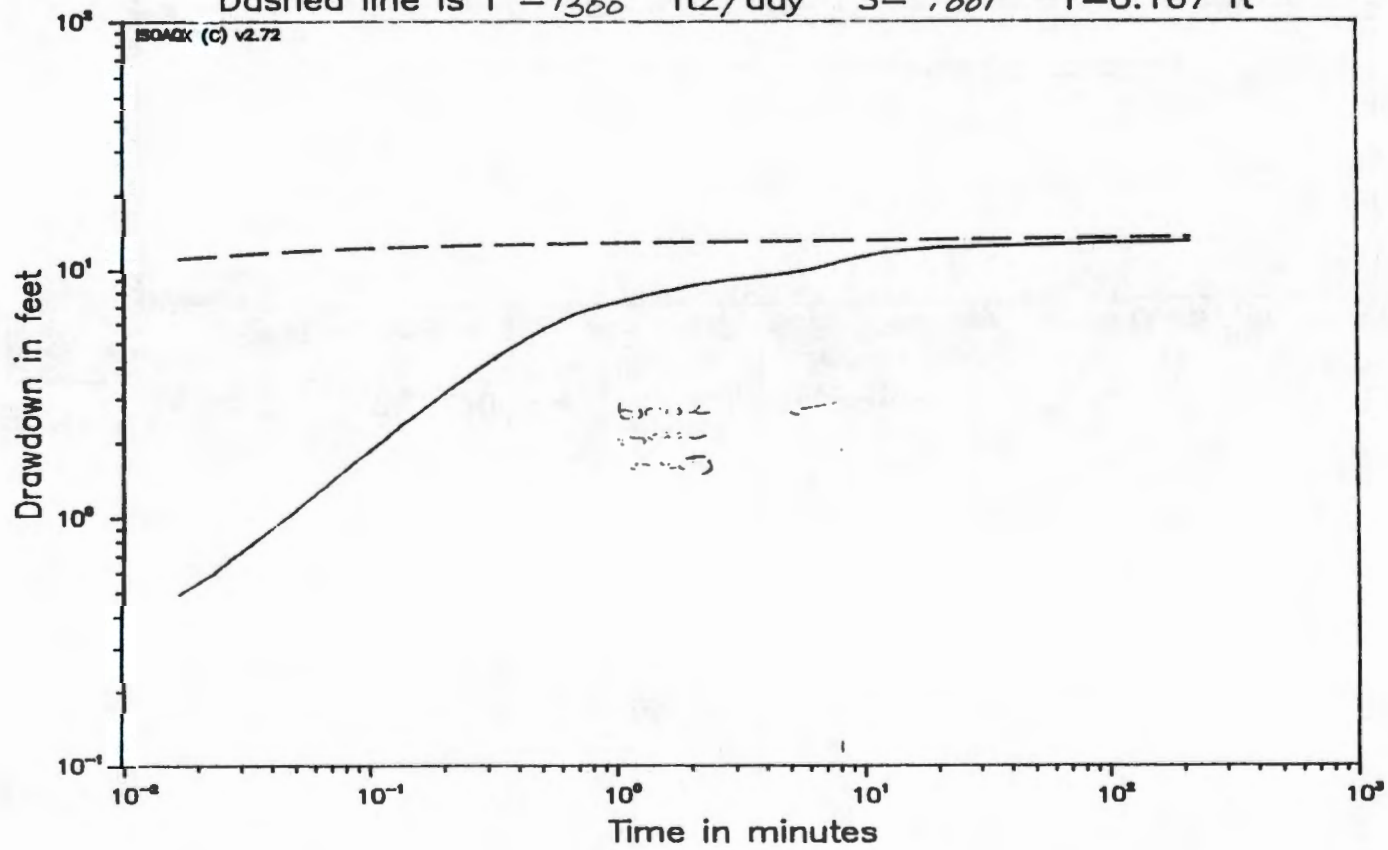
Thiss is a water table
Partial Penetration
Kd = 13.0
g b = 200
15' of screen penetration

Well 299-W26-7 well development 5/7/91
Solid line is drawdown data
Dashed line is T = 1500 ft2/day S= .01 r=0.167 ft



Theissian water table
Partial penetration
Kd = 13.0
aq b = 200'
15' of screen penetration

Well 299-W26-7 well development 5/7/91
Solid line is drawdown data
Dashed line is T = 1300 ft2/day S= .001 r=0.167 ft



Well Number: 299-W26-8

Dimensions in ft unless otherwise specified

Project: RCRA S-10

Date of Test: 5/31/90

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6.0

D: .19

Theorectical head displacement in 4 inch casing: 1.95

Location of Field Records and Data: Artest 1990 S-10 Borehole rpt

Rod within screened interval: yes

Depth below land surface of tested zone: 200 - 216

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 16.56

Length of saturated screen interval, Le: 16.56

Thickness of aquifer, H: ~200 (Test 1989)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .0666

Intial Head change, Yo: 1.85

Arbitrary time value on straight line, Tc (min): 2.0

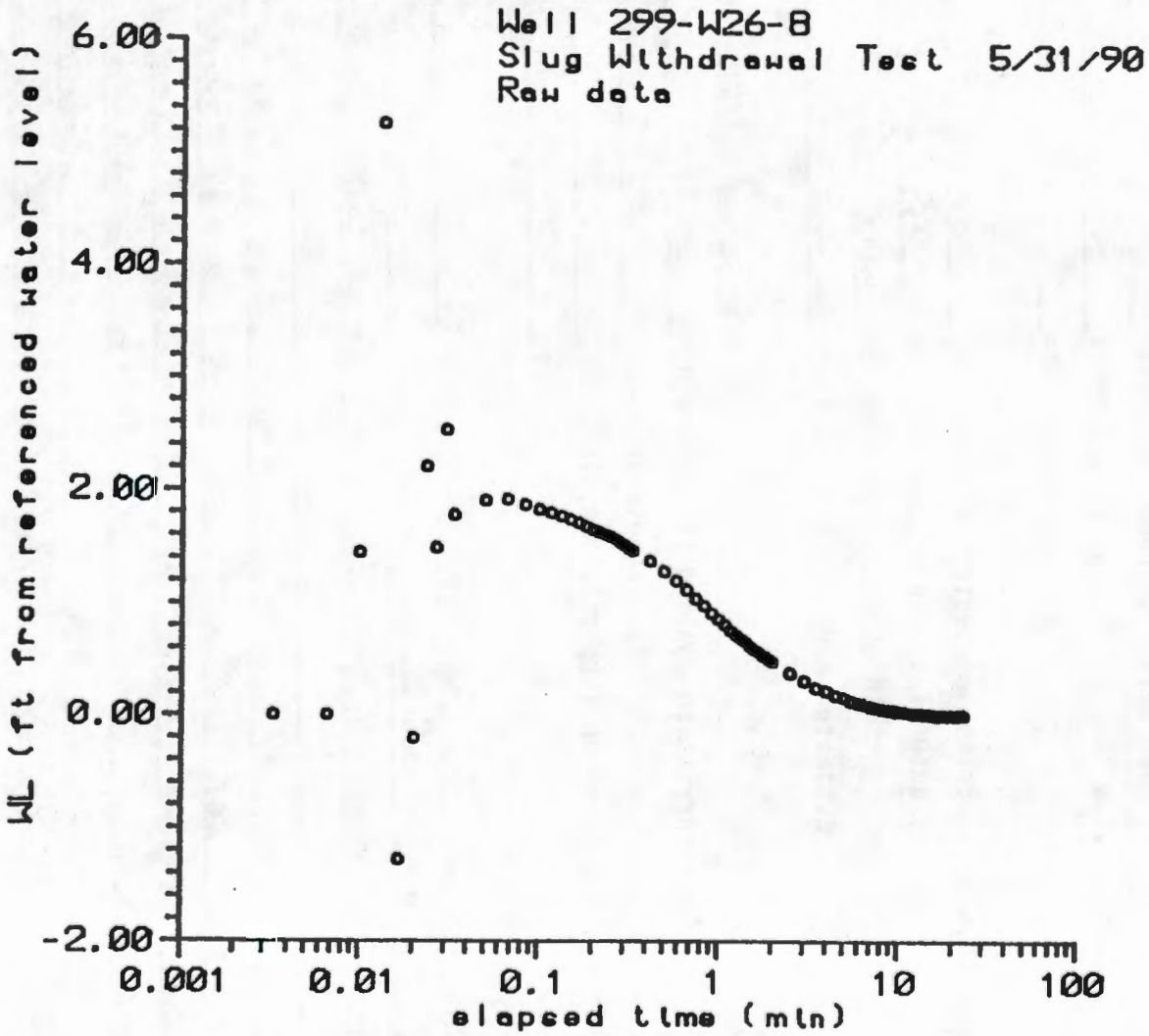
Head at Tc, Yt: .3

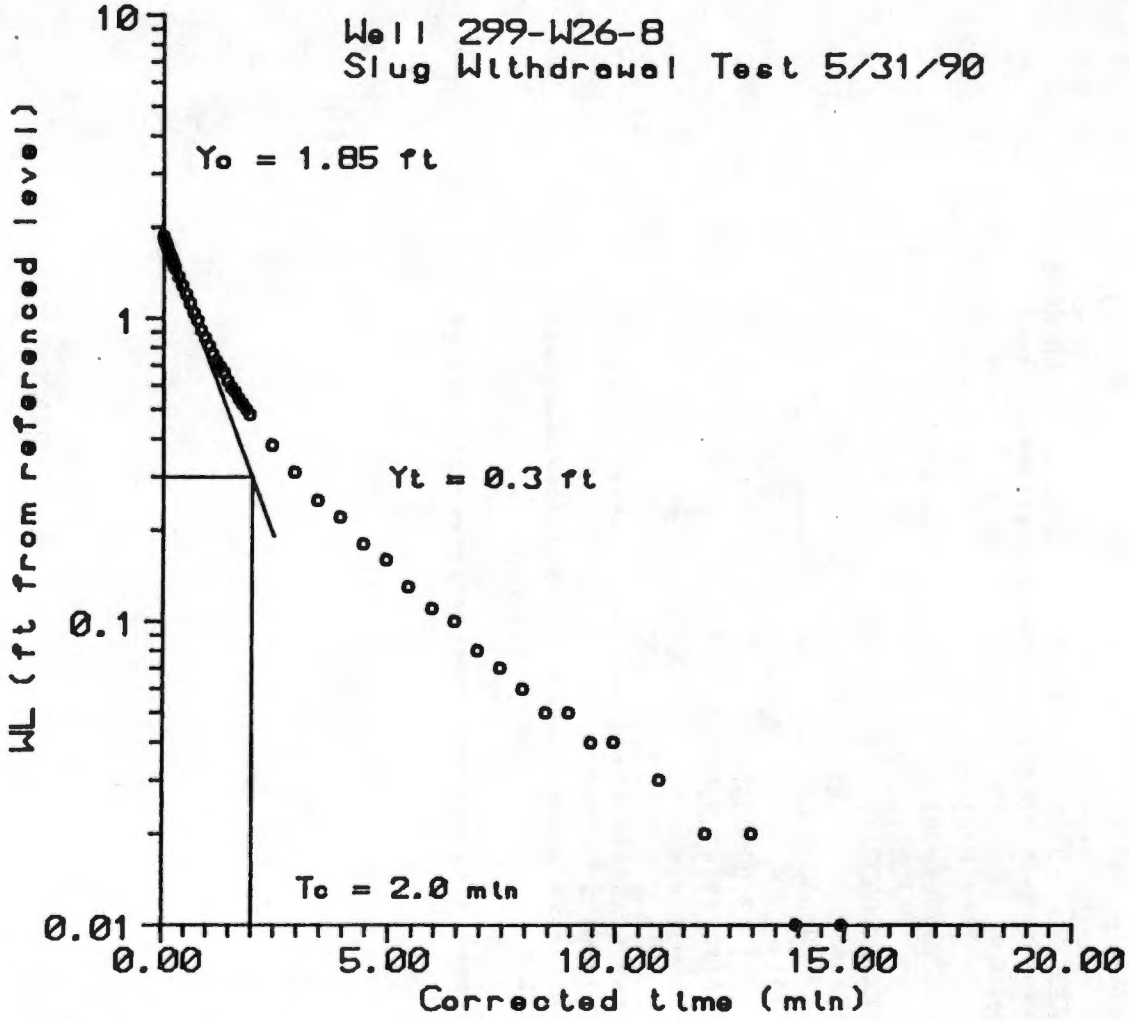
Comments: One test performed in this well
H is from water table to top of basalt as estimated from info in LAST 1989 for LLBG WMA-3.

Test probably was initiated at an elapsed time of .0099 min but did not start to decline steadily til an elapsed time of 0.0666 min. Readings jumped around between these times probably due to turbulence. Attached is a copy of Bouwer-Rice Analysis. Omitted 0 WL data from B-R plot (log scale)

Name (print): JV Borghese Signature: JV Borghese Date: 11/6/91

9413136.2009


Well 299-W26-8
Slug Withdrawal Test 5/31/90
Raw data
WL (ft from referenced water level)
6.00
4.00
2.00
0.00
-2.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W26-8
Slug Withdrawal Test 5/31/90
Yo = 1.85 ft
Yt = 0.3 ft
To = 2.0 min
WL (ft from referenced level)
10
1
0.1
0.01
0.00
5.00
10.00
15.00
20.00
Corrected time (min)

299-W26-8 Slug Withdrawal Test 5/31/90
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	16.5600	16.5600	200.0000

****
Le/Rw = 49.7297300
A= 3.0941640
B= 5.087996E-001
C= 2.6715220
SANDPACK POROSITY= 2.500000E-001
t (min)= 2.0000000
1/t= 5.000000E-001
Yo= (ft) 1.8500000
Yt= (ft) 3.000000E-001
1/t ln(Yo/Yt)= 9.095792E-001
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.4680270
****
K (ft/day) = 4.7473060
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 78.6153800
****

Well Number: 299-W26-9

Dimensions in ft unless otherwise specified

Project: RCRA S-10

Date of Test: 5/31/90

Type of Test: slug withdrawal

Slugging Rod Dimensions, L: 6

D: .19

Theorectical head displacement in 4 inch casing: 1.95

Location of Field Records and Data: Aickert 1990, Battelle rpt S-10

Rod within screened interval: yes

Depth below land surface of tested zone: 189 - 205

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 16.19

Length of saturated screen interval, Le: 16.19

Thickness of aquifer, H: ~200 from test 1989

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): 0.03

Intial Head change, Yo: 2.0

Arbitrary time value on straight line, Tc (min): 0.528

Head at Tc, Yt: 0.1

Comments: One slug withdrawal test performed in this well

H from info in test 1989 for distance from WL to top of basalt for LLBG WMA-3.

Slug rod withdrawn at an elapsed time of about .03 min.

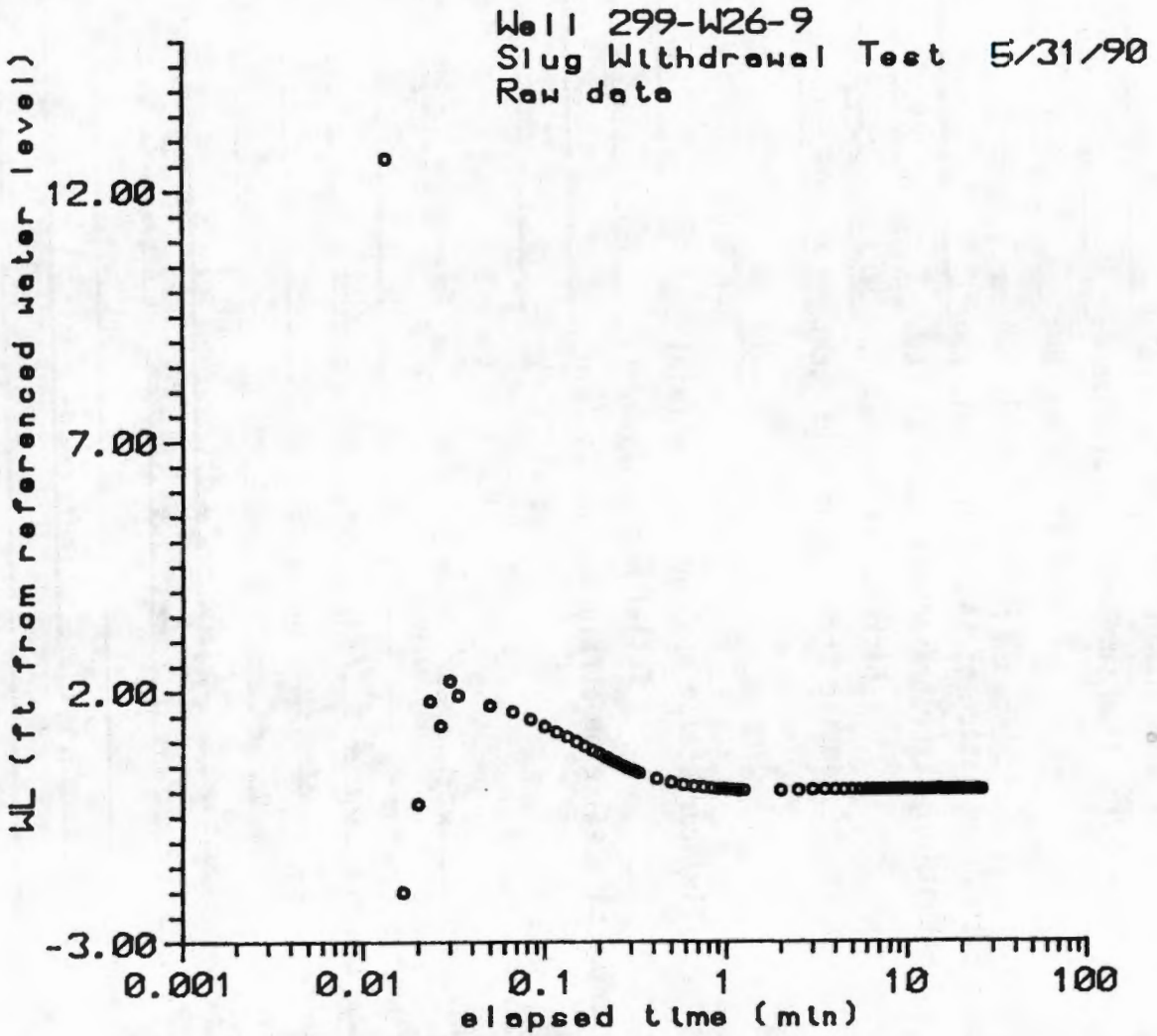
Steady decline begins at .03 min

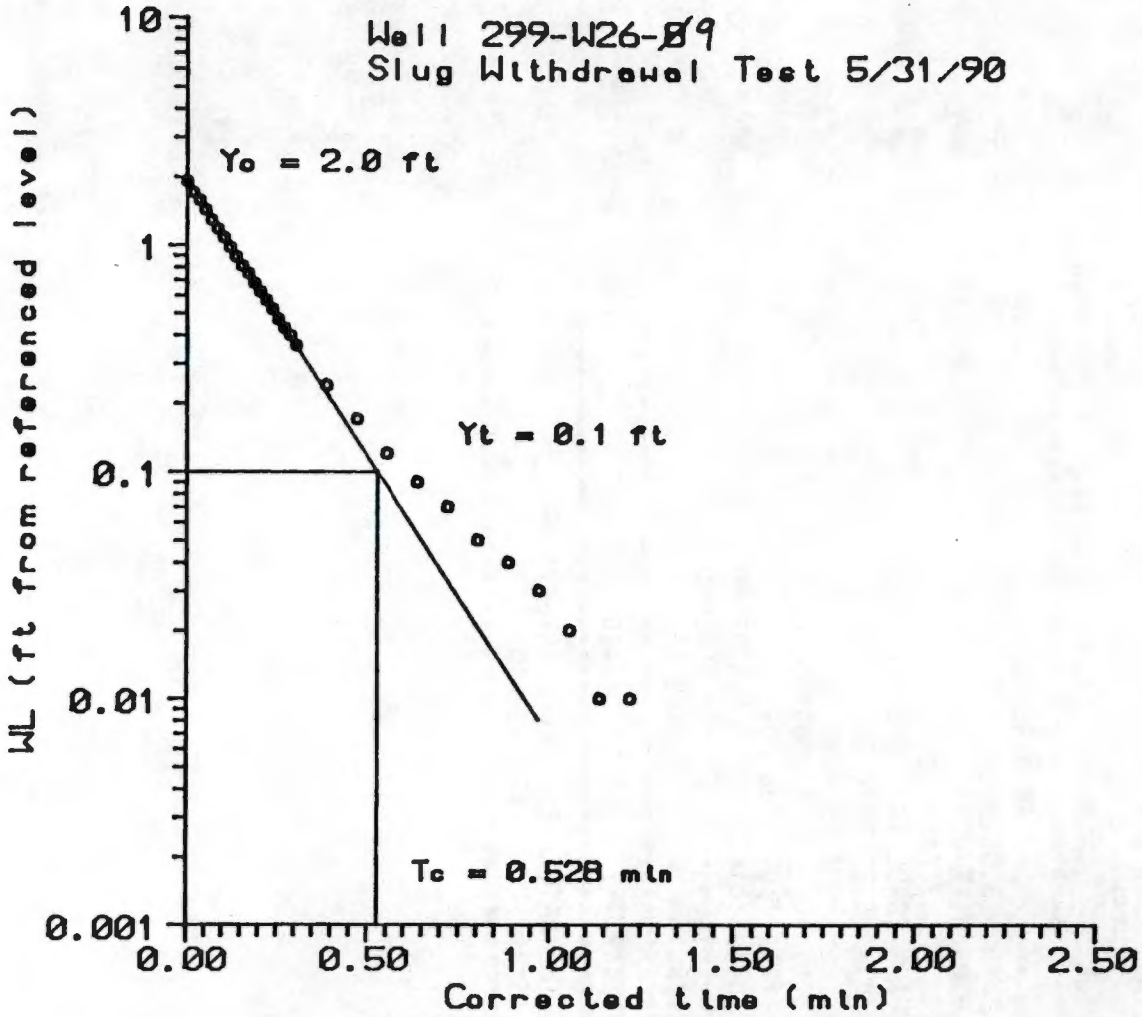
Omitted 0 data from B-R plot (log scale)

Bouwer-Rice analysis attached

Name (print): JV Boshoe Signature: JV Boshoe Date: 11/7/91

9413136.3013


Well 299-W26-9
Slug Withdrawal Test 5/31/90
Raw data
WL (ft from referenced water level)
12.00
7.00
2.00
-3.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W26-09
Slug Withdrawal Test 5/31/90
Yo = 2.0 ft
Yt = 0.1 ft
Tc = 0.528 min
WL (ft from referenced level)
10
1
0.1
0.01
0.001
0.00
0.50
1.00
1.50
2.00
2.50
Corrected time (min)

299-W26-9 Slug Withdrawal Test 5/31/90
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	16.1900	16.1900	200.0000

****
Le/Rw = 48.6186200
A= 3.0669280
B= 5.036012E-001
C= 2.6454010
SANDPACK POROSITY= 2.500000E-001
t (min)= 5.280000E-001
1/t= 1.8939390
Yo= (ft) 2.0000000
Yt= (ft) 1.000000E-001
1/t ln(Yo/Yt)= 5.6737360
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.4483210
****
K (ft/day) = 30.0474500
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 486.4682000
****

9413136.2016

Well Number: 299-W26-10

Dimensions in ft unless otherwise specified

Project: RCRA S-10 Facility

Date of Test: 5/3/91

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6.0

D: .167 } V = .1309 ft³

Theorectical head displacement in 4 inch casing: (Vr. .1373 ft³) 1.57 *

Location of Field Records and Data: RCRA records file

Rod within screened interval: yes

Depth below land surface of tested zone: 221.61 - 206.54

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 15.15

Length of saturated screen interval, Le: 15.15

Thickness of aquifer, H: ~200 (from Lect 1989)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .02

Intial Head change, Yo: 1.82

Arbitrary time value on straight line, Tc (min): 0.21

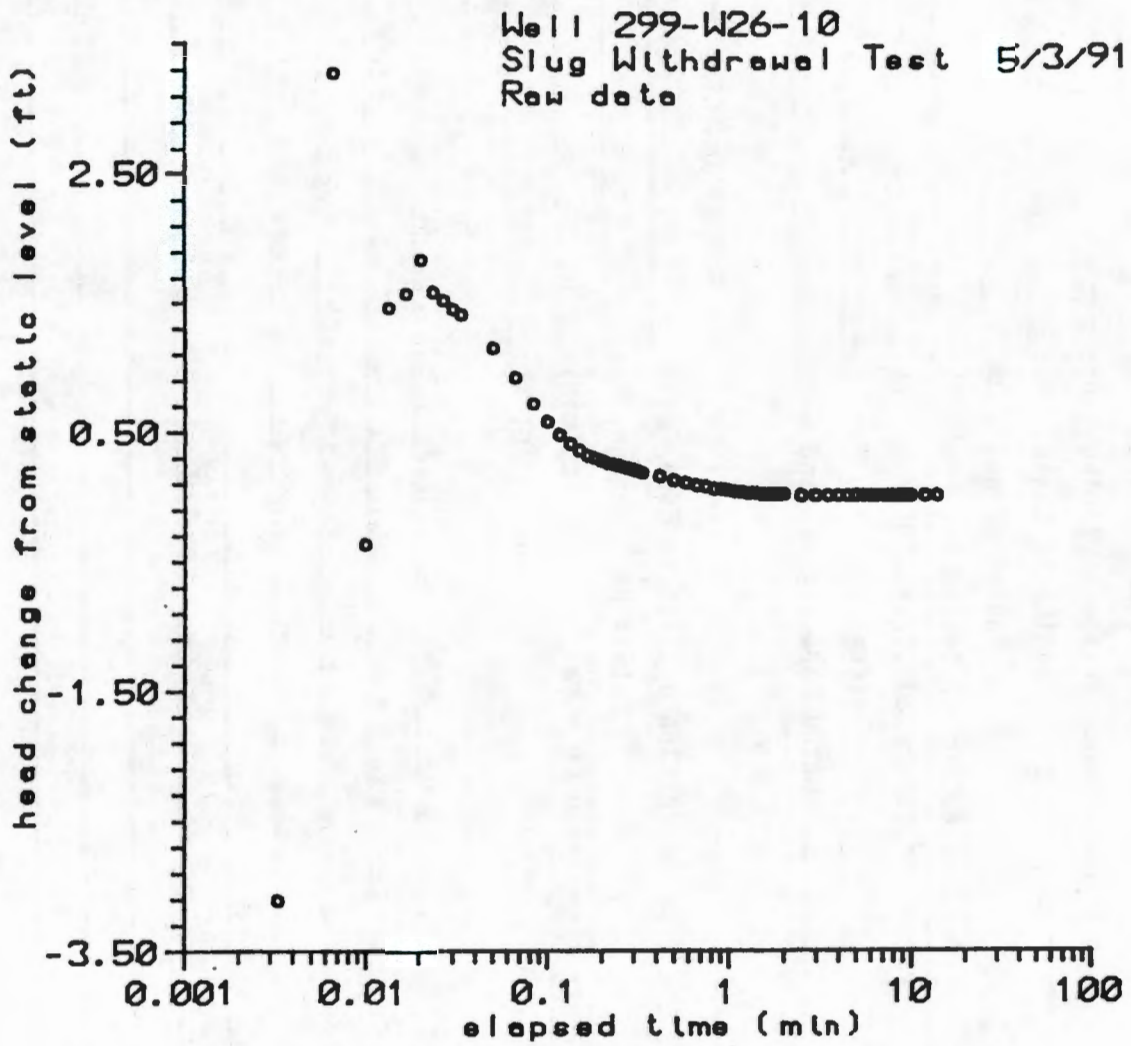
Head at Tc, Yt: .10

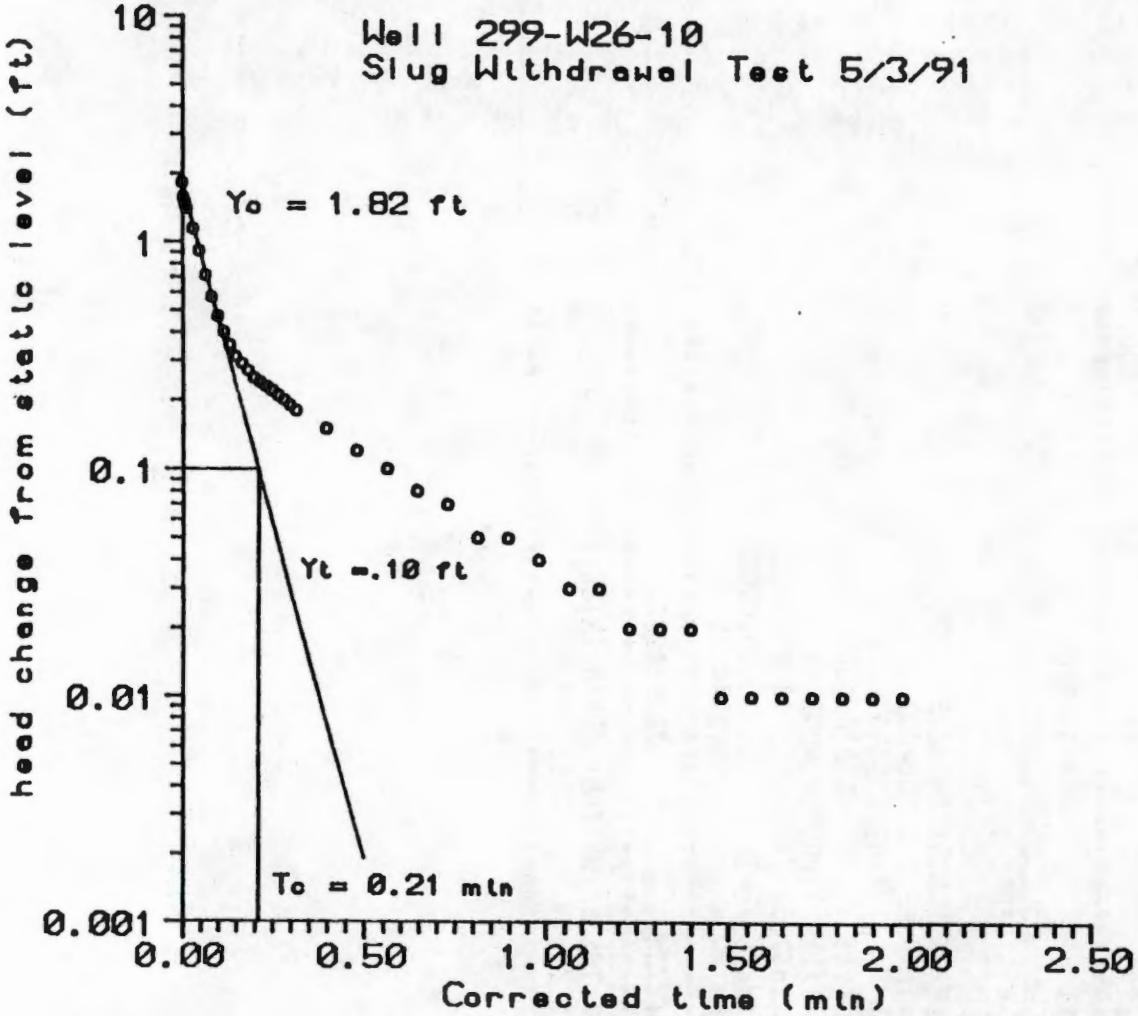
Comments: * Volume used to determine head displacement includes connecting system and 1 ft of cable (see test info form by JACoates). ~~Data~~ Initiation of data recording occurred after slugging rod withdrawn. Steady decline begins at an elapsed time about .02 min.

Ø ~~int~~ head data omitted from semilog plot.

Name (print): JV Borghese Signature: JV Borghese Date: 11/20/91

9413136.2017


Well 299-W26-10
Slug Withdrawal Test 5/3/91
Raw data
head change from static level (ft)
2.50
0.50
-1.50
-3.50
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W26-10
Slug Withdrawal Test 5/3/91
Yo = 1.82 ft
Yt =.10 ft
To = 0.21 min
head change from static level (ft)
10
1
0.1
0.01
0.001
0.00
0.50
1.00
1.50
2.00
2.50
Corrected time (min)

299-W26-10 Slug Withdrawal Test 5/3/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	15.1500	15.1500	200.0000

****
Le/Rw = 45.4954900
A= 2.9846410
B= 4.810528E-001
C= 2.5928120
SANDPACK POROSITY= 2.500000E-001
t (min)= 2.100000E-001
1/t= 4.7619050
Yo= (ft) 1.8200000
Yt= (ft) 1.000000E-001
1/t ln(Yo/Yt)= 13.8162900
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.3970300
****
K (ft/day) = 76.5542800
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 1159.7970000
****

9413136.2020

Well Number: 299-W26-10

Dimensions in ft unless otherwise specified

Project: RCRA S-10 Facility

Date of Test: 5/3/91

Type of Test: Slug Injection

Slugging Rod Dimensions, L: 6.0

D: .167

Theorectical head displacement in 4 inch casing: 1.57

Location of Field Records and Data: RCRA records file

Rod within screened interval: yes

Depth below land surface of tested zone: 221.69 - 206.54

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 15.15

Length of saturated screen interval, Le: 15.15

Thickness of aquifer, H: ~200 (from Last 1989)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): See comments

Intial Head change, Yo:

Arbitrary time value on straight line, Tc (min):

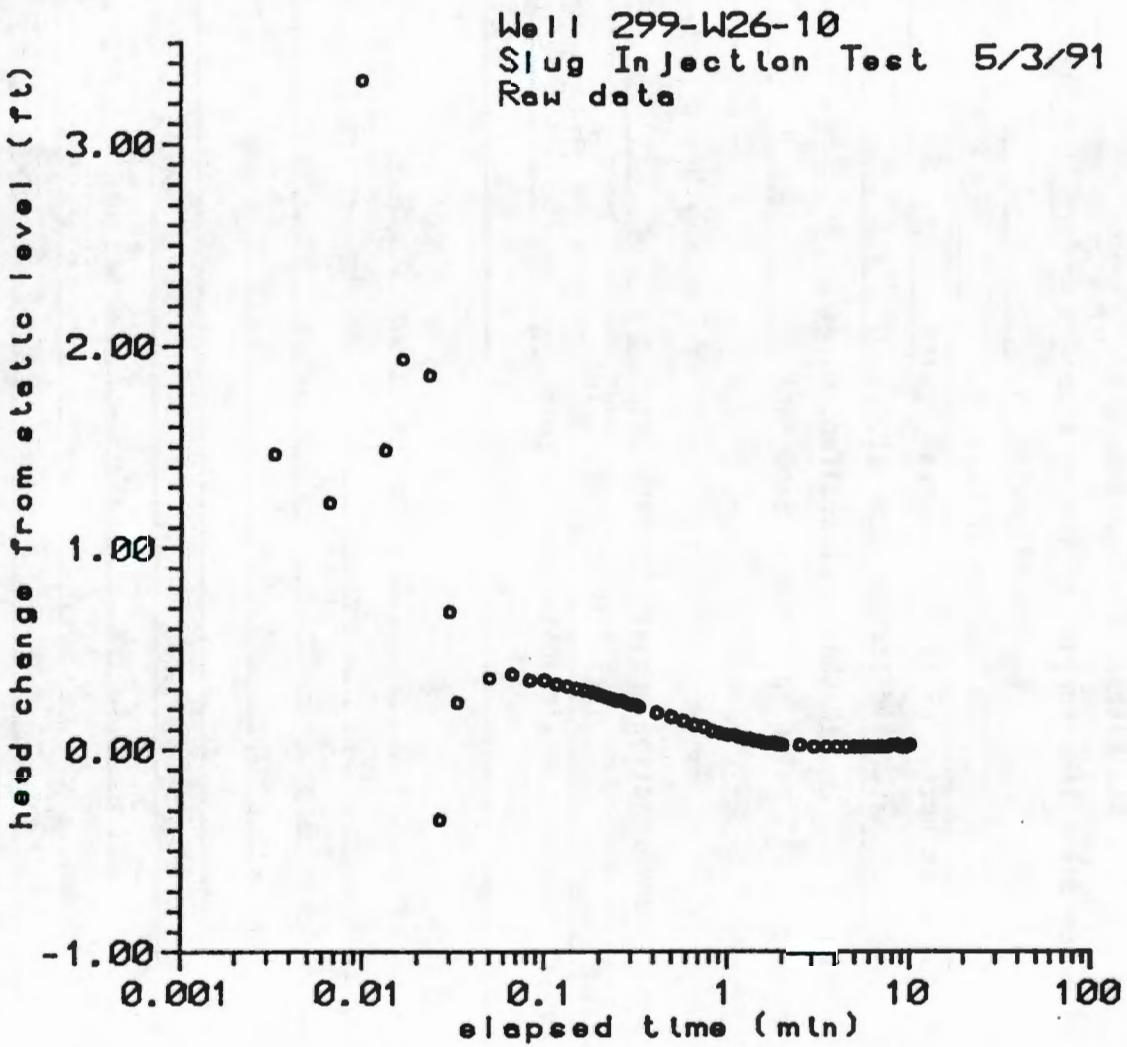
Head at Tc, Yt:

Comments: Volume used to determine head displacement includes connecting system and 1 ft of cable (see test info form in file from J.A. Coates). Initiation of data recording occured prior to injection ∴ exact t=0 unknown

Analysis of test data not done — WL bounced around too much due to turbulence and inertial effects. Steady decline of WL data began at one elapsed time of about 0.05 min at a head change from static of about 0.25 ft. Theorectical is 1.57 ft — too much of a difference to yield valid results.

