APPENDIX T

Miner Flat Dam Left Abutment Ridge Seepage Analysis, April 1997

GOLDER ASSOCIATES,
VOLUMES 1 THRU II OF II

FEBRUARY 2007

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MINER FLAT DAM
LEFT ABUTMENT RIDGE
SEEPAGE ANALYSIS

VOLUME I OF II

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Distribution:

1 Copy - Morrison-Maierle/CSSA
1 Copy - Golder Associates Inc.

April 1997

943-2769

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
cfs	cubic feet per second
Golder	Golder Associates Inc.
gph	gallons per hour
gpm	gallons per minute
ISRM	International Society for Rock Mechanics
K	Hydraulic conductivity
MM/CSSA	Morrison-Maierle/CSSA
psi	pounds per square inch
RQD	rock quality designation
USCS	Unified Soil Classification System

1.0 INTRODUCTION

This report presents the preliminary results of the Miner Flat dam - Phase I exploration program performed in 1995. This investigation was performed in accordance with the scope of work approved by Morrison-Maierle (MM/CSSA) in 1994 under an Agreement with Golder Associates Inc. dated April 28, 1994. The field investigation included core drilling, logging and testing of core, percussion hammer drilling and logging, packer testing, and installation of piezometers in order to estimate the seepage through the left abutment ridge of the proposed Miner Flat dam. Seepage through the left abutment was numerically modeled using data from this and previous geotechnical investigations. The estimated loss from seepage is approximately 0.13 cubic feet per second.

The proposed Miner Flat dam is located on the North Fork of the White River east of Arizona State Highway 73 at Mile Post 350, about 8 miles south of McNary and about 11 miles north of Whiteriver, on the Fort Apache Indian Reservation. The Fort Apache Indian Reservation comprises about 1,700,000 acres that are south of the Mogollon Rim and north of the Salt River in north-central Arizona (Figure 1). The Phase I exploration investigation was preceded by three geotechnical investigations performed by Mineral Systems, Inc. in 1981, 1982, and in late 1985 and early 1986. The purpose of the 1982 study was to determine the feasibility of constructing a dam near Miner Flat and to select an approximate alignment for the dam. The 1982 study (Robinson 1982) consisted of preparing a preliminary geologic map of the dam and reservoir area and drilling along the recommended axis of the dam. The 1985-1986 investigation (Mineral Systems, Inc. 1986) was directed towards further defining the geology of the dam axis and abutment areas. The earlier investigations defined the general suitability of the site for a gravity dam and appurtenant structures. The present investigation was performed in order to evaluate the potential for seepage through the left abutment ridge of the proposed dam and reservoir.

2.0 GEOLOGY

The Fort Apache Indian Reservation is south of the Mogollon Rim, that is considered the southern boundary of the Colorado Plateau physiographic province. The Fort Apache Indian Reservation is in the transition zone between the Colorado Plateau and the Basin and Range physiographic provinces. The North Fork of the White River originates in the White Mountains that comprise the northeast corner of the reservation. The White Mountains are composed of Tertiary and Quaternary volcanic rocks, that extend to and south of the proposed Miner Flat dam site. The volcanic rocks, predominantly basalts and andesites, were deposited on Paleozoic and Mesozoic sedimentary rocks. The sedimentary rocks, in general, strike northwest and dip gently northeast, 2° to 8°. Locally the sedimentary rocks are cut by normal faults approximately parallel to the strike of the sedimentary formations. Small folds are locally superimposed on the regional dip.

The axis of the proposed Miner Flat dam crosses the North Fork of the White River where basalt exists in both the right and left abutments. The basalt is approximately 2 million years old (Condit 1983) and consists of a sequence of flows that came down an ancestral valley of the White River. The ancestral valley was then cut by the river into the Permian sandstones of the Coconino Sandstone and Supai Group and Tertiary gravel deposits, leaving a ridge of sandstone and basalt on the left abutment. Recent deposits include colluvium on the slopes and alluvium in the river valley.

The basalt is up to 260 feet thick in the right abutment and up to 211 feet thick on the left abutment. The basalt wraps around the left abutment ridge with Coconino Sandstone on the north side of the ridge and basalt on the south side of the ridge. East of the left abutment, the basalt thins out against the Coconino Sandstone.

The Coconino Sandstone, an aeolian deposit of Permian age, is a distinctive stratigraphic unit characterized by prominent cross-bedding, uniform grain size and general cliff-forming

character (McKee 1933). The typical Coconino Sandstone extends over a vast area without any appreciable change in type of cross-bedding, purity of quartz sand, kind of cement, or general massive character (McKee 1933).

At the proposed Miner Flat dam site, the Coconino consists of friable, fine-grained, subrounded, equigranular, and well sorted quartz grains poorly cemented by siliceous cement. The Coconino Sandstone ranges in color from pale reddish brown, grayish orange pink, moderate reddish orange and moderate orange pink. Characteristic of the Coconino Sandstone are quartz overgrowths on some grains, which make the grains sparkle in sunlight. The beds of the Coconino Sandstone range from less than a foot to as much as 10 feet in thickness.

Underlying the Coconino Sandstone is the Supai Group. The Supai Group is separated into four formations that range in age from Early Pennsylvanian to Early Permian. From oldest to youngest, these formations are designated as the Watahomigi, Manakacha, and Wescogame Formations and the Esplanade Sandstone (McKee 1975). At the Miner Flat dam site, the Supai Group is represented by the Esplanade Sandstone. The Esplanade consists primarily of very fine-grained cross-stratified sandstone that forms massive cliffs. It includes small amounts of siltstone and mudstone that weather into slopes, benches, or recesses and, contains extensive beds of gypsum. The Supai Group observed at the site consist of moderate reddish orange to moderate reddish gray, calcareous siltstone, fine-grained sandstone, claystone, and light gray gypsum.

The Tertiary gravel deposits partially mantel the east end of the east abutment ridge, and slope wash from these deposits mask the bedrock. The deposits consist of bouldery gravel, coarse sand, sand and silt. The clasts are comprised of quartzite, sandstone, limestone, and chert derived from younger Precambrian and Paleozoic formations. Locally, cobbles of granite and diabase may be found.

Colluvial deposits that overlay bedrock on the left abutment is material derived from the in-place weathering of bedrock. The colluvium derived from the basalt consists of reddish brown to dark brown silt and clay, with subangular sand, gravel, cobbles and boulders composed of basalt. Colluvium derived from the Coconino Sandstone and Supai Group consist of light brown to pale reddish brown fine to medium sand, silt, and angular pieces of gravel and cobble size sandstone.

The alluvial deposits occurring in the river valley of the North Fork of the White River consist of boulders, gravel, sand, and silt. The coarser materials are derived from the local outcrops--such as basalt and sandstone--and from the Tertiary gravels. The materials are unconsolidated in the modern stream beds and poorly to moderately cemented in the older stream terraces.

3.0 FIELD INVESTIGATION

The 1995 field investigation included core and percussion hammer drilling, downhole surveying, packer testing, and installing piezometers for the purpose of obtaining hydrogeologic data for seepage analysis of the eastern abutment. The drillholes were spaced approximately 200 feet apart located along the ridge and about midway between the upstream and downstream cliffs (Figure 2) in accordance with the work plan provided by MM/CSSA on January 31, 1994.

3.1 Percussion Hammer Drilling

As a result of preliminary geologic mapping of the proposed dam site, and from earlier drilling, it was concluded that an abandoned stream channel may cross the left abutment. This channel would have developed after the deposition of the basalt and before the White River eroded its present channel. Previous drilling indicated that the bottom of the channel was below an elevation of 6,060 feet, that would be below the maximum elevation of the proposed reservoir. The material at the surface implied that the channel could be filled with highly permeable sand and gravel.

A total of 26 boreholes were drilled along the ridge between boreholes MF-102 and MF-218A (Figure 2).

Drilling was subcontracted to Layne Western Exploration (Layne) and North American Drilling (NAD), both from Phoenix, Arizona. An AP1000 percussion hammer drill rig with an open, 6 5/8-inch bit was used for the initial drilling program and an open, 9-inch bit was used for the later drilling program. The percussion hammer method uses dual wall drive pipe advanced by a single cylinder diesel pile drive hammer. Compressed air is forced down the annulus between the inner and outer drive pipe, and geologic samples are continuously returned up the center of the inner pipe. Percussion hammer drilling methods are best suited

and typically used in gravely or cobbly materials where standard penetration tests (SPT) are unable to collect representative material and blow counts.

The blow counts from the percussion hammer can be correlated to SPT equivalent blow counts (N_{60}) and relative density by recording the blow counts and pressure within the drive cylinder for the same interval. Allowing for altitude and type of hammer on the AP1000, an SPT equivalent blow count (N_{60}) was determined for each 1-foot interval. The equivalent blow counts are shown on the borehole logs in Appendix A. The SPT equivalent blow count number is used to correlate relative density or cohesion of the soils. Because an open bit was used in order to collect samples, the SPT equivalent blow counts will typically be lower than when a closed bit is used (Harder and Seed 1986). The SPT equivalent blow counts for the 9-inch bit were correlated from Sy and Campanella (1994).

Bulk samples were collected, labeled, and bagged at 5 foot intervals. Selected bulk samples were transported to Golder's Lakewood, Colorado soils laboratory for further classification and testing. Attempts were made to collect undisturbed samples in Shelby tubes below elevation 6,060. However, the soil below elevation 6,060 was typically too dense or hard to collect sufficient samples for testing. Only one sample had sufficient material for testing.

3.1.1 Material Classification

Materials encountered during percussion hammer drilling were visually classified and logged by a geological engineer in accordance with American Society for Testing and Materials (ASTM) D 2488-93. Material descriptions shown on the borehole logs (Appendix A) include: ASTM designations; density (for cohesionless soils) or consistency (for cohesive soils); color (based on the Munsell System using a Geological Society of America rock color chart); textural descriptions; percentage of minor components; and qualitative moisture content. Representative samples were tested with dilute hydrochloric acid to estimate relative calcium carbonate content.

3.1.2 Laboratory Analysis

Samples obtained from the field program were analyzed at the Golder Associates Inc. laboratory in Lakewood, Colorado in accordance with applicable ASTM standards. Laboratory testing was performed on 11 bulk samples and 1 undisturbed sample. The samples were selected from boreholes where the channel material was below elevation 6,060. The bulk samples were tested for Unified Soil Classification System (USCS) soil classification, Atterberg limits, specific gravity, and moisture density relationship (standard Proctor). The undisturbed sample consisted of clay that was tested for permeability.

The results of the laboratory testing programs are presented in Appendix B. The majority of the soil below elevation 6,060 is classified as clay (CL); one sample was classified as clayey sand (SC), although the clay content was at 49.6 percent (greater than 50 percent clay would be classified as CL). The Atterberg limits ranged from liquid limits of 27 to 40 and plastic index of 15 to 23, which indicate the clay is low to medium plasticity.

The clay sample collected in the Shelby Tube had a natural dry density of 108.2 pounds per cubic foot and natural moisture of 9.2 percent. The average permeability from laboratory testing was 2.7×10^{-7} cm/sec.

3.2 Core Drilling

Boreholes were drilled and cored along the axis of the ridge that forms the left abutment of the proposed Miner Flat dam to investigate the potential for seepage through the Supai Formation as required by the work plan provided by MM/CSSA dated January 31, 1994. The locations of the boreholes, shown on Figure 2, were in conformance with the work plan provided by MM/CSSA. Final location of the boreholes was determined in the field based on site logistics and access. All locations were approved by MM/CSSA prior to the commencement of drilling. Eight boreholes were drilled using HQ (2.375 inch diameter

core) wire-line equipment with dual-tube core barrels. The core drilling was performed by Golden Drilling Company of Canon City, Colorado. The program began on June 1, 1995 and was completed on August 30, 1995. A total of 2,263.8 feet of borehole was drilled. This included 153.2 feet of surficial materials (Tertiary gravel and colluvium) and 2,110.6 feet of rock. Surficial materials were drilled using air-rotary methods using a 6-inch diameter tricone bit. Once competent rock was encountered, 4-inch steel casing was installed and fully grouted with neat cement grout. The boreholes were then cored to their final elevation, in most cases an elevation of 5,740, as specified the work plan.

Each borehole was logged for lithology, RQD, number of natural fractures, and other engineering geologic parameters as specified in the work plan provided by MM/CSSA. In addition, all the core was photographed and stored for future reference.

Clear water was the intended drilling fluid during the planning and initial stages of drilling. The source of the water was the North Fork of the White River, supplied to the drill sites through 1-inch diameter plastic pipe from the supply pump at the river. The drilling fluid was changed to a polymer based drilling mud when core recovery and borehole stability became a problem. During the drilling of borehole MF-218 core recovery and borehole stability became a problem at a depth of approximately 160 feet. In consultation and with the agreement of MM/CSSA the drilling fluid was modified to a polymer-bentonite-additive fluid the reduced fluid loss, friction, and bedrock wetting. The benefits of the switch to the polymer-based fluid included better borehole stability, increased core recovery and faster penetration rates. The disadvantage was that packer testing could not be conducted during the drilling of the borehole as recommended by MM/CSSA but had to be delayed until the borehole was drilled to its final depth.

The work plan included six boreholes aligned with the ridge that formed the south or southeast abutment spaced 200 feet apart. Two additional boreholes were drilled due to fluid loss and borehole stability problems. MF-250 located at the north end of the series of

boreholes (Figure 2) was the first borehole to be drilled in this program. The borehole encountered basalt at a depth of 11.8 feet. Fluid loss and borehole stability became an immediate problem and the upper portion of the borehole required grouting in order to maintain the borehole. An additional borehole, MF-250A located approximately 50 feet south of MF-250, was drilled to perform packer tests in the grouted portion of the basalt. Borehole MF-218 was abandoned after fluid loss and borehole stability problems became overwhelming at a depth of 160 feet. Borehole MF-218A was drilled approximately 50 feet southeast of MF-218 as a replacement.

The overall average of core recovery was 86.3 percent. The core recovery was highest in the basalt with an average of 95.7 percent. Core recovery in the Coconino Sandstone was 82.7 percent. The core recovery was 90.0 percent in the sandstones and siltstones of the Supai Group and 100 percent in the gypsiferous sections of the Supai. Core recoveries increased by 9.6 percent in the Coconino and by 4.1 percent in the Supai as a result of changing from clear water to a polymer based drilling fluid.

3.2.1 Core Logging

Logs of lithologic and engineering properties of the rock drilled were compiled at the completion of each core run. Golder personnel were on site continuously during the drilling program to record drilling conditions and to log the core as it was extracted from the core barrels. A detailed engineering geologic log was prepared on site at the time of drilling, a portion of which is presented in Appendix A. The parameters that are presented in Appendix A include:

- Weathering or Alteration
- Rock Description
- Recovery

- Rock Quality Designation
- Fractures Per Foot Recovered
- Total Fractures
- General Comments

Detailed lithologic descriptions and drilling conditions were recorded at the time of drilling and kept separately. These detailed descriptions are available upon request.

3.2.1.1 Weathering or Alteration

Weathering or alteration describes the type and intensity of rockmass weathering or alteration classification using the International Society for Rock Mechanics (ISRM) classification system.

3.2.1.2 Rock Description

The rock description includes the rock type, the major minerals present, the grain size of the minerals or rock constituents, the texture of the rock fabric, and the color based on the Munsell System.

3.2.1.3 Recovery

The core recovery is recorded here as 100 times the length of core recovered in each core run. The percentage core recovery is calculated by dividing the recovered length by the run length. The mean core recovery for the basalt was 95.7 percent, 82.7 percent for the Coconino, and 93.1 percent for the Supai.

3.2.1.4 Rock Quality Designation

The rock quality designation (RQD) is a method for classifying recovered core to reflect the fracturing and alteration of rock masses (Deere 1963). RQD is the summation of the lengths of recovered, hard, sound core whose length are greater than two times the core diameter. For convenience RQD is recorded in the logs as 100 times the summed length. The RQD (%) is the RQD length divided by the run length and expressed as a percentage of the run length. The mean RQD for the basalt was 62.1 percent, for the Coconino was 18.8 percent, and for the Supai was 69.9 percent.

3.2.1.5 Fractures Per Foot Recovered

The fractures per foot recovered or fracture frequency is the total number of natural fractures observed in each core run divided by the total length of core recovered for that run. The mean fracture frequency for the basalt was 2.4 fractures per foot, for the Coconino was 5.9 fractures per foot, and for the Supai 2.8 fractures per foot.

3.2.1.6 General Comments

The general comments include summary notes of drilling and rockmass conditions. Contacts between formations are generally noted in the general comments.

3.2.2 Downhole Surveys

All the boreholes were surveyed to determine the accurate downhole location of the borehole. Seven of the boreholes were surveyed with an OWL TECHNICAL 780 series borehole deviation survey instrument to measure and record the path of the boreholes. Results of these surveys presented in Appendix C include the measured data of depth, inclination and bearing, and the calculated location of each survey measurement point.

3.3 Hydrological Testing Program

The objective of the hydrogeological testing was to obtain estimates of in situ hydraulic conductivity from the cored boreholes. Hydraulic conductivity was calculated from packer (injection) test data for specific intervals in the borehole.

3.3.1 Packer Testing Equipment

The test equipment included a packer assembly consisting of two inflatable packers in a straddle configuration connected by a perforated pipe providing a test interval of approximately 23 feet. Medium-duty, sliding-end, 2.7-inch uninflated outside diameter Baski Inflatable Packers were used for most of the testing. Packers were inflated from a nitrogen cylinder at the surface via an inflation line that was strapped to the drill pipe. Flow rates for this assembly ranged from approximately 1 gallon per hour (gph) to approximately 30 gallons per minute (gpm).

For the high-flow test intervals, an additional packer configuration was developed. The high-flow packer assembly consisted of 2-inch, inside diameter plumbing and a 10-foot test interval between packers. The high-flow assembly allowed testing of intervals with flow rates up to approximately 100 gpm.

During injection, the water supply was kept at a constant pressure in a baffle tank. From the baffle tank, flow was diverted to the drill pipe or bypassed through alternative valves and flow meters. The flow meters included three Omega Rotameters capable of measuring flows between 0.017 to 0.117 gpm (1 and 7 gallons gph), 0.1 to 1 gpm, and 1 to 5 gpm. Higher flow rates were measured with a turbine flow meter and totalizer, calibrated to 10 gpm for one complete revolution of the dial. Flowmeters were connected in parallel and each fitted with a valve to allow selection of a particular meter and to regulate the flow.

The pressure data acquisition equipment consisted of a number of alternative strain gauge transducers including two with a maximum pressure reading of 30 pounds per square inch (psi) and one with a maximum reading of 100 psi. Depending on the anticipated maximum pressure, the appropriate transducer was placed in the drill pipe, either below the static water level when testing below the water table or just above the top packer when testing in the unsaturated zone. The transducer cable was connected to a data logging system at the surface which processed the signal and provided the digital input to a laptop computer.

3.3.2 Testing Procedures

Testing all boreholes over their entire depths (except for unconsolidated Tertiary gravel) provided an unbiased sample of estimates for hydraulic conductivity. Complete coverage was achieved by sequentially testing adjacent intervals, starting from the bottom of each borehole. Some test interval locations varied slightly due to practical limitations of packer seating locations and borehole conditions.

Two rounds of packer testing were conducted; one in which all intervals in all boreholes were tested, and a second round which involved retesting high-flow intervals only. For the first round of packer testing, a 23-foot perforated test interval was used. This spacing was small enough to provide sufficient hydraulic conductivity estimates for adequate technical assessment of the site, yet large enough to achieve adequate coverage within the practical constraints imposed by time and budget. A second round of packer testing, using the high-flow packer assembly, was conducted to retest smaller (10-foot) intervals.

Two types of packer tests were possible: constant head (steady-state) tests, or constant rate (transient) test. In the saturated zone, either type of test could be conducted. In the unsaturated zone however, only constant head tests were conducted because results from constant rate tests reflect the saturation of the aquifer instead of providing accurate hydraulic properties.

The packer testing procedure can be summarized as follows:

a) Take manual water level measurement
b) Set and inflate packers
c) Place transducer approximately 3 to 5 feet above top packer
d) Begin logging pressure data
e) Add slug of water for falling head test and calculate an injection rate
f) Decide on test type and conduct test
g) Deflate and raise packer assembly to next interval

3.3.2.1 Flow Rate Evaluation and Choice of Test Method

After placing the packer assembly, a water level measurement was taken (if the interval was below the water table) and the packers were inflated. Before starting data acquisition, the pre-test head was set to zero by adjusting an offset function in the data logging software. Acquisition of the pressure data began after packer inflation when in the unsaturated zone. When below the water table, it was preferable to begin acquisition before packer inflation. As a result of packer inflation, the test interval may be pressurized. Test initiation was delayed until the pressure pulse dissipated and the water level returned to the static condition.

A target flow rate for the test was estimated by conducting a short-term slug test. A volume of water sufficient to fill approximately 15 to 20 feet of drill pipe (2 to 3 gallons) was added 'instantaneously' and the rate at which the head decreased was recorded. In the unsaturated zone, prior to the slug test, it was necessary to fill the test interval and the saturate the rock in the immediate vicinity of the borehole. The volume of water draining into the formation was then calculated by multiplying the head drop by the cross-sectional area of the drill pipe, and the flow rate was calculated by dividing by the time over which the head drop occurred.

The interval location and the flow rate calculated from the falling head are the two criteria that determine which test method to use. If the interval was below the water table and the flow rate is greater than 0.1 gpm, then it was possible to attempt a constant rate test. If the interval was in the unsaturated zone and/or the flow rate during the falling head period was less than 0.1 gpm, then the 'constant head' test method was used since flow rates less than 0.1 gpm are too low to measure with confidence over the short time of the test. Under these conditions, pressure was held constant and head changes were measured.

3.3.2.2 Constant Rate (Transient) Test Procedure

After the water level returned to static from the falling head test, an appropriate flow rate was selected and the water delivery was set while the valves were in the bypass position (*i.e.,* no down-hole flow). The valves were then switched to allow the constant flow to be directed down the drill pipe. Initially the pipe began to fill, as the head increased more flow entered the rock and pressure change decreased with time. The criterion for finishing the constant rate test was when the change of head with time was negligible or when the test duration reached three hours.

A practical difficulty with conducting constant rate tests was choosing an appropriate rate on the basis of a relatively small amount of information. The intent was to achieve a stable regime of radial flow in the adjacent formation (linear relationship on a semi-log plot) with the maximum possible head. It was difficult to maintain a truly constant rate over the duration of the test. If the injection of water flushed solid material from around the test interval, the shape of the pressure build-up curve could have been disturbed, and this may influence the quality of the data and analysis. Also, the injected water must travel approximately 150 feet down the drill pipe. This caused variations in the pressure data which makes analysis difficult. Although theoretically advantageous, the constant rate test method proved difficult to conduct. If the quality of the data after beginning a constant rate test was questionable, the decision was made to convert to the constant head method.

3.3.2.3 Constant Head (Steady State) Test Procedure

If a constant head is maintained, the change in rate will reduce logarithmically with time so that a steady-state analysis is acceptable with negligible error. Thiem (1906) and later Hvorslev (1951) developed equations and analysis procedures based on the assumption of steady-state radial flow. Their analyses require constant head values and corresponding pseudo-constant flow rates.

Three constant-head steps were generally achieved in three hours. Steps of equal head change, over the maximum range of available head, were attempted. The range of applicable heads were determined from the depth of the test interval or water table and the maximum practical flow rate. High permeability zones required high flow rates to achieve small increases in head thereby reducing the number of possible steps to one or two. The maximum flow rate was constrained by the available water supply and by the pressure losses in the packer assembly.

The procedure for obtaining a constant head step was to fill the drill pipe to the required head and then adjust the rate to maintain a constant head for the duration of the step. The rate was recorded at least every five minutes or when it was adjusted.

The ability to maintain a constant head varied according to the flow rate and the particular test conditions. When possible, a constant head was maintained with a variation of 0.5 feet or less. When the test interval was relatively deep, the flow rate was high and the applied head was low, the injected water had to travel over 100 feet to the water surface in the drill pipe causing short duration fluctuations in the head on the order of several feet.

If the test interval was close to the surface or the rock had low permeability, a head above the ground surface was imposed in order to obtain a high step or flow rate. This was achieved by attaching a sealed cap (stuffing box) on top of the drill pipe. This cap formed

a secure seal around the transducer cable. The water supply system in this configuration is completely closed and an increase in flow rate will increase the pressure and the effective head imposed on the test interval.

Once the final constant head step was completed, the flow was diverted to the bypass and the falling head in the drill pipe was recorded electronically (removing the pressure cap if necessary). This falling-head data was used to confirm the flow rate. After collecting several minutes of falling head data, the data acquisition was halted and the packers deflated.

3.3.3 Packer Test Analyses and Results

The Theis curve-matching method (Theis 1935) was used to analyze the constant rate (transient) tests, and the straight line fitting method (Thiem 1906 and Hvorslev 1951) was used to analyze the constant head (steady-state) test. The transient test can provide an estimate of the hydraulic conductivity and storativity as well as other information about the presence or absence of no flow or constant pressure boundaries. The accuracy of the assumptions of the transient test, however, are questionable within an unsaturated zone and it is often difficult to maintain a constant flow with sufficient accuracy to gain many of the benefits of this method.

Several constant rate tests were attempted, however, data quality was poor due to the physical constraints of maintaining consistent flow in the deeper, saturated test intervals. Once ascertained that the data being collected was not suitable for a high-quality transient analysis, the test was converted to a constant head test.

For subsequent use in seepage modeling, hydraulic conductivity values were compiled based on the lithology in which tests were conducted. Two lithologies were tested: basalt and sandstone.

Figures 6 and 7 present histograms and cumulative distribution curves of the basalt and hydraulic conductivity values, respectively. Conductivity values for the basalt range from 21.6 to 5.2 x 10^{-2} cm/sec with a geometric mean of 5.86 x 10^{-5} cm/sec. The sandstone conductivity values range from 4.68 x 10^{-3} to 3.62 x 10^{-8} cm/sec with a geometric mean of 7.86 x 10^{-5} cm/sec.

Figure 5 shows three cross sections with the packer test results posted along the borehole traces. In general the hydraulic conductivity decreases with depth.

3.4 Piezometers

After completion of the hydrological testing of the MF-218A, MF-250, MF-251, MF-252, MF-253, and MF-254 boreholes, piezometers were installed in these boreholes for long-term water-level monitoring. Piezometer construction summaries are provided in Appendix E.

Boreholes were backfilled with 3/4-inch rounded to sub-rounded gravel from the bottom of the borehole to the appropriate placement of the piezometer. Approximately 15 feet of bentonite "Holeplug" chips were placed on top of the gravel backfill. One foot of 10-12 grit silica sand was placed on top of the bentonite. The piezometer string consisted of 1.5-inch diameter, schedule-80, flush-threaded PVC with 20 feet of 0.020 inch slot for the screen. The filter pack consisted of 10-12 grit silica sand and was placed around the screen to 10 feet above the top of the screened section. Another 15 feet of bentonite "Holeplug" was placed on top of the filter pack and hydrated. The remainder of the borehole was backfilled with gravel to 10 feet below the surface except MF-218A, which was filled to 2 feet below ground surface. The installations were completed by grouting to the surface with Portland type I-II cement slurry with 5 percent Quickgel bentonite powder. Grout was allowed to settle overnight and then were topped off with additional grout the following day.

4.0 SEEPAGE MODEL

4.1 Objectives

The objective of the project as stated by the MM/CSSA work plan was to "Complete a six-hole transect on the left abutment for the purpose of investigating the potential for seepage through the Supai Formation. Specific objectives included using detailed site-specific geologic and hydrogeologic data to estimate aquifer water levels in the sandstone aquifer under boundary conditions defined by a full reservoir. Using this model, it is possible to estimate the seepage rate through the section of Coconino Sandstone, the formation that is most affected by the reservoir, that crops out along the sandstone ridge that forms the left abutment. The ridge consists of two distinct sections: 1) a "window" of Coconino Sandstone that outcrops across the ridge; and, 2) the tip of the ridge that is Coconino Sandstone overlain by Quaternary basalt. Both sections are considered to be potential preferred flow paths through the ridge. In addition, the potential for seepage through the *"gravel channel"* was evaluated.

4.2 *"Gravel Channel"* Seepage Potential

Previous core drilling and preliminary geologic mapping of the proposed dam site indicated that an abandoned river channel may cross the left abutment between boreholes MF-121 and MF-123 (Figure 2). From the previous drilling it was inferred that this channel, if it existed, would have been developed on top of the basalt surface prior to the erosion of the present channel of the North Fork of the White River. The bottom of the channel was interpreted to be at an elevation of approximately 6,055, below the maximum pool elevation of 6,060. The material at the surface implied that this channel could be filled with highly permeable sandy and cobbley gravel. If this channel exists then a potential for seepage from the reservoir exists. The *"gravel channel"* seepage potential was investigated by the use of the

percussion hammer drilling of 26 boreholes, logging of materials, laboratory analysis, and laboratory testing.

To evaluate the potential for seepage through the *"gravel channel"* a bedrock surface model was prepared from the following sources: previous drilling results, the results of the percussion hammer drilling, the bedrock contact from the 1995 core drilling program, and from selected surface outcrops. Figure 4 represents the results of the bedrock surface model. The surface model consisted of a 50 ft by 50 ft grid that covered the left abutment ridge. The bedrock elevation was estimated at each node using a Delaunay triangulation algorithm and then contoured with the 1 foot contour interval shown on Figure 4. The bedrock elevation data set contained 60 points. As with any surface modeling tool there are some inherent inaccuracies especially at the edges of the model and in areas of sparse data. Boreholes with the MF-B prefix have not been surveyed and are only approximately located. The bedrock contacts in these boreholes have been used as data for the surface modeling introducing another source of potential inaccuracy. The bedrock surface model therefore, should be used with discretion.

The surface model indicates that a true channel is not present on the left abutment. There is, however a relatively large westerly dipping bedrock surface bounded on the east by boreholes BA-1 and BA-7. The area between borehole MF-123 and BA-7 represents an area where water from the reservoir at elevation 6,060 could be lost through seepage above the bedrock surface.

Cross section A-A' (Figure 3) shows the surficial soil and top of bedrock along the existing access road between MF-218A and MF-102.

- Soils encountered in the boreholes consisted of silty or clayey sands with gravels and cobbles near the northern and southern part of the section and silty clay with none to very little gravels or cobbles in the middle of the section

- Bedrock consists of sandstone in MFB-20, MFB-21, MFB-23, MFB-32, BA-8 and BA-1 and in all the other boreholes

Cross section B-B' (Figure 3) shows the surficial soil and top of bedrock encountered in the coreholes between MF-218A and MF-102 (Figure 4). The cross section suggests the following:

- Surficial soil encountered in the coreholes consists of clayey silt, silty sand and clay across this section
- Bedrock along this section is basalt
- The basalt bedrock surface dip to the west

Cross section C-C' shows the surficial soil and top of bedrock between MF-218A and MF-218 (Figure 3). The cross section suggests the following:

- Surficial soil encountered in the boreholes consists of silty sand and sand
- Depth to bedrock is shallow

The materials encountered in boreholes with bedrock elevations below 6,060 are sandy clay (CL) with a small percentage of gravel and cobbles. The materials are stiff to very stiff. Laboratory permeability testing of remolded samples of this material averaged 2.7 x 10^{-7} cm/sec.

It is not likely that this area of a low bedrock surface will represent much of a seepage loss. Uncertainties exist as to the eastern extent of the basalt bedrock in the area between borehole MF-123 and BA-7 and in the in situ permeability of the materials. A more detailed evaluation of the necessity of seepage mitigation in this area must be completed prior to final design of the dam and appurtenant structures.

4.3 Conceptual Bedrock Model

The sandstone ridge to the south and east of the proposed dam abutment will serve to contain the proposed reservoir. This narrow strip of land is considered a potential seepage pathway from the proposed reservoir.

Geologically, the ridge is divided approximately in half; the northern portion of the ridge consists of Permian sandstones overlain by Quaternary basalt and the southern part is composed of only Permian sandstone (Figure 8). This southern sandstone "window" is bounded by the occurrence of overlying basalt to the north and south. In the north, the sandstone/basalt contact dips gently westward across the ridge and then dips steeply underneath the North Fork of the White River.

The model of the ridge is divided into two segments based on the geology described above; the "basalt" model representing the northern section of the ridge, and the "sandstone window" model, representing the southern portion of the ridge. Figure 9 shows the outlines of the models. Each model is designed to run on its own and results from each model summed for a total seepage flow rate through the ridge. The northern tip of the ridge (the left abutment of the proposed dam) is not included in the model. The seepage modeling for the dam abutment and foundation is not included in the scope of this investigation.

The basalt model consists of two layers: an upper layer of basalt and a lower layer of sandstone. Seepage flow through the ridge is estimated by simulating a full reservoir (pool elevation of 6,060 feet) on the eastern edge of the ridge and a river elevation of 5900 feet on the western edge of the ridge. The reservoir acts as a source for recharge to the ridge and the river acts as the discharge sink.

The sandstone window model is designed similarly to the basalt model except that it consists only of one layer and the river discharge elevation is defined at 5,880 feet.

5.0 MODELING METHOD

Modeling was conducted using VISUAL MODFLOW (WHS 1996), a user interface for MODFLOW. MODFLOW is a three-dimensional, finite-difference groundwater flow model developed by the USGS. Groundwater flow within the aquifer is simulated using a block-centered, finite-difference approach. Layers can be simulated as confined, unconfined, or a combination of confined and unconfined. The finite-difference equations can be solved using a variety of iterative solution methods (McDonald and Harbaugh 1988).

5.1 Sandstone Window Model

The model of the sandstone window consists of one layer with a base elevation of 5,856 feet, approximately 800 feet square. The base elevation of 5,856 represents the approximate contact elevation between the Coconino Sandstone and Supai Group. The top surface of the model is defined by the topographic surface. The model is bounded on both the north and south by the surficial occurrence of the basalt/sandstone contact. The contacts are represented in the model as no-flow boundaries. The window is bounded on the east by the pool elevation of the reservoir (6,060 feet) and on the west by the North Fork of the White River (5,880 feet). These are represented as constant head boundaries (Figure 1). The grid consists of 100 by 100 divisions, or 10,000 variably-sized cells.

Hydraulic conductivity for the sandstone window model was based on results of constant-head injection packer testing conducted in borehole intervals open to the Coconino Sandstone. Hydraulic conductivity values from tested intervals in boreholes MF-218A and MF-253 were averaged (geometric mean) yielding a value of 1.94×10^{-4} cm/sec (Figure 10).

Recharge and evapotranspiration were assumed to be negligible given the arid climate and the depth to water in the area. Since the model was run under a steady-state condition, specific storage, yield and porosity parameters for the aquifer were not necessary. The sandstone

aquifer was defined as unconfined. Output from the flow model was used by the zone budget module of MODFLOW to calculate seepage.

The zone budget module of MODFLOW allows the calculation of flow rates from one section of the modeled area to an adjacent section. Sections are defined by the user and can consist of any combination of unique areas within the model area. For this modeling exercise, the flow of interest was that through the Coconino Sandstone window to the North Fork of the White River to the west. A zone was defined therefore, as encompassing the sandstone window in the east and another zone beginning at the east edge of the river. Flows were estimated based on the resultant steady-state water level contour map predicted by the flow model.

5.2 Basalt Model

The basalt model has a base elevation of 5,880 feet, is approximately 600 feet square, and consists of two layers. The upper layer consists of basalt and the lower layer of undifferentiated sandstone. As with the sandstone window model, the top surface of the model is defined by the topography. The location of the basalt/sandstone contact was based on control points and geologic mapping on the east side of the model area and extrapolated to the western portion of the model area. The north and south edges of the model are represented by no-flow boundaries. The model is defined on the east by the pool elevation of the reservoir (6,060 feet) and on the west by the North Fork of the White River (5,900 feet). These are represented as constant head boundaries (Figure 9). The grid consists of 100 columns by 92 rows and two layers, or 18,400 cells.

Hydraulic conductivity values used in the model were based on constant-head injection packer testing conducted in basalt and sandstone. Hydraulic conductivity values from basalt intervals from nine boreholes were averaged (geometric mean) yielding values ranging five orders of magnitude, from 10^{-4} to 10^{0} cm/sec. A value was assigned to the unfractured basalt

using the geometric mean of the results in the 10^{-3} to 10^{-4} cm/sec range. The high-flow zones in the basalt were represented as three pipes with hydraulic conductivities defined by the geometric mean of the hydraulic conductivity results in the 10^{-2}, 10^{-1} and 10^{0} cm/sec ranges, respectively (Figure 10). Geometries of the pipes were determined from the relative percentages of total packer test interval represented by each conductivity value used. For example, the 1.05×10^{-2} cm/sec conductivity value used in the model represents testing done over 2.1 percent of the total 1,065 feet of basalt that was packer tested. A three-dimensional "pipe" representing 2.1 percent of the total volume of basalt in the model was defined. The "pipe" extended the full width and thickness of the basalt in the model and was assigned the 1.05×10^{-2} cm/sec conductivity value.

Recharge and evapotranspiration were assumed to be negligible given the arid climate and the depth to water in the area. Since the model was run using a steady-state condition, specific storage, yield and porosity information for the aquifer were not necessary. The basalt layer was defined as unconfined and the sandstone aquifer was defined as confined with variable storage and transmissivity. Output from the flow model was used by the zone budget module of MODFLOW to calculate seepage.

The zones for the zone budget calculations were defined in a similar manner to those for the sandstone window model. For the basalt model, the flow of interest was that from both the sandstone and basalt to the North Fork of the White River. One zone was defined, therefore, as encompassing both layers of the basalt and the sandstone in the east and another zone beginning at the east edge of the river. Flow was calculated based on the resultant steady-state water level contour map predicted by the flow model.

5.3 Modeling Assumptions and Limitations

Groundwater numerical modeling is a process of simulating the natural flow system. Due to the natural complexity and variability of the hydrogeologic system, certain simplifying

assumptions are necessary for defining the system for modeling purposes. These modeling assumptions include:

- Darcy flow conditions exist within the aquifer.

- No fracture flow occurs through the formation, that is, the ridge can be represented as a single-porosity flow system.

  For the sandstone window model, the Darcy flow and no-fracture-flow assumptions are generally valid over the majority of the sandstone. Although some fracture flow may occur through some of the friable and weathered sandstone material, packer test and geologic logging results do not indicate that high-flow zones or fracture zones exist in the sandstone window. The assumption is uncertain in the basalt model since relatively discrete high-flow zones are known to exist. The "pipes" incorporated into the basalt model were designed to account for these discrete features in the basalt.

- Each model layer is homogeneous and isotropic.

  For the sandstone window, the assumption that each layer is homogeneous and isotropic is generally valid as, according to the geologic logs, major variation within the Coconino Sandstone at the site is uncommon both laterally and with depth. This assumption holds less for the basalt, which contains discontinuities and structural features such as fractures and inter-basalt(lava)-flow-boundaries.

- Recharge and evaporation are negligible.

  Net precipitation recharge is expected to be near zero for most of the year due to the arid climate in the region. Any recharge occurring in the model area is minor, and, compared to the groundwater flux driven by the reservoir head, can be considered negligible.

- Saturated K values used in the model are similar to measured unsaturated K values.

  Hydraulic conductivities were calculated from packer test data over the entire zone predicted to be part of the flow regime under reservoir conditions. This zone includes both currently saturated and unsaturated material. Unsaturated packer test intervals were saturated by adding water

prior to commencing a test since unsaturated hydraulic conductivity values are generally higher than saturated values. This allowed greater confidence in the conductivity values obtained from unsaturated packer testing.

- No flow occurs between the sandstone and basalt (sandstone window model only).

- No flow occurs between the Coconino and Supai Group below (sandstone window model only).

  The assumption that there exists no hydrologic communication between adjacent formations is necessary for defining model boundaries, however this may not be a completely valid assumption. The competent basalt bounding the sandstone window is generally less hydraulically conductive than the sandstone but also contains high-flow zones. The particular high-flow features may have a much higher conductivity than the sandstone, therefore, flow may occur from the sandstone to a fractured basalt zone. At the lower boundary of the model, the Coconino Sandstone grades into the underlying, finer-grained Supai Group. The Supai Group has a slightly lower hydraulic conductivity. Also, it is unlikely that a significant downward hydraulic gradient exists in the Supai. This suggests that hydrologic communication would be minimal, however, effects of a no-flow boundary at the contact are uncertain.

- Laterally continuous "pipes" of higher hydraulic conductivity are conservatively representative of discrete high-flow zones in the basalt (basalt model only).

  The packer tests conducted by Golder in 1995 revealed zones of high hydraulic conductivity, presumably associated with flow through fractures or inter-(lava) flow boundaries. These discrete features, defined as "pipes" in the model, represent the most direct and continuous flow route through the ridge. The assumption that "pipes" through the basalt represent these discrete high-flow features, therefore, is a conservative assumption.

- The basalt/sandstone contact can be extrapolated from borehole logs and geologic mapping (basalt model only).

  The basalt model was based on the assumption that the basalt/sandstone contact was laterally consistent and continuous and could be extrapolated

from the control points (boreholes). This assumption was necessary to extend the contact to the west of the known control points and agrees with the geologic model of the ridge. Additional information about the location of the contact is necessary to accurately define the geometry of the basalt and sandstone.

6.0 MODELING RESULTS AND DISCUSSION

6.1 Sandstone Window Model

6.1.1 Results

Modeling results are summarized in Table 1. The water level contour map predicted by VMODFLOW is shown in Figure 11 and in cross sections in Figure 12. Water levels vary between the two defined constant-head boundaries of 6,060 and 5,880 feet elevation across the modeled area. Flow occurs generally to the west from the proposed reservoir to the river. Seepage into the river is estimated at 0.09 cubic feet per second (cfs) (7551.3 ft^3/day) across the entire interface between the sandstone window aquifer and the river. The base flow of the North Fork of the White River has been estimated by MM/CSSA as 120 cfs (Morrison Maierle, Inc. 1986). The potential loss from the reservoir is estimated to be less than 0.1 percent of the base flow, an insignificant loss.

6.1.2 Sensitivity Analysis

A sensitivity analysis was conducted to evaluate the effects on flow by changes in the hydraulic conductivity. The results of the analysis are presented in Table 2. The expected hydraulic conductivity represents the geometric mean of packer test results for the sandstone window. The model was re-run using the expected value plus one standard deviation and using the expected value minus one standard deviation. For the sandstone window model, these values are 1.94×10^{-4} cm/sec, 6.86×10^{-4} cm/sec and 5.5×10^{-5} cm/sec for the expected value, plus standard deviation and minus standard deviation, respectively. The sensitivity of the seepage rate to the hydraulic conductivity is linear (in agreement with Darcy's Law). Therefore, an order of magnitude increase in the hydraulic conductivity results in an order of magnitude increase in the seepage flow to the river.

6.1.3 Model Verification

The results of the sandstone model were verified by applying Darcy's Law:

$$Q = KiA$$

where:

Q = Flow Rate (ft^3/day)

K = Hydraulic Conductivity = 0.000194 cm/sec = 0.55 ft/day

i = Hydraulic Gradient = 180 ft per 800 ft = 0.225 ft/ft

A = Cross-sectional Area = 1000 ft length x 35 feet depth = 35,000 ft^2

resulting in a total flow of 4331 ft^3/day (0.05 cfs). The calculation and the result is included in Table 2 for comparison with the modeling and sensitivity analysis results.

6.1.4 Discussion

The relatively well-understood geometry of the sandstone window allowed construction of a straight-forward model, however, some of the simplifications required for simulating the boundary conditions are uncertain. Consideration of flow from the sandstone to the basalt would refine the model as would the consideration of flow paths through the underlying Supai Group.

6.2 Basalt Model

6.2.1 Results

The water level contour map of layer two predicted by the model is shown in Figure 11 and in cross sections in Figure 13. Water levels vary between the two defined constant-head boundaries of 6,060 and 5,900 feet elevation across the modeled area. Flow is generally to the west from the proposed reservoir to the river. Seepage into the river is estimated at 0.04

cfs (3,451 ft^3/day) across the entire interface between the basalt/sandstone aquifer and the saturated interval below the river. This represents a loss of approximately 0.03 percent of the base flow of the North Fork of the White River.

6.2.2 Sensitivity Analysis

As with the sandstone window model, a sensitivity analysis was conducted on the basalt model. Results are presented in Table 2. Hydraulic conductivity values were varied by one standard deviation from the mean for both the basalt and the sandstone layers. Simulations were run using the plus-one-standard-deviation values for both layers and the minus-one-standard-deviation values for both layers to estimate maximum and minimum flow rates. For the basalt, the expected conductivity value is 2.88×10^{-5} cm/sec and the plus- and minus-one-standard-deviation values are 2.28×10^{-4} cm/sec and 3.63×10^{-6} cm/sec, respectively. Sandstone values were 1.13×10^{-4} cm/sec, 9.2×10^{-4} cm/sec and 1.4×10^{-5} cm/sec for the expected, plus-one-standard-deviation and minus-one-standard-deviation, respectively.

6.2.3 Model Verification

A Darcy's Law calculation was conducted to verify the modeling and results included in Table 2. The following inputs were used:

K = Hydraulic Conductivity (sandstone value) = 0.000113 cm/sec = 0.32 ft/day
i = Hydraulic Gradient = 160 ft per 600 ft = 0.27 ft/ft
A = Cross-sectional Area = 600 ft length x 35 feet depth = 21,000 ft^2

resulting in a total flow of 1,814 ft3/day (0.021 cfs).

6.2.4 Discussion

The basalt model consisted of two layers, four different hydraulic conductivity values, two imported surfaces with high relief, cell rewetting and two constant head boundaries. When running the model with the cell-rewetting package included, appropriate convergence was not achieved. To achieve convergence, the cell-rewetting package was excluded and the model was run with an original water level of 6,060 feet elevation. Residual heads were damped (*i.e.*, convergence acceleration less than 1) such that cells were not dewatered prematurely.

A substantial amount of the basalt (upper layer) was dry since much of the elevation of the base of the basalt is above the pool elevation of 6,060. The high-conductivity "pipes" showed little effect on the overall resultant water table. The steady-state water table intersects the basalt -- and therefore the "pipes" -- just to the east of the river, thereby minimizing the potential high-flow effects of the "pipes" and defining the sandstone as the controlling aquifer in the system.

7.0 CONCLUSIONS

The ridge that forms the left or southeastern abutment of the proposed Miner Flat dam is composed of Coconino Sandstone that is overlain by Quaternary-Tertiary basalt and up to 50 feet of Quaternary-Tertiary gravel. Eight boreholes have been cored along the axis of the ridge and packer tests have been performed in the holes to investigate the potential for seepage through the ridge. These core holes show that the thickness of the basalt overlying the Coconino Sandstone is variable and that the eastern and western extent of the basalt is unknown as well as the extent of the basalt to the south. Rock quality indicators such as RQD and fracture frequency show that the basalt is of fair quality and not intensely fractured. Packer tests performed in the holes indicated that the sandstones of the Coconino and Supai formations have a permeability of approximately 10^{-4} cm/sec. The permeability of the basalt is dependent on the number of hydraulically connected fractures intersected by the test interval. The majority of the packer tests performed in the basalt indicated a discrete feature hydraulic conductivity of 10^{-5} cm/sec.

Twenty six additional boreholes have been drilled through the Quaternary-Tertiary gravel to determine the elevation of the bedrock and the bedrock type. The purpose of these additional holes was to investigate the potential of seepage through the surficial material overlying the bedrock. The drilling of the surficial materials has shown that the thickness of the Quaternary-Tertiary gravel deposits are variable and that a broad, flatly dipping bedrock surface exits about halfway along the axis of the ridge. The *"gravel"* deposits are primarily clay and the concentration of sands, gravels, and cobbles at the surface are lag deposits left by the removal of the finer silts and clays by erosion. The elevation of the flatly dipping bedrock surface is below the proposed pool elevation of 6,060 and could present a possible seepage pathway. Laboratory testing of the surficial materials collected from boreholes indicate that the permeability of these materials is approximately 10^{-7} cm/sec.

