TIM MORLEY

APPENDIX A OF GROUNDWATER TECHNICAL REPORT

Hydrogeology Technical Memorandum Midway Landfill Remedial Investigation

---

Seattle Engineering Department
Solid Waste Utility

June 1988

A report prepared for

Parametrix, Inc.
13020 Northup Way, Suite 8
Bellevue, Washington 98004

HYDROGEOLOGY TECHNICAL MEMORANDUM
APPENDIX A FOR THE GROUNDWATER TECHNICAL REPORT
MIDWAY LANDFILL REMEDIAL INVESTIGATION
KENT, WASHINGTON

AGI Project No. 14,169.106

by

Peter Feldman /M.S.

Peter Feldman
Hydrogeologist

Mark A. Adams

Mark A. Adams
Senior Hydrogeologist

Mackey Smith
Principal Hydrogeologist

APPLIED GEOTECHNOLOGY INC.
300 120th Avenue N.E., Building 4, Suite 215
Post Office Box 3885
Bellevue, Washington 98009
206/453-8383

and

2501 East "D" Street, Suite 215
Tacoma, Washington 98421
206/383-4380

June 1988

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES

LIST OF FIGURES
(Continued)

LIST OF TABLES

1.0 INTRODUCTION

1.1 General

This report presents the results of our hydrogeologic investigation undertaken as part of the Midway Landfill Remedial Investigation (RI). The Midway Landfill, an EPA National Priorities List site formerly operated by the City of Seattle, is located in Kent, Washington.

1.2 Nature of Problem

The Midway Landfill was established in 1966 as a disposal site for demolition debris and non-putrescible waste. Non-putrescible waste was intended to include wood and yard waste, but not household garbage. In the early 1980's, there were reports of industrial waste being dumped in the Landfill. In addition, a black foul-smelling liquid was observed to periodically form in a depression located at the south end of the Landfill (South Pond). Based on these reports and observations, EPA concluded hazardous materials had possibly been placed in the Landfill, creating a potential threat to human health and the environment. The Landfill was therefore placed on the EPA National Priorities List and a full-scale Remedial Investigation/Feasibility Study (RI/FS) was required. A comprehensive hydrogeologic investigation is necessary as part of the RI/FS to define groundwater flow conditions and leachate migration pathways, and to evaluate the extent to which leachate may have contaminated groundwater.

1.3 Purpose

The purpose of the RI is to characterize site conditions and contamination through data collection and analysis to support remedial alternatives developed in the ensuing FS. Both the RI and FS are required under the National Contingency Plan for complete evaluation of a National Priorities List site.

The purpose of our hydrogeologic investigation is to characterize groundwater conditions beneath the Landfill, specifically groundwater occurrence and movement. Groundwater quality and contaminant transport are being addressed by Parametrix, Inc. in a companion study. Parametrix is also identifying potential groundwater receptors, including local public and private water supply wells. Information developed from these investigations will be used to evaluate potential risks to human health and the environment resulting from contaminated groundwater.

1.4 Objectives

The technical objective of the hydrogeologic investigation is described in the RI Project Work Plan as follows, "define subsurface stratigraphy and geohydrology at the Midway Landfill site and surrounding areas." Specifically, this includes the following:

- Design and install a groundwater monitoring system including monitor wells and dedicated sampling pumps capable of yielding representative groundwater quality samples.
- Design and install two production wells within the Landfill to be used for either leachate extraction or monitoring.
- Characterize the hydrogeology beneath the Landfill and adjoining areas including aquifer/aquitard identification and geometry, recharge/discharge relationships, and groundwater flow directions and velocities.
- Evaluate the hydraulic and contaminant transport properties of identified aquifers and aquitards.

1.5 Scope and Authorization

All activities for the hydrogeologic investigation were accomplished under a Subconsultant Agreement between Parametrix, Inc. and Applied Geotechnology Inc. (AGI). The scope of work described in the agreement was essentially the same as the work requirements defined under:

- Tasks 2.1, Groundwater Monitor Well Installation, and Task 2.2, Leachate Well Installation in the Final Project Work Plan for Remedial Investigation, Midway Landfill, July 1986.
- Tasks 2.1.1, Subsurface Stratigraphy; 2.2.1, Leachate Characterization; and 2.2.2, Groundwater Hydrology and Characterization (except 2.2.2.3 A, D, E) in the Final Remedial Investigation Sampling and Analysis Plan for Midway Landfill, July 1986.

Our services for this investigation were limited to monitor well design and installation, and an assessment of groundwater hydrology. Monitor well sampling and groundwater quality evaluation were performed by Parametrix. Numerous scope modifications were made during the investigation. All modifications are documented in writing between AGI and Parametrix, Inc.

For the purposes of this report and investigation, the Midway Landfill is considered to be part of a larger "Study Area" encompassing the area in which groundwater monitor wells have been installed.

2.0 BACKGROUND

2.1 Landfill Location and General Description

The Midway Landfill is located approximately 15 miles south of Seattle near the crest of a narrow north-south trending upland known as the Des Moines Drift Plain. The upland is bordered by Puget Sound on the west and by the Green River Valley on the east, as shown on the Vicinity Map, Figure 1. Maximum elevations along the crest of the upland generally range between 400 and 450 feet above Mean Sea Level. Puget Sound is at Sea Level, and the Green River Valley floor is close to Sea Level, typically averaging about Elevation 30 feet.

The upland is incised with a number of steep-sided stream valleys. One unnamed stream is located northwest of the Landfill, and two other streams, the North and South Forks of Smith Creek, are located to the west and southwest, as shown on Figure 2. In addition to these major streams, there are numerous springs and seeps which discharge to the west towards Puget Sound and to the east towards the Green River Valley (Waldron, 1961 and 1962; Parametrix, August 1987).

There are no major surface water bodies in the immediate vicinity of the Midway Landfill. The closest are Lake Fenwick, located approximately one mile to the southeast, and Star Lake, located approximately one and one-half miles to the south (see Figure 2).

The Midway Landfill occupies a shallow bowl-shaped depression open to the west near the crest of the upland. The land surface generally slopes from the Landfill upward to the north, south, and east. To the west, the land surface is nearly flat across Highway 99, and then drops steeply downwards approximately 100 feet to the nearly flat-lying Parkside Wetland shown on Figure 2.

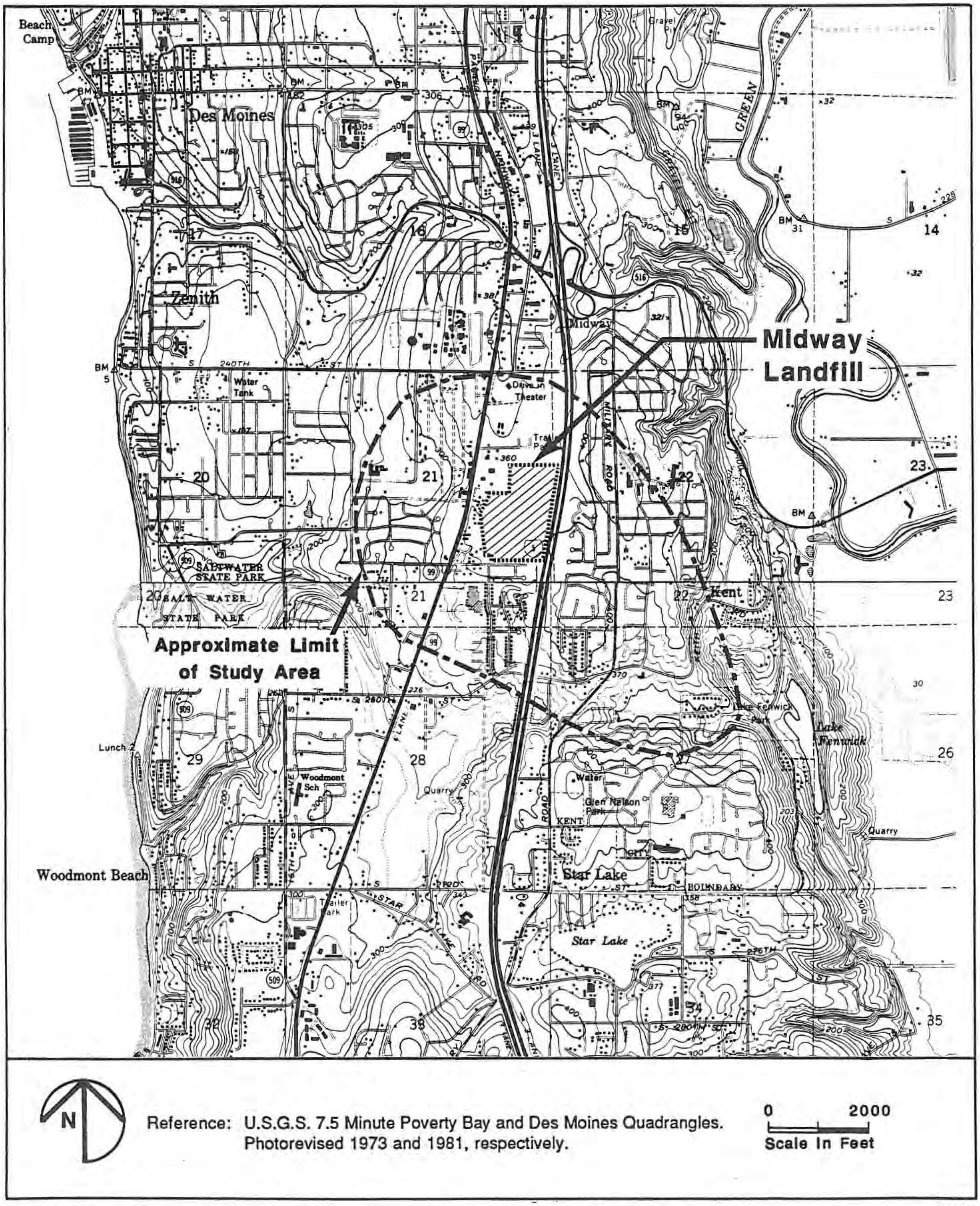
The Parkside Wetland is a peat bog. Standing water was likely historically present in the bog throughout the year. The Wetland is now drained by a ditch which discharges to a catch basin west of the Wetland near the Parkside School. Surface water entering the catch basin ultimately drains to the North Fork of the Smith River. Even with this drain, however, standing water is present in many areas of the Wetland during the winter months.

Land surface elevations in the Wetland generally range between 250 and 256 feet, with the highest elevations along the north, south, and eastern edges of the wetland. The bog surface generally slopes inwards to the center of the Wetland and towards the west, parallel to the drainage ditch.

The Midway Landfill comprises approximately 60 acres and is located between Highway 99 (Pacific Highway South) and Interstate 5 (I-5), as shown on the Landfill Site Plan, Figure 3. South 252nd Street bounds the Landfill on the south. The I-5/Highway 516 intersection is located about .7 miles north of the Landfill. Residential areas directly border the Landfill across both South 252nd Street and I-5. The area east of I-5 is known as Linda Heights. Commercial businesses line Highway 99 along the western border of the Landfill. A mobile home park extends across most of the northern border of the Landfill.

The upper surface of the Landfill generally ranges between Elevation 360 and 400, and is higher than adjoining land areas to the north and east. To the east, the fill slope ranges between 10 and 15 feet high and borders the south bound lanes of I-5. Fill slopes along the northern border of the Landfill are similar in height. In the southern portion of the Landfill, adjoining land areas are typically higher so that edge of the fill is marked by a cut bank 5 to 10 feet high.

Several shallow "ponds" are located along the perimeter of the Landfill, as shown on Figure 3. One is known as the North Pond and the other as the Middle Pond. Both receive surface water runoff from the Landfill and from other areas, and are generally dry during the summer (Parametrix, August 1987). Neither pond has an outlet.



Reference: U.S.G.S. 7.5 Minute Poverty Bay and Des Moines Quadrangles. Photorevised 1973 and 1981, respectively.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Vicinity Map

Midway Landfill
Kent, Washington

FIGURE
1

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	SM	MAA	30 November 87		

LEGEND

Outline of swampy area

Lake

Perennial creek or river

Seasonal creek or river

Ditch

255 Approximate elevation (feet) of surface water body, swamp, or spring

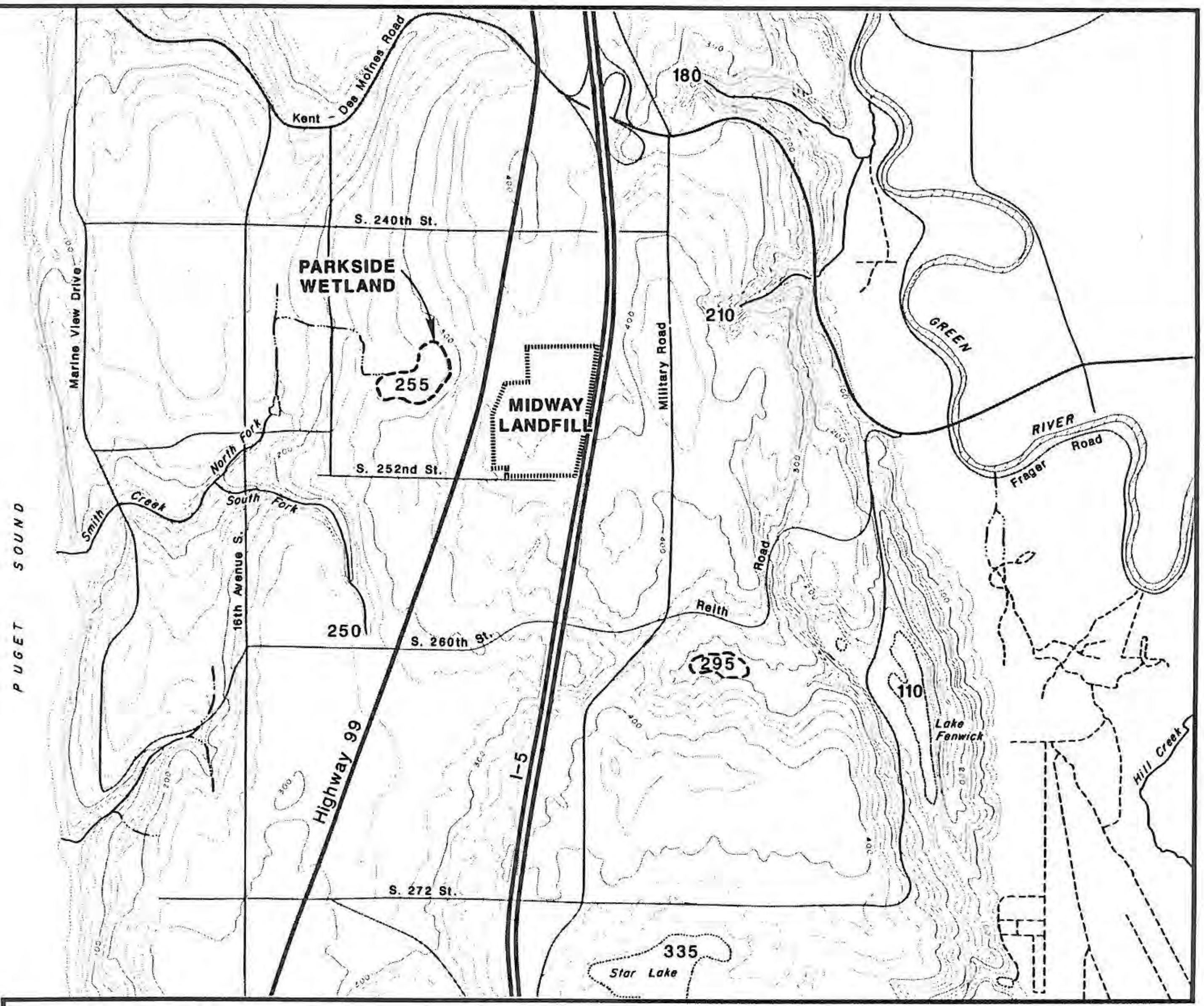
REFERENCE

Location and elevation of map features obtained from:

- Waldron, 1961, Geology of Poverty Bay Quadrangle
- Waldron, 1962, Geology of the Des Moines Quadrangle
- USGS, Photorevised 1973, Poverty Bay 7.5 Minute Quadrangle
- USGS, photorevised 1981, Des Moines 7.5 Minute Quadrangle

BASE MAP

USGS maps referred to above



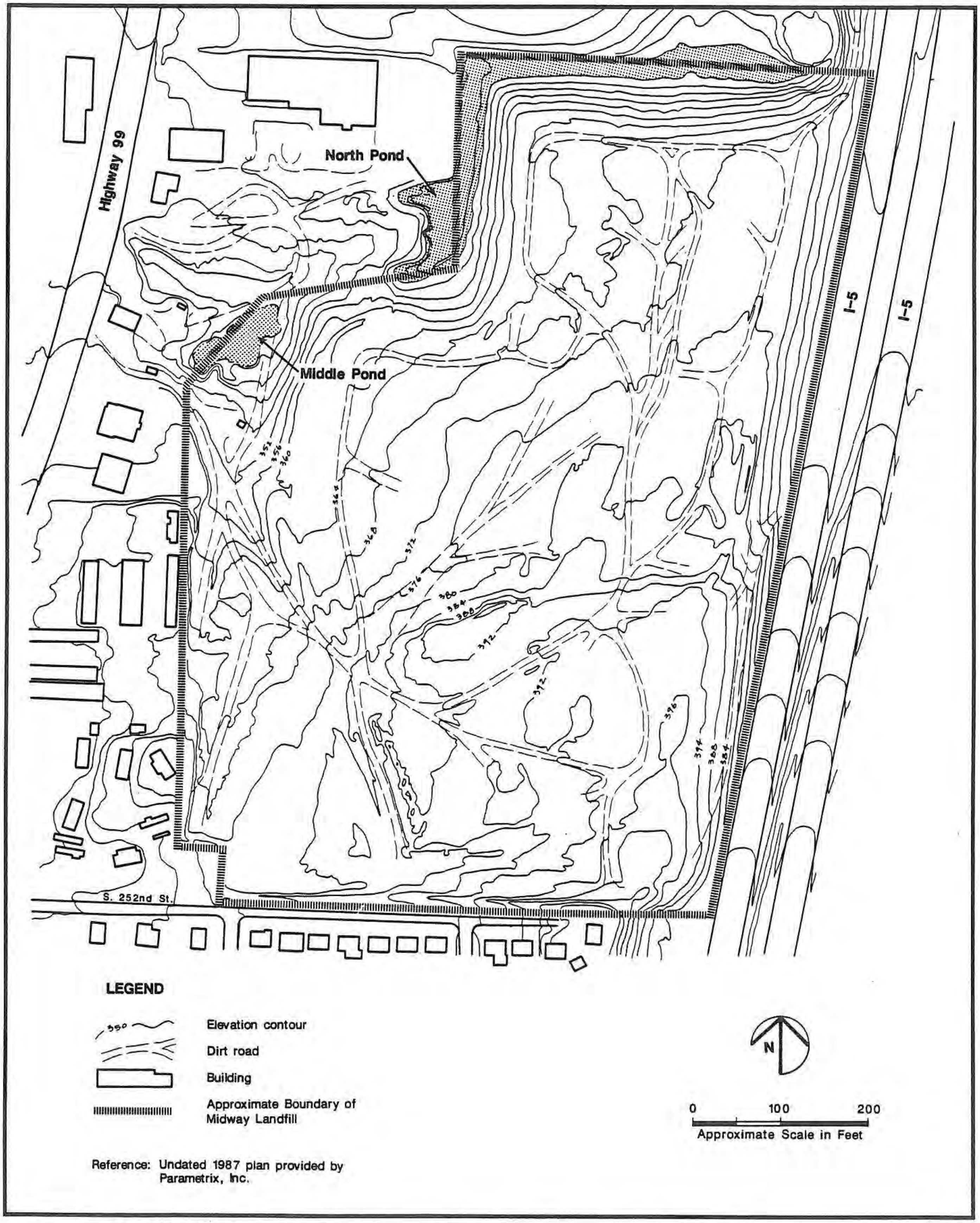
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Regional Topographic & Drainage Map

Midway Landfill
Kent, Washington

FIGURE
2

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB	MAA	2 February 88		



Reference: Undated 1987 plan provided by Parametrix, Inc.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Midway Landfill Site Plan

Midway Landfill
Kent, Washington

FIGURE
3

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB	MAA	14 January 87		

2.2 Landfill History

The Midway Landfill is located in an abandoned gravel pit begun by the Meade Sand and Gravel Company in about 1943 (Larsen, 1987). Why mining operations began at this location is not clear, although there may have been some sand and gravel exposed on the sides of a topographic depression originally located in the northern half of the Landfill property. This depression is thought to have contained a small peat bog and was likely a kettle formed by melting glacial ice.

The Washington State Department of Transportation (WDOT) began condemnation studies for the I-5 right-of-way in about 1959. A topographic map of the gravel pit prepared for these studies (WDOT, 1959) shows that a small area around the southern end of the peat bog had been mined and that the southern half of the pit had been mined down to about Elevation 275 feet. A ridge of generally higher ground divided the northern and southern halves of the gravel pit. Figure 4 is a reproduction of the 1959 WDOT topographic map, and Figure 5 is a photograph of the gravel pit in 1959.

Water typically ponded in the northern portion of the gravel pit in the topographic depression described above and became known as "Lake Meade". Lake Meade, though not present year-round, was often used as a settling pond for sand and gravel wash water. Consequently, several feet of silt and clay accumulated on the pond bottom. Another settling pond is shown on Figure 4 near the west central portion of the gravel pit, and there may have been additional settling ponds as the area of active mining moved around the gravel pit.

The 1959 topographic map also indicates that a portion of the pit extended eastward into the I-5 corridor. This rectangular area was approximately 200 feet wide and had been mined to about Elevation 275 feet, or 75 to 100 feet below original ground surface. This excavation was filled during freeway construction, as was the low area immediately east of Lake Meade. The fill material was reportedly obtained from cuts along the I-5 alignment (Larsen, 1987).

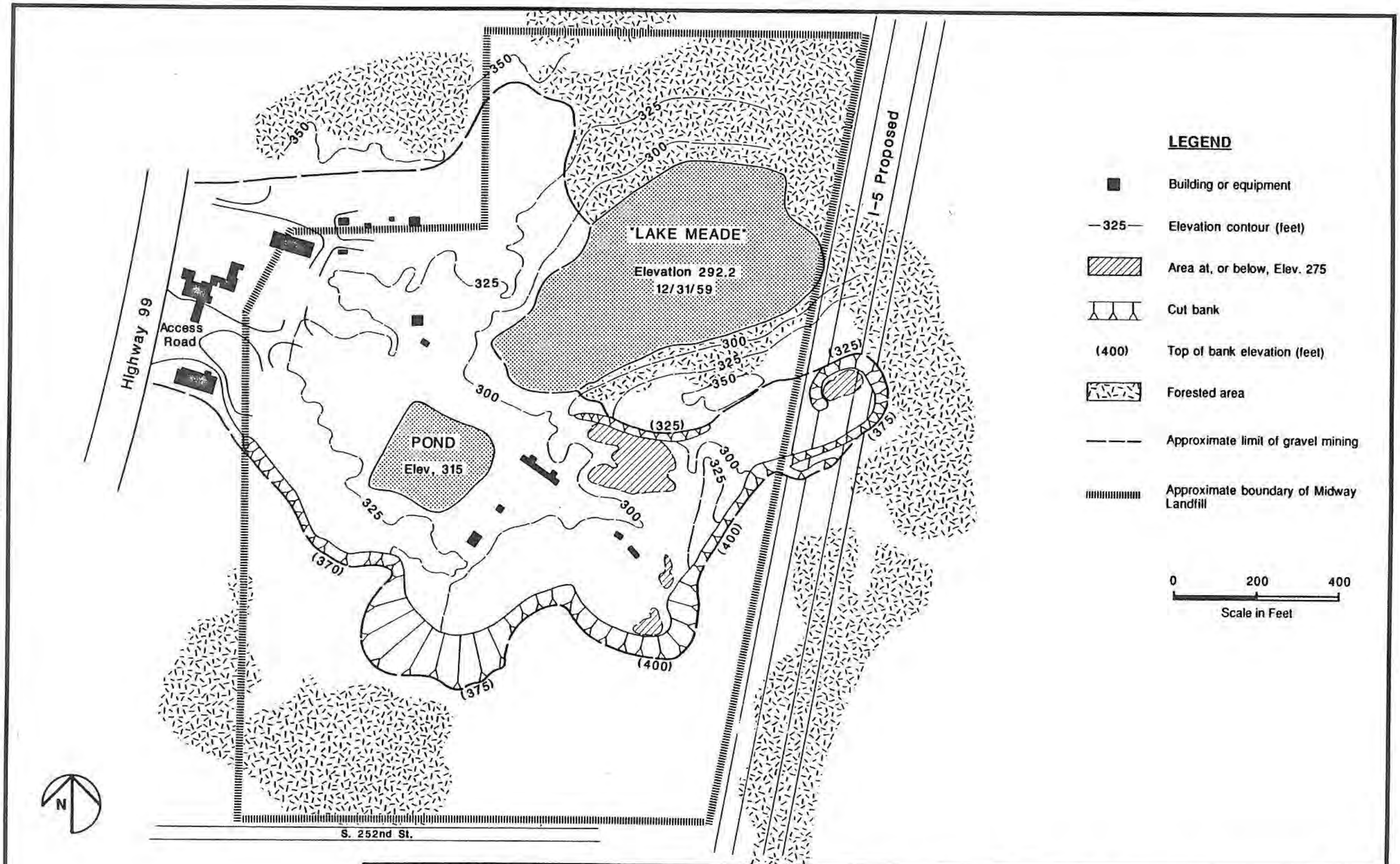
Local storm water drainage was rerouted to discharge directly into the gravel pit during highway construction. Runoff from approximately 102 acres of land east of the interstate (Parametrix, August 1987) was routed to a depression near Linda Heights Park and from there through a culvert beneath I-5 to the gravel pit. Drainage plans from 1963 (WDOT, 1963) show proposed Linda Heights storm water discharge networks in both the Lake Meade area and in the southern portion of the gravel pit. We believe it unlikely that the southern drain line was ever installed since mining continued in the southern portion of the pit after the freeway was completed. The northern distribution network may have been built although there is conflicting evidence in this regard. According to an undated memorandum in the City of Seattle's Midway field office, there were originally only two drainage pipes into the gravel pit from I-5 (one likely from Linda Heights and the other from the I-5 corridor). As landfilling progressed, french drains were installed in the fill to accommodate the storm water influx. In contrast, Larsen (1987) recalls that a "40-foot high" diffusion tower was built to accommodate the stormwater distribution into the fill.

Surface runoff from areas west of I-5 and along the I-5 corridor itself was also apparently rerouted and directed towards Lake Meade. The 1963 plans referenced above show a series of catch basins along the western edge of I-5 discharging to one series of drains in the southern part of the gravel pit and another series in Lake Meade. It is unlikely a southern drain was ever installed for the same reasons as discussed above.

The gravel pit continued to operate following freeway construction with mining restricted to the western and southern portions of the pit. The base of the gravel pit apparently never reached groundwater; however, the pit was subject to flooding from stormwater runoff. Lake Meade continued to be used as a settling pond and a dike was constructed across the southern end of the pond to prevent flooding in active mining areas. The dike was reportedly 10 to 13 feet high and had 3 to 4 feet of freeboard during mining operations (Larsen, 1987). Heavy rainfall and associated runoff broke the dike on two occasions, flooding the lower areas.

After the second dike breeching, the gravel pit owners decided to cease mining operations and subsequently arranged to lease the pit to the City of Seattle for landfilling purposes. The City of Seattle began operation of the Midway Landfill in January 1966 (Parametrix Inc., August 1985). The Landfill originally operated as a demolition and non-putrescible waste site, receiving demolition waste from commercial haulers and non-putrescible waste from the City's transfer stations (Parametrix Inc., August 1985). However, City of Seattle records indicate various industrial wastes were dumped in the Landfill with the approval of the King County Health Department. Some putrescible waste may also have been placed in the Landfill from City transfer stations; however, there are no records of putrescible waste disposal at Midway Landfill.

The landfilling operations began in the northern portion of the sand and gravel pit and moved to the south. Landfilling operations were essentially closed on October 1, 1983, although clean soils were still accepted as fill (Parametrix Inc., August 1985). Since 1983, there has been substantial clean fill placement and regrading. A pond which existed in the southwestern part of the Landfill ("South Pond") was filled in late 1986. This pond apparently was present throughout the year, although it would grow substantially during storms. Stagnant water in this pond often became dark brown or black and developed a very strong organic odor. This appearance and odor problem did not occur to any appreciable extent in the Middle and North Ponds.



Reference: 1959 Topographic map of gravel pit titled, "State vs. Romano, et al. Primary State Highway No. 1".

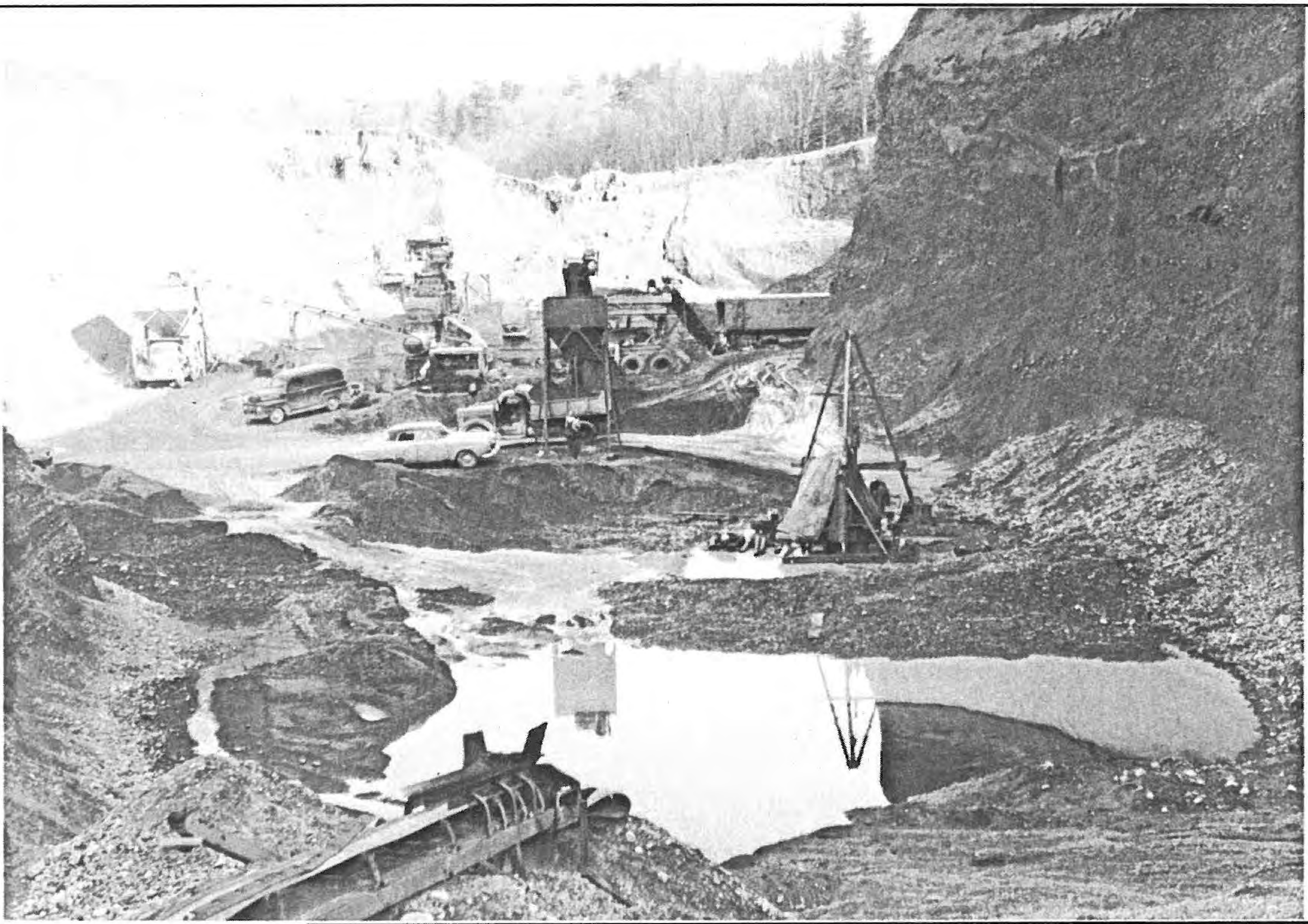
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

1959 Gravel Pit Configuration

Midway Landfill
Kent, Washington

FIGURE
4

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	CF	MAA	1 December 87		



Looking North from near middle of gravel pit.

Reference:
WSDOT Photo Archives.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Gravel Pit Operations in 1959

Midway Landfill
Kent, Washington

FIGURE
5

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB	MAA	1 December 87		

2.3 Previous Hydrogeologic Investigations

The earliest geologic investigation of the gravel pit was conducted by Boyd in 1959, as part of WDOT's I-5 land condemnation procedure. This investigation concentrated primarily on gravel reserve estimation, and included geologic mapping and exploratory borings. Geologic logs from the borings, as well as Boyd's geologic map, are available from WDOT. Boyd also took a number of gravel pit photographs, two of which are reproduced in this report.

In 1982, Golder Associates undertook the earliest hydrogeologic investigation of the Landfill. Eleven borings were drilled for this investigation; groundwater monitor wells were installed in eight of the borings (Wells BH-1B through BH-8), and it appears piezometers were installed in two borings. Most of the borings were relatively shallow (less than 150 feet in depth) and were drilled in and immediately adjacent to the Landfill. Groundwater samples were collected from all wells (except BH-3) and slug tests were conducted in selected wells. The groundwater samples were only analyzed for indicator parameters such as conductivity and pH. Consequently, no information was developed concerning specific contaminants in leachate or groundwater. The shallow wells also precluded characterization of the uppermost aquifer. Results of the investigation were summarized in a report prepared for the City of Seattle (Golder, 1982).

Golder Associates installed four additional groundwater monitor wells and fourteen gas probes in 1985. The monitor wells were numbered MW-1 through MW-4 to distinguish them from the wells installed during 1982. These wells were also relatively shallow, and were sampled for chemical analysis. Results of the investigation, which provided little additional hydrogeologic information, were summarized in the Draft EIS for closure of the Midway Landfill (Golder, 1985).

After completing their report, Golder drilled two additional wells (MW-5 and MW-6) in 1985. MW-6 was installed northeast of Lake Fenwick, and MW-5 was drilled west of Highway 99 between the Landfill and the South Fork of Smith Creek. At the conclusion of the 1982 and 1985 investigations, the uppermost aquifer beneath the Landfill was not fully penetrated or defined, nor were flow directions or hydraulic gradients defined within the aquifer.

3.0 HYDROGEOLOGIC INVESTIGATION SUMMARY

3.1 General

The purpose and general scope of our hydrogeologic investigation is described in Section 1. Specific elements of our scope of work are described below.

3.2 Existing Data Compilation and Review

A comprehensive compilation and review of existing information concerning geologic and hydrologic conditions at the Landfill, and the history of mining operations and Landfill development was conducted. Included in the review were geologic and topographic maps of the area and historical aerial photography from 1965, 1976, and 1978. People associated with the gravel mining operations were also interviewed and historical gravel pit maps were obtained from WDOT. Background information sources and documents are referenced in the text of this report where appropriate and listed in Section 7.0, References.

3.3 Monitor Well Installation

Forty-seven (47) monitor wells ranging from 20 to 377 feet deep, and 10 gas probes ranging from 72 to 220 feet deep, were installed in 23 drilled borings. The borings were designated MW-7 to MW-29 and individual well completions within borings were designated as A, B, or C, with A being the shallowest completion and C the deepest. The borings ranged from 101 to 395 feet deep, and were drilled using cable tool methods. Steel casing lined each borehole during drilling, and was then withdrawn as monitor wells were constructed, except for wells installed in the Landfill. Well locations are shown on Figure 6.

Three additional shallow groundwater monitor wells were installed in the Parkside Wetland. These wells, designated DP-1 to DP-3, were installed by driving stainless steel well points to a depth of approximately 6 feet. A complete description of well drilling and installation methodology is provided in Appendix A.

A careful record was maintained of geologic and groundwater conditions encountered in each boring. In addition, gas concentration and water quality measurements were obtained at intervals as the drilling proceeded. Gas parameters included hydrogen sulphide (ppm H_2S), percent oxygen (%O_2), and percent Lower Explosive Limit (% LEL). Water quality parameters included pH, conductivity, and occasionally, temperature.

Figure 6 shows the location of all groundwater monitor wells installed during this investigation, plus those installed in 1982 and 1985. Table 1 summarizes well installation data, and Table 2 provides depth and elevation specifications for all monitor wells installed in the Study Area. A larger scale map of the Study Area (Plate I) with monitor well locations is included in the back pocket. Detailed geologic logs and summary logs of all wells are included in Appendix B. The Summary Logs include well construction details, groundwater observations, a schematic geologic log, and field water quality and gas concentration measurements.

3.4 Single Borehole Slug Tests

Slug injection and recovery tests were performed in most wells following development. The slug test methodology and results are summarized in Appendix E.

3.5 Leachate Extraction Wells

Two 6-inch diameter leachate wells were installed, one in the northern and one in the southern portion of the Landfill. These wells, designated LW-1 and LW-2, were designed as extraction wells in case future remedial actions involved leachate removal. The well locations are shown on Figure 6 and Plate I. Summary Logs and detailed logs are provided in Appendix B.

3.6 Leachate Well Testing

Step drawdown pumping tests were conducted in both leachate wells to evaluate the landfill waste hydraulic characteristics, and well capacity and performance. Results of the pumping tests are summarized in Appendix E.

3.7 Physical Properties Testing

A comprehensive laboratory testing program was undertaken to evaluate the physical properties of soil samples recovered during drilling. These properties include moisture, density, porosity, specific gravity, grain size distribution, and hydraulic conductivity (permeability). The grain size and permeability testing was performed to supplement data obtained from the slug tests, and the specific gravity and porosity determinations were made to assist in calculating groundwater flow velocity. Results of the laboratory testing program are included in Appendix C.

3.8 Water Level Monitoring

The City of Seattle or their subcontractors have been monitoring groundwater elevations at the Landfill in the BH series wells since 1983, and in Wells MW-1B through 7 since 1985. Beginning in late 1986 with AGI's first well installation (MW-7), the City began adding each new AGI well to the monitoring program as the well was completed. In addition to this data, AGI personnel completed several separate water level monitoring rounds during the early part of 1987.

The water level data has been compiled and is included as two separate tables in Appendix D. Table D1 includes water elevation records for Wells BH-2A through BH-8 and MW-1 through MW-5 from 1984 to the present. Records from BH-1B and MW-3 are excluded because they have always been dry. Data collected prior to 1984 has been excluded as being incomplete. Table D2 includes water elevation records from all wells (including BH-1B and MW-3) from August 1986 to the present.

In addition to the City of Seattle water level monitoring, one complete round of water level measurements was made by Parametrix Inc. on February 18 and 20, 1987 in all gas probes, gas wells, and groundwater monitor wells completed in (or immediately adjacent to) the Landfill. Water level records from these dates are summarized in Table D3.

3.9 Parkside Wetland Investigation

A specific supplementary investigation was developed for the Parkside Wetland because of its close proximity to the Landfill, and because of pronounced public sensitivity to potential contamination in this area.

As part of this investigation, three shallow groundwater monitor wells (DP wells) were installed, as described previously, to evaluate water elevations in the Wetland versus those in the underlying and adjoining aquifers. Peat probes were also conducted at 19 locations to determine peat thickness and to evaluate the potential for holes or windows in the peat deposit. In addition, detailed geologic mapping was attempted in the area to determine if the geologic deposits encountered in borings near the Landfill extended to the Wetland. Most of the work for this supplemental investigation was accomplished in early October, 1987.

Table 1
Groundwater Monitor and Leachate Extraction Well Installation Data

1) Well Number	Completion Date	Boring Depth (feet)	Drill Method	No. of Well Completions	2) Gas Probes	3) Dedicated Pumps	Casing Type	4) Casing Diam. (inch)	Comments
BH-1B	27-Jan-82	104	mud rotary	1	no	no	pvc	4	Blocked at 18 feet.
BH-2	02-Feb-82	120	air/mud	2	no	no	pvc	2	
BH-3	19-Jan-82	115	auger	1	no	no	pvc	2	
BH-4	20-Jan-82	81	auger	1	no	no	pvc	2	
BH-5	21-Jan-82	88	auger	1	no	no	pvc	2	Water level in well constant since installation.
BH-6	10-Feb-82	139	air rotary	1	no	no	pvc	4	Dry after May 1986.
BH-7	15-Feb-82	137	auger	1	no	no	pvc	2	Dry after September 1986 due likely to blockage.
BH-8	11-Feb-82	111	air rotary	1	no	no	pvc	4	
MW-1	25-Mar-85	126	air rotary	1	no	no	pvc	4	
MW-2	29-Apr-85	155	air rotary	1	no	no	pvc	4	
MW-3	05-Mar-85	187	air rotary	1	no	no	pvc	4	Has always been dry.
MW-4	28-Jan-85	145	air rotary	1	no	no	pvc	4	
MW-5	18-Jun-85	85	air rotary	1	no	no	pvc	4	
MW-6	21-Jun-85	138	air rotary	1	no	no	pvc	4	Screen rupture at 117 feet repaired.
MW-7	22-Oct-86	265	cable tool	2	no	yes	pvc	2	0.5-inch water level probe installed.
MW-8	27-Feb-87	231	cable tool	2	1	yes	pvc	2	
MW-9	06-Jan-87	176	cable tool	2	no	yes	pvc	2	
MW-10	14-Nov-86	245	cable tool	2	1	yes	pvc	2	10A repaired with washdown screen,low yielding.
MW-11	02-Feb-87	279	cable tool	2	no	yes	pvc	2	Developed with air.
MW-12	13-Jan-87	266	cable tool	2	no	yes	pvc	2	
MW-13	30-Oct-86	231	cable tool	2	no	yes	pvc	2	Static water level near top of screen for 13A.
MW-14	17-Mar-87	335	cable tool	2	1	yes	pvc	2	
MW-15	04-Dec-86	300	cable tool	2	1	yes	pvc	2	
MW-16	06-Feb-87	194	cable tool	1	no	yes	pvc	2	
MW-17	09-Dec-86	145	cable tool	2	no	yes	pvc	2	17A repaired with washdown screen, low yielding.
MW-18	21-Apr-87	315	cable tool	2	no	yes	pvc	2	Developed with air.
MW-19	27-Mar-87	311	cable tool	3	no	yes	ss	2	19B and 19C partially blocked at about 53 feet, 1.4 inch O.D. narrow pump installed in 19C.
MW-20	10-Jun-87	325	cable tool	2	1	yes	pvc	2	20A screen is damaged needs repair.
MW-21	04-Jun-87	301	cable tool	3	1	yes	pvc	2	21A turbid when sampled.
MW-22	28-May-87	340	cable tool	2	no	yes	ss	2	
MW-23	12-May-87	390	cable tool	2	1	yes	pvc	2	
MW-24	19-May-87	375	cable tool	2	1	yes	pvc	2	
MW-25	23-Jun-87	101	cable tool	3	no	yes	pvc	2 & 0.5	25B is a 0.5-inch diam. water level probe.
MW-26	02-Apr-87	150	cable tool	1	no	yes	pvc	2	
MW-27	03-Aug-87	290	cable tool	3	1	yes	pvc	2	
MW-28	11-Jun-87	146	cable tool	1	no	yes	pvc	2	
MW-29	22-Jul-87	395	cable tool	2	1	yes	pvc	2	
LW-1	16-Feb-87	173	cable tool	1	no	no	ms	6	Designed as leachate extraction well.
LW-2	19-Feb-87	120	cable tool	1	no	no	ms	6	Designed as leachate extraction well.
DP-1	15-Oct-87	6	hand drive	1	no	no	ss	2	In Parkside wetland.
DP-2	15-Oct-87	6	hand drive	1	no	no	ss	2	In Parkside wetland.
DP-3	15-Oct-87	6	hand drive	1	no	no	ss	2	In Parkside wetland.

Notes:
1. BH-1 to MW-6 installed by Golder Inc., MW-7 to DP-3 installed by Applied Geotechnology Inc.
2. Gas probes are 0.5-inch diameter PVC.
3. Dedicated pumps are 1.8-inch O.D. Bennett air-actuated piston pumps. Pumps generally set 2 feet above top of screen except wells MW-13A, MW-23A, and MW-24A where pumps are set 1 foot below top of screen. In general, wells < 300 ft. deep have model 188, 1-inch piston pumps. Wells > 300 ft. have model 187, 7/8-inch piston pumps. The 7/8-inch diameter piston pumps are installed in wells: MW-14B, MW-21C, MW-22B, MW-24B, MW-29B, MW-20B, MW-23B.
4. Casing: ss = stainless steel, ms = mild steel, pvc = schedule 40 or 80.

Table 2
Groundwater Monitor and Leachate Extraction Well Depth and Elevation Specifications

Monitor Well Number	Land Surface Elevation	Meas. Point Elevation	Total Boring Depth	Bottom Hole Elevation	Screened Zone "A"			Screened Zone "B"		
					Depth	Elevation	HSU*	Depth	Elevation	HSU*
BH-1B	341.9	344.70	104	237.9	91.3 - 93.3	250.6 - 248.6	UGA	-	-	
BH-2A	374.40	376.91	120	254.4	21.5 - 23.5	352.9 - 350.9	GU	-	-	
BH-2B	374.40	377.18	120	254.4	-	-		47.5 - 49.5	326.9 - 324.9	GU
BH-3	376.90	379.68	115	261.9	113.0 - 115.0	263.9 - 261.9	GU	-	-	
BH-4	376.50	380.54	81	295.5	78.8 - 80.8	297.7 - 295.7	MID	-	-	
BH-5	390.50	392.73	88	302.5	86.2 - 88.2	304.3 - 302.3	MID	-	-	
BH-6	384.5	386.53	139	245.5	129.0 - 139.0	255.5 - 245.5	GU	-	-	
BH-7	389.20	393.01	137	252.2	128.8 - 130.8	260.4 - 258.4	UGA	-	-	
BH-8	362.0	362.61	111	251.0	101.0 - 111.0	261.0 - 251.0	GU	-	-	
MW-1	366.36	365.99	126	240.4	86.0 - 122.0	280.4 - 244.4	GU	-	-	
MW-2	382.0	384.39	155	227.0	126.0 - 156.0	256.0 - 226.0	GU	-	-	
MW-3	412.80	416.11	187	225.8	152.8 - 184.7	260.0 - 228.1	UGA	-	-	
MW-4	363.31	362.82	145	218.3	110.5 -144.25	252.8 - 219.1	GU	-	-	
MW-5	322.44	321.94	85	237.4	47.6 - 77.5	274.8 - 244.9	GU	-	-	
MW-6	272.13	271.76	138	134.1	96.0 - 113.7	176.1 - 158.4	GU	-	-	
MW-7	413.29	412.73	265	148.3	188.3 - 197.8	225.0 - 215.5	GU	222.7 - 225.7	190.6 - 187.6	SAND
MW-8	351.81	351.35	231	120.8	168.5 - 179.0	183.3 - 172.8	GU	200.9 - 206.3	150.9 - 145.5	SAND
MW-9	354.46	353.79	176	178.5	127.6 - 138.0	226.9 - 216.5	SAND	164.7 - 170.1	189.8 - 184.4	SAND
MW-10	339.17	338.77	245	94.2	192.5 - 202.2	146.7 - 137.0	SAND	222.9 - 231.9	116.3 - 107.3	SAND
MW-11	369.70	370.41	279	90.7	200.3 - 210.3	169.4 - 159.4	SAND	265.8 - 271.2	103.9 - 98.5	NGA
MW-12	375.21	374.80	266	109.2	233.8 - 239.2	141.4 - 136.0	SAND	255.4 - 258.4	119.8 - 116.8	SAND
MW-13	383.23	382.68	231	152.2	109.0 - 111.9	274.2 - 271.3	GU	196.3 - 206.8	186.9 - 176.4	NGA
MW-14	381.00	381.85	335	46.0	277.6 - 283.0	103.4 - 98.0	SGA	302.0 - 307.5	79.0 - 73.5	SGA
MW-15	438.85	438.54	300	138.9	224.1 - 234.3	214.8 - 204.6	SAND	260.2 - 265.7	178.7 - 173.2	SAND
MW-16	363.18	362.80	194	169.2	161.5 - 166.9	201.7 - 196.3	GU	-	-	
MW-17	337.43	337.08	145	192.4	87.8 - 98.2	249.6 - 239.2	SAND	126.0 - 133.0	211.4 - 204.4	SAND
MW-18	342.60	343.91	315	27.6	119.0 - 129.5	223.6 - 213.1	SAND	281.3 - 291.7	61.3 - 50.9	NGA
MW-19	368.40	370.20	311	57.4	72.5 - 82.5	295.9 - 285.9	MID	168.2 - 173.2	200.2 - 195.2	GU
MW-20	373.70	375.65	325	48.7	190.0 - 195.0	183.7 - 178.7	SAND	295.0 - 300.0	78.7 - 73.7	SGA
MW-21	358.50	359.95	301	57.5	85.4 - 95.4	273.1 - 263.1	GU	170.4 - 180.4	188.1 - 178.1	SAND
MW-22	376.80	378.28	340	36.8	268.8 - 273.0	108.0 - 103.8	NGA	300.2 - 310.2	76.6 - 66.6	NGA
MW-23	424.97	424.42	390	35.0	230.0 - 240.0	195.0 - 185.0	SAND	320.3 - 330.3	104.7 - 94.7	SGA
MW-24	419.11	418.58	375	44.1	205.5 - 215.5	213.6 - 203.6	SAND	350.5 - 355.5	68.6 - 63.6	SGA
MW-25	261.16	260.84	101	160.2	14.5 - 19.5	246.7 - 241.7	PA	40.1 - 45.1	221.1 - 216.1	PA
MW-26	369.40	370.58	150	219.4	112.0 - 117.0	257.4 - 252.4	GU	-	-	
MW-27	330.40	330.05	290	40.4	76.9 - 87.3	253.5 - 243.1	GU	147.6 - 153.0	182.8 - 177.4	GU
MW-28	375.20	374.15	146	229.2	108.0 - 113.0	267.2 - 262.2	SAND	-	-	
MW-29	428.85	428.50	395	33.9	208.1 - 218.1	220.8 - 210.8	GU	370.0 - 377.0	58.9 - 51.9	SGA
LW-1	375.60	377.25	173	202.6	61.0 - 86.0	314.6 - 289.6	MID	-	-	
LW-2	382.10	383.49	120	262.1	100.5 - 110.8	281.6 - 271.3	MID	-	-	
DP-1	253.80	255.10	6	247.8	1.7 - 5.7	252.1 - 248.1	PA			
DP-2	252.20	254.00	6	242.2	1.2 - 5.2	251.0 - 247.0	PA			
DP-3	257.00	258.50	6	251	1.5 - 5.5	255.5 - 251.5	PA			

Notes: * HSU - Hydrostatigraphic Unit.

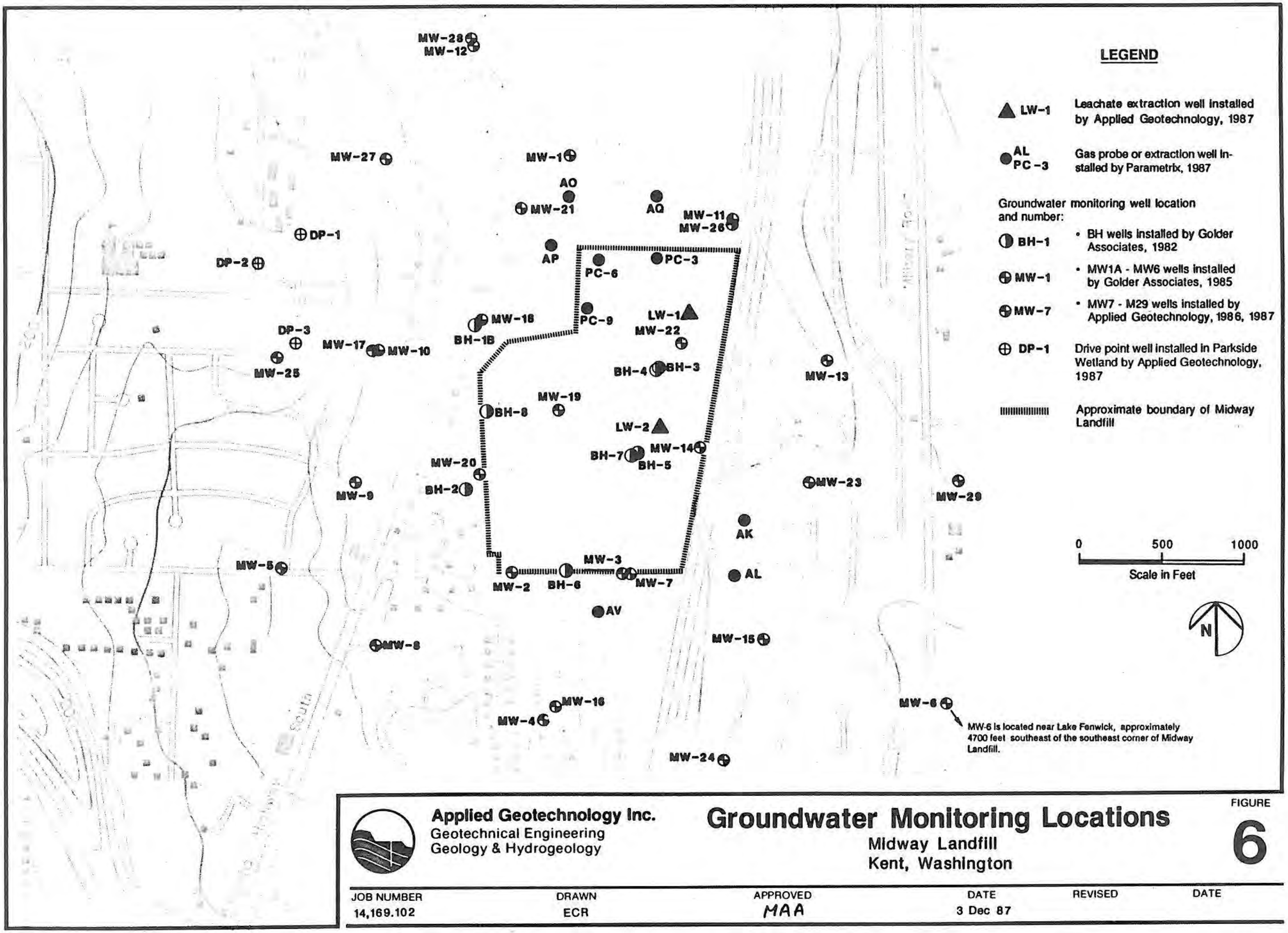
1. All values in feet. Elevation data provided by Parametrix, Inc. Datum unknown.
2. Wells BH-1B through BH-8 installed by Golder Associates, 1982; Wells MW-1 through MW-6 installed by Golder Associates, 1985; Wells MW-7 through MW-29, LW-1 and LW-2, and DP-1 through DP-3 installed by Applied Geotechnology Inc., 1986-1987.
3. Measuring points are as follows: Top of protective steel casing for MW-1,2,3,6 to 29, LW-1 and LW-2; Top of PVC well casing for BH-1 to BH-8, MW-4 and MW-5; top of drive point casing for DP-1 to DP-3.
4. Hydrostatigraphic unit designations as follows: MID - Leachate in Midway Landfill; GU - Upper Gravel Aquifer; NGA - Northern Gravel Aquifer; SGA - Southern Gravel Aquifer; SAND - Sand Aquifer; UGA - Upper Gravel Aquitard; PA - Perched Aquifer.

Table 2 (Continued)
Groundwater Monitor and Leachate Extraction Well Depth and Elevation Specifications

Monitor Well Number	Land Surface Elevation	Meas. Point Elevation	Total Boring Depth	Bottom Hole Elevation	Screened Zone "C" Depth	Screened Zone "C" Elevation	HSU*	Gas Probe Depth	Gas Probe Elevation
BH-1B	341.9	344.70	104	237.9	-	-		-	-
BH-2A	374.40	376.91	120	254.4	-	-		-	-
BH-2B	374.40	377.18	120	254.4	-	-		-	-
BH-3	376.90	379.68	115	261.9	-	-		-	-
BH-4	376.50	380.54	81	295.5	-	-		-	-
BH-5	390.50	392.73	88	302.5	-	-		-	-
BH-6	384.5	386.53	139	245.5	-	-		-	-
BH-7	389.20	393.01	137	252.2	-	-		-	-
BH-8	362.0	362.61	111	251.0	-	-		-	-
MW-1	366.36	365.99	126	240.4	-	-		-	-
MW-2	382.0	384.39	155	227.0	-	-		-	-
MW-3	412.80	416.11	187	225.8	-	-		-	-
MW-4	363.31	362.82	145	218.3	-	-		-	-
MW-5	322.44	321.94	85	237.4	-	-		-	-
MW-6	272.13	271.76	138	134.1	-	-		-	-
MW-7	413.29	412.73	265	148.3	-	-		-	-
MW-8	351.81	351.35	231	120.8	-	-		18.0 - 97.0	333.8 - 254.8
MW-9	354.46	353.79	176	178.5	-	-		-	-
MW-10	339.17	338.77	245	94.2	-	-		22.0 - 72.0	317.2 - 267.2
MW-11	369.70	370.41	279	90.7	-	-		-	-
MW-12	375.21	374.80	266	109.2	-	-		-	-
MW-13	383.23	382.68	231	152.2	-	-		-	-
MW-14	381.00	381.85	335	46.0	-	-		158.5 - 200.0	222.5 - 181.0
MW-15	438.85	438.54	300	138.9	-	-		186.6 - 216.5	252.3 - 222.4
MW-16	363.18	362.80	194	169.2	-	-		-	-
MW-17	337.43	337.08	145	192.4	-	-		-	-
MW-18	342.60	343.91	315	27.6	-	-		-	-
MW-19	368.40	370.20	311	57.4	292.4 - 297.6	76.0 - 70.8	SGA	-	-
MW-20	373.70	375.65	325	48.7	-	-		135.0 - 165.0	238.7 - 208.7
MW-21	358.50	359.95	301	57.5	290.5 - 295.5	68.0 - 63.0	NGA	40.1 - 75.1	318.4 - 283.4
MW-22	376.80	378.28	340	36.8	-	-		-	-
MW-23	424.97	424.42	390	35.0	-	-		179.5 - 220.0	245.5 - 205.0
MW-24	419.11	418.58	375	44.1	-	-		149.9 - 195.0	269.2 - 224.1
MW-25	261.16	260.84	101	160.2	69.2 - 74.2	192.0 - 187.0	SAND	-	-
MW-26	369.40	370.58	150	219.4	-	-		-	-
MW-27	330.40	330.05	290	40.4	260.0 - 265.0	70.4 - 65.4	NGA	32.8 - 63.0	297.6 - 267.4
MW-28	375.20	374.15	146	229.2	-	-		-	-
MW-29	428.85	428.50	395	33.9	-	-		140.0 - 175.0	288.9 - 253.9
LW-1	375.60	377.25	173	202.6	-	-		-	-
LW-2	382.10	383.49	120	262.1	-	-		-	-

Notes: * HSU - Hydrostatigraphic Unit.

1. All values in feet. Elevation data provided by Parametrix, Inc. Datum unknown.
2. Wells BH-1B through BH-8 installed by Golder Associates, 1982; Wells MW-1 through MW-6 installed by Golder Associates, 1985; Wells MW-7 through MW-29, LW-1 and LW-2, and DP-1 through DP-3 installed by Applied Geotechnology Inc., 1986-1987.
3. Measuring points are as follows: Top of protective steel casing for MW-1,2,3,6 to 29, LW-1 and LW-2; Top of PVC well casing for BH-1 to BH-8, MW-4 and MW-5; top of drive point casing for DP-1 to DP-3.
4. Hydrostatigraphic unit designations as follows: MID - Leachate in Midway Landfill; GU - Upper Gravel Aquifer; NGA - Northern Gravel Aquifer; SGA - Southern Gravel Aquifer; SAND - Sand Aquifer; UGA - Upper Gravel Aquitard; PA - Perched Aquifer.



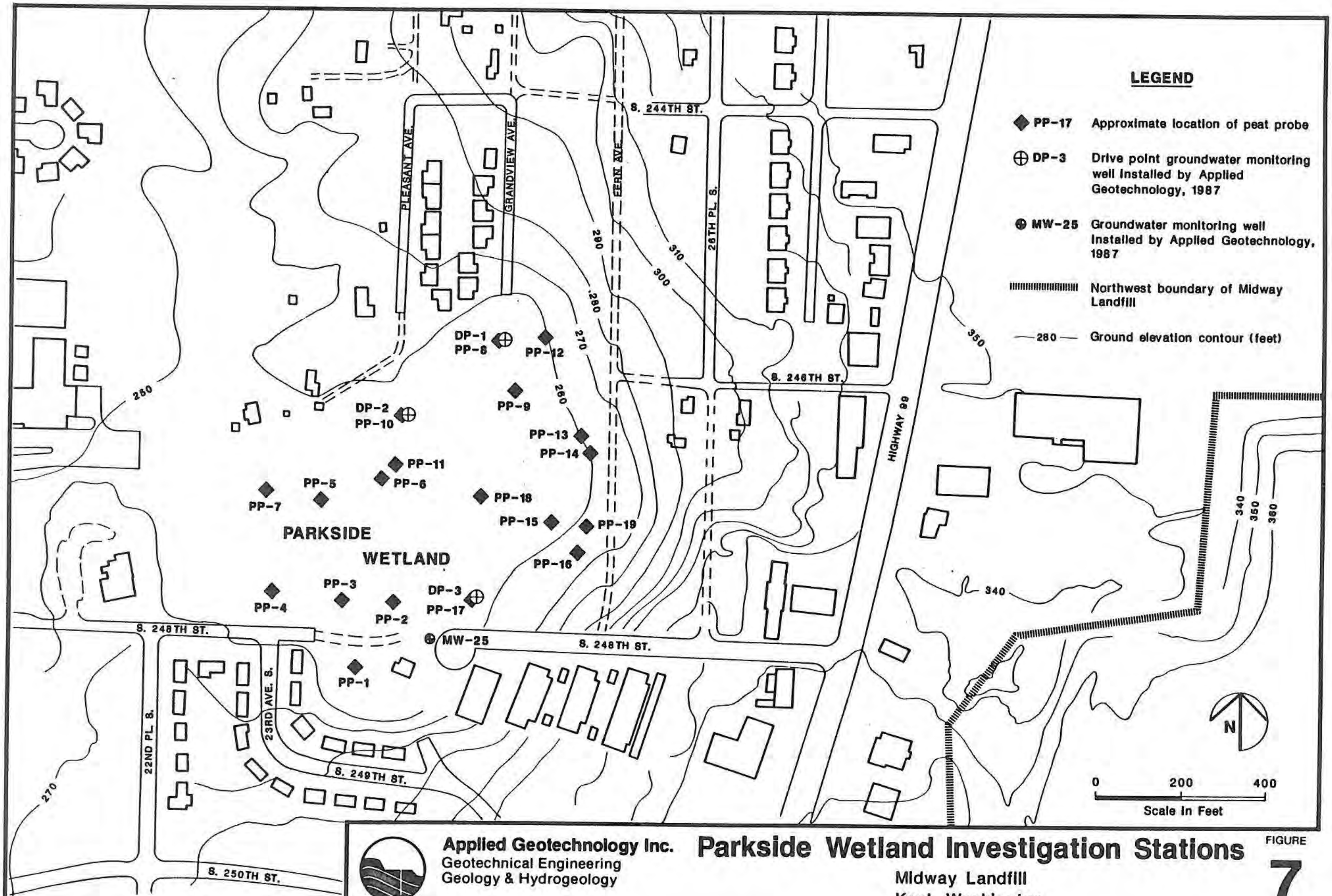
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Groundwater Monitoring Locations

Midway Landfill
Kent, Washington

FIGURE
6

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	3 Dec 87		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Parkside Wetland Investigation Stations

Midway Landfill
Kent, Washington

FIGURE
7

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	15 December 87		

BASE MAP: 5-15-86 Midway Landfill Vicinity Map by City of Seattle Dept. of Engineering.

4.0 GEOLOGY

4.1 Geologic Setting

The Midway Landfill is located on the Des Moines Drift Plain within the Puget Lowland, a north-south trending structural and topographic depression bordered on the west by the Olympic Mountains and on the east by the Cascade Mountains. The Lowland is underlain by Tertiary volcanic and sedimentary bedrock and is filled to the present-day land surface with Quaternary glacial and non-glacial sediments. Depth to bedrock beneath the Landfill is thought to exceed 1000 feet (Hall and Othberg, 1974).

Deposits of at least four glaciations have been identified in the southern Puget Lowland (Crandell, 1958). The last of these major glaciations was named the Vashon. Armstrong, et al, (1965) renamed the youngest glaciation the Fraser, and modified it to include two glacial advances or stades, separated by one interstade. The youngest stade of the Fraser Glaciation is the Sumus, while the oldest is the Vashon. Only deposits of the Vashon Stade are present in the southern and central Puget Lowland. Sumus Stade deposits are limited to the extreme northern Puget Lowland. During the Vashon Stade, a lobe of glacial ice emanating from the British Columbia coast ranges entered the Puget Lowland. The Vashon Glacier covered the entire Lowland with up to several thousand feet of ice, and at its maximum, extended a few miles south of Olympia (Thorson, 1980).

Fluvial, lacustrine, and direct ice contact processes associated with the advance and recession of the Vashon Glacier are responsible for the majority of the surface deposits and landforms throughout the Puget Lowland and the Study Area. Outwash streams of meltwater from the advancing glacier deposited sand and gravel over much of the area. Overriding glacial ice covered some areas of advance outwash with till, a non-sorted mixture of clay, silt, sand and gravel, while other areas were simply eroded and sculpted by the moving ice. As the ice receded by melting and evaporation, large quantities of water flowed over the Lowland cutting meltwater channels and depositing sediments into low-lying areas. These deposits are collectively known as recessional outwash.

Each glaciation preceding the Fraser had similar erosional and depositional processes. Consequently, the deposits of older glaciations often appear physically and hydraulically similar to those of the Vashon Stade. Older glacial deposits are frequently encountered in deeper boreholes and are often exposed in the lower sections of sea cliffs and valley walls throughout the Puget Lowland.

Glacial drifts from two older glaciations - Salmon Springs Glaciation and the older Stuck Glaciation - were mapped as occurring near the Landfill (Waldron, 1961, 1962). Salmon Springs Drift is particularly widespread and occurs along the Green River Valley walls and Puget Sound sea cliffs to Tacoma. An extensive sequence of Salmon Springs Drift is exposed in the cliffs bordering Commencement Bay (Smith, 1976).

Erosional and depositional processes similar to those occurring today operated during periods between glaciations. These processes include sedimentation through overbank flooding in alluvial river valleys, and delta building by rivers discharging into fresh water lakes and Puget Sound. Most sediments associated with these processes are finer-grained sands, silts, and clays. However, coarse sands and gravels were occasionally deposited in relatively high energy streams. Older interglacial deposits are encountered at depth within the geologic section. Waldron's (1961, 1962) geologic maps of the Des Moines and Poverty Bay Quadrangles (the Landfill is located in the Des Moines Quadrangle) show only one interglacial deposit in the area - the Puyallup Formation.

Throughout the Quaternary period, volcanic activity in the Cascade Mountains periodically spread volcanic ash over large areas of the Puget Lowland. Depositional environments during glaciations do not promote accumulation of discrete ash beds. Some ash layers have been found in the Salmon Springs Drift (Easterbrook, et al. 1981); however, ash layers are much more common in the interglacial sediments (or non-glacial sediments) and are widely used for correlation.

Another characteristic feature of interglacial periods is the occurrence of mudflow deposits. The mudflows originated as lahars on Cascade volcanoes and represent catastrophic floods associated with rapid melting of mountain glaciers during volcanic eruptions. During interglacial periods, the Lowland trough was not occupied by glacial ice so the mudflows were able to spread outward from the mountain front, long distances into the Lowland.

4.2 Study Area Geology

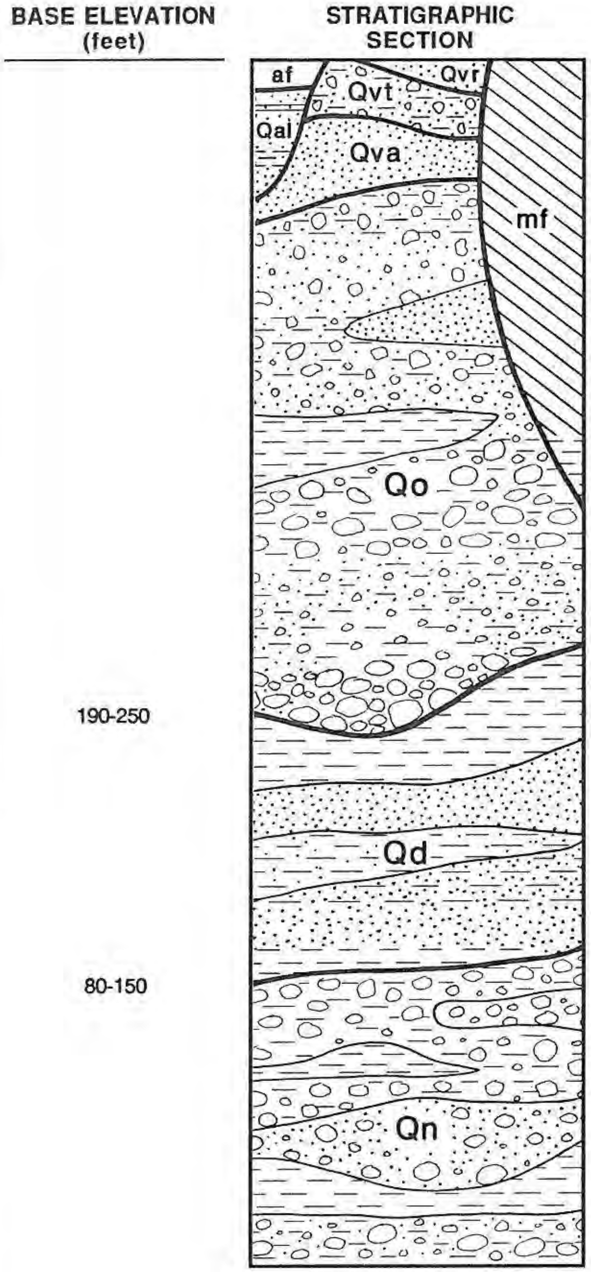
4.2.1 General

Our interpretation of geologic conditions in the Study Area is based on an understanding of the geologic setting, review of exploratory work by others, and on observations made during drilling. The sediments underlying the Study Area are diverse and complexly interbedded, but include deposits of two glaciations and one interglacial period. These sediments include glacial till and outwash deposited as Vashon Drift, glacial till and outwash deposited during what we interpret to be the Salmon Springs Glaciation, and fluvial and lacustrine sediments deposited during an older interglacial period. Sediments representing the interglacial period between the Vashon and Salmon Springs Glaciations do not appear to be present.

Sediments in the study are can be divided into nine stratigraphically distinct deposits. These deposits are, from youngest to oldest:

- Fill
- Midway Landfill
- Recent Alluvium
- Vashon Drift
  - Vashon Recessional Outwash
  - Vashon Till
  - Vashon Advance Outwash
- Outwash Gravels (possible Salmon Springs Drift)
- Deltaic Sediments (possible Salmon Springs Drift)
- Non-Glacial Sediments (possible Puyallup Formation)

The Midway Landfill, Recent Alluvium, Outwash Gravels, and Deltaic Sediments are the most clearly defined deposits in the Study Area. Only a few borings have reached the deeper Non-Glacial Sediments, and none have fully penetrated them. The Fill and Vashon Drift occur as intermittent surficial deposits with a distribution difficult to define given existing information. Figure 8 illustrates our interpretation of site stratigraphy. Detailed geologic cross sections are presented at the end of Section 4.2 as Figures 18 through 23, Geologic Cross Sections A-A' through F-F'. Figure 17 shows cross section locations. The following sections describe the deposits encountered during drilling.



GEOLOGIC UNIT	HYDROSTRATIGRAPHIC UNIT
FILL (af) Miscellaneous surficial fills. MIDWAY LANDFILL (mf) Municipal refuse and miscellaneous fills within the landfill boundary.	PERCHED AQUIFER (see also below) Seasonally perched groundwater at base of fills. LANDFILL AQUIFER Perched leachate at base of landfill.
RECENT ALLUVIUM (Qal) Recent fluvial and lacustrine sediments including peat. VASHON RECESSIONAL OUTWASH (Qvr) Thin scattered deposits of well sorted sand and silty sand. VASHON TILL (Qvt) Thin scattered deposits consisting of compact silt, sand, and gravel glacial till. VASHON ADVANCE OUTWASH (Qva) Well sorted sand deposits with trace gravel.	PERCHED AQUIFER Seasonally perched groundwater at base of Recessional Outwash or in weathered Vashon Till. Saturated thickness several inches to several feet. Perched groundwater in Parkside Wetland in sandy portions of Recent Alluvium and in Outwash Gravels north of Landfill.
OUTWASH GRAVELS (Qo) Oxidized silty sandy gravel, sandy gravel, and open work gravel with subordinate silt and sand lenses. Sand and silt proportions vary; gravel ranges from pebble to cobble size. Glacial outwash deposit.	UPPER GRAVEL AQUITARD Dense till-like mixture of silt, sand and gravel. UPPER GRAVEL AQUIFER Saturated highly permeable open work gravel and sandy gravel deposits associated with a buried channel at the base of the Outwash Gravels.
DELTAIC SEDIMENTS (Qd) Interbedded fine grained sand, silty sand, sandy silt and silt. Occasional silty clay lenses, silty gravel channel deposits, and ash layers. Trace organic matter scattered throughout entire deposit. Sediments near base of deposit often have lavender cast from abundant hypersthene(?) crystals. Occasional dropstones. Possible glacio-lacustrine/deltaic deposit.	UPPER SILT AQUITARD Discontinuous layer of interbedded silt, clayey silt, and silty fine sand at the top of the Deltaic Sediments. Maximum thickness 55 feet; generally ranges between 15 and 35 feet thick. SAND AQUIFER 20 to 60 foot thick sand beds with intervening silt, clayey silt, and silty fine sand beds. LOWER SILT AQUITARD Discontinuous layer of interbedded silt, clayey silt, and silty fine sand at base of Deltaic Sediments: generally range from 1 to 5 feet thick where present.
NON-GLACIAL SEDIMENTS (Qn) Interbedded silty gravel, sandy gravel, silt, and silty sand. Silt and sand beds often have lavender cast. Wood fragments locally abundant. Tree encountered during drilling MW-29. Terrestrial non-glacial deposit.	NORTHERN GRAVEL AQUIFER Highly permeable 5 to 30 foot thick sandy gravel channel(?) deposits between elevation +30 and +80 feet. Potentiometric head greater than elevation +220. SOUTHERN GRAVEL AQUIFER Highly permeable 5 to 30 foot thick sandy gravel channel(?) deposits between elevations +50 and +110 feet. Potentiometric head less than elevation +175 feet.

Note:
Blue color indicates water bearing zone.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Generalized Hydrogeologic Section

Midway Landfill
Kent, Washington

FIGURE
8

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAB	7 Nov 87		

4.2.2 Fill

Fills resulting from building and road construction are present throughout the Study Area. Most fills are 10 feet thick, or less, and consist of a variety of earth materials. Two of the thickest known fills underlie Interstate 5 where it crosses the historic eastern border of the gravel pit. One of the fills is up to 100 feet thick; the other, located on the eastern border of the historic Lake Meade area, is a maximum of approximately 60 feet thick. Figure 4, in Section 2.0, shows these areas prior to filling.

4.2.3 Midway Landfill

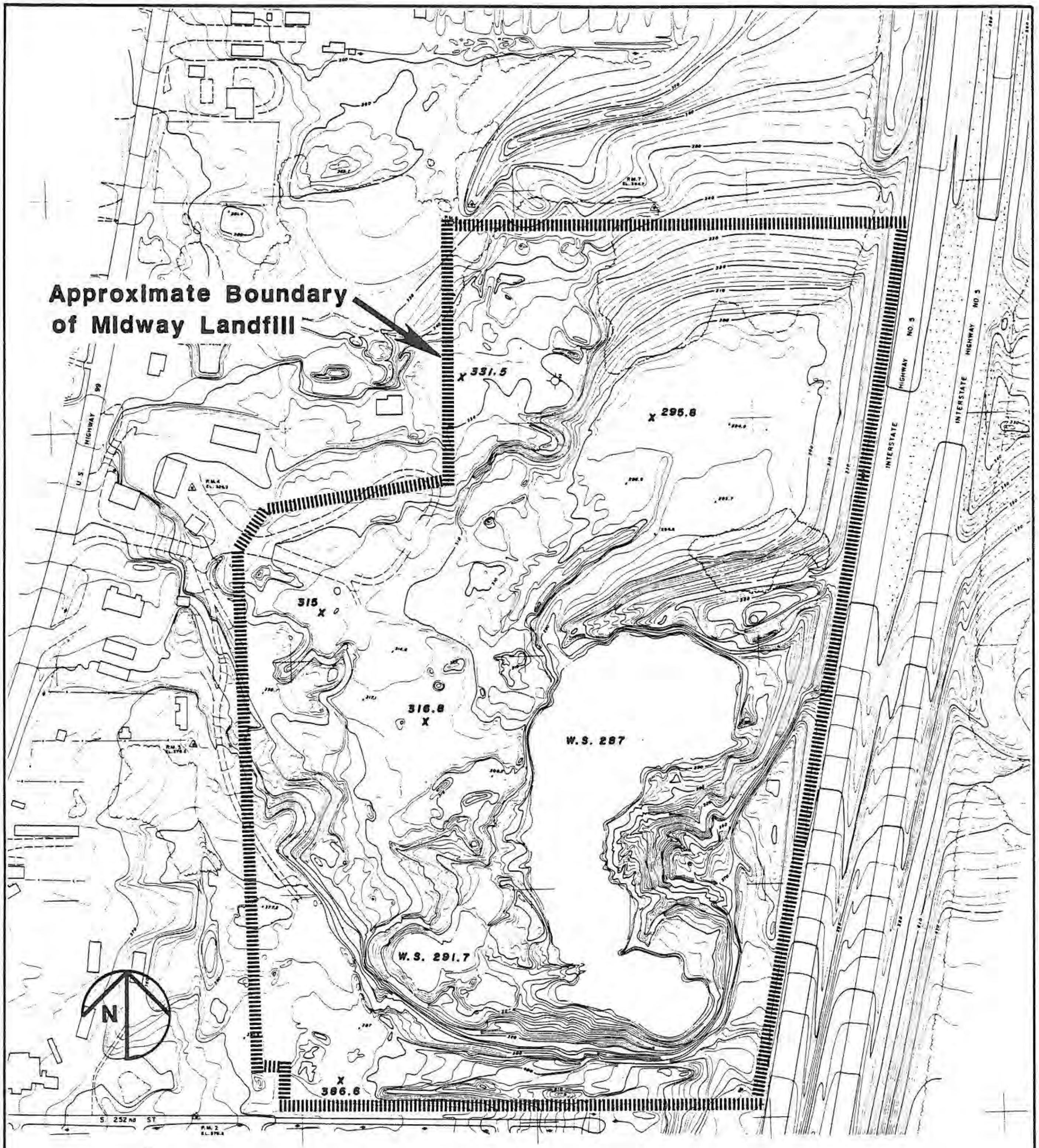
A variety of municipal wastes were placed into the Midway Landfill including miscellaneous construction debris, wood waste, yard waste, and non-putrescible waste such as tires, wire, and scrap metal. In the upper 20 to 30 feet of the Landfill, distinct fragments of various materials can be recognized. Below this level, the landfill waste is a very soft amorphous dark brown to black material with a strong organic odor. Few discrete fragments are present below the upper 20 to 30 feet, except for occasional zones of hard debris.

The Landfill is currently covered with an earthen cap which generally ranges from 1 to 10 feet thick. Fill placed to cover the historic South Pond ranges up to 40 feet deep. The fill cap varies in composition as it was derived from a number of sources over several years.

As described previously, the landfill waste was placed into the gravel pit excavation beginning in January 1966. Consequently, the original gravel pit configuration largely controls the current waste thickness, although some regrading occurred as landfilling progressed. The original 1966 gravel pit topography is shown on Figure 9, and geologic sections through the Landfill are presented on Figures 11 and 12; cross section locations are shown on Figure 10. Waste is generally thicker in the southern half of the Landfill where excavation was deepest. In this half, waste thickness increases from approximately 60 to 80 feet along the western border of the Landfill to over 120 feet in the kidney-shaped area near the eastern Landfill border. In the northern half of the Landfill, waste thickness is less, but also increases from 50 to 60 feet along the western border to between 80 and 90 feet in the historic Lake Meade area.

Wastes in the southern half of the Landfill are generally underlain by native sediments or a thin layer of fill associated with the former gravel mining operations. By contrast, up to 15 feet of fine-grained silt and clay fill underlie waste in the northern half. As described previously, these fine-grained sediments were probably derived from historic gravel washing operations in Lake Meade. Another 25-foot layer of silty/clayey fill was encountered in MW-19 near the west central portion of the Landfill. This area corresponds to the other pond shown on Figure 4 (Section 2.0).

A previous investigation (Golder, 1982) reported encountering up to 4 feet of peat beneath the fine-grained fill in the historic Lake Meade area. The peat encountered may be a remnant of the original bog occupying the area. However, it does not appear to be continuous, as it was not encountered in borings drilled for this investigation.



Reference: "Aerial Topographic Map, Midway Gravel Pit" by Walker and Associates for the City of Seattle, February 1966.

W.S. = Water Surface Elevation

0 250 500

Scale In Feet

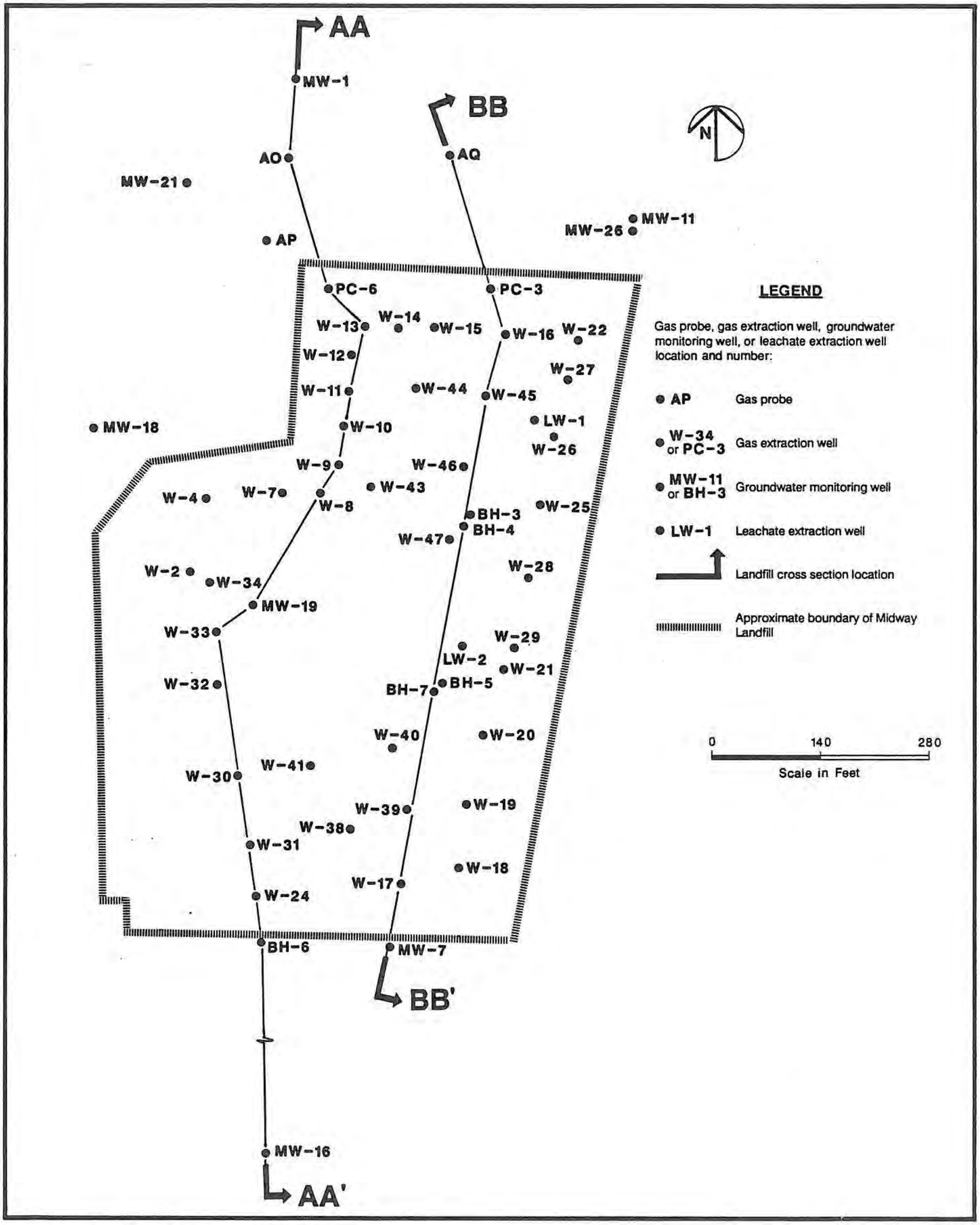
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

1966 Gravel Pit Topography

Midway Landfill
Kent, Washington

FIGURE
9

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.001	ECR	MAA	4 Dec 87		



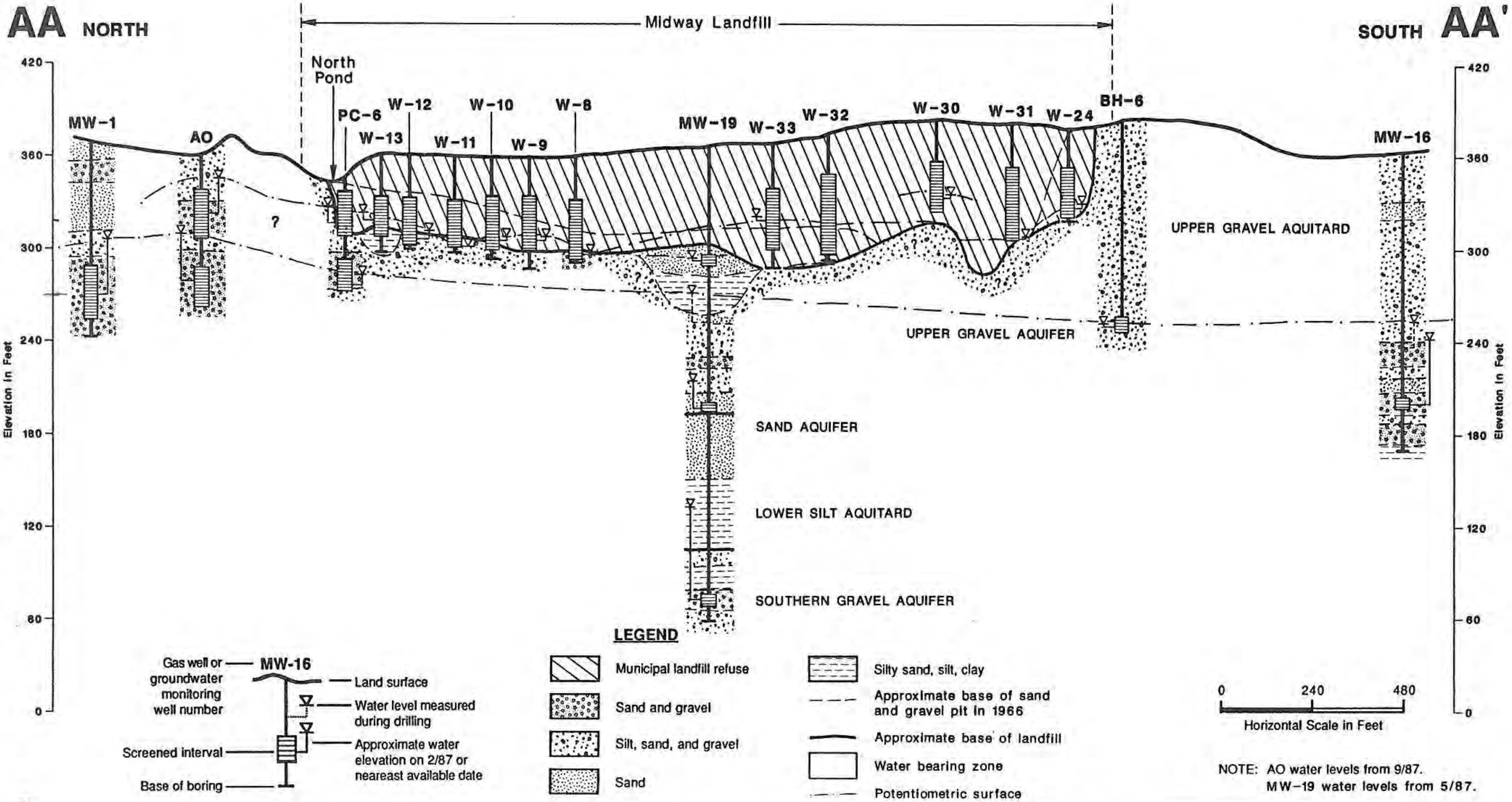
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Landfill Cross Section Locations

Midway Landfill
Kent, Washington

FIGURE
10

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	SM	MAA	7 December 87		



NOTES:

1. For cross section location refer to Figure 10.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

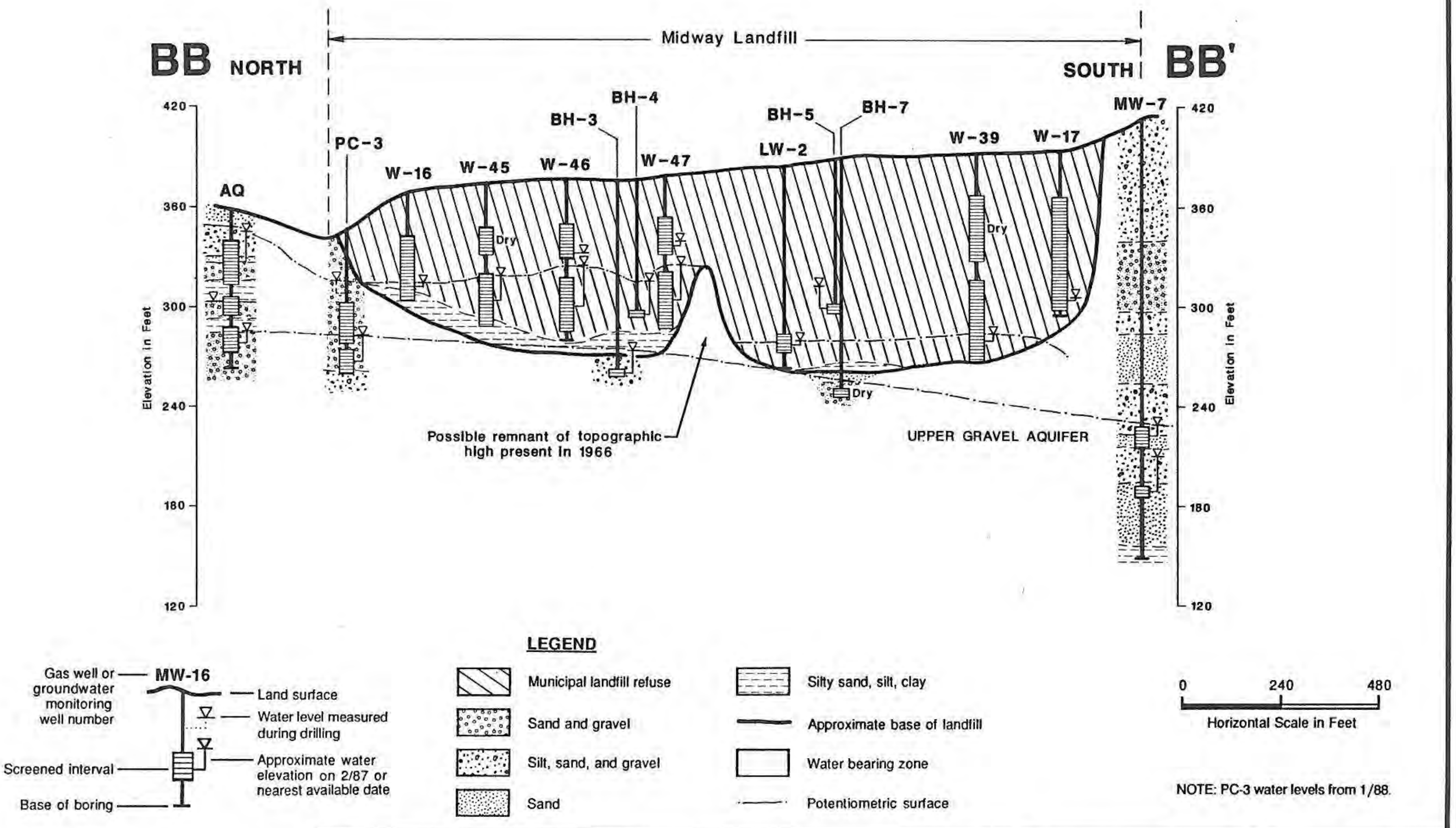
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Landfill Cross Section AA-AA'

Midway Landfill
Kent, Washington

FIGURE
11

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTE: PC-3 water levels from 1/88.

NOTES:

1. For cross section location refer to Figure 10.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Landfill Cross Section BB-BB'

Midway Landfill
Kent, Washington

FIGURE
12

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		

4.2.4 Recent Alluvium

Recent alluvial sediments occur in the Parkside Wetland as shown on Geologic Cross Section E-E'. This Wetland appears to be a depression (kettle) left by melting glacial ice which filled with sediment and then developed into a peat bog.

Figure 13 shows the thickness of peat in the Wetland and Table 3 tabulates the peat thickness data. As illustrated, peat is thickest in the central and southeastern portion of the Wetland and reaches a maximum thickness of nearly 17 feet at PP-19. In most areas, the peat is immediately underlain by gray silty clay, as shown on the Figure 14 cross sections. Observations from Well MW-25 indicate that approximately 9 feet of complexly interbedded fine-grained sand, clay, and silt underlie the peat deposit. These sediments are in turn underlain by approximately 25 feet of massive to laminated silt with a trace to some clay and thin lenses of fine-grained sand. The nature of these sediments indicates they were deposited into a lake which probably occupied the Wetland before it developed into a peat bog.

4.2.5 Vashon Recessional Outwash

Thin scattered deposits of fluvial sand occur below Fill or at land surface around the Landfill. We interpret these deposits to be glacial outwash sediments associated with recession of the Vashon glacier. Some of the sand deposits are long sinuous features (eskers); others are more typical of braided stream sediments deposited near the front of the retreating glacier. The most distinctive esker occurs as a small ridge extending generally east-west across the north end of the Landfill. The locations of sediments interpreted to be Vashon Recessional Outwash are shown on the Geologic Cross Sections.

4.2.6 Vashon Till

Vashon Till underlies Vashon Recessional Outwash where present, or is exposed at land surface in many areas around the Landfill. The Till is generally interpreted to have been deposited onto the land surface at the base of overriding Vashon glacial ice (lodgement till). It is consequently very dense and consists of a non-stratified, non-sorted mixture of clay, silt, sand, and gravel; cobbles and boulders can also be present. Till thickness ranged from 0 to 25 feet in our exploratory borings. Till thickness may be greater at other locations in the Study Area.

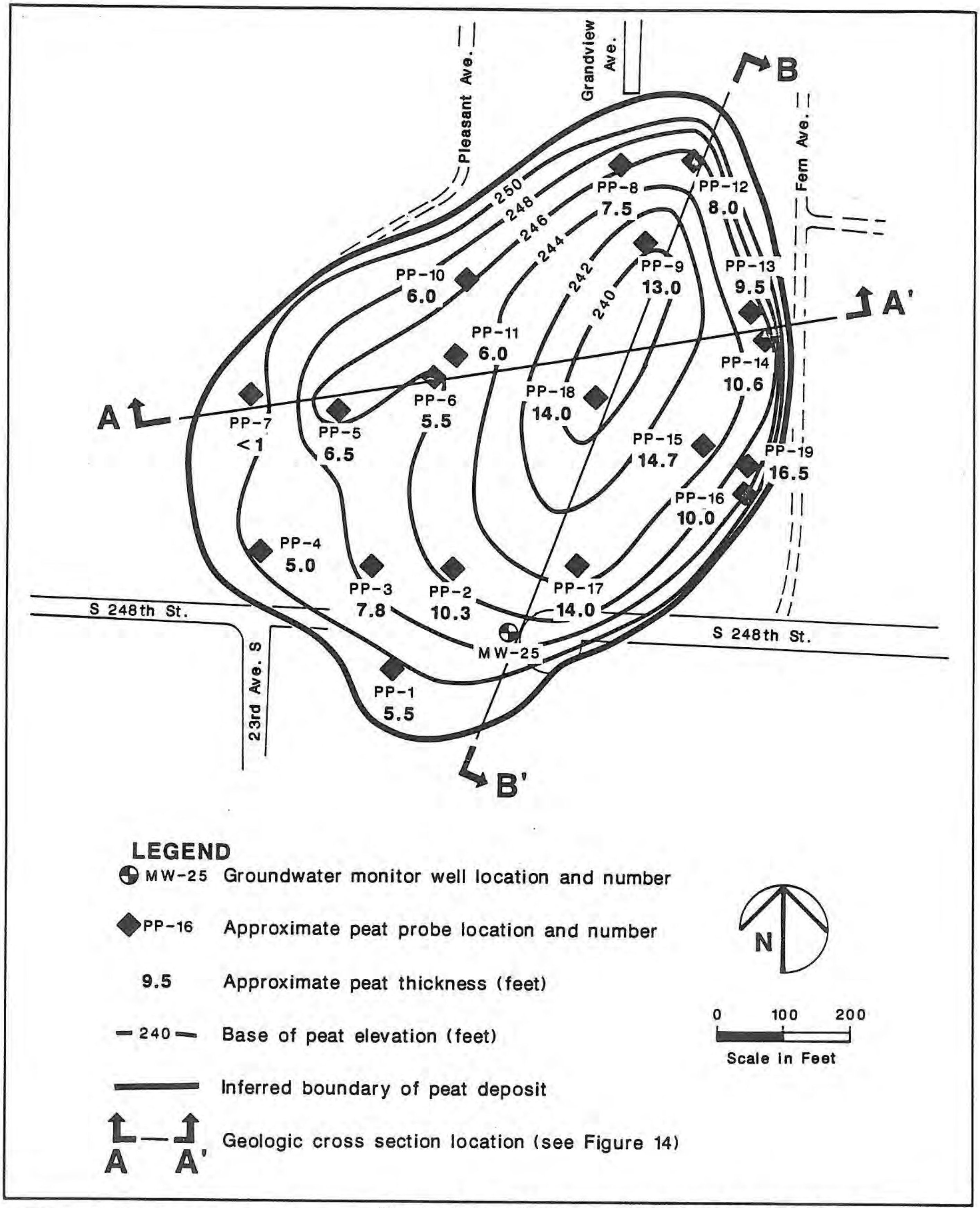
Table 3

Parkside Wetland Peat Probe Data

Peat Probe Number	1) Land Surface Elevation (feet)	2) Peat Thickness (feet)	Base Deposit	Comments
PP-1	256.4	5.5	Gray clayey silt	
PP-2	256.0	10.3	Gray clayey silt	
PP-3	255.4	7.8	Gray clayey silt	
PP-4	254.3	5.0	Gray clayey silt	
PP-5	251.9	6.5	Gray clayey silt	
PP-6	251.7	5.5	Gray clayey silt	
PP-7	251.0	<1.0	Gray clayey silt	Hard soils, no penetration
PP-8	253.8	7.5	Gray clayey silt	
PP-9	253.6	13.0	Gray clayey silt	
PP-10	252.2	6.0	Gray clayey silt	
PP-11	251.0	6.0	Gray clayey silt	
PP-12	253.6	8.0	Gray clayey silt	
PP-13	254.8	9.5	Brown sandy silt	
PP-14	255.0	10.6	Brown sandy silt	
PP-15	257.7	14.7	Brown sandy silt	
PP-16	258.1	10.0	Brown sandy silt	
PP-17	257.0	14.0	Gray clayey silt	
PP-18	254 (est)	14.0	Gray clayey silt	
PP-19	258 (est)	16.5	Gray sandy silt	

Notes:

1. Elevations provided by Parametrix, Inc. based on survey data except for estimated values.
2. Peat thickness shown is depth of peat probe refusal on silt. Actual peat thickness may be greater if peat deposits underlie the silt.



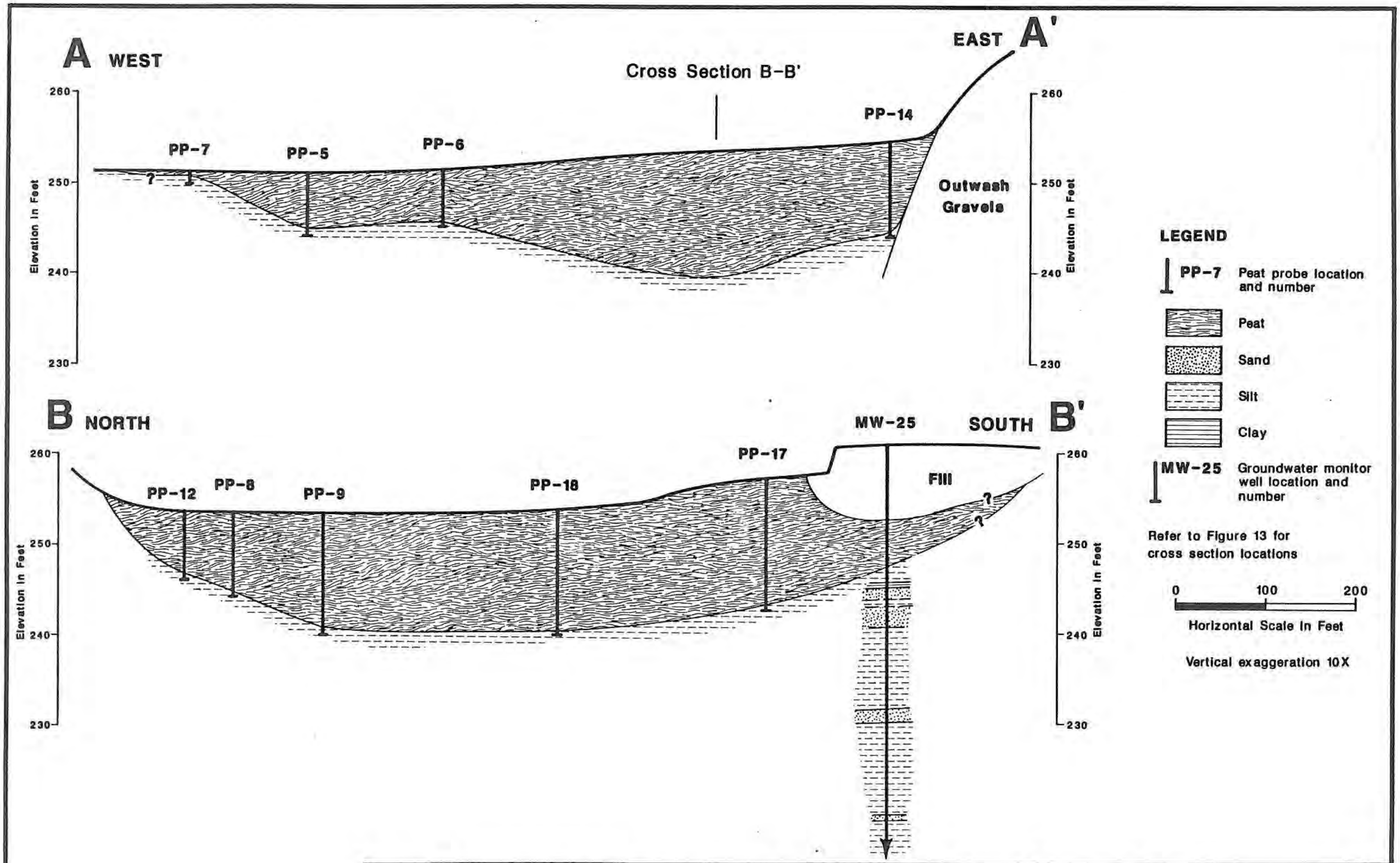
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Parkside Wetland Peat Distribution

Midway Landfill
Kent, Washington

FIGURE
13

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	12 January 88		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Parkside Wetland Cross Sections

Midway Landfill
Kent, Washington

FIGURE
14

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	13 January 88		

4.2.7 Vashon Advance Outwash

A 5 to 40-foot thick layer of fluvial sand and gravelly sand was encountered in several borings immediately adjacent to the Landfill, and east of I-5, as shown on Geologic Cross Sections C-C', E-E', and F-F'. In addition, historic photographs of the gravel pit show a 10 to 20-foot layer of sand exposed in the top of the pit walls. Figure 15 is a reproduction of a 1959 photograph showing what appears to be the southeastern wall of the gravel pit. Note the sand layer at the top of the wall. We interpret these sand deposits to be glaciofluvial sediments associated with the advance of the Vashon glacier.

4.2.8 Outwash Gravels

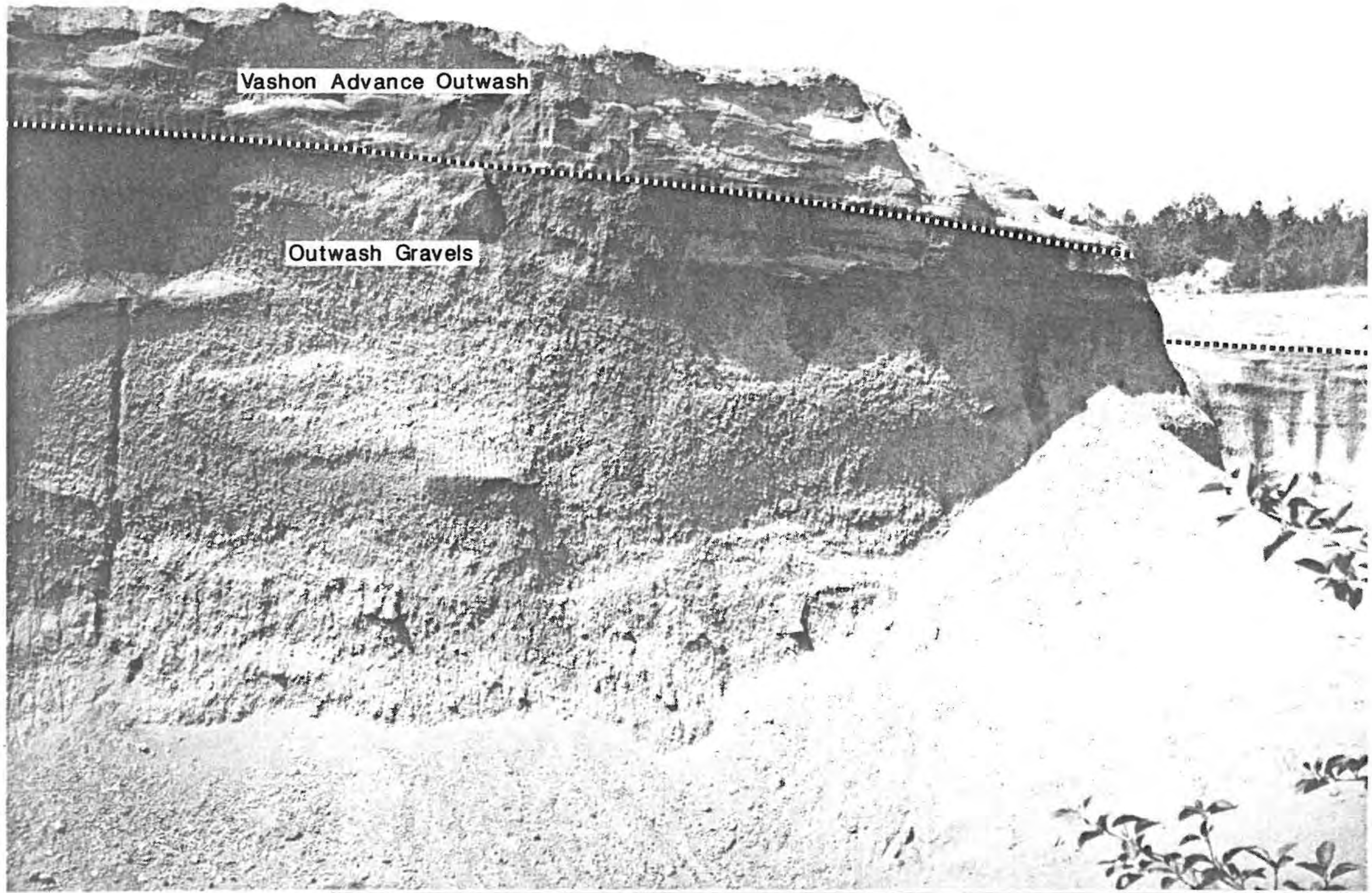
A thick deposit of older gravel underlies the Vashon Advance Outwash and other younger deposits through the Study Area, as illustrated in the Geologic Sections. The gravel ranges up to 200 feet thick and consists of a complex mixture of gravel, sandy gravel, and gravelly sand with varying proportions of silt, cobbles, and boulders. In some areas, the silt/sand/gravel mixture has a till-like appearance. In most areas, the gravels show crude bedding indicative of fluvial deposition. Sand and gravelly sand lenses within the gravels also suggest fluvial deposition. These depositional features can be seen in Figure 15.

The base of the Outwash Gravels forms a gently undulating surface ranging from Elevation 170 to 270 feet, as illustrated on Figure 16. A buried channel occurs at the base of the Outwash Gravels extending in an arc from the vicinity of MW-27 on the north through the middle of the Landfill towards MW-8 and MW-16 on the south. This channel is also shown on Figure 16. A tributary channel joins the main channel near MW-21 and extends to the northeast towards MW-11.

The lower section of the Outwash Gravels, particularly within the buried channels, tends to be cleaner with less silt than the upper section. This is particularly true near MW-21 and MW-27, where there is up to 120 feet of sandy or open-work gravel within the buried channel. There is also some variation within the main buried channel; gravels in the northern part of the Study Area are generally less silty and better sorted than those in the southern part.

We interpret this deposit to be glacial outwash. The size and distribution of particles within the gravel indicate a high energy depositional environment in close proximity to a glacial front. We do not believe this deposit is part of the Vashon Advance Outwash because it does not appear to have the physical/lithological characteristics typically associated with Vashon Outwash elsewhere in the Puget Sound area. This is due in part to grain size distribution and in part to secondary weathering patterns. Vashon

Advance Outwash is typically represented by thick sand beds with subordinate sandy gravel or gravely sand layers, and typically shows little secondary weathering. The Outwash Gravels, by contrast, are predominantly gravelly and exhibit a higher degree of consolidation and secondary weathering. Based on this, we conclude the Outwash Gravels may be of Pre-Vashon origin and may correlate with Salmon Springs Drift of similar appearance mapped by Smith (1976) and Waldron (1961, 1962).



Reference:
WSDOT Photo Archives.

View of southeastern (?) wall of gravel pit.

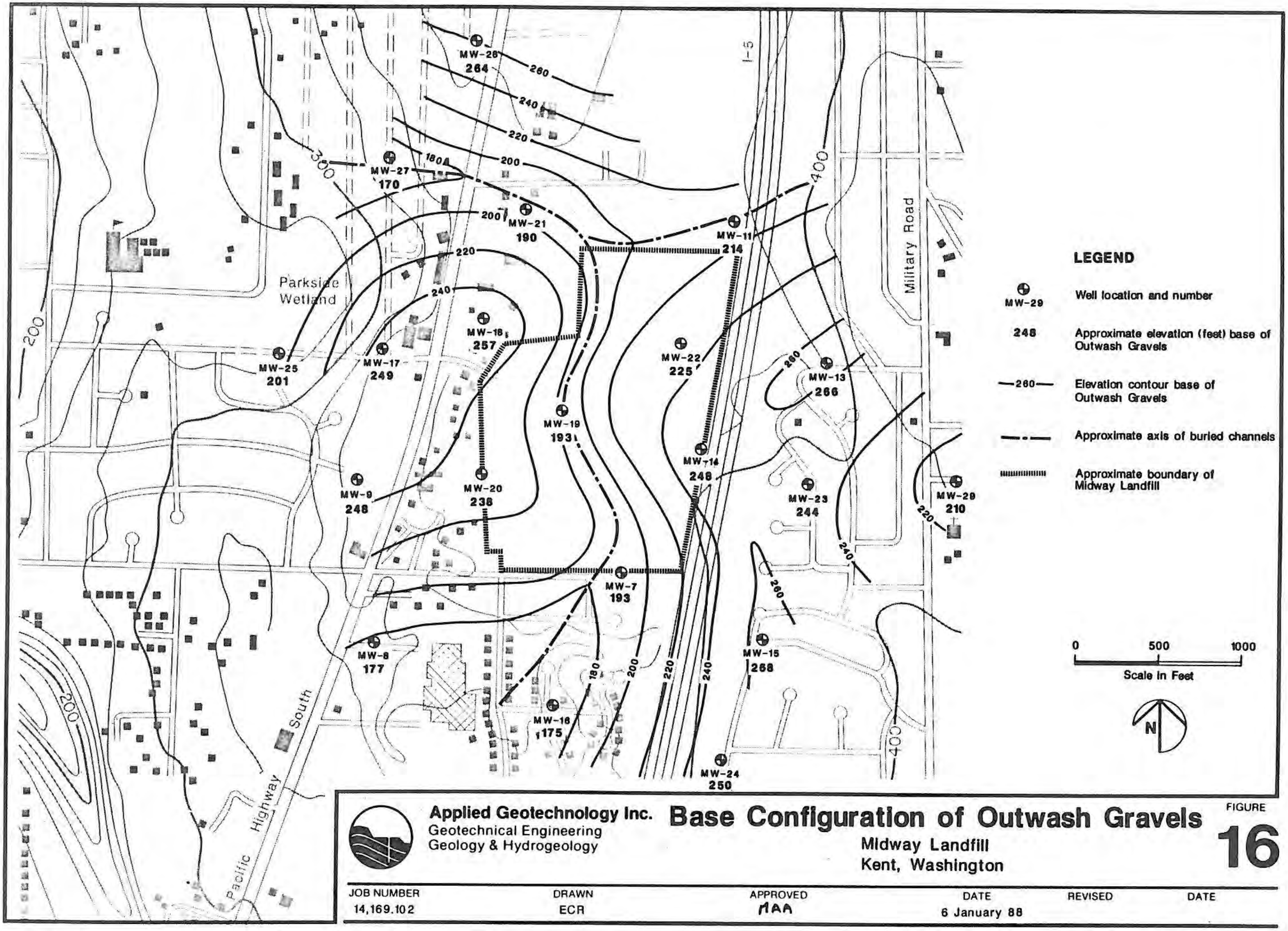
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Gravel Pit Wall in 1959

Midway Landfill
Kent, Washington

FIGURE
15

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB		1 December 87		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Base Configuration of Outwash Gravels

Midway Landfill
Kent, Washington

FIGURE
16

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	6 January 88		

4.2.9 Deltaic Sediments

Underlying the Outwash Gravels throughout the Study Area is an 80 to 180-foot thick sequence of sand, silty sand, and silt, with occasional lenses of sandy or silty gravel designated Deltaic Sediments. The distribution and lithologic variations in the Deltaic Sediments are illustrated in the Geologic Cross Sections. Some wood fragments are present as well as locally-abundant, finely-divided organic matter. The lower portion of this deposit also contains occasional volcanic ash layers.

The distribution of silt and sand beds in the Deltaic Sediments is highly variable, as the silt and sand deposits are complexly interbedded in some areas, and in others, a considerable thickness of each type is present. The maximum continuous or nearly continuous sand thickness observed in our well borings was 120+ feet in MW-15 and nearly 120 feet in MW-18. Elsewhere, the sand beds are typically 20 to 40 feet thick. Sand, as illustrated on the Geologic Cross Sections, typically contains numerous thin silt and silty sand layers, and the reverse is true for the silt beds shown.

The upper part of the Deltaic Sediments is characterized by an oxidized brown color while the lower part is typically gray with a lavender or greenish hue in some areas. The lavender and green colors may result from the presence of fine pyroxene crystals typical of Cascade volcanic rocks. The lavender and green hues and ash deposits suggest volcanic activity was occurring in the Cascade Mountains during deposition of the lower part of the Deltaic Sediments.

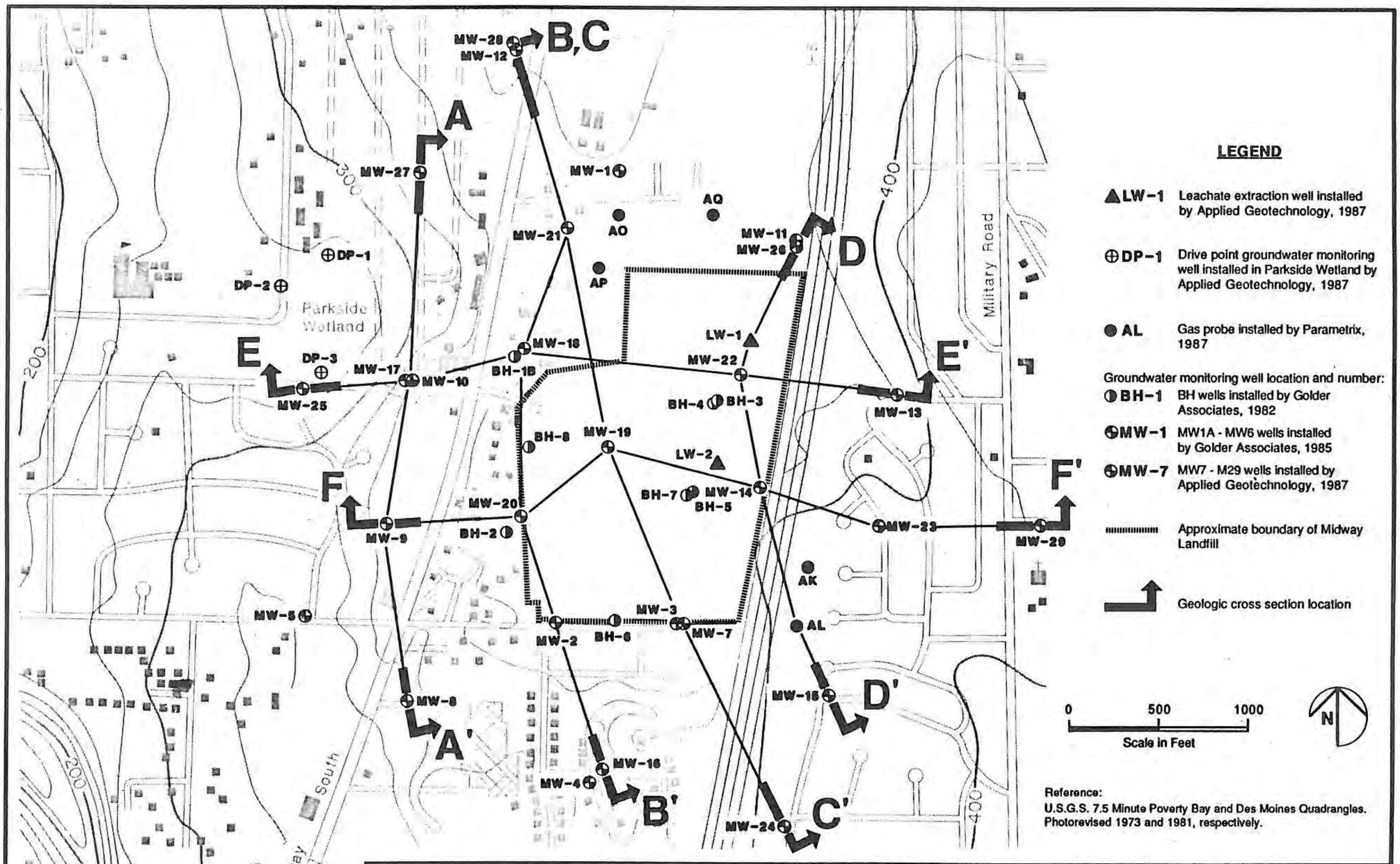
We interpret these sediments as representing a deltaic sequence. This sequence may have been deposited into a freshwater lake or isolated area of Puget Sound. Sediments of similar appearance and lithology mapped as the Puyallup Formation (Smith, 1976)) outcrop near the base of the cliffs on the north side of Commencement Bay. However, the Puyallup Formation is considered to be non-glacial in origin whereas the Deltaic Sediments underlying the Study Area contain occasional "dropstones" typically found in lake sediments near glacial fronts. Consequently, we conclude the Deltaic Sediments in the Study Area are not correlative with the Puyallup Formation, but instead may be a finer-grained facies of the overlying Salmon Springs (?) outwash.

4.2.10 Non-Glacial Sediments

Sediments of apparent non-glacial origin underlie the Deltaic Sediments to the depth explored. The top of the Non-Glacial Sediments occurs near Elevation 100 feet. These sediments are more heterogeneous than overlying deposits and are characterized by coarse grained silty or sandy gravels with intervening beds of fine grained silt or silty sand. The geologic log from the Linda Heights well suggests the gravel deposits grade with depth into a continuous sequence of fine-grained silts and sandy silts.

As with the overlying Deltaic Sediments, ash layers are locally present as are sand and silt beds with a lavender hue. In addition, much of the gravel consists of andesite clasts with large pinkish pyroxene crystals, typical of Cascade volcanics. More wood is also present, ranging in size from 1" diameter fragments to large sections of trees. These features suggest deposition during a non-glacial climatic environment with the Cascade Mountains as the source of the sediments.

The average size of the gravels in this deposit, although smaller than the Outwash Gravels, suggests a fairly high energy braided stream depositional environment. The gravels represent in-channel flood deposits, while the finer grained silts represent overbank or quiet water deposition. Some of the silty gravel deposits also look like mudflows. We interpret these sediments as being correlative with the Puyallup Formation. The description of the Puyallup Formation at its type locality is very similar to the non-glacial sediments in the Study Area (Crandell, 1958).



LEGEND

▲ LW-1	Leachate extraction well installed by Applied Geotechnology, 1987
⊕ DP-1	Drive point groundwater monitoring well installed in Parkside Wetland by Applied Geotechnology, 1987
● AL	Gas probe installed by Parametrix, 1987

Groundwater monitoring well location and number:

◑ BH-1	BH wells installed by Golder Associates, 1982
⊕ MW-1	MW1A - MW6 wells installed by Golder Associates, 1985
⊕ MW-7	MW7 - M29 wells installed by Applied Geotechnology, 1987
▨	Approximate boundary of Midway Landfill
↱	Geologic cross section location

Reference:
U.S.G.S. 7.5 Minute Poverty Bay and Des Moines Quadrangles. Photorevised 1973 and 1981, respectively.

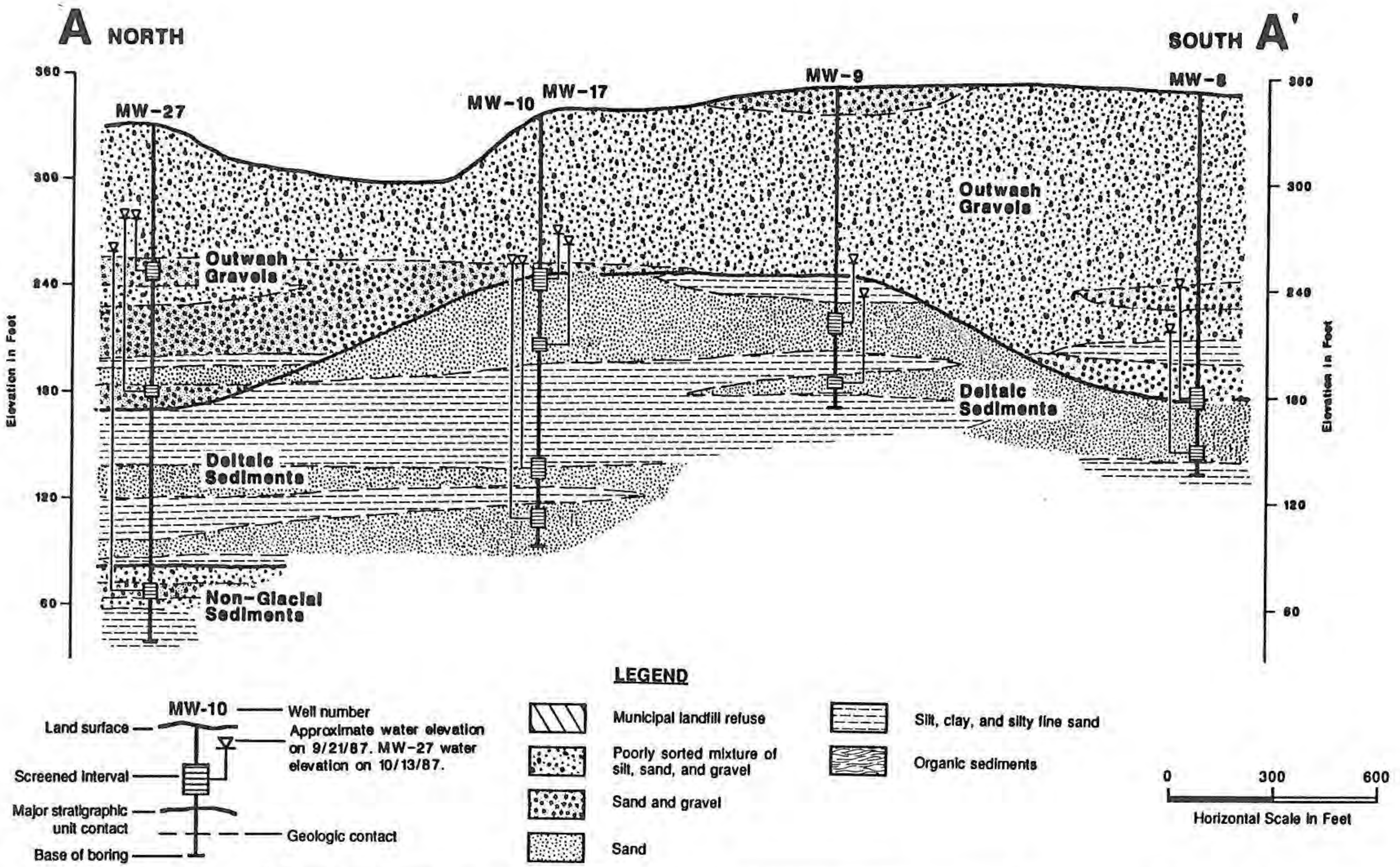
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Geologic Cross Section Locations

Midway Landfill
Kent, Washington

FIGURE
17

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	1 December 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

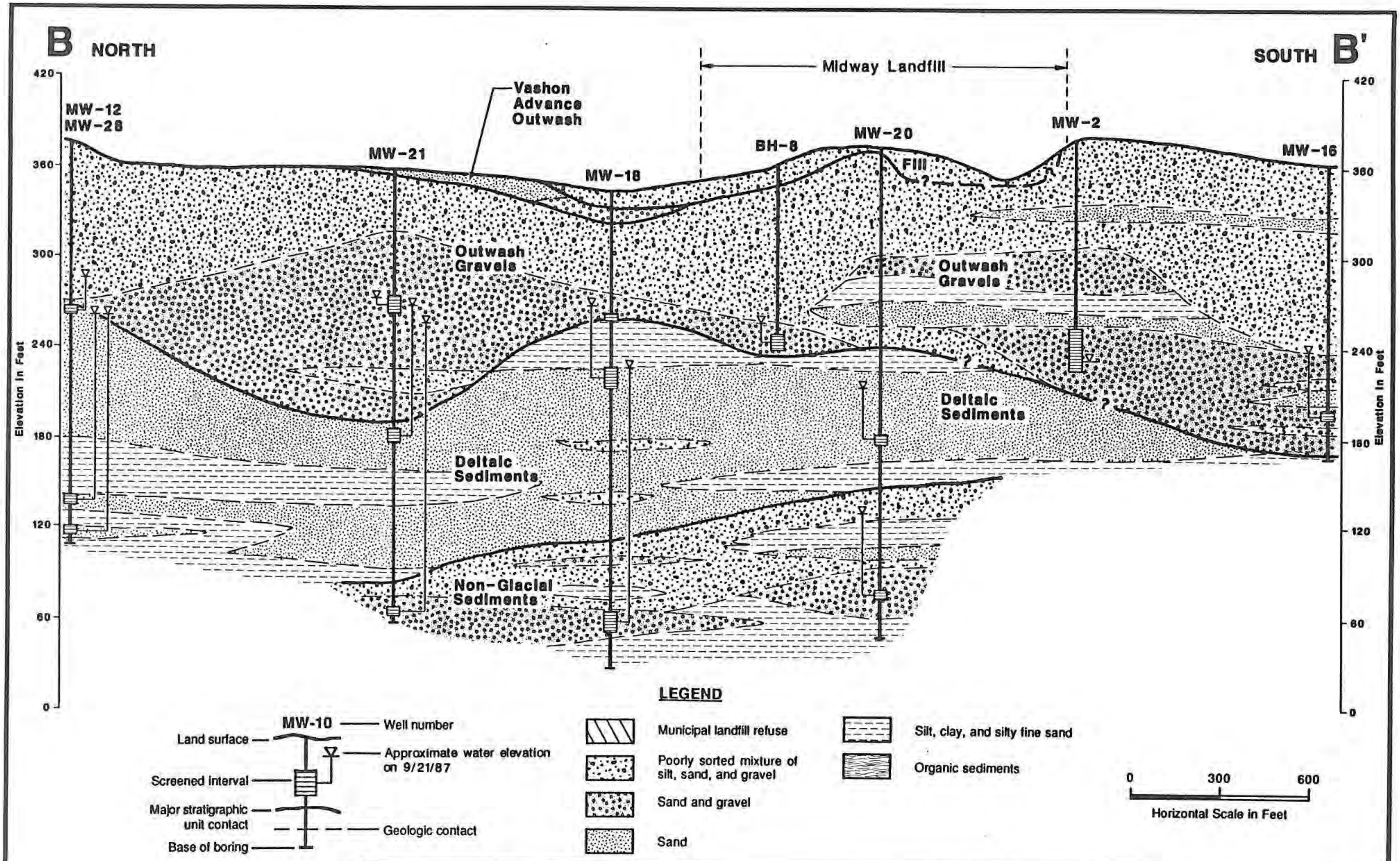
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Geologic Section A-A'

Midway Landfill
Kent, Washington

FIGURE
18

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

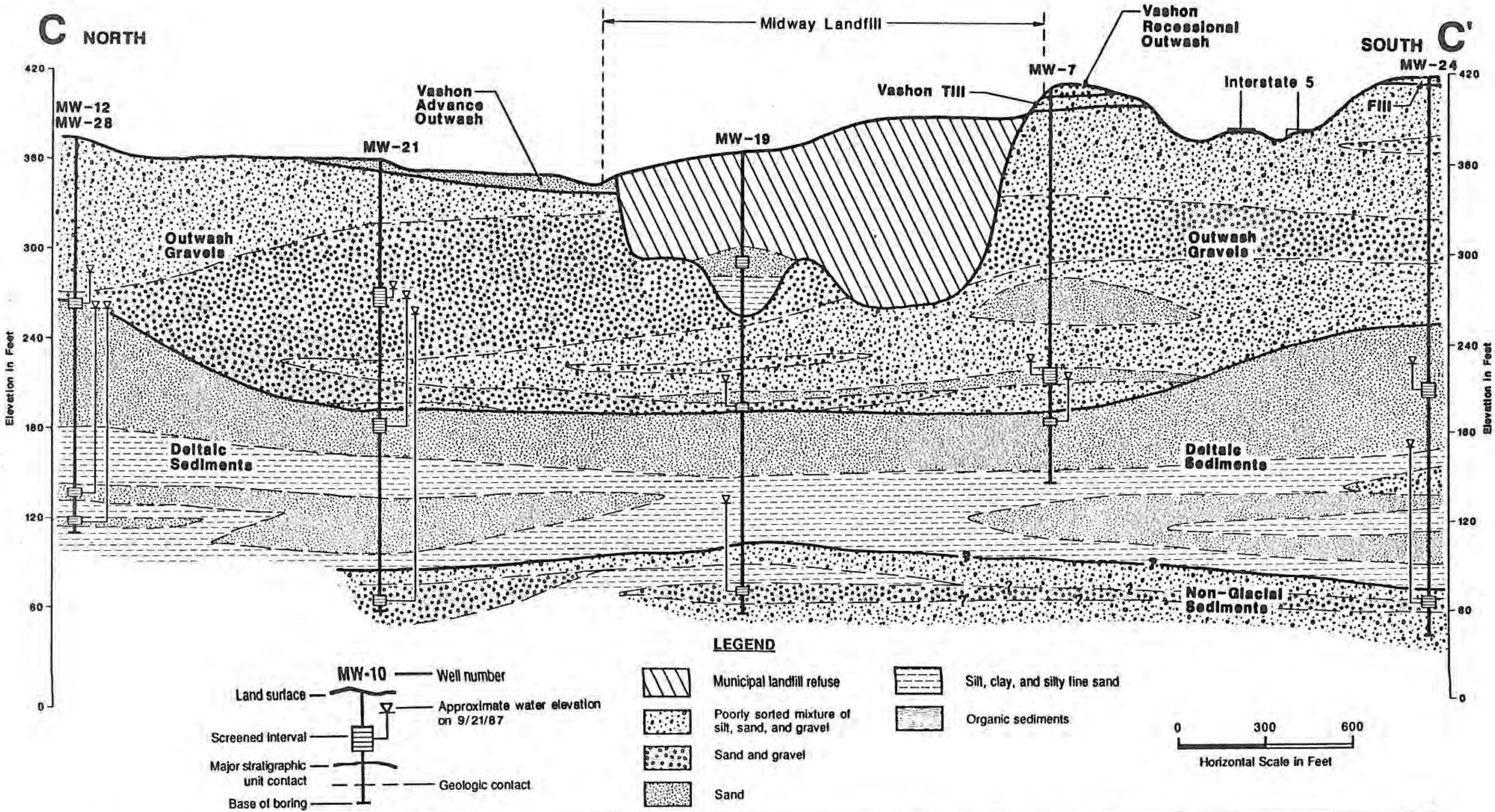
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Geologic Section B-B'

Midway Landfill
Kent, Washington

FIGURE
19

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

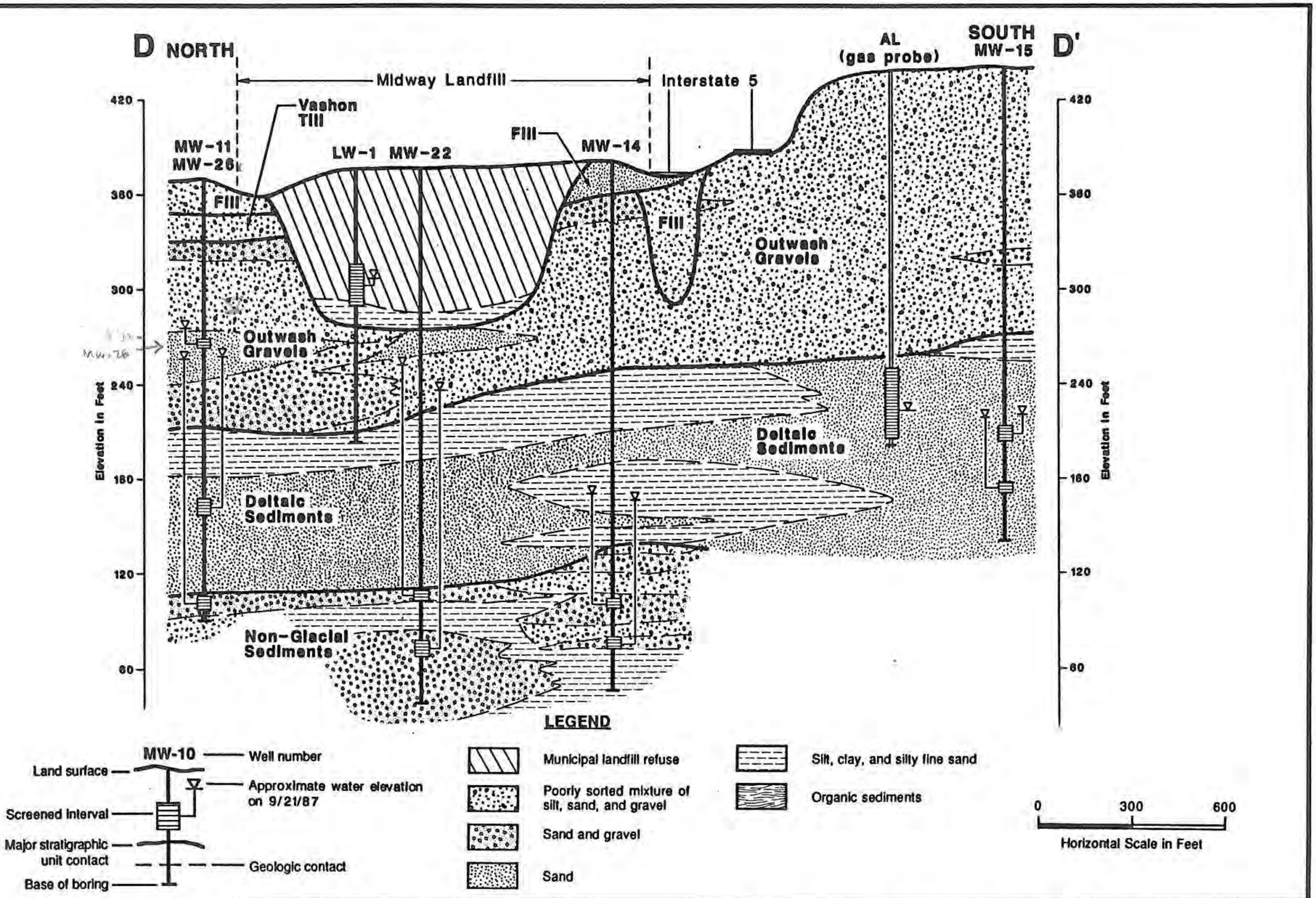
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Geologic Section C–C'

Midway Landfill
Kent, Washington

FIGURE
20

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

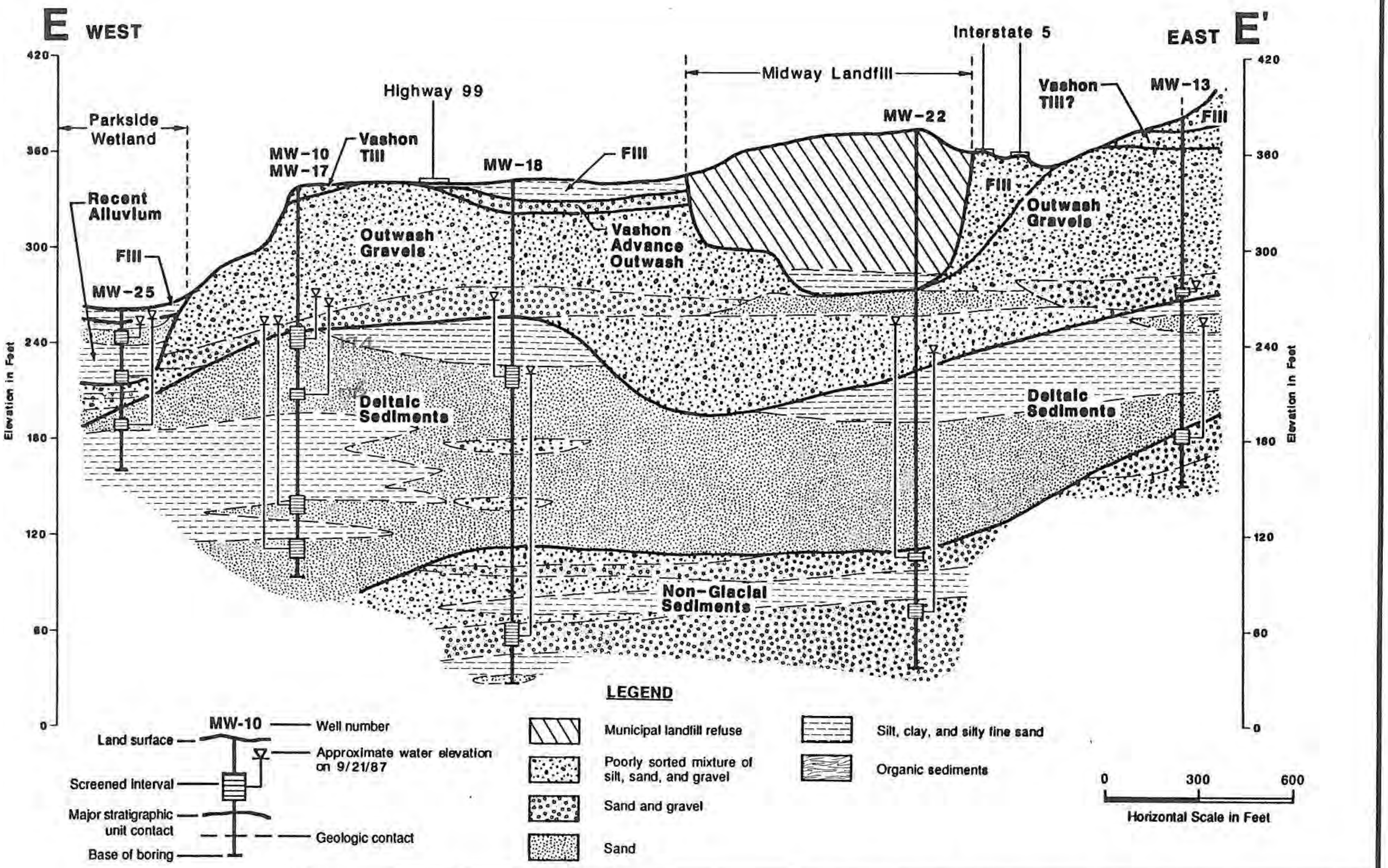
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Geologic Section D-D'

Midway Landfill
Kent, Washington

FIGURE
21

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

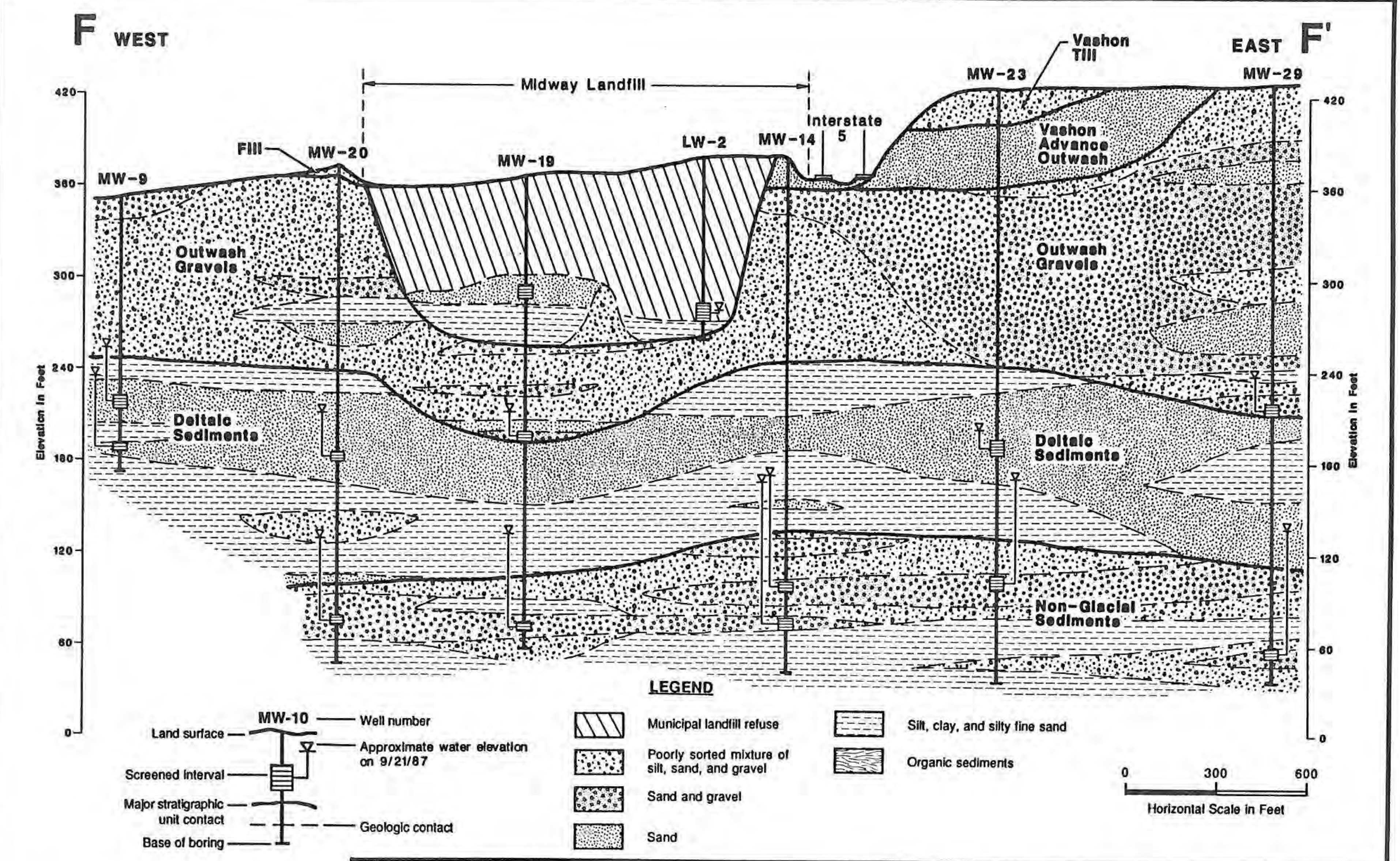
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Geologic Section E–E'

Midway Landfill
Kent, Washington

FIGURE
22

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Geologic Section F-F'

Midway Landfill
Kent, Washington

FIGURE
23

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		

5.0 GROUNDWATER

5.1 Regional Groundwater Conditions

The principal aquifers beneath the Des Moines Drift Plain are Vashon Advance Outwash Deposits and Salmon Springs Drift (Luzier, 1969). Vashon Advance Outwash consisting chiefly of well-sorted, fine to medium sand is exploited for groundwater production both north and south of the Landfill. Outwash channels eroded into older Pleistocene deposits and filled with Vashon Advance Outwash provide relatively high yields to production water supply wells in the Federal Way area, several miles south of the Landfill. However, Vashon Advance Outwash deposits have insufficient areal extent and saturated thickness at the Landfill to be suitable as a water supply aquifer.

Salmon Springs Drift occurs predominantly as coarse sand and gravel with lesser amounts of sand, silt, and till beneath the Des Moines Drift Plain. Much of the drift is densely consolidated with interstices filled by silt and clay. This material acts as an aquitard and is not suitable for groundwater production. However, highly permeable zones of coarse sandy gravel or open-work gravel occur throughout the Salmon Springs Drift. These zones are capable of yielding up to several thousand gallons per minute to production water supply wells. Little is known of potential aquifers located in older Pleistocene Deposits below Salmon Springs Drift. Some production water supply wells are completed in more permeable zones of the pre-Salmon Springs Deposits, however, there does not appear to be any widespread distribution of a single aquifer within these older deposits.

Drift similar to that mapped as Salmon Springs occurs at the Midway Landfill. This Drift includes the Outwash Gravels. While this deposit is fairly extensive throughout the area surrounding the Landfill, the majority of the Outwash Gravel acts as an aquitard. There appears to be insufficient lateral extent and saturated thickness in the more permeable zones within the Outwash Gravels to result in a suitable aquifer being present in this deposit. Test drilling for a potential City of Kent production water supply well (Linda Heights well) indicated that no suitable aquifer was encountered for production of water supply from land surface through the Vashon Advance Outwash, Outwash Gravels, and underlying older Pleistocene Deposits.

5.2 Study Area Groundwater Conditions

5.2.1 Introduction

This section of the report presents our findings and conclusions regarding groundwater occurrence and movement in the Study Area. Groundwater conditions in adjoining areas are also briefly discussed particularly as they relate to discharge conditions. However, subsurface information outside the Study Area is limited, so our conclusions regarding these areas are necessarily limited.

Because of the complex geologic conditions present in the Study Area and consequent complexity in aquifer definition and groundwater flow, a generalized overview of groundwater conditions is presented first in the next section (5.2.2), and is then followed in Section 5.2.3 with detailed descriptions and data presentation for each aquifer and aquitard.

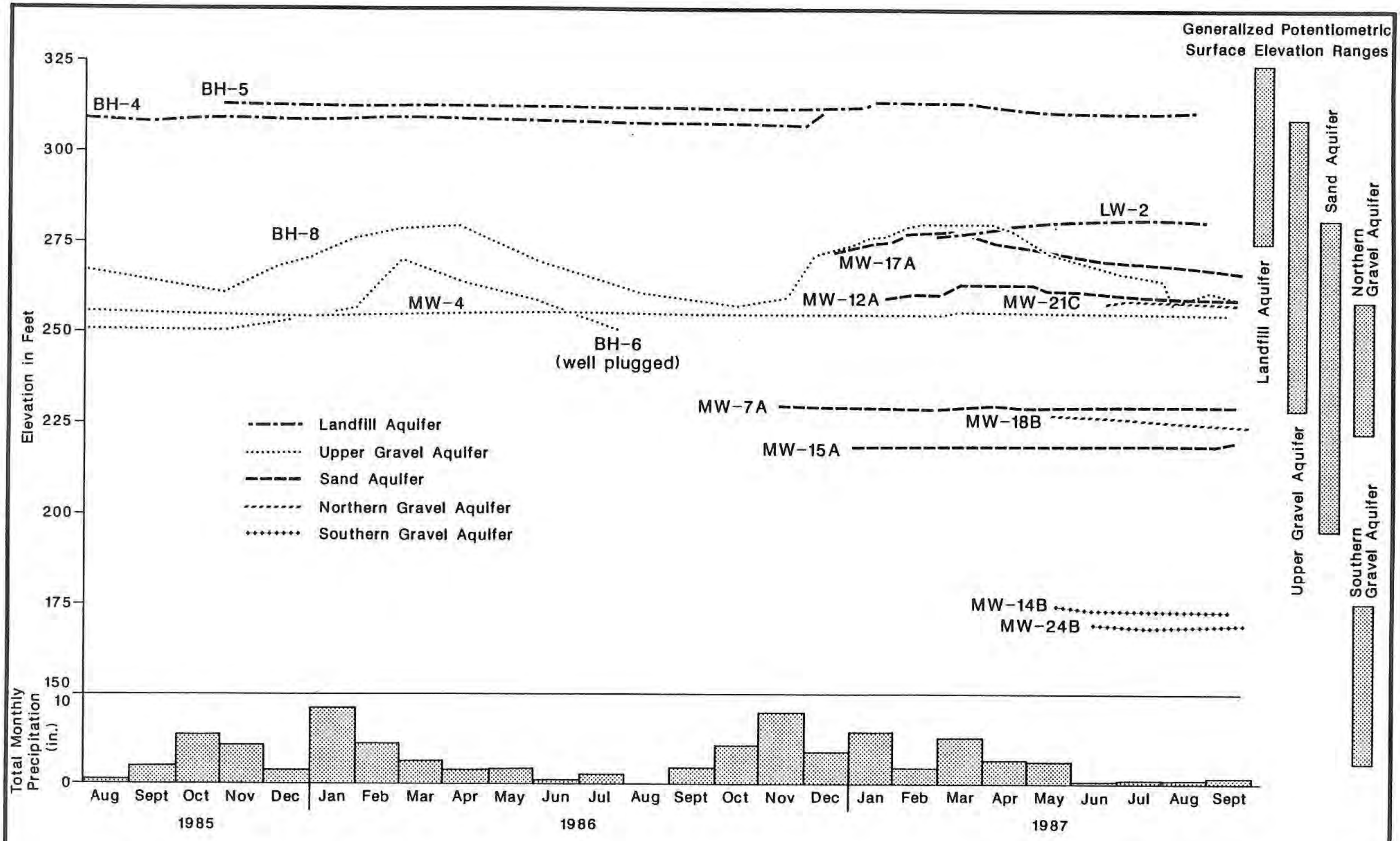
5.2.2 Overview of Groundwater Occurrence and Movement

Groundwater flow in the Study Area and adjoining portions of the Des Moines Drift Plain is highly complex, reflecting the complex interlayering of glacial and non-glacial deposits with widely varying geometry and hydraulic properties. Despite this complexity, a relatively clear picture has emerged of groundwater movement within the Study Area to an approximate depth of 300 to 350 feet (50 to 100 feet above Sea Level). As part of this picture, distinct hydrostratigraphic units have been defined within each of the geologic units on the basis of similar hydraulic properties or stratigraphic position, as follows:

Geologic Unit	Hydrostratigraphic Unit
Fill, Recent Alluvium, Vashon Recessional Outwash, Vashon Advance Outwash	Perched Aquifers
Midway Landfill	Landfill Aquifer
Outwash Gravels	Upper Gravel Aquitard Upper Gravel Aquifer
Deltaic Sediments	Upper Silt Aquitard Sand Aquifer Lower Silt Aquitard
Non-Glacial Sediments	Northern Gravel Aquifer Southern Gravel Aquifer

Figure 8 in Section 4.1 shows our interpretation of the relationship between these geologic and hydrostratigraphic units, and Figure 24 shows the relative elevations of the aquifer potentiometric surfaces. The following paragraphs provide a brief introduction to groundwater occurrence and movement within and between aquifers, and to regional discharge conditions. Detailed descriptions of each aquifer are presented in Section 5.2.3.

Perched aquifers generally represent the uppermost groundwater occurrence in the Study Area. Most perched aquifers are seasonally present within a few tens of feet of the land surface and are limited in thickness and lateral extent. They are consequently relatively unimportant to this investigation. However, there are two Perched Aquifers which are significant; one occurs in the Parkside Wetland and the other in Outwash Gravels immediately north of the landfill.



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Comparative Groundwater Elevations

Midway Landfill
Kent, Washington

FIGURE
24

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.001	ECR	MAA	18 Nov 87		

In the Parkside Wetland, saturated water bearing sediments extend essentially from land surface to approximately 10 to 20 feet deep. These sediments are underlain by much finer-grained sediments which act to isolate the Perched Aquifer from deeper groundwater. The Parkside Wetland appears to obtain most of its recharge from surface water runoff. A small percentage of recharge is also provided by discharge from underlying groundwater. Some groundwater may also discharge from springs or seeps along the western edge of the Wetland.

Perched water also occurs in the Outwash Gravels north of the Landfill. Water elevations in this zone typically range from 10 to 20 feet below land surface. The recharge source for this Perched Aquifer is not known, but appears to be to the north as groundwater flows toward the south, recharging both the Landfill and Outwash gravels.

Leachate perched at the base of the Midway Landfill is a distinct body of groundwater comprising the Landfill Aquifer. Leachate elevations are highest in the northern part of the Landfill and lowest in the southern part. The higher northern elevations reflect greater recharge in this area and the presence of a layer of fine-grained silt and clay at the base of the Landfill which retards downward leachate movement.

The overall flow pattern in the Landfill Aquifer is from the north and west towards a hydraulic sink in the south central portion of the Landfill. Leachate is discharging vertically downward in the area of the hydraulic sink. Leachate flow in the Landfill appears somewhat analogous to flow in a bathtub with the hydraulic sink corresponding to a bathtub drain.

Groundwater flowing downwards from the Landfill Aquifer enters the underlying Outwash Gravels to form the Upper Gravel Aquifer. The Upper Gravel Aquifer typically occurs near the base of the Outwash Gravels with groundwater under water table or slightly confined conditions. Groundwater flow in this aquifer is generally from the north to the south towards another hydraulic sink located beneath the southern half of the Midway Landfill. This sink coincides almost exactly with the hydraulic sink in the overlying Landfill Aquifer. Consequently, leachate in the Landfill Aquifer can flow directly down to the Upper Gravel Aquifer and then continue vertically downwards into the underlying Sand Aquifer.

In many parts of the Study Area, the Upper Gravel Aquifer is separated from the underlying Sand Aquifer by the Upper Silt Aquitard. The Upper Silt Aquitard consists of a sequence of fine-grained silts and silty fine sands occupying the uppermost part of the Deltaic Sediments. A linear window or gap in the aquitard passes north-south through the middle of the Study Area. Another window is located near MW-10/17. The hydraulic sink (described above) in the Upper Gravel Aquifer is located over part of the north-south window.

Sandy portions of the Deltaic Sediments comprise the Sand Aquifer. Groundwater in the Sand Aquifer is generally confined although it becomes unconfined in the southeastern part of the Study Area.

Horizontal groundwater flow in the Sand Aquifer is generally from the north to the southeast. A poorly defined groundwater divide occurs along the western edge of the Study Area with groundwater west of the divide possibly flowing to the southwest. Groundwater east of the divide flows southeastward toward yet another hydraulic sink located just east of the Landfill. Although this sink is not directly beneath the southern half of the Landfill as were the two sinks in the overlying aquifers, it is sufficiently close to represent a continuation of the vertical conduit for Landfill leachate.

In addition to horizontal flow, there is also a strong component of vertical flow in the Sand Aquifer. Preliminary flux calculations indicate vertical flow in many cases is equal to or greater than horizontal flow.

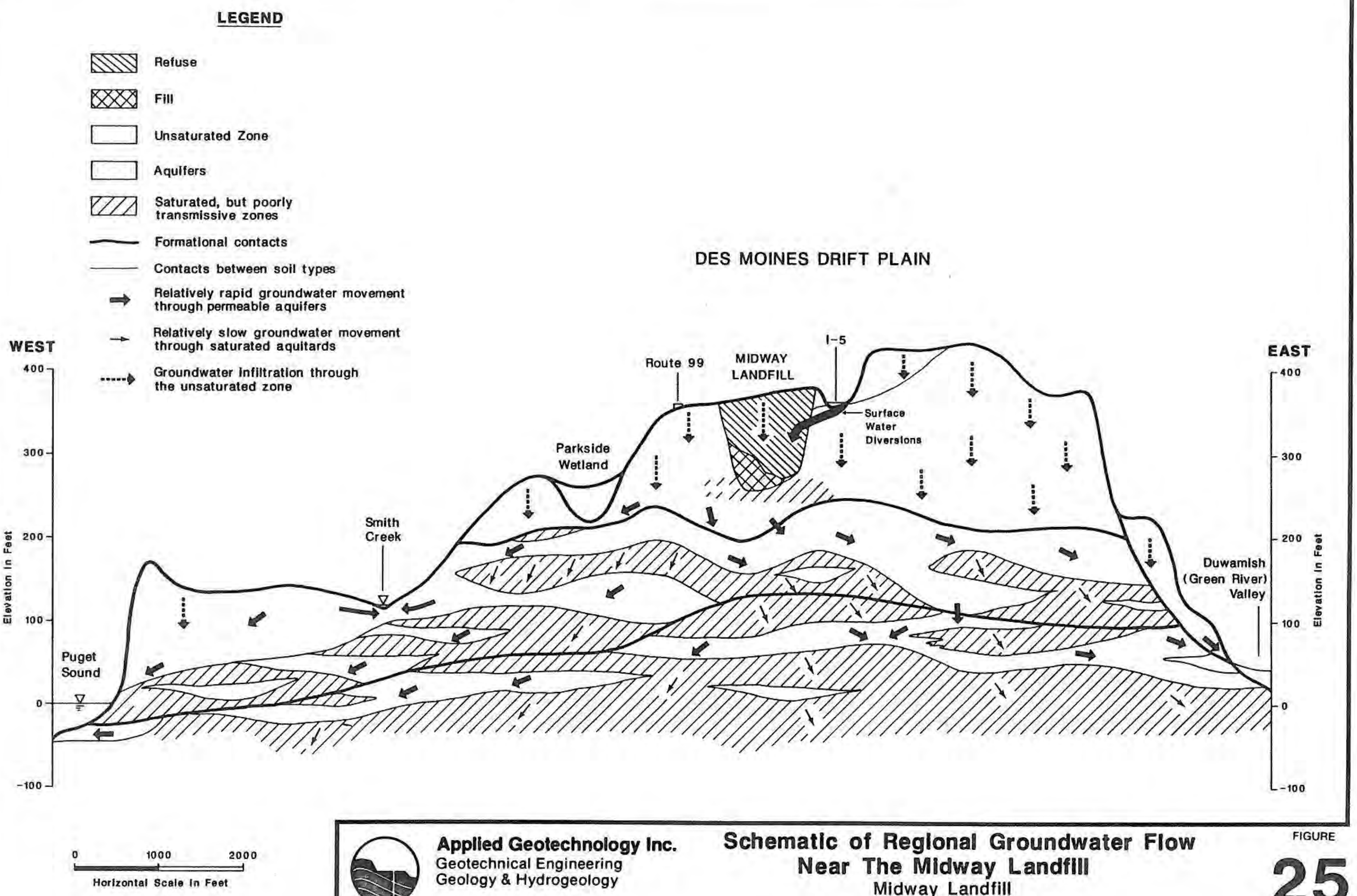
The Sand Aquifer sink apparently represents a window in the Lower Silt Aquitard, which directly underlies the Sand Aquifer between Elevations 100 and 180 feet in some areas. This aquitard is comprised of fine-grained deposits within the base of the Deltaic Sediments.

Groundwater migrating downwards out of the Sand Aquifer enters the deepest aquifers identified in the Study Area. These aquifers, designated the Northern and Southern Gravel Aquifers, occur in the Non-Glacial Sediments which underlie the Deltaic Sediments. Groundwater in the Northern Gravel Aquifer flows from north to south and appears to be truncated at an east-west line extending across the Study Area. The Southern Gravel Aquifer occurs south of this east-west line and groundwater in it flows to the east and west away from a mound or ridge located near the southeastern corner of the Landfill. The mound location coincides with the hydraulic sink in the overlying Sand Aquifer indicating downward vertical flow from the Sand Aquifer at this location.

The preceding discussion provides a general description of groundwater movement through the Study Area. Although the Study Area comprises a significant portion of the central Des Moines Drift Plain, groundwater pathways outside of the Study Area remain poorly understood. Figure 25 shows our interpretation of general groundwater flow conditions beneath and beyond the Study Area. As depicted, groundwater within the Drift Plain generally migrates downward and to the west towards Puget Sound, or to the east towards the Green River Valley.

The majority of groundwater recharge to the upland portions of the Drift Plain most likely discharges to one of these two features, with some portion migrating to deeper aquifers within the Pleistocene sequence. Some groundwater may be withdrawn by water supply wells.

Although extrapolating from site specific data to adjacent areas is difficult, we anticipate the principal potential groundwater discharge areas or sources near the Midway Landfill are:



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Schematic of Regional Groundwater Flow Near The Midway Landfill

Midway Landfill
Kent, Washington

FIGURE
25

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	12 December 88		

- Perennial streams or springs flowing to Puget Sound or the Green River Valley including Smith Creek and other smaller, unnamed drainages.

- Municipal water supply wells in the Federal Way and Des Moines areas.

- Domestic water supply wells in the Lake Fenwick area.

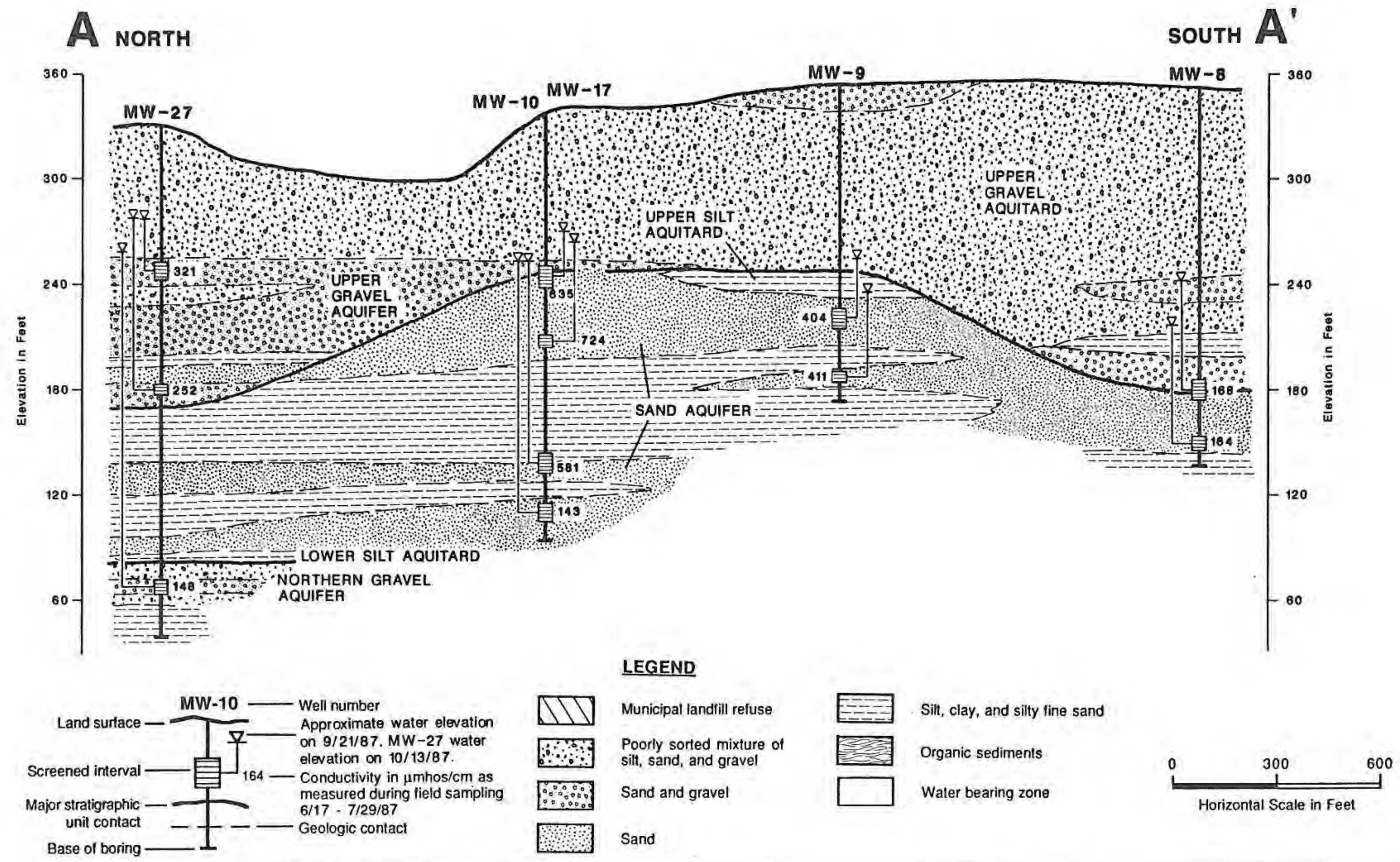
Several perennial streams near the Study Area drain the Drift Plain to both Puget Sound and the Green River Valley. These include Smith Creek, located southwest of the Landfill, an unnamed drainage south of Smith Creek, and an unnamed drainage to the northeast (Figure 2).