Name (print): JV Borghese Signature: JV Borghese Date: 11/20/91

9413136.2021


Well 299-W26-10
Slug Injection Test 5/3/91
Raw data
head change from static level (ft)
3.00
2.00
1.00
0.00
-1.00
0.001
0.01
0.1
1
10
100
elapsed time (min)

Well Number: 299-W26-11

Dimensions in ft unless otherwise specified

Project: RCRA S-10 Facility

Date of Test: May 31 1990

Type of Test: Slug rod immersion for slug w/D

Slugging Rod Dimensions, L: 6

D: 0.19

Theorectical head displacement in 4 inch casing: 1.95

Location of Field Records and Data: Aichart 1990 S-10 Borehole report

Rod within screened interval: yes

Depth below land surface of tested zone: 122-136

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 13.45

Length of saturated screen interval, Le: 13.45

Thickness of aquifer, H: ~200 (Last 1989)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): —

Intial Head change, Yo: 2.20

Arbitrary time value on straight line, Tc (min): 39

Head at Tc, Yt: 2.12

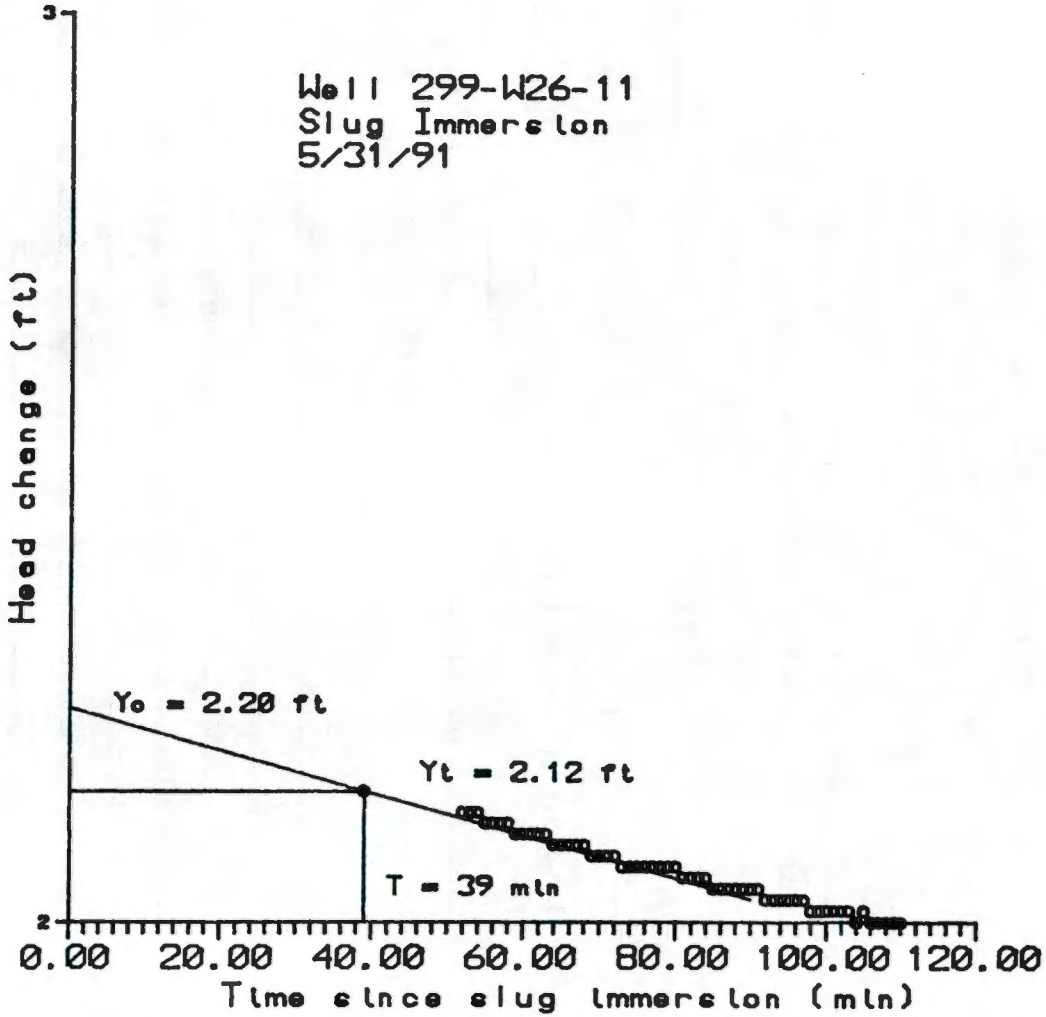
Comments: Data logger recording at 1min intervals was initiated ~42 minutes after slug was immersed in well. Head change was determined from the dif. between WL measurement taken 39 min after rod immersed and static WL. Transducer readings were converted to head change values by correlating E-tape reading at a clock time of 1309, Transducer logger reading at 1305, and reference level for test 2 at 1322.

Time = 0 is about equal to real time 1230 on 5/31/90.

Note: Well is completed in packed zone

Name (print): JV Borghese Signature: [signature] Date: 11/18/91

9413136.2023


Well 299-W26-11
Slug Immersion
5/31/91
Head change (ft)
3
2
Yo = 2.20 ft
Yt = 2.12 ft
T = 39 min
0.00
20.00
40.00
60.00
80.00
100.00
120.00
Time since slug immersion (min)

299-W26-11 Slug Immersion 5/31/90
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	13.4500	13.4500	200.0000

****
Le/Rw = 40.3903900
A= 2.8572500
B= 4.466348E-001
C= 2.4517180
SANDPACK POROSITY= 2.500000E-001
t (min)= 39.0000000
1/t= 2.564103E-002
Yo= (ft) 2.2000000
Yt= (ft) 2.1200000
1/t ln(Yo/Yt)= 9.497784E-004
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.3015010
****
K (ft/day) = 5.691521E-003 ~ 5.7 x10^-6 cm/sec
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 7.655096E-002
****

9413136.2025

Well Number: 299-W26-11

Dimensions in ft unless otherwise specified

Project: RCRA S-10 Facility

Date of Test: May 31 1990

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6

D: 0.19

Theorectical head displacement in 4 inch casing: 1.95

Location of Field Records and Data: Aichart 1990 S-10 Borehole rept

Rod within screened interval: yes

Depth below land surface of tested zone: 122 - 136

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 13.45

Length of saturated screen interval, Le: 13.45

Thickness of aquifer, H: ~200 (Last 1981)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): 0.05 min

Intial Head change, Yo: 1.97

Arbitrary time value on straight line, Tc (min): 375.95

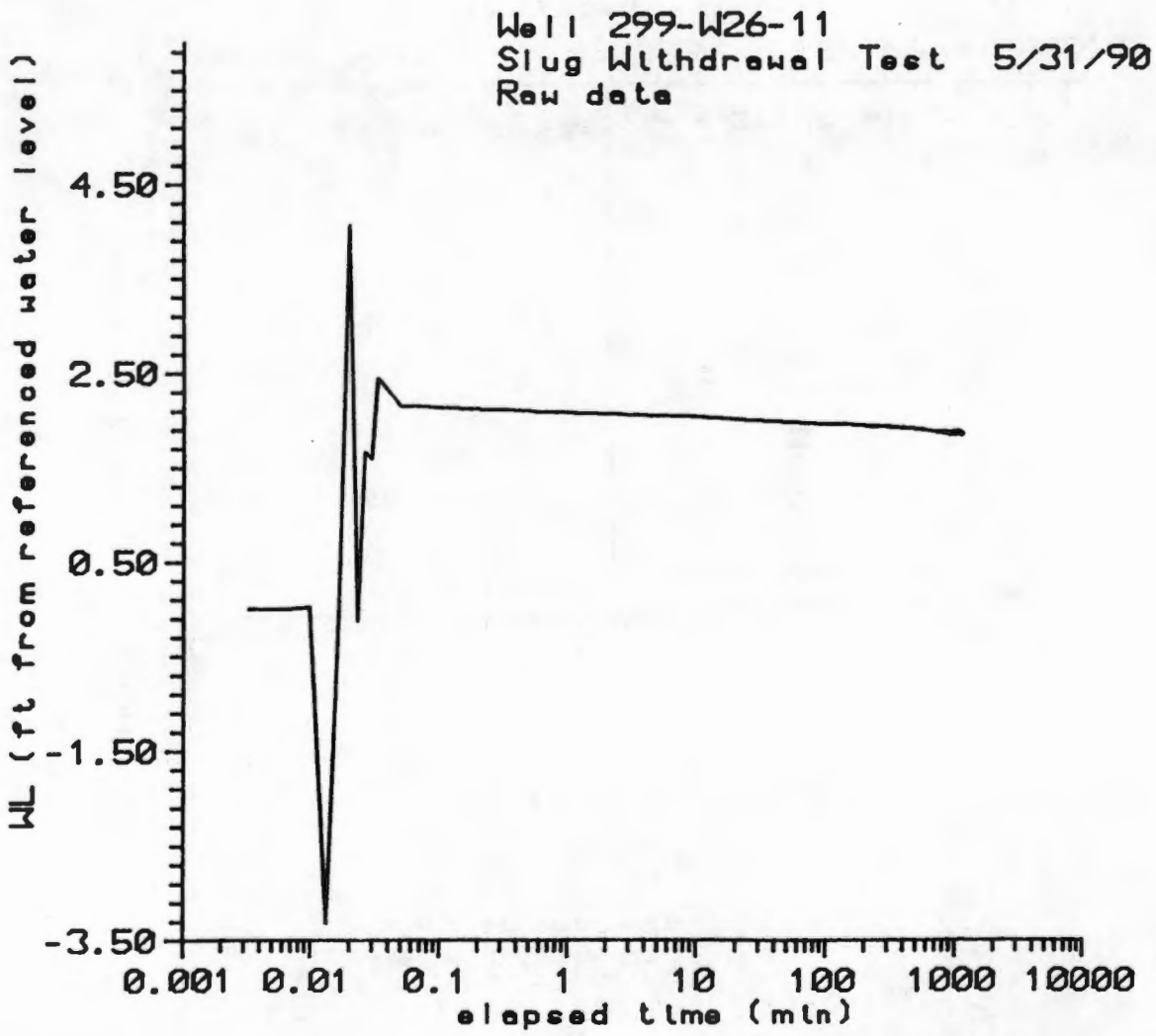
Head at Tc, Yt: 1.92

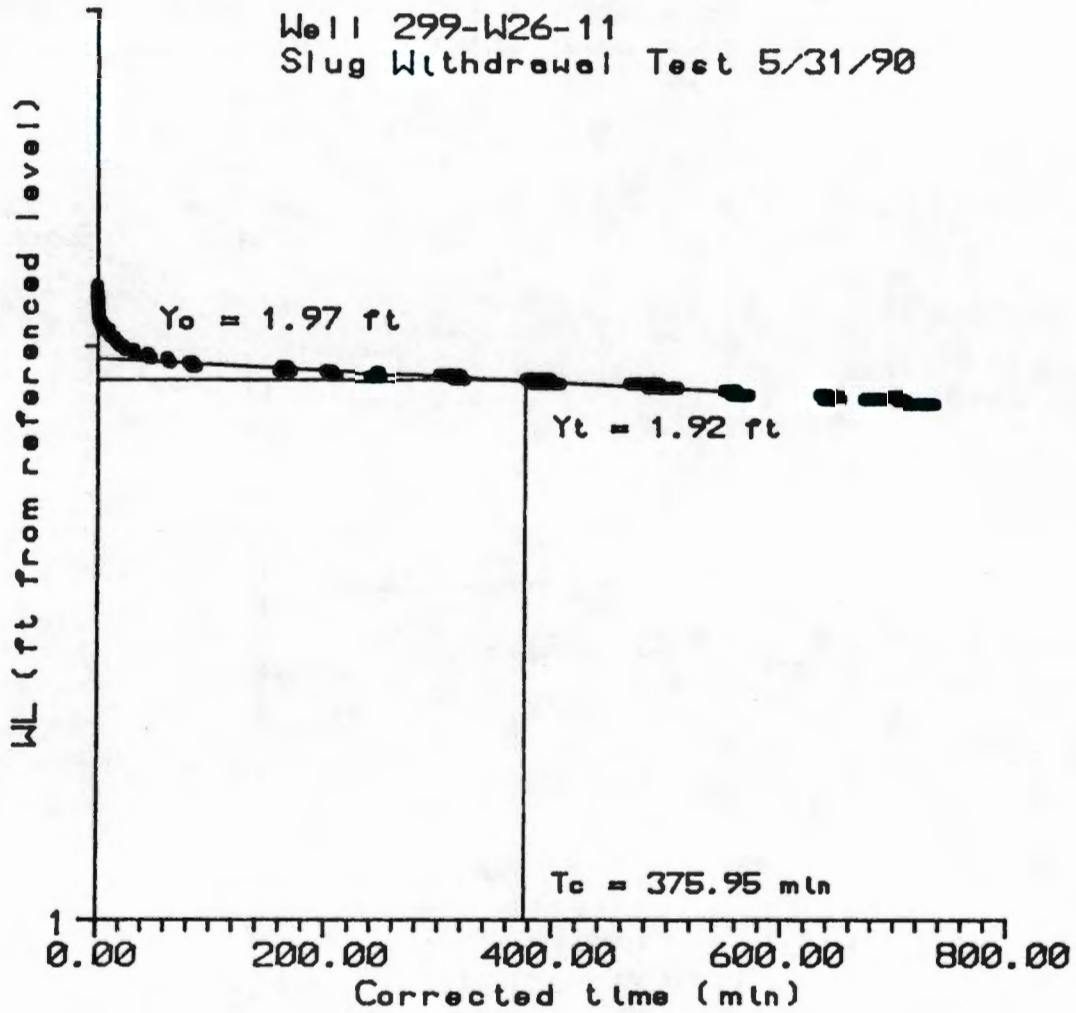
Comments: Well is in a "perched" zone. Slugging rod was pulled before wt returned to static.

Plot of time corrected data on semi-log graph clearly indicates double straight line effect. 0 - ~2 minutes represents drainage from sand pack - Analyze later data believe to represent ~~sg~~ screened unit.

Name (print): JV Borghese Signature: JV Borghese Date: 11/13/91

9413136.2029


Well 299-W26-11
Slug Withdrawal Test 5/31/90
Raw data
WL (ft from referenced water level)
4.50
2.50
0.50
-1.50
-3.50
0.001
0.01
0.1
1
10
100
1000
10000
elapsed time (min)


Well 299-W26-11
Slug Withdrawal Test 5/31/90
Yo = 1.97 ft
Yt = 1.92 ft
Tc = 375.95 min
WL (ft from referenced level)
1
0.00
200.00
400.00
600.00
800.00
Corrected time (min)

299-W26-11 Slug Withdrawal Test 5/31/90
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	13.4500	13.4500	200.0000

****
Le/Rw = 40.3903900
A= 2.8572500
B= 4.466348E-001
C= 2.4517180
SANDPACK POROSITY= 2.500000E-001
t (min)= 375.9500000
1/t= 2.659928E-003
Yo= (ft) 1.9700000
Yt= (ft) 1.9200000
1/t ln(Yo/Yt)= 6.838259E-005
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.3015010
****
K (ft/day) = 4.097808E-004
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 5.511551E-003
****

9413136.2029

Well Number: 299-W26-12

Dimensions in ft unless otherwise specified

Project: RCRA S-10 Facility

Date of Test: 5/10/91

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6.0

D: .167

Theorectical head displacement in 4 inch casing: 1.50'

Location of Field Records and Data: RCRA records file

Rod within screened interval: yes

Depth below land surface of tested zone: 228.24 - 210.22

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 18.02

Length of saturated screen interval, Le: 18.02

Thickness of aquifer, H: ~200 (Last 1989)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): 0.0333

Intial Head change, Yo: 1.90

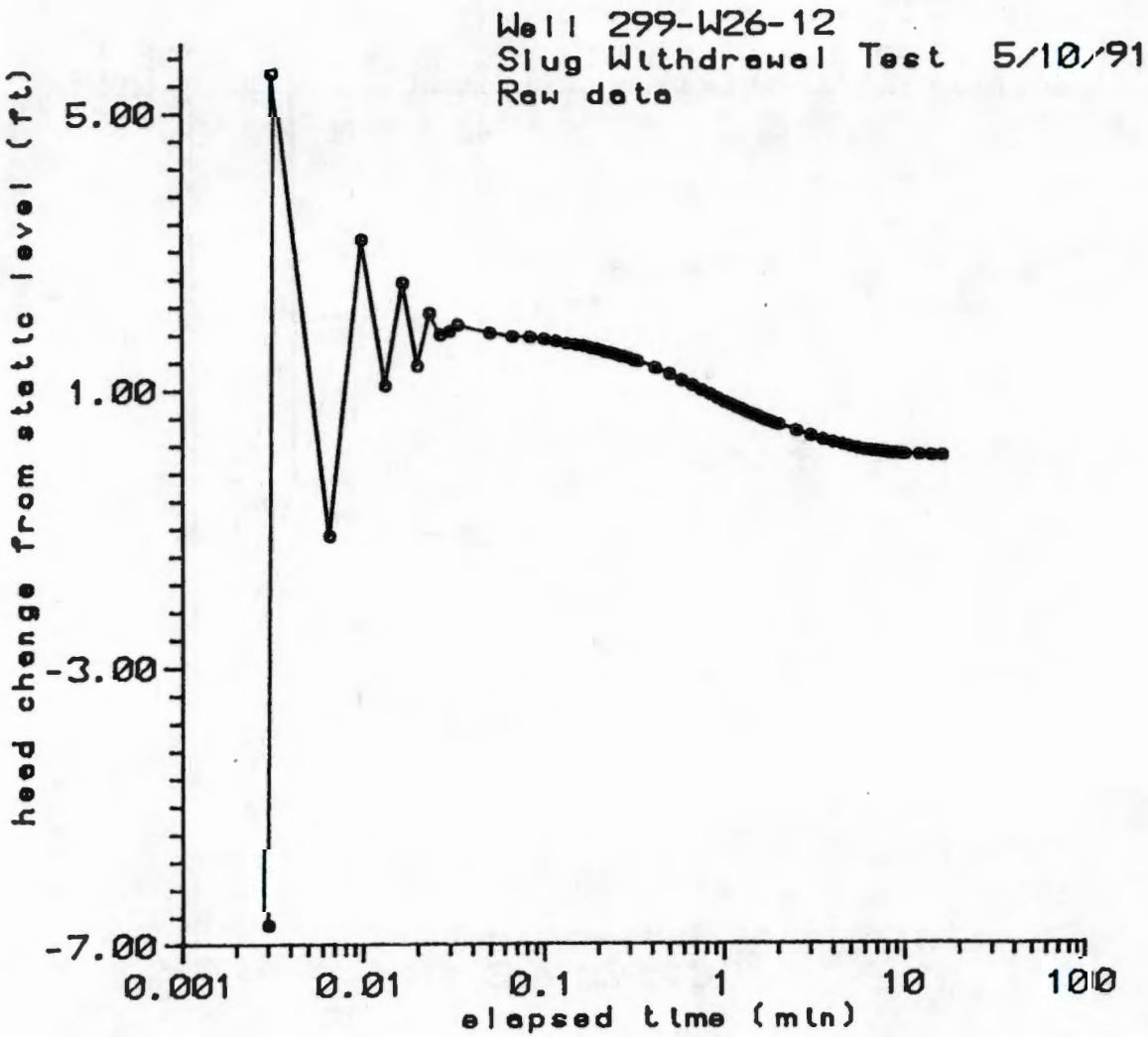
Arbitrary time value on straight line, Tc (min): 2.294

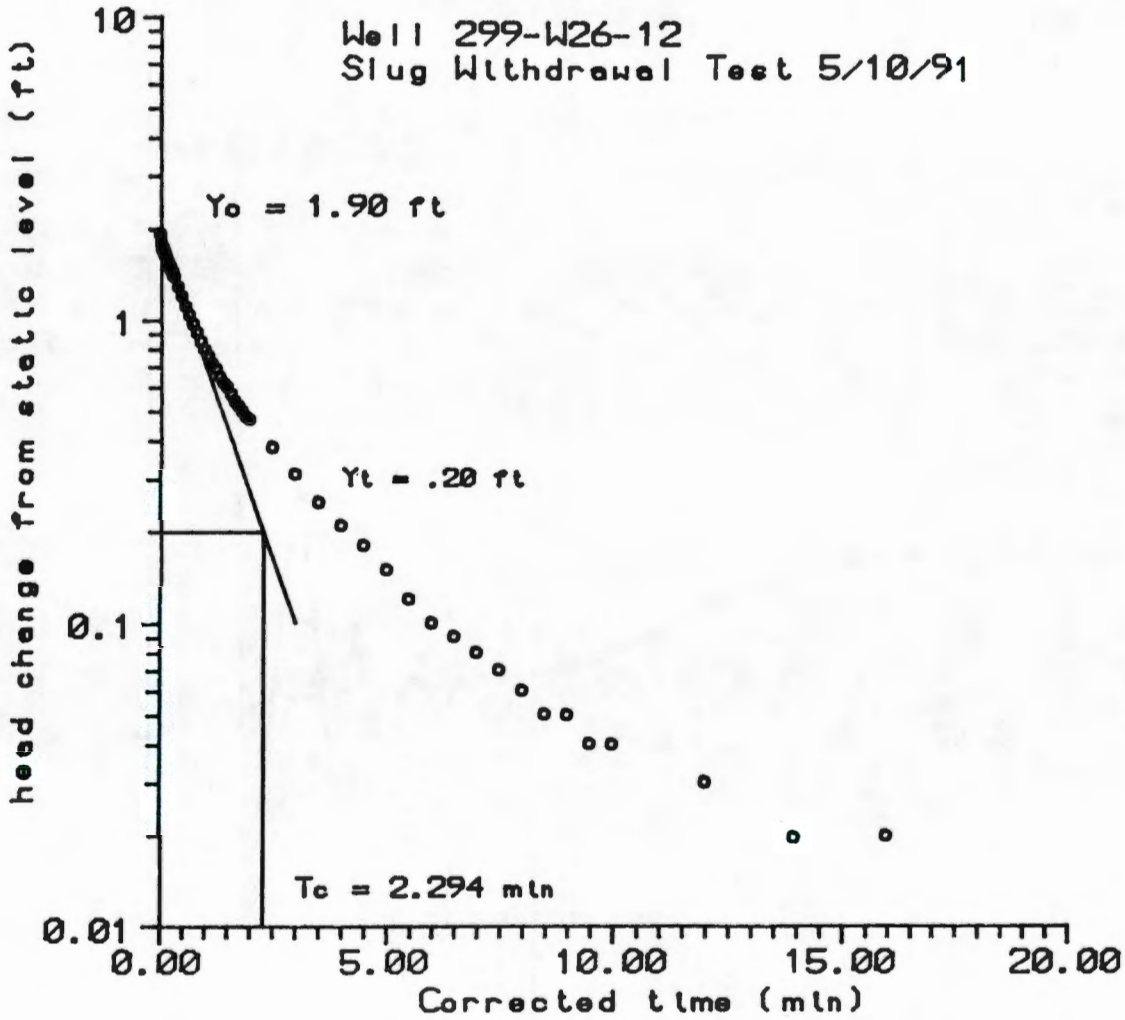
Head at Tc, Yt: .20

Comments: Recording of data initiated after rod withdrawal ∴ exact t = 0 is unknown.
WL starts gradual steady decline at an elapsed time of 0.0333 min.
On plot of raw data 1st data point actually occurs at an elapsed time of 0 min, I plotted it at a time of 0.003 min.

Name (print): J V Borghese Signature: J V Borghese Date: 11/20/91

9413136.0030


Well 299-W26-12
Slug Withdrawal Test 5/10/91
Raw data
head change from static level (ft)
5.00
1.00
-3.00
-7.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W26-12
Slug Withdrawal Test 5/10/91
Yo = 1.90 ft
Yt = .20 ft
Tc = 2.294 min
head change from static level (ft)
10
1
0.1
0.01
0.00
5.00
10.00
15.00
20.00
Corrected time (min)

299-W26-12 Slug Withdrawal Test 5/10/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	18.0200	18.0200	200.0000

****
Le/Rw = 54.1141200
A= 3.2102570
B= 5.289381E-001
C= 2.8551000
SANDPACK POROSITY= 2.500000E-001
t (min)= 2.2940000
1/t= 4.359198E-001
Yo= (ft) 1.9000000
Yt= (ft) 2.000000E-001
1/t ln(Yo/Yt)= 9.813827E-001
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5407510
****
K (ft/day) = 4.8457700
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 87.3207900
****

9413136.2033

Well Number: 299 - W26 - 12

Dimensions in ft unless otherwise specified

Project: RCRA 3-10 Facility

Date of Test: 5/10/91

Type of Test: Slug Injection

Slugging Rod Dimensions, L: 6.0

D: .167

Theorectical head displacement in 4 inch casing: 1.50

Location of Field Records and Data: RCRA records file

Rod within screened interval: yes

Depth below land surface of tested zone: 228.24 - 210.22

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 18.02

Length of saturated screen interval, Le: 18.02

Thickness of aquifer, H: ~200 (Last 1989)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .05

Intial Head change, Yo: 1.05

Arbitrary time value on straight line, Tc (min): 0.3

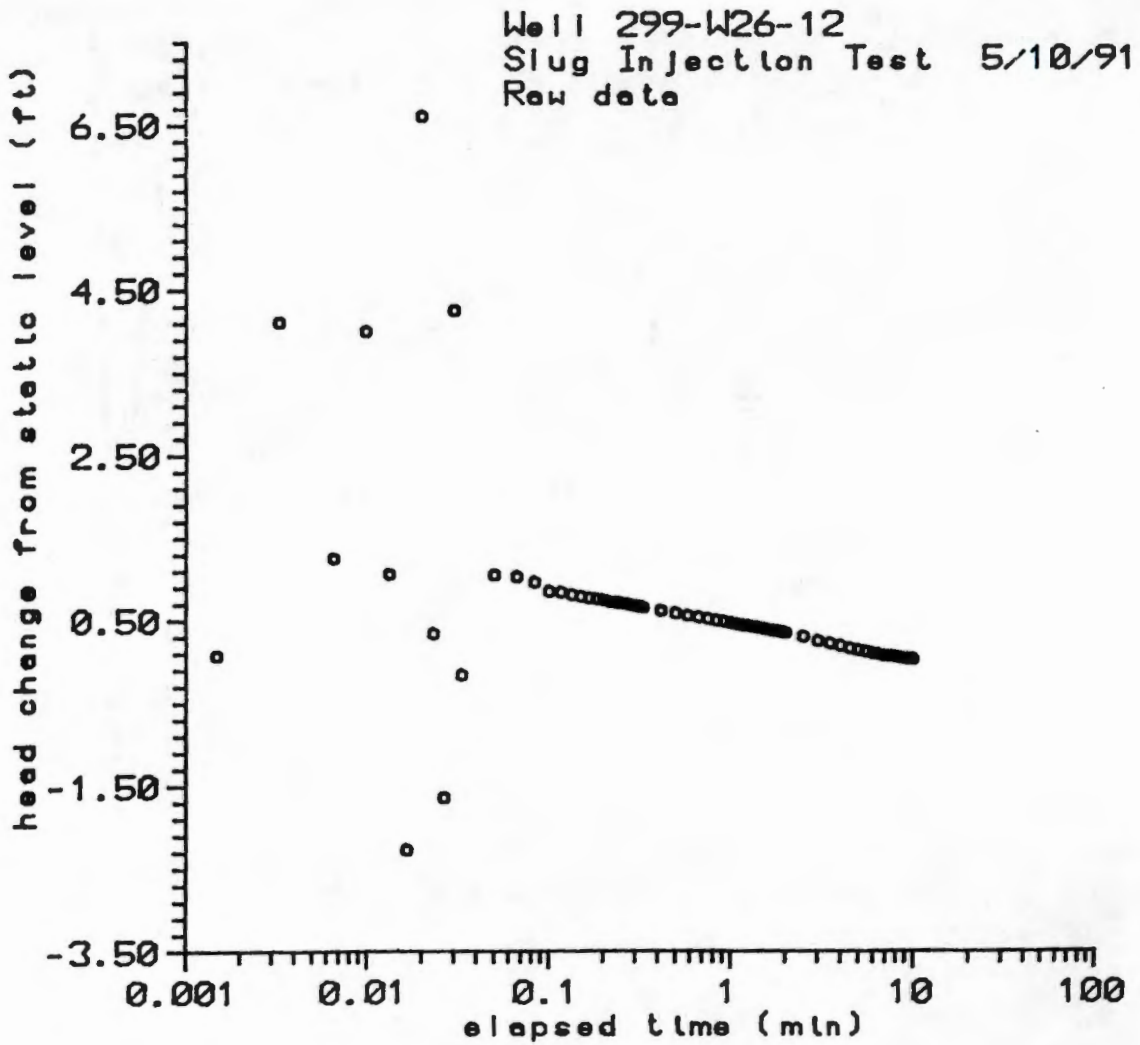
Head at Tc, Yt: 0.3833

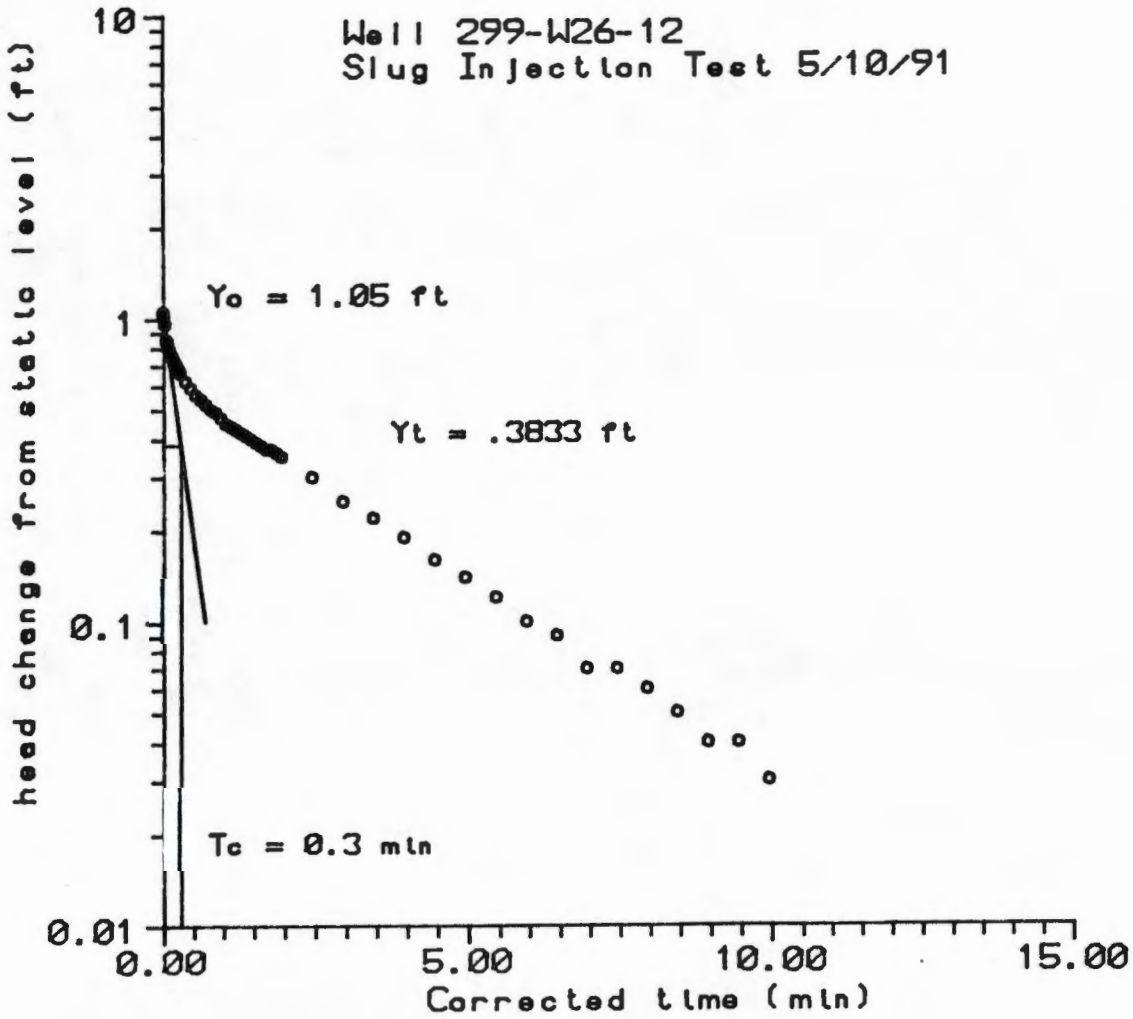
Comments: Recording of data initiated after/during rod immersion ∴ exact t = 0 is unknown.
On Raw data plot aligned time = 0 h0 = .07 plotted at t = .0015.
WL varied greatly prior to steady decline.
Limited number of pts. used to determine straight for Bouwer and Rice Analysis.

Results of Bouwer + Rice Analysis ~~are probably~~ may not be representative of Aquifer.

Name (print): TV Borghese Signature: [signature] Date: 11/21/91

9413136.0034


Well 299-W26-12
Slug Injection Test 5/10/91
Raw data
head change from static level (ft)
6.50
4.50
2.50
0.50
-1.50
-3.50
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W26-12
Slug Injection Test 5/10/91
Yo = 1.05 ft
Yt = .3833 ft
Tc = 0.3 min
head change from static level (ft)
10
1
0.1
0.01
0.00
5.00
10.00
15.00
Corrected time (min)

299-W26-12 Slug Injection Test 5/10/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	18.0200	18.0200	200.0000

****
Le/Rw = 54.1141200
A= 3.2102570
B= 5.289381E-001
C= 2.8551000
SANDPACK POROSITY= 2.500000E-001
t (min)= 3.000000E-001
1/t= 3.3333330
Yo= (ft) 1.0500000
Yt= (ft) 3.833000E-001
1/t ln(Yo/Yt)= 3.3590910
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5407510
****
K (ft/day) = 16.5861700
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 298.8829000
****

9413136.2037

Summary of Aquifer Testing Single Shell Tanks

Aquifer tests were conducted in 9 newly drilled wells to determine aquifer properties of hydraulic conductivity (K) and transmissivity (T). The following table list some of the test information.