Two hydrogeologic models were prepared to estimate the seepage losses through the bedrock of the ridge. The sandstone model representing the portion of the ridge that does not have a basalt cover is the most straight forward with the fewest simplifying assumptions. The results of the seepage modeling through the sandstone portion of the ridge indicate that the 1,000 feet of discharge length may yield approximately 0.09 cfs (7800 ft^3 per day) with a reservoir pool elevation of 6,060. The basalt model representing the portion of the ridge that is covered with the basalt over the sandstone is much more complicated with considerably more simplifying assumptions. The results of the seepage modeling through the sandstone/basalt portion of the ridge indicate that the 600 feet of discharge length may yield 0.04 cfs (3,450 ft^3 per day). The total seepage through the ridge is estimated to be approximately 0.13 cfs (11,000 ft^3 per day). Given that the base flow of the North Fork of the White River is estimated as 120 cfs the loss from the reservoir through the left abutment ridge is estimated at approximately 0.1 percent, an insignificant loss.

8.0 RECOMMENDATIONS

The purpose and scope of the left abutment seepage modeling were to investigate the potential for seepage through the Permian sandstones of the left abutment ridge. The scope was expanded from the original work plan to include the basalt section of the left abutment area and the seepage potential of the surficial material. The following recommendations are made in order to answer the unresolved potential seepage related to the operation of the proposed Miner Flat dam.

The investigation of the seepage potential through the surficial material covering the bedrock of the ridge requires only minor additional work at this time. Boreholes that have not been surveyed, those boreholes with the MF-B prefix, should be surveyed. Borehole location data would then be included in the bedrock surface model and a new bedrock surface would be estimated. The final bedrock surface map would bring to a close the present scope of work. It is recommended that prior to construction of the dam that the eastern extent of the basalt be determined and that in situ permeability testing of the surficial materials be performed. A design of seepage mitigation alternatives, if required, cannot be completed with the current information.

The investigation of the potential seepage through the Permian sandstone, in particular the Coconino Sandstone where it is not blanketed by basalt, is essentially complete at this time. The 'sandstone window' model should be integrated with the 'basalt' model to fully represent the hydrogeological interrelationship of the left abutment ridge.

The investigation of the seepage potential through the left abutment ridge where it is blanketed by basalt on the western or downstream side is incomplete and requires additional investigation. The seepage potential of the basalt model was not included as part of the original work plan. Additional data and flow modeling pertaining to the discrete feature component of this model is required to fully evaluate the seepage potential of this area. The

eastern and southern extent of the basalt must be determined to fully model the seepage potential. The western or downstream geometry of the basalt must be determined as this is the discharge area of the potential seepage through this section of the left abutment ridge. The material between the bottom of the basalt and the sandstone including Tertiary colluvium and Tertiary alluvium has not been investigated, tested, or included in the current model. This potential flow path must be included in a more inclusive model. The 'sandstone window' model must be included in a more comprehensive analysis of the seepage potential of the left abutment ridge.

The two discreet areas modeled for this investigation represent two of many possible seepage pathways that emanate from the proposed reservoir. They do not include: the specific area of the dam abutments or foundation; the north side of the reservoir through the basalt and Tertiary alluvium; or, seepage to the east of the sandstone window. Due to the complex nature of the regional and local geology, more detailed field and analytical investigations should be conducted, including:

- A seepage model of the dam abutments and foundation
- An investigation, including modeling, of the hydrogeologic properties and extent of Tertiary alluvium/colluvium deposits below the foundation and abutments and to the west
- A stream survey to define losing and gaining reaches of the North Fork of the White River and to define stream losses through the Tertiary alluvium
- Expanded data collection, in support of refining existing conceptual and numerical models of the basalt
- A large-scale seepage model incorporating existing model information and additional data on other potential flow pathways
- Exhaustive water-level data for all piezometers and wells in the area
- Hydrogeologic and geologic information on areas north of the proposed dam and east of the sandstone window including water levels, hydraulic and flow parameters, and structural, stratigraphic and lithological data.

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TABLES

TABLE 1

SEEPAGE MODELING AND SENSITIVITY ANALYSIS
MINER FLAT DAM SITE - ARIZONA

Model Output Summary

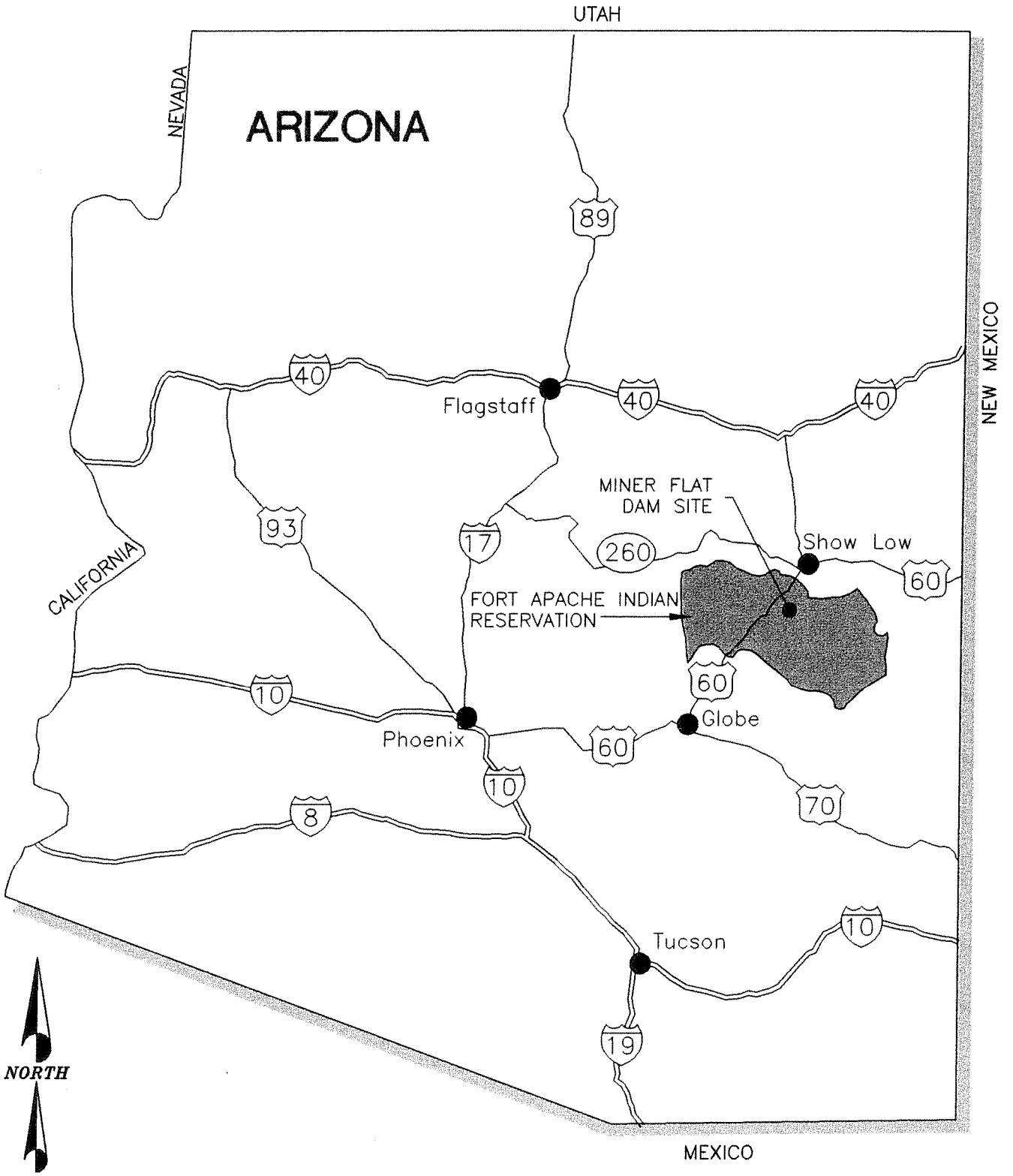
	Seepage Rate (cfs)	Dishcarge Width (feet)	Flow per foot (cfs/foot)
Sandstone Window	0.087	1000	8.70E-05
Basalt	0.040	600	6.65E-05
Total	**0.127**	**1600**	**7.94E-05**

TABLE 2

SEEPAGE RATES AT VARYING HYDRAULIC CONDUCTIVITY VALUES
MINER FLAT DAM SITE - ARIZONA

Model	Expected Value		+ 1 Standard Deviation		- 1 Standard Deviation		Darcy Calculation	
	K Value cm/sec	Seepage Rate (cfs)	K Value cm/sec	Seepage Rate (cfs)	K Value cm/sec	Seepage Rate (cfs)	K Value cm/sec	Seepage Rate (cfs)
Sandstone Window	1.94E-04	0.087	6.86E-04	0.309	5.50E-05	0.025	1.94E-04	0.050
Basalt	2.88E-05	0.040	2.28E-04	0.334	1.13E-04	0.005	2.88E-05	0.021
Total	**na**	**0.127**	**na**	**0.643**	**na**	**0.030**	**na**	**0.071**

FIGURES



Golder Associates Inc.
200 Union Blvd. Suite 500
Lakewood, Colorado 80228
Phone: (303) 980-0540
FAX. (303) 985-2080

TITLE

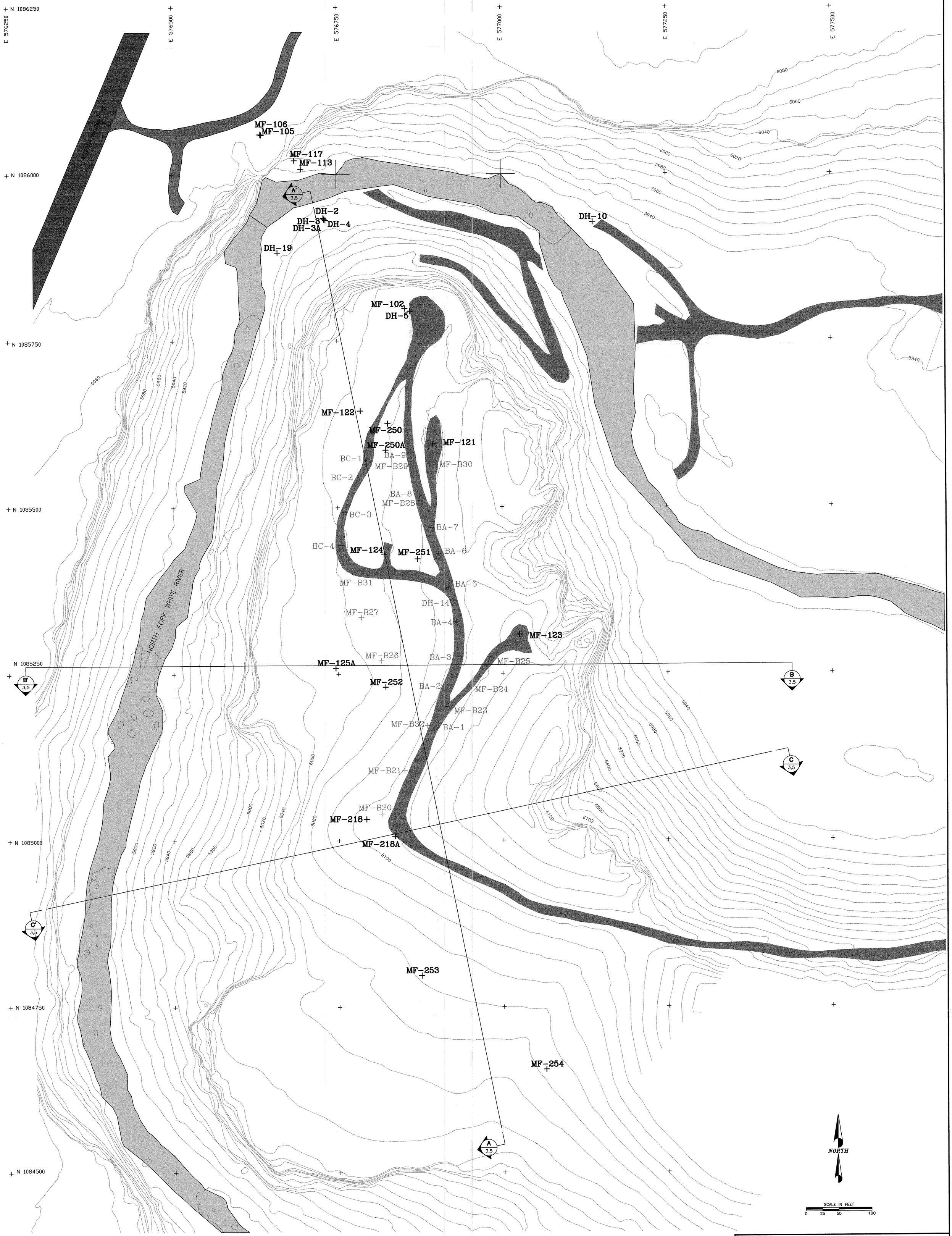
SITE LOCATION MAP

CLIENT/PROJECT

MORRISON-MAIERLE / CSSA
MINER FLAT DAM

DRAWN	KAW	DATE	APRIL 1997	JOB NO.	943-2769
CHECKED	LB	SCALE	NTS	DWG NO./REV. NO.	A006
REVIEWED	CHR	FILE NO.	2769A006	FIGURE NO.	1

Job No / Dwg No: 943-2769 / E007
Last Update: 12:42p 28-Apr-97



EXPLANATION

- NORTH FORK WHITE RIVER
- SITE ACCESS ROAD
- ARIZONA STATE HIGHWAY 73

BOREHOLE COLLAR LOCATIONS

MF-B26 +	PERCUSSION HAMMER BOREHOLE (APPROXIMATELY LOCATED)
BA-3 +	PERCUSSION HAMMER BOREHOLE
BC-4 +	PERCUSSION HAMMER BOREHOLE
DH-14 +	COREHOLE
MF-102 +	COREHOLE

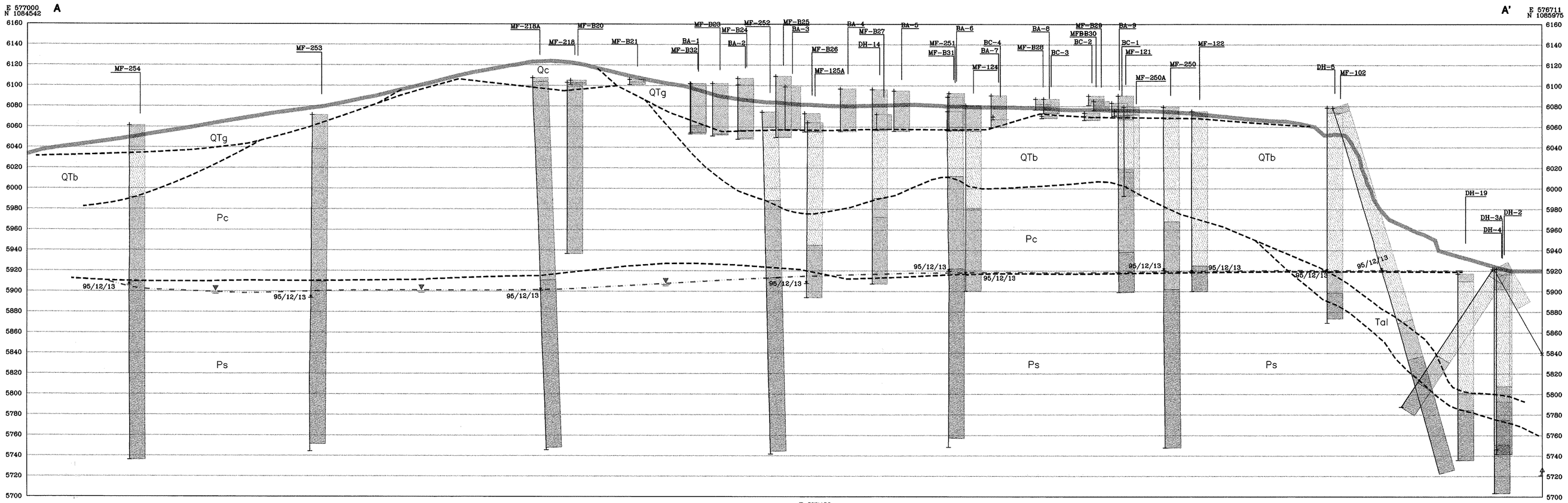
REV.	DATE	DESCRIPTION	DR. BY	APP. BY

CLIENT/PROJECT
MORRISON-MAIERLE / CSSA
MINER FLAT DAM

TITLE
BOREHOLE LOCATION MAP

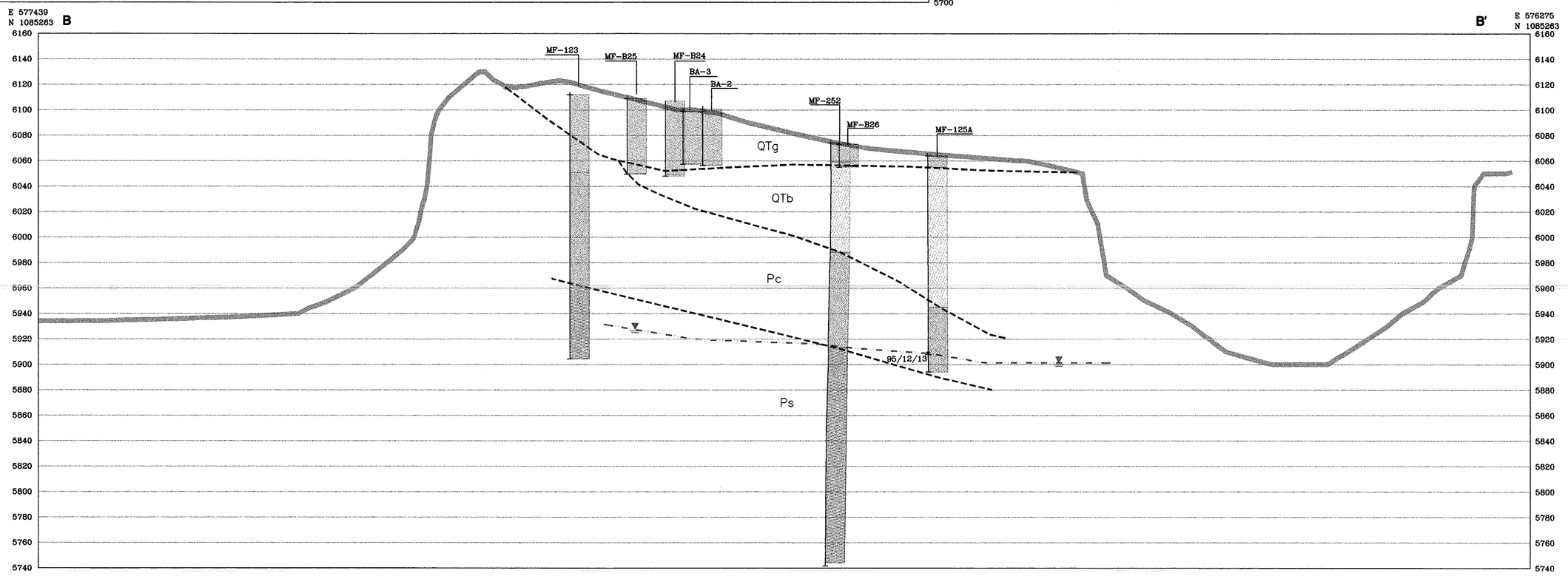
Golder Associates
Denver, Colorado

DRAWN	KAW	DATE	APRIL 1997
CHECKED	LB	SCALE	AS SHOWN
REVIEWED	CHR	JOB NO.	943-2769
APPROVED	CHR	DWG. NO.	E007
FILE NO.	2769E007	FIGURE	2



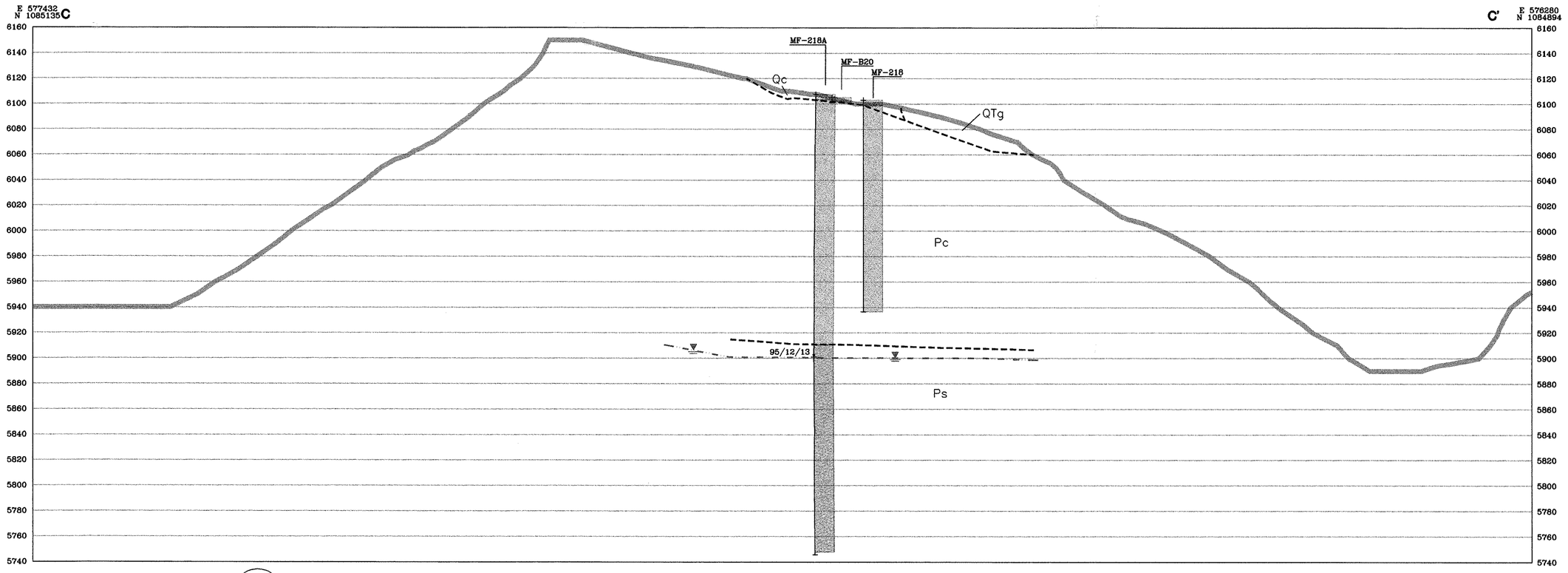
A 3 **CROSS SECTION A-A'**

SCALE IN FEET
0 25 50 100



B 3 **CROSS SECTION B-B'**

SCALE IN FEET
0 25 50 100



C 3 **CROSS SECTION C-C'**

SCALE IN FEET
0 25 50 100

EXPLANATION

BOREHOLE COLLAR LOCATIONS

MF-B26	PERCUSSION HAMMER BOREHOLE (APPROXIMATELY LOCATED)
BA-3	PERCUSSION HAMMER BOREHOLE
BC-4	PERCUSSION HAMMER BOREHOLE
DH-14	COREHOLE
MF-102	COREHOLE

95/12/13	WATER LEVEL MEASURED DEC. 13, 1995
- - ▽ - -	PIEZOMETRIC SURFACE
Qc / QTg / Tal	QUATERNARY COLLUVIUM, QUATERNARY–TERTIARY GRAVEL, TERTIARY ALLUVIUM
QTb	QUATERNARY TERTIARY BASALT
Pc	COCONINO FORMATION
Ps	SUPAI GROUP

REV.	DATE	DESCRIPTION	DR. BY	APP. BY

CLIENT/PROJECT
MORRISON-MAIERLE / CSSA
MINER FLAT DAM

TITLE
GEOLOGIC CROSS SECTIONS

Denver, Colorado

Golder Associates

DRAWN	KAW	DATE	APRIL 1997
CHECKED	LB	SCALE	AS SHOWN
REVIEWED	CHR	JOB NO.	943-2769
APPROVED	CHR	DWG. NO.	E008
FILE NO.	2769E008	FIGURE	3

Job No. / Dwg No: 943-2769 / E008
Last Update: 01:00p 28-Apr-97

Job No / Dwg No: 943-2769 / E010
Last Update: 01:25p 28-Apr-97

EXPLANATION

BA-6 6056.29 + PERCUSSION HAMMER BOREHOLE BEDROCK ELEVATION

MF-251 6059.97 + COREHOLE BEDROCK ELEVATION

MF-B23 6053.00 + PERCUSSION HAMMER BOREHOLE BEDROCK ELEVATION

Triangular Grid from 60 data points

REV.	DATE	DESCRIPTION	DR. BY	APP. BY

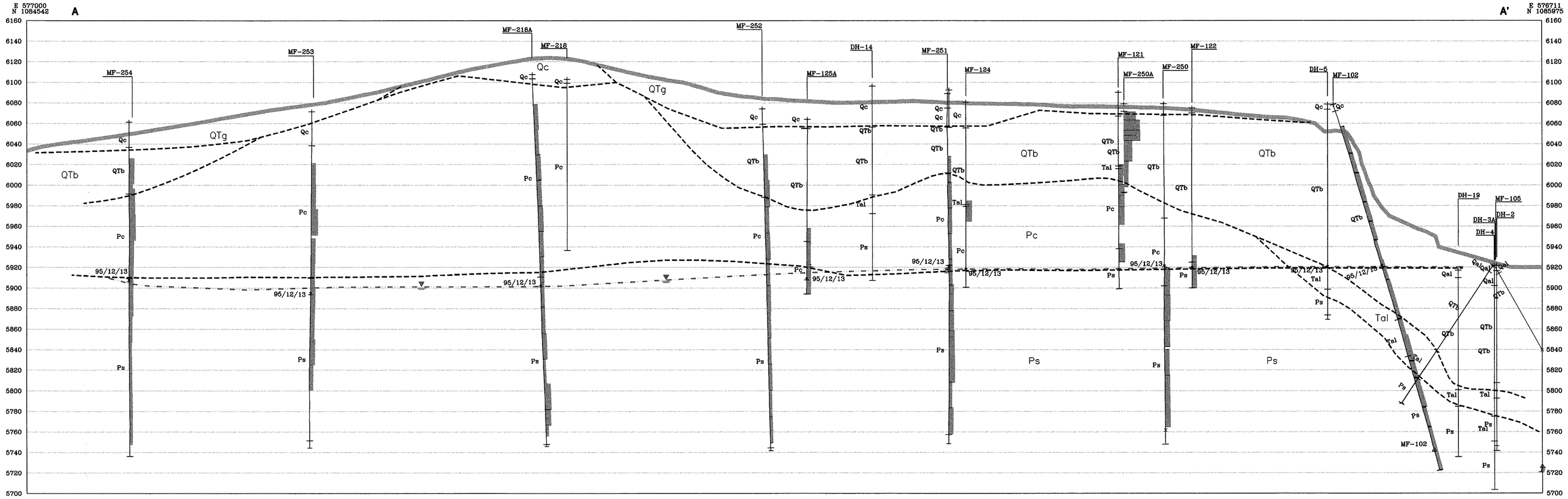
CLIENT/PROJECT
MORRISON-MAIERLE / CSSA
MINER FLAT DAM

TITLE
BEDROCK SURFACE TOPOGRAPHY

Denver, Colorado

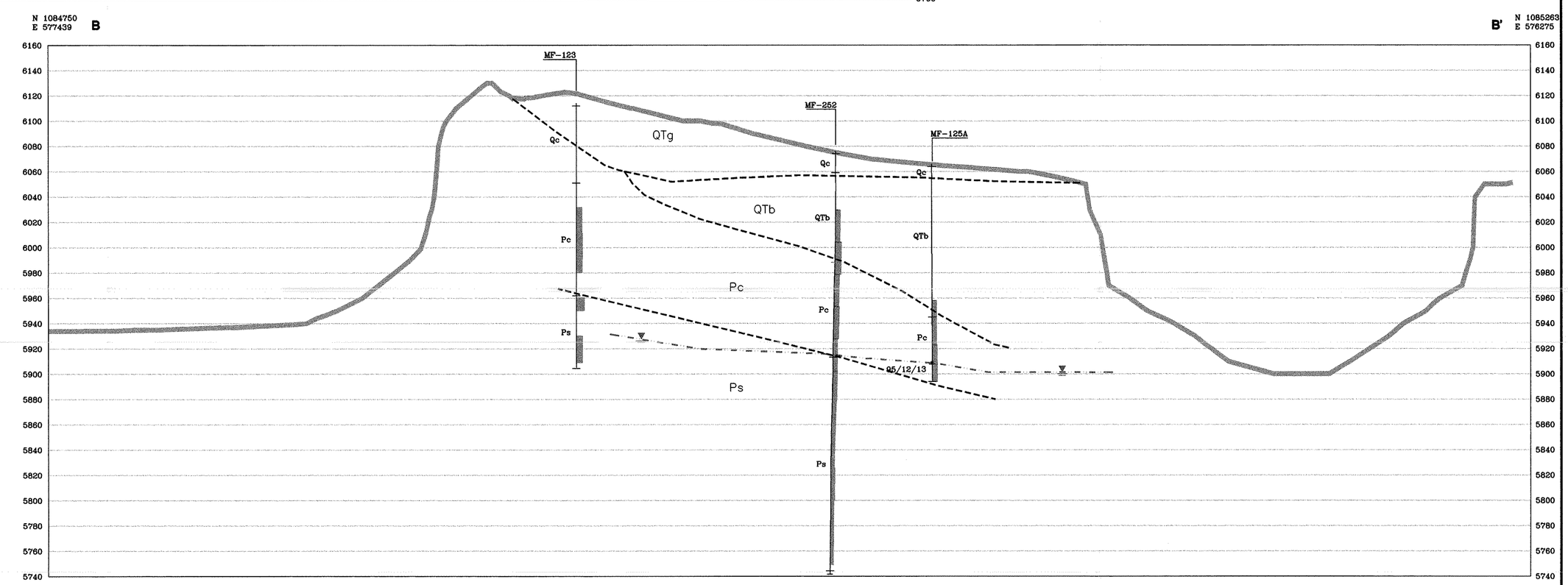
Golder Associates

DRAWN	KAW	DATE	APRIL 1997
CHECKED	LB	SCALE	AS SHOWN
REVIEWED	CHR	JOB NO.	943-2769
APPROVED	CHR	DWG. NO.	E010
FILE NO.	2769E010	FIGURE	4



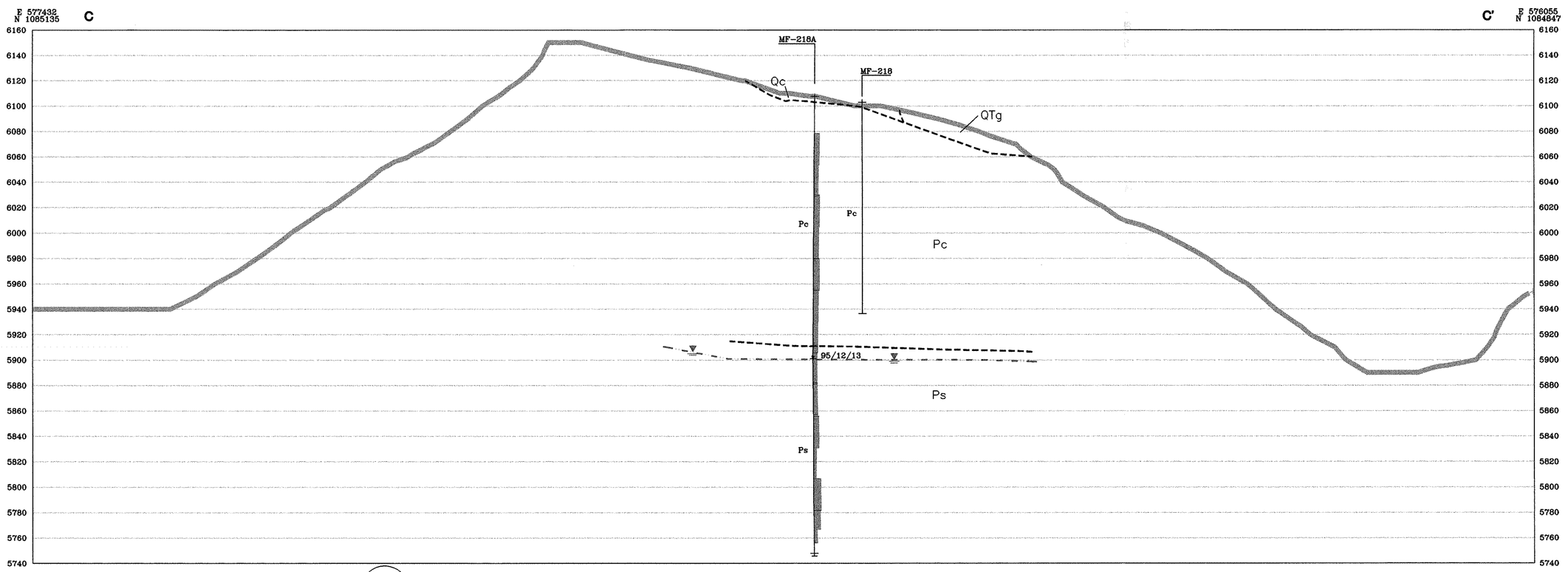
A 5 **CROSS SECTION A-A'**

SCALE IN FEET
0 25 50 100



B 5 **CROSS SECTION B-B'**

SCALE IN FEET
0 25 50 100



C 5 **CROSS SECTION C-C'**

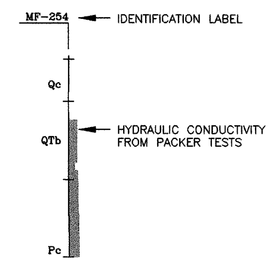
SCALE IN FEET
0 25 50 100

EXPLANATION

BOREHOLE COLLAR LOCATIONS

MF-B26	PERCUSSION HAMMER BOREHOLE (APPROXIMATELY LOCATED)
BA-3	PERCUSSION HAMMER BOREHOLE
BC-4	PERCUSSION HAMMER BOREHOLE
DH-14	COREHOLE
MF-102	COREHOLE

95/12/13	WATER LEVEL MEASURED DEC. 13, 1995
▽	PIEZOMETRIC SURFACE
Qc	QUATERNARY COLLUVIUM
QTg	QUATERNARY–TERTIARY GRAVEL
Tal	TERTIARY ALLUVIUM
QTb	QUATERNARY TERTIARY BASALT
Pc	COCONINO FORMATION
Ps	SUPAI GROUP



REV.	DATE	DESCRIPTION	DR. BY	APP. BY

CLIENT/PROJECT
MORRISON-MAIERLE / CSSA
MINER FLAT DAM

TITLE
HYDRAULIC CONDUCTIVITIES
CROSS SECTIONS

Denver, Colorado

Golder Associates

DRAWN	KAW	DATE	APRIL 1997
CHECKED	LB	SCALE	AS SHOWN
REVIEWED	CHR	JOB NO.	943-2769
APPROVED	CHR	DWG. NO.	E009
FILE NO.	2769E009	FIGURE	5

Job. No. / Dwg. No: 943-2769 / E009
Last Update: 01:19p 28-Apr-97

Figure 6
Histogram
Hydraulic Conductivity Values
Permian Sandstones

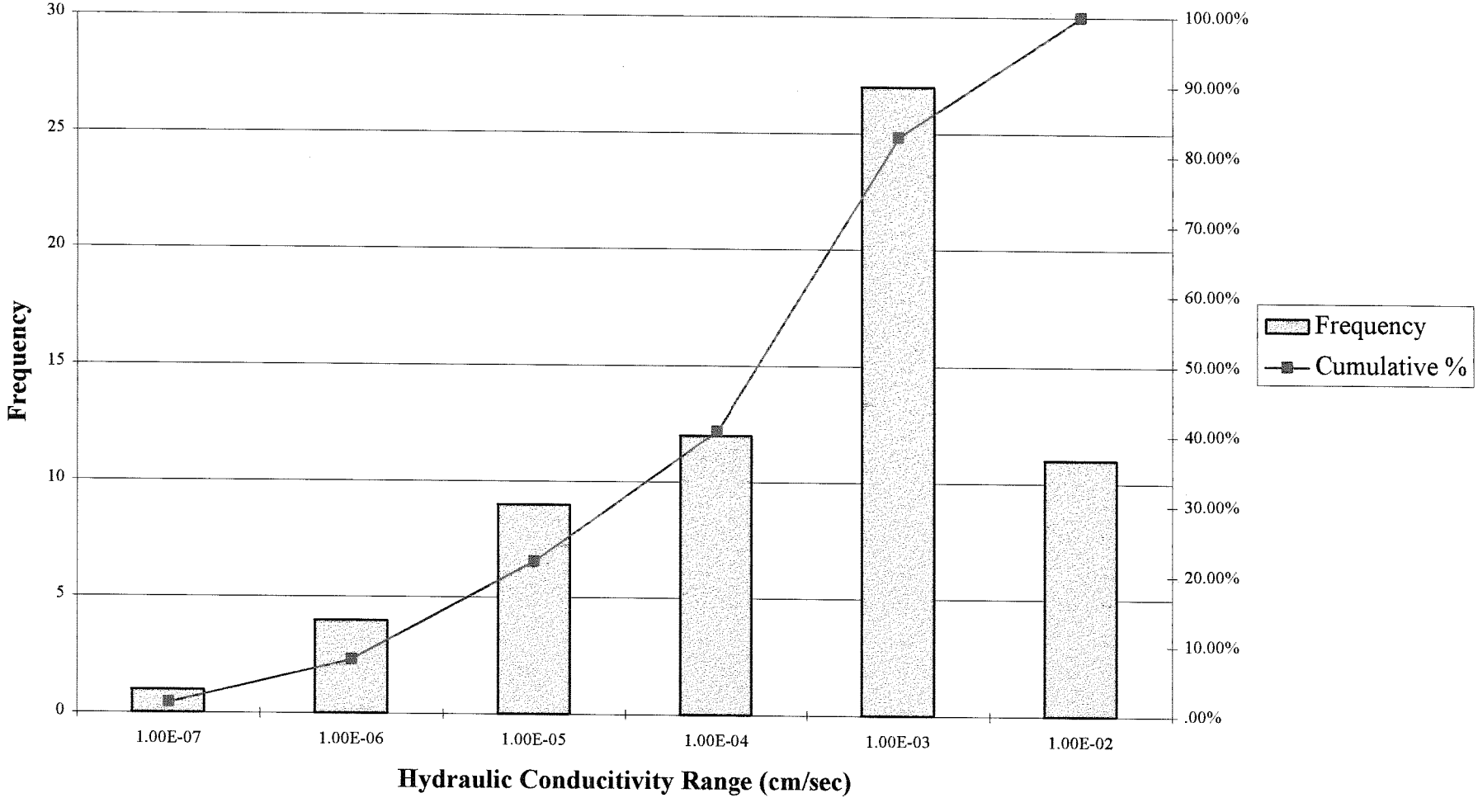
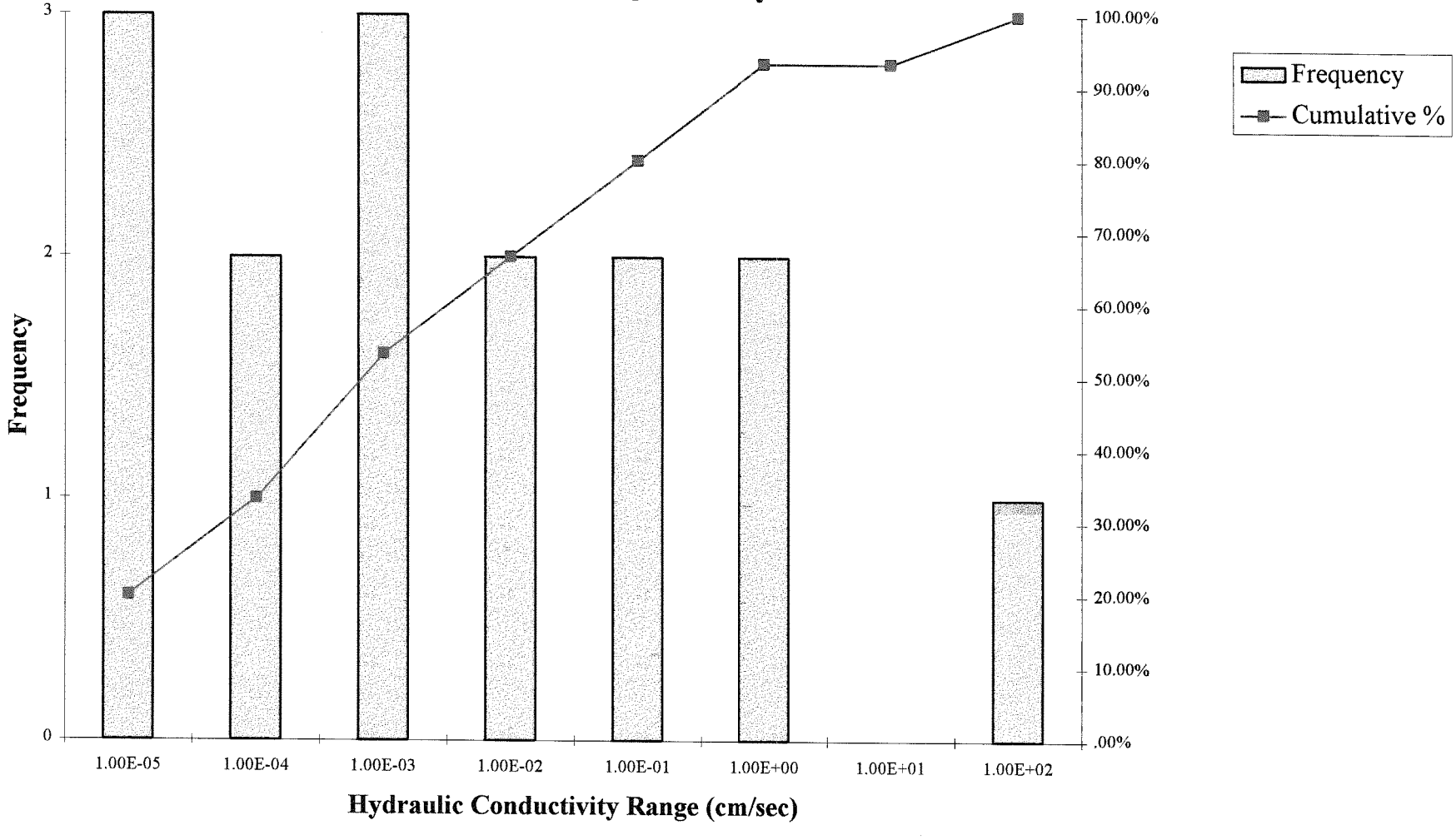
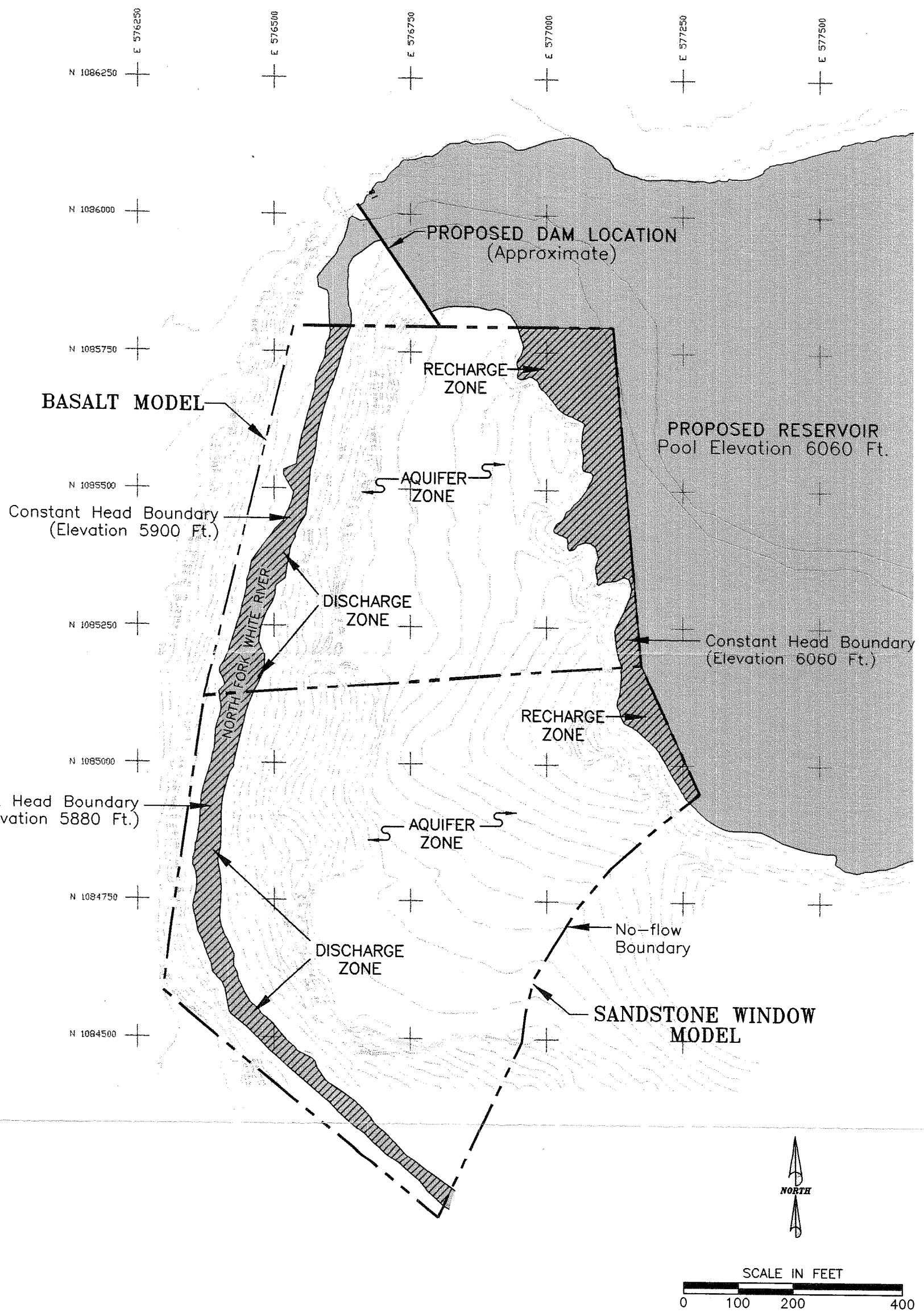