Base flow in these streams is likely comprised of groundwater discharge from aquifers identified in the Study Area. Smith Creek and the unnamed drainage northeast of the Landfill sustain perennial flows below Elevation 250 and Elevation 225, respectively. These elevations correspond closely to the approximate elevation of the Sand Aquifer potentiometric surface. Although no Sand Aquifer monitor wells are located sufficiently close to these streams to confirm this relationship, available data suggest discharge from this aquifer is the most likely source for these two streams' base flows.

The unnamed drainage south of Smith Creek flows perennially below approximately Elevation 150. Discharge from the Sand Aquifer, if present at this location, would also most likely be responsible for this stream's base flow.

5.2.3 Groundwater Occurrence

General: This section presents detailed information concerning the occurrence and distribution of aquifers and aquitards identified in the Study Area. Detailed hydrogeologic cross sections through the Study Area showing our interpretation of groundwater conditions are included on the following pages as Figures 26 through 31.



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

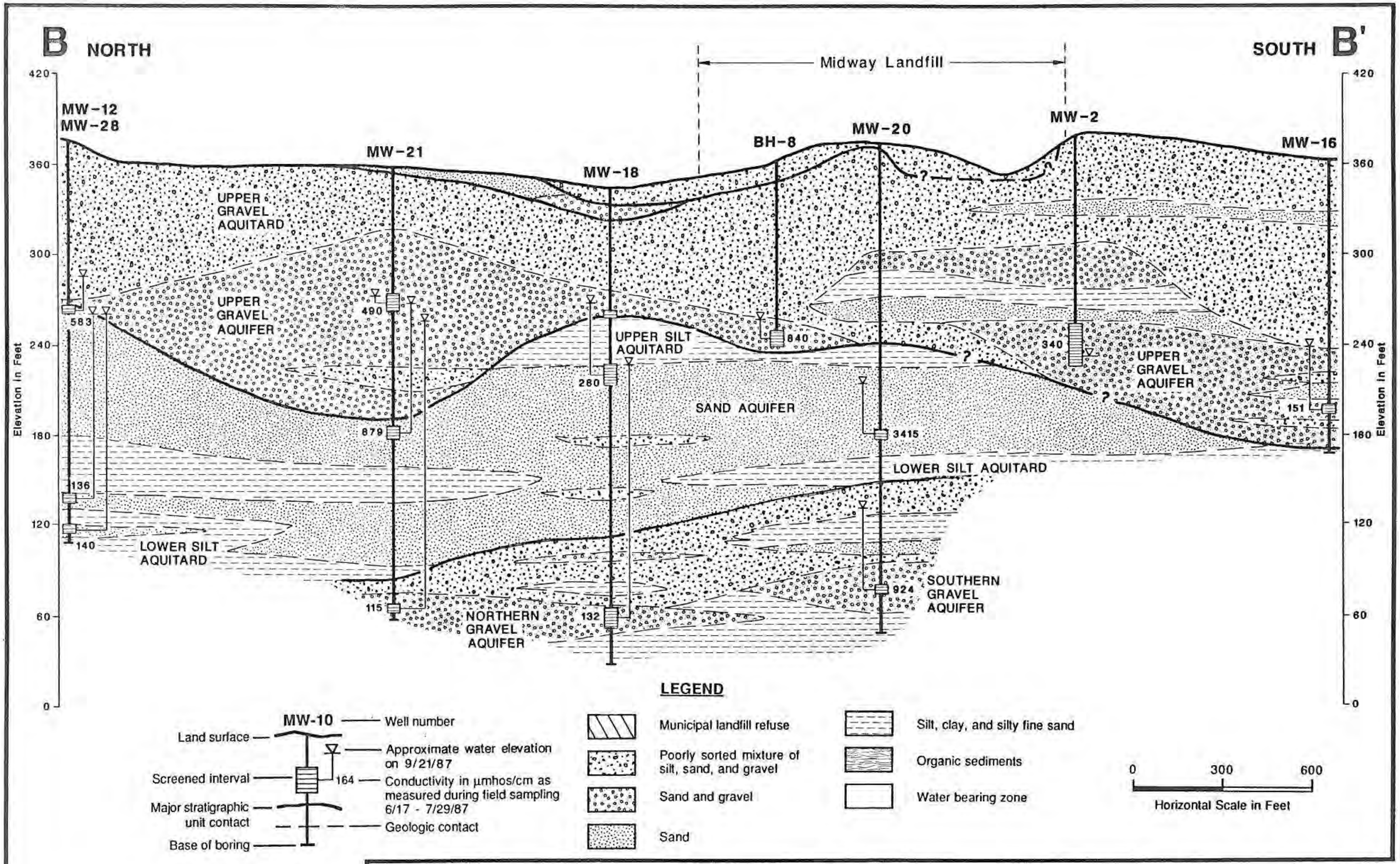
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Hydrogeologic Section A-A'

Midway Landfill
Kent, Washington

FIGURE
26

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

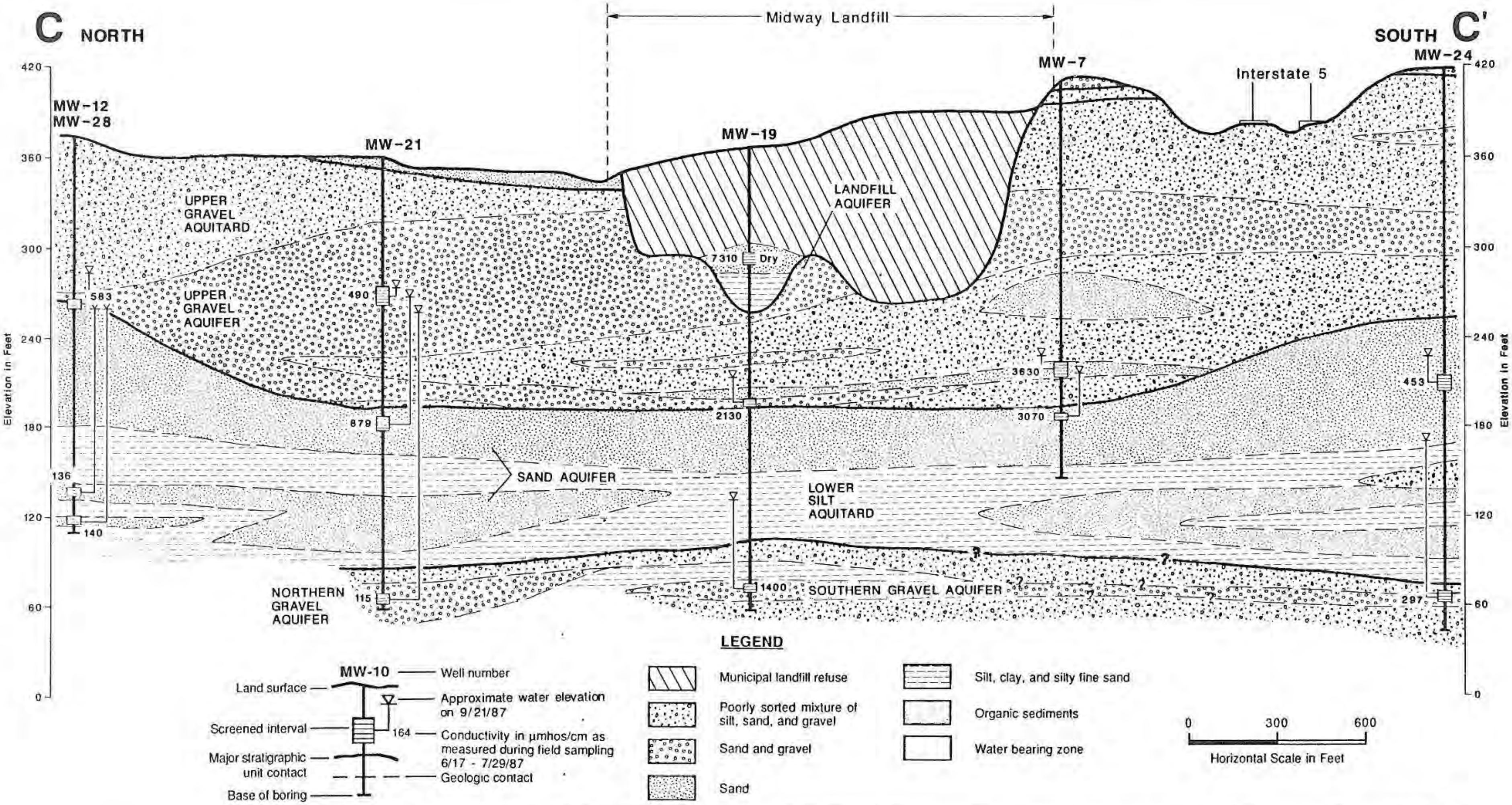
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Hydrogeologic Section B-B'

Midway Landfill
Kent, Washington

FIGURE
27

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

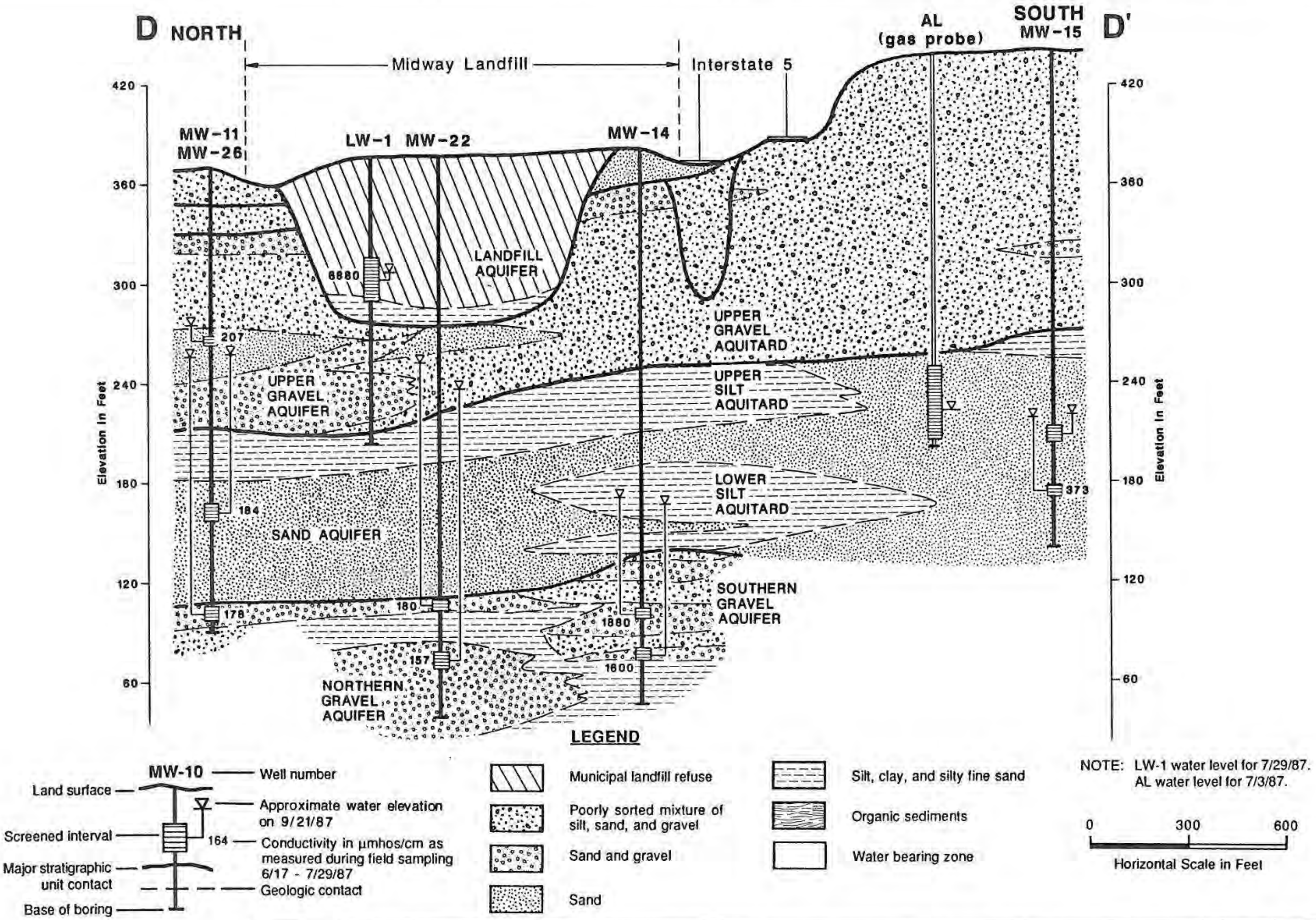
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Hydrogeologic Section C–C'

Midway Landfill
Kent, Washington

FIGURE
28

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

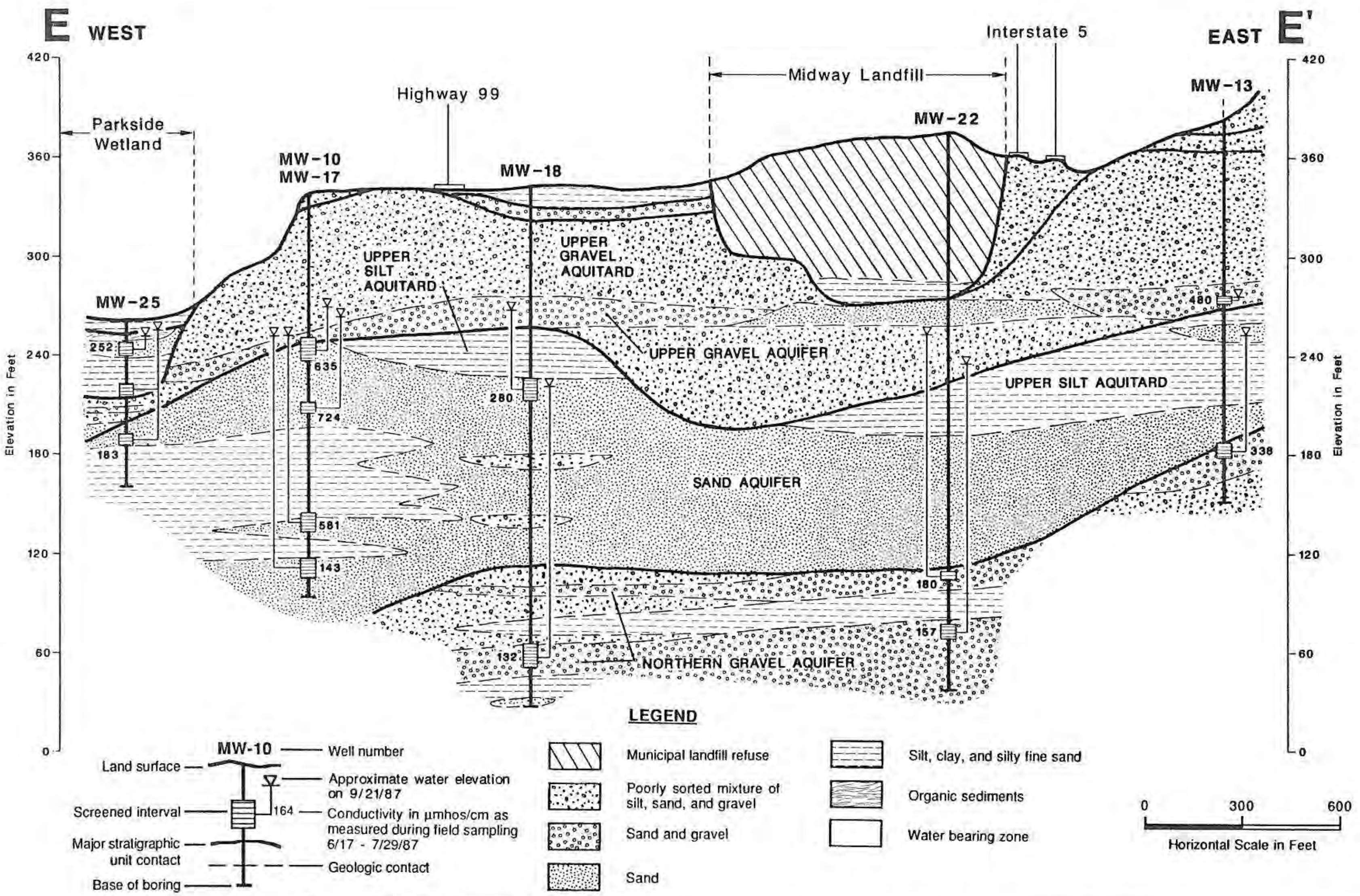
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Hydrogeologic Section D–D'

Midway Landfill
Kent, Washington

FIGURE
29

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

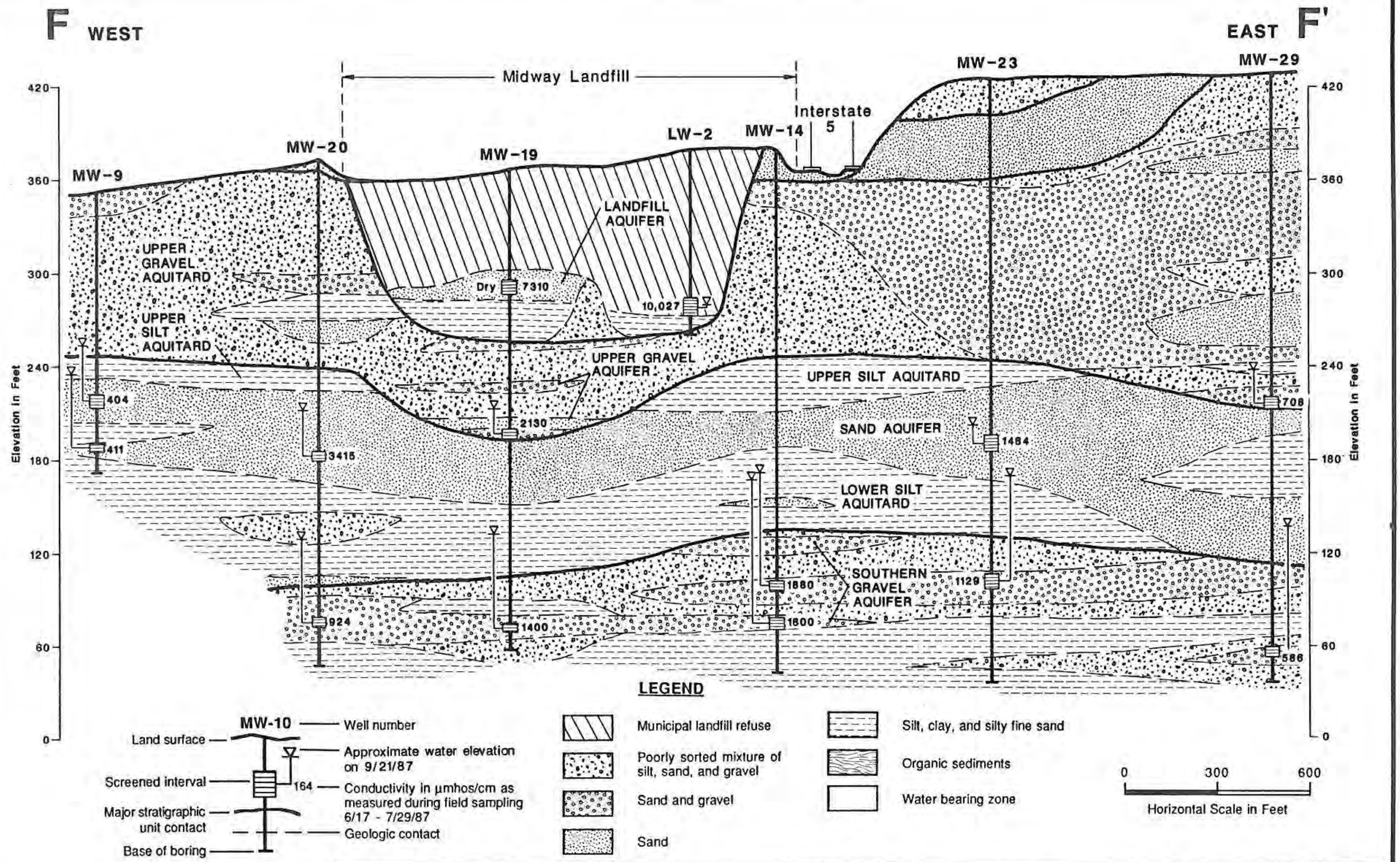
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Hydrogeologic Section E-E'

Midway Landfill
Kent, Washington

FIGURE
30

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		



NOTES:

1. For cross section location refer to Figure 17.
2. This cross section is a diagrammatic interpretation of subsurface conditions based on interpolation and extrapolation between borings. Geologic and hydrologic conditions are substantially more complex than depicted.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Hydrogeologic Section F-F'

Midway Landfill
Kent, Washington

FIGURE
31

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB/KER	MAA	1 Dec 87		

<u>Perched Aquifers:</u> Perched Aquifers occur as near-surface seasonal groundwater bodies present around the Landfill, and perched on unweathered Vashon Till or Outwash Gravels. Perched groundwater typically occurs near the base of Fills, Vashon Recessional Outwash, or in other permeable surficial soils underlain by less permeable soils. Some perched zones also occur at the contact between Vashon Advance Outwash and the Outwash Gravels because the Outwash Gravels are typically less permeable. We anticipate the maximum saturated thickness of these Perched Aquifers does not exceed a few feet.

There are also zones of perched water within the Parkside Wetland and the generally unsaturated upper portion of the Outwash Gravels. Most of the perched water bodies in the Outwash Gravels are limited in extent. However, one extensive body of perched groundwater is located immediately north of the Landfill between Well MW-21 and MW-11.

This northern groundwater body was first encountered at 35 feet below land surface while drilling MW-11. Field notes recorded during drilling indicated substantial groundwater, and there was some discussion as to whether we had drilled into an unknown storm drain, although no drain or pipe fragments were ever found. Parametrix subsequently encountered the same groundwater zone at about the same depth while drilling gas probes AP through AR and the PC series gas wells (see Figure 6, Groundwater Monitoring Locations)(Carey, 1987, 1988). This zone was not encountered, however, in either MW-21 or in MW-26.

Water levels in MW-11., in many of the A series gas probes, and in some of the PC series gas probes rose above the top of the elevation at which groundwater was first encountered, indicating the groundwater was confined. Groundwater elevations in the Perched Aquifer ranged from 12 to 20 feet below land surface; groundwater elevations in the underlying main body of the Upper Gravel Aquifer were 50 to 60 feet lower. Comparison of geologic logs from the monitoring well and gas probes also indicates this confined zone was approximately 45 to 55 feet thick, and was perched on a thin layer of silty gravel and silt. Landfill Cross Sections AA-AA' and BB-BB' show these relationships.

The recharge source for this perched/confined water bearing zone is not known, nor is its extent defined. However, water elevations in this zone decrease to the south towards the Landfill suggesting it flows into and is a recharge source for the Landfill Aquifer.

An atypical "perched" groundwater body occurs in the Recent Alluvium filling the Parkside Wetland, as shown on Hydrogeologic Cross Section E-E'. Our explorations and available water level data indicate the water table in this area is near land surface (the Wetland is often flooded during the winter), and the sediments are essentially saturated from the water table downwards to the Sand Aquifer. Groundwater in the Recent Alluvium is therefore technically not perched. However, the lower 25 feet of the Recent Alluvium is much less permeable than the upper portion and functions as an effective aquitard. Groundwater in the upper part of the Recent Alluvium can therefore be considered perched and likely has only limited hydraulic connection to the deeper aquifers.

Landfill Aquifer: Leachate forms a nearly continuous body of water at the base of the Landfill, and as scattered perched bodies within the Landfill, as shown on Landfill Cross Sections AA-AA' and BB-BB' (Section 4.2). This body of leachate is defined as the Landfill Aquifer. Although there is insufficient data to determine leachate saturated thickness and flow conditions throughout the year, data gathered in February, 1987 showed leachate elevations in the northern half of the Landfill an average of 30 to 40 feet higher than in the southern half. The difference in elevation is the result of several factors:

- The base of the northern portion of the gravel pit is higher in elevation than the southern portion.
- The fine-grained pond sediments in the Lake Meade area likely act as an aquitard to perch leachate.
- The dike used to separate the Lake Meade area from the rest of the gravel pit may still be partly or wholly intact. This dike is shown as an unquarried remnant on Landfill Section BB-BB'.
- The northern part of the Landfill receives direct recharge from surface water runoff and from perched water in the Outwash Gravels north of the Landfill, as described previously.

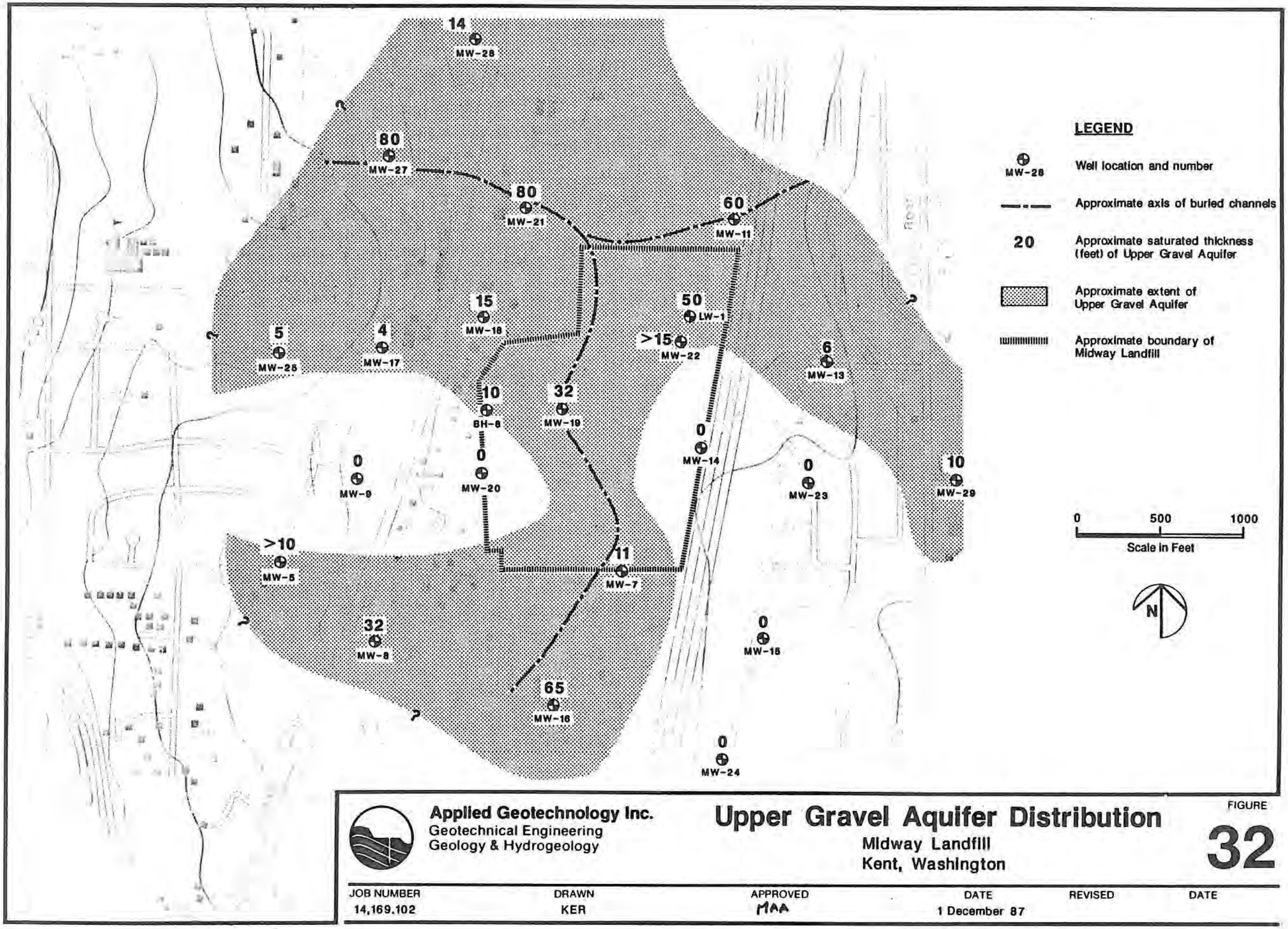
Leachate thicknesses also generally appear to increase from east to west within both the southern and northern portions of the Landfill, in accordance with the general deepening of the original gravel pit excavation. A maximum saturated thickness of 40 feet was observed in the north half of the Landfill.

Upper Gravel Aquitard: The Outwash Gravels, particularly the upper portion, are predominantly low permeability "silt bound" gravels which tend to retard groundwater movement. The upper unsaturated portion of this deposit is therefore defined as the Upper Gravel Aquitard.

The Upper Gravel Aquitard typically occurs as 50 to 100-foot thick beds of silty gravel interbedded with more permeable sand and sandy gravel zones, as shown on Hydrogeologic Cross Sections A-A' through F-F'. These gravels can be seen in the gravel pit photograph included in Section 4.0 as Figure 15. The maximum observed thickness of continuous silty gravel was nearly 180 feet at MW-15; the minimum was 40 feet at MW-21. The Upper Gravel Aquitard extends from near land surface to the first major bodies of permeable gravel which typically occur near the base of the Outwash Gravels. The base of the Upper Gravel Aquitard therefore ranges from Elevation 240 to 330 feet.

Upper Gravel Aquifer: The first major aquifer occurs near the base of the Outwash Gravels within the buried channel and tributary channels described in Section 4.2.8; only a small portion of the aquifer occurs outside the buried channel. The greatest saturated thicknesses occur at the north end of the buried channel, as shown on Figure 32, Upper Gravel Aquifer Distribution, where up to 80 feet of groundwater was observed near MW-27 and MW-21. Gravels occupying the north end of the channel in this area are of relatively high permeability compared to the Upper Gravel Aquifer in other areas.

Groundwater occurs in the Upper Gravel Aquifer generally under water table or only slightly confined conditions. Consequently, the upper surface of this aquifer can be considered as the top of the uppermost aquifer beneath the Landfill.



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

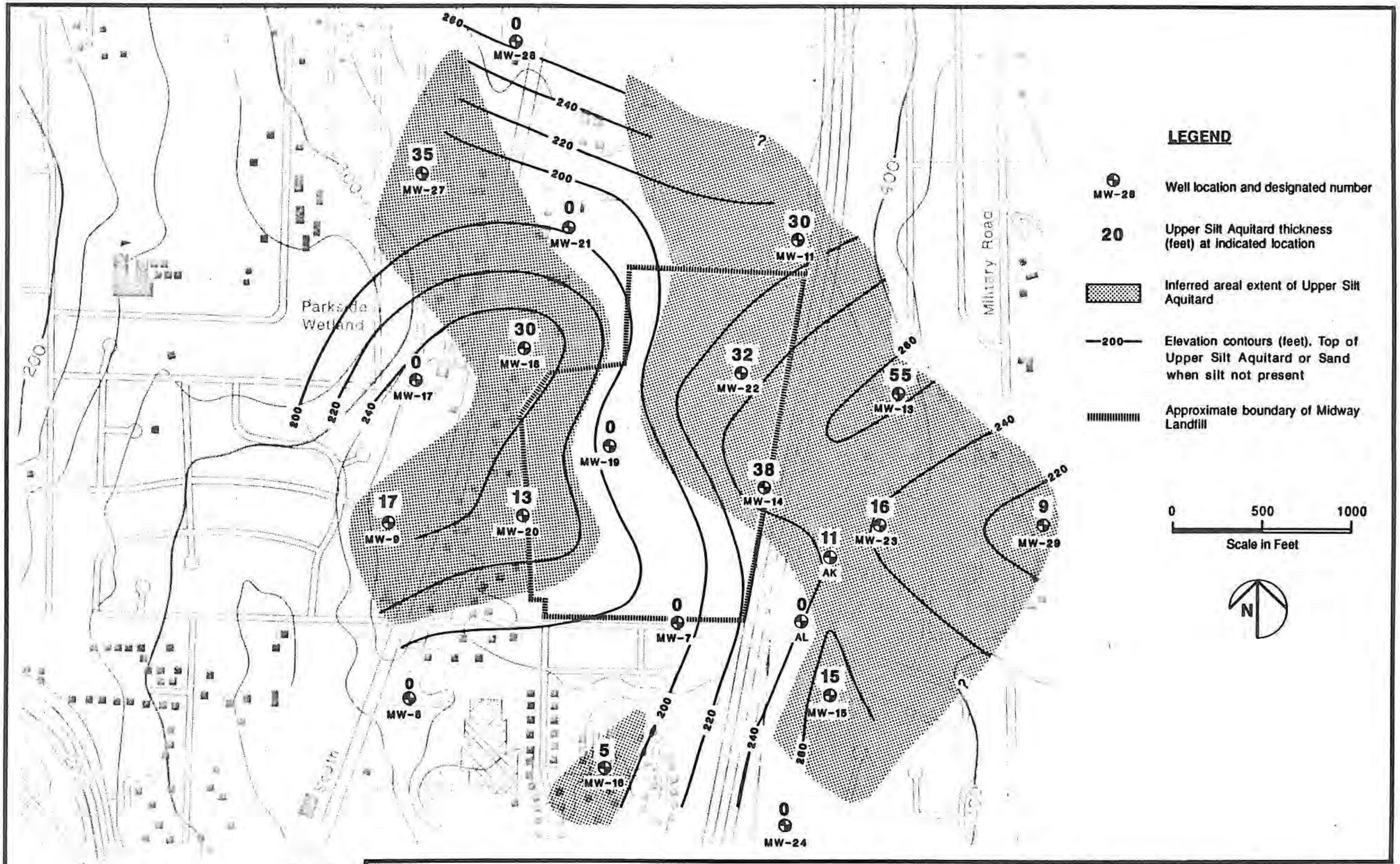
Upper Gravel Aquifer Distribution

Midway Landfill
Kent, Washington

FIGURE
32

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	1 December 87		

Upper Silt Aquitard: A 5 to 40-foot thick sequence of fine grained silt and silty fine sand designated as the Upper Silt Aquitard underlies the Upper Gravel Aquifer throughout much of the Study Area. This aquitard represents the uppermost part of the Deltaic Sediments. The aquitard thickness is shown in plan view on Figure 33, Upper Silt Aquitard Distribution and in cross section on the Hydrogeologic Cross Sections. Figure 33 also shows the topography of the upper surface of the Deltaic Sediments if the Outwash Gravels were stripped from the Study Area. As illustrated, the aquitard is absent in a band extending north-south through the Landfill and throughout most of the area south of the Landfill. This north-south "window" in the Upper Silt Aquitard coincides to a large extent with a topographic low (which corresponds to the buried channel in the Outwash Gravels), suggesting the Upper Silt Aquitard was eroded from this area during deposition of the Outwash Gravels. There is also a window in the Aquitard west of the Landfill near MW-17.



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Upper Silt Aquitard Distribution

Midway Landfill
Kent, Washington

FIGURE
33

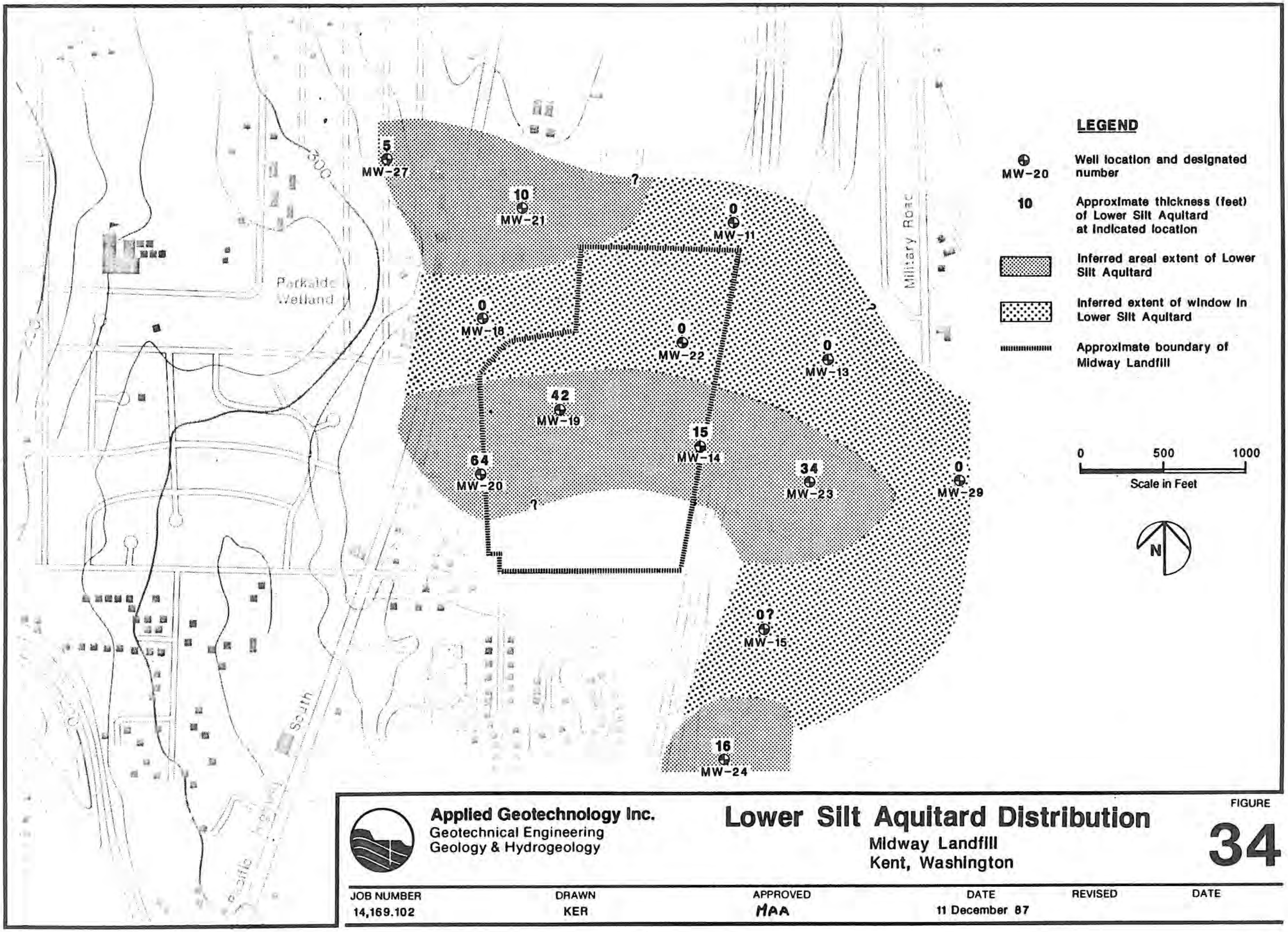
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	SM	MAA	30 November 87		

Sand Aquifer: The Sand Aquifer consists of saturated portions of the Deltaic Sediments underlying the Upper Silt Aquitard or the Outwash Gravels. Groundwater in this aquifer generally occurs under confined conditions; however, unconfined or water table conditions prevail in the southeastern portion of the Study Area.

The top of the Sand Aquifer generally occurs between Elevations 180 and 240 feet, as shown on the Hydrogeologic Sections. The base typically occurs between Elevations 90 and 110 feet, but in some areas rises to above 180 feet.

Sand Aquifer thickness and lithology vary considerably throughout the Study Area. In some locations, the aquifer consists of up to 80 feet of relatively uniform sand; in other areas, there are 20 to 30 foot thick sand beds interbedded with 10 to 30-foot beds of silt or silty fine sand. However, in most areas there is at least one relatively continuous deposit of sand ranging ranging from 30 to 80 feet thick. The sand and silt beds are not as uniform as shown on the hydrogeologic cross sections. They actually include a variety of lithologies, but have been grouped into either predominantly sand or predominantly silt units to facilitate hydrogeologic interpretation.

Lower Silt Aquitard: Fine-grained silt and silty sand occurs in many parts of the Study Area between Elevations 100 and 180 feet. These fine-grained sediments, collectively called the Lower Silt Aquitard underlie the Sand Aquifer in many areas (see Figure 31) and interfinger with it in others (see Figure 27). The Lower Silt Aquitard ranges in thickness from 0 to a maximum of approximately 50 feet. The thickness and inferred areal distribution of the Lower Silt Aquitard is shown on Figure 34. As illustrated, maximum thicknesses are located beneath the south central portion of the Landfill and directly east of the Landfill. The aquitard appears to be absent in a band extending across the north part of the Landfill and in the eastern part of the Study Area.



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Lower Silt Aquitard Distribution

Midway Landfill
Kent, Washington

FIGURE
34

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	11 December 87		

Northern and Southern Gravel Aquifers: Groundwater occurs under confined conditions in gravel beds within the Non-Glacial Sediments. The gravel beds typically range from 5 to 30 feet thick and are separated by intervening lower permeability silty sandy gravel and silt beds. There are no apparent lithologic differences between gravel beds in the northern and southern part of the Study Area, but they have substantially different potentiometric heads, electrical conductivities (i.e. total dissolved solids content), and groundwater flow directions. Potentiometric heads in the northern part of the Study Area average 90 feet higher than in the southern part, while electrical conductivities in the north are typically an order of magnitude lower than those in the south. Based on these observations, we have defined two separate aquifers, the Northern Gravel Aquifer and the Southern Gravel Aquifer. The apparent boundary separating the two aquifers trends east-west across the middle of the Landfill between Wells MW-18 and MW-19.

The entire sequence of non-glacial sediments at each well location is considered part of either the Northern or Southern Gravel Aquifer. This includes the intervening, less permeable silty sandy gravel and silt beds. Consequently, each aquifer is characterized by a mixture of less and more permeable deposits.

5.2.4 Groundwater Recharge, Movement and Discharge

Recharge From Surface Water and Precipitation: Significant groundwater recharge occurs in the Study Area through rainfall infiltration. All precipitation falling onto the Landfill surface either infiltrates directly or runs off to the North and Middle Ponds where it infiltrates or evaporates; there is no surface water runoff away from the Landfill. Precipitation in the areas surrounding the Landfill also infiltrates and evapotranspires, but some of it is captured in storm drains and carried out of the Study Area.

In areas surrounding the Landfill, some infiltrating water is temporarily detained in the seasonal Perched Aquifers described previously. The remaining infiltrating water passes directly through the Vashon Advance Outwash and enters the Outwash Gravels.

The upper part of the Outwash Gravels (Upper Gravel Aquitard) generally appears to retard vertical groundwater movement. However, there are zones of clean sandy gravel or open-work gravel which readily transmit water. The degree to which these permeable soils are interconnected is not known; however, infiltrating water likely passes preferentially downward through these more permeable zones, eventually reaching the Upper Gravel Aquifer.

Landfill Aquifer: Recharge to the Landfill Aquifer occurs through discharge of storm water into the Landfill, infiltration through the cap and North Pond, and lateral flow from the area of perched groundwater in the Outwash Gravels north of the Landfill. No recharge occurs from the Upper Gravel Aquifer since most of it is below the Landfill. Of these recharge sources, storm water discharge into the Landfill and infiltration through the North Pond probably comprise the largest volume of recharge.

Historical plans from WDOT show that surface water collected in a catch basin near Linda Heights Park is discharged directly into the north end of the Landfill through a 30-inch culvert (as described previously in Section 2.2). The culvert depth is not known, but it was likely located on the native ground surface prior to fill placement for I-5. Consequently, the culvert probably lies 90 to 100 feet below existing land surface at the base of the Landfill.

The drainage basin discharging through the Linda Heights park culvert is called the Eastside Basin, and includes approximately 102 acres of land (Parametrix, Inc. 1987). Annual discharges from this area and the annual recharge to the Landfill may be 40 to 55 million gallons based on 40 inches precipitation per year over the 102-acre area and on a runoff coefficient in the range of .35 to .5.

The North Pond also likely represents another major source of recharge to the Landfill. The North Pond receives stormwater and runoff from an approximately 87-acre area known as the I-5 Corridor Basin (Parametrix 1987). Since the North Pond has no outlet, a majority of water entering the pond likely infiltrates. We estimate recharge from this source as ranging between 30 and 45 million gallons per year based on the same parameters described previously.

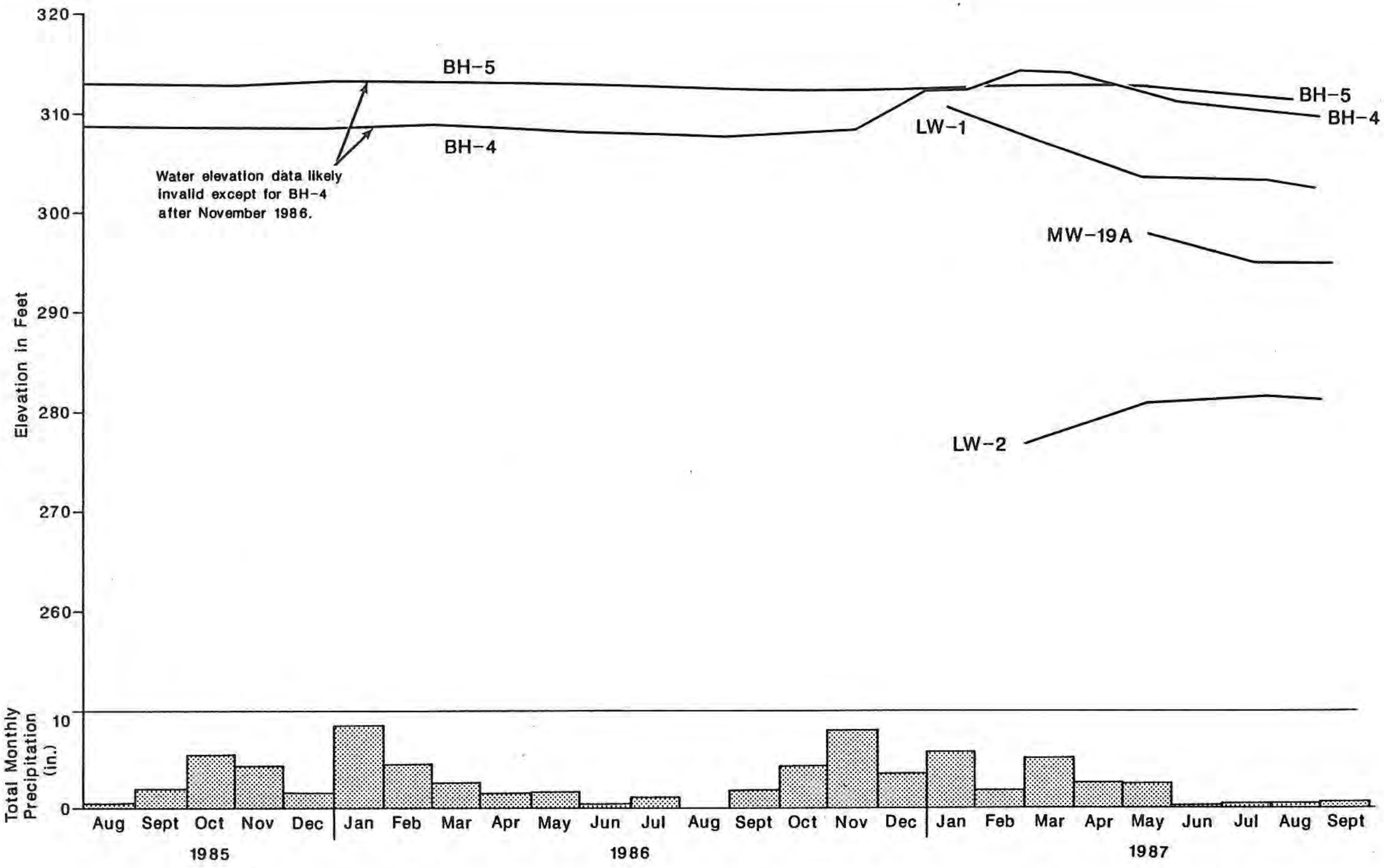
Limited water level monitoring in leachate wells LW-1 and LW-2, located in the landfill also support storm water discharge and infiltration into the northern part of the Landfill as a major recharge source (Parametrix, 1987). Continuous water level records in Well LW-1 showed water level rises ranging from 0.3 to 2.7 feet within approximately 20 to 40 hours after the beginning of a storm. The magnitude of the rise was directly proportional to the amount of precipitation. In LW-2, by contrast, water levels did not visibly respond to storms. These water level data and historical information on culvert locations suggest that most recharge occurs at the north end of the Landfill due to the recharge from the I-5 Corridor Basin and the Eastside Basin.

Direct precipitation onto the Landfill also serves as a major source of recharge to the Landfill as a whole. We estimate annual recharge from this source to be in the range of 50 to 70 million gallons. This estimate is greater than recharge from either the I-5 corridor or the Eastside Basin alone, but is less than the two combined.

Leachate elevations are generally highest in the northern part of the Landfill and are lowest in the southern part as illustrated on Figures 35 and 36. Figure 36 shows the configuration of the Landfill Aquifer potentiometric surface in February, 1987 (Figures 11 and 12, in Section 4.2, also show the potentiometric surface in cross section). As illustrated, the potentiometric surface closely resembles the 1966 gravel pit topography, and shows leachate flowing from the north and west towards a hydraulic sink in the southeastern part of the Landfill. Leachate is apparently discharging vertically downwards into the underlying Upper Gravel Aquifer at this location. During the early stages of this investigation, the Landfill Aquifer was conceptualized as mounded and draining outwards around the exterior edge of the Landfill. The actual potentiometric surface configuration does not support this concept and instead suggests internal drainage with the Landfill acting as a "bathtub".

Groundwater velocities within the Landfill Aquifer are difficult to calculate since only limited and widely variable hydraulic conductivity data is available (see Section 5.2.4, Hydraulic Parameters).

Groundwater movement within the Landfill Aquifer is primarily a function of the original gravel pit topography, recharge sources, hydraulic conductivity variations within the Landfill, and the spatial distribution of fine-grained wash pond sediments near the base of the Landfill. The higher leachate elevations in the northern part of the Landfill are primarily due to greater recharge in this area and to the perching action of the fine-grained pond sediments underlying the refuse. The Landfill base elevation is also highest in the north and west, and is lowest in the kidney-shaped area originally present in the southeastern part of the gravel pit. The hydraulic sink in this low area is probably due to a lack of fine-grained silts or clays at the base of the Landfill.



Water elevation data likely invalid except for BH-4 after November 1986.

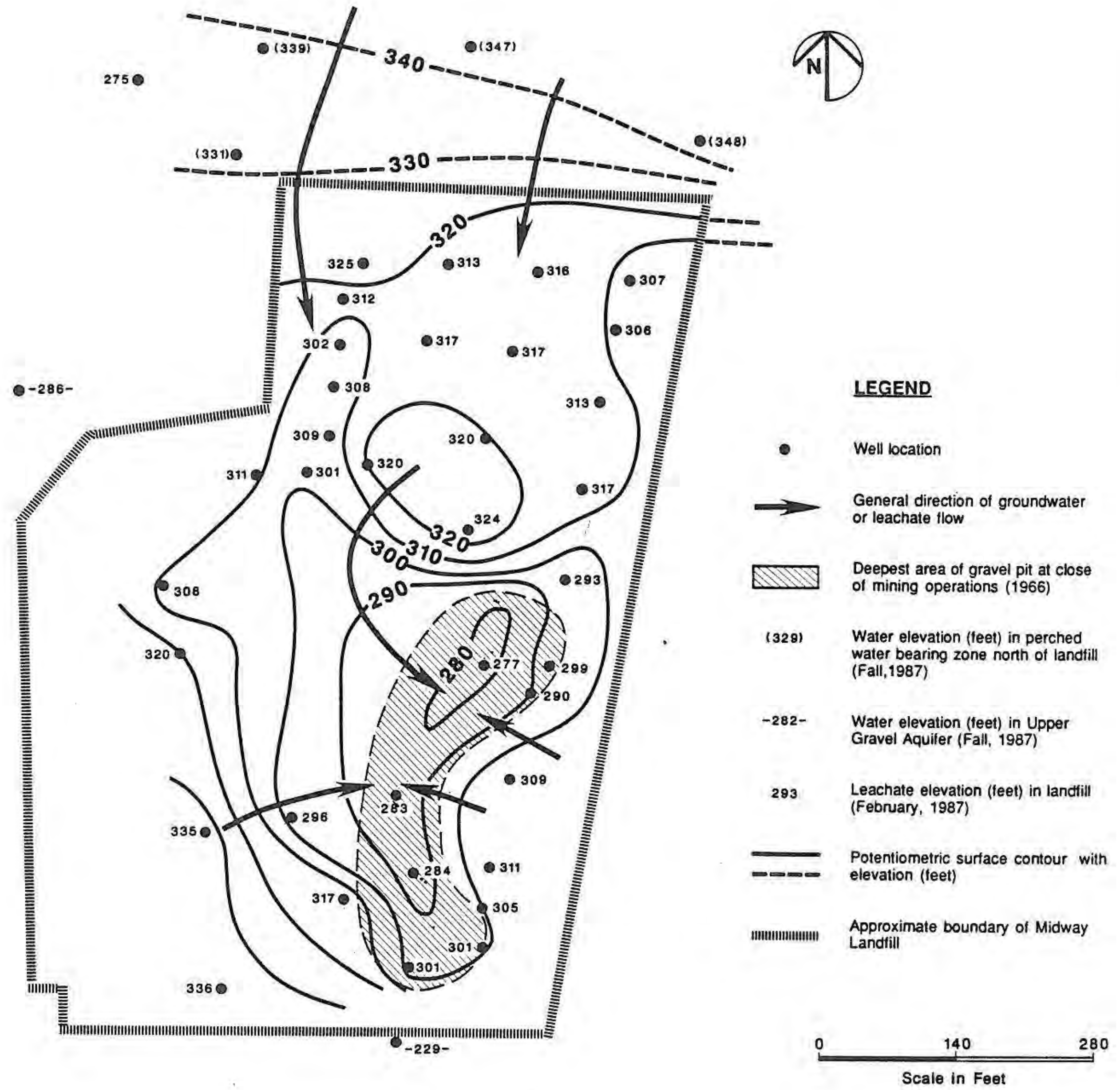
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Water Elevations – Landfill Aquifer

Midway Landfill
Kent, Washington

FIGURE
35

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.001	ECR	MAA	18 Nov 87		



NOTE: Refer to Figure 10 for the well and gas probe identification numbers.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Generalized Landfill Aquifer Potentiometric Surface

Midway Landfill
Kent, Washington

FIGURE
36

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	SM	MAA	7 December 87		

Perched Aquifer, Parkside Wetland: Perched groundwater in the Parkside Wetland appears to be principally recharged from surface water runoff. The Wetland is a low area and receives surface water runoff from surrounding higher areas to the east. In particular, a 30-inch culvert draining part of the Highway 99 corridor discharges into the northeast corner of the Wetland. Without the surface water runoff, the Parkside Wetland would likely be relatively dry.

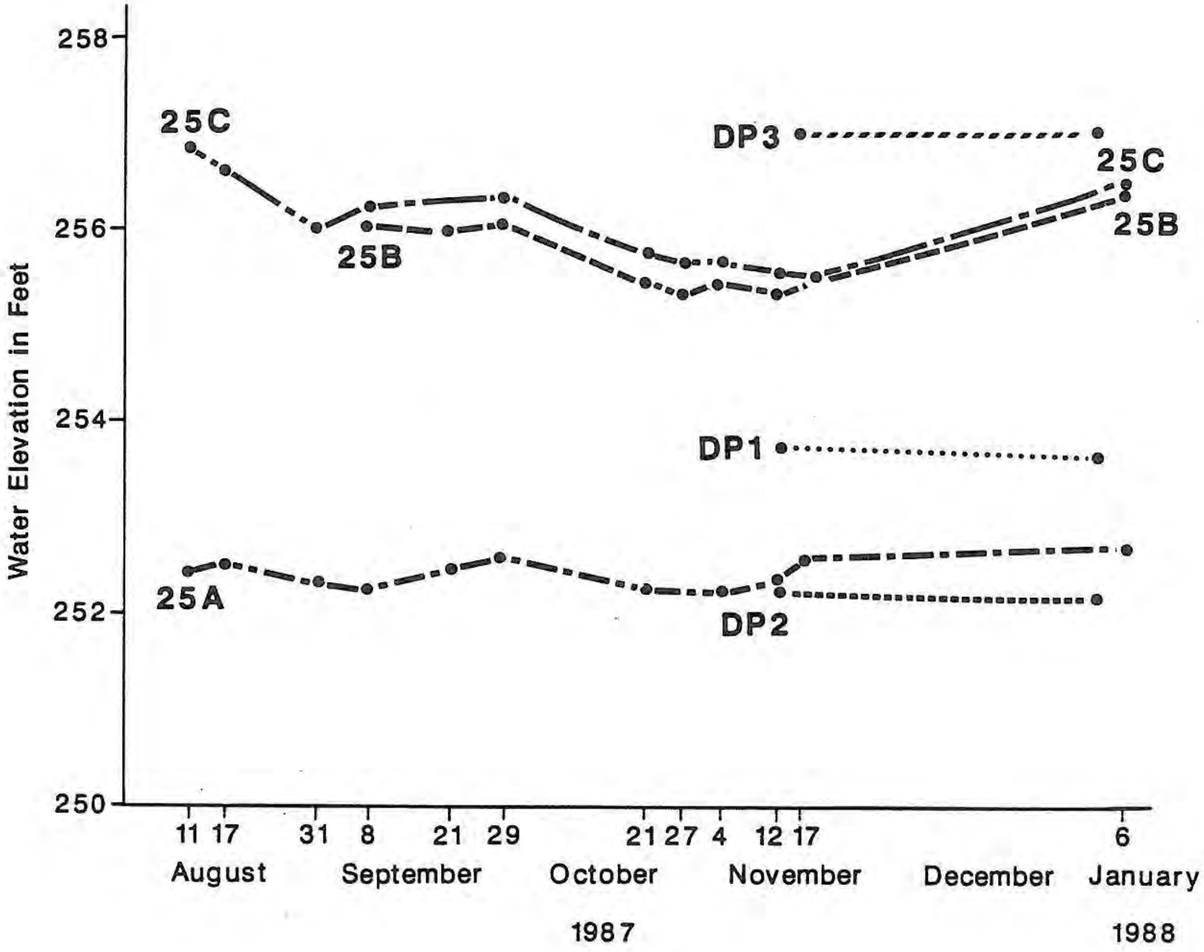
In addition to surface water recharge, the Wetland may receive minor recharge from both the Upper Gravel Aquifer and the Sand Aquifer. Groundwater elevations in the Upper Gravel Aquifer at Well MW-17, located approximately 400 feet east of the Wetland, are higher than groundwater elevations in the Wetland (see Hydrogeologic Cross Section E-E'). In addition, groundwater flow directions in the Upper Gravel Aquifer near MW-17 are generally from the northeast towards the Parkside Wetland (see Figure 39 in the next section). Both of these facts suggest that if there are permeable zones in the Outwash Gravels between MW-17 and the Parkside Wetland, the Upper Gravel Aquifer could discharge to the Wetland through springs or through subsurface flow. Some of the springs we observed near the base of the hillside during our geologic mapping may reflect this source. Most of the springs however probably represent downslope migration of stormwater runoff within the weathered surficial soil zone.

Groundwater in the Upper Gravel Aquifer migrating towards the Parkside Wetland appears to be originating north of the Midway Landfill (see Figure 39). However, there is sufficient uncertainty in groundwater flow directions within this aquifer to allow for potential migration from the northwestern part of the Landfill towards the Parkside Wetland. If flow from the Landfill is occurring, there should be evidence for it in water quality analyses from MW-17A and B. Chloride concentrations, in particular, provide a good indicator of Landfill leachate influence.

Chloride concentrations in the upper well completion (MW-17A) have consistently been at background levels. In MW-17B, completed 25 feet lower than MW-17A, chloride concentrations have been consistently but slightly elevated above background. In sampling round 4 for example, the chloride concentration was 18.5 mg/l at MW-17B versus background concentrations of 3 to 5 mg/l. This data suggests a potential for very slight Landfill influence. It also suggests that if the Landfill is truly the source of the chloride, then the Landfill leachate has been diluted by a factor of 90, as typical chloride concentrations in leachate range from 1600 to 1700 ppm. For a more detailed discussion of chloride dilution and its applicability to leachate "fingerprinting", refer to the Parametrix Appendix B report (1988).

The higher chloride concentration in MW-17B relative to MW-17A is unexpected, and cannot be completely explained given the existing data. The chloride concentration would normally be expected to be highest in the upper completion (17A) if leachate were migrating from the Landfill since the Landfill is higher in elevation than MW-17A. The fact that it is not suggests a complex flow regime with components of vertical as well as horizontal flow.

Groundwater discharge is also likely occurring into the Parkside Wetland through upward vertical flow from the underlying Upper Gravel Aquifer and Sand Aquifer. Groundwater gradients in the Parkside Wetland area are vertically upward rather than vertically downward as is typical elsewhere in the Study Area. This relationship is shown in Figure 31 and in Figure 37, which depicts water elevations in the Parkside Wetland DP wells and in the deeper MW-25 completions. The upward gradients indicate groundwater discharge and imply that groundwater in the Upper Gravel Aquifer tends to flow upward into the Parkside Wetland. However, the vertical gradients are quite low (about .16) and the fine-grained sediments comprising most of the recent alluvium have a low vertical permeability. We estimate total vertical flow into the Wetland to be about 1 to 2 gallons per minute. Most flow in the Upper Gravel Aquifer and Sand Aquifer continues laterally past and beneath the Wetland to discharge areas west of the Study Area.



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Water Elevations: Parkside Wetland Wells

Midway Landfill
Kent, Washington

FIGURE
37

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	11 January 88		

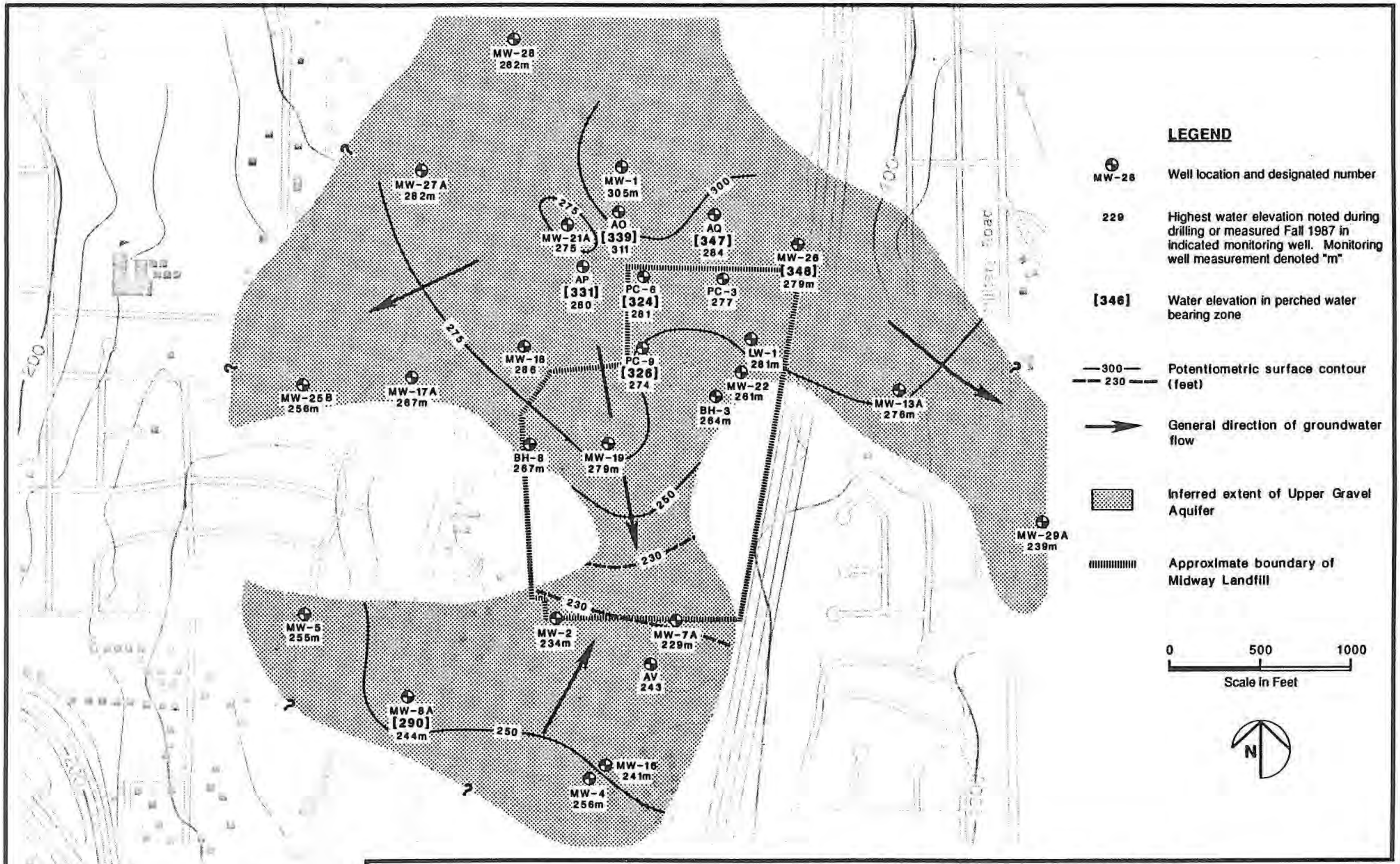
Upper Gravel Aquifer: The Upper Gravel Aquifer represents the first principal zone of saturation beneath the Landfill. Groundwater in this aquifer flows from both the northern and southern portions of the Study Area inwards towards the southern border of the Landfill, as shown on Figure 38, Upper Gravel Aquifer Potentiometric Surface. A closed depression in the potentiometric surface at the southern border of the Landfill indicates groundwater is discharging downwards to the underlying Sand Aquifer at this location. Figure 40, Upper Gravel Aquifer Contact with Sand Aquifer, shows that this hydraulic sink coincides with a window in the underlying Upper Silt Aquitard. Groundwater in the Upper Gravel Aquifer also appears to be flowing to the east towards MW-29A and to the west towards MW-25 at the Parkside Wetland. Some flow may also be occurring from the extreme northwest corner of the Landfill towards MW-21. The potentiometric surface at MW-21A appears to be depressed relative to surrounding wells and those located in the northwest corner of the Landfill. Comparison of the potentiometric surface map (Figure 38) with Figure 40 shows that MW-21 is situated over a window in the underlying Upper Silt Aquitard. Direct hydraulic connection of the Upper Gravel Aquifer and underlying Sand Aquifer in this area could be resulting in the observed potentiometric surface depression.

The flow directions described above, as well as others shown on Figure 38, are somewhat uncertain because of the difficulty correlating water level data in the Upper Gravel Aquifer. This difficulty arises from the fact that monitoring wells were typically not installed in the Upper Gravel Aquifer and where installed, were placed in the lower portion of it near the Sand Aquifer contact. Consequently, Upper Gravel Aquifer elevations in some case have been estimated from water level observations made during drilling.

The electrical conductivity and chloride concentration values shown at each well on Figure 39 are generally consistent with the overall flow pattern except for anomalously high conductivity values at Wells MW-27A, MW-28, and MW-4, and MW-29. The pairing of low chloride concentrations with elevated conductivities at these locations suggest that a source other than the Landfill is responsible for the higher concentrations of dissolved ionic species or compounds. If the Landfill was the source, both chloride and conductivity should be elevated. Instead, high chloride concentrations are limited to areas directly beneath or immediately adjacent to the Landfill as would be predicted from the pattern of flow in the Upper Gravel Aquifer.

In addition to horizontal flow in the Upper Gravel Aquifer, there is also a strong component of vertical flow. Vertical gradient values vary substantially, but in some areas reach or exceed 1.0.

The groundwater flow pattern indicates that recharge is occurring to the Upper Gravel Aquifer from direct precipitation, through recharge from the overlying Perched and Landfill Aquifers, and through lateral flow from areas north and south of the Study Area. The aquifer response to precipitation is shown on Figure 41, Water Elevations - Upper Gravel Aquifer. As illustrated, seasonal water level fluctuations in most of the wells range from 5 to 25 feet. Water levels do not appear to respond to any single precipitation event, but to seasonal increases or decreases in precipitation. Water levels generally increase to their highest level approximately 2 to 3 months after the seasonal peak precipitation.



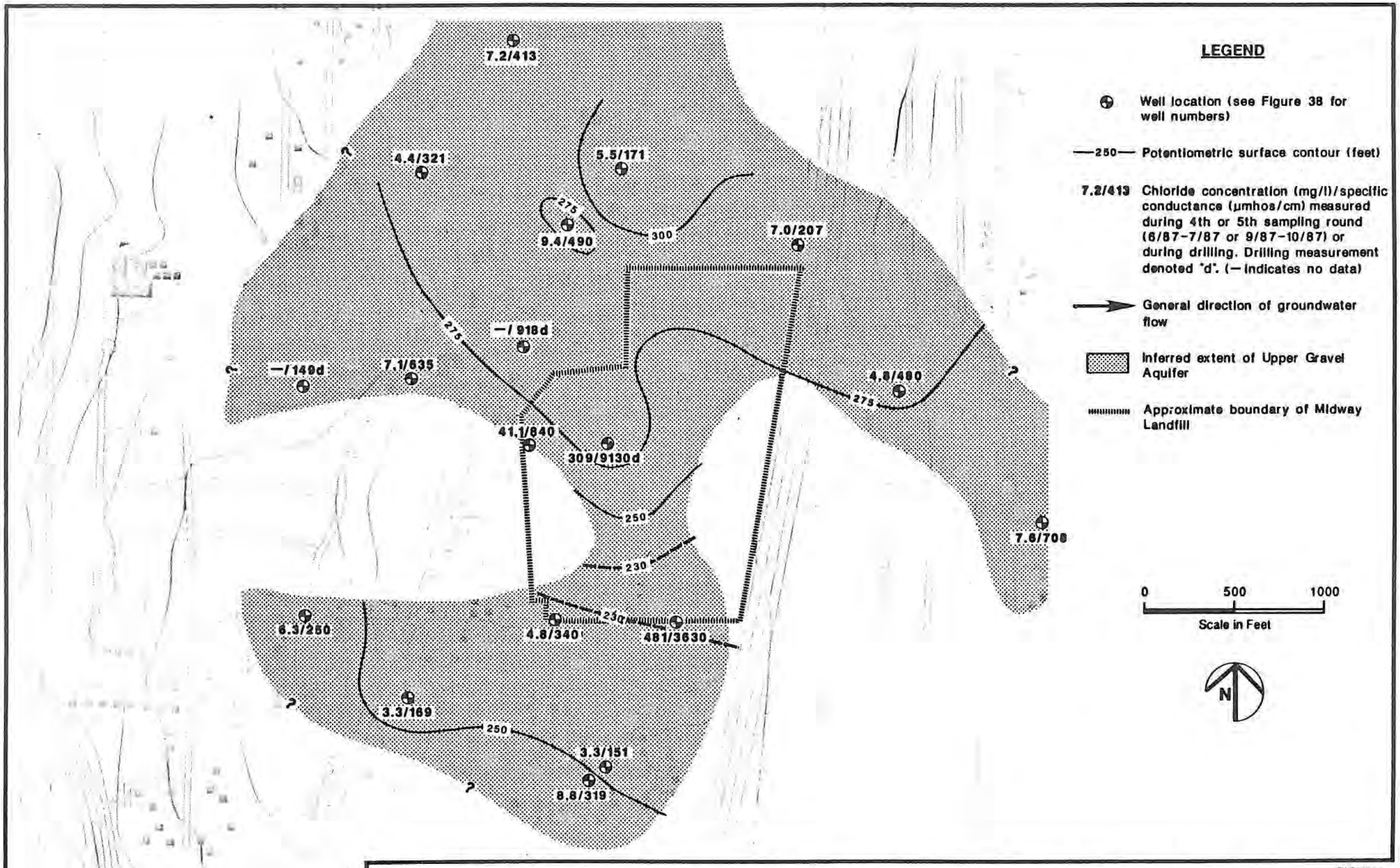
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Generalized Upper Gravel Aquifer Potentiometric Surface

Midway Landfill
Kent, Washington

FIGURE
38

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	1 December 87		



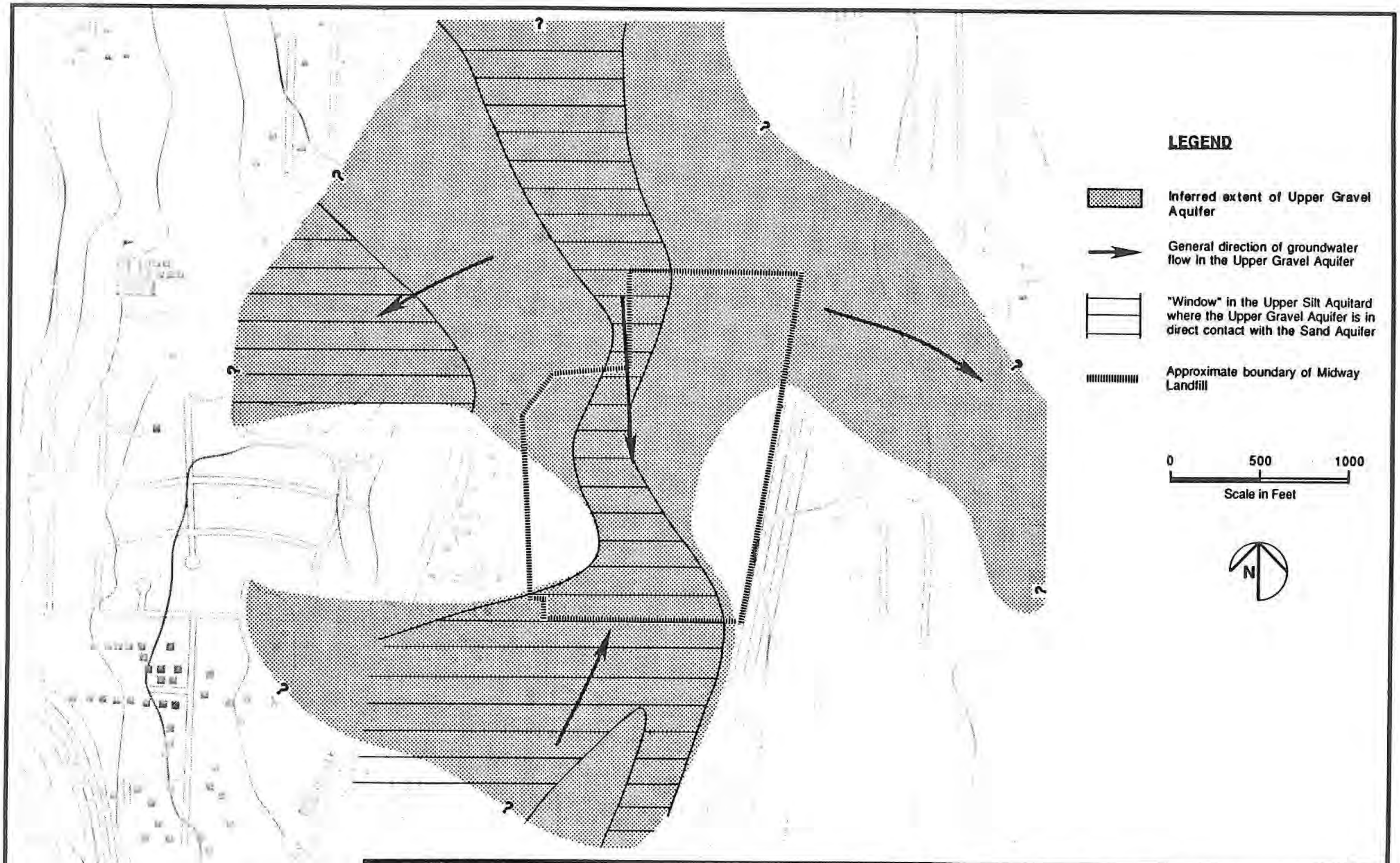
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Chloride Distribution in Upper Gravel Aquifer

Midway Landfill
Kent, Washington

FIGURE
39

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	11 January 88		



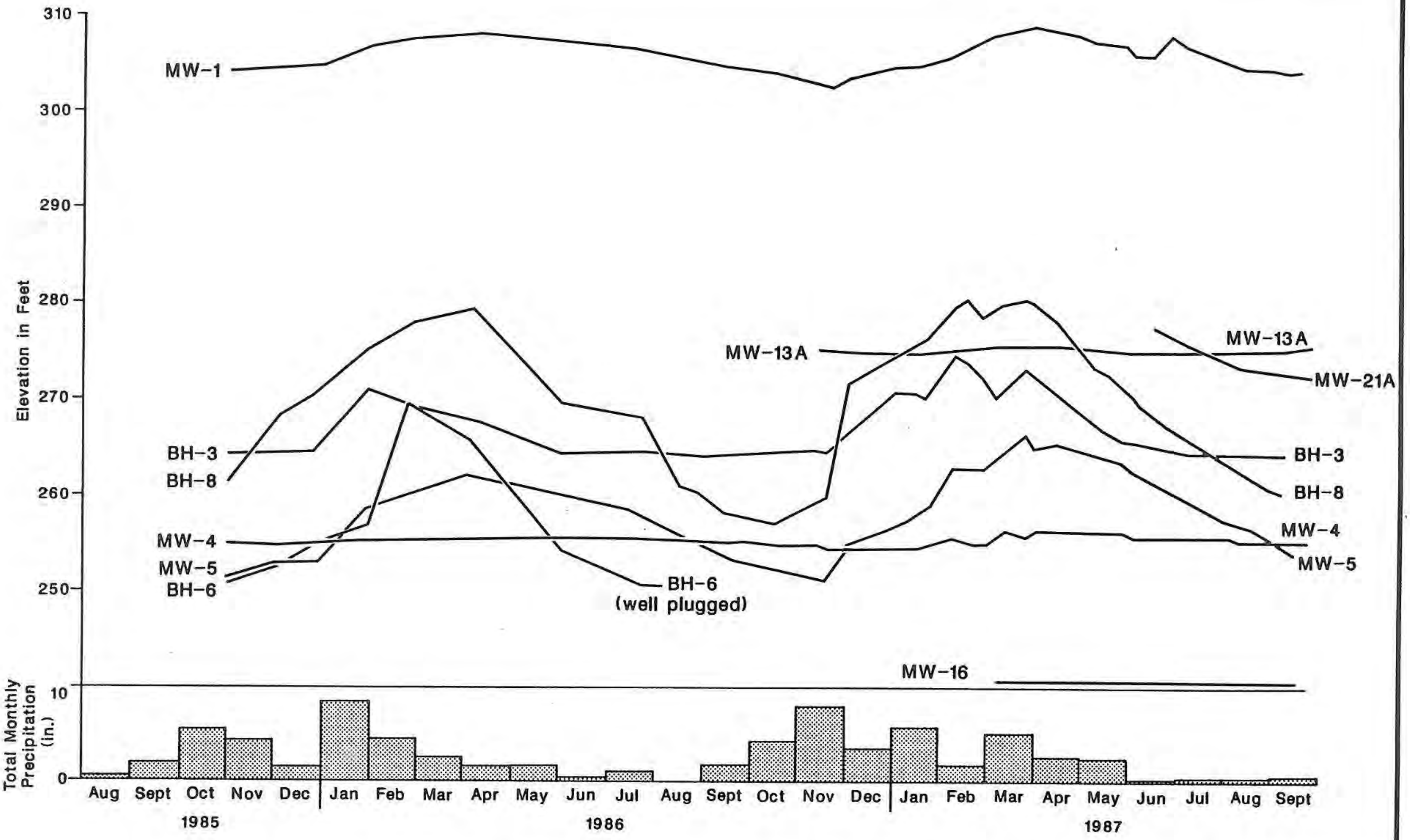
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Upper Gravel Aquifer Contact with Sand Aquifer

Midway Landfill
Kent, Washington

FIGURE
40

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	30 November 87		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Water Elevations - Upper Gravel Aquifer

Midway Landfill
Kent, Washington

FIGURE
41

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	18 Nov 87		

Sand Aquifer: Groundwater in the Upper Gravel Aquifer migrates downward through windows in the Upper Silt Aquitard, recharging the Sand Aquifer. This does not, however, appear to be the major source of groundwater to the Sand Aquifer in the Study Area. Groundwater elevations in the Sand Aquifer are highest at the extreme north end of the Study Area and generally decrease to the southeast, as shown on Figure 42, Generalized Sand Aquifer Potentiometric Surface. This pattern suggests substantial subsurface lateral flow from north of the Study Area.

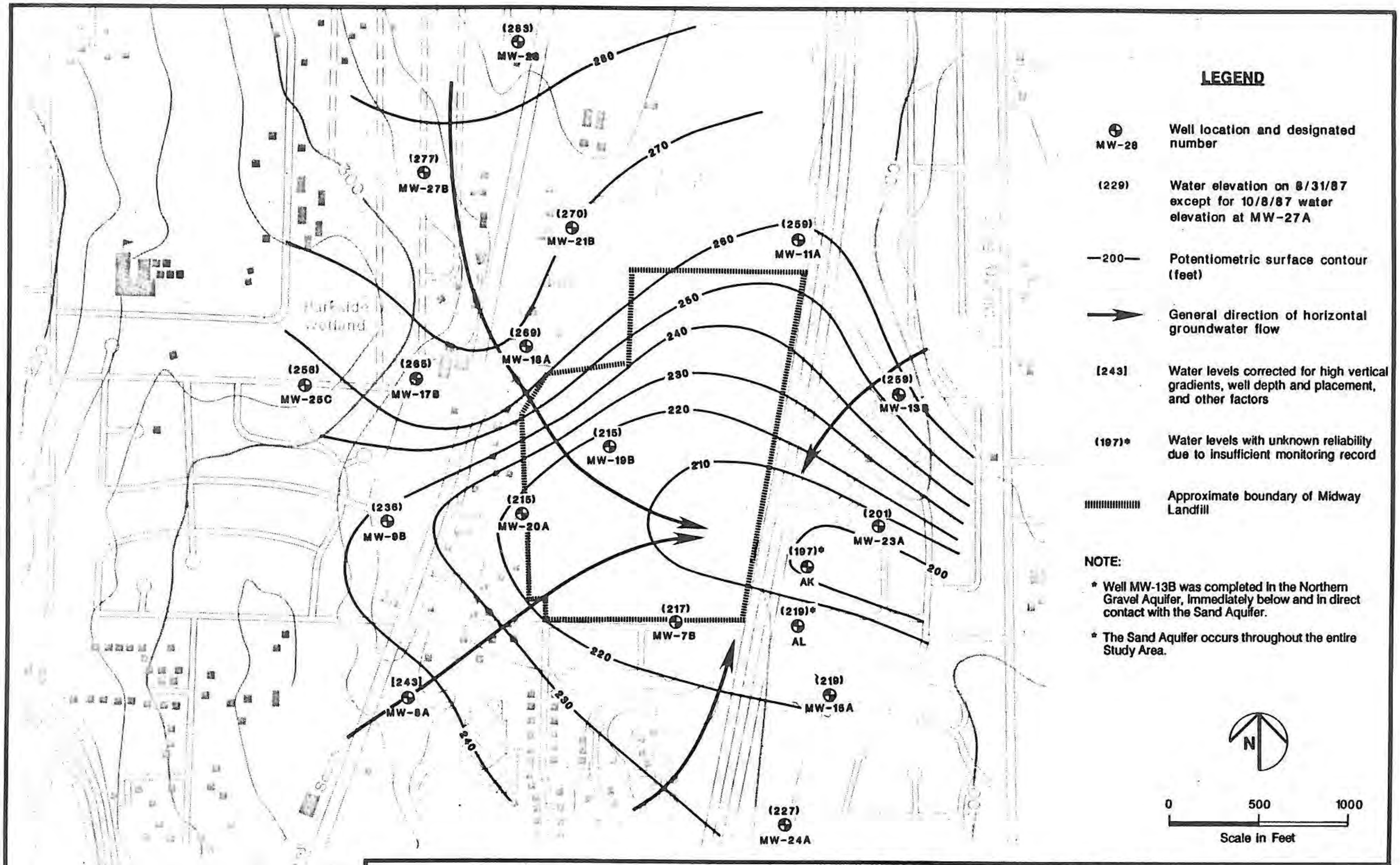
The effects of precipitation on Sand Aquifer water levels have not yet been determined as most wells completed in this aquifer were not installed until midway through the 1986-87 winter. The available data, shown on Figure 44, suggests a delayed response. The hydrograph from MW-17A, for example, shows water elevations reaching their peak approximately three months after the period of maximum precipitation.

Lateral groundwater flow in the Sand Aquifer is from north of the Landfill southeastward to a depression in the potentiometric surface located near the southeastern corner of the Landfill (see Figure 43). The portion of the Sand Aquifer south of the Landfill also appears to flow towards this hydraulic sink. The full extent or precise nature of the sink has not been defined as it appears to extend eastward beyond the existing monitoring well network. However, vertical flow in the sink would recharge the underlying Southern Gravel Aquifer. Lateral flow to the east is discussed further in Section 5.2.5, Hydraulic Relationship of Study Area Aquifers to the Lake Fenwick Area.

Groundwater electrical conductivities and chloride concentrations measured at various locations in the Sand Aquifer (shown on Figure 44) are consistent with the horizontal flow pattern described above. Chloride concentrations and conductivities are highest directly beneath the Landfill and decrease downgradient from the Landfill. An anomalously high conductivity was measured in Well MW-17B located upgradient of the Landfill (discussed previously, see Perched Aquifer: Parkside Wetland). The source of the high conductivity could be flow from the Landfill Aquifer into the Upper Gravel Aquifer and then downward into the Sand Aquifer through a window in the Upper Silt Aquitard located near this well. Another possibility is a non-Landfill source located upgradient (north) of MW-17.

A second anomalously high chloride concentration was detected in MW-21B located near the northwest corner of the Landfill. MW-21B appears to be upgradient from the Landfill and should not be receiving any flow from the Landfill. However, as discussed previously, there is some potential for leachate to enter the Upper Gravel Aquifer and flow towards MW-21. If this is occurring, vertical migration from the Upper Gravel Aquifer into the Sand Aquifer could account for the elevated chloride concentrations in MW-21B. There may also be a separate chloride source north of MW-21. Refer to the 1988 Parametrix, Appendix B report for a more detailed discussion of the chloride source and significance.

There is a strong vertical component to flow in the Sand Aquifer. Typical vertical gradients range from .05 to .6 as compared with typical horizontal gradients ranging from .02 to .10. Calculated total horizontal fluxes versus total vertical fluxes at three locations indicated that vertical flow may equal or exceed horizontal flow in areas of high vertical gradient.



NOTE:

- * Well MW-13B was completed in the Northern Gravel Aquifer, immediately below and in direct contact with the Sand Aquifer.
- * The Sand Aquifer occurs throughout the entire Study Area.

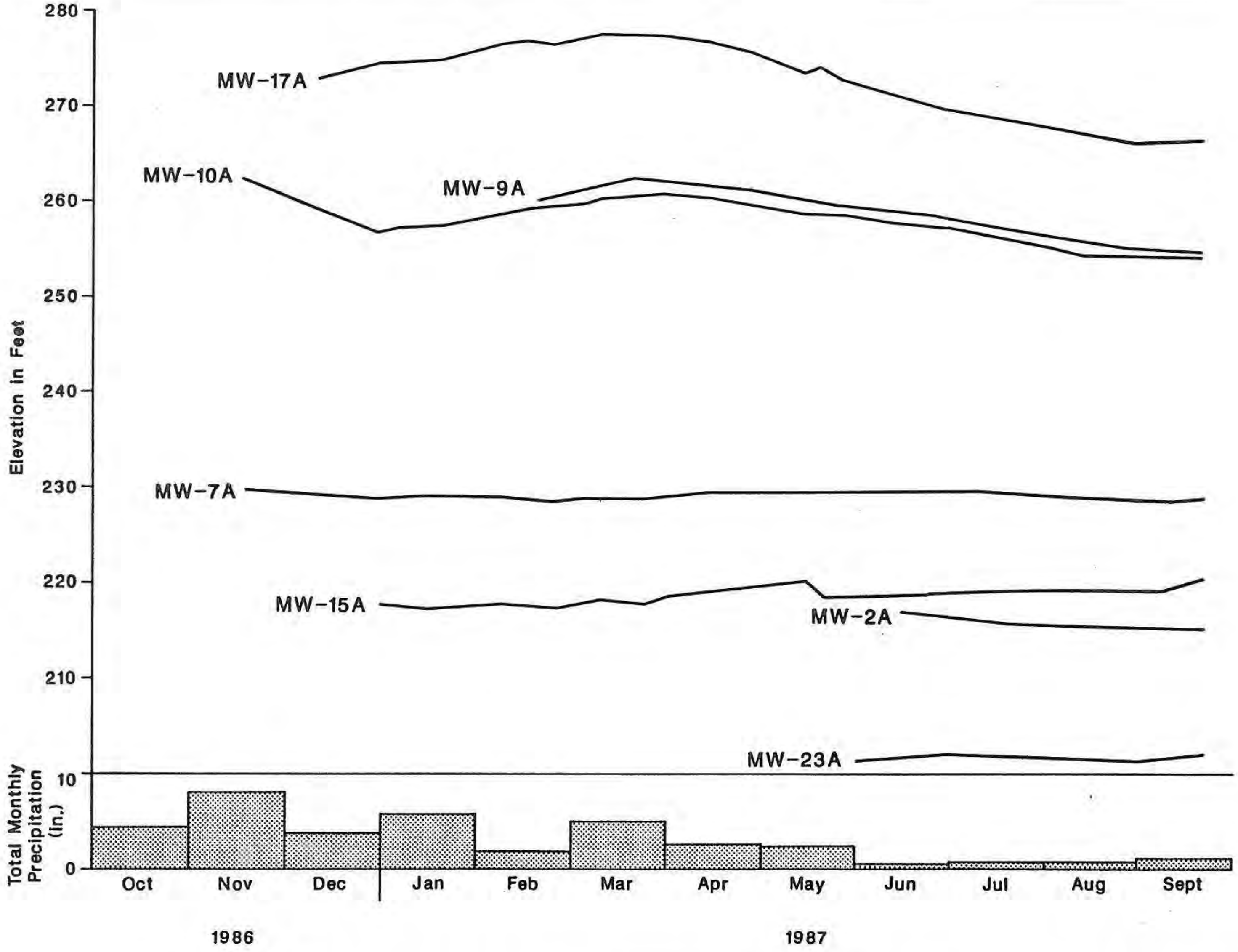
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Generalized Sand Aquifer Potentiometric Surface

Midway Landfill
Kent, Washington

FIGURE
42

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	30 November 87		



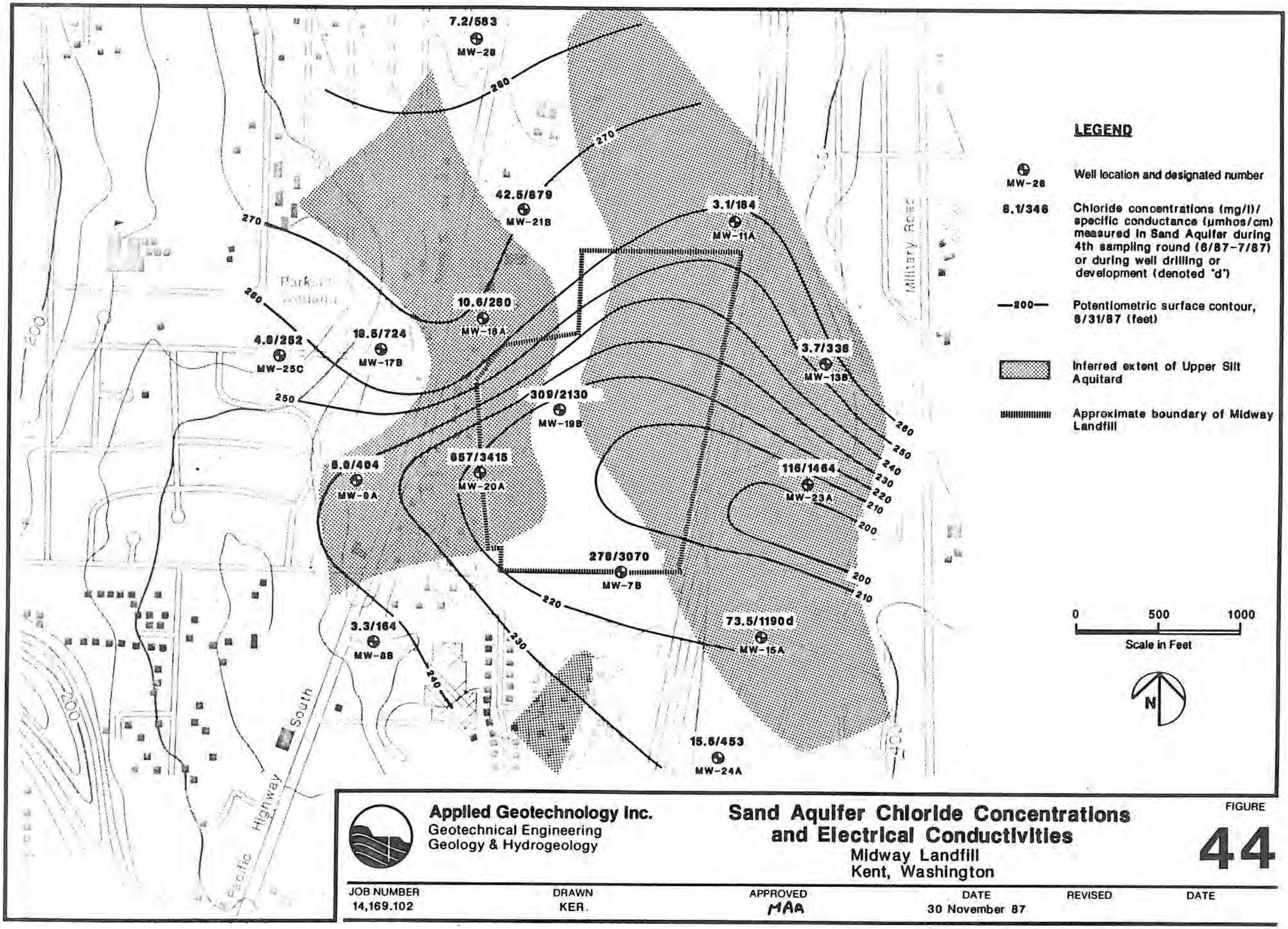
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Water Elevations - Sand Aquifer

Midway Landfill
Kent, Washington

FIGURE
43

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	23 Nov 87		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Sand Aquifer Chloride Concentrations and Electrical Conductivities

Midway Landfill
Kent, Washington

FIGURE
44

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER.	MAA	30 November 87		

Northern and Southern Gravel Aquifers: Groundwater in the Non-Glacial Sediments occurs in two separate aquifers, the Northern and Southern Gravel Aquifers. Lateral groundwater movement in the Northern Gravel Aquifer is generally from the north to the south, while movement in the Southern Gravel Aquifer is both to the east and west from a divide located near the eastern border of the Landfill. These flow patterns are shown on Figure 45, Potentiometric Surfaces: Northern or Southern Gravel Aquifers.

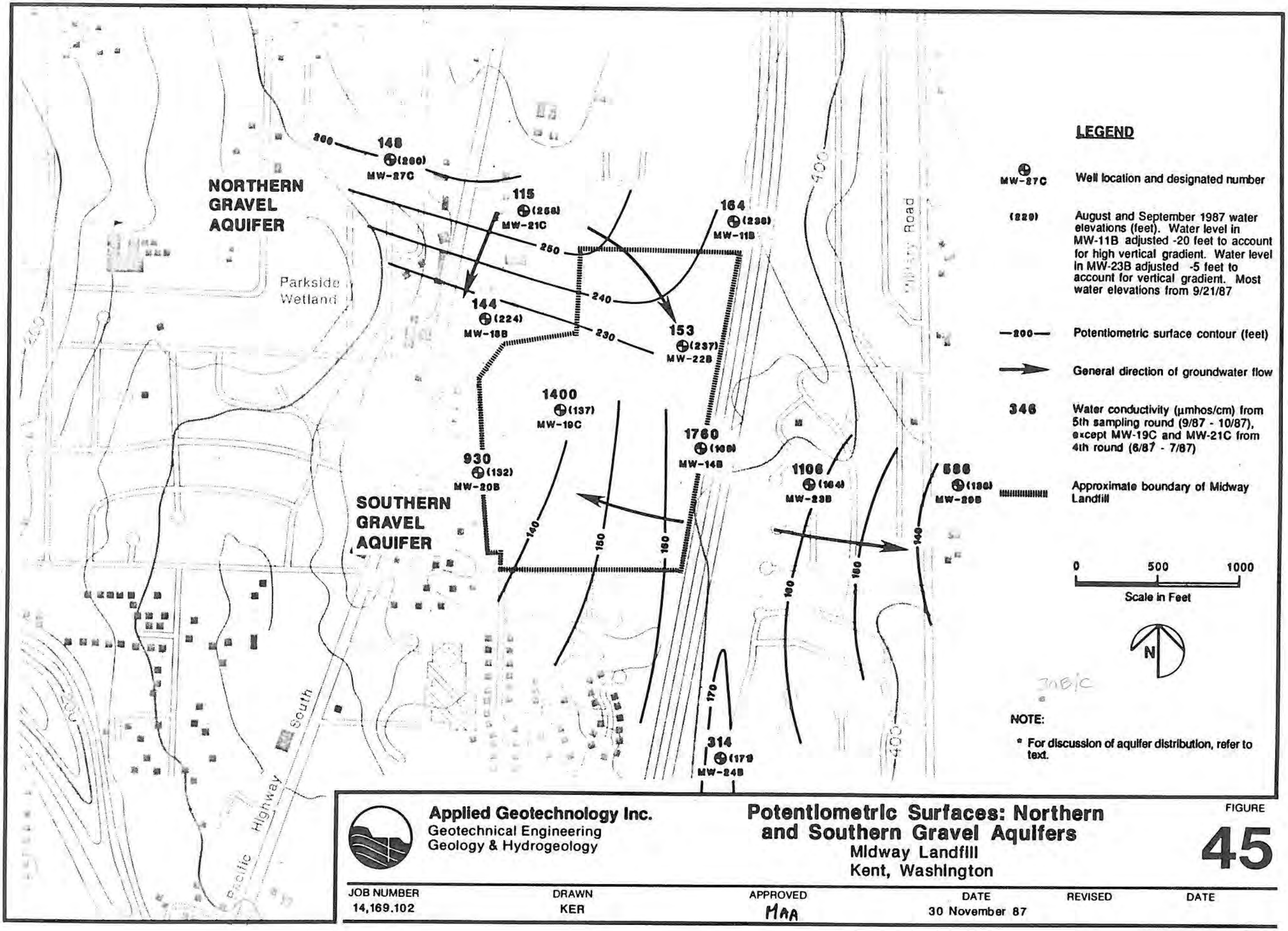
The groundwater divide (or elongate mound) in the Southern Gravel Aquifer potentiometric surface is likely caused by recharge from the Sand Aquifer. Comparison of Figure 42 with Figure 45 shows that the hydraulic sink in the Sand Aquifer is located directly over the Southern Gravel Aquifer groundwater divide.

Electrical conductivities in the Southern Gravel Aquifer also indicate direct recharge from the overlying Sand Aquifer; conductivities in the Southern Gravel Aquifer are at levels comparable to those in portions of the Sand Aquifer receiving leachate. By contrast, conductivities in the Northern Gravel Aquifer appear to be near background (100-200 umhos/cm).

The Gravel Aquifer's response to precipitation have not yet been determined due to the insufficient length of the monitoring period. The available well hydrograph data summarized on Figure 46 show no response during a period of no precipitation.

There is also a strong vertical flux component in these aquifers. Typical vertical gradients range between .2 and .7 compared with typical horizontal gradients ranging between .03 and .04.

The ultimate discharge point is not known for either the Northern or Southern Gravel Aquifers. However, considering these aquifers are 50 to 100 feet above sea level, we anticipate they discharge to Puget Sound or to sediments in the Green River Valley. The high vertical gradients discussed above also indicate groundwater flow to and recharge of deeper aquifers at or below Sea Level. This is further discussed in Section 5.2.7.



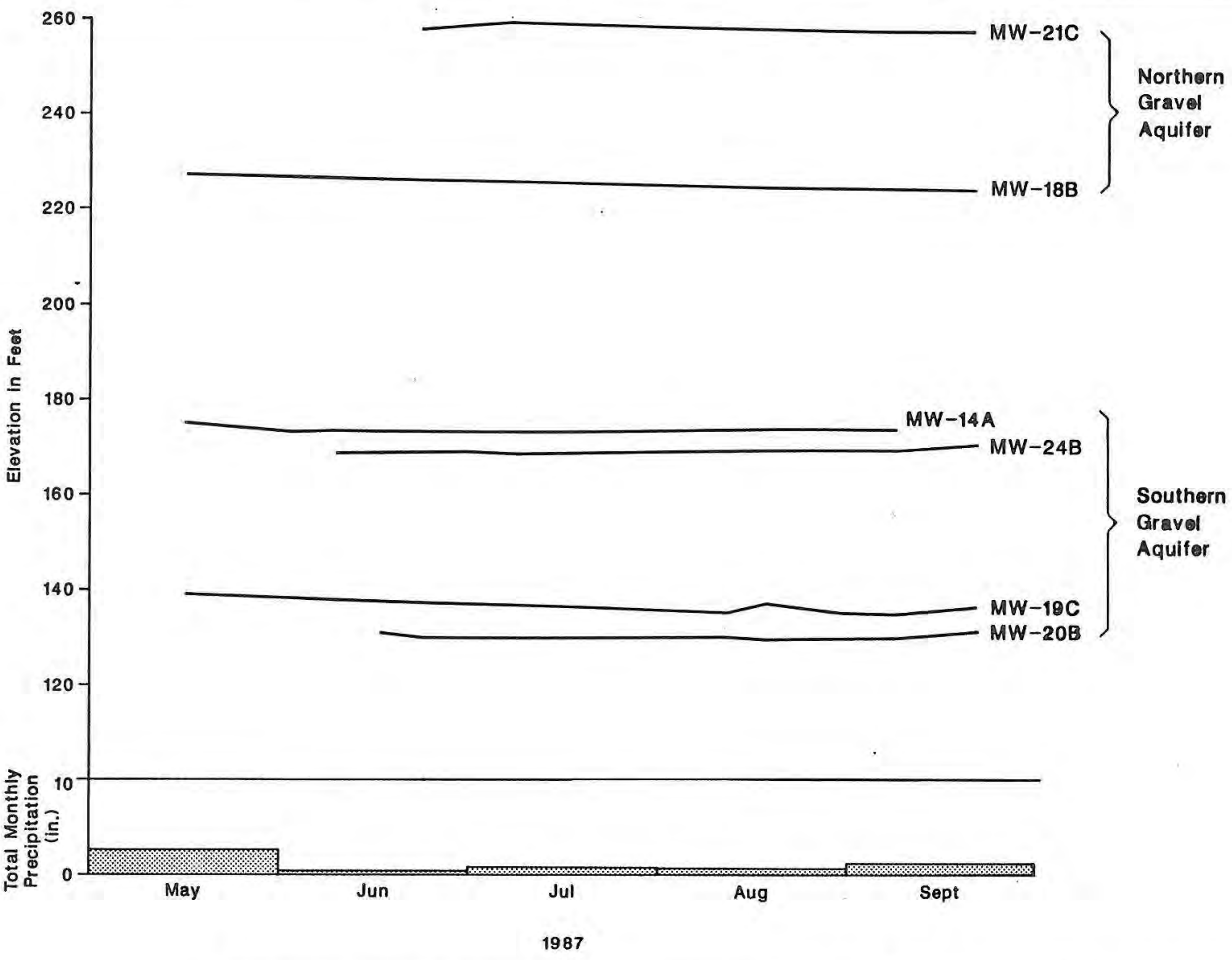
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Potentiometric Surfaces: Northern and Southern Gravel Aquifers

Midway Landfill
Kent, Washington

FIGURE
45

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	30 November 87		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Water Elevations: Northern and Southern Gravel Aquifers

Midway Landfill
Kent, Washington

FIGURE
46

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	23 Nov 87		

5.2.5 Hydraulic Relationship of Study Area Aquifers to the Lake Fenwick Area

Lake Fenwick lies approximately 6,000 feet southeast of the Midway Landfill in a narrow north-south trending depression on the flank of the Des Moines Drift Plain. The lake and surrounding residential area lie at approximately Elevation 120, or about 300 feet below the upper surface of the drift plain. Soils in this area are primarily sand and gravels, with lesser amounts of silt and clay. These soils were deposited by streams flowing between glacial ice in the Green River Valley and the higher ground of the drift plain, and are referred to as kame terrace deposits. Kame terrace deposits border much of the eastern edge of the drift plain and extend from the Green River Valley floor to a maximum elevation of approximately 400 feet (Waldron, 1962). Pleistocene glacial and non-glacial sediments correlative with those underlying the drift plain probably underlie the kame terrace deposits.

Several water supply wells exist in the Lake Fenwick area; five are currently used (Parametrix, 1988; Water Well Inventory). The actively used wells range in depth from 30 to 167 feet; well construction details and driller's logs are available for all but the deepest of these. Current water level and water quality data are not available or were not included with the well inventory conducted by Parametrix. Detailed pumping records were also unavailable; however, the deepest well is reported to serve nine homes and is pumped at an average rate of 3,375 gallons per day (Parametrix, March 1985).

Due to the limited amount of available data, detailed analysis of the hydrogeology of the Lake Fenwick area is not possible. Driller's logs indicate several water-bearing horizons at depths ranging from approximately Elevation 90 to Elevation -10. The exploited aquifers appear to be confined systems, with static head decreasing with aquifer depth, as typical of the upland portions of the drift plain.

The shallower water-bearing zones near Lake Fenwick (within 50 feet of land surface) are probably located entirely within the kame terrace deposits discussed above. Since the thickness of these deposits is not known and is not evident from the available logs, it is not clear whether the deeper wells near the Lake actually penetrate the Pleistocene sediments. Static water elevations of water bearing zones near Lake Fenwick are similar to deeper portions of the Sand Aquifer and of the Southern Gravel Aquifer identified near the Landfill.

Assessment of whether direct hydraulic connection occurs between these aquifers and those of the Lake Fenwick area is not possible given available information. Monitoring Well MW-6, located approximately 2000 feet from Lake Fenwick, is nearly 4000 feet from the nearest well on the perimeter of the Landfill (MW-24). Furthermore, MW-6 was drilled to a downhole elevation of 124 feet, which is higher than the land surface elevation in the Lake Fenwick area.

However, potentiometric surface data from MW-6, although measured in the Upper Gravel Aquifer, suggest heads in the deeper Study Area aquifers could be sufficiently high to recharge the deeper aquifers near Lake Fenwick. Hydraulic connection between the Study Area groundwater and that in the Lake Fenwick area cannot be ruled out.

If Study Area aquifers were recharging Lake Fenwick area aquifers, it would be more likely to see an upward vertical gradient, or at least a somewhat less downward gradient than evidenced by the existing data. Even if such recharge did occur, it is still doubtful that contaminants identified within the Study Area would be observable in Lake Fenwick wells due to attenuation and dilution. Of these two processes, dilution may be most significant in reducing contaminant concentrations with distance from the Landfill source. Chloride data from groundwater monitoring wells near the Landfill indicate that leachate dilution to near background occurs within about 2000 to 3000 feet of the Landfill (see Parametrix, Appendix B report, 1988). Dilution would result from hydrodynamic dispersion and from precipitation infiltrating the groundwater system over the 6000-foot distance between the Landfill and the lake, plus the large quantity of infiltration which is likely contributed by Lake Fenwick itself. The lake sits in a closed depression which receives runoff from a drainage area of over 500 acres; hence a significant amount of groundwater recharge likely takes place in this area.

In summary, given the available hydrologic information, hydraulic connection between aquifers utilized for water supply in the Lake Fenwick area and those identified near the Landfill is possible. Factors which argue against hydraulic continuity include the differing geology of the two areas and the apparent downward hydraulic gradient beneath Lake Fenwick. Factors which would greatly minimize or completely mask any potential influence from Study Area aquifers include the distance from the Landfill, which would result in substantial attenuation and dilution, and the large amount of direct groundwater recharge likely taking place within the Lake Fenwick drainage basin itself.

5.2.6 Hydraulic Relationship of Study Area Aquifers to Smith Creek

The western flank of the Des Moines Drift Plain near Midway is drained by several creeks and springs, including principally the North and South Forks of Smith Creek. Headwaters of the South Fork occur near S. 260th Street and Highway 99 (see Figure 2), approximately 3000 feet southwest of the Midway Landfill. At its closest approach, the South Fork passes within 2500 feet of the Midway Landfill. One branch of the North Fork begins at the Parkside Wetlands immediately west of the Midway Landfill.

Base flow in the forks is likely comprised of groundwater discharge from aquifers laterally equivalent to those identified in the Study Area. Both creeks sustain perennial flows below approximately Elevation 250 to 255. These elevations are below groundwater elevations in the Upper Gravel Aquifer, but are close to the 200 to 250-foot elevation range for the top of the Sand Aquifer. The deeper Northern and Southern Gravel Aquifers, or their lateral equivalents, may also discharge to Smith Creek below Elevations 100 to 200 feet. Although no monitor wells are located sufficiently close to Smith Creek to confirm these relationships, the North and South Forks are the most likely avenues for groundwater discharge on the west side of the Des Moines Drift Plain.

Although some groundwater in the Study Area likely does discharge to Smith Creek, most groundwater in this area appears to flow away from Smith Creek to the east. Potentiometric surface maps for the Upper Gravel Aquifer, Sand Aquifer, and the North and South Gravel Aquifers (Figures 38, 42, and 45) in the Study Area shows most groundwater flowing to the east. This is particularly true for the southwestern portion of the Study Area closest to the South Fork of Smith Creek, where both the Upper Gravel Aquifer and Sand Aquifer groundwater flows directly away from Smith Creek to the northeast. Groundwater flows to the west towards Smith Creek only in the underlying Southern Gravel Aquifer.

The most westerly monitoring well completed in the Southern Gravel Aquifer is MW-20B located near the western border of the Landfill. The nearest discharge point in Smith Creek would be approximately 3,800 feet to the southwest, where the creek channel drops below Elevation 100 feet.

In the northwestern part of the Study Area, a much higher proportion of groundwater potentially discharges to the North or South Forks of Smith Creek. Groundwater flow in both the Upper Gravel Aquifer and Northern Gravel Aquifer northwest of the Landfill appears to be generally to the southwest (see Figure 38 and 45).

The Upper Gravel Aquifer may contribute significantly to base flow in the branch of the North Fork near the Parkside Wetland. Groundwater elevations in the Upper Gravel Aquifer immediately north and west of the Parkside Wetland are above Elevation 260 compared with a Wetland surface elevation of approximately 255. Groundwater discharge from the deeper Northern Gravel Aquifer would occur much further down the North Fork channel, near Elevation 100 feet.

There is also some potential for Sand Aquifer groundwater discharging to Smith Creek. Figure 42 shows a poorly defined groundwater divide in the Sand Aquifer extending along the northwest side of the Landfill. Groundwater east of this divide would flow to the east or southeast, and groundwater west of the divide would flow to the south or southwest. Wells MW-27B and MW-25C are on the west side of the divide; Well MW-17B appears to be on the crest of the divide. Sand Aquifer groundwater flow at MW-17 could go either to the southeast or southwest. From MW-25 or MW-17, the nearest Smith Creek discharge points would be approximately 2600 and 3000 feet to the southwest, respectively, assuming groundwater flow in the Sand Aquifer continues to the southwest beyond the Study Area. Groundwater flow at MW-17 more likely curves around to the southeast in keeping with the flow line shown on Figure 42.

5.2.7 Potential Groundwater Discharge Areas

As previously described, most groundwater beneath the Study Area is moving laterally to the east or southeast or vertically downwards; a subordinate quantity is flowing to the west or southwest.

Flow to the east or southeast could reach the Lake Fenwick area, as discussed in Section 5.2.5, or could discharge to sediments in the Green River Valley (see Figure 2). The edge of the Green River Valley is approximately 4000 feet east of the Landfill, compared with 6000 feet between the Landfill and Lake Fenwick. Consequently, groundwater from the Study Area would likely reach the valley sediments before reaching the Lake Fenwick area.

Groundwater velocities in the Upper Gravel Aquifer are difficult to estimate given the wide variation in hydraulic conductivities and the inherent limitations of hydraulic conductivity testing (see Section 5.2.9). However, velocities (average linear velocity per Freeze and Cherry, 1979) of 0.1 to 1.4 feet/day are likely, assuming horizontal hydraulic conductivities of .001 to .01 cm/sec, porosity of 33%, and a hydraulic gradient of .017. Based on the velocities, it would take groundwater in the Study Area between 8 and 110 years to reach the Green River Valley and between 12 and 160 years to reach Lake Fenwick. Since the Landfill began operations slightly over 20 years ago it is possible groundwater in the Upper Gravel Aquifer at the Landfill when it began has still not discharged to the Green River Valley.

Velocity and travel time estimates for the Sand Aquifer also have a high degree of uncertainty because of variations in hydraulic conductivity and gradient. Testing and evaluations completed to date (see Section 5.2.9) suggest hydraulic conductivities in the Sand Aquifer range between .01 and .0001 cm/sec with a median value of approximately .001 cm/sec. Hydraulic gradients in the Study Area also vary widely, ranging from .014 to .086.

Based on these values and on an assumed porosity of .40, groundwater velocities in the Sand Aquifer range between .009 and 5.4 feet/day. An average velocity would be about .3 feet/day. If groundwater in the Sand Aquifer does flow directly from the Landfill to the Green River Valley or Lake Fenwick, and if the estimated velocities in the Study Area represent those outside the Study Area, the estimated groundwater travel times from the Landfill to the respective discharge areas are as follows:

Discharge Area	Distance from Landfill (Feet)	Minimum Travel Time (Years)	Maximum Travel Time (Years)	Average Travel Time (Years)
Green River Valley	4,000	2	1,200	30 to 40
Lake Fenwick	6,000	3	1,800	50 to 60

Both the minimum and maximum travel times are unrealistic as they reflect a combination of lowest hydraulic gradient and conductivity, and highest hydraulic gradient and conductivity, respectively. The average travel time is a more realistic estimate of travel time.

Groundwater in the deep Southern Gravel Aquifer also flows to the east and could discharge to the Green River Valley. However, groundwater would probably not discharge to Lake Fenwick, as the top of the Southern Gravel Aquifer in the Study Area lies at elevations ranging from 30 to 60 feet below the surface elevation of Lake Fenwick.

Groundwater velocities in the Southern Gravel Aquifer range from 1 to 12 feet/day based on hydraulic conductivity values of .005 to .05 cm/sec, a porosity of .35, and an average hydraulic gradient of .03. Based on these velocity values, it would take groundwater in the Southern Gravel Aquifer between 1 and 10 years to reach the Green River Valley. Although the travel times would not likely be less than a year; it could be more than 10 years. All groundwater velocities and travel times discussed above are approximate. Actual travel times could be an order of magnitude more or less than estimated times.

Groundwater in the Study Area is also moving vertically downward and moving towards Smith Creek. The ultimate discharge areas for groundwater moving downward below the Northern and Southern Gravel Aquifers cannot be determined, but both Puget Sound and the Green River Valley are likely the ultimate discharge areas for this deep groundwater.

Potential groundwater flow paths to Smith Creek are more easily conceived, although they involve several thousand feet of extrapolation beyond the borders of the Study Area. As discussed in the proceeding section, 5.2.6, portions of the Upper Gravel Aquifer, Sand Aquifer, and Northern and Southern Gravel Aquifer in the Study Area or their lateral equivalents may discharge to Smith Creek.

Travel times for groundwater in the Southern Gravel Aquifer to reach a potential Smith Creek discharge point are essentially the same as travel times to the Green River Valley, since the distance involved is similar at approximately 4,000 feet. The Northern Gravel Aquifer may also discharge to Smith Creek. However, contaminants have not been detected in this aquifer.

Groundwater in a portion of the Sand Aquifer near MW-25 and possibly MW-17 may also move towards and eventually discharge to Smith Creek. The closest discharge point to MW-25 would be approximately 2600 feet to the southeast. Given the estimated Sand Aquifer groundwater velocities described previously in this section, minimum and maximum travel times would be approximately 1 and 800 years, respectively, and an average travel time would be 20 to 30 years.

Groundwater in the Upper Gravel Aquifer adjacent to and north of the Parkside Wetland likely does discharge in part to a branch of the North Fork at or immediately below the Wetland. Travel times from the Landfill to this discharge area cannot be estimated, since no flow path has been identified from the Landfill into that portion of the Upper Gravel Aquifer discharging to the west.

5.2.8 Groundwater Chemistry in Study Area Aquifers

The scope of our work did not include evaluation of groundwater quality or contaminant transport. However, we have utilized some of the basic groundwater chemistry data obtained by Parametrix to assist in groundwater flow interpretations. The chemistry data used consisted of total dissolved solids (TDS) values and the relative abundance of the principle cations and anions plotted on trilinear (Piper) diagrams. Piper diagrams are used to differentiate between aquifers and to classify them on the basis of their dominant cations and anions. These diagrams are constructed by converting ion concentrations to milliequivalent values and then plotting them as percentages of the total. The cation and anion milliequivalents necessary to plot the trilinear diagrams were obtained from Parametrix, Inc.

The trilinear diagrams were useful in differentiating between the Northern and Southern Gravel Aquifers. Figure 47 shows that samples from these aquifers have distinctive cation/anion ratios, and thus plotting positions on the trilinear diagrams. The Northern Aquifer is characterized by low TDS values and shows no dominant cation, although it is lower in Na + K than in Ca + Mg. The Southern Gravel Aquifer shows magnesium as dominant with less Na + K.

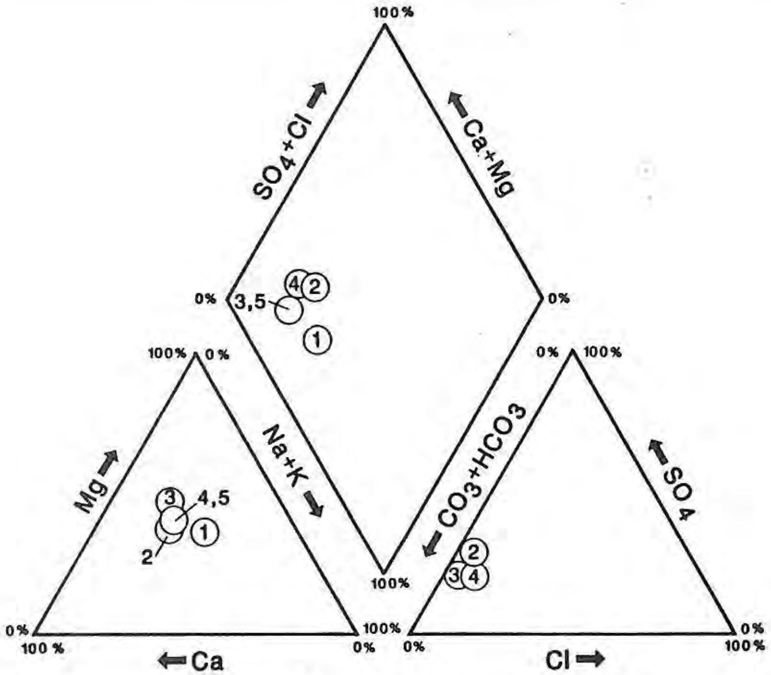
There is a general trend in the cation ratios from other Study Area aquifers which mimics this trend, as illustrated on Figure 48. Uncontaminated water (plotted white on Figure 48), as in the Northern Gravel Aquifer, generally lies in the center of the cation triangle (no dominant cation); while moderately contaminated water (plotted light dot and stripped patterns), as in the Southern Gravel Aquifer, seems to be clustered in the high Ca + Mg, low Na + K area of the triangle.

This pattern generally holds true until the most highly contaminated samples (from Wells LW-1 and LW-2) are considered. Groundwater from both these wells plots in the high Na + K, low Ca + Mg area. This data suggests that a simple leachate mixing model does not adequately describe contamination migration around and through the Landfill.

There is considerable scatter in the cation data plotted on Figure 48. Part of this may be due to a complex hydrochemical or flow environment and part may be due to analytical error. Cation-anion balances calculated for the groundwater samples consistently showed cations greater than anions by 10% or more. Cations and anions should be near equal concentration for accurate interpretation. The cation inbalance was even greater for the leachate samples (from Wells LW-1 and LW-2) with cations greater than anions by 20 to 35%.

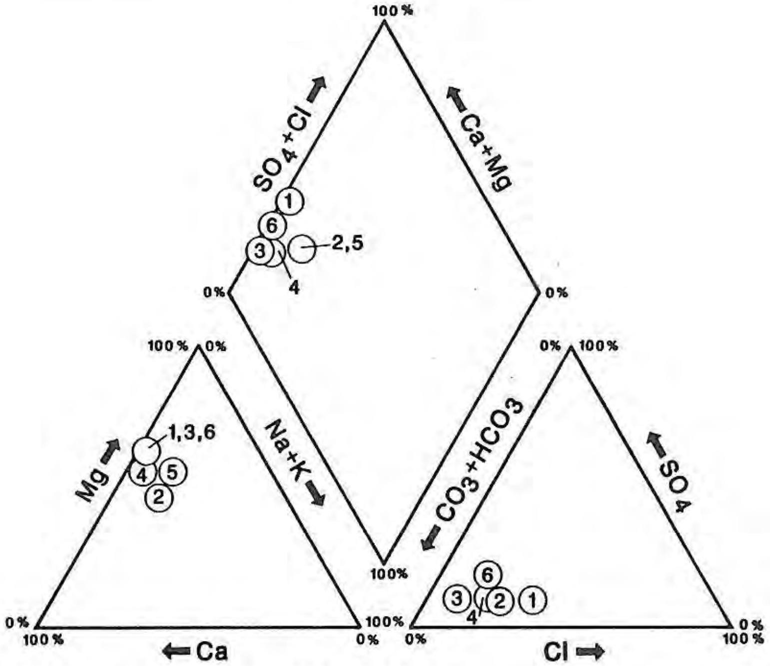
Despite inaccuracies in the cation-anion balance, plotting of the anion data for all aquifers, Figure 49, indicates a more clearly defined mixing between leachate or leachate contaminated groundwater (plotted in black) and uncontaminated waters (plotted in white). The uncontaminated waters are CO_3 and HCO^2 dominant with low concentration of Cl and SO_4. Leachate, by contrast, is Cl - CO_3 + HCO_3 dominant with almost no SO_4.

The only significant anomaly on the anion trilinear diagram is the cluster of data points in the higher SO_4 area. All of these points represent either the Upper Gravel Aquifer or Sand Aquifer in areas north or west of the Landfill. This data suggests a SO_4 source north of the Landfill and also provides support for our conclusion that groundwater generally flows from the north toward the Landfill, rather than the reverse.



Northern Gravel Aquifer

NO.	WELL	TDS
①	MW-18B	100
②	MW-21C	120
③	MW-22A	144
④	MW-22B	120
⑤	MW-27C	128



Southern Gravel Aquifer

NO.	WELL	TDS
①	MW-14A	1140
②	MW-19C	980
③	MW-20B	612
④	MW-23B	676
⑤	MW-24B	172
⑥	MW-29B	436

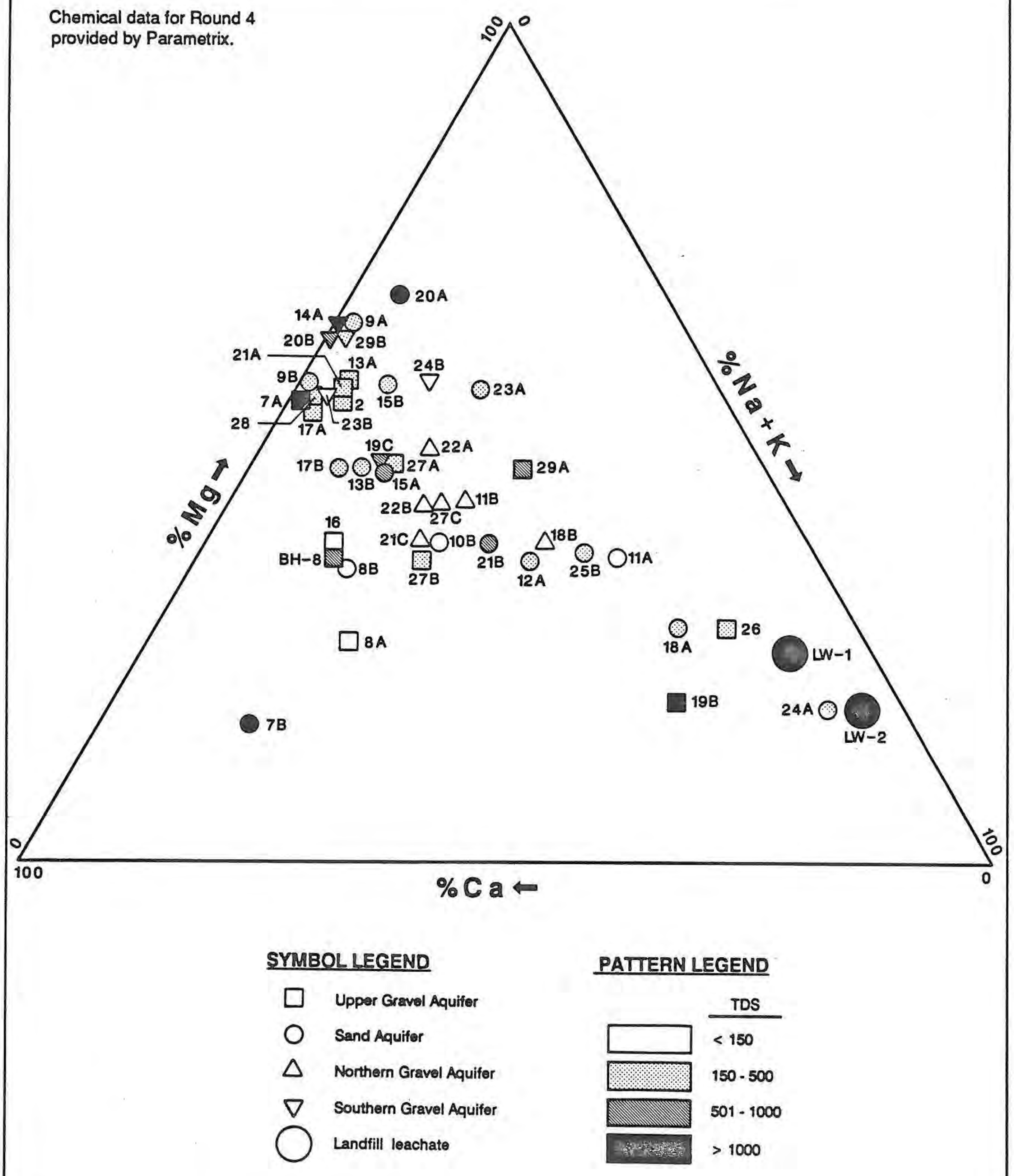
NOTE: Chemical data from Parametrix.
Total Dissolved Solids (TDS) data from Round 4.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Northern and Southern Gravel Aquifers
Trilinear Diagrams
Midway Landfill
Kent, Washington

FIGURE
47

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	2 Dec 87		


Chemical data for Round 4 provided by Parametrix.

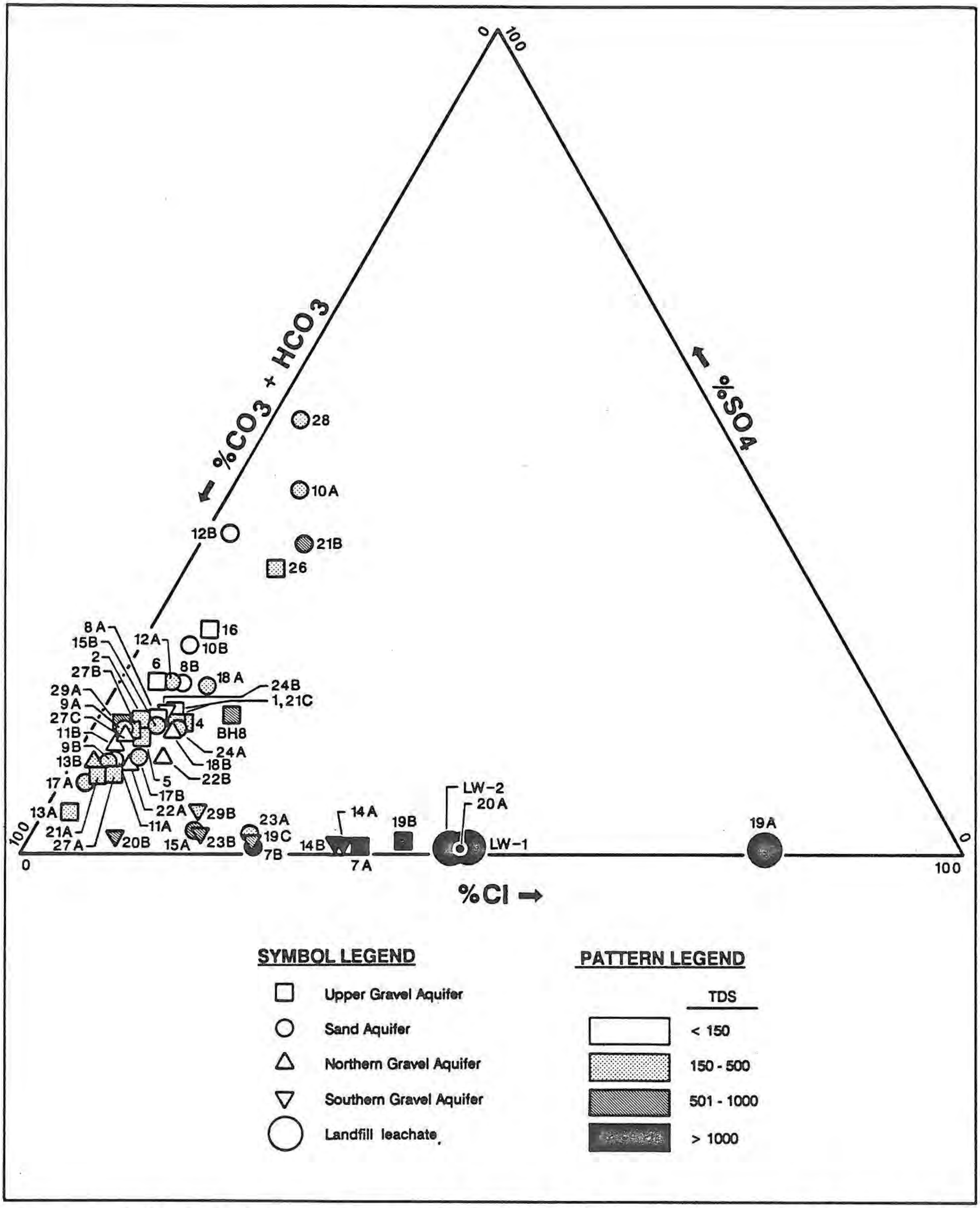
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Composite Cation Trilinear Diagram: All Aquifers

Midway Landfill
Kent, Washington

FIGURE
48

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	SM	MAA	2 December 87		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Composite Anion Trilinear Diagram: All Aquifers

Midway Landfill
Kent, Washington

FIGURE
49

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	NB	MAA	15 May 88		

5.2.9 Aquifer and Aquitard Hydraulic Properties

General: Extensive field and laboratory testing programs were undertaken to define the hydraulic properties of the hydrostratigraphic units. Slug tests were performed in most wells to estimate aquifer horizontal hydraulic conductivity. Laboratory permeability tests conducted on "undisturbed" samples obtained during drilling helped define vertical hydraulic conductivities. "Undisturbed" samples, as opposed to bulk samples, were obtained by driving heavy duty split barrel samplers, and then retrieving an intact portion of the soil sample for testing. Hydraulic conductivities were also calculated using Hazen's Approximation based on particle-size analyses (Freeze & Cherry, 1979). In addition to these laboratory tests, moisture content, dry density, and specific gravity were determined for a number of soil samples and used to estimate porosity. A complete listing of all laboratory tests is included in Table C1 (Appendix C), and results from all the tests are summarized on Table C2 to C12. Slug test results are summarized in Table E1 (Appendix E). Table 4 and Figures 50 and 51 on the following pages summarize horizontal and vertical hydraulic conductivities, respectively, for aquifers and aquitards identified in the Study Area.

Landfill Aquifer: Three wells (MW-19A, LW-1 and LW-2) were completed in the Landfill Aquifer. Leachate wells LW-1 and LW-2 were completed in refuse and MW-19A was completed in silty sand fill below the refuse.

A slug test was performed in MW-19A and pumping tests were conducted in the two leachate wells. In addition to these field tests, soil samples were obtained from the screened interval in MW-19A and tested for particle size distribution, and two triaxial permeability tests were conducted on soil samples obtained from fine-grained fill below the refuse in MW-19 and LW-1.

Pumping test data from LW-1 and LW-2 indicate hydraulic conductivity (K) values of approximately 9×10^{-4} cm/sec and 3×10^{-2} cm/sec, respectively, for municipal refuse (see Appendix E for calculations). This data suggests hydraulic conductivity values for the municipal refuse are highly variable. The Landfill Aquifer response was also quite different in the two wells. The well yield in LW-1 was low, and the leachate level recovered to near the pre-pumping level within a short time after completing the pumping test. By contrast, higher discharge rates were sustained at LW-2, but leachate levels did not fully recover following the pumping test. This indicates the Landfill was partially dewatered during the LW-2 test.

The slug test data from MW-19A indicates a hydraulic conductivity of 2×10^{-3} cm/sec for fill below municipal refuse. Hazen's approximation calculations for two soil samples taken from the MW-19A screened interval indicated K values of 5.6×10^{-3} and 2.2×10^{-4} cm/sec. These values are in reasonable agreement with the slug test value suggesting they are representative of fill near MW-19A. However, we anticipate there is a wide variety of fill material underlying the municipal waste with a corresponding wide range in horizontal hydraulic conductivities. In particular, there may be zones of sandy gravel or washed gravel with unusually high conductivities left as remnants from the gravel mining operation.

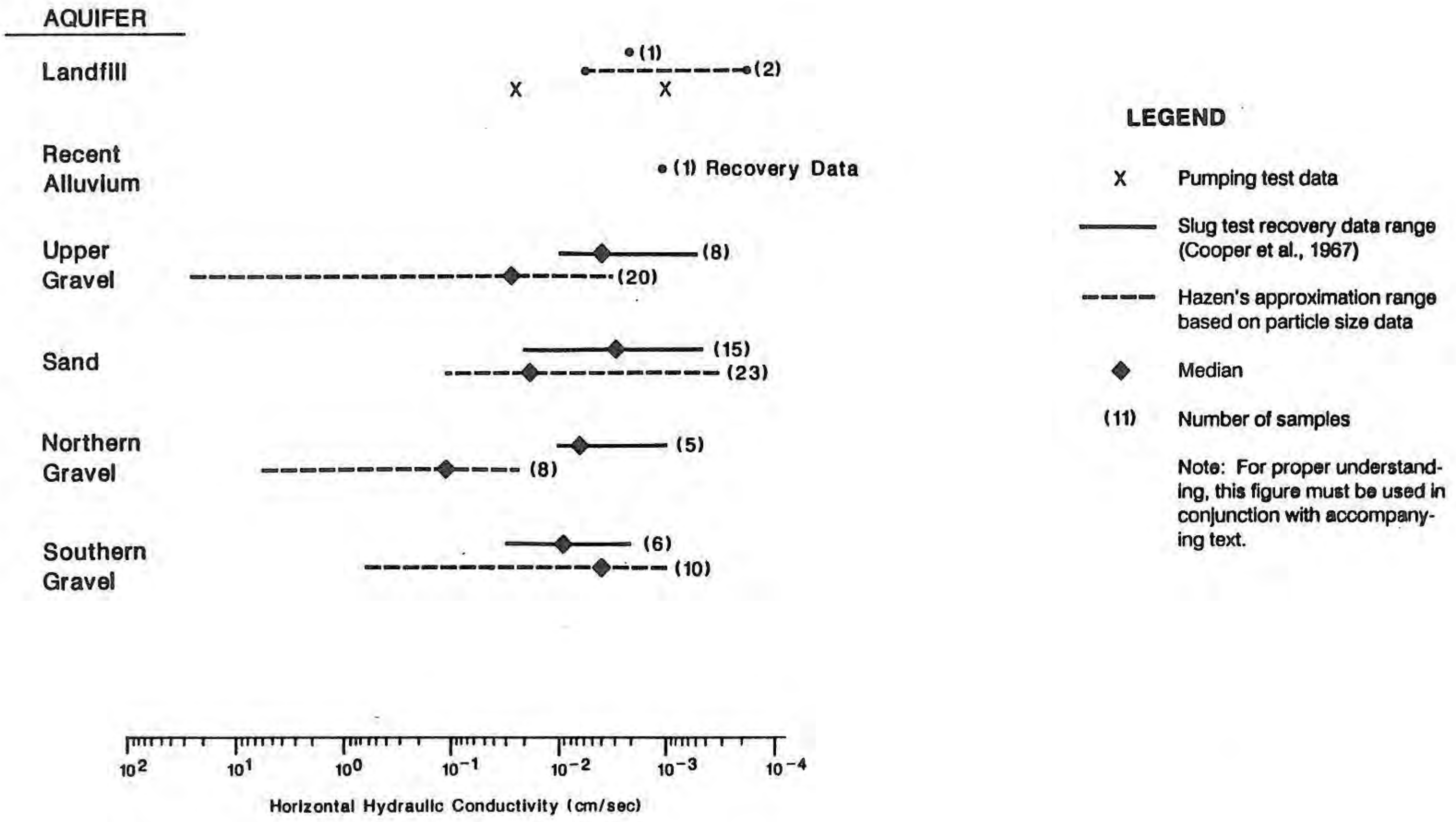
Table 4

Hydraulic Properties Summary[1]

		Hydraulic Conductivity (cm/sec)			
	Estimated Porosity (%)	Median Horizontal	Typical Range	Median Vertical	Typical Range
Landfill Aquifer	INS[2]	INS	10^{-2} to 10^{-4}	INS	INS
Perched Aquifer (Recent Alluvium)	40 - 45	INS	10^{-3} to 10^{-6}	INS	10^{-4} to 10^{-7}
Upper Gravel Aquifer	20 - 45	INS	10^{0} to 10^{-3}	INS	10^{-2} to 10^{-6}
Upper Silt Aquitard	45 - 50	INS	10^{-4} to 10^{-7}	3×10^{-6}	10^{-5} to 10^{-7}
Sand Aquifer	40 - 45	10^{-3}	10^{-2} to 10^{-4}	10^{-4}	10^{-3} to 10^{-5}
Lower Silt Aquitard	45 - 50	INS	10^{-4} to 10^{-6}	2×10^{-6}	10^{-5} to 10^{-7}
North and South Gravel Aquifers	20 - 45	INS	10^{0} to 10^{-2}	INS	10^{-1} to 10^{-3}

Notes:

1. Based on laboratory test data and published values (Todd, 1959).
2. INS = Insufficient or unrealiable data.



Note: For proper understanding, this figure must be used in conjunction with accompanying text.

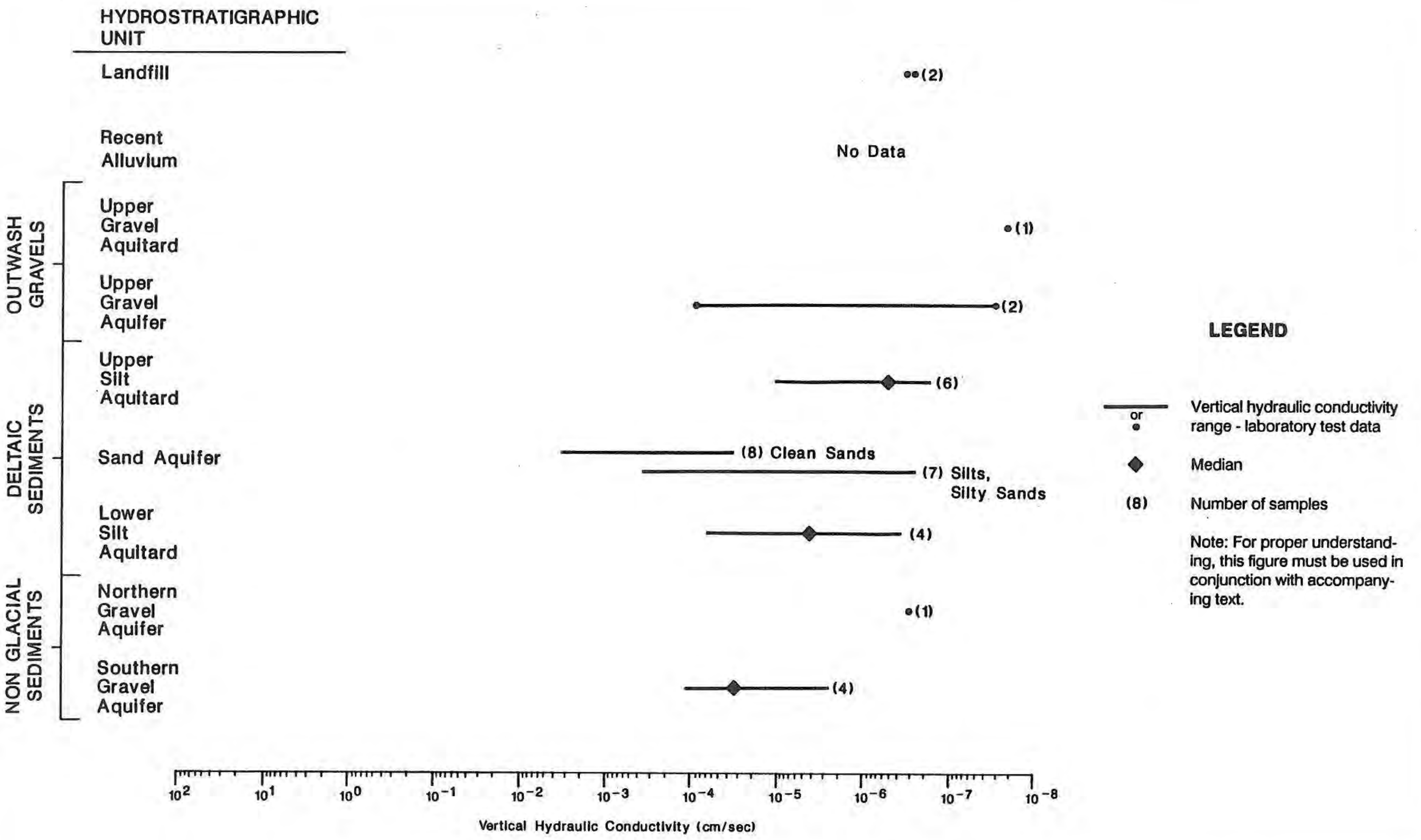
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Horizontal Hydraulic Conductivity Ranges

Midway Landfill
Kent, Washington

FIGURE
50

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MPA	14 January 88		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

FIGURE

51

Vertical Hydraulic Conductivity Ranges

Midway Landfill
Kent, Washington

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	14 January 88		

Two triaxial permeability tests were performed on samples of fine-grained fill (pond sediment) below the municipal refuse at LW-1 and MW-19. to determine the vertical permeability of materials directly underlying the municipal refuse. The test results from LW-1 and MW-19. were 3.5 x 10^{-7} and 2.8 x 10^{-7} cm/sec, respectively. These values appear reasonable for the type of material tested (e.g., the sample from LW-1 had approximately 11% clay and 56% silt), and are probably fairly representative of pond sediment vertical hydraulic conductivities

The following table summarizes the vertical and horizontal hydraulic conductivity data discussed above.

TABLE 5

Landfill Aquifer & Fine Grained Sediment
Hydraulic Conductivities (cm/sec)

	-VERTICAL-	-HORIZONTAL-		
Source	Lab. Test	Slug Test	Pump Test	Hazen's Approximation
Municipal Refuse	--	--	3 x 10^{-2} 9 x 10^{-4}	-- --
Sand Fill Below Municipal Refuse	--	2 x 10^{-5}	--	5.6 x 10^{-3} 2.2 x 10^{-4}
Fine Grained Sediment Underlying Landfill	3.5 x 10^{-7} 2.8 x 10^{-7}	-- --	-- --	-- --

Note: -- indicates no data.

Recent Alluvium: Limited testing was conducted on sediments in the Parkside Wetland. Particle size analyses were performed on two samples obtained from MW-25 at depths of 16 and 36 feet below land surface and a slug test was run in MW-25A. The two soil samples were composed predominantly of silt. We estimate vertical and horizontal conductivities for these silts would be on the order of 10^{-5} to 10^{-6} cm/sec based on published values (Freeze and Cherry, 1979). The slug test in Well MW-25A. indicated a horizontal hydraulic conductivity of approximately 10^{-3} cm/sec. This is a typical value for a medium-grained sand with a trace to some silt. However, we would expect a range of hydraulic conductivity values since Well MW-25A. was actually screened in interbedded clays, silts, and sands. The 10^{-3} cm/sec value probably represents an average horizontal conductivity, but weighted towards the zones of higher permeability.

Upper Gravel Aquitard: This aquitard is comprised of the unsaturated upper portion of the Outwash Gravels. Because the aquitard contains a substantial number of cobbles, it was virtually impossible to obtain undisturbed samples. Instead, grab samples were obtained from the bailer during drilling. These samples generally represent the formation, but are expected to have reduced silt or fine sand fractions due to the washing action of the drilling tools. Permeability tests were not conducted on these disturbed samples, but particle-size analyses were possible.

Unsaturated hydraulic conductivities are a function of soil moisture and soil-water tension. The hydraulic conductivity of unsaturated soil increases with increasing moisture content. Therefore, saturated hydraulic conductivity values for materials similar to those in the Upper Gravel Aquitard provide an upper limit for the unsaturated hydraulic conductivities.

Results of Hazen's Approximation calculations based on the particle size analyses indicate a wide range in saturated hydraulic conductivities; the highest value calculated was approximately 34 cm/sec and the lowest was approximately .008 cm/sec. The high value would correspond with clean sands and gravels, and the low value with sands and gravels containing silt. Considering the variable conditions encountered during drilling in the Upper Gravel Aquitard, we believe a wide range in hydraulic conductivities is reasonable. However, the calculated values seem too high for the soil types observed. We would expect both vertical and horizontal saturated hydraulic conductivity values to range from 10^{-1} to 10^{-6} cm/sec, with most values in the 10^{-4} to 10^{-5} cm/sec range. The anomalously high calculated K values likely result from the loss of fines during sample recovery.

Upper Gravel Aquifer: This Aquifer occurs in the lower part of the Outwash Gravels. Consequently, the difficulties discussed above for evaluating hydraulic properties in the Upper Gravel Aquitard also apply to this aquifer, except that slug test data are available to supplement the particle size data.

Results from the slug test data and particle size calculations are shown graphically in Figures 50 and 51 and are tabulated below.

Table 6

Upper Gravel Aquifer Hydraulic Conductivities

Horizontal Hydraulic Conductivity (cm/sec)

Hazen's Approximation			Slug Tests		
Range	Mean	Median	Range	Mean	Median
.004 to 25	1.96	.029	.0005 to .01	.004	.004

Vertical Hydraulic Conductivity (cm/sec)

Triaxial Permeability Test Data
.00008
.00000003

As illustrated, there is a wide range of horizontal hydraulic conductivity values and a marked discrepancy between the Hazen's Approximation calculations and the slug test data. We expect a wide range of values because of the fluvial nature of the Outwash Gravels and their complex mixture of silt, sand, and gravel. However, it is likely that neither the slug test data nor the particle size calculations fully represent in-situ hydraulic conductivities; the particle size calculations are likely skewed towards higher conductivities due to loss of fines during sampling (as described above) and the slug test data may be skewed towards lower conductivities due to interference from the sand pack around each well screen. (If formation conductivities are higher than the sand pack, then sand pack conductivity will be the limiting value.) Despite these inherent limitations, the median values for both sets of data are relatively close suggesting much of the aquifer may be characterized by horizontal conductivity in the 10^{-2} to 10^{-3} range.

Vertical hydraulic permeability (Kv) data is limited to two triaxial tests; one test indicated a Kv value of 10^{-5} cm/sec, the other 10^{-8} cm/sec. Neither of these tests is fully representative of the Outwash Gravels, since they represent only those sediments sufficiently fine grained to allow collection of an undisturbed drive sample. Most of the Outwash Gravels contained pebbles and gravel and did not allow collection of an undisturbed sample. We anticipate the Outwash Gravels have a relatively wide range of vertical hydraulic conductivities. Based on published values for similar types of sediments, vertical conductivities should be on the order of 10^{-2} to 10^{-6} cm/sec.

Upper Silt Aquitard: Representative samples of the finest-grained layers within the Upper Silt Aquitard were selected for grain size analysis and permeability testing. The grain size analyses showed all samples, except one, were a silt with less than 8% sand. Six of the samples were tested in the laboratory for vertical hydraulic conductivity. Test results indicated a median vertical conductivity of approximately 3 x 10^{-6} cm/sec and a range of approximately 10^{-5} to 10^{-8}. We believe these results are reasonable for these sediments. Moisture contents ranged from 23 to 35%, and a porosity of 42% was calculated for one sample (see Table C7, Appendix C). Silt porosities typically range between 40% and 50% (Todd, 1959).

The Upper Silt Aquitard ranges from approximately 5 to 40 feet in thickness. Using an average aquitard thickness of 20 feet and an average vertical conductivity of 3 x 10^{-6} cm/sec, the average vertical transmissivity is estimated to be approximately one gallon per day per foot (gpd/ft).

Sand Aquifer: The Sand Aquifer includes both clean sand beds and finer grained silt and silty fine sand beds. Hydraulic conductivities have been estimated for both groups as follows:

Table 7

Sand Aquifer Hydraulic Conductivities
Median Values (cm/sec)

	Hazen's Approx. (Horizontal)	Slug Test (Horizontal)	Lab Test (Vertical)
Clean Sands < 9% fines	2 x 10^{-2}	3 x 10^{-3}	1 x 10^{-3}
Sediments with >9% fines	5 x 10^{-4}	-- *	2 x 10^{-5}

* Wells were not completed in silty zones.

These values are reasonable for the type of sediments in the Sand Aquifer and indicate markedly anisotropic conditions. Average values for horizontal and vertical conductivities in the Sand Aquifer as a whole are likely on the order of 10^{-3} and 10^{-4} cm/sec, respectively. The Sand Aquifer varies from 90 to 130 feet in saturated thickness. Using an average of 110 feet and the average horizontal hydraulic conductivity results in an estimated transmissivity of approximately 1400 gallons per day per square foot (gpd/ft^2). Porosities in the Sand Aquifer range from 31 to 44 percent.

Lower Silt Aquitard: Grain size analyses indicate the finer-grained portions of the Lower Silt Aquitard are predominantly silt with less than 10 percent sand. The median vertical hydraulic conductivity of the Lower Silt Aquitard is 2 x 10^{-6} cm/sec. A porosity of 47% was measured in one sample, and the moisture content ranged between 12 and 51%.

The Lower Silt Aquitard ranges from 0 to 50 feet in thickness. Using an average thickness of 25 feet and the median vertical hydraulic conductivity, the average vertical transmissivity is estimated to be approximately 1 gpd/ft^2.

Northern and Southern Gravel Aquifers: The water bearing portions of these aquifers occur in highly permeable sand and sandy gravel deposits interbedded with less permeable silt or silty gravel deposits. Slug tests indicate the permeable portions of both aquifers have hydraulic conductivities in the range of 10^{-2} to 10^{-3} cm/sec. By contrast, hydraulic conductivities for these zones calculated on the basis of grain size data indicate higher permeabilities and a greater difference between the two aquifers. The median calculated hydraulic conductivity for the Northern Gravel Aquifer was .1 cm/sec with a range of 10^{-2} to almost 6 cm/sec; the median for the Southern Gravel Aquifer was .01 cm/sec with a much smaller range, 10^{-1} to 10^{-2} cm/sec.

The grain size data is likely more representative of aquifer conditions than the slug test data, as the slug test data appears to reflect the limiting hydraulic conductivity of the sand pack. The apparent difference between Northern and Southern Gravel aquifers is likely more a function of the samples selected for testing rather than an actual difference; there were more sand samples with lower permeability in the Southern Gravel Aquifer group. Considering the range of lithologies present in the permeable portions of the aquifers, hydraulic conductivities likely range between .01 and 1 cm/sec, although some of the open work gravel deposits could have exceedingly high permeabilities >100 cm/sec.

Three samples from finer grained portions of the Northern and Southern Gravel Aquifer were tested in the laboratory for vertical hydraulic conductivity. Two of the results were approximately 3 x 10^{-5} cm/sec; the other was 3 x 10^{-7}. These values are reasonable for the materials tested, which were classified as silt. One hydraulic conductivity of 9 x 10^{-4} cm/sec was also calculated for a silty sand from grain size data.

6.0 DATA GAPS

Groundwater occurrence and flow patterns have generally been defined within the Study Area sufficiently to evaluate groundwater contaminant transport and potential risks to human health and the environment. However, there are several areas in which data is lacking. These are described, as follows:

1. The source and extent of the shallow perched groundwater system north of the Landfill has not been defined. This perched system is important as it may be recharging the landfill and it will certainly impact construction of the proposed stormwater detention basin. However, the impact to the detention basin has been addressed in a recent study by Rittenhouse Zeman Associates (1988) and the dewatering system planned for the detention basin should act to intercept the perched water and prevent it from entering the Landfill. It is not likely that the Landfill is recharging the perched groundwater.

2. The saturated thickness and flow of leachate in the Landfill is not fully defined at any time other than February 1987. It will be important to monitor leachate level fluctuations in the future to assess the performance of remedial actions, particularly those related to installation of a Landfill cap and to termination of the current practice of discharging surface water runoff into the Landfill.

3. The full extent of the southeastern contaminant plume in the Sand Aquifer is not known. However, chloride concentrations and leachate influence appears to be decreasing in a downgradient direction, and there should be no impacts to existing public water supply systems, or the environment. No public water supply wells occur until the Lake Fenwick area, approximately 6,000 feet to the southeast.

4. The same situation exists in the Southern Gravel Aquifer as it does in the Sand Aquifer. Contaminated groundwater in this aquifer is migrating both to the east and the west out of the Study Area. However, the nearest discharge areas are approximately 4000 feet to the east and west, and it is unlikely that any of the contaminants would be at detectable levels upon discharge.

5. There is still uncertainty as to whether the slightly elevated chloride concentrations in Wells MW-17B and MW-21B reflect leachate influence or some other chloride source, and whether groundwater at MW-17B is reaching the Parkside Wetland. Given the low concentrations of chloride at these two wells, however, leachate can only constitute a small fraction of the groundwater in these areas, if it reaches the wells at all.

7.0 REFERENCES

Armstrong, J.E., Crandell, D.R., Easterbrook, D.J., and Noble, J.M., 1965, Late Pleistocene Stratigraphy and Chronology in Southwestern British Columbia and Northwestern Washington. Geol. Society of America Bulletin, V. 76, P 321-330, March 1965.

Carey, Al, 1987, 1988, Personal Communication.

Crandell, D.R., Mullineaux, F.R., and Waldron, H.H., 1958, Pleistocene Sequence in Southeastern Part of the Puget Sound Lowland, Washington; American Journal of Science, V. 256, June 1958, P. 384-397.

Easterbrook, D. J., Briggs, N.D., Westgate, J.A., and Gorton, M.P., 1981, Age of the Salmon Springs Glaciation in Washington; Geology, V. 9, P. 87-93, February 1981.

Freeze, R.D., and Cherry, J.A., 1979, Groundwater, Prentice-Hall, Inc.; Englewood Cliffs, N.J., 604 pp.

Golder Associates, 1982, Geotechnical and Hydrological Investigations for the Midway and Kent Highlands Landfill Closures, prepared for Parametrix, Inc.

Golder Associates, 1985, Monitoring Well and Gas Probe Installations at the Midway Landfill; prepared for Parametrix, Inc.

Hall, J.B., and Othberg, K.L., 1974, Thickness of Unconsolidated Sediments, Puget Lowland, Washington; Washington Division of Geology and Earth Resources, Geologic Map GM-12.

Johnson Div. UOP, 1986, Groundwater and Wells, 2nd Edition, Fletcher Driscoll-Principal Author and Editor, 1089 pages.

Larsen, By, 1987, Personal Communication.

Luzier, J.E., 1969, Geology and Ground Water Resources of Southwestern King County, Washington; Washington Department of Water Resources Water Supply Bulletin No. 28.

REFERENCES (Continued)

Parametrix, Inc., Aug. 1985, Draft Environmental Impact Statement, Midway Landfill Closure Plan; prepared for City of Seattle Engineering Department.

Parametrix, Inc., July 1987, Preliminary Draft, Midway Landfill RI/FS, Surface Water Technical Report, prepared for Seattle Engineering Department Solid Waste Utility.

Parametrix, Inc., 1988, Appendix B, Groundwater and Leachate Monitoring Technical Memorandum, for the Groundwater Technical Report, Midway Landfill Remedial Investigation, Final Report prepared for Seattle Engineering Department Solid Waste Utility.

Parametrix, Inc., 1988, Water Well Inventory.

Rittenhouse-Zeman & Associates, 1988, Midway Stormwater Detention Facility, King County, Washington; Report prepared for Parametrix, Inc., March 1988.

Smith, M. 1976, Surficial Geology of Northeast Tacoma, Pierce County, Washington; Washington Department of Natural Resources Open File Map 76-9.

Thorson, R.M., 1980, Ice-Sheet Glaciation of the Puget Lowland, Washington, during the Vashon Stade (Late Pleistocene); Quaternary Research, V. 13, p. 303-321.

Todd, David, 1959, Ground Water Hydrology, John Wiley & Sons, Inc., 336 p.

Waldron, Howard W., 1961, Geology of the Poverty Bay Quadrangle, Washington, United States Geological Survey Geologic Quadrangle Map GQ-158.

Waldron, Howard W., 1962, Geology of the Des Moines Quadrangle, Washington, U.S.G.S. Geologic Map GQ-159.

Washington Department of Transportation, 1963, Photogrammetric Map Midway Pit Area, Plate IIIA, April 3, 1963.

APPENDIX A

Field Investigation Description

APPENDIX A

Field Investigation Description

This Appendix describes the field aspects of our hydrogeologic investigation for the Midway Landfill Remedial Investigation.

Phase I and Phase II
Monitor Wells - Drilling, Installation and Development

A total of 47 groundwater monitor wells and 10 gas probes were installed in 23 drilled borings during two phases of exploration. Phase I wells included MW-7 through MW-16, and were installed between October 1986 and February 1987. Based on the results from the Phase I explorations, an additional thirteen (13) borings were drilled and completed as twenty-seven (27) Phase II monitor wells between February and July 1987. In addition to the monitor wells, two leachate extraction wells, LW-1 and LW-2, were installed in the Landfill.

Tables B1 and B2 in Appendix B summarize well installation data and pertinent depth and elevation data for each monitor well, respectively, and Plate I in the back pocket shows well locations.

All monitor well and leachate well borings were advanced using cable tool drill rigs including Bucyrus Erie 22-W Series 2 and 3, Bucyrus Erie 60 and a Speedstar 71. Steel casing was driven to temporarily line the borehole and potable water from the City of Kent was added as needed to facilitate drilling. The casing used was unvarnished, contained a minimum of chalk markings, and was sufficiently thick to allow drilling to depths of 400 feet.

Initially, 8-inch casing was used to drill all Phase I wells outside of the Landfill. However, this method proved inefficient in penetrating the large cobbles found in the upper 100 to 200 feet of each borehole. Consequently, a combination of 12-inch and 8-inch casing was used for drilling Phase II wells. The 12-inch casing was typically advanced to depths of 86 to 160 feet below land surface, which was usually sufficient to penetrate most of the cobbly and bouldery zones. Eight-inch casing was then telescoped through the 12-inch casing and advanced to full borehole depth. This technique significantly reduced casing side friction and facilitated casing extraction during well installation. Both the 8-inch and 12-inch casing was extracted with hydraulic jacks after the drive shoes were cut.

Borings were logged with respect to subsurface stratigraphy and groundwater conditions using the following methods:

- Regularly examining the drill cuttings removed from the borehole.
- Obtaining soil samples.
- Observing the resistance to drilling as indicated by drilling rate, overall rig behavior, and resistance to driving casing.
- Keeping tallies of casing installed and measuring and marking drill and bail line lengths to insure accurate logging.
- Recording water level measurements during drilling.
- Measuring electrical conductivity, pH, and occasionally temperature on groundwater samples removed from the borehole by bailing.

Relatively undisturbed samples were collected at 5-foot intervals or at major stratigraphic changes by driving a heavy-duty, 2.4-inch inside diameter split barrel sampler with a 200 or 300-pound hammer dropping approximately 30 inches. Thin-walled soil samplers were used in cohesive sediments. The number of blows/foot required to drive the sampler was recorded and is shown on the boring logs (Appendix B). After driving, the sampler was retrieved, carefully opened and the soil classified in accordance with the Unified Soil Classification System (Plate B28, Appendix B). A representative sample was collected, placed in a plastic bag and stored in plastic sample tubes. The samples were then returned to our laboratory in Bellevue for further examination and testing.

Monitor wells were constructed after each borehole was drilled. Well designs were prepared on-site by the AGI Project Manager and confirmed by Ecology personnel. Design specifications included the length and location of seals and screened interval for each well. Summary Logs showing well completion details are included in Appendix B.

The general procedures for well construction were as follows; minor departures from described procedures occurred from well to well.

- The completed borehole was bailed until relatively free of cuttings.
- Completed boreholes were backfilled to achieve a specific base depth for the PVC well. Sand, pea gravel, and bentonite pellets were used as backfill.
- The depth to backfill materials within the well was measured frequently with a weighted stainless steel line marked in 10-foot increments to accurately place screens, seals, and other construction materials, and prevent overfilling the temporary casing.

- Temporary casing was extracted after the drive shoe was cut as the wells were installed. The amount of backfill material in the casing was generally kept to 2 feet or less to prevent bridging. All well construction materials were placed dry from the top of the casing, except the cement/bentonite grout and volclay grout.

- Bentonite pellet seals were installed a minimum of 1-foot thick, and placed above and below screened intervals in most wells.

- Groundwater monitor wells were constructed of 2-inch diameter, flushed-thread coupled Schedule 40 PVC pipe with .020-inch milled slots for screened intervals. Screened interval lengths were generally 5 and 10 feet. Bottom caps were flush threaded. The casing were vented near the top to prevent the build-up of gases or creation of a vacuum.

- Gas probes placed into selected wells were constructed of 1/2-inch diameter flush-threaded PVC pipe with .020-inch milled slots. Bottom caps were flush threaded.

- Leachate wells were constructed of 6-inch diameter, flush-threaded coupled stainless steel pipe with a .125-inch milled or louvered slots for screened intervals. Screened interval lengths were 25 and 10 feet for LW-1 and LW-2, respectively. Bottom caps were flush threaded.

- Pea gravel or Aqua 8 Traction Sand was used as the formation stabilizer, around the screened section.

- A cement/bentonite grout or volclay grout was tremmied into the borehole to provide a surface seal. A mix of approximately 95 percent Portland Cement and 5 percent bentonite was used. Dry granular bentonite was placed as a surface seal in some wells.

- Steel monument cases or a steel flush-mount meter boxes with locking caps were installed over the plastic well casing upon completion of construction. Monuments were set in concrete, painted, and clearly labeled. The type of protective monument used depended on the well location. Flush-mounts were constructed so as to allow drainage of any surface water entering the meter box.

Most problems encountered during well construction were minor and were corrected. Only in MW-19B and MW-10A was the installation less than adequate. Approximately one-third of the MW-19B screen became saturated with cement/bentonite grout. Subsequent attempts to develop the well eventually cleared the screen of grout, allowing the well to be sampled.

Well MW-10A became unserviceable after the screen section ruptured during installation. A 1-inch screen was subsequently washed down across the rupture zone, allowing MW-10A to be sampled.

Site Control

The Level C site safety procedures outlined in the Safety Plan were followed during all field activities with minor exceptions. During field operations, a combination of instruments was used to test for the presence of methane, hydrogen sulfide, vinyl chloride, and organic vapors. A MSA Model 361, with both audible and visual alarm and a TIP Photoionization detector were used continuously during field operations. All test results and conditions were recorded in a daily log and are shown on the Summary Logs in Appendix B.

Equipment Decontamination and Site Housekeeping

All drilling equipment (i.e. service trucks, drill rigs) and all drilling accessories were thoroughly decontaminated prior to drilling the first boring, between each drilling location, and prior to leaving the site. The rig and equipment were not decontaminated between drilling the shallow and deep wells at each drilling location. Drilling equipment, accessories and PVC casing were decontaminated using a high-pressure steam cleaner.

Prior to starting each boring, polyethylene sheeting and plywood was placed on the ground in the drill area. Fifty-five gallon drums were placed at each boring site to collect soil cuttings and water removed from the boring. All liquid, semi-solid, and solid drill cuttings not placed directly into barrels during the drilling were captured on the plastic. When the drilling was completed, both plastic and cuttings were placed in 55-gallon drums for later disposal.

After well installation was complete, soil cuttings and water were removed from barrels, transported to and placed in pre-excavated and plastic lined cuttings pits located on Midway Landfill by Nelson Construction, a vactor truck service.

Well Development

Monitor wells were developed after installation. Wells MW-10, MW-11, MW-12, MW-17, and MW-18 were developed by air lift methods. Wells MW-7 through MW-9, MW-14 through MW-16, and MW-19 through MW-29 were developed with a Bennett pump; the submergence for these wells was insufficient to extract water by air lifting. In excess of 20 well casing volumes of water were removed to develop each well. This volume was sufficient to achieve clear return water for most wells. All development water was put in 55-gallon drums for later disposal. Air-lift equipment and the Bennett Pump were thoroughly decontaminated by steam cleaning between wells.

Aquifer Testing

Most wells were tested to determine hydraulic characteristics of the aquifer. Non-invasive slug tests (rising and falling head) were performed in the monitor wells to determine the hydraulic conductivity of the water bearing formation. Pumping tests were conducted in the leachate extraction wells. Pumping and slug test methodology and results are described in Appendix E.

Pump Installation

A dedicated piston type displacement pump (Bennett Pump) was installed in each new monitor well with access for manual measurements of water levels and attachment of equipment to power the pump.

Parkside Wetland Investigation

We investigated near surface soil and groundwater conditions in the Parkside Wetland area by:

- Geologic mapping of the wetland and surrounding areas.
- Installing three shallow drive point wells.
- Exploring peat depth with a systematic program of peat probes.

The geologic mapping met with only limited success because only a few outcrops were available for evaluation. Most of the area above the wetland was covered with thin layers of fill or slopewash, obscuring the underlying native deposits.

Three shallow wells were installed in the wetland to monitor near surface groundwater levels. The wells were installed by excavating a borehole to a depth of approximately 1.5 feet and then hand driving a Johnson stainless-steel drive point to a total depth of approximately 6 feet. The drive points had a 4-foot wire wound screen with .020 slots; stainless steel riser pipe was connected to the drive point and extended to approximately 2 feet above land surface. A locking cap was then placed over the pipe for security. The annular space was sealed against surface water infiltration with granular bentonite. Well construction details are shown on Plate B27 in Appendix B.

