CHAPTER IV

HYDROGEOLOGY

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1.0 INTRODUCTION

This report presents hydrogeological characterization and baseline monitoring information in and near the proposed Permit Area of the Wishbone Hill Coal Project. The proposed Permit Area is located approximately seven miles north of Palmer, Alaska, as shown in Figure 1-1. Baseline information presented in this report includes a discussion of the regional hydrogeologic framework, a description of the investigations conducted to characterize the baseline hydrogeology of the proposed Permit Area, and data related to groundwater flow directions, hydraulic parameters, recharge/discharge conditions and groundwater quality.

Hydrogeological investigations at the proposed Permit Area were started in August 1988. This report includes the results of four quarterly groundwater quality sampling rounds that were conducted during the baseline monitoring period from August 1988 to July 1989. It incorporates water level and piezometric head data from monitoring wells and piezometers that were collected during the period of August 1988 to June 1990. Monitoring programs will be continued throughout the mining and post-mining phases of the operation as described in Part D, Section 15.0.

The baseline monitoring program described in this report was developed to provide information in support of a surface mining permit application. During the scoping, design and implementation of the hydrogeological characterization and baseline monitoring program, meetings were held with the Alaska Division of Mining (DOM) and the Division of Geological and Geophysical Surveys (DGGS) on June 13 and October 11, 1988. The DGGS was retained by the DOM to act as a technical advisor on the hydrogeological investigations. The scope of the hydrogeological characterization and baseline monitoring program reflects the comments and suggestions received from the agencies during these meetings.

Quarterly groundwater sampling and the collection of water level and piezometric head data from monitoring wells and piezometers have been ongoing and initially continued though December 1990. In October 2008 these programs were reinitiated and are currently being maintained to expand the project’s site data base. Addendum 1 provides a compilation of all the historical groundwater monitoring results obtained to date.

2.0 REGIONAL HYDROGEOLOGY

2.1 Hydrogeologic Units

The proposed Permit Area is located on the Southeast side of the Talkeetna Mountains in the Cook Inlet Basin (Figure 1-1). Groundwater conditions in the basin are summarized by Freethey and Scully (1980). No previous investigations of groundwater conditions in or near the proposed Permit Area were found in the literature. A detailed description of the geology in the area is provided in Part C, Chapter II. Barnes and Payne (1956) provide a description of the coal geology and previous mining activities in the Wishbone Hill District, Matanuska Coal Field.

The hydrogeologic units present in the region surrounding the proposed Permit Area include sedimentary, igneous and metamorphic bedrock, glacial sediments and alluvial deposits. The general hydrogeologic characteristics of each of these units are summarized below based on Freethey and Scully (1980).

2.1.1 Igneous and Metamorphic Bedrock

Igneous and highly metamorphosed rocks underlie the entire Cook Inlet Basin. They are usually well consolidated, dense and frequently jointed and faulted. They outcrop along the Talkeetna Mountain front some two miles north of the proposed Permit Area, plunge deeply and underlie the proposed Permit Area at great depth. Hydraulic conductivity of the igneous and metamorphic bedrock is generally low except where secondary fractures or joints provide moderate permeability. Well yields are nearly all less than 5 gpm. As a result, these rocks do not constitute a significant groundwater aquifer.

2.1.2 Sedimentary Bedrock

Sedimentary rocks include well to poorly consolidated arkose, graywacke, gravel conglomerate, sandstone, siltstone, shale, coal and limestone. They form ridges, rounded hills and bluffs in the Matanuska Valley which lies between the Chugach and Talkeetna Mountains. In and near the proposed Permit Area, Cretaceous sedimentary rocks are overlain by Tertiary clastic rocks including the Chickaloon Formation which contains the coal deposits, the Wishbone Formation and the Tsadaka Formation. The Tertiary deposits include siltstones, mudstones, sandstones, claystones, coal, and fine to coarse pebble conglomerates. Hydraulic conductivity of the rocks is generally low, although some discontinuous layers of coarse-grained deposits may provide local areas of higher permeability.

2.1.3 Glacial Sediments

Quaternary glacial sediments consist of moraines and other unsorted glacial drift. They are a heterogeneous blend of gravel, sand, silt and clay. They typically occur in upland areas of basins, where bedrock may be at relatively shallow depth, and often form hummocky terrain with poorly developed surface drainage patterns. In and near the proposed Permit Area, glacial sediments mantle sedimentary bedrock with typically 5 to over 100 feet of silt to well graded gravels. Permeability of the glacial sediments is highly variable and depends on the amount of fines. This unit often supplies ample water for domestic use but supports few large-yield wells.

2.1.4 Alluvial Deposits

These deposits include Holocene flood plains, terraces, and alluvial fans consisting of well stratified silt, sand and gravel. They generally form lenticular deposits along major streams such as the Matanuska River to the south of the proposed Permit Area. Generally the permeability of these deposits is moderate to good and they provide adequate groundwater supplies to domestic wells. Some well yields greater than 1000 gpm have been reported. Significant alluvial deposits in and near the proposed Permit Area have not been identified although some alluvium of limited depth and areal extent occurs along Moose Creek.

2.2 Groundwater Recharge and Flow

Based on Freethey and Scully (1980) the regional direction of groundwater flow is primarily controlled by topography. Recharge occurs from infiltration of precipitation and seepage from surface streams and lakes. Regional discharge occurs along the major river valleys and to the Cook Inlet. The amount of recharge in the higher elevations, where bedrock units outcrop, is limited by the relatively low permeability of these units. Freethey and Scully (1980) report infiltration into igneous, metamorphic and sedimentary bedrock to be poor to moderate. Surface drainage is reported as good to very good. Thus, most rainfall and snowmelt leaves the higher elevations as surface runoff rather than infiltrating into the bedrock units. Recharge to bedrock is also limited by its low permeability in areas where it is overlain by glacial or alluvial deposits.

Glacial and alluvial deposits are principally recharged from infiltration of rainfall and snowmelt. Along loosing reaches of rivers and streams, glacial and alluvial deposits are recharged by streamflow. Relative stream gains and losses per mile of stream length are reported for four streams in the Cook Inlet Basin by Freethey and Scully (1980). These include the Eagle River Meadow Creek, the North Fork of Campbell Creek, and Ship Creek. Data from Moose Creek are not reported.

Groundwater discharge from glacial and alluvial deposits occurs primarily along gaining reaches of rivers and streams. Where glacial deposits mantle bedrock along ridges and highlands, they may also discharge vertically to the underlying bedrock (Freethey and Scully, 1980).

3.0 SITE HYDROGEOLOGY INVESTIGATIONS AND MONITORING

3.1 Investigation Strategy

Prior to field operations, the stratigraphy and regional hydrogeology of the proposed Wishbone Hill Mine site were reviewed to determine the important water-bearing units in and near the proposed Permit Area. Two primary hydrogeologic units were identified for monitoring and characterization during the baseline hydrogeologic studies.

The first major hydrogeologic unit is Tertiary sedimentary bedrock found in three formations including:

1) The Chickaloon Formation, which is comprised of shale, claystone, siltstone, sandstone, coal and pebble conglomerate;

2) The Wishbone Formation, which is comprised of pebble conglomerate, sandstone and siltstone, and;

3) The Tsadaka Formation, which is comprised of pebble conglomerate, sandstone, siltstone, and silty carbonaceous shale.

The target coal beds are found in the upper portion of the Chickaloon Formation. They include, from top to bottom, the Jonesville Group, the Premier Group and underlying Midway Seam, the Eska Group and the Burning Bed Group. This hydrogeologic unit is important since it constitutes the bedrock aquifer within the proposed Permit Area.

The sedimentary bedrock is overlain by Quaternary deposits that include glacial outwash, glacial drift, ice-marginal deposits, esker-kame terrace deposits, stream terrace gravels, alluvium, colluvium and aeolian loess. These sediments constitute the second major hydrogeologic unit in the proposed Permit Area. The Quaternary deposits consist of a wide variety of materials from clayey and silty sands to well graded gravels, and range from 0 to over 100 feet thick. Where these materials are saturated they form the uppermost aquifer in the proposed Permit Area. The recent alluvial channel deposits adjacent to Moose Creek are also included in this hydrogeologic unit.

The baseline hydrogeologic investigation concentrated on these two major hydrogeologic units. A field program that included installation of groundwater monitoring wells and piezometers, groundwater sampling, water level measurement, well testing, and surface seismic profiling was designed for the proposed Permit Area. The locations of these various facilities and investigations are shown on Plate IV-1.

The hydrogeologic investigations were conducted according to an overall strategy to characterize the hydrogeology of the proposed Permit Area. The important components of this strategy included:

- Six monitoring wells installed in bedrock to obtain representative water samples and water levels. At least one well was installed in each of the major coal groups including the Burning Bed, Eska, Premier and Jonesville. Construction data for the monitoring wells are provided in Table 3-1.

- Two of the monitoring wells in bedrock were of sufficient diameter to conduct pump tests for the purpose of determining large-scale hydrogeologic characteristics in bedrock. The drawdown during the pump testing was monitored in the pumped well and surrounding piezometers.

- Eleven monitoring wells were completed in the uppermost aquifer (i.e. glacial and alluvial sediments) for the purpose of measuring water levels and obtaining water samples. These monitoring wells were located up-gradient and down-gradient of the proposed open pits, around the proposed slurry pond location, and down-gradient of the old mine spoil piles located in the northwestern portion of the proposed Permit Area. Construction data for the monitoring wells are provided in Table 3-1.

- One of the monitoring wells in the alluvial sediments was of sufficient diameter to conduct a pump test for the purpose of determining large-scale hydrogeologic characteristics in alluvium adjacent to Moose Creek.

- Two monitoring wells were installed in the area of the old Premier underground mine to evaluate groundwater conditions and quality in the old workings. One of these wells was of sufficient diameter to conduct a pump test.

- Thirty seven piezometers in thirteen drillholes were installed at suitable depths and locations to determine the potentiometric conditions in bedrock in the areas of the proposed open pit mine. Piezometers were also located to provide monitoring during two pump tests that were conducted in bedrock. Construction data for the piezometers are provided in Table 3-2.

3.2 Field Investigations

3.2.1 Monitoring Wells

Exploration Drilling and Supply Co. and Denali Drilling of Anchorage, Alaska, were contracted by Idemitsu Alaska, Inc. to perform the drilling and well construction associated with the project in 1988. The contractors provided a variety of tire and track mounted auger and rotary drill rigs, compressors, and support equipment for the project. The air rotary drilling rigs used air/water mist, or air/foam to assist in removing the cuttings from the borehole. During drilling, soil and rock samples were obtained every five feet for examination, classification and sampling. Drilling and well installation operations were carried out from August 10 to November 10, 1988. All well completions were supervised by a hydrogeologist from Golder Associates Inc.

A total of 17 groundwater monitoring wells were installed in the proposed Permit Area in 1988. The locations of the monitoring wells are shown on Plate IV-1. The 11 groundwater monitoring wells completed in the alluvial or glacial sediments were drilled with a track-mounted auger drilling rig equipped with air rotary capabilities. Once the borehole had been drilled to the proper depth, 2-inch schedule 40 PVC flush coupled screen and casing were installed to the design depth.

Typically the wells were designed to penetrate 10 to 20 feet below the water table. Where less than 10 feet of saturated sediments was found, wells penetrated several feet into the bedrock. A filter pack was constructed using Monterey #8 sand or equivalent, that was designed to allow a maximum 2 percent passing through an 0.020-inch opening. The wells were constructed inside the hollow stem augers. Auger flights were withdrawn as the filter pack and bentonite seal were installed. The remainder of the annular space above the bentonite seal was grouted to the surface with a cement/bentonite grout. A typical well completion in alluvial and glacial sediments is shown in Figure 3-1.

Five of the six bedrock groundwater monitoring wells were constructed by drilling and driving steel casing with a top-head hammer air rotary drilling rig. The casing was driven through the glacial sediments to the top of the bedrock or until refusal. The boreholes were then advanced by air rotary to the final depth in the bedrock. One well (H88-13) was drilled using a conventional rotary rig with air and foam. Significant difficulties were encountered in drilling this hole and a biodegradable mud was eventually used to provide hole stability.

Four of the bedrock monitoring wells were completed with 2-inch diameter schedule 80 PVC flush coupled casing and screen. Two of the wells were completed with 5-inch diameter schedule 80 PVC flush coupled casing and screen to allow adequate completed diameters for pump testing. A typical pump test well completion is shown in Figure 3-2. Once the PVC flush coupled casing and screen were installed, a filter pack was constructed using Monterey #8 sand or equivalent. A bentonite seal was installed above the filter sand and the remainder of the annular space above the seal was grouted to the surface with a cement/bentonite grout. Surface casing was withdrawn while the grout was tremied into the annular space.

Completion details for each monitoring well are provided in Appendix A. A summary of completion data is presented in Table 3-1.

Monitoring wells were constructed with flush-joint threaded, schedule 40, nominal 2-inch diameter PVC pipe and well screen or flush-joint threaded, schedule 80, nominal 2-inch and 5-inch diameter PVC pipe and well screen. The well screen was machine slotted with 0.020-inch width openings in six rows of 60 degree intervals around the screen with a minimum of 44 slots per foot. The base of the well was fitted with a threaded PVC cap designed to withstand all installation and well development pressures. The drill rigs were used to set the string of PVC screen and riser pipe following drilling and cleaning of the borehole.

The typical procedure for installing the monitoring wells is summarized below.

- The well screen, bottom plug, well casing and centralizers were kept clean or cleaned as needed prior to installation in the borehole. Workmen took precautions to ensure that no grease or other contaminants contacted the well construction material. Workmen wore clean gloves while handling the screen and riser.

- The male end of each joint was fitted with an o-ring gasket and joints were tightened by hand or with decontaminated chain wrenches. Stainless steel centralizers were attached to the well screen at approximately 30-foot spacing so that the screen was centered in the borehole.

- The well screen was lowered to the predetermined level and held in place.

- The volume of Monterey #8 sand or equivalent sand that was computed to fill the annular space around the well screen to a depth of 3 to 5 feet above the well screen was carefully measured out and poured slowly into the annular space. The exact levels of materials added were measured periodically with a weighted engineering tape.

- A volume of 1/2-inch diameter bentonite pellets or course granulated bentonite to create a seal 3 to 5 feet thick was computed and carefully poured into the annular space. If the seal was constructed above the water table, exactly five gallons of water per 50 pounds of bentonite pellets were poured into the annular space. A weighted seal tamper was lowered down the borehole to tamp the pellets into a cohesive mass of clay.

- The annular space was then sealed using a cement bentonite grout (2 to 5 pounds of bentonite added per 90 pound sack of cement) that was pumped into the annulus using a side discharge tremie pipe. The cement was mixed by hand in a large trough and was approved by the on-site hydrogeologist prior to use in the well. The grout was injected continuously until it flowed out of the annular space at the surface. The well was not disturbed for a minimum of 48 hours.

- The PVC pipe was cut off 3 feet above the ground surface and a loose PVC slip cap was installed. A steel protective monument was cemented into place and a protective lockable cover was installed. A drain hole (1/4-inch

> diameter) was drilled in the monument to permit water to drain out of the annular space. A concrete protective pad was constructed around the monument.

All wells were developed by airlifting or bailing following installation. A track-mounted drill rig and separate track-mounted compressor were used in the airlifting process. Typically, the airlifting was conducted over a 24-hour period by moving to a new well location at about noon each day, and airlifting the well during the afternoon and morning of the following day. This allowed the well to recover overnight and allowed more water to be removed from the well. Some shallow gravel monitoring wells were developed by using a stainless steel bailer. The wells were repeatedly bailed and allowed to partially recover until relatively clear water was produced by the well. Estimates of well yield were obtained during airlift development by diverting water into a small channel or pipe and measuring the flow rate using a bucket and watch. Estimates of well yields varied from less than 1 gpm to over 5 gpm.

In July 1989, Tester Drilling Company was contracted by Idemitsu Alaska, Inc. to drill and install two additional monitoring wells (H89-29, H89-30) into the old underground workings of the Premier Mine. The wells were drilled and installed under the supervision of a geologist from McKinley Mining Company, Inc. Development testing and water sampling was conducted under the supervision of a hydrogeologist from Golder Associates Inc.

The two wells were drilled with an Odex drilling system using air. In each hole an 8 inch diameter surface casing was installed. Well H89-29 was drilled to a total depth of 204 feet and encountered mine voids and rubble zones over the depth interval from 177 to 201 feet. A 5 inch diameter stainless steel screen with 0.050 slot size was installed. The screen was wrapped in a filter fabric since gravel packing in the mine void was not feasible. The screened interval was isolated using two formation packers and cement grout. Well H89-30 was drilled to approximately 198 feet in depth and did not encounter mine voids. The well probably intercepted a mine piller. The well was completed as a 2-inch diameter monitor well using stainless steel screen and PVC casing. Completion details of H89-29 and H89-30 are provided in Appendix A.

During drilling of these holes with air, water production was noted by the onsite geologist. In hole H89-29, 100 to 120 gpm of water production was observed at a depth of 56.5 feet from the Chickaloon Formation. In hole H89-30, 40 to 50 gpm of water was produced from the glacial sediment/bedrock contact at a depth of 82.0 feet. These high water production rates were anomalous when compared to the other wells installed at the site and may reflect increased permeability in this area as a result of structural features or the presence of the old mine workings.

3.2.2 Piezometers

A total of 37 pneumatic piezometers were installed in 1988 in 13 exploration core or rotary boreholes (1 to 4 piezometers per borehole). The locations of the piezometers are shown in Plate IV-1.

The design of each piezometer installation was determined on site after review of geologic and geophysical logs. The generalized construction of the pneumatic piezometer boreholes is shown in Figure 3-3 and the specific piezometer completions and lithologic logs for each borehole are provided in Appendix B.

A typical installation consisted of a SINCO two-tube pneumatic piezometer tip wrapped in a filter sock made of canvas filled with Monterey #8 filter sand. The pneumatic tip assembly and lower section of hose were weighted with a 5-foot section of 5/8-inch steel rebar and lowered into the open borehole to the desired pre-measured depth. Monterey #8 filter sand was placed around the tip. Monitored bedrock intervals ranged from approximately 8 to 90 feet. Isolation of the monitored intervals was achieved by installing seals that ranged from 5 to 45 feet in thickness. Below 200 feet, seals were composed of cement and 5 percent powdered bentonite grout that was tremied into place and allowed to cure overnight. Seals above 200 feet were installed using Barroid Hole Plug, a course granulated bentonite, that was hand poured and allowed to swell in place. The remainder of the borehole was sealed with a grout mix of cement and 5 percent bentonite. A minimum 7 feet of surface casing with a locking cap was cemented in place at each hole to protect against frost heaving and to protect the piezometer installation from vandalism.

3.2.3 Seismic Survey

Approximately 4700 lineal feet of seismic refraction profiling was conducted by Northland Geophysical Company in two locations in the proposed Permit Area from August 23-27, 1988. The program consisted of a baseline profile (line S1) and one cross-profile (line S2) along the western edge of Mine Area 1, and a baseline profile (line S3) and two cross-profiles (lines S5 and S6) along the northwestern portion of Mine area 2. The locations of the profiles are shown in Plate IV-1. Northland Geophysical Company's report is included in Appendix G.

The purpose of the seismic profiles was to determine the depth to Tertiary sedimentary bedrock in selected portions of the proposed mine areas. The locations of the profiles represent areas where the proposed mine pits could extend into the Moose Creek Valley. The profiles were conducted to determine the thickness and areal extent of the alluvial/glacial sediments in these areas in order to provide a basis for evaluating potential mine inflows and hydrologic impacts of mine development.

All of the seismic lines were laid out with a geophone spacing of 25 feet resulting in a nominal spread of 575 feet. The seismic refractions resulting from the explosive energy source were recorded by a 24-channel seismic system that consisted of two integrated 12-channel GeoMetrics digital seismographs. Multiple shots were fired and recorded at each station to achieve reversed arrivals from the bedrock and a better definition of seismic velocities. The end point locations of each seismic line were determined by survey crews contracted by Idemitsu Alaska, Inc.

3.2.4 Hydraulic Head Measurement

Hydraulic heads were measured in monitoring wells and piezometers to provide data on groundwater flow gradients in glacial/alluvial sediments and bedrock. During the period from August to November 1988, head measurements were taken periodically during the field installation and testing activities. This period represented the first quarter of baseline monitoring. Head measurements during the second quarter were taken in February and March 1989. Beginning in April 1989, monthly head measurements in wells and piezometers were initiated since this was the beginning of the period when recharge to groundwater from spring run-off could be expected to occur. Monitoring on approximately a monthly interval was continued through October 1989, after which a quarterly monitoring interval was initiated and continued through June 1990.

Water levels were measured in 2- and 5-inch monitoring wells by using a Solinst electric water level probe. This probe consists of an electric water level sensor on a calibrated tape and was used to measure the depth to the standing water level in the well. During pump testing of H88-15 and 16 a Terra 8D automatic data acquisition system was used to measure water levels in the wells. This system utilizes an electric transducer to measure water pressure. Measurements are stored in electronic memory and software is available to convert measurements to water levels. Water levels were measured by an electric well probe during pump testing of well H89-29.

Pneumatic piezometers were measured using a pneumatic readout unit. This unit measures water pressures directly. Pressures are converted to hydraulic head based upon the elevation of the piezometer tip.

3.2.5 Monitoring Well Testing

Most monitoring wells were hydraulically tested by slug testing methods following well development. Slug testing provides a method of estimating the hydraulic conductivity and transmissivity of the screened interval in the well. A Solinst water level tape and a Terra 8D data logger with an electronic pressure transducer were used to collect the recovery data. The testing method involved measuring the static-water level in the well, calibrating the Terra 8D and then removing or introducing a slug of water and monitoring the recovery of the well to static water level. Tap water from Palmer, stored in newly purchased plastic five-gallon containers, was used as slug water. The slug tests were performed after the monitoring wells had been sampled so as not to affect laboratory analytical results.

In addition to slug testing, two bedrock groundwater monitoring wells (H88-15 and H88-16) were pump tested in 1988 and well H89-29 completed into the old workings of the Premier Mine was tested in July 1989. Pump test wells H88-15 and 16 were constructed of 5-inch PVC and were designed as part of a pump test cell that included nearby piezometers to measure drawdowns in the bedrock aquifer. Well H89-29 was constructed with steel casing and was not part of a test cell including piezometers. The lithology and construction logs of the pump testing wells are provided in Appendix A. Wells H88-15 and 16 were screened across a large interval of sedimentary bedrock to allow testing of a representative section of strata that will contribute to pit inflows. Well H89-29 was screened in mine voids to determine groundwater conditions in the old workings.

MW Drilling out of Anchorage, Alaska, was contracted by Golder Associates Inc. to perform the pump testing and related activities in 1988. The wells were pumped using a submersible 2-hp pump powered by a gasoline-driven generator. Water was discharged through a 1-inch galvanized drop pipe, a flow meter, and multiple flow control valves. A 75 foot discharge line carried the water away from the well site. The water discharge rate was continuously monitored and adjusted when necessary to maintain constant flow rates during the tests.

Pumping rates were chosen based on flow rates produced during the air lifting development, slug testing and initial short-term step-testing of the wells. Water levels within the wells were continuously monitored by a Terra 8D data logger equipped with an electronic pressure transducer. Piezometers were read periodically during pumping and recovery phases using a Petur pneumatic piezometer readout unit charged with nitrogen gas. Drawdown and recovery data recorded during the pump test are presented in Appendix D.

Pump testing equipment was initially set up on well H88-16 on November 10, 1988. Pumping began at 1010 hrs. on November 11 at a rate of 4.5 gallons per minute (gpm) based on development estimates. This rate turned out to be too high and the pump was stepped down to 2.8 gpm at 1152 hrs. The pump was turned off at 2017 hrs. on the 11th, and the well was monitored to recovery at 1530 hrs. on the 12th. A second pump test was started at 1200 hrs. on November 14 at a rate of 1 gpm. The pump was turned off at 0039 hrs. on the 15th. The well recovered by 1112 hrs. on November 15.

Pump testing equipment was set up on well H88-15 on November 15, 1988. A step test of the well began at 1415 hrs. on November 15 at 2 gpm initially and then at 3 gpm after 1636 hrs. The pump was turned off at 1751 hrs. on the 15th and allowed to recover overnight. The second pump test began on November 16 at 1128 hrs. at a rate of 4 gpm that was maintained throughout the test. The pump was shut down at 0021 hrs. on the 18th and the well recovered to within 3 feet of the static by 1624 hrs. on the 18th.

Groundwater monitoring well H88-14 was designed as a 5-inch diameter pump test well in the glacial/alluvial sediments adjacent to Moose Creek. However, a combination of relatively low permeability materials in which the well was completed (i.e., saturated alluvial sediments were not encountered) and minimal saturated thickness made pumping in H88-14 unfeasible. Instead, a slug test was conducted in H88-14. Well H88-14 was replaced with well H88-14A which was located immediately adjacent to Moose Creek in alluvial sediments.

Pump testing in H89-29 was conducted by Tester Drilling under contract to Idemitsu Alaska Inc. A submersible pump was set at a depth of approximately 200 feet below the top of casing on July 26, 1989. Development of the well was conducted for approximately 2 hours and clean water was produced almost immediately from the well. The pump test in H89-29 was started at approximately 0910 hours on July 27, 1989 and stopped at approximately 1355 hours on the same day. The well was pumped at an average rate of 55 gpm and produced only 0.3 feet of drawdown. Approximately 19 hours after turning off the pump the water level had recovered only 0.1 feet to approximately 0.2 feet of drawdown.

3.2.6 Water Quality Sampling and Analysis

The seventeen monitoring wells in alluvial/glacial sediments and bedrock installed in 1988 were sampled quarterly. Quarterly sampling rounds were taken in November 1988, and February, May/June, and July 1989. One round of water samples was collected from wells H89-29 and H89-30 in July 1989. The samples were collected, preserved on ice and then transported within approximately 24-hours to Inter-Mountain Laboratories, Inc. in Sheridan Wyoming for analysis. A Quality Assurance Plan describing the sample acquisition, transportation and analysis procedures is presented in Appendix H.

Samples were collected using a stainless steel bailer or a Hydrostar dedicated sampling pump. Dedicated Hydrostar pumps were installed in wells H88-10, 11, 12, 13, 15 and 16. The Hydrostar sampling system used PVC riser pipe, a stainless steel pump and stainless steel sucker rods to produce non-aerated representative groundwater samples. A pressurized air driven motor was used to power the pump for withdrawing the water during the November 1988 sampling round. In February 1989, the air motor could not be used because of site access problems during winter. A hand-powered pump was used instead. In well H89-29, the water sample was taken during operation of the submersible pump.

All wells were purged by extracting 2 to 5 times the saturated well volume to ensure that fresh, representative groundwater flowed into the well prior to sampling. Approximately 3,500 ml of water in four labeled containers was collected from each well for laboratory analysis. One of the two metal analysis samples was filtered through a 0.45 micron filter and preserved. Water samples for nutrient analysis were also preserved. Additional samples were collected for field measurements and analysis.

Water samples were analyzed for a comprehensive set of parameters as described in Appendix H. Field measurements were generally made at the time each sample was taken. These measurements included pH, conductivity, alkalinity, dissolved oxygen and temperature. In some instances, equipment problems caused by cold temperatures resulted in measurements being made after sampling (e.g. indoors) or, in the case of equipment failure, some field measurements could not be taken.

3.3 Results

3.3.1 Hydraulic Head Data

Monitoring Wells

Water levels measured in monitoring wells through June 1990 are presented in Table 3-3. These monitoring wells are completed in alluvial sediments adjacent to Moose Creek, in glacial sediments and in bedrock units. Plots of water levels in monitoring wells are provided in Appendix E-1. A discussion of water level variations is provided below.

Wells H88-14A, H88-17 and H88-19 were completed in alluvial sediments adjacent to Moose Creek at the locations shown on Plate IV-1. Well H88-14A had a maximum water level variation of 6 feet based on one high reading in April 1990. Omitting this reading, the maximum variation of other readings was only 1.5 feet. Wells H88-17 and H88-19 had variations of 1.3 and 1.5 feet, respectively. Water levels in these alluvial wells are largely influenced by the level of Moose Creek. Thus, higher levels in the wells occurred during periods of high streamflow such as during the spring runoff.

One well, H88-21, was completed in glacial sediments in Mine Area 1. It had a maximum water level variation of 6.2 feet with the highest levels occurring in May and June and the lowest levels in the fall and winter.

In Mine Area 2 wells H88-22, H88-27 and H88-28 were completed in glacial sediments. The maximum variation in these wells was 6.4, 15.0 and 12.8 feet, respectively. Seasonal fluctuations were observed with the highest water levels occurring in May to July and the lowest levels in fall and winter. An exception to this was observed in H88-22 which had a minimum water level in April 1990.

Wells H88-23, H88-24A and H88-25 were completed in glacial sediments near the proposed slurry pond. (Well H88-23 may actually be completed in the upper portion of the Tsadaka Conglomerate or in re-worked Tsadaka sediments based on a color change noted in the drill log of this hole.) Wells H88-23 and H88-24A have similar hydrographs (see Appendix E-1) with water level variations of 19.8 and 12.0 feet, respectively. The highest levels were measured in May and June 1990 and the lowest in March 1989. In general, seasonal fluctuations occur, with higher levels in May to July and lower levels in fall and winter. Well H88-25 had a maximum variation of 11.5 feet with the highest levels generally occurring in May to August and lowest levels in fall and winter. However, this well did not respond to seasonal influences the same as the other two wells in the area. In particular, H88-25 did not show the same increase in water levels in May and June 1990. This may be related to the lower hydraulic conductivity in well H88-25 compared to H88-24A as shown in Table 3-5.

On the west side of Mine Area 1 wells H88-10, H88-29 and H88-30 were completed in bedrock at the locations shown in Plate IV-1. Wells H88-10 and H88-30 were completed in the Premier coal. Well H88-29 was completed in mine voids from the old underground workings in the Premier coal. Well H88-10, which is adjacent to Moose Creek, had a maximum water level variation of 16.3 feet with the highest levels occurring in May to July and the lowest levels in fall and winter. The water levels in H88-10 ranged from approximately elevation 711 to 727 feet, whereas the elevation of Moose Creek near this well ranges from 755 to 765 feet. Water levels in H88-29, which was completed in the old mine workings, varied 10.1 feet with the highest level measured in June 1990. Water levels in H88-29 ranged from approximately 700 to 710 feet in elevation, which is well below the 750 to 760 elevation of the adjacent reach of Moose Creek. Water levels in H88-30 varied by 8.9 feet and ranged from approximately 716 to 725 feet in elevation with the highest level measured in January 1990. The existence of the old mine workings is evidently affecting bedrock water levels in these three wells. The observation that water levels in the old workings fluctuate seasonally indicates that groundwater contained in them must be discharging to an elevation below

700 feet. It is possible that stratigraphic or structural features result in discharge of this groundwater along Moose Creek at points downstream of the proposed permit boundary, although no such features have been detected. These water levels also serve to illustrate the poor hydraulic connection between Moose Creek and the underlying bedrock in the vicinity of the old workings.

In the center of Mine Area 1 well H88-15 was completed over an approximately 200 foot interval of the Premier Group. This well was used for pump testing of the strata that will contribute to mine inflow in Mine Area 1. Water levels varied 11.2 feet in this well with the higher levels occurring in May and June and the lower levels in late summer, fall and winter.

Four bedrock wells were completed in Mine Area 2. Well H88-11 was completed in the Burning Bed coal. It had a maximum variation in water level of 5.3 feet and showed no discernable seasonal fluctuations. Well H88-12 was completed in the Eska coal and had a maximum variation in water level of 4.2 feet. It also displayed no discernable seasonal fluctuations. Well H88-13, completed in the Jonesville-Premier interbed material, had a maximum fluctuation of 12.2 feet based on one anomalously high measurement in August 1989. Omitting this reading, the variation was only 3.8 feet with the highest levels occurring in May and June. Well H88-16 is a pumping well completed across approximately 350 feet of steeply dipping beds in the Premier Group and Midway coal. It displayed some apparent seasonal variation in 1990 with water levels increasing by several feet in May and June 1990.

Piezometers

A summary of piezometric heads measured in pneumatic piezometers is presented in Table 3-4. Plots of piezometric heads from these piezometers are provided in Appendix E-2 and data are tabulated in Appendix E-3. Maximum variations in piezometric heads within individual piezometers ranged from 8.9 to 68.6 feet with the vast majority of variations ranging between 9 and 30 feet. The highest heads in most piezometers occurred in May and June 1990. Relatively high values were also measured in June and July 1989. The lowest heads were generally measured in the period of September 1988 to April 1989 or in December 1989. Thus, piezometric heads vary seasonally with highest levels occurring during spring runoff in May through July and the lowest heads occurring in fall and winter.

Some individual piezometers had larger head variations. It is likely that these more variable head measurements are spurious readings caused by drilling, installation or instrument malfunction. Drilling and installation effects are caused by the introduction of drilling fluid and grout into the hole which will result in a disequilibrium between the hydraulic head in the borehole and that in the surrounding formation. Several hours to days may be required for these effects to dissipate and hydraulic head equilibrium to be established between the piezometer and the surrounding formation. Also, during the winter months, extremely cold temperatures may have resulted in malfunction of the pneumatic piezometers and read-out device (e.g. frozen water vapor in lines).

3.3.2 Seismic Survey Data

The seismic profiles conducted along lines S1 and S2 in Mine Area 1 and lines S3, S5 and S6 in Mine Area 2 (see Plate IV-1) encountered three major types of material based on seismic velocities. The uppermost layer is defined by low seismic velocities and consists of soil, loess and loose sediments. The second layer consists of unsaturated and saturated alluvial and glacial sediments defined by intermediate seismic velocities. The third layer includes Tertiary sedimentary bedrock and is defined by relatively high seismic velocities.

The seismic profile results for each line are discussed below. Cross sections along each of the profile lines are presented in Appendix G and the location of each line is shown in Plate IV-1.

Lines S1 and S2 were located along the west side of the proposed pit in Mine Area 1 where the proposed pit extends down into the Moose Creek Valley onto what is probably an old stream terrace. The ground surface along the top of the proposed pit slope ranges from approximately 780 to 800 feet in elevation in this area. The reach of Moose Creek along this portion of the proposed pit ranges from approximately 745 to 770 feet in elevation.

Line S1 (see Figure 1, Appendix G) extended northwest-southeast along the base of a relatively steep slope that forms a transition between the Moose Creek Valley (including the current floodplain and old terraces) and the higher elevation glacial terrain which extends northeast towards Wishbone Hill. A 4 to 5 foot thick low velocity zone representing surfical soils and loose sediments was encountered along S1. The bedrock and glacial/alluvial sediment contact along S1 was variable. Starting at the northwest end of the line and extending approximately 180 feet southeast along the line, bedrock was detected at 10 to 20 feet in depth. From 180 to 480 feet along the line, the bedrock contact deepened to approximately 35 to 45 feet below ground surface, probably indicating an old channel incised up to 25 feet into bedrock. From 480 to 830 feet along line S1, bedrock was encountered at depths of 15 to 25 feet below ground surface. From 830 feet to the end of the line at 1120 feet, the contact with competent bedrock deepened to 40 to 90 feet below ground surface. However, evidence of some competent rock at depths of 25 to 35 feet was also detected along this section of line S1. Northland Geophysical Company interpreted this as a possible zone of weathered Tertiary bedrock (see Appendix G). It is also possible that the seismic profiling was picking-up disturbed zones of bedrock where underground mining has occurred in the Premier Group.

Line S2 (see Figure 2, Appendix G) was oriented perpendicular to S1 and extended from the Moose Creek Valley on the west end up a relatively steep slope and into the higher glacial terrain on the east end. The portion of line S2 in the Moose Creek Valley encountered bedrock at depths of 10 to 25 feet. Line S2 did not encounter the incised channel in bedrock detected along line S1. As the line extended upslope to the east, the glacial sediments thickened to approximately 60 feet. The bedrock surface increased in elevation from west to east from approximately 750 feet to 840 feet.

Lines S3, S5 and S6 were located along the northwest side of the proposed pit in Mine Area 2. The proposed pit in this area extends most of the way down a steep slope separating the higher glacial terrain from the lower terrain in the Moose Creek Valley (see Plate IV-1). The ground surface along the top of the proposed pit slope ranges from approximately 950 to 1000 feet in elevation in this area. The adjacent reach of Moose Creek ranges from approximately 925 to 975 feet in elevation.

Line S3 (see Figure 3, Appendix G) extended northeast-southwest along the base of a relatively steep slope that forms the transition between the Moose Creek Valley and the higher elevation glacial terrain that extends up to Wishbone Hill. A 3 to 5 foot thick layer of low velocity material representing surficial soils was encountered along the northeastern half of the line. An intermediate velocity zone, approximately 5 to 20 feet thick, was encountered underneath the surficial material. The intermediate velocity material probably represents glacial sediments on the northeastern half of the line. A high velocity zone representing bedrock was encountered below the intermediate zone. On the southwestern half of the line, the shallow low velocity zone was absent and an intermediate velocity zone, ranging from 5 to 10 feet thick, was encountered directly overlying bedrock. The shallow zone along this section of the line may represent Moose Creek floodplain deposits. No significant channels or other irregularities in the bedrock surface were detected along line S3.

Lines S5 and S6 (see Figures 4 and 5, Appendix G) were oriented perpendicular to S3 and extended from the Moose Creek Valley up a steep slope and onto higher elevation terrain to the southeast. The seismic stratigraphy of these cross profiles was similar to line S3. On the Moose Creek Valley floor, bedrock was overlain by 5 to 10 feet of intermediate velocity materials probably representing alluvium. As the lines extended upslope, a 3 to 5 foot thick layer of low velocity surficial soil material was found overlying a 10 to 15 foot thick layer of intermediate velocity material, probably comprised of glacial sediments. The bedrock surface showed no significant erosional channels or other irregularities.

3.3.3 Aquifer Test Data

Slug Tests

Hydraulic properties of the bedrock and glacial/alluvial sediments were estimated with falling head slug tests. Hydraulic conductivities were calculated with the Hvorslev basic time lag method (Hvorslev, 1951). Values for transmissivity were then calculated by multiplying hydraulic conductivities by the length of saturated sandpack in each well. Test data and calculations are provided in Appendix C. Table 3-5 is a list of the values for hydraulic conductivity and transmissivity that were determined for each monitoring well.

In the glacial/alluvial wells that had water levels below the top of the sandpack, saturated thickness was taken to be the interval from the bottom of the sandpack to the water table. Inaccurate early-time data due to slug water initially filling the sandpack produced deviations from the theoretical straight line. However, later time data generally displayed the straight line necessary for acceptable analyses.

Calculated hydraulic conductivities from slug tests in glacial/alluvial sediments varied widely. Values obtained from wells in glacial sediments ranged from 0.1 to 4.2 ft/day with the exception of one value of 0.008 ft/day from well H88-25. Two tests from wells in alluvial sediments yielded values of 10.3 and 52.4 ft/day. The higher values in alluvium reflect a significantly smaller fines content in these sediments than in the glacial deposits as observed in the field and described in the borehole logs presented in Appendix A.

Calculated hydraulic conductivities in bedrock ranged from 0.005 to 4.7 ft/day. The slug test in well H88-10 recovered too rapidly for analysis (i.e., the hydraulic conductivity was too high). This well is located in an area where underground mining in the Premier Group has occurred previously. Thus, the hydraulic conductivity in H88-10 has probably been significantly enhanced by mining and associated disturbance in bedrock.

Pump Tests

Pump tests to determine representative formation hydraulic conductivities of the bedrock aquifer in Mine Areas 1 and 2 were performed in wells H88-15 and H88-16, respectively. The spatial layout and cross sections of the H88-15 and H88-16 pump test cells are shown in Figures 3-4 and 3-5, respectively. A pump test was also conducted in well H89-29 which was completed in the old workings of the Premier Mine. This test was conducted to determine groundwater conditions in the old workings.

During the tests in H88-15 and H88-16 pumping and recovery data were collected in the pump wells with a Terra 8D computerized data acquisition system. In addition, piezometric levels were monitored periodically during the pump test in the nearby piezometers. Water level data were collected with an electric water level probe during testing of well H89-29.

Several analytical approaches were used to evaluate the H88-15 and H88-16 pump test data and determine aquifer parameters. Drawdown and recovery data were analyzed using the Theis curve-matching method for non-leaky confined aquifers (Theis, 1935), the Hantush-Jacob curve-matching method for leaky confined aquifers (Hantush and Jacob, 1955), and the Jacob straight line method for non-leaky confined aquifers (Jacob, 1946). Recovery data were analyzed using the Theis recovery method (Theis, 1935). These methods were used to determine transmissivity and hydraulic conductivity of the pumping well. Piezometer data were analyzed to estimate transmissivity and hydraulic conductivity as well as specific storage of the bedrock. The data from well H89-29 were not amenable to analysis using standard methods because the well was completed in mine voids which responded to pumping as essentially a reservoir. The results of this test are discussed below. Test data and detailed analyses are presented in Appendix D.

Well H88-15 was located in relatively flat-lying Premier Group strata as shown in Figure 3-4. The well was pumped for approximately 3000 minutes at a rate of about 4 gpm. The maximum drawdown in the well was approximately 80 feet at the end of the pumping period. Recovery of the well was 99 percent complete within 209 minutes after shutting off the pump. Drawdown in response to pumping was measured in the three piezometers in hole PB-105, which is located approximately 250 feet from the pumping well. The maximum drawdown in the three piezometers ranged from 7 to 15 feet. Considering the heterogeneous nature of the bedrock, these drawdowns were quite uniform and indicate that the bedrock responded to pumping as a continuous unit at PB-105. Piezometers in holes PB-8 and PB-60, located approximately 400 and 800 feet from the pumping well, respectively, did not have a measurable response to pumping. Piezometers in hole PB-7, located approximately 450 feet from the pumping well, responded erratically during the test. It is expected that readout instrument error or frozen water vapor in the piezometer lines may have resulted in the erratic readings. A clear response to pumping could not be determined in PB-7. The lack of response in holes PB-7, 8 and 60 was probably a result of their greater distance from the pumping well.

The transmissivity calculated from the drawdown data in H88-15 is approximately 5 ft^2/day (see Figures D-1 and D-2, Appendix D) which corresponds to an average hydraulic conductivity of the test interval of 0.02 ft/day. Recovery data in H88-15 indicate a transmissivity of 2 ft^2/day and a hydraulic conductivity of 0.01 ft/day (see Figure D-3, Appendix D). The transmissivity values calculated from the PB-105 piezometer data range from 14 to 30 ft^2/day. Specific storage values range from 2×10^{-7} to 4×10^{-7} ft^{-1} (see Figure D-7, Appendix D).

The differences in transmissivity values calculated from drawdown data taken from H88-15 and piezometers in PB-105 are typical of a heterogeneous aquifer. They may result from a number of factors relating to the natural variability of the bedrock and the fact that simplifying assumptions made in the analytical models are seldom met in nature. The individual piezometers measured drawdown in only a discrete portion of the pumped interval in H88-15 (i.e. the completion interval of the piezometer as indicated in Figure 3-4 and Appendix B) and therefore are not representative of the entire pumped interval. The best estimate of the transmissivity of the entire pumped interval at the location of H88-15 is 2 ft^2/day which was calculated from data obtained in the pumped well.

The pump test data from well H88-15 start to deviate from the non-leaky Theis curve at approximately 60 minutes into the test (see Figure D-1, Appendix D). The drawdown curve approaches horizontal until a time of approximately 600 minutes into the test when drawdown data again start to increase with time. There are several possible explanations of these data. Assuming the zone being pumped behaves as a confined aquifer, the initial flattening of the drawdown curve at 60 minutes could indicate vertical leakage into the pumped zone from overlying and/or underlying units, or it could indicate a recharge boundary such as a permeable fault or lateral change to a higher transmissivity formation. The second deviation at 600 minutes may reflect another boundary (i.e. no-flow boundary) such as a low permeability fault or lateral change to a lower transmissivity formation. The drawdown data could also indicate a change from confined to unconfined conditions in the pumped zone (e.g., a delayed yield response). There are a number of structural and stratigraphic features near well H88-15 that could contribute to the drawdown response that was measured (see Figures 3-5 and 4-1). The later time drawdown effects do not affect the estimate of transmissivity made from the early time data when measured drawdown falls along the Theis curve.

Well H88-16 is located in steeply dipping (i.e. 55 degrees) Premier Group strata as indicated in cross section A-A' in Figure 3-5. The well was pumped for approximately 800 minutes at a rate of 1 gpm. The maximum drawdown in the well was approximately 46 feet at the end of the pumping period. Recovery in the well was complete within about 1350 minutes after shutting off the pump. During the pumping period measurable drawdown was not observed in any of the piezometers in holes PB-12, PB-102 and PB-13 located approximately 165, 235 and 260 feet from the pumping well, respectively.

The transmissivity calculated from the drawdown (see Figures D-4 and D-5, Appendix D) and recovery (see Figure D-6, Appendix D) data in H88-16 is approximately 2 ft^2/day which corresponds to an average hydraulic conductivity over the pumped interval of approximately 0.006 ft/day.

Hydraulic conductivity is a highly variable parameter in most natural geologic materials. The values that were obtained from the pump tests in H88-15 and H88-16 are applicable at the location and scale of the tests but may vary at other locations. The major purpose of running the large-scale pump tests was to test a large volume of the bedrock and thus obtain representative large-scale values of hydraulic conductivity.

Various errors may be associated with field testing for hydraulic conductivity. In general, the errors associated with equipment measurement (i.e. water level probes, flow meters) will be relatively small, on the order of 10 percent or less. The possible errors associated with the calculation of hydraulic conductivity by analyzing test data using an idealized model (i.e Theis analysis, Hantush analysis, etc.) will be more significant and can range up to several hundred percent depending on the degree to which the natural system meets the assumptions inherent in the analytical models.

The strata tested in both H88-15 and H88-16 are stratigraphically and structurally complex and, therefore, do not meet many of the assumptions inherent in standard pump test analysis methods (e.g. homogeneous isotropic aquifer with infinite areal extent). Therefore, the pump test results should be considered order of magnitude estimates. Qualitatively they indicate that the bedrock units are of relatively low permeability and can be expected to produce very limited amounts of water to wells or open excavations.

Well H89-29 which is completed into the open mine voids of the old Premier Mine was pumped at 55 gpm for a period of 285 minutes. The water level in the old workings decreased about 0.25 feet due to pumping. The pump test results indicate that the old workings behaved as an open reservoir rather than a porous media. Therefore, hydraulic conductivity is not a relevant parameter and the test could not be analyzed using standard aquifer analysis techniques.

The test data were analyzed (see Appendix D) to estimate the area of old workings that were influenced by the test. Based on the known volume of water pumped, the observed drawdown, an estimated extraction ratio at 50 percent in the old mine, and an estimated width of the mine of 17.4 feet (based on a 10 foot seam dipping at 35 degrees), the total length of old workings affected by pumping was 964 ft. This is approximately one half of the total length of workings on the west side of Moose Creek. These results indicate that the old workings may not be directly connected hydraulically over their entire length of approximately 3,600 feet. However, sustained pumping for days or weeks coupled with monitoring of water levels in the old workings would be required to accurately determine the degree of connection. This testing is best conducted during actual dewatering of the old workings prior to mining (see Part D, Section 11.0).

Recovery of water levels was relatively slow with a total recovery of about 0.1 foot in 1126 minutes (see Appendix D). Using the same ratio of drawdown to volume pumped that was observed during the pump test, a recovery rate of about 5 gpm was estimated for the old workings (see Appendix D).

3.3.4 Groundwater Quality Data

Laboratory analyses of groundwater samples were conducted by Inter-Mountain Laboratories, Inc. The original laboratory reports of analytical data are presented in Appendix F along with laboratory QA/QC procedures.

Field parameters for the quarterly groundwater sampling are presented in Table 3-6. Results of the laboratory analyses of quarterly groundwater samples are summarized in Table 3-7.

The analytical results obtained for well H88-13 may not be representative of actual groundwater chemistry based on drilling and sampling considerations. Mud was used during the drilling of H88-13 to prevent collapse of the borehole. The use of mud probably caused the high dissolved solids content that has been measured in this well.

The initial sampling results from well H88-25 are also probably not representative. Well H88-25 was a low producer and well development prior to sampling was very difficult. Therefore, high levels of dissolved solids in the initial sampling round may reflect the lack of adequate well development. Lab results from the February, May/June and July, 1989 sampling event for this well show a decrease in concentrations for most of the analytical parameters, probably indicating a return to native water composition.

Field measurements and laboratory analyses of samples collected during the four rounds of sampling indicate that groundwaters at the site have variable water quality. Ignoring well H88-13, which is still considered unrepresentative due to the use of mud during drilling, the groundwaters have pH values ranging from 6.1 to 11.5, total dissolved solids from 66 to 834 mg/l, total hardness from 4 to 191 mg/l, total alkalinity from 4.1 to 1521 mg/l, and acidity less than 1 mg/l. A detailed discussion of the groundwater quality results is presented below.

Field Parameters

Field parameters obtained during the November, 1988 and February, May/June and July, 1989 sampling events are summarized in Table 3-6. Values of pH measured in the field vary from slightly acidic (6.06) to basic (11.45), and generally fall between 6.5 and 8.8. The pH values for wells completed in the glacial/alluvial units range from 6.06 to 8.46 and average 7.3. Bedrock wells show a wider range of pH values from 6.96 to 11.45 and average 8.9. Laboratory measurements of pH were generally within one standard pH unit of the field measured value.

Groundwater from bedrock well H88-12 consistently had pH values in the 9.7 to 11.4 range whereas groundwater from all other wells was generally below pH 9. Well H88-12 is completed into the Eska coal unit. The Eska coal also had the highest pH value reported in the overburden/interburden geochemistry data in Part C, Chapter III (i.e. a pH value of 9.2). The reason for the anomalously high pH values in well H88-12 is not known.

Field conductivity measurements ranged from 96 to 1441 µmhos/cm. Conductivity values for the glacial/alluvial wells ranged from 96 to 741 µmhos/cm, with a mean value of 217 µmhos/cm. Higher conductivity values were measured in bedrock wells and ranged from 260 to 1441 µmhos/cm, with a mean value of 698 µmhos/cm.

Concentrations of total dissolved solids (TDS) ranged from a minimum of 66 mg/l to a maximum of 834 mg/l excluding well H88-13. During November, 1988 a TDS concentration of 2750 mg/l was measured in H88-13, where mud was used during drilling. The values measured during the succeeding three rounds were 1984, 1850 and 2008 mg/l, respectively. All wells completed in glacial/alluvial units had relatively low concentrations of TDS (66 to 202 mg/l), with the exception of H88-25. As mentioned above, the November chemical results from this well may not be representative. TDS values in this well were 716, 132, 140 and 190 mg/l for the November, 1988, and February, May/June, and July, 1989 rounds, respectively. Relatively high TDS concentrations, greater than 600 mg/l, also occurred in bedrock wells H88-11, 12, 13, and 30.

Dissolved oxygen concentrations in groundwater averaged about 12 mg/l for both glacial/alluvial and bedrock wells. Values ranged from 8.3 to 14.4 mg/l in all the wells, excluding H88-13. These values are at or near the solubility limit for oxygen and are similar to oxygen concentrations measured in surface waters.

Trace Constituents

The concentrations of trace constituents, primarily metals, in groundwater samples were generally quite low. Dissolved mercury was not detected in any of the groundwater samples at concentrations above the detection limit of 0.001 mg/l. Barium was detected in well H88-10 at a concentration of 1.1 mg/l and in wells H88-13 and H89-29 near the detection limit of 0.5 mg/l. Arsenic was measured in wells H88-11, H88-12 and H89-30 at concentrations near the detection level of 0.005 mg/l and one anomalous result of 0.20 mg/l from well H88-10 in the May/June, 1989 round. Cadmium and zinc were frequently detected in multiple wells (see Table 3-7 for details), and copper and lead less frequently, but concentrations were always at or near the detection limits for these constituents. Selenium was detected only during the February sampling event in wells H88-11, 23, 25, 27, and 28 at concentrations of 0.007, 0.01, 0.007, 0.01 and 0.01 mg/l, respectively. Aluminum was also detected in several wells at or near the detection level of 0.1 mg/l. Although an aluminum concentration of 2.6 mg/l was measured in H88-22 during November 1988, the February, May/June and July 1988 analysis indicated an aluminum concentration of 0.1, 0.2 and <0.1 mg/l respectively. Similarly, values of 1.5 and 1.7 mg/l for aluminum were detected in the November, 1988 and February samples of well H88-12, with subsequent results dropping to 0.4 mg/l in May/June and below the detection limit in July. All of the July, 1989 samples showed aluminum concentrations below detection limit.

Nutrients

Nutrient levels in the groundwater samples were variable. Total organic phosphorous concentrations ranged from the detection limit of 0.001 to 3.11 mg/l, with a mean for the glacial/alluvial wells of 0.70 and a mean of the bedrock wells of 0.042. Concentrations were typically at or near 0.1 mg/l and values greater than 1 mg/l were reported in H88-19, 22, 23, 25 and 27.

Total Kjeldahl nitrogen (TKN) concentrations up to 206 mg/l were detected in the groundwater samples, but averaged 7 mg/l for the glacial/alluvial wells and 0.9 mg/l for the bedrock wells. The unusually high value of 206 mg/l TKN reported for H88-19 during November, 1988 appears anomalous when compared with the other values of 10.8 and 38.8 mg/l from the May/June and July 1989 rounds. However, all the TKN values from this well appear unusually high. Without the 206 mg/l value from well H88-19, the mean TKN value for all other wells drops to 2.9 mg/l. For all the sampling events, nitrate concentrations were low, typically less than 1.0 mg/l. A nitrate value of 7.54 mg/l was reported in H88-22 for the February 1989 sampling round and values between 1.0 and 2.55 mg/l were reported in wells H88-17 and H88-27. Nitrite was consistently below the detection limit of 0.01 mg/l with a few exceptions at or near the detection limit in wells H88-17, 21, 23, 24A, and 25.

Major Ionic Constituents

The predominant dissolved chemical constituents in groundwater in the project area were calcium, sodium, potassium and bicarbonate. The maximum concentrations for these constituents were 57, 351, 8.8, and 906 mg/l, respectively.

Bicarbonate was the dominant anion in water samples from all wells, with the exception of H88-12 and H88-25. The carbonate anion was the dominant species in well H88-12 as a result of the high pH during the November, 1988 and February, 1989 rounds with the bicarbonate anion nonexistent. During the May/June, 1989 round the bicarbonate anion was dominant but significant amounts of carbonate were also present. During the July, 1989 round the carbonate anion was dominant but significant amounts of bicarbonate were present. The pH values vary correspondingly with the carbonate/bicarbonate ratios. Chloride was the dominant anion in well H88-25 with bicarbonate secondary.

Sodium and potassium were typically the predominant cationic species in water collected from wells completed in the bedrock units. However, in wells H88-10 and H89-29, calcium was the major cationic species while sodium and potassium were of secondary importance.

Water samples collected from wells completed in the glacial/alluvial units showed a greater variability in cation chemistry than water samples from the bedrock units. Calcium was the major cation in all wells except H88-19 and 14A where calcium was the predominant cation while sodium and potassium were of secondary importance. Sodium and potassium were the predominant cations in wells H88-24A and 25 while calcium had become the secondary cationic species.

The predominant chemical characteristics of the groundwater at the site can be illustrated graphically using the representations of Piper (1944) and Stiff (1951). The trilinear diagram proposed by Piper (Figures 3-6 to 3-9) permits the composition of a water sample to be represented by a single point on a graph. This facilitates comparison of numerous water samples to determine if the water samples are compositionally similar or whether significant variations exist in the inorganic water chemistry. The trilinear plot uses two equilateral triangles, one for anions and one for cations. Ionic concentrations are expressed in milliequivalents per liter. Each vertex represents 100 percent of a particular ion or group of ions. The cationic composition of a water sample is plotted in the cation triangle, and the composition with respect to anions is represented by a point plotted in the anion triangle. The coordinates at each point add to 100 percent. The diamond-shaped field between the two triangles is used to represent the composition of water with respect to both cations and anions. The cation and anion points plotted in the triangular fields are extended into the central plotting field by projecting them along lines parallel to the upper edges of the central field. The intersection of the lines represents the composition of the water.

Figure 3-6 displays the analytical results of the November, 1988 groundwater samples plotted on a trilinear diagram. The February, May/June and July, 1989 results are shown on Figures 3-7 to 3-9. The water chemistry of the bedrock wells with the exception of H89-29 and H88-10 clusters tightly at the bottom portion of the central diamond field indicating the dominant sodium-potassium-bicarbonate composition. Water compositions for most of the glacial/alluvial wells in the November 1988 and February 1989 sampling rounds plot closely together in the left side of the central diamond field which indicates a calcium-bicarbonate composition. Water compositions during these rounds for H88-14A, 24A, and 25 plot more towards the center of the diamond field indicating the increased percentage of sodium and potassium in these samples. Plots of glacial/alluvial wells have moved upwards and towards the center of the diamond field in the May/June and July sampling rounds, indicating higher calcium and chloride concentrations.

In Stiff diagrams the analytical values for a water analysis are plotted along horizontal axes. These axes are separated from each other and are divided by a vertical center line. Cation concentrations are plotted on one side of the center line and anion concentrations on the other. Joining the plotted concentration points for a particular water analysis produces a polygon with a shape that is characteristic of the particular water composition. Stiff diagrams of similar shape imply similar water compositions.

Figures 3-10 and 3-11 are Stiff plots of the analytical data from the four sampling rounds for bedrock and glacial/alluvial wells, respectively. Analytical data for the individual constituents for the sampling rounds were averaged to produce a composite diagram characterizing the groundwater chemistry of each well.

The water compositions of the bedrock wells are presented in Figure 3-10. The characteristic shape of the Stiff diagrams for the bedrock wells graphically illustrates the sodium-potassium-bicarbonate composition of these waters.

Stiff diagrams displaying water composition for the glacial/alluvial wells are presented Figure 3-11. These groundwaters are more variable in composition than groundwaters from the bedrock wells. Three general types of water composition were identified. Water from the glacial/alluvial wells may be characterized as either calcium-bicarbonate composition (H88-21, 22, 28, 17, 23 and 27), calcium (sodium and potassium)-bicarbonate composition (H88-19, and 14A), or variable sodium and potassium dominant water types (H88-24A, and 25). The groundwater composition in well H88-19 may be influenced by the old mine tailings that overlay the sand unit in which the well was screened.

4.0 ANALYSIS OF SITE HYDROGEOLOGY

4.1 Groundwater Flow System

4.1.1 Hydrostratigraphy

The detailed geology of the proposed Permit Area is described in Chapter II of this permit application. This section presents an overview of the geological conditions in each of the two proposed mine areas as they relate to the groundwater flow regime.

The proposed Permit Area is underlain by Tertiary sedimentary bedrock of the Chickaloon, Wishbone and Tsadaka Formations. The Chickaloon Formation is comprised of shale, claystone, siltstone, sandstone, coal and pebble conglomerate. The upper Chickaloon contains the major coal groups that will be mined including, from top to bottom, the Jonesville Group, the Premier Group and underlying Midway Seam, the Eska Group and the Burning Bed Group. Individual beds within the upper Chickaloon Formation tend to intergrade and vary in thickness over relatively short distances. Coal beds within the well defined groups tend to grade laterally into carbonaceous shale and claystone.

The Wishbone Formation is comprised of pebble conglomerate, sandstone and siltstone. The unit as a whole is competent and well cemented. It tends to contain finer sediments in its lower portion where it grades into the Chickaloon Formation.

The Tsadaka Formation is comprised of pebble conglomerate, sandstone, siltstone and silty carbonaceous shale. Spatially the Tsadaka Formation is discontinuous and not well defined across the site. It is believed to be poorly indurated and friable.

The sedimentary bedrock is overlain by Quaternary deposits including glacial outwash, glacial drift, ice-marginal deposits, esker-kame terrace deposits, stream terrace gravels, alluvium, colluvium and aeolian loess. The glacial deposits, where they were encountered in boreholes, ranged from well-graded gravels and gravel-sand mixtures with little or no fines and 5 to 25 percent cobbles and boulders, to silty sands and tills. (Grain size analyses of soil samples from glacial wells H88-21 and 22 are presented in Part C, Chapter V.) The stream alluvium consists of coarse gravel to coarse sand with some cobbles, boulders, and silt and a trace clay. The colluvium and aeolian loess is found in a surficial soil layer over portions of the site and is generally less than 5 feet thick.

A bedrock geologic map of the site is presented in Figure 4-1. Representative geological cross-sections located on Figure 4-1 have been constructed through each of the two mine areas. These sections, which include water levels in wells and piezometers, are presented in Figures 4-2 to 4-7 (Figure 4-2 is a legend for the cross-sections).

Mine Area 1

Section B-B', shown in Figure 4-3, runs northwest-southeast through the western portion of Mine Area 1. The Premier Group and underlying Midway Seam dip to the northwest. Portions of the Premier have been removed by previous room and pillar mining operations in this area. Data from wells H89-29 and H89-30 (not on section B-B') indicate that water level elevations in the old workings are approximately 710 feet (see Section 3.3.1). The piezometric levels measured in hole PB-101 may also be affected by the previous mining activities. As indicated in Figure 4-3, the piezometric head in the Premier Group (Piezometer No. 3 in hole PB-101) is below the top of the Premier and below the level of Moose Creek.

Section D-D' (Figure 4-4) runs northwest-southeast through the eastern portion of Mine Area 1. The northwest end of the section encounters an area of southeast dipping Jonesville Group coal which is separated from relatively flat-lying Premier Group coal by a northeast-southwest trending fault. The major portion of the cross-section lies in the Premier Group Coal until at the southeast end, another fault is encountered and the Wishbone Formation truncates the Premier Group. Piezometric levels in the coal groups generally decrease to the southeast. The heads in the Midway Seam underlying the Premier Group are about 20 feet higher than the corresponding heads in the Premier.

Cross-section G-G' (Figure 4-5) runs northeast-southwest through the eastern part of Mine Area 1. It shows the flat-lying Premier Group coal bounded on the southwest by the Tsadaka Formation, which has been faulted up against the Premier and on the northeast by the Wishbone Formation, which has also been faulted up against the Premier.

Mine Area 2

Section I-I' (Figure 4-6) runs northwest-southeast through the western portion of Mine Area 2. All four of the coal groups are represented on this section. They dip steeply to the southeast. The Premier Group is repeated due to the presence of a thrust fault on the southeast end of the cross-section. Other thrust faults are also located along this cross-section.

Section M-M' (Figure 4-7) runs northwest-southeast through the eastern portion of Mine Area 2. This section intersects all four major coal groups, but does not have the thrust faults shown in Section I-I'. As in Section I-I', the coal beds dip steeply to the southeast.

4.1.2 Hydrogeologic Units

Two major hydrogeologic units occur within the proposed Permit Area. Sedimentary bedrock, which includes the target coal seams and underlies the site comprises the first unit. Glacial sediments and alluvial deposits comprise the second major unit.

Bedrock Unit

Tertiary sedimentary bedrock including the Tsadaka, Wishbone and Chickaloon Formations comprises the bedrock hydrogeologic unit at the site. As discussed in Section 4.1.1, both the Tsadaka and Wishbone Formations consist mainly of pebble conglomerate, sandstone and siltstone. The Chickaloon Formation is comprised of the same materials but also includes a significant proportion of claystone, shale and coal. Individual beds in the Chickaloon tend to intergrade laterally and vary in thickness over short distances. The majority of the bedrock is well indurated, relatively competent rock.

Structural features including folds and faults have added complexity to the bedrock hydrogeologic unit. In some instances, faults have caused significant lateral or vertical offset of beds.

Where hydraulically tested in small-diameter monitoring wells and large-diameter pumping wells, the bedrock hydrogeologic unit has generally exhibited low hydraulic conductivity in the range of 0.005 to 0.03 ft/day (with the exception of wells H88-10 and H89-29, which are affected by the old underground workings in the Premier Mine). Direct observational data from the pumping tests in wells H88-15 and H88-16 indicate that the hydraulic response to pumping is limited in areal extent. These wells, which were open to several hundred feet of bedrock, produced only between 1 and 4 gpm during sustained pumping. Thus, no significant water producing zones in bedrock were identified in either pumping well. The bedrock hydrogeologic unit is best characterized as a heterogeneous, uniformly low permeability unit. It would normally be considered an aquitard rather than an aquifer based on its permeability and yield. Because the bedrock is a heterogeneous, low-permeability and structurally complex unit, the degree of hydraulic interconnection in the unit is low to moderate causing piezometric heads to vary both horizontally and vertically within the bedrock.

The bedrock formation has been faulted as shown in Figure 4-1. The old Premier and Buffalo mines encountered faults in underground workings according to Barnes and Payne (1956) who reported that mining in faults required additional underground support. They did not report any significant increases in mine inflow associated with the faults. They indicated that significant gouge zones are associated with faults. During the geotechnical drilling program for the proposed mine (Golder Associates Inc., 1989) angle hole PB-103 penetrated a fault zone at a depth of 280 feet on the north side of Mine Area 2. The core information indicated a brecciated zone with moderate weathering and a high clay content characteristic of gouge.

Based on the available information, it is anticipated that faults will be generally low permeability features because of weathering and high clay content. It is possible that significantly higher permeability zones may be associated with fractures or faults in the bedrock. However, these zones, if they exist, should be fairly localized and should not change the basic consideration of bedrock as a low permeability unit.

Glacial/Alluvial Unit

Glacial and alluvial sediments are combined into a hydrogeologic unit. Glacial sediments are extensive across the site whereas alluvial sediments are mainly confined to the Moose Creek Valley. Groundwater in this hydrogeologic unit is generally under unconfined conditions. This unit forms the uppermost aquifer at the site.

Glacial sediments are composed of a wide variety of materials ranging from clayey and silty sands to well-graded gravels. Glacial sediments range in thickness from 5 to well over 100 feet and directly overlie bedrock over most of the site.

The glacial sediments are stratified and individual layers are not continuous over significant distances. During drilling of these sediments, zones of hard material were encountered reflecting large rocks and/or zones of cementation. Localized perched groundwater conditions (i.e. saturated zones above the regional water table) were encountered during drilling. Generally these localized zones were perched on silt and clay layers or on cemented zones and could not be traced between drill holes. Thus, there are no mappable aquifer and aquitard zones within the glacial sediments at the scale of the well spacings on the site. Instead, the glacial sediments comprise a heterogeneous unconfined aquifer.

Fluvial processes in Moose Creek have sorted the glacial sediments leaving alluvium deposits comprised of cobbles, gravel and sand with some silt and clay. The alluvial deposits are of limited areal extent. They primarily are confined to the existing stream channel and flood plain of Moose Creek as evidenced by monitoring wells installed near Moose Creek that penetrate unworked glacial sediments (e.g. H88-14). Moose Creek is apparently flowing on or just above bedrock along much of its reach in and adjacent to the proposed Permit Area based on seismic information presented in Section 3.3.2 and drillhole data from wells penetrating Moose Creek alluvium (see Appendix D).

The extent and saturated thickness of the alluvial and glacial sediments are shown in Figure 4-11. Generally, the saturated alluvial sediments along Moose Creek are less than 20 feet thick. Saturated glacial sediments range from less than 20 to approximately 40 feet in Mine Area 1 and approximately 20 to 60 feet in Mine Area 2.

4.1.3 Hydraulic Parameters

Hydraulic parameters were measured in slug and pump tests conducted in bedrock and glacial/alluvial units. The distribution of hydraulic conductivity values measured in the two units is shown in Figure 4-8.

Bedrock hydraulic conductivities generally fall within the range of 0.005 to 0.03 ft/day. Values obtained from both slug tests and pump tests are consistently in this range. An exception to this range is a value of 4.7 ft/day measured in well H88-12. This well is completed into the Eska Group and represents the only test conducted in the Eska. Although it may indicate that the Eska is significantly higher in hydraulic conductivity than the other coal units, it is considered more likely that this hole encountered a zone of more extensive fracturing that may not be characteristic of the Eska at other locations. Two values of specific storage in bedrock of approximately 2×10^{-7} and 4×10^{-7} ft^{-1} were obtained from the H88-15 pump test. Specific yield (i.e. drainable porosity) of the bedrock is likely to be quite low, probably 2 to 10 percent based on the material types.

The overall average hydraulic conductivity of the bedrock is low. It is expected that the higher permeability strata will include sandstone and coal units. Siltstone, claystone and shale units will have very low hydraulic conductivities. Where strata are relatively flat-lying, the siltstone, claystone, and shale units will limit vertical leakage into the sandstone and coal. Where strata are steeply dipping the siltstone, claystone, and shale units will tend to form sub-vertical barriers to horizontal flow.

The hydraulic conductivity of the glacial sediments is highly variable. Figure 4-8 indicates that hydraulic conductivities determined from slug tests range from approximately 0.008 to 4 ft/day with most values falling between 0.1 and 1.4 ft/day. This range of hydraulic conductivities reflects the variability of material types in the glacial sediments. In general, the hydraulic conductivity of the glacial sediments is probably one to two orders of magnitude greater than the bedrock. The specific yield of the glacial sediments can be expected to be in the range of 5 to 15 percent based on material type.

Hydraulic conductivity of the alluvial sediments has been measured in two slug tests as indicated in Figure 4-8. This material exhibits the highest values measured in any materials at the site, ranging from approximately 10 to 50 ft/day. Hydraulic conductivity of stream alluvium is high because the material consists primarily of sand and gravel with little silt and clay content. The specific yield of stream alluvium is probably in the range of 10 to 20 percent.

4.1.4 Potentiometric Surface and Groundwater Flow

The uppermost aquifer in the proposed Permit Area includes glacial and alluvial sediments. Groundwater in this hydrogeologic unit is generally under unconfined or water table conditions. Approximate water table contours in the glacial/alluvial sediments are shown in Figure 4-9. These contours are based on water levels in wells completed in glacial and alluvial sediments, on the location and elevation of surface streams and lakes, and on the overall topographic contours at the site.

Figure 4-9 indicates that there is a major groundwater divide coinciding with a major topographic divide running northeast-southwest through the site. Groundwater flow is generally north and south from this divide. Horizontal gradients are variable, ranging from approximately 0.04 to 0.30 with the most common value around 0.09.

The uppermost aquifer is very heterogeneous because of the variability of the sediments of which it is composed. It is likely that many small-scale deviations in the general flow directions shown in Figure 4-9 will exist due to the aquifer variability and local topographic influences. It is also likely that localized perched water table zones will exist in areas where infiltrating water encounters layers of low permeability silt and clay within the sediments.

Piezometric levels measured in piezometers completed in bedrock are shown in Figure 4-10. This figure also presents water levels measured in monitoring wells completed in both bedrock and the glacial/alluvial sediments. In most of the bedrock holes there is a general decrease in piezometric level with depth indicating downward flow in the bedrock. However, there is significant variability in piezometric levels in bedrock, probably as a result of the heterogeneity and low permeability of the bedrock. As a result, there is also a high degree of variability in horizontal and vertical hydraulic gradients in the bedrock as indicted in Figure 4-10.

In areas where glacial/alluvial and bedrock wells are located adjacent to each other (e.g. H88-14 and H88-10, H88-27 and H88-13) there is a downward gradient from the glacial/alluvial sediments into the bedrock. Thus, at these locations bedrock is being recharged by vertical flow from the glacial/alluvial sediments.

In the westernmost area of the site, old mine workings exist in the Premier Coal Group. Well H89-29 was completed in the mine voids on the eastern side of Moose Creek and well H89-30 was completed in the mined interval (but did not encounter voids) on the western side of Moose Creek. These wells indicate that the water level in the old mine workings is at approximately elevation 710 feet which is substantially below the water levels in the overlying glacial/alluvial sediments and is also below the level of Moose Creek which flows over the old workings at approximately elevation 755 feet. Thus, the bedrock groundwater system in this area is hydraulically poorly connected with the shallow groundwater in the glacial/alluvial sediments and surface water in Moose Creek.

4.1.5 Recharge/Discharge

Recharge to the glacial/alluvial sediments aquifer originates from precipitation falling on the proposed Permit Area. Recharge is apparently occurring over most of the proposed Permit Area. Discharge from the glacial/alluvial sediments aquifer occurs by horizontal flow into Moose and possibly Buffalo Creeks and by vertical leakage into the underlying bedrock.

Water levels in wells adjacent to Moose Creek were used to determine whether discharge or recharge from the uppermost aquifer to the stream was occurring. Well H88-17 along Moose Creek in the northeastern portion of the proposed Permit Area had a water level at or slightly above the level of Moose Creek indicating that the uppermost aquifer was probably discharging to the stream in this area. Wells H88-14A and H88-19 located along Moose Creek in the northwestern portion of the proposed Permit Area both had water levels from 3 to 6 feet below the water level in Moose indicating that the stream was potentially loosing water to the uppermost aquifer in these areas. This could be a localized interaction between the stream and the highly permeable alluvial sediments and alluvial groundwater may be flowing back into the stream at locations further down stream.

Recharge to the bedrock hydrogeologic unit occurs by vertical flow from the overlying glacial and alluvial sediments. Piezometric data from bedrock (see Figure 4-10) do not indicate that there is any significant source of offsite recharge. For example, piezometric heads in piezometers PB-12, 13, 92, 100 and 102 were higher than heads in surrounding wells and piezometers. They are also located in an area which is a local topographic high. If offsite recharge was occurring, higher heads would be found in at least some of the surrounding wells and piezometers. Also, the low permeability of the bedrock and anticipated low permeability of faults (see Sections 4.1.2 and 4.1.3) make it unlikely that offsite recharge will be significant in the bedrock.

In the eastern portion of the proposed Permit Area, heads in bedrock wells and piezometers are higher than the water levels in adjacent Moose Creek. Therefore, it is likely that bedrock is discharging minor amounts of water to shallow alluvial sediments along Moose Creek in the eastern portion of the site. As discussed in Section 4.1, it appears that the heads in the bedrock in the westernmost portion of the proposed Permit Area have been depressed by the old underground workings in the Premier Mine. The water level in Moose Creek (e.g. elevation 755 feet) is higher than the piezometric head in the bedrock (e.g. 710 feet) in this area indicating potential flow from Moose Creek and shallow alluvial deposits into the bedrock and old workings. The location of groundwater discharge from the old workings is likely to be along Moose Creek south of the proposed permit area. Although the mechanism for discharge from the underground workings is not known, it is likely that discharge occurs as a result of stratigraphic or structural features that have not been mapped to date.

4.1.6 Conceptual Model of the Groundwater Flow System

This section integrates the existing hydrogeological information into an overall conceptual model of the groundwater flow system in the Permit Area. The conceptual model incorporates the current understanding of groundwater occurrence, flow directions, recharge/discharge, hydrologic boundaries to the flow system, interactions between hydrogeologic units, and interactions with surface water.

Groundwater exists in glacial sediments found over most of the Permit Area, in alluvial sediments found along Moose Creek, and in bedrock formations which underlie the glacial and alluvial sediments. These deposits are grouped into two major hydrogeological units as described in Section 4.1.2.

The glacial sediments are highly variable in size ranging from cobbles down to silty sand and till. As described in Section 4.1.3 the hydraulic conductivity of the glacial sediments is generally in the range of 0.1 to 1.4 ft/day (3.5 x 10^{-5} to 4.9 x 10^{-4} cm/sec) which according to the U.S. Department of Interior (1977) is in the low to moderate range of hydraulic conductivity and is characteristic of an aquifer with poor to fair potential domestic well yields. Alluvial sediments along Moose Creek contain fewer fines than the glacial sediments and are more permeable, with hydraulic conductivities in the range of 10 to 50 ft/day (8.5 x 10^{-3} to 1.8 x 10^{-2} cm/sec) which is in the moderate to high range of hydraulic conductivities. The limited saturated thickness of the alluvium (i.e. less than 20 feet) puts it in the range of an aquifer with good potential domestic well yields but poor potential irrigation well yields. The saturated glacial and alluvial sediments comprise the water table aquifer in the Permit Area.

Groundwater flow in the water table aquifer generally mirrors surface topography with flow from high areas towards Moose Creek as shown in Figure 4-9. Moose Creek forms a hydrogeologic boundary to the water table aquifer along the north, west and south. A topographic divide near

Wishbone Hill forms the hydrogeologic boundary of the water table aquifer to the east. A groundwater flow divide runs through the Permit Area with groundwater north of the divide flowing north into Moose Creek and groundwater south of the divide flowing southwest eventually to Moose Creek. Recharge to the water table aquifer is from local precipitation. Discharge is primarily to Moose Creek. Some local discharge occurs into Buffalo Creek which is the only other stream flowing across the Permit Area. Springs, seeps or other surface indications of possible groundwater discharge were not identified in the Permit Area except along the Moose Creek flood plain. The bedrock hydrogeologic unit that underlies the water table aquifer forms a low permeability boundary. Some vertical leakage from the water table aquifer into the underlying bedrock units occurs. However, the amount of leakage is small because of the low permeability of the bedrock.

The bedrock geologic units are described in Sections 4.1.1 and 4.1.2. They are stratigraphically and structurally complex. Folding has resulted in beds ranging in dip from horizontal to vertical and faulting has truncated geologic units resulting in distinct blocks of bedrock separated from each other by major faults. Existing information indicates that at least some of the faults have associated gouge zones and probably form very low permeability hydraulic boundaries between blocks of bedrock. The bedrock units have a significantly lower hydraulic conductivity than the overlying glacial and alluvial sediments. As discussed in Section 4.1.3 measured values are generally in the range of 0.005 to 0.03 ft/day (1.8 x 10^{-6} to 1.0 x 10^{-5} cm/sec). These values fall in the low range of hydraulic conductivity according to the U.S. Department of Interior (1977) and are characteristic of an aquitard rather than an aquifer.

Groundwater flow in the bedrock hydrogeologic unit does not occur in specific zones that are sufficiently permeable and hydraulically interconnected to be defined as aquifers. Rather, the bedrock behaves as an anisotropic and heterogeneous low permeability aquitard. As described above the bedrock has been extensively faulted and folded with specific geological units forming blocks that are separated by faults. Many of these faults are thought to form very low permeability hydraulic boundaries between blocks due to the presence of clay gouge along the fault plane. It is possible that localized fracture zones in the bedrock occur that have higher hydraulic conductivities than unfractured bedrock. However, any such zones will be localized and will not alter the basic conceptual model of the bedrock as a low permeability unit.

The groundwater flow in the bedrock is generally from areas of high to low surface topography. Heads within the bedrock are variable (i.e. they do not conform to a single piezometric surface) because of the low permeability and heterogeneous nature of the bedrock. Thus, it is not feasible to produce a piezometric contour map representative of the bedrock hydrogeologic unit. Moose Creek acts as a discharge boundary to the bedrock groundwater system on the north, west and south sides of the site. To the east, the topographic high near Wishbone Hill acts as a no-flow boundary to the bedrock flow system. In the western portion of Mine Area 1 the old underground workings in the Premier Coal Group are apparently acting as a discharge boundary.

The bedrock hydrogeologic unit is recharged by vertical leakage from overlying saturated glacial sediments and alluvium. However, due to the low permeability of the bedrock, there is poor hydraulic connection between the bedrock and the overlying water table aquifer. Evidence of this poor hydraulic communication is seen near the old underground workings where piezometric levels in bedrock are substantially lower than those in the overlying sediments and Moose Creek. Although flow directions in the bedrock may be locally variable due to stratigraphic and structural complexities, in general the bedrock groundwater flow is towards Moose Creek.

4.2 Groundwater Quality

4.2.1 General Groundwater Chemistry

Groundwater quality monitoring completed to date indicates that the groundwaters in the proposed Permit Area are variable but generally of moderate to high quality. Minimum, maximum and means of chemical characteristics of groundwaters in the proposed Permit Area are provided in Table 4-1, separated into bedrock and glacial/alluvial categories. Analysis of water from well H88-13 has been omitted from Table 4-1 because of suspected water quality effects resulting from the use of mud in this hole.

4.2.2 Suitability Classification

Water quality criteria for the State of Alaska are promulgated in the Alaska Water Quality Standards, 18AAC.70. The water quality criteria are combined with the water use designation (e.g. drinking, agricultural, aquacultural) to determine the water quality standard for a particular water body. Alaska Water Quality Standards incorporate by reference Federal Primary and Secondary Drinking Water Standards in addition to numerical criteria for other constituents not covered under Federal Regulations. These include criteria for dissolved gases, pH, temperature, and dissolved inorganic substances including TDS, chloride and sulfate.

Table 4-2 lists Federal Drinking Water Standards along with maximum concentrations measured during the baseline monitoring program. Groundwaters have not been tested for some parameters for which Federal Drinking Water Standards exist, including radionuclides, organics, and biological parameters because these parameters are not generally applicable to coal mining permit studies. As indicated in Table 4-2, the groundwater samples generally meet Federal Primary Drinking Water Standards for which analytical tests have been run. Details regarding the specific sample locations which exceed drinking water standards are presented in Table 4-3. In general, groundwater from the glacial alluvial materials exceeds Federal Secondary Drinking Water Standards for iron and manganese while groundwater from the bedrock units exceeds drinking water standards for other various parameters.

Water quality standards for agriculture and irrigation are specified in Section (1)(A)(ii) of 18AAC.70. Groundwater in the proposed Permit Area meets these standards with some exceptions. Water from H88-12 consistently exceeds the specified pH range of 5.0 to 9.0 while H88-11 and H88-16 have each exceeded this range once. The 2.5 standard for sodium adsorption ratio has been consistently exceeded by water from wells H88-11, 12, 15, 16, 24, and H89-30, and occasionally by wells H88-24 and 25.

The State of Alaska applies additional water quality standards under 18AAC.70 to regulate human activities which result in alteration to waters within the jurisdiction of the State. Standards have been developed for different types of water use, including:

A. Water Supply
  i. Drinking, culinary and food processing
  ii. Agriculture, including irrigation and stock watering
  iii. Aquiculture
  iv. Industrial

B. Water Recreation
  i. Contact recreation
  ii. Secondary recreation

C. Growth and Propagation of Fish, Shellfish, other Aquatic Life, and Wildlife

Unless otherwise designated, the most stringent standards applicable under each use will apply to discharges of groundwater. Standards under particular use categories for several water quality parameters relevant to the proposed project include:

- pH - "Shall not be less than 6.5 or greater than 8.5. Shall not vary more than 0.5 pH units from natural conditions. If the natural condition pH is outside this range, substances shall not be added that cause an increase in buffering capacity of the water" (Water Recreation - contact recreation).

- Sodium Adsorption Ratio - "Dissolved inorganic Substances; Sodium adsorption ratio less than 2.5. (Water Supply - agriculture).

- Dissolved Inorganic Substances - "Total dissolved solids from all sources shall not exceed 500 mg/l. Neither chlorides nor sulfates shall exceed 200 mg/l. (Water Supply - drinking water).

- Dissolved Gas - "Dissolved oxygen shall be greater than 7 mg/l in water used by anadromous and resident fish...In no case shall dissolved oxygen above 17 mg/l be permitted." (Growth and Propagation of Fish, Shellfish, and other Aquatic Life and wildlife).

The standards potentially apply to any releases of water at the site during operational and post closure periods.

The baseline monitoring completed to date indicate relatively high groundwater quality. No significant water quality problems have been identified in groundwaters of the Moose Creek watershed, with the exception that groundwaters possessing high sodium adsorption ratios are not suitable for irrigation supply.

5.0 CONCLUSIONS

Two primary hydrogeologic units are present in the proposed Permit Area. Tertiary sedimentary bedrock (the Chickaloon, Wishbone and Tsadaka Formations) composed of siltstone, mudstone, sandstone, claystone, coal and pebble conglomerate underlies the proposed mine site. This unit is structurally complex due to folding and faulting. In Mine Area 1 this unit ranges from relatively steeply dipping to flat-lying. In Mine Area 2 the bedrock unit is uniformly steeply dipping. Glacial sediments composed of a wide variety of materials from clayey and silty sands to well-graded gravels overlie bedrock in thicknesses typically from 5 to well over 100 feet. Recent alluvial deposits are found adjacent to Moose Creek and appear to be of limited extent and depth. Moose Creek is apparently flowing on or just above bedrock along much of its reach in and adjacent to the proposed Permit Area.

The hydrogeology of the proposed Permit Area has been investigated by a field testing program that included six monitoring wells in sedimentary bedrock, two of which are of sufficient diameter to conduct pump testing, eleven monitoring wells in glacial and alluvial sediments, one of which is large diameter, two wells into the zone mined in the old Premier Mine (one well actually intercepted mine voids) and thirty seven pneumatic piezometers in thirteen drillholes into bedrock.

Potentiometric levels measured in piezometers in bedrock were variable with depth. In the majority of holes there was an overall decrease in head with depth indicating downward flow gradients in bedrock. However, in some holes there was an overall increase in potentiometric level with depth indicating potential upward flow.

The uppermost aquifer in the proposed Permit Area is located in the glacial and alluvial sediments. Based on water levels measured in monitoring wells completed in the uppermost aquifer, there is a major groundwater flow divide running east-west through the proposed Permit Area corresponding to a topographic divide. Groundwater flows north and south from this major divide.

In general, where glacial/alluvial and bedrock wells were located next to each other (e.g. H88-14 and H88-10, H88-27 and H88-13) water levels in the glacial sediments were higher than water levels in bedrock. Thus, groundwater in the glacial sediments is probably recharging the bedrock system over most of the site.

Hydraulic characteristics of the two major hydrogeologic units have been measured in slug tests conducted in both glacial/alluvial and bedrock wells, and two pump tests conducted in bedrock wells H88-15 and H88-16. The pump test in H88-15, which is located in relatively flat lying bedrock, indicated a transmissivity in the test zone of approximately 1 to 5 ft^2/day. This corresponds to a hydraulic conductivity of $5x10^{-3}$ to $2.5x10^{-2}$ ft/day. The pump test in H88-16, which is located in steeply dipping bedrock, indicated a transmissivity of 0.2 to 2 ft^2/day and a hydraulic conductivity of $6x10^{-4}$ to $6x10^{-3}$ ft/day. In general, hydraulic conductivity of the bedrock is quite low and it is not expected to be a major source of groundwater. Hydraulic conductivity in the glacial/alluvial sediments is variable, ranging from approximately 0.008 to 52 ft/day. The limited saturated thickness of this unit over much of the site, however, limits its potential for significant groundwater yields.

Groundwater samples were collected from monitoring wells in November 1988, and February, May/June and July 1989. The field and laboratory analyses conducted through July 1989 indicate that the groundwaters in the proposed Permit Area are of relatively high quality (i.e. they generally meet Federal drinking water standards).

The pH of groundwater from glacial/alluvium wells ranged from 6.06 to 8.46 and averaged 7.31. Groundwater from bedrock wells ranged in pH from 6.96 to 11.45 and averaged 8.88. Field conductivity measurements in glacial/alluvial wells ranged from 96 to 741 μmhos/cm and averaged 217 μmhos/cm. Bedrock wells ranged in field conductivity from 260 to 1441 μmhos/cm and averaged 968 μmhos/cm. Total dissolved solids in glacial/alluvial wells generally ranged from 66 to 202 mg/l (except well H88-25 which had a TDS concentration of 716 mg/l in November 1988, but subsequent concentrations have been in the range of 130 to 190 mg/l), and in bedrock wells from 142 to 834 mg/l. Mean values of TDS for the glacial/alluvial wells and bedrock wells were 138 mg/l and 423 mg/l respectively. Well H88-13 had TDS concentrations ranging from 2750 mg/l to 1850 mg/l during the four sampling rounds. These high values were probably the result of the use of drilling mud in this hole.

Concentrations of trace constituents, primarily metals, were generally quite low. Most trace constituents were near or below their detection limits. Nutrient levels in groundwater were variable. Total organic phosphorous ranged from <0.001 to 3.14 mg/l. Total Kjeldahl nitrogen concentrations were generally below 7.4 mg/l except for high values of 206 to 10.8 mg/l measured in H88-19 which is a glacial/alluvial well located immediately down-gradient of old mine spoils. Nitrate concentrations were low with a maximum of 7.54 mg/l and nitrite was at a maximum concentration of 0.05.

The major dissolved species in groundwaters were calcium, sodium, potassium and bicarbonate with maximum concentrations of 57, 351, 8.8 and 906 mg/l, respectively. Bicarbonate was the predominant anion in all wells except H88-12 and 25. In H88-12 carbonate was dominant during the November 1988, February 1989 and July 1989 rounds as a result of high pH (11.45 to 10.26) while chloride was slightly dominant in H88-25. Sodium and potassium were the dominant cations in bedrock wells except in H88-10 and H89-29 in which calcium was dominant. In glacial/alluvium wells calcium was dominant in all wells except H88-24A and 25 where sodium and potassium were dominant.

Bedrock wells contained predominantly sodium-potassium-bicarbonate type groundwaters. The glacial/alluvial wells generally contained calcium-bicarbonate type groundwaters.

With certain exceptions, groundwaters sampled at the site met Federal Drinking Water Standards. These exceptions are detailed in Table 4-3 and include, in general, concentrations of iron, manganese and selenium in several glacial/alluvial wells and values of pH, TDS, barium and fluoride in several bedrock wells. Relatively high sodium adsorption ratios in wells H88-11, 12, 13, 15, 16, 24A, 25 and H89-30 exceeded Alaska State standards for irrigation water.

6.0 RESPONSIBLE PARTIES

This report was prepared by Golder Associates Inc., 200 Union Boulevard, Suite 100, Lakewood, Colorado 80228. Individuals conducting field work and technical analysis for this report included the following:

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David Hoekstra - Staff Engineer
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Idemitsu Alaska, Inc. and Golder Associates Inc. subcontracted various aspects of the work to the following firms:

Drill and Install Wells and Piezometers

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Pump Test Setup and Equipment

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Anchorage, AK 99511

Seismic Refraction Survey

Northland Geophysical Company
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Seattle, WA 98102

Analytical Laboratory

Inter-Mountain Laboratories
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Sheridan, WY 82801

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TABLES

TABLE 3-1

MONITORING WELL CONSTRUCTION DATA

WELL NUMBER	GEOLOGY OF SCREENED INTERVAL	COORDINATES		G. S. ELEVATION (Feet m.s.l.)	DEPTH IN FEET BELOW LAND SURFACE					
		NORTHING	EASTING		CASING SIZE (Inches)	TOTAL DRILLE	BOTTOM OF SCREEN	TOP OF SCREEN	BOTTOM OF SANDPACK	TOP OF SANDPACK
H88-10	PREMIER	2,816,923.39	657,707.19	787.5	2	200.0	197.5	172.5	200.0	159.7
H88-11	BURNING BED	2,819,202.50	662,349.80	1090.2	2	405.0	400.0	140.0	405.0	135.0
H88-12	ESKA	2,821,481.58	663,862.74	1023.7	2	185.0	125.0	95.0	126.0	89.5
H88-13	JNSVLLE-PRMR INTRBRD	2,822,647.55	665,500.06	1140.1	2	465.0	461.0	381.0	461.0	347.5
H88-14	GLACIAL SEDIMENTS	*2,816,995.3	*657,713.5	*788.9	5	19.0	18.0	8.0	19.0	6.0
H88-14A	STREAM ALLUVIUM	*2,816,842.6	*657,425.4	*771.9	2	20.0	19.0	9.0	20.0	7.0
H88-15	PREMIER/MIDWAY	2,817,411.48	660,040.14	870.7	5	300.0	292.5	92.5	293.0	84.0
H88-16	PREMIER/MIDWAY	2,819,896.54	663,436.78	1103.0	5	438.0	437.0	97.0	438.0	95.0
H88-17	STREAM ALLUVIUM	2,822,520.48	664,046.71	997.2	2	18.0	13.0	7.0	13.5	6.0
H88-19	STREAM ALLUVIUM	2,818,483.72	658,788.09	842.8	2	40.0	30.0	20.0	30.0	18.0
H88-21	GLACIAL SEDIMENTS	2,816,620.80	659,688.28	862.1	2	83.5	50.0	35.0	51.4	30.0
H88-22	GLACIAL SEDIMENTS	2,819,734.40	662,165.67	1074.2	2	51.5	50.0	10.0	51.5	7.0
H88-23	GLACIAL SEDIMENTS	2,816,470.74	662,508.83	840.0	2	105.0	94.4	44.4	105.0	39.2
H88-24A	GLACIAL SEDIMENTS	2,815,947.90	663,564.21	845.5	2	83.9	71.0	41.0	74.0	36.0
H88-25	GLACIAL SEDIMENTS	2,815,306.15	662,650.44	830.9	2	94.0	42.7	27.4	44.0	21.3
H88-27	GLACIAL SEDIMENTS	2,822,583.89	665,584.80	1128.4	2	52.0	51.0	16.0	52.0	9.0
H88-28	GLACIAL SEDIMENTS	2,824,330.30	666,403.23	1297.7	2	115.0	58.0	43.0	59.0	38.0
H89-29	MINE VOIDS	**2,816,730	**657,530	*775	5	204.0	176.0	199.0	176.0	204.0
H89-30	PREMIER	**2,816,500	**656,730	*755	2	198.7	148.0	138.0	159.0	124.0

NOTE: * APPROXIMATE SURVEY CONDUCTED ON WELLS H14 AND H14A.

** OM TOPOGRAPHIC MAP FOR WELLS H89-29 AND H89-30

TABLE 3-2
PNEUMATIC PIEZOMETER CONSTRUCTION DATA

						FILTER SAND INTERVAL (Feet)				STRATIGRAPHY OF FILTER SAND INTERVAL
PIEZO.	COORDINATES		G. S. ELEVATION	PIEZO. DEPTH	PIEZO. ELEV.	DEPTH		ELEVATION		
NUMBER	NORTHING	EASTING	(feet)	(feet)	(feet)	FROM	TO	FROM	TO	
PB-7 1	2,817,813.89	659,843.06	930.1	357.0	573.1	345.0	372.0	585.1	558.1	LOWER PREMIER
2	2,817,813.89	659,843.06	930.1	290.0	640.1	284.0	300.0	646.1	630.1	UPPER PREMIER
3	2,817,813.89	659,843.06	930.1	232.0	698.1	215.0	239.0	715.1	691.1	UPPER PREMIER
PB-8 1	2,817,398.23	659,632.99	905.2	315.0	590.2	255.5	336.0	649.7	569.2	CHICKALOON
2	2,817,398.23	659,632.99	905.2	239.5	665.7	233.5	250.0	671.7	655.2	LOWER PREMIER
3	2,817,398.23	659,632.99	905.2	187.5	717.7	177.9	193.9	727.3	711.3	UPPER PREMIER
PB-12 1	2,819,730.03	663,379.74	1094.5	334.2	760.3	245.2	384.4	849.3	710.1	CHICKALOON
2	2,819,730.03	663,379.74	1094.5	225.8	868.7	184.8	229.7	909.7	864.8	LOWER PREMIER
3	2,819,730.03	663,379.74	1094.5	142.0	952.5	125.2	167.3	969.3	927.2	MIDDLE PREMIER
4	2,819,730.03	663,379.74	1094.5	107.0	987.5	84.3	114.2	1010.2	980.3	UPPER PREMIER
PB-13 1	2,819,991.45	663,178.14	1100.8	353.0	747.8	305.0	375.0	795.8	725.8	SUB-ESKA COAL
2	2,819,991.45	663,178.14	1100.8	275.0	825.8	255.0	295.0	845.8	805.8	CHICKALOON
3	2,819,991.45	663,178.14	1100.8	220.0	880.8	179.5	240.5	921.3	860.3	ESKA
4	2,819,991.45	663,178.14	1100.8	130.0	970.8	96.0	150.5	1004.8	950.3	CHICKALOON
PB-60 1	2,817,679.49	659,278.52	915.9	199.7	716.2	160.2	204.4	755.7	711.5	CHICKALOON
2	2,817,679.49	659,278.52	915.9	141.4	774.5	126.6	149.9	789.3	766.0	LOWER JONESVILLE
PB-88 1	2,819,015.36	663,561.00	1042.5	221.7	820.8	99.0	240.5	943.5	802.0	PREMIER
PB-92 1	2,819,585.79	662,782.06	1091.2	409.7	681.5	393.7	446.8	697.5	644.4	CHICKALOON
2	2,819,585.79	662,782.06	1091.2	338.3	752.9	326.6	376.3	764.6	714.9	LOWER BURNING BED
3	2,819,585.79	662,782.06	1091.2	268.8	822.4	220.4	287.6	870.8	803.6	UPPER BURNING BED
PB-100 1	2,818,870.12	662,551.53	1075.6	396.0	679.6	358.5	401.5	717.1	674.1	CHICKALOON
2	2,818,870.12	662,551.53	1075.6	153.5	922.1	144.5	169.5	931.1	906.1	SUB-ESKA COAL
PB-101 1	2,817,050.15	658,081.10	873.8	348.0	525.8	324.4	371.2	549.4	502.6	CHICKALOON
2	2,817,050.15	658,081.10	873.8	311.5	562.3	307.3	318.0	566.5	555.8	MIDWAY SEAM
3	2,817,050.15	658,081.10	873.8	256.0	617.8	215.8	301.3	658.0	572.5	CHICKALOON/PREMIER
PB-102 1	2,820,103.96	663,579.53	1096.6	384.0	712.6	333.3	431.8	763.3	664.8	LOWER PREMIER
2	2,820,103.96	663,579.53	1096.6	277.5	819.1	254.5	295.0	842.1	801.6	UPPER PREMIER
3	2,820,103.96	663,579.53	1096.6	221.0	875.6	118.2	237.0	978.4	859.6	CHICKALOON
PB-103 1	2,820,679.51	663,004.04	1007.0	321.8	685.2	291.1	329.2	715.9	677.8	CHICKALOON
2	2,820,679.51	663,004.04	1007.0	242.8	764.2	219.4	261.2	787.6	745.8	CHICKALOON
3	2,820,679.51	663,004.04	1007.0	119.3	887.7	104.8	131.7	902.2	875.3	LOWER PREMIER
PB-104 1	2,821,611.26	664,057.28	1026.7	288.0	738.7	244.5	306.6	782.2	720.1	CHICKALOON
2	2,821,611.26	664,057.28	1026.7	215.3	811.4	173.0	235.7	853.7	791.0	LOWER PREMIER
3	2,821,611.26	664,057.28	1026.7	137.7	889.0	81.5	158.0	945.2	868.7	UPPER PREMIER
PB-105 1	2,817,405.04	660,299.33	883.4	273.5	609.9	264.0	283.5	619.4	599.9	MIDWAY/CHICKALOON
2	2,817,405.04	660,299.33	883.4	180.5	702.9	158.5	189.0	724.9	694.4	LOWER PREMIER
3	2,817,405.04	660,299.33	883.4	132.5	750.9	73.5	144.0	809.9	739.4	UPPER PREMIER

NOTES: Depth is depth below ground surface.
Elevation is elevation above mean sea level.

TABLE 3–3
MONITORING WELL STATIC WATER LEVEL ELEVATION DATA
JULY 1988 THROUGH JUNE 1990.

WELL NUMBER	G. S. ELEVATION (Feet)	STICK UP (Feet)	DATE MEASURED	WATER LEVEL ELEVATION (Feet a.m.s.l.)
H88–10	787.5	3.08	09/26/88	720.8
			09/28/88	718.9
			10/25/88	720.6
			11/03/88	719.6
			11/04/88	719.6
			11/13/88	718.9
			11/22/88	718.7
			02/09/89	713.6
			02/14/89	713.2
			02/25/89	712.6
			03/28/89	710.8
			04/18/89	716.8
			06/06/89	719.5
			07/27/89	719.2
			08/22/89	717.2
			09/24/89	716.9
			11/10/89	714.4
			12/21/89	719.0
			01/20/90	713.6
			04/17/90	727.1
			06/19/90	722.4
H88–11	1090.2	2.75	11/08/88	1035.4
			11/13/88	1051.0
			11/22/88	1061.1
			02/09/89	1072.3
			02/23/89	1072.4
			03/28/89	1072.3
			04/17/89	1075.1
			06/07/89	1074.1
			07/25/89	1074.8
			08/22/89	1070.7
			09/24/89	1074.6
			11/02/89	1075.0
			12/21/89	1074.6
			01/20/90	1075.1
			04/23/90	1075.9
			06/19/90	1074.4

TABLE 3-3
MONITORING WELL STATIC WATER LEVEL ELEVATION DATA
JULY 1988 THROUGH JUNE 1990.

WELL NUMBER	G. S. ELEVATION (Feet)	STICK UP (Feet)	DATE MEASURED	WATER LEVEL ELEVATION (Feet a.m.s.l.)
H88-12	1023.7	2.71	10/05/88	1007.5
			10/25/88	1006.8
			11/04/88	1006.7
			11/22/88	1007.6
			02/11/89	1005.9
			02/26/89	1005.5
			03/28/89	1006.3
			04/17/89	1008.1
			06/13/89	1007.6
			07/18/89	1006.9
			08/22/89	1006.9
			09/24/89	1007.7
			11/09/89	1007.4
			12/21/89	1008.2
			01/20/90	1007.0
			05/07/90	1009.7
			06/19/90	1006.9
H88-13	1140.1	2.79	11/07/88	994.7
			11/20/88	995.6
			02/11/89	994.1
			02/26/89	993.8
			03/28/89	too deep
			04/17/89	996.4
			06/14/89	996.8
			07/19/89	995.6
			08/22/89	985.4
			09/24/89	996.1
			11/03/89	996.5
			12/21/89	995.7
			01/17/90	995.1
			05/04/90	997.6
			06/19/90	997.3
H88-14	*788.9	2.00	11/13/88	778.0

TABLE 3–3
MONITORING WELL STATIC WATER LEVEL ELEVATION DATA JULY 1988 THROUGH JUNE 1990.

WELL NUMBER	G. S. ELEVATION (Feet)	STICK UP (Feet)	DATE MEASURED	WATER LEVEL ELEVATION (Feet a.m.s.l.)
H88–14A	*771.9	1.9	11/12/88	757.2
			11/13/88	757.3
			11/18/88	757.3
			11/22/88	757.2
			02/09/89	756.8
			02/15/89	757.1
			03/28/89	757.3
			04/18/89	757.8
			05/23/89	757.8
			07/25/89	757.9
			08/22/89	757.8
			09/24/89	757.7
			11/01/89	756.6
			12/22/89	757.4
			01/20/90	757.1
			04/17/90	763.1
			06/19/90	758.1
H88–15	870.7	3.00	11/05/88	838.4
			11/16/88	838.2
			11/20/88	836.9
			02/12/89	835.8
			02/28/89	835.5
			03/28/89	835.6
			04/18/89	838.5
			06/16/89	846.0
			07/18/89	838.2
			08/22/89	836.9
			09/24/89	837.2
			11/08/89	838.3
			12/21/89	837.2
			01/25/90	836.4
			05/09/90	846.7
			06/19/90	839.9
H88–16	1103.0	2.98	11/06/88	1054.0
			11/13/88	1044.2
			11/21/88	1054.1
			02/09/89	1053.8
			02/28/89	1053.8
			03/28/89	1053.6
			04/17/89	1053.9
			06/16/89	1052.1
			07/19/89	1055.5
			08/22/89	1054.8
			09/24/89	1054.7
			11/04/89	1055.2
			12/21/89	1054.8
			01/26/90	1054.1
			05/10/90	1056.2
			06/19/90	1058.6

TABLE 3–3
MONITORING WELL STATIC WATER LEVEL ELEVATION DATA
JULY 1988 THROUGH JUNE 1990.

WELL NUMBER	G. S. ELEVATION (Feet)	STICK UP (Feet)	DATE MEASURED	WATER LEVEL ELEVATION (Feet a.m.s.l.)
H88–17	997.2	2.88	10/05/88	989.3
			10/25/88	989.1
			11/07/88	989.2
			11/08/88	989.5
			11/22/88	989.2
			02/11/89	990.1
			02/16/89	988.8
			03/28/89	988.9
			04/17/89	989.9
			05/30/89	989.6
			07/11/89	989.0
			08/22/89	989.5
			09/24/89	989.6
			12/21/89	989.0
			01/19/90	989.0
			05/07/90	989.7
			06/19/90	989.3
H88–19	842.8	3.50	09/26/88	814.3
			10/25/88	814.0
			11/08/88	814.8
			02/09/89	ice
			03/28/89	ice
			04/18/89	814.8
			05/23/89	814.6
			07/10/89	815.3
			08/22/89	814.7
			09/24/89	814.8
			11/01/89	814.4
			01/24/90	813.8
			04/24/90	814.9
			06/19/90	815.0
H88–21	862.1	3.83	10/25/88	821.9
			10/28/88	822.0
			10/29/88	822.1
			10/30/88	822.1
			11/05/88	822.3
			02/11/89	818.3
			02/16/89	818.0
			03/28/89	817.2
			04/18/89	817.7
			05/23/89	823.4
			07/11/89	822.6
			08/22/89	820.6
			09/24/89	819.8
			11/03/89	820.9
			12/22/89	820.7
			01/24/90	819.4
			05/07/90	825.9
			06/19/90	823.9

TABLE 3–3
MONITORING WELL STATIC WATER LEVEL ELEVATION DATA
JULY 1988 THROUGH JUNE 1990.

WELL NUMBER	G. S. ELEVATION (Feet)	STICK UP (Feet)	DATE MEASURED	WATER LEVEL ELEVATION (Feet a.m.s.l.)
H88-22	1074.2	3.01	08/31/88	1069.9
			09/26/88	1070.9
			10/25/88	1070.2
			11/05/88	1069.3
			11/06/88	1069.5
			02/09/89	1066.3
			02/16/89	1066.1
			03/28/89	1065.2
			04/17/89	1069.0
			05/30/89	1071.1
			07/10/89	1069.2
			08/22/89	1069.0
			09/24/89	1070.8
			11/02/89	1070.2
			12/21/89	1069.5
			01/24/90	1070.4
			04/24/90	1064.7
			06/19/90	1070.5
H88-23	840.0	2.35	09/01/88	791.5
			09/26/88	791.4
			10/25/88	793.0
			10/30/88	793.4
			11/05/88	794.4
			02/12/89	791.6
			02/21/89	791.3
			03/28/89	790.0
			04/18/89	790.5
			05/24/89	794.8
			07/23/89	795.9
			08/22/89	794.7
			09/24/89	793.6
			11/11/89	793.9
			12/22/89	793.9
			01/23/90	794.1
			05/07/90	802.5
			06/19/90	809.8

TABLE 3–3
MONITORING WELL STATIC WATER LEVEL ELEVATION DATA
JULY 1988 THROUGH JUNE 1990.

WELL NUMBER	G. S. ELEVATION (Feet)	STICK UP (Feet)	DATE MEASURED	WATER LEVEL ELEVATION (Feet a.m.s.l.)
H88–24A	845.5	2.83	09/01/88	793.4
			09/26/88	793.5
			10/25/88	794.5
			11/01/88	794.9
			11/02/88	794.9
			11/05/88	795.1
			02/12/89	793.3
			02/21/89	792.6
			03/28/89	791.8
			04/18/89	792.4
			05/24/89	795.2
			07/23/89	796.5
			08/22/89	795.5
			09/24/89	794.7
			11/10/89	794.8
			12/22/89	794.8
			01/23/90	799.2
			05/08/90	802.9
			06/19/90	803.8
H88–25	830.9	2.82	09/01/88	793.3
			09/26/88	798.7
			10/25/88	798.6
			10/31/88	798.8
			11/01/88	795.1
			11/05/88	791.6
			02/12/89	798.7
			02/18/89	798.5
			02/23/89	797.6
			03/28/89	797.9
			04/18/89	798.0
			05/24/89	799.7
			07/23/89	799.1
			08/22/89	803.1
			09/24/89	798.0
			11/11/89	798.5
			12/22/89	798.4
			01/23/90	798.3
			05/08/90	800.5
			06/19/90	799.0

TABLE 3-3
MONITORING WELL STATIC
WATER LEVEL ELEVATION DATA
JULY 1988 THROUGH JUNE 1990.

WELL NUMBER	G. S. ELEVATION (Feet)	STICK UP (Feet)	DATE MEASURED	WATER LEVEL ELEVATION (Feet a.m.s.l.)
H88-27	1128.4	2.93	08/31/88	1081.1
			09/24/88	1081.6
			10/25/88	1082.4
			11/07/88	1081.8
			11/22/88	1081.0
			02/11/89	1078.8
			02/18/89	1078.5
			02/21/89	1078.3
			03/28/89	1077.6
			04/17/89	1078.3
			05/31/89	1087.6
			07/11/89	1082.2
			08/22/89	1080.7
			09/24/89	1081.0
			11/02/89	1081.7
			12/21/89	1080.3
			01/19/90	1080.1
			05/04/90	1092.8
			06/19/90	1083.6
H88-28	1297.7	3.10	10/03/88	1246.7
			10/25/88	1246.9
			11/02/88	1247.2
			11/06/88	1247.3
			11/07/88	1247.3
			02/11/89	1247.1
			02/17/89	1246.8
			02/21/89	1246.8
			03/28/89	1246.3
			04/17/89	1247.3
			05/31/89	1250.7
			07/26/89	1252.0
			08/22/89	1246.6
			09/24/89	1247.1
			11/03/89	1244.5
			12/21/89	1247.6
			01/19/90	1247.5
			05/04/90	1246.8
			06/19/90	1257.3
H89-29	*772		07/27/89	709.6
			08/25/89	702.7
			09/24/89	702.7
			11/01/89	702.0
			12/21/89	704.4
			01/23/90	699.9
			04/17/90	703.0
			06/19/90	710.0

TABLE 3-3
MONITORING WELL STATIC WATER LEVEL ELEVATION DATA JULY 1988 THROUGH JUNE 1990.

WELL NUMBER	G. S. ELEVATION (Feet)	STICK UP (Feet)	DATE MEASURED	WATER LEVEL ELEVATION (Feet a.m.s.l.)
H89-30	*753		07/27/89	706.9
			08/22/89	717.8
			09/24/89	717.3
			11/03/89	716.2
			12/21/89	719.5
			01/24/90	724.8
			04/18/90	715.9
			06/19/90	723.0

NOTES:

* Indicates approximate survey of ground surface elevation.
Stick-up is height of PVC casing above ground surface.

TABLE 3–4
REPRESENTATIVE PIEZOMETRIC HEAD DATA

Piezo. Number		G.S. Elevation (feet)	Piezometric Head Elevation (ft above MSL)														
			Aug 1988	Sep 1988	Oct 1988	Nov 1988	Feb 1989	Mar 1989	Apr 1989	Jun 1989	Jul 1989	Aug 1989	Sep 1989	Oct 1989	Dec 1989	May 1990	Jun 1990
PB–7	1	930.1	842.4	835.5		841.2	786.2	817.2	817.2	844.7	839.9	840.1	840.1	837.8	836.7		849.3
	2	930.1	875.1	866.0		868.3	866.0	866.0	866.0	868.3	863.7	863.7	863.7	861.4	857.9	870.7	870.5
	3	930.1	855.0	848.1		851.6	850.9	850.4	850.4	852.7	848.1	849.3	850.4	851.6	845.8	859.5	859.4
PB–8	1	905.2	870.4	865.5		871.7	865.5	872.9	872.9	880.2	872.9	865.5	874.1	876.5	836.2		885.1
	2	905.2	854.0	805.8		856.2	856.2	856.2	856.2	865.4	857.4	858.5	858.5	859.7	856.0	864.8	868.8
	3	905.2	856.5	852.0		856.4	835.8	856.5	856.5	861.1	854.2	854.2	854.2	856.5	854.2	858.3	840.5
PB–12	1	1094.5			1000.1	1004.7	1002.4	1004.7	1004.7	1009.3	1009.3	1007.0	1008.2	1007.0	1004.7		1013.9
	2	1094.5			1025.7	1034.8	1036.0	1039.4	1039.4	1041.7	1043.8	1040.5	1044.0	1039.4	1039.4	1053.1	1053.1
	3	1094.5			1064.2	1045.9	1042.4	1043.6	1043.6	1045.9	1048.2	1044.7	1048.2	1043.6	1045.9	1048.1	1057.3
	4	1094.5			1043.6	1048.2	1043.6	1048.2	1048.2	1048.2	1048.2	1045.9	1050.5	1045.9	1043.6	1047.8	1057.4
PB–13	1	1100.8	1047.0	1044.7	1042.5	1047.0	1044.7	1044.7	1044.7	1051.6	1050.5	1047.0	1047.0	1043.6	1047.0		1052.8
	2	1100.8	1045.1	1047.4	1045.1	1051.8	1047.4	1047.4	1047.4	1051.9	1051.9	1049.6	1050.8	1047.4	1051.9		1058.8
	3	1100.8	1051.8	1051.8	1054.0	1058.6	1030.0	1051.8	1051.8	1060.9	1059.8	1058.6	1056.3	1056.1	1059.8	1067.2	1070.1
	4	1100.8	1077.2	1052.0	1052.0	1058.9	1058.9	1056.6	1056.6	1058.9	1057.7	1056.6	1058.9	1054.3	1058.9	1064.6	1064.6
PB–60	1	915.9	847.6	865.9		847.6	868.2	868.2	868.2	870.5	845.3	868.2	870.5	868.2	900.0	878.0	899.9
	2	915.9	877.3	872.8		875.1	874.9	872.8	875.1	875.1	875.1	872.8	921.8	875.1	871.6	882.3	871.8
PB–88	1	1042.5	875.4			977.6	977.7	973.1	973.1	980.0	980.0	982.3	982.3	980.0	977.7	984.2	990.3
PB–92	1	1091.2	980.3	978.0	978.0	978.0	973.4	975.7	975.7	984.8	980.3	980.3	980.3	979.1	1000.9		991.7
	2	1091.2	1058.8	1054.2	1056.5	1056.5	1051.9	1051.9	1051.9	1061.0	1058.8	1056.5	1056.5	1054.2	1051.9		1066.2
	3	1091.2	1066.3	1059.4	1061.7	1064.0	1057.1	1053.0	1053.0	1066.3	1066.3	1064.0	1064.0	1061.7	1061.5		1073.2
PB–100	1	1075.6	902.0	886.9		860.7	938.7	943.3	943.3	964.0	962.8	967.4	970.9	966.3	970.9		991.5
	2	1075.6	1054.3	1055.0		1056.6	1056.4	1052.0	1052.0	1056.6	1054.3	1054.3	1056.6	1054.3	1056.6	1050.1	1040.5
PB–101	1	873.8	PIEZOMETER NOT FUNCTIONAL														
	2	873.8	746.6	742.0				742.0	739.7	742.0	742.0	742.0	742.0		* 737.5	748.3	748.9
	3	873.8	711.0	711.0				706.4	702.9	713.3	715.5	711.0	706.4		* 706.4	723.5	722.3
PB–102	1	1096.6		1032.6	1023.4	1021.1	1025.7	1025.7	1029.2	1034.9	1032.6	1030.3	1033.7	1025.7	1030.3		1041.8
	2	1096.6		1010.6	1006.0	1008.2	1003.7	1008.3	1008.3	1008.3		1006.0	1012.7	1006.0	1003.7	1016.9	1017.3
	3	1096.6		1046.3	1021.1	1025.6	1025.6	1029.1	1030.2	1032.5	1018.8	1025.6	1033.7	1029.1	1027.9	1037.7	1037.1
PB–103	1	1007.0			952.5	957.1	952.5	957.1	957.1	957.1	959.4		954.8	952.5	952.5		961.4
	2	1007.0			957.4	962.0	962.0	962.0	962.0	963.1	964.3		964.3	959.7	960.8	971.7	971.1
	3	1007.0			966.4	971.0	968.7	966.4	966.4	971.0	971.0		972.1	968.7	968.4	980.9	982.2
PB–104	1	1026.7			991.7			991.7	991.7	1000.9	996.3		996.3	968.8	996.3		1005.2
	2	1026.7			1000.7			945.6	945.6	1005.3	1005.1		1001.8	998.4	1003.0	893.1	1014.2
	3	1026.7			1002.5			1002.5	1002.5	1007.1	1004.8		1009.2	1004.8	1009.4	1007.0	1011.7
PB–105	1	883.4			840.1	842.3	839.9	840.1	840.1	842.3	840.1	836.6	840.1	840.1	835.2		845.8
	2	883.4			820.9	825.5	823.2	823.2	823.2	830.1	827.8	823.2	825.5	825.5	823.2	820.8	837.0
	3	883.4			826.4	828.6	826.2	828.4	828.4	835.5	828.6	828.6	828.6	828.6	824.1	833.1	840.1

* Actual date recorded Jan 3, 1990

TABLE 3-5

HYDRAULIC PARAMETERS DETERMINED FROM SLUG TESTS

WELL No.	HYDRAULIC CONDUCTIVITY (ft/day)	TRANSMISSIVITY (ft^2/day)	SCREENED UNIT
H88 - 10	Recovered too fast for analysis		BEDROCK
H88 - 11	0.005	1.3	BEDROCK
H88 - 12	4.7	169	BEDROCK
H88 - 13	0.028	3.3	BEDROCK
H88 - 14	4.2	25.4	GLACIAL SEDIMENTS
H88 - 14A	52.4	157	STREAM ALLUVIUM
H88 - 15	No slug test performed		BEDROCK
H88 - 16	0.034	11.6	BEDROCK
H88 - 17	10.3	35.0	STREAM ALLUVIUM
H88 - 19	No slug test performed		STREAM ALLUVIUM
H88 - 21	0.67	4.0	GLACIAL SEDIMENTS
H88 - 22	0.10	4.5	GLACIAL SEDIMENTS
H88 - 23	No slug test performed		GLACIAL SEDIMENTS
H88 - 24A	0.40	8.4	GLACIAL SEDIMENTS
H88 - 25	0.008	0.02	GLACIAL SEDIMENTS
H88 - 27	1.2	3.0	GLACIAL SEDIMENTS
H88 - 28	1.4	7.6	GLACIAL SEDIMENTS

NOTE: Values determined by the Hvorslev Time Lag Method.

TABLE 3-6

FIELD ANALYTICAL RESULTS OF QUARTERLY GROUNDWATER SAMPLING

Date	Well	pH	Specific Conductance μmhos	Temp. °C	Dissolved Oxygen mg/l	Alkalinity mg/l
11/22/88	H88-10	6.62	385	3.0	14.2	358.0
02/15/89		7.15	388	3.0	13.2	104.0
06/06/89		7.34	321	3.0	11.4	144.0
07/25/89		7.79	332	4.0	12.2	187.0
11/22/88	H88-11	6.96	1326	2.0	13.6	1521.0
02/15/89		8.50	1441	1.5	12.8	638.0
06/07/89		9.37	966	3.0	10.9	634.0
07/25/89		8.75	1303	2.5	12.8	48.0
11/21/88	H88-12	11.40	---	2.0	13.0	588.0
02/15/89		11.45	386	2.5	12.4	579.0
06/14/89		9.68	777	3.0	12.2	44.4
07-18-89		10.26	1045	4.0	11.8	37.9
11/20/88	H88-13	8.60	304	4.0	4.7	2565.0
02/26/89		7.42	341	2.0	11.6	1084.0
06/14/89		8.06	370	4	12.8	1621
07/19/89		8.28	1	3.5	13.6	137
11/22/88	H88-14A	6.06	162	3.0	13.5	53.0
02/15/89		7.51	214	2.0	13.1	130.0
05/23/89		7.55	139	1.0	12.8	47.0
07/25/89		7.23	96	8.0	12.6	28.0
11/20/88	H88-15	8.31	260	2.9	13.0	137.9
02/21/89		---	---	2.0	12.2	---
06/16/89		7.90	900	3.0	11.6	242.0
07-18-89		7.69	784	4.0	11.2	28.5
11/21/88	H88-16	8.79	338	3.0	9.1	577.0
02/28/89		8.38	325	3.0	13.6	---
06/16/89		9.45	300	4.0	12.2	153.0
07/19/89		8.72	272	2.5	12.2	10.8
11/08/88	H88-17	(7.34)	(198)	3.0	(9.3)	(94.4)
02/16/89		6.72	203	2.0	13.4	80.0
05/30/89		6.69	255	2.5	12.4	73.0
07/11/89		6.73	196	3.0	10.9	76.5
11/08/88	H88-19	(7.38)	(243)	4.0	(9.2)	(277.0)
02/15/89		Frozen	---	---	---	---
05/23/89		7.28	172	2.5	13.4	61.0
07/10/89		7.17	133	2.5	11.3	47.2
11/09/88	H88-21	(8.07)	(158)	(18.5)	(9.9)	(74.5)
02/16/89		7.84	210	2.0	12.4	49.0
05/23/89		7.78	160	2.5	13.0	64.0
07/11/89		7.21	150	2.5	12.0	64.0

TABLE 3-6

FIELD ANALYTICAL RESULTS OF QUARTERLY GROUNDWATER SAMPLING

Date	Well	pH	Specific Conductance μmhos	Temp. °C	Dissolved Oxygen mg/l	Alkalinity mg/l
11/05/88	H88-22	(7.66)	(192)	2.5	(9.3)	(172.0)
02/16/89		7.41	198	1.0	12.2	52.0
05/30/89		6.84	180	2.0	13.2	48.0
07/10/89		7.55	188	3.0	10.7	83.2
11/03/88	H88-23	(7.12)	(234)	(18)	(14.2)	(97.6)
02/15/89		7.24	156	2.0	14.4	55.0
05/24/89		7.06	124	2.5	12.5	41.0
07/23/89		6.78	121	2.0	11.5	3.2
11/03/88	H88-24A	(7.68)	(251)	---	(9.2)	(75.1)
02/15/89		7.68	254	2.5	13.4	70.0
05/24/89		7.30	225	2.5	12.3	57.0
07/23/89		7.40	193	2.0	11.2	7.3
11/03/88	H88-25	(8.05)	(252)	---	(8.3)	(245.0)
02/15/89		8.46	741	1.0	12.8	40.0
05/24/89		7.72	281	2.5	12.0	81.0
07/23/89		8.36	273	4.0	10.8	127.0
11/07/88	H88-27	---	---	---	---	---
02/21/89		6.96	162	1.0	13.2	86.0
05/31/89		6.83	111	2.5	12.4	45.0
07/11/89		7.13	132	4.0	12.4	48.5
11/07/88	H88-28	---	---	---	---	---
02/21/89		6.28	144	2.0	12.2	64.0
07/26/89		7.42	161	2.0	11.0	51.3
07/26/89	H89-29	7.34	294	2.0	10.6	100.6
07/28/89	H89-30	8.02	449	3.0	12.4	231.6

NOTES: -- = parameter not measured

( ) = parameter not measured in accordance with Sampling Quality Assurance Plan

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY GROUNDWATER SAMPLING

DATE	WELL	Al mg/l	As mg/l	Ba mg/l	Cd mg/l	Cu mg/l	Pb mg/l	Hg mg/l	Se mg/l	Zn mg/l	Total Cr mg/l	Dis-solved Cr mg/l	Total Fe mg/l	Dis-solved Fe mg/l	Total Mn mg/l	Dis-solved Mn mg/l
11/22/88	H88-10	<0.1	<0.005	1.0	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.19	0.08	<0.02	<0.02
02/25/89	H88-10	0.2	<0.005	1.0	0.004	<0.01	<0.02	<0.001	<0.005	<0.01	0.04	<0.02	0.35	<0.05	0.01	<0.02
06/06/89	H88-10	0.1	0.020	1.1	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.27	0.05	<0.02	<0.02
07/25/89	H88-10	<0.1	<0.005	1.1	<0.002	<0.01	<0.02	<0.001	<0.005	0.08	<0.02	<0.02	0.23	0.10	0.14	<0.02
07/25/89	H88-10 DUP	<0.1	<0.005	1.1	<0.002	<0.01	<0.02	<0.001	<0.005	0.03	<0.02	<0.02	0.21	0.08	<0.02	<0.02
11/22/88	H88-11	0.1	0.007	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	0.03	<0.02	5.18	0.08	0.07	<0.02
02/23/89	H88-11	0.1	0.008	<0.5	0.005	<0.01	<0.02	<0.001	0.007	0.01	0.03	<0.02	4.98	0.08	0.06	<0.02
06/07/89	H88-11	0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.05	0.03	<0.02	5.45	<0.05	0.10	<0.02
07/25/89	H88-11	<0.1	0.008	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.06	<0.02	<0.02	2.70	0.08	0.04	<0.02
11/21/88	H88-12	1.5	0.021	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.03	0.10	<0.02	17.30	0.18	0.25	<0.02
02/12/89	H88-12	1.7	0.030	<0.5	0.003	<0.01	0.03	<0.001	<0.005	0.03	0.07	<0.02	11.20	0.81	0.12	<0.02
06/14/89	H88-12	0.4	0.008	<0.5	<0.002	<0.01	0.03	<0.001	<0.005	0.08	0.06	0.02	8.49	0.17	0.13	<0.02
07/18/89	H88-12	<0.1	0.023	<0.5	<0.002	0.01	<0.02	<0.001	<0.005	0.08	0.11	<0.02	15.30	0.11	0.18	<0.02
11/20/88	H88-13	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	0.06	<0.02	21.70	0.11	0.28	<0.02
02/26/89	H88-13	0.2	<0.005	<0.5	0.004	<0.01	<0.02	<0.001	<0.005	0.03	0.02	<0.02	0.95	<0.05	0.05	0.04
02/26/89	H88-13 DUP	0.3	<0.005	0.5	0.004	<0.01	0.02	<0.001	<0.005	0.04	<0.02	<0.02	1.00	<0.05	0.06	0.05
06/14/89	H88-13	<0.1	<0.005	<0.5	<0.002	0.01	<0.02	<0.001	<0.005	0.02	0.02	<0.02	0.90	0.07	0.05	0.03
07/18/89	H88-13	<0.1	<0.005	0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.47	0.11	0.04	0.04
07/18/89	H88-13 DUP	<0.1	<0.005	0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.40	0.11	0.04	0.04
11/22/88	H88-14A	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	0.03	<0.02	17.40	<0.05	0.32	<0.02
11/22/88	H88-14A DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.02	<0.02	17.10	<0.05	0.31	<0.02
02/15/89	H88-14A	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.10	0.02	<0.02	12.30	0.08	0.22	<0.02
05/23/89	H88-14A	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	1.21	<0.05	<0.02	<0.02
07/25/89	H88-14A	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	7.54	<0.05	0.14	<0.02
11/20/88	H88-15	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.37	<0.05	<0.02	<0.02
02/28/89	H88-15	0.3	<0.005	<0.5	0.002	<0.01	0.02	<0.001	<0.005	0.20	<0.02	<0.02	0.18	0.06	0.03	0.03
02/28/89	H88-15 DUP	0.4	<0.005	<0.5	<0.002	<0.01	0.03	<0.001	<0.005	0.20	<0.02	<0.02	0.46	0.09	0.05	0.03

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY GROUNDWATER SAMPLING

DATE	WELL	Al mg/l	As mg/l	Ba mg/l	Cd mg/l	Cu mg/l	Pb mg/l	Hg mg/l	Se mg/l	Zn mg/l	Total Cr mg/l	Dis-solved Cr mg/l	Total Fe mg/l	Dis-solved Fe mg/l	Total Mn mg/l	Dis-solved Mn mg/l
06/16/89	H88-15	0.1	<0.005	<0.5	<0.002	0.01	<0.02	<0.001	<0.005	0.01	0.02	<0.02	0.18	0.09	0.02	0.02
06/16/89	H88-15 DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.14	0.08	0.02	<0.02
07/19/89	H88-15	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.05	<0.02	<0.02	0.98	0.08	0.02	<0.02
11/21/88	H88-16	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.08	0.02	<0.02	1.57	0.20	0.02	<0.02
02/28/89	H88-16	0.4	<0.005	<0.5	<0.002	<0.01	0.03	<0.001	<0.005	0.02	0.02	<0.02	17.70	0.09	0.05	0.03
06/16/89	H88-16	0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	1.03	<0.05	0.03	<0.02
07/19/89	H88-16	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.73	<0.05	0.02	<0.02
11/08/88	H88-17	0.1	<0.005	<0.5	0.003	<0.01	<0.02	<0.001	<0.005	0.02	0.04	<0.02	23.10	0.11	0.38	0.08
02/15/89	H88-17	0.1	<0.005	<0.5	0.005	<0.01	<0.02	<0.001	<0.005	0.01	0.02	<0.02	4.53	0.05	0.07	0.08
05/30/89	H88-17	0.3	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.16	<0.02	63.50	0.24	0.97	<0.02
05/30/89	H88-17 DUP	0.7	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.15	<0.02	64.80	0.20	1.00	<0.02
07/11/89	H88-17	<0.1	<0.005	<0.5	0.003	<0.01	<0.02	<0.001	<0.005	0.02	0.24	<0.02	89.70	0.05	1.51	0.02
11/08/88	H88-19	0.2	<0.005	<0.5	0.006	<0.01	<0.02	<0.001	<0.005	0.02	1.90	<0.02	1010.00	0.24	13.20	0.18
05/23/89	H88-19	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.13	<0.02	68.60	0.09	1.26	0.02
07/10/89	H88-19	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	0.2	<0.02	88.00	<0.05	1.39	0.02
11/05/88	H88-21	0.4	<0.005	<0.5	0.005	0.01	<0.02	<0.001	<0.005	0.04	0.30	<0.02	221.00	0.67	4.30	0.04
02/15/89	H88-21	0.1	<0.005	<0.5	0.003	<0.01	<0.02	<0.001	<0.005	0.02	0.57	<0.02	408.00	0.39	8.17	0.05
02/15/89	H88-21 DUP	0.1	<0.005	<0.5	0.003	0.01	<0.02	<0.001	<0.005	0.01	0.56	<0.02	411.00	0.39	4.30	0.04
05/23/89	H88-21	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	0.13	<0.02	109.00	<0.05	2.67	<0.02
05/23/89	H88-21 DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.13	<0.02	105.00	<0.05	2.64	<0.02
07/11/89	H88-21	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.09	<0.02	85.60	<0.05	1.65	<0.02
11/05/88	H88-22	2.6	<0.005	<0.5	0.008	0.03	<0.02	<0.001	<0.005	0.04	0.25	<0.02	174.00	4.34	4.15	0.70
02/15/89	H88-22	0.1	<0.005	<0.5	0.003	<0.01	<0.02	<0.001	<0.005	0.03	0.09	<0.02	51.20	<0.05	1.23	0.13
05/30/89	H88-22	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.14	0.13	<0.02	104.00	0.05	2.16	0.15
07/10/89	H88-22	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.05	<0.02	46.90	0.05	0.94	0.11
11/03/88	H88-23	0.1	<0.005	<0.5	0.004	0.01	<0.02	<0.001	<0.005	0.03	0.40	<0.02	331.00	0.18	5.90	0.21

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY
GROUNDWATER SAMPLING

DATE	WELL	Al mg/l	As mg/l	Ba mg/l	Cd mg/l	Cu mg/l	Pb mg/l	Hg mg/l	Se mg/l	Zn mg/l	Total Cr mg/l	Dis-solved Cr mg/l	Total Fe mg/l	Dis-solved Fe mg/l	Total Mn mg/l	Dis-solved Mn mg/l
11/03/88	H88-23 DUP	0.1	<0.005	<0.5	0.004	0.01	<0.02	<0.001	<0.005	0.03	0.45	<0.02	339.00	0.19	6.05	0.21
02/12/89	H88-23	0.1	<0.005	<0.5	0.002	0.01	<0.02	<0.001	0.010	0.01	<0.02	<0.02	0.83	<0.05	0.03	0.02
02/12/89	H88-23 DUP	0.1	<0.005	<0.5	0.002	0.01	<0.02	<0.001	0.010	0.01	<0.02	<0.02	0.76	<0.05	0.03	0.02
05/24/89	H88-23	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.13	<0.02	128.00	0.05	2.41	0.08
07/23/89	H88-23	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	0.16	<0.02	104.00	<0.05	1.93	0.06
07/23/89	H88-23 DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	0.13	<0.02	101.00	<0.05	1.85	0.06
11/03/88	H88-24A	<0.1	<0.005	<0.5	0.003	<0.01	<0.02	<0.001	<0.005	0.03	0.35	<0.02	267.00	0.09	5.90	4.58
02/21/89	H88-24A	<0.1	<0.005	<0.5	0.002	<0.01	<0.02	<0.001	<0.005	0.01	0.02	<0.02	17.10	0.05	0.83	0.46
05/24/89	H88-24A	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.14	<0.02	117.00	0.23	2.87	0.11
07/23/89	H88-24A	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	0.16	<0.02	117.00	<0.05	2.82	<0.02
11/03/88	H88-25	<0.1	<0.005	<0.5	0.004	<0.01	<0.02	<0.001	<0.005	<0.01	0.50	<0.02	379.00	<0.05	7.00	<0.02
02/19/89	H88-25	<0.1	<0.005	<0.5	0.004	<0.01	<0.02	<0.001	<0.005	0.03	0.02	<0.02	13.50	<0.05	0.23	<0.02
02/24/89	H88-25 DUP	<0.1	<0.005	<0.5	0.006	<0.01	<0.02	<0.001	0.007	0.01	0.21	<0.02	160.00	0.06	2.69	<0.02
05/24/89	H88-25	1.3	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.03	0.54	<0.02	385.00	1.01	6.40	0.07
07/23/89	H88-25	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.04	0.37	<0.02	266.00	<0.05	4.81	0.03
11/07/88	H88-27	0.1	<0.005	<0.5	0.004	0.01	<0.02	<0.001	<0.005	0.03	0.06	<0.02	18.30	0.22	0.37	0.05
02/18/89	H88-27	0.8	<0.005	<0.5	0.008	0.03	0.08	<0.001	0.010	0.10	0.05	<0.02	24.00	0.95	0.43	0.04
05/31/89	H88-27	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	0.23	<0.02	181.00	0.07	3.20	0.02
07/18/89	H88-27	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	0.1	<0.02	65.90	0.10	1.50	0.02
11/07/88	H88-28	0.1	<0.005	<0.5	0.003	<0.01	<0.02	<0.001	<0.005	0.01	0.20	<0.02	131.00	0.17	2.45	0.02
2/18/89	H88-28	0.1	<0.005	<0.5	0.004	<0.01	<0.02	<0.001	0.010	0.02	0.13	<0.02	95.60	0.09	1.47	0.09
07/26/89	H88-28	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.03	0.03	<0.02	35.90	0.06	0.52	0.03
07/27/89	H88-29	<0.1	<0.005	0.6	<0.005	<0.01	<0.02	<0.001	<0.005	0.06	<0.02	<0.02	0.23	0.14	<0.02	<0.02
07/28/89	H88-30	<0.1	0.011	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	4.60	<0.05	0.07	<0.02

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY
GROUNDWATER SAMPLING

DATE	WELL	HCO3 mg/l	CO3 mg/l	Cl mg/l	NO3 mg/l	NO2 mg/l	SO4 mg/l	Ca mg/l	Mg mg/l	K mg/l	Na mg/l	Anions meq/l	Cations meq/l	Cation/ Anion Difference %	pH (lab)	Specific Conduct-ance(lab) uhmos
11/22/88	H88-10	214	0	1.1	<0.01	<0.01	3.7	34.0	11.0	3.3	23.0	3.61	3.66	0.69	7.47	301
02/25/89	H88-10	218	0	2.5	0.11	<0.01	0.4	34.0	8.5	3.8	25.0	3.66	3.59	0.97	7.84	278
06/06/89	H88-10	225	0	2.1	0.16	<0.01	0.6	37.0	8.0	3.6	26.0	3.77	3.69	1.07	7.88	294
07/25/89	H88-10	220	0	1.8	<0.01	<0.01	<1	35.0	8.6	3.7	25.0	3.65	3.63	0.27	7.74	286
07/25/89	H88-10 DUP	220	0	1.4	0.01	<0.01	1.2	34.0	9.1	3.6	25.0	3.67	3.63	0.55	7.78	288
11/22/88	H88-11	783	12	1.1	<0.01	<0.01	1.6	2.0	0.5	1.9	300.0	13.30	13.24	0.23	8.51	1200
02/23/89	H88-11	847	18	3.9	0.03	<0.01	1.9	2.4	0.9	2.2	329.0	14.63	14.56	0.24	8.49	964
06/07/89	H88-11	906	11	1.8	0.05	<0.01	0.8	2.6	0.5	1.6	351.0	15.27	15.48	0.68	8.44	1260
07/25/89	H88-11	885	0	2.8	0.01	<0.01	3.7	2.7	0.4	2.2	343.0	14.67	15.14	1.58	8.31	1259
11/21/88	H88-12	0	344	1.4	0.04	<0.01	11.0	1.4	0.9	2.9	248.0	10.78	11.01	1.06	10.94	1180
02/12/89	H88-12	0	319	2.5	0.11	<0.01	13.0	6.4	<0.1	2.8	292.0	12.97	13.09	0.46	10.63	1085
06/14/89	H88-12	356	150	1.8	0.11	<0.01	14.0	3.4	17.3	0.5	225.0	11.19	11.37	0.80	9.63	1027
07/18/89	H88-12	189	236	2.1	<0.01	<0.01	26.0	3.2	0.1	3.0	270.0	11.58	12.00	1.78	10.10	1040
11/20/88	H88-13	2749	0	120.0	0.01	<0.01	4.1	8.1	4.5	6.1	1120.0	48.55	49.66	1.13	7.92	4285
02/26/89	H88-13	2106	0	89.0	0.06	<0.01	4.1	6.5	2.3	4.7	840.0	37.14	37.17	0.04	8.09	2560
02/26/89	H88-13 DUP	2098	0	89.3	0.07	<0.01	4.1	7.1	1.7	4.7	849.0	37.01	37.55	0.72	8.16	2540
06/14/89	H88-13	1961	0	79.0	0.07	<0.01	0.4	5.6	1.5	0.9	786.0	34.38	34.63	0.36	7.98	2900
07/19/89	H88-13	2122	0	91.0	<0.01	<0.01	0.4	6.8	2.4	4.2	843.0	37.37	37.33	0.05	8.10	2730
07/19/89	H88-13 DUP	2122	0	90.0	0.03	<0.01	1.2	6.9	1.5	4.5	843.0	37.35	37.26	0.12	8.10	2912
11/22/88	H88-14A	77	0	3.2	0.40	<0.01	13.0	16.0	2.9	0.6	14.0	1.64	1.63	0.31	7.02	167
11/22/88	H88-14A DUP	76	0	2.8	0.40	<0.01	12.0	15.0	3.0	0.5	14.0	1.61	1.63	0.62	7.05	152
02/15/89	H88-14A	78	0	5.0	0.42	<0.01	12.0	16.0	3.3	0.7	14.0	1.71	1.72	0.29	7.41	153
05/26/89	H88-14A	101	0	2.1	0.47	<0.01	11.0	16.0	3.0	1.2	21.0	1.98	2.00	0.50	7.43	177
07/25/89	H88-14A	49	0	1.8	0.18	<0.01	6.8	12.0	1.8	0.8	4.8	1.01	0.99	1.00	6.91	83
11/20/88	H88-15	160	0	2.8	0.36	<0.01	3.9	12.0	2.2	0.9	46.0	2.82	2.80	0.36	8.16	255
02/28/89	H88-15 DUP	156	11	0.7	0.09	<0.01	0.8	1.7	0.6	1.0	63.0	2.96	2.90	1.02	9.00	245
06/16/89	H88-15	255	0	28.0	0.08	<0.01	5.3	15.0	2.1	1.5	92.0	5.08	4.98	0.99	7.96	438

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY GROUNDWATER SAMPLING

DATE	WELL	HCO3 mg/l	CO3 mg/l	Cl mg/l	NO3 mg/l	NO2 mg/l	SO4 mg/l	Ca mg/l	Mg mg/l	K mg/l	Na mg/l	Anions meq/l	Cations meq/l	Cation/ Anion Difference %	pH (lab)	Specific Conduct-ance(lab) uhmos
06/16/89	H88-15 DUP	258	0	29.0	0.11	<0.01	5.8	15.0	1.1	1.6	99.0	5.17	5.20	0.29	7.87	437
07/19/89	H88-15	273	0	33.0	<0.01	<0.01	4.1	16.0	1.1	1.3	107.0	5.48	5.55	0.63	7.81	482
11/21/88	H88-16	145	0	0.7	0.50	<0.01	2.3	1.3	0.2	1.4	65.0	3.02	2.95	1.17	9.08	273
02/28/89	H88-16	160	9	0.4	0.10	<0.01	1.0	1.4	0.6	0.9	64.0	2.96	2.92	0.68	9.05	234
06/16/89	H88-16	161	6.3	1.1	0.10	<0.01	2.5	2.1	1.3	0.8	62.0	2.94	2.92	0.34	8.76	245
07/19/89	H88-16	169	0	1.4	<0.01	<0.01	0.4	3.0	0.7	1.0	60.0	2.82	2.82	0.00	8.34	242
11/08/88	H88-17	109	0	1.1	1.23	<0.01	4.1	20.0	7.2	1.8	10.0	2.00	2.08	1.96	7.05	189
02/16/89	H88-17	85	0	3.9	0.49	<0.01	8.6	18.0	5.8	1.5	7.7	1.73	1.76	0.86	6.89	184
05/30/89	H88-17	140	0	1.8	1.92	0.01	9.1	31.0	7.7	1.5	11.0	2.68	2.71	0.56	8.01	222
05/30/89	H88-17 DUP	149	0	1.8	1.94	0.01	9.1	31.0	9.4	1.4	9.6	2.83	2.75	1.43	7.57	220
07/11/89	H88-17	111	0	1.1	0.74	0.05	6.4	23.0	5.8	1.7	8.9	2.03	2.06	0.73	6.97	185
11/08/88	H88-19	146	0	2.8	<0.01	<0.01	13.0	19.0	8.8	4.8	25.0	2.74	2.88	2.49	7.28	243
05/23/89	H88-19	91	0	2.8	0.21	<0.01	15.0	22.0	3.2	1.5	11.0	1.89	1.88	0.27	6.93	173
07/10/89	H88-19	77	0	2.8	0.08	<0.01	8.6	17.0	2.6	2.3	9.2	1.53	1.52	0.33	7.02	134
11/09/88	H88-21	94	0	0.7	0.39	<0.01	3.7	23.0	3.0	1.7	6.0	1.67	1.71	1.18	7.95	152
02/16/89	H88-21	112	2.7	1.4	0.89	0.01	4.7	33.0	<0.1	2.3	7.4	2.12	2.05	1.68	8.55	165
02/15/89	H88-21 DUP	115	3	1.4	0.85	<0.01	5.3	32.0	1.7	2.3	7.3	2.19	2.12	1.62	8.53	185
05/23/89	H88-21	106	0	0.7	0.28	0.01	4.9	28.0	2.2	1.2	5.2	1.87	1.84	0.81	7.90	174
05/23/89	H88-21 DUP	104	0	0.7	0.27	<0.01	3.9	28.0	2.4	1.4	5.4	1.82	1.83	0.27	7.92	164
07/11/89	H88-21	85	0	0.4	0.28	<0.01	4.9	23.0	1.6	2.9	3.4	1.53	1.51	0.66	7.50	123
11/05/88	H88-22	124	0	1.1	0.07	<0.01	1.6	28.0	5.1	1.3	5.9	2.10	2.13	0.71	7.59	188
02/16/89	H88-22	84	0	1.4	7.54	<0.01	2.1	20.0	3.2	0.9	4.0	1.45	1.47	0.68	7.04	141
05/30/89	H88-22	123	0	1.1	<0.01	<0.01	4.3	30.0	4.0	1.0	5.3	2.13	2.09	0.95	7.87	164
07/10/89	H88-22	128	0	1.4	0.05	<0.01	3.7	30.0	4.9	1.5	5.9	2.22	2.19	0.68	7.79	185
11/03/88	H88-23	81	0	5.0	0.31	<0.01	9.5	17.0	4.5	2.4	8.7	1.69	1.67	0.60	7.12	152
11/03/88	H88-23	81	0	4.3	0.29	<0.01	10.0	16.0	5.0	2.4	8.8	1.68	1.67	0.30	7.10	157

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY GROUNDWATER SAMPLING

DATE	WELL	HCO3 mg/l	CO3 mg/l	Cl mg/l	NO3 mg/l	NO2 mg/l	SO4 mg/l	Ca mg/l	Mg mg/l	K mg/l	Na mg/l	Anions meq/l	Cations meq/l	Cation/ Anion Difference %	pH (lab)	Specific Conduct-ance(lab) uhmos
02/21/89	H88-23	68	0	1.1	0.21	0.01	2.3	14.0	4.0	1.1	3.4	1.22	1.23	0.41	7.00	118
02/21/89	H88-23 DUP	68	0	0.7	0.28	0.01	3.1	13.9	4.3	1.1	3.4	1.22	1.23	0.41	7.00	101
05/24/89	H88-23	77	0	1.4	0.30	<0.01	6.0	20.0	2.9	2.3	4.3	1.45	1.48	1.02	7.12	128
07/23/89	H88-23	66	0	1.1	0.13	<0.01	7.2	19.0	1.2	1.9	3.9	1.28	1.29	0.39	6.90	110
07/23/89	H88-23 DUP	68	0	1.1	0.14	<0.01	7.2	18.0	2.3	1.9	3.9	1.30	1.30	0.00	6.78	117
11/03/88	H88-24A	98	0	33.0	0.22	<0.01	7.6	12.0	4.7	3.3	40.0	2.72	2.77	0.91	7.59	269
02/21/89	H88-24A	99	0	22.0	0.13	0.01	7.0	18.0	6.0	2.1	22.0	2.39	2.41	0.42	7.61	210
05/24/89	H88-24A	103	0	3.5	0.07	<0.01	2.5	18.0	5.1	2.1	11.0	1.85	1.86	0.27	7.66	167
07/23/89	H88-24A	100	0	3.2	0.38	0.02	4.3	25.0	1.8	2.5	9.9	1.85	1.88	0.80	7.46	175
11/03/88	H88-25	143	0	284.0	<0.01	<0.01	45.0	57.0	12.0	8.8	171.0	11.28	11.50	0.97	8.09	1210
02/19/89	H88-25	110	0	21.0	0.37	<0.01	6.0	18.0	6.9	3.6	21.0	2.53	2.49	0.80	6.62	206
02/24/89	H88-25 DUP	120	0	59.0	0.15	<0.01	3.1	20.0	3.8	4.0	68.0	4.34	4.39	0.57	8.03	395
05/24/89	H88-25	124	0	13.0	0.12	0.01	6.6	23.0	5.8	3.5	19.0	2.56	2.57	0.19	7.87	226
07/23/89	H88-25	148	0	17.0	0.14	<0.01	6.6	22.0	3.4	3.4	36.0	3.04	3.06	0.33	7.52	268
11/07/88	H88-27	81	0	15.0	0.39	<0.01	3.7	19.0	4.9	2.0	11.0	1.86	1.88	0.53	7.17	182
02/18/89	H88-27	73	0	3.5	2.55	<0.01	5.6	16.0	4.6	1.6	4.8	1.41	1.42	0.35	7.17	115
05/31/89	H88-27	68	0	0.7	0.42	<0.01	4.7	18.0	2.1	1.3	3.5	1.27	1.24	1.20	7.03	104
07/18/89	H88-27	79	0	1.1	0.94	<0.01	3.1	18.0	4.0	1.6	4.1	1.45	1.46	0.34	7.14	128
11/07/88	H88-28	126	0	0.7	0.58	<0.01	6.4	43.0	2.8	2.9	8.2	2.76	2.81	0.90	8.89	236
02/18/89	H88-28	85	0	1.4	0.74	<0.01	2.7	18.0	4.5	1.5	4.4	1.55	1.48	2.31	6.70	140
07/26/89	H88-28	117	0	0.7	0.64	<0.01	3.1	33.0	1.8	2.2	5.3	2.05	2.07	0.49	7.29	189
07/27/89	H88-29	179	0	1.8	0.01	<0.01	5.6	27.0	8.1	3.0	22.0	3.10	3.05	0.81	7.55	266
07/28/89	H88-30	354	0	2.5	0.05	<0.01	7.2	10.0	1.9	2.5	123.0	6.03	6.10	0.58	8.17	494

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY GROUNDWATER SAMPLING

DATE	WELL	Ammonia (As N) mg/l	Total Kjeldahl Nitrogen (as N) mg/l	Ortho Phos-phorus mg/l	Total Organic Phos-phorus mg/l	Total Phos-phorus mg/l	Total Alka-linity mg/l	Total Hard-ness mg/l	Total Acid-ity mg/l	Sodium Adsorb-tion Ratio	Total Dis-solved solid mg/l	Boron mg/l	Fluoride mg/l
11/22/88	H88-10	0.45	0.7	<0.001	<0.001	0.008	358	129	<1	0.87	188	0.07	0.28
02/25/89	H88-10	0.01	0.7	0.001	0.009	0.037	179	120	<1	1.00	182	0.26	0.29
06/06/89	H88-10	0.41	1.3	0.003	0.003	0.018	185	125	<1	0.99	202	0.19	0.35
07/25/89	H88-10	0.41	1.1	0.006	0.003	0.013	180	122	<1	0.98	196	0.42	0.26
07/25/89	H88-10 DUP	0.38	0.8	0.005	0.003	0.013	180	122	<1	0.98	200	<0.01	0.27
11/22/88	H88-11	0.45	0.7	0.044	0.011	0.115	1521	7	<1	49.30	738	0.12	2.10
02/23/89	H88-11	0.42	1.4	0.008	0.013	0.142	724	9.4	<1	46.40	782	0.08	1.62
06/07/89	H88-11	0.36	1.7	0.081	0.007	0.233	760	8.4	<1	52.40	834	0.32	1.49
07/25/89	H88-11	0.41	1.0	0.018	0.001	0.124	726	8.2	<1	52.80	786	0.02	1.35
11/21/88	H88-12	0.80	0.8	0.128	0.186	1.090	588	7	<1	40.89	728	0.08	3.17
02/12/89	H88-12	1.87	0.7	0.155	0.024	0.727	632	16	<1	31.80	736	0.34	3.26
06/16/89	H88-12	0.11	1.0	0.338	0.053	0.893	543	80	<1	11.00	616	0.07	3.08
07/18/89	H88-12	0.39	2.4	0.325	0.280	1.480	549	8	<1	40.30	642	0.10	2.93
11/20/88	H88-13	1.22	2.3	0.008	0.096	0.625	2565	39	<1	78.00	2750	0.05	0.36
02/26/89	H88-13	0.70	1.7	0.011	0.021	0.109	1727	26	<1	72.40	1984	0.25	0.39
02/26/89	H88-13 DUP	0.69	1.7	0.011	0.033	0.120	1720	25	<1	73.86	1982	0.26	0.40
06/16/89	H88-13	0.02	1.1	0.016	0.023	0.137	1607	20	<1	76.50	1850	<0.01	0.43
07/19/89	H88-13	0.87	2.4	0.006	0.030	0.150	1740	27	<1	70.60	2008	0.01	0.46
07/19/89	H88-13 DUP	0.86	2.1	0.006	0.084	0.198	1740	23	<1	75.70	2026	<0.01	0.40
11/22/88	H88-14A	0.01	0.5	<0.001	0.154	1.310	53	50	<1	0.84	120	0.06	0.17
11/22/88	H88-14A DUP	0.01	0.5	<0.001	0.198	1.370	62	51	<1	0.84	106	0.06	0.17
02/15/89	H88-14A	0.04	0.5	0.017	0.555	0.983	64	54	<1	0.86	98	0.41	0.11
05/23/89	H88-14A	0.03	1.1	0.062	0.083	1.079	83	53	<1	1.25	114	<0.01	0.27
07/25/89	H88-14A	<0.01	1.3	0.006	0.029	0.284	41	38	<1	0.34	66	<0.01	0.08
11/20/88	H88-15	0.12	0.6	0.005	0.005	0.032	137.9	38	<1	3.28	172	0.16	0.05

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY GROUNDWATER SAMPLING

DATE	WELL	Ammonia (As N) mg/l	Total Kjeldahl Nitrogen (as N) mg/l	Ortho Phos-phorus mg/l	Total Organic Phos-phorus mg/l	Total Phos-phorus mg/l	Total Alka-linity mg/l	Total Hard-ness mg/l	Total Acid-ity mg/l	Sodium Adsorb-tion Ratio	Total Dis-solved solid mg/l	Boron mg/l	Fluoride mg/l
02/28/89	H88-15	0.08	0.2	0.015	0.007	0.031	133	38	<1	3.18	154	0.43	0.54
02/28/89	H88-15 DUP	0.04	0.1	0.031	<0.001	0.066	146	7	<1	10.80	176	0.39	0.54
06/16/89	H88-15	0.10	0.6	0.009	0.003	0.028	209	46	<1	5.93	304	0.11	0.50
06/16/89	H88-15 DUP	0.15	1.0	0.010	0.002	0.029	212	42	<1	6.61	302	0.07	0.50
07/19/89	H88-15	0.10	0.7	0.005	0.026	0.112	224	44	<1	7.00	294	0.12	0.49
11/21/88	H88-16	0.14	0.7	0.055	<0.001	0.070	577	4	<1	14.20	192	0.11	0.54
02/28/89	H88-16	0.04	0.2	0.032	<0.001	0.064	146	6	<1	11.30	164	0.38	0.61
06/19/89	H88-16	0.03	1.0	0.020	0.003	0.054	143	10	<1	8.30	182	0.10	0.53
07/19/89	H88-16	0.01	0.5	0.009	0.017	0.065	139	10	<1	7.99	142	<0.01	0.55
11/08/88	H88-17	0.07	0.7	0.568	0.478	1.880	69	64	<1	0.21	92	0.36	0.20
02/15/89	H88-17	0.35	0.6	0.011	0.134	0.351	70	69	<1	0.40	108	0.29	0.11
05/30/89	H88-17	0.02	1.7	0.009	0.790	3.180	115	109	<1	0.47	150	0.17	0.27
05/30/89	H88-17 DUP	0.02	1.9	0.007	0.620	2.790	123	114	<1	0.39	162	0.15	0.09
07/11/89	H88-17	<0.01	1.0	0.006	0.519	3.100	91	81	<1	0.43	112	<0.01	0.11
11/08/88	H88-19	1.40	206.0	0.004	3.100	16.200	277	83	<1	1.21	154	0.06	0.12
05/23/89	H88-19	0.31	10.8	0.031	1.880	8.320	75	67	<1	0.60	108	<0.01	0.06
07/10/89	H88-19	0.31	38.8	0.044	3.140	9.780	63	53	<1	0.55	104	0.10	0.08
11/09/88	H88-21	<0.01	0.5	0.001	0.036	2.690	74.5	71	<1	0.31	114	0.02	0.07
02/16/89	H88-21	0.45	5.7	0.137	0.646	5.960	96	84	<1	0.35	104	0.36	0.60
02/16/89	H88-21 DUP	0.54	6.5	0.146	0.191	5.960	99	87	<1	0.34	118	0.37	0.67
05/23/89	H88-21	0.02	3.1	0.022	0.371	2.740	87	79	<1	0.26	106	<0.01	0.08
05/23/89	H88-21 DUP	0.03	3.7	0.028	0.432	2.420	85	78	<1	0.26	100	<0.01	0.08
07/11/89	H88-21	<0.01	1.8	0.016	0.820	3.130	70	64	<1	0.19	98	<0.01	0.06
11/05/88	H88-22	<0.01	0.5	0.001	3.110	4.500	172	92	<1	0.27	122	0.01	0.08
02/16/89	H88-22	0.07	0.7	0.568	0.478	1.880	69	64	<1	0.21	92	0.36	0.20

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 3-7
ANALYTICAL RESULTS OF MONTHLY GROUNDWATER SAMPLING

DATE	WELL	Ammonia (As N) mg/l	Total Kjeldahl Nitrogen (as N) mg/l	Ortho Phos-phorus mg/l	Total Organic Phos-phorus mg/l	Total Phos-phorus mg/l	Total Alka-linity mg/l	Total Hard-ness mg/l	Total Acid-ity mg/l	Sodium Adsorb-tion Ratio	Total Dis-solved solid mg/l	Boron mg/l	Fluoride mg/l
05/30/89	H88-22	0.02	2.0	0.016	0.030	2.770	101	91	<1	0.24	116	0.28	0.26
07/10/89	H88-22	<0.01	1.2	0.053	1.902	4.360	105	95	<1	0.27	136	<0.01	0.10
11/03/88	H88-23	0.24	3.4	0.007	1.390	8.910	97.6	62	<1	0.48	108	0.04	0.07
11/03/88	H88-23 DUP	0.20	3.9	0.003	1.470	8.100	67	62	<1	0.48	106	0.04	0.09
02/21/89	H88-23	0.03	1.4	0.006	0.329	2.150	56	53	<1	0.21	88	<0.01	0.06
02/21/89	H88-23 DUP	0.02	1.5	0.004	0.334	2.060	56	53	<1	0.21	78	<0.01	0.06
05/24/89	H88-23	0.06	4.9	0.019	0.782	3.620	64	62	<1	0.24	82	<0.01	0.06
07/23/89	H88-23	<0.01	4.7	0.026	0.587	3.400	55	54	<1	0.23	96	<0.01	0.07
07/23/89	H88-23 DUP	<0.01	3.2	0.025	0.487	3.430	56	54	<1	0.23	96	<0.01	0.08
11/03/88	H88-24A	0.06	0.8	0.002	0.458	5.740	75.1	48	<1	2.47	168	0.07	0.21
02/21/89	H88-24A	0.01	1.5	0.019	0.724	5.180	81	70	<1	1.15	148	0.03	0.15
05/24/89	H88-24A	0.02	2.7	0.074	0.695	3.000	85	66	<1	0.62	94	<0.01	0.13
07/23/89	H88-24A	0.07	4.1	0.035	0.167	1.820	82	69	<1	0.52	116	<0.01	0.14
11/03/88	H88-25	0.06	2.4	0.006	0.826	5.460	245	191	<1	5.38	716	0.18	0.43
02/19/89	H88-25	0.08	1.4	0.034	0.575	1.120	90	75	<1	1.05	132	0.03	0.19
02/24/89	H88-25 DUP	<0.01	0.2	0.024	0.272	0.348	99	66	<1	3.66	278	0.22	0.66
05/24/89	H88-25	0.06	7.4	0.051	2.350	8.270	102	82	<1	0.93	140	<0.01	0.18
07/23/89	H88-25	<0.01	2.1	0.019	0.559	2.710	121	70	<1	1.88	190	<0.01	0.38
11/07/88	H88-27	0.04	<0.1	0.001	0.036	0.482	66	68	<1	0.57	116	0.04	0.09
02/18/89	H88-27	0.24	0.9	0.021	0.504	1.300	60	59	<1	0.27	72	<0.01	0.10
05/31/89	H88-27	0.01	1.1	0.021	0.289	2.040	56	53	<1	0.21	76	0.14	0.09
07/18/89	H88-27	<0.01	1.5	0.015	1.070	4.580	65	62	<1	0.23	112	<0.01	0.11
11/7/88	H88-28	0.07	0.5	0.072	0.704	2.990	129	119	<1	0.33	182	0.03	0.18
02/18/89	H88-28	0.06	2.3	0.031	0.299	2.550	70	63	<1	0.33	108	<0.01	0.12
07/26/89	H88-28	0.03	2.4	0.011	0.311	1.620	96	89	<1	0.24	152	<0.01	0.16
07/27/89	H88-29	0.25	0.7	0.005	0.005	0.012	147	102	<1	0.93	158	<0.01	0.17
07/28/89	H88-30	0.22	2.1	0.040	0.067	0.190	291	34	<1	9.19	366	<0.01	1.35

NOTE: DUP means duplicate analysis for lab QA/QC

TABLE 4-1

SUMMARY OF CHEMICAL ANALYSES OF GROUNDWATER IN PROPOSED PERMIT AREA

CONSTITUENT	UNITS	GLACIAL-ALLUVIAL WELLS			BEDROCK WELLS		
		Max	Mean	Min	Max	Mean	Min
pH (Lab)		8.89	7.45	6.62	10.94	8.78	7.55
pH (Field)		8.46	7.31	6.06	11.45	8.88	6.96
Specific Conductance (Lab)	µmhos/cm	1210	205	83	1260	665	234
Specific Conductance (Field)	µmhos/cm	741	217	96	1441	698	260
Temperature	°C	8.0	2.6	1.0	1.5	2.8	4.0
Dissolved Oxygen	mg/l	14.4	12.0	8.3	13.6	12.1	9.1
Alkalinity (Lab)	mg/l	358	102	41	1521	427	133
Alkalinity (Field)	mg/l	358	89	28	1521	348	10.8
Aluminum	mg/l	2.60	0.35	<0.01	1.70	0.40	<0.1
Arsenic	mg/l	0.020	0.020	<0.005	0.030	0.013	<0.005
Barium	mg/l	1.10	1.10	<0.5	0.60	0.50	<0.05
Cadmium	mg/l	0.008	0.004	<0.002	0.005	0.004	<0.002
Copper	mg/l	0.03	0.02	<0.01	0.01	0.01	<0.01
Lead	mg/l	0.08	0.08	<0.02	0.03	0.03	<0.02
Mercury	mg/l	<0.001	NA	<0.001	<0.001	NA	<0.001
Selenium	mg/l	0.010	0.009	<0.005	0.007	0.007	<0.005
Zinc	mg/l	0.14	0.03	<0.01	0.08	0.04	<0.01
Chromium	mg/l	<0.02	NA	<0.02	0.02	0.02	<0.02
Iron	mg/l	4.34	0.33	<0.05	0.84	0.14	<0.05
Manganese	mg/l	4.58	0.23	<0.02	0.05	0.03	<0.02
Chromium (Total)	mg/l	1.9	0.19	<0.02	0.11	0.05	<0.02
Iron (Total)	mg/l	1010.00	126.72	0.19	21.70	4.78	0.14
Manganese (Total)	mg/l	13.20	2.44	<0.02	0.28	0.08	<0.002
Total Hardness		191	78	48	102	26	4
Bicarbonate HC03	mg/l	225	111	49	906	328	0
Carbonate C03	mg/l	3.0	0.1	0.0	344.0	59.0	0.0
Chloride	mg/l	284.0	10.7	0.4	33.0	6.3	0.4
Nitrate N03	mg/l	7.54	0.63	<0.01	0.5	0.1	<0.01
Nitrite N02	mg/l	0.05	0.02	<0.01	<0.01	NA	<0.01
Sulfate S04	mg/l	45.0	6.7	<0.1	26.0	5.8	0.4
Calcium	mg/l	57.0	23.5	12.0	27.0	6.8	1.3
Magnesium	mg/l	12.0	4.7	<0.1	17.3	2.3	<0.1
Potassium	mg/l	8.8	2.2	0.5	3.0	1.7	0.5
Sodium	mg/l	171.0	16.0	3.4	351.0	166.4	22.0
Anions	meq/l	11.28	2.31	1.01	15.27	7.72	2.82
Cations	meq/l	11.50	2.31	0.99	15.48	7.79	2.80
Cation/Anion Difference	%	2.49	0.76	0.00	1.78	0.72	0.00
Ammonia as N	mg/l	1.40	0.17	<0.01	1.87	0.30	0.01
Total Kjeldahl Nitrogen as N	mg/l	206.0	7.0	<0.1	2.4	0.9	0.1
Ortho Phosphorus	mg/l	0.568	0.470	<0.001	0.338	0.067	0.005
Total Organic Phosphorous	mg/l	3.140	0.699	<0.001	0.280	0.042	<0.001
Total Phosporous	mg/l	16.200	3.294	0.008	1.480	0.278	0.012
Total Acidity	mg/l	<1	NA	<1	<1	NA	<1
Sodium Adsorbtion Ratio	mg/l	5.38	0.74	0.19	52.80	20.70	0.93
Total Dissolved Solids	mg/l	716	138	66	834	423	142
Boron	mg/l	0.42	0.17	<0.01	0.43	0.18	<0.01
Fluoride	mg/l	0.67	0.18	0.06	3.26	1.28	0.05

NOTE: Data from H88-13 is not included in this table because of expected effects of using mud during drilling.

