MONTANORE PROJECT
ADDENDUM TO GEOTECHNICAL REPORT
TAILINGS IMPOUNDMENT SITE
VOLUME 1 OF 2

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Montanore Project
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by:
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November 1990

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8029-010
21 November 1990

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Attention: Mr. Mark Petersmeyer
Project Director

Subject: Montanore Project
Addendum to Geotechnical Report
Tailings Impoundment Site

Gentlemen:

Morrison-Knudsen Engineers, Inc. (MKE) is pleased to submit this addendum to the March 1990 geotechnical report for the Montanore Project.

This report presents the results of the 1990 geotechnical investigations for the proposed tailings impoundment in the Little Cherry site.

The geotechnical investigations consisted of (1) geologic mapping, (2) drilling, (3) test pit excavations, and (4) laboratory testing. A description of subsurface conditions (bedrock, soils and groundwater) and a discussion of the engineering properties of construction materials (soils, waste rock and tailings) are presented.

If you have any questions about this geotechnical report, please call me at (415) 442-7743.

Very truly yours,

Alberto Pujol
Project Manager

APR/afp

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MONTANORE PROJECT

ADDENDUM TO GEOTECHNICAL REPORT

TAILINGS IMPOUNDMENT SITE

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CHAPTER 1
SUMMARY AND CONCLUSIONS

This report presents the results of the 1990 geotechnical investigation conducted by MKE at the proposed Little Cherry Creek tailings impoundment, a part of the Montanore mining project being developed by Noranda Minerals Corporation. Results of earlier geotechnical investigations at the Little Cherry site are discussed in MKE's March 1990 geotechnical report. This report is an addendum to the March 1990 report; the previous results, discussions and conclusions are not repeated or discussed herein except where changes have resulted from the 1990 investigation.

The 1990 geotechnical investigation was performed from late July through November 1990 and included (1) drilling of 27 boreholes with a total length of 2678 feet, (2) excavation of 47 test pits, (3) additional geologic mapping, (4) installation and observation of piezometers, (5) laboratory testing of soil and waste rock samples and (6) data interpretation and evaluation. The results of laboratory testing of tailings performed under a separate authorization are also discussed in this report.

The data obtained during this investigation generally support and reinforce the results and conclusions of the March 1990 report. Key conclusions, discussed in more detail in the following chapters, include:

- Dense sandy-silty or clayey gravel is the predominant soil type at all the proposed impoundment features.
- Silt layers are present in a portion of the main tailings dam area. These silts are generally stiff.
- Soft silt and clay layers are present in a portion of the diversion dam area and will require particular consideration.
- The permeability of the impoundment soils is generally less than 10^{-5} cm/sec and, in many cases, less than 10^{-6} cm/sec. Bedrock permeabilities range from less than 10^{-6} to approximately 4×10^{-4} cm/sec. Due to the highly fractured

state of most of the bedrock in the area, it is generally slightly more permeable than the overlying soils.

- Groundwater is generally contained in the fractured bedrock and confined by the overlying less-permeable soils. Groundwater levels are below the soil-bedrock contact at the north and south saddle dams, seepage collection dam and diversion channel. However, artesian pressures exist below much of the main dam and diversion dam sites.
- The soils in all borrow areas are generally gravelly. The soils in borrow area A have slightly higher fines content than those in borrow areas B, C and D. Borrow areas B and C have higher content of cobbles and boulders than borrow areas A and D.
- The waste rock tested in the laboratory is of suitable strength and durability for use in the construction of the proposed embankments.
- The results of the laboratory tests of coarse tailings indicate that the sands can be compacted to provide adequate strength for construction of a retention dam. However, the compactive effort may cause some particle breakdown. The measured permeability of compacted tailings is in the order of 10^{-3} cm/sec.
- Locating the cyclone plant near the impoundment site, as opposed to near the mill site, should be considered in order to minimize mechanical degradation of the sand by pipeline transport.

CHAPTER 2
INTRODUCTION

2.1 BACKGROUND

Noranda Minerals Corp. is developing the Montanore Project, a copper-silver mining and milling operation in Sanders and Lincoln Counties, Montana. As a part of this project, a tailings impoundment is proposed on Little Cherry Creek in the Kootenai National Forest, which is the object of these geotechnical investigations.

In 1988, a preliminary field investigation was conducted for preparation of an operations permit application. A field exploration for final design was conducted in 1989, and a geotechnical report was prepared to present the results of the 1988 and 1989 investigations (MKE, March 1990).

Evaluation of the data gathered in 1988 and 1989 led to the conclusion that further exploration was needed to (1) confirm groundwater conditions for design of the pressure relief system, (2) obtain additional data on dam foundation materials and (3) further determine the characteristics of potential construction materials in the borrow areas delineated during previous studies. The additional exploration was performed in 1990 and is the subject of this supplemental geotechnical report.

2.2 PURPOSE AND SCOPE

The purpose of this report is to present (1) the results of the 1990 geotechnical investigation and (2) data from the laboratory testing of tailings. The tailings tests were conducted under a separate program but have not been discussed in previous reports.

This report is an addendum to the March 1990 geotechnical report and provides additional support for final engineering studies and design of the proposed tailings impoundment. The results and conclusions of the March 1990 report are not presented or discussed herein, except where altered by the results of the 1990 investigations.

The scope of work for the 1990 geotechnical investigation includes the following tasks:

- Conduct field investigations consisting of:
  - Geologic mapping
  - Test pit excavations
  - Exploratory drilling, and in situ permeability testing
  - Monitoring of piezometer water levels and flow rates
- Perform laboratory testing on soil, tailings and waste rock samples
- Evaluate subsurface conditions and materials properties
- Prepare supplemental geotechnical report

2.3 AUTHORIZATION

Noranda Minerals Corp. authorized the work for this phase of the project on 31 July 1990 by Purchase Order No. 01092P. The tailings testing was authorized on 25 April 1989 by Purchase Order No. M1027.

CHAPTER 3
FIELD EXPLORATION

3.1 GENERAL

The supplemental field exploration at the Little Cherry tailings impoundment was performed between late July and early October 1990. The field exploration program consisted of drilling, test pit excavations and geologic mapping. The exploration program supplements previous explorations in 1988 and 1989, and provides specific information on (1) the foundation and hydrogeologic conditions at the proposed tailings impoundment structures and (2) the materials in proposed borrow areas.

Field exploration in 1990 consisted of 27 boreholes and 47 test pits. A summary of the exploration program is presented in Table 3.1.

3.2 GEOLOGIC MAPPING

Additional geologic mapping was performed at the impoundment site, particularly at the proposed main dam and diversion dam sites. Springs and bedrock outcrops noted during mapping are shown on the exploration plan, Figure 1.

3.3 DRILLING

Twenty seven borings totaling 2678 linear feet were drilled under the direction of MKE from late July to early October 1990 at the proposed Little Cherry impoundment site. The borings were drilled to determine the characteristics of bedrock and soils, depth to groundwater and depth to bedrock. Of the originally proposed borings (MKE, letter to Noranda dated 11 July 1990), five borings, numbered DH-33 through DH-37, were not drilled because it was judged during the exploration that the information to be obtained from these borings would not be essential to the design of the impoundment. However, nine additional borings, DH-32a and DH-43 through DH-51, were drilled in areas where

TABLE 3.1
SUMMARY OF 1990 FIELD EXPLORATION

FEATURE	BOREHOLES			TEST PITS	
	Number of Boreholes	Designation	Total Footage	Number of Test Pits	Designation
Starter Dam	8	DH-21 to 25 DH-43 to 45	815	–	–
Final Dam	3	DH-26 to 28	773	–	–
South Saddle Dam	2	DH-41 to 42	80	3	TP-216, 245, 246
North Saddle Dam	1	DH-40	154	–	–
Seepage Collection Dam	2	DH-38 to 39	150	4	TP-247 to 250
Diversion Dam	9	DH-31, 32, 32a DH-46 to 51	548	3	TP-217a, b, c
Diversion Channel	2	DH-29 to 30	158	1	TP-219
Borrow Area A	–	–	–	5	TP-201, 205, 206, 211, 215
Borrow Area B	–	–	–	5	TP-204, 209, 210, 213, 214
Borrow Area C	–	–	–	5	TP-202, 203, 207, 208, 212
Borrow Area D	–	–	–	21	TP-220 TP-224 to 231 TP-233 to 244
TOTALS	27		2678	47	

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initial borings indicated a need for further exploration. Hole depths ranged from 37 to 354 feet. Locations of the borings are shown on Figure 1 and the number of borings and drilling footage for each feature of the impoundment are presented in Table 3.1.

The borings were drilled by J.D. Welsh and Associates of Meridian, Idaho using an Acker ADII truck-mounted drill rig and a Longyear HC-150 trailer-mounted drill rig. The Longyear rig was primarily used on the deeper borings. In general, 4-inch I.D. casing was set to a depth of 5 feet, whereupon the borings were advanced by continuous coring through both soil and rock using a 3.78-inch HQ diamond drill bit and triple tube core barrels. For drillholes DH-47 through -51, holes were started with an 8-inch O.D. hollow stem continuous flight auger. When auguring became difficult, HQ coring commenced using the auger stems as casing. Drill water was recirculated, using approximately 1 part per thousand polymer drilling fluid in water. Soil samples were obtained from 2-inch O.D. standard split spoon samplers (ASTM 1586) and thin walled 3-inch Shelby tubes (ASTM 1587) where conditions permitted. However, sample recovery from Shelby tubes was poor, as the tubes were generally bent and creased because of gravels and cobbles. Additional disturbed and undisturbed samples were obtained from the core. A pocket penetrometer was used to measure approximate unconfined compressive strengths of fine-grained materials.

Field tests were performed in all borings to determine consistency and permeabilities of the subsurface materials. Standard Penetration Tests (ASTM 1586) where performed at regular intervals where soil conditions permitted. Permeability tests consisted of falling head tests in soft soils and water pressure tests in competent soils and bedrock, using procedures outlined in the U.S. Bureau of Reclamation's "Earth Manual" (1974), Method E-18. The boreholes were thoroughly flushed with clean water prior to beginning the permeability tests. Results of the permeability tests are presented in Table A.2, Appendix A and are discussed in Chapter 5.

To monitor groundwater levels, piezometers were installed in all borings except DH-32a and DH-44. Dual piezometers were installed in DH-22, -23, and -24 to differentiate

groundwater zones at different depths. Groundwater depths and artesian pressures and flows (if present) were measured at periodic intervals after installation. Groundwater levels during drilling were measured in the mornings before drilling commenced for the day.

Boring logs and piezometer installation details are presented in Appendix A. Water level data are presented in Table A.1.

3.4 TEST PITS

Forty seven test pits, ranging in depth from 5-1/2 to 17 feet, were excavated in the impoundment area and borrow areas in September and early October 1990 in order to evaluate subsurface conditions and characterize proposed borrow materials. Test pits were numbered TP-201 through TP-250, with test pits TP-218, -221, -222, -223 and -232 being omitted from the program. The test pits were excavated by Noble Excavating of Libby, Montana, using a Caterpillar/Mitsubishi E120 trackhoe or a John Deere 410 backhoe. Bulk soil samples were taken from each pit and transported to Chen-Northern in Great Falls for laboratory testing.

The number of test pits per impoundment feature or borrow area is shown in Table 3.1. Test pit locations are shown on Figures 1 and 2 and test pit logs are presented in Appendix B.

CHAPTER 4
LABORATORY TESTING

4.1 GENERAL

The types and numbers of laboratory tests performed are summarized in Table 4.1. Laboratory test results are presented in Appendix C and are summarized in Tables C-1 and C-2, Appendix C. The results are discussed and evaluated in Chapters 5 (foundation soils) and 6 (borrow soils, waste rock and tailings).

4.2 FOUNDATION SOILS

Laboratory tests were performed to supplement available data on the engineering parameters of the soils forming the foundations of the various dams. Moisture content (ASTM D2216), dry density, grain size (ASTM D422), Atterberg limits (ASTM D4318), and specific gravity (ASTM D854) were determined for selected samples obtained during the exploration. Consolidated undrained (CU) triaxial compression tests with pore pressure measurements and unconsolidated undrained (UU) triaxial compression tests were performed on Shelby Tube and core samples of clayey foundation soils. Strength parameters determined from these tests will be used in stability analyses. Consolidation tests (ASTM D2435) were also performed on undisturbed samples to aid in evaluating soil compressibility and preconsolidation loads.

4.3 BORROW SOILS

Laboratory tests were performed to evaluate engineering properties for the soils in Borrow Areas C and D and to supplement available data for the soils in other borrow areas previously investigated. These include Borrow Areas A and B, the planned diversion channel excavation and the seepage collection impoundment excavation. All borrow areas were investigated with test pits except for the diversion channel, which was investigated with two borings and one test pit.

TABLE 4.1 SUMMARY OF LABORATORY TESTS

Year	Sample Source	Moisture Content ASTM D2216	Dry Density	Sieve Analysis ASTM D422	Sieve and Hydrometer ASTM D422	Atterberg Limits ASTM D4318	Compaction ASTM D698	Specific Gravity ASTM D854	UU Triaxial ASTM D2850	CU Triaxial	Consolidation ASTM D2435	Permeability	Sodium Soundness ASTM C88	Specific Gravity & Absorption ASTM C127	L.A. Abrasion ASTM C535	Maximum & Minimum Density ASTM D4253 ASTM D4254	Sedimentation
1990	Test Pit	34		26	9	11	11	4	5*	1*		6*					
	Boring	8	7	10	1	8			6	2	4						
	Waste Rock												2	2	1	1	
	Tailings				5	1	2	1		2	2	8*				1	2
TOTAL		42	7	36	15	20	13	5	11	5	6	14	2	2	1	2	2

*Recompacted samples

Moisture content, grain size, Atterberg Limits, moisture-density relationships and specific gravity were determined for selected test pit and boring bulk samples of borrow soils. CU and UU triaxial compression tests were performed in clayey soil borrow materials that were compacted to 95% of the maximum dry density at optimum moisture content as determined by ASTM D698. Strength parameters determined from these tests will be used in stability analyses. In addition, permeability tests were performed on some of the clayey samples compacted for triaxial testing to estimate soil permeability.

4.4 WASTE ROCK

Waste rock from mine adit excavation is proposed for use in the impoundment drains, toe dike rockfill and riprap zones. Two samples of waste rock were obtained from an existing stockpile adjacent to the Libby Creek exploration adit. One of the samples consisted of gravel up to 3 inches in size, while the other consisted primarily of cobbles and gravel exceeding 1-1/2 inches in size.

Specific gravity and absorption (ASTM C127), Los Angeles abrasion (ASTM C535) and sodium sulfate soundness tests (ASTM C88) were performed to evaluate the quality of the waste rock and its resistance to mechanical and chemical degradation. A maximum - minimum density test (ASTM D4253 and D4254) was also performed to evaluate compaction characteristics of the material.

4.5 TAILINGS

A laboratory test program was undertaken to estimate (1) the engineering properties of the tailings sand, which will be used as dam construction material, and (2) the density and consolidation characteristics of the slimes after deposition in the impoundment.

A sample of tailings was provided by Noranda's Brenda Process Technology Division, Kelowna, British Columbia. The sample was prepared by Brenda from a pilot grind using Montanore site ore and was pre-separated into the various size fractions. The gradation of the whole tailings (tailings feed) was provided by Noranda (MKE, July 1990).

Gradations of the tailings sand and slimes were estimated by Krebs Engineers based on computer simulations of the cyclone process.

Samples of whole tailings, sand and slimes were made in the laboratory by mixing the appropriate weights of each size fraction. Several gradations of sands were tested to evaluate the effect of varying fines content on compacted density and permeability.

The sample of whole tailings was tested for specific gravity and Atterberg limits to evaluate density and plasticity characteristics. The samples of tailings sand were tested to determine the moisture–density relationship of the material. A maximum–minimum density test was also performed to allow comparison with the maximum density obtained from the compaction test. Gradation tests were performed after the compaction tests to estimate the amount of grain size degradation induced by compaction.

CU triaxial compression tests and permeability tests were performed on tailings sand samples compacted to 95 percent of the maximum dry density at optimum moisture content as determined by ASTM D698. Strength parameters determined from these tests will be used in stability analyses. In addition, permeability tests (ASTM D2434) were performed on samples compacted to 90 percent and 95 percent of the maximum dry density.

Two samples of slimes were formed by sedimenting slimes slurry of appropriate gradation and solids content in clear plastic cylinders. These sedimentation tests were performed to estimate the density of the settled surface tailings. Consolidation tests were performed to estimate (1) the variation of tailings density with stress and (2) the time–rate settlement characteristics .

The results of the laboratory tests are presented in Appendix C.

CHAPTER 5
SUBSURFACE CONDITIONS

5.1 GENERAL

The exploration plans for the proposed tailings impoundment area and borrow area D are presented on Figures 1 and 2, respectively. A total of 25 borings and six test pits were located in the dam foundations during the 1990 field exploration. Two borings and one test pit were located in the diversion channel. Forty test pits were located in borrow areas A through D and in the seepage collection impoundment area.

Contour maps of the soils isopachs and piezometric surface are presented on Figures 3 and 4, respectively. Revised geologic sections, updated from the March 1990 geotechnical report to show additional data from the 1990 explorations, are presented on Figures 5 through 8. New geologic sections are presented on Figures 9 through 11. The sections show generalized soil types, bedrock profiles, permeability data and groundwater levels. The information shown on Figures 3 through 11 was interpreted from the results of the exploration programs. Actual bedrock and water level locations may vary from those indicated on the figures.

5.2 BEDROCK

As in previous explorations, the bedrock observed in the borings generally consists of low-grade metamorphosed siltstone (siltite) with some zones of argillite or meta-sandstone, depending on the grain sizes of the original sediments. Occasional interbedded quartzites, apparently from silicification of mostly sand-size materials, were also observed. In boreholes DH-25, DH-26 and DH-27, the bedrock consists of a weathered conglomerate/sedimentary breccia. Quartzites are hard and show little weathering whereas the siltites and argillites vary from soft to hard depending on the degree of weathering. The conglomerate is generally soft with some harder clasts.

Virtually all bedrock shows some degree of weathering. The most intensely weathered rock can usually be broken or crumbled by hand and is essentially soil-like in its characteristics.

Weathered rock is generally light orange to brown in color due to iron staining while less weathered material is usually light gray. Less weathered rock also contains some carbonates and occasional small (less than 1/8") pyrite cubes.

Fractures in the bedrock are most commonly controlled by the relict sedimentary bedding. The relict bedding and corresponding fractures are generally smooth and planar and at varying angles from the horizontal, averaging about 30°. Cores from most boreholes also show occasional planar near-vertical joints/fractures, as well as some irregular fractures. Iron and manganese oxide staining is usually most pronounced along fractures. Some fractures are filled with clay, silt or fine sand, apparently from weathering of the parent rock. Occasional slickensides were observed. Rock Quality Designation (RQD) averaged 36%, but ranged from 0 to 100%, generally reflecting the degree of weathering. Core recovery in bedrock averaged 93% with significant core losses only in occasional very weathered rock.

As indicated in the March 1990 report, the bedrock surface generally follows the local topography. (Refer to soils isopach map: Figure 3.) The 1990 drilling further confirmed and outlined the deep bedrock channel in the eastern part of the site. Drillhole DH-28 in this channel area did not reach bedrock at a total depth of 354 feet. Nearby DH-24 reached bedrock at 324 feet depth. Outside of the channel, bedrock in the main dam area was less than 100 feet below the surface.

At the seepage collection dam, bedrock was encountered at 55 and 28 feet depths at borings DH-38 and DH-39 in the left and right abutments, respectively. Bedrock is exposed in the creek channel. A single drillhole, DH-40, at the center of the north saddle dam hit bedrock at 133 feet. Bedrock along the south saddle dam was found to be approximately ten feet below the surface while bedrock depths along the adjacent diversion channel ranged from 4 feet near the west end to 51 feet in drillhole DH-29. Drillholes at the diversion dam site show bedrock depths from 14 feet to over 60 feet, with the deeper bedrock toward the west side of the site. No major changes in bedrock conditions were observed between any of the areas.

5.3 FOUNDATION SOILS

The 1990 drillholes and test pits showed the predominant soil type throughout the impoundment site to be a dense sandy-silty or clayey gravel, often with cobbles and boulders. The particles are mostly subangular and usually derived from the local siltite bedrock. Although most clasts are hard, virtually all show some degree of weathering and occasional zones contain soft and intensely weathered clasts. The matrix material often is somewhat orange in color, reflecting widespread iron staining. The material is interpreted to be a glacial till.

Layers of sandy or clayey silt were observed in several boreholes in the area of the **main tailings dam.** The silts are stiff to hard. Pocket penetrometer readings show unconfined compressive strengths to be approximately 2 tsf within 10 feet of the surface and generally greater than 4 tsf at greater depths. Standard Penetration Test (SPT) values range from 13 blows/ft. near the surface to more than 70 blows/ft. at depth. Some areas in the silt show faint varves and the material is interpreted to be lacustrine in origin.

Layers of fine-grained soils, primarily silt, were also noted in several boreholes in the **diversion dam** area. These soils were generally soft, probably due to high artesian pressures in the area, with SPT values ranging from 0 to 15 blows/ft. Boreholes often collapsed in the soft zones and recoveries were generally poor.

Laboratory test results of samples from the dam foundations indicate a fines content of 25 to 99 percent (Figures C-1 through C-3). The fine portions of the samples generally classify as low to medium plasticity silts and clays, with liquid limits ranging between 22 and 45; plasticity indices generally are between 4 and 17 (see Figure C-7, Appendix C). Several samples were non-plastic.

Natural moisture contents of samples of foundation soils vary from 13 to 29 percent. Figure C-8, Appendix C, shows moisture content plotted against fines content for both foundation and borrow soils. The figure shows a general trend of increasing moisture with increasing fines content.

Six unconsolidated undrained (UU) triaxial compression tests were performed on Shelby Tube silty soil samples from the embankment foundations. For the tailings retention dam foundation, the measured undrained shear strength ranges from 2,800 to over 18,000 pounds per square foot (psf) (see Figure C-9, Appendix C). A UU test on one sample from the seepage collection dam abutment yielded a strength of about 2,000 psf (Figure C-9). Two UU tests on samples from a layer of soft clayey silt in the diversion dam foundation yielded undrained shear strengths of 300 and 500 psf, respectively (Figure C-10).

The undrained shear strengths and natural moisture contents of the foundation soils are plotted against depth in Figure C-13 (Appendix C). This figure includes the results of 1989 testing. The undrained shear strength and plasticity index data can be used to determine whether the soil samples are over-consolidated. For normally-consolidated clays, ratios of undrained shear strength to effective overburden pressure (c/p') can be correlated with plasticity index (P.I.) values by the following empirical relation (Terzaghi and Peck, 1967):

$$c/p' = 0.11 + 0.0037(P.I.) \quad (1)$$

Using Equation (1) for the maximum P.I. value of 17, c/p' = 0.11. Figure C-13 shows that the c/p' values for selected soil samples within 34 feet of the ground surface range from 0.1 to 4.4. The c/p' values for all samples from the tailings retention dam and seepage collection dam exceed the c/p' ratio for normally-consolidated clays (0.11 as indicated above). Therefore, the test results indicate that these materials are over-consolidated. Over-consolidation could have resulted from the weight of glacial ice or overburden that was subsequently eroded, or from desiccation.

Two consolidated undrained (CU) triaxial compression tests with pore pressure measurements were performed on Shelby Tube and core samples of sandy silt from the tailings retention and diversion dam foundations. Effective-stress paths and Mohr envelopes were plotted to obtain the strength parameters from these tests (Figure C-14A through C-15B, Appendix C).

Four consolidation tests were performed on Shelby Tube and core samples of clayey silt, clayey sand and clayey gravel with sand from the starter, diversion and seepage collection

dam foundations. Consolidation curves were plotted to obtain the compression index (Cc) value (see Appendix C). The test results indicate that the compression index ranges from 0.04 to 0.06. The shapes of the consolidation curves indicate that disturbance occurred during sampling probably due to the significant gravel content in the soil. It is not possible to estimate preconsolidation pressures with any degree of accuracy from the consolidation curves. The time-rate curves were plotted to obtain the coefficient of consolidation (Cv) value (see Appendix C). The tests indicate that the coefficient of consolidation ranges from 3.5×10^{-4} to 2.4×10^{-2} cm^2/second.

5.4 GROUNDWATER

As indicated in the March 1990 geotechnical report, the general flow direction of groundwater in the proposed impoundment site is from west to east, roughly corresponding to the site topography. A piezometric surface map is presented in Figure 4. The piezometric surface contours are based on static water levels in piezometers which penetrated bedrock. Several springs, previously unmapped, were observed during the 1990 exploration, mostly in the area of the proposed diversion dam, and are shown on Figure 1. Flow from each of these springs was generally estimated to be on the order of 1 gpm or less.

Piezometer and borehole data for the 1990 exploration are summarized in Table 5.1, with detailed data presented in Appendix A. A summary of the 1990 permeability results based on material type is presented in Table 5.2, again with detailed data in Appendix A.

Tests indicate the permeability of the soils to be generally less than 10^{-5} cm/sec and, in many cases, less than 10^{-6} cm/sec. Some zones show permeabilities up to 3×10^{-5} cm/sec, and a single zone below 260 foot depth in drillhole DH-24 has an average permeability of 3×10^{-4} cm/sec. Permeabilities do not vary greatly with soil type since even the gravelly and cobbley soils contain significant quantities of fines.

Bedrock permeabilities are dependent on the degree and nature of fracturing and range from less than 10^{-6} to approximately 4×10^{-4} cm/sec. Due to the highly fractured state of most bedrock in the area, the bedrock is generally slightly more permeable than the

TABLE 5.1
1990 BOREHOLE AND PIEZOMETER DATA
Little Cherry Creek Impoundment Site

Hole No.	Ground Elevation	Total Depth (ft)	Depth to Bedrock (ft)	Depth to Static Water (ft)	=== Piezometer Sensing Zone === Interval (ft)	Material Soil (S) or Rock (R)
DH-21	3528.7	78	70	36	27 - 78	S/R
DH-22	3428.4	74	51	7	26 - 50	S
				3	53 - 74	R
DH-23	3425.5	98	87	25	47 - 78	S
				2 AGL	81 - 98	S/R
DH-24	3430.5	336	324	9 AGL	6 - 19	S
				37 AGL	284 - 336	S/R
DH-25	3487.3	113	98	20	48 - 113	S
DH-26	3389.5	145	132	1 AGL	78 - 116	S
DH-27	3395.1	274	262	8 AGL	210 - 274	S/R
DH-28	3449.9	354	---	1 AGL	152 - 354	S
DH-29	3719.2	80	51	Dry	50 - 80	R
DH-30	3651.4	78	13	Dry	38 - 78	R
DH-31	3656.8	47	38	10	19 - 47	S/R
DH-32	3652.3	66	53	33 AGL	45 - 66	S/R
DH-32a	3633.5	64	60	AGL	0 - 64	S/R
DH-38	3349.8	77	55	55	46 - 77	S/R
DH-39	3324.1	73	28	53	50 - 73	R
DH-40	3665.8	154	133	140	83 - 154	S/R
DH-41	3594.7	34	7	29	16 - 34	R
DH-42	3607.5	47	12	32	20 - 47	R
DH-43	3422.1	40	33	8 AGL	19 - 40	S/R
DH-44	3467.4	37	---	13	0 - 37	S
DH-45	3477.8	39	---	17	18 - 39	S
DH-46	3610.7	79	14	16 AGL	40 - 79	R
DH-47	3682.9	55	---	4 AGL	21 - 55	S
DH-48	3655.2	63	50	15 AGL	48 - 59	R
DH-49	3642.6	69	61	27 AGL	57 - 69	S/R
DH-50	3675.3	60	43	10 AGL	45 - 60	R
DH-51	3671.1	45	15	12 AGL	33 - 45	R

* All depths are measured from ground level and are rounded to the nearest foot.
* No piezometers were installed in DH-32a and DH-44; water levels are from open holes.
* Water levels were measured in Sept./Oct., 1990.
* Piezometer installations in DH-24, DH-28, DH-32 and DH-47 are non-standard due to collapsing boreholes during installation.
* AGL = Above Ground Level

TABLE 5.2

SUMMARY OF FIELD PERMEABILITY TEST RESULTS

Borehole	Predominant Material	Type of Test	Permeability (10^{-4} cm/sec)
DH-21	Silt and Sand	Falling Head	5
	Silty Gravel with Sand	Packer Test	<1 to 2
	Weathered Rock	Packer Test	<1 to 4
DH-22	Silty Sand with Gravel	Falling Head	20
	Silty Sand with Gravel	Packer Test	17 to 21
	Weathered Rock	Packer Test	8 to 16
DH-23	Silt with Gravel	Packer Test	<1
	Silt	Falling Head	4
DH-24	Clayey Gravel with Sand	Falling Head	7
	Clayey Gravel with Sand	Packer Test	<1 to 750
	Weathered Rock	Packer Test	310 to 450
DH-25	Clay with Gravel	Packer Test	<1 to 2
DH-26	Clayey Gravel with Sand	Packer Test	<1 to 75
DH-27	Clayey Gravel and Cobbles	Packer Test	<1 to 20
	Weathered Rock	Packer Test	<1 to 2
DH-28	Clayey Gravel with Sand	Falling Head	1
	Clayey Gravel	Packer Test	<1 to 5

TABLE 5.2

SUMMARY OF FIELD PERMEABILITY TEST RESULTS
(CONTINUED)

Borehole	Predominant Material	Type of Test	Permeability (10^{-6} cm/sec)
DH-31	Silty Gravel with Sand	Packer Test	<1
	Weathered Rock	Packer Test	<1 to 4
DH-32	Weathered Rock	Packer Test	<1
DH-32a	Gravelly Clay with Sand	Packer Test	<1 to 33
DH-38	Sandy Clay	Falling Head	<1
	Clayey Gravel and Cobbles; Weathered Rock	Packer Test	<1 to 34
	Slightly Weathered Rock	Packer Test	<1
DH-39	Silty Gravel	Packer Test	<1
	Weathered Rock	Packer Test	50 to 57
	Slightly Weathered Rock	Packer Test	<1 to 53
DH-40	Silty Gravel with Sand and Cobbles	Packer Test	<1 to 9
	Weathered Rock	Packer Test	<1 to 10
DH-41	Weathered Rock	Packer Test	<1 to 10
DH-42	Weathered Rock	Packer Test	<1 to 13

TABLE 5.2

SUMMARY OF FIELD PERMEABILITY TEST RESULTS
(CONTINUED)

Borehole	Predominant Material	Type of Test	Permeability (10^{-4} cm/sec)
DH-43	Silty Gravel with Sand	Packer Test	2
	Weathered Rock	Packer Test	<3 to 13
DH-44	Sandy Clay; Silty Gravel	Packer Test	<1
DH-46	Weathered Rock	Packer Test	<1 to 56
DH-47	Silty Gravel and Cobbles with Sand	Packer Test	<2
DH-48	Slightly Weathered Rock	Packer Test	2 to 3
DH-49	Weathered Rock	Packer Test	<3 to 29
DH-50	Slightly Weathered Rock	Packer Test	93 to 152
DH-51	Weathered Rock	Packer Test	15 to 46

overlying soils. Fifty five percent of the intervals tested in rock show permeabilities greater than 10^{-5} cm/sec whereas only 11% of the soil intervals tested exceed the same value.

Groundwater in the impoundment site area exists in varying degrees of confinement. Static water levels are below the top of bedrock at the north and south saddle dams and at the seepage collection dam. Water levels are approximately 140 feet below the ground surface at the north saddle dam, 30 feet at the south saddle dam and 55 feet on the abutments of the seepage collection dam. Piezometers along the diversion channel are dry, indicating the groundwater level to be below the proposed depths of channel excavation. In contrast to these areas, groundwater is confined in the valley bottom in the areas of the main tailings dam and the diversion dam, and significant artesian pressures are present.

Static water levels in the abutments of the main dam and diversion dam are below ground level, although generally above bedrock, whereas all piezometers in the valley bottom show water levels above ground surface. At the main dam, pressure heads generally range from 1 to 8 feet above ground level; however, at drillhole DH-24, located in the deep bedrock channel, the pressure head is 37 feet above ground level for a piezometer approximately 300 feet below ground surface. Artesian pressure heads are generally higher in the foundation of the diversion dam, ranging from 4 feet in drillhole DH-47 to 33 feet in drillhole DH-32. All artesian flow rates are less than 1/2 gpm except for the deep piezometer in DH-24 which yields approximately 5 gpm.

Since drilling water was used for coring of the drillholes, it was generally impossible to ascertain at what depths groundwater was encountered. Drilling and piezometer data do, however, indicate that groundwater is largely contained in the bedrock and confined by the overlying soils. Dual piezometers where one piezometer is located in bedrock and the other in soil show higher water levels in bedrock. Drillhole DH-23, for example, in the main dam area, shows a water level of 2 feet above ground level at the top of bedrock and 25 feet below ground level for the soil directly above bedrock. In the diversion dam area, drillhole DH-48, which was augered to the bedrock contact at a depth of 50 feet, showed no evidence of encountering groundwater to this depth. The piezometer in the upper bedrock, however, shows a static water level of 15 feet above ground level.

CHAPTER 6
CONSTRUCTION MATERIALS

6.1 BORROW SOILS

Forty-one test pits and two borings were excavated in the diversion channel, seepage collection impoundment and borrow areas A through D. The soils range from silty gravel with sand to sandy silt and clay with gravel. The various soil types are intermixed with each other; the soil gradations change mostly with depth, being finer near the surface and becoming coarse with depth. Boulders and cobbles in a matrix of gravel, sand and fines were encountered throughout the borrow areas. The amount of cobbles in the test pits was visually estimated to range from about 10 to 50% of the soil volume. The amount of boulders encountered varied from 5 to 15% of the soil volume. The percentage of boulders may be higher in some areas and usually increases with depth. The percentages of cobbles and boulders were generally higher in borrow areas B and C than in borrow areas A and D.

Virtually all soils show some degree of weathering and iron staining and, although most clasts are hard and competent, clasts in some zones are weathered to a soft friable material. Clasts are predominantly subangular and generally derived from the siltite bedrock. Weathered bedrock was encountered in several test pits in borrow area D.

Laboratory test results of samples from the borrow areas indicate that the fines content ranges from 13 to 71% (see Summary of Soil Test Results and Figures C-3 to C-6, Appendix C). Test results indicate that, on the average, the fines content is somewhat higher in borrow area A. Greater gravel contents were usually found in those borrow areas at higher elevations. The fine portions of samples generally classify as low to medium plasticity silts and clays, with liquid limits between 18 and 36; plasticity indices generally are between 2 and 16 (see Figure C-7, Appendix C). Several samples were non-plastic.

Natural moisture contents of samples vary between 6 and 30%. The results of 11 moisture-density tests (Standard Proctor ASTM D698) on silty sandy gravels and gravelly sandy silts show maximum dry densities ranging from 100 to 132 pounds per cubic foot (pcf) and averaging 120 pcf. Optimum moisture contents range from 3 to 22 percent and average 11.7 percent. Test results indicate that the natural moisture content is generally within 5% of the optimum moisture content.

Unconsolidated undrained (UU) triaxial compression tests were performed on three samples from borrow area A (proposed as the source of core material) and two samples from the seepage collection impoundment. Sample material ranged from silty gravel with sand to gravelly clay with sand. The samples were compacted to 95% of the maximum dry density at optimum moisture content as determined by ASTM D698. The measured undrained shear strength averages about 600 psf for the material from borrow area A and 1,200 psf for the material from seepage collection impoundment excavation (see Figures C-11 and C-12, Appendix C).

One consolidated undrained (CU) triaxial compression test with pore pressure measurements was performed on a sample of silty sandy gravel from the seepage collection impoundment. The sample was compacted to 95% of the maximum dry density and at optimum moisture content as determined by ASTM D698. The stress-path plot and Mohr envelope (Figures C-16A and C-16B, Appendix C) show that the effective angle of internal friction is about 38 degrees and the cohesion is negligible.

Permeability tests were performed on the samples compacted for the triaxial tests. The measured permeabilities range from 3×10^{-6} to 2×10^{-5} centimeters per second (cm/sec). The average permeability is about 10^{-5} cm/sec.

6.2 WASTE ROCK

Samples of waste rock were taken from existing stockpiles at the Libby Creek exploration adit for laboratory testing. The sampled rock is from approximately the 4,600 foot mark

in the adit and represents the Pritchard Formation. The rock is a hard gray siltite/argillite with angular pieces. The bulk of the total amount of waste rock will eventually be from the Revette Formation which, however, could not be sampled. The rock in the Revette formation is quartzitic and is expected to be harder and more competent than the Pritchard Formation material that was tested.

Laboratory test results for waste rock are presented on Figures C-17 and C-18, Appendix C. The absorption was measured to be from 0.24 to 0.35%, with an average specific gravity of 2.75, indicating a solid nonporous rock material. Percent weight losses from the Los Angeles abrasion test were 4.3 and 16.6 for 200 and 1,000 cycles respectively, indicating good resistance to mechanical weathering. The rock is also resistant to chemical weathering, as shown by 1.1 and 4.3 percent weight losses obtained from two sodium sulfate soundness tests.

The minimum density of the waste rock was measured to be 78.5 pcf, and the maximum density was 94.4 pcf and 92.4 pcf by the dry and wet methods (ASTM D4253), respectively.

6.3 TAILINGS

A. Whole Tailings

The gradation of the whole tailings, or tailings feed, was determined by Noranda from a pilot grind and is shown on Table 6.1 below:

TABLE 6.1
WHOLE TAILINGS GRADATION

Tyler Sieve No.	Particle Size (Microns)	Cumulative % Passing, by Weight
30	600	100
65	208	99.5
100	147	90.2
150	104	69.4
200	74	52.1
270	52	35.9
400	37	25.0

A sample was prepared to the above gradation. The specific gravity was measured to be 2.71 and the material was determined to be non-plastic. The whole tailings is classified as silt with sand (ML) based on ASTM D2487.

B. Tailings Sand

Three different underflow gradations, based on results of cyclone computer simulations by Krebs Engineers, were tested to evaluate the effect of varying fines content on strength and permeability. Tailings sand samples were prepared to the gradations shown on Table 6.2.

TABLE 6.2

TAILINGS SAND GRADATIONS

	Cumulative % Passing, by Weight		
Sieve No.	Gradation No. 5	Gradation No. 7	Gradation No. 9
30	100	100	100
65	99	99	99.8
100	77	81	77.5
150	33	41	32.5
200	10	14	8.3
270	2.5	3.1	1.6
400	0.7	0.8	0.4

The compaction and strength testing caused some mechanical degradation of the sand grains, resulting in significantly higher fines content, as shown on Table 6.3.