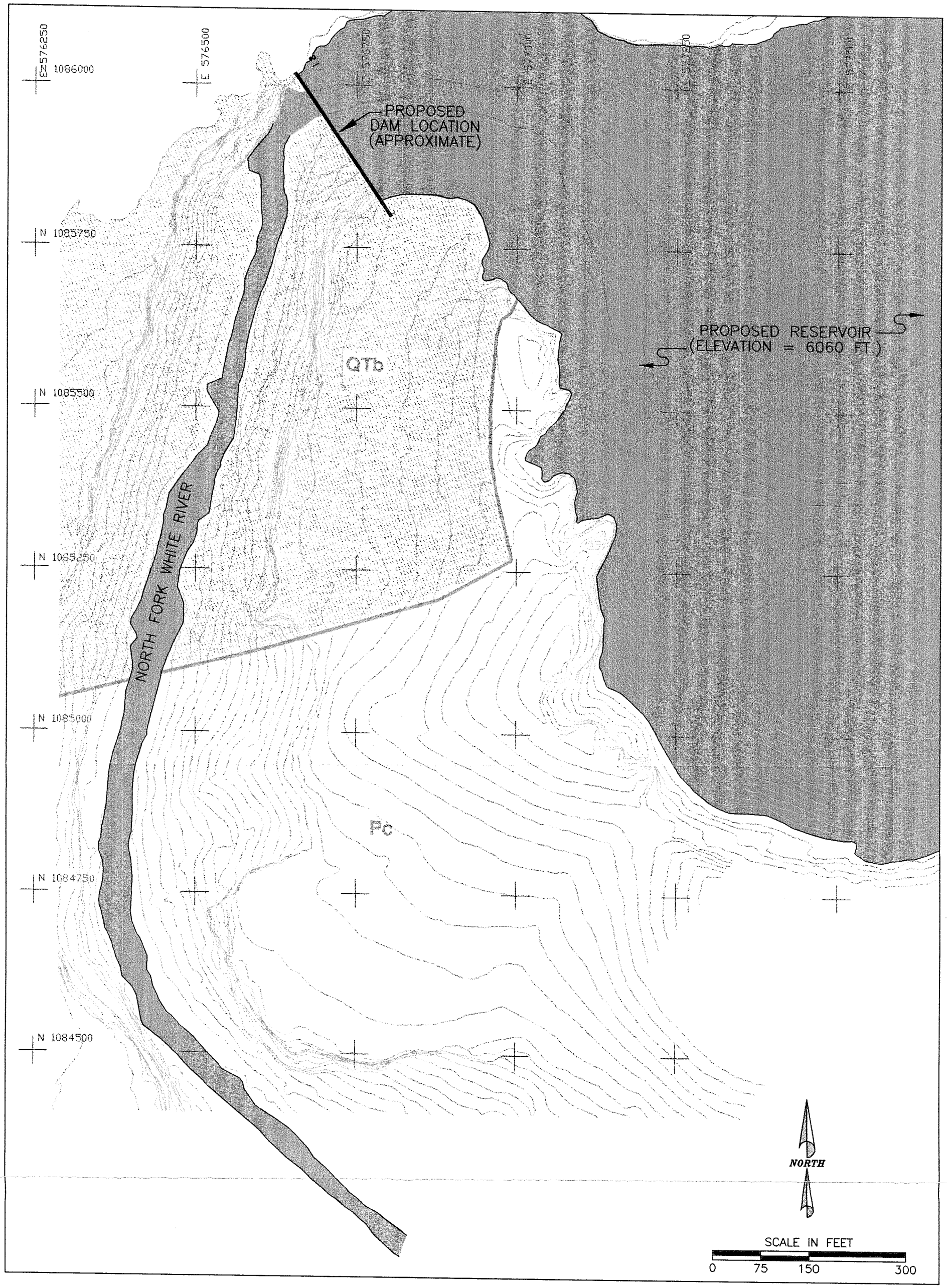
Figure 7
Histogram
Hydraulic Conductivity Values
Quaternary Basalt



Job No / Dwg No: 943-2769 / b022
Last Update: 09:24a 28-Apr-97



CLIENT/PROJECT MORRISON-MAIERLE / CSSA MINER FLAT DAM			Golder Associates Denver, Colorado			TITLE SEEPAGE ANALYSIS MODEL DEFINITION	
DRAWN KAW	CHECKED BCJ	REVIEWED CHR	DATE APRIL 1997	SCALE AS SHOWN	FILE NO. 2769B022	JOB NO. 943-2769	DWG NO./REV.NO. B022	FIGURE 8



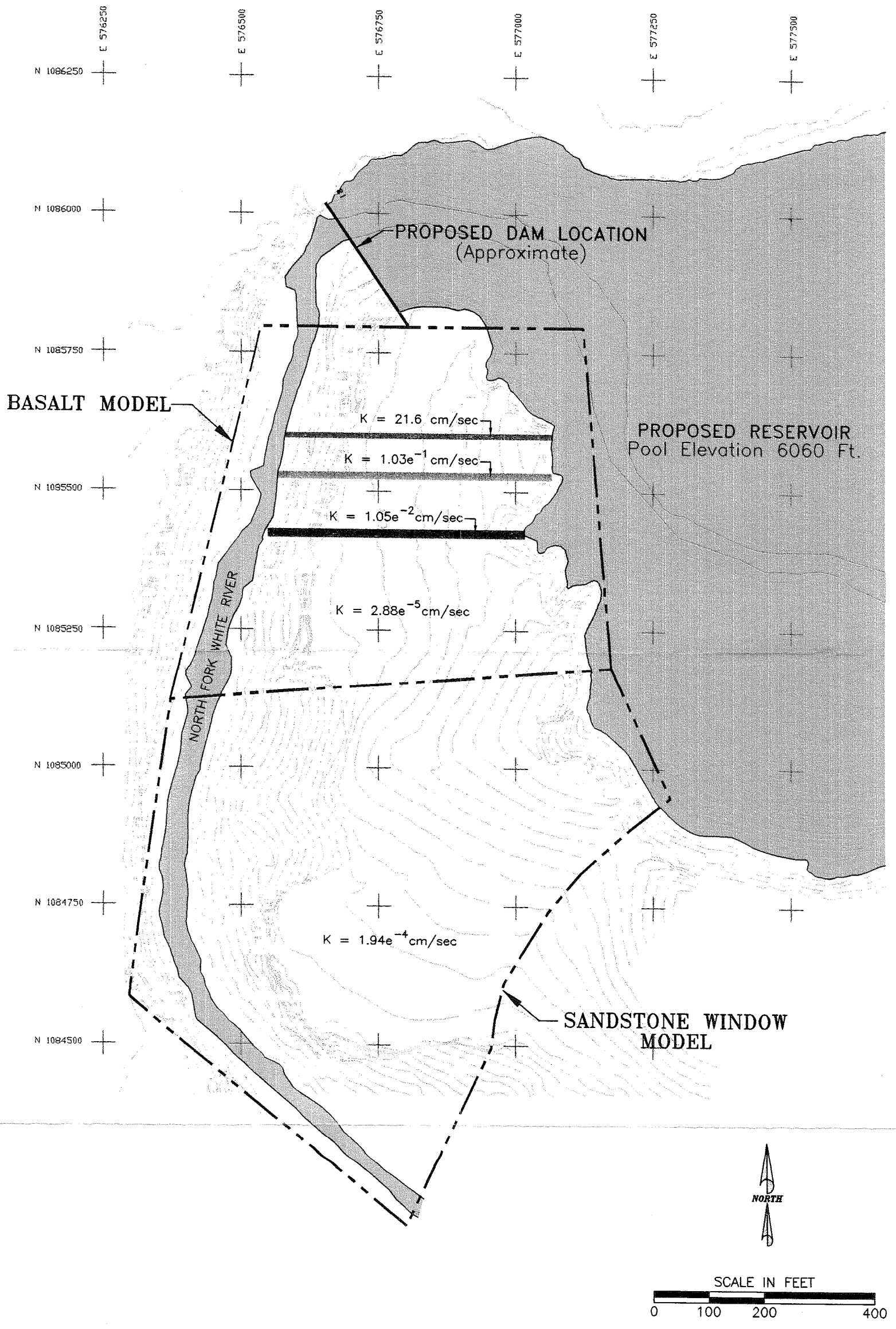
EXPLANATION

QTb – QUATERNARY BASALT

Pc – COCONINO FORMATION

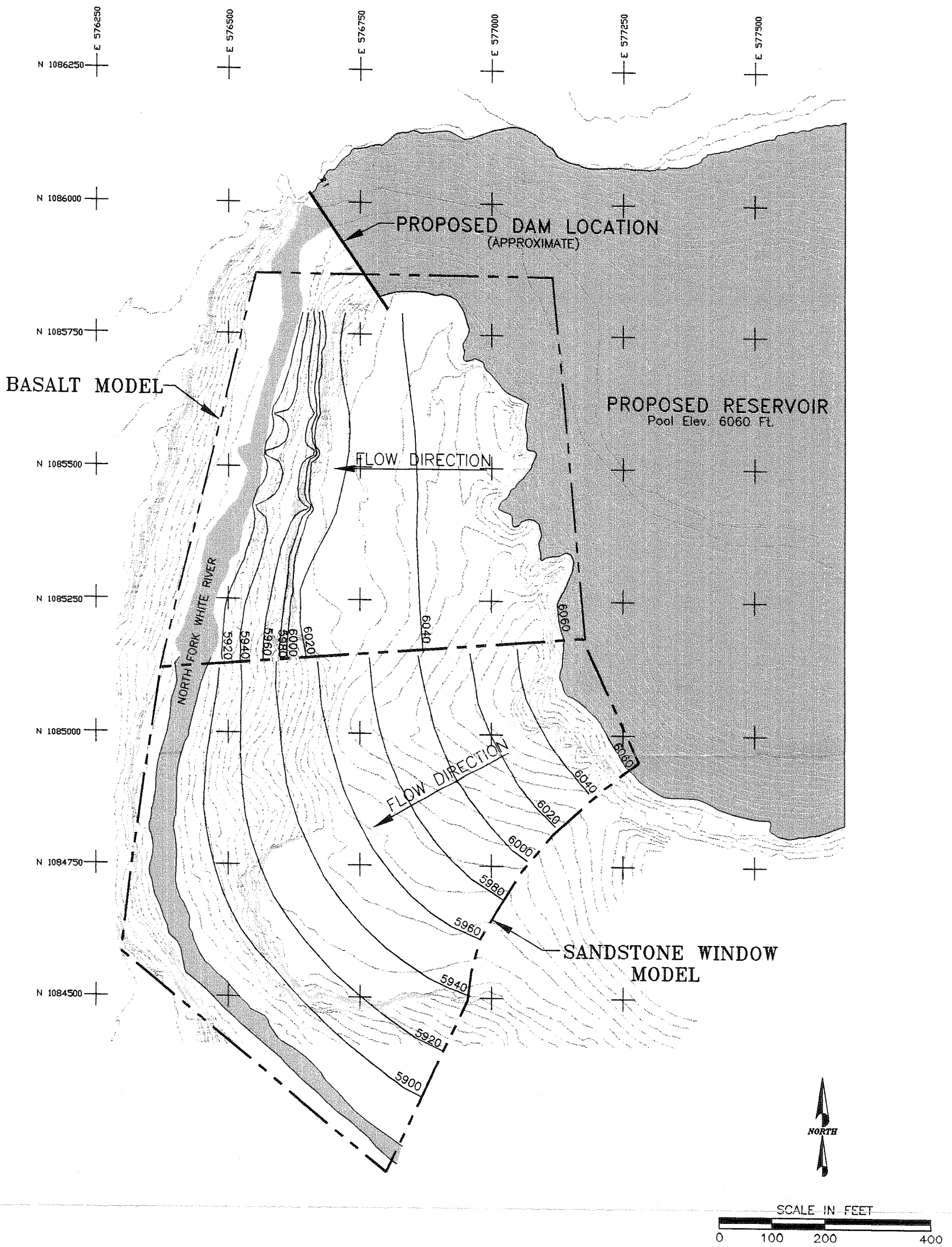
CLIENT/PROJECT: MORRISON-MAIERLE / CSSA MINER FLAT DAM			Golder Associates Denver, Colorado			TITLE: GENERALIZED GEOLOGY MAP	
DRAWN: KAW	CHECKED: BCJ	REVIEWED: CHR	DATE: APRIL 1997	SCALE: AS SHOWN	FILE NO.: 2769B021	JOB NO.: 943-2769	DWG NO./REV.NO.: B021	FIGURE: 9

Job No / Dwg No: 943-2769 / b023
Last Update: 09:26a 28-Apr-97

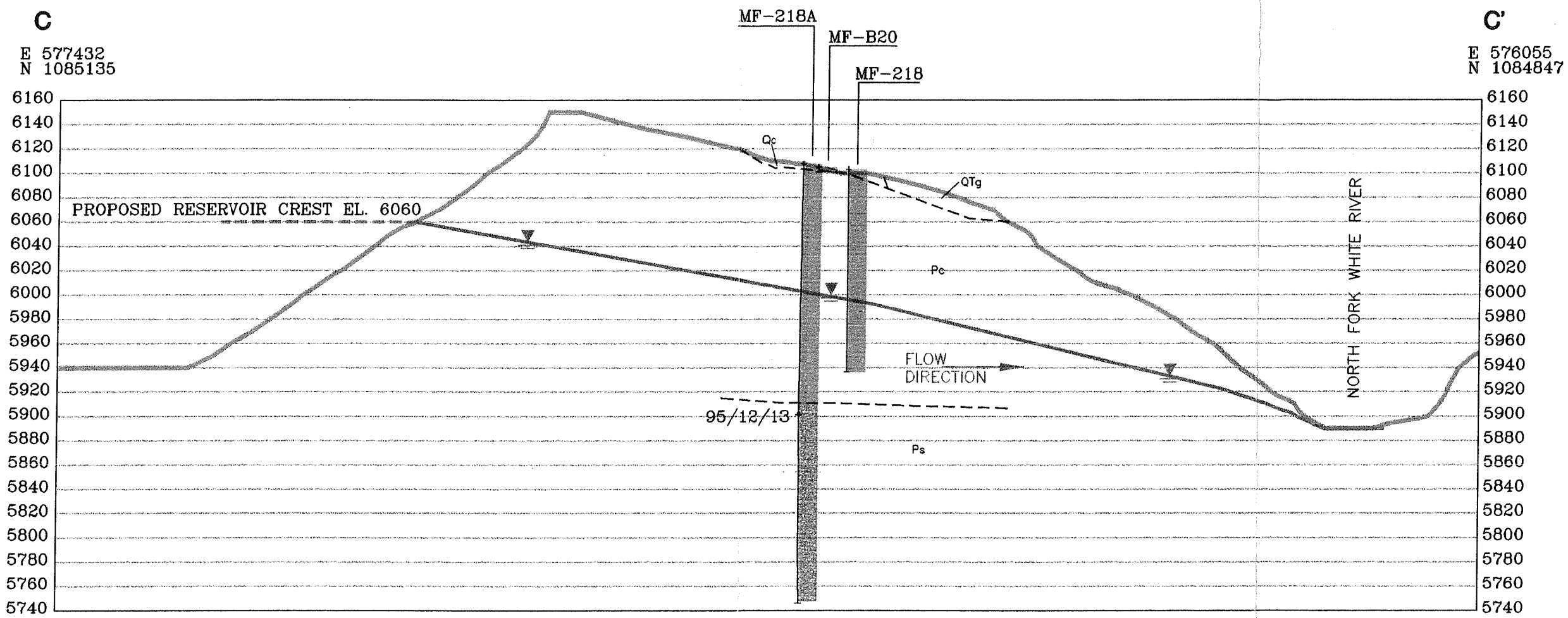


CLIENT/PROJECT MORRISON-MAIERLE / CSSA MINER FLAT DAM			Golder Associates Denver, Colorado			TITLE SEEPAGE ANALYSIS MODEL INPUT	
DRAWN KAW	CHECKED BCJ	REVIEWED CHR	DATE APRIL 1997	SCALE AS SHOWN	FILE NO. 2769B023	JOB NO. 943-2769	DWG NO./REV.NO. B023	FIGURE 10

Job No / Dwg No: 943-2769 / b024
Last Update: 09:27a 28-Apr-97



CLIENT/PROJECT MORRISON-MAIERLE / CSSA MINER FLAT DAM			Golder Associates Denver, Colorado			TITLE SEEPAGE ANALYSIS MODEL OUTPUT	
DRAWN KAW	CHECKED BCJ	REVIEWED CHR	DATE APRIL 1997	SCALE AS SHOWN	FILE NO. 2769B024	JOB NO. 943-2769	DWG NO./REV.NO. B024	FIGURE 11



EXPLANATION

BOREHOLE COLLAR LOCATIONS

MF-B26	PERCUSSION HAMMER BOREHOLE (APPROXIMATELY LOCATED)
BA-3	PERCUSSION HAMMER BOREHOLE
BC-4	PERCUSSION HAMMER BOREHOLE
DH-14	COREHOLE
MF-102	COREHOLE

95/12/13	WATER LEVEL MEASURED DEC. 13, 1995
	PIEZOMETRIC SURFACE
Qc/QTg/Tal	QUATERNARY COLLUVIUM, QUATERNARY-TERTIARY GRAVEL, TERTIARY ALLUVIUM
QTb	QUATERNARY TERTIARY BASALT
Pc	COCONINO FORMATION
Ps	SUPAI GROUP

SCALE IN FEET
0 100 200 400

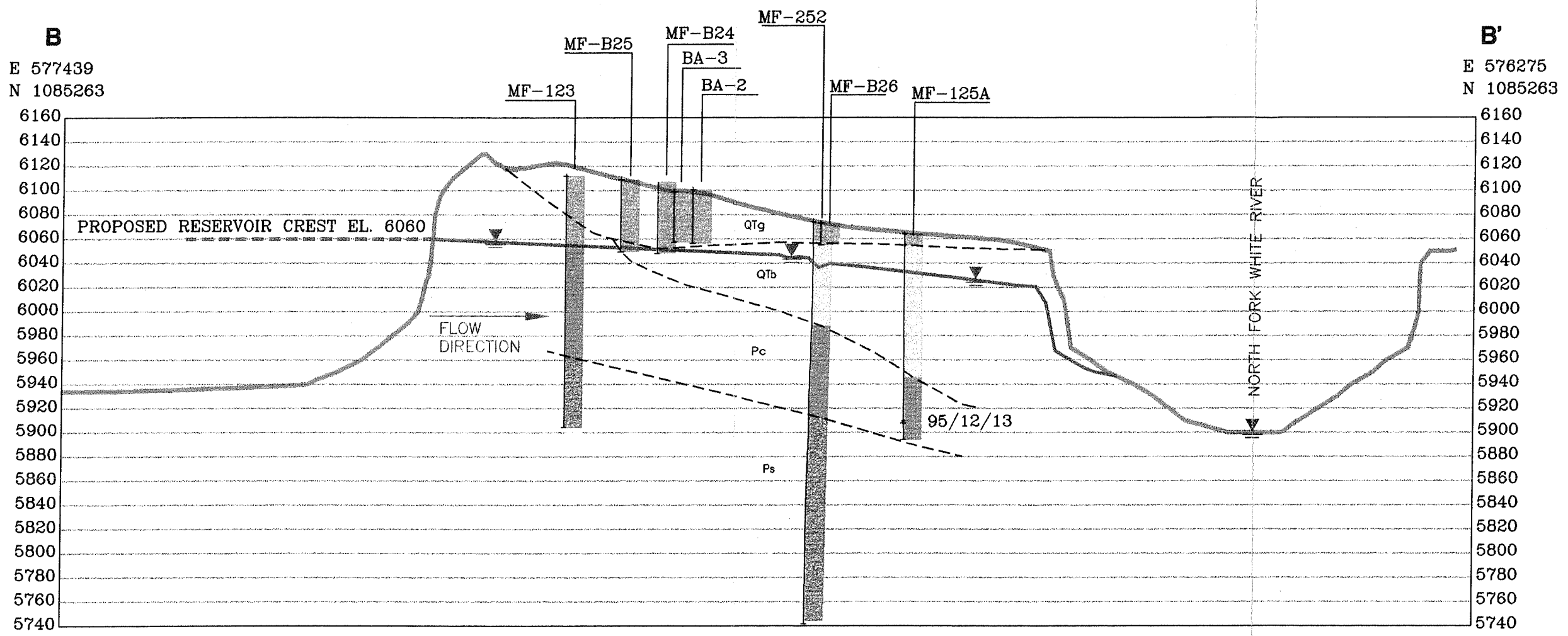
Golder Associates

CLIENT/PROJECT
MORRISON-MAIERLE / CSSA
MINER FLAT DAM

TITLE
SANDSTONE WINDOW MODEL
ESTIMATED STEADY-STATE GROUND-WATER LEVEL CROSS-SECTION

DRAWN	KAW	DATE	APRIL 1997	JOB NO.	943-2769
CHECKED	BCJ	SCALE	AS SHOWN	DWG. NO./REV. NO.	B018
REVIEWED	CHR	FILE NO.	2769B018	FIGURE NO.	12

Job No./ Dwg No: 943-2769 / b018
Last Update: 09:20a 28-Apr-97



EXPLANATION

BOREHOLE COLLAR LOCATIONS

MF-B26	PERCUSSION HAMMER BOREHOLE (APPROXIMATELY LOCATED)
BA-3	PERCUSSION HAMMER BOREHOLE
BC-4	PERCUSSION HAMMER BOREHOLE
DH-14	COREHOLE
MF-102	COREHOLE

95/12/13	WATER LEVEL MEASURED DEC. 13, 1995
	PIEZOMETRIC SURFACE
Qc/QTg/Tal	QUATERNARY COLLUVIUM, QUATERNARY-TERTIARY GRAVEL, TERTIARY ALLUVIUM
QTb	QUATERNARY TERTIARY BASALT
Pc	COCONINO FORMATION
Ps	SUPAI GROUP

SCALE IN FEET
0 100 200 400

Golder Associates

CLIENT/PROJECT
MORRISON-MAIERLE / CSSA
MINER FLAT DAM

TITLE
BASALT MODEL
ESTIMATED STEADY-STATE GROUND-WATER LEVEL CROSS-SECTION

DRAWN	KAW	DATE	APRIL 1997	JOB NO.	943-2769
CHECKED	BCJ	SCALE	AS SHOWN	DWG. NO./REV. NO.	B015
REVIEWED	CHR	FILE NO.	2769B015	FIGURE NO.	13

Job No / Dwg No: 943-2769 / b015
Last Update: 09:10a 28-Apr-97

APPENDIX A

BOREHOLE LOGS

EXPLANATION

DEPTH: The depth of the borehole at the end of each core run.

WEATHERING/ ALTERATION: A two letter code recording the type and intensity of the rock mass weathering or alteration.
The result of chemical weathering is decomposition of minerals.
Mechanical weathering results in the deterioration of the rock mass

	Type	
W	Weathering	The susceptibility of the rock or mineral to weathering
A	Argillic	Pertaining to clay or clay minerals
Q	Silicification	The introduction of, or replacement by, silica
B	Calcareous	Contains calcium carbonate

	Intensity	
F	Fresh	No visible sign of rock material weathering
S	Slightly	Discoloration indicates weathering of rock material and discontinuity surfaces.
M	Moderately	Less than half of the rock material is decomposed and/or disintegrated to a soil.
H	Highly	More than half of the rock material is decomposed and/or disintegrated to a soil.

ROCK TYPE: A six letter code recording; Rock type, Major minerals, Grain size, and Texture, bedding or sorting.

Type (First 2 letters)		Minerals (Second 2 letters)		Grain Size		Texture	
SS	Sandstone	N	None	A	Aphanitic	V	Vesicular
SI	Siltstone	V	Olivine	B	Boulder	M	Massive
SM	Silty Sandstone	Q	Quartz	C	Cobble	A	Aphanitic
BA	Basalt	B	Biotite	G	Gravel	P	Porphyrtic
GY	Gypsum	K	Potassium Feldspar	V	Very Fine	B	Bedded
		H	Hornblende	F	Fine	T	Thinly Bedded
		S	Sand	M	Medium	L	Laminated
		M	Silt	R	Coarse	R	Brecciated
		G	Gypsum	P	V.coarse	S	Scoracious
		C	Clay			X	Cross Bedded
		F	Iron				

RECOVERY: The length of core recovered from each run. Expressed as length times 100.
Blank entries reflect no recovery for that interval.

RQD: A quantitative index based on a core recovery procedure that is measured as the combined length of core greater than 2 times the diameter; expressed as the length times 100

Project	Miner Flat Dam Geotechnical Investigation - Phase I	Northing	1085626.0	Drilling Method	HQ Split Tube Core	Project #	943-27691 Task 120	Page	
Location	Sandstone Ridge	Easting	576826.4	Drilling Contractor	Golden Drilling	Logged By	L.Bush/C.Robinson	Borehole	MF-250
		Elevation	6079.2	Inclination	90	Date Started	6/2/95		
						Date Completed	6/19/95		

Depth	Weathering Alteration	Rock Description					Recovery	RQD	Recovery %	RQD %	Fractures per foot rec.	Total Fractures	General Comments
		Type	Mineral	Gr Size	Texture	Color							
11.8		OB											
18.5	WS	BA	VQ	AF	V	N3	305	305	45.5	45.5	1.6	11	
22.6	WS	BA	VQ	AV	V	N3	387	387	94.4	94.4	2.4	10	
27.6	WS	BA	P	AF	VM	N3	470	470	94.0	94.0	1.8	9	Vescular to massive
32.6	WS	BA	P	AF	MV	N3	260	260	52.0	52.0	0.8	4	massive to vescular
33.6	WS	BA	P	AF	V	N3	100	100	100.0	100.0	5.0	5	
38.5	WS	BA	VP	AF	V	N3	435	435	88.8	88.8	1.8	9	
41.2	WS	BA	P	AF	V	N3	250	250	92.6	92.6	4.1	11	
46.2	WS	BA	PQ	AF	V	N3	510	510	102.0	102.0	1.6	8	
51.2	WF	BA	VP	AF	MV	N3	500	500	100.0	100.0	1.0	5	
56.2	WF	BA	VQ	AF	M	N3	500	500	100.0	100.0	0.4	2	
61.2	WS	BA	V	AF	M	N3	485	485	97.0	97.0	1.8	9	some joints fresh
66.2	WF	BA	VQ	AF	M	N3	492	492	98.4	98.4	0.8	4	
71.2	WF	BA	VP	AF	M	N3	500	500	100.0	100.0	1.2	6	
76.2	WS	BA	VP	AF	MV	N3	460	460	92.0	92.0	1.4	7	fresh to 73.2
81.2	WS	BA	VP	AF	MV	5R6/2	494	494	98.8	98.8	2.2	11	
86.2	WS	BA	VP	AF	V	N3	500	500	100.0	100.0	1.4	7	
91.3	WS	BA	VP	AF	V	N3	503	503	98.6	98.6	1.2	6	
96.3	WF	BA	VP	AF	M	N3	481	481	96.2	96.2	0.8	4	
101.3	WF	BA	VP	AF	M	N3	510	510	102.0	102.0	0.2	1	
106.3	WS	BA	VP	AF	S	N3	500	500	100.0	100.0	1.6	8	
111.3	WS	BA	V	AF	S	N3	310	310	62.0	62.0	1.2	6	highly fractured 106.7-108.6
116.3	WF		Q	V		10R6/6	150	150	30.0	30.0	0.0	0	Basalt/sandstone contact at 109.3
118.3	WF		Q	V		10R6/6	50	50	25.0	25.0	0.0	0	No Recovery
120.8							0	0	0.0	0.0	0.0	0	No Recovery
121.5							0	0	0.0	0.0	0.0	0	No Recovery
124.6							15					0	
127.7	WF	SS	Q	V		5YR7/2	180	180	58.1	58.1	0.0	0	
131.2	WF	SS	Q	V		5YR7/1	180	180	51.4	51.4	0.0	0	
131.9	WF	SS	Q	V		10R5/4	35	35	50.0	50.0	2.9	2	
137.0	WF	SS	Q	V	X	10R5/4	360	360	70.6	70.6	2.2	11	
140.0	WF	SS	Q	V		10R5/4	312	312	104.0	104.0	4.7	14	
147.1	WF	SS	Q	V	X	10R5/4	190	190	26.8	26.8	0.6	4	
152.1	WF	SS	Q	V	X	10R5/4	470	470	94.0	94.0	3.8	19	
157.2	WF	SS	Q	V	B	10R6/6	436	436	85.5	85.5	2.4	12	
162.1	WF	SS	Q	V	B	10R6/6	110	110	22.4	22.4	0.8	4	
167.1	WF	SS	Q	V	B	10R6/6	230	230	46.0	46.0	2.8	14	
172.1	WF	SS	Q	V	XB	10R4/6	315	315	63.0	63.0	3.2	16	
177.1	WF	SS	Q	V	XB	10R4/6	260	260	52.0	52.0	3.0	15	Pc/Ps contact @177.1
182.1	WF	SS	QM	V	B	10R4/6	165	165	33.0	33.0	2.0	10	
186.0	WF	SS	QM	V	B	10R4/6	320	320	82.1	82.1	3.1	12	Siltier @ 184
191.1	WF	SS	QM	V	B	10R4/6	420	420	82.4	82.4	2.5	13	Sandy @ 187
196.1	WF	SS	Q	V	B	10R4/6	450	450	90.0	90.0	1.6	8	
201.2	WF	SS	Q	V	BL	10R4/6	376	376	73.7	73.7	2.4	12	Silty & laminated
206.2	WF	SS	Q	V	B	10R4/6	350	350	70.0	70.0	1.8	9	Highly fractured 203-205
211.7	WF	SS	QM	V	B	10R4/6	270	270	49.1	49.1	0.0	0	
216.2	WF	SI	QM	V	B	10R4/6	430	430	95.6	95.6	2.2	10	
221.2	WF	SI	QM	V	B	10R4/6	492	492	98.4	98.4	1.2	6	
226.3	WF	SS	Q	V	B	10R4/6	200	200	39.2	39.2	1.8	8	Highly fractured
231.3	WF	SS	Q	V		10R4/6	10	10	2.0	2.0	0.0	0	No Recovery
233.3	WF	SS	QM	V		10YR7/1	20	20	10.0	10.0	0.0	0	
237.5	WF	SI	QM	V	MB	10R4/6	341	341	81.2	81.2	0.2	1	
242.6	WF	SI	QM	V	M	10R4/6	525	525	102.9	102.9	1.4	7	
247.5	WF	SS	QM	VF	M	10YR8/6	410	410	83.7	83.7	0.8	4	Calcite filled fracture @15 degrees
248.1	WF	CS	MC	MC	BX	10YR6/6	4	4	6.7	6.7	0.0	0	
251.1	WF	SI	MC	MC	BX	10R3/4	286	286	95.3	95.3	0.7	2	
256.1	WF	SS	QM	VF	M	10R4/6	450	450	90.0	90.0	0.8	4	
260.5	WF	SS	QM	VF	M	10R4/6	75	75	17.0	17.0	0.0	0	Mislatch
262.5	WF	SS	QM	VF	BX	10R4/6	200	200	100.0	100.0	1.5	3	
267.5	WF	SS	QM	VF	BX	10R4/6	475	475	95.0	95.0	1.4	7	
272.5	WF	SS	QM	VF	BX	10R4/6	497	497	99.4	99.4	2.6	13	
277.5	WF	SM	QM	V	BX	10R4/6	500	500	100.0	100.0	0.6	3	
282.5	WF	SM	QM	V	BX	10R4/6	500	500	100.0	100.0	1.0	5	
287.5	WF	SM	QM	V	BX	10R4/6	376	376	75.2	75.2	0.6	3	
291.5	WF	SI	MC	VF	BX	N6	364	364	91.0	91.0	0.5	2	
296.5	WF	SM	MC	VF	BX	N6	420	420	84.0	84.0	2.2	11	
301.5	WF	SM	CS	VF	BX	N6	515	515	103.0	103.0	1.4	7	
305.1	WF	SM	CS	VF	BX	N6	360	360	100.0	100.0	1.1	4	
310.0							0	0	0.0	0.0	0.0	0	Rods dropped 4.9'
312.5	WF	SM	CS	VF	BX	N6	285	285	114.0	114.0	0.4	1	
317.5	WC	CL	GM			N6	490	490	98.0	98.0	0.0	0	Clay w/ 2.5' limestone boulder
322.3	WC	CL	SC	BV		N6	345	345	71.9	71.9	0.0	0	Gypsum @ 322.6'
327.3	WF	GY	GC	AV	M	N7	490	490	98.0	98.0	1.0	5	
331.3	WF	GY	GC	AV	M	N7	405	405	101.3	101.3	0.0	0	
eoh													End of Hole

Project	Miner Flat Dam Geotechnical Investigation - Phase I	Northing	1085586.0	Drilling Method	HQ Split Tube Core	Project #	943-27691 Task 120	Page				
Location	Sandstone Ridge	Easting	576823.1	Drilling Contractor	Golden Drilling	Logged By	D.Alloway	Borehole	MF-250A			
		Elevation	6079.2	Inclination	90	Date Started	8/29/95					
						Date Completed	8/30/95					

	Weathering	Rock Description											
Depth	Alteration	Type	Mineral	Gr.Size	Texture	Color	Recovery	RQD	Recovery %	RQD %	Fractures per foot rec.	Total Fractures	General Comments
8.7													
12.3	WF	BA	QV	AV	V	N3	340	269	94.4	74.7	0.8	3	
17.3	WS	BA	QV	AV	V	N3	463	283	92.6	56.6	2.4	12	
22.3	WS	BA	QV	VF	V	N3	452	345	90.4	69.0	1.6	8	
27.3	WS	BA	QV	VF	V	N3	429	208	85.8	41.6	0.8	4	
31.3	WS	BA	QV	AV	V	N3	291	100	72.8	25.0	2.3	9	
36.3	WS	BA	QV	AF	V	N3	508	311	101.6	62.2	1.6	8	
41.3	WS	BA	QV	AF	V	N3	500	349	100.0	69.8	1.8	9	
46.3	WF	BA	QV	AF	V	N3	500	422	100.0	84.4	1.6	8	
51.3	WF	BA	QV	AF	V	N3	500	420	100.0	84.0	1.2	6	
56.4	WF	BA	QV	AF	M	N4	515	444	101.0	87.1	0.8	4	
61.5	WF	BA	QV	AF	M	N4	500	335	98.0	65.7	2.0	10	
66.5	WF	BA	QV	AF	M	N4	484	330	96.8	66.0	0.4	2	
71.5	WF	BA	QV	AF	M	N4	508	318	101.6	63.6	0.4	2	
76.5	WS	BA	QV	AF	V	N4	500	126	100.0	25.2	2.4	12	
81.5	WS	BA	QV	AF	V	N4	491	114	98.2	22.8	2.2	11	
86.5	WM	BA	QV	AF	V	N4	507	300	101.4	60.0	2.0	10	

Project	Miner Flat Dam Geotechnical Investigation - Phase I	Northing	1085422.0	Drilling Method	HQ Split Tube Core	Project #	943-27691 Task 120	Page	
Location	Sandstone Ridge	Easting	576870.9	Drilling Contractor	Golden Drilling	Logged By	L.Bush/C.Robinson	Borehole	MF-251
		Elevation	6089.0	Inclination	90	Date Started	6/30/95		
						Date Completed	7/23/95		

Depth	Weathering Alteration	Rock Description					Recovery	RQD	Recovery %	RQD %	Fractures per foot rec.	Total Fractures	General Comments
		Type	Mineral	Gr.Size	Texture	Color							
30.0													
31.5	WF	BA	VQ	FA	AV	N6	150	100	100.0	66.7	2.0	3.0	
36.5	WF	BA	VQ	FA	AM	N6	500	450	100.0	90.0	0.4	2.0	
41.6	WF	BA	VQ	FA	AM	N5	510	390	100.0	76.5	1.0	5.0	
45.9	WM	BA	VQ	AF	AV	5Y4/4	429	227	99.8	52.8	1.6	7.0	Clay filled fractures
50.9	WS	BA	VQ	AF	AV	N4	498	255	99.6	51.0	1.4	7.0	Clay filled fractures
55.9	WS	BA	VQ	AF	AV	N4	506	255	101.2	51.0	1.0	5.0	5-20 degree clay filled fracture
60.9	WS	BA	VQ	AF	AV	N4	459	362	91.8	72.4	0.8	4.0	Clay zone at 58 ft
65.9	WF	BA	VQ	AF	AV	N4	500	500	100.0	100.0	0.8	4.0	90 deg clay filled fracture
70.9	WF	BA	VQ	AF	AV	N4	480	420	96.0	84.0	0.6	3.0	
75.9	WS	BA	VQ	AF	AV	5YR4/1	500	220	100.0	44.0	3.2	16.0	
80.9	WS	SS	Q	V	B	10R7/4	250	65	50.0	13.0	2.0	10.0	CONTACT basalt/sandstone
84.4	WS	SS	Q	V	M	10R6/6	120	50	34.3	14.3	2.3	8.0	
89.4	WS	SS	Q	V	M	10R4/6	420	50	84.0	10.0	3.8	19.0	
92.3	WH	SS	Q	F	M	5YR5/6	274	83	94.5	28.6	0.7	2.0	Very friable
97.3	WH	SS	Q	F	M	10R4/6	500	234	100.0	46.8	1.4	7.0	Very friable
102.3	WH	SS	Q	VF	M	10R3/4	498	290	99.6	58.0	1.0	5.0	Very friable
107.4	WM	SS	Q	FM	B	10YR6/6	465	218	91.2	42.7	1.8	9.0	
112.4	WM	SS	Q	FV	B	10R3/4	490	217	98.0	43.4	1.6	8.0	
117.4	WH	SS	Q	F	B	5YR3/4	486	0	97.2	0.0	1.2	6.0	Very friable
122.4	WH	SS	Q	F	B	5YR3/4	479	0	95.8	0.0	1.4	7.0	Very friable
127.4	WH	SS	Q	FV	B	5YR3/4	500	0	100.0	0.0	0.4	2.0	Very friable
132.4	WH	SS	Q	FV	B	5YR4/4	498	212	99.6	42.4	0.6	3.0	Very friable
137.4	WS	SS	Q	F	B	10R4/6	509	333	101.8	66.6	1.0	5.0	Very friable
142.4	WM	SS	Q	F	B	10R4/6	490	198	98.0	39.6	0.8	4.0	
147.4	WS	SS	Q	F	B	10R5/4	510	194	102.0	38.8	1.6	8.0	
152.4	WH	SS	Q	F	B	10R5/4	494	94	98.8	18.8	0.2	1.0	Very friable
157.4	WM	SS	Q	F	B	10R5/4	500	348	100.0	69.6	1.8	9.0	
162.4	WM	SS	Q	F	B	10R5/4	495	175	99.0	35.0	1.4	7.0	
167.4	WM	SS	Q	F	B	5YR5/6	500	159	100.0	31.8	2.4	12.0	Clay filled fracture @ 167
172.4	WM	SS	Q	F	X	10YR6/6	474	306	94.8	61.2	1.6	8.0	Pc/Ps contact
177.4	WM	SS	Q	F	X	10R4/6	505	140	101.0	28.0	1.4	7.0	
182.4	WM	SS	Q	F	B	10R4/6	491	451	98.2	90.2	0.8	4.0	
187.4	WM	SS	Q	F	B	10R4/6	504	294	100.8	58.8	1.4	7.0	
192.4	WM	SS	Q	F	B	10R4/6	498	430	99.6	86.0	0.6	3.0	
197.4	WH	SS	Q	F	B	10R4/6	478	161	95.6	32.2	0.4	2.0	Very friable zones
202.4	WH	SS	Q	F	B	10R4/6	500	0	100.0	0.0	0.2	1.0	Very little cement
207.4	WH	SS	Q	F	B	10R4/6	500	100	100.0	20.0	0.4	2.0	
211.2	WF	SM	MQ	VF	M	10R4/6	442	442	116.3	116.3	0.0	0.0	
215.8	WF	SM	MQ	VF	M	10R4/6	482	482	104.8	104.8	0.0	0.0	No nat. fractures
220.7	WF	SS	MQ	VF	M	10R4/6	487	487	99.4	99.4	0.0	0.0	No nat. fractures
225.0	WF	SS	MQ	VF	MB	10R4/6	491	346	114.2	80.5	1.4	6.0	SM to 223 R1 to 223
229.8	WF	SS	Q	VF	B	10R5/4	475	175	99.0	36.5	1.3	6.0	no fract. in SM then R2
234.0	WF	SM	Q	VF	M	10R5/4	320	42	76.2	10.0	1.7	7.0	
238.8	WF	SM	MQ	VF	M	10R5/4	407	65	84.8	13.5	1.3	6.0	
243.6	WF	SS	MQ	VF	BM	10R5/4	475	260	99.0	54.2	1.5	7.0	
248.3	WF	SS	Q	VF	BM	10R5/4	450	210	95.7	44.7	1.7	8.0	
253.0	WF	SS	Q	VF	M	10R5/4	444	312	94.5	66.4	0.4	2.0	
257.9							0		0.0	0.0	0.0	0.0	No recovery
259.1							0		0.0	0.0	0.0	0.0	No recovery
263.7	WF	CS	CM	V	M	10R5/4	453	310	98.5	67.4	0.7	3.0	
268.2	WF	SI	QM	V	BX	10R4/6	451	451	100.2	100.2	0.0	0.0	
273.0	WF	SI	QM	V	BX	10R4/6	480	395	100.0	82.3	0.8	4.0	
278.0	WF	SI	QM	V	BX	10R4/6	500	315	100.0	63.0	1.0	5.0	Silt like @ 276-277
283.1	WF	SI	QM	V	BX	10R4/6	455	455	89.2	89.2	0.4	2.0	
287.9	WF	SI	QM	V	BX	10R4/6	455	430	94.8	89.6	0.2	1.0	
292.8	WF	SI	QM	V	BX	10R4/6	260	205	53.1	41.8	0.4	2.0	
295.7	WF	SI	QM	V	BX	10R4/6	480	480	165.5	165.5	0.0	0.0	Pick up lost core
300.7	WF	SI	MQ	VF	BX	10R4/6	510	510	102.0	102.0	0.0	0.0	No nat. fractures
305.6	WF	SI	MQ	V	BX	10R4/6	490	490	100.0	100.0	0.0	0.0	No nat. fractures
310.6	WF	SI	MQ	V	BX	5Y6/4	475	475	95.0	95.0	0.2	1.0	
315.3	WF	CS	MC	A	BX	N5	485	485	103.2	103.2	0.0	0.0	
320.6	WF	CS	MC	A	BX	N5	258	232	48.7	43.8	0.4	2.0	
325.7	WF	SS	CQ	V	BX	N6	210	160	41.2	31.4	0.0	0.0	3/4" gravel 320-323
326.9	WF	SS	MQ	V	BX	5Y7/6	150	150	125.0	125.0	0.8	1.0	Black soot-like dust on barrel
332.0	WF	SS	CQ	V	BX	N6	400	400	78.4	78.4	0.2	1.0	
336.8	WF	MI	MQ	V	BX	10R4/6	405	330	84.4	68.7	0.8	4.0	
340.7	WF	MI	MQ	V	BX	10R4/6	445	445	114.1	114.1	0.5	2.0	End of hole

Project	Miner Flat Dam Geotechnical Investigation - Phase I	Northing	1085422.0	Drilling Method	HQ Split Tube Core	Project #	943-27691 Task 120	Page	
Location	Sandstone Ridge	Easting	576870.9	Drilling Contractor	Golden Drilling	Logged By	L.Bush/D.Alloway	Borehole	MF-252
		Elevation	6089.0	Inclination	90	Date Started	6/15/95		
						Date Completed	8/2/95		

Depth	Weathering Alteration	Rock Description Type	Mineral	Gr.Size	Texture	Color	Recovery	RQD	Recovery %	RQD %	Fractures per foot rec.	Total Fractures	General Comments
19.5													
21.0	WS	BA	PV	A	V	N4	149	50	99.3	33.3	4	18	
26.0	WF	BA	PV	A	M	N3	500	480	100.0	96.0	4	8	
31.0	WF	BA	PV	A	M	N3	500	452	100.0	90.4	4	6	
36.0	WS	BA	PV	A	V	N3	475	183	95.0	36.6	11	26	
41.0	WS	BA	PV	A	V	N3	455	110	91.0	22.0	12	30	
46.0	WF	BA	PV	A	V	N3	500	355	100.0	71.0	5	30	
51.0	WF	BA	PV	A	MV	N3	500	440	100.0	88.0	2	16	
56.0	WF	BA	PV	A	M	N3	470	215	94.0	43.0	7	26	
61.0	WF	BA	PV	A	M	N3	498	498	99.6	99.6	1	8	V. Little clay in fractures
66.0	WF	BA	PV	A	M	N3	500	333	100.0	66.6	7	14	
71.0	WF	BA	PV	A	M	N3	495	385	99.0	77.0	2	14	
76.0	WF	BA	PV	A	M	N3	500	390	100.0	78.0	5	8	@55, v. little clay
81.0	WF	BA	PV	A	M	N3	500	185	100.0	37.0	11	28	
86.0	WF	BA	PV	A	M	N3	494	400	98.8	80.0	3	14	CONTACT basalt/sandstone
91.0	WF	SS	Q	VF	B	10R6/6	210	0	42.0	0.0	0	0	
96.0	WF	SS	CQ	VF	B	10R6/6	320	42	64.0	8.4	4	8	Gravelly
101.0	WF	SS	CQ	VF	B	10R6/6	320	0	64.0	0.0	8	12	Highly fractured w/ clay
106.0	WF	SS	Q	VF	B	10R8/2	480	175	96.0	35.0	15	22	
111.0	WF	SS	Q	VF	B	10YR8/2	496	180	99.2	36.0	3	4	Highly fractured
116.0	WS	SS	Q	VF	B	10YR7/4	500	0	100.0	0.0	15	12	Highly fractured
121.0	WS	SS	Q	VF	B	10YR7/4	390	0	78.0	0.0	29	28	Highly fractured
122.6	WS	SS	Q	VF	B	10YR7/4	140	0	87.5	0.0	4	16	Highly fractured
127.6	WF	SS	Q	VF	B	10YR7/4	480	50	96.0	10.0	8	14	
132.6	WF	SS	Q	VF	B	10YR8/2	480	90	96.0	18.0	11	20	
137.6	WS	SS	Q	VF	SO	10R5/4	325	0	65.0	0.0	3	6	Uncemented, soil like
142.6	WS	SS	QC	VF	SO	10R5/4	355	0	71.0	0.0	2	8	
146.1	WS	SS	Q	VF	SO	10R5/4	275	0	78.6	0.0	0	0	Mostly soil like
151.2	WF	SS	Q	VF	SO	10R5/4	360	0	70.6	0.0	4	6	
156.3	WF	SS	Q	F	BD	10R6/6	436	58	85.5	11.4	10	20	
161.5	WS	SS	Q	FV	BD	10R6/6	370	0	71.2	0.0	10	20	Pc/Ps contact
166.6	WF	SS	Q	FV	M	10R6/6	321	59	62.9	11.6	6	9	Very fractured
171.7	WS	SS	Q	FV	M	10R6/6	285	0	55.9	0.0	0	0	Very fractured many orientations
176.8	WS	SM	QM	FV	BD	10R4/6	200	50	39.2	9.8	0	0	Very fractured many orientations
181.0	WS	SM	QM	F	BD	10R4/6	162	0	38.6	0.0	0	0	Very fractured many orientations
187.0	WF	SS	Q	F	BD	10R6/6	231	0	38.5	0.0	4	9	Very fractured many orientations
192.0	WS	SS	Q	F	M	10YR10/7	294	0	58.8	0.0	2	5	Very fractured clay @ 192
197.0	WF	SS	Q	F	BD	10R4/6	504	163	100.8	32.6	6	11	
202.0	WS	SS	Q	F	BD	10R4/6	509	345	101.8	69.0	3	4	
206.4	WF	SC	QC	FV	BD	10R4/6	344	189	78.2	43.0	2	10	Slipped 1' of core
211.5	WF	SC	QC	FV	BD	10R4/6	402	302	78.8	59.2	5	10	Picked up core from prev.
215.6	WF	SC	QC	FV	BD	10R4/6	500	444	122.0	108.3	5	15	
220.8	WF	SC	QC	FV	BD	10R4/6	518	457	99.6	87.9	2	8	
225.9	WF	SC	QC	F	BD	10R4/6	494	63	96.9	12.4	5	3	
231.0	WF	SC	QC	F	BD	10R4/6	512	512	100.4	100.4	0	0	No natural fractures
236.1	WF	SC	QC	F	BD	10R4/6	460	154	90.2	30.2	5	9	Slipped core
239.1	WF	SS	Q	F	BD	10R4/6	277	277	92.3	92.3	0	0	Picked up core from prev.,slipped core
242.6	WF	SC	QC	FV	BD	10R4/6	358	320	102.3	91.4	2	4	Gained 0.7' from prev., slipped 0.6'
247.4	WF	SC	QC	F	BD	10R7/4	490	294	102.1	61.2	2	7	
252.5	WF	SS	Q	FV	BD	10YR7/4	502	461	98.4	90.4	1	2	
253.8	WF	SS	Q	F	BD	10R4/6	128	61	98.5	46.9	3	9	
257.5	WF	CS	CQ	F	BD	10R4/6	420	400	113.5	108.1	1	4	
262.6	WF	SC	CQ	F	BD	10R4/6	442	442	86.7	86.7	25	0	No natural fractures, slough in hole
267.6	WF	SC	QC	F	BD	10R5/6	520	520	104.0	104.0	1	3	
272.6	WF	CS	CQ	F	BD	10R4/6	495	368	99.0	73.6	8	12	
277.7	WF	CS	CQ	F	BD	10R4/6	510	510	100.0	100.0	0	0	No natural fractures
282.6	WF	CS	CQ	VF	BD	10R4/6	495	373	101.0	76.1	6	12	
287.7	WF	CS	CQ	FV	B	10R4/6	490	440	96.1	86.3	2	6	
292.6	WF	CS	CQ	VF	B	10YR4/2	500	301	102.0	61.4	6	20	
297.7	WF	CS	CQ	F	B	10YR4/2	502	502	98.4	98.4	1	5	
302.6	WF	CM	CM	V	B	10YR4/2	505	460	103.1	93.9	4	7	
307.7	WF	CM	CM	V	B	N5	505	375	99.0	73.5	0	0	No natural fractures, clay @ 304.7-306.2
312.6	WF	MC	MC	V	B	N6	490	490	100.0	100.0	0	0	No natural fractures
317.7	WF	MC	MC	V	B	N4	504	504	98.8	98.8	0	0	No natural fractures
322.6	WF	MC	MC	V	B	N5	498	408	101.6	83.3	1	5	
327.7	WF	CM	CM	V	B	5Y4/4	500	500	98.0	98.0	0	0	No natural fractures
332.7	WF	MC	MC	V	B	5Y6/4	496	496	99.2	99.2	0	0	No natural fractures
EOH													End of Borehole