TABLE 4-2

COMPARISON OF FEDERAL DRINKING WATER QUALITY STANDARDS AND GROUNDWATER QUALITY IN THE PROPOSED PERMIT AREA

Parameter	Maximum Allowable Concentration (mg/l)	Maximum Measured Concentration In Groundwater (mg/l)
Primary Standards		
Nitrate as N	10.0	7.54
Ba	1.0	1.1
As	0.050	0.030
Cr	0.050	0.02
Pb	0.050	0.08
Ag	0.050	NM
Cd	0.010	0.008
Se	0.010	0.070
Hg	0.002	<0.001
Fluoride	4.0	3.26
Secondary Standards		
Cu	1.0	0.03
Fluoride	2.0	3.26
Fe	0.30	4.34
Mn	0.05	4.58
Zn	5.0	0.14
TDS	500	834
Chloride	250	284
Sulfate	250	45
Color	15 units	NM
Turbidity	5 NTU	NM
Odor-Thres.	3 units	NM
Corrosivity	"Rel. Low"	NM

Notes: < indicates measured values below detectable limit.

NM indicates parameter not measured

TABLE 4-3

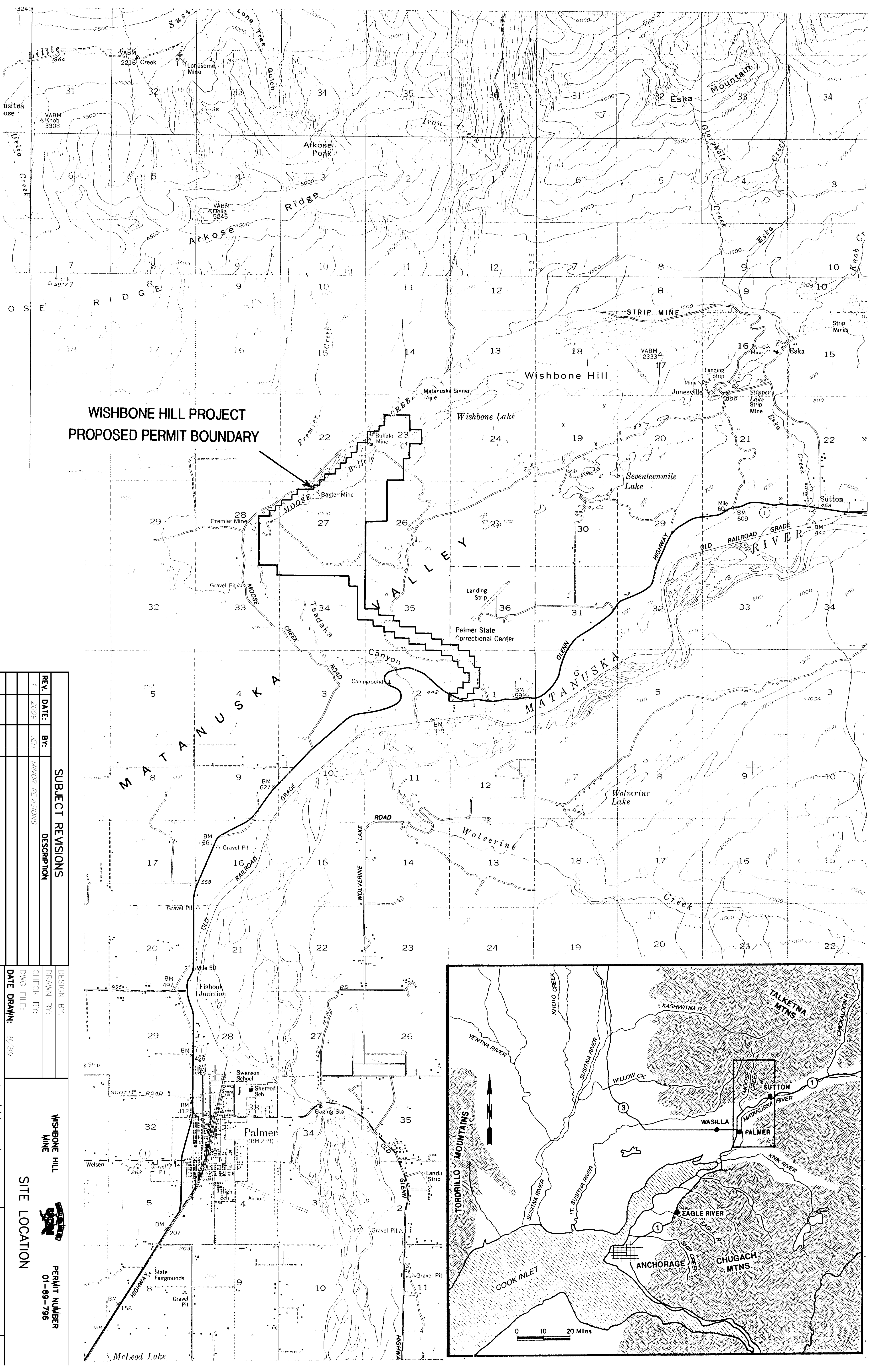
GROUNDWATER SAMPLING LOCATIONS EXCEEDING DRINKING WATER STANDARDS (DWS)

		FEDERAL PRIMARY DWS (mg/l)			FEDERAL SECONDARY DWS (mg/l)				ALASKA DWS (mg/l) Sec 18AAC.70 (1)(A)(i)	
PARAMETER		Ba	Pb	Se	FLUORIDE	Fe	Mn	pH	pH	TDS
STANDARD		1.0	0.050	0.010	2.0	0.30	0.05	6.5-8.5	6.0-8.5	500
Station ID	Date									
H88-10	11/88	1.0								
	2/89	1.0								
	6/89	1.1								
	7/89	1.1								
H88-11	11/88				2.1					738
	2/89							8.50	8.50	782
	6/89							9.37	9.37	834
	7/89							8.75	8.75	786
H88-12	11/88				3.17			11.40	11.40	728
	2/89				3.26	0.81		11.45	11.45	736
	6/89				3.08			9.68	9.68	616
	7/89				2.93			10.26	10.26	642
H88-13	11/88						0.05	8.60	8.60	2750
	2/89									1984
	6/89									1850
	7/89									2026
H88-14A	11/88							6.06		
H88-16	11/88							8.79	8.79	
	6/89							9.45	9.45	
	7/89							8.72	8.72	
H88-17	11/88						0.08			
	2/89						0.08			
H88-19	11/88						0.18			
H88-21	11/88					0.67				
	2/89					0.39	0.05			

TABLE 4-3
GROUNDWATER SAMPLING LOCATIONS EXCEEDING DRINKING WATER STANDARDS (DWS)

		FEDERAL PRIMARY DWS (mg/l)			FEDERAL SECONDARY DWS (mg/l)				ALASKA DWS (mg/l) Sec 18AAC.70 (1)(A)(i)	
PARAMETER		Ba	Pb	Se	FLUORIDE	Fe	Mn	pH	pH	TDS
STANDARD		1.0	0.050	0.010	2.0	0.30	0.05	6.5-8.5	6.0-8.5	500
Station ID	Date									
H88-22	11/88					4.34	0.7			
	2/89						0.13			
	6/89						0.15			
	7/89						0.11			
H88-23	11/88						0.21			
	2/89			0.010						
	6/89						0.08			
	7/89						0.06			
H88-24A	11/88						4.58			
	2/89						0.46			
	6/89						0.11			
H88-25	11/88									716
	6/89					1.01	0.07			
H88-27	11/88						0.05			
	2/89		0.08	0.010		0.95				
H88-28	11/88									
	2/89			0.010			0.09	6.28		

FIGURES



WISHBONE HILL PROJECT
PROPOSED PERMIT BOUNDARY

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
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DWG FILE:
DATE DRAWN: 8/89

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

WISHBONE HILL MINE

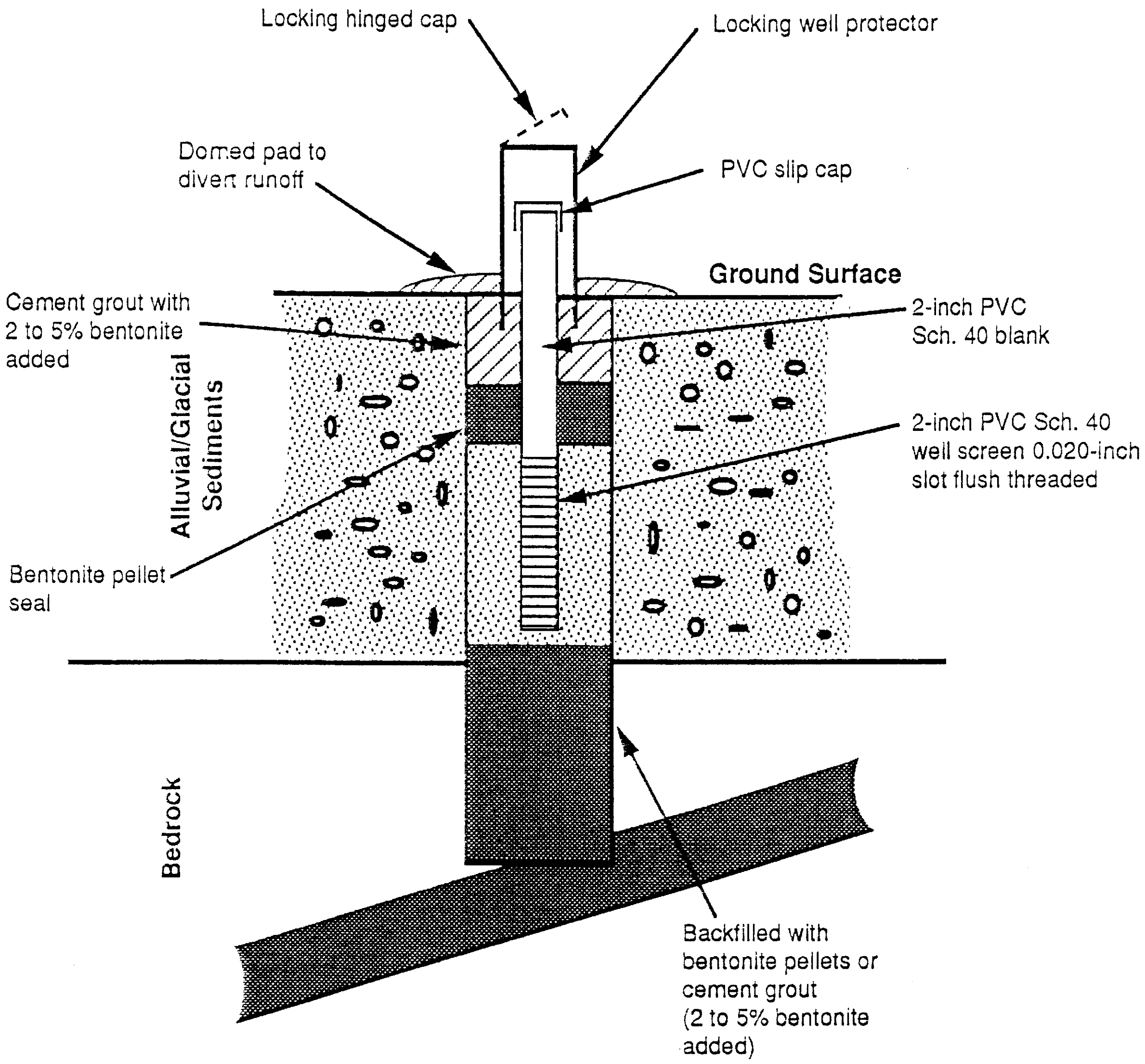
PERMIT NUMBER
01-89-796

SITE LOCATION

FIGURE No. 1-1

REV. 1

SCALE: 1" = 1 MILE



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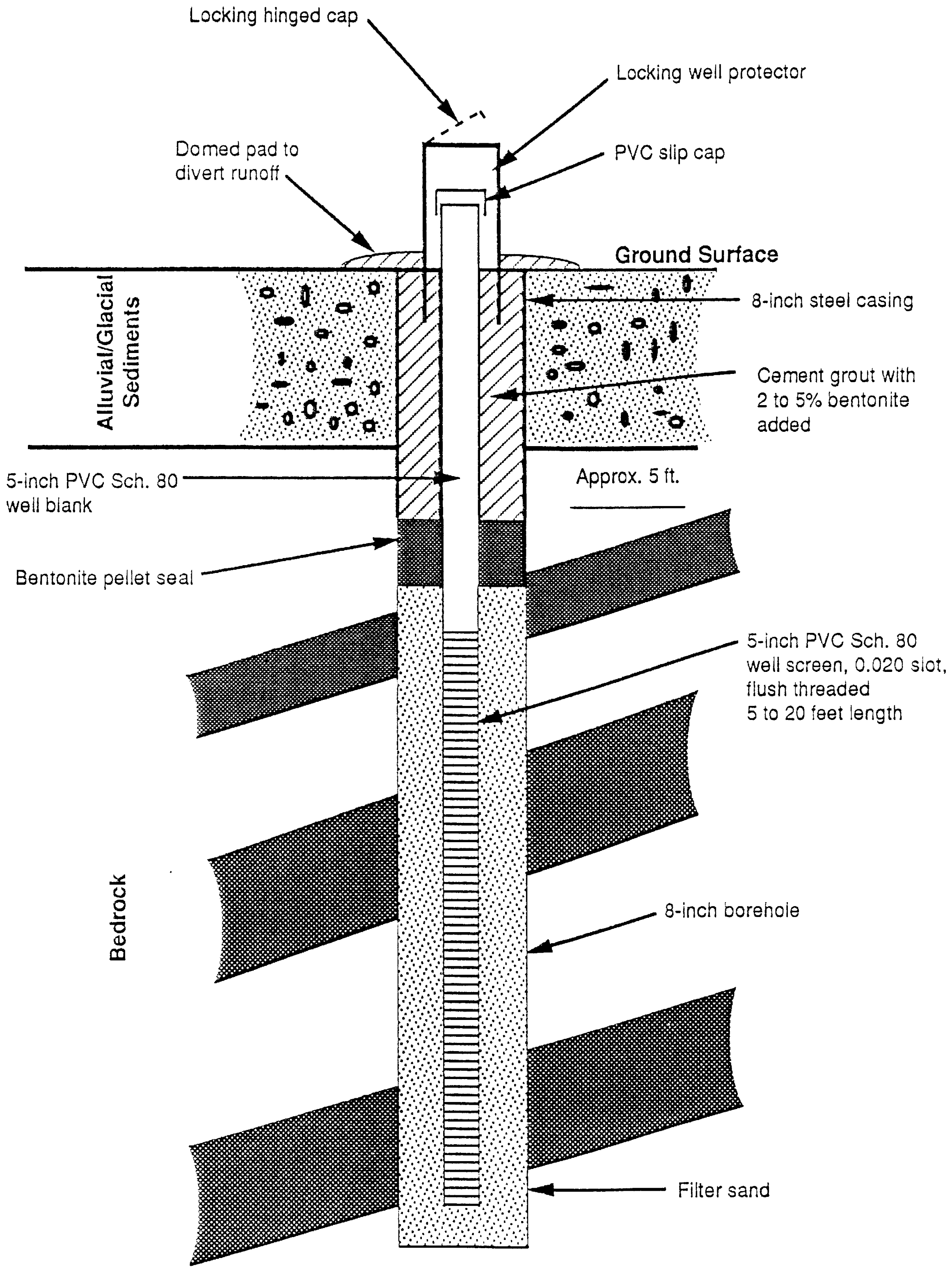
DWG FILE:
DATE DRAWN: 5/89

TYPICAL MONITORING WELL COMPLETION IN GLACIAL/ALLUVIAL SEDIMENT

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. 3-1
REV. 0
SCALE:



DESIGN BY:
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CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

TYPICAL PUMP TEST/MONITORING WELL
COMPLETION IN BEDROCK

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

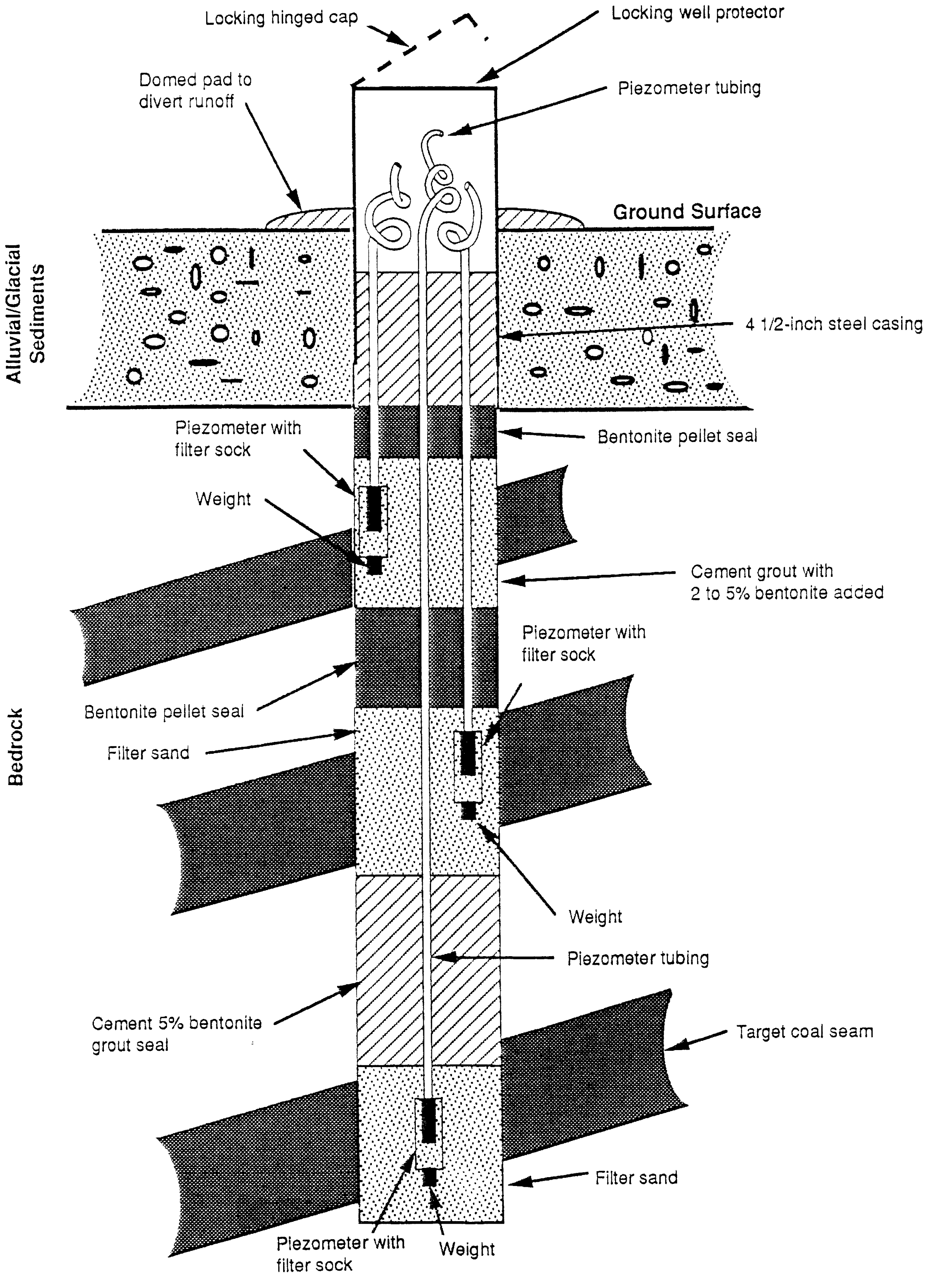
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. 3-2

REV. 0

SCALE:



DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

TYPICAL MULTIPLE PIEZOMETER
COMPLETION IN BEDROCK

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

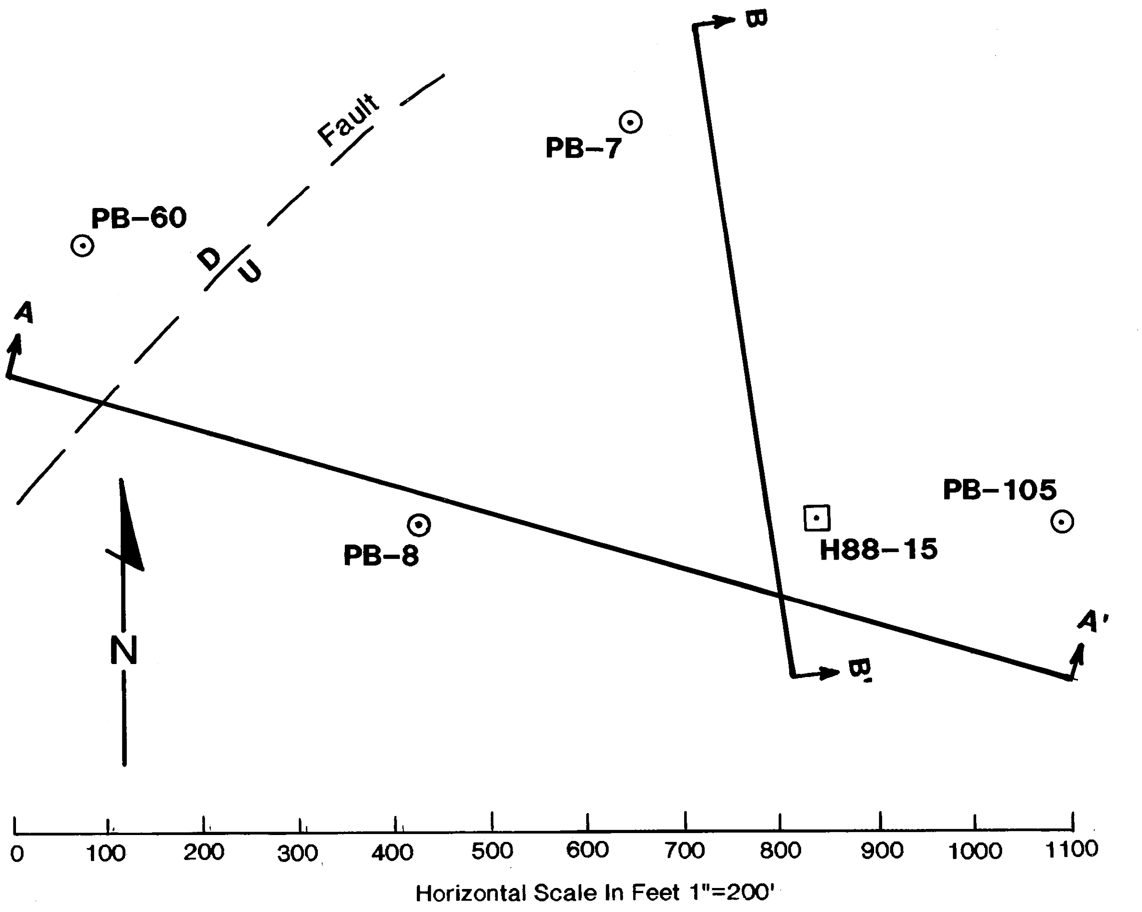
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. 3-3

SCALE:

REV. 0



H88-15 Pump Testing Cell

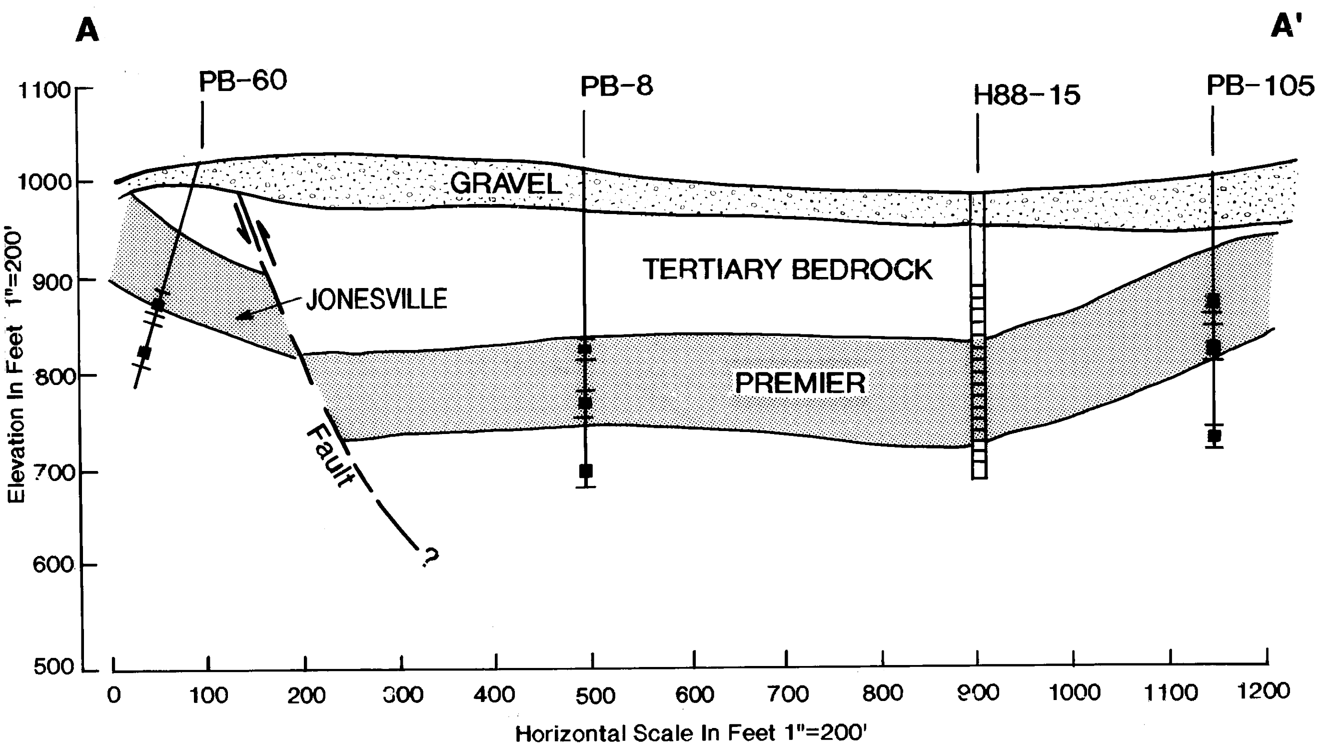
Pumping Well and Piezometer Locations

November 15, 1988
1415 Hrs.-1751 Hrs. - Step Test 2gpm-3gpm

November 16, 1988
1128 Hrs.- Pump Test Started-4 gpm

November 18,1988
0021 Hrs.- Pump Stopped
1624 Hrs.-99% Static Level Recovered

⊡	**H88- 15**	Pump Test Well
⊙	**PB-102**	Piezometer

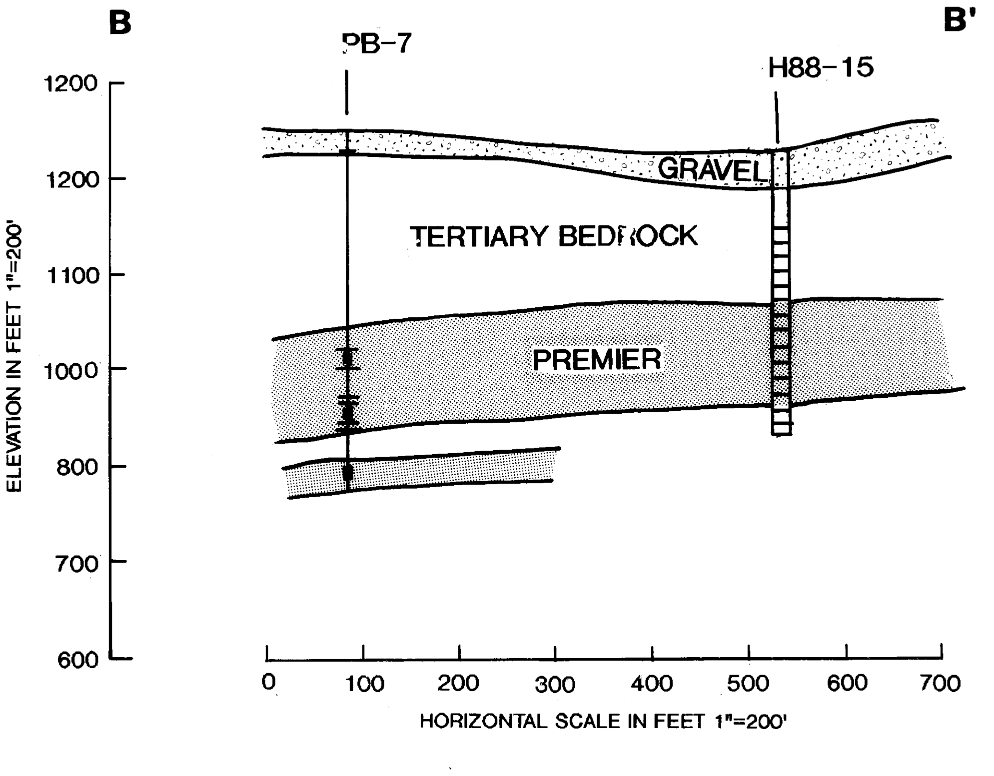


Cross Section A-A'

Screened Interval-Pump Well

Piezometer with Piezometers & Filter Pack Interval Shown

Wells and Piezometer Boreholes Are Projected to Cross Section



Cross Section B- B'

Screened Interval-Pump Well

Piezometer with Piezometers & Filter Pack Interval Shown

Wells and Piezometer Boreholes Are Projected to Cross Section

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
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DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

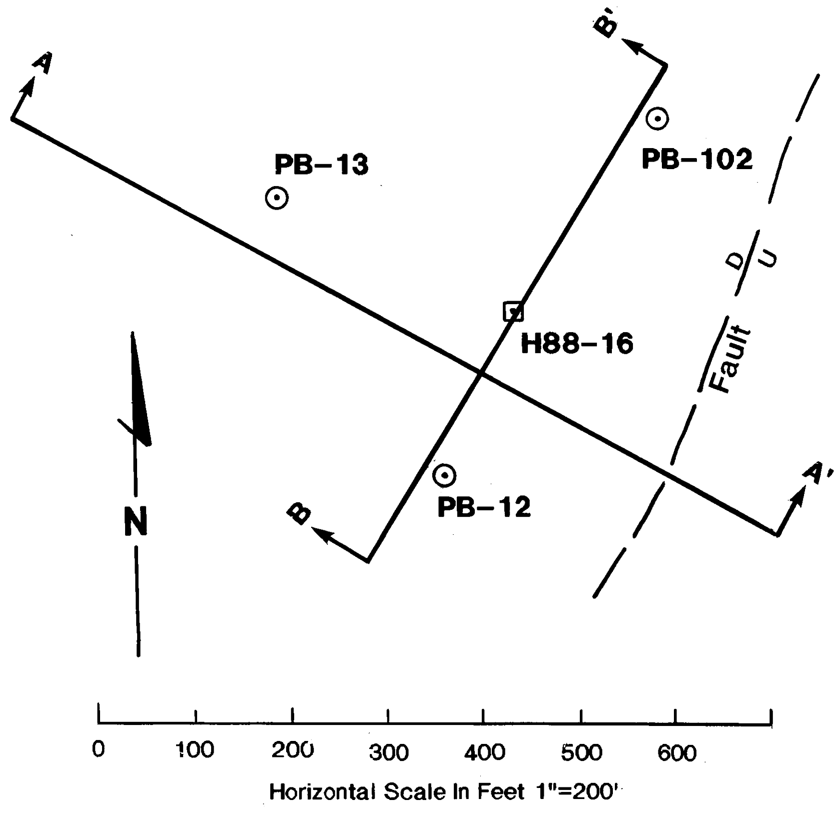
WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

WELL H88-15 PUMP TEST SECTIONS

FIGURE No. 3-4
SCALE: N/A
REV. 1



H88-16 Pump Testing Cell

Pumping Well and Piezometer Locations

November 11, 1988

1010 Hrs. - 2017 Hrs. - Step Test 2.8gpm-4.5gpm

November 14, 1988

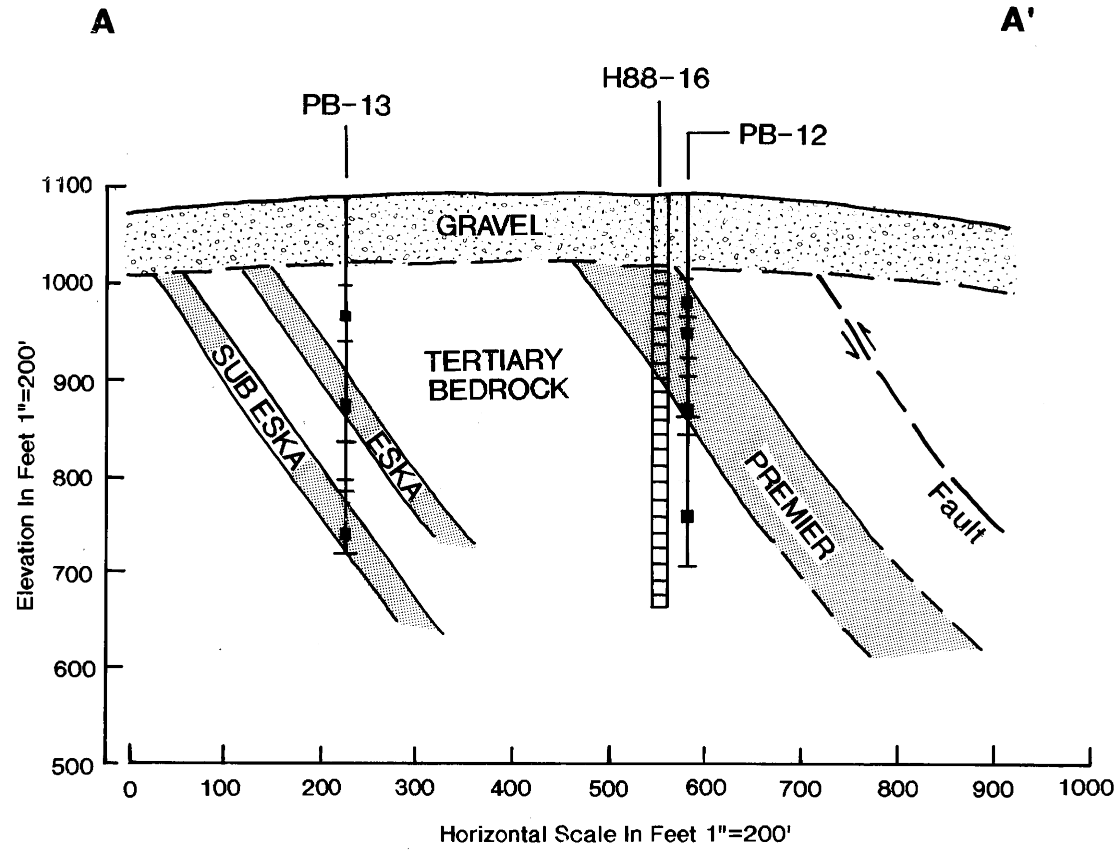
1200 Hrs.- Pump Test Started- 1 gpm

November 15, 1988

0039 Hrs.- Pump Stopped

1112 Hrs.-99% Static Level Recovered

⊡	**H88-16**	Pump Test Well
⊙	**PB-102**	Piezometer

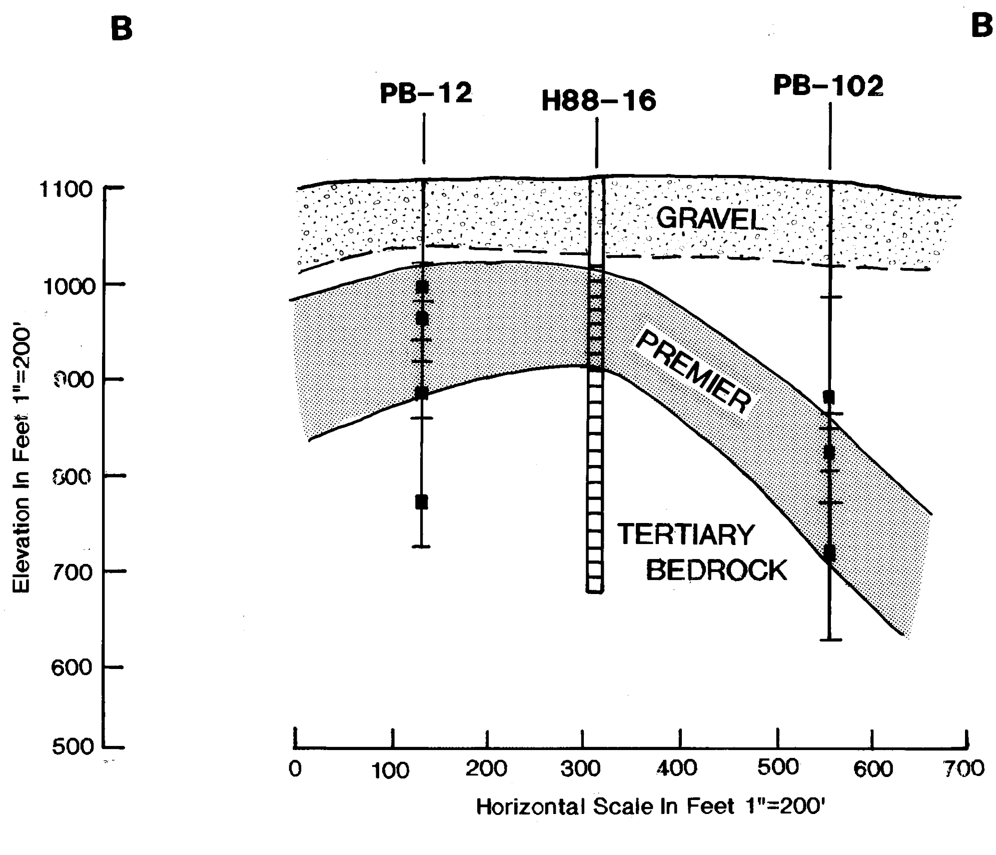


Cross Section A-A'

Screened Interval-Pump Well

Piezometer with Piezometers & Filter Pack Interval Shown

Wells and Piezometer Boreholes Are Projected to Cross Section



Cross Section B- B'

Screened Interval-Pump Well

Piezometer with Piezometers & Filter Pack Interval Shown

Wells and Piezometer Boreholes Are Projected to Cross Section

SUBJECT REVISIONS

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DATE DRAWN: 5/89

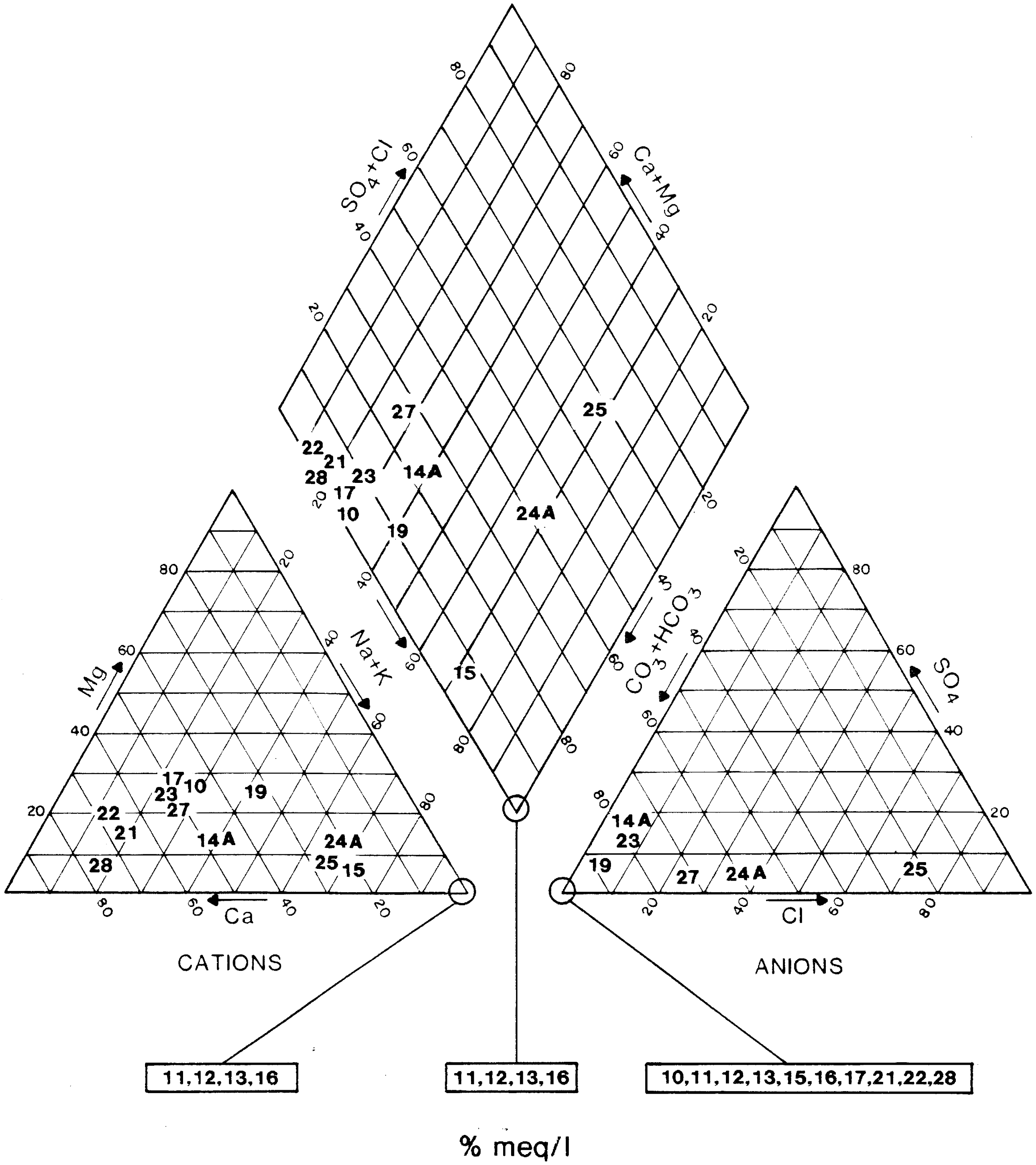
WISHBONE HILL
MINE

PERMIT NUMBER
01-89-796

WELL H88-16 PUMP TEST SECTIONS

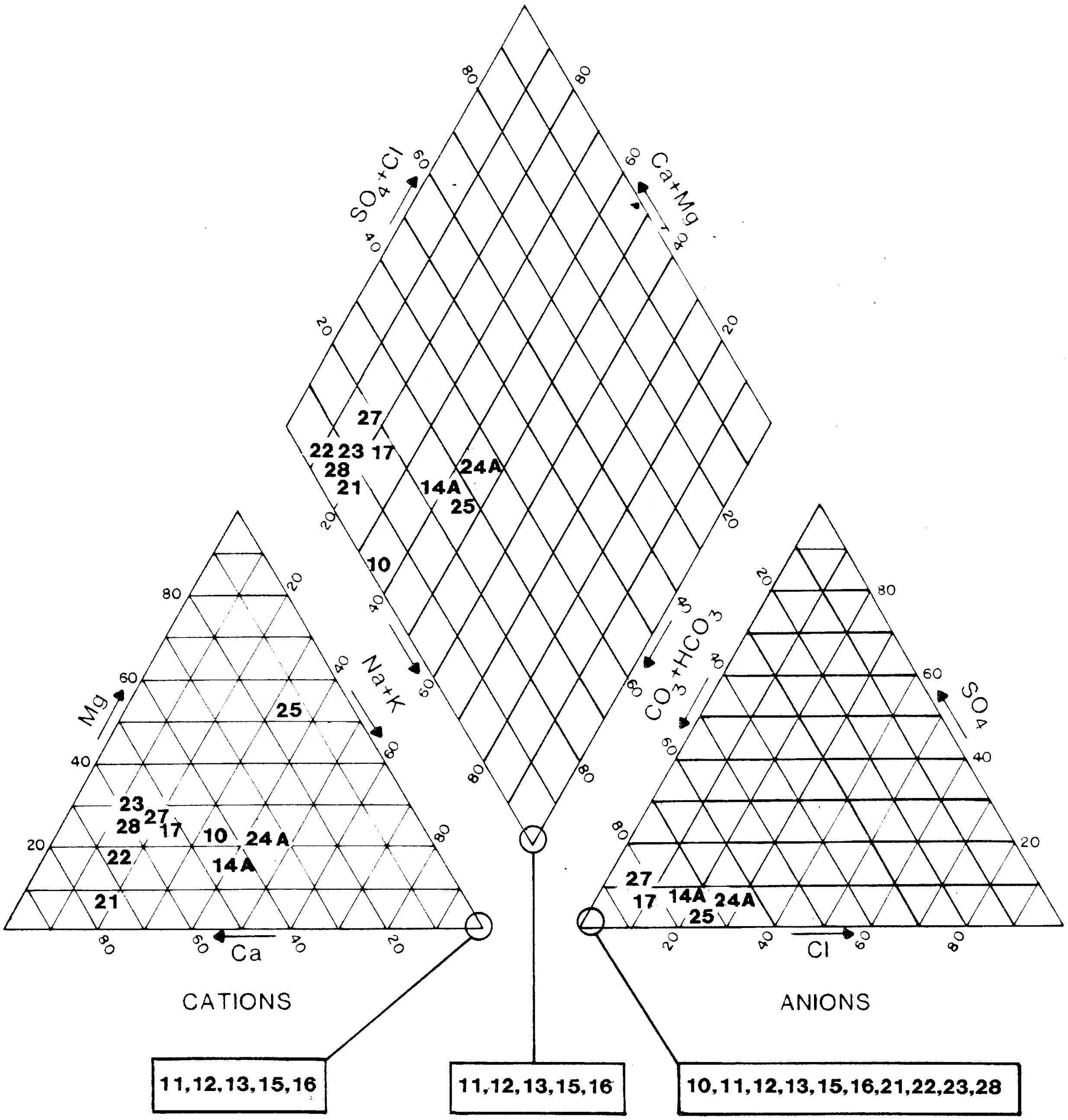
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 3-5
SCALE: N/A
REV. 1



NOTE:
WELL NUMBERS ARE INDICATED

DESIGN BY: DRAWN BY: CHECK BY: DWG FILE: **DATE DRAWN:** 5/89	TRILINEAR DIAGRAM OF NOVEMBER 1998 GROUNDWATER ANALYSES USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	WISHBONE HILL MINE PERMIT No. 01-89-796 FIGURE No. 3-6 SCALE: REV. 0



% meq/l

NOTE:
WELL NUMBERS ARE INDICATED

DESIGN BY:
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DATE DRAWN: 5/89

TRILINEAR DIAGRAM OF FEBRUARY 1989
GROUNDWATER ANALYSES

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

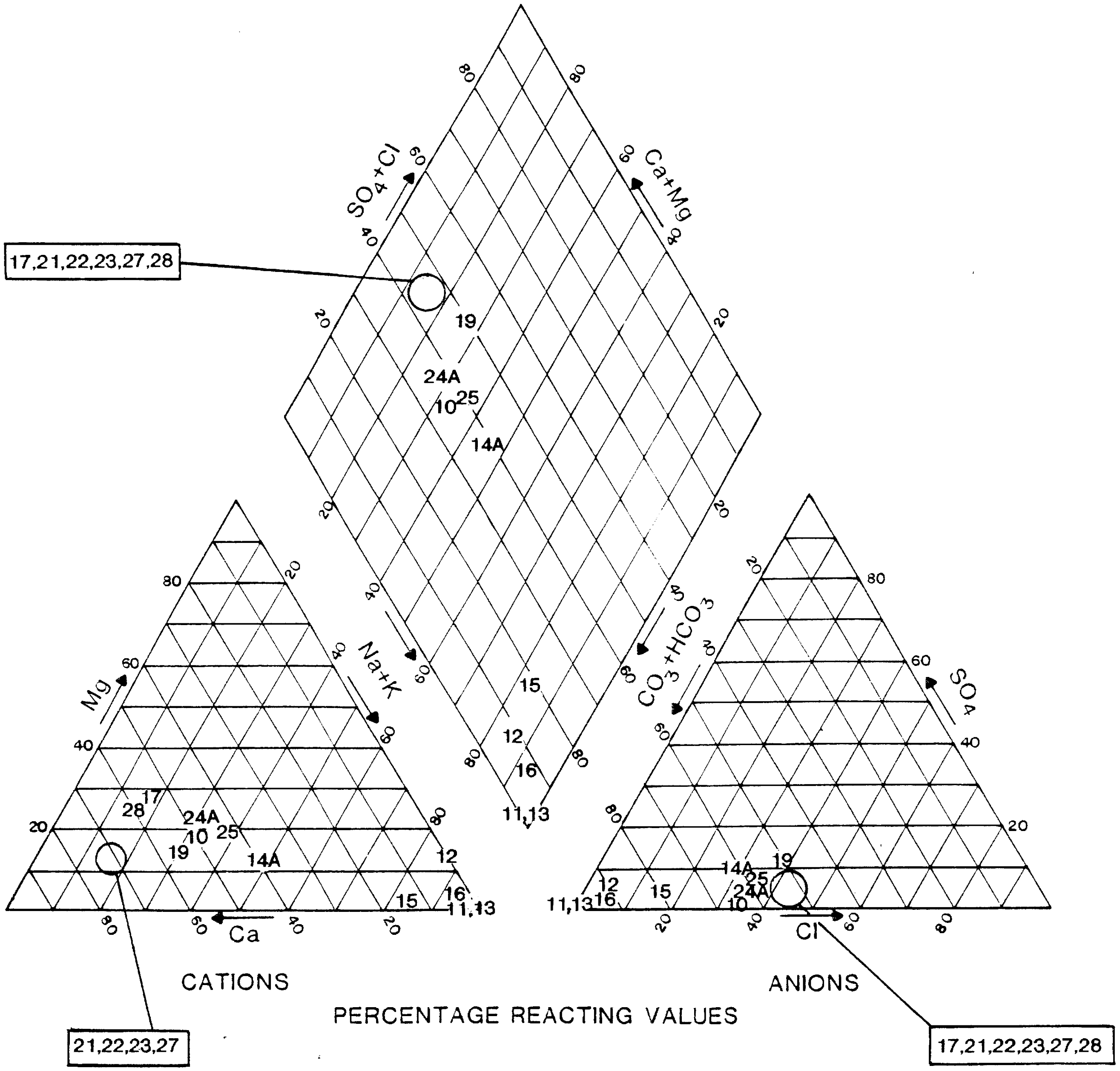
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. 3-7

REV. 0

SCALE:



NOTE: WELL NUMBERS ARE INDICATED

DESIGN BY:
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DWG FILE:
DATE DRAWN: 8/89

TRILINEAR DIAGRAM OF MAY/JUNE 1989
GROUNDWATER ANALYSES

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

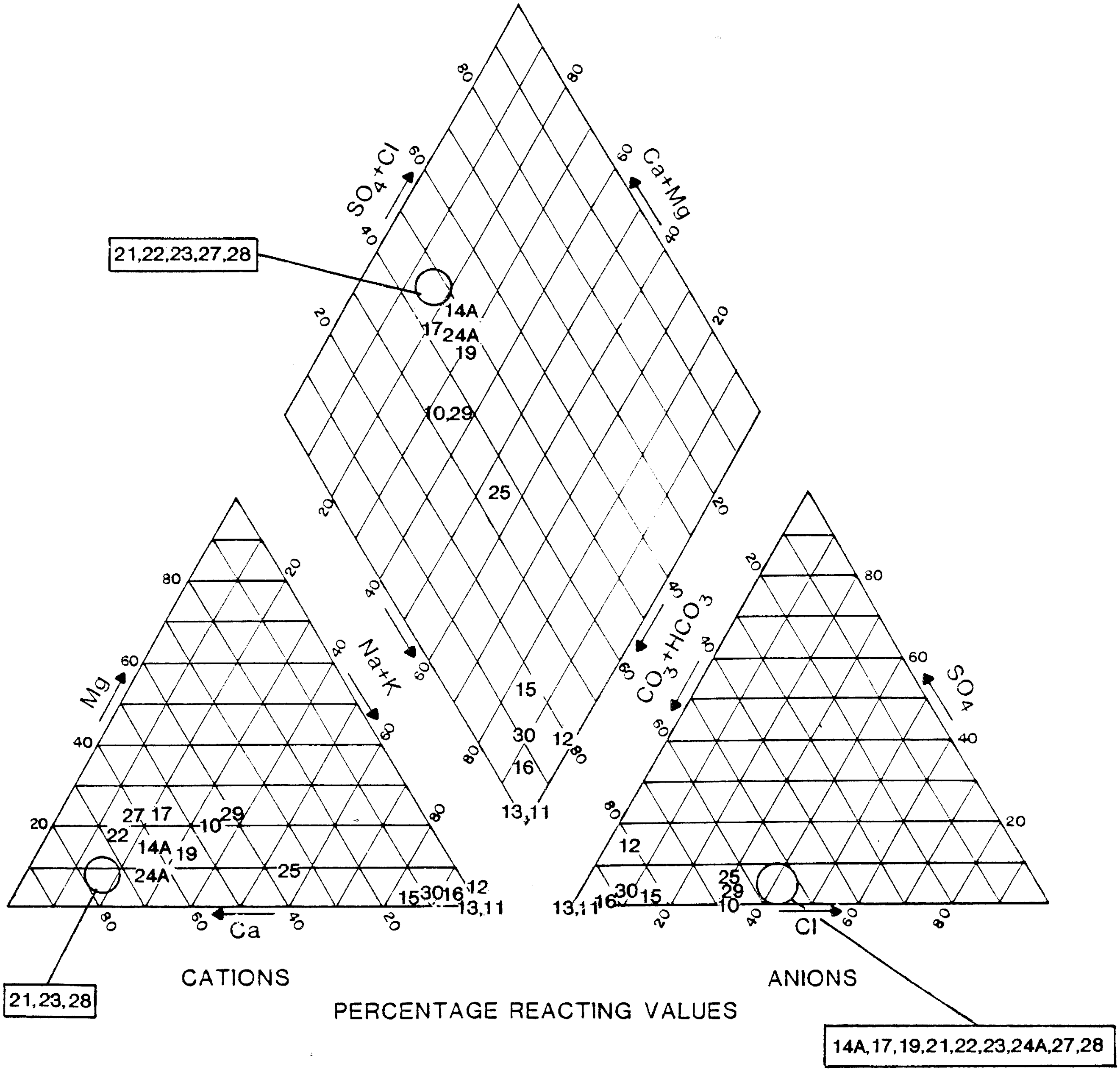
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. 3-8

REV. 0

SCALE:



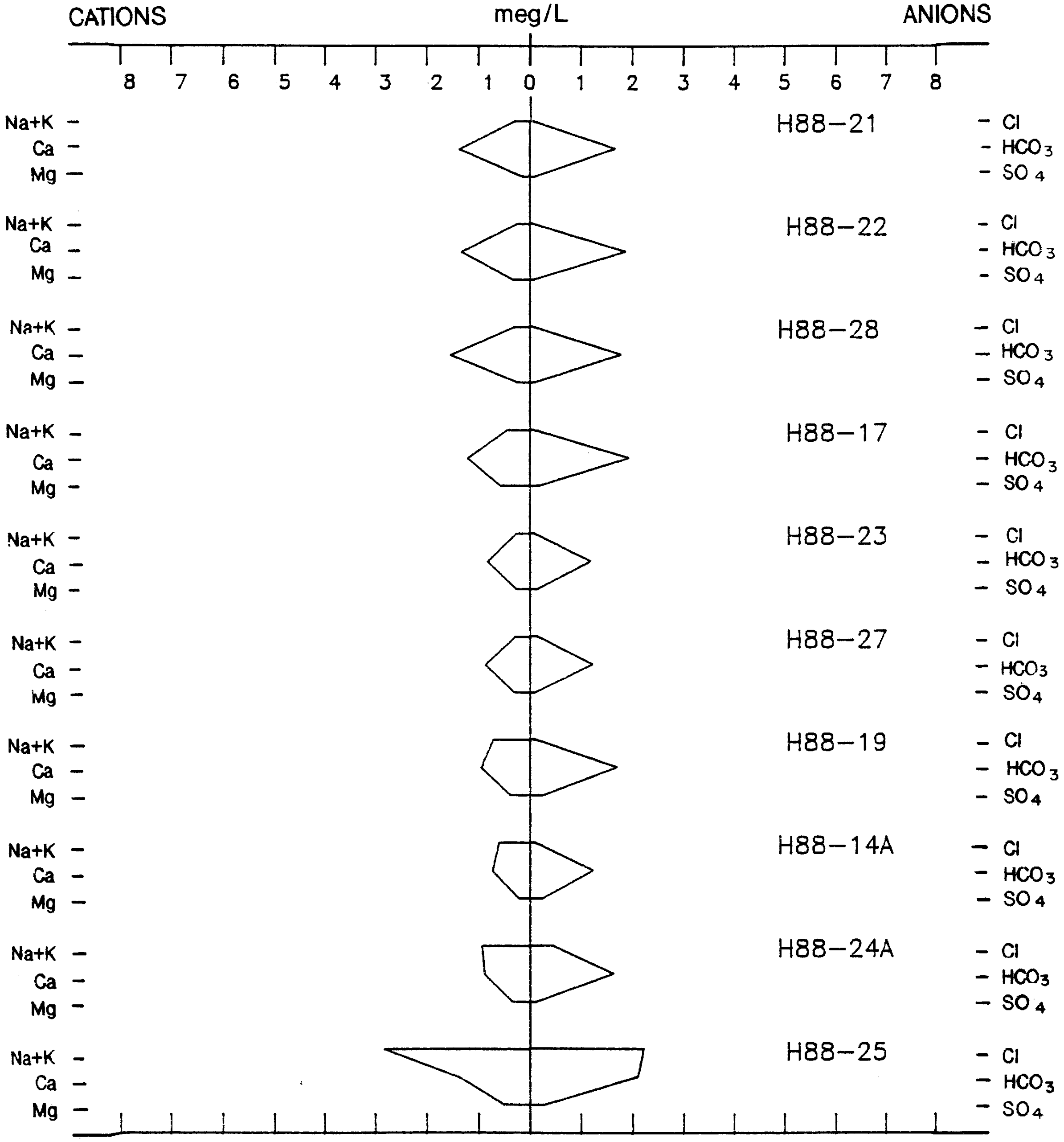
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

TRILINEAR DIAGRAM OF JULY 1989 GROUNDWATER ANALYSES

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. 3-9
REV. 0
SCALE:

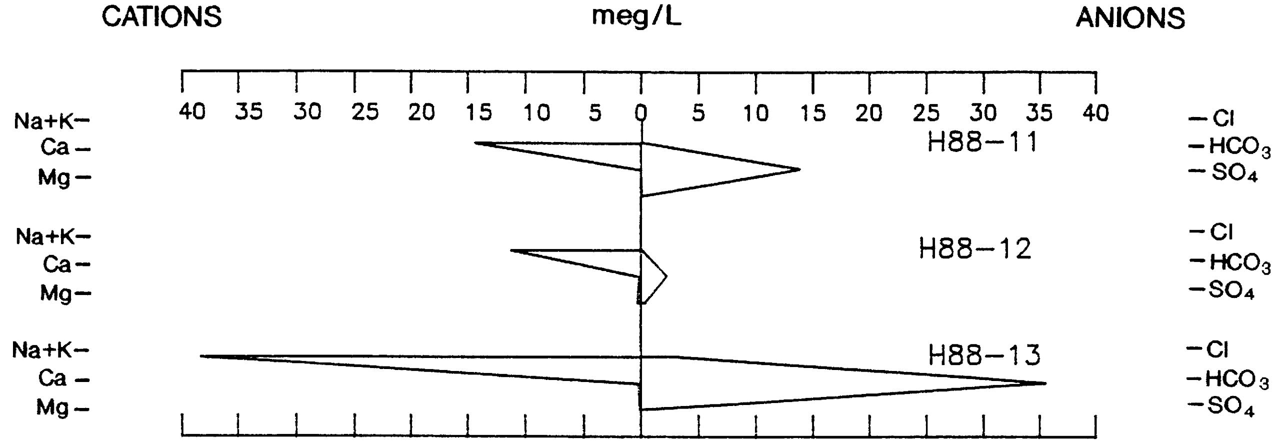


NOTE:

BASED ON NOVEMBER 1988, FEBRUARY 1989, MAY/JUNE 1989 AND JULY 1989 SAMPLES

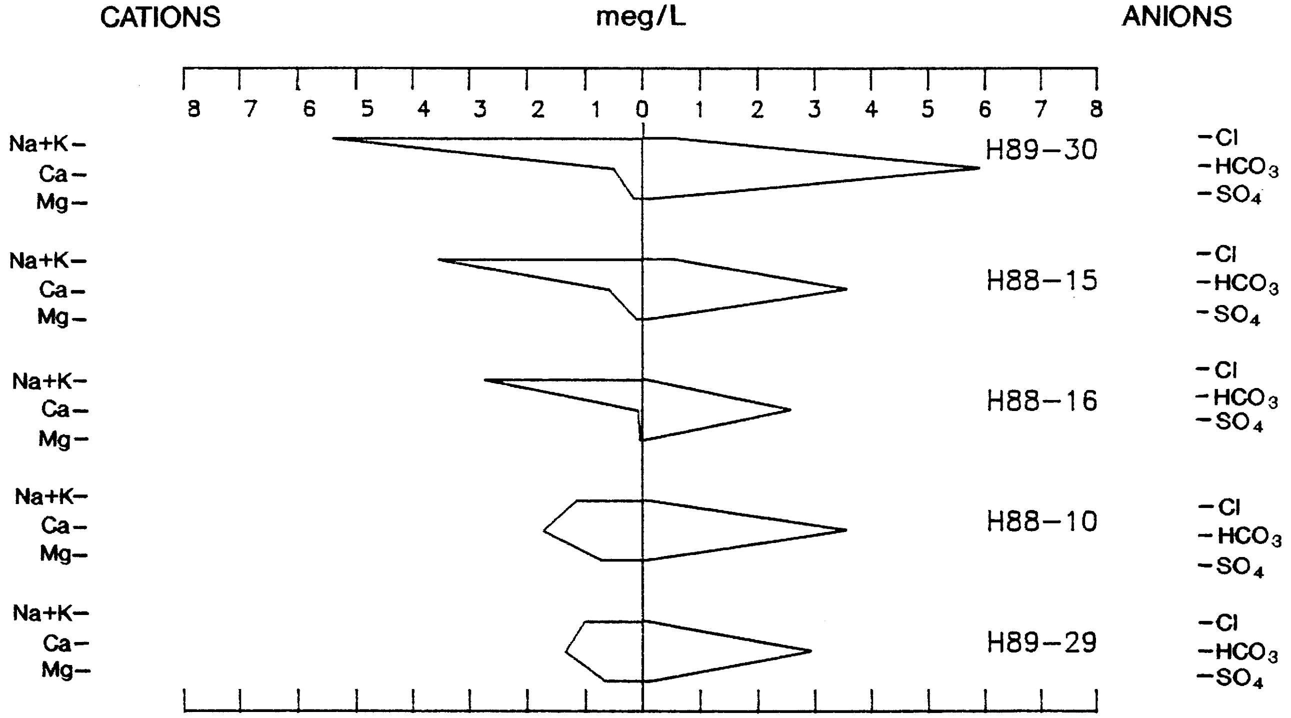
H88-19 BASED ON NOVEMBER 1988, MAY 1989 AND JULY 1989 SAMPLES

DESIGN BY: DRAWN BY: CHECK BY:	REPRESENTATIVE STIFF DIAGRAMS OF GROUNDWATER FROM GLACIAL/ALLUVIAL WELLS	WISHBONE HILL MINE	PERMIT No. 01-89-796
DWG FILE: **DATE DRAWN:** 8/89	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-10 SCALE:	REV. 0



NOTE:

BASED ON NOVEMBER 1988, FEBRUARY 1989, MAY/JUNE 1989 AND JULY 1989 SAMPLES



NOTE:

H88–27 BASED ON NOVEMBER 1988, FEBRUARY 1989, MAY 1989 AND JULY 1989 SAMPLES
H88–25 BASED ON FEBRUARY 1989, MAY 1989 AND JULY 1989 SAMPLES.
H88–28 BASED ON NOVEMBER 1988, FEBRUARY 1989 AND JULY 1989 SAMPLES.
H88–29 AND H88–30 BASED ON JULY 1989 SAMPLES.

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

REPRESENTATIVE STIFF DIAGRAMS OF GROUNDWATER
FROM BEDROCK WELLS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683–2226

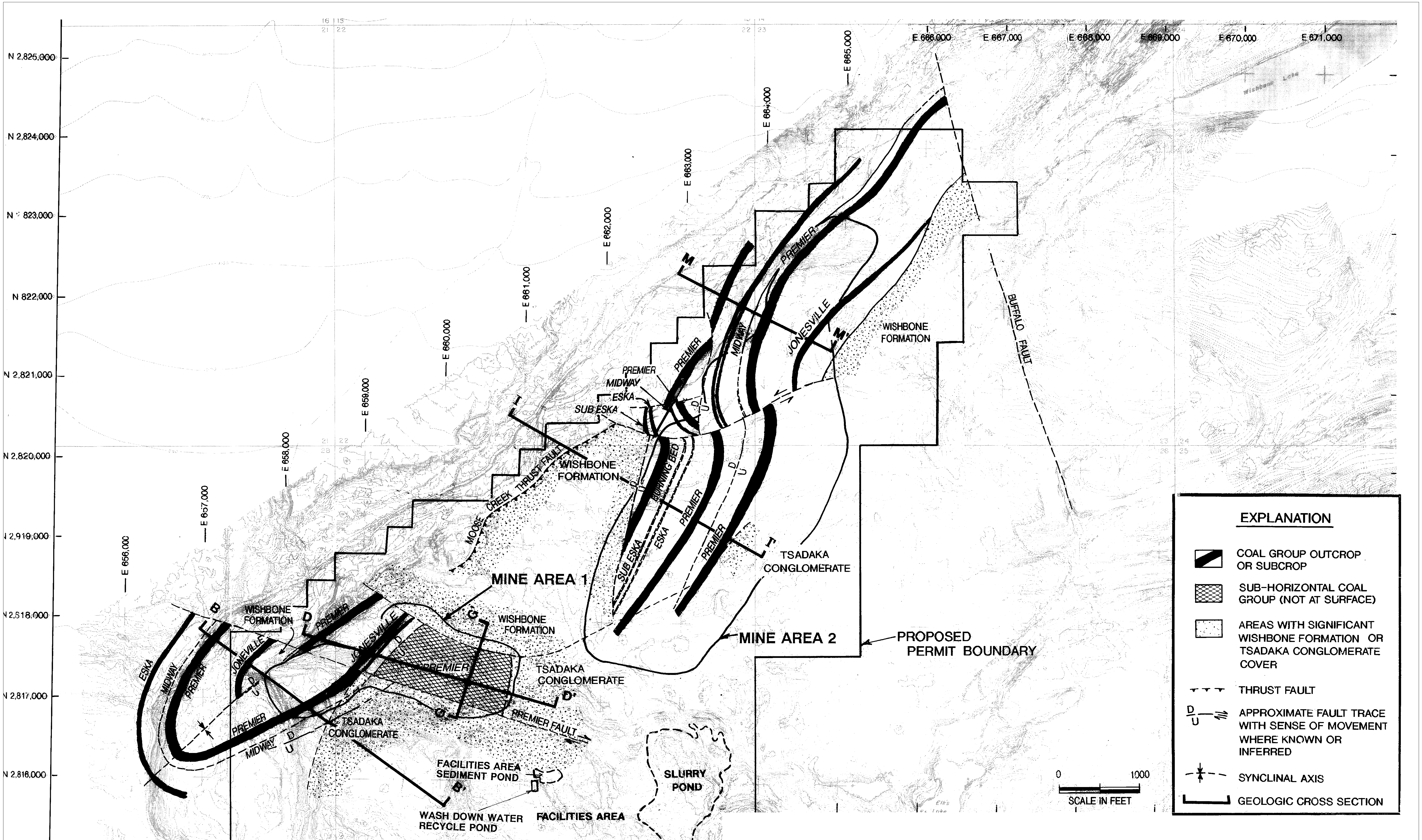
WISHBONE HILL MINE

PERMIT No. 01–89–796

FIGURE No. 3–11

SCALE:

REV. 0



SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
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DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

SITE GEOLOGY MAP AND CROSS SECTION LOCATION

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-1
SCALE: AS SHOWN
REV. 1

LEGEND

— — ——	CONTACT (DASHED WHERE APPROXIMATE)
—?—?—?—	INFERRED CONTACT
Gr	UNCONSOLIDATED QUATERNARY GRAVELS OR TILLS
Tt	TERTIARY TSADAKA CONGLOMERATE
Tw	TERTIARY WISHBONE HILL FORMATION
Tc	TERTIARY CHICKALOON FORMATION
▨	COAL GROUP (LABELLED IF IDENTIFIED)
⇃↾ ⊕\⊙ \	FAULT WITH SENSE OF MOVEMENT IF KNOWN OR INFERRED

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

LEGEND FOR GEOLOGY CROSS SECTION

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

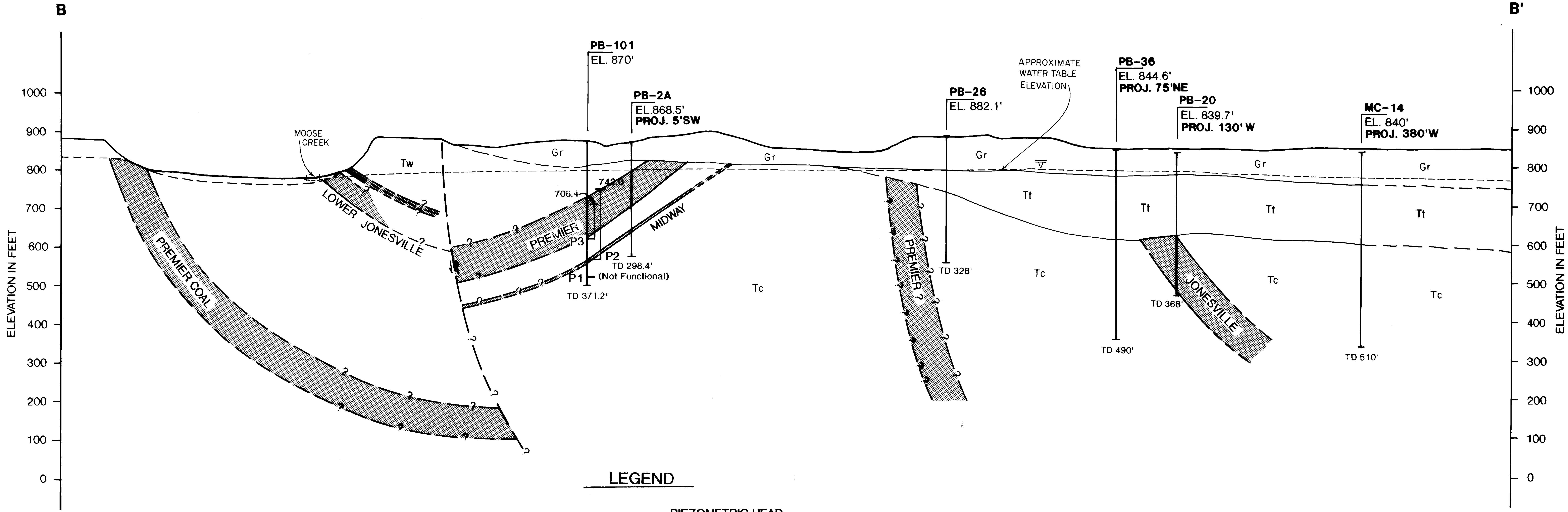
WISHBONE HILL MINE

PERMIT No. 01-89-796

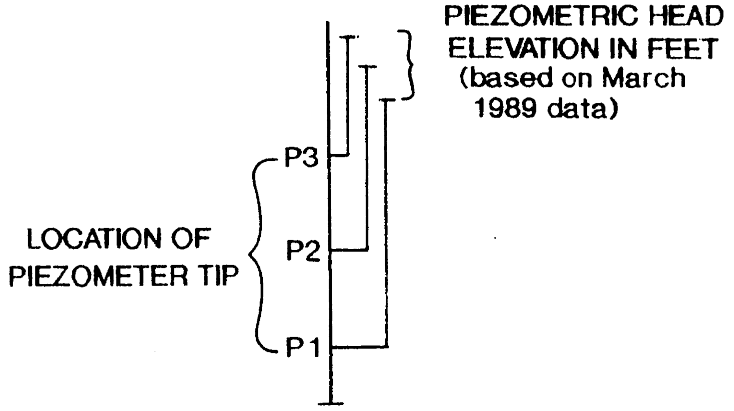
FIGURE No. 4-2

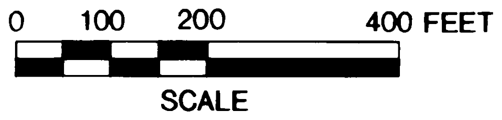
SCALE:

REV. 0



LEGEND





CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

Jerry McRae

SUBJECT REVISIONS

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1	2009	JEH	MINOR REVISIONS

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DWG FILE:
DATE DRAWN: 5/89

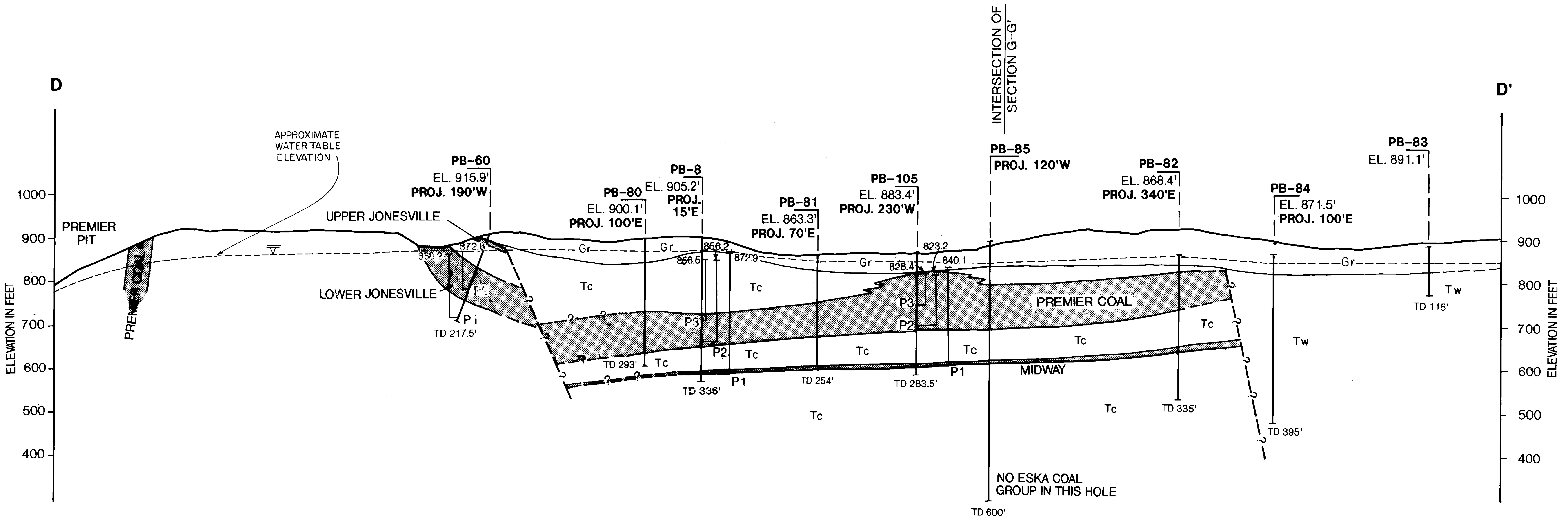
WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

CROSS SECTION B – B'

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

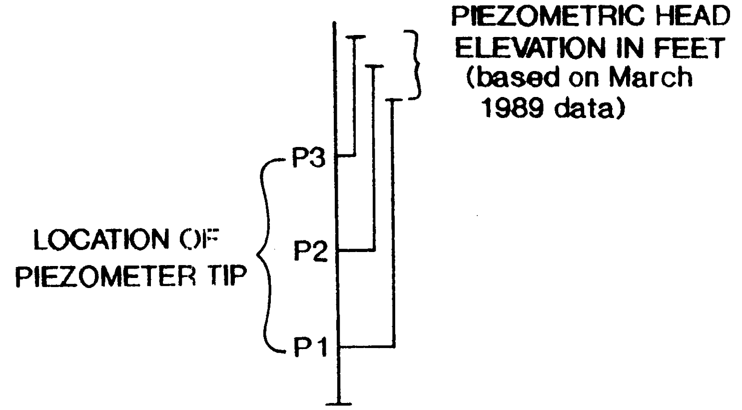
FIGURE No. 4-3
SCALE: AS SHOWN
REV. 1



NOTE:

TOP AND BASE OF ALL UNITS BASED ON STRUCTURE CONTOURS, BOREHOLES PROJECTED PARALLEL TO STRIKE OF BASE OF PREMIER COAL.

LEGEND



0 100 200 400 FEET

SCALE

CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

Jerry W. Rowe

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

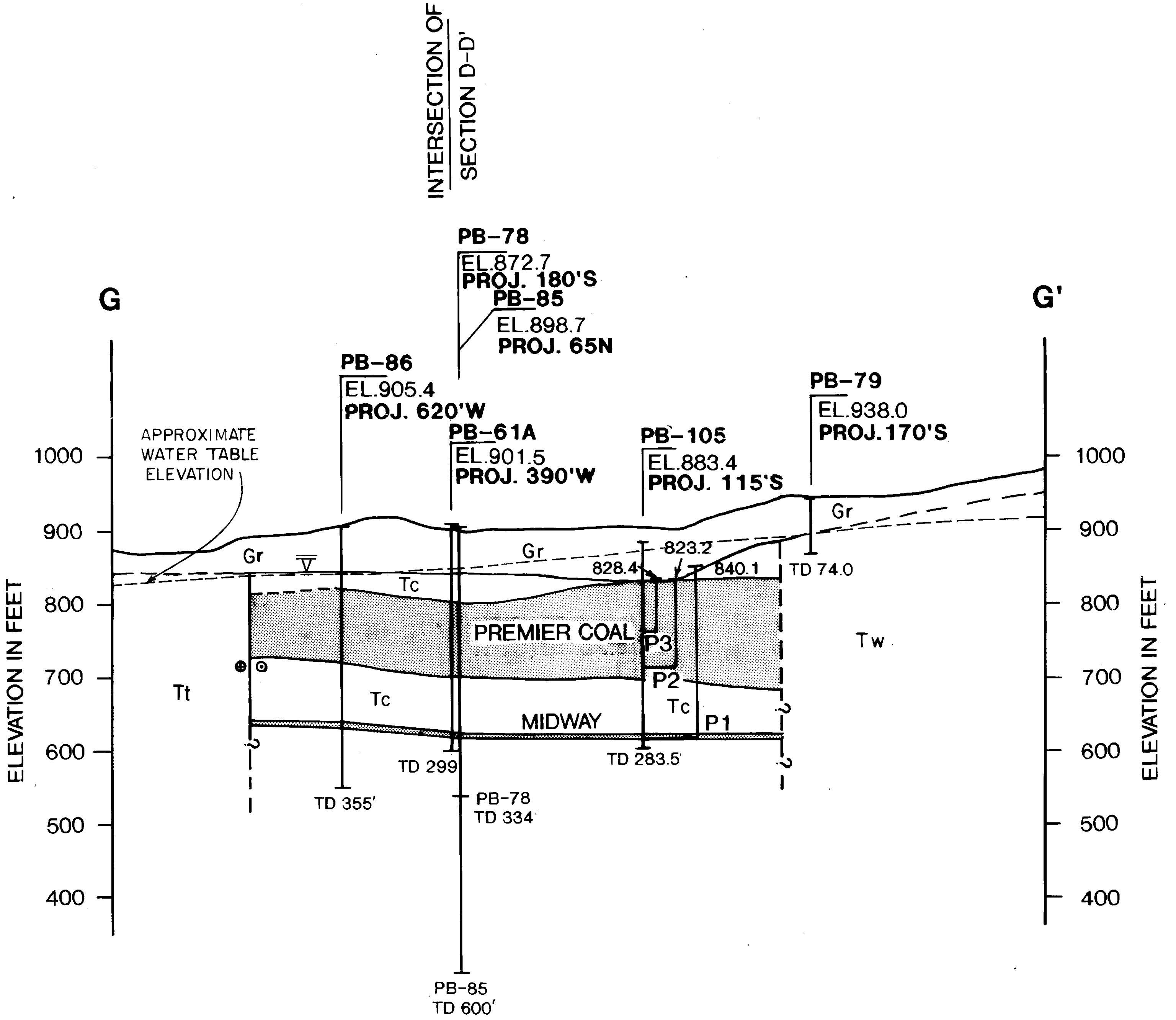
WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

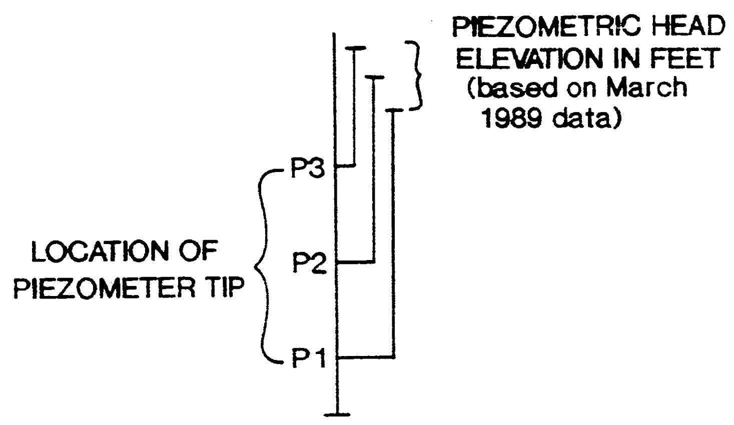
CROSS SECTION D – D'

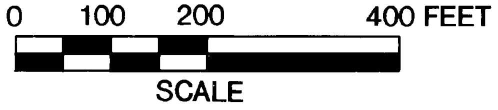
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-4
SCALE: AS SHOWN
REV. 1



LEGEND





CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

Jerry W. Rowe

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

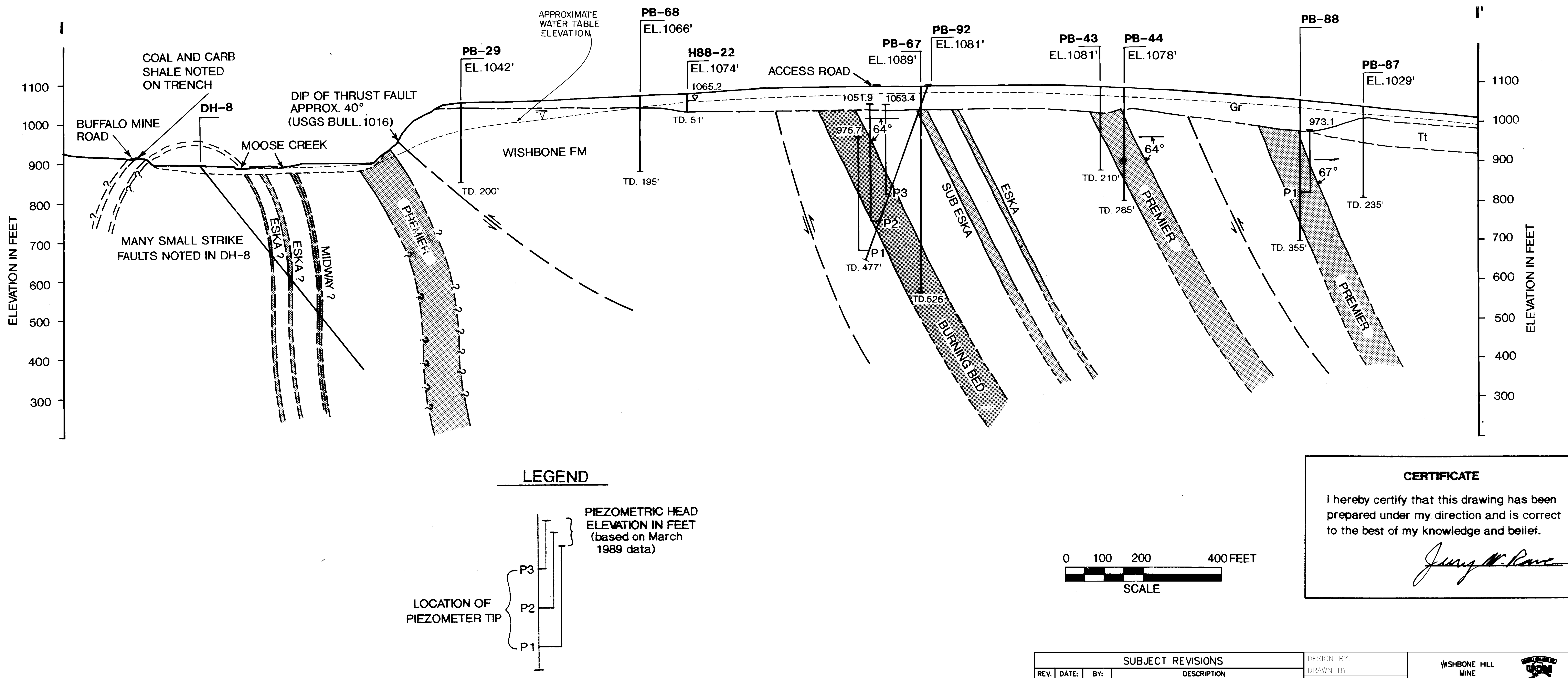
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

WISHBONE HILL MINE
PERMIT NUMBER 01-89-796

CROSS SECTION G – G'

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-5
SCALE: AS SHOWN
REV. 1



CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

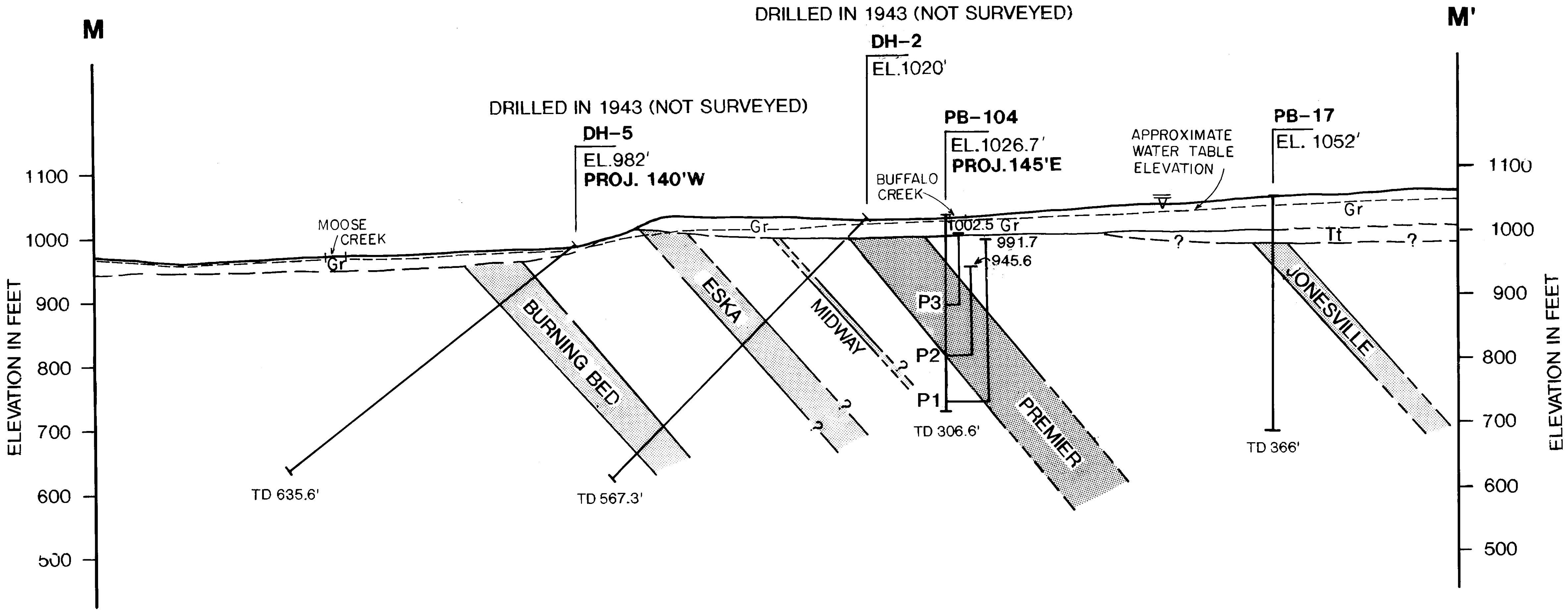
WISHBONE HILL MINE

PERMIT NUMBER
01-89-796

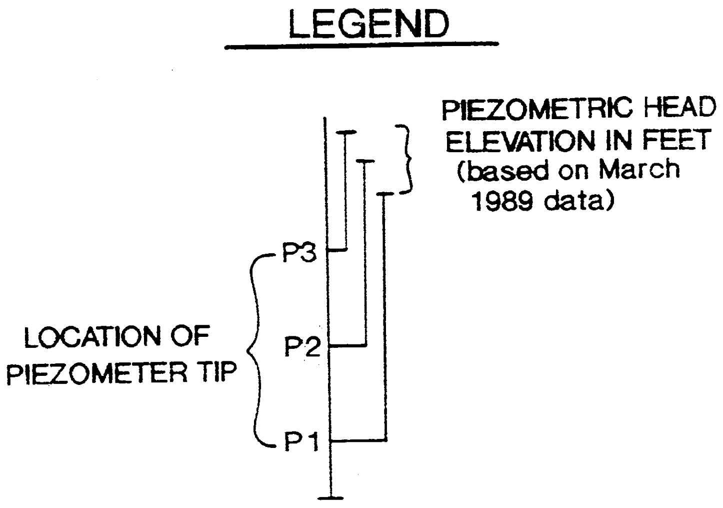
CROSS SECTION I - I'

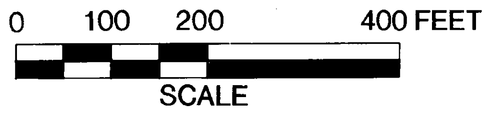
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-6
SCALE: AS SHOWN
REV. 1



LEGEND





CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

Jerry M. Rowe

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

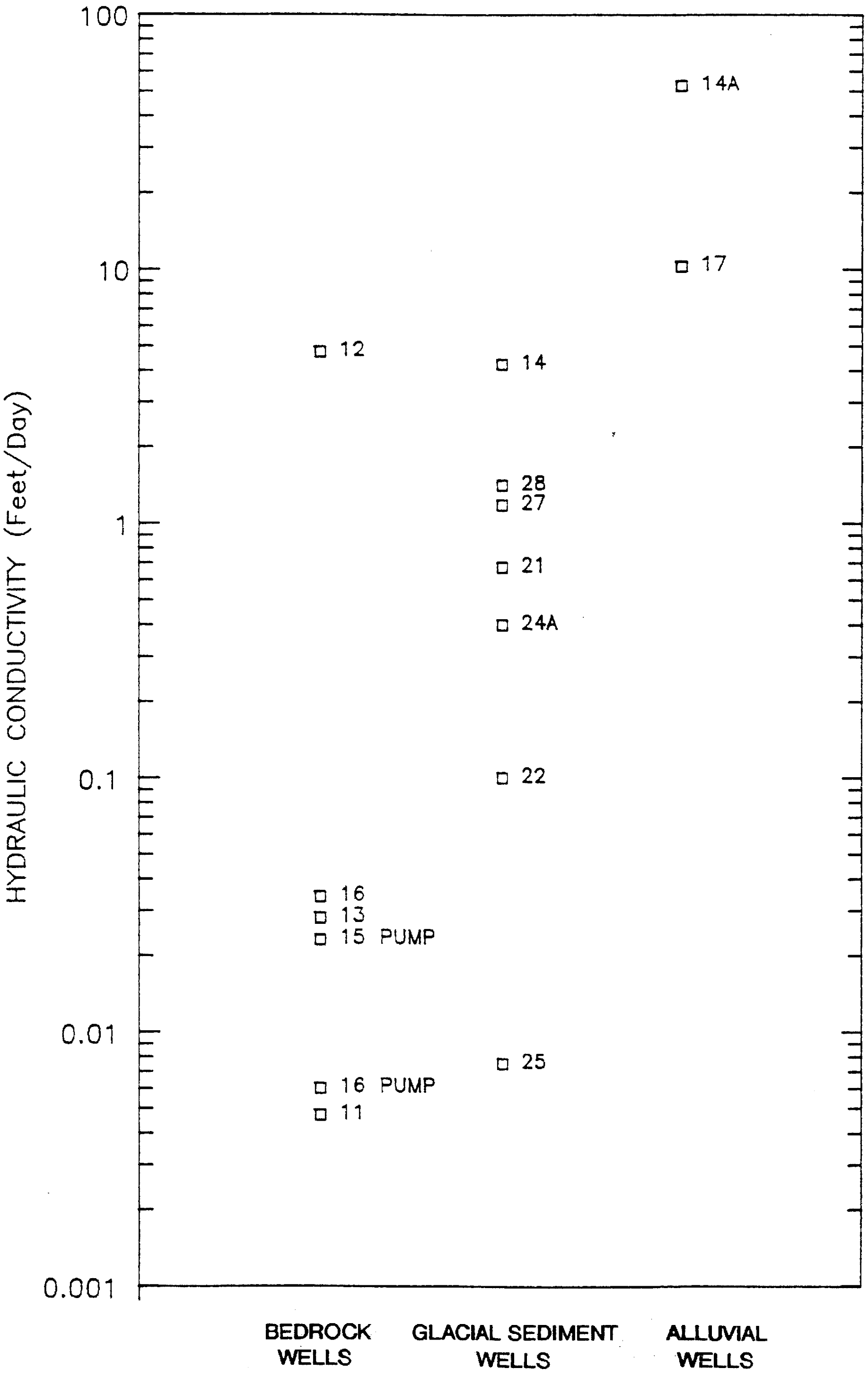
WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

CROSS SECTION M – M'

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-7
SCALE: AS SHOWN
REV. 1



NOTE: VALUES DETERMINED FROM SLUG AND PUMP TESTS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

DISTRIBUTION OF TEST VALUES
FOR HYDRAULIC CONDUCTIVITY

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

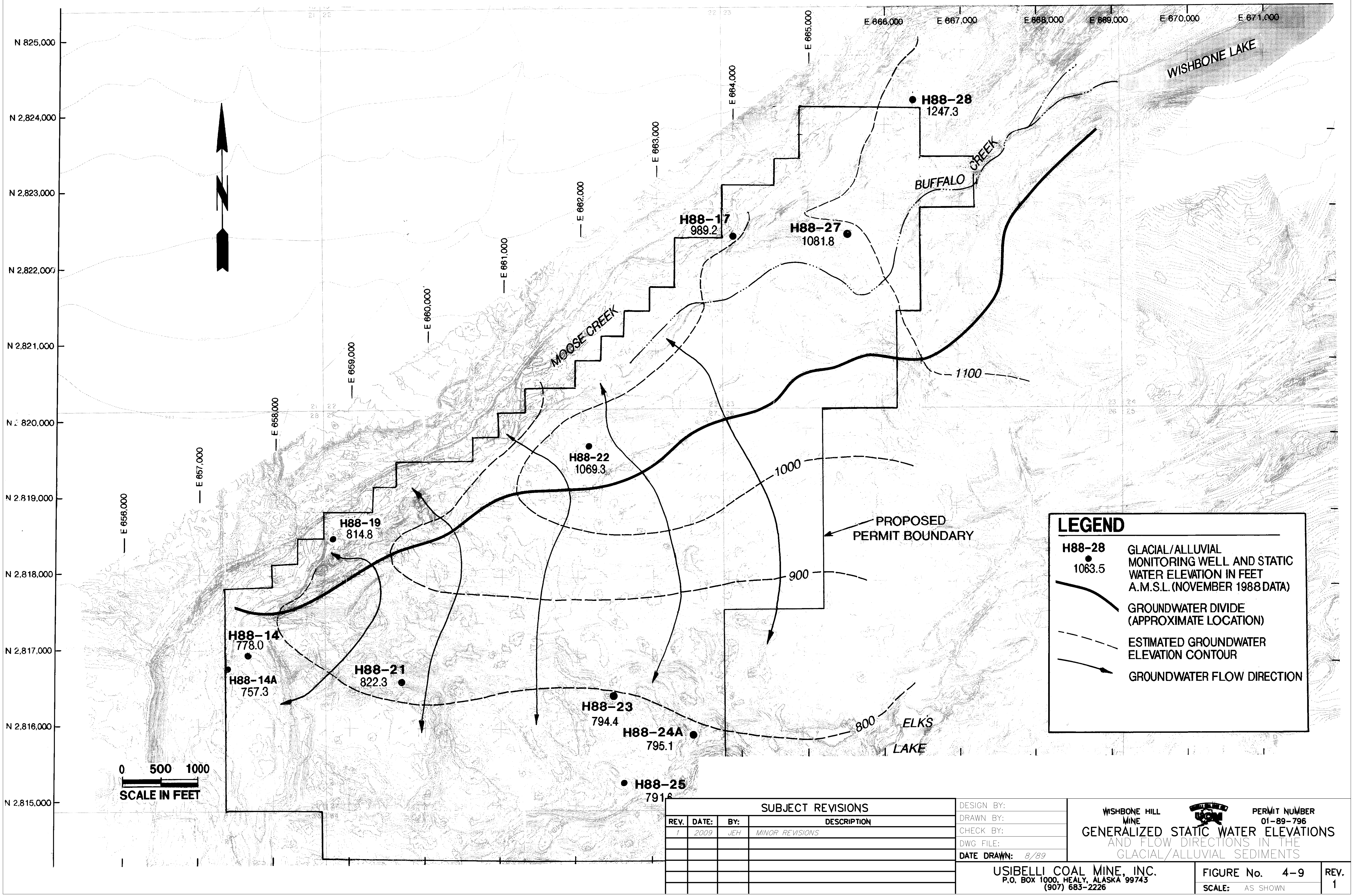
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. 4-8

SCALE:

REV. 0



SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

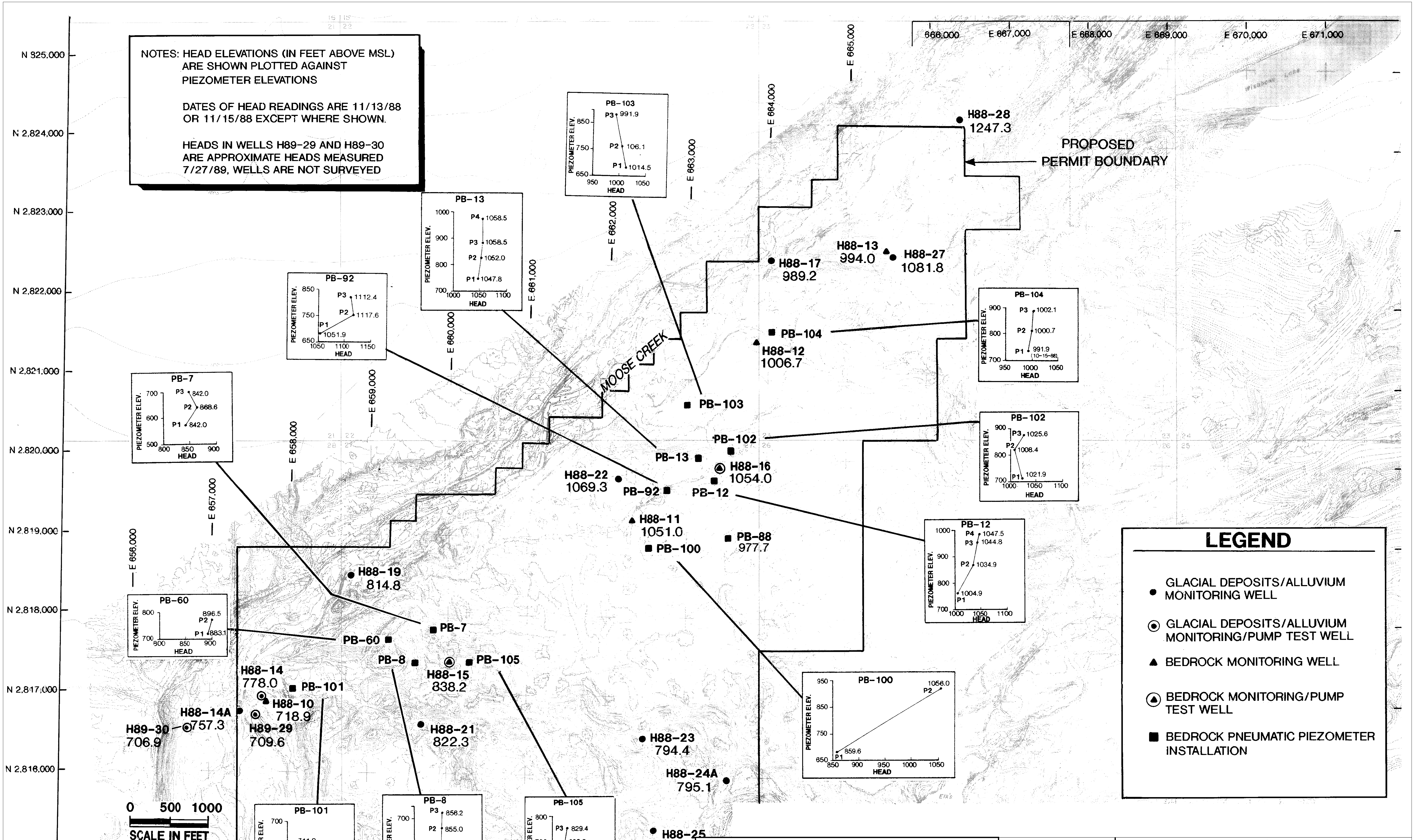
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE
PERMIT NUMBER 01-89-796

GENERALIZED STATIC WATER ELEVATIONS AND FLOW DIRECTIONS IN THE GLACIAL/ALLUVIAL SEDIMENTS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-9
SCALE: AS SHOWN
REV. 1



NOTES: HEAD ELEVATIONS (IN FEET ABOVE MSL) ARE SHOWN PLOTTED AGAINST PIEZOMETER ELEVATIONS

DATES OF HEAD READINGS ARE 11/13/88 OR 11/15/88 EXCEPT WHERE SHOWN.

HEADS IN WELLS H89-29 AND H89-30 ARE APPROXIMATE HEADS MEASURED 7/27/89, WELLS ARE NOT SURVEYED

LEGEND

- ● GLACIAL DEPOSITS/ALLUVIUM MONITORING WELL
- ⦿ GLACIAL DEPOSITS/ALLUVIUM MONITORING/PUMP TEST WELL
- ▲ BEDROCK MONITORING WELL
- Ⓐ BEDROCK MONITORING/PUMP TEST WELL
- ■ BEDROCK PNEUMATIC PIEZOMETER INSTALLATION

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

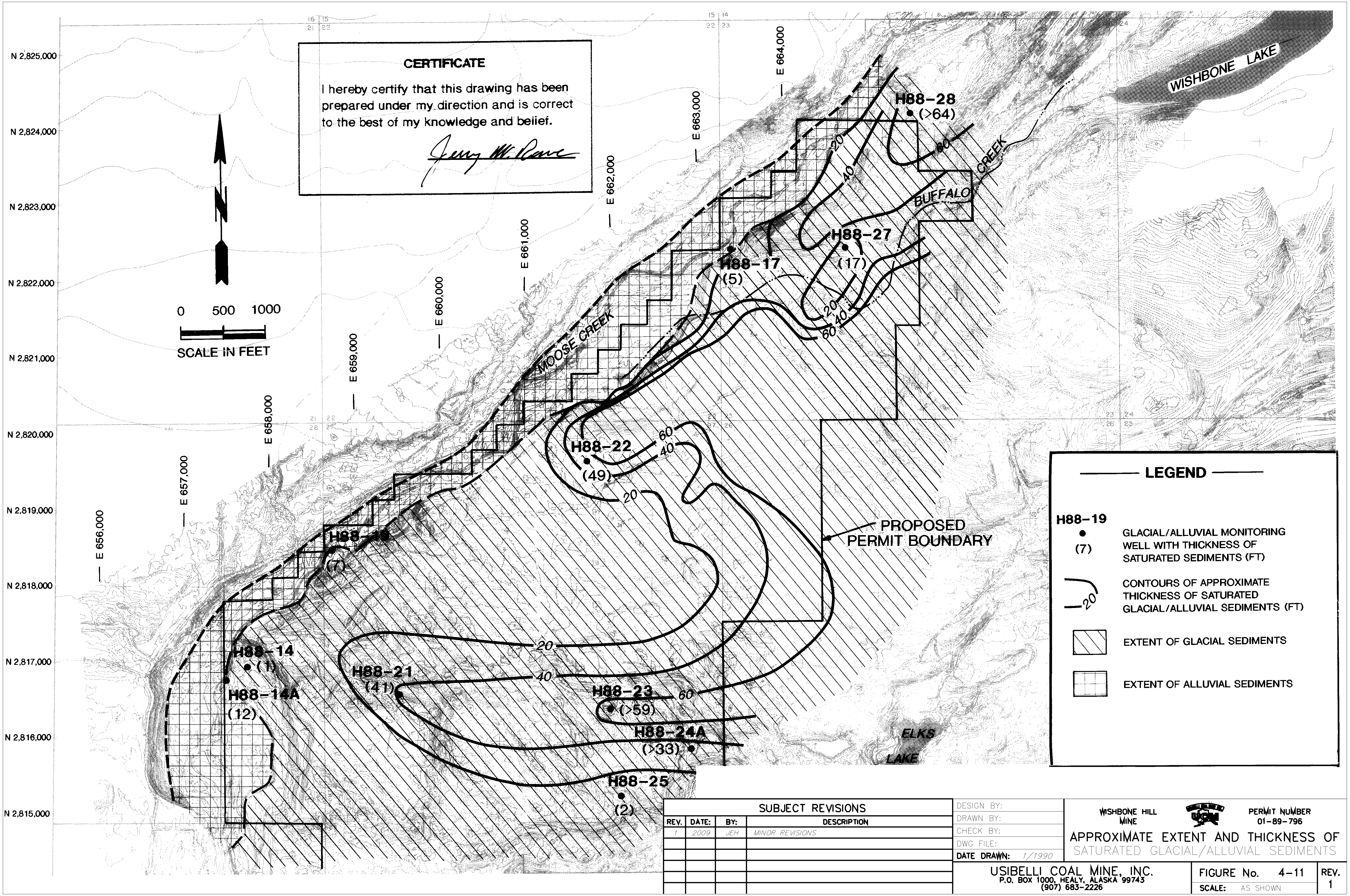
WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

POTENTMETRIC LEVELS IN PIEZOMETERS AND MONITORING WELLS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-10
SCALE: AS SHOWN
REV. 1



CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

Jerry W. Rowe

LEGEND

H88-19 ● (7) GLACIAL/ALLUVIAL MONITORING WELL WITH THICKNESS OF SATURATED SEDIMENTS (FT)

20 CONTOURS OF APPROXIMATE THICKNESS OF SATURATED GLACIAL/ALLUVIAL SEDIMENTS (FT)

▨ EXTENT OF GLACIAL SEDIMENTS

⊞ EXTENT OF ALLUVIAL SEDIMENTS

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/1990

WISHBONE HILL MINE

PERMIT NUMBER
01-89-796

APPROXIMATE EXTENT AND THICKNESS OF SATURATED GLACIAL/ALLUVIAL SEDIMENTS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-11
SCALE: AS SHOWN
REV. 1

PLATES

- ● GLACIAL DEPOSITS/ALLUVIUM MONITORING WELL
- ◉ GLACIAL DEPOSITS/ALLUVIUM MONITORING WELL/PUMP TEST WELL
- ▲ BEDROCK MONITORING WELL
- Ⓐ BEDROCK MONITORING/PUMP TEST WELL
- ■ BEDROCK PNEUMATIC PIEZOMETER INSTALLATION
- ├─┤ SEISMIC SURVEY LINE

CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

Jerry W. Rowe

0 60 120 240
SCALE IN METERS

0 250 500 1000
SCALE IN FEET

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISION

DESIGN BY:

DRAWN BY:

CHECK BY:

DWG FILE:

DATE DRAWN:

WISHBONE HILL
MINE

USIBELLI COAL MINE INC.
UCM

PERMIT NUMBER
01-89-796

SITE PLAN AND
WELL LOCATION MAP

WISHBONE HILL MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

PLATE No. IV-1
SHEET No. 1 OF 1
REV. 1

The undersigned geologist, registered professional land surveyor or registered professional engineer certifies that this map, plan view or cross section was prepared by them or under their direction as required by 11 AC 90.065(b).

Thomas W. Mat

May 2014

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	*MINOR REVISIONS*
2	1/2014	CTW	*NEW CONTOURS, CONVERT DRAWING TO GIS*

FILE NAME: PLATE IV-1 SITE PLAN.MXD

DESIGN BY:
DRAWN BY:
CHECK BY:
DATE DRAWN:
NAD83/AK STATE PLANE ZONE 4

WISHBONE HILL
MINE

PERMIT NUMBER
01-89-796

SITE PLAN AND WELL LOCATION MAP

USIBELLI COAL MINE, INC.
PO BOX 1000 HEALY, ALASKA 99743
(907) 683-2226

PLATE NO. IV-1a

SCALE: 1:6,000

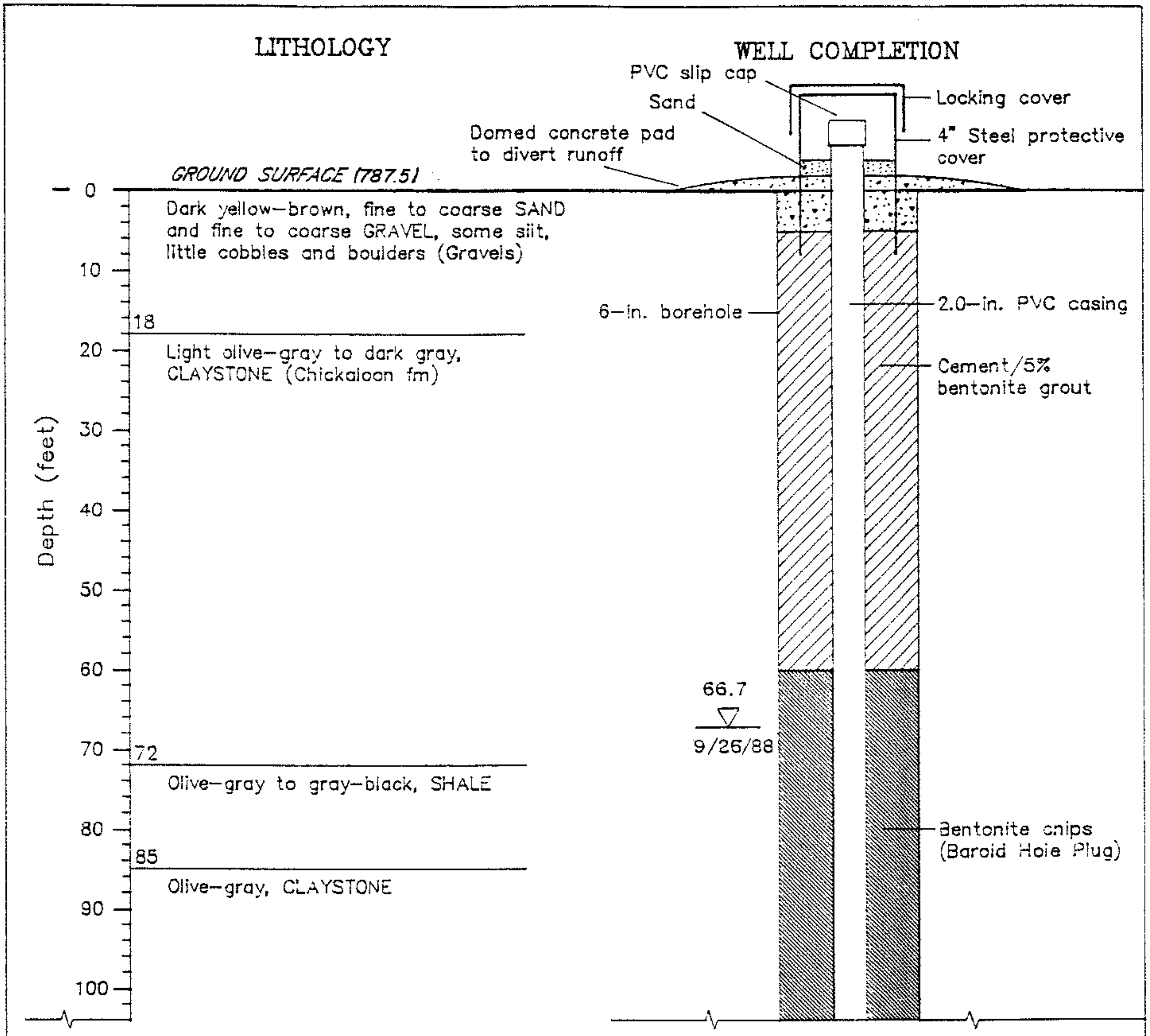
REV.
2

APPENDICES

LIST OF APPENDICES

APPENDIX A

MONITORING WELL COMPLETION AND LITHOLOGY LOGS



LEGEND

- ⁙ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ░ Sandpack
- ▽ Water Level
- ▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
- ▤ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

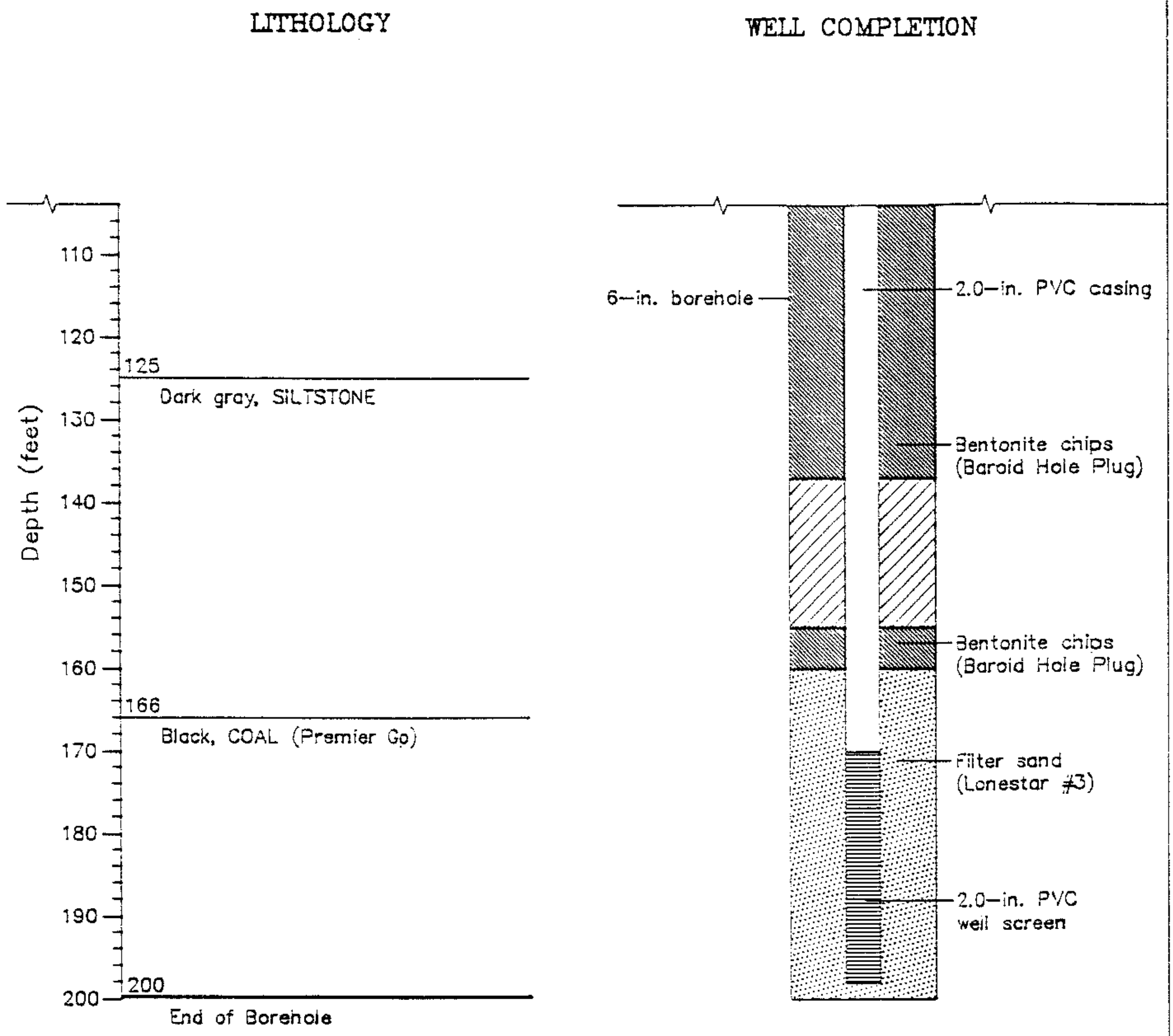
NOT TO SCALE

Date: 9/24/88
Ground Elevation: 787.5
T.O.C. Elevation: 801.2
Coordinates:
North: 2,816,923.39
East: 657,707.19

FIGURE **A-1**
WELL **H88-10**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7577 DATE 1/20/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

- ░ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ▒ Sandpack
- ▽ Water Level
- ▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
- ☰ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

NOT TO SCALE

Date: 9/24/88
Ground Elevation: 787.5
T.O.C. Elevation: 801.2
Coordinates:
North: 2,816,923.39
East: 657,707.19

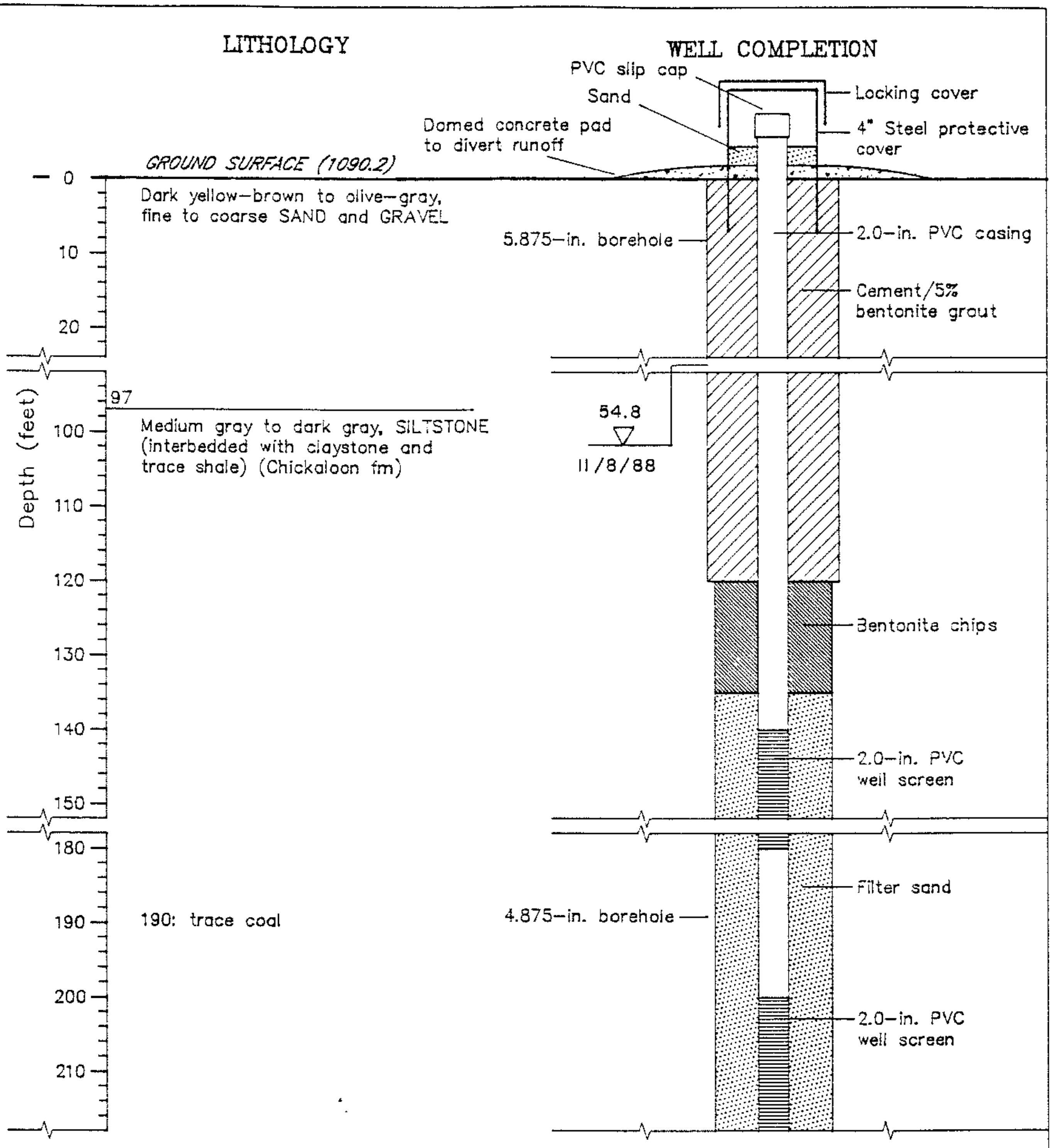
FIGURE **A-1**
WELL **H88-10**

LITHOLOGY AND WELL COMPLETION (CONT.)