The three Standard Proctor compaction tests (ASTM D698) yielded maximum dry densities ranging from 92.0 pcf to 96.3 pcf and averaging 93.7 pcf. Optimum moisture contents range from 18.3 percent to 20.5 percent and average 19.7 percent. The detailed test results are included in Appendix C.

TABLE 6.3

TAILINGS SAND GRADATIONS AFTER TESTING

	Cumulative % Passing, by Weight		
Sieve No.	Gradation No. 5	Gradation No. 7	Gradation No. 9
30	100	100	100
65	97	98	99
100	83	83	84
150	48	46	45.4
200	23	22	15.8
270	11.5	10.1	5.5
400	6.6	4.4	2.6
Tests Performed Prior to Determination of Gradation	Std. Proctor Comp., Triaxial Strength, Permeability	Same as No. 5	Std. Proctor Comp. Max. & Min. Densities

The minimum and maximum densities were determined to be 75.5 pcf and 99.8 pcf, respectively, for a sand sample with gradation No. 9. Based on these results, a relative density of 70 percent is computed to be 91 pcf. A 70 percent relative density is generally considered to be the minimum density desired to avoid liquefaction of saturated tailings sand under strong earthquake shaking.

The shear strength of samples of tailings sand gradations Nos. 5 and 7 was determined by consolidated-undrained triaxial compression tests with pore pressure measurements. The samples were compacted to 95 percent of maximum dry density. The measured shear strength parameters are similar for both gradations:

TABLE 6.4

TAILINGS STRENGTH PARAMETERS

	Effective Cohesion (ksf)	Effective Friction (Degrees)
Gradation No. 5	0.2	35
Gradation No. 7	0.3	35

These results confirm that the values of effective cohesion and friction used in previous design studies (no cohesion and 33 degrees friction) are adequate.

Several permeability tests were run on samples with gradations Nos. 5 and 7 (Appendix C). The measured permeability of the sand is in the order of 10^{-3} cm/sec. The effect of differences in fines content and density on the permeability is small and probably within the accuracy of the test results.

C. Tailings Slimes

Samples of slimes were tested in the laboratory to evaluate sedimentation and consolidation characteristics. The slimes gradation was estimated based on results of cyclone computer simulations by Krebs Engineers and is shown on Table 6.5. Sedimentatation tests were run using clear plastic cylinders to measure the density of submerged tailings under no vertical load (i.e. the density of the slimes as deposited on the surface of the pond). The measured dry densities range from 66.9 pcf to 70.5 pcf and average about 69 pcf.

TABLE 6.5

TAILINGS SLIMES GRADATION

Sieve No.	Cumulative % Passing, by Weight
100	100
150	99
200	94
270	76
400	57

Two consolidation tests were made on sedimented slimes samples to evaluate the increase in density with vertical load and, therefore, with impoundment depth. Test results, included in Appendix C, show consolidation of the samples to unrealistically high density upon application of the initial load. If the initial consolidation is omitted, analysis of the consolidation curves suggests that the average dry density of the slimes deposited in the impoundment will be in the order of 70 to 75 pcf. A value of 70 pcf was used for previous design studies and is considered adequate. The compression index Cc is estimated to be about 0.1, and the coefficient of consolidation Cv is estimated to be about 0.05 cm^2/second.

The slimes average permeability, computed from the consolidation tests, is estimated to be approximately 10^{-6} cm/sec, which is consistent with the values assumed for preliminary analyses.

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Terzaghi, K. and R.B. Peck, Soil Mechanics in Engineering Practice, John Wiley and Sons, Second Ed., 1967.

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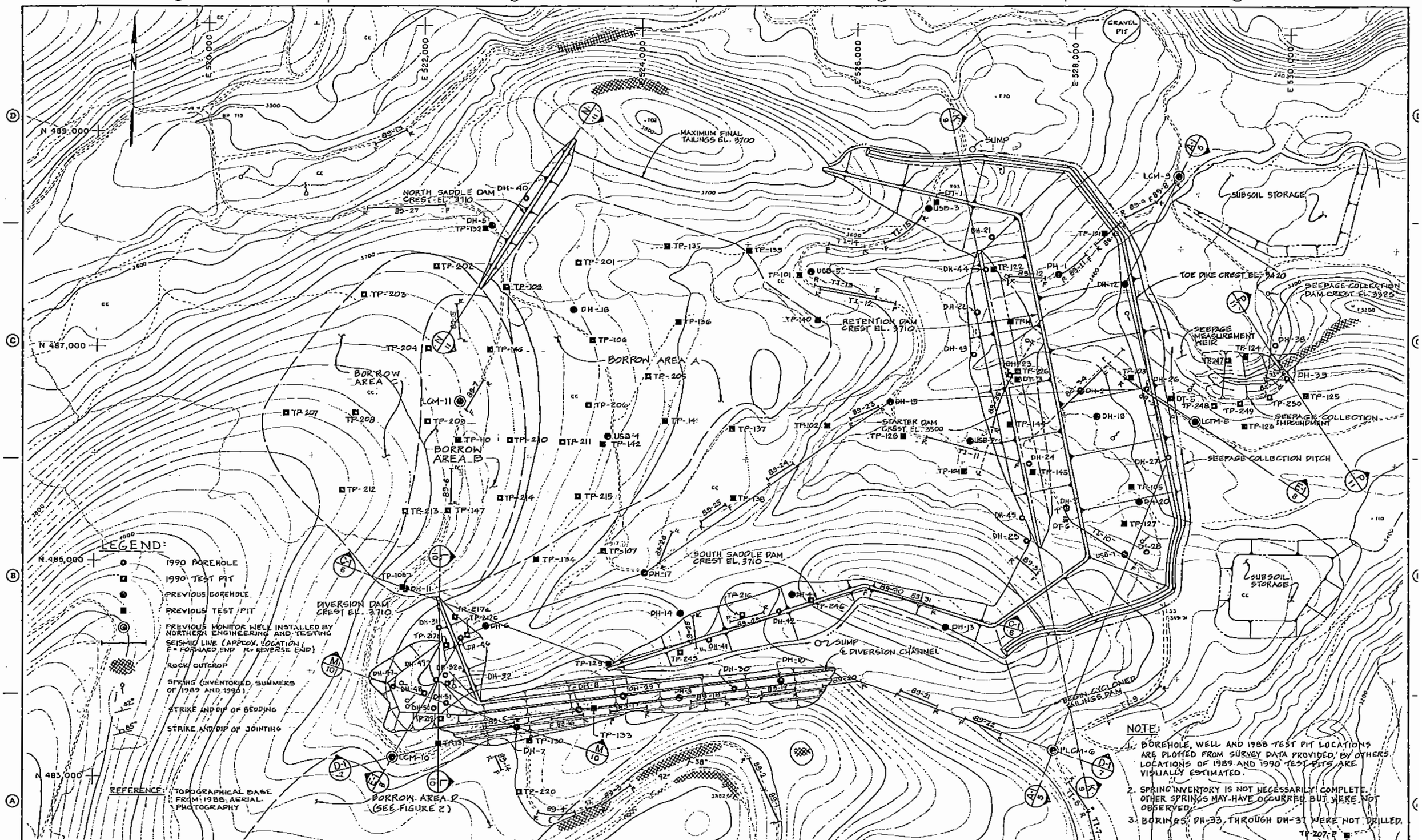


400 0 400 800
SCALE FEET

NO.	DATE	REVISIONS	BY	CHK	APP'D

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

DESIGNED EAR | DRAWN AOM | CHECKED AFR | RECOMMENDED
DATE OCT. 1990 | APPROVED

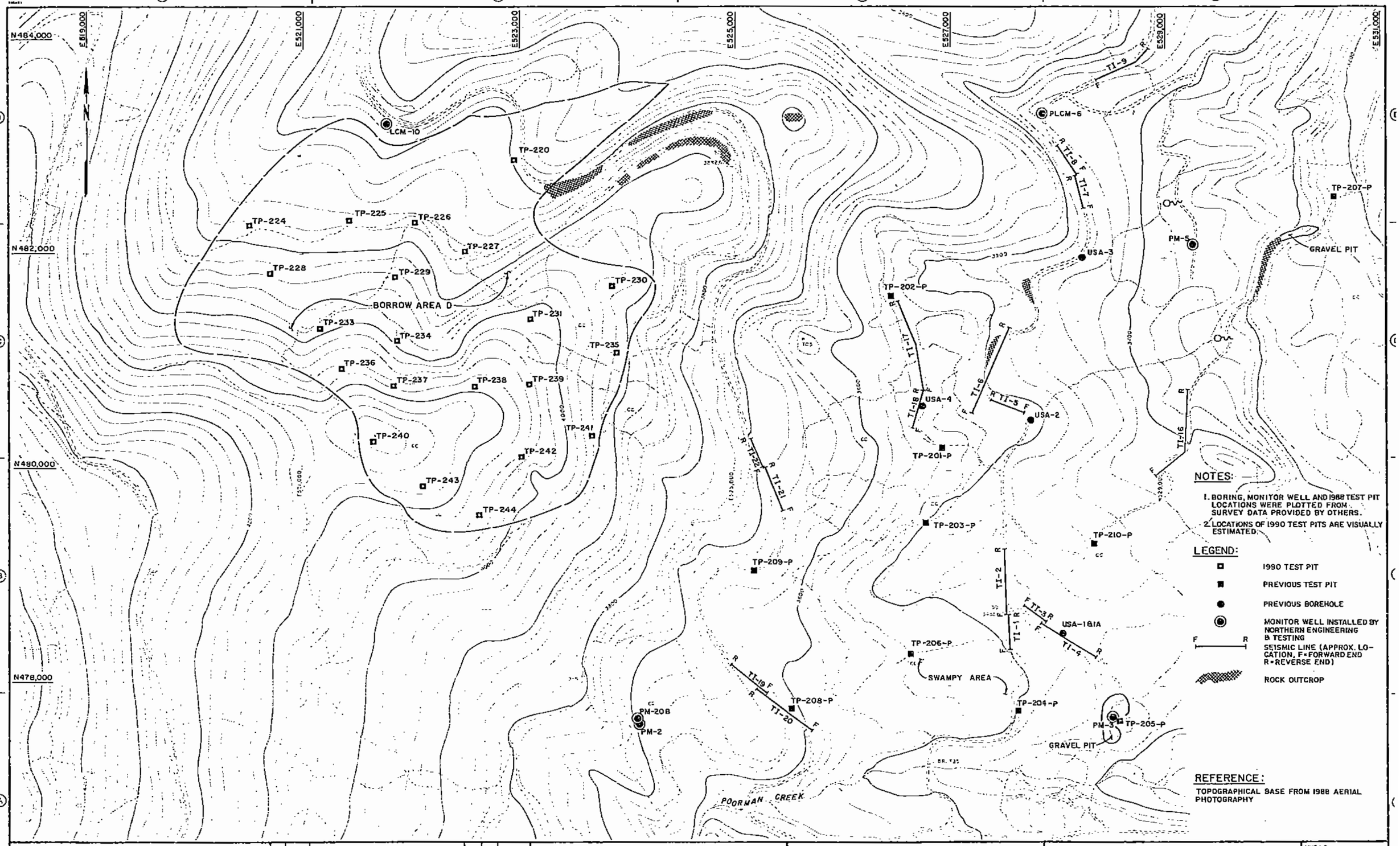
NORANDA MINERALS CORPORATION

MONTANORE PROJECT

TAILINGS IMPOUNDMENT EXPLORATION PLAN

MKE NO.
SHEET OF REV.

FIGURE 1



400 0 400 800
SCALE FEET

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180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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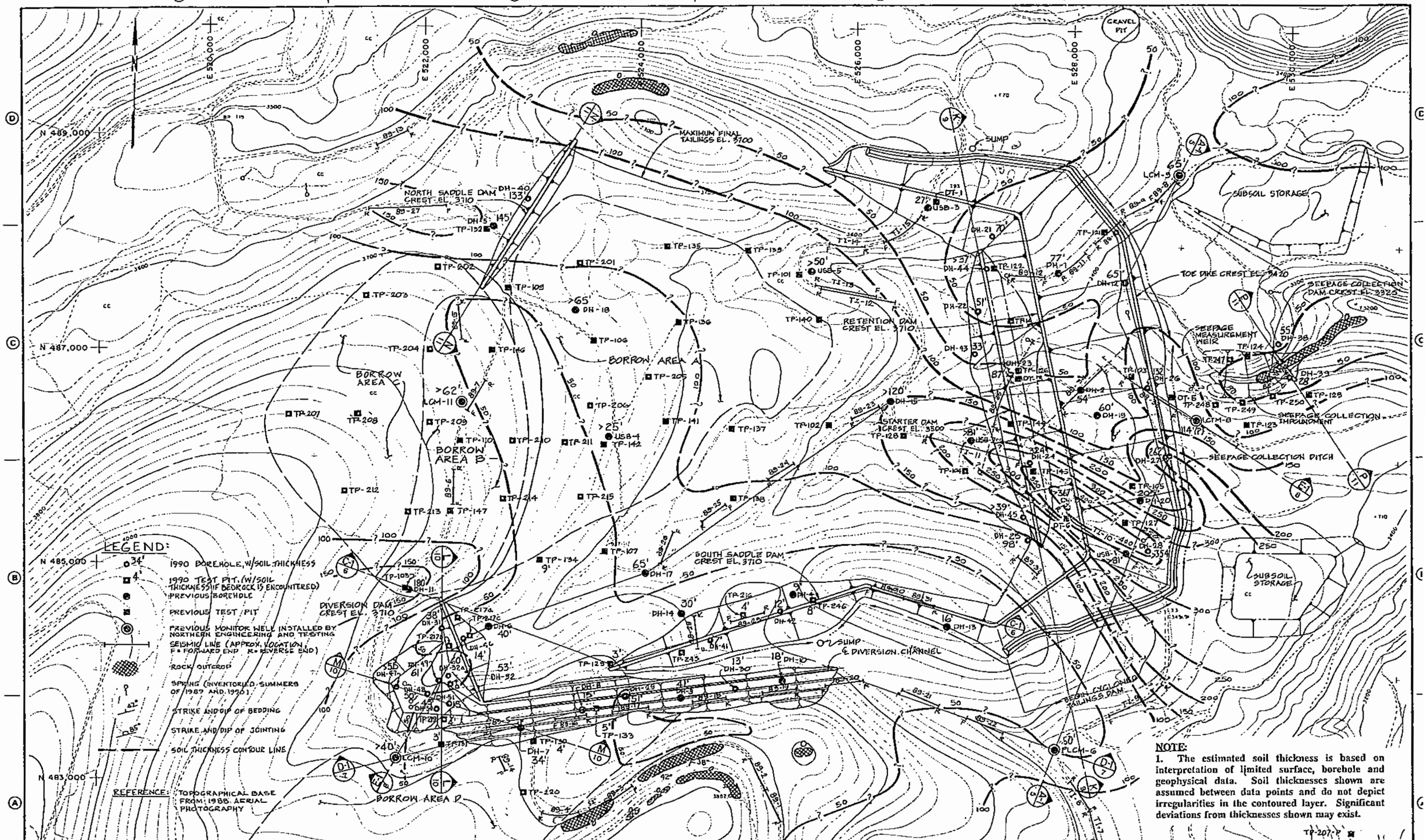
DATE OCTOBER 1990 | APPROVED

NORANDA MINERALS CORPORATION

MONTANORE PROJECT
EXPLORATION MAP
BORROW AREA D

AREA NO
SHEET 2 OF 2 REV.
FIGURE 2



NOTE:
1. The estimated soil thickness is based on interpretation of limited surface, borehole and geophysical data. Soil thicknesses shown are assumed between data points and do not depict irregularities in the contoured layer. Significant deviations from thicknesses shown may exist.

TP-207-P

400 0 400 800
SCALE FEET

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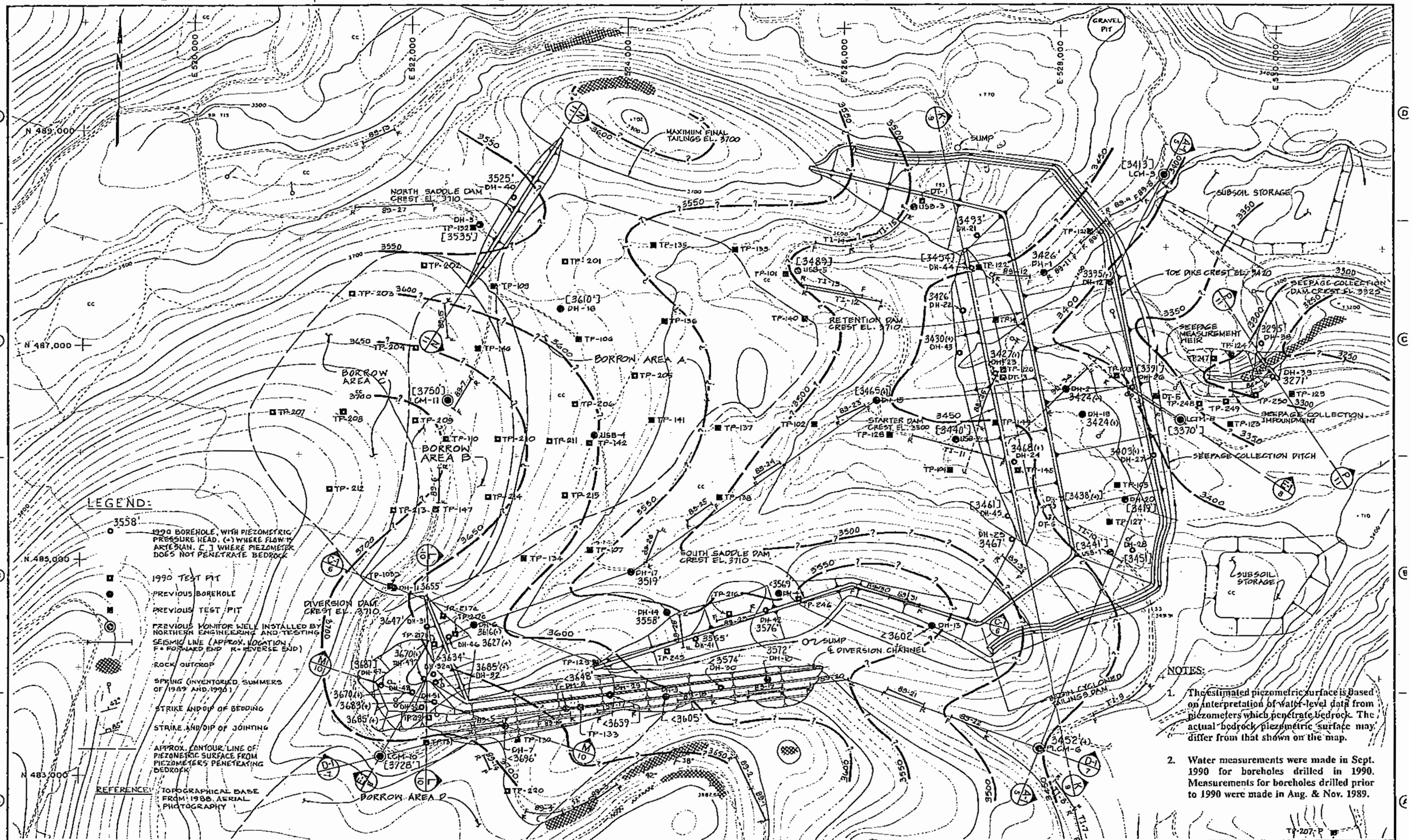
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

DESIGNED CFS DRAWN RJB CHECKED GAR RECOMMENDED
DATE NOV. 1990 APPROVED

NORANDA MINERALS CORPORATION

MONTANORE PROJECT
LITTLE CHERRY SITE
SOILS ISOPACH MAP

MKE NO.
SHEET OF REV.
FIGURE 3



NOTES:

1. The estimated piezometric surface is based on interpretation of water-level data from piezometers which penetrate bedrock. The actual bedrock piezometric surface may differ from that shown on the map.
2. Water measurements were made in Sept. 1990 for boreholes drilled in 1990. Measurements for boreholes drilled prior to 1990 were made in Aug. & Nov. 1989.

400 0 400 800
SCALE FEET

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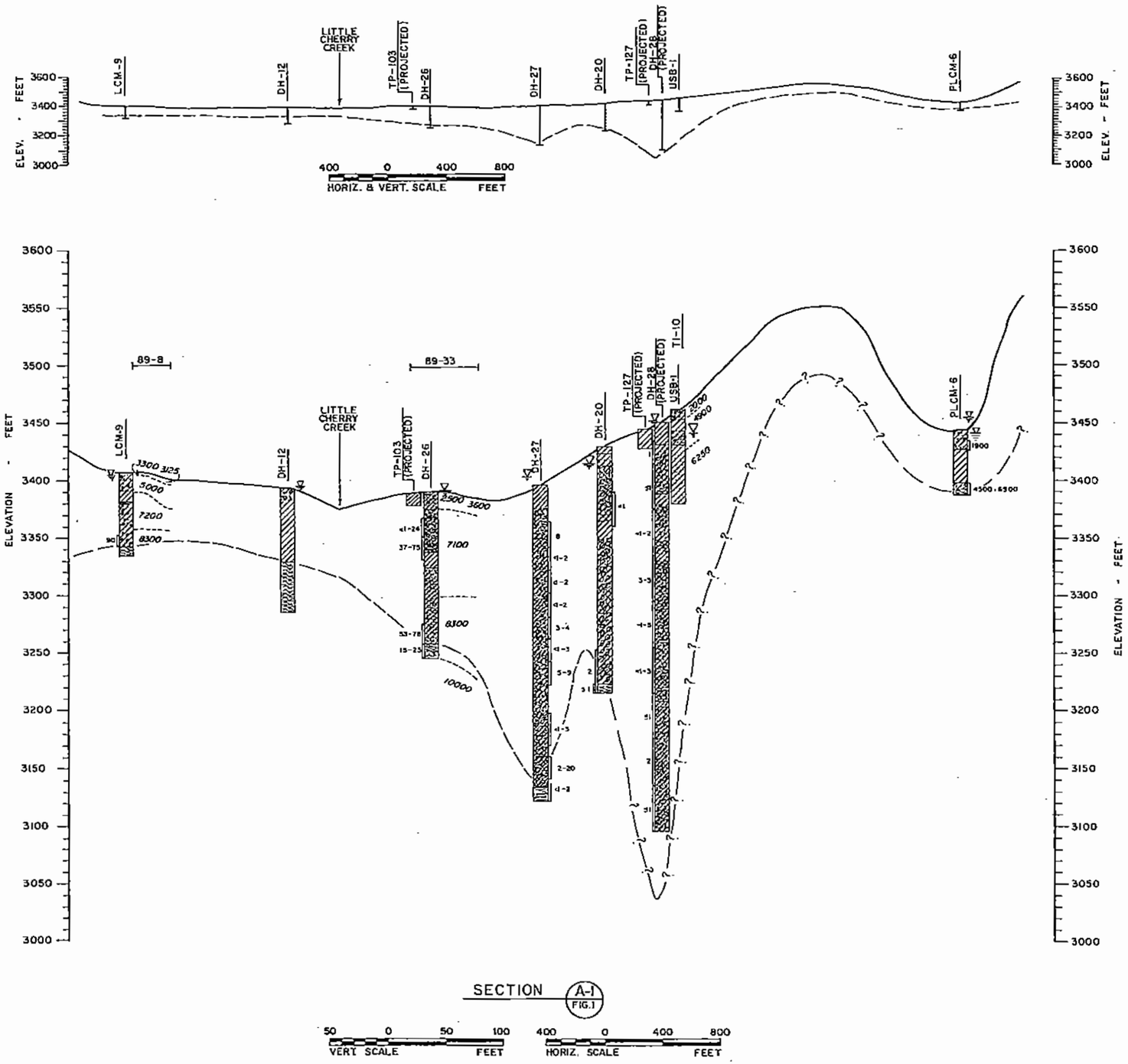
MONTANORE PROJECT
LITTLE CHERRY SITE
PIEZOMETRIC SURFACE MAP

DWG NO. | SHEET OF | REV.

FIGURE 4



NOTES:

1. THE ESTIMATED BEDROCK SURFACE IS BASED ON INTERPRETATION OF DRILL HOLE AND GEOPHYSICAL DATA. THE ACTUAL BEDROCK SURFACE MAY DIFFER FROM THAT SHOWN ON THIS SECTION.
2. FOR SPECIFIC GEOTECHNICAL INFORMATION GATHERED PRIOR TO 1990, REFER TO GEOTECHNICAL REPORT, TAILINGS IMPOUNDMENT SITE (MARCH 1990), VOLUME 2: APPENDIX B FOR SEISMIC REFRACTION RESULTS, APPENDIX C FOR DRILL LOGS, PIEZOMETER LEVELS AND PERMEABILITY TEST DATA AND APPENDIX D FOR TEST PIT LOGS. FOR INFORMATION GATHERED IN 1990, REFER TO THIS REPORT: APPENDIX A FOR DRILL LOGS, PIEZOMETER LEVELS AND PERMEABILITY TEST DATA AND APPENDIX B FOR TEST PIT LOGS.
3. WATER LEVELS SHOWN FOR 1990 BOREHOLES WERE MEASURED IN FALL 1990. OTHERS WERE MEASURED IN FALL 1989.
4. A DUAL PIEZOMETER WAS INSTALLED IN PLCM-6

LEGEND:

- 89-10 — SEISMIC LINE LONGITUDINAL TO SECTION
- 89-11 — SEISMIC LINE TRANSVERSE TO SECTION
- DH-1 — BORING
- ML, ML-CL, CL, CH* — PIEZOMETRIC SURFACE
- SW, SP*
- 27 — PERMEABILITY VALUES (NORMALIZED TO 10^{-6} CM/SEC)
- ML-SM, SM, SC*
- GM, GM-GP, GP, GW, GC*
- COBBLES AND/OR BOULDERS (IN COMBINATION WITH ANY OF THE SOILS DESIGNATED ABOVE)
- BEDROCK (GENERALLY WEATHERED)
- 2300/4000 — SEISMIC VELOCITY (FT/SEC) SHOWING APPROX. VELOCITY INTERFACES)
- TP-101 — TEST PIT
- ESTIMATED BEDROCK PROFILE INTERPRETED FROM BORING OR SEISMIC REFRACTION DATA, QUERIED WHERE INFERRED

* UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL. CLASSIFICATION IS FOR SOIL COMPONENTS OF GRAVEL SIZE AND SMALLER. MATERIAL MAY ALSO CONTAIN COBBLES AND BOULDERS.

NO.	DATE	REVISIONS	BY	CHK.	APP'D

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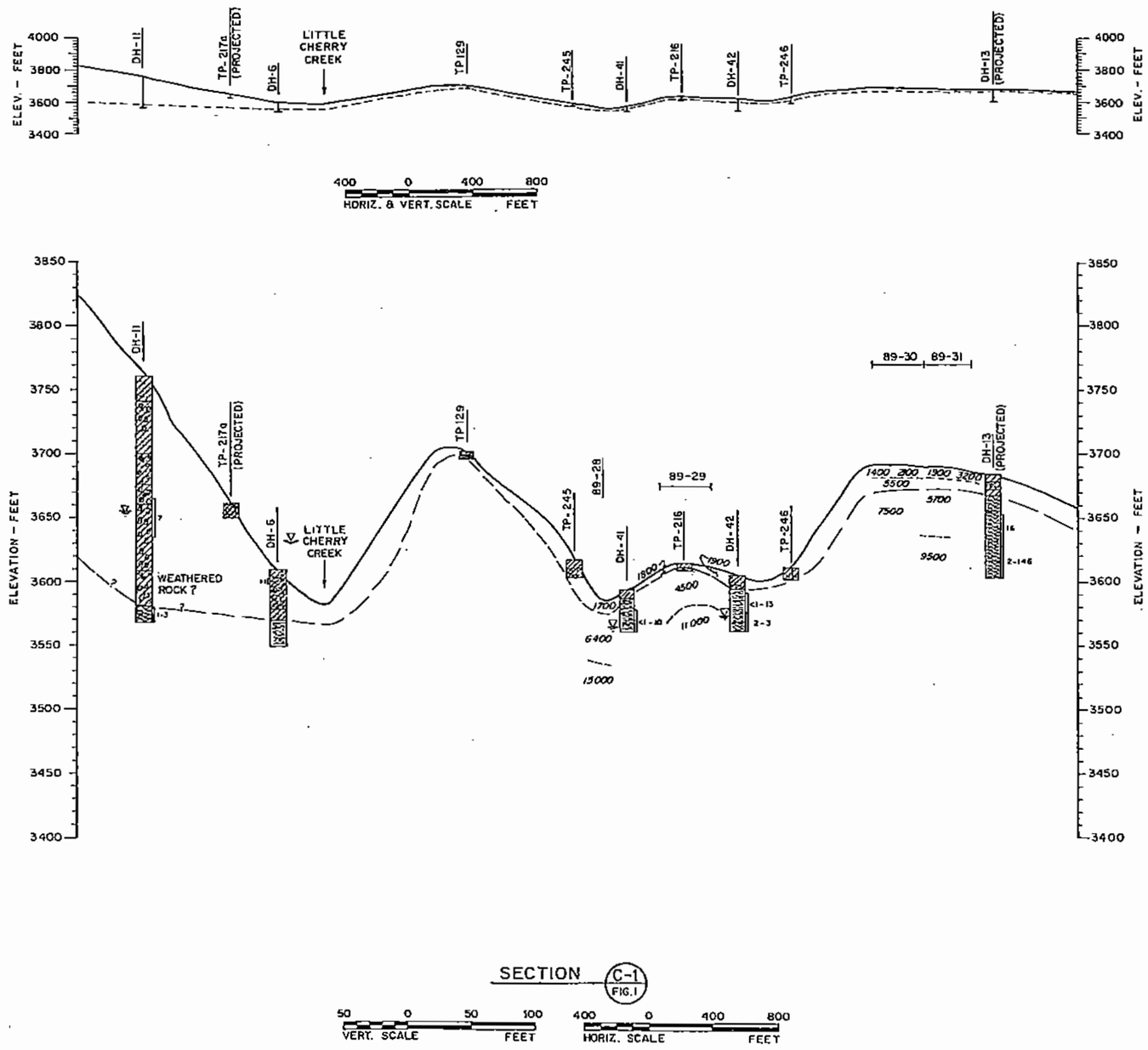
DATE NOVEMBER 1990 | APPROVED

NORANDA MINERALS CORPORATION

MONTANORE PROJECT
LITTLE CHERRY SITE
GEOLOGIC SECTION A-1

MKE NO.
SHEET OF REV.
FIGURE 5



NOTES:

1. THE ESTIMATED BEDROCK SURFACE IS BASED ON INTERPRETATION OF DRILL HOLE AND GEOPHYSICAL DATA. THE ACTUAL BEDROCK SURFACE MAY DIFFER FROM THAT SHOWN ON THIS SECTION.
2. FOR SPECIFIC GEOTECHNICAL INFORMATION GATHERED PRIOR TO 1990, REFER TO GEOTECHNICAL REPORT, TAILINGS IMPOUNDMENT SITE (MARCH 1990), VOLUME 2: APPENDIX B FOR SEISMIC REFRACTION RESULTS, APPENDIX C FOR DRILL LOGS, PIEZOMETER LEVELS AND PERMEABILITY TEST DATA AND APPENDIX D FOR TEST PIT LOGS. FOR INFORMATION GATHERED IN 1990, REFER TO THIS REPORT: APPENDIX A FOR DRILL LOGS, PIEZOMETER LEVELS AND PERMEABILITY TEST DATA AND APPENDIX B FOR TEST PIT LOGS.
3. WATER LEVELS SHOWN FOR 1990 BOREHOLES WERE MEASURED IN FALL 1990. OTHERS WERE MEASURED IN FALL 1989.

LEGEND:

- 89-10 — SEISMIC LINE LONGITUDINAL TO SECTION
- 89-11 — SEISMIC LINE TRANSVERSE TO SECTION
- DH-1 — BORING
- ML, ML-CL, CL, CH*
- PIEZOMETRIC SURFACE
- SW, SP*
- 27 — PERMEABILITY VALUES (NORMALIZED TO 10^{-4} CM/SEC)
- ML-SM, SM, SC*
- GM, GM-GP, GP, GW, GC*
- COBBLES AND/OR BOULDERS (IN COMBINATION WITH ANY OF THE SOILS DESIGNATED ABOVE)
- BEDROCK (GENERALLY WEATHERED)
- 2100/4000 — SEISMIC VELOCITY (FT/SEC) SHOWING APPROX. VELOCITY INTERFACES)
- TP-10 — TEST PIT
- ESTIMATED BEDROCK PROFILE INTERPRETED FROM BORING OR SEISMIC REFRACTION DATA, QUERIED WHERE INFERRED

* UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL. CLASSIFICATION IS FOR SOIL COMPONENTS OF GRAVEL SIZE AND SMALLER. MATERIAL MAY ALSO CONTAIN COBBLES AND BOULDERS.

NO.	DATE	REVISIONS	BY	CHK	APPD

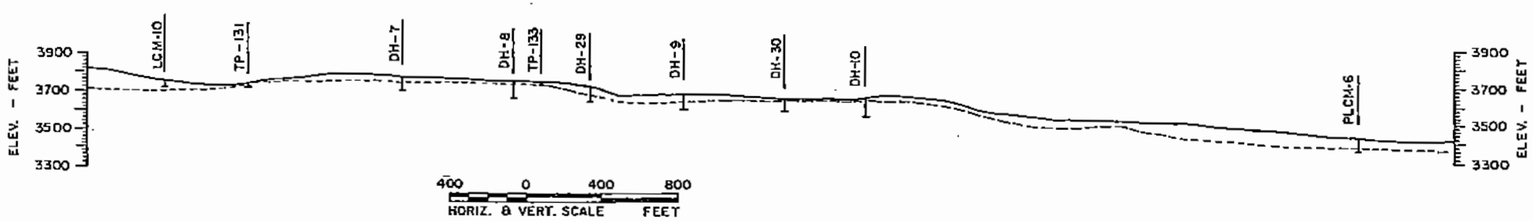
MORRISON-KNUDSEN ENGINEERS, INC.
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

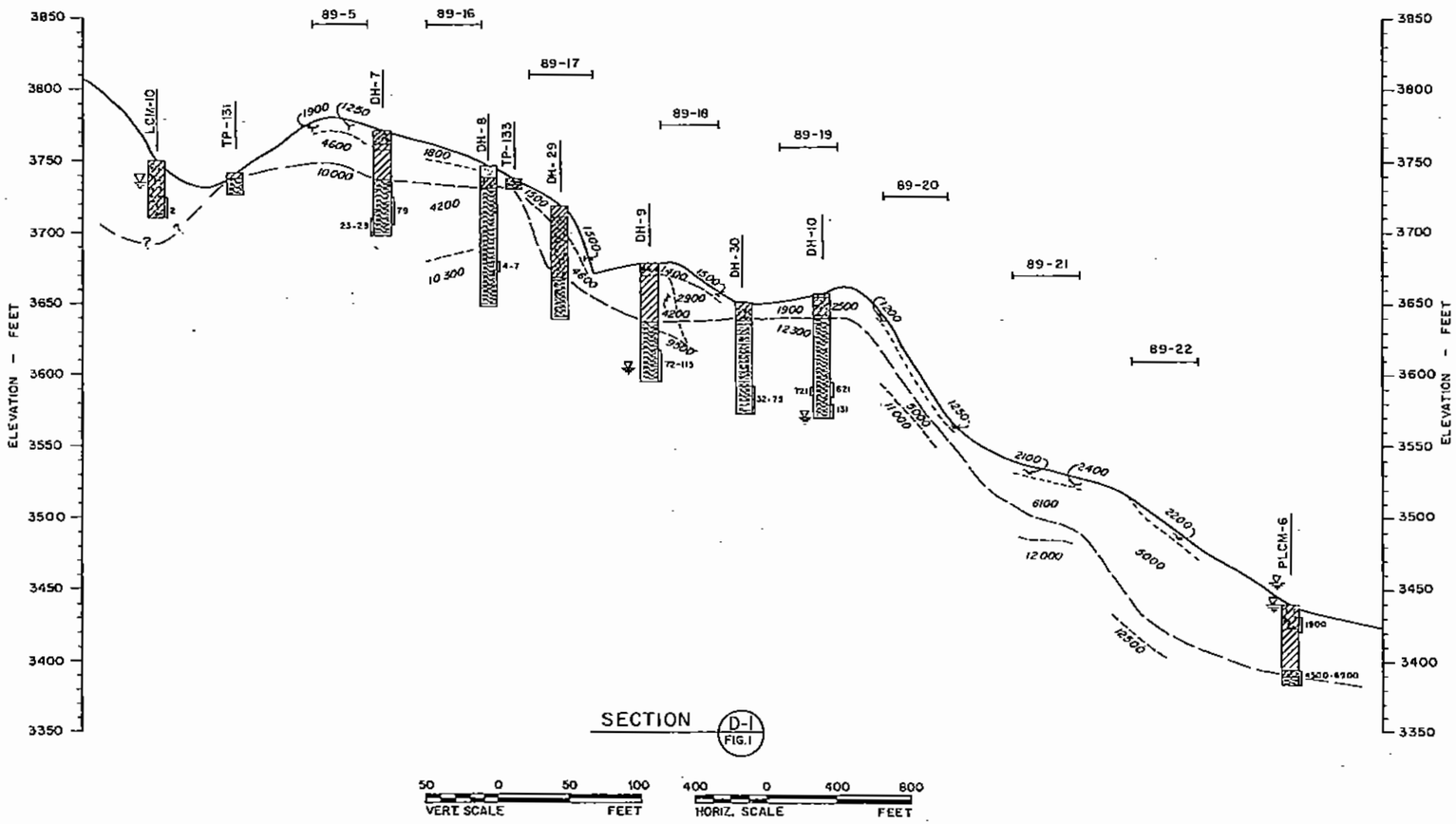
DESIGNED CFS | DRAWN VZB | CHECKED EAR | RECOMMENDED
DATE NOVEMBER 1990 | APPROVED

NORANDA MINERALS CORPORATION

MONTANORE PROJECT
LITTLE CHERRY SITE
GEOLOGIC SECTION C-1

MAKE NO.
SHEET OF REV.
FIGURE 6





NOTES:

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3. WATER LEVELS SHOWN FOR 1990 BOREHOLES WERE MEASURED IN FALL 1990. OTHERS WERE MEASURED IN FALL 1989.
4. A DUAL PIEZOMETER WAS INSTALLED IN PLCM-6

LEGEND:

- 89-10 — SEISMIC LINE LONGITUDINAL TO SECTION
- 89-11 — SEISMIC LINE TRANSVERSE TO SECTION
- DH-1 — BORING
- ML, ML-CL, CL, CH*
- PIEZOMETRIC SURFACE
- SW, SP*
- 27' — PERMEABILITY VALUES (NORMALIZED TO 10^{-6} CM/SEC)
- ML-SM, SM, SC*
- GM, GM-GP, GP, GW, GC*
- COBBLES AND/OR BOULDERS (IN COMBINATION WITH ANY OF THE SOILS DESIGNATED ABOVE)
- BEDROCK (GENERALLY WEATHERED)
- 2300 / 4000 — SEISMIC VELOCITY (FT/SEC) SHOWING APPROX. VELOCITY INTERFACES)
- TP-101 — TEST PIT
- ESTIMATED BEDROCK PROFILE INTERPRETED FROM BORING OR SEISMIC REFRACTION DATA, QUERIED WHERE INFERRED

* UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL. CLASSIFICATION IS FOR SOIL COMPONENTS OF GRAVEL SIZE AND SMALLER. MATERIAL MAY ALSO CONTAIN COBBLES AND BOULDERS.