Water levels in the DP wells were measured on two occasions.

Peat depths were measured at 18 locations throughout the wetland with a Davis peat probe. This type of probe has a sampling attachment allowing recovery of peat and the silt typically found to underlie the peat. Unfortunately the sampling attachment was broken after the first probe, so the peat depth was assumed to be the peat rod refusal depth. The validity of this method was later checked and confirmed after the sampling attachment was repaired.

APPENDIX B

Monitoring Well Logs and Installation Diagrams

APPENDIX B

Monitoring Well Logs and Installation Diagrams

This Appendix includes well completion diagrams and geologic logs for all groundwater monitoring wells, gas probes, and leachate extraction wells drilled and installed by Applied Geotechnology Inc. Logs from previous installed wells (Golder, 1982, 1985) are not included. Specifically, this Appendix includes the following:

Table B1:	Groundwater Monitor Well Installation Data
Table B2:	Groundwater Monitor Well Depth and Elevation Specifications
Plate B1:	Summary Log Legend
Plates B2 - B24:	Summary Logs for Wells MW-7 through MW-29
Plates B25 - B26:	Summary Logs for Leachate Extraction Wells LW-1 and LW-2
Plate B27:	DP Well Logs and Installation Diagrams
Plate B28:	Soil Classification Legend
Plates B29 - B53:	Geologic Logs of Boring 7 through 29; and LW-1 and LW-2
Plate B54:	Well MW-6 Repair

Table B1 summarizes well installation details such as installation date, total depth, pumping and casing type, and miscellaneous well characteristics.

Table B2 provides reference elevations and depths for all significant components of the wells and probes. The Summary Log Legend is a guide to the Summary Logs which follow. The Summary Logs include well construction details, water level data, gas, and water quality observations, and a schematic of the geologic conditions encountered. Detailed descriptions of the geologic conditions encountered are provided in the following boring logs. A guide to the soil classification system and symbols used in the boring logs is provided on the Soil Classification Legend.

Table B1

Groundwater Monitor and Leachate Extractior

1) Well Number	Completion Date	Boring Depth (feet)	Drill Method	No. of Well Completions	2) Gas Probes	3) Dedicated Pumps	4) Casing Type	Casi Di (inc	
BH-1B	27-Jan-82	104	mud rotary	1	no	no	pvc	4	Blocked at
BH-2	02-Feb-82	120	air/mud	2	no	no	pvc	2	
BH-3	19-Jan-82	115	auger	1	no	no	pvc	2	
BH-4	20-Jan-82	81	auger	1	no	no	pvc	2	
BH-5	21-Jan-82	88	auger	1	no	no	pvc	2	Water level in well constant since installation.
BH-6	10-Feb-82	139	air rotary	1	no	no	pvc	4	Dry after May 1986.
BH-7	15-Feb-82	137	auger	1	no	no	pvc	2	Dry after September 1986 due likely to blockage.
BH-8	11-Feb-82	111	air rotary	1	no	no	pvc	4	
MW-1	25-Mar-85	126	air rotary	1	no	no	pvc	4	
MW-2	29-Apr-85	155	air rotary	1	no	no	pvc	4	
MW-3	05-Mar-85	187	air rotary	1	no	no	pvc	4	Has always been dry.
MW-4	28-Jan-85	145	air rotary	1	no	no	pvc	4	
MW-5	18-Jun-85	85	air rotary	1	no	no	pvc	4	
MW-6	21-Jun-85	138	air rotary	1	no	no	pvc	4	Screen rupture at 117 feet repaired.
MW-7	22-Oct-86	265	cable tool	2	no	yes	pvc	2	0.5-inch water level probe installed.
MW-8	27-Feb-87	231	cable tool	2	1	yes	pvc	2	
MW-9	06-Jan-87	176	cable tool	2	no	yes	pvc	2	
MW-10	14-Nov-86	245	cable tool	2	1	yes	pvc	2	10A repaired with washdown screen,low yielding.
MW-11	02-Feb-87	279	cable tool	2	no	yes	pvc	2	Developed with air.
MW-12	13-Jan-87	266	cable tool	2	no	yes	pvc	2	
MW-13	30-Oct-86	231	cable tool	2	no	yes	pvc	2	Static water level near top of screen for 13A.
MW-14	17-Mar-87	335	cable tool	2	1	yes	pvc	2	
MW-15	04-Dec-86	300	cable tool	2	1	yes	pvc	2	
MW-16	06-Feb-87	194	cable tool	1	no	yes	pvc	2	
MW-17	09-Dec-86	145	cable tool	2	no	yes	pvc	2	17A repaired with washdown screen, low yielding.
MW-18	21-Apr-87	315	cable tool	2	no	yes	pvc	2	Developed with air.
MW-19	27-Mar-87	311	cable tool	3	no	yes	ss	2	19B and 19C partially blocked at about 53 feet, 1.4 inch O.D. narrow pump installed in 19C.
MW-20	10-Jun-87	325	cable tool	2	1	yes	pvc	2	20A screen is damaged needs repair.
MW-21	04-Jun-87	301	cable tool	3	1	yes	pvc	2	21A turbid when sampled.
MW-22	28-May-87	340	cable tool	2	no	yes	ss	2	
MW-23	12-May-87	390	cable tool	2	1	yes	pvc	2	
MW-24	19-May-87	375	cable tool	2	1	yes	pvc	2	
MW-25	23-Jun-87	101	cable tool	2	no	yes	pvc	2 & 0.5	25B is a 0.5-inch diam. water level probe.
MW-26	02-Apr-87	150	cable tool	1	no	yes	pvc	2	
MW-27	03-Aug-87	290	cable tool	3	1	yes	pvc	2	
MW-28	11-Jun-87	146	cable tool	1	no	yes	pvc	2	
MW-29	22-Jul-87	395	cable tool	2	1	yes	pvc	2	
LW-1	16-Feb-87	173	cable tool	1	no	no	ms	6	Designed as leachate extraction well.
LW-2	19-Feb-87	120	cable tool	1	no	no	ms	6	Designed as leachate extraction well.
DP-1	15-Oct-87	6	hand drive	1	no	no	ss	2	In Parkside wetland.
DP-2	15-Oct-87	6	hand drive	1	no	no	ss	2	In Parkside wetland.
DP-3	15-Oct-87	6	hand drive	1	no	no	ss	2	In Parkside wetland.

Notes:

1. BH-1 to MW-6 installed by Golder Inc., MW-7 to DP-3 installed by Applied Geotechnology Inc.
2. Gas probes are 0.5-inch diameter PVC.
3. Dedicated pumps are 1.8-inch O.D. Bennett air-actuated piston pumps. Pumps generally set 2 feet above top of screen except wells MW-13A, MW-23A, and MW-24A where pumps are set 1 foot below top of screen.
   In general, wells < 300 ft. deep have model 188, 1-inch piston pumps. Wells > 300 ft. have model 187, 7/8-inch piston pumps.
   The 7/8-inch diameter piston pumps are installed in wells: MW-14B, MW-21C, MW-22B, MW-24B, MW-29B, MW-20B, MW-23B.
4. Casing: ss = stainless steel, ms = mild steel, pvc = schedule 40 or 80.

Table B2

Groundwater Monitor and Leachate Extraction Well Depth and Elevation Specifications

Monitor Well Number	Land Surface Elevation	Meas. Point Elevation	Total Boring Depth	Bottom Hole Elevation	Screened Zone "A" Depth	Screened Zone "A" Elevation	HSU*	Screened Zone "B" Depth	Screened Zone "B" Elevation	HSU*
BH-1B	341.9	344.70	104	237.9	91.3 - 93.3	250.6 - 248.6	UGA	-	-	
BH-2A	374.40	376.91	120	254.4	21.5 - 23.5	352.9 - 350.9	GU	-	-	
BH-2B	374.40	377.18	120	254.4	-	-		47.5 - 49.5	326.9 - 324.9	GU
BH-3	376.90	379.68	115	261.9	113.0 - 115.0	263.9 - 261.9	GU	-	-	
BH-4	376.50	380.54	81	295.5	78.8 - 80.8	297.7 - 295.7	MID	-	-	
BH-5	390.50	392.73	88	302.5	86.2 - 88.2	304.3 - 302.3	MID	-	-	
BH-6	384.5	386.53	139	245.5	129.0 - 139.0	255.5 - 245.5	GU	-	-	
BH-7	389.20	393.01	137	252.2	128.8 - 130.8	260.4 - 258.4	UGA	-	-	
BH-8	362.0	362.61	111	251.0	101.0 - 111.0	261.0 - 251.0	GU	-	-	
MW-1	366.36	365.99	126	240.4	86.0 - 122.0	280.4 - 244.4	GU	-	-	
MW-2	382.0	384.39	155	227.0	126.0 - 156.0	256.0 - 226.0	GU	-	-	
MW-3	412.80	416.11	187	225.8	152.8 - 184.7	260.0 - 228.1	UGA	-	-	
MW-4	363.31	362.82	145	218.3	110.5 -144.25	252.8 - 219.1	GU	-	-	
MW-5	322.44	321.94	85	237.4	47.6 - 77.5	274.8 - 244.9	GU	-	-	
MW-6	272.13	271.76	138	134.1	96.0 - 113.7	176.1 - 158.4	GU	-	-	
MW-7	413.29	412.73	265	148.3	188.3 - 197.8	225.0 - 215.5	GU	222.7 - 225.7	190.6 - 187.6	SAND
MW-8	351.81	351.35	231	120.8	168.5 - 179.0	183.3 - 172.8	GU	200.9 - 206.3	150.9 - 145.5	SAND
MW-9	354.46	353.79	176	178.5	127.6 - 138.0	226.9 - 216.5	SAND	164.7 - 170.1	189.8 - 184.4	SAND
MW-10	339.17	338.77	245	94.2	192.5 - 202.2	146.7 - 137.0	SAND	222.9 - 231.9	116.3 - 107.3	SAND
MW-11	369.70	370.41	279	90.7	200.3 - 210.3	169.4 - 159.4	SAND	265.8 - 271.2	103.9 - 98.5	NGA
MW-12	375.21	374.80	266	109.2	233.8 - 239.2	141.4 - 136.0	SAND	255.4 - 258.4	119.8 - 116.8	SAND
MW-13	383.23	382.68	231	152.2	109.0 - 111.9	274.2 - 271.3	GU	196.3 - 206.8	186.9 - 176.4	NGA
MW-14	381.00	381.85	335	46.0	277.6 - 283.0	103.4 - 98.0	SGA	302.0 - 307.5	79.0 - 73.5	SGA
MW-15	438.85	438.54	300	138.9	224.1 - 234.3	214.8 - 204.6	SAND	260.2 - 265.7	178.7 - 173.2	SAND
MW-16	363.18	362.80	194	169.2	161.5 - 166.9	201.7 - 196.3	GU	-	-	
MW-17	337.43	337.08	145	192.4	87.8 - 98.2	249.6 - 239.2	SAND	126.0 - 133.0	211.4 - 204.4	SAND
MW-18	342.60	343.91	315	27.6	119.0 - 129.5	223.6 - 213.1	SAND	281.3 - 291.7	61.3 - 50.9	NGA
MW-19	368.40	370.20	311	57.4	72.5 - 82.5	295.9 - 285.9	MID	168.2 - 173.2	200.2 - 195.2	GU
MW-20	373.70	375.65	325	48.7	190.0 - 195.0	183.7 - 178.7	SAND	295.0 - 300.0	78.7 - 73.7	SGA
MW-21	358.50	359.95	301	57.5	85.4 - 95.4	273.1 - 263.1	GU	170.4 - 180.4	188.1 - 178.1	SAND
MW-22	376.80	378.28	340	36.8	268.8 - 273.0	108.0 - 103.8	NGA	300.2 - 310.2	76.6 - 66.6	NGA
MW-23	424.97	424.42	390	35.0	230.0 - 240.0	195.0 - 185.0	SAND	320.3 - 330.3	104.7 - 94.7	SGA
MW-24	419.11	418.58	375	44.1	205.5 - 215.5	213.6 - 203.6	SAND	350.5 - 355.5	68.6 - 63.6	SGA
MW-25	261.16	260.84	101	160.2	14.5 - 19.5	246.7 - 241.7	PA	40.1 - 45.1	221.1 - 216.1	PA
MW-26	369.40	370.58	150	219.4	112.0 - 117.0	257.4 - 252.4	GU	-	-	
MW-27	330.40	330.05	290	40.4	76.9 - 87.3	253.5 - 243.1	GU	147.6 - 153.0	182.8 - 177.4	GU
MW-28	375.20	374.15	146	229.2	108.0 - 113.0	267.2 - 262.2	SAND	-	-	
MW-29	428.85	428.50	395	33.9	208.1 - 218.1	220.8 - 210.8	GU	370.0 - 377.0	58.9 - 51.9	SGA
LW-1	375.60	377.25	173	202.6	61.0 - 86.0	314.6 - 289.6	MID	-	-	
LW-2	382.10	383.49	120	262.1	100.5 - 110.8	281.6 - 271.3	MID	-	-	
DP-1	253.80	255.10	6	247.8	1.7 - 5.7	252.1 - 248.1	PA			
DP-2	252.20	254.00	6	242.2	1.2 - 5.2	251.0 - 247.0	PA			
DP-3	257.00	258.50	6	251	1.5 - 5.5	255.5 - 251.5	PA			

Notes: * HSU - Hydrostatigraphic Unit.

1. All values in feet. Elevation data provided by Parametrix, Inc. Datum unknown.
2. Wells BH-1B through BH-8 installed by Golder Associates, 1982; Wells MW-1 through MW-6 installed by Golder Associates, 1985; Wells MW-7 through MW-29, LW-1 and LW-2, and DP-1 through DP-3 installed by Applied Geotechnology Inc., 1986-1987.
3. Measuring points are as follows: Top of protective steel casing for MW-1,2,3,6 to 29, LW-1 and LW-2; Top of PVC well casing for BH-1 to BH-8, MW-4 and MW-5; top of drive point casing for DP-1 to DP-3.
4. Hydrostatigraphic unit designations as follows: MID - Leachate in Midway Landfill; GU - Upper Gravel Aquifer; NGA - Northern Gravel Aquifer; SGA - Southern Gravel Aquifer; SAND - Sand Aquifer; UGA - Upper Gravel Aquitard; PA - Perched Aquifer.

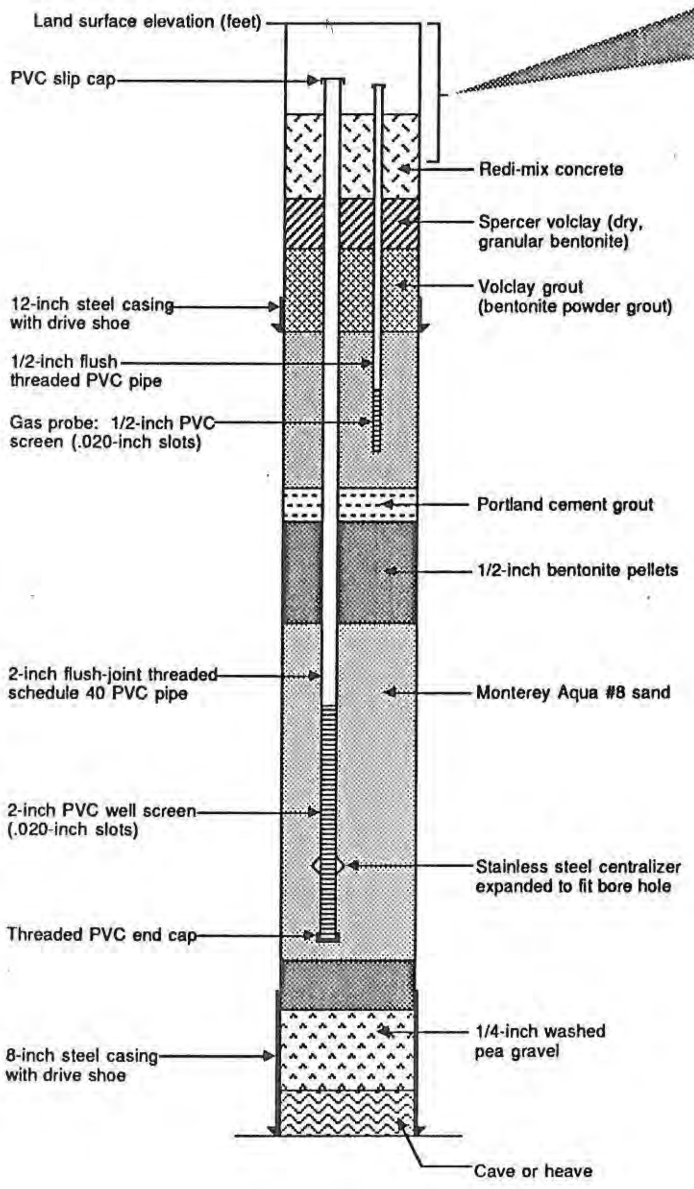
Table B2 (Continued)
Groundwater Monitor and Leachate Extraction Well Depth and Elevation Specifications

Monitor Well Number	Land Surface Elevation	Meas. Point Elevation	Total Boring Depth	Bottom Hole Elevation	Screened Zone "C" Depth	Screened Zone "C" Elevation	HSU*	Gas Probe Depth	Gas Probe Elevation
BH-1B	341.9	344.70	104	237.9	-	-		-	-
BH-2A	374.40	376.91	120	254.4	-	-		-	-
BH-2B	374.40	377.18	120	254.4	-	-		-	-
BH-3	376.90	379.68	115	261.9	-	-		-	-
BH-4	376.50	380.54	81	295.5	-	-		-	-
BH-5	390.50	392.73	88	302.5	-	-		-	-
BH-6	384.5	386.53	139	245.5	-	-		-	-
BH-7	389.20	393.01	137	252.2	-	-		-	-
BH-8	362.0	362.61	111	251.0	-	-		-	-
MW-1	366.36	365.99	126	240.4	-	-		-	-
MW-2	382.0	384.39	155	227.0	-	-		-	-
MW-3	412.80	416.11	187	225.8	-	-		-	-
MW-4	363.31	362.82	145	218.3	-	-		-	-
MW-5	322.44	321.94	85	237.4	-	-		-	-
MW-6	272.13	271.76	138	134.1	-	-		-	-
MW-7	413.29	412.73	265	148.3	-	-		-	-
MW-8	351.81	351.35	231	120.8	-	-		18.0 - 97.0	333.8 - 254.8
MW-9	354.46	353.79	176	178.5	-	-		-	-
MW-10	339.17	338.77	245	94.2	-	-		22.0 - 72.0	317.2 - 267.2
MW-11	369.70	370.41	279	90.7	-	-		-	-
MW-12	375.21	374.80	266	109.2	-	-		-	-
MW-13	383.23	382.68	231	152.2	-	-		-	-
MW-14	381.00	381.85	335	46.0	-	-		158.5 - 200.0	222.5 - 181.0
MW-15	438.85	438.54	300	138.9	-	-		186.6 - 216.5	252.3 - 222.4
MW-16	363.18	362.80	194	169.2	-	-		-	-
MW-17	337.43	337.08	145	192.4	-	-		-	-
MW-18	342.60	343.91	315	27.6	-	-		-	-
MW-19	368.40	370.20	311	57.4	292.4 - 297.6	76.0 - 70.8	SGA	-	-
MW-20	373.70	375.65	325	48.7	-	-		135.0 - 165.0	238.7 - 208.7
MW-21	358.50	359.95	301	57.5	290.5 - 295.5	68.0 - 63.0	NGA	40.1 - 75.1	318.4 - 283.4
MW-22	376.80	378.28	340	36.8	-	-		-	-
MW-23	424.97	424.42	390	35.0	-	-		179.5 - 220.0	245.5 - 205.0
MW-24	419.11	418.58	375	44.1	-	-		149.9 - 195.0	269.2 - 224.1
MW-25	261.16	260.84	101	160.2	69.2 - 74.2	192.0 - 187.0	SAND	-	-
MW-26	369.40	370.58	150	219.4	-	-		-	-
MW-27	330.40	330.05	290	40.4	260.0 - 265.0	70.4 - 65.4	NGA	32.8 - 63.0	297.6 - 267.4
MW-28	375.20	374.15	146	229.2	-	-		-	-
MW-29	428.85	428.50	395	33.9	-	-		140.0 - 175.0	288.9 - 253.9
LW-1	375.60	377.25	173	202.6	-	-		-	-
LW-2	382.10	383.49	120	262.1	-	-		-	-

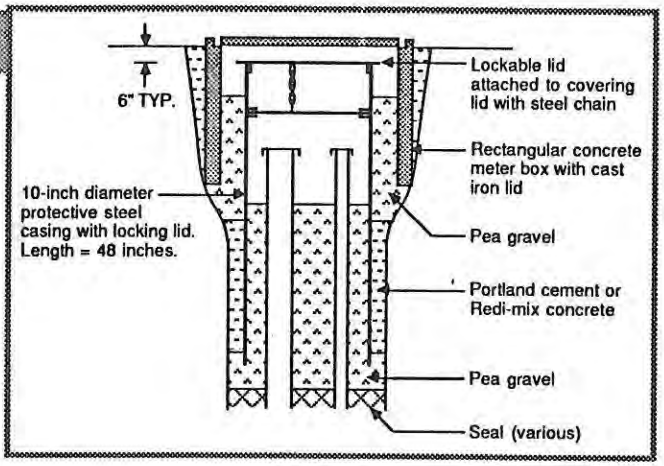
Notes: * HSU - Hydrostatigraphic Unit.

1. All values in feet. Elevation data provided by Parametrix, Inc. Datum unknown.
2. Wells BH-1B through BH-8 installed by Golder Associates, 1982; Wells MW-1 through MW-6 installed by Golder Associates, 1985; Wells MW-7 through MW-29, LW-1 and LW-2, and DP-1 through DP-3 installed by Applied Geotechnology Inc., 1986-1987.
3. Measuring points are as follows: Top of protective steel casing for MW-1,2,3,6 to 29, LW-1 and LW-2; Top of PVC well casing for BH-1 to BH-8, MW-4 and MW-5; top of drive point casing for DP-1 to DP-3.
4. Hydrostatigraphic unit designations as follows: MID - Leachate in Midway Landfill; GU - Upper Gravel Aquifer; NGA - Northern Gravel Aquifer; SGA - Southern Gravel Aquifer; SAND - Sand Aquifer; UGA - Upper Gravel Aquitard; PA - Perched Aquifer.

WELL COMPLETION DETAILS



SURFACE COMPLETION DETAIL



GEOLOGIC LOG

- ▨ Municipal landfill
- ○ Gravel
- ░ Sand
- ☰ Silt
- ≡ Clay
- ▨ Organic sediments

NOTE: Detailed geologic logs follow the summary logs.

NOTES REGARDING GROUNDWATER OBSERVATIONS

▽ Static water level in monitoring well screened at indicated depth on Sept. 21, 1987.

▽ Water levels observed during drilling with boring at indicated depth. Water levels noted represent "stabilized" levels or overnight levels.

▨ Water bearing zones defined as saturated sediments which yielded groundwater freely to the borehole.

NOTES REGARDING FIELD MEASUREMENTS

Water quality measurements made on samples of groundwater bailed from well boring during drilling.

Gas concentration measurements taken inside casing approximately 2 to 3 feet below top of casing. Measurements in percent lower explosive limit (% LEL).

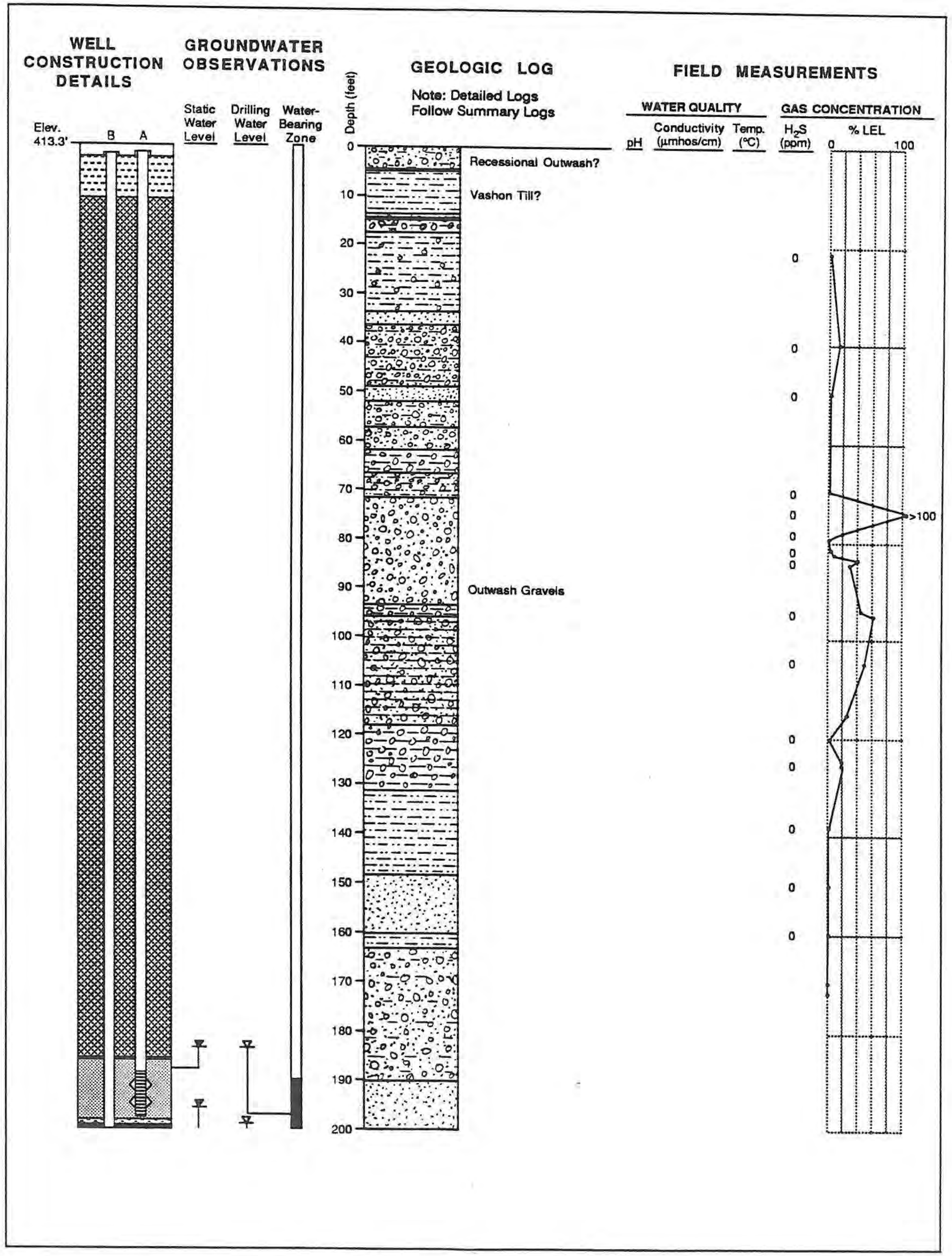
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

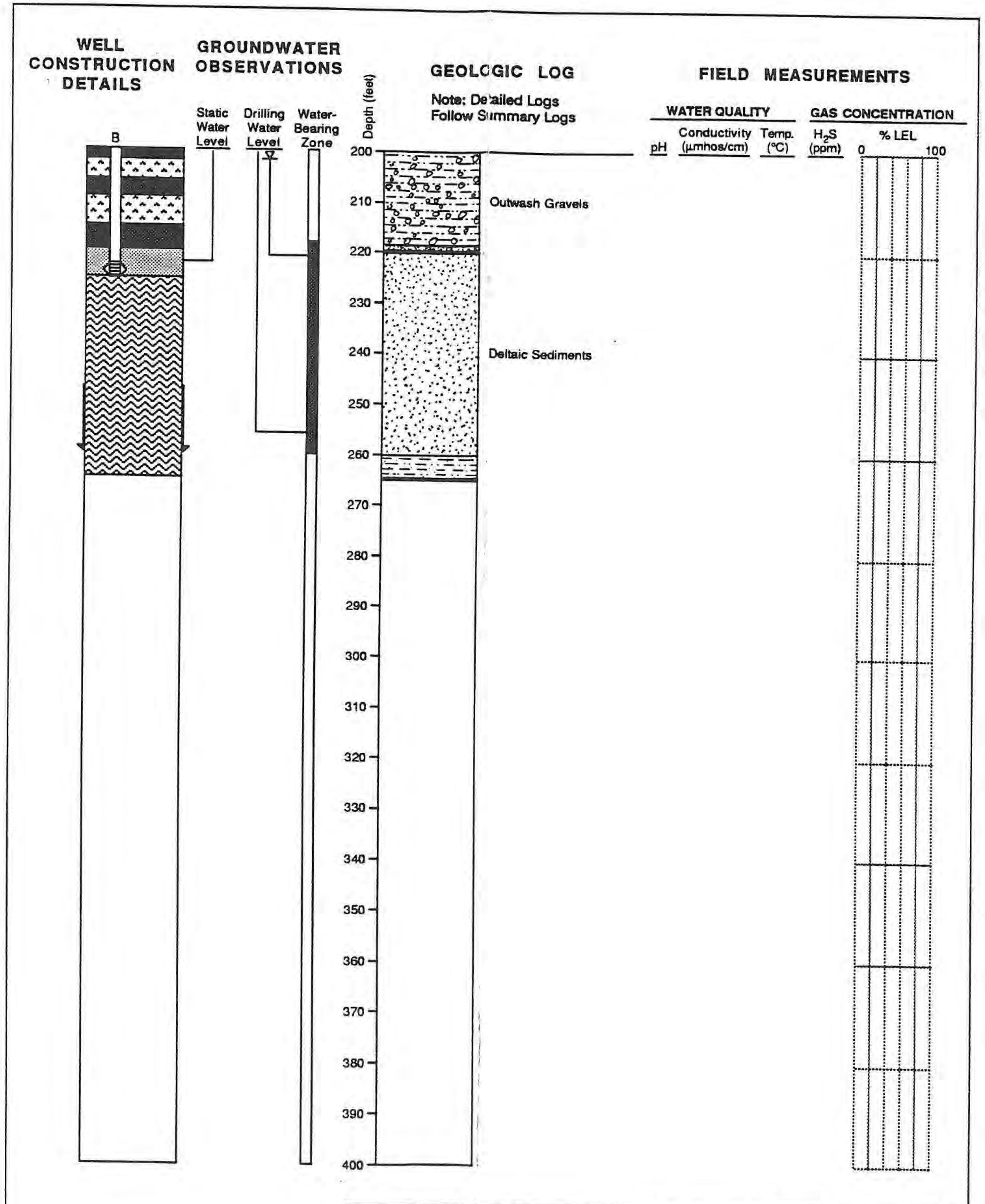
Summary Log Legend

Midway Landfill
Kent, Washington

PLATE
B1

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



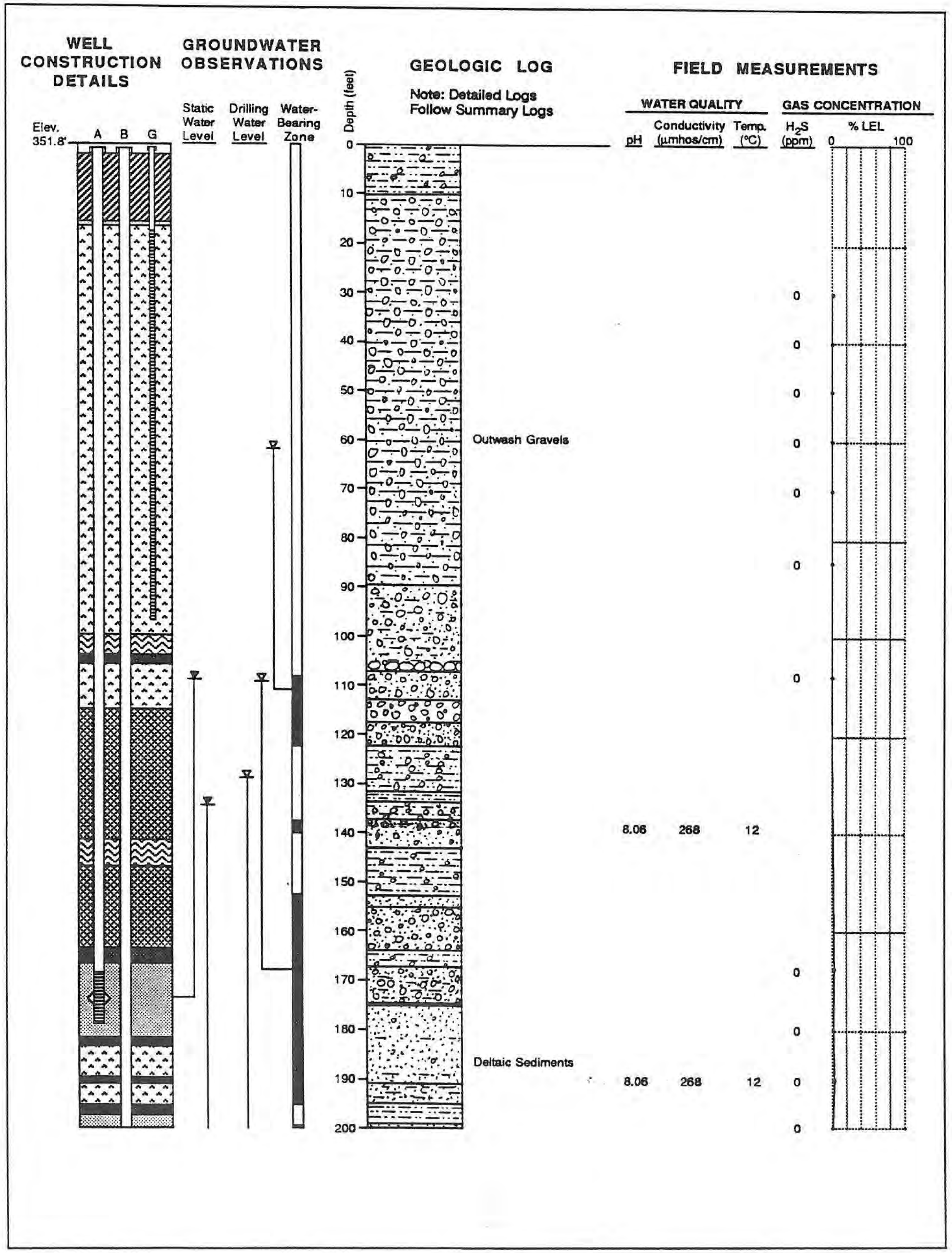


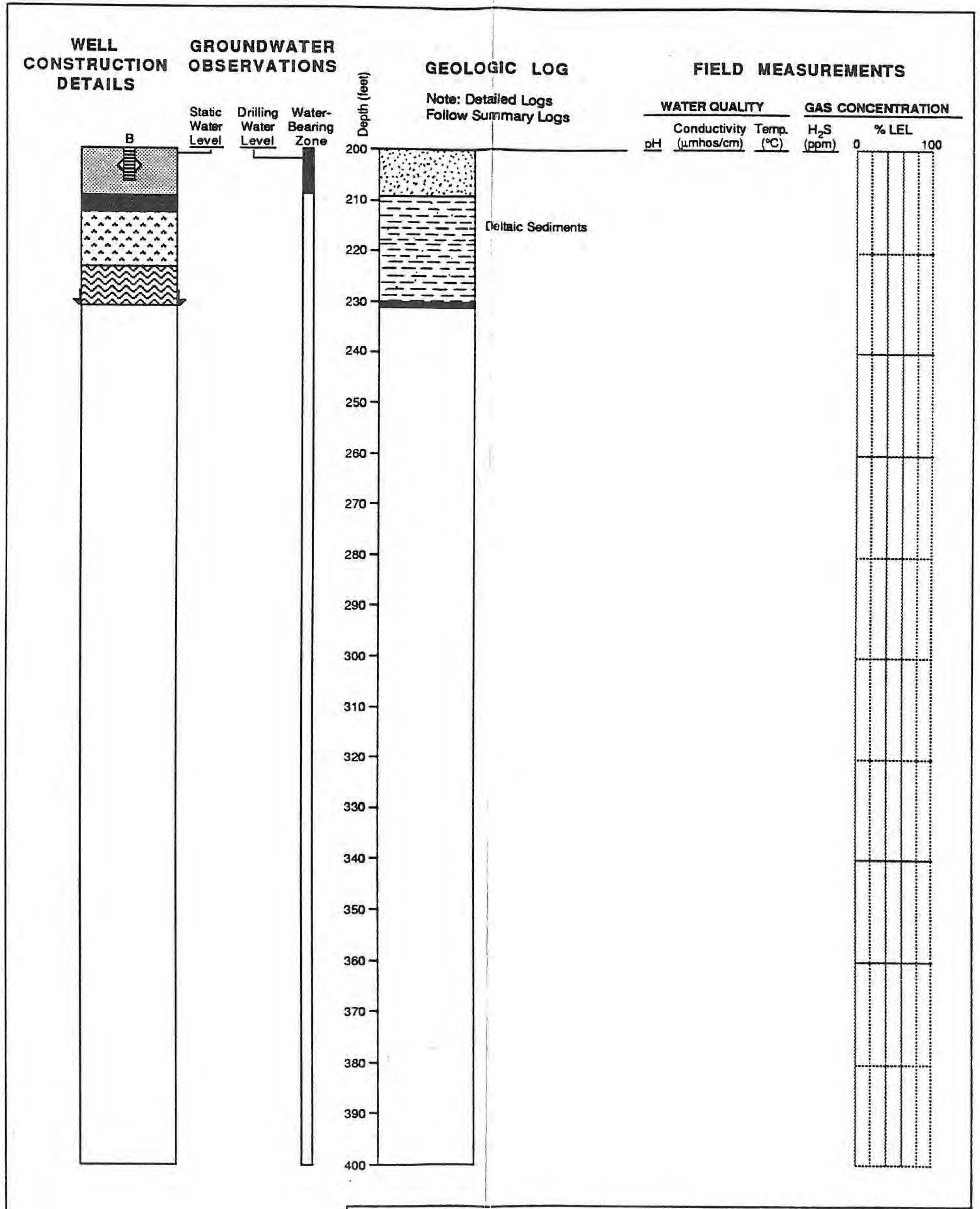
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-7
Midway Landfill
Kent, Washington

PLATE
B2

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



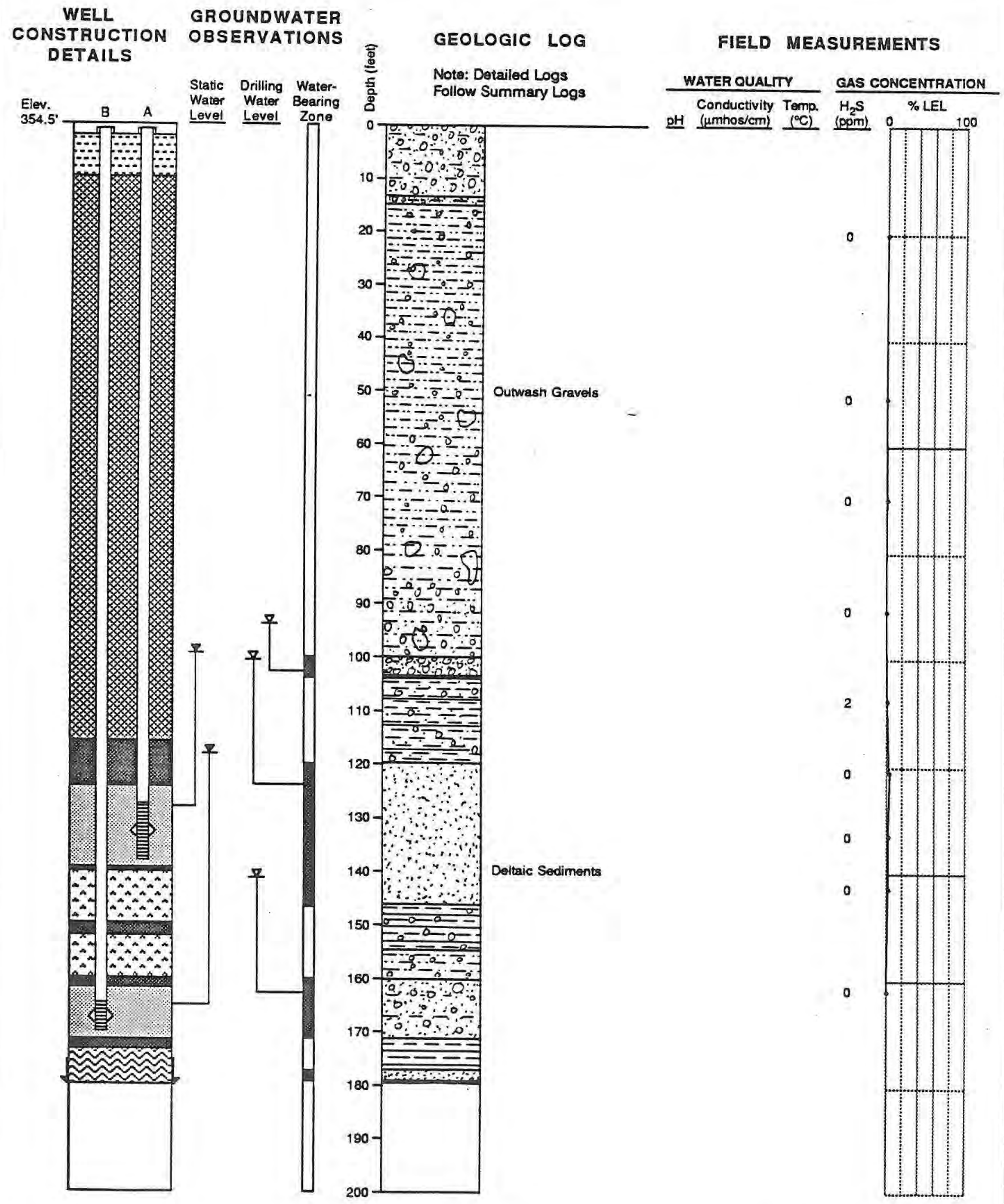


Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-8
Midway Landfill
Kent, Washington

PLATE
B3

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		

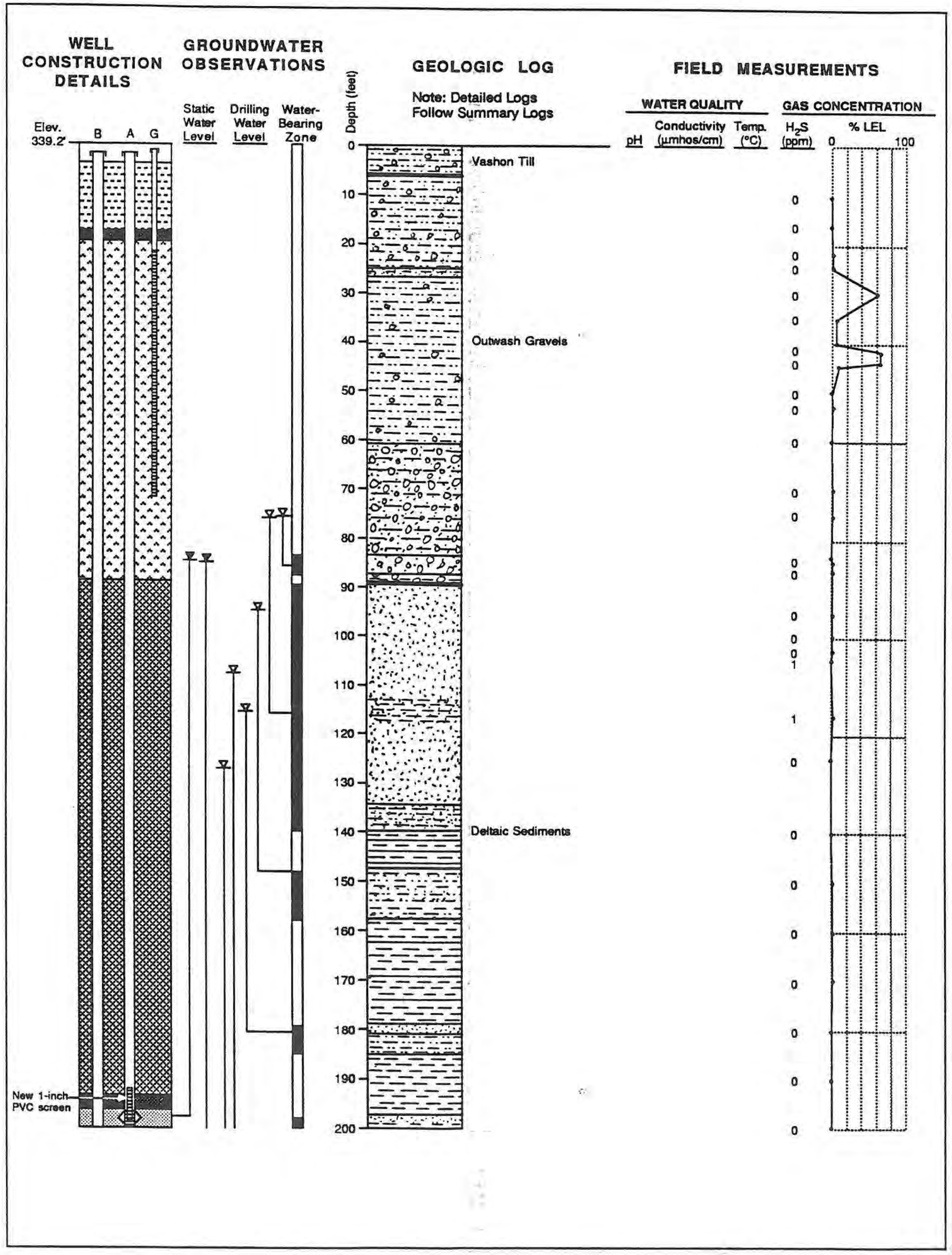


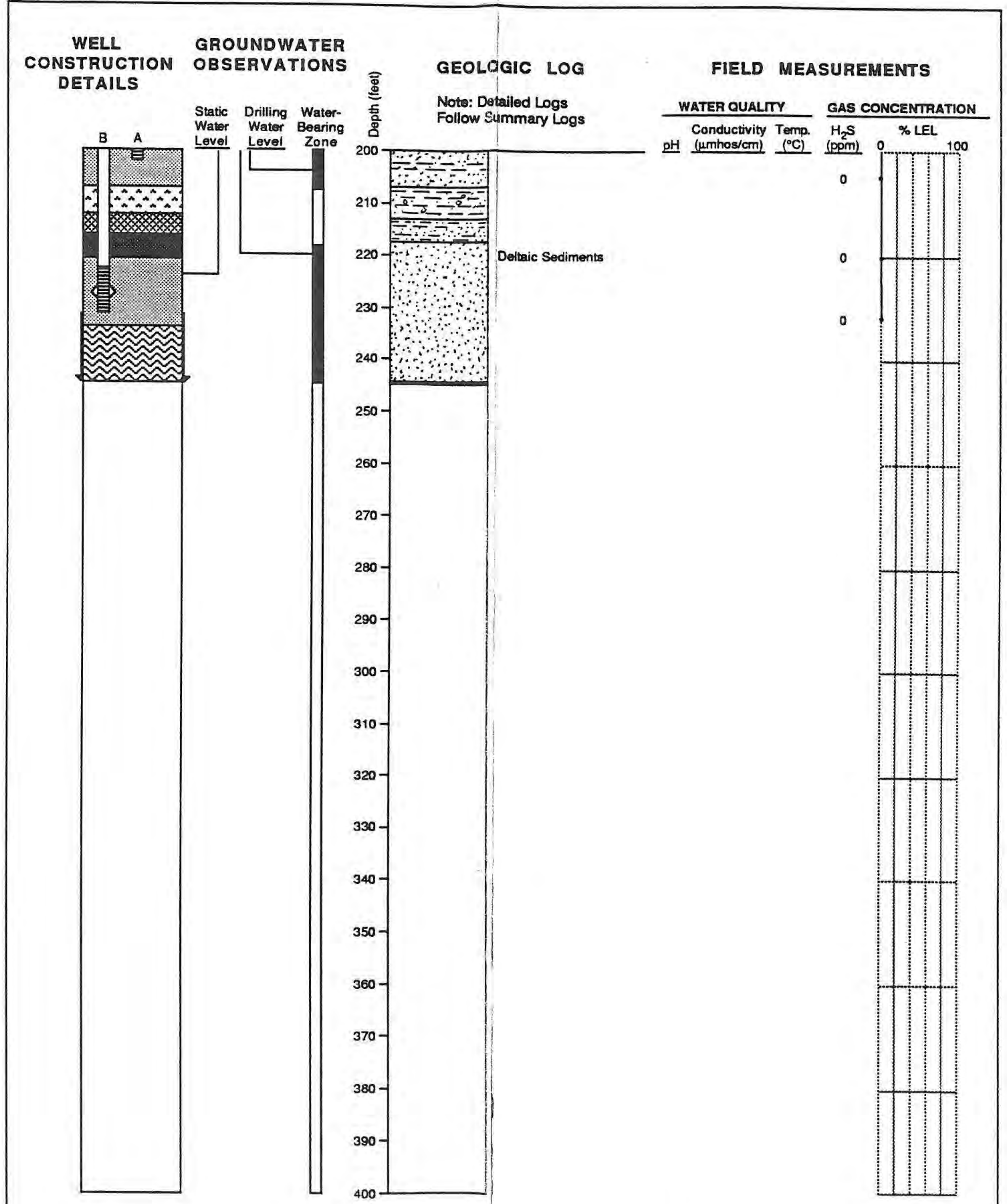
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-9
Midway Landfill
Kent, Washington

PLATE
B4

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



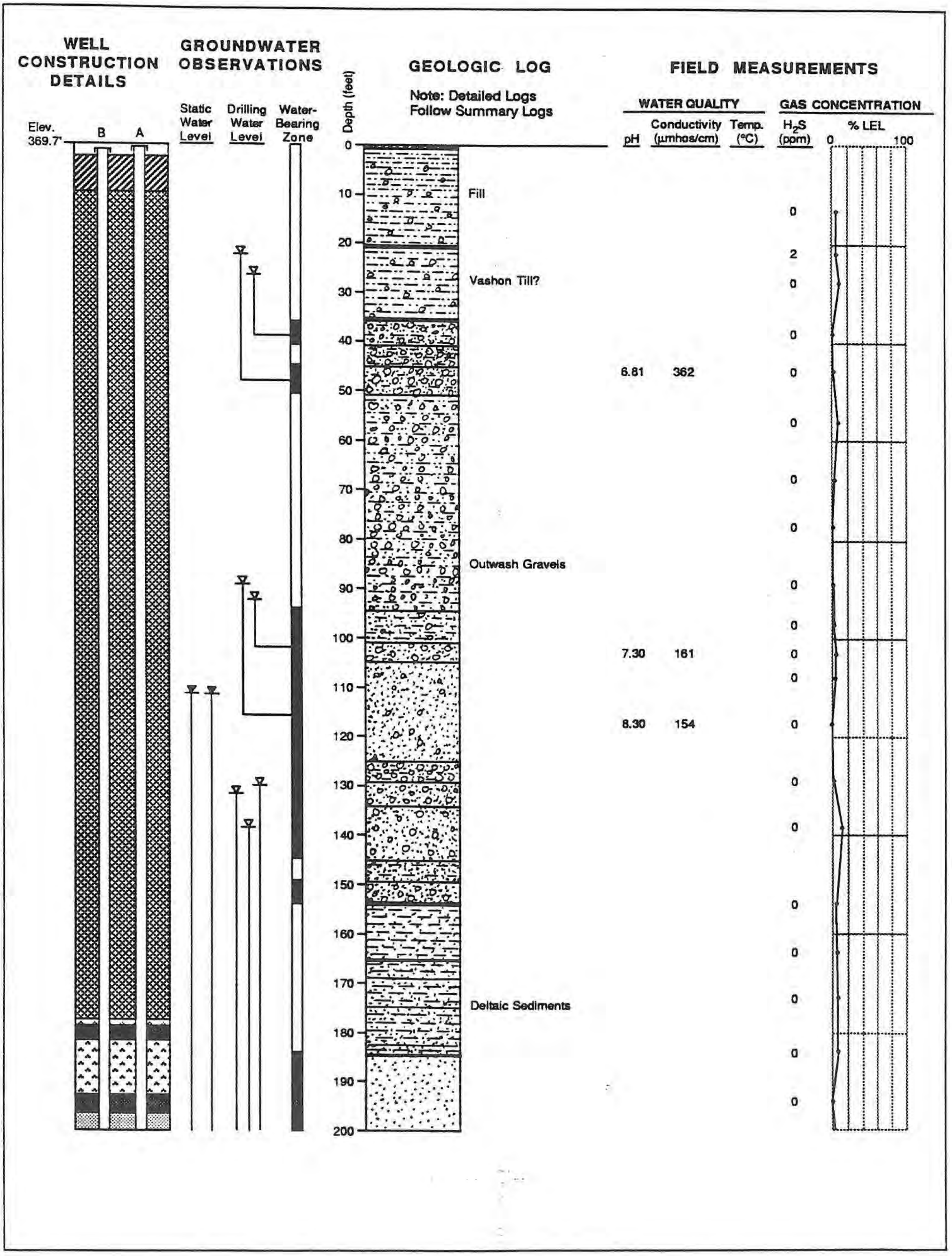


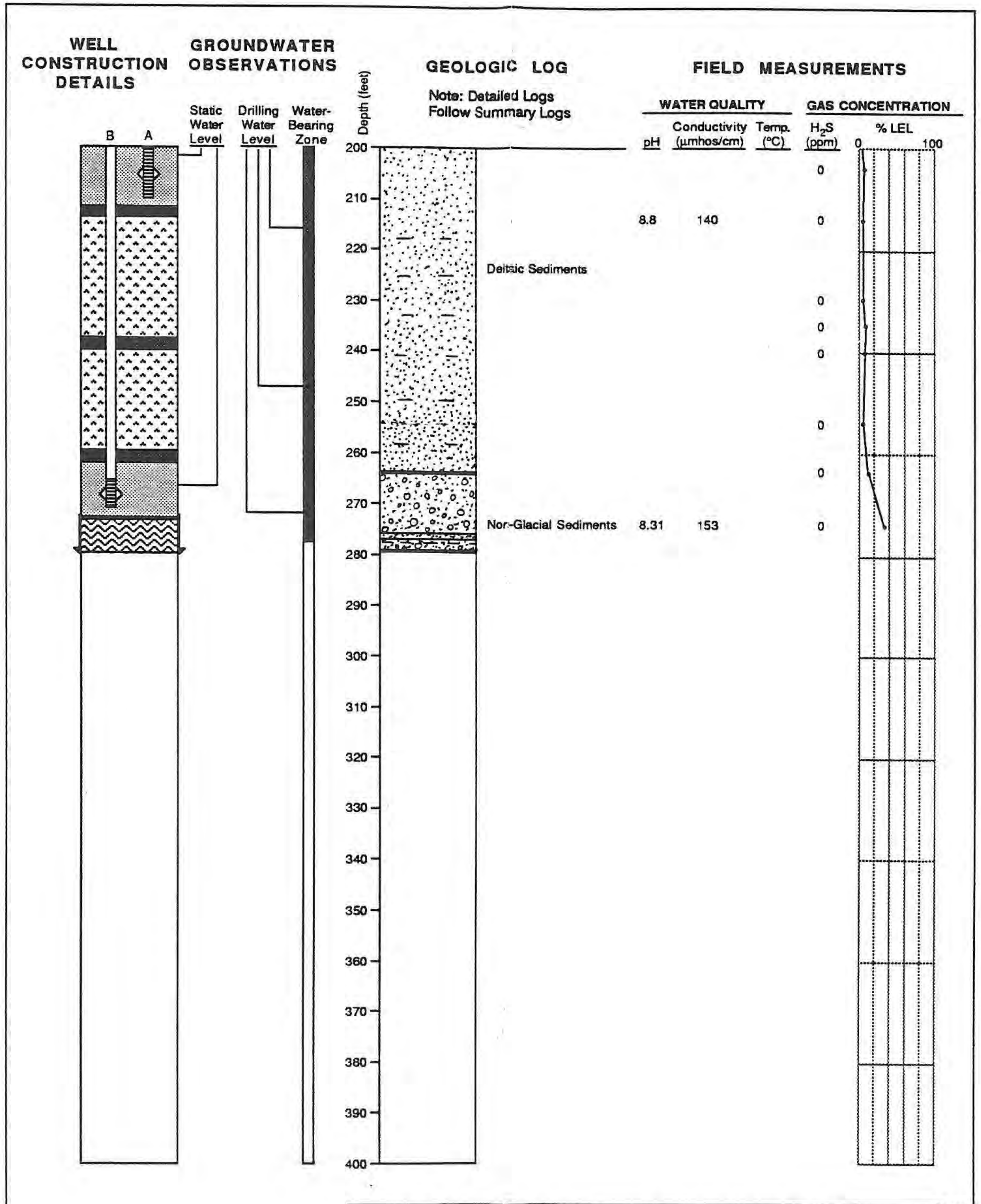
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-10
Midway Landfill
Kent, Washington

PLATE
B5

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		





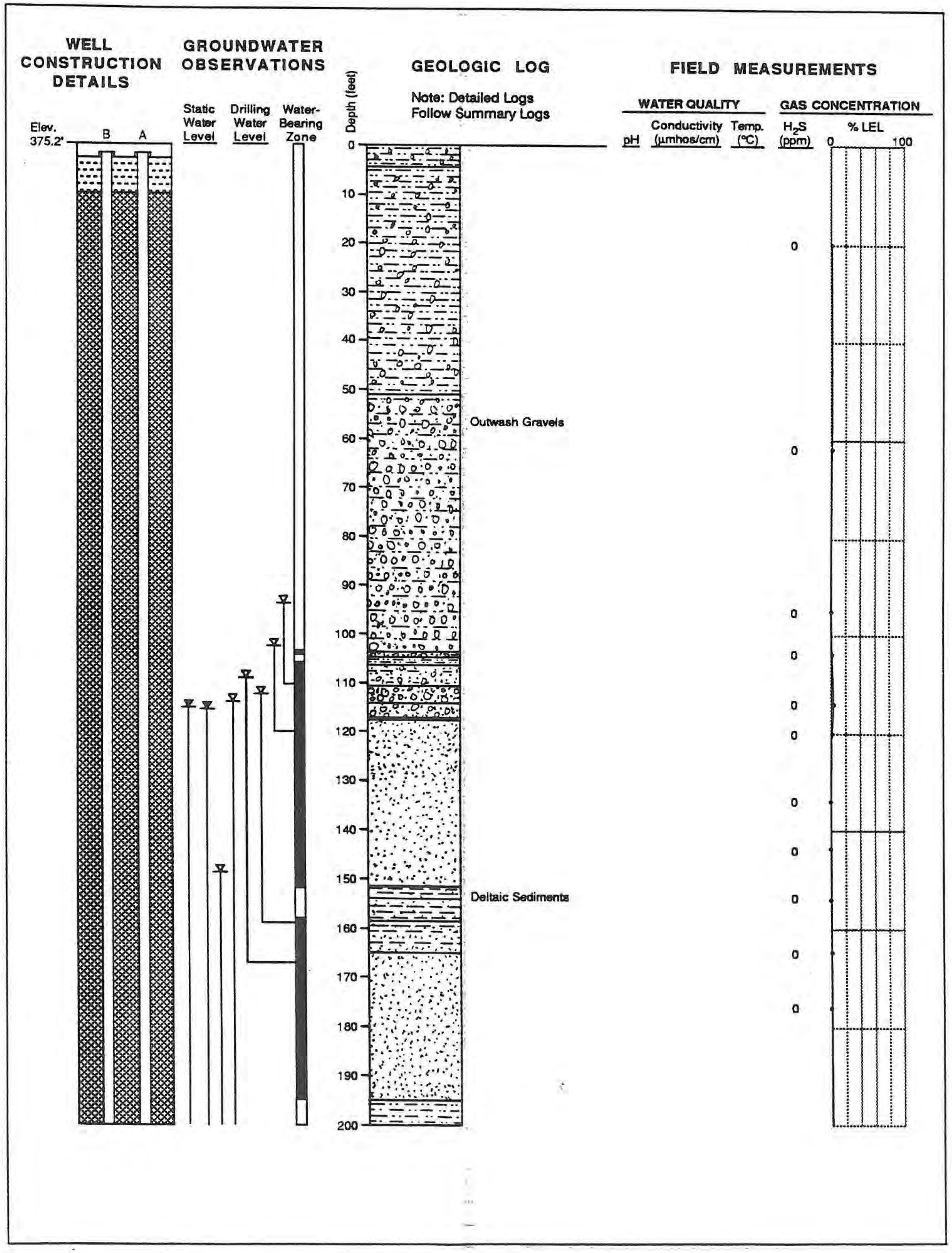
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

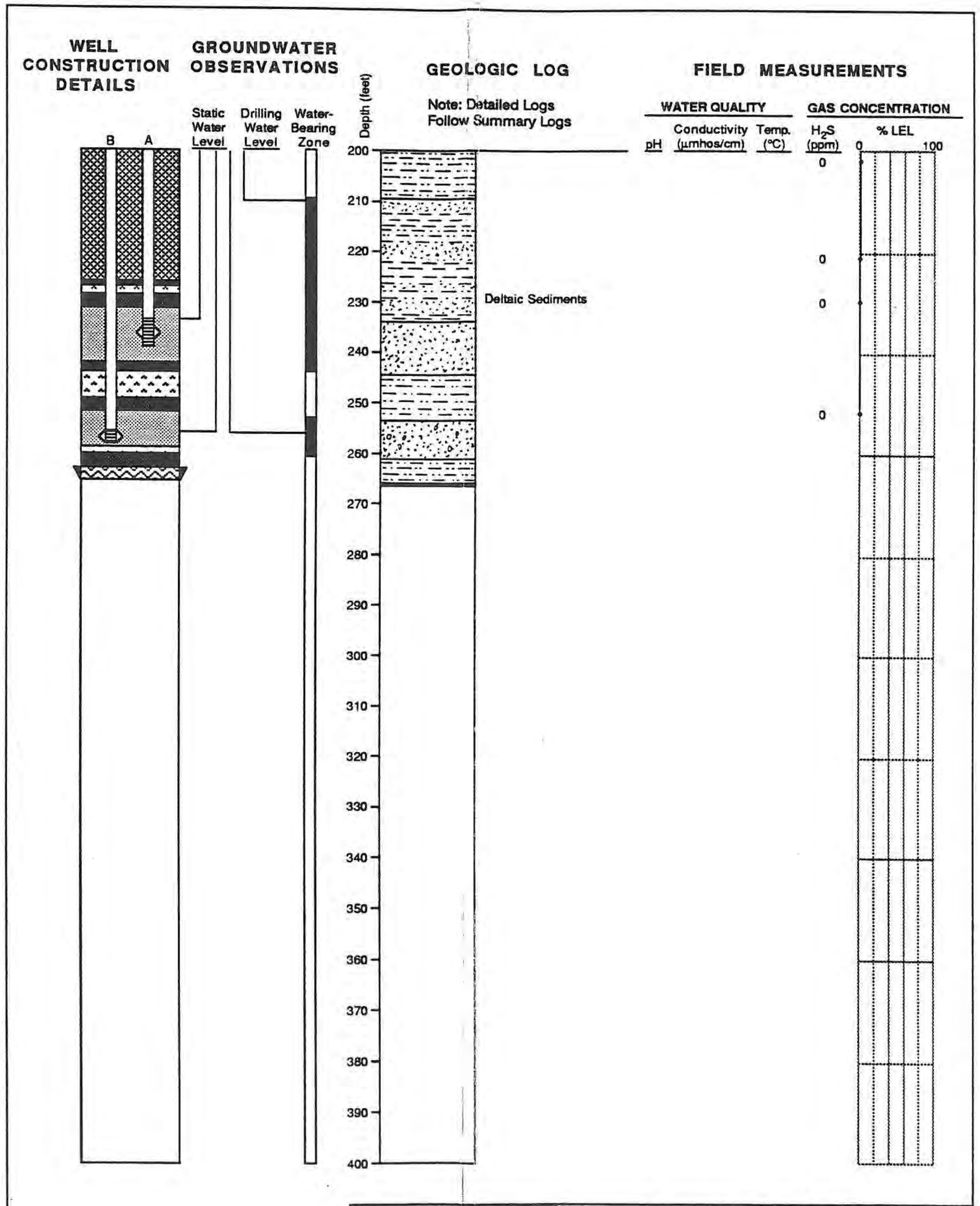
Summary Log MW-11

Midway Landfill
Kent, Washington

PLATE
B6

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



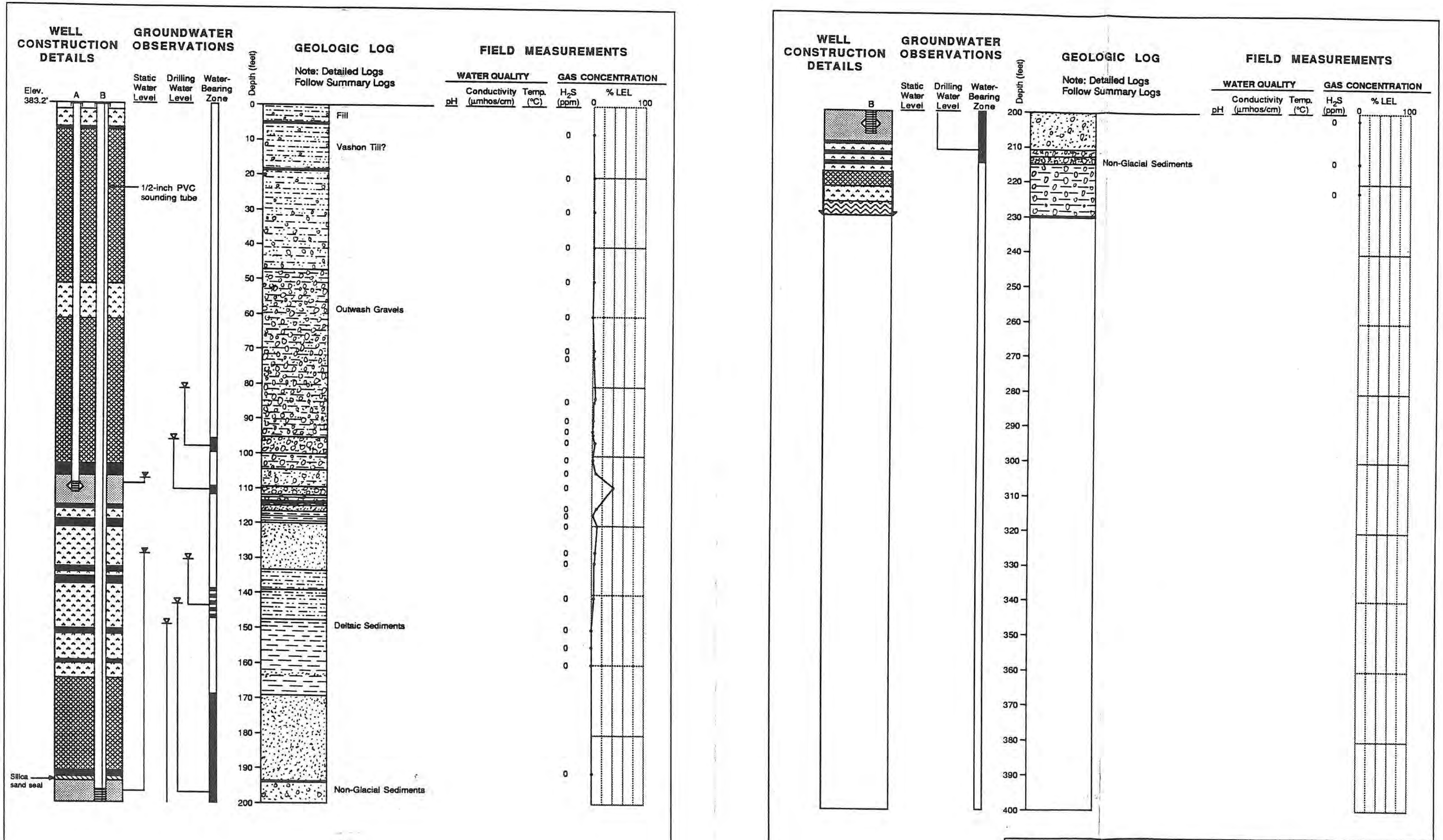


Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-12
Midway Landfill
Kent, Washington

PLATE
B7

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		

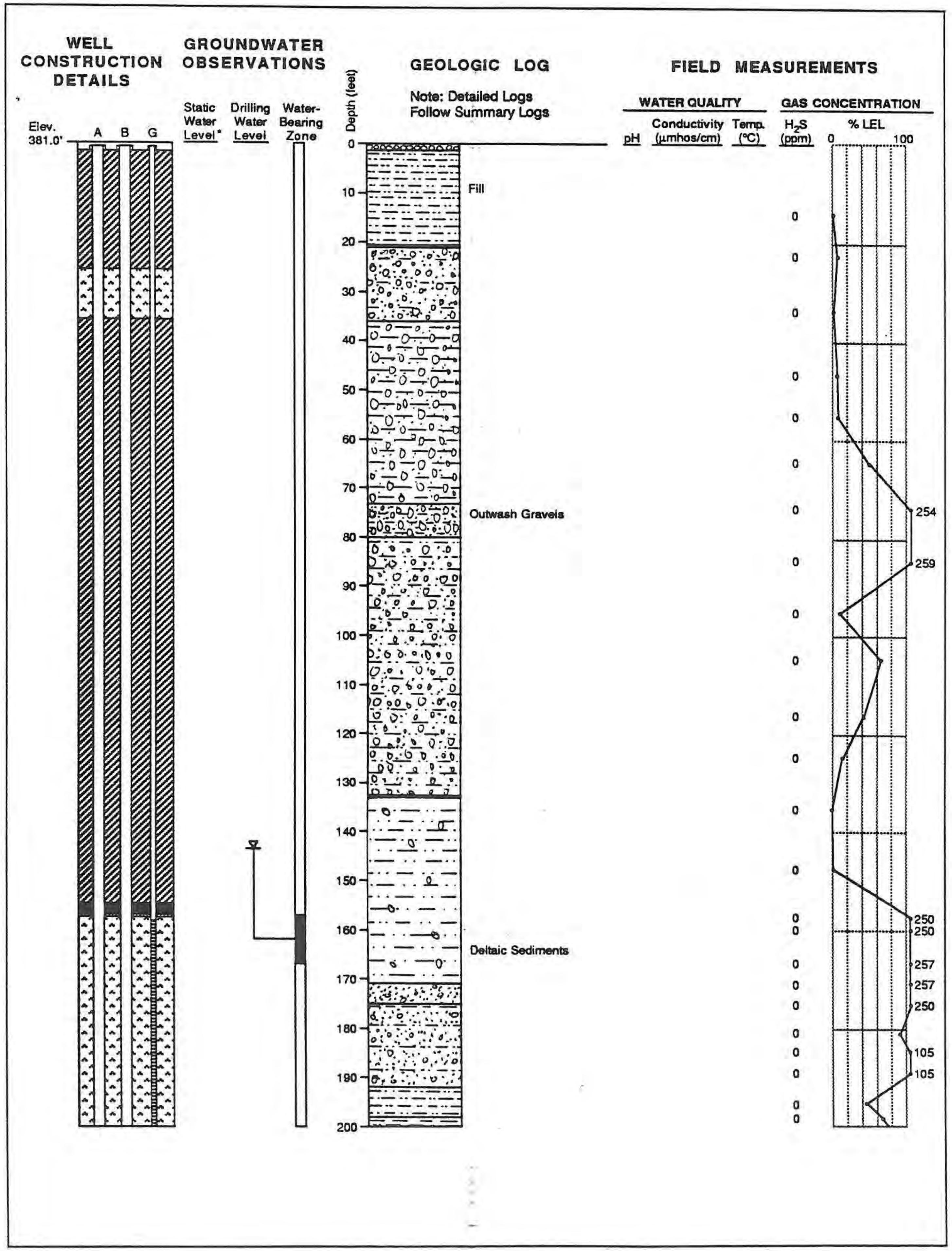


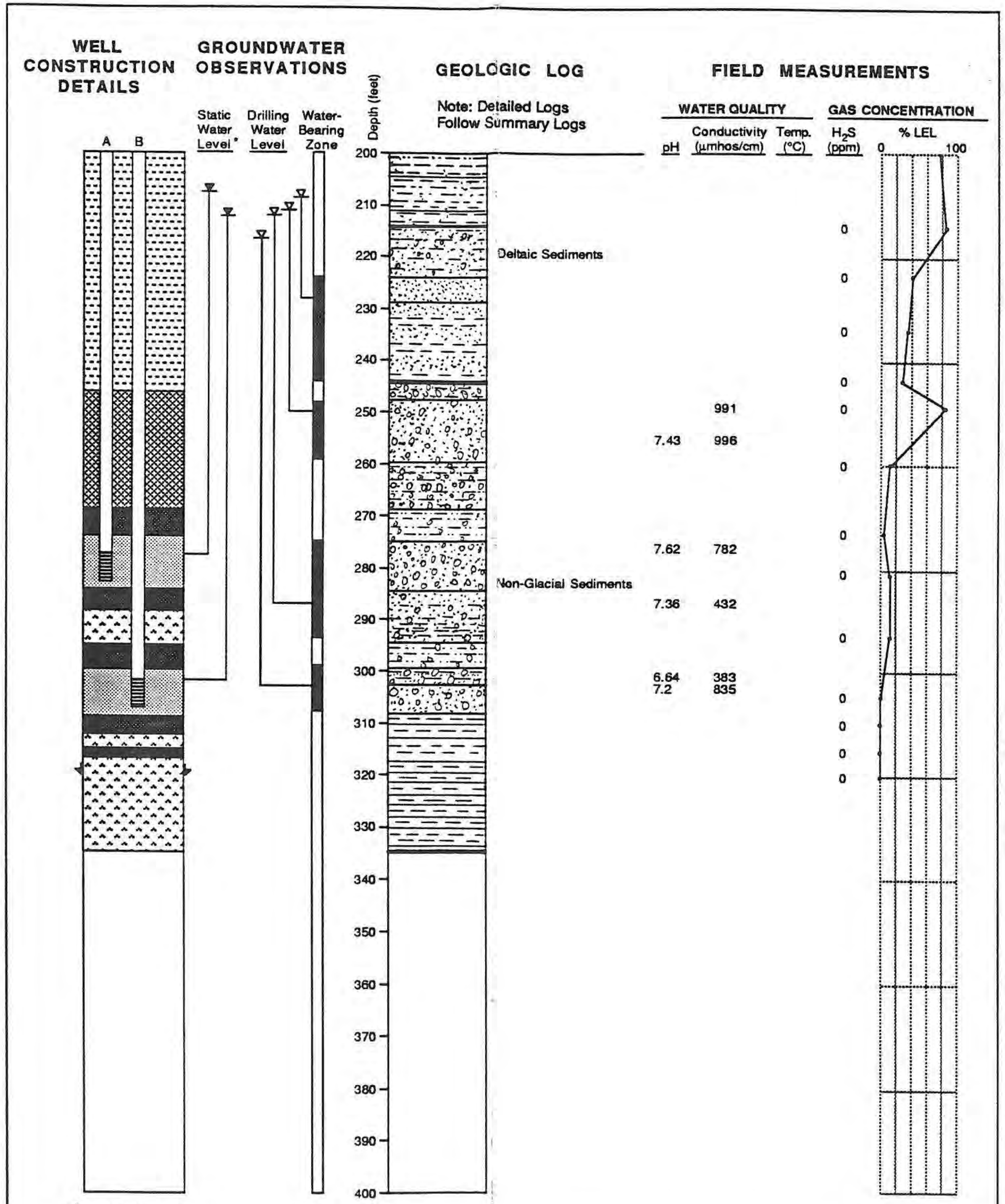
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-13
Midway Landfill
Kent, Washington

PLATE
B8

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		





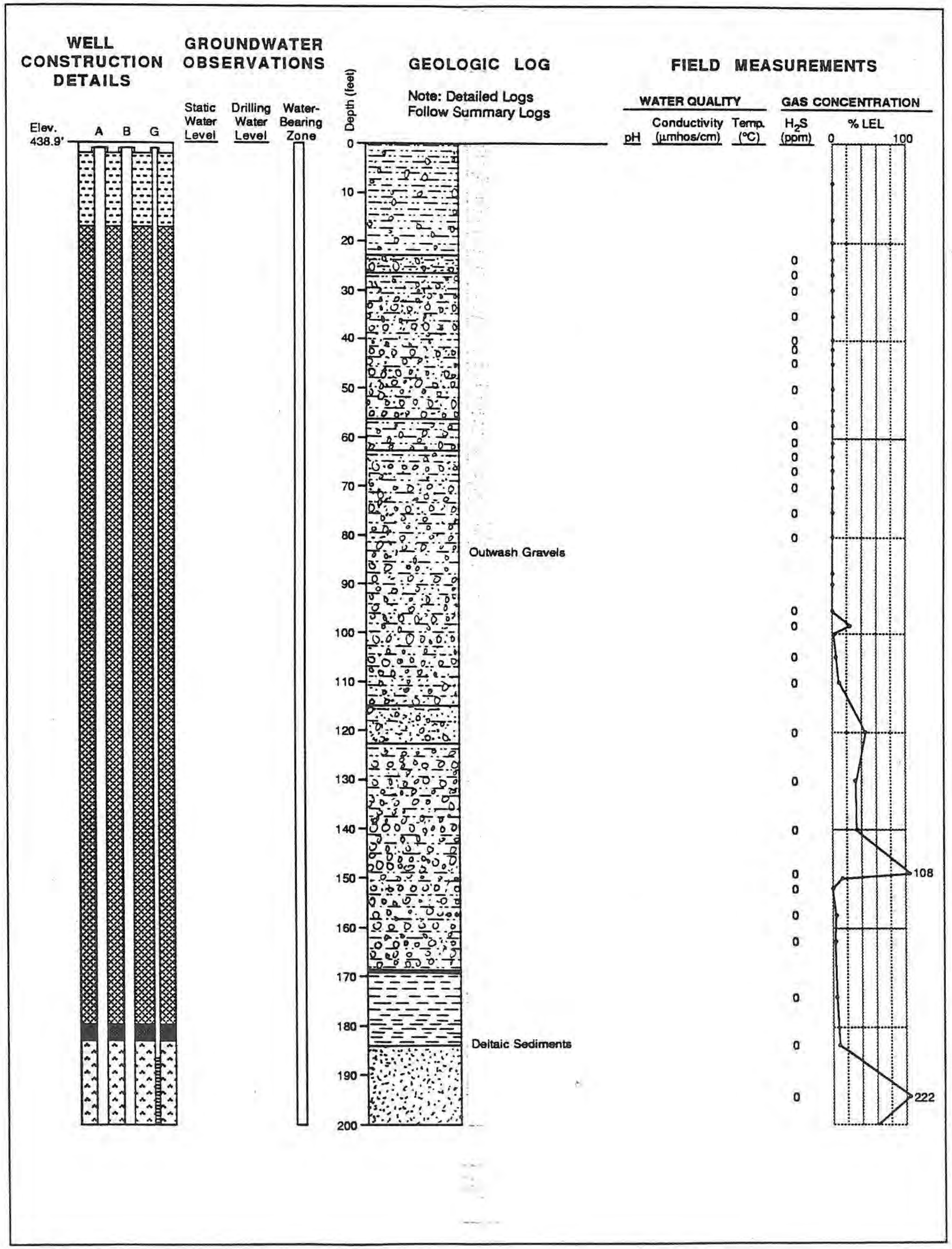
* Static water level measured on 9-08-87.

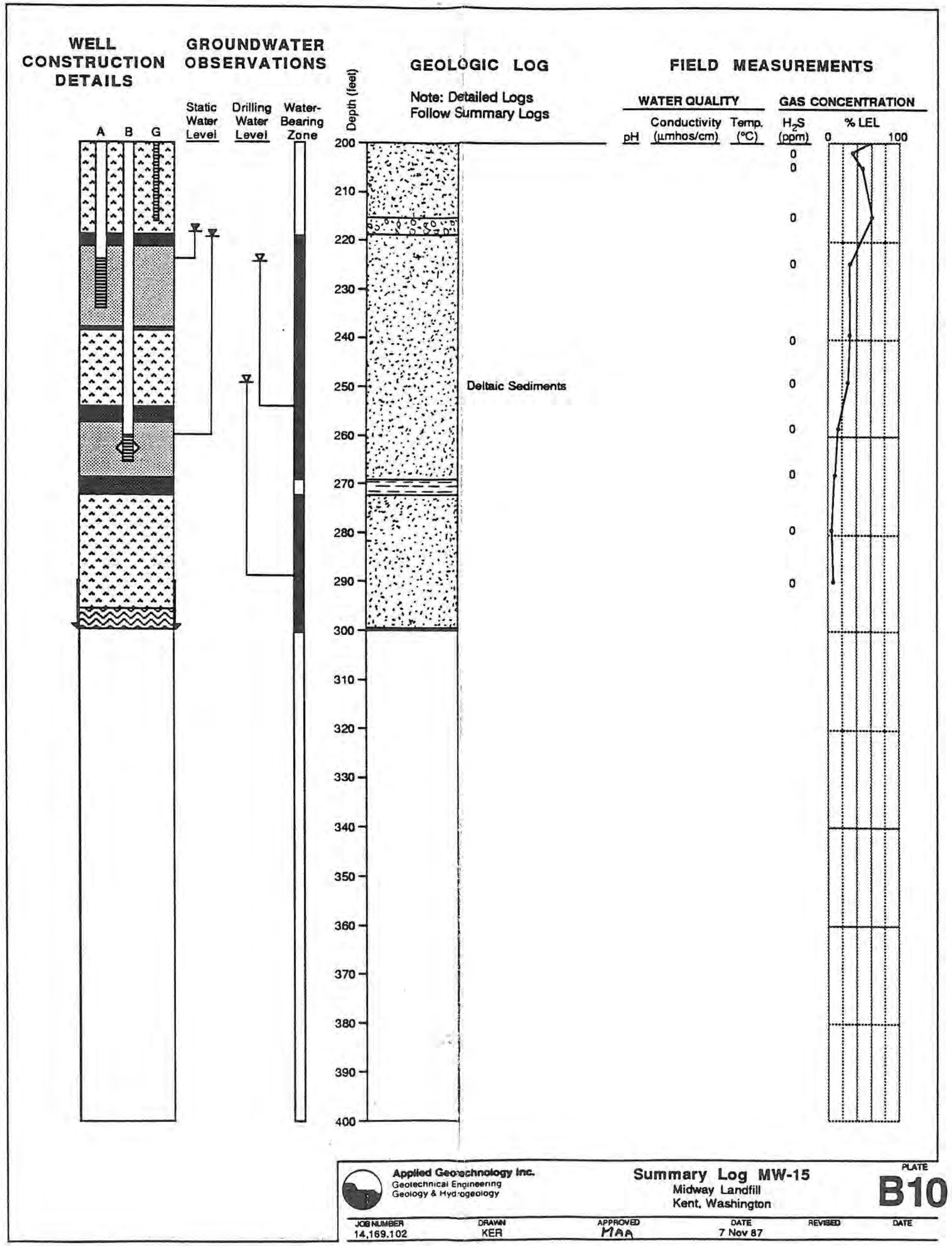
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-14
Midway Landfill
Kent, Washington

PLATE
B9

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		





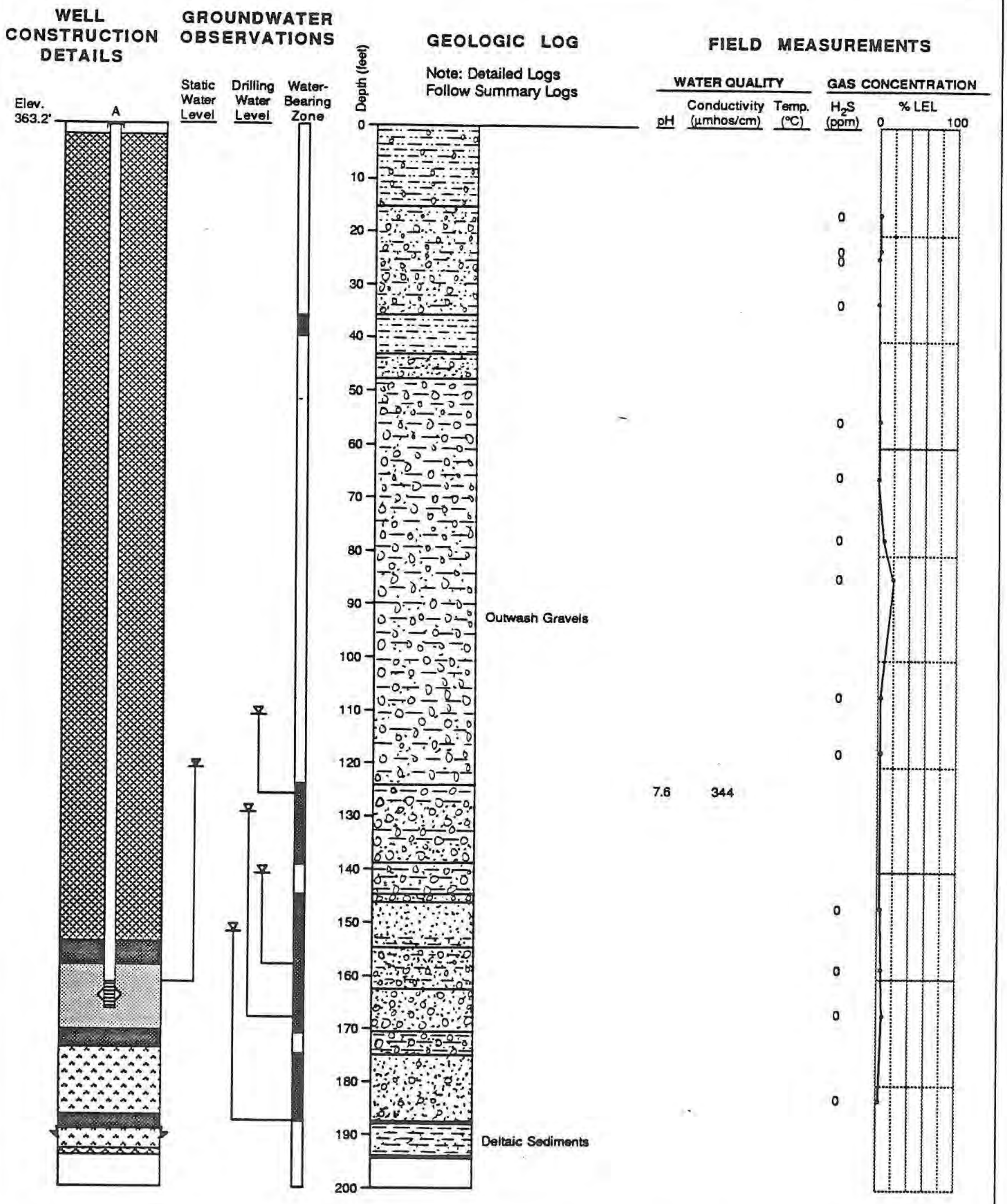
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-15

Midway Landfill
Kent, Washington

PLATE **B10**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		

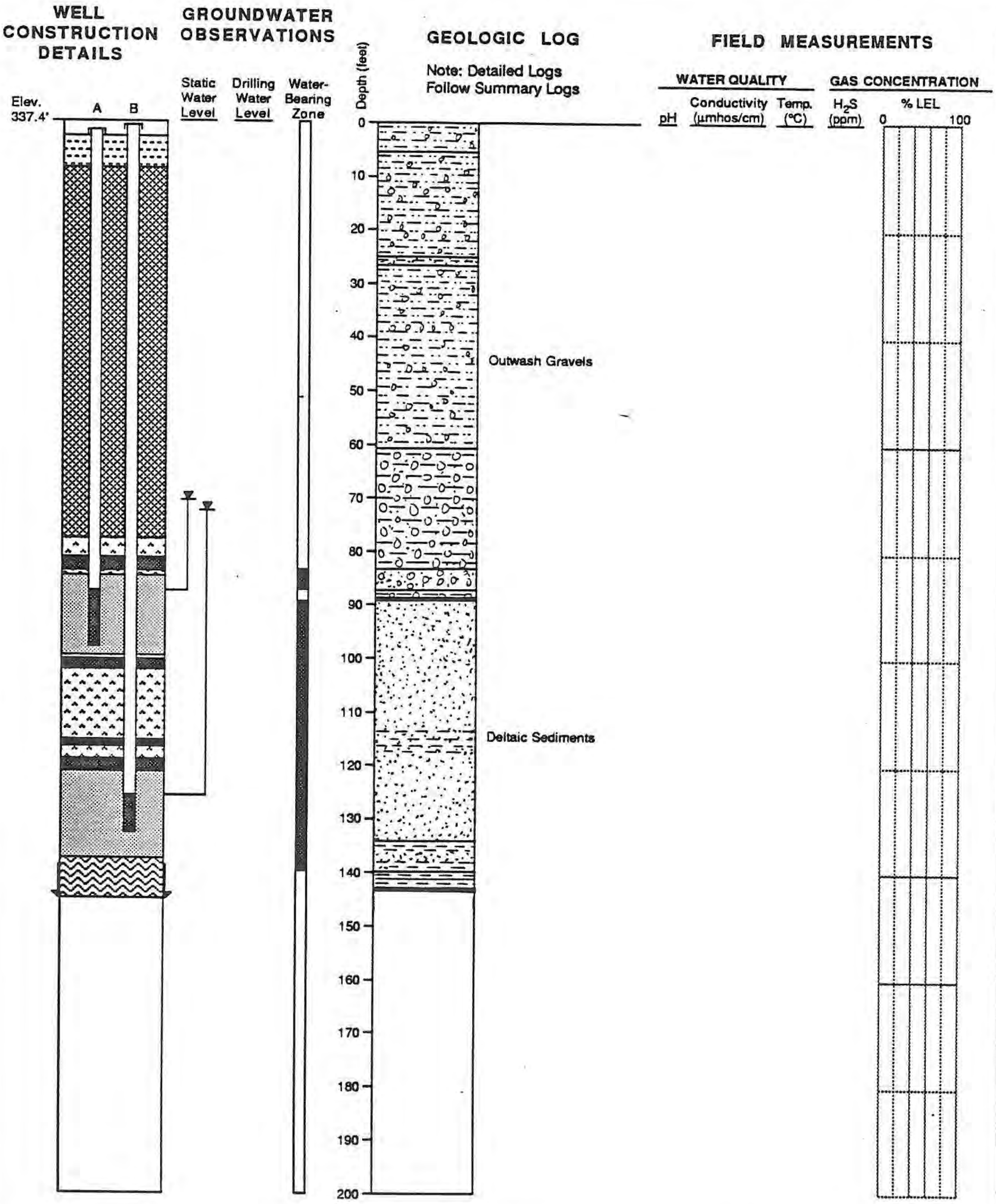


Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-16
Midway Landfill
Kent, Washington

PLATE
B11

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		

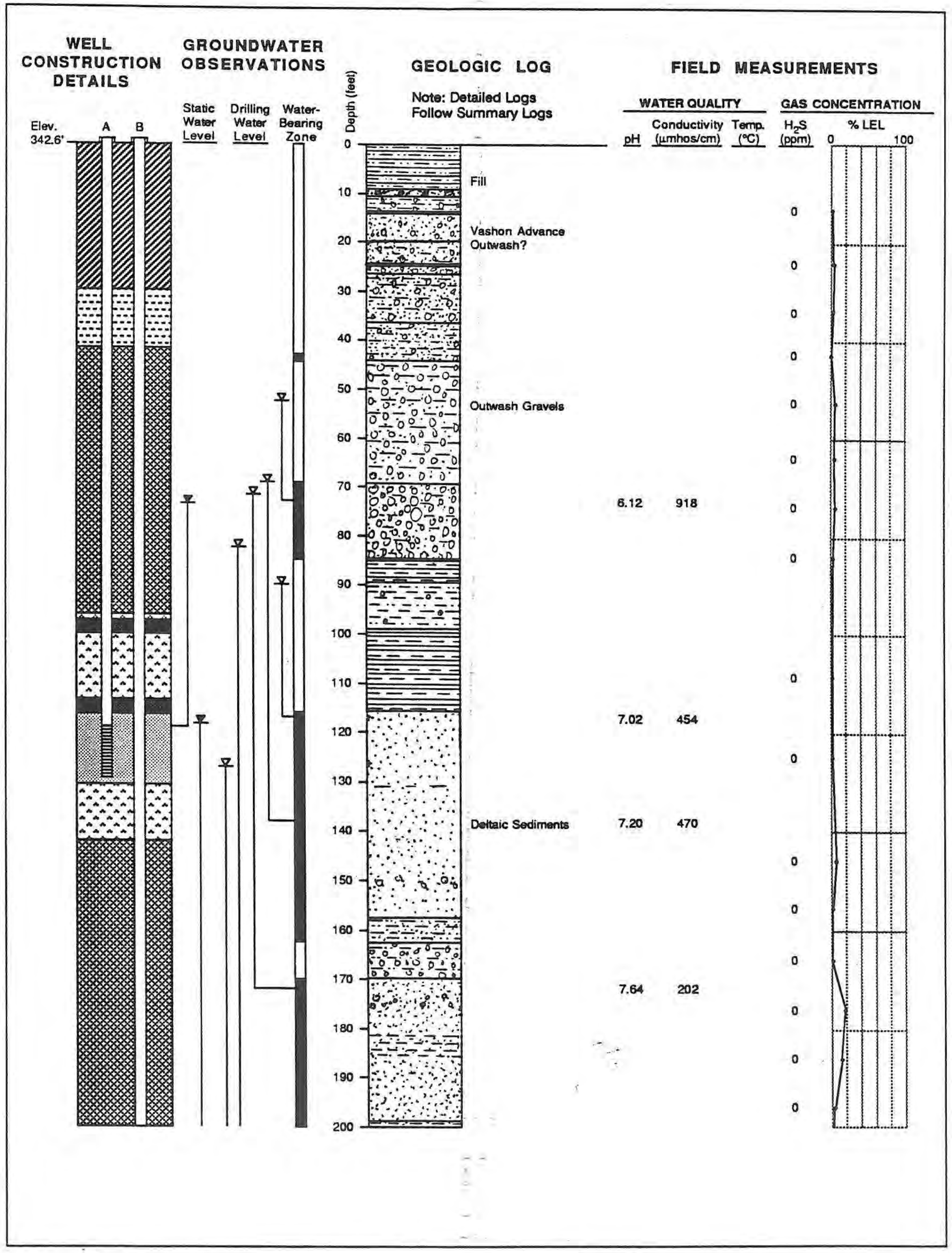


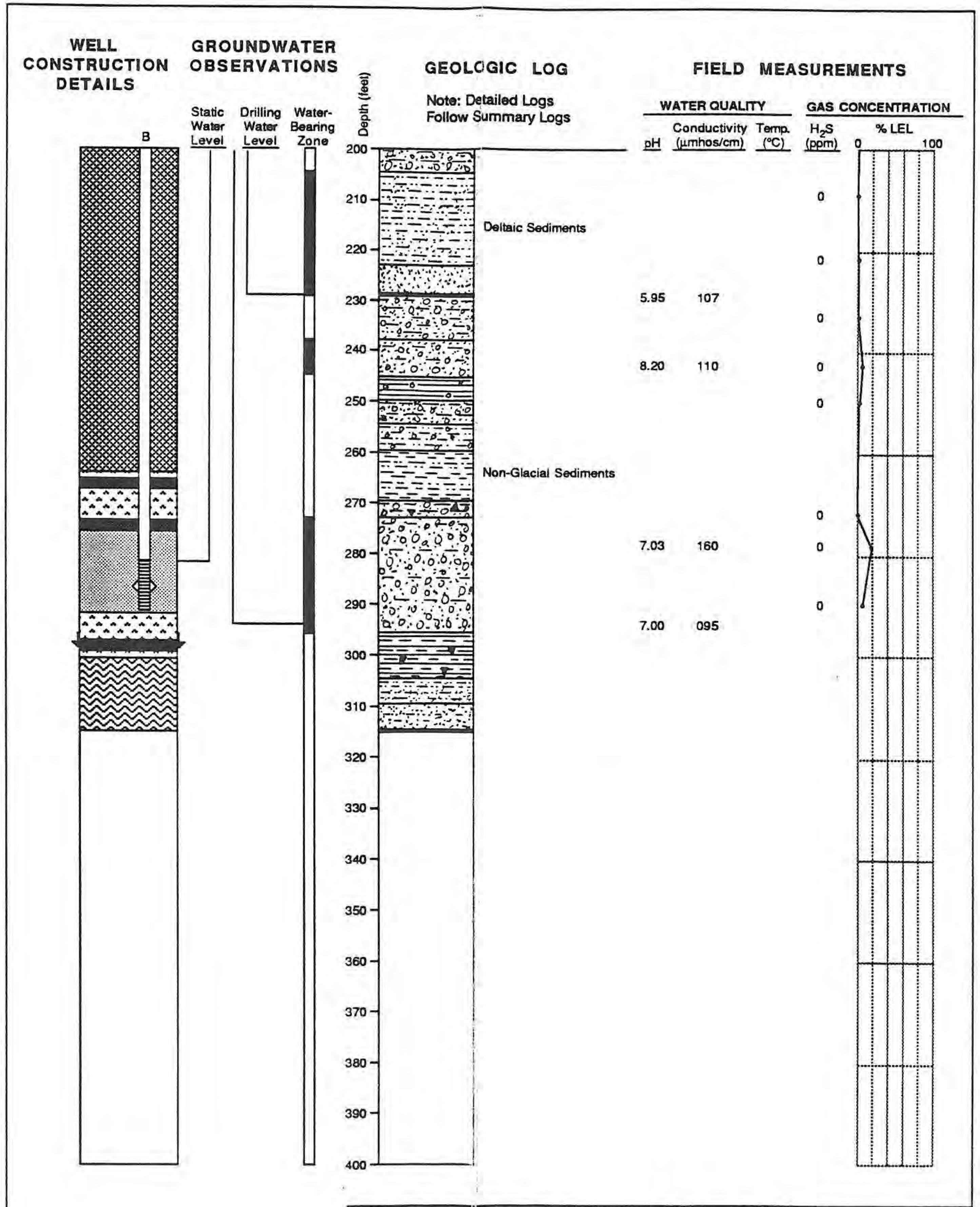
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-17
Midway Landfill
Kent, Washington

PLATE
B12

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



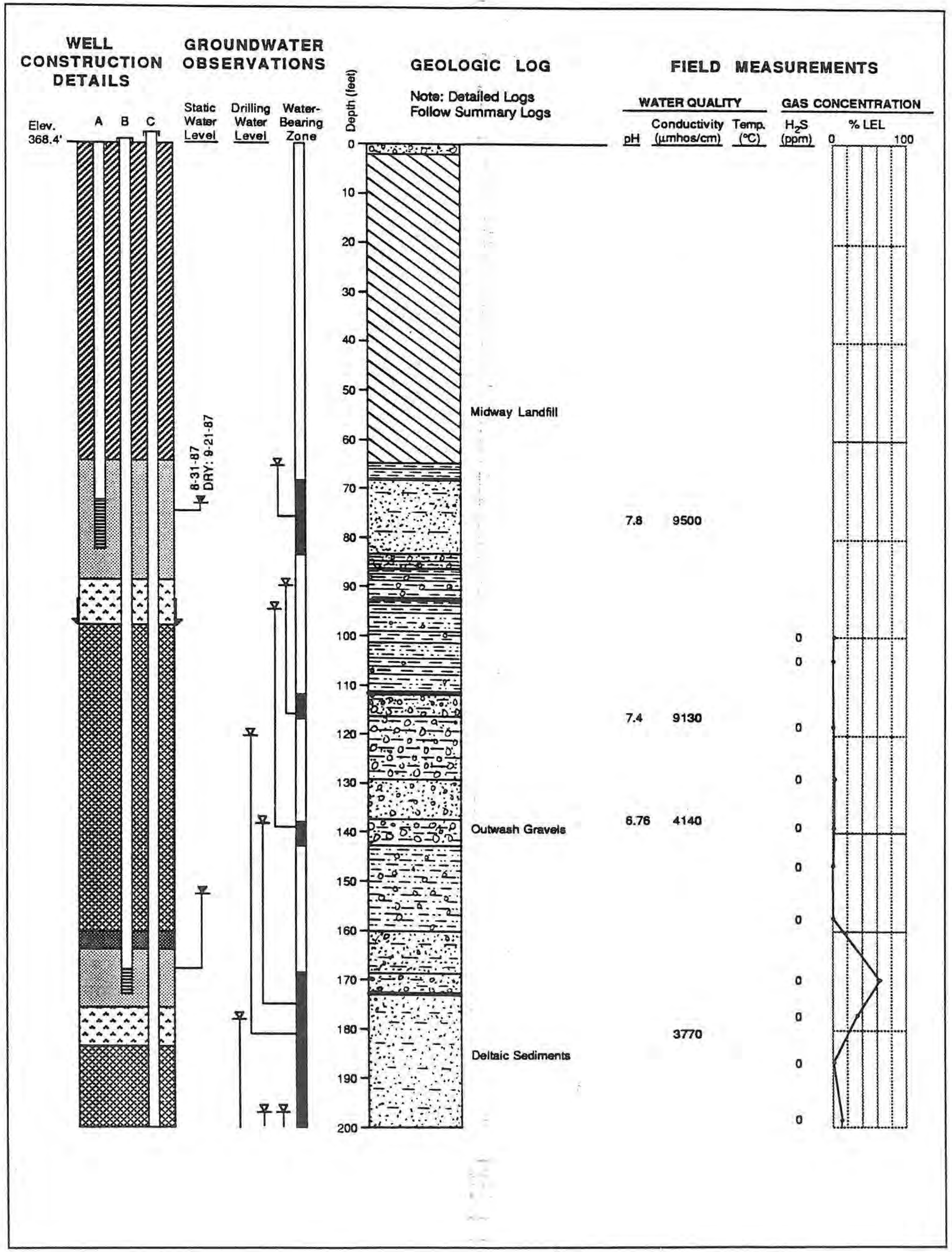


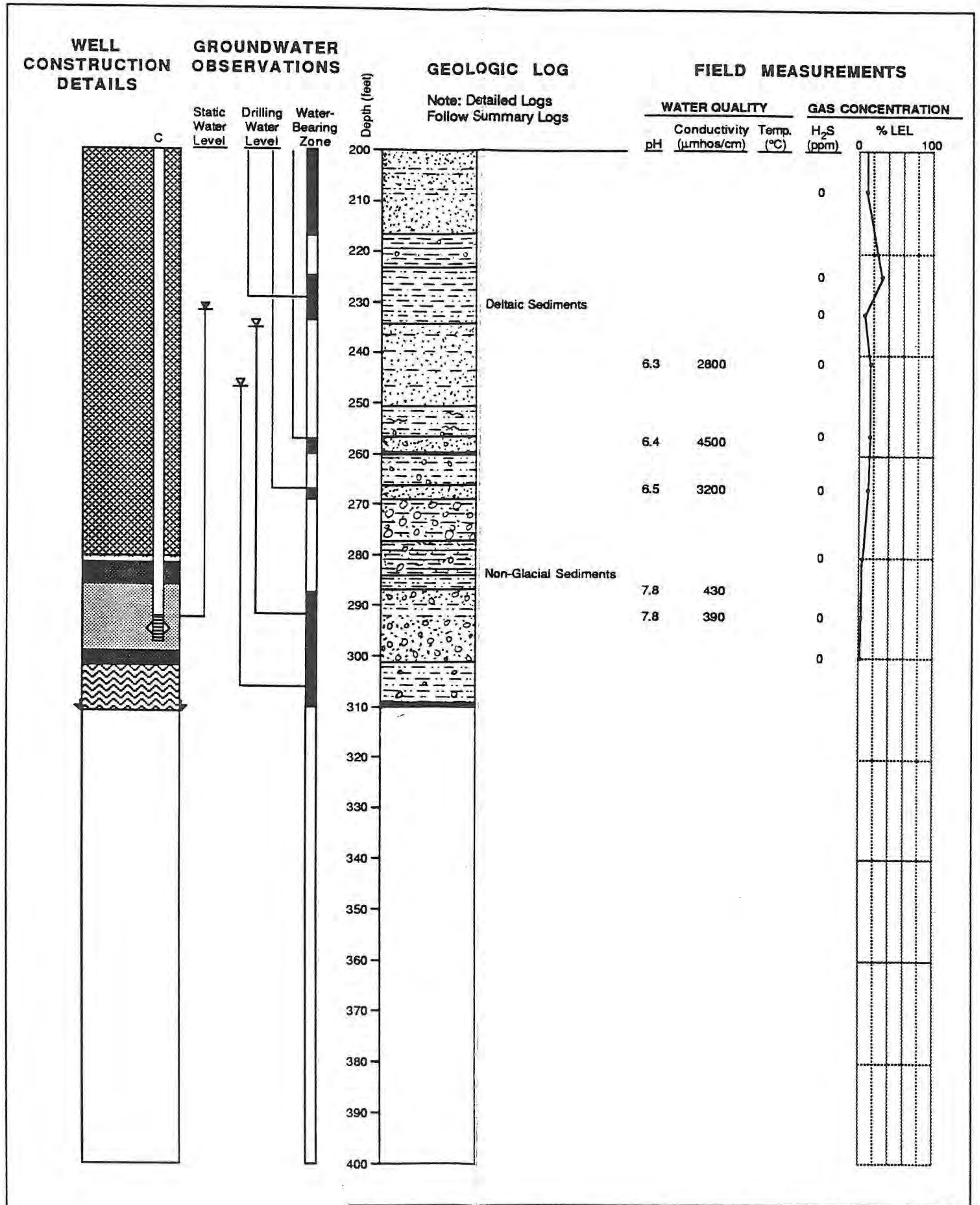
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-18
Midway Landfill
Kent, Washington

PLATE
B13

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



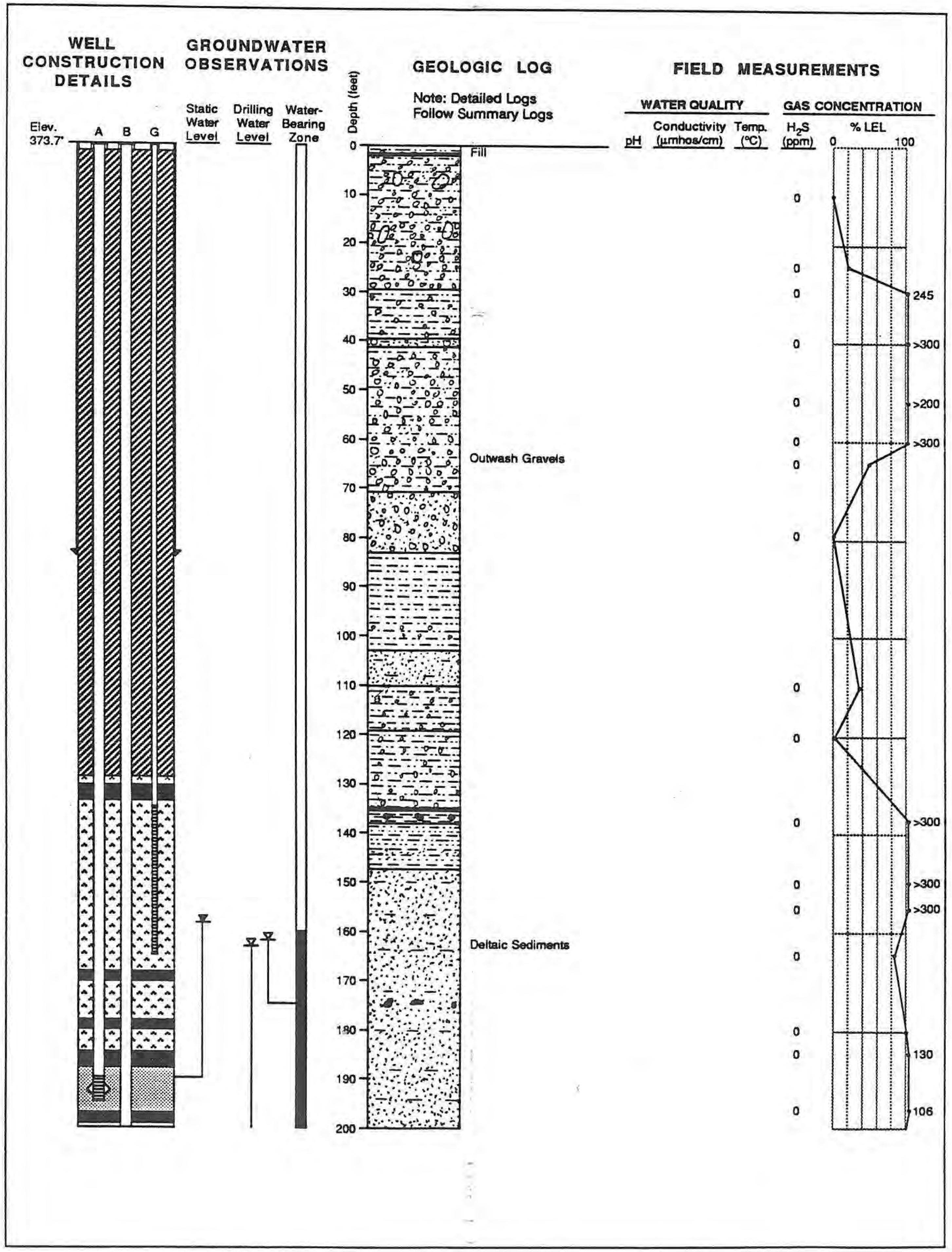


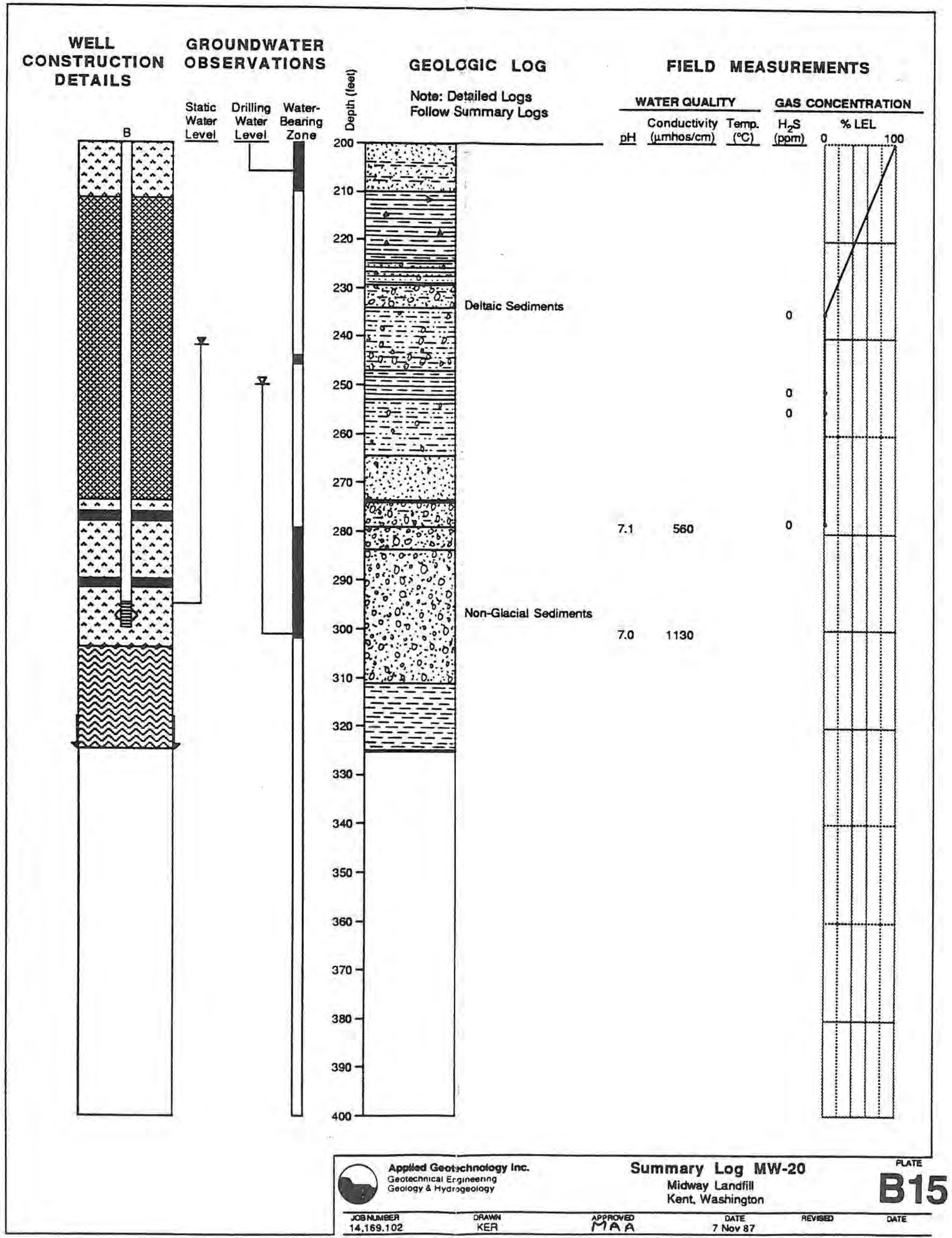
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-19
Midway Landfill
Kent, Washington

PLATE
B14

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



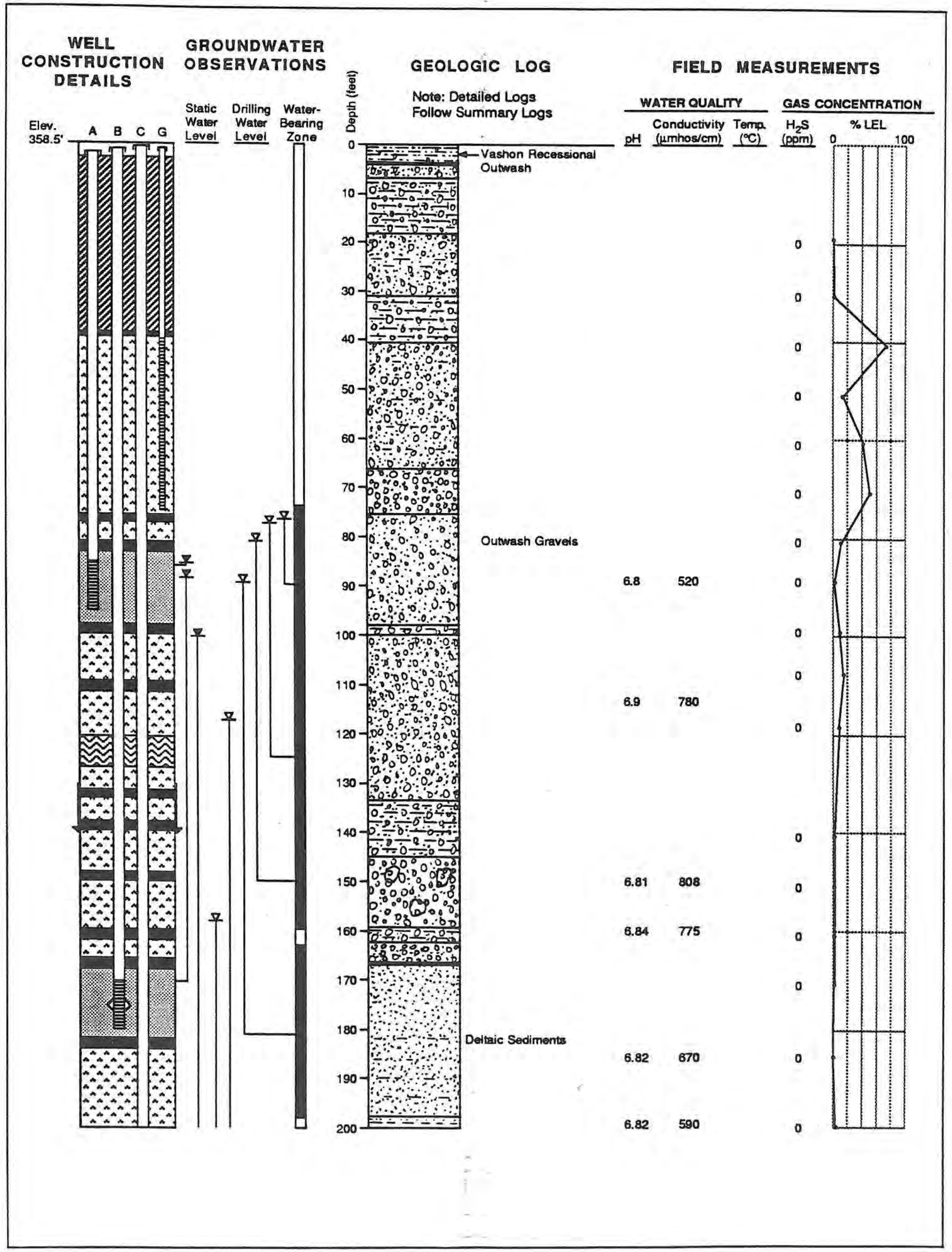


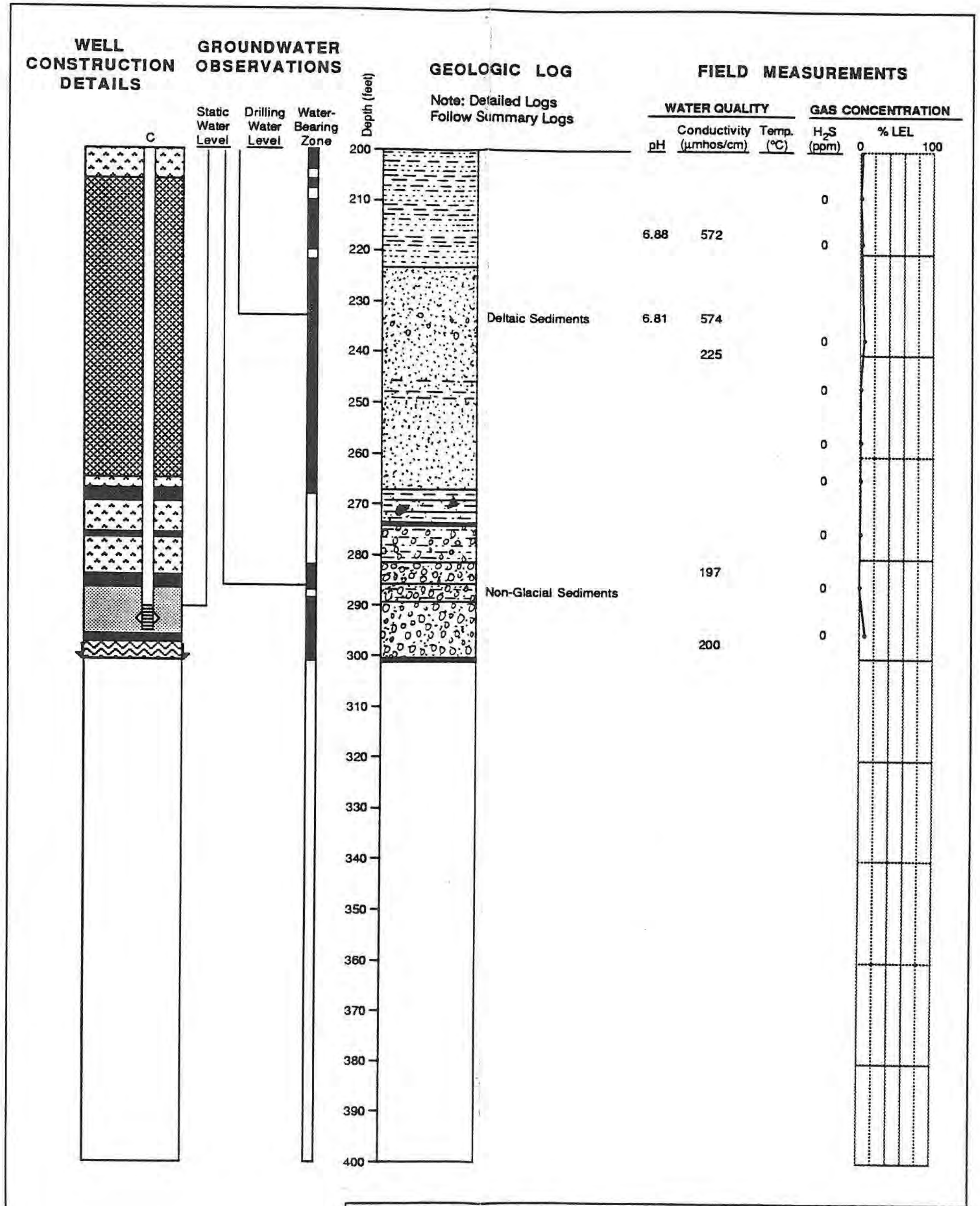
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-20
Midway Landfill
Kent, Washington

PLATE
B15

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



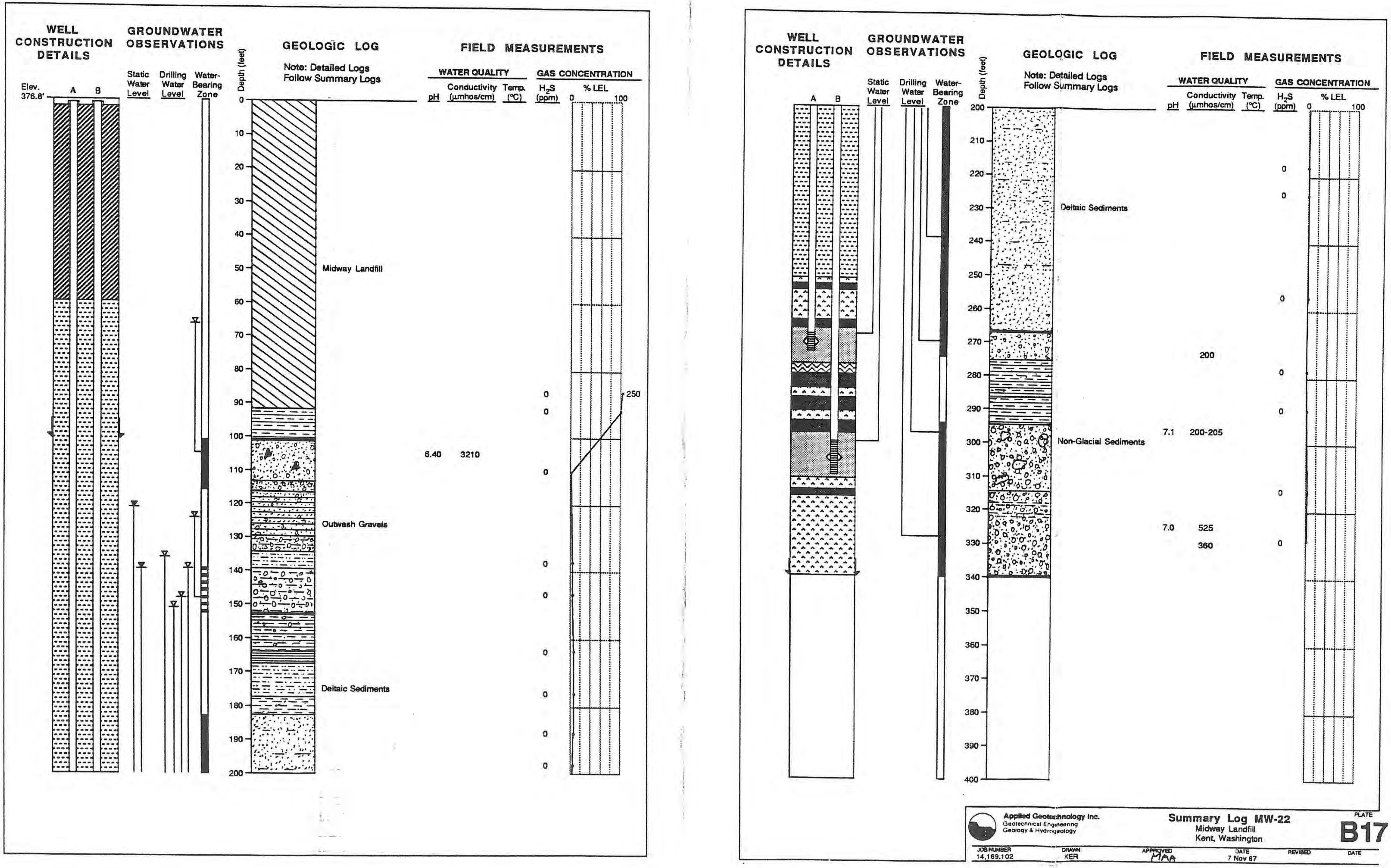


Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-21
Midway Landfill
Kent, Washington

PLATE
B16

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		

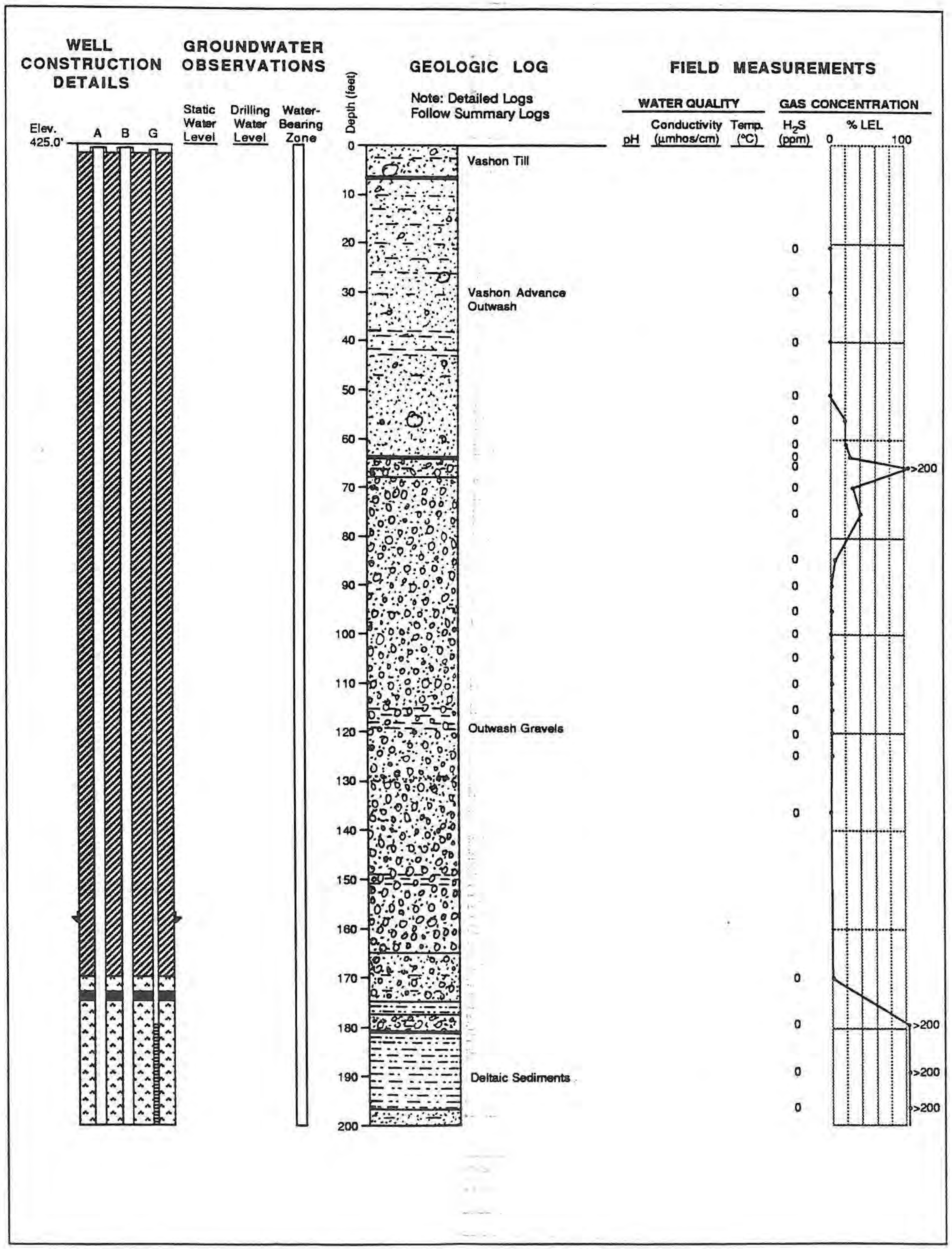


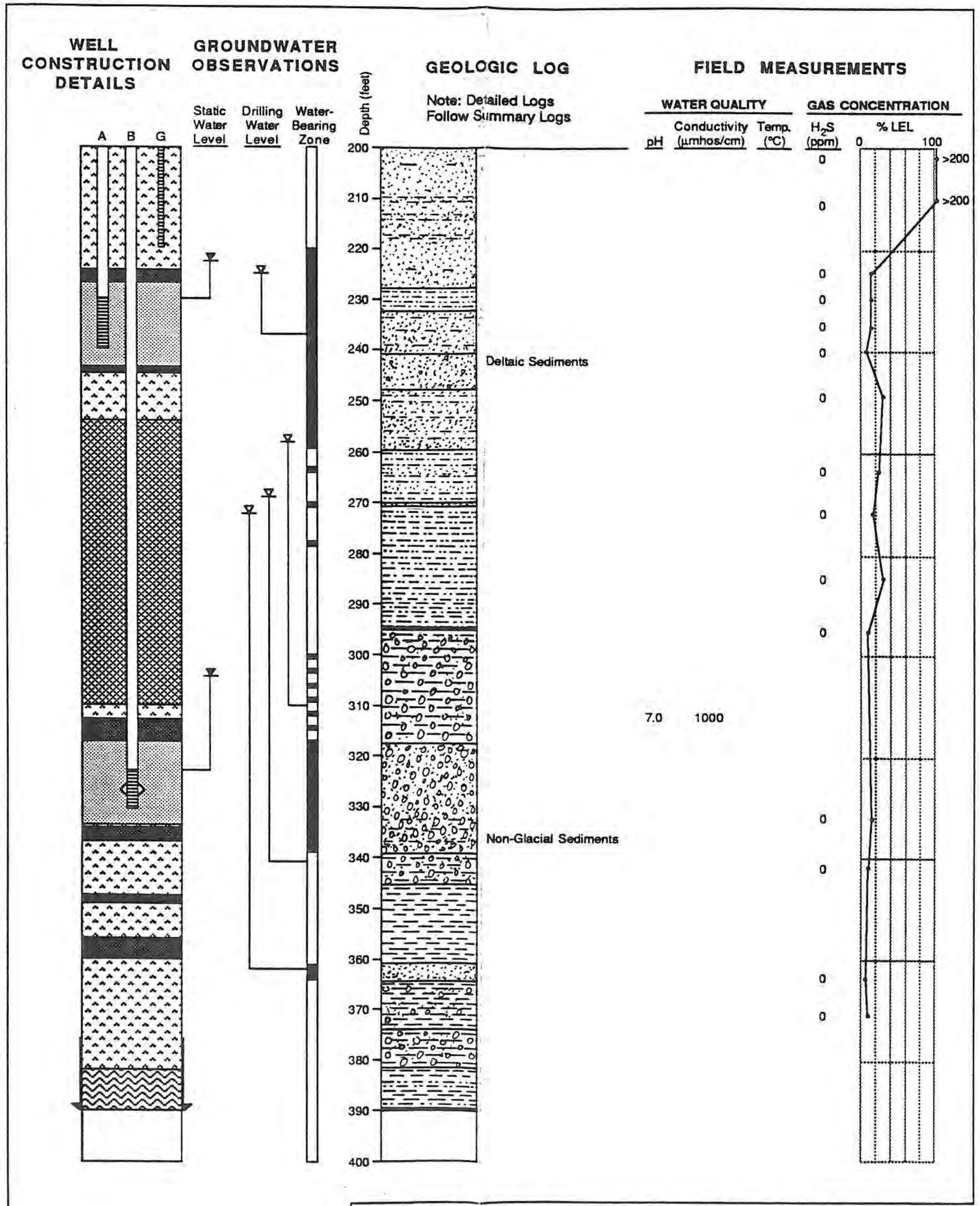
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-22
Midway Landfill
Kent, Washington

PLATE
B17

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



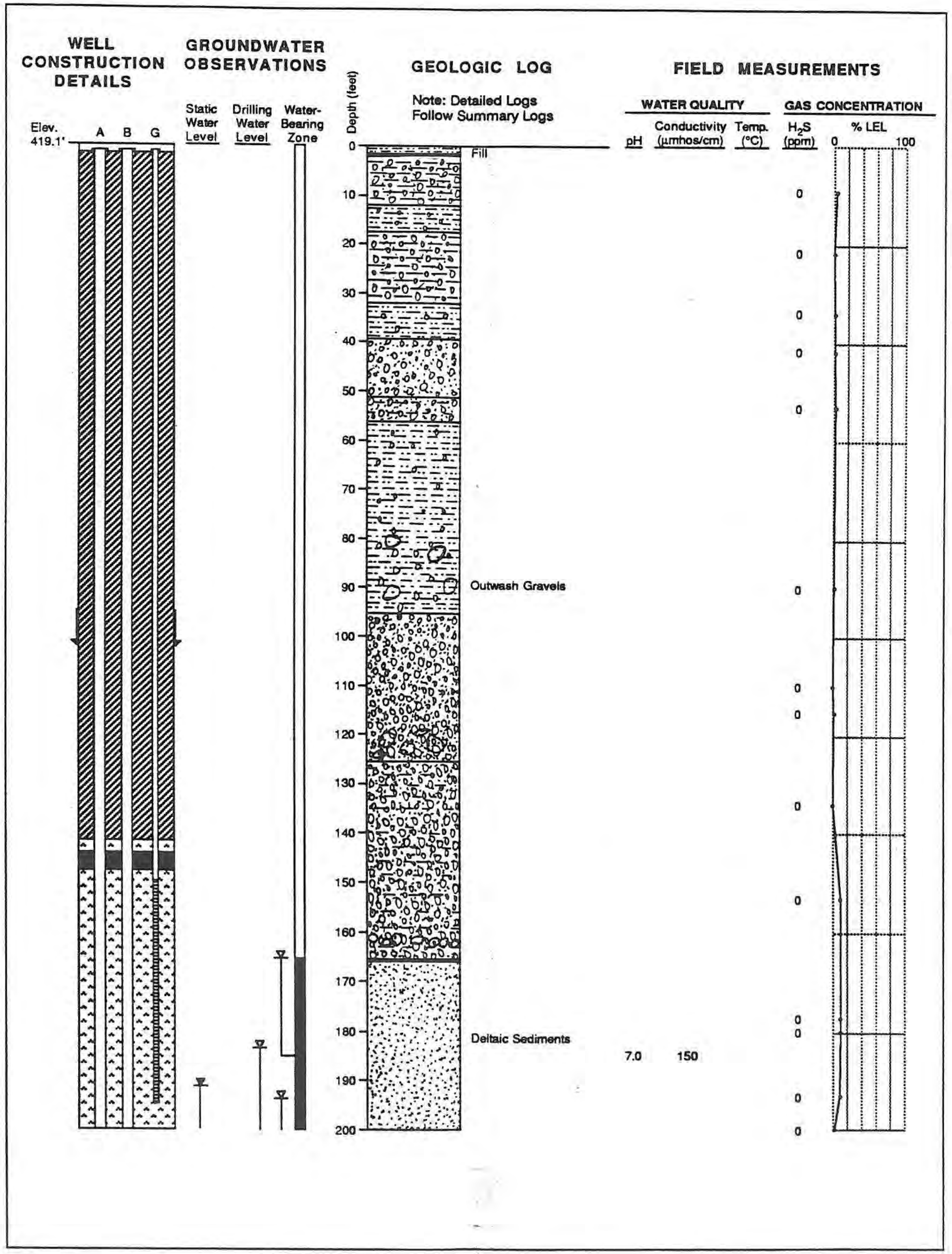


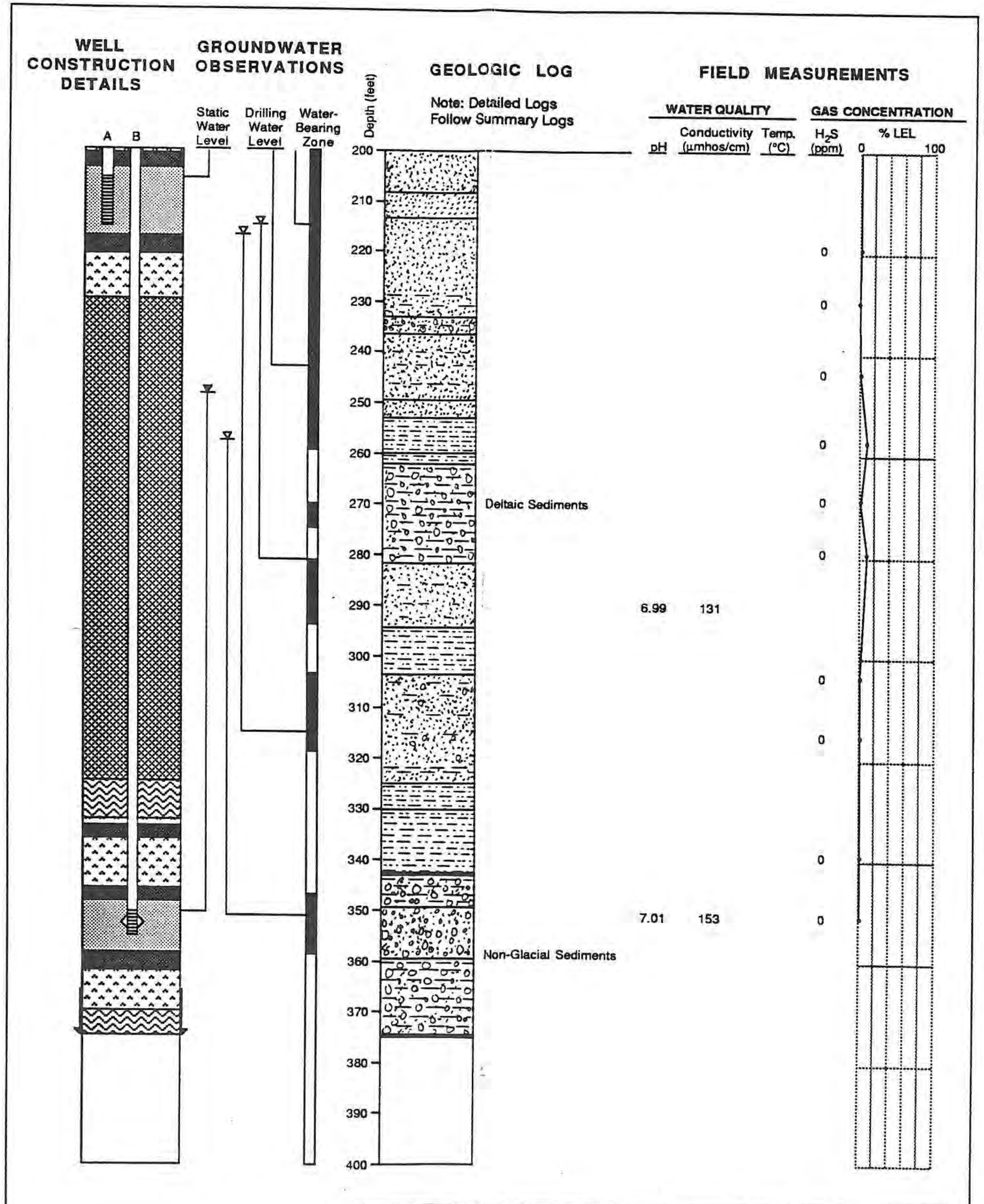
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-23
Midway Landfill
Kent, Washington

PLATE
B18

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



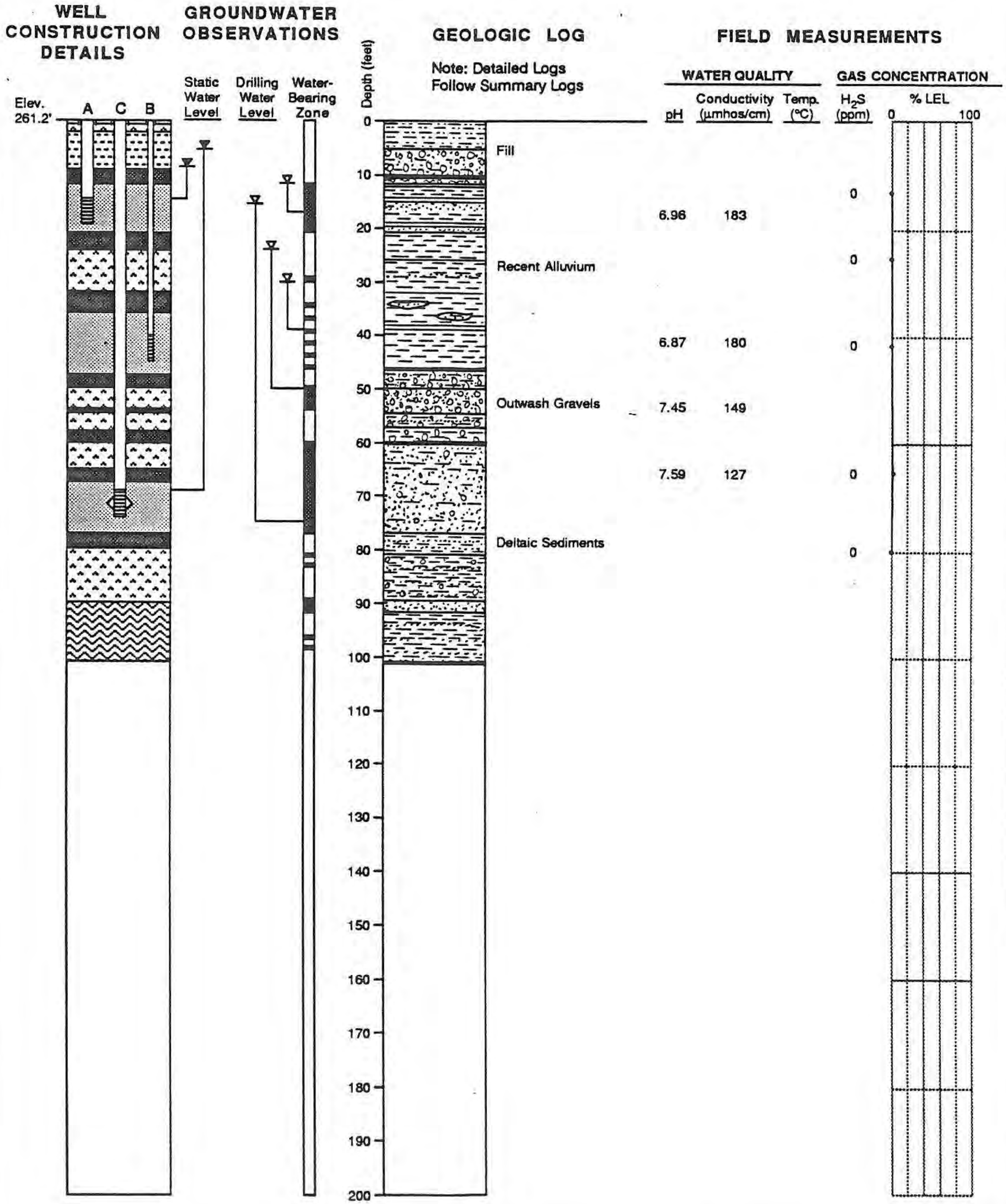


Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-24
Midway Landfill
Kent, Washington

PLATE
B19

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



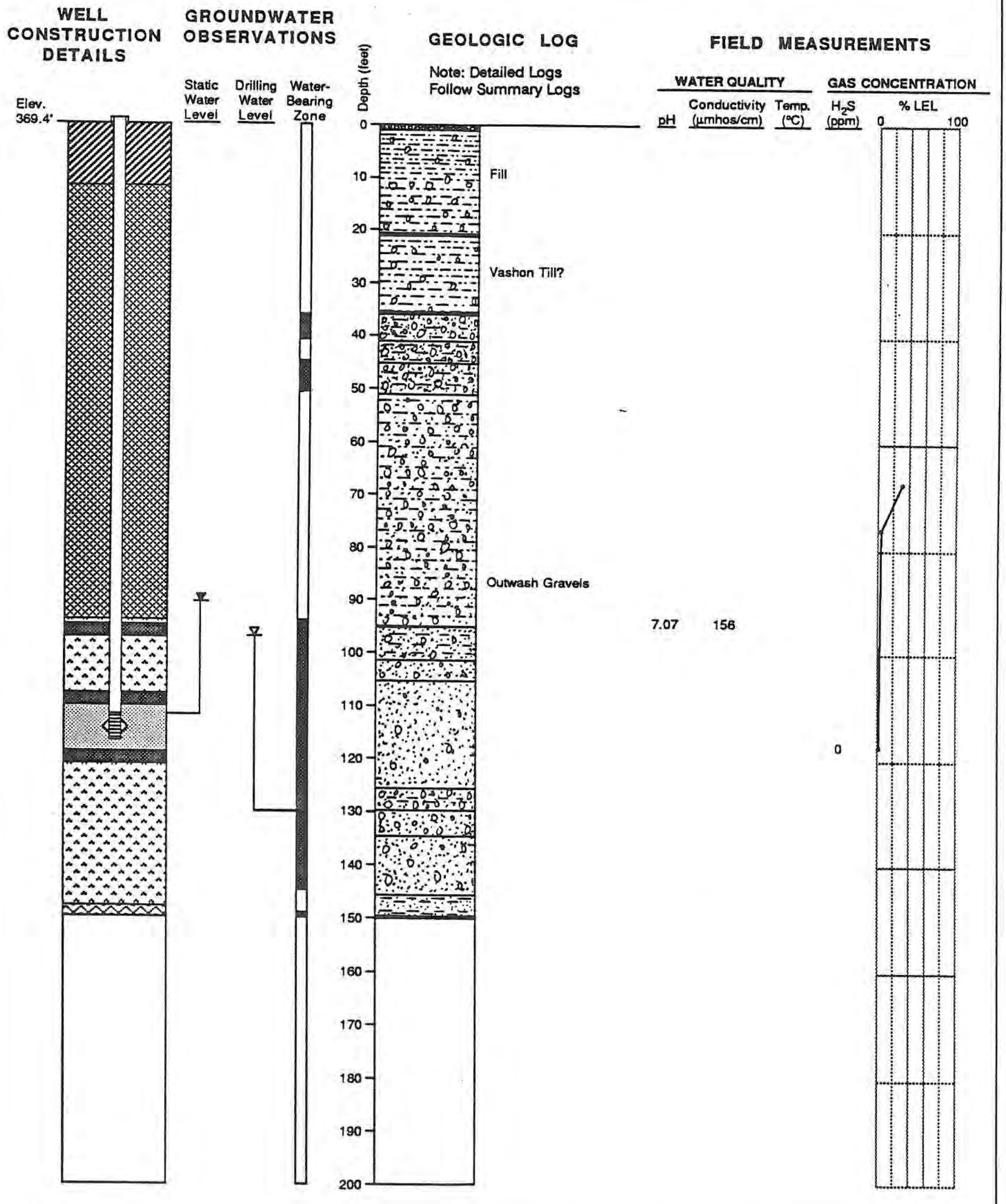
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-25

Midway Landfill
Kent, Washington

PLATE
B20

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14.169.102	KER	MAA	7 Nov 87		

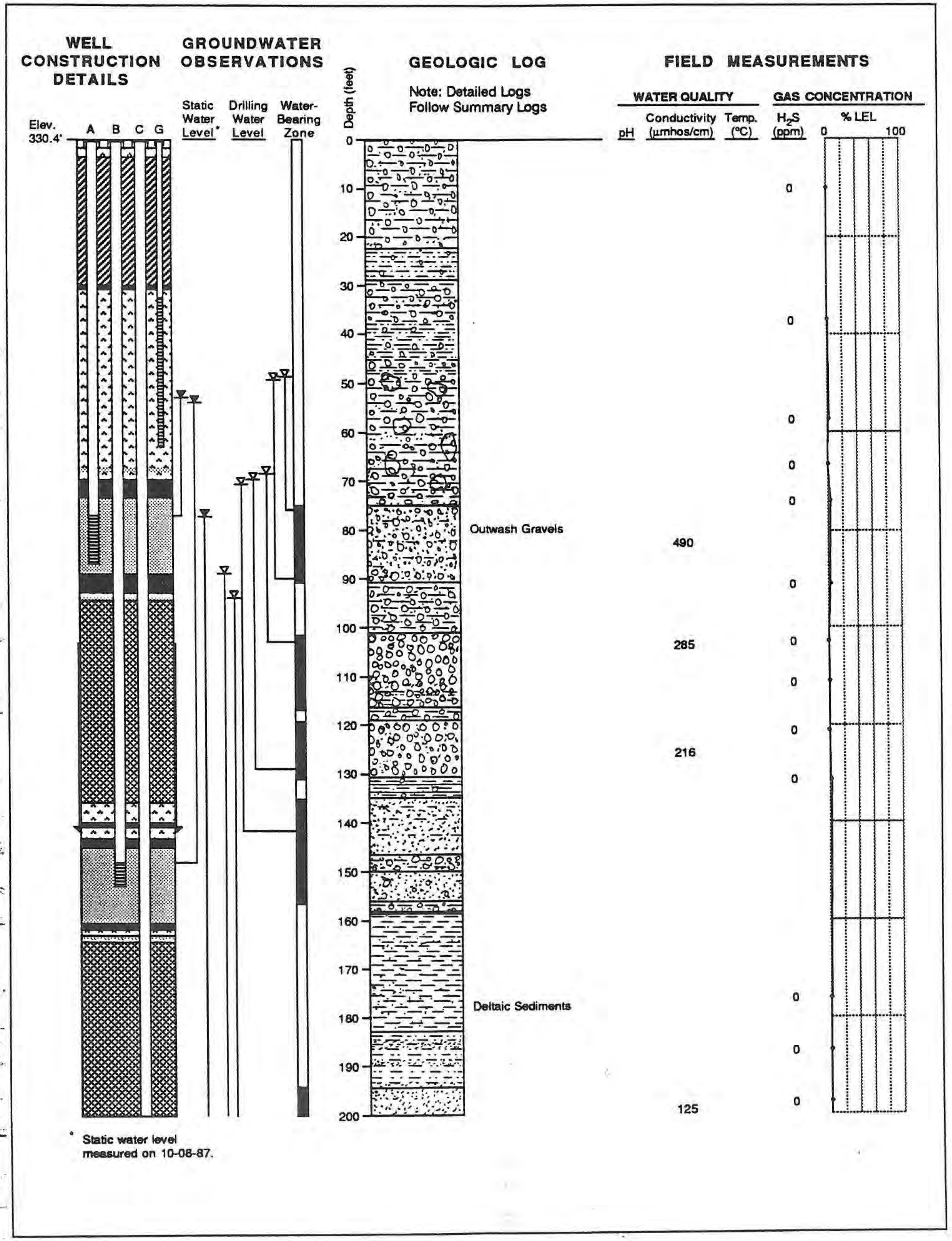


Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

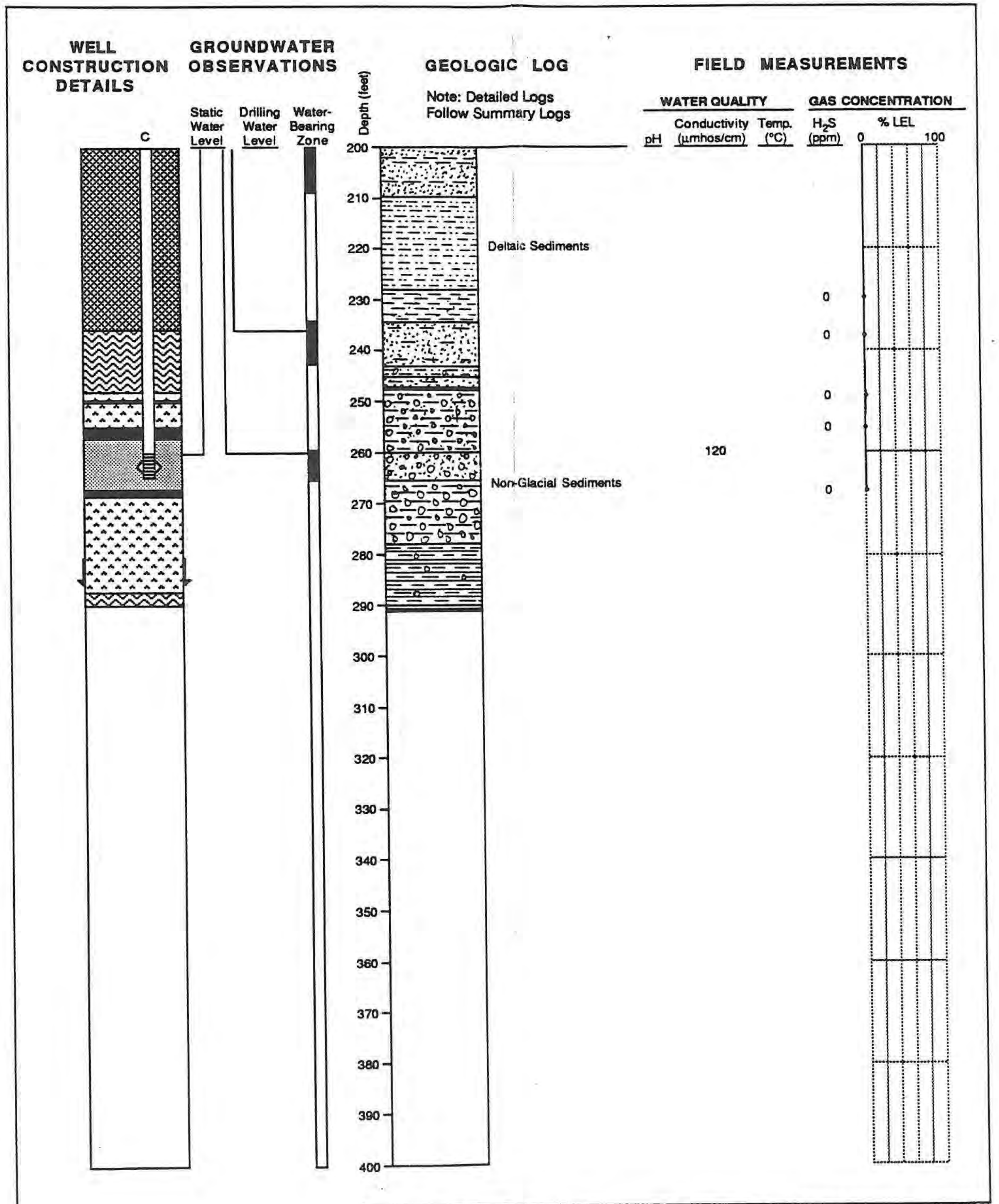
Summary Log MW-26
Midway Landfill
Kent, Washington

PLATE
B21

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



* Static water level measured on 10-08-87.