Project	Miner Flat Dam Geotechnical Investigation - Phase I	Northing	1085032.0	Drilling Method	HQ Split Tube Core	Project #	943-27691 Task 120	Page	
Location	Sandstone Ridge	Easting	576791.7	Drilling Contractor	Golden Drilling	Logged By	L.Bush/D. Allowey	Borehole	MF-218
		Elevation	6103.1	Inclination	90.0	Date Started	6/3/95		
						Date Completed	6/29/95		

Depth	Weathering Alteration	Rock Description Type	Mineral	Gr.Size	Texture	Color	Recovery	RQD	Recovery %	RQD %	Fractures per foot	Total Fractures	General Comments
8.7													
12.5	WF	SS	Q	F		10R4/6	130	0	34.2	0.0	0	0	
17.5							0	0	0.0	0.0	0	0	
21.2	WF	SS	Q	F	B	10R4/6	300	0	81.1	0.0	1	4	Highly fractured
26.2	WF	SS	Q	F	B	10R4/6	460	0	92.0	0.0	5	25	Highly fractured
26.7	WF	SS	Q	F		10R4/6	50	0	100.0	0.0	0	0	Highly fractured
31.7	WF	SS	Q	F		10R4/6	340	0	68.0	0.0	2	9	Highly fractured
33.7	WF	SS	Q	VF	B	10R4/6	168	0	84.0	0.0	0	0	
34.1	WS	SS	QC	VF	B	10R4/6	45	0	112.5	0.0	0	0	
37.5	WS	SS	QC	VF	B	10R5/4	200	0	58.8	0.0	0	0	Highly fractured
42.5	WS	SS	QC	VF	B	10R5/4	475	42	95.0	8.4	1	7	Highly fractured
47.0	WF	SS	Q	F	B	10R5/4	420	115	93.3	25.6	3	14	Highly fractured
52.0	WS	SS	Q	F	B	10R5/4	505	62	101.0	12.4	4	22	
57.0	WF	SS	QC	F	B	10R5/4	510	118	102.0	23.6	4	21	
62.0	WF	SS	Q	F	B	10R5/4	490	60	98.0	12.0	3	16	
67.0	WF	SS	Q	F	B	10R6/6	475	328	95.0	65.6	2	9	Mod. fractured @ 66ft
72.0	WS	SS	Q	F	X	10YR7/4	446	229	89.2	45.8	2	12	Very fractured @71 ft
77.0	WS	SS	QC	F	X	10R5/4	493	250	98.6	50.0	2	10	
82.0	WS	SS	QC	F	B	10R5/4	352	223	70.4	44.6	1	4	
87.0	WS	SS	Q	F	M	10YR7/4	300	110	60.0	22.0	2	10	
91.6	WS	SS	Q	F	B	10YR6/6	400	91	87.0	19.8	3	15	
96.7	WS	SS	Q	F	M	10YR6/6	401	114	78.6	22.4	3	15	
101.8	WS	SS	Q	F	M	10YR5/6	451	87	88.4	17.1	3	14	
106.5	WS	SS	QC	F	B	10YR4/6	443	135	94.3	28.7	3	12	
111.6	WS	SS	Q	F	B	10YR7/4	431	133	84.5	26.1	2	11	Highly fractured
116.7	WS	SS	QC	F	B	10YR4/6	285	60	55.9	11.8	2	8	Highly fractured
121.7	WS	SS	Q	F	M	10YR4/6	55	0	11.0	0.0	0	0	Highly fractured
126.8	WM	SS	QC	F	B	10YR4/6	110	0	21.6	0.0	0	1	Highly fractured
131.8	WS	SS	Q	F	B	5YR5/6	112	0	22.4	0.0	1	4	Highly fractured
136.8	WS	SS	Q	F	B	5YR5/6	220	0	44.0	0.0	1	3	Highly fractured
141.9	WS	SS	Q	F	M	10R5/4	212	0	41.6	0.0	2	12	Highly fractured
144.9	WF	SS	Q	F		10R5/4	40	0	13.3	0.0	0	0	Poor Recovery
149.0	WF	SI	MQ	VF	BM	10R4/6	160	0	39.0	0.0	0	1	Poor Recovery
154.0	WS	SS	MQ	F	M	10R5/4	210	86	42.0	17.2	0	2	
159.0	WF	SS	Q	VF	B	10R5/4	278	42	55.6	8.4	1	4	Highly fractured
160.0							0		0.0	0.0	0	0	Rods dropped 159-160
163.0	WF	SS	Q	F	B	10R5/4	246	49	82.0	16.3	2	5	
166.5	WF	SS	Q	F		10R5/4	45	0	12.9	0.0	0	0	End of Hole

Project	Miner Flat Dam Geotechnical Investigation - Phase I	Northing	1085007.0	Drilling Method	HQ Split Tube Core	Project #	943-27691 Task 120	Page	
Location	Sandstone Ridge	Easting	575834.8	Drilling Contractor	Golden Drilling	Logged By	D.Allowey	Borehole	MF-218A
		Elevation	8107.5	Inclination	90	Date Started	8/22/95		
						Date Completed	8/28/95		

Depth	Weathering Alteration	Rock Description					Recovery	RQD	Recovery %	RQD %	Fractures per foot rec.	Total Fractures	General Comments
		Type	Mineral	Gr.Size	Texture	Color							
6.0													
11.0	WF	SS	Q	VF	B	10R6/6	482	125	96.4	25.0	2.8	14	
16.0	WS	SS	Q	VF	B	10R6/6	512	0	102.4	0.0	4.6	23	Highly fractured, non cemented
21.0	WS	SS	Q	VF	B	10R6/6	448	0	89.6	0.0	2.8	14	Highly fractured, non cemented
22.0	WS	SS	Q	VF	B	10R6/6	80	0	80.0	0.0	2.0	2	Highly fractured, non cemented
27.0	WS	SS	Q	VF	B	5YR5/6	458	0	91.6	0.0	2.4	12	Highly fractured,poorly cemented
32.0	WS	SS	Q	VF	B	5YR5/6	492	0	98.4	0.0	4.8	24	Highly fractured,poorly cemented
37.0	WS	SS	Q	VF	B	5YR5/6	500	0	100.0	0.0	4.2	21	Highly fractured,poorly cemented
42.0	WS	SS	Q	VF	B	5YR5/6	500	0	100.0	0.0	3.2	16	Highly fractured,poorly cemented
47.0	WS	SS	Q	VF	B	5YR5/6	491	0	98.2	0.0	2.4	12	Clayey silt @ 45.7-47.3
52.0	WS	SS	MQ	VF	B	10R6/6	451	0	90.2	0.0	2.4	12	Highly fractured,poorly cemented
57.0	WS	SS	Q	VF	B	10R6/6	461	49	92.2	9.8	5.0	25	Highly fractured,poorly cemented
62.0	WS	SS	Q	FV	B	10YR8/6	512	246	102.4	49.2	2.8	14	
67.0	WF	SS	Q	FV	B	5YR5/6	486	0	97.2	0.0	11.0	55	V. Fractured, poorly cemented
72.0	WS	SS	Q	FV	B	5YR5/6	486	74	97.2	14.8	2.8	14	poorly cemented
77.0	WF	SS	Q	FV	B	5YR5/6	513	510	102.6	102.0	0.4	2	
82.0	WF	SS	Q	FV	B	5YR5/6	498	498	99.6	99.6	0.0	0	No natural fractures
87.0	WF	SS	QC	FV	B	10R4/6	513	338	102.6	67.6	2.0	10	
92.0	WS	SS	Q	FV	B	5YR6/4	478	0	95.6	0.0	3.2	16	Highly fractured,poorly cemented
97.0	WS	SS	Q	FV	B	10YR7/4	484	57	96.8	11.4	2.8	14	
102.0	WF	SS	Q	FV	B	10R6/6	500	240	100.0	48.0	1.6	8	
107.0	WF	SS	Q	VF	B	10R6/6	508	0	101.6	0.0	2.8	14	Highly fractured,poorly cemented
112.0	WF	SS	Q	VF	B	10R6/6	500	143	100.0	28.6	2.8	14	
117.0	WF	SS	CQ	VF	B	10R4/6	512	400	102.4	80.0	0.8	4	
122.0	WS	SS	Q	VF	B	10R7/4	500	248	100.0	49.6	1.2	6	
127.0	WS	SS	CQ	VF	B	10R4/6	482	0	96.4	0.0	1.8	9	
132.0	WS	SS	Q	VF	B	10R6/6	464	0	92.8	0.0	0.4	2	V. poorly cemented
137.0	WS	SS	Q	VF	B	10R6/6	450	0	90.0	0.0	1.6	8	Soil-like, non cemented
142.0	WS	SS	Q	VF	B	10R6/6	489	146	97.8	29.2	1.6	8	Soil-like, non cemented
147.0	WS	SS	Q	VF	B	10R6/6	475	0	95.0	0.0	1.8	9	V. poorly cemented
152.0	WF	SS	Q	VF	B	10R6/6	500	203	100.0	40.6	2.0	10	
157.0	WS	SS	Q	VF	B	10R6/6	480	0	96.0	0.0	2.6	13	Soil like, non cemented
162.0	WS	SS	Q	VF	B	10YR7/4	486	85	97.2	17.0	1.4	7	Soil like to poorly cemented
167.0	WS	SS	Q	VF	B	10R6/6	477	0	95.4	0.0	1.2	6	soil like
172.0	WS	SS	Q	VF	B	10R6/6	480	50	96.0	10.0	3.0	15	v. poorly cemented
177.0	WF	SS	Q	VF	XB	10R6/6	490	75	98.0	15.0	1.4	7	
182.0	WF	SS	Q	VF	B	5YR5/6	484	54	96.8	10.8	1.8	9	
187.0	WF	SS	Q	VF	B	5YR5/6	497	0	99.4	0.0	1.6	8	
192.0	WF	SS	Q	VF	B	5YR5/6	475	78	95.0	15.6	2.6	13	
197.0	WF	SS	Q	VF	B	5YR5/6	500	218	100.0	43.6	2.2	11	Pc/Ps contact
202.0	WF	SS	Q	VF	B	10R6/6	505	227	101.0	45.4	1.4	7	Weakly reactive to HCl to 232
207.0	WF	SS	Q	VF	B	10R6/6	500	448	100.0	89.6	0.4	2	
212.0	WF	SS	Q	VF	B	10R6/6	500	350	100.0	70.0	1.4	7	
217.0	WF	SS	Q	VF	B	10R4/6	501	415	100.2	83.0	0.2	1	
222.0	WF	SS	Q	VF	B	10R6/6	500	490	100.0	98.0	0.2	1	
227.0	WF	SS	Q	VF	XB	10R6/6	495	400	99.0	80.0	0.2	1	
232.0	WS	SS	Q	VF	B	10R4/6	500	50	100.0	10.0	2.0	10	Mod HCl , No nat'l fract.
237.0	WF	SS	Q	VF	B	10R4/6	511	506	102.2	101.2	0.2	1	
242.0	WF	SS	Q	VF	B	10R4/6	490	490	98.0	98.0	0.0	0	Weakly reactive, no natural fractures
247.0	WF	SS	Q	VF	B	10R6/6	511	474	102.2	94.8	0.2	1	
252.0	WF	SS	Q	VF	B	10R6/6	508	402	101.6	80.4	0.6	3	
257.0	WS	SS	Q	VF	B	10R6/6	388	0	77.6	0.0	1.8	9	
262.0	WF	SS	Q	VF	B	10R6/6	490	314	98.0	62.8	5.0	25	
267.0	WF	SC	QC	VF	B	10R4/6	511	511	102.2	102.2	0.0	0	No natural fractures
272.0	WF	SC	QC	VF	B	10R4/6	514	514	102.8	102.8	0.0	0	No natural fractures, HCl reactive
277.0	WF	CM	CM	V	B	10R4/6	444	444	88.8	88.8	0.0	0	No natural fractures, lost core
281.7	WF	CM	CM	V	B	10R4/6	533	533	113.4	113.4	0.0	0	Picked up core
286.8	WF	CM	CM	V	B	10R4/6	471	471	92.4	92.4	0.0	0	No natural fractures
291.9	WF	SI	MC	V	B	10R4/6	330	206	64.7	40.4	0.6	3	Slipped core
293.9	WF	SI	MC	V	B	10R4/6	390	314	195.0	157.0	0.5	1	Broken zone, picked up core
298.5	WF	SI	MC	V	B	5YR3/4	506	451	110.0	98.0	1.3	6	
302.0	WF	SI	MC	V	B	5YR3/4	335	335	95.7	95.7	0.0	0	no natural fractures
307.0	WF	SI	MC	V	B	N7	522	430	104.4	86.0	1.2	6	
312.0	WF	SI	MC	V	B	N7	437	437	87.4	87.4	0.0	0	No natural fractures
316.6	WF	SI	MC	V	B	N7	510	420	110.9	91.3	1.1	5	
321.7	WF	SI	MC	V	B	N7	508	466	99.6	91.4	0.8	4	
326.8	WF	SI	MC	V	B	N7	513	506	100.6	99.2	0.4	2	
331.9	WS	SI	MC	V	B	10YR6/2	490	130	96.1	25.5	0.4	2	
337.0	WF	SI	MC	V	B	N5	486	361	95.3	70.8	0.8	4	
342.0	WF	CM	MC	V	B	5YR4/4	510	469	102.0	93.8	0.6	3	Gypsum @ 345.9
347.0	WF	CM	MC	V	B	5YR4/4	483	406	96.6	81.2	0.4	2	
352.0	WF	CM	MC	V	B	5YR4/4	518	451	103.6	90.2	0.6	3	
357.0	WF	G	G	V	B	N6	496	465	99.2	93.0	0.2	1	
362.0	WF	G	G	V	B	N6	512	495	102.4	99	0.8	4	End of Hole

Project	Miner Flat Dam Geotechnical Investigation - Phase I	Northing	1084797.0	Drilling Method	HQ Split Tube Core	Project #	943-27691 Task 120	Page	
Location	Sandstone Ridge	Easting	576874.7	Drilling Contractor	Golden Drilling	Logged By	D.Allowey	Borehole	MF-253
		Elevation	6071.4	Inclination	90	Date Started	6/3/95		
						Date Completed	8/21/95		

Depth	Weathering Alteration	Rock Description Type	Mineral	Gr.Size	Texture	Color	Recovery	RQD	Recovery %	RQD %	Fractures per foot rec.	Total Fractures	General Comments
34.8													
37.2	WF	SC	QC	VF	B	10R6/6	239	70	99.6	29.2	2.1	5	
42.2	WF	SC	QC	VF	B	10R6/6	500	63	100.0	12.6	2.0	10	
47.2	WF	SS	Q	VF	B	10YR6/6	510	200	102.0	40.0	1.8	9	
52.2	WF	SS	Q	VF	B	10YR6/6	494	149	98.8	29.8	2.0	10	
57.2	WF	SS	Q	VF	B	10YR8/2	505	324	101.0	64.8	1.2	6	
62.2	WF	SC	QC	VF	B	10R4/6	520	296	104.0	59.2	1.6	8	
67.2	WF	SS	Q	VF	BX	10R6/6	504	325	100.8	65.0	1.0	5	
72.2	WF	SS	Q	VF	BX	10R6/6	490	400	98.0	80.0	0.4	2	Top 1' very friable
77.2	WS	SS	Q	VF	B	10R6/6	493	154	98.6	30.8	1.0	5	
82.2	WS	SS	Q	VF	BX	10R6/6	485	182	97.0	36.4	1.4	7	
87.2	WS	SS	Q	VF	B	10R4/6	461	0	92.2	0.0	1.4	7	
92.0	WF	SS	Q	VF	B	10R4/6	498	288	103.8	60.0	1.0	5	
97.1	WF	SS	Q	VF	B	10YR8/2	510	203	100.0	39.8	2.2	11	
102.2	WF	SS	Q	VF	B	10R6/6	508	141	99.6	27.6	1.8	9	
107.2	WS	SS	Q	VF	B	10YR8/2	290	0	58.0	0.0	1.2	6	V.poorly cemented
112.2	WS	SS	Q	VF	B	10R6/6	475	50	95.0	10.0	0.8	4	V. poorly cemented, v. fractured
117.2	WF	SS	Q	VF	B	10R7/4	483	0	96.6	0.0	2.8	14	V. poorly cemented, v. fractured
122.2	WS	SS	Q	VF	B	10YR8/2	460	0	92.0	0.0	1.4	7	V. poorly cemented
127.2	WS	SS	Q	VF	B	10YR8/2	500	0	100.0	0.0	1.6	8	V. poorly cemented
132.2	WS	SS	Q	VF	B	10YR8/2	458	0	91.6	0.0	1.8	9	
137.2	WF	SS	Q	VF	B	10R4/6	490	352	98.0	70.4	0.6	3	
142.2	WF	SS	Q	VF	B	10R6/6	497	366	99.4	73.2	0.4	2	
147.2	WF	SS	Q	VF	B	10R6/6	505	307	101.0	61.4	0.8	4	
152.2	WF	SS	Q	VF	B	10R6/6	500	89	100.0	17.8	1.0	5	
157.2	WF	SS	Q	VF	B	10R6/6	500	359	100.0	71.8	1.4	7	
162.2	WF	SS	Q	VF	B	10R6/6	505	262	101.0	52.4	1.0	5	
167.2	WF	SS	Q	VF	B	10R6/6	512	230	102.4	46.0	1.2	6	Pc/Ps contact
172.2	WF	SS	Q	VF	B	10R6/6	480	224	96.0	44.8	1.6	8	
177.2	WF	SS	Q	VF	B	10R6/6	508	380	101.6	76.0	1.2	6	
182.2	WF	SS	Q	VF	B	10R6/6	492	449	98.4	89.8	0.6	3	
187.2	WF	SS	Q	VF	B	10R6/6	504	325	100.8	65.0	1.6	8	
192.2	WF	SS	Q	VF	B	5YR5/6	492	450	98.4	90.0	0.6	3	
197.2	WF	SS	Q	VF	B	5YR5/6	500	463	100.0	92.6	0.6	3	
202.2	WF	SS	Q	VF	B	5YR5/6	520	490	104.0	98.0	0.2	1	
207.2	WF	SS	Q	VF	B	5YR4/4	473	410	94.6	82.0	0.2	1	
212.2	WF	SS	Q	VF	B	5YR4/4	459	459	91.8	91.8	0.0	0	No natural fractures
217.0	WF	SS	Q	VF	B	5YR4/4	515	515	107.3	107.3	0.0	0	No natural fractures
222.1	WF	SS	Q	VF	B	5YR4/4	520	469	102.0	92.0	0.4	2	
227.2	WF	SS	Q	VF	B	5YR4/4	483	211	94.7	41.4	1.0	5	
231.7	WF	SS	Q	VF	B	5YR4/4	480	356	106.7	79.1	0.4	2	
236.8	WF	SS	Q	VF	B	5YR4/4	504	418	98.8	82.0	0.0	0	
241.9	WF	SS	Q	VF	B	10R7/4	497	497	97.5	97.5	0.0	0	No natural fractures
247.0	WF	SS	Q	VF	B	5YR4/4	520	520	102.0	102.0	0.0	0	No natural fractures
252.0	WF	SS	Q	VF	RB	10R7/4	500	115	100.0	23.0	1.0	5	
257.1	WF	SI	MQ	VF	RB	10R6/6	494	481	96.9	94.3	0.2	1	
262.1	WF	SI	MQ	VF	B	10R4/6	496	406	99.2	81.2	0.0	0	No natural fractures
267.1	WF	SI	MQ	VF	B	10R4/6	523	512	104.6	102.4	0.2	1	
272.1	WF	SI	MQ	VF	B	10R4/6	510	510	102.0	102.0	0.0	0	No natural fractures
277.1	WF	SC	MC	V	B	10R4/6	508	488	101.6	97.6	0.2	1	
282.1	WF	SC	MC	V	B	10R4/6	507	507	101.4	101.4	0.0	0	
287.1	WF	SC	MC	V	B	5YR4/4	445	412	89.0	82.4	0.6	3	
292.0	WF	CS	CM	V	RB	5YR4/4	515	165	105.1	33.7	5.1	25	V. fractured
295.2	WF	SC	MC	V	RB	5YR5/2	300	94	93.8	29.4	0.6	2	Contact w/ Gypsum
299.2	WF	SC	MC	V	B	5YR4/4	447	447	111.8	111.8	0.0	0	No natural fractures
302.2	WF	SC	MC	V	B	5YR4/4	280	280	93.3	93.3	0.0	0	No natural fractures
307.2	WF	GY	G	A	M	N3	504	504	100.8	100.8	0.0	0	No natural fractures
312.2	WF	GY	G	A	M	N3	500	495	100.0	99.0	0.2	1	
317.2	WF	GY	G	A	B	N5	510	510	102.0	102.0	0.0	0	No natural fractures
322.2	WF	GY	G	A	B	N5	500	500	100.0	100.0	0.0	0	No natural fractures
327.2	WF	GY	G	A	B	N5	500	500	100.0	100.0	0.0	0	No natural fractures
EOH													End of Borehole

Project	Miner Flat Dam Geotechnical Investigation - Phase I	Northing	1084655.0	Drilling Method	HQ Split Tube Core	Project #	943-27691 Task 120	Page	
Location	Sandstone Ridge	Easting	577083.7	Drilling Contractor	Golden Drilling	Logged By	D.Alloway	Borehole	MF-254
		Elevation	8081.3	Inclination	90	Date Started	6/14/95		
						Date Completed	8/7/95		

Depth	Weathering Alteration	Rock Description					Recovery	RQD	Recovery %	RQD %	Fractures per foot rec.	Total Fractures	General Comments
		Type	Mineral	Gr.Size	Texture	Color							
29.3													
32.2	WF	BA	QV	F	V	N4	289	289	99.7	99.7	0.0	0	No natural fractures
37.2	WF	BA	QV	F	V	N4	488	272	97.6	54.4	1.0	5	
42.2	WF	BA	QV	F	V	N4	500	500	100.0	100.0	0.2	1	
47.2	WF	BA	QV	F	V	N4	504	410	100.8	82.0	0.4	2	1/2" clay filled fracture @15 deg 43.3-44.3, water loss
52.2	WF	BA	QV	F	V	N4	478	400	95.6	80.0	0.6	3	Slipped core
56.1	WF	BA	QV	F	M	N4	424	350	108.7	89.7	0.5	2	Begin mud use, picked core from previous
61.1	WF	BA	QV	FM	M	N4	500	455	100.0	91.0	1.0	5	
66.1	WF	BA	QV	FM	M	N4	501	221	100.2	44.2	1.6	8	Basalt/Sandstone contact @ 69.9
71.1	WF	BA	QV	FM	M	N4	470	278	94.0	55.6	1.0	5	Clay filled fractures, SS at 69.9, 100% water loss
75.9	WS	SS	Q	VF	M	10R7/4	450	0	93.7	0.0	0.0	0	Non-cemented sand
81.0	WS	SS	Q	VF	M	10R7/4	430	58	84.3	11.4	0.4	2	Non-cemented sand
86.0	WS	SS	Q	VF	M	10R4/6	362	52	72.4	10.4	0.6	3	
90.1	WS	SS	Q	VF	M	10R6/6	350	51	85.4	12.4	1.7	7	Slipped core
91.1	WS	SS	Q	VF	M	10R6/6	120	0	120.0	0.0	1.0	1	Picked up core from previous
96.1	WS	SS	Q	VF	M	10R6/6	510	212	102.0	42.4	1.0	5	
101.1	WS	SS	Q	VF	B	10R6/6	485	0	97.0	0.0	0.2	1	
104.7	WS	SS	Q	VF	B	10R6/6	306	0	85.0	0.0	0.8	3	
109.7	WS	SS	Q	VF	B	10R6/6	445	138	89.0	27.6	1.0	5	
112.2	WS	SS	Q	VF	B	10R6/6	247	49	98.8	19.6	1.2	3	
117.2	WS	SS	Q	VF	B	10R6/6	510	128	102.0	25.6	1.8	9	
122.2	WS	SS	Q	VF	B	10R6/6	500	110	100.0	22.0	1.4	7	Slipped core
127.2	WS	SS	Q	VF	B	10R6/6	512	144	102.4	28.8	0.8	4	Picked up core from previous
132.2	WS	SS	Q	VF	B	10R6/6	459	0	91.8	0.0	1.6	8	
137.2	WS	SS	Q	VF	B	5YR6/4	505	118	101.0	23.6	1.0	5	
142.2	WS	SS	Q	VF	B	5YR6/4	462	0	92.4	0.0	1.8	9	
147.1	WS	SS	Q	VF	B	5YR6/4	492	0	100.4	0.0	2.2	11	Very fractured
152.1	WS	SS	Q	VF	B	5YR5/6	475	132	95.0	26.4	1.2	6	
157.1	WS	SS	Q	VF	B	5YR5/6	512	372	102.4	74.4	0.6	3	
162.1	WF	SS	Q	VF	B	10R6/6	492	492	98.4	98.4	0.0	0	No natural fractures
167.1	WF	SS	Q	VF	B	10R6/6	508	418	101.6	83.6	0.2	1	Soil like 164.8-165.7
172.1	WS	SS	Q	VF	B	10R6/6	475	255	95.0	51.0	0.6	3	Very poorly cemented
177.1	WS	SS	Q	VF	B	10R6/6	500	130	100.0	26.0	0.4	2	Very poorly cemented
182.1	WF	SS	Q	VF	B	10YR7/4	503	356	100.6	71.2	0.6	3	Very poorly cemented
187.1	WF	SS	Q	VF	B	10YR7/4	500	448	100.0	89.6	0.6	3	
192.1	WF	SS	Q	VF	B	10YR7/4	496	450	99.2	90.0	1.2	6	
197.1	WF	SS	Q	VF	B	10R4/6	502	378	100.4	75.6	0.6	3	
202.1	WF	SS	Q	VF	B	10R4/6	500	300	100.0	60.0	0.6	3	
207.1	WF	SS	QC	VF	B	10R6/6	504	455	100.8	91.0	0.2	1	Clayey zones throughout
212.1	WF	SS	QC	VF	B	10R4/6	491	377	98.2	75.4	0.4	2	Lower part appears brecciated
217.1	WF	CS	CQ	VF	B	10R4/6	510	510	102.0	102.0	0.0	0	No natural fractures
222.1	WF	SC	QC	VF	B	10R4/6	500	393	100.0	78.6	0.4	2	
227.1	WF	SC	QC	VF	B	10R4/6	510	460	102.0	92.0	0.4	2	
232.1	WF	SC	QC	VF	B	10R4/6	507	365	101.4	73.0	0.6	3	
237.1	WF	CS	CQ	VF	B	10R4/6	498	498	99.6	99.6	0.0	0	No natural fractures
242.1	WF	CS	CQ	VF	B	10R4/6	448	422	89.6	84.4	0.6	3	Slipped core
246.7	WF	SC	QC	VF	B	10R4/6	486	448	105.7	97.4	0.9	4	Gained core from previous
251.5	WF	SC	QC	VF	B	5YR4/4	508	497	105.8	103.5	0.2	1	
254.3	WF	CG	CG	VA	B	N5	291	144	103.9	51.4	0.4	1	Gypsum at 254.8
258.3	WF	G	G	A	B	N5	398	398	99.5	99.5	0.0	0	No natural fractures
262.2	WF	G	G	A	B	N5	389	375	99.7	96.2	0.3	1	
267.2	WS	GC	GC	AF	B	5YR4/4	505	0	101.0	0.0	5.0	25	Many horiz. fractures
272.2	WS	C	C	V	B	N5	490	0	98.0	0.0	5.0	25	Soil like
277.2	WS	SI	MS	VA	B	N3	504	212	100.8	42.4	5.0	25	As above, layered clay and gypsum
282.2	WF	SC	MC	VA	B	N5	496	416	99.2	83.2	1.0	5	
287.2	WF	GC	GC	VA	B	5YR4/4	512	418	102.4	83.6	1.2	6	
292.2	WS	G	G	A	B	N3	508	508	101.6	101.6	0.6	3	
297.2	WS	GC	GC	AV	B	N5	495	472	99.0	94.4	0.6	3	
302.2	WS	GC	GC	AV	B	N5	499	499	99.8	99.8	0.6	3	
307.2	WS	GC	GC	AV	B	N5	513	513	102.6	102.6	0.4	2	
312.2	WS	G	G	A	B	N5	500	500	100.0	100.0	0.0	0	No natural fractures
317.2	WS	G	G	A	B	N5	502	502	100.4	100.4	0.0	0	No natural fractures
322.2	WS	CG	CG	VA	B	10R4/6	386	386	77.2	77.2	0.0	0	No natural fractures, slipped 1.2 ft of core
325.2	WS	CG	CG	VA	B	10R4/6	459	459	153.0	153.0	0.0	0	No natural fractures, picked up 1.1 ft of core
EOH													End of Borehole

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-1

SHEET 1 OF 4

DRILLING	START	FINISH
TIME	11:00	13:30
DATE	7/25/95	7/25/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS ROAD

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2762117.0

FILENAME: BA-1

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1	•		(0.0-5.0 ft.) Light brown (5YR 5/6), loose to compact, CLAYEY SAND with GRAVEL, 35% fine to medium subrounded sand, 20% silty clay, 20% subangular cobbles and 25% fine to coarse subangular gravel, <5% coarse subangular sand sized sandstone, dry, (SC)					
2	•							
3	•							
4	•							
5	•							
6	•		(5.0-10.0 ft.) Light brown (5YR 5/6), loose to compact, CLAYEY SAND, 70% fine to medium subrounded sand, 20% silty clay, 10% fine to coarse subangular gravel, <5% cobbles, dry, (SC)					
7	•							
8	•							
9	•							
10 (-10.0)	•		(10.0-15.0 ft.) Light brown (5YR 6/4), compact to dense, well graded SAND with CLAY and GRAVEL, 75% fine to coarse subrounded sand, 15% subangular gravel sized sandstone, 10% silty clay, <5% subangular cobbles, dry, (SW-SC)					
11	•							
12	•							
13	•							
14	•							

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: BA-1
	SAMPLING METHOD: BULK	SHEET: 2 OF 4
NORTHING: EASTING: ELEVATION	DRILLING START TIME: 11:00 DATE: 7/25/95	DRILLING FINISH TIME: 13:30 DATE: 7/25/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS: ROAD	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DRILLING CONTR: LAYNE WESTERN EXPLORATION

LOGGED BY: M.D. ALLOWAY

DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 943-2769.170

FILENAME: BA-1

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(15.0-20.0 ft.) Light brown (5YR 6/4), compact to dense, well graded SAND with CLAY and GRAVEL, 65% fine to coarse subrounded sand, 25% subangular gravel sized sandstone, 10% silty clay, <5% subrounded cobbles, damp, (SW-SC)					
17								
18								
19								
20			(-20.0) 20.0					
21			(20.0-25.0 ft.) Light brown (5YR 6/2), compact, CLAYEY SAND, 70% fine to coarse subrounded sand, 20% silty clay, 10% fine to coarse subangular gravel and cobble sized sandstone, damp, (SC)					
22								
23								
24								
25			(25.0-30.0 ft.) Light brown (5YR 6/2), compact, CLAYEY SAND, 70% fine to coarse subrounded sand, 20% silty clay, 10% fine to coarse subangular gravel and cobble sized sandstone, damp, (SC)					
26								
27								
28								
29								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: BA-1
	SAMPLING METHOD: BULK	SHEET: 3 OF 4
NORTHING: EASTING: ELEVATION		DRILLING START TIME: 11:00 DATE: 7/25/95; FINISH TIME: 13:30 DATE: 7/25/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS: ROAD	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DRILLING CONTR: LAYNE WESTERN EXPLORATION

LOGGED BY: M.D. ALLOWAY

DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 943-2769.1120

FILENAME: BA-1

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 80)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %; LIQUID LIMIT %; PLASTICITY INDEX %; LESS THAN NO. 200; OTHER TESTS
31			(30.0-35.0 ft.) Light brown (5YR 6/2), compact, CLAYEY SAND with GRAVEL, 60% fine to medium subrounded sand, 20% silty clay, 15% fine to coarse subangular gravel, 5% cobbles, <5% subangular coarse sand, damp, (SC)	
32				
33				
34				
35			(35.0-40.0 ft.) Light brown (5YR 6/2), loose to compact, CLAYEY SAND 60% fine to medium subrounded sand, 35% silty clay, <5% subangular coarse sand, damp, (SC)	
36				
37				
38				
39				
40			(-40.0) 40.0	
41			(40.0-47.0 ft.) BEDROCK, sandstone	
42				
43				
44				

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-1

SHEET 4 OF 4

DRILLING	START	FINISH
TIME	11:00	13:30
DATE	7/25/95	7/25/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS ROAD

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
46			(40.0-47.0 ft.) BEDROCK, sandstone					
47			(-47.0) 47.0 End of Borehole at 47.0 ft.					
48								
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2762/1170

FILENAME: BA-1

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BA-2 SHEET 1 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME 13:30 DATE 7/25/95; FINISH TIME 15:20 DATE 7/25/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1 2 3 4 5 6 7 8 9 10 11 12 13 14			(0.0-5.0 ft.) Pale yellowish brown (10YR 6/2), stiff, SANDY LEAN CLAY, 60% silty clay, 40% fine to medium subrounded sand, <5% coarse subangular sand sized basalt, dry, (CL) (5.0-10.0 ft.) Pale yellowish brown (10YR 6/2), stiff to very stiff, SANDY LEAN CLAY, 60% silty clay, 40% fine to coarse subrounded sand, dry, (CL) (10.0-15.0 ft.) Pale yellowish brown (10YR 6/2), stiff to hard, SANDY LEAN CLAY, 50% silty clay, 40% fine to medium subrounded sand, 10% fine to coarse subangular gravel, <5% subangular cobbles, dry, (CL)					

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: BA-2

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: BA-2
	SAMPLING METHOD: BULK	SHEET: 2 OF 3
NORTHING: EASTING: ELEVATION	DRILLING START TIME: 13:30 DATE: 7/25/95	DRILLING FINISH TIME: 15:20 DATE: 7/25/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS: ROAD	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DRILLING CONTR: LAYNE WESTERN EXPLORATION

LOGGED BY: M.D. ALLOWAY DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 943-2769 1170 FILENAME: BA-2

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10, 20, 30, 40, 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(15.0-20.0 ft.) Pale yellowish brown (10YR 6/2), very stiff to hard, SANDY LEAN CLAY, 60% silty clay, 35% fine to coarse subrounded sand, 5% fine to coarse subangular gravel sized sandstone, dry, (CL)					
17								
18								
19								
20			(-20.0) 20.0					
21			(20.0-25.0 ft.) Pale yellowish brown (10YR 6/2), compact to dense, CLAYEY SAND, 60% fine to medium subrounded sand, 30% silty clay, 10% fine to coarse subangular gravel size sandstone, damp, (SC)					
22								
23								
24								
25			(25.0-30.0 ft.) Pale yellowish brown (10YR 6/2), compact to very dense, CLAYEY SAND, 80% fine to medium subrounded sand, 20% silty clay, <5% coarse subangular sand, damp, (SC)					
26	>50							
27			@ 26.0-29.0 ft., boulders					
28	>50							
29								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BA-2 SHEET 3 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME 13:30 DATE 7/25/95; FINISH TIME 15:20 DATE 7/25/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR LAYNE WESTERN EXPLORATION

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31			(30.0-35.0 ft.) Pale yellowish brown (10YR 6/2), compact to dense, CLAYEY SAND, 60% fine to medium subrounded sand, 30% silty clay, 10% subangular coarse sand, damp, (SC)					
32								
33								
34								
35			(35.0-40.0 ft.) Pale yellowish brown (10YR 6/2), compact, CLAYEY SAND, 50% fine to medium subrounded sand, 50% silty clay, <5% subangular coarse sand, damp, (SC)					
36								
37								
38								
39								
40			(40.0-44.0 ft.) Pale yellowish brown (10YR 6/2), compact to dense, CLAYEY SAND, 60% fine to medium and 10% coarse subrounded to subangular sand sized basalt and quartz, 30% silty clay, damp, (SC)					
41								
42								
43								
44			(-44.0) 44.0 @ 44.0 ft., BASALT BEDROCK (-44.2) 44.2 End of Borehole at 44.2 ft.					

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2769120

FILENAME: BA-2

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BA-3 SHEET 1 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME 15:20 DATE 7/25/95; FINISH TIME 8:40 DATE 7/26/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR LAYNE WESTERN EXPLORATION

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-5.0 ft.) Pale yellowish brown (10YR 6/2), stiff, SANDY SILT, 55% clayey silt, 40% fine subrounded sand, <5% medium to coarse subrounded sand, <5% fine to coarse subangular sized sandstone and quartzite, dry, (ML)					
2								
3								
4								
5			(-5.0) 5.0					
6			(5.0-10.0 ft.) Pale yellowish brown (10YR 6/2), compact, CLAYEY SAND, 50% fine to coarse subrounded sand, 30% silty clay, 20% fine to coarse subrounded gravel and cobble size quartzite and sandstone, damp, (SC)					
7								
8								
9								
10			(-10.0) 10.0					
11			(10.0-15.0 ft.) Moderate yellowish brown (10YR 5/2), stiff to very stiff, SANDY LEAN CLAY, 60% silty clay, 30% fine to coarse subrounded sand, 10% fine to coarse gravel sized subangular sandstone and quartzite, damp, (CL)					
12								
13								
14								

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2769L170

FILENAME: BA-3

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-3

SHEET 2 OF 3

DRILLING	START	FINISH
TIME	15:20	8:40
DATE	7/25/95	7/26/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS ROAD

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: BA-3

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(15.0-20.0 ft.) Moderate yellowish brown (10YR 5/2), stiff to very stiff, SANDY LEAN CLAY, 70% silty clay, 20% fine to medium subrounded to subangular sand with basalt, 10% fine to coarse, subangular gravel sized sandstone, (CL)					
17								
18								
19								
20			(20.0-25.0 ft.) Light brown (5YR 5/6), stiff to very stiff, LEAN CLAY with SAND, 80% silty clay, 10% fine to medium subrounded sand, 10% coarse sand sized subangular sandstone and basalt, (CL)					
21								
22								
23								
24								
25			(25.0-30.0 ft.) Light brown (5YR 6/2), stiff to very stiff, SANDY LEAN CLAY with GRAVEL, 65% silty clay, 20% fine to coarse subrounded sand, 15% fine to coarse gravel sized subrounded sandstone and angular quartzite, (CL)					
26								
27								
28								
29								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BA-3 SHEET 3 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME 15:20 DATE 7/25/95; FINISH TIME 8:40 DATE 7/26/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31			(30.0-35.0 ft.) Light brown (5YR 6/2), stiff, LEAN CLAY with SAND, 50% silty clay, 50% fine to medium subrounded sand, <5% fine to coarse gravel and cobble sized subangular sandstone, damp, (CL)					
32								
33								
34								
35			(35.0-40.0 ft.) Light brown (5YR 6/2), very stiff, LEAN CLAY with SAND, 60% silty clay, 35% fine to medium subrounded sand, <5% fine to coarse gravel sized subangular sandstone, <5% coarse sand, damp, (CL)					
36								
37								
38								
39								
40			(40.0-41.3 ft.) Light brown (5YR 6/2), hard, LEAN SILTY CLAY with SAND, 80% silty clay, 15% fine to medium subrounded sand, 5% coarse subangular sand, damp, (CL) (-41.3) 41.3					
41	>50		@ 41.3 ft., BEDROCK, basalt (-41.7) 41.7					
42			End of Borehole at 41.7 ft.					
43								
44								

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 243-2760170

FILENAME: BA-3

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BA-4 SHEET 1 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME 9:00 DATE 7/26/95; FINISH TIME 10:05 DATE 7/26/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1	•		(0.0-5.0 ft.) Light brown (5YR 5/6), soft to firm, LEAN CLAY with SAND, 70% silty clay, 20% fine to medium subrounded sand, 10% fine to coarse subrounded gravel sized sandstone and quartzite, dry, (CL)					
2	•							
3	•							
4	•							
5	•							
6	•		(5.0-10.0 ft.) Light brown (5YR 5/6), firm to stiff, SANDY LEAN CLAY with GRAVEL, 60% silty clay, 20% fine to medium subrounded sand, 20% fine to coarse subrounded gravel sized sandstone and quartzite, (CL)					
7	•							
8	•							
9	•							
10	•		(10.0-15.0 ft.) Moderate brown (5YR 4/4), firm to stiff, LEAN CLAY, 90% silty clay, 10% fine to medium subrounded sand, (CL)					
11	•							
12	•							
13	•							
14	•							

DRILLING CONTR LAYNE INTERNATIONAL

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2769

FILENAME: BA-4

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BA-4 SHEET 2 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME 9:00 DATE 7/26/95; FINISH TIME 10:05 DATE 7/26/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR LAYNE RUBENHAUSER REMEDIATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2769.170

FILENAME: BA-4

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 80)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(15.0-20.0 ft.) Moderate brown (5YR 4/4), stiff to very stiff, LEAN CLAY with SAND, 80% silty clay, 10% fine to medium subrounded sand, 10% fine to coarse gravel and cobble sized subangular sandstone, (CL)					
17								
18								
19								
20			(20.0-25.0 ft.) Moderate brown (5YR 4/4), stiff, LEAN CLAY with SAND, 80% silty clay, 10% fine to medium subrounded sand, 10% fine to coarse subangular gravel and cobble sized subangular sandstone, (CL)					
21								
22								
23								
24								
25			(25.0-30.0 ft.) Moderate brown (5YR 4/4), stiff, LEAN CLAY with SAND, 85% silty clay, 10% fine to medium subrounded sand, 5% fine to coarse subangular gravel, (CL)					
26								
27								
28								
29								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BA-4 SHEET 3 OF 3

DRILLING	START	FINISH
TIME	9:00	10:05
DATE	7/26/95	7/26/95

NORTHING:
EASTING: ELEVATION

DRILL RIG AP1000 BECKER HAMMER — SURFACE CONDITIONS ROAD

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31	•		(30.0-35.0 ft.) Moderate brown (5YR 4/4), stiff to very stiff, LEAN CLAY with SAND, 65% silty clay, 30% fine to medium subrounded sand, <5% fine to coarse subangular gravel, (CL)					
32	•							
33	•							
34	•							
35	•		(35.0-40.4 ft.) Moderate brown to pale yellowish brown (5YR 4/4 to 10YR 6/2), very stiff to hard, SANDY LEAN CLAY with GRAVEL, 70% silty clay, 25% fine to medium subrounded sand, <5% fine to coarse gravel sized subangular sandstone, <5% coarse sand size angular basalt, (CL)					
36	•							
37	•							
38	•							
39	•							
40	•		(-40.4) 40.4					
41	•		@ 40.4 ft., BEDROCK, basalt (-41.4) 41.4 End of Borehole at 41.4 ft.					
42								
43								
44								

DRILLING CONTR LAYNE RIVERSIDE EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: BA-4

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-5

SHEET 1 OF 3

DRILLING	START	FINISH
TIME	10:05	14:20
DATE	7/26/95	7/26/95

DRILL RIG AP1000 BECKER HAMMER

SURFACE CONDITIONS ROAD

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1–14			(0.0-5.0 ft.) Moderate brown (5YR 4/4), firm to stiff, LEAN CLAY with SAND, 75% silty clay, 15% fine to medium subrounded sand, 10% fine to coarse gravel sized subangular sandstone, <5% cobble sized sandstone, (CL) (5.0-10.0 ft.) Moderate brown (5YR 4/4), firm to stiff, LEAN CLAY, 85% silty clay, 10% fine to medium subrounded sand, 5% coarse sand sized subangular sand and basalt, (CL) (10.0-15.0 ft.) Moderate brown (5YR 4/4), stiff to very stiff, LEAN CLAY, 85% silty clay, 10% fine to coarse subrounded sand, 5% coarse sand sized subangular sand and basalt, (CL)					

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2769.1120

FILENAME: BA-5

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-5

SHEET 2 OF 3

DRILLING START	DRILLING FINISH
TIME 10:05	TIME 14:20
DATE 7/26/95	DATE 7/26/95

DRILL RIG AP1000 BECKER HAMMER

SURFACE CONDITIONS ROAD

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(15.0-20.0 ft.) Moderate yellowish brown (10YR 5/2), stiff to very stiff, LEAN CLAY, 90% silty clay, 10% fine to coarse subrounded sand and subangular basalt, (CL)					
17								
18								
19								
20			(20.0-25.0 ft.) Moderate yellowish brown (10YR 5/2), stiff, LEAN CLAY with SAND, 80% silty clay, 20% fine to coarse subrounded sand and subangular basalt, (CL)					
21								
22								
23								
24								
25			(25.0-30.0 ft.) Moderate yellowish brown (10YR 5/2), stiff to very stiff, LEAN CLAY with SAND, 80% silty clay, 20% fine to coarse subrounded sand and sand size subangular basalt, (CL)					
26								
27								
28								
29								

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2762/170

FILENAME: BA-5

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BA-5 SHEET 3 OF 3 DRILLING START TIME 10:05 DATE 7/26/95 DRILLING FINISH TIME 14:20 DATE 7/26/95
NORTHING: EASTING: ELEVATION		
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31			(30.0-35.0 ft.) Moderate yellowish brown (10YR 5/2), stiff to hard, SANDY LEAN CLAY, 65% silty clay, 35% fine to medium subrounded sand, coarse sand size angular basalt, (CL)					
32								
33								
34								
35			(35.0-39.0 ft.) Moderate yellowish brown (10YR 5/2), very stiff to hard, SANDY LEAN CLAY, 70% silty clay, 30% fine to medium subrounded sand, coarse sand size subangular basalt, (CL)					
36								
37								
38	>50							
39			(-39.0) 39.0 @ 39.0 ft., BEDROCK, basalt (-39.3) 39.3 End of Borehole at 39.3 ft.					
40								
41								
42								
43								
44								

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: BA-5

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-6

SHEET 1 OF 3

DRILLING	START	FINISH
TIME	14:20	17:30
DATE	7/26/95	7/26/95

DRILL RIG AP1000 BECKER HAMMER

SURFACE CONDITIONS ROAD

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-5.0 ft.) Moderate brown (5YR 4/4), firm to stiff, LEAN CLAY with SAND, 80% silty clay, 15% fine to medium subrounded sand and subangular basalt, 5% fine to coarse gravel sized subrounded sandstone, dry, (CL)					
2								
3								
4								
5								
6			(5.0-10.0 ft.) Moderate brown (5YR 4/4), very stiff to hard, LEAN CLAY with SAND, 80% silty clay, 15% fine to medium subrounded sand and subangular basalt, 5% coarse subrounded sand and subangular basalt, <5% fine gravel sized subrounded to angular sandstone, dry, (CL)					
7								
8								
9								
10	>50		(-10.0) 10.0					
11	>50		(10.0-15.0 ft.) Moderate brown to moderate yellowish brown (5YR 4/4 to 10YR 5/2), very dense, CLAYEY SAND, 80% subrounded sand, 20% silty clay, dry, (SC)					
12	>50		@ 10.0-11.2 ft., sandstone boulder					
13	>50							
14	>50							