WISHBONE

PROJECT NO 883-2145 DWG NO 7580 DATE 1/20/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁘	Cement Grout	▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▨	Bentonite Grout	▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▩	Bentonite Pellets		
░	Sandpack		
▽	Water Level		

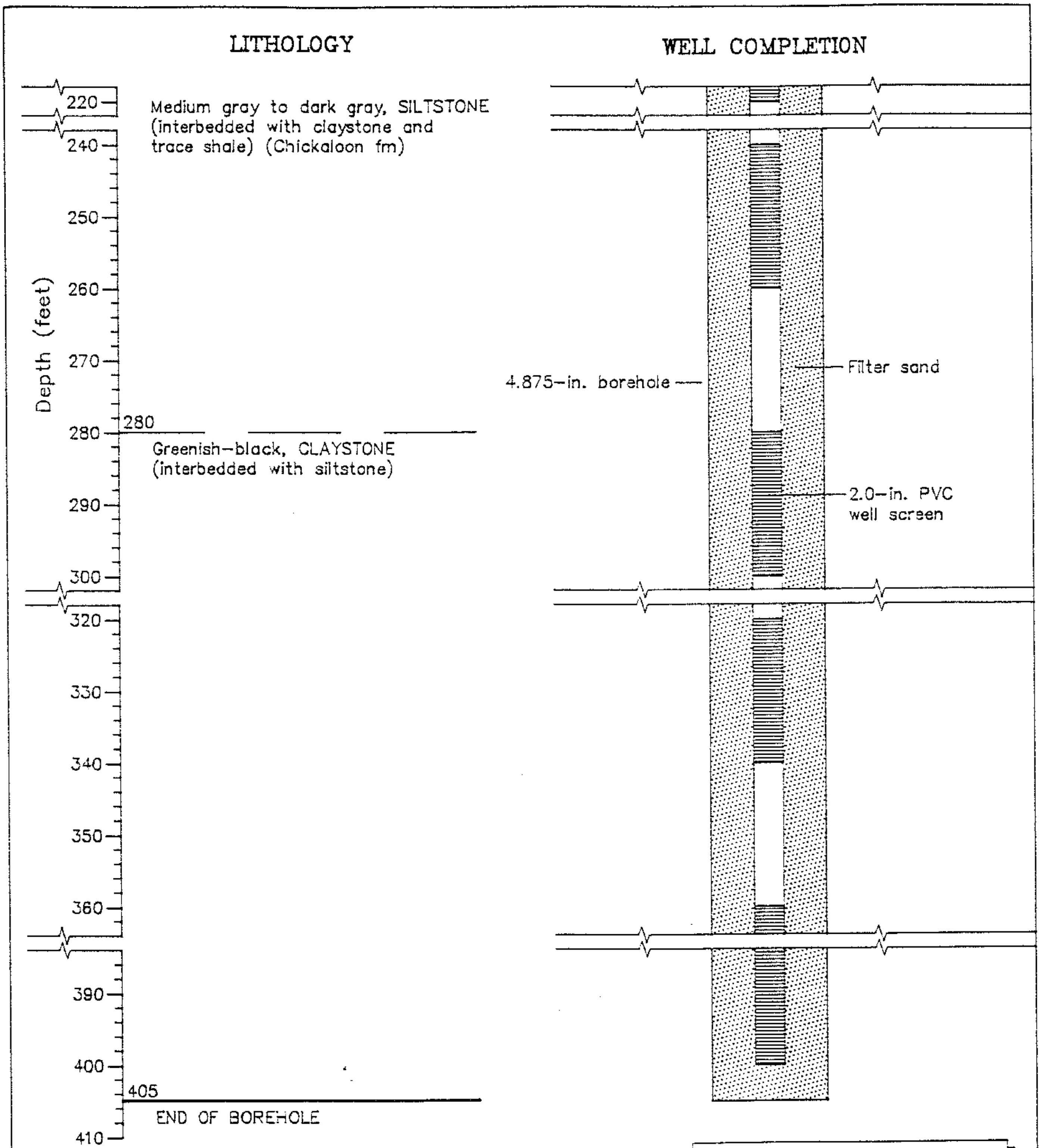
NOT TO SCALE

Date: 10/31/88
Ground Elevation: 1090.2
T.O.C. Elevation: 1093.0
Coordinates:
North: 2,819,202.50
East: 662,349.80

FIGURE **A-2**
WELL **H88-11**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7818 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

- ⁙ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ░ Sandpack
- ▽ Water Level
- ▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
- ☰ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

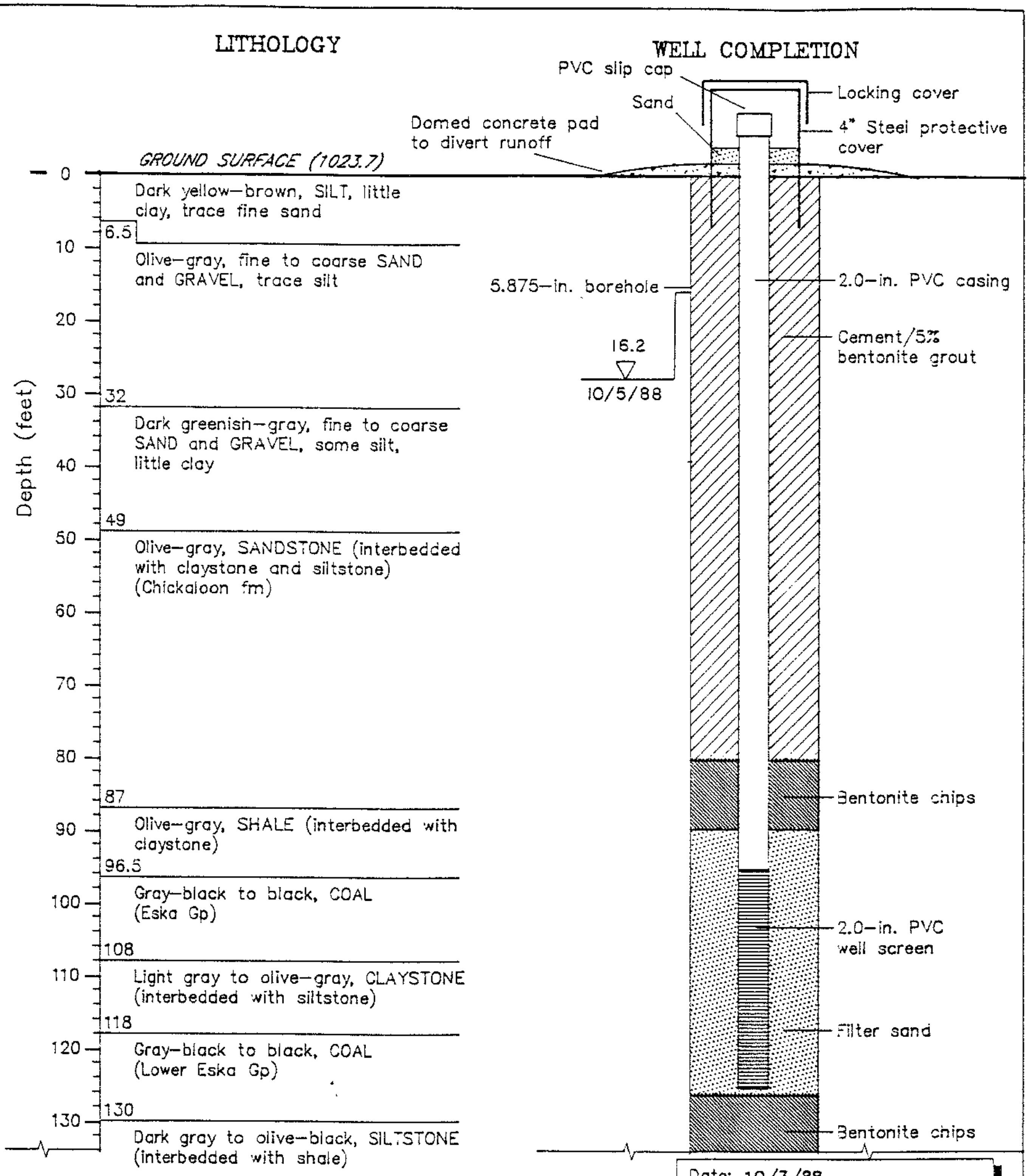
NOT TO SCALE

Date: 10/31/88
Ground Elevation: 1090.2
T.O.C. Elevation: 1093.0
Coordinates:
North: 2,819,202.50
East: 662,349.80

FIGURE **A-2**
WELL **H88-11**
LITHOLOGY AND
WELL COMPLETION CONT
WISHBONE

PROJECT NO 883-2145 DWG NO 7819 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



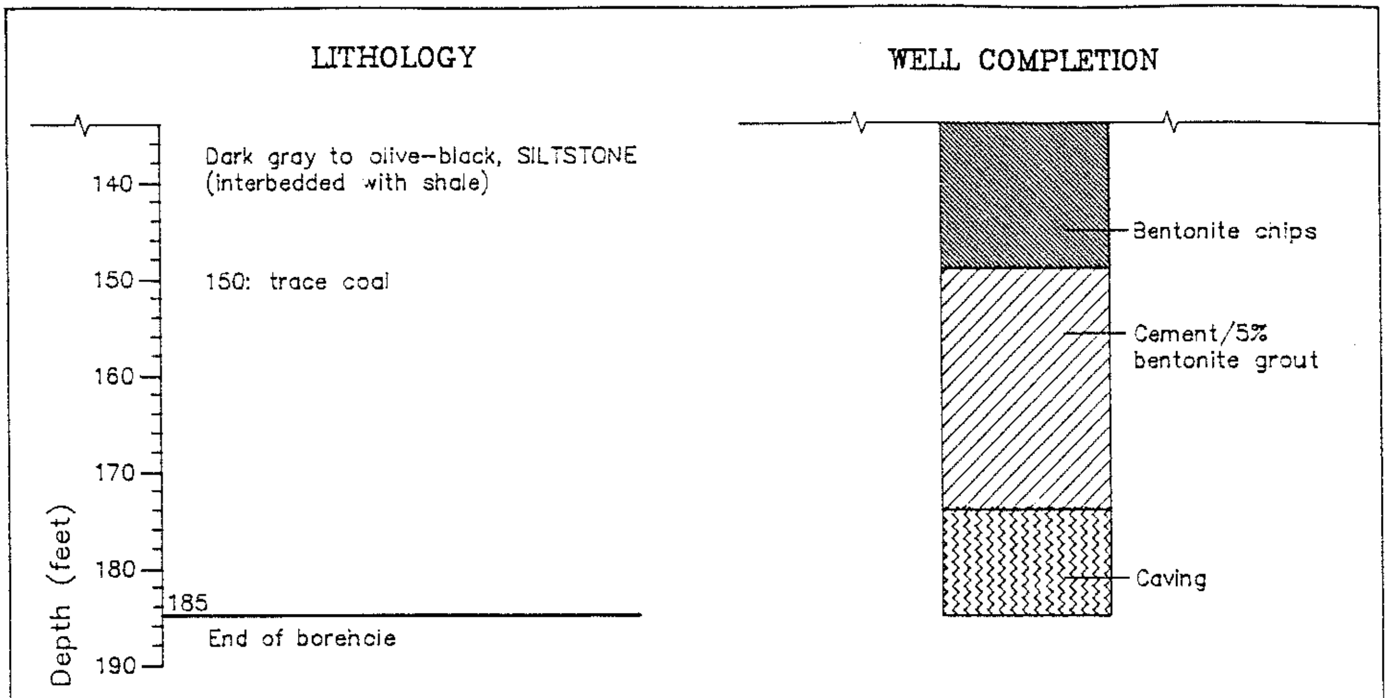
LEGEND

- ⁘ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ░ Sandpack
- ▽ Water Level
- ▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
- ☰ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

NOT TO SCALE

Date: 10/3/88
Ground Elevation: 1023.7
T.O.C. Elevation: 1026.4
Coordinates:
North: 2,821,481.58
East: 663,862.74

FIGURE **A-3**
WELL **H88-12**
LITHOLOGY AND WELL COMPLETION
WISHBONE



LEGEND

- ░ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ░ Sandpack
- ▽ Water Level
- ▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
- ▤ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

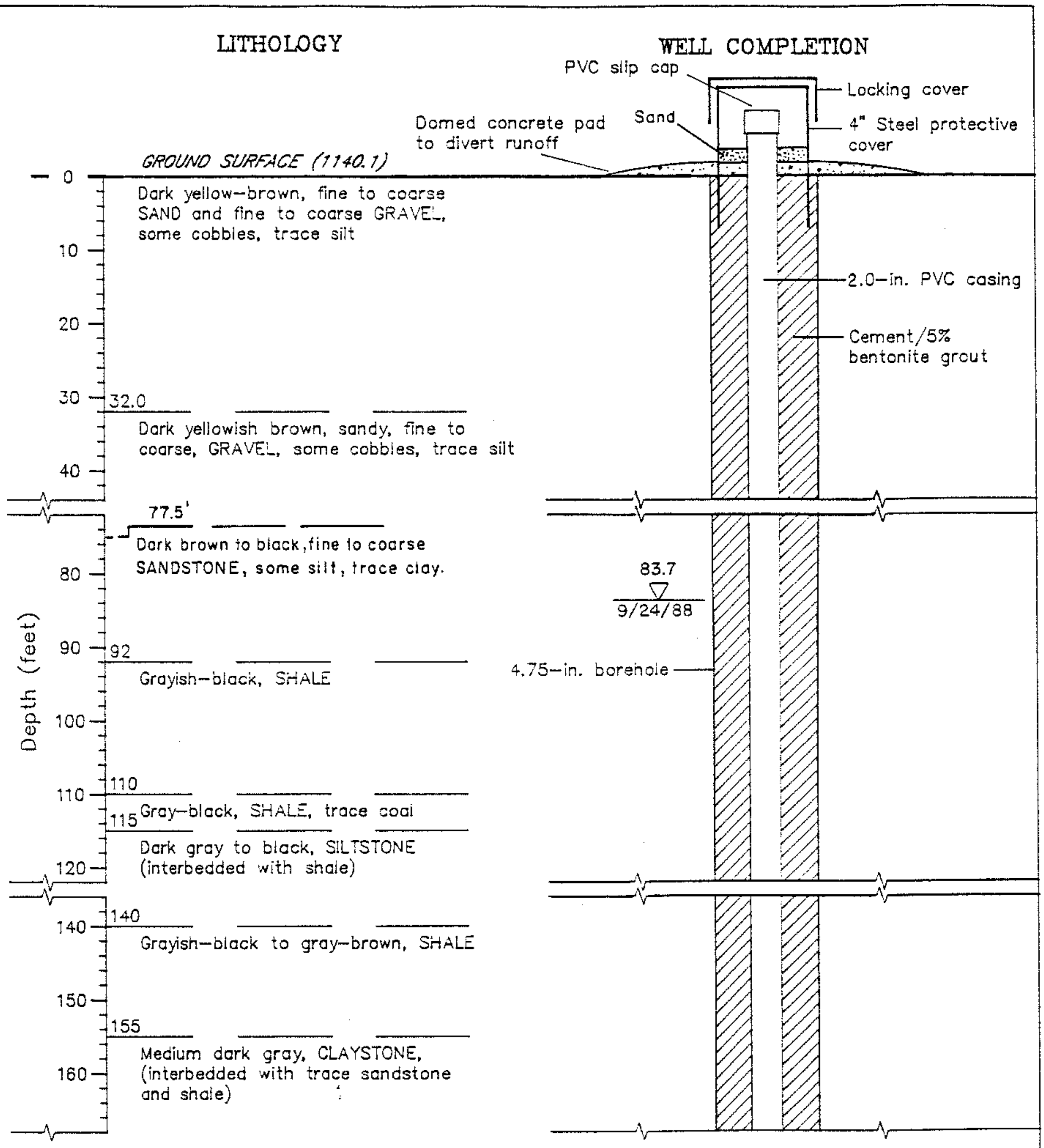
NOT TO SCALE

Date: 10/3/88
Ground Elevation: 1023.7
T.O.C. Elevation: 1026.4
Coordinates:
North: 2,821,481.58
East: 663,862.74

FIGURE **A-3**
WELL **H88-12**
LITHOLOGY AND WELL COMPLETION CONT
WISHBONE

PROJECT NO 883-2145 DWG NO 7815 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁘	Cement Grout	▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▨	Bentonite Grout	▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▩	Bentonite Pellets		
░	Sandpack		
▽	Water Level		

NOT TO SCALE

Date: 8/31/88
Ground Elevation: 1140.1
T.O.C. Elevation: 1142.9
Coordinates:
North: 2,822,647.55
East: 665,500.06

FIGURE **A-4**

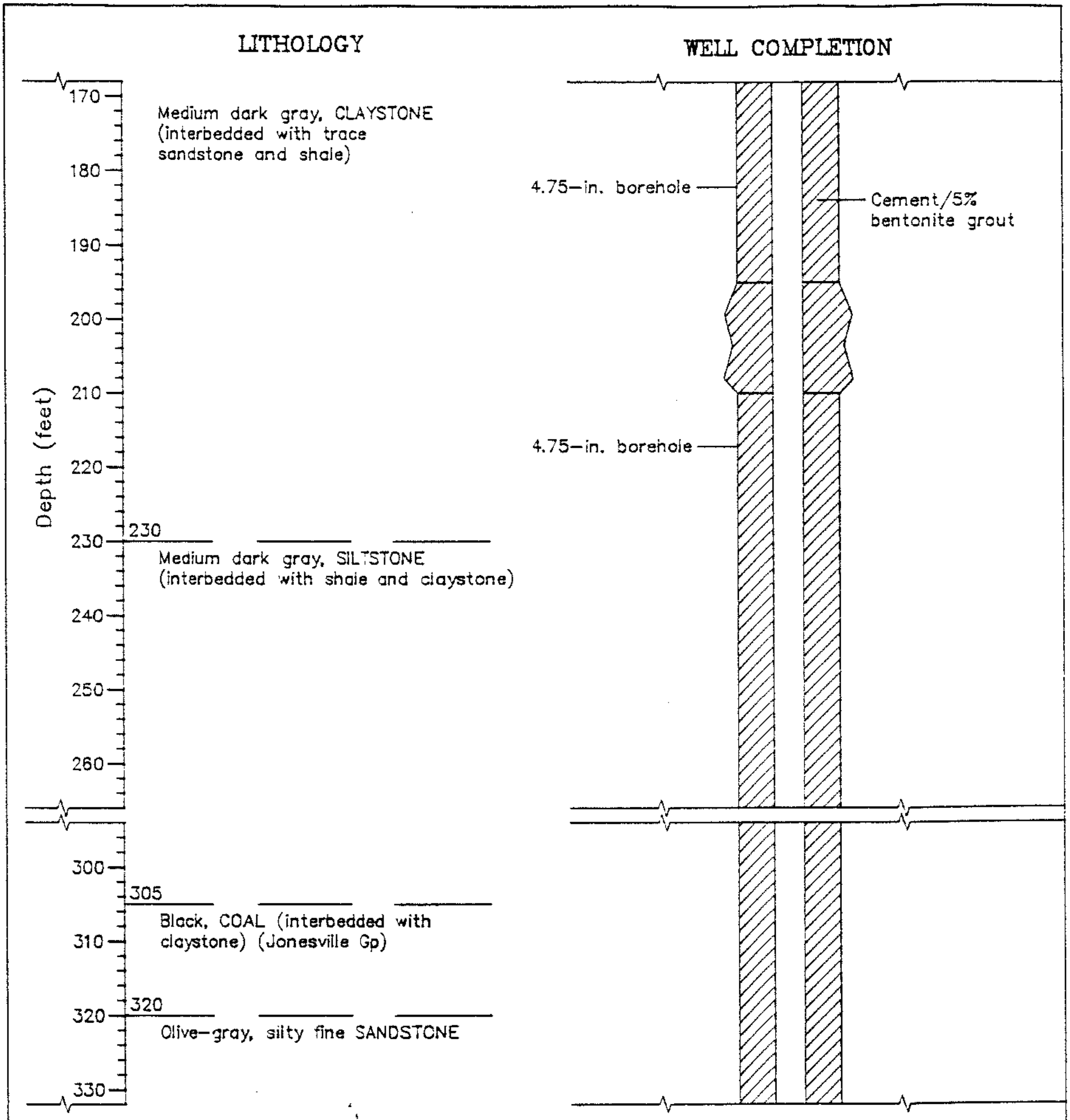
WELL **H88-13**

LITHOLOGY AND WELL COMPLETION

WISHBONE

PROJECT NO 883-2145 DWG NO 7811 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

░ Cement Grout	▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
▨ Bentonite Grout	▤ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▩ Bentonite Pellets	
░ Sandpack	
▽ Water Level	

NOT TO SCALE

Date: 8/31/88
Ground Elevation: 1140.1
T.O.C. Elevation: 1142.9
Coordinates:
North: 2,822,647.55
East: 665,500.06

FIGURE **A-4**

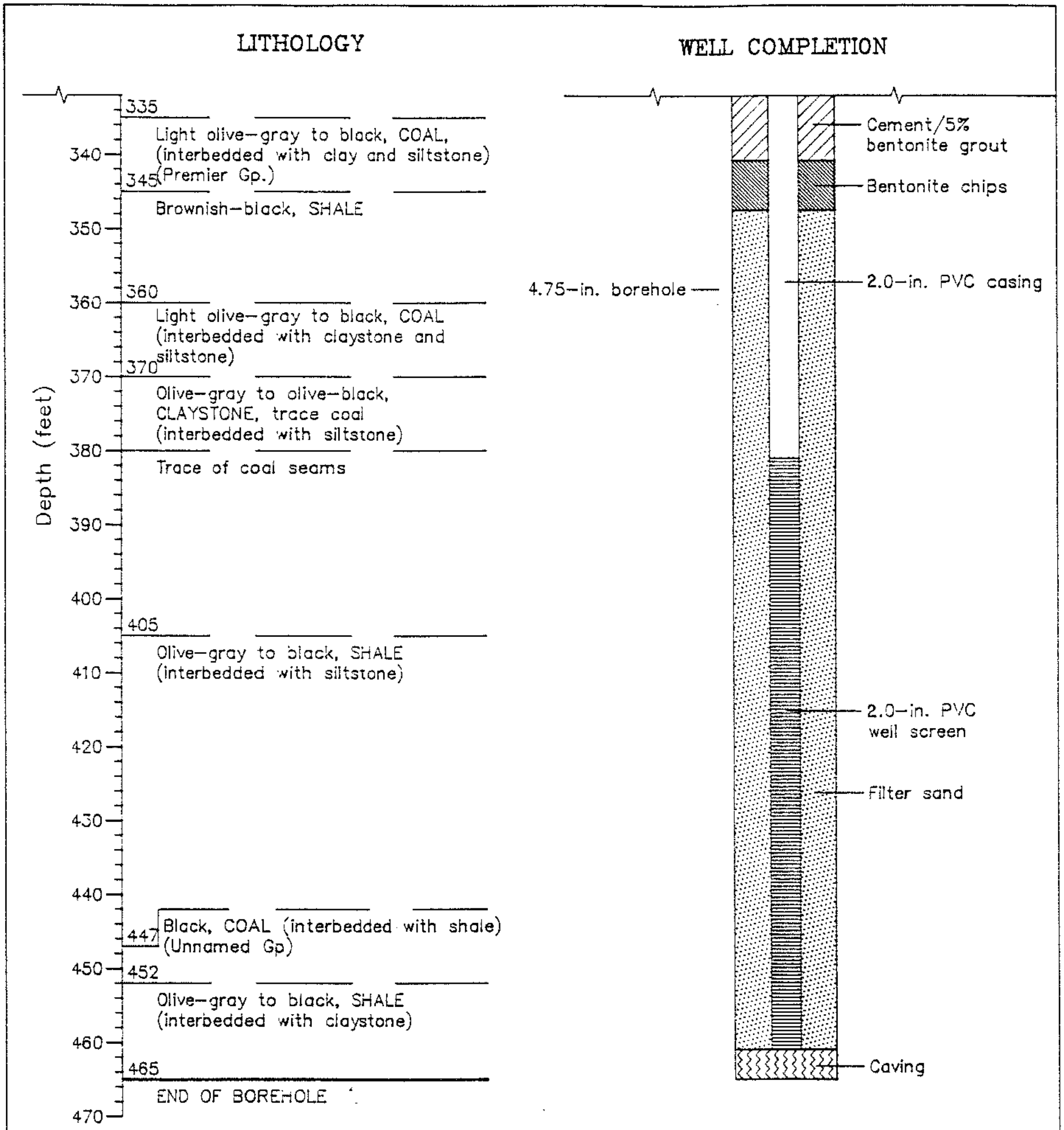
WELL **H88-13**

LITHOLOGY AND WELL COMPLETION (CONT)

WISHBONE

PROJECT NO 883-2145 DWG NO 7812 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⛆ Cement Grout	▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
▨ Bentonite Grout	▤ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▩ Bentonite Pellets	
⛆ Sandpack	
▽ Water Level	

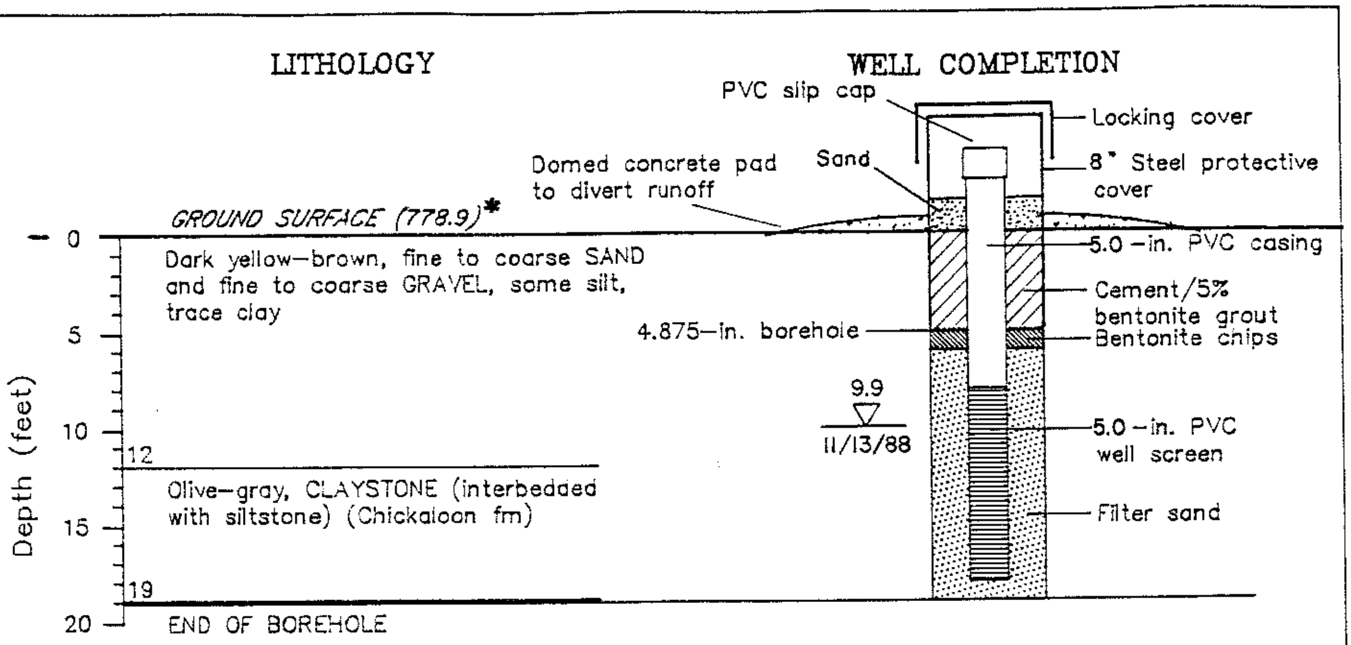
NOT TO SCALE

Date: 8/31/88
Ground Elevation: 1140.1
T.O.C. Elevation: 1142.9
Coordinates:
North: 2,822,647.55
East: 665,500.06

FIGURE **A-4**
WELL **H88-13**
LITHOLOGY AND
WELL COMPLETION (CONT)
WISHBONE

PROJECT NO 883-2145 DWG NO 7813 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



* APPROXIMATE SURVEY

LEGEND

- ⛆ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ⛆ Sandpack
- ▽ Water Level
- ▯ 5.0 Sch. 40 PVC Riser, Flush Threaded
- ▤ 5.0 Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

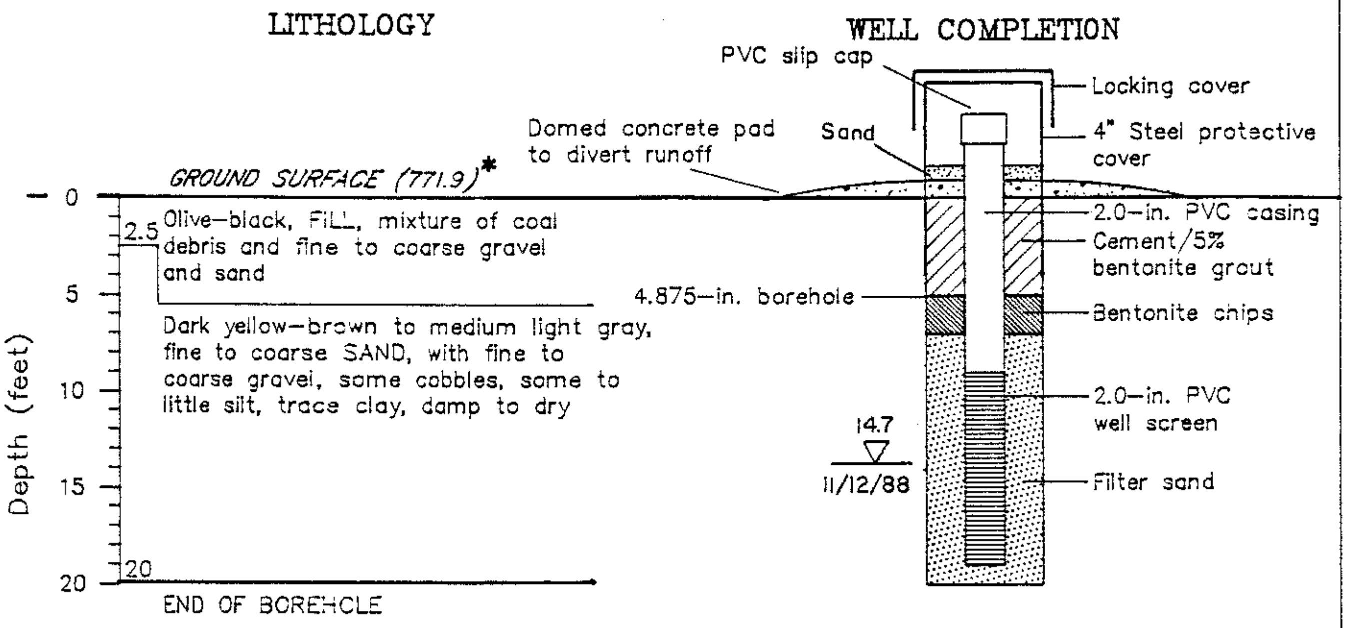
NOT TO SCALE

Date: 11/10/88
Ground Elevation: 788.9*
T.O.C. Elevation: 790.9*
Coordinates:
North: 2,816,995.3*
East: 657, 713.5*

FIGURE **A-5**
WELL **H88-14**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7810 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



* APPROXIMATE SURVEY

LEGEND

⁙ Cement Grout	▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
▨ Bentonite Grout	
▩ Bentonite Pellets	▤ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
░ Sandpack	
▽ Water Level	NOT TO SCALE

Date: 11/10/88
Ground Elevation: 771.9*
T.O.C. Elevation: 772.8*
Coordinates:
North: NS 2,816,842.6*
East: NS 657,425.4*

FIGURE **A-6**

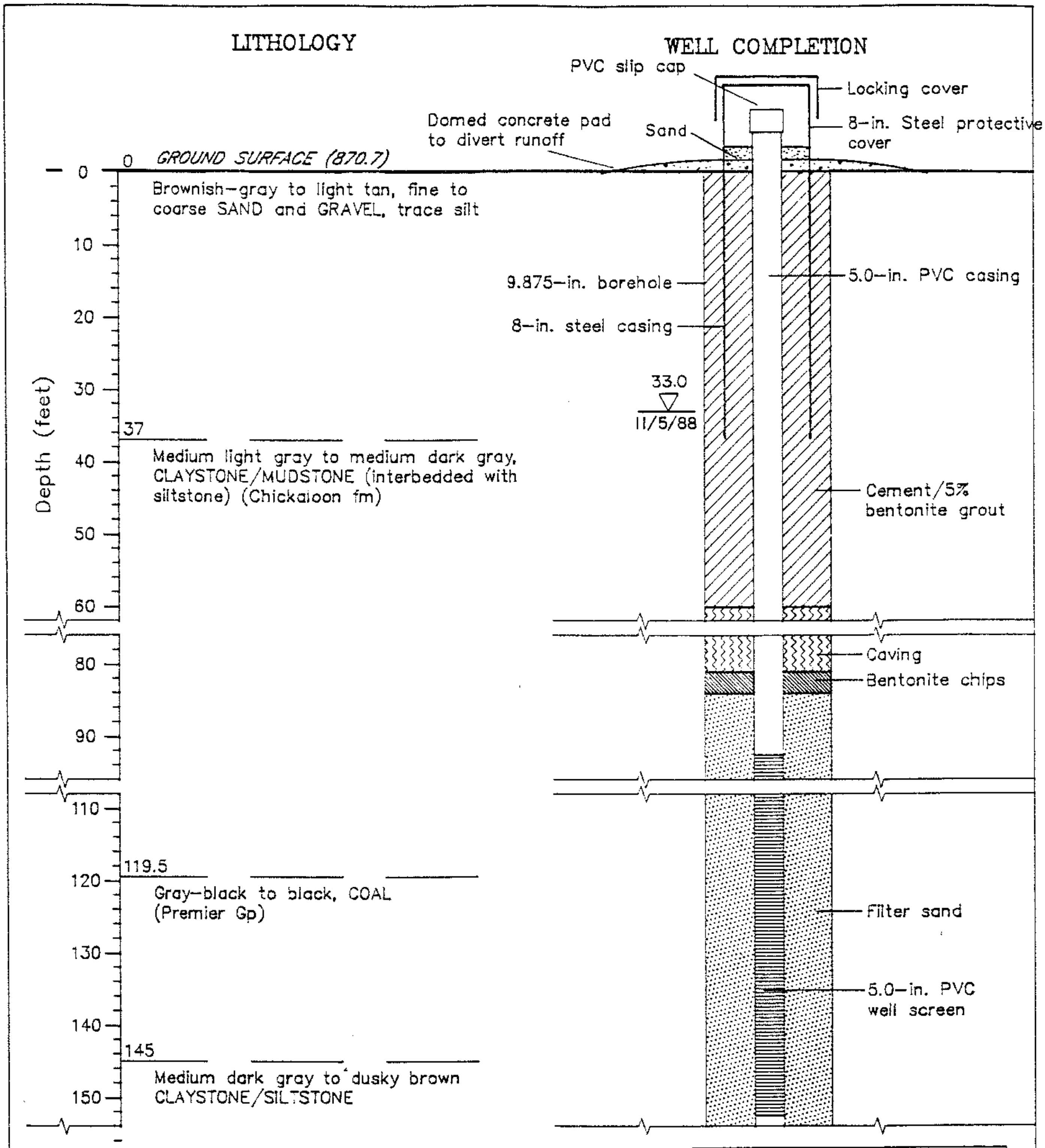
WELL **H88-14A**

LITHOLOGY AND WELL COMPLETION

WISHBONE

PROJECT NO 883-2145 DWG NO 7809 DATE 2/8/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁘	Cement Grout	▯	5.0" Sch. 80 PVC Riser, Flush Threaded
▨	Bentonite Grout	☰	5.0" Sch. 80 PVC Screen 0.020" Slots, Flush Threaded
▩	Bentonite Pellets		
░	Sandpack		
▽	Water Level		

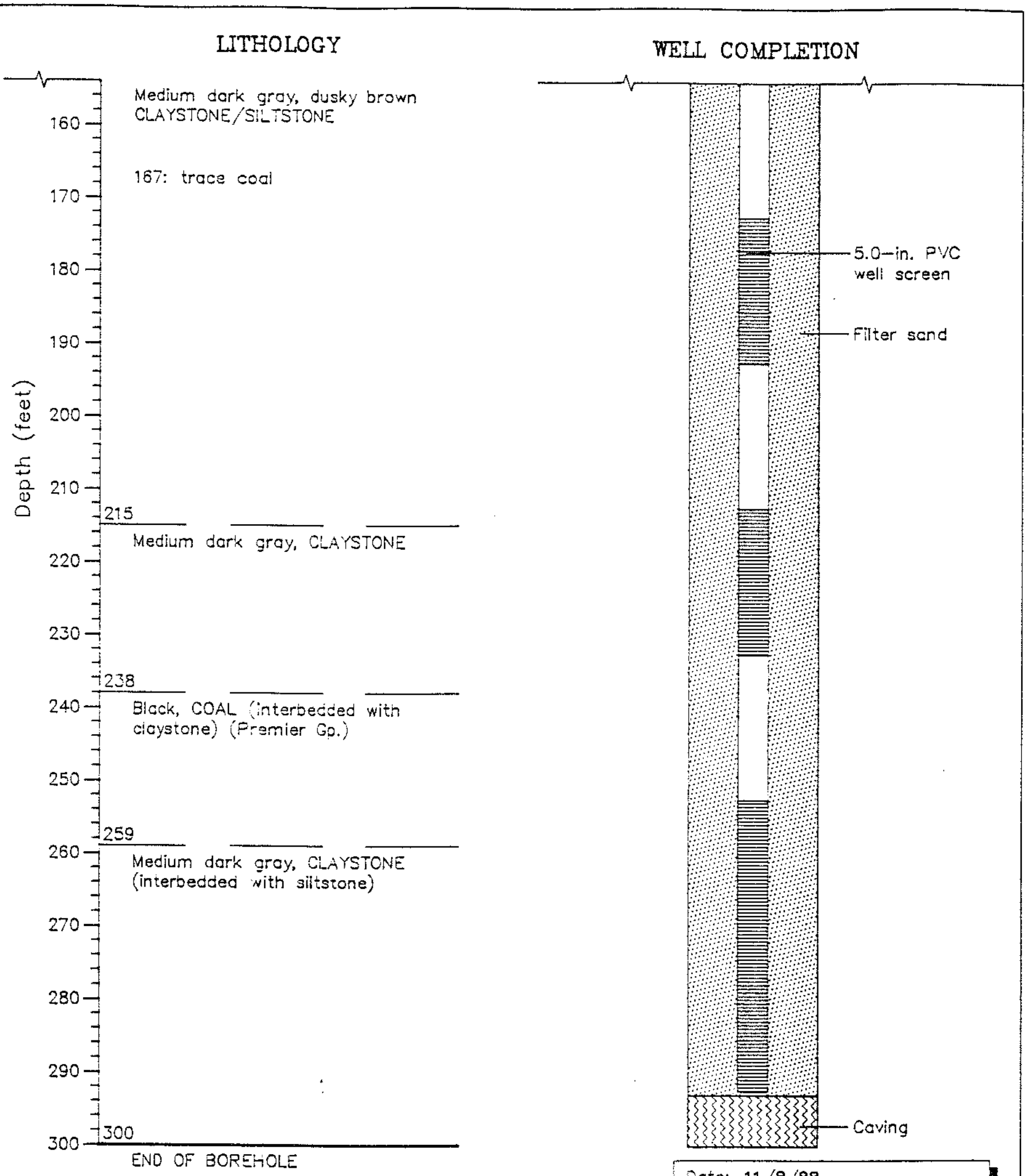
NOT TO SCALE

Date: 11/8/88
Ground Elevation: 870.7
T.O.C. Elevation: 873.7
Coordinates:
North: 2,817,411.48
East: 660,040.14

FIGURE **A-7**
WELL **H88-15**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7820 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁘	Cement Grout	▯	5.0" Sch. 80 PVC Riser, Flush Threaded
▨	Bentonite Grout		
▩	Bentonite Pellets	▤	5.0" Sch. 80 PVC Screen 0.020" Slots, Flush Threaded
▒	Sandpack		
▽	Water Level		

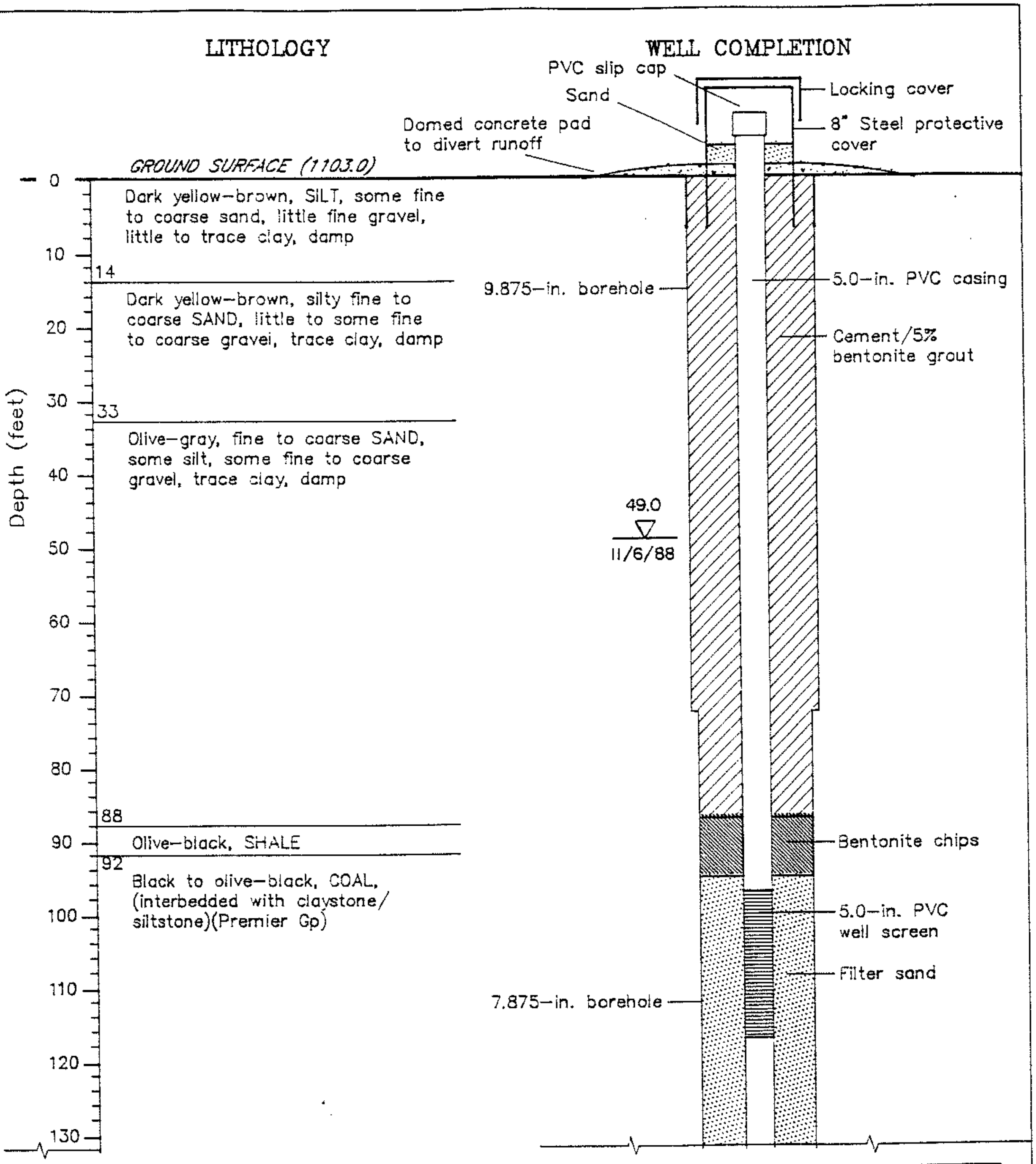
NOT TO SCALE

Date: 11/8/88
Ground Elevation: 870.7
T.O.C. Elevation: 873.7
Coordinates:
North: 2,817,411.48
East: 660,040.14

FIGURE **A-7**
WELL **H88-15**
LITHOLOGY AND WELL COMPLETION (CONT)
WISHBONE

PROJECT NO 883-2145 DWG NO 7821 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

- ⁙ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ░ Sandpack
- ▽ Water Level
- ▯ 5.0" Sch. 80 PVC Riser, Flush Threaded
- ☰ 5.0" Sch. 80 PVC Screen 0.020" Slots, Flush Threaded

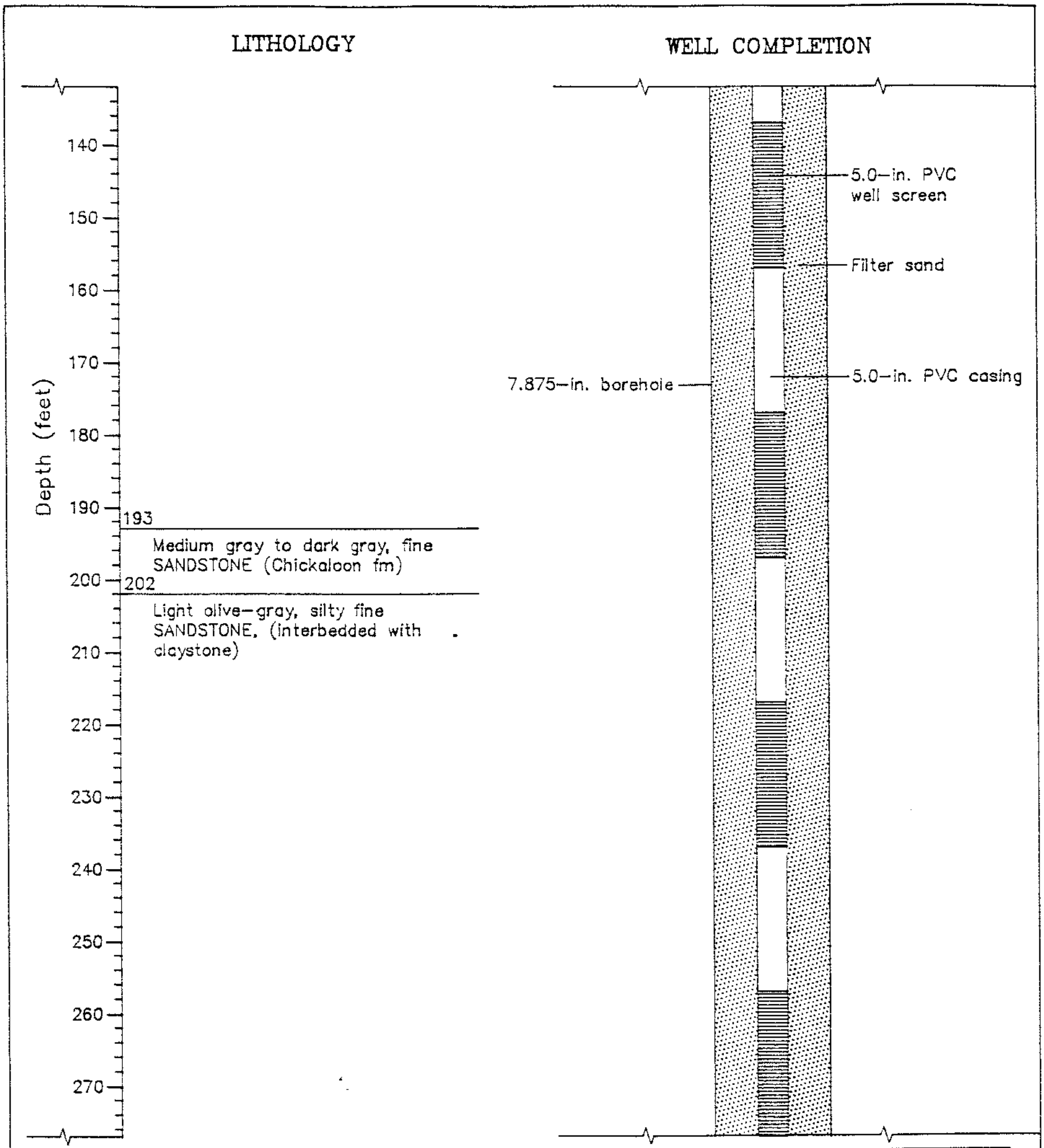
NOT TO SCALE

Date: 10/20/88
Ground Elevation: 1103.0
T.O.C. Elevation: 1106.0
Coordinates:
North: 2,819,896.54
East: 663,436.78

FIGURE **A-8**
WELL **H88-16**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7804 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

░	Cement Grout	▯	5.0" Sch. 80 PVC Riser, Flush Threaded
▨	Bentonite Grout	▤	5.0" Sch. 80 PVC Screen 0.020" Slots, Flush Threaded
▩	Bentonite Pellets		
░	Sandpack		
▽	Water Level		

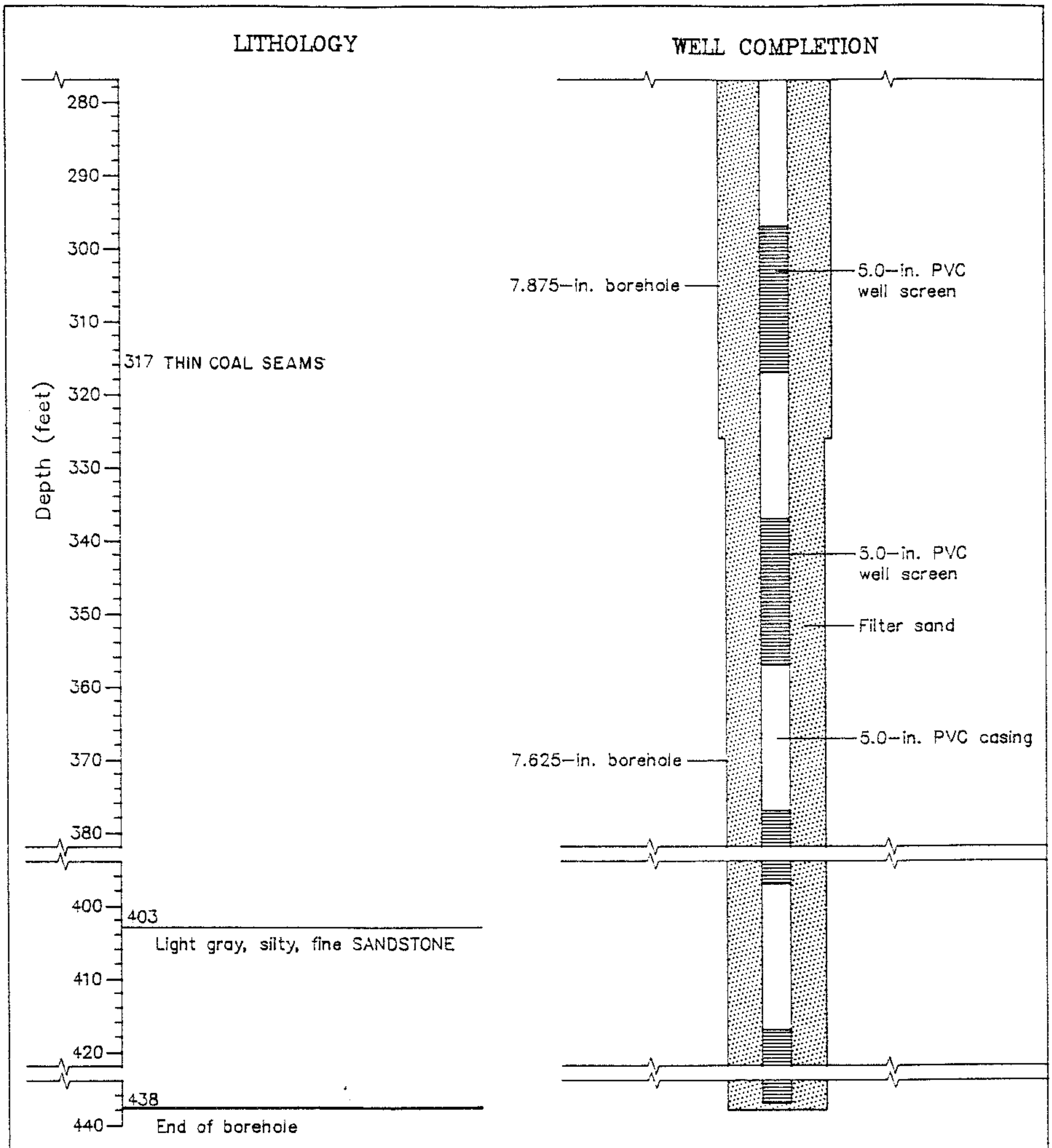
NOT TO SCALE

Date: 10/20/88
Ground Elevation: 1103.0
T.O.C. Elevation: 1106.0
Coordinates:
North: 2,819,896.54
East: 663,436.78

FIGURE **A-8**
WELL **H88-16**
LITHOLOGY AND WELL COMPLETION CONT
WISHBONE

PROJECT NO 883-2145 DWG NO 7805 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

▒	Cement Grout	▯	5.0" Sch. 80 PVC Riser, Flush Threaded
▨	Bentonite Grout	▤	5.0" Sch. 80 PVC Screen 0.020" Slots, Flush Threaded
▩	Bentonite Pellets		
░	Sandpack		
▽	Water Level		

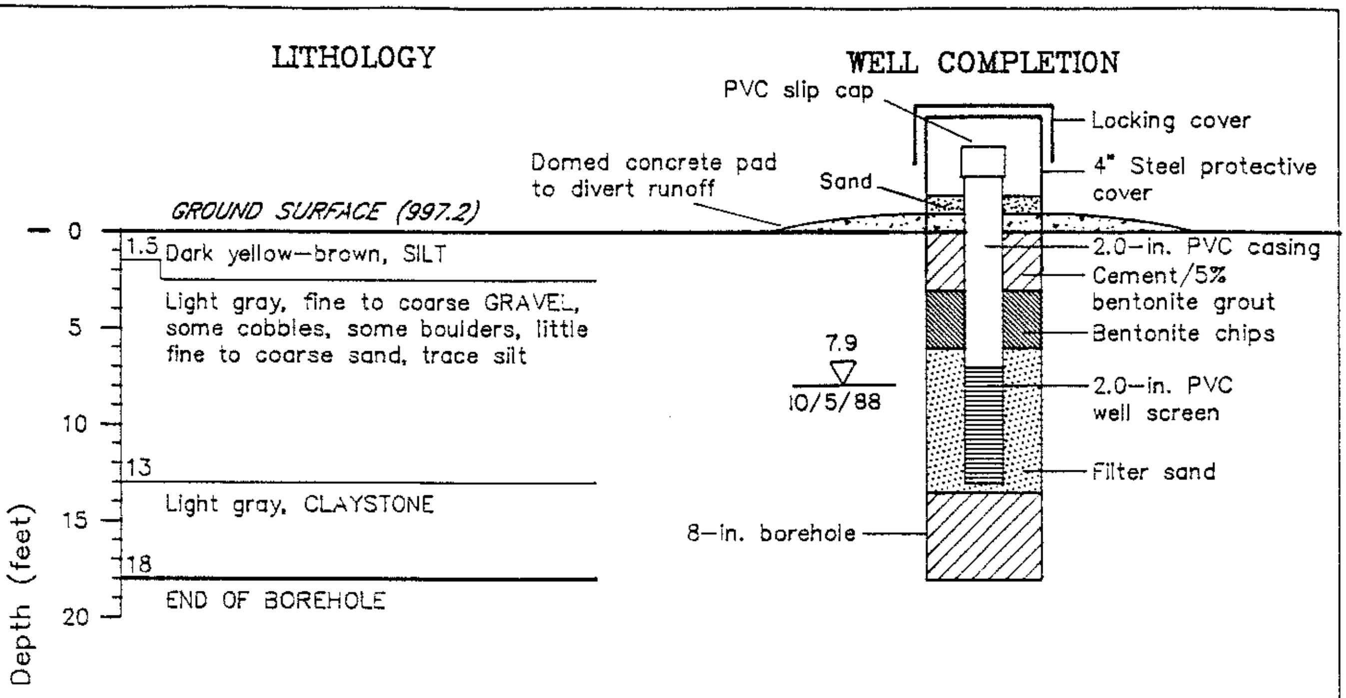
NOT TO SCALE

Date: 10/20/88
Ground Elevation: 1103.0
T.O.C. Elevation: 1106.0
Coordinates:
North: 2,819,896.54
East: 663,436.78

FIGURE **A-8**
WELL **H88-16**
LITHOLOGY AND WELL COMPLETION CONT
WISHBONE

PROJECT NO 883-2145 DWG NO 7806 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

- ⁙ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ░ Sandpack
- ▽ Water Level
- ▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
- ▤ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

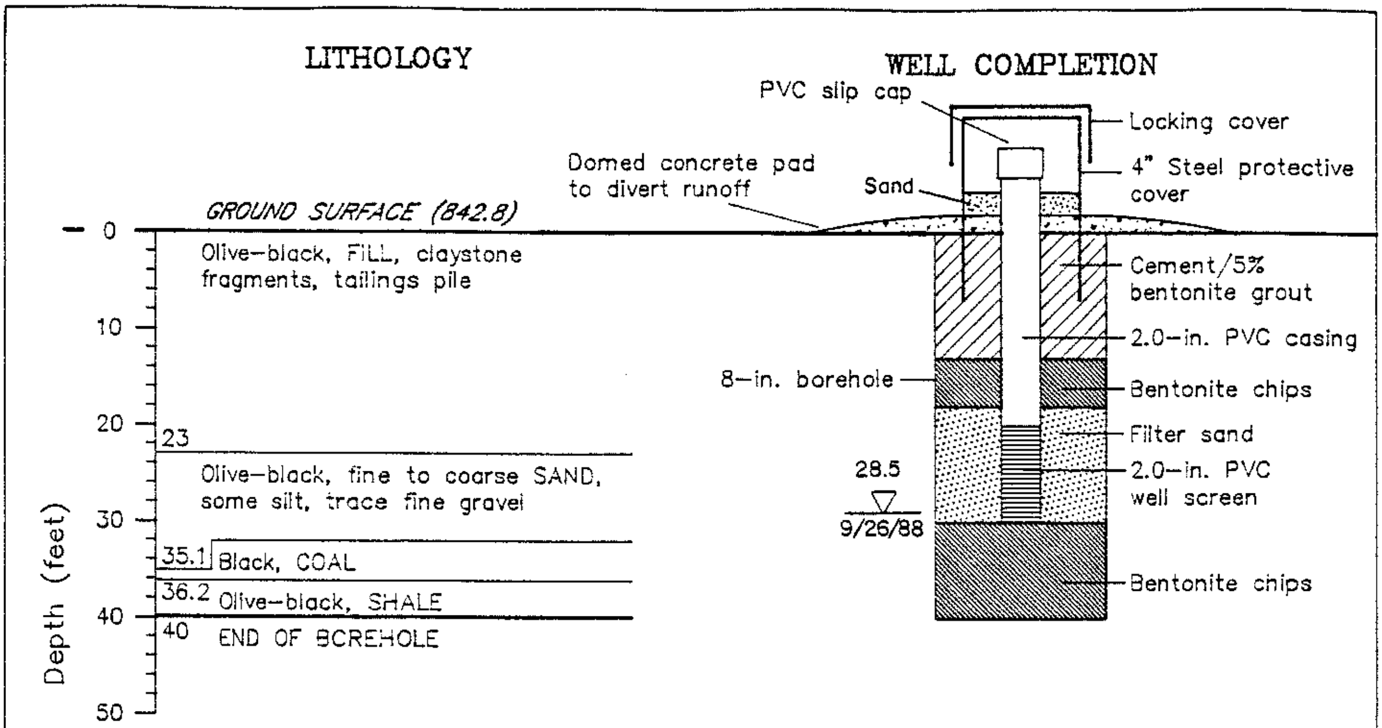
NOT TO SCALE

Date: 10/5/88
Ground Elevation: 997.2
T.O.C. Elevation: 1000.1
Coordinates:
North: 2,822,520.48
East: 664,046.71

FIGURE **A-9**
WELL **H88-17**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7807 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁘	Cement Grout
▨	Bentonite Grout
▩	Bentonite Pellets
░	Sandpack
▽	Water Level
▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

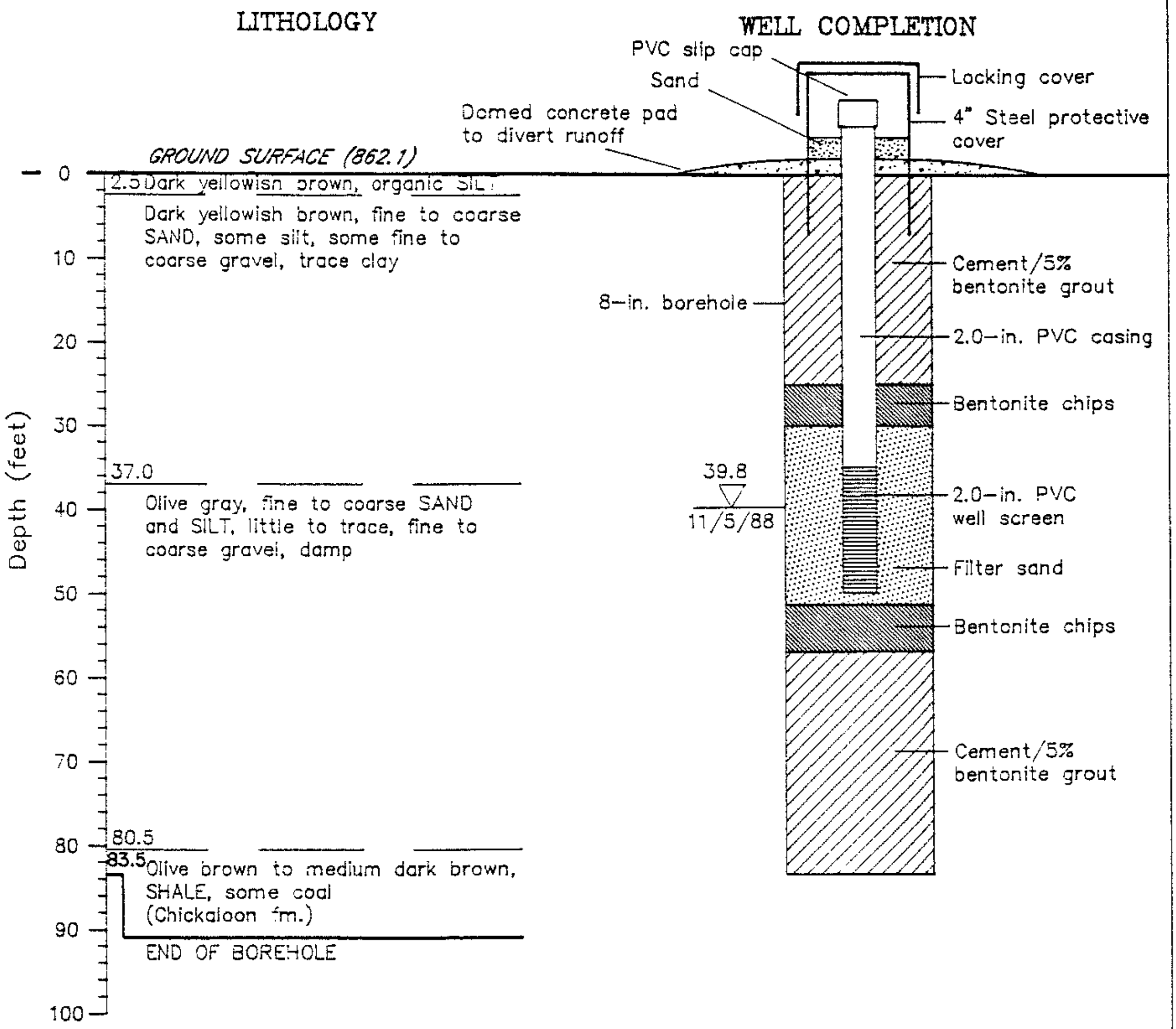
NOT TO SCALE

Date: 9/23/88
Ground Elevation: 842.8
T.O.C. Elevation: 846.3
Coordinates:
North: 2,818,483.72
East: 658,788.09

FIGURE **A-10**
WELL **H88-19**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7808 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁘ Cement Grout

▨ Bentonite Grout

▩ Bentonite Pellets

░ Sandpack

▽ Water Level

▯ 2.0" Sch. 40 PVC Riser, Flush Threaded

▤ 2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

NOT TO SCALE

Date: 10/21/88
Ground Elevation: 862.1
T.O.C. Elevation: 865.9
Coordinates:
North: 2,816,620.80
East: 659,688.28

FIGURE A-11

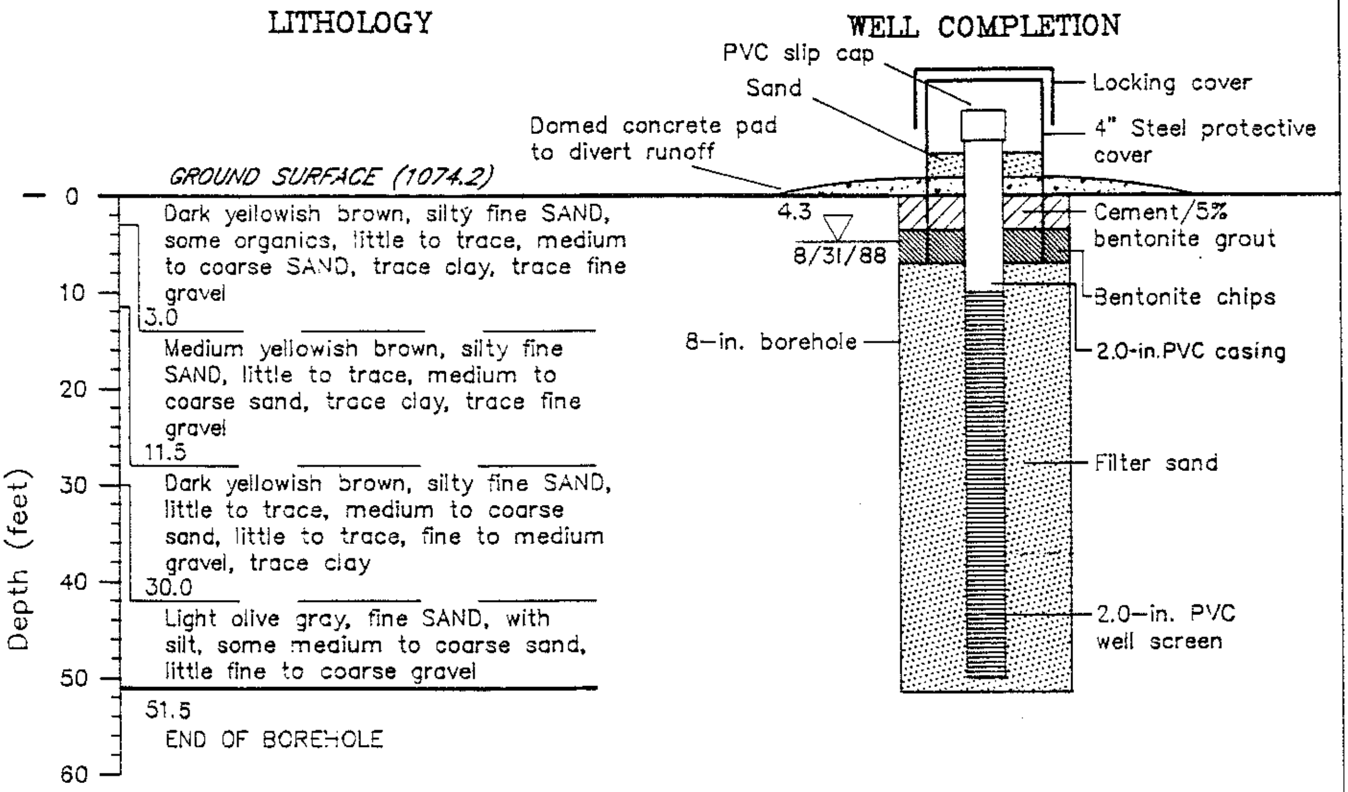
WELL H88-21

LITHOLOGY AND WELL COMPLETION

WISHBONE

PROJECT NO 883-2145 DWG NO 7651 DATE 2/9/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



Dark yellowish brown, silty fine SAND, some organics, little to trace, medium to coarse SAND, trace clay, trace fine gravel

3.0

Medium yellowish brown, silty fine SAND, little to trace, medium to coarse sand, trace clay, trace fine gravel

11.5

Dark yellowish brown, silty fine SAND, little to trace, medium to coarse sand, little to trace, fine to medium gravel, trace clay

30.0

Light olive gray, fine SAND, with silt, some medium to coarse sand, little fine to coarse gravel

51.5

END OF BOREHOLE

LEGEND

⁙	Cement Grout	▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▨	Bentonite Grout		
▩	Bentonite Pellets	▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▒	Sandpack		
▽	Water Level		

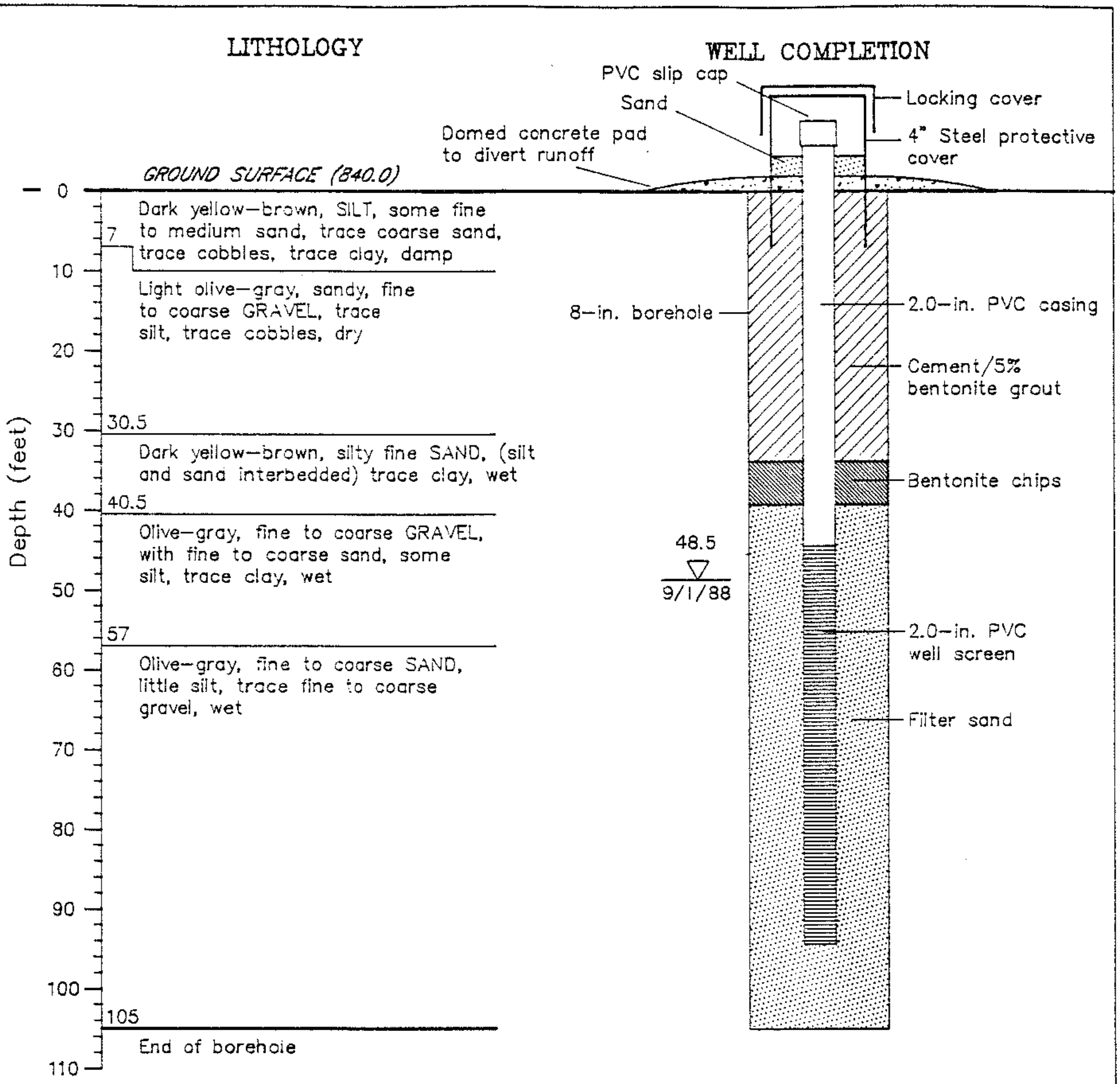
NOT TO SCALE

Date: 8/26/88
Ground Elevation: 1074.2
T.O.C. Elevation: 1077.2
Coordinates:
North: 2,819,734.40
East: 662,165.67

FIGURE **A-12**
WELL **H88-22**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7652 DATE 2/9/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



LEGEND

⁘	Cement Grout	▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▨	Bentonite Grout	▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▩	Bentonite Pellets		
⁘	Sandpack		
▽	Water Level		

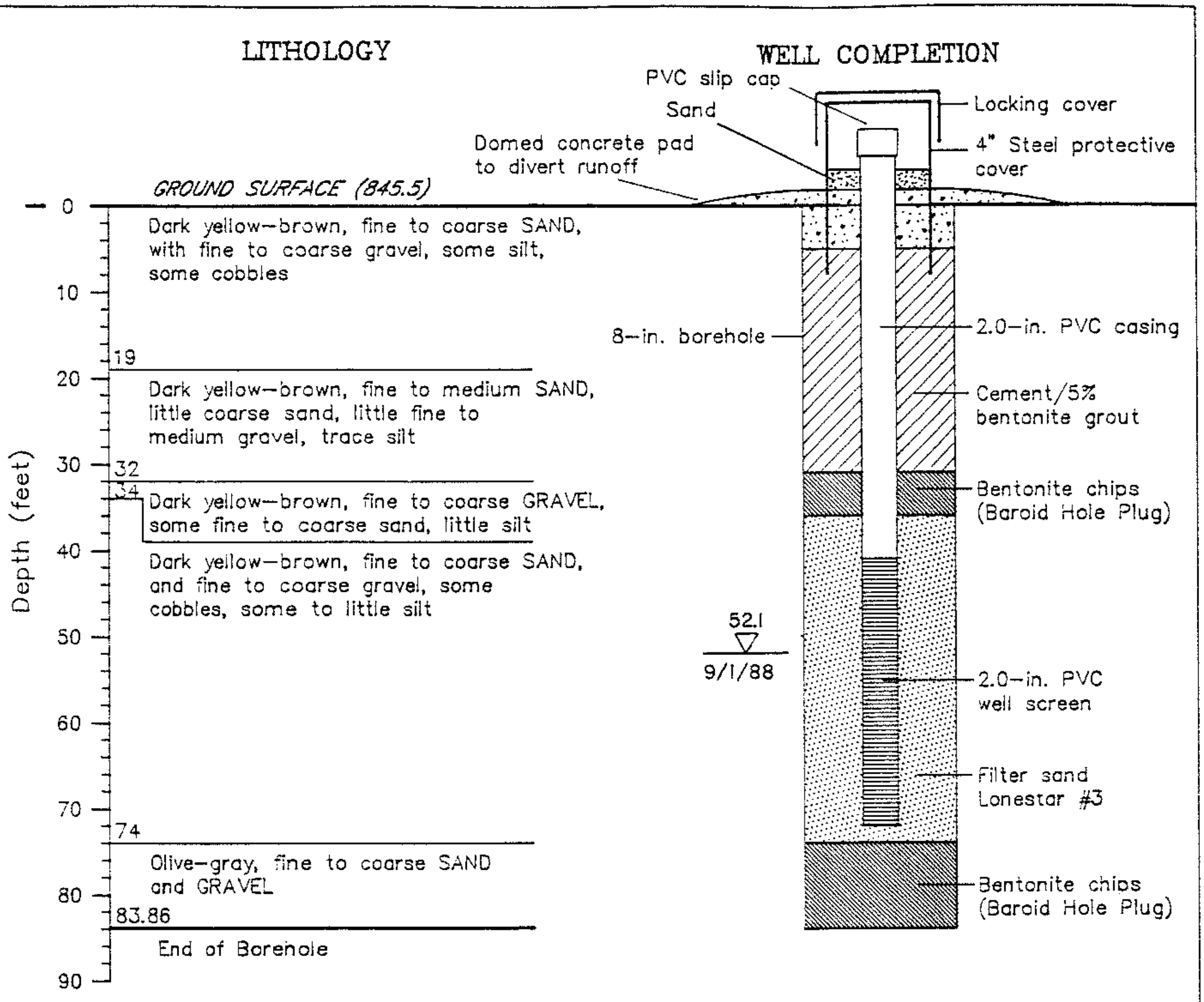
NOT TO SCALE

Date: 8/24/88
Ground Elevation: 840.0
T.O.C. Elevation: 842.4
Coordinates:
North: 2,816,470.74
East: 662,508.83

FIGURE **A-13**
WELL **H88-23**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7803 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

▒	Cement Grout	▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▨	Bentonite Grout	▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▩	Bentonite Pellets		
░	Sandpack		
▽	Water Level		

NOT TO SCALE

Date: 8/20/88
Ground Elevation: 845.5
T.O.C. Elevation: 848.3
Coordinates:
North: 2,815,947.90
East: 663,564.21

FIGURE **A-14**

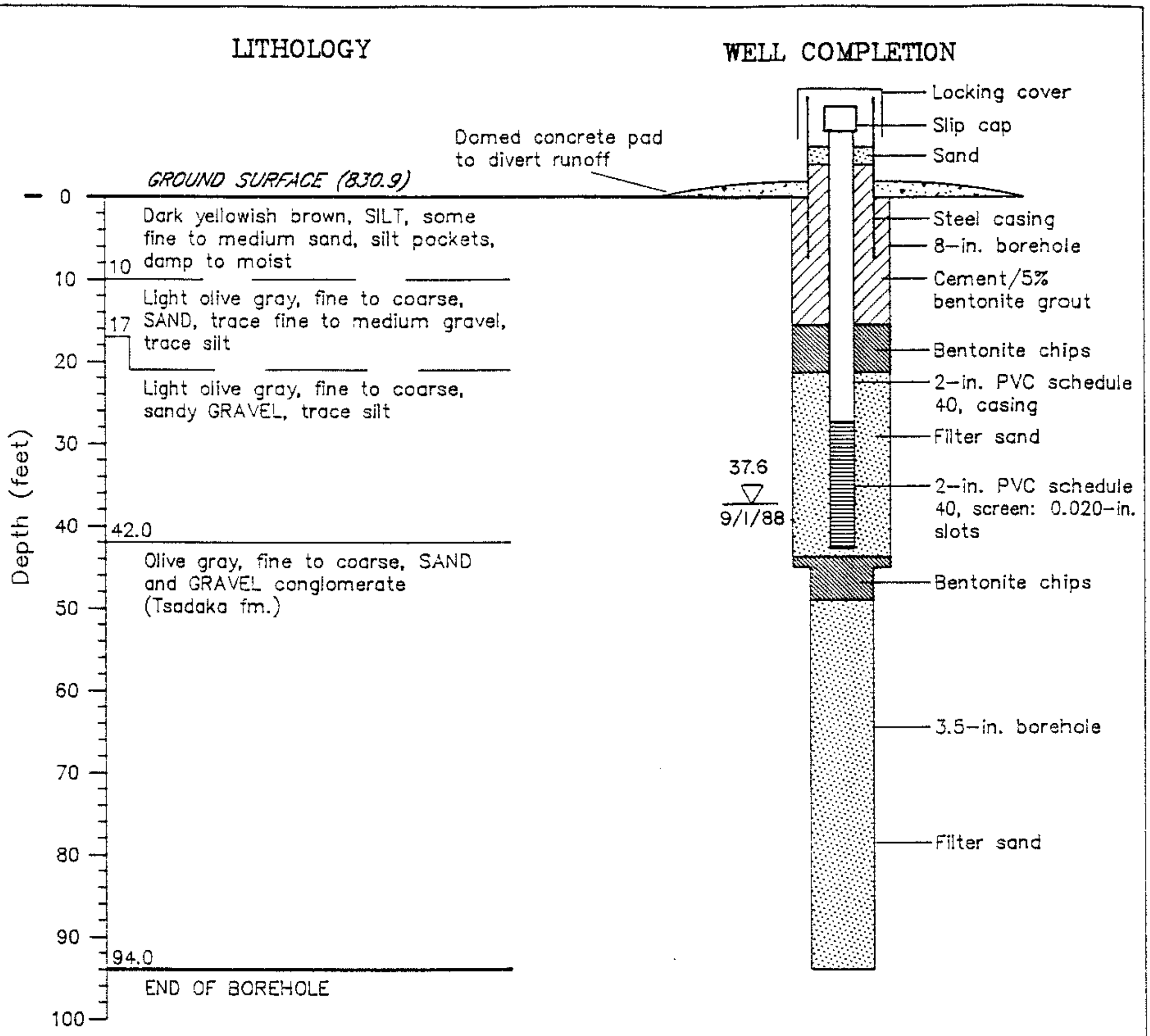
WELL **H88-24A**

LITHOLOGY AND WELL COMPLETION

WISHBONE

PROJECT NO 883-2145 DWG NO 7576 DATE 1/20/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

░	Cement Grout	▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▨	Bentonite Grout		
▩	Bentonite Pellets	▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▒	Sandpack		
▽	Water Level		

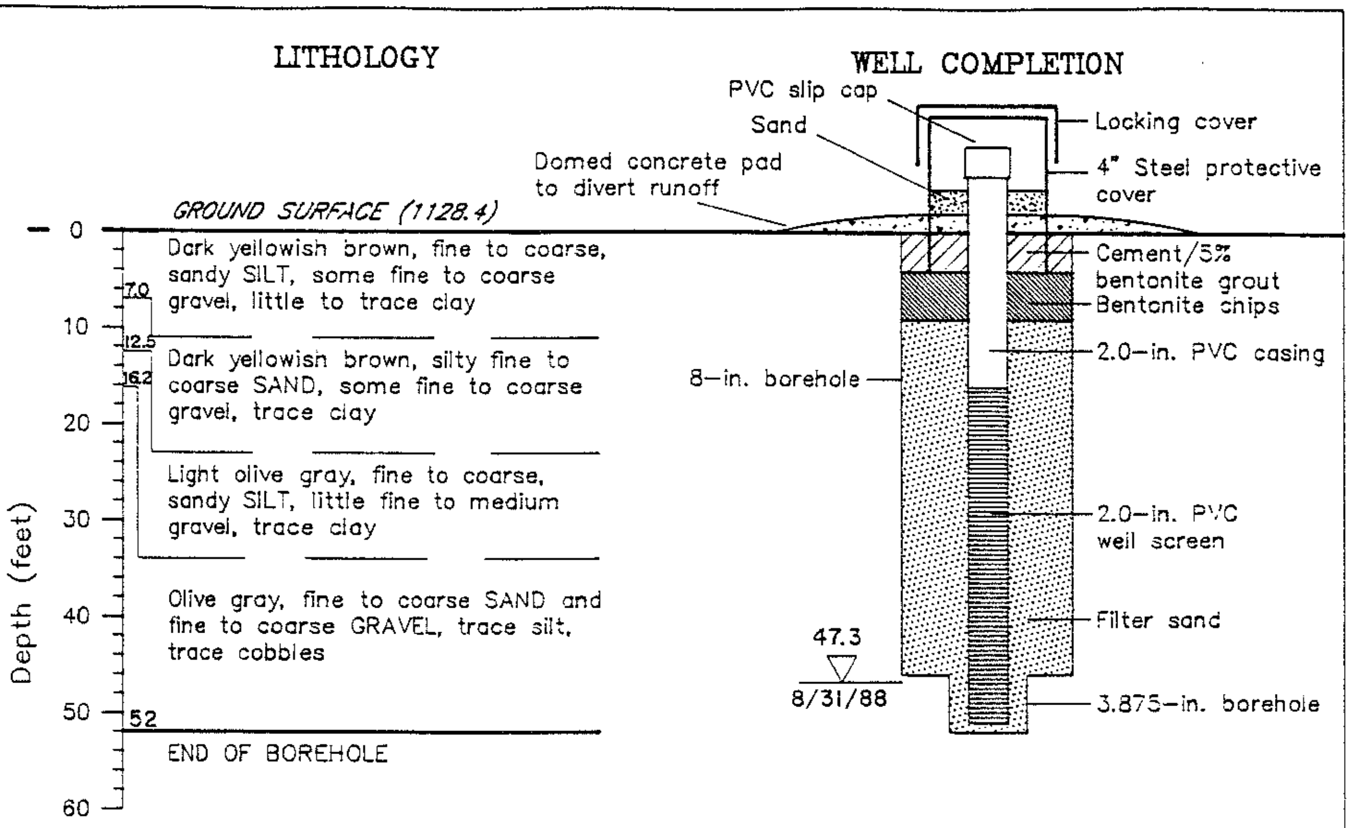
NOT TO SCALE

Date: 8/14/88
Ground Elevation: 830.9
T.O.C. Elevation: 833.7
Coordinates:
North: 2,815,306.15
East: 662,650.44

FIGURE **A-15**
WELL **H88-25**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7630 DATE 2/3/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



LEGEND

⁘	Cement Grout
▨	Bentonite Grout
▩	Bentonite Pellets
░	Sandpack
▽	Water Level
▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded

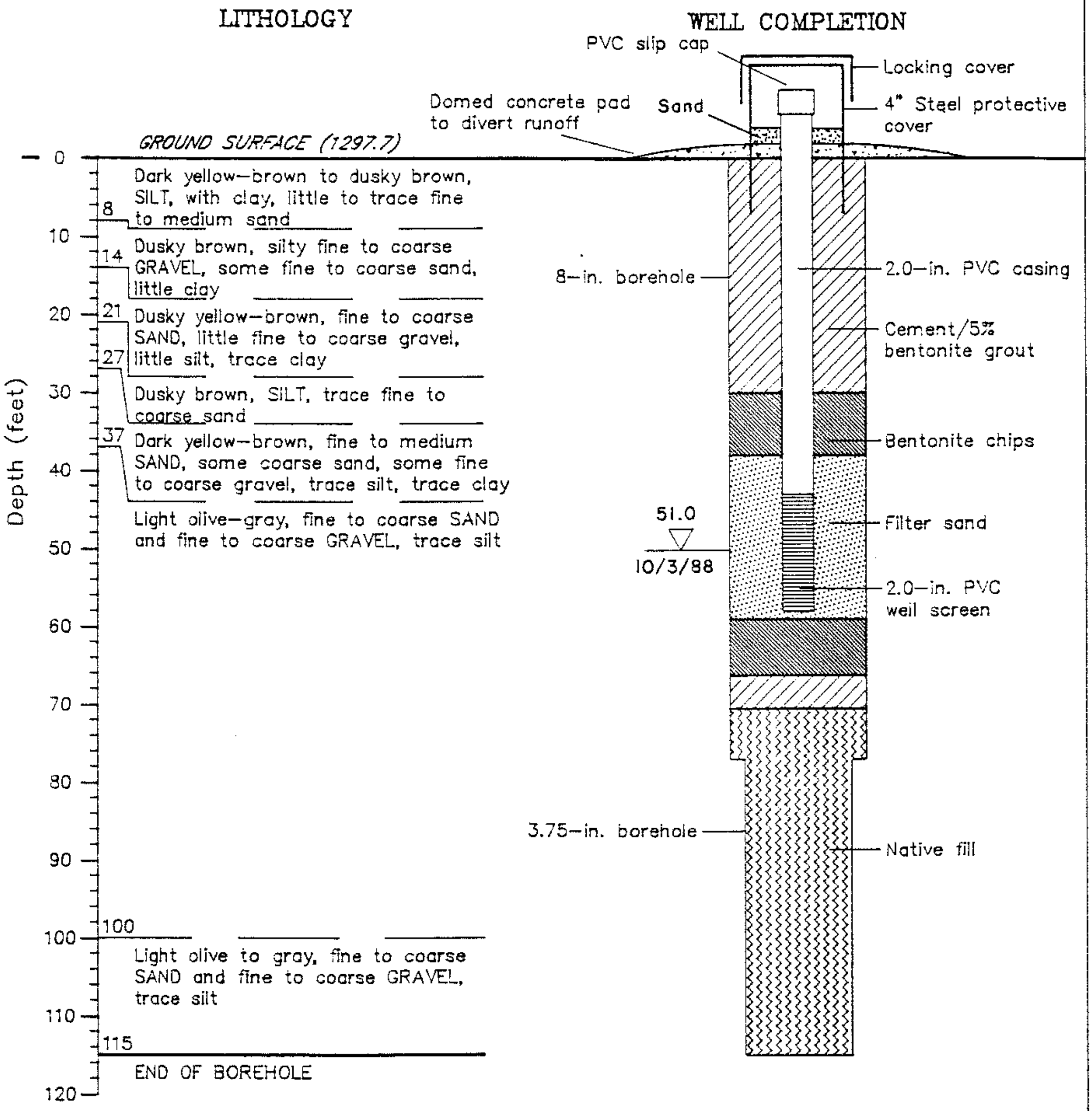
NOT TO SCALE

Date: 8/29/88
Ground Elevation: 1128.4
T.O.C. Elevation: 1131.3
Coordinates:
North: 2,822,583.89
East: 665,584.80

FIGURE **A-16**
WELL **H88-27**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7653 DATE 2/9/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



Dark yellow-brown to dusky brown, SILT, with clay, little to trace fine to medium sand

Dusky brown, silty fine to coarse GRAVEL, some fine to coarse sand, little clay

Dusky yellow-brown, fine to coarse SAND, little fine to coarse gravel, little silt, trace clay

Dusky brown, SILT, trace fine to coarse sand

Dark yellow-brown, fine to medium SAND, some coarse sand, some fine to coarse gravel, trace silt, trace clay

Light olive-gray, fine to coarse SAND and fine to coarse GRAVEL, trace silt

Light olive to gray, fine to coarse SAND and fine to coarse GRAVEL, trace silt

END OF BOREHOLE

LEGEND

⁘	Cement Grout	▯	2.0" Sch. 40 PVC Riser, Flush Threaded
▨	Bentonite Grout	▤	2.0" Sch. 40 PVC Screen 0.020" Slots, Flush Threaded
▩	Bentonite Pellets		
░	Sandpack		
▽	Water Level		

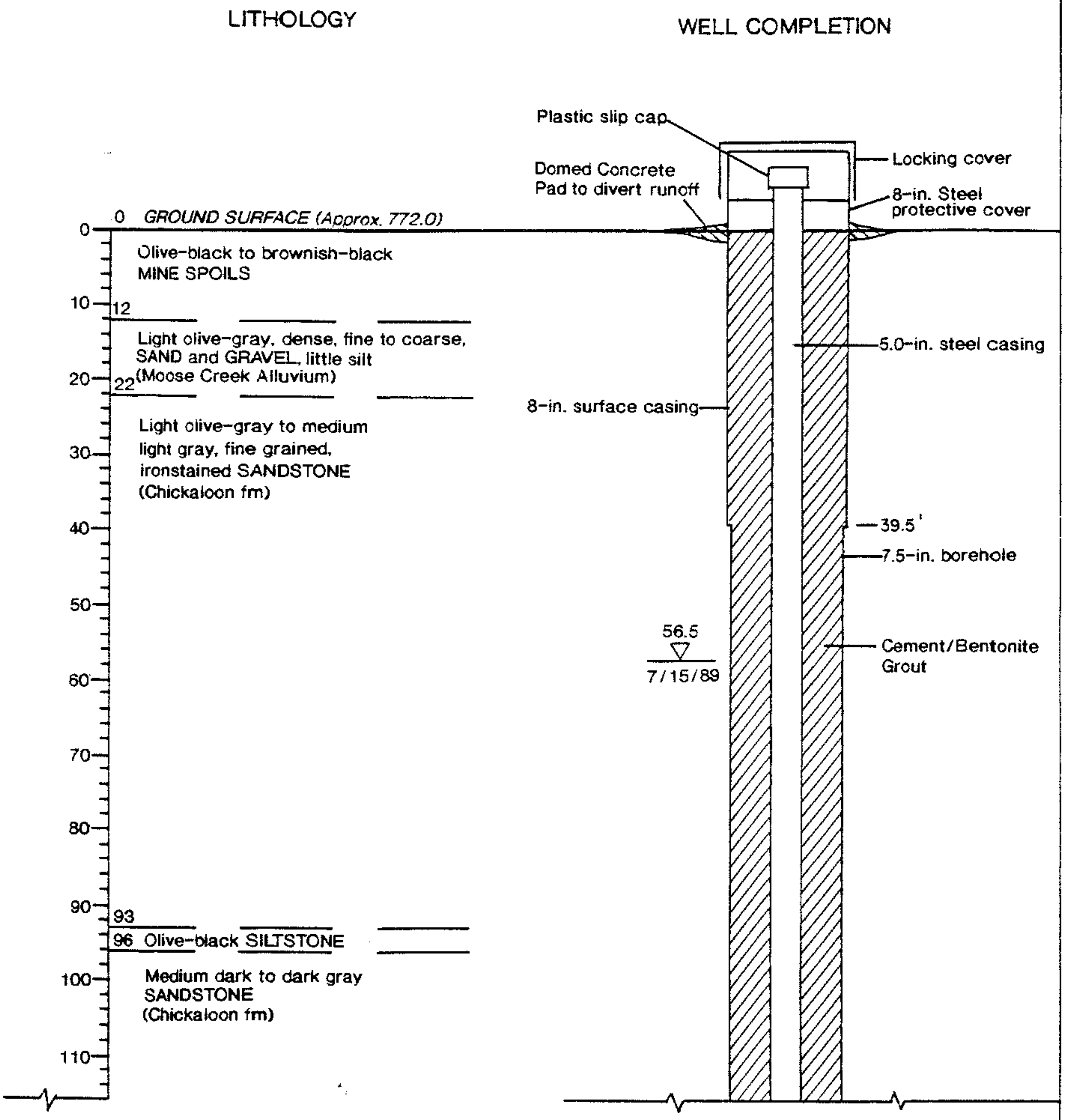
NOT TO SCALE

Date: 10/2/88
Ground Elevation: 1297.7
T.O.C. Elevation: 1300.8
Coordinates:
North: 2,824,330.3
East: 666,403.23

FIGURE **A-17**
WELL **H88-28**
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7822 DATE 2/6/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

▨ Cement Bentonite Grout

▒ Sandpack

▧ Cement Grout

▯ 5.0" Steel

▤ 5.0" Johnson Low Carbon, Stainless Steel 0.050" Slots, Filter Fabric Wrapped

▽ Water Level

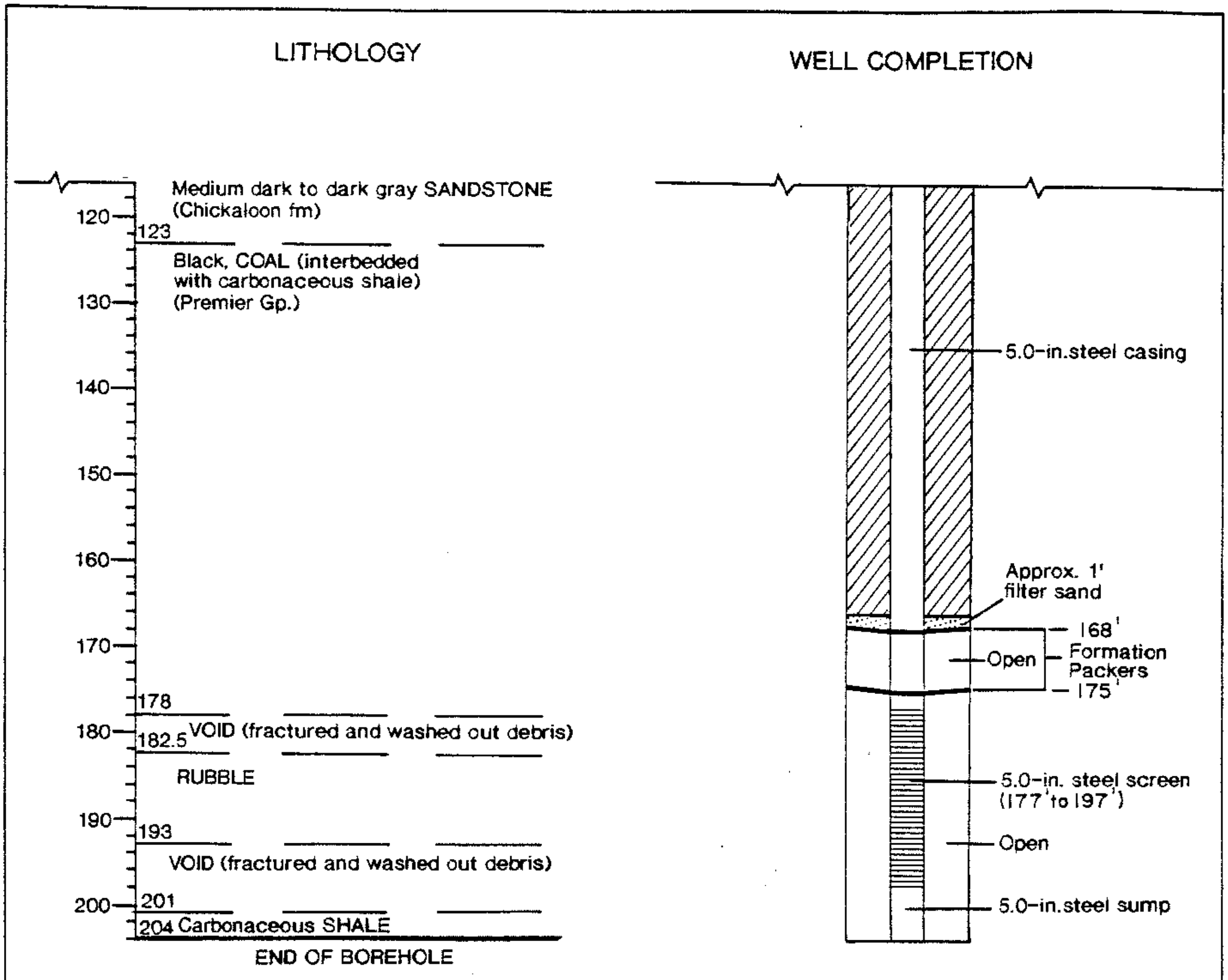
NOT TO SCALE

Date: 7/15/89
Ground Elevation: 772.0 approx.
T.O.C. Elevation:
Coordinates:
North: 2,816,710 approx.
East: 657,500 approx.

FIGURE A-18
WELL H89-29
LITHOLOGY AND WELL COMPLETION
WISHBONE

PROJECT NO 883-2145.1

DATE 8/9/89



LEGEND

▨ Cement Bentonite Grout

░ Sandpack

▧ Cement Grout

▯ 5.0" Steel

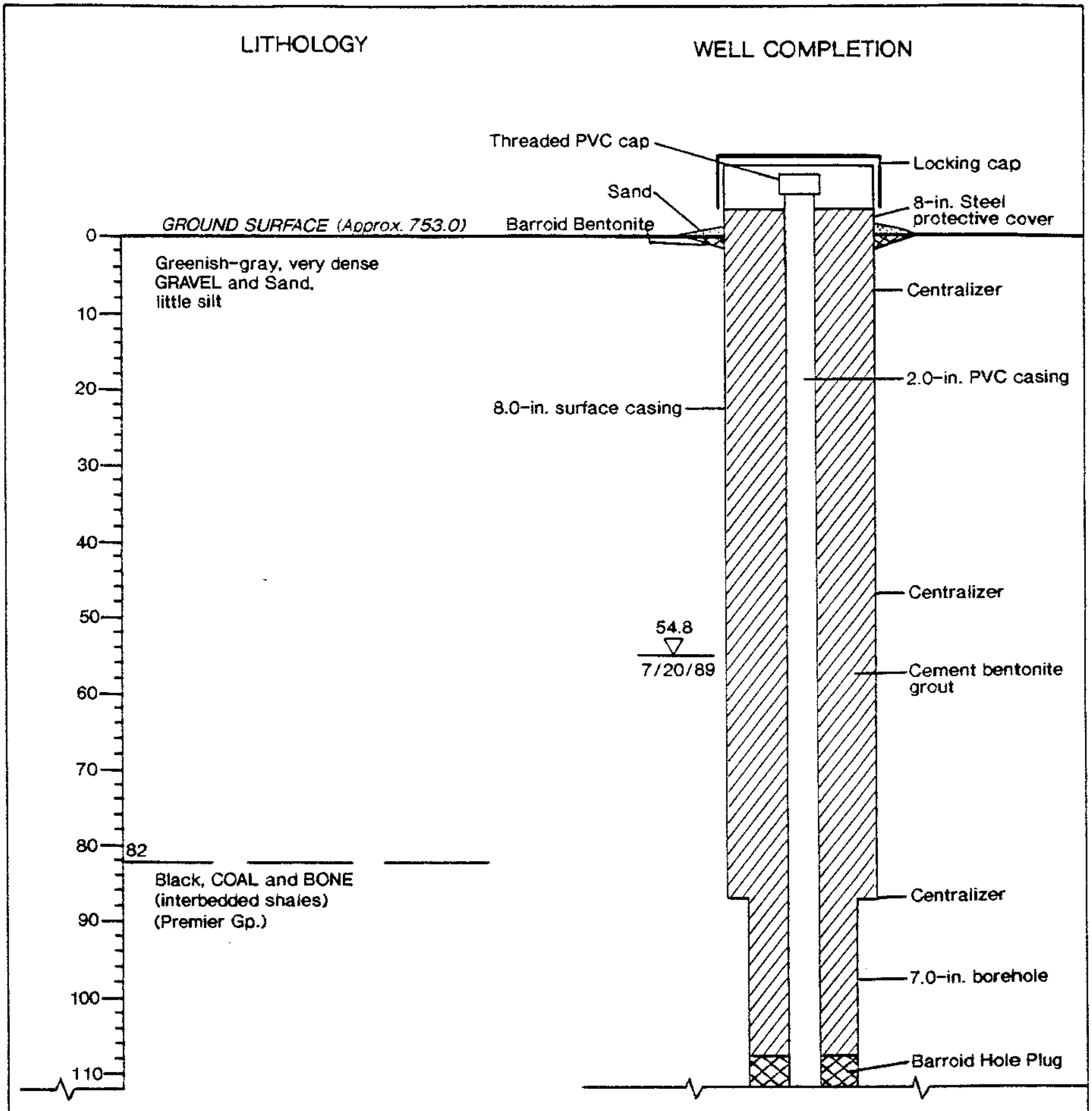
▤ 5.0" Johnson Low Carbon, Stainless Steel. 0.050" Slots, Filter Fabric Wrap

▽ Water Level

NOT TO SCALE

Date: 7/15/89
Ground Elevation: 772.0
T.O.C. Elevation:
Coordinates:
North: 2,816,710
East: 657,500

FIGURE A-18
WELL H89-29
LITHOLOGY AND
WELL COMPLETION (CONT)
WISHBONE



LEGEND

▨ Cement Bentonite Grout

▩ Barroid Hole Plug (Bentonite)

▒ Sandpack

▯ 2.0" Sch. 40 PVC Riser, Flush Threaded

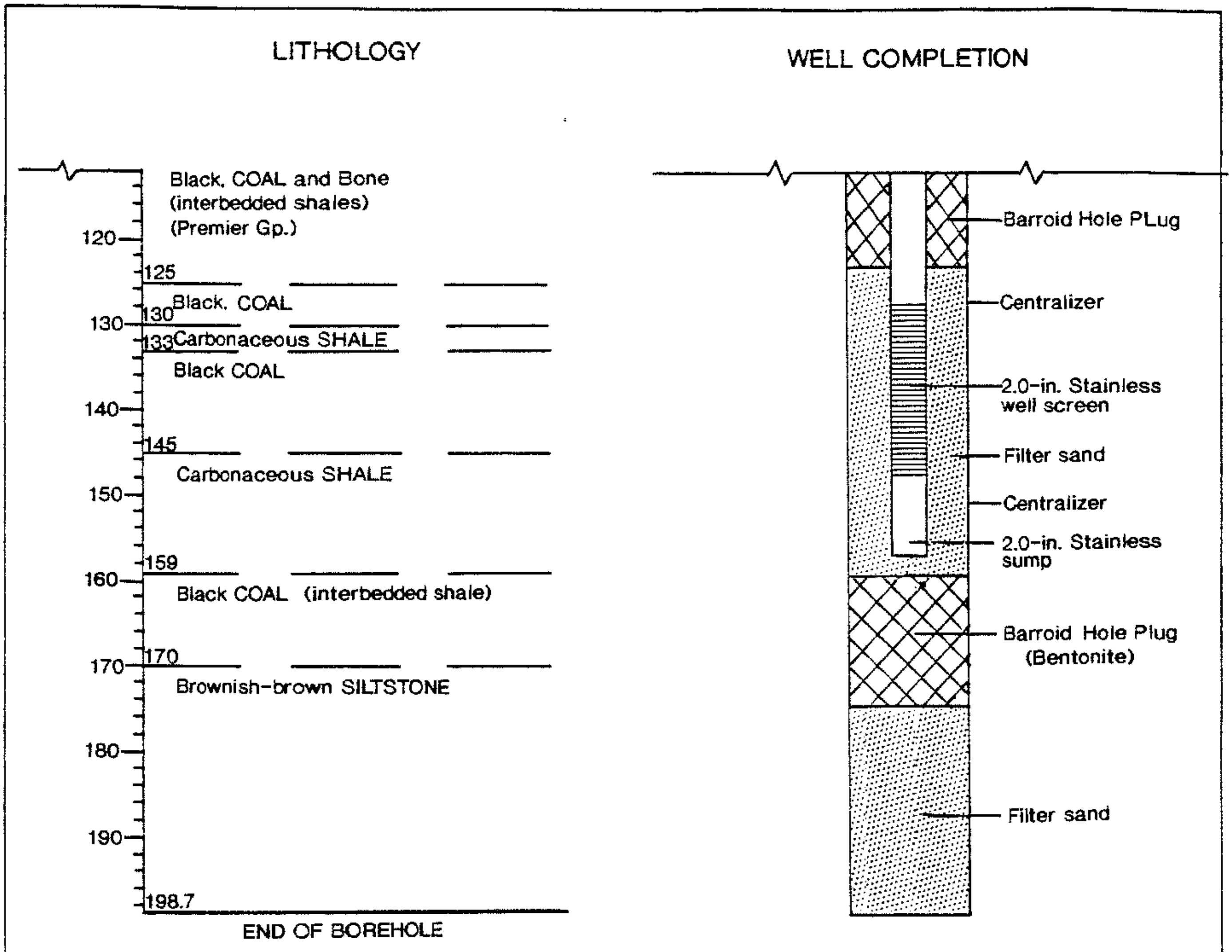
▤ 2.0" Stainless Steel screen, 0.020" slots

▽ Water Level

NOT TO SCALE

Date: 7/20/89
Ground Elevation: 753.0
T.O.C. Elevation:
Coordinates:
North: 2,816,480
East: 656,735

FIGURE A-19
WELL H89-30
LITHOLOGY AND WELL COMPLETION
WISHBONE



LEGEND

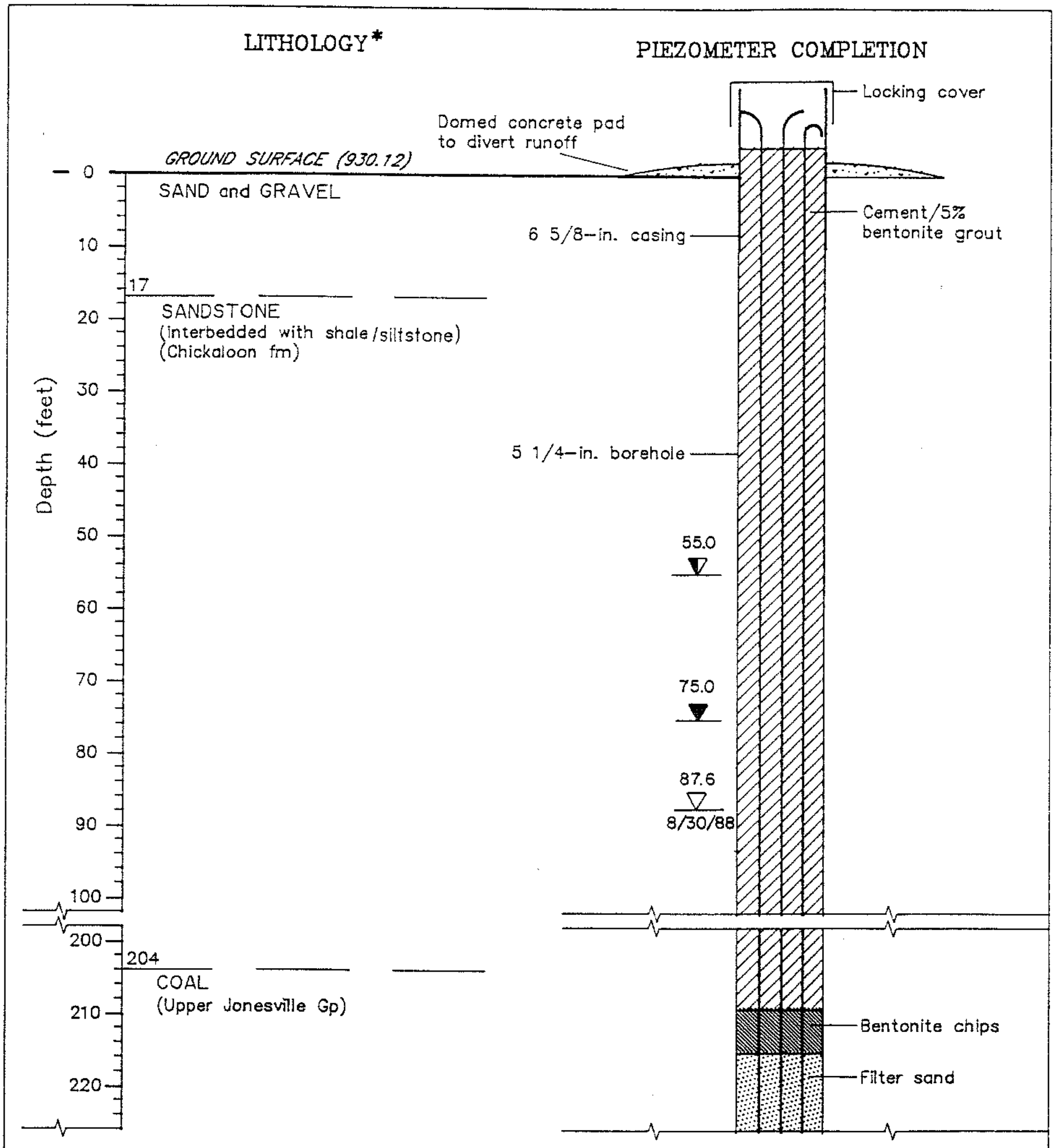
□ Cement Bentonite Grout	▯ 2.0" Sch. 40 PVC Riser, Flush Threaded
▨ Barroid Hole Plug (Bentonite)	
░ Sandpack	▤ 2.0" Stainless steel screen, 0.020" Slots
▽ Water Level	NOT TO SCALE

Date: 7/20/89
Ground Elevation: 753.0
T.O.C. Elevation:
Coordinates:
North: 2,816,480
East: 656,735

FIGURE A-19
WELL H89-30
LITHOLOGY AND
WELL COMPLETION (CONT)
WISHBONE

APPENDIX B

PIEZOMETER COMPLETION AND LITHOLOGY LOGS



LEGEND

░	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▽	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer

*Lithology inferred from geophysical logs

NOT TO SCALE

Date: 8/24/88
Piezometer Elevations:
1)573.12 2)640.12 3)698.12
Coordinates:
North: 2,817,813.89
East: 659,843 .06

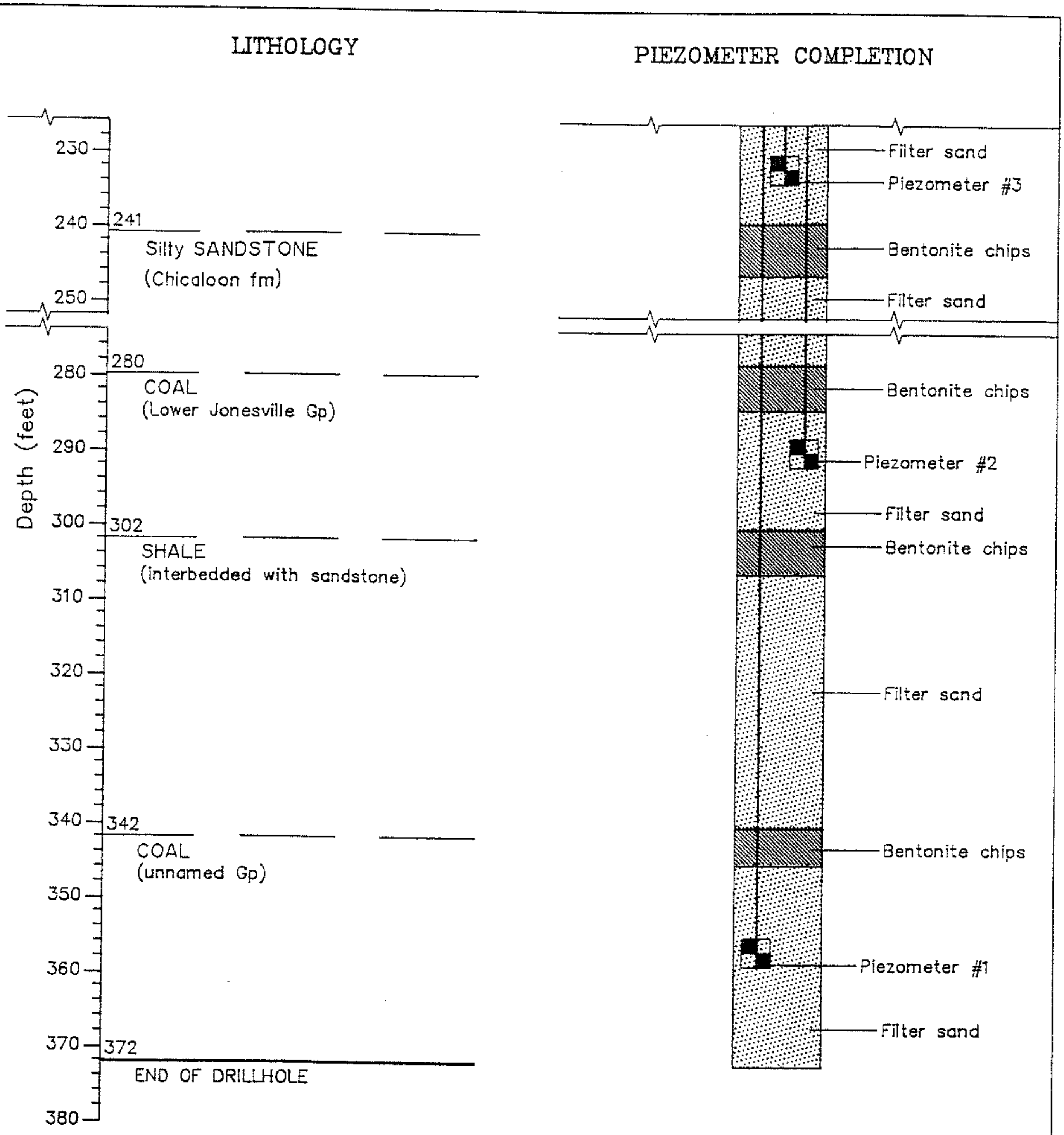
FIGURE **B-1**
WELL **PB-7**

LITHOLOGY AND PIEZOMETER COMPLETION

WISHBONE

PROJECT NO 883-2145 DWG NO 7801 DATE 2/2/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁙	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer

Lithology inferred from geophysical logs

NOT TO SCALE

Date: 8/24/88
Piezometer Elevations:
1)573.12 2)640.12 3)698.12
Coordinates:
North: 2,817,813.89
East: 659,843 .06

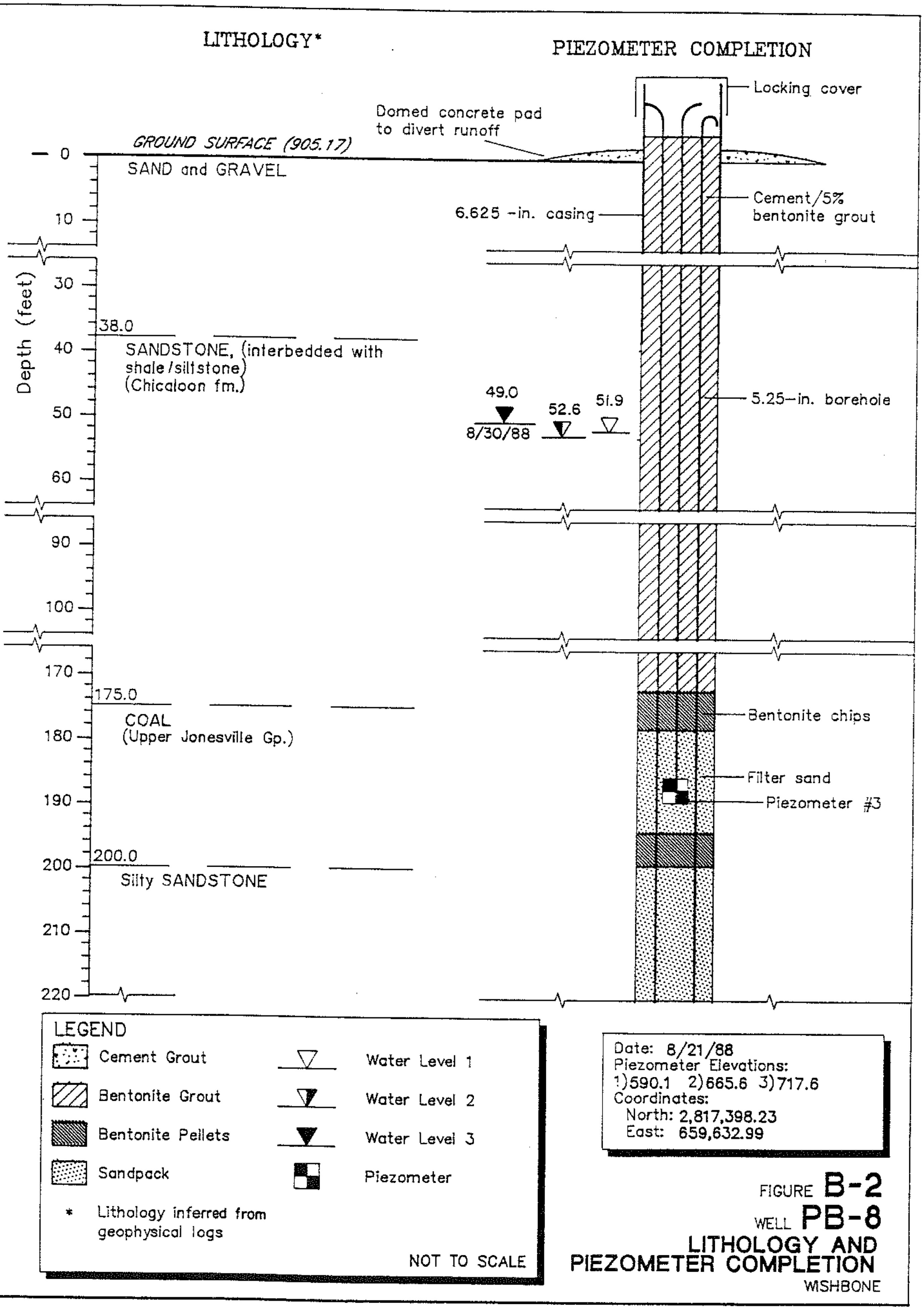
FIGURE **B-1**
WELL **PB-7**

LITHOLOGY AND PIEZOMETER COMPLETION (CONT)

WISHBONE

PROJECT NO 883-2145 DWG NO 7802 DATE 2/2/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



Date: 8/21/88
Piezometer Elevations:
1)590.1 2)665.6 3)717.6
Coordinates:
North: 2,817,398.23
East: 659,632.99

FIGURE **B-2**

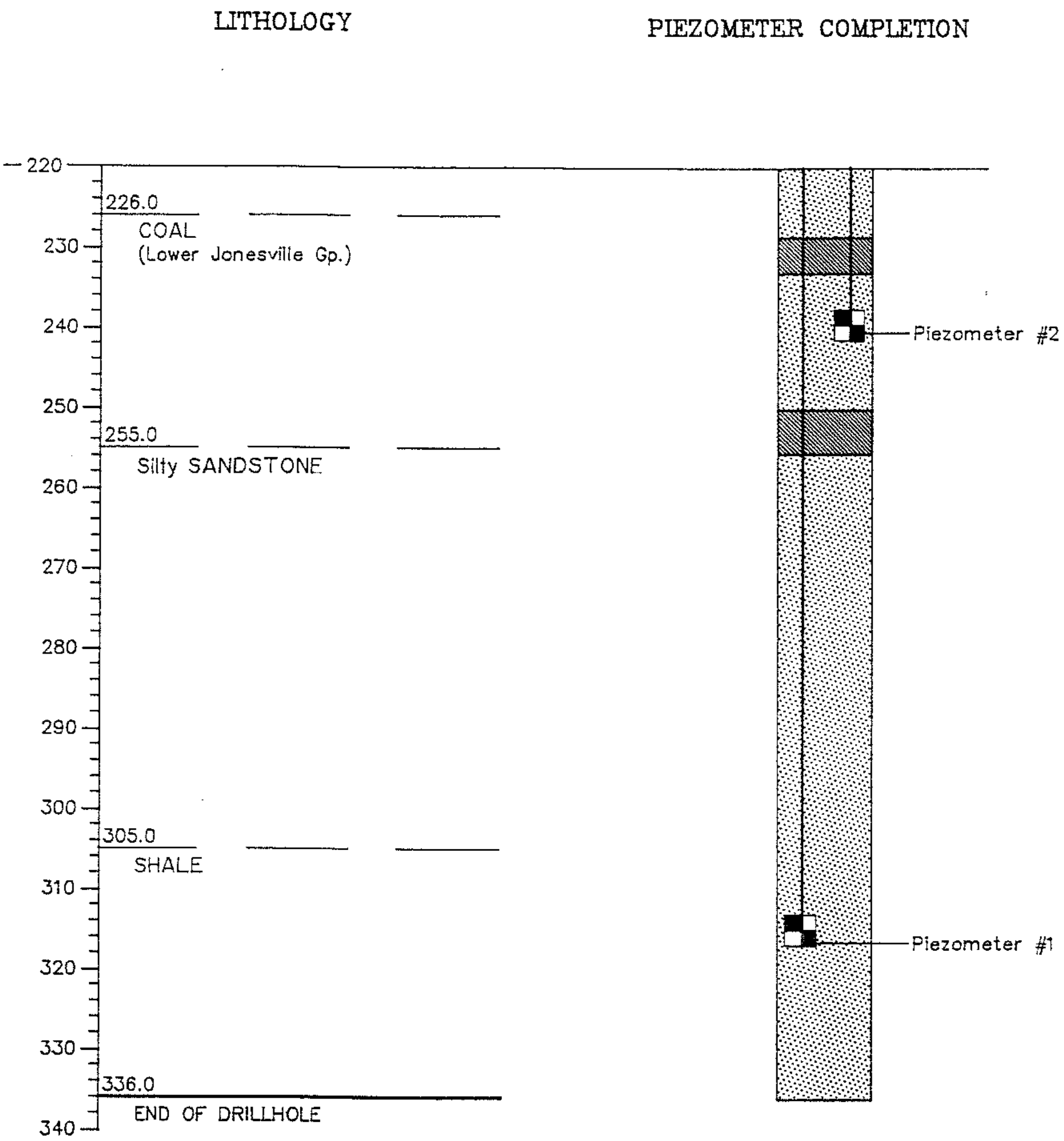
WELL **PB-8**

LITHOLOGY AND PIEZOMETER COMPLETION

WISHBONE

PROJECT NO 883-2145 DWG NO 7626 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



LEGEND

░	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▽	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
▒	Sandpack	▚	Piezometer

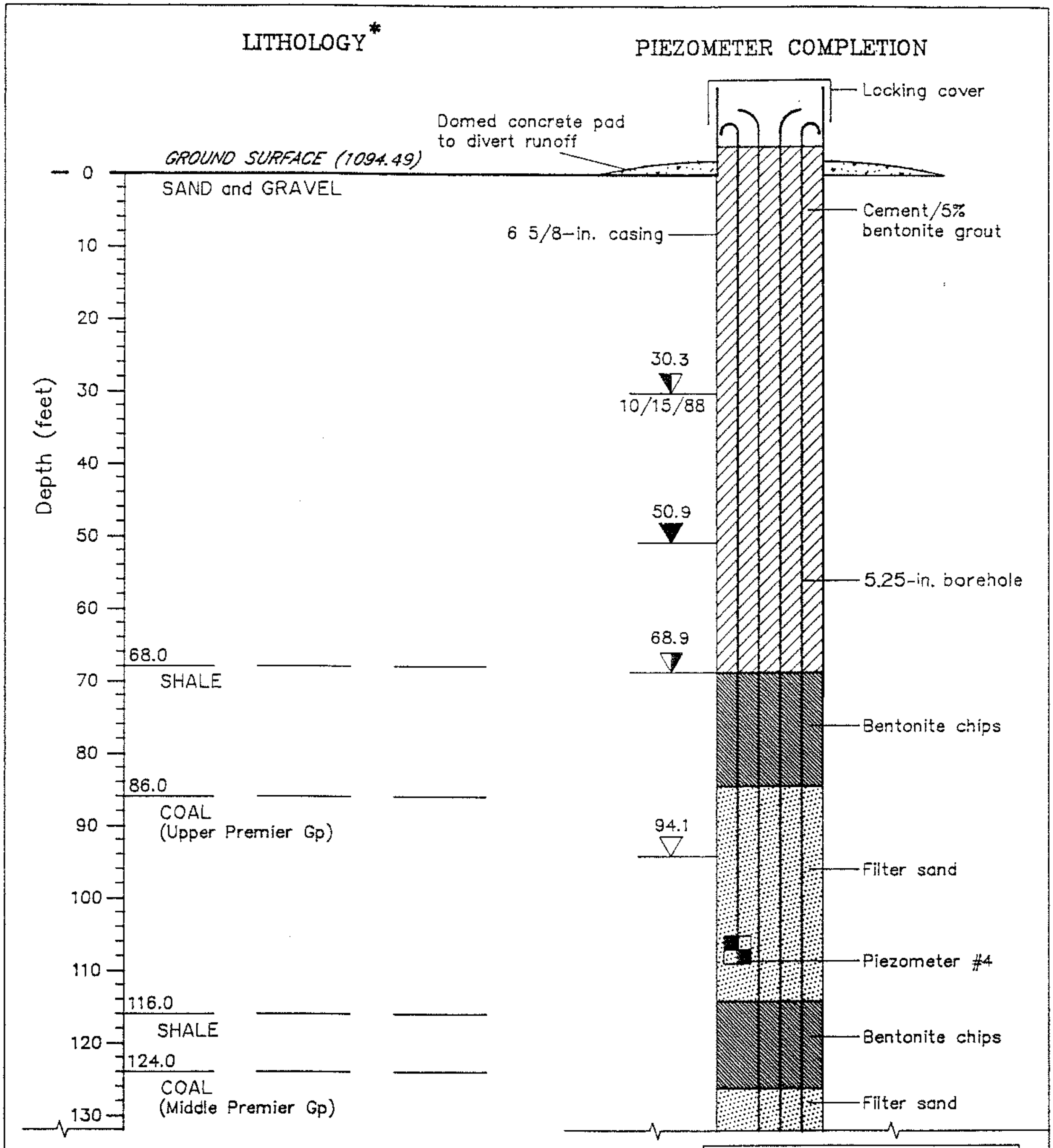
NOT TO SCALE

Date: 8/21/88
Piezometer Elevations:
1)590.1 2)665.6 3)717.6
Coordinates:
North: 2,817,398.23
East: 659,632.99

FIGURE **B-2**
WELL **PB-8**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT)
WISHBONE

PROJECT NO 883-2145 DWG NO 7627 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



* LITHOLOGY INFERRED FROM GEOPHYSICAL LOGS

LEGEND

⁘	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▽	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▼	Water Level 4
▚	Piezometer		

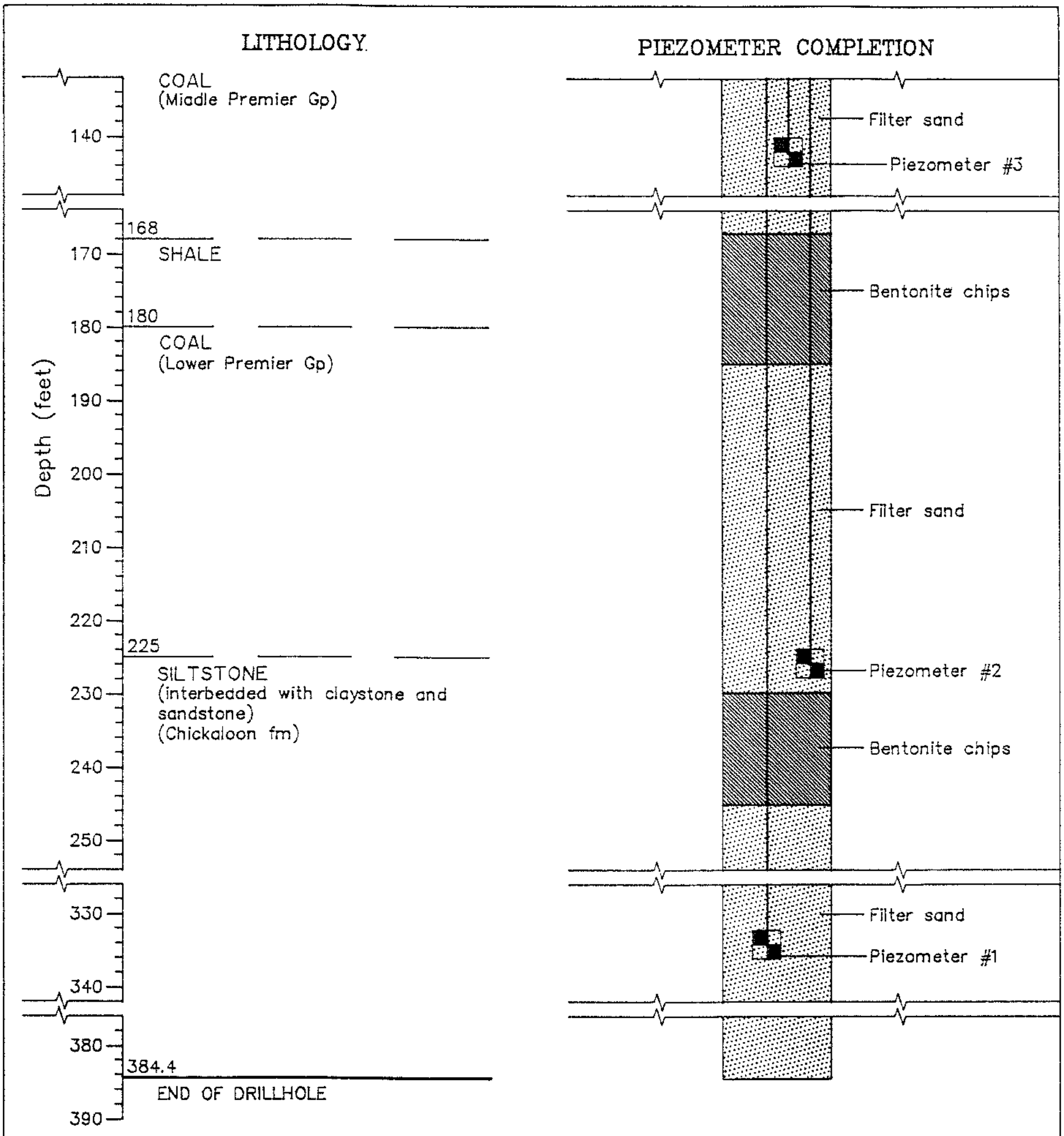
NOT TO SCALE

Date: 10/16/88
Piezometer Elevations:
1)760.3 2)868.7 3)952.5
4)987.5
Coordinates:
North: 2,819,730.03
East: 663,379.74

FIGURE **B-3**
WELL **PB-12**
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7628 DATE 2/3/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁘	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▽	Water Level 2
▩	Bentonite Pellets	▽	Water Level 3
░	Sandpack	▼	Water Level 4
▚	Piezometer		

NOT TO SCALE

Date: 10/16/88
Piezometer Elevations:
1)760.3 2)868.7 3)952.5
4)987.5
Coordinates:
North: 2,819,730.03
East: 663,379.74

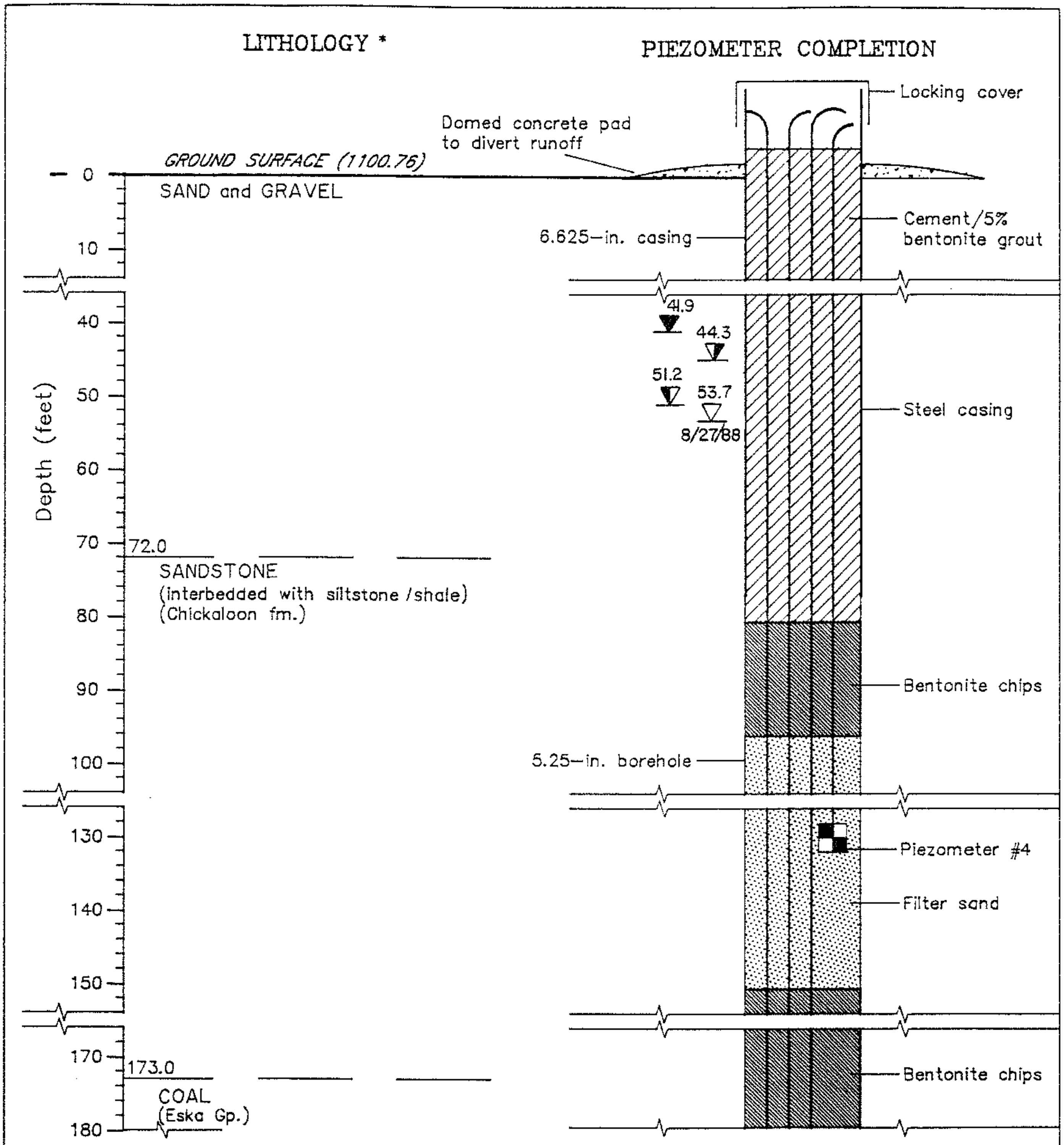
FIGURE **B-3**
WELL **PB-12**

LITHOLOGY AND PIEZOMETER COMPLETION (CONT)

WISHBONE

PROJECT NO 883-2145 DWG NO 7629 DATE 2/3/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



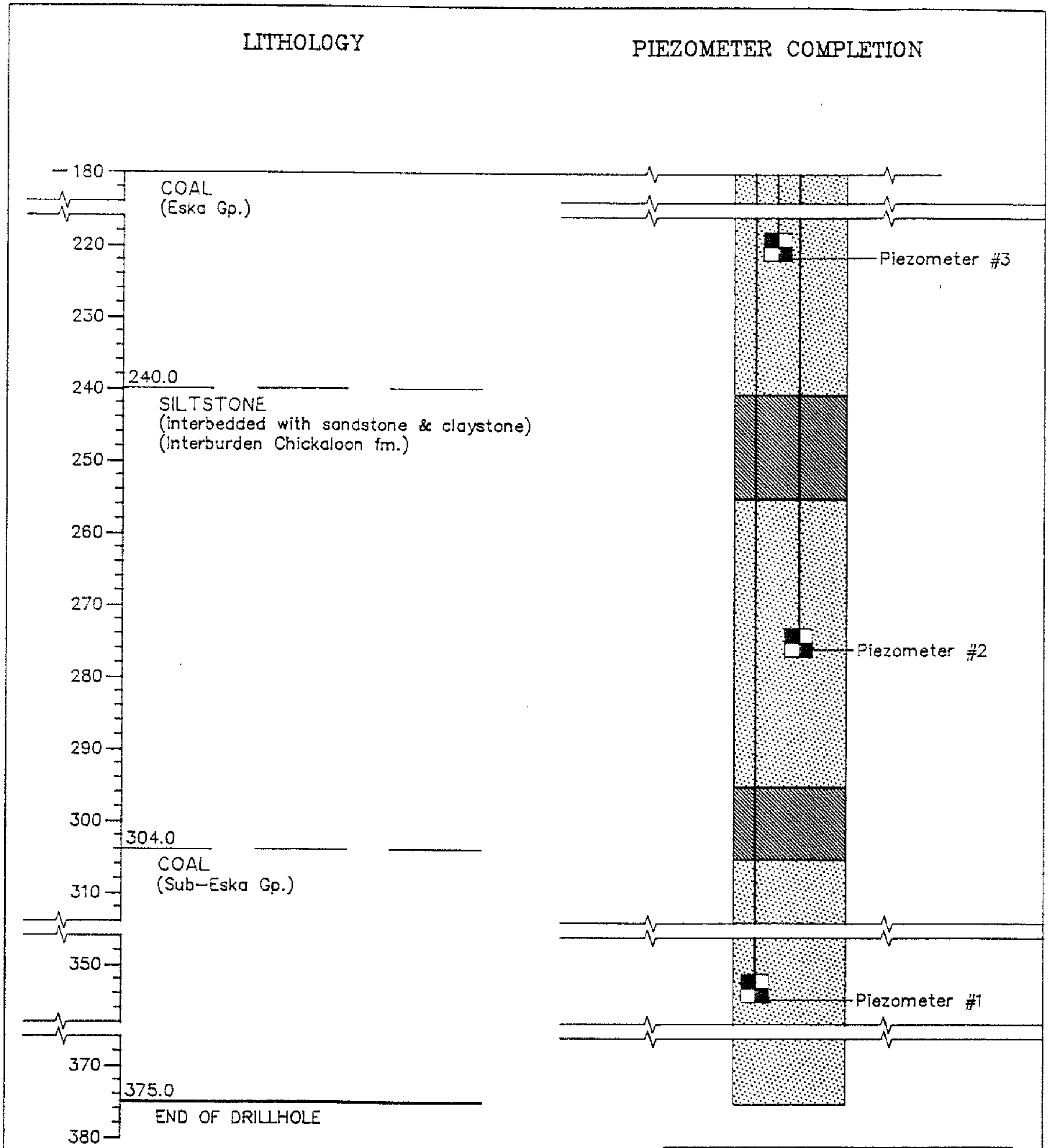
LEGEND

⁘	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▼	Water Level 4
▚	Piezometer		
*	Lithology inferred from geophysical logs		

NOT TO SCALE

Date: 8/22/89
Piezometer Elevations:
1)747.76 2)825.76 3)880.76 4)970.76
Coordinates:
North: 2,819,991.45
East: 663,178.14

FIGURE **B-4**
WELL **PB-13**
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE



LEGEND

⁘	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▼	Water Level 4
▚	Piezometer		

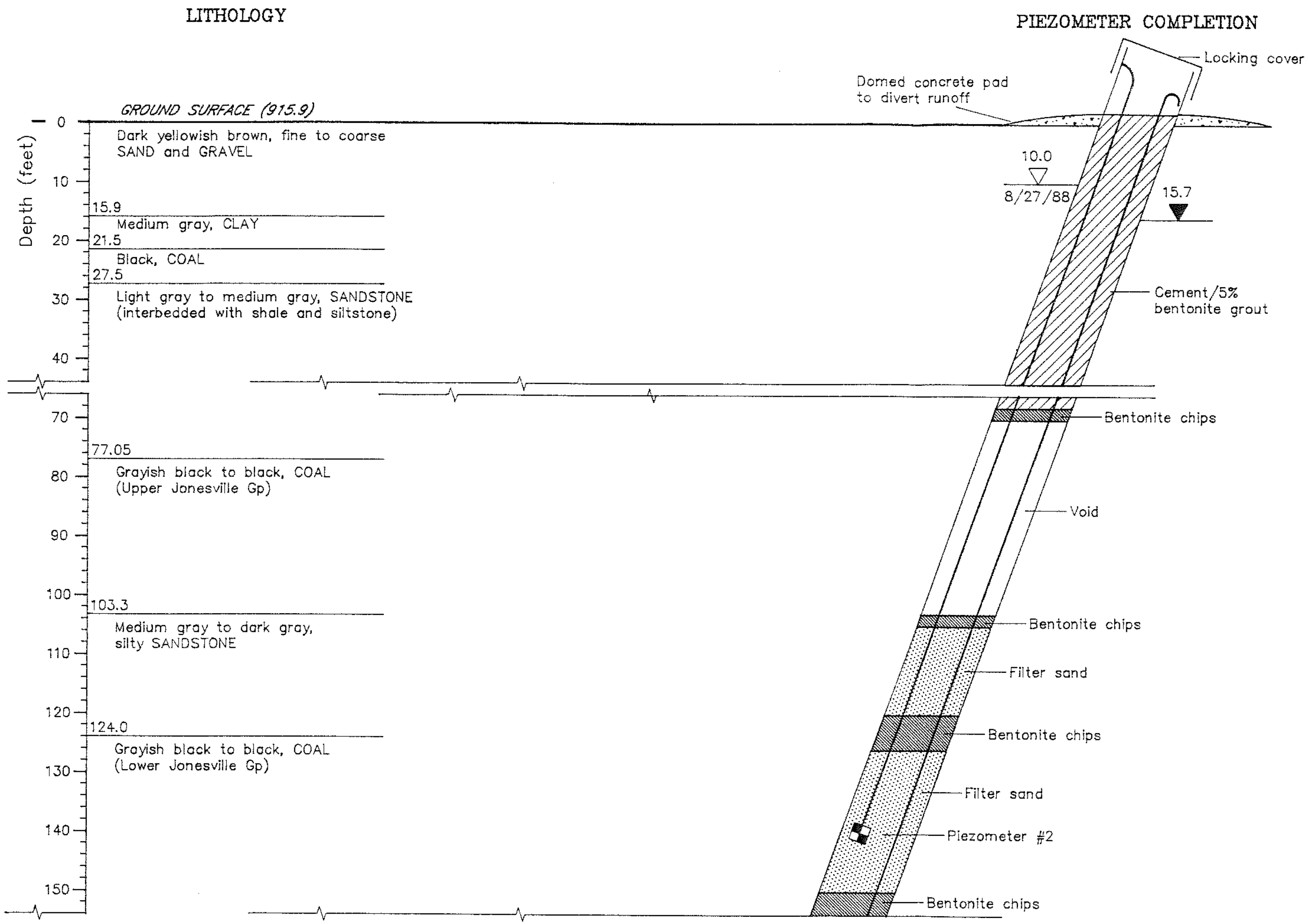
NOT TO SCALE

Date: 8/22/89
Piezometer Elevations:
1)747.76 2)825.76 3)880.76 4)970.76
Coordinates:
North: 2,819,991.45
East: 663,178.14

FIGURE **B-4**
WELL **PB-13**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT)
WISHBONE

PROJECT NO 883-2145 DWG NO 7634 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



Date: 8/14/88
Piezometer Elevations:
1)716.2 2)774.5
Coordinates:
North: 2,817,679.49
East: 659,278.52
Inclination: 70°
Azimuth: 312°

LEGEND

⁘	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer
≋	Cave		

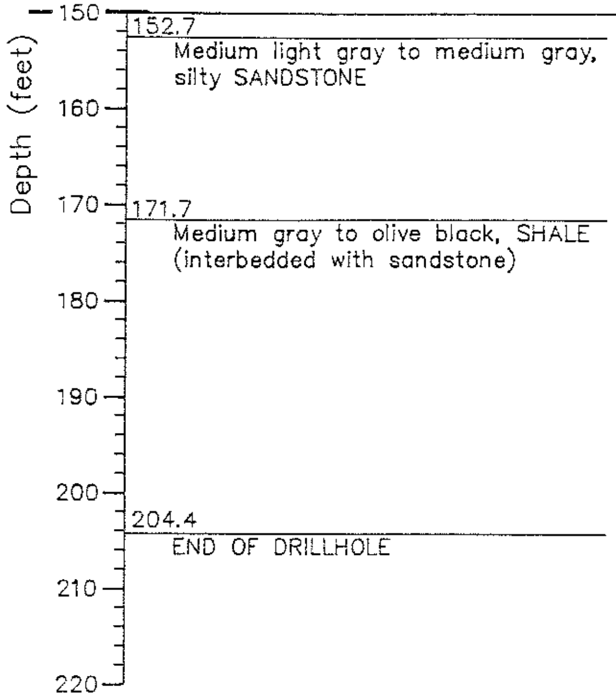
NOT TO SCALE

FIGURE **B-5**
WELL **PB-60**
LITHOLOGY AND
PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 8832145 DWG NO 7609 DATE 2/2/89 DRAWN DJH APPROVED

Golder Associates Inc.

LITHOLOGY

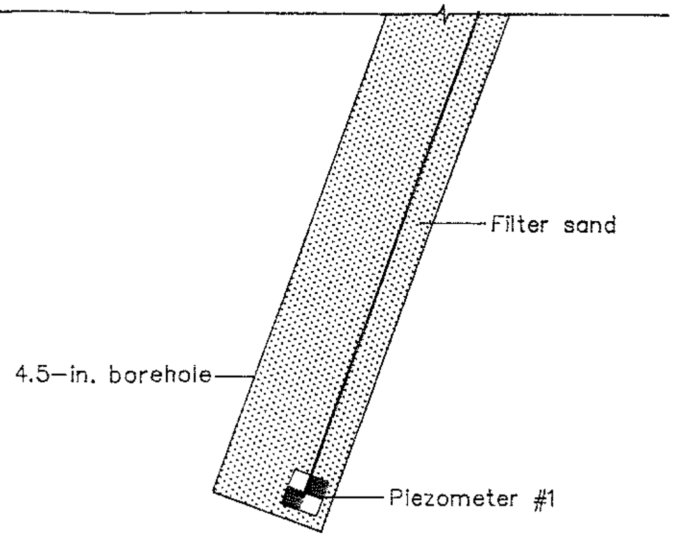


152.7
Medium light gray to medium gray, silty SANDSTONE

171.7
Medium gray to olive black, SHALE (interbedded with sandstone)

204.4
END OF DRILLHOLE

PIEZOMETER COMPLETION



Date: 8/14/88
Piezometer Elevations:
1)716.2 2)774.5
Coordinates:
North: 2,817,679.49
East: 659,278.52
Inclination: 70°
Azimuth: 312°

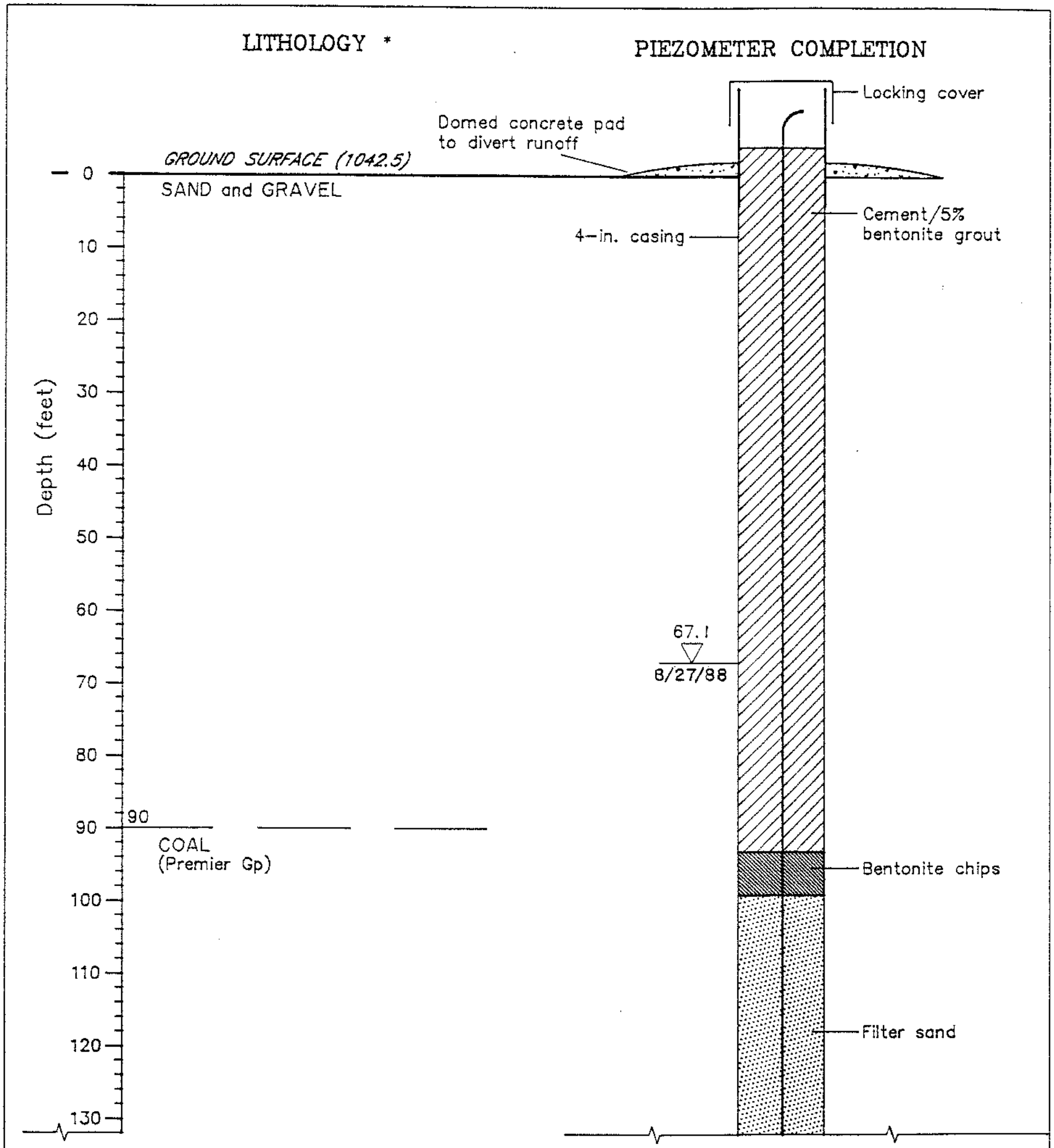
LEGEND

⁘	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▽	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer
≋	Cave		NOT TO SCALE

FIGURE **B-5**
WELL **PB-60**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT))
WISHBONE

PROJECT NO 883–2145 DWG NO 7610 DATE 2/2/89 DRAWN DJH APPROVED

Golder Associates Inc.