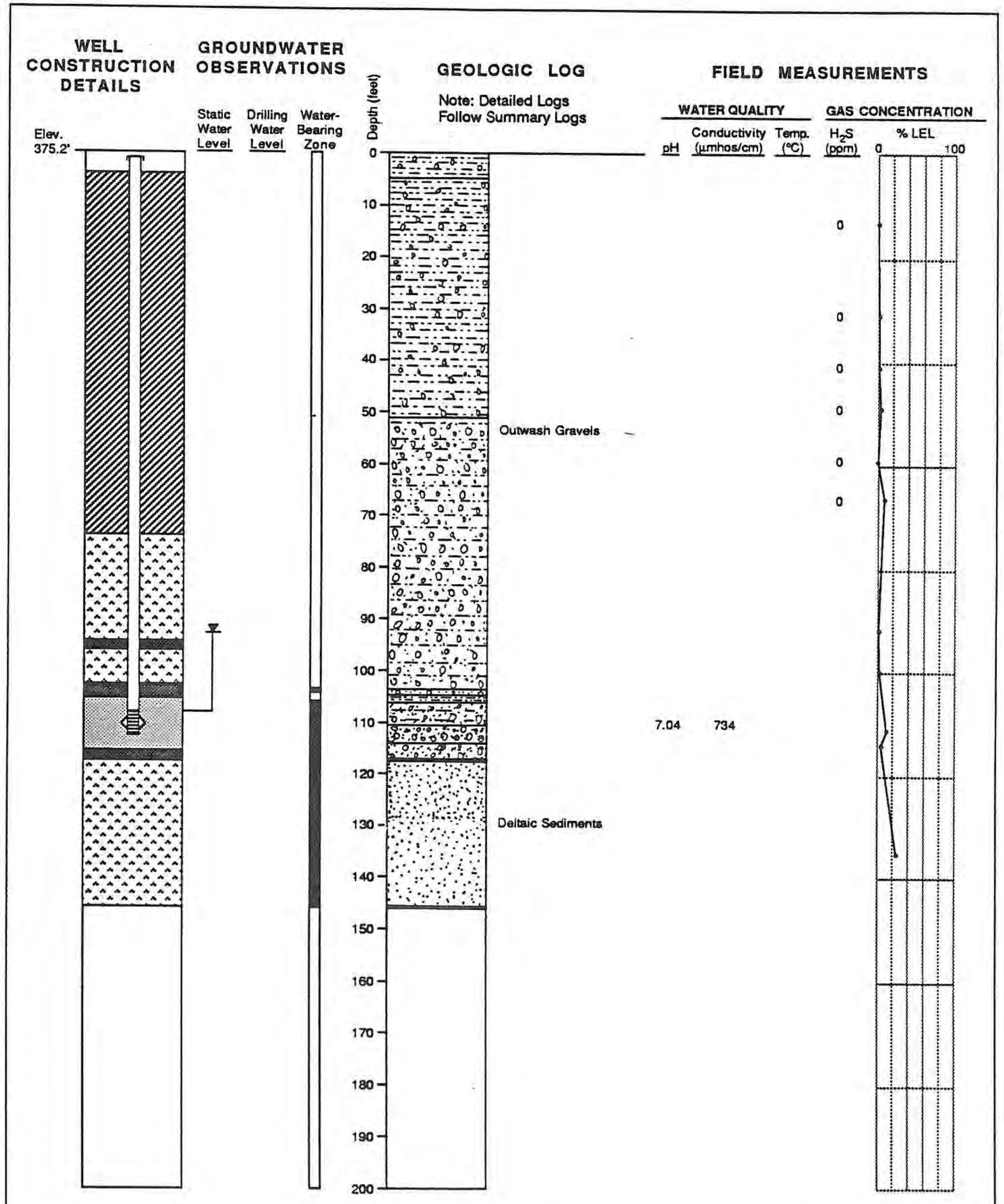


Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-27
Midway Landfill
Kent, Washington

PLATE
B22

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		

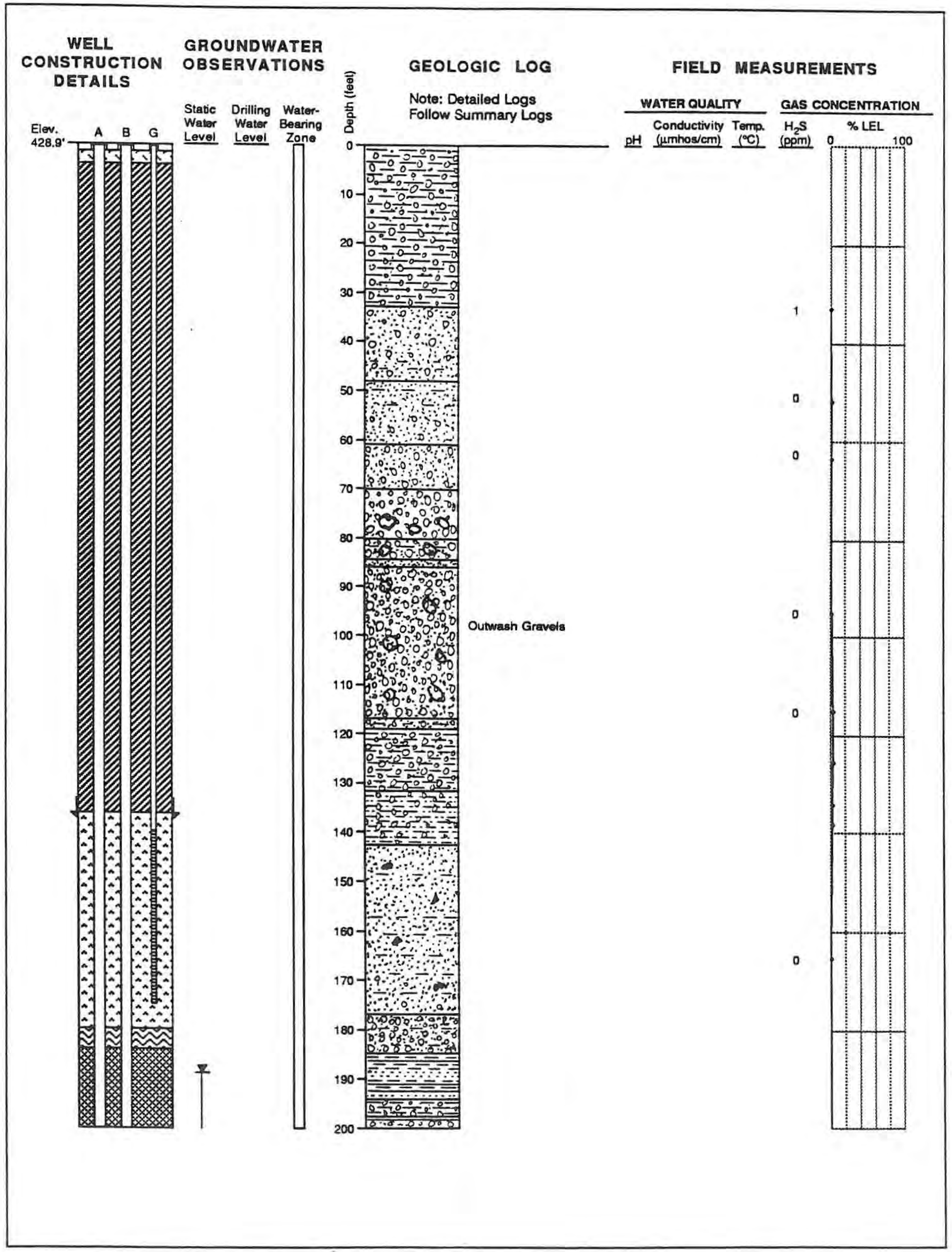


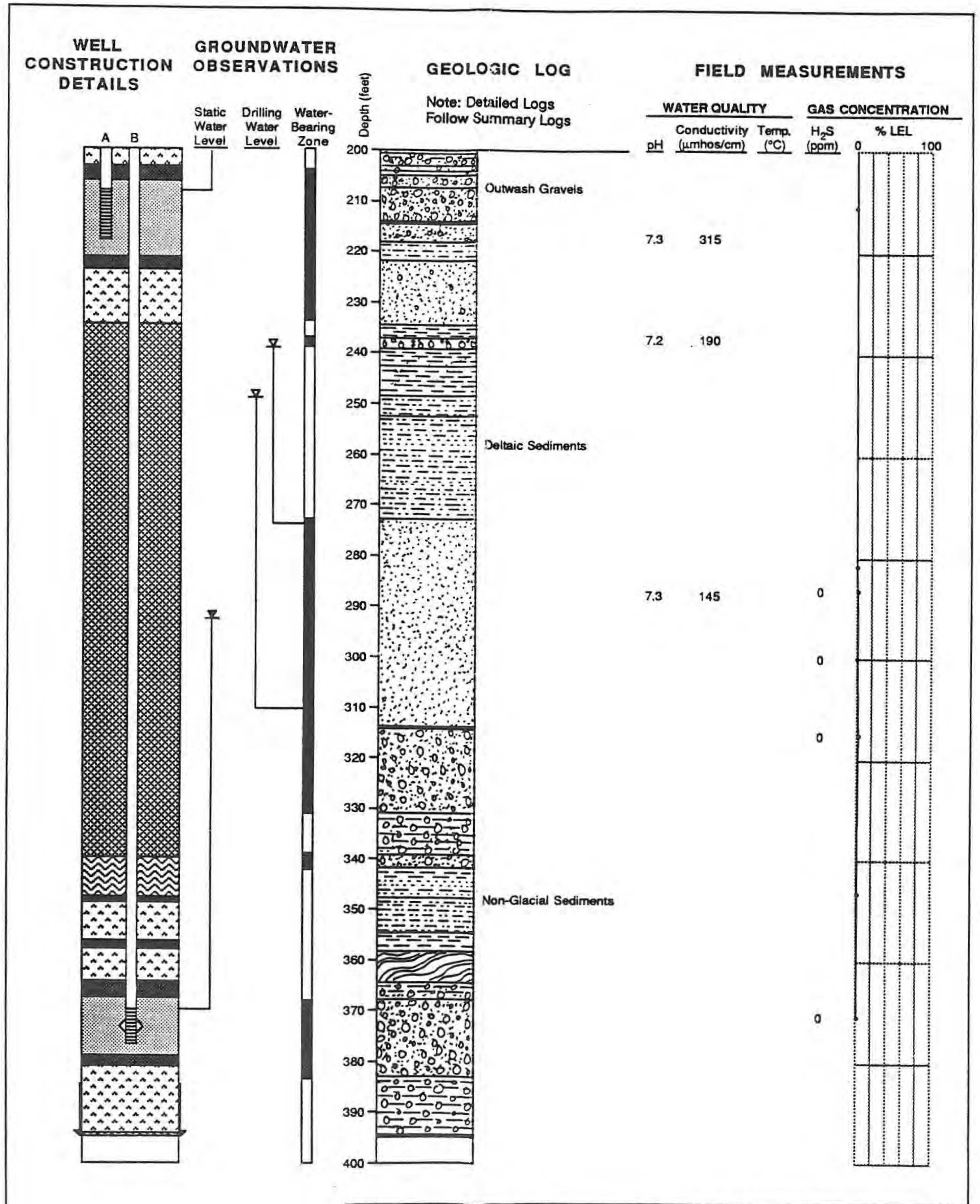
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-28
Midway Landfill
Kent, Washington

PLATE
B23

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



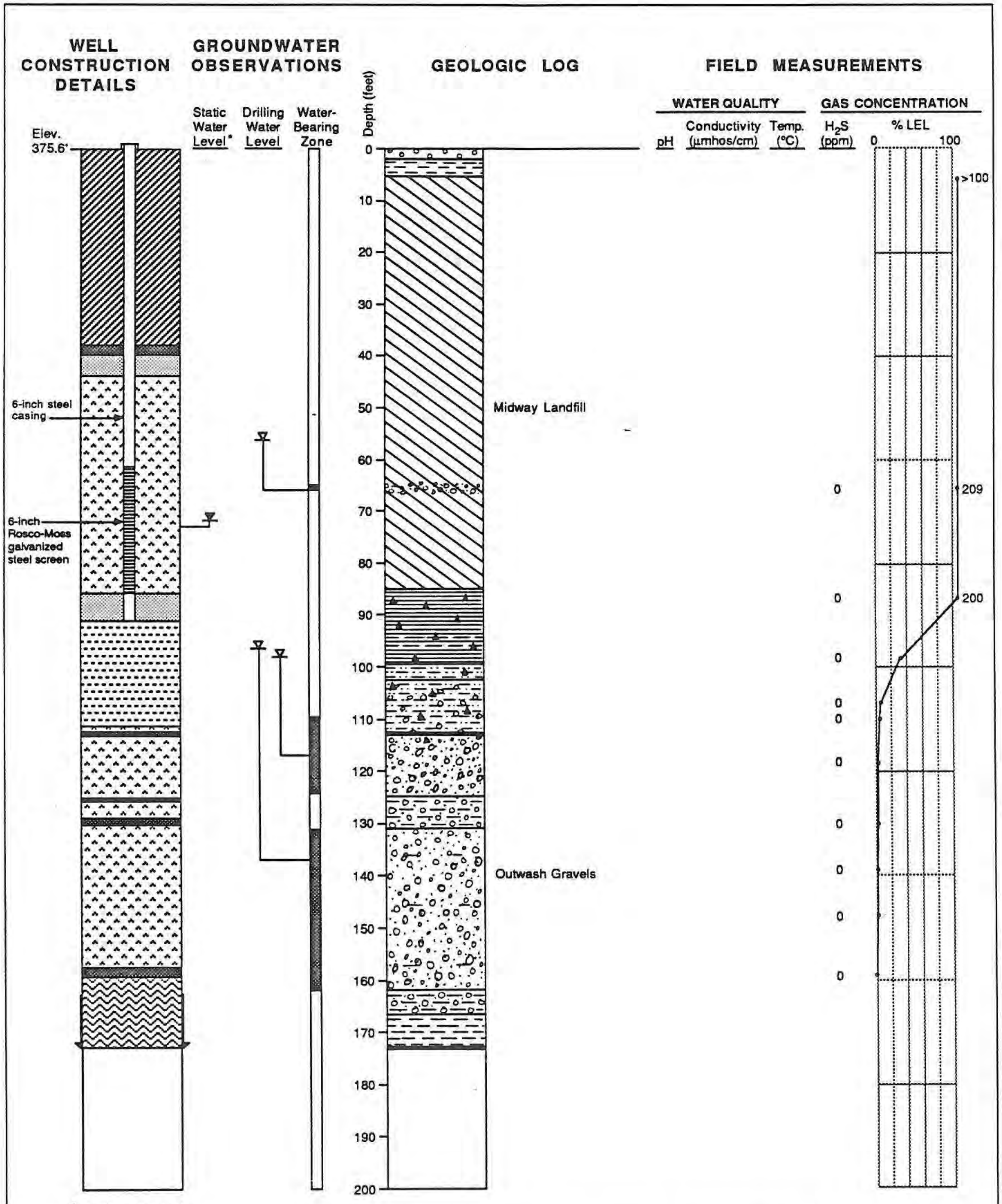


Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log MW-29
Midway Landfill
Kent, Washington

PLATE
B24

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAB	7 Nov 87		



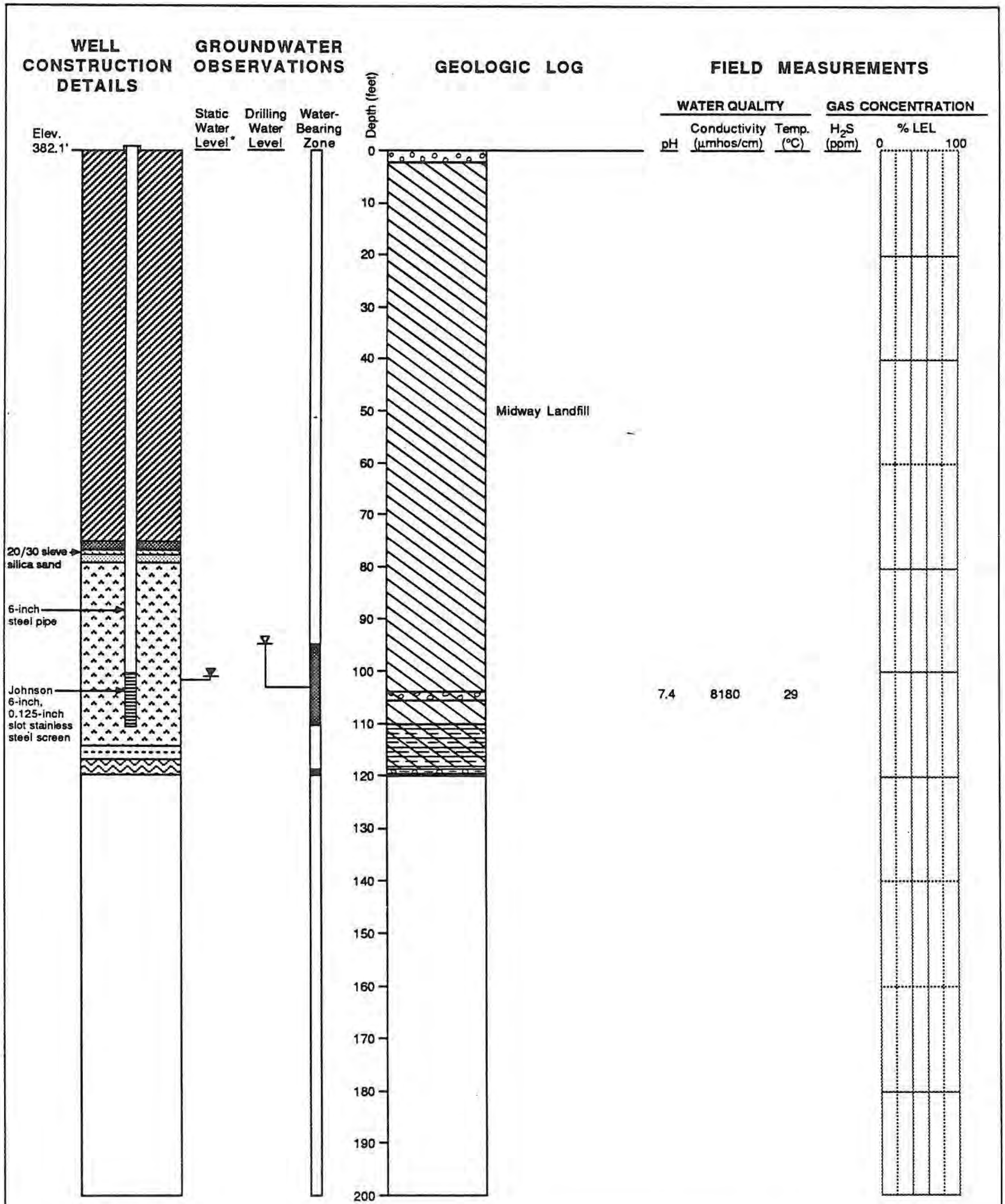
* Static water level measured on 8-25-87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Summary Log LW-1
Midway Landfill
Kent, Washington

PLATE
B25

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		



* Static water level measured on 9-01-87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

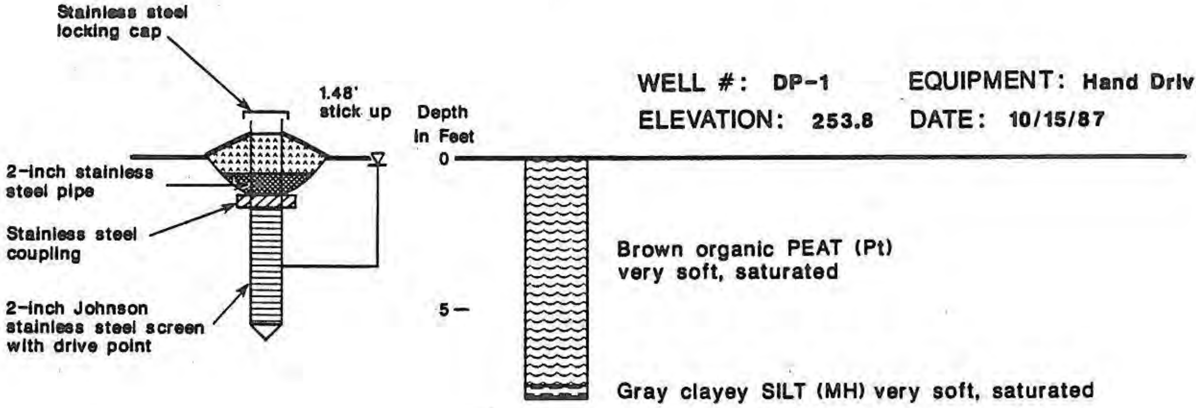
Summary Log LW-2

Midway Landfill
Kent, Washington

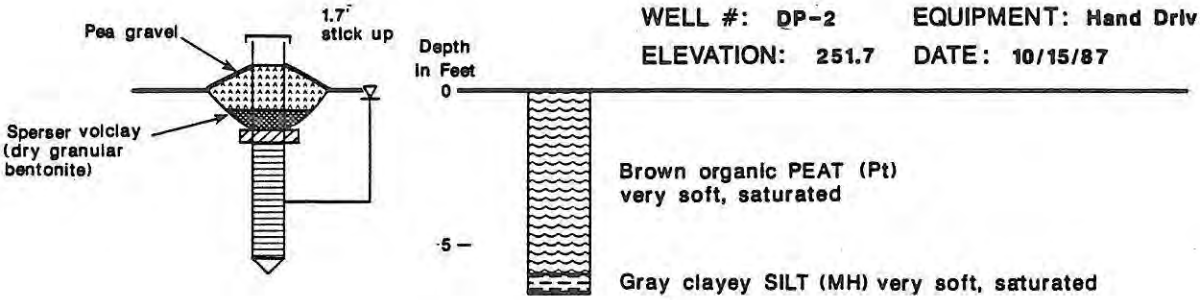
PLATE
B26

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	7 Nov 87		

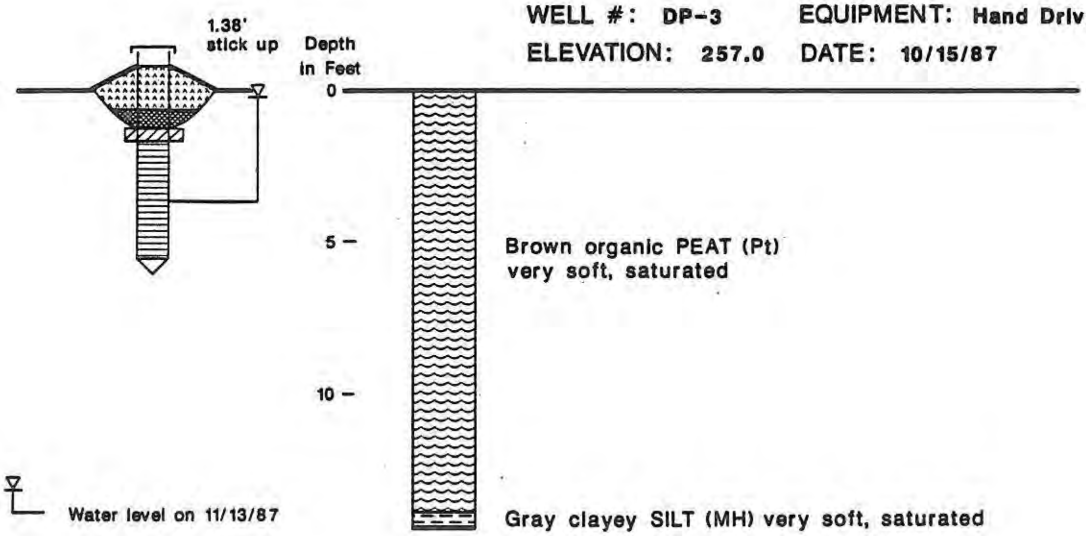
WELL #: DP-1 **EQUIPMENT:** Hand Driven
ELEVATION: 253.8 **DATE:** 10/15/87



WELL #: DP-2 **EQUIPMENT:** Hand Driven
ELEVATION: 251.7 **DATE:** 10/15/87



WELL #: DP-3 **EQUIPMENT:** Hand Driven
ELEVATION: 257.0 **DATE:** 10/15/87



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

DP-1, DP-2, and DP-3 Summary Logs

Midway Landfill
Kent, Washington

FIGURE
B27

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	12 January 88		

MAJOR DIVISIONS						TYPICAL NAMES
UNIFIED SOIL CLASSIFICATION SYSTEM	**COARSE GRAINED SOILS** MORE THAN HALF IS LARGER THAN NO. 200 SIEVE	**GRAVELS** MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	**GW**		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
				GP		POORLY GRADED GRAVELS GRAVEL-SAND MIXTURES
			GRAVELS WITH OVER 12% FINES	**GM**		SILTY GRAVELS, POORLY GRADED GRAVEL-SAND - SILT MIXTURES
				GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND - CLAY MIXTURES
		SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	**SW**		WELL GRADED SANDS, GRAVELLY SANDS
				SP		POORLY GRADED SANDS, GRAVELLY SANDS
			SANDS WITH OVER 12% FINES	**SM**		SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
				SC		CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
	FINE GRAINED SOILS MORE THAN HALF IS SMALLER THAN NO. 200 SIEVE	**SILTS AND CLAYS** LIQUID LIMIT LESS THAN 50		**ML**		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL		ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
		SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		**MH**		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
				CH		INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS
				OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
				Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

SAMPLE

- ■ Split Barrel
- ☒ Bailer
- ☰ Air Rotary Grab
- ▥ Not Recovered

GRAPHIC LOG

- —— Well Defined Change
- ／ Gradational Change
- - - - Obscure Change
- ━━ End of Exploration

BLOWS/FOOT

Hammer is 300 pounds with 30 inch drop, unless otherwise noted

S - SPT Sampler (2.0 Inch O.D.)

T - Thin Wall Sampler (2.8 Inch Sample)

H - Split Barrel Sampler (2.4 Inch Sample)

MOISTURE DESCRIPTION

Dry	- Considerably less than optimum for compaction
Moist	- Near optimum moisture content
Wet	- Over optimum moisture content
Saturated	- Below water table, in capillary zone, or in perched groundwater

LABORATORY TESTS

PO	- Porosity
Consol	- Consolidation
LL	- Liquid Limit
PL	- Plastic Limit
PM	- Permeability
GS	- Specific Gravity
SA	- Size Analysis
TP	- Triaxial Permeability
TX	- Triaxial Shear
DS	- Direct Shear
VS	- Vane Shear
Comp	- Compaction

UU - Unconsolidated • Undrained
CU - Consolidated • Undrained
DC - Consolidated • Drained

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Soil Classification/Legend

Midway Landfill
Kent, Washington

PLATE
B28

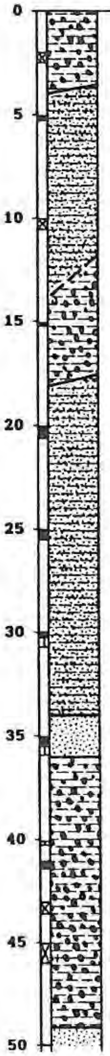
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	15 October 1987		

Equipment: BE 22-1 Cable Tool

Elevation: 413 feet

Date: 10/11/86

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
50/3			
95/10			
			4
50/6			
55/9			
70/12			
	0		15
50/2			
50/5			
	0		5



BROWN SANDY GRAVEL (GM)
dense, moist; some silt (Recessional Outwash?).

Cobbles at 4 feet.

GRAY SILTY SAND (SM)
dense, moist; with trace to some clay and 2 to 3-inch gravel (Till).

Cobbles at 5 and 9 feet.

Clay content increasing below 10 ft.

GRAY-BROWN SILTY GRAVEL (GM)
very dense, moist; with some sand, gravel to 1.5-inch diameter, and with brown sand lenses and layers.

Sand layer at 18 feet.

GRAY SILTY SAND (SM)
very dense, moist; with some gravel to 2-inch diameter and trace clay.

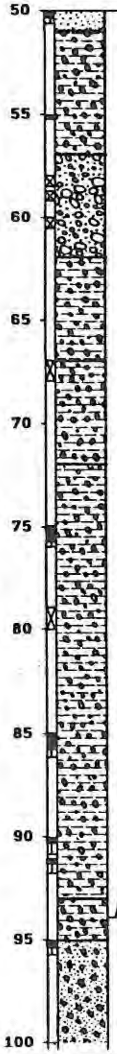
Gravel content increases below 30 ft.

LIGHT BROWN SAND (SP)
very dense, dry to moist; fine to medium grained.

GRAY SILTY SANDY GRAVEL (GM)
very dense, moist; cobble-size gravel.

Sand layer at 45.5 to 46.5 feet.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
52/9			
			3
50/3			
	0		2
			0
	0		0
	0		0
56	0		2
			>100
62			
			20
			2
			10
			40
			35
75/14			
50/10			
50/10			
			45
			65
65/8			



BROWN SAND (SP)
very dense, dry; fine grained.

GRAY-BROWN SANDY GRAVEL (GM)
very dense, moist; with some silt, gravels to 2-inch diameter.

GRAY SANDY GRAVEL (GW)
very dense, moist; trace silt, gravels to 1.5-inch diameter.

Sand content increases below 60 ft.

GRAY SILTY GRAVEL (GM)
very dense, moist; with some clay and trace sand.

Sand lens at 64 to 65 feet.

GRAY SILTY SANDY GRAVEL (GM)
very dense, moist; with trace clay, slight organic/refuse odor.

Increasing organic/refuse odor below 71 feet.

GRAY SANDY GRAVEL (GM)
very dense, moist; with varying proportions of silt and trace to some clay, moderate organic/refuse odor.

Slight organic smell below 75 feet.

DARK GRAY SILTY SANDY GRAVEL (GM)
very dense, moist; slight to strong refuse odor.

DARK GRAY SANDY GRAVEL (GP)
very dense, moist; some silt, slight sewer gas odor.

Silt content varies from 5 to 50%.

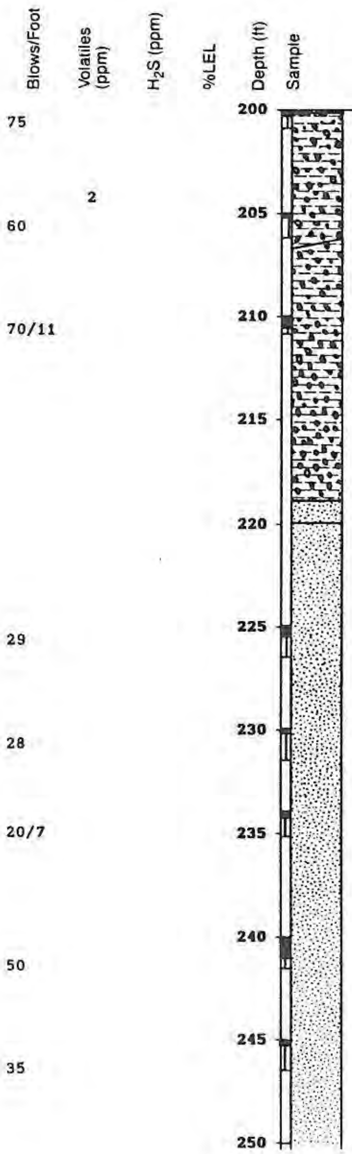
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-7 (continued)

Midway Landfill
Kent, Washington

PLATE
B29

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



GRAY TO DARK GRAY SILTY SANDY GRAVEL (GM)
very dense, wet; slight organic odor.

GRAY SILTY SANDY GRAVEL (GM)
very dense, wet; with trace to some clay matrix, clay is green-brown.

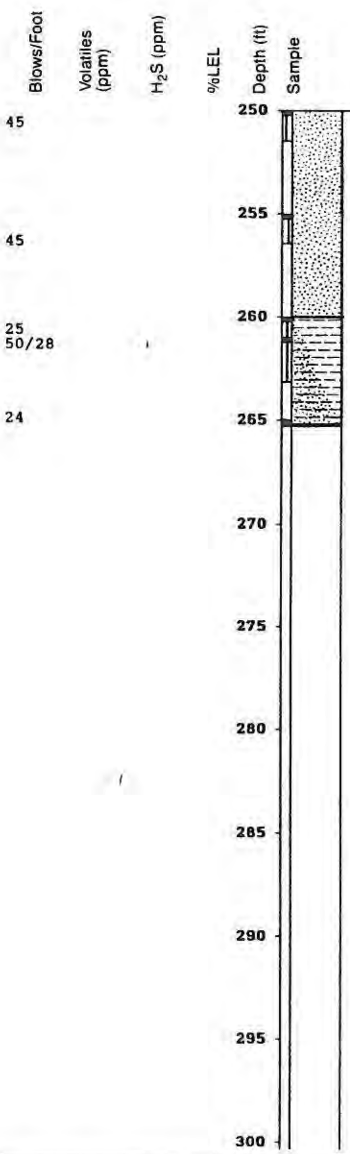
Thin water-bearing layer at 215 ft.

DARK GRAY GRAVELLY SAND (SP)
dense, saturated; medium grained, sand with some 2-inch gravels.

DARK GRAY SAND (SP)
dense, saturated; fine-grained sand with trace silt

Sand becomes finer grained below about 232 feet.

Silt increases below 236 feet.



Clayey silt layer at 251 to 252 feet.

Occasional hard green clay and silt clasts below 255 feet.

Also sand contains trace red andesite grains.

INTERBEDDED BROWN-PURPLE SANDY SILT (ML) AND SILTY SAND (SM)
hard, very dense, moist; very fine grained sand, occasional pieces of black organic matter, silt conta volcanic ash?

Boring terminated at depth of 265.3 feet on 10/11/86.

Pages reversed

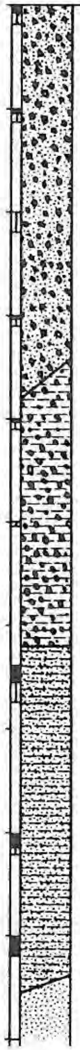
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-7

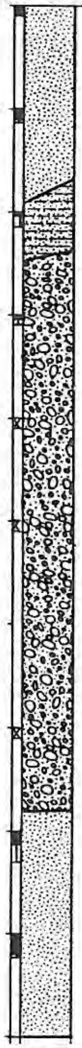
Midway Landfill
Kent, Washington

PLATE
B29

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
75/13				100		Color grades darker with depth; nearly black at 105 feet.
75/9			50	105		Becomes gray from 105 to 110 feet.
75/13				110		
50/6	0		25	115		
						Cobbles in bailer.
	0					**GRAY SILTY GRAVEL (GM)** very dense, moist; some sand and trace clay, mottled appearance.
50/6				120		
50/2	0		20 20	125		Gravel layer at 126 to 127 feet.
			2			
				130		
38						**YELLOW-BROWN SILTY SAND (SM)** very dense, moist; fine grained.
				135		
			1			
50/13				140		
90				145		
				150		



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
70/6	0		2	150		**BROWN SAND (SP)** very dense, moist; fine to medium grained with trace silt.
50/9				155		
			1			
50/10				160		**BROWN SILTY SAND (SM)** very dense, moist; with some gravel.
50/5				165		**BROWN SANDY GRAVEL (GW)** very dense, moist; with some silt.
	0		0			
				170		
			0			
				175		Gravels typically green, brown, and black below 174 feet. Split barrel sampler will not penetrate because of large gravels at 175 feet.
				180		
				185		
50/18				190		**DARK GRAY SAND (SP)** dense, saturated; fine grained with trace silt and with layers of silty sand, "water-bearing".
75/14				195		Moderate organic odor at 196 feet.
				200		

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-7 (continued)

Midway Landfill
Kent, Washington

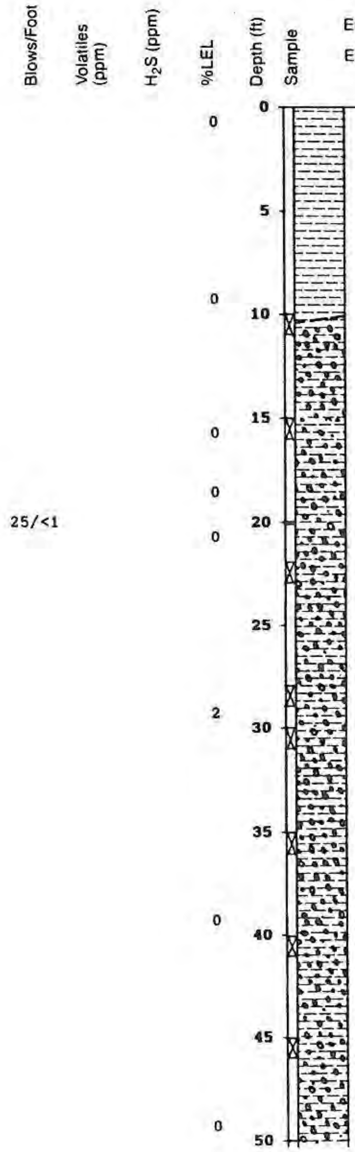
PLATE
B29

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: **71 Speed Star Cable Tool**

Elevation: **352 feet**

Date: **2/18/87**

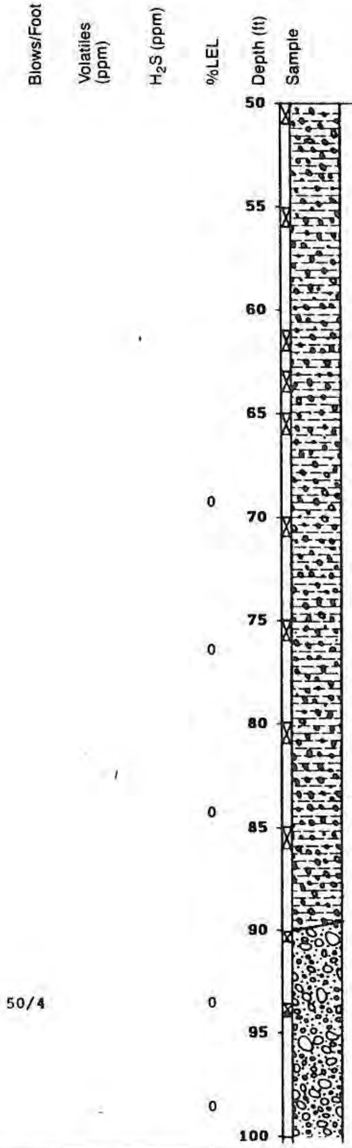


BROWN SANDY SILT (ML)
hard, moist; with some gravel.

Gravel content increases with depth.

LIGHT BROWN SILTY GRAVEL (GM)
dense, moist; with some well graded sand, rounded gravel to 2-inch diameter ("silt-bound gravel").

Gray-brown and very dense below 28 feet.



More sand at 61 to 62 feet.

Broken 5 to 6-inch cobble recovered in bailer at 85 feet.

GRAY SANDY GRAVEL (GW)
very dense, moist; coarse sand and fine to coarse subrounded gravel with a trace to some silt.

More silt at 92 to 93 feet.

More silt below 95 feet.

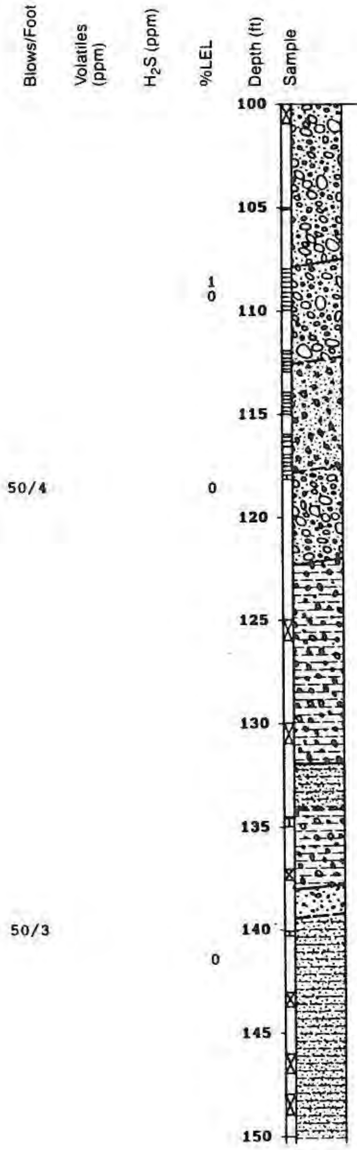
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-8 (continued)

Midway Landfill
Kent, Washington

PLATE
B30

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



Sand fraction is well graded and gravel content increases below 100 feet.

Wet below 100 feet.

Three foot boulder at 105 to 108 ft.

GRAY SANDY GRAVEL (GW)
very dense, saturated; fine to coarse subrounded gravel.

GRAY GRAVEL (GP)
dense, saturated; coarse gravel and cobbles.

No cobbles below 116 feet and gravel is medium sized.

High water flow into borehole at 117 to 118 feet.

GRAY SANDY GRAVEL (GW)
very dense, saturated; with trace silt.

GRAY SILTY SANDY GRAVEL (GM)
very dense, wet; non-water bearing, well graded sand, fine to coarse subround gravel, with lenses of gray silt?

Three inch diameter gravels recovered in bailer.

GRAY SILTY SAND (SM)
very dense, wet; fine to medium sand with a trace of gravel.

GRAY SILTY SANDY GRAVEL (GM)
very dense, wet.

GRAY GRAVELLY SAND (SW)
very dense, saturated; with a trace to some silt, some sand grains.

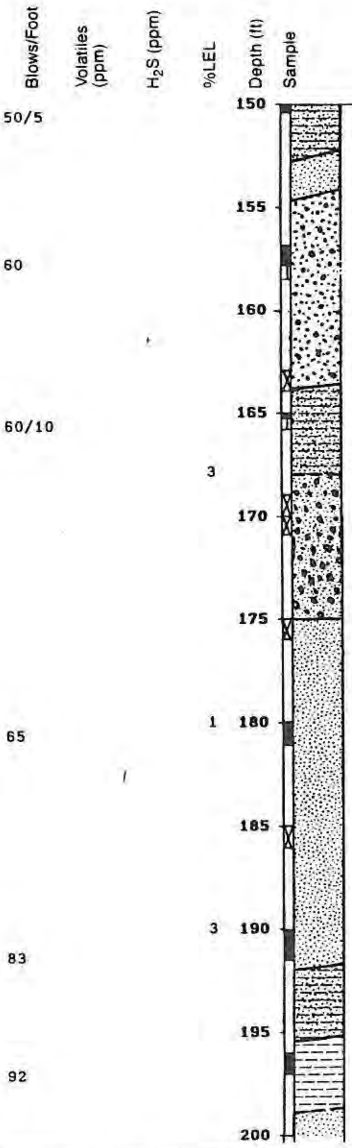
Water entering borehole below 138 ft.

GRAY SILTY SAND (SM)
very dense, saturated; with some fine gravel, gravels are soft, red andesite(?) and soft, gray sandstone.

Less gravel below 141 feet.

Silt content increases below 144 ft.

Dark gray silty lenses at 146 feet.



GRAY SAND (SP)
very dense, saturated; trace silt and gravel, gravel to 1.5-inch diameter recovered.

GRAY GRAVELLY SAND (SW)
very dense, saturated; with a trace of silt, medium to coarse sand and subround to round gravels to 1-inch diameter, gravels are dark gray and red, some red sand grains.

Sufficient silt in formation to allow open hole drilling.

Less gravel and more silt at 163 ft.

GRAY SILTY SAND (SM)
very dense, saturated; with some fine gravel.

GRAY SANDY GRAVEL (GP)
very dense, saturated; with well graded sand and subround gravels to 2-inch diameter and a trace to some silt.

GRAY SAND (SP)
very dense, saturated; with a trace of silt, medium grained sand, and a trace fine gravels.

Abundant red grains – appear to be andesite(?) fragments.

Less silt below 190 feet.

GREEN-GRAY SILTY SAND (SM)
very dense, saturated.

INTERBEDDED GREEN-GRAY TO PINK-GRAY SANDY SILT (ML)
hard, wet; with fine grained sand and occasional lenses of green-gray silty fine sand, pink silt is friable when dry – volcanic ash?

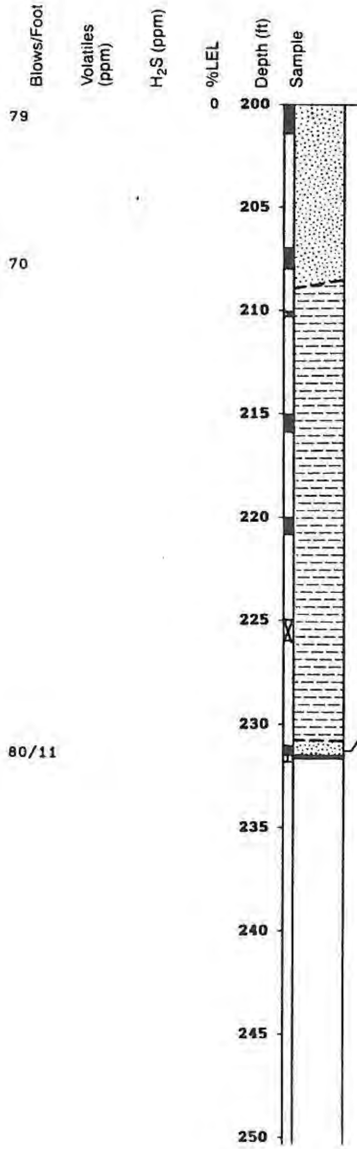
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-8 (continued)

Midway Landfill
Kent, Washington

PLATE
B30

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



GRAY SAND (SP)
very dense, saturated; very fine to medium grained sand with a trace of silt, abundant red grains.

Thin silt lenses below 205 feet. Sand becomes green-gray at 207 feet with more silt lenses.

GRAY SILT (ML)
hard, moist; with some clay and a trace of sand and fine gravel (pebbles), occasional dark gray hard silt concretions.

Less clay and dry below approximately 219 feet.

GREEN SAND (SP)
very dense, moist; with some silt and fine to medium sand that is predominantly green but contains gray, white, and black grains.

Boring terminated at depth of 231.6 feet on 2/18/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-8

Midway Landfill
Kent, Washington

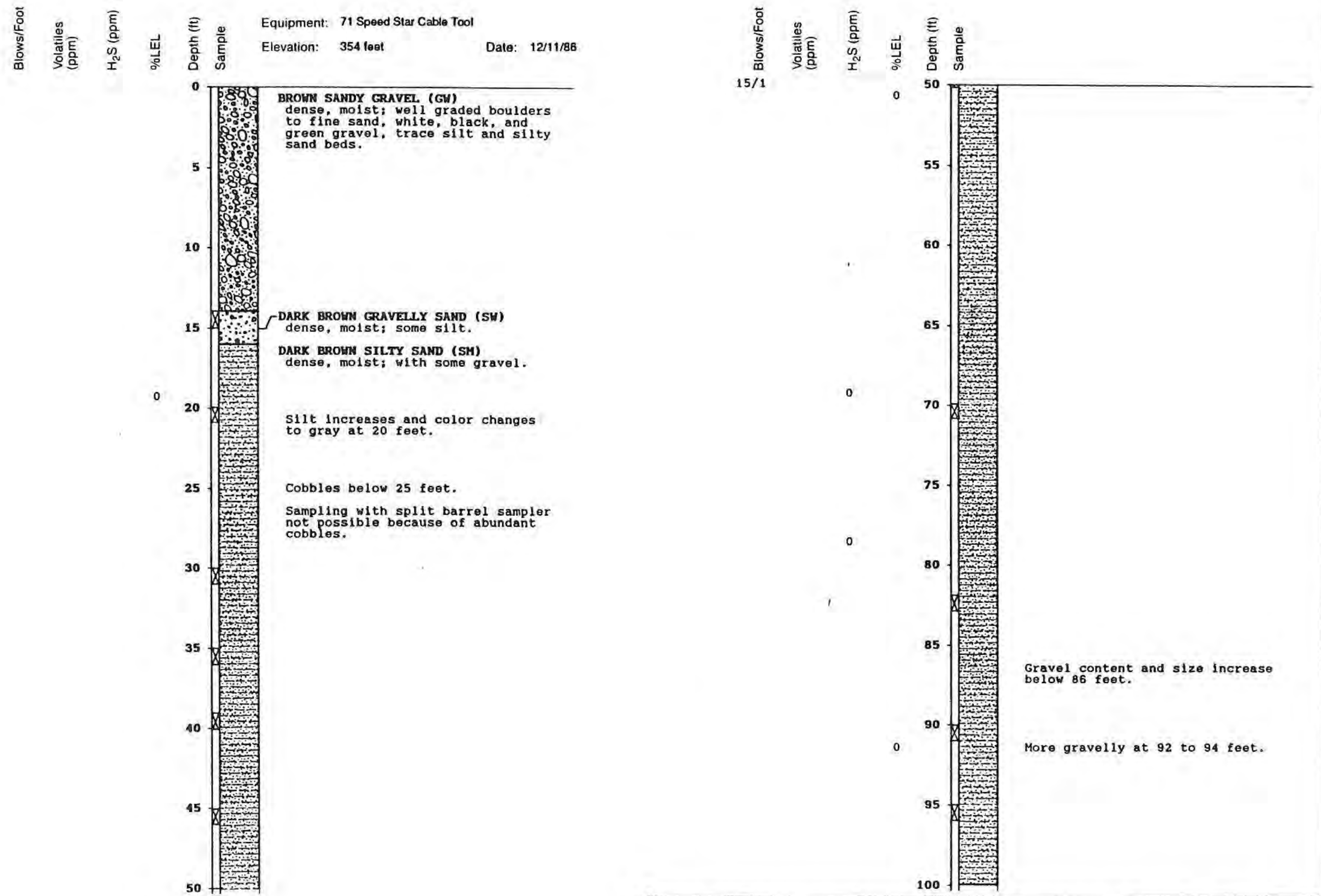
PLATE
B30

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14.169.102	PS/TG		15 October 87		

Equipment: 71 Speed Star Cable Tool

Elevation: 354 feet

Date: 12/11/86



BROWN SANDY GRAVEL (GW)
dense, moist; well graded boulders to fine sand, white, black, and green gravel, trace silt and silty sand beds.

DARK BROWN GRAVELLY SAND (SW)
dense, moist; some silt.

DARK BROWN SILTY SAND (SM)
dense, moist; with some gravel.

Silt increases and color changes to gray at 20 feet.

Cobbles below 25 feet.

Sampling with split barrel sampler not possible because of abundant cobbles.

Gravel content and size increase below 86 feet.

More gravelly at 92 to 94 feet.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

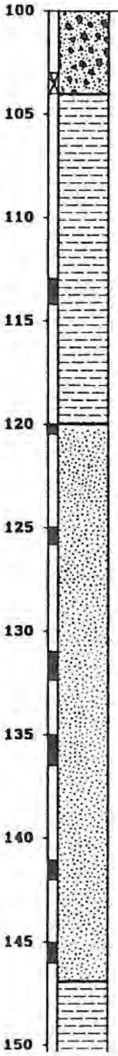
Log of Boring MW-9 (continued)

Midway Landfill
Kent, Washington

PLATE
B31

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
		0	1
		0	1
50			
70/11			
		0	3
65/11		0	1
74			
		0	1
40			
62			
		0	1
35			



GRAY SANDY GRAVEL (GP)
very dense, saturated; poorly graded.

Small volume of water entering borehole.

MOTTLED GRAY AND BROWN SILT (ML)
hard, wet; with trace fine grained sand, clay, and gravel.

Coarse gravel at 112 feet.

GRAY SAND (SP)
very dense, saturated; water bearing, sand fine grained, water entering borehole.

Sand becomes slightly coarser below approximately 129 feet ranging from fine to medium grained.

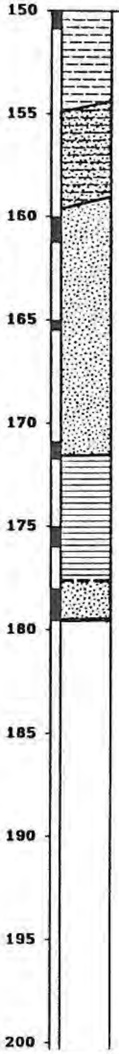
Trace organic matter below 134 feet.

Trace coarse sand at 135 feet.

Trace gravel below approximately 144 feet.

GRAY CLAYEY SILT (ML)
hard, dry to moist; with trace gravel.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
		0	0
50/6			
65/9			
60			
64			



GRAY SILTY SAND (SM)
very dense, moist; with some gravel, trace clay.

DARK GRAY SAND (SP)
very dense, saturated; water bearing, with some gravel and trace silt, sand is fine to medium grained.

Becomes blue-gray from 164 to 169 feet with some 1/2-inch gravel and abundant red grains.

Dark gray below 169 feet with some gravel.

MOTTLED GRAY AND GREEN SILTY CLAY (CL)
hard, dry to moist; with hard clay inclusions.

GRAY-GREEN SAND (SP)
very dense, saturated; water bearing, fine sand with abundant red grains.

Boring terminated at depth of 179.5 feet on 12/11/86.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-9

Midway Landfill
Kent, Washington

PLATE **B31**

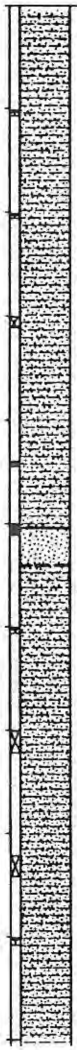
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: 71 Speed Star Cable Tool

Elevation: 339 feet

Date: 10/31/86

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				0
50/4				5
		0	0	
50/3				10
				15
		0	0	
				20
50/4				
		0	2	
50/6				25
		0	1	
50/5				30
		0	60	
				35
		0	6	
		0	6	40
		0	66	
		0	66	
50/5				45
		0	10	
		0	0	
				50



BROWN SILTY SAND (SM)
medium dense, moist; with some 1 to 3-inch gravel, occasional cobble, sand is fine grained.

Grades to gray-brown and becomes very dense at approximately 3 feet.

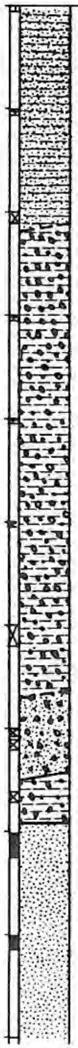
INTERBEDDED GRAY-BROWN FINE SAND AND SILT (SP/ML)
very dense, hard, moist.

GRAY-BROWN SILTY SAND (SM)
very dense, moist to wet; with some gravel.

Noted organic/refuse odor (gas) at 30 feet.

Organic/refuse odor (gas) at approximately 42 feet.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				50
		0	0	
		0	1	
50/4				55
		0	1	
		0	0	
				60
		0	0	
		0	1	
		0	0	
50/3				65
		0	0	
50/4				70
		0	1	
50/3				75
		0	2	
				80
		0	0	
				85
50/3		0	2	
		0	2	
				90
81/9				
		0	2	
				95
95/8				
		0	0	
		0	1	
				100



More gravel with cobbles below 57 ft.

MOTTLED YELLOW AND RED-BROWN SILTY GRAVEL (GM)
very dense, moist; with some sand and trace clay (Weathered Gravel)

Mottled color includes blue-green near 75 feet.

GRAY AND BLACK SANDY GRAVEL (GP)
very dense, saturated; well graded sand, trace silt, water bearing.

BROWN SILTY GRAVEL (GM)
very dense, wet; with some sand, non-water bearing.

YELLOW-BROWN SAND (SP)
very dense, saturated; water bearing, fine to medium grained sand, with trace gravel.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

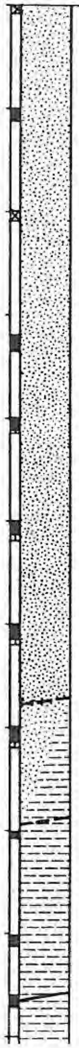
Log of Boring MW-10 (continued)

Midway Landfill
Kent, Washington

PLATE
B32

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				100
		0	1	
		1	0	
110/10				105
				110
				115
		1	3	
50/4				
50/11				120
				125
65/6				
		0	0	
50/6				130
40/6				135
		0	0	
50/2				140
45/1				145
50/2				
		0	1	
				150



Brown, fine, sandy silt layers interbedded with sand between approximately 113 and 118 feet.

Brown silt clasts in sand between approximately 118 and 123 feet; also distinct approximately 1-inch layers of red-brown medium grained sand below 118 feet, occasional wood fragments.

INTERBEDDED BROWN SAND (SP) AND GRAY AND BROWN SILT (ML)
very dense, hard, saturated; sand is fine to medium grained, massive silt.

GRAY CLAYEY SILT (ML)
hard, dry to moist; with some very fine grained sand, massive

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/2				150
				155
50/5				
		0	1	
50/1				160
				165
50/6				
50/6		0	1	170
				175
50/6				
		0	0	
				180
50/6				
				185
50/4				
		0	0	
				190
50/5				
		0	0	
				195
50/6				
				200

BLUE-GRAY SILT (ML)
hard, wet; with thin interbedded gray and brown sand (SP) layers, silt layers occasionally contain gravel "depository", sand is saturated, trace organics in sand.

BLUE-GRAY SILT (ML)
hard, moist; trace clay.

Wet below approximately 168 feet.

BROWN SAND (SP)
very dense, saturated; water bearing, with trace gravel, sand is fine to medium grain.

BLUE-GRAY SANDY SILT (ML)
hard, saturated; water bearing, sand is fine grained.

BLUE-GRAY SILT (ML)
hard, moist to wet.

Trace fine sand below approximately 193 feet.

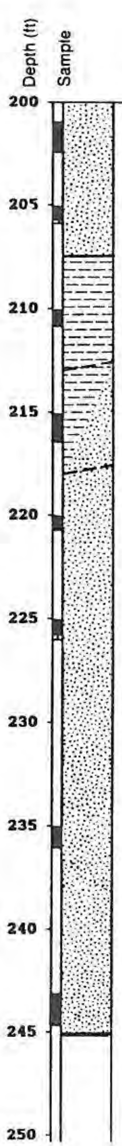
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-10 (continued)
Midway Landfill
Kent, Washington

PLATE
B32

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
		0	0
50			
		0	0
50/5			
50/5			
85/11			
		0	0
50/3			
		0	1
50/6			
		0	1
50/5			



GRAY FINE SAND (SP)
dense, saturated; making water, with interbedded sandy silt, silt, and silty sand, sand has no red grains and is micaceous.

GRAY SILT (ML)
hard, moist; with some fine grained micaceous sand and occasional gravel.

INTERBEDDED GRAY SAND (SP) AND GRAY SANDY SILT (ML)
very dense, hard, wet; fine to medium grained sand.

GRAY SAND (SP)
very dense, saturated; fine to medium grained, trace silt.

Boring terminated at depth of 245 feet on 10/31/86.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-10

Midway Landfill
Kent, Washington

PLATE **B32**

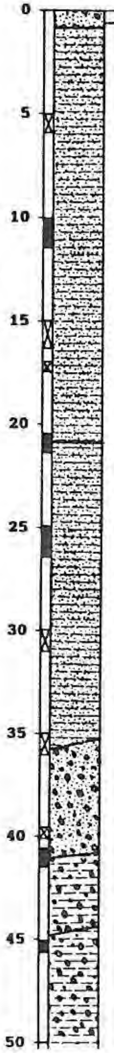
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 22-W Cable Tool

Elevation: 370 feet

Date: 1/21/87

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
22			
		0	6
70			
25/6			
		6	2
75			
		0	10
		0	1
75			
50/4			
		0	3



BLACK GRAVEL (GP)
loose, wet; 4 to 6-inch gravel surfacing.

BROWN SILTY SAND (SM)
dense, moist; with some gravel (Fill).

Becomes dark brown and medium dense at approximately 9 feet, with wood fragments.

Mottled brown and gray below approximately 18 feet.

GRAY SILTY SAND (SM)
dense, moist; with some gravel.

Interlayered sandy silt lenses between approximately 23 and 28 feet.

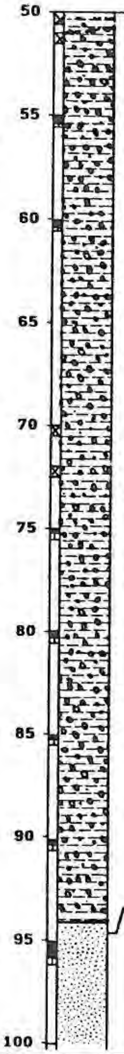
More gravel below 28 feet with occasional cobbles.

GRAY SANDY GRAVEL (GP)
dense, saturated; water bearing, sand is medium to coarse grained with some silt.

BROWN-GRAY SILTY SANDY GRAVEL (GM)
dense, moist; with trace clay.

GRAY-BROWN SANDY GRAVEL (GM) WITH INTERBEDDED THIN WELL-SORTED SANDY GRAVEL (GW) LENSES
very dense, wet to saturated; with some silt, water entering borehole.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
50/6			
		0	10
50/6			
		0	4
50/6			
		0	1
50/5			
50/5			
		0	1
50/6			
63/9			
		0	3



GRAY-BROWN SILTY SANDY GRAVEL (GM)
dense, moist; with trace clay and some cobbles, silt and sand proportions vary, sand is medium to coarse grained, angular to subrounded gravel.

Becomes mottled yellow-brown and gray at approximately 57 feet.

Becomes mottled orange and brown at approximately 83 feet.

Becomes mottled lavender and green-gray at approximately 89 feet.

Grades to blue-gray at approximately 91 feet.

PURPLE-GRAY SAND (SP)
dense, wet to saturated; with some silt and trace gravel, sand is very fine to medium grained.

Saturated at about 97 feet(?); water entering borehole.

Grades to greenish gray at about 98 feet and sand becomes well graded.

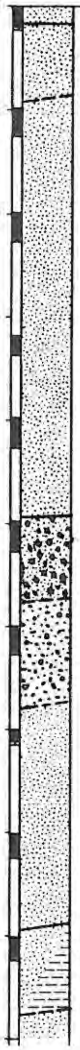
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-11 (continued)

Midway Landfill
Kent, Washington

PLATE
B33

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	
85/10				100	**YELLOW-BROWN GRAVELLY SAND (SP)** very dense, saturated; trace silt, sand is medium to coarse and water bearing.
		0	4		
34				105	**YELLOW-BROWN SAND (SP)** dense, saturated; trace gravel, sand is medium to coarse grained.
		0	4		
81/11				110	
				115	
75					
		0	0		
				120	Occasional thin silt layers.
63					
17				125	**DARK YELLOW-BROWN SANDY GRAVEL (GP)** very dense, saturated; medium to coarse grained sand with some silt.
		0	1		
80				130	**YELLOW-BROWN GRAVELLY SAND (SW)** very dense, saturated; trace silt, well graded sand.
75/9				135	**YELLOW-BROWN GRAVELLY SAND (SP)** very dense, saturated; with some silt, sand is fine to medium grained.
		0	12		
90/9				140	
80				145	**BROWN SAND WITH SANDY SILT INTERLAYERS (SP/ML)** very dense, hard, moist to wet, sand is fine grained.
				150	

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	
75				150	**BROWN GRAVELLY SAND (SP)** very dense, saturated; sand is medium to coarse grained, trace silt.
					Silt content increases below 152 ft.
		0	4	155	
83/9					**GRAY SILT (ML)** hard, moist; trace fine sand and pebbles.
75/11				160	
		0	5	165	
90/11					**INTERBEDDED GRAY SAND (SP), GRAY SILT (ML) AND GRAY CLAYEY SILT (MH)** very dense, hard, moist to wet.
85/9				170	
		0	7		
65/11				175	
88/10				180	
		0	7	185	**GRAY SAND (SP)** very dense, saturated; fine grained with trace of silt.
88					
77/10				190	
		0	0	195	
65					Trace organics noted in 196-foot sample.
				200	

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-11 (continued)

Midway Landfill
Kent, Washington

PLATE
B33

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
60				200
		0	8	205
75				210
		0	5	
38				215
100				220
75/9				225
100			6	230
50			11	235
75			9	240
34				245
				250

Becomes fine to medium grained sand.

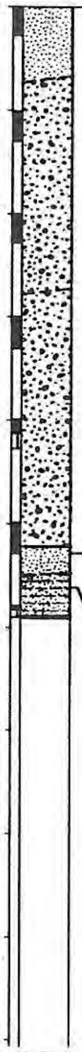
Thin layers of very fine to fine sand and silty fine sand below 217 feet.

Occasional gray silt interbeds near 240 feet.

Becomes gray-brown at approximately 243 feet.

Becomes brown with less silt below about 248 feet, sand is fine to medium grained.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
55				250
		0	6	
30				255
84/11				260
		0	14	
75/11				265
45/6				270
		0	34	
50/6				275
50/6				280
				285
				290
				295
				300



BROWN WELL-GRADED SAND (SW)
dense, saturated.

Becomes dark gray at approximately 259 feet.

DARK GRAY GRAVELLY SAND (SW)
very dense, saturated; well graded sand, trace silt in some layers.

GRAY SAND (SP)
very dense, saturated; very fine grained, with some silt.

GRAY SILTY SAND (SM)
very dense, moist to wet; with some gravel (Till).

Boring terminated at depth of 279.6 feet on 1/21/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-11

Midway Landfill
Kent, Washington

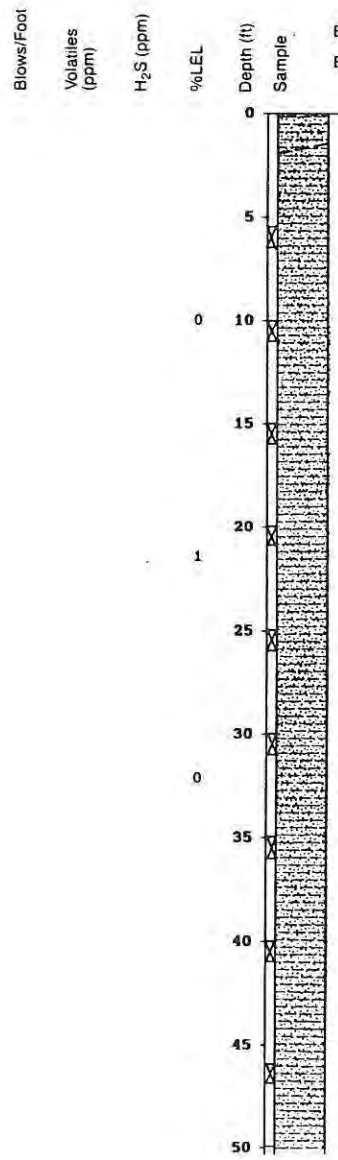
PLATE
B33

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: 71 Speed Star Cable Tool

Elevation: 375 feet

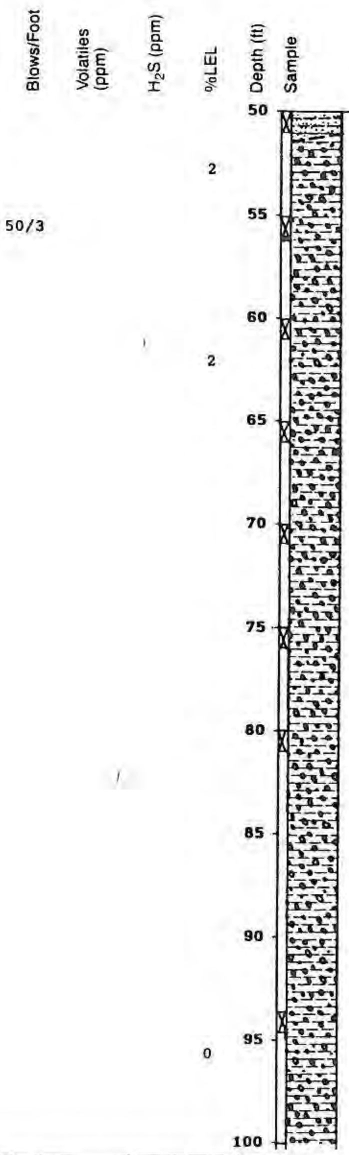
Date: 12/30/86



BROWN SILTY SAND (SM)
medium dense, moist; some fine to coarse gravel.

GRAY SILTY SAND (SM)
very dense, moist; trace to some gravel, fine to medium grained sand.

Cobbles near 45 feet.



GRAY SILTY SANDY GRAVEL (GM)
very dense, moist; fine to coarse gravel with some cobbles, silty sand and gravel proportions vary.

Less gravel near 55 feet.

More gravel below 59 feet.

Less gravel below 64 feet.

Less silt below approximately 67 ft.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

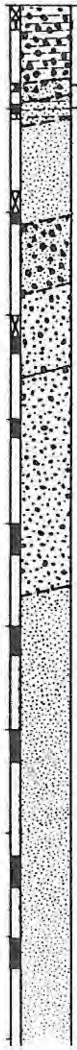
Log of Boring MW-12 (continued)

Midway Landfill
Kent, Washington

PLATE
B34

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H2S (ppm)	%LEL	Depth (ft)
				100
50/5				
			1	
50/5				105
				110
85/7				
			5	
				115
75/11				
				120
50/6			1	
				125
50/5				
				130
50/5				
		0	0	
				135
40/6				
				140
27				
		0	0	145
36/6				
				150



Less gravel below 100 feet.

GRAY SANDY GRAVEL (GP)
dense, saturated; water bearing.

GRAY-BROWN SILTY SAND (SM)
dense, wet; some gravel, non-water bearing.

YELLOW-BROWN SAND (SP)
dense, saturated; water bearing, with trace pebbles and silt, medium to coarse sand.

GRAY GRAVEL (GP)
dense, saturated; fine to medium rounded gravel with some medium sand.

BROWN GRAVELLY SAND (SW)
dense, saturated; water bearing, medium to coarse sand.

Sand fine to medium grained with trace silt near 118 feet.

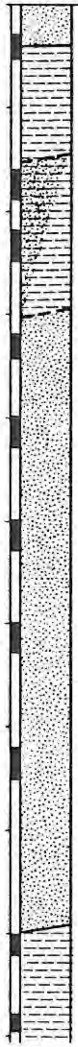
BROWN SAND (SW)
very dense, saturated; well-graded sand.

GRAY-BROWN SAND (SP)
very dense, saturated; very fine to fine grained.

Trace to abundant mica flakes below approximately 135 feet.

Becomes gray and sand is slightly coarser grained below approximately 144 feet.

Blows/Foot	Volatiles (ppm)	H2S (ppm)	%LEL	Depth (ft)
				150
75/9				
		0	0	
				155
20				
				160
75/10				
		0	0	165
70/9				
				170
37/6				
				175
22/6		0	0	
				180
40/6				
				185
15/6				
				190
				195
80/7				
75/4				
				200



GRAY SILT (ML)
hard, moist; with trace fine sand and clay.

INTERLAYERED GRAY SAND (SP) AND GRAY SILT (ML)
very dense, hard, saturated; sand layers water bearing, sand fine to medium grained, trace organic matter in silt.

GRAY SAND (SP)
very dense, saturated; water bearing, sand very fine grained with trace organics and silt.

Sand coarsens with depth: fine to medium grained at about 173 feet, medium to coarse grained at about 179 feet.

Medium grained sand with occasional wood/peat fragments from 185 to 188 feet.

Sand grades finer: very fine to fine grained with trace silt from approximately 190 to 195 feet.

GRAY SANDY SILT (ML)
hard, moist; trace pebbles and organics, sand very fine grained.

Trace very coarse sand, gravel, and wood fragments below about 198 feet.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-12 (continued)

Midway Landfill
Kent, Washington

PLATE
B34

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H$_2$S (ppm)	%LEL	Depth (ft)
				200
	0		1	
50/6				205
70/5				210
60/5				215
21		0	0	220
50/6				225
50/6		0	0	230
40/6				235
50/6				240
80				245
				250

Sample

Interbedded clayey silt near 204 ft.

Possible faint cross bedding observed in 205-foot sample.

INTERBEDDED SAND (SP) AND SILT (ML)
very dense, hard, saturated; with trace organics and layers of silty sand and sandy silt, mica flakes common.

Some mica flakes.

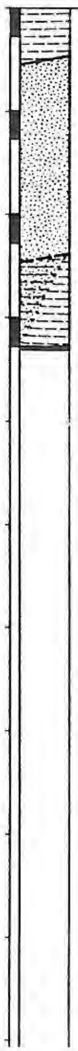
GRAY SAND (SP)
very dense, saturated; with trace silt and organics, sand very fine to fine grained, mica flakes present.

Silt content increases with depth.

GRAY SANDY SILT (ML)
very stiff to hard, wet; sand very fine grained, thin interbeds of clean fine sand, non-water bearing.

Blows/Foot	Volatiles (ppm)	H$_2$S (ppm)	%LEL	Depth (ft)
30/6				250
		0	0	
16				255
50/6				260
				265
				270
				275
				280
				285
				290
				295
				300

Sample



GRAY SAND (SP)
dense, saturated; water bearing, sand is fine to medium grained, trace 1-inch gravel and red volcanic grains.

GRAY SILTY SAND (SM) AND SANDY SILT (ML)
very dense, hard, wet.

Boring terminated at depth of approximately 266.5 feet on 12/30/86.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-12

Midway Landfill
Kent, Washington

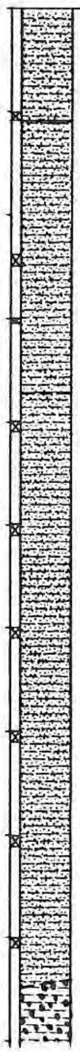
PLATE
B34

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

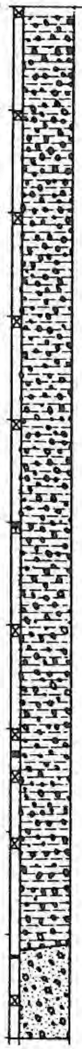
Equipment: 71 Speed Star Cable Tool

Elevation: 383 feet

Date: 10/16/86



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	
				0	
					BROWN SILTY SAND (SM) medium dense, moist; with occasional gravel, fine to medium grained sand (Fill).
				5	
					BROWN SILTY SAND (SM) dense, moist; with some gravel and trace clay, silt and gravel content varies.
		0	0		
				10	
				15	Becomes gray-brown at 15 feet.
		0	1		
				20	**GRAY-BROWN SILTY SAND (SM)** medium dense, moist; with some gravel.
					Becomes very dense at 22 feet.
				25	
					Increase in gravel and medium sand at about 28 feet.
		0	1		
				30	
				35	
		0	1		
		0	0		
		0	1		
				40	
		0	1		
					Increase in sand and gravel at about 43 feet, 2 to 3-inch gravels.
				45	
					BROWN SILTY GRAVEL (GM) very dense, moist; with some sand; silt, sand, and gravel proportions vary.
		0	1		
				50	



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	
				50	
		0	0		
		0	1		
		0	0		
				55	
		0	0		
		0	0		
		0	0		
				60	
					Brief gas odor at 61 feet.
		0	0		
					Cobbles near 62 feet.
		0	3		More sand from about 63 to 69 feet.
				65	
		0	2		
		0	2		
				70	
		0	3		
					Mottled gray-brown below approximately 73 feet.
100/7				75	
				80	
		0	1		
		0	6		
		0	3		
				85	
50/5					Becomes yellow-brown at about 86 ft.
		0	1		
				90	
					Increase in gravel at about 91 feet.
		0	0		
		0	1		
				95	
5/3					
		0	6		**YELLOW-BROWN SANDY GRAVEL (GP)** very dense, saturated; water bearing, with trace silt.
				100	

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

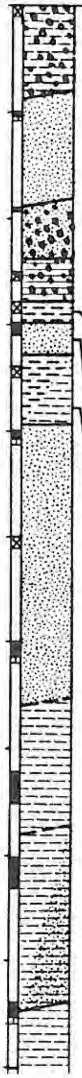
Log of Boring MW-13 (continued)

Midway Landfill
Kent, Washington

PLATE
B35

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
		0	1	100
				105
30/6		0	7	
50/3				
		0	40	
				110
		0	9	115
96/7				
		0	1	
				120
100/7		0	12	
				125
		0	7	
				130
95/6				
		0	5	
				135
32/6				
				140
15		0	4	
				145
50/6				
		0	0	
				150



ORANGE-BROWN SILTY GRAVEL (GM)
very dense, wet; with some sand.

BROWN SAND (SP)
very dense, moist; with some gravel and trace silt.

BROWN SANDY GRAVEL (GP)
very dense, saturated; water bearing.

BROWN CLAYEY GRAVEL (GC)
very dense, wet; some silt and sand.

BLUE-GRAY CLAYEY SILT (MH)
hard, moist; trace sand with thin brown silt interlayers and trace gravel.

BROWN SAND (SP)
very dense, moist; fine grained.

INTERMIXED BLUE-GRAY CLAYEY SILT AND BROWN SILT (MH/ML)
hard, wet; trace fine sand and gravel.

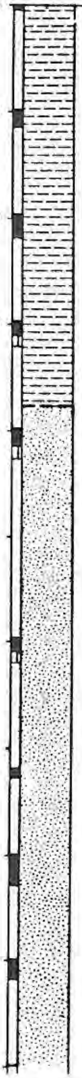
BROWN SAND (SP)
very dense, wet; very fine grained with trace silt.

BROWN SANDY SILT (ML)
hard, moist; very fine sand.

INTERLAYERED BROWN SANDY SILT (ML) AND SILTY SAND (SM)
hard, very dense, wet to saturated; fine grained sand, non-water bearing.

GRAY SILT (ML)
hard, wet; with very fine sandy zones.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				150
				155
50/6		0	0	
				160
58/7		0	0	
				165
85/8				
				170
17				
				175
				180
62/7				
				185
38/8				
				190
40				
		0	0	
				195
50/1				
				200



Wood chips (peat?) from 153 to 156 feet.

Gray clay lenses near 157 feet.

Mica flakes common below 160 feet.

Sand lens at 163 feet.
(Water entering borehole).

YELLOW-BROWN SAND (SP)
medium dense, saturated; fine to medium grained with trace silt.

Sand becomes medium to coarse grained at 179 feet.

Fine to medium grained below approximately 183 feet.

Sand becomes finer grained below about 190 feet with thin sandy silt layers.

Medium to coarse grained sand with some gravel below about 194 feet.

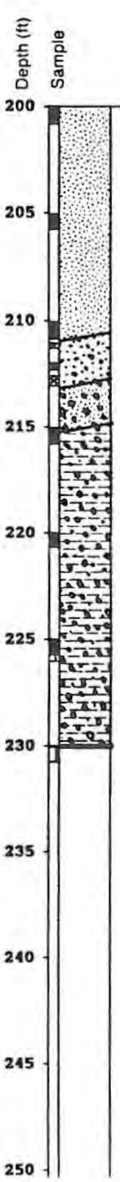
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-13 (continued)
Midway Landfill
Kent, Washington

PLATE
B35

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
50/5			
		0	0
50/2			
50/5			
		0	0
50/3			
80/9			
		0	0
80/6			
50/3			



Gravelly layer at 208 feet.

GRAY GRAVELLY SAND (SW)
very dense, saturated; well graded sand with trace silt.

GRAY SANDY GRAVEL (GP)
very dense, saturated; 1.5-inch gravels and occasional cobbles.

GRAY-BROWN SILTY SANDY GRAVEL (GM)
very dense, wet; silt, sand, and gravel proportions vary, trace clay.

Boring terminated at approximate depth of 230 feet on 10/16/86.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-13

Midway Landfill
Kent, Washington

PLATE
B35

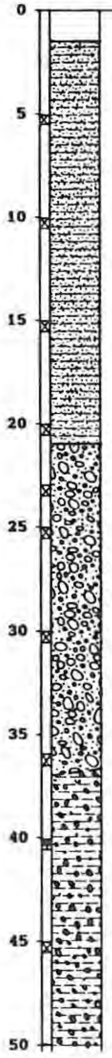
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 22-W Cable Tool

Elevation: 381 feet

Date: 3/2/87

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
		0	1
		0	7
		0	1
50/5			
		0	6



4 to 6-inch quarry spall surfacing.

BROWN SILTY SAND (SM)
medium dense, moist; with trace gravel (Fill).

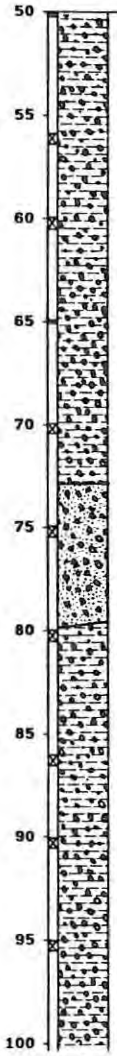
BROWN-GRAY SANDY GRAVEL (GW)
dense, moist; trace silt.

Occasional cobbles near 25 feet.

Slight seepage into borehole at approximately 30 feet.

BROWN-GRAY SILTY GRAVEL (GM)
very dense, moist; with some sand.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
50/3			
		0	8
50/1		0	50
	2.3	0	254
			293
	2.2	0	259
	0.9	0	12



Becomes mottled yellow-brown and red-brown near 50 feet.

GRAY SANDY GRAVEL (GP)
very dense, moist; with some silt, strong organic odor with steam rising from borehole, gravels to 3-inch diameter.

BROWN SILTY SANDY GRAVEL (GM)
very dense, wet.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

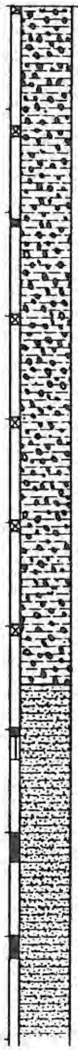
Log of Boring MW-14 (continued)

Midway Landfill
Kent, Washington

PLATE **B36**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				100
		0	65	105
50/4				110
				115
	0.4	0	41	
				120
		0	15	125
				130
21				135
		0	0	
50/7				140
70				145
		0	1	
				150

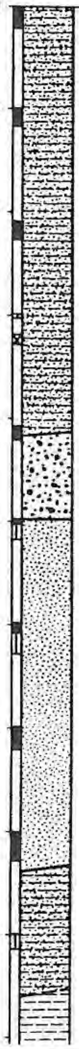


Less sand near 100 feet.

GRAY SILTY SAND (SM)
dense, moist; fine to medium sand with trace 1 to 6-inch gravel and with scattered silt pockets, color changes to brown in some zones.

Interlayered fine to medium sand lenses from approximately 144 to 153 feet.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/5				150
70				155
			250	
17			250	160
50/3				165
		0	>257	
75/10			>257	170
		0	>250	
70				175
		0	>250	
50		0	92	180
50/4			105	185
		0	>105	
32				190
		0	45	
50/4				195
		0	67	
				200



Saturated water bearing zone from approximately 157 to 166 feet.

More silt below approximately 165 feet.

BROWN SAND (SW)
very dense, moist; with trace pebbles, sand well graded fine to coarse.

6-inch silty clay layer at 174.5 ft.

BROWN SAND (SP)
very dense, moist; with trace to some gravel, sand fine to medium grained, some thin interbeds of silty very fine to medium sand

Sand becomes wet at about 179 feet.

BROWN SILTY SAND (SM)
very dense, wet; sand very fine grained.

Saturated with slight seepage into borehole below about 197 feet.

BROWN SILT (ML)
hard, moist; trace sand and clay, thinly bedded to laminated.

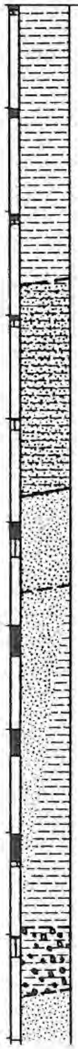
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-14 (continued)

Midway Landfill
Kent, Washington

PLATE
B36

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
75/6				200		
75/6				205		Color change to lavender at 204.5 ft.
75/6				210		
		0	85			
50/6				215		**BROWN SILTY SAND (SM)** very dense, wet; with some pebbles, sand is well graded with red andesite grains. Red-brown below about 218 feet.
75/7				220		
		0	40			
25/4				225		**LAVENDER SAND (SP)** dense, saturated; trace silt and organics, water bearing sand is fine grained.
89				230		**INTERBEDDED LAVENDER SAND (SP) AND SILT (ML)** very dense, hard, saturated; sand is very fine grained.
		0	36			
95/9				235		
25/4				240		Abundant red volcanic grains near 240 feet.
		0	28			
50/6				245		**BROWN-GRAY SILTY SANDY GRAVEL (GM)** very dense, wet to saturated; sand is fine to medium grained.
		0	83			
				250		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
				250		**GRAY AND GREENISH GRAY GRAVELLY SAND (SP)** very dense, saturated; sand is fine to medium grained with abundant red grains.
				255		
		0	14			
75/3				260		**MOTTLED GREEN-LAVENDER-GRAY SILTY SANDY GRAVEL (GM)** very dense, moist; non-water bearing.
50/3				265		
50/3				270		**GRAY SILTY SAND (SM)** very dense, moist; with some gravel.
		0	6			
50/6				275		**GRAY SANDY GRAVEL (GP)** very dense, saturated; gravel to 1 inch, sand is fine to coarse, trace silt, water bearing.
75/6		0	14	280		
50/2				285		**GRAY SAND (SP)** very dense, saturated; some subrounded to subangular gravel, with trace silt. Becomes brown-gray with more silt below 288.5 feet.
100/6				290		Increasing silt content.
		0	14			
80/10				295		**GRAY SILTY SAND (SM)** very dense, saturated; non-water bearing, with some gravel, sand is well graded medium to very coarse.
				300		

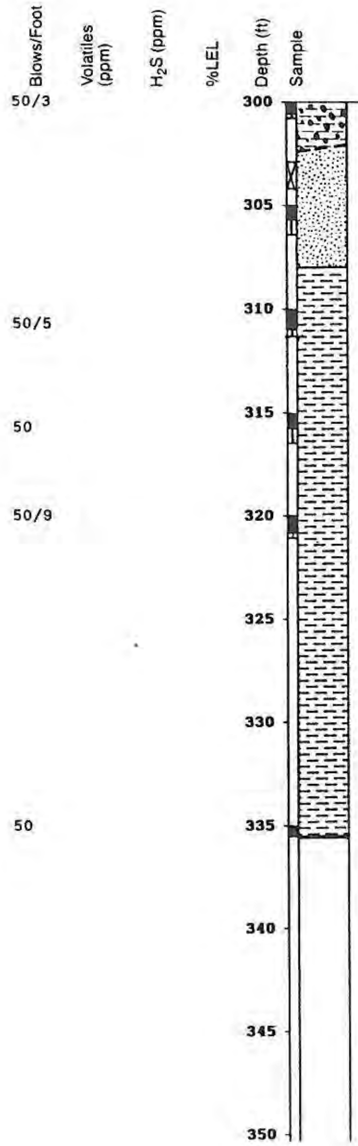
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-14 (continued)

Midway Landfill
Kent, Washington

PLATE
B36

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



GRAY SILTY GRAVEL (GM)
very dense, saturated; with sand lenses and layers, sand is water bearing with abundant red grains.

RED-GRAY TO GRAY GRAVELLY SAND (SP)
very dense, saturated; with red sand grains, trace silt, medium to coarse sand, gravels to 1 inch, occasional layers of silty sand.

GRAY CLAYEY SILT (MH)
very hard, wet; massive.

Boring terminated at depth of 335.6 feet on 3/2/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-14

Midway Landfill
Kent, Washington

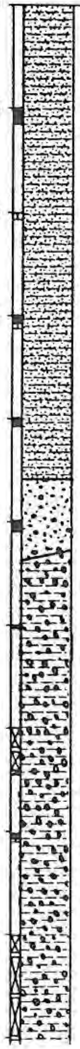
PLATE
B36

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

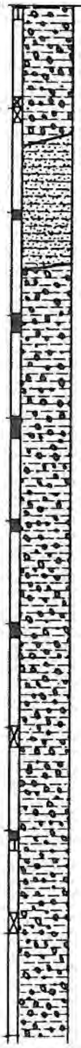
Equipment: BE 22-1 Cable Tool

Elevation: 439 feet

Date: 11/21/86



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	
				0	
					BROWN SILTY SAND (SM) medium dense, moist; with some gravel.
				5	
56/10					
			0		
50/5				10	
					Becomes very dense and gray-brown at 12 feet.
				15	
75/8			0		
50/4			0	20	
					Gravelly/cobbly zone near 20 feet.
		0	0		
					BROWN GRAVELLY SAND (SW) very dense, moist; with trace to some silt.
		0	0		
		0	0	25	
50/4					
		0	0		**BROWN SILTY SANDY GRAVEL (GM)** very dense, moist; gravel ranges up to cobble size; silt, sand and gravel proportions vary.
		0	0		
50/2		0	0	30	
		0	0		
		0	0		
				35	
					Smaller and less gravel between 36 and 39 feet.
		0	0		
				40	
50/4		0	0		
					Fine gravels near 42 feet.
		0	0		
		0	0		Less silt below 44 feet.
				45	
		0	0		
		0	0		
		0	0		
				50	



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
				50		
75/10						
			0			
			0			
				55		
		0	0			
		0	0			
						BROWN SILTY SAND (SM) very dense, moist; with trace to some gravel and lenses of brown sand.
75/7				60		
		0	0			
		0	0			
		0	0			
				65		**BROWN SILTY SANDY GRAVEL (GM)** very dense, moist; silt, sand, and gravel proportions vary widely.
75						
		0	0			
		0	0			
				70		
60						
						Sand layer at 74 to 76 feet.
				75		
75/8		0	0			
				80		
100/9		0	0			
						Cobbles near 82 feet.
						Sand lenses near 83 feet; less silt below about 83 feet.
				85		
			0			
				90		
75/11			0			
						Interlayered silty and non-silty zones near 94 feet.
				95		
		0	0			
		0	24			
				100		

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

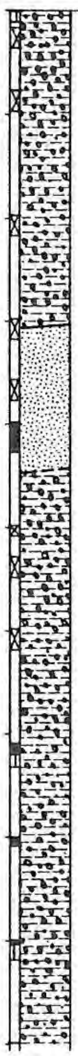
Log of Boring MW-15 (continued)

Midway Landfill
Kent, Washington

PLATE
B37

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
80/8			3	100
25/0				105
		0	6	
		0	12	
				110
				115
52		0	44	120
50/6				125
		0	32	
				130
				135
50				
50/6		0	25	140
				145
50/6				
		0	108	
		0	15	150



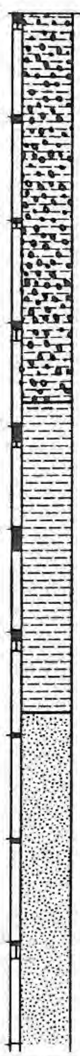
BROWN GRAVELLY SAND (SP)
very dense, wet; with trace silt, medium grained sand.

BROWN SILTY SANDY GRAVEL (GM)
very dense, moist; silt, sand, and gravel proportions vary.

Changes color to mottled green-gray and yellow-brown at about 134 feet.

Red-brown mottling with trace clay appears with other colors at about 149 feet (Weathered Horizon?).

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
80				150
		0	0	
75/6				155
		0	5	
50/5				160
		0	4	
				165
50/6				
50/4				170
		0	5	
				175
25/4				
				180
80/11				
		0	10	
50/3				185
50/3				190
		0	222	
				195
50/5				
				200



Becomes mottled gray-brown at about 154 feet, trace clay continues.

Yellow-brown mottling returns at about 163 feet.

YELLOW-BROWN SILT (ML)
hard, moist; with trace gravel and clay.

Blue-gray from 179 to 180.5 feet, mottled brown and orange-brown below 180.5 feet.

BROWN SAND (SP)
very dense, moist; fine to medium grained with trace silt, brown has yellowish cast.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-15 (continued)

Midway Landfill
Kent, Washington

PLATE **B37**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/5				200
		0	35	
		0	47	
				205
50/3				
				210
50/4				
		0	60	
				215
75				
				220
50/4				
		0	31	
				225
45/6				
				230
43/6				
				235
50/6				
		0	32	
				240
50/4				
				245
50/6				
		0	28	
				250

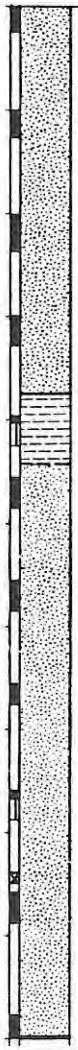
REDDISH BROWN, BROWN, BLACK, AND YELLOW SAND (SP)
very dense, moist; sand interlayered with gravelly sand, gravel has weathered appearance.

REDDISH BROWN SAND (SP)
very dense, wet; trace gravel and silt, sand is fine grained.

Saturated at about 222 feet and changes to brown.

Becomes gray-brown at about 238 ft.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				250
25/6				
				255
35/6				
		0	16	
				260
25/10				
				265
20				
		0	12	
				270
55				
50/6				
				275
40		0	6	
				280
50/6				
				285
20				
		0	9	290
32/6				
				295
50/6				
				300



BROWN SILT (ML)
hard, moist; with organics and trace clay.

PURPLE-GRAY SAND (SP)
very dense, saturated; sand is fine grained, with a trace silt, abundant red sand grains.

Some wood fragments near 283 feet (flattened pieces of branch).

Color changes to dark gray at about 291 feet, red grains still abundant.

Boring terminated at approximate depth of 300 feet on 11/21/86.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-15

Midway Landfill
Kent, Washington

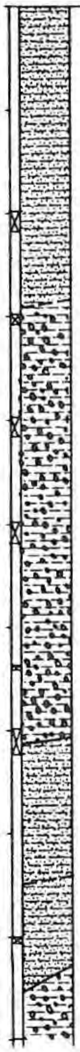
PLATE
B37

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

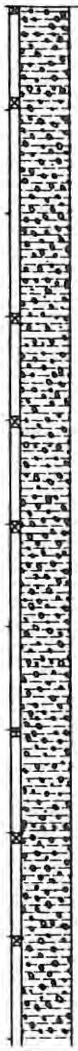
Equipment: BE 22-W Cable Tool

Elevation: 363 feet

Date: 1/26/87



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
				0	**BROWN SILTY SAND (SM)** medium dense, moist; some gravel.
				5	Dense at 5 feet.
				10	Very dense at about 10 feet.
				15	**BROWN SILTY SANDY GRAVEL (GM)** very dense, moist; silt, sand, and gravel proportions vary. ("Silt bound gravel")
			1		
				20	Gravels up to 3-inch diameter near 20 feet.
			2		
			0	25	
				30	
50/3					
			0		
				35	**BROWN SILTY SAND (SM)** very dense, saturated; water bearing, fine to medium grained (probably interbeds of fine to medium sand and silty sand).
			0		
				40	
					BROWN SILTY SAND (SM) very dense, wet; with some gravel.
				45	
					BROWN SILTY GRAVEL (GM) very dense, wet; gravel to 4-inch diameter, with trace to some sand, gravel is rounded and black.
				50	



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
				50	
				55	
			1		
					Large gravel or cobbles near 58 feet.
				60	
				65	
			1		Cobbles near 67 feet.
				70	
				75	
			8		
				80	
					More sand from 81 to 83 feet; less silt from 80 to 100 feet.
50/5			20	85	Black, green, and red gravels noted below about 83 feet.
				90	
				95	
				100	

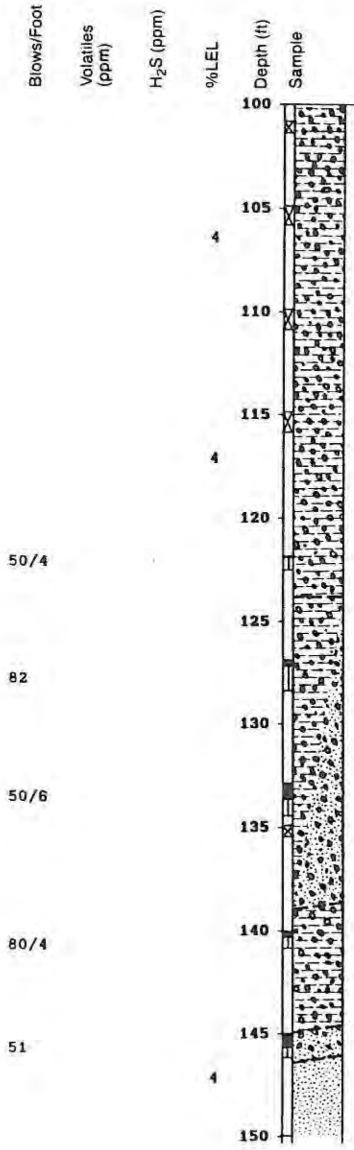
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-16 (continued)

Midway Landfill
Kent, Washington

PLATE **B38**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

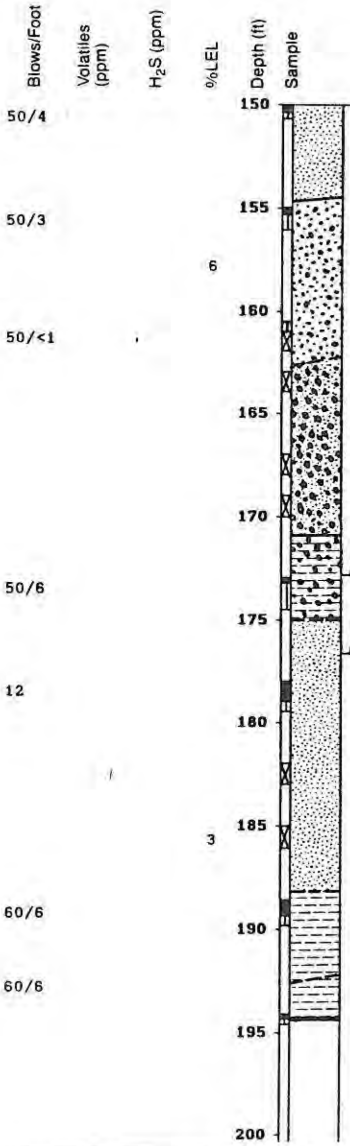


INTERLAYERED BROWN SILTY GRAVEL (GM) AND BROWN SANDY GRAVEL (GP)
very dense, saturated, water bearing, gravels to 3-inch diameter.

GRAY-BROWN SILTY GRAVEL (GM)
very dense, saturated; intermediate between water bearing and non-water bearing; black, red, and green rounded gravel, with some sand.

GRAY-BROWN SANDY GRAVEL (GP)
dense, saturated; water bearing, with silt.

DARK GRAY SAND (SP)
very dense, saturated; water bearing, medium grained with salt and pepper appearance.



With some silt between 153 and 154 feet.

DARK GRAY GRAVELLY SAND (SW)
very dense, saturated; well graded sand with trace silt, gravels range up to 1-inch diameter.

GREEN, RED, AND BLACK SANDY GRAVEL (GP)
very dense, saturated; with trace silt, gravels to 3-inch diameter.

DARK GRAY SILTY GRAVEL (GM)
very dense, saturated; non-water bearing, with some sand, gravel to 2-inch diameter.

GRAY SAND (SP)
dense, saturated; water bearing, with some gravel, fine to medium grained sand, numerous red sand grains.

No gravel below about 180 feet.

Interbedded silt layers below about 185 feet.

PURPLE-GREEN CLAYEY SILT AND PURPLE-GRAY SILT (ML)
hard, moist; with very thin (<1/4-inch) interbeds of fine gray sand with red grains.

GRAY SANDY SILT (ML)
hard, moist; very fine grained sand, massive.

Boring terminated at approximate depth of 194.3 feet on 1/26/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-16

Midway Landfill
Kent, Washington

PLATE
B38

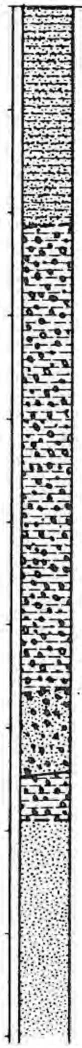
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: 71 Speed Star Cable Tool

Elevation: 337 feet

Date: 11/28/86

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
				0		**BROWN SILTY SAND (SM)** medium dense, moist; with some 1 to 3-inch gravel, occasional cobble, sand is fine grained.
				5		Grades to gray-brown and becomes very dense at about 3 feet.
				10		
				15		
				20		
				25		**INTERBEDDED GRAY-BROWN FINE SAND AND SILT (SP/ML)** very dense, hard, moist. **GRAY-BROWN SILTY SAND (SM)** very dense, moist to wet; with some gravel.
				30		Noted organic/refuse odor (gas) at 30 feet.
				35		
				40		Organic/refuse odor (gas) at approximately 42 feet.
				45		
				50		



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
				50		
				55		More gravel with cobbles below 57 ft.
				60		**MOTTLED YELLOW AND RED-BROWN SILTY GRAVEL (GM)** very dense, moist; with some sand and trace clay (Weathered Gravel)
				65		
				70		
				75		Mottled color includes blue-green near 75 feet.
				80		
				85		**GRAY AND BLACK SANDY GRAVEL (GP)** very dense, saturated; well graded sand, trace silt, water bearing.
				90		**BROWN SILTY GRAVEL (GM)** very dense, wet; with some sand, non-water bearing **YELLOW-BROWN SAND (SP)** very dense, saturated; water bearing, fine to medium grained sand, with trace gravel.
				95		
				100		

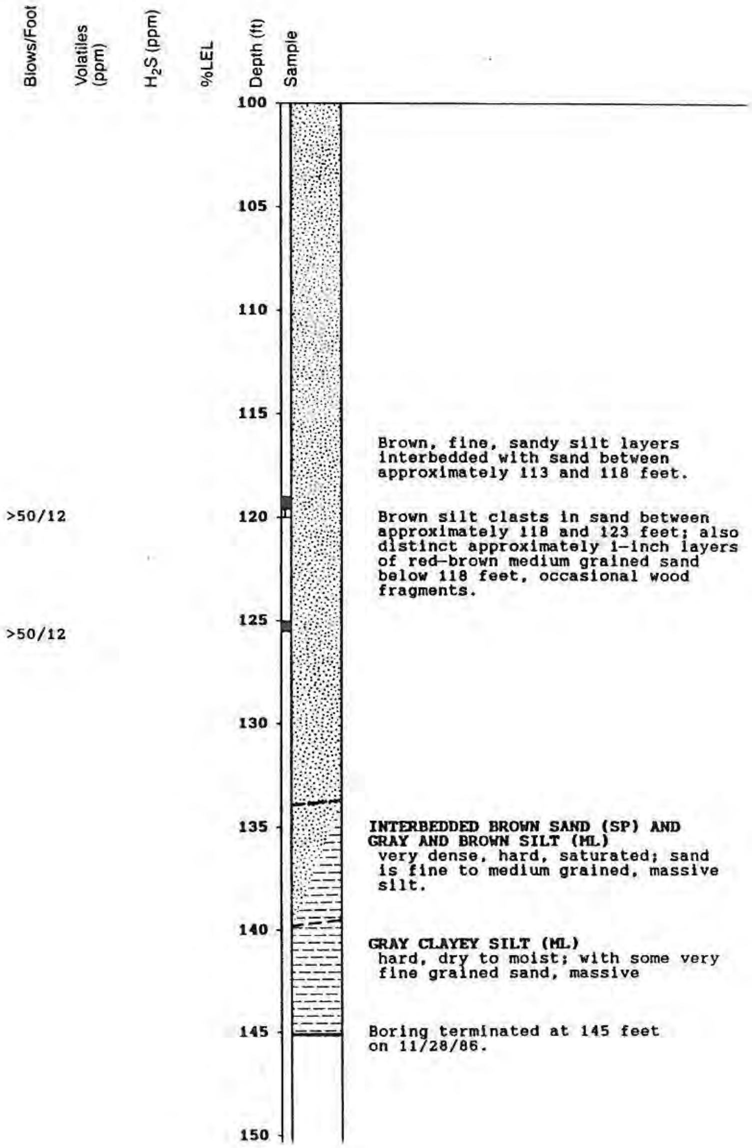
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-17 (continued)

Midway Landfill
Kent, Washington

PLATE
B39

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



Brown, fine, sandy silt layers interbedded with sand between approximately 113 and 118 feet.

Brown silt clasts in sand between approximately 118 and 123 feet; also distinct approximately 1-inch layers of red-brown medium grained sand below 118 feet, occasional wood fragments.

INTERBEDDED BROWN SAND (SP) AND GRAY AND BROWN SILT (ML)
very dense, hard, saturated; sand is fine to medium grained, massive silt.

GRAY CLAYEY SILT (ML)
hard, dry to moist; with some very fine grained sand, massive

Boring terminated at 145 feet on 11/28/86.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-17

Midway Landfill
Kent, Washington

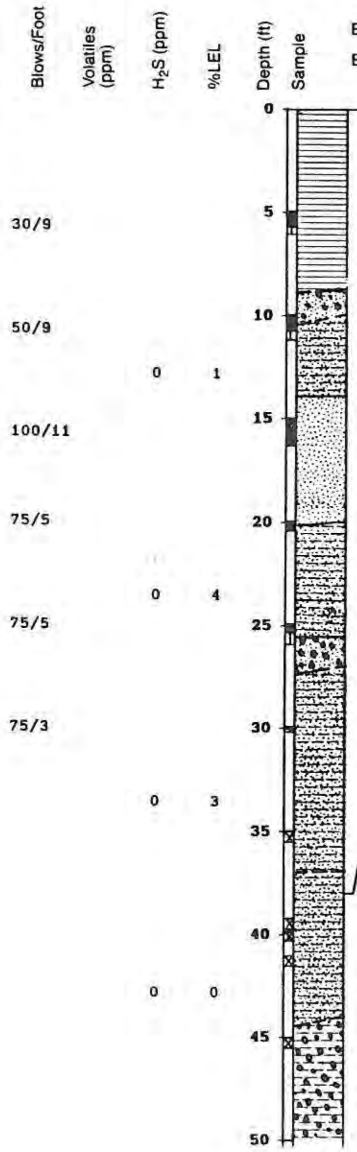
PLATE
B39

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 22-W Cable Tool

Elevation: 343 feet

Date: 3/17/87



MOTTLED GRAY AND GREEN-GRAY CLAY (CL) MIXED WITH BROWN SILTY SAND (SM)
medium dense, wet; with some gravel. (Fill)

BLACK SANDY GRAVEL (GP)
medium dense, moist; trace concrete fragments, oily.

MOTTLED GRAY AND BROWN SILTY SAND(SM)
medium dense, moist; with some gravel and trace wood fragments. (Fill)

BROWN SAND (SP)
very dense, moist; with some gravel, fine to medium grained sand.

MOTTLED BROWN, YELLOW-BROWN, AND GRAY SILTY SAND (SM)
very dense, moist; with some fine gravel, well graded sand.

MOTTLED BROWN AND ORANGE SANDY GRAVEL (GP)
very dense, moist; with trace silt, sand is fine to medium grained.

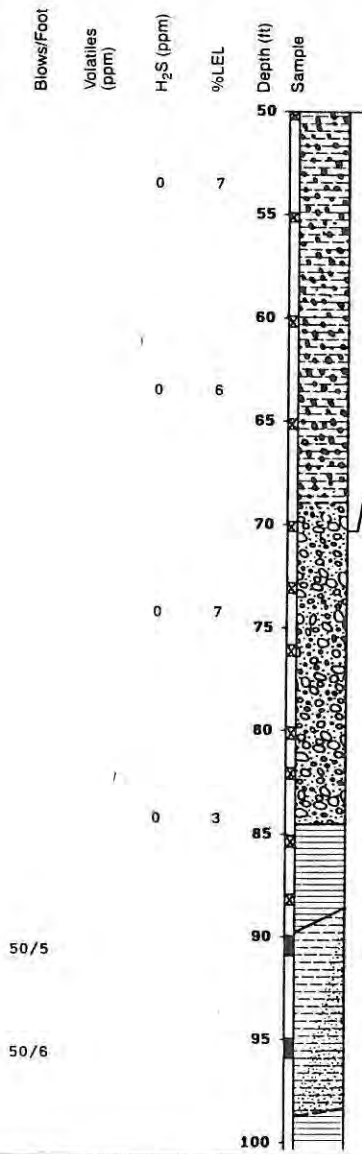
MOTTLED YELLOW-BROWN SILTY GRAVELLY SAND (SM)
very dense, moist; sand is fine to medium grained.

Becomes brown-gray at about 33 feet.

GRAY SILTY SAND (SM)
very dense, moist; sand is fine to medium grained with some gravel to 3-inch diameter.

Slight groundwater seepage (?) at 44 feet.

GRAY-BROWN SILTY GRAVEL (GM)
very dense, moist; with some sand, gravels to 3-inch diameter recovered during drilling, silt and gravel proportions vary.



BLACK-GRAY GRAVEL (GW)
very dense, saturated; water bearing, with some sand and trace silt, gravels to 4-inch diameter recovered in bailer.

More silt 80 to 82 feet.

GRAY SILTY CLAY (CL)
hard, wet; with trace sand and occasional granule to pebble size gravel. Irregular white ash (?) bands locally abundant.

Becomes blue gray at about 87 feet.

BLUE GRAY SILT (ML) AND SILTY SAND (SM)
hard, moist; trace fine gravel, very fine grained sand; finely bedded, non-horizontal.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-18 (continued)

Midway Landfill
Kent, Washington

PLATE
B40

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
				100	
50/5					
50/5				105	
		0	1		
50/4				110	
50/4				115	
25/6				120	
50/3		0	2	125	
50/4				130	
50/3				135	
50/5				140	
35/6				145	
		1	8		
				150	

INTERBEDDED GRAY, GREEN-GRAY, AND BROWN-GRAY CLAY (CL) AND CLAYEY SILT (ML)
hard, dry; laminated bedding inclined 20 to 30 degrees, some slickensided fractures.

YELLOW-BROWN SAND (SP)
dense, saturated; water bearing, sand is fine to medium grained, trace coarse sand.

Thin layer of gray silty sand at 131 feet.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
50/5				150	
75/7		0	2	155	
65/6				160	
				165	
		0	1		
16				170	
90/8				175	
		0	18		
50/5				180	
75/6		0	14	185	
75/5				190	
50/6				195	
		0	4		
				200	

INTERLAYERED YELLOW-BROWN SILTY SAND (SM) AND SAND (SP)
very dense, saturated; sand is medium grained.

BROWN-GRAY SILTY SANDY GRAVEL (GM)
very dense, saturated; gravels to 2-inch diameter.

GRAY SAND (SP)
very dense, saturated; trace silt, sand fine to medium grained.

Sand becomes brown and medium to coarse grained with trace gravel at about 174 feet.

Sand becomes fine to medium grained with trace gravel and coarse sand below about 178 feet.

Silty sand layers between 182 and 185 feet.

Grades to gray at about 193 feet.

INTERLAYERED BROWN GRAVELLY SILT (ML) AND BROWN SILTY WELL GRADED SAND (SM)
hard, dense, saturated; gravels to 2-inch diameter.

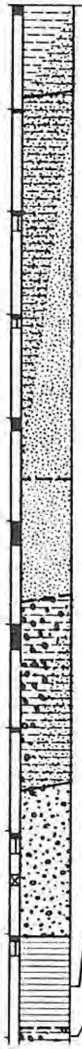
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-18 (continued)
Midway Landfill
Kent, Washington

PLATE
B40

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
				200	
75/6					
50/3				205	
		0	0		
100/11				210	
110/9				215	
50/3				220	
		0	2		
93/9				225	
100				230	
		0	2		
75/3				235	
				240	
70/5					
		0	6		
				245	
75/6					
		0	3	250	



INTERBEDDED BROWN SILTY SAND (SM) AND BROWN SAND (SP)
very dense, saturated; fine to medium grained sand.

GREEN-GRAY SAND (SP)
very dense, saturated; sand is fine to medium grained with occasional silt layers.

GREEN-GRAY GRAVELLY SILT AND SILTY GRAVELLY SAND (GM/SM)
Very hard, very dense, moist to saturated.

GREEN-GRAY GRAVELLY SAND (SW)
very dense, saturated; with trace to some silt.

GRAY CLAY (CL)
very hard, dry; with trace gravel.

GRAY SILTY SANDY GRAVEL (GM)
very dense, moist

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
				250	
75/4 100/7					
				255	
100/9					
75/5				260	
				265	
50/2					
75/6				270	
			0		
				275	
125/10					
			18		
				280	
				285	
			6	290	
				295	
75/6					
				300	

LAVENDER SILTY SAND (SM)
very dense, moist; with some gravel to 2-inch diameter.

INTERBEDDED GRAY SILT (ML) AND FINE SANDY SILT (ML)
hard, wet; with some plant fragments, possible ash layers.

GRAY SILTY GRAVEL (GM)
very dense, wet; with some sand and lenses of peat or highly organic silt. Gray, white, red, green, and brown gravel to 2-inch diameter.

GRAY SANDY GRAVEL (GP)
very dense, saturated; water bearing, with some silt; red, gray, and green gravels to 2-inch diameter, fine to coarse sand.

Less silt below 277 feet.

Large subrounded gravel to 4-inch diameter at 280 feet.

Sand content increases and gravel content and size decrease below 283 feet.

PURPLE-GRAY CLAYEY SILT (ML)
hard, dry; with wood fragments.

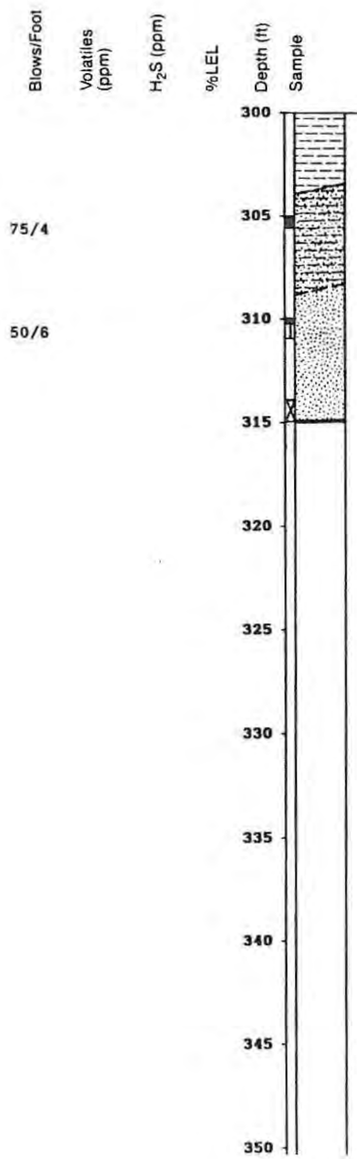
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-18 (continued)

Midway Landfill
Kent, Washington

PLATE
B40

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



GRAY SILTY SAND (SM)
very dense, moist; sand is very fine grained.

GRAY SAND (SP)
Very dense, moist to wet; trace silt, sand fine to medium grained.

Boring terminated at approximate depth of 315 feet on 3/17/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

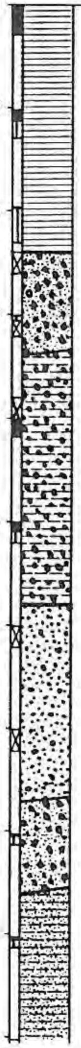
Log of Boring MW-18

Midway Landfill
Kent, Washington

PLATE
B40

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/6			1	100
36			0	105
53				110
50/3				115
			1	
50/4				120
81				125
			3	
50/5				130
50/3				135
			2	
50/6				140
50/6				145
			0	
				150



More gravel at 103 feet.

Piece of copper in sample from 105 feet.

GRAY-BROWN SANDY GRAVEL (GP)
dense, saturated; water bearing, with a trace to some silt.

GRAY-BROWN SILTY GRAVEL (GM)
very dense, saturated; non-water bearing, with some sand.

Trace sand below 125 feet.

GRAY-BROWN GRAVELLY SAND (SW)
very dense, wet; with some silt, well graded sand, fine gravel.

GRAY GRAVEL (GP)
very dense, saturated; with some silt and trace sand.

GRAY SILTY SAND (SM)
very dense, wet; with some gravel.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
91/10				150
50/6				155
			1	
50/6				160
50/3				165
50/1			64	170
50/4				175
			36	
50/5				180
				185
			4	
50/4				190
50/3				195
			14	
				200

GRAY SAND (SP)
very dense, moist to wet; with trace gravel and silt, fine grained, with thin interbeds of silt and silty sand.

INTERBEDDED GRAY SANDY GRAVEL (
AND SAND (SP)
very dense, saturated; water b
with some silt, fine gravel.

GRAY SAND (SP)
very dense, saturated; yields very slowly to borehole, with trace to some silt.

MW-19

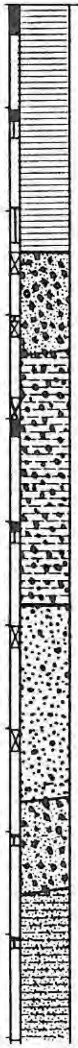
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-19 (continued)

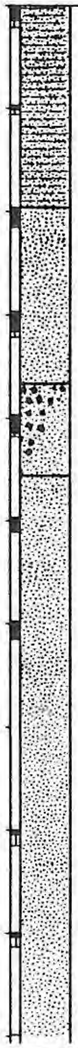
Midway Landfill
Kent, Washington

PLATE
B41

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
50/6			1	100	
					More gravel at 103 feet.
36			0	105	Piece of copper in sample from 105 feet.
53				110	
					GRAY-BROWN SANDY GRAVEL (GP) dense, saturated; water bearing, with a trace to some silt.
50/3				115	
			1		
					GRAY-BROWN SILTY GRAVEL (GM) very dense, saturated; non-water bearing, with some sand.
50/4				120	
81				125	Trace sand below 125 feet.
			3		
50/5				130	**GRAY-BROWN GRAVELLY SAND (SW)** very dense, wet; with some silt, well graded sand, fine gravel.
50/3				135	
			2		
50/6				140	**GRAY GRAVEL (GP)** very dense, saturated; with some silt and trace sand.
					GRAY SILTY SAND (SM) very dense, wet; with some gravel.
50/6				145	
			0		
				150	



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
91/10				150	
50/6				155	
			1		
50/6				160	**GRAY SAND (SP)** very dense, moist to wet; with trace gravel and silt, fine grained, with thin interbeds of silt and silty sand.
50/3				165	
					INTERBEDDED GRAY SANDY GRAVEL (GP) AND SAND (SP) very dense, saturated; water bearing, with some silt, fine gravel.
50/1			64	170	
					GRAY SAND (SP) very dense, saturated; yields water very slowly to borehole, with a trace to some silt.
50/4				175	
			36		
50/5				180	
				185	
			4		
50/4				190	
50/3				195	
			14		
				200	

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

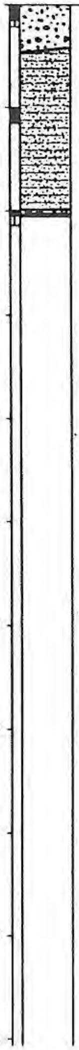
Log of Boring MW-19 (continued)

Midway Landfill
Kent, Washington

PLATE
B41

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
96/9			2	300
50/5				305
50/3				310
				315
				320
				325
				330
				335
				340
				345
				350



GRAY SILTY SAND (SM)
very dense, saturated; with some gravel.

GRAY SILTY GRAVEL (GM)
very dense, wet; with some sand.

Boring terminated at approximate depth of 310.3 feet on 3/5/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-19

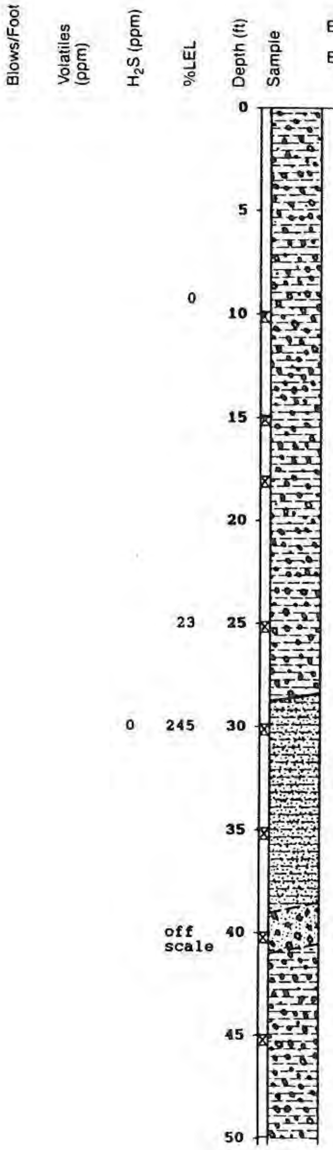
Midway Landfill
Kent, Washington

PLATE **B41**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 60, 22-W Cable Tool

Elevation: 374 feet Date: 5/29/87



Depth (ft)	Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
9				0
25				23
30			0	245
40				off scale

BROWN SILTY SANDY GRAVEL (GM)
dense, moist; (gravels and cobbles in a silty sand matrix), sand is very fine to fine-grained, boulders to 2.5 feet in diameter, sand is layered (1 to 3 mm thick beds) with weak imbrication of cobbles.

Becomes very dense at about 5 feet.

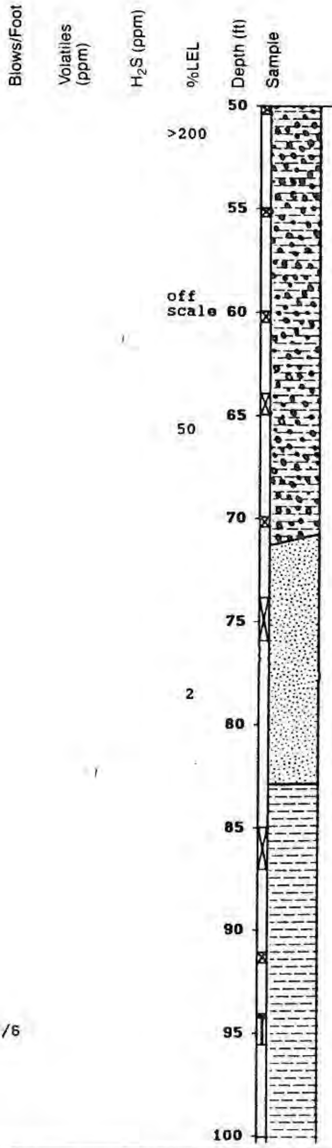
BROWN-GRAY SILTY SAND (SM)
very dense, moist to wet; with some gravels to 3 inches, less silt than in overlying gravels, well graded sand.

GRAY-BROWN GRAVELLY SAND (SW)
very dense, moist to wet; with some silt, well-graded sand and gravel with cobbles to 6-inch diameter.

GRAY-BROWN SILTY SANDY GRAVEL (GM)
very dense, wet; silt, sand, and gravel size and proportions vary. Cobbles present ranging up to 6-inch diameter.

Orange brown staining near 45 feet.

More gravel near 50 feet.



Depth (ft)	Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
51				>200
59–60				off scale
66				50
78				2
95	18/6			

Silt increases near 59 feet.

Less silt, more gravel below 64 feet.

GRAY GRAVELLY SAND (SP)
very dense, wet; medium sand, fine rounded gravels less than 2-inch diameter, occasional cobbles.

LIGHT BROWN SANDY SILT (ML)
very hard, moist; very fine sand, occasional mica flakes, orange-brown oxidized layers.

Trace rounded black gravels to 1-inch diameter and less sand below about 98 feet.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

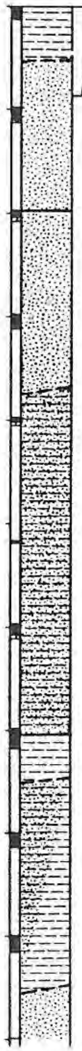
Log of Boring MW-20 (continued)

Midway Landfill
Kent, Washington

PLATE **B42**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				100
50/4				105
50/1			37	110
50/3				115
60/5			2	120
50/2				125
50/1				130
50/5		0	off scale	135
50/3				140
50/4				145
				150



LIGHT BROWN TO BROWN SAND (SP)
very dense, moist; very fine grained with trace silt.

BROWN SAND (SP)
very dense, moist; medium grained sand with some silt and 1/4-inch pebbles.

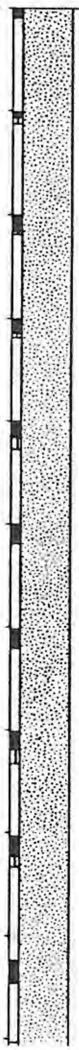
Less silty and more gravel from 113 to 115 feet.

GRAY-BROWN SILTY SAND (SM)
very dense, moist; with some gravel to 1-inch diameter, sand fine to medium grained, some layers of clean sand.

BROWN SILT (ML)
hard, dry; massive, with trace organic matter.

INTERLAYERED BROWN SILTY SAND (SM) AND FINE SANDY SILT (ML)
very dense, very hard, moist; very fine grained sand with yellow-brown oxidized layers.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/6			off scale	150
100/8		0	off scale	155
100/5				160
50/5			85	165
80/11				170
70/7				175
50/5			100	180
31			130	185
84				190
94			106	195
				200



BROWN SAND (SP)
very dense, wet; fine to medium grained with trace silt.

Saturated below about 160 feet.

Abundant mica flakes and trace of black organic matter near 175 feet.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

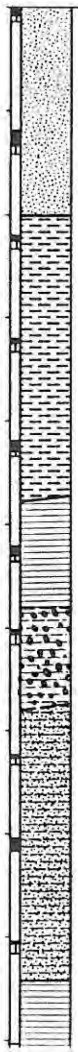
Log of Boring MW-20 (continued)

Midway Landfill
Kent, Washington

PLATE **B42**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/5				200
				205
50/3				
				210
50/3				
				215
50/2				
				220
50/3				
50/3				225
50/3				230
			2	235
100/6				
100/7				240
100/7				245
				250



Silt layers interbedded with sand below about 204 feet. Black organic silt concretions in 206-foot sample.

LAVENDER CLAYEY SILT (MH)
very stiff, moist; with trace sand and organic matter, also white ash spots and layers.

Interlayered gray-green and lavender below about 214 feet.

DARK GREENISH GRAY SANDY CLAY (CL)
very hard, wet; with some gravel (1/8 to 1 inch) and sand pockets, clay is laminated.

BROWN AND GRAY SILTY SANDY GRAVEL (GM)
very dense, moist; gravels 1/8 to 1/2-inch diameter, medium to coarse grained sand.

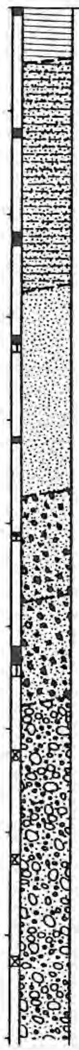
GREENISH GRAY SILTY SAND (SM)
very dense, moist; with some gravel (1/8 to 1-inch diameter), fine to medium grained sand with trace mica flakes.

Becomes gray with trace to no gravel below about 238 feet.

Sand is medium coarse to coarse grained, and there are some gravels to 1-inch diameter below 243 feet.

Saturated, water bearing, 245 to 247 feet.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
100/7				250
			2	255
100/6				
				260
50/3				
				265
50/4				
50/4				270
50/5				275
			2	
				280
37/6				
				285
				290
				295
				300



GRAY SILTY CLAY (CL)
very hard, wet; with trace gravel.

DARK GRAY SILTY SAND (SM)
very dense, wet; with some gravel to 1-inch diameter, sand very fine grained.

DARK GRAY SAND (SP)
very dense, wet; with a trace of organics and silt, fine to medium grained sand.

DARK GRAY SANDY GRAVEL (GP)
very dense, wet; sand is medium grained, 1/4 to 1-inch diameter gravel consisting of metamorphic rock, with trace to some silt.

GRAY SANDY GRAVEL (GP)
very dense, saturated; water bearing, well graded sand, gravels to 1-inch diameter.

DARK GRAY SANDY GRAVEL (GW)
very dense, saturated; well graded sand and gravel to 3-inch diameter, well rounded gravel.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

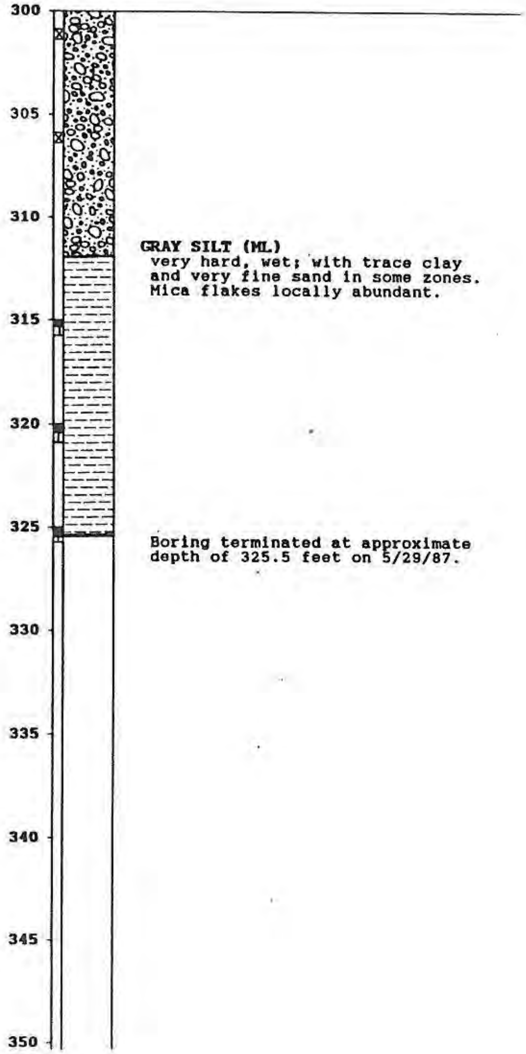
Log of Boring MW-20 (continued)

Midway Landfill
Kent, Washington

PLATE
B42

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
				300	
				305	
				310	
50/3				315	
50/5				320	
50/6				325	
				330	
				335	
				340	
				345	
				350	



GRAY SILT (ML)
very hard, wet; with trace clay and very fine sand in some zones. Mica flakes locally abundant.

Boring terminated at approximate depth of 325.5 feet on 5/29/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-20

Midway Landfill
Kent, Washington

PLATE
B42

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 60, 22-W Cable Tool

Elevation: 377 feet

Date: 4/21/87

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
				0		**DARK BROWN SILTY SAND (SM)** medium dense, moist; with trace gravel and organics.
				5		**BROWN-BLACK SANDY GRAVEL (GP)** dense, moist; trace silt
						GRAY-BROWN SILTY GRAVEL (GM) dense, moist; with some sand.
				10		
				15		
			0			
				20		**BLACK-BROWN SANDY GRAVEL (GP)** very dense, moist; fine to coarse, subangular to subrounded gravel. Trace silt at 23 to 27 feet. Cobbles at 23 feet.
				25		
				30		Cobbles at 30 feet.
			1			**BLACK-GRAY SILTY GRAVEL (GM)** very dense, moist; with some fine sand, medium to coarse gravel.
				35		
				40		
			75			**BLACK-BROWN GRAY SANDY GRAVEL (GW)** dense, moist; fine to coarse subrounded gravel with trace silt, medium to coarse sand.
				45		
						Less sand, more gravel, cobbles to 7-inch diameter from 47 to 53 feet.
				50		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample	
				50		
			15			
				55		Less sand from 55 to 60 feet.
				60		
			42			
				65		
						BROWN-GRAY GRAVEL (GP) dense, wet; fine to coarse subrounded gravel, proportions vary, with trace to some medium sand.
			52	70		
				75		
						Saturated, water bearing below about 75 feet. Sandy zone 76 to 80 feet.
				80		
			12			More sand below 82 feet. Silty zone from 84 to 86 feet.
				85		
			4			**BROWN-GRAY SANDY GRAVEL (GW)** dense, saturated; fine to medium subrounded to rounded gravel, medium sand.
				90		
				95		
			13			**BLACK-GRAY SILTY GRAVEL (GM)** very dense, saturated; with some fine to coarse sand.
				100		

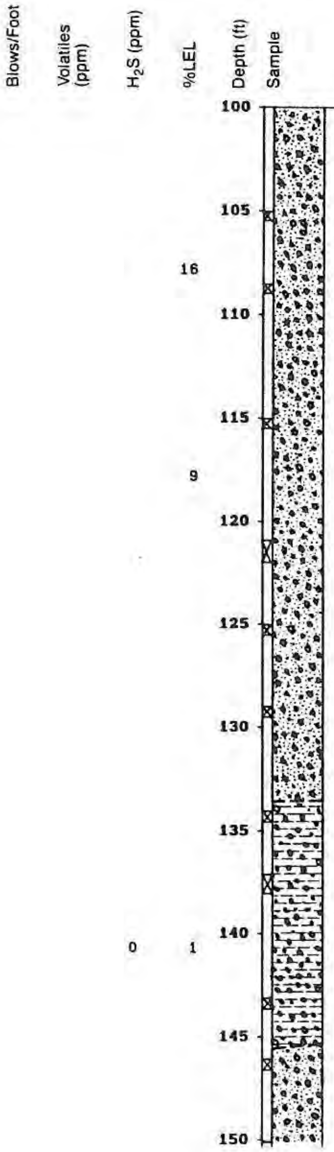
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-21 (continued)

Midway Landfill
Kent, Washington

PLATE **B43**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



BROWN-GRAY SANDY GRAVEL (GP)
dense, saturated; fine to coarse, subrounded to rounded gravel, proportions vary, medium to coarse sand.

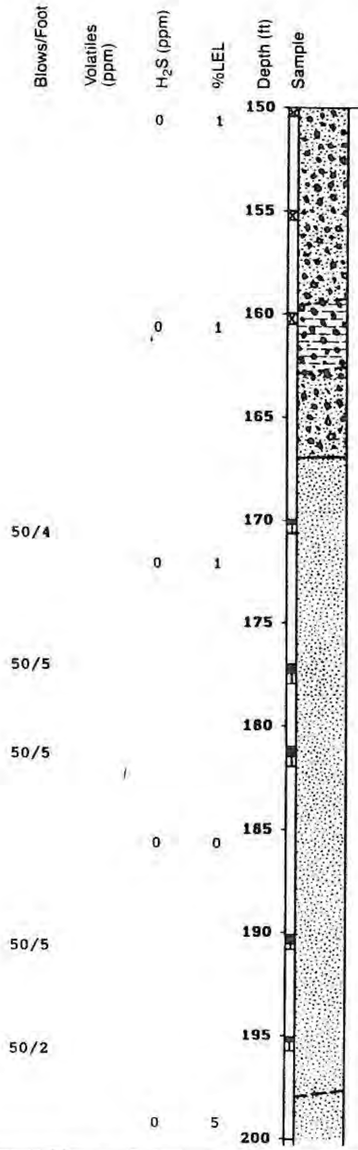
Cobbles to 8-inch diameter at 107 to 108 feet.

Trace silt and some cobbles at 116 feet.

GRAY-BLACK SILTY GRAVEL (GM)
very dense, saturated; yields much less water than overlying gravels, fine to coarse subrounded gravel with some sand and occasional cobbles.

GRAY-BLACK GRAVEL (GP)
very dense, saturated; medium to coarse gravel with trace sand, cobbles, and silt.

Sand content increases slightly below 149 feet.



Large cobbles at 159 feet.

BROWN-GRAY SILTY GRAVEL (GM)
very dense, moist; fine to coarse subrounded gravel with some sand, non-water bearing.

GRAY-BLACK GRAVEL (GP)
very dense, saturated; with some sand, trace silt.

GRAY-GREEN SAND (SP)
very dense, saturated; sand is fine grained.

Sand is very fine to fine grained with trace silt below 180 feet.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

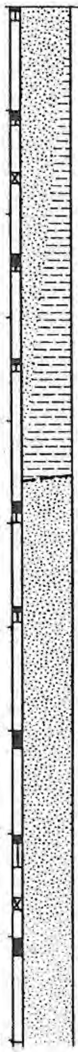
Log of Boring MW-21 (continued)

Midway Landfill
Kent, Washington

PLATE
B43

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/2				200
50/3				205
		0	3	210
50/4				
				215
50/2				
		0	4	
				220
50/5				225
50/4				230
50/4				235
		0	7	
				240
45/6				
50/5				245
		0	1	
				250



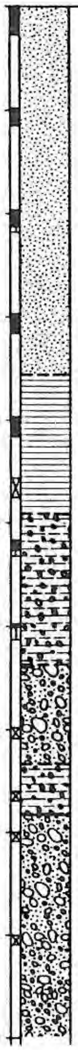
INTERLAYERED GRAY MEDIUM SAND (SP), SILTY FINE SAND (SM) AND GRAY SILT (ML)
sand is very dense, silt is very hard, saturated; trace of organic matter in silt.

GRAY SAND (SP)
very dense, saturated; grain size varies from very fine to coarse grained, fine to medium predominate.

Coarse grained with pebbles and wood fragments near 235 feet.

Silty zone from 245 to 248 feet.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
30/6				250
50/6				255
		0	1	
50/2				260
			1	265
60/5				
125/13				270
				275
75/3				
75/4				280
				285
		0	0	
				290
				295
		0	8	
				300



Sand becomes very fine grained with trace of silt at 266 feet.

GRAY SILTY CLAY (CL)
very hard, wet; with some fine gravel and trace sand, with occasional fine silty sand layers, trace organics (wood fragments).

GRAY SILTY SANDY GRAVEL (GM)
dense, wet; fine to medium gravel.

BLACK-GRAY GRAVEL (GW)
very dense, saturated; water bearing, some fine to medium sand, fine to coarse subrounded gravel.

GRAY SILTY GRAVEL (GM)
very dense, moist to wet; some sand.

BLACK-GRAY GRAVEL (GW)
very dense, saturated; with some sand, gravel fine to coarse subrounded to subangular.

Layers of silty gravel and increasing sand content below 294 feet.

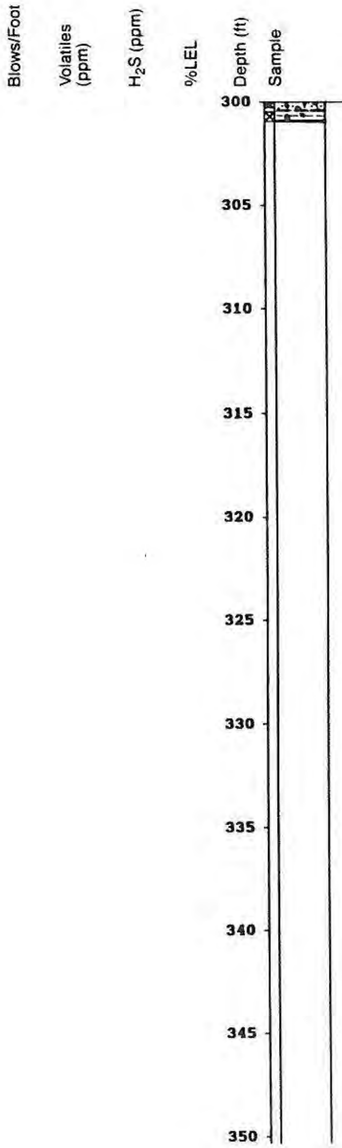
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-21 (continued)

Midway Landfill
Kent, Washington

PLATE
B43

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14.169.102	PS/TG		15 October 87		



Boring terminated at approximate depth of 301 feet on 5/12/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-21

Midway Landfill
Kent, Washington

PLATE
B43

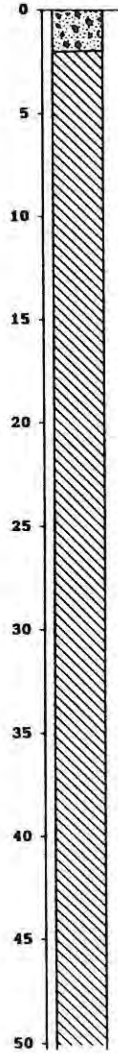
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 60, 22-W Cable Tool

Elevation: 359 feet

Date: 5/12/87

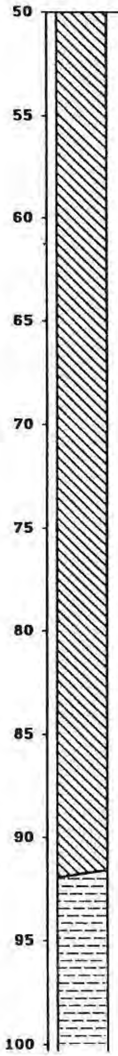
Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample



Gravelly sand fill pad.

LANDFILL REFUSE.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
			250		
			>100		



Landfill refuse contains silty and clayey soil below 84 feet.

BROWN, GRAY, AND GREEN CLAYEY SILT (ML)
soft, wet; massive, with trace to some wood and landfill debris.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

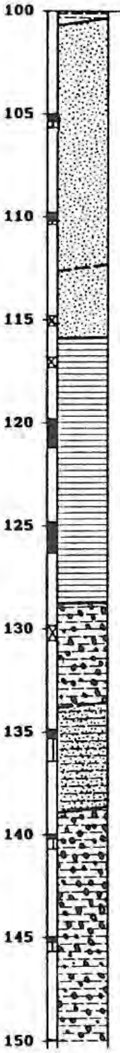
Log of Boring MW-22 (continued)

Midway Landfill
Kent, Washington

PLATE
B44

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				100
50/6				105
50/6		0	3	110
				115
40				120
40				125
				130
40				135
		0	7	
50/3				140
50/3				145
		0	6	
				150



DARK GRAY SAND (SP)
very dense, saturated; water bearing, fine to medium grained with some gravel, trace organic matter.

BROWN-GRAY GRAVELLY SAND (SP) WITH SOME INTERLAYERED SILTY SANDY GRAVEL (GM)
very dense, saturated.

BLUE-GRAY SANDY CLAY (CL)
stiff, moist; with some gravel and trace silt.

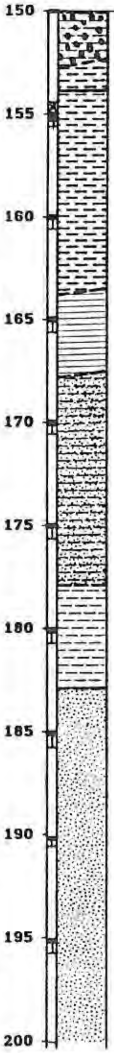
GRAY SILTY GRAVEL (GM)
dense, moist; with some sand and trace clay.

GRAY SILTY SAND (SM)
dense, wet to saturated; with some gravel, sand is fine to medium grained.

GRAY-GREEN SILTY GRAVEL (GM)
very dense, wet; with some fine to medium grained sand, thin zones of water bearing gravel.

More gravel near 143 feet.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
75/3				150
50/4				155
50/3				160
		0	>300	
50/3				165
50/3				170
50/3				175
		0	8	
50/4				180
50/3				185
		0	9	
65/5				190
50/3				195
		0	5	
				200



Mottled yellow-brown, lavender, and greenish gray below about 148 feet.

YELLOW-BROWN CLAYEY SILT (MH)
stiff, moist; with some gravel, trace sand and clay.

GRAY CLAYEY SILT (MH)
hard, moist; trace fine gravel.

BLUE-GRAY CLAY (CL)
hard, moist; trace gravel.

GRAY SILTY SAND (SM)
very dense, wet to saturated; very fine grained sand.

GRAY SILT (ML)
hard, moist; with trace fine sand.

GRAY SAND (SP)
very dense, saturated; ranges from fine to very fine grained sand, trace to some silt, finer grained zones tend to have more silt.

Grades finer grained with some silt below about 192 feet.

Changes to yellow-brown at about 196 feet.

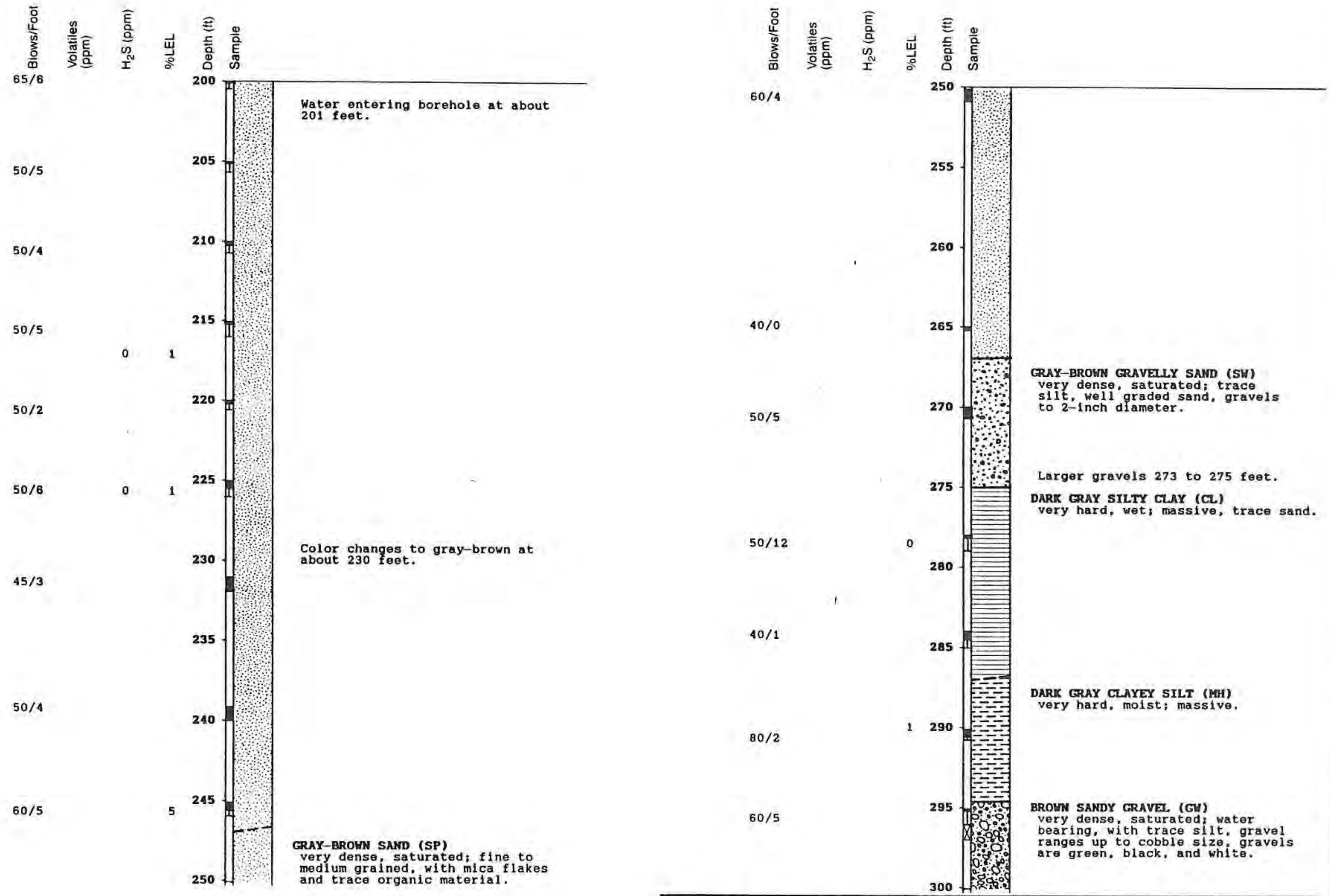
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-22 (continued)

Midway Landfill
Kent, Washington

PLATE
B44

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



Water entering borehole at about 201 feet.

Color changes to gray-brown at about 230 feet.

GRAY-BROWN SAND (SP)
very dense, saturated; fine to medium grained, with mica flakes and trace organic material.

GRAY-BROWN GRAVELLY SAND (SW)
very dense, saturated; trace silt, well graded sand, gravels to 2-inch diameter.

Larger gravels 273 to 275 feet.

DARK GRAY SILTY CLAY (CL)
very hard, wet; massive, trace sand.

DARK GRAY CLAYEY SILT (MH)
very hard, moist; massive.

BROWN SANDY GRAVEL (GW)
very dense, saturated; water bearing, with trace silt, gravel ranges up to cobble size, gravels are green, black, and white.

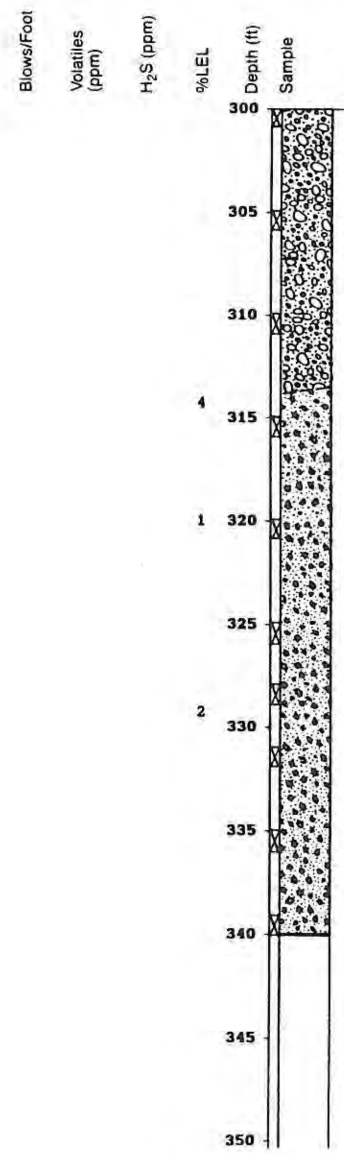
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-22 (continued)

Midway Landfill
Kent, Washington

PLATE
B44

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



More sand from 302 to 305 feet.

BROWN SANDY GRAVEL (GP)
very dense, saturated; gravels less well-graded and only range up to 2-inch diameter.

Interbedded silt layers from about 318 to 323 feet.

Becomes gray at about 323 feet and maximum gravel size increases to about 3-inch diameter.

Friable hornblende-rich white rock noted near 328 feet (indurated ash?).

Gravel sized decreases to maximum of about 1-inch diameter below 333 feet.

Boring terminated at approximate depth of 340 feet on 4/21/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-22

Midway Landfill
Kent, Washington

PLATE
B44

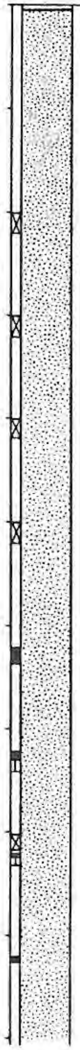
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: **BE 60, 22-W Cable Tool**

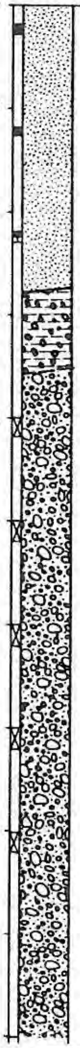
Elevation: **425 feet**

Date: **5/4/87**

Blows/Foot	Volatiles (ppm)	H2S (ppm)	%LEL	Depth (ft)	Description
				0	Two inches grass sod. **BROWN SAND (SP)** dense, moist; trace to some silt and trace gravel and cobbles, fine to medium grained sand.
				5	
				10	
				15	
			0	20	
				25	
					Trace silt or less below about 29 ft.
			0	30	
50/4					
					More gravel from 34 to 35 feet.
				35	
50					
50/6			0	40	Interbedded silty sand with black organic matter near 40 feet.
				45	
50/4					
				50	



Blows/Foot	Volatiles (ppm)	H2S (ppm)	%LEL	Depth (ft)	Description
				50	
50/6			0		Black 1/4-inch diameter charcoal(?) near 51 feet.
			20	55	
50/6					
			20	60	
50/6					
			28		
				65	**BROWN SANDY GRAVEL (GM)** very dense, moist to wet; with some silt and cobbles, well graded sand.
			>200		
			30		
				70	**BLACK, GREEN, AND RED SANDY GRAVEL (GW)** dense, moist; gravel to cobble size, medium grained sand.
			40		
				75	
				80	
			8		
				85	
			1		
				90	
				95	
			1		
				100	



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-23 (continued)

Midway Landfill
Kent, Washington

PLATE **B45**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				200
			off scale	
50/4				205
50/2			off scale	210
50/5				215
50/3				220
50/1			15	225
75			15	230
50/6			15	235
50/3			9	240
50/3				245
50			30	250

Occasional fine gravel and hard silt concretions(?) near 205 feet.

Interlayered silt and silty sand beds and occasional black organic matter from 210 feet to about 218 feet.

Becomes medium grained below 218 feet.

Saturated at about 220 feet.

Grades finer grained with trace silt below about 222 feet.

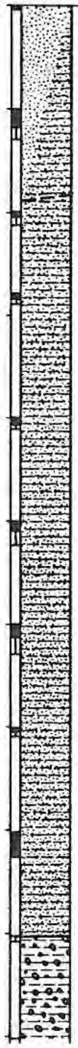
BROWN SILTY SAND (SM)
very dense, wet to saturated; fine grained.

BROWN SAND (SP)
very dense, saturated; fine grained, with trace to some silt.

BROWN SAND (SP)
very dense, saturated; trace fine gravel.

IRREGULARLY INTERLAYERED BROWN AND GRAY-BROWN SAND (SP) AND SILTY SAND (SM) very dense, saturated; very fine to fine grained sand with occasional silt layers.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
				250
50/10				255
50/3				260
50/3			23	265
50/3				270
			17	
50/6				275
50/5				280
100/4			30	285
				290
100				
50/2			11	295
				300



BROWN TO GRAY-BROWN SILTY SAND (SM)
very dense, saturated; non-water bearing, very fine grained sand, occasional thin sand layers.

Water bearing sand lens at 270 to 271 feet.

Sand obtains a lavender hue below about 274 feet.

Less silt below about 280 fee

Interbedded massive silt lay below about 288 feet.

GRAY AND LAVENDER-GRAY GRAVEL (GM)
very dense, saturated; with some sand, gravels to 3-inch diameter, thin water bearing gravel zones(?).

MW-23

00-200

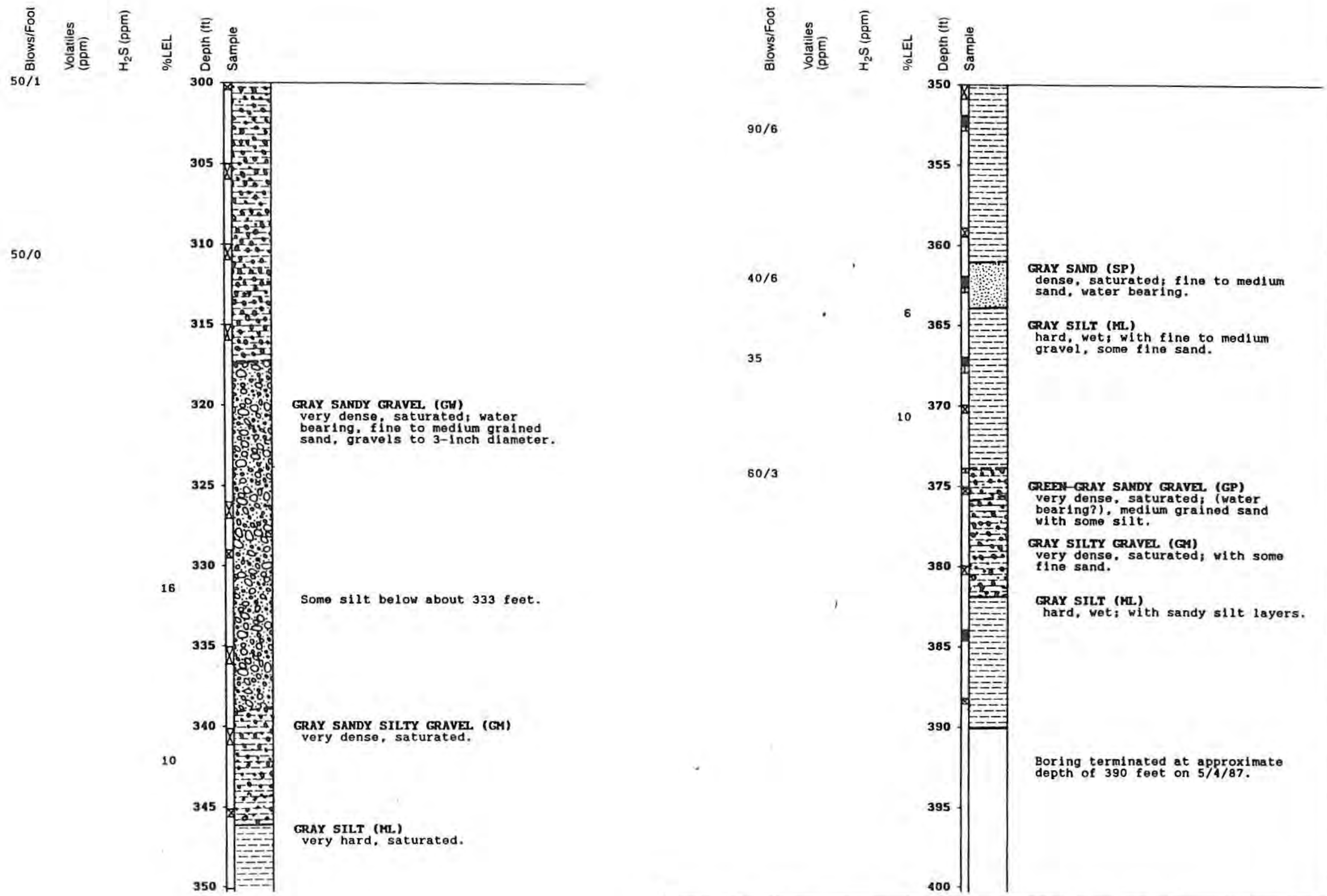
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-23 (continued)

Midway Landfill
Kent, Washington

PLATE
B45

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



GRAY SANDY GRAVEL (GW)
very dense, saturated; water bearing, fine to medium grained sand, gravels to 3-inch diameter.

Some silt below about 333 feet.

GRAY SANDY SILTY GRAVEL (GM)
very dense, saturated.

GRAY SILT (ML)
very hard, saturated.

GRAY SAND (SP)
dense, saturated; fine to medium sand, water bearing.

GRAY SILT (ML)
hard, wet; with fine to medium gravel, some fine sand.

GREEN-GRAY SANDY GRAVEL (GP)
very dense, saturated; (water bearing?), medium grained sand with some silt.

GRAY SILTY GRAVEL (GM)
very dense, saturated; with some fine sand.

GRAY SILT (ML)
hard, wet; with sandy silt layers.

Boring terminated at approximate depth of 390 feet on 5/4/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-23

Midway Landfill
Kent, Washington

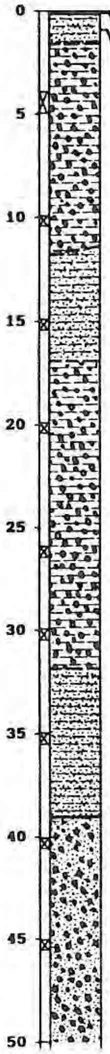
PLATE
B45

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: **BE 22-W Cable Tool**

Elevation: **419 feet** Date: **5/11/87**

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
		0	4
		0	0
		0	1
		0	2



CONCRETE

BROWN SILTY SAND (SM)
medium dense, wet to moist; with some gravel, organics and wood debris (Fill)

GRAY TO BROWN SILTY GRAVEL (GM)
dense, wet; with some well graded sand, fine to coarse subround to round gravels to 3.5-inch diameter, gravels ranged from gray, green, brown to white.

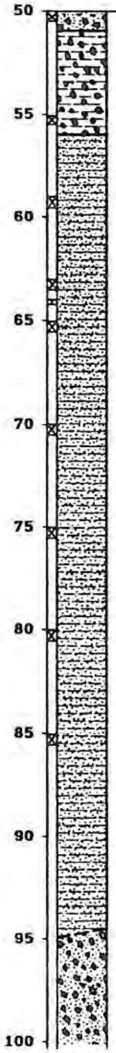
BROWN SILTY SAND (SM)
very dense, moist; with some gravel.

BROWN-GRAY SILTY GRAVEL (GM)
very dense, moist; with some sand.

GRAY-BROWN SILTY SAND (SM)
very dense, moist; with some gravel.

BROWN-BLACK SANDY GRAVEL (GP)
very dense, moist; sand is fine to medium grained, gravels to 6-inch diameter.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
		0	3
60/3			
			1



BROWN SANDY GRAVEL (GM)
very dense, moist; some silt.

BROWN SILTY SAND (SM)
very dense, moist; some gravel to 4-inch diameter, gravels are green, gray, brown, red, and white.

Gravel content decreases to a trace at 69 feet.

Gravel content increases at 74 feet.

Trace clay in matrix below about 75 feet.

Gravel content increases below 78 feet with some 6 to 8-inch cobbles.

Becomes less gravelly at 84 feet.

GREEN AND BLACK SANDY GRAVEL (GP)
very dense, moist; medium to coarse grained sand, gravels range up to 2-inch diameter.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

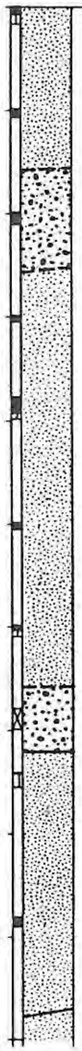
Log of Boring MW-24 (continued)

Midway Landfill
Kent, Washington

PLATE **B46**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/6			2	200
100/6				205
100/8				210
25/1				215
125			3	
				220
50/4				225
100/6			0	230
				235
50/3				
				240
100/8			2	
				245
				250



BROWN SAND (SW)
very dense, saturated.

BROWN SAND (SP)
very dense, saturated; fine to medium grained.

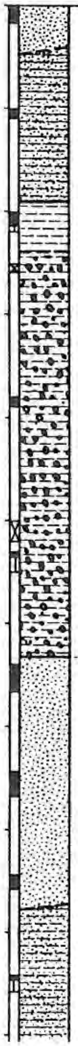
Some silt and coarse sand below about 228 feet.

GRAY-GREEN GRAVELLY SAND (SW)
very dense, saturated; with some silt.

BROWN SAND (SP)
very dense, saturated; fine to medium grained with trace to some silt.

GRAY-BROWN SAND (SP)
very dense, saturated; fine to medium grained sand.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
75/6				250
100/7				255
			11	
75				260
				265
100/6			3	
				270
				275
59/11				
			2	
				280
50/4				
				285
50/3				
				290
50/4				
				295
50/4				
				300



BROWN SILTY SAND (SM)
dense, saturated; very fine grained sand, trace fine to medium gravel near 253 feet.

DARK GRAY SANDY SILT (ML)
stiff, saturated; with some medium to coarse subrounded gravel, with silty sand layers.

DARK GRAY SILTY GRAVEL (GM)
dense, saturated; medium to coarse gravel with some sand and interbedded gray gravelly sand (water bearing).

GRAY SAND (SP)
very dense, saturated; water bearing, trace silt, sand size ranges from very fine to coarse but is predominantly fine to medium grained, black, red, and gray sand grains.

DARK GRAY SILTY SAND (SM)
very dense, saturated; non-water bearing, fine to very fine sand with thin sandy silt layers.

Some fine gravel near 300 feet.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

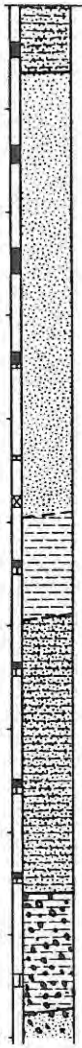
Log of Boring MW-24 (continued)

Midway Landfill
Kent, Washington

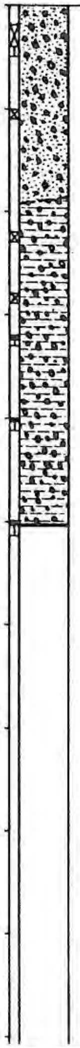
PLATE
B46

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Description
				300	
50/4					**GRAY SAND (SP)** very dense, saturated; fine to medium grained with some silt, trace fine gravel.
			1	305	
60/5					
				310	
50/3					
			2	315	
60/3					
				320	
50/6					
					Occasional silt layers below 323 ft.
				325	**LIGHT PURPLE-GRAY SANDY SILT (ML)** very stiff, saturated; very fine to fine sand.
72/3					
				330	**LIGHT PURPLE-GRAY SILTY SAND (SM)** very dense, wet; very fine to fine sand, with interbedded sandy silt layers.
72/7					
				335	Becomes gray at about 335 feet.
60/3					
			1	340	
100/6					
					GRAY SILTY GRAVEL (GM) very dense, wet; fine to coarse gravel, some fine sand.
				345	
50/2					
					RED-BLACK-GRAY SANDY GRAVEL (GP) dense, saturated; water bearing, medium to coarse gravel.
				350	



Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Description
				350	
			2		
25/0					
				355	
				360	**RED-GRAY SILTY GRAVEL (GM)** dense, saturated; with some sand, fine to coarse gravel.
					Less gravel, more sand near 164 feet.
				365	
70/1					
68/2				370	
				375	Boring terminated at approximate depth of 375.3 feet on 5/11/87.
				380	
				385	
				390	
				395	
				400	



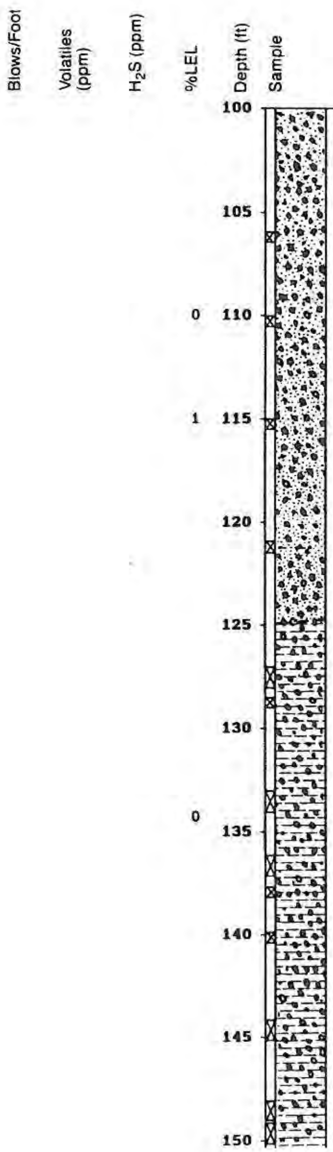
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-24

Midway Landfill
Kent, Washington

PLATE
B46

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

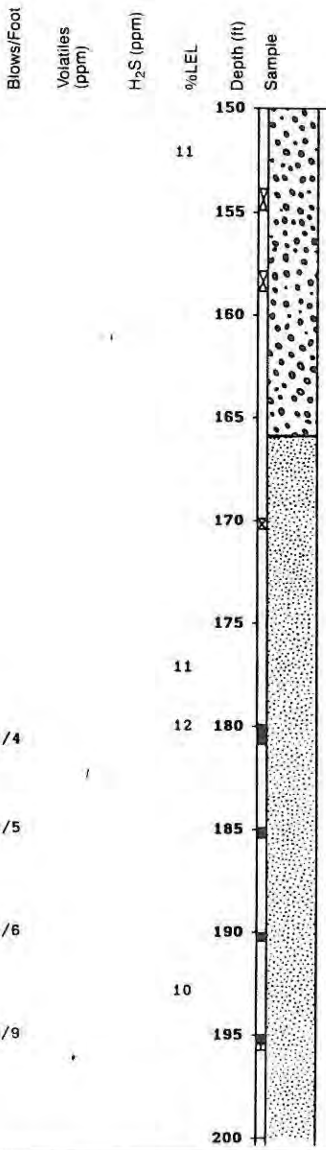


More sand below 113 feet.

Gravel size increases to cobbles below 117 feet.

GRAY SANDY GRAVEL (GM)
very dense, moist; with some silt, gravel ranges up to cobble size.

More sand near 140 feet.



Boulder at 161 feet.

BROWN SAND (SP)
dense, saturated(?); fine to medium grained.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-24 (continued)

Midway Landfill
Kent, Washington

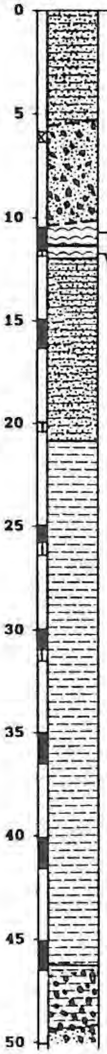
PLATE
B46

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 22-W Cable Tool

Elevation: 261 feet   Date: 6/18/87

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
20			
		0	0
25			
50/6			
15			
		0	0
20			
60			
22/6			
		0	0
80			



GRAY-BROWN SILTY SAND (SM)
dense, moist; with some gravel (Fill).

GRAY-BROWN SANDY GRAVEL (GP)
medium dense, wet; with some silt (Fill).

DARK BROWN GRAVELLY PEAT (PT)
medium stiff, saturated (Fill).

DARK BROWN PEAT (PT)
soft, wet; with some gray fine to medium sand.

BLUE-GRAY INTERLAYED SAND (SP) CLAY (CL) AND SILT (ML)
medium dense, medium stiff, saturated; water bearing, very fine grained sand.

Trace gravel 19 to 20 feet.

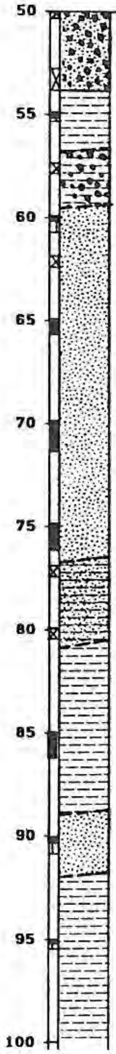
BLUE-GRAY SILT (ML)
medium stiff, wet to saturated; trace to some clay, massive.

Water bearing sand layer 29 to 30 ft.

Laminated with lenses of saturated fine sand below about 33 feet.

YELLOW-BROWN SILTY GRAVEL (GM)
very dense, wet; with some fine sand.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
50/5			
50/5			
50/5			
50/4			
		0	1
90/10			
77/9			
50/5		0	0
50/4			
50/6			
50/5			



BLACK-BROWN SANDY GRAVEL (GP)
very dense, saturated; water bearing.

YELLOW-BROWN GRAVELLY SILT (ML)
very stiff, wet to saturated; with fine grained sand layers.

YELLOW-BROWN SILTY GRAVEL (GM)
very stiff, saturated.

YELLOW-BROWN SAND (SP)
very dense, saturated; water bearing, with some silt and trace gravel, sand is fine grained, with occasional silt layers near 63 feet.

Sand becomes fine to medium grained at about 68 feet.

Sand becomes medium grained at about 73 feet.

INTERLAYERED BLUE-GRAY SILT (ML) AND YELLOW-BROWN SAND (SP)
stiff, dense, saturated; fine to medium grained sand, sand layers generally water bearing.

BLUE-GRAY SILT (ML)
stiff, saturated; with trace sand, occasional layers of sand, trace gravel 81 to 82 feet.

Green and bluish green mottling near 85 feet.

Some gravel below 85 feet, increases 88 to 89 feet.

YELLOW-BROWN SAND (SP)
very dense, saturated; water bearing.

Water bearing sand lenses 89 to 92 feet.

BLUE-GRAY SILT (ML)
hard, moist; occasional lenses of fine sand.

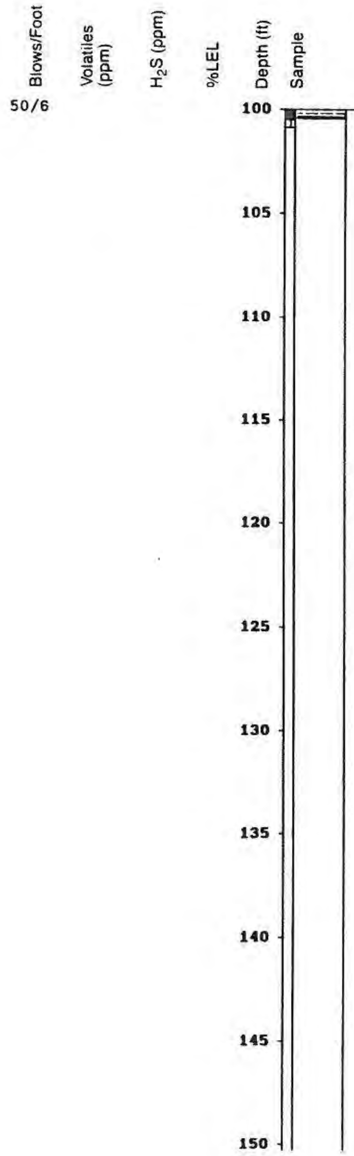
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-25 (continued)

Midway Landfill
Kent, Washington

PLATE **B47**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



Boring terminated at approximate depth of 100.5 feet on 6/18/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-25

Midway Landfill
Kent, Washington

PLATE
B47

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot | Volatiles (ppm) | H_2S (ppm) | %LEL | Depth (ft) | Sample

Equipment: BE 22-W Cable Tool

Elevation: 369 feet

Date: 3/26/87

BLACK GRAVEL (GP)
loose, wet; 4 to 6-inch gravel surfacing.

BROWN SILTY SAND (SM)
dense, moist; with some gravel (Fill).

Becomes dark brown and medium dense at about 9 feet, with wood fragments.

Mottled brown and gray below approximately 18 feet.

GRAY SILTY SAND (SM)
dense, moist; with some gravel.

Interlayered sandy silt lenses between approximately 23 and 28 feet.

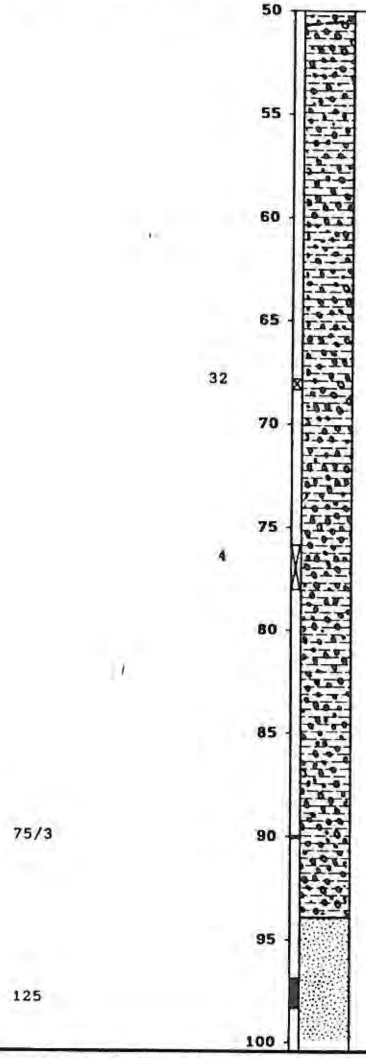
More gravel below 28 feet with occasional cobbles.

GRAY SANDY GRAVEL (GP)
dense, saturated; water bearing, sand is medium to coarse grained with some silt.

BROWN-GRAY SILTY SANDY GRAVEL (GM)
dense, moist; with trace clay.

GRAY-BROWN SANDY GRAVEL (GM) WITH INTERBEDDED THIN WELL-SORTED SANDY GRAVEL LENSES (GW)
very dense, wet to saturated; with some silt, water entering borehole.

Blows/Foot | Volatiles (ppm) | H_2S (ppm) | %LEL | Depth (ft) | Sample



GRAY-BROWN SILTY SANDY GRAVEL (GM)
dense, moist; with trace clay and some cobbles, silt and sand proportions vary, sand is medium to coarse grained, angular to subrounded gravel.

Becomes mottled yellow-brown and gray at approximately 57 feet.

Becomes mottled orange and brown at approximately 83 feet.

Becomes mottled lavender and green-gray at approximately 89 feet.

Grades to blue-gray at approximately 91 feet.

PURPLE-GRAY SAND (SP)
dense, wet to saturated; with some silt and trace gravel, sand is very fine to medium grained.

Saturated at about 97 feet(?); water entering borehole.

Grades to greenish gray at about 98 feet and sand becomes well graded.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

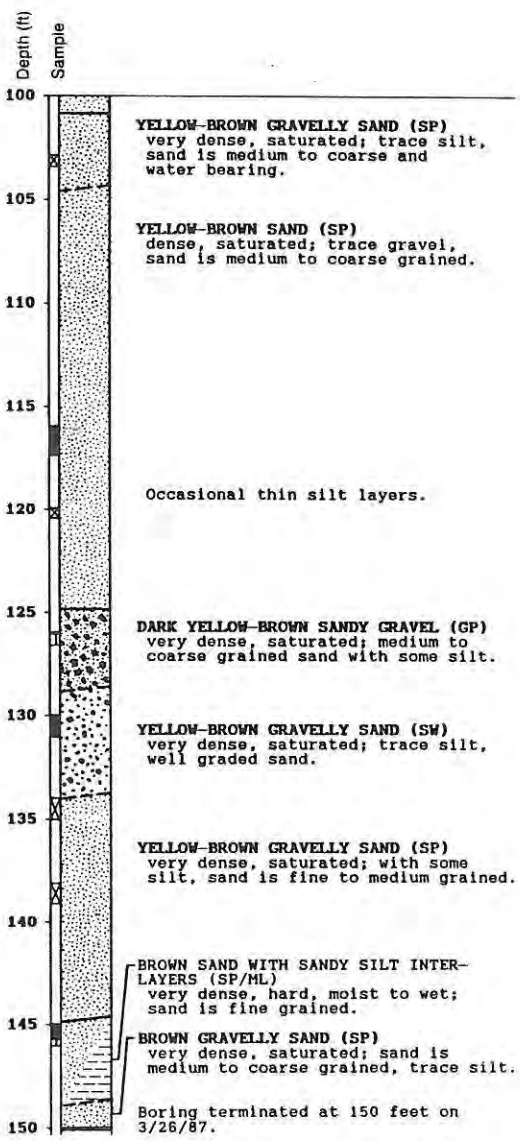
Log of Boring MW-26 (continued)

Midway Landfill
Kent, Washington

PLATE
B48

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL
120		0	1
75/7			
50/7			
150/7			



YELLOW-BROWN GRAVELLY SAND (SP)
very dense, saturated; trace silt, sand is medium to coarse and water bearing.

YELLOW-BROWN SAND (SP)
dense, saturated; trace gravel, sand is medium to coarse grained.

Occasional thin silt layers.

DARK YELLOW-BROWN SANDY GRAVEL (GP)
very dense, saturated; medium to coarse grained sand with some silt.

YELLOW-BROWN GRAVELLY SAND (SW)
very dense, saturated; trace silt, well graded sand.

YELLOW-BROWN GRAVELLY SAND (SP)
very dense, saturated; with some silt, sand is fine to medium grained.

BROWN SAND WITH SANDY SILT INTERLAYERS (SP/ML)
very dense, hard, moist to wet; sand is fine grained.

BROWN GRAVELLY SAND (SP)
very dense, saturated; sand is medium to coarse grained, trace silt.

Boring terminated at 150 feet on 3/26/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-26

Midway Landfill
Kent, Washington

PLATE
B48

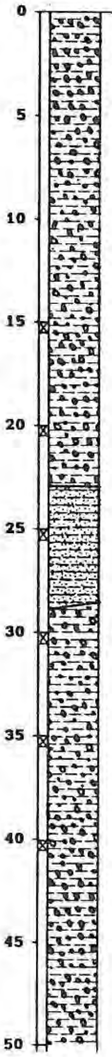
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot | Volatiles (ppm) | H_2S (ppm) | %LEL | Depth (ft) | Sample

Equipment: BE 22-W Cable Tool

Elevation: 330 feet

Date: 7/21/87



BROWN SILTY GRAVEL (GM)
dense, dry; with some sand, gravels to 5-inch diameter.

Becomes brown-gray, moist and very dense at about 5 feet.

H_2S (ppm)	%LEL
0	0

GRAY-BROWN SILTY SAND (SM)
very dense, moist; with some gravel.

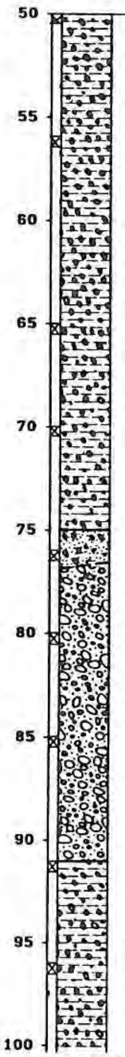
GRAY-BROWN SILTY GRAVEL (GM)
very dense, moist; with some fine to medium sand

H_2S (ppm)	%LEL
0	0

Interlayered thin blue-gray sandy silt beds from about 39 to 47 feet.

Increase in gravel size at about 47 feet, cobbles up to 6-inch diameter.

Blows/Foot | Volatiles (ppm) | H_2S (ppm) | %LEL | Depth (ft) | Sample



H_2S (ppm)	%LEL
0	1

Less gravel below about 57 feet, cobble size still ranges up to 6-inch diameter.