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 942-2769170

FILENAME: BA-6

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: BA-6
	SAMPLING METHOD: BULK	SHEET: 2 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME: 14:20 DATE: 7/26/95; FINISH TIME: 17:30 DATE: 7/26/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS: ROAD	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DRILLING CONTR: LAYNE WESTERN EXPLORATION

LOGGED BY: M.D. ALLOWAY DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 941-27691170 FILENAME: BA-6

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 80)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16	>50		(15.0-20.0 ft.) Moderate brown (5YR 4/4), hard, SANDY LEAN CLAY, 70% silty clay, 30% fine to medium subrounded sand, damp, (CL)					
	>50		@ 16.0-16.8 ft., sandstone boulder					
17								
18								
19								
20			(-20.0) 20.0					
			(20.0-25.0 ft.) Pale yellowish brown (10YR 6/2), compact to dense, POORLY GRADED SAND, fine to medium subrounded sand, dry, (SP)					
21								
22								
23								
			@ 23.5-25.0 ft., fine grained sandstone boulder					
24								
25			(-25.0) 25.0					
			(25.0-30.0 ft.) Moderate brown (5YR 4/4), stiff to very stiff, LEAN CLAY with SAND, 55% silty clay, 45% fine to medium subrounded sand, <5% fine to coarse sand size angular basalt, damp, (CL)					
26								
27								
28								
29								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: BA-6
	SAMPLING METHOD: BULK	SHEET: 3 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME: 14:20 DATE: 7/26/95; FINISH TIME: 17:30 DATE: 7/26/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS: ROAD	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DRILLING CONTR: LAYNE WESTERN EXPLORATION

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31			(30.0-35.0 ft.) Moderate brown (5YR 4/4), very stiff, SANDY LEAN CLAY, 55% silty clay, 45% fine to medium subrounded sand, (5% fine to coarse gravel and cobble size sandstone, (CL)					
32								
33								
34								
35			(35.0-36.2 ft.) Moderate brown (5YR 4/4), hard, SANDY LEAN CLAY with GRAVEL, 55% silty clay, 30% fine to medium subrounded sand, 15% fine to coarse gravel and cobble size sandstone, (CL) (-36.2) 36.2					
36			@ 36.2 ft., BEDROCK, basalt (-36.4) 36.4					
37			End of Borehole at 36.4 ft.					
38								
39								
40								
41								
42								
43								
44								

LOGGED BY: M.D. ALLOWAY

DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 943-2769.1170

FILENAME: BA-6

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-7

SHEET 1 OF 3

DRILLING	START	FINISH
TIME	8:00	8:30
DATE	7/27/95	7/27/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS ROAD

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: BA-7

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-5.0 ft.) Moderate brown (5Y 4/4), firm to hard, SANDY LEAN CLAY with GRAVEL, 65% silty clay, 20% fine to coarse subrounded sand, 15% fine to coarse gravel and cobble sized subrounded sandstone and quartzite, damp, (CL)					
2								
3								
4								
5			(-5.0) 5.0					
6			(5.0-10.0 ft.) Light brown (5YR 6/4), dense to very dense, CLAYEY SAND with GRAVEL, 50% fine to medium subrounded sand, 30% fine to coarse gravel and cobble sized subrounded to subangular sandstone and subangular quartzite, 20% silty clay, damp, (SC)					
7	>50							
8								
9								
10			(-10.0) 10.0					
11	>50		(10.0-15.0 ft.) Light brown (5YR 6/4), dense to very dense, POORLY GRADED SAND with GRAVEL, 70% fine to medium subrounded sand, 30% gravel sized subrounded and subangular sandstone, <5% silty clay, damp, (SP)					
12								
13								
14								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: BA-7
	SAMPLING METHOD: BULK	SHEET: 2 OF 3
NORTHING: EASTING: ELEVATION		DRILLING START TIME: 8:00 DATE: 7/27/95; FINISH TIME: 8:30 DATE: 7/27/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS: ROAD	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %; LIQUID LIMIT %; PLASTICITY INDEX %; LESS THAN NO. 200; OTHER TESTS
16			(15.0-20.0 ft.) Light brown (5YR 6/4), compact to dense, POORLY GRADED SAND with GRAVEL, 70% fine to medium subrounded sand, 30% gravel sized subrounded and subangular sandstone, <5% silty clay, damp, (SP)	
17			@ 17.0-17.5 ft., 10% silty clay	
18				
19				
20			(-20.0) 20.0	
21			(20.0-25.0 ft.) Light brown (5YR 6/4), dense to very dense, POORLY GRADED SAND with GRAVEL, 70% fine to medium subrounded sand, 30% gravel sized subrounded and subangular sandstone, <5% silty clay, damp, (SP)	
22				
23				
24	>50			
25			(25.0-28.0 ft.) Light brown (5YR 6/4), compact to dense, POORLY GRADED SAND with GRAVEL, 70% fine to medium subrounded sand, 30% gravel sized subrounded and subangular sandstone, <5% silty clay, damp, (SP)	
26				
27				
28			(-28.0) 28.0	
29			(28.0-30.5 ft.) Light brown (5YR 6/4), very stiff to hard, LEAN CLAY with SAND, 80% silty clay, 20% fine to medium subrounded sand, damp, (CL)	

DRILLING CONTR: LAYNE WESTERN EXPLORATION

LOGGED BY: M.D. ALLOWAY

DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 943-2769170

FILENAME: BA-7

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-7

SHEET 3 OF 3

DRILLING	START	FINISH
TIME	8:00	8:30
DATE	7/27/95	7/27/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS ROAD

DRILLING CONTR LAYNE WESTERN EXPLORATION

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31			(28.0-30.5 ft.) Light brown (5YR 6/4), very stiff to hard, LEAN CLAY with SAND, 80% silty clay, 20% fine to medium subrounded sand, damp, (CL) (-30.5) 30.5					
32			@ 30.5 ft., BEDROCK, basalt (-31.0) 31.0					
33			End of Soil Borehole at 31.0 ft.					
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2769120

FILENAME: BA-7

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK
NORTHING: EASTING: ELEVATION	BORING NO. BA-8 SHEET 1 OF 1 DRILLING START TIME 8:00 DATE 8/1/95 DRILLING FINISH TIME 9:00 DATE 8/1/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS: ROAD
ANGLE: VERTICAL BEARING: NA	
SAMPLE HAMMER	

DRILLING CONTR: LAYNE WESTERN EXPLORATION

LOGGED BY: M.D. ALLOWAY

DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 943-27691170

FILENAME: BA-8

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10, 20, 30, 40, 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
0			(0.0-5.0 ft.) Moderate yellowish brown (10YR 5/2), loose to compact, SILTY SAND with GRAVEL, 60% fine to medium subrounded sand, 20% silt, 20% fine to coarse subangular to subrounded gravel sized sandstone, damp, (SM)					
5			(5.0-10.0 ft.) Moderate yellowish brown (10YR 5/2), compact to dense, SILTY SAND with GRAVEL, 60% fine to medium subrounded sand, 20% silt, 20% fine to coarse subangular to subrounded gravel sized sandstone, damp, (SM)					
10			(10.0-13.2 ft.) Moderate yellowish brown (10YR 5/2), dense, SILTY SAND with GRAVEL, 60% fine to medium subrounded sand, 20% silt, 20% fine to coarse subangular to subrounded gravel sized sandstone, damp, (SM)					
13	>50		(-13.2) 13.2 @ 13.2 ft., BEDROCK, sandstone					
14			(-14.0) 14.0 End of Borehole at 14.0 ft.					

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BA-9

SHEET 1 OF 1

DRILLING	START	FINISH
TIME	9:00	9:35
DATE	8/1/95	8/1/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS ROAD

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: BA-9

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-5.0 ft.) Pale yellowish brown (10YR 6/2), loose to dense, SILTY SAND, 60% fine to medium subrounded sand, 20% silt, 20% fine to coarse subrounded gravel sized sandstone, damp, (SM)					
2								
3								
4								
5			(5.0-10.0 ft.) Pale yellowish brown (10YR 6/2), dense to very dense, SILTY SAND with GRAVEL, 60% fine to medium subrounded sand, 20% silt, 20% fine to coarse subrounded gravel sized sandstone, <5% clay, damp, (SM)					
6	>50							
7								
8								
9								
10			(10.0-13.6 ft.) Pale yellowish brown (10YR 6/2), compact to dense, SILTY SAND, 60% fine to medium subrounded sand, 30% clayey silt, 10% fine to coarse subrounded gravel sized sandstone, damp, (SM)					
11								
12								
13								
14	>50		(-13.6) 13.6 @ 13.6 ft., BEDROCK, basalt (-14.0) 14.0 End of Borehole at 14.0 ft.					

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK
BORING NO.	BC-1
SHEET	1 OF 1
DRILLING START TIME	9:35
DRILLING FINISH TIME	9:50
DRILLING START DATE	8/1/95
DRILLING FINISH DATE	8/1/95
NORTHING:	
EASTING:	
ELEVATION	
DRILL RIG	AP1000 BECKER HAMMER
SURFACE CONDITIONS	ROAD
ANGLE	VERTICAL
BEARING	NA
SAMPLE HAMMER	

DRILLING CONTR: LAYNE WESTERN EXPLORATION

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10, 20, 30, 40, 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
0			(0.0-4.5 ft.) Pale yellowish brown (10YR 6/2), loose to dense, SILTY SAND, 60% fine subrounded sand, 30% silt, 10% fine to coarse gravel sized subrounded sandstone, dry, (SM)					
4.5 (-4.5)			@ 4.5 ft., BEDROCK, basalt					
5.3 (-5.3)			End of Borehole at 5.3 ft.					

LOGGED BY: M.D. ALLOWAY

DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 943-2769.1120

FILENAME: BC-1

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BC-2 SHEET 1 OF 1 DRILLING START TIME 9:50 DATE 8/1/95 DRILLING FINISH TIME 10:20 DATE 8/1/95
NORTHING: EASTING: ELEVATION		
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-27691.170

FILENAME: BC-2

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10, 20, 30, 40, 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-5.0 ft.) Moderate yellowish brown (10YR 5/2), loose to dense, CLAYEY SAND, 80% fine to coarse subrounded sand, 20% silty clay, damp, (SC)					
2								
3								
4								
5			(5.0-6.7 ft.) Moderate yellowish brown (10YR 5/2), compact, CLAYEY SAND, 80% fine to coarse subrounded sand, 20% silty clay, damp, (SC)					
6								
7			(-6.7) 6.7 @ 6.7 ft., BEDROCK, basalt (-7.0) 7.0 End of Soil Borehole at 7.0 ft.					
8								
9								
10								
11								
12								
13								
14								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. BC-3

SHEET 1 OF 1

DRILLING	START	FINISH
TIME	10:40	10:45
DATE	8/1/95	8/1/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS ROAD

DRILLING CONTR LAYNE WESTERN EXPLORATION

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-2.0 ft.) Moderate yellowish brown (10YR 5/2), loose, SILTY SAND, 80% fine to medium sand, <5% coarse subrounded sand, 20% silt, dry, (SM)					
2			(-2.0) 2.0 @ 2.0 ft., BEDROCK, basalt (-2.5) 2.5					
3			End of Borehole at 2.5 ft.					
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-2769170

FILENAME: BC-3

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: BC-4
	SAMPLING METHOD: BULK	SHEET: 1 OF 1
NORTHING: EASTING: ELEVATION		DRILLING START TIME: 10:45 DATE: 8/1/95; FINISH TIME: 11:00 DATE: 8/1/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS: ROAD	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DRILLING CONTR: LAYNE WESTERN EXPLORATION

LOGGED BY: M.D. ALLOWAY

DATE: SEPTEMBER 1995 CHK'D BY: L. BUSH

JOB NO.: 943-27691170

FILENAME: BC-4

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10, 20, 30, 40, 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-2.5 ft.) Moderate yellowish brown (10YR 5/2), loose to compact, SILTY SAND, 80% fine to medium subrounded sand, 20% silt, dry, (SM)					
2								
3	>50		(-2.5) 2.5 @ 2.5 ft., BEDROCK, basalt (-2.8) 2.8 End of Borehole at 2.8 ft.					
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. BC-5 SHEET 1 OF 1
NORTHING: EASTING: ELEVATION		DRILLING START TIME 11:00 DATE 8/1/95; FINISH TIME 11:40 DATE 8/1/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS ROAD	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

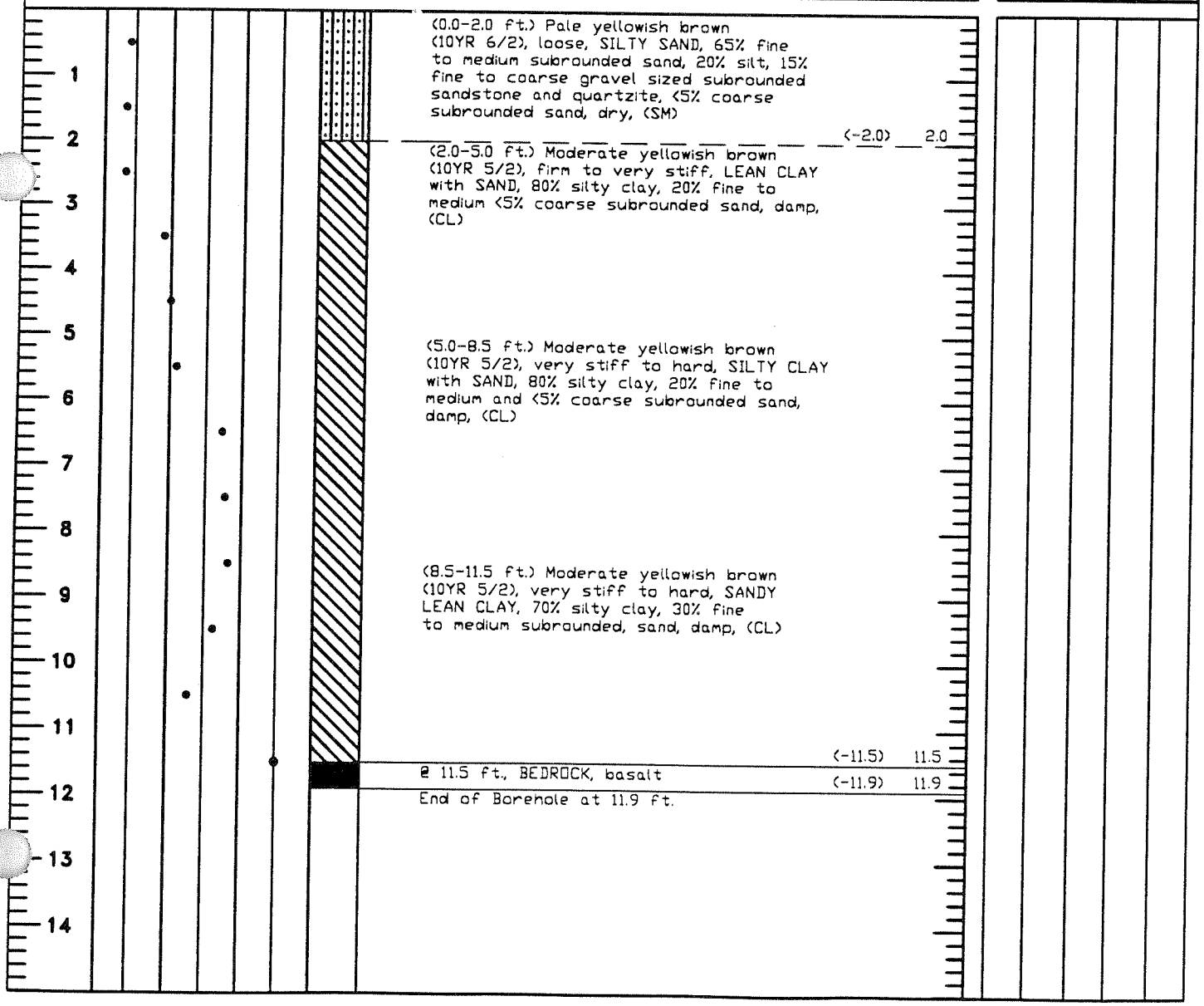
DRILLING CONTR LAYNE WESTERN EXPLORATION

LOGGED BY M.D. ALLOWAY

DATE SEPTEMBER 1995 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: BC-5



DESCRIPTION OF MATERIAL

(0.0-2.0 ft.) Pale yellowish brown (10YR 6/2), loose, SILTY SAND, 65% fine to medium subrounded sand, 20% silt, 15% fine to coarse gravel sized subrounded sandstone and quartzite, <5% coarse subrounded sand, dry, (SM)

(-2.0) 2.0

(2.0-5.0 ft.) Moderate yellowish brown (10YR 5/2), firm to very stiff, LEAN CLAY with SAND, 80% silty clay, 20% fine to medium <5% coarse subrounded sand, damp, (CL)

(5.0-8.5 ft.) Moderate yellowish brown (10YR 5/2), very stiff to hard, SILTY CLAY with SAND, 80% silty clay, 20% fine to medium and <5% coarse subrounded sand, damp, (CL)

(8.5-11.5 ft.) Moderate yellowish brown (10YR 5/2), very stiff to hard, SANDY LEAN CLAY, 70% silty clay, 30% fine to medium subrounded, sand, damp, (CL)

(-11.5) 11.5

@ 11.5 ft., BEDROCK, basalt

(-11.9) 11.9

End of Borehole at 11.9 ft.

TEST RESULTS	WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B20

SHEET 1 OF 1

DRILLING	START	FINISH
TIME	9:50	10:30
DATE	12/9/95	12/9/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DRILLING CONTR NORTH AMERICAN DRILLING

DEPTH IN FEET (ELEVATION)	SPT (N_{50}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-2.5 ft.) Dark yellowish orange (10YR 6/6), very loose to loose, SAND, fine to medium grain, <5% fine subangular gravel, dry (SP)					
2			(-2.5) 2.5					
3	>50		(2.5-4.0 ft.) BEDROCK, Sandstone					
4	>50		(-4.0) 4.0 End of Borehole at 4.0 ft.					
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: MFB20

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B21 SHEET 1 OF 1
NORTHING: EASTING: ELEVATION		DRILLING START TIME 10:35 DATE 12/9/95; FINISH TIME 11:10 DATE 12/9/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2769 1120 FILENAME: MFB21

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-2.5 ft.) Light brown (5YR 5/6) to dark yellowish orange (10YR 6/6), very loose to compact, SAND, fine to medium grain, <5% fine subangular gravel, dry (SP)					
2			(-2.5) 2.5					
3	>50		(2.5-5.0 ft.) BEDROCK, Sandstone					
4								
5			(-5.0) 5.0					
6			End of Borehole at 5.0 ft.					
7								
8								
9								
10								
11								
12								
13								
14								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: MF-B23
		SHEET: 1 OF 4
	SAMPLING METHOD: BULK	DRILLING: START TIME 13:10 / FINISH TIME 17:00
NORTHING: EASTING: ELEVATION		DATE: START 12/9/95 / FINISH 12/9/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DRILLING CONTR: NORTH AMERICAN DRILLING

LOGGED BY: L. BUSH/C. ROBINSON

DATE: FEBRUARY 1996 CHK'D BY: L. BUSH

JOB NO.: 943-27691170

FILENAME: MFB23

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-5.0 ft.) Light brown (5YR 5/6) to dark yellowish orange (10YR 6/6), compact, SAND, fine to medium grain, 10% fine to coarse subrounded gravel, <5% clay, dry (SP)					
2								
3								
4								
5			(-5.0) 5.0					
6			(5.0-8.0 ft.) Moderate yellowish brown (10YR 5/4), very stiff to hard, LEAN SILTY CLAY, 30% fine to medium sand, <5% to 10% f. gravel, dry, (CL)					
7	>50							
8			(-8.0) 8.0					
9	>50		(8.0-12.0 ft.) Moderate yellowish brown (10YR 5/4), hard, CLAYEY SILT, 20% fine to medium sand, <5% fine to coarse subrounded gravel, dry, (ML)					
10								
11								
12			(-12.0) 12.0					
13			(12.0-16.0 ft.) Grayish orange (10YR 7/4), loose to dense, SILTY SAND, fine grain, 40% clayey silt, <5% fine to coarse subrounded gravel, dry (SM)					
14								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B23

SHEET 2 OF 4

DRILLING

START	FINISH
TIME 13:10	TIME 17:00
DATE 12/9/95	DATE 12/9/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2769170

FILENAME: MFB23

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 80)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(12.0-16.0 ft.) Grayish orange (10YR 7/4), loose to dense, SILTY SAND, fine grain, 40% clayey silt, <5% fine to coarse subrounded gravel, dry (SM)					
			(-16.0) 16.0					
17			(16.0-19.0 ft.) Grayish orange (10YR 7/4), very stiff to hard, CLAYEY SILT, 30% fine sand, <5% fine subrounded gravel, dry (ML)					
18								
			(-19.0) 19.0					
19			(19.0-26.0 ft.) Grayish orange (10YR 7/4), dense to very dense, SILTY SAND, fine grained, 30% clayey silt, <5% fine to coarse subrounded gravel, dry (SM)					
20								
21								
22								
23								
24								
25								
			(-26.0) 26.0					
26			(26.0-47.0 ft.) Light brown (5YR 6/4), compact to dense, SAND, fine to medium grain, <5% to 10% fine to coarse subangular gravel, dry (SP)					
27								
28								
29								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B23

SHEET 3 OF 4

DRILLING	START	FINISH
TIME	13:10	17:00
DATE	12/9/95	12/9/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DRILLING CONTR NORTH AMERICAN DRILLING

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31			(26.0-47.0 ft.) Light brown (5YR 6/4), compact to dense, SAND, fine to medium grain, <5% to 10% fine to coarse subangular gravel, dry (SP)					
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 913-27691120

FILENAME: MFB23

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: MF-B23
	SAMPLING METHOD: BULK	SHEET: 4 OF 4
		DRILLING START TIME: 13:10 DATE: 12/9/95
		DRILLING FINISH TIME: 17:00 DATE: 12/9/95
NORTHING: EASTING: ELEVATION		
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS:	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER:		

DRILLING CONTR: NORTH AMERICAN DRILLING

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
46			(26.0-47.0 ft.) Light brown (5YR 6/4), compact to dense, SAND, fine to medium grain, <5% to 10% fine to coarse subangular gravel, dry (SP)					
47			(-47.0) 47.0					
48	>50		(47.0-49.0 ft.) Moderate yellowish brown (10YR 5/4), compact to dense, SAND, fine to medium grain, <5% to 20% clay, 10% fine gravel, (SP-SC)					
49			(-49.0) 49.0					
50			(49.0-51.0 ft.) BEDROCK, Sandstone					
51			(-51.0) 51.0					
52			End of Borehole at 51.0 ft.					
53								
54								
55								
56								
57								
58								
59								

LOGGED BY: L. BUSH/C. ROBINSON
DATE: FEBRUARY 1996 CHK'D BY: L. BUSH

JOB NO.: 943-2769.170
FILENAME: MFB23

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: MF-B24
	SAMPLING METHOD: BULK	SHEET: 1 OF 4
NORTHING: EASTING: ELEVATION		DRILLING START TIME: 14:15 DATE: 12/11/95; FINISH TIME: 17:40 DATE: 12/11/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS:	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER:		

DRILLING CONTR: NORTH AMERICAN DRILLING

LOGGED BY: L. BUSH/C. ROBINSON CHK'D BY: L. BUSH

DATE: FEBRUARY 1996

JOB NO.: 943-27691170

FILENAME: MFB24

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %; LIQUID LIMIT %; PLASTICITY INDEX %; LESS THAN NO. 200; OTHER TESTS
1			(0.0-10.0 ft.) Moderate yellowish brown (10YR 5/4) to moderate brown (5YR 4/4), firm to hard, LEAN SILTY CLAY, 10% fine to medium sand, 10% fine subrounded gravel, <5% roots, dry, (CL)	
2				
3				
4				
5				
6				
7				
8				
9				
10			(10.0-14.0 ft.) Moderate yellowish brown (10YR 5/4), hard, sandy LEAN SILTY CLAY, 25% fine to medium sand, 5% fine subrounded to subangular gravel, <5% carbon, 4" sandstone cobble at 10', damp, (CL)	
11				
12				
13			(-14.0) 14.0	
14	>50		(14.0-57.7 ft.) Moderate yellowish brown (10YR 5/4), compact to very dense, interbedded SILTY SAND and SAND, <5% to 20% fine subrounded to subangular gravel, <5% subrounded to subangular sandstone cobbles to 4.5", 6" silty clay seams at 34' and 55', dry, (SM and SP)	

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B24

SHEET 2 OF 4

DRILLING	START	FINISH
TIME	14:15	17:40
DATE	12/11/95	12/11/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DRILLING CONTR NORTH AMERICAN DRILLING

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(14.0-57.7 ft.) Moderate yellowish brown (10YR 5/4), compact to very dense, interbedded SILTY SAND and SAND, <5% to 20% fine subrounded to subangular gravel, <5% subrounded to subangular sandstone cobbles to 4.5", 6" silty clay seams at 34' and 55', dry, (SM and SP)					
17								
18								
19								
20								
21	>50							
22								
23								
24								
25								
26								
27								
28								
29								

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2762/1170

FILENAME: MFB24

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK
NORTHING: EASTING: ELEVATION	BORING NO. MF-B24 SHEET 3 OF 4 DRILLING START TIME 14:15 DATE 12/11/95 DRILLING FINISH TIME 17:40 DATE 12/11/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS
ANGLE: VERTICAL BEARING: NA	
SAMPLE HAMMER	

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31 32 33 34 35 36 37 38 39 40 41 42 43 44			(14.0-57.7 ft.) Moderate yellowish brown (10YR 5/4), compact to very dense, interbedded SILTY SAND and SAND, <5% to 20% fine subrounded to subangular gravel, <5% subrounded to subangular sandstone cobbles to 4.5", 6" silty clay seams at 34' and 55', dry, (SM and SP)					

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-27691120

FILENAME: MFB24

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B24

SHEET 4 OF 4

DRILLING	START	FINISH
TIME	14:15	17:40
DATE	12/11/95	12/11/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: MFB24

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10, 20, 30, 40, 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
46			(14.0-57.7 ft.) Moderate yellowish brown (10YR 5/4), compact to very dense, interbedded SILTY SAND and SAND, <5% to 20% fine subrounded to subangular gravel, <5% subrounded to subangular sandstone cobbles to 4.5", 6" silty clay seams at 34' and 55', dry, (SM and SP)					
47								
48								
49								
50								
51								
52								
53								
54								
55	>50							
56								
57								
58			(-57.7) 57.7 (57.7-59.0 ft.) BEDROCK, Basalt					
59			(-59.0) 59.0 End of Borehole at 59.0 ft.					

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B25 SHEET 1 OF 4
NORTHING: EASTING: ELEVATION		DRILLING START TIME 9:15 DATE 12/12/95; FINISH TIME 13:30 DATE 12/12/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2769170 FILENAME: MFB25

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 80)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-7.0 ft.) Moderate brown (5YR 4/4), soft to very stiff, LEAN SILTY CLAY, 20% to 30% fine to medium sand, 10% fine subangular gravel, <5% roots, damp to dry, (CL)					
2								
3								
4								
5								
6								
7			(-7.0) 7.0					
8			(7.0-9.0 ft.) Dark yellowish brown (10YR 6/6), compact, SAND, 10% fine to coarse subrounded gravel, 10% silty clay, dry (SP-SC)					
9			(-9.0) 9.0					
10			(9.0-13.0 ft.) Moderate brown (5YR 4/4), very stiff to hard, LEAN SILTY CLAY, 10% fine to coarse sand, <5% fine to coarse subrounded to rounded gravel, quartzite cobble at 11', damp (CL)					
11								
12								
13			(-13.0) 13.0					
14			(13.0-21.0 ft.) Moderate brown (5YR 4/4), compact to dense, SILTY SAND, 10% fine to coarse subrounded to rounded gravel, 10% silty clay, dry (SM)					

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B25 SHEET 2 OF 4
NORTHING: EASTING: ELEVATION		DRILLING START TIME 9:15 DATE 12/12/95; FINISH TIME 13:30 DATE 12/12/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(13.0-21.0 ft.) Moderate brown (5YR 4/4), compact to dense, SILTY SAND, 10% fine to coarse subrounded to rounded gravel, 10% silty clay, dry (SM)					
17								
18								
19								
20								
21			(-21.0) 21.0					
22			(21.0-59.0 ft) Moderate brown (5YR 4/4), dense and hard, interbedded SILTY SAND and LEAN SILTY CLAY, fine to medium grain sand, <5% fine to coarse gravel, 1% quartzite and sandstone cobbles, calcareous stringers at 38' to 38.5' and at 55', damp to dry, (SM and CL)					
23								
24								
25								
26								
27								
28								
29								

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON CHK'D BY L. BUSH

DATE FEBRUARY 1996

JOB NO.: 943-27691170

FILENAME: MFB25

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B25 SHEET 3 OF 4 DRILLING START TIME 9:15 DATE 12/12/95 DRILLING FINISH TIME 13:30 DATE 12/12/95
NORTHING: EASTING: ELEVATION		
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/G. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2769.1120

FILENAME: MFB25

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31			(21.0-59.0 ft) Moderate brown (5YR 4/4), dense and hard, interbedded SILTY SAND and LEAN SILTY CLAY, fine to medium grain sand, <5% fine to coarse gravel, 1% quartzite and sandstone cobbles, calcareous stringers at 38' to 38.5' and at 55', damp to dry, (SM and CL)					
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B25

SHEET 4 OF 4

DRILLING	START	FINISH
TIME	9:15	13:30
DATE	12/12/95	12/12/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
46			(21.0-59.0 ft) Moderate brown (5YR 4/4), dense and hard, interbedded SILTY SAND and LEAN SILTY CLAY, fine to medium grain sand, <5% fine to coarse gravel, 1% quartzite and sandstone cobbles, calcareous stringers at 38' to 38.5' and at 55', damp to dry, (SM and CL)					
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59	>50		(59.0-59.5 ft.) BEDROCK, Basalt (-59.0) 59.0					
			End of Borehole at 59.5 ft. (-59.5) 59.5					

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: MFB25

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B26 SHEET 1 OF 2
NORTHING: EASTING: ELEVATION		DRILLING START TIME 15:05 DATE 12/12/95; FINISH TIME 16:23 DATE 12/12/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON CHK'D BY L. BUSH

DATE FEBRUARY 1996

JOB NO.: 943-2769170

FILENAME: MFB26

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-3.0 ft.) Grayish orange (10YR 7/4), soft to firm, SILT, <5% fine sand, dry (ML)					
2								
3			(-3.0) 3.0					
4			(3.0-5.0 ft.) Pale yellowish brown (10YR 6/2) to light brown (5YR 6/4), loose, SAND, fine to medium grain, <5% coarse sand, 20% fine to coarse subangular gravel to 3", dry (SP)					
5			(-5.0) 5.0					
6			(5.0-15.0 ft.) Light brown, (5YR 6/4), firm to hard, LEAN SILTY CLAY, and SILTY SAND, fine grained, <5% fine gravel, dry (CL)					
7								
8								
9								
10								
11								
12								
13								
14								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION: MINER FLAT DAM, SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER	BORING NO.: MF-B26
	SAMPLING METHOD: BULK	SHEET: 2 OF 2
NORTHING: EASTING: ELEVATION		DRILLING: START TIME 15:05 DATE 12/12/95; FINISH TIME 16:23 DATE 12/12/95
DRILL RIG: AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE: VERTICAL BEARING: NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(15.0-17.0 ft.) Pale yellowish brown (10YR 6/2), dense to very dense, SAND, fine grained, 10% silty clay, dry, (SP)					
17	>50		(-17.0) 17.0 (17.0-18.0 ft) BEDROCK, Sandstone					
18	>50		(-18.0) 18.0 End of Borehole at 18.0 ft.					
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								

DRILLING CONTR: NORTH AMERICAN DRILLING

LOGGED BY: L. BUSH/C. ROBINSON CHK'D BY: L. BUSH

DATE: FEBRUARY 1996

JOB NO.: 943-2769.1170

FILENAME: MFB26

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B27

SHEET 1 OF 1

DRILLING	START	FINISH
TIME	16:35	17:16
DATE	12/12/95	12/12/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2769-1170

FILENAME: MFB27

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-3.0 ft.) Grayish orange (10YR 7/4), very loose to loose, SAND and LEAN SILTY CLAY, fine grain, <5% fine gravel, dry (SP and CL)					
2								
3			(-3.0) 3.0					
4			(3.0-5.0 ft.) Pale yellowish brown (10YR 6/2), compact, SAND, fine to medium grain, <5% fine subangular gravel, dry (SP)					
5			(-5.0) 5.0					
6			(5.0-11.0 ft.) Pale brown (5YR 5/6), compact to dense, SAND and LEAN SILTY CLAY, <5% fine to coarse gravel, dry (SP and CL)					
7								
8								
9								
10								
11			(-11.0) 11.0					
12			(11.0-14.0 ft.) Light brown (5YR 5/6), dense, SAND, fine grain, <5% silty clay, dry, (SP)					
13								
14			(-14.0) 14.0					
			(14.0-14.3 ft.) Light brown (5YR 5/6), hard, LEAN SILTY CLAY, 10% fine sand, dry, (CL)					
			(-14.3) 14.3					
	>50		(14.3-15.0 ft.) BEDROCK, Basalt					
			End of Borehole at 15.0 ft.					

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B28 SHEET 1 OF 1 DRILLING START TIME 7:55 DATE 12/13/95 DRILLING FINISH TIME 10:15 DATE 12/13/95
NORTHING: EASTING: ELEVATION		
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-3.0 ft.) Dark yellowish orange (10YR 6/6) to pale yellowish brown (10YR 6/2), loose to compact, SAND, fine grain, 10% fine angular gravel, dry (SP)					
2								
3			(-3.0) 3.0					
3			(3.0-4.5 ft.) Moderate brown (5YR 4/4), very stiff, LEAN SILTY CLAY, 20% fine to medium sand, <5% fine gravel, dry, (CL)					
4			(-4.5) 4.5					
5			(4.5-5.0 ft.) Light brown (5YR 5/6), dense, SAND, fine to medium grain, 10% to 20% fine to coarse subangular to subrounded gravel, <5% silty clay, dry (SP)					
5	>50		(-5.0) 5.0					
6			(5.0-10.2 ft.) BEDROCK, Sandstone					
6	>50							
7								
7	>50							
8								
8	>50							
9								
9	>50							
10			(-10.2) 10.2					
10			End of Borehole at 10.2 ft.					
11								
12								
13								
14								

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: MFB28

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B29

SHEET 1 OF 1

DRILLING	START	FINISH
TIME	10:25	10:45
DATE	12/13/95	12/13/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL **BEARING** NA

SAMPLE HAMMER

SURFACE CONDITIONS

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
0			(0.0-6.0 ft.) Moderate yellowish brown (10YR 5/4) to light brown (5YR 5/6), loose to dense, SAND, fine to medium grain, 10% fine to coarse subangular gravel, <5% clay, dry (SP)					
6			(-6.0) 6.0 (6.0-9.0 ft.) BEDROCK, Sandstone					
9			(-9.0) 9.0 End of Borehole at 9.0 ft.					

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/G. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-27691170

FILENAME: MFB29

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B30 SHEET 1 OF 1 DRILLING START TIME 11:00 DATE 12/13/95 DRILLING FINISH TIME 11:30 DATE 12/13/95
NORTHING: EASTING: ELEVATION		
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/G. ROBINSON CHK'D BY L. BUSH

DATE FEBRUARY 1996

JOB NO.: 943-2769.1170

FILENAME: MFB30

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10, 20, 30, 40, 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-3.5 ft.) Moderate yellowish brown (10YR 5/4), loose to compact, SAND, fine to medium grain, <5% fine angular gravel, dry (SP)					
2								
3								
(-3.5) 3.5								
4			(3.5-9.0 ft.) BEDROCK, Sandstone					
5								
6								
7								
8								
(-9.0) 9.0								
9			End of Borehole at 9.0 ft.					
10								
11								
12								
13								
14								

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B31 SHEET 1 OF 2
NORTHING: EASTING: ELEVATION		DRILLING START TIME 12:30 DATE 12/13/95; FINISH TIME 13:55 DATE 12/13/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR: NORTH AMERICAN DRILLING

LOGGED BY: L. BUSH/C. ROBINSON

DATE: FEBRUARY 1996 CHK'D BY: L. BUSH

JOB NO.: 943-27691120

FILENAME: MFB31

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 80)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1	•		(0.0-3.0 ft.) Pale yellowish brown (10YR 6/2), very loose to loose, SILTY SAND, fine to medium grain, <5% fine to coarse subrounded gravel, dry (SM)					
2	•							
3	•		(-3.0) 3.0					
4	•		(3.0-12.0 ft.) Moderate yellowish brown (10YR 6/2) to moderate brown (5YR 4/4), firm to hard, LEAN SILTY CLAY, 5% to 40% fine sand, 10% fine subrounded gravel, dry (CL)					
5	•							
6	•							
7	•							
8	•							
9	•							
10	•							
11	•							
12	•		(-12.0) 12.0					
13	•		(12.0-18.0 ft.) Moderate yellowish brown (10YR 6/2) to moderate brown (5YR 4/4), dense, CLAYEY SAND, fine grain, 40% silty clay, <5% fine gravel, dry (SC)					
14	•							

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B31 SHEET 2 OF 2 DRILLING START TIME 12:30 DATE 12/13/95 DRILLING FINISH TIME 13:55 DATE 12/13/95
NORTHING: EASTING: ELEVATION		
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
16			(12.0-18.0 ft.) Moderate yellowish brown (10YR 6/2) to moderate brown (5YR 4/4), dense, CLAYEY SAND, fine grain, 40% silty clay, <5% fine gravel, dry (SC)					
17								
18	>50		(-18.0) 18.0 (18.0-18.5 ft.) BEDROCK, Basalt (-18.5) 18.5					
19			End of Borehole at 18.5 ft.					
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON CHK'D BY L. BUSH

DATE FEBRUARY 1996

JOB NO.: 943-27691170

FILENAME: MFB31

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B32

SHEET 1 OF 4

DRILLING	START	FINISH
TIME	14:20	16:00
DATE	12/13/95	12/13/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
1			(0.0-3.0 ft.) Moderate yellowish brown (10YR 5/4), very loose to loose, SAND, fine to medium grain, dry, (SP)					
2								
3			(-3.0) 3.0					
4			(3.0-3.5 ft.) Moderate brown (5YR 4/4), very stiff, LEAN SANDY SILTY CLAY, fine to medium grain, dry (CL) (-3.5) 3.5					
5			(3.5-6.0 ft.) Light brown (5YR 5/6), loose to compact, CLAYEY SAND, fine to medium grain, <5% fine to coarse subangular gravel to 4%, damp (SC)					
6			(-6.0) 6.0					
7			(6.0-29.0 ft.) Moderate brown (5YR 4/4), compact to dense, SAND, fine to medium grain, <5% clay, <5% to 20% fine subangular gravel, <5% sandstone cobbles to 4", dry (SP)					
8								
9								
10								
11								
12								
13								
14								

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON CHK'D BY L. BUSH

DATE FEBRUARY 1996

JOB NO.: 943-27691170

FILENAME: MFB32

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION MINER FLAT DAM SANDSTONE RIDGE	DRILLING METHOD: BECKER HAMMER SAMPLING METHOD: BULK	BORING NO. MF-B32 SHEET 2 OF 4
NORTHING: EASTING: ELEVATION		DRILLING START TIME 14:20 DATE 12/13/95; FINISH TIME 16:00 DATE 12/13/95
DRILL RIG AP1000 BECKER HAMMER	SURFACE CONDITIONS	
ANGLE VERTICAL BEARING NA		
SAMPLE HAMMER		

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2769/170

FILENAME: MFB32

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %; LIQUID LIMIT %; PLASTICITY INDEX %; LESS THAN NO. 200; OTHER TESTS
16			(6.0-29.0 ft.) Moderate brown (5YR 4/4), compact to dense, SAND, fine to medium grain, <5% clay, <5% to 20% fine subangular gravel, <5% sandstone cobbles to 4", dry (SP)	
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28			(-29.0) 29.0	
29			(29.0-47.5 ft.) Moderate reddish orange (10R 6/6) to moderate orange pink (10R 7/4), compact to very dense, interbedded CLAYEY SAND and SAND, fine to medium grain, <5% to 20% fine to coarse gravel, dry, (SC and SP)	

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B32

SHEET 3 OF 4

DRILLING	START	FINISH
TIME	14:20	16:00
DATE	12/13/95	12/13/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 50)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
31			(29.0-47.5 ft.) Moderate reddish orange (10R 6/6) to moderate orange pink (10R 7/4), compact to very dense, interbedded CLAYEY SAND and SAND, fine to medium grain, <5% to 20% fine to coarse gravel, dry, (SC and SP)					
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44	>50							

DRILLING CONTR NORTH AMERICAN DRILLING

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2769.1120

FILENAME: MFB32

SOIL BOREHOLE LOG

Golder Associates

SITE NAME AND LOCATION

MINER FLAT DAM
SANDSTONE RIDGE

NORTHING:
EASTING: ELEVATION

DRILLING METHOD: BECKER HAMMER

SAMPLING METHOD: BULK

BORING NO. MF-B32

SHEET 4 OF 4

DRILLING	START	FINISH
TIME	14:20	16:00
DATE	12/13/95	12/13/95

DRILL RIG AP1000 BECKER HAMMER

ANGLE VERTICAL BEARING NA

SAMPLE HAMMER

SURFACE CONDITIONS

DRILLING CONTR NORTH AMERICAN DRILLING

DEPTH IN FEET (ELEVATION)	SPT (N_{60}) EQUIVALENT BLOWCOUNT FROM BECKER HAMMER BLOW COUNTS (10 20 30 40 60)	SYMBOL	DESCRIPTION OF MATERIAL	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	LESS THAN NO. 200	OTHER TESTS
46			(29.0-47.5 ft.) Moderate reddish orange (10R 6/6) to moderate orange pink (10R 7/4), interbedded CLAYEY SAND and SAND, fine to medium grain, <5% to 20% fine to coarse gravel, dry, (SC and SP)					
47								
	>50		(-47.5) 47.5					
48			(47.5-49.0 ft.) BEDROCK, Sandstone					
	>50							
49			(-49.0) 49.0					
			End of Borehole at 49.0 ft.					
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								

LOGGED BY L. BUSH/C. ROBINSON

DATE FEBRUARY 1996 CHK'D BY L. BUSH

JOB NO.: 943-2769\170

FILENAME: MFB32

APPENDIX B

LABORATORY TESTS RESULTS

TABLE 1
SUMMARY OF SOIL DATA

Project Name: MMCSSA/MINER FLAT/AZ
Location: ARIZONA
Project Number: 943-27691.170

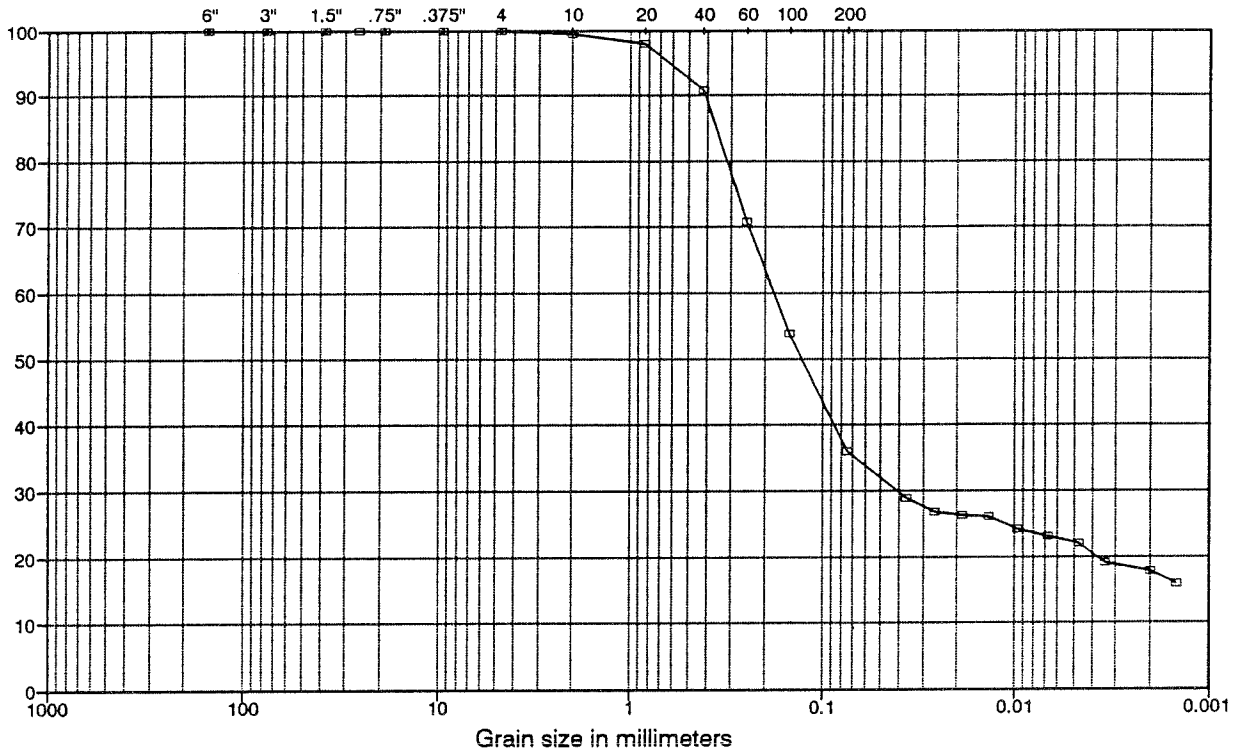
BORING NO.	SAMPLE NO.	SAMPLE DEPTH (ft)	USCS SOIL CLASSI-FICATION	NATURAL MOISTURE %	ATTERBERG LIMITS				GRAIN SIZE DISTRIBUTION		SPECIFIC GRAVITY	MOIST/DEN RELATIONSHIP STANDARD PROCTOR		ADDITIONAL TESTS COMMENTS (SEE NOTES)
					L.L.	P.L.	P.I.	S.L.	% FINER NO. 4 SIEVE	% FINER NO. 200 SIEVE		PCF(DRY)	MOIST(%)	
BA-1	--	35-40'	--	--	--	--	--	--	100	36	2.57	127.0	9.5	--
BA-2	--	35-40'	SC	--	27	12	15	--	100	50	2.57	124.5	11.0	--
BA-2	--	40-45'	--	--	30	13	17	--	--	--	--	--	--	--
BA-3	--	30-35'	CL	--	29	14	15	--	100	51	2.60	--	--	--
BA-3	--	35-40'	CL	--	34	16	18	--	100	62	2.64	--	--	--
BA-4	--	30-35'	CL	--	40	17	23	--	100	67	2.58	115.0	15.0	--
BA-4	--	35-40'	CL	--	35	19	16	--	100	71	2.65	--	--	--
BA-5	--	30-35'	CL	--	34	17	17	--	100	65	2.63	113.0	15.5	--
BA-5	--	35-39	CL	--	38	18	20	--	100	70	2.63	--	--	--
BA-6	--	25-30'	CL	--	37	15	22	--	100	57	2.66	--	--	--
BA-6	--	30-35'	CL	--	34	16	18	--	100	54	2.64	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

NOTES:
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
PI = PLASTIC INDEX
SL = SHRINKAGE LIMIT

T = TRIAXIAL TEST
U = UNCONFINED COMPRESSION TEST
C = CONSOLIDATION TEST
P = PROCTOR TEST
DS = DIRECT SHEAR TEST
Perm = PERMEABILITY

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS	Coarse	Fine	Cor	Med	Fine	
COBBLES	GRAVEL		SAND			FINES (Silt and Clay)

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-1	--	--	--	--	2.57	Coarse to fine SAND and FINES
SAMPLE NO.							
DEPTH	35-40'						