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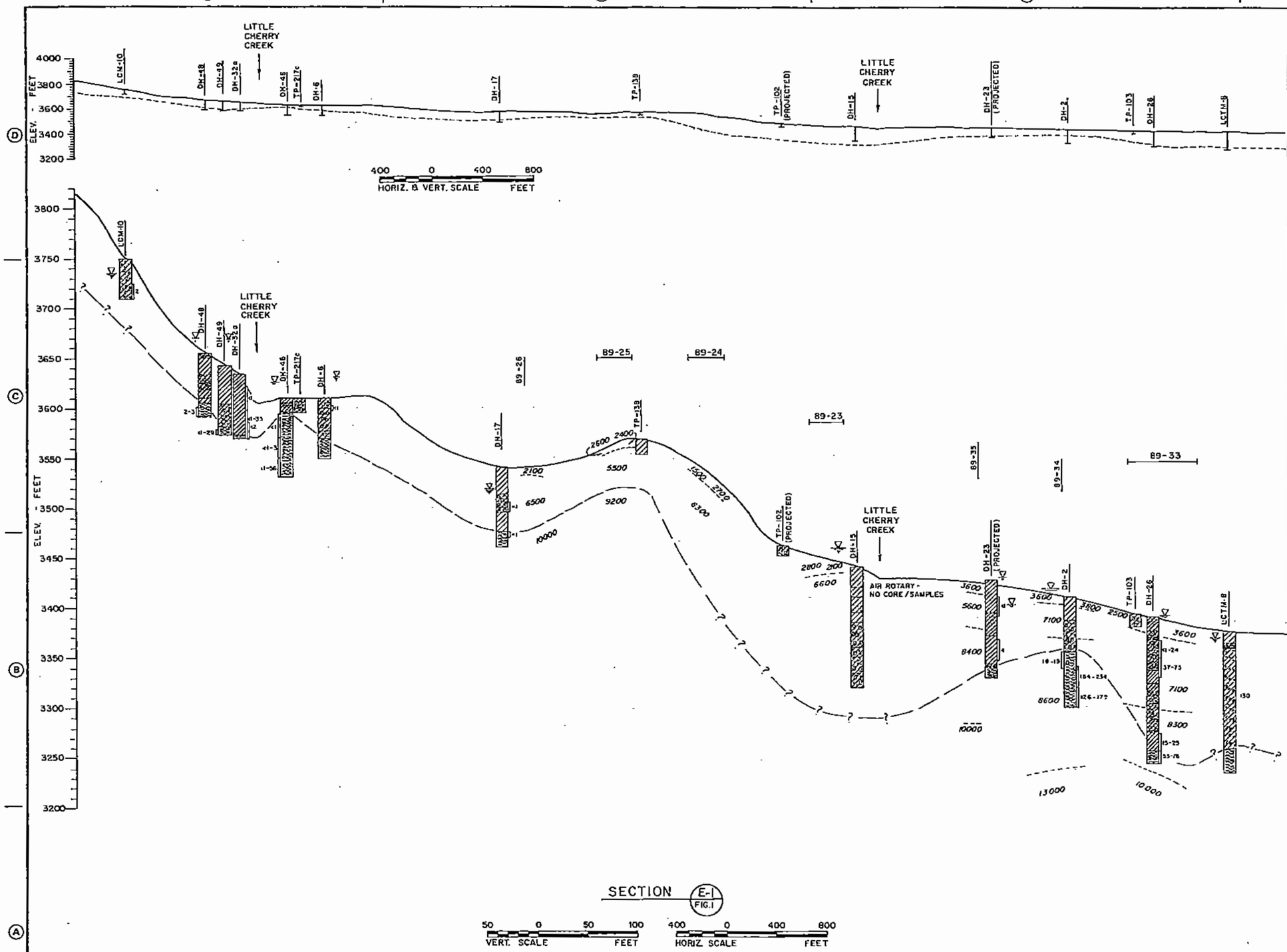
NORANDA MINERALS CORPORATION

MONTANORE PROJECT
LITTLE CHERRY SITE
GEOLOGIC SECTION D-1

MKE NO.
SHEET OF REV.
FIGURE 7



NOTES:

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3. WATER LEVELS SHOWN FOR 1990 BOREHOLES WERE MEASURED IN FALL 1990. OTHERS WERE MEASURED IN FALL 1989.
4. A DUAL PIEZOMETER WAS INSTALLED IN PLCM-DH-23

LEGEND:

- 89-10 — SEISMIC LINE LONGITUDINAL TO SECTION
- 89-11 — SEISMIC LINE TRANSVERSE TO SECTION
- DH-1 — BORING
- ML, ML-CL, CL, CH*
- PIEZOMETRIC SURFACE
- SW, SP*
- 37 — PERMEABILITY VALUES (NORMALIZED TO 10^{-4} CM/SEC)
- ML-SM, SM, SC*
- GM, GM-GP, GP, GW, GC*
- COBBLES AND/OR BOULDERS (IN COMBINATION WITH ANY OF THE SOILS DESIGNATED ABOVE)
- BEDROCK (GENERALLY WEATHERED)
- 2300 4000 — SEISMIC VELOCITY (FT/SEC) SHOWING APPROX. VELOCITY INTERFACES)
- TP-10 — TEST PIT
- ESTIMATED BEDROCK PROFILE INTERPRETED FROM BORING OR SEISMIC REFRACTION DATA, QUERIED WHERE INFERRED

* UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL. CLASSIFICATION IS FOR SOIL COMPONENTS OF GRAVEL SIZE AND SMALLER. MATERIALS MAY ALSO CONTAIN COBBLES AND BOULDERS.

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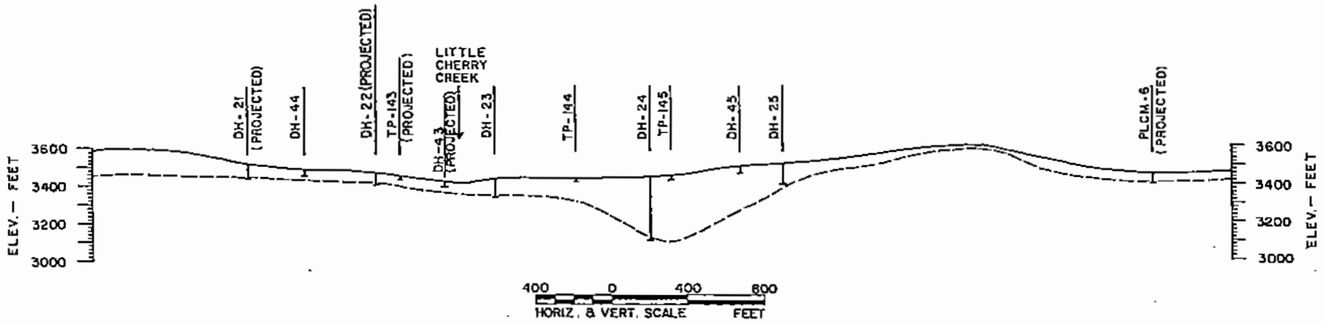
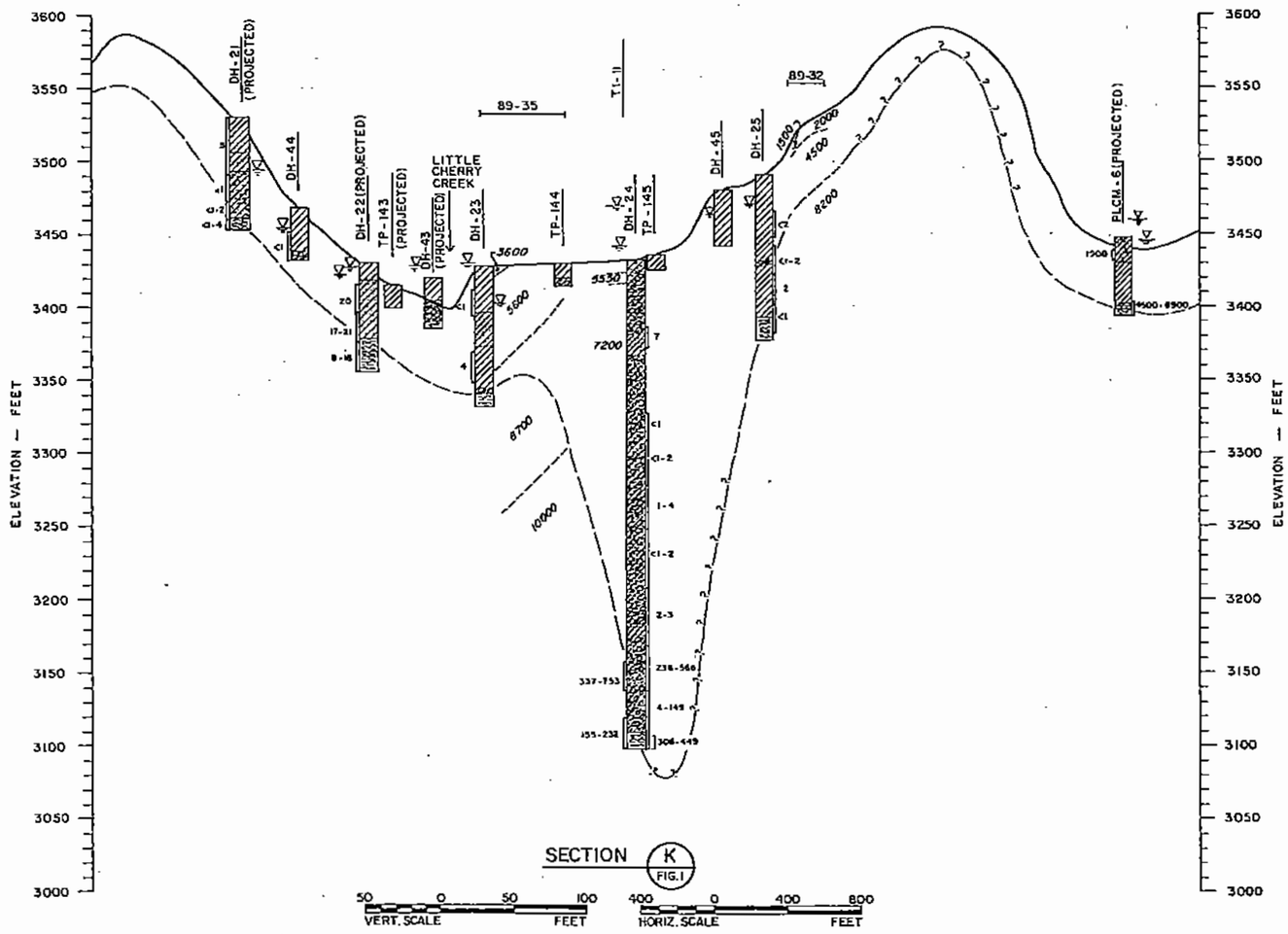
MONTANORE PROJECT
LITTLE CHERRY SITE
GEOLOGIC SECTION E-1

MKE NO.
SHEET OF REV.
FIGURE 8





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3. WATER LEVELS SHOWN FOR 1990 BOREHOLES WERE MEASURED IN FALL 1990. OTHERS WERE MEASURED IN FALL 1989.
4. DUAL PIEZOMETERS WERE INSTALLED IN DH-22, DH-23, DH-24 AND PLCM-6.

LEGEND:

- 89-10 — SEISMIC LINE LONGITUDINAL TO SECTION
- 89-11 — SEISMIC LINE TRANSVERSE TO SECTION
- DH-1 — BORING
- ML, ML-CL, CL, CH*
- PIEZOMETRIC SURFACE
- SW, SP*
- 27 — PERMEABILITY VALUES (NORMALIZED TO 10^{-5} CM/SEC)
- ML-SM, SM, SC*
- GM, GM-GP, GP, GW, GC*
- COBBLES AND/OR BOULDERS (IN COMBINATION WITH ANY OF THE SOILS DESIGNATED ABOVE)
- BEDROCK (GENERALLY WEATHERED)
- 2300 / 4000 — SEISMIC VELOCITY (FT/SEC) SHOWING APPROX. VELOCITY INTERFACES)
- TP-101 — TEST PIT
- ESTIMATED BEDROCK PROFILE INTERPRETED FROM BORING OR SEISMIC REFRACTION DATA, QUERIED WHERE INFERRED

* UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL. CLASSIFICATION IS FOR SOIL COMPONENTS OF GRAVEL SIZE AND SMALLER. MATERIAL MAY ALSO CONTAIN COBBLES AND BOULDERS.

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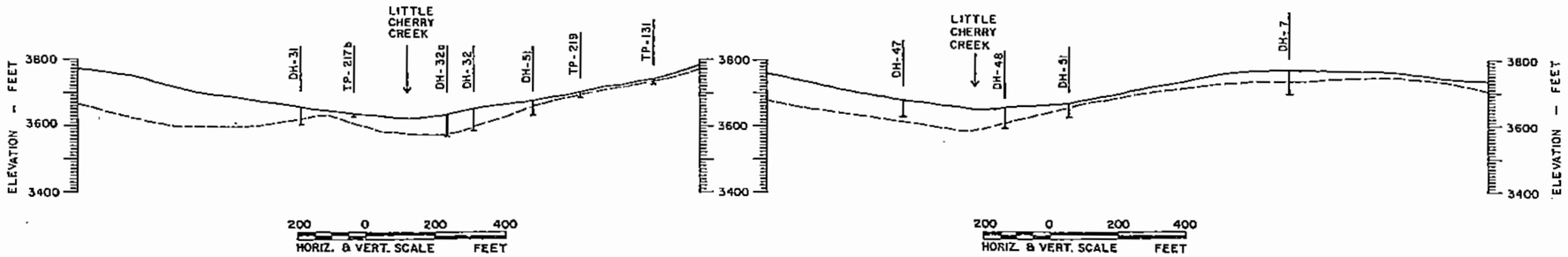
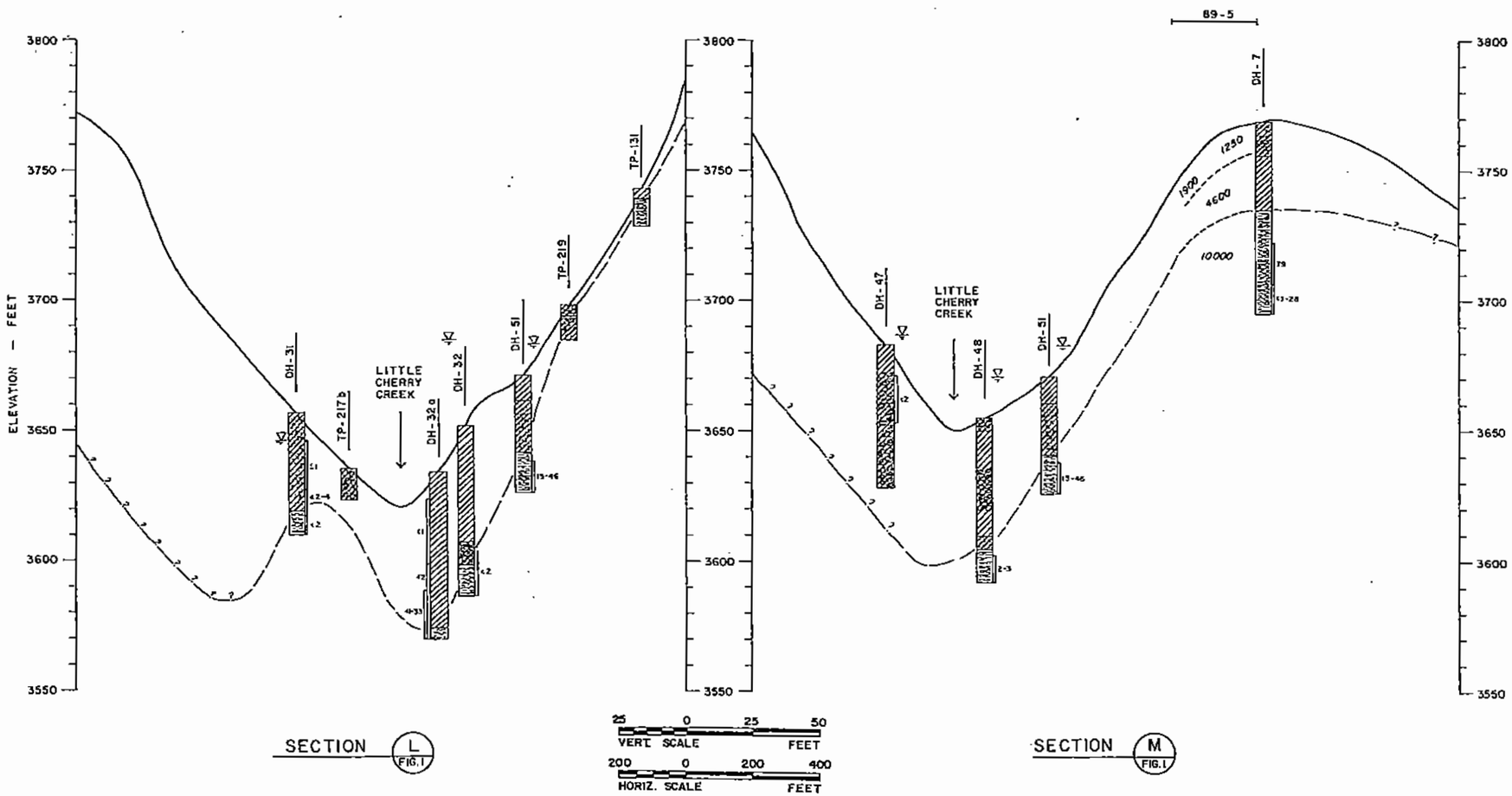
MONTANORA PROJECT
LITTLE CHERRY SITE
GEOLOGIC SECTION K

MKE NO.
SHEET OF REV.
FIGURE 9

DIETERICH-POST RECORDS NO. 11119





SECTION L FIG. 1

SECTION M FIG. 1

NOTES:

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3. WATER LEVELS SHOWN FOR 1990 BOREHOLES WERE MEASURED IN FALL 1990. OTHERS WERE MEASURED IN FALL 1989.

LEGEND:

- 89-10 — SEISMIC LINE LONGITUDINAL TO SECTION
- 89-11 — SEISMIC LINE TRANSVERSE TO SECTION
- DH-1 — BORING
- ML, ML-CL, CL, CH*
- PIEZOMETRIC SURFACE
- SW, SP*
- 127 — PERMEABILITY VALUES (NORMALIZED TO 10^{-6} CM/SEC)
- ML-SM, SM, SC*
- GM, GM-GP, GP, GW, GC*
- COBBLES AND/OR BOULDERS (IN COMBINATION WITH ANY OF THE SOILS DESIGNATED ABOVE)
- BEDROCK (GENERALLY WEATHERED)
- 2100 / 4000 — SEISMIC VELOCITY (FT/SEC) SHOWING APPROX. VELOCITY INTERFACES)
- TP-101 — TEST PIT
- ESTIMATED BEDROCK PROFILE INTERPRETED FROM BORING OR SEISMIC REFRACTION DATA, QUERIED WHERE INFERRED

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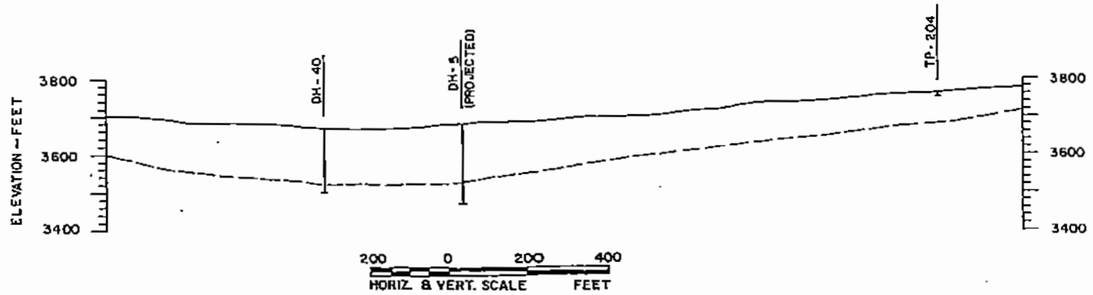
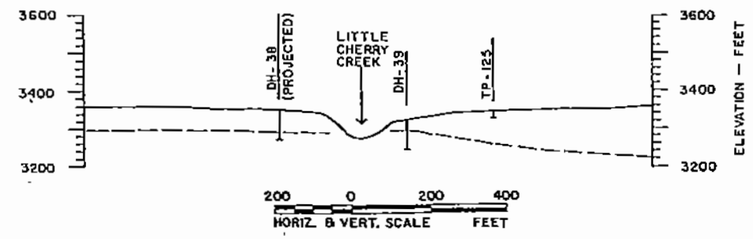
MONTANORE PROJECT
LITTLE CHERRY SITE
GEOLOGIC SECTIONS L & M

MKE NO.
SHEET OF REV.
FIGURE 10





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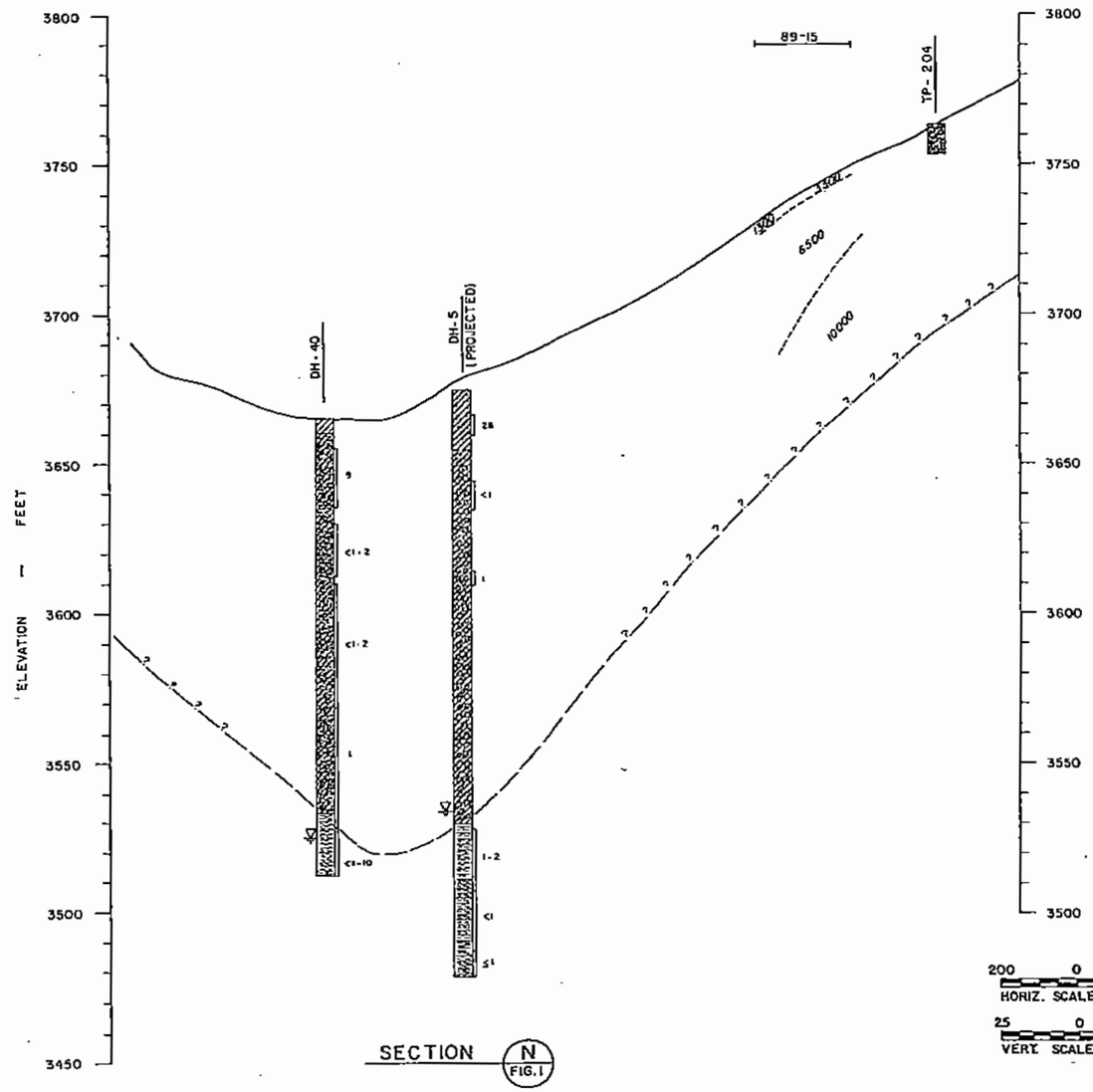
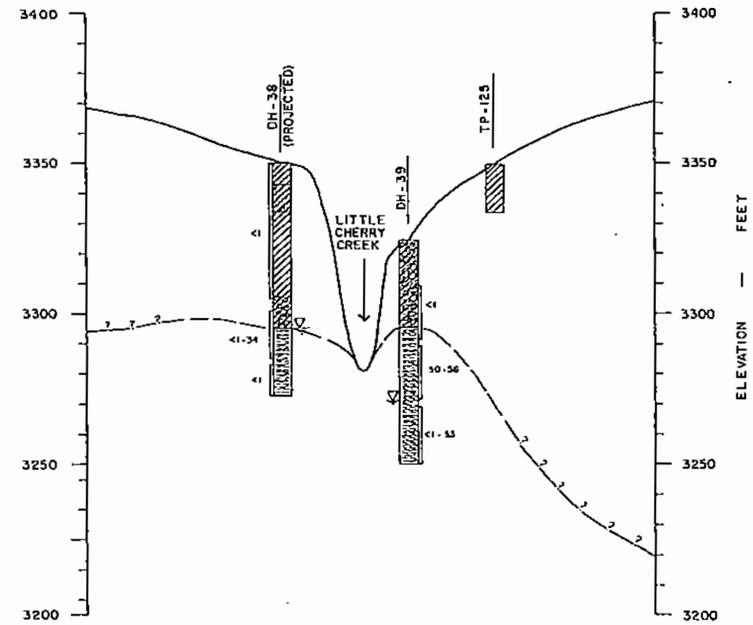


SECTION N FIG. I



SECTION P FIG I

LEGEND:

- 89-10 — SEISMIC LINE LONGITUDINAL TO SECTION
- 89-11 — SEISMIC LINE TRANSVERSE TO SECTION
- DH-1 — BORING
- ML, ML-CL, CL, CH* — ML, ML-CL, CL, CH*
- PIEZOMETRIC SURFACE
- SW, SP* — SW, SP*
- 27 — PERMEABILITY VALUES (NORMALIZED TO 10^{-6} CM/SEC)
- ML-SM, SM, SC* — ML-SM, SM, SC*
- GM, GM-GP, GP, GW, GC* — GM, GM-GP, GP, GW, GC*
- COBBLES AND/OR BOULDERS (IN COMBINATION WITH ANY OF THE SOILS DESIGNATED ABOVE)
- BEDROCK (GENERALLY WEATHERED)
- 2300/4000 — SEISMIC VELOCITY (FT/SEC) SHOWING APPROX. VELOCITY INTERFACES)
- TP-101 — TEST PIT
- ESTIMATED BEDROCK PROFILE INTERPRETED FROM BORING OR SEISMIC REFRACTION DATA, QUERIED WHERE INFERRED

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MONTANORE PROJECT
LITTLE CHERRY SITE
GEOLOGIC SECTIONS N & P

MKE NO | SHEET OF | REV.
FIGURE 11

APPENDIX A
DRILL LOGS

APPENDIX A
DRILL LOGS

CONTENTS

SECTION

A.1 Drilling

A.2 Sampling

A.3 Permeability Tests

A.4 Piezometer Installation

TABLE

A.1 Depth to Water from Ground Surface

A.2 1990 Field Permeability Test Results

A.3 1990 Drillhole locations

FIGURE

A.1 Visual Soil Classification System

A.2 Piezometer Construction

A.3 Dual Piezometer Construction

-- Drill Logs (DH-21 through DH-51)

APPENDIX A
DRILL LOGS

A.1 DRILLING

Drilling equipment for the 1990 field explorations consisted of a truck-mounted Acker AD II and a trailer-mounted Longyear HC-150 drill rig. Holes were drilled with a continuous hollow stem flight auger or diamond bit in soil and a diamond bit in rock. An engineering geologist or geotechnical engineer of Morrison-Knudsen Engineers (MKE) observed the drilling and kept a log of the materials and subsurface conditions encountered.

In general, 4-inch inside diameter (I.D.) casing was set to a depth of 5 feet, at which point continuous coring commenced through both soil and rock, using a 3.78-inch outside diameter (O.D.) HQ diamond drill bit and triple tube core barrel. Drill water was recirculated, with approximately 1 part per thousand polymer fluid ("Clear Mud") added to the drill water to improve core recovery and help maintain an open borehole.

Drillholes DH-47, -48, -49, -50 and -51 were started with a 8" O.D. hollow stem flight auger, changing over to HQ coring when augering became difficult. Drillhole DH-47 was augered to 15 feet in depth, but was too crooked to be used for coring due to the presence of boulders and cobbles. The hole was therefore offset 3 feet and redrilled, with HQ coring beginning at 5 feet.

All core was withdrawn from the core barrel, placed in core boxes, cleansed as necessary and marked with wooden blocks showing the depth and core run number at the bottom of each core run. Core boxes were labeled with the project name, borehole number, coring interval, core box number and date. A color photograph was taken of each box of core.

Soil information entered on the drill logs includes percent recovery, color, moisture, and consistency. For gravel size material and larger, parent rock type, angularity, weathering and maximum particle size were also noted. Visual estimates were made of the percentages of cobbles, gravel, sand and fines, and the material was classified in accordance with ASTM D2488 (Figure A-1). Where possible, a pocket penetrometer was used to estimate the unconfined compressive strength of fine-grained soils.

Rock information entered on the drill logs includes percent recovery, Rock Quality Designation (RQD), rock type, color, weathering, hardness, structure and any other notable characteristics. RQD is the ratio of the cumulative length of the core pieces 4 inches or longer to the total length of the core run. Mechanical core breaks caused by drilling or handling are disregarded. Special note was made of the characteristics of breaks and/or joints, which were diagrammed on the drill logs. Other conditions recorded on the drill logs included color of the return water, areas of water loss, penetration rates and drill action.

Water levels measured in the borings during and after drilling are presented in Table A.1. The boring locations were surveyed by others. Survey data are presented on Table A.3.

A.2 SAMPLING

Soil samples obtained from drilling consist of disturbed samples (Standard Penetration Test samples and bulk core samples) and undisturbed samples (Shelby Tube samples and samples cut by hand from the core). The number of undisturbed samples was very limited due to the absence of cohesive non-gravelly soils.

SPT samples were obtained using a standard 2-inch (ASTM D1586) split barrel sampler, driven by a 140 pound hammer with a 30-inch free-fall drop. After a boring was cleaned of all loose material, the sampler was inserted and measurements

was driven 18 inches or until refusal (more than 50 blows to penetrate 6 inches). The number of blows required to drive each 6 inches of penetration was recorded. The sampler was removed from the boring and opened. The length of material recovered from the sampler was measured and recorded. A complete material description was entered on the boring log including soil type, particle shape, color, moisture, density or consistency and plasticity. Visual classification of the samples was made in accordance with ASTM D2488. Samples were double sealed in plastic bags labeled with sample number, boring number, project name and sample depth interval and date.

Undisturbed Shelby tube samples were obtained in cohesive soil in conformance with ASTM D1587. The boring was cleaned of all loose material and the sampler inserted to the bottom of the hole. A thin-walled 3-inch diameter sampler, 30 inches long, was advanced 2 feet, or until refusal, by hydraulically pushing in one continuous motion with the drill rig. Upon retrieval, the length of the sample was measured and recorded. The ends of the tube were sealed with plastic caps, and the caps sealed with duct tape. The sample tubes were labelled with the project name, boring number, sample number and sample depth interval. The tubes were also marked "Top" and "Bottom" to show sample orientation. Care was taken during handling and transport to maintain the tubes in a vertical position and to minimize soil disturbance.

Undisturbed samples were taken from the core of certain fine-grained soils which were too stiff to permit Shelby tube samples. Approximately 8-inch lengths were cut from the core with a knife, wrapped in foil and double sealed in plastic bags. The samples were labeled with the sample number, borehole number, sampling interval, project name and date. Core was taken during handling and transport to minimize sample disturbance.

A.3 PERMEABILITY TESTS

Field permeability tests consisted of falling head tests in soft soils and water pressure tests in competent soils and bedrock. Tests were performed using method E-18 procedures outlined in the U.S. Bureau of Reclamations "Earth Manual" (1974).

Falling head tests were performed in an uncased section at the bottom of the boring. After advancing the hole and pulling up the core barrel to the top of the test section (typically 10 to 30 foot length), the uncased section was cleaned out with water. A single pneumatic wireline packer was used to seal the hole below the core barrel. On certain tests the packer could not be seated and the entire depth of the hole was tested. No pressure was applied during the falling head tests. Water inflow was determined by filling the drill rods with water and measuring the drop in water level over time.

Permeability values for tests performed in uncased sections in soils were determined from the formula given below for water pressure tests using packers. For this type of test, the differential head of water equals the gravity head only, since there is no applied pressure. Due to the minimal drops in water level relative to the total differential head during these tests, permeability results were calculated using the midpoint of the drop as a constant water level.

Water pressure tests in bedrock and competent soils were performed by using a single pneumatic wireline packer. Prior to testing, the holes were flushed with clean water until the water return was clear. The maximum applied water pressure was approximately 1 psi per foot of depth above the packer. In soils, however, the maximum pressure was often limited to 5 or 10 psi since higher pressures could wash out the packer. Each packer test was generally run in two or three segments of water pressure: the first at one-half of the maximum water pressure determined for the test interval, the second at the maximum water pressure, and, if significant flow was noted, a third at one-half of the maximum pressure. Tests were run at

a constant pressure and a generally constant flow rate for 5 minutes. The flow meters were periodically calibrated.

The permeability was calculated from the following formula:

$$k = Q \ln(L/r)/2\pi LH$$

where: k = permeability
Q = constant rate of flow into the hole
L = test section length
H = differential head of water (gravity head plus applied pressure head)
r = radius of hole tested

The results of the constant head and packer tests are shown in Table A.2.

A.4 PIEZOMETER INSTALLATION

Piezometers were installed in all borings, except DH-32A and DH-44, immediately after drilling was completed. A piezometer typically consisted of 1-inch I.D., Schedule 80 PVC pipe, with 10 or 20 feet of 0.02-inch width machine slotted screen section at the bottom. Number 8 or number 16 silica sand was used to backfill around the bottom of the piezometer. The sand extended to at least 1 foot above the slotted section. It should be noted that drillholes DH-24, 28, -32 and -47 experienced some collapsing during piezometer installation and that the sand and backfill intervals in these holes contain collapsed material and/or voids. A steel protective casing with a lockable lid was set in concrete at each piezometer, except DH-32. Construction details of the piezometers are presented on Figures A-2 and A-3.

TABLE A.1 (SHEET 1 OF 2)
DEPTH TO WATER FROM GROUND SURFACE

DRILL-HOLE	COMPLETION DATE	DEPTH (FT)	7/31	AUGUST 1	2	3	4	5	6	7	8	9	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
DH-21	8/9/90	78.0										(23.2)		57.0			58.2							58.2		33.0				
DH-22(S)	8/16/90	74.0												(2.3)	3.9	5.0	7.4					7.8		6.5		6.5				
(D)															2.5	1.7	2.7					2.4		1.9		1.9				
DH-23(S)	8/6/90	98.0							24.5		24.0		25.0				25.0									25.0				
(D)											>2.3A		2.3A				>2.3A									>2.3A	2.4A			
DH-24(S)	8/21/90	336.0										(1.0A)	(1.1A)	(0.7A)	(>0.0A)	(>1.0A)	(>1.4A)	(>1.4A)	(>1.4A)	(>6.5A)						>2.0A	>7.9A			
(D)																								34A		34A				
DH-25	8/6/90	113.0							(7.4)	(7.0)	(9.0)	17.2	18.2				18.4													
DH-26	8/4/90	145.0			(2.5)	(0.0)	(>1.5A)	1.5A	2.0A		1.7A		1.5A				1.5A													
DH-27	8/6/90	274.0			(4.7)	(15.6)	(7.5)	(4.0)	(3.3)	>2.5A	>2.5A		>2.5A				>2.5A													
DH-28	8/29/90	354.0																					(4.5)	(3.4)						
DH-29	8/24/90	80.0																					54.5	72.7						
DH-30	8/24/90	78.0																												
DH-31	8/22/90	47.0																			3.0									
DH-32	9/3/90	66.0																												
DH-32a	9/6/90	64.0																												
DH-38	8/16/90	77.0													(4.8)	(5.3)														
DH-39	8/1/90	73.0	(5.5)	(49.0)			52.2			52.2			52.2				52.2													
DH-40	8/20/90	154.0															(13.6)	(32.4)	(94.9)	130.6										
DH-41	8/21/90	33.5																		27.0										
DH-42	8/20/90	46.6																	11.2	28.6										
DH-43	8/25/90	40.0																						0.0						
DH-44	8/26/90	37.0																												
DH-45	8/27/90	39.0																												
DH-46	9/1/90	79.0																												
DH-47	9/30/90	68.0																												
DH-48	9/26/90	63.0																												
DH-49	9/30/90	69.0																												
DH-50	9/26/90	60.0																												
DH-51	9/27/90	45.0																												

Notes: 1. DH-22, DH-23 and DH-24 are dual piezometers, indicated as S = Shallow and D = Deep.
2. No piezometers were installed in DH-32 and DH-44. Water levels are from open boreholes.
3. Parentheses ( ) indicate water levels during drilling. Water levels may be influenced by drilling water.
4. A = Artesian Flow. Artesian water levels greater than 10 feet are calculated from pressure gauge readings and are rounded to the nearest foot.
5. Piezometer installations in DH-24, DH-26, DH-32 and DH-4 7 are non-standard, due to collapsing boreholes during installation.