Sandy zone near 61 feet.

H_2S (ppm)	%LEL
0	0

Large cobbles near 68 feet.

H_2S (ppm)	%LEL
0	4

BLACK-BROWN SANDY GRAVEL (GP)
very dense, saturated; water bearing, fine to coarse sand, trace silt, cobbles to 6-inch diameter.

BLACK SANDY GRAVEL (GW)
very dense, saturated; water bearing, fine to coarse sand, fine to coarse gravel with cobbles to 11-inch diameter.

Trace silt near 82 feet.

H_2S (ppm)	%LEL
0	2

BROWN-GRAY SILTY GRAVEL (GM)
very dense, saturated; non-water bearing, with some sand, cobbles to 8-inch diameter.

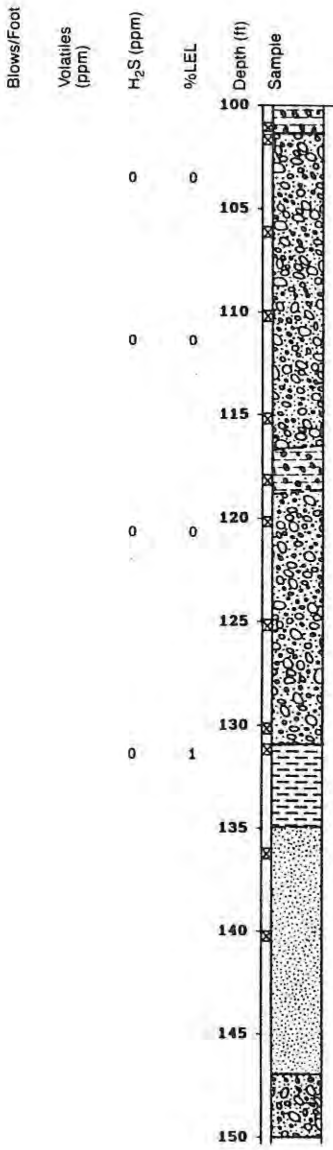
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-27 (continued)

Midway Landfill
Kent, Washington

PLATE
B49

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



GRAY-BLACK GRAVEL (GW)
very dense, saturated.

Trace sand below 110 feet.

Thin layers of yellow-brown silty sand 113 to 114 feet.

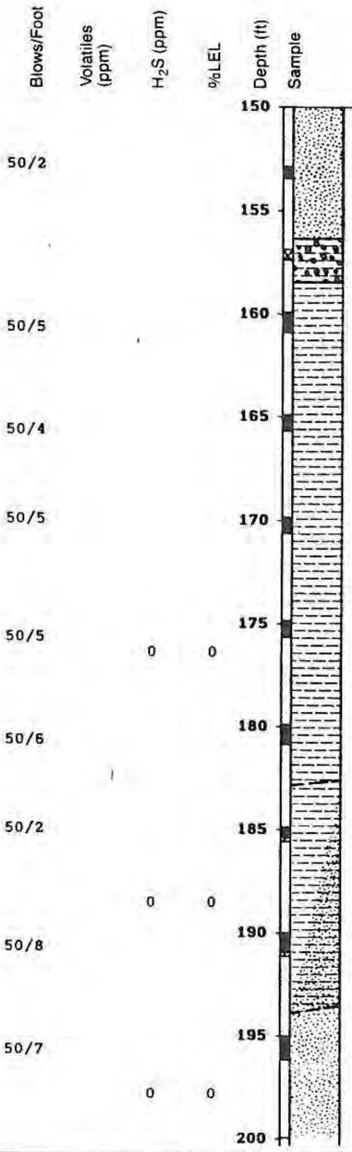
YELLOW-GREEN-BROWN SILTY GRAVEL (GM)
very dense, saturated.

BLACK-GRAY GRAVEL (GW)
very dense, saturated; water bearing, some sand, medium to coarse gravel, some cobbles to 6-inch diameter.

GRAY-BROWN CLAYEY SILT (MH)
hard, wet; with trace sand and occasional pebbles.

GRAY SAND (SP)
very dense, saturated; with trace to some silt, trace fine gravel.

GRAY SANDY GRAVEL (GW)
dense, saturated; with some silt 1/8 to 4-inch gravel, medium grained sand.



GRAY SAND (SP)
dense, saturated; with some gravel, medium to coarse grained sand.

GRAY SILTY GRAVEL (GM)
dense, wet; with some sand, 1/8 to 3-inch gravel.

GRAY SILT (ML)
hard, saturated; with trace very fine sand, and trace mica flakes.

With some very fine sand below 174 feet.

INTERBEDDED GRAY SANDY SILT (ML) AND SILTY SAND (SM)
hard, very dense, saturated; sand is very fine to medium grained.

GRAY SAND (SP)
dense, saturated; fine grained with occasional silt layers.

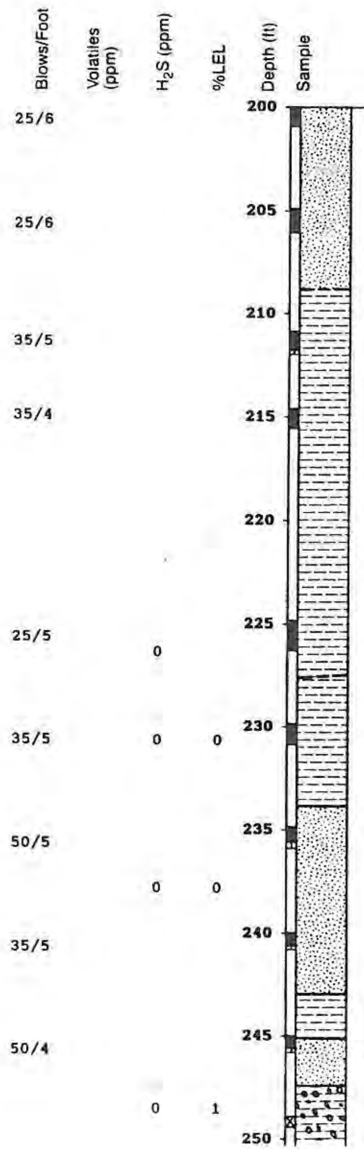
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-27 (continued)

Midway Landfill
Kent, Washington

PLATE
B49

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



GRAY SANDY SILT (ML)
hard, saturated; very fine grained sand, trace mica flakes, occasional zones of gray-green color.

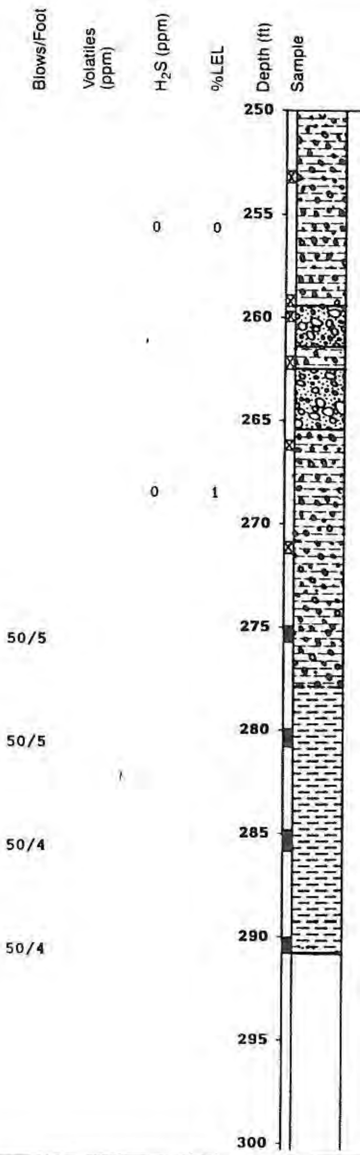
Slight swamp gas odor near 226 feet.

GRAY SILT (ML)
hard, saturated; laminated, with trace very fine sand, some mica flakes.

GRAY SAND (SP)
dense, saturated; water bearing, with trace to some silt, mica flakes, fine grained sand.

GRAY SANDY SILT (ML)
hard, saturated; with some gravel.

GRAY SAND (SP)
dense, saturated; with a trace of silt and gravel, fine to medium grained.



GRAY SILTY GRAVEL (GM)
dense, wet; 1/8 to 3-inch diameter gravel, some sand.

GRAY SANDY GRAVEL (GW) dense, saturated; very coarse grained sand, gravel to 3-inch diameter.

GRAY SILTY GRAVEL (GM) dense, moist.

GRAY SANDY GRAVEL (GW)
dense, saturated.

GRAY SILTY GRAVEL (GM)
dense, wet; ranges from a trace to some sand, trace clay.

GRAY CLAYEY SILT (MH)
hard, saturated; with trace pebbles, laminated with slight greenish tint.

Boring terminated at approximate depth of 291 feet on 7/21/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-27

Midway Landfill
Kent, Washington

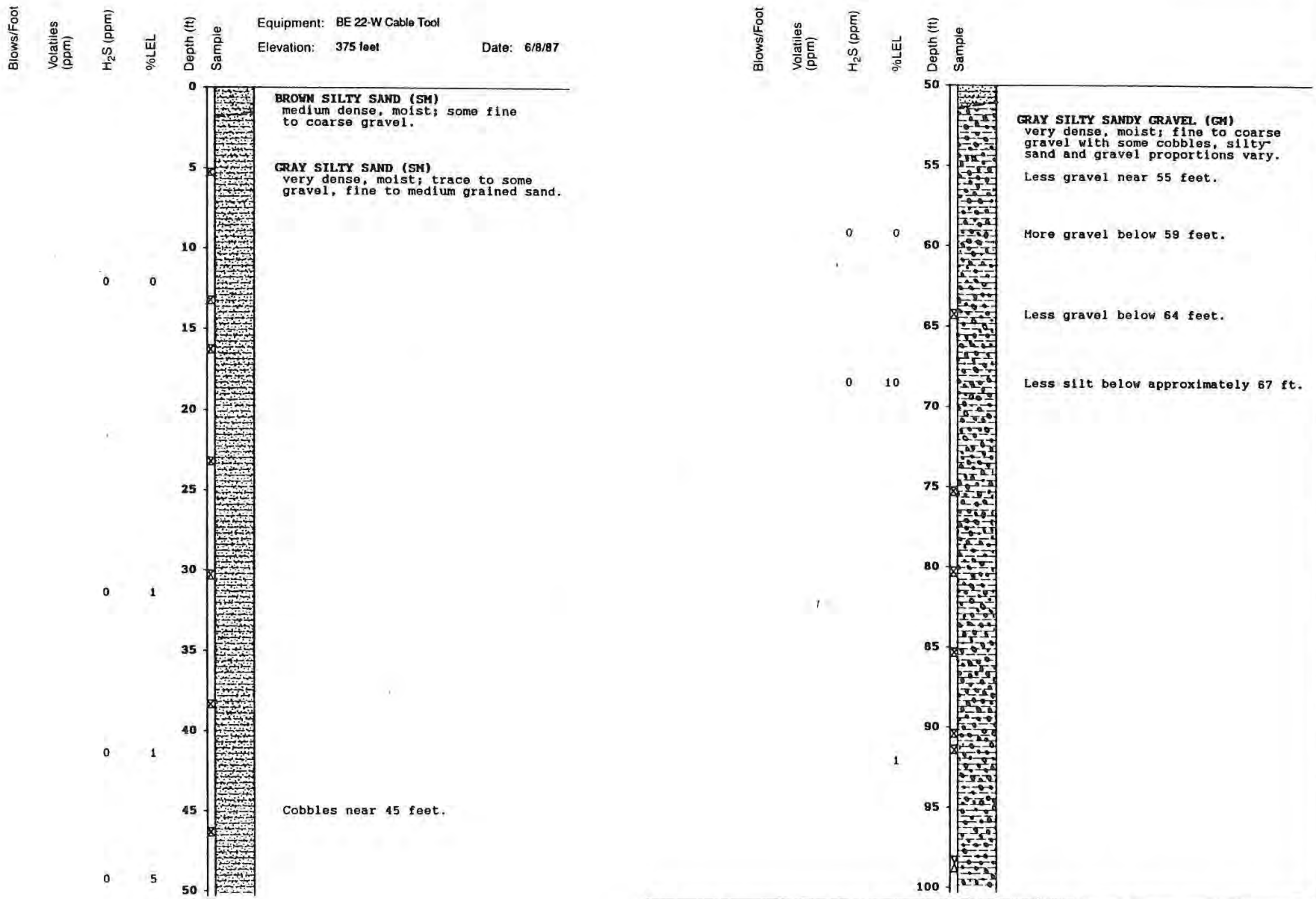
PLATE
B49

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 22-W Cable Tool

Elevation: 375 feet

Date: 6/8/87



BROWN SILTY SAND (SM)
medium dense, moist; some fine to coarse gravel.

GRAY SILTY SAND (SM)
very dense, moist; trace to some gravel, fine to medium grained sand.

Cobbles near 45 feet.

GRAY SILTY SANDY GRAVEL (GM)
very dense, moist; fine to coarse gravel with some cobbles, silty sand and gravel proportions vary.

Less gravel near 55 feet.

More gravel below 59 feet.

Less gravel below 64 feet.

Less silt below approximately 67 ft.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-28 (continued)

Midway Landfill
Kent, Washington

PLATE **B50**

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
			4	100
				105
50/5			14	110
75/6				115
75/6				120
75/5			4	125
				130
80/10				
				135
50/2				
				140
75/6				
				145
				150

Less gravel below 100 feet.

GRAY SANDY GRAVEL (GP)
dense, saturated; water bearing.

GRAY-BROWN SILTY SAND (SM)
dense, wet; some gravel; non-water bearing.

YELLOW-BROWN SAND (SP)
dense, saturated; water bearing, with trace pebbles and silt, medium to coarse sand.

GRAY GRAVEL (GP)
dense, saturated; fine to medium rounded gravel with some medium sand.

BROWN GRAVELLY SAND (SW)
dense, saturated; water bearing, medium to coarse sand.

Sand fine to medium grained with trace silt near 118 feet.

BROWN SAND (SW)
very dense, saturated; well-graded sand.

GRAY-BROWN SAND (SP)
very dense, saturated; very fine to fine grained.

Trace to abundant mica flakes below approximately 135 feet.

Becomes gray and sand is slightly coarser grained below about 144 feet.

Boring terminated at depth of 146 feet on 6/8/87.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-28

Midway Landfill
Kent, Washington

PLATE
B50

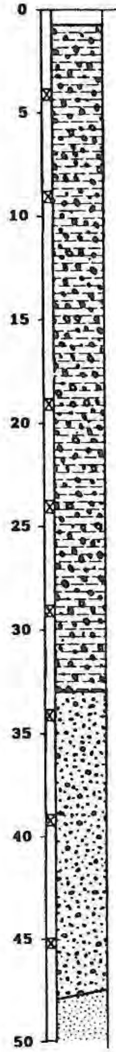
JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample

Equipment: BE 22-W Cable Tool

Elevation: 429 feet

Date: 7/2/87



Grass, sod and topsoil.

BROWN-GRAY SILTY GRAVEL (GM)
dense, dry; with a trace of sand, gravel is 1/8 to 4-inch diameter, well rounded.

Oxidized orange-brown staining below about 7 feet.

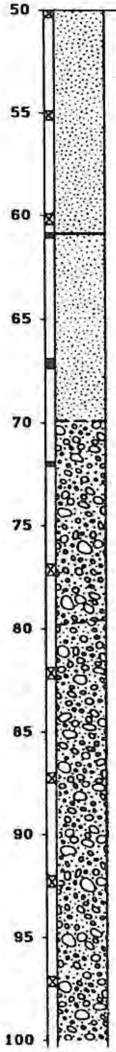
Becomes gray at about 12 feet.

Trace cobbles near 24 feet.

BROWN GRAVELLY SAND (SW)
dense, dry; with gravel 1/8 to 1.5-inch diameter, well graded sand.

With trace silt below about 43 feet.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	Sample
		0	1		
25/0					
		0	1		
75/6					
50/2					
		0	2		



BROWN AND GRAY SAND (SP)
dense, dry; with some silt, fine to medium sand.

Less silt (trace) and trace gravels to 2-inch diameter below 53 feet.

BROWN-GRAY GRAVELLY SAND (SP)
dense, dry; medium to coarse grained, gravel 1/8 to 4-inch diameter.

GRAY GRAVEL (GW)
dense, moist; with some coarse sand, gravels 1/8 to 4-inch diameter.

Cobbles to 10-inch diameter from 74 to 84 feet.

GRAY SANDY GRAVEL (GW)
dense, moist; with cobbles and trace silt, coarse grained sand - some red grains, cobble size varies but ranges up to 10-inch plus.

Coarse sand layer from 84 to 86 feet.

Becomes brown-gray at about 96 feet.

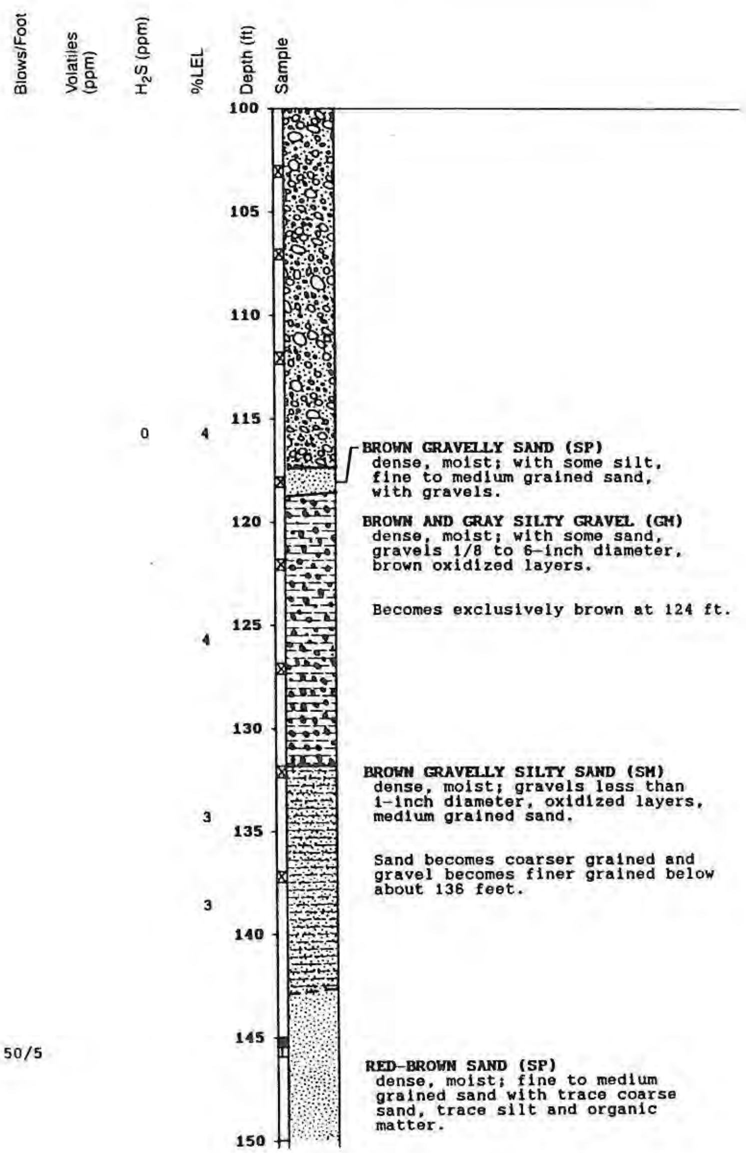
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring MW-29 (continued)

Midway Landfill
Kent, Washington

PLATE
B51

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



BROWN GRAVELLY SAND (SP)
dense, moist; with some silt, fine to medium grained sand, with gravels.

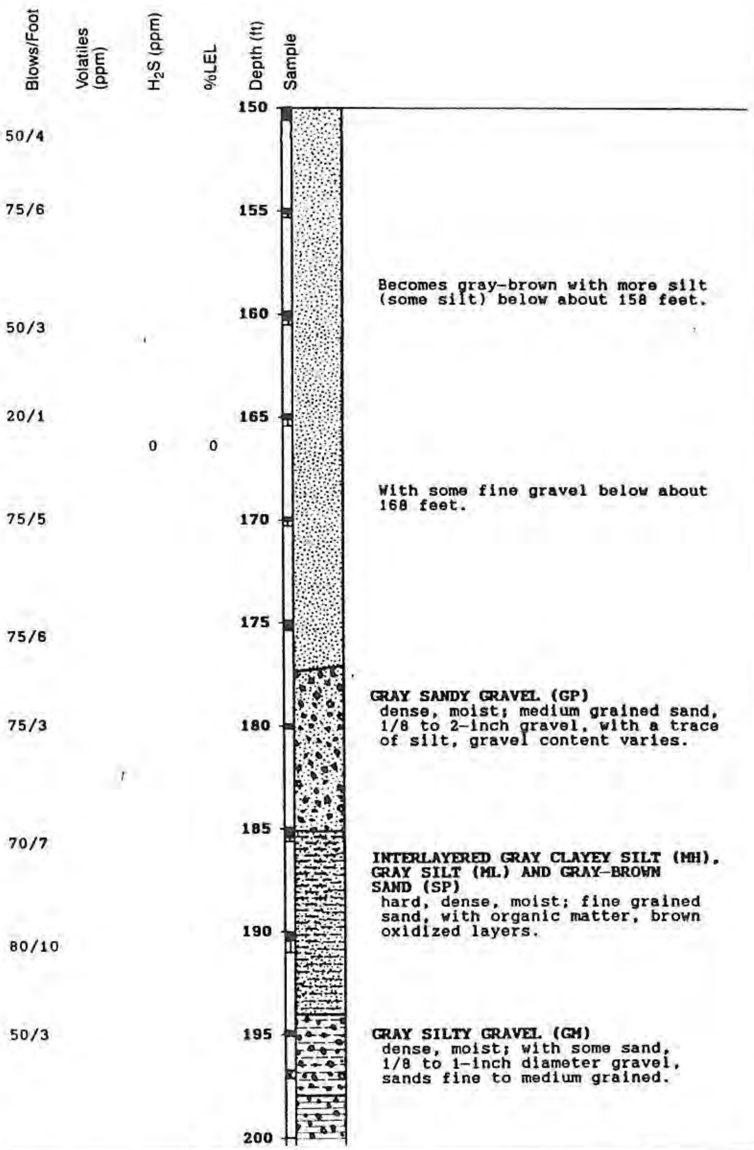
BROWN AND GRAY SILTY GRAVEL (GM)
dense, moist; with some sand, gravels 1/8 to 6-inch diameter, brown oxidized layers.

Becomes exclusively brown at 124 ft.

BROWN GRAVELLY SILTY SAND (SM)
dense, moist; gravels less than 1-inch diameter, oxidized layers, medium grained sand.

Sand becomes coarser grained and gravel becomes finer grained below about 136 feet.

RED-BROWN SAND (SP)
dense, moist; fine to medium grained sand with trace coarse sand, trace silt and organic matter.



Becomes gray-brown with more silt (some silt) below about 158 feet.

With some fine gravel below about 168 feet.

GRAY SANDY GRAVEL (GP)
dense, moist; medium grained sand, 1/8 to 2-inch gravel, with a trace of silt, gravel content varies.

INTERLAYERED GRAY CLAYEY SILT (MH), GRAY SILT (ML) AND GRAY-BROWN SAND (SP)
hard, dense, moist; fine grained sand, with organic matter, brown oxidized layers.

GRAY SILTY GRAVEL (GM)
dense, moist; with some sand, 1/8 to 1-inch diameter gravel, sands fine to medium grained.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

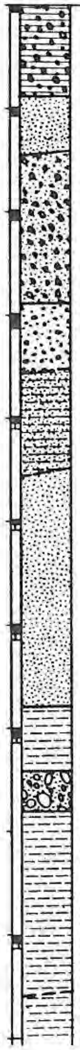
Log of Boring MW-29 (continued)

Midway Landfill
Kent, Washington

PLATE
B51

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
70/7				200
70/6				205
70/6				210
		0	0	
100/9				215
50/2				220
70/6				225
50/3				230
50/2				235
				240
50/2				245
				250



GRAY CLAYEY GRAVEL (GC)
dense, moist; with some silt and fine grained sand, thin 1/8 to 1-inch sand lenses.

BROWN GRAVELLY SAND (SP)
dense, saturated; water bearing, medium grained sand, trace silt.

GRAY SANDY GRAVEL (GP)
dense, saturated; 1/8 to 3-inch size gravel, medium to coarse grained sand.

BROWN SAND (SW)
dense, saturated; well graded, with some fine gravel.

BROWN SILTY SAND (SM)
dense, saturated; fine to medium grained.

GRAY SAND (SP)
dense, saturated; fine to medium grained with pockets of coarse sand and with trace gravel to 1-inch diameter.

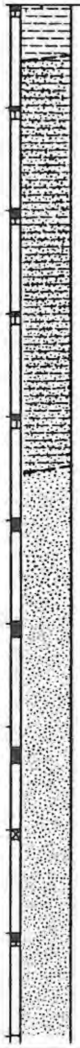
Occasional silt layers below about 230 feet.

GRAY SILT (ML)
hard, saturated.

GRAY GRAVEL (GW)
dense, saturated; water bearing.

GRAY SILT (ML)
hard, saturated; with trace very fine sand and clay.

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)
50/3				250
50/3				255
50/4				260
70/7				265
50/3				270
20/8				275
50/3				280
		0	0	
				285
50/4				
		0	1	
				290
70/7				295
				300



GRAY SANDY SILT (ML)
hard, saturated; very fine to fine grained sand.

GRAY SILTY SAND (SM)
dense, saturated; fine grained with occasional sand layers.

GRAY SAND (SP)
dense, saturated; fine to medium grained, with none to trace of silt.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

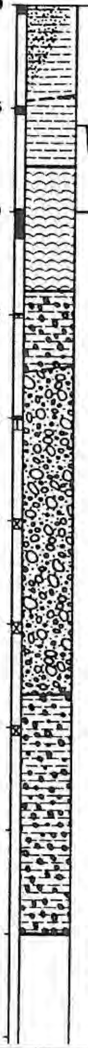
Log of Boring MW-29 (continued)
Midway Landfill
Kent, Washington

PLATE
B51

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	
70/6		0	1	300	
50/6				305	
50/4				310	
70/6		0	4	315	**GRAY GRAVELLY SAND (SW)** dense, saturated; medium to coarse grained sand with 1/8 to 1/2-inch gravel.
50/6				320	More gravel below 319 feet. Less gravel near 323 feet.
50/4				325	
70/7				330	**GRAY SILTY GRAVEL (GM)** dense, saturated; with some sand.
50/5				335	Less gravel below 336 feet, more silt and sand.
70/8				340	**GRAY GRAVELLY SAND (SW)** dense, saturated; 1/8 to 1/4-inch gravel, red sand grains, well graded fine to coarse sand.
50/3			1	345	**INTERBEDDED GRAY SILT (ML) AND SILTY SAND (SM)** hard, dense, saturated; trace gravel, red sand grains.
				350	

Blows/Foot	Volatiles (ppm)	H_2S (ppm)	%LEL	Depth (ft)	
70/7				350	**IRREGULARLY INTERMIXED GRAY SILTY SAND (SM) AND GRAY-WHITE ASH** sand is dense, saturated; ash has thin black organic (charcoal?) layering, ash is friable with contorted bedding.
70/7				355	Piece of wood at 354 feet. **BROWN SILT (ML)** hard, saturated, with some very fine grained sand.
50/6				360	**BROWNISH BLACK PEAT (PT)** hard, saturated; laminated with porous structure. Tree (?)
70/4				365	**MULTI-COLORED SILTY GRAVEL (GM)** dense, saturated; with some sand, 1/8 to 1-inch size gravel, red sand grains.
50/2		0	1	370	**GRAY SANDY GRAVEL (GW)** dense, saturated; water bearing, 1/8 to 1-inch size gravel, well graded sand.
				375	
				380	Coarser gravel to 4-inch diameter below 378 feet.
				385	**GRAY SILTY GRAVEL (GM)** dense, saturated; 1/8 to 4-inch diameter gravel.
				390	
				395	Boring terminated at approximate depth of 395 feet on 7/2/87.
				400	



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

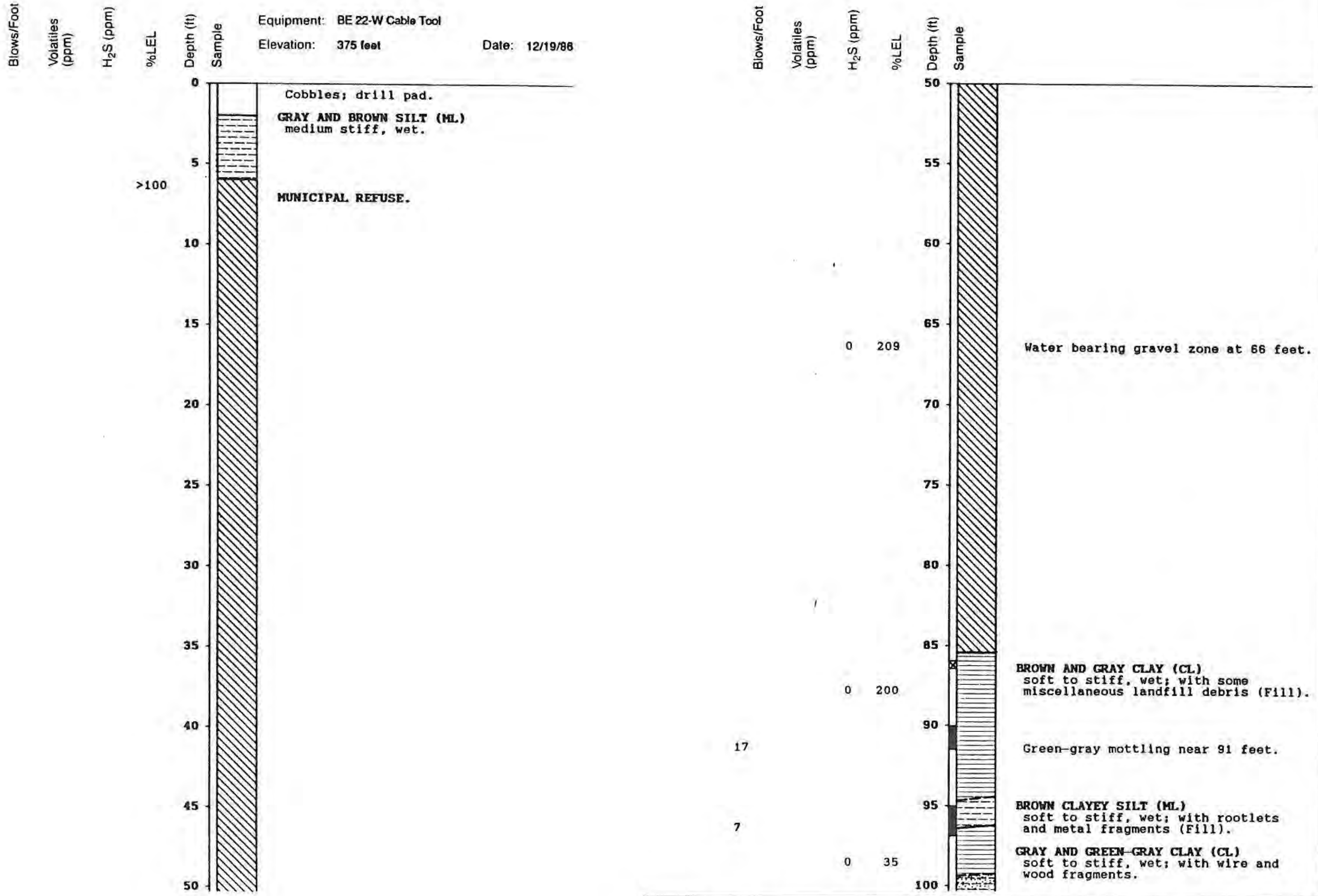
Log of Boring MW-29

Midway Landfill
Kent, Washington

PLATE
B51

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 22-W Cable Tool
Elevation: 375 feet
Date: 12/19/86



Cobbles; drill pad.

GRAY AND BROWN SILT (ML)
medium stiff, wet.

MUNICIPAL REFUSE.

Water bearing gravel zone at 66 feet.

BROWN AND GRAY CLAY (CL)
soft to stiff, wet; with some miscellaneous landfill debris (Fill).

Green-gray mottling near 91 feet.

BROWN CLAYEY SILT (ML)
soft to stiff, wet; with rootlets and metal fragments (Fill).

GRAY AND GREEN-GRAY CLAY (CL)
soft to stiff, wet; with wire and wood fragments.

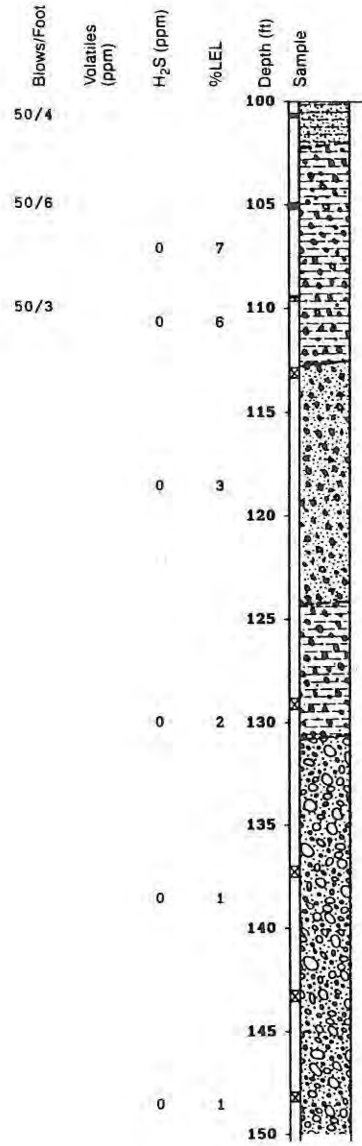
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring LW-1 (continued)

Midway Landfill
Kent, Washington

PLATE
B52

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



MOTTLED GRAY AND GRAY-GREEN SILTY SAND (SM)
very dense, moist; with some subrounded to subangular gravel and some wood fragments, trace clay (Fill).

GRAY SILTY SANDY GRAVEL (GM)
very dense, moist; with some metal fragments (Fill).

Water bearing zone at 109.5 feet.

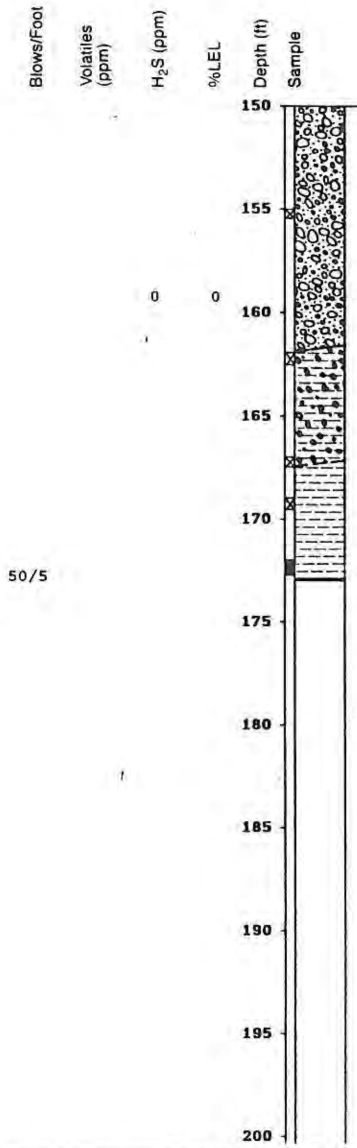
Silt decreases below 112 feet.

BROWN SANDY GRAVEL (GP)
very dense, saturated; with metal fragments (Fill).

GRAY-BROWN SILTY GRAVEL (GM)
very dense, wet; with some sand.

GRAY SANDY GRAVEL (GW)
very dense, saturated; water bearing, sand is medium to coarse grained, large subrounded to subangular gravel to 8-inch diameter, trace silt.

Sand becomes coarse grained below approximately 146 feet.



Sand becomes finer grained below approximately 152 feet.

GRAY SILTY GRAVEL (GM)
very dense, wet; with some coarse sand, orange-brown silt balls (moist to wet).

MOTTLED BROWN-GRAY SILT (ML)
hard, moist to wet; with some fine gravel.

Becomes gray at about 171 feet.

Boring terminated at approximate depth of 173 feet on 12/19/86.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring LW-1

Midway Landfill
Kent, Washington

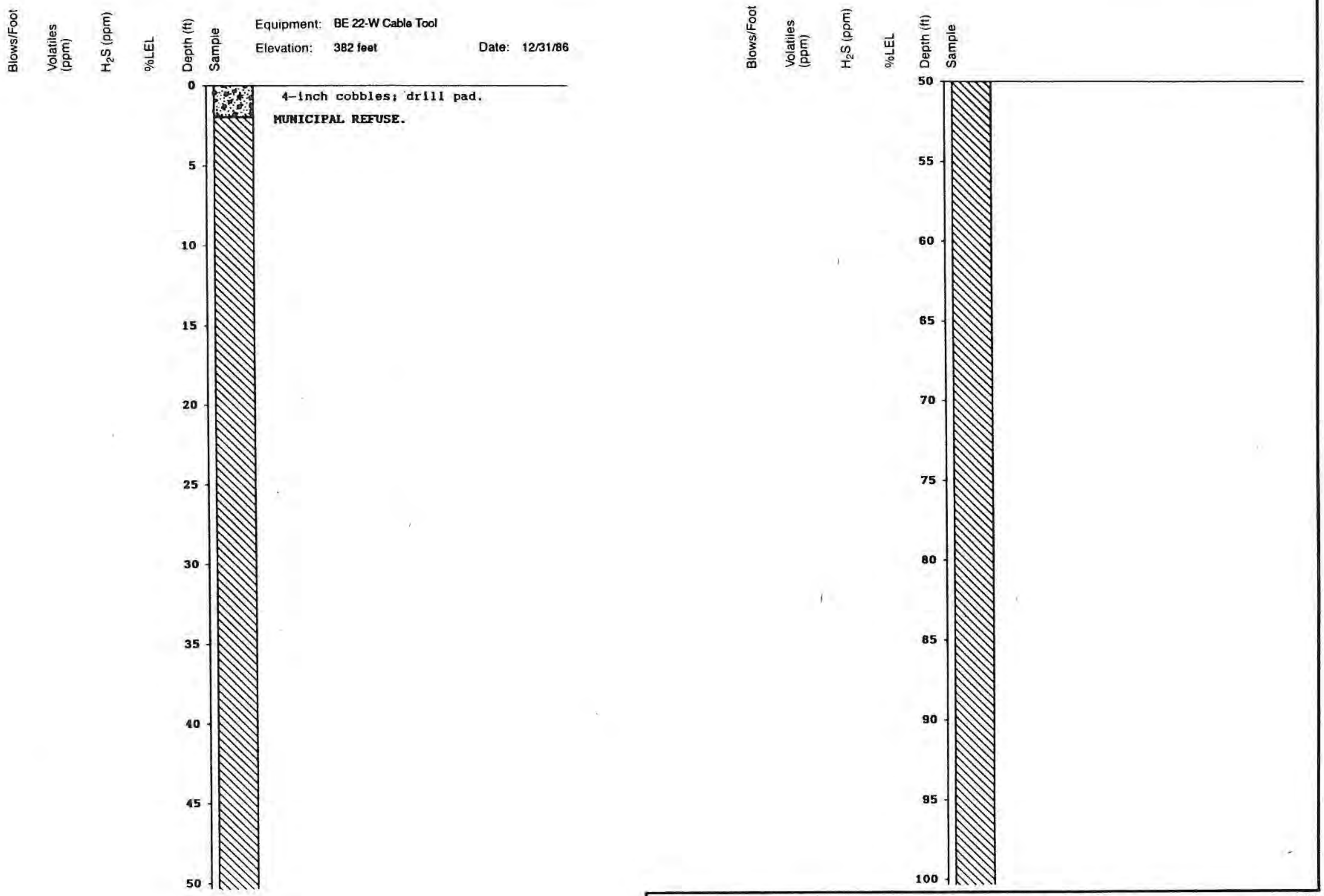
PLATE
B52

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		

Equipment: BE 22-W Cable Tool

Elevation: 382 feet

Date: 12/31/86



4-inch cobbles; drill pad.

MUNICIPAL REFUSE.

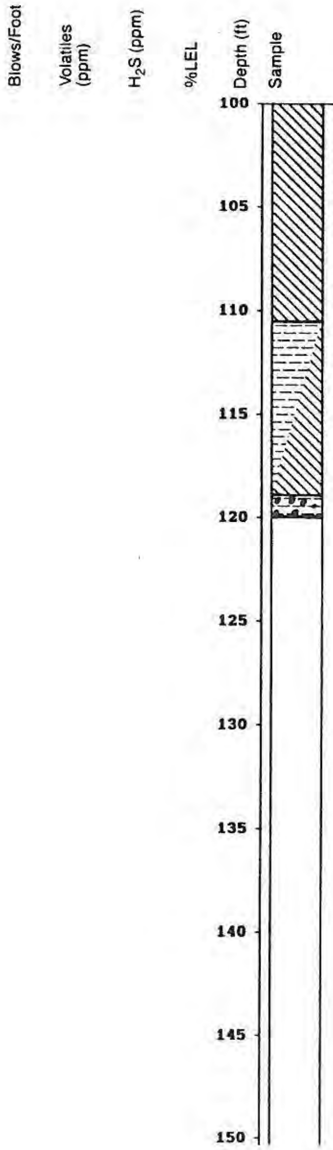
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring LW-2 (continued)

Midway Landfill
Kent, Washington

PLATE
B53

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG	MAA	15 October 87		



Water bearing gravel at 104 feet.

GRAY CLAYEY SILT (ML) AND REFUSE MIXTURE
soft, saturated.

BROWN SILTY GRAVEL (GM)
dense, saturated.

Boring terminated at 120 feet on 12/31/86.

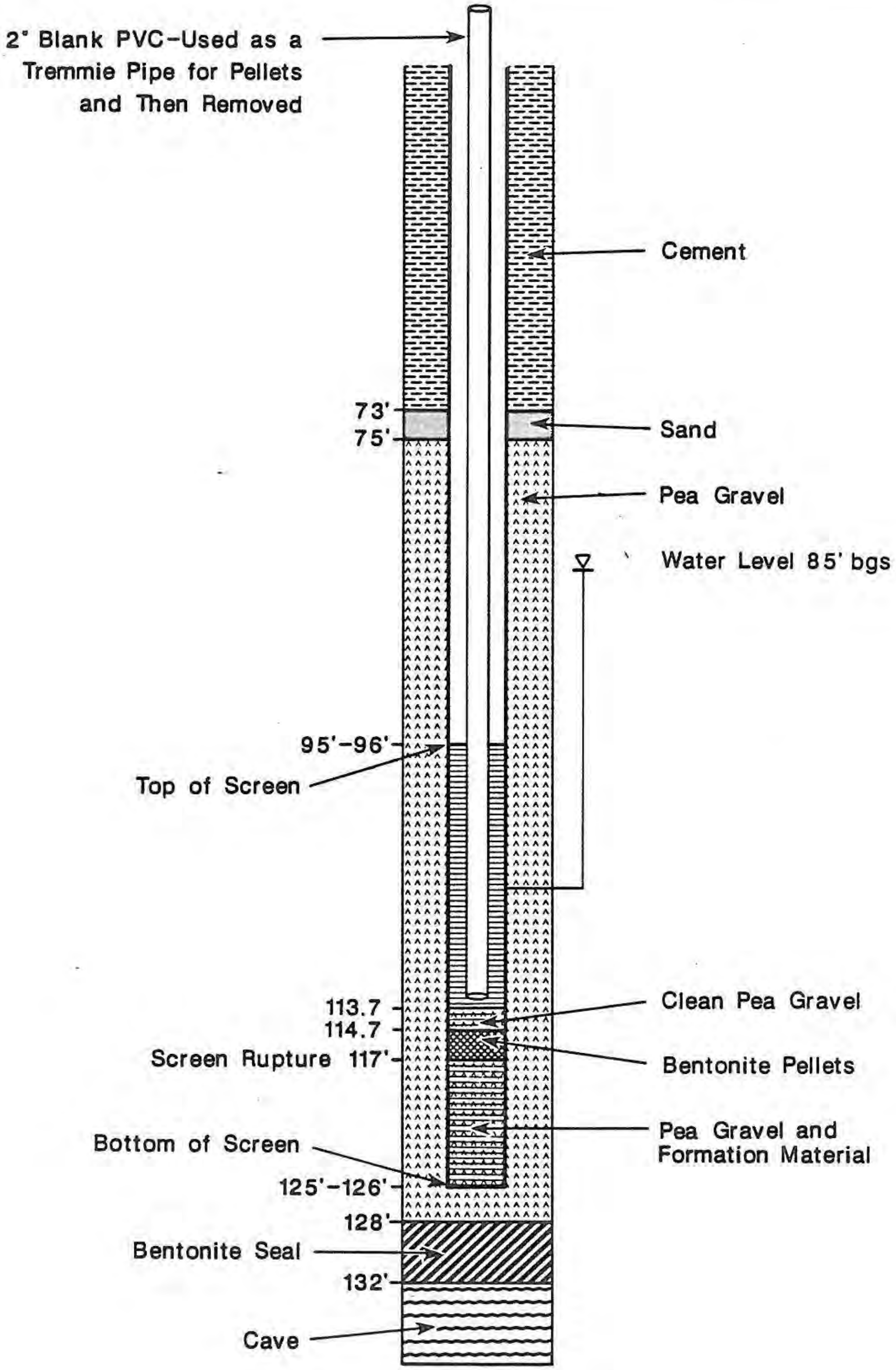
Blows/Foot
Volatiles (ppm)
H_2S (ppm)
%LEL
Depth (ft)
Sample

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Log of Boring LW-2
Midway Landfill
Kent, Washington

PLATE
B53

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	PS/TG		15 October 87		



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Well MW-6 Repair

Midway Landfill
Kent, Washington

PLATE
B54

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	ECR	MAA	11 January 88		

APPENDIX C

Physical Properties Testing

APPENDIX C

Physical Properties Testing

General

A total of 165 soil samples recovered during drilling were tested to supplement field observations and to define the general physical and hydraulic properties of subsurface sediments. Basic classification tests (moisture density and particle size analyses) were performed on samples chosen as representative of the stratigraphic units encountered. Based on results of laboratory examination and initial classification tests, additional testing was performed (triaxial, and falling head permeability tests) to provide additional hydraulic conductivity data. A brief discussion of test methodology is provided below.

Following the test methodology discussion are Tables C1 and C2, which respectively summarize the laboratory testing schedule and the laboratory testing results. These are followed in turn by Plates C1 through C47, which present particle size analysis results.

Soil Classification

All soil samples were visually examined by our representative in the field at the time they were obtained. They were subsequently packaged and returned to our laboratory where they were re-examined and the original description verified or modified. They were not modified, however, to incorporate information obtained from the particle size analysis. The descriptions recorded in the detailed geologic logs (Appendix B) were based on the Unified Soil Classification System and on our best field judgement. Classifications modified to incorporate particle size analysis results are shown on Plates C1 through C47.

Moisture Density

Moisture content and dry density tests were performed on 55 samples. The purpose of these tests is to determine the in-place moisture content and the associated dry unit weight (dry density) of the soil sample tested.

The moisture content is determined in general accordance with the ASTM Test Method D-2216-80 and the dry unit weight is computed on the basis of this result and the volume of the sample container. The information obtained provides data necessary to calculate porosity.

Specific Gravity

Specific gravity tests were performed on six samples in general accordance with ASTM Test Method D-854-83. The results of measured and estimated specific gravities were used with moisture density data to calculate porosity values.

Particle Size Analysis

Detailed grain size analyses were conducted on 161 samples. Mechanical analysis alone was performed on 99 samples, and mechanical analysis in combination with hydrometer analysis was performed on 62 samples.

Particle size analysis tests were performed in general accordance with ASTM Test Method D-422-63. Particle size and hydrometer analyses were used to classify sediments more accurately than possible in the field and to calculate hydraulic conductivity using Hazen's Approximation (Freeze & Cherry, 1979).

Permeability Testing

Permeability tests were performed on 40 samples. Two test methods were used to run the permeability tests. Finer-grained silts and clays were tested in a triaxial cell using back-pressure saturation and a constant head. Coarser-grained soils were tested in flexible wall permeameters using the falling head method. Several coarser-grained samples were also tested in the triaxial apparatus as a check of the falling head method. Twenty tests were run using each method.

Permeability testing was performed in general accordance with the department of the Army, Office of the Chief of Engineers, Engineer Manual EM110-2-1906, 30 November 1970.

Triaxial Constant Head Testing

For the constant head tests in the triaxial cell, the testing procedure was as follows:

1. Sample is extruded into flexible membrane holder, weighed, measured, and mounted in a triaxial cell.

2. Following cell assembly, the cell is filled with de-aired water, and an initial cell pressure is applied.

3. De-aired water is applied to the bottom of the sample through a gravity feed and is allowed to saturate the sample (gravity saturation).

4. System is replumbed so that back pressure can be applied to both top and bottom of sample. In this configuration, pore pressures can also be monitored.

The reason for back pressure saturation technique is as follows: gas bubbles in the pores of a compacted or undisturbed specimen of fine-grained soil will invalidate the results of permeability testing. It is known that an increase in pressure will cause a reduction in volume of gas bubbles, and also an increased weight of gas dissolved in water. To each degree of saturation, there corresponds a certain additional pressure (back pressure) which if applied to the pore fluid of the sample, will cause complete saturation.

5. Sample is then saturated through application of cell pressure and back pressure until a minimum of 90% saturation is obtained (% saturation is measured by B Test).

6. Triaxial cell is replumbed to permit inflow of de-aired water to base of sample at 2 to 4 psi higher pressure (high back pressure) than pressure at top of sample (low back pressure). This induces flow through sample.

7. Flow exiting sample at top is routed through a volume change device in which flow can be measured.

8. Sample permeability is calculated from flow data obtained under constant flow conditions using the relationship K = Q/Ia, where:

   Q = flow rate
   i = hydraulic gradient
   a = cross sectional area of sample

<u>Test Method for Falling Head Permeability in Flexible Wall Permeameter</u>

General: Technique employed to run falling head permeability test is similar in initial stage to technique used for constant head test previously described.

1. Sample is extruded into flexible membrane holder, weighed, and measured, and mounted in a triaxial cell.

2. Following assembly of cell, cell is filled with de-aired water, and cell pressure is applied.

3. De-aired water is applied to bottom of sample and allowed to gravity saturate.

4. Following gravity saturation, system is plumbed into wall mounted calibrated burette filled with de-aired water. Water is allowed to flow from wall-mounted burette through sample into an overflow container maintained at a constant head. The water level is measured at constant time intervals as the test proceeds.

5. A minimum of 4 timed "trials" are run and averaged for each permeability determination.

Table C1
Laboratory Testing Schedule

Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Laboratory Analysis Moisture Content	Dry Density	Porosity	Specific Gravity	Hydrometer	Sieve Analysis	Triaxial Permeability	Falling Head Permeability
MW-7	145.0	Grav. Aquitard	*					*		
	170.0	Grav. Aquitard	*					*		
	190.0	Upper Gravel	*	*	*	*	*	*		
	195.0	Upper Gravel	*	*	*		*	*		
	210.0	Upper Gravel	*				*	*		
	220.0	Upper Gravel	*					*		
	225.0	Sand Aquifer	*	*	*		*	*		
	230.0	Sand Aquifer	*	*	*		*	*		
	240.0	Sand Aquifer	*	*	*			*		*
	250.0	Sand Aquifer	*					*		
MW-8	94.0	Grav. Aquitard	*					*		
MW-9	70.0	Grav. Aquitard	*				*	*		
	155.0	Sand Aquifer	*					*		
	179.0	Sand Aquifer	*	*	*			*		
MW-10	105.0	Sand Aquifer	*		*			*		
	148.25	Sand Aquifer	*				*	*		
	170.5	Sand Aquifer	*	*			*	*	*	
	202.0	Sand Aquifer	*	*	*			*		
	225.5	Sand Aquifer	*					*		
MW-11	80.0	Grav. Aquitard	*	*				*		
	141.0	Upper Gravel	*					*		
	171.0	Upper Silt	*	*			*	*	*	
	191.0	Sand Aquifer	*	*	*			*		*
	276.0	North Gravel	*					*		
MW-12	120.5	Sand Aquifer	*	*				*		*
	162.0	Sand Aquifer	*				*	*		
	176.0	Sand Aquifer	*					*		
	205.0	Sand Aquifer	*				*	*		
	221.0	Sand Aquifer	*					*		
	246.0	Sand Aquifer	*				*	*		
MW-13	105.0	Grav. Aquitard	*				*	*		
	109.5	Upper Gravel	*	*	*	*	*	*		
	136.5	Upper Silt	*	*	*		*	*	*	
	165.0	Upper Silt	*				*	*		
	180.0	Sand Aquifer	*	*	*			*		*
	185.0	Sand Aquifer	*	*	*			*		
	195.5	Sand Aquifer	*					*		
	200.5	North Gravel	*	*	*		*	*		
	220.0	North Gravel	*					*		

Table C1
Laboratory Testing Schedule

			Laboratory Analysis							
Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Moisture Content	Dry Density	Porosity	Specific Gravity	Hydrometer	Sieve Analysis	Triaxial Permeability	Falling Head Permeability
MW-14	50.0	Grav. Aquitard	*					*		
	110.0	Grav. Aquitard	*					*		
	150.5	Upper Silt	*					*		
	181.0	Sand Aquifer	*					*		
	210.0	Sand Aquifer	*				*	*		
	231.0	Lower Silt	*	*	*		*	*		*
	275.0	South Gravel	*					*		
	305.0	South Gravel	*					*		
	315.0	South Gravel	*	*		*	*	*	*	
MW-15	90.0	Grav. Aquitard	*					*		
	176.0	Upper Silt	*				*	*		
	200.0	Sand Aquifer	*					*		
	231.0	Sand Aquifer	*	*	*			*		*
	289.0	Sand Aquifer	*					*		
MW-16	85.0	Grav. Aquitard	*					*		
	135.0	Upper Gravel	*					*		
	155.0	Upper Gravel	*	*	*			*		
	188.5	Upper Silt	*				*	*		
MW-17	119.0	Sand Aquifer	*					*		
	125.0	Sand Aquifer	*					*		
MW-18	60.0	Grav. Aquitard						*		
	76.0	Upper Gravel	*	*		*		*		
	90.5	Upper Silt	*				*	*		
	102.5	Upper Silt	*	*			*	*	*	
	121.0	Sand Aquifer	*					*		
	151.0	Sand Aquifer	*	*				*	*	
	175.5	Sand Aquifer	*					*		
	265.5	North Gravel	*				*	*		
	277.0	North Gravel	*					*		
	284.0	North Gravel	*					*		
	298.0	North Gravel	*	*			*	*	*	
MW-19	69.0	Landfill	*					*		
	76.0	Landfill	*	*		*	*	*		
	82.4	Landfill	*					*		
	88.0	Landfill	*	*					*	
	125.0	Upper Gravel	*					*		
	150.0	Upper Gravel	*					*	*	
	180.0	Sand Aquifer	*	*	*			*	*	
	230.0	Lower Silt	*				*	*		
	251.0	Lower Silt	*				*	*		
	295.0	South Gravel	*					*		*
	305.0	South Gravel	*					*		

Table C1
Laboratory Testing Schedule

Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Laboratory Analysis							
			Moisture Content	Dry Density	Porosity	Specific Gravity	Hydrometer	Sieve Analysis	Triaxial Permeability	Falling Head Permeability
MW-20	94.0	Upper Gravel	*				*	*		
	115.0	Upper Gravel	*					*		
	135.5	Upper Silt	*	*			*	*	*	
	190.0	Sand Aquifer	*	*	*			*		*
	211.0	Lower Silt	*	*			*	*	*	
	226.0	Lower Silt	*				*	*		
	236.0	Lower Silt	*				*	*		
	281.0	South Gravel	*	*				*		*
	301.0	South Gravel	*					*		
	320.0	South Gravel	*	*	*		*	*		
MW-21	41.5	Grav. Aquitard	*					*		
	89.0	Upper Gravel	*					*		
	137.0	Upper Gravel	*					*		
	177.5	Sand Aquifer	*	*				*		*
	205.5	Sand Aquifer	*				*	*		
	235.5	Sand Aquifer	*	*						
	270.0	Lower Silt	*	*		*	*	*	*	
	290.0	North Gravel	*							
MW-22	105.0	Upper Gravel	*					*		
	121.0	Upper Gravel	*	*			*	*	*	
	165.5	Upper Silt	*				*	*		
	195.5	Sand Aquifer	*				*	*		
	270.0	North Gravel	*					*		
	284.0	North Gravel	*	*	*		*	*		
	300.0	North Gravel	*					*		
	328.0	North Gravel	*					*		
MW-23	51.0	Grav. Aquitard	*					*		
	70.0	Grav. Aquitard	*					*		
	210.0	Sand Aquifer	*					*		
	240.0	Sand Aquifer	*	*				*		*
	260.0	Sand Aquifer	*					*		
	310.0	South Gravel	*					*		
	352.0	South Gravel	*				*	*		
MW-24	154.0	Grav. Aquitard	*					*		
	205.0	Sand Aquifer	*	*				*		*
	237.0	Sand Aquifer	*					*		
	250.0	Sand Aquifer	*					*		
	260.0	Sand Aquifer	*				*	*		
	282.0	Sand Aquifer	*					*		
	302.0	Sand Aquifer	*					*		
	307.0	Sand Aquifer	*	*				*		*
	327.0	Sand Aquifer	*					*		
	332.0	Lower Silt	*	*			*	*	*	

Table C1
Laboratory Testing Schedule

			Laboratory Analysis							
Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Moisture Content	Dry Density	Porosity	Specific Gravity	Hydrometer	Sieve Analysis	Triaxial Permeability	Falling Head Permeability
MW-24 (cont)	332.5	Lower Silt	*				*	*		
	337.5	Lower Silt	*				*	*		
	355.0	South Gravel	*					*		
	366.5	South Gravel	*				*	*		
MW-25	16.0	Recent Allluv.	*	*			*	*		*
	36.0	Recent Allluv.	*				*	*		
	55.0	Upper Gravel	*				*	*		
	71.0	Sand Aquifer	*					*		
	86.0	Sand Aquifer	*	*			*	*	*	
	100.5	Sand Aquifer	*				*	*		
MW-26	68.0	Grav. Aquitard	*					*		
	76.0	Grav. Aquitard	*					*		
	98.0	Upper Gravel	*	*				*		*
	117.0	Upper Gravel	*					*		
MW-27	80.0	Upper Gravel	*					*		
	153.0	Upper Gravel	*					*		
	160.0	Upper Silt	*	*			*	*	*	
	180.0	Upper Silt	*				*	*		
	225.0	Sand Aquifer	*	*			*	*	*	
	260.0	North Gravel	*					*		
	280.0	North Gravel	*				*	*		
MW-28	5.0	Grav. Aquitard	*					*		
	48.0	Grav. Aquitard	*					*		
	98.0	Grav. Aquitard	*					*		
	110.0	Sand Aquifer	*	*				*		*
	136.0	Sand Aquifer	*	*				*		*
MW-29	9.0	Grav. Aquitard	*					*		
	103.0	Grav. Aquitard	*					*		
	185.0	Grav. Aquitard	*	*			*	*	*	
	200.0	Grav. Aquitard	*				*	*		
	215.0	Upper Gravel	*					*		
	270.0	Sand Aquifer	*					*		
	305.0	Sand Aquifer	*					*		
	325.0	South Gravel	*					*		
	345.0	South Gravel	*	*						*
	355.0	South Gravel	*	*			*	*		*
	375.0	South Gravel	*					*		

Table C1
Laboratory Testing Schedule

			Laboratory Analysis							
Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Moisture Content	Dry Density	Porosity	Specific Gravity	Hydrometer	Sieve Analysis	Triaxial Permeability	Falling Head Permeability
LW-1	91.0	Landfill	*	*			*	*		
	96.0	Landfill	*				*	*	*	
	143.0	Upper Gravel	*					*		
	172.5	Upper Silt	*	*			*	*		*

Table C2
Summary of Laboratory Testing Results

			Laboratory Analysis					
Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Moisture Content (%)	Dry Density (pcf)	Porosity (%)	Specific Gravity	Triaxial Permeability (cm/sec)	Falling Head Permeability (cm/sec)
MW-7	145.0	Grav. Aquitard	16.6					
	170.0	Grav. Aquitard	1.2					
	190.0	Upper Gravel	11.0	127.6	24	2.76		
	195.0	Upper Gravel	17.5	113.0	32			
	210.0	Upper Gravel	5.0					
	220.0	Upper Gravel	10.2					
	225.0	Sand Aquifer	22.9	97.6	42			
	230.0	Sand Aquifer	19.4	108.0	35			
	240.0	Sand Aquifer	20.7	108.4	31			3.2E-06
	250.0	Sand Aquifer	11.6					
MW-8	94.0	Grav. Aquitard	8.4					
MW-9	70.0	Grav. Aquitard	8.5					
	155.0	Sand Aquifer	6.9					
	179.0	Sand Aquifer	15.0	102.3	39			
MW-10	105.0	Sand Aquifer	21.2	105.1	37			
	148.25	Sand Aquifer	20.5					
	170.5	Sand Aquifer	30.8	91.7			9.8E-07	
	202.0	Sand Aquifer	26.1	93.2	44			
	225.5	Sand Aquifer	16.9					
MW-11	80.0	Grav. Aquitard	10.3					
	141.0	Upper Gravel	12.3					
	171.0	Upper Silt	27.6	89.5			8.5E-07	
	191.0	Sand Aquifer	25.1	98.1	38			3.0E-04
	276.0	North Gravel	21.9					
MW-12	120.5	Sand Aquifer	23.8	106.4				3.3E-04
	162.0	Sand Aquifer	30.6					
	176.0	Sand Aquifer	22.9					
	205.0	Sand Aquifer	28.4					
	221.0	Sand Aquifer	30.8					
	246.0	Sand Aquifer	32.7					
MW-13	105.0	Grav. Aquitard	12.1					
	109.5	Upper Gravel	12.6	125.5	25	2.82		
	136.5	Upper Silt	23.0	96.3	42		1.8E-07	
	165.0	Upper Silt	34.8					
	180.0	Sand Aquifer	18.3	106.3	33			1.9E-03
	185.0	Sand Aquifer	22.8	105.5	37			
	195.5	Sand Aquifer	13.1					
	200.5	North Gravel	20.7	106.8	36			
	220.0	North Gravel	4.6					

Table C2
Summary of Laboratory Testing Results

			Laboratory Analysis					
Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Moisture Content (%)	Dry Density (pcf)	Porosity (%)	Specific Gravity	Triaxial Permeability (cm/sec)	Falling Head Permeability (cm/sec)
MW-14	50.0	Grav. Aquitard	4.7					
	110.0	Grav. Aquitard	5.1					
	150.5	Upper Silt	11.9					
	181.0	Sand Aquifer	9.4					
	210.0	Sand Aquifer	29.3					
	231.0	Lower Silt	9.4	98.9	47			6.3E-05
	275.0	South Gravel	15.7					
	305.0	South Gravel	25.5					
	315.0	South Gravel	26.7	97.5		2.80	2.68E-06	
MW-15	90.0	Grav. Aquitard	3.2					
	176.0	Upper Silt	31.2					
	200.0	Sand Aquifer	10.8					
	231.0	Sand Aquifer	19.3	98.9	36			1.2E-04
	289.0	Sand Aquifer	25.0					
MW-16	85.0	Grav. Aquitard	5.7					
	135.0	Upper Gravel	2.5					
	155.0	Upper Gravel	7.9	111.9	33			
	188.5	Upper Silt	28.2					
MW-17	119.0	Sand Aquifer	5.3					
	125.0	Sand Aquifer	16.6					
MW-18	60.0	Grav. Aquitard						
	76.0	Upper Gravel	0.4					
	90.5	Upper Silt	30.1					
	102.5	Upper Silt	30.9	88.5			3.4E-06	
	121.0	Sand Aquifer	18.9					
	151.0	Sand Aquifer	23.9	100.3			1.1E-03	
	175.5	Sand Aquifer	13.3					
	265.5	North Gravel	22.1					
	277.0	North Gravel	5.7					
	284.0	North Gravel	6.7					
	298.0	North Gravel	31.8	84.6			3.1E-07	
MW-19	69.0	Landfill	25.0					
	76.0	Landfill	22.3	104.2		2.80		
	82.4	Landfill	21.3					
	88.0	Landfill	27.4	97.6			2.8E-07	
	125.0	Upper Gravel	2.3					
	150.0	Upper Gravel	13.6				8.3E-05	
	180.0	Sand Aquifer	17.4	106.9	36		7.5E-05	
	230.0	Lower Silt	22.6					
	251.0	Lower Silt	22.5					
	295.0	South Gravel	9.8					1.3E-04
	305.0	South Gravel	15.3					

Table C2
Summary of Laboratory Testing Results

			Laboratory Analysis					
Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Moisture Content (%)	Dry Density (pcf)	Porosity (%)	Specific Gravity	Triaxial Permeability (cm/sec)	Falling Head Permeability (cm/sec)
MW-20	94.0	Upper Gravel	21.3					
	115.0	Upper Gravel	9.9					
	135.5	Upper Silt	28.6	91.3			2.0E-07	
	190.0	Sand Aquifer	18.1	104.2	35			2.0E-04
	211.0	Lower Silt	50.8	68.8			7.2E-07	
	226.0	Lower Silt	20.3					
	236.0	Lower Silt	14.0					
	281.0	South Gravel	8.1	113.6				1.2E-04
	301.0	South Gravel	1.0					
	320.0	South Gravel	22.3	99.5	41			
MW-21	41.5	Grav. Aquitard	1.2					
	89.0	Upper Gravel	6.9					
	137.0	Upper Gravel	0.5					
	177.5	Sand Aquifer	24.5	100.2				1.0E-03
	205.5	Sand Aquifer	21.4					
	235.5	Sand Aquifer	23.9	95.3				
	270.0	Lower Silt	22.4	105.5		2.81	4.3E-07	
	290.0	North Gravel	16.3					
MW-22	105.0	Upper Gravel	21.1					
	121.0	Upper Gravel	13.3	125.9			2.8E-08	
	165.5	Upper Silt	30.2					
	195.5	Sand Aquifer	23.5					
	270.0	North Gravel	9.4					
	284.0	North Gravel	26.6	97.6	43			
	300.0	North Gravel	0.9					
	328.0	North Gravel	3.8					
MW-23	51.0	Grav. Aquitard	15.2					
	70.0	Grav. Aquitard	0.7					
	210.0	Sand Aquifer	5.3					
	240.0	Sand Aquifer	26.1	101.6				8.5E-04
	260.0	Sand Aquifer	13.5					
	310.0	South Gravel	1.9					
	352.0	South Gravel	25.0					
MW-24	154.0	Grav. Aquitard	4.1					
	205.0	Sand Aquifer	18.5	111.1				3.1E-04
	237.0	Sand Aquifer	11.0					
	250.0	Sand Aquifer	11.6					
	260.0	Sand Aquifer	12.5					
	282.0	Sand Aquifer	20.7					
	302.0	Sand Aquifer	11.2					
	307.0	Sand Aquifer	19.4	106.5				2.6E-05
	327.0	Sand Aquifer	13.2					
	332.0	Lower Silt	11.6	109.4			7.4E-06	

Table C2
Summary of Laboratory Testing Results

			Laboratory Analysis					
Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Moisture Content (%)	Dry Density (pcf)	Porosity (%)	Specific Gravity	Triaxial Permeability (cm/sec)	Falling Head Permeability (cm/sec)
MW-24 (cont)	332.5	Lower Silt	21.4					
	337.5	Lower Silt	11.7					
	355.0	South Gravel	7.8					
	366.5	South Gravel	1.8					
MW-25	16.0	Recent Alluv.	17.5	110.6				2.2E-06
	36.0	Recent Alluv.	22.9					
	55.0	Upper Gravel	11.4					
	71.0	Sand Aquifer	19.0					
	86.0	Sand Aquifer	19.3	113.0			3.1E-07	
	100.5	Sand Aquifer	32.9					
MW-26	68.0	Grav. Aquitard	14.4					
	76.0	Grav. Aquitard	3.9					
	98.0	Upper Gravel	18.9	101.3				3.8E-05
	117.0	Upper Gravel	15.4					
MW-27	80.0	Upper Gravel	0.6					
	153.0	Upper Gravel	19.5					
	160.0	Upper Silt	23.6	103.8			2.0E-07	
	180.0	Upper Silt	29.8					
	225.0	Sand Aquifer	28.4	96.0			1.6E-05	
	260.0	North Gravel	0.7					
	280.0	North Gravel	28.6					
MW-28	5.0	Grav. Aquitard	11.3					
	48.0	Grav. Aquitard	21.0					
	98.0	Grav. Aquitard	17.3					
	110.0	Sand Aquifer	16.0	114.3				1.8E-04
	136.0	Sand Aquifer	22.2	101.7				3.8E-04
MW-29	9.0	Grav. Aquitard	0.7					
	103.0	Grav. Aquitard	1.2					
	185.0	Grav. Aquitard	31.8	88.0			2.3E-08	
	200.0	Grav. Aquitard	12.1					
	215.0	Upper Gravel	14.4					
	270.0	Sand Aquifer	15.2					
	305.0	Sand Aquifer	14.1					
	325.0	South Gravel	12.5					
	345.0	South Gravel	21.5	105.1				3.5E-05
	355.0	South Gravel	23.2	95.4				3.0E-05
	375.0	South Gravel	6.7					

Table C2
Summary of Laboratory Testing Results

Boring Number	Sample Depth (ft)	Hydrostratigraphic Unit 1)	Moisture Content (%)	Dry Density (pcf)	Porosity (%)	Specific Gravity	Triaxial Permeability (cm/sec)	Falling Head Permeability (cm/sec)
			Laboratory Analysis					
LW-1	91.0	Landfill	73.9	52.7				
	96.0	Landfill	29.7				3.5E-07	
	143.0	Upper Gravel	0.6					
	172.0	Upper Silt	21.2	100.7				1.0E-05

Note: Laboratory moisture content values for samples collected from saturated zones may not represent actual field values.

Table C3
Landfill Aquifer Grain Size and Hydraulic Conductivity Data

Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	Grain Size				Hydraulic Conductivity (cm/sec)	
				% +#4	% -#200	d10 (mm)	d50 (mm)	Hazen's 1) Approximation	2) Vertical
MW-19	69.0	SM		0	10	0.075	0.25	5.60E-03	
	76.0	SM		0	13	0.015	0.14	2.2E-04	
	82.4	SM		0	12	--	0.2		
	88.0	CL?		--	--	--	--		2.8E-07 (T)
LW-1	91.0	ML		0	97	<0.001	0.0035		
	96.0	ML		9	67	0.0014	0.035		3.5E-07 (T)

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.

Table C4
Recent Alluvium Grain Size and Hydraulic Conductivity Data

				Grain Size				Hydraulic Conductivity (cm/sec)	
Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	% +#4	% -#200	d10 (mm)	d50 (mm)	Hazen's 1) Approximation	2) Vertical
MW-25	16.0	ML		0	61	0.008	0.058		
	36.0	ML		0	93	0.0028	0.012		
Mean									
Standard Deviation									

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.

Table C5
Upper Gravel Aquitard Grain Size and Hydraulic Condutivity Data

				Grain Size				Hydraulic Conductivity (cm/sec)	
Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	% +#4	% -#200	d10 (mm)	d50 (mm)	Hazen's 1) Approximation	2) Vertical
MW-7	145.0	SM		0	34	--	0.12		
	170.0	GW		93	1	5.8	21	34	
MW-8	94.0	SM		38	15	--	2.6	--	
MW-9	70.0	SM		5	29	0.0054	0.25		
MW-11	80.0	SM		24	18	--	0.7	--	
MW-13	105.0	SM		22	31	0.017	0.47		
MW-14	50.0	GM		46	15	--	3.4	--	
	110.0	GM		45	17	--	3.5	--	
MW-15	90.0	GM		45	14	--	3.2	--	
MW-16	85.0	GM		53	12	--	5.5	--	
MW-18	60.0	GP		87	3	3.1	23	9.6	
MW-21	41.5	GW		76	1	0.85	48	7.2E-01	
MW-23	51.0	SP		0	8	0.09	0.29	8.1E-03	
	70.0	GW		74	1	0.74	15	5.5E-01	
MW-24	154.0	SW		43	1	0.82	3.8	6.7E-01	
MW-26	68.0	SM		7	27	--	0.53		
	76.0	SM		24	28	--	0.44		
MW-28	5.0	SM		12	18	--	1.7	--	
	48.0	SM		4	30	--	0.35		
	98.0	SM		8	27	--	0.82		
MW-29	9.0	GP		87	6	0.4	35	1.6E-01	
	103.0	GP		87	0	1.5	35	2.2	
	185.0	ML		0	97	<0.001	0.009		2.3E-08 (T)
	200.0	SM		31	32	0.0035	0.41		

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.

Table C6
Upper Gravel Aquifer Grain Size and Hydraulic Conductivity Data

				Grain Size				Hydraulic Conductivity (cm/sec)	
Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	% +#4	% -#200	d10 (mm)	d50 (mm)	Hazen's 1) Approximation	2) Vertical
Clean Sands and Gravels (<9% fines)									
MW-7	220.0	GP		51	2	0.22	19	4.8E-02	
MW-11	141.0	SP		11	7	0.17	0.45	2.9E-02	
MW-16	135.0	GW		79	5	2	13	4	
	155.0	SP	33	13	7	0.15	1.2	2.2E-02	
MW-18	76.0	GW		89	1	5.0	30	25	
MW-20	115.0	SW		6	8	0.1	0.6	1.0E-02	
MW-21	89.0	SP		45	2	0.78	2.9	6.1E-01	
MW-22	105.0	SP		0	6	0.09	0.14	8.1E-03	
MW-26	117.0	SP		2	5	0.2	0.57	4.0E-02	
MW-27	80.0	GW		68	1	0.44	15	1.9E-01	
	153.0	SP		0	2	0.21	0.5	4.4E-02	
MW-29	215.0	SP		21	4	0.17	0.69	2.9E-02	
LW-1	143.0	GW		82	1	3	13	9	
Mean								3	
Standard Deviation								6.8	
Soils With >9% Fines									
MW-7	190.0	SM	24	19	18	0.023	0.37	5.3E-02	
	195.0	SM	32	10	12	0.06	0.24	3.6E-03	
	210.0	GM		47	10	0.09	2.9	8.1E-03	
MW-13	109.5	SM		1	10	0.07	0.9	4.9E-03	
MW-19	125.0	SM		21	9	0.09	2.5	8.1E-03	
	150.0	SM		34	9	0.12	0.8	1.4E-02	8.3E-05 (T)
MW-20	94.0	ML		1	54	0.011	0.06		
MW-21	137.0	GM		59	12	--	11	--	
MW-22	121.0	SM		13	49	<0.001	0.081		2.8E-08 (T)
MW-25	55.0	GM		39	48	0.0042	0.09		
MW-26	98	SM		0	10	0.081	0.3	6.6E-03	
Mean								1.4E-02	
Standard Deviation								1.6E-02	

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.

Table C7

Upper Silt Aquitard Grain Size and Hydraulic Conductivity Data

Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	Grain Size				Hydraulic Conductivity (cm/sec)	
				% +#4	% -#200	d10 (mm)	d50 (mm)	Hazen's 1) Approximation	2) Vertical
MW-11	171.0	ML		0	98	<0.001	0.015		8.5E-07 (T)
MW-13	136.5	ML	42	0	91	0.0023	0.025		1.8E-07 (T)
	165.0	ML		0	78	0.011	0.03		
MW-14	150.5	SP		0	7	0.091	0.2	8.3E-03	
MW-15	176.0	ML		2	90	<0.001	0.0095		
MW-16	188.5	ML		0	98	0.0019	0.0094		
MW-18	90.5	ML		0	100	0.0022	0.012		
	102.5	ML		0	99	<0.001	0.0094		3.4E-06 (T)
MW-20	135.5	ML		0	99	<0.001	0.0046		2.0E-07 (T)
MW-22	165.5	ML		0	98	0.0022	0.007		
MW-27	160.0	ML		0	93	0.0017	0.0095		2.0E-07 (T)
	180.0	ML		0	96	0.0034	0.025		
LW-1	172.5	ML		0	92	0.0026	0.015		1.0E-05 (F)
Mean									2.5E-06
Standard Deviation									3.6E-06

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.

Table C8
Sand Aquifer Grain Size and Hydraulic Conductivity Data

Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	Grain Size % +#4	Grain Size % -#200	Grain Size d10 (mm)	Grain Size d50 (mm)	Hydraulic Conductivity (cm/sec) Hazen's 1) Approximation	Hydraulic Conductivity (cm/sec) 2) Vertical
Clean Sands (<9% Fines)									
MW-10	105.0	SP	37	0	8	0.09	0.15	8.1E-03	
MW-12	120.5	SP		0	4	0.17	0.35	2.9E-02	3.3E-04 (F)
	176.0	SP		0	3	0.15	0.25	2.2E-02	
MW-13	180.0	SP	33	1	3	0.18	0.48	3.2E-02	1.9E-03 (F)
	195.5	SP		31	3	0.21	0.66	4.4E-02	
MW-15	200.0	SP		0	4	0.15	0.3	2.2E-02	
	231.0	SP	36	0	8	0.08	0.16	6.4E-03	1.2E-04 (F)
MW-17	125.0	SP		1	8	0.083	0.18	6.9E-03	
MW-18	121.0	SP		0	3	0.19	0.34	3.6E-02	
	151.0	SP		0	5	0.017	0.32	2.9E-04	1.1E-03 (T)
	175.5	SP		3	4	0.35	0.7	1.2E-01	
MW-21	177.5	SP		0	7	0.085	0.23	7.2E-03	1.0E-03 (F)
MW-23	240.0	SP		0	5	0.16	0.31	2.6E-02	8.5E-04 (F)
MW-24	205.0	SP		0	4	0.14	0.4	2.0E-02	3.1E-04 (F)
	250.0	SP		1	5	0.13	0.34	1.7E-02	
	282.0	SP		0	6	0.13	0.33	1.7E-02	
	302.0	SP		0	6	0.13	0.43	1.7E-02	
	307.0	SP		0	6	0.14	0.56	2.0E-02	2.6E-05 (F)
	327.0	SP		1	8	0.092	0.37	8.5E-03	
MW-25	71.0	SP		0	6	0.098	0.27	9.6E-03	
MW-28	110.0	SP		0	4	0.2	0.54	4.0E-02	
Mean								2.4E-02	7.0E-04
Standard Deviation								2.4E-02	5.9E-04
Soils with >9% Fines									
MW-7	225.0	SM	42	0	14	0.018	0.16	3.2E-04	
	230.0	SM	35	0	13	0.025	0.16	6.2E-04	
	240.0	SM	31	0	12	--	0.16	--	
	240.0	SM			22	--	--		3.2E-06 (F)
	250.0	SM		0	21	--	0.17		
MW-9	155.0	GM		44	20	--	3		
	179.0	SM	39	0	10	--	0.12	--	
MW-10	148.25	ML		0	85	0.0028	0.014		
	170.5	ML		0	100	0.0015	0.013		9.8E-07 (T)
	202.0	SM	44	0	39	--	0.099		
	225.5	SM		0	13	--	0.16	--	
MW-11	191.0	SM	38	0	18	--	0.11	--	3.0E-04 (F)
MW-12	162.0	ML		0	99	0.0029	0.017		
	205.0	ML		0	97	0.0058	0.031		
	221.0	SM		0	17	--	0.1	--	
	246.0	ML		0	97	0.007	0.08		

Table C8 (Continued)
Sand Aquifer Grain Size and Hydraulic Conductivity Data

				Grain Size				Hydraulic Conductivity (cm/sec)	
Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	% +#4	% -#200	d10 (mm)	d50 (mm)	Hazen's 1) Approximation	2) Vertical
MW-13	185.0	SM	37	0	17	--	0.21	--	
MW-14	181.0	SM		0	18	--	0.3	--	
	210.0	ML		0	98	0.0059	0.016		
MW-15	289.0	SM		0	13	--	0.16	--	
MW-17	119.0	SM		0	39	--	0.13		
MW-19	180.0	SM		0	20	--	0.17		7.5E-05 (T)
MW-20	190.0	SM	35	0	21	--	0.22		2.0E-04 (F)
MW-21	205.5	ML		0	59	0.0054	0.055		
MW-22	195.5	ML		0	62	0.011	0.056		
MW-23	210.0	SM		0	15	--	0.28		
	260.0	SM		1	35	--	0.17		
MW-24	237.0	SM		7	10	--	0.36		
	260.0	SM		21	35	0.0045	0.23		
MW-25	86.0	SM		25	45	0.0032	0.15		3.1E-07 (T)
	100.5	ML		0	99	0.0024	0.012		
MW-27	225.0	ML		0	81	0.0047	0.033		1.6E-05 (T)
MW-28	136.0	SM		0	11	--	0.18		
MW-29	270.0	SM		0	28	--	0.15		
	305.0	SM		0	20	--	0.18		
Mean									5.4E-05
Standard Deviation									9.7E-05

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.

Table C9
Lower Silt Aquitard Grain Size and Hydraulic Conductivity Data

Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	Grain Size				Hydraulic Conductivity (cm/sec)	
				% +#4	% -#200	d10 (mm)	d50 (mm)	Hazen's 1) Approximation	2) Vertical
MW-14	231.0	ML	47	0	77	0.0091	0.04		6.3E-05 (F)
MW-19	230.0	SM		0	45	0.0085	0.096		
	251.0	ML		0	57	0.0025	0.053		
MW-20	211.0	ML		0	92	<0.001	0.01		7.2E-07 (T)
	226.0	ML		3	62	0.0022	0.06		
	236.0	ML		19	52	0.01	0.07		
MW-21	270.0	ML		0	96	0.0021	0.02		4.3E-07 (T)
MW-24	332.0	SM		0	37	0.012	0.1		7.4E-06 (T)
	332.5	SM		0	39	0.016	0.09		
	337.5	SM		0	45	0.006	0.094		
Mean									1.8E-05
Standard Deviation									2.6E-05

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.

Table C10
Northern Gravel Aquifer Grain Size and Hydraulic Conductivity Data

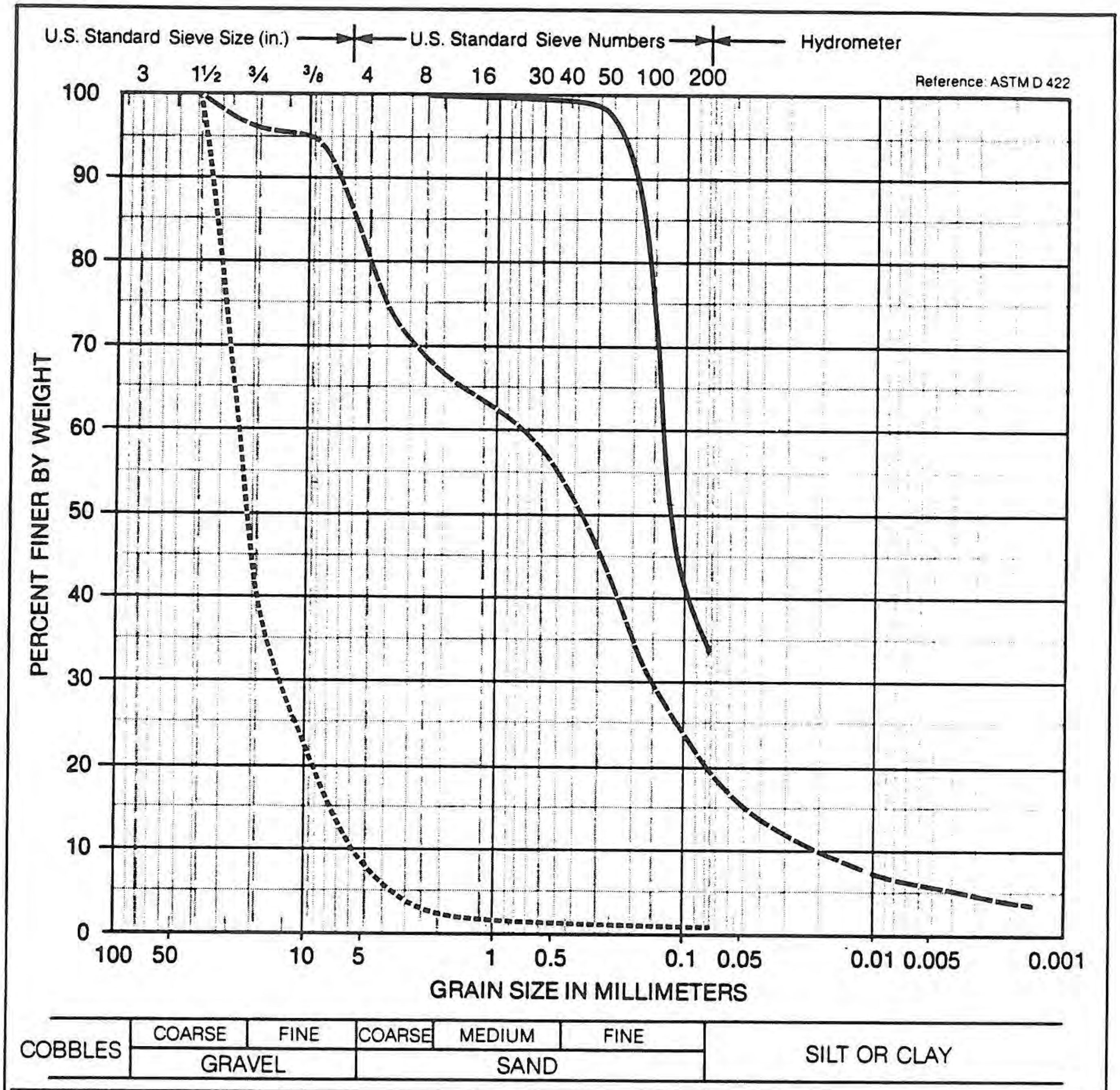
				Grain Size				Hydraulic Conductivity (cm/sec)	
Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	% +#4	% -#200	d10 (mm)	d50 (mm)	Hazen's 1) Approximation	2) Vertical
Clean Gravels and Sands (<9% Fines)									
MW-13	200.5	SP	36	3	4	0.16	0.3	2.56E-02	
	220.0	GP		62	4	0.3	14	9.0E-02	
MW-18	277.0	GW		65	3	0.55	12	3.0E-01	
	284.0	SW		47	3	0.25	4.7	6.2E-02	
MW-22	270.0	SP		33	4	0.27	1.6	7.3E-02	
	300.0	GP		65	1	2.14	7	5.8	
	328.0	GP		74	1	2.4	13	5.8	
MW-27	260.0	GP		60	0	0.45	18	2.0E-01	
Mean								1.5	
Standard Deviation								2.5	
Soils With >9% Fines									
MW-11	276.0	SM		3	30	--	0.12		
MW-18	265.5	ML		0	57	0.0024	0.044		
	298.0	GM		43	43	0.0023	1.5		3.1E-07 (T)
MW-22	284.0	ML	43	0	99	0.0013	0.0091		
MW-27	280.0	ML		8	89	<0.001	0.0053		

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.

Table C11
Southern Gravel Aquifer Grain Size and Hydraulic Conductivity Data

								Hydraulic Conductivity (cm/sec)	
				Grain Size				Hazen's 1)	2)
Boring Number	Sample Depth (ft)	Soil Type	Porosity (%)	% +#4	% -#200	d10 (mm)	d50 (mm)	Approximation	Vertical
Clean Gravels and Sands (<9% Fines)									
MW-14	275.0	SP		9	5	0.12	0.5	1.4E-02	
	305.0	SP		0	2	0.19	0.3	3.6E-02	
MW-19	295.0	SP		5	4	0.21	0.8	4.4E-02	
	305.0	SP		0	6	0.18	0.53	3.2E-02	
MW-20	281.0	SP		40	8	0.13	3.3	1.7E-02	1.2E-04 (F)
	301.0	GW		55	2	0.53	5.8	2.8E-01	
MW-23	310.0	SW		21	5	0.34	2.3	1.2E-01	
MW-24	355.0	SW		33	4	0.43	2.8	1.8E-01	
MW-29	375.0	GW		62	4	0.85	8	7.2E-01	
Mean								1.6E-01	
Standard Deviation								2.2E-01	
Soils With >9% Fines									
MW-14	315.0	ML		0	99	0.0055	0.022		2.68E-06 (T)
MW-20	320.0	ML	41	23	75	0.0034	0.025		
MW-23	352.0	ML		0	98	0.002	0.011		
MW-24	366.5	SM		39	15	0.03	2.4	9.0E-04	
MW-29	325.0	SM		0	15	--	0.35	--	
	345.0	ML?		--	--	--	--		3.5E-05 (F)
	355.0	ML		0	72	0.0097	0.044		3.0E-05 (F)
Mean									2.3E-05
Standard Deviation									1.4E-05

Notes: 1) Hazen's Permeability Approximation ($k = d10^2$) was calculated for gravels and sands with less than 20% fines.
2) Vertical Hydraulic Conductivity Test type: (T) - Triaxial Permeability; (F) Falling Head Permeability.



Symbol	Sample Source	Classification
━━━	MW-7 at 145.0 feet	Silty fine sand (SM)
┅┅┅	MW-7 at 170.0 feet	Fine to coarse gravel (GW) some sand
— — —	MW-7 at 190.0 feet	Silty gravelly sand (SM) trace clay

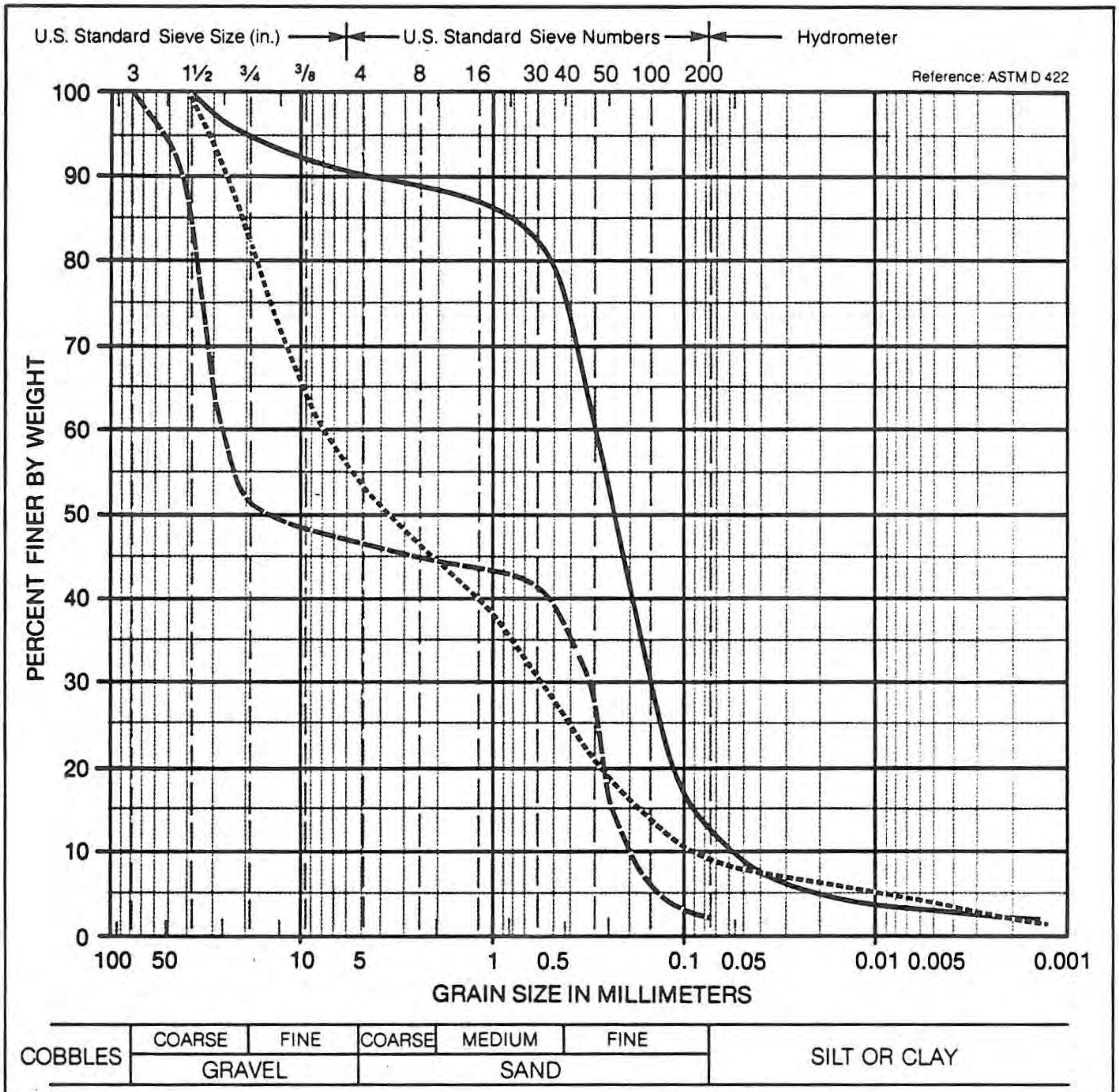
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-7 at 195.0 feet	Fine to medium sand (SM) some silt and gravel
·······	MW-7 at 210.0 feet	Sandy gravel (GM) some silt
– – –	MW-7 at 220.0 feet	Sandy coarse gravel (GP) trace silt

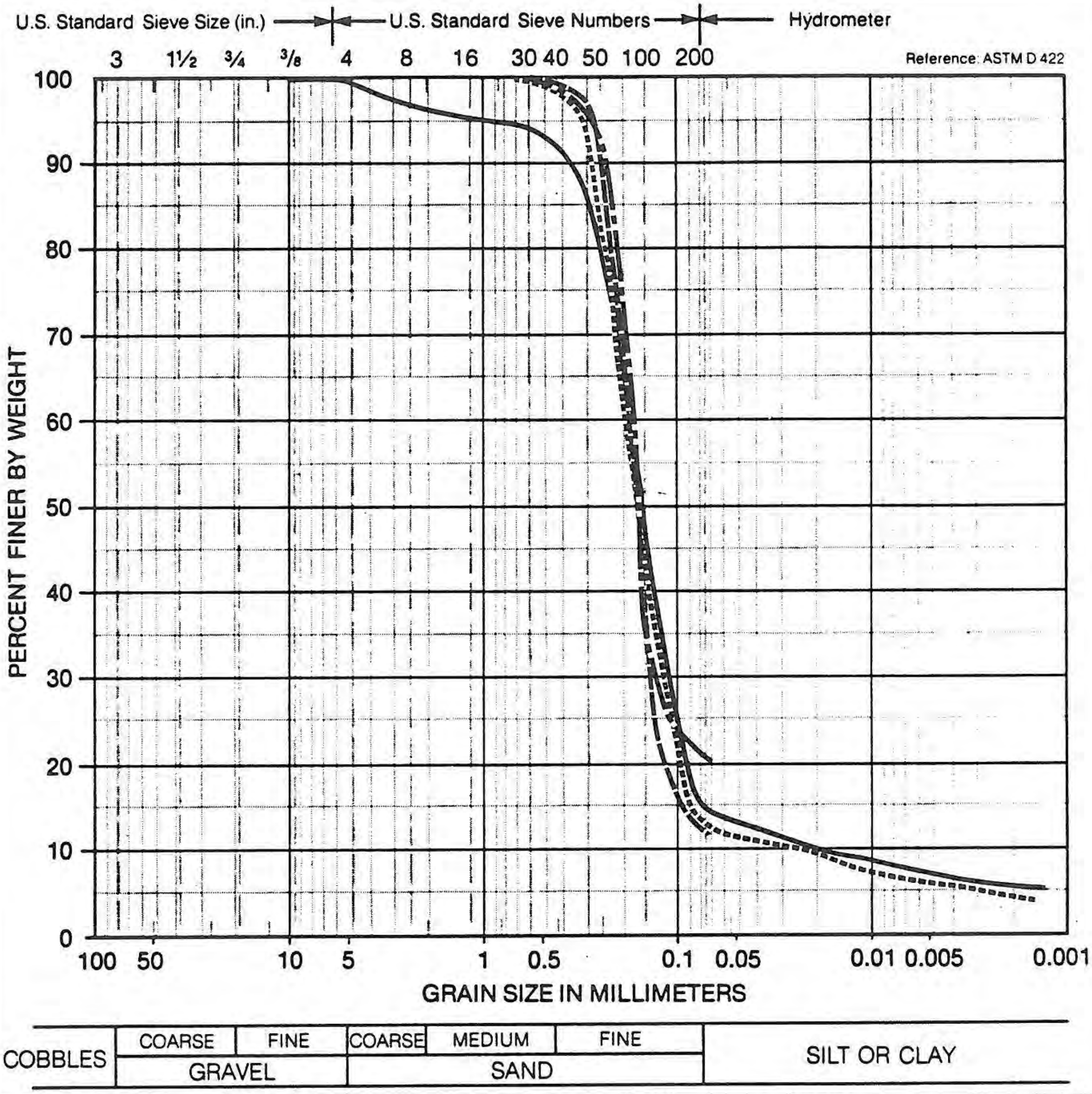
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Mdway Landfill
Kent, Washington

PLATE
C2

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
——	MW-7 at 225.0 feet	Silty fine sand (SM) trace gravel and clay
--------	MW-7 at 230.0 feet	Silty fine sand (SM) trace clay
— — —	MW-7 at 240.0 feet	Fine sand (SM) some silt
— - —	MW-7 at 250.0 feet	Silty sand (SM)

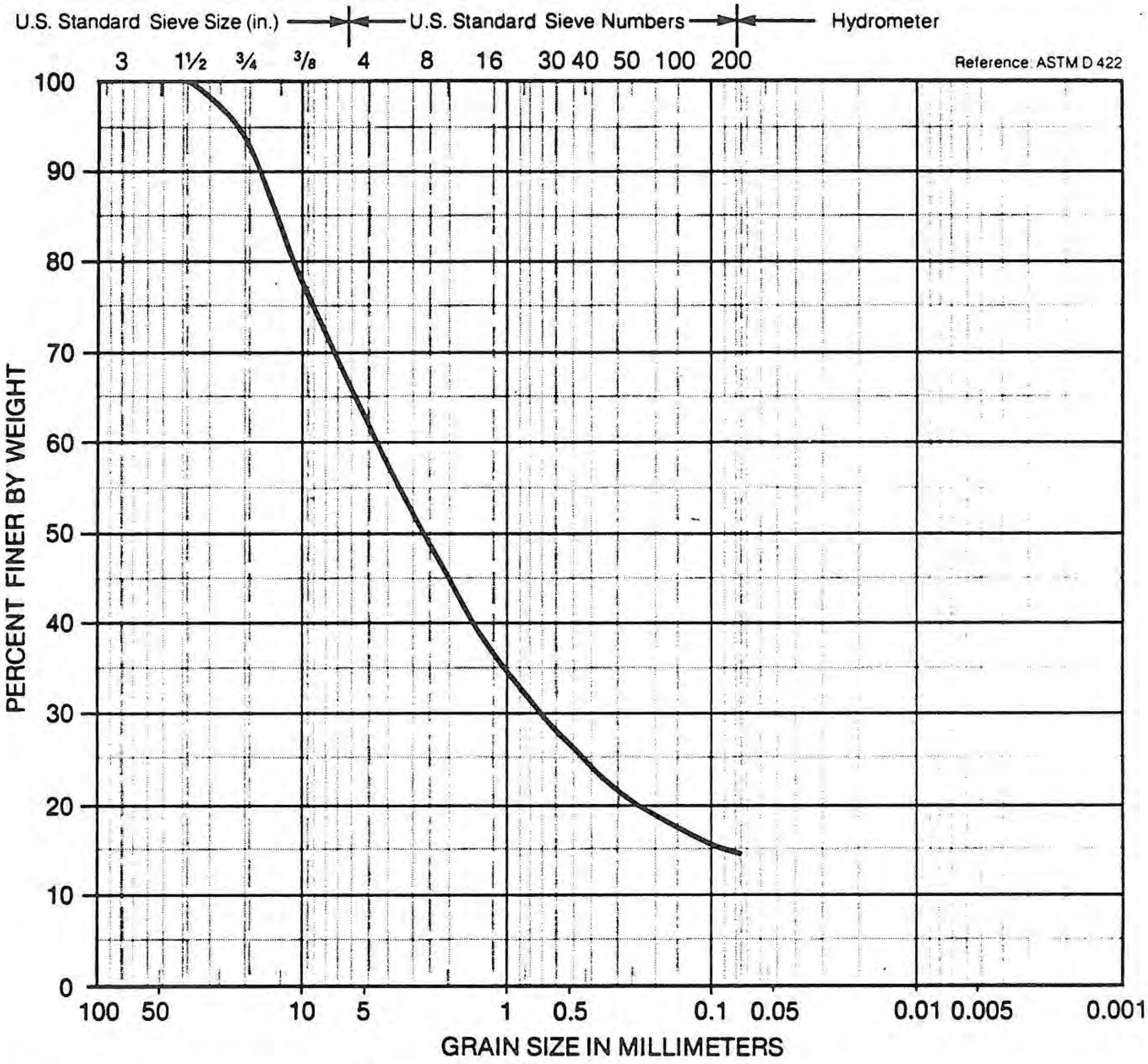
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT OR CLAY
	GRAVEL		SAND			

Symbol	Sample Source	Classification
—	MW-8 at 94.0 feet	Silty gravelly sand (SM)

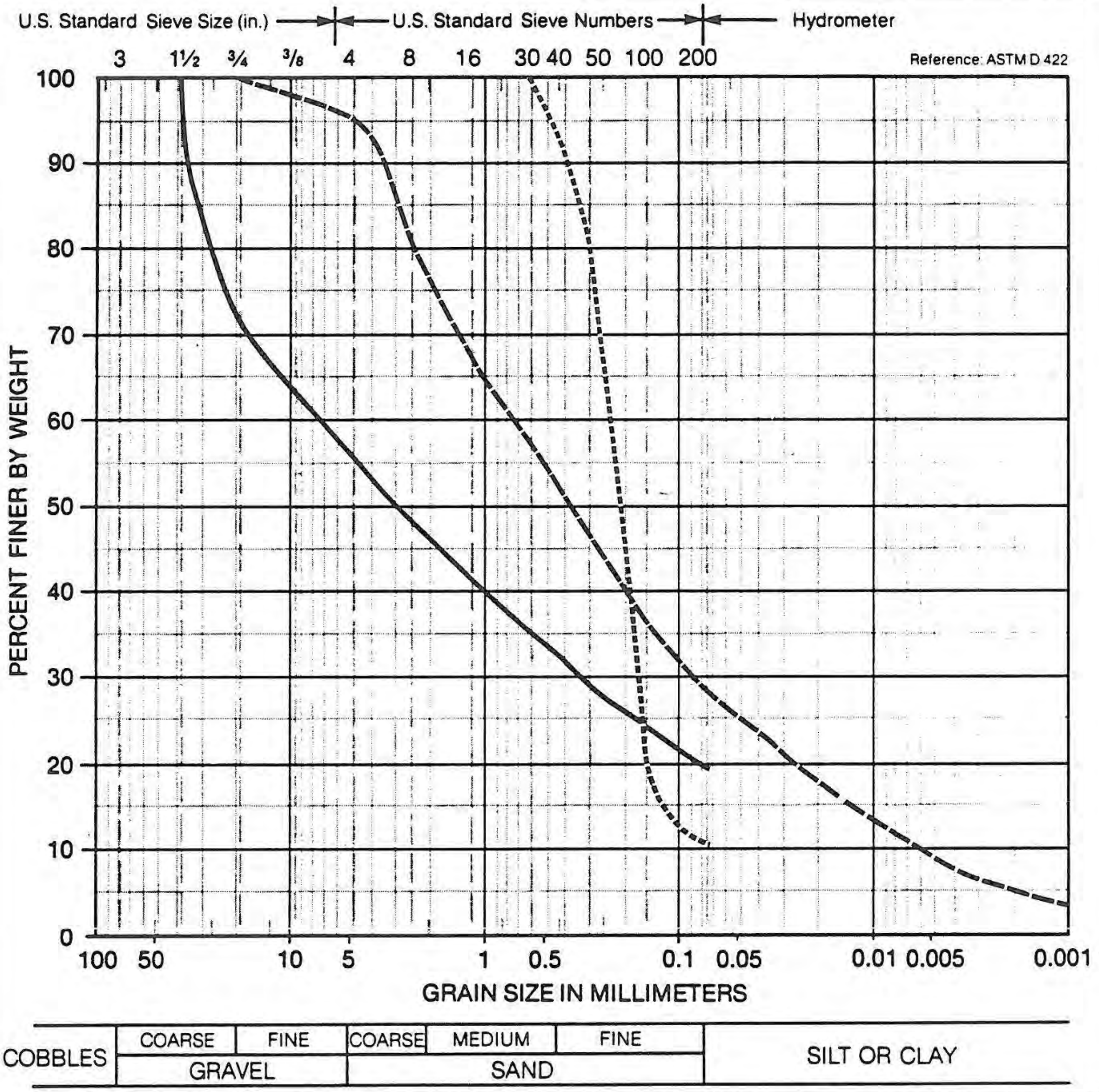
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
— — —	MW-9 at 70.0 feet	Silty sand (SM) trace gravel and clay
———	MW-9 at 155.0 feet	Silty sandy gravel (GM)
▪▪▪▪▪▪▪	MW-9 at 179.0 feet	Fine sand (SM) some silt

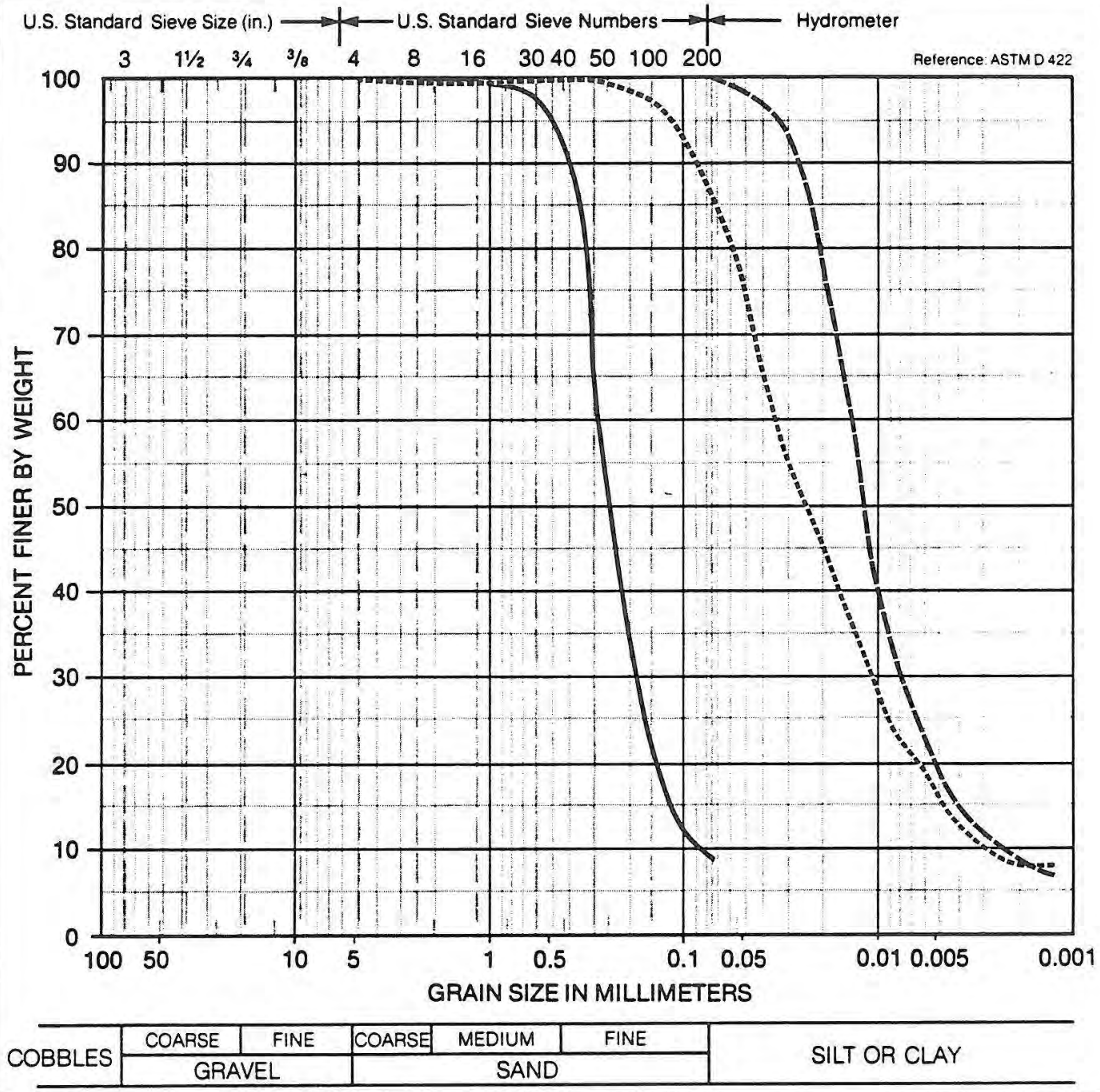
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14.169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
━━━━	MW-10 at 105.0 feet	Fine sand (SP) some silt
┅┅┅┅	MW-10 at 148.25 feet	Sandy silt (ML) some clay
╍╍╍╍	MW-10 at 170.5 feet	Silt (ML) some clay

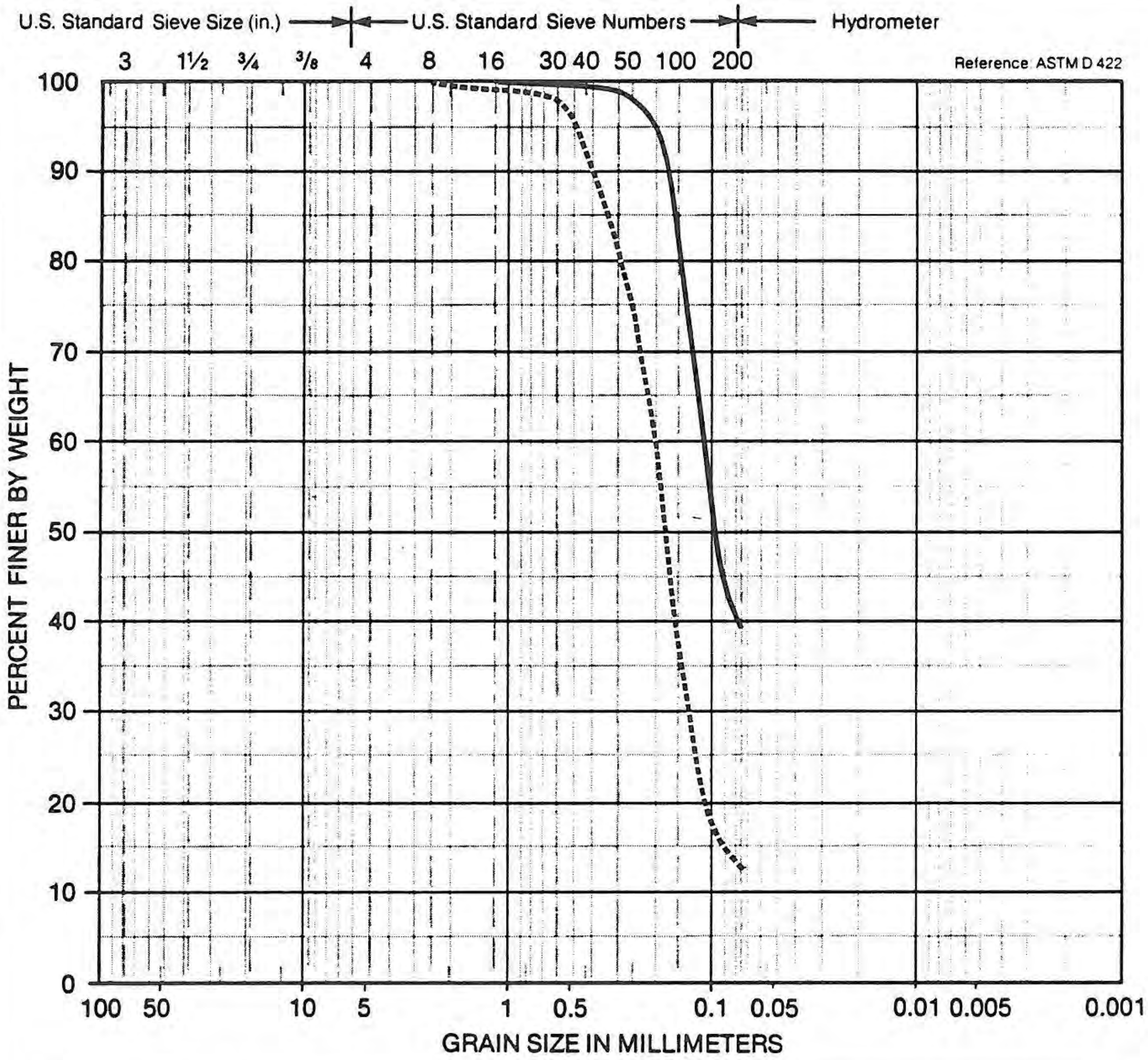
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
━━━━	MW-10 at 202.0 feet	Silty fine sand (SM) trace organics
┅┅┅┅	MW-10 at 225.5 feet	Silty fine sand (SM)

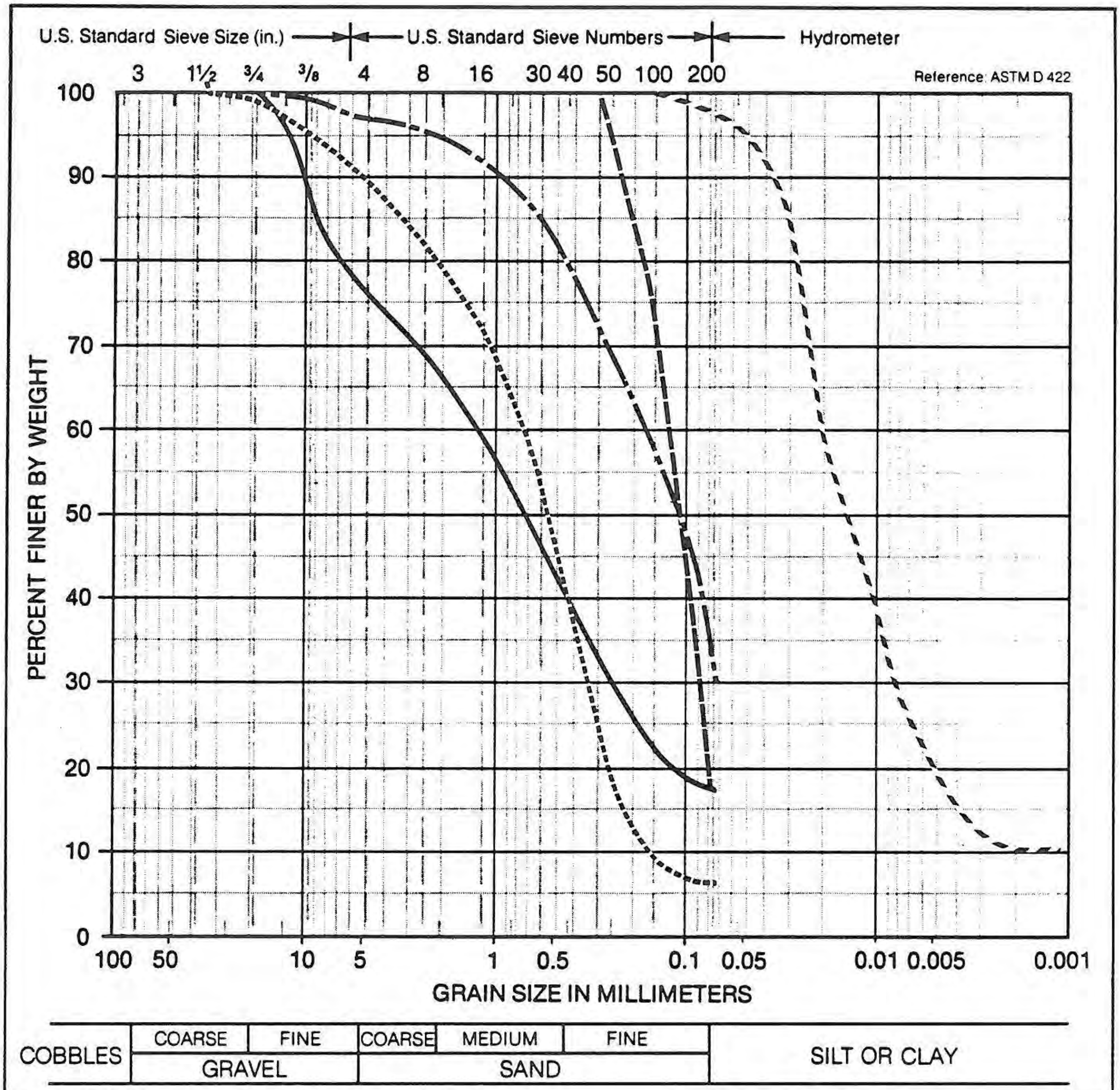
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-11 at 80.0 feet	Silty gravelly sand (SM)
▪▪▪▪▪▪▪▪	MW-11 at 141.0 feet	Fine to coarse sand (SP) some gravel and silt
▬ ▬ ▬ ▬	MW-11 at 171.0 feet	Silt (ML) some clay, trace sand
▬▬ ▬▬	MW-11 at 191.0 feet	Silty fine sand (SM)
▬▬ ▪ ▬	MW-11 at 276.0 feet	Silty sand (SM) trace gravel

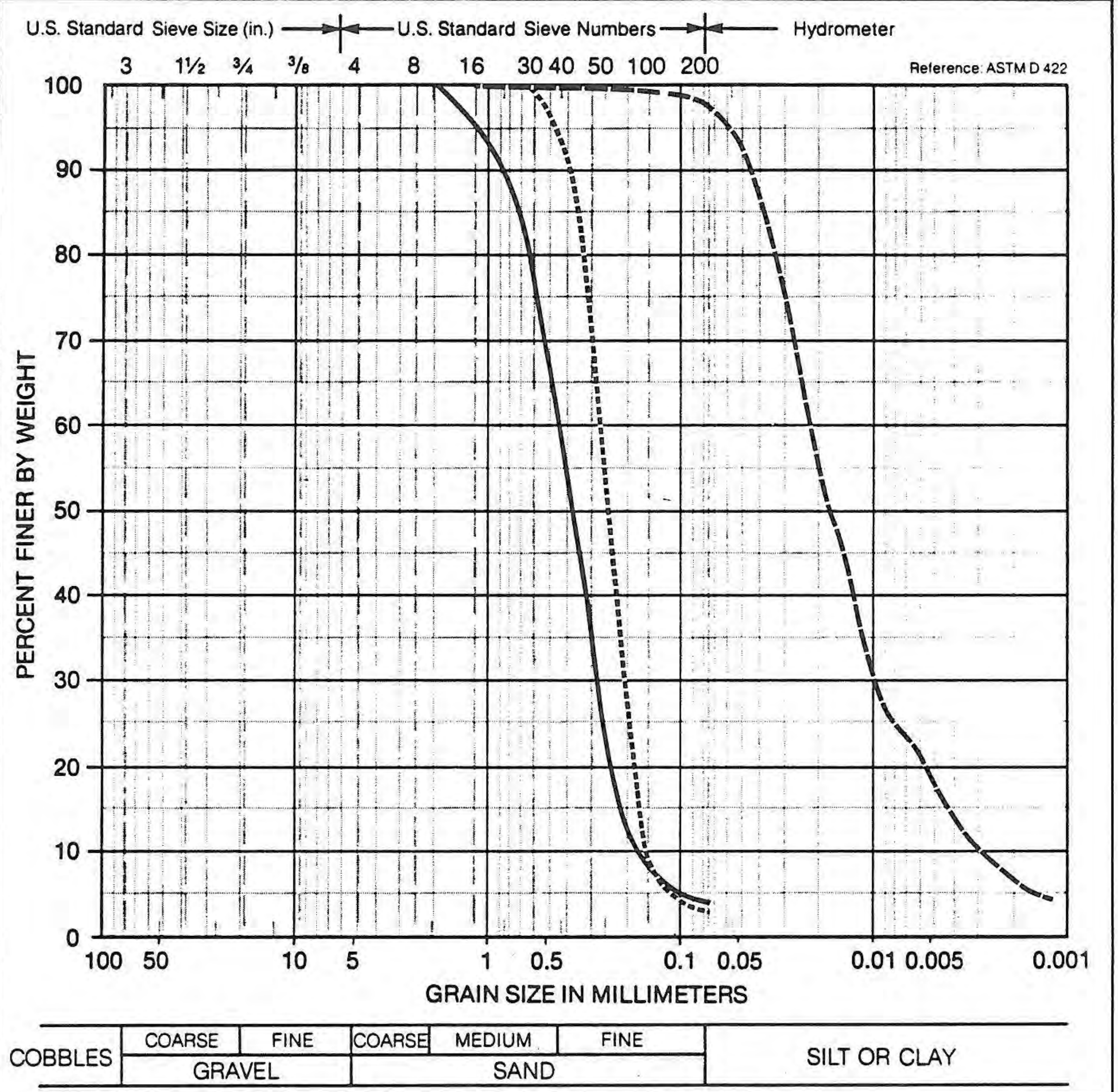
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
━━━	MW-12 at 120.5 feet	Medium to fine grained sand (SP) trace silt
▪▪▪▪	MW-12 at 176.0 feet	Fine sand (SP) trace silt
▬ ▬	MW-12 at 162.0 feet	Silt (ML) some clay, trace sand

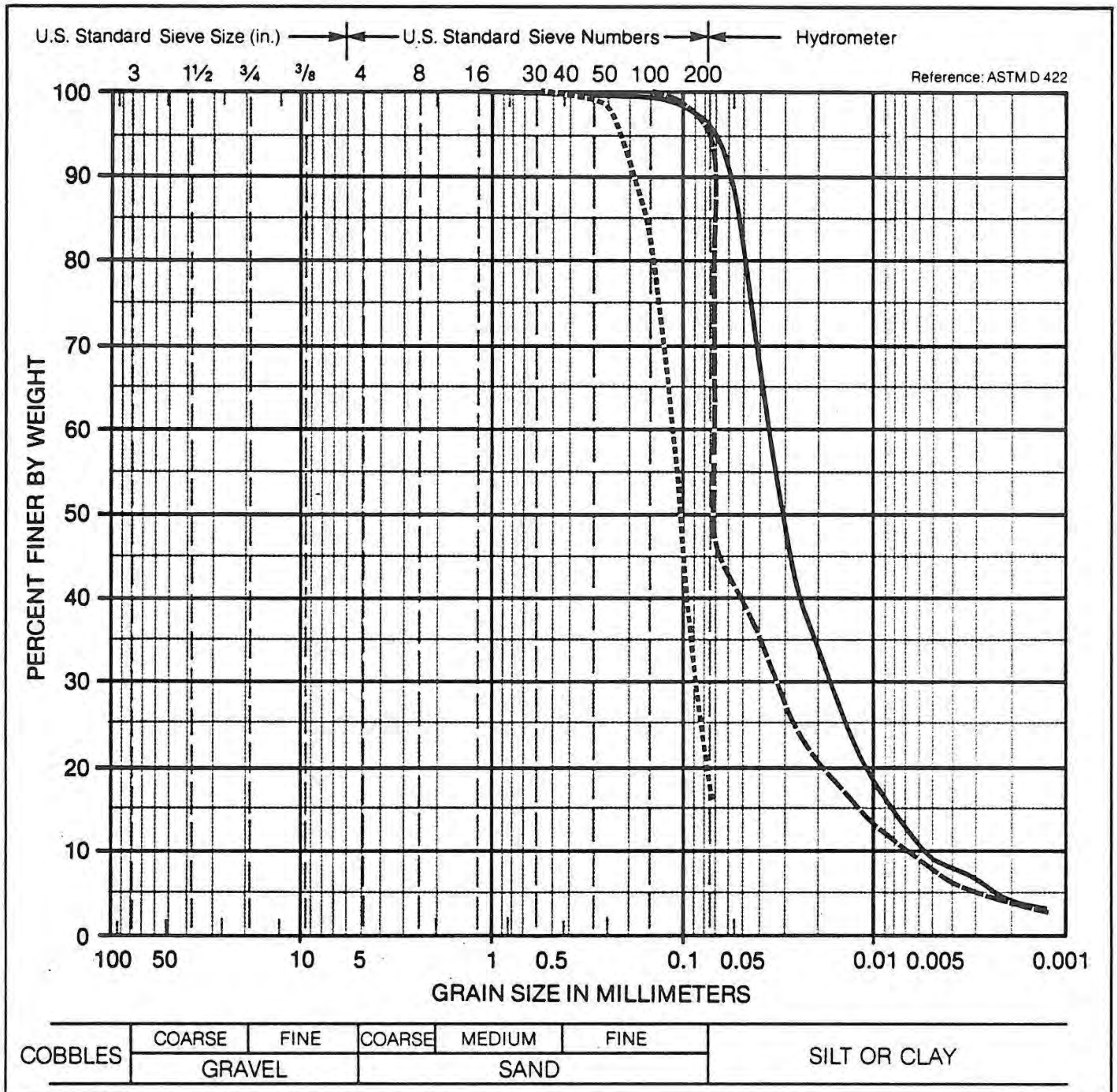
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C9

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
━━━	MW-12 at 205.0 feet	Silt (ML) trace sand and clay
┅┅┅	MW-12 at 221.0 feet	Silty fine sand (SM)
━ ━ ━	MW-12 at 246.0 feet	Silt (ML) trace sand and clay

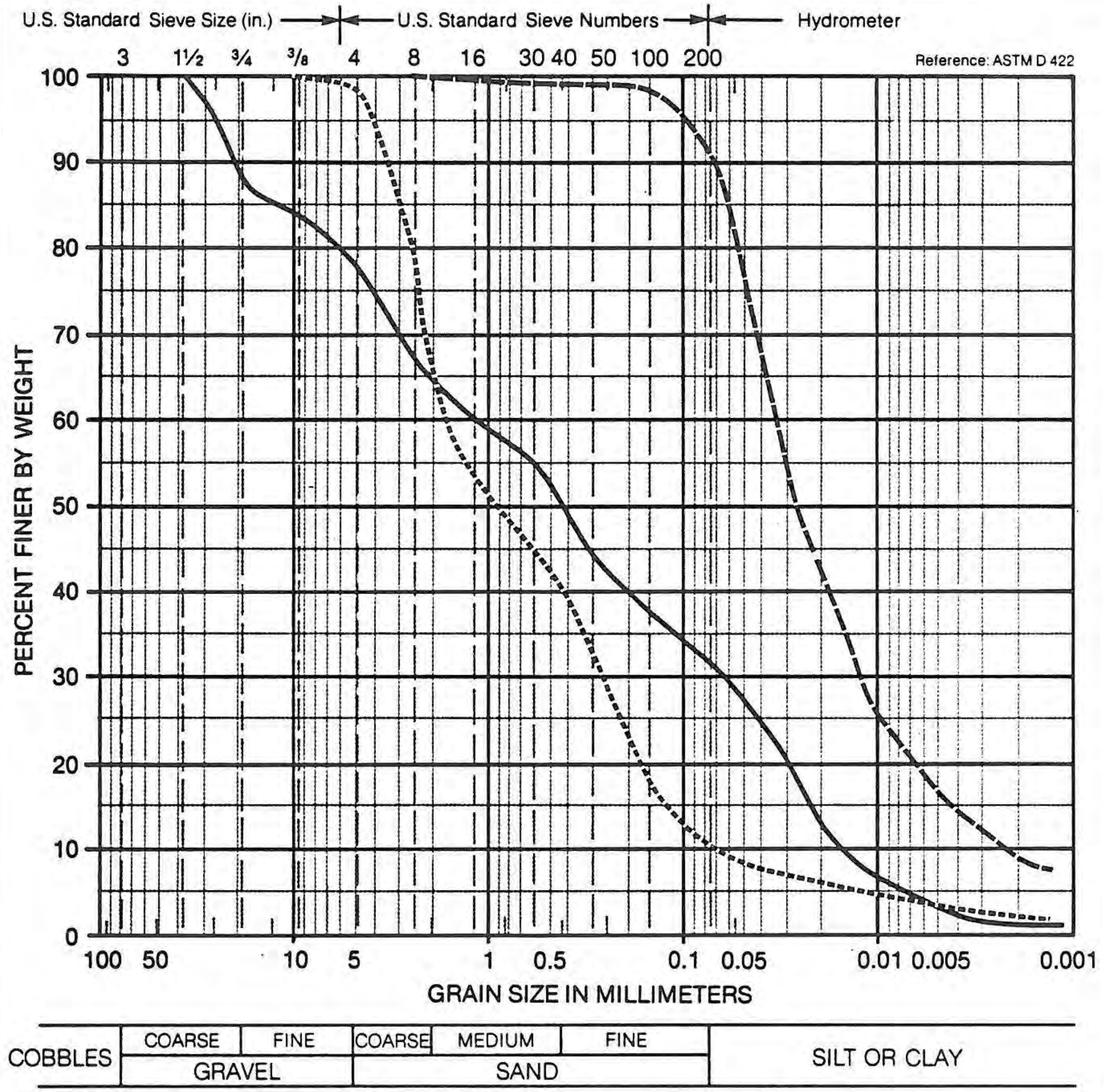
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C10

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-13 at 105.0 feet	Gravelly silty sand (SM)
▪▪▪▪▪▪▪	MW-13 at 109.5 feet	Fine to coarse sand (SM) some silt, trace clay
— — —	MW-13 at 136.5 feet	Silt (ML) some sand and clay

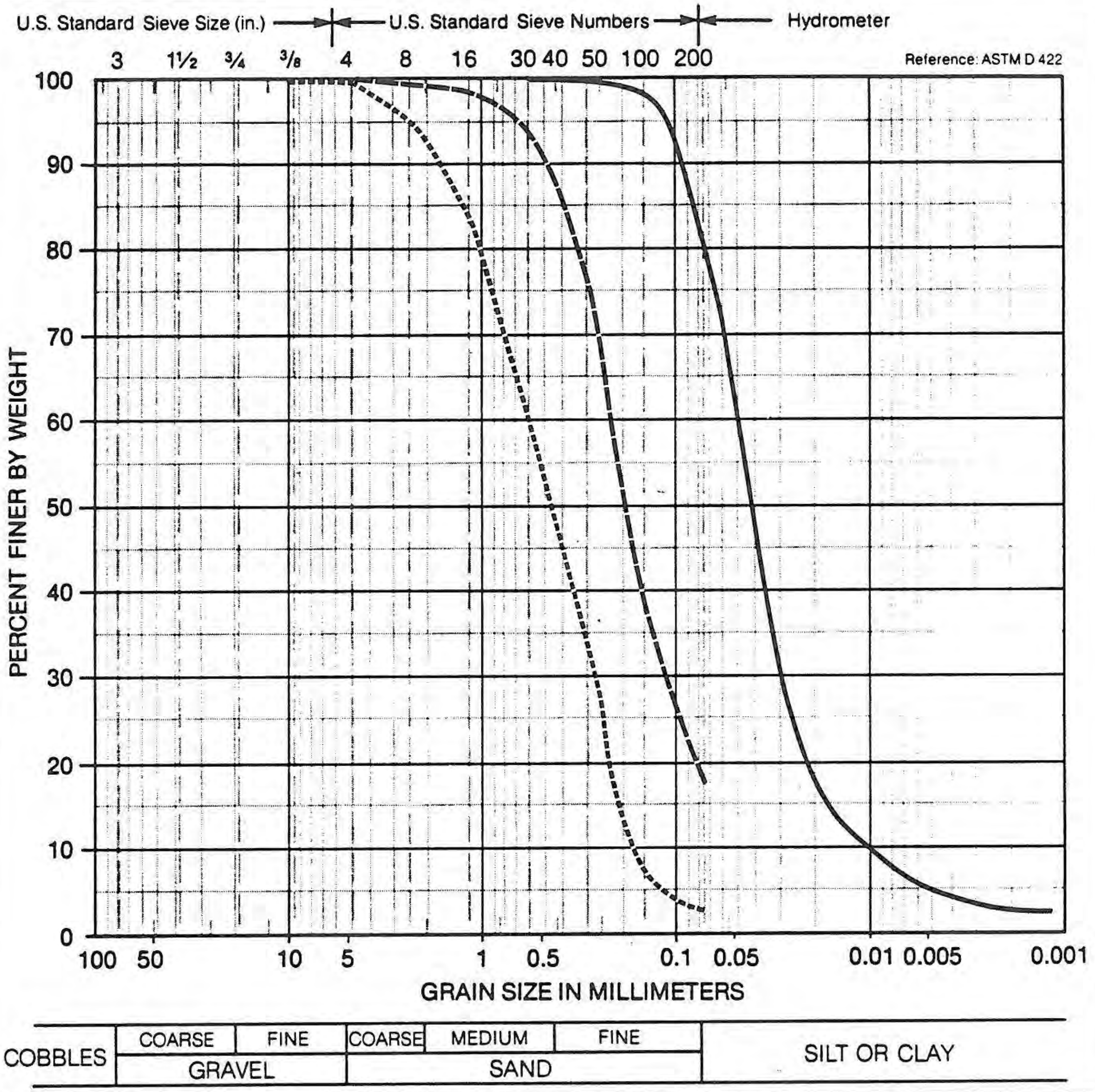
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C11

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
───	MW-13 at 165.0 feet	Sandy silt (ML) trace clay
▪▪▪▪▪▪▪	MW-13 at 180.0 feet	Fine to medium sand (SP) trace silt and gravel
— — —	MW-13 at 185.0 feet	Silty fine sand (SM)

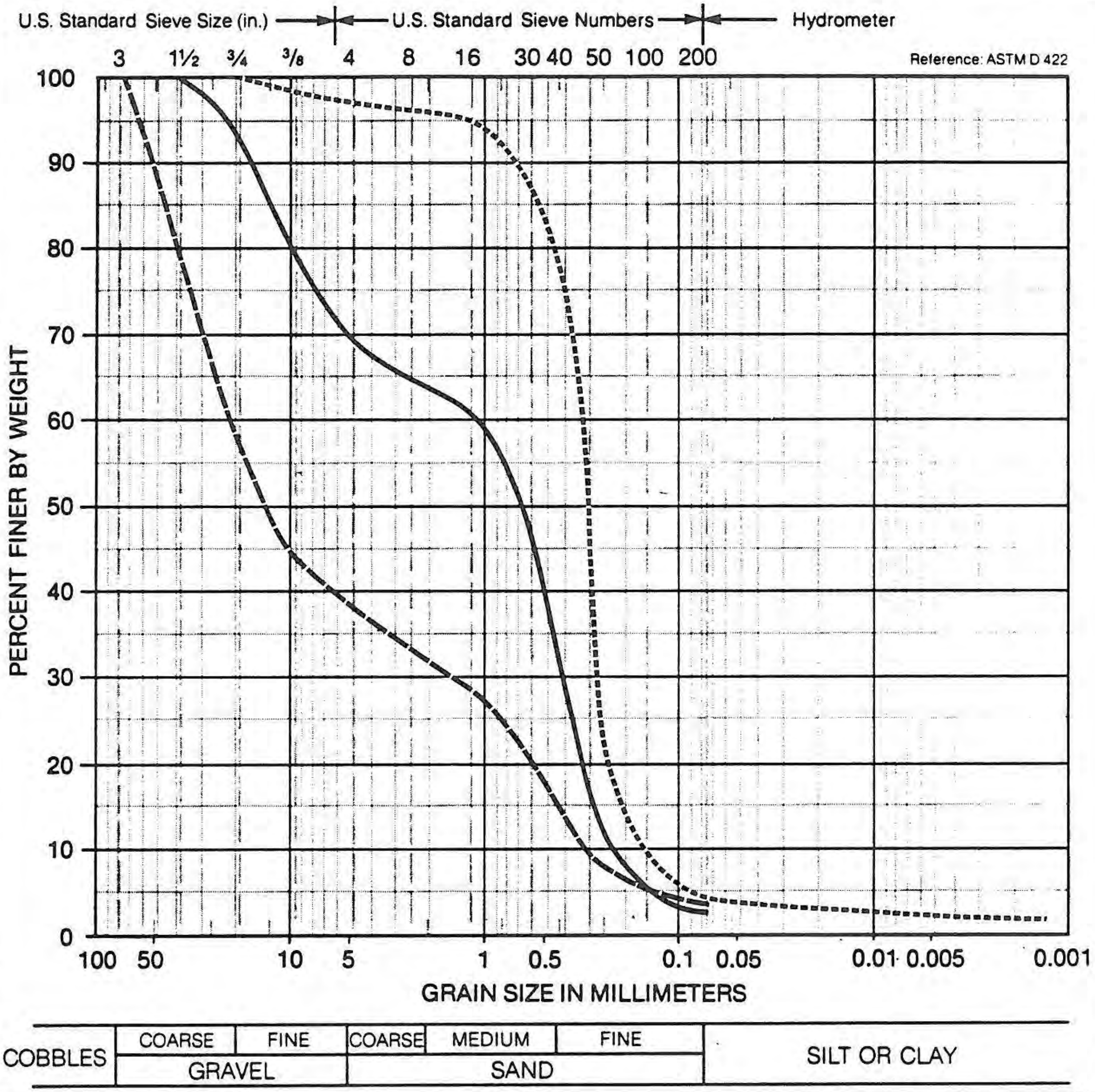
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C12

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
WJ	14,169.102	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-13 at 195.5 feet	Gravelly fine to medium sand (SP) trace silt
▪▪▪▪▪▪▪	MW-13 at 200.5 feet	Fine to medium sand (SP) trace silt and gravel
— — —	MW-13 at 220.0 feet	Sandy gravel (GP) trace silt

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C13

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		

APPENDIX D

Groundwater Elevation Data

APPENDIX D

Groundwater Elevation Data

This Appendix summarizes most water level data collected for this and previous hydrogeologic investigations at the Midway Landfill. The water level data are summarized in the following three tables:

Table D1: Groundwater Elevation Records: Selected BH and MW Monitor Wells January 1984 to Present

Table D2: Groundwater Elevation Records: All Wells August 1986 to Present

Table D3: Gas Extraction Well or Gas Probe Water Level Data From Landfill

Table D1 summarizes groundwater elevation data from wells installed prior to 1986 during previous investigations by Golder Associates. Water level data included in the Table date from January 1984 to the present. Data available from as early as 1981 were excluded in part because of the sheer volume of data and in part because it did not provide any information beyond that already available from examining the post-1984 data. Wells included in Table D1 are BH-2A, BH-2B, BH-3, BH-4, BH-5, BH-6, BH-8, MW-1, MW-2, MW-4, and MW-5. Wells BH-1B and BH-7 were excluded because they have always been dry and Well MW-6 was excluded because water level data from it cannot be readily correlated with study area water levels.

Table D2 is a complete summary of all water level data and includes all wells installed during our hydrogeologic investigation and previous investigations. Water level records included in Table D2 extend from August 13, 1986 to the present for all the wells included in Table D1, plus Wells BH-1B, BH-7, and MW-6 through MW-29. Wells MW-7 through MW-29 were installed by AGI.

Water level monitoring began in the first Golder BH wells in 1982 or 1983. Monitoring of the first five AGI wells (MW-7, MW-10, MW-13, MW-15, and MW-17) began in December 1986. New AGI monitor wells were added to the monitoring program as they were installed. The last well, MW-27, was included in the monitoring program in October 1987.

Table D3 is a summary of one water level measurement round made during February 1987, in all accessible gas probes and gas extraction wells in and immediately adjacent to the Landfill, and a summary of miscellaneous measurements from other probes and wells in 1987 and 1988. No other synoptic water level data from the landfill is available, to our knowledge, except that obtained from Wells BH-7, BH-5, LW-1, LW-2 and MW-19A.

All three tables were compiled using Lotus Version 2.1 software. The tables were constructed to simplify the addition of more water level data as it becomes available.

Most of the wells installed by AGI are double or triple completions. The relative depths of the screen zones in the multiple completions are designated by the letters A, B, or C attached to the well number. The shallowest well is designated by the letter A, such as MW-7A, while the deeper well or wells are designated by the following letters B and C. MW-27C would be the deepest of three wells placed in the Boring MW-27.

Most of the water level data included in Tables D1 and D2 was collected by City of Seattle personnel. This data is presented as is; questionable or inconsistent data has not been removed or flagged. In most cases, questionable data consists of a sudden increase or decrease in water elevation followed by an equally sudden return to the previous water elevation. These jumps reflect difficulties in obtaining consistently accurate water level measurements in deep wells. They did not have an adverse impact on data interpretation since consistent water level measurements generally preceded and followed the aberrant measurement. Measurement frequency for any given well varied slightly, but in general the wells were measured on a weekly basis. Raw field data is compiled by the City of Seattle Midway Landfill staff, and then transferred to Seattle Solid Waste Utility headquarters. This data is then made available to AGI and other contractors working on the Midway RI. A few measurements listed in the tables were obtained by AGI staff.

All well survey elevations were surveyed by Parametrix Inc. The City of Seattle instructed Parametrix to initiate their survey from a benchmark located south of the southwest corner of the Midway Landfill at the corner of Highway 99 and South 252nd Street (phone conversation with Clark Rowland of Parametrix, 10/6/87). The datum for this benchmark is unknown (phone conversation with Bill Blackenchip, Seattle Engineering, 10/19/87). For each well, the top of casing, top of monument, and ground surface were surveyed. Water level measurements are generally depth below top of casing.

Following Tables D1, D2, and D3 are hydrographs of most wells showing water level variations with time.

Table D1
Groundwater Elevation Records: Selected BH and MW Monitor Wells
January 1984 to Present*

Well No.	BH-2A		BH-2B		BH-3		BH-4		BH-5		BH-6	
Meas. Pt. Elevation	376.91		377.18		379.68		380.54		392.73		386.53	
Screen Elevation	252.9 - 250.9		326.9 - 324.9		263.9 - 261.9		297.7 - 295.7		304.3 - 302.3		255.5 - 245.5	
Date	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)
03-Jan-84	NA	NA	NA	NA	112.73	266.95	81.46	299.08	79.15	313.58	NA	NA
01-Feb-84	NA	NA	NA	NA	112.67	267.01	71.68	308.86	79.19	313.54	115.33	271.20
01-Mar-84	NA	NA	NA	NA	114.00	265.68	71.38	309.16	78.89	313.84	115.38	271.15
02-Apr-84	NA	NA	NA	NA	113.74	265.94	71.21	309.33	78.67	314.06	115.14	271.39
01-May-84	NA	NA	NA	NA	114.60	265.08	70.73	309.81	77.80	314.93	117.63	268.90
01-Jun-84	NA	NA	NA	NA	114.42	265.26	70.90	309.64	78.34	314.39	NA	NA
02-Jul-84	NA	NA	NA	NA	114.74	264.94	71.05	309.49	78.30	314.43	121.39	265.14
01-Aug-84	NA	NA	NA	NA	115.84	263.84	71.28	309.26	78.14	314.59	123.81	262.72
31-Aug-84	24.96	351.95	48.83	328.35	115.86	263.82	71.63	308.91	78.43	314.30	128.89	257.64
01-Oct-84	25.29	351.62	49.82	327.36	115.85	263.83	71.93	308.61	78.76	313.97	129.00	257.53
01-Nov-84	25.30	351.61	50.16	327.02	115.82	263.86	71.74	308.80	78.47	314.26	131.48	255.05
30-Nov-84	16.29	360.62	50.08	327.10	114.76	264.92	71.72	308.82	78.62	314.11	130.00	256.53
02-Jan-85	17.70	359.21	49.07	328.11	112.84	266.84	71.55	308.99	79.15	313.58	121.08	265.45
31-Jan-85	21.32	355.59	49.38	327.80	115.08	264.60	71.07	309.47	79.04	313.69	123.60	262.93
01-Mar-85	19.51	357.40	49.82	327.36	115.48	264.20	71.07	309.47	78.75	313.98	126.14	260.39
01-Apr-85	15.46	361.45	50.29	326.89	115.66	264.02	71.55	308.99	79.14	313.59	129.78	256.75
01-May-85	22.44	354.47	50.55	326.63	115.75	263.93	71.22	309.32	78.97	313.76	130.69	255.84
29-May-85	23.99	352.92	51.31	325.87	115.71	263.97	71.44	309.10	78.89	313.84	134.24	252.29
19-Jun-85	24.78	352.13	51.35	325.83	115.69	263.99	71.52	309.02	79.15	313.58	135.51	251.02
31-Oct-85	11.19	365.72	51.32	325.86	115.59	264.09	72.58	307.96	79.78	312.95	135.72	250.81
05-Dec-85	7.18	369.73	51.34	325.84	115.50	264.18	72.21	308.33	79.92	312.81	134.12	252.41
26-Dec-85	13.00	363.91	50.84	326.34	114.89	264.79	72.08	308.46	79.51	313.22	131.13	255.40
28-Jan-86	10.88	366.03	48.50	328.68	109.08	270.60	71.65	308.89	79.65	313.08	129.68	256.85
25-Feb-86	11.15	365.76	47.29	329.89	110.48	269.20	71.58	308.96	79.61	313.12	116.84	269.69
09-Apr-86	14.63	362.28	47.30	329.88	112.21	267.47	71.85	308.69	80.36	312.37	120.66	265.87
30-May-86	18.17	358.74	50.34	326.84	115.46	264.22	72.25	308.29	79.68	313.05	132.42	254.11
20-Jul-86	22.72	354.19	51.30	325.88	115.00	264.68	72.79	307.75	79.80	312.93	Dry	NA
13-Aug-86	24.53	352.38	51.39	325.79	115.40	264.28	72.71	307.83	80.43	312.30	Dry	NA
20-Aug-86	24.68	352.23	51.31	325.87	115.44	264.24	72.77	307.77	78.78	313.95	Dry	NA
27-Aug-86	24.77	352.14	51.36	325.82	115.40	264.28	72.73	307.81	80.07	312.66	Dry	NA
03-Sep-86	24.77	352.14	51.36	325.82	115.42	264.26	72.74	307.80	80.10	312.63	Dry	NA
17-Sep-86	24.88	352.03	51.50	325.68	115.40	264.28	72.81	307.73	79.35	313.38	Dry	NA
24-Sep-86	24.75	352.16	51.39	325.79	115.40	264.28	72.44	308.10	79.82	312.91	Dry	NA
15-Oct-86	24.79	352.12	51.38	325.80	115.27	264.41	73.19	307.35	80.55	312.18	Dry	NA
12-Nov-86	25.44	351.47	51.40	325.78	114.98	264.70	72.81	307.73	80.57	312.16	Dry	NA
19-Nov-86	25.21	351.70	51.41	325.77	115.11	264.57	72.47	308.07	80.24	312.49	Dry	NA
17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	20.37	356.54	51.40	325.78	115.82	263.86	72.36	308.18	80.33	312.40	Dry	NA
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	19.15	357.76	51.41	325.77	109.30	270.38	68.00	312.54	80.09	312.64	Dry	NA
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	18.31	358.60	51.38	325.80	109.18	270.50	68.19	312.35	80.32	312.41	Dry	NA

* See Notes at end of table.

Table D1 (Continued)
Groundwater Elevation Records: Selected BH and MW Monitor Wells
January 1984 to Present

Well No.	BH-2A		BH-2B		BH-3		BH-4		BH-5		BH-6	
Meas. Pt. Elevation	376.91		377.18		379.68		380.54		392.73		386.53	
Screen Elevation	252.9 - 250.9		326.9 - 324.9		263.9 - 261.9		297.7 - 295.7		304.3 - 302.3		255.5 - 245.5	
Date	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)
15-Jan-87												
21-Jan-87	18.31	358.60	51.36	325.82	109.58	270.10	67.68	312.86	79.91	312.82	Dry	NA
10-Feb-87	16.50	360.41	51.27	325.91	104.87	274.81	66.00	314.54	79.64	313.09	Dry	NA
17-Feb-87	16.43	360.48	51.26	325.92	105.70	273.98	66.25	314.29	80.09	312.64	Dry	NA
25-Feb-87	17.10	359.81	52.32	324.86	107.14	272.54	66.04	314.50	79.69	313.04	Dry	NA
05-Mar-87	16.26	360.65	51.33	325.85	107.59	272.09	66.53	314.01	81.25	311.48	Dry	NA
10-Mar-87	15.72	361.19	51.12	326.06	105.16	274.52	66.09	314.45	78.99	313.74	Dry	NA
24-Mar-87	15.93	360.98	51.13	326.05	106.38	273.30	66.72	313.82	79.61	313.12	Dry	NA
31-Mar-87	17.31	359.60	51.05	326.13	107.70	271.98	66.26	314.28	79.24	313.49	Dry	NA
14-Apr-87	17.37	359.54	51.17	326.01	NA	NA	NA	NA	79.23	313.50	Dry	NA
28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-May-87												
12-May-87	18.14	358.77	51.24	325.94	112.70	266.98	67.88	312.66	79.81	312.92	Dry	NA
19-May-87	18.98	357.93	51.31	325.87	113.43	266.25	68.35	312.19	79.72	313.01	Dry	NA
26-May-87	19.86	357.05	58.31	318.87	114.02	265.66	68.46	312.08	79.70	313.03	Dry	NA
01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Jun-87	20.36	356.55	51.30	325.88	113.88	265.80	69.06	311.48	80.13	312.60	Dry	NA
09-Jun-87	21.09	355.82	51.35	325.83	114.46	265.22	68.80	311.74	80.02	312.71	Dry	NA
16-Jun-87	21.62	355.29	51.32	325.86	NA	NA	NA	NA	NA	NA	Dry	NA
23-Jun-87	22.16	354.75	51.33	325.85	NA	NA	NA	NA	NA	NA	Dry	NA
30-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-Jul-87	23.05	353.86	51.33	325.85	115.24	264.44	69.27	311.27	NA	NA	Dry	NA
20-Jul-87	23.60	353.31	51.22	324.69	115.10	264.58	69.53	311.01	81.00	311.73	Dry	NA
27-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Aug-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Aug-87	24.00	352.91	51.00	324.91	115.00	264.68	69.95	310.59	81.00	311.73	Dry	NA
17-Aug-87	24.00	352.91	51.00	324.91	110.00	269.68	62.00	318.54	81.00	311.73	Dry	NA
31-Aug-87	24.40	352.51	81.30	294.61	115.00	264.68	70.00	310.54	77.00	315.73	Dry	NA
08-Sep-87	24.40	352.51	51.20	324.71	115.20	264.48	77.00	303.54	77.00	315.73	Dry	NA
11-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
21-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
29-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D1 (Continued)
Groundwater Elevation Records: Selected BH and MW Monitor Wells
January 1984 to Present

Well No.	BH-8		MW-1		MW-2		MW-4		MW-5	
Meas. Pt. Elevation	362.61		365.99		384.39		362.82		321.94	
Screen Elevation	261.0 - 251.0		280.4 - 244.4		256.0 - 226.0		252.8 - 219.1		274.8 - 244.9	
Date	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)
03-Jan-84	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Feb-84	85.68	276.93	NA	NA	NA	NA	NA	NA	NA	NA
01-Mar-84	86.06	276.55	NA	NA	NA	NA	NA	NA	NA	NA
02-Apr-84	85.60	277.01	NA	NA	NA	NA	NA	NA	NA	NA
01-May-84	86.29	276.32	NA	NA	NA	NA	NA	NA	NA	NA
01-Jun-84	87.83	274.78	NA	NA	NA	NA	NA	NA	NA	NA
02-Jul-84	89.36	273.25	NA	NA	NA	NA	NA	NA	NA	NA
01-Aug-84	91.98	270.63	NA	NA	NA	NA	NA	NA	NA	NA
31-Aug-84	94.78	267.83	NA	NA	NA	NA	NA	NA	NA	NA
01-Oct-84	97.58	265.03	NA	NA	NA	NA	NA	NA	NA	NA
01-Nov-84	98.64	263.97	NA	NA	NA	NA	NA	NA	NA	NA
30-Nov-84	92.84	269.77	NA	NA	NA	NA	NA	NA	NA	NA
02-Jan-85	88.38	274.23	NA	NA	NA	NA	NA	NA	NA	NA
31-Jan-85	89.13	273.48	NA	NA	NA	NA	NA	NA	NA	NA
01-Mar-85	9.52	353.09	NA	NA	NA	NA	NA	NA	NA	NA
01-Apr-85	91.88	270.73	NA	NA	NA	NA	NA	NA	NA	NA
01-May-85	92.29	270.32	57.28	308.71		384.39	106.31	256.51	NA	NA
29-May-85	94.80	267.81	57.69	308.30	144.10	240.29	106.38	256.44	NA	NA
19-Jun-85	95.18	267.43	58.15	307.84	144.10	240.29	106.51	256.31	NA	NA
31-Oct-85	101.01	261.60	61.62	304.37	146.90	237.49	107.93	254.89	70.15	251.79
05-Dec-85	94.22	268.39	61.04	304.95	147.46	236.93	108.15	254.67	69.21	252.73
26-Dec-85	91.92	270.69	61.06	304.93	146.92	237.47	107.84	254.98	68.89	253.05
28-Jan-86	87.00	275.61	58.73	307.26	146.26	238.13	107.46	255.36	63.13	258.81
25-Feb-86	84.48	278.13	58.08	307.91	145.63	238.76	107.46	255.36	62.00	259.94
09-Apr-86	83.58	279.03	57.70	308.29	144.00	240.39	107.31	255.51	59.62	262.32
30-May-86	93.08	269.53	58.31	307.68	144.34	240.05	106.95	255.87	61.43	260.51
20-Jul-86	94.48	268.13	59.04	306.95	145.25	239.14	107.33	255.49	63.70	258.24
13-Aug-86	101.40	261.21	60.04	305.95	146.41	237.98	107.46	255.36	66.34	255.60
20-Aug-86	102.31	260.30	60.23	305.76	146.52	237.87	107.40	255.42	66.46	255.48
27-Aug-86	102.75	259.86	60.44	305.55	146.81	237.58	107.50	255.32	67.17	254.77
03-Sep-86	102.88	259.73	60.54	305.45	146.98	237.41	107.59	255.23	67.53	254.41
17-Sep-86	104.56	258.05	61.00	304.99	147.52	236.87	107.81	255.01	68.35	253.59
24-Sep-86	104.76	257.85	60.83	305.16	147.53	236.86	107.63	255.19	68.83	253.11
15-Oct-86	105.38	257.23	61.57	304.42	148.04	236.35	108.06	254.76	69.71	252.23
12-Nov-86	103.54	259.07	62.42	303.57	148.70	235.69	107.75	255.07	70.45	251.49
19-Nov-86	102.66	259.95	63.16	302.83	148.84	235.55	108.31	254.51	70.57	251.37
17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	90.93	271.68	62.08	303.91	149.17	235.22	108.16	254.66	66.71	255.23
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	88.25	274.36	61.05	304.94	149.57	234.82	107.93	254.89	65.30	256.64
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	86.89	275.72	60.93	305.06	149.82	234.57	108.19	254.63	68.63	253.31

Table D1 (Continued)
Groundwater Elevation Records: Selected BH and MW Monitor Wells
January 1984 to Present

Well No.	BH-8		MW-1		MW-2		MW-4		MW-5	
Meas. Pt. Elevation	362.61		365.99		384.39		362.82		321.94	
Screen Elevation	261.0 - 251.0		280.4 - 244.4		256.0 - 226.0		252.8 - 219.1		274.8 - 244.9	
Date	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)	Depth to Water (feet)	Water Level Elev. (feet)
15-Jan-87										
21-Jan-87	86.44	276.17	60.53	305.46	149.72	234.67	107.87	254.95	63.01	258.93
10-Feb-87	82.67	279.94	59.86	306.13	149.67	234.72	107.08	255.74	59.07	262.87
17-Feb-87	82.14	280.47	58.48	307.51	149.74	234.65	107.89	254.93	58.97	262.97
25-Feb-87	83.78	278.83	58.42	307.57	149.51	234.88	107.84	254.98	58.88	263.06
05-Mar-87	83.53	279.08	58.11	307.88	149.35	235.04	106.92	255.90	57.69	264.25
10-Mar-87	82.62	279.99	57.60	308.39	149.14	235.25	106.60	256.22	56.74	265.20
24-Mar-87	82.05	280.56	56.61	309.38	149.14	235.25	106.97	255.85	55.57	266.37
31-Mar-87	82.44	280.17	56.66	309.33	148.93	235.46	106.43	256.39	56.65	265.29
14-Apr-87	84.50	278.11	57.38	308.61	148.85	235.54	106.58	256.24	56.30	265.64
28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-May-87			58.67	307.32	148.95	235.44	106.92	255.90		
12-May-87	89.16	273.45	58.26	307.73	148.72	235.67	106.60	256.22	58.00	263.94
19-May-87	90.24	272.37	58.65	307.34	148.76	235.63	106.66	256.16	58.43	263.51
26-May-87	91.34	271.27	58.81	307.18	148.78	235.61	106.64	256.18	NA	NA
01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Jun-87	92.32	270.29	59.39	306.60	148.93	235.46	106.95	255.87	59.54	262.40
09-Jun-87	93.20	269.41	59.40	306.59	149.00	235.39	106.93	255.89	60.05	261.89
16-Jun-87	94.10	268.51	59.65	306.34	149.16	235.23	106.99	255.83	60.53	261.41
23-Jun-87	94.93	267.68	57.81	308.18	149.26	235.13	107.00	255.82	61.13	260.81
30-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	61.60	260.34
07-Jul-87	96.48	266.13	58.79	307.20	149.31	235.08	106.95	255.87	62.19	259.75
20-Jul-87	97.88	264.73	59.82	306.04	149.47	234.94	107.02	255.80	63.23	258.71
27-Jul-87	NA	NA	60.16	305.70	149.65	234.76	107.20	255.62	63.82	258.12
03-Aug-87	NA	NA	60.38	305.48	149.64	234.77	107.06	255.76	64.32	257.62
11-Aug-87	99.75	262.86	60.80	305.06	149.78	234.63	107.33	255.49	64.95	256.99
17-Aug-87	105.20	257.41	61.35	304.51	150.04	234.37	107.59	255.23	65.49	256.45
31-Aug-87	101.70	260.91	60.98	304.88	150.19	234.22	107.54	255.28	66.41	255.53
08-Sep-87	102.00	260.61	NA	NA	NA	NA	NA	NA	NA	NA
11-Sep-87	NA	NA	61.37	304.49	150.35	234.06	107.63	255.19	67.19	254.75
14-Sep-87	NA	NA	61.26	304.60	150.39	234.02	107.69	255.13	67.33	254.61
21-Sep-87	NA	NA	NA	NA	149.77	234.62	107.25	255.57	65.64	256.30
29-Sep-87	NA	NA	62.22	303.77	150.67	233.72	107.86	254.96	68.37	253.57

Notes:
1. All values in feet.
2. Measuring point elevations provided by Parametrix, Inc. in feet above datum established by City of Seattle.
3. Measuring points as follows: **Top of protective steel casing for MW-1, MW-2,3,6 to 29. **Top of PVC well casing for BH-1 to BH-8, MW-4 and MW-5.
4. NA indicates no data; ERR indicates erroneous water depth measurement.
5. Measuring point for BH-5 was lowered 3.03 feet in July 1987. Tabulated water levels are 3.03 feet lower than actual field measurements for the period prior to 7-20-87.

Table D2
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	Well No.	BH-1B		BH-2A		BH-2B		BH-3		BH-4		BH-5		BH-6	
Meas. Pt. Elevation	Meas. Pt. Elevation	344.70		376.91		377.18		379.68		380.54		392.73		386.53	
Screen Elevation	Screen Elevation	250.6 - 248.6		352.9 - 350.9		326.9- 324.9		263.9 - 261.9		297.7 - 295.7		304.3 - 302.3		255.5 - 245.5	
Date	Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	13-Aug-86	dry	NA	24.53	352.38	51.39	325.79	115.40	264.28	72.71	307.83	80.43	312.30	Dry	NA
20-Aug-86	20-Aug-86	dry	NA	24.68	352.23	51.31	325.87	115.44	264.24	72.77	307.77	78.78	313.95	Dry	NA
27-Aug-86	27-Aug-86	dry	NA	24.77	352.14	51.36	325.82	115.40	264.28	72.73	307.81	80.07	312.66	Dry	NA
03-Sep-86	03-Sep-86	dry	NA	24.77	352.14	51.36	325.82	115.42	264.26	72.74	307.80	80.10	312.63	Dry	NA
17-Sep-86	17-Sep-86	dry	NA	24.88	352.03	51.50	325.68	115.40	264.28	72.81	307.73	79.35	313.38	Dry	NA
24-Sep-86	24-Sep-86	dry	NA	24.75	352.16	51.39	325.79	115.40	264.28	72.44	308.10	79.82	312.91	Dry	NA
15-Oct-86	15-Oct-86	dry	NA	24.79	352.12	51.38	325.80	115.27	264.41	73.19	307.35	80.55	312.18	Dry	NA
12-Nov-86	12-Nov-86	dry	NA	25.44	351.47	51.40	325.78	114.98	264.70	72.81	307.73	80.57	312.16	Dry	NA
19-Nov-86	19-Nov-86	dry	NA	25.21	351.70	51.41	325.77	115.11	264.57	72.47	308.07	80.24	312.49	Dry	NA
17-Nov-86	17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	02-Dec-86	dry	NA	20.37	356.54	51.40	325.78	115.82	263.86	72.36	308.18	80.33	312.40	Dry	NA
11-Dec-86	11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	31-Dec-86	dry	NA	19.15	357.76	51.41	325.77	109.30	270.38	68.00	312.54	80.09	312.64	Dry	NA
07-Jan-87	07-Jan-87	dry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	14-Jan-87	dry	NA	18.31	358.60	51.38	325.80	109.18	270.50	68.19	312.35	80.32	312.41	Dry	NA
15-Jan-87	15-Jan-87														
21-Jan-87	21-Jan-87	dry	NA	18.31	358.60	51.36	325.82	109.58	270.10	67.68	312.86	79.91	312.82	Dry	NA
10-Feb-87	10-Feb-87	dry	NA	16.50	360.41	51.27	325.91	104.87	274.81	66.00	314.54	79.64	313.09	Dry	NA
17-Feb-87	17-Feb-87	dry	NA	16.43	360.48	51.26	325.92	105.70	273.98	66.25	314.29	80.09	312.64	Dry	NA
25-Feb-87	25-Feb-87	dry	NA	17.10	359.81	52.32	324.86	107.14	272.54	66.04	314.50	79.69	313.04	Dry	NA
05-Mar-87	05-Mar-87	dry	NA	16.26	360.65	51.33	325.85	107.59	272.09	66.53	314.01	81.25	311.48	Dry	NA
10-Mar-87	10-Mar-87	dry	NA	15.72	361.19	51.12	326.06	105.16	274.52	66.09	314.45	78.99	313.74	Dry	NA
24-Mar-87	24-Mar-87	dry	NA	15.93	360.98	51.13	326.05	106.38	273.30	66.72	313.82	79.61	313.12	Dry	NA
31-Mar-87	31-Mar-87	dry	NA	17.31	359.60	51.05	326.13	107.70	271.98	66.26	314.28	79.24	313.49	Dry	NA
14-Apr-87	14-Apr-87	NA	NA	17.37	359.54	51.17	326.01	NA	NA	NA	NA	79.23	313.50	Dry	NA
28-Apr-87	28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-May-87	12-May-87	dry	NA	18.14	358.77	51.24	325.94	112.70	266.98	67.88	312.66	79.81	312.92	Dry	NA
15-May-87	15-May-87														
19-May-87	19-May-87	dry	NA	18.98	357.93	51.31	325.87	113.43	266.25	68.35	312.19	79.72	313.01	Dry	NA
26-May-87	26-May-87	dry	NA	19.86	357.05	58.31	318.87	114.02	265.66	68.46	312.08	79.70	313.03	Dry	NA
01-Jun-87	01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Jun-87	02-Jun-87	dry	NA	20.36	356.55	51.30	325.88	113.88	265.80	69.06	311.48	80.13	312.60	Dry	NA
09-Jun-87	09-Jun-87	dry	NA	21.09	355.82	51.35	325.83	114.46	265.22	68.80	311.74	80.02	312.71	Dry	NA
16-Jun-87	16-Jun-87	dry	NA	21.62	355.29	51.32	325.86	NA	NA	NA	NA	NA	NA	Dry	NA
23-Jun-87	23-Jun-87	NA	NA	22.16	354.75	51.33	325.85	NA	NA	NA	NA	NA	NA	Dry	NA
30-Jun-87	30-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-Jul-87	07-Jul-87	NA	NA	23.05	353.86	51.33	325.85	115.24	264.44	69.27	311.27	NA	NA	Dry	NA
20-Jul-87	20-Jul-87	blocked	NA	23.60	353.31	51.22	325.96	115.10	264.58	69.53	311.01	81.00	311.73	Dry	NA
27-Jul-87	27-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Aug-87	03-Aug-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Aug-87	11-Aug-87	ERR	ERR	24.00	352.91	51.00	326.18	115.00	264.68	69.95	310.59	81.00	311.73	Dry	NA
17-Aug-87	17-Aug-87	ERR	ERR	24.00	352.91	51.00	326.18	110.00	269.68	62.00	318.54	81.00	311.73	Dry	NA
31-Aug-87	31-Aug-87	ERR	ERR	24.40	352.51	81.30	295.88	115.00	264.68	70.00	310.54	77.00	315.73	Dry	NA
08-Sep-87	08-Sep-87	ERR	ERR	24.40	352.51	51.20	325.98	115.20	264.48	77.00	303.54	77.00	315.73	Dry	NA
11-Sep-87	11-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Sep-87	14-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
21-Sep-87	21-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
29-Sep-87	29-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1. All values in feet.
2. Measuring point elevations provided by Parametrix, Inc. in feet above datum established by City of Seattle.
3. Measuring points as follows: **Top of protective steel casing for MW-1, MW-2,3,6 to 29. **Top of PVC well casing for BH-1 to BH-8, MW-4 and MW-5.
4. NA indicates no data; ERR indicates erroneous water depth measurement.