Sample Type: Date Tested: 10/19/95 USCS: ---

TECH: RCS
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

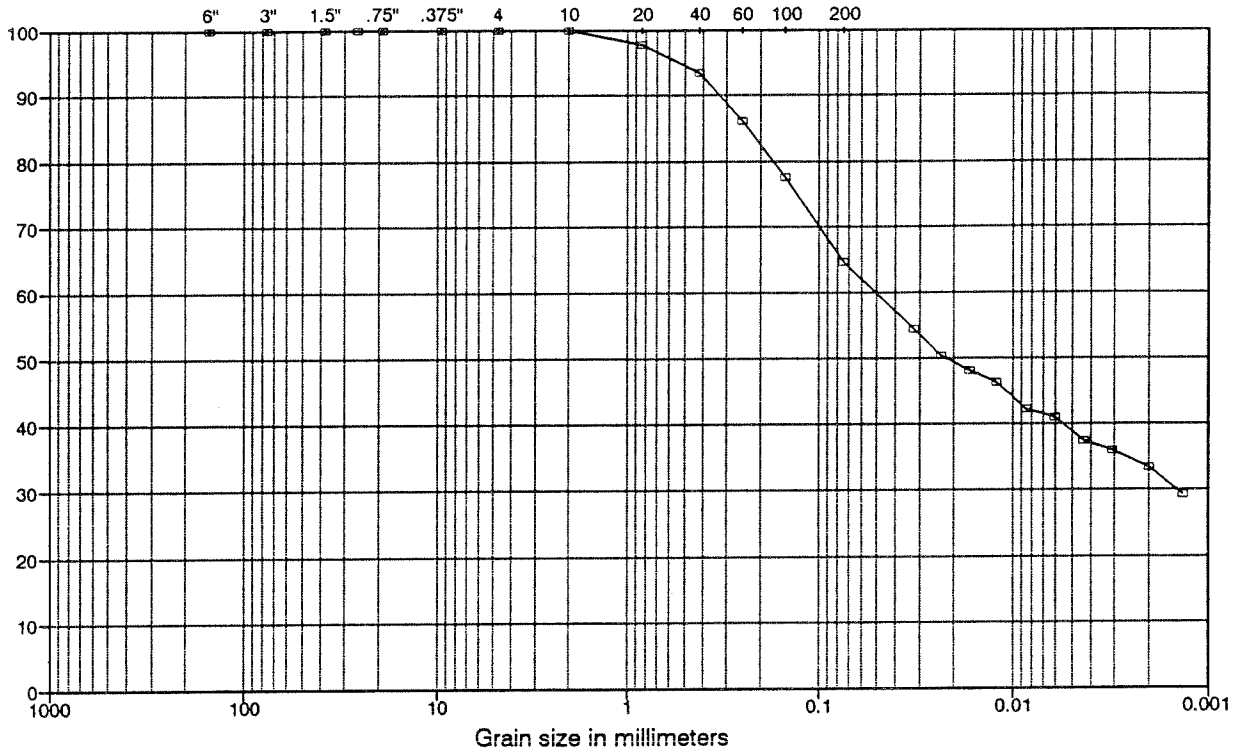
MMCSSA/MINER FLAT/AZ
943-27691.170

FILENAME: Z769140

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS	COBBLES	GRAVEL		SAND			FINES (Silt and Clay)
		Coarse	Fine	Cor	Med	Fine	

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-5	--	34	17	17	2.63	Silty CLAY and medium to fine SAND
SAMPLE NO.							
DEPTH	30-35'						
Sample Type:		Date Tested: 10/18/95					USCS: CL

TECH: RCS
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

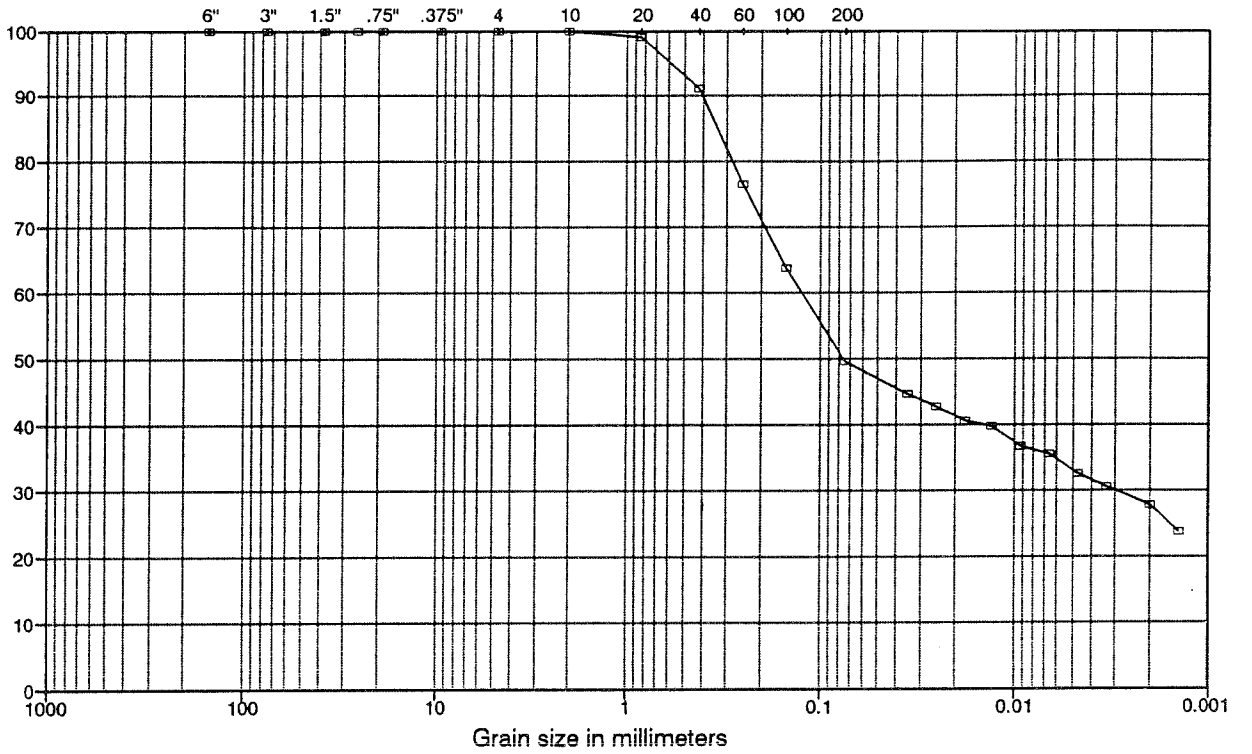
MMCSSA/MINER FLAT/AZ
943-27691.170

FILENAME: 2769535

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS	Coarse	Fine	Cor	Med	Fine	
COBBLES	GRAVEL		SAND			FINES (Silt and Clay)

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-2	--	27	12	15	2.57	Medium to fine SAND and silty CLAY
SAMPLE NO.							
DEPTH	35-40'						

Sample Type: Date Tested: 10/19/95 USCS: SC

TECH: BRB
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

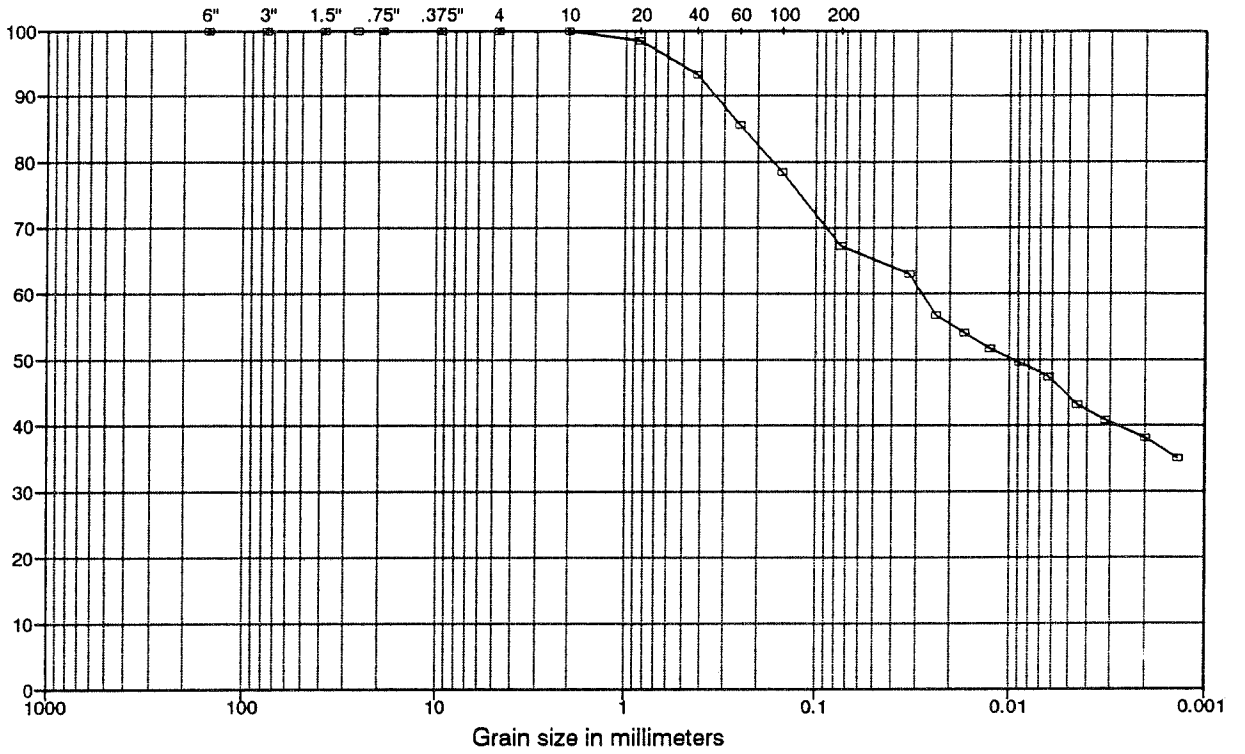
MMCSSA/MINER FLAT/AZ
943-27691.170

FILENAME: 2769240

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS	Coarse	Fine	Cor	Med	Fine	
COBBLES	GRAVEL		SAND			FINES (Silt and Clay)

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-4	--	40	17	23	2.58	Silty CLAY and medium to fine SAND
SAMPLE NO.							
DEPTH	30-35'						

Sample Type: Date Tested: 10/19/95 USCS: CL

TECH: RCS
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

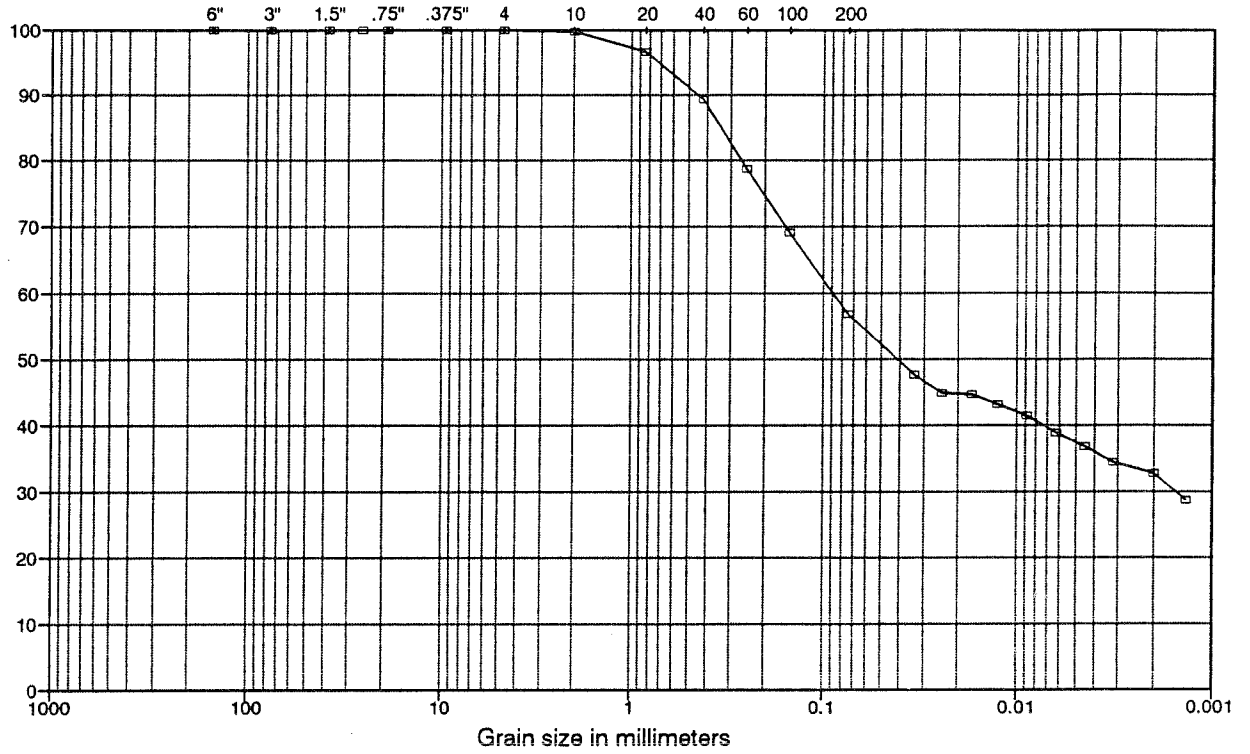
MMCSSA/MINER FLAT/AZ
943-27691.170

FILENAME: 276935

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS	Coarse	Fine	Cor	Med	Fine	
COBBLES	GRAVEL		SAND			FINES (Silt and Clay)

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-6	--	37	15	22	2.66	Silty CLAY and medium to fine SAND
SAMPLE NO.							
DEPTH	25-30'						

Sample Type: Date Tested: 10/18/95 USCS: CL

TECH: RCS
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

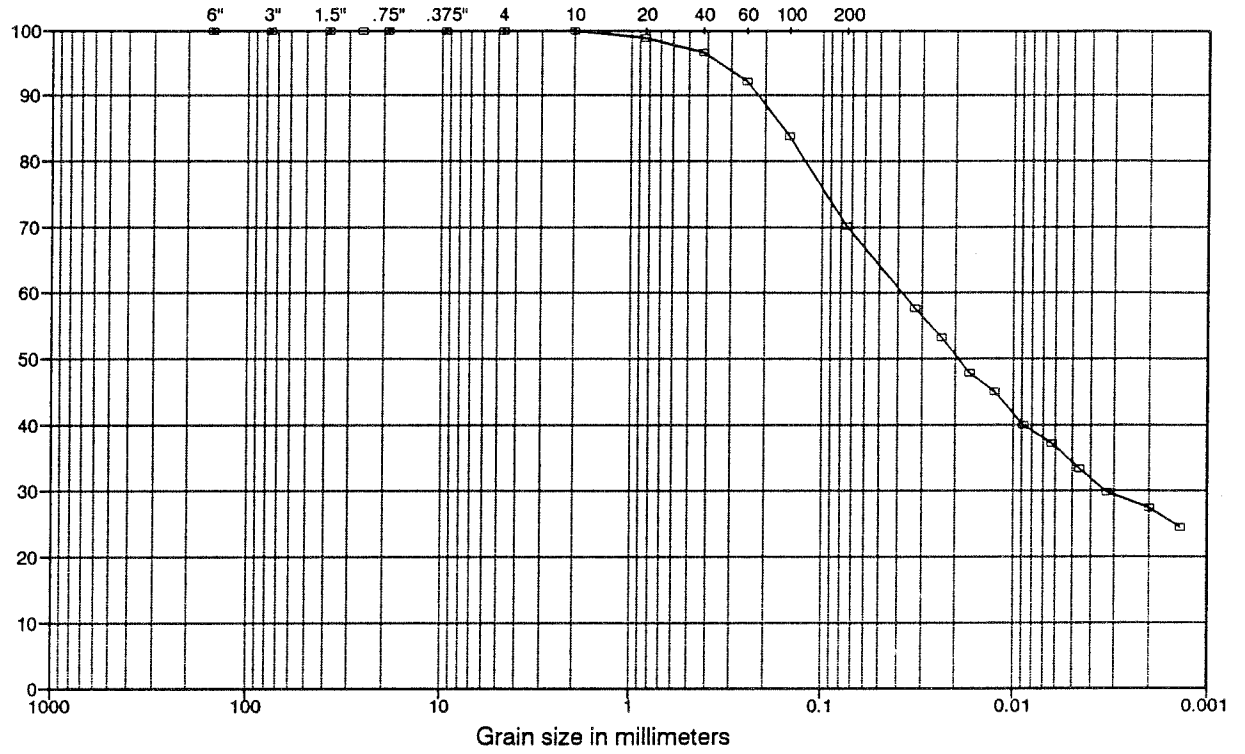
MMCSSA/MINER FLAT/AZ
943-27691.170

FILENAME: Z769630

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS

COBBLES	Coarse	Fine	Cor	Med	Fine	FINES (Silt and Clay)
	GRAVEL		SAND			

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-5	--	38	18	20	2.63	Silty CLAY with some medium to fine sand
SAMPLE NO.							
DEPTH	35-39'						

Sample Type: Date Tested: 10/18/95 USCS: CL

TECH: RCS
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

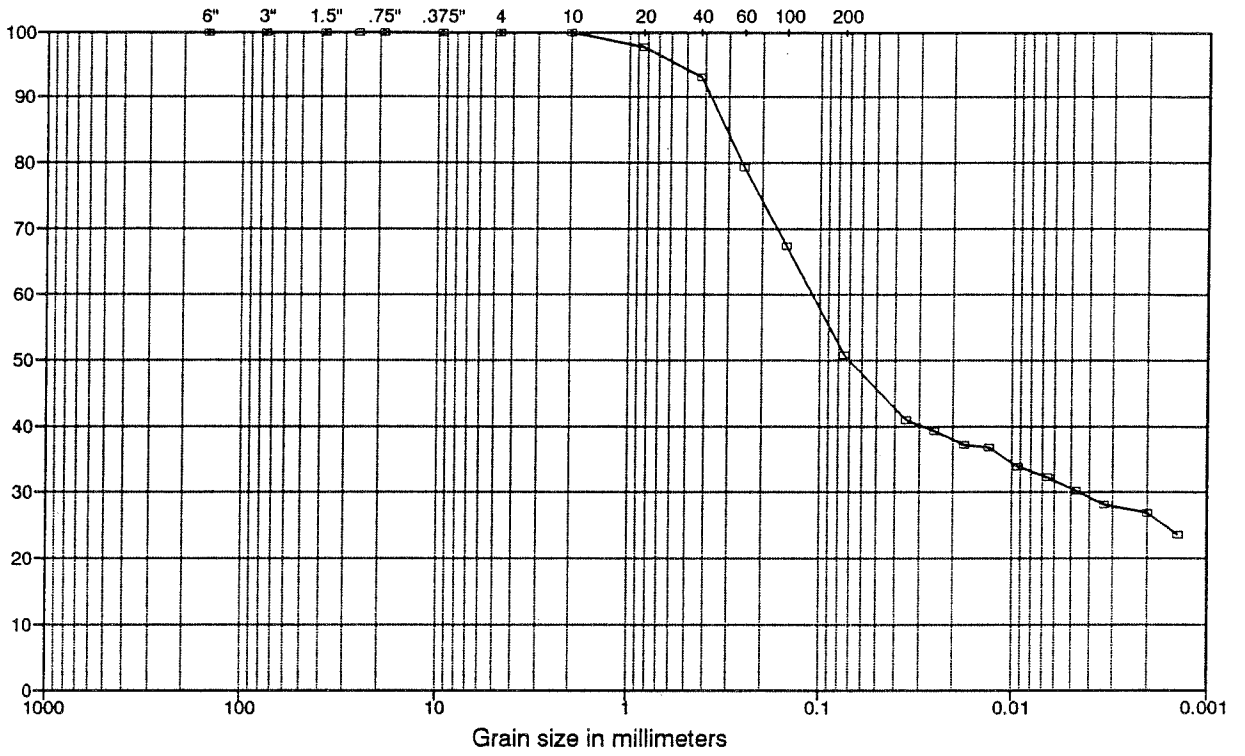
MMCSSA/MINER FLAT/AZ
943-27691.170

FILENAME: 2769539

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS	Coarse	Fine	Cor	Med	Fine	
COBBLES	GRAVEL		SAND			FINES (Silt and Clay)

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-3	--	29	14	15	2.60	Silty CLAY and medium to fine SAND
SAMPLE NO.							
DEPTH	30-35'						

Sample Type: Date Tested: 10/18/95 USCS: CL

TECH: RCS
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

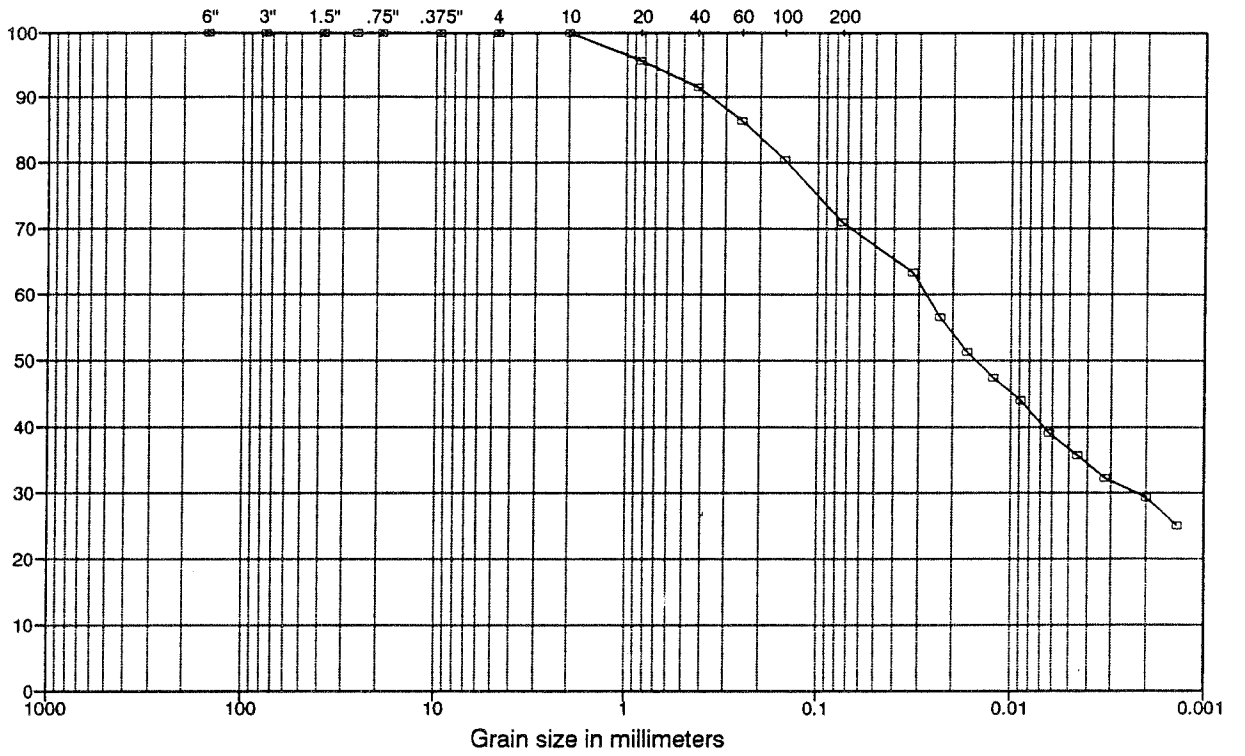
MMCSSA/MINER FLAT/AZ
943-2769.170

FILENAME: 2769335

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS	COBBLES	GRAVEL		SAND			FINES (Silt and Clay)
		Coarse	Fine	Cor	Med	Fine	

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-4	--	35	19	16	2.65	Silty CLAY with some medium to fine sand
SAMPLE NO.							
DEPTH	35-40'						

Sample Type: Date Tested: 10/19/95 USCS: CL

TECH: BRB
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

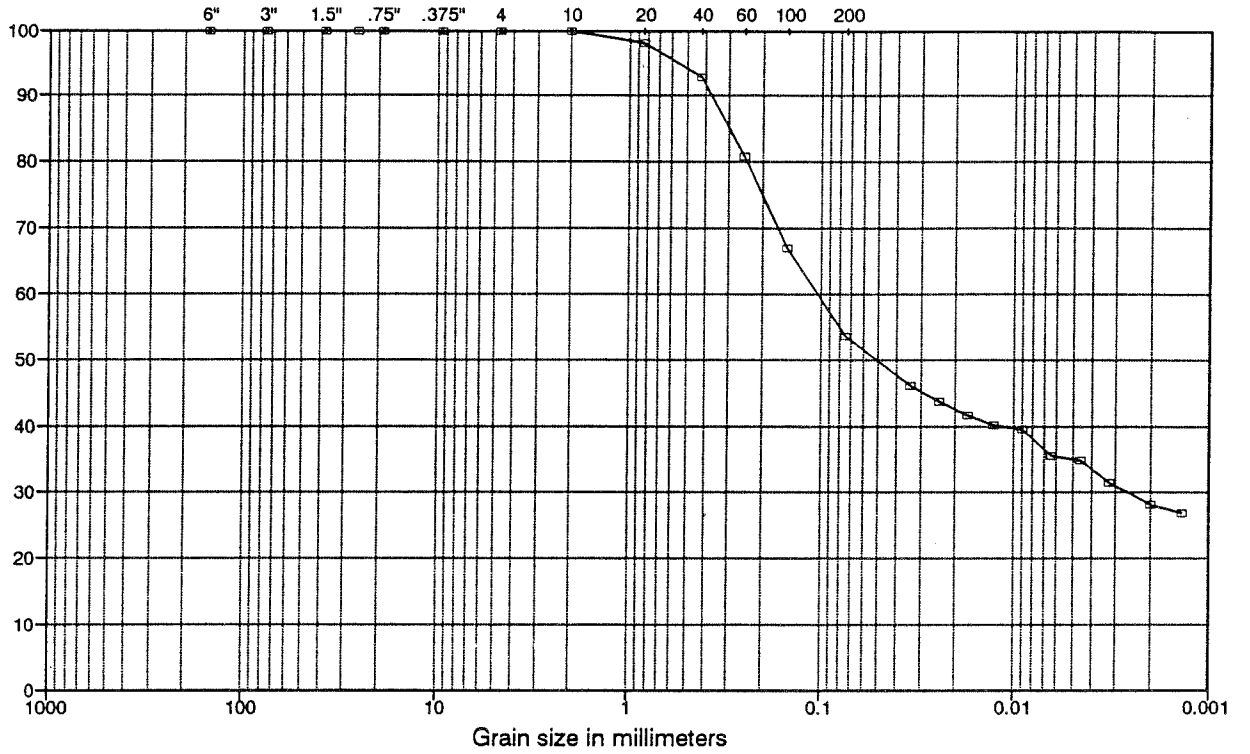
MMCSSA/MINER FLAT/AZ
943-27691.170

FILENAME: 27691A0

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



USCS

COBBLES	Coarse	Fine	Cor	Med	Fine	FINES (Silt and Clay)
	GRAVEL		SAND			

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-6	--	34	16	18	2.64	Silty CLAY and medium to fine SAND
SAMPLE NO.							
DEPTH	30-35'						
Sample Type:		Date Tested: 10/19/95					USCS: CL

TECH: RCS
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

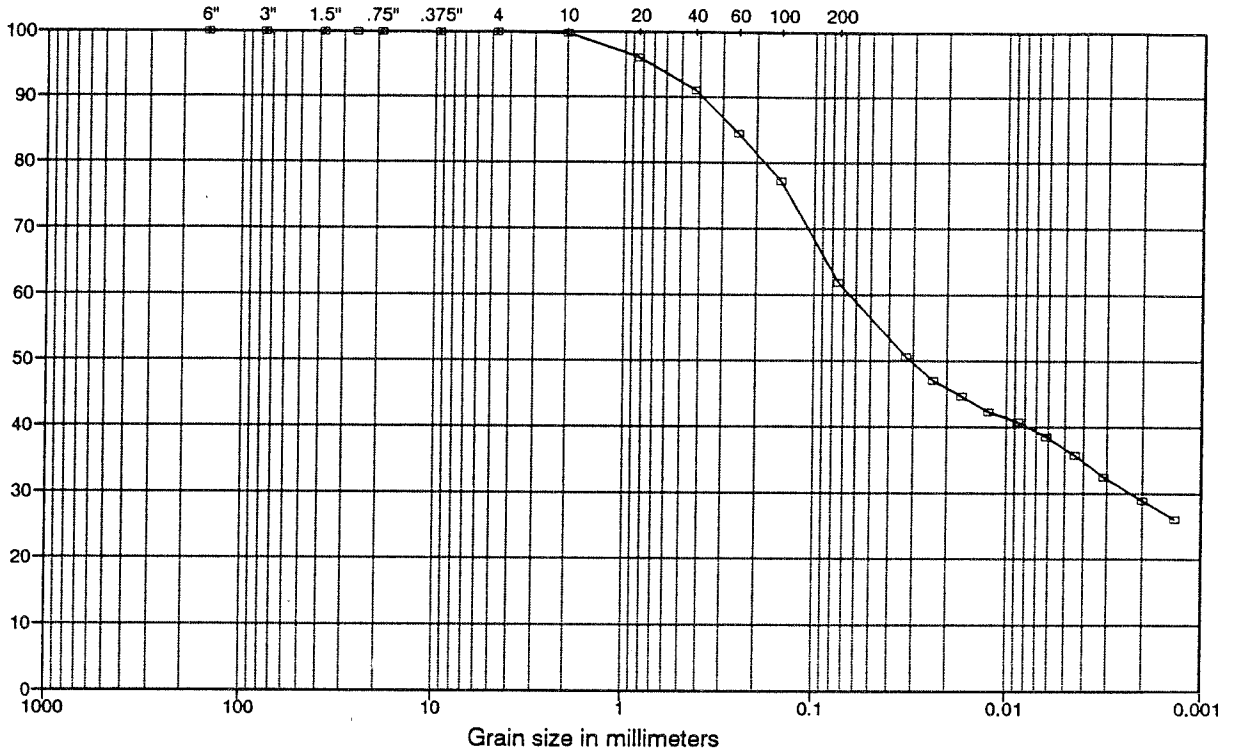
MMCSSA/MINER FLAT/AZ
943-27691.170

FILENAME: 2769635

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE SIZE DISTRIBUTION ASTM D421 AND D422

US STANDARD SIEVE OPENING SIZES



% PASSING

USCS

COBBLES	Coarse	Fine	Cor	Med	Fine	FINES (Silt and Clay)
	GRAVEL		SAND			

SAMPLE ID		W%	LL	PL	PI	Gs	DESCRIPTION
BOREHOLE	BA-3	--	34	16	18	2.64	Silty CLAY and medium to fine SAND
SAMPLE NO.							
DEPTH	35-40'						

Sample Type: Date Tested: 10/18/95 USCS: CL

TECH: RCS
DATE: 10/23/95
CHECKED: ASF
REVIEWED:

MMCSSA/MINER FLAT/AZ
943-27691.170

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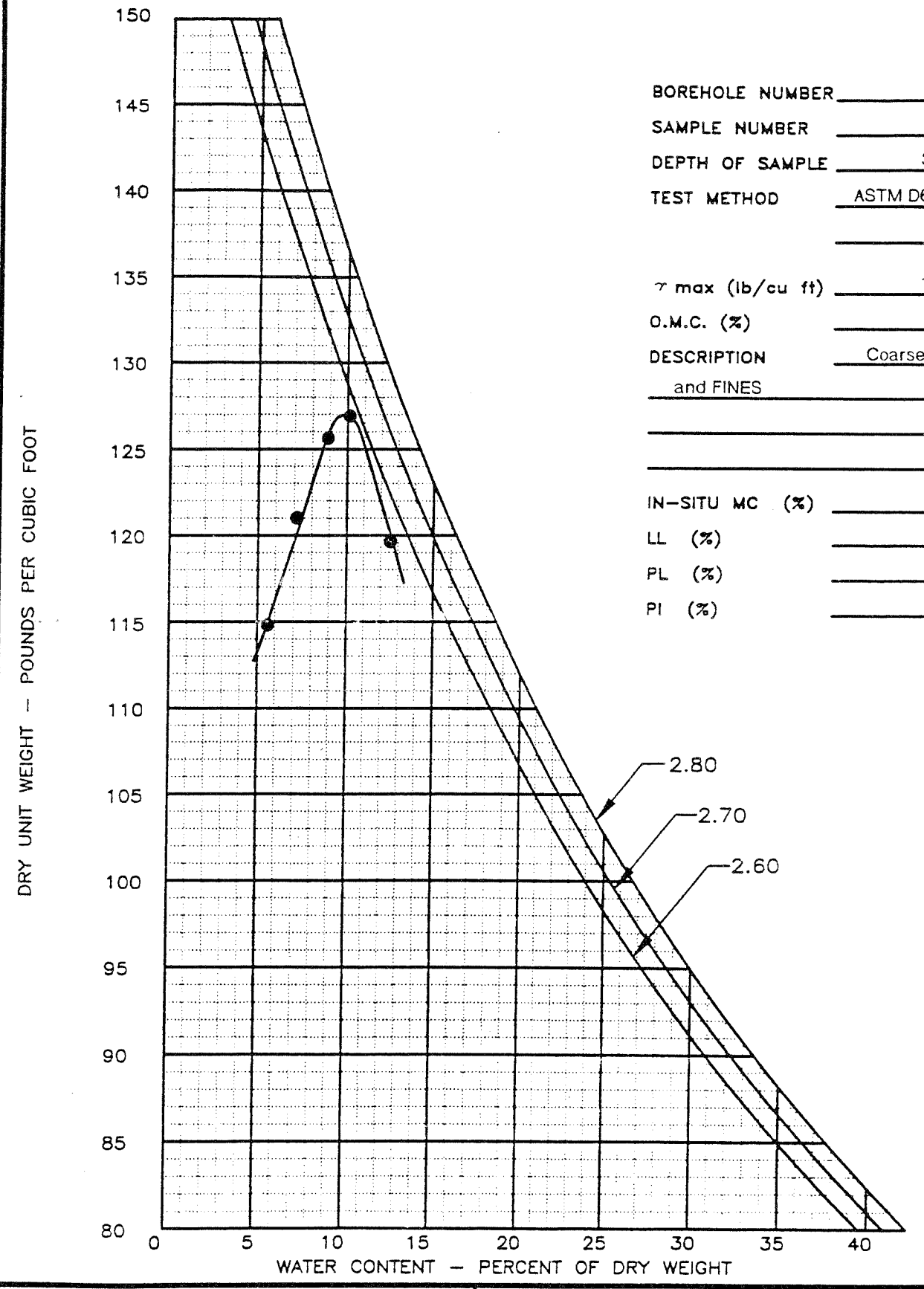
GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO



BOREHOLE NUMBER BA-1

SAMPLE NUMBER

DEPTH OF SAMPLE 35-40'

TEST METHOD ASTM D698 METHOD A

γ max (lb/cu ft) 127.0

O.M.C. (%) 9.5

DESCRIPTION Coarse to fine SAND and FINES

IN-SITU MC (%)

LL (%)

PL (%)

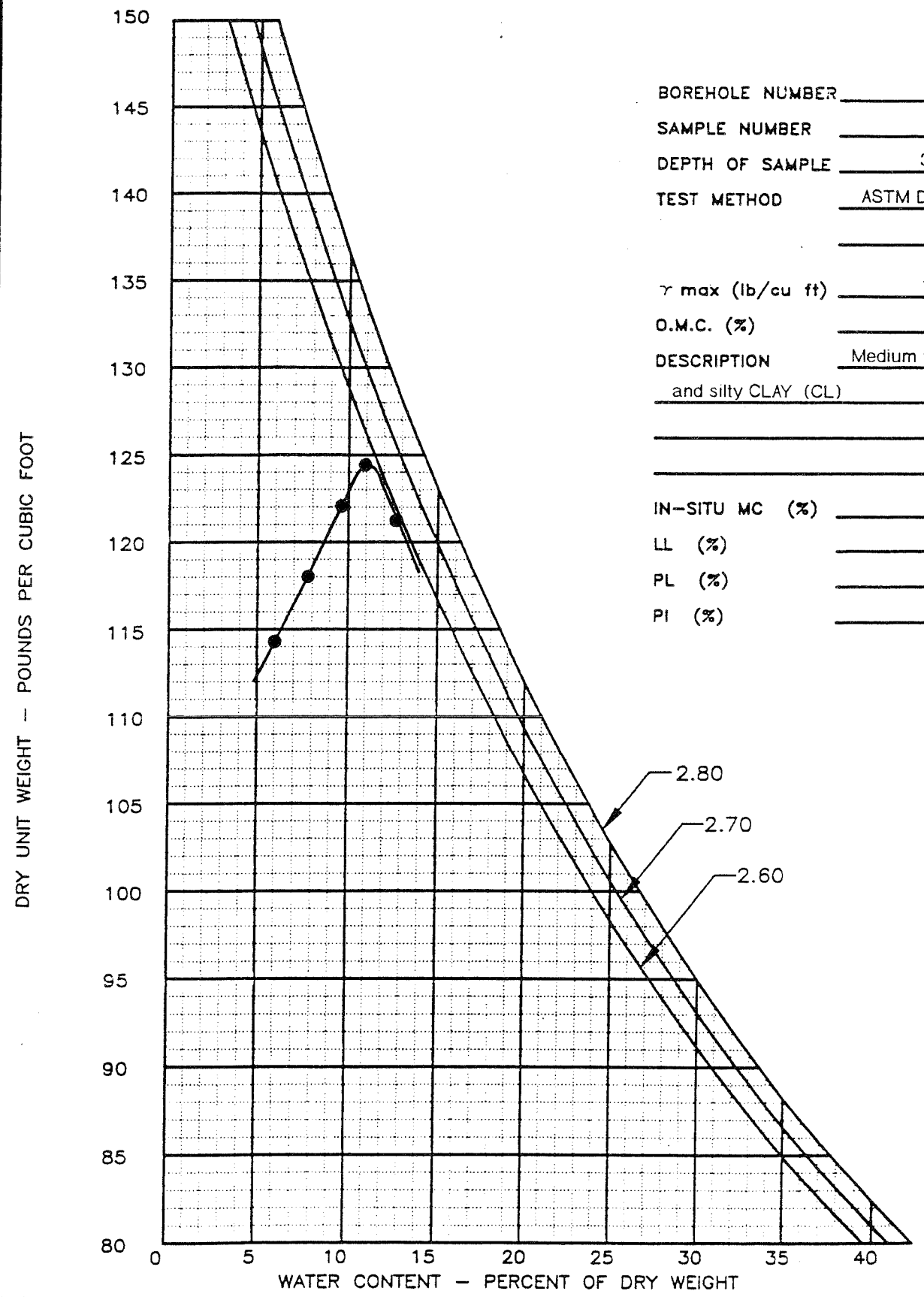
PI (%)

Golder Associates Denver, Colorado

TITLE

PROCTOR CURVE SAMPLE #BA-1

CLIENT/PROJECT					
MMCSSA/MINER FLAT/AZ	DRAWN	ASF	DATE	OCTOBER 1995	JOB NO. 943-27691
	CHECKED	KMR	SCALE	AS SHOWN	DWG NO./REV. NO.
	REVIEWED		FILE NO.	WATER.DWG	FIGURE NO.



BOREHOLE NUMBER BA-2

SAMPLE NUMBER

DEPTH OF SAMPLE 35-40'

TEST METHOD ASTM D698 METHOD A

γ max (lb/cu ft) 124.5

O.M.C. (%) 11.0

DESCRIPTION Medium to fine SAND and silty CLAY (CL)

IN-SITU MC (%)

LL (%) 27

PL (%) 12

PI (%) 15

Golder Associates Denver, Colorado

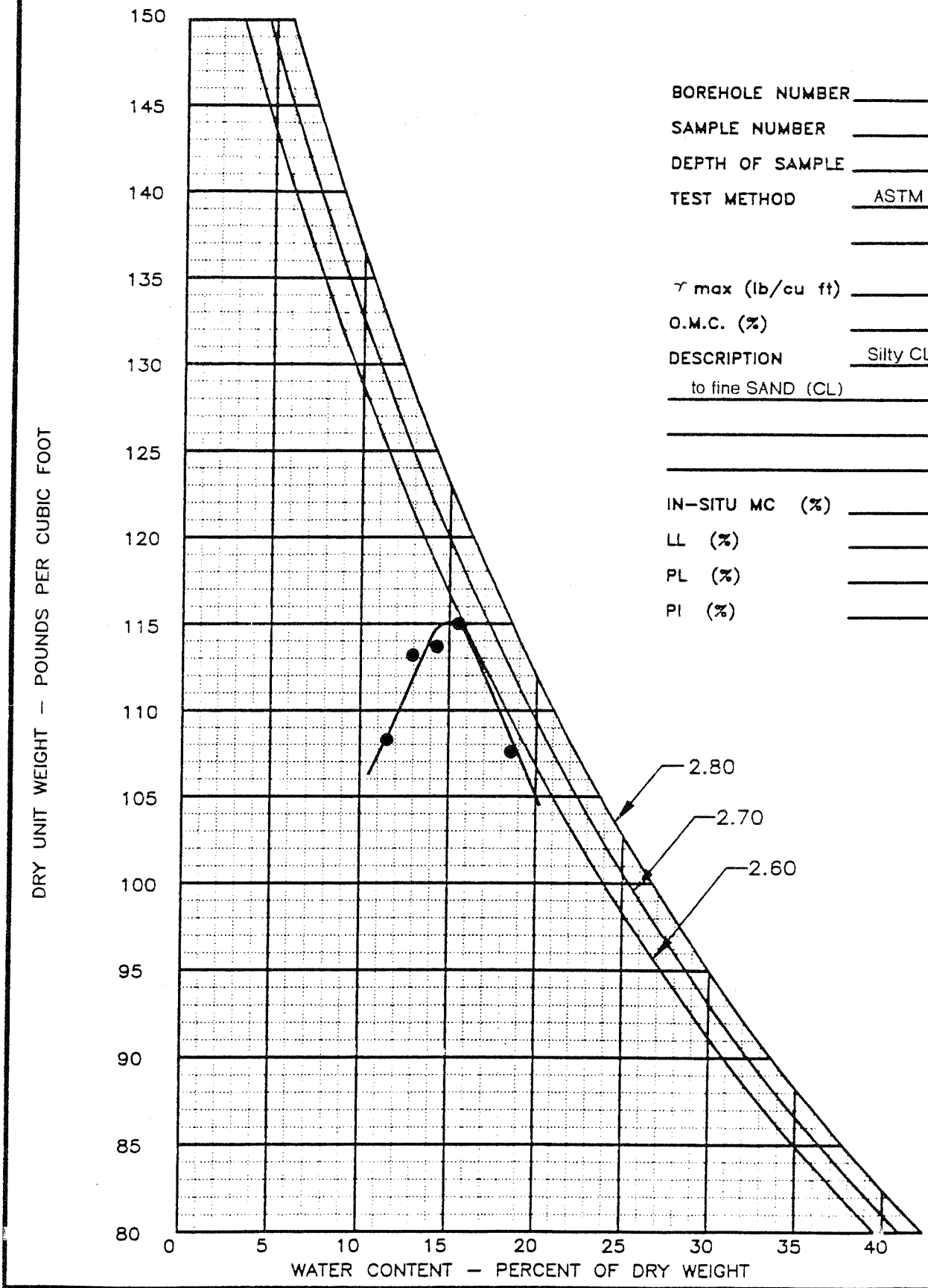
TITLE

PROCTOR CURVE SAMPLE #BA-2

CLIENT/PROJECT

MMCSSA/MINER FLAT/AZ

DRAWN	ASF	DATE	OCTOBER 1995	JOB NO.	943-27691
CHECKED	KMR	SCALE	AS SHOWN	DWG NO./REV. NO.	
REVIEWED		FILE NO.	WATER.DWG	FIGURE NO.	



BOREHOLE NUMBER	BA-4
SAMPLE NUMBER	
DEPTH OF SAMPLE	30-35'
TEST METHOD	ASTM D698 METHOD A
γ max (lb/cu ft)	115.0
O.M.C. (%)	15.0
DESCRIPTION	Silty CLAY and medium to fine SAND (CL)
IN-SITU MC (%)	
LL (%)	40
PL (%)	17
PI (%)	23

Golder Associates Denver, Colorado

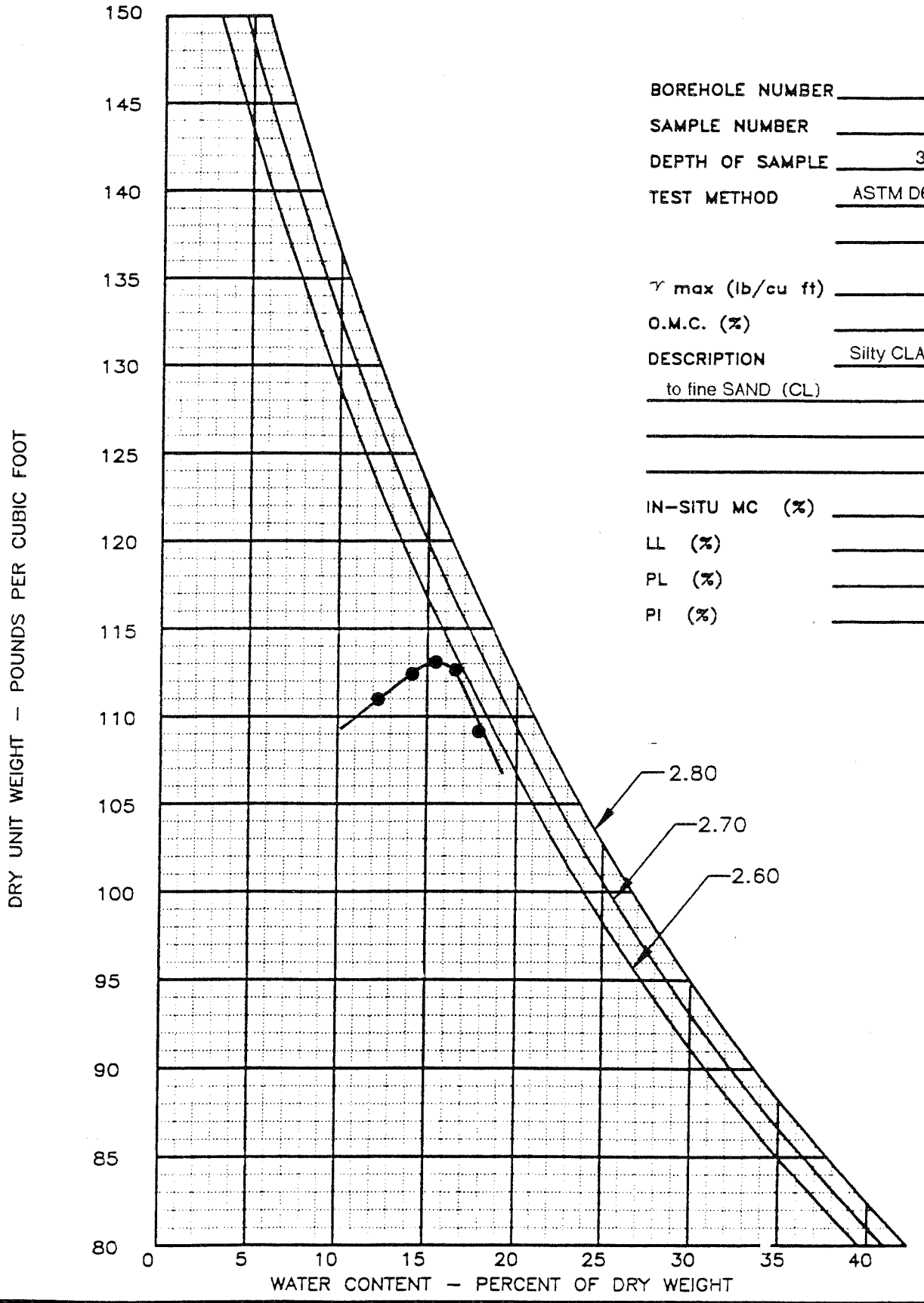
TITLE

PROCTOR CURVE
SAMPLE #BA-4

CLIENT/PROJECT

MMCSSA/MINER FLAT/AZ

DRAWN	ASF	DATE	OCTOBER 1995	JOB NO.	943-27691
CHECKED	KMR	SCALE	AS SHOWN	DWG NO./REV. NO.	
REVIEWED		FILE NO.	WATER.DWG	FIGURE NO.	