F:\NORANDA\DEPTHTAB.MON

TABLE A.1 (SHEET 2 OF 2)
DEPTH TO WATER FROM GROUND SURFACE

DRILL-HOLE	COMPLETION DATE	DEPTH (FT)	SEPTEMBER 1	3	4	5	6	7	8	9	24	25	26	27	28	29	30	31	10/1	Average Flow Rate (gpm)
DH-21	8/9/90	76.0							34.7				36.0						37.0	
DH-22(S)	8/16/90	74.0							6.8				7.4						7.4	
(D)									2.1				2.5						2.5	
DH-23(S)	8/6/90	98.0							25.1				25.2							0.22
(D)									2.4A				1.9A							4.8
DH-24(S)	8/21/90	336.0							>5.2A	8.7A			9.4A							
(D)									39A				37A							
DH-25	8/8/90	113.0							19.4				19.9							
DH-26	8/4/90	145.0							1.4A				1.1A							-
DH-27	8/6/90	274.0							5.4A	7.3A			7.5A							0.13
DH-28	8/29/90	354.0							0.5A				1.1A							
DH-29	8/24/90	60.0							Dry				Dry							
DH-30	8/24/90	78.0							77.1				Dry							
DH-31	8/22/90	47.0							9.5				9.8							
DH-32	9/3/90	66.0		(2.0)	>3.3A	30A			19A		21.0A		33A							0.28
DH-32a	9/6/90	64.0					0.0	A	A				A							Approx 0.25
DH-36	8/18/90	77.0							54.3				55.3						55.4	
DH-39	8/1/90	73.0							52.6				52.7							
DH-40	8/20/90	164.0							138.5				140.4							
DH-41	8/21/90	33.5							28.1				29.4							
DH-42	8/20/90	46.6							30.4				31.8							
DH-43	8/25/90	40.0							>4.5A				7.6A							0.038
DH-44	8/28/90	37.0							12.5				13.4						14.5	
DH-45	8/27/90	39.0							15.7				17.0							
DH-46	9/1/90	79.0							19A				16A							0.64
DH-47	9/30/90	55.0																	3.7A	0.055
DH-48	9/28/90	63.0										(3.8)	15.0A							0.14
DH-49	9/30/90	69.0																	27.5A0	0.21
DH-50	9/28/90	60.0													10A					0.50
DH-51	9/27/90	45.0											(>0.5A)	11.5A						0.10

F:\NORANDA\DEPTHTAB.MON

TABLE A.2
1990 FIELD PERMEABILITY TEST RESULTS
Little Cherry Creek Impoundment Site

HOLE NUMBER	TEST INTERVAL (ft)	SECTION LENGTH (ft)	FLOW RATE Q (gpm)	APPLIED PRESSURE (psi)	GROUND WATER LEVEL (ft)	TOTAL HEAD (ft)	PERMEABILITY k (E-06 cm/s)
DH-21	0.0 - 38.0	38.0	0.051	0	23.2	16.7	4.8
	38.0 - 58.0	20.0	< 0.010	10	23.2	49.3	< 0.5
	38.0 - 58.0	20.0	< 0.010	20	23.2	72.4	< 0.4
	58.0 - 78.0	20.0	< 0.010	10	57.0	83.1	< 0.3
	58.0 - 78.0	20.0	0.090	20	57.0	106.2	2.2
	72.0 - 78.0	6.0	0.050	10	57.0	83.1	3.9
	72.0 - 78.0	6.0	< 0.010	20	57.0	106.2	< 0.6
	72.0 - 78.0	6.0	< 0.010	40	57.0	152.4	< 0.4
DH-22	16.0 - 35.0	19.0	0.039	0	5.2	5.4	19.7
	36.0 - 55.0	19.0	0.120	5	5.0	19.6	16.7
	36.0 - 55.0	19.0	0.240	10	5.0	31.1	21.0
	36.0 - 55.0	19.0	0.400	20	5.0	54.2	20.1
	56.0 - 74.0	18.0	0.100	10	1.7	26.3	10.8
	56.0 - 74.0	18.0	0.270	20	1.7	49.4	15.6
	56.0 - 74.0	18.0	0.430	40	1.7	95.6	12.8
	56.0 - 74.0	18.0	0.070	10	1.7	26.3	7.6
DH-23	15.5 - 34.5	19.0	< 0.010	5	24.5	36.1	< 0.8
	15.5 - 34.5	19.0	< 0.010	10	24.5	47.6	< 0.6
	58.0 - 80.0	22.0	0.040	0	24.5	24.6	3.9
DH-24	45.7 - 61.7	16.0	0.009	0	-1.0	3.8	7.4
	105.0 - 123.0	18.0	< 0.010	10	-1.0	25.1	< 1.1
	105.0 - 123.0	18.0	< 0.010	40	-1.0	94.4	< 0.3
	126.0 - 154.0	28.0	< 0.010	20	-1.5	47.7	< 0.4
	126.0 - 154.0	28.0	0.086	40	-1.5	93.9	1.8
	126.0 - 154.0	28.0	0.090	60	-1.5	140.1	1.3
	156.0 - 184.0	28.0	0.050	10	-3.0	23.1	4.3
	156.0 - 184.0	28.0	0.067	20	-3.0	46.2	2.9
	156.0 - 184.0	28.0	0.060	40	-3.0	92.4	1.3
	156.0 - 184.0	28.0	0.080	60	-3.0	138.6	1.2
	186.0 - 224.0	38.0	0.010	20	-3.0	46.2	0.3
	186.0 - 224.0	38.0	0.142	40	-3.0	92.4	2.4
	186.0 - 224.0	38.0	0.158	60	-3.0	138.6	1.8
	226.0 - 264.0	38.0	0.090	20	-3.0	46.2	3.0
	226.0 - 264.0	38.0	0.110	40	-3.0	92.4	1.9
	226.0 - 264.0	38.0	0.220	60	-3.0	138.6	2.5
	266.0 - 294.0	28.0	0.000	10	-34.0	-7.9	0.0
	266.0 - 294.0	28.0	4.317	20	-34.0	15.2	568.0
	266.0 - 294.0	28.0	7.250	40	-34.0	61.4	236.1
	276.0 - 294.0	18.0	4.020	20	-34.0	15.2	752.5
	276.0 - 294.0	18.0	7.900	40	-34.0	61.4	366.1
	276.0 - 294.0	18.0	1.800	20	-34.0	15.2	337.0
	296.0 - 336.0	40.0	< 0.010	15	-34.0	3.7	< 4.1
	296.0 - 336.0	40.0	3.800	30	-34.0	38.3	148.5
	296.0 - 336.0	40.0	5.550	45	-34.0	73.0	113.8
	313.0 - 336.0	23.0	3.800	30	-34.0	38.3	232.4
	313.0 - 336.0	23.0	4.840	45	-34.0	73.0	155.4
	326.0 - 336.0	10.0	3.833	30	-34.0	38.3	449.0
	326.0 - 336.0	10.0	4.980	45	-34.0	73.0	306.3
DH-25	24.0 - 43.0	19.0	< 0.010	5	7.0	18.6	< 1.5
	24.0 - 43.0	19.0	< 0.010	10	7.0	30.1	< 0.9

NOTE: Negative ground water levels are levels above ground surface.

TABLE A.2
1990 FIELD PERMEABILITY TEST RESULTS
Little Cherry Creek Impoundment Site

HOLE NUMBER	TEST INTERVAL (ft)	SECTION LENGTH (ft)	FLOW RATE Q (gpm)	APPLIED PRESSURE (psi)	GROUND WATER LEVEL (ft)	TOTAL HEAD (ft)	PERMEABILITY k (E-06 cm/s)
	24.0 - 43.0	19.0	< 0.010	20	7.0	53.2	< 0.5
	48.0 - 68.0	20.0	< 0.010	10	9.0	32.1	< 0.8
	48.0 - 68.0	20.0	0.040	20	9.0	55.2	1.9
	68.0 - 88.0	20.0	0.033	10	9.0	37.1	2.3
	88.0 - 108.0	20.0	< 0.010	10	17.2	40.3	< 0.6
	88.0 - 108.0	20.0	< 0.010	20	17.2	63.4	< 0.4
DH-26	23.0 - 40.0	17.0	< 0.010	5	2.5	14.6	< 2.0
	23.0 - 40.0	17.0	< 0.010	10	2.5	26.1	< 1.1
	23.0 - 40.0	17.0	0.400	20	2.5	49.2	24.2
	23.0 - 40.0	17.0	< 0.010	10	2.5	26.1	< 1.1
	39.0 - 60.0	21.0	0.733	10	0.0	24.6	75.0
	39.0 - 60.0	21.0	1.233	20	0.0	47.7	65.1
	39.0 - 60.0	21.0	0.360	10	0.0	24.6	36.9
	134.0 - 145.0	11.0	0.133	10	-1.5	22.6	24.6
	134.0 - 145.0	11.0	0.160	20	-1.5	45.7	14.6
	116.0 - 145.0	29.0	0.550	10	-1.5	22.6	47.3
	116.0 - 145.0	29.0	1.217	20	-1.5	45.7	51.8
	116.0 - 145.0	29.0	0.740	10	-1.5	22.6	63.7
DH-27	32.0 - 54.0	22.0	0.100	5	15.5	30.1	8.1
	53.0 - 74.0	21.0	< 0.010	5	15.5	30.1	< 0.8
	53.0 - 74.0	21.0	< 0.010	10	15.5	41.6	< 0.6
	53.0 - 74.0	21.0	0.050	20	15.5	64.7	1.9
	74.0 - 94.0	20.0	< 0.010	10	7.5	33.6	< 0.8
	74.0 - 94.0	20.0	0.010	20	7.5	56.7	0.5
	74.0 - 94.0	20.0	0.092	40	7.5	102.9	2.3
	93.0 - 114.0	21.0	0.010	10	7.5	33.6	0.7
	93.0 - 114.0	21.0	0.040	20	7.5	56.7	1.8
	93.0 - 114.0	21.0	0.090	40	7.5	102.9	2.2
	116.0 - 134.0	18.0	0.050	10	7.5	33.6	4.2
	116.0 - 134.0	18.0	0.080	20	7.5	56.7	4.0
	116.0 - 134.0	18.0	0.100	40	7.5	102.9	2.8
	132.0 - 154.0	22.0	0.010	10	4.0	30.1	0.8
	132.0 - 154.0	22.0	0.110	40	4.0	99.4	2.7
	152.0 - 174.0	22.0	0.100	10	4.0	30.1	8.1
	152.0 - 174.0	22.0	0.200	20	4.0	53.2	9.1
	152.0 - 174.0	22.0	0.190	40	4.0	99.4	4.6
	198.0 - 227.0	29.0	0.017	10	-6.7	19.4	1.7
	198.0 - 227.0	29.0	0.100	20	-6.7	42.5	4.6
	198.0 - 227.0	29.0	0.120	30	-6.7	65.6	3.6
	198.0 - 227.0	29.0	0.125	40	-6.7	88.7	2.7
	198.0 - 227.0	29.0	0.010	20	-6.7	42.5	0.5
	236.0 - 254.0	18.0	0.133	10	-6.7	19.4	19.5
	236.0 - 254.0	18.0	0.083	20	-6.7	42.5	5.6
	236.0 - 254.0	18.0	0.200	40	-6.7	88.7	6.4
	236.0 - 254.0	18.0	0.010	10	-6.7	19.4	1.5
	256.0 - 274.0	18.0	< 0.010	10	-6.7	19.4	< 1.5
	256.0 - 274.0	18.0	0.060	40	-6.7	88.7	1.9
DH-28	16.0 - 34.0	18.0	0.004	0	4.5	10.1	1.1
	36.0 - 74.0	38.0	0.006	10	3.4	29.5	0.3
	36.0 - 74.0	38.0	0.025	20	3.4	52.6	0.7

TABLE A.2
1990 FIELD PERMEABILITY TEST RESULTS
Little Cherry Creek Impoundment Site

HOLE NUMBER	TEST INTERVAL (ft)	SECTION LENGTH (ft)	FLOW RATE Q (gpm)	APPLIED PRESSURE (psi)	GROUND WATER LEVEL (ft)	TOTAL HEAD (ft)	PERMEABILITY k (E-06 cm/s)
	36.0 - 74.0	38.0	0.067	30	3.4	75.7	1.4
	76.0 - 114.0	38.0	< 0.010	10	3.4	29.5	< 0.5
	76.0 - 114.0	38.0	< 0.010	20	3.4	52.6	< 0.3
	76.0 - 114.0	38.0	0.120	40	3.4	98.8	1.9
	116.0 - 154.0	38.0	0.100	20	3.4	52.6	3.0
	116.0 - 154.0	38.0	0.210	40	3.4	98.8	3.3
	116.0 - 154.0	38.0	0.440	60	3.4	145.0	4.7
	156.0 - 194.0	38.0	< 0.010	20	10.0	59.2	< 0.3
	156.0 - 194.0	38.0	0.167	40	10.0	105.4	2.5
	156.0 - 194.0	38.0	0.480	60	10.0	151.6	4.9
	196.0 - 234.0	38.0	< 0.010	20	10.0	59.2	< 0.3
	196.0 - 234.0	38.0	0.158	40	10.0	105.4	2.3
	196.0 - 234.0	38.0	0.240	60	10.0	151.6	2.5
	236.0 - 274.0	38.0	0.025	30	-0.5	71.8	0.5
	236.0 - 274.0	38.0	0.090	60	-0.5	141.1	1.0
	272.0 - 314.0	42.0	0.092	30	-0.5	71.8	1.8
	272.0 - 314.0	42.0	0.183	60	-0.5	141.1	1.9
	316.0 - 354.0	38.0	< 0.010	30	-0.5	71.8	< 0.2
	316.0 - 354.0	38.0	0.013	60	-0.5	141.1	0.1
	316.0 - 354.0	38.0	0.117	80	-0.5	187.3	1.0
DH-30	58.0 - 78.0	20.0	1.420	20	76.6	117.2	31.7
	58.0 - 78.0	20.0	4.175	40	76.6	163.4	66.9
	58.0 - 78.0	20.0	3.367	20	76.6	117.2	75.2
DH-31	11.0 - 29.0	18.0	< 0.010	5	8.5	23.1	< 1.2
	11.0 - 29.0	18.0	< 0.010	10	8.5	34.6	< 0.8
	39.0 - 47.0	8.0	< 0.010	10	8.5	34.6	< 1.5
	39.0 - 47.0	8.0	0.040	20	8.5	57.7	3.7
	29.0 - 47.0	18.0	< 0.010	10	8.5	32.6	< 0.9
	29.0 - 47.0	18.0	0.060	20	8.5	55.7	3.1
DH-32	48.0 - 66.0	18.0	0.000	5	-30.0	-17.0	0.0
	48.0 - 66.0	18.0	0.000	10	-30.0	-5.4	0.0
	48.0 - 66.0	18.0	< 0.010	20	-30.0	17.7	< 1.6
	48.0 - 66.0	18.0	0.010	40	-30.0	63.9	0.4
DH-32a	11.0 - 34.0	23.0	< 0.010	10	0.0	26.1	< 0.9
	46.0 - 64.0	18.0	< 0.010	10	-10.0	13.1	< 2.2
	46.0 - 64.0	18.0	0.425	20	-10.0	36.2	33.4
	46.0 - 64.0	18.0	0.320	30	-10.0	59.3	15.4
	46.0 - 64.0	18.0	0.010	20	-10.0	36.2	0.8
	35.6 - 64.0	28.4	< 0.010	10	-10.0	13.1	< 1.5
	35.6 - 64.0	28.4	< 0.010	20	-10.0	36.2	< 0.5
	35.6 - 64.0	28.4	< 0.010	30	-10.0	59.3	< 0.3
DH-38	0.0 - 45.0	45.0	0.002	0	51.9	22.5	0.1
	48.0 - 65.0	17.0	< 0.010	10	51.9	78.0	< 0.4
	48.0 - 65.0	17.0	0.090	20	51.9	101.1	2.6
	48.0 - 65.0	17.0	1.700	41	51.9	149.6	33.8
	67.0 - 77.0	10.0	< 0.010	20	51.9	101.1	< 0.4
	67.0 - 77.0	10.0	0.010	40	51.9	147.3	0.3
DH-39	15.0 - 33.0	18.0	< 0.010	5	52.0	38.6	< 0.7
	35.0 - 53.0	18.0	1.850	20	52.0	93.2	56.5
	35.0 - 53.0	18.0	1.240	10	52.0	70.1	50.3

TABLE A.2
1990 FIELD PERMEABILITY TEST RESULTS
Little Cherry Creek Impoundment Site

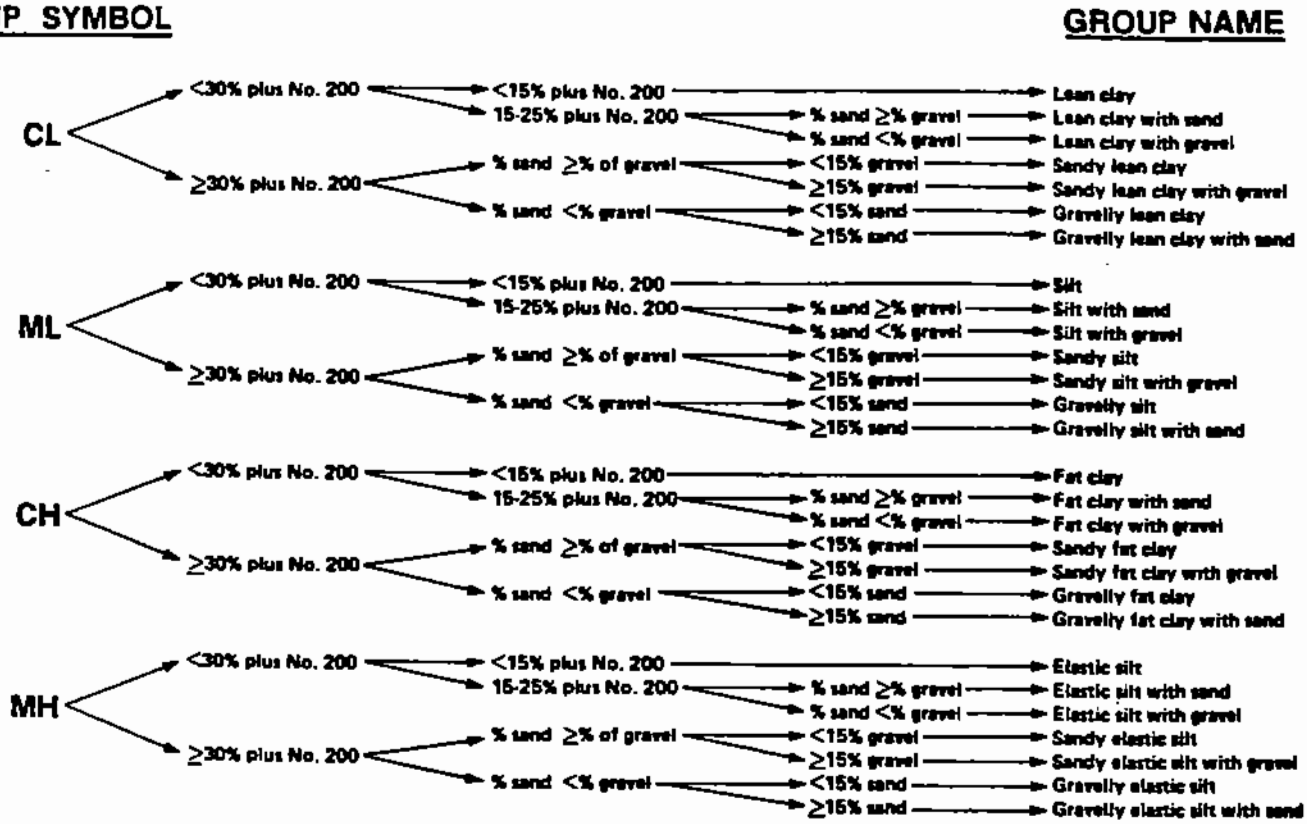
HOLE NUMBER	TEST INTERVAL (ft)	SECTION LENGTH (ft)	FLOW RATE Q (gpm)	APPLIED PRESSURE (psi)	GROUND WATER LEVEL (ft)	TOTAL HEAD (ft)	PERMEABILITY k (E-06 cm/s)
	55.0 - 73.0	18.0	< 0.010	10	52.0	78.1	< 0.4
	55.0 - 73.0	18.0	0.010	20	52.0	101.2	0.3
	55.0 - 73.0	18.0	2.620	40	52.0	147.4	50.6
	55.0 - 73.0	18.0	1.880	20	52.0	101.2	52.9
	55.0 - 73.0	18.0	1.460	10	52.0	78.1	53.2
DH-40	10.0 - 30.0	20.0	0.117	5	32.4	34.6	8.9
	36.0 - 53.0	17.0	< 0.010	5	130.5	57.1	< 0.5
	36.0 - 53.0	17.0	0.050	10	130.5	68.6	2.2
	36.0 - 53.0	17.0	0.070	20	130.5	91.7	2.3
	56.0 - 96.0	40.0	< 0.010	10	94.9	100.1	< 0.1
	56.0 - 96.0	40.0	0.120	20	94.9	123.2	1.5
	56.0 - 96.0	40.0	0.220	40	94.9	169.4	1.9
	96.0 - 135.0	39.0	0.120	20	130.5	164.7	1.1
	96.0 - 135.0	39.0	0.200	40	130.5	210.9	1.4
	136.0 - 154.0	18.0	< 0.010	20	130.5	179.7	< 0.2
	136.0 - 154.0	18.0	0.850	50	130.5	249.0	9.7
	136.0 - 154.0	18.0	< 0.010	20	130.5	179.7	< 0.2
DH-41	16.5 - 33.5	17.0	< 0.010	5	27.0	38.6	< 0.8
	16.5 - 33.5	17.0	0.160	10	27.0	50.1	9.5
	16.5 - 33.5	17.0	< 0.010	5	27.0	38.6	< 0.8
DH-42	14.0 - 29.0	15.0	< 0.010	5	26.8	34.6	< 1.0
	14.0 - 29.0	15.0	0.188	10	26.8	46.1	13.4
	29.0 - 46.6	17.6	0.050	10	26.8	50.9	2.8
	29.0 - 46.6	17.6	0.050	20	26.8	74.0	2.0
DH-43	10.0 - 30.0	20.0	< 0.010	5	-7.6	4.0	< 6.6
	10.0 - 30.0	20.0	0.010	10	-7.6	15.5	1.7
	34.0 - 40.0	6.0	< 0.010	10	-7.6	19.5	< 3.4
	34.0 - 40.0	6.0	0.083	20	-7.6	42.6	12.8
DH-44	17.0 - 37.0	20.0	< 0.010	10	10.8	33.9	< 0.8
DH-46	17.0 - 39.0	22.0	< 0.010	10	2.1	27.7	< 0.9
	41.0 - 59.0	18.0	< 0.010	10	-18.5	7.1	< 4.0
	41.0 - 59.0	18.0	0.006	20	-18.5	30.2	0.6
	41.0 - 59.0	18.0	0.060	30	-18.5	53.3	3.2
	61.0 - 79.0	18.0	0.575	20	-18.5	29.2	56.0
	61.0 - 79.0	18.0	< 0.010	40	-18.5	75.4	< 0.4
DH-47	12.0 - 30.0	18.0	< 0.010	10	-3.7	19.4	< 1.5
DH-48	53.0 - 63.0	10.0	0.020	20	-15.0	34.2	2.6
	53.0 - 63.0	10.0	0.030	40	-15.0	80.4	1.7
DH-49	63.0 - 69.0	6.0	< 0.010	20	-27.5	19.7	< 3.3
	63.0 - 69.0	6.0	0.160	40	-27.5	65.9	15.9
	63.0 - 69.0	6.0	0.500	60	-27.5	112.1	29.2
	63.0 - 69.0	6.0	< 0.010	40	-27.5	65.9	< 1.0
DH-50	45.0 - 60.0	15.0	1.100	20	-10.0	38.7	93.3
	45.0 - 60.0	15.0	2.860	30	-10.0	61.8	151.9
	45.0 - 60.0	15.0	< 0.010	20	-10.0	38.7	< 0.8
DH-51	33.0 - 45.0	12.0	0.250	21	-11.5	39.0	25.0
	33.0 - 45.0	12.0	0.710	30	-11.5	59.8	46.3
	33.0 - 45.0	12.0	0.140	20	-11.5	36.7	14.9

TABLE A.3
1990 DRILLHOLE LOCATIONS
Little Cherry Creek Impoundment Site

HOLE NO.	COORDINATES northing	COORDINATES easting	ELEVATION GROUND	ELEVATION TOP OF CASING	
DH-21	488098	527261	3528.7	3530.5	
DH-22	487408	527133	3428.4	3432.0	
DH-23	486783	527448	3425.5	3428.4	
DH-24	485980	527626	3430.5	3432.7	
DH-25	485277	527604	3487.3	3489.5	
DH-26	486684	528704	3389.5	3391.9	
DH-27	486048	528914	3395.1	3397.6	
DH-28	485178	528850	3449.9	3452.2	
DH-29	483764	523878	3719.2	3721.9	
DH-30	483867	524909	3651.4	3653.4	
DH-31	484400	522199	3656.8	3659.3	
DH-32	483878	522287	3652.3	3655.7	*
DH-32a	483993	522250	3633.5		**
DH-38	487139	529903	3349.8	3353.1	
DH-39	486781	530024	3324.1	3327.1	
DH-40	488387	522964	3665.8	3669.1	
DH-41	484343	524663	3594.7	3596.7	
DH-42	484583	525332	3607.5	3610.1	
DH-43	486998	527101	3422.1	3423.9	
DH-44	487763	527224	3467.4		**
DH-45	485488	527564	3477.8	3479.0	
DH-46	484320	522392	3610.7	3613.3	
DH-47	483885	521783	3682.9	3685.2	
DH-48	483802	522077	3655.2	3658.1	
DH-49	483931	522193	3642.6	3644.5	
DH-50	483674	522153	3675.3	3677.8	
DH-51	483720	522275	3671.1	3673.4	

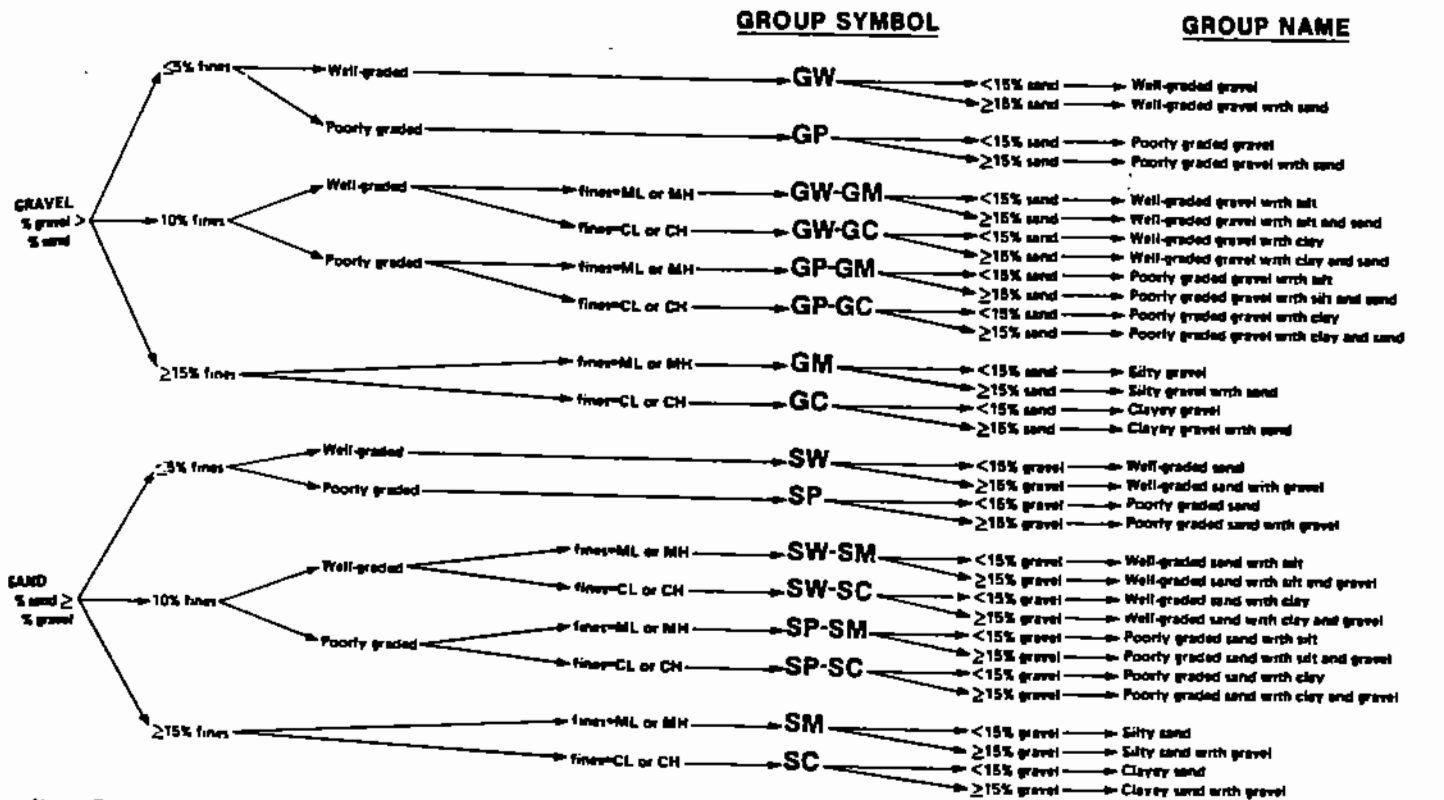
* No protective casing was installed. Elevation is at top of standpipe.

** No piezometer installed.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

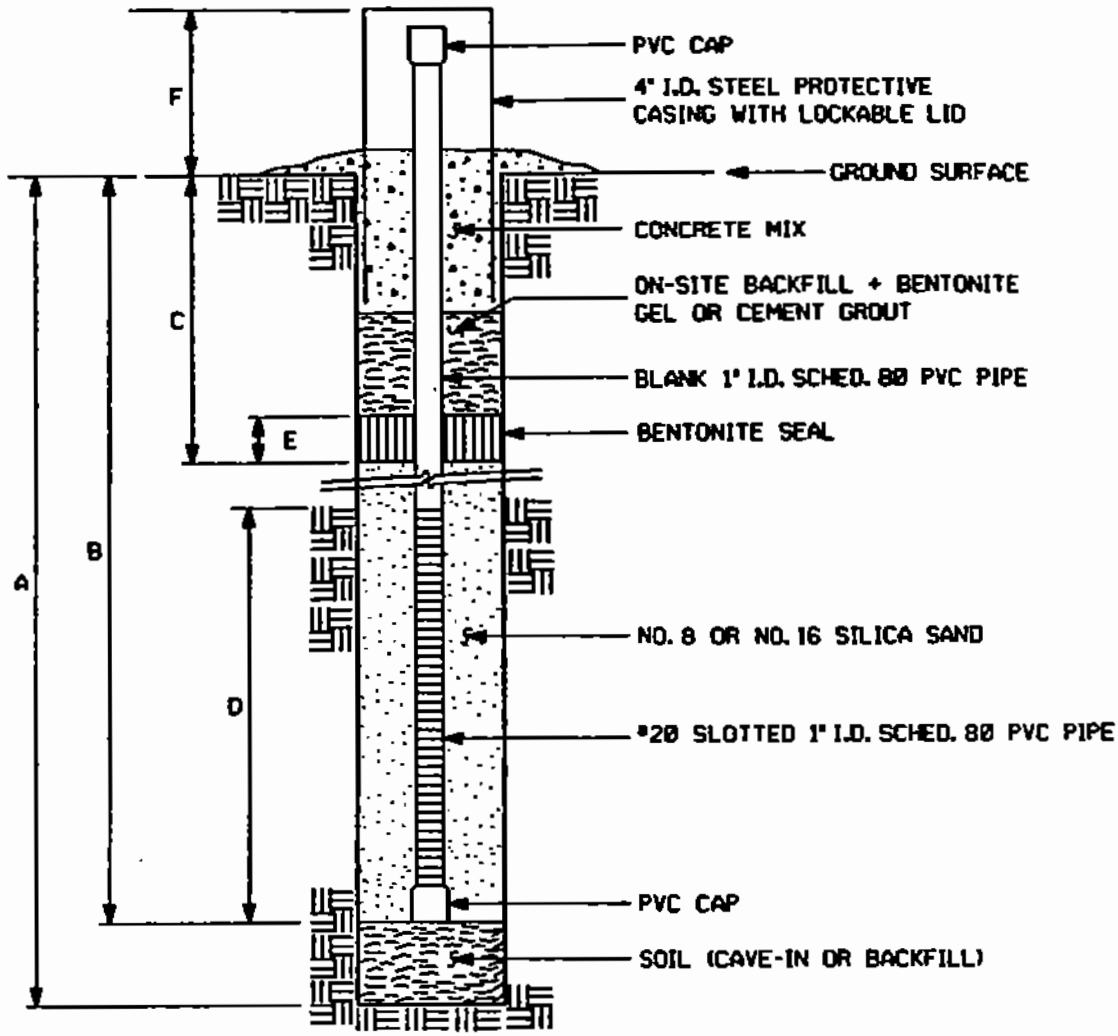
FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

Figure A-1 Visual Soil Classification System (ASTM, 1984)

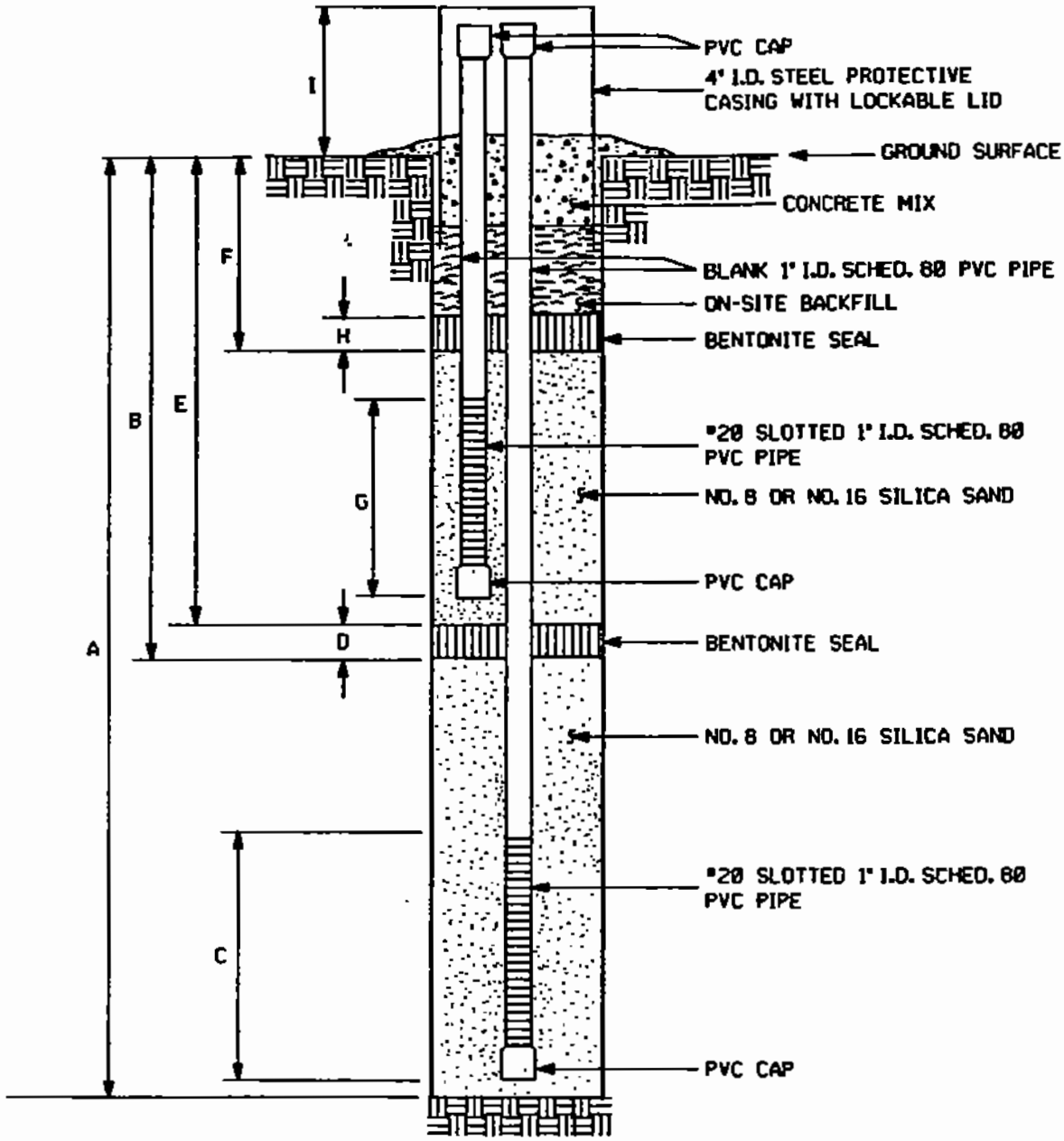


BORING NO.	DIMENSIONS (FT.)						NOTES
	A	B	C	D	E	F	
DH-21	78	78	27	20	3	1.8	
DH-25	113	113	47.5	20	3	2.2	
DH-26	145	118	78	20	2	2.4	
DH-27	274	274	210	20	2	2.5	BOTTOM OF SLOTTED PVC AT 249'
DH-28	354	354	152	20	3	2.3	10' SUMP BELOW SLOTTED PVC
DH-29	80	80	50	20	5	2.7	
DH-30	78	78	38	20	3	2.0	
DH-31	47	47	19	10	5	2.5	BOTTOM OF SLOTTED PVC AT 46'
DH-32	66	66	60	10	-	-	NO BENTONITE INSTALLED DUE TO
DH-38	77	77	46	20	2	3.3	COLLAPSING HOLE, BOTTOM OF PVC AT 55'
DH-39	73	73	50	10	3.5	3.0	
DH-40	154	154	83	20	3	3.3	BOTTOM OF SLOTTED PVC AT 152'
DH-41	33.5	33.5	16	10	3	2.0	BOTTOM OF SLOTTED PVC AT 30'
DH-42	46.6	46.6	19.6	20	3	2.6	
DH-43	40	40	19	20	3	1.8	
DH-45	39	39	18	20	3.5	1.2	
DH-46	79	79	40	20	3	2.6	BOTTOM OF SLOTTED PVC AT 78'
DH-47	55	55	21	20	3	2.3	
DH-48	63	59	48	10	2.5	2.9	
DH-49	69	69	57	10	2	1.9	
DH-50	60	60	45	10	3	2.5	
DH-51	45	45	33	10	2.5	2.3	

PIEZOMETER CONSTRUCTION

FIGURE A-2 (Not to scale)