LEGEND

▨	Cement Grout
▨	Bentonite Grout
▨	Bentonite Pellets
▨	Sandpack
*	Lithology inferred from geophysical logs
▽	Water Level 1
▚	Piezometer

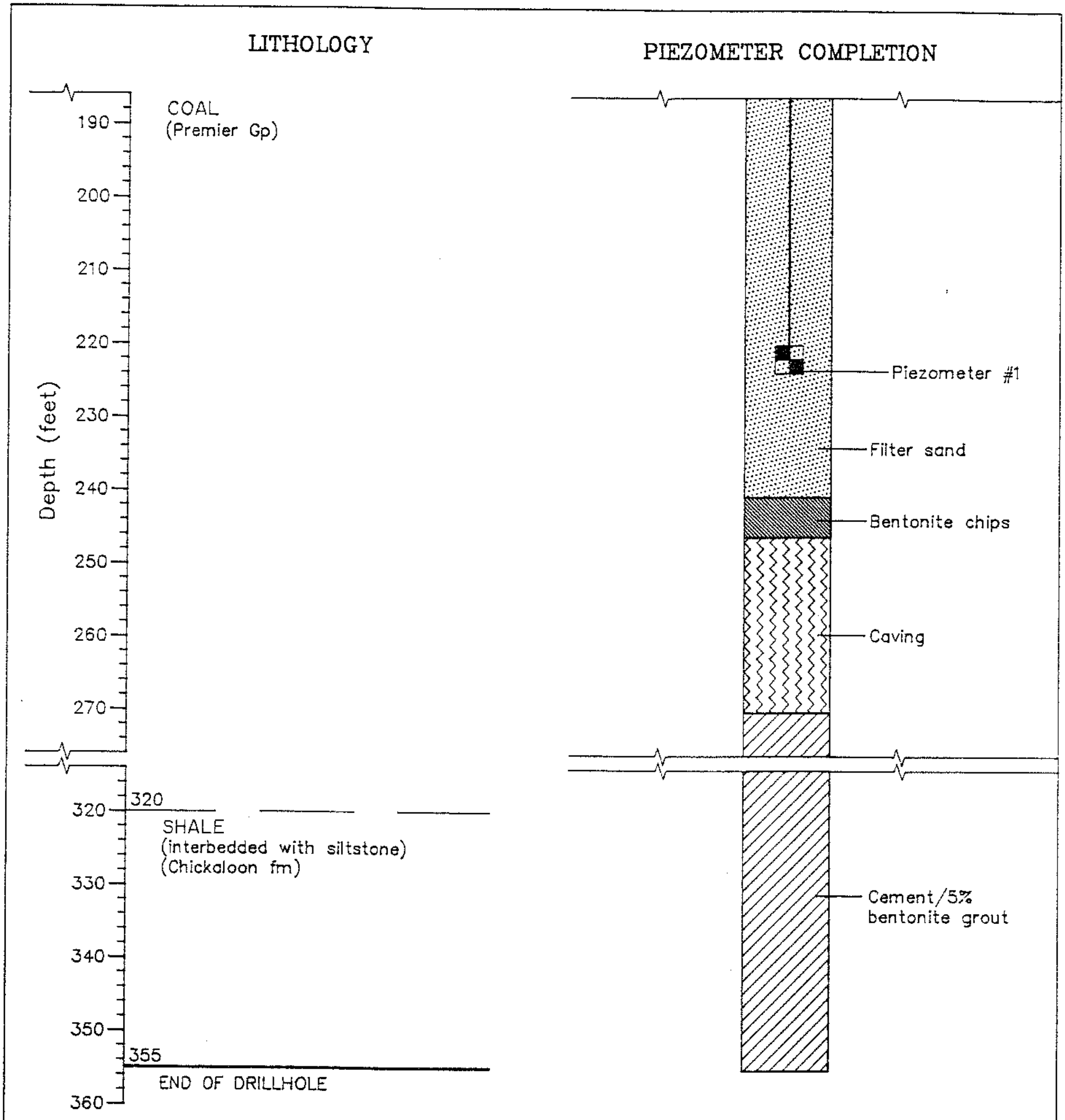
NOT TO SCALE

Date: 8/5/88
Piezometer Elevations:
1)820.8
Coordinates:
North: 2,819,015.36
East: 663,561.00

FIGURE **B-6**
WELL **PB-88**
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7632 DATE 2/3/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

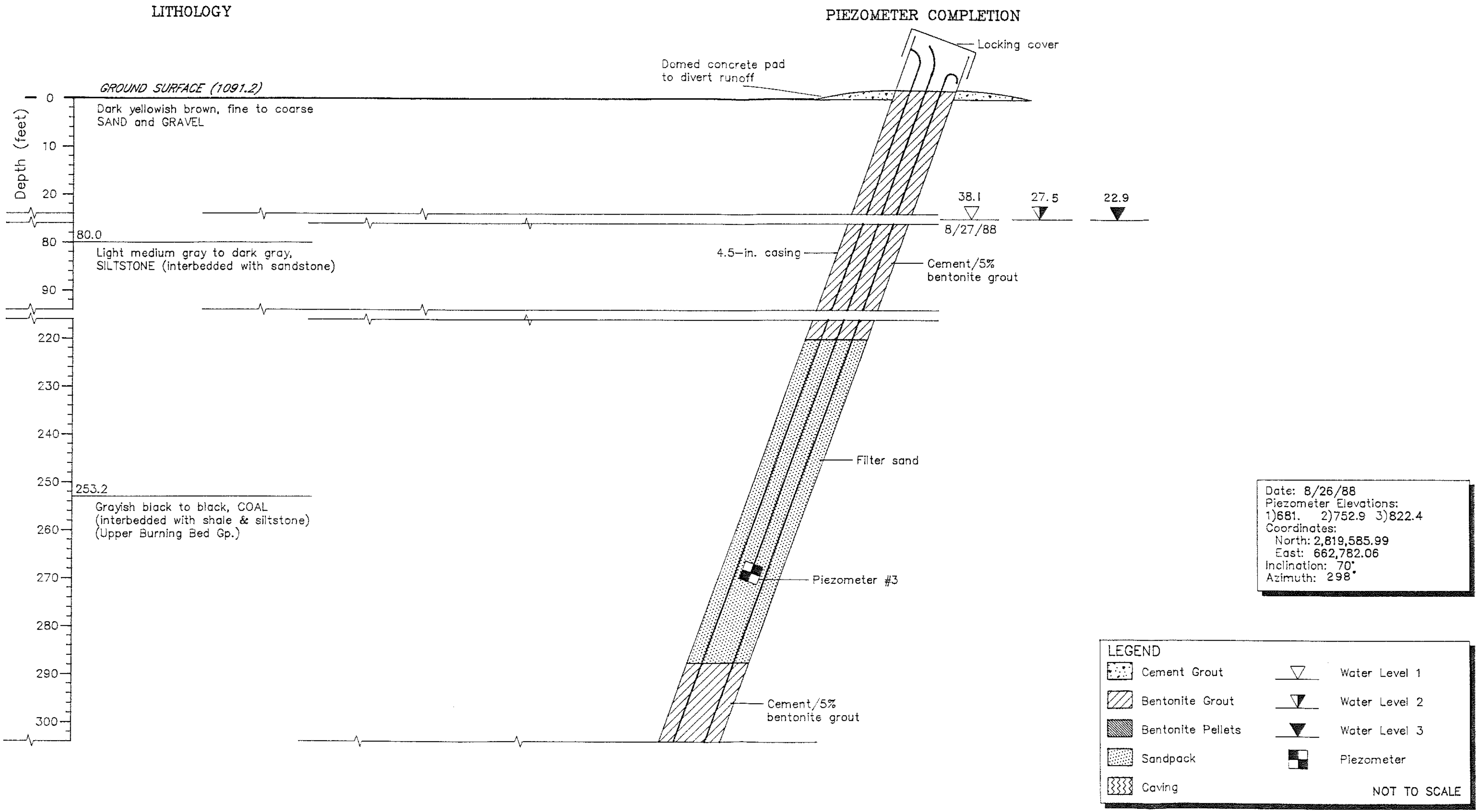
- ⁘ Cement Grout
- ▽ Water Level 1
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ▒ Sandpack
- ▚ Piezometer

Lithology inferred from geophysical logs NOT TO SCALE

Date: 8/5/88
Piezometer Elevations:
1)820.8
Coordinates:
North: 2,819,015.36
East: 663,561.00

FIGURE **B-6**
WELL **PB-88**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT)
WISHBONE

PROJECT NO 883-2145 DWG NO 7635 DATE 2/3/89 DRAWN JSS APPROVED RM **Golder Associates Inc.**



Date: 8/26/88
Piezometer Elevations:
1)681. 2)752.9 3)822.4
Coordinates:
North: 2,819,585.99
East: 662,782.06
Inclination: 70°
Azimuth: 298°

FIGURE **B-7**

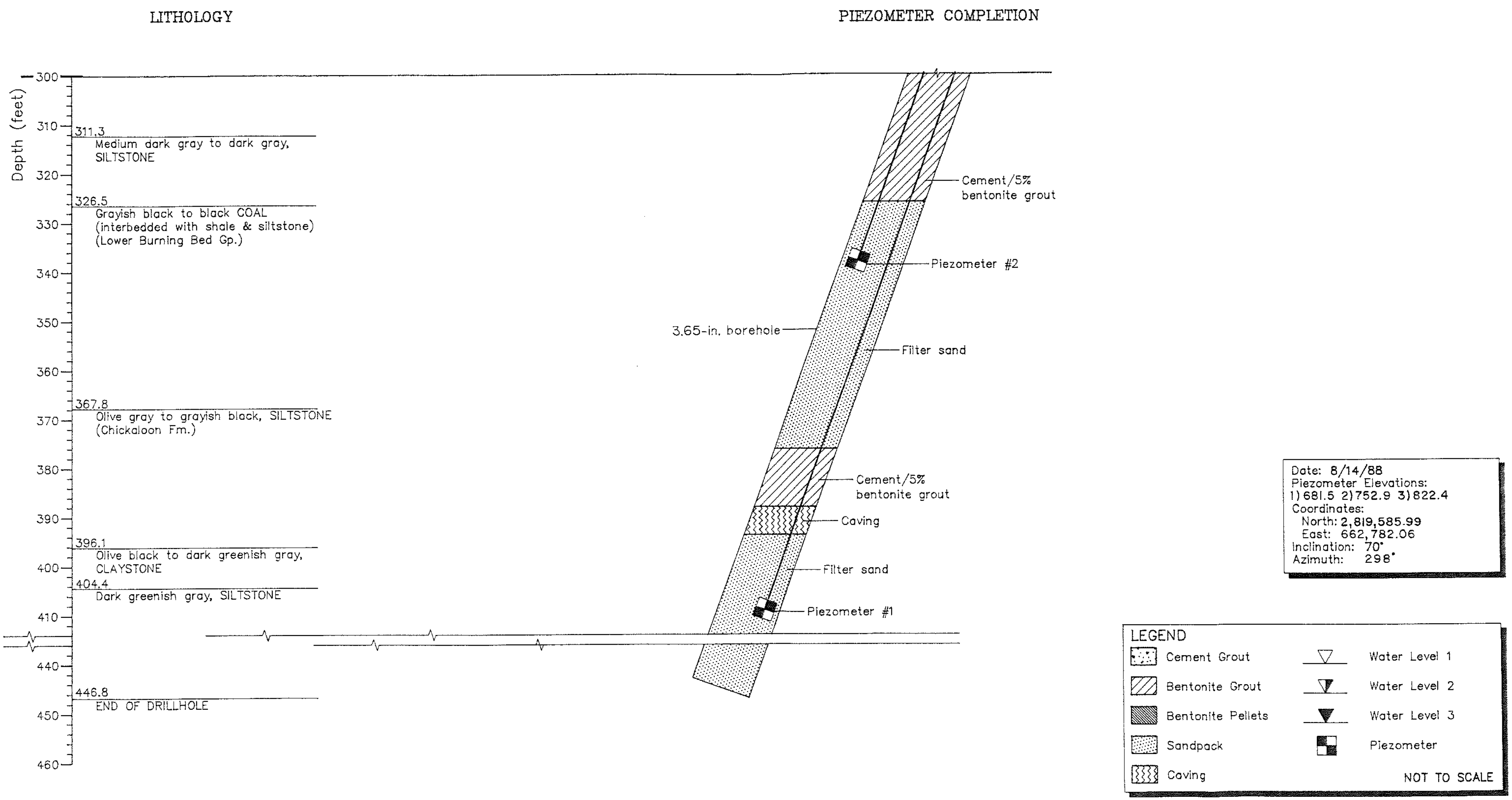
WELL **PB-92**

LITHOLOGY AND PIEZOMETER COMPLETION

WISHBONE HILL

PROJECT NO 883-2145 DWG NO 7611 DATE 2/2/89 DRAWN DJH APPROVED

Golder Associates Inc.

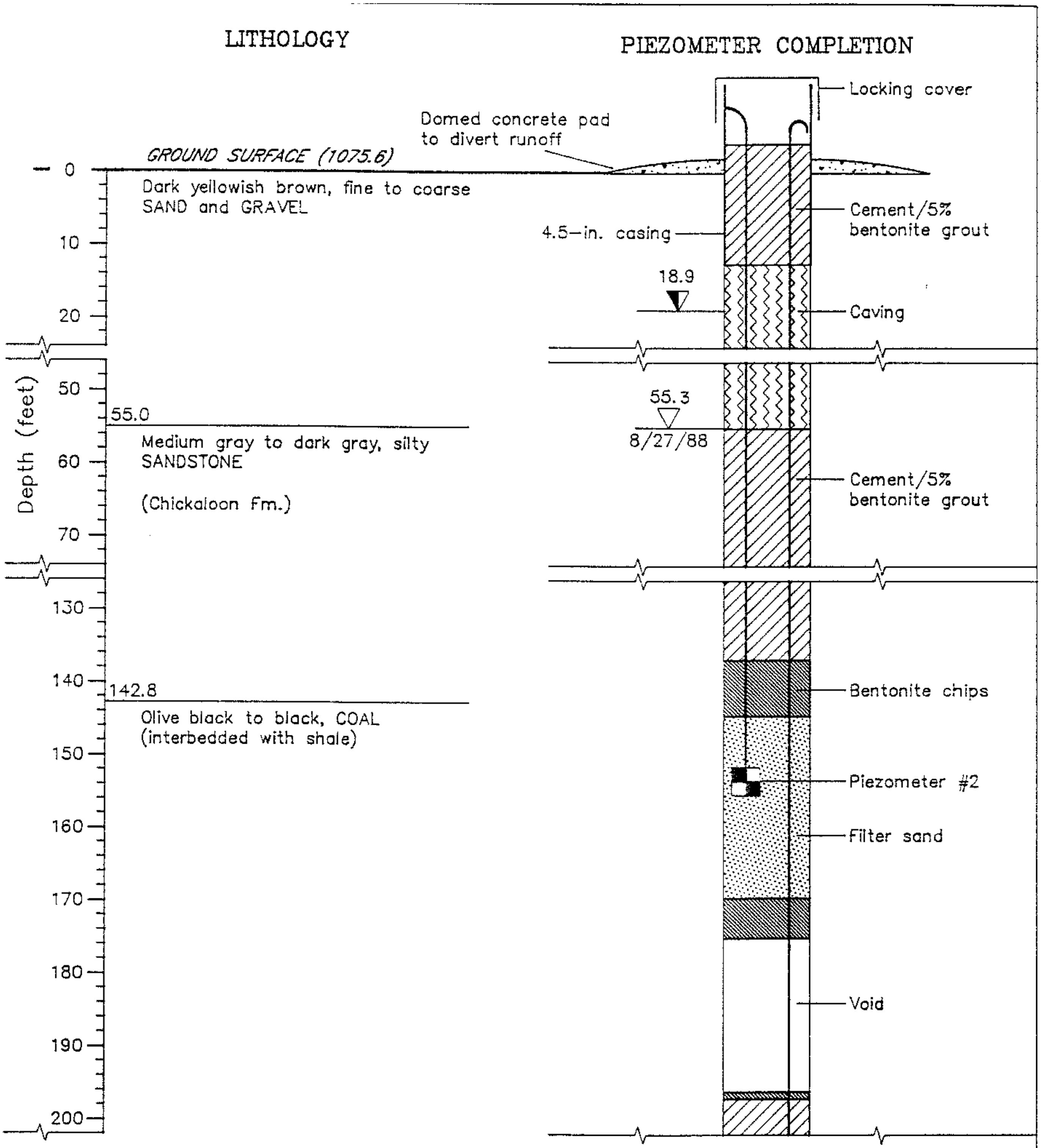


Date: 8/14/88
Piezometer Elevations:
1) 681.5 2) 752.9 3) 822.4
Coordinates:
North: 2,819,585.99
East: 662,782.06
Inclination: 70°
Azimuth: 298°

FIGURE **B-7**
WELL **PB-92**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT))
WISHBONE

PROJECT NO 8832145 DWG NO 7612 DATE 2/2/89 DRAWN DJH APPROVED

Golder Associates Inc.



LEGEND

░	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▚	Piezometer
░	Sandpack		

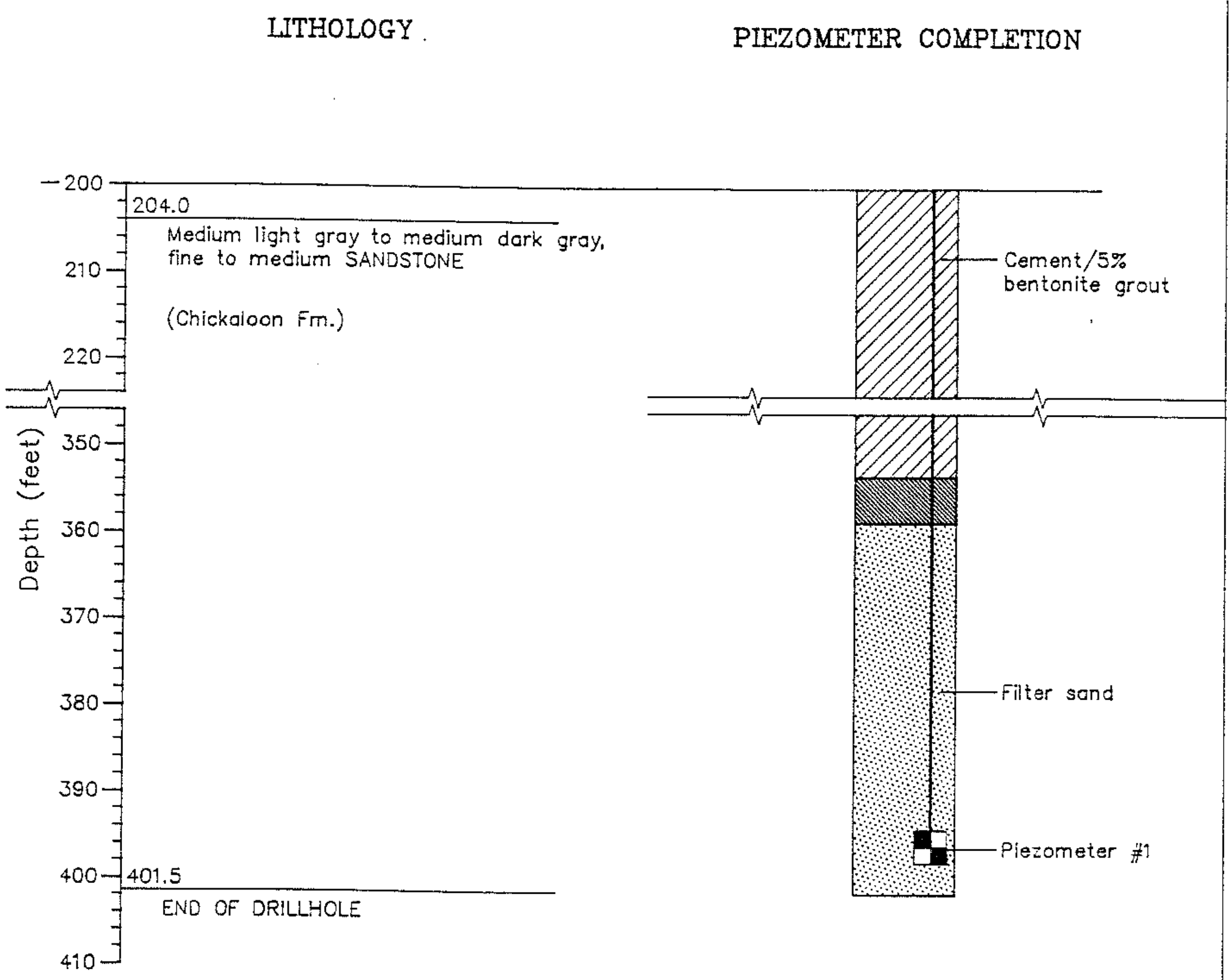
NOT TO SCALE

Date: 7/14/88
Piezometer Elevations:
1)679.6 2)922.1
Coordinates:
North: 2,818,870.12
East: 662,551.53

FIGURE B-8
WELL PB-100
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 883–2145 DWG NO 7616 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



LEGEND

▨	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▚	Piezometer
▨	Sandpack		

NOT TO SCALE

Date: 7/14/88
Piezometer Elevations:
1)679.6 2)922.1
Coordinates:
North: 2,818,870.12
East: 662,551.53

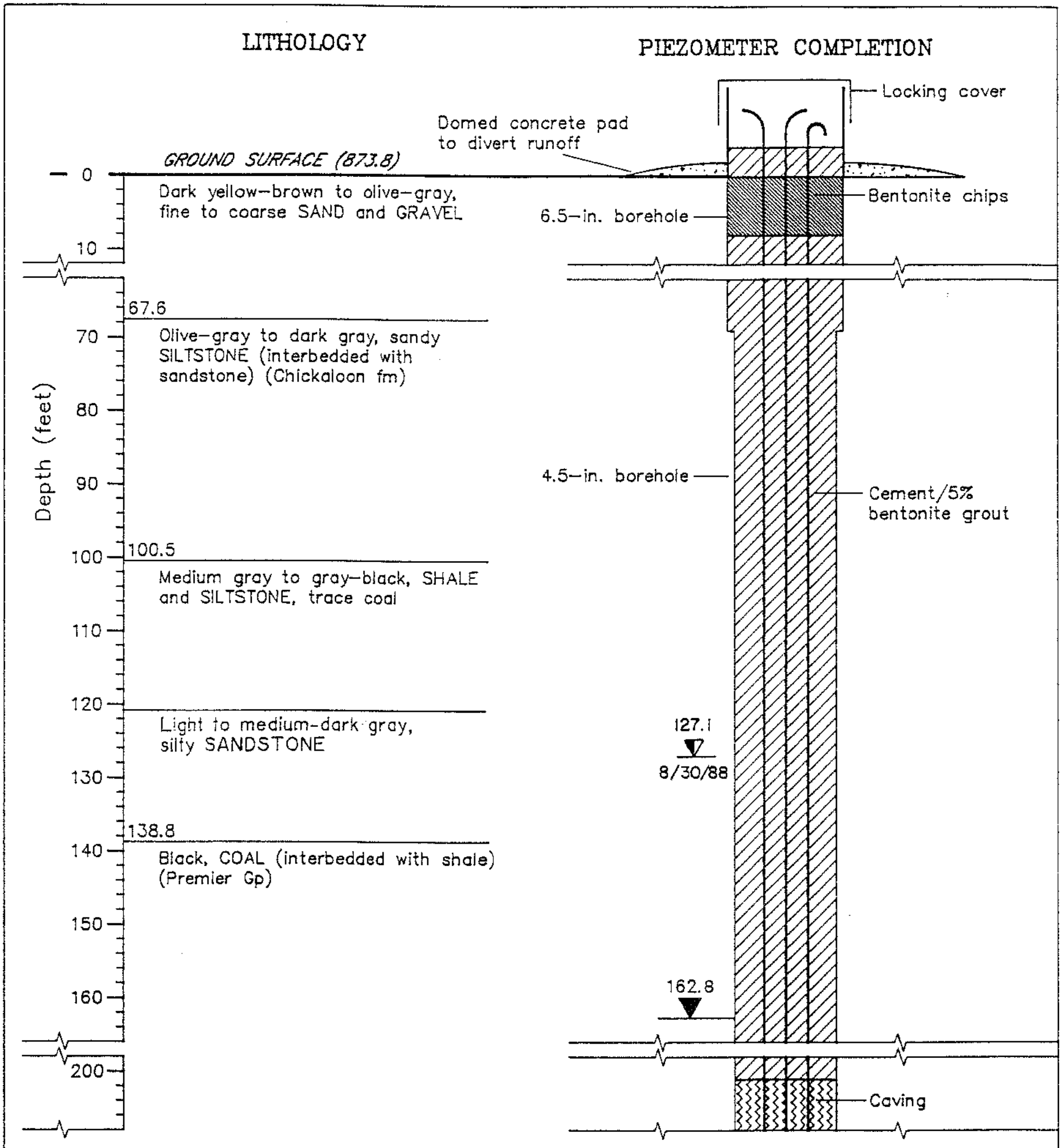
FIGURE **B-8**
WELL **PB-100**

LITHOLOGY AND PIEZOMETER COMPLETION (CONT)

WISHBONE

PROJECT NO 883-2144 DWG NO 7617 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



LEGEND

▒	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer

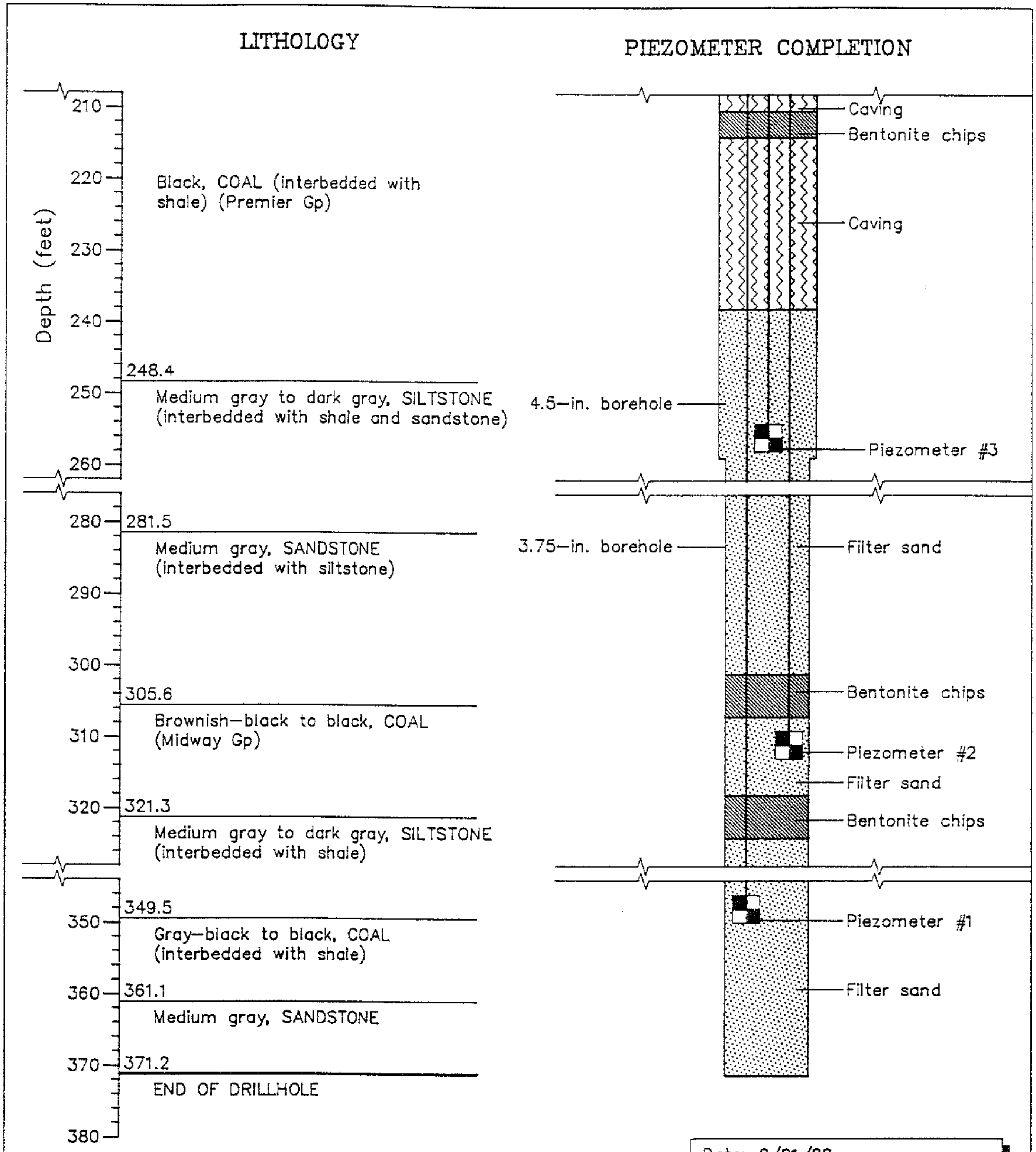
NOT TO SCALE

Date: 8/21/88
Piezometer Elevations:
1)525.8 2)562.3 3)617.8
Coordinates:
North: 2,817,050.15
East: 658,081.00

FIGURE **B-9**
WELL **PB-101**
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7816 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



LITHOLOGY

PIEZOMETER COMPLETION

LEGEND

⁘	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer

NOT TO SCALE

Date: 8/21/88
Piezometer Elevations:
1)525.8 2)562.3 3)617.8
Coordinates:
North: 2,817,050.15
East: 658,081.00

FIGURE **B-9**

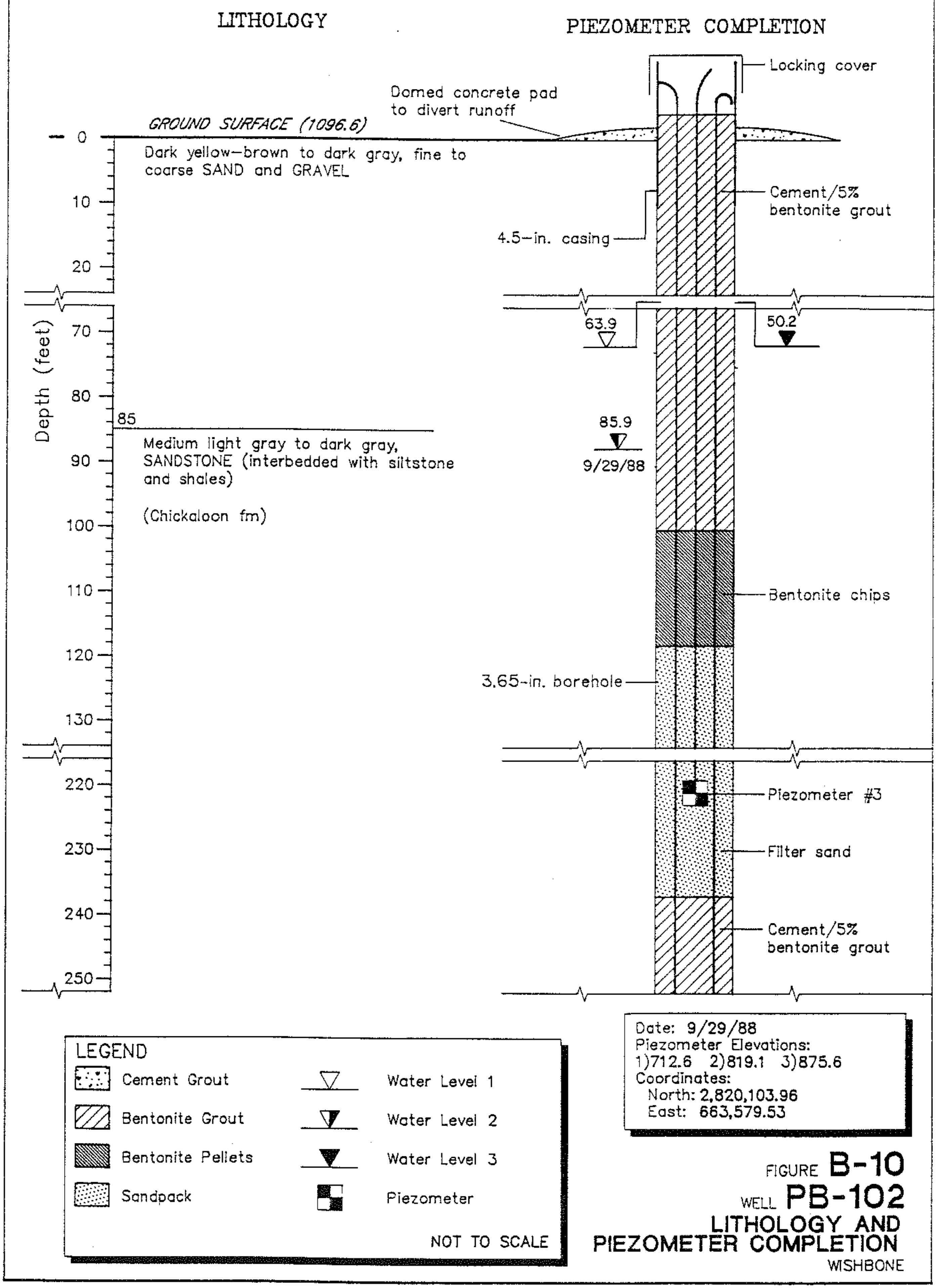
WELL **PB-101**

LITHOLOGY AND PEIZOMETER COMPLETION (CONT)

WISHBONE

PROJECT NO 883–2145 DWG NO 7817 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.

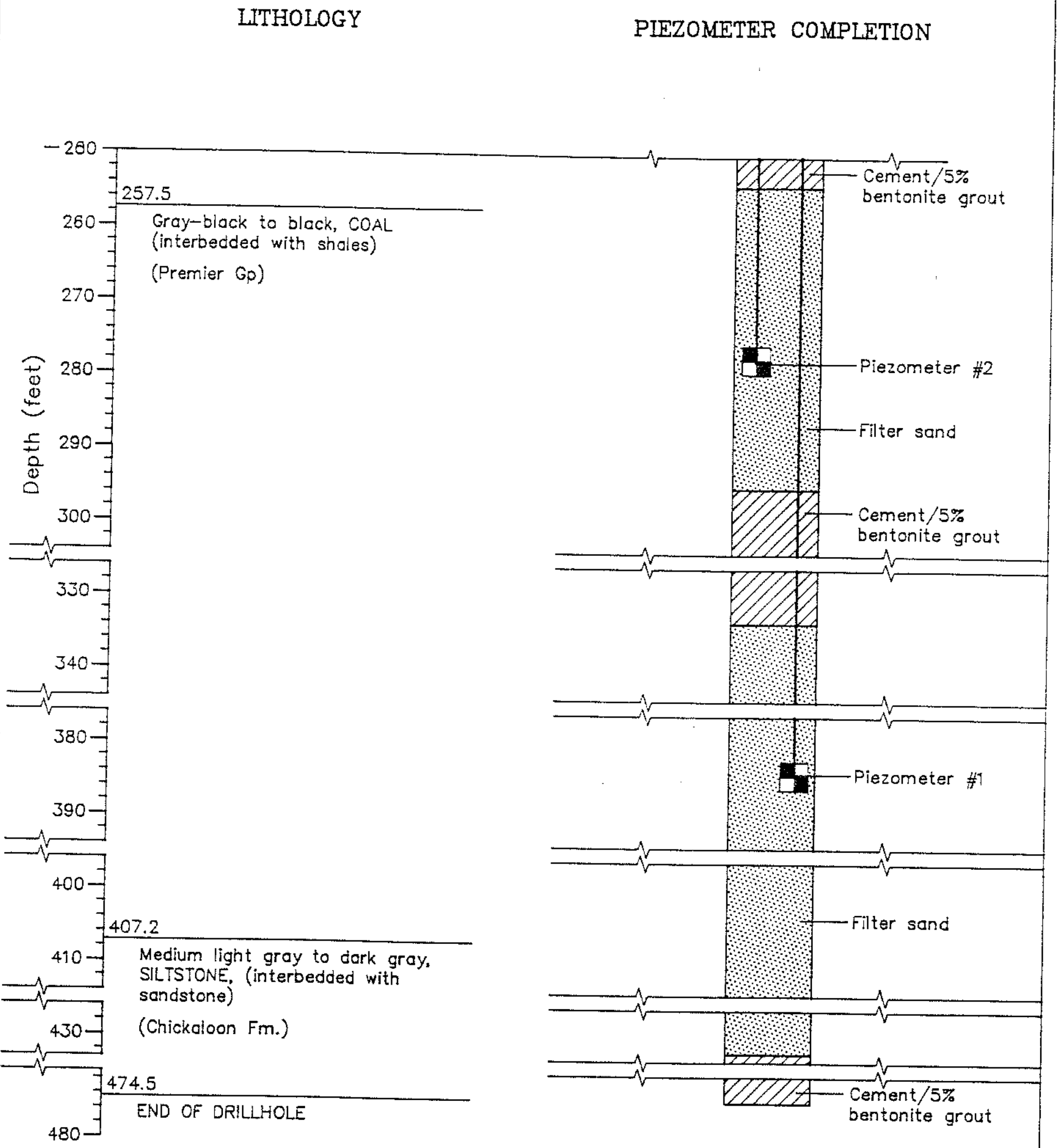


Date: 9/29/88
Piezometer Elevations:
1)712.6 2)819.1 3)875.6
Coordinates:
North: 2,820,103.96
East: 663,579.53

FIGURE **B-10**
WELL **PB-102**
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 883–2145 DWG NO 7620 DATE 2/2/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⁙	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▽	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer

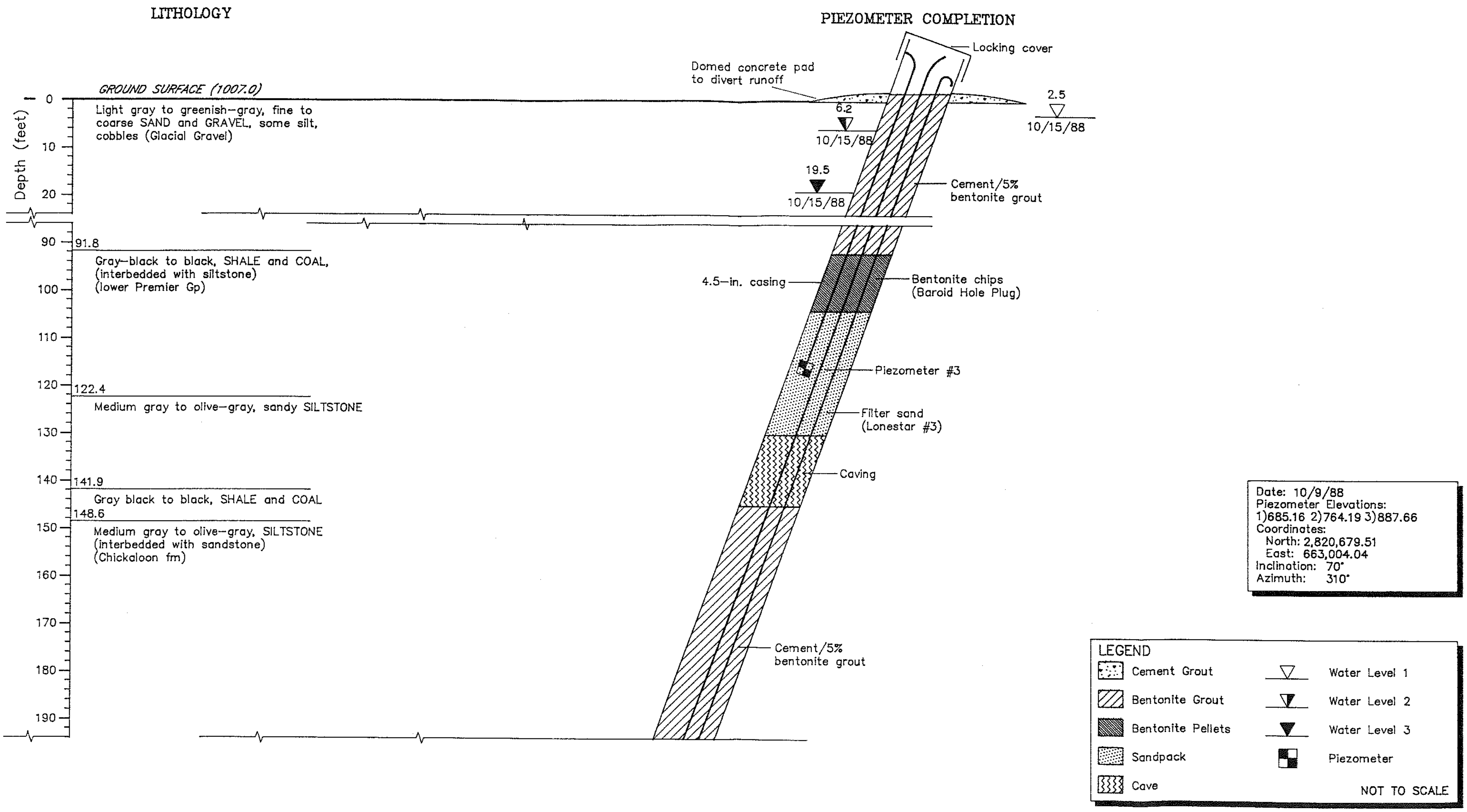
NOT TO SCALE

Date: 9/29/88
Piezometer Elevations:
1)712.6 2)819.1 3)875.6
Coordinates:
North: 2,820,103.96
East: 663,579.53

FIGURE **B-10**
WELL **PB-102**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT)
WISHBONE

PROJECT NO 883-2145 DWG NO 7621 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.

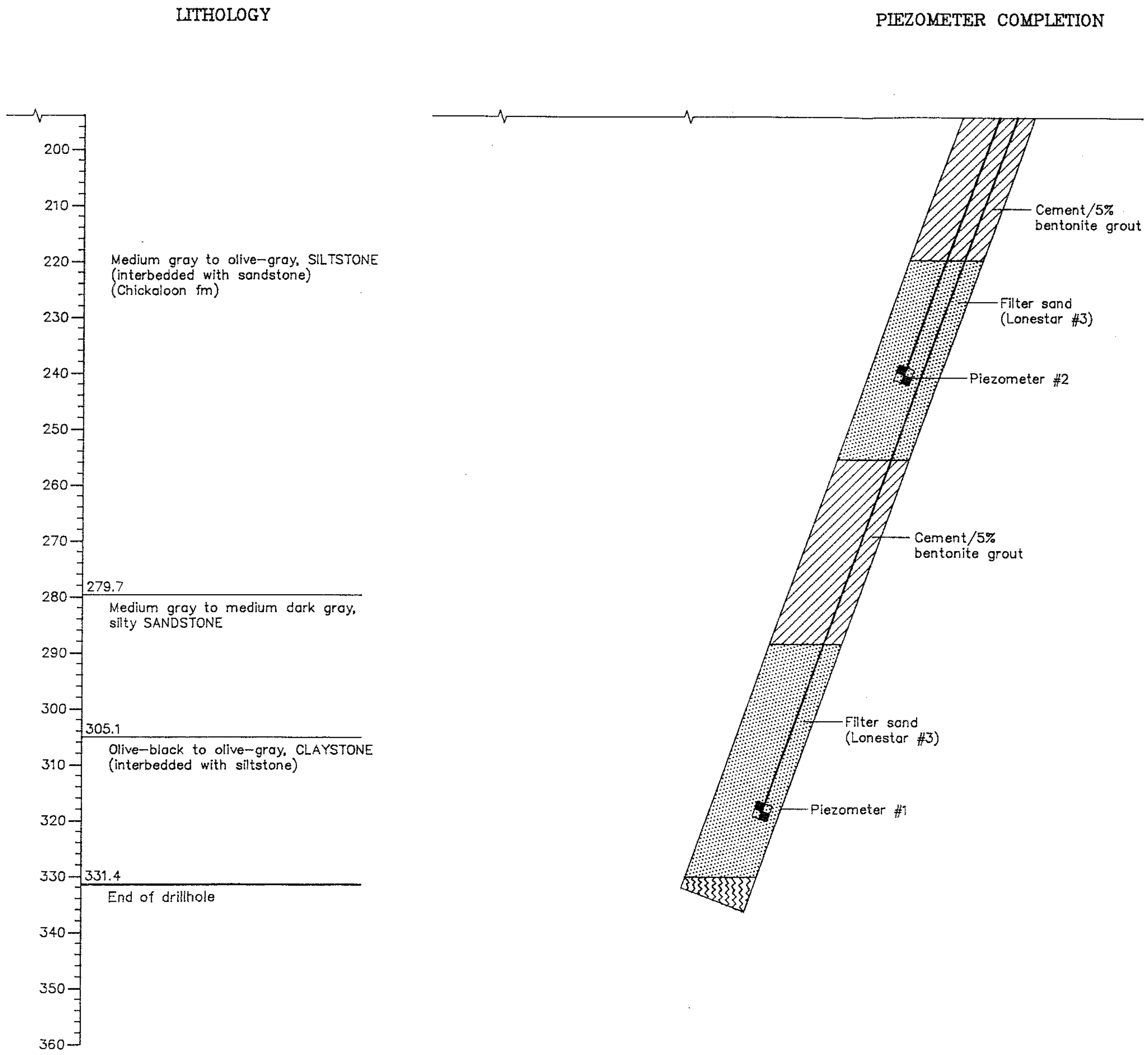


Date: 10/9/88
Piezometer Elevations:
1)685.16 2)764.19 3)887.66
Coordinates:
North: 2,820,679.51
East: 663,004.04
Inclination: 70°
Azimuth: 310°

FIGURE **B-11**
WELL **PB-103**
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7581 DATE 1/20/89 DRAWN JSS APPROVED

Golder Associates Inc.



Date: 10/9/88
Piezometer Elevations:
1)685.16 2)764.19 3)887.66
Coordinates:
North: 2,820,679.51
East: 663,004.04
Inclination: 70°
Azimuth: 310°

LEGEND

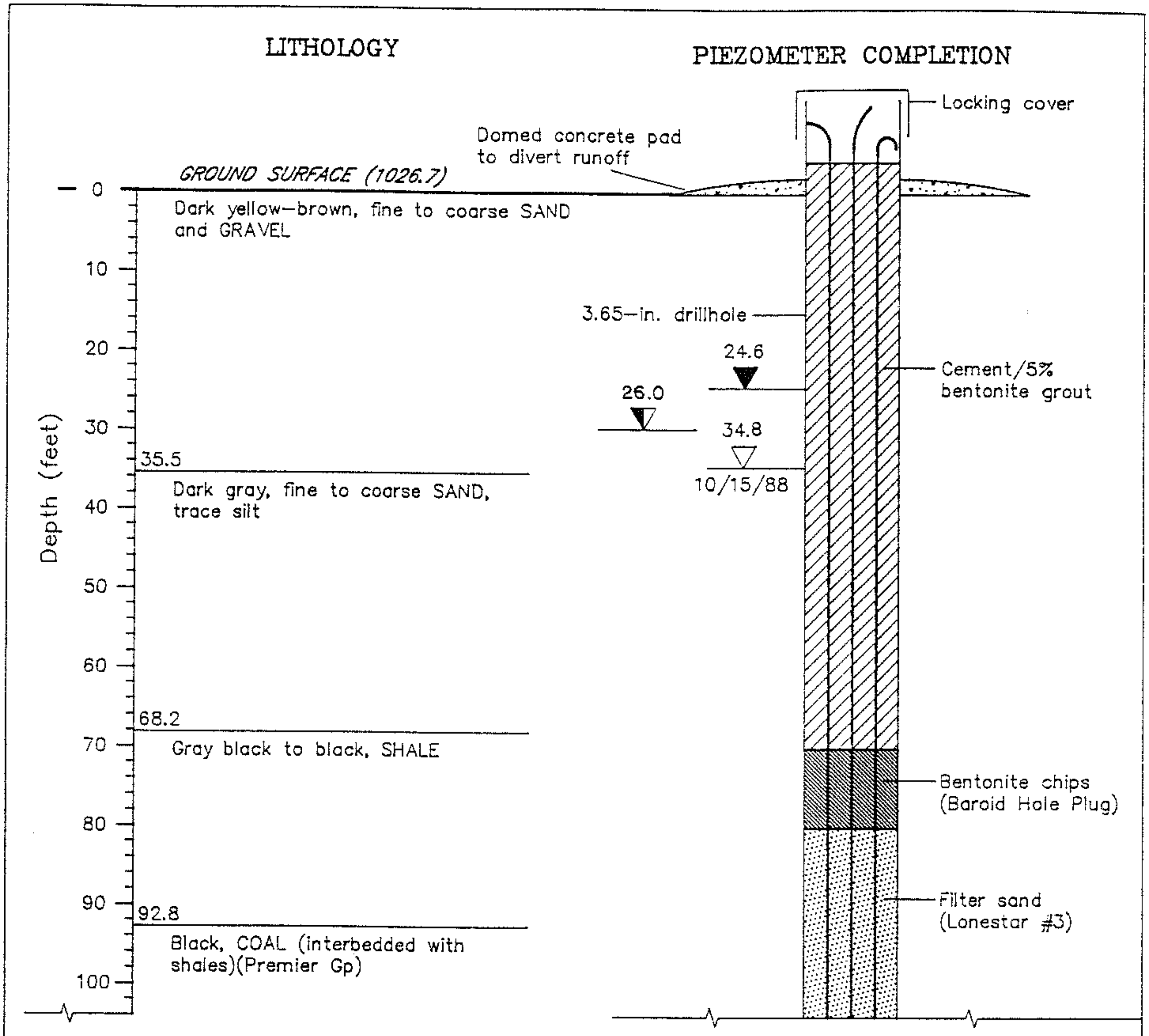
⁘	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▽	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer
⦚	Cave		

NOT TO SCALE

FIGURE **B-11**
WELL **PB-103**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT)
WISHBONE

PROJECT NO 883-2145 DWG NO 7582 DATE 1/20/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

- ░ Cement Grout
- ▨ Bentonite Grout
- ▩ Bentonite Pellets
- ░ Sandpack
- ▽ Water Level 1
- ▼ Water Level 2
- ▼ Water Level 3
- ▚ Piezometer

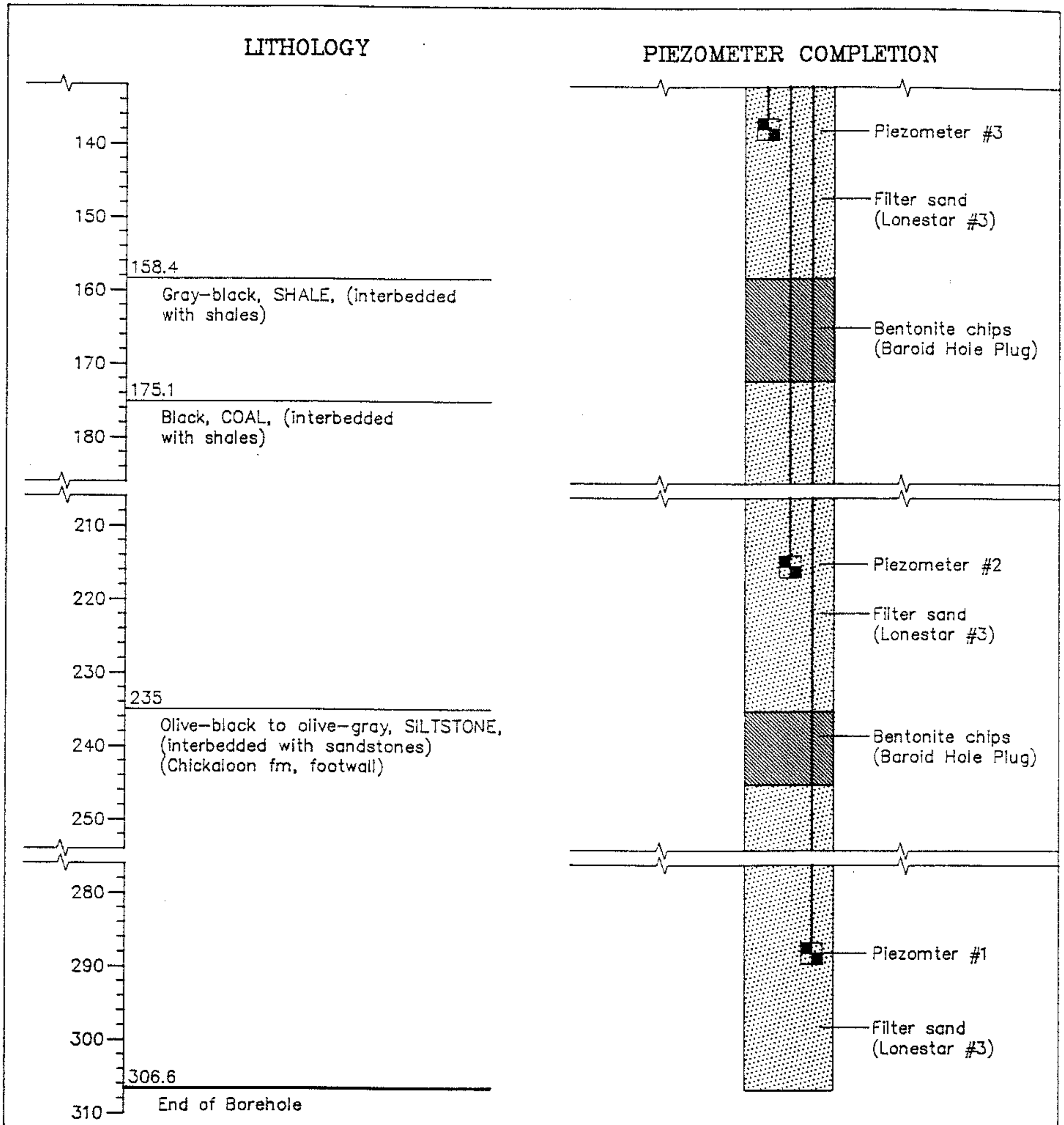
NOT TO SCALE

Date: 10/15/88
Piezometer Elevations:
1)738.7 2)811.4 3)889.0
Coordinates:
North: 2,821,611.26
East: 664,057.33

FIGURE **B-12**
WELL **PB-104**
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7578 DATE 1/20/89 DRAWN JSS APPROVED RM

Golder Associates Inc.



LEGEND

⛆	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▼	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer

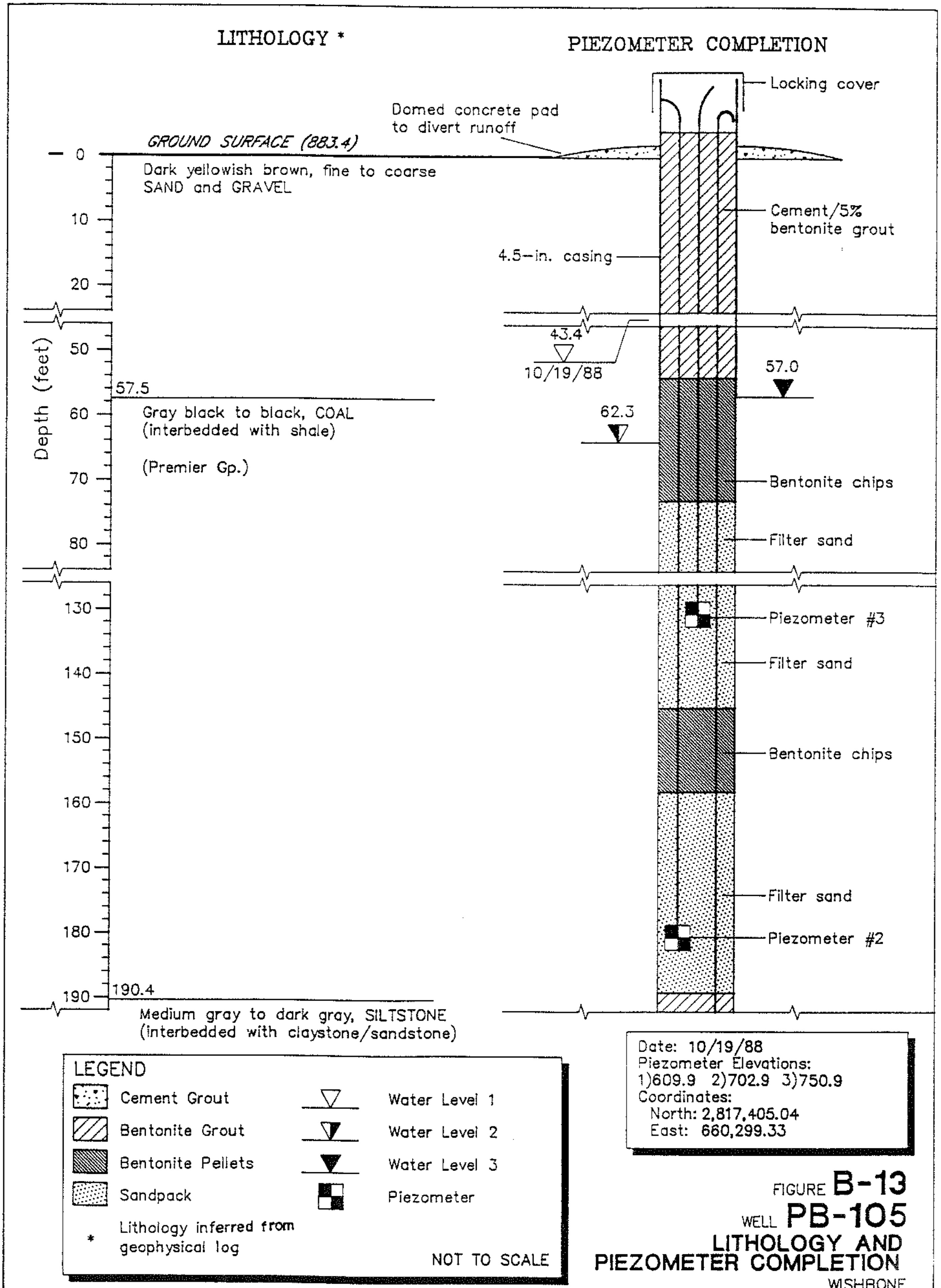
NOT TO SCALE

Date: 10/15/88
Piezometer Elevations:
1) 738.7 2) 811.4 3) 889.0
Coordinates:
North: 2,821,611.26
East: 664,057.33

FIGURE **B-12**
WELL **PB-104**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT)
WISHBONE

PROJECT NO 883-2145 DWG NO 7579 DATE 1/20/89 DRAWN JSS APPROVED RM

Golder Associates Inc.

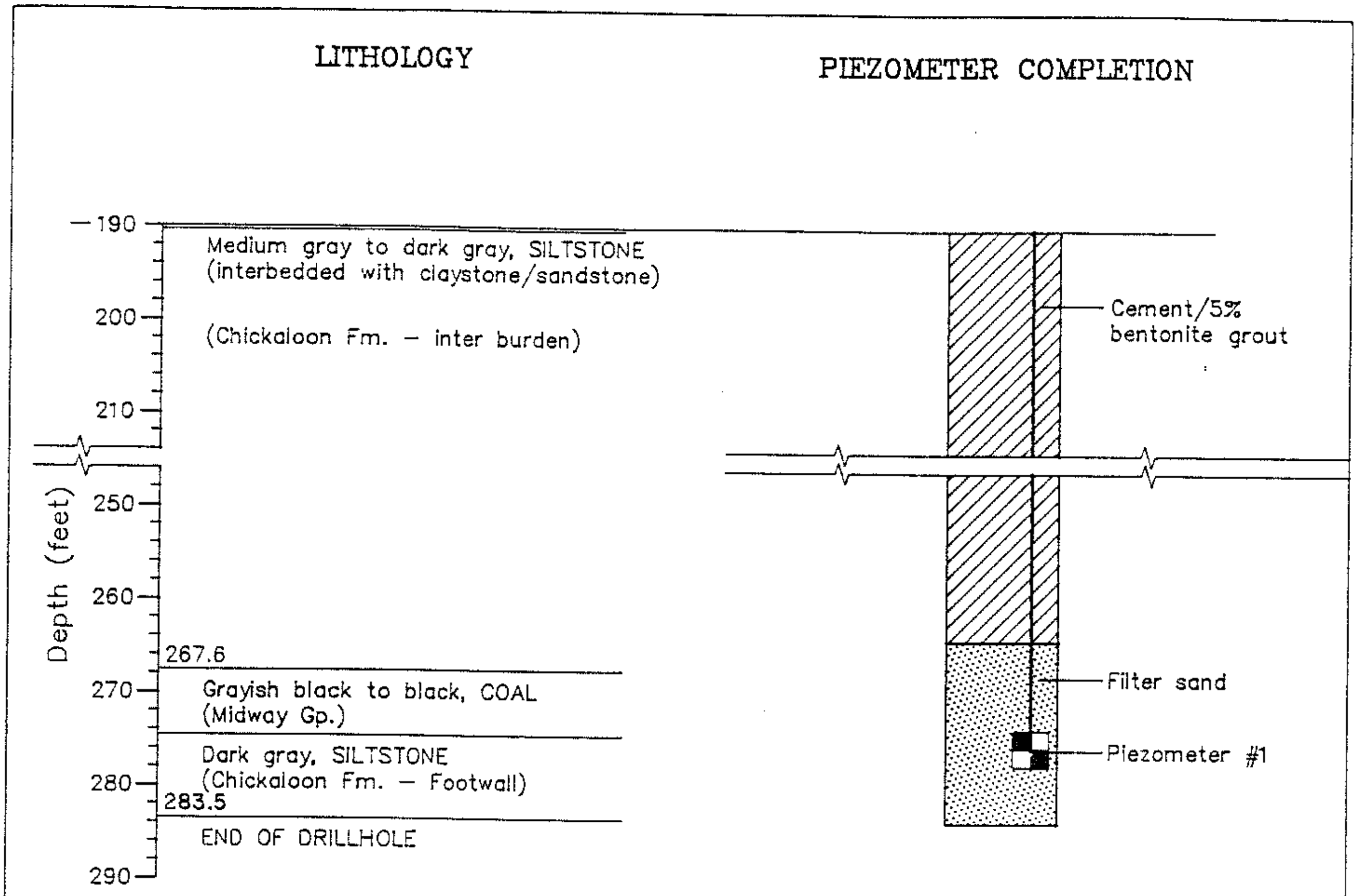


Date: 10/19/88
Piezometer Elevations:
1)609.9 2)702.9 3)750.9
Coordinates:
North: 2,817,405.04
East: 660,299.33

FIGURE **B-13**
WELL **PB-105**
LITHOLOGY AND PIEZOMETER COMPLETION
WISHBONE

PROJECT NO 883-2145 DWG NO 7613 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.



LEGEND

⁙	Cement Grout	▽	Water Level 1
▨	Bentonite Grout	▽	Water Level 2
▩	Bentonite Pellets	▼	Water Level 3
░	Sandpack	▚	Piezometer

NOT TO SCALE

Date: 10/19/88
Piezometer Elevations:
1)609.9 2)702.9 3)750.9
Coordinates:
North: 2,817,405.04
East: 660,299.33

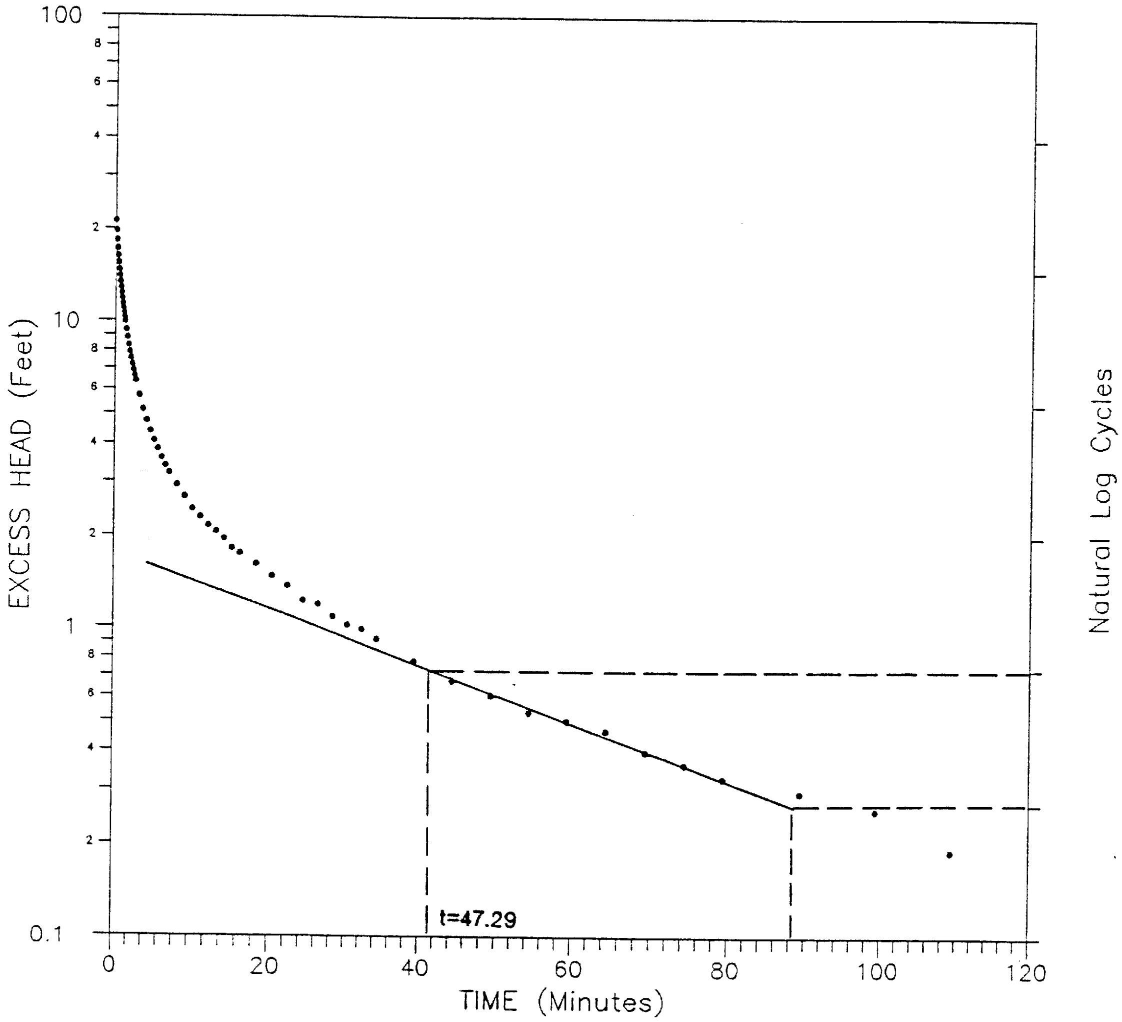
FIGURE **B-13**
WELL **PB-105**
LITHOLOGY AND PIEZOMETER COMPLETION (CONT)
WISHBONE

PROJECT NO 883–2145 DWG NO 7614 DATE 2/2/89 DRAWN DJH APPROVED RM

Golder Associates Inc.

APPENDIX C

SLUG TEST DATA AND ANALYSIS



t= 47.29 min.

L= 267 feet

D= 4 7/8 inches

d= 2 inches

m= 100

$$K=\frac{(d)^2\ln\left(\frac{2\ m\ L}{D}\right)}{8\ L\ t}$$

T=KL

K= 0.0047 ft/day

T= 1.25 ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-11

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

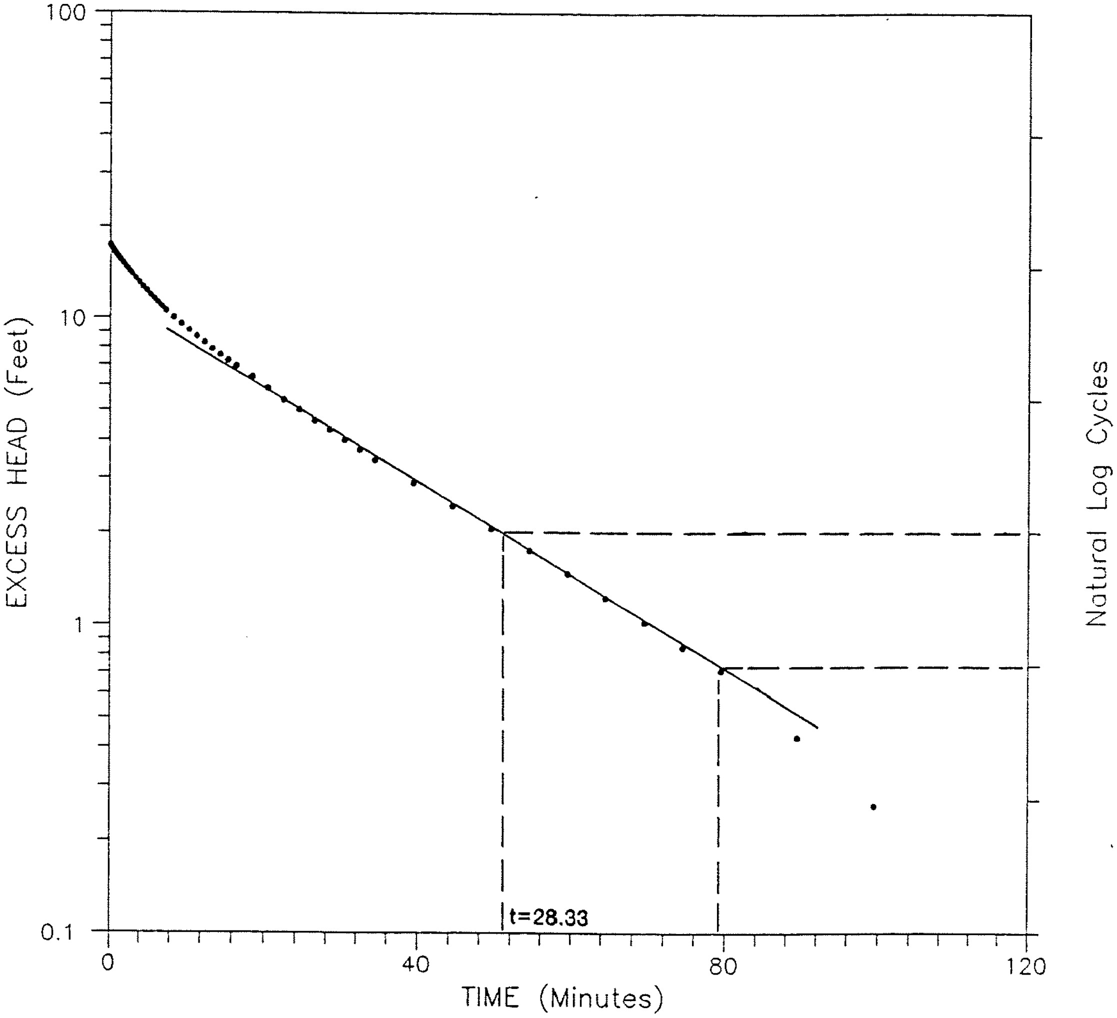
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-1

SCALE:

REV. 0



t= 28.33 min.

L= 36 feet

D= 5 7/8 inches

d= 2 inches

m= 100

$$K = \frac{(d)^2 \ln\left(\frac{2\,m\,L}{D}\right)}{8\ L\ t}$$

T=KL

K= 4.71 ft/day

T= 169.5 ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-12

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

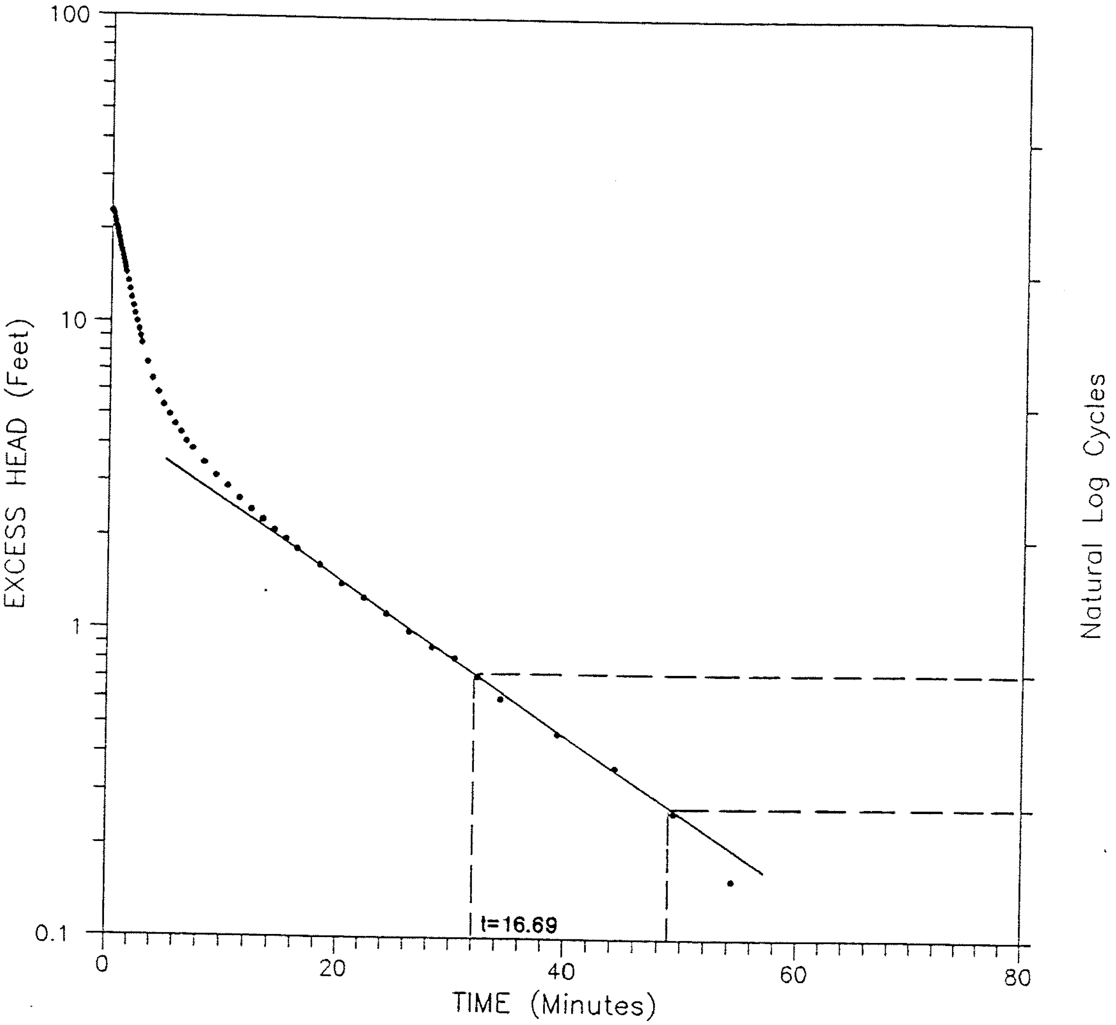
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-2

REV. 0

SCALE:



t= 16.69 min.

L= 118 feet

D= 4 3/4 inches

d= 2 inches

m= 100

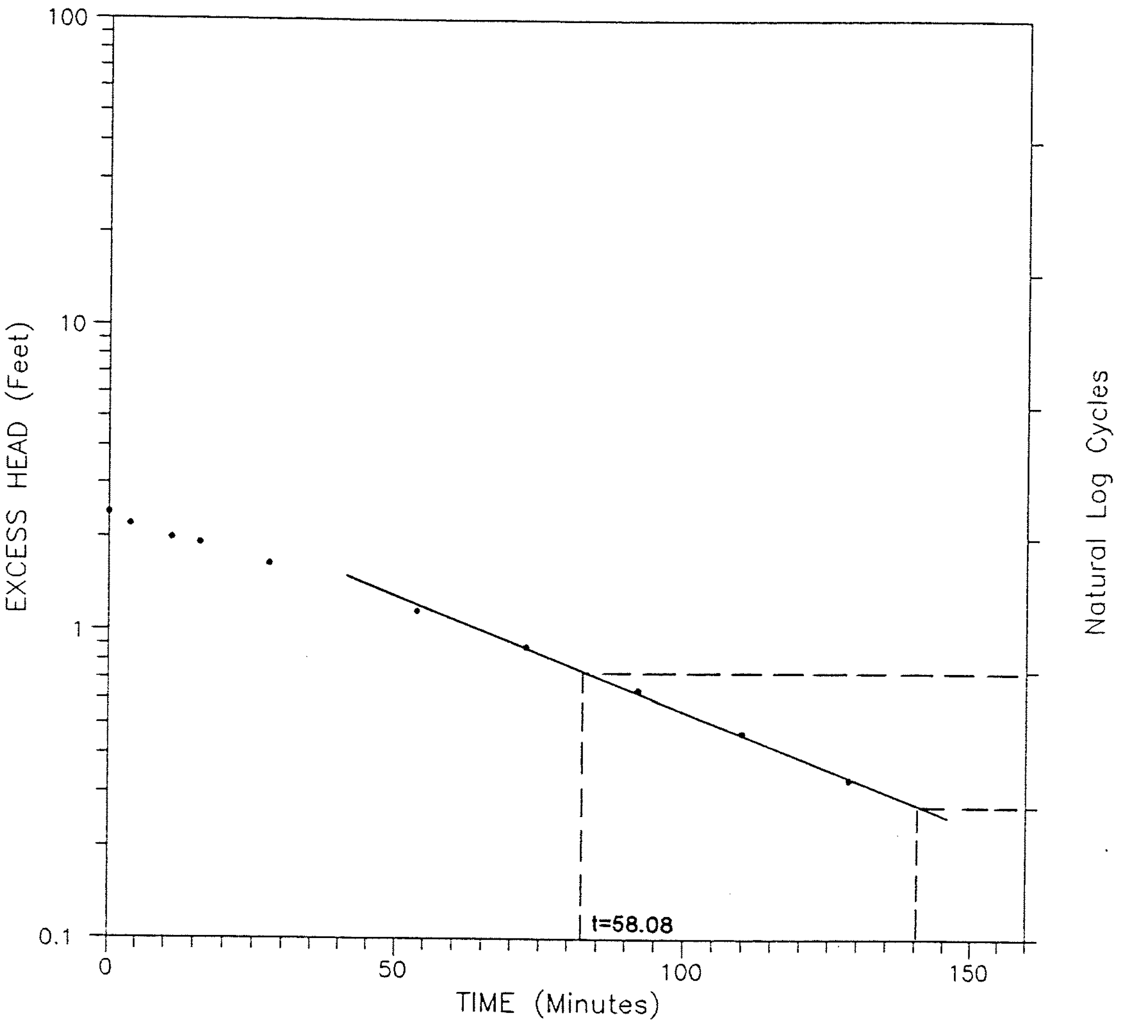
$$K=\frac{(d)^2\ln\left(\frac{2\,m\,L}{D}\right)}{8\;L\;t}$$

T=KL

K= 0.028 ft/day

T= 3.25 ft^2/day

DESIGN BY:	HVORSLEV FALLING HEAD ANALYSIS H88-13	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. C-3	REV. 0
DATE DRAWN: 1/89		SCALE:	



t= 58.08 min.

L= 6.1 feet

D= 4 7/8 inches

d= 2 inches

m= 10

$$K=\frac{(d)^2 \ln\left(\frac{2\ m\ L}{D}\right)}{8\ L\ t}$$

T=KL

K= 4.24 ft/day

T= 25.4 ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-14

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

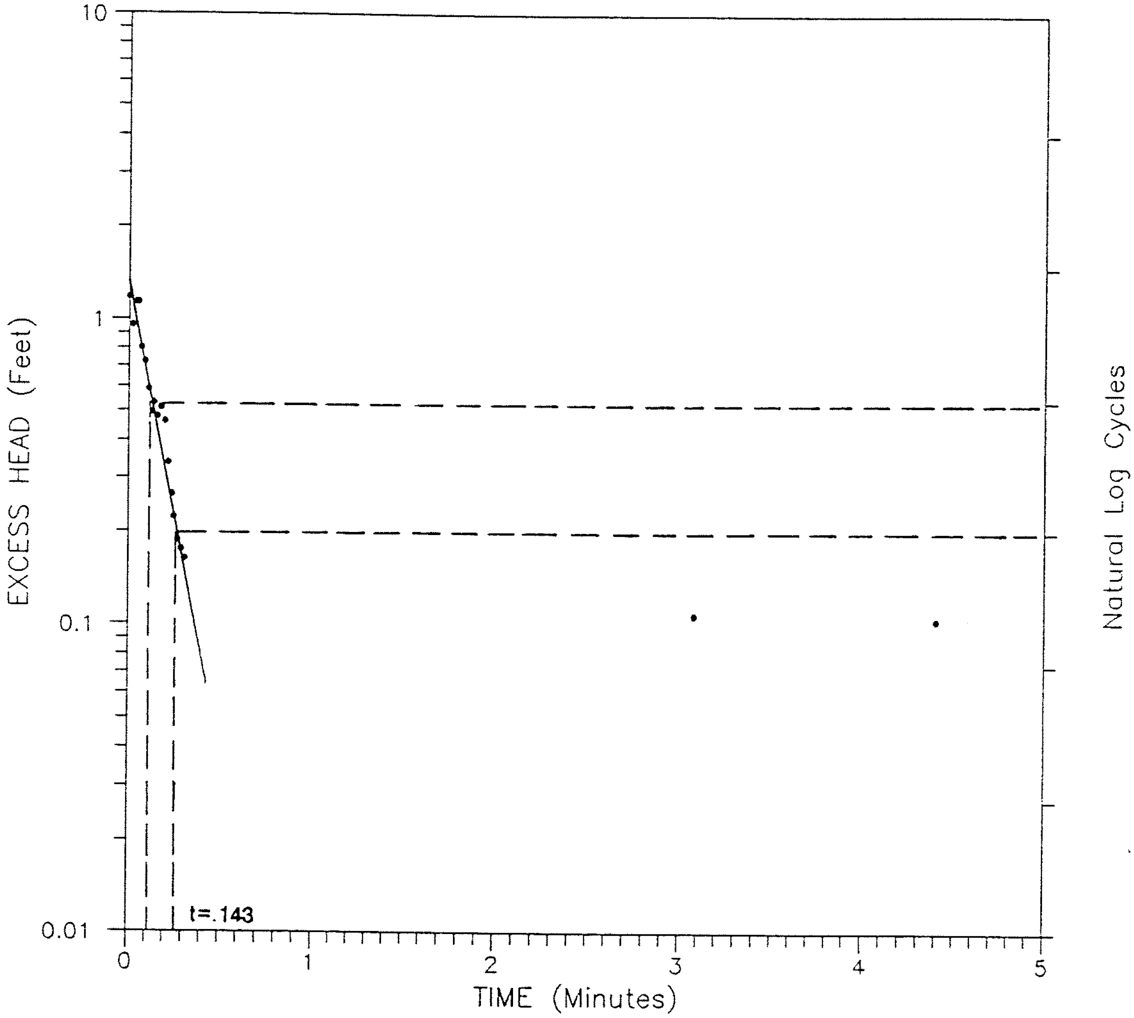
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-4

REV. 0

SCALE:



t= .143 min.

L= 3 feet

D= 8 inches

d= 2 inches

m= 10

$$K=\frac{(d)^2 \ln\left(\frac{2\,m\,L}{D}\right)}{8\,L\,t}$$

T=KL

K= 52.39 ft/day

T= 157.16 ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-14A

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

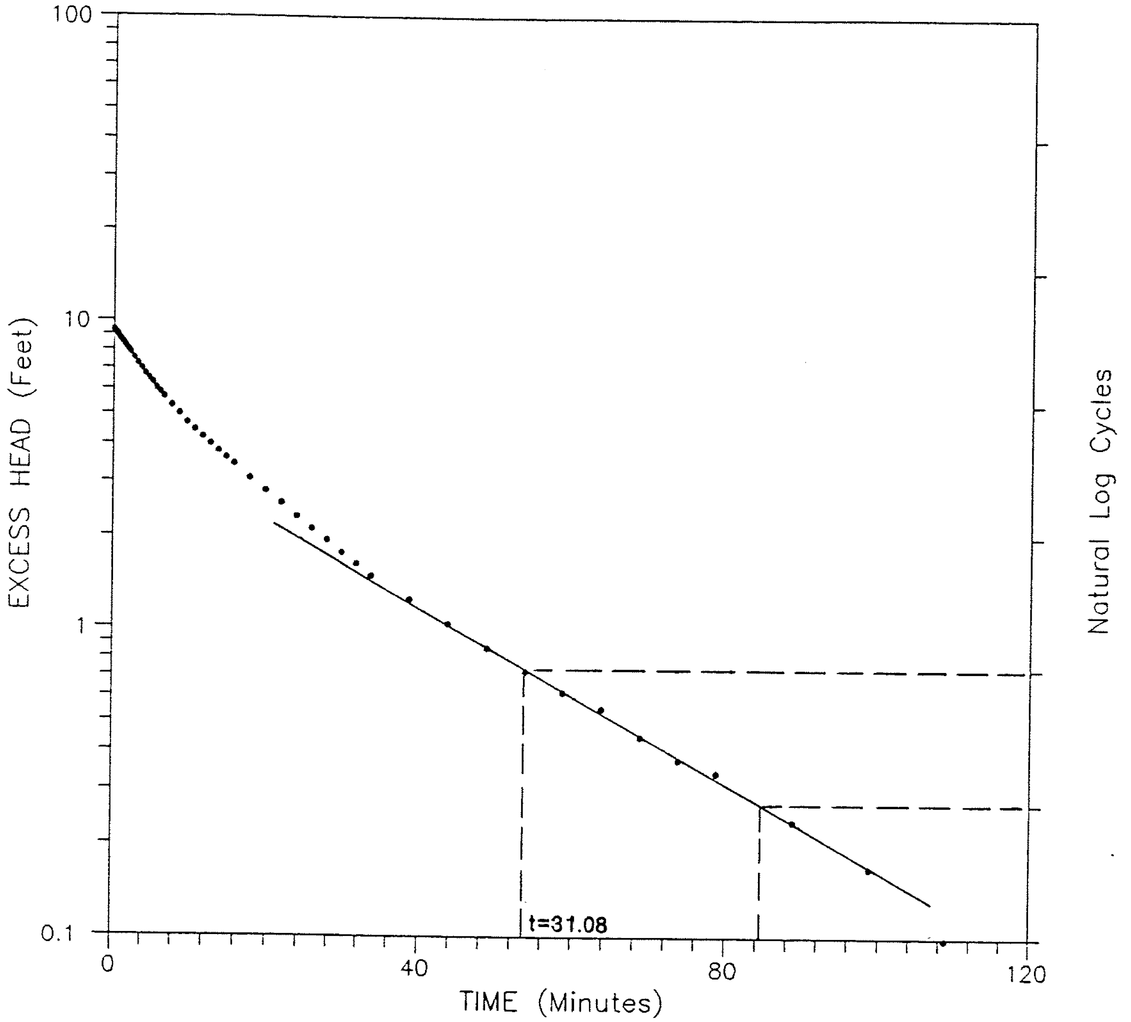
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-5

REV. 0

SCALE:



t= 31.08 min.
L= 343 feet
D= 7 7/8 inches
d= 5 inches
m= 100

$$K=\frac{(d)^2 \ln\left(\frac{2\,m\,L}{D}\right)}{8\;L\;t}$$

T=KL

K= .034 ft/day

$T=11.62$ ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-16

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

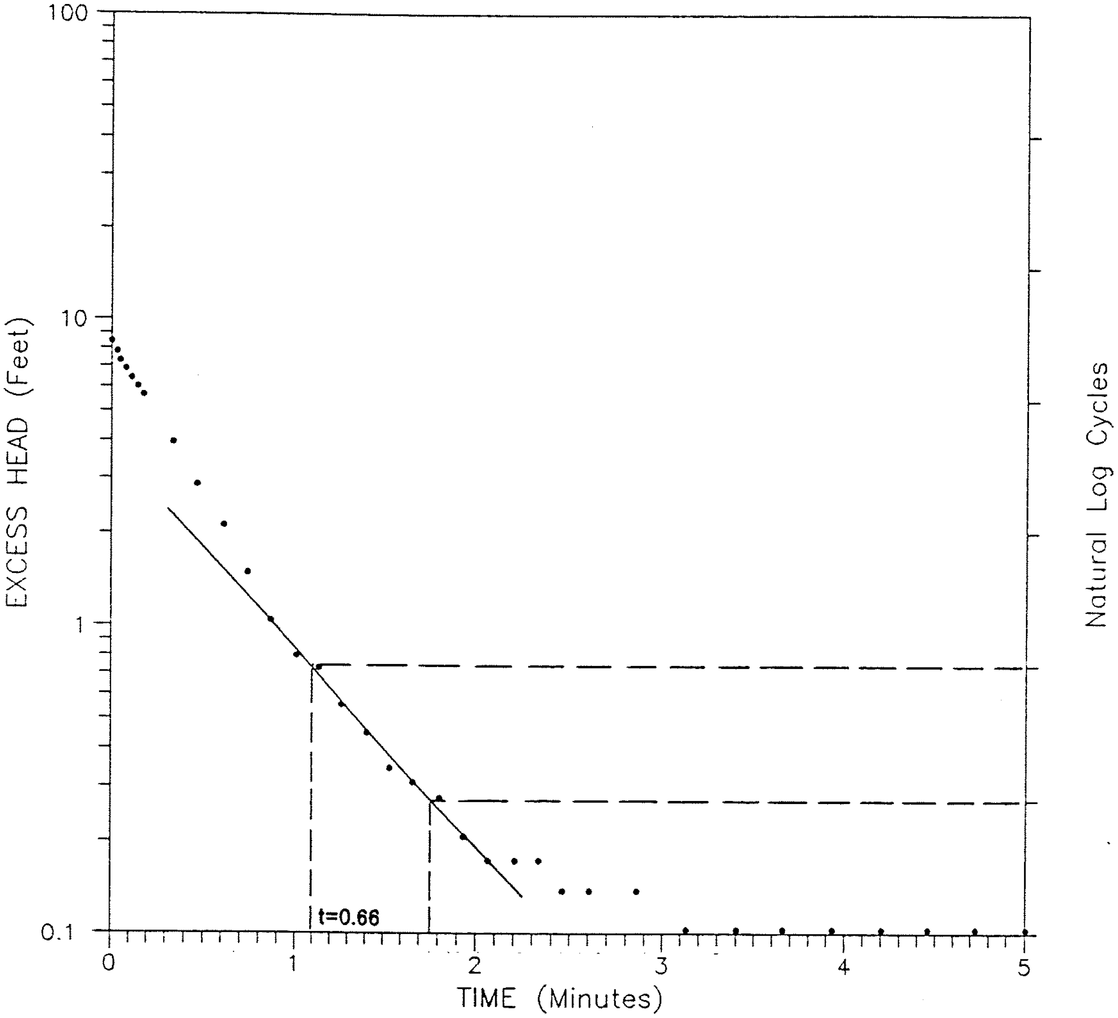
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-6

REV. 0

SCALE:



t= **0.66** min.

L= **3.4** feet

D= **8** inches

d= **2** inches

m= **10**

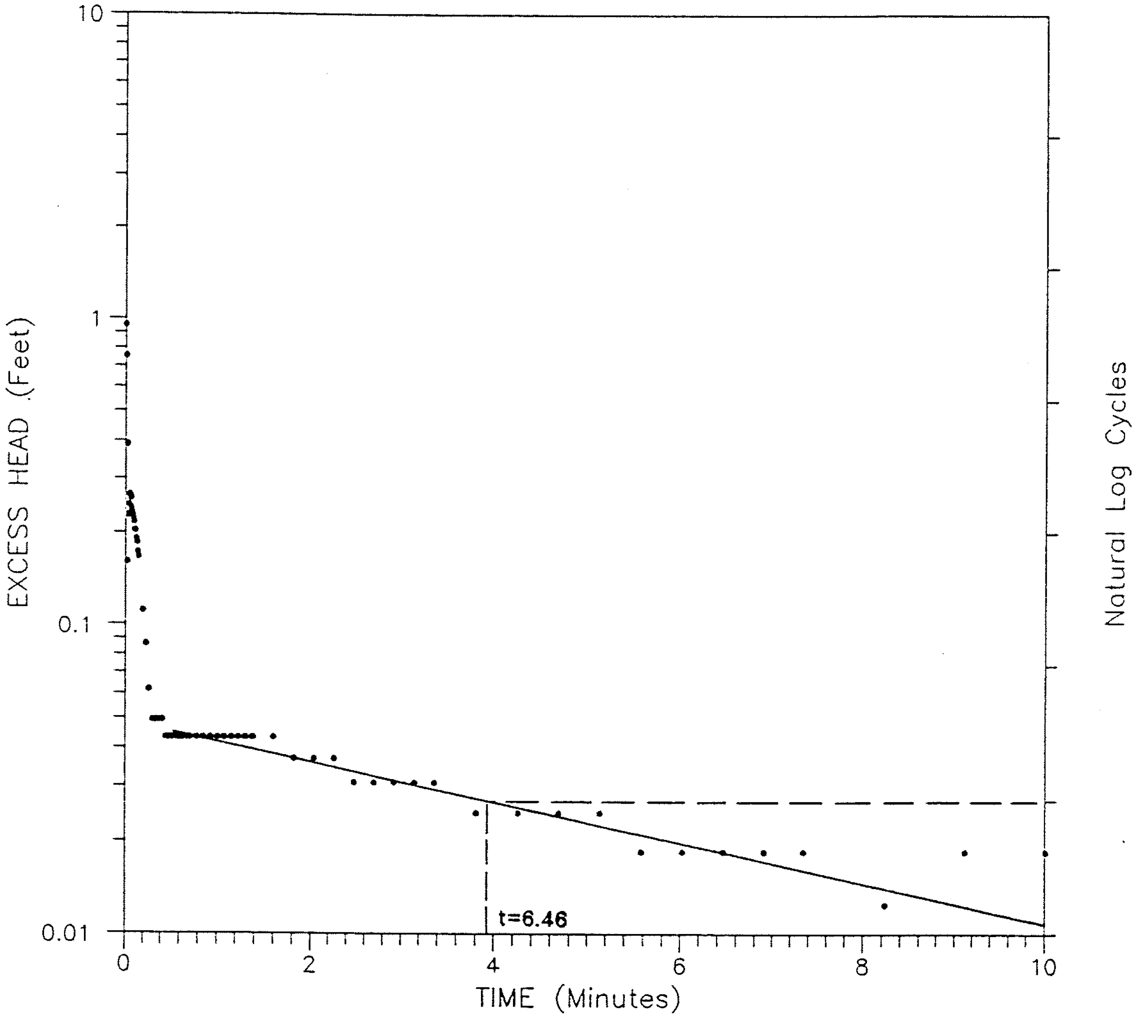
$$K=\frac{(d)^2 \ln\left(\frac{2\,m\,L}{D}\right)}{8\ L\ t}$$

T=KL

K= 10.29 ft/day

T= 35.0 ft^2/day

DESIGN BY:	HVORSLEV FALLING HEAD ANALYSIS H88-17	WISHBONE HILL MINE PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. C-7
DATE DRAWN: 1/89		SCALE:
		REV. 0



t= 6.46 min.
L= 6 feet
D= 8 inches
d= 2 inches
m= 10

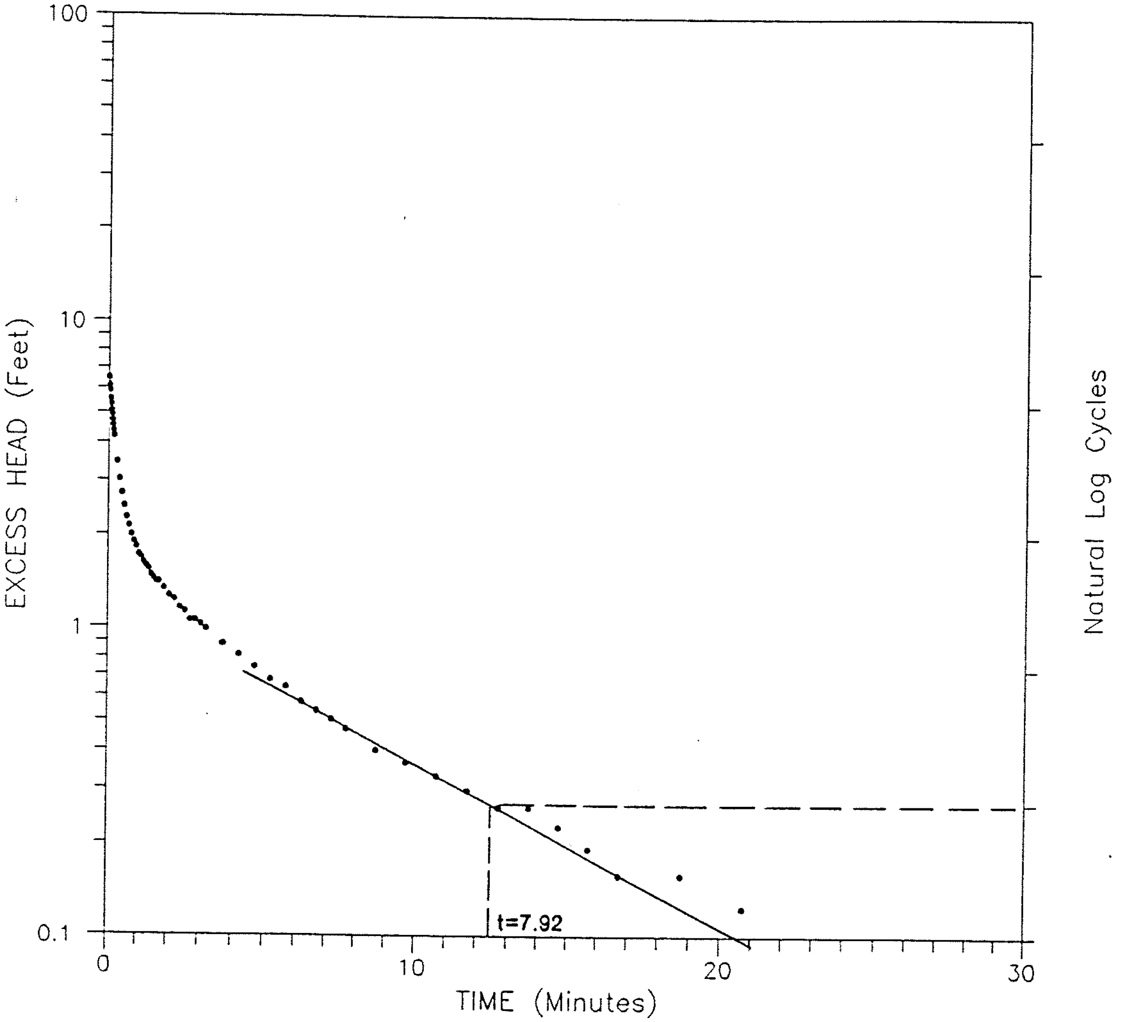
$$K= \frac{(d)^2 \ln\left(\frac{2\,m\,L}{D}\right)}{8\;L\;t}$$

T=KL

K= 0.67 ft/day

T= 4.02 ft^2/day

DESIGN BY:	HVORSLEV FALLING HEAD ANALYSIS H88-21	WISHBONE HILL MINE PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. C-8 REV. 0
DATE DRAWN: 1/89		SCALE:



t= 7.92 min.
L= 45 feet
D= 8 inches
d= 2 inches
m= 10

$$K=\frac{(d)^2 \ln\left(\frac{2\,m\,L}{D}\right)}{8\ L\ t}$$

T=KL

K= 0.10 ft/day

T= 4.5 ft^2/day

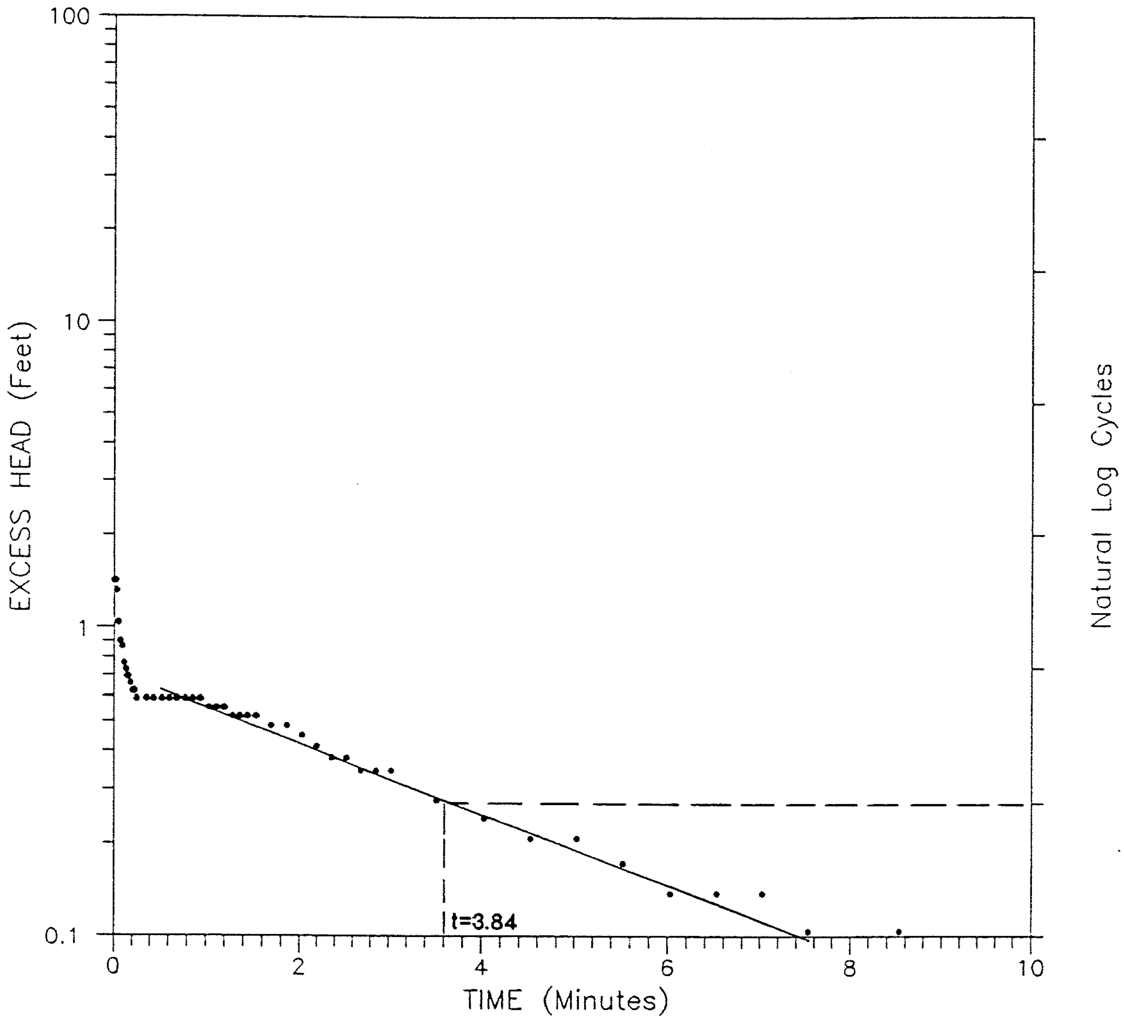
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-22

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. C-9
REV. 0
SCALE:



t= 3.84 min.
L= 20.8 feet
D= 8 inches
d= 2 inches
m= 10

$$K=\frac{(d)^2 \ln\left(\frac{2\ m\ L}{D}\right)}{8\ L\ t}$$

T=KL

K= 0.40 ft/day

T= 8.4 ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-24A

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

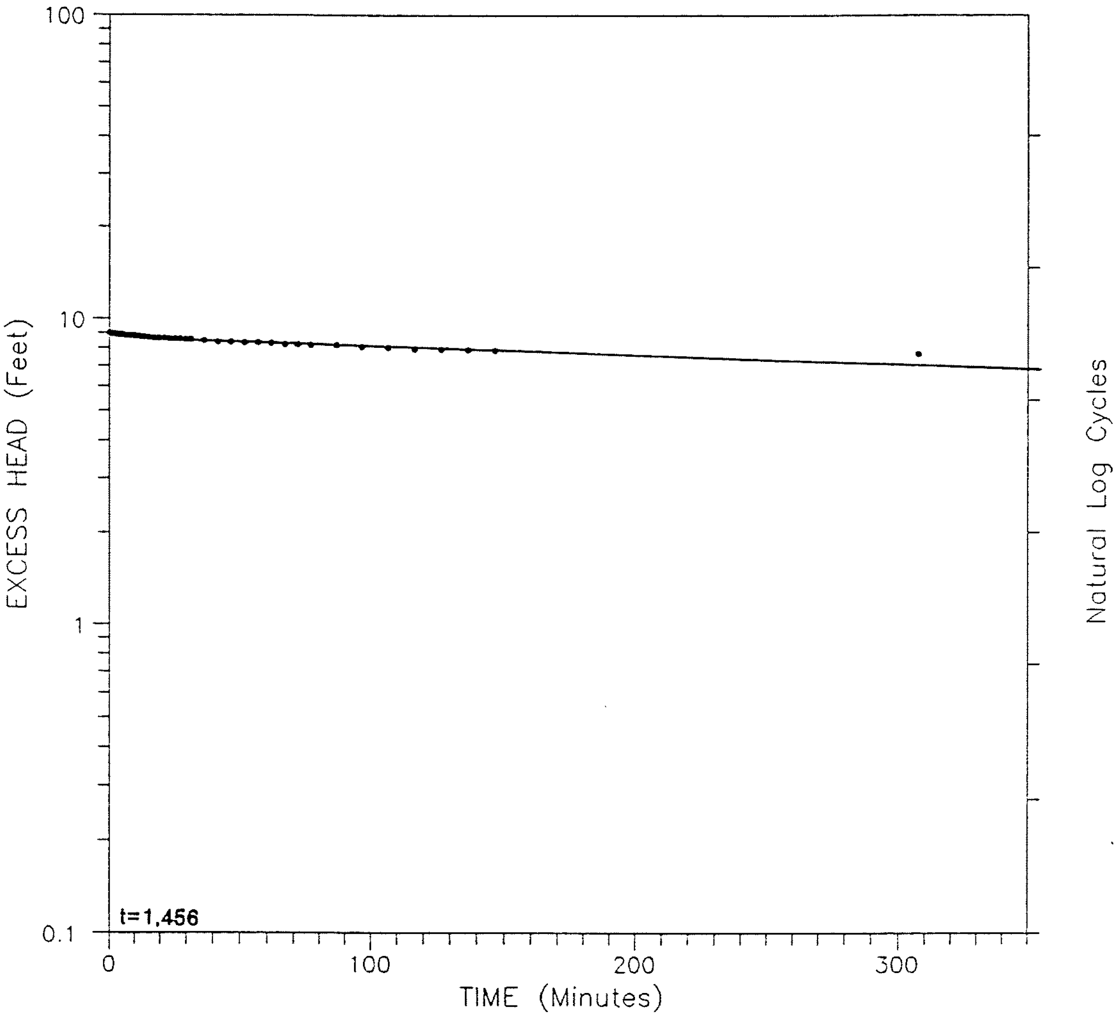
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-10

REV. 0

SCALE:



t= 1,456 min.

L= 2 feet

D= 6 inches

d= 2 inches

m= 10

$$K=\frac{(d)^2 \ln\left(\frac{2\ m\ L}{D}\right)}{8\ L\ t}$$

T=KL

K= 0.0075 ft/day

T=0.016 ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-25

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

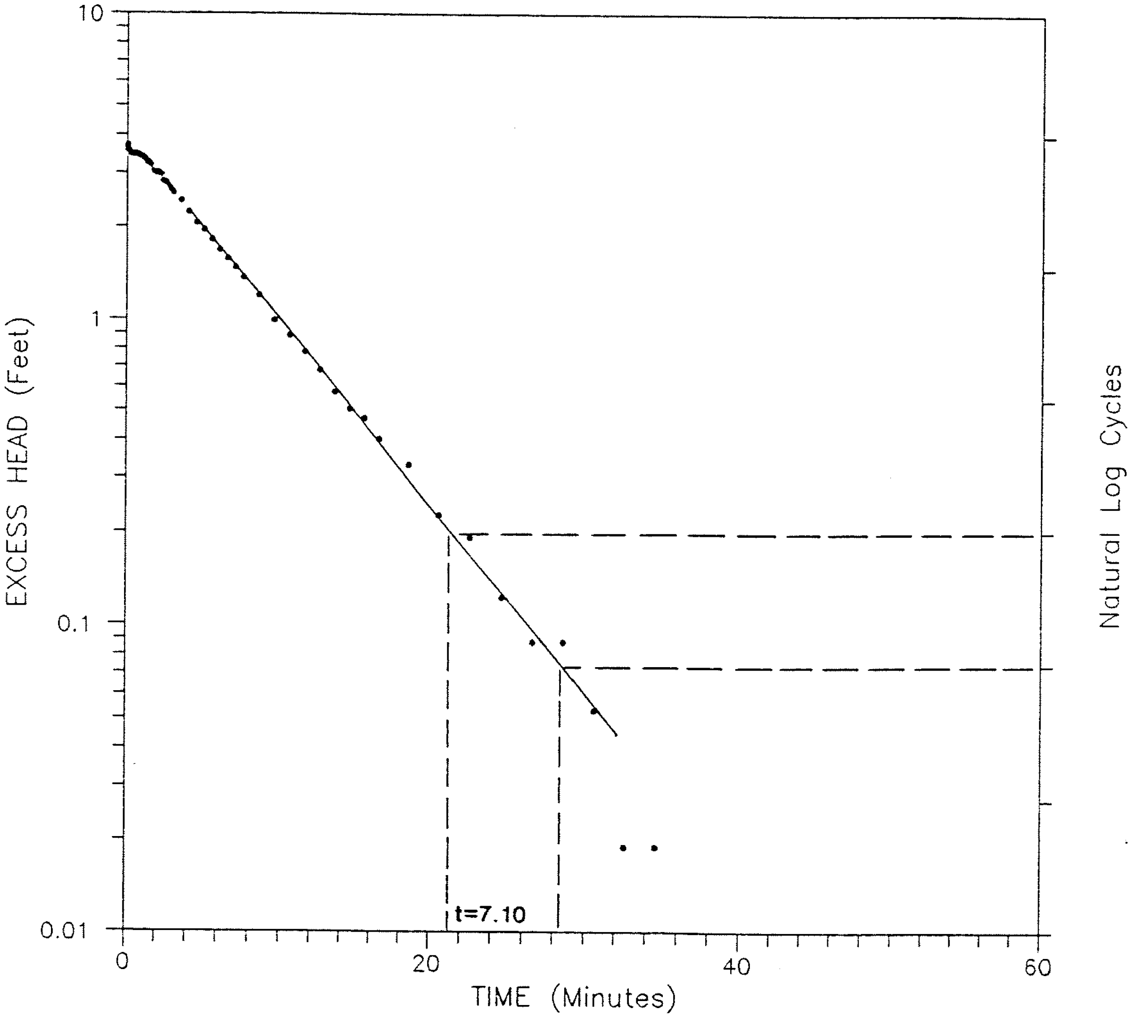
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-11

REV. 0

SCALE:



t= 7.10 min.
L= 2.5 feet
D= 8 inches
d= 2 inches
m= 10

$$K=\frac{(d)^2 \ln\left(\frac{2\,m\,L}{D}\right)}{8\ L\ t}$$

T=KL

K= 1.2 ft/day

T= 3.0 ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-27

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

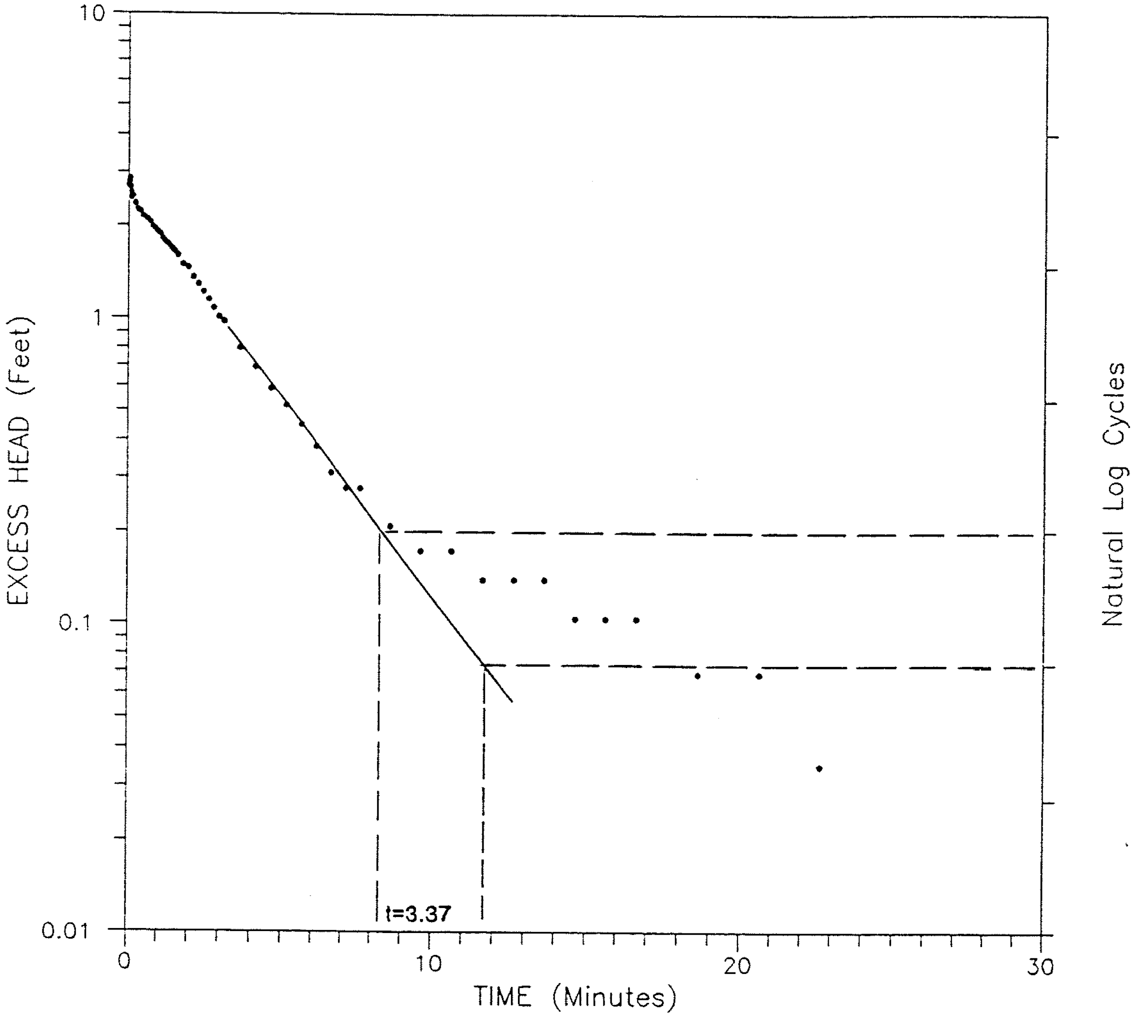
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-12

REV. 0

SCALE:



t= 3.37 min.

L= 5.5 feet

D= 8 inches

d= 2 inches

m= 10

$$K=\frac{(d)^2 \ln\left(\frac{2\ m\ L}{D}\right)}{8\ L\ t}$$

T=KL

K= 1.38 ft/day

T= 7.6 ft^2/day

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 1/89

HVORSLEV FALLING HEAD ANALYSIS
H88-28

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. C-13

REV. 0

SCALE:

APPENDIX D

PUMP TEST DATA AND ANALYSIS

TABLE D–1
H88–15 PUMPING TEST CELL
PIEZOMETER MEASURMENTS

PB–7
BASE ELEVATION (G.S.)= 930.1 ft.

PIEZO-METER NUMBER	PIEZO-METER ELEV. FT. MSL	DATE	ELAPSED TIME (MIN)	PIEZO ELEV. (FT)	DRAWDOWN FROM REF W.L.
1	573.1	11/15/88	–1297	841.2	–0.03
		11/16/88	50	833.2	7.99
REFERENCE		11/16/88	295	840.1	1.11
W.L.=	841.2	11/16/88	447	840.1	1.11
		11/17/88	1400	836.7	4.55
		11/17/88	1484	814.9	26.32
		11/17/88	1720	841.2	–0.03
		11/17/88	1841	817.2	24.03
		11/18/88	2989	837.7	3.52
2	640.1	11/15/88	–1293	868.3	0.05
		11/16/88	52	863.7	4.63
REFERENCE		11/16/88	297	866.0	2.34
W.L.=	868.3	11/16/88	449	866.0	2.34
		11/17/88	1402	861.4	6.93
		11/17/88	1486	863.7	4.63
		11/17/88	1721	868.1	0.16
		11/17/88	1844	864.8	3.49
		11/18/88	3000	863.6	4.75
3	698.1	11/15/88	–1288	851.6	0.02
		11/16/88	56	848.1	3.46
REFERENCE		11/16/88	299	852.6	–1.01
W.L.=	851.6	11/16/88	452	848.1	3.46
		11/17/88	1405	848.1	3.46
		11/17/88	1487	848.1	3.46
		11/17/88	1724	850.4	1.17
		11/17/88	1846	848.1	3.46
		11/18/88	3003	848.1	3.46

PB–105
BASE ELEVATION (G.S.)= 883.4 ft.

PIEZO-METER NUMBER	PIEZO-METER ELEV. FT. MSL	DATE	ELAPSED TIME (MIN)	PIEZO ELEV. (FT)	DRAWDOWN FROM REF W.L.
1	609.9	11/15/88	–1358	842.3	–0.04
		11/16/88	82	837.8	4.54
REFERENCE		11/16/88	309	837.8	4.54
W.L.=	842.3	11/16/88	339	837.6	4.65
		11/16/88	473	837.8	4.54
		11/17/88	1458	837.8	4.54
		11/17/88	1530	838.9	3.39
		11/17/88	1770	837.8	4.54
		11/17/88	1889	835.5	6.83
		11/18/88	2940	833.2	9.12
2	702.9	11/15/88	–1357	825.5	–0.02
		11/16/88	83	820.9	4.56
REFERENCE		11/16/88	311	818.6	6.85
W.L.=	825.5	11/16/88	340	818.6	6.85
		11/16/88	475	818.6	6.85
		11/17/88	1459	814.1	11.43
		11/17/88	1531	815.2	10.29
		11/17/88	1771	814.0	11.55
		11/17/88	1890	814.1	11.43
		11/18/88	2941	810.6	14.87
3	750.9	11/15/88	–1356	828.6	–0.04
		11/16/88	84	825.2	3.38
REFERENCE		11/16/88	312	826.4	2.24
W.L.=	828.6	11/16/88	341	824.1	4.52
		11/16/88	476	825.2	3.38
		11/17/88	1460	824.1	4.52
		11/17/88	1533	824.1	4.52
		11/17/88	1773	824.1	4.52
		11/17/88	1891	824.0	4.64
		11/18/88	2942	821.8	6.81

PB–8
BASE ELEVATION (G.S.)= 905.2

PIEZO-METER NUMBER	PIEZO-METER ELEV. FT. MSL	DATE	ELAPSED TIME (MIN)	PIEZO ELEV. (FT)	DRAWDOWN FROM REF W.L.
1	590.2	11/15/88	–1393	871.7	0.05
		11/16/88	27	870.3	1.39
REFERENCE		11/16/88	280	872.9	–1.17
W.L.=	871.7	11/16/88	327	870.4	1.27
		11/16/88	462	870.4	1.27
		11/17/88	1426	868.0	3.72
		11/17/88	1519	869.2	2.49
		11/17/88	1757	870.4	1.27
		11/17/88	1877	870.3	1.39
		11/18/88	2963	843.4	28.28
		11/18/88	3022	868.0	3.72
2	665.7	11/15/88	–1390	856.2	–0.04
		11/16/88	31	854.0	2.25
REFERENCE		11/16/88	281	856.2	–0.04
W.L.=	856.2	11/16/88	329	854.0	2.25
		11/16/88	464	856.2	–0.04
		11/17/88	1444	851.7	4.54
		11/17/88	1521	855.1	1.10
		11/17/88	1759	856.1	0.07
		11/17/88	1879	854.0	2.25
		11/18/88	2964	851.7	4.54
		11/18/88	3023	853.8	2.36
3	717.7	11/15/88	–1388	856.4	–0.03
		11/16/88	32	852.0	4.45
REFERENCE		11/16/88	283	856.5	–0.14
W.L.=	856.4	11/16/88	330	854.1	2.27
		11/16/88	465	852.0	4.45
		11/17/88	1445	849.7	6.74
		11/17/88	1522	853.1	3.30
		11/17/88	1761	853.1	3.30
		11/17/88	1880	852.0	4.45
		11/18/88	2965	851.8	4.56
		11/18/88	3024	852.0	4.45

PB–60
BASE ELEVATION (G.S.)= 915.9 ft.

PIEZO-METER NUMBER	PIEZO-METER ELEV. FT. MSL	DATE	ELAPSED TIME (MIN)	PIEZO ELEV. (FT)	DRAWDOWN FROM REF W.L.
1	716.2	11/15/88	–1407	847.6	22.88
		11/16/88	40	868.2	2.28
REFERENCE		11/16/88	288	870.5	–0.01
W.L.=	870.5	11/16/88	427	870.5	–0.01
		11/17/88	1413	865.9	4.57
		11/17/88	1498	867.1	3.42
		11/17/88	1734	869.4	1.13
		11/17/88	1855	868.2	2.28
		11/18/88	2974	867.1	3.42
2	774.5	11/15/88	–1420	875.1	0.04
		11/16/88	42	872.8	2.32
REFERENCE		11/16/88	289	872.8	2.32
W.L.=	875.1	11/16/88	429	875.1	0.04
		11/17/88	1415	872.8	2.32
		11/17/88	1500	873.9	1.18
		11/17/88	1736	875.1	0.04
		11/17/88	1858	872.7	2.43
		11/18/88	2978	872.8	2.32

Pump Test Startup –	11/16/88	11:28
Pump Test Shutdown –	11/18/88	00:21

TABLE D–2
H88–16 PUMPING TEST CELL
PIEZOMETER MEASURMENTS

PB–12
BASE ELEVATION (G.S.)= 1094.5 ft.

PIEZO– METER NUMBER	PIEZO– METER ELEV. FT. MSL	DATE	ELAPSED TIME (MIN)	PIEZO ELEV. (FT)	DRAWDOWN FROM REF. W.L
1	760.3	11/09/88	-7130	1004.7	-0.03
REFERENCE		11/10/88	-5769	1004.7	-0.05
W.L.=	1004.7	11/10/88	-5534	1008.9	-4.16
		11/11/88	-4391	1004.3	0.43
		11/11/88	-4297	1000.1	4.57
		11/11/88	-4190	1002.4	2.27
		11/11/88	-3811	1002.4	2.27
		11/12/88	-2951	1004.7	-0.03
		11/13/88	-1309	1004.7	-0.03
		11/14/88	-93	1004.7	-0.03
		11/14/88	-25	1005.9	-1.18
		11/14/88	48	1004.7	-0.03
		11/14/88	390	1004.7	-0.03
		11/14/88	475	1004.7	-0.03
		11/14/88	629	1007.0	-2.33
		11/15/88	724	1008.2	-3.47
		11/15/88	780	1004.7	-0.03
		11/15/88	1330	1004.7	-0.03
		11/15/88	1380	1005.9	-1.18
2	868.7	11/09/88	-7128	1039.4	-2.40
REFERENCE		11/10/88	-5767	1040.5	-3.54
W.L.=	1037.0	11/10/88	-5532	1043.8	-6.75
		11/10/88	-5443	1039.3	-2.28
		11/11/88	-4387	1031.2	5.85
		11/11/88	-4295	1032.5	4.47
		11/11/88	-4188	1033.7	3.33
		11/11/88	-3810	1030.2	6.77
		11/12/88	-2949	1007.3	29.67
		11/13/88	-1308	1034.8	2.18
		11/14/88	-91	1011.9	25.09
		11/14/88	-23	1037.1	-0.11
		11/14/88	49	1037.0	0.01
		11/14/88	392	1034.7	2.30
		11/14/88	477	1034.8	2.18
		11/14/88	630	1034.7	2.30
		11/15/88	729	1032.5	4.47
		11/15/88	782	1030.2	6.77
		11/15/88	1332	1031.4	5.62
		11/15/88	1381	1034.7	2.30
3	952.5	11/09/88	-7126	1044.7	1.26
REFERENCE		11/10/88	-5764	1012.7	33.33
W.L.=	1046.0	11/10/88	-5530	1047.9	-1.94
		11/10/88	-5440	1045.7	0.35
		11/11/88	-4386	1046.1	-0.11
		11/11/88	-4293	1041.3	4.70
		11/11/88	-4187	1045.4	0.58
		11/11/88	-3808	1041.3	4.70
		11/12/88	-2948	1041.3	4.70
		11/13/88	-1306	1045.9	0.12
		11/14/88	-90	1045.9	0.12
		11/14/88	-22	1045.9	0.12
		11/14/88	50	1045.8	0.23
		11/14/88	394	1045.9	0.12
		11/14/88	478	1045.8	0.23
		11/14/88	631	1044.7	1.26
		11/15/88	730	1043.6	2.41
		11/15/88	783	1044.7	1.26
		11/15/88	1333	1041.3	4.70
		11/15/88	1382	1043.6	2.41
4	970.8	11/09/88	-7125	1029.2	10.81
REFERENCE		11/10/88	-5762	1063.6	-23.58
W.L.=	1040.0	11/10/88	-5529	1031.5	8.51
		11/10/88	-5439	1031.3	8.74
		11/11/88	-4385	1033.8	6.22
		11/11/88	-4291	1029.2	10.81
		11/11/88	-4186	1032.6	7.37
		11/11/88	-3807	1031.5	8.51
		11/12/88	-2947	1031.5	8.51
		11/13/88	-1305	1031.5	8.51
		11/14/88	-89	1031.5	8.51
		11/14/88	-21	1031.5	8.51
		11/14/88	51	1040.5	-0.54
		11/14/88	396	1031.5	8.51
		11/14/88	480	1032.6	7.37
		11/14/88	632	1036.0	4.04
		11/15/88	732	1029.2	10.81
		11/15/88	784	1029.2	10.81
		11/15/88	1334	1029.2	10.81
		11/15/88	1383	1031.5	8.51

PB–13
BASE ELEVATION (G.S.)= 1100.8 ft.

PIEZO– METER NUMBER	PIEZO– METER ELEV. FT. MSL	DATE	ELAPSED TIME (MIN)	PIEZO ELEV. (FT)	DRAWDOWN FROM REF. W.L
1	747.8	11/09/88	-6420	1046.4	0.65
REFERENCE		11/10/88	-5075	1047.0	-0.04
W.L.=	1047.0	11/10/88	-4829	819.9	227.13
		11/10/88	-4749	NR	NR
		11/11/88	-3659	1042.5	4.55
		11/11/88	-3480	1044.7	2.25
		11/11/88	-3082	1042.9	4.09
		11/12/88	-2243	1044.7	2.25
		11/13/88	-606	1047.0	-0.04
		11/14/88	638	1046.9	0.07
		11/14/88	758	1047.0	-0.04
		11/14/88	1121	1047.0	-0.04
		11/14/88	1224	1047.0	-0.04
		11/14/88	1358	1050.5	-3.48
		11/15/88	1464	1049.3	-2.34
		11/15/88	1509	1047.0	-0.04
		11/15/88	2087	1047.0	-0.04
2	825.8	11/09/88	-6418	1047.4	2.24
REFERENCE		11/10/88	-5068	1048.5	1.10
W.L.=	1049.6	11/10/88	-4826	1051.9	-2.33
		11/10/88	-4743	1047.4	2.24
		11/11/88	-3658	1047.4	2.24
		11/11/88	-3475	1049.6	-0.04
		11/11/88	-3083	1049.6	-0.04
		11/12/88	-2241	1049.6	-0.04
		11/13/88	-603	1051.8	-2.22
		11/14/88	640	1049.5	0.07
		11/14/88	760	1049.6	-0.04
		11/14/88	1123	1047.4	2.24
		11/14/88	1226	1049.6	-0.04
		11/14/88	1361	1051.8	-2.22
		11/15/88	1466	1051.8	-2.22
		11/15/88	1510	1049.6	-0.04
		11/15/88	2088	1048.5	1.10
3	880.8	11/09/88	-6417	1056.3	2.26
REFERENCE		11/10/88	-5067	1056.8	1.80
W.L.=	1058.6	11/10/88	-4822	1060.7	-2.10
		11/10/88	-4741	1056.6	2.03
		11/11/88	-3657	1056.3	2.26
		11/11/88	-3472	1057.5	1.11
		11/11/88	-3083	1056.3	2.26
		11/12/88	-2240	1058.6	-0.04
		11/13/88	-600	1058.6	-0.04
		11/14/88	642	1056.3	2.26
		11/14/88	762	1058.6	-0.04
		11/14/88	1125	1056.3	2.26
		11/14/88	1227	1058.5	0.08
		11/14/88	1363	1056.3	2.26
		11/15/88	1467	1034.5	24.06
		11/15/88	1511	1056.3	2.26
		11/15/88	2090	1057.5	1.11
4	970.8	11/09/88	-6415	1054.3	3.70
REFERENCE		11/10/88	-5066	1054.5	3.47
W.L.=	1058.0	11/10/88	-4821	1058.8	-0.77
		11/10/88	-4738	1055.7	2.35
		11/11/88	-3656	1057.7	0.26
		11/11/88	-3470	1057.7	0.26
		11/11/88	-3084	1058.9	-0.88
		11/12/88	-2239	1056.6	1.41
		11/13/88	-598	1058.9	-0.88
		11/14/88	643	1056.5	1.52
		11/14/88	763	1056.6	1.41
		11/14/88	1127	1058.8	-0.77
		11/14/88	1228	1061.1	-3.06
		11/14/88	1364	1057.7	0.26
		11/15/88	1468	1056.6	1.41
		11/15/88	1512	1056.6	1.41
		11/15/88	2092	1056.6	1.41

Pump Test Startup –	11/14/88	12:00
Pump Test Shutdown –	11/15/88	00:39

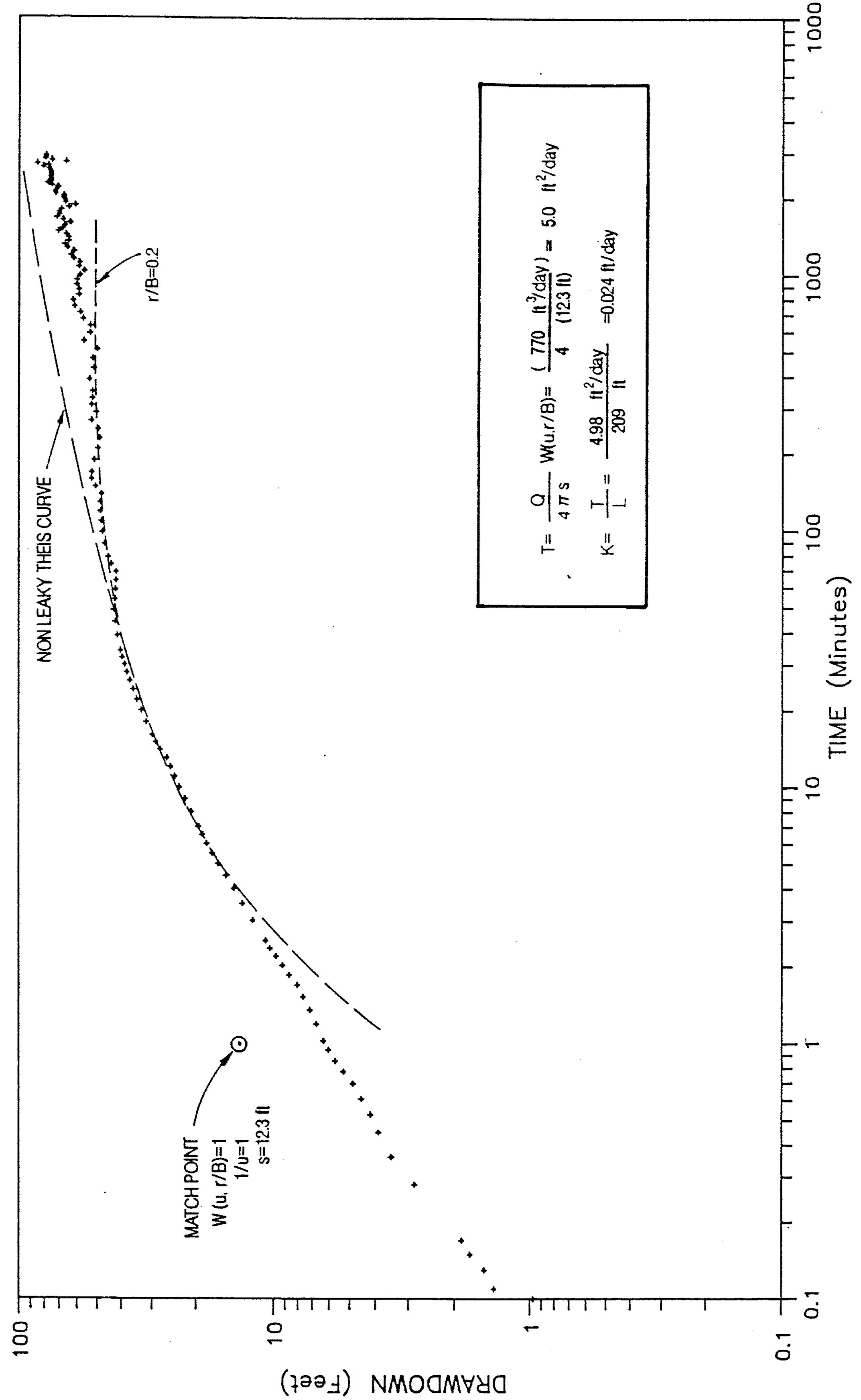
TABLE D-2
H88-16 PUMPING TEST CELL
PIEZOMETER MEASURMENTS

PB-102

BASE ELEVATION (G.S.)= 1096.8

PIEZO- METER NUMBER	PIEZO- METER ELEV. FT. MSL	DATE	ELAPSED TIME (MIN)	PIEZO ELEV. (FT)	DRAWDOWN FROM REF W.L.
1	712.6	11/09/88	-7115	1025.7	-1.72
		11/10/88	-5743	1030.3	-6.31
	REFERENCE	11/10/88	-5521	1030.3	-6.31
W.L. =	1024.0	11/10/88	-5431	NR	NR
		11/11/88	-4210	1014.2	9.75
		11/11/88	-3793	1013.1	10.90
		11/12/88	-2940	1016.5	7.46
		11/13/88	-1290	1022.3	1.72
		11/14/88	-69	NR	NR
		11/14/88	-36	1023.4	0.57
		11/14/88	29	1025.7	-1.72
		11/14/88	411	1021.1	2.87
		11/14/88	514	1021.1	2.87
		11/14/88	650	1021.1	2.87
		11/15/88	770	1021.1	2.87
		11/15/88	1355	1021.1	2.87
		11/15/88	1392	1021.1	2.87
2	819.1	11/09/88	-7112	1004.9	3.43
		11/10/88	-5742	1008.3	-0.02
	REFERENCE	11/10/88	-5518	1006.0	2.28
W.L. =	1008.3	11/10/88	-5426	1008.2	0.10
		11/11/88	-4205	1006.0	2.28
		11/11/88	-3791	1010.6	-2.31
		11/12/88	-2939	1008.2	0.10
		11/13/88	-1289	1008.3	-0.02
		11/14/88	-64	1005.9	2.39
		11/14/88	-34	985.4	22.93
		11/14/88	31	1008.3	-0.02
		11/14/88	413	1008.2	0.10
		11/14/88	516	1008.3	-0.02
		11/14/88	652	1006.0	2.28
		11/15/88	771	1008.2	0.10
		11/15/88	1356	1008.2	0.10
		11/15/88	1393	1008.3	-0.02
3	875.6	11/09/88	-7110	1023.3	2.25
		11/10/88	-5740	1024.5	1.10
	REFERENCE	11/10/88	-5517	1025.6	-0.04
W.L. =	1025.6	11/10/88	-5422	1025.5	0.07
		11/11/88	-4202	1025.6	-0.04
		11/11/88	-3789	1034.8	-9.21
		11/12/88	-2938	1025.6	-0.04
		11/13/88	-1288	1025.6	-0.04
		11/14/88	-61	1023.3	2.25
		11/14/88	-33	1016.4	9.24
		11/14/88	33	1025.6	-0.04
		11/14/88	414	1024.5	1.10
		11/14/88	517	1026.8	-1.19
		11/14/88	653	1027.8	-2.22
		11/15/88	773	1025.6	-0.04
		11/15/88	1358	1025.6	-0.04
		11/15/88	1395	1025.6	-0.04

Pump Test Startup -	11/14/88	12:00
Pump Test Shutdown -	11/15/88	00:39



$$T= \frac{Q}{4\pi s} W(u,r/B)= \frac{(770 \ ft^3/day)}{4 \ (12.3 \ ft)} = 5.0 \ ft^2/day$$

$$K= \frac{T}{L} = \frac{4.98 \ ft^2/day}{209 \ ft} =0.024 \ ft/day$$

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 3/89

H88-15 PUMPING DATA
JACOB-HANTUSH LEAKY AQUIFER ANALYSIS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

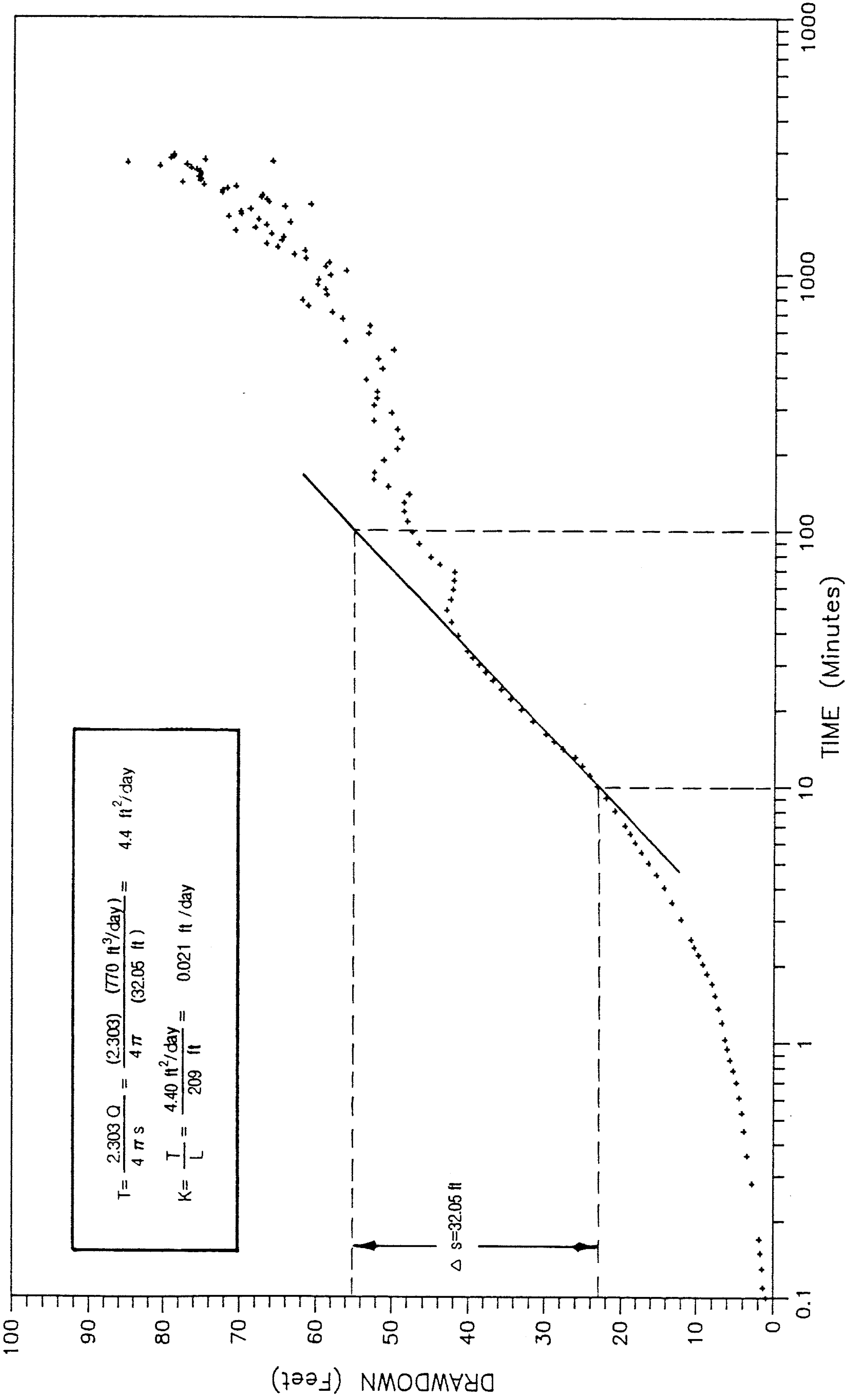
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. D-1

REV. 0

SCALE:



$$T = \frac{2.303\ Q}{4\ \pi\ s} = \frac{(2.303)}{4\pi}\ \frac{(770\ ft^3/day)}{(32.05\ ft)} = \ 4.4\ ft^2/day$$

$$K = \frac{T}{L} = \frac{4.40\ ft^2/day}{209\ ft} = \ 0.021\ ft/day$$

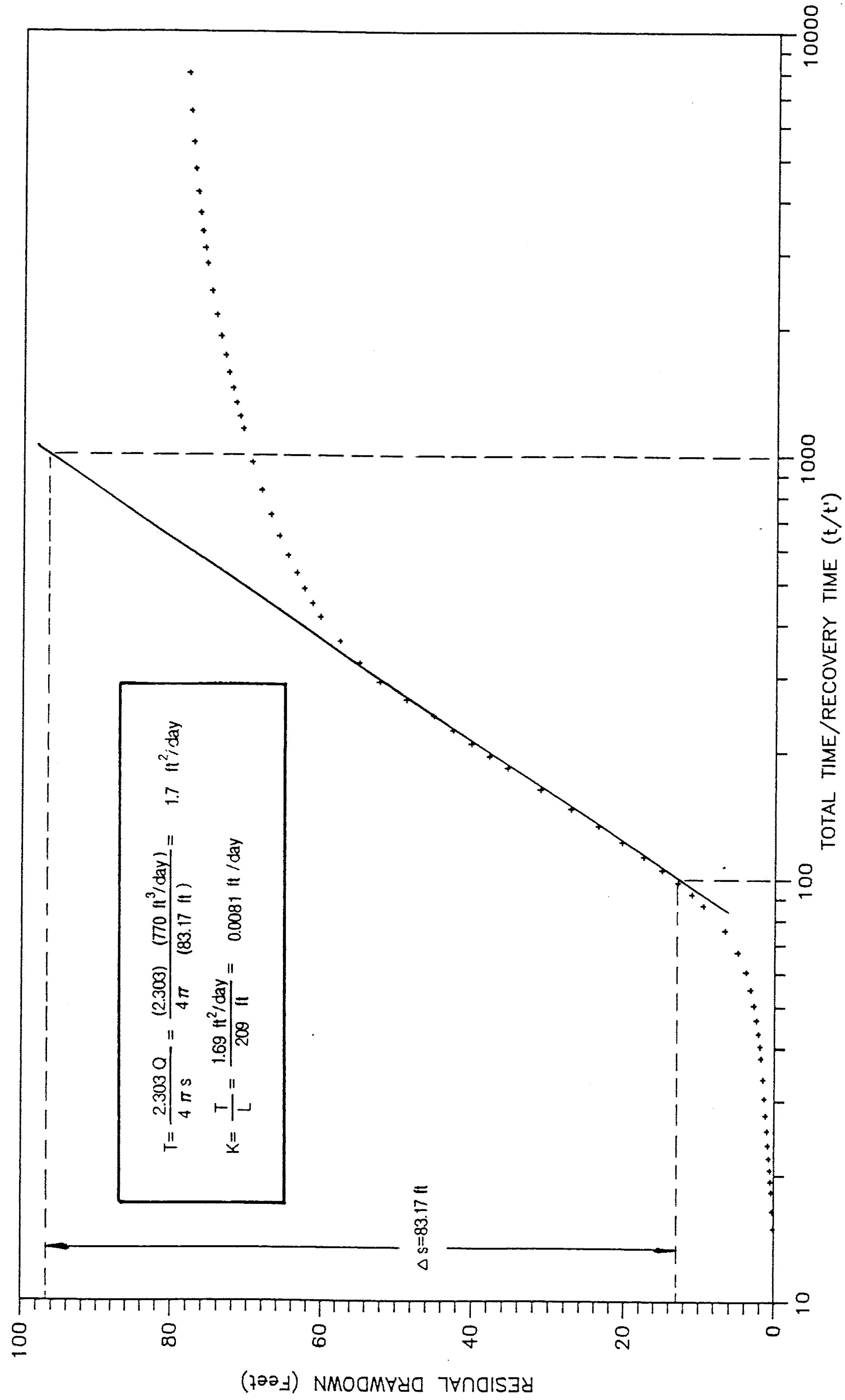
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 3/89

H88-15 PUMPING DATA
COOPER-JACOB SEMI-LOG ANALYSIS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. D-2
SCALE:
REV. 0



$$T=\frac{2.303\ Q}{4\ \pi\ s}=\frac{(2.303)}{4\pi}\ \frac{(770\ ft^3/day)}{(83.17\ ft)}=\ 1.7\ ft^2/day$$

$$K=\frac{T}{L}=\frac{1.69\ ft^2/day}{209\ ft}=\ 0.0081\ ft\ /day$$

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 3/89

H88-15 RECOVERY DATA
COOPER-JACOB SEMI-LOG ANALYSIS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

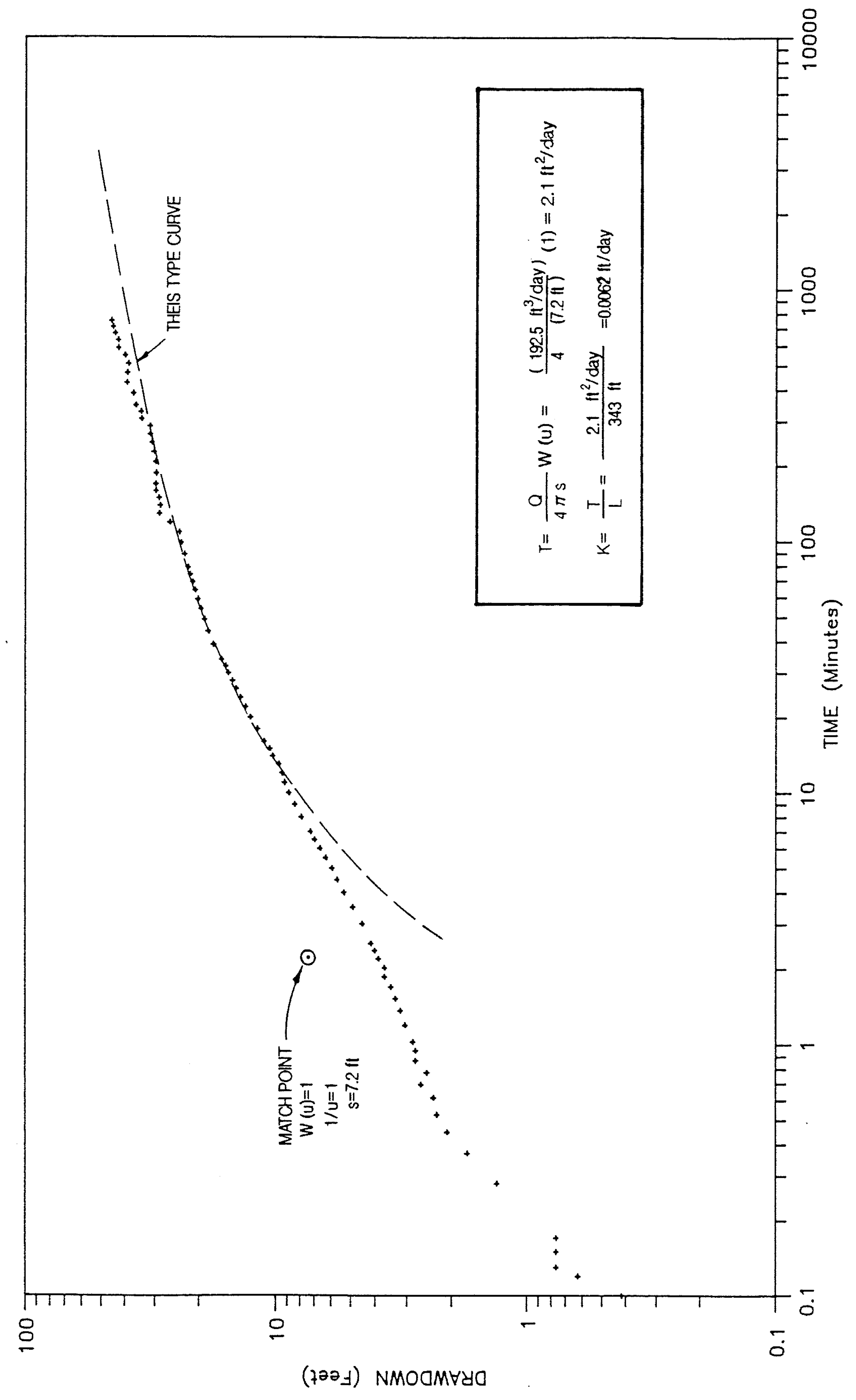
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. D-3

REV. 0

SCALE:



$T = \frac{Q}{4\pi s} W(u) = \frac{(192.5\ ft^3/day)}{4\ (7.2\ ft)}(1) = 2.1\ ft^2/day$

$K = \frac{T}{L} = \frac{2.1\ ft^2/day}{343\ ft} = 0.0062\ ft/day$

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 3/89

H88–16 PUMPING DATA
THEIS ANALYSIS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

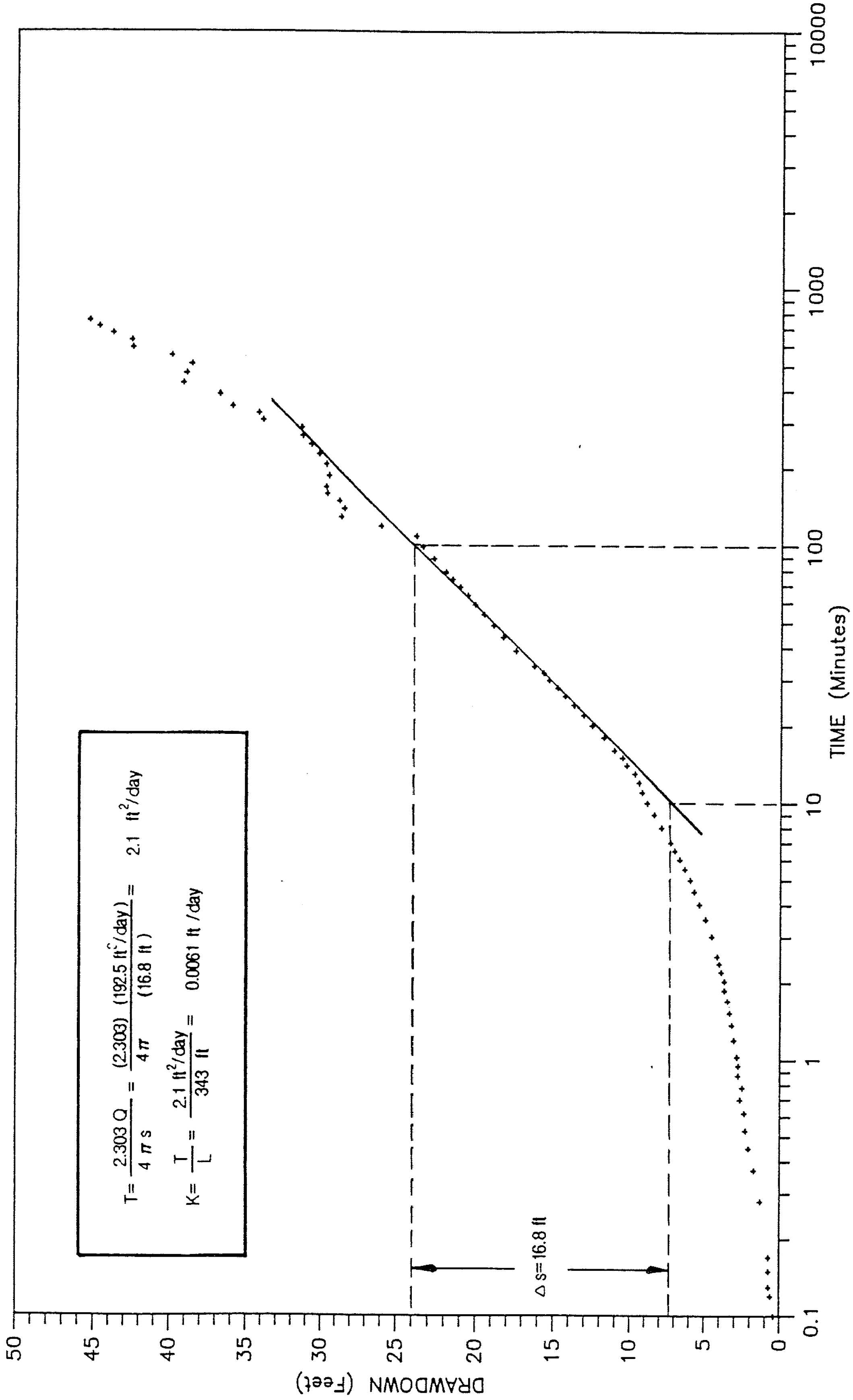
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. D-4

REV. 0

SCALE:



$$T=\frac{2.303\,Q}{4\,\pi\,s}=\frac{(2.303)\;(192.5\ \text{ft}^2/\text{day})}{4\,\pi\quad(16.8\ \text{ft})}=\quad 2.1\ \text{ft}^2/\text{day}$$

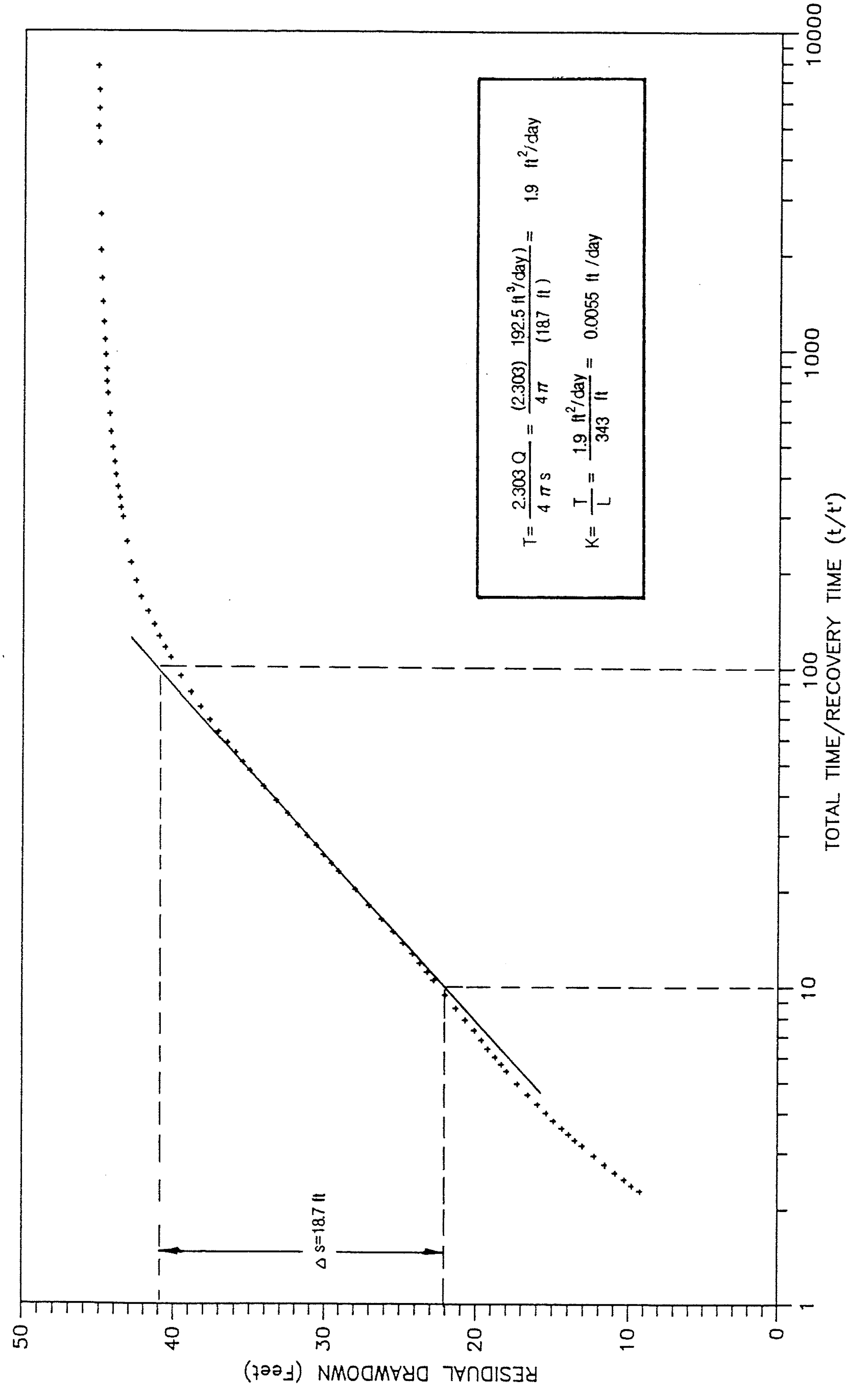
$$K=\frac{T}{L}=\frac{2.1\ \text{ft}^2/\text{day}}{343\ \text{ft}}=\quad 0.0061\ \text{ft}/\text{day}$$

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 3/89

H88−16 PUMPING DATA
COOPER−JACOBS SEMI−LOG ANALYSIS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683−2226

WISHBONE HILL MINE
PERMIT No. 01−89−796
FIGURE No. D−5
REV. 0
SCALE:



$$T= \frac{2.303\,Q}{4\,\pi\,s} = \frac{(2.303)}{4\pi}\frac{192.5\ ft^3/day)}{(18.7\ ft)} = 1.9\ ft^2/day$$

$$K= \frac{T}{L} = \frac{1.9\ ft^2/day}{343\ ft} = 0.0055\ ft\ /day$$

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 3/89

H88-16 RECOVERY DATA
COOPER-JACOBS SEMI-LOG ANALYSIS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

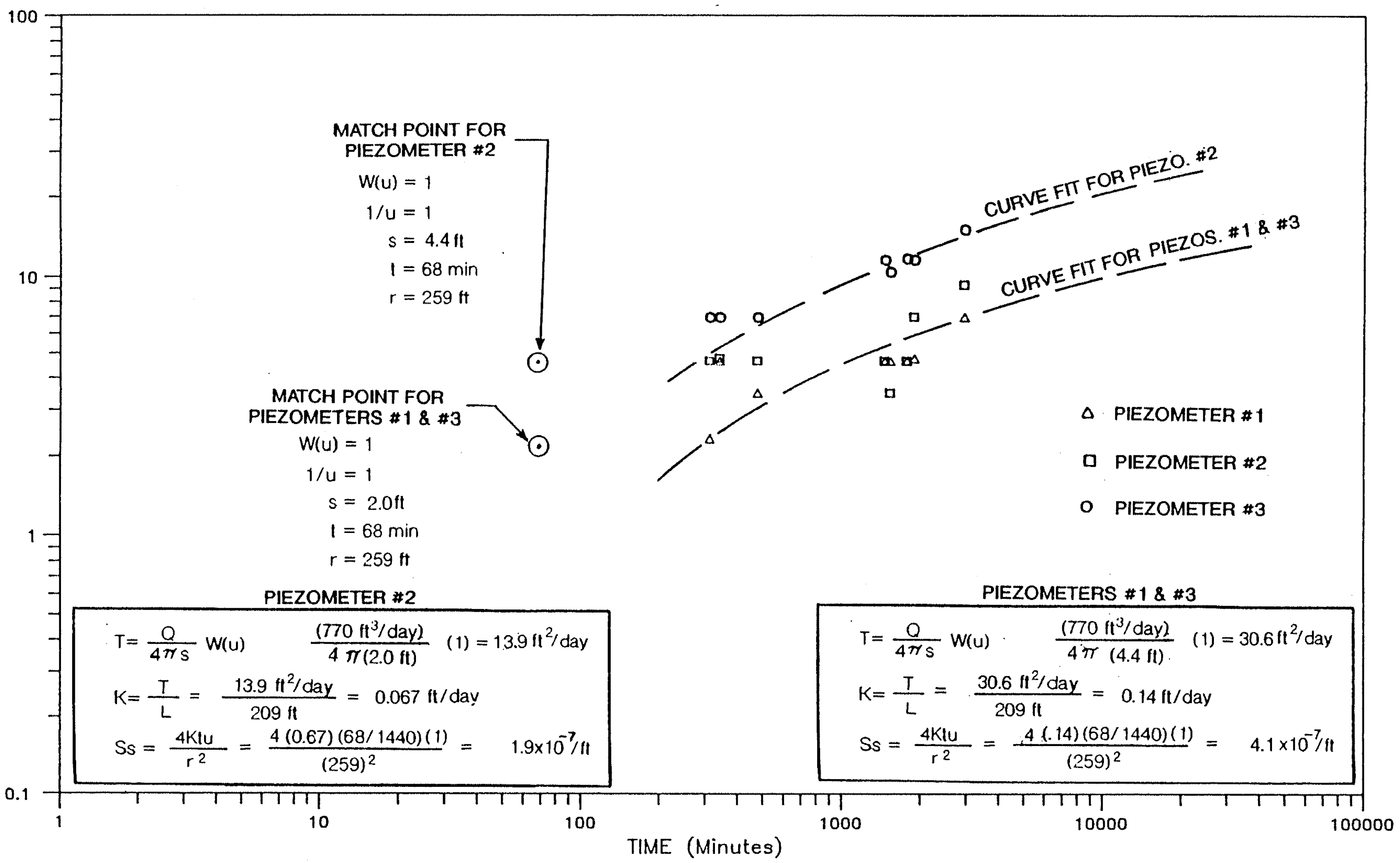
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. D-6

REV. 0

SCALE:



MATCH POINT FOR PIEZOMETER #2

W(u) = 1
1/u = 1
s = 4.4 ft
t = 68 min
r = 259 ft

MATCH POINT FOR PIEZOMETERS #1 & #3

W(u) = 1
1/u = 1
s = 2.0ft
t = 68 min
r = 259 ft

PIEZOMETER #2

$$T= \frac{Q}{4\pi s} W(u) \qquad \frac{(770\ ft^3/day)}{4\ \pi(2.0\ ft)} \ (1) = 13.9\ ft^2/day$$

$$K= \frac{T}{L} = \frac{13.9\ ft^2/day}{209\ ft} = 0.067\ ft/day$$

$$Ss = \frac{4Ktu}{r^2} = \frac{4\ (0.67)\ (68/1440)\ (1)}{(259)^2} = 1.9x10^{-7}/ft$$

PIEZOMETERS #1 & #3

$$T= \frac{Q}{4\pi s} W(u) \qquad \frac{(770\ ft^3/day)}{4\pi\ \ (4.4\ ft)} \ (1) = 30.6\ ft^2/day$$

$$K= \frac{T}{L} = \frac{30.6\ ft^2/day}{209\ ft} = 0.14\ ft/day$$

$$Ss = \frac{4Ktu}{r^2} = \frac{4\ (.14)\ (68/1440)\ (1)}{(259)^2} = 4.1\ x10^{-7}/ft$$

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 3/89

H88-15 PUMPING DATA
THEIS ANALYSIS

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

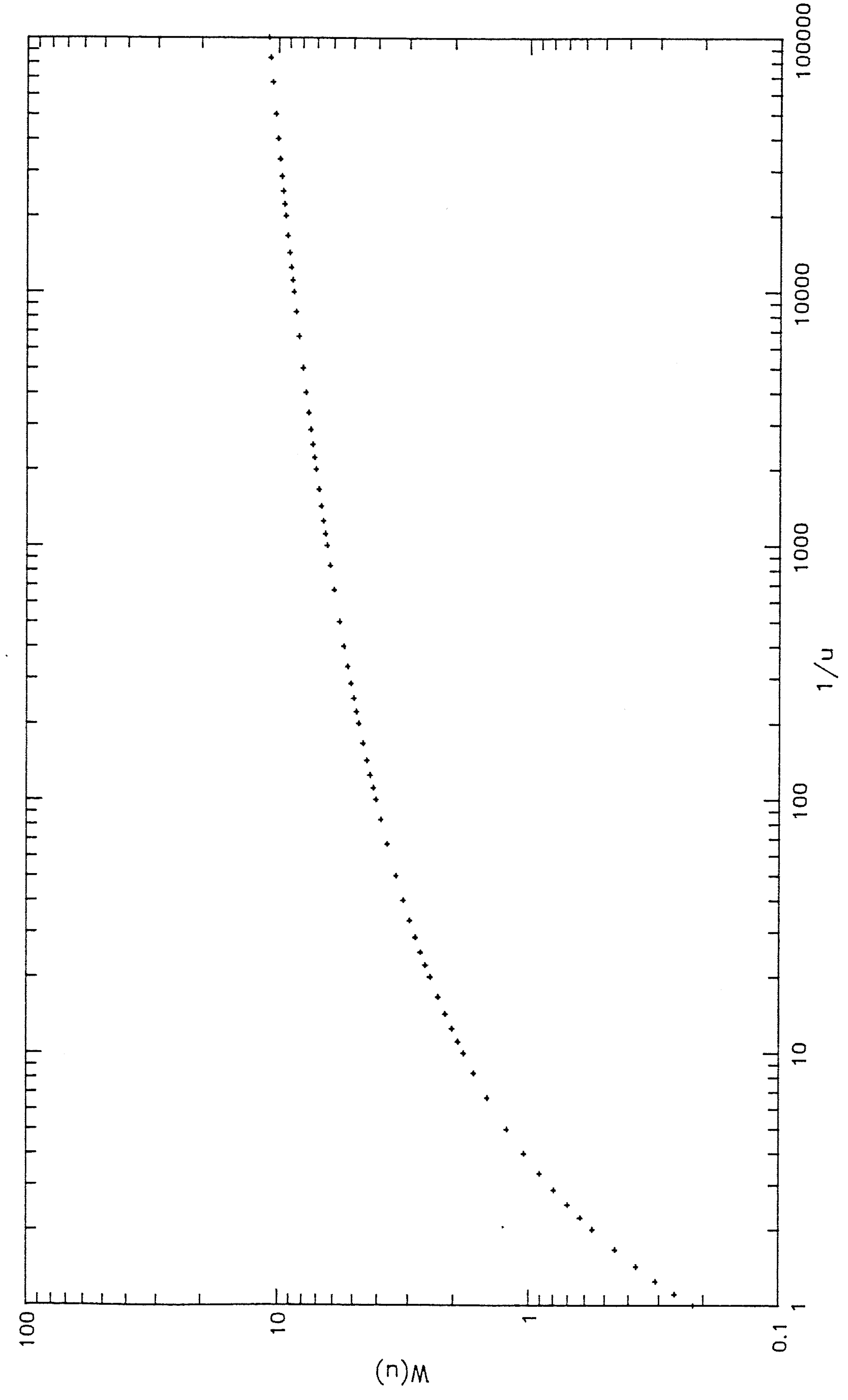
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. D-7

REV. 0

SCALE:



DESIGN BY:	THEIS TYPE CURVE	WISHBONE HILL MINE PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. D-8 REV. 0
DATE DRAWN: 3/89		SCALE:

WELL H89-29 PUMP TEST

G.S. ELEV = 772 ft approx PUMP ON 7/27/80 0910 hr
T.O.C. ELEV = 774.6 ft approx PUMP OFF 7/27/89 1355 hr
S.W.L. ELEV = 709.6 ft approx

ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAWDOWN (ft)	FLOW METER READING (gal)	CUMMULATIVE FLOW (gal)	AVG FLOW RATE (gpm)
0.0	64.98	0.00	2915	0	0.0
0.5	65.06	0.08			
1.0	65.06	0.08			
1.5	65.06	0.08			
3.0	65.06	0.08			
4.0	65.06	0.08			
4.5	65.06	0.08			
5.0	65.06	0.08	3201	286	57.2
7.0	65.06	0.08			
8.0	65.06	0.08			
9.0	65.06	0.08			
10.0	65.06	0.08	3475	560	56.0
11.0	65.06	0.08			
12.0	65.06	0.08			
13.0	65.06	0.08			
14.0	65.06	0.08			
15.0	65.08	0.10	3749	834	55.6
16.0	65.08	0.10			
17.0	65.08	0.10			
18.0	65.08	0.10			
19.0	65.08	0.10			
20.0	65.08	0.10	4023	1108	55.4
22.0	65.08	0.10			
24.0	65.08	0.10			
26.0	65.08	0.10			
28.0	65.08	0.10			
30.0	65.08	0.10	4597	1682	56.1
32.0	65.08	0.10			
34.0	65.08	0.10			
36.0	65.08	0.10			
38.0	65.08	0.10			
40.0	65.08	0.10	5121	2206	55.2
45.0	65.11	0.13			
50.0			5670	2755	55.1
75.0	65.14	0.16			
107.0	65.18	0.20			
122.0	65.18	0.20			
129.0	65.20	0.22	10030	7115	55.2
150.0	65.18	0.20			
160.0	65.16	0.18	11736	8821	55.1
210.0	65.18	0.20			
225.0	65.21	0.23	15271	12356	54.9
256.0	65.21	0.23	17018	14103	55.1
285.0	65.30	0.32	18590	15675	55.0

PUMP TURNED OFF AT 285 MIN ELAPSED TIME (CLOCK TIME 1355 HR)

0.25	65.23	0.25
1	65.22	0.24
2.5	65.25	0.27
3.5	65.24	0.26
4.5	65.23	0.25
5.5	65.23	0.25
6.5	65.24	0.26
7.5	65.23	0.25
8.5	65.22	0.24
10	65.23	0.25
14	65.22	0.24
15	65.22	0.24
49	65.17	0.19
1136	65.15	0.17

Golder Associates

Subject: Analysis of H89-29 Pump Test.