BOREHOLE NUMBER	BA-5
SAMPLE NUMBER	
DEPTH OF SAMPLE	30-35'
TEST METHOD	ASTM D698 METHOD A
γ max (lb/cu ft)	113.0
O.M.C. (%)	15.5
DESCRIPTION	Silty CLAY and medium to fine SAND (CL)
IN-SITU MC (%)	
LL (%)	34
PL (%)	17
PI (%)	17

Golder Associates Denver, Colorado

TITLE

PROCTOR CURVE SAMPLE #BA-5

CLIENT/PROJECT		DRAWN	ASF	DATE	OCTOBER 1995
MMCSSA/MINER FLAT/AZ		CHECKED	KMR	SCALE	AS SHOWN
		REVIEWED		FILE NO.	WATER.DWG

JOB NO. 943-27691

DWG NO./REV. NO.

FIGURE NO.

943-27691.170
MMCSSA/MINER FLAT/AZ

TABLE 2
SUMMARY OF FLEXIBLE WALL PERMEABILITY TEST RESULTS

SAMPLE NUMBER	BA-5 30-35'								
Sample Length (cm)	9.60								
Sample Diameter (cm)	7.26								
Sample Dry Density (pcf)	108.2								
Maximum Dry Density (pcf)	--								
Compaction (%)	--								
Initial Moisture Content (%)	9.2								
Optimum Moisture Content (%)	--								
Effective Stress (psi)	5								
Back Pressure (psi)	95								
Gradient	13								
Average Permeability (cm/sec)	$2.7X10^{-7}$								

APPENDIX C

DOWNHOLE SURVEYS

BOREHOLE: MF-218A
COLLAR COORDINATES
NORTH 1,085,010.0 *
EAST 576,800.0 *
ELEVATION 6,007.0 * (Estimated)

Miner Flat Dam
Main Access Road
BOREHOLE - AS DRILLED

Surveyed By: DA
Date Surveyed: August 29, 1995
Time Surveyed: 10:03 am

Raw Data From Owl Technical Assoc.
Model 780

HOLE DEPTH (ft.)	INCLINATION (from Vert.) °	DIRECTION North=360 °	TRUE DEPTH (ft.)	DISTANCE NORTH (ft.)	DISTANCE EAST (ft.)	CLOSURE (ft.)	NORTHING (ft.)	EASTING (ft.)	ELEVATION (ft.)
0.0	0.0 °	0 °	0.00	0.00	0.00	0.00	1,085,010.0	576,800.0	6,007.0
10.0	2.4 °	11 °	10.00	0.21	0.04	0.21	1,085,010.2	576,800.0	5,997.0
20.0	1.6 °	0 °	19.99	0.55	0.08	0.56	1,085,010.6	576,800.1	5,987.0
30.0	3.0 °	18 °	29.98	0.94	0.16	0.95	1,085,010.9	576,800.2	5,977.0
40.0	2.8 °	2 °	39.97	1.43	0.25	1.45	1,085,011.4	576,800.3	5,967.0
50.0	2.8 °	0 °	49.96	1.92	0.26	1.94	1,085,011.9	576,800.3	5,957.0
60.0	2.7 °	356 °	59.94	2.40	0.24	2.41	1,085,012.4	576,800.2	5,947.1
70.0	2.4 °	351 °	69.93	2.84	0.19	2.85	1,085,012.8	576,800.2	5,937.1
80.0	2.0 °	358 °	79.93	3.22	0.15	3.23	1,085,013.2	576,800.2	5,927.1
90.0	2.7 °	10 °	89.92	3.63	0.19	3.63	1,085,013.6	576,800.2	5,917.1
100.0	2.5 °	351 °	99.91	4.08	0.20	4.08	1,085,014.1	576,800.2	5,907.1
110.0	2.7 °	15 °	109.90	4.52	0.22	4.52	1,085,014.5	576,800.2	5,897.1
120.0	2.8 °	354 °	119.89	4.99	0.26	5.00	1,085,015.0	576,800.3	5,887.1
130.0	2.4 °	343 °	129.88	5.43	0.17	5.44	1,085,015.4	576,800.2	5,877.1
140.0	1.8 °	347 °	139.87	5.79	0.07	5.79	1,085,015.8	576,800.1	5,867.1
150.0	2.6 °	355 °	149.86	6.17	0.02	6.17	1,085,016.2	576,800.0	5,857.1
160.0	1.8 °	11 °	159.85	6.55	0.03	6.55	1,085,016.5	576,800.0	5,847.1
170.0	1.8 °	351 °	169.85	6.85	0.04	6.85	1,085,016.9	576,800.0	5,837.2
180.0	2.0 °	10 °	179.84	7.18	0.04	7.18	1,085,017.2	576,800.0	5,827.2
190.0	1.7 °	349 °	189.84	7.50	0.04	7.50	1,085,017.5	576,800.0	5,817.2
200.0	2.0 °	2 °	199.83	7.82	0.02	7.82	1,085,017.8	576,800.0	5,807.2
210.0	1.6 °	343 °	209.83	8.13	-0.01	8.13	1,085,018.1	576,800.0	5,797.2
220.0	1.5 °	347 °	219.82	8.39	-0.08	8.39	1,085,018.4	576,799.9	5,787.2
230.0	1.8 °	323 °	229.82	8.64	-0.21	8.64	1,085,018.6	576,799.8	5,777.2
240.0	2.0 °	322 °	239.81	8.90	-0.41	8.91	1,085,018.9	576,799.6	5,767.2
250.0	2.0 °	317 °	249.81	9.17	-0.64	9.19	1,085,019.2	576,799.4	5,757.2
260.0	2.7 °	346 °	259.80	9.52	-0.81	9.56	1,085,019.5	576,799.2	5,747.2
270.0	2.7 °	353 °	269.79	9.99	-0.90	10.03	1,085,020.0	576,799.1	5,737.2
280.0	2.5 °	353 °	279.78	10.44	-0.95	10.48	1,085,020.4	576,799.0	5,727.2
290.0	2.5 °	350 °	289.77	10.87	-1.02	10.92	1,085,020.9	576,799.0	5,717.2
300.0	2.7 °	345 °	299.76	11.31	-1.12	11.37	1,085,021.3	576,798.9	5,707.2
310.0	2.7 °	350 °	309.75	11.77	-1.22	11.83	1,085,021.8	576,798.8	5,697.3
320.0	1.6 °	329 °	319.74	12.12	-1.33	12.20	1,085,022.1	576,798.7	5,687.3
330.0	1.7 °	327 °	329.74	12.37	-1.48	12.45	1,085,022.4	576,798.5	5,677.3
340.0	1.7 °	320 °	339.73	12.60	-1.66	12.71	1,085,022.6	576,798.3	5,667.3
350.0	2.2 °	334 °	349.73	12.89	-1.84	13.02	1,085,022.9	576,798.2	5,657.3
359.9	2.6 °	336 °	359.62	13.27	-2.01	13.42	1,085,023.3	576,798.0	5,647.4

Missed the target of the designed hole (0.0°,0.0°) by:
13.3 ft. North
2.0 ft. East
0.3 ft. Higher
13.42 feet Total
3.73% Tolerance

Error Analysis
Bottom Coordinates

Northing	1,085,023.3	+/- 0.1
Easting	576,798.0	+/- 0.3
Elevation	5,647.4	+/- 0.0

EXPLANATION

HOLE DEPTH: Length along the borehole axis from the collar to the point of the survey, NOT vertical depth.

INCLINATION: Equivalent to "Dip" with the exception that 0° INCLINATION = VERTICAL and 90° INCLINATION = HORIZONTAL. INCLINATION greater than 90° implies UP.

DIRECTION: Equivalent to "Bearing" of the borehole at the point of survey. Measured on a magnetic azimuth (0°-360°) system.

DISTANCE NORTH, DISTANCE EAST – Distances from the collar calculated on a TRUE NORTH-SOUTH grid.

CLOSURE: The horizontal distance from the collar of the borehole to the survey point.

NORTHING, EASTING, ELEV.: Coordinates calculated from the collar coordinates. Collar coordinates furnished by Geodetic Surveys, Inc..
(* Estimated coordinates have not been surveyed.)

BOREHOLE: MF250
COLLAR COORDINATES

NORTH	1,085,615.0 *
EAST	576,875.0 *
ELEVATION	6,081.0 * (Estimated)

Miner Flat Dam

Sandstone Ridge

BOREHOLE - AS DRILLED

Surveyed By: lb/cr

Date Surveyed: June 19, 1995

Time Surveyed: 12:45 pm

Raw Data From Owl Technical Assoc.

HOLE DEPTH (ft.)	Model 780 INCLINATION (from Vert.) °	DIRECTION North=360 °	TRUE DEPTH (ft.)	DISTANCE NORTH (ft.)	DISTANCE EAST (ft.)	CLOSURE (ft.)	NORTHING (ft.)	EASTING (ft.)	ELEVATION (ft.)
0.0	0.0 °	0 °	0.00	0.00	0.00	0.00	1,085,615.0	576,875.0	6,081.0
5.0	0.5 °	108 °	5.00	-0.01	0.02	0.02	1,085,615.0	576,875.0	6,076.0
10.0	1.3 °	316 °	10.00	0.03	0.00	0.03	1,085,615.0	576,875.0	6,071.0
20.0	0.5 °	106 °	20.00	0.10	-0.03	0.10	1,085,615.1	576,875.0	6,061.0
30.0	1.7 °	83 °	30.00	0.10	0.15	0.19	1,085,615.1	576,875.2	6,051.0
40.0	1.2 °	40 °	39.99	0.20	0.37	0.42	1,085,615.2	576,875.4	6,041.0
50.0	1.0 °	45 °	49.99	0.34	0.50	0.60	1,085,615.3	576,875.5	6,031.0
60.0	1.1 °	35 °	59.99	0.48	0.61	0.78	1,085,615.5	576,875.6	6,021.0
70.0	1.0 °	37 °	69.99	0.63	0.72	0.96	1,085,615.6	576,875.7	6,011.0
80.0	0.9 °	29 °	79.99	0.77	0.81	1.12	1,085,615.8	576,875.8	6,001.0
90.0	0.4 °	85 °	89.98	0.84	0.89	1.22	1,085,615.8	576,875.9	5,991.0
100.0	1.7 °	99 °	99.98	0.82	1.07	1.35	1,085,615.8	576,876.1	5,981.0
110.0	1.2 °	47 °	109.98	0.87	1.29	1.56	1,085,615.9	576,876.3	5,971.0
120.0	1.8 °	79 °	119.98	0.97	1.52	1.80	1,085,616.0	576,876.5	5,961.0
130.0	0.9 °	35 °	129.97	1.07	1.72	2.02	1,085,616.1	576,876.7	5,951.0
140.0	1.0 °	41 °	139.97	1.20	1.82	2.18	1,085,616.2	576,876.8	5,941.0
150.0	1.9 °	101 °	149.97	1.23	2.04	2.38	1,085,616.2	576,877.0	5,931.0
160.0	0.5 °	37 °	159.96	1.23	2.23	2.55	1,085,616.2	576,877.2	5,921.0
170.0	0.9 °	129 °	169.96	1.22	2.32	2.62	1,085,616.2	576,877.3	5,911.0
180.0	1.7 °	109 °	179.96	1.12	2.52	2.76	1,085,616.1	576,877.5	5,901.0
190.0	1.8 °	72 °	189.96	1.12	2.81	3.02	1,085,616.1	576,877.8	5,891.0
200.0	1.8 °	90 °	199.95	1.17	3.12	3.33	1,085,616.2	576,878.1	5,881.0
210.0	1.5 °	43 °	209.95	1.26	3.37	3.59	1,085,616.3	576,878.4	5,871.1
220.0	1.7 °	49 °	219.94	1.45	3.57	3.85	1,085,616.5	576,878.6	5,861.1
230.0	2.4 °	61 °	229.94	1.65	3.87	4.20	1,085,616.7	576,878.9	5,851.1
240.0	1.4 °	44 °	239.93	1.84	4.13	4.52	1,085,616.8	576,879.1	5,841.1
250.0	1.1 °	43 °	249.93	2.00	4.28	4.73	1,085,617.0	576,879.3	5,831.1
260.0	1.3 °	44 °	259.93	2.15	4.43	4.92	1,085,617.2	576,879.4	5,821.1
270.0	1.6 °	47 °	269.92	2.33	4.61	5.16	1,085,617.3	576,879.6	5,811.1
280.0	1.1 °	40 °	279.92	2.50	4.77	5.39	1,085,617.5	576,879.8	5,801.1
290.0	1.1 °	44 °	289.92	2.64	4.90	5.57	1,085,617.6	576,879.9	5,791.1
300.0	1.2 °	43 °	299.92	2.78	5.04	5.76	1,085,617.8	576,880.0	5,781.1
310.0	1.7 °	54 °	309.91	2.95	5.23	6.00	1,085,617.9	576,880.2	5,771.1
316.6	2.7 °	65 °	316.51	3.07	5.45	6.26	1,085,618.1	576,880.5	5,764.5
320.0	1.9 °	100 °	319.90	3.10	5.58	6.38	1,085,618.1	576,880.6	5,761.1
330.0	2.1 °	58 °	329.90	3.16	5.90	6.69	1,085,618.2	576,880.9	5,751.1
331.3	2.3 °	61 °	331.20	3.19	5.94	6.74	1,085,618.2	576,880.9	5,749.8

Missed the target of the designed hole (0.0°,0.0°) by:

3.2	ft. North
5.9	ft. East
0.1	ft. Higher
6.74	feet Total
2.04%	Tolerance

Error Analysis
Bottom Coordinates

Northing	1,085,618.2	+/- 0.3
Easting	576,880.9	+/- 0.1
Elevation	5,749.8	+/- 0.0

EXPLANATION

HOLE DEPTH: Length along the borehole axis from the collar to the point of the survey, NOT vertical depth.

INCLINATION: Equivalent to "Dip" with the exception that 0° INCLINATION = VERTICAL and 90° INCLINATION = HORIZONTAL. INCLINATION greater than 90° implies UP.

DIRECTION: Equivalent to "Bearing" of the borehole at the point of survey. Measured on a magnetic azimuth (0° -360°) system.

DISTANCE NORTH, DISTANCE EAST – Distances from the collar calculated on a TRUE NORTH-SOUTH grid.

CLOSURE: The horizontal distance from the collar of the borehole to the survey point.

NORTHING, EASTING, ELEV.: Coordinates calculated from the collar coordinates. Collar coordinates furnished by Geodetic Surveys, Inc.. (* Estimated coordinates have not been surveyed.)

BOREHOLE: MF-250A
COLLAR COORDINATES

NORTH	1,085,615.0 *
EAST	576,840.0 *
ELEVATION	6,081.0 * (Estimated)

Miner Flat Dam

DAM END OF SANDSTONE RIDGE

BOREHOLE - AS DRILLED

Surveyed By: CHR

Date Surveyed: September 1, 1995

Time Surveyed: 2:23 pm

Raw Data From Owl Technical Assoc.

HOLE DEPTH (ft.)	Model 780 INCLINATION (from Vert.) °	DIRECTION North=360 °	TRUE DEPTH (ft.)	DISTANCE NORTH (ft.)	DISTANCE EAST (ft.)	CLOSURE (ft.)	NORTHING (ft.)	EASTING (ft.)	ELEVATION (ft.)
0.0	0.0 °	0 °	0.00	0.00	0.00	0.00	1,085,615.0	576,840.0	6,081.0
5.0	0.9 °	55 °	5.00	0.02	0.03	0.04	1,085,615.0	576,840.0	6,076.0
6.0	0.8 °	290 °	6.00	0.03	0.03	0.04	1,085,615.0	576,840.0	6,075.0
7.5	0.8 °	94 °	7.50	0.03	0.03	0.05	1,085,615.0	576,840.0	6,073.5
10.0	1.0 °	93 °	10.00	0.03	0.07	0.08	1,085,615.0	576,840.1	6,071.0
15.0	1.0 °	359 °	15.00	0.07	0.11	0.13	1,085,615.1	576,840.1	6,066.0
20.0	1.0 °	117 °	20.00	0.10	0.15	0.18	1,085,615.1	576,840.2	6,061.0
25.0	1.6 °	84 °	25.00	0.08	0.26	0.27	1,085,615.1	576,840.3	6,056.0
30.0	1.6 °	78 °	29.99	0.10	0.40	0.41	1,085,615.1	576,840.4	6,051.0
35.0	1.4 °	58 °	34.99	0.15	0.52	0.54	1,085,615.2	576,840.5	6,046.0
40.0	1.4 °	61 °	39.99	0.21	0.62	0.66	1,085,615.2	576,840.6	6,041.0
45.0	1.3 °	58 °	44.99	0.27	0.73	0.78	1,085,615.3	576,840.7	6,036.0
50.0	1.3 °	49 °	49.99	0.34	0.82	0.88	1,085,615.3	576,840.8	6,031.0
55.0	1.5 °	63 °	54.99	0.41	0.92	1.00	1,085,615.4	576,840.9	6,026.0
60.0	1.5 °	83 °	59.99	0.44	1.04	1.13	1,085,615.4	576,841.0	6,021.0
65.0	1.5 °	81 °	64.98	0.46	1.17	1.26	1,085,615.5	576,841.2	6,016.0
70.0	1.6 °	81 °	69.98	0.48	1.30	1.39	1,085,615.5	576,841.3	6,011.0
75.0	1.6 °	96 °	74.98	0.49	1.44	1.52	1,085,615.5	576,841.4	6,006.0
80.0	1.6 °	103 °	79.98	0.46	1.58	1.65	1,085,615.5	576,841.6	6,001.0
85.0	1.4 °	112 °	84.98	0.43	1.70	1.76	1,085,615.4	576,841.7	5,996.0
86.0	1.4 °	114 °	85.98	0.42	1.73	1.78	1,085,615.4	576,841.7	5,995.0

Missed the target of the designed hole (0.0°,0.0°) by:

0.4	ft. North
1.7	ft. East
0.0	ft. Higher
1.78	feet Total
2.07%	Tolerance

Error Analysis
Bottom Coordinates

Northing	1,085,615.4	+/- 0.1
Easting	576,841.7	+/- 0.0
Elevation	5,995.0	+/- 0.0

EXPLANATION

HOLE DEPTH: Length along the borehole axis from the collar to the point of the survey, NOT vertical depth.

INCLINATION: Equivalent to "Dip" with the exception that 0° INCLINATION = VERTICAL and 90° INCLINATION = HORIZONTAL. INCLINATION greater than 90° implies UP.

DIRECTION: Equivalent to "Bearing" of the borehole at the point of survey. Measured on a magnetic azimuth (0°-360°) system.

DISTANCE NORTH, DISTANCE EAST -- Distances from the collar calculated on a TRUE NORTH-SOUTH grid.

CLOSURE: The horizontal distance from the collar of the borehole to the survey point.

NORTHING, EASTING, ELEV.: Coordinates calculated from the collar coordinates. Collar coordinates furnished by Geodetic Surveys, Inc.. (* Estimated coordinates have not been surveyed.)

BOREHOLE: MF-251
COLLAR COORDINATES
NORTH 1,085,390.0 *
EAST 576,875.0 *
ELEVATION 6,089.0 * (Estimated)

Miner Flat Dam
Secondary Access Road
BOREHOLE - AS DRILLED

Surveyed By: da
Date Surveyed: August 21, 1995
Time Surveyed: 5:03 pm,

Raw Data From Owl Technical Assoc.

HOLE DEPTH (ft.)	Model 780 INCLINATION (from Vert.) °	DIRECTION North=360 °	TRUE DEPTH (ft.)	DISTANCE NORTH (ft.)	DISTANCE EAST (ft.)	CLOSURE (ft.)	NORTHING (ft.)	EASTING (ft.)	ELEVATION (ft.)
0.0	0.0 °	0 °	0.00	0.00	0.00	0.00	1,085,390.0	576,875.0	6,089.0
10.0	1.8 °	110 °	10.00	-0.05	0.15	0.16	1,085,389.9	576,875.1	6,079.0
20.0	2.0 °	189 °	19.99	-0.28	0.27	0.39	1,085,389.7	576,875.3	6,069.0
30.0	2.0 °	291 °	29.99	-0.39	0.08	0.40	1,085,389.6	576,875.1	6,059.0
40.0	2.1 °	309 °	39.98	-0.21	-0.23	0.31	1,085,389.8	576,874.8	6,049.0
50.0	0.9 °	210 °	49.98	-0.16	-0.41	0.44	1,085,389.8	576,874.6	6,039.0
60.0	1.6 °	352 °	59.97	-0.09	-0.47	0.48	1,085,389.9	576,874.5	6,029.0
70.0	2.1 °	288 °	69.97	0.10	-0.66	0.67	1,085,390.1	576,874.3	6,019.0
80.0	2.0 °	113 °	79.96	0.09	-0.68	0.68	1,085,390.1	576,874.3	6,009.0
90.0	2.1 °	97 °	89.95	-0.00	-0.33	0.33	1,085,390.0	576,874.7	5,999.0
100.0	2.1 °	14 °	99.95	0.15	-0.11	0.19	1,085,390.2	576,874.9	5,989.1
110.0	2.0 °	25 °	109.94	0.49	0.01	0.49	1,085,390.5	576,875.0	5,979.1
120.0	2.1 °	222 °	119.94	0.51	-0.04	0.51	1,085,390.5	576,875.0	5,969.1
130.0	2.2 °	304 °	129.93	0.48	-0.32	0.58	1,085,390.5	576,874.7	5,959.1
140.0	2.2 °	342 °	139.92	0.77	-0.54	0.94	1,085,390.8	576,874.5	5,949.1
150.0	2.0 °	67 °	149.91	1.02	-0.44	1.11	1,085,391.0	576,874.6	5,939.1
160.0	2.0 °	33 °	159.91	1.24	-0.18	1.25	1,085,391.2	576,874.8	5,929.1
170.0	1.9 °	98 °	169.90	1.36	0.08	1.36	1,085,391.4	576,875.1	5,919.1
180.0	1.9 °	6 °	179.90	1.50	0.26	1.53	1,085,391.5	576,875.3	5,909.1
190.0	1.4 °	252 °	189.89	1.63	0.16	1.64	1,085,391.6	576,875.2	5,899.1
200.0	1.6 °	176 °	199.89	1.45	0.05	1.45	1,085,391.5	576,875.1	5,889.1
210.0	1.1 °	79 °	209.89	1.33	0.16	1.34	1,085,391.3	576,875.2	5,879.1
220.0	1.9 °	87 °	219.88	1.36	0.42	1.42	1,085,391.4	576,875.4	5,869.1
230.0	1.4 °	76 °	229.88	1.40	0.70	1.56	1,085,391.4	576,875.7	5,859.1
240.0	0.9 °	74 °	239.88	1.45	0.90	1.70	1,085,391.4	576,875.9	5,849.1
250.0	0.9 °	69 °	249.88	1.50	1.05	1.83	1,085,391.5	576,876.0	5,839.1
260.0	0.9 °	68 °	259.87	1.56	1.19	1.96	1,085,391.6	576,876.2	5,829.1
270.0	1.4 °	81 °	269.87	1.60	1.39	2.12	1,085,391.6	576,876.4	5,819.1
280.0	1.0 °	71 °	279.87	1.65	1.59	2.29	1,085,391.7	576,876.6	5,809.1
290.0	1.0 °	76 °	289.87	1.70	1.76	2.44	1,085,391.7	576,876.8	5,799.1
300.0	1.0 °	166 °	299.87	1.64	1.86	2.48	1,085,391.6	576,876.9	5,789.1
310.0	0.9 °	165 °	309.86	1.48	1.90	2.41	1,085,391.5	576,876.9	5,779.1
320.0	0.5 °	176 °	319.86	1.36	1.93	2.36	1,085,391.4	576,876.9	5,769.1
330.0	0.3 °	124 °	329.86	1.30	1.95	2.34	1,085,391.3	576,877.0	5,759.1
331.8	0.4 °	142 °	331.66	1.29	1.96	2.35	1,085,391.3	576,877.0	5,757.3

Missed the target of the designed hole (0.0°,0.0°) by:
1.3 ft. North
2.0 ft. East
0.1 ft. Higher
2.35 feet Total
0.71% Tolerance

Error Analysis
Bottom Coordinates

Northing	1,085,391.3	+/- 0.3
Easting	576,877.0	+/- 0.1
Elevation	5,757.3	+/- 0.0

EXPLANATION

HOLE DEPTH: Length along the borehole axis from the collar to the point of the survey, NOT vertical depth.

INCLINATION: Equivalent to "Dip" with the exception that 0° INCLINATION = VERTICAL and 90° INCLINATION = HORIZONTAL. INCLINATION greater than 90° implies UP.

DIRECTION: Equivalent to "Bearing" of the borehole at the point of survey. Measured on a magnetic azimuth (0°-360°) system.

DISTANCE NORTH, DISTANCE EAST -- Distances from the collar calculated on a TRUE NORTH-SOUTH grid.

CLOSURE: The horizontal distance from the collar of the borehole to the survey point.

NORTHING, EASTING, ELEV.: Coordinates calculated from the collar coordinates. Collar coordinates furnished by Geodetic Surveys, Inc..
(* Estimated coordinates have not been surveyed.)

BOREHOLE: MF-252
COLLAR COORDINATES

NORTH	1,085,205.0 *
EAST	576,845.0 *
ELEVATION	6,082.0 * (Estimated)

Miner Flat Dam

Secondary Access Road

BOREHOLE - AS DRILLED

Surveyed By: DA

Date Surveyed: August 22, 1995

Time Surveyed: 09:29 am

Raw Data From Owl Technical Assoc.

HOLE DEPTH (ft.)	Model 780 INCLINATION (from Vert.) °	DIRECTION North=360 °	TRUE DEPTH (ft.)	DISTANCE NORTH (ft.)	DISTANCE EAST (ft.)	CLOSURE (ft.)	NORTHING (ft.)	EASTING (ft.)	ELEVATION (ft.)
0.0	0.0 °	0 °	0.00	0.00	0.00	0.00	1,085,205.0	576,845.0	6,082.0
10.0	2.5 °	8 °	10.00	0.22	0.03	0.22	1,085,205.2	576,845.0	6,072.0
20.0	2.4 °	323 °	19.99	0.60	-0.07	0.60	1,085,205.6	576,844.9	6,062.0
30.0	1.8 °	19 °	29.98	0.91	-0.14	0.93	1,085,205.9	576,844.9	6,052.0
40.0	1.6 °	22 °	39.97	1.19	-0.04	1.19	1,085,206.2	576,845.0	6,042.0
50.0	1.6 °	24 °	49.97	1.45	0.07	1.45	1,085,206.4	576,845.1	6,032.0
60.0	1.7 °	21 °	59.97	1.72	0.18	1.73	1,085,206.7	576,845.2	6,022.0
70.0	1.5 °	21 °	69.96	1.98	0.28	2.00	1,085,207.0	576,845.3	6,012.0
80.0	1.6 °	23 °	79.96	2.23	0.38	2.26	1,085,207.2	576,845.4	6,002.0
90.0	2.2 °	54 °	89.95	2.47	0.59	2.54	1,085,207.5	576,845.6	5,992.0
100.0	2.1 °	57 °	99.95	2.68	0.90	2.83	1,085,207.7	576,845.9	5,982.1
110.0	1.8 °	18 °	109.94	2.93	1.10	3.13	1,085,207.9	576,846.1	5,972.1
120.0	2.2 °	51 °	119.93	3.20	1.30	3.46	1,085,208.2	576,846.3	5,962.1
130.0	2.5 °	30 °	129.93	3.51	1.56	3.84	1,085,208.5	576,846.6	5,952.1
140.0	2.5 °	24 °	139.92	3.90	1.76	4.28	1,085,208.9	576,846.8	5,942.1
150.0	1.5 °	26 °	149.91	4.22	1.90	4.63	1,085,209.2	576,846.9	5,932.1
160.0	1.6 °	20 °	159.91	4.46	2.01	4.90	1,085,209.5	576,847.0	5,922.1
170.0	1.3 °	14 °	169.90	4.71	2.08	5.15	1,085,209.7	576,847.1	5,912.1
180.0	2.2 °	55 °	179.90	4.93	2.27	5.42	1,085,209.9	576,847.3	5,902.1
190.0	2.4 °	39 °	189.89	5.20	2.56	5.79	1,085,210.2	576,847.6	5,892.1
200.0	2.2 °	48 °	199.88	5.49	2.83	6.18	1,085,210.5	576,847.8	5,882.1
210.0	2.4 °	39 °	209.87	5.78	3.11	6.56	1,085,210.8	576,848.1	5,872.1
220.0	2.3 °	49 °	219.87	6.07	3.39	6.96	1,085,211.1	576,848.4	5,862.1
230.0	1.3 °	37 °	229.86	6.30	3.61	7.26	1,085,211.3	576,848.6	5,852.1
240.0	1.5 °	18 °	239.86	6.51	3.72	7.50	1,085,211.5	576,848.7	5,842.1
250.0	1.4 °	20 °	249.85	6.75	3.80	7.75	1,085,211.8	576,848.8	5,832.1
260.0	1.9 °	10 °	259.85	7.03	3.87	8.03	1,085,212.0	576,848.9	5,822.2
270.0	1.7 °	9 °	269.84	7.34	3.92	8.32	1,085,212.3	576,848.9	5,812.2
280.0	1.7 °	11 °	279.84	7.63	3.98	8.60	1,085,212.6	576,849.0	5,802.2
290.0	1.3 °	22 °	289.84	7.88	4.05	8.86	1,085,212.9	576,849.0	5,792.2
300.0	2.2 °	29 °	299.83	8.16	4.18	9.16	1,085,213.2	576,849.2	5,782.2
310.0	1.1 °	22 °	309.83	8.41	4.31	9.45	1,085,213.4	576,849.3	5,772.2
320.0	1.5 °	12 °	319.82	8.63	4.37	9.67	1,085,213.6	576,849.4	5,762.2
330.0	2.5 °	20 °	329.82	8.96	4.48	10.02	1,085,214.0	576,849.5	5,752.2

Missed the target of the designed hole (0.0°,0.0°) by:

9.0	ft. North
4.5	ft. East
0.2	ft. Higher
10.02	feet Total
3.04%	Tolerance

Error Analysis
Bottom Coordinates

Northing	1,085,214.0	+/- 0.2
Easting	576,849.5	+/- 0.2
Elevation	5,752.2	+/- 0.0

EXPLANATION

HOLE DEPTH: Length along the borehole axis from the collar to the point of the survey, NOT vertical depth.

INCLINATION: Equivalent to "Dip" with the exception that 0° INCLINATION = VERTICAL and 90° INCLINATION = HORIZONTAL. INCLINATION greater than 90° implies UP.

DIRECTION: Equivalent to "Bearing" of the borehole at the point of survey. Measured on a magnetic azimuth (0°-360°) system.

DISTANCE NORTH, DISTANCE EAST – Distances from the collar calculated on a TRUE NORTH-SOUTH grid.

CLOSURE: The horizontal distance from the collar of the borehole to the survey point.

NORTHING, EASTING, ELEV.: Coordinates calculated from the collar coordinates. Collar coordinates furnished by Geodetic Surveys, Inc..
(* Estimated coordinates have not been surveyed.)

BOREHOLE: MF-253
COLLAR COORDINATES

NORTH	1,084,815.0 *
EAST	576,940.0 *
ELEVATION	6,079.0 * (Estimated)

MINER FLAT

ROAD E

BOREHOLE - AS DRILLED

Surveyed By: DA

Date Surveyed: June 19, 1995

Time Surveyed: 12:45 pm

Raw Data From Owl Technical Assoc.

HOLE DEPTH (ft.)	Model 780 INCLINATION (from Vert.) °	DIRECTION North=360 °	TRUE DEPTH (ft.)	DISTANCE NORTH (ft.)	DISTANCE EAST (ft.)	CLOSURE (ft.)	NORTHING (ft.)	EASTING (ft.)	ELEVATION (ft.)
0.0	0.0 °	0 °	0.00	0.00	0.00	0.00	1,084,815.0	576,940.0	6,079.0
10.0	0.7 °	31 °	10.00	0.05	0.03	0.06	1,084,815.1	576,940.0	6,069.0
20.0	0.3 °	107 °	20.00	0.10	0.09	0.13	1,084,815.1	576,940.1	6,059.0
30.0	0.9 °	158 °	30.00	0.02	0.14	0.14	1,084,815.0	576,940.1	6,049.0
40.0	1.0 °	217 °	40.00	-0.13	0.12	0.17	1,084,814.9	576,940.1	6,039.0
50.0	1.0 °	232 °	50.00	-0.25	-0.00	0.25	1,084,814.8	576,940.0	6,029.0
60.0	1.0 °	257 °	59.99	-0.32	-0.16	0.36	1,084,814.7	576,939.8	6,019.0
70.0	1.1 °	223 °	69.99	-0.41	-0.31	0.51	1,084,814.6	576,939.7	6,009.0
80.0	0.9 °	179 °	79.99	-0.56	-0.37	0.67	1,084,814.4	576,939.6	5,999.0
90.0	0.9 °	158 °	89.99	-0.71	-0.34	0.79	1,084,814.3	576,939.7	5,989.0
100.0	0.8 °	278 °	99.99	-0.78	-0.38	0.86	1,084,814.2	576,939.6	5,979.0
110.0	1.1 °	211 °	109.99	-0.85	-0.50	0.98	1,084,814.2	576,939.5	5,969.0
120.0	0.6 °	287 °	119.99	-0.92	-0.60	1.09	1,084,814.1	576,939.4	5,959.0
130.0	1.3 °	253 °	129.98	-0.93	-0.76	1.20	1,084,814.1	576,939.2	5,949.0
140.0	1.3 °	229 °	139.98	-1.04	-0.95	1.41	1,084,814.0	576,939.1	5,939.0
150.0	1.3 °	261 °	149.98	-1.13	-1.15	1.61	1,084,813.9	576,938.9	5,929.0
160.0	0.5 °	143 °	159.98	-1.19	-1.23	1.71	1,084,813.8	576,938.8	5,919.0
170.0	0.7 °	161 °	169.98	-1.28	-1.19	1.74	1,084,813.7	576,938.8	5,909.0
180.0	1.0 °	177 °	179.98	-1.42	-1.16	1.84	1,084,813.6	576,938.8	5,899.0
190.0	0.7 °	162 °	189.97	-1.57	-1.14	1.94	1,084,813.4	576,938.9	5,889.0
200.0	1.0 °	174 °	199.97	-1.71	-1.11	2.04	1,084,813.3	576,938.9	5,879.0
210.0	0.9 °	171 °	209.97	-1.88	-1.09	2.17	1,084,813.1	576,938.9	5,869.0
220.0	0.7 °	161 °	219.97	-2.01	-1.06	2.27	1,084,813.0	576,938.9	5,859.0
230.0	1.1 °	170 °	229.97	-2.17	-1.02	2.39	1,084,812.8	576,939.0	5,849.0
240.0	1.0 °	189 °	239.97	-2.35	-1.02	2.56	1,084,812.7	576,939.0	5,839.0
250.0	0.9 °	176 °	249.97	-2.51	-1.03	2.71	1,084,812.5	576,939.0	5,829.0
260.0	0.2 °	287 °	259.97	-2.58	-1.04	2.78	1,084,812.4	576,939.0	5,819.0
270.0	1.4 °	295 °	269.96	-2.53	-1.16	2.78	1,084,812.5	576,938.8	5,809.0
280.0	1.2 °	287 °	279.96	-2.44	-1.38	2.81	1,084,812.6	576,938.6	5,799.0
290.0	1.7 °	245 °	289.96	-2.48	-1.61	2.95	1,084,812.5	576,938.4	5,789.0
300.0	1.4 °	268 °	299.96	-2.54	-1.87	3.16	1,084,812.5	576,938.1	5,779.0
310.0	1.5 °	272 °	309.95	-2.54	-2.12	3.31	1,084,812.5	576,937.9	5,769.0
320.0	1.4 °	277 °	319.95	-2.52	-2.37	3.46	1,084,812.5	576,937.6	5,759.1

Missed the target of the designed hole (0.0°,0.0°) by:

2.5	ft. North
1.9	ft. East
20.0	ft. Higher
20.29	feet Total
6.34%	Tolerance

Error Analysis
Bottom Coordinates

Northing	1,084,812.5	+/- 0.2
Easting	576,937.6	+/- 0.2
Elevation	5,759.1	+/- 0.0

EXPLANATION

HOLE DEPTH: Length along the borehole axis from the collar to the point of the survey, NOT vertical depth.

INCLINATION: Equivalent to "Dip" with the exception that 0° INCLINATION = VERTICAL and 90° INCLINATION = HORIZONTAL. INCLINATION greater than 90° implies UP.

DIRECTION: Equivalent to "Bearing" of the borehole at the point of survey. Measured on a magnetic azimuth (0°-360°) system.

DISTANCE NORTH, DISTANCE EAST – Distances from the collar calculated on a TRUE NORTH-SOUTH grid.

CLOSURE: The horizontal distance from the collar of the borehole to the survey point.

NORTHING, EASTING, ELEV.: Coordinates calculated from the collar coordinates. Collar coordinates furnished by Geodetic Surveys, Inc.. (* Estimated coordinates have not been surveyed.)

BOREHOLE: MF-254
COLLAR COORDINATES
NORTH 1,084,687.0 *
EAST 577,105.0 *
ELEVATION 6,082.0 * (Estimated)

Miner Flat Dam
Secondary Access Road - South End
BOREHOLE - AS DRILLED

Surveyed By: DA
Date Surveyed: August 22, 1995
Time Surveyed: 10:15 am

Raw Data From Owl Technical Assoc.

HOLE DEPTH (ft.)	Model 780 INCLINATION (from Vert.) °	DIRECTION North=360 °	TRUE DEPTH (ft.)	DISTANCE NORTH (ft.)	DISTANCE EAST (ft.)	CLOSURE (ft.)	NORTHING (ft.)	EASTING (ft.)	ELEVATION (ft.)
0.0	0.0 °	0 °	0.00	0.00	0.00	0.00	1,084,687.0	577,105.0	6,082.0
10.0	0.9 °	86 °	10.00	0.01	0.08	0.08	1,084,687.0	577,105.1	6,072.0
20.0	0.5 °	200 °	20.00	-0.03	0.14	0.14	1,084,687.0	577,105.1	6,062.0
30.0	0.8 °	318 °	30.00	-0.02	0.08	0.08	1,084,687.0	577,105.1	6,052.0
40.0	0.4 °	23 °	40.00	0.06	0.05	0.08	1,084,687.1	577,105.0	6,042.0
50.0	0.8 °	195 °	50.00	0.03	0.04	0.05	1,084,687.0	577,105.0	6,032.0
60.0	1.1 °	225 °	60.00	-0.11	-0.04	0.11	1,084,686.9	577,105.0	6,022.0
70.0	1.0 °	304 °	69.99	-0.12	-0.18	0.22	1,084,686.9	577,104.8	6,012.0
80.0	0.9 °	297 °	79.99	-0.04	-0.33	0.33	1,084,687.0	577,104.7	6,002.0
90.0	0.7 °	322 °	89.99	0.04	-0.43	0.44	1,084,687.0	577,104.6	5,992.0
100.0	1.2 °	283 °	99.99	0.12	-0.57	0.58	1,084,687.1	577,104.4	5,982.0
110.0	1.2 °	277 °	109.99	0.15	-0.78	0.79	1,084,687.2	577,104.2	5,972.0
120.0	1.3 °	237 °	119.99	0.10	-0.98	0.98	1,084,687.1	577,104.0	5,962.0
130.0	1.1 °	206 °	129.98	-0.05	-1.12	1.12	1,084,687.0	577,103.9	5,952.0
140.0	1.1 °	220 °	139.98	-0.21	-1.22	1.24	1,084,686.8	577,103.8	5,942.0
150.0	0.1 °	142 °	149.98	-0.29	-1.28	1.31	1,084,686.7	577,103.7	5,932.0
160.0	1.3 °	251 °	159.98	-0.33	-1.38	1.42	1,084,686.7	577,103.6	5,922.0
170.0	0.9 °	291 °	169.98	-0.34	-1.56	1.59	1,084,686.7	577,103.4	5,912.0
180.0	1.1 °	276 °	179.98	-0.30	-1.73	1.75	1,084,686.7	577,103.3	5,902.0
190.0	1.1 °	277 °	189.97	-0.28	-1.92	1.94	1,084,686.7	577,103.1	5,892.0
200.0	0.5 °	133 °	199.97	-0.30	-1.98	2.00	1,084,686.7	577,103.0	5,882.0
210.0	0.4 °	109 °	209.97	-0.34	-1.92	1.95	1,084,686.7	577,103.1	5,872.0
220.0	1.0 °	291 °	219.97	-0.32	-1.96	1.99	1,084,686.7	577,103.0	5,862.0
230.0	1.1 °	268 °	229.97	-0.29	-2.14	2.16	1,084,686.7	577,102.9	5,852.0
240.0	1.1 °	290 °	239.97	-0.26	-2.33	2.34	1,084,686.7	577,102.7	5,842.0
250.0	0.8 °	304 °	249.97	-0.19	-2.48	2.48	1,084,686.8	577,102.5	5,832.0
260.0	1.2 °	280 °	259.96	-0.13	-2.64	2.64	1,084,686.9	577,102.4	5,822.0
270.0	1.1 °	292 °	269.96	-0.08	-2.83	2.83	1,084,686.9	577,102.2	5,812.0
280.0	1.0 °	298 °	279.96	-0.00	-3.00	3.00	1,084,687.0	577,102.0	5,802.0
290.0	1.1 °	281 °	289.96	0.06	-3.17	3.17	1,084,687.1	577,101.8	5,792.0
300.0	0.4 °	134 °	299.96	0.05	-3.24	3.24	1,084,687.1	577,101.8	5,782.0
310.0	0.8 °	162 °	309.96	-0.04	-3.19	3.19	1,084,687.0	577,101.8	5,772.0
320.0	1.2 °	261 °	319.96	-0.12	-3.27	3.27	1,084,686.9	577,101.7	5,762.0
325.1	1.5 °	270 °	325.05	-0.13	-3.39	3.39	1,084,686.9	577,101.6	5,756.9

Missed the target of the designed hole (0.0°,0.0°) by:
0.1 ft. North
3.4 ft. East
0.0 ft. Higher
3.39 feet Total
1.04% Tolerance

Error Analysis
Bottom Coordinates

Northing	1,084,686.9	+/- 0.3
Easting	577,101.6	+/- 0.0
Elevation	5,756.9	+/- 0.0

EXPLANATION

HOLE DEPTH: Length along the borehole axis from the collar to the point of the survey, NOT vertical depth.

INCLINATION: Equivalent to "Dip" with the exception that 0° INCLINATION = VERTICAL and 90° INCLINATION = HORIZONTAL. INCLINATION greater than 90° implies UP.

DIRECTION: Equivalent to "Bearing" of the borehole at the point of survey. Measured on a magnetic azimuth (0°-360°) system.

DISTANCE NORTH, DISTANCE EAST – Distances from the collar calculated on a TRUE NORTH-SOUTH grid.

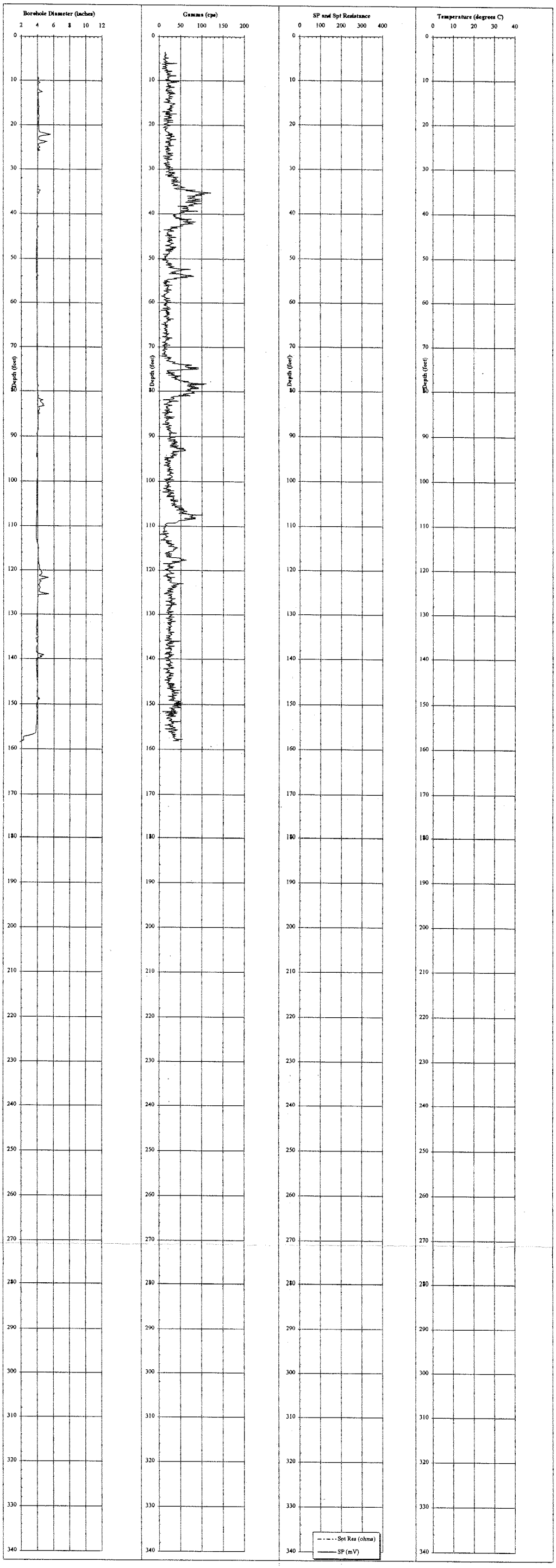
CLOSURE: The horizontal distance from the collar of the borehole to the survey point.

NORTHING, EASTING, ELEV.: Coordinates calculated from the collar coordinates. Collar coordinates furnished by Geodetic Surveys, Inc..
(* Estimated coordinates have not been surveyed.)