80290201/A2



BORING NO.	DIMENSIONS (FT.)									NOTES
	A	B	C	D	E	F	G	H	I	
DH-22	74	52.5	20	3	49.5	26	20	4	3.6	
DH-23	98	80.5	10	2.5	78	46.5	20	35	2.9	
DH-24	336	284	20	2	19	5.5	10	0*	2.2	10' SUMP AT BOTTOM ADDITIONAL BENTONITE SEAL FROM 19' TO 21' *CONCRETE FROM 5.5' TO SURFACE

DUAL PIEZOMETER CONSTRUCTION

FIGURE A-3 (Not to scale)

80290201/A3

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-21
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 8/8 - 8/9/90	HOLE SIZE: HQ	ORIENTATION: VERTICAL
LOCATION: STARTER DAM · L. ABUTMENT	ELEVATION: 3528.7	DEPTH TO WATER: 37'	DEPTH TO ROCK: 69.5'
DRILLING CONTRACTOR: J.D. WELSH (Scott Corn - Driller)	SAMPLES:	CORE BOXES: 8	DEPTH OF HOLE: 78.0'
DRILL MAKE - MODEL: ACKER AD-11	LOGGED BY: E. RENNAT		REVIEWED BY:

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									FILL - lt. brn SILT (due to pad construction) (ML)		Clear-cut area; grass & small trees to ~4' high
	2											
	4									(Approx.) bottom of fill		No water return until ~6.0'
	6		4½" O.D.							SILT w/ Roots (ML)		lt. brown water return
	8											
	10			RUN 1 D 2.0 C 2.2 - 100%						~2" Tree root at top; Sandy SILT with Gravel (ML) - very stiff to hard - max. particle size ~1" mostly siltite, some qtzite		
	12	SAMPLE TAKEN 9/10/90		RUN 2 D 5.0 C 5.1		BOX 1				~50% Clay & Silt, orange color; ~30% Sand - med-coarse; ~20% gravel - fine, subangular		Drill Rate 0.44 ft/min
	14											
	16			- 100								
	18			RUN 3 D 3.2 C 3.0						~2" clean qtzite piece; 3 siltite piece SILT/FINE SAND (ML/SM)		
	20			- 100		BOX 2						

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A MORRISON KNUDSEN COMPANY

SHEET 1 OF 4 | HOLE NO. DH-21

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-21
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING DRILL ACTION WATER LOSS CORE LOSS STANDARD PENETRATION WATER PRESSURE TEST LAB CLASSIFICATION PIEZOMETERS
	20	SPT 1		24 34 37						(ct'd) SANDY SILT (ML) - lt. brn ; some fine sand - v. little <5% gravel		SPT #1 24-34-37 (went through 2 gravel pieces, ~1½" Diam)
	22			RUN 4 D 5° C ~4²						} gravel		
										SAND (SW) med. to coarse, subangular ; few fines ~10% gravel, subangular to subrounded		
	24						BOX 2					
				~ 95 RUN 5 D 5° C 4²								clean contact
	26									SILTY SAND (SM) - lt. brn - fine sand - occ'l trace gravel - v. dense		Penetrometer avg. 3.5 tsf
	28											
				~ 98 RUN 6 D 3° C 2²						FINE SAND / SILT (SM/ML) ~10% Subangular gravel ; mostly isolated 1" Diam. pieces - v. dense		
	30											
	32											Drill Rate 0.50 ft/min
				~ 97 RUN 7 D 5° C 4²			BOX 3			·3" piece siltite - 33± grades into silty SAND (SW) (med-cse) w/ same gravel		
	34											Perm'y Test 1 (0 - 38°) Falling Head Test 4' drop in 30 min
	36											
										} more gravel		
	38			~ 96 RUN 8						SILTY GRAVEL w/ SAND (GM) - ~40% fine subangular Gravel ; weathered - orange red matrix color, clayey (core holds together well)		
	40						BOX 4					

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SHEET 2 OF 4 HOLE NO. DH-21

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-21
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			RUN 8 D 5° C 5°						(ctd) SILTY GRAVEL w/ SAND (GM) - ~50% Gravel - some clay - orange-red color - gravel is well-graded, subangular, max size ≈ 1" weathered siltite & fine meta-sandstone predominate - partially lithified - matl is hard; can be interpreted as a weathered sedimentary pebble breccia		core is being extracted in solid 5" pieces - all breaks are mechanical
	42			100		Box 4						
	44			RUN 9 D 5° C 5°								
	46											Packer Test 2 (38° - 58°) 0 gpm at 20 psi
	48			100 RUN 10 D 5° C 5°								
	50									orange (little red) color		Drill Rate 0.54 ft/min
	52			100 RUN 11 D 5° C 5°		Box 5				53° - 63° reddish color		
	54											
	56											
	58			100 RUN 12		Box 6						
	60											

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 3 OF 4 HOLE NO. DH-21

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-21

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY SR	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			RUN 12 D 5° C 5°						(ct'd) SILTY GRAVEL w/ SAND (GM) - hard, partially lithified		
	62				100	Box 6						
	64			RUN 13 D 5° C 5°						63° → bedrock : orange color		Packer Test 3 (58° - 78°) ~0.01 gpm at 20 psi
	66											
	68	SPT 2		17 32 50/2½"	100							SPT #2 68° 17 - 32 - 50/2½" SPT "cast" is recovered in core
	70			RUN 14 D 5° C 5°		Box 7				69.5 Bedrock Weathered (orange) SILTITE/ARGILLITE (?); breaks easily along relict bedding (~50° ∡); dark staining & occ'l slickensides along open surfaces		
	72				100							Packer Test 4 (72° - 78°) 0.05 gpm at 10 psi
	74			RUN 15 D 5° C 5°								
	76					Box 8						Drill Rate 0.5 ft/min (driller using more pressure than previously
	78			40	100			50°		78° BOH		RQD = 40 in split barrel; breaks along bedding w/ handling
	80									Piezometer w/ 20' Slotted Casing at bottom of hole; sand to 27' depth; bentonite to 24°		

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SHEET 4 OF 4 HOLE NO. DH-21

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-22
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 8/15 - 8/16/90	HOLE SIZE: HQ	ORIENTATION: VERTICAL
LOCATION: STARTER DAM	ELEVATION: 3428.4	DEPTH TO WATER: 7'	DEPTH TO ROCK: 50.7'
DRILLING CONTRACTOR: ID WELSH (S. Corn - Driller)	SAMPLES	CORE BOXES: 7	DEPTH OF HOLE: 74.0'
DRILL MAKE - MODEL: ACKER AD-II	LOGGED BY: E. RENNAT		REVIEWED BY: [illegible]

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Surface: Lt brn SILT(ML) w/cobbles & roots; possible disturbed (fill) material in top 2'-6'		Edge of clear cut; grasses stumps; nearby fir trees to ~20' high
	2		4½" OD									good water return: V. light tan-gray color
	4											
	6	SPT #1		2 5 8						V. light gray-tan SILTY CLAY (CL/CH); fine interlayers of orange iron-stained clay		SPT #1 2-5-8
				RUN 1 D 5° C 25		BOX 1				root		Penetrometer: 1.6 to 3.5 tsf; avg 2.0 tsf
	8	SAMPLE 9/10/90								- Angular quartzite pieces up to 1½"		
	10	SHELBY 1		- 50						- ~9.5' Color change to lt. brown/med. brown; ~10% Sand, minor gravel	3"	- Penetrometer: 2.5 tsf; Shelby Tube penetrates ~4' - end is crushed
				RUN 2 D 5° C 50						Med brown SILTY SAND w/ GRAVEL (SM); weathered & stained ~30% SILT ~50% med-cse sand 20% fine subangular gravel; occ pieces up to 1½"		
	12											
	14			- 100								
	16	SPT #2		17 20 28								SPT #2 17-20-28
				RUN 3 D 5° C 39		BOX 2						Drill Rate 0.66 ft/min
	18											
				- 78								
	20											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-22

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
	ER	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20	SPT #3		12 20 35						(ctd) med. brn SILTY SAND w/ GRAVEL (SM)		SPT #3 12-20-35 (in clean SILTY SAND no G)
				RUN 4		BOX 2				20° to 24° < 5% fine gravel; mat'l is soft, may be cuttings & disturbed mat'l		Packer Test 1 (16°-35°) (Falling Head)
	22			D 5° C 5°								
	24				~100					24° + Core is firm (slight clay), fine gravel ~10%, occurs mostly in small (~4") zones		
		SHELBY 2										Shelby #2 - penetrates 5" - crushed
	26	SPT #4		26 39 45						- hard, < 5 tsf		SPT #4 26-39-45
				RUN 5								
	28			D 5° C ~3°								
					~60	BOX 3						
	30	SPT #5		14 19 27								SPT #5 14-19-27 (~no gravel.)
	32			RUN 6 D 5° C 5°								
	34				~100					- gradual increase to ~ 25% fine ~~sand~~ Gravel; subangular to subrounded; often red & yellow colored; max size 1½", $D_{90} \approx 1/2"$		
				RUN 7								
	36			D 5° C 7°								
	38					BOX 4						
	40				96							

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-22

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40	SPT 6		11 26 36						(ctd) med brown SILTY SAND w/ GRAVEL (SM) ~20% SILT ~60%+ SAND - fine to cse ~20% Fine Gravel; subangular to sub rounded		SPT #6 11-26-36 (~no gravel in SPT)
	42			RUN 8 D 5° C 4°		BOX 4						Packer Test 2 (36° - 55°)
	44											
				-	96							
	46	SPT 7		22 30 26						~45° to 48° med. gray brown, hard, SILTY CLAY (CL) - faint (relict?) bedding at 35° ∠		SPT #7 22-30-26
				RUN 9 D 5° C 4°								Penetrometer avg. > 4.5 tsf
	48									irreg, sharp contact		
										Angular, tabular pieces of yellow weathered SILTITE in SILTY CLAY Matrix (matrix ~40%)		
				-	94							
	50	SPT #8		32 50/5"		BOX 5						SPT # 8 32 - 50/5" bottom of SPT in v. weathered, friable shaly rock
										Gradual, weathered contact		
	52			RUN 10 D 2° C 2°						BEDROCK Yellow weathered fine SS/SILTITE alternating w/ ~25% lt. gray argillite laminae 1/16" to 1/2" thick. fairly regular bedding at 45° ∠; most breaks along bedding, frequently stained dark, some faint slickensides		
				-	87							
				RUN 11 D 1° C 1°								
	54			62	100							
				RUN 12 D 5° C 5°								
	56											Drill Rate 0.44 ft/min
	58			LP 5"		BOX 6						
	60			56	100							

PROJECT	JOB NO.	HOLE NO.
MONTAHORE	8029	DH-22

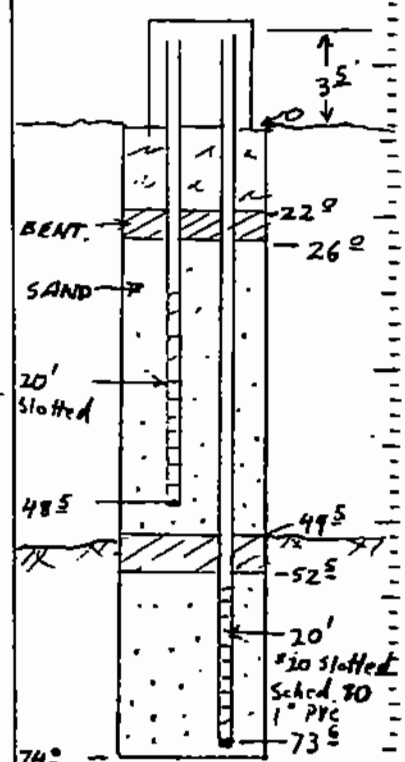
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
	ER	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	ROX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			RUN 13						(ctd) BEDROCK - Orange weathered fine Metasandstone - less gray argillite than above (~5%)		
				D 4.0								
				C 3.2		Box 6						Packer Test 3 (56.0 - 74.0)
	62									- zones of hard white qtz arenite (?) w/ occ'l weathered pyrite (<1%)		0.27 gpm at 20 psi
				LP 5"								
				30	80							
	64			RUN 14								
				D 5.0				45°				
				C 5.0								
	66											
				LP 10½"								
	68											PIEZOMETER
				44	100							
				RUN 15		Box 7						
	70			D 5.0								
				C 2.6								
				CL 2.4								
	72			LP 6"								
										More orange in ~ last 2'; core loss; last 6" of core is v. weathered & friable		
	74			24	52							
										BOH = 74.0		
	76											
	78											
	80											



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SHEET 4 OF 4 | HOLE NO. DH-22

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-23
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 8/5 - 8/6/90	HOLE SIZE: HQ	ORIENTATION: VERTICAL
LOCATION: STARTER DAM	ELEVATION: 3425.5	DEPTH TO WATER: 25'/Artesian	DEPTH TO ROCK: 86.5'
DRILLING CONTRACTOR: J.D. WELSH (S. Corn - Driller)	SAMPLES	CORE BOXES: 9	DEPTH OF HOLE: 98.0'
DRILL MAKE - MODEL: ACKER AD-11	LOGGED BY: E. RENNAT	REVIEWED BY: CF Slater	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Lt. brn SILT w/ Roots (ML)		- Clear-cut area; grasses & scattered small fir trees
	2											- Drill w/ "Clear Mud" polymer drilling fluid ~1:1000 in water
	4											- cased to 5.0'
		SAMPLE TAKEN 5.0-15.0 9/10		RUN 1 D 5.0 C 5.0						← 2" Root		
	6									Lt. brn SILT (ML) w/ ~10% GRAVEL, trace SAND		
										- gravel is mostly subangular, $D_{50} \approx 1/4 - 1/2$", mostly quartzite & gray siltite		Penetrometer: 2.5 to 4.5+ tsf
	8									← 1½" thick med. gray shale		
				-	100	BOX 1				9.0-19.5 Silt is mostly clean - < 2% gravel		
	10	SPT 1		14 19 17								SPT # 1 14-19-17
				RUN 2 D 5.0 C 5.0						- very stiff to hard		[RUN 2 (10.0-15.0) was dropped out of core barrel - may be out of order]
	12											
	14											
				-	100							Drill Rate 0.38 ft/min
				RUN 3 D 5.0 C 5.0+								
	16											
	18					BOX 2						Penetrometer avg 4.0 tsf
	20			-	100							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-23
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	20			RUN 4 D 4.5						(ct'd) Lt. brn. SILT (ML) w/ up to 10% GRAVEL		
										19.5 – 22.0: ~10% + Gravel, 22.0–24.0 < 5% Gravel		
	22					BOX 2						
										– hard; core holds together well		
	24									← ~2" piece		
		SPT 2		21 21 27								SPT # 2 21-21-27
	26			RUN 5 D 5.0 C ~2.7 CL ~2.3								
	28					BOX 3						Packer Test 1 (15.5 to 34.5) 0 gpm at 10 psi
				–	54							
	30			RUN 6 D 5.0 C 4.8								Pocket Penetrometer: > 5 tsf
												Drill Rate 0.66 ft/min
	32									SILTY SAND w/ GRAVEL (SM) ~20% brn silt ~50% med-cse sand ~30% gravel; subangular, mostly fine; iron stained		
	34			–	96					– dense; core holds together well		
				RUN 7 D 2.5 C 2.2						} 35.0 → 36.0 more clayey, little gravel		
	36			–	88							
				RUN 8 D 2.5 C 2.5		BOX 4						
	38											
	40				100							

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

SHEET 2 OF 5 HOLE NO. DH-23

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-23

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
	SR	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			RUN 9 D 5° C 5°						(ctd) Silty SAND w/GRAVEL (SM) 40.5 → 45.8 mostly silty fine sand; little to no gravel in most zones		
	42					Box 4						
	44											
					100							Packer Test 2 (36° - 55°) 0 gpm at 5 psi
				RUN 10 D 5° C 4.9								
	46											
	48											
					98	Box 5						
	50	SPT 3		17 35 28								SPT #3 17-35-28
				RUN 11 D 5° C 2.5								
	52											
	54											
					50					Lt. Brn SILT, clayey (ML) - clean, firm - varved (?) ~1/4" wide grayer lines ~1/2" apart - very stiff to hard		
				RUN 12 D 5° C 2.6								
	56											
	58			CL 2.4								
					52							
	60											

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-23
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			RUN 13		BOX 5				Lt. brn. SILT (ML) (cont'd)		Hand Sample 1 (60.8'-61.5')
				D 5°	10					- v. stiff to hard		Sieve Analysis: 94% Fines
		#1		C 5°	10							Atterbergs: Nonplastic
												Drill Rate ~ 1.0 ft/min
	62											60°-65° Penetrometer
												2.0 → 3.0 tsf
												avg. 2.25 tsf
	64											
				-	100							
		SPT 4		16		BOX 6						SPT #4
				18								16-18-23
	66			23								
				RUN 14								
				D 5°	10							
	68			C ~45								Drill Rate 1.1 ft/min.
										- slightly more clayey (?)		Packer Test 3
	70			-	~90							(58°-80°)
				RUN 15								Falling Head
				D 5°								3.1 ft in 30 min
				C 5°	10							
	72											Penetrometer:
												2.0 - 4.0 tsf
												Avg. 3.3 tsf
	74											
				-	100							
		SPT 5		10		BOX 7						SPT #5
	76			16								10-16-16
				16								
				RUN 16								
				D 5°								
	78			C ~45								
	80				~90							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-23
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	80			RUN 17		BOX 7				(cont'd) Clayey SILT (ML)		
				D 5°								
				C 5°								
	82											
										SILTY GRAVEL (GM)		
	84									} 4" siltite cobble - weathered - sub angular to angular		
				- 100						- transition into bedrock		
				RUN 18								Packer Test 4 (79° - 98°)
	86			D 5°		BOX 8						
				C 5°								FALLING HEAD artesian flow - no test
										(APPROX.) BEDROCK		
	88									Weathered orange to lt. gray SILTITE to fine META-SS		
										- breaks fairly easily along bedding planes (~48° from horizontal)		
										- slight iron-stained slickensides along some joints		
	90			65 100						- covered w/ orange clayey cuttings		Drill Rate 0.4 ft/min
				RUN 19								
				D 5°								
				C 5°								
	92			LP 15"								
										} 15" hard lt. gray to pinkish siltstone piece		
	94					BOX 9		48°				Drill Rate 0.35 ft/min.
				78 100								PIEZOMETER
				RUN 20								
	96			D 3°							RANDOM FILL	2.5' 0°
				C 2.8							BENT.	43° 46.5
											SAND	20' slotted sched. 80 PVC
	98			38 94						98° BOH		75.5
											BENT.	78° 80.5
	100										SAND	10' slotted sched 80
												98°

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 5 OF 5 HOLE NO. DH-23

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-24
SITE Little Cherry Creek	DATE - STARTED 8/7/90 FINISHED 8/21/90	HOLE SIZE HQ	ORIENTATION V
LOCATION ℄ Starter Dam, S of midpoint	ELEVATION 3430±	DEPTH TO WATER 4/26/90 bore piezometers	DEPTH TO ROCK 32±
DRILLING CONTRACTOR JD Welsh	SAMPLES ∅	CORE BOXES 31	DEPTH OF HOLE 336±
DRILL MAKE - MODEL Longyear HC-150	LOGGED BY CF Slater		REVIEWED BY

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Road Fill (compacted, ~locally derived). Clayey gravel with sand (GC)		Drill to 4± 6" surface casing
	2											
	4			RUN 1 D 6± C 14						CLAYEY GRAVEL with SAND (GC) slightly firm, orangish to yel'ish brn w/ occ. red streaks, gravel to coarse sand in ~30% silty clay matrix (med. plast), gravel is subrounded.		HQ coring with polymer (clear mud) drilling fluid.
	6											
	8			–	28							
	10			RUN 2 D 15 C 12						Some lt. grey siltite cobbles.		core barrel clogged
				–	100							
	12			RUN 3 D 34 C 32						Sandy clay (CL). fine gravel to coarse sd in silty clay matrix.		
	14			–	89	Box 1				subrounded to subangular gravel		
	16			RUN 4 D 32 C 23						CLAYEY GRAVEL to GRAVELLY CLAY (GC/CL) with SAND and COBBLES greenish to orangish brown, mod. firm, ~40% cobbles + lg gravel.		Drill Rate 0.20 ft/min.
				–	90							
	18			RUN 5 D 3± C 12						dk brn to blk matrix (organic?)		
	20											

MORRISON-KNUDSEN ENGINEERS, INC. HOLE DH-24

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. LH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			–	47					CLAYEY GRAVEL with SAND (GC) and COBBLES. ~70% grey Siltite/Qtzite cobbles + lg gravel in grnish brown, soft to mod'ly soft SDY SILTY CLAY to GRAV. SLTY SAND matrix (sm grav.) Mod to no plast.		
				RUN D C	6 3° 2°							
	22											
				–	73							
	24											3/7/90
				RUN D C	7 3° 1°	Box 2						5/6/90
	26											Drill Rate ~0.90 ft/min
				–	63							
				RUN D C	8 2° 1°							
	28											
				–	80							
				RUN D C	9 3° 2°							
	30											
				–	73					becoming greenish brown w/ some orangish brown		
	32											
				RUN D C	10 2° 2°							core barrel clogging
				–	100							
	34			–	80							
				RUN D C	12 2° 2°							
	36					Box 3						
				–	100							
				RUN D C	13 3° 2°							Packer Test attempted (17-40') packer did not seat – no results
	38											
				–	67							
	40											

PROJECT MONTANORE		JOB NO. 5029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME. COLOR. CONSISTENCY. GRAIN SIZE. PLASTICITY. CLASSIFICATION. WEATHERING. HARDNESS. STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			RUN	14					CLAYEY GRAVEL with SAND (GC) and COBBLES greenish to orangish brn. ~40% lt.gr. Siltite cobbles + coarse gravel. Scattered dk grey cobbles also ~60% fine gravel to clay matrix, mod. soft.		
				C	15							
				–	100							
	42			RUN	15							
				D	23							
				C	19							
	44			–	76							
				RUN	16							
				D	50							Drill Rate ~0.11 ft/min
				C	21							
	46					Box 4						
	48			–	48							
				RUN	17							
	50			D	50					CLAYEY SAND (SC) orange-brown w/some brn-orange, ~55% fine to coarse sd, ~45% clay med. plast. Some coarse to fine gravel, faintly bedded.		
				C	41							
	52									COBBLES and CLAYEY SAND (SC) Clysand matrix, as above, w/ ~60% cobbles, some gravel		
				–	92							
	54			RUN	18							
				D	32							
				C	28							
	56			–	93					some oxide-coated, fractured cobble surfaces. Other fractures are healed.		
				RUN	19					SDY CLY SILT Siltst clasts in silt matrix		
	58			D	33							
				C	21							Packer Test 1 (Falling Head) 45± to 61±
						Box 5						
	60			–	64							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			RUN 20						CLAYEY SAND with GRAVEL (SC) and COBBLES, similar to above. some clasts w/ oxide coating		
				C 1º								
				– 71								
	62			RUN 21						some soft, lt grey to white SLT/CLAY clasts – sand to gravel size (decomposed clasts?)		Drill Rate ~ 0.12 ft/min
				D 2º								
				C 2º								
				– 87								
	64			RUN 22								
				D 4º								
				C 2º								
	66									CLAYEY GRAVEL with SAND (GC) and COBBLES, orangish to yellowish brown, ~60% rounded gravel, ~40% clay to sd (weathered Ss matrix), mod. soft to mod. hard. Some black oxide staining on clasts + in matrix. hard		
				– 68								
	68			RUN 23								
				D 3º								
				C 3º								
	70											
				– 100								
				RUN 24								8/9/90 2m water level 1º above GL
	72			D 3º		BOX 6						
				C 2º						Some slickensides		
				– 77								
	74			RUN 25								
				D 1º								
				C 3º								
	76											
				– 80								
	78			RUN 26								
				D 2º								
				C 2º								
	80			– 100								

PROJECT MONTAMORE			JOB NO. 8025	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	80			RUN	27					CLAYEY GRAVEL (GC) with SAND and COBBLES, as above.		Falling head packer test attempted (66-84') Packer didn't seat - Tight hole. - All added water flowed out of casing
				D	4e							
	82			C	2e							
						Box 7						
				-	65							
	84			RUN	28							
				D	2e							
				C	2e							
				-	100							
	86			RUN	29							Drill Rate ~0.22 ft/min
				D	3e							
				C	2e							
	88											
				-	73							
				RUN	30					hard matrix		
	90			D	4e							
				C	3e					sl. soft to sl. firm		
	92									- slickensides		
				-	69							
	94			RUN	31	Box 8						* Almost no core recovery - mislatched core barrel caused core loss.
				D	5e							
				(C	1e)							
	96											Packer tests attempted at 78-99' + 58-99'. Packer didn't seat. No results
	98											8/9/90 pm Water at GL (0')
				-	*20					dk orange brown		8/14/90 am Water 1' above GL.
				RUN	32							8/15/90 Water level ~0' above GL
	100			-	80							

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	100			RUN	33					CLAYEY GRAVEL with SAND to CLAYEY SAND with GRAVEL (GC/SC) and COBBLES, orangish to greenish brown, mod soft to dense, 20-60% rounded to well rounded, oxide-coated gravel, some slickensides. Scattered gravel clasts are weathered to silt/clay. Ss matrix is partially weathered to clay/silt.		Drill Rate ~0.16 ft/min
				D	4[e]							
				C	3[z]							
	102											
				-	93		H.B. "					
	104			RUN	34							
				D	2[s]							
				C	2[s]							
	106			-	100							
				RUN	35	9						
				D	3[e]	Box						
	108			C	2[z]							
				-	90							
	110			RUN	36							
				D	3[e]							
				C	2[s]							
	112											
				-	66							
	114			RUN	37							
				D	3[z]					} sandy (coarse)		
				C	2[z]							
	116											
				-	62							
				RUN	38							
	118			D	3[e]							
				C	2[z]							
				-	73							
	120											

PROJECT MONTAINORE		JOB NO. 8029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION / DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES / CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box #	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	120			RUN	59					CLAYEY GRAVEL with SAND to CLAYEY SAND with GRAVEL (GC/SC) and COBBLES.		
				D	3°							
				C	2°							
	122									as above, orangish-greenish brown, with consolidated/lithified intervals.		Hole left overnight w/ packer in. Water above GL.
				–	93							8/15/90
				RUN	40							
	124			–	100							8/16/90 Water at GL w/ small amount of flow (casing is no longer sealed at surface)
				RUN	41							
				D	3°					hard, lithified		
				C	3°	Box 10						
	126									mod. loose		Drill Rate ~0.12 ft/min
				–	94							
	128			RUN	42							
				D	5°					Occasional fractures in "matrix" are coated w/ black oxide +/or slickensided.		
				C	4°		HB					
	130									continues to be hard to mod. hard, ~lithified matrix.		
	132			–	94	Box 11						
				RUN	43							barrel clogged up
				–	100		mB					
				RUN	44							
	134			D	3°							
				C	3°							
	136			74	86							
				RUN	45							
	138			D	3°							
				C	2°		HB					
	140			–	72							

PROJECT MONTANORE		JOB NO. E029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION -
LOCATION	ELEVATION / DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES / CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	BPT/RQD	RECOVERY	Box #	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	140			RUN	46							
				D	3.3					CLAYEY GRAVEL (GC) with SAND and COBBLES.		
	142			C	3.3					orangish to greenish brown,		
						Box 12	mB			as above, but sl. hard / sl. dense matrix (more weathered?)		
				-	89					Core comes fairly whole, but crumbles more easily when removed from core sleeve.		
	144			RUN	47					Scattered gravel clasts weathered to silt/clay.		
				D	1.5							
				C	3.1							
	146									~20-30% cobbles (mostly Siltst)		
										~30-40% fine to coarse gravel		
	148			-	69					~30-40% sand, silt, clay		
										Fractures in matrix or along cobbles often have org-brn clay coating, thin black oxide coating +/or slickensides.		
				RUN	48							
				C	1.5							
	150			-	100							
				RUN	49							core barrel clogged.
				-	100							
				RUN	50							Packer Test 3 (126-154.2)
				D	3.1							
	152			C	2.8							
						Box 13						
				-	85							
	154											8/16/90 Water level 0.1 above GL
				RUN	51					hard		8/17/90 Water level 1.0 above GL w/ small amount of flow from outside of casing.
				-	100							
	156			RUN	52							
				D	2.6							
				C	2.3							
				-	88					v. soft, weathered (incl several lg. gravel clasts)		
	158			RUN	53							
				D	3.8					sl soft silt/weathered Ss cobble		
	160			C	2.5							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	160									Clayey gravel (GC) with sand and cobbles, as above.		
				–	66							
	162			RUN	54					Clayey gravel (GC) N. loose, w/ some weathered clasts ~50% med-lg well-rounded to sub-angular gravel		
				D	2							
				C	2							
				–	95					~25-35% fine gravel to fine sand		
	164									~15-25% silt/clay (high plast.)		
				RUN	55	Box 14				dk brn bedded ss cobble		
				D	2					org-brn meta-ss cobble		Drill Rate ~0.13 ft/min
				C	1							
	166			–	75							
				RUN	56					Clayey gravel (GC) similar to 162-164, but gravel is small + rounded		
				D	2							
				C	1							
	168			–	82							
				RUN	57							
				D	1							
				C	1					Sand/Silt/Clay is slightly dense to dense (similar to previous page).		
	170			–	100							
				RUN	58							
				D	4							
				C	2							
	172											
				–	73	Box 15						
	174			RUN	59							
				D	3					hard, ~lithified congl.		
				C	2							
	176											
				–	58							
	178			RUN	60							Core is disturbed + somewhat washed out. Corrected below w/ a little bentonite.
				D	3							
				C	1							
	180			–	50							

PROJECT MONTANORE		JOB NO. 5029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION / DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES / CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY		DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	180									Clayey gravel (GC) with sand and cobbles, as above.		Packer Test 4 (156' to 164')
				RUN	61							
				D	1?							
				C	1?							
	182			—	100							
				RUN	62							
				C	1?							
	184			—	66							
				RUN	63							Added bentonite to polymer drilling fluid to keep hole open.
				D	3?							
				C	2?							
	186			—	97							Core is not washed out or disturbed as above
				RUN	64							
	188			D	5?					purplish brn Slite cobble		
				C	4?	Box 16						
	190									yellowish tan Slite cobble		
				—	98							
	192			RUN	65							Drill Rate ~0.12 ft/min
				D	2?							
				C	2?							
	194			—	100							8/17/90
				RUN	66							8/18/90 Water flowing from casing at 1' above GL (~0.1 gal/min)
				C	1?							
				—	92							
	196			RUN	67							
				D	2?							
				C	1?							
				—	85							
	198			RUN	68							
				D	2?							
				C	2?	Box 17						
							AB	—		bluish-greenish black cobble, weathered, w/ pyrite crystals.		
	200			—	100							

PROJECT	MONTANORE	JOB NO.	2029	HOLE NO.	DH-24
SITE		DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION		ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR		SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL		LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	200			RUN	69					Clayey gravel (GC) with sand and cobbles, as above.		
				D	4º							
				C	2º							
	202									sl. weathered congl, hard.		
				-	73							
	204			RUN	70					white Qtzite cobble		Drill Rate ~0.11 ft/min
				D	23							
				C	23							
	206			-	100					SANDY SILTY CLAY (CL) brown, high plast, massive, abundant silt-size mica flakes, sl. soft-sl. firm.		top of Run 71 is washed out, but intact portions of brn silty clay remain.
				RUN	71							
				D	28							
				C	18					congl. cobble (?)		
	208			-	64	Box 18				CLAYEY GRAVEL (GC) with SAND and COBBLES, similar to above, Org-brown, hard (lithified) to sl. loose (weathered), Fractures w/in matrix + along cobbles/gravel have black oxide coating, few to some slickensides.		
				RUN	72							
	210			D	3º							
				C	5º							
				-	100							
	212									Qtz cobble		
				RUN	73					~20% cobbles		
				D	27					~40% subrounded to rounded gravel		
				C	2º					~10-20% fine to coarse sand.		
	214			-	74					~20-30% high plast. silt/clay.		
				RUN	74							
	216			D	32							
				C	32		HB					
	218			-	64	Box 19	HB					
				RUN	75							
				D	31					some brown SDY SLTY CLAY matrix		
	220			C	26							

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	220			–	84					some brown SDY SLTY CLAY matrix		Packer Test 5 (186' to 224')
	222			RUN D C	76 2.5 2.5					CLAYEY GRAVEL (GC) with SAND and COBBLES, as above sl dense/firm to hard, some slickensided surfaces. Little black oxide coating.		
	224			–	100							
				RUN D C	77 3.0 2.7					brn-grey bedded Sltst cobble		
	226			–	90							8/18/90
				RUN D C	78 3.2 2.4	Box 20						8/19/90 Small water flow (~0.1 gal/min) from top of casing (1' above GL)
	228											
	230			–	73					grey + brown, massive SLTY CLAY (CL)		
				RUN D C	79 3.0 2.3					dk grn-grey Sltst		
	232			–	73							
				RUN D C	80 1.7 1.5					med brn SLTY CLAY		
	234			–	88							
				RUN D C	81 3.0 2.8					hard		
	236									Qtzite boulder w/ banded rust stains		
				–	93							
	238			RUN D C	82 2.8 2.8					hard		
	240											

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	BPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	240			-	100					hard, but parts along oxide-coated slickensided fractures		
				RW	83		HB	-		Qtzite boulder		
	242			D C	3" 3"					Qtzite boulder		
				-	100		bed	45°		purplish brown Sltite cobble		
	244			RW	84					Sltite cobble w/ Sd/Slt-filled fractures.		
				D C	5" 4"			55°		purplish brown Sltite boulder w/ some Qtz-healed fractures		
	246									varved Sltite boulder		
							HB	-				
	248			-	98	BOX 22		45°		orange brown Metasedimentary boulder hard but crumbly towards base. Bedding 1/16-2" thick. 'Flowy' structure.		
				RW	85							
	250			D C	5" 5"					as below, but org-brn as above		
	252			LP	1"		HB HB	-		SILTY SAND to CLAYEY SILT (SM/ML) lt. greenish tan, dense/hard, faintly bedded, few org-brn oxide coated layers, varved at base.		
							bed	5-10°				
				91	100					SILTY CLAY (CL) lt. grn-tan, high plast., v. firm to hard, varved		
	254			RW	86							
										Coral as below, but lt. grn-grey as above		
	256			D C	5" 4"		HB	-		sand to silt		
										Clayey gravel with sand (GC), as below		
	258			-	96	BOX 23	HB	-		grey-blue Qtzite		
				RW	87					hard, dark orange-brn staining		
	260											

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	260			D C	3.5 2.7		4B			COBBLES in CLAYEY GRAVEL (GC) w/ SAND, orange-brown - dk brn Ss cobble		
	262			–	77					- brn SLTY CLAY		Packer Test 6 (226 - 264')
				RUN D C	88 1.9 1.9							
	264			–	100					- org-brn stained Qtzite w/ few fractures parallel + perpend. to old bedding planes		
				RUN D C	89 4.3 3.3					blue-black cobble (Serpentinite?) some slickensides, firm		
	266									- Qtzite w/ banded org-brn staining		
	268			–	81	Box 24				- some mod soft, brn clay/weathered sltst (weathered cobble?)		
				RUN D C	90 2.5 2.5					- brn Ss cobble		
	270			–	100					- Qtzite cobble w/ 2 fracture sets w/ some oxide coating + thin clay filling		
				RUN D C	91 3.3 2.6					- Qtzite cobble		Drill Rate ~0.15 ft/min
	272									- dk grey sltite/Argil. cobble		
	274			–	81		4B			- Qtzite cobble		8/14/90 Small water flow (~0.1 gal/min) from 1.4 ft
				RUN D C –	92 1.6 1.3 81					- Meta-Ss/Qtzite cobble		8/20/90 Water level - same Drill rate ~0.05 ft/min (slow due to Qtzite)
	276			–	40		MB			- Qtzite boulder w/ banded staining		
				RUN D C	94 5.0 5.0					hard		Changed to a softer bit. Core now coming directly from core barrel rather than the split sleeve. ∴ more disturbed.
	278					Box 25				sl to mod hard		
	280			–	100							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION / DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES / CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	250											
				RUN	95							
	252			D	24							
				C	21							
				–	100					CLAYEY SANDY GRAVEL (GC) with COBBLES, similar to above. Orange-brown, mod. soft to hard/dense, core varies from crumbling easily to being broken only by hammer. Some slickensided surfaces w/ a little oxide staining. Most fractures/breaks occur along cobble edges, but some are w/in matrix.		Hole starting to make water
	264			RUN	96							
				D	1°							
				C	3"							
	286											
				–	93							Packer Test 7 (264-294')
				RUN	97	Box 26						
	288			D	3"							
				C	3"							Packer Test 8 (274-294')
	290											
				–	100							
				RUN	98							
	292			D	3"							Artesian flow ~2 gal/min.
				C	3"					v. firm		8/20/90 Artesian flow from 6" above GL
	294			–	100							
				RUN	99							8/21/90 Artesian flow from 6" above GL (5.9 gal/min)
				D	5"							
	296			C	4"	Box 27				- blue-black serpentinite cobble		
										- siltite boulder		
	298									↓ hard		Drill Rate ~0.17 ft/sec
				–	90							
				RUN	100							
	300											

PROJECT MONTANORE		JOB NO. E029	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	300			D C	5 5					↓ Same fractures + clasts w/ mod'ly heavy black oxide coating		
										- fracture w/ 1/8" dk brn-black mod hard to sl soft filling (organic?)		
	302											
	304			-	100					SANDY CLAYEY GRAVEL (GC) with COBBLES and BOULDERS, firm, matrix is ~40% fine to coarse sand, ~60% clay (weathered Ss) mod. plast.		
				RUN	101							
				D C	3 2							
	306			-	88	Box 28						
				RUN	102							
	308			D C	5 5							
										- org-brn bedded Sltite cobble (from Wallace Fm)		
	310											
										- gr Siltst boulder		
	312			-	100					bedded Sltite cobble (Wallace Fm)		
				RUN	103							
				D C	5 5							
	314									- Sltst boulder w/ several fractures (both open + closed)		
	316					Box 29				- dk org-brn Sltite/argillite boulder (Wallace Fm) w/ abundant flow banding sl. soft, crumbly		
				-	100							
				RUN	104							Drill Rate 0.16 ft/min.
	318			D C	5 5					- meta-Ss boulder w/ few open fractures w/ oxide staining + few closed fractures		
	320											

PROJECT MONTANORE			JOB NO. 8079	HOLE NO. DH-24
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	320									Siltite boulder (1' long)		
	322			—	100					Clayey gravel (GC), as above		
				RW	105							
				D	5"							
	324			C	5"					TOP OF BEDROCK		
							MB			slickensided contact w/ talc		Packer Test 9 (296' - 336') note: reverse flow of 36 gal/min thru gage at 0 psi. 5 gal/min flowed out of casing (above packer) Equilibrium ≈ 10 psi
						Box 30	bed.	30°		Siltite, yellowish to orangish tan, hard, sl-mod. weathered,		
	326						HB					
				100	100		HB					
				RW	106							Drill Rate ~ 0.13 ft/min
	328											
				D	3"					broken zone, mod'ly clayey some black oxide coating		
				C	3"							
	330									Siltite/argillite, greenish + pinkish tan, interbedded, abundant flow banding, sl. weathered.		
				87	100							Packer Test 10 (313' - 336') note: artesian below packer
				RW	107							
	332			D	5"							Packer Test 11 (326' - 336') note: no reverse flow thru gage when 0 psi.
				C	1"	Box 31				orange + black oxide staining		
	334											
				90	96					Siltite, orange-brown, mod. to highly weathered.		
	336											
										TD 336'		Both piezometers have artesian flow
										Piezometer installation. 20-ft slots 306-326' bentonite seal ~ 282-~284' } lower		
										bentonite seal ~ 19-25' 10-ft slots 7-17' cement surface - 5' } upper		

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-25

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LITTLE CHERRY	8/6 - 8/8/90	HQ	VERTICAL

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
STARTER DAM - RT. ABUTMENT	3487.3	20'	98.4' (?)