Well Number	Type of Test	Date of Test	Depth from land surface of Tested Interval	K ft^2/day	Lithology of screened interval
2-W10-17	slug injection slug withdrawal	1/15/91	205-224	380[a] 260[a]	silty sandy gravel to sand
2-W10-18	slug injection slug withdrawal	1/16/91	202-220	-- 140	silty sandy gravel
2-W15-22	slug injection slug withdrawal	1/15/91	202-222	250[a] 50	silty sandy gravel
2-W18-25	slug injection slug withdrawal	12/12/90	196-216	20 20	silty sandy gravel
2-W19-31	slug injection slug withdrawal	1/17/91	207-227	100[a] 120	slighty silty sandy gravel
2-W19-32	slug injection slug withdrawal 1st line slug withdrawal 2nd line	1/14/91	205-225	1.0[a] 4.5 1.0	silty sandy gravel
2-W22-39	aquifer test file not found 12/17/91				
2-W23-13	slug injection slug withdrawal	12/12/90	199-219	90[a] --	muddy sandy gravel to sand
2-W23-14	slug injection slug withdrawal	4/12/91	199-218	1.4 1.4	gravelly sandy mud

[a] value suspect

Pertinent Notes:

- The "The Bouwer and Rice Slug Test - An Update" was used to determine K. ref; Bouwer, 1989: Ground Water vol 27, no.3.
- Tests were conducted in completed wells.
- All of the above wells are screened in the upper unconfined aquifer which is in the Ringold Formation in this area.
- Wells were tested by WHC.
- Test analyses were not reviewed.
- In some of the tests the initiation of data recording occurred after slugging rod was withdrawn or injected. Because of this the exact t=0 is unknown, which may result in a shift of the data. The shift of the data will yield different values of Yo and Tc (for the same Yt) and therefore a different K. Small shifts will yield very little change in K.
- Tests from wells 2-W10-18, 2-W19-32, and 2-W23-14 exhibited changes in slope of the recovery curve (wave like), this may be due to "damping".

Jane V. Borghese

9413136.2038

Well Number: 299-W10-17

Dimensions in ft unless otherwise specified

Project: RCRA SST TY tank farm

Date of Test: 1/15/91

Type of Test: slug injection

Slugging Rod Dimensions, L: 6

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: 205 - 224

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 19

Length of saturated screen interval, Le: 19

Thickness of aquifer, H: 250 (estimated)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .0333

Intial Head change, Yo: 1.20

Arbitrary time value on straight line, Tc (min): .06

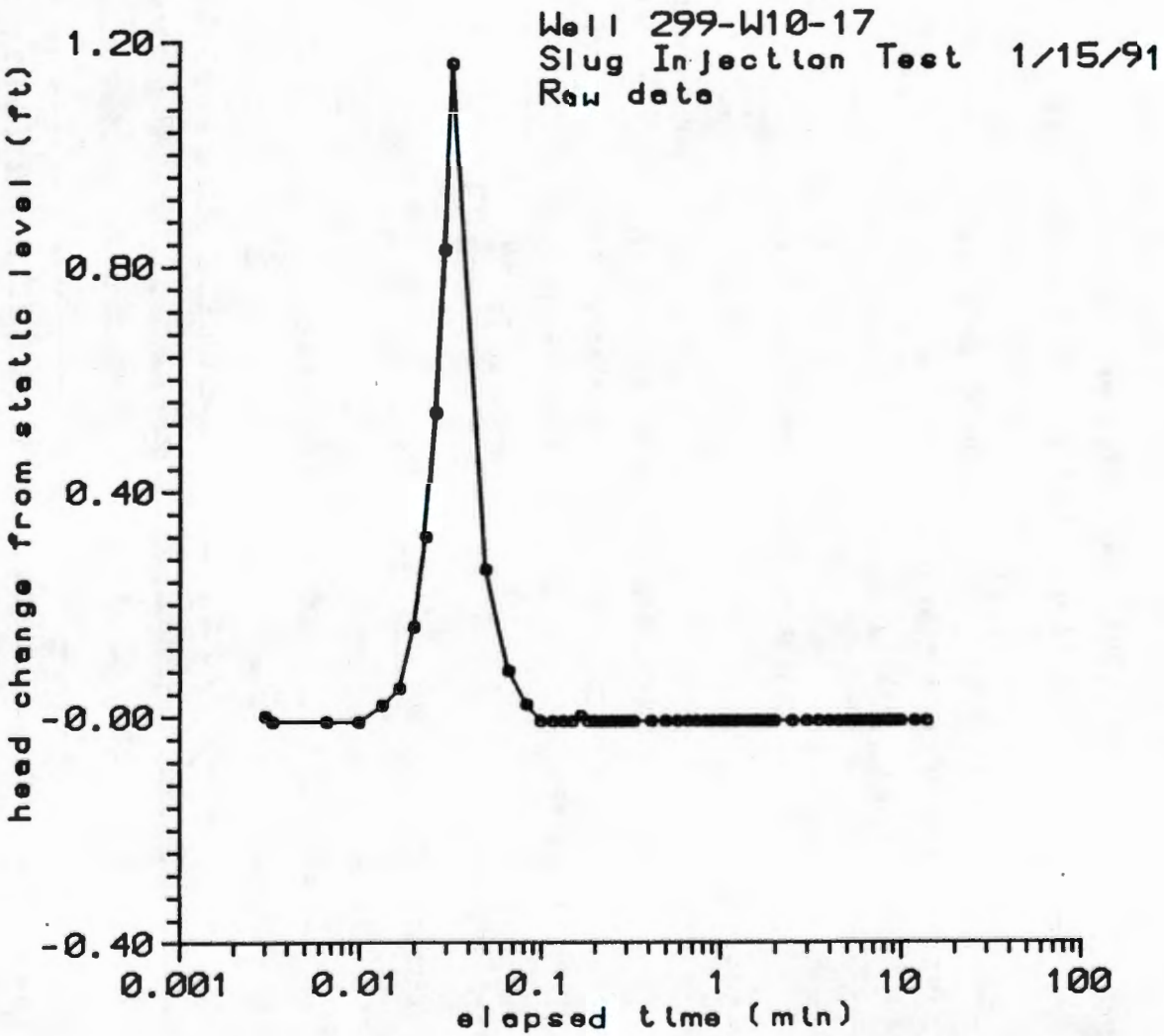
Head at Tc, Yt: 0.01

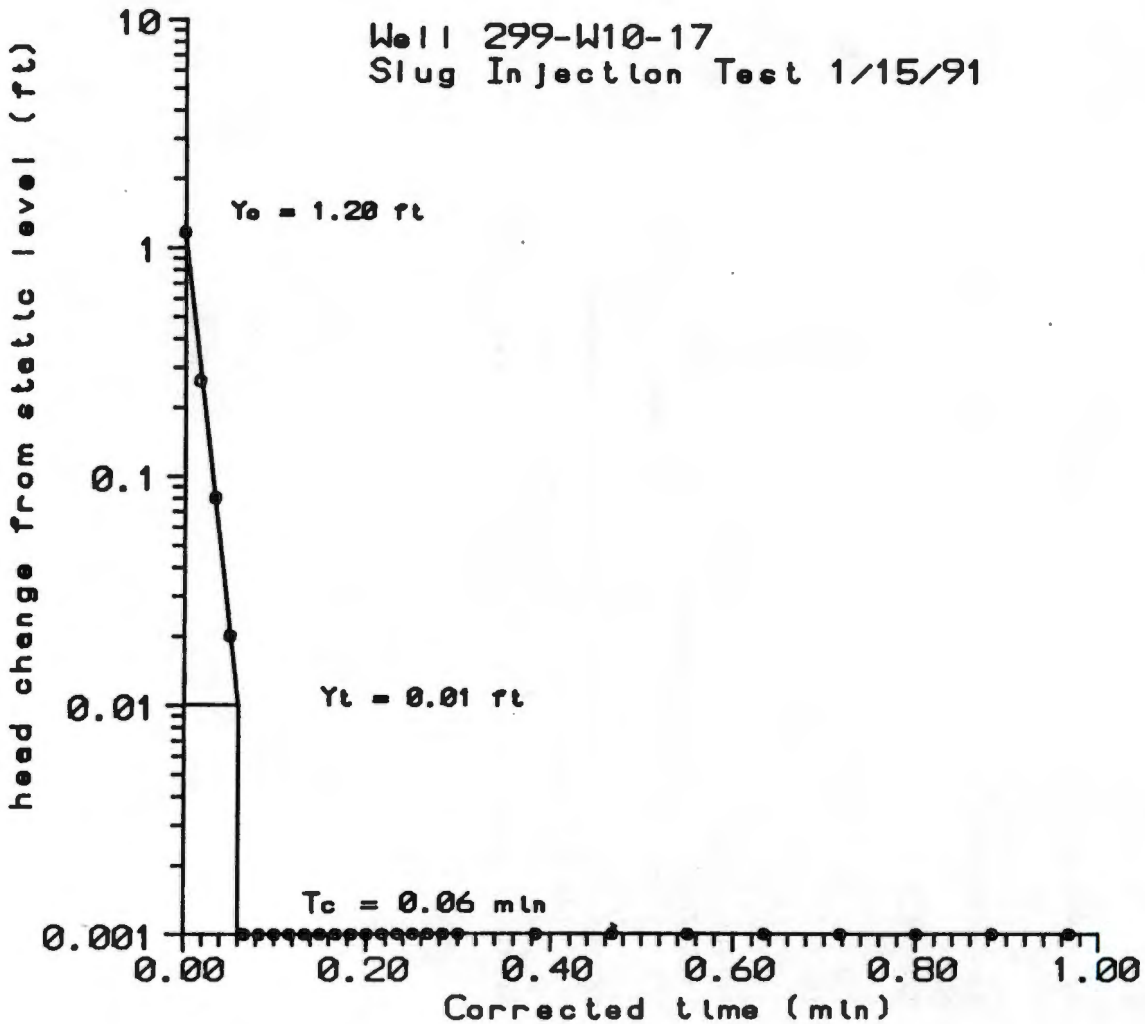
Comments: time Ø plotted at an elapsed time of .003 on Raw data graph.
Initiation of data recording occurred prior to slug injection.
On semilog plot only plotted time corrected data that were <1min - changed -.01 and 0 head change values to .001 so that they could be plotted.

Because of limited # of data points to straight line ~~tota~~ results are very approximate.

Name (print): JV Borghese Signature: JV Borghese Date: 12/3/91

9413136.2039


Well 299-W10-17
Slug Injection Test 1/15/91
Raw data
head change from static level (ft)
1.20
0.80
0.40
-0.00
-0.40
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W10-17
Slug Injection Test 1/15/91
Yo = 1.20 ft
Yt = 0.01 ft
Tc = 0.06 min
head change from static level (ft)
10
1
0.1
0.01
0.001
0.00
0.20
0.40
0.60
0.80
1.00
Corrected time (min)

299-W10-17 Slug Injection Test 1/15/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	19.0000	19.0000	250.0000

****
Le/Rw = 57.0570600
A= 3.2844110
B= 5.365443E-001
C= 2.9479060
SANDPACK POROSITY= 2.500000E-001
t (min)= 6.000000E-002
1/t= 16.6666700
Yo= (ft) 1.2000000
Yt= (ft) 1.000000E-002
1/t ln(Yo/Yt)= 79.7915300
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5907410
****
K (ft/day) = 381.0170000
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 7239.3220000
****

Well Number: 299-W10-17

Dimensions in ft unless otherwise specified

Project: RCRA SST TY Tank Farm

Date of Test: 1/15/91

Type of Test: slug withdrawal

Slugging Rod Dimensions, L: 6

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: 205 -224

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 19

Length of saturated screen interval, Le: 19

Thickness of aquifer, H: 250 (estimated from Liu's report)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .0133

Intial Head change, Yo: 2.18

Arbitrary time value on straight line, Tc (min): .10

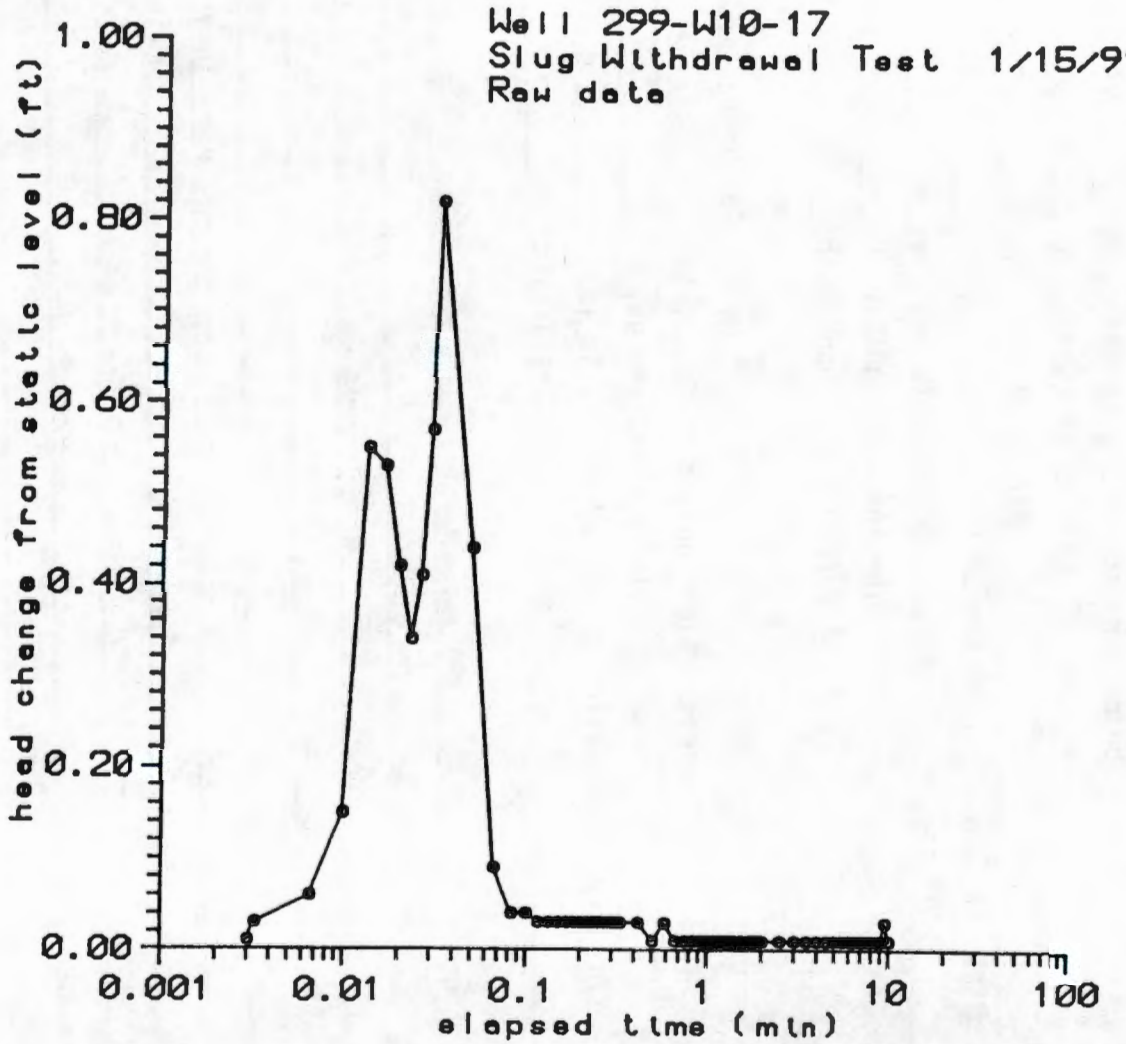
Head at Tc, Yt: .01

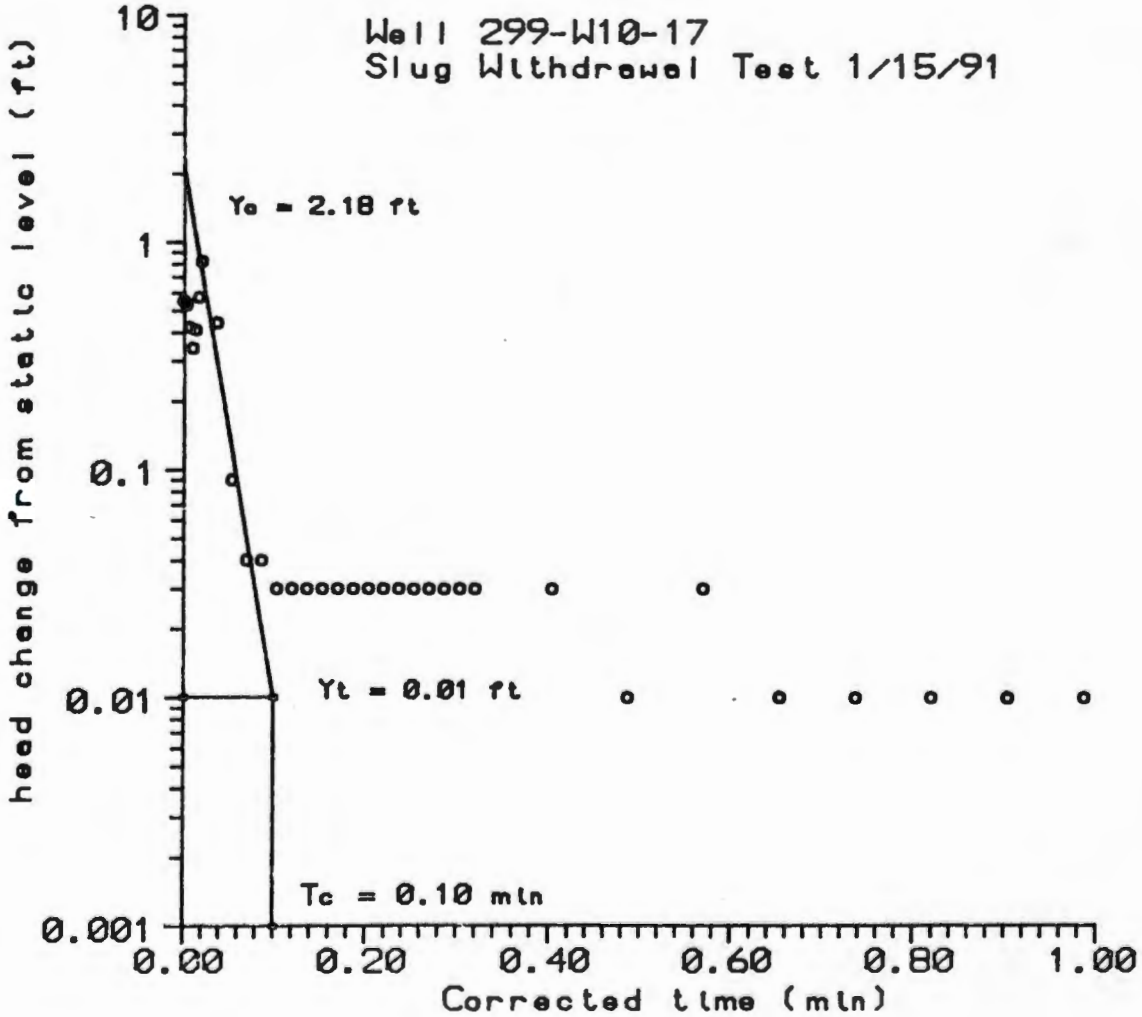
Comments: Time 0 ~~observed~~ at an elapsed time of .003 on Raw data graph.
Initiation of data recording occurred after slugging rod removal.

Because of fluctuations in water level at test beginning, observed Yo << theoretical and limited # of points to draw straight line believe test results to be very approximate.

Name (print): J V Bergeson Signature: J V Bergeson Date: 12/3/91

9413136.2043


Well 299-W10-17
Slug Withdrawal Test 1/15/91
Raw data
head change from static level (ft)
1.00
0.80
0.60
0.40
0.20
0.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W10-17
Slug Withdrawal Test 1/15/91
Yo = 2.18 ft
Yt = 0.01 ft
Tc = 0.10 min
head change from static level (ft)
10
1
0.1
0.01
0.001
0.00
0.20
0.40
0.60
0.80
1.00
Corrected time (min)

299-W10-17 Slug Withdrawal Test 1/15/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	19.0000	19.0000	250.0000

****
Le/Rw = 57.0570600
A= 3.2844110
B= 5.365443E-001
C= 2.9479060
SANDPACK POROSITY= 2.500000E-001
t (min)= 1.000000E-001
1/t= 10.0000000
Yo= (ft) 2.1800000
Yt= (ft) 1.000000E-002
1/t ln(Yo/Yt)= 53.8449500
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5907410
****
K (ft/day) = 257.1180000
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 4885.2420000
****

9413136.2046

Well Number: 299-W10-18

Dimensions in ft unless otherwise specified

Project: SST TY Tank Farm RCRA

Date of Test: 1/16/91

Type of Test: slug injection

Slugging Rod Dimensions, L: 6

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: 202 - 220.9

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 18.92

Length of saturated screen interval, Le: 18.92

Thickness of aquifer, H: 250 (estimated from Lindsey)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min):

Intial Head change, Yo: NA

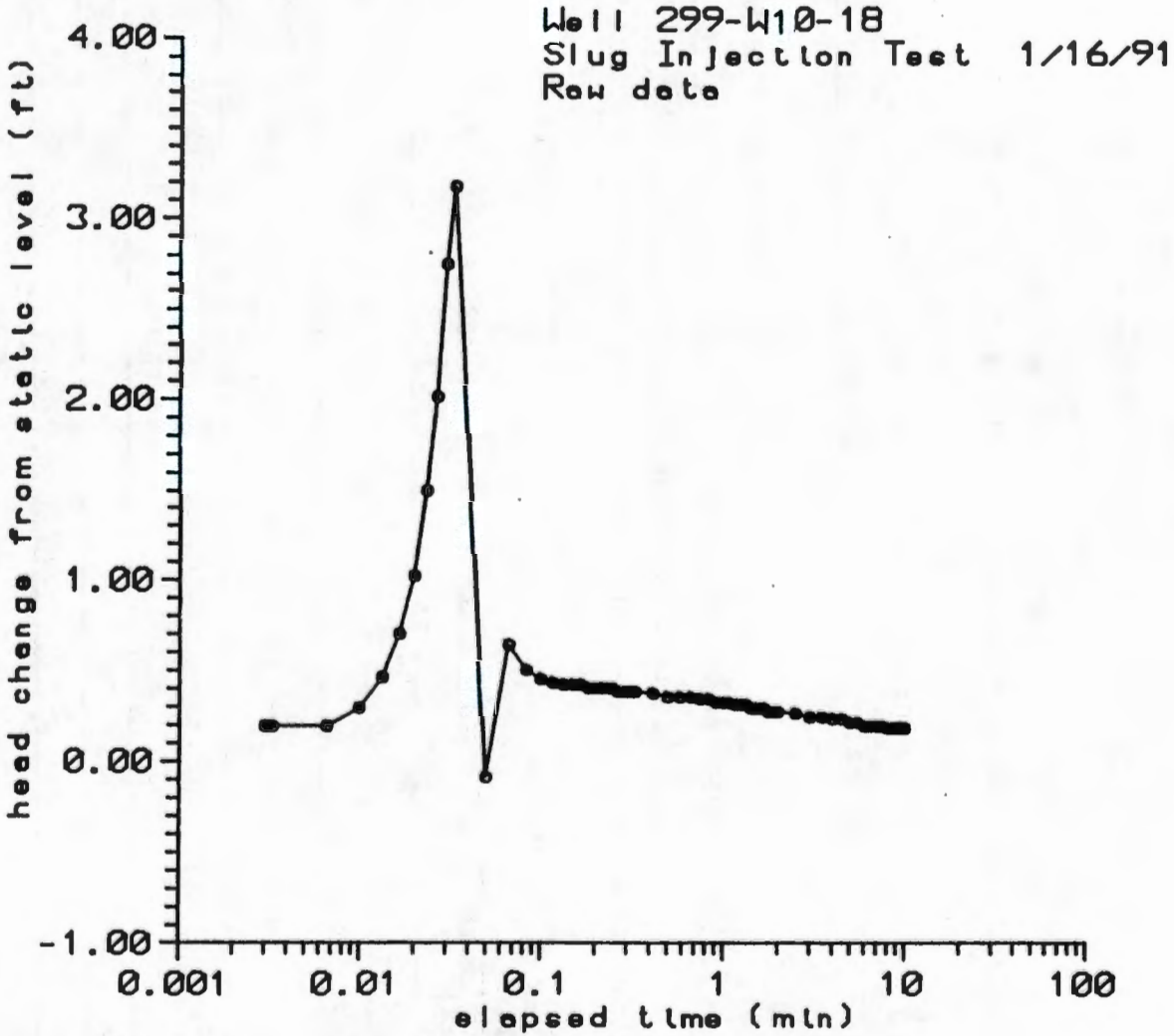
Arbitrary time value on straight line, Tc (min):

Head at Tc, Yt:

Comments: Not enough data points to confidently draw straight line for Bouwer Rice Analysis. See Slug withdrawal test for analysis and K value.

Name (print): J V Boyhese Signature: [signature] Date: 12/4/91

9413136.2047


Well 299-W10-18
Slug Injection Test 1/16/91
Raw data
head change from static level (ft)
4.00
3.00
2.00
1.00
0.00
-1.00
0.001
0.01
0.1
1
10
100
elapsed time (min)

Well Number: 299-W10-18

Dimensions in ft unless otherwise specified

Project: SST T/Tank Farm RCRA

Date of Test: 1/16/91

Type of Test: slug withdrawal

Slugging Rod Dimensions, L: 6

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: 202 - 220.9

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 18.92

Length of saturated screen interval, Le: 18.92

Thickness of aquifer, H: 250 (estimated from Lindsey

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .0333

Intial Head change, Yo: 1.48

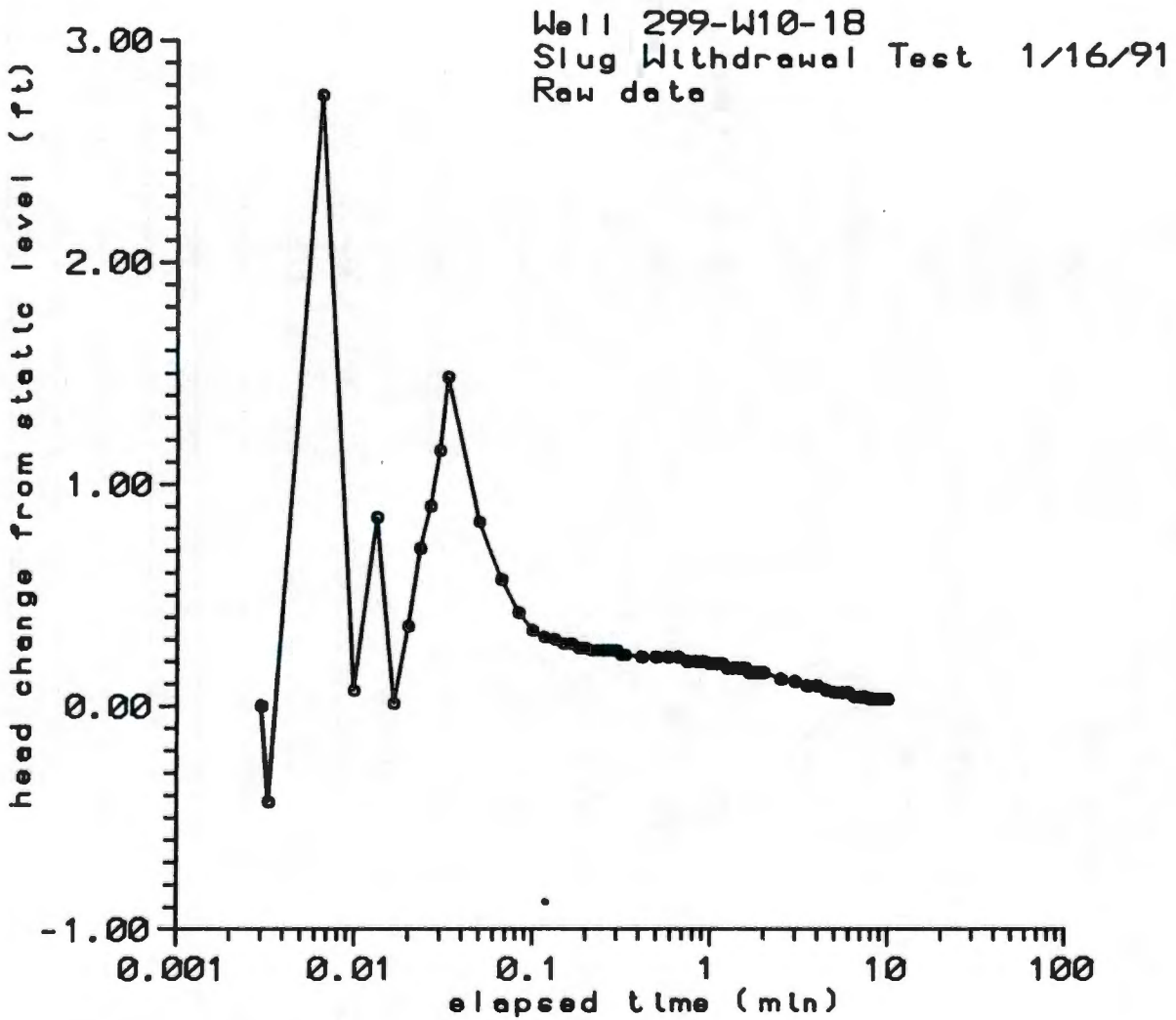
Arbitrary time value on straight line, Tc (min): .075

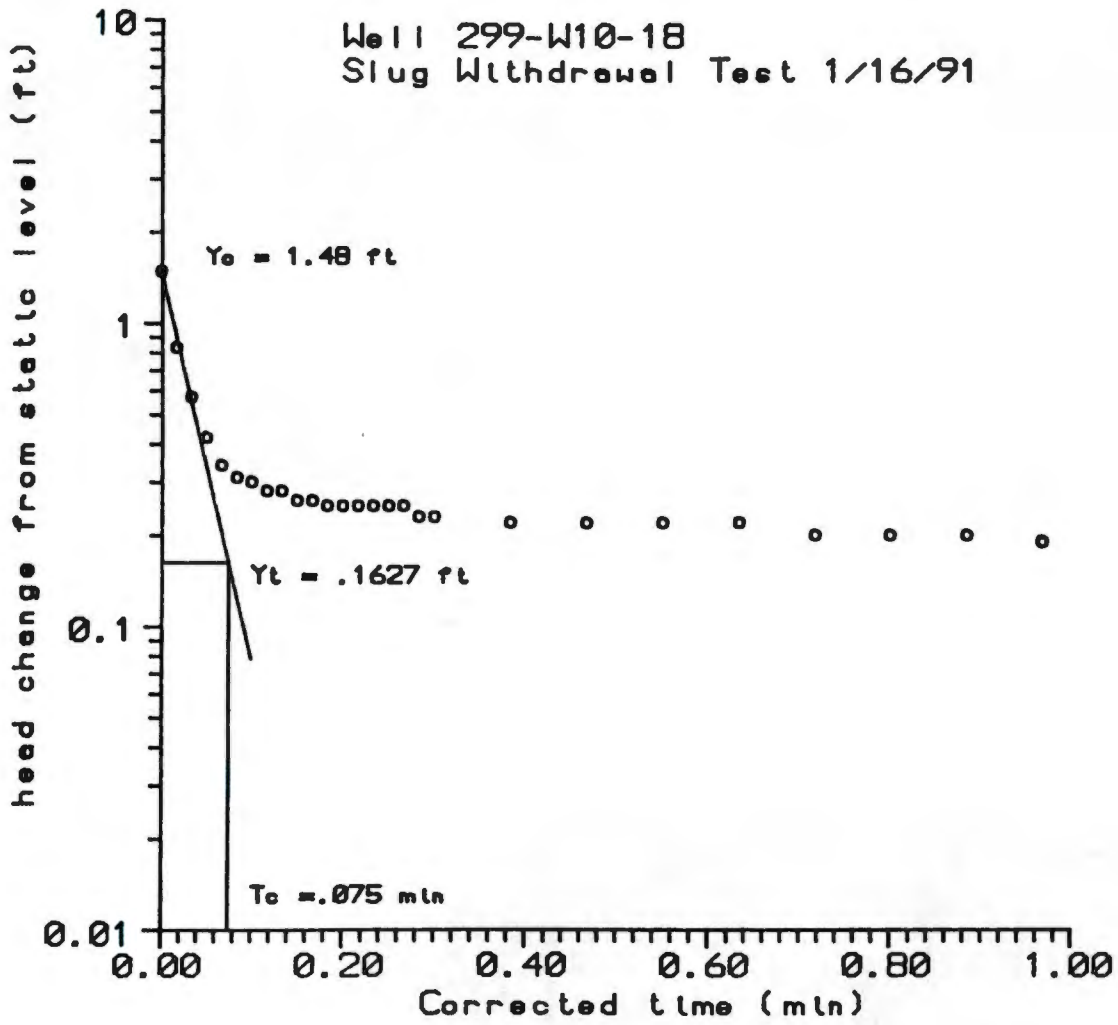
Head at Tc, Yt: .1627

Comments: On Raw data plot elapsed time of 0 plotted at elapsed time of .003 min.
Lots of fluctuations at test beginning - small # of data pts to fit straight line too.