Made by: JR

Checked by:

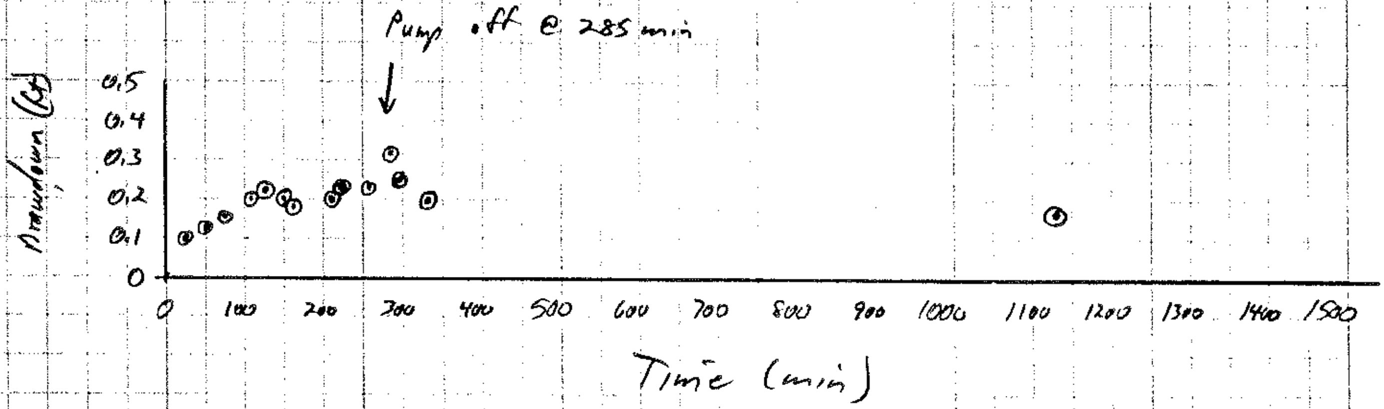
Approved by:

Job No. 883-2145

Date: 8/18/89

Sheet No.

Plot of Drawdown vs Time Data



Assumptions / Observations

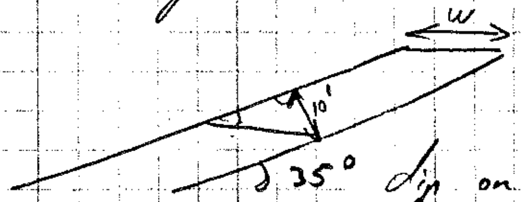
1) Based on initial drawdown of approx 0.1 ft and change in drawdown from 0.3 ft at end of test to 0.25 ft at beginning of recovery, it is likely that velocity head resulted in 0.05 to 0.10 ft of drawdown near well. Therefore, the actual decrease in water level in the mine void due to pumping was on the order of 0.25 ft

2) The accuracy of the electric water level probe is approximately 0.10 ft to 0.05 ft

3) Additional water level data from pump test contractor is not available for this analysis

Analysis

Assume an open reservoir with width



dip on coal based on X-sections from SRK

$$\frac{10\text{ ft}}{W} = \sin 35°$$

$$W = 10 / \sin 35° = 17.4\text{ ft}$$

Golder Associates

Subject: Analysis of H89-29 Pump Test

Made by: JM

Checked by:

Approved by:

Job No. 883-2145

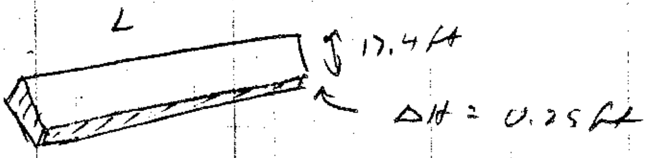
Date: 8/18/89

Sheet No. ②

Length of old workings influenced by pump test is unknown, estimate based on Vol of water removed, drawdown + width

Vol Removed = 15,675 gal = 2,096 ft^3

Change in WL = 0.25 ft



Assume 50% extraction

Void Ratio = 0.50

$$Vol = W \times L \times \Delta H \times \text{Void Ratio}$$

$$L = \frac{Vol}{W \times \Delta H \times \text{Void Rat.}} = \frac{2{,}096}{(17.4)(.25)(.5)}$$

$$= 964 \text{ ft}$$

This indicates that all of the old workings may not be directly interconnected. Length of old workings on west side of Moose Creek is approx 2000 ft. Within accuracy of this analysis the results may indicate that there is not direct interconnection of old workings beneath Moose Creek.

Recovery

from 0.25 to 0.17 ft in 1136 min – say 0.1 ft recovery

Based on drawdown data 15,675 gal = 0.25 ft drawdown

∴ 0.1 ft recovery = 6,270 gal

which is $\frac{6{,}270 \text{ gal}}{1136 \text{ min}}$ = 5.5 gpm

APPENDIX E

APPENDIX E-1

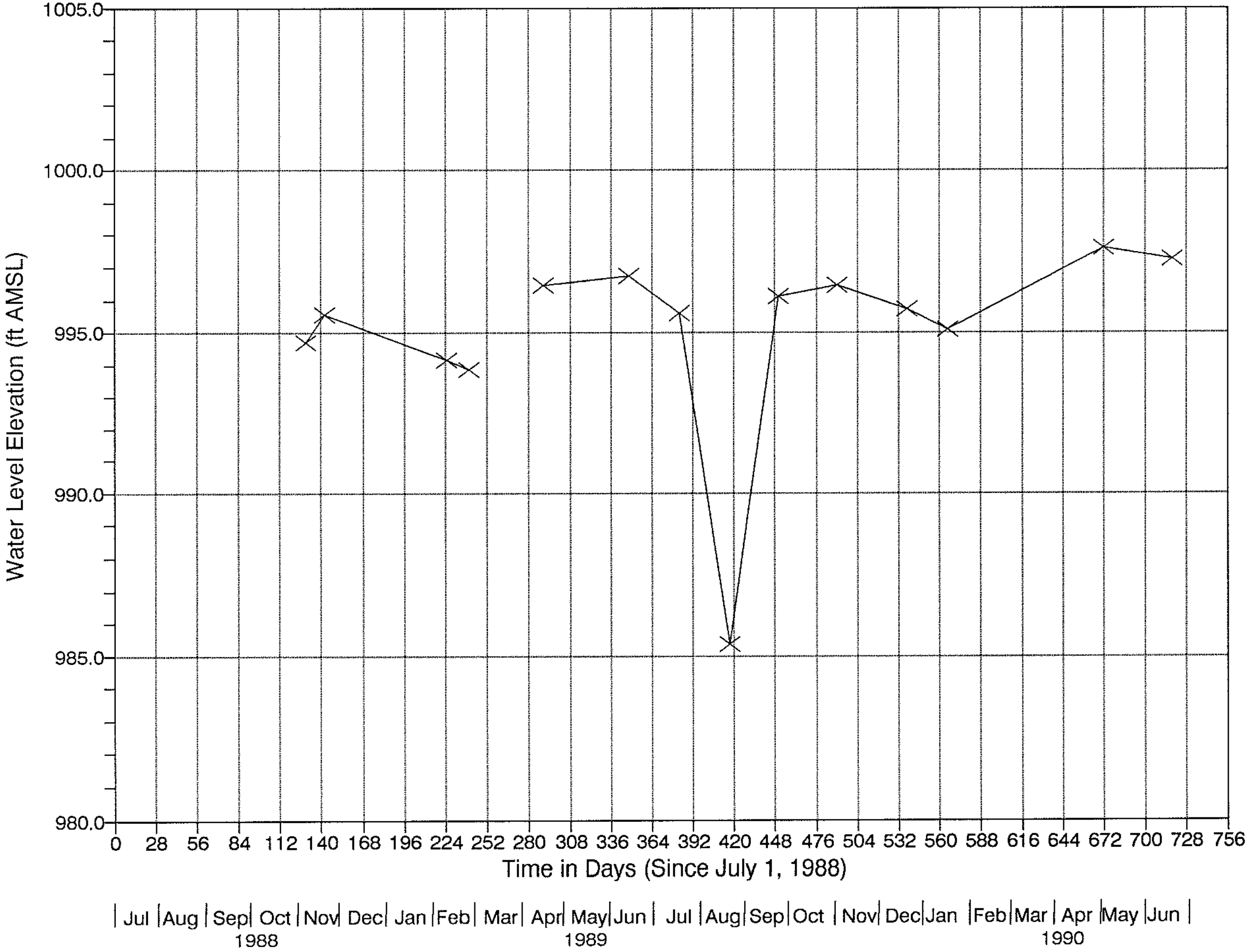
WATER LEVEL PLOTS FOR MONITORING WELLS

WATER LEVELS IN H88-10

WATER LEVELS IN H88-11

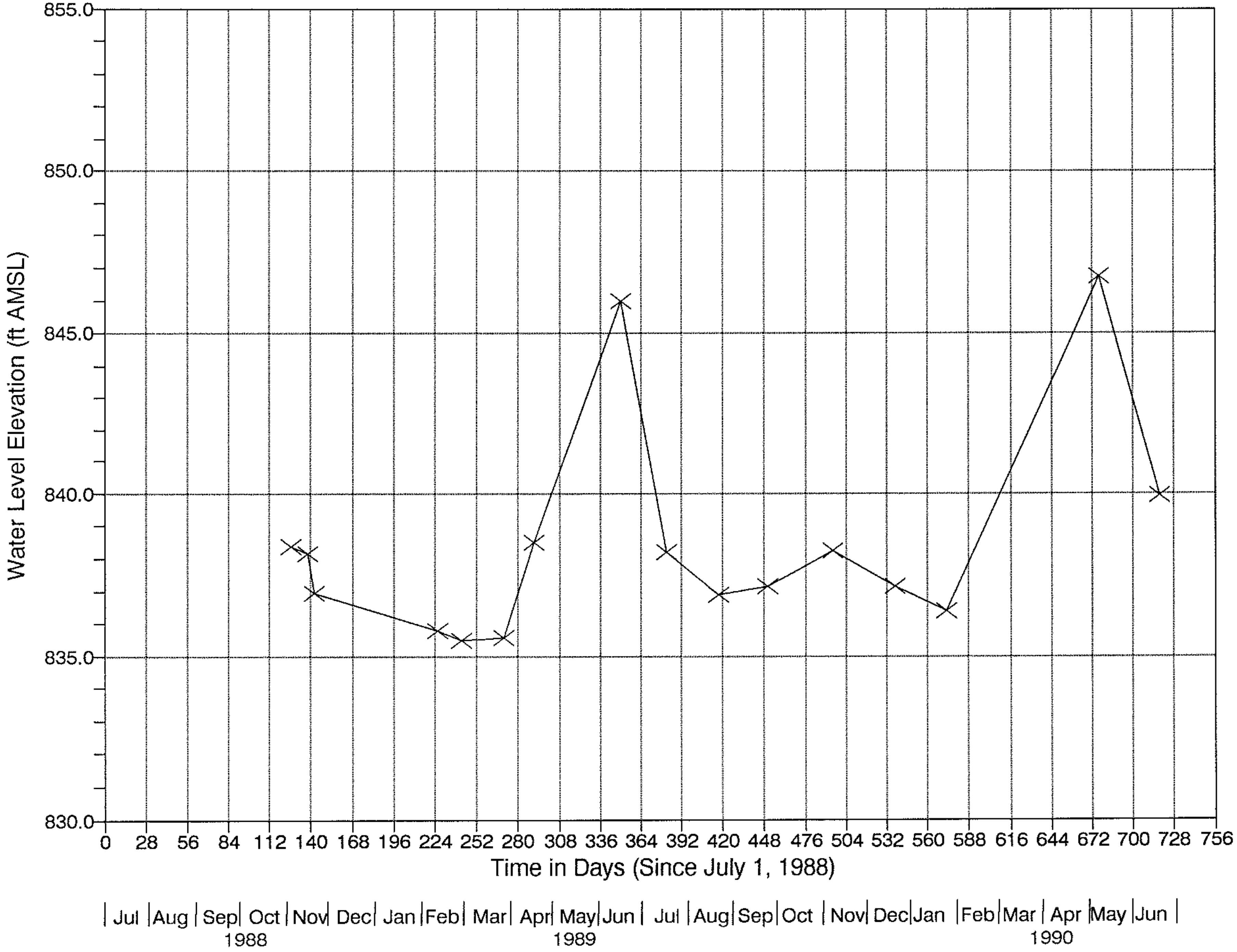
WATER LEVELS IN H88-12

WATER LEVELS IN H88-13

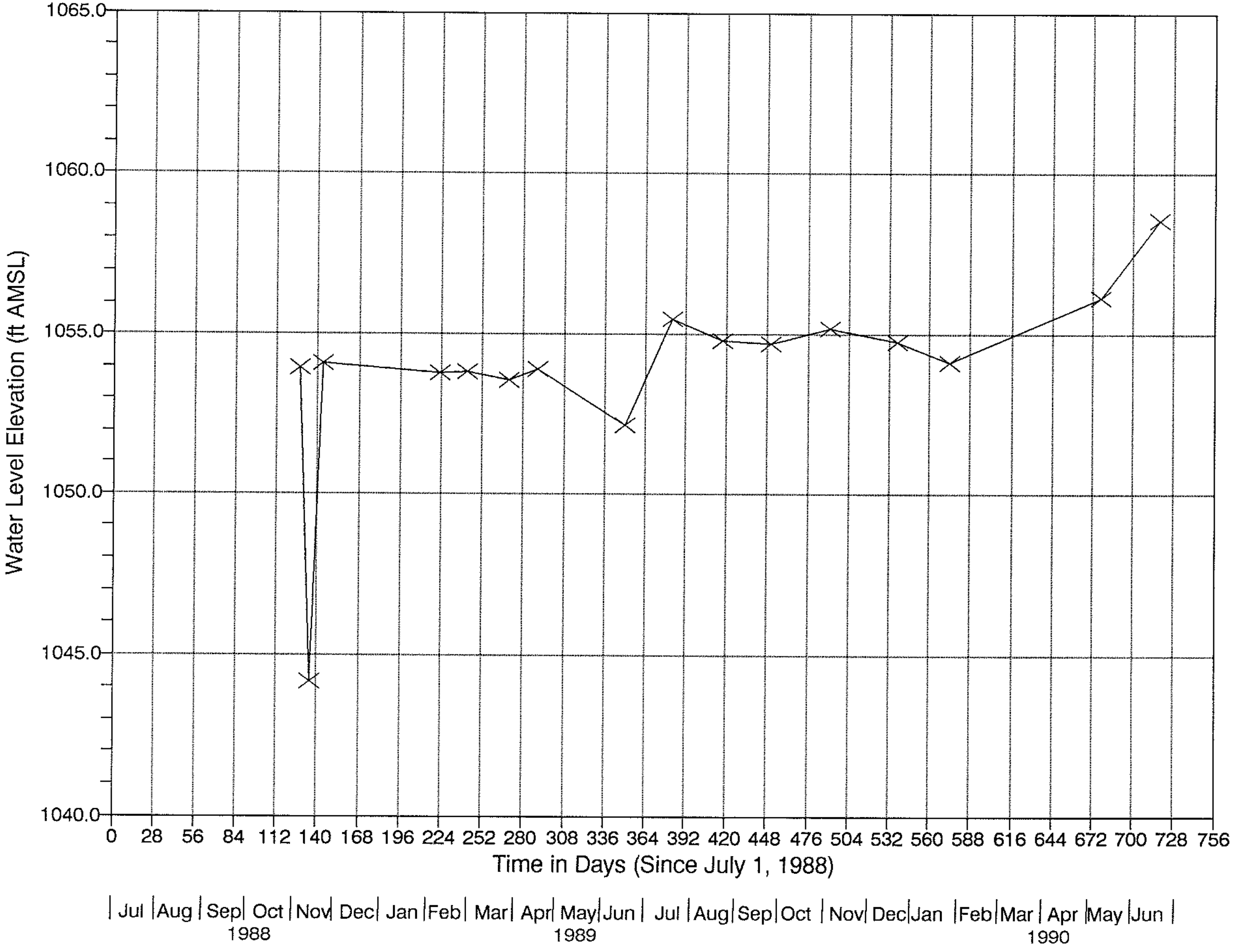


WATER LEVELS IN H88-14A

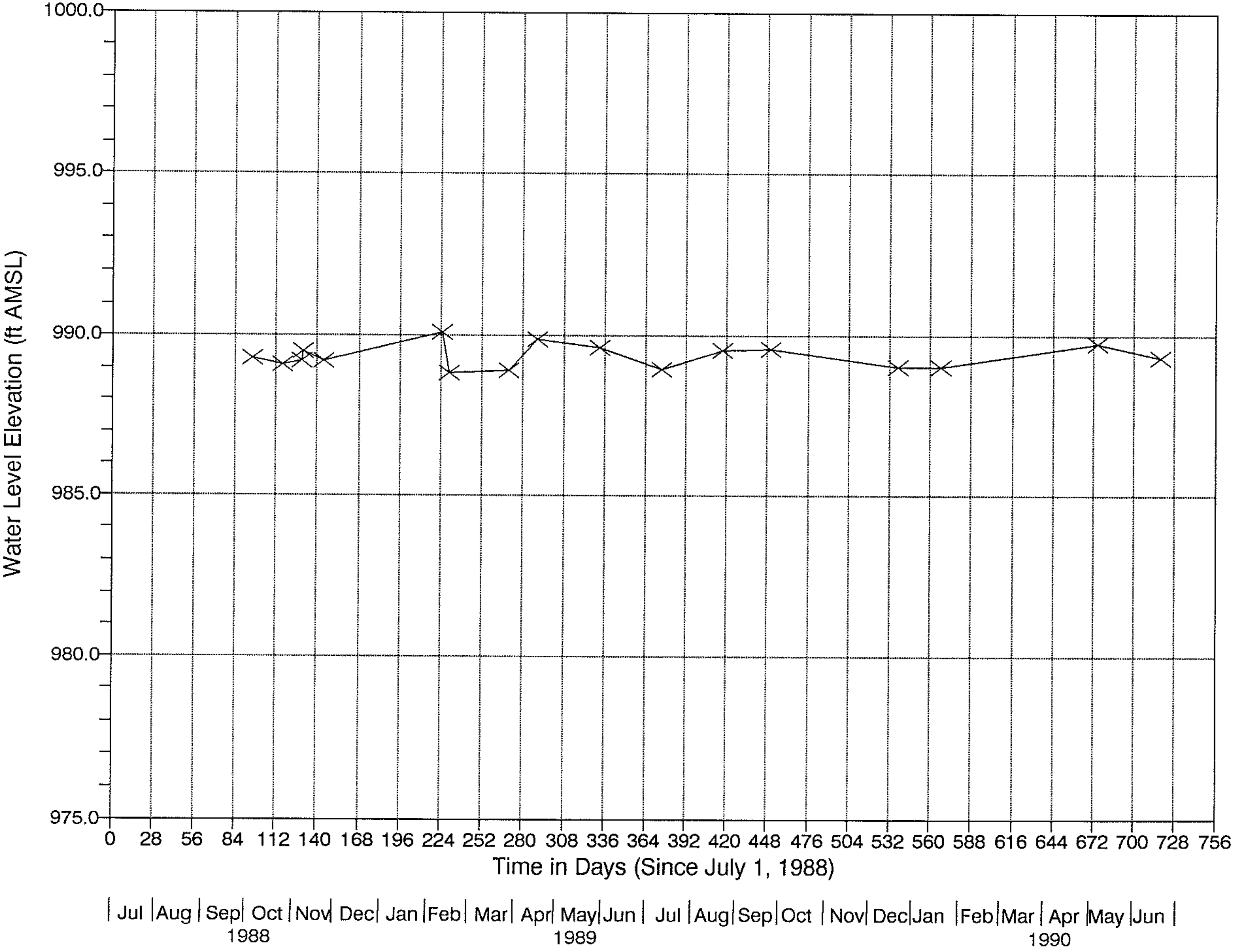
WATER LEVELS IN H88-15



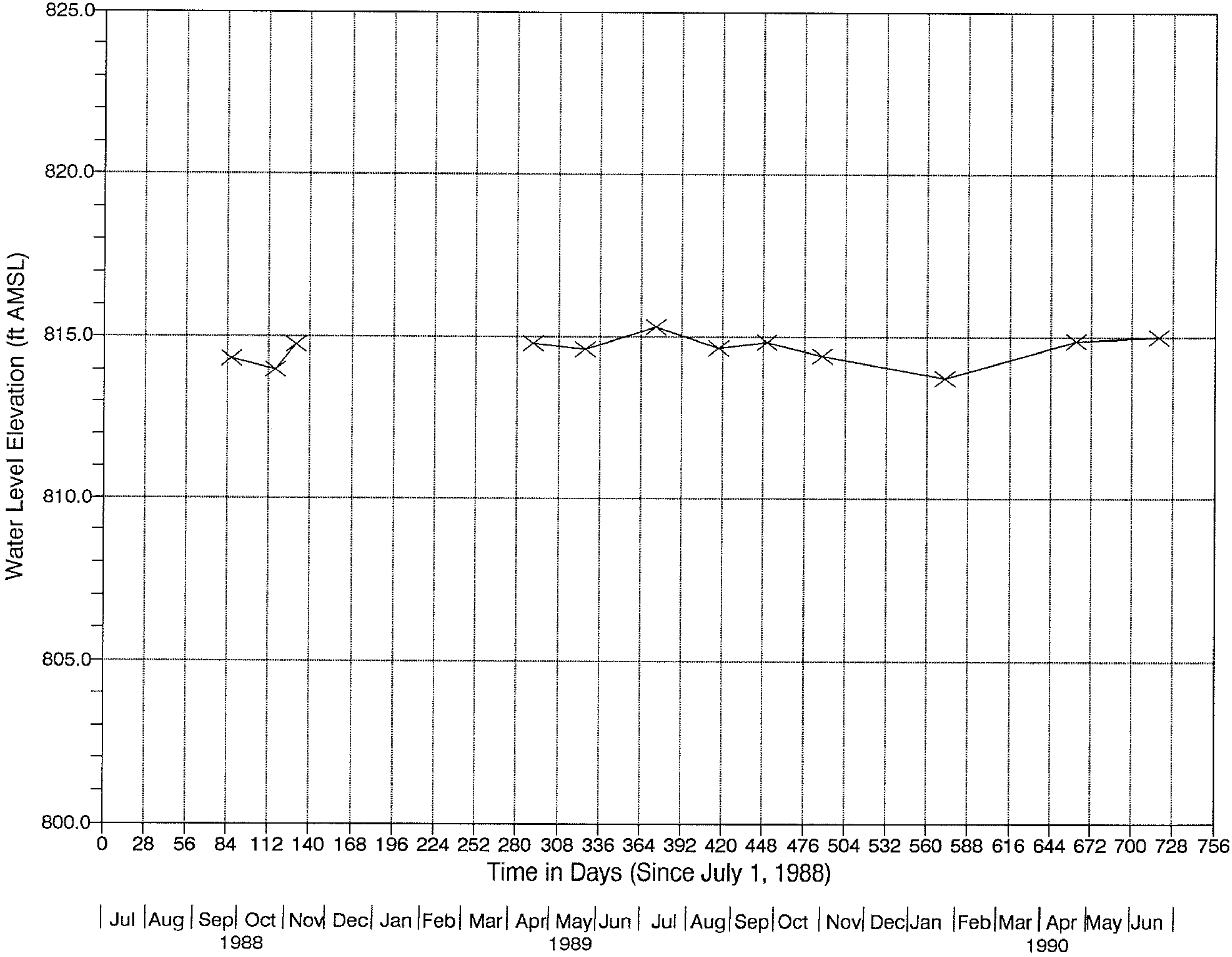
WATER LEVELS IN H88-16



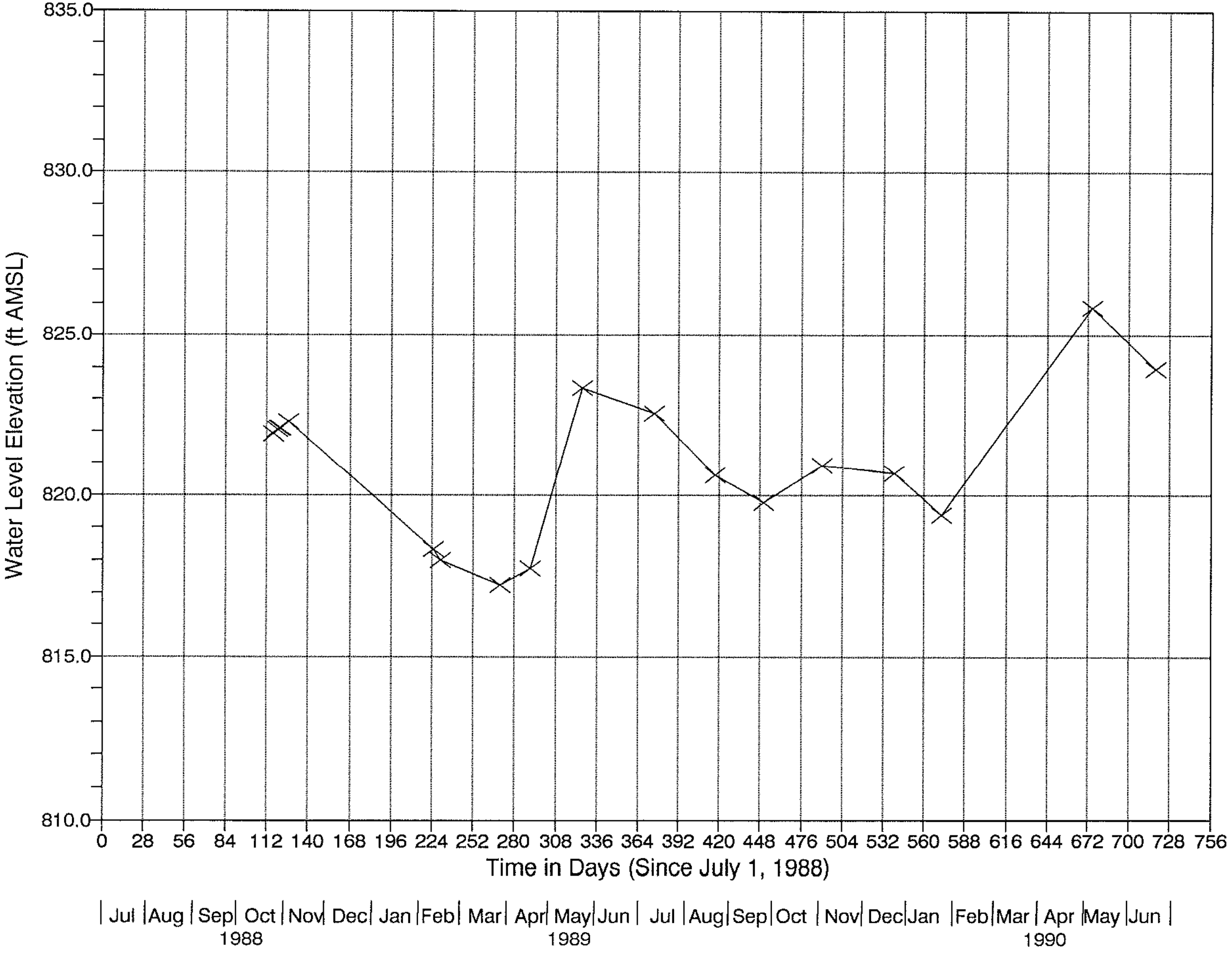
WATER LEVELS IN H88-17



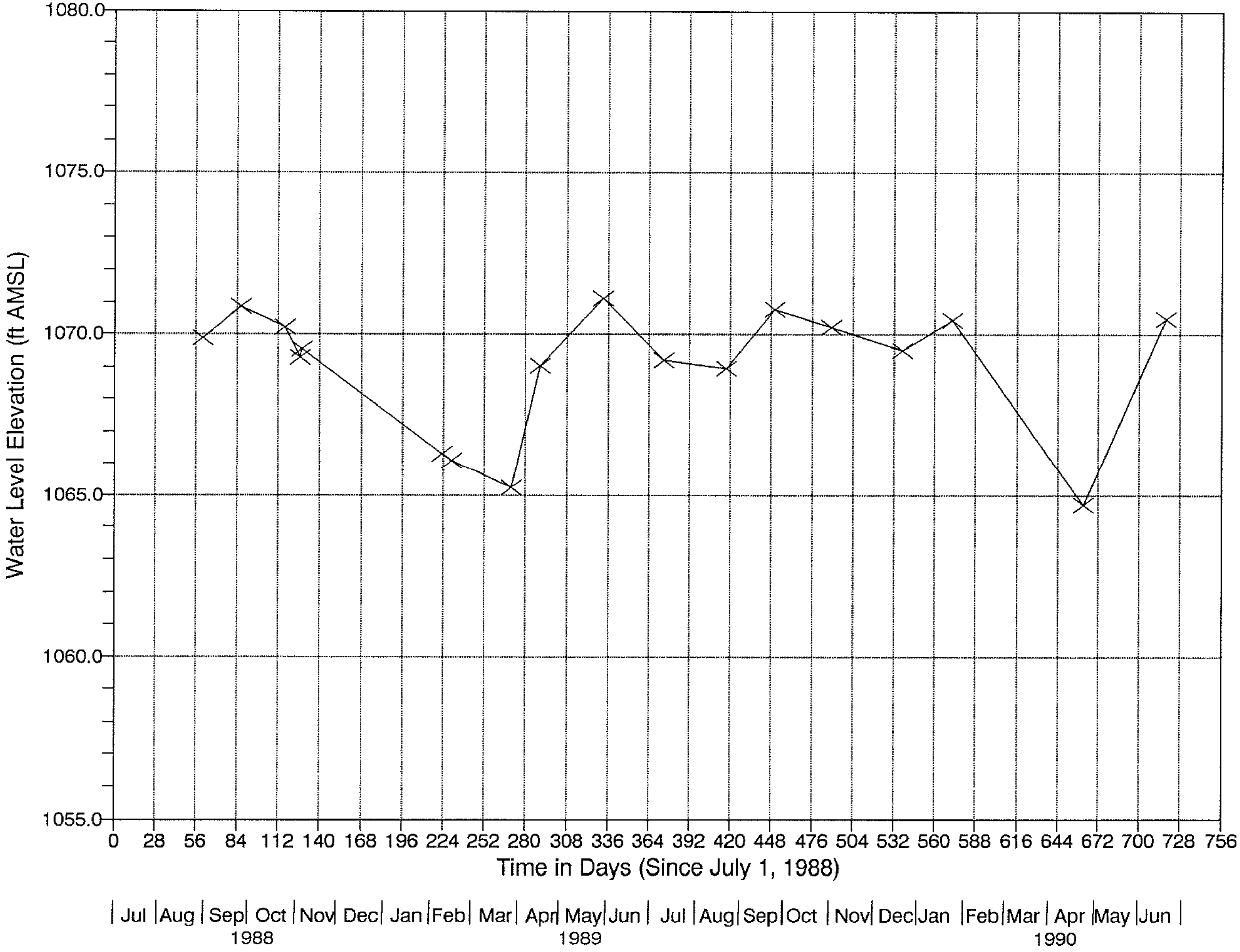
WATER LEVELS IN H88-19



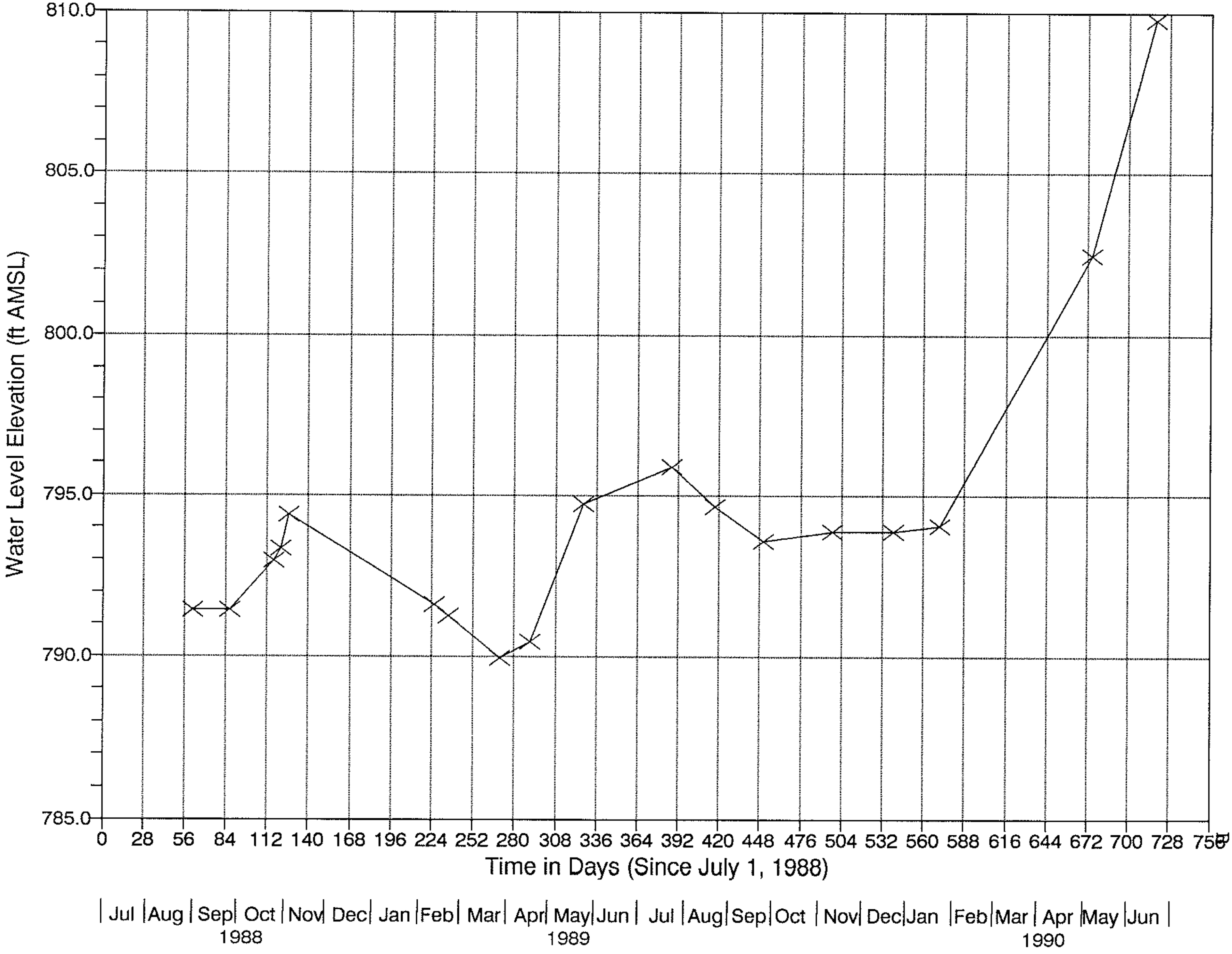
WATER LEVELS IN H88-21



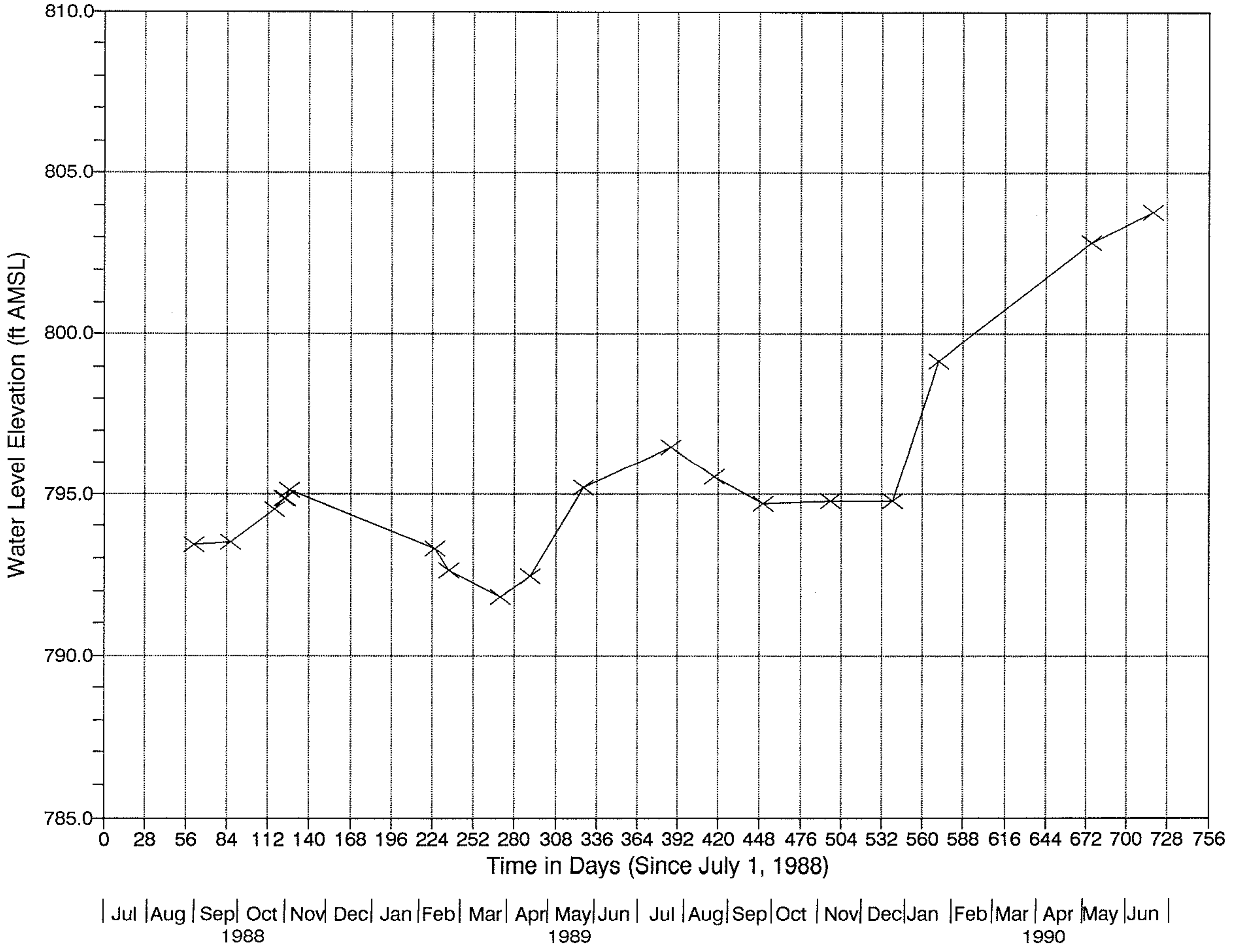
WATER LEVELS IN H88-22



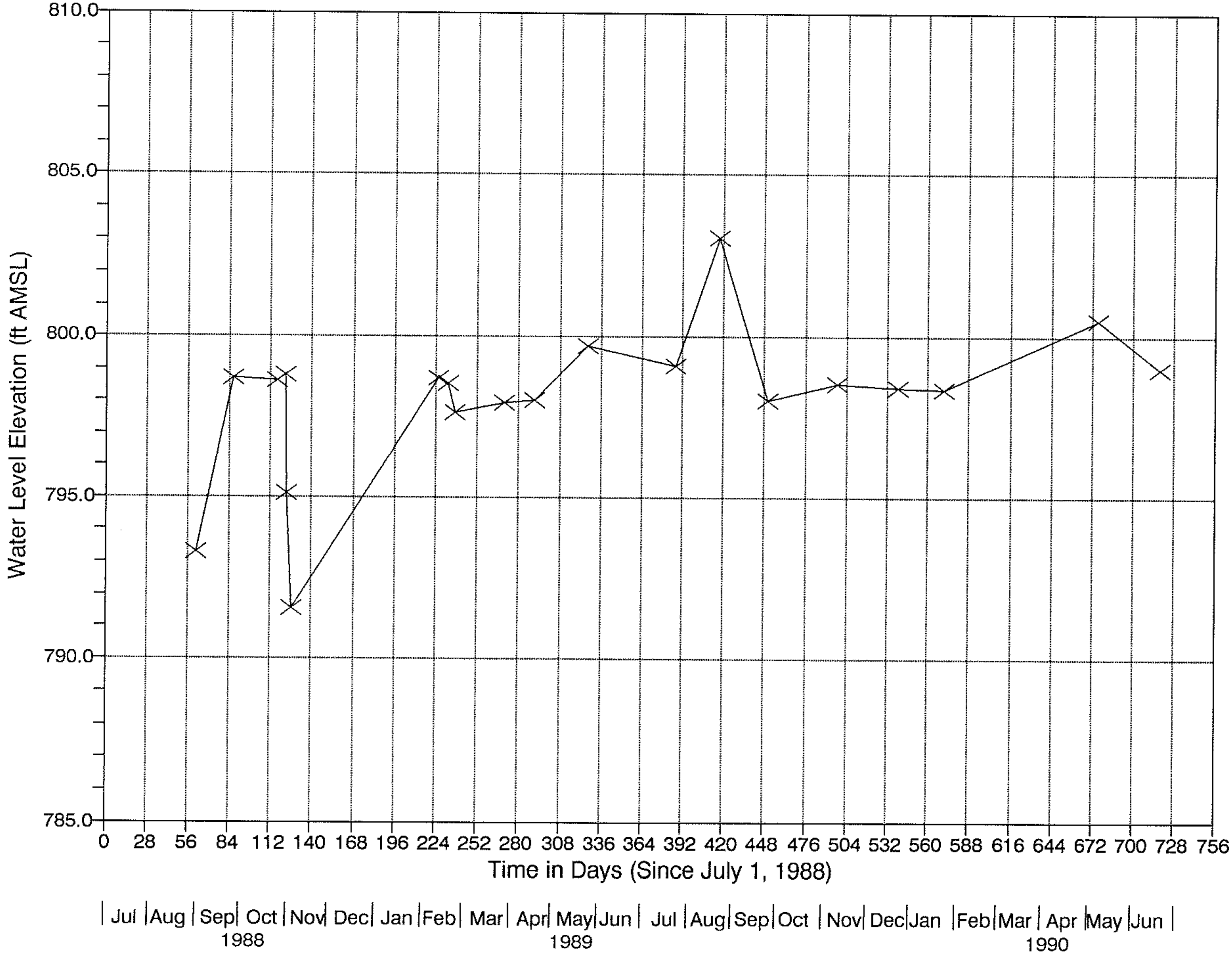
WATER LEVELS IN H88-23



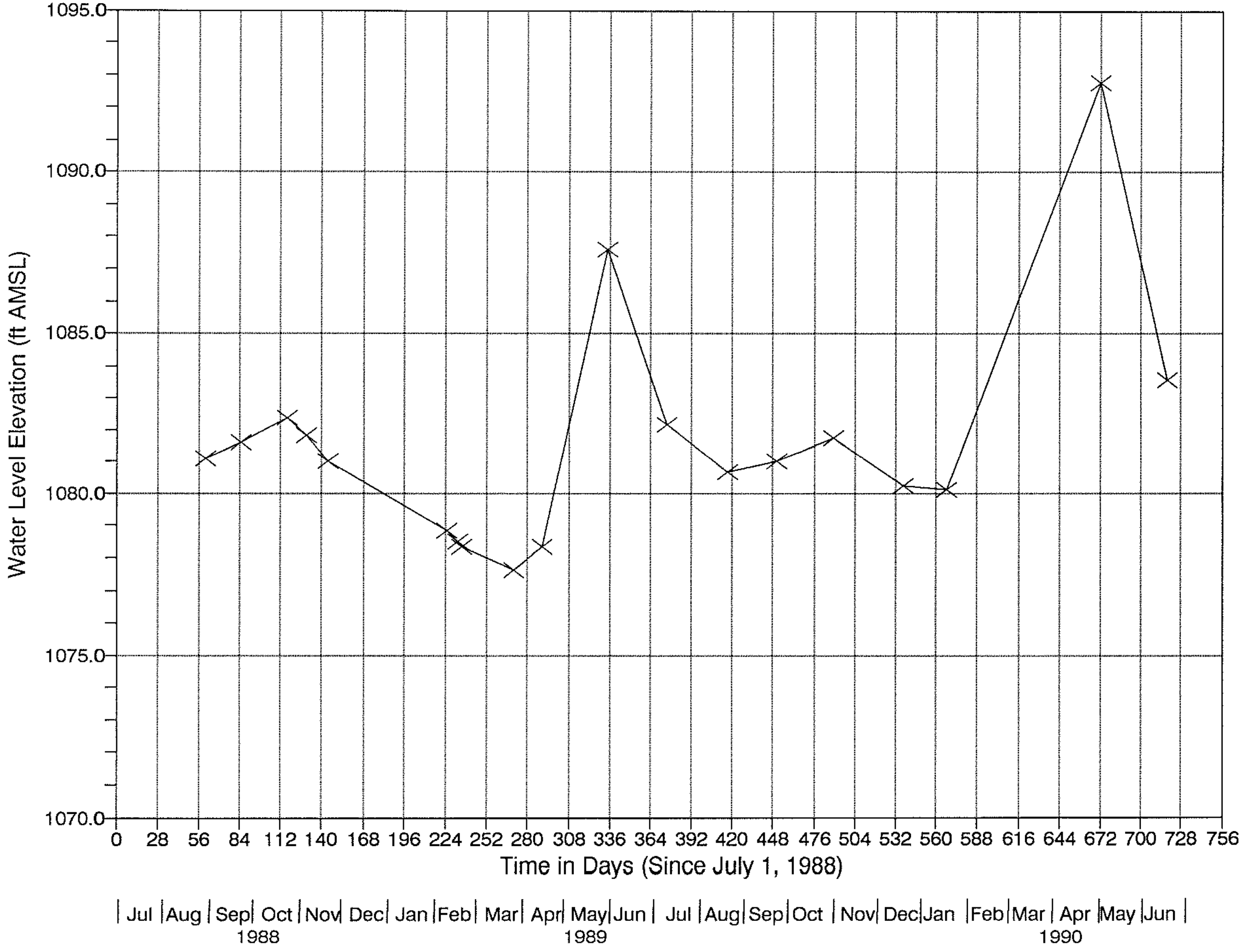
WATER LEVELS IN H88-24A



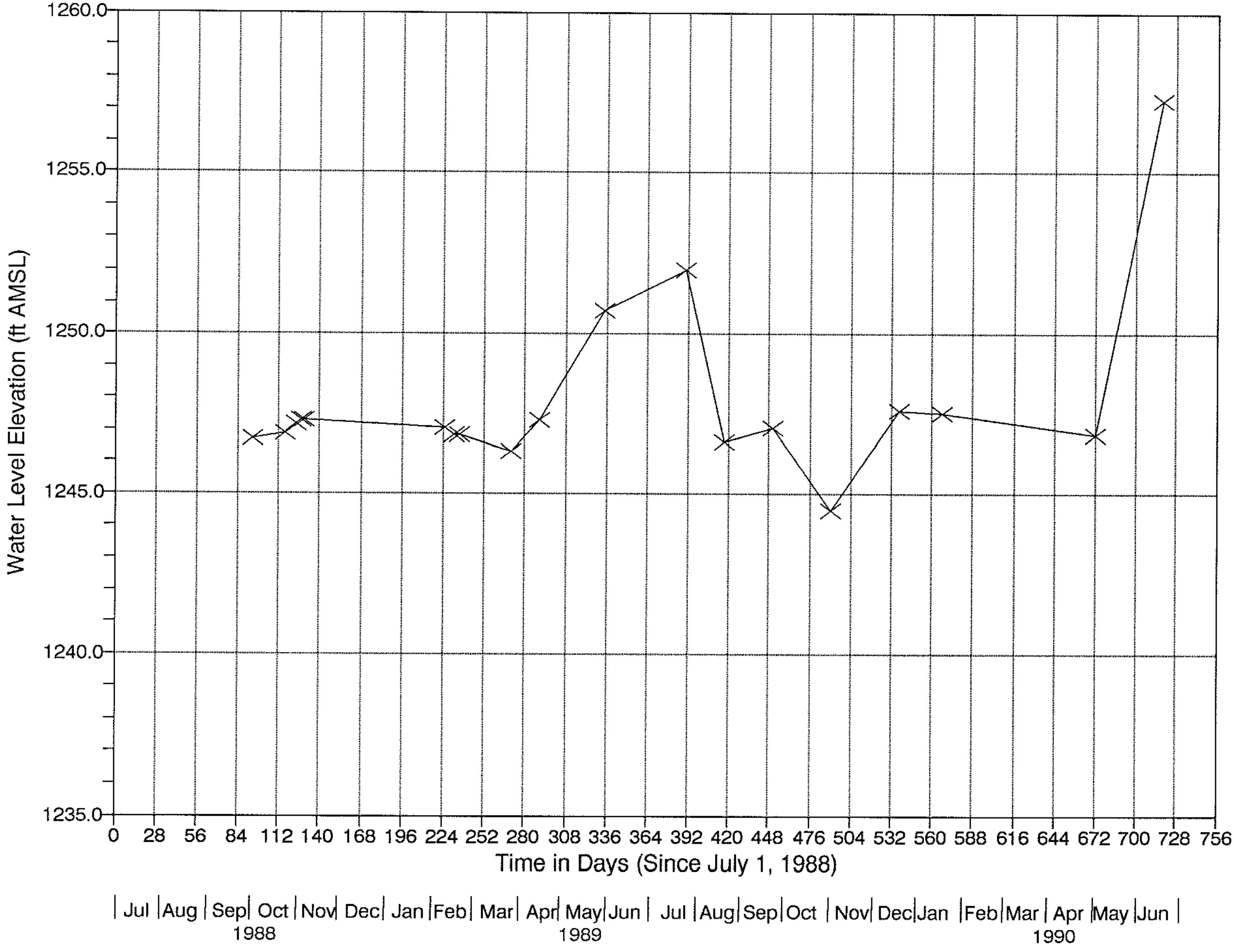
WATER LEVELS IN H88-25



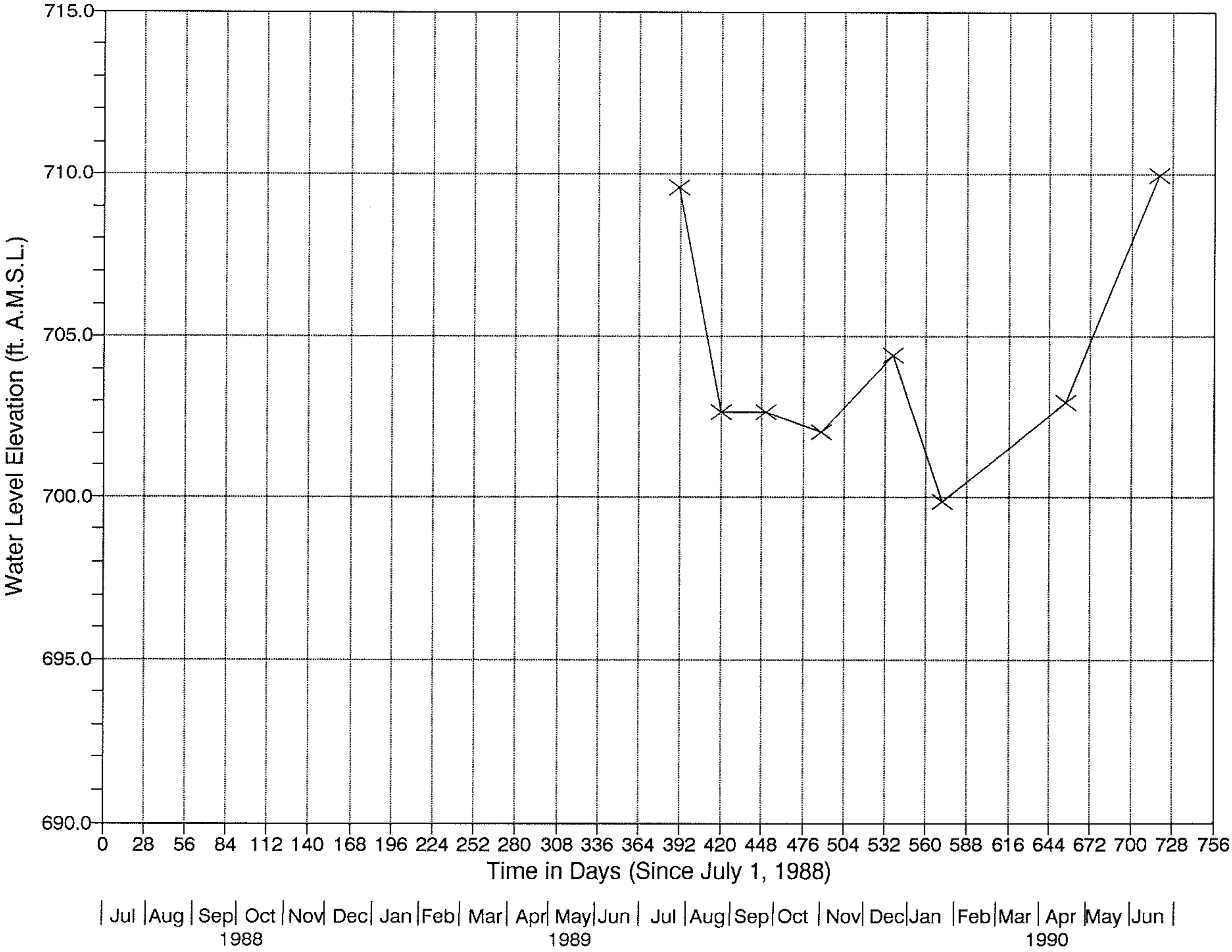
WATER LEVELS IN H88-27



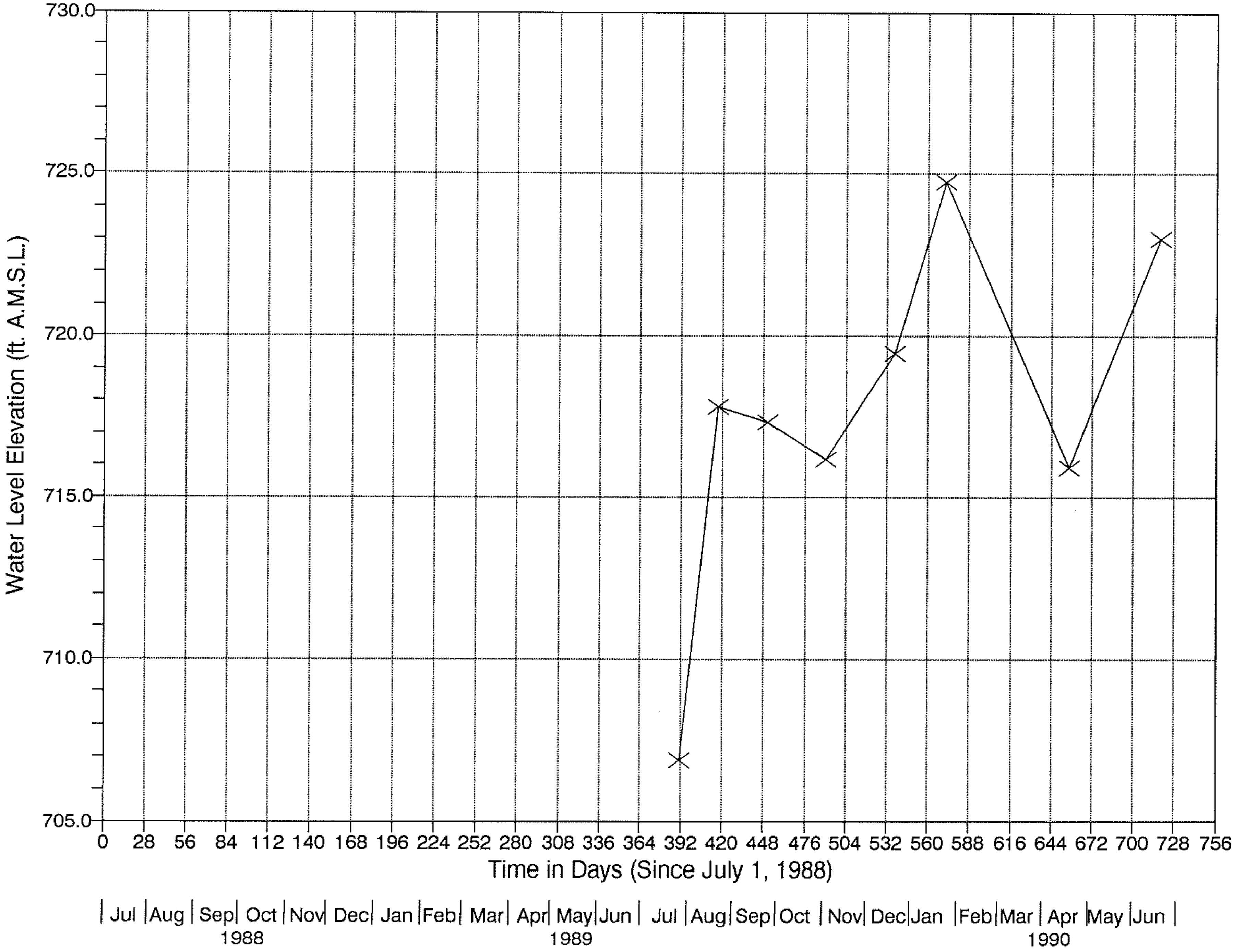
WATER LEVELS IN H88-28



WATER LEVELS IN H89-29



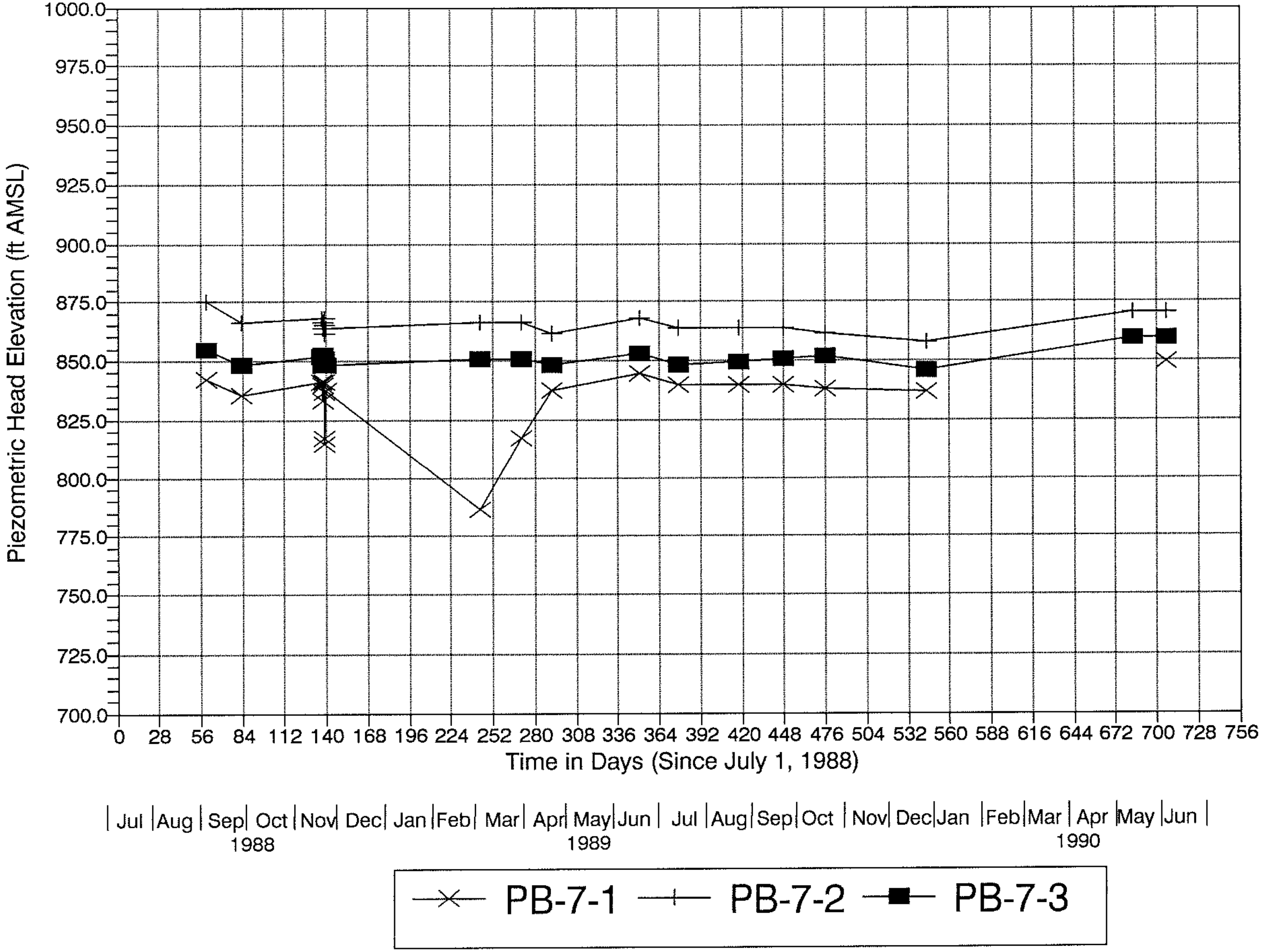
WATER LEVELS IN H89-30



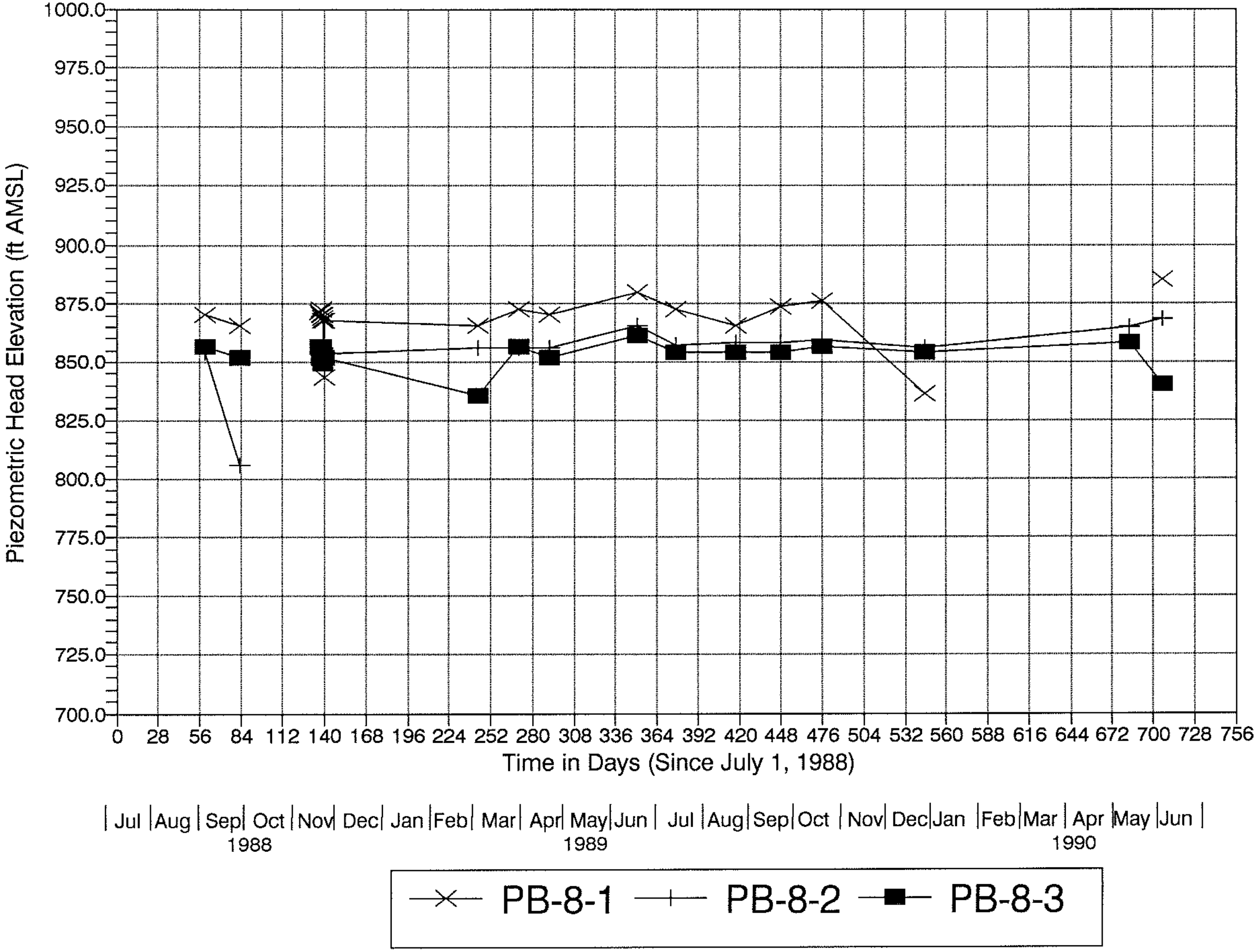
APPENDIX E-2

PIEZOMETRIC HEAD PLOTS FOR PIEZOMETERS

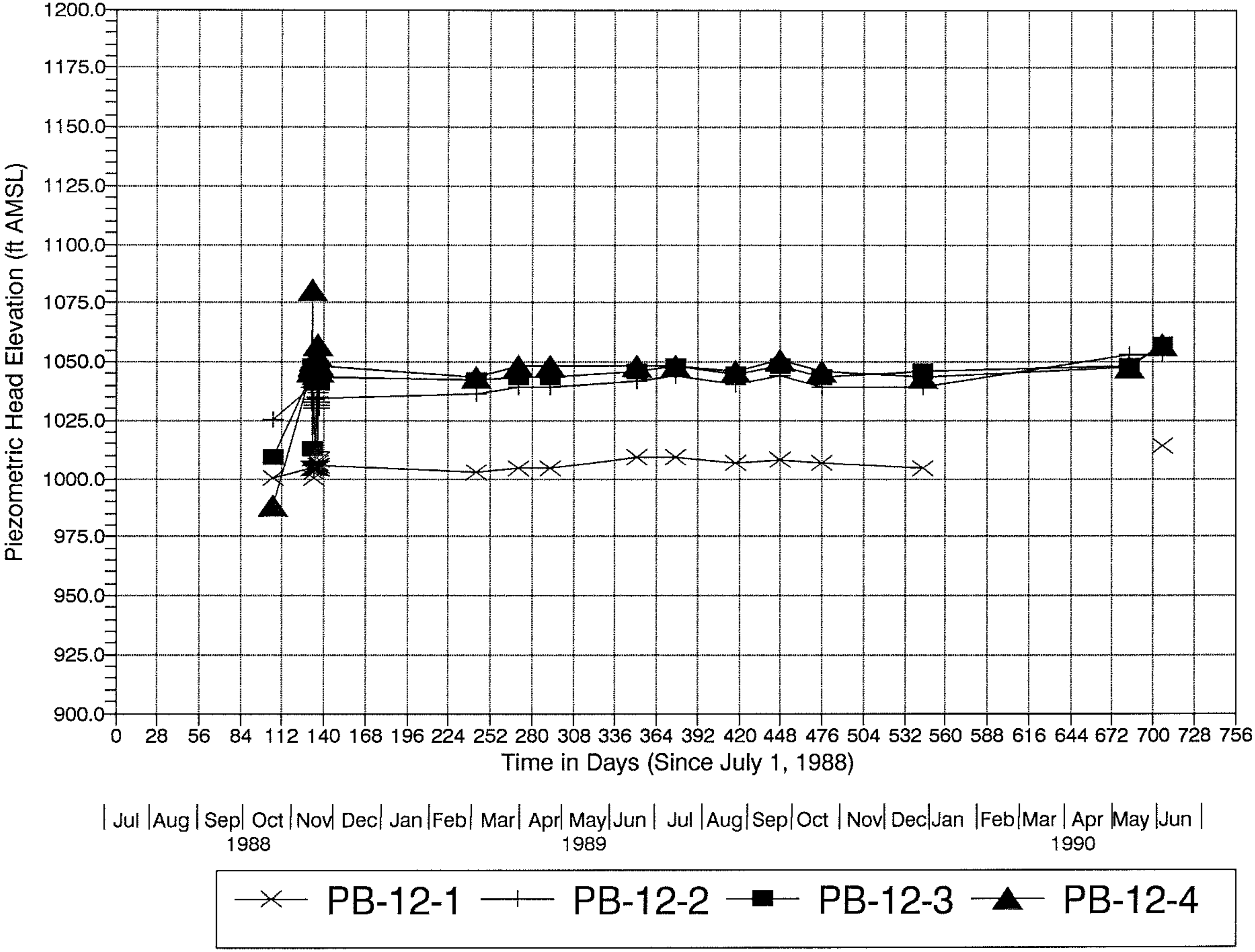
PIEZOMETRIC HEAD LEVELS IN PB-7



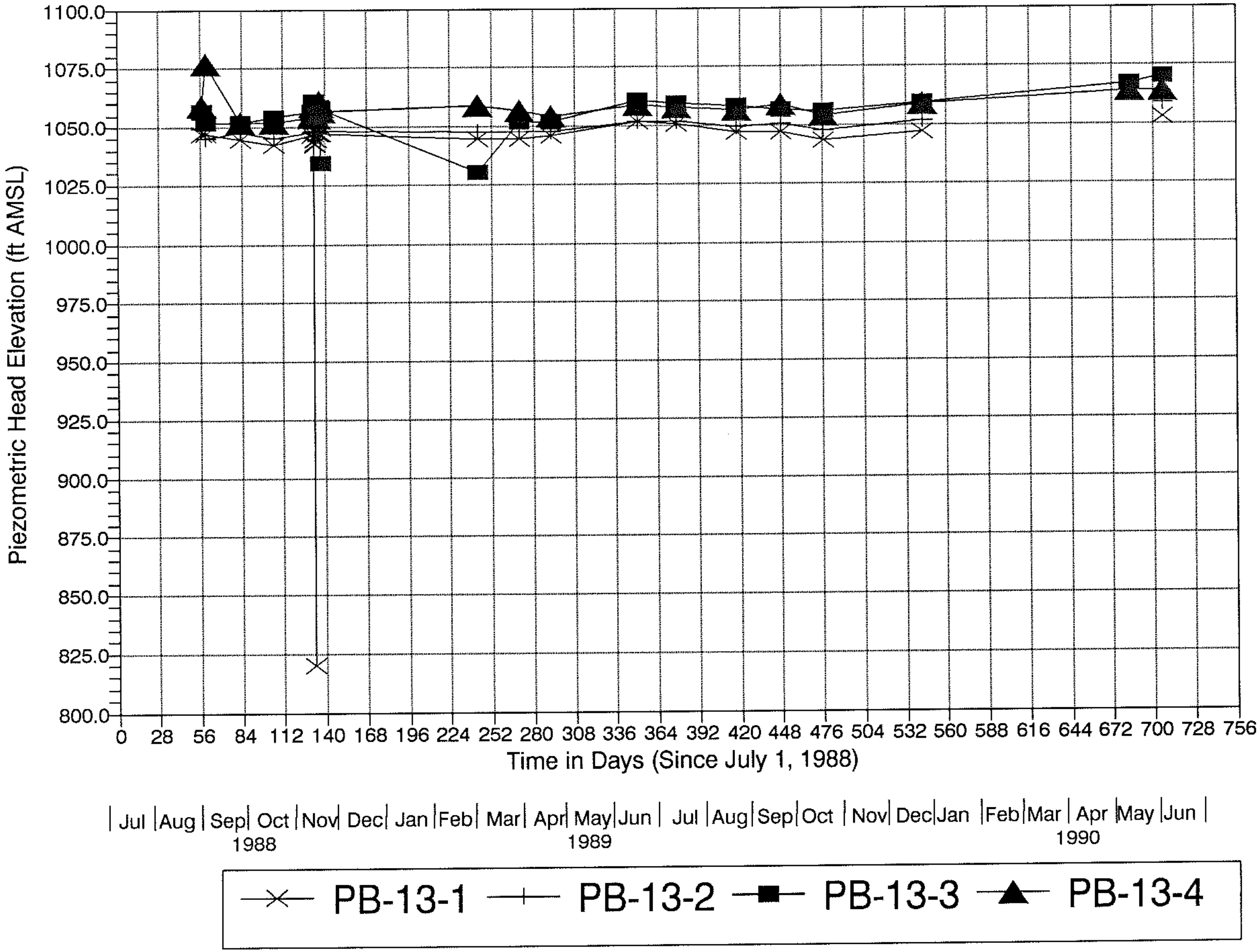
PIEZOMETRIC HEAD LEVELS IN PB-8



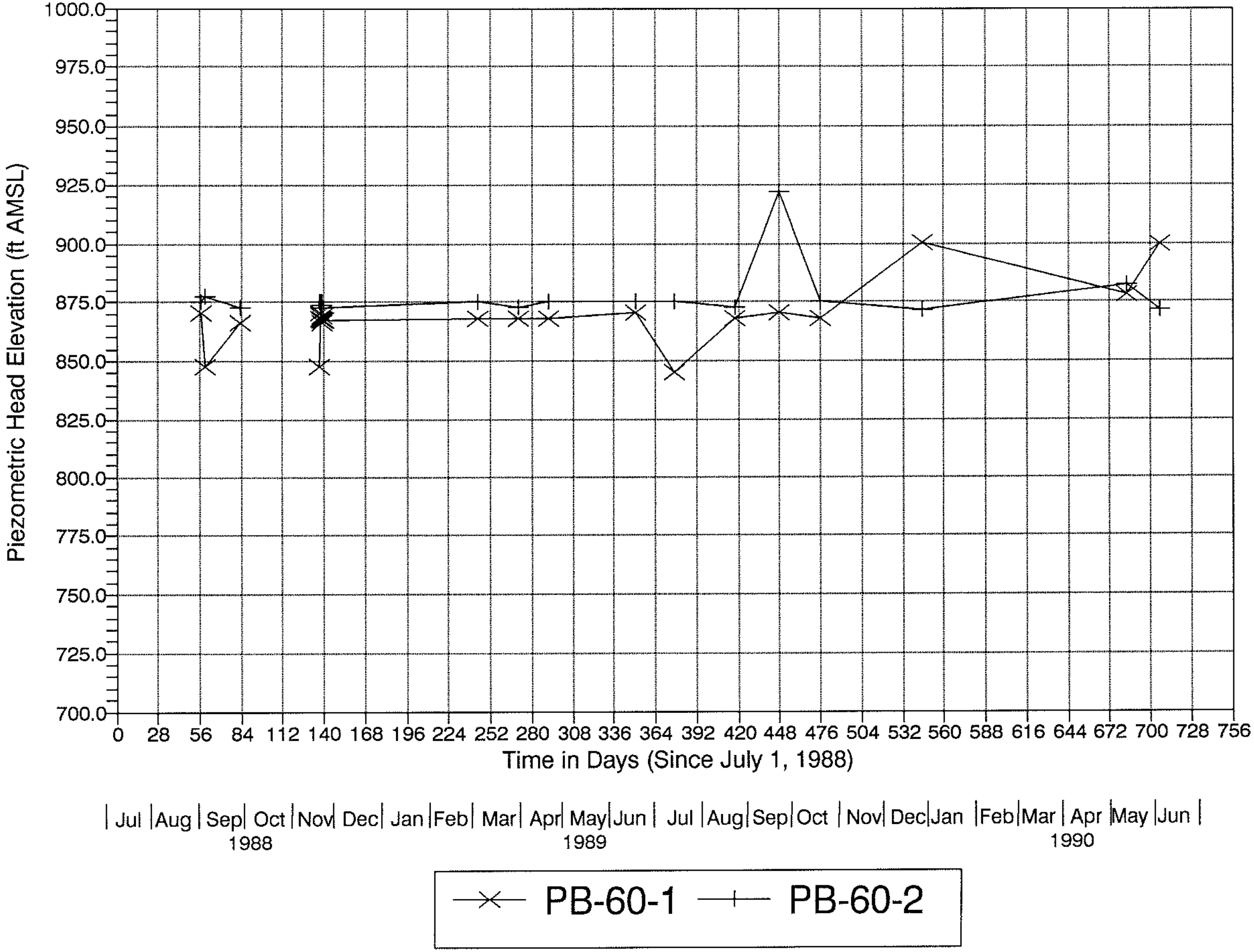
PIEZOMETRIC HEAD LEVELS IN PB-12



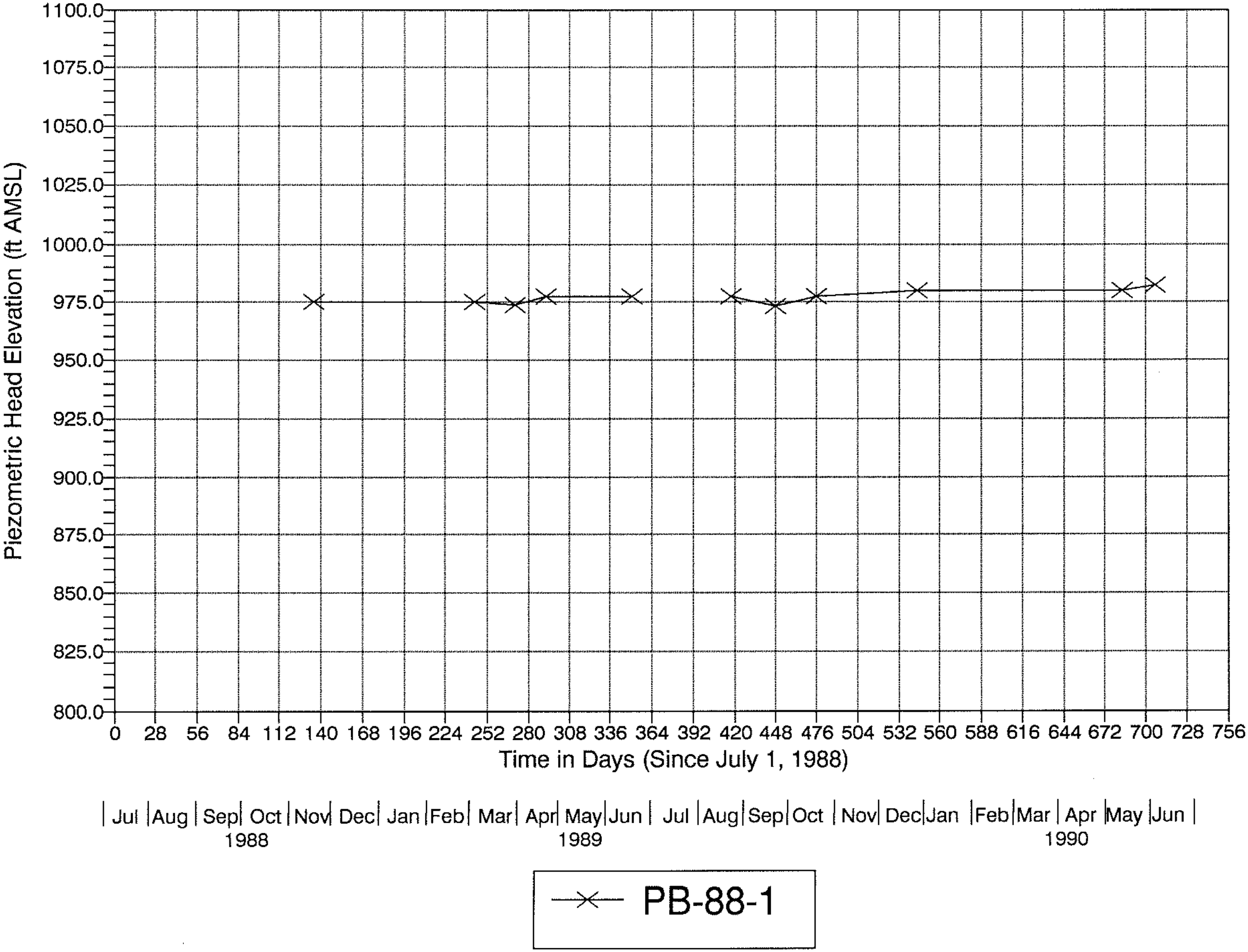
PIEZOMETRIC HEAD LEVELS IN PB-13



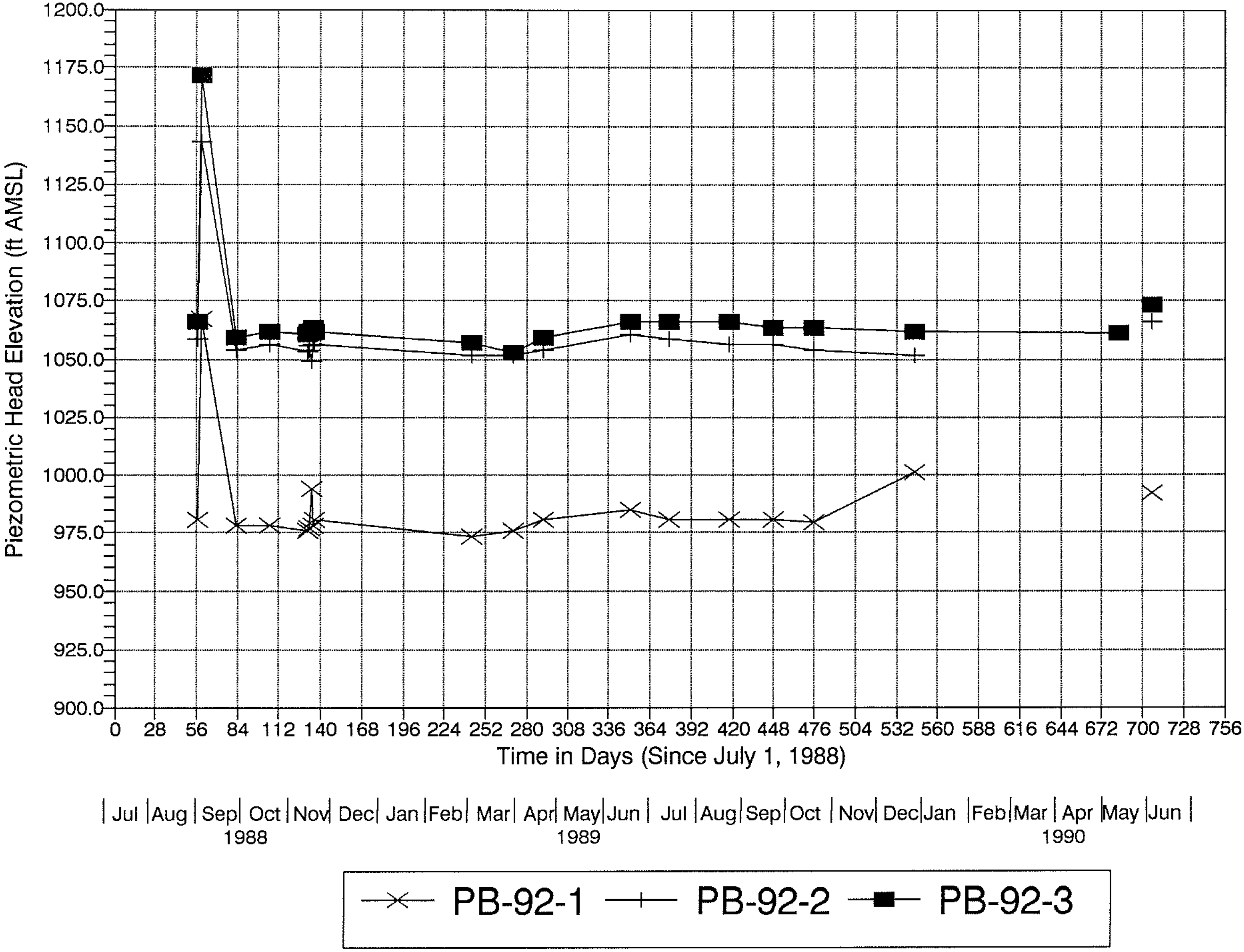
PIEZOMETRIC HEAD LEVELS IN PB-60



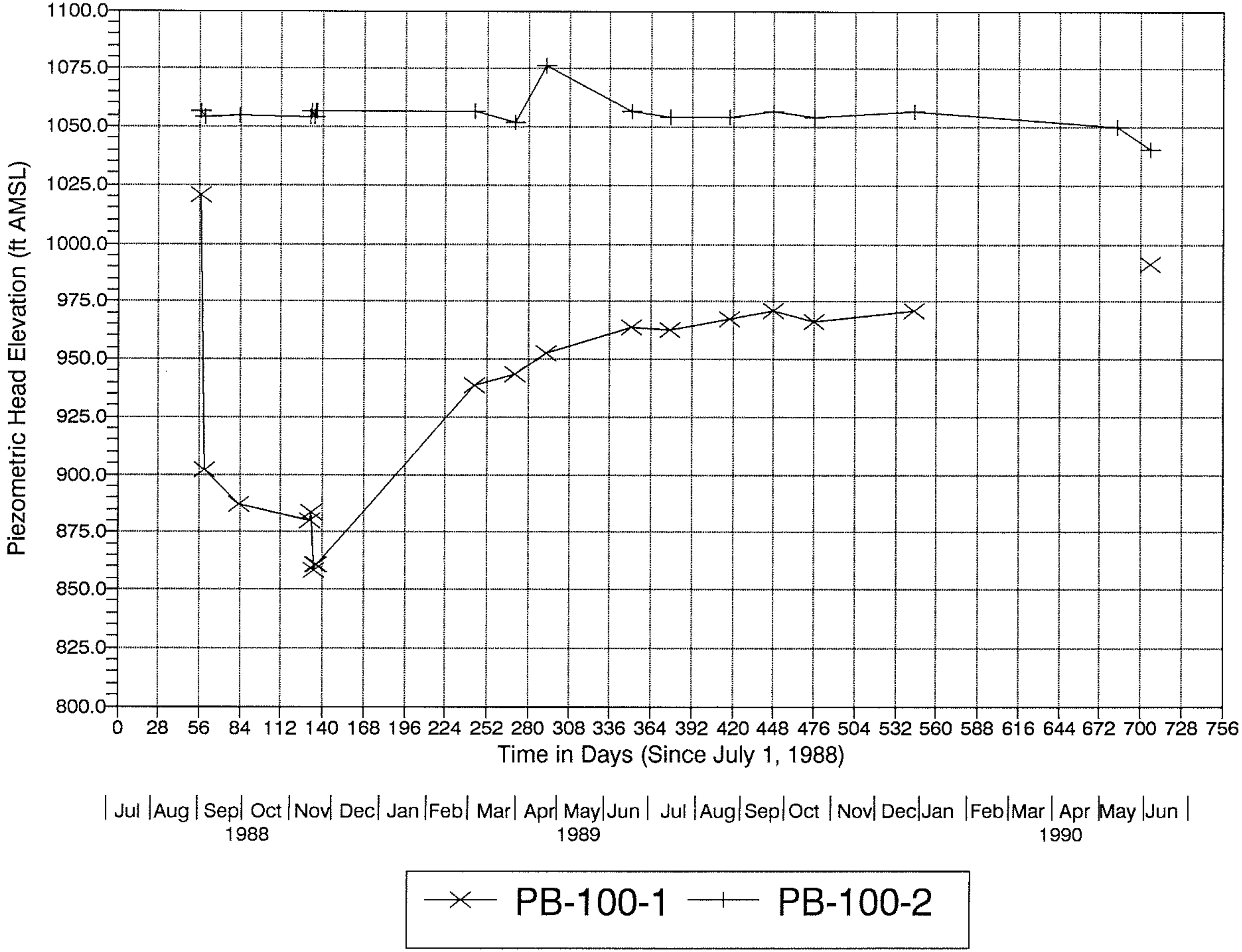
PIEZOMETRIC HEAD LEVELS IN PB-88



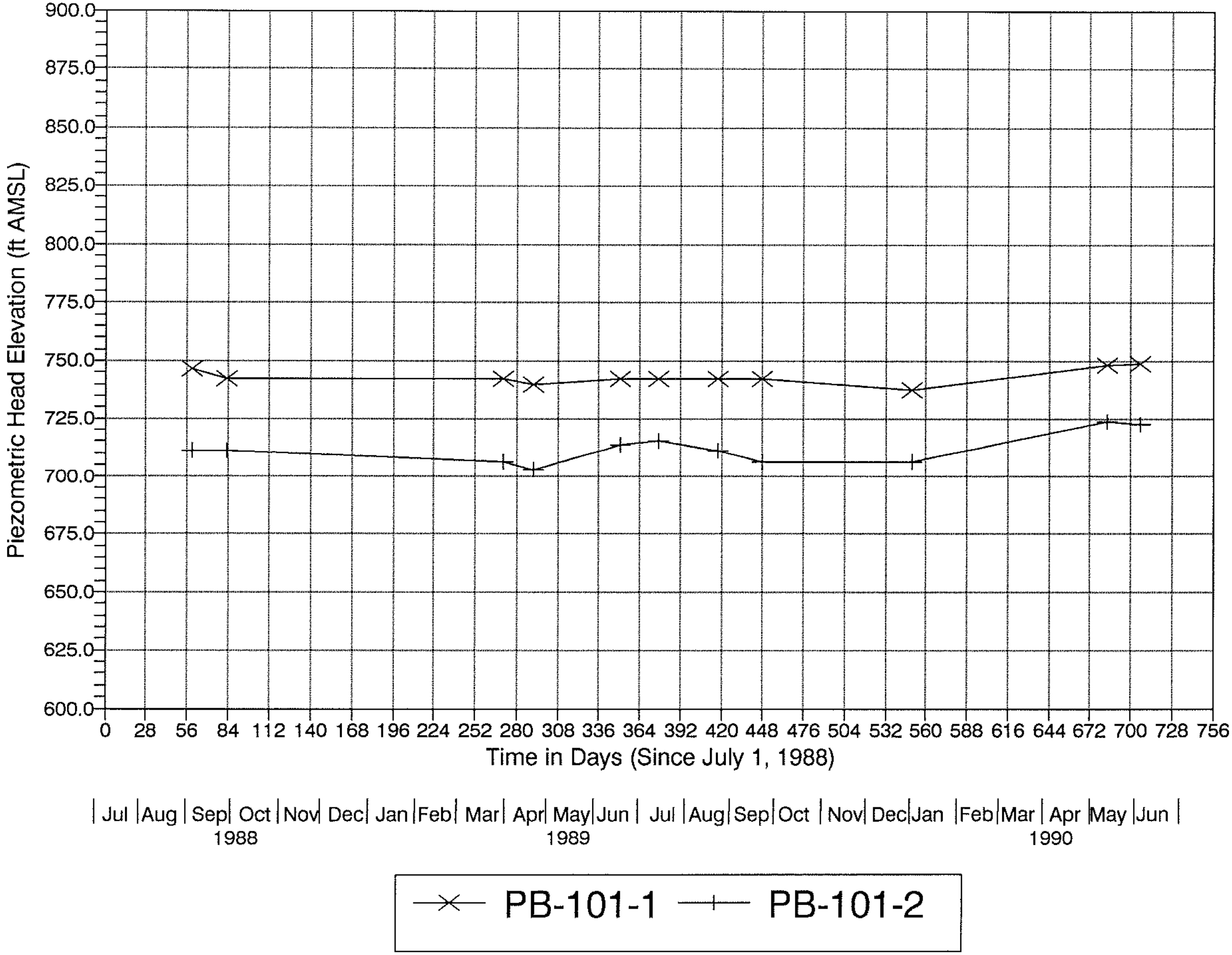
PIEZOMETRIC HEAD LEVELS IN PB-92



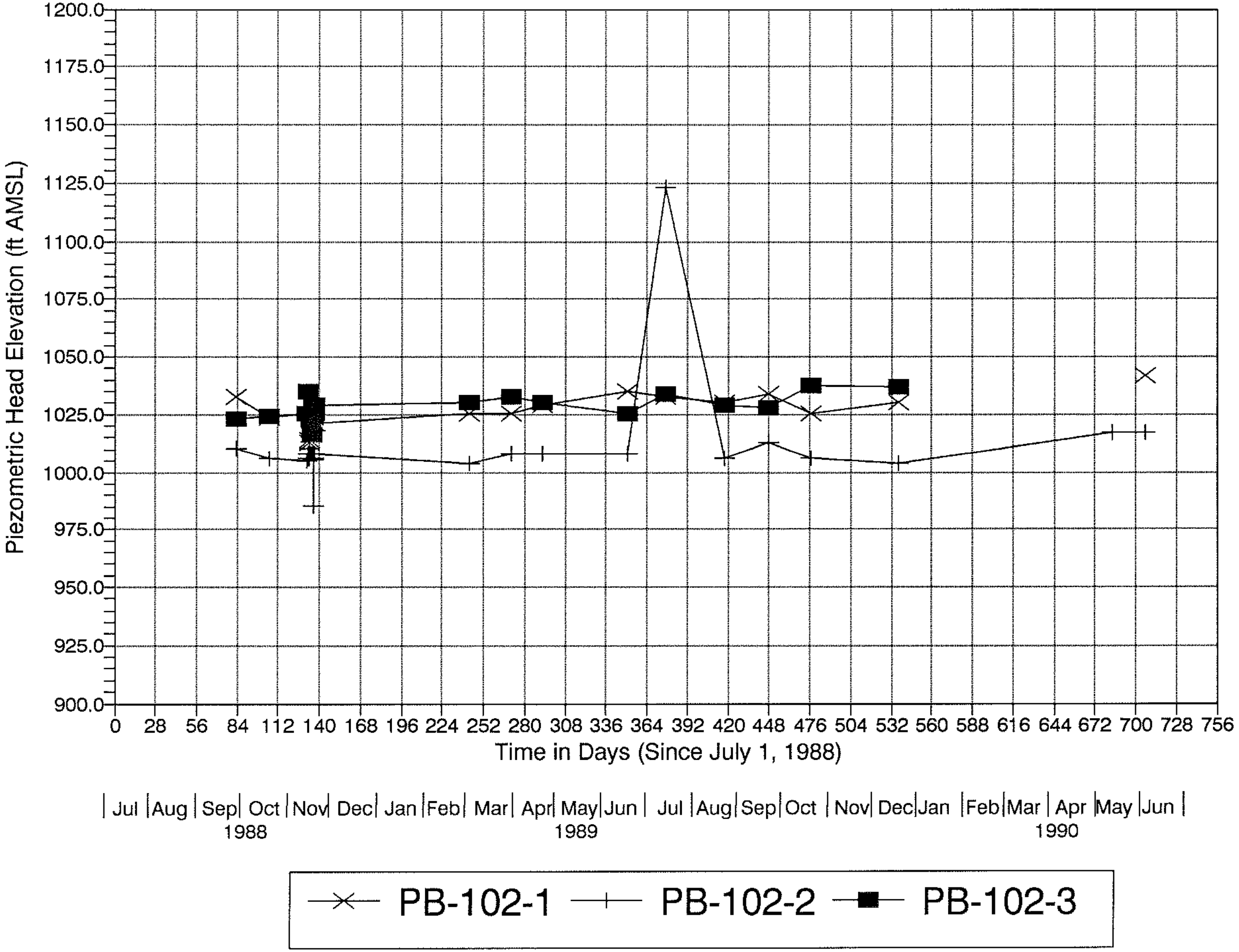
PIEZOMETRIC HEAD LEVELS IN PB-100



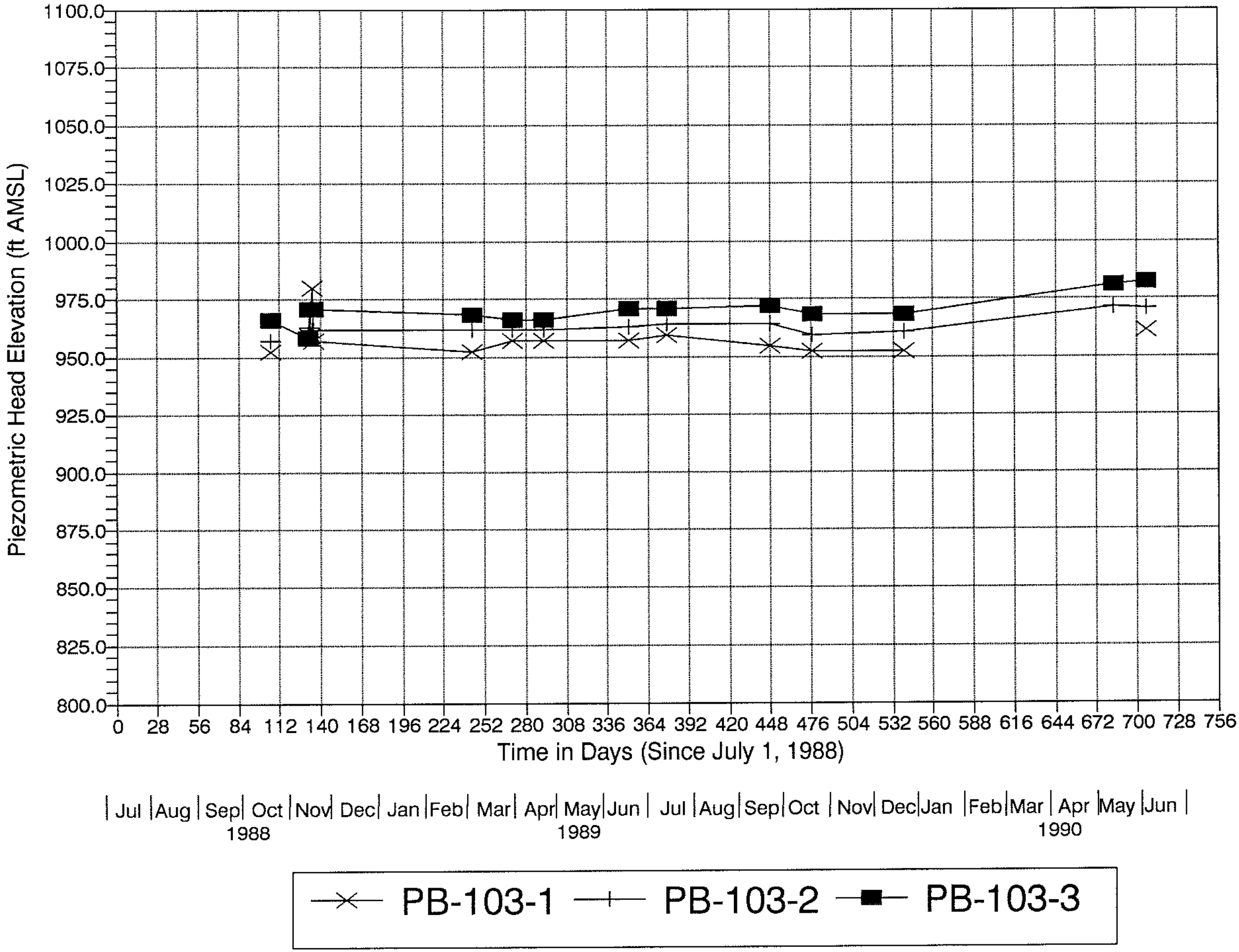
PIEZOMETRIC HEAD LEVELS IN PB-101



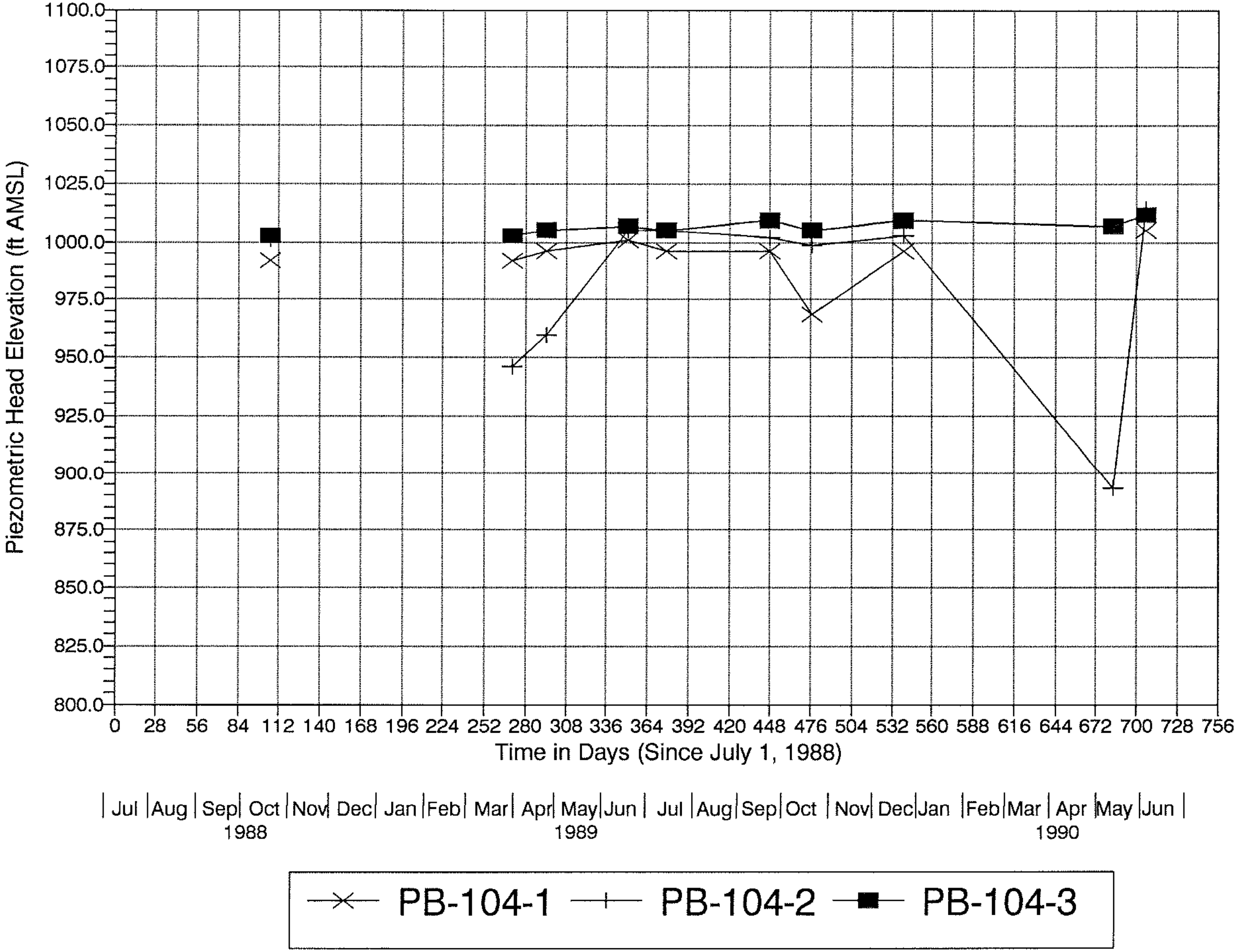
PIEZOMETRIC HEAD LEVELS IN PB-102



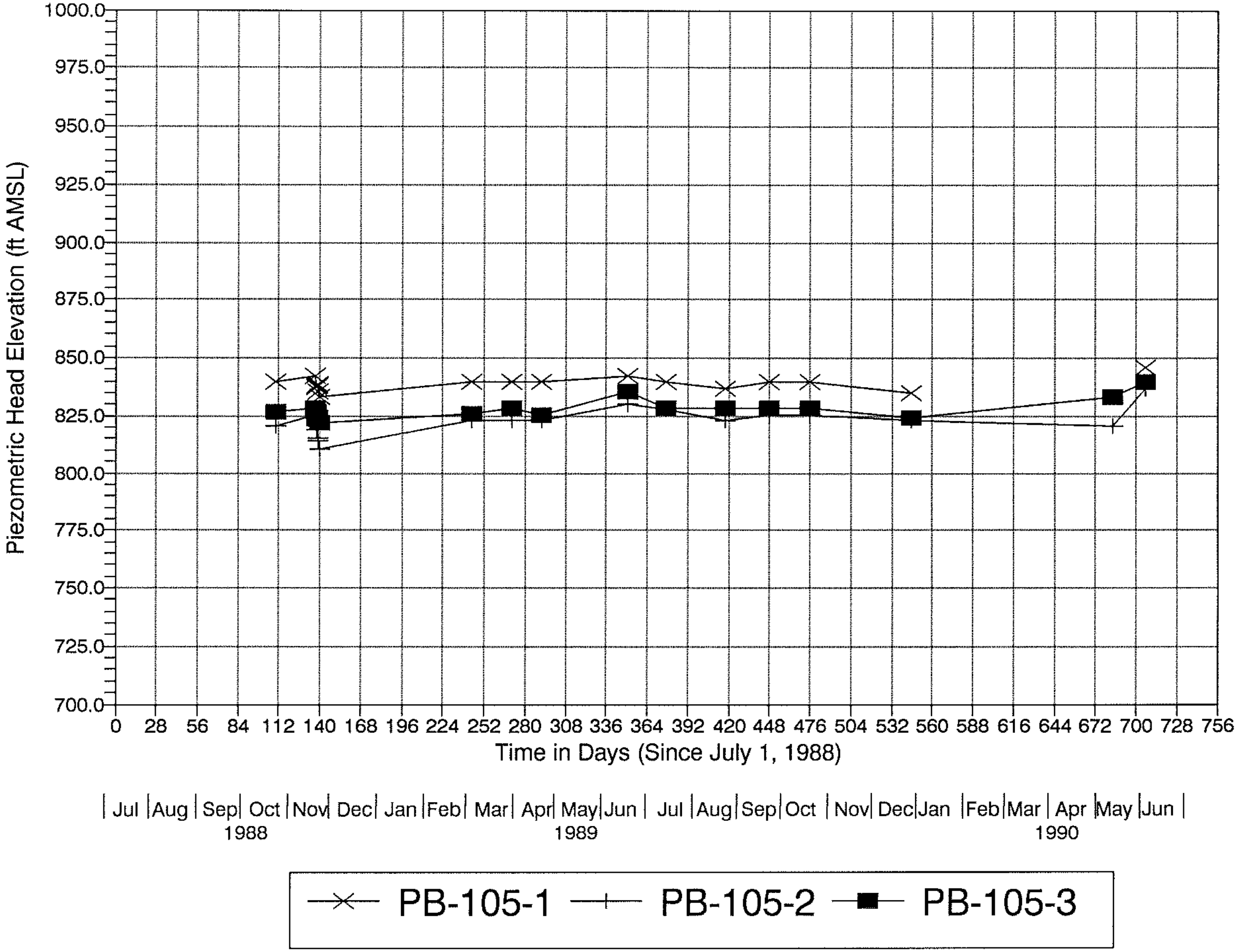
PIEZOMETRIC HEAD LEVELS IN PB-103



PIEZOMETRIC HEAD LEVELS IN PB-104



PIEZOMETRIC HEAD LEVELS IN PB-105



APPENDIX E-3

PNEUMATIC PIEZOMETER DATA

TABLE E-1

32325

PIEZOMETER DATA FOR PB-7

7/01/88

BASE ELEVATION (G.S.)= 930.1 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	573.1	08/30/88		117.00	269.3	842.4
		09/22/88		114.00	262.4	835.5
		11/15/88	13:51	116.50	268.1	841.2
		11/16/88	12:18	113.00	260.1	833.2
		11/16/88	16:23	116.00	267.0	840.1
		11/16/88	18:55	116.00	267.0	840.1
		11/17/88	10:48	114.50	263.6	836.7
		11/17/88	12:12	105.00	241.8	814.9
		11/17/88	16:08	116.50	268.1	841.2
		11/17/88	18:09	106.00	244.1	817.2
		11/18/88	13:17	114.95	264.6	837.7
		03/01/89	13:47	92.50	213.1	786.2
		03/29/89	15:28	106.00	244.1	817.2
		04/18/89	19:23	114.90	264.5	837.6
		06/17/89	16:01	118.00	271.6	844.7
		07/13/89	13:02	115.90	266.8	839.9
		08/23/89	17:32	116.00	267.0	840.1
		09/22/89	17:50	116.00	267.0	840.1
		10/20/89	15:46	115.00	264.7	837.8
		12/28/89	15:19	114.50	263.6	836.7
		05/16/90	09:17	NR	NR	NR
		06/08/90	10:11	120.00	276.2	849.3
2	640.1	08/30/88		102.00	235.0	875.1
		09/22/88		98.00	225.9	866.0
		11/15/88	13:55	99.00	228.2	868.3
		11/16/88	12:20	97.00	223.6	863.7
		11/16/88	16:25	98.00	225.9	866.0
		11/16/88	18:57	98.00	225.9	866.0
		11/17/88	10:50	96.00	221.3	861.4
		11/17/88	12:14	97.00	223.6	863.7
		11/17/88	16:09	98.95	228.0	868.1
		11/17/88	18:12	97.50	224.7	864.8
		11/18/88	13:28	96.95	223.5	863.6
		03/01/89	13:50	98.00	225.9	866.0
		03/29/89	15:29	98.00	225.9	866.0
		04/18/89	19:25	96.00	221.3	861.4
		06/17/89	16:03	99.00	228.2	868.3
		07/13/89	13:05	97.00	223.6	863.7
		08/23/89	17:32	97.00	223.6	863.7
		09/22/89	17:53	97.00	223.6	863.7
		10/20/89	15:49	96.00	221.3	861.4
		12/28/89	15:22	94.50	217.8	857.9
		05/16/90	09:18	100.05	230.6	870.7
		06/08/90	10:12	100.00	230.4	870.5
3	698.1	08/30/88		68.00	156.9	855.0
		09/22/88		65.00	150.0	848.1
		11/15/88	14:00	66.50	153.5	851.6
		11/16/88	12:24	65.00	150.0	848.1
		11/16/88	16:27	66.95	154.5	852.6
		11/16/88	19:00	65.00	150.0	848.1
		11/17/88	10:53	65.00	150.0	848.1
		11/17/88	12:15	65.00	150.0	848.1
		11/17/88	16:12	66.00	152.3	850.4
		11/17/88	18:14	65.00	150.0	848.1
		11/18/88	13:31	65.00	150.0	848.1
		03/01/89	13:51	66.20	152.8	850.9
		03/29/89	15:31	66.00	152.3	850.4
		04/18/89	19:26	65.00	150.0	848.1
		06/17/89	16:04	67.00	154.6	852.7
		07/13/89	13:06	65.00	150.0	848.1
		08/23/89	17:32	65.50	151.2	849.3

TABLE E-1

32325

PIEZOMETER DATA FOR PB-7

7/01/88

BASE ELEVATION (G.S.)= 930.1 ft.

PIEZO- METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
3	698.1	09/22/89	17:55	66.00	152.3	850.4
		10/20/89	15:51	66.50	153.5	851.6
		12/28/89	15:25	64.00	147.7	845.8
		05/16/90	09:42	69.95	161.4	859.5
		06/08/90	10:14	69.90	161.3	859.4

NR indicates no reading

TABLE E-2
PIEZOMETER DATA FOR PB-8

BASE ELEVATION (G.S.)= 905.2 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	590.2	08/30/88		114.00	280.2	870.4
		09/22/88		112.00	275.3	865.5
		11/09/88	16:42	NR	NR	NR
		11/15/88	12:15	114.50	281.5	871.7
		11/16/88	11:55	113.95	280.1	870.3
		11/16/88	16:08	115.00	282.7	872.9
		11/16/88	16:55	114.00	280.2	870.4
		11/16/88	19:10	114.00	280.2	870.4
		11/17/88	11:14	113.00	277.8	868.0
		11/17/88	12:47	113.50	279.0	869.2
		11/17/88	16:45	114.00	280.2	870.4
		11/17/88	18:45	113.95	280.1	870.3
		11/18/88	12:51	102.95	253.2	843.4
		11/18/88	13:50	113.00	277.8	868.0
		03/01/89	13:13	112.00	275.3	865.5
		03/29/89	15:57	115.00	282.7	872.9
		04/18/89	19:51	114.00	280.2	870.4
		06/17/89	16:20	118.00	290.0	880.2
		07/13/89	13:17	115.00	282.7	872.9
		08/23/89	17:49	112.00	275.3	865.5
		09/22/89	18:10	115.50	283.9	874.1
		10/20/89	16:29	116.50	286.3	876.5
		12/29/89	12:59	100.00	246.0	836.2
		05/16/90	10:51	NR	NR	NR
		06/08/90	09:40	120.00	294.9	885.1
2	665.7	08/30/88		81.00	188.3	854.0
		09/22/88		60.00	140.1	805.8
		11/09/88	16:42	NR	NR	NR
		11/15/88	12:18	82.00	190.5	856.2
		11/16/88	11:59	81.00	188.3	854.0
		11/16/88	16:09	82.00	190.5	856.2
		11/16/88	16:57	81.00	188.3	854.0
		11/16/88	19:12	82.00	190.5	856.2
		11/17/88	11:32	80.00	186.0	851.7
		11/17/88	12:49	81.50	189.4	855.1
		11/17/88	16:47	81.95	190.4	856.1
		11/17/88	18:47	81.00	188.3	854.0
		11/18/88	12:52	80.00	186.0	851.7
		11/18/88	13:51	80.95	188.1	853.8
		03/01/89	13:14	82.00	190.5	856.2
		03/29/89	15:59	82.00	190.5	856.2
		04/18/89	19:53	82.00	190.5	856.2
		06/17/89	16:18	86.00	199.7	865.4
		07/13/89	13:19	82.50	191.7	857.4
		08/23/89	17:50	83.00	192.8	858.5
		09/22/89	18:11	83.00	192.8	858.5
		10/20/89	16:31	83.50	194.0	859.7
		12/29/89	13:06	81.90	190.3	856.0
		05/16/90	10:56	85.75	199.1	864.8
		06/08/90	09:42	87.50	203.1	868.8
3	717.7	08/30/88		60.00	138.8	856.5
		09/22/88		58.00	134.3	852.0
		11/09/88	16:42	NR	NR	NR
		11/15/88	12:20	59.95	138.7	856.4
		11/16/88	12:00	58.00	134.3	852.0
		11/16/88	16:11	60.00	138.8	856.5
		11/16/88	16:58	58.95	136.4	854.1
		11/16/88	19:13	58.00	134.3	852.0
		11/17/88	11:33	57.00	132.0	849.7
		11/17/88	12:50	58.50	135.4	853.1
		11/17/88	16:49	58.50	135.4	853.1

TABLE E-2
PIEZOMETER DATA FOR PB-8

BASE ELEVATION (G.S.)= 905.2 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
3	717.7	11/17/88	18:48	58.00	134.3	852.0
		11/18/88	12:53	57.95	134.1	851.8
		11/18/88	13:52	58.00	134.3	852.0
		03/01/89	13:15	50.95	118.1	835.8
		03/29/89	16:00	60.00	138.8	856.5
		04/18/89	19:54	58.00	134.3	852.0
		06/17/89	16:19	62.00	143.4	861.1
		07/13/89	13:20	59.00	136.5	854.2
		08/23/89	17:52	59.00	136.5	854.2
		09/22/89	18:12	59.00	136.5	854.2
		10/20/89	16:32	60.00	138.8	856.5
		12/29/89	13:09	59.00	136.5	854.2
		05/16/90	11:00	60.75	140.6	858.3
		06/08/90	09:43	53.00	122.8	840.5

NR indicates no reading.

TABLE E-3
PIEZOMETER DATA FOR PB-12

BASE ELEVATION (G.S.)= 1094.5 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	760.3	10/15/88		104.00	239.8	1000.1
		11/09/88	13:10	106.00	244.4	1004.7
		11/10/88	11:51	106.01	244.4	1004.7
		11/10/88	15:46	107.80	248.6	1008.9
		11/10/88	17:07	NR	NR	NR
		11/11/88	10:49	105.80	244.0	1004.3
		11/11/88	12:23	104.00	239.8	1000.1
		11/11/88	14:10	105.00	242.1	1002.4
		11/11/88	20:29	105.00	242.1	1002.4
		11/12/88	10:49	106.00	244.4	1004.7
		11/13/88	14:11	106.00	244.4	1004.7
		11/14/88	10:27	106.00	244.4	1004.7
		11/14/88	11:35	106.50	245.6	1005.9
		11/14/88	12:48	106.00	244.4	1004.7
		11/14/88	18:30	106.00	244.4	1004.7
		11/14/88	19:55	106.00	244.4	1004.7
		11/14/88	22:29	107.00	246.7	1007.0
		11/15/88	00:04	107.50	247.9	1008.2
		11/15/88	01:00	106.00	244.4	1004.7
		11/15/88	10:10	106.00	244.4	1004.7
		11/15/88	11:00	106.50	245.6	1005.9
		02/28/89	19:27	105.00	242.1	1002.4
		03/29/89	12:24	106.00	244.4	1004.7
		04/19/89	11:18	106.00	244.4	1004.7
		06/17/89	14:37	108.00	249.0	1009.3
		07/13/89	11:24	108.00	249.0	1009.3
		08/23/89	15:07	107.00	246.7	1007.0
		09/22/89	15:57	107.50	247.9	1008.2
		10/20/89	11:24	107.00	246.7	1007.0
		12/28/89	11:56	106.00	244.4	1004.7
		05/16/90	14:43	NR	NR	NR
		06/08/90	10:59	110.00	253.6	1013.9
2	868.7	10/15/88		68.00	157.0	1025.7
		11/09/88	13:12	74.00	170.7	1039.4
		11/10/88	11:53	74.50	171.8	1040.5
		11/10/88	15:48	75.90	175.1	1043.8
		11/10/88	17:17	73.95	170.6	1039.3
		11/11/88	10:53	70.40	162.5	1031.2
		11/11/88	12:25	71.00	163.8	1032.5
		11/11/88	14:12	71.50	165.0	1033.7
		11/11/88	20:30	70.00	161.5	1030.2
		11/12/88	10:51	60.00	138.6	1007.3
		11/13/88	14:12	72.00	166.1	1034.8
		11/14/88	10:29	62.00	143.2	1011.9
		11/14/88	11:37	73.00	168.4	1037.1
		11/14/88	12:49	72.95	168.3	1037.0
		11/14/88	18:32	71.95	166.0	1034.7
		11/14/88	19:57	72.00	166.1	1034.8
		11/14/88	22:30	71.95	166.0	1034.7
		11/15/88	00:09	71.00	163.8	1032.5
		11/15/88	01:02	70.00	161.5	1030.2
		11/15/88	10:12	70.50	162.7	1031.4
		11/15/88	11:01	71.95	166.0	1034.7
		02/28/89	19:29	72.50	167.3	1036.0
		03/29/89	12:27	74.00	170.7	1039.4
		04/19/89	11:20	74.00	170.7	1039.4
		06/17/89	14:38	75.00	173.0	1041.7
		07/13/89	11:25	75.90	175.1	1043.8
		08/23/89	15:08	74.50	171.8	1040.5
		09/22/89	15:59	76.00	175.3	1044.0
		10/20/89	17:54	74.00	170.7	1039.4
		12/28/89	11:58	74.00	170.7	1039.4

TABLE E-3
PIEZOMETER DATA FOR PB-12

BASE ELEVATION (G.S.)= 1094.5 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
2	868.7	05/16/90	14:32	80.00	184.4	1053.1
		06/08/90	11:01	80.00	184.4	1053.1
3	952.5	10/15/88		24.00	56.7	1009.2
		11/09/88	13:14	39.50	92.2	1044.7
		11/10/88	11:56	25.50	60.2	1012.7
		11/10/88	15:50	40.90	95.4	1047.9
		11/10/88	17:20	39.90	93.2	1045.7
		11/11/88	10:54	40.10	93.6	1046.1
		11/11/88	12:27	38.00	88.8	1041.3
		11/11/88	14:13	39.80	92.9	1045.4
		11/11/88	20:32	38.00	88.8	1041.3
		11/12/88	10:52	38.00	88.8	1041.3
		11/13/88	14:14	40.00	93.4	1045.9
		11/14/88	10:30	40.00	93.4	1045.9
		11/14/88	11:38	40.00	93.4	1045.9
		11/14/88	12:50	39.95	93.3	1045.8
		11/14/88	18:34	40.00	93.4	1045.9
		11/14/88	19:58	39.95	93.3	1045.8
		11/14/88	22:31	39.50	92.2	1044.7
		11/15/88	00:10	39.00	91.1	1043.6
		11/15/88	01:03	39.50	92.2	1044.7
		11/15/88	10:13	38.00	88.8	1041.3
		11/15/88	11:02	39.00	91.1	1043.6
		02/28/89	19:31	38.50	89.9	1042.4
		03/29/89	12:28	39.00	91.1	1043.6
		04/19/89	11:21	39.00	91.1	1043.6
		06/17/89	14:39	40.00	93.4	1045.9
		07/13/89	11:26	41.00	95.7	1048.2
		08/23/89	15:09	39.50	92.2	1044.7
		09/22/89	16:00	41.00	95.7	1048.2
		10/20/89	17:56	39.00	91.1	1043.6
		12/28/89	12:02	40.00	93.4	1045.9
		05/16/90	14:27	40.95	95.6	1048.1
		06/08/90	11:02	45.00	104.8	1057.3
4	987.5	08/31/88		0.00	1.1	988.6
		11/09/88	13:15	25.00	58.4	1045.9
		11/10/88	11:58	40.00	92.8	1080.3
		11/10/88	15:51	26.00	60.7	1048.2
		11/10/88	17:21	25.90	60.5	1048.0
		11/11/88	10:55	27.00	63.0	1050.5
		11/11/88	12:29	25.00	58.4	1045.9
		11/11/88	14:14	26.50	61.8	1049.3
		11/11/88	20:33	26.00	60.7	1048.2
		11/12/88	10:53	26.00	60.7	1048.2
		11/13/88	14:15	26.00	60.7	1048.2
		11/14/88	10:31	26.00	60.7	1048.2
		11/14/88	11:39	26.00	60.7	1048.2
		11/14/88	12:51	29.95	69.7	1057.2
		11/14/88	18:36	26.00	60.7	1048.2
		11/14/88	20:00	26.50	61.8	1049.3
		11/14/88	22:32	27.95	65.2	1052.7
		11/15/88	00:12	25.00	58.4	1045.9
		11/15/88	01:04	25.00	58.4	1045.9
		11/15/88	10:14	25.00	58.4	1045.9
		11/15/88	11:03	26.00	60.7	1048.2
		02/28/89	19:32	24.00	56.1	1043.6
		03/29/89	12:29	26.00	60.7	1048.2
		04/19/89	11:22	25.90	60.5	1048.0
		06/17/89	14:40	26.00	60.7	1048.2
		07/13/89	11:27	26.00	60.7	1048.2

TABLE E-3
PIEZOMETER DATA FOR PB-12

BASE ELEVATION (G.S.)= 1094.5 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
4	987.5	08/23/89	15:10	25.00	58.4	1045.9
		09/22/89	16:02	27.00	63.0	1050.5
		10/20/89	17:57	25.00	58.4	1045.9
		12/28/89	12:04	24.00	56.1	1043.6
		05/16/90	14:26	25.85	60.3	1047.8
		06/08/90	11:02	30.00	69.9	1057.4

NR indicates no reading.

TABLE E-4
PIEZOMETER DATA FOR PB-13

BASE ELEVATION (G.S.)= 1100.8 ft.

PIEZO- METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	747.8	08/27/88		130.00	299.2	1047.0
		08/30/88		130.00	299.2	1047.0
		09/22/88		129.00	296.9	1044.7
		10/15/88		128.00	294.7	1042.5
		11/09/88	13:00	129.70	298.6	1046.4
		11/10/88	11:25	130.00	299.2	1047.0
		11/10/88	15:31	31.00	72.1	819.9
		11/10/88	16:51	NR	NR	NR
		11/11/88	11:01	128.00	294.7	1042.5
		11/11/88	14:00	129.00	296.9	1044.7
		11/11/88	20:38	128.20	295.1	1042.9
		11/12/88	10:37	129.00	296.9	1044.7
		11/13/88	13:54	130.00	299.2	1047.0
		11/14/88	10:38	129.95	299.1	1046.9
		11/14/88	12:38	130.00	299.2	1047.0
		11/14/88	18:41	130.00	299.2	1047.0
		11/14/88	20:24	130.00	299.2	1047.0
		11/14/88	22:38	131.50	302.7	1050.5
		11/15/88	00:24	131.00	301.5	1049.3
		11/15/88	01:09	130.00	299.2	1047.0
		11/15/88	10:47	130.00	299.2	1047.0
		02/28/89	19:04	129.00	296.9	1044.7
		03/29/89	12:03	129.00	296.9	1044.7
		04/19/89	11:02	129.50	298.1	1045.9
		06/17/89	14:23	132.00	303.8	1051.6
		07/13/89	11:11	131.50	302.7	1050.5
		08/23/89	14:56	130.00	299.2	1047.0
		09/22/89	14:37	130.00	299.2	1047.0
		10/21/89	11:49	128.50	295.8	1043.6
		12/27/89	13:07	130.00	299.2	1047.0
		05/16/90	14:16	NR	NR	NR
		06/08/90	11:14	132.50	305.0	1052.8
2	825.8	08/27/88		97.00	223.8	1049.6
		08/30/88		95.00	219.3	1045.1
		09/22/88		96.00	221.6	1047.4
		10/15/88		95.00	219.3	1045.1
		11/09/88	13:02	96.00	221.6	1047.4
		11/10/88	11:32	96.50	222.7	1048.5
		11/10/88	15:34	98.00	226.1	1051.9
		11/10/88	16:57	96.00	221.6	1047.4
		11/11/88	11:02	96.00	221.6	1047.4
		11/11/88	14:05	97.00	223.8	1049.6
		11/11/88	20:37	97.00	223.8	1049.6
		11/12/88	10:39	97.00	223.8	1049.6
		11/13/88	13:57	97.95	226.0	1051.8
		11/14/88	10:40	96.95	223.7	1049.5
		11/14/88	12:40	97.00	223.8	1049.6
		11/14/88	18:43	96.00	221.6	1047.4
		11/14/88	20:26	97.00	223.8	1049.6
		11/14/88	22:41	97.95	226.0	1051.8
		11/15/88	00:26	97.95	226.0	1051.8
		11/15/88	01:10	97.00	223.8	1049.6
		11/15/88	10:48	96.50	222.7	1048.5
		02/28/89	19:06	96.00	221.6	1047.4
		03/29/89	12:06	96.00	221.6	1047.4
		04/19/89	11:04	96.00	221.6	1047.4
		06/17/89	14:25	98.00	226.1	1051.9
		07/13/89	11:12	98.00	226.1	1051.9
		08/23/89	14:57	97.00	223.8	1049.6
		09/22/89	14:39	97.50	225.0	1050.8
		10/21/89	11:52	96.00	221.6	1047.4
		12/27/89	15:08	98.00	226.1	1051.9

TABLE E-4
PIEZOMETER DATA FOR PB-13

BASE ELEVATION (G.S.)= 1100.8 ft.

PIEZOMETER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
2	825.8	05/16/90	14:14	NR	NR	NR
		06/08/90	11:15	101.00	233.0	1058.8
3	880.8	08/27/88		76.00	175.5	1056.3
		08/30/88		74.00	171.0	1051.8
		09/22/88		74.00	171.0	1051.8
		10/15/88		75.00	173.2	1054.0
		11/09/88	13:03	76.00	175.5	1056.3
		11/10/88	11:33	76.20	176.0	1056.8
		11/10/88	15:38	77.90	179.9	1060.7
		11/10/88	16:59	76.10	175.8	1056.6
		11/11/88	11:03	76.00	175.5	1056.3
		11/11/88	14:08	76.50	176.7	1057.5
		11/11/88	20:37	76.00	175.5	1056.3
		11/12/88	10:40	77.00	177.8	1058.6
		11/13/88	14:00	77.00	177.8	1058.6
		11/14/88	10:42	76.00	175.5	1056.3
		11/14/88	12:42	77.00	177.8	1058.6
		11/14/88	18:45	76.00	175.5	1056.3
		11/14/88	20:27	76.95	177.7	1058.5
		11/14/88	22:43	76.00	175.5	1056.3
		11/15/88	00:27	66.50	153.7	1034.5
		11/15/88	01:11	76.00	175.5	1056.3
		11/15/88	10:50	76.50	176.7	1057.5
		02/28/89	19:10	64.50	149.2	1030.0
		03/29/89	12:08	74.00	171.0	1051.8
		04/19/89	11:05	74.00	171.0	1051.8
		06/17/89	14:26	78.00	180.1	1060.9
		07/13/89	11:14	77.50	179.0	1059.8
		08/23/89	14:59	77.00	177.8	1058.6
		09/22/89	14:40	76.00	175.5	1056.3
		10/21/89	11:53	75.90	175.3	1056.1
		12/27/89	14:09	77.50	179.0	1059.8
		05/16/90	14:06	80.75	186.4	1067.2
		06/08/90	11:16	82.00	189.3	1070.1
4	970.8	08/27/88		38.00	88.1	1058.9
		08/30/88		46.00	106.4	1077.2
		09/22/88		35.00	81.2	1052.0
		10/15/88		35.00	81.2	1052.0
		11/09/88	13:05	36.00	83.5	1054.3
		11/10/88	11:34	36.10	83.7	1054.5
		11/10/88	15:39	37.95	88.0	1058.8
		11/10/88	17:02	36.59	84.9	1055.7
		11/11/88	11:04	37.50	86.9	1057.7
		11/11/88	14:10	37.50	86.9	1057.7
		11/11/88	20:36	38.00	88.1	1058.9
		11/12/88	10:41	37.00	85.8	1056.6
		11/13/88	14:02	38.00	88.1	1058.9
		11/14/88	10:43	36.95	85.7	1056.5
		11/14/88	12:43	37.00	85.8	1056.6
		11/14/88	18:47	37.95	88.0	1058.8
		11/14/88	20:28	38.95	90.3	1061.1
		11/14/88	22:44	37.50	86.9	1057.7
		11/15/88	00:28	37.00	85.8	1056.6
		11/15/88	01:12	37.00	85.8	1056.6
		11/15/88	10:52	37.00	85.8	1056.6
		02/28/89	19:11	38.00	88.1	1058.9
		03/29/89	12:11	37.00	85.8	1056.6
		04/19/89	11:06	36.00	83.5	1054.3
		06/17/89	14:27	38.00	88.1	1058.9
		07/13/89	11:15	37.50	86.9	1057.7

TABLE E-4

PIEZOMETER DATA FOR PB-13

BASE ELEVATION (G.S.)= 1100.8 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
4	970.8	08/23/89	14:59	37.00	85.8	1056.6
		09/22/89	14:42	38.00	88.1	1058.9
		10/21/89	11:54	36.00	83.5	1054.3
		12/27/89	14:10	38.00	88.1	1058.9
		05/16/90	14:02	40.50	93.8	1064.6
		06/08/90	11:17	40.50	93.8	1064.6

NR indicates no reading.