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
J.D. WELSH (S. Corn - Driller)		10	113.0'

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
ACKER AD-11	E. RENNAT	JF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									SILT (ML) Lt brn w/ tree roots		Dense fir trees
												Recirculating w/ ~1:100 polymer drilling fluid ("Clean Mud") in water
	2		5" OD									
										- transition to clay (CL/CH)		- Reddish drill water return
	4											
				RUN 1								RUN 1 Rocks jammed up bit ∴ no recovery
	6			D 35								
				C 02								
				CL 33								
	8			- 6								
				RUN 2						Red-orange CLAY (CL/CH) w/ subangular GRAVEL		
				D 45								
	10			C 36		BOX 1				- v. weathered; most pieces break w/ finger pressure		
										- ~30% gravel; $D_{50} \approx 1/2"$		
	12									- mat'l is hard; can be regarded as partially lithified		Pocket penetrometer: > 5 tsf
				- 79								
				RUN 3						← 3" cobble		
	14			D 50								
				C 39								
				CL 29								
	16											
				- 60								
	18			RUN 4								
				D 50								
				C 25								
	20											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-25

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			(RUN 4)		BOX 1				(ct'd) Orange-red CLAY w/ v. weathered subangular GRAVEL		
				CL	25					- Gravel pieces are blending into clay/silt matrix		
	22									- hard, coherent		
				-	50							
				RUN 5								
				D	50							
	24			C	46					- less red coloring w/ depth		
												Packer Test 1 (24° - 43°)
	26					BOX 2						0 gpm at 20 psi
	28			-	92							
				RUN 6								
				D	50							
				C	1							Drill Rate 0.8 ft/min
	30			CL	39							
	32											
				-	22							
				RUN 7								
	34			D	50							
				C	45							Drill Rate 1.5 ft/min
	36											
	38			-	90	BOX 3						
		SPT 1		12								SPT #1
				16								12-16-20
				20								
	40			RUN 8								

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

SHEET 2 OF 6 HOLE NO. DH-25

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-25

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			(RUN 8) D 5° C 4°						(ctd) Orange-red CLAY (CL) w/ v. weathered gravel, trace sand		
	42			- 80		Box 3				- more competent gravel pieces w/ depth		
				RUN 9 D 5° C 2¹								
	44											Drill Rate 0.6 ft/min
				CL 2¹								
	46											
	48			- 58								
				RUN 10 D 5° C 4⁶								
	50									gravel is hard & competent - occasional cobble-size pieces - mostly sub-rounded ~ siltite & quartzite		
	52					Box 4				~8" lt gray fine meta-SS weathered; crumbles in hand		
				- 92								
				RUN 11 D 5° C 5°						more gravels: ~50% sand ~10%		PACKER TEST 2 (48° - 68°) 0.04 gpm at 20 psi
	54											
	56											
	58			- 100								
				RUN 12		Box 5				Sharp Contact 59° → 61¹ Pink & white (CL/CH) hard clay - weathered igneous(?) boulder		
	60											

PROJECT		JOB NO.	HOLE NO.
MONTANORE		8029	DH-25
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION / DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES / CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			RUN 12						59.0 → 61? hard pink & white CLAY (weathered igneous(?) boulder) - cracks while drying		
				D 5.0								
				C 5.0		BOX 5						
	62									(ctd) weathered orange CLAY (CL) w/ GRAVEL & SAND - subangular to angular - most gravel 1/4" - 1/2" diam. ~ 50% clay ? silt? ~ 40% gravel ~ 10% sand - med → cse		
				- 100								
				RUN 13								
	64			D 5.0								
				C 5.0								
	66											
	68			- 100								
				RUN 14								
				D 5.0								
				C 4.8								
	70											
						BOX 6						
	72											Drill Rate 0.92 ft/min
				- 96								
				RUN 15								
	74			D 5.0								
				C 5.0								
	76											
						BOX 7						
	78			- 100								
		SPT 2		8								SPT #2
				14								8 - 14 - 21
				21								
	80			RUN 16								

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-25

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	80			RUN 16						(ctd) GRAVELLY CLAY (CL)		
				D 5°								
				C 5°								
	82					Box 7						
					100							
				RUN 17								
				D 5°								
	84			C 4°						dark brown		Run 17 pushed out of barrel w/o sleeve - all pieces are not necessarily in the right order.
								MB				
	86											PACKER TEST 3 (68° - 88°) 0.3 gpm at 10 psi
					94							
	88			RUN 18								
				D 5°								
				C 4°								
	90					Box 8						
	92				98							
				RUN 19								
				D 5°								
	94			C 5°								
	96											
	98				100					BEDROCK (?) (V. Approx.)		NOTE: "Bedrock" is not typical of the rock units underlying the area (eg. siltites) Although possessing rock-like qualities, this material is partially lithified overburden.
				RUN 20		Box 9				V. Weathered SEDIMENTARY BRECCIA orange clayey - clasts often blending into matrix		
	100											

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

SHEET 5 OF 6 | HOLE NO. DH-25

PROJECT		JOB NO.	HOLE NO.
MONTANORE		8029	DH-25
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION / DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES / CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	100			(RUN 20) D 5.0 C 5.0		BOX 9				(ct'd) SEDIMENTARY BRECCIA - weathered, orange color - clayey		Packer Test 4 (88' to 108') 0 gpm at 20 psi
	102			- 100								
				RUN 21 D 5.0 C 5.0								~100% Water Return
	104									2" dk. brown zone		Drill Rate 0.58 ft/min
	106											
	108			- 100								
				RUN 22 D 5.0 C 4.2		BOX 10						
	110											
	112									slickensides		
				- 84						113' BOH		
	114											Install Piezometer: - 20' #20 Sched. 80 PVC Screen (on bottom)
	116											- sand brought up to 47.5' BGL - 3' Bentonite plug
	118											- random fill to surface
	120											

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 1 OF 1 HOLE NO. DH-25

PROJECT Montanore			JOB NO. 8029	HOLE NO. DH-26
SITE Little Cherry Creek	DATE - STARTED FINISHED 8/1/90 – 8/4/90		HOLE SIZE HQ	ORIENTATION V
LOCATION main dam - center, downstream toe	ELEVATION 3389±	DEPTH TO WATER artesian on 9/26/90	DEPTH TO ROCK 131.6 (?)	
DRILLING CONTRACTOR JD Welsh	SAMPLES 1	CORE BOXES 11	DEPTH OF HOLE 145.0	
DRILL MAKE - MODEL Acker AD-II	LOGGED BY CF Slater		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE, TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									CLY SDY SILT (ML) orange-brn, damp [organic soil +/or fill]		Advanced surface casing
	2											
	4											Drilling fluid: clean water
	6			RUN 1 D 5e C 2e						GRAVELLY SANDY LEAN CLAY to CLAYEY GRAVEL with SAND (CL/GC) orangish tan, moist, mod. firm, gradational layers avg 8", scattered cobbles.		HQ coring w/water (no additives)
	8											Drill rate ~0.3 ft/min
				–	56							
	10			RUN 2 D 3e C 0e						predominantly SDY CLY GRAVEL (GC) gravel avg. 1¼", dense		
	12			–	26	Box						Core barrel clogged
	14			RUN 3 D 1 in C 1 in –	80							
		SPT-1		50	100							Split-spoon sample 50 blows/5"
	16			RUN 4 –	100							
	18			Run 5 D 3e C 2e						CLAYEY GRAVEL with SAND (GC) moist, some cobbles, subangular to subrounded gravel (50-75%)		
				–	87							
	20											

PROJECT Montanore			JOB NO. 5029	HOLE NO. DH-26
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			RUN 6								note: in some intervals the clayey matrix washes out, especially at the top of cores
				C	2°					- cobble (gr Ss)		
				-	100					- cobble (gr Qtzite)		
	22			RUN 7								
				D	3s					- cobble (gr Ss)		~0.3 ft/min
				C	2s							
	24											
				-	60					- cobble (gr Ss)		
	26			RUN 8		Box 2						
				D	2°					SDY CLY GRAVEL (GC) with COBBLES orange brown matrix, stmod firm		
				C	1s							
					85							
	28			RUN 9								
				D	3°							
				C	2s							
	30			-	93					- fractured boulder w/ gravel-filled fracture		
				RUN 10								
				D	3°					flat cobbles interbedded w/clayey layers		Packer test #1 (17° to 33s) poor seal / no results
				C	2s							
	32			-	77							8/1/90 pm wtr level 2s below GL
	34			RUN 11								5/2/90 wtr level 2s below GL
				D	2°							
				C	2°					cobbles w/ both healed + open fractures		
				-	100							Continue taking short cores due to clogging
	36			RUN 12		Box 3						
				D	4s							
				C	2s					"		
	38									"		Packer test 2 (23-40')
										"		
				-	58					orange-brn, soft CLAY matrix		had difficulty getting core out due to jammed pin
	40											

PROJECT Montignore			JOB NO. 5029	HOLE NO. DH-26
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY		DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			Run	13							
				D	3.5							
				C	2.3							
	42											
				–	66							
	44			Run	14					CLY SDY GRAVEL (GC) w/COBBLES, orangish-greenish brown matrix, st. to mod. firm 50-75% sm. to lg gravel + cobbles		Drill rate ~0.3 ft/min
				D	2.0							
				C	1.3							
				–	60							
	46			Run	15							
				D	2.0							
				C	1.9							
				–	95							
	48			Run	16							
				D	5.0							
				C	2.3							
	50						bd. in clasts	30°		mod. soft, brown Ss/Siltst cobbles (?)		
	52			–	58							
				Run	17	4				SILTY GRAVELLY CLAY, orange-brown + brn-grey, faintly bedded, firm. Gravelly lean clay (CL).		driller was sidetracked + overdrilled core
				D	7.5							
	54			C	4.3	Box	bd.	20°		SDY SLTY CLAY (CL) orangish-brn to tan, bedded to ½" -mod. hard, damp.		
										SLTY to GRAVELLY CLAY (CL) orangish brn, moist, med. plast., firm.		
	56											
										GRAV'LY SLTY CLAY to SLTY CLY GRAVEL (GC/CL) interbedded, orange- to greenish brown, sl. firm.		Packer test 3 (39-60°)
	58											
				–	63							
	60									– Qtzite cobble		

PROJECT Montanore			JOB NO. 3029	HOLE NO. DH-76
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60	SPT 2		5 50	50					as above		Split-spoon sample refusal 50 blows/6"
				RUN	18					SANDY to GRAVELLY SILTY CLAY (CL) orange-brown to tan, firm, med-plast, moist, interbedded 6-12" thick.		
	62			D	4°							
				C	3°							
							bed.	25°				
	64											
				–	90							
				Run	19					SDY CLY GRAVEL (GC) w/ few COBBLES orangish to greenish brown, mod. loose. ~40-55% sm. to lg. gravel, 10-20% sand, 30-40% clay+silt.		
	66			D	3°							
				C	2°							core barrel grinding
				–	83	Box 5						
	68			Run	20							
				D	5°							core barrel is grinding
				C	2°							
	70									- cobble (lt gr. Siltst) fractured w/some dk brn stain		
	72			–	46					SANDY CLAY with GRAVEL (CL) orange-tan.		
				RUN	21							
	74			D	2°							
				C	2°							
				–	100					CLAYEY GRAVEL with SAND (GC) w/ few cobbles+boulders. Orange-brn matrix, firm to sl. firm. Rounded to subangular gravel.		
				RUN	22							
	76			D	3°							
				C	3°							
				–	100							8/2/90 pm water level C° below GL
	78			RUN	23	Box 6						8/3/90 am water level at GL but not flowing out of casing (1° above GL)
				D	4°							
				C	2°							
	80											

PROJECT Montanore			JOB NO. E029	HOLE NO. DH-26
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	80									CLY SDY GRAVEL (~as above), mod'ly loose, subangular grav.		
				-	73							
	82			RUN	24							Drill rate ~0.2 ft/min
				D	32							
				C	26							
	84											
				-	74					GRAV'LY SDY CLAY to GRAV'LY CLY SAND (CL-SC) Orange brown, dense/firm, damp, scattered subrounded gravel to 2".	
	86			RUN	25							
				D	32							
				C	32							
	88			-	100					GRAVELLY CLAY with SAND to CLAYEY GRAVEL with SAND (CL/GC) w/ COBBLES Orange brown, sl. to mod. firm.		
				RUN	26							
				D	52							
	90			C	22							
						Box #7						
	92			-	50							
	94			RUN	27							
				D	42							
				C	22							
	96											While setting up packer test water was flowing ~0.7 gal/min from 3' above GL. Packer test 4 attempted Leaking - no results (78-98')
				-	49							
	98			RUN	28					grey siltst/ss cobbles in sandy clay matrix with gravel to 1".		Clear Mud (polymer drilling fluid) added to drill water
				D	35							
				C	35							
	100											

PROJECT Montanore		JOB NO. 5029	HOLE NO. DH-26
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME. COLOR. CONSISTENCY. GRAIN SIZE. PLASTICITY. CLASSIFICATION. WEATHERING. HARDNESS. STRUCTURE	WATER DATA	REMARKS SAMPLING DRILL ACTION WATER LOSS CORE LOSS STANDARD PENETRATION WATER PRESSURE TEST LAB CLASSIFICATION PIEZOMETERS
	100			-	100					SLTY CLY SDY GRAVEL (GC) orange brown, mod'ly firm/ sl. dense, rounded to well rounded gravel ~40-60% subrounded gravel ~10% sand 30-50% clay + silt		~0.2 ft/min
	102			RUN D C	24 5.5 5.0	Box 8						
	104									greenish to orangish brown matrix, firm		
	106			-	100							
	108			RUN D C -	30 2.0 1.8 90					scattered cobbles (Sltite + ss)		
	110			RUN D C	31 4.0 3.4					matrix - firm to sl. soft; CLY SDY SILT (ML) brn-gr, layer or pocket 2" thick, not lithified - sl. firm		Packer Test #5 attempted (88-109') no results
	112			-	85							
	114			RUN D C	32 4.0 3.6	Box 9				firm except for scattered gr, weathered zones up to 0.2 thick		Packer test #6 attempted (~100.5 - 117.8) No results.
	116			-	90							8/3/90 pm wtr level 2.2 below GL
	118			RUN D C	33 5.0 2.7					few fractured gravel clasts with oxide coating + lightly slickensided.		8/4/90 am v. low flow from 1.5 above GL.
	120											

PROJECT Montanore		JOB NO. 8C29	HOLE NO. DH-26
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	120											
				-	54							
	122											possible top of bedrock
				RUN	34					SLTY GRAV'LY SAND (SM) greenish tan, sl. weathered, fine grav. w/ scattered coarse grav., coarse sd, firm.		
				D	5°							
				C	5°							
	124									Sltst / Ss / Concl (sltst clasts) grn-gr, interbedded, hard.		Drill rate ~0.3 ft/min.
	126									- 0± cobble(?) of congl + varved clay (or bedrock?)		
				-	100		bed	30°				
				RUN	35					CLAYEY GRAVEL with SAND (GC) (weathered congl) Coarse grav. in slty clay matrix org-brn to org tan, mod. firm + weathered, some slickensides.		
	128			D	5°							
				C	5°							
	130					Box 10						
				-	100					TOP OF BEDROCK (?)		
	132											
				RUN	36					Conglomerate Yellowish-tan, damp, ~50% sm. grav. w/ scattered lg grav. or cobbles with clay + silt. Matrix supported. Firm except for occ. soft weathered zones to 0±. Subangular to subrounded clasts. Faint bedding shown by clast orientation. Pyrite crystals within gravel clasts + matrix		
				D	5°							
				C	5°							
	134											
	136											
				100	100							
				RUN	37							
	138			D	3°	Box 11						
				C	3°							
				100	100							
	140											

PROJECT	Montanore	JOB NO.	3029	HOLE NO.	DH-26
SITE	Little Cherry Creek	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION		ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR		SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL		LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	BPT/ROD	RECOVERY	Box #	DISCONT INU-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	140			ROM	38					CONGLOMERATE, as above		Packer Test 8 (116-145')
				D	5°							
				C	5°							
	142											Packer Test 7 (134-145')
	144			100	100	Box 12						Bubbles appearing w/o packer. w/ packer at 116, sm. amt of artesian flow occurred
	146									TD 145°		Water level after installing piezometer 8/4/90 pm 1° above GL 8/5/90 am 1° above GL Piezometer installation: 26 ft sand (to 117°) 1 ft bentonite 40 ft sand (to 78°) ~2 ft bentonite (~78° - 76°) fill to surface 20 ft slotted pipe (94° to 114°) unslotted pipe to surface 4 ft casing cemented at surface, ~2½ ft above GL.

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-27

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LITTLE CHERRY	8/1 - 8/6/90	HQ	VERT.

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
MAIN DAM - TOE	3395.1	Artesian	261.5

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
J.D. WELSH (J. Petersen, S. Stuart)	1	5	274.0

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
LONGYEAR HC-150	E. RENNAT	CF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Lt. brn Sandy SILT (ML)		Formerly clear-cut area; grasses; trees to ~20' high
	2		5" OD									'Clear Mud' polymer fluid used in drilling water (~1:1000)
	4											-Water is being recirculated
	6			RUN 1 D 6.0 C 3.0						Lt brown-orange SILT (ML) w/ trace sand; firm; ~2" Diam, tree root at 5.0'		begin coring at 5'
	8	1/10/90		CL 2.0						-v. stiff		Penetrometer UCS = 225 tsf
	10	5.0-14.0		- 60						← 1" siltstone; subangular		
	12	SAMPLE		RUN 2 D 4.0 C 3.6		BOX 1				10.0'+ Gravelly SILT (ML) w/ SAND ~20% gravel (sub-angular to subrounded $D_{50} \approx$ 1/2", occ'l pieces to 2"), very dense		100% Drill Water Return
	14	SPT-1		- 90								
				17 31 46								
	16			RUN 3 D 3.5 C 3.3								hole is washing out; add 5' of casing (10' total casing)
	18									increasing gravel content w/ depth		
				- 94		BOX 2						
	20			RUN 4 D 1.0 C 0.8								

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 1 OF 14 HOLE NO. DH-27

PROJECT		JOB NO.	HOLE NO.
MONTANORE		8029	DH-27
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION / DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES / CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY CF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			RUN 5						(ct'd) SILTY GRAVEL (GM) with Cobbles (~50% G & Cobbles)		
				D 4	10							
				C 2	4					- mostly subangular; some rounded; siltstone & fine sandstone predominate; lge. pieces are lt. gray siltstone, angular		Drill Rate 0.22 ft/min
	22			CL 1	6							
				-	60							100% Water Return - lt. brn.
	24			RUN 6								
				D 4	3							
				C 3	8	Box 2						
	26											
	28			-	78							
				RUN 7								
				D 5	9							
				C 4	5							
	30											
												attempt Packer Test 1 (23°-44°); leaks past packer; no test
	32									- slight increase in gravel & cobble portion (up to 70%) w/ depth		
				-	90							
				RUN 8								
	34			D 4	7							
				C 3	5	Box 3						Packer Test 2 (32°-54°1)
	36											- ~0.1 gpm at 5 psi
												- leaks past packer at 10 psi
	38			-								
				RUN 9								
				D 3	9							
				C 3	9							
	40											

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-27
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY CF Slater	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	40					Box 3				(ctd) SILTY GRAVEL (GM) with Cobbles		
					100					~ 25% cobbles		
				RUN 10						- orange - brown sandy silt (~25%)		
	42			D 3.0						- gravel & cobbles mostly of lt. gray siltstone (sltly metamorphic); hard; rounded to angular; most large pieces are angular, many breaks along bedding; iron staining on some surfaces		
				C 2.3								
					77							
	44			RUN 11								
				D 5.0								
				C 4.3		Box 4						
	46											
										47"-49" - Sandy silt is a darker brown; oil-like		Drill Rate ~ 0.2 ft/min
	48									} 6" Siltstone/Siltite Cobble		
					86							
				RUN 12								
	50			D 2.5								
				C 2.4								
					96							
	52			RUN 13								
				D 2.5								
				C 2.4								100% Drill Water Return
					96							
	54			RUN 14								
				D 4.0								
				C 3.6								
	56					Box 5				- occ'l quartzite pieces		
					90							
	58			RUN 15								
				D 4.0						← DK brn-blk sandy silt		
				C 3.4								
	60											

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-27
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY CF Slater	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			RUN 15		BOX 5				(ct'd) GRAVEL & COBBLES w/ Sandy SILT (GM)		
										- ~20% orange-brn Sandy Silt (iron stained)		
	62			-	85					- ~80% cobbles & gravel; mostly subrounded, -lge pieces (up to 4") are mostly lt gray siltite/siltstone w/ regular joints/fractures, often along bedding		
				RUN 16								
				D	20							
				C	2							
	64			-	100							
				RUN 17								
				D	50							
				C	35							Packer Test 3 (53° - 74°) 0.05 gpm at 20 psi
	66					BOX 6						
	68											
				-	72							
				RUN 18								
	70			D	50							
				C	42							
	72									} v. poorly cemented Sandstone - crumbles in hand		
				-	84							
	74			RUN 19								
				D	50							
				C	33					SILT lens (?) core loss; v. soft (flowing) lt brn SILT (ML) w/ trace sand		- no change noted in drill rate or pressure
	76					BOX 7						
				CL	1.7							Drill Rate 0.20 ft/min
	78									GRAVEL & COBBLES w/ sandy Silt (as previously		
				-	66							
				RUN 20						← well-rounded 3" cobble		
	80											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-27

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
	ER	CF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	80			RUN 20 D 5° C 3¹						(ct'd) GRAVEL & COBBLES w/ Sandy SILT (GM)		
										~20% orange-brn Sandy Silt, some clay, indurated (breaks easily); Occ'ly gray, more sand		
	82			CL 1⁹								
						BOX 7				~80% Gravel & Cobbles; mostly subrounded		100% Drill Water Return
				- 62								
	84			RUN 21 D 5° C 2⁴						82'+ Grayer, more clayey sand-silt; often jammed tightly in core barrel		Drill Rate 0.22 ft/min
	86			CL 2⁶								
												Packer Test #4 (74°-94°) ~0.1 gpm at 40 psi
	88											
				- 48								
				RUN 22 D 5° C 3⁹								Drill Rate 0.15 ft/min
	90			CL 1¹								
	92									~91°-94° no cobbles		
	94			- 78								
				RUN 23 D 5° C 4⁹		BOX 8						
	96									~95°-98°: sltly more iron staining; core is held together by fines; resembles weak conglomerate		
	98			- 98								
				RUN 24								
	100					9						

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-27
SITE	DATE - STARTED FINISHED	HOLE SIZE HQ	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY CF Slater	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	100			RUN 24						(ct'd) GRAVEL & COBBLES w/ Sandy SILT (GM)		
				D 4 5						- as prev. page		
				C 2 9								
				CL 1 6						most pieces are lt. gray siltites (hard); occ'l pieces of lt. tan w/ brn flecks soft fine sandstone (friable)		
	102											
				- 64								
				RUN 25		BOX 9						
	104			D 3 2								
				C 3 1								
	106											Packer Test 5 (93°-114°) ~0.1 gpm at 40 psi
				- 97								
				RUN 26								
				D 5 0								
	108			C 3 0								
	110											
				- 60								
	112			RUN 27								
				D 2 3								
				C 2 1								
				- 91								
	114			RUN 28								
				D 5 0						~114 - 116 SILT Lens (?), core loss; some v. soft sandy silt (lt. brn) at top of run		~100% Drill Water return (lt. brn)
				C 2 9								
	116			CL 2 1		BOX 10						
	118											
				- 58								
				RUN 29								
	120											

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-27
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY CFSlater	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	120			RUN 29 D 5 C 3	6					COBBLES & GRAVEL w/ Sandy SILT (GM) - as previous page		Packer Test 6 (116° – 134°) 0.10 gpm at 40 psi
	122			CL	14	BOX 10						
	124				72							
				RUN 30 D 2 C 2								
	126				92							Drill Rate: 0.21 ft/min
				RUN 31 D 3 C 3								
	128				97							
	130			RUN 32 D 4 C 2						6½" Lt. gray Siltite cobble		
				CL	5	BOX 11						
	132											Drill Rate 0.28 ft/min
	134				63							-135' drill "bogs down" -1' run
				RUN 33 D 1 C 1								
				RUN 34 D 4 C 3						136 - 138 mostly fine gravel size except for few 2"+ pieces silt & fine gravel indurated;		
	136											
	138				90	BOX 12						
				RUN 35								
	140											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-27

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY CF Slater	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	140			(RUN 35) D 5.0 C 4.6						9" siltite/SS cobble		
										(ctd) COBBLES & GRAVEL w/ Sandy SILT (GM) - as prev. pages		
	142					BOX 12						~100% Drill Water return
										8" siltite/SS cobble		
	144			- 92 RUN 36 D 3.5 C 3.2						- silt is clayey, indurated		Packer Test 7 (132.0 - 154.0) 0.10 gpm at 40 psi
	146											
	148			- 91 RUN 37 D 4.0 C 3.6								Drill Rate 0.22 ft/min
	150											
	152			- 90 RUN 38 D 2.5 C 2.5		BOX 13						
	154			- 100 RUN 39 D 5.0 C 2.1						~154-156 washed out no fines; mostly fine gravel (subangular to subrounded)		
	156			CL 2.1								
	158			- 58 RUN 40		BOX 14						
	160											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-27

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
	ER	CFSlater

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	160			(RUN 40)						(ctd) COBBLES & GRAVEL w/ Sandy SILT (GM) - as prev. pages		
				D 5°								
				C 3°								Drill Rate 0.18 ft/min
	162			CL 1'		BOX 14						
				- 78								
	164			RUN 41						9" siltite/ss cobble		
				D 5°								
				C 3°								Packer Test 8 (152° - 174°) 0.20 gpm at 20 psi
	166											
				- 86								
	168			RUN 42								
				D 5°								
				C 2°								
												~100% Water Return
	170			CL 2°								
	172			- 50								
				RUN 43								
				D 1°								
				C 1°								
	174			- 100		BOX 15						
				RUN 44								
				D 4°								
				C 3°								
	176											
				- 80								
	178			RUN 45								
				D 5°								Drill Rate 0.24 ft/min
				C 2°								
	180			CL 2°								

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-27
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	180			(RUN 45)		BOX 15				(ct'd) COBBLES & GRAVEL w/ silty SAND (GM) - as prev. pages		
	182			- 54								
				RUN 46								
	184			D 48								Drill Rate 0.22 ft/min
				C 46								
	186											
				- 96		BOX 16						
	188			RUN 47								
				D 50								
				C 52								
	190											
	192											
				- 100						- sm. gravel w/ scattered lg grav., subangular, ~ horiz. bedding		
				RUN 48								
				D 38								
	194			C 38						- Siltite cobble w/ oxide-coated fractures		Packer Test 9 attempted (174± - 196±) no results
						BOX 17				- lg subrounded gravel/congl partially weathered		
	196			- 100						- Sltst cobble w/ oxide-coated fracture (soft - disintegrating)		8/4/90
				RUN 49								8/5/90
				D 32						- Siltite cobble		
	198			C 29						mod. firm to mod soft		
												Drill Rate 0.19 ft/min.
	200			- 83								

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 10 OF 14 HOLE NO. DH-27

PROJECT MONTANORE			JOB NO. F029	HOLE NO. DH-27
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	200			RUN	50							
				D	32							
				C	39							Drill Rate ~0.16 ft/sec
	202											
	204			–	100					banded siltst/ss cobble		
				RUN	51					siltst cobble		
				D	32					Congl.		
				C	28							
	206					Box 18				SANDY SILTY CLAY (CL)		
				–	93					tan w/org stain, mod soft to mod hard, fine to coarse sd, faintly bedded. scattered lg. gravel. (weathered siltst/ss)		
				RUN	52							
	208			D	42					CLAYEY GRAVEL with SAND (GC)		
				C	32					Sm-lg gravel/cobbles (siltst+ss) in coarse ss matrix (org-to grn-brn) mod'ly firm w/some intervals sl. firm. Cobbles easily fall out of core. Partial weathering of ss matrix to clay. Grnish to bluish grey subrounded gravel. (conglomerate/cobblestone)		
	210											
				–	84							
	212			RUN	53							
				D	32							
				C	32							
	214									grey Meta-ss cobble		
				–	100							
				RUN	54					cobble - gr siltst w/orange-brn staining/streaking.		
	216			D	22							
				C	23					matrix-supported congl, hard w/few soft zones. Matrix partially weathering to clay.		
				–	100							
				RUN	55							
	218			D	30							
				C	29	Box 19						
										cobble/grn-gr siltst		
	220			–	97							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-27
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	220			RUN D C	56 4.0 3.4					Congl. as above ~45-75% sm-lg, subrounded to subangular gravel with SANDY SLTY CLAY (weathered Ss + Sltst) Clayey gravel with sand (GC)		Drill Rate ~ 0.15 ft/min
	222											
	224			-	85					Clayey gravel with sand (GC) as above, but soft, weathered matrix, congl easily falls apart, clayey, few weathered clasts.		
				RUN D C	57 3.0 2.5							Packer Test 10 (198.0 to 227.0)
	226			-	83							
	228			RUN D C	58 2.0 1.8							
				-	90	Box 20				- cobble (gr Sltst)		
	230			RUN D C	59 2.7 1.1					Congl., slightly weathered (stained) ~competent Clayey gravel with sand (GC)		
				-	41							
	232			RUN D C	60 2.3 2.3					weathered congl. - unweathered, subangular to rounded gravel in soft CLY SAND/SILT matrix Clayey gravel with sand (GC)		
	234			-	100							8/5/90 pm wtr level 3.9 below GL
				RUN D C	61 3.0 2.4					slightly weathered, competent		8/6/90 am wtr level 3.3 below GL
	236											Sm amt of artesian flow when packer was set at 234'
	238			RUN D C	62 1.5 1.3					gr Sltst cobble w/ orange streaks/stains + healed, stained fractures - fractured cobble		Core barrel clogged
				-	100							
				RUN D C	63 4.5 4.3	Box 21				becoming bouldery		
	240						HB			- metaqtzite boulder (1.8 long) few fractures w/ thin clay coating		

PROJECT	MONTANORE	JOB NO.	2029	HOLE NO.	DH-27
SITE		DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION		ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR		SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL		LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	240											~Drill Rate 0.11 ft/min.
	242									metaqtzite cobble		
				–	100		MB	–		gr Sltite boulder (1' long) w/ few fractures - healed or w/ trace of oxide or clay		
				RUN	64							
	244			D	4°					gr Sltite		
				C	1°					soft, weathered		
	246											
				–	100							losing some drill fluid
				RUN	65					lt. gr. Ss boulder (1' long)		
	248			D	5°							
				C	5°					" " "		Drill Rate ~0.14 ft/min
	250					Box 22	mostly MB			mod'ly weathered congl - core comes out ~whole, but breaks easily. Mod. firm to hard		
	252			76	100							
				RUN	66		HB	–		soft, weathered		Packer Test II (236 - 254')
				D	2°					Congl, grey (as above, but w/o orange-red stain) Matrix becoming harder. Few fractures along lg clasts, sl. weathered.		
				C	1°							
	254			SS	93							
				RUN	67							
				D	5°							
				C	5°							
						Box 23				Clayey gravel with sand (GC).		
	256									Mod'ly weathered (GC) core breaks fairly easily, some orange-brn oxide staining, few black-oxide-stained fractures.		
								60°		thin broken/broken zone		
	258											
				~45	100							
				RUN	68					becoming more darkly stained some slickensided clasts		
	260											

PROJECT MONTANORE		JOB NO. E029	HOLE NO. DH-27
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	260			D 6° C 4°						soft Clayey gravel with sand (GC) as above. soft		Drill Rate ~0.23 ft/min
										TOP OF BEDROCK		
	262						bed	55°		Metaconglomerate. Orange Brown congl. similar to above, but w/ metamorphic flow structure, mod. weathered, some irreg. slickensided surfaces (incl. along gravel surfaces).		
	264			38	83	Box 24						
				RUN	69							
				D 5° C 5°						mod. smooth fractures w/ clayey, polished/slickensided surfaces		
	266											
	268						bed	65°		becoming harder, less weathered		
				90	100							
				RUN	70					Siltite/Argillite interbedded w/ cce. gravel, hard, brn - orangish brn, sl. weathered.		
	270			D 5° C 4°			MB			fractures w/ 1/16" clay + slickensides		Packer Test 12 (258 - 274')
	272						HB			Siltite/argillite, orange, highly weathered, clayey		
						Box 25	bed	65°		Shear zone, clayey w/ planar texture, some slickensides		
	274			40	82							
										TD 274°		Water level 8/6/90 pm 23 below GL after piezometer installed 8/7/90 am 1/2 gal/min
										Piezometer installation: 20-ft slots 229 - 249° sand from ~210 - BOH bentonite seal ~208 - 210		

PROJECT: MONTANORE		JOB NO. 5029	HOLE NO. DH-28
SITE: Little Cherry Creek	DATE - STARTED FINISHED: 8/23/90 - 8/29/90	HOLE SIZE: HQ	ORIENTATION: V
LOCATION: south end, downstream toe of main dam	ELEVATION: 3449.9	DEPTH TO WATER: artesian 5/22/90	DEPTH TO ROCK: NE
DRILLING CONTRACTOR: JD Welsh	SAMPLES: 2	CORE BOXES: 30	DEPTH OF HOLE: 354.0
DRILL MAKE - MODEL: Longyear HC-150	LOGGED BY: CF Slater		REVIEWED BY:

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0											Advance surface casing to 5.0.
	2									GRAVELLY CLAY to CLAYEY GRAVEL (CL/GC) (weathered gravelly Ss) orange-tan, mod. soft to sl. firm, mod. to high plast.		
	4											
	6			RUN D C	1 3.0 0.6							HQ coring with polymer (clear mud) drilling fluid.
				–	20							
	8			RUN –	2 80							
	10			RUN D C	3 5.0 0.3							
	12					BOX 1						
				–	6							
	14			RUN D C	4 2.0 1.5							
				1	7.5					Ss weathered to SANDY CLAY (CL) with GRAVEL ~60-75% clay, ~10-25% fine to med sand, ~15% sm-med gravel, high plast.		
	16	SPT 1		18 50/5	66							Split-spoon sample refusal 50 blows/5"
				RUN D C	5 5.0 1.9							
	18											
	20											

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			-	28							
				RUN	6							Drill rate ~0.20 ft/min
	22			D	3.0							
				C	1.4					- soft (decomposed) Sltst cobble		
				-	47							
	24									SANDY CLAYEY GRAVEL (GC) orange-brn, matrix (decomposed Ss) is sl. firm to hard, high plast. ~35-45% clay, ~7-15% fine to med. sand. V. weathered. ~40-60% sm-lg, rounded to well-rounded gravel. Scatter cobbles. Some decomposed gravel clasts. Some oxide staining.		
		SPT	N	45 25/3	57							split-spoon sample refusal 25 blows/3" (no progress in last 15 blows)
				RUN	7							
	26			D	5.0							
				C	2.3							
	28											
				-	46					- Sltst cobble - lavender volcanic cobble - v. weathered sltst cobble		
				RUN	8							
	30			D	2.7							
				C	1.4							Packer Test 1 (Falling Head) (16-34')
				-	52	Box 2						
	32			RUN	9							
				D	2.3							
				C	1.2							
				-	50							8/23/90 Water level 4.3 below GL
	34			-	66							8/24/90 Water level 4.3 below GL
				RUN	11							
				D	2.2							
	36			C	2.2							
				-	100							
				RUN	12							
	38			D	5.0							
				C	3.6							
	40											

PROJECT MONTANORE		JOB NO. E029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			–	67					– lt gr Sltst cobble (partially disintegrated with both open + closed fractures		
	42			RUN D C	13 2½ 2½					– 60% small, rounded gravel matrix as above. Clayey gravel (GC) V. firm to hard		
	44			–	100					Sandy Clay w/ scattered gravel + cobbles (CL) 65 to 80% clay, 20-35% fine to coarse sand. V. firm to hard		
				RUN D C	14 5 3	BOX 3	HB	–				
	46											
	48			–	72					– cobble w/ fracture (mod. oxide coating)		
				RUN D C	15 5 3							Drill Rate ~0.14 ft/min
	50									SANDY SILTY CLAYEY GRAVEL (GC) (as on previous page.) Sl. soft to mod'ly firm matrix (core tends to part around gravel clasts). Some clasts starting to disintegrate.		
	52			–	74							
	54			RUN D C	16 5 3							
	56											
	58			–	60							
	60			RUN	17							

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			D C	5% 4%	Box 4				Clayey gravel (GC) with cobbles, as above		
										org-brn Sltite (from Wallace Fm)		
	62											
				-	80					black Sltite/Argillite cobble		
	64									lg. gravel of soft, lt. gr. Sltst w/ musc.		
				RUN	18					firm		
				D C	5% 9%					GRAVELY SANDY CLAY (CL) (v. weathered Ss), orange-brn, hard/dense. ~15-35% subrounded to angular fine gravel, ~5-15% sand, ~60-80% clay. High plast.		
	66						MB	-				
	68			-	100	Box 5				weathered clast		
				RUN	19					Clayey gravel (GC) w/ cobbles		
	70			D C	5% 3%					weathered clast		Packer Test 2 (36-74')
	72									soft, med. gr. Sltst cobble w/musc.		
				-	70							
	74			RUN	20							Drill Rate ~0.17 ft/min
				D C	5% 2%					highly weathered Sltst cobble w/ stained mica		
	76											
	78			-	54							
				RUN	21							
	80			C	2%							