Table D2 (Continued)
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	BH-7		BH-8		MW-1		MW-2		MW-3		MW-4		MW-5	
Meas. Pt. Elevation	393.01		362.61		365.99		384.39		416.11		362.82		321.94	
Screen Elevation	260.0 - 258.0		261.0 - 251.0		280.4 - 244.4		256.0 - 226.0		260.0 - 228.1		252.8 - 219.1		274.8 - 244.9	
Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	NA	NA	101.40	261.21	60.04	305.95	146.41	237.98	dry	NA	107.46	255.36	66.34	255.60
20-Aug-86	92.73	300.28	102.31	260.30	60.23	305.76	146.52	237.87	dry	NA	107.40	255.42	66.46	255.48
27-Aug-86	92.67	300.34	102.75	259.86	60.44	305.55	146.81	237.58	dry	NA	107.50	255.32	67.17	254.77
03-Sep-86	92.69	300.32	102.88	259.73	60.54	305.45	146.98	237.41	dry	NA	107.59	255.23	67.53	254.41
17-Sep-86	92.67	300.34	104.56	258.05	61.00	304.99	147.52	236.87	dry	NA	107.81	255.01	68.35	253.59
24-Sep-86	NA	NA	104.76	257.85	60.83	305.16	147.53	236.86	dry	NA	107.63	255.19	68.83	253.11
15-Oct-86	dry	NA	105.38	257.23	61.57	304.42	148.04	236.35	dry	NA	108.06	254.76	69.71	252.23
12-Nov-86	dry	NA	103.54	259.07	62.42	303.57	148.70	235.69	dry	NA	107.75	255.07	70.45	251.49
19-Nov-86	dry	NA	102.66	259.95	63.16	302.83	148.84	235.55	dry	NA	108.31	254.51	70.57	251.37
17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	dry	NA	90.93	271.68	62.08	303.91	149.17	235.22	dry	NA	108.16	254.66	66.71	255.23
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	dry	NA	88.25	274.36	61.05	304.94	149.75	234.64	dry	NA	107.93	254.89	65.30	256.64
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	dry	NA	86.89	275.72	60.93	305.06	149.82	234.57	dry	NA	108.19	254.63	68.63	253.31
15-Jan-87														
21-Jan-87	dry	NA	86.44	276.17	60.53	305.46	149.72	234.67	dry	NA	107.87	254.95	63.01	258.93
10-Feb-87	dry	NA	82.67	279.94	59.86	306.13	149.67	234.72	dry	NA	107.08	255.74	59.07	262.87
17-Feb-87	dry	NA	82.14	280.47	58.48	307.51	149.74	234.65	dry	NA	107.89	254.93	58.97	262.97
25-Feb-87	dry	NA	83.78	278.83	58.42	307.57	149.51	234.88	dry	NA	107.84	254.98	58.88	263.06
05-Mar-87	dry	NA	83.53	279.08	58.11	307.88	149.35	235.04	dry	NA	106.92	255.90	57.69	264.25
10-Mar-87	dry	NA	82.62	279.99	57.60	308.39	149.14	235.25	dry	NA	106.60	256.22	56.74	265.20
24-Mar-87	dry	NA	82.05	280.56	56.61	309.38	149.14	235.25	dry	NA	106.97	255.85	55.57	266.37
31-Mar-87	dry	NA	82.44	280.17	56.66	309.33	148.93	235.46	dry	NA	106.43	256.39	56.65	265.29
14-Apr-87	dry	NA	84.50	278.11	57.38	308.61	148.85	235.54	dry	NA	106.58	256.24	56.30	265.64
28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-May-87	dry	NA	89.16	273.45	58.26	307.73	148.72	235.67	dry	NA	106.60	256.22	58.00	263.94
15-May-87					58.67	307.32	148.95	235.44			106.92	255.90		
19-May-87	dry	NA	90.24	272.37	58.65	307.34	148.76	235.63	dry	NA	106.66	256.16	58.43	263.51
26-May-87	dry	NA	91.34	271.27	58.81	307.18	148.78	235.61	dry	NA	106.64	256.18	NA	NA
01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Jun-87	dry	NA	92.32	270.29	59.39	306.60	148.93	235.46	dry	NA	106.95	255.87	59.54	262.40
09-Jun-87	dry	NA	93.20	269.41	59.40	306.59	149.00	235.39	dry	NA	106.93	255.89	60.05	261.89
16-Jun-87	dry	NA	94.10	268.51	59.65	306.34	149.16	235.23	dry	NA	106.99	255.83	60.53	261.41
23-Jun-87	dry	NA	94.93	267.68	57.81	308.18	149.26	235.13	dry	NA	107.00	255.82	61.13	260.81
30-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	61.60	260.34
07-Jul-87	dry	NA	96.48	266.13	58.79	307.20	149.31	235.08	dry	NA	106.95	255.87	62.19	259.75
20-Jul-87	blocked	NA	97.88	264.73	59.82	306.17	149.47	234.92	dry	NA	107.02	255.80	63.23	258.71
27-Jul-87	NA	NA	NA	NA	60.16	305.83	149.65	234.74	dry	NA	107.20	255.62	63.82	258.12
03-Aug-87	NA	NA	NA	NA	60.38	305.61	149.64	234.75	dry	NA	107.06	255.76	64.32	257.62
11-Aug-87	blocked	NA	99.75	262.86	60.80	305.19	149.78	234.61	dry	NA	107.33	255.49	64.95	256.99
17-Aug-87	blocked	NA	105.20	257.41	61.35	304.64	150.04	234.35	dry	NA	107.59	255.23	65.49	256.45
31-Aug-87	blocked	NA	101.70	260.91	60.98	305.01	150.19	234.20	dry	NA	107.54	255.28	66.41	255.53
08-Sep-87	blocked	NA	102.00	260.61	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Sep-87	NA	NA	NA	NA	61.37	304.62	150.35	234.04	dry	NA	107.63	255.19	67.19	254.75
14-Sep-87	NA	NA	NA	NA	61.26	304.73	150.39	234.00	dry	NA	107.69	255.13	67.33	254.61
21-Sep-87	NA	NA	NA	NA	NA	NA	149.77	234.62	dry	NA	107.25	255.57	65.64	256.30
29-Sep-87	NA	NA	NA	NA	62.22	303.77	150.67	233.72	dry	NA	104.86	257.96	68.37	253.57

Table D2 (Continued)
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	MW-6		MW-7A		MW-7B		MW-8A		MW-8B		MW-9A		MW-9B	
Meas. Pt. Elevation	271.76		412.73		412.73		351.35		351.35		353.79		353.79	
Screen Elevation	176.1 - 158.4		225.0 - 215.5		190.6 - 187.6		183.3 - 172.8		150.9 - 145.5		226.5 - 216.5		189.8 - 184.8	
Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Oct-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Nov-86	NA	NA	182.80	229.93	196.40	216.33	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Dec-86	NA	NA	183.90	228.83	197.50	215.23	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	NA	NA	183.86	228.87	197.44	215.29	NA	NA	NA	NA	NA	NA	NA	NA
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	NA	NA	184.26	228.47	197.87	214.86	NA	NA	NA	NA	NA	NA	NA	NA
15-Jan-87			183.45	229.28	197.00	215.73					95.40	258.39	118.70	235.09
21-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Feb-87	NA	NA	183.71	229.02	197.12	215.61	NA	NA	NA	NA	93.17	260.62	118.42	235.37
17-Feb-87	NA	NA	184.48	228.25	198.16	214.57	NA	NA	NA	NA	NA	NA	NA	NA
25-Feb-87	NA	NA	184.17	228.56	197.60	215.13	NA	NA	NA	NA	93.71	260.08	120.30	233.49
05-Mar-87	NA	NA	183.66	229.07	196.83	215.90	106.92	244.43	116.26	235.09	92.70	261.09	113.65	240.14
10-Mar-87	NA	NA	NA	NA	NA	NA	106.56	244.79	120.46	230.89	91.89	261.90	114.43	239.36
24-Mar-87	NA	NA	183.80	228.93	196.20	216.53	106.51	244.84	121.56	229.79	91.54	262.25	114.40	239.39
31-Mar-87	NA	NA	182.89	229.84	196.26	216.47	106.62	244.73	122.85	228.50	91.68	262.11	115.30	238.49
14-Apr-87	NA	NA	183.10	229.63	196.14	216.59	106.61	244.74	121.95	229.40	84.14	269.65	116.55	237.24
28-Apr-87	NA	NA	183.17	229.56	196.28	216.45	NA	NA	NA	NA	92.70	261.09	116.95	236.84
12-May-87	NA	NA	183.98	228.75	195.78	216.95	106.90	244.45	128.00	223.35	93.29	260.50	117.95	235.84
15-May-87			183.32	229.41	196.22	216.51	107.23	244.12	128.4	222.95	93.71	260.08	118.67	235.12
19-May-87	NA	NA	182.98	229.75	195.79	216.94	107.08	244.27	129.05	222.30	93.60	260.19	118.79	235.00
26-May-87	NA	NA	182.95	229.78	195.63	217.10	107.11	244.24	132.75	218.60	94.00	259.79	117.59	236.20
01-Jun-87	NA	NA	NA	NA	NA	NA	107.46	243.89	132.88	218.47	NA	NA	NA	NA
02-Jun-87	NA	NA	183.26	229.47	196.04	216.69	NA	NA	NA	NA	94.38	259.41	119.00	234.79
09-Jun-87	NA	NA	183.21	229.52	195.77	216.96	107.54	243.81	133.47	217.88	94.75	259.04	118.82	234.97
16-Jun-87	NA	NA	183.30	229.43	195.72	217.01	107.55	243.80	133.49	217.86	94.98	258.81	119.05	234.74
23-Jun-87	NA	NA	183.39	229.34	195.75	216.98	107.84	243.51	133.84	217.51	95.48	258.31	119.09	234.70
30-Jun-87	NA	NA	NA	NA	NA	NA	107.74	243.61	133.76	217.59	95.67	258.12	118.60	235.19
07-Jul-87	NA	NA	183.39	229.34	195.60	217.13	NA	NA	NA	NA	96.20	257.59	119.04	234.75
20-Jul-87	85.76	186.00	183.47	229.26	195.55	217.18	108.00	243.35	134.27	217.08	96.80	256.99	119.89	233.90
27-Jul-87	85.83	185.93	183.54	229.19	195.65	217.08	NA	NA	NA	NA	NA	NA	NA	NA
03-Aug-87	85.65	186.11	dry	NA	195.64	217.09	NA	NA	NA	NA	NA	NA	NA	NA
11-Aug-87	85.78	185.98	183.71	229.02	195.64	217.09	NA	NA	NA	NA	97.80	255.99	120.44	233.35
17-Aug-87	86.01	185.75	dry	NA	195.06	217.67	NA	NA	NA	NA	98.00	255.79	120.85	232.94
31-Aug-87	85.83	185.93	184.04	228.69	195.90	216.83	108.04	243.31	133.00	218.35	98.65	255.14	121.33	232.46
08-Sep-87	NA	NA	NA	NA	NA	NA	108.24	243.11	135.10	216.25	98.70	255.09	121.34	232.45
11-Sep-87	85.83	185.93	184.18	228.55	198.05	214.68	NA	NA	NA	NA	NA	NA	NA	NA
14-Sep-87	85.81	185.95	184.30	228.43	196.00	216.73	NA	NA	NA	NA	NA	NA	NA	NA
21-Sep-87	NA	NA	183.80	228.93	195.30	217.43	108.77	242.58	134.65	216.70	99.10	254.69	117.95	235.84
29-Sep-87	86.00	185.76	184.58	228.15	196.29	216.44	NA	NA	NA	NA	NA	NA	NA	NA

Table D2 (Continued)
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	MW-10A		MW-10B		MW-11A		MW-11B		MW-12A		MW-12B		MW-13A		MW-13B	
Meas. Pt. Elevation	338.77		338.77		370.41		370.41		374.80		374.80		382.68		382.68	
Screen Elevation	146.7 - 137.0		116.3 - 107.3		169.4 - 159:4		103.9 - 98.5		141.4 - 136.0		119.8 - 116.8		274.2 - 271.3		186.9 - 176.4	
Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Oct-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Nov-86	76.60	262.17	85.15	253.62	NA	NA	NA	NA	NA	NA	NA	NA	107.30	275.38	129.10	253.58
02-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	107.65	275.03	128.45	254.23
31-Dec-86	82.11	256.66	82.33	271.77	NA	NA	NA	NA	NA	NA	NA	NA	107.60	275.08	128.22	254.46
07-Jan-87	81.45	257.32	81.68	257.09	NA	NA	NA	NA	NA	NA	NA	NA	107.94	274.74	128.60	254.08
14-Jan-87	81.51	257.26	81.48	257.29	NA	NA	NA	NA	NA	NA	NA	NA	108.00	274.68	128.59	254.09
15-Jan-87	NA		81.35	257.42					113.80	261.00	114.40	260.40	107.65	275.03	128.20	254.48
21-Jan-87	81.36	257.41	81.30	257.47	NA	NA	NA	NA	NA	NA	NA	NA	107.68	275.00	128.34	254.34
10-Feb-87	80.11	258.66	79.42	259.35	NA	NA	NA	NA	112.67	262.13	112.91	261.89	107.08	275.60	127.59	255.09
17-Feb-87	79.36	259.41	79.59	259.18	NA	NA	NA	NA	112.66	262.14	112.93	261.87	107.93	274.75	128.50	254.18
25-Feb-87	79.65	259.12	79.81	258.96	NA	NA	NA	NA	112.81	261.99	113.00	261.81	107.45	275.23	NA	NA
05-Mar-87	79.08	259.69	79.10	259.67	110.79	259.62	111.50	258.91	112.24	262.56	112.57	262.23	106.87	275.81	127.56	255.12
10-Mar-87	78.32	260.45	78.40	260.37	110.61	259.80	111.18	259.23	111.96	262.84	112.25	262.55	106.64	276.04	127.31	255.37
24-Mar-87	NA	NA	NA	NA	110.82	259.59	110.87	259.54	NA	NA	NA	NA	107.18	275.50	127.87	254.81
31-Mar-87	78.05	260.72	78.21	260.56	NA	NA	NA	NA	111.77	263.03	112.08	262.72	106.76	275.92	127.47	255.21
14-Apr-87	78.45	260.32	78.60	260.17	NA	NA	NA	NA	NA	NA	NA	NA	106.80	275.88	127.45	255.23
28-Apr-87	78.97	259.80	79.09	259.68	NA	NA	NA	NA	112.06	262.74	112.35	262.45	106.75	275.93	127.87	254.81
12-May-87	79.55	259.22	79.65	259.12	110.65	259.76	110.73	259.68	112.33	262.47	112.61	262.19	106.77	275.91	127.91	254.77
15-May-87	79.97	258.80	80.14	258.63	111.05	259.36	110.99	259.42	112.67	262.13	112.94	261.86	107.30	275.38	128.46	254.22
19-May-87	79.76	259.01	79.87	258.90	110.85	259.56	110.86	259.55	112.44	262.36	112.69	262.11	106.90	275.78	128.08	254.60
26-May-87	80.22	258.55	80.33	258.44	110.75	259.66	110.81	259.60	112.70	262.10	112.97	261.83	106.77	275.91	128.05	254.63
01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	107.28	275.40	128.50	254.18
02-Jun-87	80.49	258.28	80.62	258.15	111.24	259.17	111.24	259.17	112.90	261.90	113.19	261.61	NA	NA	NA	NA
09-Jun-87	80.83	257.94	81.00	257.77	111.00	259.41	111.01	259.40	113.09	261.71	113.39	261.41	107.00	275.68	128.37	254.31
16-Jun-87	81.10	257.67	81.17	257.60	NA	NA	NA	NA	113.06	261.74	113.32	261.48	106.98	275.70	128.45	254.23
23-Jun-87	81.59	257.18	81.82	256.95	111.23	259.18	111.25	259.16	113.52	261.28	113.81	260.99	107.05	275.63	128.59	254.09
30-Jun-87	81.63	257.14	81.80	256.97	NA	NA	NA	NA	113.47	261.33	113.73	261.07	NA	NA	NA	NA
07-Jul-87	82.08	256.69	82.19	256.58	NA	NA	NA	NA	113.86	260.94	114.11	260.69	106.96	275.72	128.62	254.06
20-Jul-87	82.62	256.15	82.72	256.05	111.47	258.94	111.61	258.80	114.00	260.80	114.30	260.50	107.21	275.47	128.60	254.08
27-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Aug-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Aug-87	83.46	255.31	83.58	255.19	111.45	258.96	111.47	258.94	114.50	260.30	114.75	260.05	107.00	275.68	128.70	253.98
17-Aug-87	83.97	254.80	84.05	254.72	111.87	258.54	112.00	258.41	114.80	260.00	115.00	259.80	107.43	275.25	129.00	253.68
31-Aug-87	84.36	254.41	84.44	254.33	111.70	258.71	111.72	258.69	115.00	259.80	115.10	259.70	107.00	275.68	123.86	258.82
08-Sep-87	NA	NA	NA	NA	111.85	258.56	111.88	258.53	115.10	259.70	115.10	259.70	107.00	275.68	128.95	253.73
11-Sep-87	84.72	254.05	84.85	253.92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
21-Sep-87	84.56	254.21	84.65	254.12	112.12	258.29	112.20	258.21	114.88	259.92	115.19	259.61	106.68	276.00	128.57	254.11
29-Sep-87	85.18	253.59	85.28	253.49	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D2 (Continued)
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	MW-14A		MW-14B		MW-15A		MW-15B		MW-16		MW-17A		MW-17B	
Meas. Pt. Elevation	381.85		381.85		438.54		438.54		362.80		337.08		337.08	
Screen Elevation	103.4 - 98.0		79.0 - 73.5		214.9 - 204.6		178.7 - 173.2		201.7 - 196.3		249.6 - 239.2		211.4 - 204.4	
Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Oct-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	64.30	272.78	68.00	269.08
31-Dec-86	NA	NA	NA	NA	220.75	217.79	222.00	216.54	NA	NA	62.64	274.44	67.00	270.08
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	62.80	274.28	67.02	270.06
14-Jan-87	NA	NA	NA	NA	221.24	217.30	222.44	216.10	NA	NA	62.35	274.73	66.64	270.44
15-Jan-87					220.25	218.29	221.40	217.14			62.20	274.88	66.50	270.58
21-Jan-87	NA	NA	NA	NA	220.90	217.64	222.10	216.44	NA	NA	62.31	274.77	66.80	270.28
10-Feb-87	NA	NA	NA	NA	220.73	217.81	221.91	216.63	NA	NA	60.44	276.64	64.89	272.19
17-Feb-87	NA	NA	NA	NA	221.09	217.45	222.27	216.27	NA	NA	60.15	276.93	64.67	272.41
25-Feb-87	NA	NA	NA	NA	221.12	217.42	222.27	216.27	NA	NA	60.52	276.56	65.11	271.97
05-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	122.26	240.54	59.90	277.18	64.52	272.56
10-Mar-87	NA	NA	NA	NA	220.40	218.14	221.46	217.08	126.97	235.83	59.47	277.61	64.08	273.00
24-Mar-87	NA	NA	NA	NA	220.70	217.84	221.94	216.60	122.38	240.42	59.46	277.62	64.21	272.87
31-Mar-87	NA	NA	NA	NA	220.12	218.42	221.33	217.21	121.81	240.99	59.58	277.50	64.39	272.69
14-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	121.91	240.89	60.35	276.73	65.00	272.08
28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	121.80	241.00	61.82	275.26	NA	NA
12-May-87	NA	NA	NA	NA	219.76	218.78	220.95	217.59	121.80	241.00	63.08	274.00	66.99	270.09
15-May-87	206.72	175.13	211.72	170.13	218.10	220.44	219.35	219.19	122.22	240.58	63.44	273.64	67.23	269.85
19-May-87	NA	NA	NA	NA	219.73	218.81	220.95	217.59	121.88	240.92	63.61	273.47	67.31	269.77
26-May-87	NA	NA	NA	NA	219.61	218.93	220.86	217.68	121.80	241.00	64.38	272.70	68.00	269.08
01-Jun-87	NA	NA	NA	NA	220.00	218.54	221.26	217.28	NA	NA	NA	NA	NA	NA
02-Jun-87	208.67	173.18	213.56	168.29	NA	NA	NA	NA	122.12	240.68	64.73	272.35	68.14	268.94
09-Jun-87	208.25	173.60	213.70	168.15	219.75	218.79	220.94	217.60	122.08	240.72	65.45	271.63	68.82	268.26
16-Jun-87	208.27	173.58	213.24	168.61	219.69	218.85	220.89	217.65	122.10	240.70	66.09	270.99	69.21	267.87
23-Jun-87	208.27	173.58	213.23	168.62	219.63	218.91	220.86	217.68	122.09	240.71	66.65	270.43	69.71	267.37
30-Jun-87	NA	NA	NA	NA	219.37	219.17	220.60	217.94	NA	NA	67.13	269.95	NA	NA
07-Jul-87	NA	NA	NA	NA	219.48	219.06	220.72	217.82	121.90	240.90	67.60	269.48	70.37	266.71
20-Jul-87	208.30	173.55	213.23	168.62	219.38	219.16	220.55	217.99	121.93	240.87	68.42	268.66	71.00	266.08
27-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	122.08	240.72	68.81	268.27	71.28	265.80
03-Aug-87	NA	NA	NA	NA	219.20	219.34	220.40	218.14	121.88	240.92	69.10	267.98	71.51	265.57
11-Aug-87	207.93	173.92	213.00	168.85	219.20	219.34	220.46	218.08	121.88	240.92	69.57	267.51	71.90	265.18
17-Aug-87	208.00	173.85	213.00	168.85	219.49	219.05	220.75	217.79	122.37	240.43	69.90	267.18	72.14	264.94
31-Aug-87	207.90	173.95	213.00	168.85	219.33	219.21	220.55	217.99	122.23	240.57	70.29	266.79	72.49	264.59
08-Sep-87	208.00	173.85	213.10	168.75	219.44	219.10	220.70	217.84	NA	NA	NA	NA	NA	NA
11-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	122.33	240.47	70.62	266.46	72.78	264.30
14-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	122.24	240.56	70.68	266.40	72.83	264.25
21-Sep-87	NA	NA	NA	NA	218.20	220.34	219.31	219.23	121.22	241.58	70.25	266.83	72.40	264.68
29-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	122.44	240.36	70.77	266.31	72.87	264.21

Table D2 (Continued)
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	MW-18A		MW-18B		MW-19A		MW-19B		MW-19C		MW-20A		MW-20B	
Meas. Pt. Elevation	343.91		343.91		370.20		370.20		370.20		375.65		375.65	
Screen Elevation	223.6 - 213.1		61.3 - 50.9		295.9 - 285.9		200.2 - 195.2		76.0 - 70.0		183.7 - 178.7		78.7 - 73.7	
Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Oct-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Jan-87														
21-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-May-87	67.05	276.86	116.72	227.19	72.14	298.06	149.88	220.32	230.98	139.22				
19-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
26-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
09-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
16-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	158.69	216.96	244.53	131.12
23-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	159.71	215.94	245.66	129.99
30-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-Jul-87	72.02	271.89	117.94	225.97	NA	NA	NA	NA	NA	NA	159.72	215.93	245.61	130.04
20-Jul-87	NA	NA	118.33	225.58	75.00	295.20	153.00	217.20	234.00	136.20	159.90	215.75	245.70	129.95
27-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Aug-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Aug-87	74.00	269.91	118.75	225.16	79.72	290.48	154.25	215.95	235.00	135.20	160.00	215.65	245.48	130.17
17-Aug-87	74.48	269.43	119.25	224.66	73.00	297.20	153.00	217.20	233.00	137.20	160.14	215.51	245.79	129.86
31-Aug-87	74.92	268.99	119.25	224.66	75.00	295.20	155.00	215.20	235.00	135.20	160.44	215.21	245.70	129.95
08-Sep-87	75.24	268.67	119.26	224.65	75.00	295.20	156.00	214.20	235.10	135.10	160.45	215.20	245.80	129.85
11-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
21-Sep-87	75.20	268.71	119.76	224.15	dry	NA	154.70	215.50	233.70	136.50	160.20	215.45	244.10	131.55
29-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D2 (Continued)
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	MW-21A		MW-21B		MW-21C		MW-22A		MW-22B		MW-23A		MW-23B	
Meas. Pt. Elevation	359.95		359.95		359.95		378.28		378.28		424.42		424.42	
Screen Elevation	273.1 - 263.1		188.1 - 178.1		68.0 - 63.0		108.0 - 103.0		76.6 - 66.6		195.0 - 185.0		104.7 - 94.7	
Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Oct-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Jan-87														
21-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-May-87											220.75	203.67	258.15	166.27
19-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
26-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	222.83	201.59	255.49	168.93
09-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	222.50	201.92	255.40	169.02
16-Jun-87	82.19	277.76	85.35	274.60	NA	NA	NA	NA	NA	NA	222.47	201.95	255.24	169.18
23-Jun-87	82.80	277.15	86.14	273.81	101.97	257.98	122.60	255.68	141.21	237.07	222.56	201.86	255.48	168.94
30-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	222.18	202.24	255.11	169.31
07-Jul-87	84.05	275.90	87.25	272.70	100.41	259.54	122.55	255.73	141.39	236.89	222.47	201.95	255.86	168.56
20-Jul-87	85.00	274.95	88.15	271.80	101.00	258.95	125.00	253.28	141.59	236.69	222.50	201.92	255.33	169.09
27-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Aug-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Aug-87	86.20	273.75	89.30	270.65	101.40	258.55	121.64	256.64	141.73	236.55	222.50	201.92	255.00	169.42
17-Aug-87	86.44	273.51	89.62	270.33	102.00	257.95	123.00	255.28	142.00	236.28	222.89	201.53	255.00	169.42
31-Aug-87	86.50	273.45	90.00	269.95	102.00	257.95	122.00	256.28	142.00	236.28	223.00	201.42	255.00	169.42
08-Sep-87	87.00	272.95	90.37	269.58	102.20	257.75	123.23	255.05	142.32	235.96	223.10	201.32	255.00	169.42
11-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
21-Sep-87	87.16	272.79	90.20	269.75	102.00	257.95	122.75	255.53	141.12	237.16	222.21	202.21	254.00	170.42
29-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D2 (Continued)
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	MW-24A		MW-24B		MW-25A		MW-25B		MW-25C		MW-26	
Meas. Pt. Elevation	418.58		418.58		260.84		260.84		260.84		370.58	
Screen Elevation	213.6 - 203.6		68.6 - 63.6		246.7 - 241.7		221.1 - 216.1		192.0 - 186.0		257.4 - 252.4	
Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Oct-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Jan-87												
21-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-May-87											91.09	279.49
19-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
26-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
09-Jun-87	192.35	226.23	249.63	168.95	NA	NA	NA	NA	NA	NA	90.02	280.56
16-Jun-87	NA	NA	249.49	169.09	NA	NA	NA	NA	NA	NA	NA	NA
23-Jun-87	192.28	226.30	NA	NA	NA	NA	NA	NA	NA	NA	91.18	279.40
30-Jun-87	192.00	226.58	249.40	169.18	NA	NA	NA	NA	NA	NA	NA	NA
07-Jul-87	192.05	226.53	249.84	168.74	NA	NA	NA	NA	NA	NA	NA	NA
20-Jul-87	192.00	226.58	249.50	169.08	NA	NA	NA	NA	NA	NA	91.30	279.28
27-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Aug-87	191.80	226.78	249.50	169.08	NA	NA	NA	NA	NA	NA	NA	NA
11-Aug-87	191.77	226.81	249.40	169.18	8.40	252.44	NA	NA	4.00	256.84	91.32	279.26
17-Aug-87	192.00	226.58	249.49	169.09	3.37	257.47	NA	NA	4.24	256.60	91.84	278.74
31-Aug-87	191.88	226.70	249.34	169.24	8.50	252.34	NA	NA	4.80	256.04	81.60	288.98
08-Sep-87	192.00	226.58	249.40	169.18	8.60	252.24	4.8	256.04	4.60	256.24	91.70	278.88
11-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
21-Sep-87	191.28	227.30	247.69	170.89	8.40	252.44	4.9	255.94	4.82	256.02	92.01	278.57
29-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D2 (Continued)
Groundwater Elevation Records: All Monitor Wells
August 1986 to Present
Midway RI/FS

Well No.	MW-27A		MW-27B		MW-27C		MW-28		MW-29A		MW-29B	
Meas. Pt. Elevation	330.05		330.05		330.05		374.15		428.50		428.50	
Screen Elevation	253.5 - 243.1		182.8 - 177.4		70.4 - 65.4		267.2 - 262.2		220.8 - 210.8		58.9 - 51.9	
Date	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.	Depth to Water	Water Elev.
13-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27-Aug-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Sep-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Oct-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Nov-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Dec-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-Jan-87												
21-Jan-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25-Feb-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31-Mar-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
28-Apr-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15-May-87												
19-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
26-May-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
09-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
16-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
23-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
30-Jun-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27-Jul-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-Aug-87	NA	NA	NA	NA	NA	NA	90.60	283.55	189.50	239.00	294.50	134.00
11-Aug-87	NA	NA	NA	NA	NA	NA	90.60	283.55	189.70	238.80	296.00	132.50
17-Aug-87	NA	NA	NA	NA	NA	NA	81.00	293.15	190.00	238.50	294.00	134.50
31-Aug-87	81.60	248.45	NA	NA	NA	NA	NA	NA	189.80	238.70	294.40	134.10
08-Sep-87	NA	NA	NA	NA	NA	NA	91.45	282.70	190.00	238.50	294.55	133.95
11-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
21-Sep-87	NA	NA	NA	NA	NA	NA	91.95	282.20	188.63	239.87	292.59	135.91
29-Sep-87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D3
Gas Extraction Well or Gas Probe Water Level Data From Landfill

Well No.	Ground Elevation (ft)	Screen Interval Depth (ft)	Screen Unit	Date	Depth to Water Below Ground Surface	Groundwater Elevation	Comments
1	352.0	19 - 48.5	Landfill	--	--	--	
2	363.0	32 - 60.5	Landfill	2/18/87	--	--	Obstruction at 25.7 feet.
3	362.0	27 - 51.5	Landfill	2/18/87	30.58	332.2	
4	359.1	25 - 59	Landfill	--	--	--	Obstruction at 29 feet.
5	361.6	22 - 65	Landfill	2/18/87	34.31	327.3	
6	358.1	25 - 59	Landfill	2/18/87	37.64	320.5	
7	361.3	25 - 68	Landfill	2/18/87	50.22	311.1	
8	364.8	26 - 66	Landfill	2/18/87	63.17	301.6	
9	360.8	26 - 61	Landfill	2/18/87	51.67	309.1	
10	359.9	26 - 63	Landfill	2/18/87	51.62	308.3	
11	360.6	26 - 60	Landfill	2/18/87	58.31	302.3	
12	362.0	25.5 - 60.5	Landfill	2/18/87	50.37	311.6	
13	362.2	26 - 53	Landfill	2/18/87	37.26	324.9	
14	365.2	26 - 64	Landfill	2/18/87	--	--	Obstruction.
15	366.7	23 - 58	Landfill	2/18/87	54.11	312.6	
16	370.2	24 - 59	Landfill	2/18/87	53.69	316.5	
17	392.0	26 - 96	Landfill	2/20/87	91	301.0	
18	399.9	23 - 100	Landfill	2/20/87	99	300.9	
19	397.8	25 - 92.5	Landfill	2/20/87	86	311.8	
20	393.6	25 - 91	Landfill	2/20/87	85	308.6	
21	384.3	25 - 98	Landfill	2/20/87	94	290.3	
22	374.2	26 - 71	Landfill	2/18/87	67.75	306.5	
23	385.0	19 - 77	Landfill	2/20/87	40	345.0	
24	384.1	23.5 - 57.5	Landfill	2/18/87	47.58	336.5	
25	376.8	25.5 - 85	Landfill	2/20/87	60	316.8	
26	373.8	24 - 79	Landfill	2/20/87	61	312.8	
27	374.5	24 - 79	Landfill	2/18/87	68.80	305.7	
28	380.4	22.5 - 88.5	Landfill	2/20/87	87	293.4	
29	380.8	24 - 87	Landfill	2/20/87	82	298.8	
30	381.1	23 - 49	Landfill	2/18/87	46.53	334.6	
31	381.5	25.5 - 75.5	Landfill	2/18/87	74	307.5	
32	368.1	24 - 80	Landfill	2/18/87	--	--	Obstruction at 24.2 feet.
33	364.7	24 - 66	Landfill	2/18/87	44.53	320.2	
34	363.0	24 - 66	Landfill	2/18/87	54.87	308.1	
35S	396.52	25 - 42	Landfill	2/20/87	41	355.5	
35D	396.52	45 - 98	Landfill	2/20/87	91	305.5	
36S	395.36	25 - 46	Landfill	2/20/87	42	353.4	
36D	395.36	49 - 94	Landfill	2/20/87	91	304.4	
37S	393.86	25 - 48	Landfill	2/20/87	Dry	--	Dry.
37D	393.86	51 - 98	Landfill	2/20/87	97	296.9	
38S	391.69	26 - 56	Landfill	2/20/87	Dry	--	Dry.
38D	391.69	68 - 110	Landfill	2/20/87	75	316.7	
39S	393.63	26 - 64	Landfill	2/20/87	Dry	--	Dry.
39D	393.63	76 - 126	Landfill	2/20/87	110	283.6	
40S	393.33	26 - 64	Landfill	2/20/87	Dry	--	Dry.
40D	393.33	76 - 126	Landfill	2/20/87	110	283.3	

Table D3 (Continued)
Gas Extraction Well or Gas Probe Water Level Data From Landfill

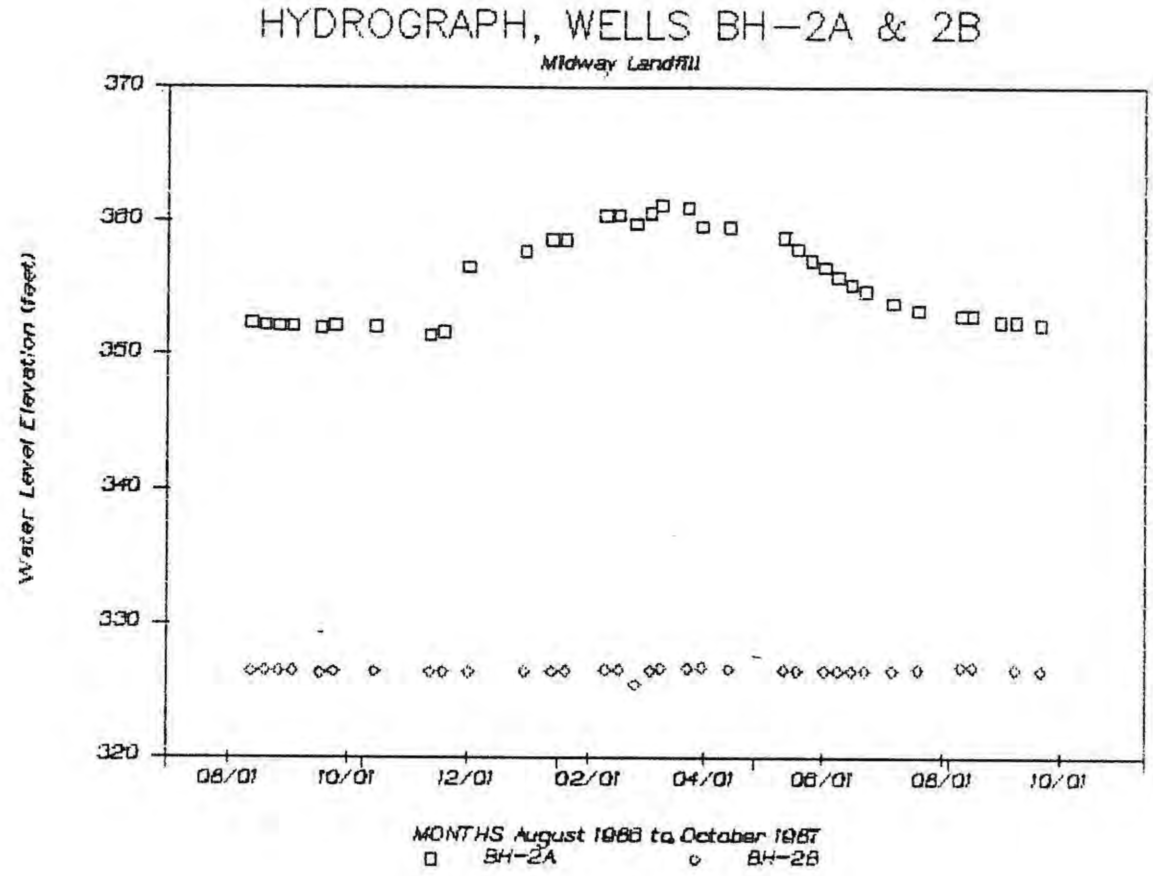
Well No.	Ground Elevation (ft)	Screen Interval Depth (ft)	Screen Unit	Date	Depth to Water Below Ground Surface	Groundwater Elevation	Comments
41S	386.80	26 - 60	Landfill	2/20/87	Dry	--	Dry.
41D	386.80	72 - 118	Landfill	2/20/87	91	295.8	
42S	371.75	26 - 32	Landfill	2/18/87	31.72 (Dry)	--	Height of water 0.28 feet.
42D	371.75	44 - 62	Landfill	2/18/87	60.95	310.8	
43S	369.02	26 - 39	Landfill	2/18/87	38.51 (Dry)	--	Height of water 0.49 feet.
43D	369.02	51 - 76	Landfill	2/18/87	48.50	320.4	
44S	397.96	26 - 40.5	Landfill	2/18/87	40.35 (Dry)	--	Height of water 0.15 feet.
44D	397.96	52 - 79	Landfill	2/18/87	51.15	316.8	
45S	373.75	26 - 42	Landfill	2/18/87	--	--	Obstruction at 34 feet.
45D	373.75	54 - 82	Landfill	2/18/87	57.01	316.7	
46S	373.08	26 - 47.5	Landfill	2/18/87	43.22	329.9	
46D	373.08	59 - 93	Landfill	2/18/87	53.05	320.0	
47S	376.85	26 - 43.5	Landfill	2/18/87	40.28	336.6	
47D	376.85	55 - 85	Landfill	2/18/87	52.24	324.6	
PD1S	~385	25 - 65	Outwash Gravel	2/20/87	Dry	--	Dry.
PD1D	~385	80 - 130	Outwash Gravel	2/20/87	128	~257	
PD2S	379.48	28 - 63	Outwash Gravel	2/20/87	Dry	--	Dry.
PD2D	379.48	80 - 130	Outwash Gravel	2/20/87	Dry	--	Dry.
PD3S	375.78	27 - 57	Outwash Gravel	2/20/87	56	319.8	Height of water 1.0 feet.
PD3D	375.78	70 - 115	Outwash Gravel	2/20/87	113	262.8	
PD4S	371.64	28 - 68	Outwash Gravel	2/20/87	Dry	--	Dry.
PD4D	371.64	80 - 130	Outwash Gravel	2/20/87	Dry	--	Dry.
PD5S	366.86	25 - 60	Outwash Gravel	2/20/87	Dry	--	Dry.
PD5D	366.86	80 - 120	Outwash Gravel	2/20/87	118	248.9	
PD6S	362.47	25 - 50	Outwash Gravel	2/20/87	Dry	--	Dry.
PS6D	362.47	69 - 109	Outwash Gravel	2/20/87	94	268.5	
PD7S	360.07	28.5 - 58.5	Outwash Gravel	2/20/87	56	304.1	
PD7D	360.07	77.5 - 117.5	Outwash Gravel	2/20/87	89	271.1	
PD8S	357.41	26.5 - 46.5	Outwash Gravel	2/20/87	46 (Dry)	--	Height of water 0.5 feet.
PD8D	357.41	66.5 - 101.5	Outwash Gravel	2/20/87	86	271.4	
PD9S	356.00	26 - 44	Outwash Gravel	2/20/87	Dry	--	Dry.
PD9D	356.00	56 - 96	Outwash Gravel	2/20/87	80.5	275.5	
PD10S	356.12	26 - 51	Outwash Gravel	2/20/87	47	309.1	
PD10D	356.12	61.5 - 101.5	Outwash Gravel	2/20/87	81	375.1	
PD11S	356.73	26 - 51	Outwash Gravel	2/20/87	Dry	--	Dry.
PD11D	356.73	61 - 101	Outwash Gravel	2/20/87	76	280.7	
PD12S	357.79	23 - 38	Outwash Gravel	2/20/87	Dry	--	Dry.
PD12D	357.79	49 - 79	Outwash Gravel	2/20/87	78	279.8	Height of water 1.0 feet.
PA1S	344.8	25 - 29	Fill	2/18/87	12.75	332.1	Obstruction at 24 feet.
PA1D	344.8	32 - 67	Outwash Gravel	2/18/87	56.66	288.1	
PA2S	~340.0	25 - 35	Outwash Gravel	--	--	--	
PA2D	~340.0	38 - 67	Outwash Gravel	--	--	--	
PA3S	352.12	25 - 55	Outwash Gravel	2/20/87	Dry	--	Dry.
PA3D	352.12	58 - 93	Outwash Gravel	2/20/87	Dry	--	Dry.

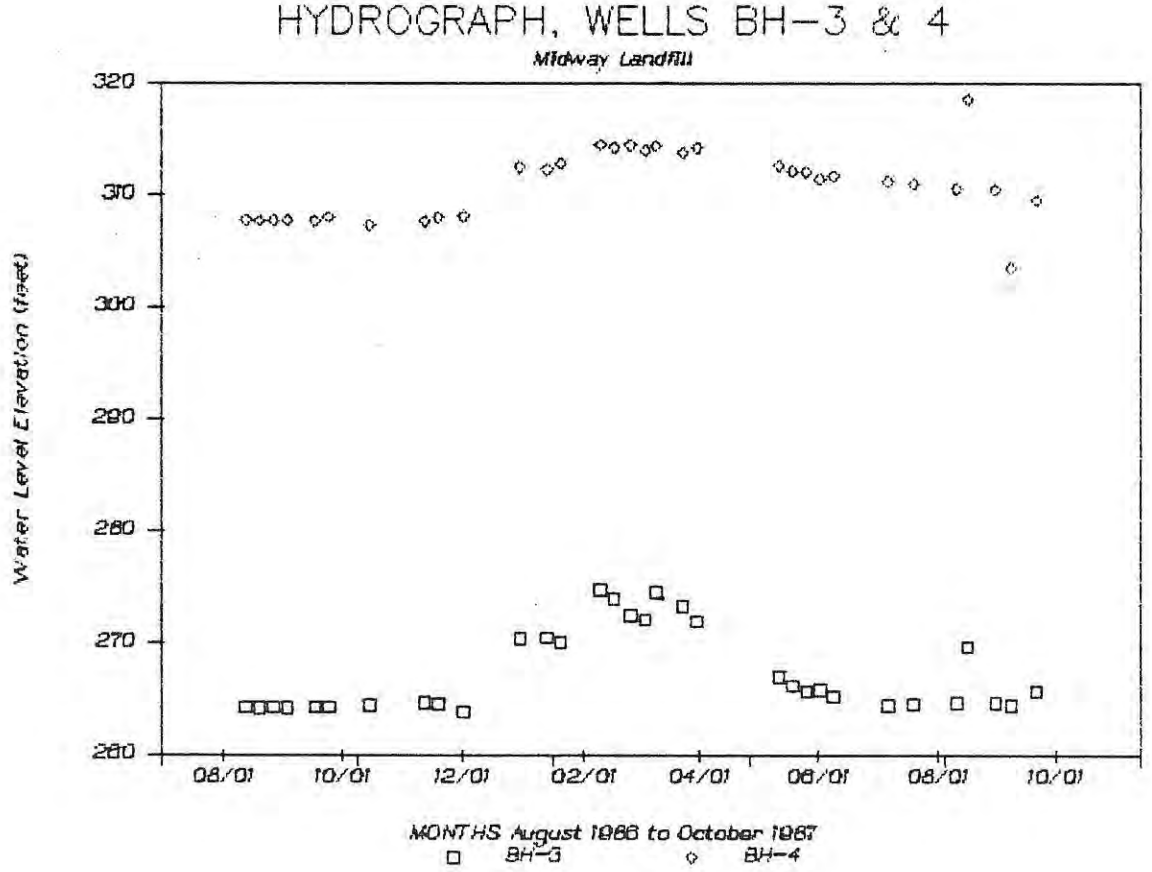
Table D3 (Continued)
Gas Extraction Well or Gas Probe Water Level Data From Landfill

Well No.	Ground Elevation (ft)	Screen Interval Depth (ft)	Screen Unit	Date	Depth to Water Below Ground Surface	Groundwater Elevation	Comments
PA4S	359.79	25 - 44	Outwash Gravel	2/20/87	Dry	--	Dry.
PA4D	359.79	47 - 98	Outwash Gravel	2/20/87	Dry	--	Dry.
PA5S	372.71	25 - 60	Outwash Gravel	2/20/87	Dry	--	Dry.
PA5D	372.71	63 - 118	Outwash Gravel	2/20/87	Dry	--	Dry.
PA6S	373.67	25 - 63	Outwash Gravel	2/20/87	30	343.7	
PA6D	373.67	66 - 120	Outwash Gravel	2/20/87	55	318.7	
PA7S	383.36	25 - 60	Outwash Gravel	2/20/87	Dry	--	Dry.
PA7D	383.36	63 - 117	Outwash Gravel	2/20/87	74.9	308.5	
PA8S	385.99	25 - 52	Outwash Gravel	2/20/87	48.5	337.5	
PA8D	385.99	55 - 112	Outwash Gravel	2/20/87	109	277.0	
PA9S	404.94	25 - 64	Outwash Gravel	2/20/87	44.5	360.4	
PA9D	404.94	67 - 138	Outwash Gravel	2/20/87	Dry	--	Dry.
PA10S	404.54	25 - 66	Outwash Gravel	2/20/87	Dry	--	Dry.
PA10D	404.54	69 - 133	Outwash Gravel	2/20/87	Dry	--	Dry.
PC1S	344.2	41 - 51	Outwash Gravel	11/23/87	Dry	--	Drilling completed 11/23/87.
PC1D	344.2	57 - 82	Outwash Gravel	11/23/87	61.7	282.5	Drilling completed 11/23/87.
PC2S	345.3	40 - 50	Outwash Gravel	11/2/87	16.0	329.3	Drilling completed 12/1/87.
PC2D	345.3	56.5 - 81.5	Outwash Gravel	12/2/87	59.1	286.2	Drilling completed 12/1/87.
PC3S	344.5	43.5 - 68.5	Outwash Gravel	12/8/87	66.9	277.6	Drilling completed 12/8/87.
PC3D	344.5	72 - 87	Outwash Gravel	12/8/87	66.9	277.6	Drilling completed 12/8/87.
PC4S	345.5	20 - 40	Landfill	12/11/87	31.1	314.4	Drilling completed 12/11/87.
PC5S	345.1	51 - 61	Outwash Gravel	12/21/87	Dry	--	Drilling completed 12/18/87.
PC5D	345.1	66 - 76	Outwash Gravel	12/21/87	64.3	280.8	Drilling completed 12/18/87.
PC6S	346.1	11 - 41	Landfill	12/22/87	19.0	327.1	Drilling completed 12/22/87.
PC6D	~346.5	52 - 76	Outwash Gravel	1/5/88	64.7	281.8	Drilling completed 1/5/88.
PC7S	345.6	13 - 38	Landfill	12/28/87	18.0	327.6	Drilling completed 12/24/87.
PC7D	~346.0	55 - 75	Outwash Gravel	1/15/88	69.0	277.0	Drilling completed 1/14/88.
PC8S	~351	25 - 32	Outwash Gravel	2/18/87	13.4	~338	
PC8D	~351	35 - 76	Outwash Gravel	2/18/87	59.27	~292	
PC9S	343.9	12 - 37	Landfill	12/30/87	16.9	327.0	Drilling completed 12/29/87.
PC9D	~345.5	53.5 - 76.5	Outwash Gravel	1/12/88	68.8	276.7	Drilling completed 1/12/88.
AI-D	378.41	93 - 118	Outwash Gravel	--	--	--	
AJ-W	403.49	183 - 203	Sand Aquifer	7/3/87	157.5	245.5	Drilling completed 6/25/87.
AK-W	431.03	206 - 239	Sand Aquifer	7/2/87	234.5	196.5	Drilling completed 6/25/87.
AL-W	437.24	188 - 233	Sand Aquifer	7/3/87	218	219	Drilling completed 7/3/87.
AM-D	~370	83 - 118	Outwash Gravel	8/11/87	90.2	279.8	Drilling completed 8/5/87.
AN-M	364.45	22 - 32	Outwash Gravel	9/8/87	19.7	341.3	Drilling completed 8/27/87.
AN-W	364.45	75 - 85	Outwash Gravel	9/8/87	56.7	304.3	Drilling completed 8/27/87.

Table D3 (Continued)
Gas Extraction Well or Gas Probe Water Level Data From Landfill

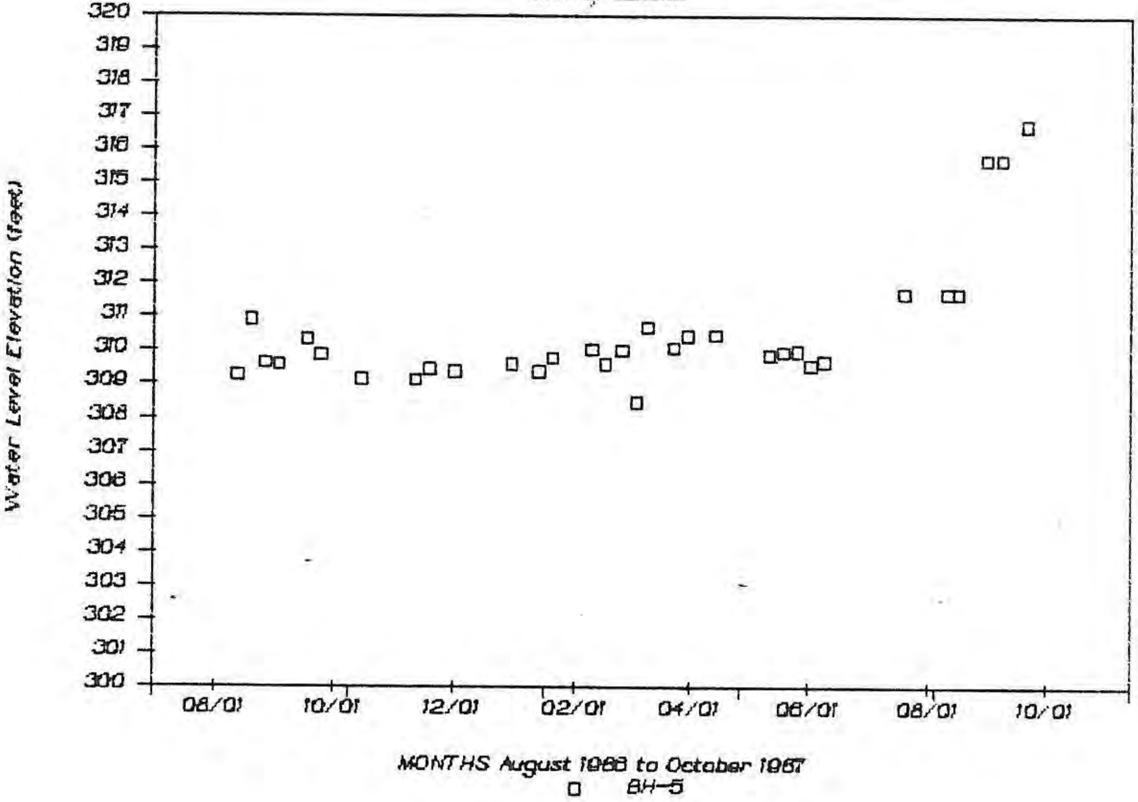
Well No.	Ground Elevation (ft)	Screen Interval Depth (ft)	Screen Unit	Date	Depth to Water Below Ground Surface	Groundwater Elevation	Comments
AO-M	356.18	21 - 51	Outwash Gravel	9/8/87	16.7	341.3	Drilling completed 8/17/87.
AO-W	356.18	73 - 98	Outwash Gravel	9/8/87	48.7	309.3	Drilling completed 8/17/87.
AP-M	357.16	30 - 50	Outwash Gravel	9/8/87	26.1	328.9	Drilling completed 8/12/87.
AP-W	357.16	97 - 112	Outwash Gravel	9/8/87	77.0	278.0	Drilling completed 8/12/87.
AQ-M	360.87	23 - 48	Outwash Gravel	9/11/87	14.2	349.8	Drilling completed 9/11/87.
AQ-D	360.87	74 - 89	Outwash Gravel	9/4/87	77	287	Drilling completed 9/3/87.
AR-M	354.38	20 - 45	Outwash Gravel	9/22/87	9.3	342.7	Drilling completed 9/17/87.
AR-D	354.38	73 - 93	Outwash Gravel	9/22/87	75.1	276.9	Drilling completed 9/17/87.
AV-W	390.67	135 - 150	Outwash Gravel	11/12/87	148.58	242.09	Drilling completed 10/7/87.


HYDROGRAPH, WELLS BH-2A & 2B
Midway Landfill
Water Level Elevation (feet)
370
360
350
340
330
320
08/01
10/01
12/01
02/01
04/01
06/01
08/01
10/01
MONTHS August 1986 to October 1987
□ BH-2A
◇ BH-2B


HYDROGRAPH, WELLS BH-3 & 4
Midway Landfill
Water Level Elevation (feet)
320
310
300
290
280
270
260
08/01
10/01
12/01
02/01
04/01
06/01
08/01
10/01
MONTHS August 1986 to October 1987
□ BH-3
◇ BH-4

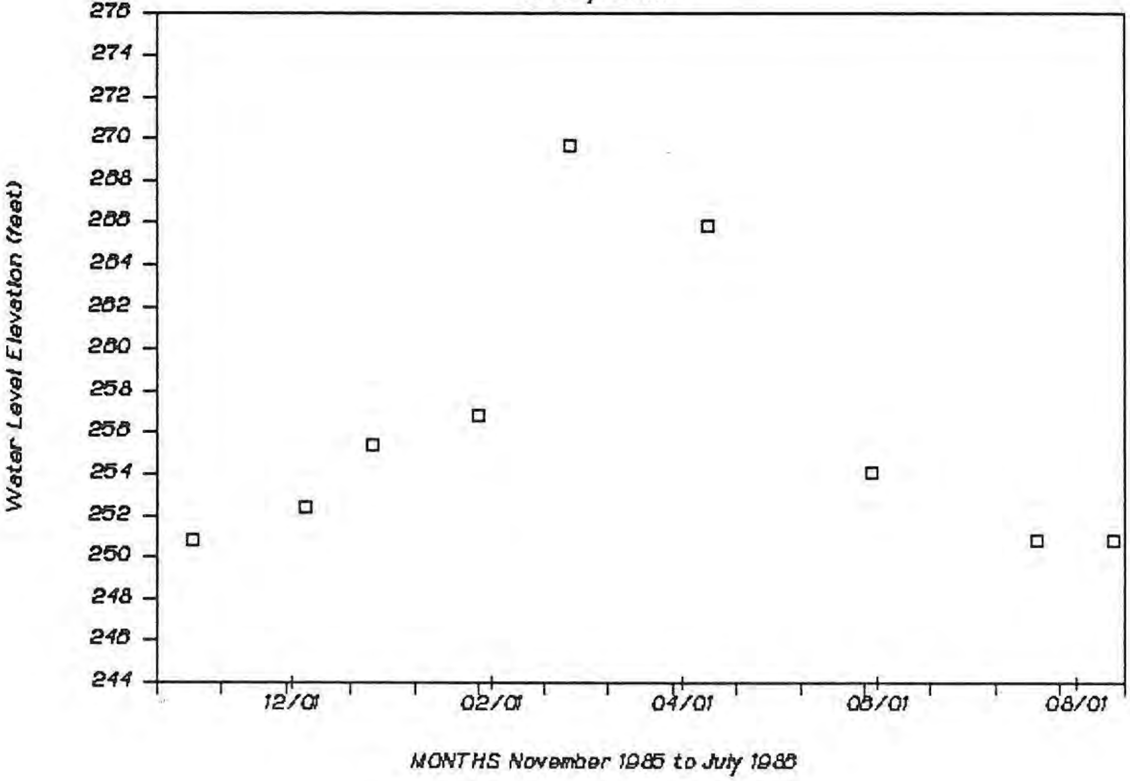
HYDROGRAPH, WELL BH–5

Midway Landfill



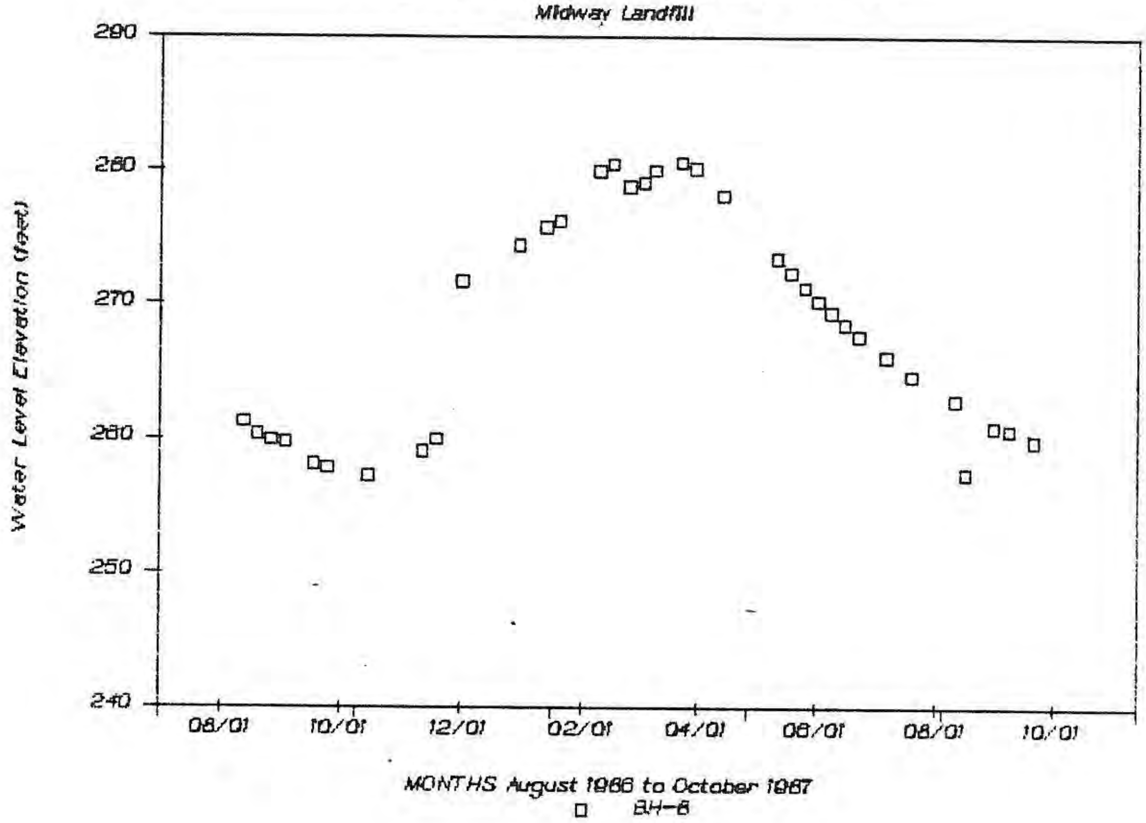
HYDROGRAPH, WELL BH–6

Midway Landfill



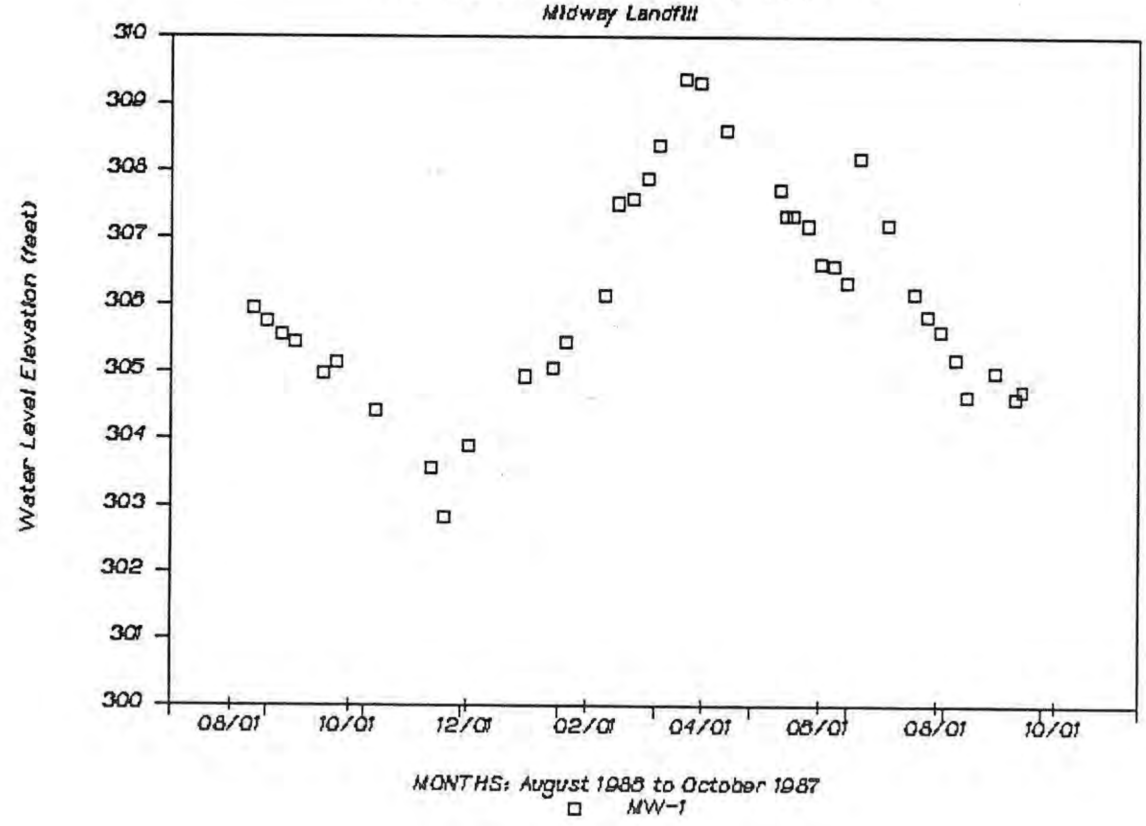
HYDROGRAPH, WELL BH-8

Midway Landfill



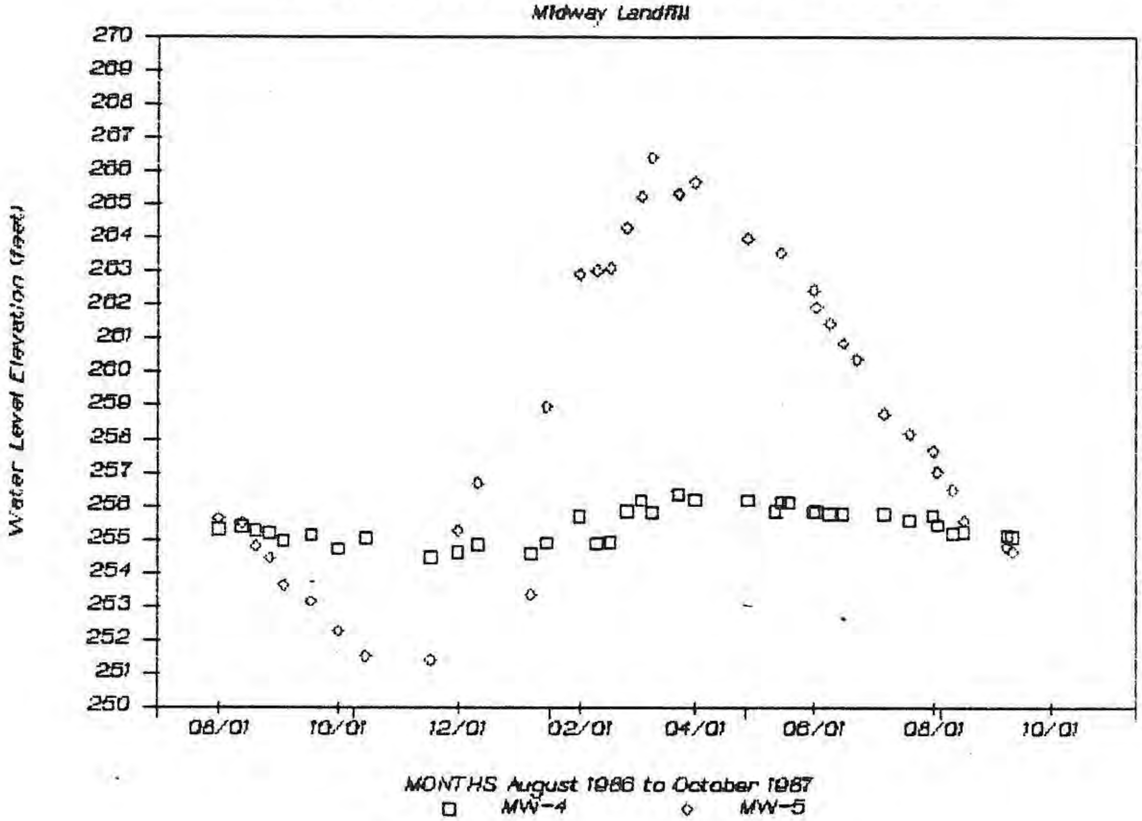
HYDROGRAPH WELL MW-1

Midway Landfill



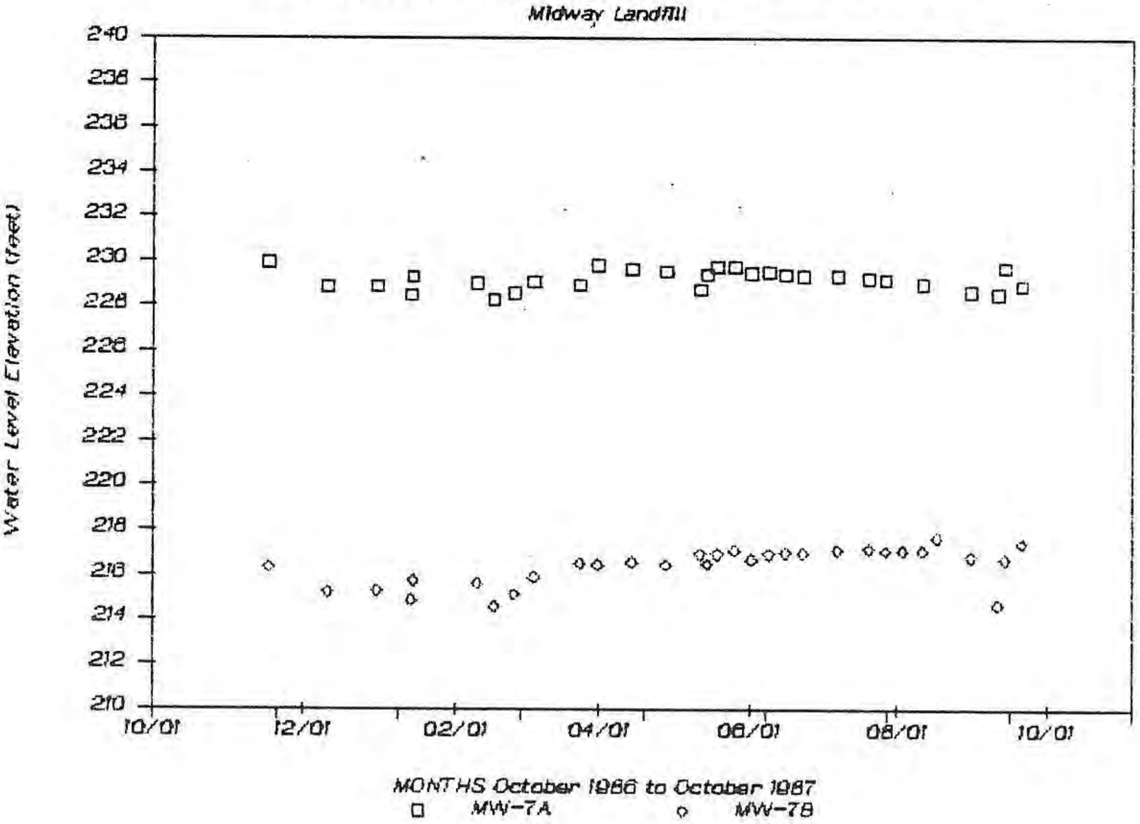
HYDROGRAPH, WELLS MW-4 & 5

Midway Landfill



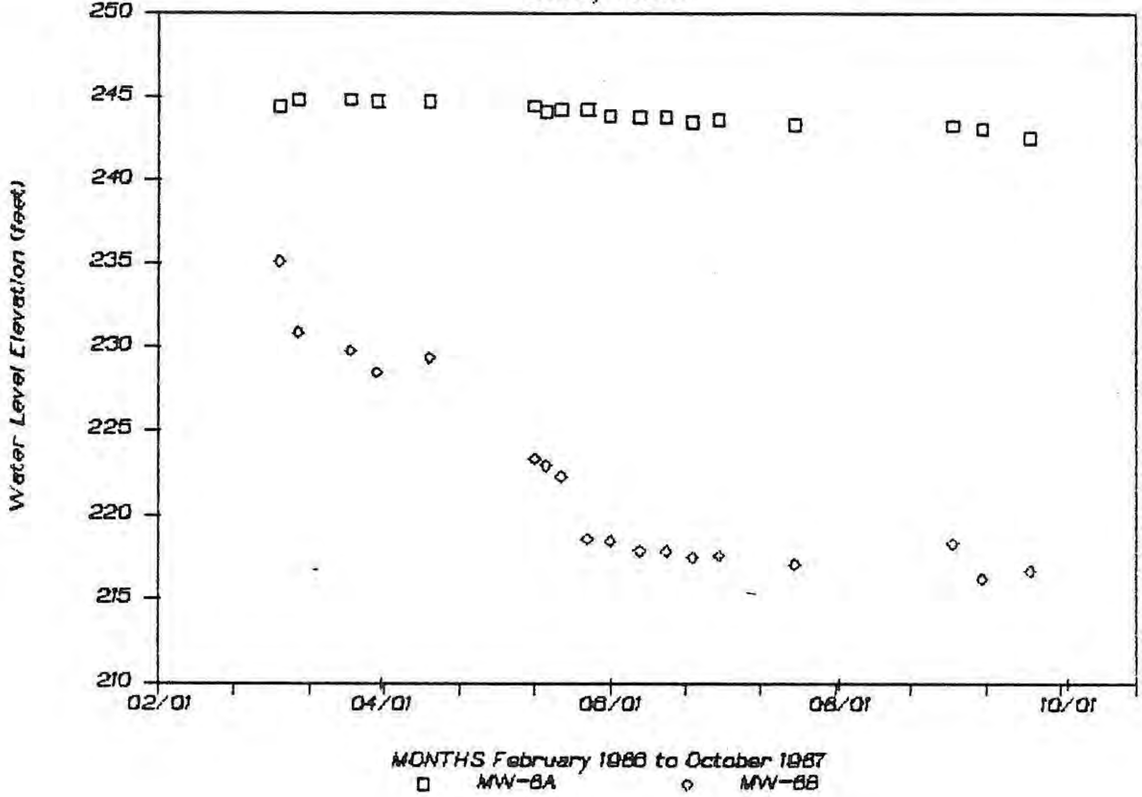
HYDROGRAPH, WELLS MW-7A & 7B

Midway Landfill



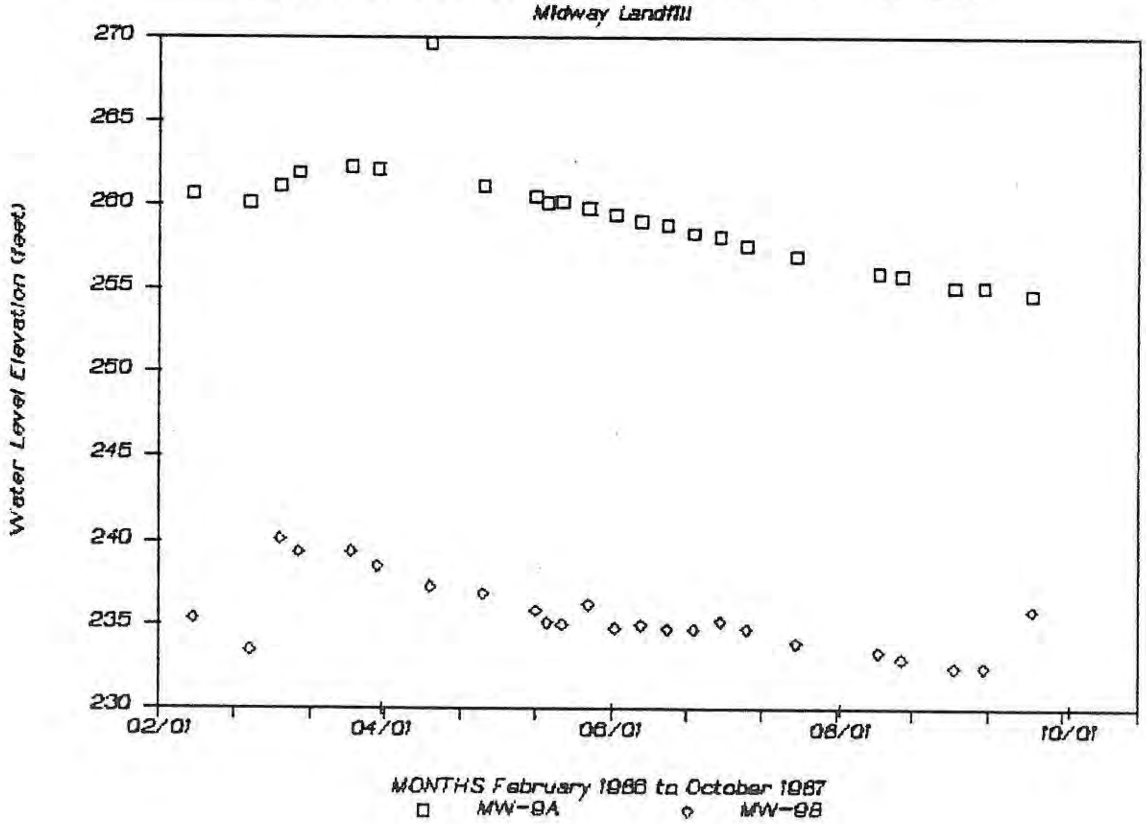
HYDROGRAPH, WELLS MW–8A & 8B

Midway Landfill



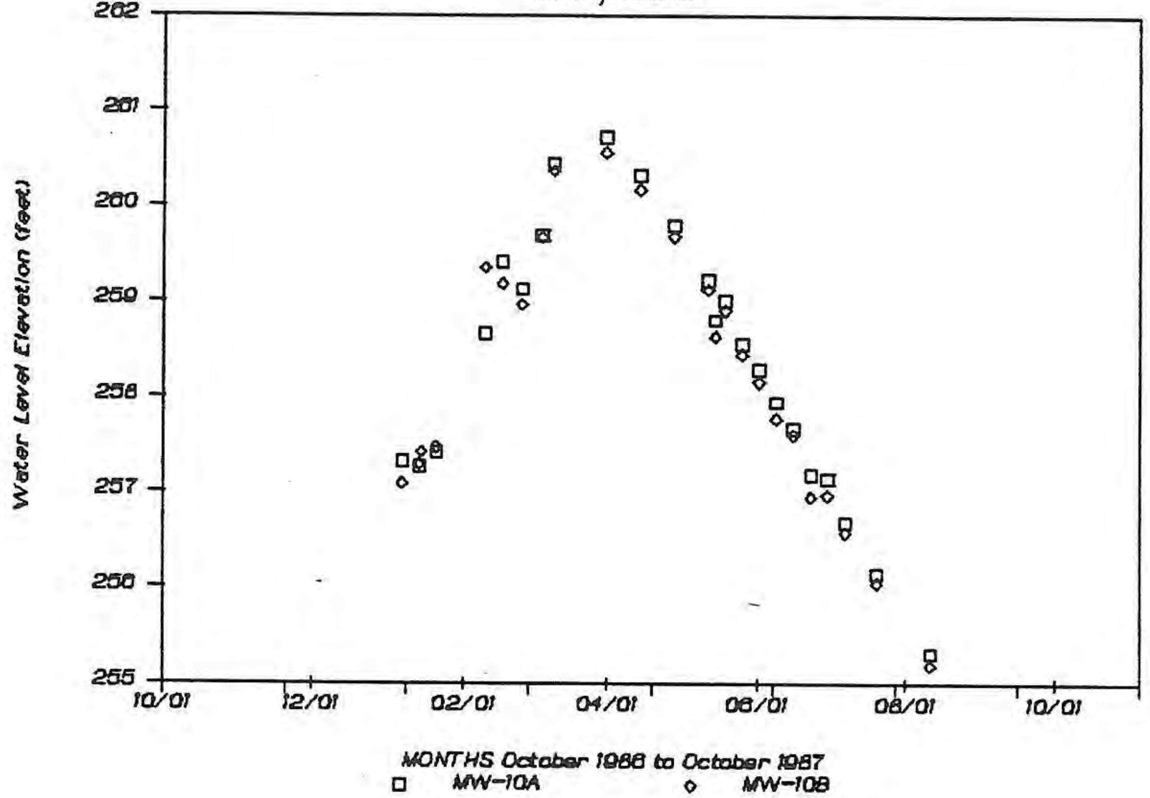
HYDROGRAPH, WELLS MW–9A & 9B

Midway Landfill



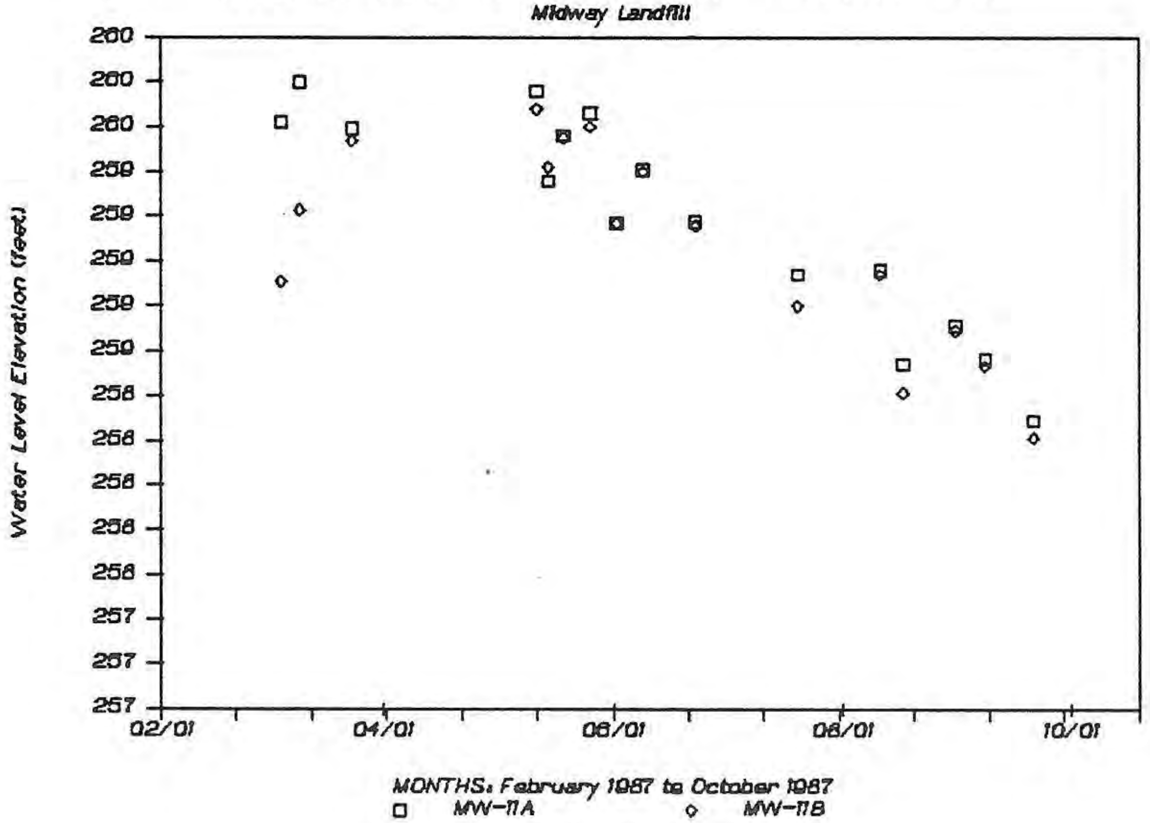
HYDROGRAPH, WELLS MW–10A & 10B

Midway Landfill



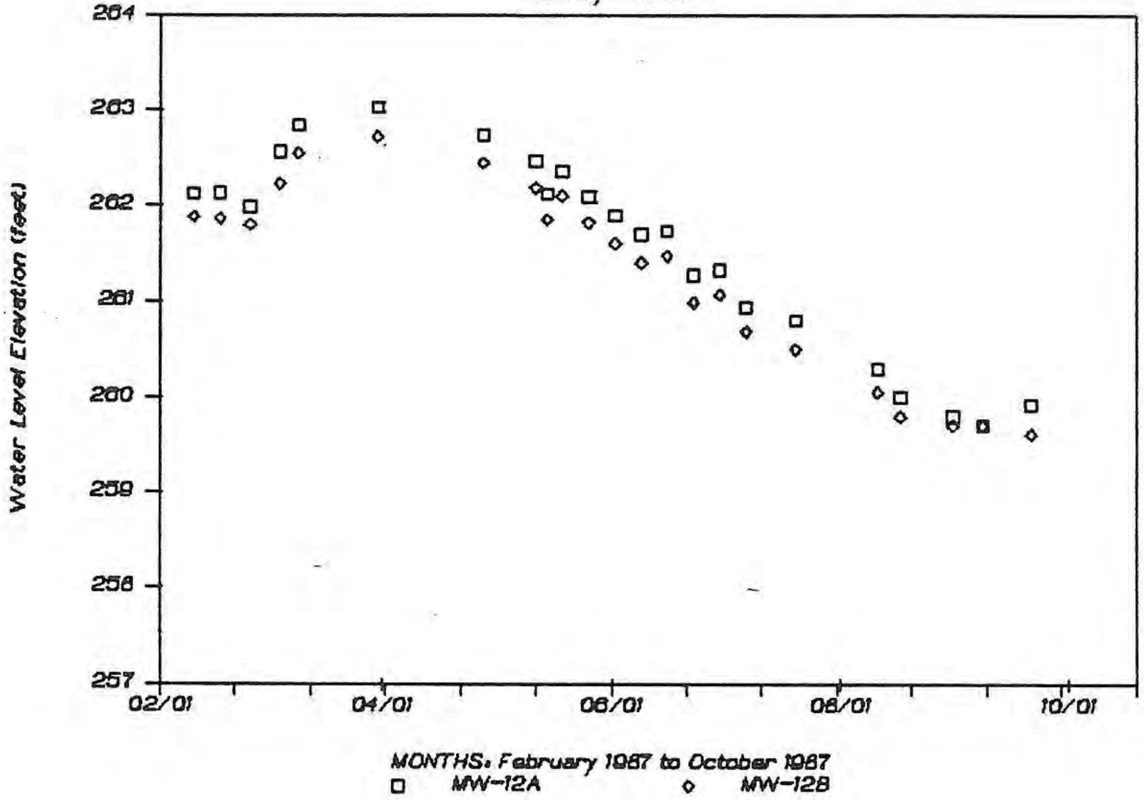
HYDROGRAPH, WELLS MW–11A & 11B

Midway Landfill



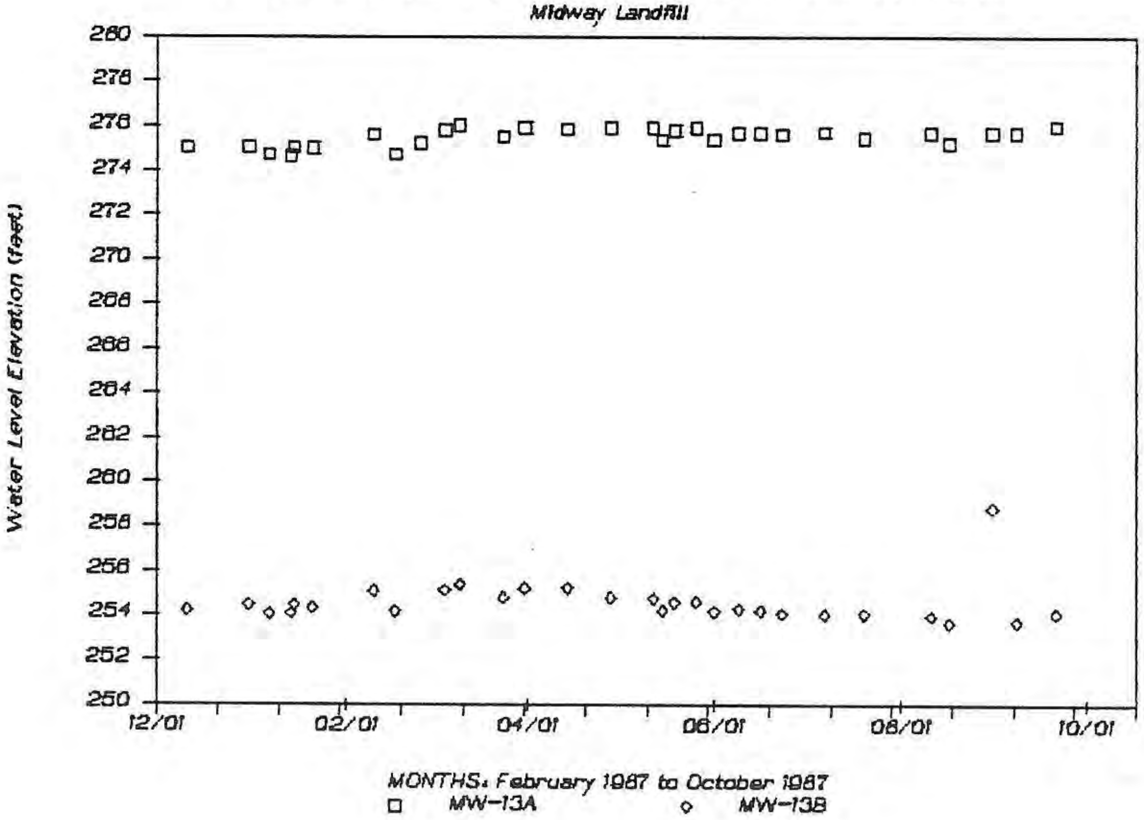
HYDROGRAPH, WELLS MW–12A & 12B

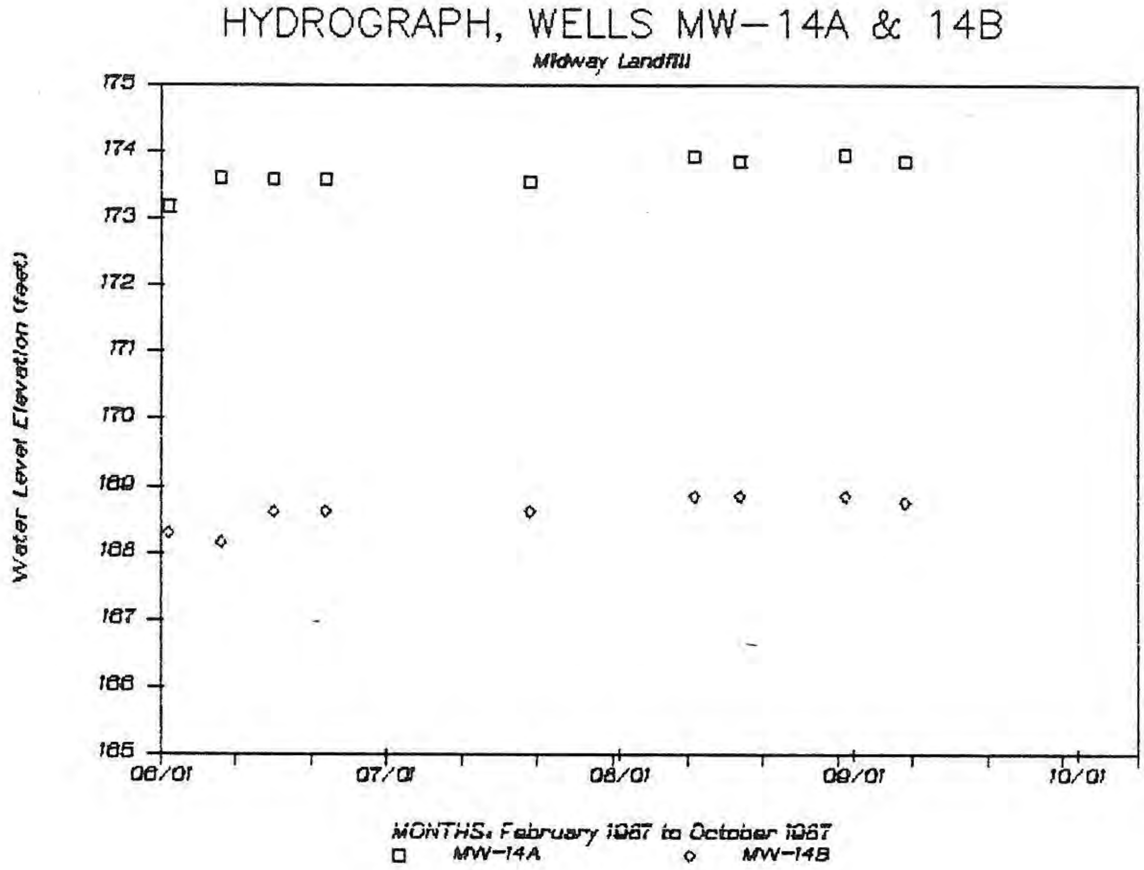
Midway Landfill

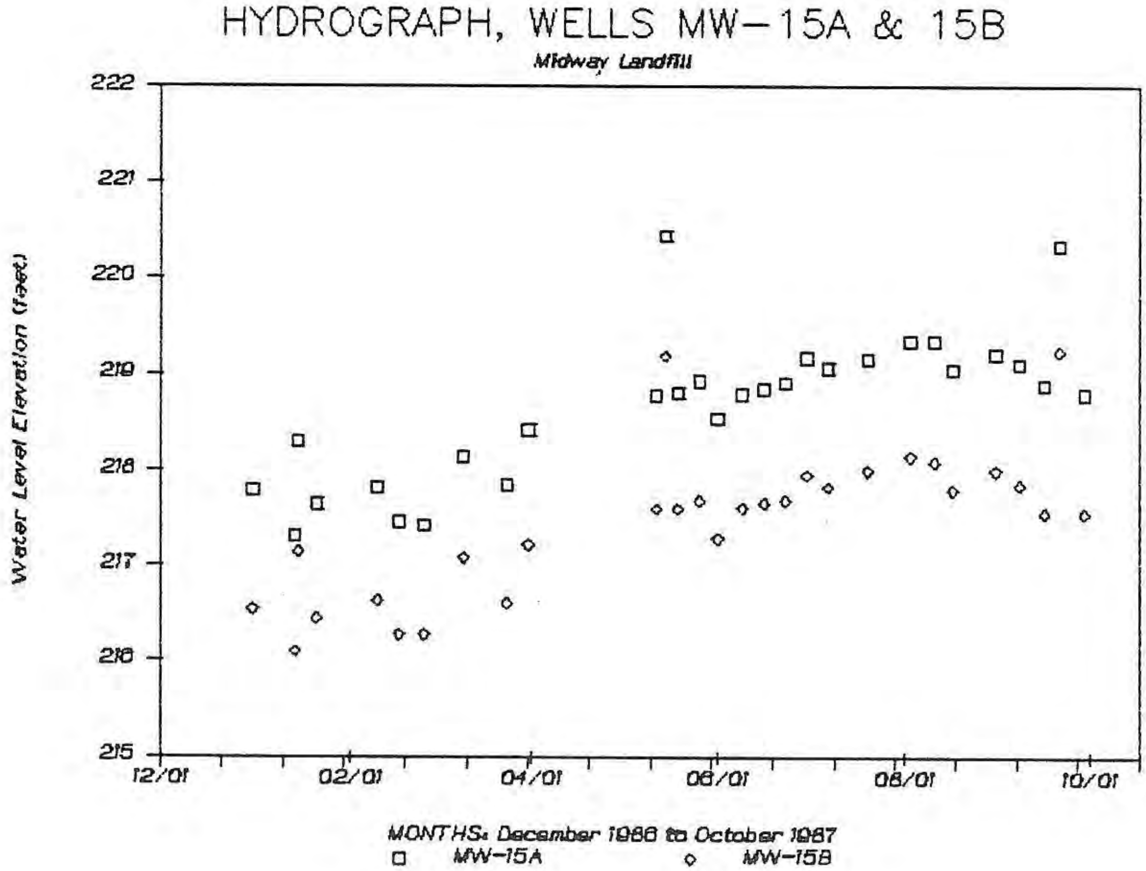


HYDROGRAPH, WELLS MW–13A & 13B

Midway Landfill

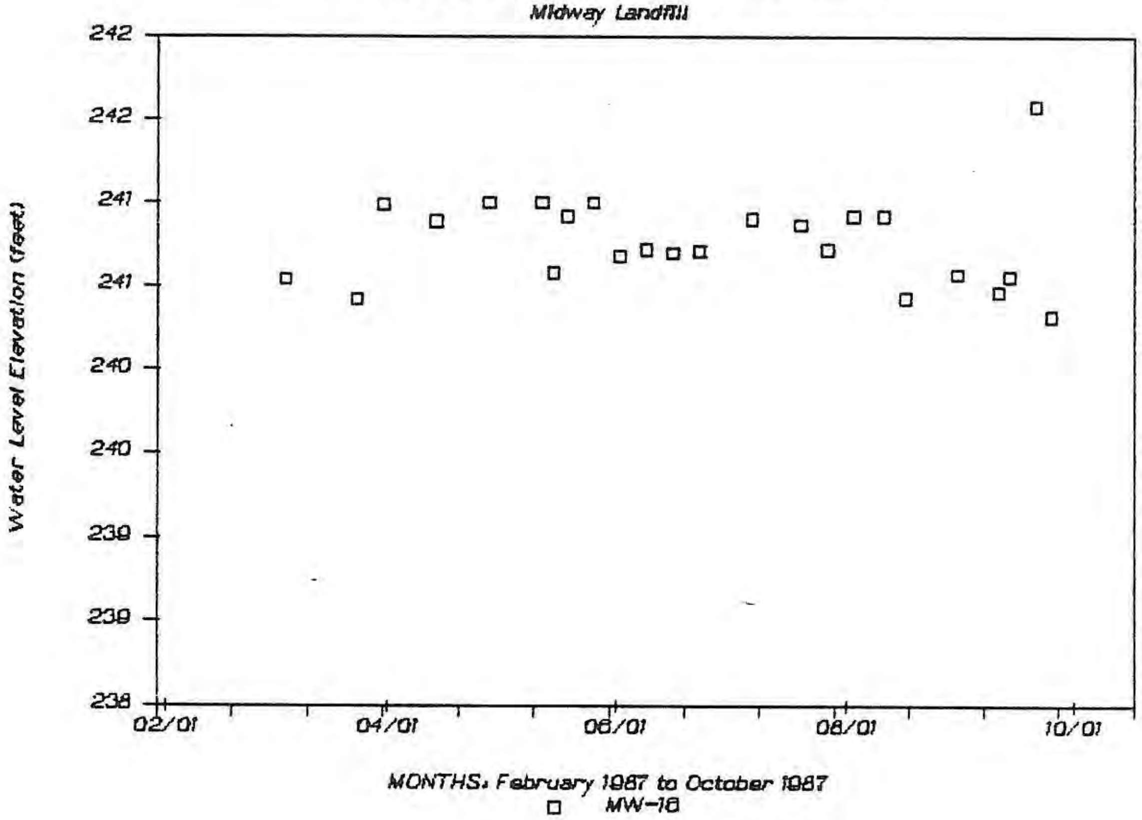



HYDROGRAPH, WELLS MW–14A & 14B
Midway Landfill
Water Level Elevation (feet)
175
174
173
172
171
170
169
168
167
166
165
06/01
07/01
08/01
09/01
10/01
MONTHS: February 1987 to October 1987
□ MW–14A
◇ MW–14B


HYDROGRAPH, WELLS MW–15A & 15B
Midway Landfill
Water Level Elevation (feet)
222
221
220
219
218
217
216
215
12/01
02/01
04/01
06/01
08/01
10/01
MONTHS: December 1986 to October 1987
□ MW–15A
◇ MW–15B

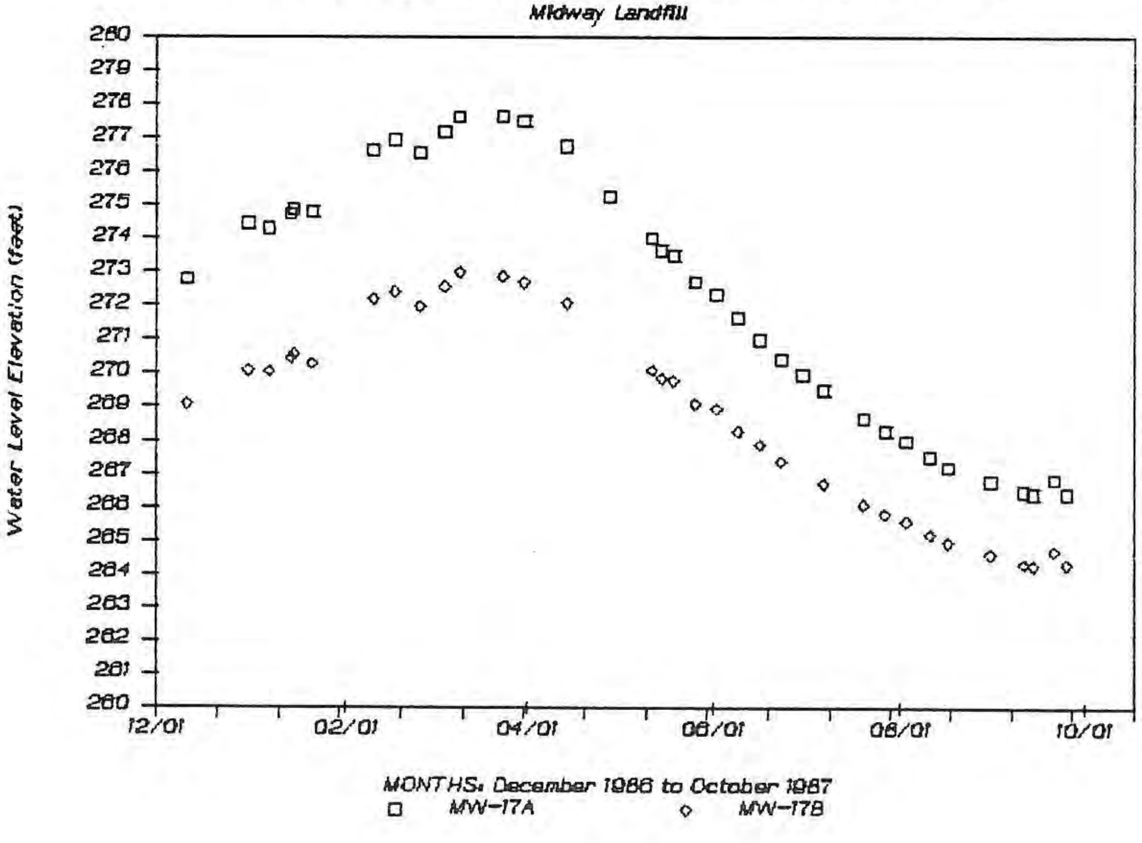
HYDROGRAPH, WELL MW-16

Midway Landfill



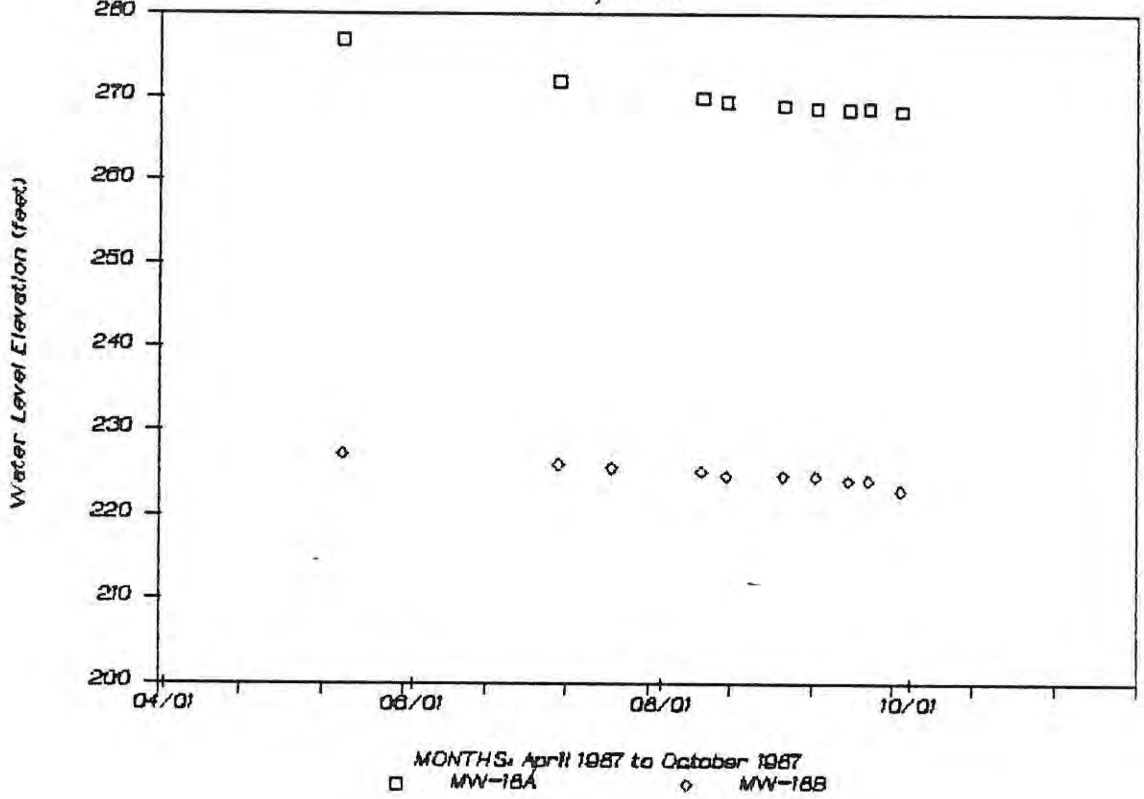
HYDROGRAPH, WELLS MW-17A & 17B

Midway Landfill



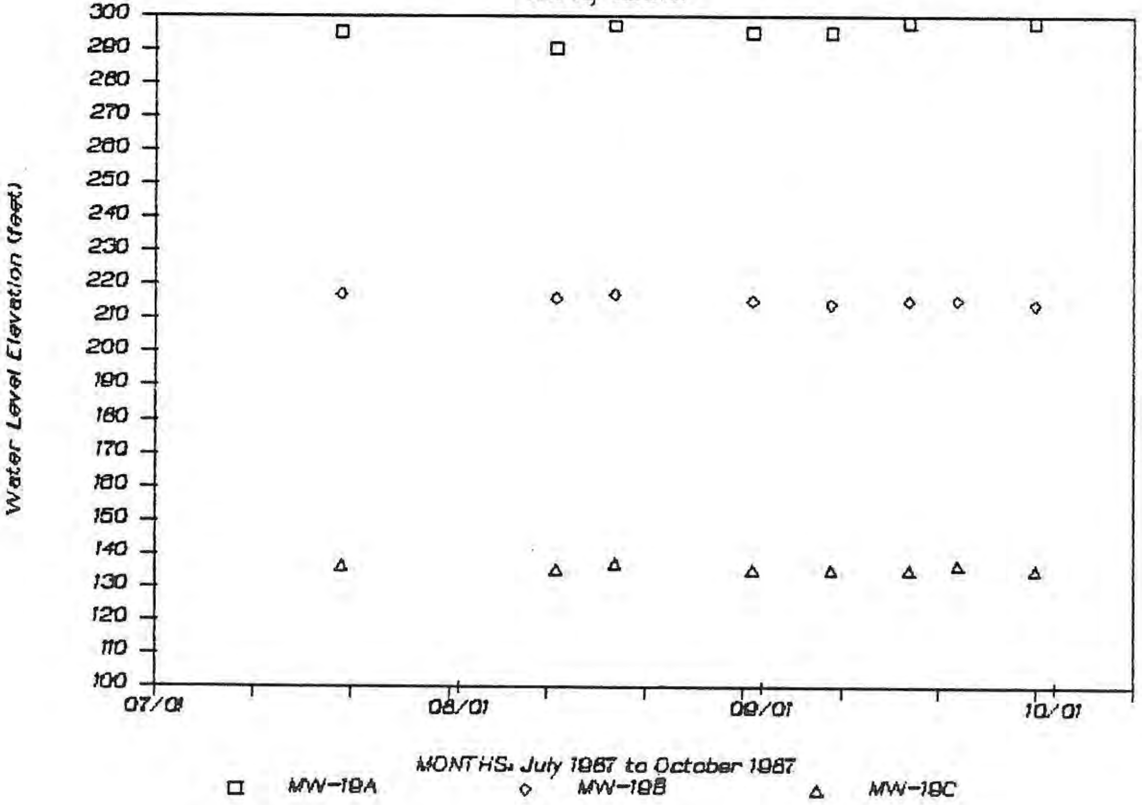
HYDROGRAPH, WELLS MW−18A & 18B

Midway Landfill



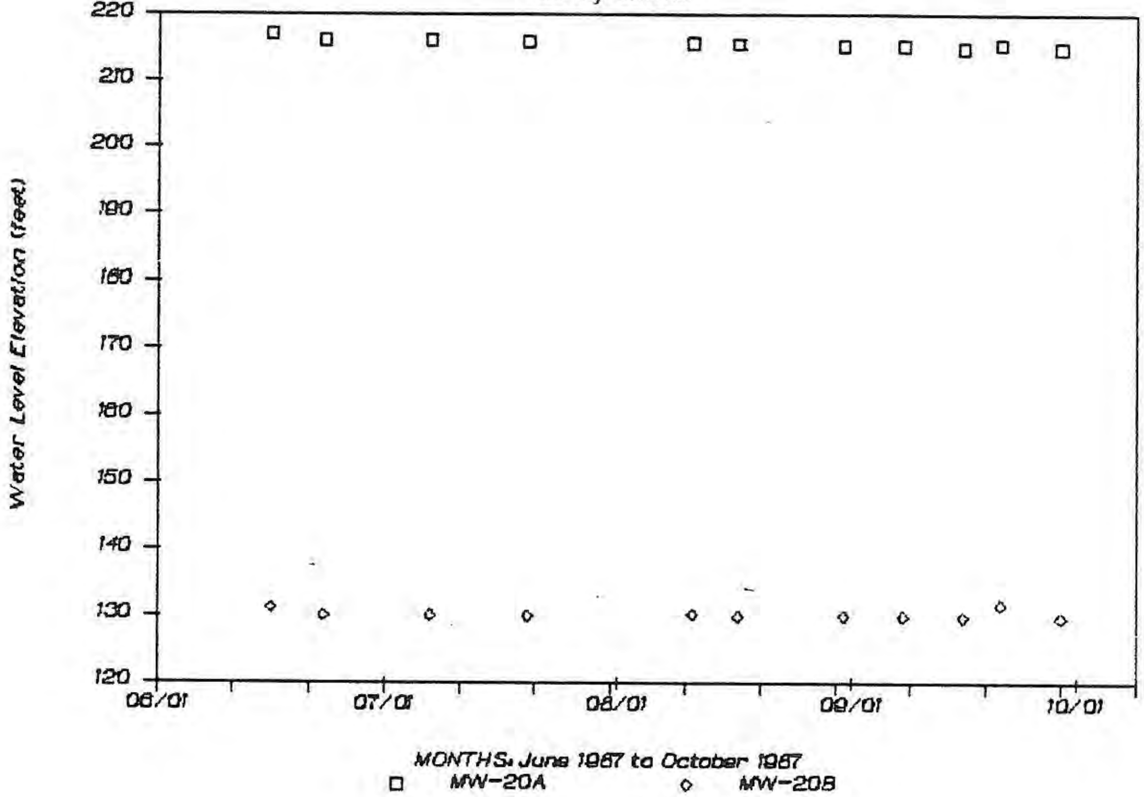
HYDROGRAPH, WELLS MW−19A, 19B, &19C

Midway Landfill



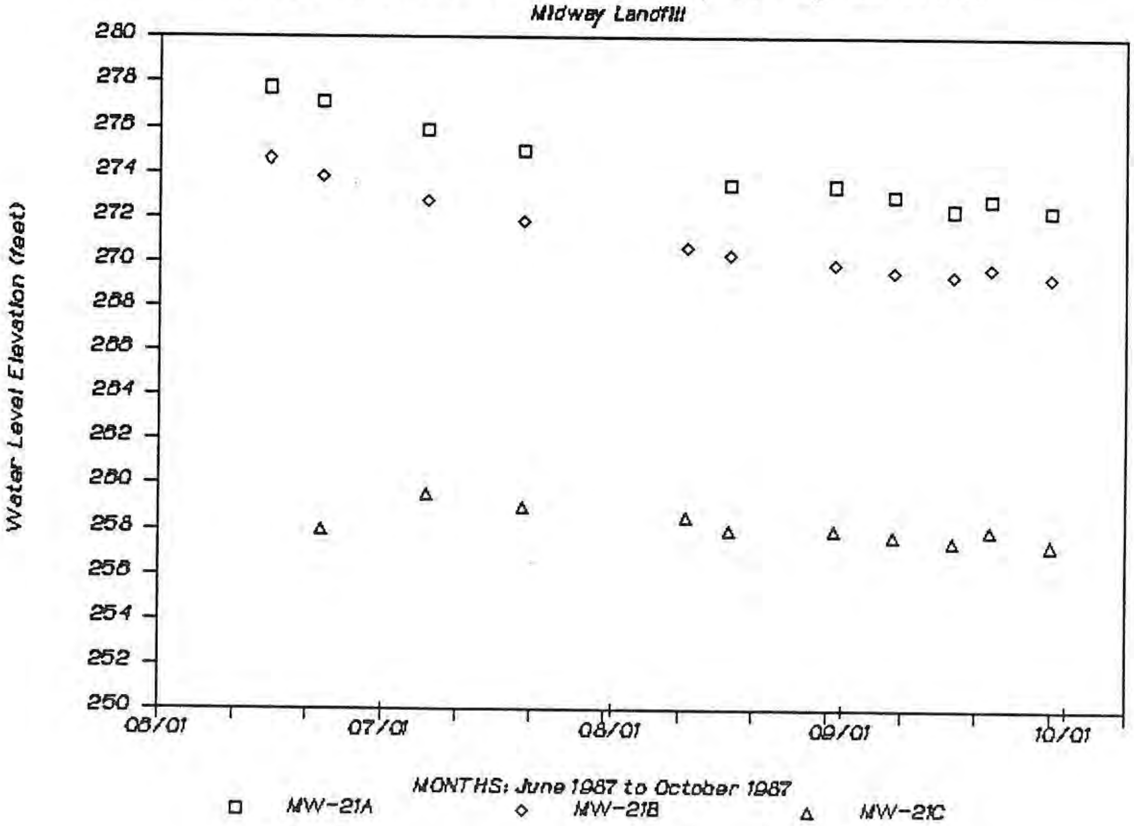
HYDROGRAPH, WELLS MW−20A & 20B

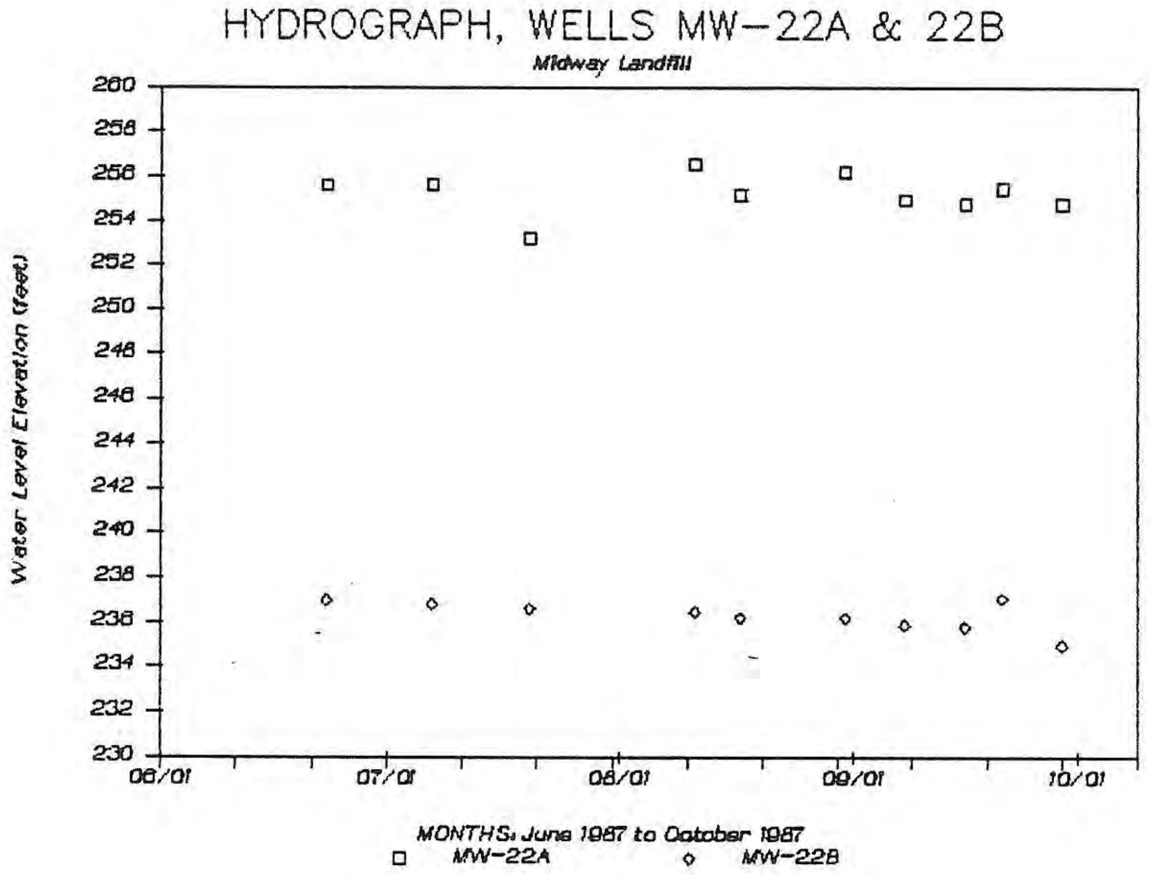
Midway Landfill

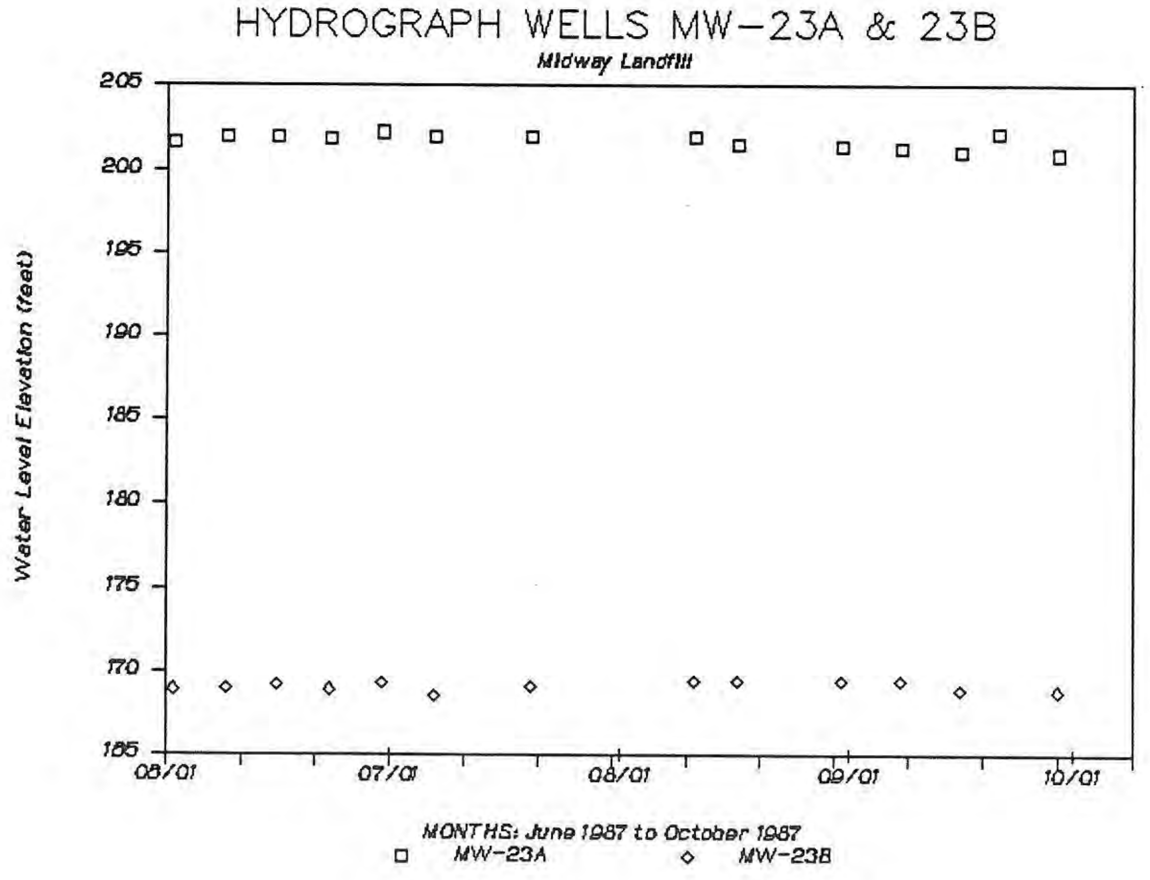


HYDROGRAPH MW−21A, 21B, & 21C

Midway Landfill

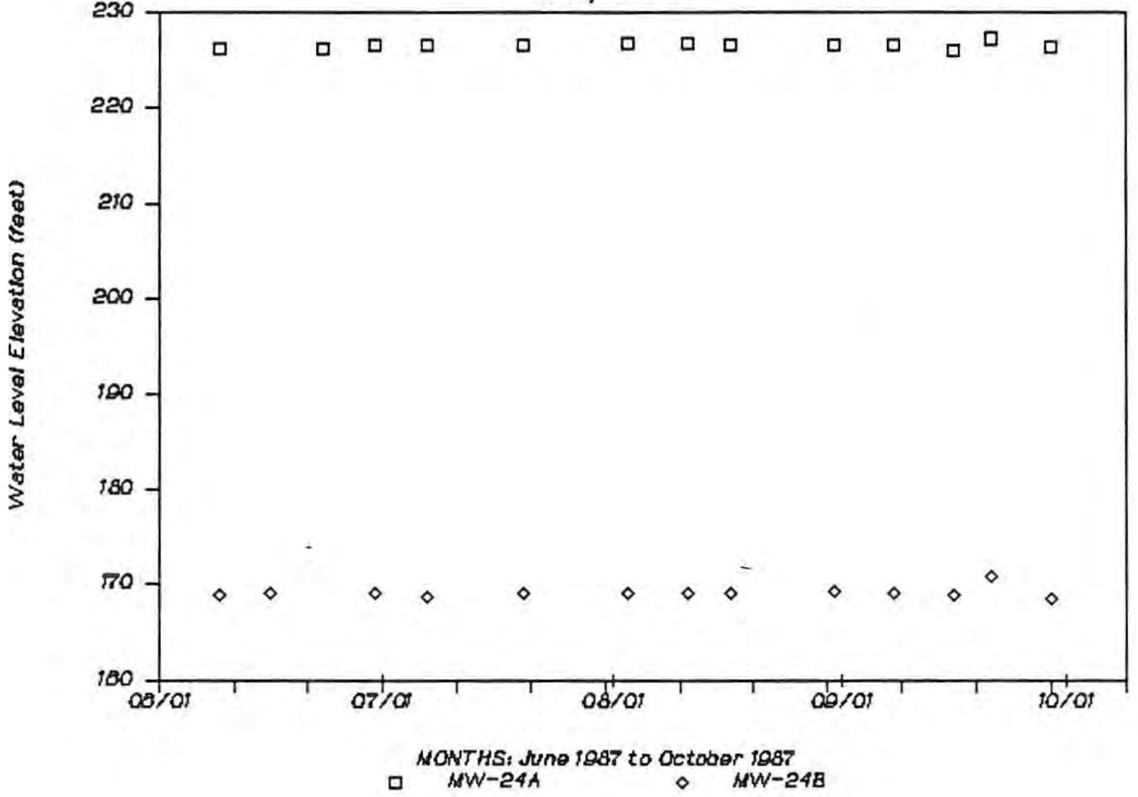



HYDROGRAPH, WELLS MW−22A & 22B
Midway Landfill
Water Level Elevation (feet)
260
258
256
254
252
250
248
246
244
242
240
238
236
234
232
230
06/01
07/01
08/01
09/01
10/01
MONTHS: June 1987 to October 1987
□ MW−22A
◇ MW−22B


HYDROGRAPH WELLS MW−23A & 23B
Midway Landfill
Water Level Elevation (feet)
205
200
195
190
185
180
175
170
165
06/01
07/01
08/01
09/01
10/01
MONTHS: June 1987 to October 1987
□ MW−23A
◇ MW−23B

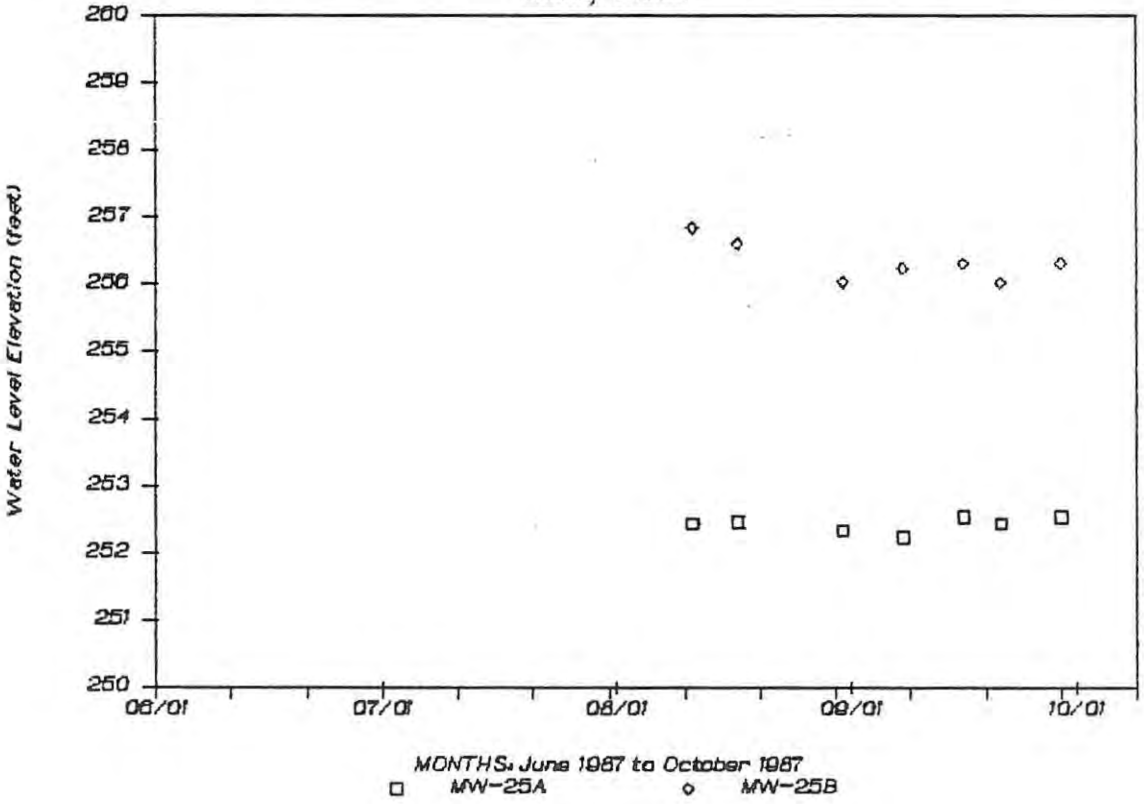
HYDROGRAPH WELLS MW–24A & 24B

Midway Landfill



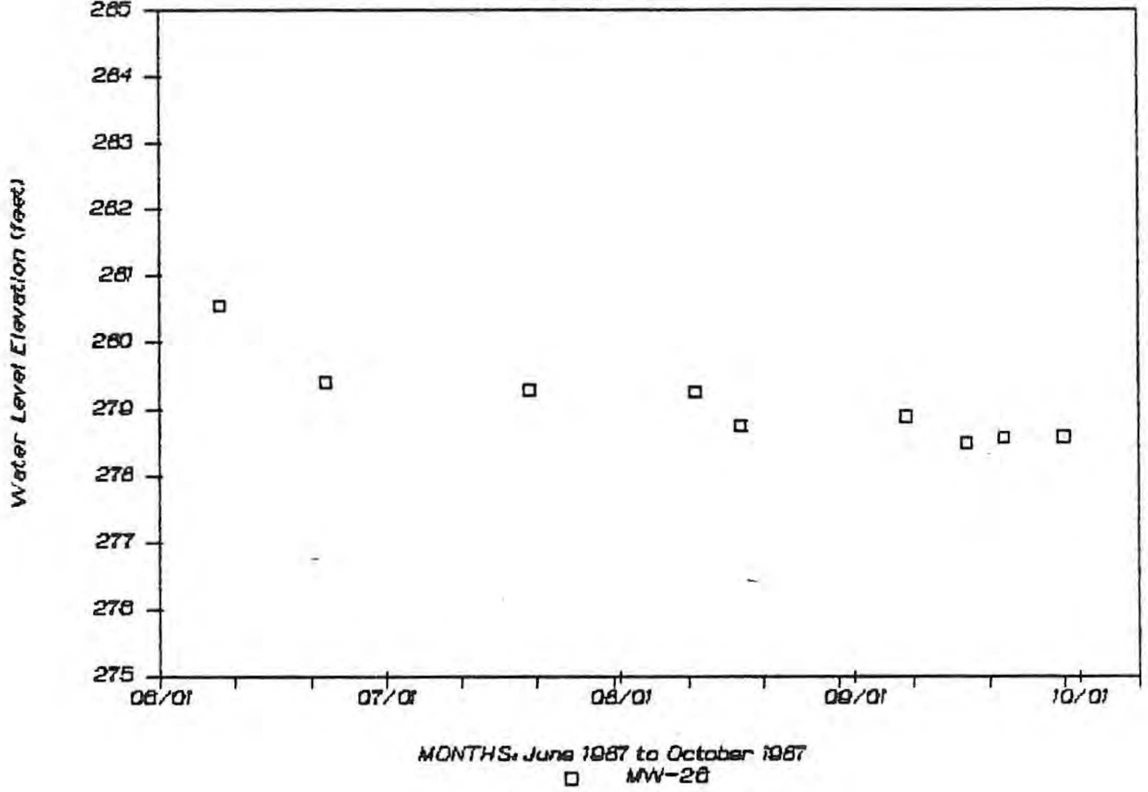
HYDROGRAPH, WELLS MW–25A & 25B

Midway Landfill



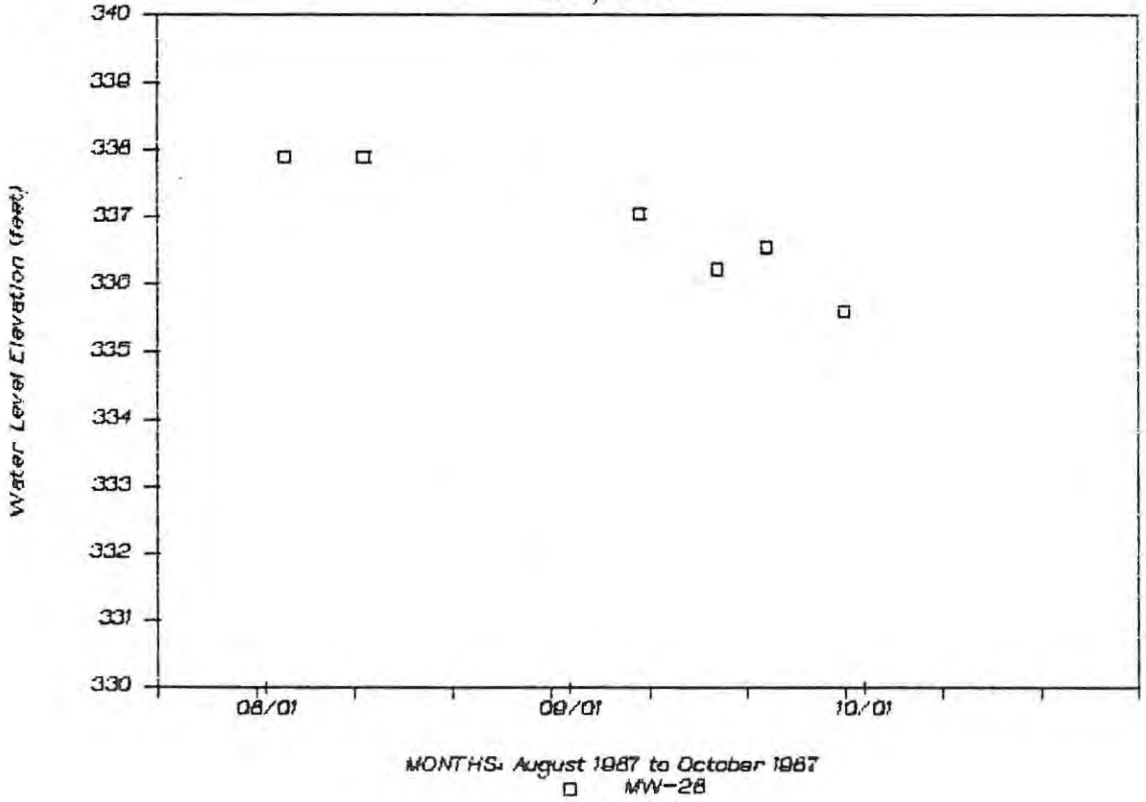
HYDROGRAPH, WELL MW-26

Midway Landfill



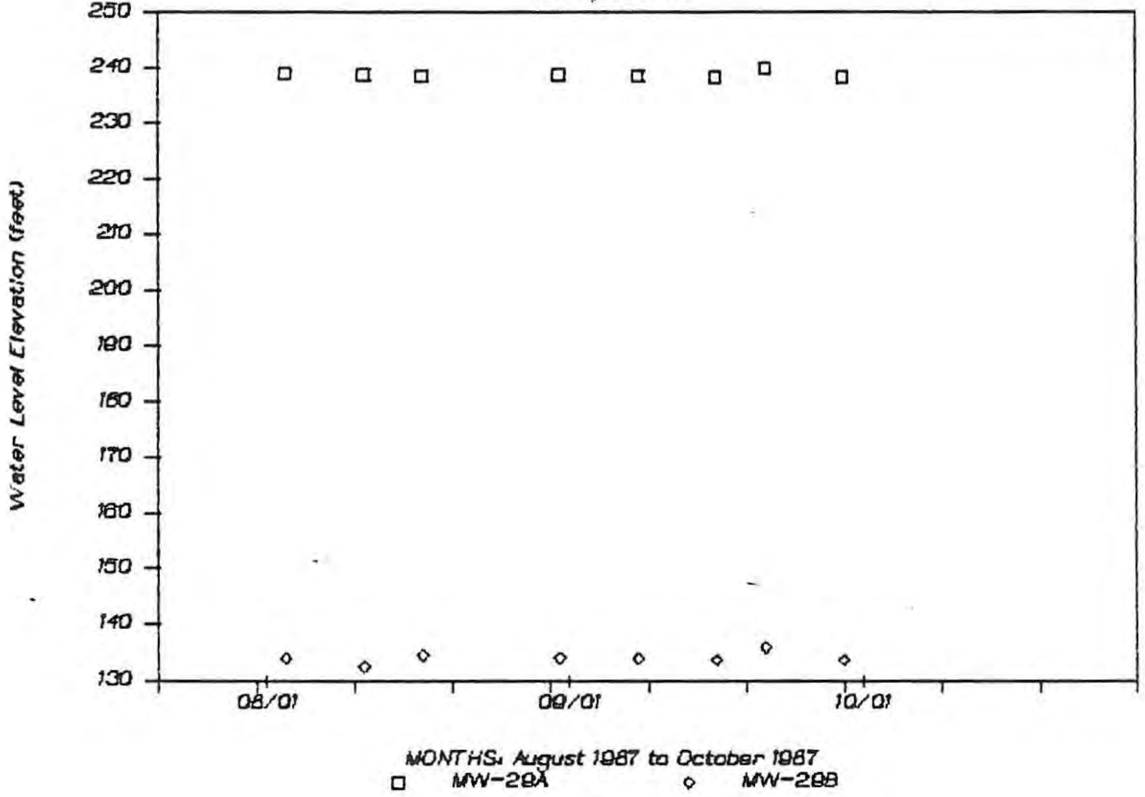
HYDROGRAPH, WELL MW-28

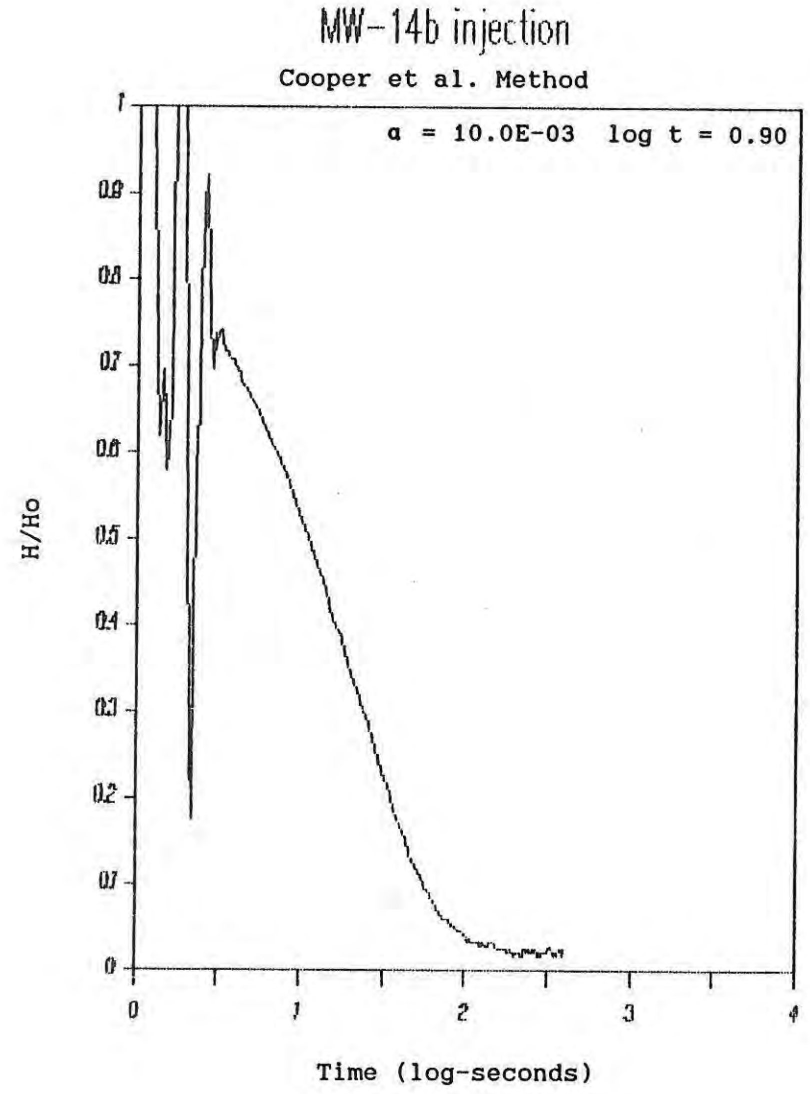
Midway Landfill



HYDROGRAPH, WELLS MW−29 A & B

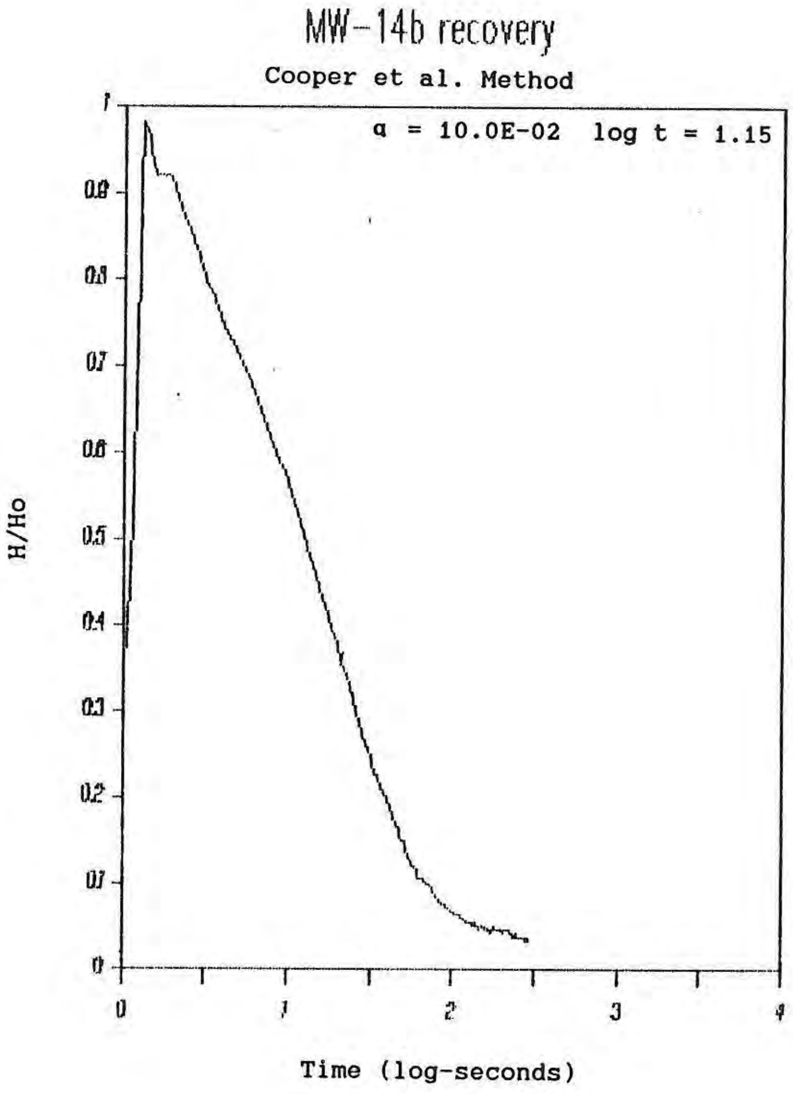
Midway Landfill





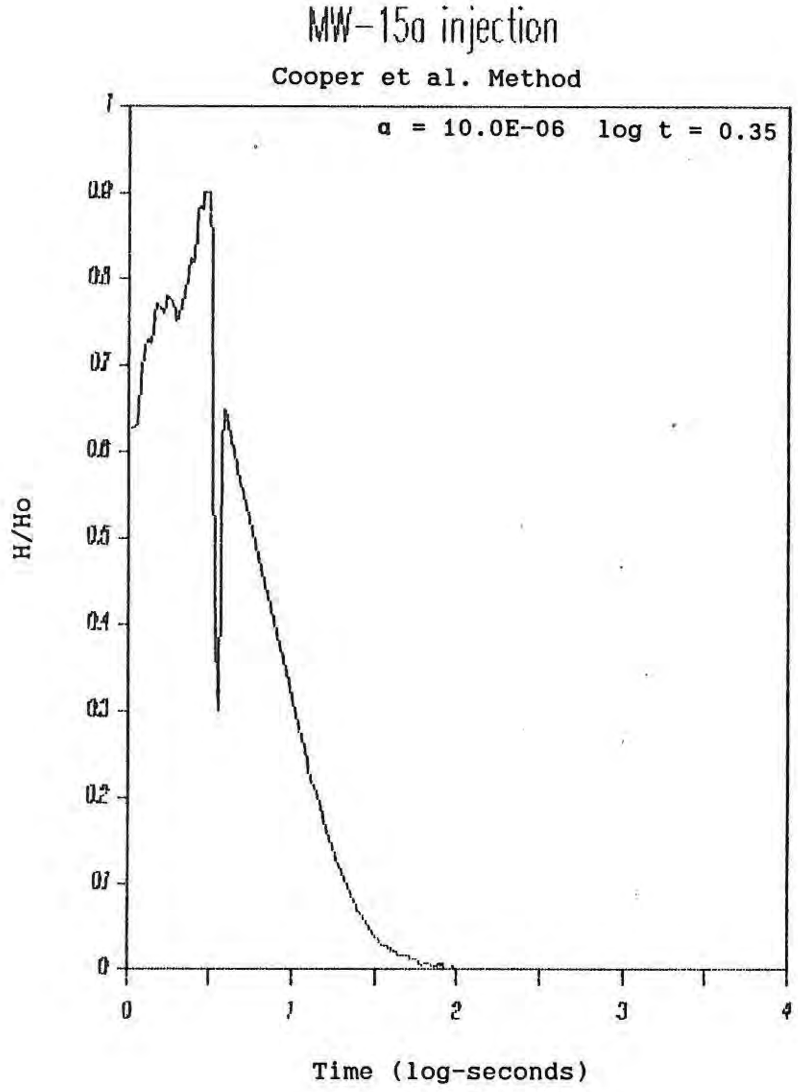
MW–14b injection

Cooper et al. Method



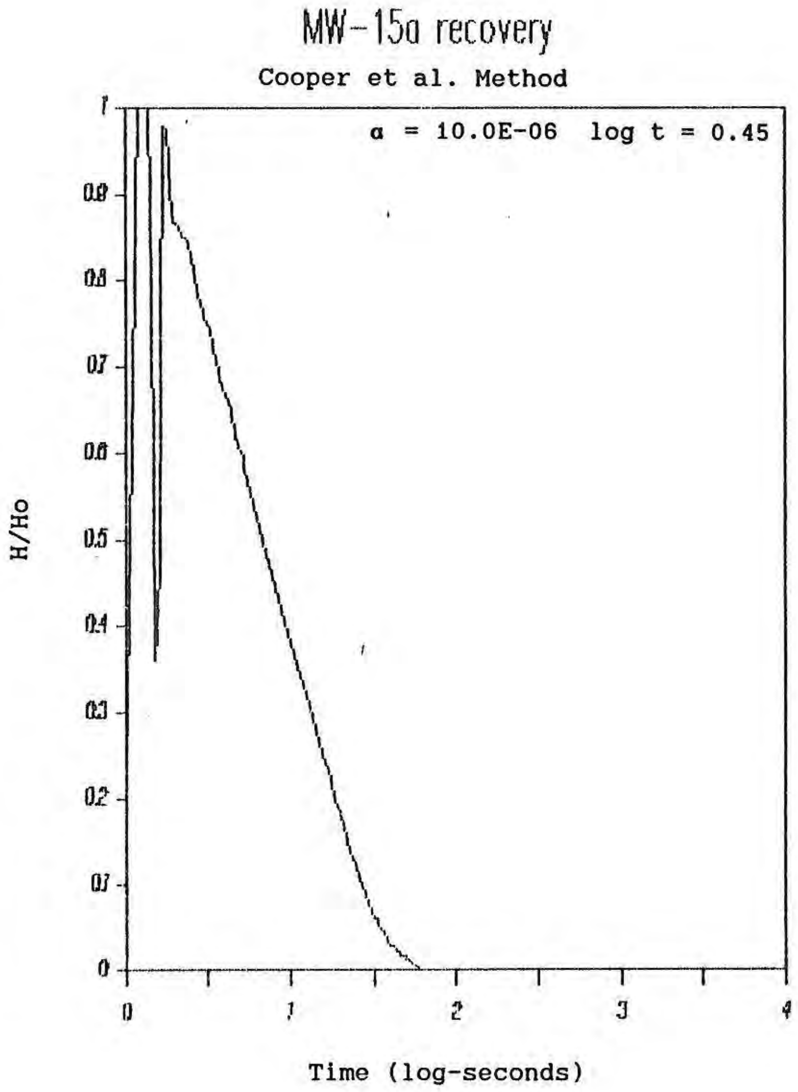
MW–14b recovery

Cooper et al. Method



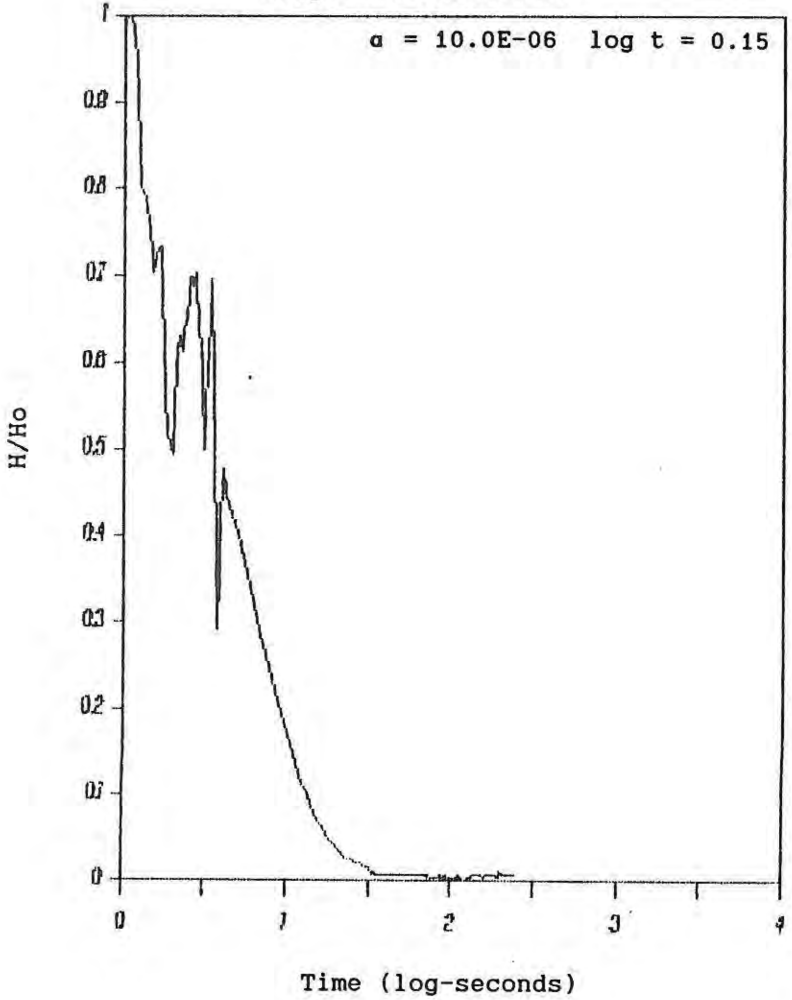
MW-15a injection

Cooper et al. Method



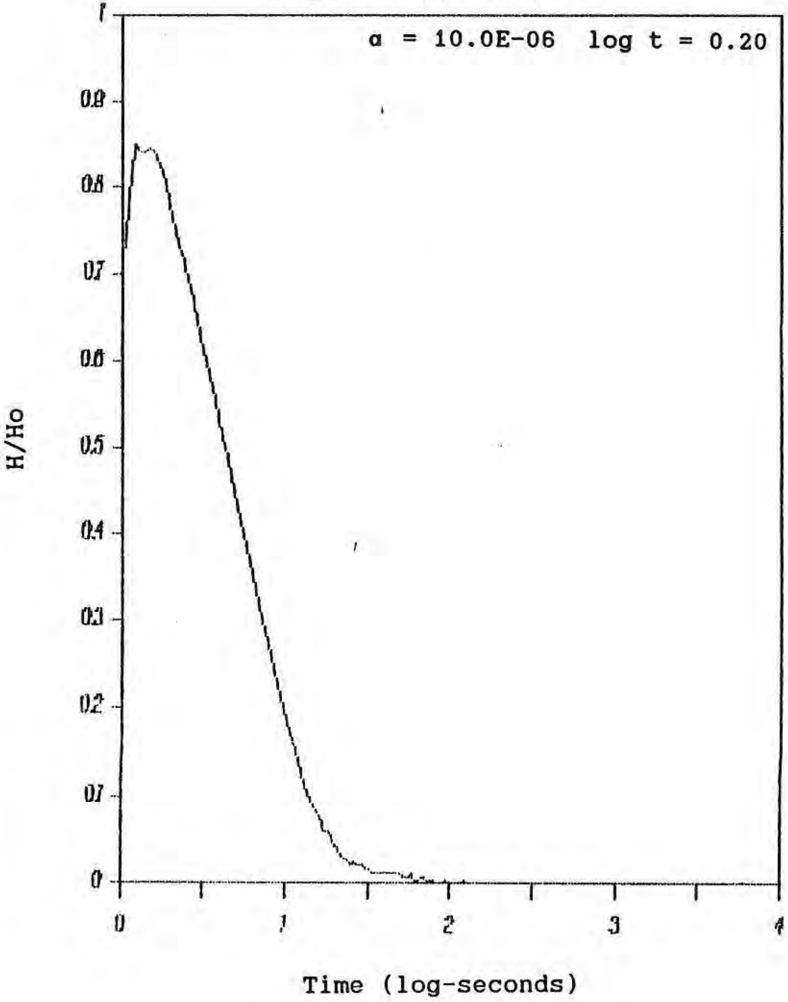
MW-15a recovery

Cooper et al. Method



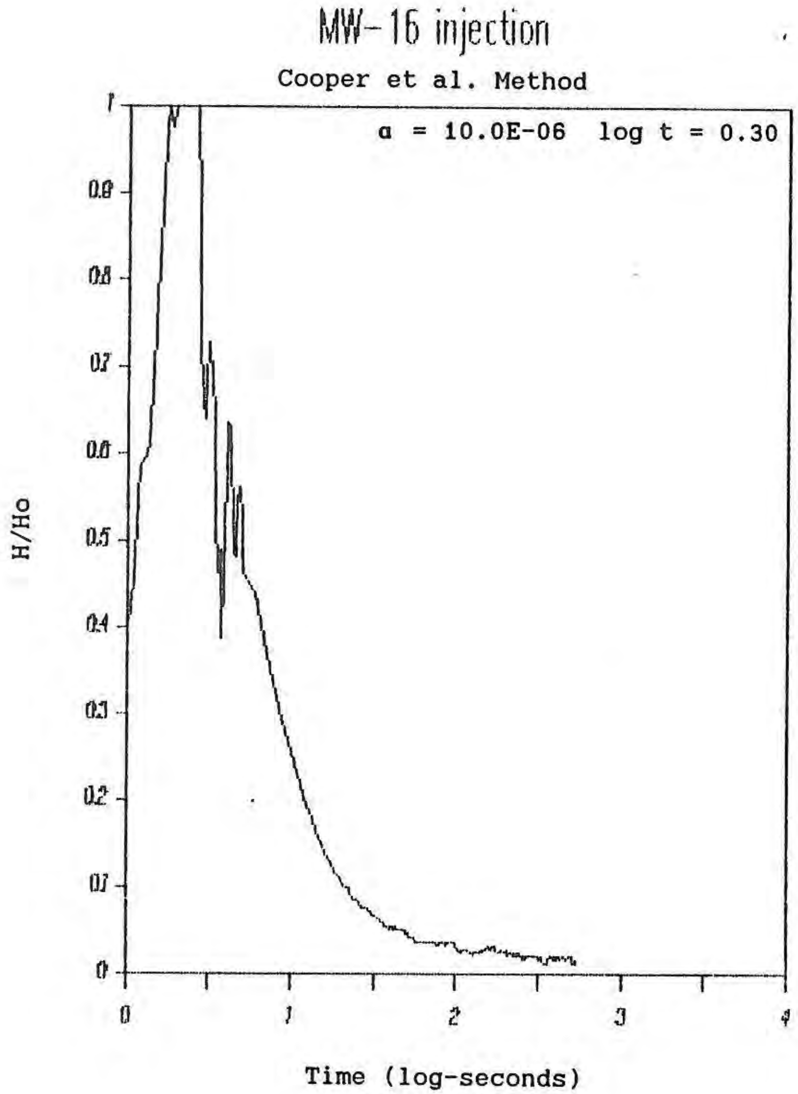
MW-15b injection

Cooper et al. Method



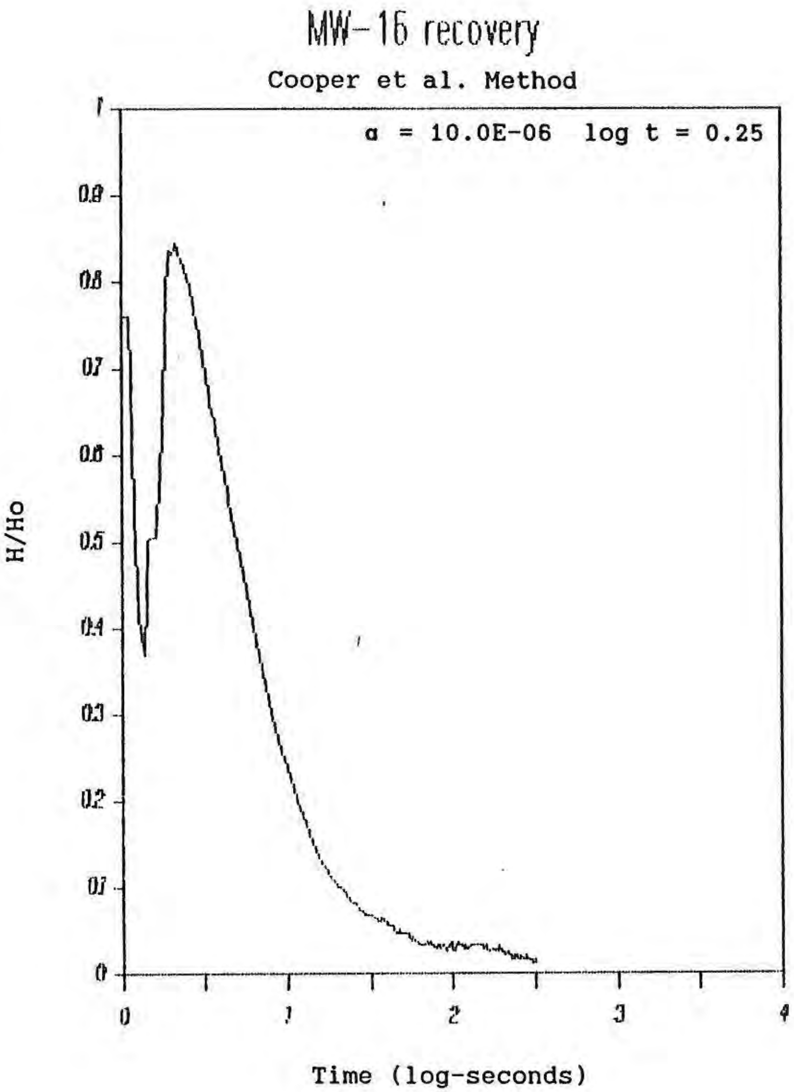
MW-15b recovery

Cooper et al. Method



MW-16 injection

Cooper et al. Method

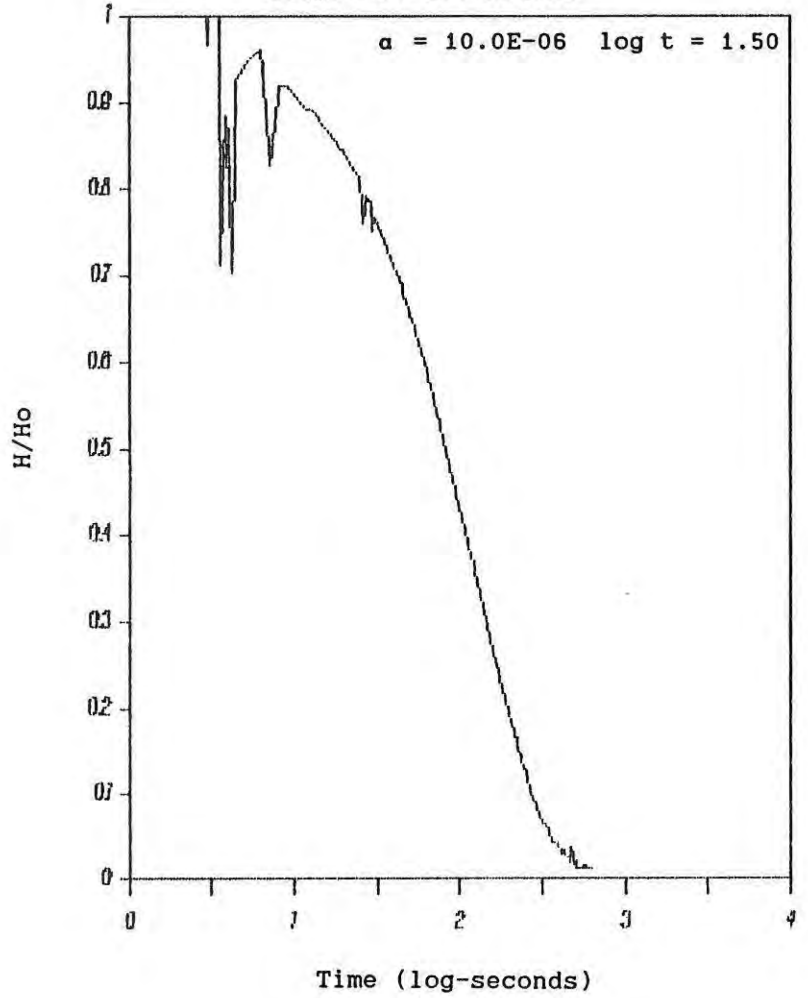


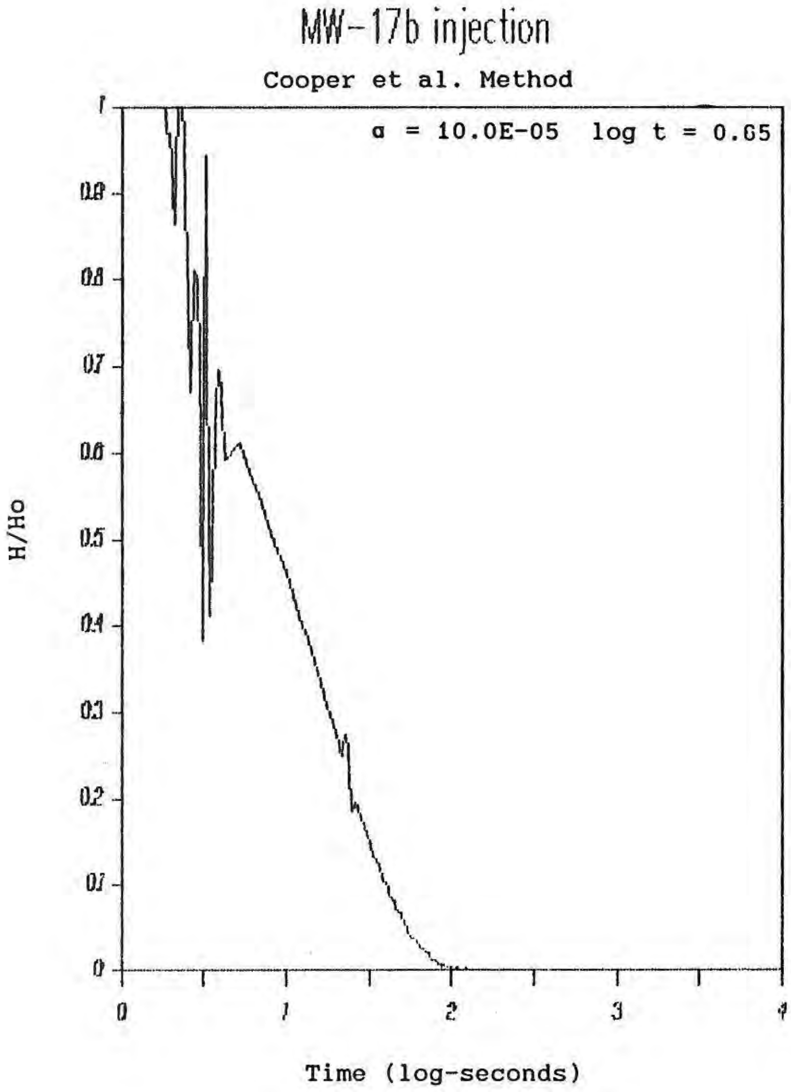
MW-16 recovery

Cooper et al. Method

MW-17a injection

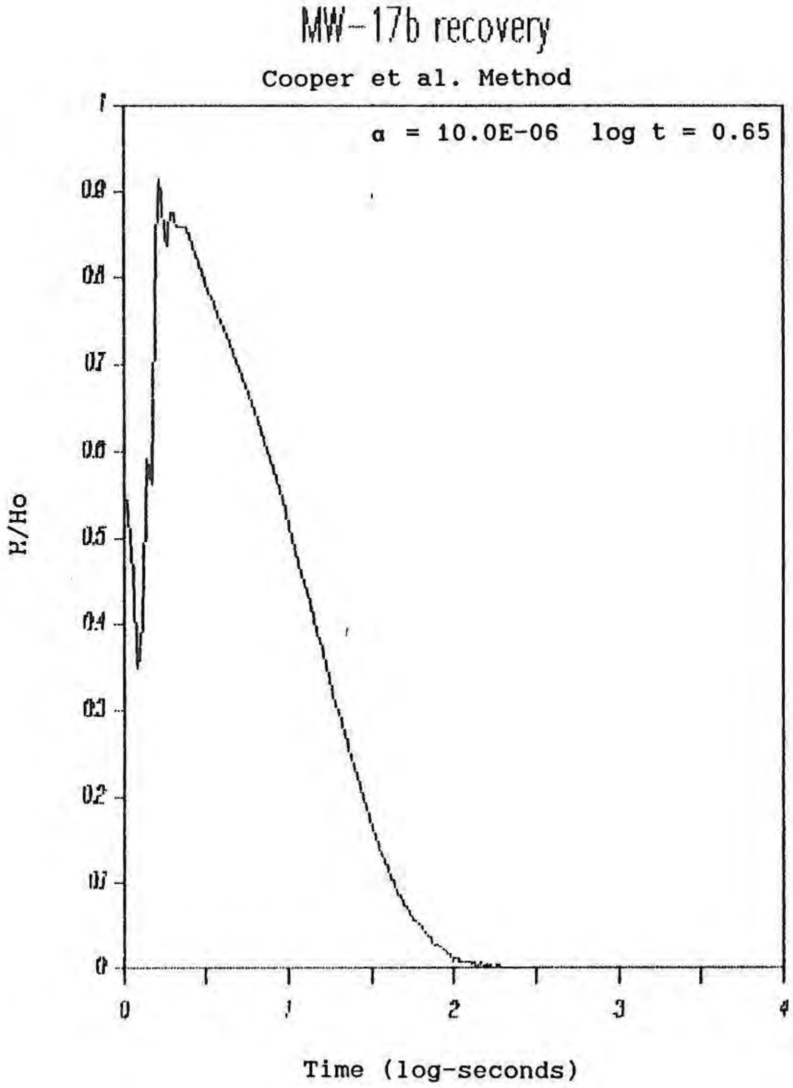
Cooper et al. Method





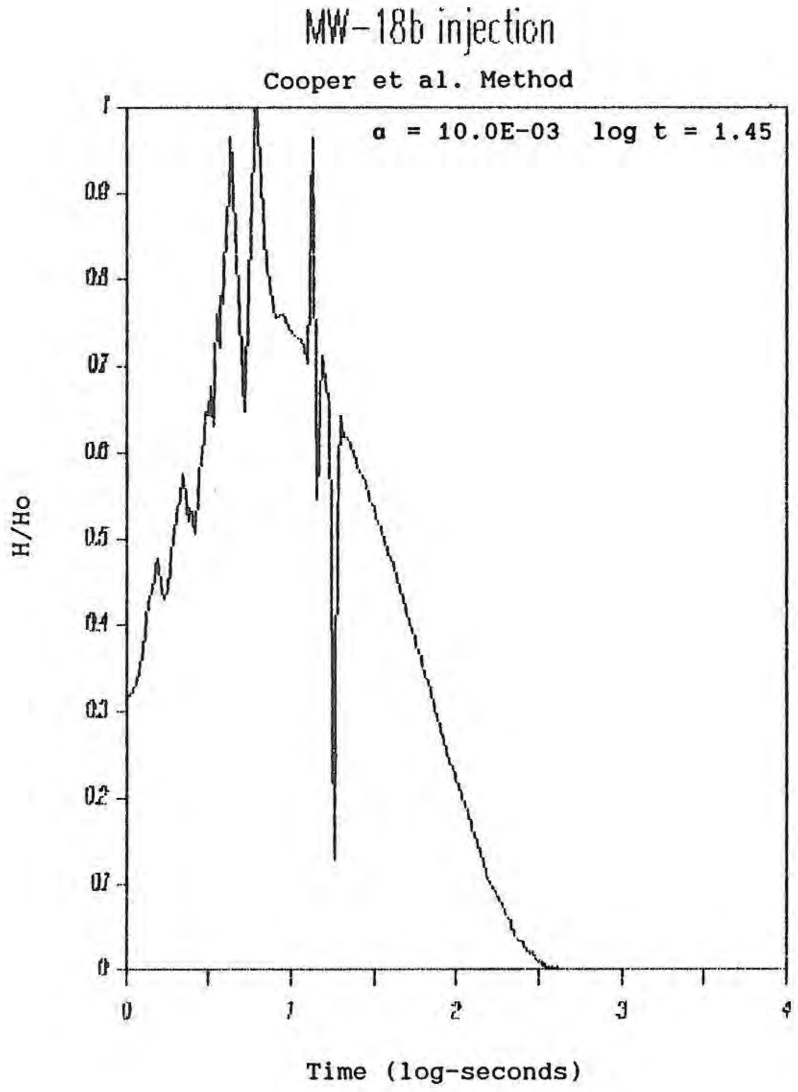
MW-17b injection

Cooper et al. Method

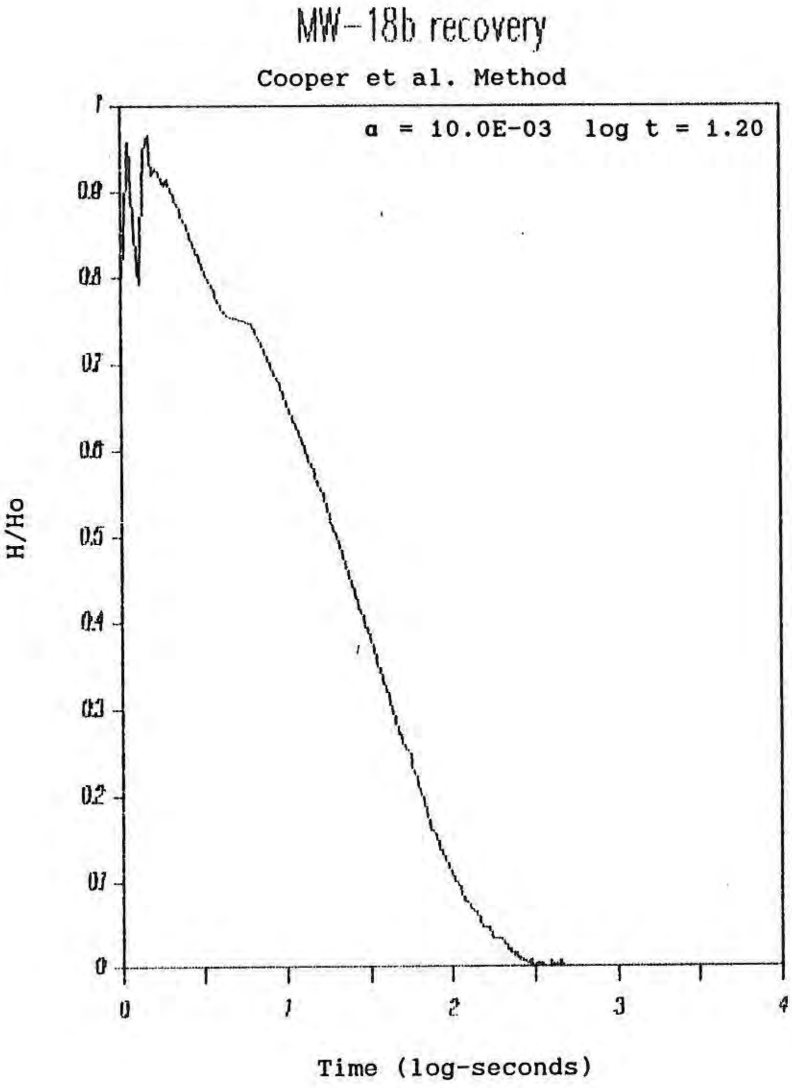


MW-17b recovery

Cooper et al. Method


MW-18b injection

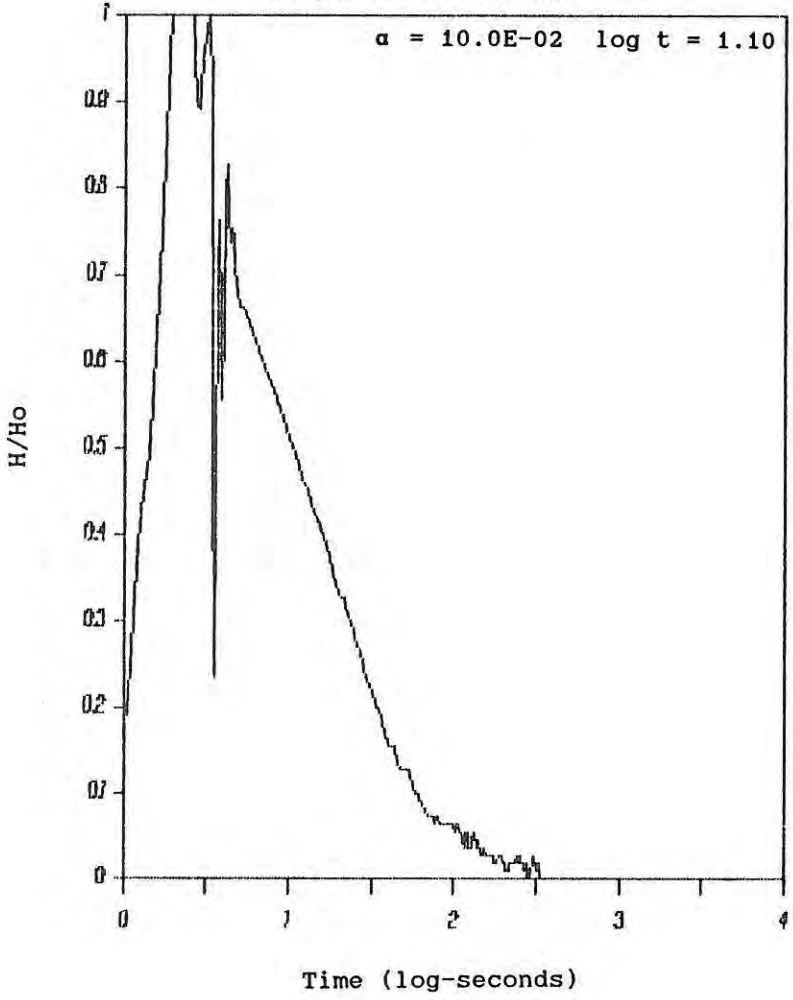
Cooper et al. Method


MW-18b recovery

Cooper et al. Method

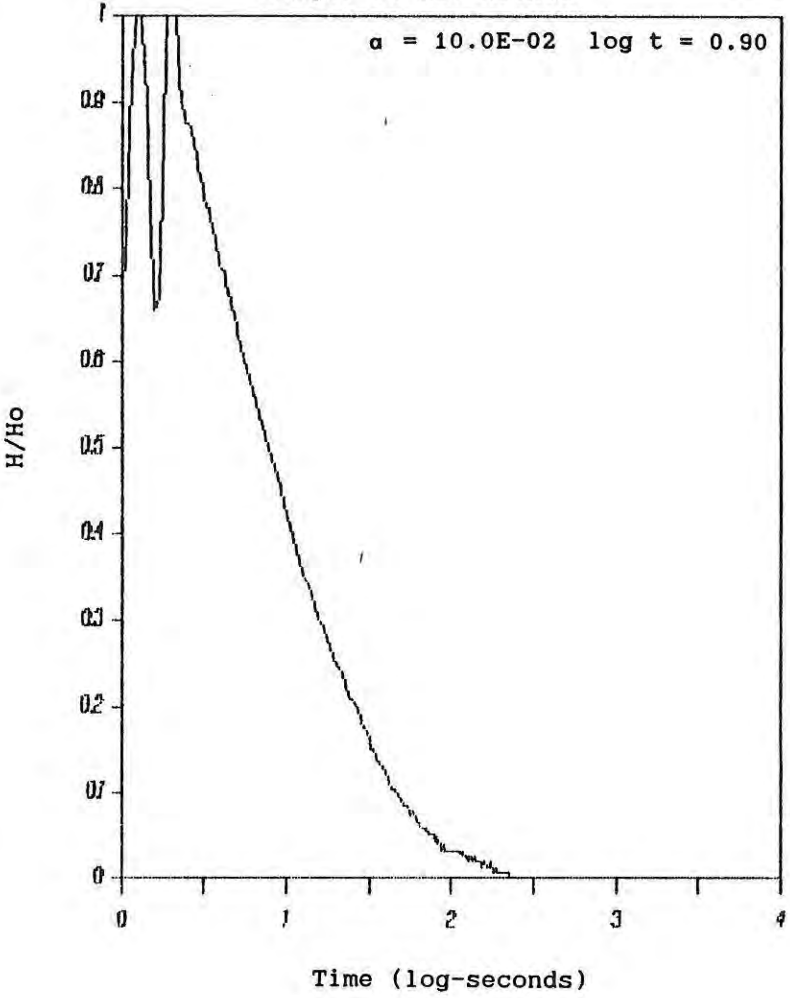
MW-19a injection

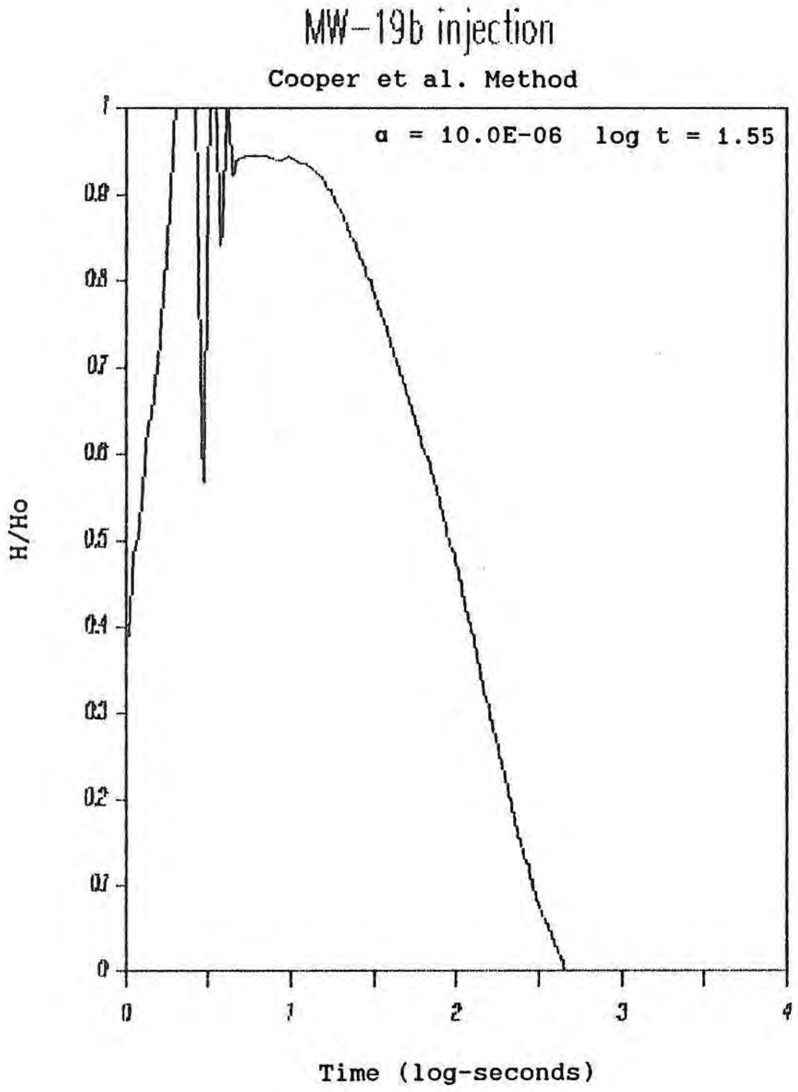
Cooper et al. Method

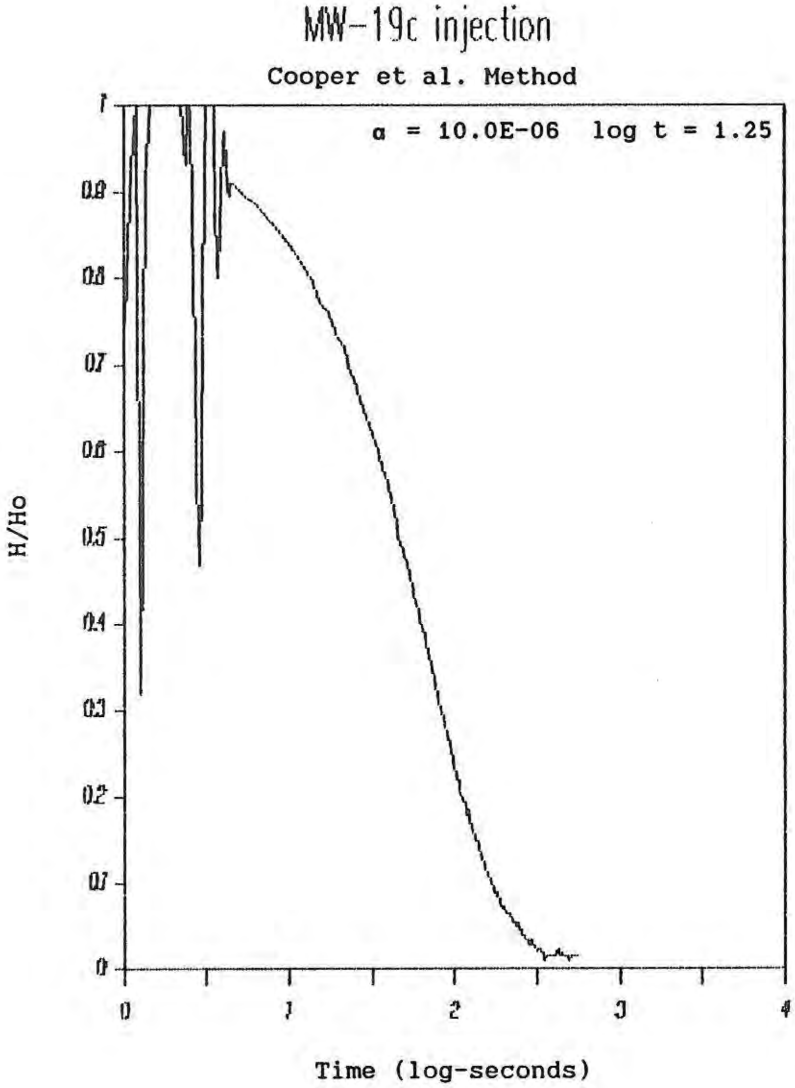


MW-19a recovery

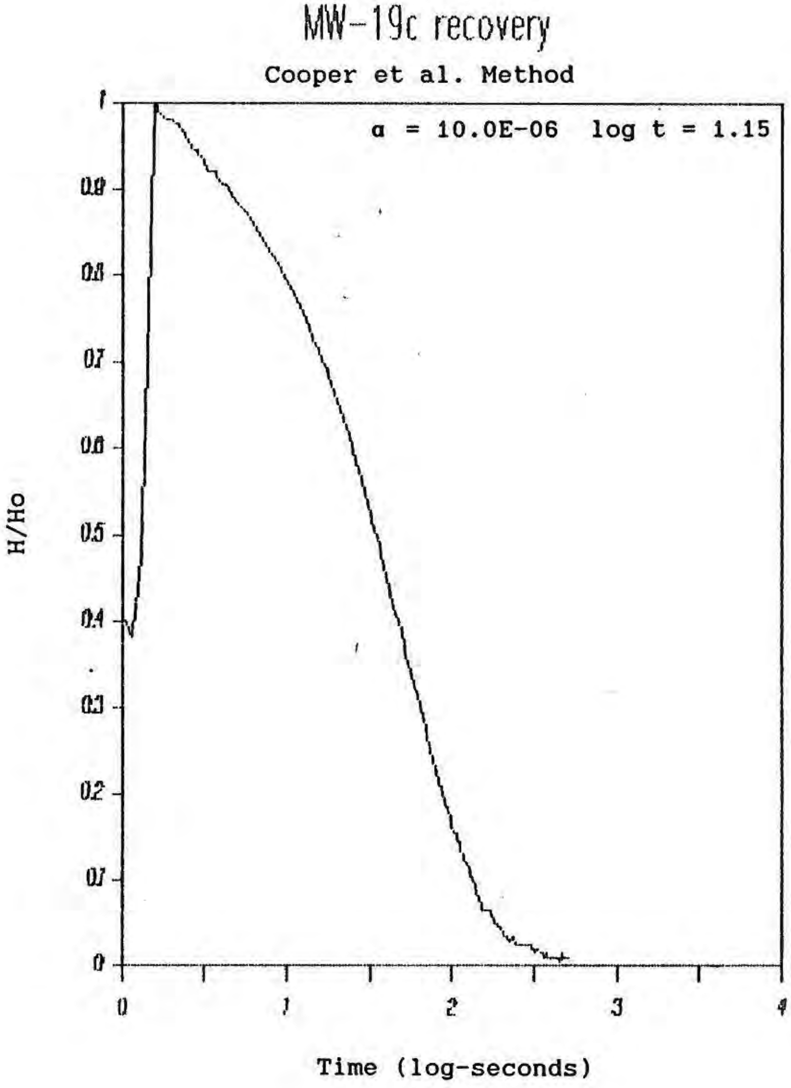
Cooper et al. Method



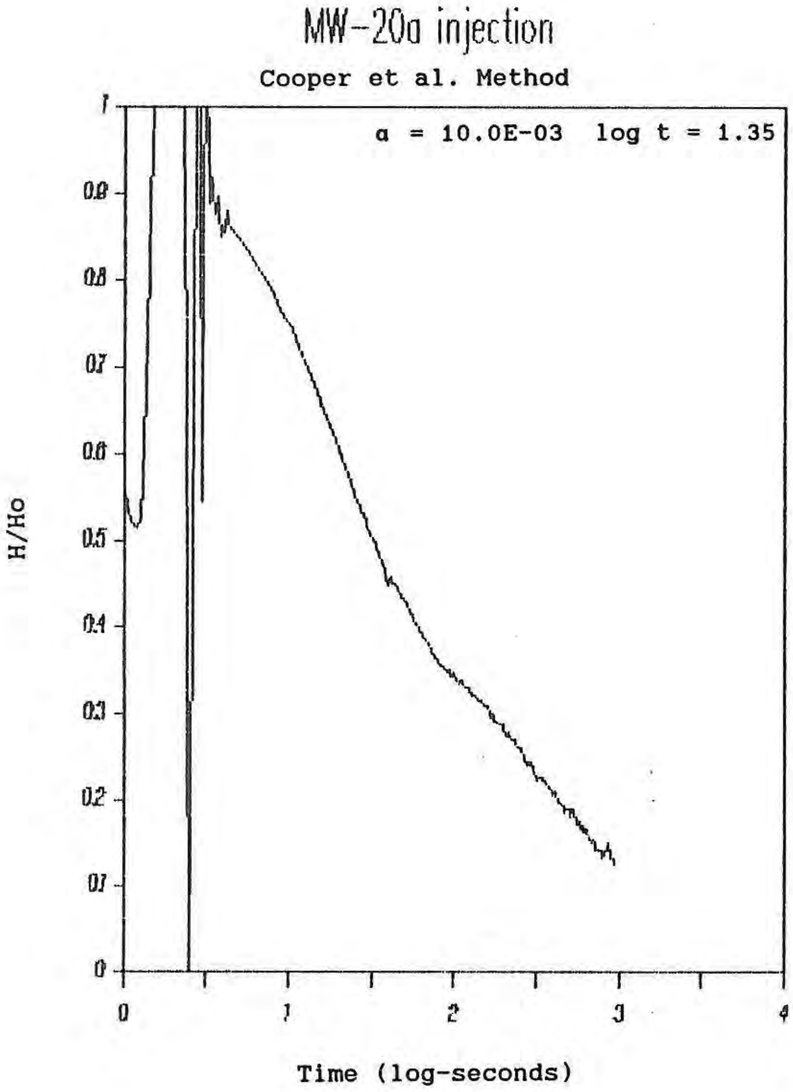

MW-19b injection
Cooper et al. Method
α = 10.0E-06 log t = 1.55
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)