TABLE E-5
PIEZOMETER DATA FOR PB-60

BASE ELEVATION (G.S.)= 915.9 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	716.2	08/27/88		67.00	154.3	870.5
		08/30/88		57.00	131.4	847.6
		09/22/88		65.00	149.7	865.9
		11/09/88	16:25	NR	NR	NR
		11/13/88	17:05	NR	NR	NR
		11/15/88	12:01	57.00	131.4	847.6
		11/16/88	12:08	66.00	152.0	868.2
		11/16/88	16:16	67.00	154.3	870.5
		11/16/88	18:35	67.00	154.3	870.5
		11/17/88	11:01	65.00	149.7	865.9
		11/17/88	12:26	65.50	150.9	867.1
		11/17/88	16:22	66.50	153.2	869.4
		11/17/88	18:23	66.00	152.0	868.2
		11/18/88	13:02	65.50	150.9	867.1
		03/01/89	12:49	66.00	152.0	868.2
		03/29/89	15:12	66.00	152.0	868.2
		04/18/89	19:38	66.00	152.0	868.2
		06/17/89	15:53	67.00	154.3	870.5
		07/13/89	12:54	56.00	129.1	845.3
		08/23/89	17:19	66.00	152.0	868.2
		09/22/89	17:40	67.00	154.3	870.5
		10/20/89	16:01	66.00	152.0	868.2
		12/29/89	12:37	79.90	183.8	900.0
		05/16/90	09:00	70.25	161.8	878.0
		06/08/90	13:27	79.85	183.7	899.9
2	774.5	08/27/88		42.00	100.6	875.1
		08/30/88		43.00	102.8	877.3
		09/22/88		41.00	98.3	872.8
		11/09/88	16:25	NR	NR	NR
		11/13/88	17:05	NR	NR	NR
		11/15/88	11:48	42.00	100.6	875.1
		11/16/88	12:10	41.00	98.3	872.8
		11/16/88	16:17	41.00	98.3	872.8
		11/16/88	18:37	42.00	100.6	875.1
		11/17/88	11:03	41.00	98.3	872.8
		11/17/88	12:28	41.50	99.4	873.9
		11/17/88	16:24	42.00	100.6	875.1
		11/17/88	18:26	40.95	98.2	872.7
		11/18/88	13:06	41.00	98.3	872.8
		03/01/89	12:50	41.95	100.4	874.9
		03/29/89	15:14	41.00	98.3	872.8
		04/18/89	19:39	42.00	100.6	875.1
		06/17/89	15:54	42.00	100.6	875.1
		07/13/89	12:56	42.00	100.6	875.1
		08/23/89	17:21	41.00	98.3	872.8
		09/22/89	17:42	62.50	147.3	921.8
		10/20/89	16:02	42.00	100.6	875.1
		12/29/89	12:39	40.50	97.1	871.6
		05/16/90	09:04	45.15	107.8	882.3
		06/08/90	13:29	40.55	97.3	871.8

NR indicates no reading.

TABLE E-6
PIEZOMETER DATA FOR PB-88

BASE ELEVATION (G.S.)= 1042.5 ft.

PIEZO- METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	820.8	08/30/88		67.00	154.6	975.4
		08/30/88		67.00	154.6	975.4
		11/09/88	14:10	66.50	153.4	974.2
		11/10/88	10:21	67.89	156.6	977.4
		11/13/88	12:05	67.95	156.8	977.6
		11/13/88	16:39	NR	NR	NR
		03/01/89	11:42	68.00	156.9	977.7
		03/29/89	11:34	66.00	152.3	973.1
		04/19/89	11:39	68.00	156.9	977.7
		06/17/89	15:01	69.00	159.2	980.0
		07/13/89	11:53	69.00	159.2	980.0
		08/23/89	16:42	70.00	161.5	982.3
		09/22/89	16:56	70.00	161.5	982.3
		10/20/89	17:24	69.00	159.2	980.0
		12/28/89	13:45	68.00	156.9	977.7
		05/16/90	15:17	70.85	163.4	984.2
		06/08/90	10:35	73.50	169.5	990.3

NR indicates no reading.

TABLE E-7
PIEZOMETER DATA FOR PB-92

BASE ELEVATION (G.S.)= 1091.2 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	681.5	08/27/88		130.00	298.8	980.3
		08/30/88		168.00	385.8	1067.3
		09/22/88		129.00	296.5	978.0
		10/15/88		129.00	296.5	978.0
		11/09/88	13:48	128.00	294.2	975.7
		11/10/88	10:57	128.50	295.3	976.8
		11/10/88	16:10	128.50	295.3	976.8
		11/12/88	10:23	135.95	312.4	993.9
		11/13/88	13:38	129.00	296.5	978.0
		11/14/88	10:17	130.00	298.8	980.3
		02/28/89	18:48	127.00	291.9	973.4
		03/29/89	11:11	128.00	294.2	975.7
		04/18/89	12:24	130.00	298.8	980.3
		06/17/89	14:47	132.00	303.3	984.8
		07/13/89	11:39	130.00	298.8	980.3
		08/23/89	14:41	130.00	298.8	980.3
		09/22/89	16:14	130.00	298.8	980.3
		10/20/89	17:40	129.50	297.6	979.1
		12/28/89	13:21	139.00	319.4	1000.9
		05/16/90	15:05	NR	NR	NR
		06/08/90	10:45	135.00	310.2	991.7
2	752.9	08/27/88		133.00	305.9	1058.8
		08/30/88		170.00	390.6	1143.5
		09/22/88		131.00	301.3	1054.2
		10/15/88		132.00	303.6	1056.5
		11/09/88	13:50	130.70	300.6	1053.5
		11/10/88	11:07	131.90	303.3	1056.2
		11/10/88	16:13	131.00	301.3	1054.2
		11/12/88	10:28	128.95	296.6	1049.5
		11/13/88	13:41	132.00	303.6	1056.5
		11/14/88	10:19	132.00	303.6	1056.5
		02/28/89	18:50	130.00	299.0	1051.9
		03/29/89	11:15	130.00	299.0	1051.9
		04/18/89	12:27	131.00	301.3	1054.2
		06/17/89	14:49	134.00	308.1	1061.0
		07/13/89	11:41	133.00	305.9	1058.8
		08/23/89	14:44	132.00	303.6	1056.5
		09/22/89	16:16	132.00	303.6	1056.5
		10/20/89	17:42	131.00	301.3	1054.2
		12/28/89	13:24	130.00	299.0	1051.9
		05/16/90	15:10	NR	NR	NR
		06/08/90	10:48	136.25	313.3	1066.2
3	822.4	08/27/88		106.00	243.9	1066.3
		08/30/88		152.00	349.3	1171.7
		09/22/88		103.00	237.0	1059.4
		10/15/88		104.00	239.3	1061.7
		11/09/88	13:52	103.50	238.2	1060.6
		11/10/88	11:10	104.00	239.3	1061.7
		11/10/88	16:15	104.00	239.3	1061.7
		11/12/88	10:30	103.95	239.2	1061.6
		11/13/88	13:43	105.00	241.6	1064.0
		11/14/88	10:20	104.00	239.3	1061.7
		02/28/89	18:53	102.00	234.7	1057.1
		03/29/89	11:18	100.20	230.6	1053.0
		04/18/89	12:28	103.00	237.0	1059.4
		06/17/89	14:51	106.00	243.9	1066.3
		07/13/89	11:42	106.00	243.9	1066.3
		08/23/89	14:44	105.00	241.6	1064.0
		09/22/89	16:17	105.00	241.6	1064.0
		10/20/89	17:43	104.00	239.3	1061.7

TABLE E-7
PIEZOMETER DATA FOR PB-92

BASE ELEVATION (G.S.)= 1091.2 ft.

PIEZO- METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
3	822.4	12/28/89	13:27	103.90	239.1	1061.5
		05/16/90	15:00	NR	NR	NR
		06/08/90	10:50	109.00	250.8	1073.2

NR indicates no reading

TABLE E-8
PIEZOMETER DATA FOR PB-100

BASE ELEVATION (G.S.)= 1075.6 ft.

PIEZO- METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	679.6	08/27/88		147.60	340.9	1020.5
		08/30/88		96.00	222.4	902.0
		09/22/88		89.40	207.3	886.9
		11/09/88	14:18	86.50	200.6	880.2
		11/10/88	10:56	87.90	203.8	883.4
		11/12/88	11:52	76.95	178.7	858.3
		11/13/88	13:10	78.00	181.1	860.7
		11/14/88	10:08	77.95	181.0	860.6
		03/01/89	11:10	112.00	259.1	938.7
		03/29/89	11:50	114.00	263.7	943.3
		04/19/89	11:59	118.00	272.9	952.5
		06/17/89	15:10	123.00	284.4	964.0
		07/13/89	12:08	122.50	283.2	962.8
		08/23/89	16:54	124.50	287.8	967.4
		09/22/89	17:12	126.00	291.3	970.9
		10/20/89	16:52	124.00	286.7	966.3
		12/28/89	14:53	126.00	291.3	970.9
		05/16/90	15:46	NR	NR	NR
		06/08/90	12:11	135.00	311.9	991.5
2	922.1	08/27/88		58.00	134.5	1056.6
		08/30/88		57.00	132.2	1054.3
		09/22/88		57.30	132.9	1055.0
		11/09/88	14:20	57.00	132.2	1054.3
		11/10/88	10:59	57.90	134.3	1056.4
		11/12/88	11:54	57.00	132.2	1054.3
		11/13/88	13:29	58.00	134.5	1056.6
		11/14/88	10:10	57.95	134.4	1056.5
		03/01/89	11:13	57.90	134.3	1056.4
		03/29/89	11:52	56.00	129.9	1052.0
		04/19/89	12:00	66.50	154.0	1076.1
		06/17/89	15:12	58.00	134.5	1056.6
		07/13/89	12:10	57.00	132.2	1054.3
		08/23/89	16:54	57.00	132.2	1054.3
		09/22/89	17:13	58.00	134.5	1056.6
		10/20/89	16:54	57.00	132.2	1054.3
		12/28/89	14:58	58.00	134.5	1056.6
		05/16/90	15:37	55.15	128.0	1050.1
		06/08/90	12:13	51.00	118.4	1040.5

NR indicates no reading

TABLE E-9

PIEZOMETER DATA FOR PB-101

BASE ELEVATION (G.S.)= 873.8 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	525.8			Piezometer 101-1 is not functional		
2	562.3	08/30/88		80.00	184.3	746.6
		09/22/88		78.00	179.7	742.0
		03/29/89	16:35	78.00	179.7	742.0
		04/18/89	20:22	77.00	177.4	739.7
		06/17/89	15:39	78.00	179.7	742.0
		07/13/89	13:52	78.00	179.7	742.0
		08/23/89	18:38	78.00	179.7	742.0
		09/22/89	18:57	78.00	179.7	742.0
		01/02/90	15:52	76.00	175.2	737.5
		05/16/90	16:31	80.75	186.0	748.3
		06/08/90	12:36	81.00	186.6	748.9
3	617.8	08/30/88		40.00	93.2	711.0
		09/22/88		40.00	93.2	711.0
		03/29/89	16:36	38.00	88.6	706.4
		04/18/89	20:23	36.50	85.1	702.9
		06/17/89	15:40	41.00	95.5	713.3
		07/13/89	13:54	42.00	97.7	715.5
		08/23/89	18:36	40.00	93.2	711.0
		09/22/89	18:58	38.00	88.6	706.4
		01/03/90	15:55	38.00	88.6	706.4
		05/16/90	16:24	45.45	105.7	723.5
		06/08/90	12:37	44.95	104.5	722.3

TABLE E-10
PIEZOMETER DATA FOR PB-102

BASE ELEVATION (G.S.)= **1096.6** ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	712.6	09/22/88		139.00	320.0	1032.6
		10/15/88		135.00	310.8	1023.4
		11/09/88	13:25	136.00	313.1	1025.7
		11/10/88	12:17	138.00	317.7	1030.3
		11/10/88	15:59	138.00	317.7	1030.3
		11/10/88	17:29	NR	NR	NR
		11/11/88	13:50	131.00	301.6	1014.2
		11/11/88	20:47	130.50	300.5	1013.1
		11/12/88	11:00	132.00	303.9	1016.5
		11/13/88	14:30	134.50	309.7	1022.3
		11/14/88	10:51	NR	NR	NR
		11/14/88	11:24	135.00	310.8	1023.4
		11/14/88	12:29	136.00	313.1	1025.7
		11/14/88	18:51	134.00	308.5	1021.1
		11/14/88	20:34	134.00	308.5	1021.1
		11/14/88	22:50	134.00	308.5	1021.1
		11/15/88	00:50	134.00	308.5	1021.1
		11/15/88	10:35	134.00	308.5	1021.1
		11/15/88	11:12	134.00	308.5	1021.1
		02/28/89	20:01	136.00	313.1	1025.7
		03/29/89	12:38	136.00	313.1	1025.7
		04/19/89	10:46	137.50	316.6	1029.2
		06/17/89	14:11	140.00	322.3	1034.9
		07/13/89	10:59	139.00	320.0	1032.6
		08/23/89	16:18	138.00	317.7	1030.3
		09/22/89	14:57	139.50	321.1	1033.7
		10/21/89	12:05	136.00	313.1	1025.7
		12/20/89	16:18	138.00	317.7	1030.3
		05/16/90	13:48	NR	NR	NR
		06/08/90	11:27	143.00	329.2	1041.8
2	819.1	09/22/88		83.00	191.5	1010.6
		10/15/88		81.00	186.9	1006.0
		11/09/88	13:28	80.50	185.8	1004.9
		11/10/88	12:18	82.00	189.2	1008.3
		11/10/88	16:02	81.00	186.9	1006.0
		11/10/88	17:34	81.95	189.1	1008.2
		11/11/88	13:55	81.00	186.9	1006.0
		11/11/88	20:49	83.00	191.5	1010.6
		11/12/88	11:01	81.95	189.1	1008.2
		11/13/88	14:31	82.00	189.2	1008.3
		11/14/88	10:56	80.95	186.8	1005.9
		11/14/88	11:26	72.00	166.3	985.4
		11/14/88	12:31	82.00	189.2	1008.3
		11/14/88	18:53	81.95	189.1	1008.2
		11/14/88	20:36	82.00	189.2	1008.3
		11/14/88	22:52	81.00	186.9	1006.0
		11/15/88	00:51	81.95	189.1	1008.2
		11/15/88	10:36	81.95	189.1	1008.2
		11/15/88	11:13	82.00	189.2	1008.3
		02/28/89	20:03	80.00	184.6	1003.7
		03/29/89	12:42	82.00	189.2	1008.3
		04/19/89	10:48	82.00	189.2	1008.3
		06/17/89	14:13	82.00	189.2	1008.3
		07/13/89	11:00	132.00	304.0	* 1123.1
		08/23/89	16:20	81.00	186.9	1006.0
		09/22/89	14:59	83.90	193.6	1012.7
		10/21/89	12:08	81.00	186.9	1006.0
		12/23/89	13:36	80.00	184.6	1003.7
		05/16/90	10:56	85.75	197.8	1016.9
		06/08/90	11:29	85.90	198.2	1017.3

TABLE E-10
PIEZOMETER DATA FOR PB-102

BASE ELEVATION (G.S.)= **1096.6** ft.

PIEZO- METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
3	875.6	11/09/88	13:30	64.00	147.7	1023.3
		11/10/88	12:20	64.50	148.9	1024.5
		11/10/88	16:03	65.00	150.0	1025.6
		11/10/88	17:38	64.95	149.9	1025.5
		11/11/88	13:58	65.00	150.0	1025.6
		11/11/88	20:51	69.00	159.2	1034.8
		11/12/88	11:02	65.00	150.0	1025.6
		11/13/88	14:32	65.00	150.0	1025.6
		11/14/88	10:59	64.00	147.7	1023.3
		11/14/88	11:27	60.95	140.8	1016.4
		11/14/88	12:33	65.00	150.0	1025.6
		11/14/88	18:54	64.50	148.9	1024.5
		11/14/88	20:37	65.50	151.2	1026.8
		11/14/88	22:53	65.95	152.2	1027.8
		11/15/88	00:53	65.00	150.0	1025.6
		11/15/88	10:38	65.00	150.0	1025.6
		11/15/88	11:15	65.00	150.0	1025.6
		02/28/89	20:04	65.00	150.0	1025.6
		03/29/89	12:43	66.50	153.5	1029.1
		04/19/89	10:50	67.00	154.6	1030.2
		06/17/89	14:14	68.00	156.9	1032.5
		07/13/89	11:01	67.00	154.6	1030.2
		08/23/89	16:20	65.00	150.0	1025.6
		09/22/89	15:00	68.50	158.1	1033.7
		10/21/89	12:08	66.50	153.5	1029.1
		12/23/89	13:39	66.00	152.3	1027.9
		05/16/90	13:32	70.25	162.1	1037.7
		06/08/90	11:31	70.00	161.5	1037.1

* indicates suspect value.
NR indicates no reading.

TABLE E-11
PIEZOMETER DATA FOR PB-103

BASE ELEVATION (G.S.)= 1007.0 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	685.2	10/15/88		116.00	267.3	952.5
		11/09/88	15:42	NR	NR	NR
		11/10/88	12:47	119.00	274.2	959.4
		11/12/88	11:18	128.00	294.8	980.0
		11/13/88	14:45	118.00	271.9	957.1
		03/01/89	10:22	116.00	267.3	952.5
		03/29/89	13:00	118.00	271.9	957.1
		04/19/89	09:59	118.00	271.9	957.1
		06/17/89	13:26	118.00	271.9	957.1
		07/13/89	10:43	119.00	274.2	959.4
		09/22/89	15:35	117.00	269.6	954.8
		10/21/89	13:14	116.00	267.3	952.5
		12/23/89	12:51	116.00	267.3	952.5
		05/16/90	12:32	NR	NR	NR
		06/08/90	11:53	119.90	276.2	961.4
2	764.2	10/15/88		84.00	193.2	957.4
		11/09/88	15:42	NR	NR	NR
		11/10/88	12:49	86.50	198.9	963.1
		11/12/88	11:19	86.00	197.8	962.0
		11/13/88	14:46	86.00	197.8	962.0
		03/01/89	10:25	86.00	197.8	962.0
		03/29/89	12:58	86.00	197.8	962.0
		04/19/89	10:00	86.00	197.8	962.0
		06/17/89	13:27	86.50	198.9	963.1
		07/13/89	10:44	87.00	200.1	964.3
		09/22/89	15:36	87.00	200.1	964.3
		10/21/89	13:16	85.00	195.5	959.7
		12/23/89	12:53	85.50	196.6	960.8
		05/16/90	12:39	90.25	207.5	971.7
		06/08/90	11:56	90.00	206.9	971.1
3	887.7	10/15/88		34.00	78.7	966.4
		11/09/88	15:42	30.59	70.9	958.6
		11/10/88	12:50	35.95	83.2	970.9
		11/12/88	11:21	36.00	83.3	971.0
		11/13/88	14:49	36.00	83.3	971.0
		03/01/89	10:26	35.00	81.0	968.7
		03/29/89	13:00	34.00	78.7	966.4
		04/19/89	10:01	34.00	78.7	966.4
		06/17/89	13:28	36.00	83.3	971.0
		07/13/89	10:45	36.00	83.3	971.0
		09/22/89	15:37	36.50	84.4	972.1
		10/21/89	13:17	35.00	81.0	968.7
		12/23/89	12:55	34.90	80.7	968.4
		05/16/90	12:42	40.35	93.2	980.9
		06/08/90	11:58	40.90	94.5	982.2

NR indicates no reading.

TABLE E-12
PIEZOMETER DATA FOR PB-104

BASE ELEVATION (G.S.)= 1026.7 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	738.7	10/15/88		110.00	253.0	991.7
		11/13/88	15:22	NR	NR	NR
		03/29/89	14:28	110.00	253.0	991.7
		04/21/89	10:21	112.00	257.6	996.3
		06/17/89	13:39	114.00	262.2	1000.9
		07/13/89	12:25	112.00	257.6	996.3
		09/22/89	15:19	112.00	257.6	996.3
		10/21/89	12:23	100.00	230.1	968.8
		12/23/89	13:09	112.00	257.6	996.3
		05/16/90	13:12	NR	NR	NR
		06/08/90	11:40	115.90	266.5	1005.2
2	811.4	10/15/88		82.00	189.3	1000.7
		11/13/88	15:24	NR	NR	NR
		03/29/89	14:31	58.00	134.2	945.6
		04/21/89	10:22	64.00	148.0	959.4
		06/17/89	13:40	84.00	193.9	1005.3
		07/13/89	12:26	83.90	193.7	1005.1
		09/22/89	15:21	82.50	190.4	1001.8
		10/21/89	12:25	81.00	187.0	998.4
		12/23/89	13:10	83.00	191.6	1003.0
		05/16/90	13:03	35.15	81.7	893.1
		06/08/90	11:41	87.90	202.8	1014.2
3	889.0	10/15/88		49.00	113.5	1002.5
		11/13/88	15:26	NR	NR	NR
		03/29/89	14:33	49.00	113.5	1002.5
		04/21/89	10:23	50.00	115.8	1004.8
		06/17/89	13:41	51.00	118.1	1007.1
		07/13/89	12:27	50.00	115.8	1004.8
		09/22/89	15:22	51.90	120.2	1009.2
		10/21/89	12:26	50.00	115.8	1004.8
		12/23/89	13:12	52.00	120.4	1009.4
		05/16/90	13:01	50.95	118.0	1007.0
		06/08/90	11:23	53.00	122.7	1011.7

NR indicates no reading.

TABLE E-13
PIEZOMETER DATA FOR PB-105

BASE ELEVATION (G.S.)= 883.4 ft.

PIEZO- METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
1	609.9	10/19/88		100.00	230.2	840.1
		11/15/88	12:50	101.00	232.4	842.3
		11/16/88	12:50	99.00	227.9	837.8
		11/16/88	16:37	99.00	227.9	837.8
		11/16/88	17:07	98.95	227.7	837.6
		11/16/88	19:21	99.00	227.9	837.8
		11/17/88	11:46	99.00	227.9	837.8
		11/17/88	12:58	99.50	229.0	838.9
		11/17/88	16:58	99.00	227.9	837.8
		11/17/88	18:57	98.00	225.6	835.5
		11/18/88	12:28	97.00	223.3	833.2
		03/01/89	13:33	99.95	230.0	839.9
		03/29/89	16:11	100.00	230.2	840.1
		04/18/89	19:02	99.97	230.1	840.0
		06/17/89	16:28	101.00	232.4	842.3
		07/13/89	13:30	100.00	230.2	840.1
		08/23/89	18:03	98.50	226.7	836.6
		09/22/89	18:25	100.00	230.2	840.1
		10/20/89	16:16	100.00	230.2	840.1
		12/29/89	15:14	97.90	225.3	835.2
		05/16/90	10:22	NR	NR	NR
		06/08/90	09:59	102.50	235.9	845.8
2	702.9	10/19/88		51.00	118.0	820.9
		11/15/88	12:51	53.00	122.6	825.5
		11/16/88	12:51	51.00	118.0	820.9
		11/16/88	16:39	50.00	115.7	818.6
		11/16/88	17:08	50.00	115.7	818.6
		11/16/88	19:23	50.00	115.7	818.6
		11/17/88	11:47	48.00	111.2	814.1
		11/17/88	12:59	48.50	112.3	815.2
		11/17/88	16:59	47.95	111.1	814.0
		11/17/88	18:58	48.00	111.2	814.1
		11/18/88	12:29	46.50	107.7	810.6
		03/01/89	13:34	52.00	120.3	823.2
		03/29/89	16:12	52.00	120.3	823.2
		04/18/89	19:03	52.00	120.3	823.2
		06/17/89	16:29	55.00	127.2	830.1
		07/13/89	13:31	54.00	124.9	827.8
		08/23/89	18:05	52.00	120.3	823.2
		09/22/89	18:28	53.00	122.6	825.5
		10/20/89	16:17	53.00	122.6	825.5
		12/29/89	15:16	52.00	120.3	823.2
		05/16/90	10:29	50.95	117.9	820.8
		06/08/90	10:00	58.00	134.1	837.0
3	750.9	10/19/88		33.00	75.5	826.4
		11/15/88	12:52	34.00	77.7	828.6
		11/16/88	12:52	32.50	74.3	825.2
		11/16/88	16:40	33.00	75.5	826.4
		11/16/88	17:09	32.00	73.2	824.1
		11/16/88	19:24	32.50	74.3	825.2
		11/17/88	11:48	32.00	73.2	824.1
		11/17/88	13:01	32.00	73.2	824.1
		11/17/88	17:01	32.00	73.2	824.1
		11/17/88	18:59	31.95	73.1	824.0
		11/18/88	12:30	31.00	70.9	821.8
		03/01/89	13:35	32.95	75.3	826.2
		03/29/89	16:13	33.90	77.5	828.4
		04/18/89	19:04	32.50	74.3	825.2
		06/16/89	16:30	37.00	84.6	835.5
		07/12/89	13:32	34.00	77.7	828.6
		08/22/89	18:06	34.00	77.7	828.6

TABLE E-13

PIEZOMETER DATA FOR PB-105

BASE ELEVATION (G.S.)= 883.4 ft.

PIEZO-METER NUMBER	PIEZOMETER ELEV. FT. MSL	DATE	TIME	GAUGE READING (PSI)	HEAD ABOVE PIEZO (FT.)	PIEZO ELEV. (FT)
3	750.9	09/21/89	18:28	34.00	77.7	828.6
		10/20/89	16:18	34.00	77.7	828.6
		12/29/89	15:18	32.00	73.2	824.1
		05/16/90	10:31	35.95	82.2	833.1
		06/08/90	10:02	39.00	89.2	840.1

NR indicates no reading

APPENDIX F

ANALYTICAL LABORATORY RESULTS

SAMPLE DATA INTEGRITY SHEETS

LABORATORY ANALYTICAL RESULTS
SAMPLE DATA INTEGRITY SHEETS

NOVEMBER 1988
FEBRUARY 1989
MAY/JUNE 1989
JULY 1989

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378-12, WP1178-1
(Analyzed concurrently with Golder Associates samples)
Analyzed: November 16-25, 1988

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l	21.0	27.0	19.0-38.0
Cadmium, ug/l	8.0	9.1	6.7-10.8
Lead, ug/l	42.0	43.0	34.0-54.0
Mercury, ug/l	2.1	2.0	1.5-2.5
Selenium, ug/l	11.7	11.0	6.5-14.1

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083, ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: November 23, 1988

Parameter	Result	True Value	% Recovery
Aluminum, ug/l	900	970	92.8
Barium, ug/l	990	990	100.0
Chromium, ug/l	98	103	95.1
Copper, ug/l	95	100	95.0
Iron, ug/l	95	102	93.1
Manganese, ug/l	100	102	98.0
Zinc, ug/l	90	100	90.0

NUTRIENT ANALYSIS

Identification: EPA QC WP284-1, WS378-1
(Analyzed concurrently with Golder Associates samples)
Analyzed: November 29 - December 6, 1988

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l	0.17	0.15	0.11-0.19
Nitrate as N, mg/l	0.13	0.10	0.06-0.16
Total Kjeldahl as N, mg/l	0.18	0.15	0.11-0.19
Orthophosphate as P, mg/l	0.03	0.04	0.02-0.06

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP287, WP1178-1
(Analyzed concurrently with Golder Associates samples)
Analyzed: December 1 - 9, 1988

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l....................	22.4	27.0	19.8-34.2
Cadmium, ug/l....................	8.0	9.1	6.7-10.8
Lead, ug/l.......................	51.0	43.0	34.0-54.0
Mercury, ug/l....................	0.6	0.7	0.3-1.1
Selenium, ug/l...................	26.5	25.0	17.4-28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083, ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: December 3, 1988

Parameter	Result	True Value	% Recovery
Aluminum, ug/l...................	105	97	108.2
Barium, ug/l.....................	104	99	105.1
Chromium, ug/l...................	98	103	95.1
Copper, ug/l.....................	100	100	100.0
Iron, ug/l.......................	109	102	106.9
Manganese, ug/l..................	101	102	99.0
Zinc, ug/l.......................	100	101	99.0

NUTRIENT ANALYSIS

Identification: EPA QC WP284-1,5,6
(Analyzed concurrently with Golder Associates samples)
Analyzed: November 29 - December 6, 1988

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l...............	0.18	0.15	0.11-0.19
Nitrate as N, mg/l...............	0.14	0.18	0.14-0.22
Total Kjeldahl as N, mg/l........	0.38	0.40	0.27-0.55
Orthophosphate as P, mg/l........	0.95	1.03	0.94-1.18

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP287, WS378 #18, #12, & #5
(Analyzed concurrently with Golder Associates samples)
Analyzed: February 24 - March 6, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l......................	49.0	51.0	41.6 - 58.7
Cadmium, ug/l......................	6.0	7.4	5.3 - 8.8
Lead, ug/l.........................	39.0	34.0	27.6 - 39.8
Mercury, ug/l......................	3.1	3.0	2.16 - 3.78
Selenium, ug/l.....................	20.0	25.0	17.4 - 28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 1, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l.....................	98.6	97	101.6
Barium, ug/l.......................	102	99	103.0
Chromium, ug/l.....................	93.5	103	90.8
Copper, ug/l.......................	96.5	100	96.5
Iron, ug/l.........................	104	102	102.0
Manganese, ug/l....................	99.2	102	97.3
Zinc, ug/l.........................	99.5	101	98.5

NUTRIENT ANALYSIS

Identification: EPA QC WS 378, WP 486
(Analyzed concurrently with Golder Associates samples)
Analyzed: February 22 - March 16, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l................	1.97	2.00	1.78 - 2.18
Nitrate as N, mg/l................	0.09	0.10	0.06 - 0.16
Total Kjeldahl as N, mg/l.........	0.51	0.50	0.42 - 0.57
Orthophosphate as P, mg/l.........	0.49	0.50	0.46 - 0.54

GOLDER ASSOCIATES, INC.

QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP287, WS378 #18, #12, & #5
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 8 - 9, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l....................	31.8	31.0	25.1 - 36.2
Cadmium, ug/l....................	7.0	7.4	5.3 - 8.8
Lead, ug/l.......................	37.0	34.0	27.6 - 39.8
Mercury, ug/l....................	1.9	2.6	1.85 - 3.29
Selenium, ug/l...................	20.0	25.0	17.4 - 28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 7, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l...................	121	97	124.7
Barium, ug/l.....................	99	99	100.0
Chromium, ug/l...................	94	103	91.3
Copper, ug/l.....................	105	100	105.0
Iron, ug/l.......................	98	102	96.1
Manganese, ug/l..................	97	102	95.1
Zinc, ug/l.......................	105	101	104.0

NUTRIENT ANALYSIS

Identification: EPA QC WS 378, WP 284
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 3 - March 19, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l...............	0.46	0.50	0.42 - 0.57
Nitrate as N, mg/l...............	0.18	0.18	0.14 - 0.22
Total Kjeldahl as N, mg/l........	0.46	0.50	0.42 - 0.57
Orthophosphate as P, mg/l........	0.05	0.04	0.02 - 0.06

QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378-4,12 WP287-1
(Analyzed concurrently with Golder Associates samples)
Analyzed: June 26 - 30, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l....................	67.9	62.0	48.1-73.2
Cadmium, ug/l....................	2.0	2.7	1.8-3.4
Lead, ug/l.......................	26.0	26.0	19.4-33.4
Mercury, ug/l....................	1.2	1.6	1.1 - 2.1
Selenium, ug/l...................	26.6	25.0	17.4-28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083 ICAP-19
(Analyzed concurrently with Golder Associates samples)
Analyzed: June 22 - 27, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l...................	103.0	97	106.2
Barium, ug/l.....................	105.0	97	108.2
Chromium, ug/l...................	96.0	103	93.2
Copper, ug/l.....................	109	103	105.8
Iron, ug/l.......................	105	102	102.9
Manganese, ug/l..................	100	102	98.0
Zinc, ug/l.......................	107	101	105.9

NUTRIENT ANALYSIS

Identification: EPA QC WP284
(Analyzed concurrently with Golder Associates samples)
Analyzed: June 22 - 30, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l...............	1.37	1.52	1.34 - 1.70
Nitrate as N, mg/l...............	1.59	1.60	1.44 - 1.76
Total Kjeldahl as N, mg/l........	5.32	4.78	4.32 - 5.44
Orthophosphate as P, mg/l........	0.134	0.14	0.13 - 0.15

QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378-4,12 WP287-1
(Analyzed concurrently with Golder Associates samples)
Analyzed: July 19 - 20, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l....................	30.5	31.0	25.1 - 36.2
Cadmium, ug/l....................	3.0	2.7	1.8 - 3.4
Lead, ug/l.......................	27.0	26.0	19.4 - 33.4
Mercury, ug/l....................	1.2	1.6	1.1 - 2.1
Selenium, ug/l...................	21.9	25.0	17.4 - 28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083 ICAP-19
(Analyzed concurrently with Golder Associates samples)
Analyzed: July 19, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l...................	107	97	110.3
Barium, ug/l.....................	101	97	104.1
Chromium, ug/l...................	102	103	99.0
Copper, ug/l.....................	105	103	101.9
Iron, ug/l.......................	105	102	102.9
Manganese, ug/l..................	100	102	98.0
Zinc, ug/l.......................	109	101	107.9

NUTRIENT ANALYSIS

Identification: EPA QC WP284
(Analyzed concurrently with Golder Associates samples)
Analyzed: June 22 - July 4, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l...............	1.23	1.52	1.34 - 1.70
Nitrate as N, mg/l...............	1.54	1.60	1.44 - 1.76
Total Kjeldahl as N, mg/l........	5.32	4.78	4.32 - 5.44
Orthophosphate as P, mg/l........	0.265	0.27	0.25 - 0.29

CONSTITUENT	STANDARD DETECTION LIMIT	METHOD REFERENCE	
Acidity	1	EPA 305.1	Titrimetric, 8.3
Alkalinity	1	EPA 310.1	Titrimetric, 4.5
Aluminum	0.1	EPA 200.7	ICP
Ammonia Nitrogen	0.01	EPA 350.1	Colorimetric, Automated Phenat
Arsenic	0.005	EPA 206.2	AA, Furnace Technique
Barium	0.5	EPA 200.7	ICP
Bicarbonate	1	EPA 310.1	Titrimetric, 4.5
Boron	0.01	EPA 200.7	ICP
Cadmium	0.002	EPA 213.2	AA, Furnace Technique
Calcium	1	EPA 215.2	Titrimetric, EDTA
Carbonate	1	EPA 310.1	Titrimetric, 8.3
Chloride	1	EPA 325.3	Titrimetric, Mercuric Nitrate
Chromium	0.02	EPA 200.7	ICP
Color	1	SM 204.A	Visual Comparison Method
Cobalt	0.01	EPA 200.7	ICP
Conductivity	10	EPA 120.1	Specific Conductance, umhos-2
Copper	0.01	EPA 200.7	ICP
Cyanide	0.005	EPA 335.3	Colorimetric, Automated UV
Dissolved Solids	1	EPA 160.1	Gravimetric, 180C
Fluoride	0.05	EPA 340.2	Potentiometric, ISE
Hardness	1	EPA 130.2	Titrimetric, EDTA
Hydroxide	1	EPA 310.1	Titrimetric
Iron	0.05	EPA 200.7	ICP
Kjeldahl Nitrogen	0.1	EPA 351.1	Colorimetric, Automated Phenat
Lead	0.002	EPA 239.2	AA Furnace Technique
Magnesium	0.1	EPA 200.7	ICP
Manganese	0.02	EPA 200.7	ICP
Mercury	0.001	EPA 245.1	Manual Cold Vapor Technique
Molybdenum	0.02	EPA 200.7	ICP
Nickel	0.01	EPA 200.7	ICP
Nitrate Nitrogen	0.01	EPA 353.2	Color, Auto, Cadmium Reduction
Nitrite Nitrogen	0.01	EPA 353.2	Colorimetric, Automated
pH	0.1	EPA 150.1	Electrometric
Phenols	0.005	EPA 420.2	Color, Auto with Distillation
Phosphorus	0.005	EPA 365.2	Colorimetric, Ascorbic Acid
Potassium	0.5	SM 322.B	Flame Photometer
Selenium	0.005	EPA 270.2	AA, Furnace Technique
Settleable Solids	0.1	EPA 160.2	Volumetric, Imhoff Cone
Silica	0.1	EPA 200.7	ICP
Silver	0.01	EPA 200.7	ICP
Sodium	0.5	SM 325.B	Flame Photometer
Sulfate	1	EPA 375.3	Gravimetric
Sulfide	0.04	EPA 376.1	Titrimetric, Iodine
Suspended Solids	1	EPA 160.2	Gravimetric, 103-105C
Thallium	0.1	EPA 200.7	ICP
Turbidity	0.05	EPA 180.1	Nephelometric
Vanadium	0.1	EPA 200.7	ICP
Zinc	0.01	EPA 200.7	ICP

SM = Standard Methods, 16th Ed., 1985.
EPA = EPA Methods Manual, EPA-600/4-79-020, 1983.

ANALYTICAL RESULTS
FOR
DISSOLVED CHROMIUM, IRON AND MANGANESE

NOVEMBER 1988

GOLDER ASSOCIATES

Wishbone Hills Project

Trace Metal Analysis
Dissolved Concentrations (mg/l)

Lab No.:	Sample Identification:	Chromium	Iron	Manganese
886643	883-2146-7-30-88-1	<0.02	<0.05	<0.02
886644	883-2146-7-30-88-2	<0.02	<0.05	<0.02
886445	883-2146-7-30-88-3	<0.02	0.16	<0.02
886446	883-2146-7-30-88-4	<0.02	<0.05	<0.02
886447	883-2146-7-30-88-5	<0.02	<0.05	<0.02
886448QC	883-2146-7-30-88-3	<0.02	<0.05	<0.02
886861	883-2146-83188-1	<0.02	<0.05	<0.02
886862	883-2146-83188-2	<0.02	<0.05	<0.02
886863	883-2146-83188-3	<0.02	0.12	0.03
886864	883-2146-83188-4	<0.02	0.24	<0.02
886865	883-2146-83188-5	<0.02	0.05	<0.02
886868QC	883-2146-83188-3	<0.02	0.12	0.03
886973	883-2146-92388-1	<0.02	<0.05	<0.02
886974	883-2146-92388-2	<0.02	0.05	<0.02
886975	883-2146-92388-4	<0.02	0.06	<0.02
886976	883-2146-92388-5	<0.02	<0.05	<0.02
886979QC	883-2146-92388-5	<0.02	<0.05	<0.02
887119	883-2146-102188-5	<0.02	<0.05	<0.02
887120	883-2146-102188-3	<0.02	0.06	<0.02
887121	883-2146-102188-2	<0.02	<0.05	<0.02
887122	883-2146-102188-4	<0.02	<0.05	<0.02
887123	883-2146-102188-1	<0.02	<0.05	<0.02
887124QC	883-2146-102188-5	<0.02	<0.05	<0.02
887181	883-2145-H88-21	<0.02	0.67	0.04
887182	883-2145-H88-22	<0.02	4.34	0.70
887183	883-2145-H88-23	<0.02	0.18	0.21
887184	883-2145-H88-24A	<0.02	0.09	4.58
887185	883-2145-H88-25	<0.02	<0.05	<0.02
887186QC	883-2145-H88-23	<0.02	0.19	0.21
887194	883-2145-H88-17	<0.02	0.11	0.08
887195	883-2145-H88-19	<0.02	0.24	0.18
887196	883-2145-H88-27	<0.02	0.22	0.05
887197	883-2145-H88-28	<0.02	0.17	0.02

GOLDER ASSOCIATES

Wishbone Hills Project

Trace Metal Analysis
Dissolved Concentrations (mg/l)

Lab No.:	Sample Identification:	Chromium	Iron	Manganese
887221	883-2146-111888-1	<0.02	<0.05	<0.02
887222	883-2146-111888-2	<0.02	<0.05	<0.02
887223	883-2146-111988-3	<0.02	0.10	<0.02
887224	883-2146-111988-4	<0.02	0.08	<0.02
887225	883-2146-111988-5	<0.02	<0.05	<0.02
887228QC	883-2146-111988-4	<0.02	0.08	<0.02
887234	883-2145-H88-10MW	<0.02	0.08	<0.02
887235	883-2145-H88-11MW	<0.02	0.08	<0.02
887236	883-2145-H88-12MW	<0.02	0.18	<0.02
887237	883-2145-H88-13MW	<0.02	0.11	<0.02
887238	883-2145-H88-14AMW	<0.02	<0.05	<0.02
887239	883-2145-H88-15	<0.02	<0.05	<0.02
887240	883-2145-H88-16MW	<0.02	0.20	<0.02
887241QC	883-2145-H88-14AMW	<0.02	<0.05	<0.02
887409	883-2146-12-20-88-1	<0.02	<0.05	<0.02
887410	883-2146-12-20-88-2	<0.02	<0.05	<0.02
887411	883-2146-12-20-88-3	<0.02	0.05	<0.02
887412	883-2146-12-20-88-4	<0.02	0.12	<0.02
887413	883-2146-12-20-88-5	<0.02	<0.05	<0.02
887416QC	883-2146-12-20-88-3	<0.02	0.05	<0.02

GOLDER ASSOCIATES

Wishbone Hills Project

Trace Metal Analysis
Dissolved Concentrations (mg/l)

Lab No.:	Sample Identification:	Chromium	Iron	Manganese
886643	883-2146-7-30-88-1	<0.02	<0.05	<0.02
886644	883-2146-7-30-88-2	<0.02	<0.05	<0.02
886445	883-2146-7-30-88-3	<0.02	0.16	<0.02
886446	883-2146-7-30-88-4	<0.02	<0.05	<0.02
886447	883-2146-7-30-88-5	<0.02	<0.05	<0.02
886448QC	883-2146-7-30-88-3	<0.02	<0.05	<0.02
886861	883-2146-83188-1	<0.02	<0.05	<0.02
886862	883-2146-83188-2	<0.02	<0.05	<0.02
886863	883-2146-83188-3	<0.02	0.12	0.03
886864	883-2146-83188-4	<0.02	0.24	<0.02
886865	883-2146-83188-5	<0.02	0.05	<0.02
886868QC	883-2146-83188-3	<0.02	0.12	0.03
886973	883-2146-92388-1	<0.02	<0.05	<0.02
886974	883-2146-92388-2	<0.02	0.05	<0.02
886975	883-2146-92388-4	<0.02	0.06	<0.02
886976	883-2146-92388-5	<0.02	<0.05	<0.02
886979QC	883-2146-92388-5	<0.02	<0.05	<0.02
887119	883-2146-102188-5	<0.02	<0.05	<0.02
887120	883-2146-102188-3	<0.02	0.06	<0.02
887121	883-2146-102188-2	<0.02	<0.05	<0.02
887122	883-2146-102188-4	<0.02	<0.05	<0.02
887123	883-2146-102188-1	<0.02	<0.05	<0.02
887124QC	883-2146-102188-5	<0.02	<0.05	<0.02
887181	883-2145-H88-21	<0.02	0.67	0.04
887182	883-2145-H88-22	<0.02	4.34	0.70
887183	883-2145-H88-23	<0.02	0.18	0.21
887184	883-2145-H88-24A	<0.02	0.09	4.58
887185	883-2145-H88-25	<0.02	<0.05	<0.02
887186QC	883-2145-H88-23	<0.02	0.19	0.21
887194	883-2145-H88-17	<0.02	0.11	0.08
887195	883-2145-H88-19	<0.02	0.24	0.18
887196	883-2145-H88-27	<0.02	0.22	0.05
887197	883-2145-H88-28	<0.02	0.17	0.02

GOLDER ASSOCIATES

Wishbone Hills Project

Trace Metal Analysis
Dissolved Concentrations (mg/l)

Lab No.:	Sample Identification:	Chromium	Iron	Manganese
887221	883-2146-111888-1	<0.02	<0.05	<0.02
887222	883-2146-111888-2	<0.02	<0.05	<0.02
887223	883-2146-111988-3	<0.02	0.10	<0.02
887224	883-2146-111988-4	<0.02	0.08	<0.02
887225	883-2146-111988-5	<0.02	<0.05	<0.02
887228QC	883-2146-111988-4	<0.02	0.08	<0.02
887234	883-2145-H88-10MW	<0.02	0.08	<0.02
887235	883-2145-H88-11MW	<0.02	0.08	<0.02
887236	883-2145-H88-12MW	<0.02	0.18	<0.02
887237	883-2145-H88-13MW	<0.02	0.11	<0.02
887238	883-2145-H88-14AMW	<0.02	<0.05	<0.02
887239	883-2145-H88-15	<0.02	<0.05	<0.02
887240	883-2145-H88-16MW	<0.02	0.20	<0.02
887241QC	883-2145-H88-14AMW	<0.02	<0.05	<0.02
887409	883-2146-12-20-88-1	<0.02	<0.05	<0.02
887410	883-2146-12-20-88-2	<0.02	<0.05	<0.02
887411	883-2146-12-20-88-3	<0.02	0.05	<0.02
887412	883-2146-12-20-88-4	<0.02	0.12	<0.02
887413	883-2146-12-20-88-5	<0.02	<0.05	<0.02
887416QC	883-2146-12-20-88-3	<0.02	0.05	<0.02

LABORATORY ANALYTICAL RESULTS
SAMPLE DATA INTEGRITY SHEETS

NOVEMBER 1988
FEBRUARY 1989
MAY/JUNE 1989
JULY 1989

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8810-7-25-89.41

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR

Date 7-25-89

Time 13:53 LAST Sample Collected

Media WATER

Station H8810

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

TOTAL DEPTH: 145.00 / SAT. THICKNESS: 69.60

WATER LEVEL: 75.26 / PURGE VOLUME: 33.06

Sample Description INITIALLY CLEAR GOING TURBID AFTER 1ST QUART THEN CLEARING UP @ ≅ 15-20 GALLONS - THEN @ ≅ 30 GALLONS A STRONG SULPHUR ODOR BEGAN

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 4°C / D-O2: 12.2

PH: 7.79 / 25: 332 - final TEST of (4)

ALKALINITY: 1820 as CaCO4

Aliquot Amount	Container	Preservation/Amount
1/2 Gallon	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC - 1
250 ML	"	NITRIC - 1
250 ML	"	FILTERED NITRIC - 1

Sampler (signature)

Date 7-25-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2145

Site Location Alaska Sample ID 883-2145-H88-10-6-6-89

Sampling Location

Technical Procedure Reference(s) G.D. - MEMO DATED - 3RD QUARTER SAMPLING

Type of Sampler HYDROSTAR

Date 6-6-89 Time 21:38

Media WATER Station H8810

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) DEPTH = 153.30 WATER LEVEL: 75.47

SATURATED THICKNESS: 77.83 - AMOUNT PURGED = 33.06 GALS

TOTAL AMOUNT PURGED: ≅ 49.00 GALS

Sample Description CLEAR - SUSPENDED PARTICLES - STRONG SULPHUR ODOUR

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 3 °C

D-O2: 11.4 PH: 7.34 μS: 321 - (FINAL F.M.'s of (4) TAKEN) ALKALINITY = 144.0 mg/L

Aliquot Amount	Container		Preservative/Amount
1/2 GAL	PLASTIC JUG		NONE
1 LITRE	" "		SULPHURIC - 1
250 mL	" "		NITRIC - 1
250 mL	" "	FILTERED	NITRIC - 1

Sampler (signature) Matthew F W Date 6-6-89

Supervisor (signature) Date

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H8810-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR

Date 2-25-89

Time 15:49

Media WATER

Station H8810

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
DEPTH of WELL - 147.82 - SATURATED THICKNESS - 69.80
WATER LEVEL - 78.02 - AFTER PURGING 70 GALLONS - WATER
LEVEL WAS ~~[illegible]~~ 40 .02 - 78.00

Sample Description CLEAR - 70 GALLON - STRONG SULPHUR ODOR
THAT WOULD COME & GO

Field Measurements on Sample (pH, conductivity, etc.)
PH = 7.15 - uS = 388 - TEMP = 3°C - D.O = 3.20
ALKALINITY = 104.0 mg/L

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	PLASTIC	NONE
500 ML	"	SULPHUR - 1
250 ML	"	NITRIC - 1
250 ML	"	NITRIC - 1

SEAL NO. # 3608 - 3609

Sampler (signature) Matthew F W

Date 2-25-89

Supervisor (signature)

Date

Golder Associates Inc.

Sample Site: 883-2145-H88-10MW
Lab No: 887234
Date Sampled: 11/22/88 @ 1240
Date Received: 11/29/88

Lab pH, s.u.	7.47
Lab Conductivity, umhos/cm @ 25C	301
Total Dissolved Solids (180), mg/l	188
Total Dissolved Solids (calc), mg/l	180
Boron, mg/l	0.07
Fluoride, mg/l	0.28
Ammonia Nitrogen as N, mg/l	0.45
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	0.008
Total Alkalinity as CaCO3, mg/l	175
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	129
Sodium Adsorption Ratio	0.87

	mg/l	meq/l
Bicarbonate as HCO3	214	3.50
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	<0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	3.7	0.08
Calcium	34	1.70
Magnesium	11	0.89
Potassium	3.3	0.08
Sodium	23	0.99

Major Anions	3.61
Major Cations	3.66
Cation/Anion Difference	0.69 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	1.0	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.19
Manganese	<0.02

Sample Site: 883-2145-H8810-2-15-89MW
Lab No: 897637
Date Sampled: 02/25/89 @ 1549
Date Received: 02/28/89

Lab pH, s.u.	7.84
Lab Conductivity, umhos/cm @ 25C	278
Total Dissolved Solids (180), mg/l	182
Total Dissolved Solids (calc), mg/l	181
Boron, mg/l	0.26
Fluoride, mg/l	0.29
Ammonia Nitrogen as N, mg/l	0.01
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	0.009
Total Phosphorus as P, mg/l	0.037
Total Alkalinity as CaCO3, mg/l	179
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	120
Sodium Adsorption Ratio	1.00

	mg/l	meq/l
Bicarbonate as HCO3	218	3.57
Carbonate as CO3	0	0.00
Chloride	2.5	0.07
Nitrate as N, mg/l	0.11	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.4	0.01
Calcium	34	1.70
Magnesium	8.5	0.70
Potassium	3.8	0.10
Sodium	25	1.09

Major Anions	3.66
Major Cations	3.59
Cation/Anion Difference	0.97 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	1.0	Lead	<0.02
Cadmium	0.004	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.04
Iron	0.35
Manganese	0.01

Sample Site: 883-2145-H8810-6-6-89MW
Lab No: 898178
Date Sampled: 06/06/89 @ 2121
Date Received: 06/09/89

Lab pH, s.u.	7.88
Lab Conductivity, umhos/cm @ 25C	294
Total Dissolved Solids (180), mg/l	202
Total Dissolved Solids (calc), mg/l	187
Boron, mg/l	0.19
Fluoride, mg/l	0.35
Ammonia Nitrogen as N, mg/l	0.41
Total Kjeldahl Nitrogen, mg/l	1.3
Ortho Phosphorus as P, mg/l	0.003
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.018
Total Alkalinity as CaCO3, mg/l	185
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	125
Sodium Adsorption Ratio	0.99

	mg/l	meq/l
Bicarbonate as HCO3	225	3.69
Carbonate as CO3	0	0.00
Chloride	2.1	0.06
Nitrate as N, mg/l	0.16	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.6	0.01
Calcium	37	1.83
Magnesium	8.0	0.66
Potassium	3.6	0.09
Sodium	26	1.11

Major Anions	3.77
Major Cations	3.69
Cation/Anion Difference	1.07 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	0.05
Arsenic	0.020	Manganese	<0.02
Barium	1.1	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.27
Manganese	<0.02

Sample Site: 883-2145-H8810-7-25-89-4th-MW
Lab No: 898604 (Duplicate Analysis)
Date Sampled: 07/25/89 @ 1326
Date Received: 07/31/89

Lab pH, s.u.	7.78
Lab Conductivity, umhos/cm @ 25C	288
Total Dissolved Solids (180), mg/l	200
Total Dissolved Solids (calc), mg/l	182
Boron, mg/l	<0.01
Fluoride, mg/l	0.27
Ammonia Nitrogen as N, mg/l	0.38
Total Kjeldahl Nitrogen, mg/l	0.8
Ortho Phosphorus as P, mg/l	0.005
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.013
Total Alkalinity as CaCO3, mg/l	180
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	122
Sodium Adsorption Ratio	0.98

	mg/l	meq/l
Bicarbonate as HCO3	220	3.60
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.2	0.03
Calcium	34	1.70
Magnesium	9.1	0.75
Potassium	3.6	0.09
Sodium	25	1.09

Major Anions	3.67
Major Cations	3.63
Cation/Anion Difference	0.55 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.08
Arsenic	<0.005	Manganese	<0.02
Barium	1.1	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.03

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.21
Manganese	<0.02

Sample Site: 883-2145-H8810-7-25-89-4th-MW
Lab No: 898599
Date Sampled: 07/25/89 @ 1326
Date Received: 07/31/89

Lab pH, s.u.	7.74
Lab Conductivity, umhos/cm @ 25C	286
Total Dissolved Solids (180), mg/l	196
Total Dissolved Solids (calc), mg/l	182
Boron, mg/l	0.42
Fluoride, mg/l	0.26
Ammonia Nitrogen as N, mg/l	0.41
Total Kjeldahl Nitrogen, mg/l	1.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.013
Total Alkalinity as CaCO3, mg/l	180
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	122
Sodium Adsorption Ratio	0.98

	mg/l	meq/l
Bicarbonate as HCO3	220	3.60
Carbonate as CO3	0	0.00
Chloride	1.8	0.05
Nitrate as N, mg/l	<0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	<1	<0.01
Calcium	35	1.74
Magnesium	8.6	0.71
Potassium	3.7	0.09
Sodium	25	1.09

Major Anions	3.65
Major Cations	3.63
Cation/Anion Difference	0.27 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.10
Arsenic	<0.005	Manganese	<0.02
Barium	1.1	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.08

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.23
Manganese	0.14

SAMPLE INTEGRITY DATA SHEET

Plant/Site WishBone Hills

Project No. 8832145

Site Location Palmer Alaska

Sample ID 8832145-H8811-7-25-89-41

Sampling Location

Technical Procedure Reference(s)

Type of Sampler Hydrostar

Date 7-25-89

Time 10:30 final Sample Collected

Media WATER

Station H8811

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Total depth : 147.52 / Purge volume : 62.09
Saturated Thickness : 126.97 · water Level : 22.54

Sample Description clear with few suspended particles and air bubbles

Field Measurements on Sample (pH, conductivity, etc.) Temp: 2.5°C / D-O2: 12.8
PH: 8.25 / uS = 1303 - final test of (4) Taken
Alkalinity : 48.0 as CaCO3

Aliquot Amount	Container	Preservation/Amount
1/2 Gallon	Plastic Jug	NONE
1 Litre	"	Sulphuric - 1
250ml	"	Nitric - 1
250ml	" Filtered	Nitric - 1

Sampler (signature) Matthew

Date 7-25-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hills Project No. 883-2145

Site Location Palmer Alaska Sample ID 8832145-H8811-6-7-89-M

Sampling Location

Technical Procedure Reference(s) G.D. Memo Dated 3rd Quarter Sampling

Type of Sampler Hydrostar

Date 6-7-89 Time 15:02

Media Water Station H88-11

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) Water Level: 23.25 - Depth: 150.21

Saturated Thickness: 129.56 - Amount Purged 63 Gals

Sample Description Turbid - Suspended Air Bubbles

Field Measurements on Sample (pH, conductivity, etc.) Temp: 3°C

D-O2: 10.85 . PH: 9.37 - µS: 966 - Final Field

Measurements of (4) Taken - Alkalinity = 634.0 mg/L as CaCO3

Aliquot Amount	Container	Preservative/Amount
1/2 Gal	Plastic Jug	None
1 Litre	"	Sulphuric - 1
250 mL	"	Nitric - 1
250 mL	"	Filtered Nitric - 1

Sampler (signature) Date 6-7-89

Supervisor (signature) Date

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H8811-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BOILER

Date 2-23-89 Time 15:07

Media WATER Station H8811

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH of WELL=147.52 - SAT. THICKNESS= 126.97

WATER LEVEL = 20.55 - AMOUNT PURGED 58.50 GALLONS

PUMP CABLE BROKE - I HAD TO STOP 17.60 GALLONS SHORT

Sample Description CLEAR BECOMING SLIGHTLY TURBID

Field Measurements on Sample (pH, conductivity, etc.) @ 58.50 GALLONS

PH= 8.45 - kS= 1441 - TEMP: 1.5°C D-O₂: 12.8

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	PLASTIC	NONE
500 ML	"	SULPHURIC 1
250 ML	"	NITRIC 1
250 ML	"	NITRIC 1

SEAL No. # 3511 + 3512

Sampler (signature) Matthew F Date 2-23-89

Supervisor (signature) Date

Golder Associates Inc.

Sample Site: 883-2145-H88-11MW
Lab No: 887235
Date Sampled: 11/22/88 @ 1049
Date Received: 11/29/88

Lab pH, s.u.	8.51
Lab Conductivity, umhos/cm @ 25C	1200
Total Dissolved Solids (180), mg/l	738
Total Dissolved Solids (calc), mg/l	703
Boron, mg/l	0.12
Fluoride, mg/l	2.10
Ammonia Nitrogen as N, mg/l	0.45
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.044
Total Organic Phosphorus as P, mg/l	0.011
Total Phosphorus as P, mg/l	0.115
Total Alkalinity as CaCO3, mg/l	662
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	7
Sodium Adsorption Ratio	49.3

	mg/l	meq/l
Bicarbonate as HCO3	783	12.83
Carbonate as CO3	12	0.41
Chloride	1.1	0.03
Nitrate as N, mg/l	<0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.6	0.03
Calcium	2.0	0.10
Magnesium	0.5	0.04
Potassium	1.9	0.05
Sodium	300	13.05

Major Anions	13.30
Major Cations	13.24
Cation/Anion Difference	0.23 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	0.007	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.02
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.03
Iron	5.18
Manganese	0.07

Sample Site: 883-2145-H8811-2-15-89MW
Lab No: 897631
Date Sampled: 02/23/89 @ 1507
Date Received: 02/27/89

Lab pH, s.u.	8.49
Lab Conductivity, umhos/cm @ 25C	964
Total Dissolved Solids (180), mg/l	782
Total Dissolved Solids (calc), mg/l	773
Boron, mg/l	0.08
Fluoride, mg/l	1.62
Ammonia Nitrogen as N, mg/l	0.42
Total Kjeldahl Nitrogen, mg/l	1.4
Ortho Phosphorus as P, mg/l	0.008
Total Organic Phosphorus as P, mg/l	0.013
Total Phosphorus as P, mg/l	0.142
Total Alkalinity as CaCO3, mg/l	724
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	9.4
Sodium Adsorption Ratio	46.4

	mg/l	meq/l
Bicarbonate as HCO3	847	13.89
Carbonate as CO3	18	0.59
Chloride	3.9	0.11
Nitrate as N, mg/l	0.03	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.9	0.04
Calcium	2.4	0.12
Magnesium	0.9	0.07
Potassium	2.2	0.06
Sodium	329	14.31

Major Anions	14.63
Major Cations	14.56
Cation/Anion Difference	0.24 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	0.08
Arsenic	0.008	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.005	Mercury	<0.001
Copper	<0.01	Selenium	0.007
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.03
Iron	4.98
Manganese	0.06

Sample Site: 883-2145-H8811-6-7-89MW
Lab No: 898177
Date Sampled: 06/07/89 @ 1432
Date Received: 06/09/89

Lab pH, s.u.	8.44
Lab Conductivity, umhos/cm @ 25C	1260
Total Dissolved Solids (180), mg/l	834
Total Dissolved Solids (calc), mg/l	813
Boron, mg/l	0.32
Fluoride, mg/l	1.49
Ammonia Nitrogen as N, mg/l	0.36
Total Kjeldahl Nitrogen, mg/l	1.7
Ortho Phosphorus as P, mg/l	0.081
Total Organic Phosphorus as P, mg/l	0.007
Total Phosphorus as P, mg/l	0.233
Total Alkalinity as CaCO3, mg/l	760
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	8.4
Sodium Adsorption Ratio	52.4

	mg/l	meq/l
Bicarbonate as HCO3	906	14.85
Carbonate as CO3	11	0.35
Chloride	1.8	0.05
Nitrate as N, mg/l	0.05	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.8	0.02
Calcium	2.6	0.13
Magnesium	0.5	0.04
Potassium	1.6	0.04
Sodium	351	15.27

Major Anions	15.27
Major Cations	15.48
Cation/Anion Difference	0.68 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.05

Trace Metals (Total Concentrations), mg/l

Chromium	0.03
Iron	5.45
Manganese	0.10

Sample Site: 883-2145-H8811-7-25-89-4th-MW
Lab No: 898600
Date Sampled: 07/25/89 @ 0957
Date Received: 07/31/89

Lab pH, s.u.	8.31
Lab Conductivity, umhos/cm @ 25C	1259
Total Dissolved Solids (180), mg/l	786
Total Dissolved Solids (calc), mg/l	788
Boron, mg/l	0.02
Fluoride, mg/l	1.35
Ammonia Nitrogen as N, mg/l	0.41
Total Kjeldahl Nitrogen, mg/l	1.0
Ortho Phosphorus as P, mg/l	0.018
Total Organic Phosphorus as P, mg/l	0.001
Total Phosphorus as P, mg/l	0.124
Total Alkalinity as CaCO3, mg/l	726
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	8.2
Sodium Adsorption Ratio	52.8

	mg/l	meq/l
Bicarbonate as HCO3	885	14.51
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	3.7	0.08
Calcium	2.7	0.13
Magnesium	0.4	0.03
Potassium	2.2	0.06
Sodium	343	14.92

Major Anions	14.67
Major Cations	15.14
Cation/Anion Difference	1.58 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.08
Arsenic	0.008	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.06

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	2.70
Manganese	0.04

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8812-2-18 89

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR

Date 2-18-89

Time 12:53 FINAL MEASUREMENTS

Media WATER

Station H88 12

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
TD = 106.62 / WL = 23.88 / SAT. THICKNESS 85.20
PURGE VOLUME 41.90

Sample Description AFTER 2 GALLONS WATER WAS TURBID
MUDDY GRAY BROWN

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 4°C / D-O2: 11.8
PH: 10.26 / EC: 1045 - FINAL TESTS OF
(4) - ALKALINITY: 37.9 as CaCO3

Aliquot Amount	Container	Preservation/Amount
1/2 Gallon	Plastic Jug	NONE
1 LITRE	"	SULPHURIC 1
1 250 ML	"	NITRIC 1
1 250 ML	"	FILTERED NITRIC 1

Sampler (signature)

Date 2-18-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WishBone Hills
Project No. 8832145
Site Location Palmer Alaska
Sample ID 8832145-H8812-6-14-89 MW
Sampling Location

Technical Procedure Reference(s)
Type of Sampler Hydrostar
Date 6-14-89
Time 9:58
Media Water
Station H8812
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Water Level : 24.55 . T.D = 106.62 . Sat. Thick = 85.70
Volume Purged : 41.91

Sample Description Gray Muddy Color

Field Measurements on Sample (pH, conductivity, etc.) Temp = 3°C - D-O2 = 12.2
pH = 9.68 - μS = 777 - Final Field Measurements
out of (4) - Alkalinity = 44.4 mg/L

Aliquot Amount	Container	Preservation/Amount
1/2 Gal	Plastic Jug	None
1 Litre	"	Sulphuric - 1
1 250mL	"	Nitric - 1
1 250 mL	" Filtered	Nitric - 1

Sampler (signature) Matthew F
Date 6-14-89
Supervisor (signature)
Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H8812-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR

Date 2-26-89

Time 14:07

Media WATER

Station H8812

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH of Hole 106.22 · SATURATED THICKNESS = 25.70

WATER LEVEL = 80.22 - AMOUNT PURGED: ≃ 50 GALS

Sample Description VERY TURBID - MILKY BROWN MUDDY COLOR

Field Measurements on Sample (pH, conductivity, etc.)

pH = 11.45 µS = 386 · TEMP. 2.5°C - D-O_2: 12.4

ALKALINITY 529.0 mg/L

Aliquot Amount	Container		Preservation/Amount
1/2 GAL	Plastic		NONE
500 mL	Plastic		SULPHURIC / 1
250 mL	Plastic	FILTERED	NITRIC / 1
250 mL	Plastic		NITRIC / 1

SEAL NO. # 3608-3609

Sampler (signature)

Date 2-26-89

Supervisor (signature)

Date

Golder Associates Inc.

Sample Site: 883-2145-H88-12MW
Lab No: 887236
Date Sampled: 11/21/88 @ 1328
Date Received: 11/29/88

Lab pH, s.u.	10.94	*
Lab Conductivity, umhos/cm @ 25C	1180	
Total Dissolved Solids (180), mg/l	728	
Total Dissolved Solids (calc), mg/l	581	
Boron, mg/l	0.08	
Fluoride, mg/l	3.17	
Ammonia Nitrogen as N, mg/l	0.80	
Total Kjeldahl Nitrogen, mg/l	0.8	
Ortho Phosphorus as P, mg/l	0.128	
Total Organic Phosphorus as P, mg/l	0.186	
Total Phosphorus as P, mg/l	1.09	
Total Alkalinity as CaCO3, mg/l	526	
Total Acidity as CaCO3, mg/l	<1	
Total Hardness as CaCO3, mg/l	7	
Sodium Adsorption Ratio	40.8	

	mg/l	meq/l	
Bicarbonate as HCO3	0	0.00	
Carbonate as CO3	344	11.48	
Hydroxide as OH	17	0.97	*
Chloride	1.4	0.04	
Nitrate as N, mg/l	0.04	0.00	
Nitrite as N, mg/l	<0.01	0.00	
Sulfate	11	0.23	
Calcium	1.4	0.07	
Magnesium	0.9	0.07	
Potassium	2.9	0.08	
Sodium	248	10.79	

Major Anions	10.78
Major Cations	11.01
Cation/Anion Difference	1.06 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	1.5	Lead	<0.02
Arsenic	0.021	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.03
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.10
Iron	17.3
Manganese	0.25

√

Sample Site: 883-2145-H8812-2-15-89MW
Lab No: 897638
Date Sampled: 02/26/89 @ 1407
Date Received: 02/28/89

Lab pH, s.u	10.63
Lab Conductivity, umhos/cm @ 25C	1085
Total Dissolved Solids (180), mg/l	736
Total Dissolved Solids (calc), mg/l	635
Boron, mg/l	0.34
Fluoride, mg/l	3.26
Ammonia Nitrogen as N, mg/l	1.87
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.155
Total Organic Phosphorus as P, mg/l	0.024
Total Phosphorus as P, mg/l	0.727
Total Alkalinity as CaCO3, mg/l	632
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	16
Sodium Adsorption Ratio	31.8

	mg/l	meq/l
Bicarbonate as HCO3	0	0.00
Carbonate as CO3	319	10.63
Hydroxide as OH	34	2.00
Chloride	2.5	0.07
Nitrate as N, mg/l	0.11	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	13	0.26
Calcium	6.4	0.32
Magnesium	<1.0	<0.01
Potassium	2.8	0.07
Sodium	292	12.70

Major Anions	12.97
Major Cations	13.09
Cation/Anion Difference	0.46 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	1.7	Iron	0.81
Arsenic	0.030	Manganese	<0.02
Barium	<0.5	Lead	0.03
Cadmium	0.003	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.03

Trace Metals (Total Concentrations), mg/l

Chromium	0.07
Iron	11.2
Manganese	0.12

Sample Site: 883-2145-H8812-6-14-89MW
Lab No: 898273
Date Sampled: 06/14/89 @ 0958
Date Received: 06/19/89

Lab pH, s.u.	9.63
Lab Conductivity, umhos/cm @ 25C	1027
Total Dissolved Solids (180), mg/l	616
Total Dissolved Solids (calc), mg/l	586
Boron, mg/l	0.07
Fluoride, mg/l	3.08
Ammonia Nitrogen as N, mg/l	0.11
Total Kjeldahl Nitrogen, mg/l	1.0
Ortho Phosphorus as P, mg/l	0.338
Total Organic Phosphorus as P, mg/l	0.053
Total Phosphorus as P, mg/l	0.893
Total Alkalinity as CaCO3, mg/l	543
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	80
Sodium Adsorption Ratio	11.0

	mg/l	meq/l
Bicarbonate as HCO3	356	5.84
Carbonate as CO3	150	5.01
Chloride	1.8	0.05
Nitrate as N, mg/l	0.11	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	14	0.28
Calcium	3.4	0.17
Magnesium	17.3	1.42
Potassium	0.5	0.01
Sodium	225	9.77

Major Anions	11.19
Major Cations	11.37
Cation/Anion Difference	0.80 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.4	Iron	0.17
Arsenic	0.008	Manganese	<0.02
Barium	<0.5	Lead	0.03
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	0.02	Zinc	0.08

Trace Metals (Total Concentrations), mg/l

Chromium	0.06
Iron	8.49
Manganese	0.13

Sample Site: 883-2145-H8812-7-18-89-4th-MW
Lab No: 898494
Date Sampled: 07/18/89 @ 1231
Date Received: 07/24/89

Lab pH, s.u.	10.10
Lab Conductivity, umhos/cm @ 25C	1040
Total Dissolved Solids (180), mg/l	642
Total Dissolved Solids (calc), mg/l	634
Boron, mg/l	0.10
Fluoride, mg/l	2.93
Ammonia Nitrogen as N, mg/l	0.39
Total Kjeldahl Nitrogen, mg/l	2.4
Ortho Phosphorus as P, mg/l	0.325
Total Organic Phosphorus as P, mg/l	0.280
Total Phosphorus as P, mg/l	1.48
Total Alkalinity as CaCO3, mg/l	549
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	8
Sodium Adsorption Ratio	40.3

	mg/l	meq/l
Bicarbonate as HCO3	189	3.10
Carbonate as CO3	236	7.87
Chloride	2.1	0.06
Nitrate as N, mg/l	<0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	26	0.55
Calcium	3.2	0.16
Magnesium	0.1	0.01
Potassium	3.0	0.08
Sodium	270	11.75

Major Anions	11.58
Major Cations	12.00
Cation/Anion Difference	1.78 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.11
Arsenic	0.023	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.08

Trace Metals (Total Concentrations), mg/l

Chromium	0.11
Iron	15.3
Manganese	0.18

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8813-2-19-89-4

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR

Date 2-19-89

Time 17:51 - LAST Sample Collected

Media WATER

Station H8813

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
TOTAL DEPTH: 176.92 / SAT. THICKNESS: 22.89
PURGE Volume: 13.63 WATER LEVEL: 151.69

Sample Description WATER WAS CLEAR - HAS SUSPENDED AIR BUBBLES - THE ODOR of AN OLD SEPTIC TANK

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 3.5°C / D-O2: 13.6
PH = 8.28 / uS = 1 . ALKALINITY: 1320

Aliquot Amount	Container	Preservation/Amount
½ Gallon	Plastic Jug	NONE
1 LITRE	"	Sulphuric / 1
1 250 ML	"	NITRIC
1 250 ML	"	FILTERED NITRIC / 1

Sampler (signature)

Date 2-19-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 8832145

Site Location PALMER ALASKA Sample ID 8832145-H8813-6-14-89M

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDRASTAR

Date 6-14-89 Time 15:26

Media WATER Station H8813

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) TOTAL DEPTH: 176.92 - SAT. THICK: 22.37

WL = 150.54 VOLUME TO PURGE 13.63

Sample Description WATER IS CLEAR - SAMPLE REMAINED CLEAR THROUGHOUT THE PURGING - SAMPLE DID NOT NEED TO BE FILTERED FOR AKALINITY

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 4°C

D-O2 = 12.8 / PH = 8.06 / μS = 0320 $^{\times 10}$ - THESE MEASUREMENTS ARE FINAL OF (4) - ALKALINITY: 1621.0 $\sim\frac{c}{l}$

NOTE → I HAD RUN OUT OF 1K - CONDUCTIVITY CALIBRATION SOLUTION - SO I HAD TO USE 10K

Aliquot Amount	Container	Preservative/Amount
1/2 Gal	Plastic Jug	NONE
1 LITRE	"	SULPHURIC 1
1 250ML	"	NITRIC 1
1 250ML	"	FILTERED NITRIC 1

Sampler (signature) Matthew K [illegible] Date 6-14-89

Supervisor (signature) Date

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 8832145
Site Location ALASKA
Sample ID 8832145-H8813-2-15-89-MW
Sampling Location

Technical Procedure Reference(s)
Type of Sampler HYDROSTAR
Date 2-26-89
Time 12.48
Media WATER
Station ~~#33-2~~ H88/3
Sample Type: [✓ grab] time composite space composite
Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
DEPTH of HOLE 176.92 SATURATED THICKNESS = 26.87
WATER LEVEL = 149.05 - AMOUNT PURGED: 18 GALLONS

Sample Description SLIGHTLY - FAINTLY TURBID

Field Measurements on Sample (pH, conductivity, etc.)
PH = 7.42 - 25 = 341 TEMP = 2°C - D-O$_2$ = 11.6

Aliquot Amount	Container		Preservation/Amount
1/2 GAL	PLASTIC		NONE
500 ML	"		SULPHURIC / 1
250 ML	"	FILTERED	NITRIC / 1
250 ML	"		NITRIC / 1

SEAL NO. # 3608 - 3609

Sampler (signature) Matthew
Date 2-26-89
Supervisor (signature)
Date

Golder Associates Inc.

Sample Site: 883-2145-H88-13MW
Lab No: 887237
Date Sampled: 11/20/88 @ 1601
Date Received: 11/29/88

Lab pH, s.u.	7.92
Lab Conductivity, umhos/cm @ 25C	4285
Total Dissolved Solids (180), mg/l	2750
Total Dissolved Solids (calc), mg/l	2610
Boron, mg/l	0.05
Fluoride, mg/l	0.36
Ammonia Nitrogen as N, mg/l	1.22
Total Kjeldahl Nitrogen, mg/l	2.3
Ortho Phosphorus as P, mg/l	0.008
Total Organic Phosphorus as P, mg/l	0.096
Total Phosphorus as P, mg/l	0.625
Total Alkalinity as CaCO3, mg/l	2254
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	39
Sodium Adsorption Ratio	78.0

	mg/l	meq/l
Bicarbonate as HCO3	2749	45.07
Carbonate as CO3	0	0.00
Chloride	120	3.39
Nitrate as N, mg/l	0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	4.1	0.09
Calcium	8.1	0.41
Magnesium	4.5	0.37
Potassium	6.1	0.16
Sodium	1120	48.72

Major Anions	48.55
Major Cations	49.66
Cation/Anion Difference	1.13 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.02
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.06
Iron	21.7
Manganese	0.28

Sample Site: 883-2145-H8813-2-15-89MW
Lab No: 897640 (Duplicate Analysis)
Date Sampled: 02/26/89 @ 1748
Date Received: 02/28/89

Lab pH, s.u.	8.16
Lab Conductivity, umhos/cm @ 25C	2540
Total Dissolved Solids (180), mg/l	1982
Total Dissolved Solids (calc), mg/l	1984
Boron, mg/l	0.26
Fluoride, mg/l	0.40
Ammonia Nitrogen as N, mg/l	0.69
Total Kjeldahl Nitrogen, mg/l	1.7
Ortho Phosphorus as P, mg/l	0.011
Total Organic Phosphorus as P, mg/l	0.033
Total Phosphorus as P, mg/l	0.120
Total Alkalinity as CaCO3, mg/l	1720
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	25
Sodium Adsorption Ratio	73.86

	mg/l	meq/l
Bicarbonate as HCO3	2098	34.39
Carbonate as CO3	0	0.00
Chloride	89.3	2.52
Nitrate as N, mg/l	0.07	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	4.1	0.09
Calcium	7.1	0.36
Magnesium	1.7	0.14
Potassium	4.7	0.12
Sodium	849	36.93

Major Anions	37.01
Major Cations	37.55
Cation/Anion Difference	0.72 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.3	Iron	<0.05
Arsenic	<0.005	Manganese	0.05
Barium	0.5	Lead	0.02
Cadmium	0.004	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.04

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	1.00
Manganese	0.06

Sample Site: 883-2145-H8813-2-15-89MW
Lab No: 897639
Date Sampled: 02/26/89 @ 1748
Date Received: 02/28/89

Lab pH, s.u.	8.09
Lab Conductivity, umhos/cm @ 25C	2560
Total Dissolved Solids (180), mg/l	1984
Total Dissolved Solids (calc), mg/l	1979
Boron, mg/l	0.25
Fluoride, mg/l	0.39
Ammonia Nitrogen as N, mg/l	0.70
Total Kjeldahl Nitrogen, mg/l	1.7
Ortho Phosphorus as P, mg/l	0.011
Total Organic Phosphorus as P, mg/l	0.021
Total Phosphorus as P, mg/l	0.109
Total Alkalinity as CaCO3, mg/l	1727
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	26
Sodium Adsorption Ratio	72.4

	mg/l	meq/l
Bicarbonate as HCO3	2106	34.53
Carbonate as CO3	0	0.00
Chloride	89.0	2.51
Nitrate as N, mg/l	0.06	0.01
Nitrite as N, mg/l	0.01	<0.01
Sulfate	4.1	0.09
Calcium	6.5	0.32
Magnesium	2.3	0.19
Potassium	4.7	0.12
Sodium	840	36.54

Major Anions	37.14
Major Cations	37.17
Cation/Anion Difference	0.04 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	<0.05
Arsenic	<0.005	Manganese	0.04
Barium	<0.5	Lead	0.02
Cadmium	0.004	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.03

Trace Metals (Total Concentrations), mg/l

Chromium	0.02
Iron	0.95
Manganese	0.05

Sample Site: 883-2145-H8813-6-14-89MW
Lab No: 898274
Date Sampled: 06/14/89 @ 15:12
Date Received: 06/19/89

Lab pH, s.u.	7.98
Lab Conductivity, umhos/cm @ 25C	2900
Total Dissolved Solids (180), mg/l	1850
Total Dissolved Solids (calc), mg/l	1834
Boron, mg/l	<0.01
Fluoride, mg/l	0.43
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	1.1
Ortho Phosphorus as P, mg/l	0.016
Total Organic Phosphorus as P, mg/l	0.023
Total Phosphorus as P, mg/l	0.137
Total Alkalinity as CaCO3, mg/l	1607
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	20
Sodium Adsorption Ratio	76.5

	mg/l	meq/l
Bicarbonate as HCO3	1961	32.14
Carbonate as CO3	0	0.00
Chloride	79	2.22
Nitrate as N, mg/l	0.07	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.4	0.01
Calcium	5.6	0.28
Magnesium	1.5	0.12
Potassium	0.9	0.02
Sodium	786	34.21

Major Anions	34.38
Major Cations	34.63
Cation/Anion Difference	0.36 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.07
Arsenic	<0.005	Manganese	0.03
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	0.02
Iron	0.90
Manganese	0.05

Sample Site: 883-2145-H8813-7-19-89-4th-MW
Lab No: 898503 (Duplicate Analysis)
Date Sampled: 07/18/89 @ 1705
Date Received: 07/24/89

Lab pH, s.u.	8.10
Lab Conductivity, umhos/cm @ 25C	2912
Total Dissolved Solids (180), mg/l	2026
Total Dissolved Solids (calc), mg/l	1987
Boron, mg/l	<0.01
Fluoride, mg/l	0.40
Ammonia Nitrogen as N, mg/l	0.86
Total Kjeldahl Nitrogen, mg/l	2.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.084
Total Phosphorus as P, mg/l	0.198
Total Alkalinity as CaCO3, mg/l	1740
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	23
Sodium Adsorption Ratio	75.7

	mg/l	meq/l
Bicarbonate as HCO3	2122	34.79
Carbonate as CO3	0	0.00
Chloride	90	2.53
Nitrate as N, mg/l	0.03	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.2	0.03
Calcium	6.9	0.35
Magnesium	1.5	0.12
Potassium	4.5	0.11
Sodium	843	36.68

Major Anions	37.35
Major Cations	37.26
Cation/Anion Difference	0.12 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.11
Arsenic	<0.005	Manganese	0.04
Barium	0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.40
Manganese	0.04

Sample Site: 883-2145-H8813-7-19-89-4th-MW
Lab No: 898495
Date Sampled: 07/19/89 @ 1705
Date Received: 07/24/89

Lab pH, s.u.	8.10
Lab Conductivity, umhos/cm @ 25C	2730
Total Dissolved Solids (180), mg/l	2008
Total Dissolved Solids (calc), mg/l	1988
Boron, mg/l	0.01
Fluoride, mg/l	0.46
Ammonia Nitrogen as N, mg/l	0.87
Total Kjeldahl Nitrogen, mg/l	2.4
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.030
Total Phosphorus as P, mg/l	0.150
Total Alkalinity as CaCO3, mg/l	1740
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	27
Sodium Adsorption Ratio	70.6

	mg/l	meq/l
Bicarbonate as HCO3	2122	34.79
Carbonate as CO3	0	0.00
Chloride	91	2.57
Nitrate as N, mg/l	<0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.4	0.01
Calcium	6.8	0.34
Magnesium	2.4	0.20
Potassium	4.2	0.11
Sodium	843	36.68

Major Anions	37.37
Major Cations	37.33
Cation/Anion Difference	0.05 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.11
Arsenic	<0.005	Manganese	0.04
Barium	0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.47
Manganese	0.04

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 8832145
Site Location PALMER ALASKA
Sample ID 8832145-H8814-7-25-89-4TH M
Sampling Location

Technical Procedure Reference(s)
Type of Sampler Bail
Date 7-25-89
Time 16:22 - final Sample Collected
Media WATER
Station H8814
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
TOTAL DEPTH: 19.30 / PURGE Volume: 1.27 -
SAT THICKNESS: 2.60 / WATER LEVEL 20.27

Sample Description TURBID MUDDY BROWN

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 8°C / D-O_2: 12.6
PH: 7.23 / AS: 096 - final TEST of (4)
ALKALINITY: 28.0 as $CaCO_3$

Aliquot Amount	Container	Preservation/Amount
1/2 Gal	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC - 1
250 ML	"	NITRIC - 1
250 ML	"	FILTERED NITRIC - 1

Sampler (signature) Matthew F.
Date 7-25-89
Supervisor (signature)
Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS — Project No. 8832145

Site Location ALASKA, PALMER — Sample ID 8832145-H8814-5-23-89-M1

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 5-23-89 — Time 12:12 - FINAL TEST

Media WATER — Station H88 14

Sample Type: grab — time composite — space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

TOTAL DEPTH: 24.30 - WATER LEVEL: 20.45 - SATURATED THICKNESS 3.85

AMOUNT PURGED 34 GALS.

Sample Description MUDDY GRAY

USE LAST READING - GSD

Field Measurements on Sample (pH, conductivity, etc.) (1ST reading) LAST reading

PH: (7.55) 7.49 µS: (139) 145 TEMP (1°C) 2°C D-O2 = (12.8) 12.2

THESE FIELD MEASUREMENTS ARE THE FINAL OF FOUR (4) TESTS TAKEN THROUGHOUT THE SAMPLING - ALKALINITY = 47.0 mg/L

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC / 1
250 ML	"	NITRIC / 1
250 ML	" FILTERED	NITRIC / 1

Sampler (signature) Matthew F [illegible] — Date 5-23-89

Supervisor (signature) — Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 883-2145

Site Location H88 #14A

Sample ID 883-2145-H8814A-2-15-89-M

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 2-15-89

Time 16:38:00

Media WATER

Station H88#14A

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

WL=16.70 —— BTC= 19.30 - SATURATED THICKNESS= 2.60

PURGED 7 GALLONS TOTAL - BAILER HIT BOTTOM A FEW TIMES

I CONTINUED TO BAIL UNTIL WATER CLEARED FOR SAMPLING

Sample Description CLEAR - SLIGHTLY SILTY

Field Measurements on Sample (pH, conductivity, etc.)

PH=7.51 / μS=214 / TEMP=2°C / D-O=13.1

T. ALKILINITY = 130.0 MG/L

Aliquot Amount	Container		Preservation/Amount
1/2 GAL	PLASTIC		NONE
1 LITRE	"		SULPHURIC - 1
1 250 ML	"	FILTERED	NITRIC - 1
"	"	UNFILTERED	" "

Sampler (signature)

Date 2-15-89

Supervisor (signature)

Date

Golder Associates Inc.

Sample Site: 883-2145-H88-14A MW (DUPLICATE ANALYSES)
Lab No: 887241
Date Sampled: 11/22/88 @ 1460
Date Received: 11/29/88

Lab pH, s.u.	7.05
Lab Conductivity, umhos/cm @ 25C	152
Total Dissolved Solids (180), mg/l	106
Total Dissolved Solids (calc), mg/l	85
Boron, mg/l	0.06
Fluoride, mg/l	0.17
Ammonia Nitrogen as N, mg/l	0.01
Total Kjeldahl Nitrogen, mg/l	0.5
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	0.198
Total Phosphorus as P, mg/l	1.37
Total Alkalinity as CaCO3, mg/l	62
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	51
Sodium Adsorption Ratio	0.84

	mg/l	meq/l
Bicarbonate as HCO3	76	1.24
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.40	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	12	0.26
Calcium	15	0.77
Magnesium	3.0	0.25
Potassium	0.5	0.01
Sodium	14	0.60

Major Anions	1.61
Major Cations	1.63
Cation/Anion Difference	0.62 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.02
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	17.1
Manganese	0.31

Sample Site: 883-2145-H88-14A MW
Lab No: 887238
Date Sampled: 11/22/88 @ 1460
Date Received: 11/29/88

Lab pH, s.u.	7.02
Lab Conductivity, umhos/cm @ 25C	167
Total Dissolved Solids (180), mg/l	120
Total Dissolved Solids (calc), mg/l	86
Boron, mg/l	0.06
Fluoride, mg/l	0.17
Ammonia Nitrogen as N, mg/l	0.01
Total Kjeldahl Nitrogen, mg/l	0.5
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	0.154
Total Phosphorus as P, mg/l	1.31
Total Alkalinity as CaCO3, mg/l	63
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	50
Sodium Adsorption Ratio	0.84

	mg/l	meq/l
Bicarbonate as HCO3	77	1.26
Carbonate as CO3	0	0.00
Chloride	3.2	0.09
Nitrate as N, mg/l	0.40	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	13	0.26
Calcium	16	0.77
Magnesium	2.9	0.24
Potassium	0.6	0.02
Sodium	14	0.60

Major Anions	1.64
Major Cations	1.63
Cation/Anion Difference	0.31 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.03
Iron	17.4
Manganese	0.32

Sample Site: 883-2145-H8814A-2-15-89MW
Lab No: 897604
Date Sampled: 02/15/89 @ 1638
Date Received: 02/20/89

Lab pH, s.u.	7.41
Lab Conductivity, umhos/cm @ 25C	153
Total Dissolved Solids (180), mg/l	98
Total Dissolved Solids (calc), mg/l	90
Boron, mg/l	0.41
Fluoride, mg/l	0.11
Ammonia Nitrogen as N, mg/l	0.04
Total Kjeldahl Nitrogen, mg/l	0.5
Ortho Phosphorus as P, mg/l	0.017
Total Organic Phosphorus as P, mg/l	0.555
Total Phosphorus as P, mg/l	0.983
Total Alkalinity as CaCO3, mg/l	64
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	54
Sodium Adsorption Ratio	0.86

	mg/l	meq/l
Bicarbonate as HCO3	78	1.28
Carbonate as CO3	0	0.00
Chloride	5.0	0.14
Nitrate as N, mg/l	0.42	0.03
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	12	0.26
Calcium	16	0.80
Magnesium	3.3	0.27
Potassium	0.7	0.02
Sodium	14	0.63

Major Anions	1.71
Major Cations	1.72
Cation/Anion Difference	0.29 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	0.08
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.10

Trace Metals (Total Concentrations), mg/l

Chromium	0.02
Iron	12.3
Manganese	0.22

Sample Site: 883-2145-H88-14-5-23-89MW
Lab No: 898101
Date Sampled: 05/23/89 @ 1157
Date Received: 05/26/89

Lab pH, s.u.	7.43
Lab Conductivity, umhos/cm @ 25C	177
Total Dissolved Solids (180), mg/l	114
Total Dissolved Solids (calc), mg/l	104
Boron, mg/l	<0.01
Fluoride, mg/l	0.27
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	1.1
Ortho Phosphorus as P, mg/l	0.062
Total Organic Phosphorus as P, mg/l	0.083
Total Phosphorus as P, mg/l	1.079
Total Alkalinity as CaCO3, mg/l	83
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	53
Sodium Adsorption Ratio	1.25

	mg/l	meq/l
Bicarbonate as HCO3	101	1.66
Carbonate as CO3	0	0.00
Chloride	2.1	0.06
Nitrate as N, mg/l	0.47	0.03
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	11	0.23
Calcium	16	0.81
Magnesium	3.0	0.25
Potassium	1.2	0.03
Sodium	21	0.91

Major Anions	1.98
Major Cations	2.00
Cation/Anion Difference	0.50 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	1.21
Manganese	<0.02

Sample Site: 883-2145-H8814-7-25-89-4th-MW
Lab No: 898598
Date Sampled: 07/25/89 @ 1551
Date Received: 07/31/89

Lab pH, s.u.	6.91
Lab Conductivity, umhos/cm @ 25C	83
Total Dissolved Solids (180), mg/l	66
Total Dissolved Solids (calc), mg/l	52
Boron, mg/l	<0.01
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	1.3
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.029
Total Phosphorus as P, mg/l	0.284
Total Alkalinity as CaCO3, mg/l	41
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	38
Sodium Adsorption Ratio	0.34

	mg/l	meq/l
Bicarbonate as HCO3	49	0.81
Carbonate as CO3	0	0.00
Chloride	1.8	0.05
Nitrate as N, mg/l	0.18	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	6.8	0.14
Calcium	12	0.61
Magnesium	1.8	0.15
Potassium	0.8	0.02
Sodium	4.8	0.21

Major Anions	1.01
Major Cations	0.99
Cation/Anion Difference	1.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	7.54
Manganese	0.14

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145 H8815-2-18-89 41

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR

Date 2-18-89

Time 18:18 - FINAL MEASUREMENTS

Media WATER

Station H88 15

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

T.D. = 171.97 / SAT. THICKNESS: 133.77 -

PURGE VOLUME = 300.00 / W/L: 39.89

Sample Description STARTED CLEAR AT 50 GALLONS THE WATER HAD LOST ITS CLARITY - BECOMING TURBID MURKY GRAY. AT ≅ 200 GALLONS THE CLARITY HAD RETURNED

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 4°C / D-O2 = 11.2

PH = 7.69 / 25 = 784 - FINAL MEASUREMENTS OF (4)

ALKALINITY = 28.5 as $CaCO_3$

Aliquot Amount	Container		Preservation/Amount
1/2 GALLON	PLASTIC JUG		NONE
1 LITRE	"		SULPHURIC 1
1 250 ML	"		NITRIC 1
1 250 ML	"	FILTERED	NITRIC 1

Sampler (signature) Date 2-18-89

Supervisor (signature) Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883245

Site Location PALMER ALASKA Sample ID 883245-H8815-6-16-89 MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDRASTAR

Date 6-16-89 Time 15:33

Media WATER Station H8815

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) WL: 38.15 - TOTAL DEPTH = 171.97 SAT. THICK = 133.27

TOTAL PURGE VOLUME - 300 Gals

Sample Description CLEAR - STRONG SULPHUR ODOR

($D\text{-}O_2$ = 11.6 / PH: 7.90 / 45= 0090^{x10})

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 3°C

$D\text{-}O_2$ = 11.6 / PH: 7.90 / 45: 0090^{x10} - THESE ARE FINAL MEASUREMENTS of (4) ALKALINITY 242.0 mg/l

Aliquot Amount	Container	Preservative/Amount
1/2 Gal	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC 1
1 250 mL	"	NITRIC 1
1 250 mL	"	FILTERED NITRIC 1

Sampler (signature) Date 6-16-89

Supervisor (signature) Date

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 8832145
Site Location ALASKA
Sample ID 8832145-H8815-2-15-89-M
Sampling Location

Technical Procedure Reference(s)
Type of Sampler HYDROSTAR HAND PUMP
Date 2-28-89 Time 16:49
Media WATER Station H8815
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
DEPTH of HOLE = 171.97 - SATURATED THICKNESS = 133.77
WL = 38.20 AMOUNT PURGED 83.26

Sample Description CLEAR

Field Measurements on Sample (pH, conductivity, etc.)
PH = 8.24 - uS = 303 - TEMP = 3°C - D-O_2 = 13.20
ALKALINITY 29.7 mg/L

Aliquot Amount	Container	Preservation/Amount
1/2 Gallon	Plastic	NONE
500 ML	"	Sulfuric 1
250 ML	"	Nitric 1
250 ML	"	Nitric 1

SEAL NO. #

Sampler (signature) Date 2-28-89
Supervisor (signature) Date

Golder Associates Inc.

Sample Site: 883-2145-H88-15
Lab No: 887239
Date Sampled: 11/20/88 @ 1249
Date Received: 11/29/88

Lab pH, s.u.	8.16
Lab Conductivity, umhos/cm @ 25C	255
Total Dissolved Solids (180), mg/l	172
Total Dissolved Solids (calc), mg/l	147
Boron, mg/l	0.16
Fluoride, mg/l	0.50
Ammonia Nitrogen as N, mg/l	0.12
Total Kjeldahl Nitrogen, mg/l	0.6
Ortho Phosphorus as P, mg/l	0.005
Total Organic Phosphorus as P, mg/l	0.005
Total Phosphorus as P, mg/l	0.032
Total Alkalinity as CaCO3, mg/l	132
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	38
Sodium Adsorption Ratio	3.28

	mg/l	meq/l
Bicarbonate as HCO3	160	2.63
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.36	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	3.9	0.08
Calcium	12	0.58
Magnesium	2.2	0.18
Potassium	0.9	0.02
Sodium	46	2.02

Major Anions	2.82
Major Cations	2.80
Cation/Anion Difference	0.36 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.37
Manganese	<0.02

Sample Site: 883-2145-H8815-2-15-89MW
Lab No: 897667 (Duplicate Analysis)
Date Sampled: 02/28/89 @ 1355
Date Received: 03/03/89

Lab pH, s.u.	9.00
Lab Conductivity, umhos/cm @ 25C	245
Total Dissolved Solids (180), mg/l	176
Total Dissolved Solids (calc), mg/l	155
Boron, mg/l	0.39
Fluoride, mg/l	0.54
Ammonia Nitrogen as N, mg/l	0.04
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.031
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	0.066
Total Alkalinity as CaCO3, mg/l	146
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	7
Sodium Adsorption Ratio	10.8

	mg/l	meq/l
Bicarbonate as HCO3	156	2.56
Carbonate as CO3	11	0.35
Chloride	0.7	0.02
Nitrate as N, mg/l	0.09	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.8	0.02
Calcium	1.7	0.08
Magnesium	0.6	0.05
Potassium	1.0	0.02
Sodium	63	2.75

Major Anions	2.96
Major Cations	2.90
Cation/Anion Difference	1.02 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.4	Iron	0.09
Arsenic	<0.005	Manganese	0.03
Barium	<0.5	Lead	0.03
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.46
Manganese	0.05

Sample Site: 883-2145-H8815-2-15-89MW
Lab No: 897666
Date Sampled: 02/28/89 @ 1649
Date Received: 03/03/89

Lab pH, s.u.	8.45
Lab Conductivity, umhos/cm @ 25C	227
Total Dissolved Solids (180), mg/l	154
Total Dissolved Solids (calc), mg/l	144
Boron, mg/l	0.43
Fluoride, mg/l	0.54
Ammonia Nitrogen as N, mg/l	0.08
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	0.015
Total Organic Phosphorus as P, mg/l	0.007
Total Phosphorus as P, mg/l	0.031
Total Alkalinity as CaCO3, mg/l	133
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	38
Sodium Adsorption Ratio	3.18

	mg/l	meq/l
Bicarbonate as HCO3	158	2.59
Carbonate as CO3	1.8	0.06
Chloride	2.1	0.06
Nitrate as N, mg/l	0.03	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	3.1	0.06
Calcium	11	0.53
Magnesium	2.8	0.23
Potassium	1.0	0.03
Sodium	45	1.96

Major Anions	2.77
Major Cations	2.75
Cation/Anion Difference	0.36 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.3	Iron	0.06
Arsenic	<0.005	Manganese	0.03
Barium	<0.5	Lead	0.02
Cadmium	0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<.02
Iron	0.18
Manganese	0.03

Sample Site: 883-2145-H8815-6-16-89MW
Lab No: 898279 (Duplicate)
Date Sampled: 06/16/89 @ 1511
Date Received: 06/19/89

Lab pH, s.u.	7.87
Lab Conductivity, umhos/cm @ 25C	437
Total Dissolved Solids (180), mg/l	302
Total Dissolved Solids (calc), mg/l	278
Boron, mg/l	0.07
Fluoride, mg/l	0.50
Ammonia Nitrogen as N, mg/l	0.15
Total Kjeldahl Nitrogen, mg/l	1.0
Ortho Phosphorus as P, mg/l	0.010
Total Organic Phosphorus as P, mg/l	0.002
Total Phosphorus as P, mg/l	0.029
Total Alkalinity as CaCO3, mg/l	212
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	42
Sodium Adsorption Ratio	6.61

	mg/l	meq/l
Bicarbonate as HCO3	258	4.23
Carbonate as CO3	0	0.00
Chloride	29	0.81
Nitrate as N, mg/l	0.11	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	5.8	0.12
Calcium	15	0.76
Magnesium	1.1	0.09
Potassium	1.6	0.04
Sodium	99	4.31

Major Anions	5.17
Major Cations	5.20
Cation/Anion Difference	0.29 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.08
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.14
Manganese	0.02

Sample Site: 883-2145-H8815-6-~~11~~16-89MW
Lab No: 8988275
Date Sampled: 06/16/89 @ 1511
Date Received: 6/19/89

Lab pH, s.u.	7.96
Lab Conductivity, umhos/cm @ 25C	438
Total Dissolved Solids (180), mg/l	304
Total Dissolved Solids (calc), mg/l	269
Boron, mg/l	0.11
Fluoride, mg/l	0.50
Ammonia Nitrogen as N, mg/l	0.10
Total Kjeldahl Nitrogen, mg/l	0.6
Ortho Phosphorus as P, mg/l	0.009
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.028
Total Alkalinity as CaCO3, mg/l	209
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	46
Sodium Adsorption Ratio	5.93

	mg/l	meq/l
Bicarbonate as HCO3	255	4.18
Carbonate as CO3	0	0.00
Chloride	28	0.78
Nitrate as N, mg/l	0.08	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	5.3	0.11
Calcium	15	0.75
Magnesium	2.1	0.17
Potassium	1.5	0.04
Sodium	92	4.02

Major Anions	5.08
Major Cations	4.98
Cation/Anion Difference	0.99 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	0.09
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.02
Iron	0.18
Manganese	0.02

Sample Site: 883-2145-H8815-7-18-89-4th-MW
Lab No: 898496
Date Sampled: 07/19/89 @ 1705
Date Received: 07/24/89

Lab pH, s.u.	7.81
Lab Conductivity, umhos/cm @ 25C	482
Total Dissolved Solids (180), mg/l	294
Total Dissolved Solids (calc), mg/l	295
Boron, mg/l	0.12
Fluoride, mg/l	0.49
Ammonia Nitrogen as N, mg/l	0.10
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.005
Total Organic Phosphorus as P, mg/l	0.026
Total Phosphorus as P, mg/l	0.112
Total Alkalinity as CaCO3, mg/l	224
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	44
Sodium Adsorption Ratio	7.00

	mg/l	meq/l
Bicarbonate as HCO3	273	4.47
Carbonate as CO3	0	0.00
Chloride	33	0.92
Nitrate as N, mg/l	<0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	4.1	0.09
Calcium	16	0.79
Magnesium	1.1	0.09
Potassium	1.3	0.03
Sodium	107	4.64

Major Anions	5.48
Major Cations	5.55
Cation/Anion Difference	0.63 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.08
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.05

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.98
Manganese	0.02

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8816-2-19-89-4TH

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR

Date 2-19-89

Time 13:15 final TEST

Media WATER

Station H88 16

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

TD = 403.00 / WL = 54.93 / SAT. THICKNESS 350.00

PURGE Volume = 200 Gals

Sample Description CLEAR - NO ODOR

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 2.5°C /

D-O2 = 12.2 / PH = 8.22 / 25 = 222 · final MEASUREMENT

of (4) - ALKALINITY = 10.8 as CaCO3

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	Plastic Jug	NONE
1 LITRE	"	Sulphuric - 1
1 250 ML	"	NITRIC - 1
1 250 ML	"	filtered NITRIC - 1

Sampler (signature) Matthew F. Wealch

Date 2-19-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISH BONE HILLS Project No. 8832145

Site Location PALMER ALASKA Sample ID 883-2145-H8816-6-16-89m.

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR

Date 6-16-89 Time 11:20

Media WATER Station H8816

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) TOTAL DEPTH = 403.00 - SATURATED THICKNESS : 350.85

PURGE VOLUME = 200 GALS

Sample Description SLIGHTLY TURBID -

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 4°C

D-O2 = 12.2 / PH: 9.45 / μS = 0030 x10 - THESE MEASUREMENTS ARE FINAL OF (4) ALKALINITY = 153.0 mg/L

Aliquot Amount	Container	Preservative/Amount
1/2 Gal	PLASTIC JUG	NONE
1 LITER	"	SULPHURIC 1
1 250ML	"	NITRIC 1
1 250mL	"	FILTERED NITRIC 1

Sampler (signature) Walter F [illegible] Date 2-16-89

Supervisor (signature) Date

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 883214S

Site Location ALASKA

Sample ID 8832145-H8816-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler HYDROSTAR HAND PUMP

Date 2-28-89

Time 13:55

Media WATER

Station H8816

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH OF WELL 403.00 - SATURATED THICKNESS: 350.85

WATER LEVEL: 52.15 - AMOUNT TO PURGE: 210.51 GAL

AMOUNT ACTUALLY PURGED: 33 GALLONS

Sample Description CLEAR

Field Measurements on Sample (pH, conductivity, etc.)

PH: 8.38 - μS: 325 TEMP: 3°C D-O_2: 13.6

ALKALINITY: 49.7 mg/l

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	PLASTIC	NONE
500 ML	"	SULPHUR - 1
850 ML	" FILTER	NITRIC - 1
850 ML	"	NITRIC - 1

SEAL NO. #

Sampler (signature) Matthew

Date 2-28-89

Supervisor (signature)

Date

Golder Associates Inc.

Sample Site: 883-2145-H88-16MW
Lab No: 887240
Date Sampled: 11/21/88 @ 1558
Date Received: 11/29/88

Lab pH, s.u.	9.08
Lab Conductivity, umhos/cm @ 25C	273
Total Dissolved Solids (180), mg/l	192
Total Dissolved Solids (calc), mg/l	158
Boron, mg/l	0.11
Fluoride, mg/l	0.54
Ammonia Nitrogen as N, mg/l	0.14
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.055
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	0.070
Total Alkalinity as CaCO3, mg/l	146
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	4
Sodium Adsorption Ratio	14.2

	mg/l	meq/l
Bicarbonate as HCO3	145	2.37
Carbonate as CO3	16	0.54
Chloride	0.7	0.02
Nitrate as N, mg/l	0.50	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	2.3	0.05
Calcium	1.3	0.06
Magnesium	0.2	0.02
Potassium	1.4	0.04
Sodium	65	2.83

Major Anions	3.02
Major Cations	2.95
Cation/Anion Difference	1.17 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.08
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.02
Iron	1.57
Manganese	0.02

Sample Site: 883-2145-H8816-2-15-89 MW
Lab No: 897665
Date Sampled: 02/28/89
Date Received: 03/03/89 @ 1355

Lab pH, s.u.	9.05
Lab Conductivity, umhos/cm @ 25C	234
Total Dissolved Solids (180), mg/l	164
Total Dissolved Solids (calc), mg/l	156
Boron, mg/l	0.38
Fluoride, mg/l	0.61
Ammonia Nitrogen as N, mg/l	0.04
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	0.032
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	0.064
Total Alkalinity as CaCO3, mg/l	146
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	6.0
Sodium Adsorption Ratio	11.3

	mg/l	meq/l
Bicarbonate as HCO3	160	2.63
Carbonate as CO3	9	0.29
Chloride	0.4	0.01
Nitrate as N, mg/l	0.10	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.0	0.02
Calcium	1.4	0.07
Magnesium	0.6	0.05
Potassium	0.9	0.02
Sodium	64	2.78

Major Anions	2.96
Major Cations	2.92
Cation/Anion Difference	0.68 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.4	Iron	0.09
Arsenic	<0.005	Manganese	0.03
Barium	<0.5	Lead	0.03
Cadmium	0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	17.7
Manganese	0.05

Sample Site: 883-2145-H8816-6-16-89-MW
Lab No: 8988276
Date Sampled: 06/16/89 @ 1120
Date Received: 06/19/89

Lab pH, s.u.	8.76
Lab Conductivity, umhos/cm @ 25C	245
Total Dissolved Solids (180), mg/l	182
Total Dissolved Solids (calc), mg/l	155
Boron, mg/l	0.10
Fluoride, mg/l	0.53
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	1.0
Ortho Phosphorus as P, mg/l	0.020
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.054
Total Alkalinity as CaCO3, mg/l	143
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	10
Sodium Adsorption Ratio	8.30

	mg/l	meq/l
Bicarbonate as HCO3	161	2.64
Carbonate as CO3	6.3	0.21
Chloride	1.1	0.03
Nitrate as N, mg/l	0.10	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	2.5	0.05
Calcium	2.1	0.10
Magnesium	1.3	0.11
Potassium	0.8	0.02
Sodium	62	2.69
Major Anions		2.94
Major Cations		2.92
Cation/Anion Difference		0.34 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	1.03
Manganese	0.03

Sample Site: 883-2145-H8816-7-19-89-4th-MW
Lab No: 898497
Date Sampled: 07/19/89 @ 1330
Date Received: 07/24/89

Lab pH, s.u..................................	8.34
Lab Conductivity, umhos/cm @ 25C..........	242
Total Dissolved Solids (180), mg/l........	142
Total Dissolved Solids (calc), mg/l.......	149
Boron, mg/l................................	<0.01
Fluoride, mg/l.............................	0.55
Ammonia Nitrogen as N, mg/l...............	0.01
Total Kjeldahl Nitrogen, mg/l.............	0.5
Ortho Phosphorus as P, mg/l...............	0.009
Total Organic Phosphorus as P, mg/l.......	0.017
Total Phosphorus as P, mg/l...............	0.065
Total Alkalinity as CaCO3, mg/l...........	139
Total Acidity as CaCO3, mg/l..............	<1
Total Hardness as CaCO3, mg/l.............	10
Sodium Adsorption Ratio...................	7.99

	mg/l	meq/l
Bicarbonate as HCO3...........	169	2.77
Carbonate as CO3..............	0	0.00
Chloride......................	1.4	0.04
Nitrate as N, mg/l............	<0.01	<0.01
Nitrite as N, mg/l............	<0.01	<0.01
Sulfate.......................	0.4	0.01
Calcium.......................	3.0	0.15
Magnesium.....................	0.7	0.06
Potassium.....................	1.0	0.02
Sodium........................	60	2.59

Major Anions..............................	2.82
Major Cations.............................	2.82
Cation/Anion Difference...................	0.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum..............	<0.1	Iron..................	<0.05
Arsenic...............	<0.005	Manganese.............	<0.02
Barium................	<0.5	Lead..................	<0.02
Cadmium...............	<0.002	Mercury...............	<0.001
Copper................	<0.01	Selenium..............	<0.005
Chromium..............	<0.02	Zinc..................	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium..............	<0.02
Iron..................	0.73
Manganese.............	0.02

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8817-7-11-89-41

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAIL

Date 7-11-89

Time 12:29

Media WATER

Station H8817

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
WLEVEL: 15.53 / DEPTH: 14.10 - SAT. THICKNESS
2.85 / PURGE VOLUME: 1.39 Gals

Sample Description INITIALLY CLEAR TURNING TURBID MUDDY
GRAY BROWN AFTER FIRST BAIL

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 3°C / D-O_2: 10.9
PH: 6.23 / ds = 196 - FINAL MEASUREMENTS
of (4) ALKALINITY: 76.5 as $CaCO_3$

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	Plastic Jug	NONE
1 LITRE	"	SULPHURIC 1
1 250 ML	"	NITRIC 1
1 250 ML	"	FILTERED NITRIC 1

Sampler (signature) Matthew F

Date 7-11-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WishBone Hills

Project No. 8832145

Site Location Palmer Alaska

Sample ID 8832145-H8817-5-30-89 MW

Sampling Location

Technical Procedure Reference(s) G.D. Memo - Dated - 3RD Quarter Sampling

Type of Sampler Bailer

Date 5-30-89

Time 12:09 - Final Test

Media Water

Station H88 17

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Water Level: 14.85 Total Depth: 19.71

Saturated Thickness 4.86 -

Amount Purged 2.91

Sample Description Muddy Gray Brown

Field Measurements on Sample (pH, conductivity, etc.) Temp: 2.5°C / D-O_2: 12.4

pH: 6.69 / µS: 255 - These Field Measurements are the Final of (4) Taken During Sampling

Alkalinity: 73.0 mg/L as $CaCO_3$ - Tested 48 HRS After Sampling

Aliquot Amount	Container	Preservation/Amount
1/2 Gal	Plastic Jug	None
1 Liter	"	Sulphuric - 1
1 250 ML	"	Nitric - 1
1 250 ML	" Filtered	Nitric - 1

Sampler (signature) Matthew

Date 5-30-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H8817-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 2-16-89 Time 13:45

Media WATER Station H88 17

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

TOTAL DEPTH = 14.10 - WL = 11.25 - SATURATED THICKNESS = 2.55

AMOUNT PURGED 4 GALS TOTAL

Sample Description SLIGHTLY TURBID - mostly clear

Field Measurements on Sample (pH, conductivity, etc.)

PH = 6.72 μS : 203 Temp = 2°C - D-O_2 = 13.40

T. ALKALINITY 80 mg/L

Aliquot Amount	Container		Preservation/Amount
1/2 GAL	PLASTIC		NONE
500 mL	"		SULPHURIC / 1
250 mL	"	UNFILTERED	NITRIC / 1
250 mL	"	FILTERED	NITRIC / 1

Sampler (signature) Date 2-16-89

Supervisor (signature) Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883 2145
Site Location ALASKA Sample ID 883 2145 H8817
Sampling Location

Technical Procedure Reference(s)
Type of Sampler BAILER
Date 11-8-88 Time 12:33 / 12:37
Media WATER Station H88 17
Sample Type: [✓ grab] time composite space composite
Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
DEPTH OF WELL 15.25 DEPTH TO WATER 10.90
30 GALLONS WATER PURGED (BAILED)

Sample Description DARK MUDDY GRAY

Field Measurements on Sample (pH, conductivity, etc.) PH NOT WORKING
TEMP 3°C / O_2 12.00

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC 1 VIAL
1 250 ML	" FILTERED	NITRIC 1 VIAL
1 250 ML	" UNFILTERED	" "

Sampler (signature) Matthew F [illegible] Date 11-8-88
Supervisor (signature) Date

Golder Associates

Sample Site: 883-2145-H88-17
Lab No: 887194
Date Sampled: 11/08/88 @ 1235
Date Received: 11/11/88

Lab pH, s.u.	7.05
Lab Conductivity, umhos/cm @ 25C	189
Total Dissolved Solids (180), mg/l	116
Total Dissolved Solids (calc), mg/l	98
Boron, mg/l	0.05
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.04
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	0.807
Total Phosphorus as P, mg/l	1.95
Total Alkalinity as CaCO3, mg/l	90
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	79
Sodium Adsorption Ratio	0.51

	mg/l	meq/l
Bicarbonate as HCO3	109	1.79
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	1.23	0.09
Nitrite as N, mg/l	<0.01	0.00
Sulfate	4.1	0.09
Calcium	20	0.99
Magnesium	7.2	0.59
Potassium	1.8	0.05
Sodium	10	0.45

Major Anions	2.00
Major Cations	2.08
Cation/Anion Difference	1.96 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.003	Zinc	0.02
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.04
Iron	23.1
Manganese	0.38

Sample Site: 883-2145-H8817-2-15-89MW
Lab No: 897601
Date Sampled: 02/16/89 @ 1301
Date Received: 02/20/89

Lab pH, s.u.	6.89
Lab Conductivity, umhos/cm @ 25C	184
Total Dissolved Solids (180), mg/l	108
Total Dissolved Solids (calc), mg/l	88
Boron, mg/l	0.29
Fluoride, mg/l	0.11
Ammonia Nitrogen as N, mg/l	0.35
Total Kjeldahl Nitrogen, mg/l	0.6
Ortho Phosphorus as P, mg/l	0.011
Total Organic Phosphorus as P, mg/l	0.134
Total Phosphorus as P, mg/l	0.351
Total Alkalinity as CaCO3, mg/l	70
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	69
Sodium Adsorption Ratio	0.40

	mg/l	meq/l
Bicarbonate as HCO3	85	1.40
Carbonate as CO3	0	0.00
Chloride	3.9	0.11
Nitrate as N, mg/l	0.49	0.04
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	8.6	0.18
Calcium	18	0.91
Magnesium	5.8	0.48
Potassium	1.5	0.04
Sodium	7.7	0.33

Major Anions	1.73
Major Cations	1.76
Cation/Anion Difference	0.86 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.005	Mercury	0.001
Copper	<0.01	Selenium	<0.005
Chromium	0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.02
Iron	4.53
Manganese	0.07

Sample Site: 883-2145-H88-17-5-30-89MW
Lab No: 898145 (DUPLICATE ANALYSIS)
Date Sampled: 05/30/89 @ 1643
Date Received: 06/05/89

Lab pH, s.u.	7.57
Lab Conductivity, umhos/cm @ 25C	220
Total Dissolved Solids (180), mg/l	162
Total Dissolved Solids (calc), mg/l	135
Boron, mg/l	0.15
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	1.9
Ortho Phosphorus as P, mg/l	0.007
Total Organic Phosphorus as P, mg/l	0.620
Total Phosphorus as P, mg/l	2.790
Total Alkalinity as CaCO3, mg/l	123
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	114
Sodium Adsorption Ratio	0.39

	mg/l	meq/l
Bicarbonate as HCO3	149	2.45
Carbonate as CO3	0	0.00
Chloride	1.8	0.05
Nitrate as N, mg/l	1.94	0.14
Nitrite as N, mg/l	0.01	<0.01
Sulfate	9.1	0.19
Calcium	31	1.52
Magnesium	9.4	0.77
Potassium	1.4	0.04
Sodium	9.6	0.42

Major Anions	2.83
Major Cations	2.75
Cation/Anion Difference	1.43 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.7	Iron	0.20
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.15
Iron	64.8
Manganese	1.00

Sample Site: 883-2145-H88-17-5-30-89MW
Lab No: 898142
Date Sampled: 05/30/89 @ 1643
Date Received: 06/05/89

Lab pH, s.u.	8.01
Lab Conductivity, umhos/cm @ 25C	222
Total Dissolved Solids (180), mg/l	150
Total Dissolved Solids (calc), mg/l	131
Boron, mg/l	0.17
Fluoride, mg/l	0.27
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	1.7
Ortho Phosphorus as P, mg/l	0.009
Total Organic Phosphorus as P, mg/l	0.790
Total Phosphorus as P, mg/l	3.180
Total Alkalinity as CaCO3, mg/l	115
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	109
Sodium Adsorption Ratio	0.47

	mg/l	meq/l
Bicarbonate as HCO3	140	2.30
Carbonate as CO3	0	0.00
Chloride	1.8	0.05
Nitrate as N, mg/l	1.92	0.14
Nitrite as N, mg/l	0.01	<0.01
Sulfate	9.1	0.19
Calcium	31	1.55
Magnesium	7.7	0.63
Potassium	1.5	0.04
Sodium	11	0.49

Major Anions	2.68
Major Cations	2.71
Cation/Anion Difference	0.56 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.3	Iron	0.24
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.16
Iron	63.5
Manganese	0.97

Sample Site: 883-2145-H8817-7-11-89-4th-MW
Lab No: 898498
Date Sampled: 07/11/89 @ 1202
Date Received: 07/24/89

Lab pH, s.u.	6.97
Lab Conductivity, umhos/cm @ 25C	185
Total Dissolved Solids (180), mg/l	112
Total Dissolved Solids (calc), mg/l	101
Boron, mg/l	<0.01
Fluoride, mg/l	0.11
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	1.0
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.519
Total Phosphorus as P, mg/l	3.10
Total Alkalinity as CaCO3, mg/l	91
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	81
Sodium Adsorption Ratio	0.43

	mg/l	meq/l
Bicarbonate as HCO3	111	1.82
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.74	0.05
Nitrite as N, mg/l	0.05	<0.01
Sulfate	6.4	0.13
Calcium	23	1.15
Magnesium	5.8	0.48
Potassium	1.7	0.04
Sodium	8.9	0.39

Major Anions	2.03
Major Cations	2.06
Cation/Anion Difference	0.73 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.05
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.003	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	0.24
Iron	89.7
Manganese	1.51

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8819-7-10-89-4

Sampling Location

Technical Procedure Reference(s)

Type of Sampler Bail

Date 7-10-89

Time 11:33 - LAST Sample of 4

Media WATER

Station H8819

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
TOTAL DEPTH : 34.26 / WATER LEVEL : 35.39
SATURATED THICKNESS: 2.71 - PURGED VOLUME : 2 Gals

Sample Description VERY TURBID - Black

Field Measurements on Sample (pH, conductivity, etc.) Temp = 2.5°C
0-O_2 = 11.25 / PH: 7.19 / uS: 133 - final
TEST (MEASUREMENTS) of (4) TAKEN
ALKALINITY = 42.2 as $CaCO_3$

Aliquot Amount	Container	Preservation/Amount
1/2 Gallon	Plastic Jug	NONE
1 LITRE	"	Sulphuric 1
1 250 ml	"	Nitric 1
1 250 ml	"	Nitric 1

Sampler (signature) Matthew [illegible] Date 7-10-89

Supervisor (signature) Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H88.19.5.23-89

Sampling Location

Technical Procedure Reference(s) APPENDIX B GROUND WATER SAMPLING

Type of Sampler BAILER

Date 5-23-89

Time 14:54 FINAL TEST

Media WATER

Station H8819

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH 38.20 - WATER LEVEL 36.05 - SATURATED THICKNESS 2.15

AMOUNT PURGED 1.33 GALS

Sample Description TURBID BLACK

Field Measurements on Sample (pH, conductivity, etc.) PH = 7.28 / µS: 172

~~PH:~~ TEMP: 2.5°C / D-O2: 13.4 - FINAL TESTS OF FOUR (4)

ALKALINITY = TOO TURBID TO TEST

ALSO TO TURBID TO FILTER AS OF 24:02:00 (5-24)

(ALKALINITY = 61.0 mg/L @ 18:09-5-26-89)

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	〃	SULPHURIC 1
1 250 ML	〃	NITRIC 1
1 250 ML	〃 FILTERED	NITRIC 1

Sampler (signature) Matthew

Date 5-23-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISH BONE HILLS

Project No. 883-2145

Site Location ALASKA

Sample ID 883-2145-H8819

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 11-8-88

Time 4:35

Media WATER

Station H88 19

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
DEPTH of WELL 34.26 DEPTH TO WATER 31.55
SATURATED THICKNESS 2.71 · TOO SHALLOW for PURGING

Sample Description BLACK MUDDY COLOR

Field Measurements on Sample (pH, conductivity, etc.) TEMP 4°C / O_2 7.50
PH - NOT WORKING

Aliquot Amount	Container		Preservation/Amount
1/2 GALLON	PLASTIC JUG		NONE
1 LITRE	"		SULPHURIC 1 VIAL
1 250 ML	"	UNFILTERED	NITRIC "
1 250 ML	"	FILTERED	NITRIC "

Sampler (signature) Matthew J W[illegible]

Date 11-8-88

Supervisor (signature)

Date

Golder Associates

Sample Site: 883-2145-H88-19
Lab No: 887195
Date Sampled: 11/08/88 @ 1635
Date Received: 11/11/88

Lab pH, s.u.	7.28
Lab Conductivity, umhos/cm @ 25C	243
Total Dissolved Solids (180), mg/l	154
Total Dissolved Solids (calc), mg/l	145
Boron, mg/l	0.06
Fluoride, mg/l	0.12
Ammonia Nitrogen as N, mg/l	1.40
Total Kjeldahl Nitrogen, mg/l	206.0
Ortho Phosphorus as P, mg/l	0.004
Total Organic Phosphorus as P, mg/l	3.10
Total Phosphorus as P, mg/l	16.2
Total Alkalinity as CaCO3, mg/l	120
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	83
Sodium Adsorption Ratio	1.21

	mg/l	meq/l
Bicarbonate as HCO3	146	2.39
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	<0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	13	0.27
Calcium	19	0.94
Magnesium	8.8	0.72
Potassium	4.8	0.12
Sodium	25	1.10

Major Anions	2.74
Major Cations	2.88
Cation/Anion Difference	2.49 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.006	Zinc	0.02
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	1.90
Iron	1010
Manganese	13.2

Sample Site: 883-2145-H88-19-5-23-89MW
Lab No: 898102
Date Sampled: 05/23/89 @ 1431
Date Received: 05/26/89

Lab pH, s.u.	6.93
Lab Conductivity, umhos/cm @ 25C	173
Total Dissolved Solids (180), mg/l	108
Total Dissolved Solids (calc), mg/l	100
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.31
Total Kjeldahl Nitrogen, mg/l	10.8
Ortho Phosphorus as P, mg/l	0.031
Total Organic Phosphorus as P, mg/l	1.88
Total Phosphorus as P, mg/l	8.32
Total Alkalinity as CaCO3, mg/l	75
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	67
Sodium Adsorption Ratio	0.60

	mg/l	meq/l
Bicarbonate as HCO3	91	1.49
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.21	0.02
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	15	0.30
Calcium	22	1.09
Magnesium	3.2	0.26
Potassium	1.5	0.04
Sodium	11	0.49

Major Anions	1.89
Major Cations	1.88
Cation/Anion Difference	0.27 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.09
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.13
Iron	68.6
Manganese	1.26

Sample Site: 883-2145-H8819-7-10-89-4th-MW
Lab No: 898499
Date Sampled: 07/10/89 @ 1056
Date Received: 07/24/89

Lab pH, s.u.	7.02
Lab Conductivity, umhos/cm @ 25C	134
Total Dissolved Solids (180), mg/l	104
Total Dissolved Solids (calc), mg/l	80
Boron, mg/l	0.10
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.31
Total Kjeldahl Nitrogen, mg/l	38.8
Ortho Phosphorus as P, mg/l	0.044
Total Organic Phosphorus as P, mg/l	3.14
Total Phosphorus as P, mg/l	9.78
Total Alkalinity as CaCO3, mg/l	63
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	53
Sodium Adsorption Ratio	0.55

	mg/l	meq/l
Bicarbonate as HCO3	77	1.26
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.08	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	8.6	0.18
Calcium	17	0.85
Magnesium	2.6	0.21
Potassium	2.3	0.06
Sodium	9.2	0.40

Major Anions	1.53
Major Cations	1.52
Cation/Anion Difference	0.33 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.20
Iron	88.0
Manganese	1.39

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 8832145
Site Location PALMER ALASKA
Sample ID 8832145-H8821-7-11-89-[illegible]
Sampling Location

Technical Procedure Reference(s)
Type of Sampler BAIL
Date 7-11-89 Time 16:00
Media WATER Station H8821
Sample Type: [✓ grab] time composite space composite
Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
WL: INITIAL = 47.77 - final WL: 47.76
SAT. THICKNESS: 4.77 / T.D: 52.70

Sample Description TURBID - MUDDY - MILKY GRAY BROWN

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 2.5°C / D-O2 = 12.0
pH = 7.21 / uS = 150 - final of 4 TESTS
ALKALINITY = 24.0 as CaCO3

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	Plastic Jug	NONE
1 LITRE	"	Sulphuric 1
1 250 ML	"	NITRIC 1
1 250 ML	"	filtered NITRIC 1

Sampler (signature) Matthew F W Date 7-11-89
Supervisor (signature) Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H8821-5-23-89-M

Sampling Location

Technical Procedure Reference(s) APPENDIX B - GROUND WATER SAMPLING

Type of Sampler BAILER

Date 5-23-89

Time 17:00 FINAL TEST

Media WATER

Station H8821

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
DEPTH 57.50 - SATURATED THICKNESS = 10.53 - WL = 46.97
TOTAL PURGED = 6 GALS

Sample Description MUDDY GRAY
TOO TURBID TO PERFORM FILTERING ON SITE - SAMPLE MUST BE ALLOWED TO SETTLE OUT

Field Measurements on Sample (pH, conductivity, etc.) PH = (7.64) - Es = (153) 160
LAST READING TEMP = (2.5°C) 2.5 - D-O2 = (12.2) 13.0 ALKALINITY = SAMPLE TO TURBID TO PERFORM ALKALINITY TEST AT 12:36:00 (5-24) ALKALINITY = 204.0 mg/L @ 18:26/5-26-8

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC 1
1 250 ML	"	NITRIC 1
1 250 ML	" FILTERED	NITRIC 1

Sampler (signature)

Date 5-23-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS - H8821 Project No. 883 2145

Site Location ALASKA Sample ID 8832145-H8821-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 2-16-89 Time 14:30:00

Media WATER Station H8821

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH - 52.70 - WL = 47.93 - SATURATED THICKNESS - 4.77

WATER PURGED 10:00:00 5 GALS - 15:15:00 2 GALS = 7 GALS TOTAL

Sample Description TURBID - MUDDY

Field Measurements on Sample (pH, conductivity, etc.)

PH: 7.84 / µS: 210 / TEMP: 2°C / D-O_2: 12.4

ALKALINITY 49.0 mg/L

Aliquot Amount	Container		Preservation/Amount
1/2 GAL	PLASTIC		NONE
500 ML	"		SULPHUR / 1
250 ML	"	FILTERED	NITRIC / 1
250 ML	"	UNFILTERED	NITRIC 1

Sampler (signature) Matthew L. [illegible] Date 2-16-89

Supervisor (signature) Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-HBB-21

Sampling Location WISHBONE HILLS

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 11-5-88

Time 12:36

Media WATER

Station

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH of Hole 53.58 - DEPTH TO WATER LEVEL 43.65 - TO TOP of PVC

10.03 SATURATED THICKNESS - 15 GALLONS PURGED

MUDDY GRAY COLOR

Sample Description MUDDY GRAY COLOR - SILTY - TURBID

Field Measurements on Sample (pH, conductivity, etc.) EQUIPMENT NOT WORKING

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	Plastic Jug	NONE
1 LITRE	"	Sulphuric 1 vial
1 250ML	" UNFILTERED	NITRIC "
1 250 ML	" FILTERED	NITRIC "

Sampler (signature)

Date 11-5-88

Supervisor (signature)

Date

Golder Associates

Sample Site: 883-2145-H88-21
Lab No: 887181
Date Sampled: 11/05/88 @ 1236
Date Received: 11/09/88

Lab pH, s.u.	7.95
Lab Conductivity, umhos/cm @ 25C	152
Total Dissolved Solids (180), mg/l	114
Total Dissolved Solids (calc), mg/l	84
Boron, mg/l	0.02
Fluoride, mg/l	0.07
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.5
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	0.036
Total Phosphorus as P, mg/l	2.69
Total Alkalinity as CaCO3, mg/l	77
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	71
Sodium Adsorption Ratio	0.31

	mg/l	meq/l
Bicarbonate as HCO3	94	1.54
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.39	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	3.7	0.08
Calcium	23	1.16
Magnesium	3.0	0.25
Potassium	1.7	0.04
Sodium	6.0	0.26

Major Anions	1.67
Major Cations	1.71
Cation/Anion Difference	1.18 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.4	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.005	Zinc	0.04
Copper	0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.30
Iron	221
Manganese	4.30

Sample Site: 883-2145-H8821-2-15-89MW
Lab No: 897605 (Duplicate Analysis)
Date Sampled: 02/16/89 @ 1445
Date Received: 02/20/89

Lab pH, s.u.	8.53
Lab Conductivity, umhos/cm @ 25C	185
Total Dissolved Solids (180), mg/l	118
Total Dissolved Solids (calc), mg/l	109
Boron, mg/l	0.37
Fluoride, mg/l	0.67
Ammonia Nitrogen as N, mg/l	0.54
Total Kjeldahl Nitrogen, mg/l	6.5
Ortho Phosphorus as P, mg/l	0.146
Total Organic Phosphorus as P, mg/l	0.191
Total Phosphorus as P, mg/l	5.96
Total Alkalinity as CaCO3, mg/l	99
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	87
Sodium Adsorption Ratio	0.34

	mg/l	meq/l
Bicarbonate as HCO3	115	1.88
Carbonate as CO3	3.0	0.10
Chloride	1.4	0.04
Nitrate as N, mg/l	0.85	0.06
Nitrite as N, mg/l	0.01	<0.01
Sulfate	5.3	0.11
Calcium	32	1.60
Magnesium	1.7	0.14
Potassium	2.3	0.06
Sodium	7.3	0.32

Major Anions	2.19
Major Cations	2.12
Cation/Anion Difference	1.62 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.3	Iron	0.39
Arsenic	<0.005	Manganese	0.05
Barium	<0.5	Lead	<0.02
Cadmium	0.003	Mercury	0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.58
Iron	411
Manganese	8.22

21

Improperly designated "Sample Site" per conversation w Duane Madsen, 5/1/89. Should be H88-21. GSD

Sample Site: 883-2145-H8817-2-15-89MW
Lab No: 897603 → is actually H88-21
Date Sampled: 02/16/89 @ 1445
Date Received: 02/20/89

Lab pH, s.u.	8.55
Lab Conductivity, umhos/cm @ 25C	165
Total Dissolved Solids (180), mg/l	104
Total Dissolved Solids (calc), mg/l	107
Boron, mg/l	0.36
Fluoride, mg/l	0.60
Ammonia Nitrogen as N, mg/l	0.45
Total Kjeldahl Nitrogen, mg/l	5.7
Ortho Phosphorus as P, mg/l	0.137
Total Organic Phosphorus as P, mg/l	0.646
Total Phosphorus as P, mg/l	5.96
Total Alkalinity as CaCO3, mg/l	96
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	84
Sodium Adsorption Ratio	0.35

	mg/l	meq/l
Bicarbonate as HCO3	112	1.83
Carbonate as CO3	2.7	0.09
Chloride	1.4	0.04
Nitrate as N, mg/l	0.89	0.06
Nitrite as N, mg/l	0.01	<0.01
Sulfate	4.7	0.10
Calcium	33	1.64
Magnesium	<1.0	0.03
Potassium	2.3	0.06
Sodium	7.4	0.32

Major Anions	2.12
Major Cations	2.05
Cation/Anion Difference	1.68 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	0.39
Arsenic	<0.005	Manganese	0.05
Barium	<0.5	Lead	<0.02
Cadmium	0.003	Mercury	0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	0.57
Iron	408
Manganese	8.17

Sample Site: 883-2145-H8821-2-15-89MW
Lab No: 897603
Date Sampled: 02/16/89 @ 1445
Date Received: 02/20/89

Lab pH, s.u.	8.55
Lab Conductivity, umhos/cm @ 25C	165
Total Dissolved Solids (180), mg/l	104
Total Dissolved Solids (calc), mg/l	107
Boron, mg/l	0.36
Fluoride, mg/l	0.60
Ammonia Nitrogen as N, mg/l	0.45
Total Kjeldahl Nitrogen, mg/l	5.7
Ortho Phosphorus as P, mg/l	0.137
Total Organic Phosphorus as P, mg/l	0.646
Total Phosphorus as P, mg/l	5.96
Total Alkalinity as CaCO3, mg/l	96
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	84
Sodium Adsorption Ratio	0.35

	mg/l	meq/l
Bicarbonate as HCO3	112	1.83
Carbonate as CO3	2.7	0.09
Chloride	1.4	0.04
Nitrate as N, mg/l	0.89	0.06
Nitrite as N, mg/l	0.01	<0.01
Sulfate	4.7	0.10
Calcium	33	1.64
Magnesium	<1.0	0.03
Potassium	2.3	0.06
Sodium	7.4	0.32

Major Anions	2.12
Major Cations	2.05
Cation/Anion Difference	1.68 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	0.39
Arsenic	<0.005	Manganese	0.05
Barium	<0.5	Lead	<0.02
Cadmium	0.003	Mercury	0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	0.57
Iron	408
Manganese	8.17

iml
Inter·Mountain
Laboratories, Inc.

1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945

1714 Phillips Circle
Gillette, Wyoming 82716
Tel. (307) 682-8945

MAY 05

May 1, 1989

Golder Associates, Inc.
Attn: Greg Davis
17301 W. Colfax
Suite 3275
Golden, CO 80401

RE: Wishbone Hills Water Samples - 03/24/89 Report Revision

Dear Greg,

As discussed in our phone conversation today, a mistake was made on the identification of one of the samples reported from our laboratory on March 24, 1989.

The sample identified by our lab number 897603 was reported as 883-2145-H8817-2-15-89MW. The correct identification of this sample is 883-2145-H8821-2-15-89MW. A revised copy of the report page is attached.

If you have any questions, please call at your convenience.

Sincerely,

Duane H. Madsen
Inter-Mountain Labs, Inc.
1633 Terra Avenue
Sheridan, WY 82801
(307) 672-8945

cc: Golder Associates, Inc.
-Redmond, WA
-Anchorage, AK

Sample Site: 883-2145-H88-21-5-23-89MW
Lab No: 898103
Date Sampled: 05/23/89 @ 1657
Date Received: 05/26/89

Lab pH, s.u.	7.90
Lab Conductivity, umhos/cm @ 25C	174
Total Dissolved Solids (180), mg/l	106
Total Dissolved Solids (calc), mg/l	94
Boron, mg/l	<0.01
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	3.1
Ortho Phosphorus as P, mg/l	0.022
Total Organic Phosphorus as P, mg/l	0.371
Total Phosphorus as P, mg/l	2.74
Total Alkalinity as CaCO3, mg/l	87
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	79
Sodium Adsorption Ratio	0.26

	mg/l	meq/l
Bicarbonate as HCO3	106	1.73
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.28	0.02
Nitrite as N, mg/l	0.01	<0.01
Sulfate	4.9	0.10
Calcium	28	1.40
Magnesium	2.2	0.18
Potassium	1.2	0.03
Sodium	5.2	0.23

Major Anions	1.87
Major Cations	1.84
Cation/Anion Difference	0.81 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.13
Iron	109
Manganese	2.67

Sample Site: 883-2145-H88-21-5-23-89MW
Lab No: 898107 (DUPLICATE ANALYSIS)
Date Sampled: 05/23/89 @ 1657
Date Received: 05/26/89

Lab pH, s.u.	7.92
Lab Conductivity, umhos/cm @ 25C	164
Total Dissolved Solids (180), mg/l	100
Total Dissolved Solids (calc), mg/l	92
Boron, mg/l	<0.01
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	3.7
Ortho Phosphorus as P, mg/l	0.028
Total Organic Phosphorus as P, mg/l	0.432
Total Phosphorus as P, mg/l	2.42
Total Alkalinity as CaCO3, mg/l	85
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	78
Sodium Adsorption Ratio	0.26

	mg/l	meq/l
Bicarbonate as HCO3	104	1.70
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.27	0.02
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	3.9	0.08
Calcium	28	1.37
Magnesium	2.4	0.20
Potassium	1.4	0.03
Sodium	5.4	0.23

Major Anions	1.82
Major Cations	1.83
Cation/Anion Difference	0.27 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.13
Iron	105
Manganese	2.64

Sample Site: 883-2145-H8821-7-11-89-4th-MW
Lab No: 898500
Date Sampled: 07/11/89 @ 1504
Date Received: 07/24/89

Lab pH, s.u.	7.50
Lab Conductivity, umhos/cm @ 25C	123
Total Dissolved Solids (180), mg/l	98
Total Dissolved Solids (calc), mg/l	78
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	1.8
Ortho Phosphorus as P, mg/l	0.016
Total Organic Phosphorus as P, mg/l	0.820
Total Phosphorus as P, mg/l	3.13
Total Alkalinity as CaCO3, mg/l	70
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	64
Sodium Adsorption Ratio	0.19

	mg/l	meq/l
Bicarbonate as HCO3	85	1.40
Carbonate as CO3	0	0.00
Chloride	0.4	0.01
Nitrate as N, mg/l	0.28	0.02
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	4.9	0.10
Calcium	23	1.15
Magnesium	1.6	0.13
Potassium	2.9	0.08
Sodium	3.4	0.15

Major Anions	1.53
Major Cations	1.51
Cation/Anion Difference	0.66 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.09
Iron	85.6
Manganese	1.65

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-HB822-7-10-89-4TH

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAIL

Date 7-10-89

Time 14:50

Media WATER

Station HB822

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.) TOTAL DEPTH: 51.30 / SAT. THICK: 40.20 / VOLUME PURGED: 19.26 - WATER LEVEL: 12.40

Sample Description TURBID - MILKY - MUDDY - GRAYISH - BROWN

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 3°C / D-O2: 10.65 PH: 7.55 / μS: 188 - FINAL MEASUREMENT of (4) ALKALINITY 83.2 AS CACO3

Aliquot Amount	Container	Preservation/Amount
1/2 Gallon	Plastic Jug	NONE
1 LITRE	"	SULPHURIC
1 250 ML	"	NITRIC
1 250 ML	" (FILTERED)	NITRIC

Sampler (signature)

Date 7-10-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 883-2145-
Site Location PALMER ALASKA
Sample ID 883-2145-H8822-5-30-89
Sampling Location

Technical Procedure Reference(s) G. DAVIS - MEMO - DATED 3RD QUARTER SAMPLING
Type of Sampler BAILER
Date 0 5-30-89
Time 14:25 . FINAL TEST
Media WATER
Station H88 22
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
WATER LEVEL = 10.5 - TOTAL DEPTH = 55.84 .
SATURATED THICKNESS = 44.24 - AMOUNT PURGED: 22.90
~~[illegible]~~

Sample Description MUDDY GRAY BROWN

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 2°C / D-O$_2$ = 13.2
PH = 6.84 . µS = 180 ALKALINITY = 48.0 mg/L as $CaCO_3$
THESE FIELD MEASUREMENTS ARE FINAL OUT OF (4) TAKEN THROUGHOUT THE SAMPLING

Aliquot Amount	Container		Preservation/Amount	
1/2 Gallon	PLASTIC JUG		NONE ~~SULPHURIC~~	~~1~~
1 LITRE	"		~~N~~ SULPHURIC	1
1 250 ML	"		NITRIC	1
1 250 M	"	FILTERED	NITRIC	1

Sampler (signature)
Date 5-30-89
Supervisor (signature)
Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISH BONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H8822-2-15-89-MU

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BOILER

Date 2-16-89 Time 16.52

Media WATER Station H8822

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH = 51.30 - W/L = 11.10 - SAT. THICKNESS 40.20

TOTAL AMOUNT PURGED = 21 GALS

Sample Description TURBID · MUDDY

Field Measurements on Sample (pH, conductivity, etc.)

PH = 7.41 μS = 198 TEMP = 1 °C D-O_2 = 12.2

T. ALKALINITY = 52.0 mg/L

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC	NONE
500 ML	"	SULPHURIC
250 ML	" UNFILTERED	NITRIC
250 ML	" FILTERED	NITRIC

Sampler (signature) Matthew F Date 2-16-89

Supervisor (signature) Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site

Project No. 883-2145- [redacted]

Site Location Alaska

Sample ID 883-2145-H88-22

Sampling Location WISHBONE HILLS

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 11-5-88

Time 2:19

Media WATER

Station

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH of Hole - 52.16 - DEPTH ~~of~~ to WATER LEVEL 7.93 -

TOTAL PURGED 26 GALLONS - SATURATED THICKNESS 44.23

Sample Description MUDDY GRAY COLOR - SILTY - TURBID

Field Measurements on Sample (pH, conductivity, etc.) TEMP 2.5°C

PH METER NOT WORKING

D-O METER NOT WORKING

WATER TOO TURBID for ALKILINITY

Aliquot Amount	Container		Preservation/Amount
1/2 HALF GAL	PLASTIC JUG		NONE
1 LITRE	"		1 VIAL - SULPHURIC
1 250 ML	"	UNFILTERED	1 VIAL - NITRIC
1 250 ML	"	FILTERED	" - NITRIC

Sampler (signature)

Date 11-5-88

Supervisor (signature)

Date

Golder Associates

Sample Site: 883-2145-H88-22
Lab No: 867182
Date Sampled: 11/05/88 @ 1419
Date Received: 11/09/88

Lab pH, s.u.	7.59
Lab Conductivity, umhos/cm @ 25C	188
Total Dissolved Solids (180), mg/l	122
Total Dissolved Solids (calc), mg/l	104
Boron, mg/l	0.01
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.5
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	3.11
Total Phosphorus as P, mg/l	4.50
Total Alkalinity as CaCO3, mg/l	102
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	92
Sodium Adsorption Ratio	0.27

	mg/l	meq/l
Bicarbonate as HCO3	124	2.03
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.07	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.6	0.03
Calcium	28	1.42
Magnesium	5.1	0.42
Potassium	1.3	0.03
Sodium	5.9	0.26

Major Anions	2.10
Major Cations	2.13
Cation/Anion Difference	0.71 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	2.6	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.008	Zinc	0.04
Copper	0.03		

Trace Metals (Total Concentrations), mg/l

Chromium	0.25
Iron	174
Manganese	4.15

Sample Site: 883-2145-H8822-2-15-89MW
Lab No: 897602
Date Sampled: 02/16/89 @ 1642
Date Received: 02/20/89

Lab pH, s.u.	7.04
Lab Conductivity, umhos/cm @ 25C	141
Total Dissolved Solids (180), mg/l	92
Total Dissolved Solids (calc), mg/l	73
Boron, mg/l	0.36
Fluoride, mg/l	0.20
Ammonia Nitrogen as N, mg/l	0.07
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.568
Total Organic Phosphorus as P, mg/l	0.478
Total Phosphorus as P, mg/l	1.88
Total Alkalinity as CaCO3, mg/l	69
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	64
Sodium Adsorption Ratio	0.21

	mg/l	meq/l
Bicarbonate as HCO3	84	1.37
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	7.54	0.54
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	2.1	0.04
Calcium	20	1.02
Magnesium	3.2	0.26
Potassium	0.9	0.02
Sodium	4.0	0.17

Major Anions	1.45
Major Cations	1.47
Cation/Anion Difference	0.68 % *

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	<0.05
Arsenic	<0.005	Manganese	0.13
Barium	<0.5	Lead	<0.02
Cadmium	0.003	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.03

Trace Metals (Total Concentrations), mg/l

Chromium	0.09
Iron	51.2
Manganese	1.23

* Nitrates undetectable in raw sample; not included as a major anion.

Sample Site: 883-2145-H88-22-5-30-89MW
Lab No: 898143
Date Sampled: 05/30/89 @ 1411
Date Received: 06/05/89

Lab pH, s.u.	7.87
Lab Conductivity, umhos/cm @ 25C	164
Total Dissolved Solids (180), mg/l	116
Total Dissolved Solids (calc), mg/l	106
Boron, mg/l	0.28
Fluoride, mg/l	0.26
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	2.0
Ortho Phosphorus as P, mg/l	0.016
Total Organic Phosphorus as P, mg/l	0.030
Total Phosphorus as P, mg/l	2.77
Total Alkalinity as CaCO3, mg/l	101
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	91
Sodium Adsorption Ratio	0.24

	mg/l	meq/l
Bicarbonate as HCO3	123	2.01
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	<0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	4.3	0.09
Calcium	30	1.50
Magnesium	4.0	0.33
Potassium	1.0	0.03
Sodium	5.3	0.23

Major Anions	2.13
Major Cations	2.09
Cation/Anion Difference	0.95 %

Trace Metals (Dissolved. Concentrations), mg/l

Aluminum	0.2	Iron	0.05
Arsenic	<0.005	Manganese	0.15
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.14

Trace Metals (Total Concentrations), mg/l

Chromium	0.13
Iron	104
Manganese	2.16

Sample Site: 883-2145-H8822-7-10-89-4th-MW
Lab No: 898501
Date Sampled: 07/10/89 @ 1404
Date Received: 07/24/89

Lab pH, s.u.	7.79
Lab Conductivity, umhos/cm @ 25C	185
Total Dissolved Solids (180), mg/l	136
Total Dissolved Solids (calc), mg/l	110
Boron, mg/l	<0.01
Fluoride, mg/l	0.10
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	1.2
Ortho Phosphorus as P, mg/l	0.053
Total Organic Phosphorus as P, mg/l	1.902
Total Phosphorus as P, mg/l	4.36
Total Alkalinity as CaCO3, mg/l	105
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	95
Sodium Adsorption Ratio	0.27

	mg/l	meq/l
Bicarbonate as HCO3	128	2.10
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	0.05	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	3.7	0.08
Calcium	30	1.49
Magnesium	4.9	0.40
Potassium	1.5	0.04
Sodium	5.9	0.26

Major Anions	2.22
Major Cations	2.19
Cation/Anion Difference	0.68 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.05
Arsenic	<0.005	Manganese	0.11
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.05
Iron	46.9
Manganese	0.94

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8823-2-23-89-

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAIL

Date 2-23-89

Time 18:42 LAST Sample Collected

Media WATER

Station H8823

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

TOTAL DEPTH = 83.97 - SAT. THICKNESS : 32.87

PURGE VOLUME : 16.07 - WATER LEVEL : 50.88

Sample Description TURBID MUDDY -

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 2°C / D-O2 = 11.5

PH = 6.28 / μs = 121 - ALKALINITY TESTED 24 HRS LATER : 3.2 as $CaCO_3$ - PARAMETERS - final of X

I DID NOT HAVE THE FILTER UNIT OR ALKALINITY KIT

Aliquot Amount	Container	Preservation/Amount
1/2 Gal	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC - 1
250 ML	"	NITRIC - 1
250 ML	"	FILTERED NITRIC - 1

Sampler (signature)

Date 2-23-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8823-5-24-89-MW

Sampling Location

Technical Procedure Reference(s) MEMO - 3RD QUARTER SAMPLING - G.D.