PROJECT MONTANORE		JOB NO. 2029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY		DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	80			–	100					CLAYEY GRAVEL with SAND and COBBLES (GC), as above		
				RUN	22							
	82			D	3"					orange-brown, mod. firm (falls apart around lg. clasts), light to med black oxide coating on clasts, some faint slickensides		
				C	3"							
				–	100							
	84									Cobbles mostly Sltst. Few weathered clasts. High plast. matrix.		
				RUN	23							
				D	5"					~40-60% sm-lg rounded gravel		
				C	2"					~10-20% fine to med. sand		
	86									~30-45% clay		
						BOX 6						
	88			–	54							
				RUN	24							
	90			D	5"							
				C	4"							
										Gravelly clay with sand (CL)		
	92						MB	–		~20-30% sm-med gravel		
										~15-25% sand		
							HB	–		~50-60% slt/clay		
										(firm to hard)		
				–	94							
	94									Clayey gravel with sand (GC), as above.		
				RUN	25							
				D	3"					firm to med. firm		
				C	2"							
	96											
				–	77					↓ med. firm to med soft		
				RUN	26							
	98			D	1"							
				C	2"							
						BOX 7						
	100											

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	100			–	50					CLAYEY GRAVEL with SAND and COBBLES (similar to above) (GC)		8/24/90 water level >10' below GL
				RUN	27					brownish orange, med. firm to med. soft, mod. black oxide coating around clasts, some slickensides.		8/25/90 water 3± below GL
	102			D	3'					~20% lg gravel + cobbles		
				C	2'					~35-40% sm. gravel		
				–	97					~5-10% sand		
	104			RUN	28					~25-35% clay		
				D	4'							
				C	2'							
	106											
				–	65							
	108			RUN	29							
				D	3'							
	110			C	3'							
	112			–	78	Box 8						
				RUN	30							Packer Test 3 76' - 114'
	114			C	C±							
				–	60							
				RUN	31							Drill rate ~0.14 ft/min
				D	5'							
	116			C	2'							
	118			–	42							
	120			RUN	32							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-2B
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY		DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	120			D	50					CLAYEY GRAVEL with SAND (GC) and COBBLES.		
				C	37					as above (orange-brn, mod. firm, high plast. matrix.) mod-heavy oxide coating		
	122									-orange-brn bedded Siltite cobble		
				-	74							
	124			RUN	33					~15% large gravel ~30-40% small gravel ~10-20% sand ~25-40% clay		
				D	50							
				C	31							
	126											
						BOX 9						
	128									-V. weathered Slst cobble (disintegrating)		
				-	78							
										-V. weathered Siltst cobble (disintegrating)		
				RUN	34					↓ firm		
	130			D	50							
				C	43							
	132											
				-	84							
	134			RUN	35							
				D	30							
				C	26							
	136			-	87							
						BOX 10						
				RUN	36							
	138			D	40					↓ mod. firm		
				C	33							
	140											

PROJECT MONTANORE			JOB NO. 6029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	140			-	93					Becoming yellowish tan		
				RUN	37					CLAYEY GRAVEL with SAND (GC) and COBBLES, as above.		
	142			D	3e							
				C	1s							Drill Rate ~0.17 ft/min
				-	50					v. weathered Sltst cobble (disintegrating)		
	144			RUN	38							
				D	5e							
				C	4e					SANDY SILTY CLAY (CL) yellowish tan, high plast, hard, ~70-80% clay, ~10-20% silt, ~5-10% fine to med. sand. (Heavily weathered Ss + Sltst)		
	146									sl. to mod. firm		
	148			-	80					Clayey gravel with sand (GC) and cobbles, as above		
				RUN	39							
	150			D	5e							
				C	2s							Packer Test 4 (116-154')
	152					Box 11				slate cobble		
				-	50					heavily weathered gr Sltst cobble (disintegrating)		
	154			RUN	40							
				D	4e							
				C	2e							
	156											
				-	50							8/25/90 Water in rods above GL
	158			RUN	41							8/26/90 Water level 5± below GL
	160									hard		

PROJECT MONTANCRE		JOB NO. 8029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	160			D	5º					} hard, fine gravel / coarse sand		
				C	2º					} abundant black/dk brown oxide (?) coating around cobbles + in matrix.		
	162			–	58					CLAYEY GRAVEL (GC) with SAND and COBBLES (as above), yellowish tan, high plast matrix (decomposed Ss/Sltst) mod. firm to firm.		
				RUN	42							
	164			D	37							
				C	22					~brn banded Sltite cobble		
	166			–	62	Box 12				~15-20% Sltite/Ss cobbles ~40-50% sm. to lg., rounded to well-rounded gravel. ~5-10% fine to coarse sd ~25-35% clay Some Sltst clasts are decomposed. Mod. black + orange-brown staining on some clasts.		
				RUN	43							
	168			D	55							
				C	1º							
	170											
				–	80							
	172			RUN	44							
				D	2º					↓ sl. to mod. firm becoming orangish tan		
				C	2º							
				–	100							
	174			RUN	45							Drill Rate ~0.17 ft/min.
				D	5º							
				C	39							
	176											
	178			–	78							
	180			RUN	46							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	BPT/RQD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	180			D C	4" 3"	Box 13				sl. firm to firm		Drill Rate ~ 0.20 ft/min.
	182			—	78					small fracture zone w/ dk orange-brown staining + some slickensides.		
										Clayey gravel (GC) as above		
				RUN —	47 100							
	184			RUN D C	48 4" 2"					firm to hard		
	186			—	66					mod. soft, several disintegrating clasts		
	188			RUN D C	49 5" 4"					mod. firm to firm		
	190											
	192			—	88	Box 14						
												Packer Test 5 (156 - 194')
	194			RUN —	50 85					med. grained ss weathered to sdy CLAY (~55% clay, ~45% sand, med. plast.)		
				RUN —	51 61							
	196			RUN D C	52 5" 4"					heavy black + orange-brn staining mod. firm to hard		
	198											
	200			—	82					dk grey Siltite boulder		

PROJECT MONTANORE		JOB NO. 6029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	200									mod. firm		
				RUN	53					fractured cobble		
				D	37							
	202			C	37					Ss. Clayey sand (SC)		
						Box 15						
				–	100					firm.		
	204											Drill Rate ~0.22 ft/min
				RUN	54					Well-graded GRAVEL with CLAY (GW-GC)		
				D	52					Orange brown, firm		
				C	42					~60-80% sm-med subround gravel		
	206									~20-30% sand/silt/clay		
										scattered lg gravel + cobbles		
	208											
				–	96							
										sl. to mod. firm		
				RUN	55							
	210			D	50							
				C	32							
	212									heavy slickensides		
						Box 16						
				–	62							8/26/90 Water level 92 below GL
	214											
				RUN	56							8/27/90 Water level 102 below GL
				D	22							
				C	12							
	216			–								
				RUN	57							
				D	32					becoming more cobbley with more matrix		
				C	24							
	218											
				–	80					heavy red-brn oxide staining + slickensides		
				RUN	58							
	220											

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 11 OF 18 | HOLE NU-70

PROJECT	MONTANORE	JOB NO.	8029	HOLE NO.	DH-28
SITE		DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION		ELEVATION	DEPTH TO WATER	DEPTH TO ROCK	
DRILLING CONTRACTOR		SAMPLES	CORE BOXES	DEPTH OF HOLE	
DRILL MAKE - MODEL		LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	220			D C	3e 2e					heavy black oxide coating, some slickensides		
				—	83							
	222			RUN D C	59 2e 2e					CLAYEY GRAVEL with SAND (GC) and COBBLES Orange-tan to orange-brown, sl. to mod. firm, mod. black oxide coating on many clasts, some slickensides, med-high plast. matrix. ~20-30% grey siltite cobbles ~30-40% subrounded-rounded gravel ~10-20% fine to coarse sand ~20-30% clay + silt		Drill Rate ~0.11 ft/min
	224			—	100	Box 17						
				RUN D C	60 3e 2e							
	226			—	88							
	228			RUN D C	61 4e 2e					heavy black oxide coating (~1/16" thick)		
	230			—	65							
	232			RUN D C	62 2e 2e							Packer Test 6 (196-234')
	234			—	100							
				RUN D C	63 3e 2e							
	236			—	69	Box 18				Firm to hard		
	238			RUN D C	64 3e 3e							
	240											

PROJECT MONTANORE		JOB NO. 2029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB. CLASSIFICATION, PIEZOMETERS)
	240			–	100				firm to hard		
	242			RUN D C	65 27 27	bed.	~0°		Ss interbedded w/ some siltst, yel-tan, hard, faintly bedded, mod. weathered, 40-60% fine to coarse sd. 30-40% slt, 10-25% clay. Silty sand to sandy silt (SM/ML).		
	244			–	100				clayey gravel with sand (GC)		
				RUN D C	66 50 50				Siltst to Ss, tan to orange-brown, hard, faintly bedded, lt. to mod. weathered, fine sand (to med. at base. Silty sand to sandy silt (SM/ML)		
	246								Clayey gravel with sand (GC)		
	248			68	100		Box 19		heavy black oxide coating + slickensides.		
				RUN D C	67 50 40				Ss, orange-brn, hard, ~50-70% fine to coarse sd. some fine to coarse gravel. Silty sand (SM).		
	250										
	252			–	80				CLAYEY GRAVEL with SAND (GC) and COBBLES. Orange-tan, mod. firm to hard.		
	254			RUN D C	68 35 28				↓ mod. firm to firm		
	256			–	78		Box 20				
	258			RUN D C	69 35 24						
	260										

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	260			-	67				CLAYEY GRAVEL with SAND (GC) and COBBLES		
				RUN	70				Orange-tan, sl. to mod. firm, highly weathered (some disintegrating clasts), moderate black oxide staining on clasts, few slickensides, mod. to high plast. matrix.		
	262			D	48						
				C	48						
									~15-25% Sltite cobbles		
	264								~35-45% sm. to lg. rounded gravel		
									~10-15% fine to coarse sand		
									~25-30% clay		
				-	94						8/27/90 Water level 14± below GL
	266										
				RUN	71						8/28/90 Water level 12± below GL
				D	52						
				C	52						
	268								mod. firm to firm		
									Sltite cobble		
									Box 21		
	270										
				-	100						
				RUN	72						
	272			D	32	HB					Packer Test 7 (236-274')
				C	32						
						MB					
				-	100	HB					
	274										
				RUN	73				Argillite cobble		
				D	52						
				C	52						
	276										
									Box 22		
	278								soft		
				-	100						
				RUN	74						
	280										

MORRISON-KNUDSEN ENGINEERS, INC.

PROJECT MONTANCRE			JOB NO. 5029	HOLE NO. DH-78
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	280			D	5%					soft		
				C	4%					CLAYEY GRAVEL with SAND (GC) and COBBLES, as above. firm		
	282									fractured Sh/serpentinite cobble		
				—	92					qtzite cobble		Drill Rate ~0.16 ft/min
	284			RUN	75					hard		
				D	4%							
				C	4%					slickensides		
	286					Box 23				heavily oxide-stained matrix		
				—	100							
	288			RUN	76							
				D	25							
				C	25							
	290			—	100					mod. firm		
				RUN	77							
				D	4%							
	292			C	3%							
						Box 24				hard		
	294									mod. loose/soft		
				—	78							
				RUN	78							
	296			D	4%							
				C	23							
	298											
				—	68							
				RUN	79							
	300											

PROJECT MONTANORE			JOB NO. E029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY		DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	300			D C	3% 7%					hard		
	302			–	82					Clayey gravel with sand (GC)		
				RUN D C	80 3% 3%					hard Ss/Gravst (coarse sand to fine gravel)		
	304											
				–	81	Box 25						
	306											
				RUN D C	81 5% 4%					-Siltite cobble w/ qtz-filled fracture		
	308											
	310			–	96					Ss, med. grey, hard, faintly bedded, 45-70% fine-med. sand, 30-55% silt + clay. Silty sand to sandy silt (SM/ML)		Attempted Packer test 276-314. Didn't seat.
				RUN D C	82 3% 2%					-polished surface Clayey gravel with sand (GC) and cobbles		Packer Test 8 (272-314')
	312			–	97					-polished/slicken sided clasts		
	314			RUN D C	83 5% 3%	Box 26				-Siltite cobble w/ many healed fractures (1 open fracture)		
	316									-blue-green cobble -Siltite boulder w/ several oxide-coated or clay filled fractures		
	318			–	70							
	320			RUN	84					CLAYEY SAND (SC) grey-brn, mod. dense, ~60-70% med-coarse sand, ~30-40% clay.		Drilling v. steady/smooth

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	BPT/ROD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	320			D C	5" 11					meta-Ss (cobblestone?) boulder		
	322									SILTY CLAYEY GRAVEL with SAND (GM/GC) (weathered conglomerate) grey w/ some orange-brown stain, hard w/ some firm, ~65% sm-med subangular to subrounded Ss/Sltst gravel.		
				—	98							8/28/90 Water level 91 below GL
	324			RUN	85							8/29/90 Water level 76 below GL
				D C	5" 5"					oxide coating around cobble slickensided		
	326					Box 27						
	328			—	100							
				RUN	86							
	330			D C	5" 5"							
	332											Drill rate ~0.17 ft/min.
				—	100							
	334			RUN	87					orange-brown staining		
				D C	5" 5"							
	336					Box 28				meta-Ss boulder w/ banded staining		
	338			—	100					meta-Ss boulder w/ banded staining		
	340			RUN	88					clayey, rough fracture along boulder partially slickensided.		

PROJECT MONTANORE			JOB NO. 2C29	HOLE NO. DH-28
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY		DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	340			D	5ft							
				C	5ft		HB					
	342			LP	1ft		HB			- Boulder (5ft long) grey meta-Ss w/ brown banded staining, bedding ~80°, few open + closed fractures ~parallel to bedding, w/moderate coating (calcite(?) and black + yellow oxide) + a little clay, few faint slickensides.		
					100		HB					
	344			RUN	89							
				D	5°							
				C	5°	Box 29				- oxide coated		
	346									slickensides on serpentine coating		
										- green - tan Sltite cobble		
	348				100							
				RUN	90							
	350			D	5ft					SILTY CLAYEY GRAVEL with SAND (GM/GC) tan to orange-tan, firm (weathered conglomerate)		
				C	4ft					- slickensided		Packer Test 9 (316 - 354ft)
	352					Box 30				crumbly		
					88							
	354									TD 354ft		Water Level after piezometer installed 8/30/90 pm 1.9 below GL
										Piezometer installation: 20-ft of slots 324ft - 344ft w/ 10-ft somp; sand ~ 152ft - 354ft; bentonite seal at 152ft; blocked at 19ft		

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-29

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LITTLE CHERRY	8/24 - 9/24/90	HQ	VERTICAL

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DIVERSION CHANNEL	3719.2	> 80'	51'

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
J.D. WELSH (Driller: Scott Corn)		7	80.0'

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
ACKER AD-II	E. RENNAT	J.F. Later

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INJ-ITIES TYPE	DISCONT INJ-ITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Med. brn SANDY SILT (ML) w/ angular gravel; Roots		Dense fir & cedar trees to ~40' high
	2		4" ID									Drilling w/ "Clear Mud" ~1:1000 in drill water
												~100% Water return ~tan color
	4									Angular pieces of mostly quartz, some iron staining; up to 2" size		
	6			RUN 1 D 2.0 C 0.5 – 25								
	8			RUN 2 D 2.5 C 0.5 – 20		BOX 1				Lt. brown silty GRAVEL with Sand (GM)		Drill Rate: 0.25 ft/min
										– gravel is ~subangular		
	10			RUN 3 D 5.0 C 4.2								
	12	SAMPLE 10.0' to 45.0 9/10/90					HB			– core holds together well		Drill Fluid is slitly darkpi tan to lt. brn
	14			– 84								10.0' to 29.5' Sieve Analysis: 34% Gravel 26% Sand 40% Fines LL = 24 PI = 6
	16			RUN 4 D 5.0 C 5.0								
	18					BOX 2						
	20			– 100								

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SHEET 1 OF 4 HOLE NO. DH-29

PROJECT MONTANORE		JOB NO. 2029	HOLE NO. DH-29
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	20	SAMPLE 10° - 45° (BAG 1)		RUN 5 D 4.5 C 4.1		BOX 2				(ctd) Lt. brn. SILTY GRAVEL w/ SAND (GM/SM)		
	22											
	24			- 91								
				RUN 6 D 5.3 C 5.1								
	26											
	28											
				- 96								
	30	SAMPLE 10° - 45° 9/10/90 (BAG 2)		RUN 7 D 5.2 C 5.1		BOX 3						Drill Rate 0.58 ft/min
	32											29.5' to 45.0'
	34											Sieve Analysis: 35% Gravel 36% Sand 29% Fines
				- 99								
	36			RUN 8 D 5.0 C 5.0								
	38					BOX 4						
	40			- 100								

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SHEET - OF 11 | HOLE

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-29

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			RUN 9						(ctd) silty GRAVEL w/ Sand (GM/SM)		
				D	5°							
				C	5°							
	42	SAMPLE (10°-45°)										~100% Drill Water Return - lt. brown
	44					BOX 4						
				-	100							
				RUN 10						more gravel pieces - up to 70%; angular pieces, mostly lt. brown SILTITE; occ'l heavy orange iron staining		
	46			D	5°							
				C	5°							
	48											
				-	100							
	50			RUN 11								
				D	4°							
				C	2.8	BOX 5				BEDROCK - Lt. reddish brown & gray META-SANDSTONE/SILTITE		
	52			LP	4½"					- weathered; most pieces break easily in hand		Drill Rate 0.42 ft/min
				16	95					- often breaks along relict bedding (~25°∡); fine, fairly regular bedding		~50% Water Return
	54			RUN 12								
				D	2.8					- some even joints at ~60°; silty more iron stained than rest of rock		- 0% Water Return pumping ~15gpm
				C	2.6							
	56									- some zones v. broken - angular pieces		
				0	96					- occ'l weathered pyrite cubes (~½")		
				RUN 13								
				D	5.2							
	58			C	2.9							- Regain Water Return ~90%; lt brown color
				C	2.3	BOX 6						
	60											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-29

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			(RUN	13)					(ctd) META-SANDSTONE / SILTITE		
				0	56							
	62			RUN	14							
				D	5"							
				C	4"							
	64					BOX 6						
				LP	8"							
	66											
				0	84							
				RUN	15							
	68			D	5"					- grades into little-weathered purplish & grey colors (interbedded)		
				C	4"					- almost all breaks along relict bedding (~25° ∡); mostly 3" pieces		
	70									- possible slickensides on occ'l joint surfaces		~100% Drill Water Return - color is grayish brown
				LP	4"							
	72			13	90							
				RUN	16							
				D	5"							
				C	4"							Drill Rate : 0.42 ft/min.
	74					BOX 7						
	76									- changes back to more weathered; brownish color · occ'l irreg vugs (~1/8")		
				29	90							Install piezometer: - 20' #20 1" slotted PVC in Bottom - 30' #8 Sand (up to 50') - 5' Bentonite Plug
				RUN	17							
	78			D	3"							
				C	3"							
				LP	5"							
				15	~100							
	80									BOH - 80'		

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 11 OF 11 HOLE NO. DH-29

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-30
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 7/23 - 8/24/90	HOLE SIZE: HQ	ORIENTATION: VERTICAL
LOCATION: DIVERSION CHANNEL	ELEVATION: 3651.4	DEPTH TO WATER: > 78'	DEPTH TO ROCK: 13'
DRILLING CONTRACTOR: J.D. WELSH (Driller: Scott Corn)	SAMPLES	CORE BOXES: 7	DEPTH OF HOLE: 78.0
DRILL MAKE - MODEL: ACKER AD-11	LOGGED BY: E RENNAT	REVIEWED BY: JF Slater	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0											Dense fir trees, ~40' high
	2		4" ID							Lt. brn SILT (ML)		Drilling w/ "Clear Mud" ~1:1000 in drill water; recirculating
										Fill for drill pad		
	4									Lt. brn SILT w/ tree roots (ML)		
										Root		
	6	SAMPLE (5.0 - 13.5) 9/10/90		RUN 1 D 5.0 C 2.5 CL 2.5		BOX 1				Orange CLAYEY GRAVEL w/ SAND (GC) - weathered, iron stained - roots at top - gravel is subangular, occ'ly rounded - lge piece ~2"; most pieces are orange siltite / meta SS; 1 piece dk gray siltite		5.0' to 13.5' Sieve Analysis: 53% Gravel 28% Sand 19% Fines LL=30 PI=8 Lge root interferes w/ recovery on run 1
	8											
	10			- 50 RUN 2 D 3.5 C 2.4 CL 1.1								Drill Rate: 0.50 ft/min
	12											
				- 71						Approx. 13.0' - BEDROCK		
	14			RUN 3 D 3.3 C 2.5 CL 0.8						Lt. Orange SILTITE / fine METASANDSTONE - breaks easily in hand; most breaks along relict bedding (~10°∡); some jts at ~70°∡		~100% Drill Water Return - lt. orange-brn color
	16			0 76								
				RUN 4 D 3.2 C 3.0								
	18									} small (~1/8" to 1/4") irreg. vugs in rk		
	20			10 94		BOX 2						

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 1 OF 4 HOLE NO. [illegible]

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-30

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			RUN 5						(ctd) SILTITE / META-SANDSTONE		
				D 5°								
				C 4°								
	22											
	24					Box 2						
				0	80							
				RUN 6								
	26			D 4°								
				C 3°								
				LP 4"								
	28											
				17	88							
				RUN 7						Rock is slightly harder; more siliceous cementing		
	30			D 5°								
				C 4°								
	32			LP 6"								
								35		purplish color		
	34			33	98	Box 3				Rock is softer again · breaks w/ any handling		
				RUN 8								Drill Rate 0.58 ft/min.
				D 3°								
				C 2"								
	36							45				
				0	80							
				RUN 9								
				D 3°						Y. friable - much of core is broken into angular pieces (avg size - ½")		
	38			C 2°								
	40			13	93							

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-30
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	40			RUN 10		BOX 3				(c'td) SILTITE / METASS		
				D 3.3						- orange		
				C 2.3						- V. weathered; crumbles w/ any handling		
	42			CL 1.5								
				O 61								
	44			RUN 11		BOX 4				} irreg. vugs (~1/8-1/4") ~10% of core surface		Gear box overheating - drop drill rate to 0.40 ft/min
				D 3.7								
				C 3.8								
	46											~100% Drill Water Return
					100							
	48			RUN 12								
				D 3.0								
				C 2.9						Slickensides on ~65° ∡ break		
	50			* 97								* RQD is ~65 in split barrel; II after boxing & attempting to wash
				RUN 13								
				D 2.5								
				D 2.3								
	52											
				O 92								
				RUN 14						Bedrock becomes more competent, more siliceous; fine, irregular relict bedding; irreg. breaks		
	54			D 5.0						- some weathered pyrite cubes (<1%) (~1/8" in size)		
				C 5.0						- less orange color; more brown; occly reddish		
				LP 6"								
	56					BOX 5						
	58			38	100							
				RUN 15								
				D 5.0								
				C 4.3						~59.5-60.5 gray color, harder		
	60											

MORRISON-KNUDSEN ENGINEERS, INC. | HOLE

PROJECT	JOB NO.	HOLE NO.
MONTANORE	5029	DH-30

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			(RUN 15)		BOX 5						
	62			24	86					mostly gray color; less weathering & iron staining		
				RUN 16								
	64			D 5°								
				C 5°						some small irreg. vugs on core surfaces		
	66			LP 7"								
										intense fracturing (~70° to 90° ∡ from horizontal); v. regular surfaces w/ some iron staining; no joint filling.		
	68			18	100	BOX 6						Drill Rate: 0.18 ft/min
				RUN 17								
				D 5°						- med. gray · hard; smooth core surface; fine irregular bedding (~20° ∡)		switch to high range: Drill Rate: 0.52 ft/min
				C 5°								
	70									- breaks are ~ regular; often along relict bedding; some filled w/ angular sand of similar material; occ'ly sltly iron stained		
				LP 5"								
	72			84	100							Packer Test 1 (58° - 78°) 4.2 gpm at 40 psi
				RUN 18								
	74			D 5°								
				C 5°								
				LP 11"		BOX 7						
	76											
	78			46	100					BOH 78°		Piezometer installed: 20' #20 slotted 1" PVC on bottom; #8 sand to 38' (40'); 3' bentonite plug
	80											

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 1 OF 1 | HOLE

PROJECT: MONTANORE		JOB NO. 7029	HOLE NO. DH-31
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 8/22 - 8/22/90	HOLE SIZE: 4.0	ORIENTATION: VERTICAL
LOCATION: DIVERSION DAM	ELEVATION: 3656.8	DEPTH TO WATER: 10'	DEPTH TO ROCK: 37.5'
DRILLING CONTRACTOR: J.D. WELSH	SAMPLES	CORE BOXES: 4	DEPTH OF HOLE: 47.0'
DRILL MAKE - MODEL: ACKER 20-11	LOGGED BY: E. RENNAT		REVIEWED BY: [illegible]

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									SILTY GRAVEL w/ SAND (GM) w/ Cobbles, Roots (at top)		Dense fir trees to 40' high; cobbles & boulders in road cut
	2		4" ID							- lt-med brown low plasticity - gravel & cobbles (~30%) are angular to subangular; ~4" max. ~ 40% silt, 20% sand; 10% clay		Drilling w/ "Clear Mud" ~1:1000 in water; recirculating
	4											
	6			RUN 1 D 4° C 3°						- lt. tan color; ~40% gravel, 30% sand; 15% silt; 10% clay; occ'l cobble - some iron staining in matrix		
	8		9/10/90		- 98	BOX 1				rocks are mostly hard; gray & purplish; low grade metamorphics (eg. siltites)		
	10			RUN 2 D 5° C 4°								~100% Water return, light tan color
	12		SAMPLE (5° - 16°)									
	14				- 97					matrix is sltly darker - more silty		
				RUN 3 D 5° C 4°						mostly clean lt. brn SILT (ML)		Drill Rate: 0.25 ft/min.
	16											
	18				- 90	BOX 2						
				RUN 4								
	20											

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

SHEET 1 OF 3 | HOLE NO. DH-31

PROJECT	JOB NO.	HOLE NO.
MONTANORE	2029	DU-31

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK 37.5'
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE 47.0'
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			(RUN 4) D 5.0 C 5.1						(ctd) SILTY GRAVEL w/ SAND (GM)		shift drill into high gear; drill rate = 0.58 ft/min
	22					BOX 2				matrix is firm; core holds together v. well		
	24			- 100 RUN 5 D 5.0 C 4.9								
	26											
	28			- 96 RUN 6 D 5.0 C 4.4 CL 3.6		BOX 3				Core loss: probable washing out of silty materials		Packer Test 1 (18.0 - 29.0) no flow at 10 psi
	30											
	32											
	34	SPT 1		- 28 26 32 42						v. weathered lt gray-tan METASANDSTONE - crumbles to sand under finger pressure (ctd) SILTY GRAVEL w/ SAND (GM)		SPT 1: 26-32-42 (12" rec.) clayey silt w/ v. weathered gravel
	36			RUN 7 D 4.5 C 3.8								
	38			- 84 RUN 8		BOX 4				BEDROCK 37.5' Orange, weathered METASANDSTONE/SILTITE - regular relict bedding at ~30° - most breaks along bedding		
	40											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	3029	DH-31

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			(RUN 8)						(ctd) Orange, weathered METASANDSTONE / SILTITE (Bedrock)		
				D 5°								
				C 4°								
	42			LP 8"		BOX 4						Drill Rate 0.67 ft/min.
				H6 96						43' to BOH: darker orange-brown, often soft & broken		
	44			RUN								
				D 2°								
				C 2°								Packer Test 2 (39° - 47°) 0.04 gpm at 20 psi
	46											
				0	100							Packer Test 3 (29° - 47°) 0.06 gpm at 20 psi
										47° BOH		
	48											Piezometer:
	50											10' #20 Slotted Sched. 80 1" PVC (~1' off bottom)
												12' #20 Sand
	52											16' #8 Sand (to 19' BGL)
												5' Bentonite Plug
	54											
	56											
	58											
	60											

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SHEET 3 OF 3 HOLE NO. DH-31

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-32
SITE Little Cherry Creek	DATE - STARTED FINISHED 9/2/90 - 9/3/90	HOLE SIZE HQ	ORIENTATION V
LOCATION south end of diversion dam	ELEVATION 3652.3	DEPTH TO WATER artesian 9/26/90	DEPTH TO ROCK 52.7
DRILLING CONTRACTOR JD Welsh	SAMPLES 7	CORE BOXES 4	DEPTH OF HOLE 66.0
DRILL MAKE - MODEL Longyear HC-150	LOGGED BY CF Slater	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Road fill (material from nearby) similar to below. Includes cobbles, scattered boulders + possibly downed trees. (CL)		Advanced casing part way. Core to 8.0. Advanced casing to 5.0.
	2									SANDY SILTY CLAY (CL) w/ some gravel. greyish tan, mod. soft to sl. firm, high plast., ~50-70% clay, ~15-25% silt, ~10-20% fine to coarse sand, ~5-15% Siltite gravel.		
	4			RUN D C	1 4.0 1.3							Coring w/ HQ, using polymer drilling fluid.
	6			—	33							
	8	SPT-1		5 9 12	67					orangish brown w/ some greyish tan		Split-spoon sample (8.0 - 9.2)
	10			RUN D C —	2 3.0 1.2							
	12			RUN D C —	3 2.0 0.2 10							mislatched core barrel caused low recovery
				RUN —	4 45							
	14			RUN D C —	5 2.2 0.0 0	Box —						
	16			RUN D C —	6 3.0 0.0 0							
	18											
	20	SPT-2		5	2							Split-spoon sample (19.3 - 20.8)

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PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-32
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	20			1 1 –	0							Cored 19.3-21.5 (run 7) using heavy drilling fluid. No recovery
	22	S-1			35				?	SILTY CLAYEY SANDY GRAVEL (GM-GC) brown, mod. soft, high plast.		Shelby sample (high volume of stuff may account for low recovery)
	24	S-2			88							Shelby Sample (partially dented at bottom)
	26			RUN D C	8 4.0 0.2	Box 1						lab analysis - core 23-25.5 31% gravel 26% sand 43% fines LL = 22 PI = 5
	28			–	18					SANDY CLAY with GRAVEL to GRAVELLY CLAY, becoming sl. reddish brown, soft; 15-30% sm. subangular to subrounded gravel; some large gravel. Sandy clay with gravel to gravelly clay (CL)		9/2/90 Water 0.3 below GL
	30			RUN D C	9 5.0 0.6							9/3/90 Water at GL Run 9 was drilled 3.0, then pushed 2.0 (in process of 'setting' core)
	32											
	34			–	12							Attempted falling head test (no packer) 15.0-35.2. Hole squeezing in. No measurement
		SPT-3		1 1/4	80		RUN – –	10 90 95		scattered cobbles		Split-spoon sample 1 blow/9". Wt + pushing drove rest. (est. ~1/4 blow)
	36			–	80							
				RUN –	13 70							No Shelby taken at 37.0 because partially through rock + because caving is so great.
	38			RUN D C –	14 2.0 0.3 15							
	40	SPT-4		4 8	0							Split-spoon sample 39-40.5

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-32
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			7								
				RUN	14							
				D	5"							
	42			C	1"							
		SPT attempted										
				—	20							
	44			—	100					Qtzite cobble		SPT attempted at 44" Weight bouncing on cobble after 1st blow.
				RUN	18					coarse sd to med gravel, subangular to angular, firm, at least partially brecciated.		
				D	35							
	46			C	28							
				—	80	Box 2						
	48			RUN	19							
				—	70					Siltite boulder (1" long) from Wallace Fm. Several fractures parallel to bedding (fairly rough w/ some clay filling		
		SPT	5	6 30/1	0		bed 35°					Split-spoon sample, 1st blow penetrated 4" (slate)
	50			RUN	20							
				D	3"							
				C	2"							
	52			—	73							
				RUN	21					Top of Bedrock (Wallace Fm)		Siltite/Argillite orange brown, interbedded hard, sl.-med. weathered
	54			D	3"					fracture in black layer w/ 1/8" clay/silt/sand layer + some slickensides.		
				C	3"					rough fractures, ~clean		
										meta-breccia (bl-gr w/ orange stain) w/ sm. irreg (meta'd) qtz veinlets, hard		
				73	100					fracture oblique to bedding, w/ thin clay filling		
	56			RUN	22							
				D	3"					brecciated zone (1" thick) coarse sand/silt/clay		
				C	2"							
	58									thin shear zone w/ sand/silt/clay		
				43	93	Box 3						Packer Test 1 (48-66")
				RUN	23					brecciated zone (small angular gravel size w/ ~20-40% clay/silt		
	60											

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-32
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	BPT/ROD	RECOVERY	Box #	DISCONT INFITIES TYPE	DISCONT INFITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			D C	3" 2"							
	62			34	69					broken zone w/ med. sand to small gravel-size angular to subangular fragments. ~30-40% silt/clay.		Siltite w/ some black argillite layers 1/32"-1/3" thick.
				RUN	24					Siltite w/ argillite, pinkish brown w/ black, hard, sl.-mod. weathered.		
				D C	3" 3"							
	64						med. 25°			brecciated zone w/ angular fragments from coarse sand to "2" (avg ~1/2"). ~15-25% clay/silt.		orange-brown siltite/argil.
				47	97	Box 4				3/4"-wide fracture zone w/ 1/4" clay		9/3/90 Water at GL
	66									TD 66'		9/4/90 Water at GL (inside casing)
												Difficulty installing piezometer due to caving. Estimate piezometer to be as follows:
												10-ft of slots from 48'-58' w/ 1-ft sump
												sand from 60-66'
												caved in above 60'

PROJECT MONTANORE		JOB NO. FC29	HOLE NO. DH-32a
SITE Little Cherry Creek	DATE - STARTED FINISHED 9/5/90 - 9/6/90	HOLE SIZE HQ	ORIENTATION V
LOCATION offset of DH-32 (downslope)	ELEVATION 3633±	DEPTH TO WATER artesian 9/6/90	DEPTH TO ROCK 60±
DRILLING CONTRACTOR ED Welsh	SAMPLES 10	CORE BOXES 5	DEPTH OF HOLE 64±
DRILL MAKE - MODEL Longyear HC-150	LOGGED BY CF Slater	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0											Surface casing drilled to 5±. Using polymer (Clear mud) in drilling fluid
	2											
	4			RUN	1					SANDY GRAVELY SILTY CLAY (CL) brown, mod. soft-mod. firm, massive, high plast. matrix, scattered lg. gravel. ~25-35% subrounded to subangular fine gravel to med sand ~65-75% silty clay		Start coring at 4± through 1± cuttings
	6			–	13							
		SPT-1		11 9 9	47					Siltst gravel penetrated by SPT		Split-spoon sample
	8			RUN D –	2 2± 74					firm		Shelby sample attempted at ~9±. No penetration. Tube bent along 1/8 of rim.
		E-S-1										
	10	SPT-2		29 27 21	60							Split-spoon sample
				RUN D C	3 5± 2±							
	12			–	58							
	14	SPT-3		7 7 15	27					soft		Split-spoon sample rock jammed into tip.
	16			RUN D C	4 5± 1±							
	18			–	38							
		SPT-4		12 19	1					soft		Split-spoon sample Rock sheared by spoon in tip (only recovery)
	20											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8529	DH-32a

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			24						Similar to above, but soft ~40-50% sand + fine gravel ~50-60% silt + clay Lean clay w/ sand + gravel (CL)		
				RUN D C	5 5° 0°							Packer Test 1 (7-26')
	22			1	18							
	24	SPT-5	RUN 6	1 1	0 34							Split-spoon 1 blow/12" 2nd blow/-2° no recovery; Run 6 (24-26') 34% rec.
	26	Shelby	2		100					mod. firm to firm ~25-35% sand + fine gravel ~65-75% silt + clay Lean clay w/ sand + gravel (CL)		Shelby sample - dented all around rim.
				RUN D C	7 2° 0°							
	28			1	38							
	30	SPT-6		3 9 16	50							Split-spoon sample
				RUN D C	8 5° 2°					firm to v. firm ~45-65% sand + fine gravel (subrounded to angular) ~35-55% silt + clay Fat clay with sand + gravel (CL) to clayey gravel with sand (GC)		Packer Test 2 (11-34')
	32			1	52							9/5/90 Water level 0± below GL
	34	SPT-7		20 +8	15					soft (GC/CL) as above, except that sand-silt-clay component is mod soft to soft.		9/6/90 Water at GL Split-spoon sample
				RUN C	9 1°							
	36			1	50							
				RUN D C	10 2 2°					soft		
	38											
	40	SPT-8		20 37	83							Split-spoon sample refusal 52 blows/6"

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-32a
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	40			52						SANDY GRAVELLY SILTY CLAY (CL) to CLAYEY GRAVEL with SAND (GC)		
				RUN	11					brown to reddish brown, low to med. plast, firm-dense, scattered cobbles, crudely bedded. Abundant brownish red + yellow gravel.		
				D	5.0							
	42			C	3.0							
				–	76					~10-40% sm-med. subrounded to angular gravel		
	44			RUN	12					~20-40% fine to coarse sand		
				D	3.5	Box 3				~40-80% silt + clay		
				C	2.1							
	46											
				–	60							
	48			RUN	13					SANDY GRAVELLY CLAY (CL) to SANDY CLAYEY GRAVEL (GC)		
				C	1.3					orange-brown, mod. firm to firm, med. to high plast. matrix, ~massive, scattered cobbles.		
				–	87							
				RUN	14							Drill Rate ~ 0.33 ft/min
	50			D	2.2					Some of sandy matrix weathered to clay. (weathered Ss)		
				C	1.1							
				–	55							
				RUN	15					~35-55% sm. to lg. subrounded to subangular gravel		
	52			D	2.8					~10-30% fine to coarse sand		
				C	2.2					~35-55% silt + clay		
				–	79	Box 4						
	54			RUN	16							
				D	2.8							
				C	2.3							
	56			–	82							
				RUN	17							
				D	2.4							
	58			C	2.3							
				–	96							
				RUN	18							
	60									TOP OF BEDROCK		

PROJECT MONTANORE		JOB NO. 6029	HOLE NO. DH-32a
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			D C	5º 4½					TOP OF BEDROCK Siltite, brown, hard, faintly bedded, unfractured		
	62			11	83	Box 5	bed. 23-28°			Siltite/Ss/Argilite, orange-brown, interbedded, 5-10 fract/ft. parallel to bedding (smooth w/ 1/8" filling). Competent between fractures.		probable slight artesian flow observed several hours after rods pulled.
	64									TD 64º		Packer Test 3 (46-64º) Packer Test 4 (35º to 64º) No piezometer is installed in this hole (not scheduled)

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-38

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LITTLE CHERRY	8/16 - 8/18/90	HQ	VERTICAL

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
SEEPAGE COLLEC'N DAM - LT. ABUT'T	3349.8	55'	55°

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
J.D. WELSH (S. CORN - Driller)		8	77.0