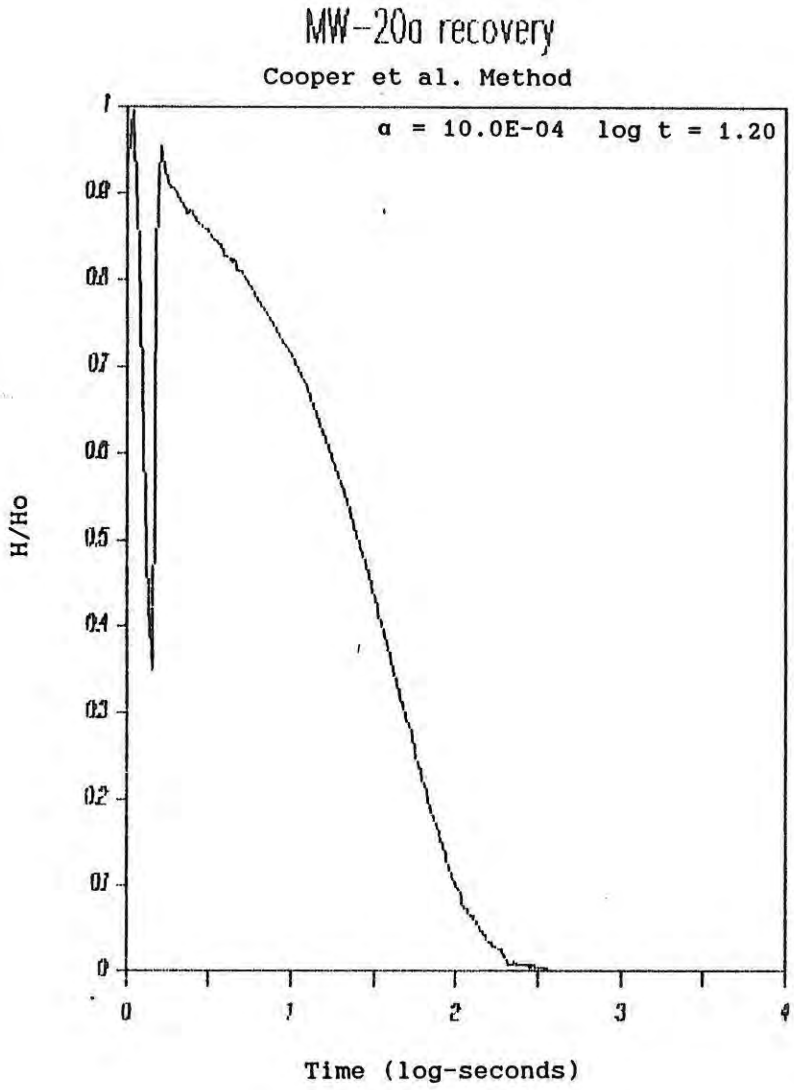

MW-19c injection

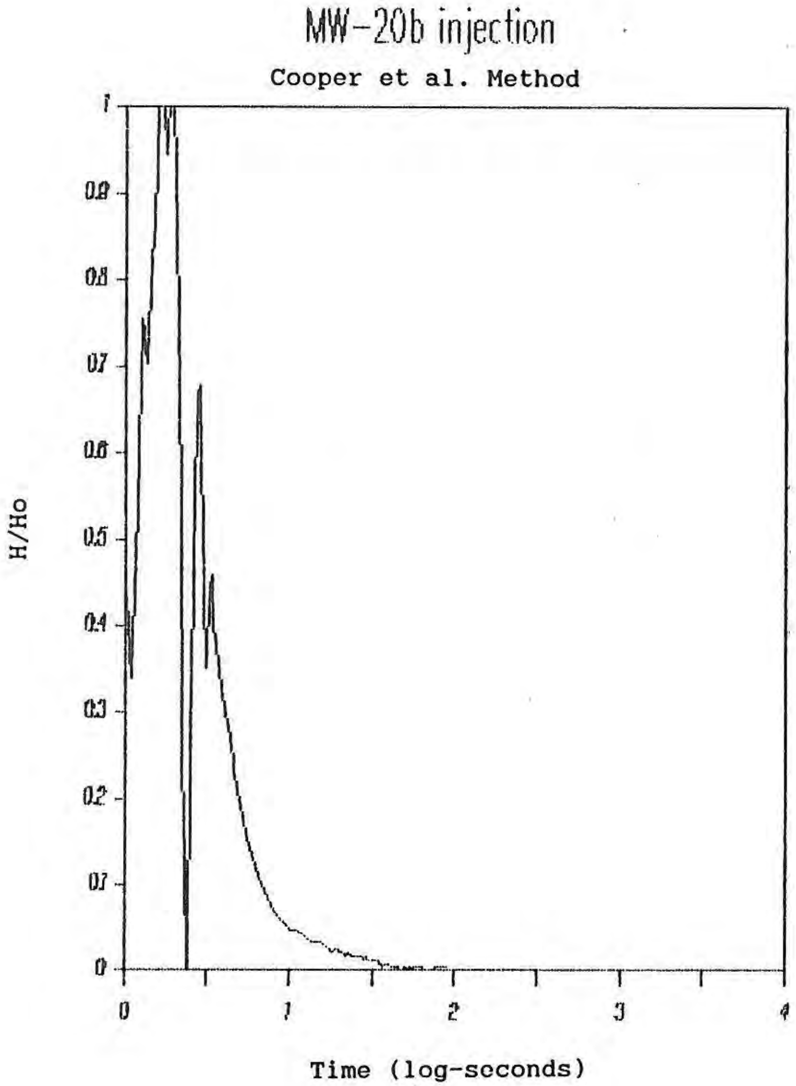
Cooper et al. Method


MW-19c recovery

Cooper et al. Method

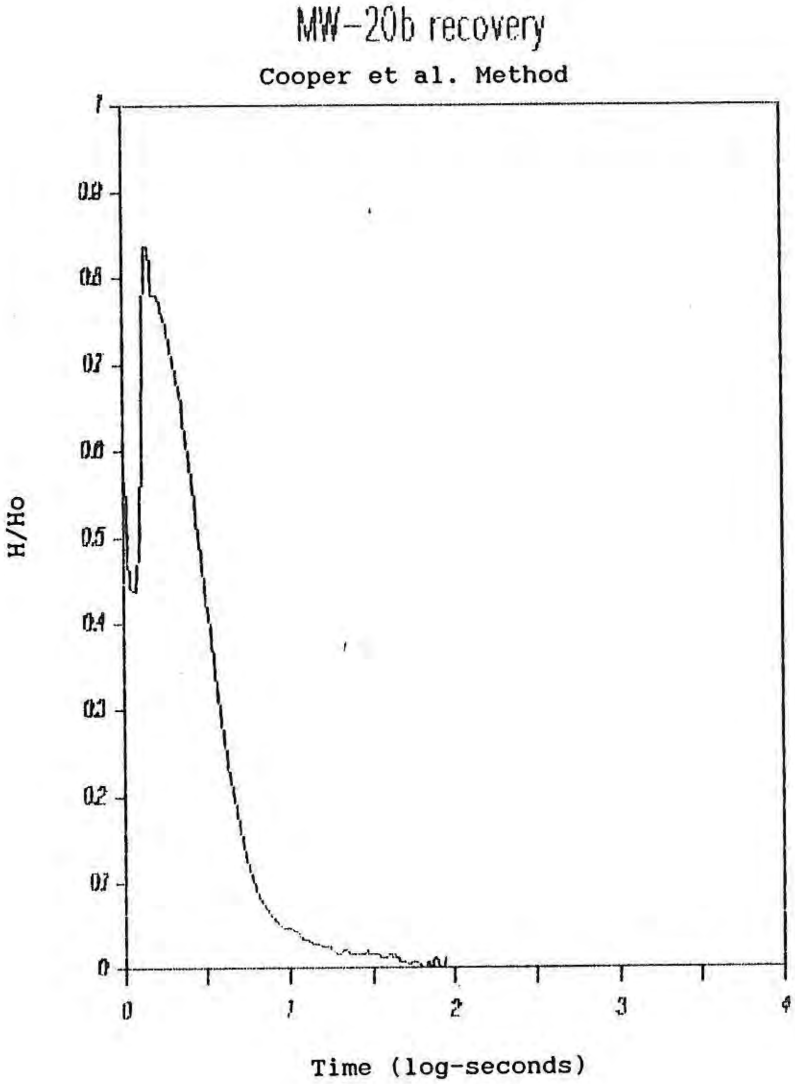

MW-20a injection
Cooper et al. Method
α = 10.0E-03 log t = 1.35
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-20a recovery
Cooper et al. Method
α = 10.0E-04 log t = 1.20
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)



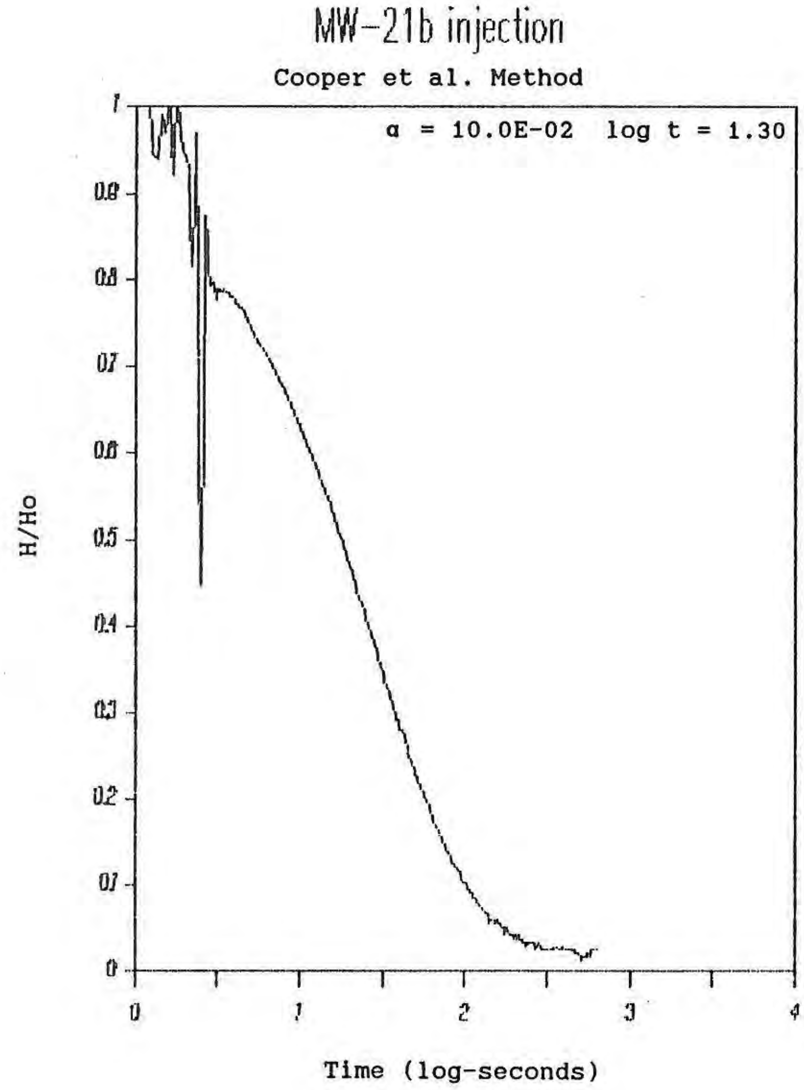
MW-20b injection

Cooper et al. Method

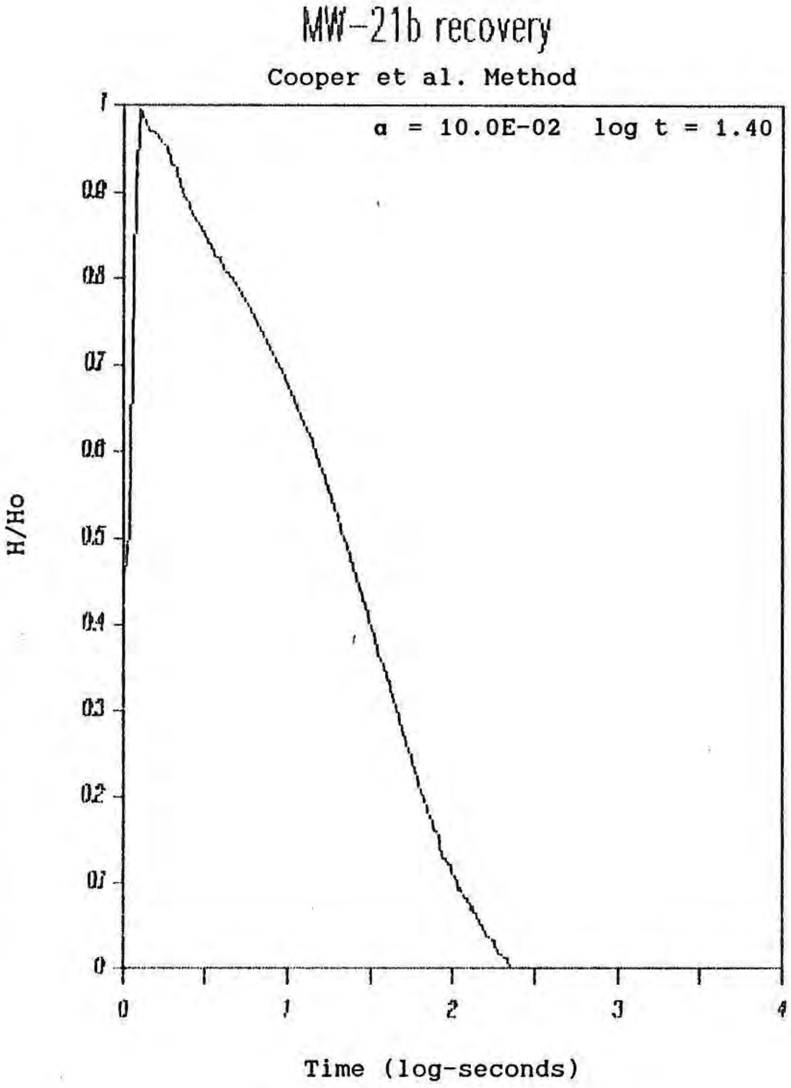


MW-20b recovery

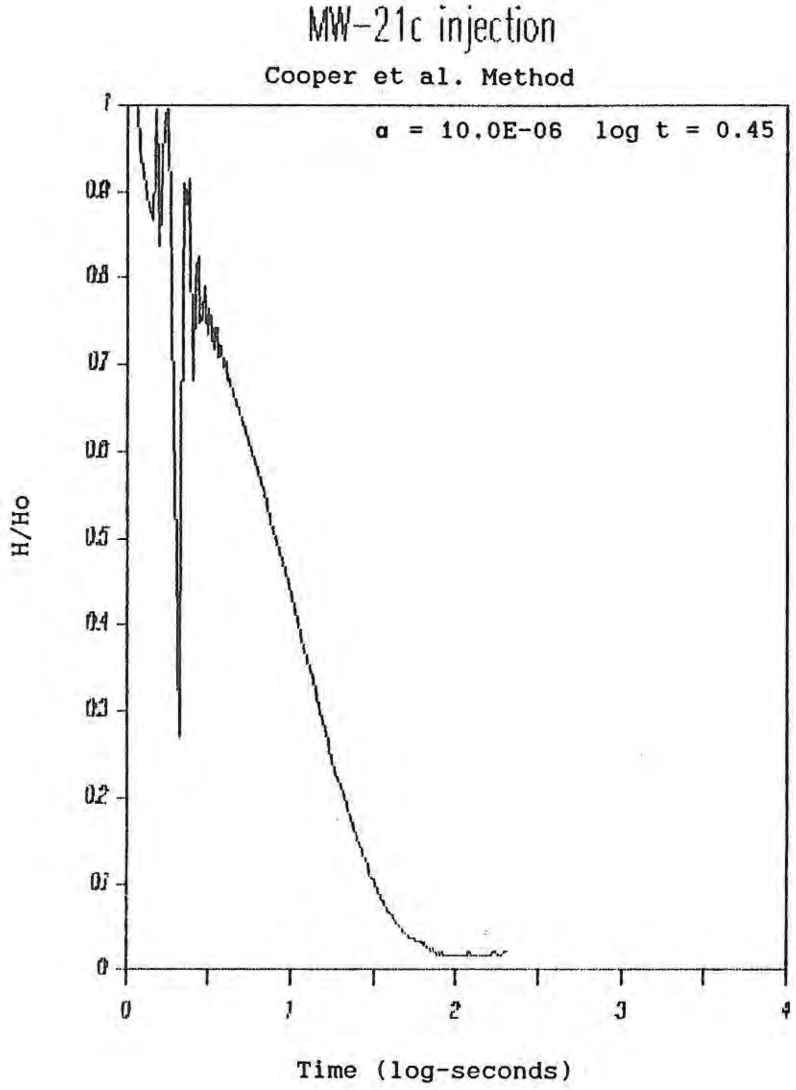
Cooper et al. Method


MW-21b injection

Cooper et al. Method

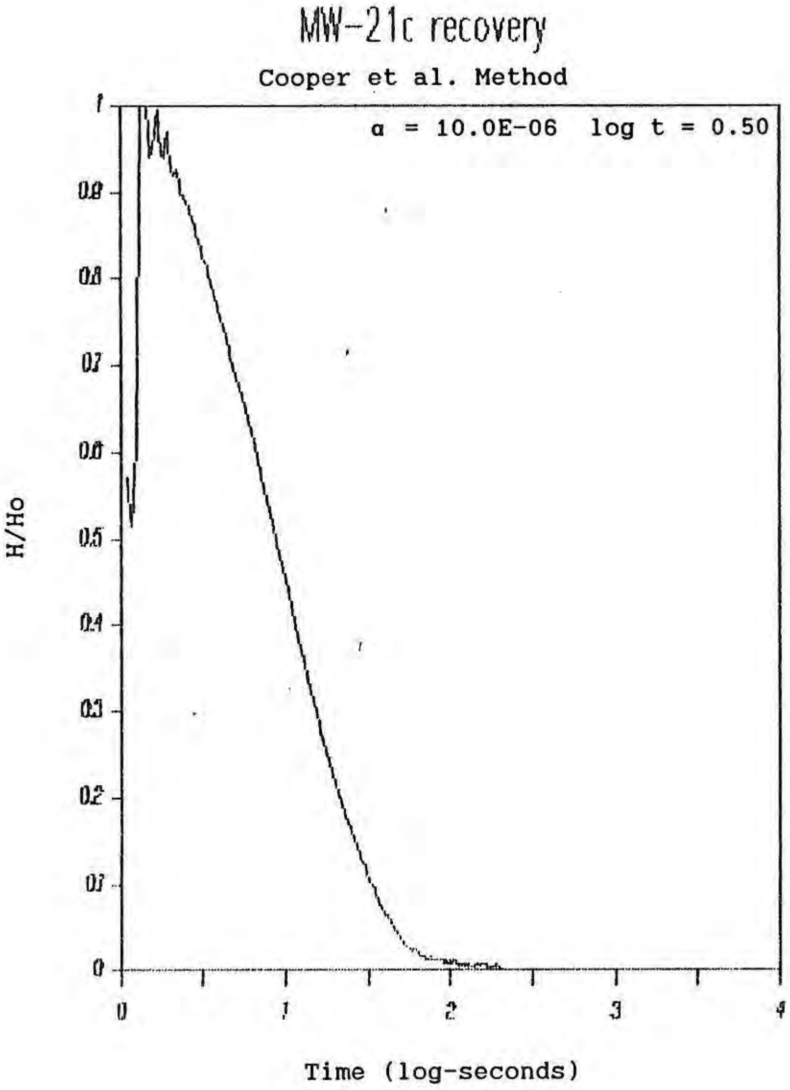

MW-21b recovery

Cooper et al. Method



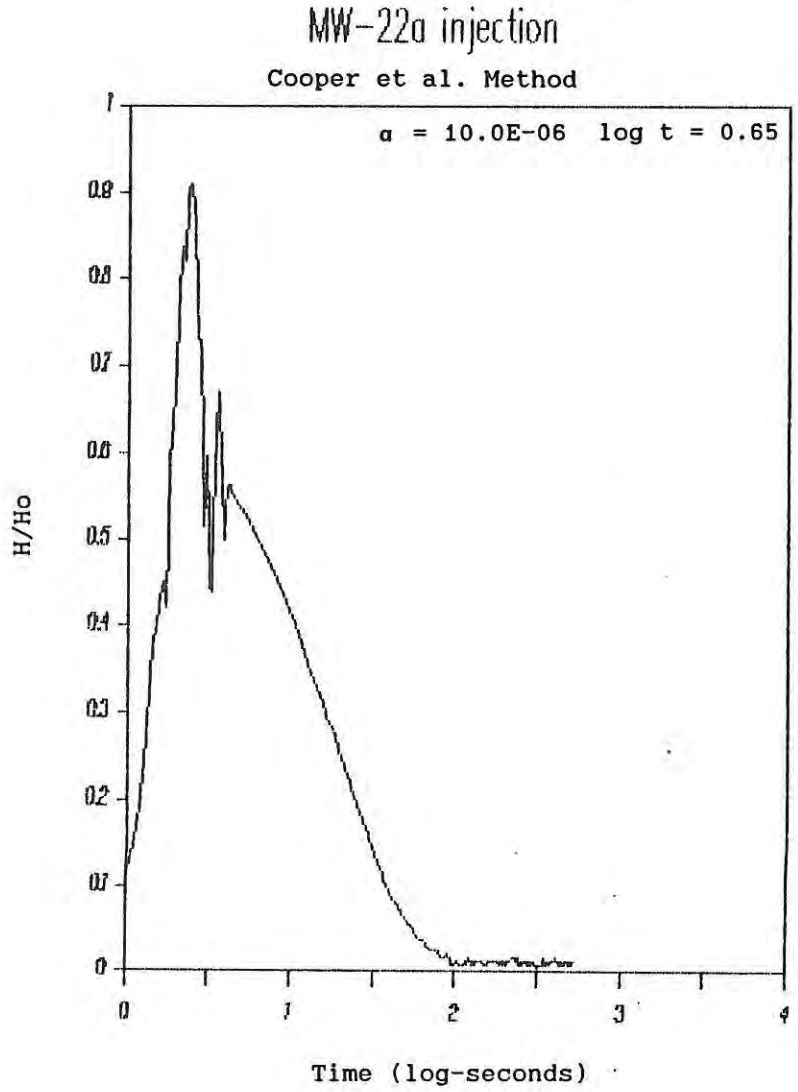
MW-21c injection

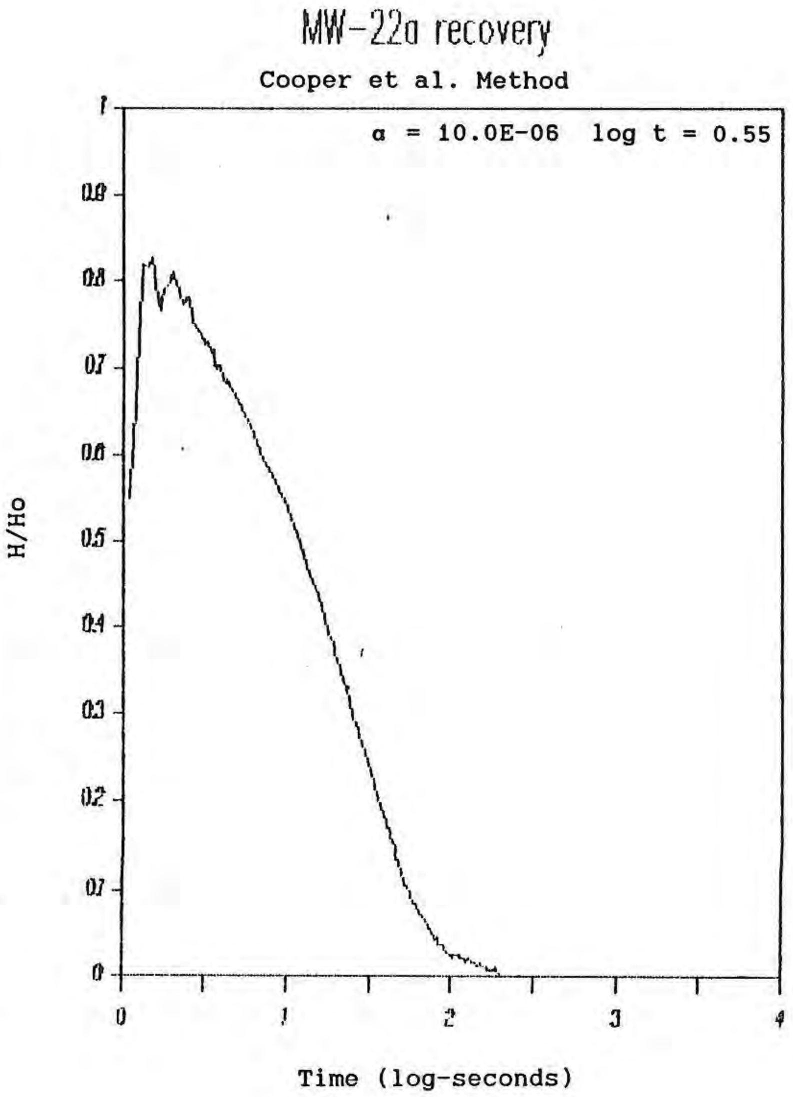
Cooper et al. Method

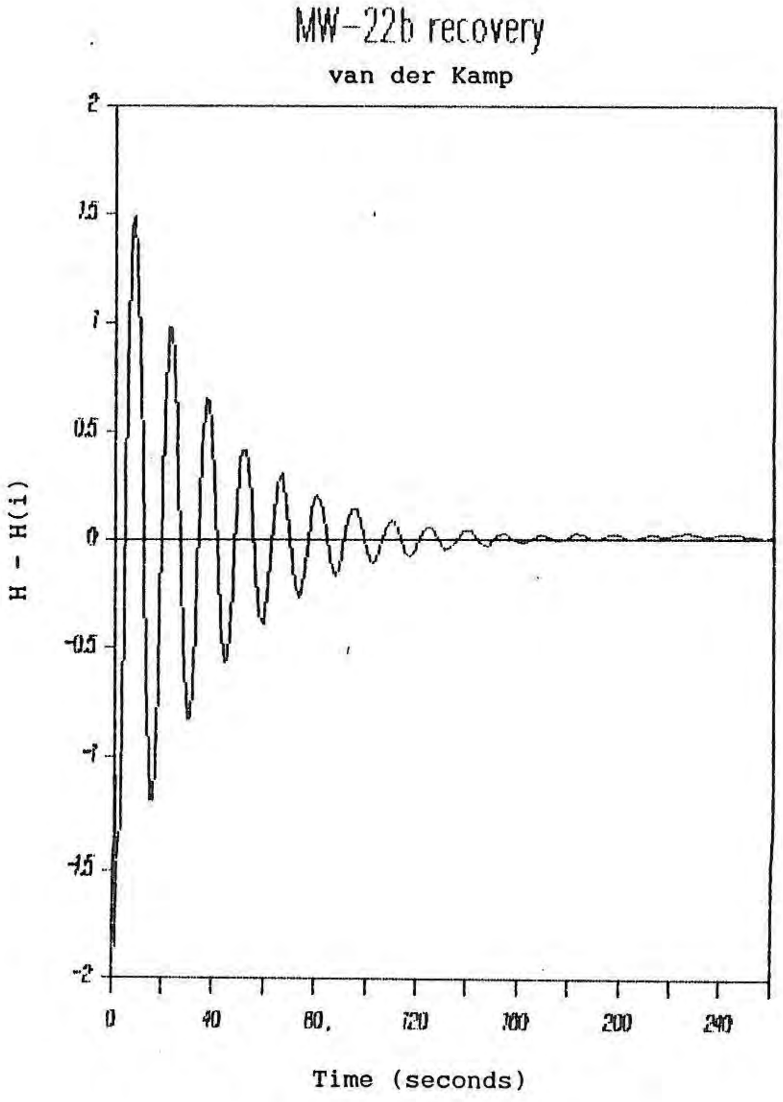


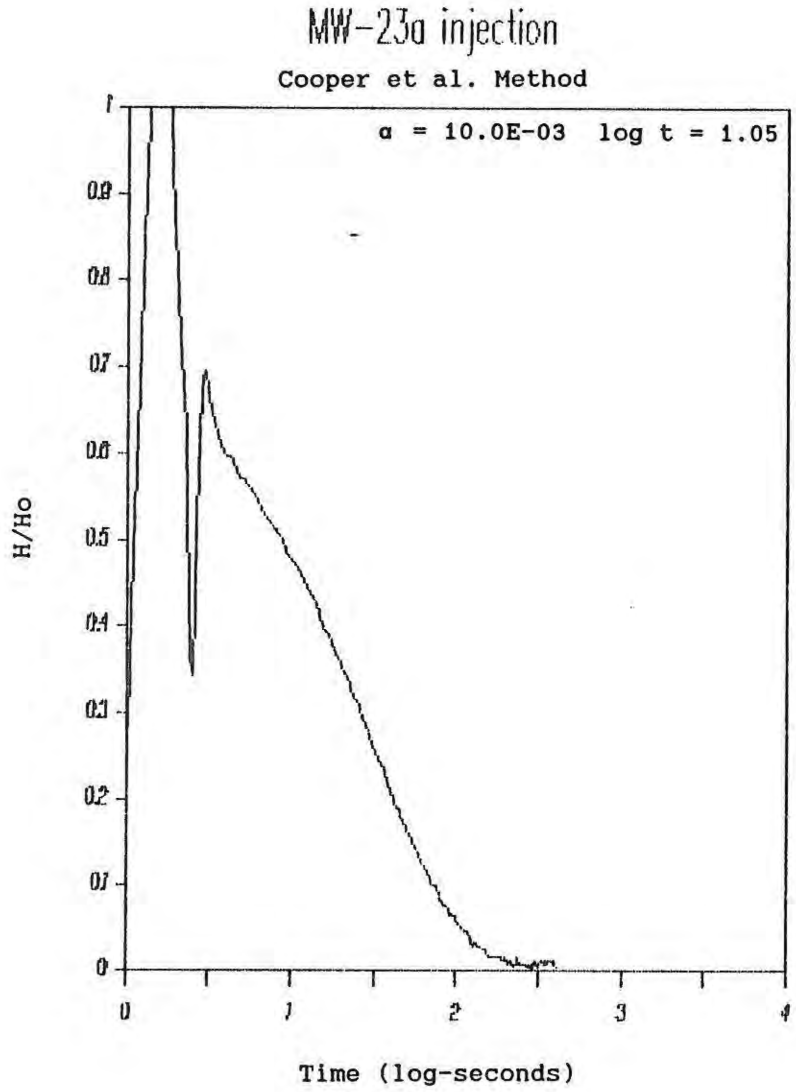
MW-21c recovery

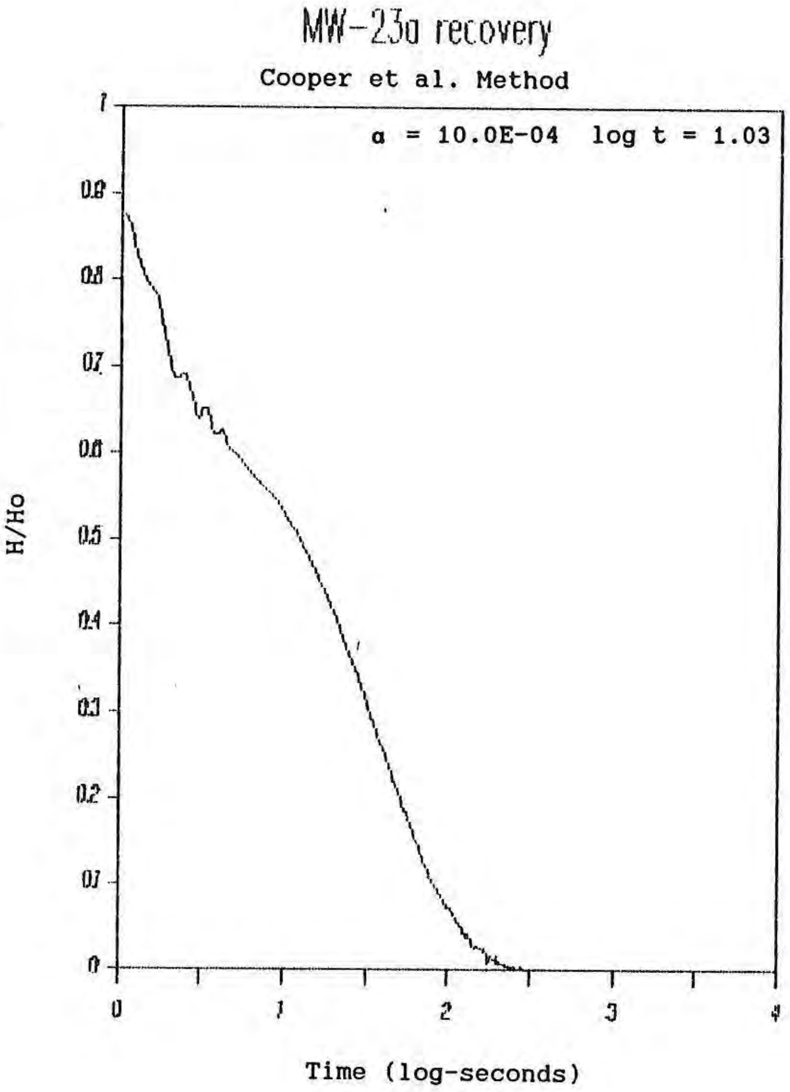
Cooper et al. Method

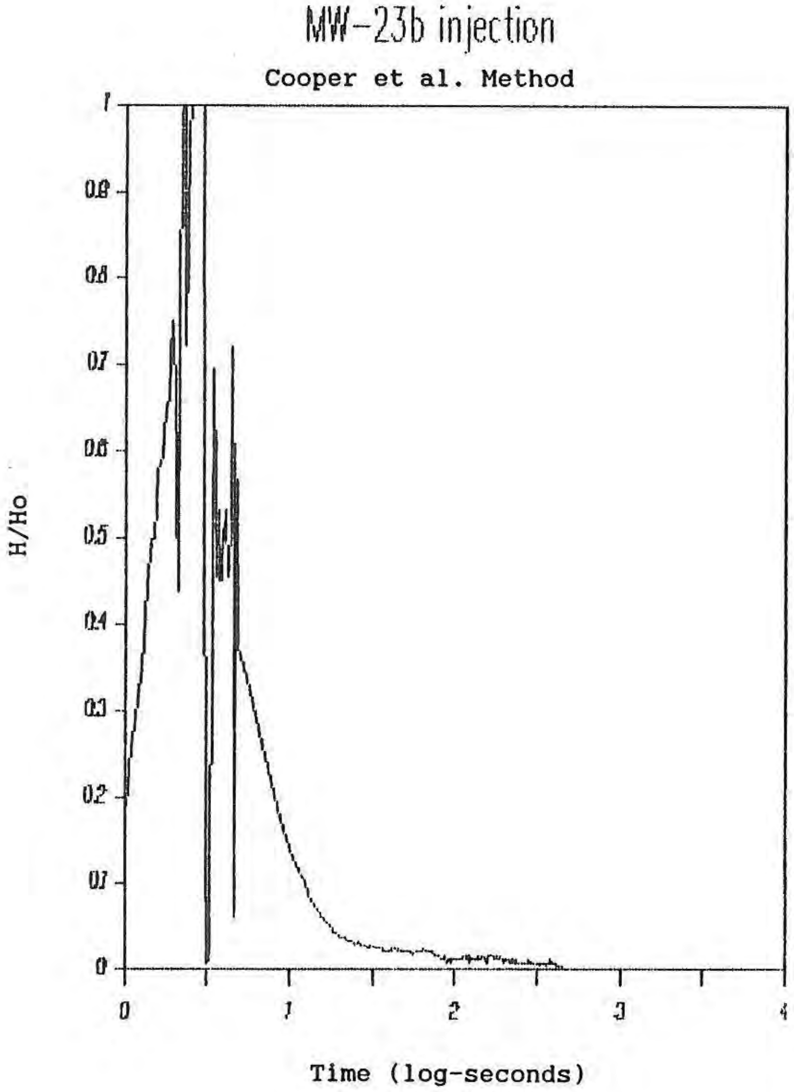

MW-22a injection
Cooper et al. Method
α = 10.0E-06 log t = 0.65
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-22a recovery
Cooper et al. Method
α = 10.0E-06 log t = 0.55
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-22b recovery
van der Kamp
H - H(i)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
40
80
120
160
200
240
Time (seconds)

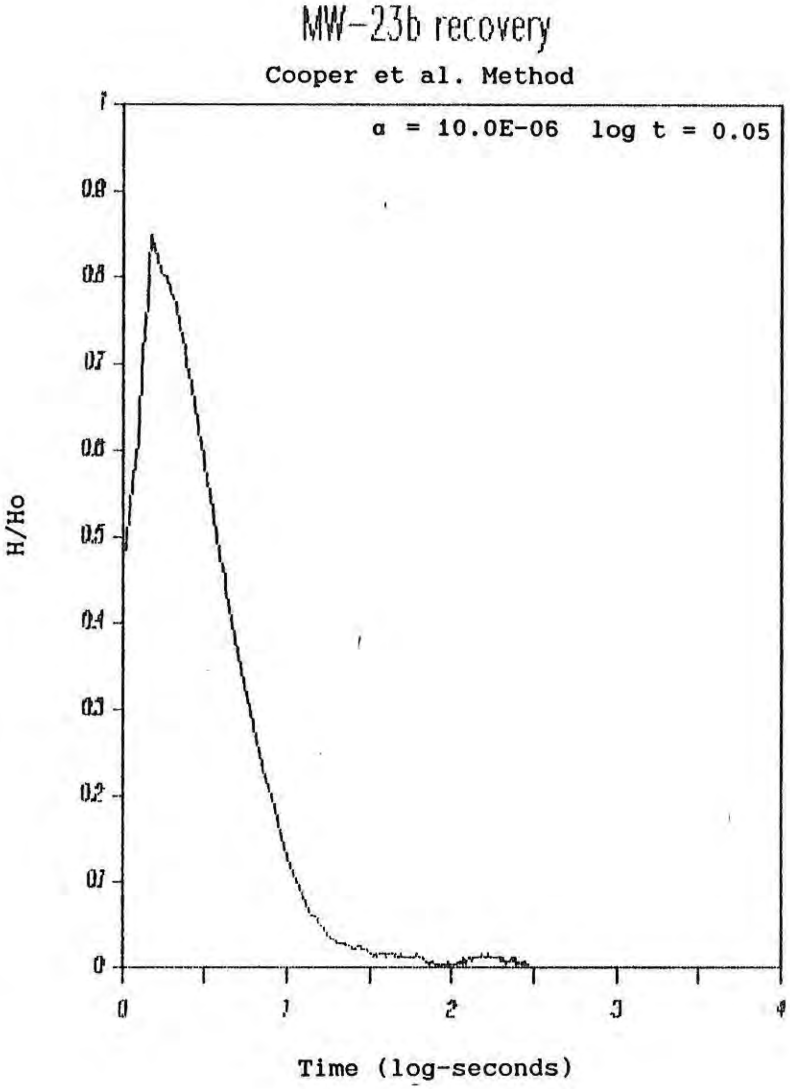

MW-23a injection
Cooper et al. Method
α = 10.0E-03 log t = 1.05
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-23a recovery
Cooper et al. Method
α = 10.0E-04 log t = 1.03
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)



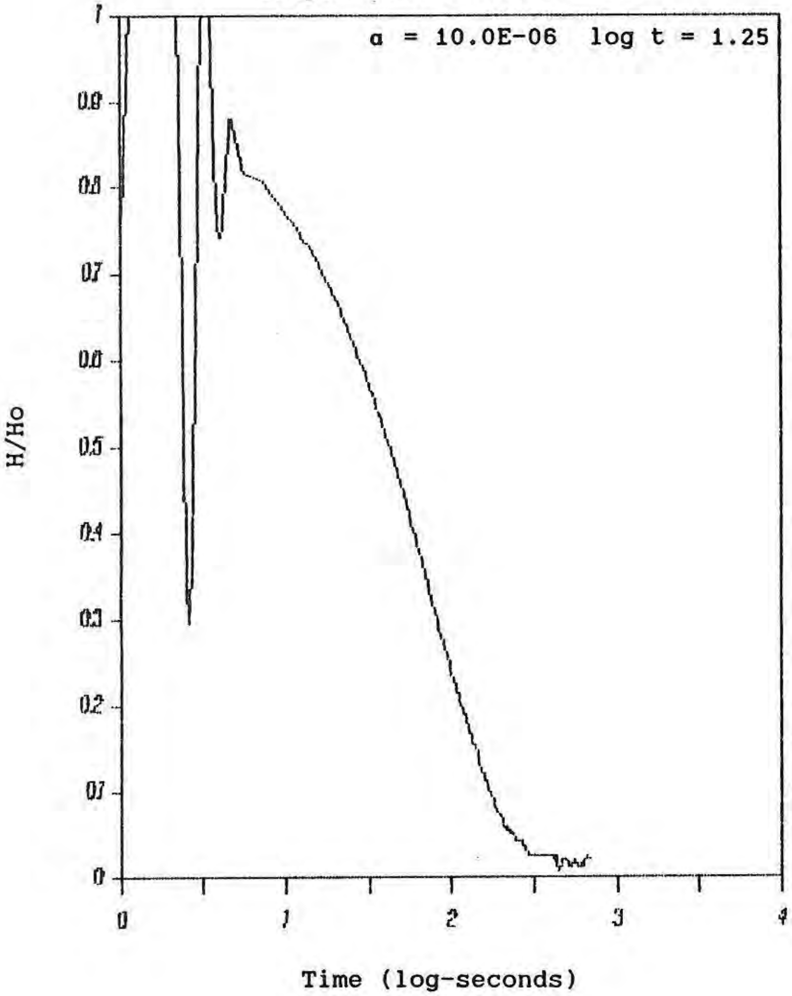
MW–23b injection

Cooper et al. Method



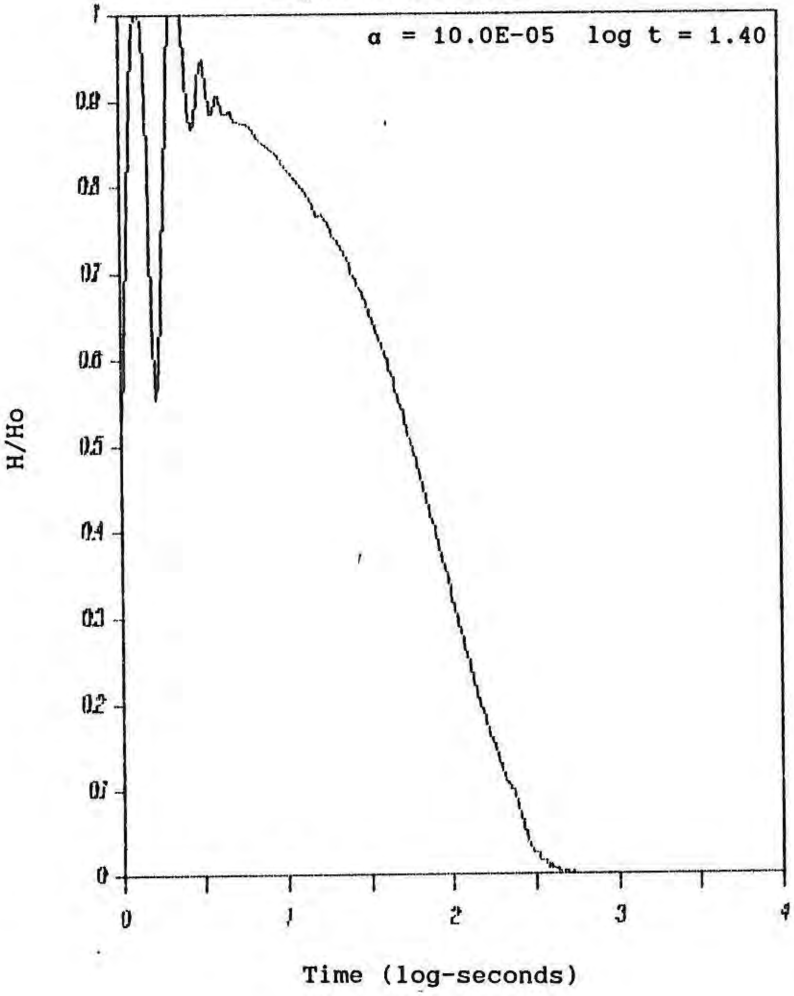
MW–23b recovery

Cooper et al. Method



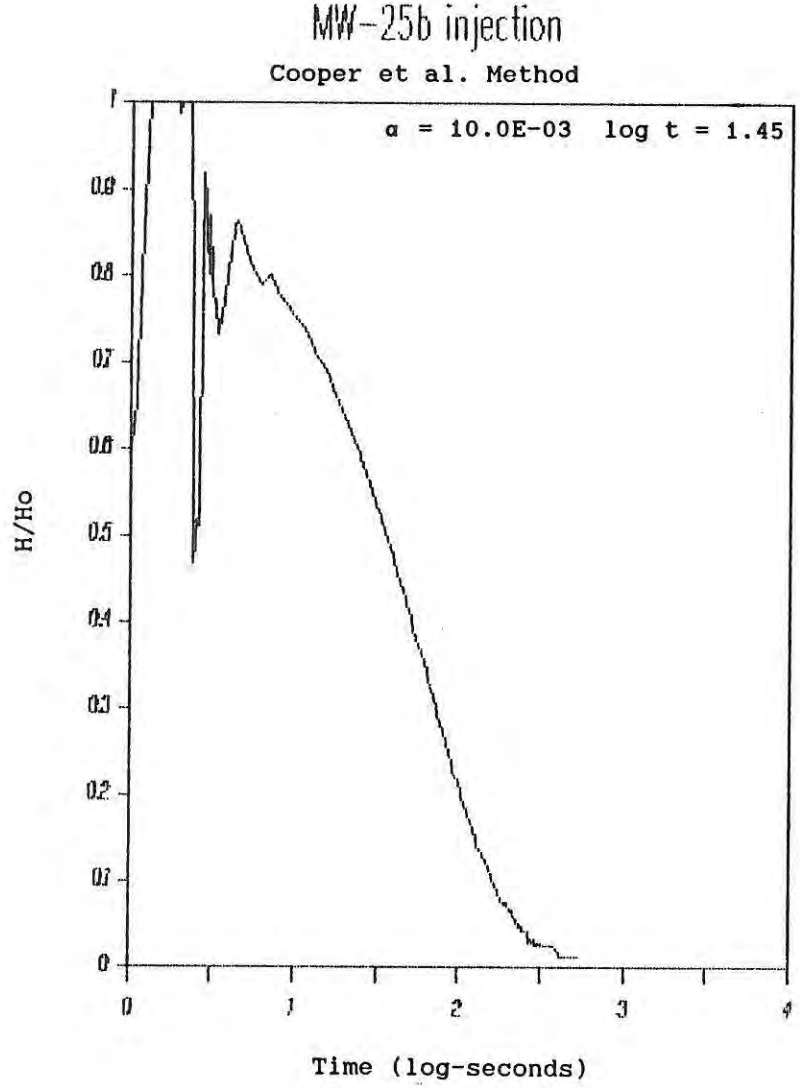
MW-24a injection

Cooper et al. Method

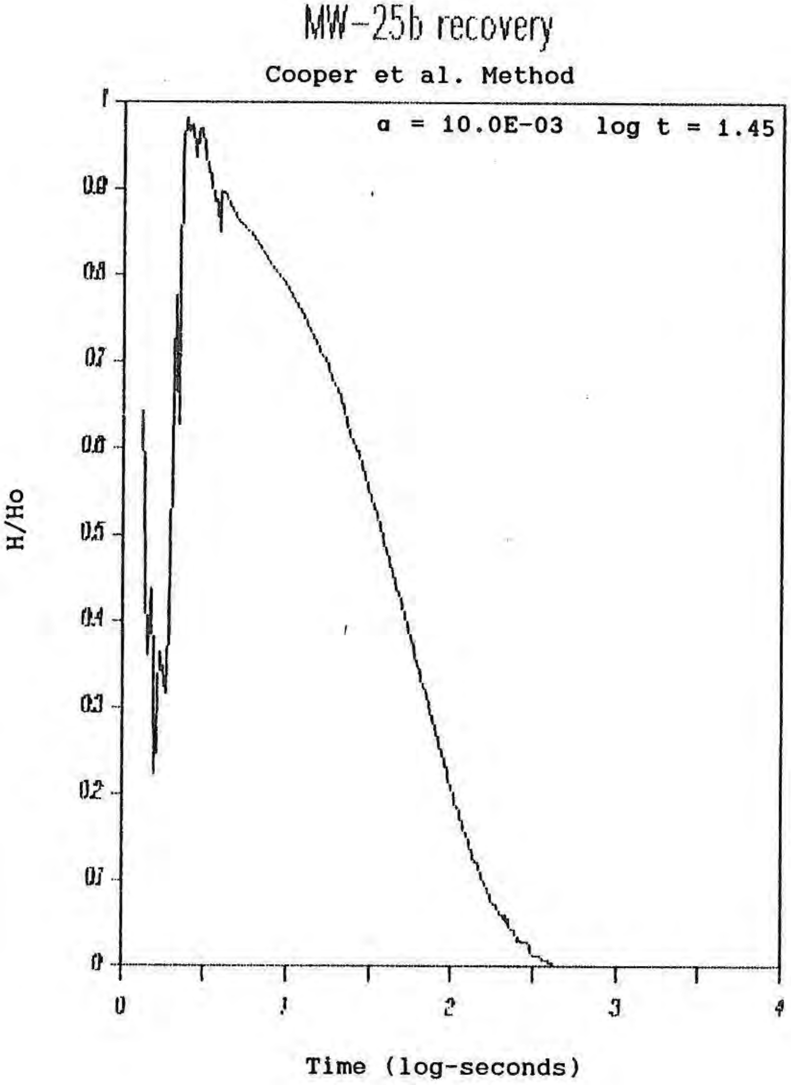


MW-24a recovery

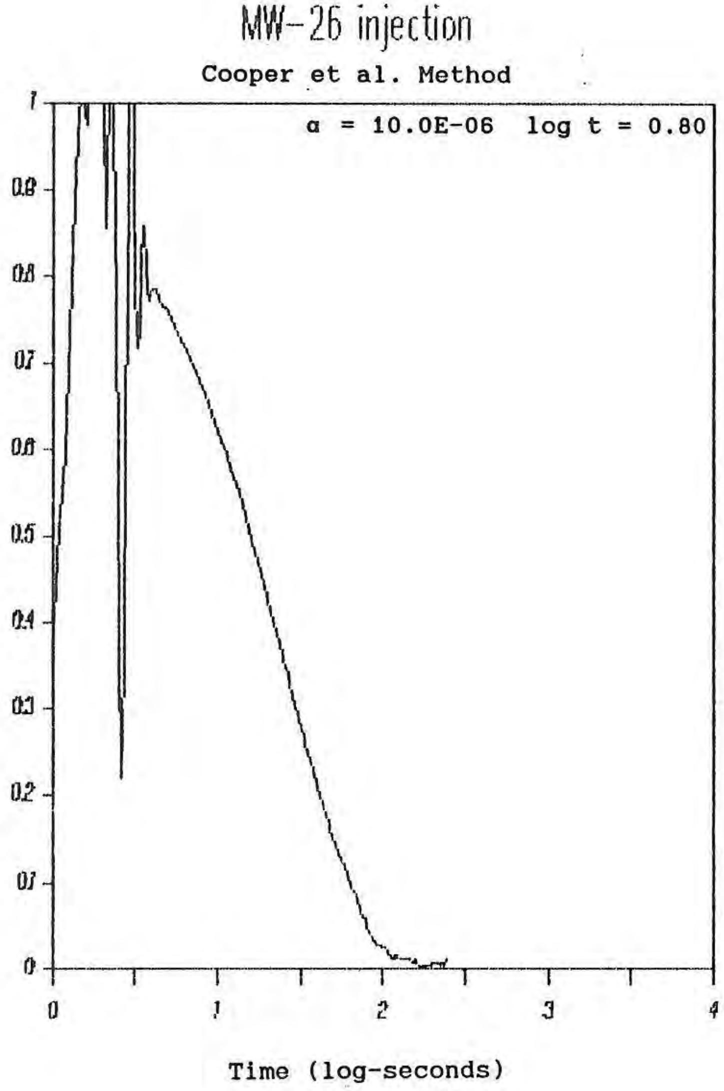
Cooper et al. Method


MW-25b injection

Cooper et al. Method

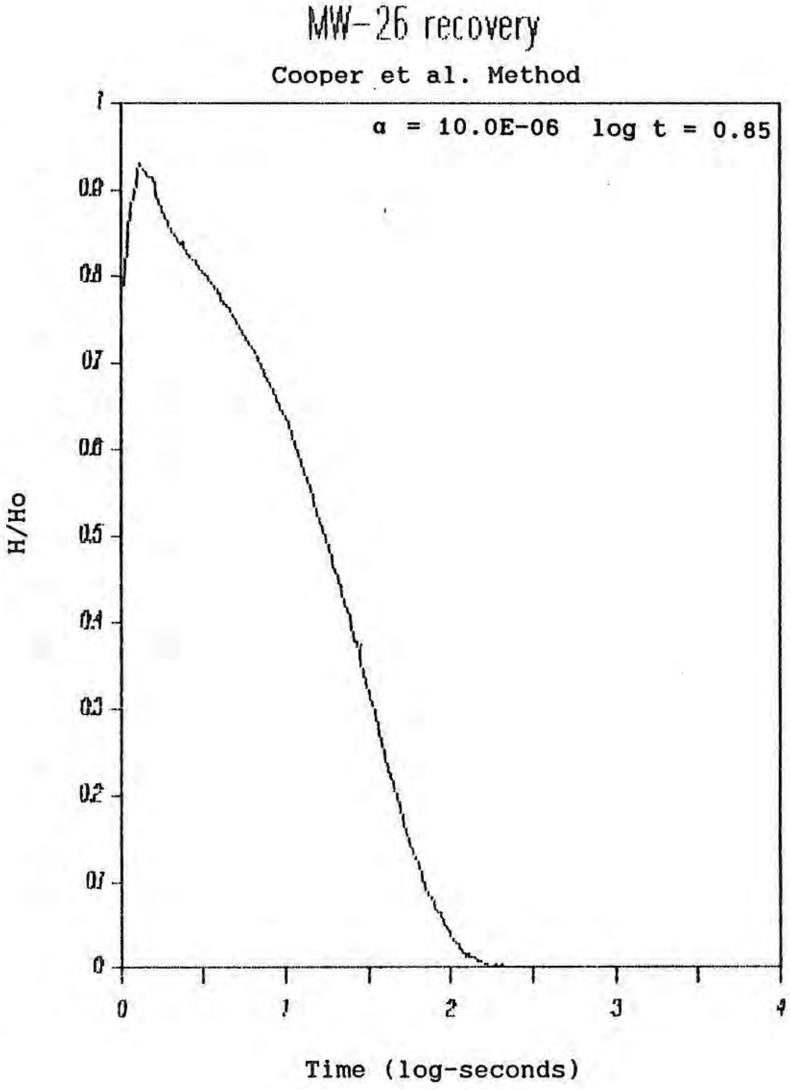

MW-25b recovery

Cooper et al. Method



MW-26 injection

Cooper et al. Method

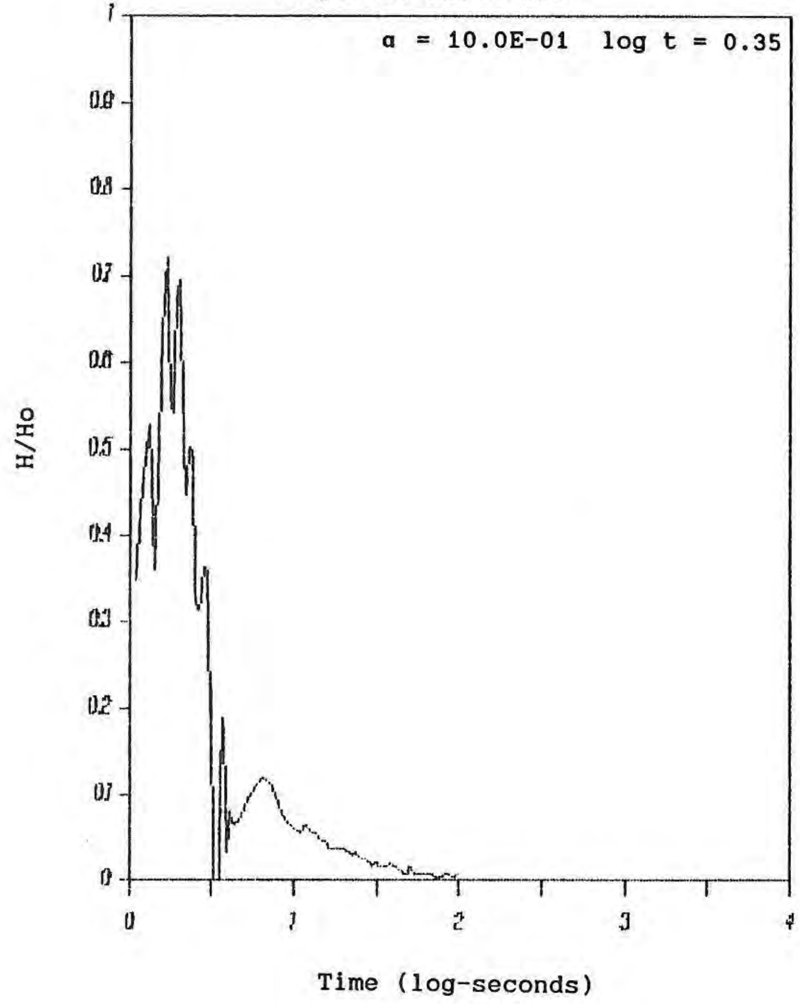


MW-26 recovery

Cooper et al. Method

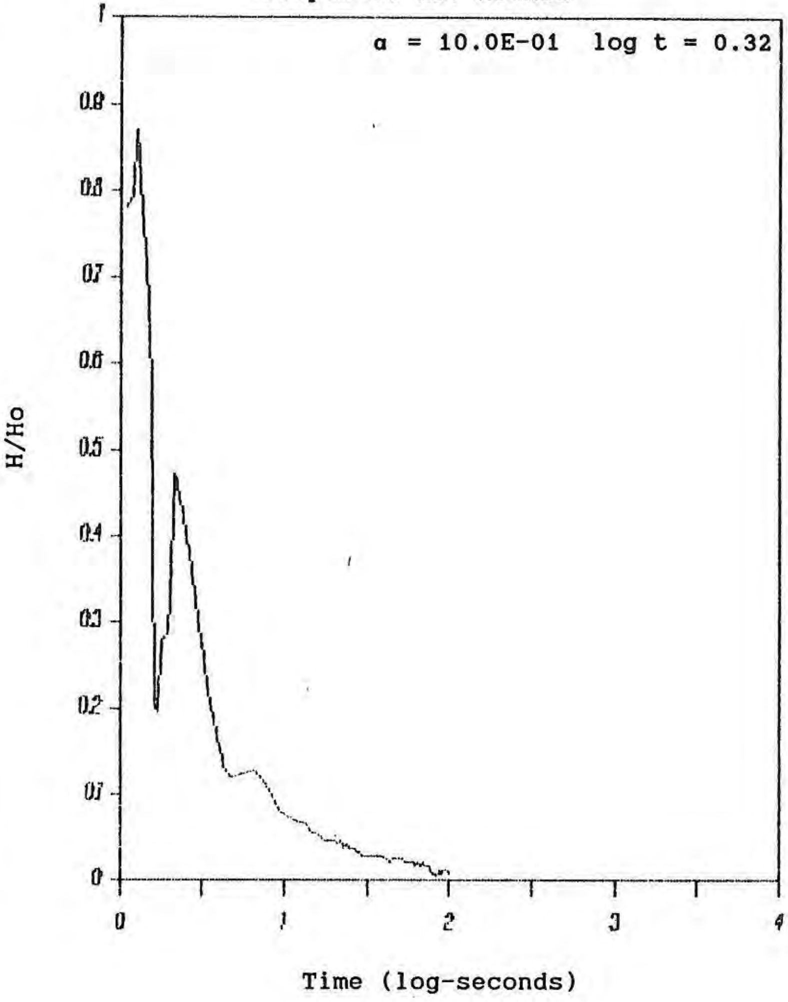
MW-27a injection

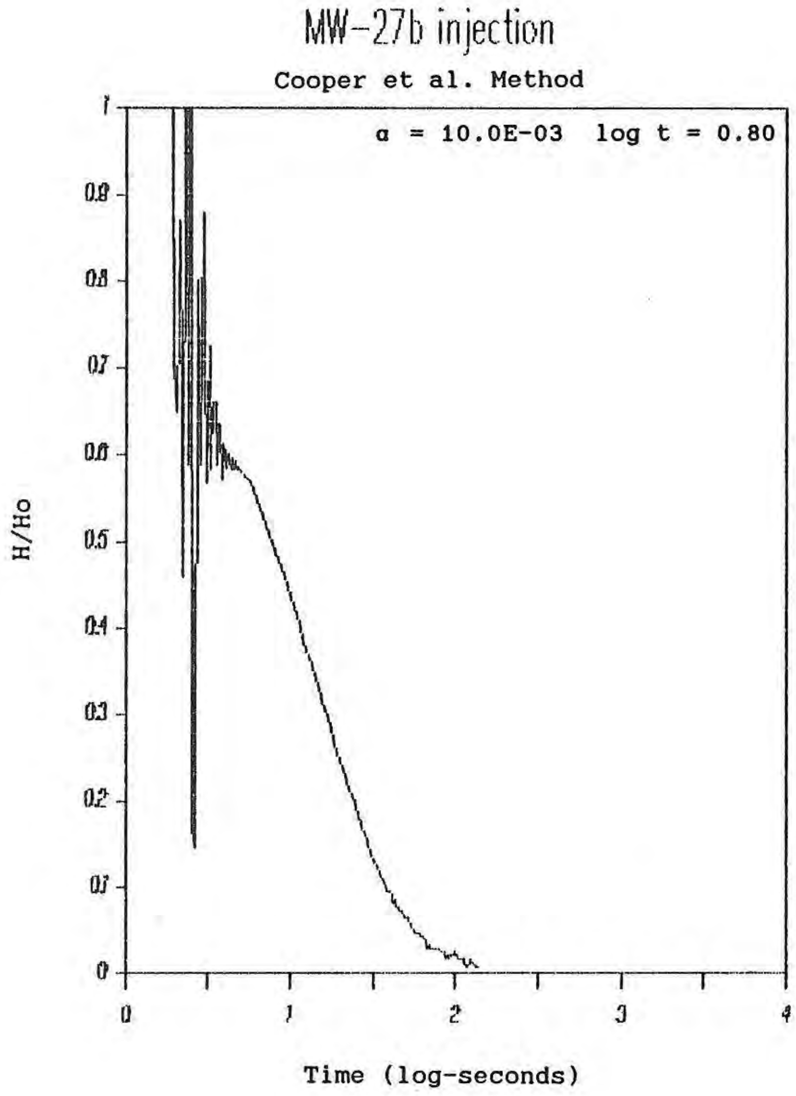
Cooper et al. Method

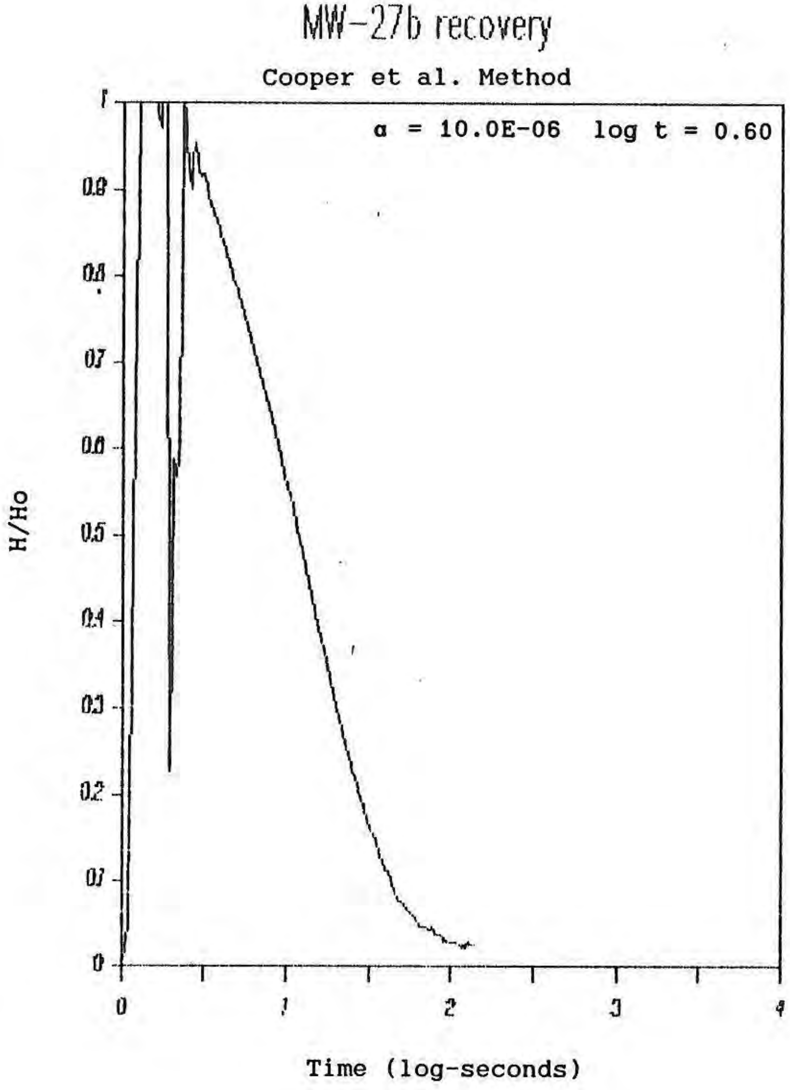


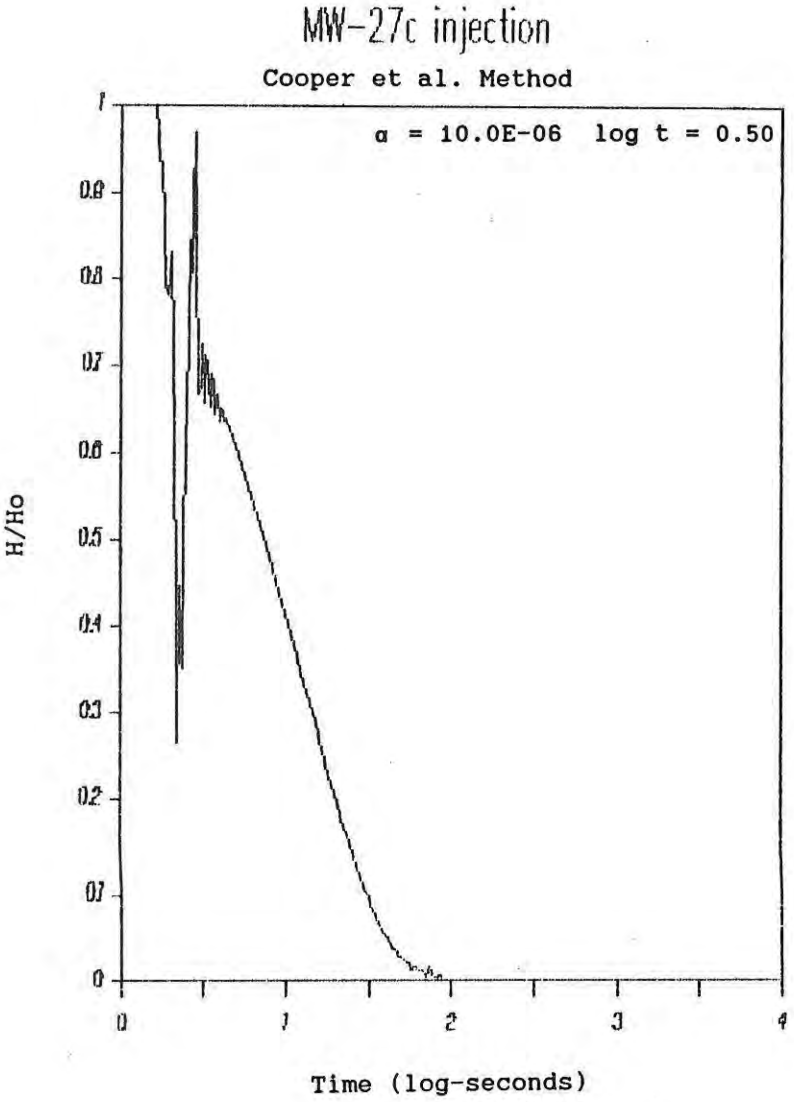
MW-27a recovery

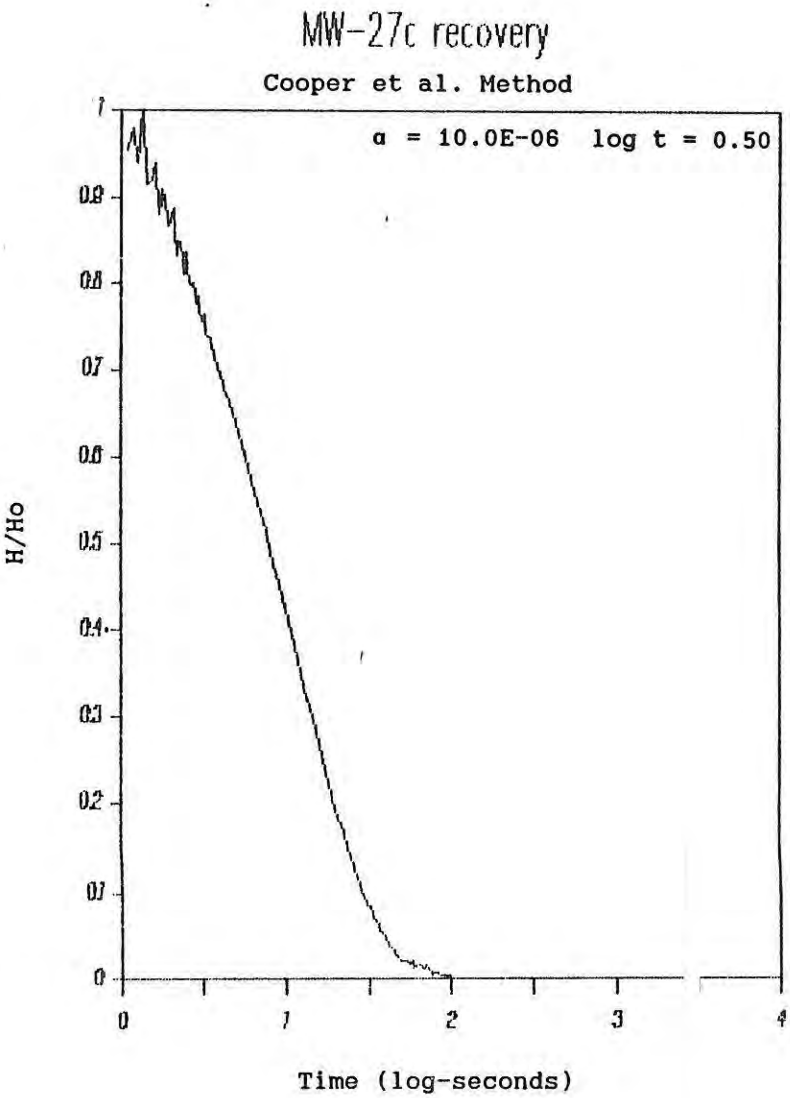
Cooper et al. Method

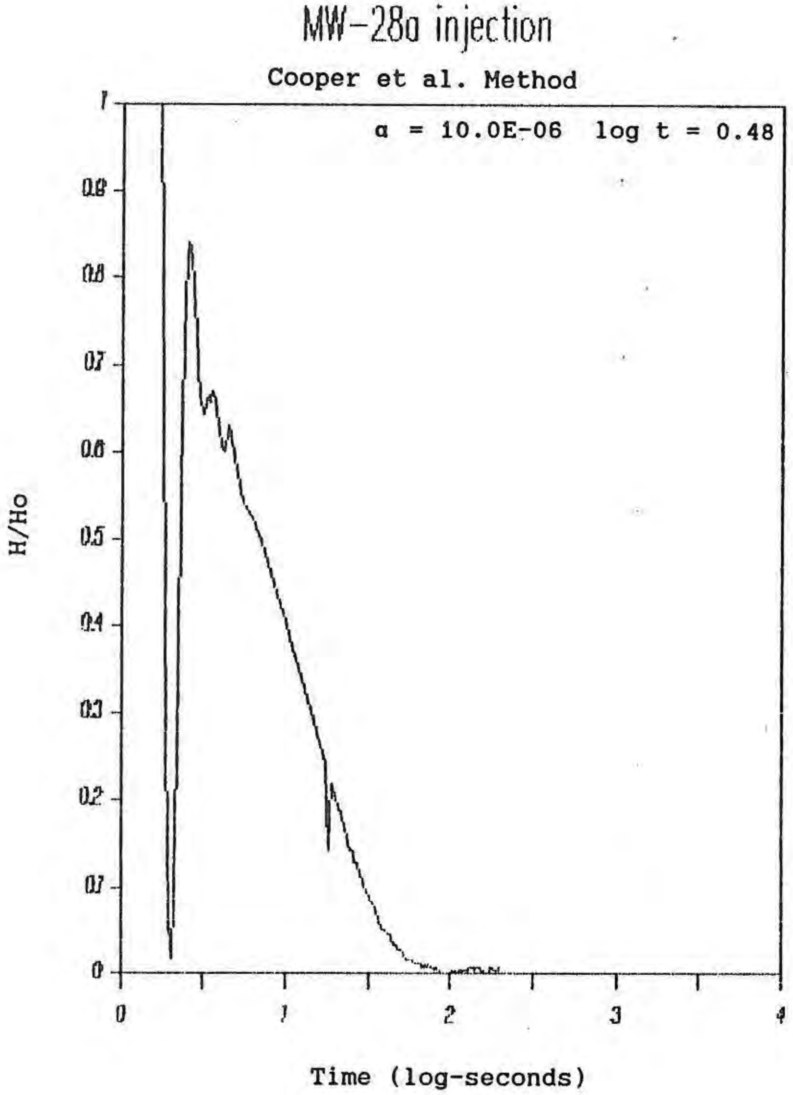


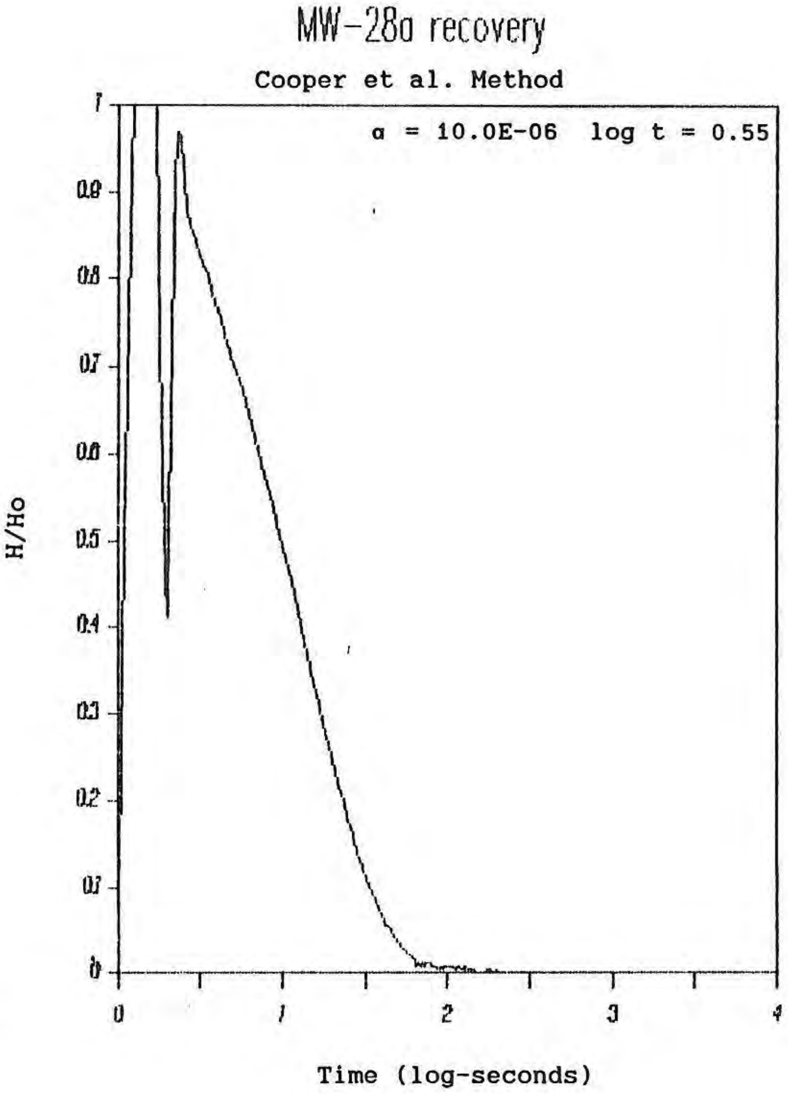

MW-27b injection
Cooper et al. Method
α = 10.0E-03 log t = 0.80
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)

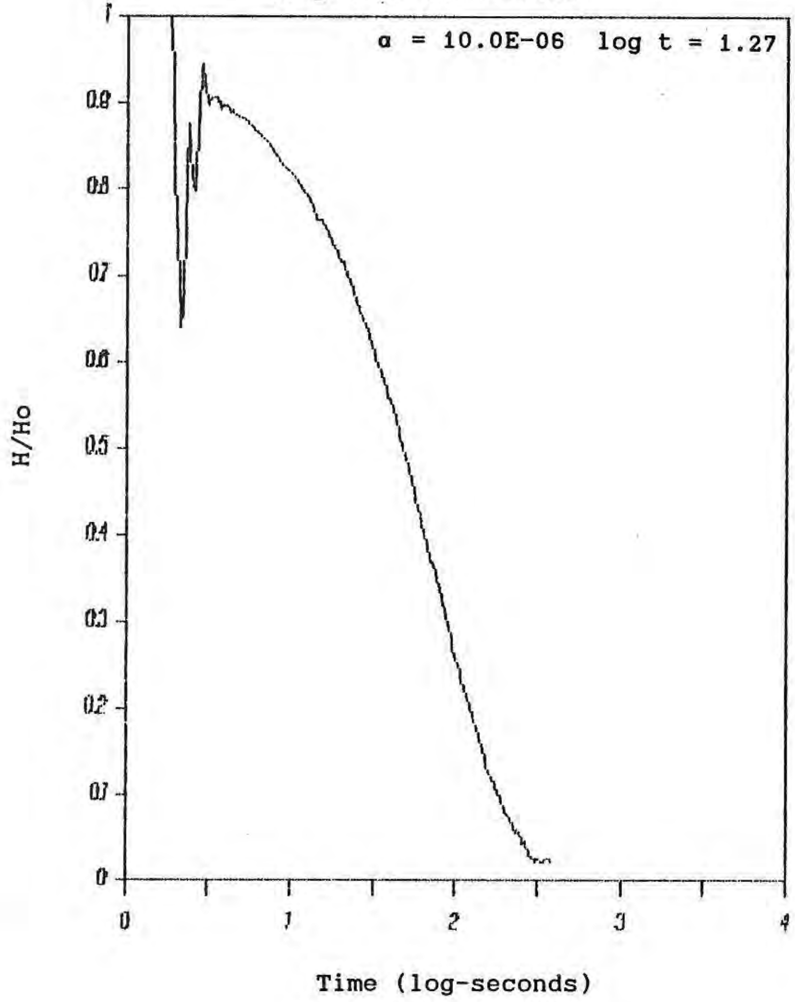

MW-27b recovery
Cooper et al. Method
α = 10.0E-06 log t = 0.60
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-27c injection
Cooper et al. Method
α = 10.0E-06 log t = 0.50
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-27c recovery
Cooper et al. Method
α = 10.0E-06 log t = 0.50
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)

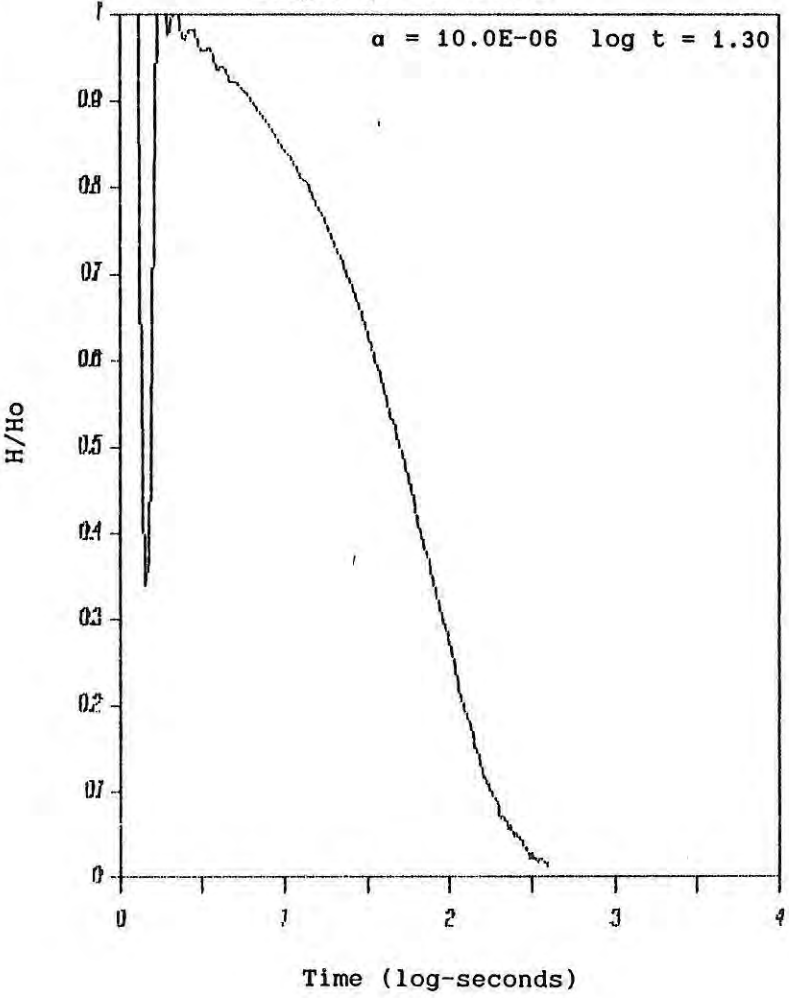

MW-28a injection
Cooper et al. Method
a = 10.0E-06 log t = 0.48
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-28a recovery
Cooper et al. Method
a = 10.0E-06 log t = 0.55
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)



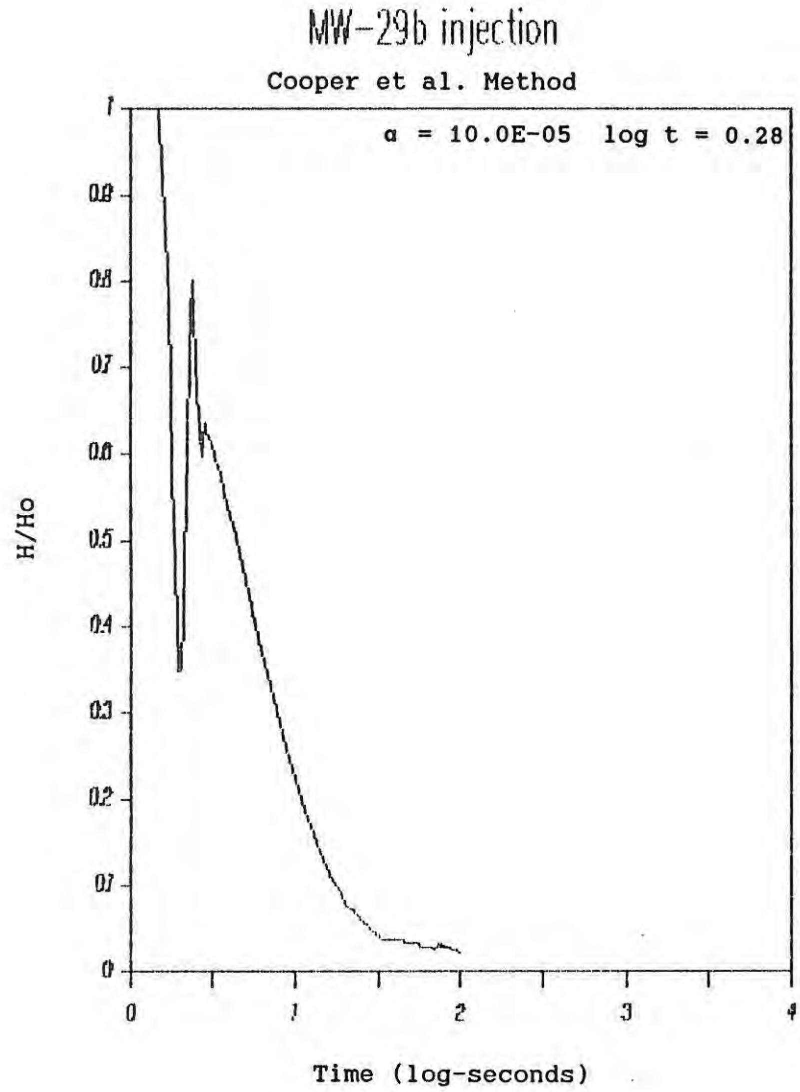
MW-29a injection

Cooper et al. Method



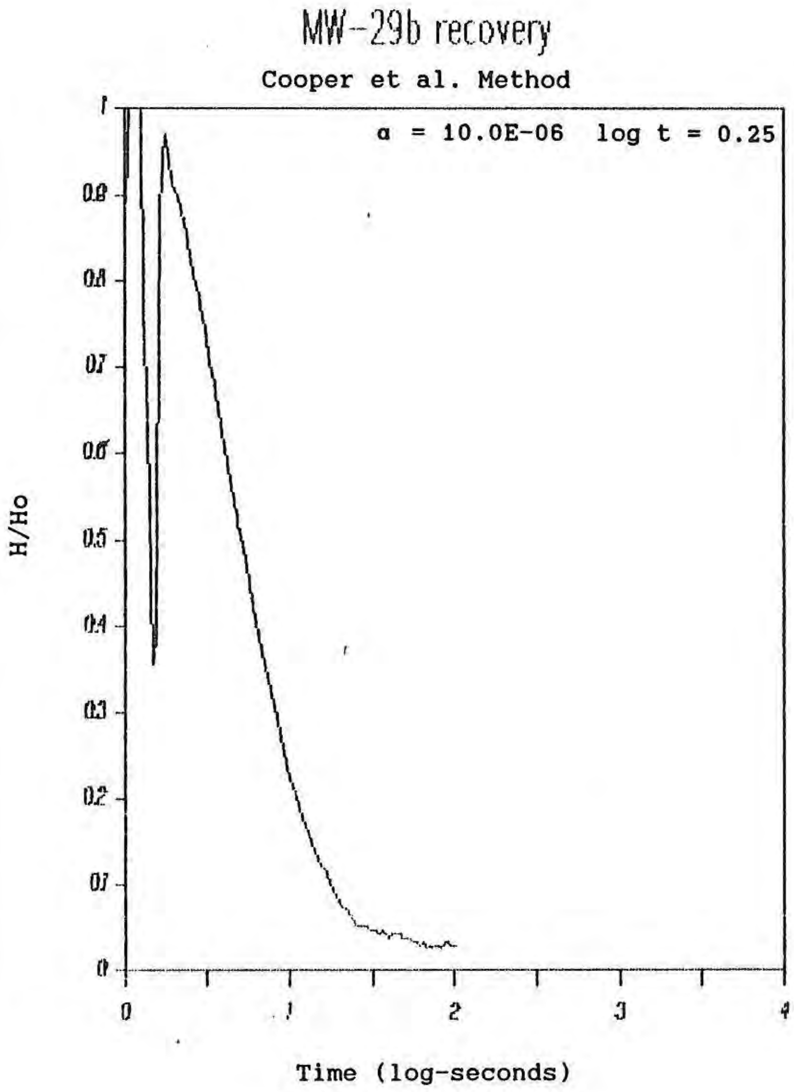
MW-29a recovery

Cooper et al. Method



MW-29b injection

Cooper et al. Method



MW-29b recovery

Cooper et al. Method

DISTRIBUTION

30 Copies	Mr. Tim Morley Parametrix, Inc. 13020 Northup Way, Suite 8 Bellevue, Washington 98004

Quality Assurance/Technical Review by:

John E. Newby, P.E.
President

MAA/MS/tag

APPENDIX E

Aquifer Testing

APPENDIX E

Aquifer Testing

Pumping Test Analyses and Hydraulic Conductivity Calculations

Horizontal conductivities for the Landfill Aquifer were calculated based on pump tests at Wells LW-1 and LW-2. These tests were conducted between August 25 and September 1, 1987. Well LW-1 was pumped with a 4-inch submersible Jacuzzi pump (9.0 gallon per minute rating) and a gas powered generator. Flow rates from Well LW-1 were measured using a Rockwell inline flow meter (0 to 12 gallon per minute). Tests on Well LW-2 required higher capacity equipment. A Grundfos/Franklin pump (50 gallons per minute) was used. Three-phase electrical power was supplied by a diesel generator. Flow rates from Well LW-2 were measured using a Neptune flow meter rated at 0 to 70 gallons per minute. Flow rates in both wells were controlled by a gate valve located on the outlet of the flow meter. Discharged water was pumped into a 5,000+ gallon tank truck provided by the City of Seattle.

Water levels in the wells were measured as changes in head using a calibrated Sinco pressure transducer connected to a data logger. The data logging system was developed by AGI specifically for recording real time data from pore pressure transducers. The system is battery powered and consists of a solid state, modular, 6-wire bridge supply and amplifier; a 12-bit (+), high-speed, auto-zero analog to digital converter; and a lap top MS-DOS computer. The system is capable of recording hydraulic head at 15 samples per second with an absolute accuracy of 0.01 feet. The computer graphically displays the real time data and saves time, millivolt, and calculated head to a 3-1/2-inch floppy disk for later reduction and evaluation. Field plots were made of drawdown versus time to evaluate test progress.

The pumping test on Well LW-1 included three step drawdown stages and a recovery period. The step drawdown stages consisted of pumping rates of 1.0, 2.0 and 3.5 gallons per minute with each stage lasting approximately 60 minutes. The total drawdown on Well LW-1 was 11.07 feet. Well recovery was monitored for 90 minutes. During that time, the water level recovered 8.55 feet.

The pumping test on Well LW-2 consisted of three stages with pumping rates of 20 to 25 gallons per minute. The initial stage consisted of 25 minutes at a pump rate of 20 gallons per minute. Pumping was then stepped up to approximately 24 gallons per minute for 35 minutes. At the end of the second stage, the drawdown in the well was 1.40 feet. The pumping rate was then increased to a maximum of 25 gallons per minute and maintained for 173 minutes. Maximum drawdown at the end of the test was 2.98 feet. The well recovery was monitored for 15 hours at the end of which there remained 1.03 feet of residual drawdown.

Horizontal hydraulic conductivities for the Landfill Aquifer have been estimated based on pumping test recovery data at LW-1 and LW-2. The straight line Cooper and Jacob method (Johnson Div. UOP, 1986) was used to calculate transmissivity (T) from the well recovery data. Hydraulic conductivity (K) is derived from the relationship K = T/b, where b equals the saturated thickness of the aquifer. The procedure is as follows:

Cooper and Jacob Equation: $T = \frac{264Q}{s}$ where:

T = Coefficient of transmissivity in gpd/ft

Q = Pumping rate, in gpm

s = Slope of the time-drawdown graph expressed as the change in drawdown between any two times on the log cycle scale whose ratio is 10 (one log cycle).

Time versus drawdown plots for the pumping wells are shown on Plates E1 and E2 (+ = time since test started; +' = time since pumping stopped), and calculations based on these plots and assumed saturated aquifer thicknesses of 12.0 and 9.4 feet for LW-1 and LW-2, respectively, as follows:

Well No.	Method	Transmissivity	Hydraulic Conductivity
LW-1	Cooper and Jacob Recovery Data	$T = \frac{264 \times 3.5 \text{ gpm}}{4.1 \text{ feet}}$	K = 225 gpd/ft/12.0 ft.
		= 154 gpd/ft	= 13.0 gpd/ft^2
		= 3m^2/day	= 6.0 x 10^{-4} cm/s
LW-2	Cooper and Jacob Recovery Data	$T = \frac{264 \times 24.6 \text{ gpm}}{1.3 \text{ feet}}$	K = 5000 gpd/ft/9.4 ft.
		= 5000 gpd/ft	= 532 gpd/ft^2
		= 62m^2/day	= 2.5 x 10^{-2} cm/s

Hydraulic Conductivity Estimates from Slug Tests

Non-invasive slug tests (rising and falling head) were performed on the screened water-bearing formations penetrated by monitor wells MW-7 through MW-29. The slug method provides data for a single point, in-situ estimate of transmissivity (T) and hydraulic conductivity (K) for a given screened interval. The tests were initiated by a near instantaneous water level change, produced by the immersion (injection test) or withdrawal (recovery test) of a solid cylinder of known volume. The displaced volume creates a disequilibrium in head between the borehole and the water-bearing formation. Water level recovery with time was recorded as changes in head by a barometrically uncorrected pressure transducer connected to a data logger. The field data were stored on floppy disks for later reduction and evaluation.

Four methods of analysis were used to estimate the hydraulic conductivity of the water-bearing formations. These include Hvorslev (1951), Cooper et. al. (1967), Bouwer and Rice (1976), and Van der Kamp (1976). The applicability of any method to a particular well depends primarily upon (1) the response of the well to the slug (i.e. overdamped or underdamped), (2) the presence of confined or water table conditions in the aquifer, and (3) well construction effects (i.e. partial penetration, sand pack effects, degree of development). The methods of Cooper et. al. (1967) and Hvorslev (1951) were used for wells exhibiting an overdamped response in both confined and unconfined aquifers. The method of Bouwer and Rice (1976) was used exclusively for wells completed at or near the water table. The method of Van der Kamp (1976) was used to estimate hydraulic parameters for a well exhibiting underdamped oscillations. Following is a description of the Cooper, et. al. Method.

In the Cooper, et. al. (1967) Method, the slug test response history is plotted as log time versus change in elevation head over static elevation head (H/Ho). This plot is compared with a set of analytical aquifer response curves. After determining a satisfactory match between the slug test response and one of the analytical aquifer response curves, the log time match point is determined. Plate E1 shows the analytical curves used. Plate E2 gives an example of the MW-25B well recovery curve superimposed on the analytical curves for match point determination. An example computation of transmissivity and hydraulic conductivity for MW-25B is as follows:

$$T = x\, r_c^2/t$$

where: T = Transmissivity
x = 1.0 = match point value (i.e. $1.0 = Tt/(r_c)^2$
r_c = casing radius
t = time at match point

$K = T/b$

where: K = hydraulic conductivity
b = aquifer thickness

MW-25B recovery (Plate E2)

$x = 1.0$, $r_c = 1.0$ in. = 2.54 cm, $b = 7.0$ ft. = 213 cm

$\log t = 1.5$ (Plate E2), $t = 30$ sec

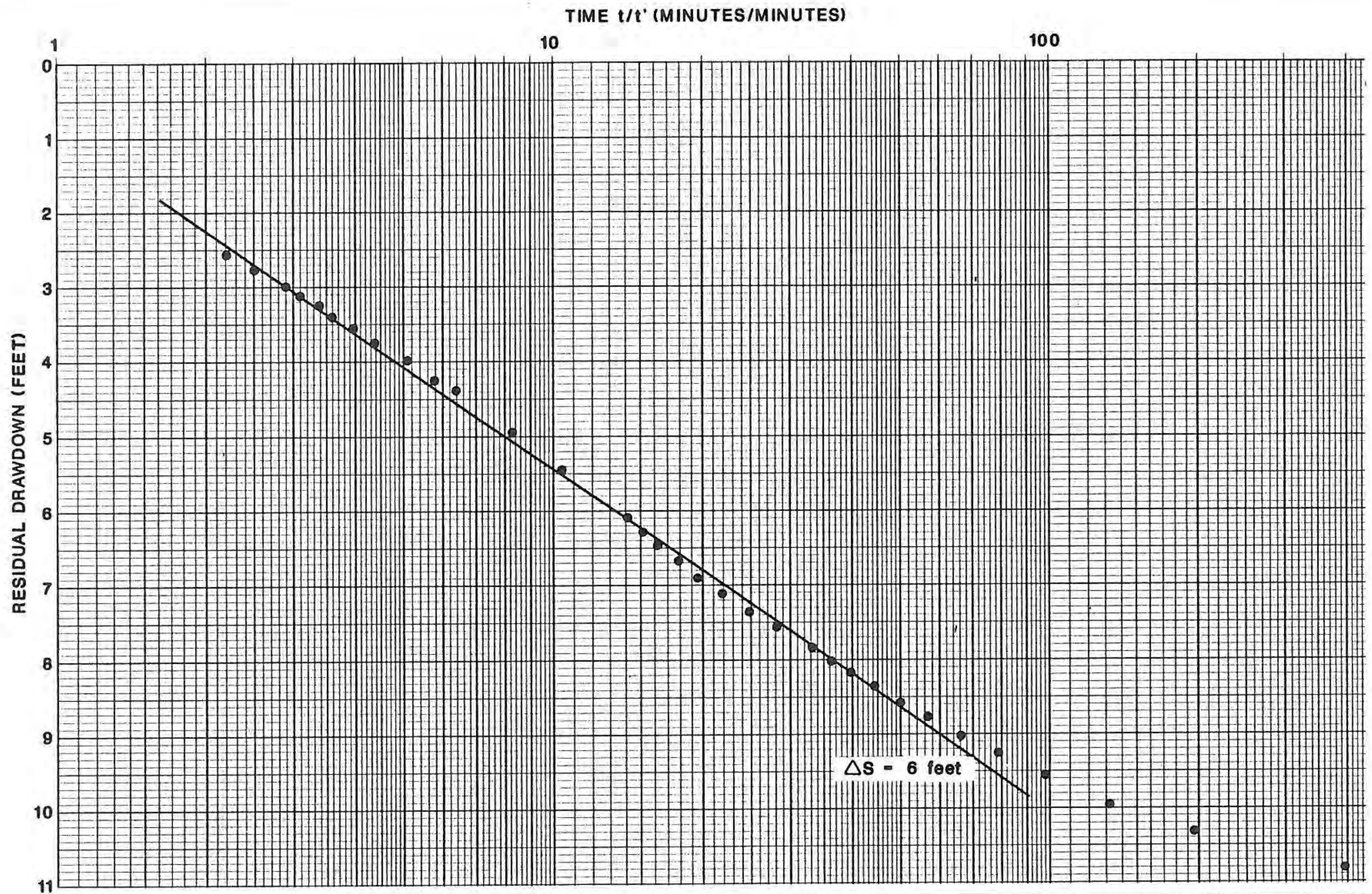
$$T = 1.0\ (2.54\ \text{cm})^2/30\ \text{sec}$$

$$= 2 \times 10^{-1}\ \text{cm}^2/\text{sec}$$

$$K = \frac{2.0 \times 10^{-1}\ \text{cm}^2/\text{sec}}{213\ \text{cm}}$$

$$= 9 \times 10^{-4}\ \text{cm/sec}$$

Slug test analyses are summarized in Table E1. Values for log t used in the Cooper, et. al. analysis are given on each of the aquifer response curves which follow Table E1.



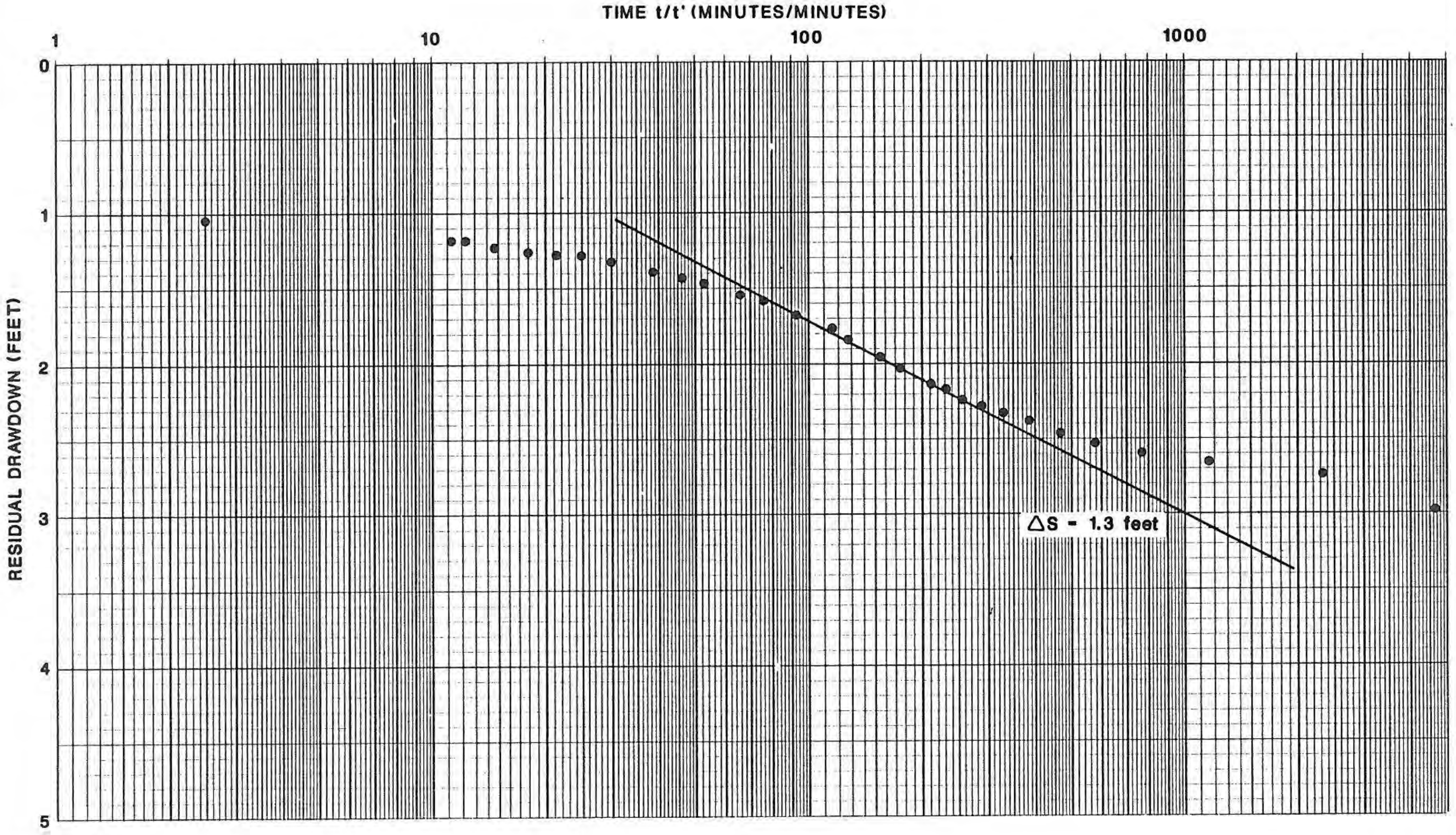
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Recovery Plot of Pumping Well LW-1

Midway Landfill
Kent, Washington

PLATE
E1

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	14 December 87		



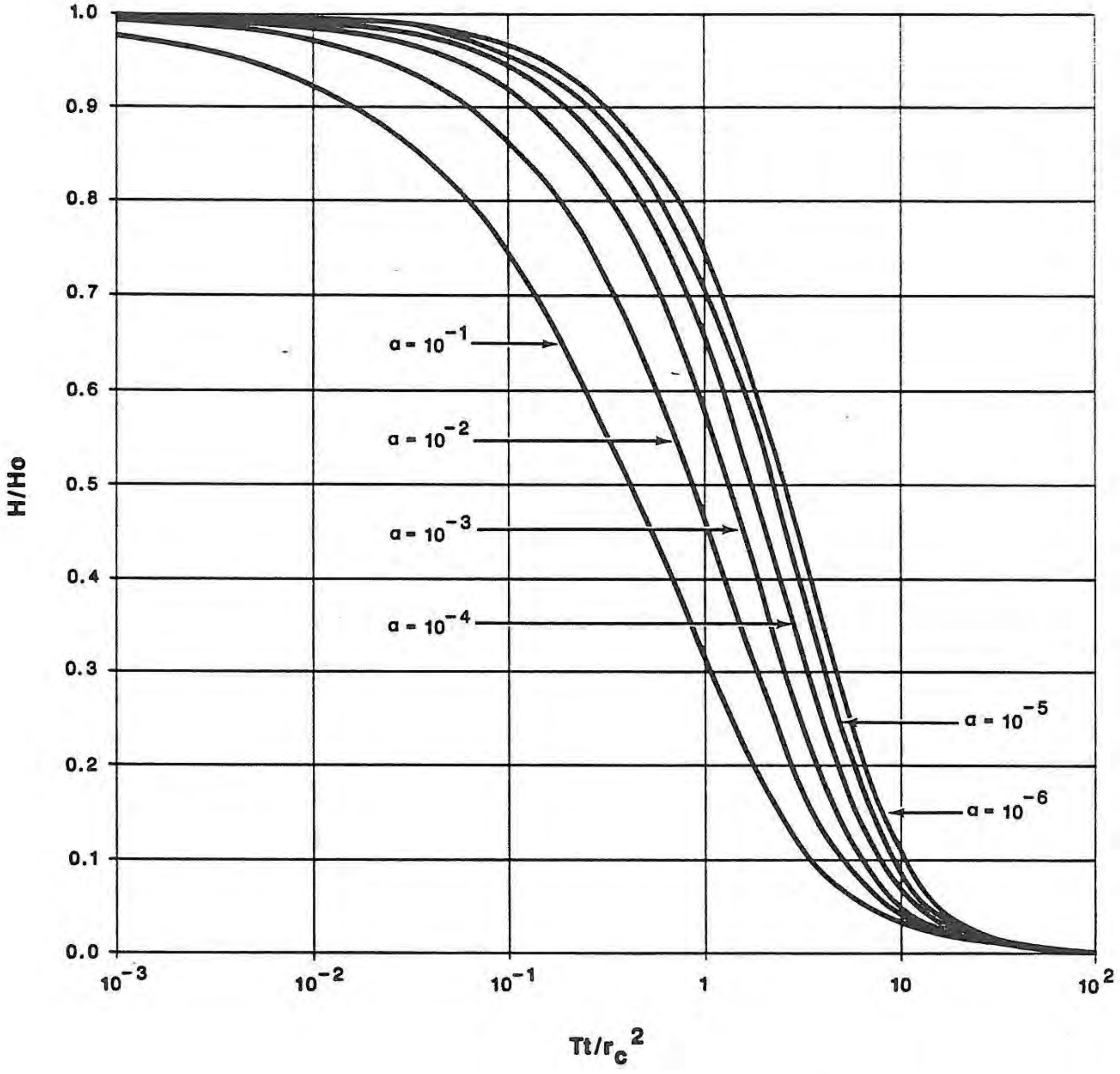
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Recovery Plot of Pumping Well LW-2

Midway Landfill
Kent, Washington

PLATE
E2

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	14 December 87		



Reference: Cooper, Bredehoeft, and Papadapolos, 1967.

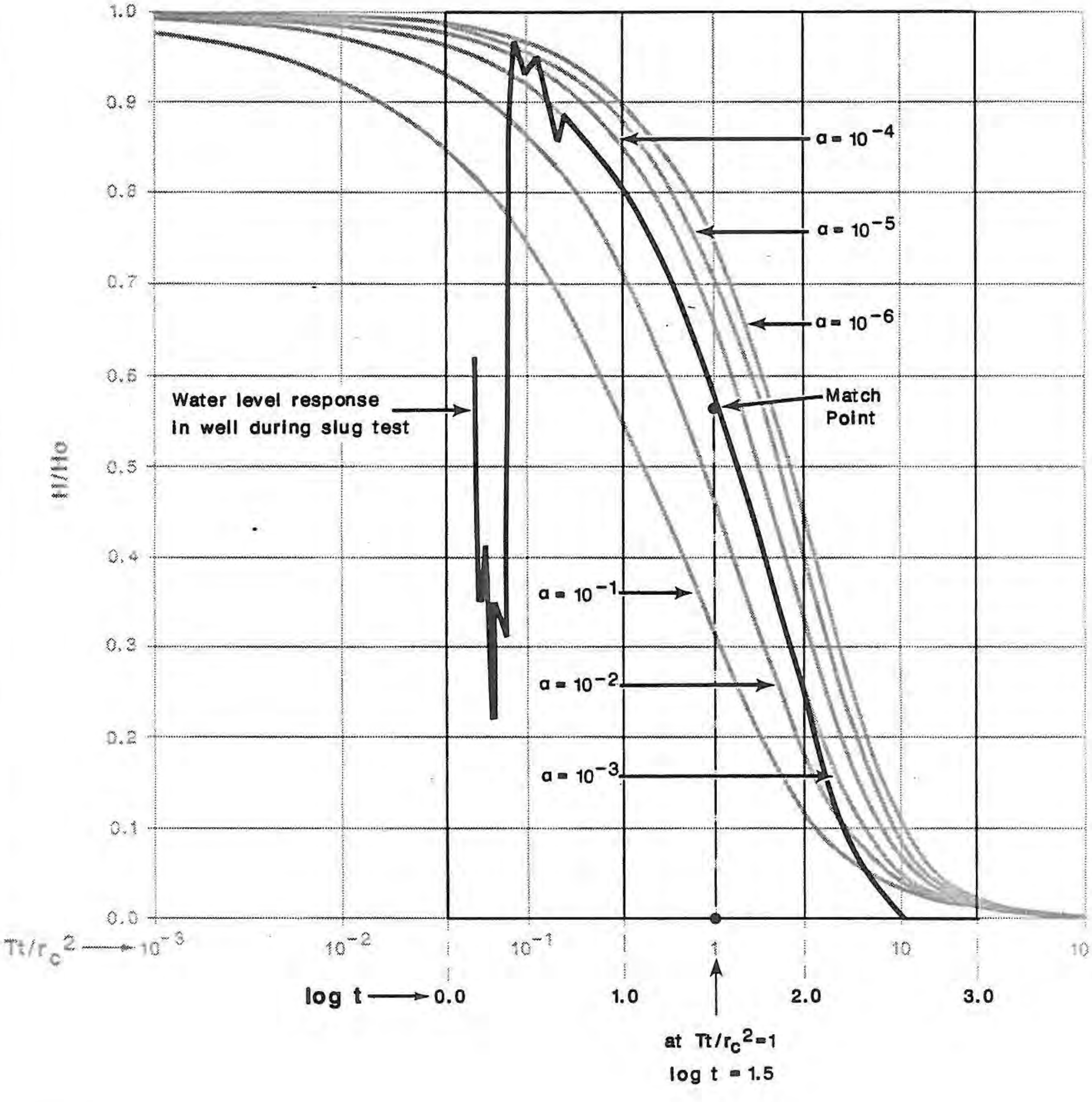
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Type Curves of H/Ho versus Tt/r_c^2 for Six Values of α

Midway Landfill
Kent, Washington

PLATE
E3

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	14 December 87		



Note: See text for explanation and interpretation of this figure.

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Example of Match Point Determination

Midway Landfill
Kent, Washington

PLATE
E4

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	KER	MAA	14 December 87		

Table E1
Single Borehole Slug Test Summary

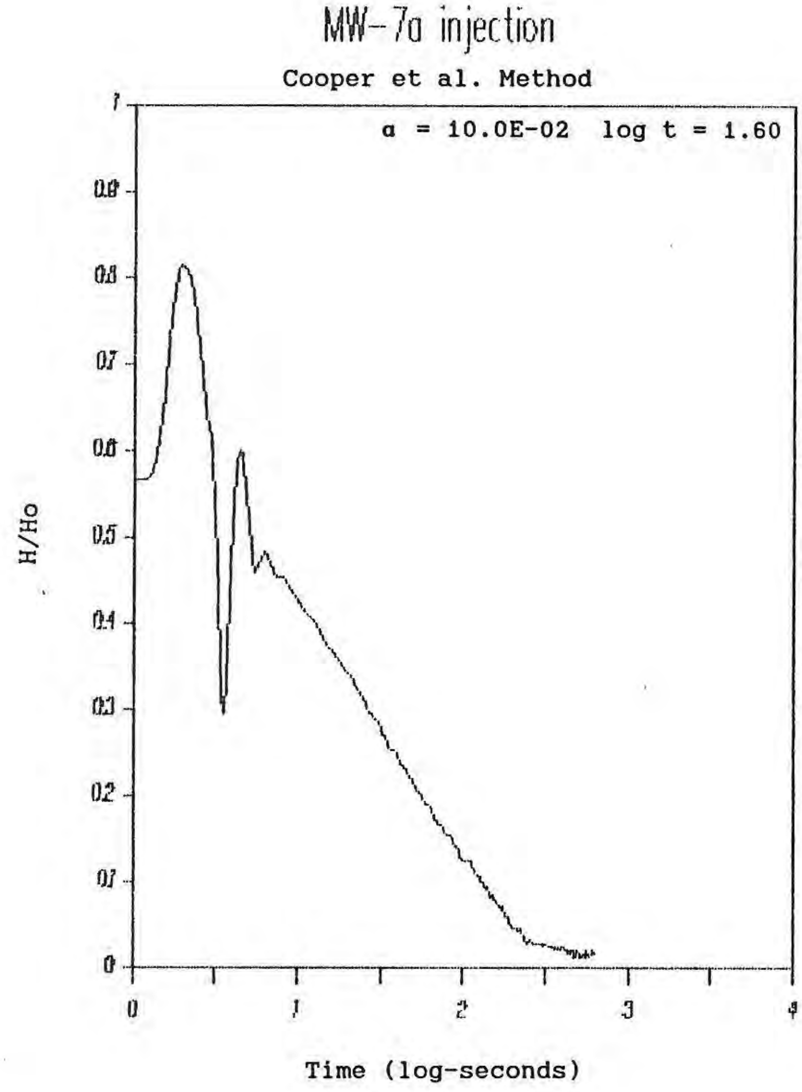
	Hydraulic Conductivity (K) and Transmissivity (T)								
	Cooper et al., 1967				Hvorslev, 1951				
	K (cm/sec)		T (gpd/ft)		K (cm/sec)		T (gpd/ft)		
	INJ	REC	INJ	REC	INJ	REC	INJ	REC	
Landfill Aquifer									
MW-19A	1.0E-03	2.0E-03	2.9E+02	4.6E+02	1.0E-03	2.0E-03	2.3E+02	3.5E+02	
Recent Alluvium									
MW-25A	3.0E-03	1.0E-03	3.5E+02	1.7E+02	1.0E-03	1.0E-03	1.7E+02	1.2E+02	(e)
Upper Gravel Aquifer									
MW-7A	4.0E-04	8.0E-04	1.2E+02	1.7E+02	1.0E-03	7.0E-04	2.3E+02	1.2E+02	
MW-8A	ND	5.0E-04	ND	1.2E+02	8.0E-04	4.0E-04	1.7E+02	1.2E+02	
MW-13A	6.0E-04	NA	4.6E+01	ND	3.0E-04		2.3E+01		(a)
MW-16A	1.0E-02	1.0E-02	1.2E+03	1.2E+03	5.0E-03	5.0E-03	5.8E+02	5.8E+02	
MW-19B	9.0E-04	2.0E-03	1.2E+02	2.3E+02	3.0E-04	7.0E-04	3.5E+01	1.2E+02	
MW-21A	NA	NA	NA	NA	NA	NA	NA	NA	
MW-26A	5.0E-03	5.0E-03	5.8E+02	5.8E+02	2.0E-03	1.0E-03	1.7E+02	1.7E+02	
MW-27A	8.0E-03	8.0E-03	1.7E+03	1.7E+03	8.0E-03	7.0E-03	1.7E+03	1.7E+03	
MW-27B	5.0E-03	7.0E-03	5.8E+02	1.2E+03	3.0E-03	2.0E-03	3.5E+02	2.3E+02	
MW-29A	9.0E-04	8.0E-04	1.7E+02	1.7E+02	3.0E-04	3.0E-04	5.8E+01	5.8E+01	
Mean	3.9E-03	4.3E-03	5.6E+02	6.7E+02	2.3E-03	2.1E-03	3.7E+02	3.9E+02	
Standard Deviation	3.5E-03	3.5E-03	5.7E+02	5.7E+02	2.5E-03	2.3E-03	5.1E+02	5.3E+02	
Sand Aquifer									
MW-7B	8.0E-03	6.0E-03	4.1E+02	3.5E+02	2.0E-03	2.0E-03	1.7E+02	1.2E+02	
MW-8B	ND	ND	ND	ND	ND	ND	ND	ND	
MW-9A	1.0E-03	3.0E-03	2.9E+02	6.4E+02	8.0E-04	1.0E-03	1.7E+02	2.3E+02	
MW-9B	2.0E-04	4.0E-04	2.9E+01	4.6E+01	3.0E-04	4.0E-04	4.1E+01	4.1E+01	
MW-10A	ND	ND	ND	ND	ND	ND	ND	ND	
MW-10B	ND	ND	ND	ND	ND	ND	ND	ND	
MW-11A	5.0E-03	4.0E-03	1.2E+03	1.2E+03	1.0E-03	1.0E-03	2.9E+02	2.3E+02	
MW-12A	1.0E-03	1.0E-03	1.7E+02	1.2E+02	5.0E-04	4.0E-04	5.8E+01	4.1E+01	
MW-12B	7.0E-03	7.0E-03	4.1E+02	3.5E+02	2.0E-03	1.0E-03	1.2E+02	1.2E+02	
MW-15A	8.0E-03	5.0E-03	1.7E+03	1.2E+03	2.0E-03	2.0E-03	5.2E+02	4.1E+02	(b)
MW-15B	2.0E-02	2.0E-02	2.9E+03	2.3E+03	7.0E-03	6.0E-03	1.2E+03	5.8E+02	
MW-17A	5.0E-04	ND	1.2E+02	ND	2.0E-04		3.5E+01		
MW-17B	5.0E-03	6.0E-03	1.2E+03	1.2E+03	2.0E-03	2.0E-03	2.9E+02	2.9E+02	
MW-18A	ND	ND	ND	ND	ND	ND	ND	ND	
MW-20A	1.0E-03	2.0E-03	1.7E+02	2.9E+02	5.0E-04	9.0E-04	5.8E+01	1.2E+02	
MW-21B	9.0E-04	7.0E-04	1.7E+02	1.7E+02	7.0E-04	5.0E-04	1.2E+02	1.2E+02	
MW-23A	2.0E-03	2.0E-03	3.5E+02	3.5E+02	9.0E-04	7.0E-04	1.7E+02	1.7E+02	(c)
MW-24A	1.0E-03	7.0E-04	2.3E+02	1.2E+02	3.0E-04	2.0E-04	5.8E+01	4.1E+01	(d)
MW-25B	1.0E-03	1.0E-03	1.2E+02	1.2E+02	6.0E-04	6.0E-04	5.8E+01	5.8E+01	
MW-28A	1.0E-02	8.0E-03	1.2E+03	1.2E+03	3.0E-03	3.0E-03	4.1E+02	2.9E+02	
Mean	4.5E-03	4.5E-03	6.6E+02	6.3E+02	1.5E-03	1.4E-03	2.3E+02	1.9E+02	
Standard Deviation	5.1E-03	4.8E-03	7.6E+02	6.1E+02	1.6E-03	1.4E-03	2.8E+02	1.5E+02	

Table E1
Single Borehole Slug Test Summary
(Continued)

Hydraulic Conductivity (K) and Transmissivity (T)

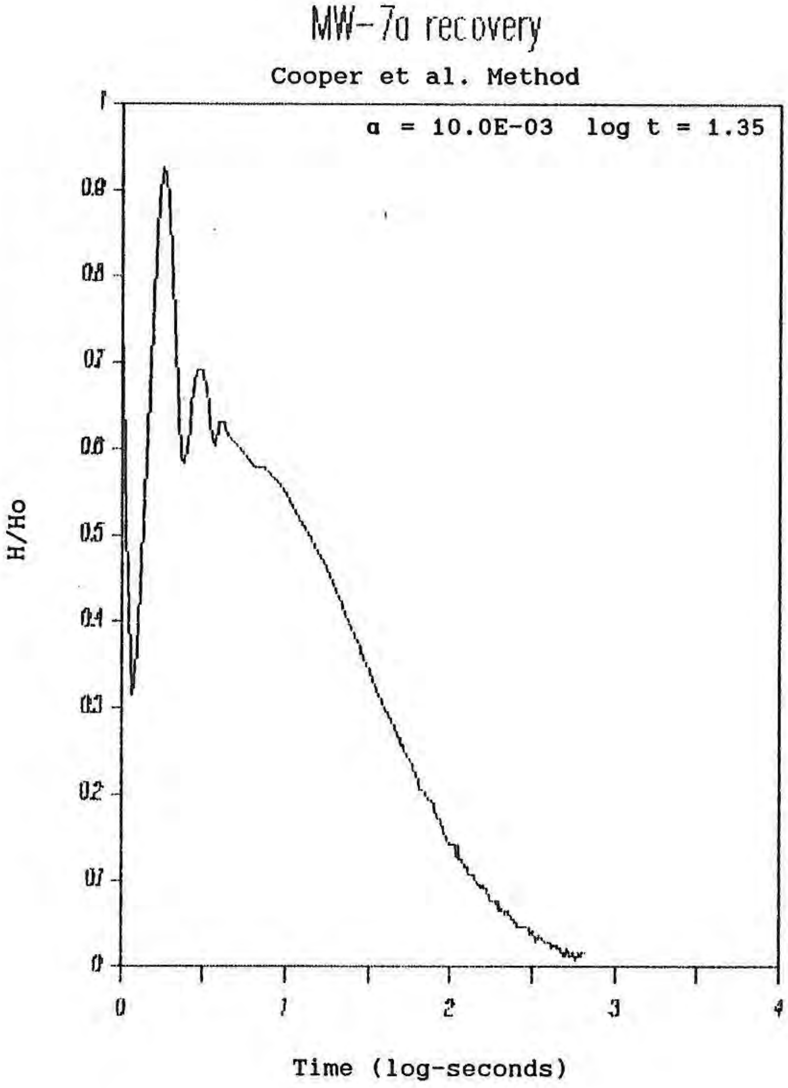
	Cooper et al., 1967				Hvorslev, 1951			
	K (cm/sec)		T (gpd/ft)		K (cm/sec)		T (gpd/ft)	
	INJ	REC	INJ	REC	INJ	REC	INJ	REC
Northern Gravel Aquifer								
MW-11B	NA	NA	NA	NA	7.0E-03	7.0E-03	1.2E+03	1.2E+03
MW-13B	1.0E-02	6.0E-03	2.9E+03	1.2E+03	5.0E-03	2.0E-03	1.2E+03	5.2E+02
MW-18B	6.0E-04	1.0E-03	1.2E+02	2.3E+02	3.0E-04	6.0E-04	5.8E+01	1.2E+02
MW-21C	1.0E-02	1.0E-02	1.2E+03	1.2E+03	3.0E-03	3.0E-03	3.5E+02	3.5E+02
MW-22A	8.0E-03	6.0E-03	1.2E+03	5.8E+02	3.0E-03	2.0E-03	3.5E+02	2.3E+02
MW-22B (f)	NA	NA	NA	NA	NA	NA	NA	NA
MW-27C	9.0E-03	9.0E-03	1.2E+03	1.2E+03	3.0E-03	3.0E-03	3.5E+02	3.5E+02
Mean	7.5E-03	6.4E-03	1.3E+03	8.6E+02	3.6E-03	2.9E-03	5.7E+02	4.5E+02
Standard Deviation	3.5E-03	3.1E-03	9.0E+02	3.9E+02	2.1E-03	2.0E-03	4.3E+02	3.4E+02
Southern Gravel Aquifer								
MW-14A	2.0E-03	3.0E-03	2.9E+02	3.5E+02	8.0E-04	1.0E-03	1.2E+02	1.2E+02
MW-14B	3.0E-03	2.0E-03	4.1E+02	2.3E+02	2.0E-03	2.0E-03	2.3E+02	2.3E+02
MW-19C	2.0E-03	2.0E-03	2.3E+02	2.9E+02	5.0E-04	7.0E-04	5.8E+01	1.2E+02
MW-20B	3.0E-02	3.0E-02	3.5E+03	3.5E+03	9.0E-03	9.0E-03	1.2E+03	1.2E+03
MW-23B	NA	2.0E-02	NA	3.5E+03	4.0E-03	4.0E-03	5.8E+02	5.8E+02
MW-24B	NA	NA	NA	NA	8.0E-03	7.0E-03	1.2E+03	1.2E+03
MW-29B	1.0E-02	1.0E-02	2.3E+03	2.3E+03	3.0E-03	3.0E-03	5.8E+02	5.8E+02
Mean	9.4E-03	1.1E-02	8.1E+02	1.3E+03	3.9E-03	3.8E-03	5.5E+02	5.6E+02
Standard Deviation	1.1E-02	1.1E-02	8.7E+02	1.3E+03	3.1E-03	2.9E-03	4.3E+02	4.2E+02

Note: (a) also K = 0.0004 cm/sec and T = 35 gpd/ft per Bouwer and Rice (1976) analysis.
(b) also K = 0.003 cm/sesc and T = 2300 gpd/ft per Bouwer and Rice (1976) analysis.
(c) also K = 0.0009 cm/sec and T = 1200 gpd/ft per Bouwer and Rice (1976) analysis.
(d) also K = 0.0004 cm/sec and T = 290 gpd/ft per Bouwer and Rice (1976) analysis.
(e) also K = 0.001 cm/sec and T = 230 gpd/ft per Bouwer and Rice (1976) analysis.
(f) K = 6.0 cm/sec and T = 43000 gpd/ft per van der Kamp (1976) analysis.
ND indicates no data recovered.
NA indicates non-analyzable data.
INJ indicates injection test.
REC indicates recovery test.