Name (print): JV Borghese Signature: JV Borghese Date: 12/4/91

9413136.2049


Well 299-W10-18
Slug Withdrawal Test 1/16/91
Raw data
head change from static level (ft)
3.00
2.00
1.00
0.00
-1.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W10-18
Slug Withdrawal Test 1/16/91
Yo = 1.48 ft
Yt = .1627 ft
To =.075 min
head change from static level (ft)
10
1
0.1
0.01
0.00
0.20
0.40
0.60
0.80
1.00
Corrected time (min)

299-W10-18 Slug Withdrawal Test 1/16/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	18.9200	18.9200	250.0000

****
Le/Rw = 56.8168100
A= 3.2651890
B= 5.365443E-001
C= 2.9354390
SANDPACK POROSITY= 2.500000E-001
t (min)= 7.500000E-002
1/t= 13.3333300
Yo= (ft) 1.4800000
Yt= (ft) 1.627000E-001
1/t ln(Yo/Yt)= 29.4385200
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5878730
****
K (ft/day) = 141.0116000
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 2667.9400000
****

9413136.2052

Well Number: 299-W15-22

Dimensions in ft unless otherwise specified

Project: RCRA SST TY Tank Farm

Date of Test: 1/15/91

Type of Test: Slug Injection

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: 202.92 - 222.45

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 19

Length of saturated screen interval, Le: 19

Thickness of aquifer, H: 250 (estimated)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .03

Intial Head change, Yo: 3.85

Arbitrary time value on straight line, Tc (min): .0697

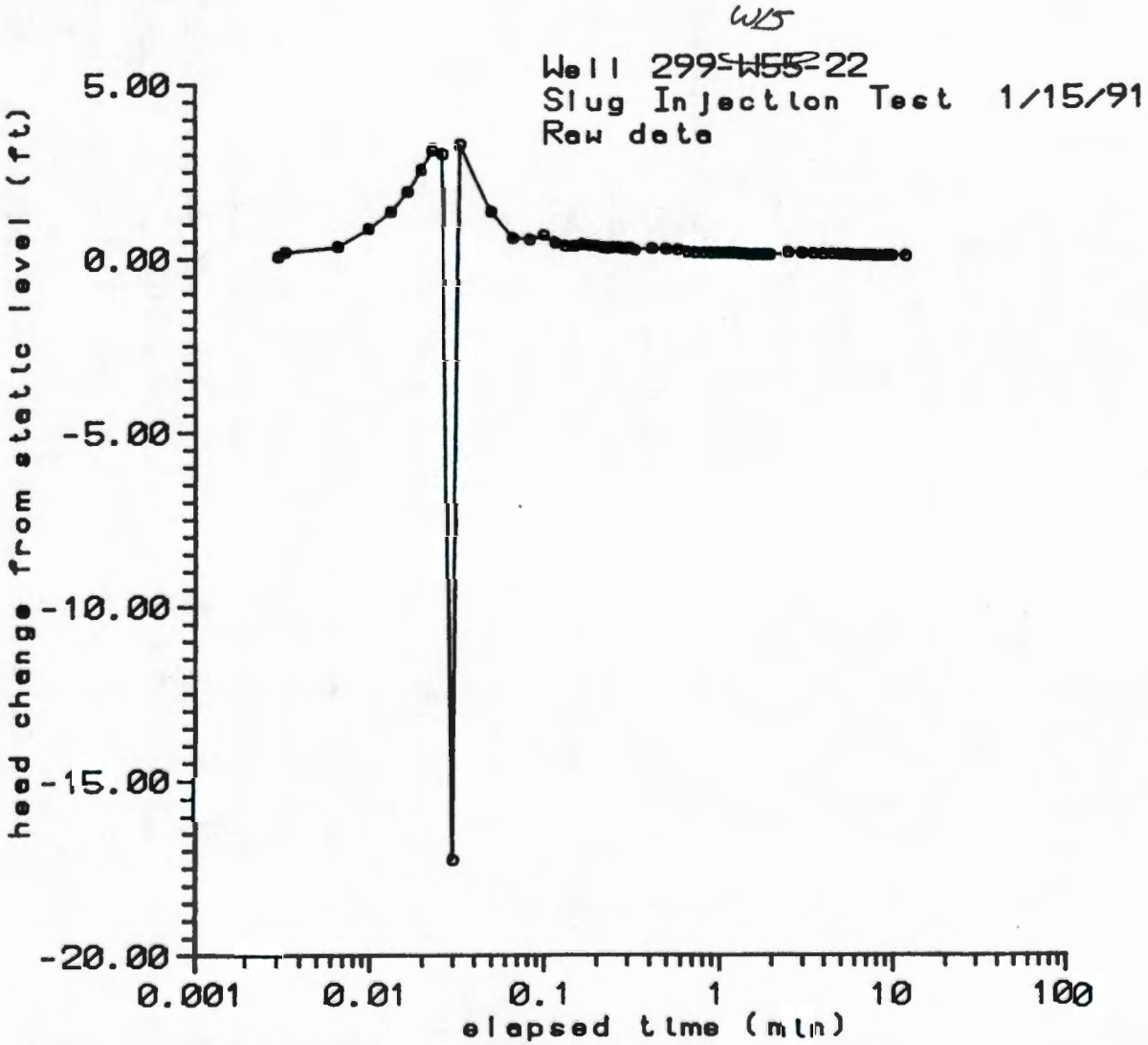
Head at Tc, Yt: ~~.0697~~ .1

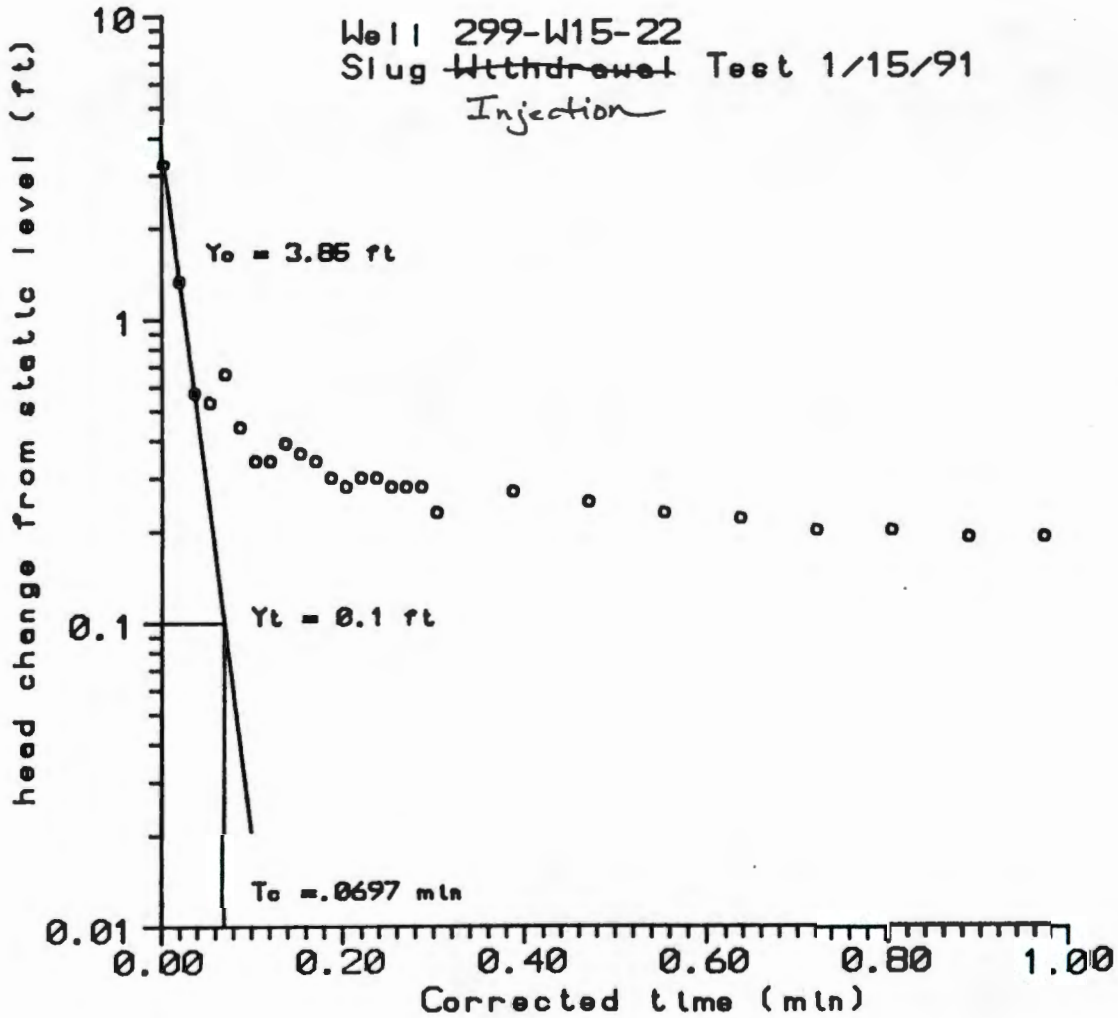
Comments: On Raw data plot plotted time 0 at an elapsed time of .0030 min.
For semilog graph the time correction applied to the data was 0.03 min.

Results from this analysis are questionable because of: limited # of pts for straight line, non-instantaneous slug injection, Head change varying greatly, ~~%~~ % greater than theoretical head change.
Note for ~~ref.~~ static level used 208.88 not the referenced level 202.92 — Baseline data indicates 208.88 is static

Name (print): JV Borghese Signature: JV Borghese Date: 12/10/91

9413136.2053


W15
Well 299-W15-22
Slug Injection Test 1/15/91
Raw data
head change from static level (ft)
5.00
0.00
-5.00
-10.00
-15.00
-20.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W15-22
Slug ~~Withdrawal~~ Test 1/15/91
Injection
Yo = 3.85 ft
Yt = 0.1 ft
To =.0697 min
head change from static level (ft)
10
1
0.1
0.01
0.00
0.20
0.40
0.60
0.80
1.00
Corrected time (min)

299-W15-22 Slug Injection Test 1/15/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	19.0000	19.0000	250.0000

****
Le/Rw = 57.0570600
A= 3.2844110
B= 5.365443E-001
C= 2.9479060
SANDPACK POROSITY= 2.500000E-001
t (min)= 6.970000E-002
1/t= 14.3472000
Yo= (ft) 3.8500000
Yt= (ft) 1.000000E-001
1/t ln(Yo/Yt)= 52.3767300
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5907410
****
K (ft/day) = 250.1070000
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 4752.0340000
****

9413136.2056

Well Number: 299-W15-22

Dimensions in ft unless otherwise specified

Project: RCRA SST TY Tank Farm

Date of Test: 1/15/91

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: 202.95 - 222.45

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 19

Length of saturated screen interval, Le: 19

Thickness of aquifer, H: 250 (estimated)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .0917

Intial Head change, Yo: 1.25

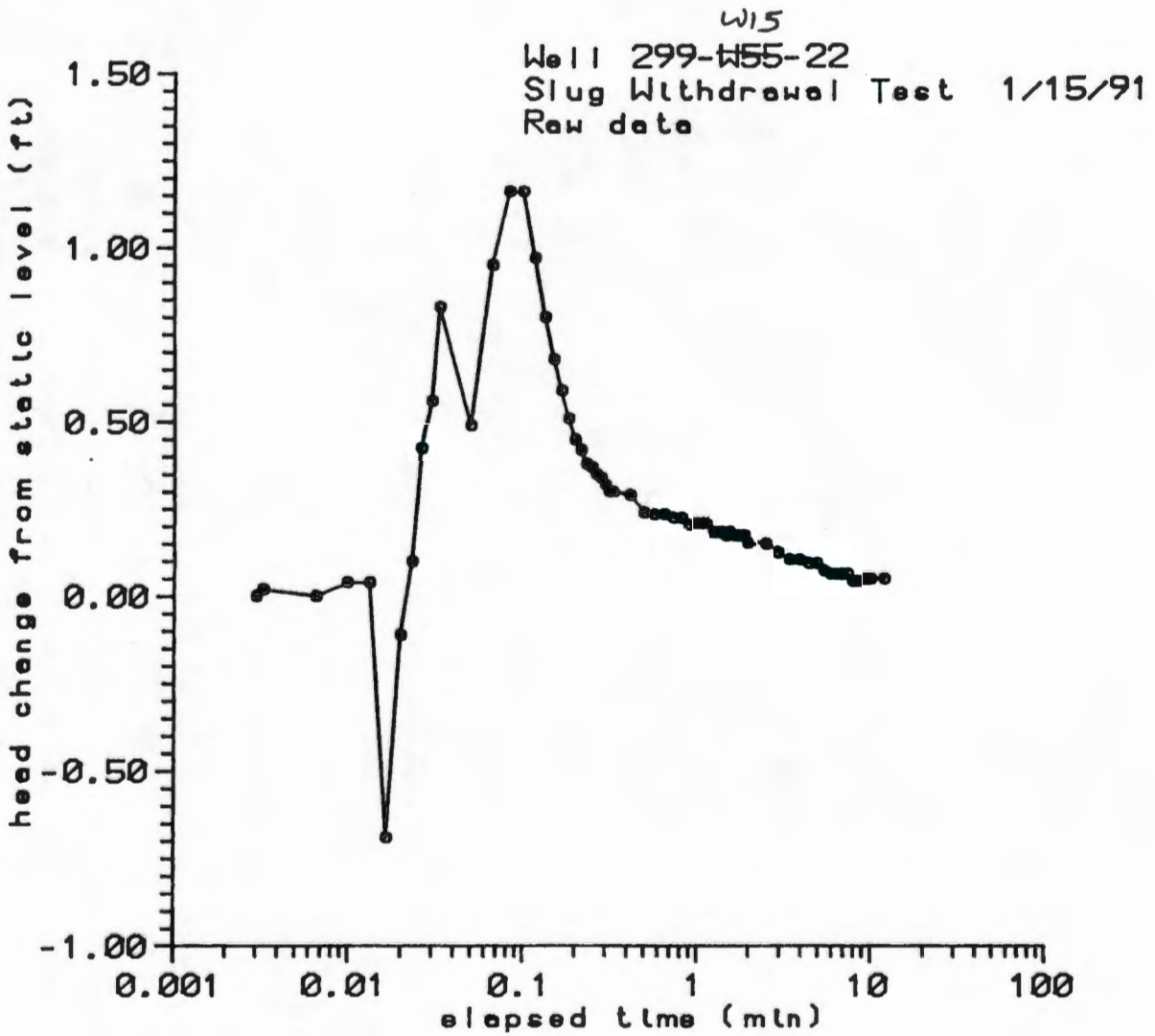
Arbitrary time value on straight line, Tc (min): .20

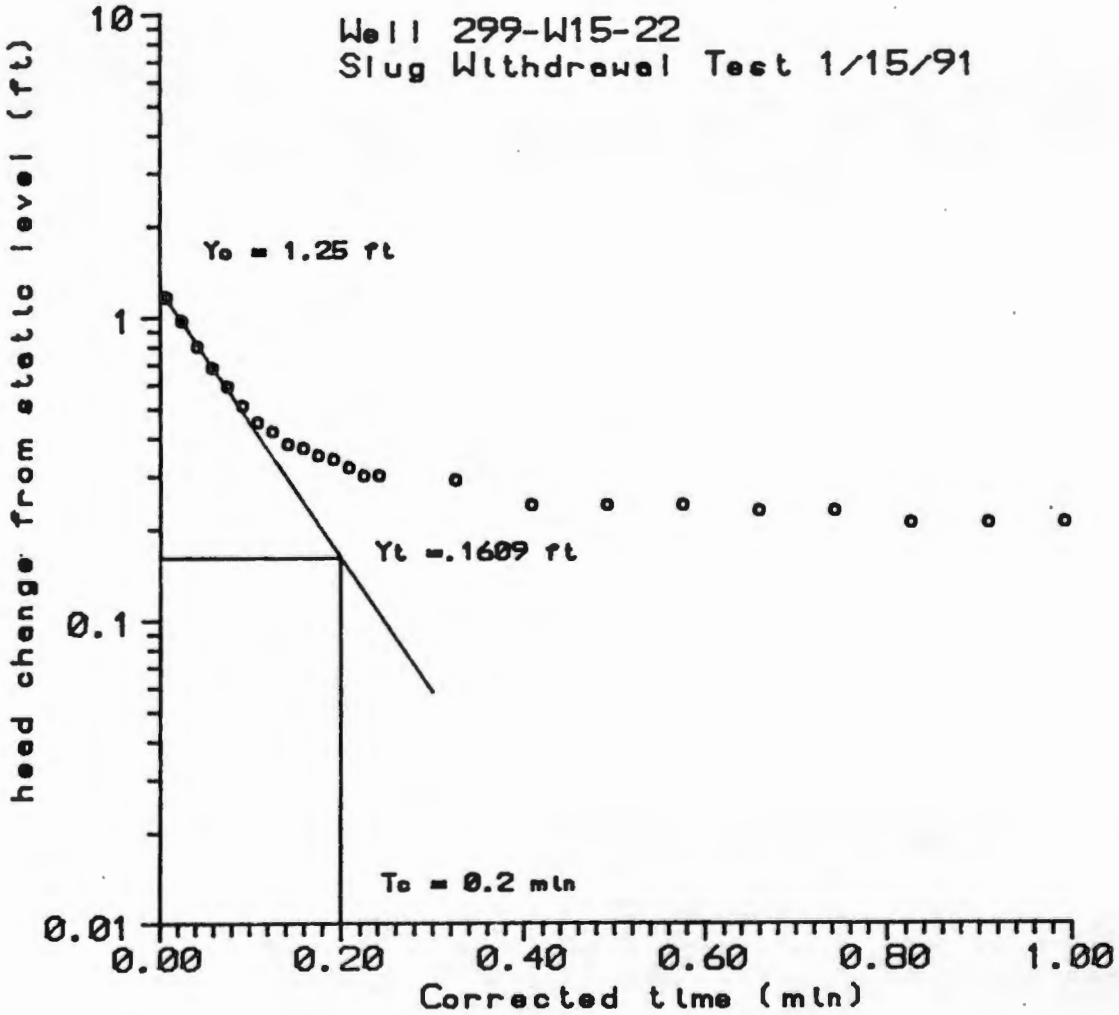
Head at Tc, Yt: .1609

Comments: On Raw data plot time 0 is plotted at an elapsed time of .003 min. Used static level of 202.88 determined from baseline data. Determined Yo by doing a regression analysis on the first 5 time corrected data points ($r^2 = .99$). From raw data plot — looks like it took ~5 secs to pull slugging rod → wh may have been responding while rod was being removed! — so much for instantaneous assumption.

Name (print): J D Bagbase Signature: J D Bagbase Date: 12/10/91

9413136.2057


W15
Well 299-~~W55~~-22
Slug Withdrawal Test 1/15/91
Raw data
head change from static level (ft)
1.50
1.00
0.50
0.00
-0.50
-1.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W15-22
Slug Withdrawal Test 1/15/91
Yo = 1.25 ft
Yt =.1609 ft
To = 0.2 min
head change from static level (ft)
10
1
0.1
0.01
0.00
0.20
0.40
0.60
0.80
1.00
Corrected time (min)

299-W15-22 Slug Withdrawal Test 1/15/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	19.0000	19.0000	250.0000

****
Le/Rw = 57.0570600
A= 3.2844110
B= 5.365443E-001
C= 2.9479060
SANDPACK POROSITY= 2.500000E-001
t (min)= 2.000000E-001
1/t= 5.0000000
Yo= (ft) 1.2500000
Yt= (ft) 1.609000E-001
1/t ln(Yo/Yt)= 10.2505800
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5907410
****
K (ft/day) = 48.9481100
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 930.0140000
****

Well Number: 299-W18-25

Dimensions in ft unless otherwise specified

Project: RCRA SST

Date of Test: 12/12/90

Type of Test: Slug injection

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records file

Rod within screened interval: ~~yes~~ (WL 193.79)

Depth below land surface of tested zone: 196 - 216

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 22.2

Length of saturated screen interval, Le: 20

Thickness of aquifer, H: 350

Estimated Porosity of Sand Pack: NA

For Bouwer and Rice Analysis

Time correction applied to data (min): .0133

Intial Head change, Yo: 1.51

Arbitrary time value on straight line, Tc (min): .3

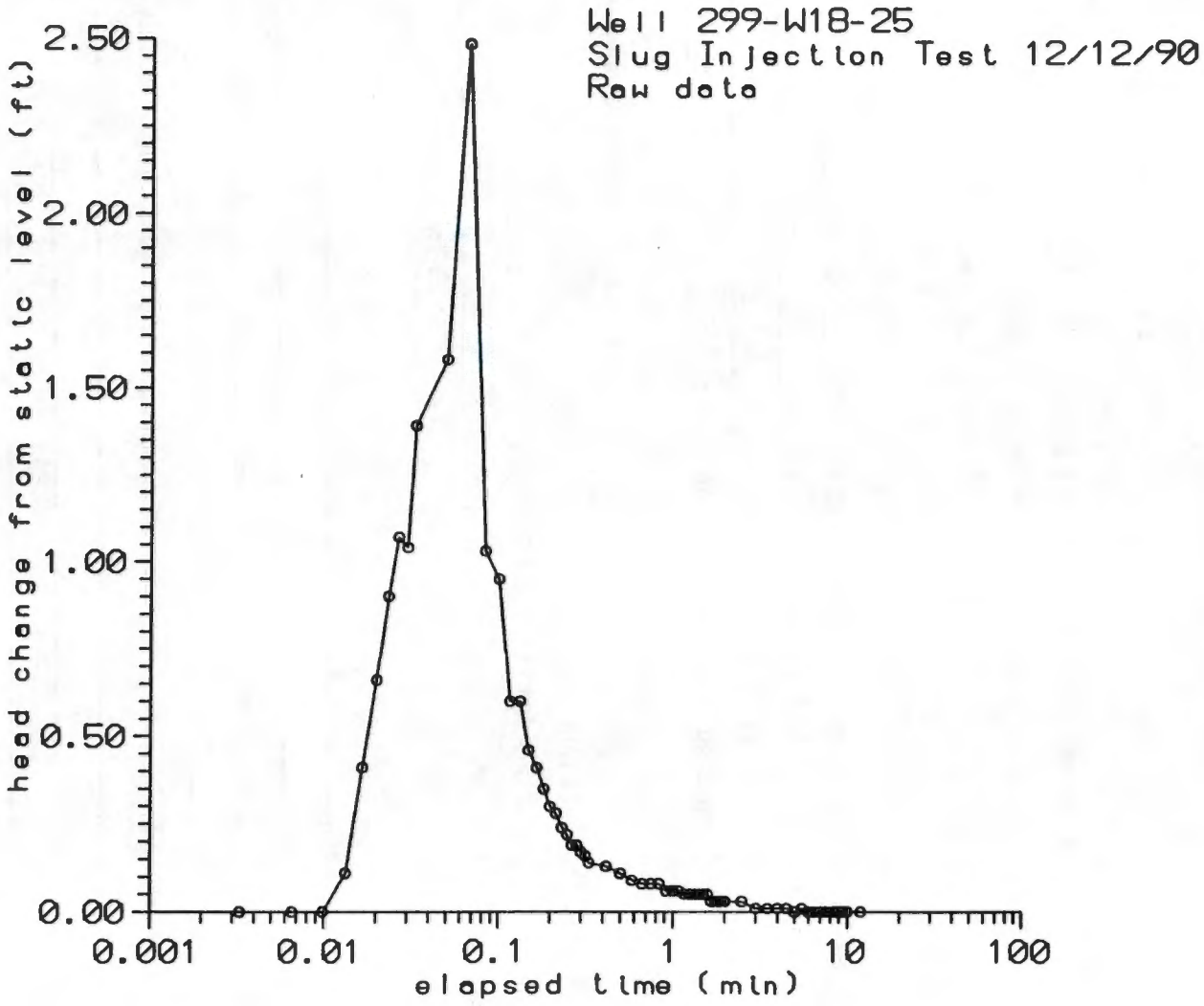
Head at Tc, Yt: .1384

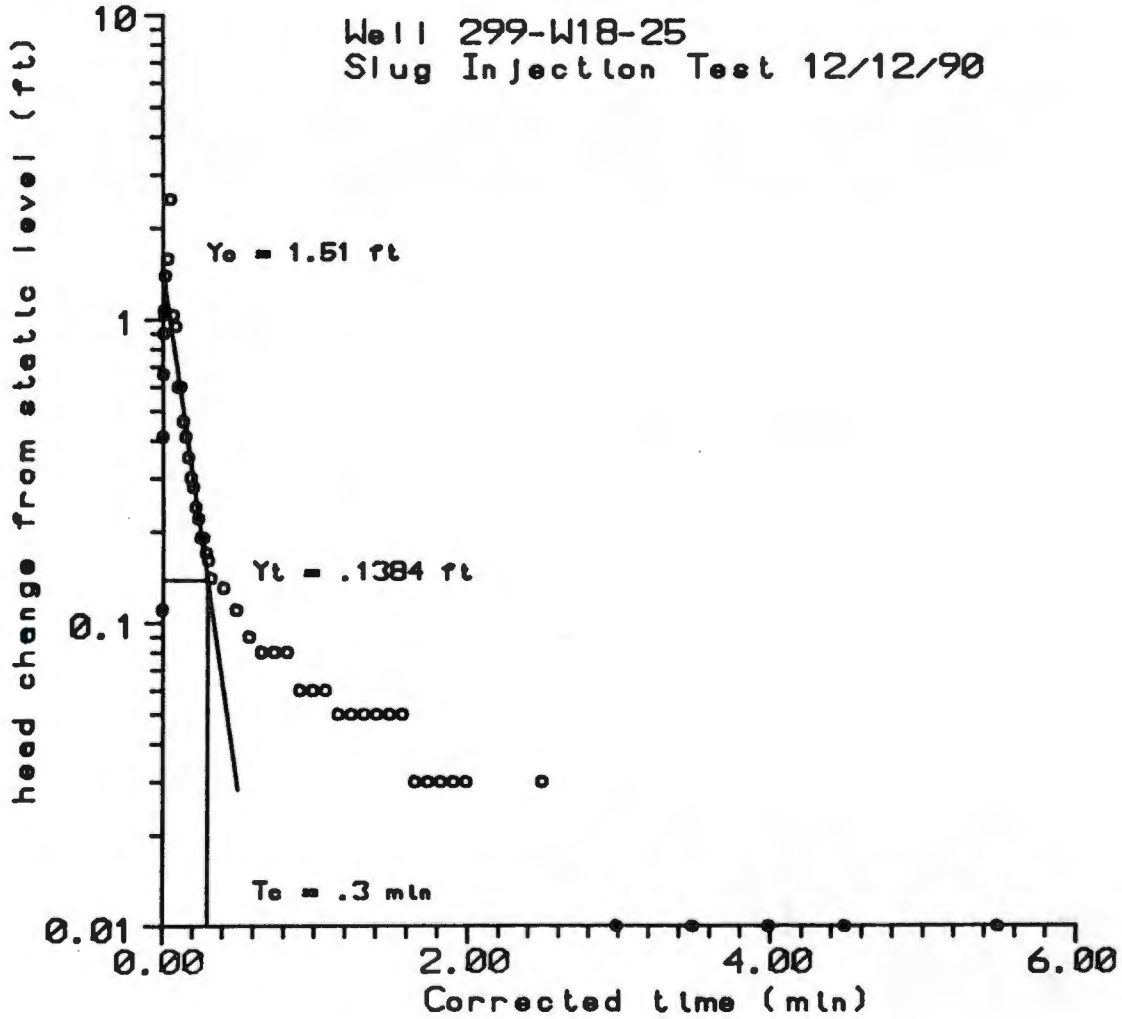
Comments: 50 psi transducer was used

Heads = 0 were not plotted on semilog graph.

Name (print): JV Borghese Signature: JV Borghese Date: 12/19/91

9413136.2061


Well 299-W18-25
Slug Injection Test 12/12/90
Raw data
head change from static level (ft)
2.50
2.00
1.50
1.00
0.50
0.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W18-25
Slug Injection Test 12/12/90
Yo = 1.51 ft
Yt = .1384 ft
To = .3 min
head change from static level (ft)
10
1
0.1
0.01
0.00
2.00
4.00
6.00
Corrected time (min)

299-W18-25 Slug Injection Test 12/12/90
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.1670	.3330	20.0000	22.2000	350.0000

****
Le/Rw = 60.0600600
A= 3.3422070
B= 5.482054E-001
C= 3.0164010
t (min)= 3.000000E-001
1/t= 3.3333330
Yo= (ft) 1.5100000
Yt= (ft) 1.384000E-001
1/t ln(Yo/Yt)= 7.9657230
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.6857420
****
K (ft/day) = 21.4795300
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 429.5906000
****

9413136.2064

Well Number: 299-W18-25

Dimensions in ft unless otherwise specified

Project: RCRA SST

Date of Test: 12/12/90

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: ~~1.67~~ 2.18

Location of Field Records and Data: RCRA Records file

Rod within screened interval: yes (WL 193.79

Depth below land surface of tested zone: 196 - 216

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 22.2

Length of saturated screen interval, Le: 20

Thickness of aquifer, H: 350

Estimated Porosity of Sand Pack: N/A Head change occurs in casing

For Bouwer and Rice Analysis

Time correction applied to data (min): .0099

Intial Head change, Yo: 1.7

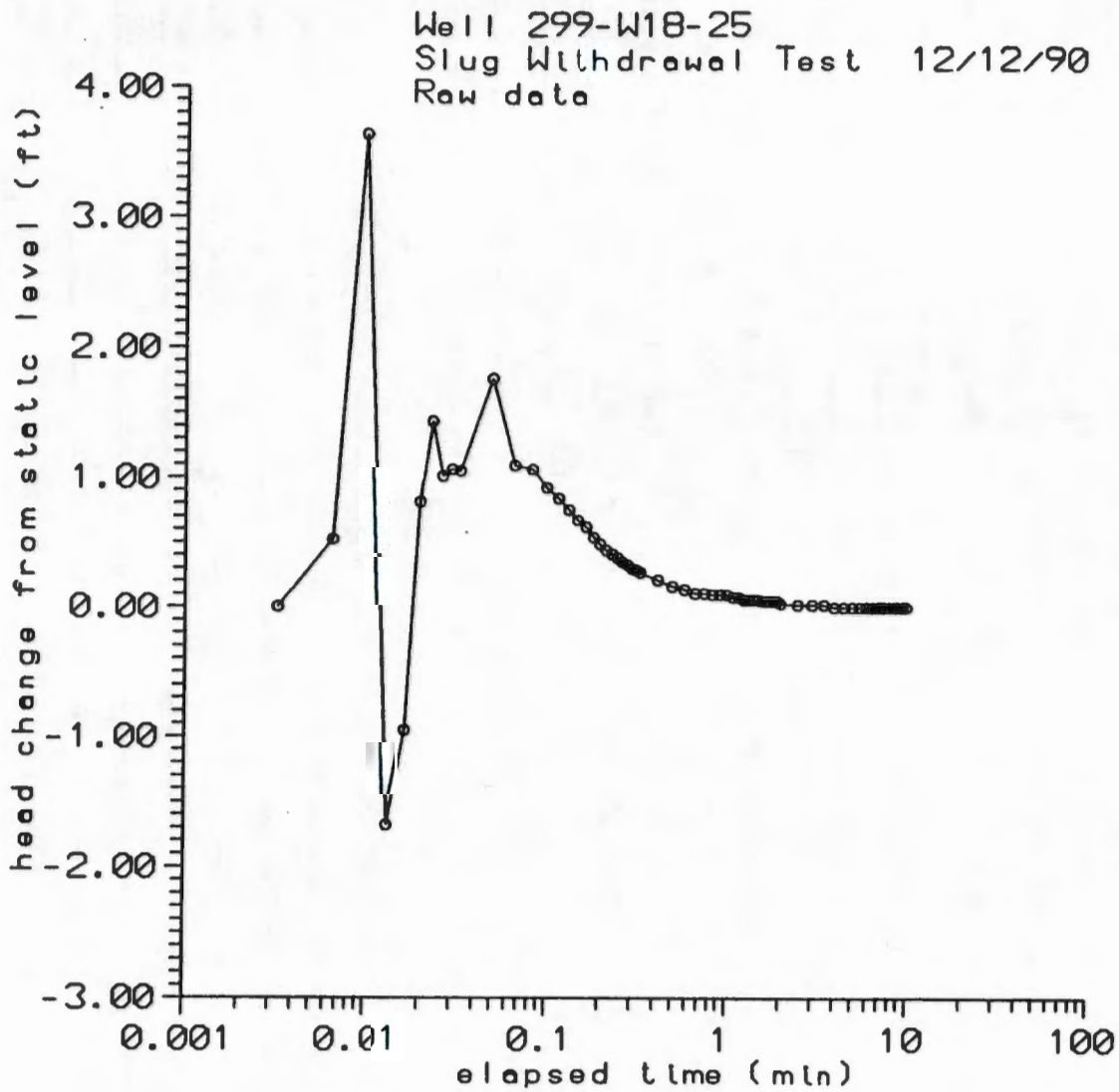
Arbitrary time value on straight line, Tc (min): 0.4

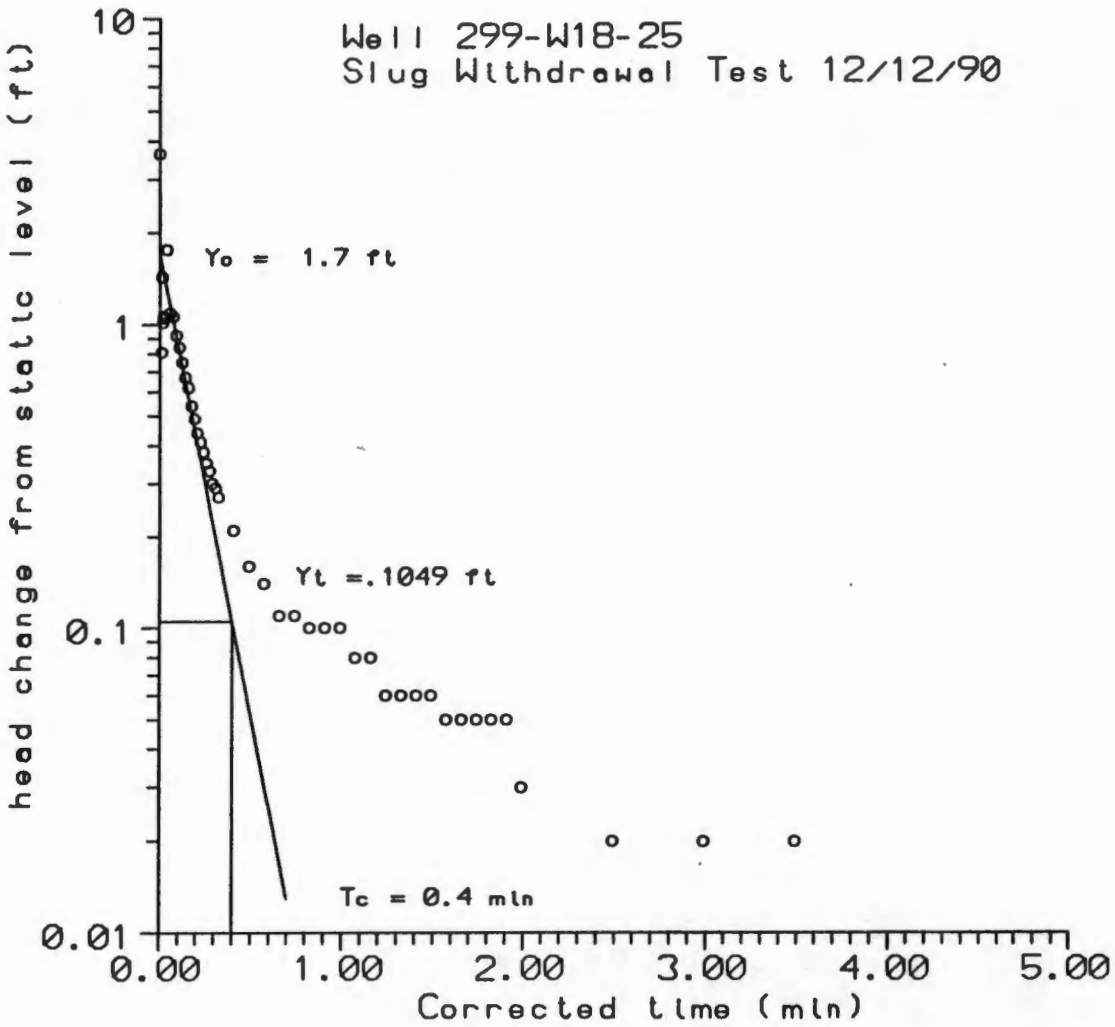
Head at Tc, Yt: 0.1049

Comments: Deleted negative values from semilog plot. To determin straight line ran regression on time corrected data (t_c = .0401 to .2234) r^2 = .96 eqn of line log y = -3.03219x + .233496

Name (print): JVBorghese Signature: JVBorghese Date: 12/17/91

9413136.2065


Well 299-W18-25
Slug Withdrawal Test 12/12/90
Raw data
head change from static level (ft)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W18-25
Slug Withdrawal Test 12/12/90
Yo = 1.7 ft
Yt =.1049 ft
Tc = 0.4 min
head change from static level (ft)
10
1
0.1
0.01
0.00
1.00
2.00
3.00
4.00
5.00
Corrected time (min)

299-W18-25 Slug Withdrawal Test 12/12/90

****

THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.

****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.1670	.3330	20.0000	22.2000	350.0000

****

Le/Rw = 60.0600600
A= 3.3422070
B= 5.482054E-001
C= 3.0164010
t (min)= 4.000000E-001
1/t= 2.5000000
Yo= (ft) 1.7000000
Yt= (ft) 1.049000E-001
1/t ln(Yo/Yt)= 6.9634400
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.6857420

****

K (ft/day) = 18.7768800

****

T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 375.5377000

****

9413136.2068

Well Number: 299-W19-31

Dimensions in ft unless otherwise specified

Project: RCRA SST

Date of Test: 1/17/91

Type of Test: Slug Injection

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records file

Rod within screened interval: yes (see comment)

Depth below land surface of tested zone: 207 - 227

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 21.62

Length of saturated screen interval, Le: 20.0

Thickness of aquifer, H: 350 (estimated)

Estimated Porosity of Sand Pack: N/A

For Bouwer and Rice Analysis

Time correction applied to data (min): .0283

Intial Head change, Yo: 1.75

Arbitrary time value on straight line, Tc (min): ~~.0985~~ .075

Head at Tc, Yt: .0985

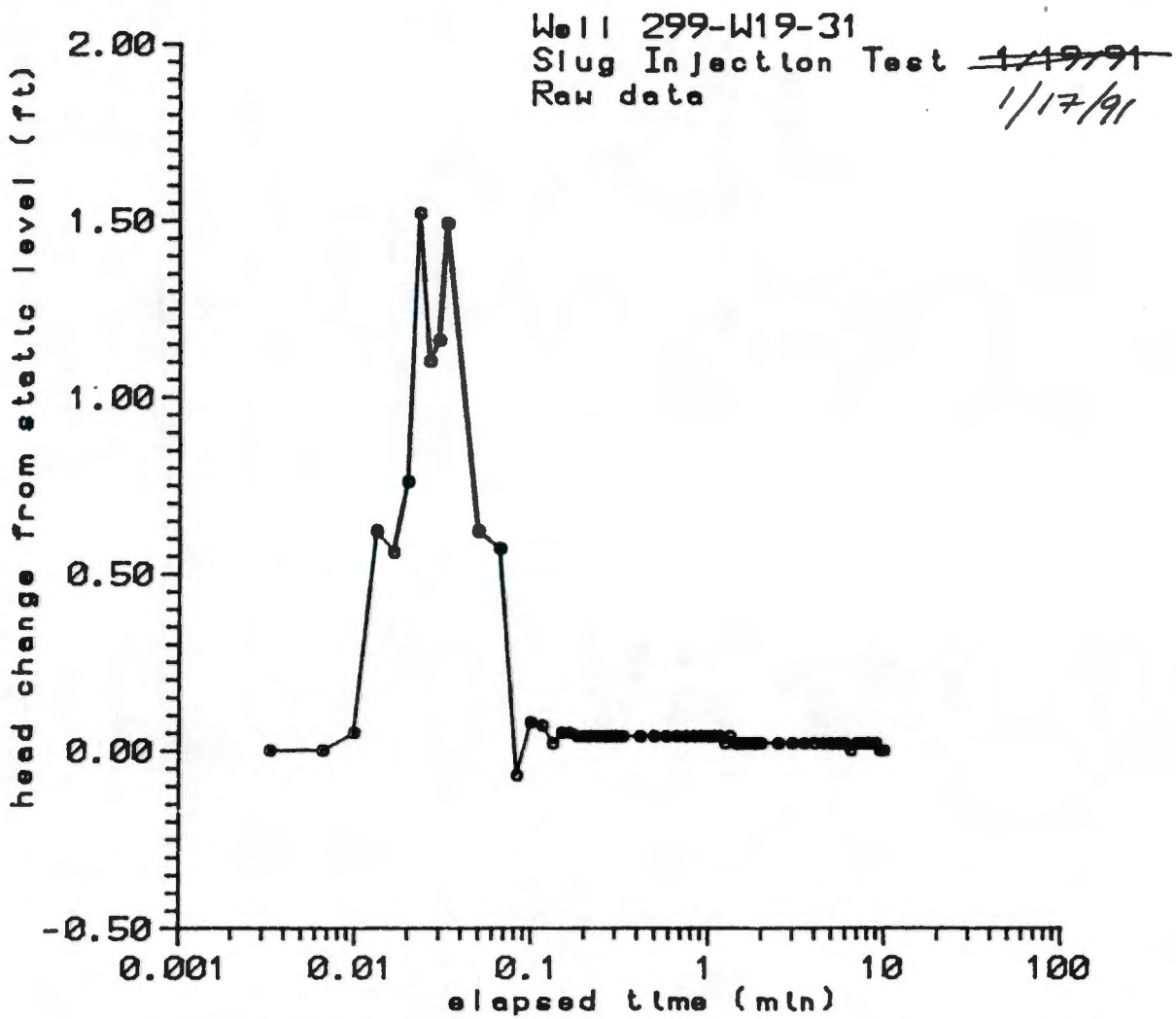
Comments: Water level prior to test was 205.54, rod is within screen but head change occurs within casing.