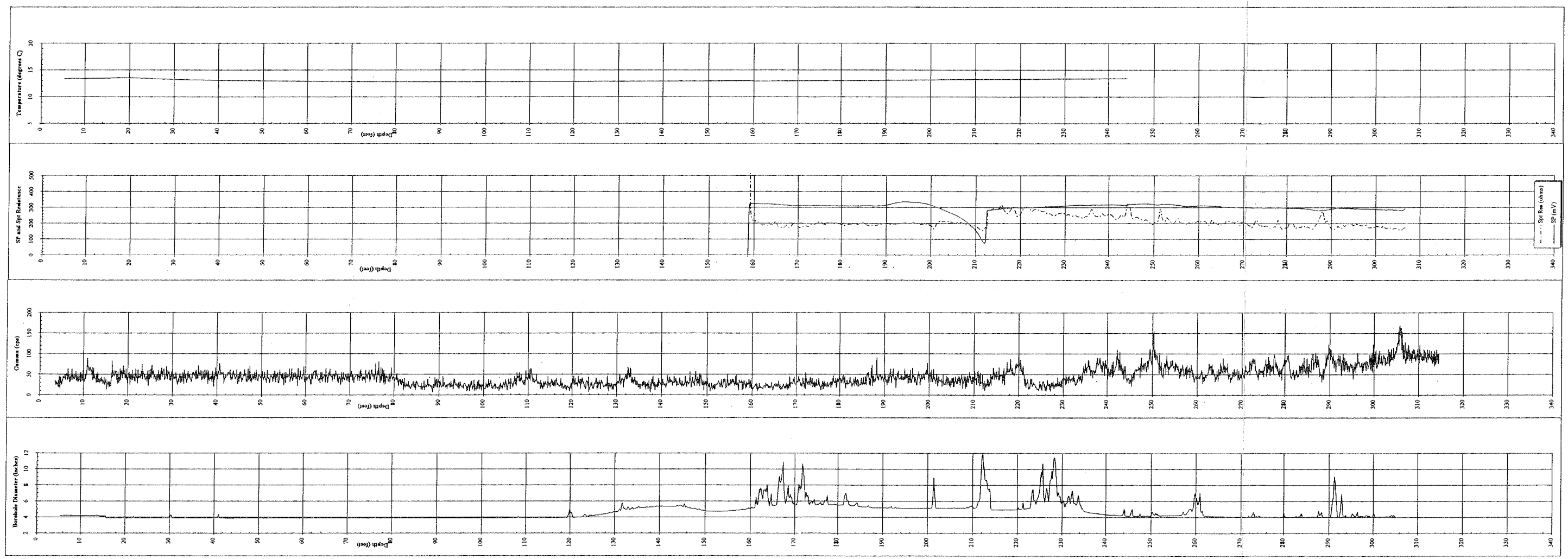
APPENDIX D

GEOPHYSICS

Miner Flat Borehole MF218



Miner Flat Borehole MF218A



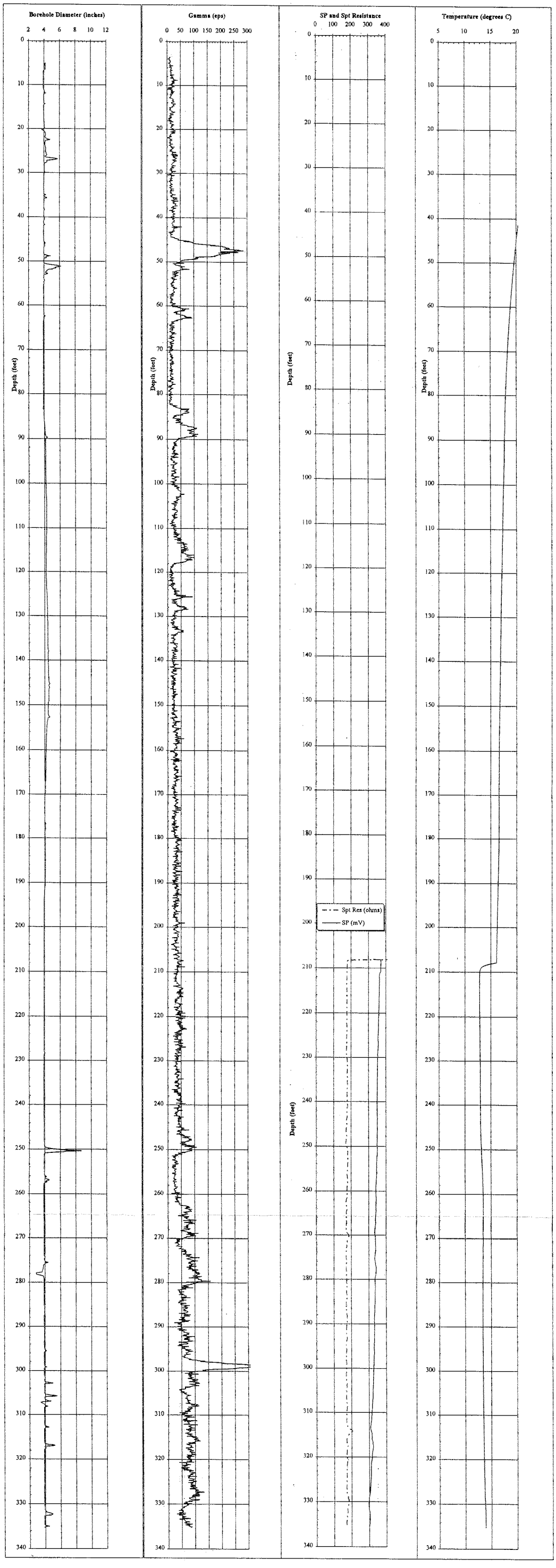
September 1995

MF218 BOPH.XLS Composite Plot

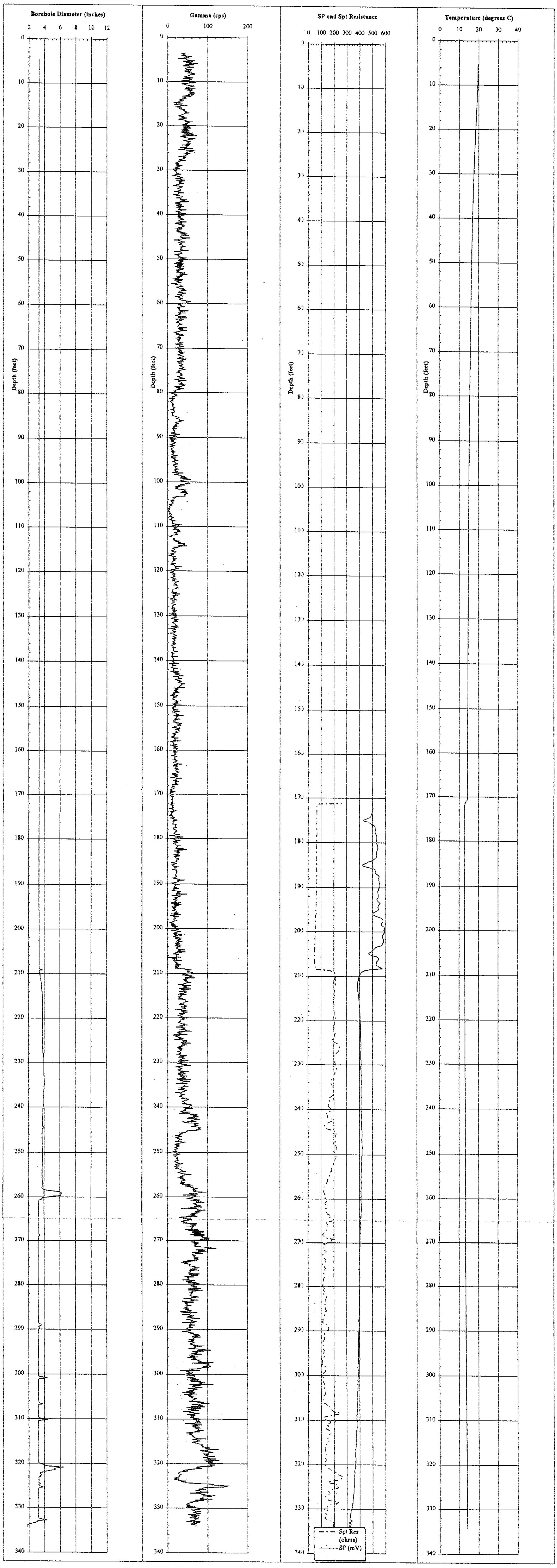
Page 1 of 1

Oxbar Associates

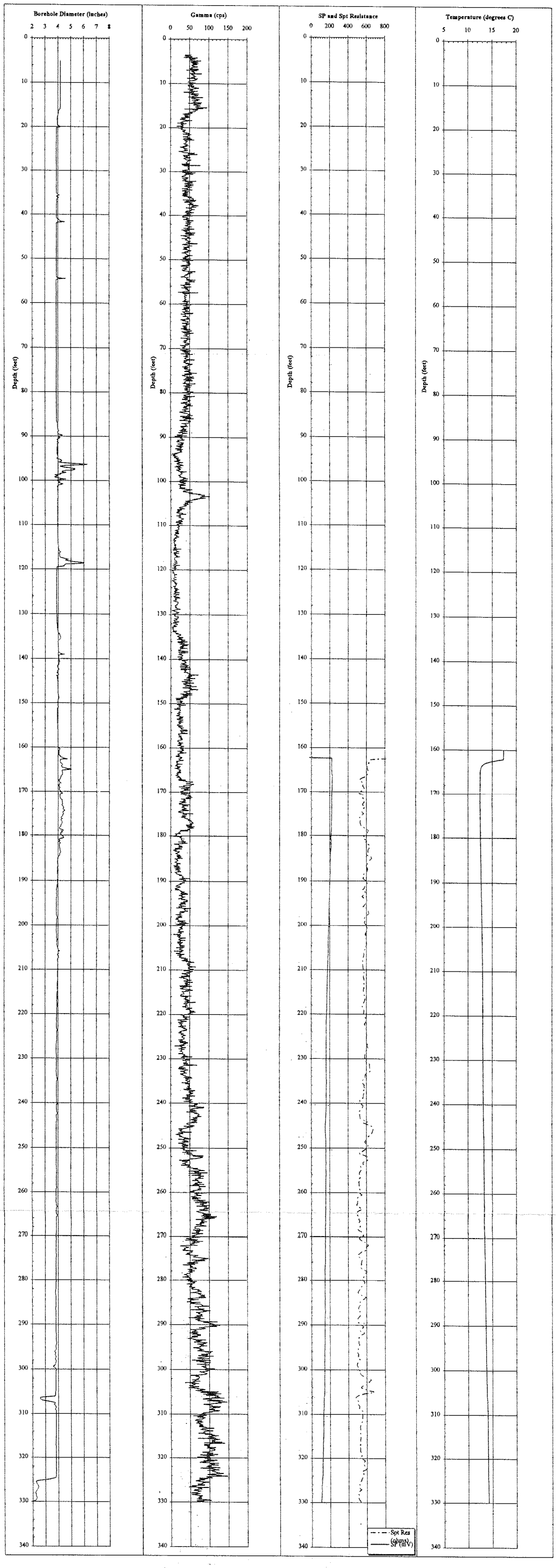
Miner Flat Borehole MF250



Miner Flat Borehole MF251

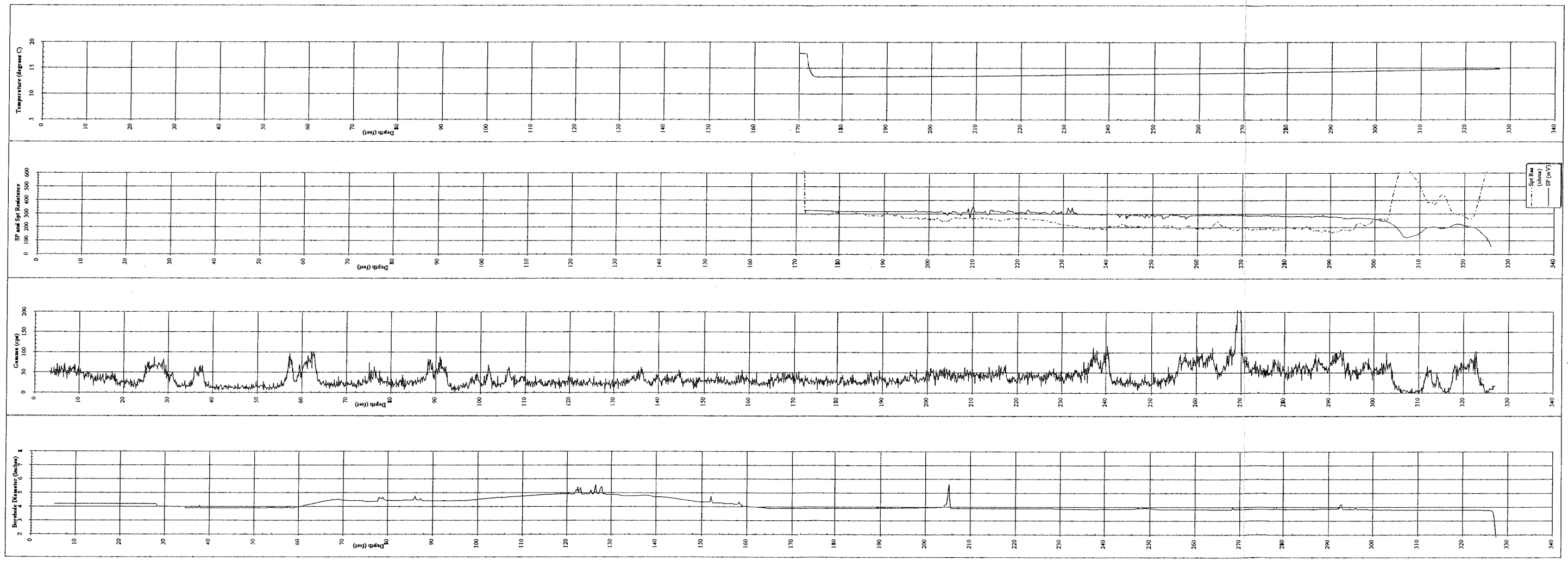


Miner Flat Borehole MF252



943-27901.F90

Miner Flat Borehole MF253



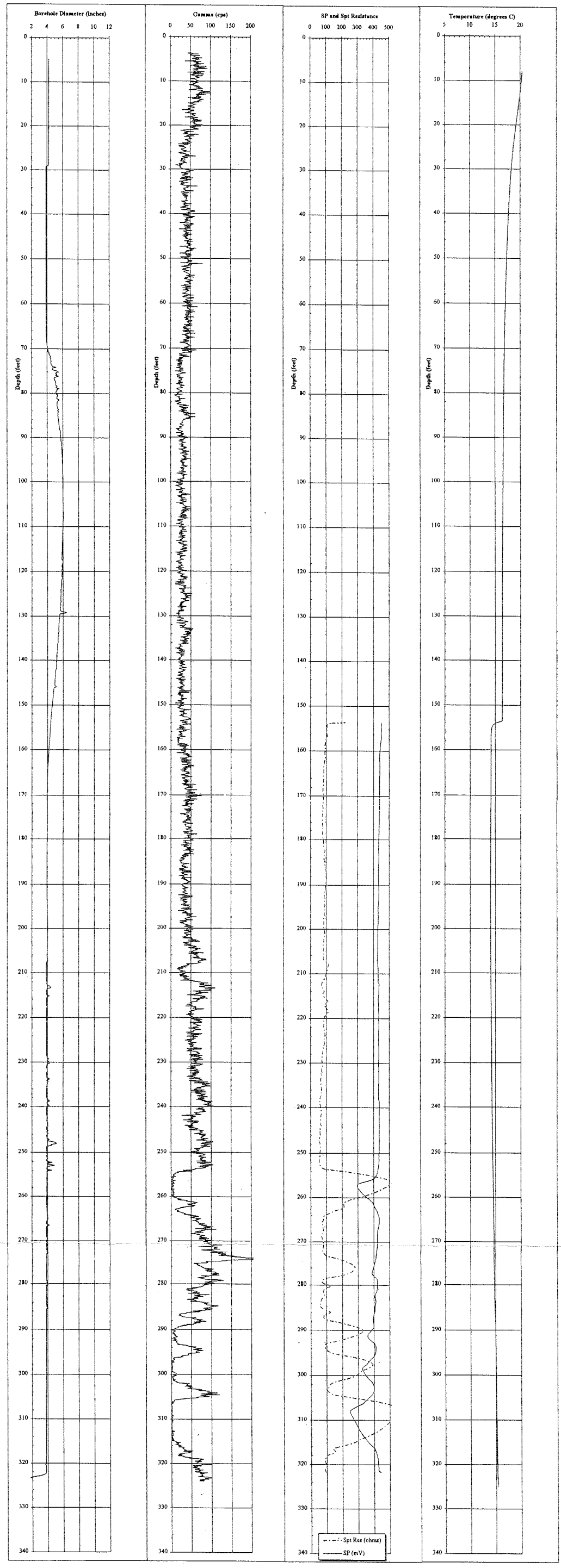
September 1995

MF253GPH.DGS, Composite Plot

Page 1 of 1

Golder Associates

Miner Flat Borehole MF254



APPENDIX E

PIEZOMETER INSTALLATIONS

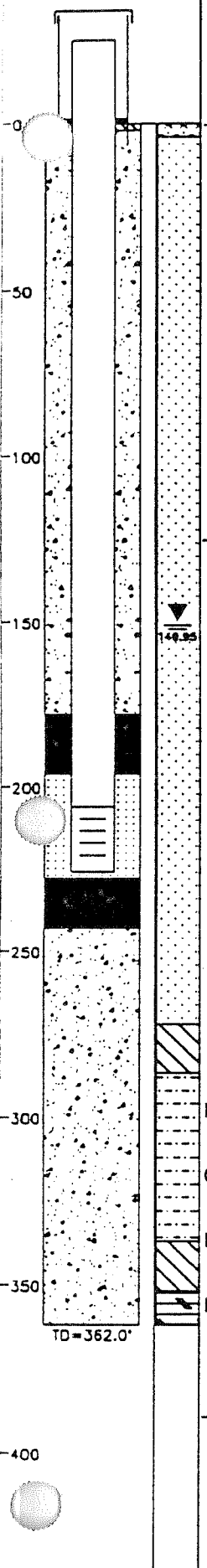
Well No. MF-218A

Boring No. X-Ref: MF-218A

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1085006.50 Easting: 576834.81

Elevation Ground Level 6107.52 ft.
Top of PVC Casing 6108.42 ft.



Drilling Summary:

Total Depth	362.0 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	0.90 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	6 ft.-2 in., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	8/21/95	14:00	8/28/95	17:30
Casing:				
S1	12/18/95	9:52	12/18/95	9:55
C1	12/18/95	9:55	12/18/95	10:28
Filter Placement:	12/18/95	10:28	12/18/95	10:55
Cementing:	12/18/95	16:04	12/18/95	16:08
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 0.90	-	206.00	C1	6108.42	-	5901.52
206.00	-	226.00	S1	5901.52	-	5881.52

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (196.0-228.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-2.0 ft.)

Backfill: 3/4 in. Gravel (2.0-178.0 and 243.0-362.0 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (178.0-196.0 and 228.0-243.0 ft.)

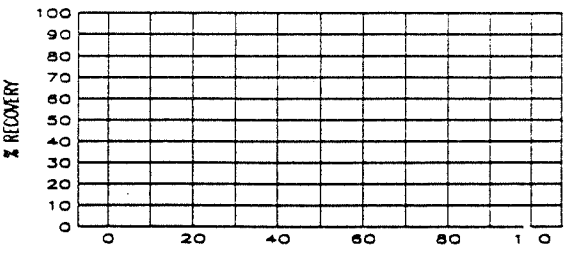
Well Development

Water Level on 12/18/95 = 149.95 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments: Used coupling (PVC) at 130.0 ft.; glued with Uni-Weld 1200 PVC Cement/ACE 44393 PVC Pipe Cleaner. Upper backfilling took only ~18 gallons of gravel; may have bridged.

Not to Horiz. Scale

Supervised by B. Johnson
Job Number 943-27691.140

Site Miner Flat Dam
File Name MF-218A

Well No. MF-250

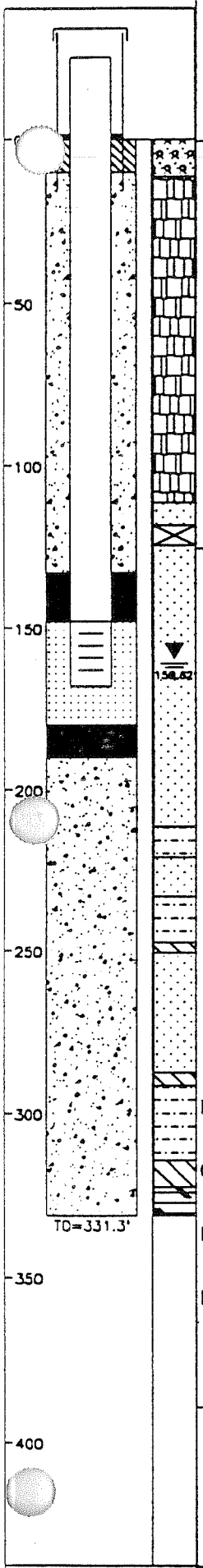
Boring No. X-Ref: MF-250

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1085825.57 Easting: 576826.36

Elevation Ground Level 6079.16 ft.

Top of PVC Casing 6080.06 ft.



Drilling Summary:

Total Depth	331.3 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	0.90 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	15 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	6/2/95	7:00	6/19/95	12:45
Casing:				
S1	12/16/95	9:50	12/16/95	9:58
C1	12/16/95	9:58	12/16/95	10:09
Filter Placement:	12/16/95	10:15	12/16/95	11:30
Cementing:	12/18/95	16:50	12/18/95	17:00
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 0.90	-	148.00	C1	6080.06	-	5931.16
148.00	-	168.00	S1	5931.16	-	5911.16

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (148.0-180.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-133.0 and 190.0-331.3 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (133.0-148.0 and 180.0-190.0 ft.)

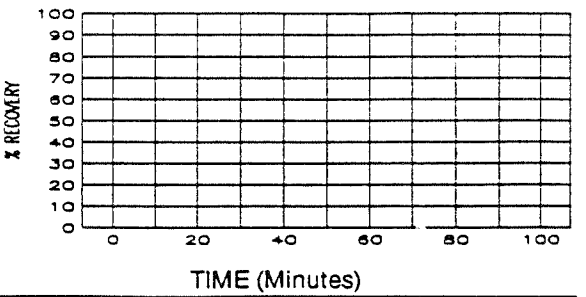
Well Development

Water Level on 12/18/95 = 159.62 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments:

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-250

Well No. MF-251

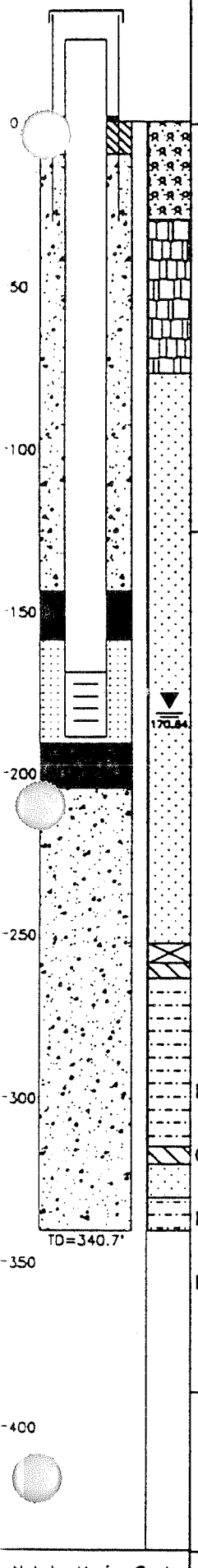
Boring No. X-Ref: MF-251

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1085422.42 Easting: 576870.86

Elevation Ground Level 6088.96 ft.

Top of PVC Casing 6089.96 ft.



Not to Horiz. Scale

Drilling Summary:

Total Depth	340.7 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	1.00 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	30 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	6/2/95	17:57	7/23/95	17:30
Casing:				
S1	12/16/95	14:15	12/16/95	14:17
C1	12/16/95	14:17	12/16/95	14:37
Filter Placement:	12/16/95	14:37	12/16/95	14:50
Cementing:	12/18/95	17:05	12/18/95	17:15
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 1.00	-	169.00	C1	6089.96	-	5919.96
169.00	-	189.00	S1	5919.96	-	5899.96
	-				-	
	-				-	
	-				-	
	-				-	

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (159.0-191.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-144.0 and 205.0-340.7 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (144.0-159.0 and 191.0-205.0 ft.)

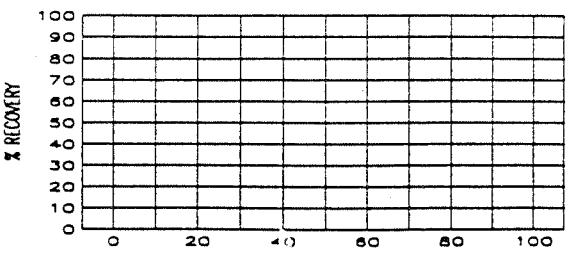
Well Development

Water Level on 12/18/95 = 170.84 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments:

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-251

Well No. MF-252

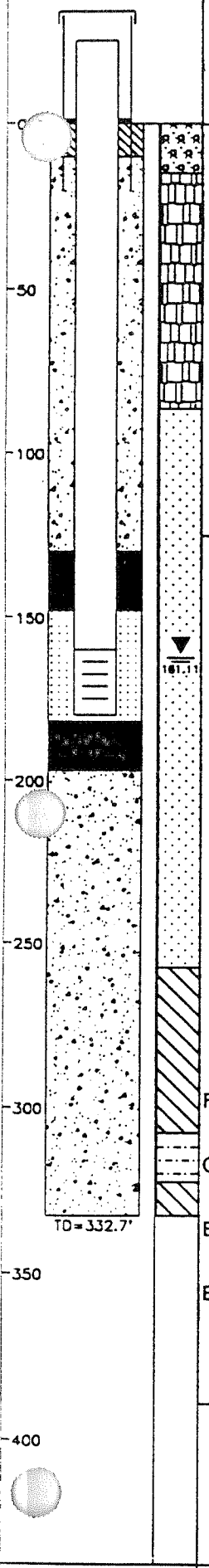
Boring No. X-Ref: MF-252

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1085229.89 Easting: 576821.43

Elevation Ground Level 6074.16 ft.

Top of PVC Casing 6074.91 ft.



Drilling Summary:

Total Depth	332.7 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	0.75 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	20 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	6/15/95	7:30	8/2/95	11:30
Casing:				
S1	12/17/95	14:42	12/17/95	14:45
C1	12/17/95	14:45	12/17/95	15:30
Filter Placement:	12/17/95	16:00	12/17/95	16:30
Cementing:	12/18/95	16:32	12/18/95	16:40
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 0.75	-	160.00	C1	6074.91	-	5914.16
160.00	-	180.00	S1	5914.16	-	5894.16

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (148.0-182.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-130.0 and 197.0-332.7 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (130.0-148.0 and 182.0-197.0 ft.)

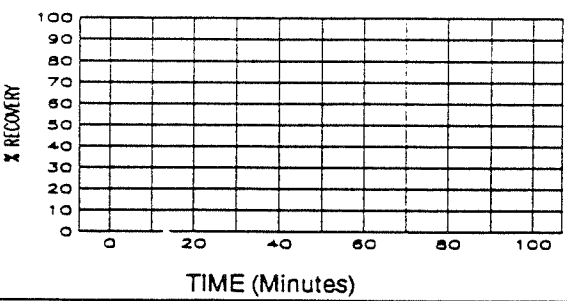
Well Development

Water Level on 12/18/95 = 161.11 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments: Some caving/bridging near top of upper bentonite seal, added additional 1/2 bag to ensure at least 15 ft. of seal; used coupling (galvanized steel) at 150.0 ft.

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27891.140

Site Miner Flat Dam

File Name MF-252

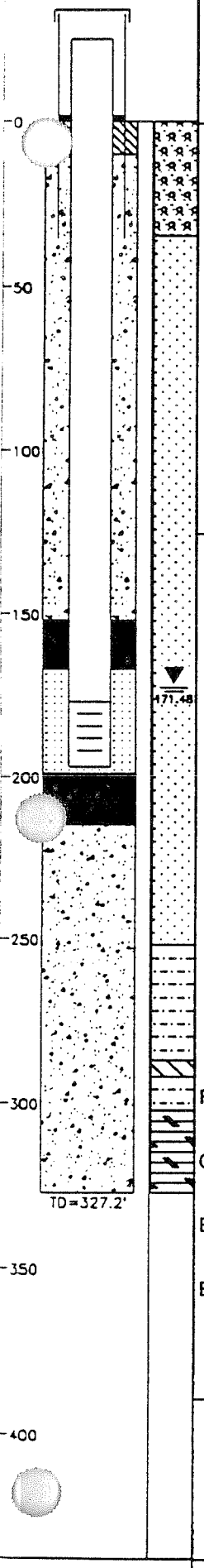
Boring No. X-Ref: MF-253

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1084797.33 Easting: 576874.74

Elevation Ground Level 6071.41 ft.

Top of PVC Casing 6072.61 ft.



Drilling Summary:

Total Depth	327.2 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	1.20 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	35 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	8/3/95	14:42	8/21/95	13:50
Casing:				
S1	12/15/95	8:56	12/15/95	9:00
C1	12/15/95	9:00	12/15/95	9:08
Filter Placement:	12/15/95	9:10	12/15/95	11:30
Cementing:	12/18/95	15:45	12/18/95	15:50
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 1.20	-	177.00	C1	6072.61	-	5894.41
177.00	-	197.00	S1	5894.41	-	5874.41

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (167.0-199.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-152.0 and 215.0-327.2 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (152.0-167.0 and 199.0-215.0 ft.)

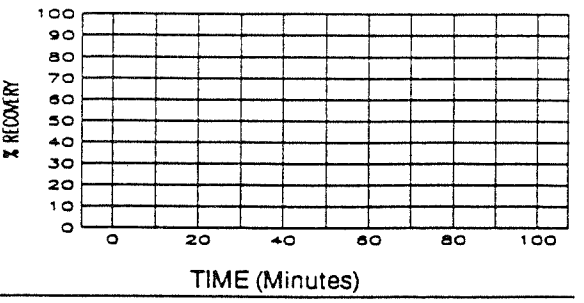
Well Development

Water Level on 12/18/95 = 171.48 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments:

Not to Horiz. Scale

Supervised by B. Johnson Site Miner Flat Dam

Job Number 943-27691.140 File Name MF-253

Well No. MF-254

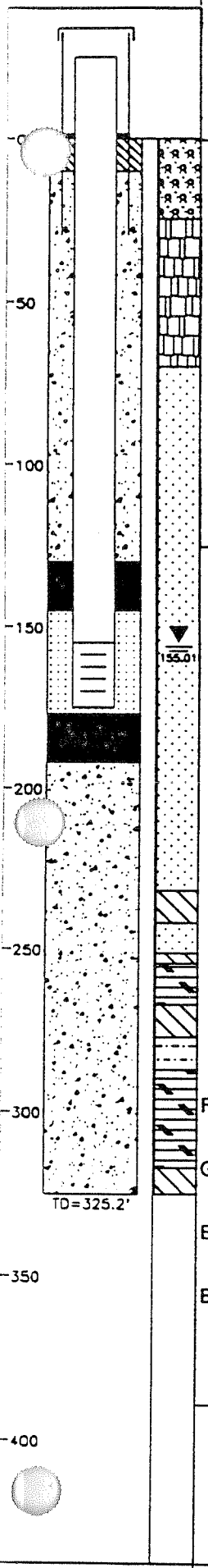
Boring No. X-Ref: MF-254

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1084655.39 Easting: 577063.74

Elevation Ground Level 6061.25 ft.

Top of PVC Casing 6062.05 ft.



Drilling Summary:

Total Depth	325.2 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	0.80 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	29.5 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	8/13/95	12:45	8/8/95	11:30
Casing:				
S1	12/15/95	14:33	12/15/95	14:35
C1	12/15/95	14:35	12/15/95	14:50
Filter Placement:	12/15/95	14:50	12/15/95	15:30
Cementing:	12/18/95	15:22	12/18/95	15:30
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 0.80	-	155.00	C1	6062.05	-	5906.25
155.00	-	175.00	S1	5906.25	-	5886.25

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (145.0-177.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-130.0 and 192.0-325.2 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (130.0-145.0 and 177.0-192.0 ft.)

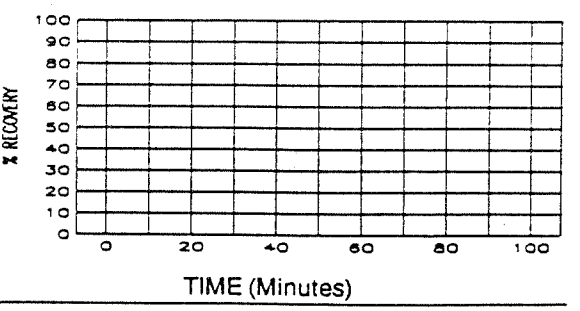
Well Development

Water Level on 12/18/95 = 155.01 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments:

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-254

Well No. MF-218A

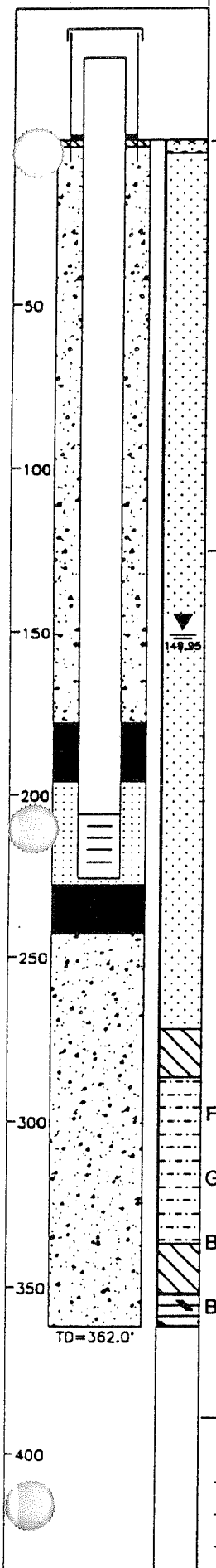
Boring No. X-Ref: MF-218A

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1085006.50 Easting: 576834.81

Elevation Ground Level 6107.52 ft.

Top of PVC Casing 6108.42 ft.



Drilling Summary:

Total Depth	362.0 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	0.90 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	6 ft.-2 in., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	8/21/95	14:00	8/28/95	17:30
Casing:				
S1	12/18/95	9:52	12/18/95	9:55
C1	12/18/95	9:55	12/18/95	10:28
Filter Placement:	12/18/95	10:28	12/18/95	10:55
Cementing:	12/18/95	16:04	12/18/95	16:08
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 0.90	-	206.00	C1	6108.42	-	5901.52
206.00	-	226.00	S1	5901.52	-	5881.52

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (196.0-228.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-2.0 ft.)

Backfill: 3/4 in. Gravel (2.0-178.0 and 243.0-362.0 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (178.0-196.0 and 228.0-243.0 ft.)

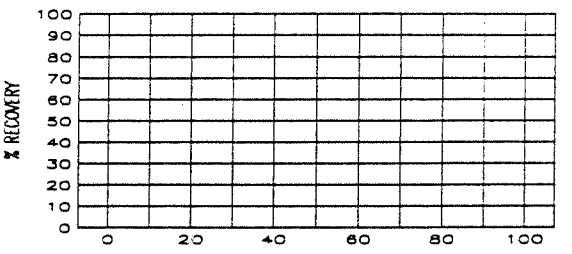
Well Development

Water Level on 12/18/95 = 149.95 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments: Used coupling (PVC) at 130.0 ft.; glued with Uni-Weld 1200 PVC Cement/ACE 44393 PVC Pipe Cleaner. Upper backfilling took only ~18 gallons of gravel; may have bridged.

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-218A

Well No. MF-250

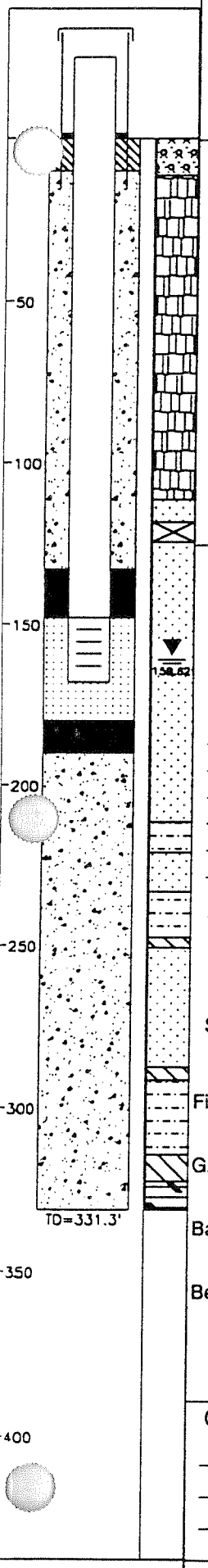
Boring No. X-Ref: MF-250

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1085625.57 Easting: 576826.36

Elevation Ground Level 6079.16 ft.

Top of PVC Casing 6080.06 ft.



Drilling Summary:

Total Depth	331.3 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	0.90 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	15 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	6/2/95	7:00	6/19/95	12:45
Casing:				
S1	12/16/95	9:50	12/16/95	9:58
C1	12/16/95	9:58	12/16/95	10:09
Filter Placement:	12/16/95	10:15	12/16/95	11:30
Cementing:	12/18/95	16:50	12/18/95	17:00
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 0.90	-	148.00	C1	6080.06	-	5931.16
148.00	-	168.00	S1	5931.16	-	5911.16

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (148.0-180.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-133.0 and 190.0-331.3 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (133.0-148.0 and 180.0-190.0 ft.)

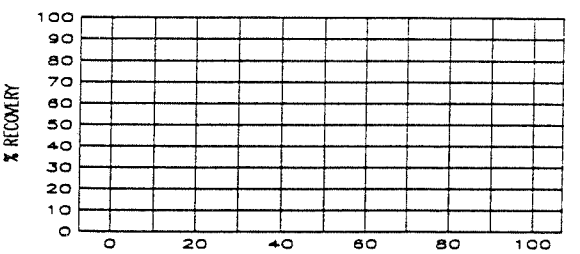
Well Development

Water Level on 12/18/95 = 159.62 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments:

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-250

Well No. MF-251

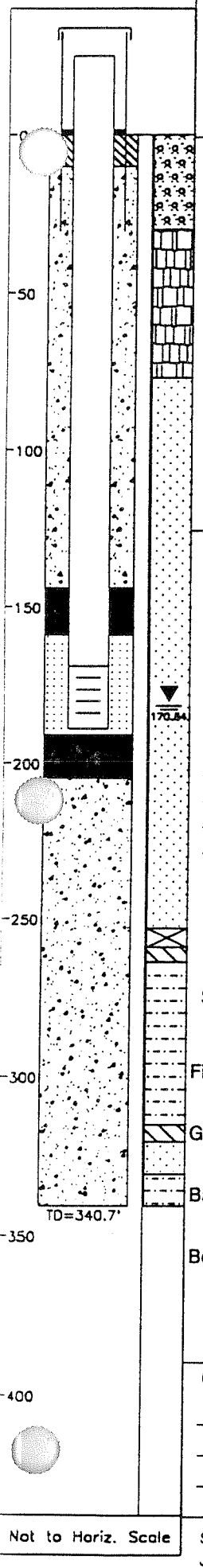
Boring No. X-Ref: MF-251

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1085422.42 Easting: 576870.86

Elevation Ground Level 6088.96 ft.

Top of PVC Casing 6089.96 ft.



Drilling Summary:

Total Depth	340.7 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	1.00 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	30 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	6/2/95	17:57	7/23/95	17:30
Casing:				
S1	12/16/95	14:15	12/16/95	14:17
C1	12/16/95	14:17	12/16/95	14:37
Filter Placement:	12/16/95	14:37	12/16/95	14:50
Cementing:	12/18/95	17:05	12/18/95	17:15
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 1.00	-	169.00	C1	6089.96	-	5919.96
169.00	-	189.00	S1	5919.96	-	5899.96

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (159.0-191.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-144.0 and 205.0-340.7 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (144.0-159.0 and 191.0-205.0 ft.)

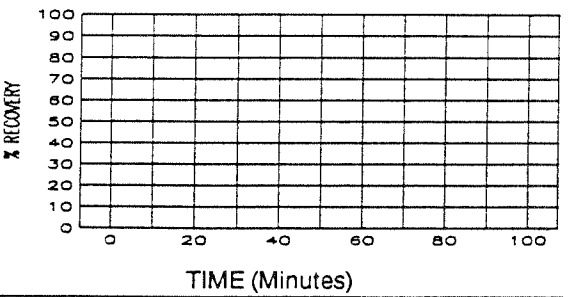
Well Development

Water Level on 12/18/95 = 170.84 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments:

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-251

Well No. MF-252

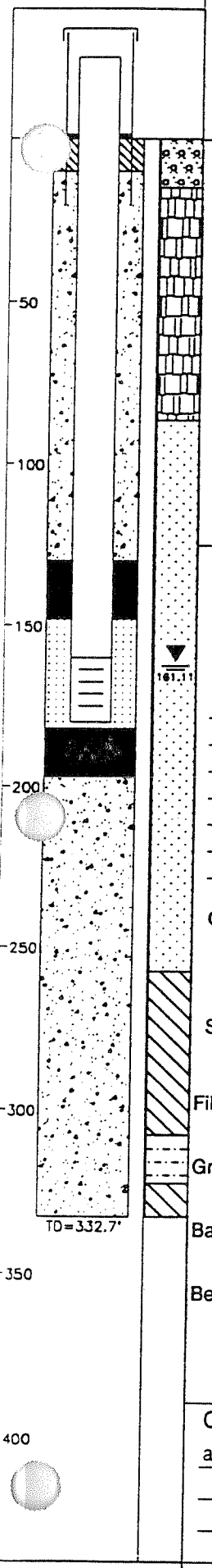
Boring No. X-Ref: MF-252

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1085229.89 Easting: 576821.43

Elevation Ground Level 6074.16 ft.

Top of PVC Casing 6074.91 ft.



Drilling Summary:

Total Depth	332.7 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	0.75 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	20 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	6/15/95	7:30	8/2/95	11:30
Casing:				
S1	12/17/95	14:42	12/17/95	14:45
C1	12/17/95	14:45	12/17/95	15:30
Filter Placement:	12/17/95	16:00	12/17/95	16:30
Cementing:	12/18/95	16:32	12/18/95	16:40
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 0.75	-	160.00	C1	6074.91	-	5914.16
160.00	-	180.00	S1	5914.16	-	5894.16

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (148.0-182.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-130.0 and 197.0-332.7 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (130.0-148.0 and 182.0-197.0 ft.)

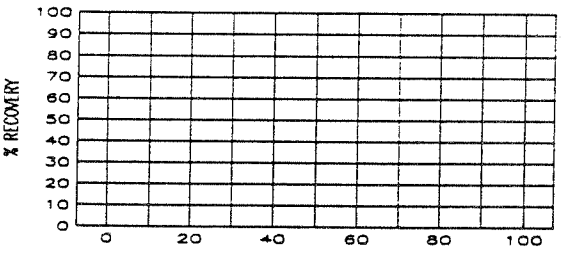
Well Development

Water Level on 12/18/95 = 161.11 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments: Some caving/bridging near top of upper bentonite seal, added additional 1/2 bag to ensure at least 15 ft. of seal; used coupling (galvanized steel) at 150.0 ft.

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-252

Well No. MF-253

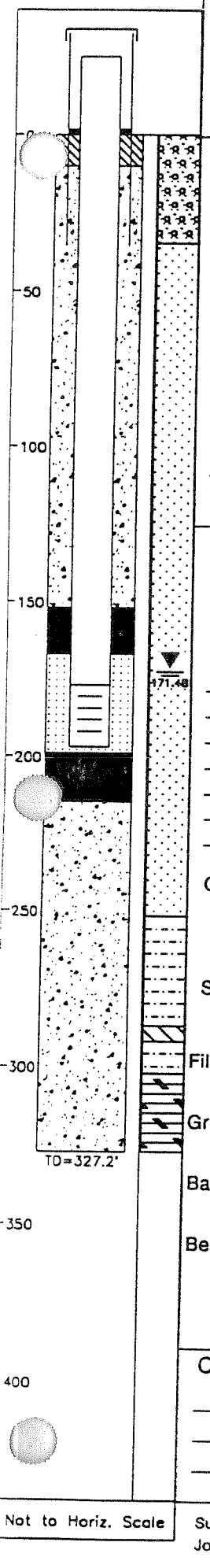
Boring No. X-Ref: MF-253

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1084797.33 Easting: 576874.74

Elevation Ground Level 6071.41 ft.

Top of PVC Casing 6072.61 ft.



Drilling Summary:

Total Depth	327.2 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	1.20 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	35 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	8/3/95	14:42	8/21/95	13:50
Casing:				
S1	12/15/95	8:56	12/15/95	9:00
C1	12/15/95	9:00	12/15/95	9:08
Filter Placement:	12/15/95	9:10	12/15/95	11:30
Cementing:	12/18/95	15:45	12/18/95	15:50
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 1.20	-	177.00	C1	6072.61	-	5894.41
177.00	-	197.00	S1	5894.41	-	5874.41

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (167.0-199.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-152.0 and 215.0-327.2 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (152.0-167.0 and 199.0-215.0 ft.)

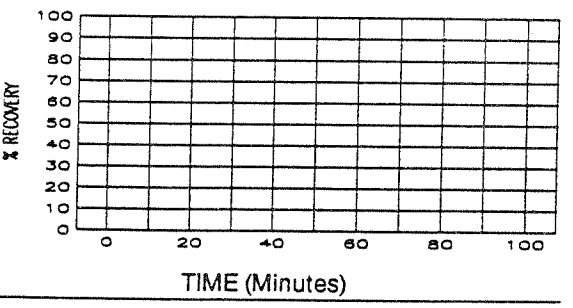
Well Development

Water Level on 12/18/95 = 171.48 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments:

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-253

Well No. MF-254

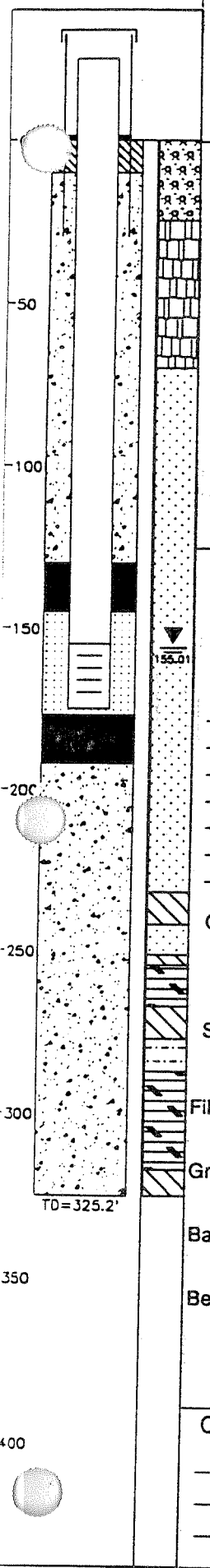
Boring No. X-Ref: MF-254

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: Northing: 1084655.39 Easting: 577063.74

Elevation Ground Level 6061.25 ft.

Top of PVC Casing 6062.05 ft.



Drilling Summary:

Total Depth	325.2 ft.
Borehole Diameter	3.65 in.
Casing Stickup Height	0.80 ft.
Driller	B. Mathews
Rig	Dresser DBS-25
Bit(s)	RSG 3.65 in. Core Bit
Drilling Fluid	Polymer/Water
Protective Casing	29.5 ft., 4 in. dia. Steel

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	6/13/95	12:45	8/8/95	11:30
Casing:				
S1	12/15/95	14:33	12/15/95	14:35
C1	12/15/95	14:35	12/15/95	14:50
Filter Placement:	12/15/95	14:50	12/15/95	15:30
Cementing:	12/18/95	15:22	12/18/95	15:30
Development:				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log

Casing string(s): C = Casing S = Screen

Depth			String(s)	Elevation		
+ 0.80	-	155.00	C1	6062.05	-	5906.25
155.00	-	175.00	S1	5906.25	-	5886.25

Casing: C1 1.5 in. Schedule 80, Flush Threaded PVC

Screen: S1 1.5 in. Schedule 80, Flush Threaded 0.020 Slot PVC

Filter Pack: 10-12 Silica Sand (145.0-177.0 ft.)

Grout Seal: Portland Type I-II Cement Slurry with 5% Quickgel Bentonite Powder (0.0-10.0 ft.)

Backfill: 3/4 in. Gravel (10.0-130.0 and 192.0-325.2 ft.)

Bentonite Seal: Wyoming Grade 3/8 in. Bentonite Holeplug Bentonite Chips (130.0-145.0 and 177.0-192.0 ft.)

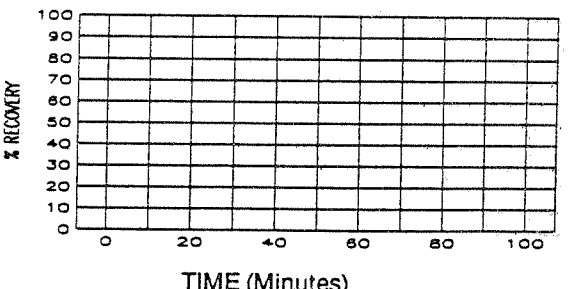
Well Development

Water Level on 12/18/95 = 155.01 FBTC

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments:

Not to Horiz. Scale

Supervised by B. Johnson

Job Number 943-27691.140

Site Miner Flat Dam

File Name MF-254