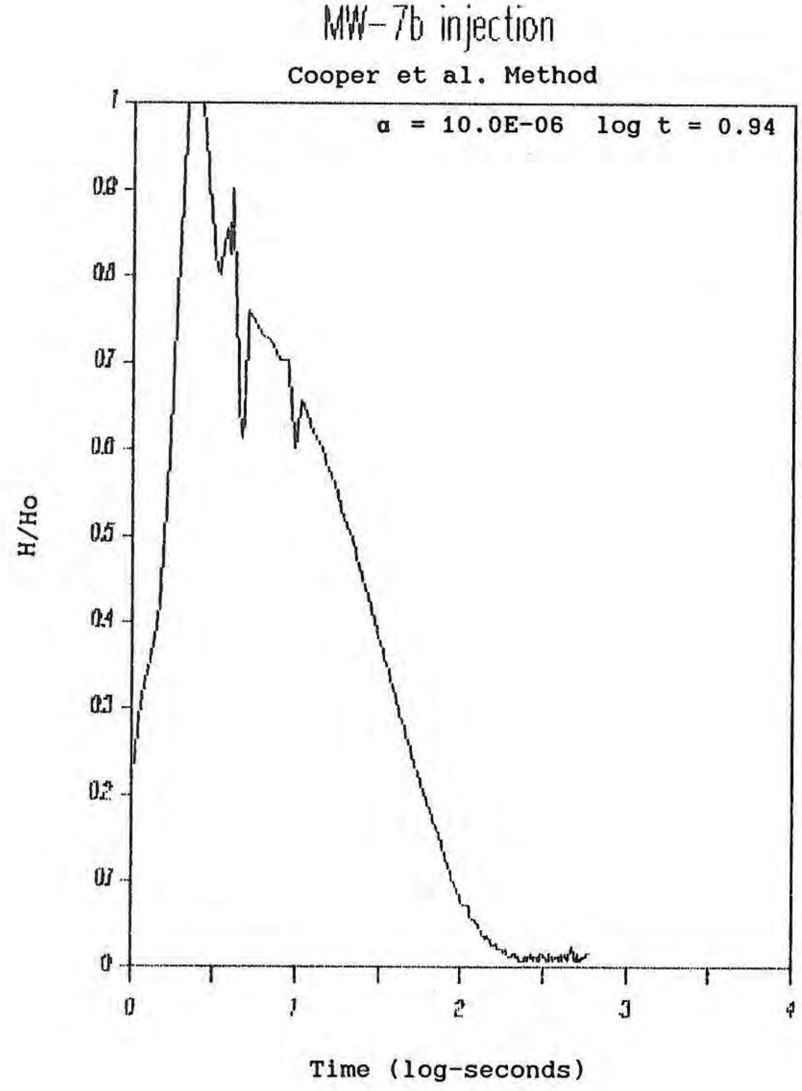
MW-7a injection

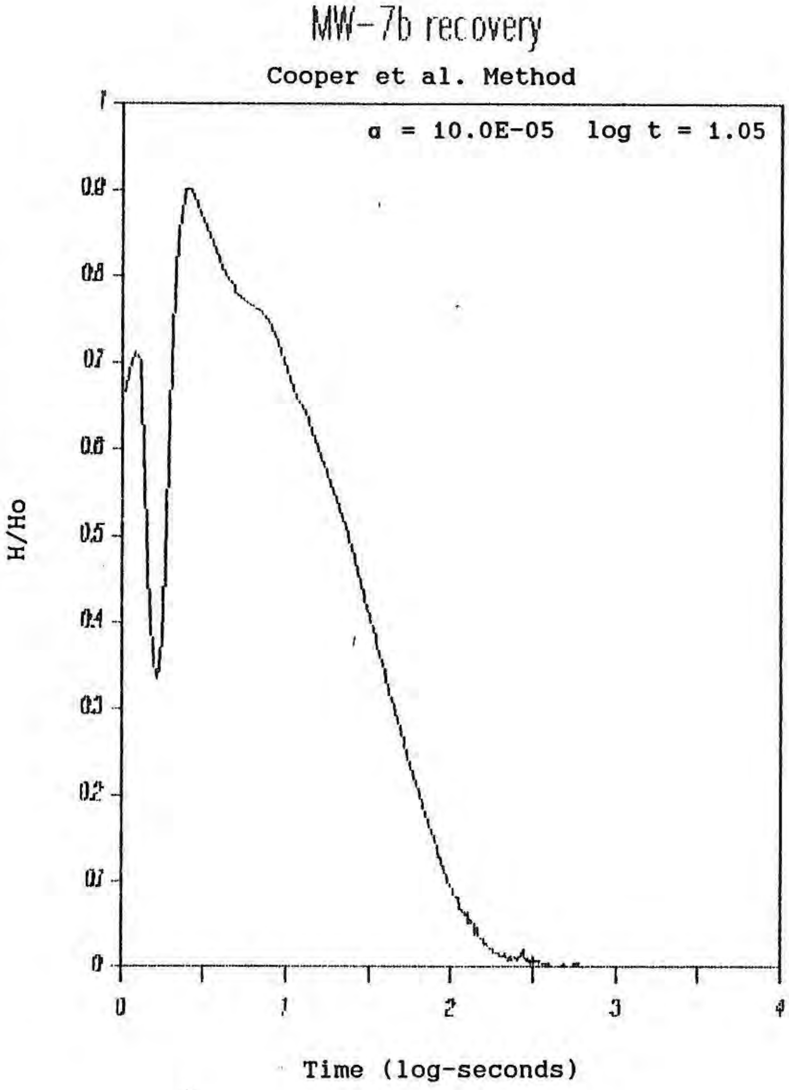
Cooper et al. Method



MW-7a recovery

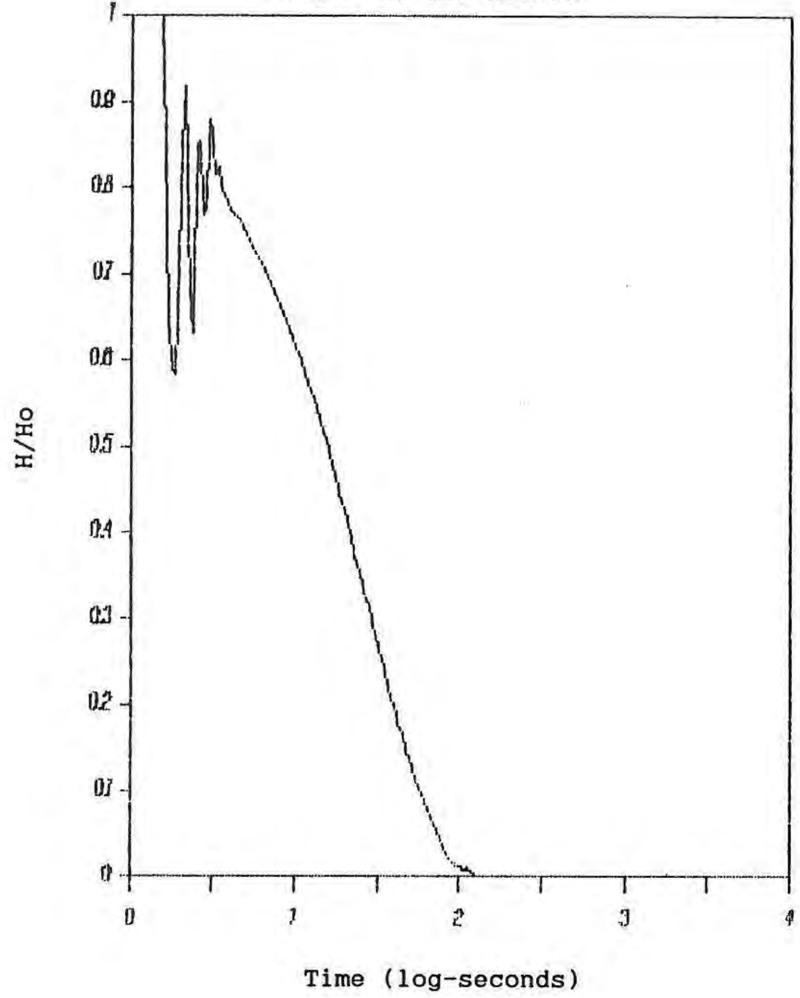
Cooper et al. Method


MW-7b injection
Cooper et al. Method
α = 10.0E-06 log t = 0.94
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-7b recovery
Cooper et al. Method
α = 10.0E-05 log t = 1.05
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)

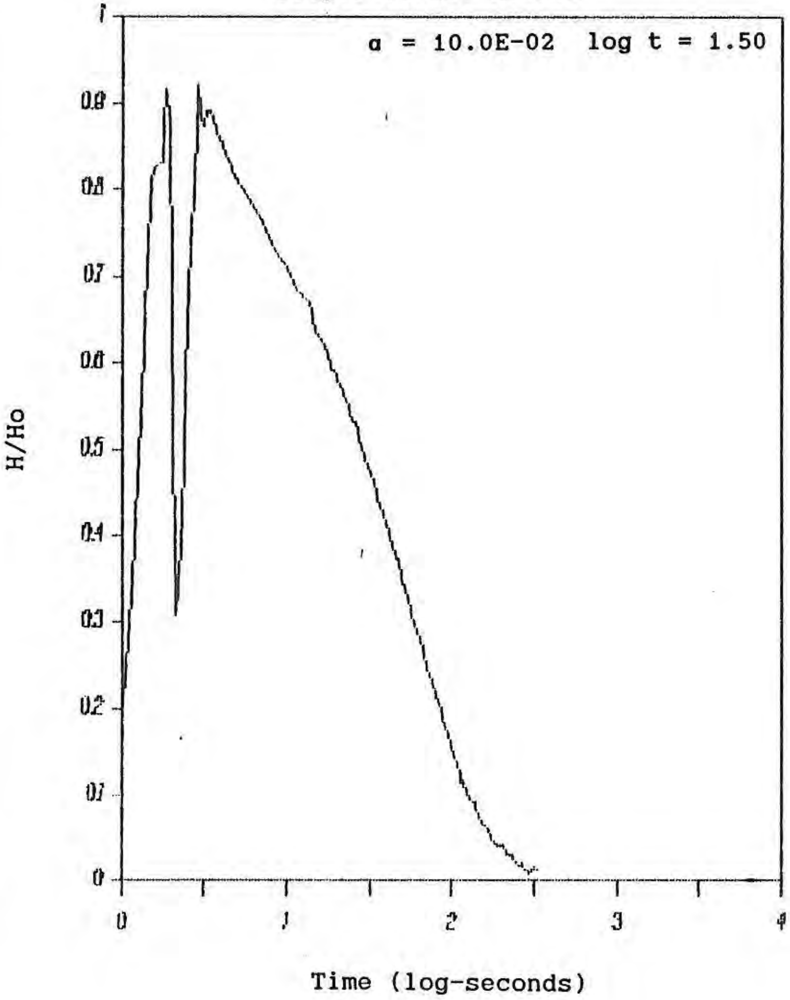
MW-8a injection

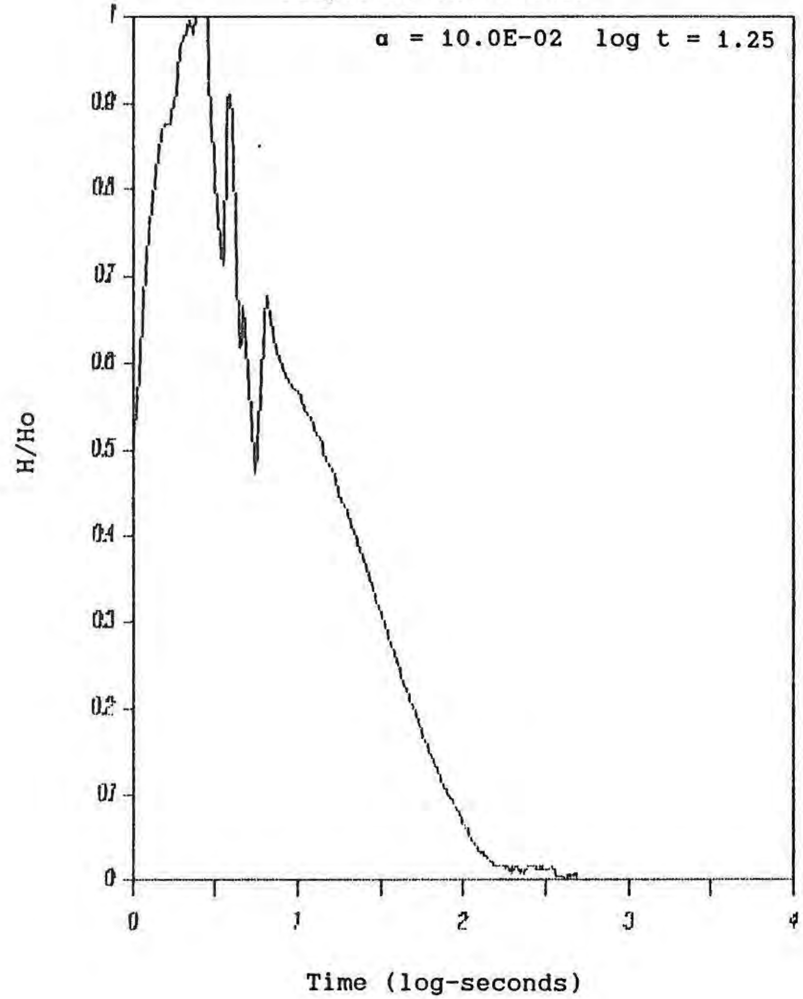
Cooper et al. Method



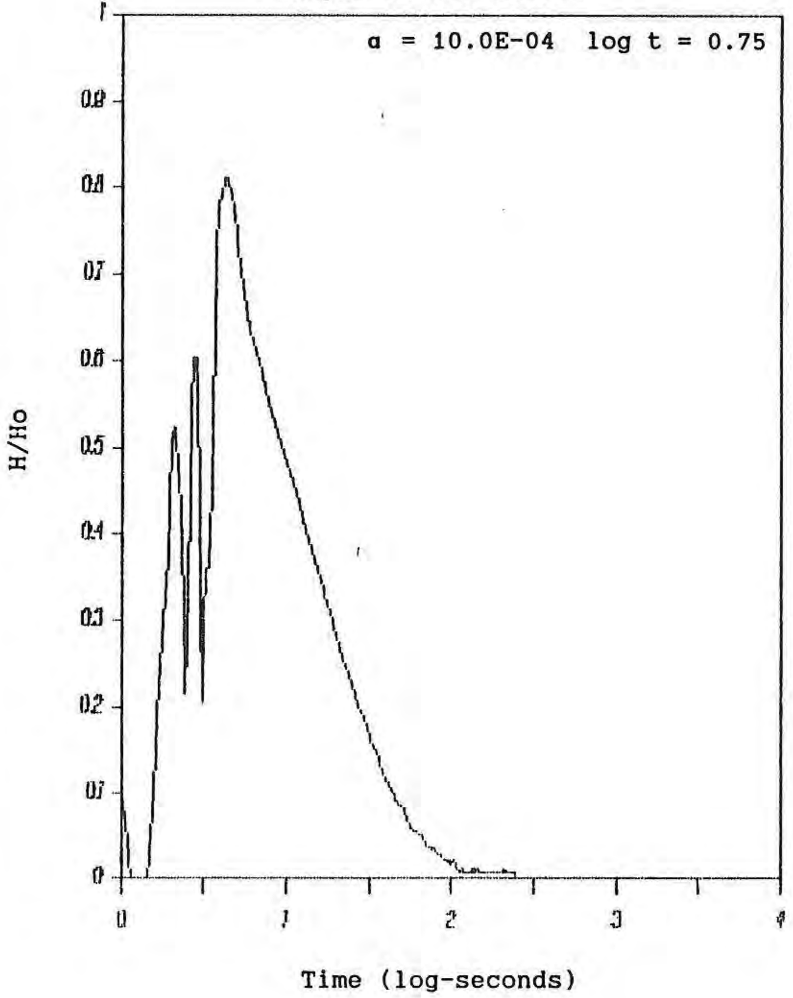
MW-8a recovery

Cooper et al. Method

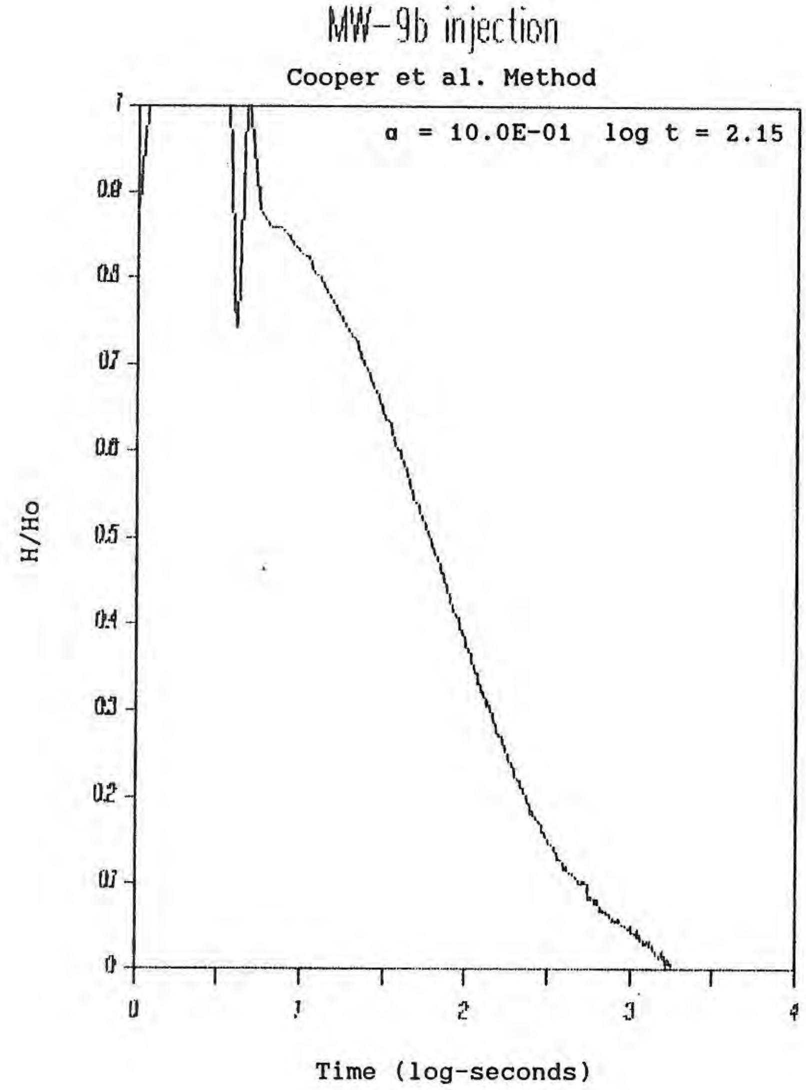


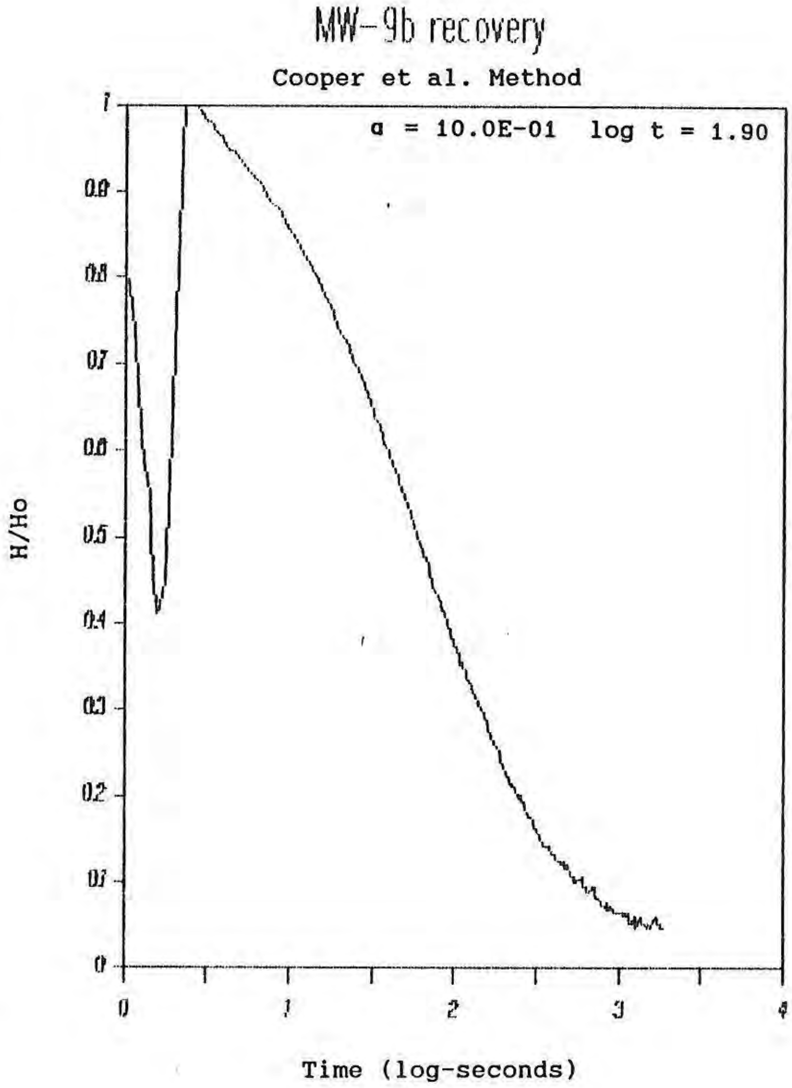

MW-9a injection

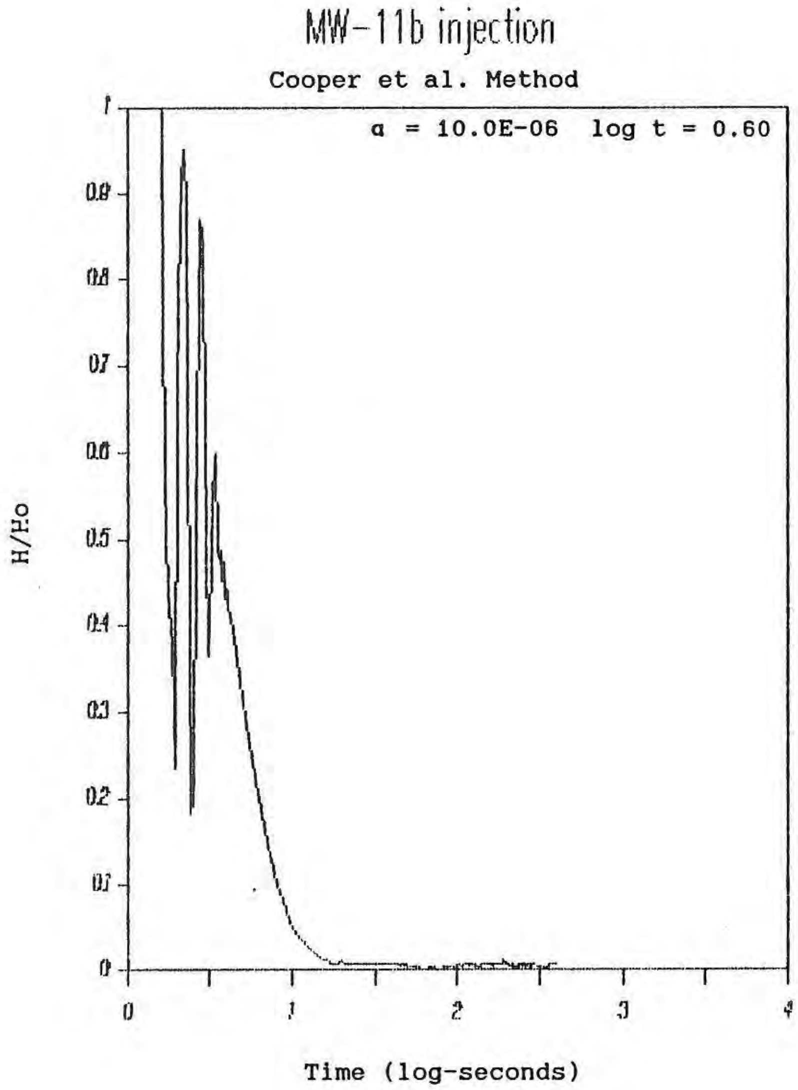
Cooper et al. Method


MW-9a recovery

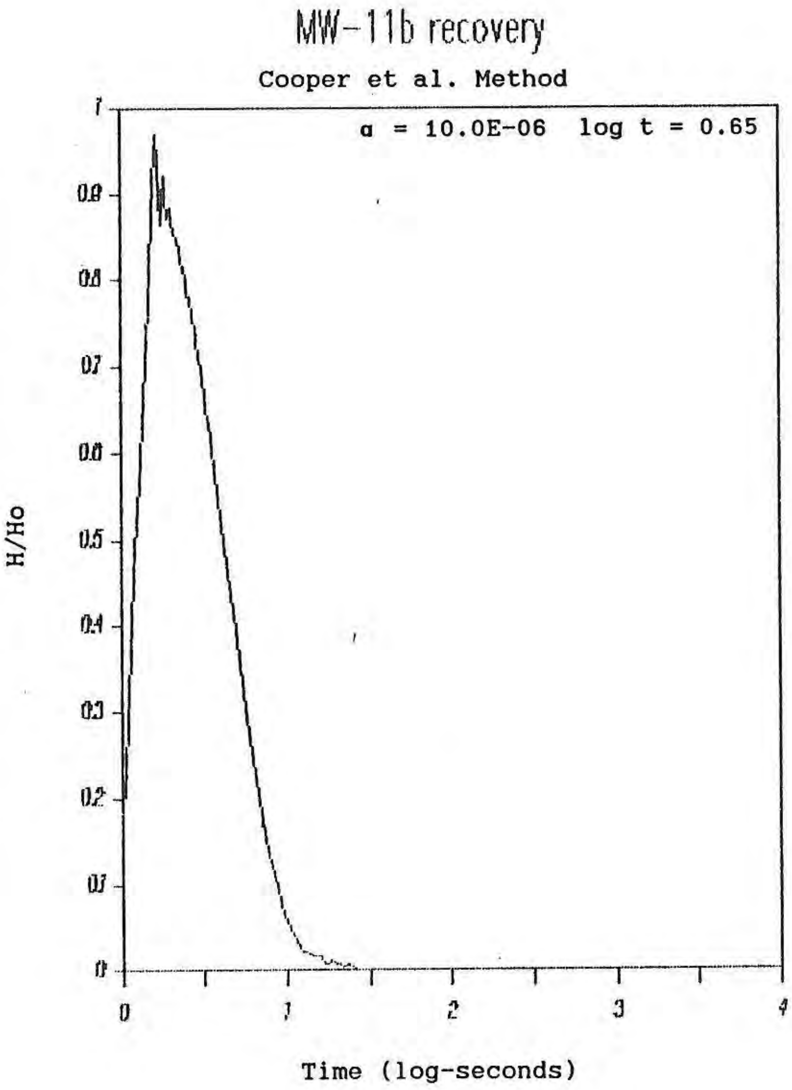
Cooper et al. Method


MW-9b injection
Cooper et al. Method
α = 10.0E-01 log t = 2.15
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-9b recovery
Cooper et al. Method
α = 10.0E-01 log t = 1.90
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)


MW-11b injection

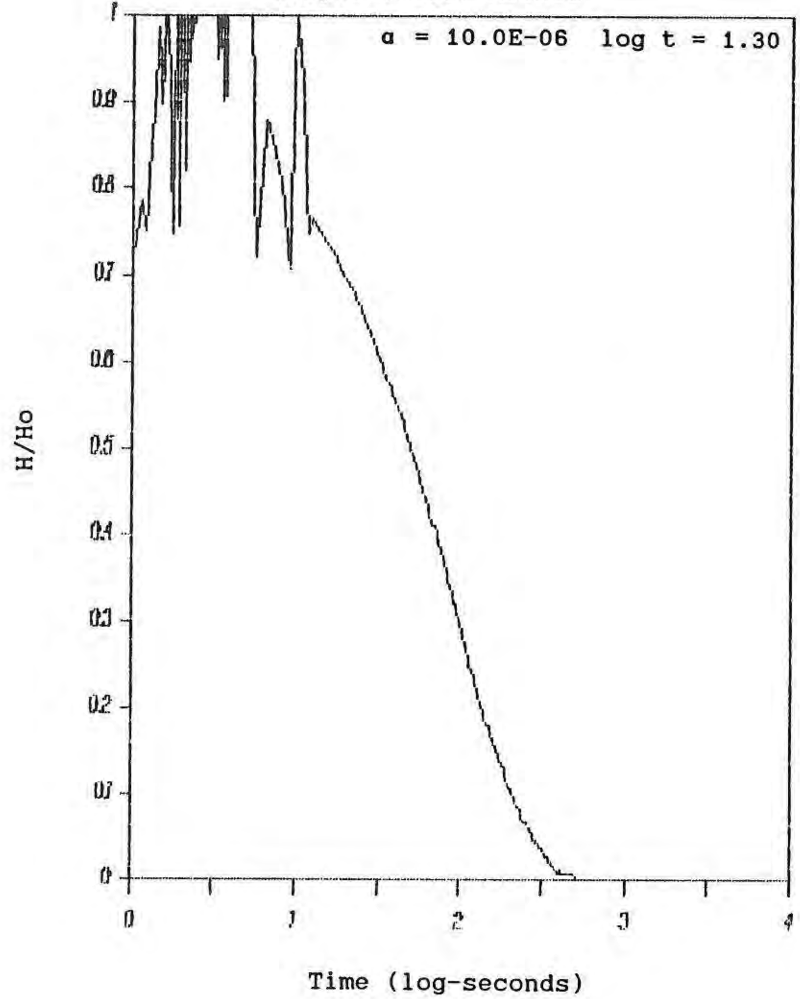
Cooper et al. Method


MW-11b recovery

Cooper et al. Method

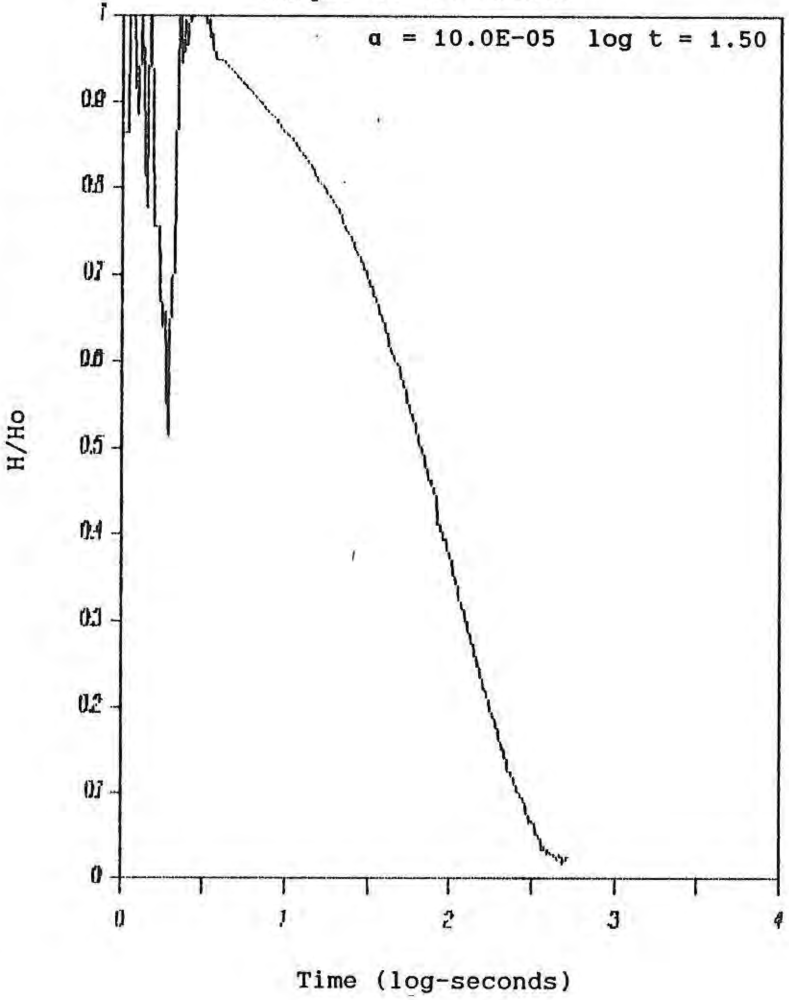
MW-12a injection

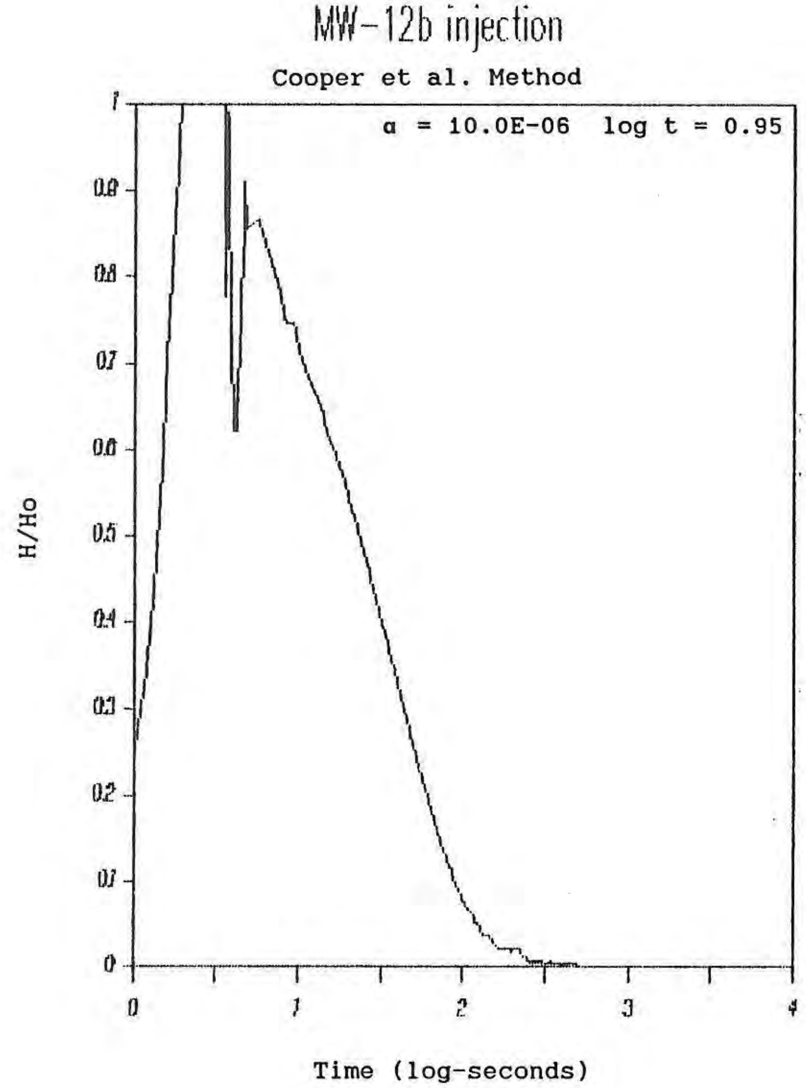
Cooper et al. Method



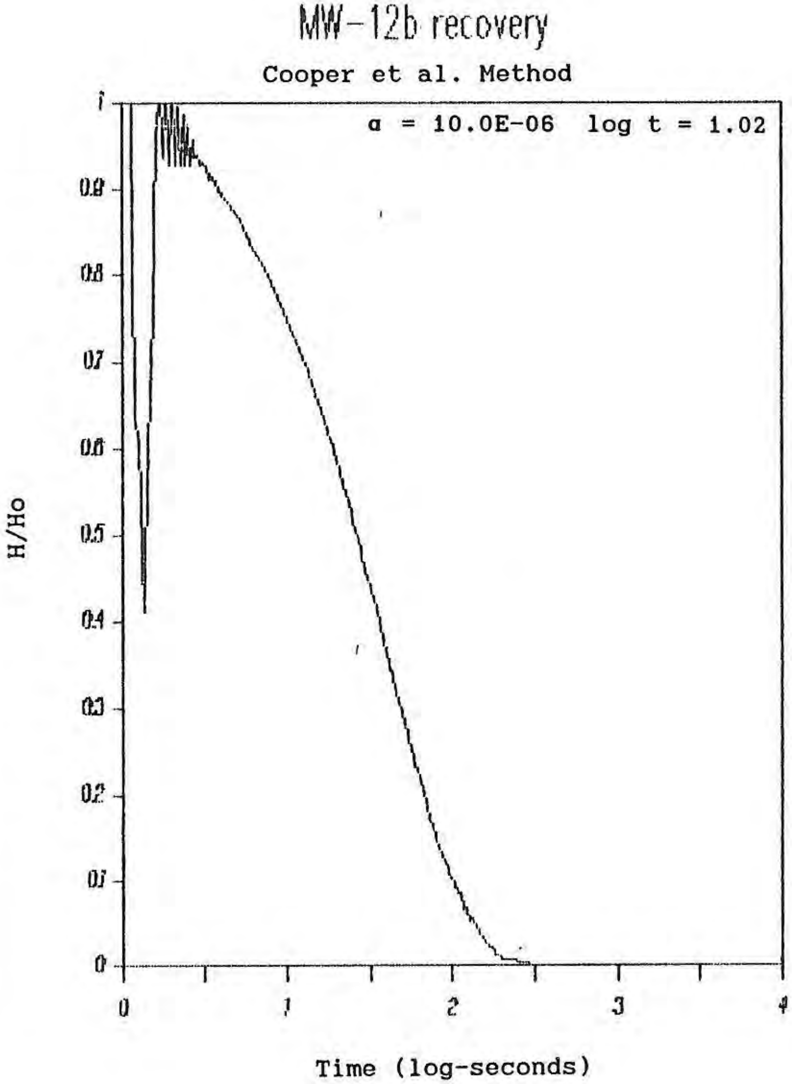
MW-12a recovery

Cooper et al. Method

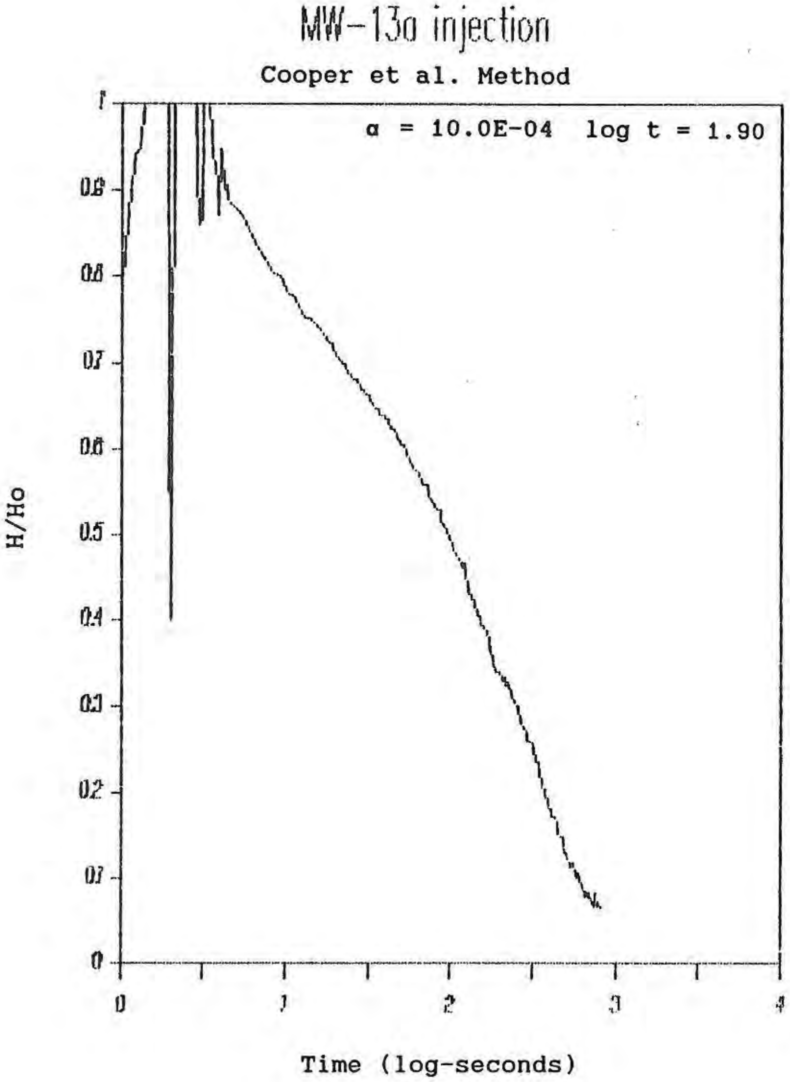


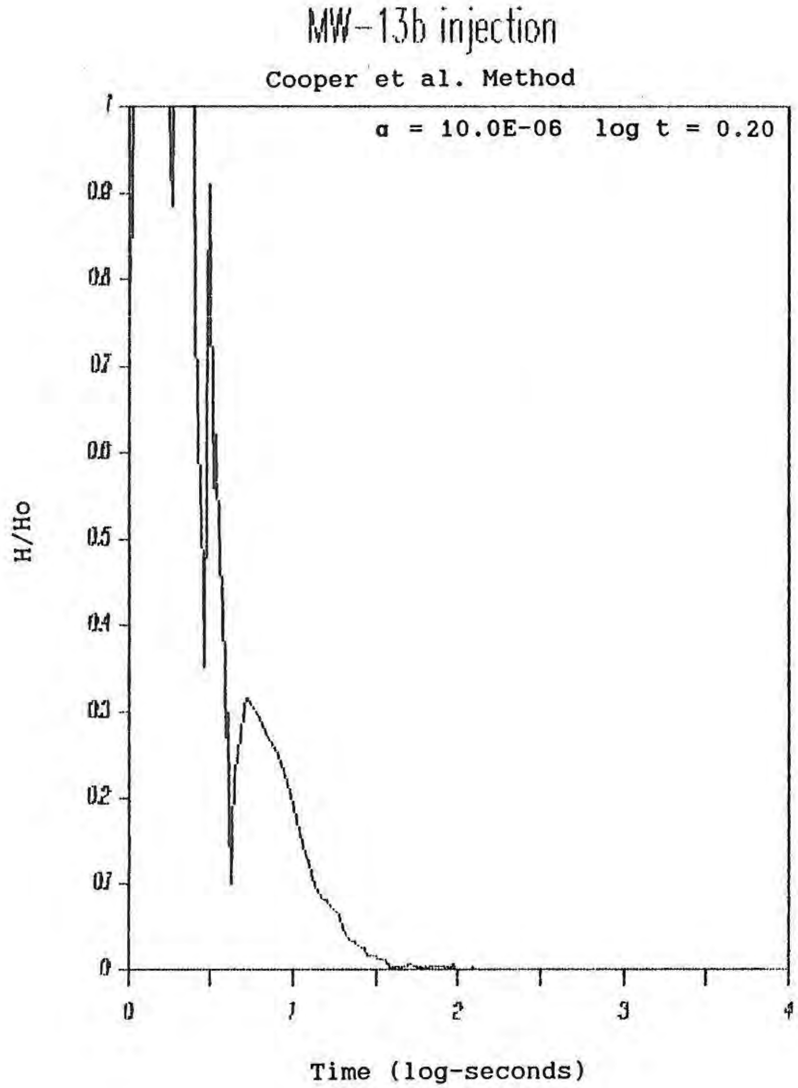

MW-12b injection

Cooper et al. Method


MW-12b recovery

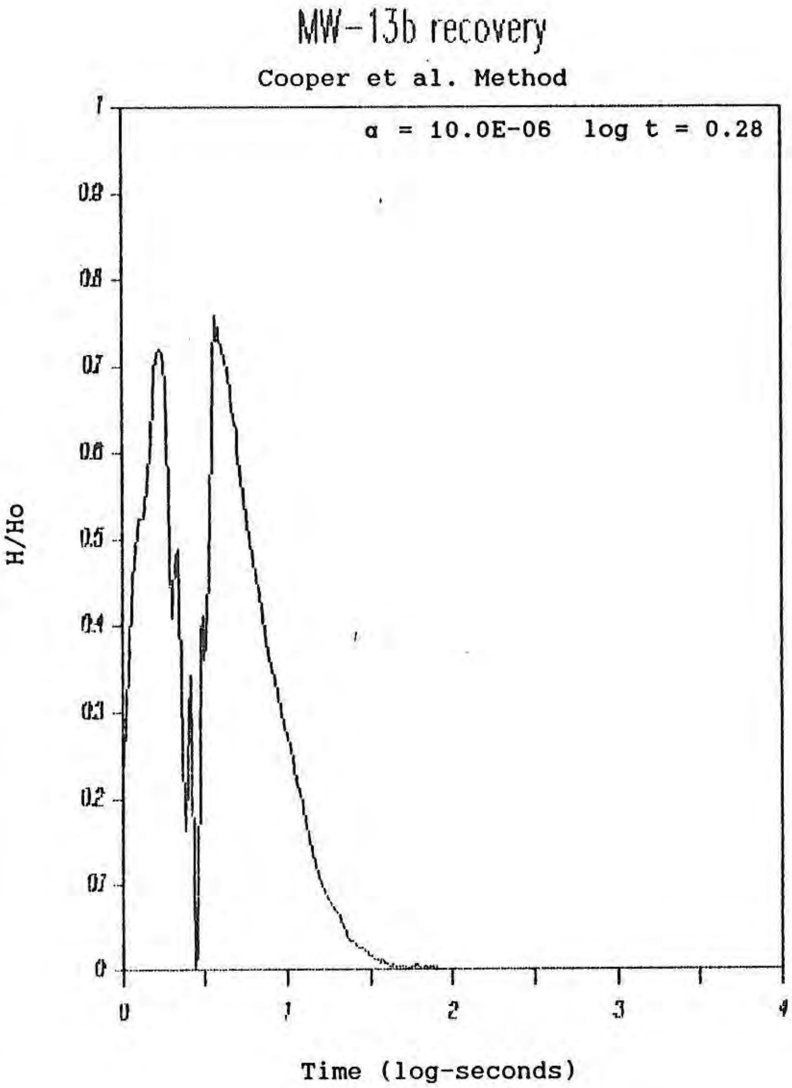
Cooper et al. Method


MW-13a injection
Cooper et al. Method
α = 10.0E-04 log t = 1.90
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
Time (log-seconds)



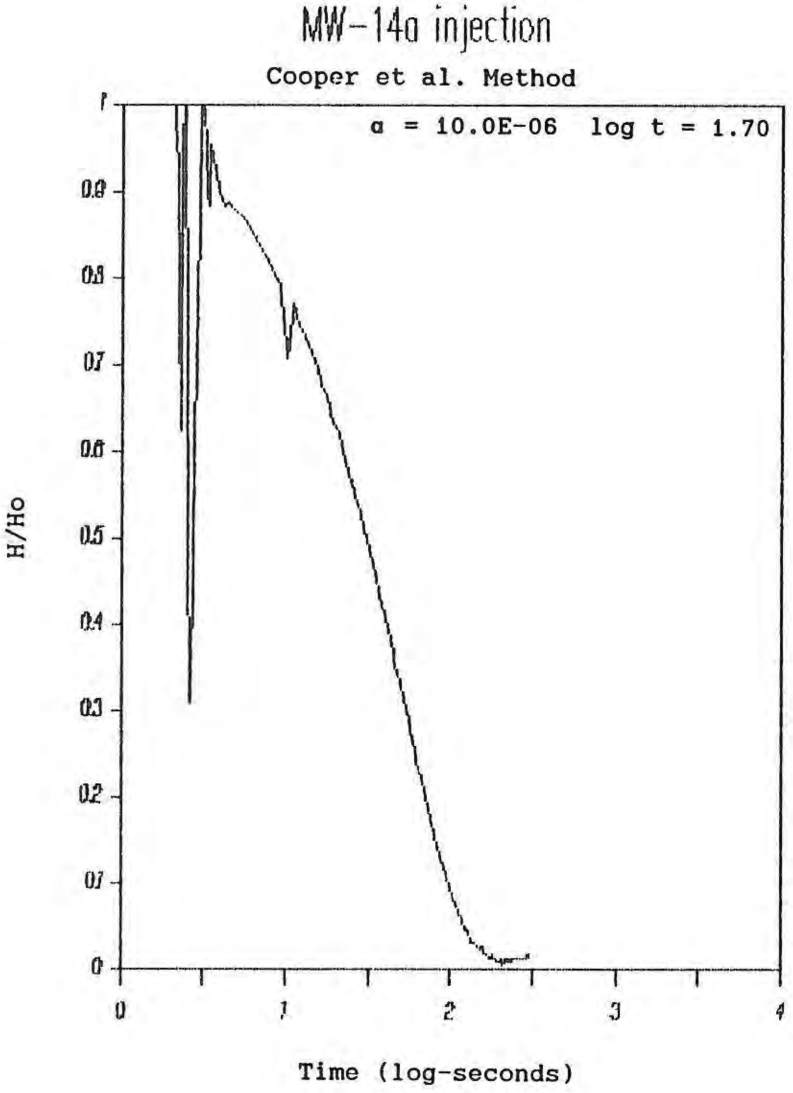
MW-13b injection

Cooper et al. Method



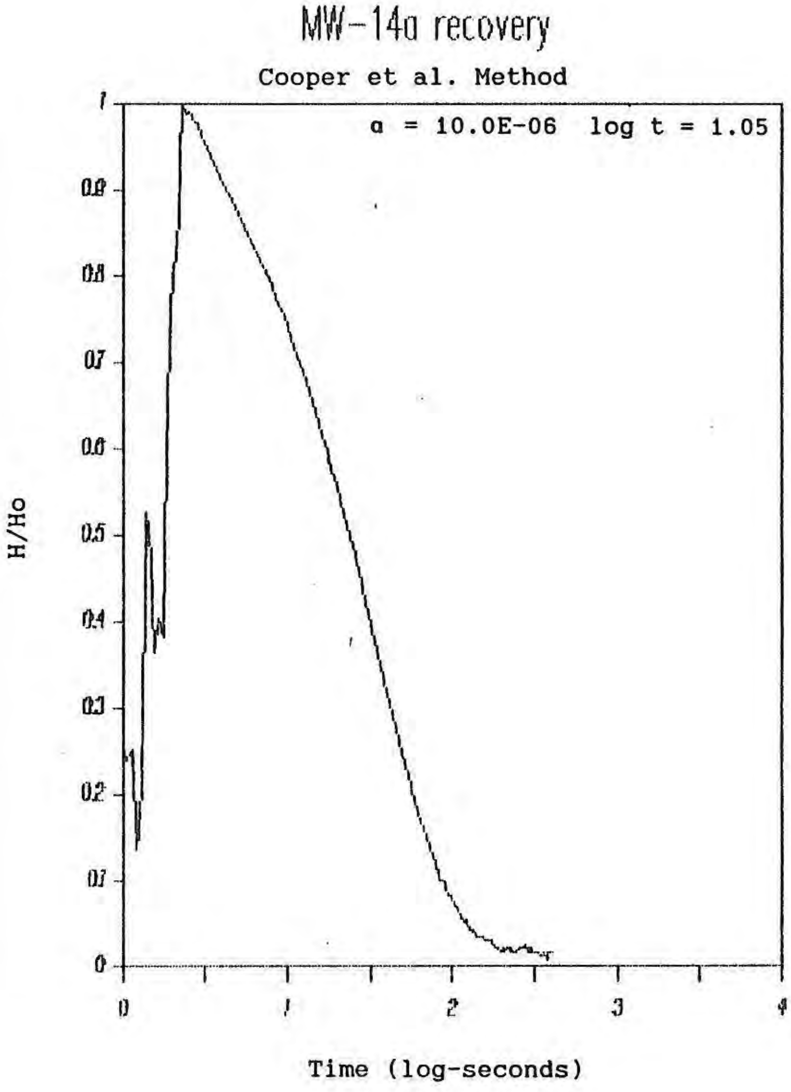
MW-13b recovery

Cooper et al. Method



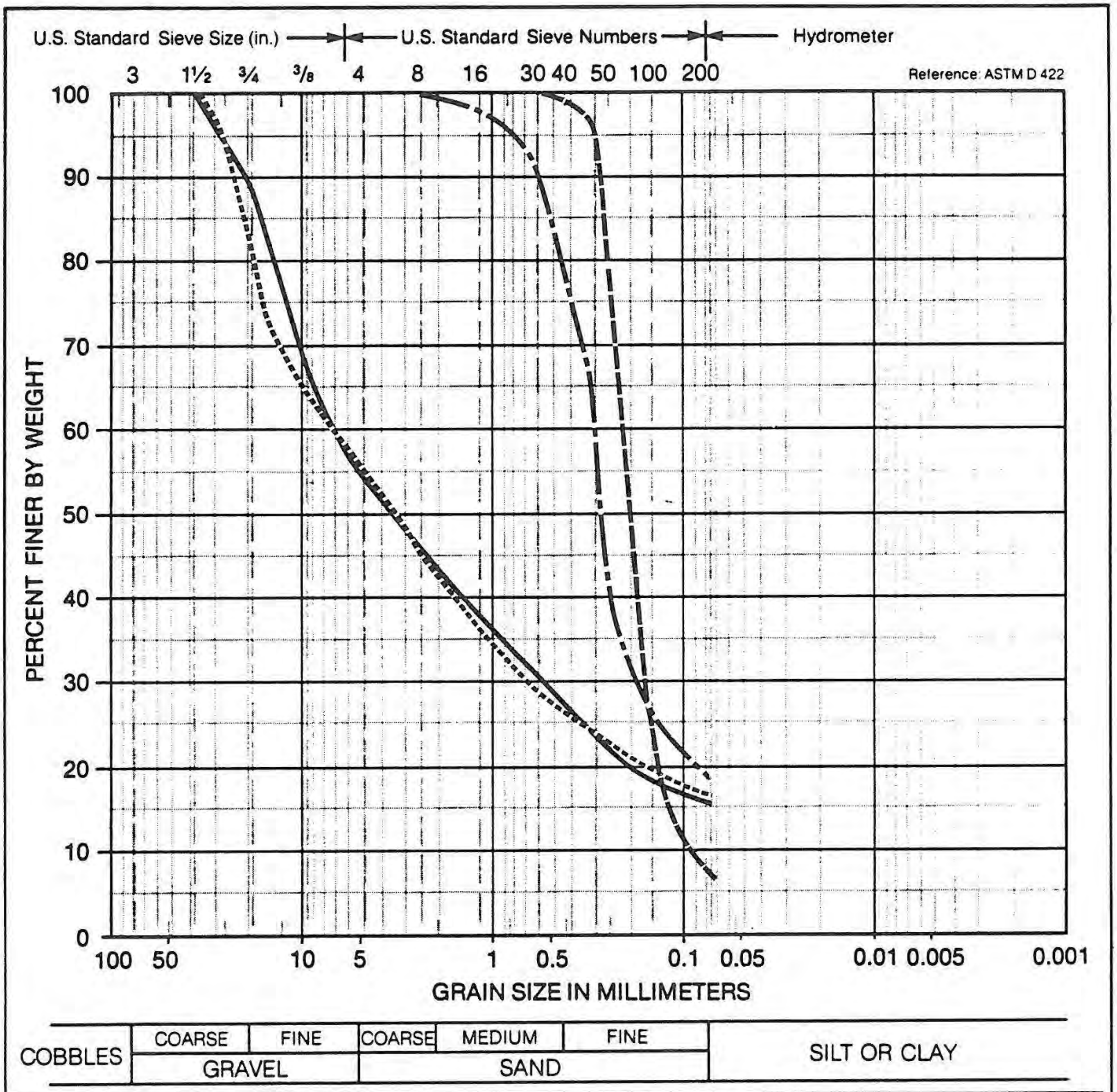
MW-14a injection

Cooper et al. Method



MW-14a recovery

Cooper et al. Method



Symbol	Sample Source	Classification
———	MW-14 at 50.0 feet	Silty sandy gravel (GM)
▪▪▪▪▪▪▪▪	MW-14 at 110.0 feet	Silty sandy gravel (GM)
— — —	MW-14 at 150.5 feet	Fine sand (SP) some silt
— · —	MW-14 at 181.0 feet	Silty sand (SM)

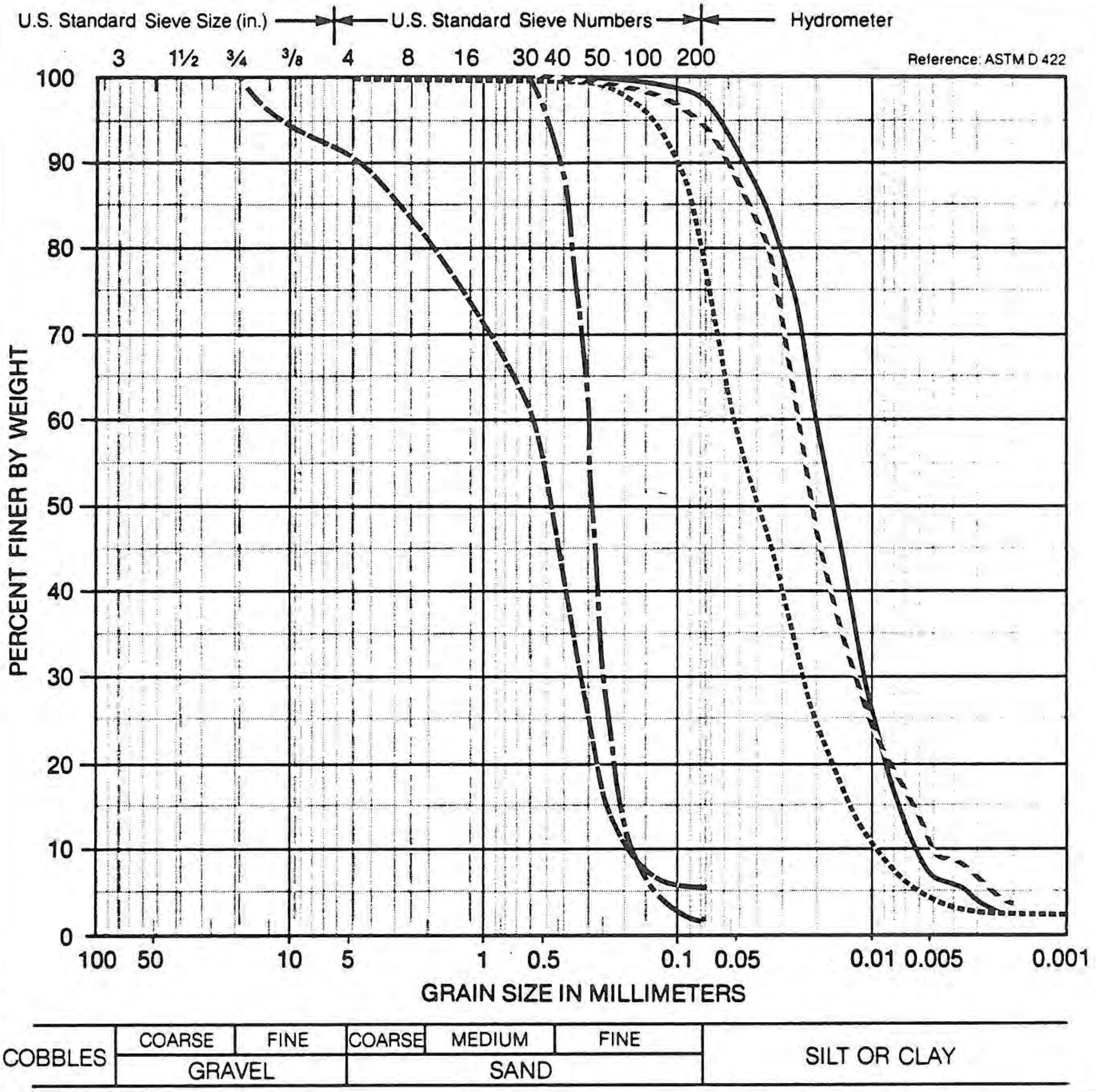
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C14

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-14 at 210.0 feet	Silt (ML) trace sand and clay
┅┅┅	MW-14 at 231.0 feet	Sandy silt (ML) trace clay
— — —	MW-14 at 275.0 feet	Coarse to fine sand (SP) some gravel, trace silt
—·—	MW-14 at 305.0 feet	Fine sand (SP) trace silt
- - - -	MW-14 at 315.0 feet	Silt (ML) trace sand

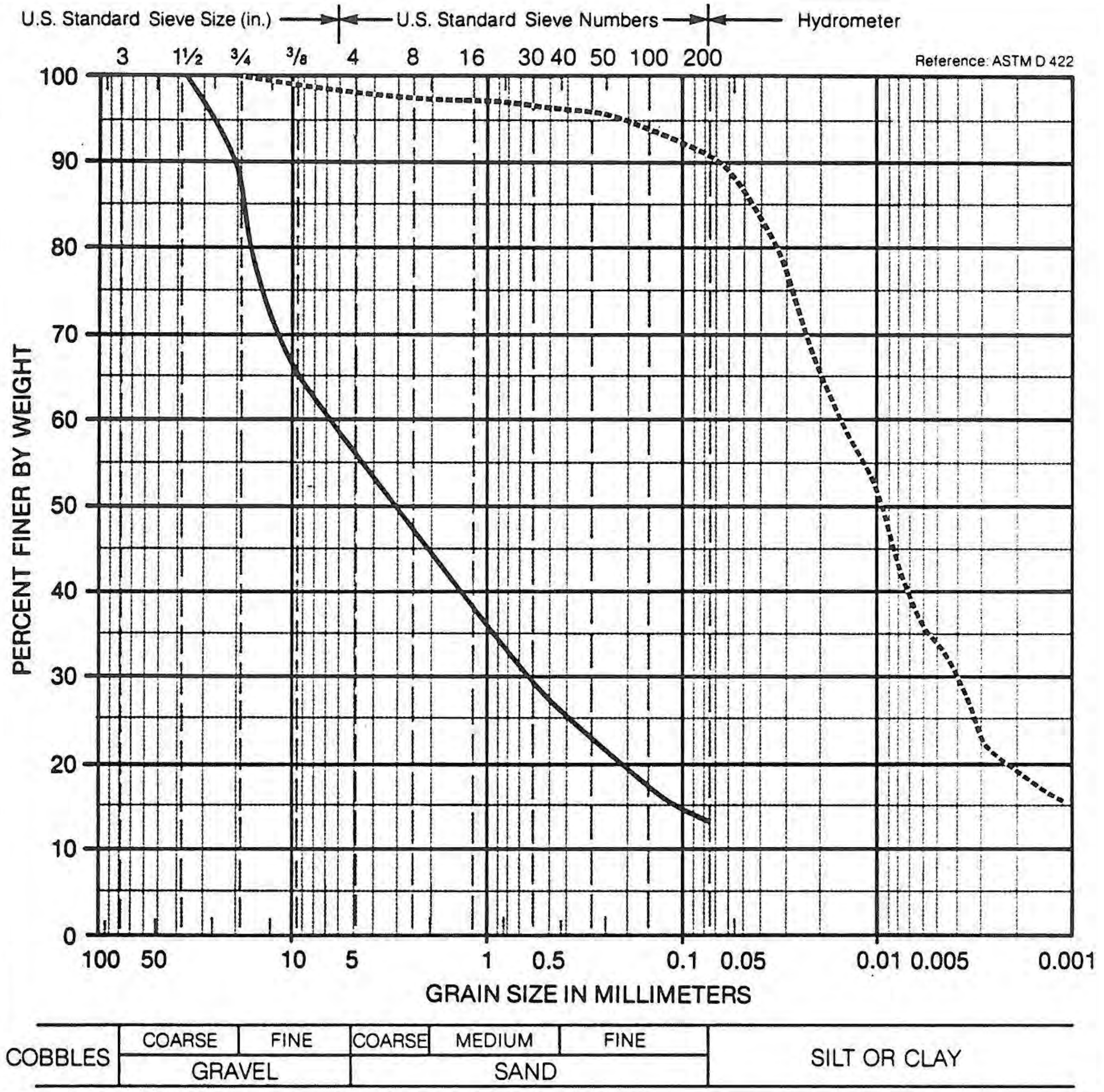
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C15

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
WJ	14,169.102	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-15 at 90.0 feet	Silty sandy gravel (GM)
--------	MW-15 at 176.0 feet	Clayey silt (ML) some sand, trace gravel

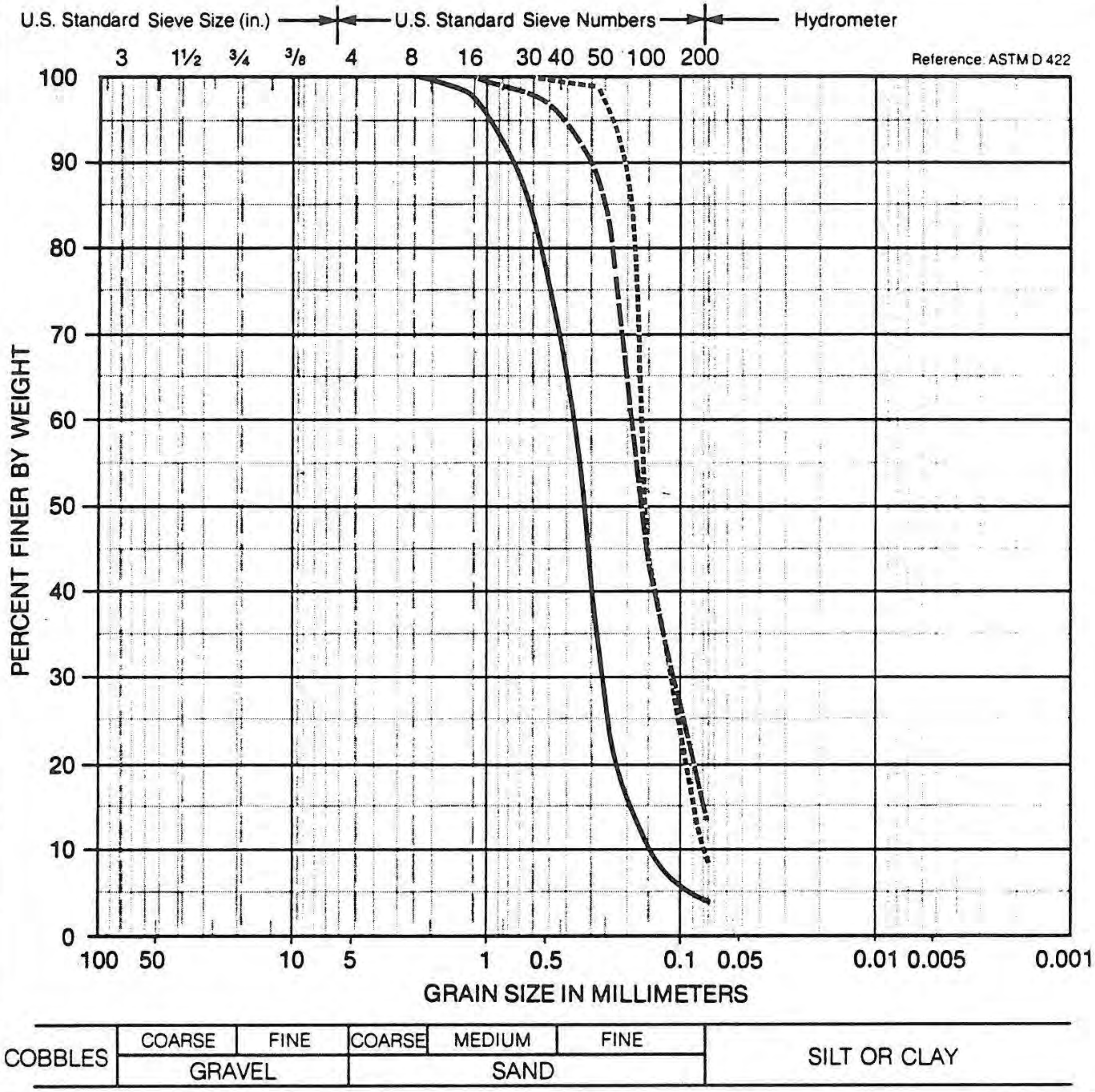
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C16

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-15 at 200.0 feet	Fine to medium sand (SP) trace silt
········	MW-15 at 231.0 feet	Fine sand (SP) some silt
— — —	MW-15 at 289.0 feet	Silty sand (SM)

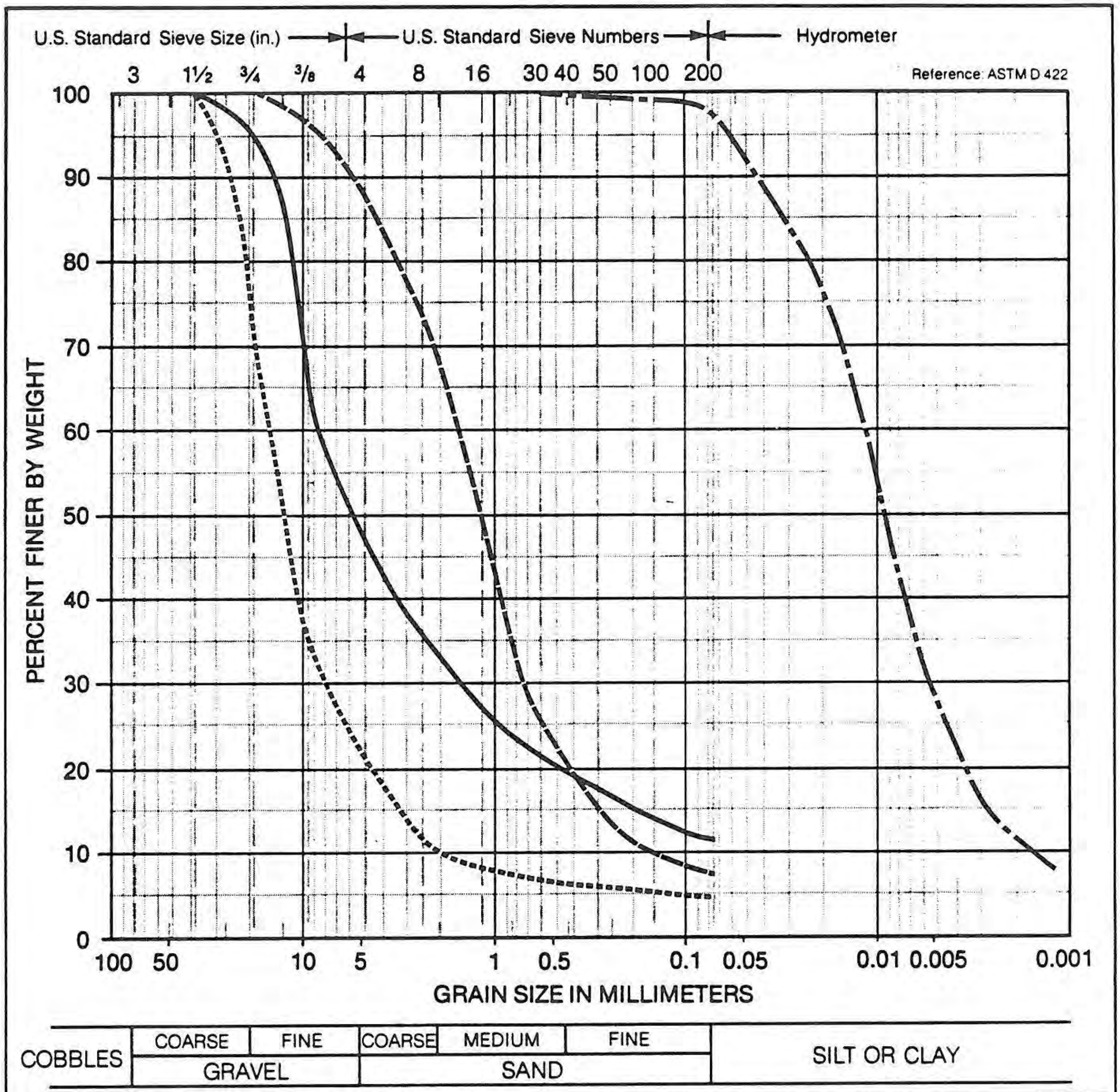
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C17

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
——	MW-16 at 85.0 feet	Sandy gravel (GM) some silt
- - - - -	MW-16 at 135.0 feet	Sandy gravel (GW) trace silt
— — —	MW-16 at 155.0 feet	Fine to coarse sand (SP) some gravel and silt
— - —	MW-16 at 188.5 feet	Silt (ML) some clay, trace sand

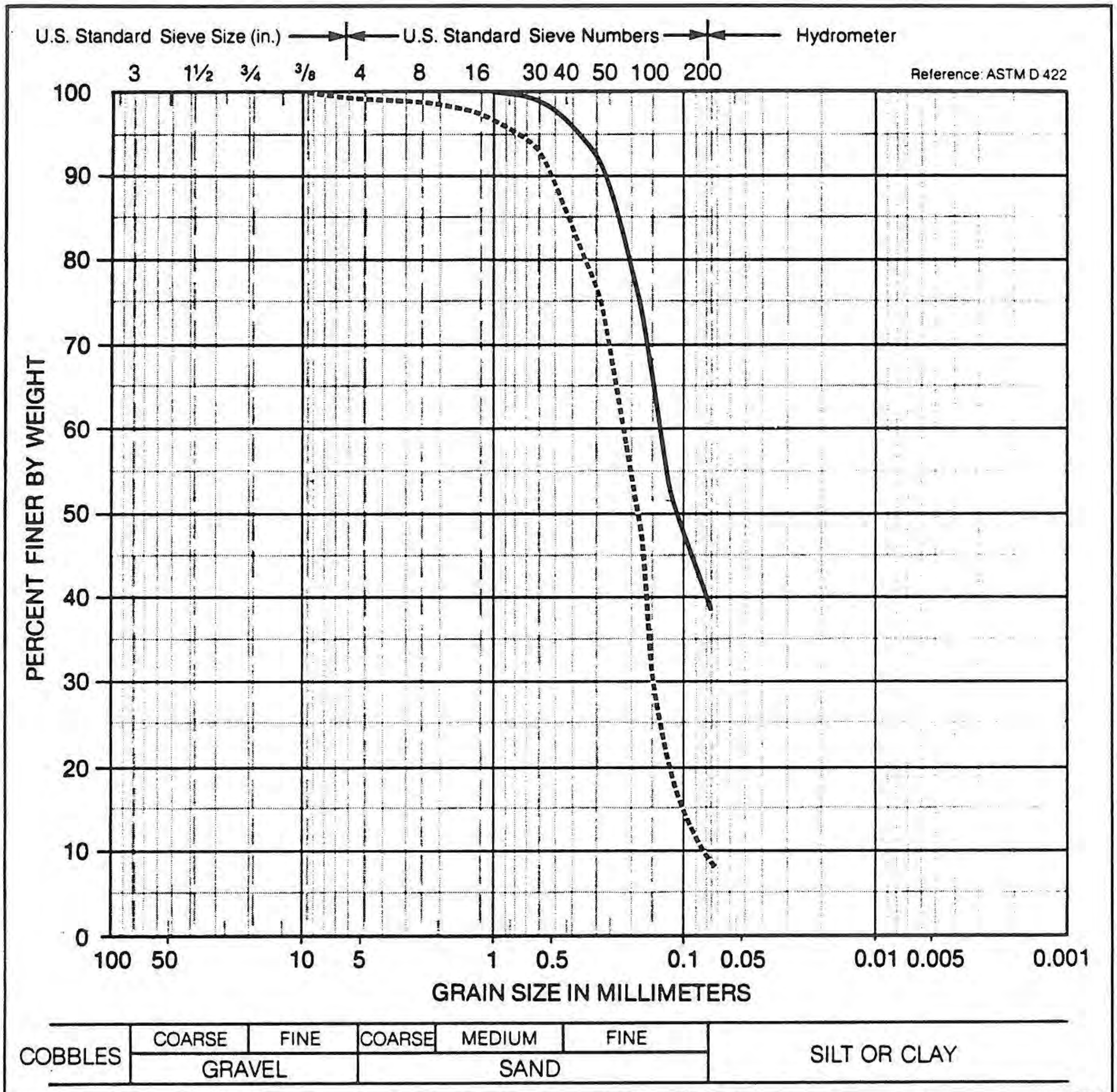
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C18

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
—	MW-17 at 119.0 feet	Silty sand (SM)
┅	MW-17 at 125.0 feet	Fine to medium sand (SP) some silt

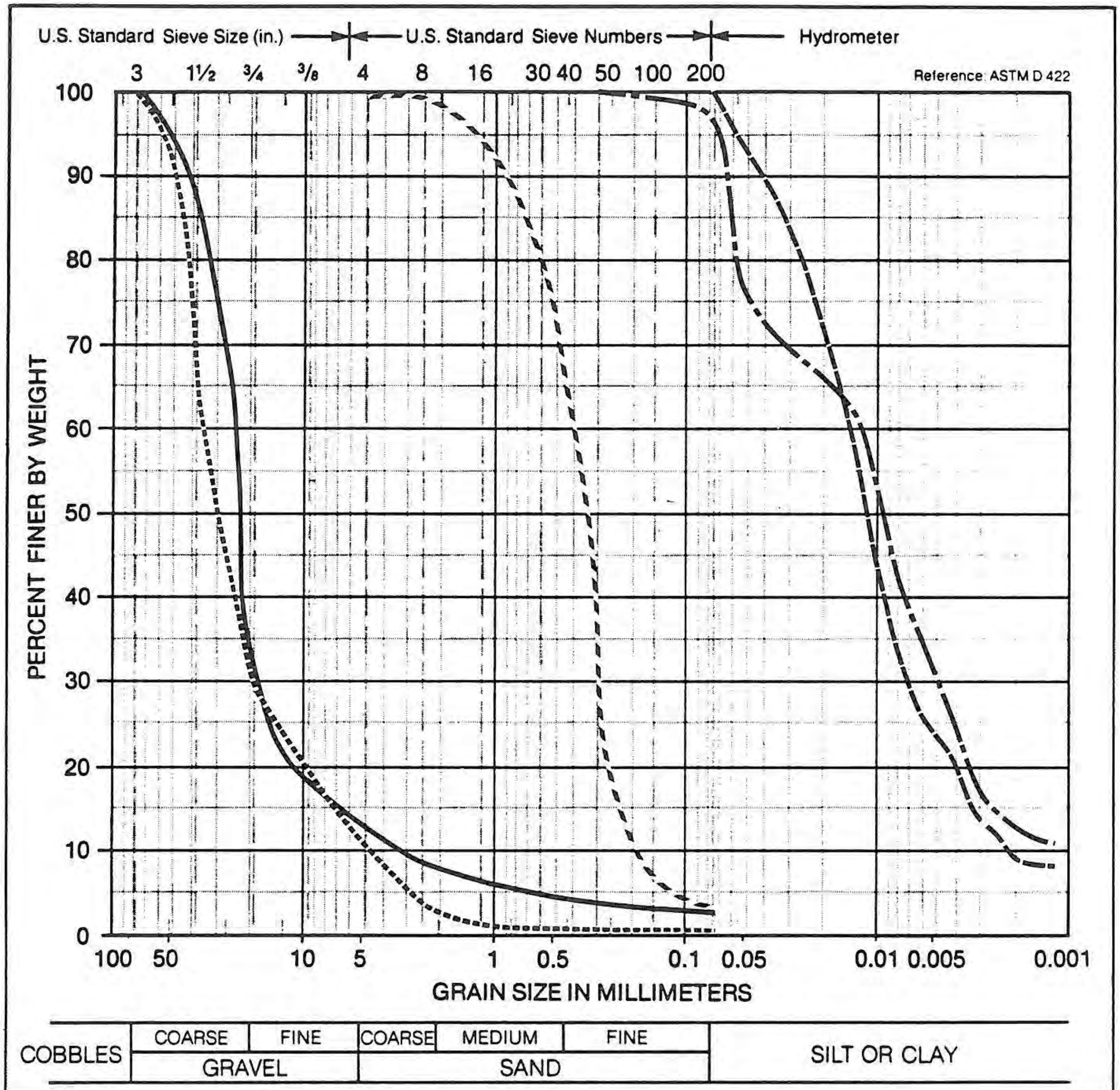
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C19

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
WJ	14,169.102	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-18 at 60.0 feet	Fine to coarse gravel (GP) some sand, trace silt
········	MW-18 at 76.0 feet	Fine to coarse gravel (GW) some sand
———·	MW-18 at 90.5 feet	Silt (ML) some clay
—·—	MW-18 at 102.5 feet	Silt (ML) some clay, trace sand
- - - -	MW-18 at 121.0 feet	Fine to medium sand (SP) trace silt

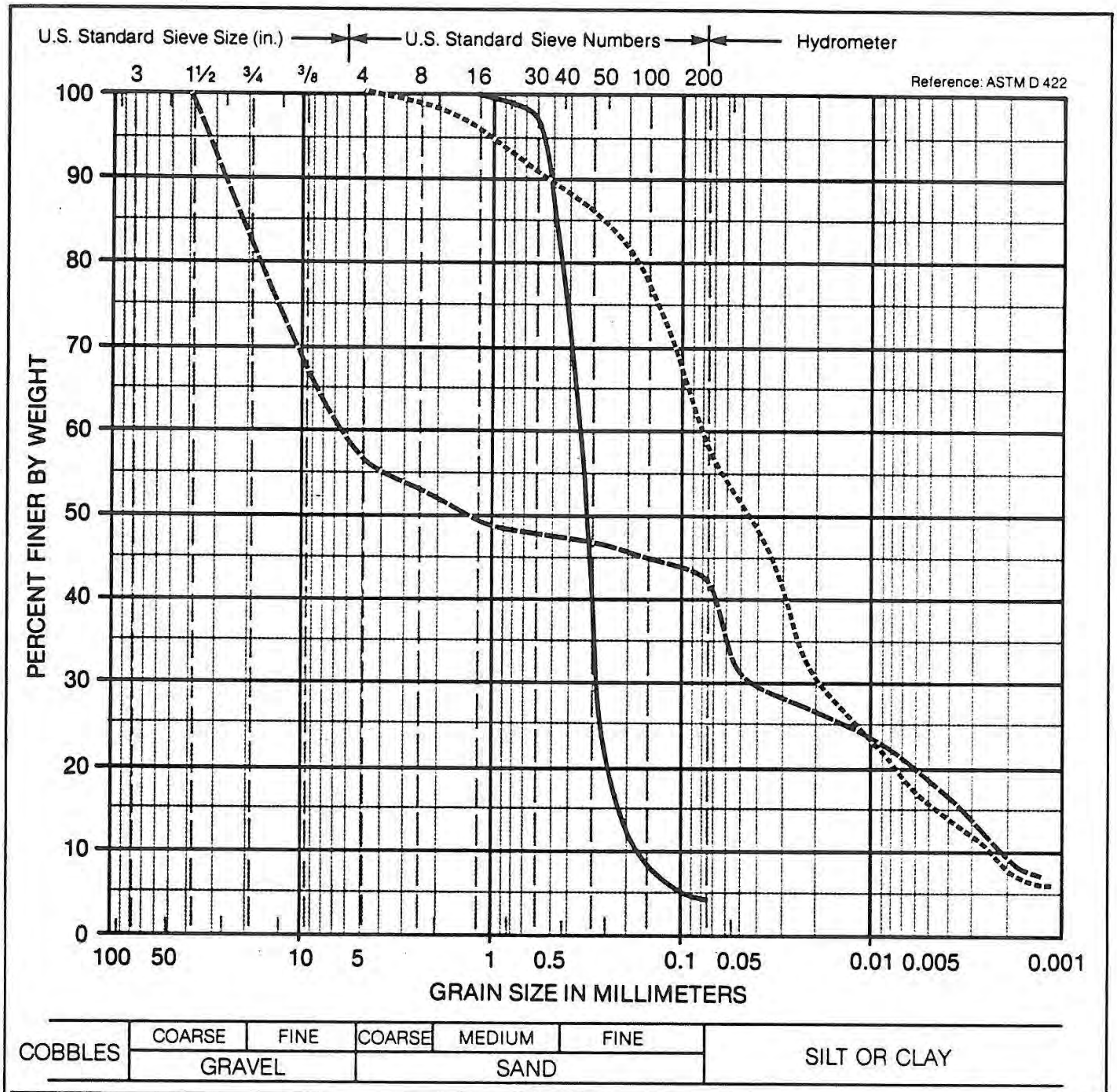
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C20

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-18 at 151.0 feet	Fine to medium sand (SP) trace silt
▪▪▪▪▪▪▪▪	MW-18 at 265.5 feet	Sandy silt (ML) some clay
— — —	MW-18 at 298.0 feet	Sandy silty gravel (GM) some clay

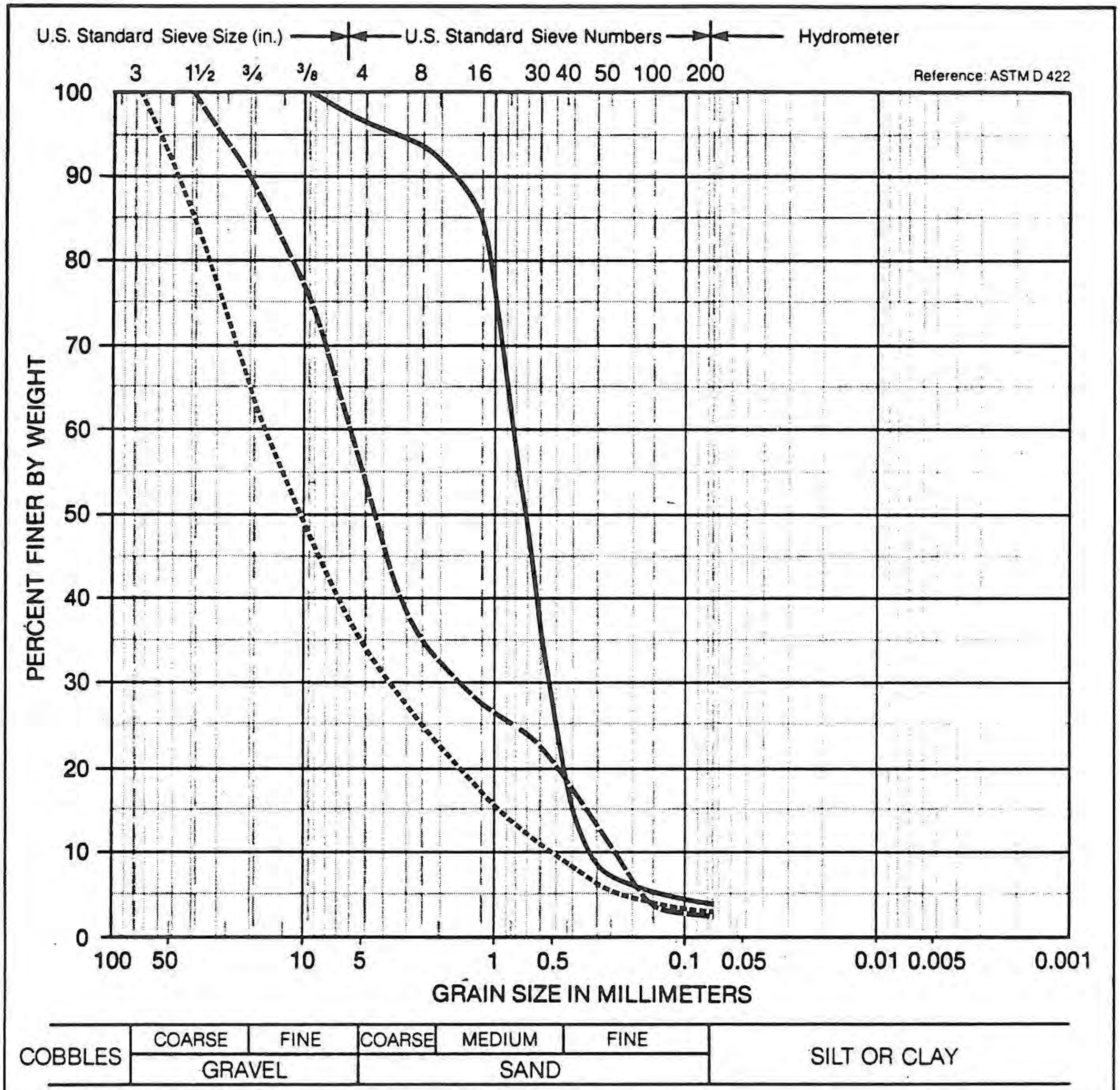
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C21

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
━━━	MW-18 at 175.5 feet	Fine to medium sand (SP) trace silt and gravel
┅┅┅	MW-18 at 277.0 feet	Sandy gravel (GW) trace silt
╍╍╍	MW-18 at 284.0 feet	Gravelly sand (SW) trace silt

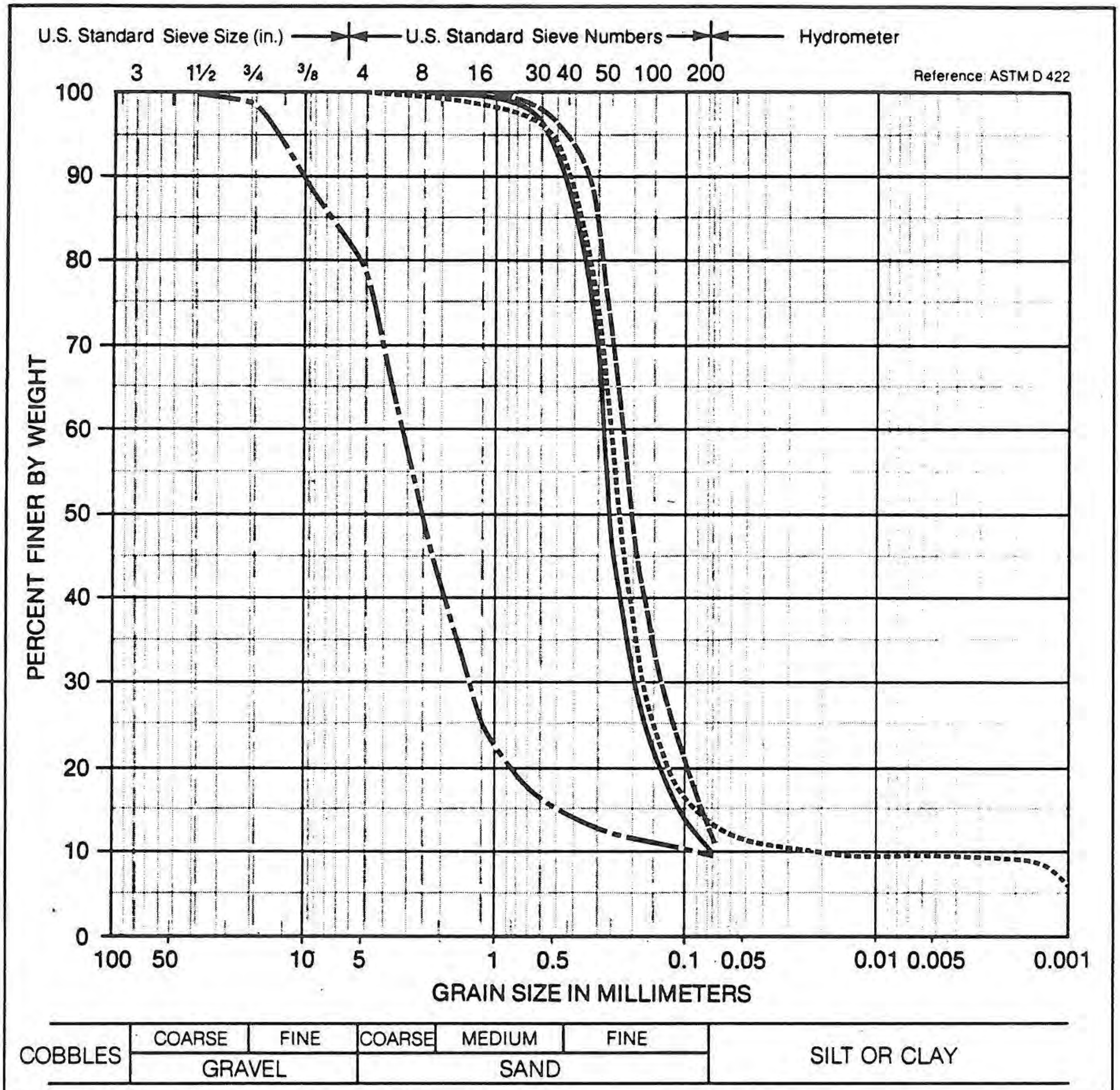
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C22

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14.169.102	MAA	October 15, 1987		



Symbol	Sample Source	Classification
━━━	MW-19 at 69.0 feet	Fine sand (SM) some silt
┅┅┅	MW-19 at 76.0 feet	Fine sand (SM) some clay, trace silt
— — —	MW-19 at 82.4 feet	Fine sand (SM) some silt
▬ - -	MW-19 at 125 feet	Gravelly sand (SM) some silt

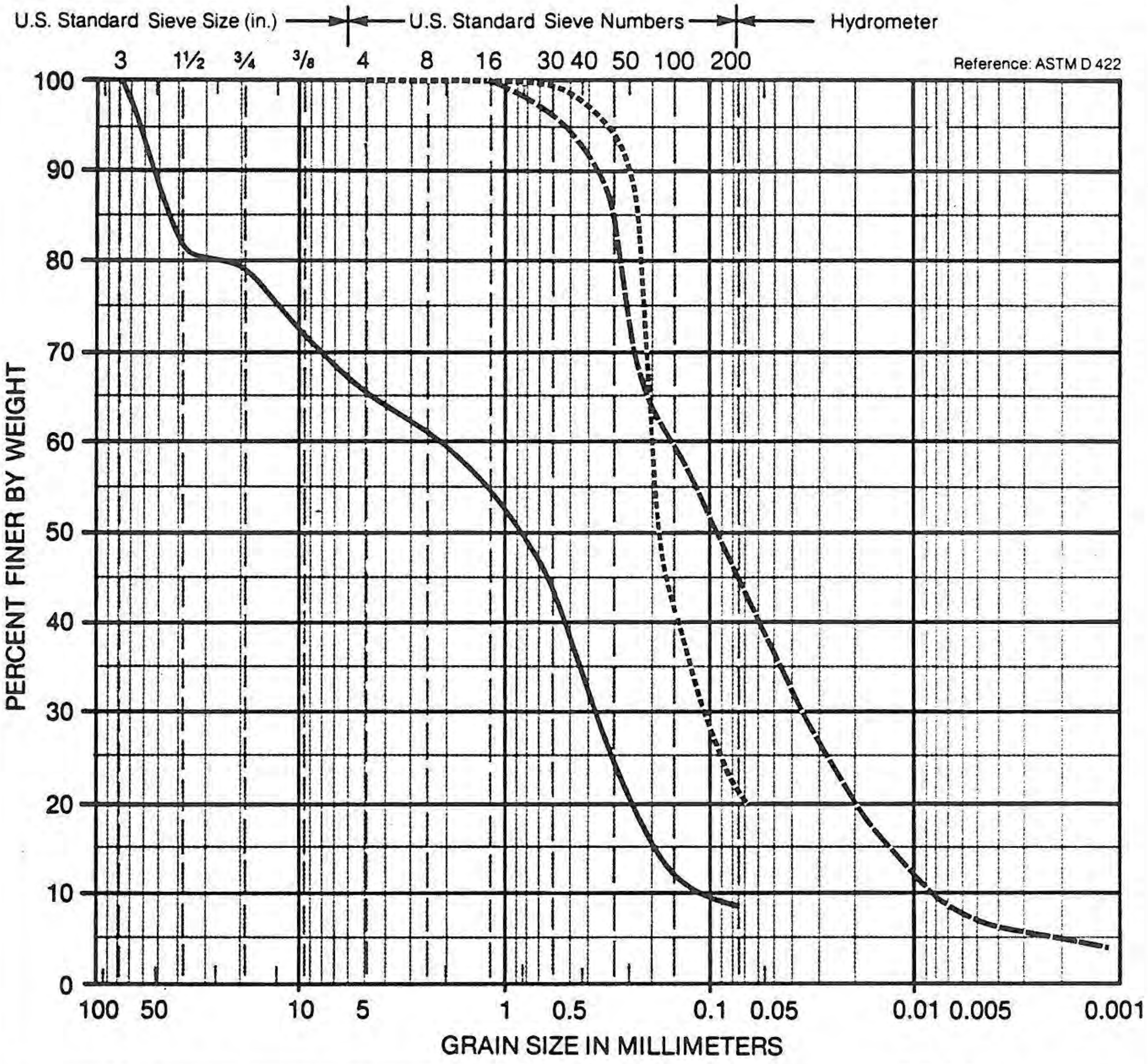
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C23

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AM	14,169.102	MAA	October 15, 1987		



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
——	MW-19 at 150.0 feet	Gravelly sand (SM) some silt
▪▪▪▪	MW-19 at 180.0 feet	Silty fine sand (SM)
— —	MW-19 at 230.0 feet	Silty sand (SM) trace clay

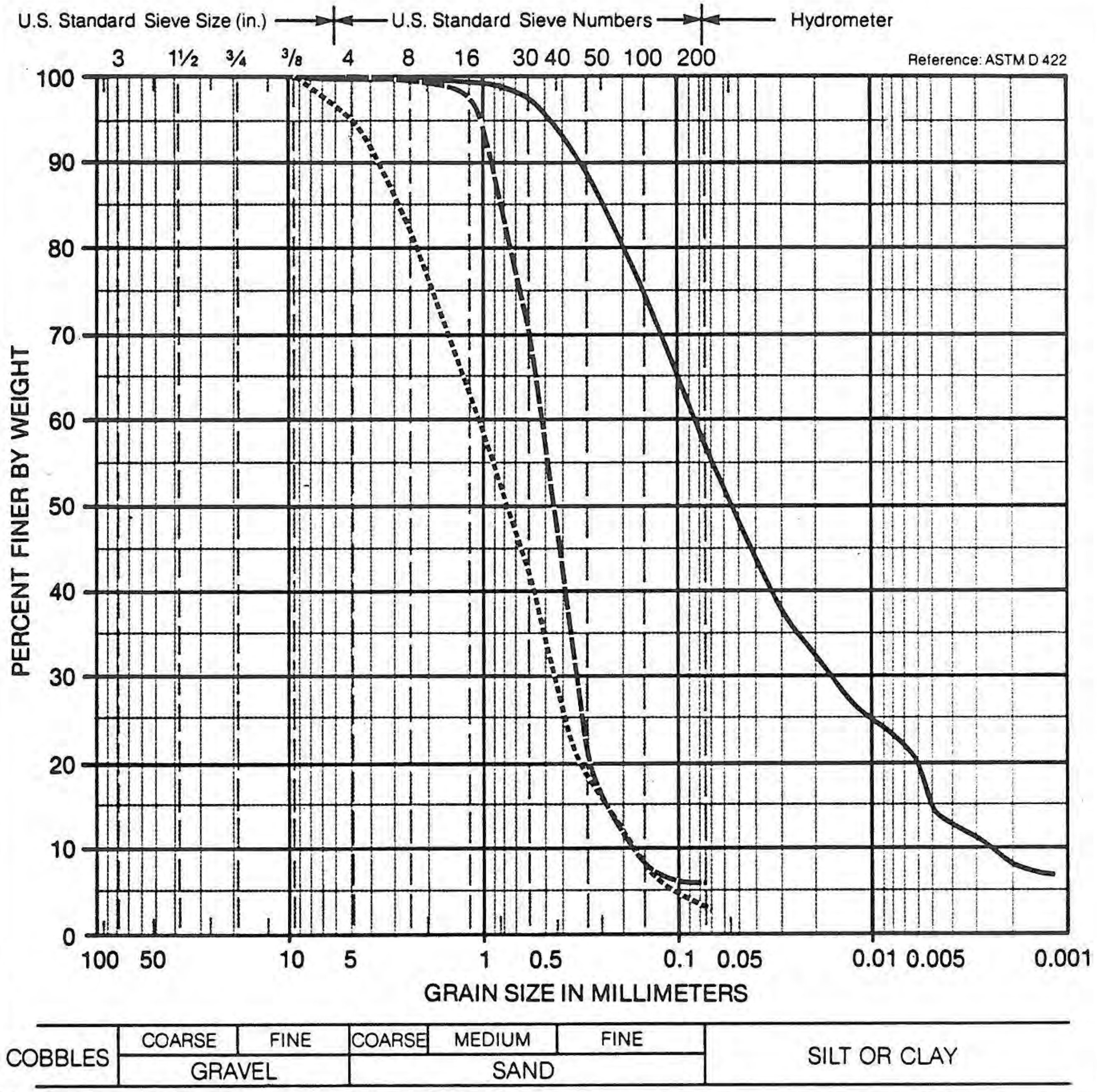
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C24

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
——	MW-19 at 251.0 feet	Sandy silt (ML) some clay
·······	MW-19 at 195.0 feet	Fine to coarse sand (SP) trace silt and gravel
— — —	MW-19 at 305.0 feet	Fine to medium sand (SP) some silt

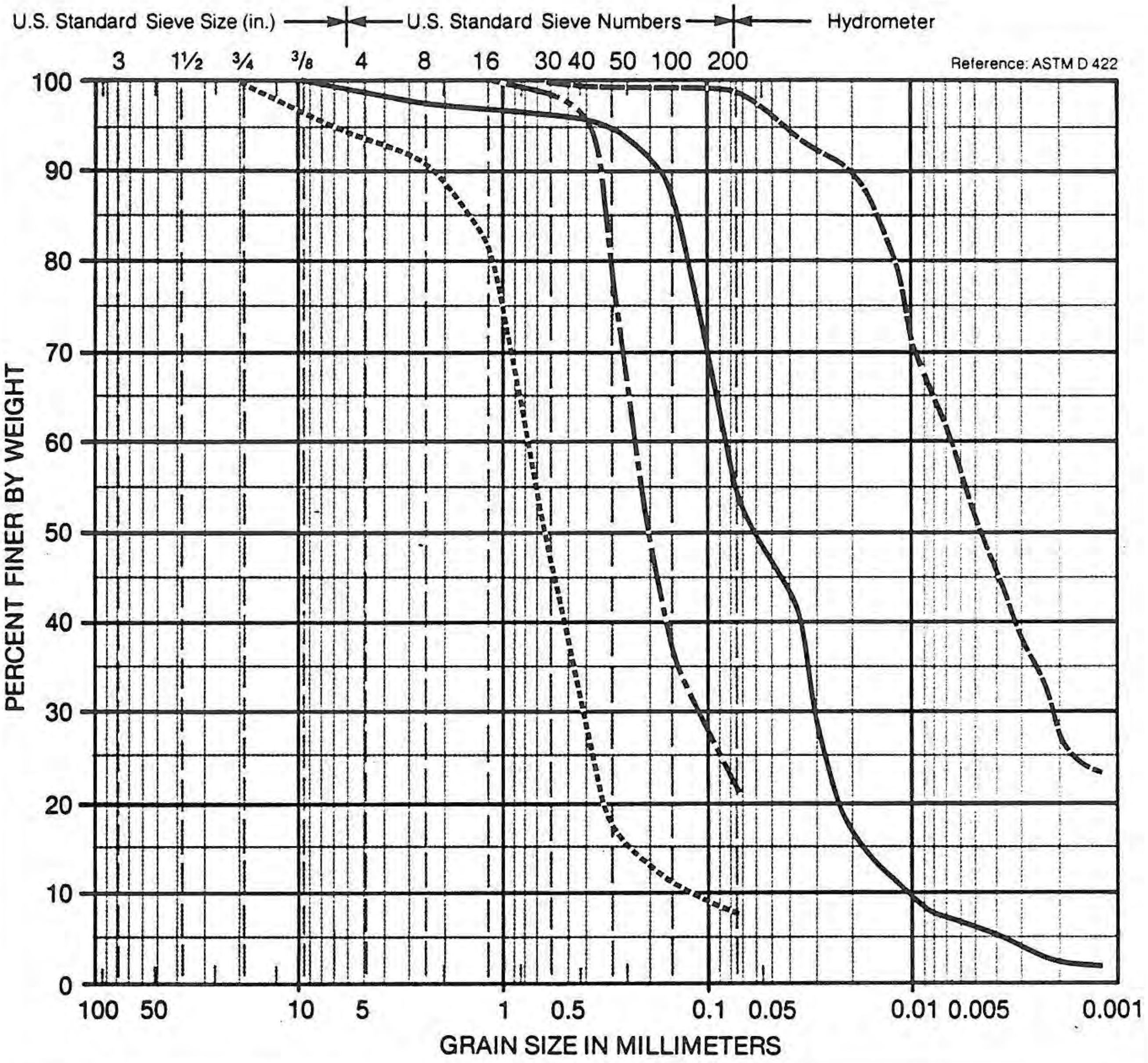
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C25

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT OR CLAY
	GRAVEL		SAND			

Symbol	Sample Source	Classification
———	MW-20 at 94.0 feet	Sandy silt (ML) trace gravel and clay
▪▪▪▪▪▪▪▪	MW-20 at 115.0 feet	Fine to coarse sand (SW) some silt and gravel
— — —	MW-20 at 135.0 feet	Clayey silt (ML)
—·—	MW-20 at 190.0 feet	Silty fine sand (SM)

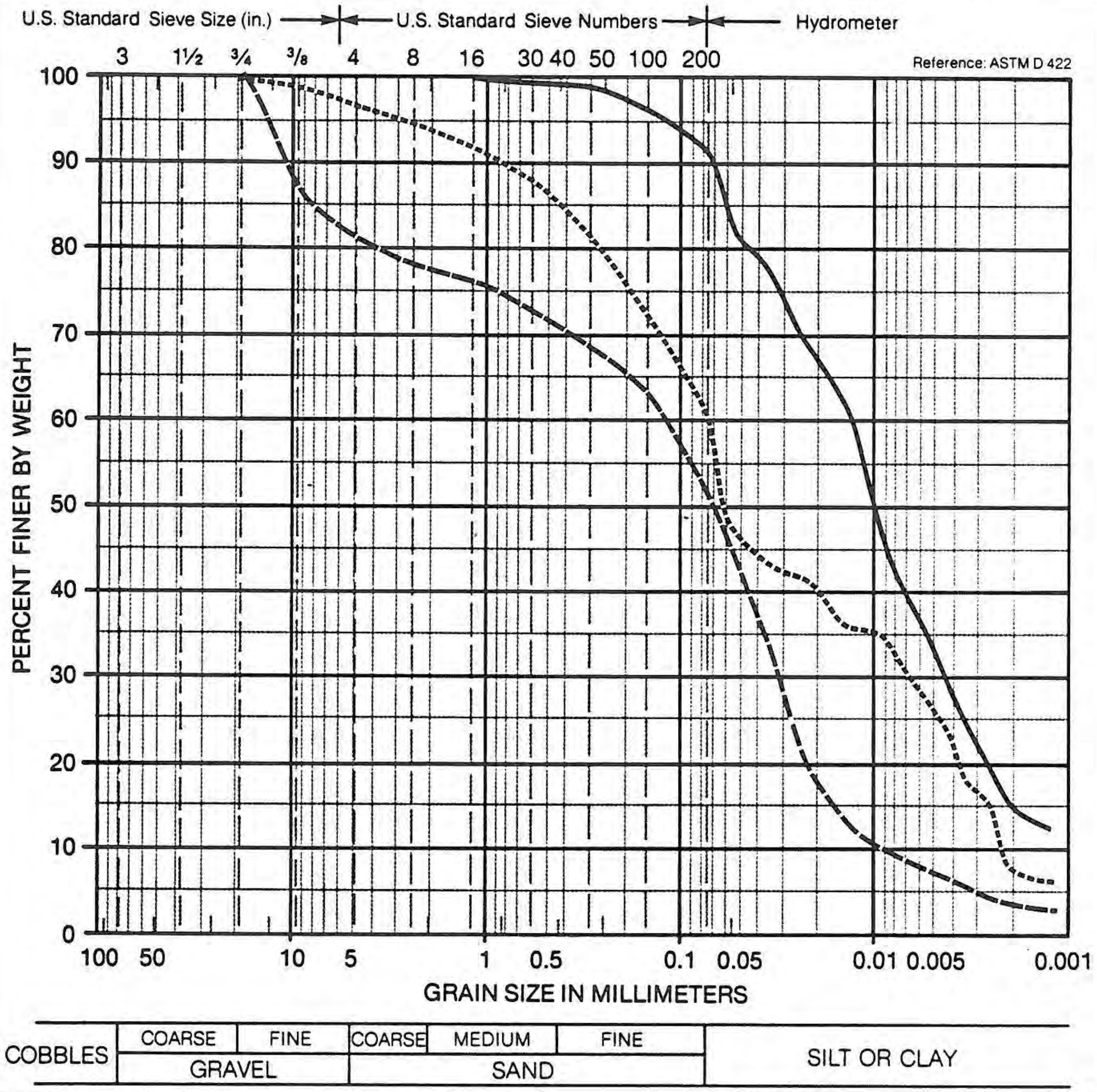
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C26

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
───	MW-20 at 211.0 feet	Clayey silt (ML) some sand
┄┄┄	MW-20 at 226.0 feet	Sandy silt (ML) some clay, trace gravel
— —	MW-20 at 236.0 feet	Gravelly sandy silt (ML) trace clay

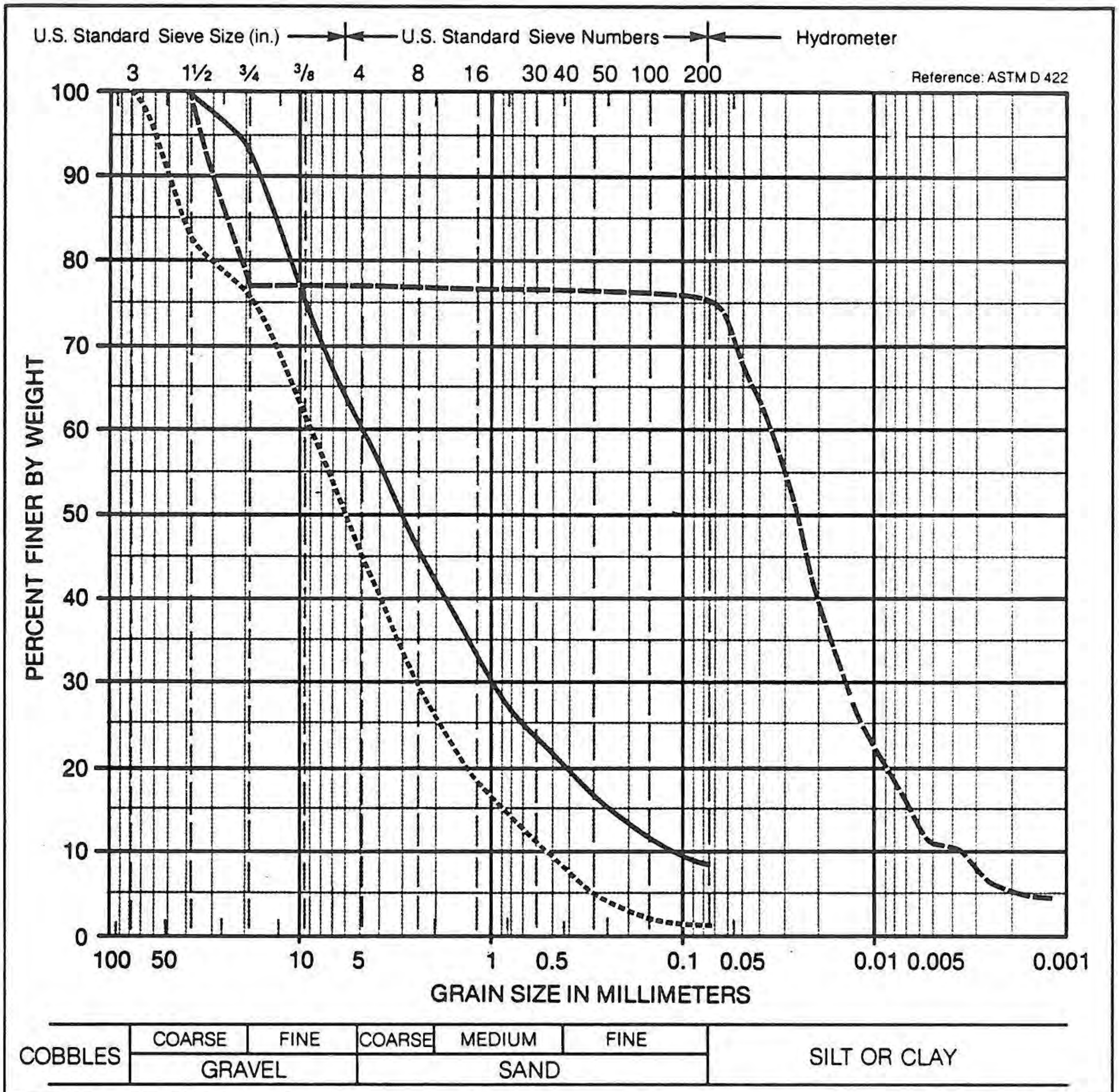
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C27

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
――	MW-20 at 281.0 feet	Gravelly sand (SP) some silt
┅┅	MW-20 at 301.0 feet	Sandy gravel (GW) trace silt
– –	MW-20 at 320.0 feet	Gravelly silt (ML) trace sand and clay

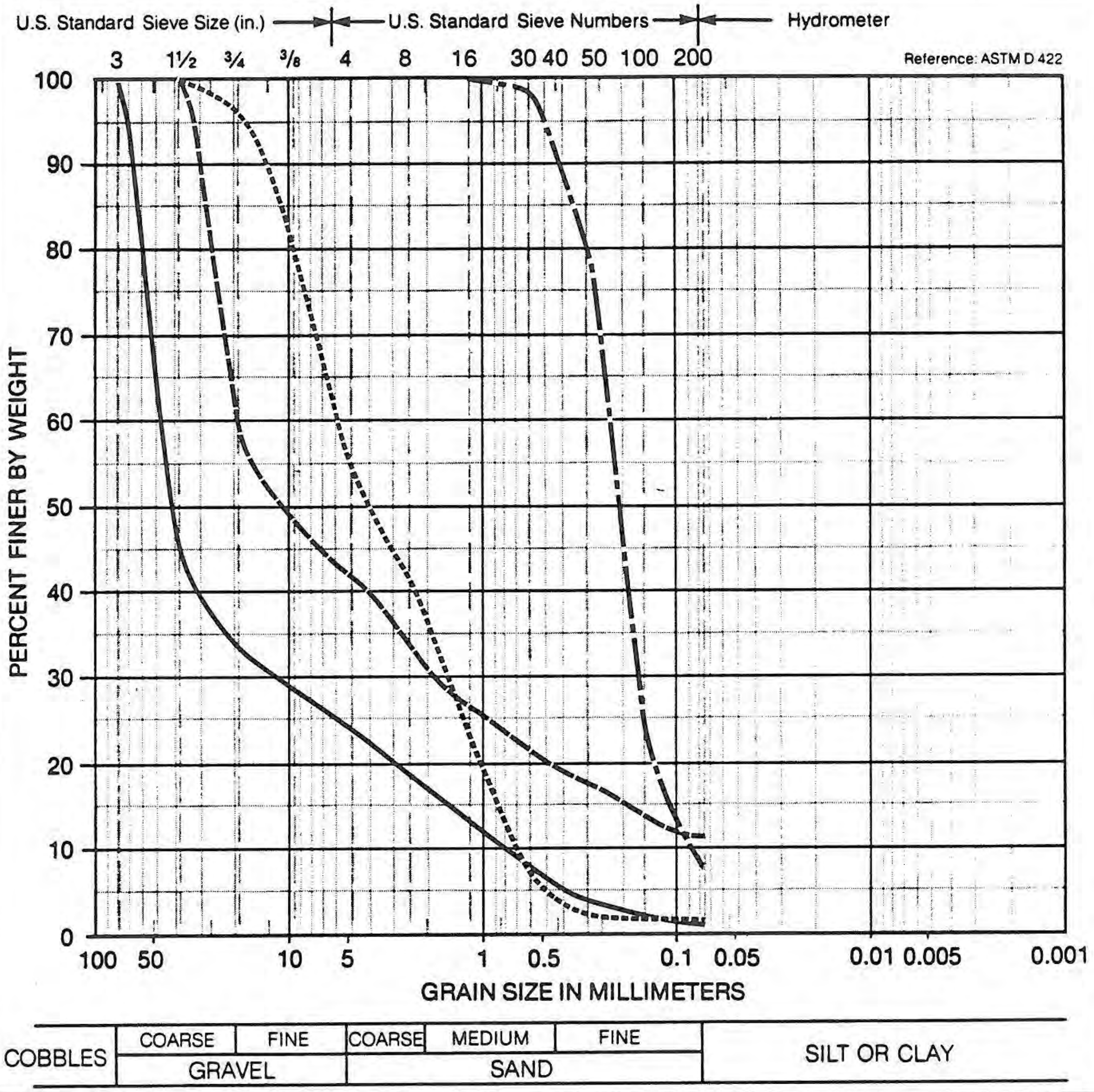
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C28

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
——	MW-21 at 41.5 feet	Sandy gravel (GW)
••••••••	MW-21 at 89.0 feet	Gravelly sand (SP) trace silt
— — —	MW-21 at 137.0 feet	Sandy gravel (GM) some silt
—·—	MW-21 at 177.5 feet	Fine sand (SP) some silt

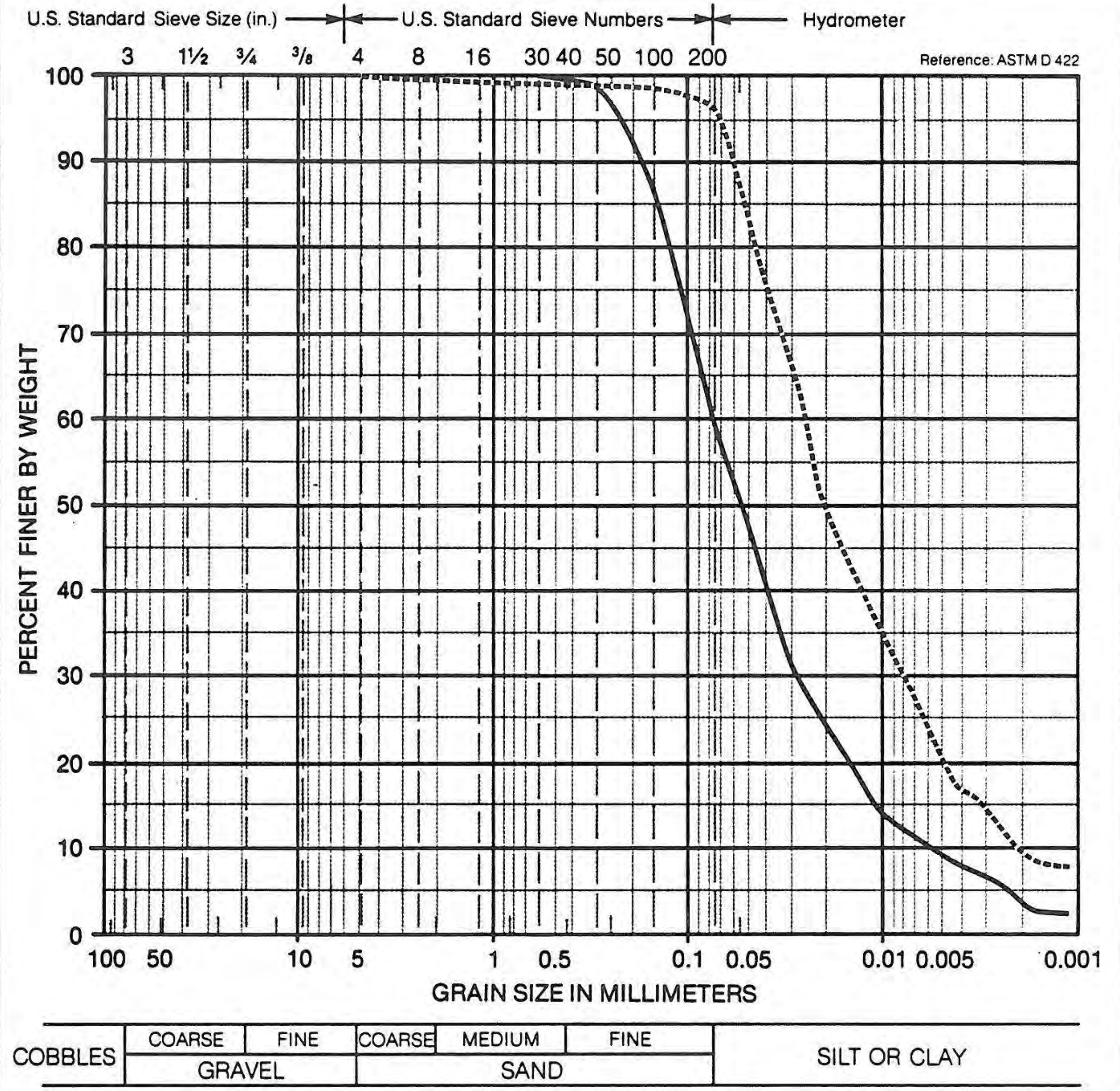
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C29

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
WJ	14,169.102	MAA	10 October 87		



Symbol	Sample Source	Classification
——	MW-21 at 205.5 feet	Sandy silt (ML) trace clay
- - - -	MW-21 at 270.0 feet	Silt (ML) some clay, trace sand

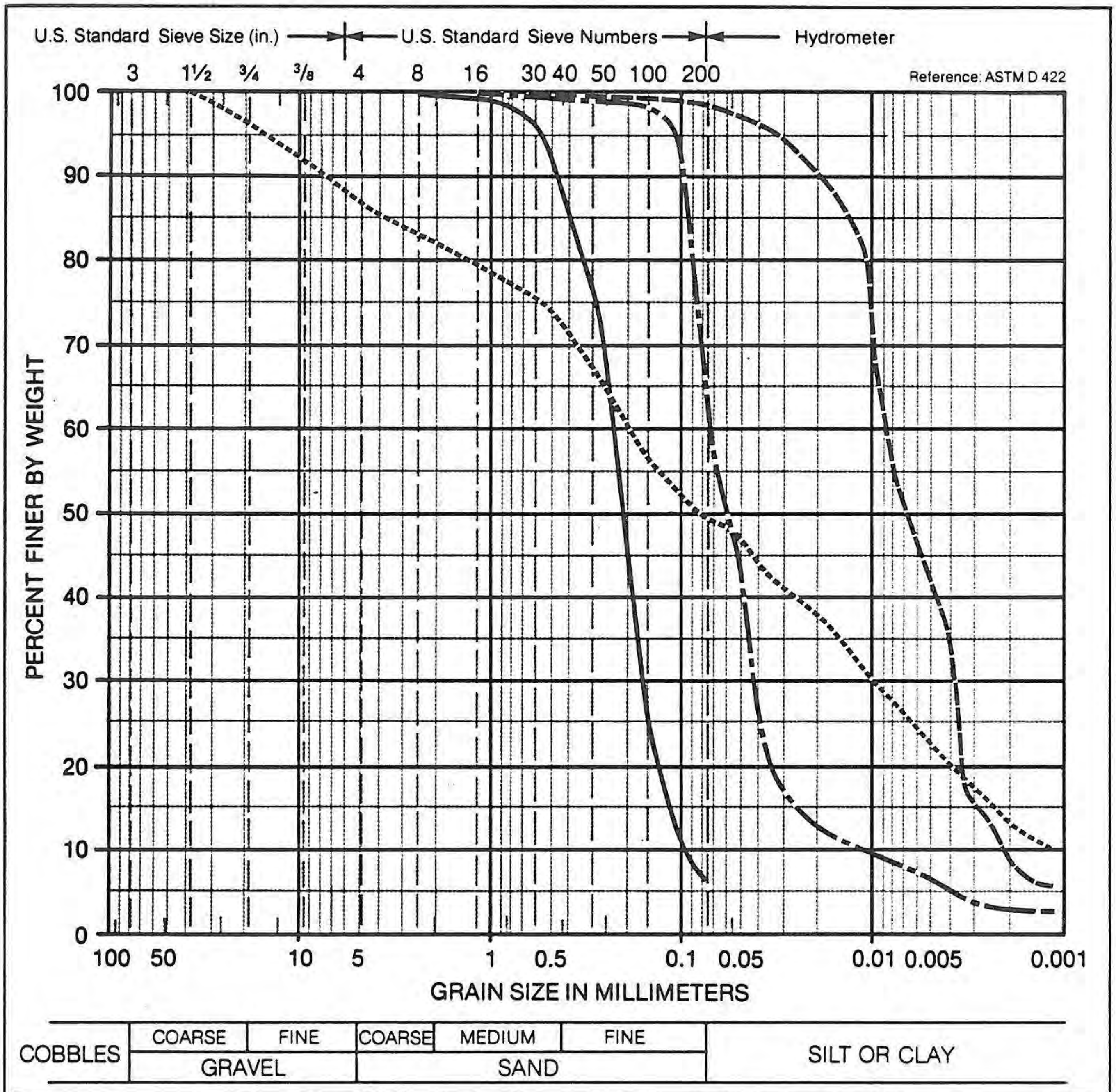
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C30

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-22 at 105.0 feet	Fine sand (SP) some silt
--------	MW-22 at 121.0 feet	Gravelly silty sand (SM) some clay
— — —	MW-22 at 165.5 feet	Silt (ML) some clay, trace sand
— - —	MW-22 at 195.5 feet	Sandy silt (ML) trace clay

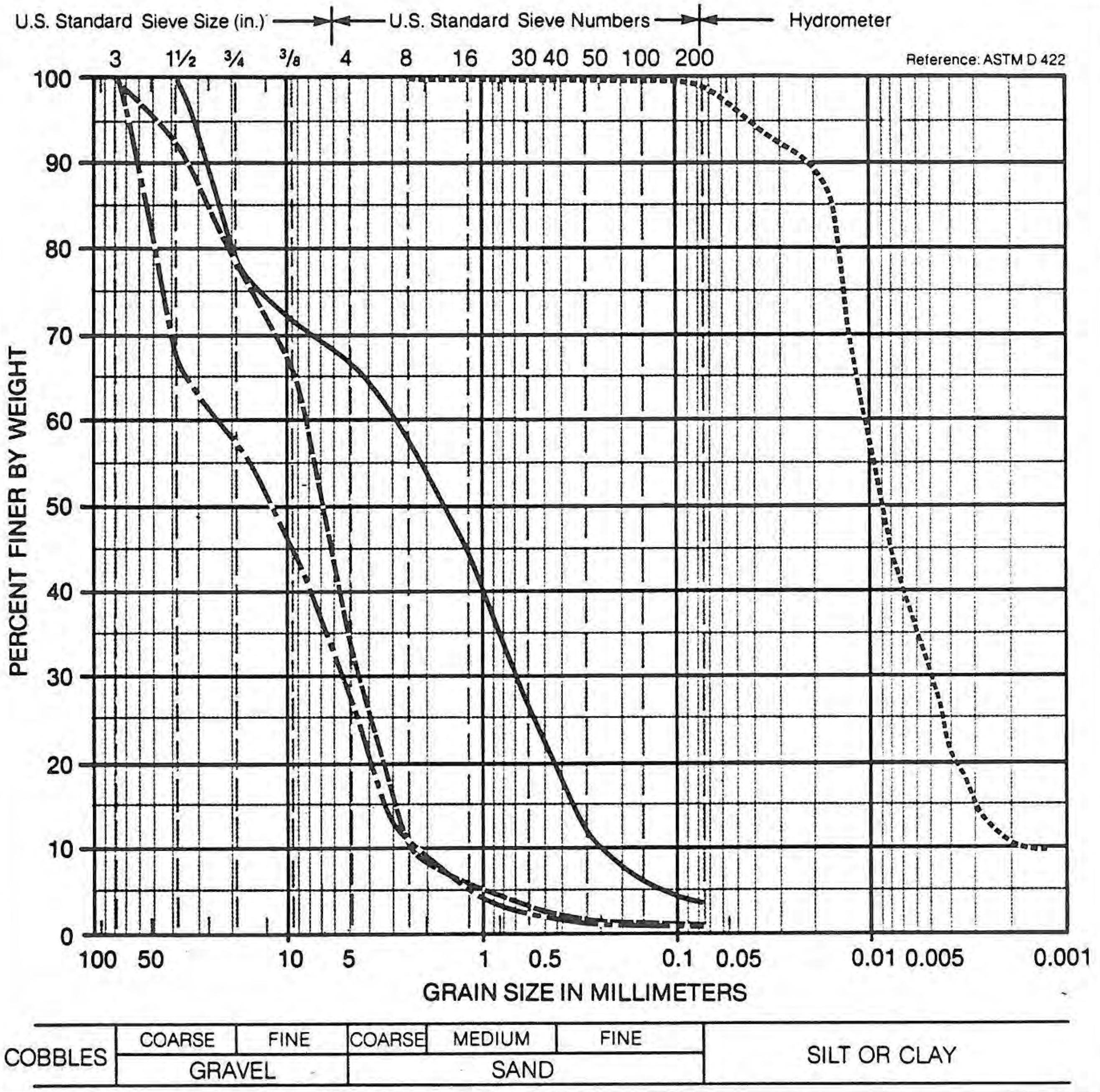
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C31

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-22 at 270.0 feet	Gravelly sand (SP) trace silt
▪▪▪▪▪▪▪▪	MW-22 at 284.0 feet	Silt (ML) some clay
— — —	MW-22 at 300.0 feet	Sandy gravel (GP)
—·—·—	MW-22 at 328.0 feet	Sandy gravel (GP)

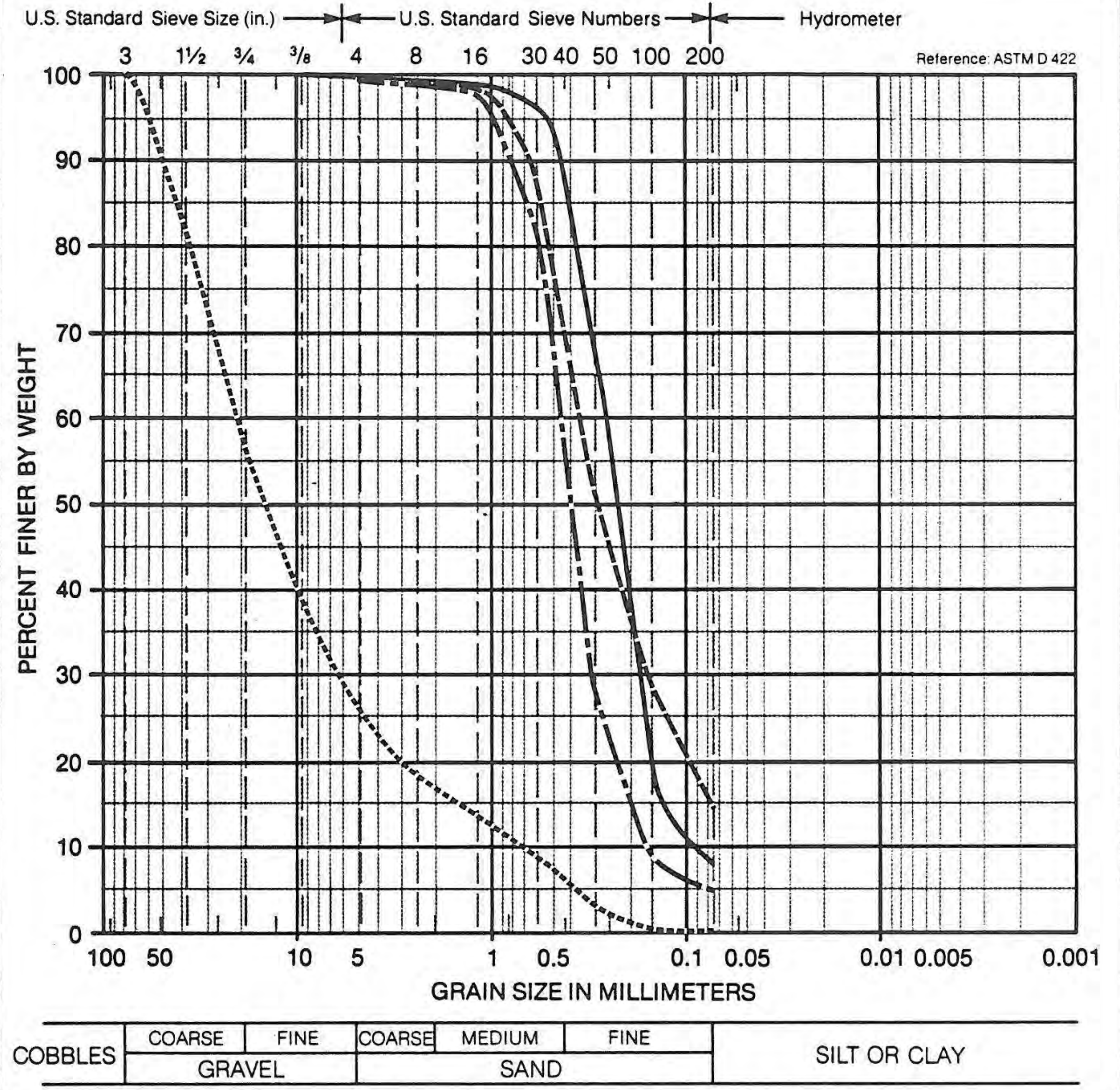
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C32

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
——	MW-23 at 51.0 feet	Fine sand (SP) some silt
········	MW-23 at 70.0 feet	Sandy gravel (GW)
— — —	MW-23 at 210.0 feet	Silty sand (SM)
— - —	MW-23 at 240.0 feet	Fine to medium sand (SP) trace silt

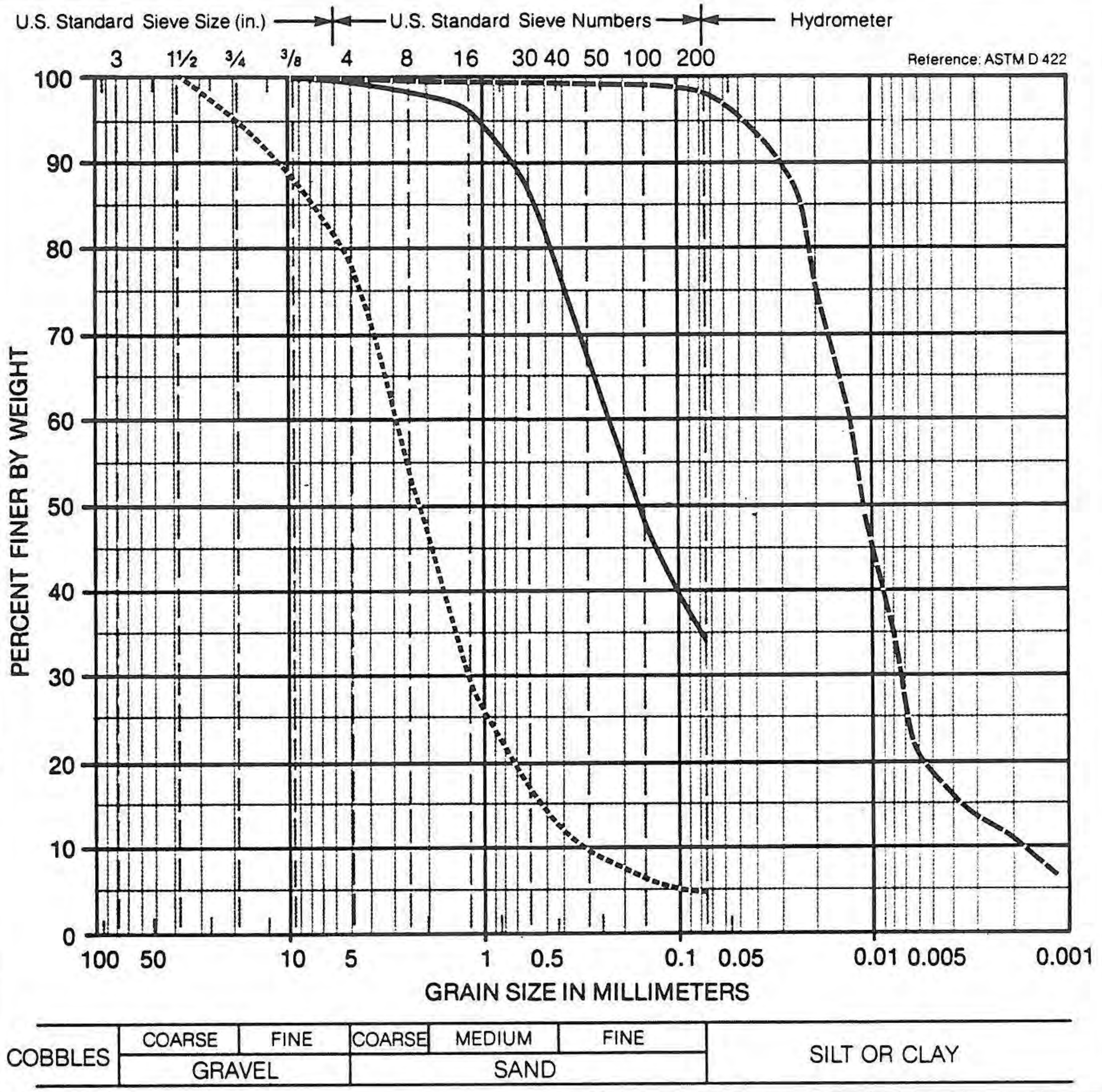
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C33

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-23 at 260.0 feet	Silty sand (SM) trace gravel
▪▪▪▪▪▪▪▪	MW-23 at 310.0 feet	Gravelly sand (SW) trace silt
— — —	MW-23 at 352.0 feet	Silt (ML) some clay, trace sand

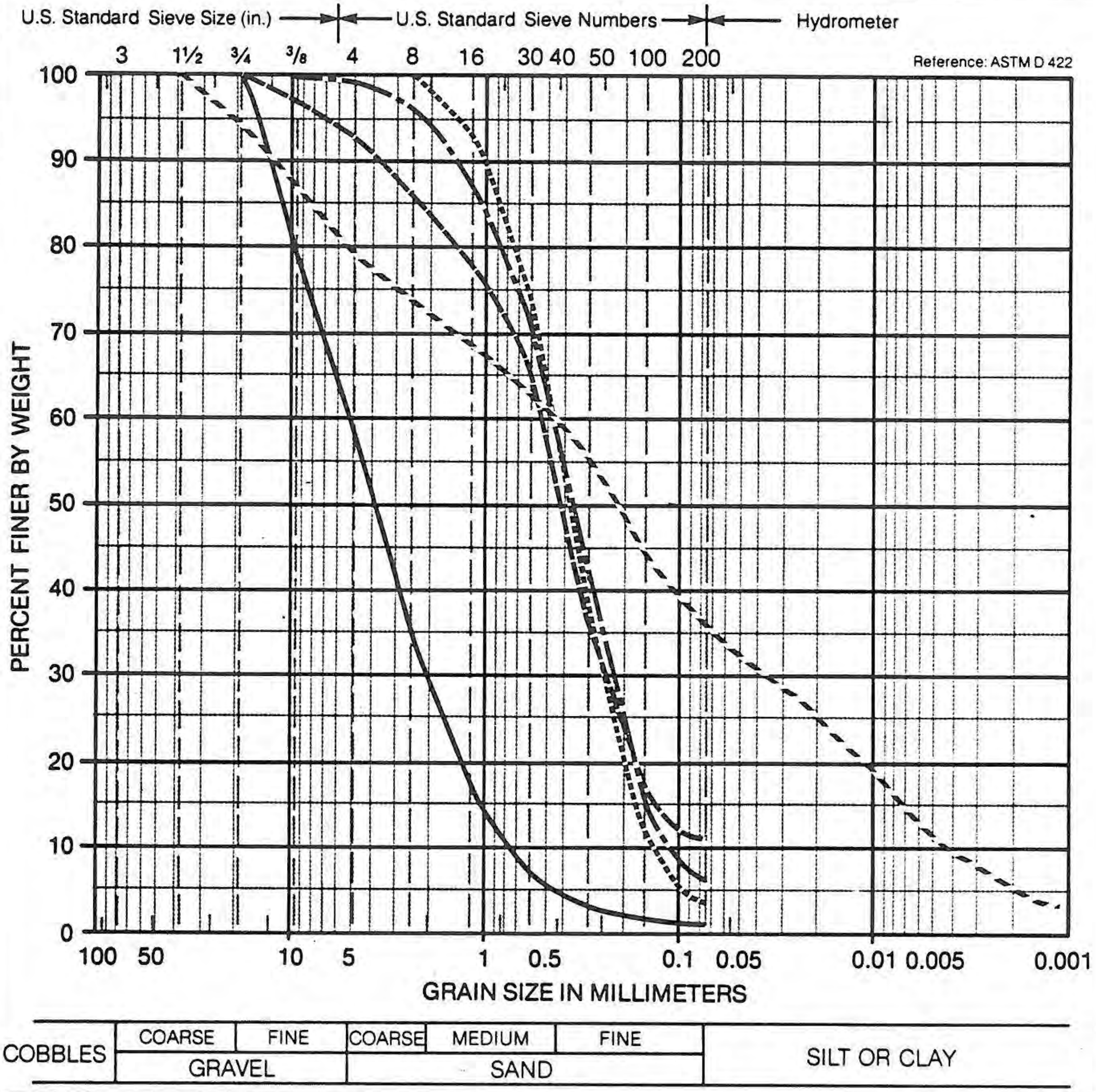
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C34

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
——	MW-24 at 154.0 feet	Gravelly sand (SW) trace silt
▪▪▪▪▪▪▪	MW-24 at 205.0 feet	Fine to medium sand (SP) trace silt
— —	MW-24 at 237.0 feet	Fine to medium sand (SM) some silt
—·—	MW 24 at 250.0 feet	Fine to medium sand (SP) some silt
- - - -	MW 24 at 260.0 feet	Gravelly silty sand (SM) trace clay

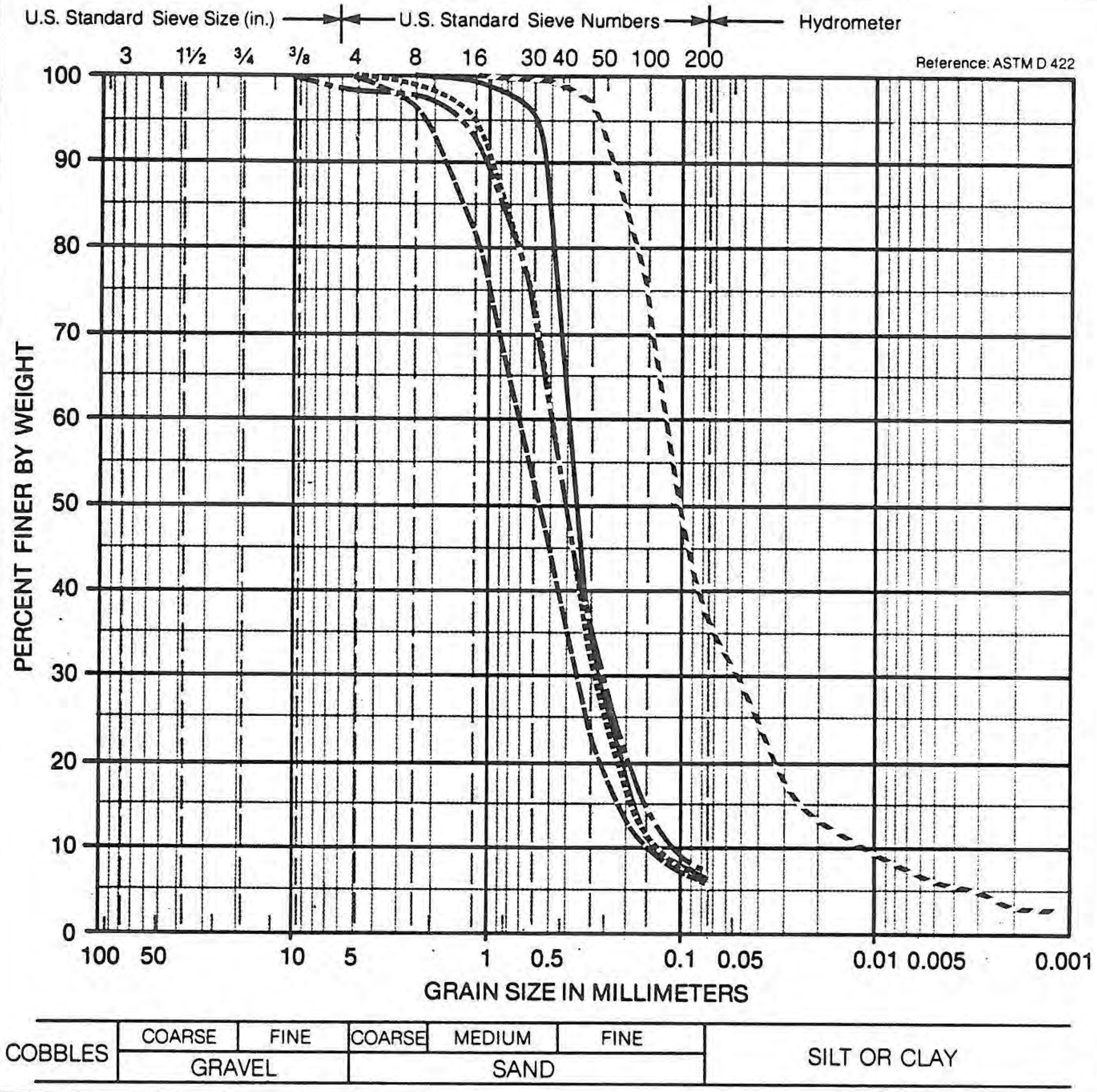
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C35

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-24 at 282.0 feet	Fine to medium sand (SP) some silt
········	MW-24 at 302.0 feet	Fine to medium sand (SP) some silt
— — —	MW-24 at 307.0 feet	Fine to medium sand (SP) some silt
—·—	MW-24 at 327.0 feet	Fine to medium sand (SP) some silt
- - - -	MW-24 at 332.0 feet	Silty sand (SM) trace clay

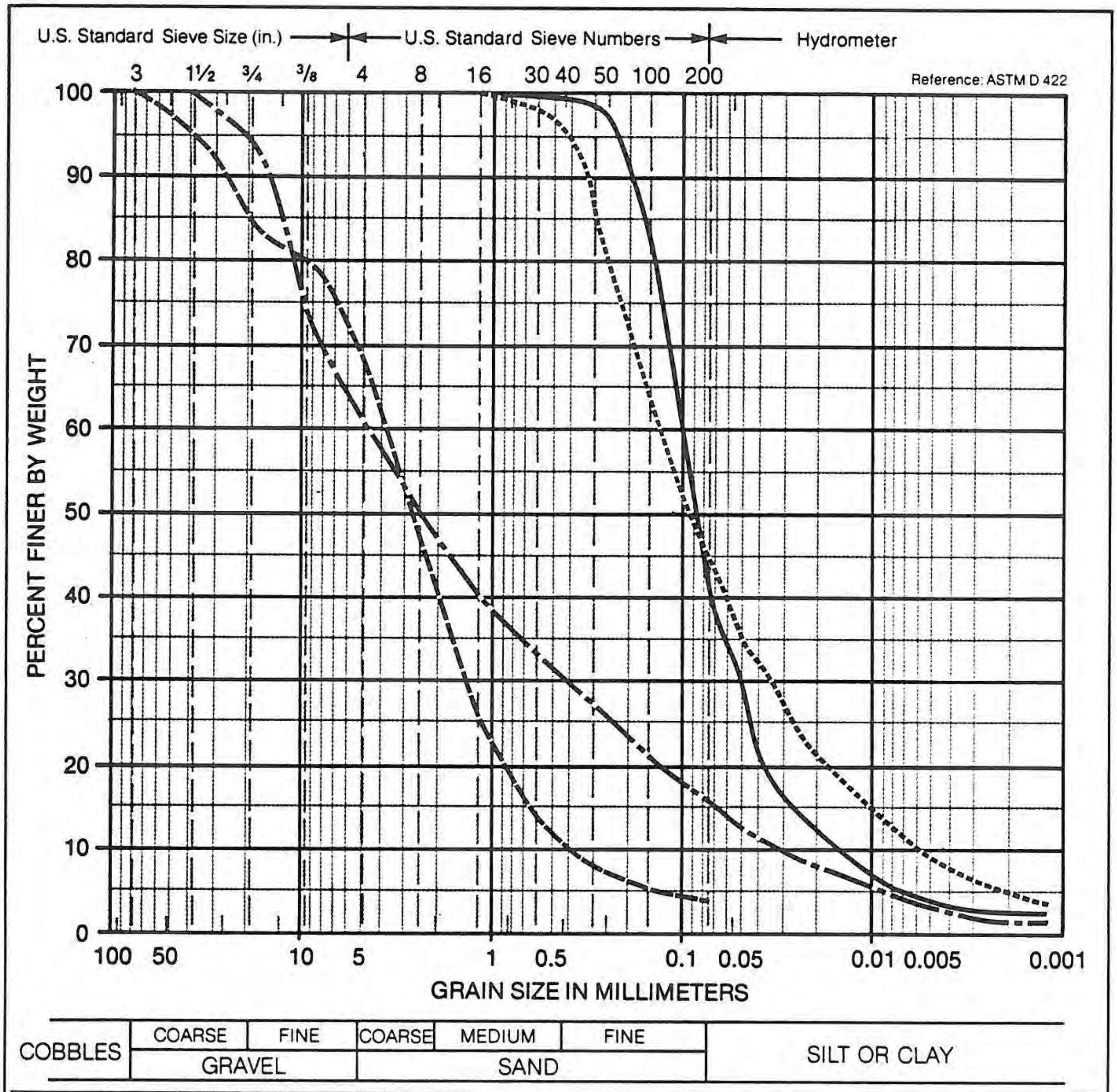
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C36

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-24 at 332.5 feet	Silty sand (SM) trace clay
┅┅┅	MW-24 at 337.5 feet	Silty sand (SM) trace clay
– – –	MW-24 at 355.0 feet	Gravelly sand (SW) trace silt
—‐‐—	MW-24 at 366.5 feet	Silty gravelly sand (SM) trace clay

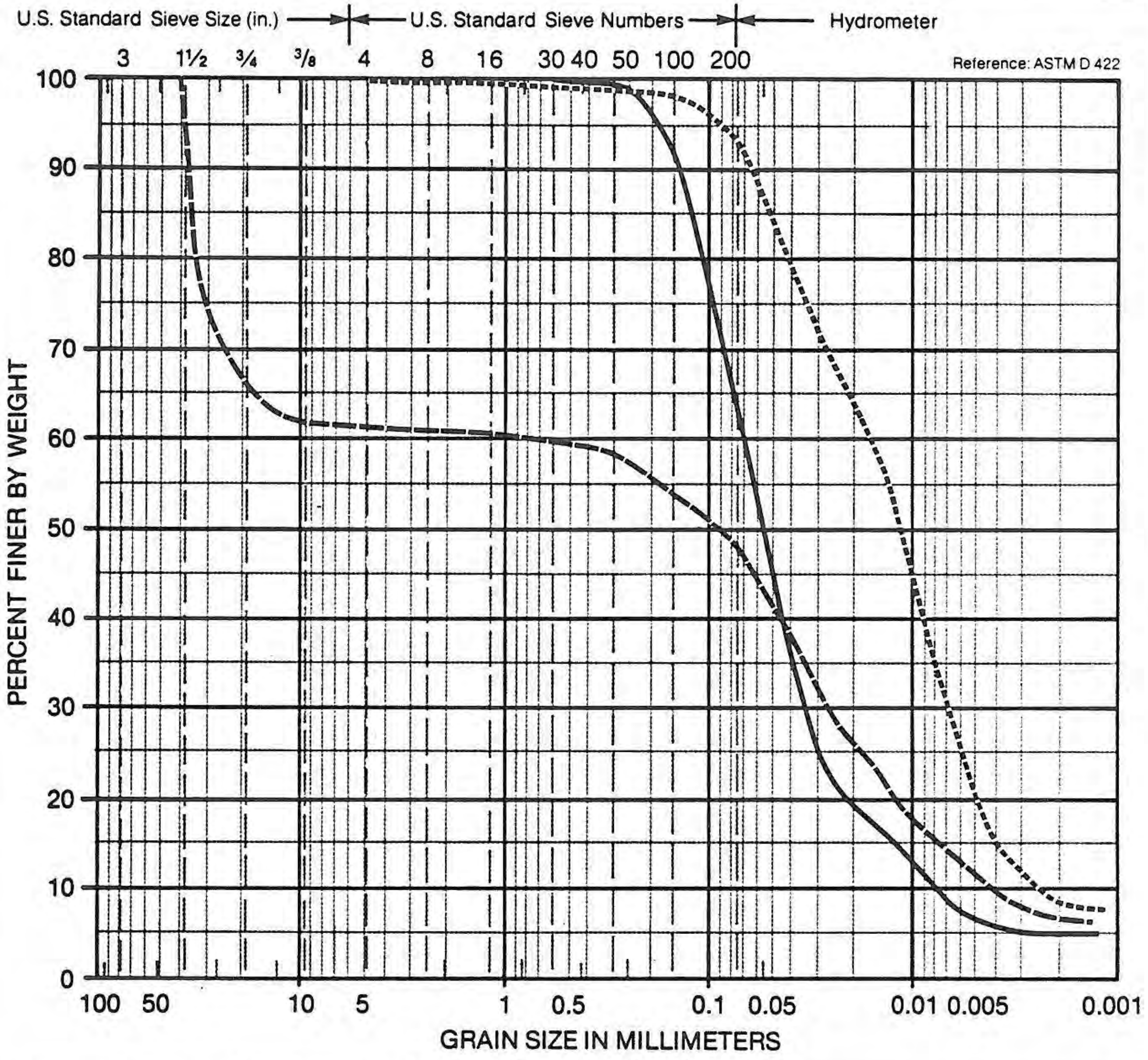
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C37

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
———	MW-25 at 16.0 feet	Sandy silt (ML) with trace clay
▪▪▪▪▪▪	MW-25 at 36.0 feet	Silt (ML) some sand and clay
— — —	MW-25 at 55.0 feet	Sandy silty gravel (GM) some clay

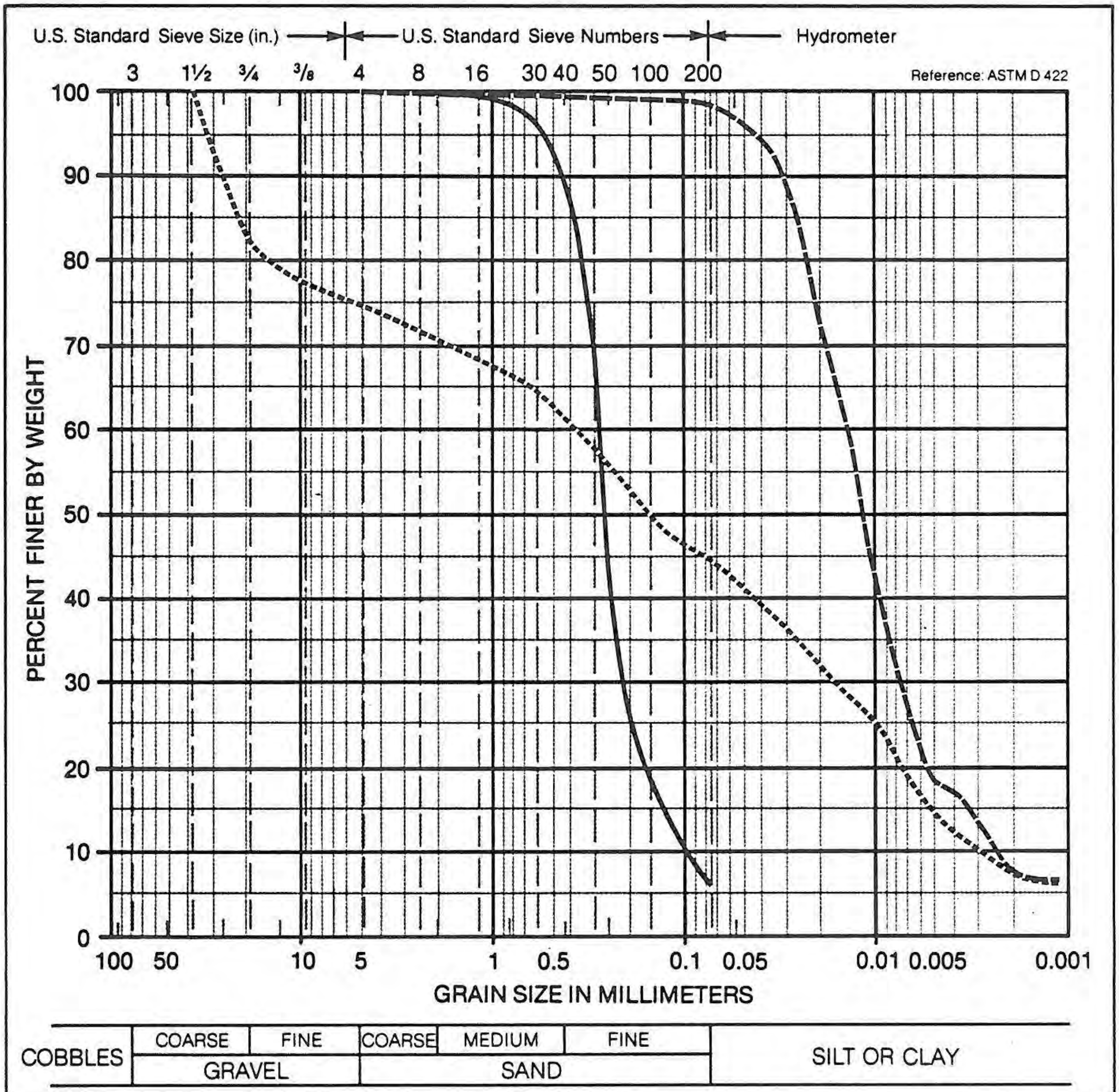
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C38

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-25 at 71.0 feet	Fine sand (SP) some silt
········	MW-25 at 86.0 feet	Gravelly silty sand (SM) trace clay
— — —	MW-25 at 100.5 feet	Silt (ML) some clay, trace sand

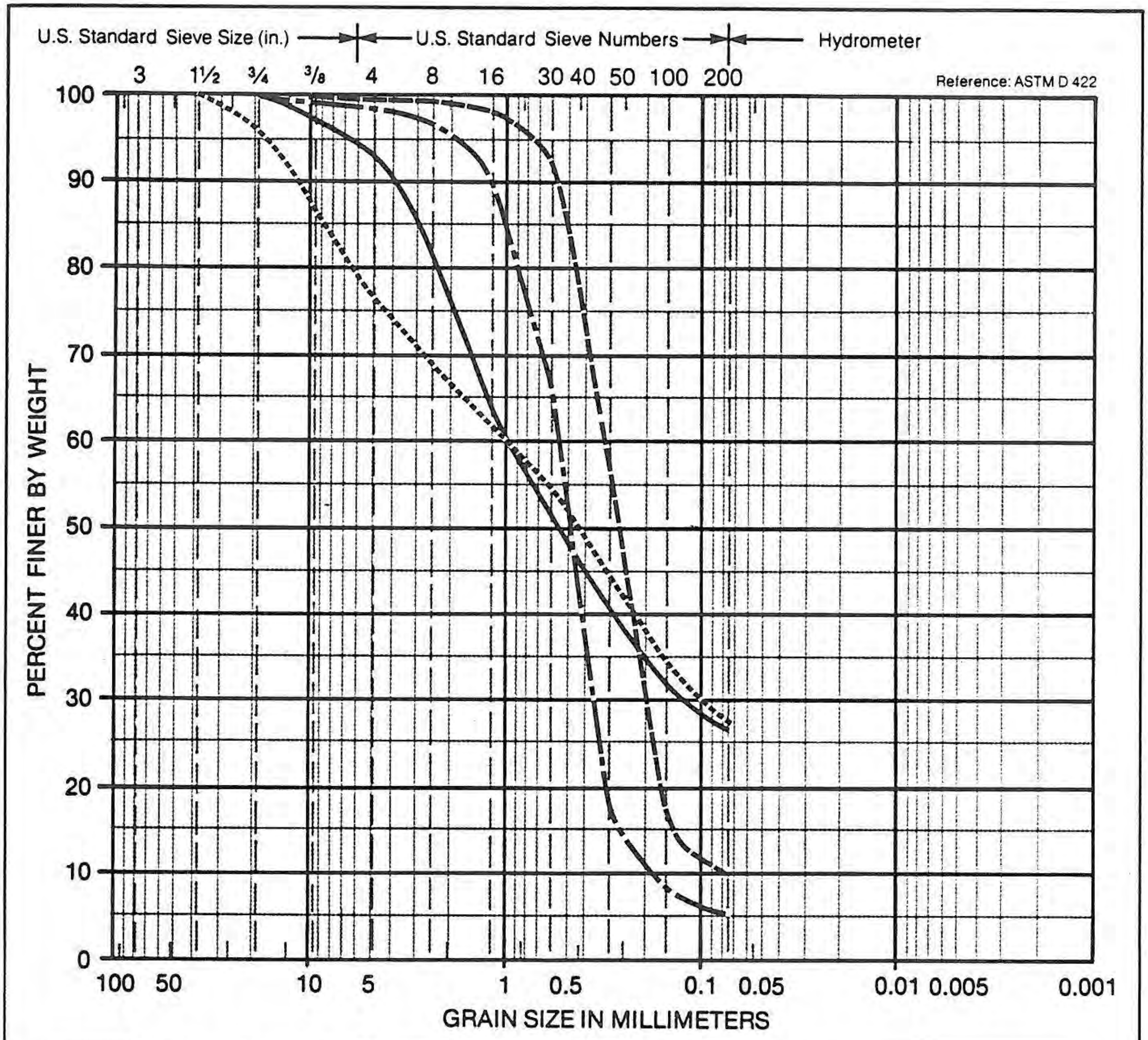
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C39

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT OR CLAY
	GRAVEL		SAND			

Symbol	Sample Source	Classification
———	MW-26 at 68.0 feet	Silty sand (SM) some gravel
••••••••	MW-26 at 76.0 feet	Gravelly silty sand (SM)
— — —	MW-26 at 98.0 feet	Fine to medium sand (SM) some silt, trace gravel
— · —	MW-26 at 117.0 feet	Fine to medium sand (SP) trace silt and gravel

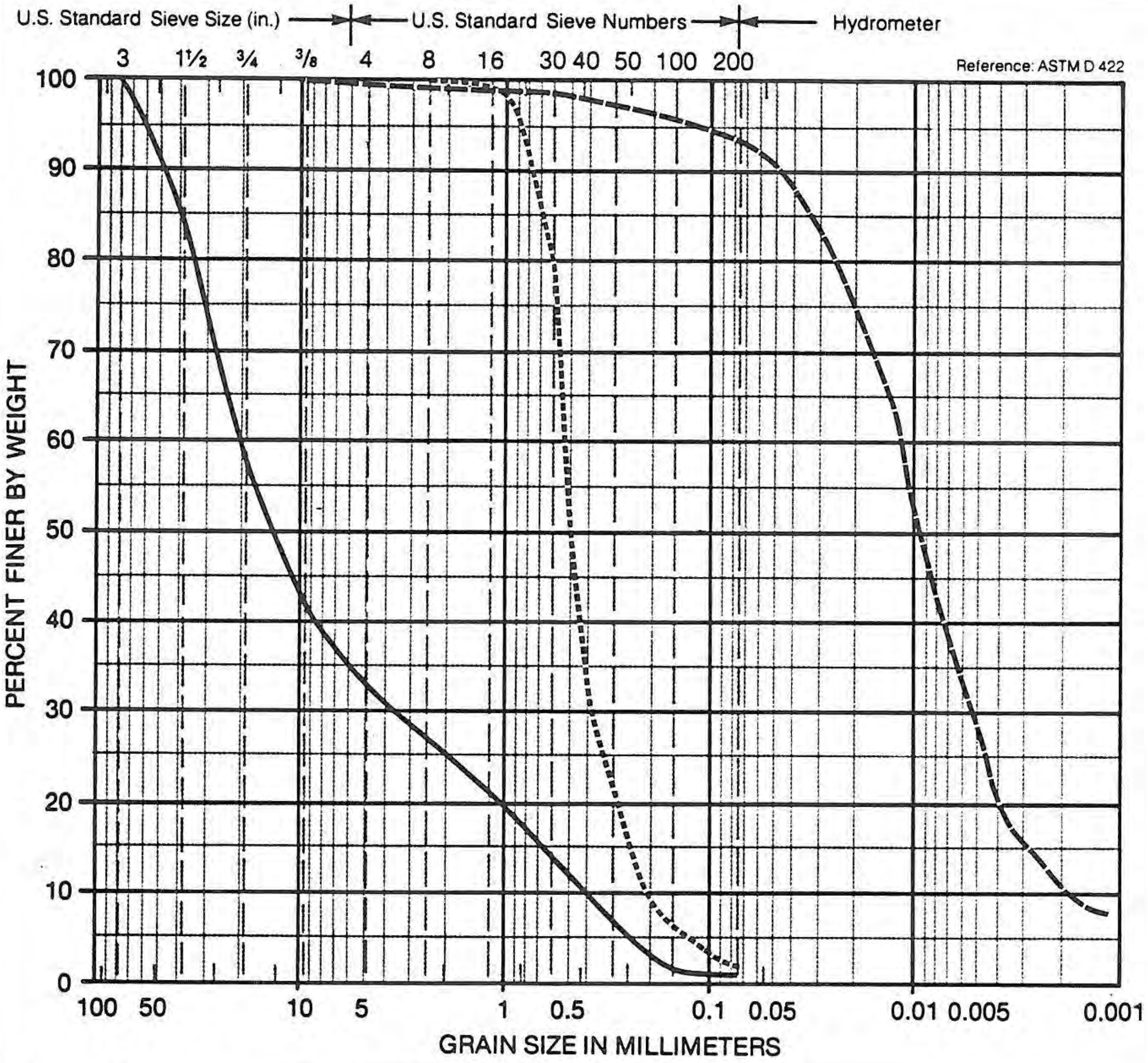
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C40

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



<table>
<tr><td rowspan="2">COBBLES</td><td>COARSE</td><td>FINE</td><td>COARSE</td><td>MEDIUM</td><td>FINE</td><td rowspan="2">SILT OR CLAY</td></tr>
<tr><td colspan="2">GRAVEL</td><td colspan="3">SAND</td></tr>
</table>

Symbol	Sample Source	Classification
———	MW-27 at 80.0 feet	Sandy gravel (GW) trace silt
--------	MW-27 at 153.0 feet	Fine to medium sand (SP) trace silt
— — —	MW-27 at 160.0 feet	Silt (ML) some clay and sand

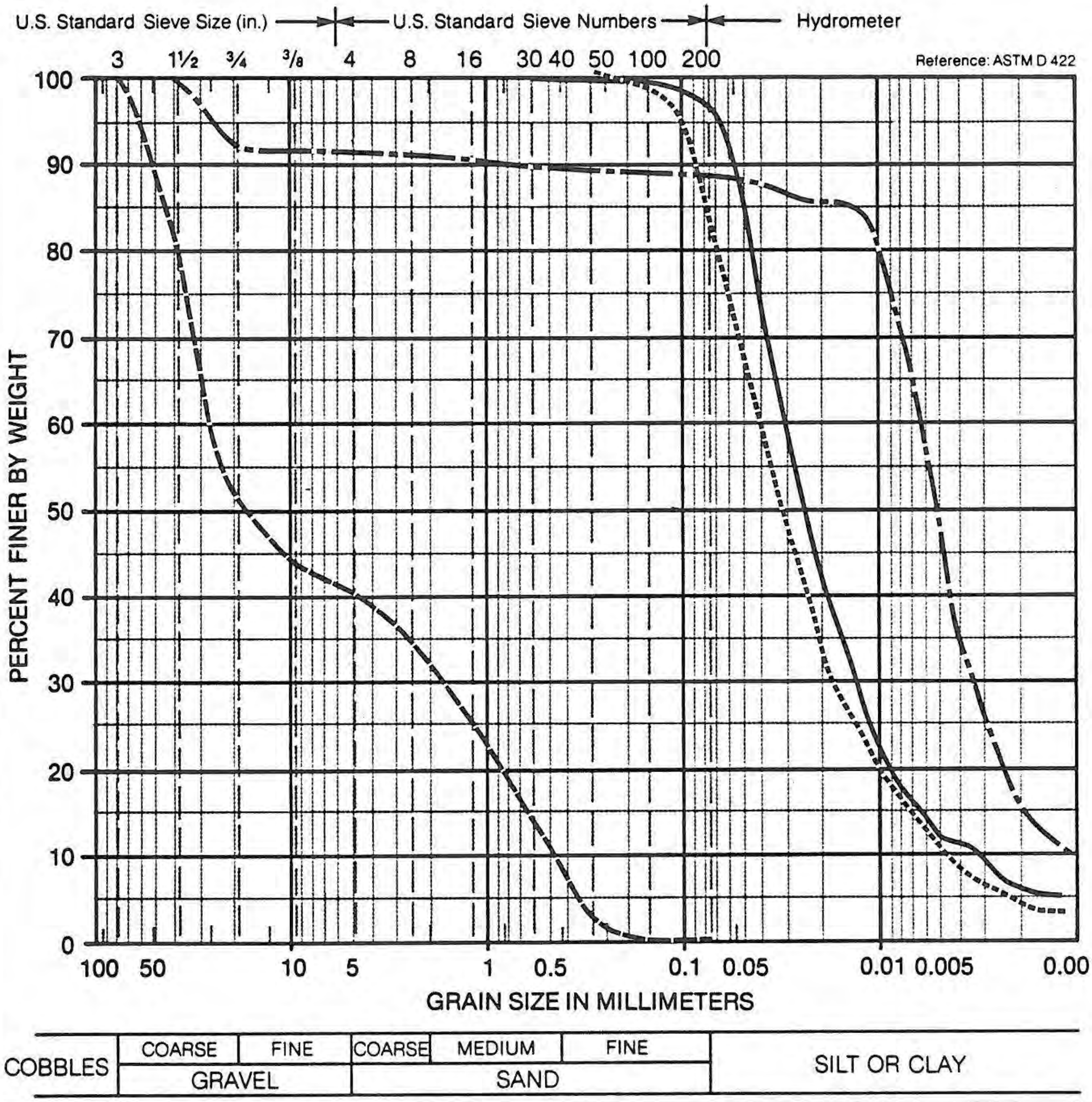
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C41

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-27 at 180.0 feet	Silt (ML) trace clay and sand
········	MW-27 at 225.0 feet	Sandy silt (ML) trace clay
— — —	MW-27 at 260.0 feet	Sandy gravel (GP)
— - —	MW-27 at 280.0 feet	Clayey silt (ML) some gravel, trace sand

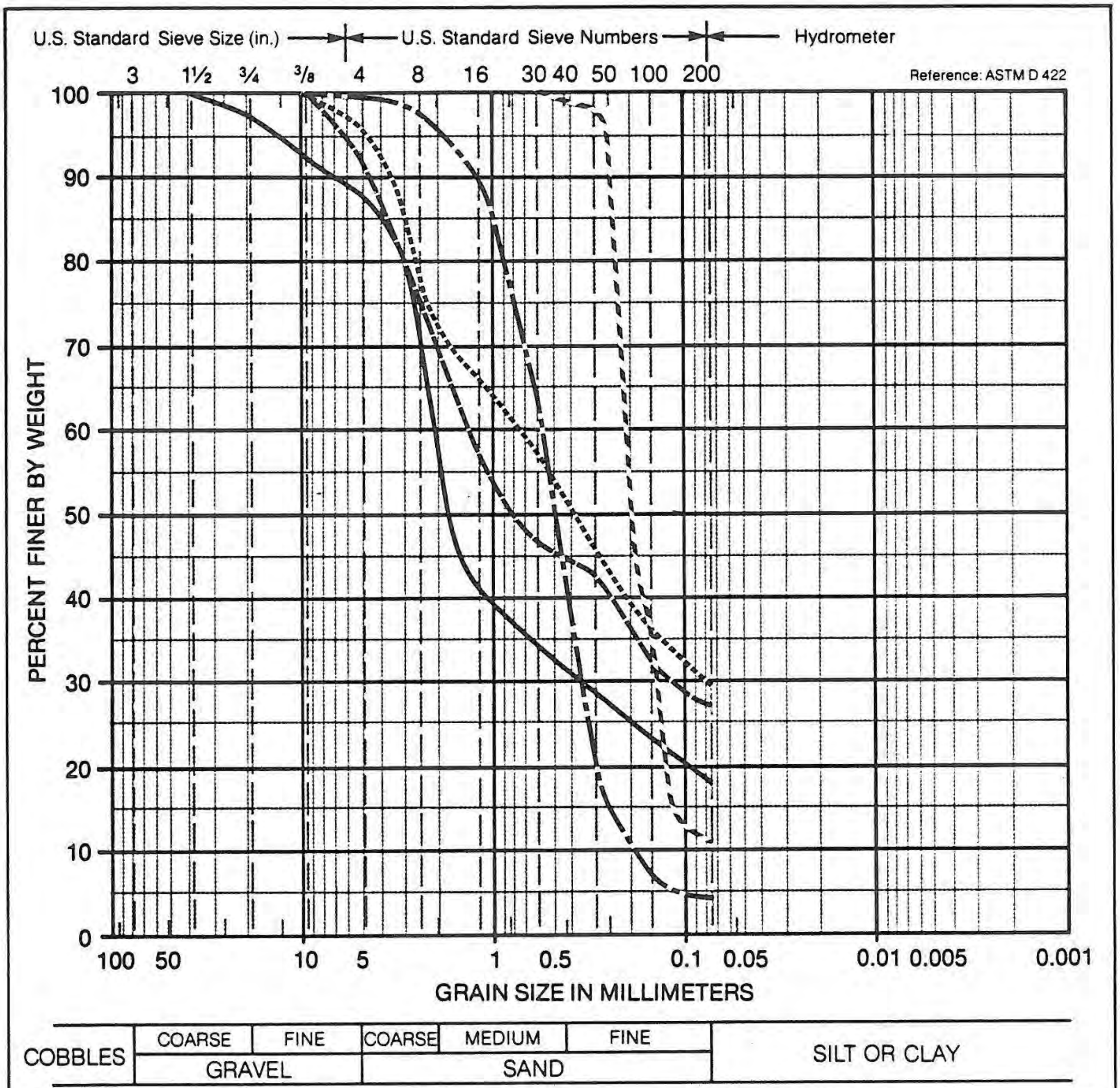
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C42

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	MW-28 at 5.0 feet	Silty sand (SM) some gravel
········	MW-28 at 48.0 feet	Silty sand (SM) trace gravel
— — —	MW-28 at 98.0 feet	Silty sand (SM) some gravel
—·—	MW-28 at 110.0 feet	Fine to medium sand (SP) trace silt
- - - -	MW-28 at 136.0 feet	Fine sand (SM) some silt

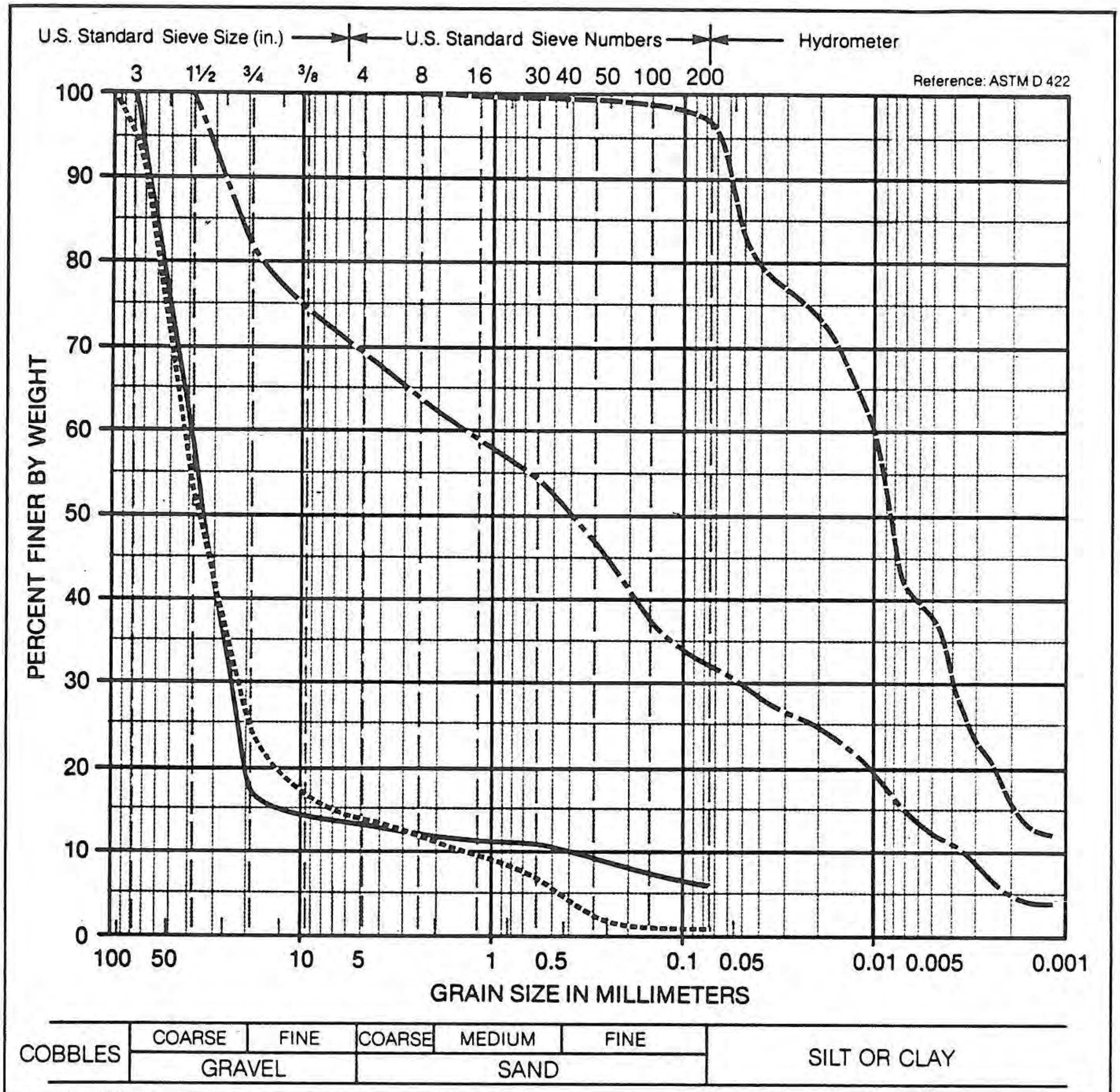
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C43

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
———	MW-29 at 9.0 feet	Coarse gravel (GP) some sand and silt
········	MW-29 at 103.0 feet	Sandy gravel (GP) trace silt
— — —	MW-29 at 185.0 feet	Clayey silt (ML) trace sand
— - —	MW-29 at 200.0 feet	Silty gravelly sand (SM) trace clay

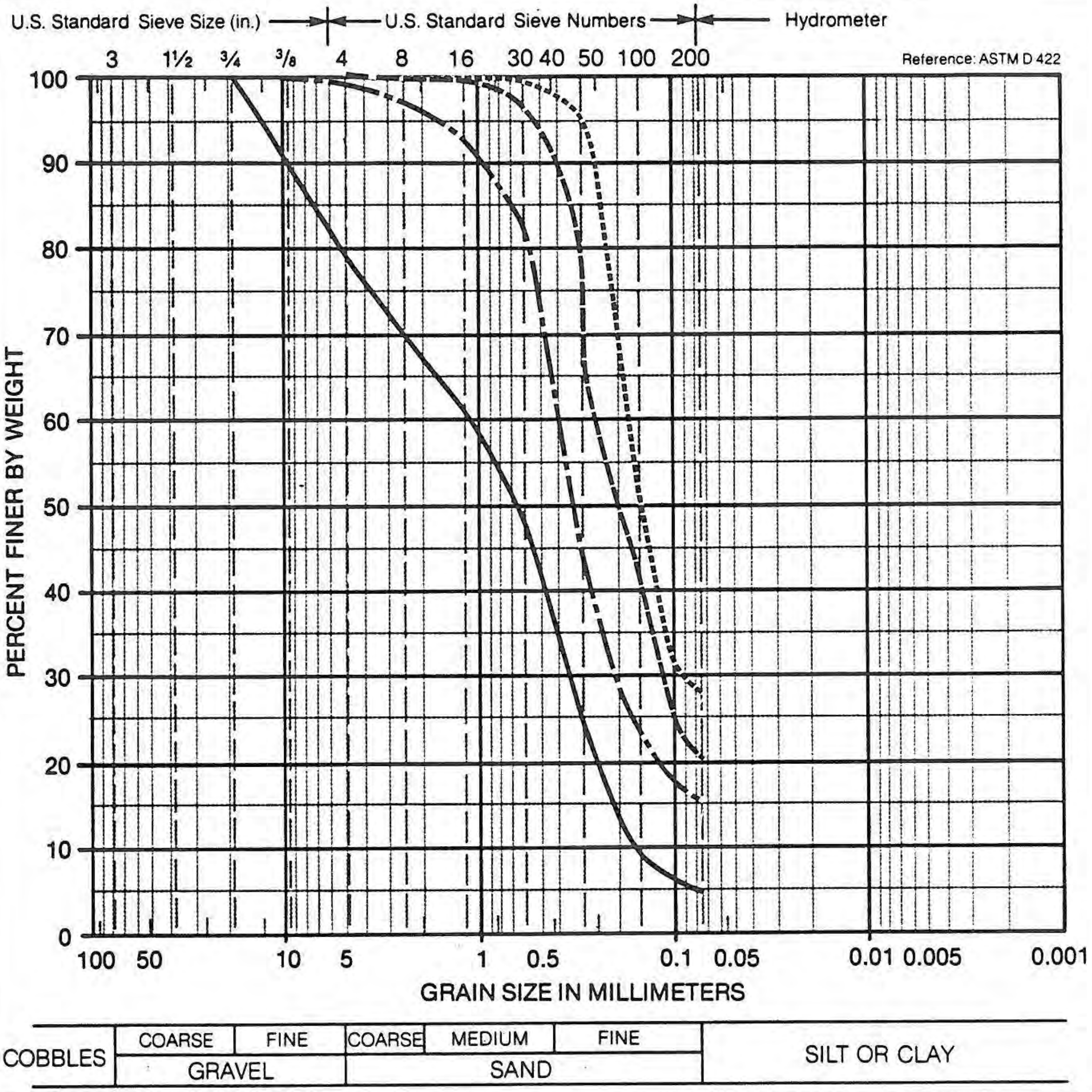
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C44

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
——	MW-29 at 215.0 feet	Gravelly sand (SP) trace silt
--------	MW-29 at 270.0 feet	Silty fine sand (SM)
— — —	MW-29 at 305.0 feet	Silty sand (SM)
— - —	MW-29 at 325.0 feet	Silty fine to medium sand (SM)

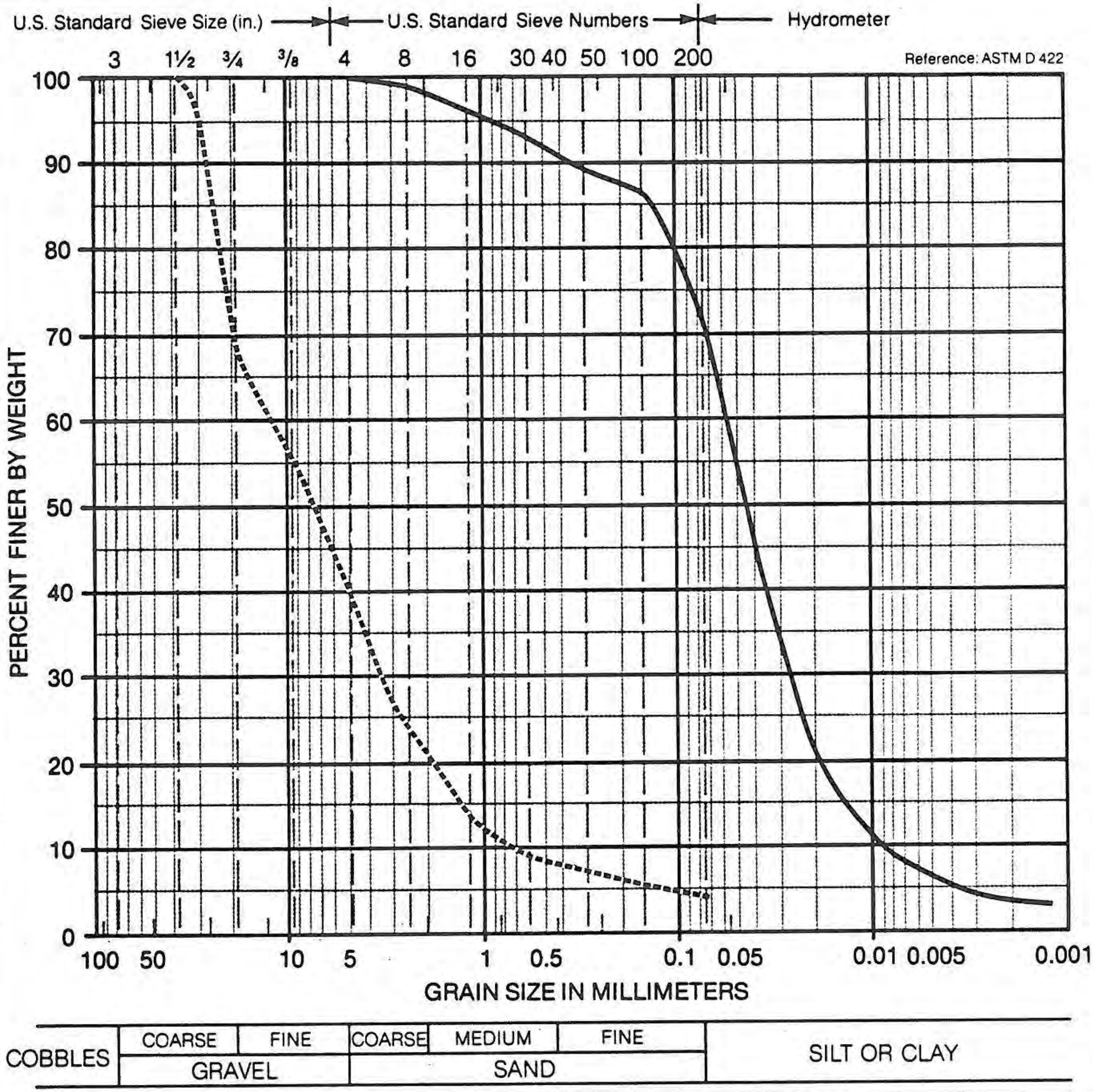
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C45

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	10 October 87		



Symbol	Sample Source	Classification
━━━━	MW-29 at 355.0 feet	Sandy silt (ML) trace clay
■■■■■■■■	MW-29 at 375.0 feet	Sandy gravel (GW) trace silt

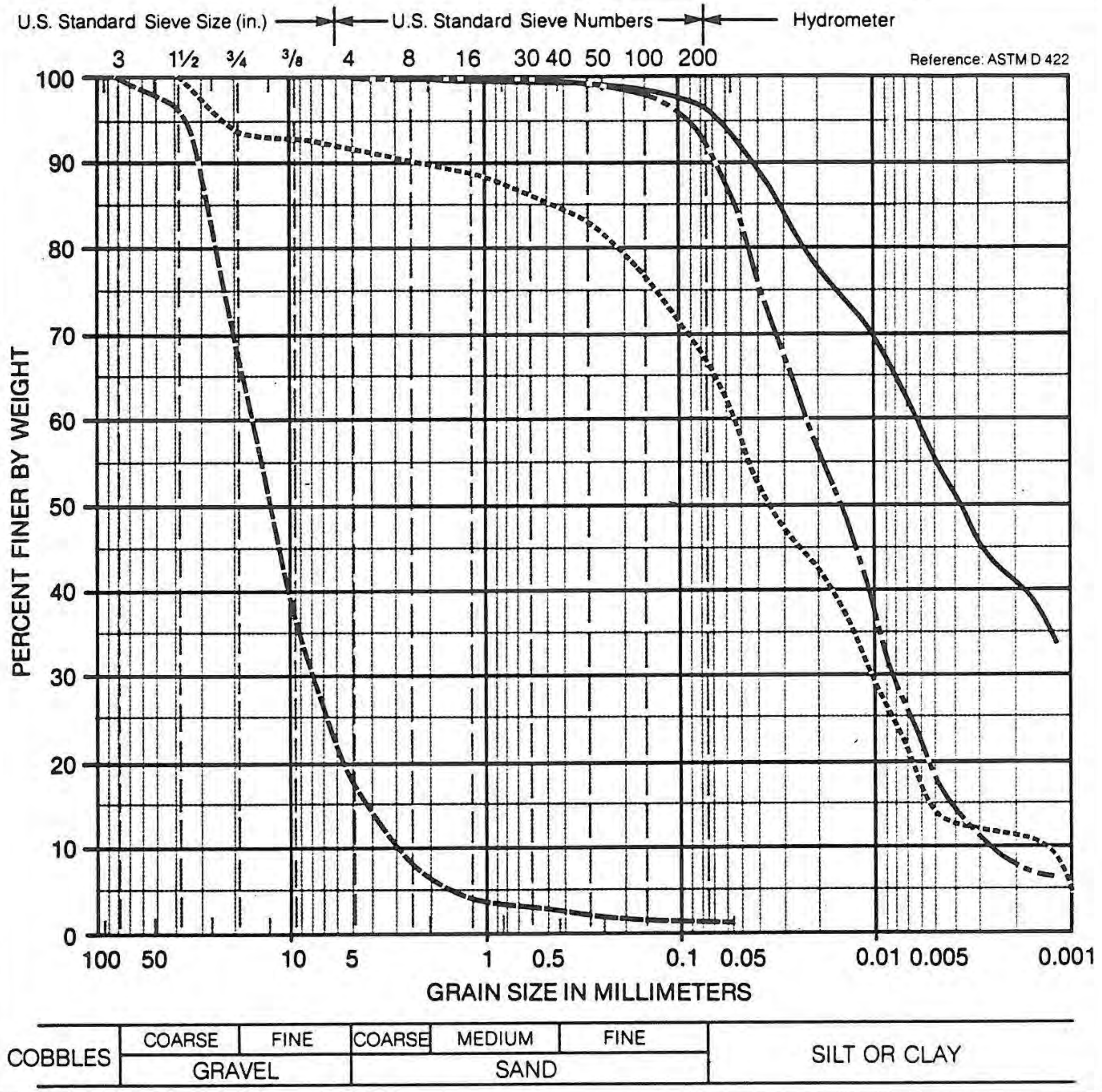
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C46

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14,169.102	WJ	MAA	October 15, 1987		



Symbol	Sample Source	Classification
———	LW-1 at 91.0 feet	Clayey silt (ML) trace sand
••••••••	LW-1 at 96.0 feet	Sandy silt (ML) some clay and gravel
— — —	LW-1 at 143.0 feet	Sandy gravel (GW) trace silt
—·—	LW-1 at 172.5 feet	Silt (ML) some sand and clay

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Particle Size Analysis

Midway Landfill
Kent, Washington

PLATE
C47

JOB NUMBER	DRAWN	APPROVED	DATE	REVISED	DATE
14169.102	WJ	MAA	October 15, 1987		