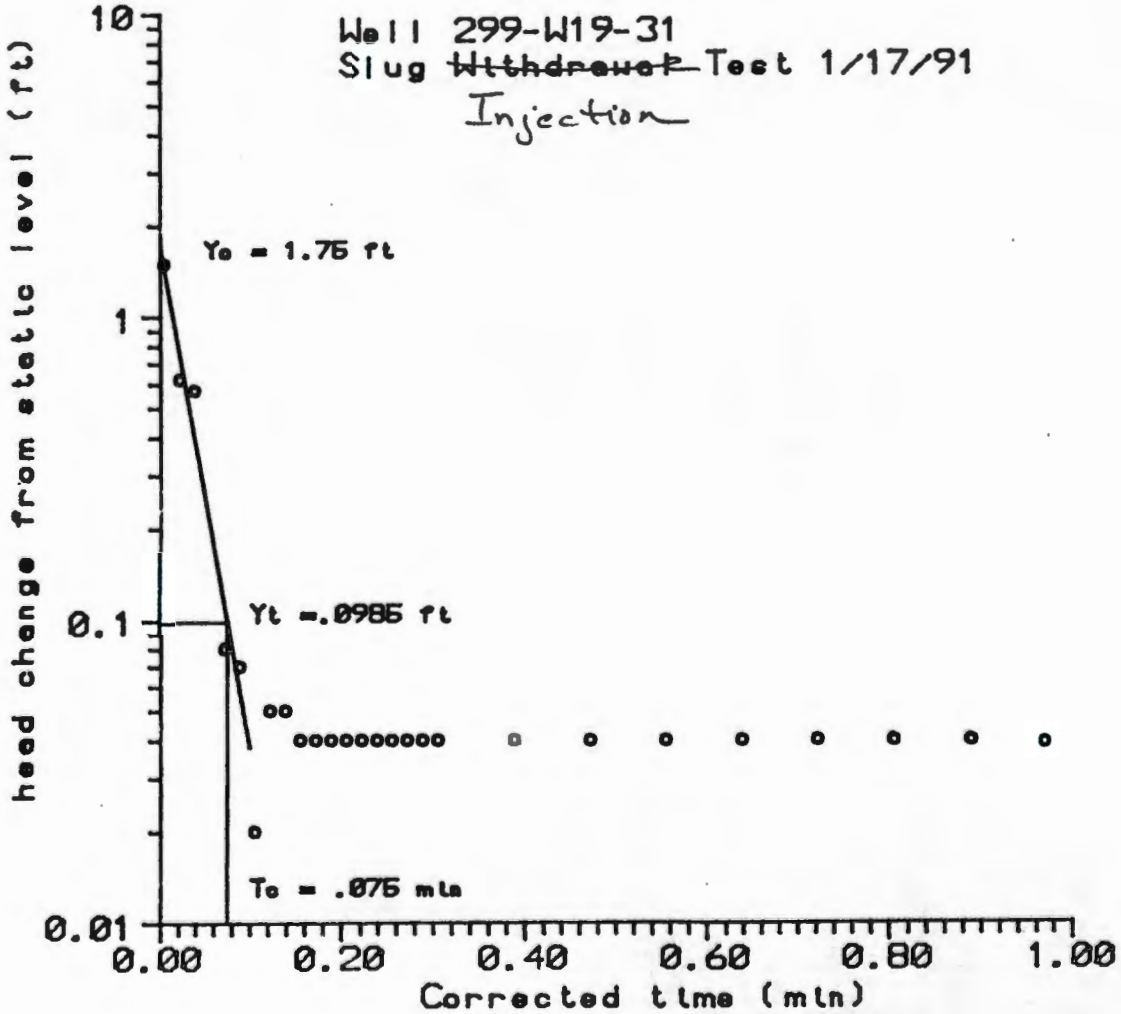
Performed linear regression on first 5 time corrected data points (omitted - head value) ($r^2 = .96$) to determine Yo.

Limited # of points to determine straight line.

Name (print): JV Borghese Signature: [signature] Date: 12/11/91

9413136.2069


Well 299-W19-31
Slug Injection Test ~~1/19/91~~ 1/17/91
Raw data
head change from static level (ft)
2.00
1.50
1.00
0.50
0.00
-0.50
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W19-31
Slug ~~Withdrawal~~ Test 1/17/91
Injection
Yo = 1.75 ft
Yt =.0985 ft
To = .075 min
head change from static level (ft)
10
1
0.1
0.01
0.00
0.20
0.40
0.60
0.80
1.00
Corrected time (min)

299-W19-31 Slug Injection Test 1/17/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.1670	.3330	20.0000	21.6200	350.0000

****
Le/Rw = 60.0600600
A= 3.3422070
B= 5.482054E-001
C= 3.0164010
t (min)= 7.500000E-002
1/t= 13.3333300
Yo= (ft) 1.7500000
Yt= (ft) 9.850000E-002
1/t ln(Yo/Yt)= 38.3641900
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.6738100
****
K (ft/day) = 102.9893000
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 2059.7850000
****

Well Number: 299-W19-31

Dimensions in ft unless otherwise specified

Project: RCRA SST

Date of Test: 1/17/91

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA FIELD RECORD FILE

Rod within screened interval: yes (H2O in casing)

Depth below land surface of tested zone: 207-227

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 21.62

Length of saturated screen interval, Le: 20.0

Thickness of aquifer, H: 350 (estimated)

Estimated Porosity of Sand Pack: N/A

For Bouwer and Rice Analysis

Time correction applied to data (min): .0099

Intial Head change, Yo: 2.4513

Arbitrary time value on straight line, Tc (min): .07

Head at Tc, Yt: .1011

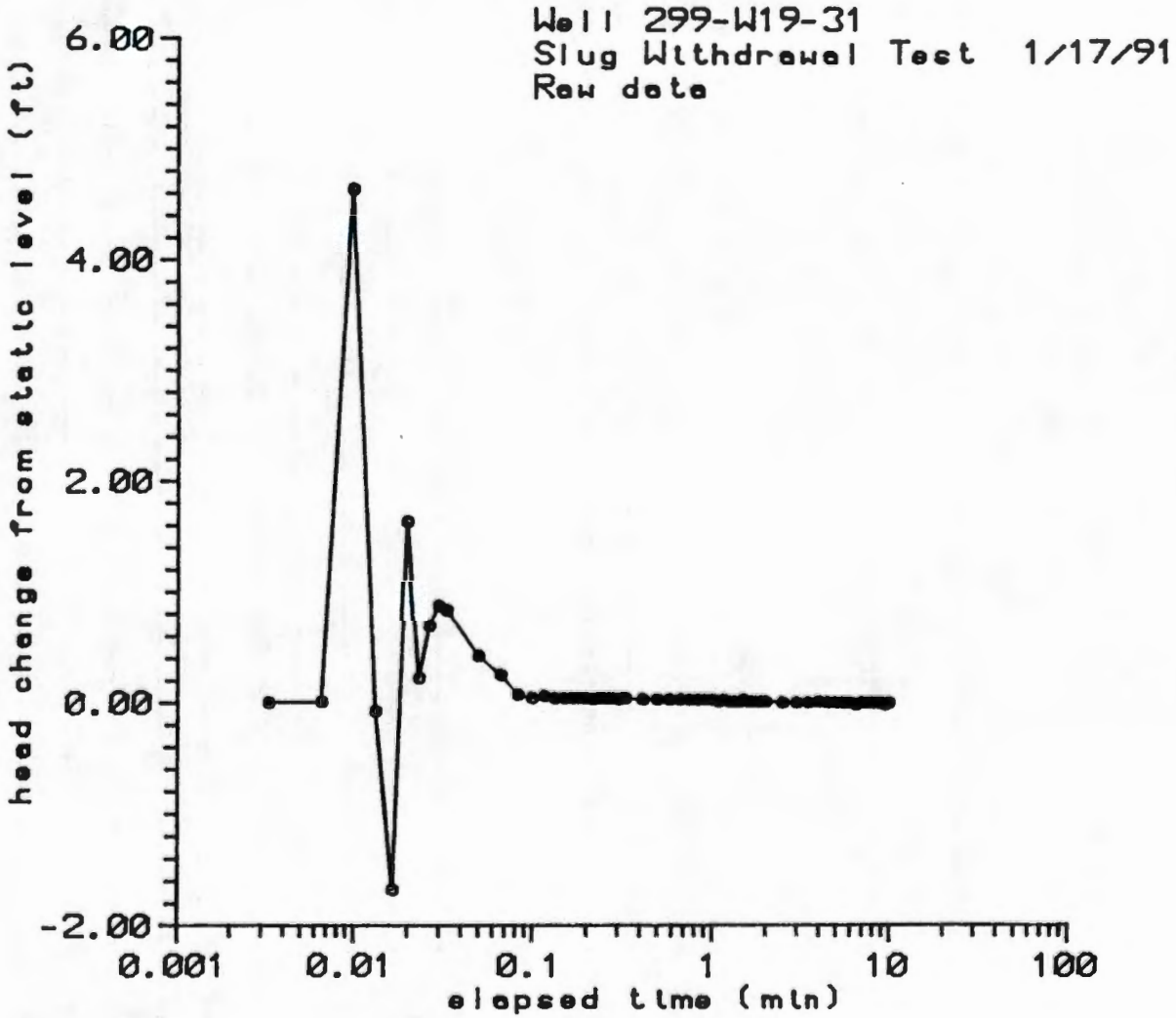
Comments: To determine straight line for Bouwer - Rice Analysis performed linear regression on data from tc = .0201 to .0901 (six pts) (r^2 = .98)

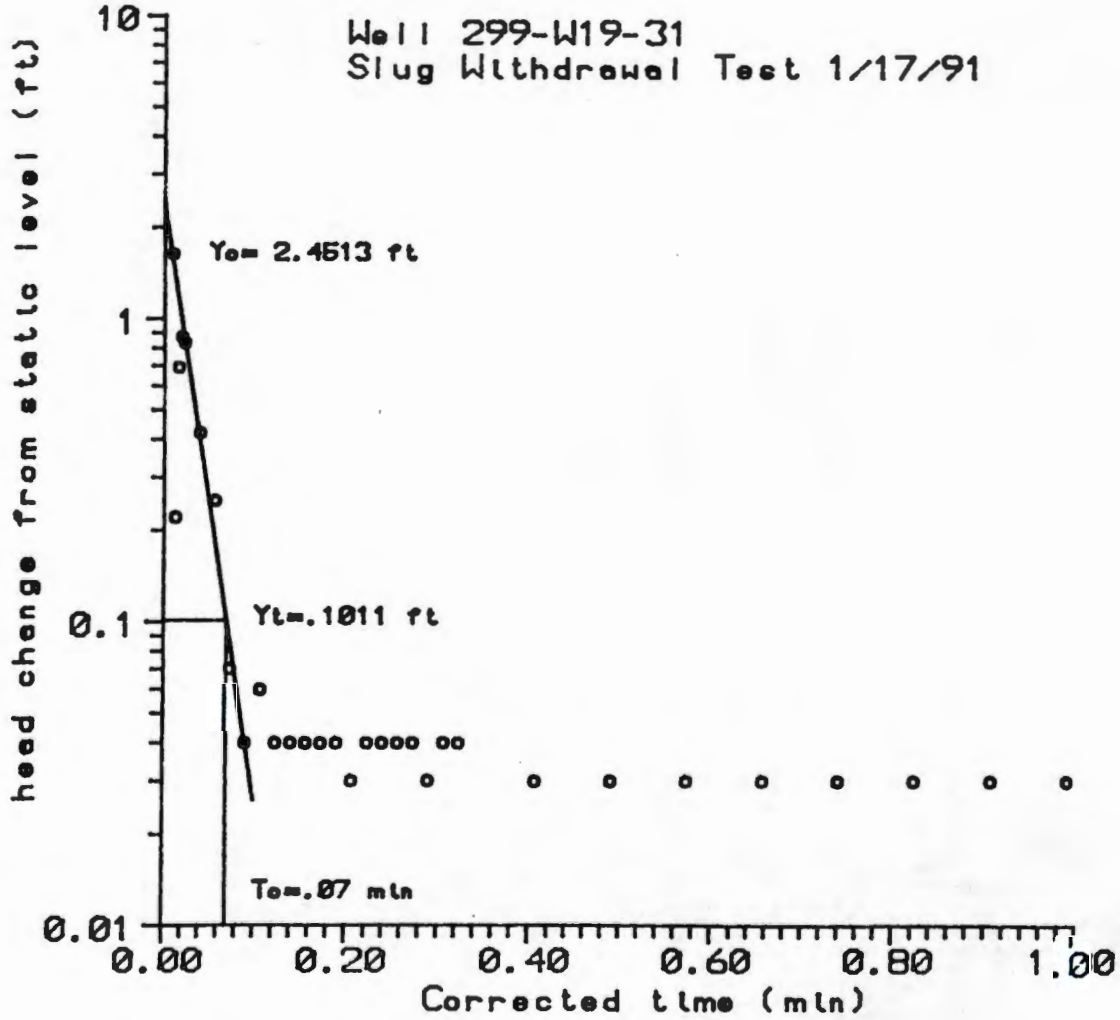
Note: A 5 psi transducer was used — not as sensitive as a 5 or 10 psi transducer.

Head change occurs mostly in casing, some in screen. Lot's of fluctuation in WL.

Name (print): JV Borghese Signature: JV Borghese Date: 12/12/91

9413136.2073


Well 299-W19-31
Slug Withdrawal Test 1/17/91
Raw data
head change from static level (ft)
6.00
4.00
2.00
0.00
-2.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W19-31
Slug Withdrawal Test 1/17/91
Yo= 2.4513 ft
Yt=.1011 ft
To=.07 min
head change from static level (ft)
10
1
0.1
0.01
0.00
0.20
0.40
0.60
0.80
1.00
Corrected time (min)

299-W19-31 Slug Withdrawal Test 1/17/91

****

THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.

****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.1670	.3330	20.0000	21.6200	350.0000

****

Le/Rw = 60.0600600
A= 3.3422070
B= 5.482054E-001
C= 3.0164010
t (min)= 7.000000E-002
1/t= 14.2857100
Yo= (ft) 2.4500000
Yt= (ft) 1.011000E-001
1/t ln(Yo/Yt)= 45.5390400
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.6738100

****

K (ft/day) = 122.2503000

****

T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 2445.0050000

****

Well Number: 299-W19-32

Dimensions in ft unless otherwise specified

Project: RCRA SST

Date of Test: 1/14/91

Type of Test: slug injection

Slugging Rod Dimensions, L: 6

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records file

Rod within screened interval: yes

Depth below land surface of tested zone: 205.8 - 225.6

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 19.8

Length of saturated screen interval, Le: 19.8

Thickness of aquifer, H: 350 estimated

Estimated Porosity of Sand Pack: N/A

For Bouwer and Rice Analysis

Time correction applied to data (min): ~~0.133~~ 0.0133

Intial Head change, Yo: .75

Arbitrary time value on straight line, Tc (min): 8.0

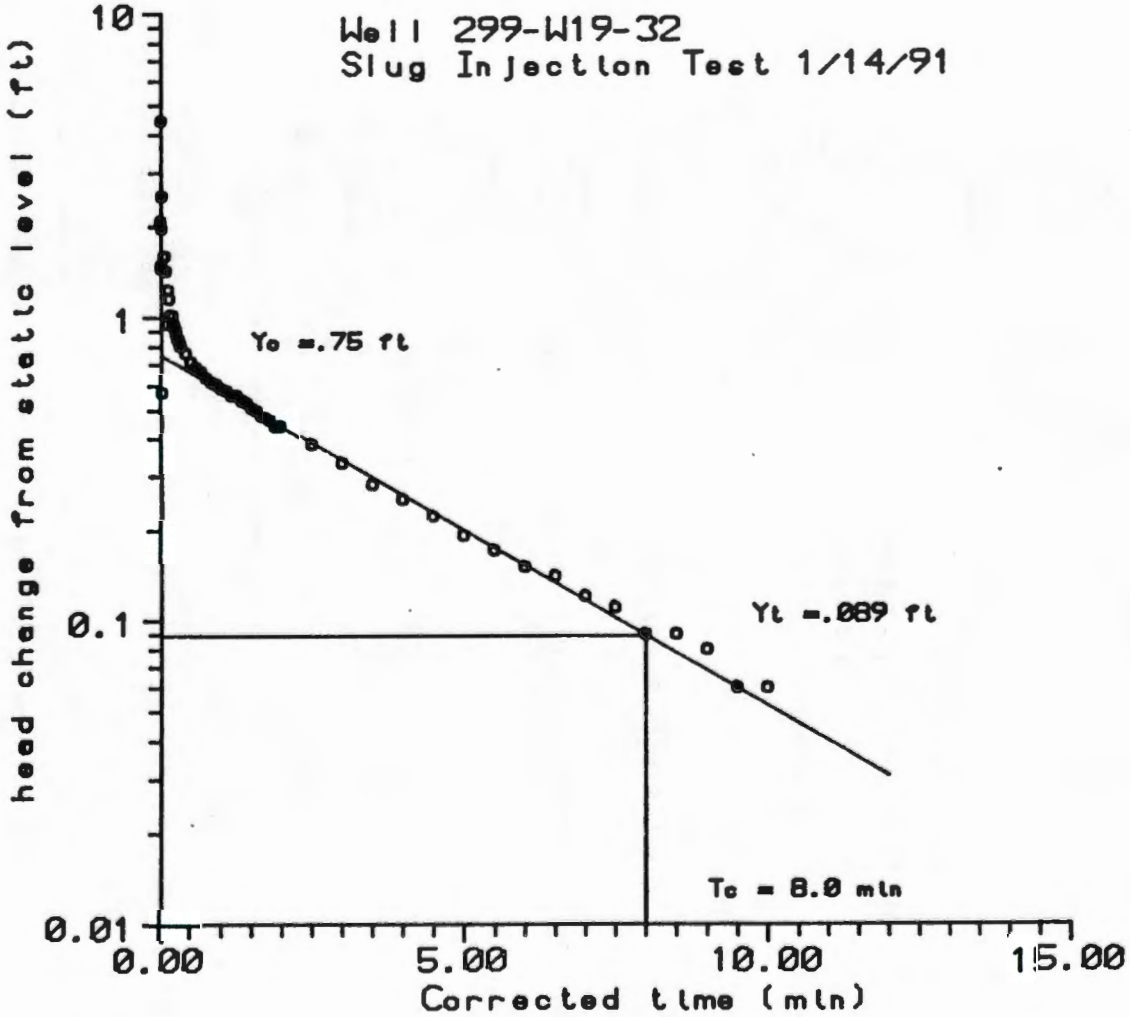
Head at Tc, Yt: .089

Comments: 50 psi transducer was used
top of screen 205.6 ∴ WL change for injection
will be in casing and for withdrawal in screen

Lots of fluctuation at beginning of test

Name (print): JV Boslee Signature: JV Boslee Date: 12/17/91

9413136.2027

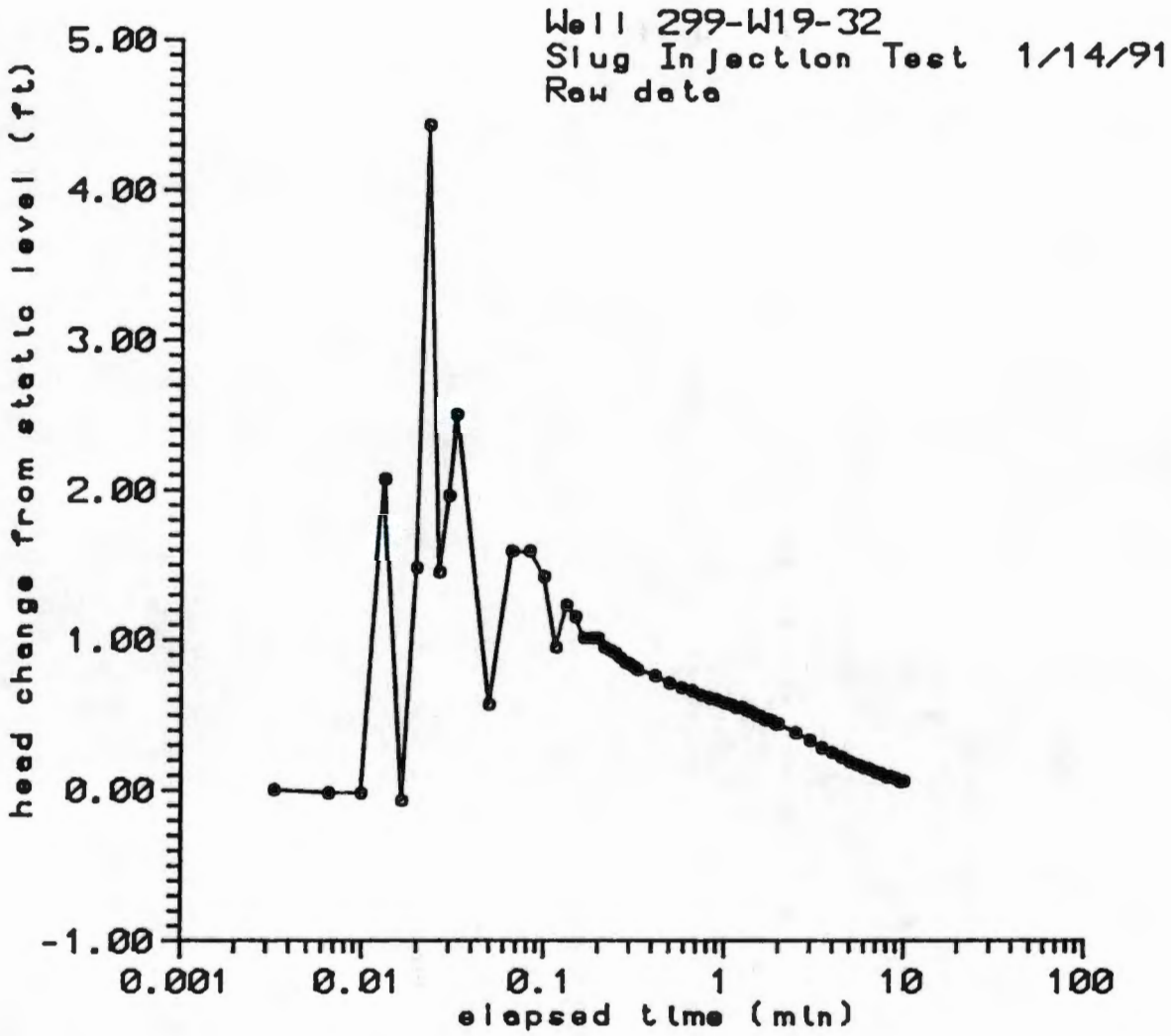

Well 299-W19-32
Slug Injection Test 1/14/91
Yo =.75 ft
Yt =.089 ft
To = 8.0 min
head change from static level (ft)
10
1
0.1
0.01
0.00
5.00
10.00
15.00
Corrected time (min)

299-W19-32 Slug Injection Test 1/14/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.1670	.3330	19.8000	19.8000	350.0000

****
Le/Rw = 59.4594600
A= 3.3231830
B= 5.482054E-001
C= 3.0164010
t (min)= 8.0000000
1/t= 1.250000E-001
Yo= (ft) 7.500000E-001
Yt= (ft) 8.900000E-002
1/t ln(Yo/Yt)= 2.664296E-001
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.6283470
****
K (ft/day) = 7.101751E-001
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 14.0614700
****

9413136.2079


Well 299-W19-32
Slug Injection Test 1/14/91
Raw data
head change from static level (ft)
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
0.001
0.01
0.1
1
10
100
elapsed time (min)

Well Number: 299-W19-32

Dimensions in ft unless otherwise specified

Project: RCRA SST

Date of Test: 1/14/92

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: 205.8 - 225.6 (WL 205.8)

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 19.8

Length of saturated screen interval, Le: 19.8

Thickness of aquifer, H: 350 (estimated)

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .0133

	1st line	2nd line
Intial Head change, Yo:	1.8	.80
Arbitrary time value on straight line, Tc (min):	2.0	8.0
Head at Tc, Yt:	.2493	.1240

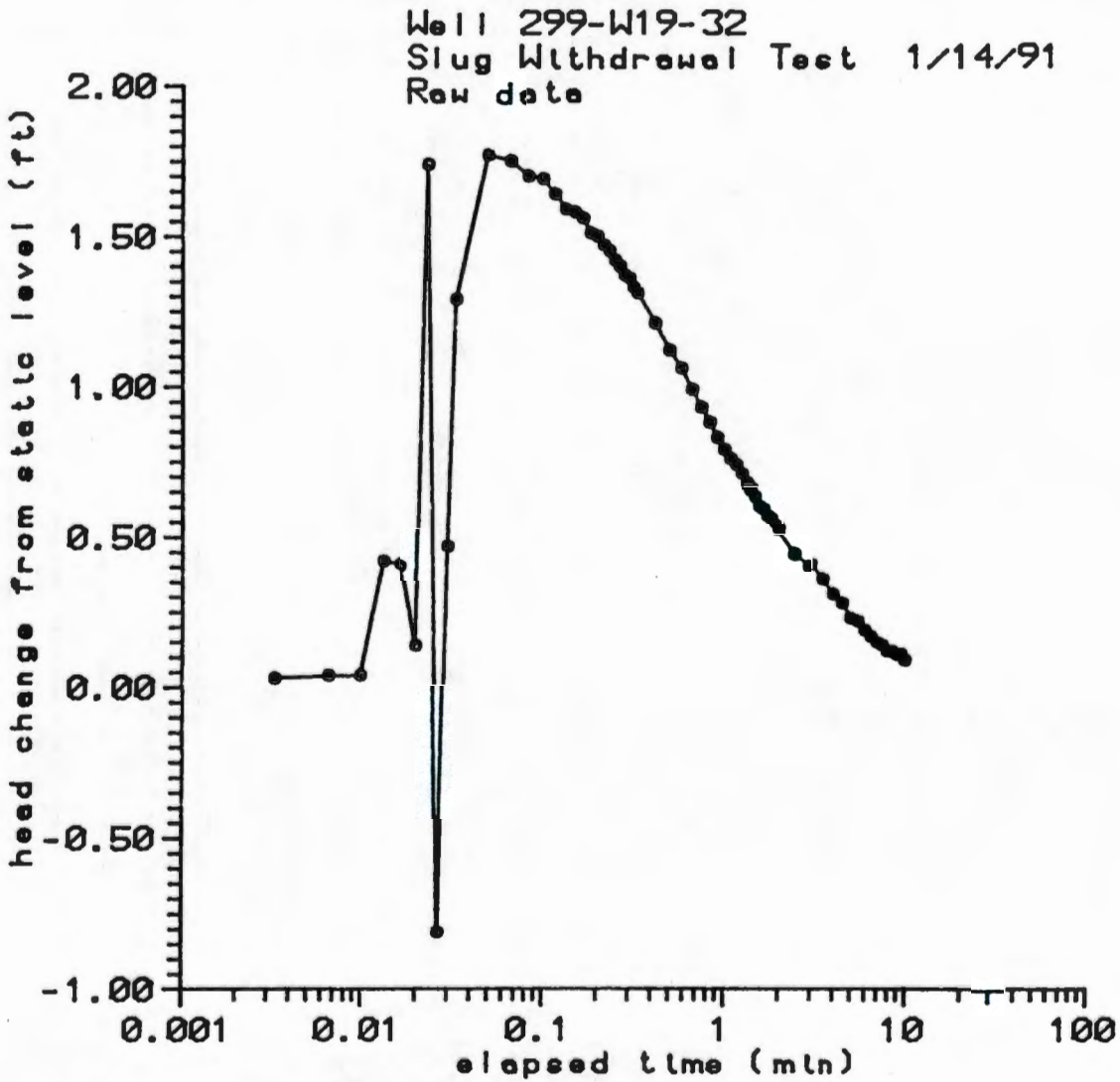
Comments: 50 psi transducer was used

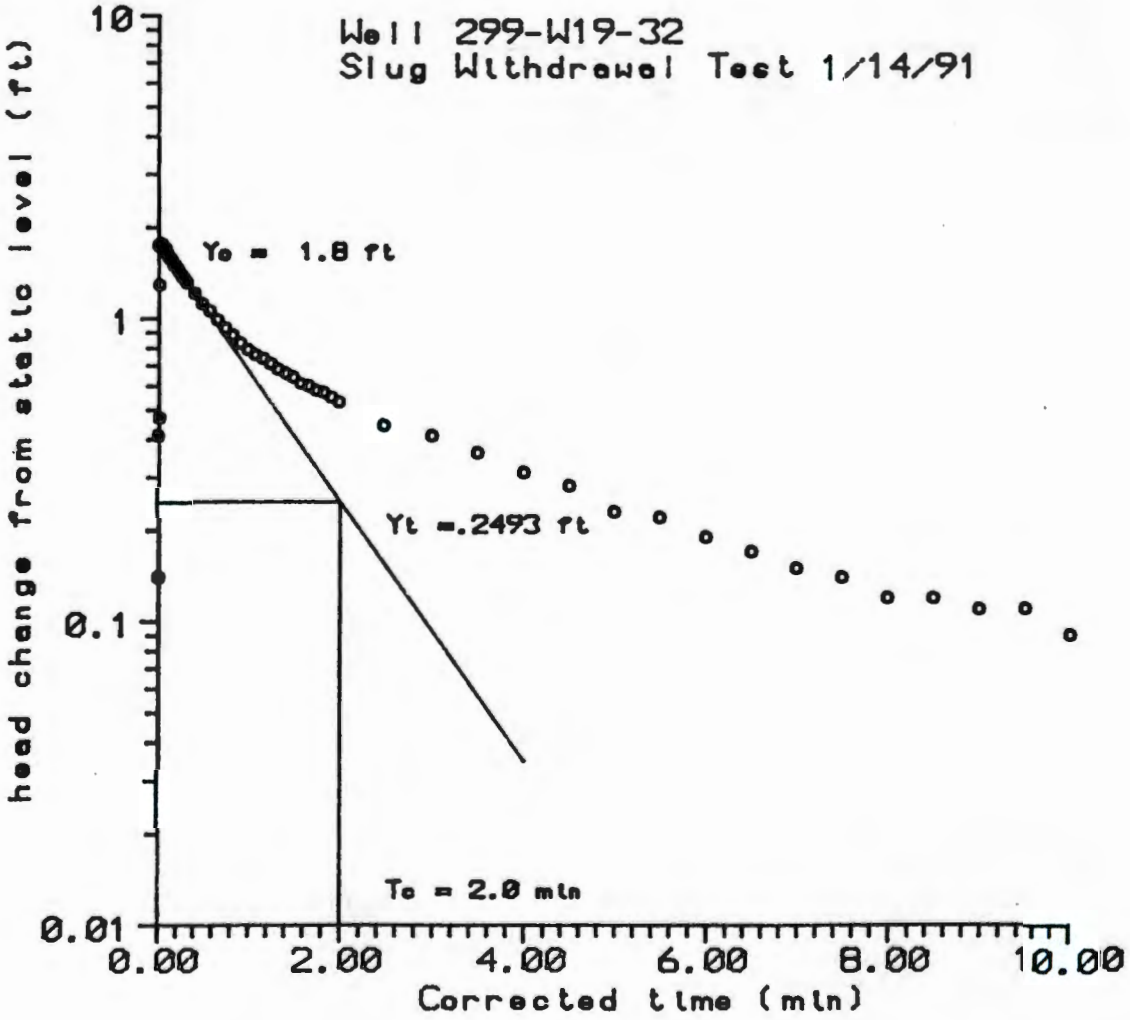
Semi log plot exhibits double straight line.

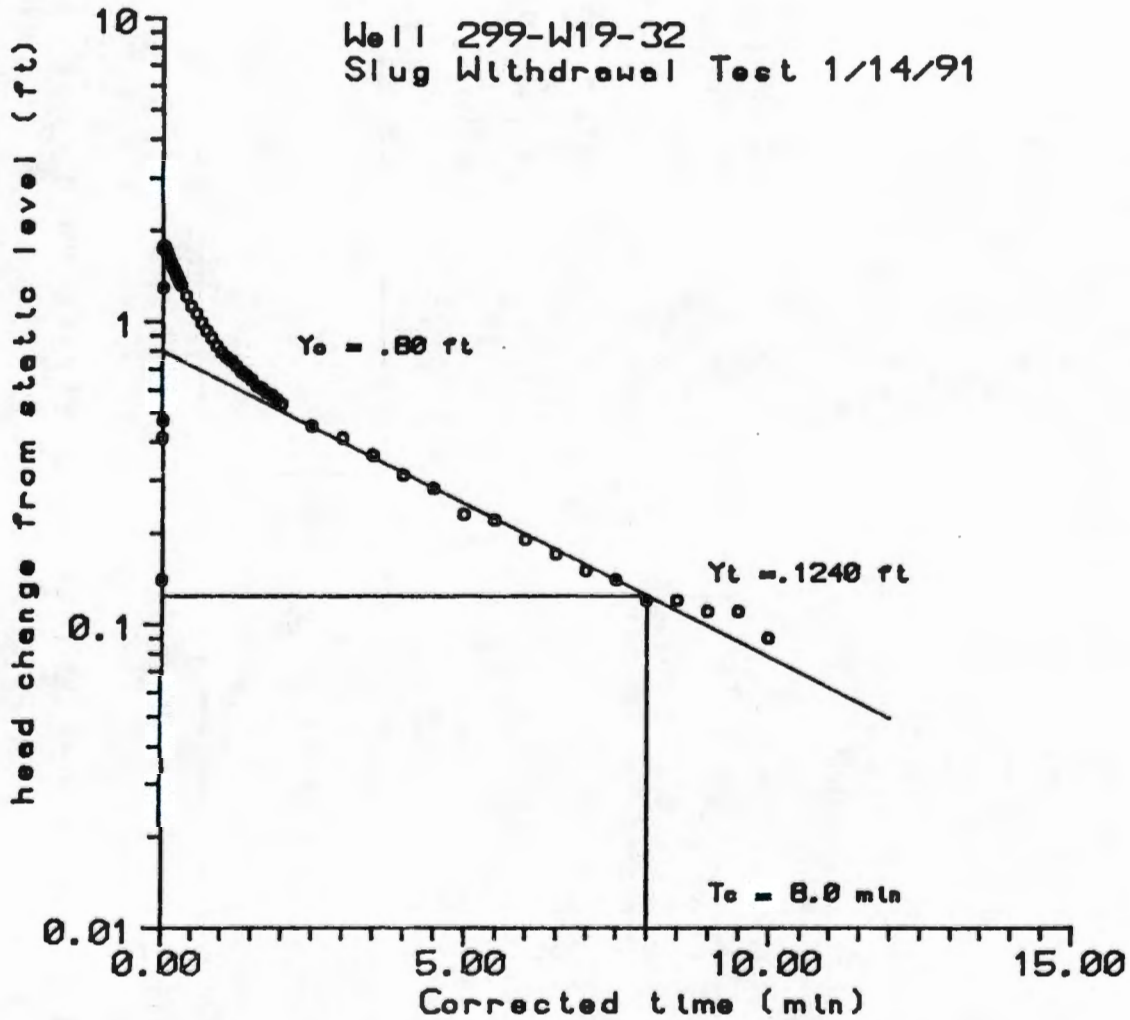
Some fluctuation at test beginning.