Type of Sampler BAIL

Date 5-24-89

Time 14:07 FIRST SAMPLE TESTED / 14:31 LAST SAMPLE TES

Media WATER

Station H88 23

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
WATER LEVEL: 52.00 TOTAL DEPTH: 99.15 SATURATED THICKNESS: 47.15
AMOUNT PURGED PRIOR TO PARAMETERS + SAMPLING 16.07

Sample Description MUDDY GRAY COLOR

Field Measurements on Sample (pH, conductivity, etc.) TEMP: 2.5°C / D-O_2: 12.45
PH: 7.06 / uS: 124 ALKALINITY = 41.0 mg/L
THESE ARE FINAL PARAMETER MEASUREMENTS OUT OF (4) - 1 FOR EACH SAMPLE - (4) SAMPLES COLLECTED

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC 1
1 250ML	"	NITRIC 1
1 250 ML	" FILTERED	NITRIC 1

(1 250ML SAMPLE FILTERED 24 HRS AFTER COLLECTED)
(SULPHURIC ACID ADDED TO 1 LITRE SAMPLE ≅ 4 HRS AFTER COLLECTED)

Sampler (signature) Matthew F W

Date 5-24-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145 H8823-2-15-89 MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 2-21-89

Time 13:52 - 15:40

Media WATER

Station H88 23

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH OF HOLE = 83.97 - SATURATED THICKNESS : 32.87

WATER LEVEL: 51.10 - TOTAL WATER PURGED: 19.72

Sample Description CLEAR BECOMING TURBID

Field Measurements on Sample (pH, conductivity, etc.)

PH = 7.24 / uS = 156 / TEMP: 2°C / D-O2 : 14.4

ALKALINITY : 55 mg/L

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC	NONE
500 ML	"	SULPHURIC / 1
250 ML	"	NITRIC / 1
250 ML	"	NITRIC / 1

SEAL NO. 3509 - 3510

Sampler (signature)

Date 2-21-89

Supervisor (signature)

Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hills
Project No. 883-2145
Site Location " "
Sample ID 883-2145-488-23
Sampling Location Well No. # 23

Technical Procedure Reference(s)
Type of Sampler Bailer
Date 11-3-88
Time 2:30
Media Water
Station
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Well Depth 95.00 Depth to Water Level 47.89 To Top of PVC
Saturated Thickness 47.11 10.2 Gallons Purged

Sample Description Dark Muddy Gray Color Silty

Field Measurements on Sample (pH, conductivity, etc.) Instruments Not Working

Aliquot Amount	Container	Preservation/Amount
1/2 Gal	Plastic Jar	None
1 Litre	"	Sulphuric 1 Vial
1 250 ML	" Filtered	Nitric " "
1 250 ML	" Unfiltered	

Sampler (signature)
Date 11-3-88
Supervisor (signature)
Date

Golder Associates

Sample Site: 883-2145-H88-23 (DUPLICATE ANALYSES)
Lab No: 887186
Date Sampled: 11/03/88 @ 1430
Date Received: 11/09/88

Lab pH, s.u.	7.10
Lab Conductivity, umhos/cm @ 25C	157
Total Dissolved Solids (180), mg/l	106
Total Dissolved Solids (calc), mg/l	87
Boron, mg/l	0.04
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	0.20
Total Kjeldahl Nitrogen, mg/l	3.9
Ortho Phosphorus as P, mg/l	0.003
Total Organic Phosphorus as P, mg/l	1.47
Total Phosphorus as P, mg/l	8.10
Total Alkalinity as CaCO3, mg/l	67
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	62
Sodium Adsorption Ratio	0.48

	mg/l	meq/l
Bicarbonate as HCO3	81	1.33
Carbonate as CO3	0	0.00
Chloride	4.3	0.12
Nitrate as N, mg/l	0.29	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	10	0.21
Calcium	16	0.82
Magnesium	5.0	0.41
Potassium	2.4	0.06
Sodium	8.8	0.38

Major Anions	1.68
Major Cations	1.67
Cation/Anion Difference	0.30 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.004	Zinc	0.03
Copper	0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.45
Iron	339
Manganese	6.05

Sample Site: 883-2145-H88-23
Lab No: 887183
Date Sampled: 11/03/88 @ 1430
Date Received: 11/09/88

Lab pH, s.u.	7.12
Lab Conductivity, umhos/cm @ 25C	152
Total Dissolved Solids (180), mg/l	108
Total Dissolved Solids (calc), mg/l	87
Boron, mg/l	0.04
Fluoride, mg/l	0.07
Ammonia Nitrogen as N, mg/l	0.24
Total Kjeldahl Nitrogen, mg/l	3.4
Ortho Phosphorus as P, mg/l	0.007
Total Organic Phosphorus as P, mg/l	1.39
Total Phosphorus as P, mg/l	8.91
Total Alkalinity as CaCO3, mg/l	67
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	62
Sodium Adsorption Ratio	0.48

	mg/l	meq/l
Bicarbonate as HCO3	81	1.33
Carbonate as CO3	0	0.00
Chloride	5.0	0.14
Nitrate as N, mg/l	0.31	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	9.5	0.20
Calcium	17	0.86
Magnesium	4.5	0.37
Potassium	2.4	0.06
Sodium	8.7	0.38

Major Anions	1.69
Major Cations	1.67
Cation/Anion Difference	0.60 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.004	Zinc	0.03
Copper	0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.40
Iron	331
Manganese	5.90

Sample Site: 883-2145-H8823-2-15-89MW
Lab No: 897629 (Duplicate Analysis)
Date Sampled: 02/21/89 @ 1540
Date Received: 02/24/89

Lab pH, s.u.	7.03
Lab Conductivity, umhos/cm @ 25C	101
Total Dissolved Solids (180), mg/l	78
Total Dissolved Solids (calc), mg/l	60
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	1.5
Ortho Phosphorus as P, mg/l	0.004
Total Organic Phosphorus as P, mg/l	0.334
Total Phosphorus as P, mg/l	2.06
Total Alkalinity as CaCO3, mg/l	56
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	53
Sodium Adsorption Ratio	0.21

	mg/l	meq/l
Bicarbonate as HCO3	68	1.12
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.28	0.02
Nitrite as N, mg/l	0.01	<0.01
Sulfate	3.1	0.06
Calcium	13.9	0.70
Magnesium	4.3	0.35
Potassium	1.1	0.03
Sodium	3.4	0.15

Major Anions	1.22
Major Cations	1.23
Cation/Anion Difference	0.41 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.002	Mercury	<0.001
Copper	<0.01	Selenium	0.010
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.76
Manganese	0.03

Sample Site: 883-2145-H8823-2-15-89MW
Lab No: 897627
Date Sampled: 02/21/89 @ 1540
Date Received: 02/24/89

Lab pH, s.u.	7.00
Lab Conductivity, umhos/cm @ 25C	118
Total Dissolved Solids (180), mg/l	88
Total Dissolved Solids (calc), mg/l	60
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	1.4
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.329
Total Phosphorus as P, mg/l	2.15
Total Alkalinity as CaCO3, mg/l	56
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	53
Sodium Adsorption Ratio	0.21

	mg/l	meq/l
Bicarbonate as HCO3	68	1.12
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.21	0.02
Nitrite as N, mg/l	0.01	<0.01
Sulfate	2.3	0.05
Calcium	14	0.72
Magnesium	4.0	0.33
Potassium	1.1	0.03
Sodium	3.4	0.15

Major Anions	1.22
Major Cations	1.23
Cation/Anion Difference	0.41 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.002	Mercury	<0.001
Copper	<0.01	Selenium	0.010
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.83
Manganese	0.03

Sample Site: 883-2145-H88-23-5-24-89MW
Lab No: 898104
Date Sampled: 05/24/89 @ 1407
Date Received: 05/26/89

Lab pH, s.u.	7.12
Lab Conductivity, umhos/cm @ 25C	128
Total Dissolved Solids (180), mg/l	82
Total Dissolved Solids (calc), mg/l	75
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.06
Total Kjeldahl Nitrogen, mg/l	4.9
Ortho Phosphorus as P, mg/l	0.019
Total Organic Phosphorus as P, mg/l	0.782
Total Phosphorus as P, mg/l	3.62
Total Alkalinity as CaCO3, mg/l	64
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	62
Sodium Adsorption Ratio	0.24

	mg/l	meq/l
Bicarbonate as HCO3	77	1.27
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	0.30	0.02
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	6.0	0.12
Calcium	20	0.99
Magnesium	2.9	0.24
Potassium	2.3	0.06
Sodium	4.3	0.19

Major Anions	1.45
Major Cations	1.48
Cation/Anion Difference	1.02 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.05
Arsenic	<0.005	Manganese	0.08
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.13
Iron	128
Manganese	2.41

Sample Site: 883-2145-H8823-7-23-89-4th-MW
Lab No: 898532 (Duplicate Analysis)
Date Sampled: 07/23/89 @ 1806
Date Received: 07/26/89

Lab pH, s.u.	6.78
Lab Conductivity, umhos/cm @ 25C	117
Total Dissolved Solids (180), mg/l	96
Total Dissolved Solids (calc), mg/l	67
Boron, mg/l	<0.01
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	3.2
Ortho Phosphorus as P, mg/l	0.025
Total Organic Phosphorus as P, mg/l	0.487
Total Phosphorus as P, mg/l	3.43
Total Alkalinity as CaCO3, mg/l	56
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	54
Sodium Adsorption Ratio	0.23

	mg/l	meq/l
Bicarbonate as HCO3	68	1.11
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.14	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	7.2	0.15
Calcium	18	0.89
Magnesium	2.3	0.19
Potassium	1.9	0.05
Sodium	3.9	0.17

Major Anions	1.30
Major Cations	1.30
Cation/Anion Difference	0.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	0.06
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.13
Iron	101
Manganese	1.85

Sample Site: 883-2145-H8823-7-23-89-4th-MW
Lab No: 898530
Date Sampled: 07/23/89 @ 1806
Date Received: 07/26/89

Lab pH, s.u.	6.90
Lab Conductivity, umhos/cm @ 25C	110
Total Dissolved Solids (180), mg/l	96
Total Dissolved Solids (calc), mg/l	67
Boron, mg/l	<0.01
Fluoride, mg/l	0.07
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	4.7
Ortho Phosphorus as P, mg/l	0.026
Total Organic Phosphorus as P, mg/l	0.587
Total Phosphorus as P, mg/l	3.40
Total Alkalinity as CaCO3, mg/l	55
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	54
Sodium Adsorption Ratio	0.23

	mg/l	meq/l
Bicarbonate as HCO3	66	1.09
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.13	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	7.2	0.15
Calcium	19	0.97
Magnesium	1.2	0.10
Potassium	1.9	0.05
Sodium	3.9	0.17

Major Anions	1.28
Major Cations	1.29
Cation/Anion Difference	0.39 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	0.06
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.16
Iron	104
Manganese	1.93

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8824A-2-23-89-4

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAIL

Date 7-23-89 Time 20:42

Media WATER Station H8824A

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

TOTAL DEPTH: 69.25 / SAT. THICKNESS: 14.05

PURGE VOLUME: 6.89 / WATER LEVEL = 56.25

Sample Description CLEAR THEN MUDDY

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 2°C / D-O2 : 11.2

PH = 7.40 / μS = 193 FINAL TEST OF (4) PERFORMED

ALKALINITY : 7.3 ms CaCO3 - PERFORMED 24 HRS LATER - AS

I DO NOT HAVE THE ALKALINITY KIT OR FILTER UNIT

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC 1
250 ML	"	NITRIC 1
250 ML	"	FILTERED NITRIC 1

Sampler (signature) Date 7-23-89

Supervisor (signature) Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 8832145
Site Location PALMER ALASKA
Sample ID 8832145-H8824A-5-24-89MW
Sampling Location

Technical Procedure Reference(s) G. DAVIS MEMO - 3RD QUARTER SAMPLING + APPENDIX 3
Type of Sampler BAIL
Date 5-24-89
Time 16:05 FIRST TEST / 16:30 FINAL TEST
Media WATER
Station H88 24A
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
WATER LEVEL: 57.52 - TOTAL DEPTH: 74.11 SATURATED THICKNESS 16.59 AMOUNT TO PURGE: 6.87 - PRIOR TO PARAMETER & SAMPLING

Sample Description MUDDY · GRAY

Field Measurements on Sample (pH, conductivity, etc.) TEMP 2.5°C / D-O2: 12.25
PH: 7.30 / EC: 225 ALKALINITY = 57.0 mg/L
THESE ARE FINAL FIELD PARAMETERS OUT OF (4) 1 FOR EACH SAMPLE COLLECTED - (4 SAMPLES COLLECTED)

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC 1
1 250 ML	"	NITRIC 1
1 250 ML	" FILTERED	NITRIC 1

(SULPHURIC ACID ADDED ≈ 2 HRS AFTER SAMPLE (1 LITRE) WAS COLLECTED)
(1 250 ML SAMPLE FILTERED 24 HRS AFTER COLLECTED)

Sampler (signature) Matthew F
Date 5-24-89
Supervisor (signature)
Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 8832145

Site Location ALASKA
Sample ID 8832145-H88 24A-2-15-89 M

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 2-21-89
Time 12:12 - 13:07

Media WATER
Station H88 24A

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH of HOLE: 69.75 - SATURATED THICKNESS: 14.05

WATER LEVEL = 55.70

Sample Description TURBID

Field Measurements on Sample (pH, conductivity, etc.)

pH: 7.68 μS: 254 TEMP: 2.5 °C D-O_2: 13.4

ALKALINITY: 70 mg/L

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC	NONE
500 ML	"	SULPHURIC / 1
250 ML	"	NITRIC / 1
250 ML	"	NITRIC / 1

Sample SEAL NO. 3509 - 3510

Sampler (signature)
Date 2-21-89

Supervisor (signature)
Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 883-2145
Site Location " "
Sample ID 883-2145-488-24A
Sampling Location WISHBONE HILLS WELL No # 24A

Technical Procedure Reference(s)
Type of Sampler BAILER
Date 11-3-88
Time 5:15
Media WATER
Station # 24A
Sample Type: [✓ grab] time composite space composite
Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
DEPTH of WELL - 70.86 DEPTH TO WATER LEVEL 43.26
SATURATED THICKNESS - 27.40 - WATER PURGED 15.5 GAL

Sample Description TURBID MUDDY GRAY SILTY

Field Measurements on Sample (pH, conductivity, etc.) INSTRUMENTS NOT WORKING

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	" "	SULPHURIC 1 VIAL
1 250 ML	" FILTERED	NITRIC 1 VIAL
1 250 ML	" UNFILTERED	" "

Sampler (signature)
Date 11-3-88
Supervisor (signature)
Date

Golder Associates

Sample Site: 883-2145-H88-24A
Lab No: 887184
Date Sampled: 11/03/88 @ 1715
Date Received: 11/09/88

Lab pH, s.u.	7.59
Lab Conductivity, umhos/cm @ 25C	269
Total Dissolved Solids (180), mg/l	168
Total Dissolved Solids (calc), mg/l	148
Boron, mg/l	0.07
Fluoride, mg/l	0.21
Ammonia Nitrogen as N, mg/l	0.06
Total Kjeldahl Nitrogen, mg/l	0.8
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.458
Total Phosphorus as P, mg/l	5.74
Total Alkalinity as CaCO3, mg/l	80
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	48
Sodium Adsorption Ratio	2.47

	mg/l	meq/l
Bicarbonate as HCO3	98	1.60
Carbonate as CO3	0	0.00
Chloride	33	0.94
Nitrate as N, mg/l	0.22	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	7.6	0.16
Calcium	12	0.58
Magnesium	4.7	0.39
Potassium	3.3	0.08
Sodium	40	1.72

Major Anions	2.72
Major Cations	2.77
Cation/Anion Difference	0.91 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.003	Zinc	0.03
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.35
Iron	267
Manganese	5.90

Sample Site: 883-2145-H8824A-2-15-89MW
Lab No: 897628
Date Sampled: 02/21/89 @ 1307
Date Received: 02/24/89

Lab pH, s.u.	7.61
Lab Conductivity, umhos/cm @ 25C	210
Total Dissolved Solids (180), mg/l	148
Total Dissolved Solids (calc), mg/l	125
Boron, mg/l	0.03
Fluoride, mg/l	0.15
Ammonia Nitrogen as N, mg/l	0.01
Total Kjeldahl Nitrogen, mg/l	1.5
Ortho Phosphorus as P, mg/l	0.019
Total Organic Phosphorus as P, mg/l	0.724
Total Phosphorus as P, mg/l	5.18
Total Alkalinity as CaCO3, mg/l	81
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	70
Sodium Adsorption Ratio	1.15

	mg/l	meq/l
Bicarbonate as HCO3	99	1.62
Carbonate as CO3	0	0.00
Chloride	22	0.61
Nitrate as N, mg/l	0.13	0.01
Nitrite as N, mg/l	0.01	<0.01
Sulfate	7.0	0.15
Calcium	18	0.91
Magnesium	6.0	0.49
Potassium	2.1	0.05
Sodium	22	0.96

Major Anions	2.39
Major Cations	2.41
Cation/Anion Difference	0.42 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	0.46
Barium	<0.5	Lead	<0.02
Cadmium	0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.02
Iron	17.1
Manganese	0.83

Sample Site: 883-2145-H88-24A-5-24-89MW
Lab No: 898105
Date Sampled: 05/24/89 @ 1605
Date Received: 05/26/89

Lab pH, s.u.	7.66
Lab Conductivity, umhos/cm @ 25C	167
Total Dissolved Solids (180), mg/l	94
Total Dissolved Solids (calc), mg/l	93
Boron, mg/l	<0.01
Fluoride, mg/l	0.13
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	2.7
Ortho Phosphorus as P, mg/l	0.074
Total Organic Phosphorus as P, mg/l	0.695
Total Phosphorus as P, mg/l	3.00
Total Alkalinity as CaCO3, mg/l	85
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	66
Sodium Adsorption Ratio	0.62

	mg/l	meq/l
Bicarbonate as HCO3	103	1.69
Carbonate as CO3	0	0.00
Chloride	3.5	0.10
Nitrate as N, mg/l	0.07	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	2.5	0.05
Calcium	18	0.89
Magnesium	5.1	0.42
Potassium	2.1	0.05
Sodium	11	0.50

Major Anions	1.85
Major Cations	1.86
Cation/Anion Difference	0.27 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	0.23
Arsenic	<0.005	Manganese	0.11
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.14
Iron	117
Manganese	2.87

Sample Site: 883-2145-H8824A-7-23-89-4th-MW
Lab No: 898529
Date Sampled: 07/23/89 @ 2015
Date Received: 07/26/89

Lab pH, s.u.	7.46
Lab Conductivity, umhos/cm @ 25C	175
Total Dissolved Solids (180), mg/l	116
Total Dissolved Solids (calc), mg/l	96
Boron, mg/l	<0.01
Fluoride, mg/l	0.14
Ammonia Nitrogen as N, mg/l	0.07
Total Kjeldahl Nitrogen, mg/l	4.1
Ortho Phosphorus as P, mg/l	0.035
Total Organic Phosphorus as P, mg/l	0.167
Total Phosphorus as P, mg/l	1.82
Total Alkalinity as CaCO3, mg/l	82
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	69
Sodium Adsorption Ratio	0.52

	mg/l	meq/l
Bicarbonate as HCO3	100	1.64
Carbonate as CO3	0	0.00
Chloride	3.2	0.09
Nitrate as N, mg/l	0.38	0.03
Nitrite as N, mg/l	0.02	<0.01
Sulfate	4.3	0.09
Calcium	25	1.24
Magnesium	1.8	0.15
Potassium	2.5	0.06
Sodium	9.9	0.43

Major Anions	1.85
Major Cations	1.88
Cation/Anion Difference	0.80 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	0.16
Iron	117
Manganese	2.82

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER AK

Sample ID 8832145-H8825-7-23-89-4TH

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAIL

Date 7-23-89 / 7-25-89

Time 17:50 LAST Sample COLLECTED

Media WATER

Station H8825

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
TOTAL DEPTH: 44.45 · SAT. THICKNESS: 8.35
PURGE VOLUME: 4.08 - WATER LEVEL: 39.08

Sample Description TURBID MUDDY BROWN

Field Measurements on Sample (pH, conductivity, etc.) TEMP= 4°C / D-O2: 10.8
PH: 8.36 - EC= 223 - ALKALINITY: ~~139~~12
7-23-89 - H8825 WENT DRY DURING SAMPLING - I RESUMED
SAMPLING 7-25-89

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	PLASTIC JUG	NONE
1 LITRE	"	SULFURIC 1
1 250ML	"	NITRIC 1
1 250ML	"	FILTERED NITRIC 1

Sampler (signature) Date 7-23-89

Supervisor (signature) Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 8832145
Site Location ALASKA
Sample ID 8832145-H8825-5-24-89 MV
Sampling Location

Technical Procedure Reference(s) MEMO G.D. DATED 3RD QUARTER SAMPLING
Type of Sampler BAILER
Date 5-24-89
Time 11:48 FIRST TEST 12:13 FINAL TEST
Media WATER
Station H88 25
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

WATER LEVEL = 38.40 TOTAL DEPTH: 49.36
SATURATED THICKNESS: 10.69 AMOUNT TO PURGE 6.59 (TOTAL PURGE PRIOR TO TESTS (PARAMETER)

Sample Description MUDDY GRAY COLOR

Field Measurements on Sample (pH, conductivity, etc.) PH = 7.72 - μs = 281
TEMP: 2.5°C / D-O_2 = 12.00 - ALKALINITY = 81.0 mg/l
THESE PARAMETERS ARE THE FINAL MEASUREMENTS READINGS OUT OF 4 -
ONE MEASURE SET OF FIELD PARAMETERS FOR EACH SAMPLE - (4 SAMPLES TAKEN)

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	"	Y SULPHURIC / 1
1 250 ML	"	NITRIC 1
1 250 ML	" FILTERED	NITRIC 1

- (1 250ML SAMPLE FILTERED 24 HRS AFTER COLLECTED)
· (SULPHURIC ACID ADDED TO 1 LITRE SAMPLE ≅ 6HRS AFTER COLLECTED)

Sampler (signature) Matthew
Date 5-24-89
Supervisor (signature)
Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H8825-2-15-89-1

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAIL

Date 2-23-89

Time 11:02 - 11:52 - 12:02

Media WATER

Station H8825

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH OF HOLE: 44.45 SATURATED THICKNESS: 4.91

WATER LEVEL: 36.10 - AMOUNT PURGED = 5 GALLONS

Sample Description TURBID

Field Measurements on Sample (pH, conductivity, etc.) @ 11:18:00 PH: 7.83 μS: 261

TEMP: 1.5°C D-O_2 = 11.6 (AFTER 3 GALLON PURGE) @ 11:34

AFTER 5 GALLON PURGE = PH = 8.46 - μS = 741 - TEMP: 1°C

D-O_2: 12.8

Aliquot Amount	Container		Preservation/Amount
1/2 GAL	PLASTIC		NONE
500 ML	"		SULPHURIC - 1
250 ML	"	FILTERED	NITRIC - 1
250 ML	"		NITRIC - 1

SEAL NO. # 3511 + # 3512

Sampler (signature) Matthew F.

Date 2-23-89

Supervisor (signature)

Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 883-2145

Site Location ALASKA

Sample ID 8832145-48825-2-15-89-M

Sampling Location

Technical Procedure Reference(s)

Type of Sampler Bailer

Date 2-19-89

Time 14:15 - 14:43

Media WATER

Station 48825

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH of WELL 44.46 - SATURATED THICKNESS: 9.26

W/L = 35.20

Sample Description clear - Becoming Turbid

Field Measurements on Sample (pH, conductivity, etc.)

PH = 7.51 μS: 268 TEMP 6°C - D.O₂: 6.6

Aliquot Amount	Container		Preservation/Amount
1/2 GAL	Plastic		NONE
500 ML	"		Sulphuric - 1
250 ML	"	Filtered	Nitric - 1
250 ML	"		" "

Sampler (signature)

Date 2-19-89

Supervisor (signature)

Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site H88-25
Project No. 8332145
Site Location WISHBONE HILLS
Sample ID 8332145-H88-25
Sampling Location

Technical Procedure Reference(s)
Type of Sampler BAILER
Date 11-3-88
Time 12:33
Media WATER
Station H88-25
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
WATER LEVEL - 41.13 / TOTAL DEPTH - 45.24 SATURATED THICKNESS 4.11
WATER PURGED 2 GALS WELL WENT DRY

Sample Description TURBID - DARK MUDDY GRAYISH BROWN

Field Measurements on Sample (pH, conductivity, etc.) INSTRUMENTS NOT WORKING

Aliquot Amount	Container	Preservation/Amount
HALF GALLON	PLASTIC JUG	NONE
ONE LITRE	"	1 VIAL SULPHURIC
250 MLS	" UNFILTERED	1 VIAL NITRIC
250 MLS	" FILTERED	1 VIAL NITRIC

Sampler (signature)
Date 11-3-88
Supervisor (signature)
Date

Golder Associates

Sample Site: 883-2145-H88-25
Lab No: 887185
Date Sampled: 11/03/88 @ 1233
Date Received: 11/09/88

Lab pH, s.u.	8.09
Lab Conductivity, umhos/cm @ 25C	1210
Total Dissolved Solids (180), mg/l	716
Total Dissolved Solids (calc), mg/l	648
Boron, mg/l	0.18
Fluoride, mg/l	0.43
Ammonia Nitrogen as N, mg/l	0.06
Total Kjeldahl Nitrogen, mg/l	2.4
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.826
Total Phosphorus as P, mg/l	5.46
Total Alkalinity as CaCO3, mg/l	117
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	191
Sodium Adsorption Ratio	5.38

	mg/l	meq/l
Bicarbonate as HCO3	143	2.34
Carbonate as CO3	0	0.00
Chloride	284	8.00
Nitrate as N, mg/l	<0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	45	0.94
Calcium	57	2.87
Magnesium	12	0.96
Potassium	8.8	0.23
Sodium	171	7.44

Major Anions	11.28
Major Cations	11.50
Cation/Anion Difference	0.97 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.004	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.50
Iron	379
Manganese	7.00

Sample Site: 883-2145-H8825-2-15-89MW
Lab No: 897614
Date Sampled: 02/19/89 @ 1415
Date Received: 02/20/89

Lab pH, s.u.	6.62
Lab Conductivity, umhos/cm @ 25C	206
Total Dissolved Solids (180), mg/l	132
Total Dissolved Solids (calc), mg/l	130
Boron, mg/l	0.03
Fluoride, mg/l	0.19
Ammonia Nitrogen as N, mg/l	0.08
Total Kjeldahl Nitrogen, mg/l	1.4
Ortho Phosphorus as P, mg/l	0.034
Total Organic Phosphorus as P, mg/l	0.575
Total Phosphorus as P, mg/l	1.12
Total Alkalinity as CaCO3, mg/l	90
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	75
Sodium Adsorption Ratio	1.05

	mg/l	meq/l
Bicarbonate as HCO3	110	1.80
Carbonate as CO3	0	0.00
Chloride	21	0.58
Nitrate as N, mg/l	0.37	0.03
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	6.0	0.12
Calcium	18	0.92
Magnesium	6.9	0.57
Potassium	3.6	0.09
Sodium	21	0.91

Major Anions	2.53
Major Cations	2.49
Cation/Anion Difference	0.80 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.004	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.03

Trace Metals (Total Concentrations), mg/l

Chromium	0.02
Iron	13.5
Manganese	0.23

Sample Site: 883-2145-H8825-2-15-89MW
Lab No: 897632
Date Sampled: 02/24/89 @ 0845
Date Received: 02/27/89

Lab pH, s.u.	7.89
Lab Conductivity, umhos/cm @ 25C	462
Total Dissolved Solids (180), mg/l	348
Total Dissolved Solids (calc), mg/l	298
Boron, mg/l	0.17
Fluoride, mg/l	0.66
Ammonia Nitrogen as N, mg/l	0.01
Total Kjeldahl Nitrogen, mg/l	2.8
Ortho Phosphorus as P, mg/l	0.007
Total Organic Phosphorus as P, mg/l	0.202
Total Phosphorus as P, mg/l	2.870
Total Alkalinity as CaCO3, mg/l	103
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	76
Sodium Adsorption Ratio	4.37

	mg/l	meq/l
Bicarbonate as HCO3	126	2.06
Carbonate as CO3	0	0.00
Chloride	107	3.02
Nitrate as N, mg/l	1.70	0.12
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	9.9	0.21
Calcium	21	1.04
Magnesium	5.8	0.48
Potassium	4.7	0.12
Sodium	88	3.81

Major Anions	5.41
Major Cations	5.45
Cation/Anion Difference	0.37 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	0.06
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.006	Mercury	<0.001
Copper	<0.01	Selenium	0.007
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.21
Iron	160
Manganese	2.69

Sample Site: 883-2145-H8825-2-15-89MW
Lab No: 897664
Date Sampled: 03/01/89 @ 1412
Date Received: 03/03/89

Lab pH, s.u.	8.03
Lab Conductivity, umhos/cm @ 25C	395
Total Dissolved Solids (180), mg/l	278
Total Dissolved Solids (calc), mg/l	217
Boron, mg/l	0.22
Fluoride, mg/l	0.63
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	0.024
Total Organic Phosphorus as P, mg/l	0.272
Total Phosphorus as P, mg/l	0.348
Total Alkalinity as CaCO3, mg/l	99
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	66
Sodium Adsorption Ratio	3.66

	mg/l	meq/l
Bicarbonate as HCO3	120	1.97
Carbonate as CO3	0	0.00
Chloride	59	2.30
Nitrate as N, mg/l	0.15	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	3.1	0.06
Calcium	20	1.01
Magnesium	3.8	0.31
Potassium	4.0	0.10
Sodium	68	2.97

Major Anions	4.34
Major Cations	4.39
Cation/Anion Difference	0.57 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.3	Iron	0.18
Arsenic	<0.005	Manganese	0.04
Barium	<0.5	Lead	<0.02
Cadmium	0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.03
Iron	17.7
Manganese	0.31

Sample Site: 883-2145-H88-25-5-24-89MW
Lab No: 898106
Date Sampled: 05/24/89 @ 1148
Date Received: 05/26/89

Lab pH, s.u.	7.87
Lab Conductivity, umhos/cm @ 25C	226
Total Dissolved Solids (180), mg/l	140
Total Dissolved Solids (calc), mg/l	133
Boron, mg/l	<0.01
Fluoride, mg/l	0.18
Ammonia Nitrogen as N, mg/l	0.06
Total Kjeldahl Nitrogen, mg/l	7.4
Ortho Phosphorus as P, mg/l	0.051
Total Organic Phosphorus as P, mg/l	2.35
Total Phosphorus as P, mg/l	8.27
Total Alkalinity as CaCO3, mg/l	102
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	82
Sodium Adsorption Ratio	0.93

	mg/l	meq/l
Bicarbonate as HCO3	124	2.03
Carbonate as CO3	0	0.00
Chloride	13	0.38
Nitrate as N, mg/l	0.12	0.01
Nitrite as N, mg/l	0.01	<0.01
Sulfate	6.6	0.14
Calcium	23	1.16
Magnesium	5.8	0.48
Potassium	3.5	0.09
Sodium	19	0.84

Major Anions	2.56
Major Cations	2.57
Cation/Anion Difference	0.19 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	1.3	Iron	1.01
Arsenic	<0.005	Manganese	0.07
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.03

Trace Metals (Total Concentrations), mg/l

Chromium	0.54
Iron	385
Manganese	6.40

Inter-Mountain Laboratories, Inc.

Sample Site: 883-2145-H8825-7-23-89-4th-MW
Lab No: 898531
Date Sampled: 07/23/89 @ 2035
Date Received: 07/26/89

Lab pH, s.u.	7.52
Lab Conductivity, umhos/cm @ 25C	268
Total Dissolved Solids (180), mg/l	190
Total Dissolved Solids (calc), mg/l	161
Boron, mg/l	<0.01
Fluoride, mg/l	0.38
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	2.1
Ortho Phosphorus as P, mg/l	0.019
Total Organic Phosphorus as P, mg/l	0.559
Total Phosphorus as P, mg/l	2.71
Total Alkalinity as CaCO3, mg/l	121
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	70
Sodium Adsorption Ratio	1.88

	mg/l	meq/l
Bicarbonate as HCO3	148	2.42
Carbonate as CO3	0	0.00
Chloride	17	0.47
Nitrate as N, mg/l	0.14	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	6.6	0.14
Calcium	22	1.12
Magnesium	3.4	0.28
Potassium	3.4	0.09
Sodium	36	1.57

Major Anions	3.04
Major Cations	3.06
Cation/Anion Difference	0.33 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Manganese	0.03
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.04

Trace Metals (Total Concentrations), mg/l

Chromium	0.37
Iron	266
Manganese	4.81

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-HB827-2-11-89-4TH

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAIL

Date 2-11-89

Time 10:06

Media WATER

Station HB827

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
TOTAL DEPTH: 52.95 / SOT. THICKNESS: 0.13 /
PURGE VOLUME: 0.06 · WATER LEVEL: 53.56

Sample Description TURBID MILKY BROWN · MUDDY color
clear initially

Field Measurements on Sample (pH, conductivity, etc.) PH = 7.13 / ks: 132
D-O2 = 12.4 / TEMP: 4°C FINAL MEASUREMENTS
of (4) ALKALINITY = 48.5 as $CaCO_3$

Aliquot Amount	Container	Preservation/Amount
1/2 GALLON	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC
1 250 ML	"	NITRIC
1 250 ML	"	FILTERED NITRIC

Sampler (signature)

Date 2-11-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 883 2145

Site Location PALMER ALASKA

Sample ID 8832145-H8827-5-31-89M.

Sampling Location

Technical Procedure Reference(s) G.D. MEMO - 3RD QUARTER SAMPLING

Type of Sampler BAILER

Date 5-31-89

Time FINAL TEST of (4) 11:39

Media WATER

Station H88 27

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
TOTAL DEPTH = 57.29 - WATER LEVEL = 43.13 - SATURATED THICKNESS = 9.66 AMOUNT PURGED = 1 GAL

Sample Description GRAY MUDDY BROWN

Field Measurements on Sample (pH, conductivity, etc.) PH = 6.83 / µS = 111
TEMP = 2.5°C / D-O2 = 12.4 - THESE ARE FINAL MEASUREMENTS of (4) - ALKALINITY - 6-1-89 = 45.0 mg/l
ALKALINITY TESTED 48 HRS AFTER SAMPLING -

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC JUG	NONE
1 LITRE	"	SULPHURIC / 1
1 250 ML	"	NITRIC / 1
1 250 ML	" FILTERED	NITRIC / 1

Sampler (signature) Date 5-31-89

Supervisor (signature) Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 8832145
Site Location ALASKA Sample ID 8832145-H8827-2-15-89-MW
Sampling Location

Technical Procedure Reference(s)
Type of Sampler BAILER
Date 2-21-89 Time 10:28
Media WATER Station H8827
Sample Type: [✓ grab] time composite space composite
Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
1/2 GALLON

Sample Description CLEAR BECOMING TURBID

Field Measurements on Sample (pH, conductivity, etc.)
0-O$_2$ = 13.2 TEMP = 2°C
THE 0-O$_2$ METER WAS NOT WORKING WHEN I SAMPLED
#8827 ON 2-19-89 - THIS IS A RE-TEST. (0-O$_2$)

Aliquot Amount Container Preservation/Amount

Sampler (signature) Matthew Date 2-21-89
Supervisor (signature) Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H88-27-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 2-18-89 Time 13:00 / 15:49

Media WATER Station H8827

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
DEPTH of WELL 52.95 - WATER LEVEL = 52.82
SATURATED THICKNESS = .15

Sample Description VERY CLEAR - TO TURBID - BACK TO NOT QUITE SO CLEAR - 2 Samples collected AT 13:00
2 MORE Samples collected 15:49

Field Measurements on Sample (pH, conductivity, etc.) PH = 7:02 uS = 156 : @ 12:55 / PH = 6.96 uS = 162 : @ 16:00

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC	NONE
500 ML	"	SULPHURIC 1
250 ML	"	NITRIC 1
250 ML	"	" "

Sampler (signature) Date 2-18-89

Supervisor (signature) Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883 2145

Site Location ALASKA Sample ID 883-2145-H88-27

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 11-7-88 Time 2:35

Media WATER Station #27

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

DEPTH of Hole 53.21 DEPTH To WATER 49.53

30 GALLONS PURGED (BAILED) - DARK MUDDY GRAY

Sample Description DARK MUDDY GRAY

Field Measurements on Sample (pH, conductivity, etc.) ~~TEMP~~ INSTRUMENTS NOT WORKING

Aliquot Amount	Container	Preservation/Amount
1/2 Gallon	Plastic Jug	NONE
1 LITRE	"	SULPHURIC 1 VIAL
1 250 ML	" FILTERED	NITRIC 1 VIAL
1 250 ML	" UNFILTERED	

Sampler (signature) Matthew L Wendel Date 11-7-88

Supervisor (signature) Date

Golder Associates

Sample Site: 883-2145-H88-27
Lab No: 887196
Date Sampled: 11/07/88 @ 1444
Date Received: 11/11/88

Lab pH, s.u.	7.17
Lab Conductivity, umhos/cm @ 25C	182
Total Dissolved Solids (180), mg/l	116
Total Dissolved Solids (calc), mg/l	95
Boron, mg/l	0.04
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	0.04
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	0.036
Total Phosphorus as P, mg/l	0.482
Total Alkalinity as CaCO3, mg/l	66
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	68
Sodium Adsorption Ratio	0.57

	mg/l	meq/l
Bicarbonate as HCO3	81	1.32
Carbonate as CO3	0	0.00
Chloride	15	0.43
Nitrate as N, mg/l	0.39	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	3.7	0.08
Calcium	19	0.96
Magnesium	4.9	0.40
Potassium	2.0	0.05
Sodium	11	0.47

Major Anions	1.86
Major Cations	1.88
Cation/Anion Difference	0.53 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.004	Zinc	0.03
Copper	0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.06
Iron	18.3
Manganese	0.37

Sample Site: 883-2145-H8827-2-15-89MW
Lab No: 897615
Date Sampled: 02/18/89 @ 1600
Date Received: 02/22/89

Lab pH, s.u.	7.17
Lab Conductivity, umhos/cm @ 25C	115
Total Dissolved Solids (180), mg/l	72
Total Dissolved Solids (calc), mg/l	71
Boron, mg/l	<0.01
Fluoride, mg/l	0.10
Ammonia Nitrogen as N, mg/l	0.24
Total Kjeldahl Nitrogen, mg/l	0.9
Ortho Phosphorus as P, mg/l	0.021
Total Organic Phosphorus as P, mg/l	0.504
Total Phosphorus as P, mg/l	1.30
Total Alkalinity as CaCO3, mg/l	60
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	59
Sodium Adsorption Ratio	0.27

	mg/l	meq/l
Bicarbonate as HCO3	73	1.19
Carbonate as CO3	0	0.00
Chloride	3.5	0.10
Nitrate as N, mg/l	2.55	0.18
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	5.6	0.12
Calcium	16	0.79
Magnesium	4.6	0.38
Potassium	1.6	0.04
Sodium	4.8	0.21

Major Anions	1.41
Major Cations	1.42
Cation/Anion Difference	0.35 % *

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.8	Iron	0.95
Arsenic	<0.005	Manganese	0.04
Barium	<0.5	Lead	0.08
Cadmium	0.008	Mercury	<0.001
Copper	0.03	Selenium	0.010
Chromium	<0.02	Zinc	0.10

Trace Metals (Total Concentrations), mg/l

Chromium	0.05
Iron	24.0
Manganese	0.43

* Nitrates undetectable in raw sample; not included as a major anion.

Sample Site: 883-2145-H88-27-5-31-89MW
Lab No: 898144
Date Sampled: 05/31/89 @ 1115
Date Received: 06/05/89

Lab pH, s.u.	7.03
Lab Conductivity, umhos/cm @ 25C	104
Total Dissolved Solids (180), mg/l	76
Total Dissolved Solids (calc), mg/l	64
Boron, mg/l	0.14
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	0.01
Total Kjeldahl Nitrogen, mg/l	1.1
Ortho Phosphorus as P, mg/l	0.021
Total Organic Phosphorus as P, mg/l	0.289
Total Phosphorus as P, mg/l	2.04
Total Alkalinity as CaCO3, mg/l	56
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	53
Sodium Adsorption Ratio	0.21

	mg/l	meq/l
Bicarbonate as HCO3	68	1.12
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.42	0.03
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	4.7	0.10
Calcium	18	0.89
Magnesium	2.1	0.17
Potassium	1.3	0.03
Sodium	3.5	0.15

Major Anions	1.27
Major Cations	1.24
Cation/Anion Difference	1.20 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	0.07
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium	0.23
Iron	181
Manganese	3.20

Sample Site: 883-2145-H8827-7-11-89-4th-MW
Lab No: 898502
Date Sampled: 07/18/89 @ 0925
Date Received: 07/24/89

Lab pH, s.u.	7.14
Lab Conductivity, umhos/cm @ 25C	128
Total Dissolved Solids (180), mg/l	112
Total Dissolved Solids (calc), mg/l	71
Boron, mg/l	<0.01
Fluoride, mg/l	0.11
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	1.5
Ortho Phosphorus as P, mg/l	0.015
Total Organic Phosphorus as P, mg/l	1.07
Total Phosphorus as P, mg/l	4.58
Total Alkalinity as CaCO3, mg/l	65
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	62
Sodium Adsorption Ratio	0.23

	mg/l	meq/l
Bicarbonate as HCO3	79	1.29
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.94	0.07
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	3.1	0.06
Calcium	18	0.91
Magnesium	4.0	0.33
Potassium	1.6	0.04
Sodium	4.1	0.18

Major Anions	1.45
Major Cations	1.46
Cation/Anion Difference	0.34 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.10
Arsenic	<0.005	Manganese	0.02
Barium	<0.5	Lead	<0.02
Cadmium	0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	0.10
Iron	65.9
Manganese	1.50

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location PALMER ALASKA

Sample ID 8832145-H8828-7-25-89-4

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAIL

Date 7-25-89

Time 18:42 final Sample Taken

Media WATER

Station H8828

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

TOTAL DEPTH : 58.27 / SAT. THICKNESS = 5.09

WATER LEVEL : 53.18 / PURGE VOLUME = 2.48

Sample Description TURBID MUDDY BROWN.

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 2°C / D-O_2 = 11.0

PH: 7.42 / μs = 161 - final Test of (4)

ALKALINITY = 51.3 as $CaCO_3$

Aliquot Amount	Container	Preservation/Amount
1/2 Gal	Plastic Jug	NONE
1 Litre	"	Sulphuric - 1
250 ml	"	Nitric - 1
250 ml	" Filtered	Nitric - 1

Sampler (signature) Matthew F. Mc...

Date 7-25-89

Supervisor (signature)

Date

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE Hills ALASKA

Project No. 8832145

Site Location

Sample ID 8832145-H8828-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 2-18-89

Time 14:34

Media WATER

Station H8828

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

WATER LEVEL = 53.90 - SATURATED THICKNESS: 5.07 - DEPTH of WELL = 58.97

Sample Description STARTED OUT CLEAR - FIRST 2 GALLONS - BECOMING CLOUDY

Field Measurements on Sample (pH, conductivity, etc.)

PH = 7.28 - µS = 163 - D-O_2 = METER - NOT WORKING D.I. WATER JUG POPPED OPEN AND SPLASHED ON D-O_2 METER - OR IT SIMPLY NEEDS A NEW MEMBRANE

Aliquot Amount	Container	Preservation/Amount
1/2 GAL	PLASTIC	NONE
500 ML	"	SULPHURIC - 1
250 ML	"	NITRIC - 1
250 ML	"	" - "

Sampler (signature) Matthew F. Wendel Date 2-18-89

Supervisor (signature) Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832145

Site Location ALASKA

Sample ID 8832145-H8828-2-15-89-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 2-21-89 Time 11:05

Media WATER Station H8828

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

1/2 GALLON

Sample Description CLEAR BECOMING TURBID

Field Measurements on Sample (pH, conductivity, etc.)

D-O_2 = 12.2 TEMP = 2°C

THE D-O_2 METER WAS NOT WORKING WHEN I SAMPLED H8828 ON 2-19-89. THIS IS A RE-TEST. (D-O_2)

Aliquot Amount Container Preservation/Amount

Sampler (signature) Matthew F [illegible] Date 2-21-89

Supervisor (signature) Date

Golder Associates Inc.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 883-2145

Site Location WISHBONE HILLS

Sample ID 883-2145-H88-28

Sampling Location

Technical Procedure Reference(s)

Type of Sampler BAILER

Date 11-7-88

Time 11:00

Media WATER

Station WELL NO. #28

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

WELL DEPTH 60.36 / WATER LEVEL 53.53

SATURATED THICKNESS 6.86 / WATER PURGED 5 GALLONS

Sample Description MUDDY BROWN COLOR -

Field Measurements on Sample (pH, conductivity, etc.)

INSTRUMENTS NOT FUNCTIONING

Aliquot Amount	Container		Preservation/Amount	
1/2 GAL	PLASTIC JUG		NONE	
1 LITRE	"		SULPHURIC	1 VIAL
2 250 MLS	"	UNFILTERED	NITRIC	"
1 250 MLS	"	FILTERED	"	"

Sampler (signature) Matthew F

Date 11-7-88

Supervisor (signature)

Date

Golder Associates

Sample Site: 883-2145-H88-28
Lab No: 887197
Date Sampled: 11/07/88 @ 1058
Date Received: 11/11/88

Lab pH, s.u.	8.89
Lab Conductivity, umhos/cm @ 25C	236
Total Dissolved Solids (180), mg/l	182
Total Dissolved Solids (calc), mg/l	141
Boron, mg/l	0.03
Fluoride, mg/l	0.18
Ammonia Nitrogen as N, mg/l	0.07
Total Kjeldahl Nitrogen, mg/l	0.5
Ortho Phosphorus as P, mg/l	0.072
Total Organic Phosphorus as P, mg/l	0.704
Total Phosphorus as P, mg/l	2.99
Total Alkalinity as CaCO3, mg/l	129
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	119
Sodium Adsorption Ratio	0.33

	mg/l	meq/l
Bicarbonate as HCO3	126	2.07
Carbonate as CO3	15	0.50
Chloride	0.7	0.02
Nitrate as N, mg/l	0.58	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	6.4	0.13
Calcium	43	2.15
Magnesium	2.8	0.23
Potassium	2.9	0.07
Sodium	8.2	0.36

Major Anions	2.76
Major Cations	2.81
Cation/Anion Difference	0.90 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.003	Zinc	0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	0.20
Iron	131
Manganese	2.45

Sample Site: 883-2145-H8828-2-15-89MW
Lab No: 897613
Date Sampled: 02/18/89 @ 1434
Date Received: 02/22/89

Lab pH, s.u.	6.70
Lab Conductivity, umhos/cm @ 25C	140
Total Dissolved Solids (180), mg/l	108
Total Dissolved Solids (calc), mg/l	74
Boron, mg/l	<0.01
Fluoride, mg/l	0.12
Ammonia Nitrogen as N, mg/l	0.06
Total Kjeldahl Nitrogen, mg/l	2.3
Ortho Phosphorus as P, mg/l	0.031
Total Organic Phosphorus as P, mg/l	0.299
Total Phosphorus as P, mg/l	2.55
Total Alkalinity as CaCO3, mg/l	70
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	63
Sodium Adsorption Ratio	0.24

	mg/l	meq/l
Bicarbonate as HCO3	85	1.40
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	0.74	0.05
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	2.7	0.06
Calcium	18	0.88
Magnesium	4.5	0.37
Potassium	1.5	0.04
Sodium	4.4	0.19

Major Anions	1.55
Major Cations	1.48
Cation/Anion Difference	2.31 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.09
Arsenic	<0.005	Manganese	0.09
Barium	<0.5	Lead	<0.02
Cadmium	0.004	Mercury	<0.001
Copper	<0.01	Selenium	0.010
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	0.13
Iron	95.6
Manganese	1.47

Sample Site: 883-2145-H8828-7-26-89-4th-MW
Lab No: 890601
Date Sampled: 07/26/89 @ 1810
Date Received: 07/31/89

Lab pH, s.u.	7.29
Lab Conductivity, umhos/cm @ 25C	189
Total Dissolved Solids (180), mg/l	152
Total Dissolved Solids (calc), mg/l	103
Boron, mg/l	<0.01
Fluoride, mg/l	0.16
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	2.4
Ortho Phosphorus as P, mg/l	0.011
Total Organic Phosphorus as P, mg/l	0.311
Total Phosphorus as P, mg/l	1.62
Total Alkalinity as CaCO3, mg/l	96
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	89
Sodium Adsorption Ratio	0.24

	mg/l	meq/l
Bicarbonate as HCO3	117	1.92
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.64	0.05
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	3.1	0.06
Calcium	33	1.63
Magnesium	1.8	0.15
Potassium	2.2	0.06
Sodium	5.3	0.23

Major Anions	2.05
Major Cations	2.07
Cation/Anion Difference	0.49 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.06
Arsenic	<0.005	Manganese	0.03
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.03

Trace Metals (Total Concentrations), mg/l

Chromium	0.03
Iron	35.9
Manganese	0.52

Sample Site: 883-2145-H8830-7-28-89-4th-MW
Lab No: 898603
Date Sampled: 07/28/89 @ 1942
Date Received: 07/31/89

Lab pH, s.u.	8.17
Lab Conductivity, umhos/cm @ 25C	494
Total Dissolved Solids (180), mg/l	366
Total Dissolved Solids (calc), mg/l	321
Boron, mg/l	<0.01
Fluoride, mg/l	1.35
Ammonia Nitrogen as N, mg/l	0.22
Total Kjeldahl Nitrogen, mg/l	2.1
Ortho Phosphorus as P, mg/l	0.040
Total Organic Phosphorus as P, mg/l	0.067
Total Phosphorus as P, mg/l	0.190
Total Alkalinity as CaCO3, mg/l	291
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	34
Sodium Adsorption Ratio	9.19

	mg/l	meq/l
Bicarbonate as HCO3	354	5.81
Carbonate as CO3	0	0.00
Chloride	2.5	0.07
Nitrate as N, mg/l	0.05	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	7.2	0.15
Calcium	10	0.52
Magnesium	1.9	0.16
Potassium	2.5	0.06
Sodium	123	5.36

Major Anions	6.03
Major Cations	6.10
Cation/Anion Difference	0.58 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	0.011	Manganese	<0.02
Barium	<0.5	Lead	<0.02
Cadmium	<0.002	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	4.60
Manganese	0.07

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS

Project No. 8832146.001

Site Location PALMER ALASKA

Sample ID 8832146.001-#89-29-2-26-89-4TH-MW

Sampling Location

Technical Procedure Reference(s)

Type of Sampler 50AA MYERS - 5HP / 230 VOLT / SINGLE PHASE 4" PUMP

Date 2-26-89 Time 12:15

Media WATER Station #89 29

Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
T.D = 204.0 - SAT. THICKNESS: 138.86
WATER LEVEL: 65.14 - volume PURGED = 17018.5 Gals
AS of 4 HRS 16 MINUTES - 22 SECONDS INTO THE PUMP TEST

Sample Description CLEAR - A SULPHUR ODOR WOULD COME AND GO

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 2°C / D-O₂ = 10.6
PH = 7.34 / uS = 294 - final PARAMETERS of (4)
TAKEN ALKALINITY = 100.6 as CaCO3

Aliquot Amount	Container	Preservation/Amount
1/2 Gallon	Plastic Jug	NONE
1 LITRE	"	Sulphuric 1
1 250 ML	"	Nitric 1
1 250 ML	" Filtered	Nitric 1

Sampler (signature) Date 2-26-89

Supervisor (signature) Date

Golder Associates

Sample Site: 883-2145-H8829-7-27-89-4th-MW
Lab No: 898602
Date Sampled: 07/27/89 @ 1140
Date Received: 07/31/89

Lab pH, s.u.	7.55
Lab Conductivity, umhos/cm @ 25C	266
Total Dissolved Solids (180), mg/l	158
Total Dissolved Solids (calc), mg/l	155
Boron, mg/l	<0.01
Fluoride, mg/l	0.17
Ammonia Nitrogen as N, mg/l	0.25
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.005
Total Organic Phosphorus as P, mg/l	0.005
Total Phosphorus as P, mg/l	0.012
Total Alkalinity as CaCO3, mg/l	147
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	102
Sodium Adsorption Ratio	0.93

	mg/l	meq/l
Bicarbonate as HCO3	179	2.93
Carbonate as CO3	0	0.00
Chloride	1.8	0.05
Nitrate as N, mg/l	0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	5.6	0.12
Calcium	27	1.36
Magnesium	8.1	0.67
Potassium	3.0	0.08
Sodium	22	0.94

Major Anions	3.10
Major Cations	3.05
Cation/Anion Difference	0.81 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.14
Arsenic	<0.002	Manganese	<0.02
Barium	0.6	Lead	<0.02
Cadmium	<0.005	Mercury	<0.001
Copper	<0.01	Selenium	<0.005
Chromium	<0.02	Zinc	0.06

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.23
Manganese	<0.02

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS
Project No. 8832146.001 4TH
Site Location Palmer Alaska
Sample ID 8832146.001-H8930-7-28-89
Sampling Location

Technical Procedure Reference(s)
Type of Sampler HYDROSTAR - CHECK BALL PUMP WITH AIR TOOL
Date 7-28-89
Time 20:03 - Final Sample of (4)
Media WATER
Station H8930
Sample Type: [✓ grab] time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
TOTAL DEPTH = 164.96 / SAT - THICKNESS = 118.56
WATER LEVEL = 46.40 - VOLUME PURGED = 55 GALS

Sample Description TURBID - MUDDY BROWN - SUSPENDED PARTICLES VERY FINE

Field Measurements on Sample (pH, conductivity, etc.) TEMP = 3°C / D-O2 = 12.4
PH = 8.02 / µs = 449 - final field PARAMETERS of (4)
ALKALINITY = 231.6 as $CaCO_3$

Aliquot Amount	Container		Preservation/Amount
1/2 Gallon	Plastic Jug		None
1 Liter	"		Sulphuric - 1
1 250 ML	"		Nitric - 1
1 250 ML	"	Filtered	Nitric - 1

Sampler (signature)
Date 7-28-89
Supervisor (signature)
Date

Golder Associates

APPENDIX G

SEISMIC REFRACTION SURVEY REPORT

SEISMIC REFRACTION SURVEY

WISHBONE HILL MINE

MATANUSKA COAL FIELD, ALASKA

INTRODUCTION

Approximately 4700 lineal feet of seismic refraction profiling was completed in the Western Lease Area of the Wishbone Hill Mine, Matanuska Coal Field, Alaska, from August 23-27, 1988. The seismic program consisted of a baseline profile (Line S1) and a cross-profile (Line S2) in Mine Area No. 1, as well as a baseline profile (Line S3) and two cross-profiles (Lines S5 and S6) in Mine Area No. 2.

The purpose of the seismic investigation was to map the depth to the bedrock interface in Mine Areas No. 1 and 2 in order to assist in the evaluation of the hydrologic impacts of the mine development. The results of the seismic survey are presented as interpreted depth sections for each of the seismic lines in Figures 1 through 5. Each of the depth sections is described in detail below.

FIELD PROCEDURE

All seismic refraction data for the Wishbone Hill project were recorded using a 24-channel seismic system consisting of two GeoMetrics ES-1210F digital seismographs mated with a common timing trigger, together with a string of 24 Sensor SM-4 14 Hz. vertical geophones. The seismic energy source consisted of the two-component explosive KINESTIK, and shot size varied from one-third pound to one pound. Atlas Staticmaster seismic blasting caps were utilized to assure accurate timing of the seismic arrivals. At least five shots were recorded into each 24-channel seismic spread to achieve reversed arrivals from the bedrock refractor, as well as definition of seismic velocities in the overburden.

A geophone spacing of 25 feet was used thoughout the survey, resulting in a nominal spread length of 575 feet. A seismic "spread" is defined as one cable length of coverage using 24 geophones, whereas a seismic "line" consists of a single, continuous linear profile which may be composed of one spread or of a number of spreads laid end-to-end. Multiple spreads along a given line have been designated by successive alphabetical letters, as Line S3, Spreads A,B,C,and D. Where possible, consecutive spreads were overlapped by at least two geophones to permit continuity of interpretation along the seismic profiles.

The locations of the ends of the seismic lines and their intersections were determined by a survey crew subsequent to the completion of the seismic field work. The geophone positions indicated on the interpreted depth sections (Figures 1 through 5) were determined by manually plotting the coordinates of the seismic line end points on the topographic base sheet for the Wishbone Hill Mine. Individual geophone elevations were then interpolated from the topographic base sheet.

INTERPRETATION PROCEDURE

The initial phase of the interpretation procedure followed standard seismic refraction data reduction techniques. Seismic compressional wave ("P" wave) arrival times were picked as the first "breaks" on the field records, and time-distance plots were generated using these arrival times and the geophone locations. These time-distance curves were then analyzed to determine the number of subsurface layers present and the velocities and depths of the shallow layers.

For Mine Area No. 2 (Seismic Lines S3, S5, and S6), the analysis of the depth to bedrock was completed on the time-distance curves. Bedrock depth was calculated at each of the shotpoints using the time-intercept method. This method assumes planar refracting interfaces with shallow dips relative to the topographic surface. The bedrock interface beneath Mining Area No. 2 appears to obey these simplifying assumptions, so that the time-intercept analysis was considered sufficient for the purposes of the seismic investigation in this area.

In Mine Area No. 1 (Seismic Lines S1 and S2), however, the configuration of the bedrock interface is more complex. Thus the time-intercept method was neither sufficient nor appropriate for calculating depth to the bedrock interface. For these two seismic profiles, a more sophisticated method of analysis termed the Generalized Reciprocal Method (GRM) was utilized. The GRM belongs to a class of solutions called delay time methods, wherein both forward and reverse bedrock arrivals are recorded on as many geophones as possible, with the goal of determining a depth point beneath each geophone. The GRM interpretive procedure was developed by the Geological Survey of New South Wales, Australia, for mineral resource investigations. It is particularly well suited for defining the configuration of an undulating bedrock interface.

Northland Geophysical Company utilizes a suite of computer routines known as the "GREMLIN^{R}" package (an acronym for Generalized REciprocal Method of Line INterpretation) written by Dr. Robert W. Lankston of Geo-Compu-Graph, Inc., Fayetteville, Arkansas, for implementing the GRM procedures. Seismic Lines S1 and S2 in the Wishbone Hill Mine Area No. 1 were interpreted and the final depth sections for these two lines were generated using this software package.

INTERPRETED DEPTH SECTIONS

In Figures 1 through 5 the interpreted depth sections are presented as velocity profiles, with the numbers in the profiles representing seismic velocities in feet per second (fps). Shallow (overburden) interfaces are represented by a dashed line on all the profiles. For Lines S3, S5, and S6, the bedrock interface is represented by interpolated straight line segments between calculated depth points at the shotpoint locations. For Lines S1 and S2, the computer-generated bedrock depths are expressed as a series of arcs which represent the loci of possible points on the bedrock refractor. The envelope of these arcs is taken as the best representation of the surface of the refractor.

Distance along the depth sections corresponds to horizontal distance along the seismic lines as determined by survey, and the individual geophone positions are indicated by (+) symbols at their respective interpolated elevations.

Seismic Line S1

The baseline profile in Mine Area No. 1 was designated Line S1. It consisted of two 24-channel spreads with a total line length of 1095 feet. As indicated in Figure 1, the seismic stratigraphy beneath this line consisted of a three-layer system: a thin low-velocity surficial layer with a thickness of 4 to 5 feet and a seismic velocity of 900 to 1500 feet per second (fps); a second layer of unsaturated alluvial and/or glacial sands and gravels with a velocity of 2500 to 3500 fps; and competent bedrock with a velocity ranging from about 8200 to 11,000 fps.

From geophone positions A20 to B12 the bedrock interface is seen to be relatively planar and dipping slightly to the southeast. For the rest of the profile, however, this interface is irregular. Therefore the more simplified analysis using the time-intercept method was considered inadequate for this seismic line, and a computer solution utilizing the GRM software was undertaken.

Beneath the northwestern third of the line (geophone positions A8 through A19) a channel-like feature is observed in the bedrock surface. Overburden velocities of 4500 to 4600 fps were observed below a depth of approximately 13 to 15 feet in this zone, suggesting saturated alluvium within the channel.

Beneath the southeastern end of Line S1 (geophone positions B13 through B24) the competent bedrock refracting interface appears to lie at somewhat greater depths. However, the time-distance curves for this interval show some evidence of scattered occurrences of high-velocity material shallower than the competent refracting horizon (as indicated by the zones annotated with "?" marks). Thus the overburden in this zone (exhibiting seismic velocities of 2400 to 3300 fps) may be partially composed of highly weathered Tertiary bedrock rather than alluvial or glaciofluvial materials; the higher velocity intervals within the overburden may represent more resistive beds within weathered bedrock. In the deeper competent bedrock, the computer velocity analysis indicates a velocity transition from about 8800 fps to greater than 11,000 fps southeast of approximate geophone positions B15 - B17.

Seismic Line S2

Line S2 was a 565-foot cross-profile perpendicular to Line S1 and intersecting the baseline at its midpoint. The interpreted depth section for this line is given in Figure 2. This depth section was also calculated using the GRM computer software.

The bedrock interface is seen to lie at relatively shallow depths beneath the southwest portion of this line, corresponding with the shallow bedrock "bench" mapped beneath the central portion of Line S1. Bedrock depths increase northeast of the main access road, indicating that the prominent topographic high along this portion of the profile may be partially glacial in origin. The computer velocity analysis indicates a bedrock velocity transition from about 9500 fps to about 6300 fps northeast of approximate geophone positions A18-A19, suggesting a transition to less competent bedrock beneath the northeast portion of the profile.

Seismic Line S3

The seismic baseline for Mine Area No. 2 was designated Line S3. This line consisted of four contiguous seismic spreads totalling 2011 feet in length. The interpreted depth section is presented in Figure 3 at a horizontal scale of 1"=200' and a vertical scale of 1"=50'.

The seismic stratigraphy was interpreted as a three-layer system beneath the northeastern half of the line, with a thin (3 to 5 feet) layer of low-velocity surficial material overlying 10 to 15 feet of unsaturated material with a velocity of 2000 to 4000 fps. The surficial layer appears to correlate with a layer of loess which was observed while excavating the shot-holes on the upland areas. This layer is not present along the southwestern half of Line S3, where the seismic stratigraphy was interpreted to consist of one relatively thin layer of intermediate velocity (1800 - 3000 fps) overlying bedrock.

Bedrock depths beneath Line S3 were calculated only at the shotpoints using the time-intercept method. Bedrock depths between the shotpoints were interpolated as straight-line segments. Manual velocity analysis on the time-distance curves indicates that the bedrock velocity is relatively consistent beneath the entire length of Line S3, although it appears to decrease slightly from southwest to northeast. In the vicinity of the gulley at geophone positions A14 and A15, a saturated overburden velocity of 5500 fps was noted beneath the area of ponding in the gulley. The time-distance curves were examined for evidence of faulting in the bedrock in this zone (as suggested by earlier geologic mapping in the area), but no such evidence was observed.

Seismic Line S5

Line S5 was a 496-foot cross-profile which was perpendicular to Line S3 and intersected the baseline at its midpoint. The interpreted depth section for Line S5 is given in Figure 4. The seismic stratigraphy is very similar to that of Line S3, with the thin surficial (loess) layer present on the upland area at the southeast end of the line disappearing to the northwest.

Bedrock depths were calculated only at the shotpoints using the time-intercept method. Competent bedrock is seen to lie at relatively shallow depths (6 to 12 feet) beneath the northwest end of the profile on the floodplain, while beneath the upland area at the southeast end it is somewhat deeper (15 to 20 feet). Manual velocity analysis on the time-distance curves indicates a slight increase in bedrock velocity from northwest to southeast in the vicinity of geophone positions A13 - A15.

Seismic Line S6

Line S6 was a 520-foot seismic profile oriented perpendicular to the baseline and intersecting Line S3 at the junction of Spreads S3A and S3B. The interpreted depth section for Line S6 is presented in Figure 5. A seismic stratigraphy similar to that of Lines S3 and S5 was observed. Bedrock depths were calculated only at the shotpoints using the time-intercept method. The bedrock interface is seen to be at a shallow depth of about 5 feet beneath the floodplain at the northwest end of Line S6, while beneath the upland area at the southeast end of the profile it occurs at depths of 12 to 20 feet.

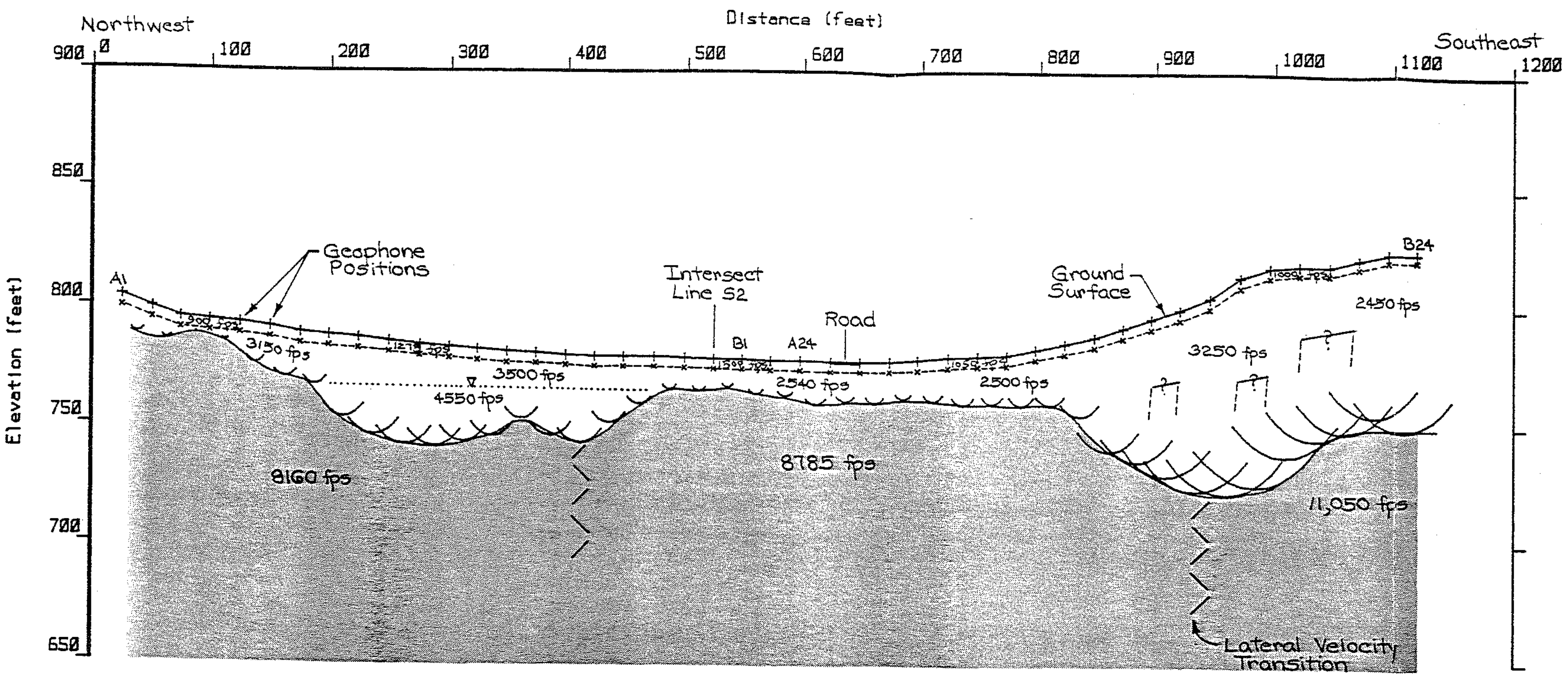
ACCURACY AND LIMITATIONS

The results of the Wishbone Hill Mine seismic investigation should be considered to be of a reconnaissance nature, since little borehole information is yet available in the vicinity of the seismic lines to help refine the seismic depth estimates.

A complete computer solution using the Generalized Reciprocal Method was carried out for Lines S1 and S2 (Mine Area No. 1), so that no further computational effort is recommended to improve the confidence level in the location of the competent bedrock refracting horizon. The ambiguities present in the interpretation of the overburden composition beneath the southeastern quarter of the profile may be resolved by future borehole information in this area.

The interpretation of bedrock depths in Mine Area No. 2 (Lines S3, S5, and S6) was restricted to the use of time-intercept calculations at the shotpoints. Due to the simplifying assumptions inherent in the use of time-intercept calculations, the confidence level in this bedrock depth interpretation is lower than for the more rigorous computer solutions in Mine Area No. 1. More detailed calculations are not recommended for these lines at this time, however, since the bedrock interface appears to be at relatively shallow depth and is approximately planar in nature.

It should be noted that the bedrock interface portrayed on the interpreted depth sections for the Wishbone Hill Mine represents the competent refracting horizon within the bedrock. A zone of weathered bedrock may be present at depths shallower than the indicated interface.



EXPLANATION:

Nominal Geophone Spacing = 25 feet.

Numbers in Profile Represent Seismic Wave Velocity in Feet per Second.

Arcs represent loci of possible points on the bedrock refractor; the envelope of these loci is taken as the surface of the refractor.

Shallow (overburden) interfaces are represented by dashed lines.

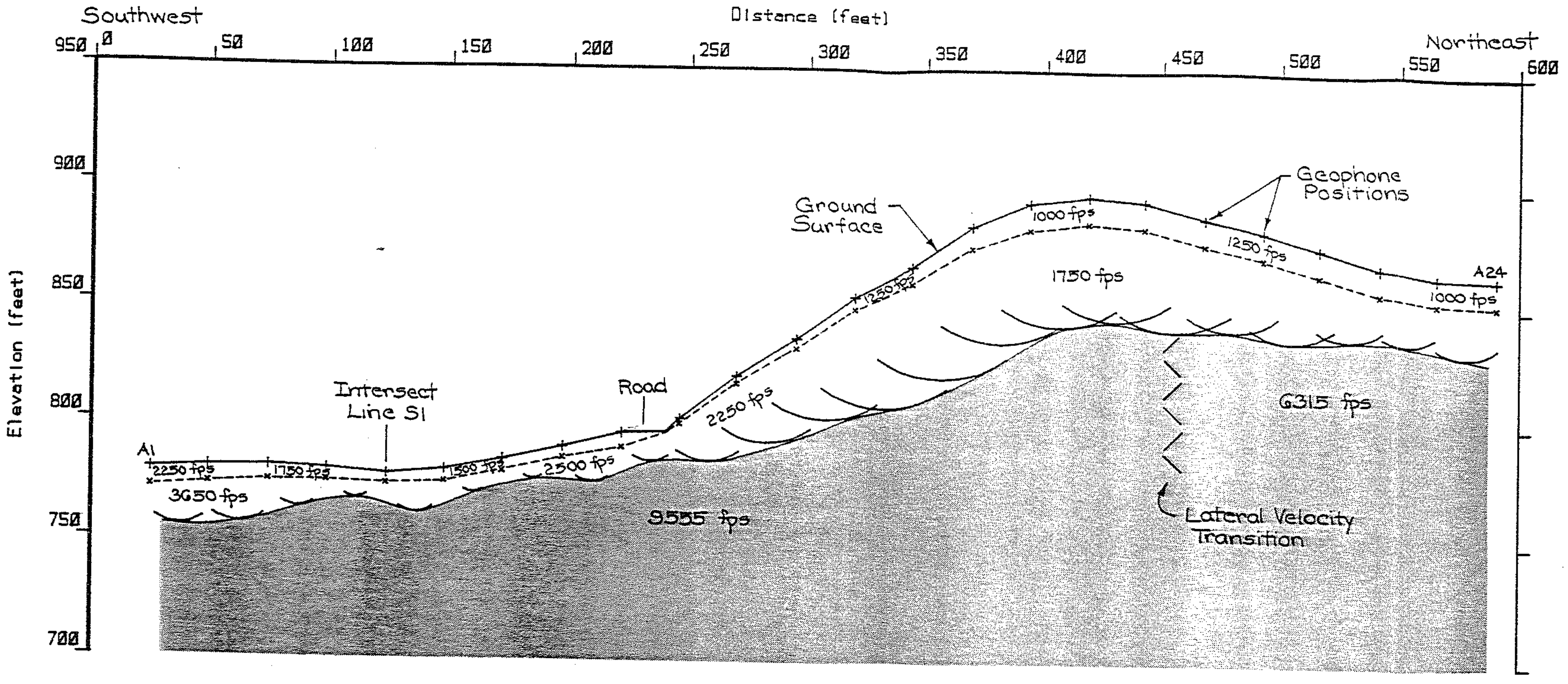
NORTHLAND GEOPHYSICAL
Seattle, Washington

DEPTH SECTION

SEISMIC LINE S1

Wishbone Hill Mine

Horizontal Scale:	1" = 100'	December 1988
Vertical Scale:	1" = 50'	Figure 1



EXPLANATION:

Nominal Geophone Spacing = 25 feet.

Numbers in Profile Represent Seismic Wave Velocity in Feet per Second.

Arcs represent loci of possible points on the bedrock refractor;
the envelope of these loci is taken as the surface of the refractor.

Shallow (overburden) interfaces are represented by dashed lines.

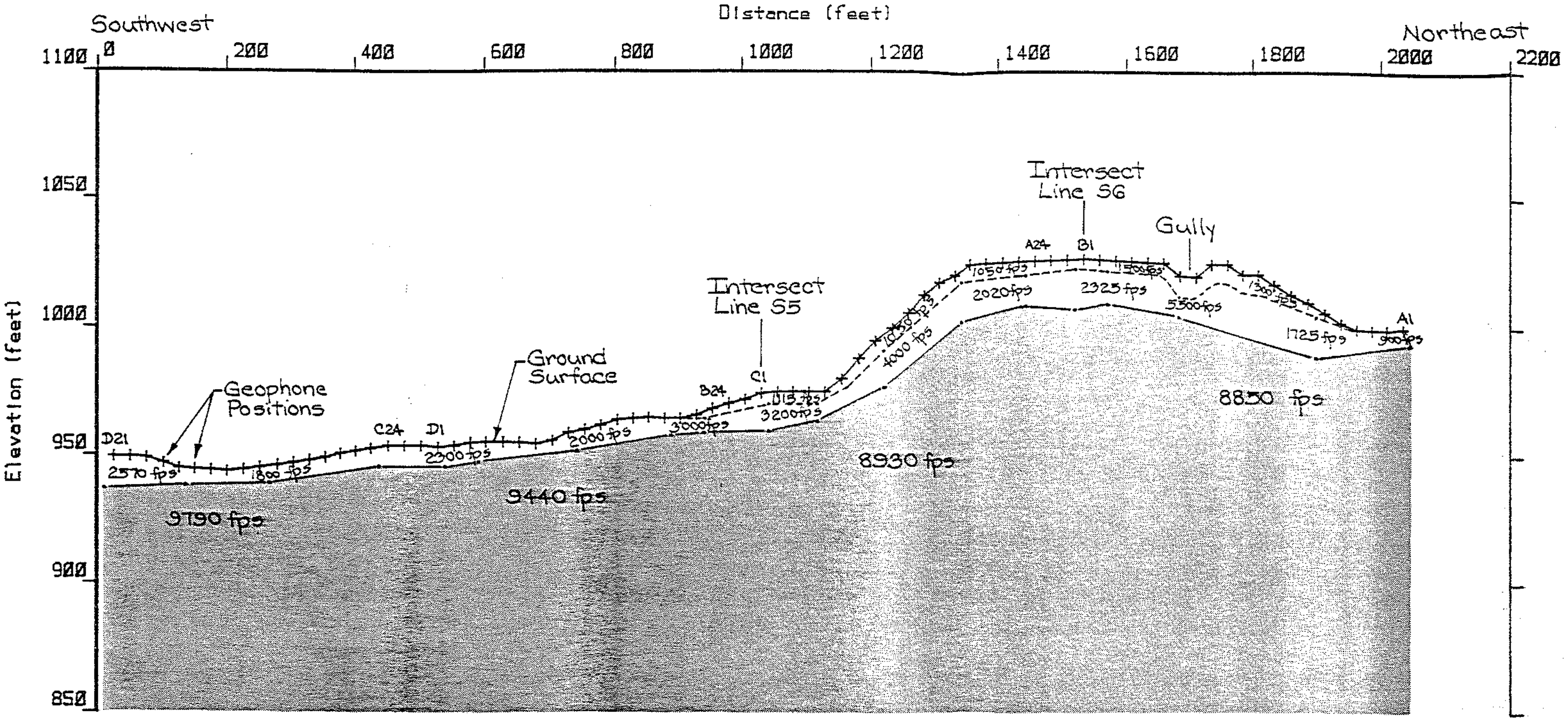
NORTHLAND GEOPHYSICAL
Seattle, Washington

DEPTH SECTION

SEISMIC LINE S2

Wishbone Hill Mine

Horizontal Scale :	1"=50'	December 1988
Vertical Scale :	1"=50'	Figure 2



EXPLANATION:

Nominal Geophone Spacing = 25 feet.

Numbers in Profile Represent Seismic Wave Velocity in Feet per Second.

Bedrock depths are calculated only at shotpoints; between shotpoints the bedrock interface is represented by interpolated straight line segments.

Shallow (overburden) interfaces are represented by dashed lines.

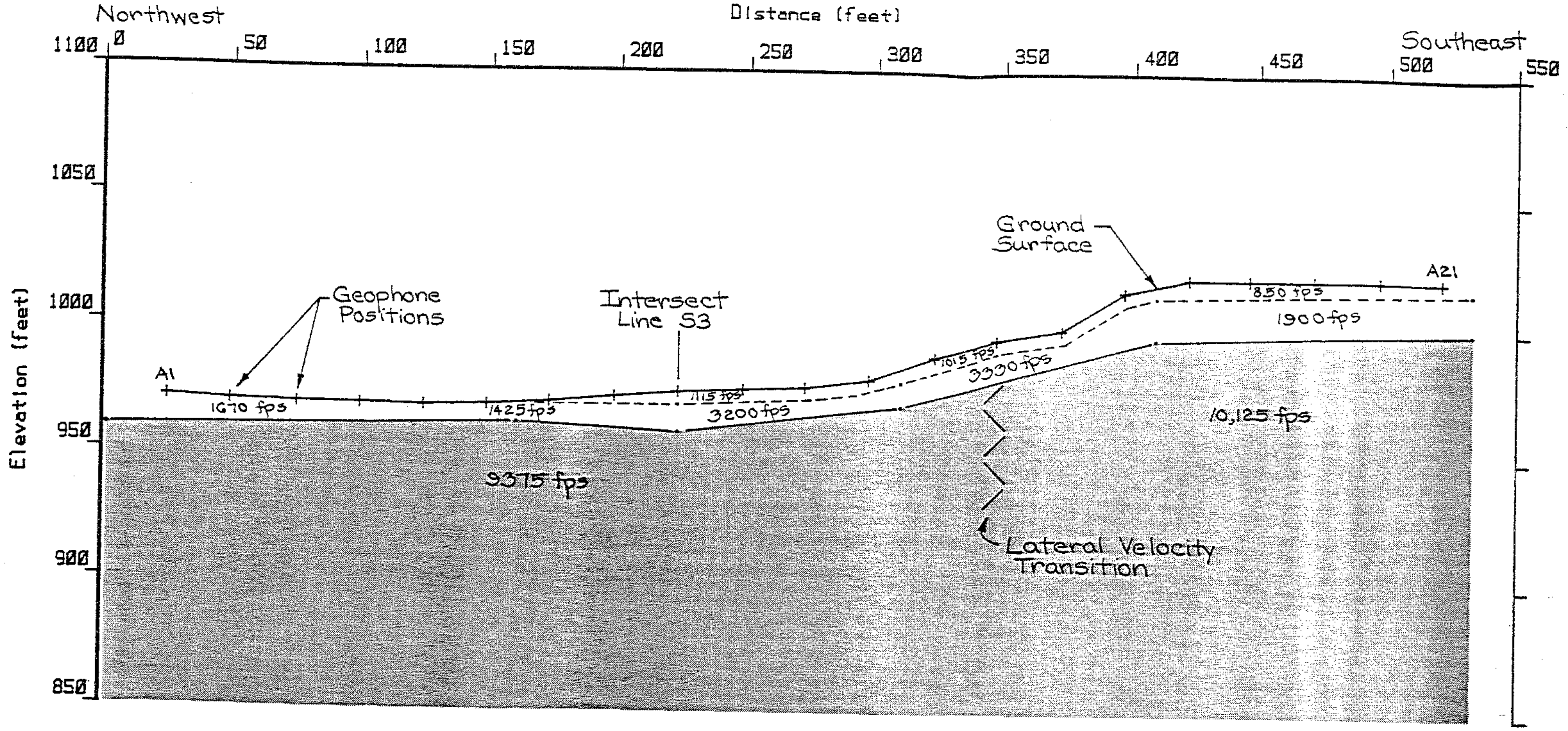
NORTHLAND GEOPHYSICAL
Seattle, Washington

DEPTH SECTION

SEISMIC LINE S3

Wishbone Hill Mine

Horizontal Scale:	1"=200'	December 1988
Vertical Scale:	1"=50'	Figure 3



EXPLANATION:

Nominal Geophone Spacing = 25 feet.

Numbers in Profile Represent Seismic Wave Velocity in Feet per Second.

Bedrock depths are calculated only at shotpoints; between shotpoints the bedrock interface is represented by interpolated straight line segments.

Shallow (overburden) interfaces are represented by dashed lines.

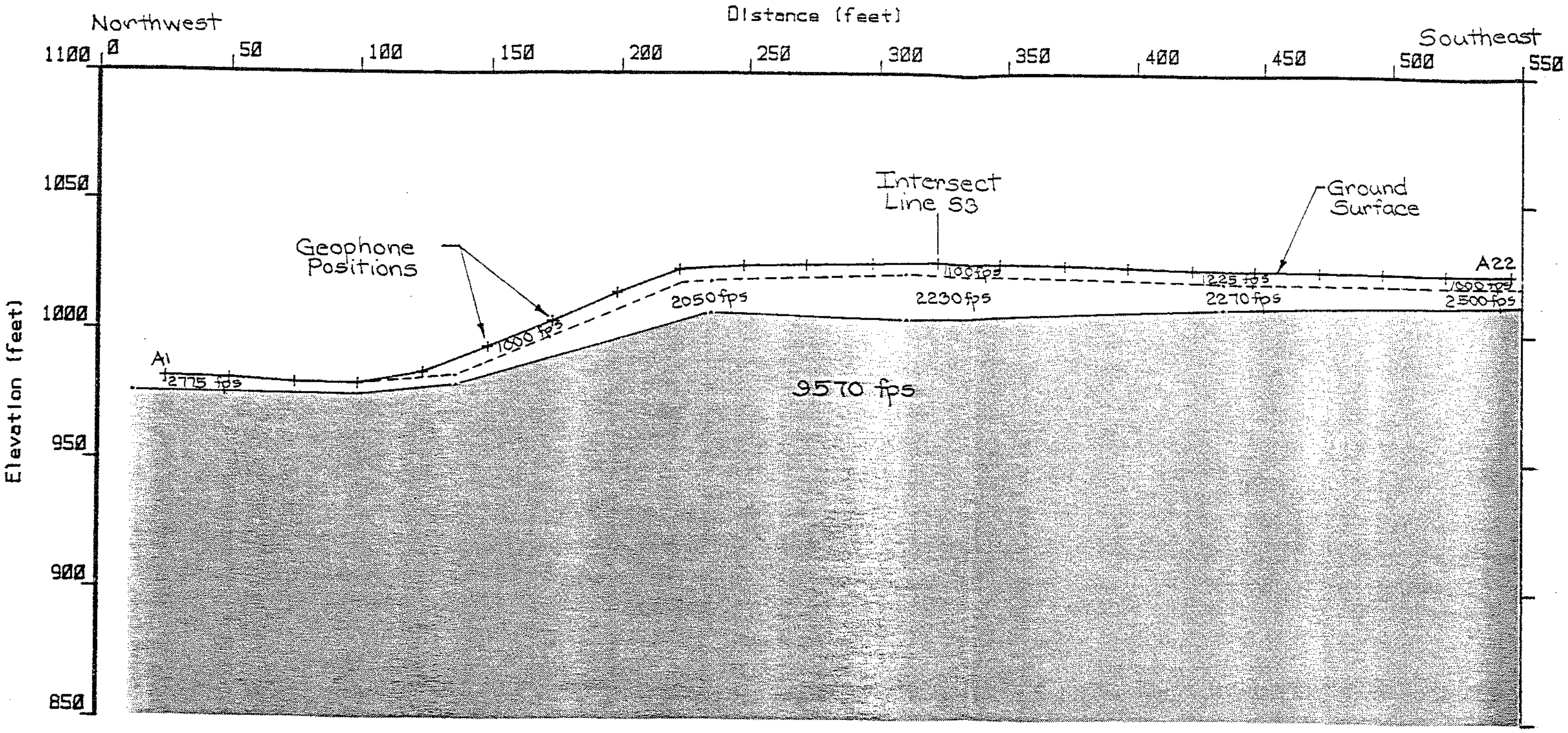
NORTHLAND GEOPHYSICAL
Seattle, Washington

DEPTH SECTION

SEISMIC LINE S5

Wishbone Hill Mine

Horizontal Scale:	1"=50'	December 1988
Vertical Scale:	1"=50'	Figure 4



EXPLANATION:

Nominal Geophone Spacing = 25 feet.

Numbers in Profile Represent Seismic Wave Velocity in Feet per Second.

Bedrock depths are calculated only at shotpoints; between shotpoints the bedrock interface is represented by interpolated straight line segments.

Shallow (overburden) interfaces are represented by dashed lines.

NORTHLAND GEOPHYSICAL
Seattle, Washington

DEPTH SECTION

SEISMIC LINE S6

Wishbone Hill Mine

Horizontal Scale:	1"=50'	December 1988
Vertical Scale:	1"=50'	Figure 5

APPENDIX H

SAMPLING QUALITY ASSURANCE PLAN

883-2145

SAMPLING QUALITY ASSURANCE PLAN
FOR
PRE-MINING GROUNDWATER AND SURFACE WATER INVESTIGATIONS

WISHBONE HILLS PROJECT
PALMER, ALASKA

Revision -0-

Prepared for
McKinley Mining Consultants, Inc.

883-2145

Golder Associates Inc.
Anchorage, Alaska

Reviewed and approved by:

A Krause 11/4/88
A. Krause, GAI Project Manager

J Rowe 11/1/88
J. Rowe, GAI Hydrogeology Task Leader

G Laird
G. Laird, GAI Hydrology Task Leader

11/1/88
G. Mills, GAI Corporate QA Officer

TABLE OF CONTENTS

1. INTRODUCTION

It is Golder Associates Inc. (GAI) corporate policy to establish appropriate Quality Assurance (QA) program controls for all hydrological and hydrogeological sampling investigations. In keeping with this policy, certain QA program elements and procedures have been selected for use on this project and are defined by this Sampling QA Plan (SQAP). The purpose of the SQAP is to provide a procedural framework that will ensure that the sampling activities completed as part of this project are fully documented, defensible, and in compliance with established sampling practices.

2. PROJECT LOCATION AND DESCRIPTION

The hydrological and hydrogeological sampling activities discussed in this plan are part of the scope of site characterization activities to be conducted by Golder Associates Inc. as part of the pre-mining investigations for the Wishbone Hill Mine project, near Palmer, Alaska. Site topography and location are shown on the sampling location maps included as Figures 4-1 and 4-2.

3. PROJECT ORGANIZATION AND RESPONSIBILITIES

Primary responsibility for the implementation of the requirements of this SQAP lies with the Project Manager and the Task Leaders for each area of investigation. The QA Manager is responsible for the preparation and update of this SQAP, and has the independence, authority, and access to technical staff to ensure the proper implementation of the requirements discussed in this plan. Project assignments are as follows:

- A. Krause, Project Manager
- J. Rowe, Hydrogeology Task Leader
- G. Laird, Hydrology Task Leader
- G. Mills, QA Manager

4. SAMPLING LOCATION AND FREQUENCY

4.1 Location

Surface water sampling shall be performed at 7 locations, as shown in detail on Figure 4-1 and as described below:

- on Moose Creek, at the northeastern limits of the Wishbone Hill Western Lease permit boundary,
- on Moose Creek, upstream from its confluence with Buffalo Creek,
- on Moose Creek, on the western side of the Wishbone Hill Western Lease permit boundary,

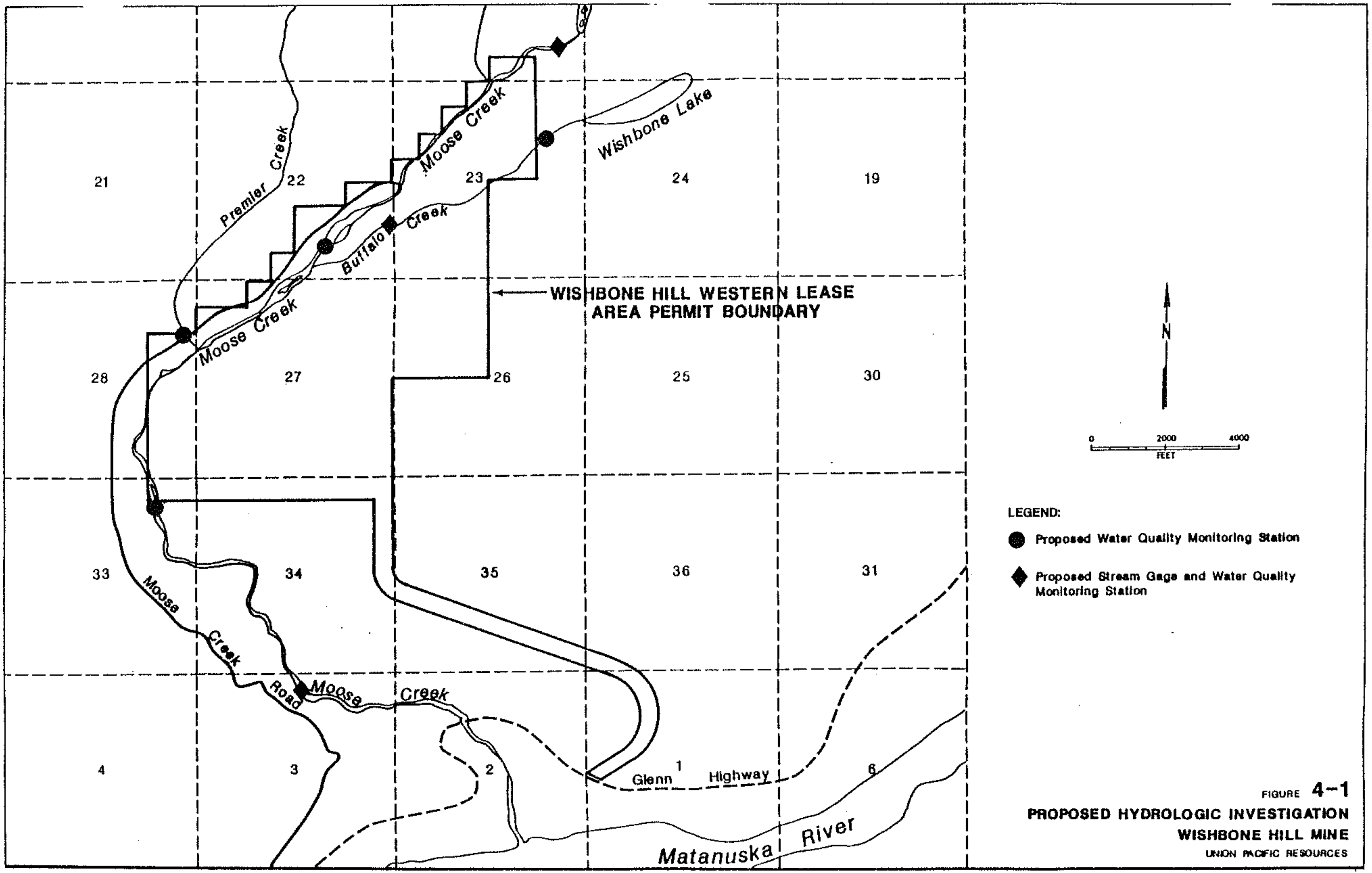


FIGURE 4-1

PROPOSED HYDROLOGIC INVESTIGATION

WISHBONE HILL MINE

UNION PACIFIC RESOURCES

PROJECT NO 883-2145-000 DWG NO 10909 DATE 10/31/88 DRAWN LD APPROVED JR

Golder Associates

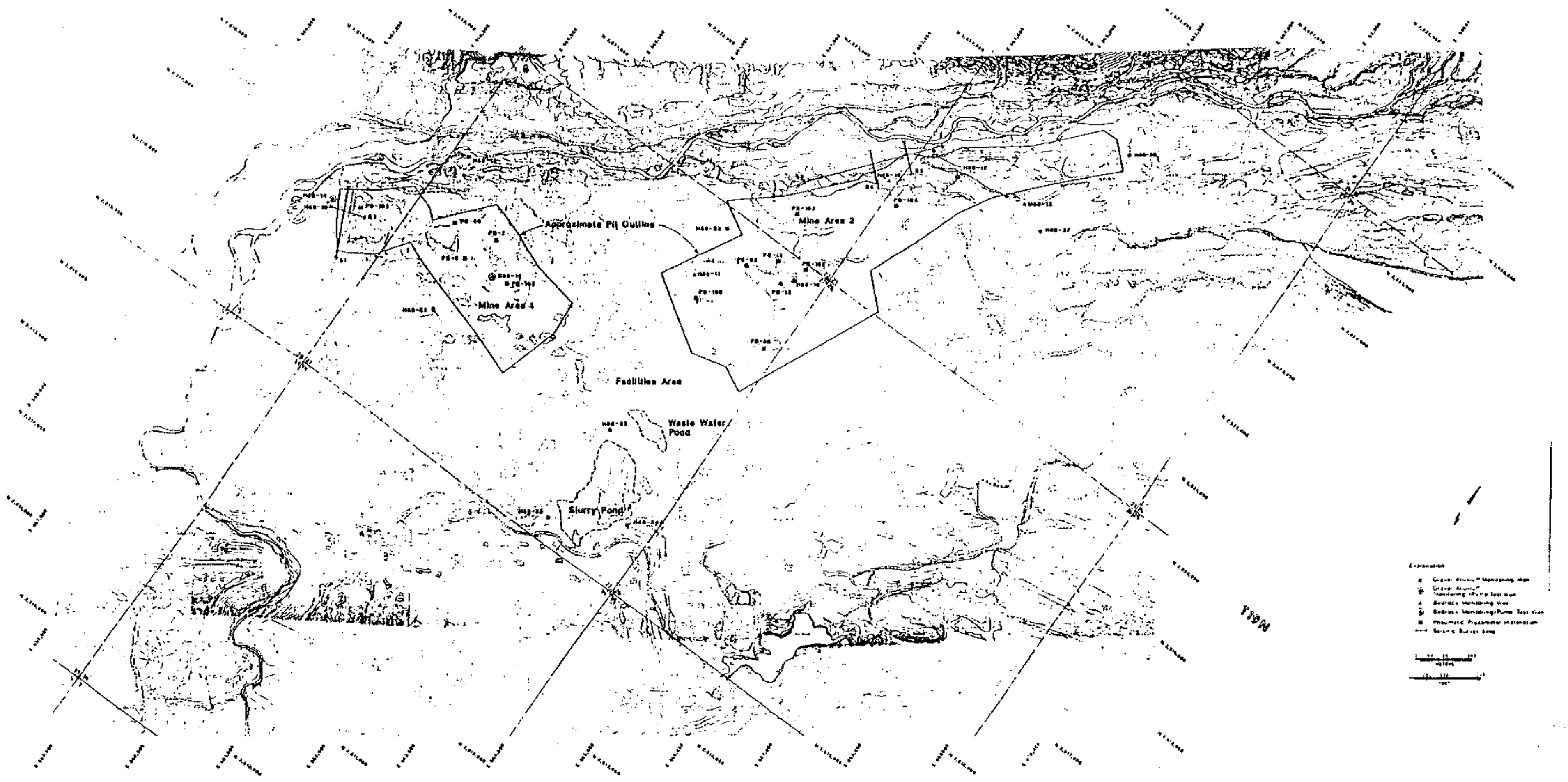


FIGURE **4–2**

SITE PLAN AND WELL LOCATIONS

MCKINLEY MINING CONSULTANTS, INC.
WISHBONE HILL MINE

PROJECT NO 883-2145 DWG NO 9161 DATE 10/31/88 DRAWN CW APPROVED JR

Golder Associates

- on Moose Creek, to the south of the southern limits of the Wishbone Hill Western Lease permit boundary,
- on Buffalo Creek, upstream from its confluence with Moose Creek,
- on Premier Creek, near its confluence with Moose Creek, and
- on Buffalo Creek, at the northeastern limits of the Wishbone Hill Western Lease permit boundary.

Groundwater sampling shall be performed using 16 separate monitoring well installations, as shown in detail on Figure 4-2. Water levels shall be measured and recorded in each well prior to sampling. Piezometric levels shall be measured in each piezometer installation shown in Figure 4-2.

4.2 Sampling Frequency

Water quality samples shall be taken from each surface water sampling location on a monthly basis for an entire year and subjected to the full range of field and laboratory analyses described in Section 7. Additional samples shall be taken, at the direction of the Task Leader, during two separate storm events; during each event, periodic samples shall be taken from selected locations and subjected to all required field measurements and analyses. At the direction of the Task Leader, ten samples shall be selected from the total group of storm event samples, and routed to the laboratory for analysis of settleable solids and total suspended solids.

On a quarterly basis, one pair of groundwater water quality samples shall be taken from the groundwater monitoring locations described in Section 4.1 and subjected to the full range of field and laboratory analyses described in Section 7. Water/piezometric levels shall be measured quarterly in each monitoring well/piezometer location described in Section 4.1. More frequent measurements may be taken at the discretion of the Task Leader or Project Manager.

5. SAMPLING PROCEDURES

All sampling activities on this project shall be conducted in compliance with Appendix A, "Surface Water Sampling Procedure", or Appendix B, "Groundwater Sampling Procedure." Water levels shall be measured as required by Appendix C, and piezometric levels shall be measured as required by Appendix D.

6. SAMPLE HANDLING AND CHAIN OF CUSTODY PROCEDURES

6.1 Sample Container Preparation and Transport

All sample containers shall be prepared and labeled by the analytical laboratory; containers shall be made of high-density linear polyethylene or borosilicate glass, with airtight caps. The containers shall be given a distilled/deionized water rinse prior to use. Samples shall be transported in suitable coolers with adequate "blue ice" cold packs to maintain the interior temperature below 4 degrees Centigrade.

6.2 Sample Chain of Custody

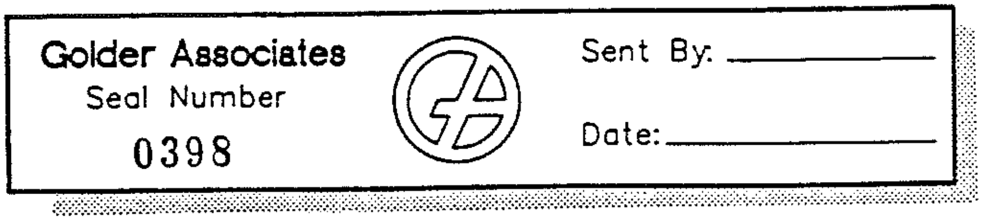
Labels shall be filled out on all sample containers sent to the analytical laboratory. Containers shall be secured with a tamper-proof seal (Figure 6-1), and shall be accompanied by a sample chain of custody record (Figure 6-2). Each seal shall be assigned a unique number which shall be entered on the chain of custody record, sample integrity data sheet, and the Field Report form (see Appendices A and B). When samples are ready for shipment, the Task Leader or designated Field Hydrologist shall release the sample to the carrier, who shall sign the custody form. The pink copy of the form shall retained by the Task Leader or Field Hydrologist, and the remainder of the form shall be shipped or mailed with the sample. Upon receipt, the laboratory's sample custodian shall verify the identification and integrity of the sample, sign the form, and return the original copy of the form to the GAI Task Leader.

7. PARAMETERS FOR ANALYSIS AND ANALYTICAL PROCEDURES

The following analyses shall be performed on all samples delivered to the laboratory; where specified, analytical procedures shall comply with the appropriate EPA standard method from EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes. Where procedures are indicated as the laboratory's option, copies shall be appended to the analytical results when presented to the GAI project manager for review. The laboratory shall perform at least one duplicate analysis each sampling round as a quality control check on the applicable analytical procedures.

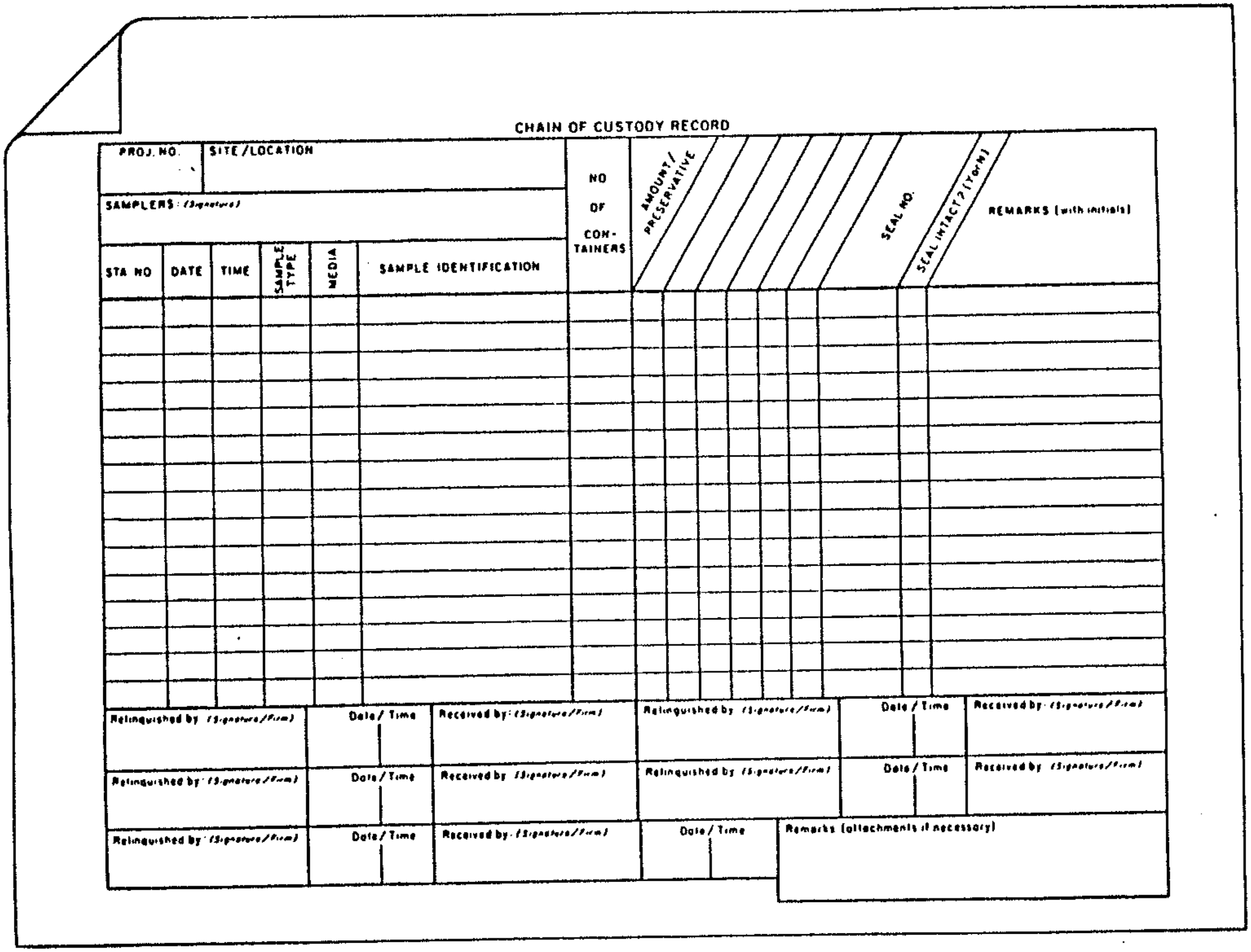
Test or Compound of Interest	Method
Total acidity	Laboratory option
Total alkalinity	Titrimetric (EPA 310.1)
Total hardness	Titrimetric (EPA 130.2)
Settleable solids	Laboratory option
Total dissolved solids	Gravimetric (EPA 160.1 or SM 208c)
Total suspended solids	Laboratory option
Color	Laboratory option
Carbonate	Laboratory option
Bicarbonate	Laboratory option
Sulfate	Gravimetric (EPA 375.3)
Chloride	Titrimetric (EPA 325.3)
Nitrate	Laboratory option

FIGURE 6-1



EXAMPLE OF TAMPER-PROOF SEAL

FIGURE 6-2



CHAIN OF CUSTODY RECORD

PROJ. NO.

SITE/LOCATION

SAMPLERS: *(Signature)*

STA NO	DATE	TIME	SAMPLE TYPE	MEDIA	SAMPLE IDENTIFICATION	NO OF CON-TAINERS	AMOUNT/ PRESERVATIVE						SEAL NO.	SEAL INTACT? (Y or N)	REMARKS (with initials)

Relinquished by: *(Signature/Firm)*

Date/Time

Received by: *(Signature/Firm)*

Relinquished by: *(Signature/Firm)*

Date/Time

Received by: *(Signature/Firm)*

Relinquished by: *(Signature/Firm)*

Date/Time

Received by: *(Signature/Firm)*

Relinquished by: *(Signature/Firm)*

Date/Time

Received by: *(Signature/Firm)*

Relinquished by: *(Signature/Firm)*

Date/Time

Received by: *(Signature/Firm)*

Date/Time

Remarks (attachments if necessary)

SAMPLE CHAIN OF CUSTODY RECORD FORM

Golder Associates

Test or Compound of Interest	Method
Sodium	AA (EPA 273.1)
Potassium	AA (EPA 258.1)
Calcium	AA or Titrimetric (EPA 215.1/.2)
Magnesium	AA (EPA 242.1) or CAL (SM 313c)
Arsenic	AA (EPA 206.2 or .3)
Iron (total)	AA (EPA 236.1 or .2)
Manganese (total)	AA (EPA 243.1 or .2)
Cadmium	AA (EPA 213.1 or .2)
Selenium	AA (EPA 270.2 or .3)
Zinc	AA (EPA 289.1 or .2)
Mercury	CV TECH (EPA 245.1)
Lead	AA (EPA 239.1 of .2)
Chromium (total)	AA (EPA 218.1 or .2)
Aluminum	AA (EPA 202.1 or .2)
Copper	AA (EPA 220.1 or .2)
Barium	AA (EPA 208.2)
Boron	Color, CARM (SM 405b) or CURC (EPA 212.3)
Fluoride	Potentiometric (EPA 340.2)
Nitrite	Colorimetric, (EPA 352.1 or 353.2)
Ammonium ion	Potentiometric (EPA 350.3
Total nitrogen (Kjedahl)	Titrimetric (EPA 351.3) or potentiometric (EPA 351.4)
Phosphate (organic)	Laboratory option
Phosphorus (total)	S. Digest (EPA 365.4)

The following tests or examinations will be performed as part of the field sampling activities and are described in detail in Appendices A and B.

- o Total dissolved oxygen
- o pH
- o Conductivity
- o Temperature
- o Turbidity (surface water only)
- o Alkalinity

8. PROCEDURE ALTERATION CHECKLISTS

Changes in the sampling procedures discussed in Section 5 and Appendices A and B may be required in response to field situations, and may be implemented under the authority of the Task Leader provided that they are documented on a Procedure Alteration Checklist (Figure 8-1) and verbally reported to the Project Manager within 24 hours. The Procedure Alteration Checklist shall be submitted to the Appropriate Project Manager and QA Manager for review within 2 working days. All approved Procedure Alteration Checklists will be submitted to the client with the final report. Disapproval of the checklist shall automatically require re-performance of the sampling activity concerned.

9. REVIEW OF ANALYTICAL REPORTS

The results of laboratory analyses (including the duplicate analyses performed as internal quality control checks) shall be submitted to the GAI Project Manager for review and approval prior to transmittal to the client. Acceptance shall be documented by the GAI Project Manager's dated signature on the transmittal memo or submittal letter sent to the client.

10. RECORDS

Copies of all Field Report forms, completed Chain of Custody forms, laboratory analyses and supporting procedures, sample integrity data sheets, and transmittal letters or memoranda shall be retained in project records.

FIGURE 8-1

Procedural Alteration Checklist

Sample Program Identification: ______________________________

Material to be Sampled: ______________________________

Measurement Parameter: ______________________________

Standard Procedure for Analysis: ______________________________

____

Reference: ______________________________

Variation from Standard Procedure: ______________________________

____

Reason for Variation: ______________________________

____

____

____

Special Equipment, Material, or Personnel Required: ______________________________

____

____

Alteration Requested By: ____________________ Date: __________

Title: ______________________________

Reviewed by: ____________________ Title: GAI Project Manager Date: __________

Comments: ______________________________

____

____

____

Reviewed by: ____________________ Title: GAI QA Officer Date: __________

Comments: ______________________________

____

____

____

APPENDIX A

SURFACE WATER SAMPLING PROCEDURE

APPENDIX A:

SURFACE WATER SAMPLING PROCEDURE

1. METHOD DESCRIPTION

This method uses hand-operated dippers, samplers, or containers to obtain samples from gauging stations or the stream surface. Instructions are also provided for obtaining stream velocity measurements, which may be appropriately conducted in conjunction with sampling.

2. EQUIPMENT REQUIREMENTS

All water sampling devices shall be designed so that only suitable noncontaminating materials (such as glass, teflon, or appropriate grades of stainless steel) come into contact with the water sample. Sampling, velocity measurement, and support equipment may include the following items:

- stainless steel dipper, or decontaminated 1 gallon container, for collecting samples
- calibrated pH/conductivity meter with field calibration solutions
- folding rule
- calibrated dissolved oxygen meter and temperature probe, with field calibration solutions
- sufficient quantities of pure deionized distilled rinse water for in-process decontamination of samplers (roughly 4 gallons)
- small quantity of nitric acid, for preservation of samples for trace metals analysis
- small quantity of sulfuric acid, for preservation of samples
- calibrated turbidimeter, with precleaned test vials
- field alkalinity test kit
- pre-labeled sample containers in sufficient quantities
- Sample Integrity Data Sheets, sample seals, chain of custody forms, and Field Log forms
- cooler or coolers with sufficient capacity for transporting all required samples and "blue ice" refrigerant packages

- o 24 size "C" batteries, for "Datapod" and Data Storage Modules (DSMs)
- o paper towels
- o filtration unit and 45 micron filters
- o velocity measurement forms, as required
- o survey rod
- o digital readout velocity meter
- o hip waders

3. PROCEDURE

3.1 Preliminary Activities

Review the location of the sampling or velocity measurement activity on a site map with an appropriate level of detail. Review the scope of the field activity with the Task Leader, prepare all required field equipment (using the bulleted items in Section 2 as a checklist), verify battery charge adequacy where appropriate, and perform all required equipment calibrations. Verify adequacy of containers, coolers, and condition of "blue ice" ice packs.

3.2 Sampling

1. Place all required field measurement calibration solutions in the stream for temperature adjustment; activate the pH/conductivity meter, dissolved oxygen/temperature meter, and turbidimeter. Prepare the filtration unit and alkalinity kit. Calibrate each device as required by the manufacturer's instructions. The dissolved oxygen/temperature meter must remain activated for the entire shift.

2. Samples shall be taken using the type of device most appropriate for the location. Withdraw the sample and transfer it to an appropriate container. Split the primary sample between three sample containers. Filter a portion of the primary sample into a 250 ml container and label the sample as "filtered." Prepare a separate aliquot container for the pH, conductivity, temperature, turbidity, and dissolved oxygen content measurements described in item 4 below.

3. After filling each individual sample container, add the appropriate preservative, immediately cap, seal, and complete the sample container label information. Place all samples in a cooler with a "blue ice" ice pack. Samples must be transported at no more than 4 degrees centigrade.

4. Perform all required field measurements; note that it may take ten minutes or more for readings to stabilize. Using the aliquot sample, measure

the pH to the nearest 0.1 pH unit with a decontaminated probe. Measure conductivity and the temperature at the time of the conductivity reading with a decontaminated probe. Measure dissolved oxygen content. Evaluate turbidity and observe color. Determine alkalinity. Observe weather conditions. Record all values and observations on the Field Report form (Exhibit A) and/or Sample Integrity Data Sheet (Exhibit B) for the corresponding sealed sample.

4. All sampling devices and test probes shall be cleaned as required and decontaminated by a final rinse with pure deionized/ distilled water prior to subsequent sampling activities.

5. After completion of all sampling activities, the Task Leader shall record the completion time on the Field Report.

6. If a gauging station exists at the sampling site, observe the water depth as measured by the "Datapod" and verify by an overcheck with the survey rod or folding rule. Record all values. Check battery condition on the Datapod, and change the DSM and batteries if power and memory is not sufficient to last until the next servicing. Initial and date the servicing log on the Datapod.

3.3 Stream Velocity Measurements

1. Select a stream section no more that a half mile from a gauging station such that:

- o the cross section to be measured lies within a straight reach,
- o the stream bed at the cross section is relatively free from boulders,
- o flow is relatively uniform,
- o no tributaries or diversions exist between the gauging station and the section to be measured.

2. Assemble the flowmeter and check operation; locate the line of measurement across the stream and record the distance from an arbitrary entry point to the right and left edge of water (REW/LEW). Record time and gauged height of water from the closest associated station (include rod overcheck measurement as well) on the velocity measurement form (Exhibit C).

3. Wade the measurement line and record water velocities every two feet from REW to LEW (approximately 25 measurements). Meter height must be established at each measurement point; measure the depth using the meter's rod, multiply by 0.6, and subtract from the depth to obtain the required value. Be sure to stand downstream from the meter, and observe the velocity for a minimum of 40 seconds. Note that the velocities may fluctuate in turbulent water, so typical values should be recorded. Repeat the process for each measurement point until LEW is reached. Record completion time and gauge height on the velocity measurement form.

4104 148th Avenue NE
Redmond, Washington 98052

(206) 883-0777

O

PROJECT	
LOCATION	
CONTRACTOR	OWNER
WEATHER	TEMP. ° at AM ° at PM
PRESENT AT SITE	

HE FOLLOWING WAS NOTED:

FIELD REPORT

OPIES TO

SIGNED

Exhibit B

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146- - - -

Sampling Location ______

Technical Procedure Reference(s) ______

Type of Sampler ______

Date ______ Time ______

Media ______ Station ______

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of __ subsamples across channel at depths __ to __ feet below water surface

Sample Description Baseline water quality of

Field Measurements on Sample (pH, conductivity, etc.) temperature __ °C

pH __ dissolved oxygen __ mg/l

conductivity __ umhos/cm turbidity __ NTU

water level - held staff __ staff gage __ Datapod __

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	none
500 ml	plastic bottle	sulfuric acid
250 ml	plastic bottle	nitric acid
250 ml filtered	plastic bottle	nitric acid

WEATHER temperature ______ wind ______

precipitation ______ sunlight ______

Sampler (signature) ______ Date ______

Supervisor (signature) ______ Date ______

Golder Associates

Exhibit C

DISCHARGE MEASUREMENT WITH CURRENT METER

Station No.__________

Date____________________, 19__ Surveyor____________________
Width_________ Area_________ Velocity_________ Discharge__________
Gage Height (fixed)__________ (held)_________ (Datapod)__________
Method_______________ No. sec.______ G.H.change_______ in____ hrs.
Conditions____

Distance from Initial Point	Stream Depth	depth of meter	height of meter	measured velocity	average velocity

APPENDIX B:

GROUNDWATER SAMPLING PROCEDURE

APPENDIX B:

GROUNDWATER SAMPLING PROCEDURE

1. METHOD DESCRIPTION

This method uses portable submersible electric pumps, air diaphragm pumps, or bailers of a suitable diameter and design to extract groundwater samples from the monitored interval. All downhole pumps or bailers shall be designed so that only suitable noncontaminating materials (such as glass, teflon, or appropriate grades of stainless steel) come into contact with the groundwater sample.

2. SAMPLING EQUIPMENT REQUIREMENTS

- portable electric submersible pump or air diaphragm pump with all required tubing and accessories
- electrical water measuring device or steel measuring tape
- teflon or stainless steel bailer, with a bottom check valve
- calibrated pH meter and probe
- pocket thermometer
- calibrated conductivity/temperature probe
- calibrated dissolved oxygen meter
- sufficient quantities of pure deionized distilled rinse water for in-process decontamination of bailers and probes
- small quantity of nitric acid, for preservation of samples for trace metals analysis
- field alkalinity test kit

3. SAMPLING PROCEDURE

3.1 Purge and Stabilize Well

1. Calculate the total well bore storage volume. Subtract the observed depth to water from the logged depth of the well to obtain the actual water column height; add the as-constructed volume of the sand/gravel pack around the well screen.

2. Wells may be sampled using bailers or portable submersible or air bladder style pumps. Either device may be used as a dedicated sampler, (i.e., left in the well and not used to sample other wells) or as a non-dedicated sampler, which may be used to sample other wells. A combination of dedicated and non-dedicated samplers may be used depending on individual well characteristics. Dedicated samplers must be decontaminated with a distilled/deionized water rinse prior to initial installation. Non-dedicated samplers must be similarly decontaminated prior to each use.

Use the sampling device to purge a minimum of two well bore volumes. Purge water must be released onto the surface of the ground at a location where it cannot re-enter the well bore. After two volumes have been purged, measure the conductivity and pH of the purged water at least three times with decontaminated pH, conductivity, and temperature probes to determine if conditions have stabilized. As a general guideline, well conditions will be considered stable if pH readings are within + 0.2 pH units, conductivity is within + 50 millimhos/cm, and temperature readings are within + 0.5 degrees centigrade. Continue pumping until stabilization occurs or five well volumes have been purged; if stabilization has not occurred after five well volumes, the decision to initiate sampling or continue to purge shall be as directed by the Task Leader. A summary of the stabilization process shall be entered in the Field Log along with a description of the well conditions and readings when purging is terminated.

If the well being sampled produces a low yield, it may not be possible to purge two well volumes due to the excessive time required for well recovery. In this case, evacuate at least one complete well volume and allow the well to recover sufficiently to collect a sample. As a general rule, if the well is bailed or pumped dry and does not recover to at least 50% of its initial water level within 30 minutes, use the alternate purging procedure just described. Appropriate entries should be made in the Field Report describing the situation and the actions taken.

3.2 Withdraw Samples

1. When the well has stabilized, the pump shall be activated to obtain groundwater samples, or a sample obtained with a decontaminated downhole bailer. Split the sample between two sample containers (one of which shall have an "M" preparation code for trace metals analysis) and a separate aliquot container for the pH, conductivity, temperature, alkalinity, and dissolved oxygen content measurements described in item 3 below. Immediately measure the temperature of the aliquot sample with a decontaminated pocket thermometer and record on a Field Report from (see Exhibit A).

2. After filling each individual sample container, immediately cap, seal, and record the identification number. Samples for metallic analysis shall be preserved prior to capping by adding nitric acid until the pH is less than 2. Place all samples in a cooler with an icepack that ensures an interior temperature of no more than 4 degrees centigrade. Complete the sample integrity data sheet (Exhibit B).

3. Adjust or calibrate the pH meter, conductivity tester, and dissolved oxygen meter as required. Using the aliquot sample, measure the pH to the nearest 0.1 pH unit with a decontaminated pH probe. Measure conductivity and the temperature at the time of the conductivity reading with a decontaminated probe. Measure dissolved oxygen content. Evaluate turbidity and determine color. Record all values and observations on the Field Report form and or sample integrity data sheet for the corresponding sealed sample.

4. Withdraw the downhole pump equipment from wells not equipped with dedicated sampling devices; all pumps, downhole accessories, bailers, water level measurement devices, and test probes shall be cleaned as required and decontaminated by a final rinse with deionized/distilled water prior to subsequent sampling activities.

5. After completion of all sampling activities, the Task Leader or Field Hydrologist shall ensure that the inner cap is installed on the well and shall lock the protective cover. Record the well closure time on the Field Report form.

4104 148th Avenue NE
Redmond, Washington 98052

(206) 883-0777

O

PROJECT	
LOCATION	
CONTRACTOR	OWNER
WEATHER	TEMP. ° at AM ° at PM
PRESENT AT SITE	

HE FOLLOWING WAS NOTED:

OPIES TO

FIELD REPORT

SIGNED

SAMPLE INTEGRITY DATA SHEET

Plant/Site ______________________ Project No. ______________

Site Location ______________________ Sample ID ______________

Sampling Location ______________________

Technical Procedure Reference(s) ______________________

Type of Sampler ______________________

Date ______________ Time ______________

Media ______________ Station ______________

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

____

____

____

Sample Description ______________________

____

____

Field Measurements on Sample (pH, conductivity, etc.) ______________________

____

____

____

Aliquot Amount	Container	Preservation/Amount

Sampler (signature) ______________________ Date ______________

Supervisor (signature) ______________________ Date ______________

Golder Associates

APPENDIX C

TP-1.4.6

TECHNICAL PROCEDURE FOR WATER LEVEL MEASUREMENT USING A WATER LEVEL SOUNDER OR TAPE MEASURE

1.0 PURPOSE

1.1 This technical procedure is to be used to establish a uniform procedure for measuring water levels in drill holes and piezometers.

2.0 APPLICABILITY

2.1 This technical procedure is applicable to all personnel measuring water levels.

3.0 DEFINITIONS

3.1 Electric Water Level Sounder (EWS). An instrument for measuring water levels in boreholes. An EWS is essentially an open circuit involving an ammeter and battery mounted on a reel on which insulated two-wire electric cord (calibrated by length) is wound. The circuit is closed when the exposed ends of the two wires are immersed in water. Amperage is registered on a meter on the reel.

4.0 REFERENCES

4.1 Cooley, R.L., et al, 1972, Hydrologic Engineering Methods for Water Resources Development, Vol. 10-Principles of Groundwater Hydrology, Section 6.01, U.S. Army Corps of Engineers (HEC-IHD-1000)

5.0 DISCUSSION

5.1 None

6.0 RESPONSIBILITY

6.1 Field Engineer/Geologist: Responsible for measurement in compliance with this technical procedure.

6.2 Task Leader: Responsible for:

- Direct supervision of personnel taking the measurements
- Assurance that equipment and material are available to permit accomplishment of the task

7.0 EQUIPMENT AND MATERIAL

7.1 Electric water-level sounder or measuring tape with a wetting surface.

7.2 Folding rule.

7.3 Field notebook or appropriate Water Level Reading forms (Exhibit A)

7.4 Data on well identification number and locations.

7.5 Spare battery for electric water-level meter.

7.6 Indelible ink pens

8.0 PROCEDURE

8.1 Record well identification number and measuring device type and serial number.

8.2 Each water level sounder or measuring tape used for recording water levels shall have the depth graduations checked with an independent folding rule or measuring tape for calibration prior to use.

8.3 Clean all downhole instruments and equipment before and after measurements between wells. Cleaning shall be with a non-phosphate detergent rinse followed by a rinse with approved tap water, then rinse with organic free distilled/deionized water.

8.4 Measure and record distance from ground level to top of casing or standpipe. Measure the vertical distance from the top of casing or standpipe to the point of the elevation survey mark (if different from top of casing or standpipe).

8.5 Turn on EWS, check battery, lower wire into borehole or standpipe and stop at depth where amperage indicates a completed circuit. Record length of wire below casing collar or top of standpipe to the nearest 0.01 foot. The markings on the wire line need to be independently checked with a measuring tape for accuracy, both above ground and down-hole.

8.6 If a measuring tape is used, lower the tape (with a weight attached) into the borehole. The tape must be lowered a sufficient length to be submerged within the well water and have it's wettable surface corresponding to the surface of the well water. The total length of the tape within the well (from the top of casing or standpipe) and the length of the wetted surface to the submerged end of the tape shall be recorded.

8.7 For verification of the precision of the instrumentation repeat the above process on one randomly selected well per day of active measurement.

8.8 Record date, time well designation, measuring devince and all measurements on a Water Level Readings Form (Exhibit A) in triplicate. The personnel making the measurement shall initial or aasign each measurement recorded. All Water Level Readings Forms shall be hand delivered to the Project Document Custodian.

TP-1.4-6 "Exhibit A"

RECORD OF WATER LEVEL READINGS

Job. No. ______ Project Name ______ Location ______

Bore-Hole No.	Date	Time	Measuring Device/ Serial No.	Measurement Point (M.P.)	Water Level below M.P.	Correction to Survey Mark	Survey Mark Elevation	Water Level Elevation	By	Comments

APPENDIX D

PNEUMATIC PIEZOMETER MEASUREMENT

APPENDIX D

PNEUMATIC PIEZOMETER MEASUREMENT

1. METHOD DESCRIPTION

This method uses a portable pneumatic readout device to measure piezometric pressures in pneumatic piezometers.

2. EQUIPMENT REQUIREMENTS

- Portable pneumatic readout device
- Compressed nitrogen supply

3. MEASUREMENT PROCEDURE

3.1 Fill Readout with Nitrogen

1. Attach compressed nitrogen bottle to supply input fitting on readout device using the included connector.

2. Close the piezo bypass valve on the readout device, open the valve on the external nitrogen bottle and then open the internal supply tank valve on the readout device. Fill the readout internal supply tank using the tank pressure gage to determine when the tank is full.

3. Close the valve on the nitrogen bottle and the internal supply tank valve on the readout device. Disconnect the nitrogen bottle.

4. The internal supply tank will provide sufficient nitrogen for several readings. The external nitrogen supply should be available for filling the internal tank as needed.

3.2 Measure Piezometer Levels

1. Attach the piezometer tubing to the piezometer input fitting on the readout device. Both the piezometer tubing and readout box are equipped with a quick-connect fitting.

2. Open the internal supply tank valve to supply nitrogen to the readout device. The pressure being supplied to the piezometer can be read from the supply pressure gage.

3. Open the piezo bypass valve to pressurize the piezometer tubing. The piezo pressure gage (large gage) will show increased pressure until the supply pressure equals the water pressure at the piezometer tip. Once nitrogen is observed returning up the exhaust tubing on the piezometer, shut off the bypass valve and let the piezo gage stabilize. Record the pressure (psi) on the piezo gage on the Field Report form.

4. Once the reading is taken, turn off the supply valve and disconnect the piezometer tubing from the readout box.

ADDENDA

ADDENDUM 1

HISTORICAL GROUNDWATER MONITORING DATA

Table 1 - Piezometric Head Elevation Data

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-7	1	573.10	8/30/1988	117.00	269.30	842.40	
			9/22/1988	114.00	262.40	835.50	
			11/15/1988	116.50	268.10	841.20	
			11/16/1988	116.00	267.00	840.10	
			11/16/1988	113.00	260.10	833.20	
			11/17/1988	114.50	263.60	836.70	
			11/17/1988	106.00	244.10	817.20	
			11/17/1988	105.00	241.80	814.90	
			11/17/1988	116.50	268.10	841.20	
			11/18/1988	114.95	264.60	837.70	
			3/1/1989	92.50	213.10	786.20	
			3/29/1989	106.00	244.10	817.20	
			4/18/1989	114.90	264.50	837.60	
			6/17/1989	118.00	271.60	844.70	
			7/13/1989	115.90	266.80	839.90	
			8/23/1989	116.00	267.00	840.10	
			9/22/1989	116.00	267.00	840.10	
			10/20/1989	115.00	264.70	837.80	
			6/8/1990	120.00	276.20	849.30	
			7/16/1990	121.00	278.40	851.50	
			8/29/1990	119.00	273.90	847.00	
			9/25/1990	118.50	272.70	845.80	
			11/3/1990	117.00	269.30	842.40	
			10/29/2008	121.60	280.90	854.00	
			10/29/2008	121.70	281.13	854.23	
			10/29/2008	121.80	281.36	854.46	
			1/20/2009	122.70	283.44	856.54	Zero at 2.4, needs gas cap
			1/20/2009	122.80	283.67	856.77	Zero at 2.4, needs gas cap
	2	640.10	8/30/1988	102.00	235.00	875.10	
			9/22/1988	98.00	225.90	866.00	
			11/15/1988	99.00	228.20	868.30	
			11/16/1988	97.00	223.60	863.70	
			11/16/1988	98.00	225.90	866.00	
			11/17/1988	98.95	228.00	868.10	
			11/17/1988	96.00	221.30	861.40	
			11/17/1988	97.50	224.70	864.80	
			11/17/1988	97.00	223.60	863.70	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-7	2	640.10	11/18/1988	96.95	223.50	863.60	
			3/1/1989	98.00	225.90	866.00	
			3/29/1989	98.00	225.90	866.00	
			4/18/1989	96.00	221.30	861.40	
			6/17/1989	99.00	228.20	868.30	
			7/13/1989	97.00	223.60	863.70	
			8/23/1989	97.00	223.60	863.70	
			9/22/1989	97.00	223.60	863.70	
			10/20/1989	96.00	221.30	861.40	
			12/28/1989	94.50	217.80	857.90	
			5/16/1990	100.05	230.60	870.70	
			6/8/1990	100.00	230.40	870.50	
			7/16/1990	101.00	232.70	872.80	
			8/29/1990	100.00	230.40	870.50	
			9/25/1990	98.50	227.00	867.10	
			11/3/1990	98.00	225.90	866.00	
			10/29/2008	100.60	232.39	872.49	
			10/29/2008	100.50	232.16	872.26	
			10/29/2008	100.10	231.23	871.33	
			1/20/2009	101.90	235.39	875.49	Zero at 2.2, needs small cap
			1/20/2009	101.80	235.16	875.26	Zero at 2.2, needs small cap
	3	698.10	8/30/1988	68.00	156.90	855.00	
			9/22/1988	65.00	150.00	848.10	
			11/15/1988	66.50	153.50	851.60	
			11/16/1988	66.95	154.50	852.60	
			11/16/1988	65.00	150.00	848.10	
			11/17/1988	65.00	150.00	848.10	
			11/17/1988	66.00	152.30	850.40	
			11/18/1989	65.00	150.00	848.10	
			3/1/1989	66.20	152.80	850.90	
			3/29/1989	66.00	152.30	850.40	
			4/18/1989	65.00	150.00	848.10	
			6/17/1989	67.00	154.60	852.70	
			7/13/1989	65.00	150.00	848.10	
			8/23/1989	66.50	151.20	849.30	
			9/22/1989	66.00	152.30	850.40	
			10/20/1989	66.50	153.50	851.60	
			12/28/1989	64.00	147.70	845.80	
			5/16/1990	69.95	161.40	859.50	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-7	3	698.10	6/8/1990	69.90	161.30	859.40	
			7/16/1990	70.00	161.50	859.60	
			8/29/1990	70.00	161.50	859.60	
			9/25/1990	67.95	156.80	854.90	
			11/3/1990	66.00	152.30	850.40	
PB-8	1	590.20	8/30/1988	114.00	280.20	870.40	
			9/22/1988	112.00	275.30	865.50	
			11/15/1988	114.50	281.50	871.70	
			11/16/1988	115.00	282.70	872.90	
			11/16/1988	113.95	280.10	870.30	
			11/16/1988	114.00	280.20	870.40	
			11/17/1988	113.00	277.80	868.00	
			11/17/1988	113.50	279.00	869.20	
			11/17/1988	114.00	280.20	870.40	
			11/17/1988	113.95	280.10	870.30	
			11/18/1988	113.00	277.80	868.00	
			11/18/1988	102.95	253.20	843.40	
			3/1/1989	112.00	275.30	865.50	
			3/29/1989	115.00	282.70	872.90	
			4/18/1989	114.00	280.20	870.40	
			6/17/1989	118.00	290.00	880.20	
			7/13/1989	115.00	282.70	872.90	
			8/23/1989	112.00	275.30	865.50	
			9/22/1989	115.50	283.90	874.10	
			10/20/1989	116.50	286.30	876.50	
			12/29/1989	100.00	246.00	836.20	
			6/8/1990	120.00	294.90	885.10	
			7/16/1990	121.00	297.30	887.50	
			8/29/1990	100.00	246.00	836.20	
			9/25/1990	118.00	290.00	880.20	
			11/3/1990	116.00	285.10	875.30	
			10/29/2008	123.80	285.98	876.18	
			10/29/2008	124.00	286.44	876.64	
			1/21/2009	125.10	288.98	879.18	Zero at 3.0
			1/21/2009	125.00	288.75	878.95	Zero at 3.0
	2	665.70	8/30/1988	81.00	188.30	854.00	
			9/22/1988	60.00	140.10	805.80	
			11/15/1988	82.00	190.50	856.20	
			11/16/1988	81.00	188.30	854.00	
			11/16/1988	82.00	190.50	856.20	
			11/17/1988	81.50	189.40	855.10	
			11/17/1988	81.95	190.40	856.10	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-8	2	665.70	11/17/1988	80.00	186.00	851.70	
			11/17/1988	81.00	188.30	854.00	
			11/18/1988	80.00	186.00	851.70	
			11/18/1988	80.95	188.10	853.80	
			3/1/1989	82.00	190.50	856.20	
			3/29/1989	82.00	190.50	856.20	
			4/18/1989	82.00	190.50	856.20	
			6/17/1989	86.00	199.70	865.40	
			7/13/1989	82.50	191.70	857.40	
			8/23/1989	83.00	192.80	858.50	
			9/22/1989	83.00	192.80	858.50	
			10/20/1989	83.50	194.00	859.70	
			12/29/1989	81.90	190.30	856.00	
			5/16/1990	85.75	199.10	864.80	
			6/8/1990	87.50	203.10	868.80	
			7/16/1990	88.00	204.30	870.00	
			8/29/1990	86.95	201.90	867.60	
			9/25/1990	86.00	199.70	865.40	
			11/3/1990	86.00	199.70	865.40	
			10/29/2008	88.10	203.51	869.21	
			10/29/2008	88.90	205.36	871.06	
			1/21/2009	89.60	206.98	872.68	Zero at 3.0
			1/21/2009	89.90	207.67	873.37	Zero at 3.0
	3	717.70	8/30/1988	60.00	138.80	856.50	
			9/22/1988	58.00	134.30	852.00	
			11/15/1988	59.95	138.70	856.40	
			11/16/1988	60.00	138.80	856.50	
			11/16/1988	58.00	134.80	852.00	
			11/16/1988	58.95	136.40	854.10	
			11/17/1988	57.00	132.00	849.70	
			11/17/1988	58.00	134.30	852.00	
			11/17/1988	58.50	135.40	853.10	
			11/18/1988	58.00	134.30	852.00	
			11/18/1988	57.95	134.10	851.80	
			3/1/1989	50.95	118.10	835.80	
			3/29/1989	60.00	138.80	856.50	
			4/18/1989	58.00	134.40	852.00	
			6/17/1989	62.00	143.40	861.10	
			7/13/1989	59.00	136.50	854.20	
			8/23/1989	59.00	136.00	854.20	
			9/22/1989	59.00	136.50	854.20	
			10/20/1989	60.00	138.80	856.50	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-8	3	717.7	12/29/1989	59.00	136.50	854.20	
			5/16/1990	60.75	140.60	858.30	
			6/8/1990	53.00	122.80	840.50	
			7/16/1990	63.50	146.90	864.60	
			8/29/1990	63.00	145.70	863.40	
			9/25/1990	62.00	143.40	861.10	
			11/3/1990	60.00	138.80	856.50	
			10/29/2008	64.80	149.69	867.39	
			1/21/2009	66.50	153.62	871.32	Zero at 2.9
			1/21/2009	66.60	153.85	871.55	Zero at 2.9
PB-12	1	760.30	10/15/1988	104.00	239.80	1000.10	
			11/9/1988	106.00	244.40	1004.70	
			11/10/1988	106.01	244.40	1004.70	
			11/10/1988	107.80	248.60	1008.90	
			11/11/1988	105.00	242.10	1002.40	
			11/11/1988	104.00	239.80	1000.10	
			11/11/1988	105.80	244.00	1004.30	
			11/12/1988	106.00	244.40	1004.70	
			11/13/1988	106.00	245.60	1004.70	
			11/14/1988	106.50	245.60	1005.90	
			11/14/1988	107.00	246.70	1004.70	
			11/14/1988	106.00	244.40	1005.90	
			11/15/1988	106.00	244.40	1004.70	
			11/15/1988	106.50	245.60	1005.90	
			11/15/1988	107.50	247.90	1008.20	
			2/28/1989	105.00	242.10	1002.40	
			3/29/1989	106.00	244.40	1004.70	
			4/19/1989	106.00	244.40	1004.70	
			6/8/1989	110.00	253.60	1013.90	
			6/17/1989	108.00	249.00	1009.30	
			7/13/1989	108.00	249.00	1009.30	
			8/23/1989	107.00	246.70	1007.00	
			9/22/1989	4107.50	247.90	1008.20	
			10/20/1989	107.00	246.70	1007.00	
			12/28/1989	106.00	244.40	1004.70	
			6/8/1990	110.00	253.60	1013.90	
			7/16/1990	112.00	258.20	1018.50	
			8/29/1990	111.00	255.90	1016.20	
			9/25/1990	108.50	250.20	1010.50	
			11/3/1990	100.00	230.60	990.90	
			10/27/2008	117.10	270.50	1030.80	
			10/27/2008	117.30	270.96	1031.26	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-12	1	760.30	1/20/2009	117.80	272.12	1032.42	Zero at 2.3
			1/20/2009	117.90	272.35	1032.65	Zero at 2.3
	2	868.70	10/15/1988	68.00	157.00	1025.70	
			11/9/1988	74.00	170.70	1039.40	
			11/10/1988	74.50	171.80	1040.50	
			11/10/1988	73.95	170.60	1039.30	
			11/10/1988	75.90	175.10	1043.80	
			11/11/1988	71.00	163.80	1032.50	
			11/11/1988	70.40	162.50	1031.20	
			11/11/1988	70.00	161.50	1030.20	
			11/11/1988	71.50	165.00	1033.70	
			11/12/1988	60.00	138.60	1007.30	
			11/13/1988	72.00	166.10	1034.80	
			11/14/1988	71.95	166.00	1034.70	
			11/14/1988	72.95	168.30	1037.00	
			11/14/1988	73.00	168.40	1037.10	
			11/14/1988	62.00	143.20	1011.90	
			11/14/1988	72.00	166.10	1034.80	
			11/15/1988	70.50	162.70	1031.40	
			11/15/1988	71.00	163.80	1032.50	
			11/15/1988	70.00	161.50	1030.20	
			11/15/1988	71.95	166.00	1034.70	
			2/28/1989	72.50	167.30	1036.00	
			3/29/1989	74.00	170.70	1039.40	
			4/19/1989	74.00	170.70	1039.40	
			6/17/1989	75.00	173.00	1041.70	
			7/13/1989	75.90	175.10	1043.80	
			8/23/1989	74.50	171.80	1040.50	
			9/22/1989	76.00	175.30	1044.00	
			10/20/1989	74.00	170.70	1039.40	
			12/28/1989	74.00	170.70	1039.40	
			5/16/1990	80.00	184.40	1053.10	
			6/8/1990	80.00	184.40	1053.10	
			7/16/1990	80.00	184.40	1053.10	
			8/29/1990	78.50	181.00	1049.70	
			9/25/1990	77.00	177.60	1046.30	
			11/3/1990	76.00	175.30	1044.00	
			10/27/2008	78.20	180.64	1049.34	
			10/27/2008	78.30	180.87	1049.57	
			1/20/2009	78.50	181.34	1050.04	Zero at 2.1
			1/20/2009	79.00	182.49	1051.19	Zero at 2.1
			1/20/2009	78.90	182.26	1050.96	Zero at 2.1

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)^1	Water Level Elevation (feet amsl)^2	Field Notes^3
PB-12	3	952.50	10/15/1988	24.00	56.70	1009.20	
			11/9/1988	39.50	92.20	1044.70	
			11/10/1988	25.50	60.20	1012.70	
			11/10/1988	40.90	95.40	1047.90	
			11/10/1988	39.90	93.20	1045.70	
			11/11/1988	38.00	88.80	1041.30	
			11/11/1988	39.80	92.90	1045.40	
			11/11/1988	40.10	93.60	1046.10	
			11/12/1989	38.00	88.80	1041.30	
			11/13/1988	40.00	93.40	1045.90	
			11/14/1988	40.00	93.40	1045.90	
			11/14/1988	39.50	92.20	1044.70	
			11/14/1988	39.95	93.30	1045.80	
			11/15/1988	39.50	92.20	1044.70	
			11/15/1988	38.00	88.80	1041.30	
			11/15/1988	39.00	91.10	1043.60	
			2/28/1989	38.50	89.90	1042.40	
			3/29/1989	39.00	91.10	1043.60	
			4/19/1989	39.00	91.10	1043.60	
			6/17/1989	40.00	93.40	1045.90	
			7/13/1989	41.00	95.70	1048.20	
			8/23/1989	39.50	92.20	1044.70	
			9/22/1989	40.00	95.70	1048.20	
			10/20/1989	39.00	91.10	1043.60	
			12/28/1989	40.00	93.40	1045.90	
			5/16/1990	40.95	95.60	1048.10	
			6/8/1990	45.00	104.80	1057.30	
			7/16/1990	45.00	104.90	1057.40	
			8/29/1990	44.00	102.60	1055.10	
			9/25/1990	43.00	100.30	1052.80	
			11/3/1990	42.00	98.00	1050.50	
			10/27/2008	41.20	95.17	1047.67	
			10/27/2008	41.10	94.94	1047.44	
			10/27/2008	41.40	95.63	1048.13	
			1/20/2009	42.70	98.64	1051.14	Zero at 2.1
	4	987.50	8/31/1988	0.00	1.10	988.60	
			11/9/1988	25.00	58.40	1045.90	
			11/10/1988	25.90	60.50	1048.00	
			11/10/1988	40.00	92.80	1080.30	
			11/10/1988	26.00	60.70	1048.20	
			11/11/1988	26.50	61.80	1049.30	
			11/11/1988	25.00	58.40	1045.90	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-12	4	987.50	11/11/1988	26.00	60.70	1048.20	
			11/11/1988	27.00	63.00	1050.50	
			11/12/1989	26.00	60.70	1048.20	
			11/13/1989	26.00	60.70	1048.20	
			11/14/1988	29.95	69.70	1057.20	
			11/14/1988	27.95	65.20	1052.70	
			11/14/1988	26.00	60.70	1048.20	
			11/14/1988	26.50	61.80	1049.30	
			11/15/1989	25.00	58.40	1045.90	
			11/15/1989	26.00	60.70	1048.20	
			2/28/1989	24.00	56.10	1043.60	
			3/29/1989	26.00	60.70	1048.20	
			4/19/1989	25.90	60.50	1048.00	
			8/23/1989	25.00	58.40	1045.90	
			9/22/1989	27.00	63.00	1050.50	
			10/20/1989	25.00	58.40	1045.90	
			12/28/1989	24.00	56.10	1043.60	
			5/16/1990	25.85	60.30	1047.80	
			6/8/1990	30.00	69.90	1057.40	
			6/17/1989	26.00	60.70	1048.20	
			7/13/1989	26.00	60.70	1048.20	
			7/16/1990	29.00	67.60	1055.10	
			8/29/2009	29.00	67.60	1055.10	
			9/25/1990	28.00	65.30	1052.80	
			11/3/1990	28.00	65.30	1052.80	
			10/27/2008	26.60	61.45	1048.95	
			10/27/2008	26.70	61.68	1049.18	
			1/20/2009	28.20	65.14	1052.64	Zero at 2.1
			1/20/2009	28.10	64.91	1052.41	Zero at 2.1
PB-13	1	747.80	8/27/1988	130.00	299.20	1047.00	
			8/30/1988	130.00	299.20	1047.00	
			9/22/1988	129.00	296.90	1044.70	
			10/15/1988	128.00	294.70	1042.50	
			11/9/1988	129.70	298.60	1046.40	
			11/10/1988	130.00	299.20	1047.00	
			11/10/1988	31.00	72.10	819.90	
			11/11/1988	128.00	294.70	1042.50	
			11/11/1988	129.00	296.90	1044.70	
			11/11/1988	128.20	295.10	1042.90	
			11/12/1988	129.00	296.90	1044.70	
			11/13/1989	130.00	299.20	1047.00	
			11/14/1988	131.50	302.70	1050.50	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-13	1	747.80	11/14/1988	129.95	299.10	1046.90	
			11/14/1988	130.00	299.20	1047.00	
			11/15/1988	131.00	301.50	1049.30	
			11/15/1988	130.00	299.20	1047.00	
			2/28/1989	129.00	296.90	1044.70	
			3/29/1989	129.00	296.90	1044.70	
			4/19/1989	129.50	298.10	1045.90	
			6/17/1989	132.00	303.80	1051.60	
			7/13/1989	131.50	302.70	1050.50	
			8/23/1989	130.00	299.20	1047.00	
			9/22/1989	130.00	299.20	1047.00	
			10/21/1989	128.50	295.80	1043.60	
			12/27/1989	130.00	299.20	1047.00	
			6/8/1990	132.50	305.00	1052.80	
			7/16/1990	136.00	313.00	1060.80	
			8/29/1990	133.95	308.30	1056.10	
			9/25/1990	132.00	303.80	1051.60	
			11/3/1990	132.00	303.80	1051.60	
			10/27/2008	135.30	312.54	1060.34	
			10/27/2008	134.40	310.46	1058.26	
			10/27/2008	134.50	310.70	1058.50	
			1/19/2009	135.60	313.24	1061.04	Zero at 2.4
			1/19/2009	136.60	315.55	1063.35	Zero at 2.4
	2	825.80	8/27/1988	97.00	223.80	1049.60	
			8/30/1988	95.00	219.30	1045.10	
			9/22/1988	96.00	221.60	1047.40	
			10/15/1988	95.00	219.30	1045.10	
			11/9/1988	96.00	221.60	1047.40	
			11/10/1988	98.00	226.10	1051.90	
			11/10/1988	96.00	221.60	1047.70	
			11/10/1988	96.50	222.70	1048.50	
			11/11/1988	96.00	221.60	1047.40	
			11/11/1988	97.00	223.80	1049.60	
			11/12/1988	97.00	223.80	1049.60	
			11/13/1988	97.95	226.00	1051.80	
			11/14/1988	96.95	223.70	1049.50	
			11/14/1988	96.00	221.60	1047.40	
			11/14/1988	97.00	223.80	1049.60	
			11/14/1988	97.95	226.00	1051.80	
			11/15/1988	97.95	226.00	1051.80	
			11/15/1988	97.00	223.80	1049.60	
			11/15/1988	96.50	222.70	1048.50	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)^1	Water Level Elevation (feet amsl)^2	Field Notes^3
PB-13	2	825.80	2/28/1989	96.00	221.60	1047.40	
			3/29/1989	96.00	221.60	1047.40	
			4/19/1989	96.00	221.60	1047.40	
			6/17/1989	98.00	226.10	1051.90	
			7/13/1989	98.00	226.10	1051.90	
			8/23/1989	97.00	223.80	1049.60	
			9/22/1989	97.50	225.00	1050.80	
			10/21/1989	96.00	221.60	1047.40	
			12/27/1989	98.00	226.10	1051.90	
			6/8/1990	101.00	233.00	1058.80	
			7/16/1990	102.00	235.30	1061.10	
			8/29/1990	100.00	230.70	1056.50	
			9/25/1990	100.00	230.70	1056.50	
			11/3/1990	100.00	230.70	1056.50	
			10/27/2008	99.20	229.15	1054.95	
			10/27/2008	100.40	231.92	1057.72	
			1/19/2009	102.50	236.78	1062.58	Zero at 2.3
			1/19/2009	101.80	235.16	1060.96	Zero at 2.3
			1/19/2009	102.20	236.08	1061.88	Zero at 2.3
	3	880.80	8/27/1988	76.00	175.50	1056.30	
			8/30/1988	74.00	171.00	1051.80	
			9/22/1988	74.00	171.00	1051.80	
			10/15/1988	75.00	173.20	1054.00	
			11/9/1988	76.00	175.50	1056.30	
			11/10/1988	76.20	176.00	1056.80	
			11/10/1988	77.90	179.90	1060.70	
			11/10/1988	76.10	175.80	1056.60	
			11/11/1988	76.50	176.70	1057.50	
			11/11/1988	76.00	175.50	1056.30	
			11/12/1988	77.00	177.80	1058.60	
			11/13/1988	77.00	177.80	1058.60	
			11/14/1988	77.00	177.80	1058.60	
			11/14/1988	76.00	175.50	1056.30	
			11/14/1988	76.95	177.70	1058.50	
			11/15/1988	76.00	175.50	1056.30	
			11/15/1988	76.50	176.70	1057.50	
			11/15/1988	66.50	153.70	1034.50	
			2/28/1989	64.50	149.20	1030.00	
			3/29/1989	74.00	171.00	1051.80	
			4/19/1989	74.00	171.00	1051.80	
			6/17/1989	78.00	180.10	1060.90	
			7/13/1989	77.50	179.00	1059.80	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-13	3	880.80	8/23/1989	77.00	177.80	1058.60	
			9/22/1989	76.00	175.50	1056.30	
			10/21/1989	75.90	175.30	1056.10	
			12/27/1989	77.50	179.00	1059.80	
			5/16/1990	80.75	186.40	1067.20	
			6/8/1990	82.00	189.30	1070.10	
			7/16/1990	81.90	189.10	1069.90	
			8/29/1990	79.00	182.40	1063.20	
			9/25/1990	78.00	180.10	1060.90	
			11/3/1990	79.00	182.40	1063.20	
			10/27/2008	79.20	182.95	1063.75	
			10/27/2008	79.60	183.88	1064.68	
			1/19/2009	80.80	186.65	1067.45	Zero at 2.3
			1/19/2009	80.70	186.42	1067.22	Zero at 2.3
	4	970.80	8/27/1988	38.00	88.10	1058.90	
			8/30/1988	46.00	106.40	1077.20	
			9/22/1988	35.00	81.20	1052.00	
			10/15/1988	35.00	81.20	1052.00	
			11/9/1988	36.00	83.50	1054.30	
			11/10/1988	36.10	83.70	1054.50	
			11/10/1988	36.59	84.90	1055.70	
			11/10/1988	37.95	88.00	1058.80	
			11/11/1988	38.00	88.10	1058.90	
			11/11/1988	37.50	86.90	1057.70	
			11/12/1988	37.00	85.80	1056.60	
			11/13/1988	38.00	88.10	1058.90	
			11/14/1988	38.95	90.30	1061.10	
			11/14/1988	37.00	85.80	1056.60	
			11/14/1988	37.95	88.00	1058.80	
			11/14/1988	36.95	85.70	1056.50	
			11/14/1988	37.50	86.90	1057.70	
			5/16/1990	40.50	93.80	1064.60	
			11/15/1988	37.00	85.80	1056.60	
			2/28/1989	38.00	88.10	1058.90	
			3/29/1989	37.00	85.80	1056.60	
			4/19/1989	36.00	83.50	1054.30	
			6/17/1989	38.00	88.10	1058.90	
			7/13/1989	37.50	86.90	1057.70	
			8/23/1989	37.00	85.80	1056.60	
			9/22/1989	38.00	88.10	1058.90	
			10/21/1989	36.00	83.50	1054.30	
			12/27/1989	38.00	88.10	1058.90	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-13	4	970.8	6/8/1990	40.50	93.80	1064.60	
			7/16/1990	40.00	92.70	1063.50	
			8/29/1990	39.95	92.50	1063.30	
			9/25/1990	40.00	92.70	1063.50	
			11/3/1990	39.95	92.50	1063.30	
			10/27/2008	38.90	89.86	1060.66	
			10/27/2008	38.80	89.63	1060.43	
			1/19/2009	41.10	94.94	1065.74	Zero at 2.3
PB-60	1	716.20	8/27/1988	67.00	154.30	870.50	
			8/30/1988	57.00	131.40	847.50	
			9/22/1988	65.00	149.70	865.90	
			11/15/1988	57.00	131.40	847.60	
			11/16/1988	66.00	152.00	868.20	
			11/16/1988	67.00	154.30	870.50	
			11/17/1988	65.50	150.90	867.10	
			11/17/1988	65.00	149.70	865.90	
			11/17/1988	66.00	152.00	868.20	
			11/17/1988	66.50	153.20	869.40	
			11/18/1988	65.50	150.90	867.10	
			3/1/1989	66.00	152.00	868.20	
			3/29/1989	66.00	152.00	868.20	
			4/18/1989	66.00	152.00	868.20	
			6/17/1989	67.00	154.30	870.50	
			7/13/1989	56.00	129.10	845.30	
			8/23/1989	66.00	152.00	868.20	
			9/22/1989	67.00	154.30	870.50	
			10/20/1989	66.00	152.00	868.20	
			12/29/1989	79.90	183.80	900.00	
			5/16/1990	70.25	161.80	878.00	
			6/8/1990	79.85	183.70	899.90	
			7/16/1990	70.90	163.20	879.40	
			8/29/1990	70.00	161.20	877.40	
			9/25/1990	58.95	135.90	852.10	
			11/3/1990	68.00	156.60	872.80	
	2	774.50	8/27/1988	42.00	100.60	875.10	
			8/30/1988	43.00	102.80	877.30	
			9/22/1988	41.00	98.30	872.80	
			11/15/1988	42.00	100.60	875.10	
			11/16/1988	41.00	98.30	872.80	
			11/16/1988	42.00	100.60	875.10	
			11/17/1988	41.00	98.30	872.80	
			11/17/1988	42.00	100.60	875.10	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-60	2	774.50	11/17/1988	41.50	99.40	873.90	
			11/17/1988	40.95	98.20	872.70	
			11/18/1988	41.00	98.30	872.80	
			3/1/1989	41.95	100.40	874.90	
			3/29/1989	41.00	98.30	872.80	
			4/18/1989	42.00	100.60	875.10	
			6/17/1989	42.00	100.60	875.10	
			7/13/1989	42.00	100.60	875.10	
			8/23/1989	41.00	98.30	872.80	
			9/22/1989	62.50	147.30	921.80	
			10/20/1989	42.00	100.60	875.10	
			12/29/1989	40.50	97.10	871.60	
			5/16/1990	45.15	107.80	882.30	
			6/8/1990	40.55	97.30	871.80	
			7/16/1990	45.90	109.50	884.00	
			8/29/1990	46.00	109.70	884.20	
			9/25/1990	45.00	107.40	881.90	
			11/3/1990	44.00	105.10	879.60	
PB-88	1	820.80	8/30/1988	67.00	154.60	975.40	
			11/9/1988	66.50	153.40	974.20	
			11/10/1988	67.89	156.60	977.40	
			11/13/1988	67.95	156.80	977.60	
			3/1/1989	68.00	156.90	977.70	
			3/29/1989	66.00	152.30	973.10	
			4/19/1989	68.00	156.90	977.70	
			6/17/1989	69.00	159.20	980.00	
			7/13/1989	69.00	159.20	980.00	
			8/23/1989	70.00	161.50	982.30	
			9/22/1989	70.00	161.50	982.30	
			10/20/1989	69.00	159.20	980.00	
			12/28/1989	68.00	156.90	977.70	
			5/16/1990	70.85	163.40	984.20	
			6/8/1990	73.50	169.50	990.30	
			7/16/1990	74.00	170.60	991.40	
			8/29/1990	71.95	165.90	986.70	
			9/25/1990	71.00	163.80	984.60	
			11/3/1990	70.00	161.50	982.30	
			1/20/2009	74.30	171.63	992.43	Zero at 2.3
			1/20/2009	74.40	171.86	992.66	Zero at 2.3
			1/20/2009	74.80	172.79	993.59	Zero at 2.3
			10/29/2008	73.40	169.55	990.35	
			10/29/2008	73.10	168.86	989.66	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-92	1	681.50	6/8/1990	135.00	310.20	991.70	
			7/16/1990	136.00	312.50	994.00	
			8/29/1990	134.00	307.90	989.40	
			9/25/1990	132.95	305.50	987.00	
			11/3/1990	132.00	303.30	984.80	
			1/20/2009	144.50	333.80	1015.30	Zero at 2.3, needs cover bag for piezo ends
			1/20/2009	144.80	334.49	1015.99	Zero at 2.3, needs cover bag for piezo ends
			1/20/2009	145.20	335.41	1016.91	Zero at 2.3, needs cover bag for piezo ends
			10/27/2008	144.40	333.56	1015.06	
			10/27/2008	144.50	333.80	1015.30	
	2	752.90	6/8/1990	138.00	317.30	1070.20	
			7/16/1990	136.25	313.30	1066.20	
			8/29/1990	133.00	305.90	1058.80	
			9/25/1990	134.00	308.10	1061.00	
			11/3/1990	133.00	305.90	1058.80	
			1/20/2009	138.00	318.78	1071.68	Zero at 2.1
			1/20/2009	138.20	319.24	1072.14	Zero at 2.1
			1/20/2009	138.30	319.47	1072.37	Zero at 2.1
			10/27/2008	137.30	317.16	1070.06	
			10/27/2008	138.10	319.01	1071.91	
	3	822.40	12/28/1989	103.90	239.10	1061.50	
			6/8/1990	109.00	250.80	1073.20	
			7/16/1990	110.00	253.10	1075.50	
			8/29/1990	107.00	246.20	1068.60	
			9/25/1990	106.00	243.90	1066.30	
			11/3/1990	106.00	243.90	1066.30	
			1/20/2009	110.20	254.56	1076.96	Zero at 2.1
			1/20/2009	110.10	254.33	1076.73	Zero at 2.1
			10/27/2008	109.20	252.25	1074.65	
			10/27/2008	109.40	252.71	1075.11	
PB-100	1	679.60	8/27/1988	147.60	340.90	1020.50	
			8/30/1988	96.00	222.40	902.00	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-100	1	679.60	9/22/1988	89.40	207.30	886.90	
			11/9/1988	86.50	200.60	880.20	
			11/10/1988	87.90	203.80	883.40	
			11/12/1988	76.95	178.70	858.30	
			11/13/1988	78.00	181.10	860.70	
			11/14/1988	77.95	181.00	860.60	
			3/1/1989	112.00	259.10	938.70	
			3/29/1989	114.00	263.70	943.30	
			4/19/1989	118.00	272.90	952.50	
			6/17/1989	123.00	284.40	964.00	
			7/13/1989	122.50	283.20	962.80	
			8/23/1989	124.50	287.80	967.40	
			9/22/1989	126.00	291.30	970.90	
			10/20/1989	124.00	286.70	966.30	
			12/28/1989	126.00	291.30	970.90	
			6/8/1990	135.00	311.90	991.50	
			7/16/1990	136.00	314.20	993.80	
			8/29/1990	134.00	309.60	989.20	
			9/25/1990	133.00	307.30	986.90	
			11/3/1990	134.00	309.60	989.20	
			10/27/2008	153.40	354.35	1033.95	
			10/27/2008	153.50	354.59	1034.19	
			10/27/2008	153.20	353.89	1033.49	
			1/20/2009	153.30	354.12	1033.72	Zero at 2.3, needs larger lock
			1/20/2009	152.90	353.20	1032.80	Zero at 2.3, needs larger lock
			1/20/2009	153.20	353.89	1033.49	Zero at 2.3, needs larger lock
	2	922.10	8/27/1988	58.00	134.50	1056.60	
			8/30/1988	57.00	132.20	1054.30	
			9/22/1988	57.30	132.90	1055.00	
			11/9/1988	57.00	132.00	1054.30	
			11/12/1988	57.90	134.30	1056.40	
			11/12/1988	57.00	132.20	1054.30	
			11/13/1988	58.00	134.50	1056.60	
			11/14/1988	57.95	134.40	1056.50	
			3/1/1989	57.90	134.30	1056.40	
			3/29/1989	56.00	129.90	1052.00	
			4/19/1989	66.50	154.00	1076.10	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)^1	Water Level Elevation (feet amsl)^2	Field Notes^3
PB-100	2	922.10	6/17/1989	58.00	134.50	1056.60	
			7/13/1989	57.00	132.20	1054.30	
			8/23/1989	57.00	132.20	1054.30	
			9/22/1989	58.00	134.50	1056.60	
			10/20/1989	57.00	132.20	1054.30	
			12/28/1989	58.00	134.50	1056.60	
			5/16/1990	55.15	128.00	1050.10	
			6/8/1990	51.00	118.40	1040.50	
			8/29/1990	57.00	132.20	1054.30	
			9/25/1990	58.00	134.50	1056.60	
			11/3/1990	58.00	134.50	1056.60	
			1/20/2009	63.00	145.53	1067.63	Zero at 2.2, had frozen plug, needs dust cap
			1/20/2009	63.10	145.76	1067.86	Zero at 2.2, had frozen plug, needs dust cap
PB-101	2	562.30	8/30/1988	80.00	184.30	746.60	
			9/22/1988	78.00	179.70	742.00	
			4/18/1989	77.00	177.40	739.70	
			1/2/1990	76.00	175.20	737.50	
			5/16/1990	80.75	186.00	748.30	
			6/8/1990	81.00	186.60	748.90	
			7/16/1990	82.00	188.90	751.20	
			8/29/1990	81.50	187.70	750.00	
			9/25/1990	80.00	184.30	746.60	
			10/29/2008	83.80	193.58	755.88	
			10/29/2008	83.60	193.58	755.88	
			10/29/2008	83.70	193.35	755.65	
			1/20/2009	84.60	195.43	757.73	Zero at 2.1
			1/20/2009	84.70	195.66	757.96	Zero at 2.1
	3	617.80	8/30/1988	40.00	93.20	711.00	
			3/29/1989	38.00	88.60	706.40	
			4/18/1989	36.50	85.10	702.90	
			6/17/1989	41.00	95.50	713.30	
			7/13/1989	42.00	97.70	715.50	
			1/3/1990	38.00	88.60	706.40	
			5/16/1990	45.45	105.70	723.50	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-101	3	617.80	6/8/1990	44.95	104.50	722.30	
			7/16/1990	44.00	102.30	720.10	
			8/29/1990	42.00	97.70	715.50	
			9/25/1990	44.00	102.30	720.10	
			10/29/2008	42.00	97.02	714.82	
			1/20/2009	41.80	96.56	714.36	Zero at 2.1
			1/20/2009	41.70	96.33	714.13	Zero at 2.1
PB-102	1	712.60	9/22/1988	139.00	320.00	1032.60	
			10/15/1988	135.00	310.80	1023.40	
			11/9/1988	136.00	313.10	1025.70	
			11/10/1988	138.00	317.70	1030.30	
			11/11/1988	131.00	301.60	1014.20	
			11/11/1988	130.50	300.50	1013.10	
			11/12/1988	132.00	303.90	1016.50	
			11/13/1988	134.50	309.70	1022.30	
			11/14/1988	135.00	310.80	1023.40	
			11/14/1988	136.00	313.10	1025.70	
			11/14/1988	134.00	308.50	1021.10	
			11/15/1988	134.00	308.50	1021.10	
			2/28/1989	136.00	313.10	1025.70	
			3/29/1989	136.00	313.10	1025.70	
			4/19/1989	137.50	316.60	1029.20	
			6/17/1989	140.00	322.30	1034.90	
			7/13/1989	139.00	320.00	1032.60	
			8/23/1989	138.00	317.70	1030.30	
			9/22/1989	139.50	321.10	1033.70	
			10/21/1989	136.00	313.10	1025.70	
			12/20/1989	138.00	317.70	1030.30	
			6/8/1990	143.00	329.20	1041.80	
			7/16/1990	144.00	331.50	1044.10	
			8/29/1990	141.95	326.80	1039.40	
			9/25/1990	140.00	322.30	1034.90	
			11/3/1990	142.00	326.90	1039.50	
			10/27/2008	142.30	328.71	1041.31	
			10/27/2008	142.00	328.02	1040.62	
			10/27/2008	142.20	328.48	1041.08	
			1/19/2009	144.20	333.10	1045.70	Zero at 2.4
			1/19/2009	144.50	333.80	1046.40	Zero at 2.4
	2	819.10	9/22/1988	83.00	191.50	1010.60	
			10/15/1988	81.00	186.90	1006.00	
			11/9/1988	80.50	185.80	1004.90	
			11/10/1988	82.00	189.20	1008.30	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-102	2	819.10	11/10/1988	81.95	189.10	1008.20	
			11/10/1988	81.00	186.90	1006.00	
			11/11/1988	81.00	186.90	1006.00	
			11/11/1988	83.00	191.50	1010.60	
			11/12/1988	81.95	189.10	1008.20	
			11/13/1988	82.00	189.20	1008.30	
			11/14/1988	80.95	186.80	1005.90	
			11/14/1988	72.00	166.30	985.40	
			11/14/1988	82.00	189.20	1008.30	
			11/14/1988	81.95	189.10	1008.20	
			11/14/1988	82.00	189.20	1008.30	
			11/14/1988	81.00	186.90	1006.00	
			11/15/1988	81.95	189.10	1008.20	
			11/15/1988	82.00	189.20	1008.30	
			2/28/1989	80.00	184.60	1003.70	
			3/29/1989	82.00	189.20	1008.30	
			4/19/1989	82.00	189.20	1008.30	
			6/17/1989	82.00	189.20	1008.30	
			7/13/1989	132.00	304.00	1123.10	
			8/23/1989	81.00	186.90	1006.00	
			9/22/1989	83.90	193.60	1012.70	
			10/21/1989	81.00	186.90	1006.00	
			12/23/1989	80.00	184.60	1003.70	
			5/16/1990	85.75	197.80	1016.90	
			6/8/1990	85.90	198.20	1017.30	
			7/16/1990	86.00	198.40	1017.50	
			9/25/1990	84.00	193.80	1012.90	
			11/3/1990	84.00	193.80	1012.90	
			10/27/2008	87.50	202.13	1021.23	
			10/27/2008	87.20	201.43	1020.53	
			1/19/2009	87.40	201.89	1020.99	Zero at 2.3
			1/19/2009	88.00	203.28	1022.38	Zero at 2.3
			1/19/2009	88.40	204.20	1023.30	Zero at 2.3
	3	875.60	11/9/1988	64.00	147.70	1023.30	
			11/10/1988	65.00	150.00	1025.60	
			11/10/1988	64.50	148.90	1024.50	
			11/10/1988	64.95	149.90	1025.50	
			11/11/1988	65.00	150.00	1025.60	
			11/11/1988	69.00	159.20	1034.80	
			11/12/1988	65.00	150.00	1025.60	
			11/13/1988	65.00	150.00	1025.60	
			11/14/1988	60.95	140.80	1016.40	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-102	3	875.60	11/14/1988	65.50	151.20	1026.80	
			11/14/1988	65.95	152.20	1027.80	
			11/14/1988	64.00	147.70	1023.30	
			11/14/1988	65.00	150.00	1025.60	
			11/14/1988	64.50	148.90	1024.50	
			11/15/1988	65.00	150.00	1025.60	
			2/28/1989	65.00	150.00	1025.60	
			3/29/1989	66.50	153.50	1029.10	
			4/19/1989	67.00	154.60	1030.20	
			6/17/1989	68.00	156.90	1032.50	
			7/13/1989	67.00	154.60	1030.20	
			8/23/1989	65.00	150.00	1025.60	
			9/22/1989	68.50	158.10	1033.70	
			12/23/1989	66.00	152.30	1027.90	
			5/16/1990	70.25	162.10	1037.70	
			6/8/1990	70.00	161.50	1037.70	
			7/16/1990	70.00	161.50	1037.00	
			8/29/1990	69.95	161.40	1037.00	
			9/25/1990	68.50	158.10	1033.70	
			11/3/1990	69.00	159.20	1034.80	
			10/27/2008	73.30	169.32	1044.92	
			10/27/2008	73.40	169.55	1045.15	
			1/19/2009	75.70	174.87	1050.47	Zero at 2.3
			1/19/2009	75.80	175.10	1050.70	Zero at 2.3
PB-103	1	685.20	10/15/1988	116.00	267.30	952.50	
			11/10/1988	119.00	274.20	959.40	
			11/12/1988	128.00	294.80	980.00	
			11/13/1988	118.00	271.90	957.10	
			3/1/1989	116.00	267.30	952.50	
			3/29/1989	118.00	271.90	957.10	
			4/19/1989	118.00	271.90	957.10	
			6/17/1989	118.00	271.90	957.10	
			7/13/1989	119.00	274.20	959.40	
			9/22/1989	117.00	269.60	954.80	
			10/21/1989	116.00	267.30	952.50	
			12/23/1989	116.00	267.30	952.50	
			6/8/1990	119.90	276.20	961.40	
			7/16/1990	121.00	278.70	936.90	
			8/29/1990	119.50	275.30	960.50	
			9/25/1990	118.00	271.90	957.10	
			11/3/1990	119.00	274.20	959.40	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-103	2	764.20	10/15/1988	84.00	193.20	957.40	
			11/10/1988	86.50	198.90	963.10	
			11/12/1988	86.00	197.80	962.00	
			11/13/1988	86.00	197.80	962.00	
			3/1/1989	86.00	197.80	962.00	
			3/29/1989	86.00	197.80	962.00	
			4/19/1989	86.00	197.80	962.00	
			6/17/1989	86.50	198.90	963.10	
			7/13/1989	87.00	200.10	964.30	
			9/22/1989	87.00	200.10	964.30	
			10/21/1989	85.00	195.50	959.70	
			12/23/1989	85.50	196.60	960.80	
			5/16/1990	90.25	207.50	971.70	
			6/8/1990	90.00	206.90	971.10	
			7/16/1990	82.00	188.60	952.80	
			8/29/1990	90.00	206.90	971.10	
			9/25/1990	89.95	206.80	971.00	
			11/3/1990	90.00	206.90	971.10	
	3	887.70	10/15/1988	34.00	78.70	966.40	
			11/9/1988	30.59	70.90	958.60	
			11/10/1988	35.95	83.20	970.90	
			11/12/1988	36.00	83.30	971.00	
			11/13/1988	36.00	83.30	971.00	
			3/1/1989	35.00	81.00	968.70	
			3/29/1989	34.00	78.70	966.40	
			4/19/1989	34.00	78.70	966.40	
			6/17/1989	36.00	83.30	971.00	
			7/13/1989	36.00	83.30	971.00	
			9/22/1989	36.50	84.40	972.10	
			10/21/1989	35.00	81.00	968.70	
			12/23/1989	34.90	80.70	968.40	
			5/16/1990	40.35	93.20	980.90	
			6/8/1990	40.90	94.50	982.20	
			7/16/1990	41.00	94.70	982.40	
			8/29/1990	39.00	90.10	977.80	
			9/25/1990	40.00	92.40	980.10	
			11/3/1990	39.00	90.10	977.80	
PB-104	1	738.70	10/15/1988	110.00	253.00	991.70	
			3/29/1989	110.00	253.00	991.70	
			4/21/1989	112.00	257.60	996.30	
			6/17/1989	114.00	262.20	1000.90	
			7/13/1989	112.00	257.60	996.30	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-104	1	738.70	9/22/1989	112.00	257.60	996.30	
			10/21/1989	100.00	230.10	968.80	
			12/23/1989	112.00	257.60	996.30	
			6/8/1990	115.90	266.50	1005.20	
			7/16/1990	115.00	264.50	1003.20	
			8/29/1990	114.00	262.20	1000.90	
			9/25/1990	114.00	262.20	1000.90	
			11/3/1990	113.95	262.10	1000.80	
			10/27/2008	117.50	271.43	1010.13	
			10/27/2008	118.00	272.58	1011.28	
			1/19/2009	118.80	274.43	1013.13	Zero at 2.3
			1/19/2009	119.00	274.89	1013.59	Zero at 2.3
	2	811.40	10/15/1988	82.00	189.30	1000.70	
			3/29/1989	58.00	134.20	945.60	
			4/21/1989	64.00	148.00	959.40	
			6/17/1989	84.00	193.90	1005.30	
			7/13/1989	83.90	193.70	1005.10	
			9/22/1989	82.50	190.40	1001.80	
			10/21/1989	81.00	187.00	998.40	
			12/23/1989	83.00	191.60	1003.00	
			5/16/1990	35.15	81.70	893.10	
			6/8/1990	87.90	202.80	1014.20	
			7/16/1990	87.00	200.80	1012.20	
			8/29/1990	75.00	173.20	984.60	
			9/25/1990	84.00	193.90	1005.30	
			11/3/1990	86.00	198.50	1009.90	
			10/27/2008	88.20	203.74	1015.14	
			10/27/2008	88.60	204.67	1016.07	
			10/27/2008	88.80	205.13	1016.53	
			1/19/2009	89.30	206.28	1017.68	Zero at 2.2
			1/19/2009	89.60	206.98	1018.38	Zero at 2.2
			1/19/2009	89.70	207.21	1018.61	Zero at 2.2
	3	889.00	10/15/1988	49.00	113.50	1002.50	
			3/29/1989	49.00	113.50	1002.50	
			4/21/1989	50.00	115.80	1004.80	
			6/17/1989	51.00	118.10	1007.10	
			7/13/1989	50.00	115.80	1004.80	
			9/22/1989	51.90	120.20	1009.20	
			10/21/1989	50.00	115.80	1004.80	
			12/23/1989	52.00	120.40	1009.40	
			5/16/1990	50.95	118.00	1007.00	
			6/8/1990	53.00	122.70	1011.70	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-104	3	889.00	7/16/1990	53.00	122.70	1011.70	
			8/29/1990	51.95	120.30	1009.30	
			9/25/1990	68.50	158.30	1047.30	
			11/3/1990	52.00	120.40	1009.40	
			10/27/2008	52.80	121.97	1010.97	
			10/27/2008	52.90	122.20	1011.20	
			10/27/2008	53.00	122.43	1011.43	
			1/19/2009	54.00	124.74	1013.74	Zero at 2.2
			1/19/2009	53.10	122.66	1011.66	Zero at 2.2
			1/19/2009	53.90	124.51	1013.51	Zero at 2.2
PB-105	1	609.90	10/19/1988	100.00	230.20	840.10	
			11/15/1988	101.00	232.40	842.30	
			11/16/1988	98.95	227.70	837.60	
			11/16/1988	99.00	227.70	837.80	
			11/16/1988	99.00	227.90	837.80	
			11/17/1988	98.00	225.60	835.50	
			11/17/1988	99.50	229.00	838.90	
			11/17/1988	99.00	227.90	837.80	
			11/18/1988	97.00	223.30	833.20	
			3/1/1989	99.95	230.00	839.90	
			3/29/1989	100.00	230.20	840.10	
			4/18/1989	99.97	230.10	840.00	
			6/17/1989	101.00	232.40	842.30	
			7/13/1989	100.00	230.20	840.10	
			8/23/1989	98.50	226.70	836.60	
			9/22/1989	100.00	230.20	840.10	
			10/20/1989	100.00	230.20	840.10	
			12/29/1989	97.90	225.30	835.20	
			6/8/1990	102.50	235.90	845.80	
			7/16/1990	104.00	239.30	849.20	
			8/29/1990	102.00	234.70	844.60	
			9/25/1990	101.00	232.40	842.30	
			11/4/1990	100.00	230.20	840.10	
			10/27/2008	99.00	228.69	838.59	
			10/29/2008	98.80	228.23	838.13	
			1/21/2009	100.40	231.92	841.82	Zero at 3.1
	2	702.90	10/19/1988	51.00	118.00	820.90	
			11/15/1988	53.00	122.60	825.50	
			11/16/1988	50.00	115.70	818.60	
			11/16/1988	51.00	118.00	820.90	
			11/17/1988	47.95	111.10	814.00	
			11/17/1988	48.00	111.20	814.10	
			11/17/1988	48.50	112.30	815.20	
			11/18/1988	46.50	107.70	810.60	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)^1	Water Level Elevation (feet amsl)^2	Field Notes^3
PB-105	2	702.90	3/1/1989	52.00	120.30	823.20	
			3/29/1989	52.00	120.30	823.20	
			4/18/1989	52.00	120.30	823.20	
			6/17/1989	55.00	127.20	830.10	
			7/13/1989	54.00	124.90	827.80	
			8/23/1989	52.00	120.30	823.20	
			9/22/1989	53.00	122.60	825.50	
			10/20/1989	53.00	122.60	825.50	
			12/29/1989	52.00	120.30	823.20	
			5/16/1990	50.95	117.90	820.80	
			6/8/1990	58.00	134.10	837.00	
			6/9/1990	58.00	134.10	837.00	
			7/16/1990	57.95	133.80	836.70	
			8/29/1990	56.00	129.50	832.40	
			9/25/1990	54.50	126.10	829.00	
			11/3/1990	55.00	127.20	830.10	
			11/4/1990	55.00	127.20	830.10	
			10/27/2008	55.70	128.67	831.57	
			10/29/2008	55.80	128.90	831.80	
			1/21/2009	58.40	134.90	837.80	Zero at 3.0
			1/21/2009	58.20	134.44	837.34	Zero at 3.0
			1/21/2009	58.30	134.67	837.57	Zero at 3.0
	3	750.90	10/19/1988	33.00	75.50	826.40	
			11/15/1988	34.00	77.70	828.60	
			11/16/1988	32.00	73.20	824.10	
			11/16/1988	32.50	74.30	825.20	
			11/16/1988	33.00	75.50	826.40	
			11/17/1988	31.95	73.10	824.00	
			11/17/1988	32.00	73.20	824.10	
			11/18/1988	31.00	70.90	821.80	
			3/1/1989	32.95	75.30	826.20	
			3/29/1989	33.90	77.50	828.40	
			4/18/1989	32.50	74.30	825.20	
			6/16/1989	37.00	84.60	835.50	
			7/12/1989	34.00	77.70	828.60	
			8/22/1989	34.00	77.70	828.60	
			9/21/1989	34.00	77.70	828.60	
			10/20/1989	34.00	77.70	828.60	
			12/29/1989	32.00	73.20	824.10	
			5/16/1990	35.95	82.20	833.10	
			6/8/1990	39.00	89.20	840.10	
			7/16/1990	38.00	86.90	837.80	
			8/29/1990	37.50	85.70	836.60	
			9/25/1990	36.00	82.30	833.20	

Piezometer Bed ID	Piezometer Number	Piezometer Elevation (feet amsl)	Date Gauged	Piezometer Pressure (psi)	Height of Water (feet)[1]	Water Level Elevation (feet amsl)[2]	Field Notes[3]
PB-105	3	750.90	11/4/1990	36.00	82.30	833.20	
			10/29/2008	36.50	84.32	835.22	
			1/21/2009	39.00	90.09	840.99	Zero at 3.0, needs new fitting (cracked)
			1/21/2009	39.10	90.32	841.22	Zero at 3.0, needs new fitting (cracked)
			1/21/2009	38.90	89.86	840.76	Zero at 3.0, needs new fitting (cracked)

Abbreviations

amsl: Above mean sea level

psi: Pounds per square inch

Additional Notes

[1] - PSI to feet of water conversion for all results from 2008 and later used a factor of 2.31. Factors for PSI to feet conversion prior to 2008 varied.

[2] - The calculation method for water level elevation is shown in Attachment 1.

[3] - The pressure gauge on the pneumatic pressure indicator used in January 2009 could not be adjusted to 0.0. Zero values are noted.

Table 2 - Monitoring Well Static Water Level Elevation Data

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-10	9/26/1988	788.00	na	720.80
	9/28/1988		na	718.90
	10/25/1988		na	720.60
	11/3/1988		na	719.60
	11/4/1988		na	719.60
	11/13/1988		na	718.90
	11/22/1988		na	718.70
	2/9/1989		na	713.60
	2/14/1989		na	713.20
	2/25/1989		na	712.60
	3/28/1989		na	710.80
	4/18/1989		na	716.80
	6/6/1989		na	719.50
	7/27/1989		na	719.20
	8/22/1989		na	717.20
	9/24/1989		na	716.90
	11/10/1989		na	714.40
	12/21/1989		na	719.00
	1/20/1990		na	713.60
	4/17/1990		na	727.10
	6/19/1990		na	722.40
	8/1/1990		na	717.10
	8/29/1990		na	716.60
	9/26/1990		na	723.00
	10/30/1990		na	720.80
H88-10	11/6/2008	785.37	71.40	713.97
	1/20/2009		77.59	707.78
H88-11	11/8/1988	1092.95	na	1035.40
	11/13/1988		na	1051.00
	11/22/1988		na	1061.10
	2/9/1989		na	1072.30
	2/23/1989		na	1072.40
	3/28/1989		na	1072.30
	4/17/1989		na	1075.10
	6/7/1989		na	1074.10
	7/25/1989		na	1074.80
	8/22/1989		na	1070.70
	9/24/1989		na	1074.60
	11/2/1989		na	1075.00
	12/21/1989		na	1074.60
	1/20/1990		na	1075.10
	4/23/1990		na	1075.90

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-11	6/19/1990	1092.95	na	1074.40
	8/1/1990		na	1068.60
	8/29/1990		na	1073.70
	9/26/1990		na	1074.20
	10/31/1990		na	1074.50
	11/2/2008		17.95	1075.00
	1/20/2009		19.89	1073.06
H88-12	10/5/1988	1026.41	na	1007.50
	10/25/1988		na	1006.80
	11/4/1988		na	1006.70
	11/22/1988		na	1007.60
	2/11/1989		na	1005.90
	2/26/1989		na	1005.50
	3/28/1989		na	1006.30
	4/17/1989		na	1008.10
	6/13/1989		na	1007.60
	7/18/1989		na	1002.50
	8/22/1989		na	1006.90
	9/24/1989		na	1007.70
	11/9/1989		na	1007.40
	12/21/1989		na	1008.20
	1/20/1990		na	1007.00
	1/21/1990		na	1007.00
	5/7/1990		na	1009.70
	6/16/1990		na	1006.90
	6/19/1990		na	1006.90
	7/30/1990		na	1006.40
	8/29/1990		na	1006.30
	9/26/1990		na	1006.90
	11/1/1990		na	1006.60
	11/12/2008		22.19	1004.22
	1/19/2009		20.24	1006.17
H88-13	11/4/1988	1142.89	na	994.00
	11/7/1988		na	994.70
	11/20/1988		na	995.60
	2/11/1989		na	994.10
	2/26/1989		na	993.80
	3/28/1989		na	too deep
	4/17/1989		na	996.80
	6/14/1989		na	992.40
	7/19/1989		na	991.20
	8/22/1989		na	985.40
	9/24/1989		na	996.10
	11/3/1989		na	996.50

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-13	12/21/1989	1142.89	na	995.70
	1/17/1990		na	995.10
	5/4/1990		na	997.60
	6/19/1990		na	997.30
	7/30/1990		na	995.40
	8/29/1990		na	994.90
	9/26/1990		na	994.70
	11/1/1990		na	994.20
	11/12/2008		147.34	995.55
	1/19/2009		148.35	994.54
H88-14	11/13/1988	790.90	na	778.00
	2/9/1989		na	773.90
	5/23/1989		na	773.90
	7/25/1989		na	773.90
	7/18/1990		na	757.80
	8/29/1990		na	758.60
	9/26/1990		na	758.00
	10/20/1990		na	757.40
H88-14A	11/12/1988	773.80	na	757.20
	11/13/1988		na	757.30
	11/18/1988		na	757.30
	11/22/1988		na	757.20
	2/9/1989		na	756.80
	2/15/1989		na	757.10
	3/28/1989		na	757.30
	4/18/1989		na	753.40
	5/23/1989		na	757.80
	7/25/1989		na	757.90
	8/22/1989		na	757.80
	9/24/1989		na	757.70
	11/1/1989		na	756.60
	12/22/1989		na	757.40
	1/20/1990		na	757.10
	4/17/1990		na	763.10
	6/19/1990		na	758.10
	7/18/1990		na	757.80
	8/29/1990		na	758.60
	9/26/1990		na	758.00
	10/20/1990		na	754.70
	11/4/2008		15.55	758.25
	1/20/2009		15.61	758.19
H88-15	11/5/1988	873.70	na	838.40
	11/16/1988		na	838.20
	11/20/1988		na	836.90

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-15	2/12/1989	873.70	na	835.80
	2/28/1989		na	835.50
	3/28/1989		na	835.60
	4/18/1989		na	838.50
	6/16/1989		na	846.00
	7/18/1989		na	833.80
	8/22/1989		na	836.90
	9/24/1989		na	838.30
	11/8/1989		na	838.30
	12/21/1989		na	837.20
	1/25/1990		na	836.40
	5/9/1990		na	846.70
	6/19/1990		na	839.90
	7/30/1990		na	836.80
	8/29/1990		na	836.00
	9/26/1990		na	837.30
	11/5/1990		na	839.10
	11/7/2008		36.63	837.07
	1/20/2009		38.00	835.70
H88-16	11/6/1988	1105.98	na	1054.00
	11/13/1988		na	1044.20
	11/21/1988		na	1054.10
	2/9/1989		na	1053.80
	2/28/1989		na	1053.80
	3/28/1989		na	1053.60
	4/17/1989		na	1053.90
	6/16/1989		na	1052.10
	7/19/1989		na	1055.50
	8/22/1989		na	1054.80
	9/24/1989		na	1054.70
	11/4/1989		na	1055.20
	12/21/1989		na	1054.80
	1/26/1990		na	1054.10
	5/10/1990		na	1056.20
	6/19/1990		na	1058.60
	7/31/1990		na	1056.70
	8/29/1990		na	1056.10
	9/26/1990		na	1055.90
	11/1/1990		na	1056.20
	11/3/2008		54.70	1051.28
	1/20/2009		55.72	1050.26
H88-17	10/5/1988	1000.08	na	989.30
	10/25/1988		na	989.10
	11/7/1988		na	989.20

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-17	11/8/1988	1000.08	na	989.50
	11/22/1988		na	989.20
	2/11/1989		na	990.10
	2/16/1989		na	988.80
	3/28/1989		na	988.90
	4/17/1989		na	989.90
	5/30/1989		na	989.60
	7/11/1989		na	984.60
	8/22/1989		na	989.50
	9/24/1989		na	989.60
	12/21/1989		na	989.00
	1/19/1990		na	989.00
	5/7/1990		na	989.70
	6/19/1990		na	989.30
	7/19/1990		na	989.10
	8/29/1990		na	989.20
	9/26/1990		na	989.20
	10/20/1990		na	989.20
	10/31/2008		10.67	989.41
	1/19/2009		10.78	989.30
H88-19	9/26/1988	846.30	na	814.30
	10/25/1988		na	814.00
	11/8/1988		na	814.80
	2/9/1989		na	ice
	3/28/1989		na	ice
	4/18/1989		na	810.40
	5/23/1989		na	814.60
	7/10/1989		na	815.30
	8/22/1989		na	814.70
	9/24/1989		na	814.80
	11/1/1989		na	814.40
	1/24/1990		na	813.80
	4/24/1990		na	814.90
	6/19/1990		na	815.00
	7/18/1990		na	814.40
	8/29/1990		na	815.10
	9/26/1990		na	814.40
	10/20/1990		na	814.10
	11/6/2008		31.64	814.66
	1/20/2009		31.99	814.31
H88-21	10/25/1988	865.93	na	821.90
	10/28/1988		na	822.00
	10/29/1988		na	822.10
	10/30/1988		na	822.10

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-21	11/5/1988	865.93	na	822.30
	2/11/1989		na	818.30
	2/16/1989		na	818.00
	3/28/1989		na	817.20
	4/18/1989		na	817.70
	5/23/1989		na	823.40
	7/11/1989		na	822.60
	8/22/1989		na	820.60
	9/24/1989		na	819.80
	11/3/1989		na	820.90
	12/22/1989		na	820.70
	1/24/1990		na	819.40
	5/7/1990		na	825.90
	6/19/1990		na	823.90
	7/18/1990		na	822.30
	8/29/1990		na	820.10
	9/26/1990		na	819.90
	10/23/1990		na	820.90
	11/10/2008		46.60	819.33
	1/20/2009		48.23	817.70
H88-22	8/31/1988	1077.21	na	1069.90
	9/26/1988		na	1070.90
	10/25/1988		na	1070.20
	11/5/1988		na	1069.30
	11/6/1988		na	1068.50
	2/9/1989		na	1066.30
	2/16/1989		na	1066.10
	3/28/1989		na	1065.20
	4/17/1989		na	1064.60
	5/30/1989		na	1071.10
	7/10/1989		na	1069.20
	8/22/1989		na	1069.00
	9/24/1989		na	1070.80
	11/2/1989		na	1069.50
	12/21/1989		na	1069.50
	1/24/1990		na	1070.40
	4/24/1990		na	1064.70
	6/19/1990		na	1070.50
	7/18/1990		na	1067.20
	8/29/1990		na	1068.30
	9/26/1990		na	1070.50
	10/25/1990		na	1069.70
	11/4/2008		10.25	1066.96
	1/20/2009		12.02	1065.19

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-23	9/1/1988	842.35	na	791.50
	9/26/1988		na	791.40
	10/25/1988		na	793.00
	10/30/1988		na	793.40
	11/5/1988		na	794.40
	2/12/1989		na	791.60
	2/21/1989		na	791.30
	3/28/1989		na	790.00
	4/18/1989		na	790.50
	5/24/1989		na	794.80
	7/23/1989		na	795.90
	8/22/1989		na	794.70
	9/24/1989		na	793.60
	11/11/1989		na	793.90
	12/22/1989		na	793.90
	1/23/1990		na	794.10
	5/7/1990		na	802.50
	6/19/1990		na	809.80
	7/29/1990		na	800.30
	8/29/1990		na	797.20
	9/26/1990		na	795.70
	10/23/1990		na	795.40
	12/23/1990		na	795.40
	11/11/2008		52.30	790.05
	1/21/2009		54.02	788.33
H88-24A	9/1/1988	848.33	na	793.40
	9/26/1988		na	793.50
	10/25/1988		na	794.50
	11/1/1988		na	794.90
	11/2/1988		na	794.90
	11/5/1988		na	795.10
	2/12/1989		na	793.30
	2/21/1989		na	792.60
	3/28/1989		na	791.80
	4/18/1989		na	792.40
	5/24/1989		na	795.20
	7/23/1989		na	796.50
	8/22/1989		na	795.50
	9/24/1989		na	794.70
	11/10/1989		na	794.80
	12/22/1989		na	794.80
	1/23/1990		na	799.20
	5/8/1990		na	802.90
	6/19/1990		na	803.80

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-24A	7/29/1990	848.33	na	797.60
	7/29/1990		na	800.10
	8/29/1990		na	796.20
	9/26/1990		na	795.90
	10/23/1990		na	793.30
	11/11/2008		56.54	791.79
	1/21/2009		57.52	790.81
H88-25	9/1/1988	833.72	na	793.30
	9/26/1988		na	798.70
	10/25/1988		na	798.60
	10/31/1988		na	798.80
	11/1/1988		na	765.10
	11/5/1988		na	791.60
	2/12/1989		na	798.70
	2/18/1989		na	798.50
	2/23/1989		na	797.60
	3/28/1989		na	797.90
	4/18/1989		na	793.60
	5/24/1989		na	799.70
	7/23/1989		na	799.10
	8/22/1989		na	803.10
	9/24/1989		na	798.00
	11/11/1989		na	798.50
	12/22/1989		na	798.40
	1/23/1990		na	798.30
	5/8/1990		na	800.50
	6/19/1990		na	799.00
	7/29/1990		na	797.70
	8/29/1990		na	795.50
	9/26/1990		na	794.40
	9/26/1990		na	794.90
	10/23/1990		na	795.60
	11/11/2008		33.85	799.87
	1/21/2009		34.21	799.51
H88-27	8/31/1988	1131.33	na	1081.10
	9/24/1988		na	1081.60
	10/25/1988		na	1082.40
	11/7/1988		na	1081.80
	11/22/1988		na	1081.00
	2/11/1989		na	1078.80
	2/18/1989		na	1078.50
	2/21/1989		na	1078.30
	3/28/1989		na	1077.60
	4/17/1989		na	1078.30

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H88-27	5/31/1989	1131.33	na	1087.60
	7/11/1989		na	1082.20
	8/22/1989		na	1080.70
	9/24/1989		na	1081.00
	11/2/1989		na	1081.70
	12/21/1989		na	1080.30
	5/4/1990		na	1092.80
	6/19/1990		na	1083.60
	7/18/1990		na	1081.50
	8/29/1990		na	1080.10
	9/26/1990		na	1081.50
	10/23/1990		na	1081.30
	10/30/2008		47.28	1084.05
	1/19/2009		52.22	1079.11
H88-28	10/3/1988	1300.80	na	1246.70
	10/25/1988		na	1246.90
	11/2/1988		na	1247.20
	11/6/1988		na	1247.30
	11/7/1988		na	1247.30
	2/11/1989		na	1247.10
	2/17/1989		na	1246.80
	2/21/1989		na	1246.80
	3/28/1989		na	1246.30
	4/17/1989		na	1247.30
	5/31/1989		na	1250.70
	7/26/1989		na	1252.00
	8/22/1989		na	1246.60
	9/24/1989		na	1247.10
	11/3/1989		na	1244.50
	12/21/1989		na	1247.60
	1/19/1990		na	1247.50
	5/4/1990		na	1246.80
	6/19/1990		na	1257.30
	7/19/1990		na	1248.60
	8/29/1990		na	1248.10
	9/26/1990		na	1247.60
	10/24/1990		na	1247.10
	10/30/2008		55.28	1245.52
	1/20/2009		54.97	1245.83
H89-29	7/27/1989	778.00	na	709.60
	8/25/1989		na	702.70
	9/24/1989		na	702.70
	11/1/1989		na	702.00
	12/21/1989		na	704.40

Well ID	Gauging Date	Measuring Point Elevation (feet amsl)	Depth to Water (feet)	Water Level Elevation (feet amsl)
H89-29	1/23/1990	778.00	na	699.90
	4/17/1990		na	703.00
	6/19/1990		na	710.00
	7/31/1990		na	702.80
	8/29/1990		na	702.10
	9/26/1990		na	698.70
	11/5/2008		63.72	714.28
	1/20/2009		69.56	708.44
H89-30	7/27/1989	753	na	706.90
	8/22/1989		na	717.80
	9/24/1989		na	171.30
	11/3/1989		na	176.20
	12/21/1989		na	179.50
	1/24/1990		na	724.80
	4/18/1990		na	715.90
	6/19/1990		na	723.00
	7/19/1990		na	709.50
	8/29/1990		na	716.80
	9/26/1990		na	723.60
	10/25/1990		na	722.20

Abbreviations

amsl:	Above mean sea level
na:	Data not available

Table 3 - Analytical Results of Field Measured Groundwater Quality Parameters

Well ID	Sample Date	Temperature (^{o}C)	pH	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos)	Alkalinity (mg/L)
H88-10	11/22/1988	3	6.62			14.2		385	358
	2/15/1989	3	7.15			13.2		388	104
	6/6/1989	3	7.34			11.4		321	144
	7/25/1989	4	7.79			12.2		332	187
	11/9/1989	1.1	7.53					301	153
	1/20/1990	6.5	6.97			4.48		318	53
	4/17/1990	4.4	7.87			4.2		322	160
	8/1/1990		8			3.6		317	205
	10/30/1990	3.3	7			4.2		310	173
	11/6/2008	4.3	7.78	286	1.81	0.54	-178.5		
H88-11	1/22/1988	2	6.96			13.6		1326	1521
	2/15/1989	1.5	8.5			12.8		1441	638
	6/7/1989	3	9.37			10.9		966	634
	7/25/1989	2.5	8.75			12.8		1303	48
	11/2/1989	2.8	8.16			1.19		1172	714
	1/20/1990	2.9	8.22			3.75		1262	501
	4/23/1990	4.4	8.66			3.6		1192	705
	8/1/1990		8.66			2.6		1010	250
	10/30/1990	0	8.19			3		1092	713
	11/2/2008	4.32	8.67	1263	18.11	0.47	-193.8		
H88-12	11/21/1988	2	11.4			13			588
	2/15/1989	2.5	11.45			12.4		386	579
	6/14/1989	3	9.68			12.2		777	44.4
	7/18/1989	4	10.26			11.8		1045	37.9
	11/9/1989	0.6	9.89			2.98		1004	192
	1/20/1990	3.8	9.66			2.32		1006	496
	5/7/1990	5.6	9.75			4.5		947	85
	7/30/1990		8.18			3.6		957	455
	11/1/1990	0	9.46			5.2		1015	429
	11/12/2008	2.92	9.33	926	96.3	0.6	-72.5		
H88-13	11/20/1988	4	8.6			4.7		304	2565
	2/26/1989	2	7.42			11.6		341	1084
	6/14/1989	4	8.06			12.8		370	1621
	7/19/1989	3.5	8.28			13.6		1	137
	11/3/1989	3.3	7.49			1.4		1501	1470
	1/19/1990	3.8	8.11			3.29			873
	5/4/1990	10.9	8.32			15.2		2440	1372
	7/30/1990	6	9.71			1.69		2950	1482
	11/1/1990	1	8.27			4.24		2710	1452
	11/12/2008	3.17	8.66	2595	6.98	4.24	97.7		
H88-14A	11/22/1988	3	6.06			13.5		162	53
	2/15/1989	2	7.51			13.1		214	130
	5/23/1989	1	7.55			12.8		139	47
	7/25/1989	8	7.23			12.6		96	28
	11/1/1989		5.56					149	122
	1/20/1990	0.8	6.78			14.42		168	43
	4/17/1990	2.2	7.25			12.8		212	81
	7/18/1990	8.1	7.92			13.1		108	50
	10/20/1990	3.6	7.03			11.8		134	720
	11/4/2008	2.21	6.61	135	1.77	6.31	133.5		
H88-15	11/20/1988	2.9	8.31			13		260	137.9
	2/21/1989	2				12.2			

Well ID	Sample Date	Temperature (^{o}C)	pH	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos)	Alkalinity (mg/L)
H88-15	6/16/1989	3	7.9			11.6		900	242
	7/18/1989	4	7.69			11.2		784	28.5
	11/8/1989	1.4	8.06			0.28		188	158
	1/25/1990	3.3	8.01			5.36		539	122
	5/9/1990	3.4	9.05			2.9		315	130
	7/30/1990	3.7	7.9			1.6		510	218
	11/5/1990	1	7.88			5		403	186
	11/7/2008	4	7.54	538	47	0.41	-150		
H88-16	11/21/1988	3	8.79			9.1		338	577
	2/28/1989	3	8.38			13.6		325	
	6/16/1989	4	9.45			12.2		300	153
	7/19/1989	2.5	8.72			12.2		272	10.8
	11/4/1989	4.2	9.19			1.47		124	135
	1/26/1990	2.4	9.3			0.9		244	99
	5/10/1990	4.1	8.76			2.1		239	130
	7/31/1990	4	9.58			2		244	125
	11/2/1990	2	9.04			2.8		252	128
	11/3/2008	5.1	9.19	261	48	2.81	-76.1		
H88-17	11/8/1988	3	7.34			9.3		198	94.4
	2/16/1989	2	6.72			13.4		203	80
	5/30/1989	2.5	6.69			12.4		255	73
	7/11/1989	3	6.73			10.9		196	76.5
	11/2/1989		6			5.59		221	99
	1/19/1990	2.3	6.46			8.99		192	72
	5/7/1990	7	8.72			8.7		301	191
	7/19/1990	5.9	6.75			8.4		189	136
	10/20/1990	3.5	7.07			8.8		217	79
	10/31/2008	3.34	6.57	168	1.04	5.98	234.6		
H88-19	11/8/1988	4	7.38			9.2		243	277
	2/15/1989	frozen	--			--		--	--
	5/23/1989	2.5	7.28			13.4		172	61
	7/10/1989	2.5	7.17			11.3		133	47.2
	11/1/1989	3	5.6					189	103
	1/24/1990	1.8	6.42			8.41		168	41
	4/24/1990	3.3	7.34			7.9		180	86
	7/18/1990	5.7	6.86			9.6		144	55
	10/20/1990	7.2	6.99			13.3		164	55
	11/6/2008	4.37	6.66	182	157	3.72	145		
H88-21	11/9/1988	18.5	8.07			9.9		158	74.5
	2/16/1989	2	7.84			12.4		210	49
	5/23/1989	2.5	7.78			13		160	64
	7/11/1989	2.5	7.21			12		150	64
	11/3/1989		6.65			6.28		66	512
	1/24/1990	2.6	7.57			6.28		150	471
	5/7/1990	4.8	6.25			11.9		164	88
	7/19/1990	4.9	7.65			9		131	53
	10/23/1990	1	7.25			10		127	30
	11/10/2008	4.22	6.97	118	2.23	11.09	145.4		
H88-22	11/5/1988	2.5	7.66			9.3		192	172
	2/16/1989	1	7.41			12.2		198	52
	5/30/1989	2	6.84			13.2		180	48
	7/10/1989	3	7.55			10.7		188	83.2
	11/2/1989		6.03			3.15		178	92

Well ID	Sample Date	Temperature (^{o}C)	pH	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos)	Alkalinity (mg/L)
H88-22	1/24/1990	2	7.63			4.25		177	87
	4/24/1990	3.3	7.28			9.4		157	82
	7/18/1990	3.6	7.32			6.4		199	72
	10/25/1990	1	7.43			7.2		182	88
	11/4/2008	3.53	7.93	186	68.4	1.19	-124.3		
H88-23	11/3/1988	18	7.12			14.2		234	97.6
	2/15/1989	2	7.24			14.4		156	55
	5/24/1989	2.5	7.06			12.5		124	41
	7/23/1989	2	6.78			11.5		121	3.2
	11/11/1989	1.1	6.9					116	46
	1/23/1990	1.8	6.52			11.4		110	378
	5/7/1990	3.1	6.71			12.2		106	61
	7/29/1990	3.7	6.61			2.5		133	51
	10/23/1990	1	7.16			10.4		109	48
	11/11/2008	4.46	6.41	98	5.33	9.61	157.4		
H88-24A	11/3/1988		7.68			9.2		251	75.1
	2/15/1989	2.5	7.68			13.4		254	70
	5/24/1989	2.5	7.3			12.3		225	57
	7/23/1989	2	7.4			11.2		193	7.3
	11/10/1989	1.1	7.36					151	73
	1/23/1990	2.6	6.97			5.92		141	443
	5/8/1990	3.3	6.36			7.5		132	61
	7/29/1990	4.1	7.75			9.6		156	71
	10/23/1990	1	6.98			8.2		126	52
	11/11/2008	4.74	6.57	109	12.3	8.2	145.2		
H88-25	11/3/1988		8.05			8.3		252	245
	2/15/1989	1	8.46			12.8		741	40
	5/24/1989	2.5	7.72			12		281	81
	7/23/1989	4	8.36			10.8		273	127
	11/11/1989	-0.6	8.29					259	97
	1/23/1990	0.6	8.39			10.7		3	631
	5/8/1990	4.2	7.58			10.3		144	140
	7/29/1990	5.7	7.85			8.9		183	144
	10/23/1990	1	7.92			9.8		158	105
	11/10/2008	2.65	7.85	101	170	9.61	141.6		
H88-27	11/7/1988	-	-			-		-	-
	2/21/1989	1	6.96			13.2		162	86
	5/31/1989	2.5	6.83			12.4		111	45
	7/11/1989	4	7.13			12.4		132	48.5
	11/2/1989		5.98			5.54		162	72
	1/19/1990	7.9	6.51			11.99		141	
	5/4/1990	7.3	5.85			10.4		117	35
	7/18/1990	4.9	7.05			10.8		114	42
	10/23/1990	1	6.72			7		106	40
	10/30/2008	5.35	6.54	105	12.4	8.56	223.2		
H88-28	11/7/1988								
	2/21/1989	2	6.28			12.2		144	64
	7/26/1989	2	7.42			11		161	51.3
	11/3/1989		5.28			5.03		112	50
	1/19/1990	1.8	6.13			7.8		119	55
	5/4/1990	10.1	5.91			8.29		113	50
	7/19/1990	0.3	8.42			10.8		153	54
	10/24/1990	-1	6.27			9.92		110	51
	10/30/2008	5.9	5.8	91	22.2	8.42	264		

Well ID	Sample Date	Temperature (^{o}C)	pH	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos)	Alkalinity (mg/L)
H89-29	7/26/1989	2	7.34			10.6		294	100.6
	11/1/1989	5	6.71					232	229
	1/23/1990	3.5	7.13			2.21		250	86
	4/17/1990	3.8	7.13			3.46		241	103
	7/31/1990					4.14			173
	10/30/1990	1	5.6			5.54		225	98
	11/5/2008	4.43	7.63	236	2.06	0.72	-192.2		
H89-30	7/28/1989	3	8.02			12.4		449	231.6
	11/3/1989		7.25			3.5		521	286
	1/23/1990	2.7	8.32			1.94		537	175
	4/18/1990	4.5	8.47			4.62		525	288
	7/19/1990	8.9	7.18			2.22		575	320
	10/25/1990	2	8.07			6.48		528	268

Note: Blank cells represent data not collected.

Abbreviations

^{o}C: Degrees Celsius

µS/cm: Microsiemens per centimeter

mg/L: Milligrams per liter

µmhos: Micromhos

mV: Millivolts

NTU: Nephelometric Turbidity Units

ORP: Oxidation reduction potential

pH: Power of hydrogen

Table 4 - Analytical Resutls of Groundwater Sampling

Station ID	Date Collected	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Aluminum, Total (mg/L)	Ammonia as Nitrogen (mg/L)	Arsenic, Dissolved (mg/L)	Arsenic, Total (mg/L)	Barium, Dissolved (mg/L)	Barium, Total (mg/L)	Bicarbonate, HCO3 (mg/L)	Boron (mg/L)	Cadmium, Dissolved (mg/L)	Cadmium, Total (mg/L)	Calcium, Dissolved (mg/L)	Calcium, Total (mg/L)	Carbonate, CO3 (mg/L)	Chloride (mg/L)	Chromium, Dissolved (mg/L)	Chromium, Total (mg/L)	Cobalt, Dissolved (mg/L)	Copper, Dissolved (mg/L)	Copper, Total (mg/L)	Fluoride (mg/L)	Hardness as CaCO3 (mg/L)	Iron, Dissolved (mg/L)	Iron, Total (mg/L)	Kjeldahl Nitrogen, Total (mg/L)	Lead, Dissolved (mg/L)	Lead, Total (mg/L)	Magnesium, Dissolved (mg/L)	Magnesium, Total (mg/L)
H88-10	22-Nov-88	358	ND		0.45	ND		1		214	0.07	ND		34		0	1.1	ND	ND		ND		0.28	129	0.08	0.19	0.7	ND		11	
H88-10	25-Feb-89	179	0.2		0.01	ND		1		218	0.26	0.004		34		0	2.5	ND	0.04		ND		0.29	120	ND	0.35	0.7	ND		8.5	
H88-10	06-Jun-89	185	0.1		0.41	0.02		1.1		225	0.19	ND		37		0	2.1	ND	ND		ND		0.35	125	0.05	0.27	1.3	ND		8	
H88-10	25-Jul-89	180	ND		0.41	ND		1.1		220	0.42	ND		35		0	1.8	ND	ND		ND		0.26	122	0.1	0.23	1.1	ND		8.6	
H88-10	09-Nov-89	176	0.2		ND	ND		ND		215	0.13	ND		31		0	1.1	ND	0.02		ND		0.26	116	ND	0.28	0.6	ND		9.2	
H88-10	20-Jan-90	178	ND		0.44	ND		1.15		217	0.02	ND		34		0	2	ND	ND		ND		0.3	121	ND	0.19	1.4	ND		8.6	
H88-10	17-Apr-90	178	ND		0.5	ND		1.1		217	0.05	ND		38		0	2.3	ND	ND		ND		0.33	127	0.15	0.21	0.6	ND		7.5	
H88-10	01-Aug-90	179	ND		0.6	ND		1.3		219	0.13	ND		34		0	1.2	ND	ND		ND		0.32	129	0.18	0.21	1.1	ND		11	
H88-10	30-Oct-90	170	ND		0.64	ND		1.4		207	0.01	ND		31		0	1.8	ND	ND		ND		0.34	119	0.06	0.19	0.8	ND		10	
H88-10	06-Nov-08	153	ND	ND		ND	ND	1.11	1.01			ND	ND	27.6	27.7		1.1	ND	0.0002		0.3	0.4	0.2	105	106	112		0.14	0.1	8580	8620
H88-11	22-Nov-88	1521	0.1		0.45	0.007		ND		783	0.12	ND		2		12	1.1	ND	0.03		ND		2.1	7	0.08	5.18	0.7	ND		0.5	
H88-11	22-Feb-89	724	0.1		0.42	0.008		ND		847	0.08	0.005		2.4		18	3.9	ND	0.03		ND		1.62	9.4	0.08	4.98	1.4	ND		0.9	
H88-11	07-Jun-89	760	0.1		0.36	ND		ND		906	0.32	ND		2.6		11	1.8	ND	0.03		ND		1.49	8.4	ND	5.45	1.7	ND		0.5	
H88-11	25-Jul-89	726	ND		0.41	0.008		ND		885	0.02	ND		2.7		0	2.8	ND	ND		ND		1.35	8.2	0.08	2.7	1	ND		0.4	
H88-11	02-Nov-89	762	ND		0.29	ND		ND		911	ND	ND		2.3		9	1.8	ND	0.02		ND		1.38	8	0.29	1.95	0.4	ND		0.5	
H88-11	20-Jan-90	725	ND		0.4	0.013		ND		810	0.08	ND		2.6		37	2.6	ND	ND		ND		1.36	9	ND	1.55	1	ND		0.5	
H88-11	23-Apr-90	725	0.4		0.41	ND		ND		881	0.04	ND		3.6		2	2.3	ND	0.02		ND		1.2	31	0.93	1.69	0.6	ND		5.2	
H88-11	01-Aug-90	718	ND		0.5	0.007		ND		875	0.14	ND		4		0	1.7	ND	ND		ND		1.35	11	ND	1.75	1	ND		0.2	
H88-11	31-Oct-90	682	ND		0.62	ND		ND		809	0.01	ND		4.5		11	2.1	ND	ND		ND		1.33	14	ND	2.03	1.2	ND		0.6	
H88-11	02-Nov-08	692	3	0.717		0.0064	0.0063	0.153	0.16			0.00006	0.00006	0.221	2.26		2.3	ND	0.0016		ND	0.7	1.1	8.5	ND	466		ND	0.22	67	703
H88-12	21-Nov-88	588	1.5		0.8	0.021		ND		0	0.08	ND		1.4		344	1.4	ND	0.1		ND		3.17	7.16	0.18	17.3	0.8	ND		0.9	
H88-12	12-Feb-89	632	1.7		1.87	0.03		ND		0	0.34	0.003		6.4		319	2.5	ND	0.07		ND		3.26	16	0.81	11.2	0.7	0.03		ND	
H88-12	14-Jun-89		0.4			0.008		ND		356		ND		3.4		150	1.8	0.02	0.06		ND				0.17	8.49		0.03		17.3	
H88-12	16-Jun-89	543			0.11						0.07												3.08	80			1				
H88-12	18-Jul-89	549	ND		0.39	0.023		ND		189	0.1	ND		3.2		236	2.1	ND	0.11		0.01		2.93	8	0.11	15.3	2.4	ND		0.1	
H88-12	09-Nov-89	574	ND		ND	0.022		ND		182	0.08	ND		2.6		255	ND	ND	ND		ND		3.35	9	ND	4.37	0.3	ND		0.6	
H88-12	20-Jan-90	542	ND		0.24	0.019		ND		336	0.11	ND		2.3		166	0.4	ND	0.03		ND		3.58	7	0.12	6.66	1.6	ND		0.2	
H88-12	07-May-90	528	ND		ND	0.011		ND		411	ND	ND		3.2		115	1.2	ND	0.03		0.01		3.59	8	0.21	7.76	0.4	ND		ND	
H88-12	30-Jul-90	515			0.24					478	0.21			2.8		74	0.8						3.38	8			2.2			0.2	
H88-12	01-Nov-90	493			0.31					406	0.02			2.5		96	1.1						2.91	8			0.5			0.5	
H88-12	12-Nov-08	506	157	2.72		0.0018	0.0017	0.0561	0.0129			ND	0.00005	0.97	1.75		1.0	0.0008	0.0071		0.3	5.2	4.0	8.7	144	2700		0.16	1.79	227	1050
H88-13	20-Nov-88	2565	ND		1.22	ND		ND		2749	0.05	ND		8.1		0	120	ND	0.06		ND		0.36	39	0.11	21.7	2.3	ND		4.5	
H88-13	26-Feb-89	1727	0.2		0.7	ND		ND		2106	0.25	0.004		6.5		0	89	ND	0.02		ND		0.39	26	ND	0.95	1.7	ND		2.3	
H88-13	14-Jun-89		ND			ND		ND		1961		ND		5.6		0	79	ND	0.02		0.01				0.07	0.9		ND		1.5	
H88-13	16-Jun-89	1607			0.02						ND												0.43	20			1.1				
H88-13	18-Jul-89		ND			ND		0.5				ND						ND	ND		ND				0.11	0.47		ND			
H88-13	19-Jul-89	1740			0.87					2122	0.01			6.8		0	91						0.46	27			2.4			2.4	
H88-13	03-Nov-89	1595	0.2		0.72	ND		ND		1946	0.03	ND		4.6		0	73	ND	ND		ND		0.38	17	0.26	3.3	0.7	ND		1.3	
H88-13	19-Jan-90	1562	ND		0.84	0.019		ND		1906	ND	ND		4.5		0	95	ND	ND		ND		0.49	49	0.06	0.42	1.6	ND		1.8	
H88-13	04-May-90	1486	ND		0.84	ND		ND		1813	ND	ND		4		2	71	ND	ND		ND		0.47	16	ND	0.19	0.8	ND		1.6	
H88-13	30-Jul-90	1550	ND		0.82	ND		ND		1894	0.15	ND		4		0	68	ND	0.02		ND		0.45	25	ND	2.89	1.5	ND		3.6	
H88-13	01-Nov-90	1457	ND		0.9	ND		0.5		1740	0.01	ND		5.6		19	76	ND	ND		ND		0.54	24	0.06	0.1	1	ND		2.6	
H88-13	12-Nov-08	1510	6.1	0.0644		0.002	0.002	0.588	0.583			ND	0.00007	1.64	1.72		63.4	1.4	5.5		0.2	1.1	ND	8.9	35	163		0.06	0.43	1110	1130
H88-14	20-Oct-90									58				11		0	2.5													2.6	
H88-14	01-Nov-90		ND			ND		ND				ND						ND	0.02		ND				0.07	5.42		ND			
H88-14A	22-Nov-88	53	ND		0.01	ND		ND		77	0.06	ND		16		0	3.2	ND	0.03		ND		0.17	50	ND	17.4	0.5	ND		2.9	
H88-14A	15-Feb-89	64	ND		0.04	ND		ND		78	0.41	ND		16		0	5	ND	0.02		ND		0.11	54	0.08	12.3	0.5	ND		3.3	
H88-14A	23-May-89	83	ND		0.03	ND		ND			ND	ND						ND	ND		ND		0.27	53	ND	1.21	1.1	ND			
H88-14A	26-May-89									101				16		0	2.1													3	
H88-14A	25-Jul-89	41	ND		ND	ND		ND		49	ND	ND		12		0	1.8	ND	ND		ND		0.08	38	ND	7.54	1.3	ND		1.8	
H88-14A	01-Nov-89	55	ND		ND	ND		ND		66	ND	ND		17		0	1.8	ND	0.04		ND		0.08	51	0.06	23.4	0.2	ND		2.2	
H88-14A	20-Jan-90	65	ND		ND	ND		ND		79	0.02	ND		19		0	4.9	ND	0.02		ND		0.15	59	ND	9.64	0.6	ND		2.8	
H88-14A	17-Apr-90	88	0.9		ND	ND		ND		107	0.04	ND		26		0	2.9	ND	0.04		ND		0.11	79	2.42	18.4	0.5	ND		3.3	
H88-14A	18-Jul-90		ND			ND		ND		61		ND		12		0	1	ND	0.02		ND				ND	13.9		ND		1.8	
H88-14A	20-Oct-90	48	ND		ND	ND		ND			0.11	ND						ND	0.02		ND		0.12	38	ND	21	1.2	ND			
H88-14A	04-Nov-08	50	4.5	0.039		ND	ND	0.0408	0.0406			ND	0.00002	16	15.5		1.8	0.0002	0.0004		1.1	1.4	ND	51.3	ND	62		0.04	2.52	3210	3070
H88-15	20-Nov-88	137.9	ND		0.12	ND		ND		160	0.16	ND		12		0	2.8	ND	ND		ND		0.05	38	ND	0.37	0.6	ND		2.2	
H88-15	28-Feb-89	133	0.3		0.08	ND		ND			0.43	0.002						ND	ND		ND		0.54	38	0.06	0.18	0.2	0.02			
H88-15	16-Jun-89	209	0.1		0.1	ND		ND		255	0.11	ND		15		0	28	ND	0.02		0.01		0.5	46	0.09	0.18	0.6	ND		2.1	
H88-15	19-Jul-89	224	ND		0.1	ND		ND		273	0.12	ND		16		0	33	ND	ND		ND		0.49	44	0.08	0.98	0.7	ND		1.1	
H88-15	24-Jan-90	230	ND		0.2	ND		ND		281	ND	ND		15		0	40	ND	ND		0.01		0.5	51	0.48	0.54	0.4	0.02		3.4	
H88-15	09-May-90	130	0.1		0.14	ND		ND		140	0.28	ND		9.7		9	5.3	ND	ND		ND		0.53	33	ND	0.12	0.1	ND		2.1	
H88-15	30-Jul-90	207	ND		0.1	ND		ND		252	0.24	ND		13		0	26	ND	ND		ND		0.09	38	0.07	0.08	0.9	ND		1.5	
H88-15	05-Nov-90	194	ND		0.05	ND		ND		236	0.2	ND		12		0	28	ND	ND		ND		0.52	40	ND	ND	0.1	ND		2.4	
H88-15	08-Nov-90	217	ND		ND	ND		ND		264	ND	ND		15		0	28	ND	0.08		ND		ND	44	ND	0.16	0.8	ND		1.8	
H88-15	07-Nov-08	210	2	0.499		ND	ND	0.199	0.219			ND	ND	13.2	12.8		29.7	0.0002	0.0018		ND	1.7	0.6	39.5	60	962		ND	0.32	1690	1840
H88-16	21-Nov-88	577	0.2		0.14	ND		ND		145	0.11	ND		1.3		0	0.7	ND	0.02		ND		0.54	4	0.2	1.57	0.7	ND		0.2	
H88-16	28-Feb-89	146	0.4		0.04	ND		ND		160	0.38	ND		1.4		9	0.4	ND	0.02		ND		0.61	6	0.09	17.7	0.2	0.03		0.6	
H88-16	16-Jun-89		0.1			ND		ND		161		ND		2.1		6.3	1.1	ND	ND		ND				ND	1.03		ND		1.3	
H88-16	19-Jun-89	143			0.03						0.1												0.53	10			1				
H88-16	19-Jul-89	139	ND		0.01	ND		ND		169	ND	ND		3		0	1.4	ND	ND		ND		0.55	10	ND	0.73	0.5	ND		0.7	
H88-16	04-Nov-89	302	ND		ND	ND		ND		368	ND	ND		6.8		0	4.6	ND	ND		ND		1.56	18	0.18	6.98	ND	ND		0.1	
H88-16	26-Jan-90	135	ND		0.1	ND		ND		165	ND	ND		2.8		0	0.7	ND	ND		ND		0.61	16	0.11	0.56	0.1	ND		2.2	
H88-16	10-May-90	137	0.1		0.11	ND		ND		155	0.24	ND		2.8		6	0.5	ND	ND		ND		0.7	11	ND	0.39	0.1	ND		1.1	
H88-16	31-Jul-90	136	ND		0.07	ND		ND		166	0.2	ND		3.2		0	0.5	ND	ND		ND		0.61	16	0.06	0.32	1.6	ND		2.1	
H88-16	02-Nov-90	128	ND		0.8	ND		ND			0.01	ND						ND	ND		ND		0.58	9	0.06	0.34	1	ND			
H88-16	05-Nov-90									156				3.3		0	0.7													0.4	
H88-16	03-Nov-08	140	16.3	0.836		0.0009	0.001	0.0525	0.07			ND	ND	1.9	2.11		0.5	ND	1.4		0.3	1.5	0.5	8.9	37	1130		0.02	0.38	592	881
H88-17	08-Nov-88	69	0.1		0.07	ND		ND		109	0.36	0.003		20		0	1.1	ND	0.04		ND		0.2	64	0.11	23.1	0.7	ND		7.2	
H88-17	15-Feb-89	70	0.1		0.35	ND		ND			0.29	0.005						ND	0.02		ND		0.11	69	0.05	4.53	0.6	ND			
H88-17	16-Feb-89									85				18		0	3.9													5.8	
H88-17	30-May-89	115	0.3		0.02	ND		ND		140	0.17	ND		31		0	1.8	ND	0.16		ND		0.27	109	0.24	63.5	1.7	ND		7.7	
H88-17	11-Jul-89	91	ND		ND	ND		ND		111	ND	0.003		23		0	1.1	ND	0.24		ND		0.11	81	0.05	89.7	1	ND		5.8	
H88-17	02-Nov-89	99	0.3		ND	ND		ND		121	0.05	ND		25		0	1.1	ND	0.08		ND		0.09	90	0.54	43.6	ND	ND		6.9	
H88-17	19-Jan-90	80	ND		ND	ND		ND		97	ND	ND		22		0	3.1	ND	ND		ND		0.09	79	0.27	0.28	0.2	ND		5.6	
H88-17	07-May-90	148	ND		0.04	ND		ND		181	ND	ND		37		0	1.7	ND	0.07		0.01		0.09	141	0.19	22	0.4	ND		12	
H88-17	18-Jul-90	84	ND		0.06	ND		ND		102	0.12	ND		24		0	0.6	ND	0.5		ND		0.11	72	ND	229	2.9	ND		2.9	
H88-17	20-Oct-90		ND			ND		ND		115		ND		20		0	1.8	ND	0.13		ND				ND	231.5		ND		8.5	

Table 4 - Analytical Resutls of Groundwater Sampling

Station ID	Date Collected	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Manganese, Dissolved (mg/L)	Manganese, Total (mg/L)	Mercury, Dissolved (mg/L)	Nickel, Dissolved (mg/L)	Nickel, Total (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)	Organic Phosphorous, Total (mg/L)	Ortho Phosphorous (mg/L)	Phosphorous, Total (mg/L)	Phosphorus, Dissolved (mg/L)	Phosphorus, Total (mg/L)	Potassium, Dissolved (mg/L)	Potassium, Total (mg/L)	Selenium, Dissolved (mg/L)	Selenium, Total (mg/L)	Sodium Adsorption Ratio	Sodium, Dissolved (mg/L)	Sodium, Total (mg/L)	Solids, Total Dissolved (mg/L)	Sulfate (mg/L)	Zinc, Dissolved (mg/L)	Zinc, Total (mg/L)
H88-10	22-Nov-88	358	ND	ND	ND	ND			ND	ND	ND	ND	0.008			3.3		ND		0.87	23		188	3.7	ND	
H88-10	25-Feb-89	179	0.2	ND	0.01	ND			0.11	ND	0.009	0.001	0.037			3.8		ND		1	25		182	0.4	ND	
H88-10	06-Jun-89	185	0.1	ND	ND	ND			0.16	ND	0.003	0.003	0.018			3.6		ND		0.99	26		202	0.6	0.02	
H88-10	25-Jul-89	180	ND	ND	0.14	ND			ND	ND	0.003	0.006	0.013			3.7		ND		0.98	25		196	ND	0.08	
H88-10	09-Nov-89	176	0.2	ND	ND	ND			ND	ND	0.001	0.006	0.01			3.7		ND		1	25		170	ND	ND	
H88-10	20-Jan-90	178	ND	ND	ND	ND			ND	ND	0.002	0.005	0.008			4		ND		1.06	27		196	0.5	ND	
H88-10	17-Apr-90	178	ND	0.02	0.02	ND			ND	ND	0.004	0.005	0.015			3.4		ND		0.89	23		178	0.7	0.01	
H88-10	01-Aug-90	179	ND	ND	ND	ND			0.01	ND	0.046	0.012	0.147			3.1		ND		0.85	22		176	0.5	ND	
H88-10	30-Oct-90	170	ND	ND	ND	ND			ND	ND	0.013	0.007	0.017			3.7		ND		0.94	24		169	0.5	0.01	
H88-10	06-Nov-08	153	ND	12.4	12.3		0.6	0.6	ND	ND				ND	ND	2930	2990	ND	ND		17900	17900	156	0.7	1.2	1.4
H88-11	22-Nov-88	1521	0.1	ND	0.07	ND			ND	ND	0.011	0.044	0.115			1.9		ND		49.3	300		738	1.6	0.02	
H88-11	22-Feb-89	724	0.1	ND	0.06	ND			0.03	ND	0.013	0.008	0.142			2.2		0.007		46.4	329		782	1.9	0.01	
H88-11	07-Jun-89	760	0.1	ND	0.1	ND			0.05	ND	0.007	0.081	0.233			1.6		ND		52.4	351		834	0.8	0.05	
H88-11	25-Jul-89	726	ND	ND	0.04	ND			0.01	ND	0.001	0.018	0.124			2.2		ND		52.8	343		786	3.7	0.06	
H88-11	02-Nov-89	762	ND	ND	0.04	ND			0.03	ND	0.013	0.057	0.112			0.9		ND		54.9	357		810	1.6	ND	
H88-11	20-Jan-90	725	ND	ND	0.03	ND			ND	ND	0.006	0.001	0.096			2		ND		48.7	327		826	0.9	ND	
H88-11	23-Apr-90	725	0.4	0.03	0.03	ND			ND	ND	0.005	0.011	0.102			2.4		ND		25.2	320		786	0.9	0.02	
H88-11	01-Aug-90	718	ND	ND	0.04	ND			ND	ND	0.005	0.007	0.013			2.8		ND		41.8	319		755	0.6	0.01	
H88-11	31-Oct-90	682	ND	ND	0.04	ND			ND	ND	0.007	0.01	0.109			2.2		ND		35.3	304		768	0.6	0.01	
H88-11	02-Nov-08	692	3	1.76	8.22		ND	0.7	ND	ND				0.11	0.11	ND	1590	ND	ND		329000	327000	769	ND	0.5	2.5
H88-12	21-Nov-88	588	1.5	ND	0.25	ND			0.04	ND	0.186	0.128	1.09			2.9		ND		40.89	248		728	11	0.03	
H88-12	12-Feb-89	632	1.7	ND	0.12	ND			0.11	ND	0.024	0.155	0.727			2.8		ND		31.8	292		736	13	0.03	
H88-12	14-Jun-89		0.4	ND	0.13	ND			0.11	ND						0.5		ND			225			14	0.08	
H88-12	16-Jun-89	543									0.053	0.338	0.893							11			616			
H88-12	18-Jul-89	549	ND	ND	0.18	ND			ND	ND	0.28	0.325	1.48			3		ND		40.3	270		642	26	0.08	
H88-12	09-Nov-89	574	ND	ND	0.08	ND			0.01	ND	0.084	0.3	1.16			2.4		ND		38	263		664	12	0.03	
H88-12	20-Jan-90	542	ND	ND	0.1	ND			ND	ND	0.003	0.259	0.643			1.2		ND		41.7	253		678	9.6	ND	
H88-12	07-May-90	528	ND	ND	0.16	ND			ND	ND	0.837	0.299	1.94			2.1		ND		36.7	238		690	7.9	0.02	
H88-12	30-Jul-90	515							ND	ND	0.008	0.305	0.507			1.8				35.7	232		550	5.1		
H88-12	01-Nov-90	493							ND	ND	0.002	0.288	0.675			2.8				34.3	223		586	6.8		
H88-12	12-Nov-08	506	157	5.61	29.6		1.1	4.8	ND	ND				0.35	0.45	899	1310	ND	ND		251000	244000	706	0.3	1.7	8.7
H88-13	20-Nov-88	2565	ND	ND	0.28	ND			0.01	ND	0.096	0.008	0.625			6.1		ND		78	1120		2750	4.1	0.02	
H88-13	26-Feb-89	1727	0.2	0.04	0.05	ND			0.06	ND	0.021	0.011	0.109			4.7		ND		72	840		1984	4.1	0.03	
H88-13	14-Jun-89		ND	0.03	0.05	ND			0.07	ND						0.9		ND			786			0.4	0.02	
H88-13	16-Jun-89	1607									0.023	0.016	0.137							76.5			1850			
H88-13	18-Jul-89		ND	0.04	0.04	ND												ND							0.02	
H88-13	19-Jul-89	1740							ND	ND	0.03	0.006	0.15			4.2				70.6	843		2008	0.4		
H88-13	03-Nov-89	1595	0.2	0.03	0.06	ND			ND	ND	0.013	0.023	0.163			4.4		ND		82	779		1880	ND	0.02	
H88-13	19-Jan-90	1562	ND	0.02	0.03	ND			ND	ND	0.009	0.007	0.156			6		ND		78	771		1898	0.1	0.01	
H88-13	04-May-90	1486	ND	ND	0.02	ND			0.08	ND	0.019	0.006	0.18			4.8		ND		76.4	714		1776	ND	ND	
H88-13	30-Jul-90	1550	ND	ND	0.05	ND			ND	ND	0.013	0.051	0.156			4.8		ND		63.7	732		1736	ND	0.01	
H88-13	01-Nov-90	1457	ND	ND	ND	ND			ND	ND	0.009	0.019	0.17			4		ND		61	694		1764	ND	0.02	
H88-13	12-Nov-08	1510	6.1	3.24	4.93		1.5	3.6	ND	ND				0.36	0.36	2640	2620	1.6	1.5		748000	740000	1700	ND	2.1	4.9
H88-14	20-Oct-90								0.41	0.01						0.6					12			11		
H88-14	01-Nov-90		ND	ND	0.12	ND												ND							0.01	
H88-14A	22-Nov-88	53	ND	ND	0.32	ND			0.4	ND	0.154	ND	1.31			0.6		ND		0.84	14		120	13	0.01	
H88-14A	15-Feb-89	64	ND	ND	0.22	ND			0.42	ND	0.555	0.017	0.983			0.7		ND		0.86	14		98	12	0.1	
H88-14A	23-May-89	83	ND	ND	ND	ND					0.083	0.062	1.079					ND		1.25			114		ND	
H88-14A	26-May-89								0.47	ND						1.2					21			11		
H88-14A	25-Jul-89	41	ND	ND	0.14	ND			0.18	ND	0.029	0.006	0.284			0.8		ND		0.34	4.8		66	6.8	0.02	
H88-14A	01-Nov-89	55	ND	0.02	0.5	ND			0.43	ND	0.067	0.008	0.64			0.7		ND		0.51	8.2		74	12	ND	
H88-14A	20-Jan-90	65	ND	0.08	0.28	ND			0.55	ND	0.042	0.012	0.195			1		ND		0.76	13		104	14	0.01	
H88-14A	17-Apr-90	88	0.9	0.08	0.36	ND			0.44	ND	0.002	0.008	0.381			0.7		ND		0.53	11		108	12	0.03	
H88-14A	18-Jul-90		ND	0.02	0.3	ND			0.16	ND						0.7		ND			8.9			6.1	0.06	
H88-14A	20-Oct-90	48	ND	0.03	0.53	ND					0.102	0.017	0.676					ND		0.81			71		0.06	
H88-14A	04-Nov-08	50	4.5	0.14	1.45		0.6	0.6	0.2	ND				ND	ND	479	467	ND	ND		3820	3690	81	13.8	6.6	2.5
H88-15	20-Nov-88	137.9	ND	ND	ND	ND			0.36	ND	0.005	0.005	0.032			0.9		ND		3.28	46		172	3.9	ND	
H88-15	28-Feb-89	133	0.3	0.03	0.03	ND					0.007	0.015	0.031					ND		3.18			154		0.2	
H88-15	16-Jun-89	209	0.1	0.02	0.02	ND			0.08	ND	0.003	0.009	0.028			1.5		ND		5.93	92		304	5.3	0.01	
H88-15	19-Jul-89	224	ND	ND	0.02	ND			ND	ND	0.026	0.005	0.112			1.3		ND		7	107		294	4.1	0.05	
H88-15	24-Jan-90	230	ND	ND	ND	ND			ND	ND	0.002	0.003	0.035			1.5		ND		6.74	111		322	4.2	0.02	
H88-15	09-May-90	130	0.1	ND	ND	ND			ND	ND	0.002	0.007	0.019			1.2		ND		3.89	51		170	7	ND	
H88-15	30-Jul-90	207	ND	ND	ND	ND			ND	ND	0.003	0.005	0.006			1.5		ND		6.6	94		262	4.8	0.01	
H88-15	05-Nov-90	194	ND	ND	ND	ND			ND	ND	0.009	0.008	0.014			1.1		ND		6.4	93		278	4.8	0.04	
H88-15	08-Nov-90	217	ND	ND	ND	ND			9	ND	ND	0.009	0.016			1.7		ND		7.15	109		294	2.7	0.01	
H88-15	07-Nov-08	210	2	11.6	23.5		0.3	2.2	ND	ND				0.04	0.08	1170	1240	ND	ND		95000	90100	254	0.7	1.3	4.4
H88-16	21-Nov-88	577	0.2	ND	0.02	ND			0.5	ND	ND	0.055	0.07			1.4		ND		14.2	65		192	2.3	0.08	
H88-16	28-Feb-89	146	0.4	0.03	0.05	ND			0.1	ND	ND	0.032	0.064			0.9		ND		11.3	64		164	1	0.02	
H88-16	16-Jun-89		0.1	ND	0.03	ND			0.1	ND						0.8		ND			62			2.5	0.01	
H88-16	19-Jun-89	143									0.003	0.02	0.054							8.3			182			
H88-16	19-Jul-89	139	ND	ND	0.02	ND			ND	ND	0.017	0.009	0.065			1		ND		7.99	60		142	0.4	ND	
H88-16	04-Nov-89	302	ND	0.07	0.35	ND			ND	ND	ND	0.049	0.049			3.5		ND		14	135		398	4.1	0.01	
H88-16	26-Jan-90	135	ND	ND	ND	ND			ND	ND	ND	0.007	0.051			0.9		ND		6.05	56		162	0.2	0.01	
H88-16	10-May-90	137	0.1	ND	ND	ND			0.01	ND	0.002	0.013	0.043			0.8		ND		7.4	58		146	0.1	ND	
H88-16	31-Jul-90	136	ND	ND	ND	ND			0.01	ND	0.001	0.007	0.027			0.9		ND		5.86	55		142	0.2	0.07	
H88-16	02-Nov-90	128	ND	ND	ND	ND					0.007	0.01	0.043					ND		7.72			146		0.01	
H88-16	05-Nov-90								ND	ND						0.7					55			0.3		
H88-16	03-Nov-08	140	16.3	2.63	14.7		0.2	1.6	ND	ND				0.03	0.15	727	824	ND	ND		61500	60000	170	ND	0.5	5.7
H88-17	08-Nov-88	69	0.1	0.08	0.38	ND			1.23	ND	0.478	0.568	1.88			1.8		ND		0.21	10		92	4.1	0.02	
H88-17	15-Feb-89	70	0.1	0.08	0.07	ND					0.134	0.011	0.351					ND		0.4			108		0.01	
H88-17	16-Feb-89								0.49	ND						1.5					7.7			8.6		
H88-17	30-May-89	115	0.3	ND	0.97	ND			1.92	0.01	0.79	0.009	3.18			1.5		ND		0.47	11		150	9.1	ND	
H88-17	11-Jul-89	91	ND	0.02	1.51	ND			0.74	0.05	0.519	0.006	3.1			1.7		ND		0.43	8.9		112	6.4	0.02	
H88-17	02-Nov-89	99	0.3	0.02	0.85	ND			1.18	ND	0.112	0.016	4.5			1.8		ND		0.43	9.5		122	5.8	0.02	
H88-17	19-Jan-90	80	ND	ND	ND	ND			0.8	ND	0.02	0.028	2.48			1.9		ND		0.33	6.7		130	9.6	0.01	
H88-17	07-May-90	148	ND	0.02	0.04	ND			3.02	ND	0.799	ND	2.29			1.7		ND		0.46	13		188	8.5	0.04	
H88-17	18-Jul-90	84	ND	0.03	4.33	ND			0.96	ND	0.476	0.027	7.16			1.9		ND		0.44	8.5		122	5.5	0.07	
H88-17	20-Oct-90		ND	ND	5.14	ND			0.28	ND						1.9		ND			10			12	0.11	

Station ID	Date Collected	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Aluminum, Total (mg/L)	Ammonia as Nitrogen (mg/L)	Arsenic, Dissolved (mg/L)	Arsenic, Total (mg/L)	Barium, Dissolved (mg/L)	Barium, Total (mg/L)	Bicarbonate, HCO3 (mg/L)	Boron (mg/L)	Cadmium, Dissolved (mg/L)	Cadmium, Total (mg/L)	Calcium, Dissolved (mg/L)	Calcium, Total (mg/L)	Carbonate, CO3 (mg/L)	Chloride (mg/L)	Chromium, Dissolved (mg/L)	Chromium, Total (mg/L)	Cobalt, Dissolved (mg/L)	Copper, Dissolved (mg/L)	Copper, Total (mg/L)	Fluoride (mg/L)	Hardness as CaCO3 (mg/L)	Iron, Dissolved (mg/L)	Iron, Total (mg/L)	Kjeldahl Nitrogen, Total (mg/L)	Lead, Dissolved (mg/L)	Lead, Total (mg/L)	Magnesium, Dissolved (mg/L)	Magnesium, Total (mg/L)
H88-17	25-Oct-90	94			0.07						0.12												0.08	84			2.3				
H88-17	31-Oct-08	72	5.1	0.0148		ND	ND	0.0627	0.0617			0.00003	0.00002	18.3	18.4		1.0	ND	ND		1.4	1.4	ND	70.1	ND	23		ND	ND	5850	5850
H88-19	08-Nov-88	277	0.2		1.4	ND		ND		146	0.06	0.006		19		0	2.8	ND	1.9		ND		0.12	83	0.24	1010	206	ND		8.8	
H88-19	23-May-89	75	ND		0.31	ND		ND		91	ND	ND		22		0	2.8	ND	0.13		ND		0.06	67	0.09	68.6	10.8	ND		3.2	
H88-19	10-Jul-89	63	ND		0.31	ND		ND		77	0.1	ND		17		0	2.8	ND	0.2		ND		0.08	53	ND	88	38.8	ND		2.6	
H88-19	01-Nov-89	89	0.2		0.24	ND		ND		108	ND	ND		24		0	1.4	ND	0.21		0.02		0.06	74	0.33	78.5	58.3	ND		3	
H88-19	24-Jan-90	58	ND		0.32	ND		ND		71	0.07	ND		19		0	4.7	ND	0.21		ND		0.05	51	0.14	93	5.3	ND		0.7	
H88-19	24-Apr-90	72	ND		0.36	ND		ND		88	ND	ND		21		0	5.7	ND	0.15		ND		0.08	65	0.09	56.6	39	ND		3.4	
H88-19	18-Jul-90	62	ND		0.39	ND		ND		75	0.18	ND		12		0	0.8	ND	0.24		ND		0.09	43	ND	98.2	24.4	ND		3	
H88-19	20-Oct-90	69	ND		0.39	ND		ND		84	0.11	ND		17		0	1.1	ND	0.11		ND		0.06	57	ND	102.5	11.2	ND		3.6	
H88-19	06-Nov-08	79	4.6	20.5		ND	0.0106	0.0613	0.432			0.00008	0.00004	21	23.6		1.2	ND	32.7		1.1	81.5	ND	21.6	ND	29600		ND	20.4	4470	11900
H88-21	05-Nov-88		0.4			ND		ND				0.005						ND	0.3		0.01				0.67	221		ND			
H88-21	09-Nov-88	74.5			ND					94	0.02			23		0	0.7						0.07	71			0.5			3	
H88-21	15-Feb-89		0.1			ND		ND				0.003						ND	0.57		ND				0.39	408		ND			
H88-21	16-Feb-89	96			0.45					112	0.36			33		2.7	1.4						0.6	84			5.7			ND	
H88-21	23-May-89	87	ND		0.02	ND		ND		106	ND	ND		28		0	0.7	ND	0.13		ND		0.08	79	ND		3.1			2.2	
H88-21	11-Jul-89	70	ND		ND	ND		ND		85	ND	ND		23		0	0.4	ND	0.09		ND		0.06	64	ND	85.6	1.8	ND		1.6	
H88-21	03-Nov-89	76	0.4		ND	ND		ND		93	0.12	ND		24		0	ND	ND	0.07		ND		0.07	68	0.85	58.6	0.3	ND		1.9	
H88-21	24-Jan-90	80	ND		0.13	ND		ND		98	ND	ND		25		0	1.1	ND	0.42		ND		0.05	76	0.05	340	2.4	ND		3.4	
H88-21	07-May-90	96	ND		0.04	ND		ND		117	ND	ND		26		0	1.1	ND	0.25		0.03		0.09	86	0.07	208	1.4	ND		5	
H88-21	18-Jul-90		ND			ND		ND		90		ND		26		0	0.7	ND	0.32		ND				ND	250		ND		1.7	
H88-21	23-Oct-90	62	ND		ND	ND		ND		76	0.08	ND		21		0	1.1	ND	0.14		ND		0.08	63	0.15	187.1	2.5	ND		2.4	
H88-21	10-Nov-08	61	ND	0.0768		ND	ND	0.0103	0.0112			ND	ND	18.2	18.3		0.6	0.0008	0.0016		0.5	0.7	0.028	58.5	ND	74		ND	0.03	3110	3140
H88-22	05-Nov-88	172	2.6		ND	ND		ND		124	0.01	0.008		28		0	1.1	ND	0.25		0.03		0.08	92	4.34	174	0.5	ND		5.1	
H88-22	15-Feb-89		0.1			ND		ND				0.003						ND	0.09		ND				ND	51.2		ND			
H88-22	16-Feb-89	69			0.07					84	0.36			20		0	1.4						0.2	64			0.7			3.2	
H88-22	23-May-89																									109		ND			
H88-22	30-May-89	101	0.2		0.02	ND		ND		123	0.28	ND		30		0	1.1	ND	0.13		ND		0.26	91	0.05	104	2	ND		4	
H88-22	10-Jul-89	105	ND		ND	ND		ND		128	ND	ND		30		0	1.4	ND	0.05		ND		0.1	95.172	0.05	46.9	1.2	ND		4.9	
H88-22	02-Nov-89	101	ND		ND	ND		ND		123	ND	ND		27		0	ND	ND	0.09		ND		0.07	89	0.09	55.6	0.4	ND		5.2	
H88-22	24-Jan-90	98	ND		0.7	ND		ND		120	ND	ND		28		0	1.1	ND	0.07		ND		0.08	81	0.1	53.5	0.9	ND		2.8	
H88-22	24-Apr-90	5	ND		0.07	ND		ND		120	ND	ND		27		0	0.9	ND	0.05		ND		0.08	89	0.07	29.4	0.5	ND		5.4	
H88-22	18-Jul-90	102	ND		0.05	ND		ND		125	0.01	ND		29		0	0.4	ND	0.24		ND		0.11	91	ND	188	6.2	ND		4.5	
H88-22	25-Oct-90	92	ND		0.01	ND		ND		112	0.07	ND		28		0	1.1	ND	0.15		ND		0.11	90	0.11	182.1	2.1	ND		5.1	
H88-22	04-Nov-08	82	2.6	1.98		0.0023	0.0026	0.0167	0.0375			ND	0.00004	25.5	26.8		0.5	ND	0.0037		0.1	5.2	ND	90.9	ND	3140		ND	0.78	4830	5810
H88-23	03-Nov-88	97.6	0.1		0.24	ND		ND		81	0.04	0.004		17		0	5	ND	0.4		0.01		0.07	62	0.18	331	3.4	ND		4.5	
H88-23	12-Feb-89		0.1			ND		ND				0.002						ND	ND		0.01				ND	0.83		ND			
H88-23	21-Feb-89	56			0.03					68	ND			14		0	1.1						0.06	53			1.4			4	
H88-23	24-May-89	64	ND		0.06	ND		ND		77	ND	ND		20		0	1.4	ND	0.13		ND		0.06	62	0.05	128	4.9	ND		2.9	
H88-23	23-Jul-89	55	ND		ND	ND		ND		66	ND	ND		19		0	1.1	ND	0.16		ND		0.07	54	ND	104	4.7	ND		1.2	
H88-23	11-Nov-89	55	0.1		ND	ND		ND		67	0.13	ND		16		0	ND	ND	ND		ND		0.06	62	ND	36.9	0.8	ND		5.1	
H88-23	23-Jan-90	77	ND		0.3	ND		ND		94	ND	ND		18		0	4	ND	0.11		ND		0.15	59	ND	87.2	1.8	ND		3.2	
H88-23	07-May-90	52	ND		0.07	ND		ND		64	ND	ND		15		0	1.7	ND	0.07		0.01		0.05	48	0.1	59.3	0.6	ND		2.7	
H88-23	29-Jul-90	60	0.2		0.15	ND		ND		74	0.1	ND		16		0	0.7	ND	0.44		ND		0.07	54	0.24	392	3.9	ND		3.4	
H88-23	23-Oct-90	59	ND		0.09	ND		ND		72	0.08	ND		18		0	1.1	ND	0.17		ND		0.06	63	0.05	316.3	5.7	ND		4.5	
H88-23	11-Nov-08	48	4.2	0.206		ND	ND	0.00454	0.00565			0.00002	0.00003	12.8	12.7		0.7	0.6	1.2		1.4	2.1	ND	43.4	ND	218		ND	0.07	2850	2850
H88-24A	03-Nov-88	75.1	ND		0.06	ND		ND		98	0.07	0.003		12		0	33	ND	0.35		ND		0.21	48	0.09	267	0.8	ND		4.7	
H88-24A	21-Feb-89	81	ND		0.01	ND		ND		99	0.03	0.002		18		0	22	ND	0.02		ND		0.15	70	0.05	17.1	1.5	0.03		6	
H88-24A	24-May-89	85	0.2		0.02	ND		ND		103	ND	ND		18		0	3.5	ND	0.14		ND		0.13	66	0.23	177	2.7	ND		5.1	
H88-24A	23-Jul-89	82	ND		0.07	ND		ND		100	ND	ND		25		0	3.2	ND	0.16		ND		0.14	69	ND	177	4.1	ND		1.8	
H88-24A	10-Nov-89	76	0.1		ND	ND		1		93	0.01	ND		19		0	0.4	ND	0.08		ND		0.1	60	ND	75.2	4	ND		2.9	
H88-24A	23-Jan-90	72	ND		0.14	ND		ND			0.04	ND						ND	0.84		ND		0.11	52	0.12	692	7.4	ND			
H88-24A	26-Jan-90									88				18		0	2													1.5	
H88-24A	07-May-90	68	ND		0.1	ND		ND		83	ND	ND		15		0	2	ND	0.23		0.01		0.09	57	0.21	205	0.7	ND		4.6	
H88-24A	29-Jul-90	74	ND		0.04	ND		ND		90	0.13	ND		17		0	1.3	ND	0.24		ND		0.12	58	0.14	223	4.5	ND		3.6	
H88-24A	23-Oct-90	64	ND		ND	ND		ND		78	0.08	ND		19		0	1.1	ND	0.16		ND		0.1	61	0.1	236.8	1.3	ND		3.4	
H88-24A	11-Nov-08	52	ND	0.541		ND	ND	0.00722	0.0111			0.00003	ND	13.9	13.7		0.7	0.8	2		0.7	2.6	ND	48.9	ND	671		ND	0.14	3430	3600
H88-25	03-Nov-88	245	ND		0.06	ND		ND		143	0.18	0.004		57		0	284	ND	0.5		ND		0.43	191	ND	379	2.4	ND		12	
H88-25	19-Feb-89	90	ND		0.08	ND		ND		110	0.03	0.004		18		0	21	ND	0.02		ND		0.19	75	ND	13.5	1.4	ND		6.9	
H88-25	24-May-89	102	1.3		0.06	ND		ND		124	ND	ND		23		0	13	ND	0.54		ND		0.18	82	1.01	385	7.4	ND		5.8	
H88-25	23-Jul-89	121	ND		ND	ND		ND		148	ND	ND		22		0	17	ND	0.37		ND		0.38	70	ND	266	2.1	ND		3.4	
H88-25	11-Nov-89	80	1		ND	ND		ND		98	0.27	ND		19		0	5.7	ND	ND		ND		0.15	63	1.3	107	0.6	ND		3.8	
H88-25	23-Jan-90	52	ND		0.16	ND		ND		63	0.03	ND		18		0	1.2	ND	0.37		ND		0.07	46	0.24	300	3.2	ND		0.5	
H88-25	07-May-90	80	ND		0.09	ND		ND		98	ND	ND		16		0	3	ND	0.82		0.01		0.17	60	0.38	601	4.8	ND		5.1	
H88-25	29-Jul-90	90	0.1		0.07	ND		ND		110	0.19	ND		18		0	2.4	ND	0.27		ND		0.29	55	0.18	309	4.2	ND		2.4	
H88-25	25-Oct-90	76	ND		ND	ND		ND		93	0.17	ND		16		0	2.8	ND	0.04		ND		0.24	52	0.13	44.5	0.6	ND		2.9	
H88-25	11-Nov-08	34	16.8	6.51		0.0014	0.0022	0.00152	0.03			ND	0.00051	8.46	8.95		0.5	2.7	16.1		1.9	14.2	ND	35	ND	5660		0.06	3.11	1280	3080
H88-27	07-Nov-88	66	0.1		0.04	ND		ND		81	0.04	0.004		19		0	15	ND	0.06		0.01		0.09	68	0.22	18.3	ND	ND		4.9	
H88-27	18-Feb-89	60	0.8		0.24	ND		ND		73	ND	0.008		16		0	3.5	ND	0.05		0.03		0.1	59	0.95	24	0.9	0.08		4.6	
H88-27	31-May-89	56	0.2		0.01	ND		ND		68	0.14	ND		18		0	0.7	ND	0.23		ND		0.09	53	0.07	181	1.1	ND		2.1	
H88-27	18-Jul-89	65	ND		ND	ND		ND		79	ND	ND		18		0	1.1	ND	0.1		ND		0.11	62	0.1	65.9	1.5	ND		4	
H88-27	02-Nov-89	61	0.1		ND	ND		ND		74	ND	ND		18		0	1.4	ND	0.05		ND		0.07	55	0.29	30	1.2	ND		2.7	
H88-27	20-Jan-90	61	ND		ND	ND		ND		74	ND	ND		17		0	2.2	ND	0.06		ND		0.08	54	0.15	46	0.2	ND		2.4	
H88-27	04-May-90	46	ND		0.06	ND		ND		56	ND	ND		15		0	1	ND	0.25		ND		0.11	40	0.26	182	3	ND		0.7	
H88-27	18-Jul-90	53	ND		ND	ND		ND		64	0.05	ND		15		0	0.7	ND	0.33		ND		0.11	51	ND	293	10	ND		3.3	
H88-27	23-Oct-90	50	ND		ND	ND		ND		61	0.08	ND		15		0	1.1	ND	0.08		ND		0.08	48	0.09	118.2	1.6	ND		2.6	
H88-27	30-Oct-08	51	406	0.262		0.0006	0.0006	0.0171	0.015			0.02	ND	13.6	13.1		0.7	0.0009	0.0015	1	3.8	2.7	ND	45.1	411	395		0.24	0.14	3090	2990
H88-28	07-Nov-88	129	0.1		0.07	ND		ND		126	0.03	0.003		43		0	0.7	ND	0.2		ND		0.18	119	0.17	131	0.5	ND		2.8	
H88-28	18-Feb-89	70	0.1		0.06	ND		ND		85	ND	0.004		18		0	1.4	ND	0.13		ND		0.12	63	0.09	95.6	2.3	ND		4.5	
H88-28	26-Jul-89	96	ND		0.03	ND		ND		117	ND	ND		33		0	0.7	ND	0.03		ND		0.16	89	0.06	35.9	2.4	ND		1.8	
H88-28	03-Nov-89	68	0.3		ND	ND		ND		83	ND	ND		20		0	ND	ND	0.07		ND		0.12	60	0.53	53.6	1.3	ND		2.2	
H88-28	19-Jan-90	61	ND		ND	ND		ND		74	0.04	ND		20		0	1.3	ND	0.08		ND		0.08	59	0.05	72.5	1.4	ND		2.1	
H88-28	04-May-90	59	ND		0.11	ND		ND		72	ND	ND		19		0	1	ND	0.15		0.01		0.1	52	0.11	110	1.2	ND		1	
H88-28	18-Jul-90	84	ND		0.08	ND		ND		102	0.09	ND		16		0	0.4	ND	0.18		0.01		0.13	75	ND	161	4.6	ND		8.4	
H88-28	24-Oct-90	61	ND		0.05	ND		ND		74	0.07	ND		19		0	1.1	ND	0.08		ND		0.13	56	0.11	124.8	3.4	ND		1.8	
H88-28	30-Oct-08	44	3	0.437		ND	0.0008	0.00627	0.0113			0.00002	0.00003	11.5	11.8		0.5	0.0002	0.0021	0.1	0.5	4.5	ND	39.2	ND	952		0.12	1.6	2170	2390
H89-29	27-Jul-89	147	ND		0.25	ND		0.6		179	ND	ND		27		0	1.8	ND	ND		ND		0.17	102	0.14	0.23	0.7	ND		8.1	
H89-29	01-Nov-89	125	0.2		ND	ND		ND		153	0.03	ND		30		0	1.1	ND	ND		ND		0.09	110	1.22	1.23	0.5	ND		8.8	
H89-29	23-Jan-90	119	ND		0.13	ND		ND		145	ND	ND		34		0	2.7	ND	ND		ND		0.11	118	0.22	2.59	0.8	ND		7.9	
H89-29	17-Apr-90	105	ND		ND	ND		ND		127	0.05	ND		33		0	6.9	ND	ND		ND		0.11	112	2.45	3.26	0.5	ND		7.5	

Station ID	Date Collected	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Manganese, Dissolved (mg/L)	Manganese, Total (mg/L)	Mercury, Dissolved (mg/L)	Nickel, Dissolved (mg/L)	Nickel, Total (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)	Organic Phosphorous, Total (mg/L)	Ortho Phosphorous (mg/L)	Phosphorous, Total (mg/L)	Phosphorus, Dissolved (mg/L)	Phosphorus, Total (mg/L)	Potassium, Dissolved (mg/L)	Potassium, Total (mg/L)	Selenium, Dissolved (mg/L)	Selenium, Total (mg/L)	Sodium Adsorption Ratio	Sodium, Dissolved (mg/L)	Sodium, Total (mg/L)	Solids, Total Dissolved (mg/L)	Sulfate (mg/L)	Zinc, Dissolved (mg/L)	Zinc, Total (mg/L)
H88-17	25-Oct-90	94									0.03	0.007	6.2							0.49			122			
H88-17	31-Oct-08	72	5.1	0.17	0.49		1.3	1	0.7	ND				ND	ND	940	941	ND	ND		6760	6780	83	8.1	1.4	0.9
H88-19	08-Nov-88	277	0.2	0.18	13.2	ND			ND	ND	3.1	0.004	16.2			4.8		ND		1.21	25		154	13	0.02	
H88-19	23-May-89	75	ND	0.02	1.26	ND			0.21	ND	1.88	0.031	8.32			1.5		ND		0.6	11		108	15	ND	
H88-19	10-Jul-89	63	ND	0.02	1.39	ND			0.08	ND	3.14	0.044	9.78			2.3		ND		0.55	9.2		104	8.6	0.01	
H88-19	01-Nov-89	89	0.2	0.11	1.57	ND			0.15	ND	3.34	0.023	10.9			3.3		ND		0.66	13		124	15	0.05	
H88-19	24-Jan-90	58	ND	0.05	1.92	ND			0.42	ND	0.293	0.019	2.09			2		ND		0.83	14		114	15	0.02	
H88-19	24-Apr-90	72	ND	0.07	0.93	ND			0.62	ND	0.53	0.004	6.23			5.2		ND		0.72	13		114	19	0.02	
H88-19	18-Jul-90	62	ND	0.31	1.92	ND			0.14	ND	1.13	0.156	5.32			4.5		ND		0.64	9.6		114	7.7	0.01	
H88-19	20-Oct-90	69	ND	0.05	1.9	ND			1.32	ND	1.02	0.016	4.797			3.1		ND		0.56	9.6		118	5.8	0.06	
H88-19	06-Nov-08	79	4.6	6.46	744		1.1	31	ND	ND				ND	1.13	817	5570	ND	ND		7810	7390	104	13.1	2.9	84.3
H88-21	05-Nov-88		0.4	0.04	4.3	ND												ND							0.04	
H88-21	09-Nov-88	74.5							0.39	ND	0.036	0.001	2.69			1.7				0.31	6		114	3.7		
H88-21	15-Feb-89		0.1	0.05	8.17	ND												ND							0.02	
H88-21	16-Feb-89	96							0.89	0.01	0.646	0.137	5.96			2.3				0.35	7.4		104	4.7		
H88-21	23-May-89	87	ND	ND	2.67	ND			0.28	0.01	0.371	0.022	2.74			1.2		ND		0.26	5.2		106	4.9	0.01	
H88-21	11-Jul-89	70	ND	ND	1.65	ND			0.28	ND	0.82	0.016	3.13			2.9		ND		0.19	3.4		98	4.9	ND	
H88-21	03-Nov-89	76	0.4	0.08	1.24	ND			0.25	ND	0.1	0.166	4.4			1.7		ND		0.24	4.7		86	2.1	0.02	
H88-21	24-Jan-90	80	ND	ND	7.18	ND			0.31	ND	0.394	0.02	4.98			1.3		ND		0.2	4		110	3.1	ND	
H88-21	07-May-90	96	ND	0.02	4.44	ND			0.35	ND	0.635	0.009	4.9			3		ND		0.31	6.6		138	4	0.07	
H88-21	18-Jul-90		ND	ND	5.37	ND			0.33	ND						1.2		ND			2.4			3.1	0.03	
H88-21	23-Oct-90	62	ND	ND	4.04	ND			0.3	ND	1.099	0.022	4.581			1.8		ND		0.04	0.7		88	3	0.04	
H88-21	10-Nov-08	61	ND	0.11	2.87		0.9	1.5	0.2	ND				ND	0.006	576	589	ND	ND		3010	3000	80	3.1	1	1.7
H88-22	05-Nov-88	172	2.6	0.7	4.15	ND			0.07	ND	3.11	0.001	4.5			1.3		ND		0.27	5.9		122	1.6	0.04	
H88-22	15-Feb-89		0.1	0.13	1.23	ND												ND							0.03	
H88-22	16-Feb-89	69							7.54	ND	0.478	0.568	1.88			0.9				0.21	4		92	2.1		
H88-22	23-May-89																									
H88-22	30-May-89	101	0.2	0.15	2.16	ND			ND	ND	0.03	0.016	2.77			1		ND		0.24	5.3		116	4.3	0.14	
H88-22	10-Jul-89	105	ND	0.11	0.94	ND			0.05	ND	1.902	0.053	4.36			1.5		ND		0.27	5.9		136	3.7	ND	
H88-22	02-Nov-89	101	ND	0.07	1.51	ND			ND	ND	0.042	0.025	0.936			1.6		ND		0.26	5.7		112	2.5	ND	
H88-22	24-Jan-90	98	ND	0.05	1.73	ND			ND	ND	ND	0.019	1.25			4.3		ND		0.34	7.2		96	2.8	0.01	
H88-22	24-Apr-90	5	ND	0.07	0.76	ND			0.02	ND	0.048	0.01	0.954			1.5		ND		0.23	5.1		106	2.6	0.02	
H88-22	18-Jul-90	102	ND	0.07	4.66	ND			ND	ND	0.593	0.049	4.41			1.5		ND		0.24	5.4		124	3.1	ND	
H88-22	25-Oct-90	92	ND	0.1	5.33	ND			0.01	ND	0.746	0.024	4.822			1.5		ND		0.07	1.7		91	3	0.1	
H88-22	04-Nov-08	82	2.6	44.8	238		0.5	3.3	ND	ND				0.02	0.09	1090	1270	ND	ND		4700	4990	99	2.5	1.3	8.4
H88-23	03-Nov-88	97.6	0.1	0.21	5.9	ND			0.31	ND	1.39	0.007	8.91			2.4		ND		0.48	8.7		108	9.5	0.03	
H88-23	12-Feb-89		0.1	0.02	0.03	ND												0.01							0.01	
H88-23	21-Feb-89	56							0.21	0.01	0.329	0.006	2.15			1.1				0.21	3.4		88	2.3		
H88-23	24-May-89	64	ND	0.08	2.41	ND			0.3	ND	0.782	0.019	3.62			2.3		ND		0.24	4.3		82	6	ND	
H88-23	23-Jul-89	55	ND	0.06	1.93	ND			0.13	ND	0.587	0.026	3.4			1.9		ND		0.23	3.9		96	7.2	0.01	
H88-23	11-Nov-89	55	0.1	0.08	0.65	ND			4.8	ND	0.208	0.052	1.64			1.6		ND		0.18	3.3		78	3.7	ND	
H88-23	23-Jan-90	77	ND	0.04	1.62	ND			0.46	ND	0.402	0.039	3.4			2.3		ND		0.66	12		108	4.4	0.06	
H88-23	07-May-90	52	ND	0.05	1.1	ND			0.46	ND	1.01	0.006	2.59			1.7		ND		0.25	4		118	2.8	0.02	
H88-23	29-Jul-90	60	0.2	0.02	8.21	ND			0.39	ND	0.873	0.012	3.7			2.2		ND		0.26	4.4		65	3.8	0.06	
H88-23	23-Oct-90	59	ND	ND	7.81	ND			0.39	ND	0.736	0.02	5.688			1.7		ND		0.04	0.8		90	3.5	0.04	
H88-23	11-Nov-08	48	4.2	0.17	4.71		0.6	0.9	0.3	ND				ND	0.11	581	623	ND	ND		2860	2840	66	2.1	1.3	1.9
H88-24A	03-Nov-88	75.1	ND	4.58	5.9	ND			0.22	ND	0.458	0.002	5.74			3.3		ND		2.47	40		168	7.6	0.03	
H88-24A	21-Feb-89	81	ND	0.46	0.83	ND			0.13	0.01	0.724	0.019	5.18			2.1		ND		1.15	22		148	7	0.01	
H88-24A	24-May-89	85	0.2	0.11	2.87	ND			0.07	ND	0.695	0.074	3			2.1		ND		0.62	11		94	2.5	ND	
H88-24A	23-Jul-89	82	ND	ND	2.82	ND			0.38	0.02	0.167	0.035	1.82			2.5		ND		0.52	9.9		116	4.3	0.02	
H88-24A	10-Nov-89	76	0.1	ND	2.2	ND			0.08	ND	3.16	0.033	9.17			2.1		ND		0.45	8.1		94	2.7	0.01	
H88-24A	23-Jan-90	72	ND	0.26	17.9	ND					3.55	0.042	9.6					ND		0.6			102		0.01	
H88-24A	26-Jan-90								0.08	ND						3.7					9.9			1.9		
H88-24A	07-May-90	68	ND	0.03	5.97	ND			0.23	ND	0.466	0.006	3.22			1.7		ND		0.41	7.2		110	2.2	0.02	
H88-24A	29-Jul-90	74	ND	ND	7.22	ND			0.28	ND	0.169	0.014	2.44			2.4		ND		0.45	7.8		77	3	0.03	
H88-24A	23-Oct-90	64	ND	ND	7.3	ND			0.19	ND	1.089	0.022	5.447			1.9		ND		0.11	2		105	2.7	0.05	
H88-24A	11-Nov-08	52	ND	0.21	25		0.8	1.4	0.3	ND				ND	0.02	738	800	ND	ND		3840	3780	70	2.2	ND	2.9
H88-25	03-Nov-88	245	ND	ND	7	ND			ND	ND	0.826	0.006	5.46			8.8		ND		5.38	171		716	45	ND	
H88-25	19-Feb-89	90	ND	ND	0.23	ND			0.37	ND	0.575	0.034	1.12			3.6		ND		1.05	21		132	6	0.03	
H88-25	24-May-89	102	1.3	0.07	6.4	ND			0.12	0.01	2.35	0.051	8.27			3.5		ND		0.93	19		140	6.6	0.03	
H88-25	23-Jul-89	121	ND	0.03	4.81	ND			0.14	ND	0.559	0.019	2.71			3.4		ND		1.88	36		190	6.6	0.04	
H88-25	11-Nov-89	80	1	0.04	1.79	ND			0.21	ND	1.32	0.042	8.17			2.5		ND		0.74	14		104	4.1	0.02	
H88-25	23-Jan-90	52	ND	0.02	5.67	ND			0.42	ND	0.134	0.042	1.75			2.4		ND		0.24	3.6		104	3	0.01	
H88-25	07-May-90	80	ND	0.02	11.9	ND			0.33	ND	1.84	0.025	8.13			2.1		ND		0.71	13		106	4.4	0.04	
H88-25	29-Jul-90	90	0.1	ND	8.43	ND			0.17	ND	0.278	0.024	3.53			2.9		ND		1.07	18		99	4	0.04	
H88-25	25-Oct-90	76	ND	ND	0.91	ND			0.08	ND	0.061	0.04	0.984			2.2		ND		0.79	13		110	2.8	0.02	
H88-25	11-Nov-08	34	16.8	1.59	84.5		2.2	11.9	0.3	ND				0.06	0.13	947	1550	ND	ND		4500	3880	69	2.2	2.1	16.3
H88-27	07-Nov-88	66	0.1	0.05	0.37	ND			0.39	ND	0.036	0.001	0.482			2		ND		0.57	11		116	3.7	0.03	
H88-27	18-Feb-89	60	0.8	0.04	0.43	ND			2.55	ND	0.504	0.021	1.3			1.6		0.01		0.27	4.8		72	5.6	0.1	
H88-27	31-May-89	56	0.2	0.02	3.2	ND			0.42	ND	0.289	0.021	2.04			1.3		ND		0.21	3.5		76	4.7	ND	
H88-27	18-Jul-89	65	ND	0.02	1.5	ND			0.94	ND	1.07	0.015	4.58			1.6		ND		0.23	4.1		112	3.1	0.02	
H88-27	02-Nov-89	61	0.1	ND	0.91	ND			0.38	ND	0.045	0.04	0.617			1.4		ND		0.23	3.8		84	2.3	0.02	
H88-27	20-Jan-90	61	ND	ND	1.25	ND			0.25	ND	0.02	0.026	1.08			2.1		ND		0.27	4.7		102	2	0.01	
H88-27	04-May-90	46	ND	ND	3.83	ND			0.67	ND	1.75	0.047	7.95			2.5		ND		0.25	3.6		76	1.4	0.01	
H88-27	18-Jul-90	53	ND	ND	6.42	ND			0.55	ND	2.56	0.065	6.3			2.1		ND		0.14	2.4		92	1.8	ND	
H88-27	23-Oct-90	50	ND	ND	4.01	ND			0.51	ND	0.246	0.016	2.216			1.6		ND		0.14	2.3		80	1.9	0.07	
H88-27	30-Oct-08	51	406	14.9	8.6		1.4	1.4	0.7	ND				0.02	0.03	896	812	ND	ND		2830	2750	65	2.8	2.8	1.9
H88-28	07-Nov-88	129	0.1	0.02	2.45	ND			0.58	ND	0.704	0.072	2.99			2.9		ND		0.33	8.2		182	6.4	0.01	
H88-28	18-Feb-89	70	0.1	0.09	1.47	ND			0.74	ND	0.299	0.031	2.55			1.5		0.01		0.33	4.4		108	2.7	0.02	
H88-28	26-Jul-89	96	ND	0.03	0.52	ND			0.64	ND	0.311	0.011	1.62			2.2		ND		0.24	5.3		152	3.1	0.03	
H88-28	03-Nov-89	68	0.3	0.07	1.14	ND			0.45	ND	0.206	0.2	2.09			1.9		ND		0.26	4.6		110	2.3	0.02	
H88-28	19-Jan-90	61	ND	0.13	1.1	ND			0.38	ND	0.125	0.045	1.03			1.8		ND		0.16	2.8		112	2	0.01	
H88-28	04-May-90	59	ND	0.09	1.94	ND			0.41	ND	0.41	0.21	2.67			2.2		ND		0.25	4.1		98	2.8	0.04	
H88-28	18-Jul-90	84	ND	0.12	2.66	ND			0.45	ND	0.737	0.079	2.84			2.7		ND		0.23	4.7		130	2.6	0.03	
H88-28	24-Oct-90	61	ND	ND	2.32	ND			0.33	ND	1.452	0.015	4.523			1.5		ND		0.17	3		110	1.7	0.09	
H88-28	30-Oct-08	44	3	1.4	12.3		0.99	1.8	0.6	ND				0.02	0.04	514	592	ND	ND		3130	3160	80	1.3	1.3	3.4
H89-29	27-Jul-89	147	ND	ND	ND	ND			0.01	ND	0.005	0.005	0.012			3		ND		0.93	22		158	5.6	0.06	
H89-29	01-Nov-89	125	0.2	0.04	0.03	ND			ND	ND	0.004	0.006	0.017			2.4		ND		0.35	8.4		128	6.6	0.47	
H89-29	23-Jan-90	119	ND	0.03	0.03	ND			ND	ND	ND	0.004	0.007			1.3		ND		0.27	6.7		140	10	0.77	
H89-29	17-Apr-90	105	ND	0.04	0.04	ND			ND	ND	0.007	0.003	0.015			1.3		ND		0.24	5.7		124	14	0.5	

Station ID	Date Collected	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Aluminum, Total (mg/L)	Ammonia as Nitrogen (mg/L)	Arsenic, Dissolved (mg/L)	Arsenic, Total (mg/L)	Barium, Dissolved (mg/L)	Barium, Total (mg/L)	Bicarbonate, HCO3 (mg/L)	Boron (mg/L)	Cadmium, Dissolved (mg/L)	Cadmium, Total (mg/L)	Calcium, Dissolved (mg/L)	Calcium, Total (mg/L)	Carbonate, CO3 (mg/L)	Chloride (mg/L)	Chromium, Dissolved (mg/L)	Chromium, Total (mg/L)	Cobalt, Dissolved (mg/L)	Copper, Dissolved (mg/L)	Copper, Total (mg/L)	Fluoride (mg/L)	Hardness as CaCO3 (mg/L)	Iron, Dissolved (mg/L)	Iron, Total (mg/L)	Kjeldahl Nitrogen, Total (mg/L)	Lead, Dissolved (mg/L)	Lead, Total (mg/L)	Magnesium, Dissolved (mg/L)	Magnesium, Total (mg/L)
H89-29	31-Jul-90	112	ND		0.04	ND		ND		137	0.14	ND		29		0	1.5	ND	ND		ND		0.11	109	2.59	3.55	0.9	ND		8.8	
H89-29	30-Oct-90	101	ND		0.06	ND		ND		123	0.01	ND		28		0	1.4	ND	ND		ND		0.22	103	0.06	3.47	0.5	ND		7.9	
H89-29	05-Nov-08	122	ND	ND		ND	ND	648	667			ND	ND	24.1	24.7		1.3	0.0003	0.0005		0.4	0.4	ND	96.3	1160	1230		0.04	0.06	8050	8410
H89-30	28-Jul-89	291	ND		0.22	0.011		ND		354	ND	ND		10		0	2.5	ND	ND		ND		1.35	34	ND	4.6	2.1	ND		1.9	
H89-30	03-Nov-89	140	0.8		ND	ND		ND		157	0.2	ND		3		7	ND	ND	ND		ND		0.54	9	0.54	4.11	0.3	ND		0.2	
H89-30	24-Jan-90	301	ND		ND	ND		ND		367	ND	ND		5		0	2.5	ND	ND		ND		1.71	18	1.14	2.52	0.8	ND		1.2	
H89-30	17-Apr-90	298	1.1		0.36	ND		ND		364	0.05	ND		4.4		0	3.9	ND	ND		ND		1.64	30	1.17	2.49	0.6	ND		4.5	
H89-30	18-Jul-90	299	ND		0.36	ND		ND		364	0.18	ND		4.7		0	2.2	ND	ND		ND		1.64	18	ND	2.71	0.9	ND		1.5	
H89-30	25-Oct-90	282	ND		0.26	ND		ND		344	0.11	ND		3.1		0	2.5	ND	ND		ND		1.85	14	0.05	1.51	0.3	ND		1.6	
H89-30	18-Jul-90	ND		0.36	ND	ND		364	0.18	ND		4.7		0	0.75	5.96	ND	ND		1.64	ND	2.71	0.9	ND		1.5		0.09	0.14		
H89-30	25-Oct-90	ND		0.26	ND	ND		344	0.11	ND		3.1		0	0.61	5.81	ND	ND		1.85	0.05	1.51	0.3	ND		1.6		0.09	0.14		
H88-EB	12-Nov-08	ND	ND	ND		ND	ND	0.09	0.18			ND	ND	ND	ND		ND	ND	0.4		0.8	1.4	ND	ND	ND	ND		ND	0.02	ND	ND

Note: Blank cells indicate component was not analyzed.

Abbreviations

CaCO3:	Calcium carbonate
mg/L:	Milligrams per liter
ND:	Not detected. If available, reporting limits are provided in the database (Attachment 3).

Station ID	Date Collected	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Manganese, Dissolved (mg/L)	Manganese, Total (mg/L)	Mercury, Dissolved (mg/L)	Nickel, Dissolved (mg/L)	Nickel, Total (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)	Organic Phosphorous, Total (mg/L)	Ortho Phosphorous (mg/L)	Phosphorous, Total (mg/L)	Phosphorus, Dissolved (mg/L)	Phosphorus, Total (mg/L)	Potassium, Dissolved (mg/L)	Potassium, Total (mg/L)	Selenium, Dissolved (mg/L)	Selenium, Total (mg/L)	Sodium Adsorption Ratio	Sodium, Dissolved (mg/L)	Sodium, Total (mg/L)	Solids, Total Dissolved (mg/L)	Sulfate (mg/L)	Zinc, Dissolved (mg/L)	Zinc, Total (mg/L)
H89-29	31-Jul-90	112	ND	0.05	0.04	ND			ND	ND	ND	ND	ND			1.7		ND		0.24	5.8		121	9.1	0.24	
H89-29	30-Oct-90	101	ND	0.04	0.04	ND			0.01	ND	0.007	0.007	0.01			1.7		ND		0.2	4.7		131	11	0.17	
H89-29	05-Nov-08	122	ND	26.7	28.1		0.7	0.9	ND	ND				ND	ND	2240	2370	ND	ND		7000	7590	133	2.4	1.3	3.3
H89-30	28-Jul-89	291	ND	ND	0.07	ND			0.05	ND	0.067	0.04	0.19			2.5		ND		9.19	123		366	7.2	0.02	
H89-30	03-Nov-89	140	0.8	0.04	0.06	ND			ND	ND	0.043	0.04	0.143			0.6		ND		8.82	59		152	ND	0.01	
H89-30	24-Jan-90	301	ND	0.05	0.07	ND			ND	ND	0.046	0.012	0.076			1.8		ND		13.5	130		362	2.7	0.02	
H89-30	17-Apr-90	298	1.1	0.12	0.13	ND			ND	ND	0.058	0.046	0.14			1.8		ND		9.92	124		368	1.6	0.01	
H89-30	18-Jul-90	299	ND	0.09	0.14	ND			ND	ND	0.106	0.016	0.198			2		ND		13.1	128		338	1.1	0.02	
H89-30	25-Oct-90	282	ND	0.09	0.14	ND			ND	ND	0.012	0.007	0.099			2.2		ND		14.3	125		357	1.2	0.05	
H89-30	18-Jul-90	ND		ND	ND	0.106	0.016	0.198			2			13.1	128		338	1.1	0.02							
H89-30	25-Oct-90	ND		ND	ND	0.012	0.007	0.099			2.2			14.3	125		357	1.2	0.05							
H88-EB	12-Nov-08	ND	ND	0.06	0.08		ND	0.2	ND	ND				ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	1.8	5.8

Note: Blank cells indicate component was not analyzed.

Abbreviations

CaCO3:	Calcium carbonate
mg/L:	Milligrams per liter
ND:	Not detected. If available, reporting limits are provided in the database (Attachment 3).

ADDENDUM 2

COMPARATIVE ANALYSIS OF HISTORICAL GROUNDWATER MONITORING DATA
FROM MWH REPORT DATED MAY 03, 2013

Table A2-1 Water Quality Analysis for Bedrock Wells

		Baseline (1988-1990)					2008		
CONSTITUENT	**UNITS**	**MAX**	**MEAN**	**MIN**	**STD.DEV.**	**mean ± std.dev.**	**MAX**	**MEAN**	**MIN**
pH (Field)		11.45	8.37	5.6	1.1	7.27 to 9.47	9.33	8.4	7.54
Specific Conductance (Field)	µS/cm	2950	696.27	1	619.9	76.37 to 1316.17	4606	1524	401
Temperature	°C	10.9	3.15	0	1.7	1.45 to 4.85	5.1	4.03	2.92
Dissolved Oxygen	mg/L	15.2	7.13	0.28	4.75	2.38 to 11.88	4.24	**1.4**	0.41
Alkalinity (Lab)	mg/L	2565	560.215	101	558.534	1.681 to 1118.75	1510	476.143	122
Alkalinity (Field)	mg/L	2565	441.26	10.8	519	0 to 960.26	NA		NA
Aluminum (diss.)[1]	mg/L	1.7	0.1388	0.0058	0.3087	0 to 0.4475	0.157	0.044	0.002
Arsenic (diss.)[1]	mg/L	0.03	0.0095	0.0025	0.0083	0.0012 to 0.0178	0.0064	0.0028	0.0009
Barium (diss.)[1]	mg/L	1.4	0.282	0.027	0.403	0 to 0.685	1.11	0.4009	0.0525
Cadmium (diss.)[1]	mg/L	0.005	0.00071	0.00005	0.00145	0 to 0.00216	0.00006	0.000053	0.00005
Copper (diss.)[1]	mg/L	0.01	0.00124	0.00008	0.0032	0 to 0.00444	0.0004	0.00024	0.00008
Lead (diss.)[1]	mg/L	0.03	0.003	0.000004	0.0085	0 to 0.0115	0.00016	0.000063	0.000004
Mercury (diss.)[2]	mg/L	ND		ND		0 to 0	NA		NA
Selenium (diss.)[1,2]	mg/L	0.007	0.00067	0.0004	0.0013	0 to 0.00197	0.0016	0.0008	0.0004
Zinc (diss.)[3]	mg/L	0.77	0.06	0.0007	0.13	0 to 0.19	0.002	0.0012	0.0005
Chromium (diss.)[1,2]	mg/L	0.02	0.0009	0.0001	0.0039	0 to 0.0048	0.0014	0.00056	0.0001
Iron (diss.)[3]	mg/L	2.59	0.226	0.0312	0.484	0 to 0.71	1.16	0.225	0.0336
Manganese (diss.)[1]	mg/L	0.07	0.0124	0.002	0.0157	0 to 0.0281	0.0267	0.009	0.00176
Chromium (Total)[1]	mg/L	0.11	0.017	0.000032	0.026	0 to 0.043	0.0071	0.0026	0.0002
Iron (Total)	mg/L	21.7	3.07	0.0646	4.766	0 to 7.836	2.7	0.966	0.112
Manganese (Total)[3]	mg/L	0.35	0.053	0.003	0.07	0 to 0.123	0.0296	0.017	0.0049
Hardness as CaCO3	mg/L	129	45.57	4	44.1	1.47 to 89.67	105	39.4	8.5
Bicarbonate HCO3	mg/L	2749	586.85	0	666.04	0 to 1252.89	NA		NA
Carbonate CO3	mg/L	344	32.3	0	78.11	0 to 110.41	NA		NA

Table A2-1 (Cont.) Water Quality Analysis for Bedrock Wells

		Baseline (1988-1990)					2008		
CONSTITUENT	**UNITS**	**MAX**	**MEAN**	**MIN**	**STD.DEV.**	**mean ± std.dev.**	**MAX**	**MEAN**	**MIN**
Chloride^4	mg/L	120	17.4	0.028	30.453	0 to 47.853	63.4	14.2	0.5
Nitrate (as N)^{1,2}	mg/L	9	0.204	0.003	1.2	0 to 1.404	0.008	0.0058	0.00327
Nitrite (as N)^2	mg/L	ND		ND		0 to 0	ND		ND
Sulfate^3	mg/L	26	4.066	0.1	4.9	0 to 8.966	2.4	0.66	0.155
Calcium (diss.)	mg/L	38	12.33	1.3	12.466	0 to 24.796	27.6	9.95	0.22
Magnesium (diss.)^4	mg/L	17.3	3.52	0.096	3.86	0 to 7.38	8.58	2.9	0.067
Potassium (diss.)^4	mg/L	6.1	2.42	0.5	1.37	1.05 to 3.79	2.93	1.64	0.727
Sodium (diss.)	mg/L	1120	238.3	4.7	270.57	0 to 508.87	748	215.63	7
Ammonia (as N)^3	mg/L	1.87	0.359	0.01	0.352	0.007 to 0.771	NA		NA
Total Kjeldahl Nitrogen (as N)^4	mg/L	2.4	0.9	0.0798	0.565	0.335 to 1.465	NA		NA
Ortho Phosphorus^4	mg/L	0.338	0.052	0.001	0.095	0 to 0.147	NA		NA
Total Organic Phosphorus^3	mg/L	0.837	0.033	0.0006	0.114	0 to 0.147	NA		NA
Total Phosphorus	mg/L	1.94	0.218	0.006	0.3845	0 to 0.6025	0.45	0.166	0.004
Sodium Adsorption Ratio		82	25.32	0.2	26.38	0 to 51.7	NA		NA
Total Dissolved Solids	mg/L	2750	616.7	121	624.44	0 to 1241.14	1700	555.43	133
Boron^3	mg/L	0.43	0.111	0.00464	0.11	0.001 to 0.221	NA		NA
Fluoride^4	mg/L	3.59	0.994	0.05	1.047	0 to 2.041	4	0.97	0.0745

Key:
1 – More than 50% ND.
2 – Not enough data to calculate ND (for either all or some wells).
3 – Less than 50% ND.
4 – Less than 10% ND.
% – percent
µS/cm - microSiemens per centimeter
°C – degrees Celsius

CaCO$_3$ – calcium carbonate
Max – maximum
mg/L – milligrams per liter
Min – minimum
NA – not available
ND – non-detect
Std. Dev. – standard deviation

Bold indicates value is above or below the mean ± std.dev. value.

Table A2-2 Water Quality Analysis for Glacial-Alluvial Wells

		Baseline (1988-1990)					2008		
CONSTITUENT	**UNITS**	**MAX**	**MEAN**	**MIN**	**STD.DEV.**	**mean ± std.dev.**	**MAX**	**MEAN**	**MIN**
pH (Field)		8.72	7.04	2	0.886	6.154 to 7.926	7.93	6.79	5.8
Specific Conductance (Field)	µS/cm	741	172.128	3	79.566	92.562 to 251.694	326	223.5	147
Temperature	°C	18.5	3.447	-1	3.177	0.27 to 6.624	5.9	4.077	2.21
Dissolved Oxygen	mg/L	14.42	10.285	2.5	2.66	7.625 to 12.945	11.09	7.27	1.19
Alkalinity (Lab)	mg/L	277	80.62	5	36.26	44.36 to 116.88	82	57.3	34
Alkalinity (Field)	mg/L	720	107.36	3.2	126.81	0 to 234.17	NA		NA
Aluminum (diss.)[1]	mg/L	2.6	0.131	0.1306	0.3436	0 to 0.4746	0.406	0.0518	0.0026
Arsenic (diss.)[1]	mg/L	0.0002	0.0002	0.0002	0	0.0002 to 0.0002	0.0023	**0.0011**	0.0002
Barium (diss.)[1]	mg/L	1	0.0275	0.0003	0.1114	0 to 0.1389	0.0627	0.0228	0.0015
Cadmium (diss.)[1]	mg/L	0.008	0.001	0.00002	0.0018	0 to 0.0028	0.0018	0.0002	0.00002
Copper (diss.)[1]	mg/L	0.03	0.0027	0.0001	0.0063	0 to 0.009	0.0038	**0.0013**	0.0001
Lead (diss.)[1]	mg/L	0.08	0.0039	0.000006	0.0157	0 to 0.0196	0.0002	0.0001	0.000006
Mercury (diss.)	mg/L	ND		ND		0 to 0	NA		NA
Selenium	mg/L	0.01	0.01	0.01	0	0.01 to 0.01	ND		ND
Zinc (diss.)[2]	mg/L	0.14	0.0289	0.0023	0.0277	0.0012 to 0.0566	0.0066	0.0025	0.001
Chromium (diss.)[1]	mg/L	0.0002	0.0001	0.000041	0.0001	0 to 0.0002	0.0027	**0.0008**	0.00004
Iron (diss.)[2]	mg/L	4.34	0.2364	0.0255	0.5498	0 to 0.7862	0.411	0.0695	0.025
Manganese (diss.)[2]	mg/L	4.58	0.1121	0.0002	0.4892	0 to 0.6013	0.0448	0.007	0.0001
Chromium (Total)[2]	mg/L	1.9	0.1909	0.0062	0.2479	0 to 0.4388	0.0327	0.0068	0.0004
Iron (Total)	mg/L	1010	146.055	0.28	161.244	0 to 307.299	29.6	4.08	0.023
Manganese (Total)[2]	mg/L	17.9	3.0332	0.0153	3.1933	0 to 6.2265	0.744	0.1122	0.0005
Hardness as CaCO3	mg/L	191	68.51	38	22.05	46.46 to 90.56	90.9	50.4	21.6
Bicarbonate HCO3	mg/L	181	94.184	49	24.004	70.18 to 118.188	NA		NA
Carbonate CO3	mg/L	2.7	0.03	0	0.288	0 to 0.318	NA		NA

Table A2-2 (Cont.) Water Quality Analysis for Glacial-Alluvial Wells

		Baseline (1988-1990)					2008		
CONSTITUENT	**UNITS**	**MAX**	**MEAN**	**MIN**	**STD.DEV.**	**mean ± std.dev.**	**MAX**	**MEAN**	**MIN**
Chloride[3]	mg/L	284	6.278	0.278	30.38	0 to 36.658	1.8	0.82	0.5
Nitrate (as N)[3]	mg/L	7.54	0.57	0.01	1.0057	0 to 1.5757	0.7	0.345	0.0454
Nitrite (as N)[4]	mg/L	0.05	0.016	0.01	0.013	0.003 to 0.029	ND		ND
Sulfate SO4	mg/L	45	6.0287	1.4	5.69	0.339 to 11.7	13.8	5.12	1.3
Calcium (diss.)	mg/L	57	21.16	12	6.88	14.28 to 28.04	25.5	15.93	8.46
Magnesium (diss.)	mg/L	12	3.843	0.5	2.186	1.657 to 6.029	5.85	3.43	1.28
Potassium (diss.)	mg/L	8.8	2.118	0.6	1.157	0.961 to 3.275	1.09	**0.758**	0.479
Sodium (diss.)	mg/L	171	10.57	0.7	18.556	0 to 29.126	7.81	4.326	2.83
Ammonia (as N)[2]	mg/L	1.4	0.1044	0.0061	0.1884	0 to 0.2928	NA		NA
Total Kjeldahl Nitrogen (as N)[3]	mg/L	206	6.507	0.095	23.31	0 to 29.817	NA		NA
Ortho Phosphorus	mg/L	0.568	0.0453	0.001	0.09	0 to 0.1353	NA		NA
Total Organic Phosphorus[3]	mg/L	3.55	0.76	0.002	0.8661	0 to 1.6261	NA		NA
Total Phosphorus	mg/L	16.2	3.806	0.195	2.8775	0.9285 to 6.6835	1.13	**0.2064**	0.006
Sodium Adsorption Ratio		5.38	0.5321	0.04	0.649	0 to 1.1811	NA		NA
Total Dissolved Solids	mg/L	716	116.86	65	69.563	47.297 to 186.423	104	79.7	65
Boron[2]	mg/L	0.41	0.073	0.0092	0.092	0 to 0.165	NA		NA
Fluoride	mg/L	0.6	0.1255	0.05	0.0861	0.0394 to 0.2116	0.0631	0.05	0.028

Key:
1 – More than 50% ND.
2 – Less than 50% ND.
3 – Less than 10% ND.
4 – Not enough data to calculate ND.
% – percent
µS/cm - microSiemens per centimeter
°C – degrees Celsius
$CaCO_3$ – calcium carbonate

diss. - dissolved
Max – maximum
mg/L – milligrams per liter
Min – minimum
NA – not available
ND – non-detect
Std. Dev. – standard deviation

Bold indicates value is above or below the mean ± std.dev. value.

Table A2-3 Groundwater Hydrology – Water Levels[1] in Monitoring Wells and Piezometers

		Baseline (1988-1990)				2008-2009			
Monitoring Well	**feet amsl**	**MIN**	**month**	**MAX**	**month**		**2008 (Nov)**	**2009 (Jan)**	
H88-10		710.8	Mar	727.1	Apr		714	**707.8**	
H88-11		1035.4	Nov	1075.9	Apr		1075	1073.1	
H88-12		1005.5	Feb	1009.7	May		**1004.2**	1006.2	
H88-13		985.4	Aug	997.6	May		995.6	994.5	
H88-14A		756.6	Nov	763.1	Apr		758.3	758.2	
H88-15		835.5	Feb	846.7	May		837.1	835.7	
H88-16		1044.2	Nov	1058.6	Jun		1051.3	1050.3	
H88-17		988.8	Feb	990.1	Feb		989.4	989.3	
H88-19		813.8	Jan	815.3	Jul		814.7	814.3	
H88-21		817.2	Mar	825.9	May		819.3	817.7	
H88-22		1064.7	Apr	1071.1	May		1067	1065.2	
H88-23		790	Mar	809.8	Jun		790.1	**788.3**	
H88-24A		791.8	Mar	803.8	Jun		791.8	**790.8**	
H88-25		765.1	Nov	803.1	Aug		799.9	799.5	
H88-27		1077.6	Mar	1092.8	May		1084.1	1079.1	
H88-28		1244.5	Nov	1257.3	Jun		1245.5	1245.8	
H89-29		698.7	Sep	710	Jun		**714.3**	708.4	
H89-30		171.3	Sep	724.8	Jan		NA	NA	
Piezometer	**feet amsl**	**MIN**	**month**	**MAX**	**month**	**2008 (Jan)**	**2008 (Oct)**	**2009 (Jan)**	**2009 (Sep)**
PB-100-1		858.3	Nov	1020.5	Aug		**1033.9**[2]	**1033.7**[2]	
PB-100-2		1040.5	Jun	1076.1	Apr			1067.8	
PB-101-2		737.5	Jan	751.2	Jul		**755.6**	**757.9**	
PB-101-3		702.9	Apr	723.5	May		714.8	714.1	
PB-102-1		1013.1	Nov	1044.1	Jul		1041	**1046.4**	
PB-102-2		985.4	Nov	1123.1	Jul		1020.5	1022.2	
PB-102-3		1016.4	Nov	1037.7	Jun		**1044.9**	**1050.7**[2]	
PB-103-1		936.9	Jul	980	Nov				
PB-103-2		952.8	Jul	971.7	May				
PB-103-3		958.6	Nov	982.4	Jul				
PB-104-1		968.8	Oct	1005.2	Jun		**1011.3**	**1013.6**	
PB-104-2		893.1	May	1014.2	Jun		**1015.9**	**1018.3**	
PB-104-3		1002.5	Mar	1047.3	Sep		1011.2	1013	
PB-105-1		833.2	Nov	849.2	Jul		838.6	841.8	840.9
PB-105-2		810.6	Nov	837	Jun		831.8	**837.6**	825.3
PB-105-3		821.8	Nov	840.1	Jun		835.2	**841**	
PB-12-1		990.9	Nov	1018.5	Jul		**1031.3**[2]	**1032.6**[2]	

Table A2-3 (Cont.) Groundwater Hydrology – Water Levels[1] in Monitoring Wells and Piezometers

		Baseline (1988-1990)				2008-2009			
Piezometer	**feet amsl**	**MIN**	**month**	**MAX**	**month**	**2008 (Jan)**	**2008 (Oct)**	**2009 (Jan)**	**2009 (Sep)**
PB-12-2		1007.3	Nov	1053.1	Jul		1049.6	1050.9	
PB-12-3		1009.2	Oct	1057.4	Jul		1047.7	1051.1	
PB-12-4		988.6	Aug	1080.3	Nov		1048.9	1052.6	
PB-13-1		819.9	Nov	1060.8	Jul		1059	**1061.1**	
PB-13-2		1045.1	Aug	1061.1	Jul		1057.7	**1061.8**	
PB-13-3		1030	Feb	1070.1	Jun		1064.7	1067.2	
PB-13-4		1052	Oct	1077.2	Aug		1060.7	1065.7	
PB-60-1		845.3	Jul	900	Dec				
PB-60-2		871.6	Dec	921.8	Sep				
PB-7-1		786.2	Feb	851.5	Jul		**854.2**	**856.7**	
PB-7-2		857.9	Dec	875.1	Aug		872.1	**875.4**	
PB-7-3		845.8	Dec	859.6	Aug				
PB-8-1		836.2	Dec	887.5	Jul		876.6	879.1	
PB-8-2		805.8	Sep	870	Jul		**871.1**	**872.7**	
PB-8-3		835.8	Feb	864.6	Jul		**867.4**	**871.5**	
PB-88-1		973.1	Mar	991.4	Jul	**992.8**	989.7		
PB-92-1		984.8	Nov	994	Jul	**1016**	**1015.1** [3]		
PB-92-2		1058.8	Aug	1070.2	Jun	**1072.1**	**1071.9**		
PB-92-3		1061.5	Dec	1075.5	Jul	**1076.9**	1075.1		

Key:
1 – Feet above mean sea level.
2 – Value is within 2% of 1988-90 calculated Max.
3 – Value is within 3% of 1988-90 calculated Max.
% – percent
amsl – above mean sea level
Max – maximum
Min – minimum

Bold indicates water levels above or below 1988-1990 maximum or minimum.