Name (print): JV Borghese Signature: JV Borghese Date: 12/17/91

9413136.2081


Well 299-W19-32
Slug Withdrawal Test 1/14/91
Raw data
head change from static level (ft)
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W19-32
Slug Withdrawal Test 1/14/91
Yo = 1.8 ft
Yt =.2493 ft
To = 2.0 min
head change from static level (ft)
10
1
0.1
0.01
0.00
2.00
4.00
6.00
8.00
10.00
Corrected time (min)


Well 299-W19-32
Slug Withdrawal Test 1/14/91
Yo = .80 ft
Yt =.1240 ft
To = 8.0 min
head change from static level (ft)
10
1
0.1
0.01
0.00
5.00
10.00
15.00
Corrected time (min)

299-W19-32 Slug Withdrawal Test 1/14/92 Line 1
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	19.8000	19.8000	350.0000

****
Le/Rw = 59.4594600
A= 3.3231830
B= 5.482054E-001
C= 3.0164010
SANDPACK POROSITY= 2.500000E-001
t (min)= 2.0000000
1/t= 5.000000E-001
Yo= (ft) 1.8000000
Yt= (ft) 2.493000E-001
1/t ln(Yo/Yt)= 9.884425E-001
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.6283470
****
K (ft/day) = 4.5950060
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 90.9811000
****

9413136.2085

9413136.2086

```
299-W19-32 Slug Withdrawal Test 1/14/92  Line 2
**************************************************
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
**************************************************
**************************************************
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
**************************************************
Rc (ft)    Rw (ft)   Le (ft)    Lw (ft)    H (ft)
--------------------------------------------------
  .2205     .3330   19.8000     19.8000    350.0000
**************************************************
Le/Rw =          59.4594600
A=          3.3231830
B=  5.482054E-001
C=          3.0164010
SANDPACK POROSITY=  2.500000E-001
t (min)=          8.0000000
1/t=  1.250000E-001
Yo= (ft)  8.000000E-001
Yt= (ft)  1.240000E-001
1/t ln(Yo/Yt)=  2.330413E-001
ln[(H-Lw)/Rw]=          6.0000000
ln(Re/Rw)=          2.6283470
**************************************************
K (ft/day) =          1.0833470
**************************************************
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)=          21.4502600
**************************************************
```

Well Number: 299-W23-13

Dimensions in ft unless otherwise specified

Project: SST

Date of Test: 12/12/90

Type of Test: Slug injection

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: Screen 198.4-219.4 (WL 198.57)

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 20.83

Length of saturated screen interval, Le: 20.83

Thickness of aquifer, H: 350

Estimated Porosity of Sand Pack: N/A (majority of Δ in casing)

For Bouwer and Rice Analysis

Time correction applied to data (min): 0

Intial Head change, Yo: 1.80

Arbitrary time value on straight line, Tc (min): .10

Head at Tc, Yt: .057

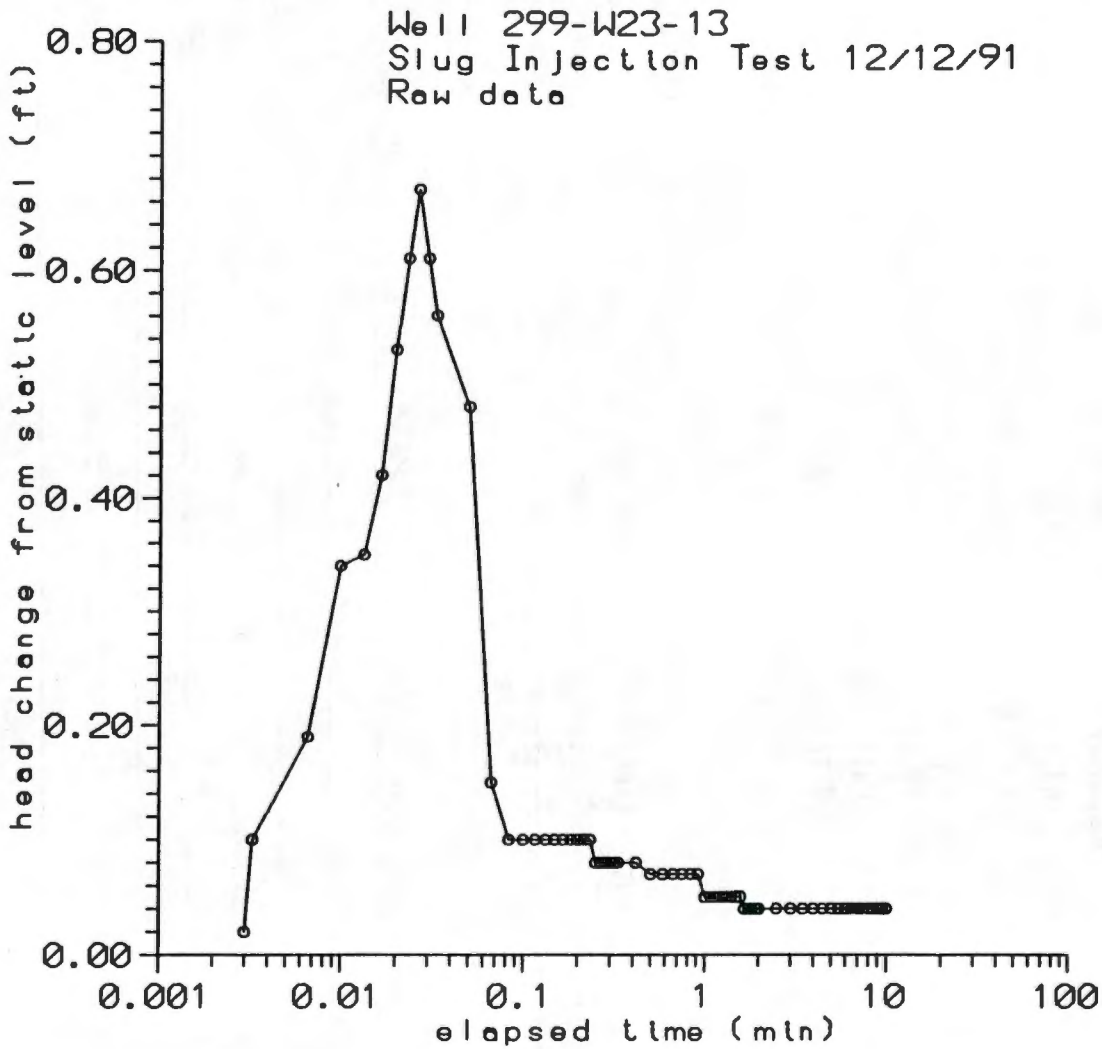
Comments: on raw data plot - plotted time 0 at .003 time correction 0, data recording initiated after slug injection.
Ran linear regression on t = .0266 to .0833 data r^2 = .94 log y = -15.0910x + .265052

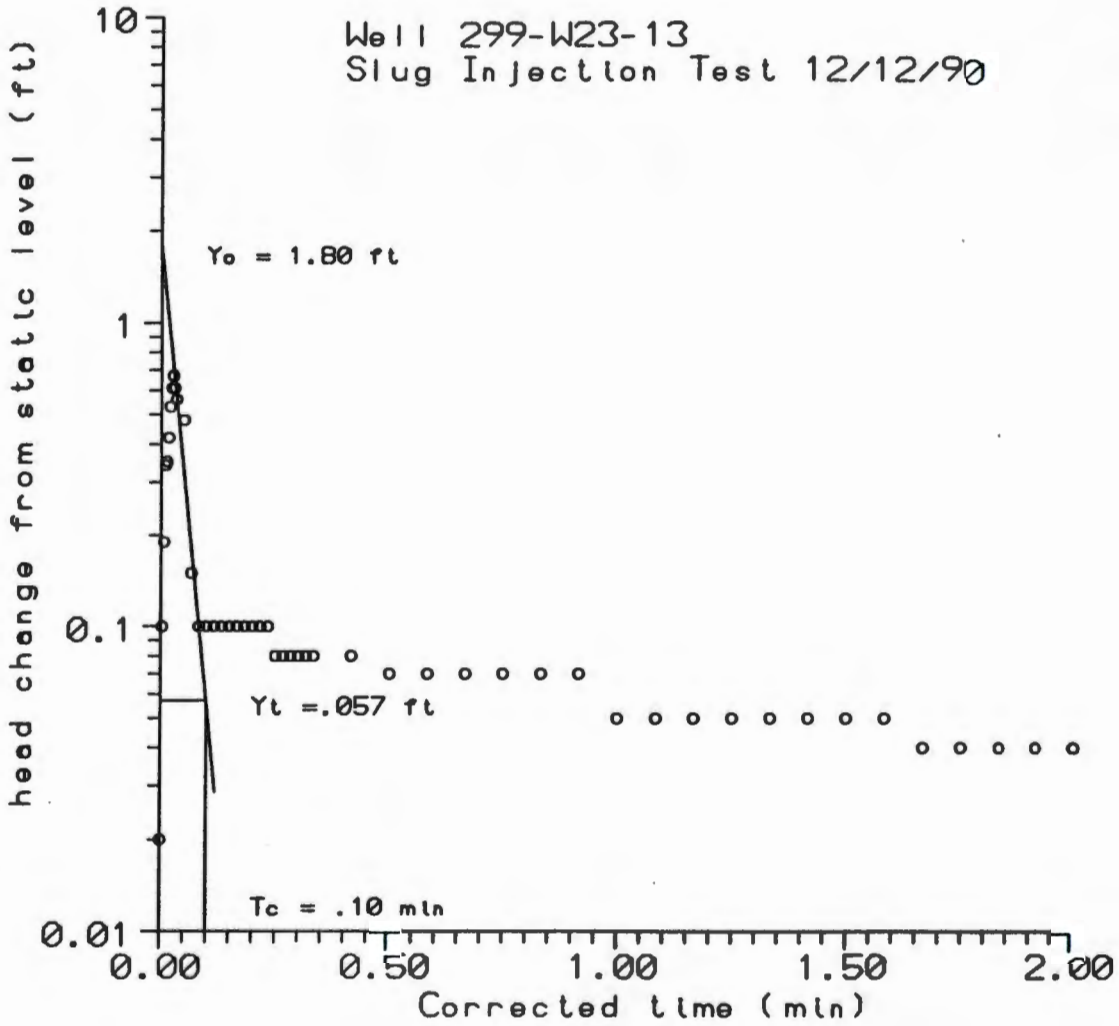
Limited # of points for straight line determination

50 psi transducer was used

Name (print): JV Boghosian Signature: JV Boghosian Date: 12/10/91

9413136.2087


Well 299-W23-13
Slug Injection Test 12/12/91
Raw data
head change from static level (ft)
0.80
0.60
0.40
0.20
0.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W23-13
Slug Injection Test 12/12/90
Yo = 1.80 ft
Yt =.057 ft
Tc = .10 min
head change from static level (ft)
10
1
0.1
0.01
0.00
0.50
1.00
1.50
2.00
Corrected time (min)

299-W23-13 Slug Injection Test 12/12/90
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.1670	.3330	20.8300	20.8300	350.0000

****
Le/Rw = 62.5525500
A= 3.4158890
B= 5.665609E-001
C= 3.0754290
t (min)= 1.000000E-001
1/t= 10.0000000
Yo= (ft) 1.8000000
Yt= (ft) 5.700000E-002
1/t ln(Yo/Yt)= 34.5249100
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.6673110
****
K (ft/day) = 88.7732800
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 1849.1470000
****

9413136.2090

Well Number: 299-W23-13

Dimensions in ft unless otherwise specified

Project: RCRA SST

Date of Test: 12/12

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records file

Rod within screened interval: yes

Depth below land surface of tested zone: 198.57 - 219.4

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 20.83

Length of saturated screen interval, Le: 20.83

Thickness of aquifer, H: 350

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min):

Intial Head change, Yo: NA

Arbitrary time value on straight line, Tc (min):

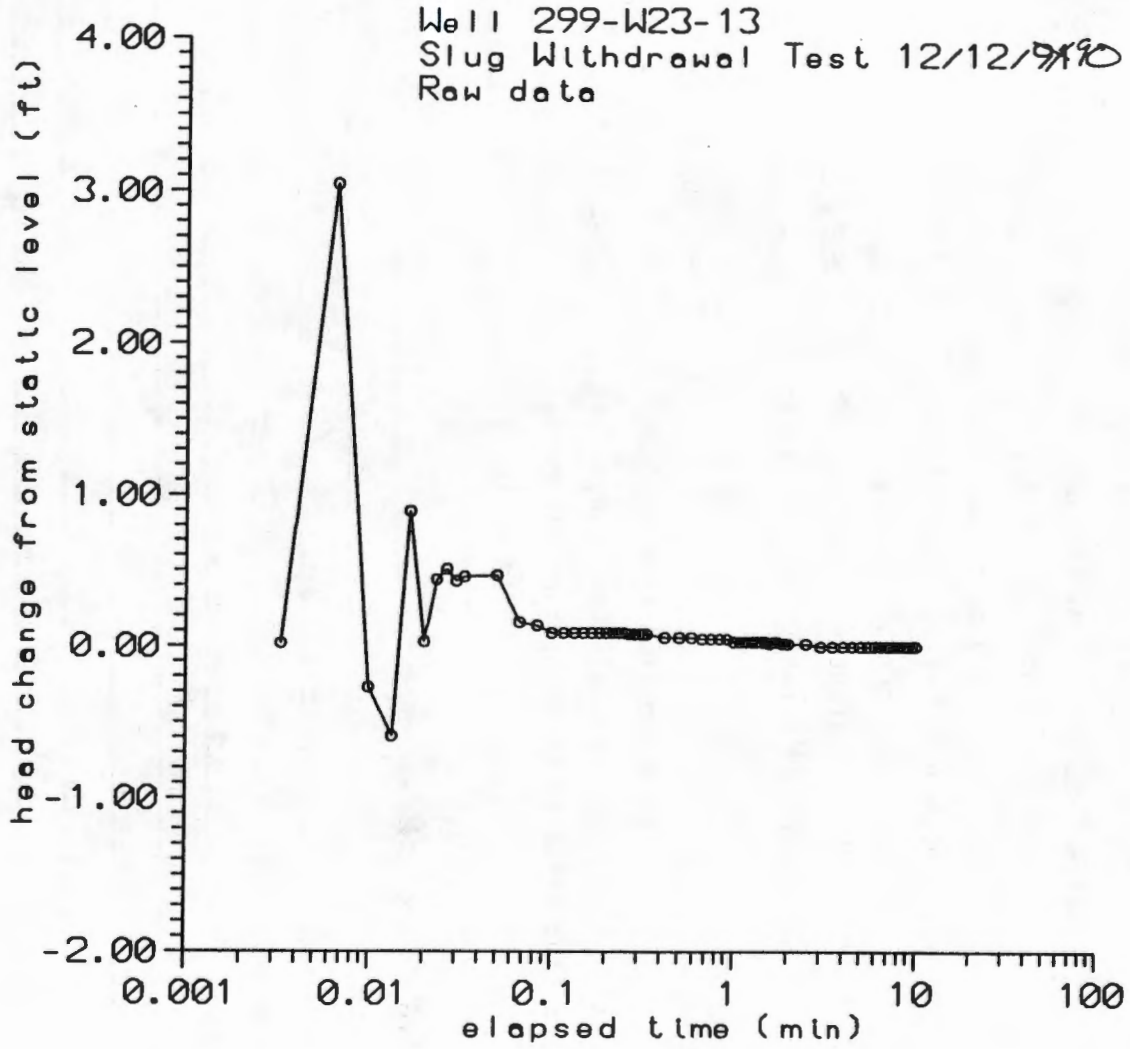
Head at Tc, Yt:

Comments: 50 psi transducer

WL probably responded as slugging rod was being withdrawn - therefore not enough data to analyze

Name (print): JV Borghese Signature: JV Borghese Date: 12/18/91

9413136.2091


Well 299-W23-13
Slug Withdrawal Test 12/12/90
Raw data
head change from static level (ft)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
0.001
0.01
0.1
1
10
100
elapsed time (min)

Well Number: 299-W23-14

Dimensions in ft unless otherwise specified

Project: SS T

Date of Test: 4/12/91

Type of Test: Injection (Slug)

Slugging Rod Dimensions, L: 6

D: .2

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Records File

Rod within screened interval: yes

Depth below land surface of tested zone: 199.52 - 218.5

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 18.98

Length of saturated screen interval, Le: 18.98

Thickness of aquifer, H: 350

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .0133

Intial Head change, Yo: .8311

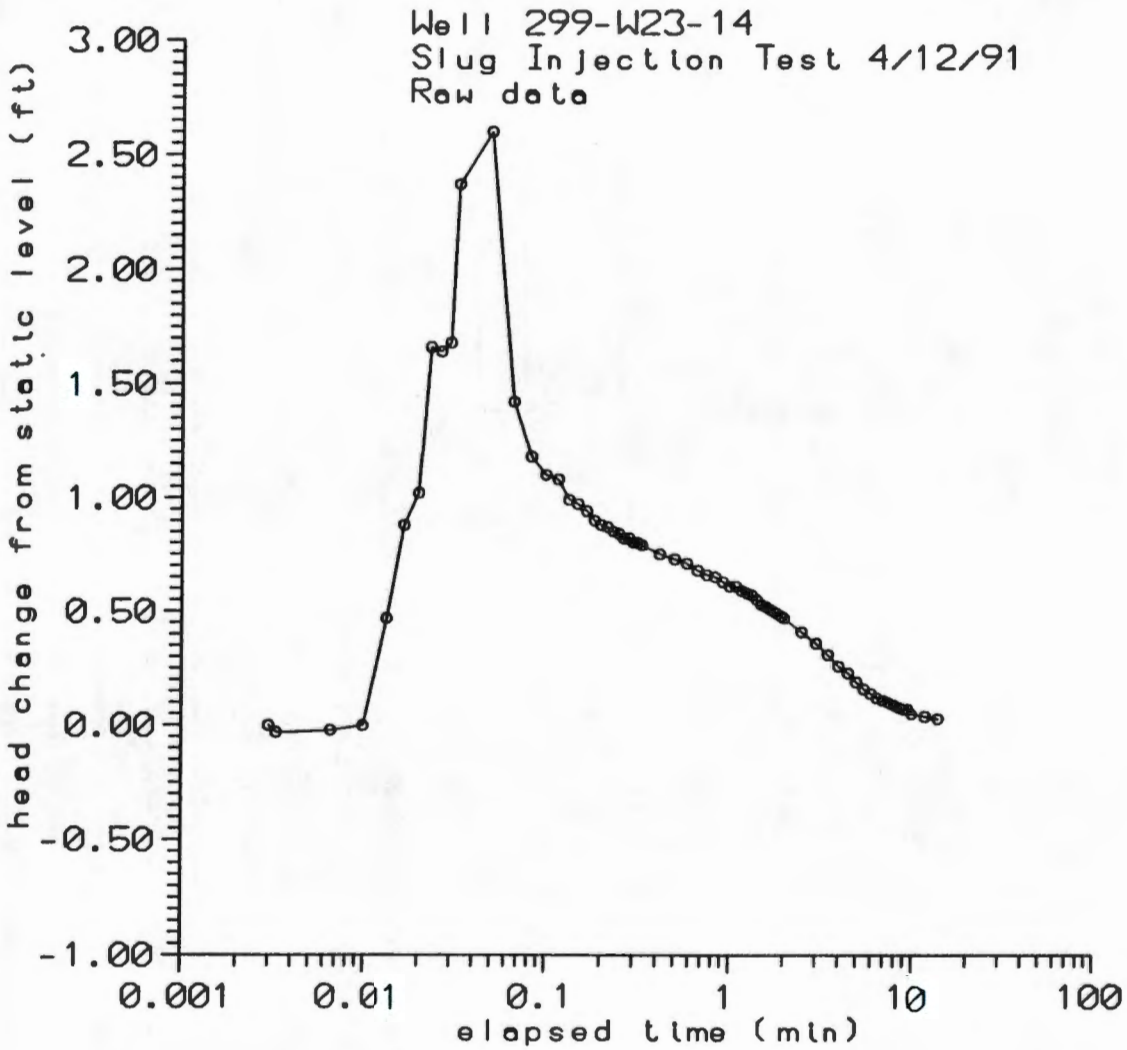
Arbitrary time value on straight line, Tc (min): 2.0

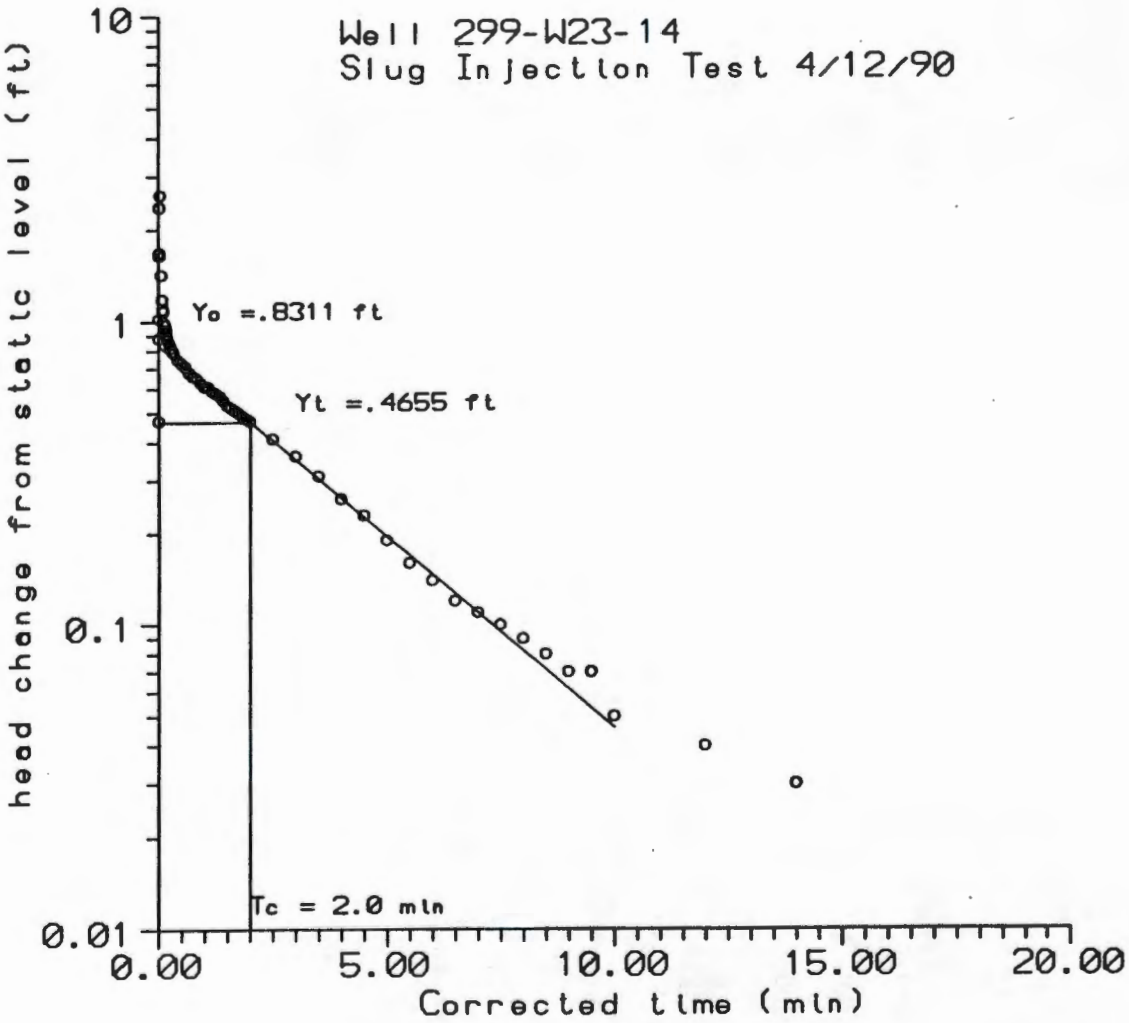
Head at Tc, Yt: .4655

Comments: 10 psi transducer used on raw data plotted t=0 at .003 performed linear regression on t= .32 to 4.98 r^2=.997
log y = -0.12588x + -0.08034
Analyzed second straight line from semilog plot.
Raw data plot shows wave - reason? effects of 3 permeable zones? damping effect?

Name (print): J V Borghese Signature: J V Borghese Date: 12/18/91

9413136.2093


Well 299-W23-14
Slug Injection Test 4/12/91
Raw data
head change from static level (ft)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W23-14
Slug Injection Test 4/12/90
Yo =.8311 ft
Yt =.4655 ft
Tc = 2.0 min
head change from static level (ft)
10
1
0.1
0.01
0.00
5.00
10.00
15.00
20.00
Corrected time (min)

299-W23-13 Slug Injection Test 4/12/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	18.9800	18.9800	350.0000

****
Le/Rw = 56.9969900
A= 3.2844110
B= 5.365443E-001
C= 2.9479060
SANDPACK POROSITY= 2.500000E-001
t (min)= 2.0000000
1/t= 5.000000E-001
Yo= (ft) 8.311000E-001
Yt= (ft) 4.655000E-001
1/t ln(Yo/Yt)= 2.898190E-001
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5894600
****
K (ft/day) = 1.3847040
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 26.2816800
****

9413136.2096

Well Number: 299-W23-14

Dimensions in ft unless otherwise specified

Project: SST

Date of Test: 4/12/91

Type of Test: Slug withdrawal

Slugging Rod Dimensions, L: 6.0

D: .20

Theorectical head displacement in 4 inch casing: 2.18

Location of Field Records and Data: RCRA Record File

Rod within screened interval: yes

Depth below land surface of tested zone: 199.52 - 218.5

Radius of casing, Rc: .167

Radius of well, Rw: .333

Distance from WT to bottom of tested interval, Lw: 18.98

Length of saturated screen interval, Le: 18.98

Thickness of aquifer, H: 350

Estimated Porosity of Sand Pack: .25

For Bouwer and Rice Analysis

Time correction applied to data (min): .066

Intial Head change, Yo: .9306

Arbitrary time value on straight line, Tc (min): 5.0

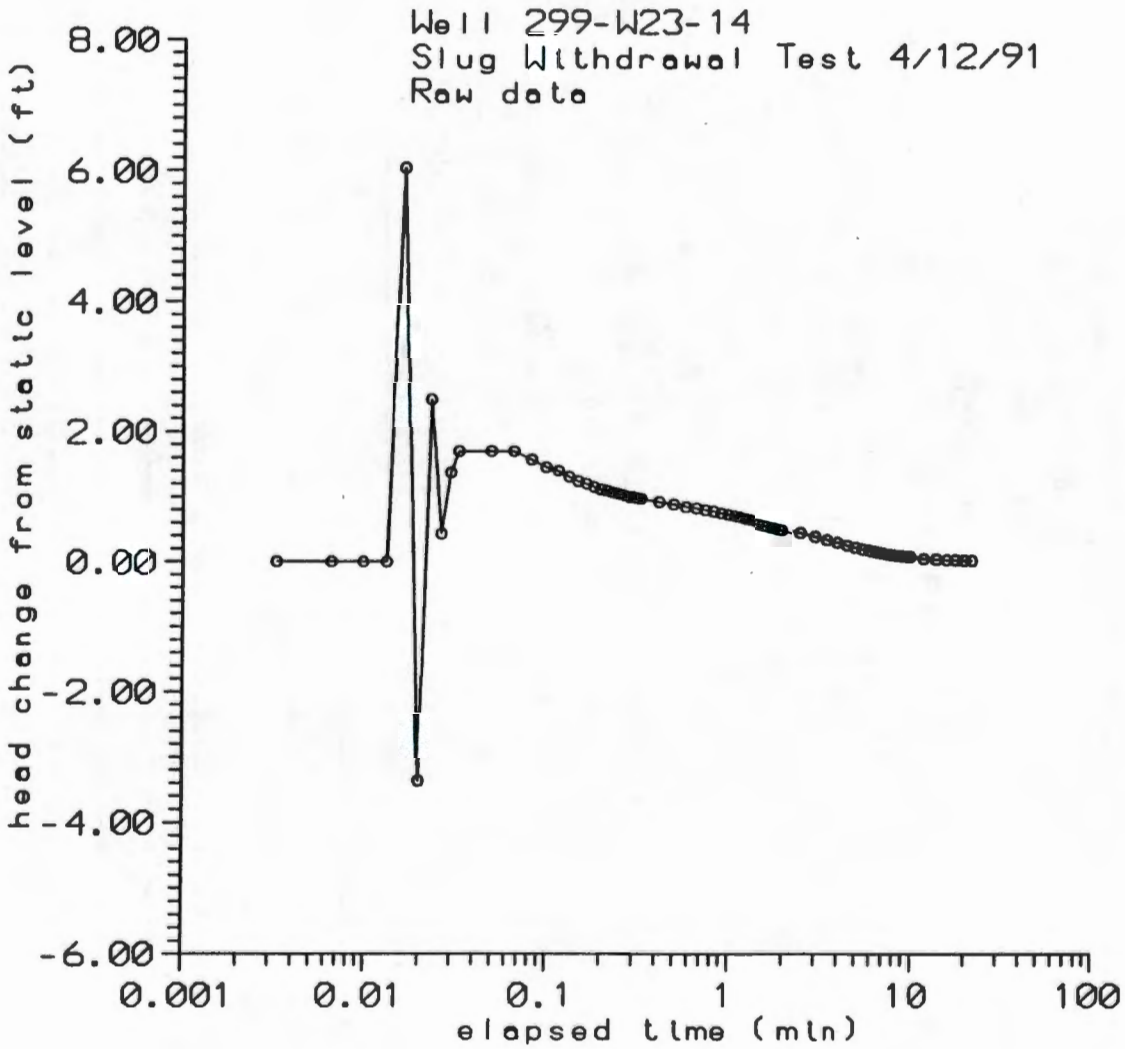
Head at Tc, Yt: .2232

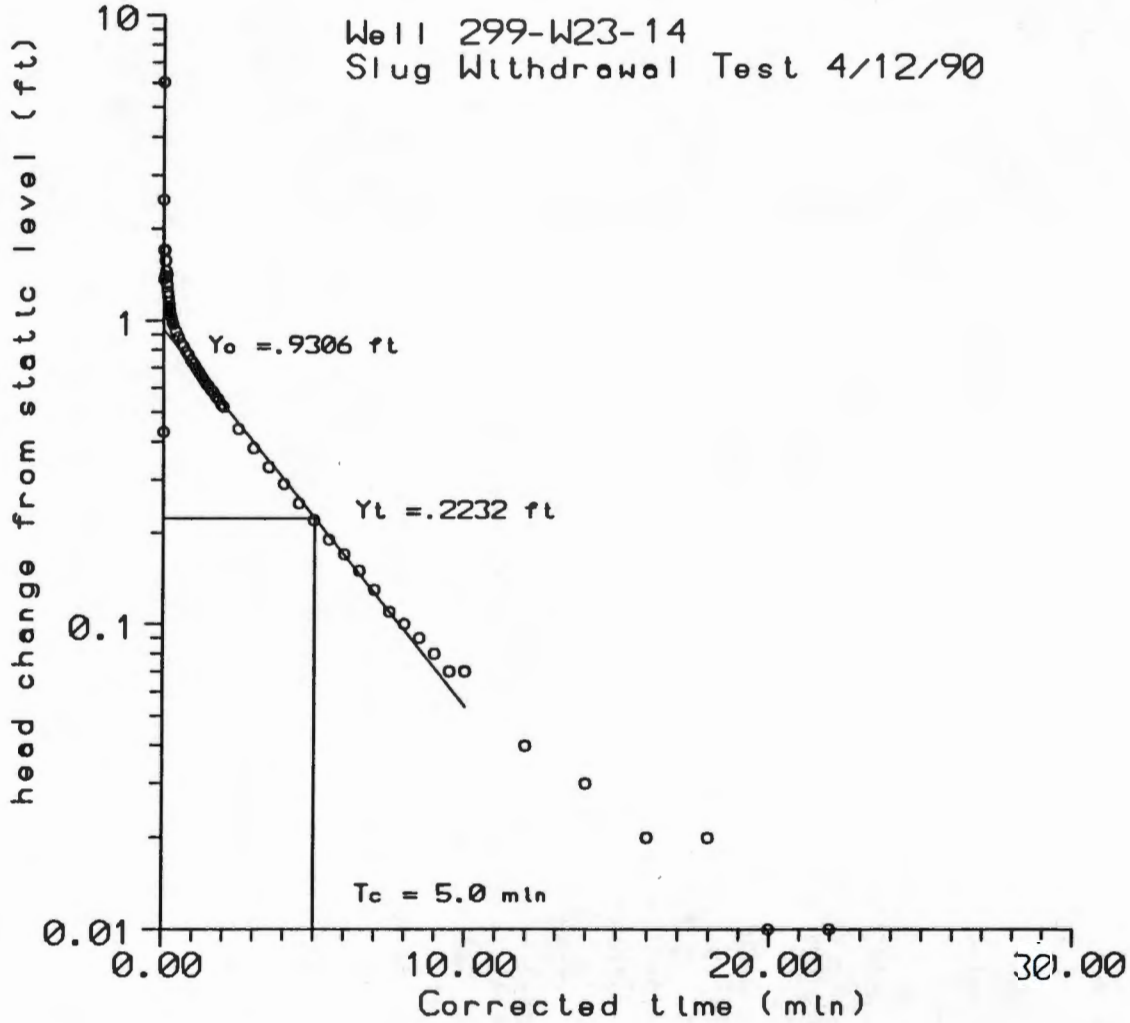
Comments: Erase my values for semilog plot performed linear regression on tc of .73 to 7.9 min r^2 = .998, log g = -.012403x + -.03124

Some fluctuation at test beginning

Name (print): Borghese Signature: J V Borghese Date: 12/18/91

9413136.2097


Well 299-W23-14
Slug Withdrawal Test 4/12/91
Raw data
head change from static level (ft)
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
0.001
0.01
0.1
1
10
100
elapsed time (min)


Well 299-W23-14
Slug Withdrawal Test 4/12/90
Yo =.9306 ft
Yt =.2232 ft
Tc = 5.0 min
head change from static level (ft)
10
1
0.1
0.01
0.00
10.00
20.00
30.00
Corrected time (min)

299-W23-14 Slug Withdrawal Test 4/12/91
****
THE BELOW HYDRAULIC CONDUCTIVITY VALUE WAS CALCULATED
USING THE BOUWER AND RICE SLUG TEST METHOD.
SOURCE= "THE BOUWER AND RICE SLUG TEST-AN UPDATE"
GROUND WATER, VOL 27, NO. 3, MAY-JUNE 1989.
****
****
RADIUS OF CASING USED IN CALCULATIONS HAS BEEN
CORRECTED FOR THE THICKNESS OF GRAVEL OR SAND
PACK DUE TO WATER LEVEL CHANGES IN THE SCREEN OR
OPEN INTERVAL OF WELL.
****

Rc (ft)	Rw (ft)	Le (ft)	Lw (ft)	H (ft)
.2205	.3330	18.9800	18.9800	350.0000

****
Le/Rw = 56.9969900
A= 3.2844110
B= 5.365443E-001
C= 2.9479060
SANDPACK POROSITY= 2.500000E-001
t (min)= 5.0000000
1/t= 2.000000E-001
Yo= (ft) 9.306000E-001
Yt= (ft) 2.232000E-001
1/t ln(Yo/Yt)= 2.855523E-001
ln[(H-Lw)/Rw]= 6.0000000
ln(Re/Rw)= 2.5894600
****
K (ft/day) = 1.3643180
****
T OF THE SATURATED SCREEN INTERVAL
(ft2/day)= 25.8947600
****

9413136.2100

APPENDIX C

200 WEST AREA GROUNDWATER CONTAMINANT REPORT

9413136.2101

9413136.2102

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Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Arsenic	2-W10-15	6.00	6.00	6.00	1	0
Arsenic	2-W10-4	8.00	8.00	8.00	1	0
Arsenic	2-W10-8	101.00	101.00	101.00	1	0
Arsenic	2-W10-9	20.00	16.00	18.00	2	0
Arsenic	2-W15-12	7.00	7.00	7.00	1	0
Arsenic	2-W15-15	5.00	5.00	5.00	6	5
Arsenic	2-W15-4	20.00	20.00	20.00	1	0
Arsenic	2-W18-15	10.00	10.00	10.00	1	0
Arsenic	2-W18-21	5.00	5.00	5.00	7	6
Arsenic	2-W19-21	18.00	14.00	16.00	2	0
Arsenic	2-W19-27	12.00	12.00	12.00	1	0
Arsenic	2-W22-20	7.00	7.00	7.00	1	0
Arsenic	2-W7-6	10.00	5.00	6.33	6	3
Arsenic, filtered	2-W10-15	5.00	5.00	5.00	1	0
Arsenic, filtered	2-W10-4	6.00	6.00	6.00	1	0
Arsenic, filtered	2-W10-9	16.00	15.00	15.50	2	0
Arsenic, filtered	2-W15-4	24.00	24.00	24.00	1	0
Arsenic, filtered	2-W18-15	12.00	12.00	12.00	1	0
Arsenic, filtered	2-W18-21	5.00	5.00	5.00	7	6
Arsenic, filtered	2-W19-21	14.00	13.00	13.50	2	0
Arsenic, filtered	2-W19-27	12.00	12.00	12.00	1	0
Arsenic, filtered	6-47-60	7.00	5.00	6.00	2	1
Carbon Tetrachloride by GC/MS	2-W10-13	18.00	7.00	11.78	9	0
Carbon Tetrachloride by GC/MS	2-W10-4	2800.00	2590.00	2663.33	3	0
Carbon Tetrachloride by GC/MS	2-W10-8	49.00	49.00	49.00	1	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Carbon Tetrachloride by GC/MS	2-W10-9	2300.00	1700.00	2000.00	2	0
Carbon Tetrachloride by GC/MS	2-W11-14	860.00	650.00	766.67	3	0
Carbon Tetrachloride by GC/MS	2-W11-7	2500.00	2080.00	2290.00	2	0
Carbon Tetrachloride by GC/MS	2-W14-2	1050.00	920.00	983.33	3	0
Carbon Tetrachloride by GC/MS	2-W14-5	860.00	300.00	630.00	3	0
Carbon Tetrachloride by GC/MS	2-W14-6	320.00	280.00	300.00	10	0
Carbon Tetrachloride by GC/MS	2-W15-10	4200.00	2800.00	3620.00	4	0
Carbon Tetrachloride by GC/MS	2-W15-11	5550.00	4350.00	4900.00	3	0
Carbon Tetrachloride by GC/MS	2-W15-12	1920.00	1320.00	1580.00	3	0
Carbon Tetrachloride by GC/MS	2-W15-15	800.00	264.00	471.00	7	0
Carbon Tetrachloride by GC/MS	2-W15-16	8700.00	1780.00	6997.14	7	0
Carbon Tetrachloride by GC/MS	2-W15-18	2600.00	14.00	1298.83	6	0
Carbon Tetrachloride by GC/MS	2-W15-19	1500.00	710.00	1105.00	2	0
Carbon Tetrachloride by GC/MS	2-W15-20	193.00	192.00	192.50	2	0
Carbon Tetrachloride by GC/MS	2-W15-24	380.00	380.00	380.00	1	0
Carbon Tetrachloride by GC/MS	2-W15-4	2090.00	1830.00	1960.00	2	0
Carbon Tetrachloride by GC/MS	2-W15-7	2390.00	2310.00	2350.00	2	0
Carbon Tetrachloride by GC/MS	2-W15-8	1110.00	130.00	620.00	2	0
Carbon Tetrachloride by GC/MS	2-W18-15	120.00	89.00	106.33	3	0
Carbon Tetrachloride by GC/MS	2-W18-17	2000.00	12.00	553.50	4	0
Carbon Tetrachloride by GC/MS	2-W18-20	14.00	5.00	9.50	2	1
Carbon Tetrachloride by GC/MS	2-W18-21	180.00	92.00	139.00	7	0
Carbon Tetrachloride by GC/MS	2-W18-23	928.00	195.00	679.50	8	0
Carbon Tetrachloride by GC/MS	2-W18-24	1400.00	575.00	816.71	7	0
Carbon Tetrachloride by GC/MS	2-W18-26	250.00	208.00	229.00	2	0
Carbon Tetrachloride by GC/MS	2-W18-4	194.00	98.00	137.33	3	0
Carbon Tetrachloride by GC/MS	2-W18-5	3640.00	3310.00	3516.67	3	0
Carbon Tetrachloride by GC/MS	2-W18-9	210.00	121.00	165.50	2	0
Carbon Tetrachloride by GC/MS	2-W19-1	7.00	7.00	7.00	1	0
Carbon Tetrachloride by GC/MS	2-W19-11	115.00	115.00	115.00	1	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Carbon Tetrachloride by GC/MS	2-W19-12	20.00	20.00	20.00	1	0
Carbon Tetrachloride by GC/MS	2-W19-13	39.00	33.00	36.00	3	0
Carbon Tetrachloride by GC/MS	2-W19-15	127.00	63.00	84.20	5	0
Carbon Tetrachloride by GC/MS	2-W19-16	209.00	120.00	162.40	5	0
Carbon Tetrachloride by GC/MS	2-W19-18	89.00	9.00	44.50	4	0
Carbon Tetrachloride by GC/MS	2-W19-19	20.00	10.00	15.00	2	0
Carbon Tetrachloride by GC/MS	2-W19-2	22.00	22.00	22.00	1	0
Carbon Tetrachloride by GC/MS	2-W19-20	42.00	23.00	33.40	5	0
Carbon Tetrachloride by GC/MS	2-W19-23	37.00	20.00	28.50	2	0
Carbon Tetrachloride by GC/MS	2-W19-24	24.00	14.00	19.00	5	0
Carbon Tetrachloride by GC/MS	2-W19-25	31.00	21.00	26.00	2	0
Carbon Tetrachloride by GC/MS	2-W19-26	30.00	30.00	30.00	1	0
Carbon Tetrachloride by GC/MS	2-W19-27	13.00	7.00	10.00	2	0
Carbon Tetrachloride by GC/MS	2-W19-28	51.00	50.00	50.50	2	0
Carbon Tetrachloride by GC/MS	2-W19-3	120.00	49.00	87.67	3	0
Carbon Tetrachloride by GC/MS	2-W19-9	120.00	99.00	110.25	4	0
Carbon Tetrachloride by GC/MS	2-W22-20	13.00	9.00	10.75	4	0
Carbon Tetrachloride by GC/MS	2-W6-2	132.00	87.00	105.67	9	0
Carbon Tetrachloride by GC/MS	2-W7-4	278.00	5.00	166.33	9	2
Carbon Tetrachloride by GC/MS	2-W7-5	43.00	23.00	29.50	8	0
Carbon Tetrachloride by GC/MS	2-W7-8	5.00	4.00	4.50	2	1
Carbon Tetrachloride by GC/MS	6-38-70	58.00	29.00	37.00	5	0
Carbon Tetrachloride by GC/MS	6-39-79	990.00	430.00	767.50	8	0
Chloroform	2-W10-14	7.00	5.00	5.29	7	6
Chloroform	2-W10-4	21.00	16.00	19.00	3	0
Chloroform	2-W10-9	16.00	14.00	15.00	2	0
Chloroform	2-W11-14	10.00	4.00	6.00	3	2
Chloroform	2-W11-7	37.00	15.00	26.00	2	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Chloroform	2-W14-2	12.00	7.00	9.33	3	0
Chloroform	2-W14-5	12.00	3.00	6.67	3	2
Chloroform	2-W14-6	6.00	3.00	3.30	10	9
Chloroform	2-W15-10	27.00	13.00	20.75	4	0
Chloroform	2-W15-11	40.00	21.00	31.33	3	0
Chloroform	2-W15-12	26.00	20.00	23.00	3	0
Chloroform	2-W15-15	10.00	3.00	5.86	7	3
Chloroform	2-W15-16	71.00	33.00	48.86	7	1
Chloroform	2-W15-18	27.00	5.00	14.50	6	2
Chloroform	2-W15-19	179.00	173.00	176.00	2	0
Chloroform	2-W15-20	11.00	9.00	10.00	2	0
Chloroform	2-W15-24	31.00	31.00	31.00	1	0
Chloroform	2-W15-4	19.00	16.00	17.50	2	0
Chloroform	2-W15-7	24.00	19.00	21.50	2	0
Chloroform	2-W15-8	1650.00	1540.00	1595.00	2	0
Chloroform	2-W18-17	204.00	13.00	100.75	4	0
Chloroform	2-W18-20	26.00	25.00	25.50	2	0
Chloroform	2-W18-21	5.00	4.00	4.71	7	6
Chloroform	2-W18-23	8.00	4.00	6.00	8	1
Chloroform	2-W18-24	23.00	13.00	18.43	7	0
Chloroform	2-W18-26	38.00	18.00	28.00	2	0
Chloroform	2-W18-4	632.00	420.00	520.67	3	0
Chloroform	2-W18-5	28.00	19.00	24.67	3	0
Chloroform	2-W18-9	19.00	7.00	13.00	2	0
Chloroform	2-W19-16	5.00	4.00	4.60	5	2
Chloroform	2-W19-20	6.00	3.00	4.40	5	4
Chloroform	2-W19-23	7.00	4.00	5.50	2	1
Chloroform	2-W19-24	6.00	3.00	4.20	5	4
Chloroform	2-W19-25	5.00	3.00	4.00	2	1
Chloroform	2-W19-28	10.00	9.00	9.50	2	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Chloroform	2-W19-9	5.00	3.00	3.75	4	3
Chloroform	2-W22-20	10.00	8.00	8.75	4	0
Chloroform	2-W27-1	14.00	5.00	7.40	5	1
Chloroform	2-W7-4	6.00	5.00	5.22	9	0
Chloroform	6-39-79	6.00	3.00	5.50	8	1
Chromium	2-W10-13	89.00	24.00	40.14	7	0
Chromium	2-W10-14	91.00	34.00	52.33	6	0
Chromium	2-W10-15	174.00	174.00	174.00	1	0
Chromium	2-W10-16	138.00	138.00	138.00	1	0
Chromium	2-W10-4	66.00	66.00	66.00	1	0
Chromium	2-W10-8	6180.00	6180.00	6180.00	1	0
Chromium	2-W10-9	181.00	157.00	169.00	2	0
Chromium	2-W11-14	46.00	46.00	46.00	1	0
Chromium	2-W11-7	47.00	47.00	47.00	1	0
Chromium	2-W14-10	16.00	10.00	13.00	2	1
Chromium	2-W14-2	298.00	298.00	298.00	1	0
Chromium	2-W15-10	14.00	14.00	14.00	1	0
Chromium	2-W15-11	31.00	31.00	31.00	1	0
Chromium	2-W15-12	65.00	65.00	65.00	1	0
Chromium	2-W15-15	108.00	13.00	51.17	6	0
Chromium	2-W15-16	142.00	44.00	66.67	6	0
Chromium	2-W15-17	577.00	29.00	145.00	6	0
Chromium	2-W15-18	129.00	36.00	61.50	6	0
Chromium	2-W15-19	20.00	20.00	20.00	1	0
Chromium	2-W15-20	41.00	41.00	41.00	1	0
Chromium	2-W15-24	39.00	39.00	39.00	1	0
Chromium	2-W15-8	48.00	48.00	48.00	1	0
Chromium	2-W18-17	85.00	10.00	23.71	7	3

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Chromium	2-W18-20	51.00	51.00	51.00	1	0
Chromium	2-W18-21	133.00	30.00	63.00	7	0
Chromium	2-W18-22	107.00	37.00	83.17	6	0
Chromium	2-W18-23	68.00	32.00	52.86	7	0
Chromium	2-W18-24	109.00	22.00	51.50	6	0
Chromium	2-W18-26	18.00	18.00	18.00	1	0
Chromium	2-W18-4	22.00	22.00	22.00	1	0
Chromium	2-W18-5	21.00	21.00	21.00	1	0
Chromium	2-W18-9	28.00	28.00	28.00	1	0
Chromium	2-W19-1	149.00	149.00	149.00	1	0
Chromium	2-W19-19	11.00	11.00	11.00	1	0
Chromium	2-W19-23	10.00	10.00	10.00	1	0
Chromium	2-W19-28	47.00	47.00	47.00	1	0
Chromium	2-W19-3	11.00	11.00	11.00	1	0
Chromium	2-W22-20	316.00	316.00	316.00	1	0
Chromium	2-W27-1	21.00	13.00	17.00	2	0
Chromium	2-W6-2	103.00	44.00	67.86	7	0
Chromium	2-W7-1	75.00	29.00	48.83	6	0
Chromium	2-W7-2	85.00	20.00	38.17	6	0
Chromium	2-W7-3	114.00	25.00	62.57	7	0
Chromium	2-W7-4	144.00	23.00	69.00	7	0
Chromium	2-W7-5	88.00	23.00	40.67	6	0
Chromium	2-W7-6	67.00	10.00	34.67	6	1
Chromium	2-W7-7	96.00	96.00	96.00	1	0
Chromium	2-W7-8	147.00	147.00	147.00	1	0
Chromium	2-W7-9	463.00	463.00	463.00	1	0
Chromium	2-W8-1	54.00	23.00	35.83	6	0
Chromium	2-W9-1	186.00	18.00	59.33	6	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Chromium, filtered	2-W10-13	15.00	10.00	10.71	7	6
Chromium, filtered	2-W10-14	12.00	10.00	10.33	6	5
Chromium, filtered	2-W10-15	94.00	94.00	94.00	1	0
Chromium, filtered	2-W10-16	41.00	41.00	41.00	1	0
Chromium, filtered	2-W10-4	65.00	63.00	64.33	3	0
Chromium, filtered	2-W10-8	10.00	10.00	10.00	1	0
Chromium, filtered	2-W10-9	152.00	135.00	142.33	3	0
Chromium, filtered	2-W14-2	10.00	10.00	10.00	3	2
Chromium, filtered	2-W14-6	11.00	10.00	10.17	6	5
Chromium, filtered	2-W15-10	21.00	15.00	17.33	3	0
Chromium, filtered	2-W15-11	33.00	22.00	27.33	3	0
Chromium, filtered	2-W15-16	12.00	10.00	11.29	7	2
Chromium, filtered	2-W15-18	26.00	10.00	13.67	6	3
Chromium, filtered	2-W18-21	10.00	10.00	10.00	7	6
Chromium, filtered	2-W18-5	14.00	13.00	13.67	3	0
Chromium, filtered	2-W19-12	49.00	49.00	49.00	1	0
Chromium, filtered	2-W19-18	12.00	10.00	11.00	4	2
Chromium, filtered	2-W19-24	15.00	10.00	11.00	5	4
Chromium, filtered	2-W19-3	10.00	10.00	10.00	4	3
Chromium, filtered	2-W22-20	339.00	296.00	315.75	4	0
Chromium, filtered	2-W27-1	24.00	10.00	14.33	6	1
Chromium, filtered	2-W6-2	59.00	26.00	36.78	9	0
Chromium, filtered	2-W7-1	16.00	10.00	11.00	6	5
Chromium, filtered	2-W7-2	17.00	10.00	12.33	6	1
Chromium, filtered	2-W7-4	18.00	10.00	12.57	7	3
Chromium, filtered	2-W7-5	15.00	10.00	11.33	6	1
Chromium, filtered	2-W8-1	14.00	10.00	11.00	6	4
Chromium, filtered	2-W9-1	11.00	10.00	10.33	6	3
Chromium, filtered	6-32-708	25.00	20.00	22.75	4	0
Chromium, filtered	6-35-66	26.00	20.00	22.75	4	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Chromium, filtered	6-35-78A	13.00	10.00	11.50	2	1
Chromium, filtered	6-36-61A	15.00	10.00	12.75	4	1
Fluoride	2-W10-15	4600.00	4600.00	4600.00	1	0
Fluoride	2-W10-16	1800.00	1800.00	1800.00	1	0
Fluoride	2-W10-4	3270.00	2900.00	3113.33	3	0
Fluoride	2-W10-8	1200.00	1200.00	1200.00	1	0
Fluoride	2-W10-9	5200.00	4200.00	4816.67	3	0
Fluoride	2-W11-14	962.00	500.00	720.67	3	1
Fluoride	2-W11-7	1300.00	1200.00	1250.00	2	0
Fluoride	2-W14-10	640.00	500.00	546.67	3	2
Fluoride	2-W14-2	1090.00	900.00	988.00	3	0
Fluoride	2-W14-5	2260.00	1600.00	1920.00	3	0
Fluoride	2-W14-6	3320.00	2470.00	2804.00	10	0
Fluoride	2-W15-12	1870.00	1600.00	1723.33	3	0
Fluoride	2-W15-16	706.00	600.00	651.86	7	0
Fluoride	2-W15-18	700.00	500.00	599.33	6	1
Fluoride	2-W15-24	600.00	600.00	600.00	1	0
Fluoride	2-W15-4	12800.00	10200.00	11500.00	2	0
Fluoride	2-W15-7	527.00	500.00	513.50	2	1
Fluoride	2-W15-8	592.00	500.00	546.00	2	1
Fluoride	2-W18-24	700.00	577.00	611.00	7	0
Fluoride	2-W18-26	500.00	500.00	500.00	2	1
Fluoride	2-W18-4	500.00	500.00	500.00	3	2
Fluoride	2-W18-5	700.00	589.00	637.00	3	0
Fluoride	2-W18-8	500.00	500.00	500.00	1	0
Fluoride	2-W18-9	500.00	500.00	500.00	2	1
Fluoride	2-W19-11	667.00	500.00	583.50	2	0
Fluoride	2-W19-12	600.00	600.00	600.00	1	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Fluoride	2-W19-13	900.00	500.00	743.33	3	1
Fluoride	2-W19-15	705.00	500.00	560.40	5	3
Fluoride	2-W19-16	892.00	500.00	598.40	5	2
Fluoride	2-W19-18	655.00	500.00	538.75	4	2
Fluoride	2-W19-2	500.00	500.00	500.00	1	0
Fluoride	2-W19-20	1700.00	500.00	1002.80	5	2
Fluoride	2-W19-24	1850.00	500.00	870.00	5	4
Fluoride	2-W19-25	1700.00	1500.00	1600.00	2	0
Fluoride	2-W19-27	500.00	500.00	500.00	2	1
Fluoride	2-W19-3	600.00	524.00	571.50	4	0
Fluoride	2-W19-9	756.00	500.00	651.50	4	1
Fluoride	2-W22-12	600.00	500.00	550.00	4	1
Fluoride	2-W22-22	504.00	500.00	500.80	5	4
Fluoride	2-W7-6	500.00	500.00	500.00	7	5
Fluoride	6-29-78	625.00	500.00	568.33	3	1
Fluoride	6-32-708	509.00	500.00	502.25	4	3
Fluoride	6-32-72	560.00	500.00	536.00	3	1
Fluoride	6-32-77	676.00	500.00	598.67	3	1
Fluoride	6-35-66	521.00	500.00	505.25	4	3
Fluoride	6-38-70	691.00	500.00	569.20	5	2
Fluoride	6-40-62	547.00	500.00	526.67	3	1
Fluoride	6-44-64	745.00	500.00	549.00	5	4
Fluoride	6-47-60	744.00	500.00	607.67	3	1
Fluoride, Low Detection Level	2-W10-4	2830.00	2830.00	2830.00	1	0
Fluoride, Low Detection Level	2-W10-9	4730.00	4730.00	4730.00	1	0
Fluoride, Low Detection Level	2-W14-2	1110.00	1110.00	1110.00	1	0
Fluoride, Low Detection Level	2-W14-5	1750.00	1750.00	1750.00	1	0
Fluoride, Low Detection Level	2-W14-6	3620.00	2480.00	2911.11	9	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Fluoride, Low Detection Level	2-W15-10	383.00	383.00	383.00	1	0
Fluoride, Low Detection Level	2-W15-11	484.00	484.00	484.00	1	0
Fluoride, Low Detection Level	2-W18-15	279.00	279.00	279.00	1	0
Fluoride, Low Detection Level	2-W18-5	649.00	649.00	649.00	1	0
Fluoride, Low Detection Level	2-W19-13	595.00	595.00	595.00	1	0
Fluoride, Low Detection Level	2-W19-15	520.00	390.00	443.33	3	0
Fluoride, Low Detection Level	2-W19-16	612.00	515.00	562.33	3	0
Fluoride, Low Detection Level	2-W19-18	410.00	410.00	410.00	1	0
Fluoride, Low Detection Level	2-W19-19	341.00	341.00	341.00	1	0
Fluoride, Low Detection Level	2-W19-20	339.00	272.00	305.50	2	0
Fluoride, Low Detection Level	2-W19-21	231.00	205.00	218.00	2	0
Fluoride, Low Detection Level	2-W19-23	418.00	418.00	418.00	1	0
Fluoride, Low Detection Level	2-W19-24	367.00	322.00	344.50	2	0
Fluoride, Low Detection Level	2-W19-25	370.00	370.00	370.00	1	0
Fluoride, Low Detection Level	2-W19-26	376.00	376.00	376.00	1	0
Fluoride, Low Detection Level	2-W19-3	538.00	538.00	538.00	1	0
Fluoride, Low Detection Level	2-W19-5	469.00	469.00	469.00	1	0
Fluoride, Low Detection Level	2-W19-9	644.00	574.00	607.33	3	0
Fluoride, Low Detection Level	2-W22-1	471.00	471.00	471.00	1	0
Fluoride, Low Detection Level	2-W22-12	528.00	528.00	528.00	1	0
Fluoride, Low Detection Level	2-W22-20	217.00	217.00	217.00	1	0
Fluoride, Low Detection Level	2-W22-22	467.00	467.00	467.00	1	0
Fluoride, Low Detection Level	2-W22-26	469.00	469.00	469.00	1	0
Fluoride, Low Detection Level	2-W23-10	283.00	240.00	258.67	3	0
Fluoride, Low Detection Level	2-W27-1	267.00	267.00	267.00	1	0
Fluoride, Low Detection Level	6-29-78	470.00	433.00	455.33	3	0
Fluoride, Low Detection Level	6-32-70B	433.00	393.00	409.67	3	0
Fluoride, Low Detection Level	6-32-72	396.00	356.00	380.67	3	0
Fluoride, Low Detection Level	6-32-77	630.00	487.00	556.33	3	0
Fluoride, Low Detection Level	6-35-66	353.00	309.00	333.33	3	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Fluoride, Low Detection Level	6-35-70	353.00	353.00	353.00	1	0
Fluoride, Low Detection Level	6-35-78A	368.00	368.00	368.00	1	0
Fluoride, Low Detection Level	6-36-61A	363.00	315.00	333.00	3	0
Fluoride, Low Detection Level	6-37-82A	219.00	219.00	219.00	1	0
Fluoride, Low Detection Level	6-38-65	262.00	262.00	262.00	1	0
Fluoride, Low Detection Level	6-38-70	410.00	326.00	375.33	3	0
Fluoride, Low Detection Level	6-39-79	399.00	384.00	391.00	3	0
Fluoride, Low Detection Level	6-40-62	352.00	334.00	341.33	3	0
Fluoride, Low Detection Level	6-43-88	204.00	204.00	204.00	1	0
Fluoride, Low Detection Level	6-44-64	356.00	348.00	351.00	3	0
Fluoride, Low Detection Level	6-45-69A	359.00	359.00	359.00	1	0
Fluoride, Low Detection Level	6-47-60	609.00	559.00	584.00	2	0
Fluoride, Low Detection Level	6-48-71	430.00	430.00	430.00	1	0
Gross alpha	2-W10-14	1.64	1.35	1.50	2	0
Gross alpha	2-W10-3	18.40	9.25	12.53	5	0
Gross alpha	2-W10-8	1.41	.53	.97	2	0
Gross alpha	2-W10-9	3.93	2.19	3.06	2	0
Gross alpha	2-W11-11	3.16	2.09	2.63	2	0
Gross alpha	2-W11-14	273.00	173.00	239.80	5	0
Gross alpha	2-W11-23	1.29	1.06	1.18	2	0
Gross alpha	2-W11-24	.66	.23	.44	2	1
Gross alpha	2-W11-7	13.20	.87	3.71	5	0
Gross alpha	2-W14-10	5.76	5.25	5.51	2	0
Gross alpha	2-W14-2	1.16	.71	.94	2	0
Gross alpha	2-W14-6	2.45	.72	1.36	4	3
Gross alpha	2-W15-10	1.03	.78	.90	2	0
Gross alpha	2-W15-11	1.64	1.08	1.36	2	0
Gross alpha	2-W15-15	3.72	2.18	2.86	3	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Gross alpha	2-W15-16	3.58	2.77	3.18	2	0
Gross alpha	2-W15-17	1.67	1.28	1.48	2	0
Gross alpha	2-W15-18	1.48	1.26	1.37	2	0
Gross alpha	2-W15-2	.89	.34	.57	5	2
Gross alpha	2-W15-3	1.69	1.02	1.42	5	1
Gross alpha	2-W15-6	1.43	.69	1.05	5	1
Gross alpha	2-W15-7	.48	.46	.47	2	0
Gross alpha	2-W18-15	49.20	30.80	40.48	5	0
Gross alpha	2-W18-17	1.50	-.20	.33	13	11
Gross alpha	2-W18-20	2.41	.17	1.15	10	3
Gross alpha	2-W18-21	20.40	19.70	20.05	2	0
Gross alpha	2-W18-24	1.94	1.16	1.55	2	1
Gross alpha	2-W18-5	1.14	1.02	1.08	2	0
Gross alpha	2-W18-7	.48	.11	.25	4	3
Gross alpha	2-W19-11	2570.00	1930.00	2323.33	3	0
Gross alpha	2-W19-12	2.99	2.77	2.88	2	0
Gross alpha	2-W19-13	8.48	3.11	6.55	5	0
Gross alpha	2-W19-14	4.37	1.20	3.10	5	1
Gross alpha	2-W19-15	235.00	49.30	142.13	7	0
Gross alpha	2-W19-16	989.00	407.00	696.00	11	0
Gross alpha	2-W19-17	36.10	17.10	22.93	4	0
Gross alpha	2-W19-18	3710.00	1930.00	2553.85	13	0
Gross alpha	2-W19-19	594.00	285.00	504.44	16	0
Gross alpha	2-W19-2	114.00	75.10	93.56	13	0
Gross alpha	2-W19-20	391.00	213.00	349.85	13	0
Gross alpha	2-W19-21	16.10	11.80	14.08	4	0
Gross alpha	2-W19-23	208.00	94.60	150.13	12	0
Gross alpha	2-W19-24	469.00	273.00	373.08	12	0
Gross alpha	2-W19-25	285.00	154.00	217.45	11	0
Gross alpha	2-W19-26	305.00	189.00	246.57	7	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Gross alpha	2-W19-27	9.77	7.04	8.39	5	0
Gross alpha	2-W19-3	3100.00	1610.00	2130.00	15	0
Gross alpha	2-W19-9	1360.00	613.00	900.57	7	0
Gross alpha	2-W22-1	5.78	1.74	4.03	4	0
Gross alpha	2-W22-10	7.71	-.09	1.70	5	3
Gross alpha	2-W22-18	5.71	1.02	2.05	5	0
Gross alpha	2-W22-2	6.17	4.93	5.36	5	0
Gross alpha	2-W22-21	13.60	11.60	12.60	2	0
Gross alpha	2-W22-22	6.36	.68	2.13	5	0
Gross alpha	2-W23-10	39.50	17.10	27.47	11	0
Gross alpha	2-W23-11	17.20	10.60	15.08	5	0
Gross alpha	2-W23-4	59.90	21.50	38.21	9	0
Gross alpha	2-W23-8	3.78	3.78	3.78	1	0
Gross alpha	2-W23-9	56.50	17.50	23.38	13	0
Gross alpha	2-W26-3	1.14	.76	.95	2	0
Gross alpha	2-W26-6	1.25	.95	1.10	2	0
Gross alpha	2-W27-1	13.00	5.24	8.63	5	0
Gross alpha	2-W6-2	2.16	.48	1.32	2	1
Gross alpha	2-W7-2	1.73	.64	1.19	2	1
Gross alpha	2-W7-4	1.87	.38	1.20	3	1
Gross alpha	2-W7-5	1.59	1.18	1.39	2	0
Gross alpha	2-W7-6	28.40	8.88	18.64	2	0
Gross alpha	2-W8-1	1.81	.87	1.34	2	1
Gross alpha	2-W9-1	1.87	1.77	1.82	2	0
Gross alpha	6-29-78	1.77	.92	1.30	6	1
Gross alpha	6-32-62	2.49	1.70	1.95	4	0
Gross alpha	6-32-708	2.17	.69	1.43	2	1
Gross alpha	6-32-72	.99	-.22	.24	7	6
Gross alpha	6-32-77	2.16	.88	1.73	6	0
Gross alpha	6-35-66	2.40	1.39	1.74	3	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Gross alpha	6-35-78A	15.40	9.73	13.17	5	0
Gross alpha	6-36-61A	1.75	1.43	1.59	2	0
Gross alpha	6-36-61B	2.64	-.03	.76	4	2
Gross alpha	6-38-70	52.20	19.60	42.21	15	0
Gross alpha	6-39-79	10.10	6.50	8.09	6	0
Gross alpha	6-40-62	2.65	1.56	1.91	6	0
Gross alpha	6-43-88	.39	-.11	.07	4	3
Gross alpha	6-44-64	3.00	1.33	1.95	6	0
Gross alpha	6-45-69A	1.76	1.09	1.37	4	0
Gross alpha	6-47-60	2.14	1.42	1.78	2	0
Gross alpha	6-48-71	1.80	.72	1.26	4	0
Gross beta	2-W10-1	49.30	32.10	41.80	6	0
Gross beta	2-W10-13	10.20	4.84	6.91	8	0
Gross beta	2-W10-14	7.50	2.02	5.18	7	1
Gross beta	2-W10-15	45.20	45.20	45.20	1	0
Gross beta	2-W10-16	17.80	17.80	17.80	1	0
Gross beta	2-W10-3	163.00	28.70	90.33	6	0
Gross beta	2-W10-4	79.90	54.10	67.00	2	0
Gross beta	2-W10-8	17.50	2.79	8.86	3	0
Gross beta	2-W10-9	49.80	45.40	48.20	3	0
Gross beta	2-W11-11	54.40	53.20	53.80	2	0
Gross beta	2-W11-14	193.00	72.80	125.53	7	0
Gross beta	2-W11-15	22.90	14.40	18.75	4	0
Gross beta	2-W11-18	70.10	64.70	67.40	2	0
Gross beta	2-W11-23	13.30	3.82	9.21	3	0
Gross beta	2-W11-24	8.90	5.99	7.45	2	0
Gross beta	2-W11-7	64.00	22.00	50.28	6	0
Gross beta	2-W14-10	20.30	5.78	12.09	4	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Gross beta	2-W14-2	54.40	34.50	44.45	2	0
Gross beta	2-W14-5	39.90	25.60	32.75	2	0
Gross beta	2-W14-6	40.60	9.79	17.19	9	0
Gross beta	2-W15-10	14.00	12.70	13.35	2	0
Gross beta	2-W15-11	16.30	15.00	15.65	2	0
Gross beta	2-W15-15	7.15	3.03	4.97	7	0
Gross beta	2-W15-16	11.30	5.05	7.72	6	0
Gross beta	2-W15-17	10.60	3.43	7.61	5	0
Gross beta	2-W15-18	8.82	4.52	6.57	6	0
Gross beta	2-W15-19	11.60	10.30	10.95	2	0
Gross beta	2-W15-2	6.82	3.41	4.91	6	0
Gross beta	2-W15-20	7.57	2.85	5.21	2	0
Gross beta	2-W15-24	2.54	2.54	2.54	1	0
Gross beta	2-W15-3	128.00	77.20	96.75	6	0
Gross beta	2-W15-4	10.10	8.57	9.34	2	0
Gross beta	2-W15-6	4.95	3.68	4.33	5	0
Gross beta	2-W15-7	20.30	19.70	20.00	2	0
Gross beta	2-W15-8	336.00	18.80	79.22	6	0
Gross beta	2-W18-15	16.60	7.16	12.02	5	0
Gross beta	2-W18-17	24.60	-1.28	3.94	19	1
Gross beta	2-W18-20	9.78	.70	4.16	16	2
Gross beta	2-W18-21	9.25	3.39	6.53	7	0
Gross beta	2-W18-22	6.46	2.29	5.09	6	0
Gross beta	2-W18-23	4.71	.49	3.16	9	3
Gross beta	2-W18-24	7.37	2.56	4.04	6	0
Gross beta	2-W18-26	7.08	4.94	6.01	2	0
Gross beta	2-W18-5	8.13	6.95	7.54	2	0
Gross beta	2-W18-7	10.90	3.16	6.29	5	0
Gross beta	2-W18-9	9.82	1.20	4.31	7	2
Gross beta	2-W19-1	8.69	8.69	8.69	1	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Gross beta	2-W19-11	3160.00	278.00	2154.50	4	0
Gross beta	2-W19-12	339.00	108.00	261.33	3	0
Gross beta	2-W19-13	18.70	12.90	15.82	5	0
Gross beta	2-W19-14	11.50	6.32	8.98	5	0
Gross beta	2-W19-15	325.00	78.20	201.48	8	0
Gross beta	2-W19-16	1540.00	286.00	758.67	12	0
Gross beta	2-W19-17	63.60	45.70	50.25	4	0
Gross beta	2-W19-18	6180.00	396.00	3254.06	17	0
Gross beta	2-W19-19	1750.00	533.00	1057.05	21	0
Gross beta	2-W19-2	163.00	66.50	120.90	17	0
Gross beta	2-W19-20	2610.00	753.00	1360.11	18	0
Gross beta	2-W19-21	11.60	3.32	7.50	6	0
Gross beta	2-W19-23	632.00	134.00	308.18	17	0
Gross beta	2-W19-24	3430.00	1650.00	2497.65	17	0
Gross beta	2-W19-25	5110.00	1910.00	3271.88	16	0
Gross beta	2-W19-26	799.00	222.00	498.33	9	0
Gross beta	2-W19-27	13.60	3.71	8.26	7	0
Gross beta	2-W19-28	393.00	328.00	360.50	2	0
Gross beta	2-W19-3	2870.00	239.00	1627.78	18	0
Gross beta	2-W19-5	27.30	17.90	22.60	2	0
Gross beta	2-W19-9	1100.00	353.00	669.71	7	0
Gross beta	2-W22-1	30.80	27.80	29.15	4	0
Gross beta	2-W22-10	64.80	32.80	48.22	6	0
Gross beta	2-W22-12	9.61	5.17	7.95	4	0
Gross beta	2-W22-18	18.50	12.40	14.40	5	0
Gross beta	2-W22-2	40.00	15.40	22.42	6	0
Gross beta	2-W22-20	32.40	19.70	27.53	3	0
Gross beta	2-W22-21	170.00	164.00	167.00	2	0
Gross beta	2-W22-22	7.64	3.41	5.31	7	0
Gross beta	2-W22-26	23.30	18.80	21.05	2	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Gross beta	2-W23-1	404.00	11.40	84.37	6	0
Gross beta	2-W23-10	44.10	8.45	17.98	11	0
Gross beta	2-W23-11	8.59	4.10	6.48	6	0
Gross beta	2-W23-2	1180.00	102.00	541.41	17	0
Gross beta	2-W23-3	131.00	33.70	82.45	6	0
Gross beta	2-W23-4	77.70	7.50	43.25	13	0
Gross beta	2-W23-7	1200.00	187.00	394.88	17	0
Gross beta	2-W23-8	3.78	3.78	3.78	1	0
Gross beta	2-W23-9	51.10	10.10	18.01	17	0
Gross beta	2-W26-3	3.32	2.79	3.00	3	0
Gross beta	2-W26-6	6.56	4.41	5.54	3	0
Gross beta	2-W27-1	9.71	4.96	7.36	8	0
Gross beta	2-W6-2	16.40	10.20	13.10	8	0
Gross beta	2-W7-1	7.12	2.65	4.22	7	1
Gross beta	2-W7-2	6.79	3.11	4.80	7	0
Gross beta	2-W7-3	8.75	1.77	5.10	8	2
Gross beta	2-W7-4	15.70	7.79	12.10	8	0
Gross beta	2-W7-5	15.40	5.16	9.27	7	0
Gross beta	2-W7-6	55.10	7.63	23.23	7	0
Gross beta	2-W7-7	4.51	2.67	3.59	2	0
Gross beta	2-W7-8	8.74	3.96	6.35	2	0
Gross beta	2-W7-9	7.84	5.86	6.85	2	0
Gross beta	2-W8-1	8.27	4.24	6.24	7	0
Gross beta	2-W9-1	10.90	3.67	7.21	7	0
Gross beta	6-29-78	4.75	1.61	2.80	8	3
Gross beta	6-32-62	9.02	6.04	7.28	5	0
Gross beta	6-32-70B	40.00	23.80	33.58	8	0
Gross beta	6-32-72	18.70	2.51	12.04	8	0
Gross beta	6-32-77	5.11	3.06	4.06	7	0
Gross beta	6-35-66	12.20	7.24	10.28	8	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Gross beta	6-35-70	32.80	17.30	23.02	6	0
Gross beta	6-35-78A	9.88	4.24	6.05	7	0
Gross beta	6-36-61A	9.80	7.04	8.42	2	0
Gross beta	6-36-61B	9.75	5.15	7.41	5	0
Gross beta	6-37-82A	8.71	5.91	6.85	6	0
Gross beta	6-38-65	20.00	14.10	16.42	6	0
Gross beta	6-38-70	437.00	252.00	338.89	19	0
Gross beta	6-39-79	6.09	3.67	4.97	6	0
Gross beta	6-40-62	10.30	4.38	7.08	8	0
Gross beta	6-43-88	6.65	1.87	3.88	6	1
Gross beta	6-44-64	21.40	18.30	19.88	8	0
Gross beta	6-45-69A	3.63	3.24	3.48	6	0
Gross beta	6-47-60	7.96	5.73	6.52	8	0
Gross beta	6-48-71	5.01	2.09	3.36	6	1
Iodine-129 (Drinking Water Standard)	2-W10-3	.17	.17	.17	1	0
Iodine-129 (Drinking Water Standard)	2-W11-14	2.24	2.24	2.24	1	0
Iodine-129 (Drinking Water Standard)	2-W11-3	.10	.10	.10	1	0
Iodine-129 (Drinking Water Standard)	2-W12-1	.24	.24	.24	1	0
Iodine-129 (Drinking Water Standard)	2-W15-7	.10	.10	.10	1	0
Iodine-129 (Drinking Water Standard)	2-W19-15	2.68	1.29	1.99	2	0
Iodine-129 (Drinking Water Standard)	2-W19-16	4.56	2.25	3.41	2	0
Iodine-129 (Drinking Water Standard)	2-W19-18	6.12	6.12	6.12	1	0
Iodine-129 (Drinking Water Standard)	2-W19-19	1.77	1.77	1.77	1	0
Iodine-129 (Drinking Water Standard)	2-W19-2	7.10	7.10	7.10	1	0
Iodine-129 (Drinking Water Standard)	2-W19-20	2.33	2.33	2.33	1	0
Iodine-129 (Drinking Water Standard)	2-W19-23	1.29	1.29	1.29	1	0
Iodine-129 (Drinking Water Standard)	2-W19-24	1.97	1.97	1.97	1	0
Iodine-129 (Drinking Water Standard)	2-W19-25	2.22	2.22	2.22	1	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Iodine-129 (Drinking Water Standard)	2-W19-28	.89	.57	.73	2	0
Iodine-129 (Drinking Water Standard)	2-W19-3	15.50	5.58	10.54	2	0
Iodine-129 (Drinking Water Standard)	2-W19-9	1.54	1.54	1.54	1	0
Iodine-129 (Drinking Water Standard)	2-W21-1	3.37	3.37	3.37	1	0
Iodine-129 (Drinking Water Standard)	2-W22-20	1.21	.34	.85	3	0
Iodine-129 (Drinking Water Standard)	2-W22-22	2.18	2.04	2.11	2	0
Iodine-129 (Drinking Water Standard)	2-W22-7	1.63	1.63	1.63	1	0
Iodine-129 (Drinking Water Standard)	2-W22-9	23.90	23.90	23.90	1	0
Iodine-129 (Drinking Water Standard)	2-W23-9	.41	.41	.41	1	0
Iodine-129 (Drinking Water Standard)	2-W27-1	.34	-.00	.17	2	1
Iodine-129 (Drinking Water Standard)	6-32-62	.06	.02	.04	2	1
Iodine-129 (Drinking Water Standard)	6-32-708	3.25	.86	2.05	2	0
Iodine-129 (Drinking Water Standard)	6-35-66	6.56	1.49	4.03	2	0
Iodine-129 (Drinking Water Standard)	6-35-70	87.80	10.30	26.58	5	0
Iodine-129 (Drinking Water Standard)	6-38-65	3.51	.92	1.81	3	0
Iodine-129 (Drinking Water Standard)	6-38-70	1.99	.32	1.24	3	0
Iodine-129 (Drinking Water Standard)	6-40-62	.27	.03	.15	2	1
Nitrate	2-W10-13	51000.00	7700.00	13355.00	8	0
Nitrate	2-W10-14	22200.00	18500.00	20900.00	7	0
Nitrate	2-W10-15	292000.00	292000.00	292000.00	1	0
Nitrate	2-W10-16	163000.00	163000.00	163000.00	1	0
Nitrate	2-W10-4	222000.00	194000.00	208666.67	3	0
Nitrate	2-W10-8	32200.00	32200.00	32200.00	1	0
Nitrate	2-W10-9	426000.00	356000.00	381000.00	3	0
Nitrate	2-W11-14	125000.00	116000.00	121333.33	3	0
Nitrate	2-W11-23	34000.00	34000.00	34000.00	1	0
Nitrate	2-W11-7	215000.00	203000.00	209000.00	2	0
Nitrate	2-W14-10	101000.00	500.00	38600.00	3	1

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Nitrate	2-W14-2	65300.00	52100.00	60000.00	3	0
Nitrate	2-W14-5	290000.00	49400.00	135933.33	3	0
Nitrate	2-W14-6	51400.00	14500.00	23490.00	10	0
Nitrate	2-W15-10	101000.00	38800.00	64220.00	5	0
Nitrate	2-W15-11	131000.00	95000.00	108000.00	3	0
Nitrate	2-W15-12	124000.00	116000.00	118666.67	3	0
Nitrate	2-W15-15	26700.00	4490.00	11532.86	7	0
Nitrate	2-W15-16	76900.00	67000.00	71085.71	7	0
Nitrate	2-W15-17	23200.00	16700.00	19100.00	5	0
Nitrate	2-W15-18	95700.00	68900.00	76350.00	6	0
Nitrate	2-W15-19	95400.00	82400.00	88900.00	2	0
Nitrate	2-W15-20	8500.00	7200.00	7850.00	2	0
Nitrate	2-W15-24	2800.00	2800.00	2800.00	1	0
Nitrate	2-W15-4	662000.00	397000.00	529500.00	2	0
Nitrate	2-W15-7	56200.00	54800.00	55500.00	2	0
Nitrate	2-W15-8	139000.00	71100.00	105050.00	2	0
Nitrate	2-W18-15	1570.00	1200.00	1396.67	3	0
Nitrate	2-W18-17	2810000.00	500.00	562900.00	5	2
Nitrate	2-W18-20	600.00	500.00	533.33	3	2
Nitrate	2-W18-21	3000.00	2200.00	2490.00	7	0
Nitrate	2-W18-22	17300.00	13800.00	15883.33	6	0
Nitrate	2-W18-23	6800.00	5620.00	6210.00	9	0
Nitrate	2-W18-24	23700.00	15600.00	19814.29	7	0
Nitrate	2-W18-26	8600.00	5700.00	7150.00	2	0
Nitrate	2-W18-4	65300.00	39100.00	47866.67	3	0
Nitrate	2-W18-5	277000.00	255000.00	263666.67	3	0
Nitrate	2-W18-8	5000.00	5000.00	5000.00	1	0
Nitrate	2-W18-9	4770.00	1400.00	3085.00	2	0
Nitrate	2-W19-1	1300.00	1300.00	1300.00	1	0
Nitrate	2-W19-11	93100.00	44800.00	68950.00	2	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Nitrate	2-W19-12	16700.00	16700.00	16700.00	1	0
Nitrate	2-W19-13	21000.00	17000.00	19166.67	3	0
Nitrate	2-W19-15	109000.00	70300.00	93040.00	5	0
Nitrate	2-W19-16	50900.00	39100.00	46700.00	5	0
Nitrate	2-W19-18	146000.00	33900.00	99325.00	4	0
Nitrate	2-W19-19	1280000.00	1250000.00	1265000.00	2	0
Nitrate	2-W19-2	245000.00	245000.00	245000.00	1	0
Nitrate	2-W19-20	1050000.00	940000.00	1014000.00	5	0
Nitrate	2-W19-21	700.00	500.00	560.00	5	3
Nitrate	2-W19-23	586000.00	495000.00	540500.00	2	0
Nitrate	2-W19-24	1230000.00	584000.00	952200.00	5	0
Nitrate	2-W19-25	931000.00	804000.00	867500.00	2	0
Nitrate	2-W19-26	1300000.00	1300000.00	1300000.00	1	0
Nitrate	2-W19-27	900.00	900.00	900.00	2	0
Nitrate	2-W19-28	277000.00	266000.00	271500.00	2	0
Nitrate	2-W19-3	56100.00	27100.00	41450.00	4	0
Nitrate	2-W19-5	2430.00	2100.00	2265.00	2	0
Nitrate	2-W19-9	34400.00	16200.00	21875.00	4	0
Nitrate	2-W22-1	12400.00	3830.00	7443.33	3	0
Nitrate	2-W22-12	2400.00	1300.00	1845.00	4	0
Nitrate	2-W22-2	6100.00	6100.00	6100.00	1	0
Nitrate	2-W22-20	199000.00	124000.00	151250.00	4	0
Nitrate	2-W22-22	24900.00	2810.00	16422.00	5	0
Nitrate	2-W22-26	15000.00	12800.00	13900.00	2	0
Nitrate	2-W23-10	158000.00	101000.00	126800.00	5	0
Nitrate	2-W23-11	1200.00	1200.00	1200.00	1	0
Nitrate	2-W23-4	1000.00	1000.00	1000.00	1	0
Nitrate	2-W23-9	4300.00	4300.00	4300.00	1	0
Nitrate	2-W26-3	1800.00	1800.00	1800.00	1	0
Nitrate	2-W26-6	3400.00	3400.00	3400.00	1	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Nitrate	2-W27-1	70500.00	29000.00	47583.33	6	0
Nitrate	2-W6-2	80700.00	24600.00	68050.00	10	0
Nitrate	2-W7-1	45100.00	41700.00	43442.86	7	0
Nitrate	2-W7-2	42000.00	23600.00	28914.29	7	0
Nitrate	2-W7-3	8800.00	2040.00	3742.50	8	0
Nitrate	2-W7-4	78800.00	72300.00	74800.00	8	0
Nitrate	2-W7-5	50300.00	42400.00	45600.00	7	0
Nitrate	2-W7-6	8400.00	5300.00	6184.29	7	0
Nitrate	2-W7-7	11600.00	10600.00	11100.00	2	0
Nitrate	2-W7-8	26600.00	25300.00	25950.00	2	0
Nitrate	2-W7-9	17800.00	17300.00	17550.00	2	0
Nitrate	2-W8-1	30400.00	27900.00	29371.43	7	0
Nitrate	2-W9-1	20300.00	17000.00	18828.57	7	0
Nitrate	6-29-78	8660.00	7410.00	7953.33	3	0
Nitrate	6-32-70B	19700.00	18100.00	18950.00	4	0
Nitrate	6-32-72	9170.00	8470.00	8863.33	3	0
Nitrate	6-32-77	5770.00	5530.00	5646.67	3	0
Nitrate	6-35-66	28500.00	23500.00	25125.00	4	0
Nitrate	6-35-70	29200.00	26900.00	28200.00	3	0
Nitrate	6-35-78A	1100.00	500.00	749.00	3	0
Nitrate	6-36-61A	21600.00	20800.00	21200.00	4	0
Nitrate	6-36-61B	9300.00	9300.00	9300.00	1	0
Nitrate	6-37-82A	39300.00	39300.00	39300.00	1	0
Nitrate	6-38-65	171000.00	161000.00	166000.00	2	0
Nitrate	6-38-70	276000.00	220000.00	243400.00	5	0
Nitrate	6-39-79	6360.00	4000.00	5910.00	8	0
Nitrate	6-40-62	46500.00	41100.00	44600.00	3	0
Nitrate	6-43-88	9400.00	9400.00	9400.00	1	0
Nitrate	6-44-64	55000.00	45800.00	52440.00	5	0
Nitrate	6-45-69A	25600.00	21400.00	23500.00	2	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Nitrate	6-47-60	23500.00	21700.00	22733.33	3	0
Nitrate	6-48-71	25100.00	25100.00	25100.00	1	0
Plutonium-239/40	2-W10-13	.05	-.00	.01	4	3
Plutonium-239/40	2-W15-17	.04	-.00	.01	3	2
Plutonium-239/40	2-W15-8	8.27	8.27	8.27	1	0
Plutonium-239/40	2-W18-17	.43	-.00	.06	8	7
Plutonium-239/40	2-W19-23	.06	-.00	.01	7	5
Plutonium-239/40	2-W19-24	.12	-.00	.02	7	6
Plutonium-239/40	2-W19-25	.05	-.01	.01	7	5
Plutonium-239/40	2-W22-2	.12	.12	.12	1	0
Plutonium-239/40	2-W7-3	.01	-.00	.00	4	3
Technetium-99	2-W10-1	514.00	500.00	507.00	2	0
Technetium-99	2-W10-13	24.90	17.30	20.73	6	0
Technetium-99	2-W11-18	558.00	15.40	286.70	2	0
Technetium-99	2-W14-2	351.00	247.00	299.00	2	0
Technetium-99	2-W15-15	12.60	2.35	5.85	6	5
Technetium-99	2-W15-16	18.70	11.80	13.70	6	0
Technetium-99	2-W15-17	17.00	7.95	12.56	5	0
Technetium-99	2-W15-18	27.40	-1.98	10.62	6	1
Technetium-99	2-W15-19	31.40	31.40	31.40	1	0
Technetium-99	2-W15-4	49.20	46.00	47.60	2	0
Technetium-99	2-W18-24	46.00	-1.90	8.11	6	5
Technetium-99	2-W18-3	20.40	7.15	13.78	2	1
Technetium-99	2-W19-1	46.70	24.40	33.67	3	0
Technetium-99	2-W19-11	2870.00	355.00	1768.33	3	0
Technetium-99	2-W19-12	2350.00	701.00	1525.50	2	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Technetium-99	2-W19-15	1030.00	657.00	848.40	5	0
Technetium-99	2-W19-16	1720.00	14.30	1150.86	5	1
Technetium-99	2-W19-17	178.00	115.00	155.50	4	0
Technetium-99	2-W19-18	9200.00	967.00	4800.44	16	0
Technetium-99	2-W19-19	24600.00	8530.00	13741.25	16	0
Technetium-99	2-W19-20	25400.00	10600.00	14056.25	16	0
Technetium-99	2-W19-23	1850.00	907.00	1270.27	15	0
Technetium-99	2-W19-24	41000.00	27.20	26975.15	15	0
Technetium-99	2-W19-25	33000.00	8810.00	20057.86	14	0
Technetium-99	2-W19-26	7290.00	1040.00	3168.75	8	0
Technetium-99	2-W19-3	1280.00	-13.70	973.79	13	1
Technetium-99	2-W19-5	117.00	72.90	94.95	2	0
Technetium-99	2-W19-9	1020.00	265.00	563.80	5	0
Technetium-99	2-W22-18	69.40	62.50	65.95	2	0
Technetium-99	2-W22-20	184.00	178.00	181.00	2	0
Technetium-99	2-W23-10	19.80	4.70	12.25	2	1
Technetium-99	2-W23-2	5150.00	103.00	2760.82	17	0
Technetium-99	2-W23-7	7830.00	117.00	2279.82	17	0
Technetium-99	2-W23-9	81.20	25.50	53.35	2	0
Technetium-99	2-W6-2	107.00	69.40	86.27	7	0
Technetium-99	2-W7-1	8.22	5.83	6.88	6	3
Technetium-99	2-W7-2	8.17	2.77	4.96	6	5
Technetium-99	2-W7-4	81.20	65.20	73.91	7	0
Technetium-99	2-W7-5	39.40	19.80	32.38	6	0
Technetium-99	2-W7-8	9.86	9.86	9.86	1	0
Technetium-99	2-W8-1	18.10	12.80	15.97	6	0
Technetium-99	2-W9-1	19.20	3.95	14.11	6	1
Technetium-99	6-32-70B	210.00	189.00	199.33	3	0
Technetium-99	6-32-72	86.40	47.70	64.13	3	0
Technetium-99	6-35-66	44.70	37.40	40.87	3	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Technetium-99	6-35-70	135.00	95.50	118.13	4	0
Technetium-99	6-38-65	92.40	92.40	92.40	1	0
Technetium-99	6-38-70	4230.00	2370.00	3352.50	16	0
Trichloroethylene	2-W10-4	28.00	22.00	24.33	3	0
Trichloroethylene	2-W10-9	19.00	15.00	17.00	2	0
Trichloroethylene	2-W11-7	7.00	6.00	6.50	2	0
Trichloroethylene	2-W14-2	12.00	8.00	10.33	3	0
Trichloroethylene	2-W15-10	8.00	7.00	7.50	4	0
Trichloroethylene	2-W15-11	11.00	9.00	10.00	3	0
Trichloroethylene	2-W15-12	10.00	8.00	8.67	3	0
Trichloroethylene	2-W15-16	50.00	5.00	13.00	7	1
Trichloroethylene	2-W15-4	12.00	11.00	11.50	2	0
Trichloroethylene	2-W15-7	12.00	10.00	11.00	2	0
Trichloroethylene	2-W18-17	15.00	5.00	7.50	4	3
Trichloroethylene	2-W22-20	41.00	25.00	31.75	4	0
Trichloroethylene	2-W7-7	6.00	5.00	5.50	2	1
Trichloroethylene	6-38-70	8.00	3.00	4.20	5	4
Tritium	2-W10-1	54800.00	53700.00	54250.00	2	0
Tritium	2-W10-13	421.00	13.00	253.43	7	4
Tritium	2-W10-15	60600.00	60600.00	60600.00	1	0
Tritium	2-W10-16	53200.00	53200.00	53200.00	1	0
Tritium	2-W10-3	118000.00	107000.00	112500.00	2	0
Tritium	2-W10-4	88500.00	76300.00	82400.00	2	0
Tritium	2-W10-5	9810.00	9310.00	9560.00	2	0
Tritium	2-W10-8	4090.00	2730.00	3353.33	3	0
Tritium	2-W10-9	65000.00	57900.00	60633.33	3	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Tritium	2-W11-14	6890.00	6890.00	6890.00	1	0
Tritium	2-W11-23	1080.00	1080.00	1080.00	1	0
Tritium	2-W11-3	560.00	242.00	401.00	2	1
Tritium	2-W11-9	2740.00	2740.00	2740.00	1	0
Tritium	2-W12-1	6730.00	5650.00	6190.00	2	0
Tritium	2-W14-10	1700.00	1090.00	1352.50	4	0
Tritium	2-W14-2	80300.00	51200.00	65750.00	2	0
Tritium	2-W14-5	6280.00	1780.00	4030.00	2	0
Tritium	2-W14-6	11400.00	5560.00	8202.00	5	0
Tritium	2-W15-10	7110.00	4840.00	5975.00	2	0
Tritium	2-W15-11	18100.00	14700.00	16400.00	2	0
Tritium	2-W15-15	680.00	240.00	407.17	6	1
Tritium	2-W15-16	33700.00	-13.50	5729.28	6	4
Tritium	2-W15-17	261.00	-136.00	32.80	5	4
Tritium	2-W15-18	472.00	-23.80	173.15	6	4
Tritium	2-W15-19	301.00	196.00	248.50	2	1
Tritium	2-W15-2	1190.00	103.00	646.50	2	1
Tritium	2-W15-24	252.00	252.00	252.00	1	0
Tritium	2-W15-4	202000.00	155000.00	178500.00	2	0
Tritium	2-W15-7	2040.00	976.00	1508.00	2	0
Tritium	2-W18-15	484.00	67.20	192.44	5	4
Tritium	2-W18-17	3300.00	-97.90	633.96	8	4
Tritium	2-W18-20	521.00	-58.00	189.63	8	6
Tritium	2-W18-21	734.00	-60.60	248.59	6	4
Tritium	2-W18-22	1150.00	-61.20	372.91	6	4
Tritium	2-W18-23	615.00	-77.90	169.46	8	7
Tritium	2-W18-26	256.00	179.00	217.50	2	1
Tritium	2-W19-11	886.00	680.00	783.00	2	0
Tritium	2-W19-12	816.00	282.00	469.33	3	2
Tritium	2-W19-13	593.00	-46.40	169.32	5	4

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Tritium	2-W19-15	2770.00	779.00	1266.00	6	0
Tritium	2-W19-16	2200.00	124.00	971.50	6	2
Tritium	2-W19-18	4960.00	426.00	1866.43	7	0
Tritium	2-W19-19	3190.00	1060.00	1676.67	21	0
Tritium	2-W19-2	77400.00	24700.00	58242.86	7	0
Tritium	2-W19-20	3760.00	1350.00	2033.53	17	0
Tritium	2-W19-23	1990.00	456.00	874.94	16	0
Tritium	2-W19-24	2820.00	943.00	1857.06	16	0
Tritium	2-W19-25	3010.00	1350.00	2020.00	16	0
Tritium	2-W19-26	2090.00	424.00	1297.11	9	1
Tritium	2-W19-28	411.00	235.00	323.00	2	0
Tritium	2-W19-3	950.00	334.00	535.44	9	2
Tritium	2-W19-5	826.00	369.00	597.50	2	1
Tritium	2-W19-9	562.00	60.00	288.12	5	3
Tritium	2-W21-1	90400.00	82100.00	86250.00	2	0
Tritium	2-W22-1	2960.00	792.00	1683.00	4	0
Tritium	2-W22-10	121000.00	93700.00	103700.00	3	0
Tritium	2-W22-12	25200.00	20100.00	22650.00	2	0
Tritium	2-W22-2	67300.00	6700.00	22066.67	6	0
Tritium	2-W22-20	216000.00	193000.00	203000.00	3	0
Tritium	2-W22-22	1810.00	-127.00	1160.43	7	1
Tritium	2-W22-26	132000.00	86500.00	109250.00	2	0
Tritium	2-W22-7	364000.00	335000.00	349500.00	2	0
Tritium	2-W22-9	7560000.00	5880000.00	6773333.33	3	0
Tritium	2-W23-10	687000.00	553000.00	605000.00	6	0
Tritium	2-W23-11	1240.00	341.00	877.17	6	1
Tritium	2-W23-4	5450000.00	8510.00	961154.62	13	0
Tritium	2-W23-8	178000.00	178000.00	178000.00	1	0
Tritium	2-W23-9	1520000.00	215000.00	1262647.06	17	0
Tritium	2-W26-6	1450.00	-48.40	509.87	3	2

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Tritium	2-W27-1	5760.00	267.00	2894.88	8	1
Tritium	2-W6-1	59700.00	59600.00	59650.00	2	0
Tritium	2-W6-2	15800.00	10500.00	14000.00	8	0
Tritium	2-W7-4	850.00	283.00	480.29	7	1
Tritium	2-W7-5	886.00	113.00	350.50	6	3
Tritium	2-W7-6	1050.00	590.00	838.83	6	0
Tritium	2-W7-7	411.00	365.00	388.00	2	0
Tritium	2-W7-8	517.00	489.00	503.00	2	0
Tritium	2-W9-1	265.00	-123.00	93.15	6	5
Tritium	6-29-78	498.00	104.00	275.50	6	3
Tritium	6-32-62	2240.00	1990.00	2124.00	5	0
Tritium	6-32-70B	269000.00	231000.00	253166.67	6	0
Tritium	6-32-72	146000.00	134000.00	139200.00	5	0
Tritium	6-32-77	567.00	64.10	245.82	5	4
Tritium	6-35-66	1210000.00	1100000.00	1155000.00	6	0
Tritium	6-35-70	1180000.00	787000.00	985142.86	7	0
Tritium	6-36-61A	29500.00	29500.00	29500.00	1	0
Tritium	6-36-61B	32200.00	77.80	7217.76	5	2
Tritium	6-38-65	452000.00	397000.00	420285.71	7	0
Tritium	6-38-70	1460.00	914.00	1112.80	5	0
Tritium	6-40-62	88100.00	76600.00	81766.67	6	0
Tritium	6-44-64	814.00	511.00	664.71	7	0
Uranium	2-W10-1	2.18	1.84	2.01	2	0
Uranium	2-W10-13	1.22	.49	.71	7	0
Uranium	2-W10-14	.79	.36	.62	6	0
Uranium	2-W10-3	14.80	7.38	11.09	2	0
Uranium	2-W10-4	.99	.74	.86	2	0
Uranium	2-W10-8	1.15	1.04	1.10	2	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Uranium	2-W10-9	2.38	1.94	2.16	2	0
Uranium	2-W11-14	207.00	207.00	207.00	1	0
Uranium	2-W11-3	1.29	.72	1.00	2	0
Uranium	2-W11-9	1.08	1.08	1.08	1	0
Uranium	2-W14-10	1.10	1.10	1.10	1	0
Uranium	2-W14-2	1.07	.95	1.01	2	0
Uranium	2-W14-5	.71	.48	.59	2	0
Uranium	2-W14-6	.72	.63	.68	2	0
Uranium	2-W15-15	3.64	2.33	3.10	5	0
Uranium	2-W15-16	3.52	1.41	2.23	5	0
Uranium	2-W15-17	.69	.45	.59	4	0
Uranium	2-W15-18	.80	.58	.70	4	0
Uranium	2-W15-19	1.39	.61	1.00	2	0
Uranium	2-W15-20	1.65	.53	1.09	2	0
Uranium	2-W15-24	.67	.67	.67	1	0
Uranium	2-W15-4	4.51	2.70	3.61	2	0
Uranium	2-W18-17	.43	.43	.43	1	0
Uranium	2-W18-20	1.11	1.11	1.11	1	0
Uranium	2-W18-21	24.00	14.20	20.86	5	0
Uranium	2-W18-22	.88	.51	.63	5	0
Uranium	2-W18-23	2.11	.61	1.15	8	0
Uranium	2-W18-24	1.10	.64	.82	5	0
Uranium	2-W18-26	2.13	1.41	1.77	2	0
Uranium	2-W19-1	4.39	4.39	4.39	1	0
Uranium	2-W19-11	1030.00	1030.00	1030.00	1	0
Uranium	2-W19-15	27.70	27.70	27.70	1	0
Uranium	2-W19-16	478.00	478.00	478.00	1	0
Uranium	2-W19-18	1130.00	1130.00	1130.00	1	0
Uranium	2-W19-19	547.00	547.00	547.00	1	0
Uranium	2-W19-2	8.80	8.80	8.80	1	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Uranium	2-W19-20	2.04	2.04	2.04	1	0
Uranium	2-W19-21	20.90	15.10	18.00	2	0
Uranium	2-W19-23	126.00	126.00	126.00	1	0
Uranium	2-W19-24	397.00	397.00	397.00	1	0
Uranium	2-W19-25	311.00	311.00	311.00	1	0
Uranium	2-W19-26	340.00	340.00	340.00	1	0
Uranium	2-W19-27	8.57	8.34	8.46	2	0
Uranium	2-W19-28	53.30	28.40	40.85	2	0
Uranium	2-W19-3	737.00	737.00	737.00	1	0
Uranium	2-W19-5	7.34	6.70	7.02	2	0
Uranium	2-W21-1	1.47	1.46	1.47	2	0
Uranium	2-W22-1	5.15	3.42	4.29	2	0
Uranium	2-W22-12	1.04	.75	.89	2	0
Uranium	2-W22-2	6.25	4.47	5.10	3	0
Uranium	2-W22-20	6.90	5.92	6.51	4	0
Uranium	2-W22-26	4.71	3.90	4.31	2	0
Uranium	2-W22-7	1.48	.73	1.11	2	0
Uranium	2-W22-9	5.36	4.19	4.78	2	0
Uranium	2-W23-1	6.28	5.42	5.85	2	0
Uranium	2-W23-10	19.50	19.50	19.50	1	0
Uranium	2-W23-11	11.40	11.40	11.40	1	0
Uranium	2-W23-2	5.97	4.76	5.50	4	0
Uranium	2-W23-4	14.70	14.70	14.70	1	0
Uranium	2-W23-9	17.80	17.80	17.80	1	0
Uranium	2-W26-3	1.08	1.08	1.08	1	0
Uranium	2-W26-6	1.43	1.43	1.43	1	0
Uranium	2-W27-1	5.55	5.55	5.55	1	0
Uranium	2-W6-2	1.50	.83	1.11	6	0
Uranium	2-W7-1	.62	.45	.51	6	0
Uranium	2-W7-2	.90	.56	.72	6	0

Constituent	Well	Max of Result	Min of Result	Average of Result	Count of Result	Count of LT
Uranium	2-W7-3	1.52	.68	.99	7	0
Uranium	2-W7-4	1.61	1.02	1.38	7	0
Uranium	2-W7-5	3.45	.91	1.46	6	0
Uranium	2-W7-6	10.10	1.86	5.89	6	1
Uranium	2-W7-7	.74	.64	.69	2	0
Uranium	2-W7-8	1.05	.77	.91	2	0
Uranium	2-W7-9	1.60	.78	1.19	2	0
Uranium	2-W8-1	1.44	.57	.80	6	0
Uranium	2-W9-1	1.08	.62	.90	5	0
Uranium	6-32-70B	3.25	1.08	1.65	6	0
Uranium	6-32-72	.42	.06	.30	5	1
Uranium	6-35-66	2.39	1.84	2.10	6	0
Uranium	6-35-70	3.95	1.75	2.54	7	0
Uranium	6-36-61A	1.26	1.26	1.26	1	0
Uranium	6-38-65	2.18	1.46	1.71	5	0
Uranium	6-44-64	.96	.96	.96	1	0
Uranium	6-45-69A	.69	.69	.69	1	0
Uranium	6-47-60	2.28	1.44	1.88	6	0

J. S. Schmid	H4-56	X
K. M. Singleton	H4-56	X
J. C. Sonnichson	H4-14	X
G. D. Spice	H4-56	X
L. C. Swanson	H5-29	X
K. M. Thompson	A5-15	X
P. D. Thorne	K6-96	X
S. J. Trent	H4-56	X (4)
D. K. Tyler	H5-29	X
D. C. Weekes	H5-29	X
B. A. Williams	H4-56	X
C. D. Wittreich	H4-55	X (4)
M. I. Wood	N3-13	X
Central Files	L8-04	X(2)
IRM Clearance	H4-17	X
EDMC	H4-22	X (2)

9413136.2134

DISTRIBUTION SHEET

To: DISTRIBUTION

From: Geosciences Group

Date: April 6, 1992

Project Title/Work Order:

Hydrogeologic Model for the 200 West Groundwater Aggregate Area

EDT No.: 157784

ECN No.:

Name	MSIN	With Attachment	EDT/ECN & Comment	EDT/ECN Only
D. B. Barnett	H4-56	X		
B. N. Bjornstad	K6-96	X		
J. V. Borghese	H4-56	X (2)		
R. W. Bryce	K6-96	X		
J. A. Caggiano	H5-29	X		
M. A. Chamness	K6-96	X		
R. A. Carlson	H4-55	X		
M. P. Connelly	H4-56	X (4)		
C. D. Delaney	H4-56	X		
D. B. Erb	H4-55	X		
K. R. Fecht	H4-56	X		
B. H. Ford	H5-29	X (2)		
M. J. Galgoul	H4-55	X		
E. D. Goller	A5-19	X		
M. C. Hagood	H4-55	X		
A. C. Harris	A5-19	X		
F. N. Hodges	H5-29	X		
D. G. Horton	H4-56	X		
R. L. Jackson	H4-56	X		
V. G. Johnson	H5-29	X		
W. L. Johnson	H4-55	X		
G. L. Kasza	H5-29	X		
R. Khaleel	H4-14	X		
A. J. Knepp	H4-56	X		
G. V. Last	K6-96	X		
A. G. Law	H4-56	X		
J. W. Lindberg	H4-56	X		
K. A. Lindsey	H4-56	X		
W. J. McMahon	H4-56	X		
R. B. Mercer	H4-56	X		
D. R. Newcomer	K6-96	X		
P. M. Pak	A5-19	X		
S. P. Reidel	H5-29	X		
K. D. Reynolds	H5-29	X		
V. J. Rohay	H4-56	X		

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INFORMATION RELEASE REQUEST

References: WHC-CM-3-4

COMPLETE FOR ALL TYPES OF RELEASE

Purpose

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- [] Visual Aid

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[X] Technical Report
[] Thesis or Dissertation
[] Manual
[] Brochure/Flier
[] Software/Database
[] Controlled Database
[] Other

New ID Number: WHC-SD-EN-TI-014, REV. 0

Existing ID Number (include revision, volume, etc.):

If previously cleared, list ID number:

Date Release Required: 2/07/92

Title: HYDROGEOLOGIC MODEL FOR THE 200 WEST GROUNDWATER AGGREGATE AREA

Unclassified Category: UC-

Impact Level: 4

COMPLETE FOR SPEECH OR PRESENTATION

Title of Journal: N/A

Group or Society Sponsoring: N/A

Date(s) of Conference or Meeting: N/A

City/State: N/A

Will proceedings be published? [] Yes [X] No

Will material be handed out? [] Yes [X] No

Title of Conference or Meeting: N/A

CHECKLIST FOR SIGNATORIES

Review Required per WHC-CM-3-4	Yes	No	Reviewer Name (printed)	Signature	Date
Classification/Unclassified Controlled Nuclear Information	[]	[X]			
Patent - General Counsel	[X]	[]	~~B. D. WILLIAMSON~~		2/3/92
Legal - General Counsel	[X]	[]	~~B. D. WILLIAMSON~~		2/3/92
Applied Technology/Export Controlled Information or International Program	[]	[X]			
WHC Program	[]	[]			
Communications	[]	[X]			
DOE-RL Program	[]	[X]			
Publication Services	[X]	[]	D. E. SMITH	S. Hermann for D.E.S.	6/5/92
Other Program	[]	[X]			
References Available to Intended Audience	[X]	[]	J. STONE	J. Stone	6/5/92
Transmit to DOE-HQ/Office of Scientific and Technical Information	[]	[X]			

Information conforms to all applicable requirements. The above information is certified to be correct.

Author/Requestor (Printed/Signature): S. J. TRENT — Date: 1/31/92

Responsible Manager (Printed/Signature): R. A. CARLSON for RAC — Date: 1/31/92

Intended Audience: [] Internal [] Sponsor [X] External

INFORMATION RELEASE ADMINISTRATION APPROVAL STAMP

Stamp is required before release. Release is contingent upon resolution of mandatory comments.

APPROVED FOR RELEASE — OFFICIAL DOCUMENT — NS — 6/5/92

Date Received: 2/3/92 JJG

1 JUN 1992 RECEIVED EDMC

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'on Release Request

Part 1

9413136.2136