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
ACKER AD-II	E RENNAT	CF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Clayey SILT (ML) w/ minor Gravel -lt. gray brown		Edge of clearcut; edge of L. Cherry Ck. ravine; grassy; 50' firs
	2		4½ O.D.									Drilling w/ ~1:1000 Clear Mud in water
	4									~7° + Lt. brn-tan SAND w/ SILT & GRAVEL (SP-SM) ~10% SILT ~80% fine sand ~10% subangular gravel		
	6	SPT 1		12 27 26								SPT #1 12-27-26 ½-1" gravel at bottom of SPT; (7" Rec.)
				RUN 1 D 5° C-4'		BOX 1						
	8									2" well-rounded siltite piece		
				- ~90								
	10	SPT 2		20 21 30						Lt brn SILTY SAND (SM) ~fine sand ~0 to 5% fine subangular gravel ~20% clay ~25% silt ~50% fine sand		SPT #2: 20-28-30 (10" Rec.)
	12			RUN 2 D 5° C-4'								
	14									- dense / v. stiff		Drill Rate 0.50 ft/min
				- ~92		BOX 2						
	16	SPT #3		16 25 28						grades into SANDY SILT (ML) - Lt. brn ~40% SILT ~40% SAND ~30% CLAY - plastic ~10% GRAVEL - angular, hard pieces of mostly quartzite & siltite; max size ~2"		SPT #3 (12" Rec.) 16-25-28
				RUN 3 D 5° C-5'								
	18											~100% Water Return
	20			- ~100								

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A MORRISON KNUDSEN COMPANY

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-38

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20	SPT 4		38 50 5½"						(c'd) lt. brn SANDY SILT (ML) - no visible bedding		SPT #4 : 38-50/5½" (1" Rec.)
	22			RUN 4 D 5.9 C ~2.0		BOX 2						Drill Rate 0.38 ft/min
	24			~40								
	26	SPT 5		23 36 31						finer mat'l : ~ no Gravel ~ 20% SAND ~ 40% SILT ~ 40% CLAY slthy lighter, grayer color		SPT #5 : 23-36-31 (10" Rec.)
	28			RUN 5 D 5.0 C ~4.2								
	30	SPT 6		~94 23 24 35		BOX 3						SPT #6 : 23-24-35 (7" Rec.)
	32			RUN 6 D 5.0 C ~3.8						grades into SILT (ML) - plastic, v. stiff to hard - v. faint, irreg. bedding		
	34	HS1		~78						Pocket Penetrometer 2.5 - 4.5 tsf avg. 3.7 tsf		HS-1 : Sieve Analysis: LL = 32 PI = 4 99% Fines
	36	SPT 7		9 13 18								SPT #7 : 9-13-18 (16" Rec)
	38			RUN 7 D 5.0 C ~3.2		BOX 4						
	40			~74								

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-38

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
	ER	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40	SPT 8		14 19 20						(ct'd) SILT (ML)		SPT #8 14-19-20 (18" Rec.)
	42			RUN 8 D 5.0 C 4.2		BOX 4						Drill Rate 0.50 ft/min. ~100% Drill Water Return
	44									GRAVEL, irreg. sharp contact COBBLES & BOULDERS in SANDY SILTY CLAY matrix (GM) - ~30% matrix - subangular, hard, weathered pieces		FALLING HEAD TEST 1 (0-45°) - tight
	46	SPT 9		34 38 50+ 5½"						18" SILTITE/ARGILLITE boulder; grn-gray breaks along 45° relict bedding, stained surfaces		SPT #9 34-38-50/5½" (2" Rec.)
	48			RUN 9 D 5.0 C 4.2		BOX 5						
	50	SPT 10		14 31 37						silfite (?) cobble (4") - massive		SPT #10 - no Recovery 14-31-37
	52			RUN 10 D 3.7 C 3.9						Dirty quartzite cobble (5") - one face is v. smooth & even, iron stained		PACKER TEST 2 (48°-65°) 1.7 gpm at 40 psi
	54			RUN 11 D 4.3 C 3.10						(Approx.) BEDROCK - SILTITE/ARGILLITE		Drill Rate 0.33 ft/min
	56									Grnish brn, v. weathered, breaks easily, esp. along relict bedding (~30°+); some n. vertical stained joints		Hole is 'booting' (i.e. closing up) at bottom; thicken 'Clear Mud' mix to ~ 1:500 - reduced water return ~25%
	58			RUN 12 D 2.5 C 2.4		BOX 6				- bedding angle is ~ 50°		
	60											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-38

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY GR	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			RUN 12	96					(ctd) Weathered brown-green SILTITE; most breaks along bedding (~60° ∡); crumbles in hand; black and orange staining along surfaces		~10% Drill Water Return (drilling w/ 500 psi) - gushes from rods when opened
				RUN 13								
				D 4 5								
				C 3 2								
	62					BOX 6						Drill Rate 0.33 ft/min
	64									} weathered to silt; no relict bedding		
					84							
				RUN 14								
				D 1 5								
				C 1 2								
	66			0	100							
				RUN 15						— Rock becomes more competent - pieces can no longer be crumbled by hand; s/tly coarser(?) - SILTITE / Fine META-SS		
				D 3 5								
				C 3 2								
	68											Packer Test 3 (67° to 77°) 0.01 gpm at 40 psi
	70			0	91							
				RUN 16								
				D 4 5								
				C 4 2						— Finer grained - SILTITE		
	72					BOX 7						
	74			12	93							
				RUN 17								
				D 2 5								
				C 2 5								
	76			LP 5"								
				18	100	BOX 8				BOH 77°		
	78									Install piezometer: 20' Slotted (#20) Sched. 80 PVC (1" O.D.); sand to 46° ft (31'); bentonite to 44° ft (2');		
	80											

PROJECT MONTANORE		JOB NO. 6029	HOLE NO. DH-39
SITE Little Cherry Creek	DATE - STARTED FINISHED 7/30/90 - 7/31/90	HOLE SIZE -Q	ORIENTATION V
LOCATION seepage collection dam - rt. abutment	ELEVATION 3324±	DEPTH TO WATER 52½ 9/26/90	DEPTH TO ROCK 28º
DRILLING CONTRACTOR JD Welsh	SAMPLES ~	CORE BOXES 7	DEPTH OF HOLE 73º
DRILL MAKE - MODEL Longyear HC-150	LOGGED BY E. Rennet / C. Slater	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box #	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0		6" OD casing							SILT (ML) w/ gravel, lt. brn.		cased to 4º
	2									SANDY SILTY GRAVEL (GM) with COBBLES lt. orn-orange; some iron staining of silt; gravel + cobbles (up to 4½" diameter) of Siltst. + Qtzite, angular ~30% cobbles ~50% gravel ~20% matrix, mostly silt		
	4			RUN 1								'Clean Mud' polymer drilling fluid added to drill water (~1:1000).
				D 4º								
				C 3º								
	6					Box 1						
				–	B3							
	8			RUN 2								
				D 5º								
				C 3º								
	10											Drill rate: ~0.42 ft/min.
												20% drill-water return
	12			–	74							
				RUN 3								
	14			D 5º								
				C 4º								
	16									loose		
				–	96							
	18			RUN 4								
				D 5º								
				C 3º								
	20											

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-39
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20											
	22			–	70					22-23' soil is dk brown-black sandy mat'l with oily appearance.		
				RUN	5							
	24			D	5°	Box 2						
				C	3½							
	26											
				–	72							
	28									TOP OF BEDROCK		
				RUN	6					Siltite, grey to black; laminated to finely bedded, mod. hard; sl. weathered; ~3-4 fractures/ft parallel to bedding (some w/ silt filling + iron-staining)		
				D	5°							
	30			C	5°							Packer Test 1 (15-33') 0 gpm at 5 psi leaking at 10 psi
						Box 3				mostly even		
	32									heavily weathered		
				–	100					brown, mod. to highly weathered		
				RUN	7		bed.	30°				
	34			D	5°							Drill rate ~0.35 ft/min
				C	5°							
	36											
				48	100							
	38											
				RUN	8							
				D	5°					Siltite/Argillite, as below		
	40			C	4½							

PROJECT MONTANORE			JOB NO. 2029	HOLE NO. DH-39
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box #	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40									Siltite/argillite (inter bedded) tan to yellowish brown, frequent fractures + some brecciated zones w/ abundant brn-orange clay filling, highly weathered.		
	42			7	90	Box 4						
				RUN	9					} intensely fractured, clayey		
	44			D C	5" 4"		bed	30°		Siltite/Ss, lt. grn-brown; laminated; hard; mod. to highly weathered; fractured vertically + along bedding planes. Oxide staining within rock + on some fracture surfaces. Some brn-orange clay filling		Drill rate ~0.25 ft/min.
	46											
				10	90							
	48			RUN	10					- brecciated zone		
				D C	5" 5"							
	50					Box 5				Siltite/fine Ss, greenish - purplish brown to grey, hard, sl. to mod. weathered, few med. rough fractures along bedding planes w/ some oxide staining.		Packer test 2 (35-53 ft)
	52			44	100							
				RUN	11							
	54			D C	5" 2"					- brecciated zone		core barrel clogged.
				14	67							
	56			RUN	12					- broken zone w/ brn-orange clayey silt.		
				D C	5" 4"							
	58									Siltite lt. to dk grey, laminated, slightly weathered, sub-planar fractures subparallel + oblique to bedding w/ thin clay filling or some oxide staining.		
	60			38	96							

PROJECT MONTANORE			JOB NO. 5029	HOLE NO. DH-39
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60											
				RUN	13							
	62			D	2½							
				C	2½	Box 6						
				18	100					-0± thick brecciated zone w/clay		
				RUN	14							
	64			D	1½							
				C	1½					- fractures oblique to bedding		
				22	100							
				RUN	15					- vertical fractures most predominant. Some qtz-healed. Some clay/sd filled up to 1/4" thick.		
	66			D	4±							
				C	4±							
	68											Packer Test 3 (55 - 73 ft)
				74	100	Box 7						
				RUN	16							
	70			D	1±							
				C	4±							
	72											
				53	100							7/31/90 p.m. Water level at 16½
	74									TD 73±		
										Piezometer installation: 10 ft no. 20 slotted pipe (1") sand to 50± bentonite seal 46½ - 50±		

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-40

SITE	DATE - STARTED FINISHED -	HOLE SIZE	ORIENTATION
LITTLE CHERRY	8/18 - 8/20/90	HQ	VERTICAL

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
NORTH SADDLE DAM	3665.8	140'	132.6'

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
J.D. WELSH (S. Corn - Driller)		15	154.0

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
ACKER AD-11	E. RENNAT	JF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0		4" ID CASING							Lt brown SILT (ML) - dry - w/ roots		Dense forest - 60' firs
	2									Gray SILTITE gravel & cobbles		~100% Water Return - lt tan color
	4											Drilling w/ ~ 1:1000 "Clear Mud" w/ water
	6	SPT 1		27 26 28						Lt brown SILTY GRAVEL w/ SAND & COBBLES (GM) ~40% fines ~plastic ~15% SAND ~25% GRAVEL } subangular to subrounded; ~20% COBBLES } mostly gray or gray-green SILTITE; Iron stained surfaces		SPT #1 : 27-26-28 (12" Rec.) Clay & Gravel
				RUN 1 D 5° C-43								Drill Rate 0.33 ft/min.
	8					BOX 1						
				- 86								
	10	SPT #2		39 32 50/3"						- less gravel & cobbles to ~12' depth.		SPT #2 : 39-32-50/3" (11" Rec.) Clay & Gravel
	12			RUN 2 D 5° C-5°						} 5" brn SILTITE cobble		
	14											
				- - 100								
	16			RUN 3 D 5° C 43								
	18					BOX 2						
	20			- 96								

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-40
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			RUN 4						(ctd) SILTY GRAVEL w/ SAND & COBBLES (GM)		
				D 5°								
				C 41		BOX 2						
	22											
	24											
				- 98								
				RUN 5						Gray siltite boulder		
	26			D 5°								
				C 5°								
	28					BOX 3						Packer Test 1 (10° - 30°) ~ 0.12 gpm at 5 psi
	30			- 100								
				RUN 6								
				D 45								
	32			C 45								Drill Rate 0.50 ft/min
	34			- 100								
				RUN 7								
				D 35		BOX 4						
	36			C 35								
	38			- 100								
				RUN 8								
				D 5°								
				C 5°								
	40											

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-40
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			(RUN 8)		BOX 4				(Cont'd) SILTY GRAVEL w/ SAND & COBBLES (GM)		
	42											
				-	100							
				RUN 9								
				D	5.0							Drill Rate: 0.42 ft/min
	44			C	4.8							
	46											
				-	96	BOX 5						
	48			RUN 10								
				D	5.2							
				C	4.5							
	50											
	52											Packer Test 2 (36.0 - 53.0) 0.07 gpm at 20 psi
				-	90							
				RUN 11								
				D	5.0							
	54			C	1.8							3.2' Core loss - ~2½' of tan cuttings in barrel; otherwise mat'l is unchanged
				CL	3.2							
	56					BOX 6						
				-	36							
	58			RUN 12								
				D	3.5							
				C	3.6							
	60											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-40

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			(RUN 12)						(cont'd) SILTY GRAVEL w/ SAND & COBBLES (occ'l boulder) (GM)		
				-	100							
				RUN 13								
	62			D 5 0						2 6' Med. gray SILTITE boulder hard, RQD = 90; nearly horizontal core breaks w/ staining; little weathering		Drill Rate 0.33 ft/min
				C 5 0		BOX 6						
	64											
	66			-	100							
				RUN 14								
				D 3 5								
	68			C 3 4								
	70			-	97							
				RUN 15								
				D 3 3		BOX 7						
				C 3 1								
	72											
				-	94							
				RUN 16								
	74			D 5 2								
				C 5 0								
	76											
	78					BOX 8						
				-	96							
				RUN 17								
				D 4 5								
	80			C 3 3								

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-40

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	80			(RUN 17)						(ct'd) SILTY GRAVEL w/ SAND & COBBLES (GM)		
	82			-	84							
				RUN 18		BOX 8						
	84			D	5.0							Drill Rate 0.42 ft/min
				C	4.2							
	86											
	88			-	94							
				RUN 19						88.5 gravel & cobbles only ~20%; ~80% clayey sandy silt		
				D	3.3							
				C	2.7					GRAVELLY SILT w/ SAND (ML)		
	90					BOX 9						
				-	92							
				RUN 20						91.3		
	92			D	4.7							Packer Test 3 (56.0-96.0) 0.22 gpm at 40 psi
				C	4.6							
	94											
	96			-	98							
				RUN 21								
				D	2.8							
				C	1.7	BOX 10						
	98				68							
				RUN 22								
				D	5.0							
	100			C	5.0							

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-40

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	100			(RUN 22)						(ctd) SILTY GRAVEL w/ SAND & COBBLES (GM)		Drill Rate 0.33 ft/min
	102					BOX 10						
				-	100							
	104			RUN 23								~100% Water Return - tan color
				D	3							
				C	3							
	106											
				-	94							
				RUN 24								
	108			D	3							
				C	3							
	110			-	100	BOX 11						
				RUN 25								
				D	2							
				C	2							
	112			-	100							
				RUN 26								Drill Rate 0.42 ft/min
				D	5							
				C	5							
	114											
	116											
				-	100							
				RUN 27								
	118			D	3							
				C	3	BOX 12						
	120			-	100							

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SHEET 6 OF 8 HOLE NO. DH-40

PROJECT MONTANORE		JOB NO. 8027	HOLE NO. [illegible]
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	120			RUN 28 D 5.0 C 4.7						(ct'd) SILTY GRAVEL w/ SAND & COBBLES (GM)		Drill Rate 0.36 ft/min.
	122											
	124					BOX 12						
				- 94 RUN 29 D 5.0 C 1.8								RUN 29 (125°-130°) mislatch
	126			CL 3.3								
	128											
	130			- 36 RUN 30 D 5.0 C 5.0						← clean white qtzite - 2½" subrounded		
	132					BOX 13				irreg., sharp contact		
	134									BEDROCK Lt orange SILTITE; weathered; breaks mostly along relict bedding (~35° ∡) every 2→4"; some vertical joints; occ'l irreg break; weathered to silt along some breaks		Packer Test 4 (96° - 135°) 0.21 gpm at 40 psi
				- 100 RUN 31 D 4.2 C 4.5								
	136							35				
				LP 5"								
	138											
				26 100 RUN 32		BOX 14						
	140											

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SHEET 7 OF 8 HOLE NO. [illegible]

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-40
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL -	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	140			(RUN 32) D 5.2 C 5.1						(ctd) lt. orange SILTITE - BEDROCK		
	142			LP 16"		BOX 14						
	144			48	98							
				RUN 33 D 5.0 C 5.0								
	146											
	148											
				50	100							
	150			RUN 34 D 4.5 C 4.5		BOX 15						
	152			LP 12"								
	154			80	100					154.0 BOH		
	156									Install 1" O.D. Sched. 80 PVC Piezometer - 20' #20 Slotted PVC - 2.0' off bottom - Sand (#8 & #20) to 83.0 depth (71.0') - 3' Bentonite plug		
	158											
	160											

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SHEET 8 OF 8 HOLE NO. DH-40

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-41
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 8/21 - 8/21/90	HOLE SIZE: HQ	ORIENTATION: VERTICAL
LOCATION: SOUTH SADDLE DAM	ELEVATION: 3594.7	DEPTH TO WATER: 29'	DEPTH TO ROCK: 7°
DRILLING CONTRACTOR: J.D WELSH Scott Corn - Driller	SAMPLES	CORE BOXES: 3	DEPTH OF HOLE: 33.5
DRILL MAKE - MODEL: ACKER AD-11	LOGGED BY: E. RENNAT	REVIEWED BY: [illegible]	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0		4" ID							Lt-med brown SANDY SILT (ML) w/ Subangular Gravel, Roots - some clay; ~ plastic		Dense fir trees; to ~40' high
	2											Drilling w/ "Clear Mud" ~1:1000 in water
	4											
	6	SPT 1		20 25 22	D 1.8 C ~1.0							SPT 1 20-25-22 (10" Rec.) Clayey Silt w/ Sand & Gravel
				RUN 1								
	8			RUN 2 D 3.2 C 2.8 LP 4"						BEDROCK - Fine META-SANDSTONE/SILTITE - orange & med brown; some sltly purplish zones - weathered - breaks often along relict bedding (~10°∡) - irreg. bedding		
	10	SPT 2		12 50/5½"	88	BOX 1						SPT 2 : 50/5½"
				RUN 3 D 2.9 C 2.2 LP 4"								Drill Rate: 0.28 ft/min
	12			13	92					1/4" irreg. quartz vein		Drill Fluid coming up around casing
				RUN 4 D 1.1 0	100							
	14			RUN 5 D 5.0 C 4.9								
	16			LP 13½"						hard purplish piece; siliceous cementing		
	18			52	98	BOX 2						
				RUN 6 D 5.0 C 4.9								
	20											

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SHEET 1 OF 2 | HOLE NO. DH-41

PROJECT	JOB NO.	HOLE NO.
MONTANORE	2029	DH-41

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			RUN 6						(ctd) META-SANDSTONE / SILTITE		
	22			LP 6½"								
				32	98	BOX 2						
	24			RUN 7								
				D 5°								
				= 5°								
										4" piece is ½ quartz		
	26			LP 6½"								Drill Rate 0.50 ft/min
	28			33	100							
				RUN 8								
				D 5°		BOX 3						
	30			C 46								Packer Test 1 (13.5 - 33.5) 0.16 gpm at 10 psi
	32											
				20	92							
	34									BOH 33.5'		Piezometer: 10' #20 Slotted 1" PVC pipe (bottom at 30')
	36											# 20 Sand to 16' 3' Bentonite plug
	38											
	40											

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SHEET 7 OF 7 HOLE NO. DH-41

PROJECT	JOB NO.	HOLE NO.
MONTANORE	3029	DH-42

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LITTLE CHERRY	8/20 - 8/20/90	HQ	VERTICAL

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
SOUTH SADDLE DAM	3607.5	32'	12'

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
J.D. WELSH - Driller: Scott Corn		4	46.6

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
ACKER AD-11	E. Reinhart	CF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									~0°-2° Fill mat'l for drill pad Lt brn SILT (ML) w/ occ'l Cobbles		Dense fir trees; ~40' high
	2		4" ID							Approx. original ground Lt. brn SILTY SAND w/ GRAVEL (SM) - weathered, angular to sub-angular gravel - dense / stiff		
	4											
	6	SPT 1		11 17 22								SPT #1 11-17-22 (12" Rec.) lt. brn clayey sand w/ weathered gravel - SPT sample holds together well
	8	SAMPLE 59-11° 8/20/90		RUN 1 D 4 5 C 4 5 CL 2 3 - ~40		BOX 1				grading into: SILTY GRAVEL (GM) - most fines apparently washed out during drilling ⇒ core loss - mostly fine - medium gravel		
	10	SPT 2		16 50/ 5"								SPT 2 16-50/5" (8" Rec.) Weathered angular gravel
	12			RUN 2 D 4 5 C 3 1 CL 1 2 - ~70						BEDROCK - Weathered SILTITE/ fine META-SANDSTONE - lt brown & gray, finely interlayered, lt. brown is dominant; orange iron staining - irreg. bedding - most breaks along relict bedding (~20°∡); some vertical joints and irregular breaks; often w/ heavy iron staining - more weathered portions break under hand pressure		
	14			RUN 3 D 5° C 5°								
	16											
	18			34 100 RUN 4		BOX 2						
	20											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	3029	DH-42

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			RUN 4						(ctd) SILTITE BEDROCK		
				D 5°						harder, less weathered piece; possible siliceous cementing; healed fractures, iron stained		
				C 4I						← gray clayey matl in joint; possible slickensides		
	22			LP	4½"							
				50	94	Box 2						
	24			RUN 5						↓ more weathered zone(?)		
				D 5°						↓ more breaks are irregular;		
				C 5°								Drill Rate 0.42 ft/min
	26											
				LP	5½"							
	28											Packer Test 1 (14.0 - 29.0) 0 flow at 5 psi ~0.2 gpm at 10 psi
				30	100							
				RUN 6								
	30			D 3°								
				C 3°								
				LP	4"							
	32			10	91							
				RUN 7		Box 3						
				D 3°								
	34			C 3°								
				LP	4"							
	36			20	84							
				RUN 8								
				D 3°								
				C 3°								
	38			LP	7"					relict bedding is flattening (~10° ∡); still irregular		
				44	100	Box 4						
	40			RUN 9								

PROJECT MONTANORE		JOB NO. 2029	HOLE NO. DH-42
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	40			(RU N9) D 4.8 C 4.2						(ct'd) SILTITE BEDROCK		Packer Test 2 (29.0 - 46.6) 0.05 gpm at 10 psi
	42			LP 5½"								
	44			27 98 RU N10 D 2.4 C ~2.4		BOX 4						
	46				~100							
										BOH - 46.6		Piezometer: - 20' #20 Slotted PVC (on bottom) - ~27' Sand - ~3' Bentonite Plug
	48											
	50											
	52											
	54											
	56											
	58											
	60											

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SHEET 3 OF 3 | HOLE NO. DH-42

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-43
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 8/25 - 8/25/90	HOLE SIZE: HQ	ORIENTATION
LOCATION: STARTER DAM (~300' SSE of DH-22)	ELEVATION: 3422.1	DEPTH TO WATER: Artesian	DEPTH TO ROCK: 33'
DRILLING CONTRACTOR: J.D. WELSH (Driller = Scott Corn)	SAMPLES	CORE BOXES: 4	DEPTH OF HOLE: 40.0'
DRILL MAKE - MODEL: ACKER AD-11	LOGGED BY: E. RENNAT		REVIEWED BY: CF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0		4" ID							Lt. brown SILT (ML) w/ Angular Gravel & Cobbles, Roots		Grasses & sml bushes; at edge of clear cut; ~100' N & 20' above L. Cherry Crk.
	2											Drilling w/ "Clear Mud" ~1:1000 in drill water
	4											~100% Drill Water Return - tan color
	6	SPT 1		25 26 39		BOX 1				Lt to med. brown Sandy Silt w/ Gravel (ML) - ~10% Clay - 40% Silt - 30% Sand - 20% Gravel - angular / subangular - some v. weathered - 1" to 3" size - mostly siltite		SPT 1 25-26-39 no recovery
	8			RUN 1 D 5.0 C 2.4 CL 2.6								Drill Water is slitly darker
	10	SPT 2		15 29 33	~48							SPT 2 15-29-33 (15" rec) stiff sandy SILT w/ Gravel
	12			RUN 2 D 5.0 C 4.5						Lt. brown SILT w/ Sand (ML) - no gravel - stiff; irreg. breaks at ~45° - occ'l iron stains		Drill Rate 0.42 ft/min
	14				~90					SILTY GRAVEL w/ Sand & Cobbles (GM) Clasts: - 50% Gravel - Subangular - 10% Cobbles (~6" max) (~40% V. stiff matrix: - orange colored) - 15% Sand - 15% Silt - 10% Clay		
	16	SPT 3		22 33 50/4"								SPT 3 22-33-50/4" Clayey SILT w/ Gravel
	18			RUN 3 D 5.0 C 4.4		BOX 2						
	20				~98							

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 1 OF 7 | HOLE NO. DH-43

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-43

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20	SPT 4		14 37 50/5½						(ctd) SILT GRAVEL w/ SAND & COBBLES (GM) matrix is ~20%		SPT 4 14-37-50/5½" (9" Rec.)
	22			RUN 4 D 5° C 3°		BOX 2				- occ'l black oil-like stains		
	24			- ~74								
	26			RUN 5 D 5° C 5°								~100 Drill Water Return - lt brown color
	28											Packer Test 1 (10° - 30°) ~no flow at 10 psi
	30			- 100						~9" greenish meta SS cobble		
	32			RUN 6 D 2° C 2°		BOX 3						Drill Rate 0.33 ft/min.
	34			- 88 RUN 7 D 3° C 2° LP 6"				30°		BEDROCK Lt. orange METASANDSTONE / SILTITE - mostly breaks along relict bedding (30° ∡)		
	36			20 91 RUN 8 D 4° C 4°						weathered zone - orange, soft		Packer Test 2 (34° - 40°) 0.06 gpm at 20 psi
	38					BOX 4				less weathered zones - rock is more siliceous; lt pinkish color ← quartz-healed joint (~60° ∡)		Install Piezometer - 20' #20 slotted Sched. 80 PVC on bottom - 21' #8 Sand - 3' Bentonite plug
	40			33 100						BOH - 40°		

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SHEET 2 OF 2 | HOLE NO. DH-43

PROJECT: MONTANORE		JOB NO. 3029	HOLE NO. DH-44
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 8/26 - 8/26/90	HOLE SIZE: 4"	ORIENTATION: VERTICAL
LOCATION: STARTER DAM (~350' SSW of DH-21)	ELEVATION: 3467.4	DEPTH TO WATER: 13'	DEPTH TO ROCK: —
DRILLING CONTRACTOR: J.D. WELSH (Driller: Scott Corn)	SAMPLES	CORE BOXES: 3	DEPTH OF HOLE: 37.0'
DRILL MAKE - MODEL: ACKER AD-II	LOGGED BY: E. RENNAT	REVIEWED BY: [illegible]	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									FILL for pre-existing drill pad		Edge of clearcut; pine trees ~20' high
										Lt brn SILT w/ GRAVEL & cobbles; Roots		
	2		4" I.D.									Using "Clear Mud" ~1:100 in drill water
										Approx.		
	4									Lt. orange-brown Sandy SILT w/ Gravel (ML)		~100% Drill Water Return - lt orange-brown
										~ 30% Clay ~ 30% Silt ~ 20% Sand ~ 20% Gravel - rounded to angular; max size ~2"; some weathering, but mod. hard; mostly SILTITES		
	6	SPT 1		16 19 20								SPT 1 : 16-19-20 (12" Rec.) layer Sandy Silt & Gravel
				RUN 1 D 5.0 C 4.5		BOX 1						
	8									fewer gravels		
	10				96							
		SPT 2		8 14 17								SPT 2 : 8-14-17 (8" Rec.) Sandy silty clay w/ occ'l gravel
	12			RUN 2 D 5.0								
										~5% fine gravel.		Drill Rate: 0.46 ft/min.
	14									2 1" thick layers of clean lt. brown silt		
		HS-1								HS-1 Sieve Analysis: 6% Gravel, 23% Sand, 71% Fines; LL=27, PI=6		Hand Sample 1
		SPT 3		23 18 20								SPT 3 23-18-20 (10" Rec.) Sandy Silt w/ occ'l fine gravel
	16			RUN 3 D 3.0 C 1.8		BOX 2						
	18				60							
				RUN 4 D 2.5 C 0 CL 2.5						less clay — more silt (ML)		Attempt Shelby Tube #1 (18.2') penetrates 1" - crushed
										Core Loss		
	20											

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 1 OF 2 | HOLE NO. DH-44

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-44

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			RUN 4	0					(ctd) Sandy clayey Silt w/ Gravel		RUN 4 - drilled w/ straight H_2O
		SPT 4		24 28 33						Lt brown SILT (ML) - clean, hard		SPT4: 24-28-33 (10" Rec.) small gravel in top 1"; clean SILT
	22	#2		RUN 5						SILTY GRAVEL w/ SAND (GM) - lt. brown ~50% fine to med gravel ~20% sand ~30% silt		Attempt Shelby Tube #2 (22°) penetrates 3½" - crushed
	24			D 4° C 4°								HS-2 Sieve Analysis: 4% Gravel 6% Sand 90% Fines
	26					BOX 2				red color		Drill Water changes color to reddish brown for ~ ½ foot at ~25° - ~100% return
		#2 SPT 5		18 34 38	81					sharp contact Lt brn stiff silty Clay w/ trace sand (CL)		SPT 5: 18-34-38 (18" Rec.) top 7" is brown silty clay; rest is reddish brown silt w/ weathered gravel
	28			RUN 6						sharp contact Sandy Clay w/ GRAVEL ~20% gravel; (CL) mostly med reddish brown color		
	30			D 5° C 5°								
	32				100							Packer Test 1 (17° - 37°)
		SPT 6		18 43 50/2"		BOX 3						SPT 6: 18-43-50/2"
	34			RUN 7						SILTY GRAVEL w/ SAND (GM) - ~70% gravel & cobbles max size ~4" - mostly lt. gray siltite; little weathering - matrix color is lt orange-brown; silt, sand, & Clay		
				D 5° C 4°								Drill Rate 0.50 ft/min
	36				92							
										37° BOH		no piezometer
	38											
	40											

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 2 OF 2 | HOLE

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-45
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 8/26 - 8/27/90	HOLE SIZE: HQ	ORIENTATION: VERTICAL
LOCATION: STARTER DAM (~200' NNE of DH-25)	ELEVATION: 3477.8	DEPTH TO WATER: 17'	DEPTH TO ROCK: -
DRILLING CONTRACTOR: J.D. WELSH (Scott Corn - Driller)	SAMPLES	CORE BOXES: 4	DEPTH OF HOLE: 39.0
DRILL MAKE - MODEL: ACKER AD-11	LOGGED BY: E. RENNAT	REVIEWED BY: [illegible]	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0											Edge of clearcut; fir trees to ~40' high
												~ 1:1000 "Clear Mud" in drill water; not recirculating
	2									Gravelly SILT (ML) - lt orange - brown - ROOTS to ~ 4' ~ 20% Clay ~ 40% Silt ~ 10% Sand ~ 30% Gravel subangular to rounded, mostly gray siltite		
		SPT 1		15 50/4"								SPT 1 : 15-50/4" (5" Rec.) mostly angular fine to med. gravel
	4			RUN 1 D 5.0 C-1.3						← 3" Cobble		
				- ~24								
		SPT 2		14 20 22								SPT 2 : 14-20-22 (9" Rec.)
	6			RUN 2 D 5.0 C-5.0		BOX 1						Drill Rate 0.50 ft/min
	8											
				- ~100								
	10	SPT 3		10 17 23								SPT 3 : 10-17-23 (13" Rec.)
	12	SAMPLE 11.5-18.0 9/10/90		RUN 3 D 5.0 C-4.6								
	14			- ~92						color is more orange; occly reddish - some gravel pieces more weathered - sltly more cse sand / fine gravel size		
		SPT 4		10 13 15		BOX 2						SPT 4 : 10-13-15 (15½" Rec.)
	16			RUN 4 D 5.9 C-4.5								
	18											
	20			- ~90						reddish orange color - matrix is ~ stiff clay/silt		

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SHEET 1 OF 2 HOLE NO. DH-45

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-45
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	20	SPT 5		13 18 22		BOX 2				Reddish-Orange Gravelly CLAY/SILT (CL/ML) - ~30% rounded to angular gravel - most is weathered & soft; often blends into matrix		SPT 5 13-18-22 (12 1/2" Rec.) clay w/ v. weathered gravel, cast is well preserved in core run
	22	HS1		RU#5 D 5.0 C 5.0								Hand Sample 1 (22.6-23.2) Sieve Analysis: 3% Gravel, 7% Sand, 90% Fines; LL=45, PI=17
	24			- 100						mostly yellow weathered gravel		
	26	SPT 6		22 31 36								SPT 6: 22-31-36 (2 1/2" Rec.) yellowish clay w/ gravel
				RU#6 D 5.0 C 0.2 CL 4.3		BOX 3				core loss		Core lifter snap ring jams in core barrel → core loss
	28			- 14								
	30	SPT 7		10 22 22						Red clay - ~10% gravel		SPT 7: 10-22-22 (8 1/2" Rec.) red clay
	32			RU#7 D 4.0 C 2.2 C						yellow-orange; ~30%+ gravel, less weathered		
	34	SPT 8		- 68 19 33 25								SPT 8: 19-33-25 (2" Rec.) - rock
	36			RU#8		BOX 4				larger pieces (3"+) of ~hard gray siltite - more brownish color; 6" piece		Drill Rate 0.46 ft/min
	38											
										39.0 - BOH		Piezometer: 20' #20 Slotted Schedule 80 PVC on bottom; 21' #8 Sand; 3 1/2' Bentonite Plug
	40											

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SHEET 2 OF 2 HOLE NO. DH-45

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-46
SITE: Little Cherry Creek	DATE - STARTED FINISHED: 8/31/90 - 9/1/90	HOLE SIZE: HQ	ORIENTATION: V
LOCATION: downstream of diversion dam	ELEVATION: 3610±	DEPTH TO WATER: artesian 9/26/90	DEPTH TO ROCK: 13.5
DRILLING CONTRACTOR: JD Welsh	SAMPLES: 2	CORE BOXES: 7	DEPTH OF HOLE: 79.0
DRILL MAKE - MODEL: Longyear HC-150	LOGGED BY: CF Slater	REVIEWED BY:	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box #	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0	SPT-1		1/2 1/2 4	93					SANDY SILTY CLAY, dk brown, peaty (CH)		Split-spoon sample (1st blow penetrated 12")
										SILTY CLAY (organic soil), dk brn, sl. soft, high plast, ~70-80% clay, ~20-30% silt, some organic material. Fat clay (CL).		
	2											Advance surface casing to 5.0. No sample 1.0 to 5.0
	4									GRAVELLY fat CLAY with SAND and COBBLES (CL) dk brown; 20-35% gravel, 65-80% matrix. Gravelly fat clay with sand (CH)		
	6			RUN D C	1 1.0 1.0 56							HQ coring w/ Clear Mud in drilling fluid
				RUN D C	2 1.0 0.8 66					matrix becoming orange-brown		
	8			RUN D C	3 5.0 0.7							most of matrix is washed out.
	10					Box 1						
	12				14							
		SPT-2		7 50	50					Top of Bedrock		Split-spoon sample Refusal 50 blows/6" (hit bedrock on 6th blow)
	14			RUN D C	4 4.5 2.3					Siltite (orange-brn) interbedded w/ some thin shaley layers. Most fractures along bedding planes - few oblique, mod-highly weathered pinkish tan meta-Ss (hard)		
	16			36	60		bed. 35-40°			5-10 fractures/ft. highly weathered (clayey) fractures have some black oxide staining.		pump sucking air is partially responsible for low core recovery
	18			RUN C	5 0.2 13			?				sluff
				RUN	6							
	20											

MORRISON-KNUDSEN ENGINEERS, INC.
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PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-46
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY		DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING DRILL ACTION WATER LOSS CORE LOSS / STANDARD PENETRATION WATER PRESSURE TEST LAB CLASSIFICATION PIEZOMETERS
	20			D C	4.0 3.8		bed -30°			Siltite/Argillite w/ few black shaley layers, clay-filled fractures (~4-10/ft, mostly along bedding planes, highly weathered, clayey along bedding planes.		
	22			34	95							
				RUN	7					↓ becoming more competent, less weathered.		Attempted Packer Test at 11-28' but did not seat.
	24			D C	5.0 4.9							
	26			80	98	Box 2				hard, ~1 fracture/ft (clay-filled) some qtz-healed fractures up to 1/20" thick, sl-mod. weathered.		
	28			RUN	8					Sltite/argillite, reddish brown, interbedded, 10-17 fractures/ft (along bedding planes) w/ thin lt. tan clay filling, mod. weathered.		Drill Rate ~0.08 ft/min
				RUN	9							
	30			D C	5.0 4.5							
	32			56	90					Sltite/argillite w/ few sandy layers. Yellowish to orangish tan, highly weathered (clayey), breaks easily along clayey bedding planes mod-highly weathered.		
	34			RUN	10					-subvertical fracture zone (75-90°) 1½" wide. Main fracture: filled w/ ¼-⅓" dark brown, high plast. clay + brecciated qtz grains (up to coarse-sand size). 4 other sub-parallel fractures have little/no filling. Strike ~30° from strike of bedding. Approx. ¼" dip slip.		
				D C	3.0 3.0							
	36			30	100	Box 3						Packer Test 1 (17-39')
				RUN	11							
	38			C	1.6					crumbly		
				25	80					↓ becoming harder, less weathered		8/31/90 water level 1.8 below GL
				RUN	12							9/1/90 water level 2.1 below GL.
	40											

PROJECT MONTANORE		JOB NO. 8029	HOLE NO. DH-46
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	Box #	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	40			D C	3.5 3.0					Slate/Argillite/meta-Ss, yellowish to orangish tan, interbedded, mod. weathered, (as above) 1-3 fractures/ft		
	42			43	86					broken zone, med. brown		
				RUN	13							
	44			D C	3.7 3.4	Box 4						
										5-12 fractures/ft		
	46			8	92							
				RUN	14							
				D C	2.8 2.6					↓ becoming pinkish brown		
	48			0	93							
				RUN	15							
	50			D C	5.0 4.8					2-5 fractures/ft		
	52									↓ becoming orangish brown		
				44	96							
	54			RUN	16	Box 5						
				D C	5.0 4.5							
	56											Packer Test 2 (41-59')
	58			34	90					Ss		
				RUN	17							
	60											

PROJECT MONTANORE			JOB NO. 8029	HOLE NO. DH-46
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY		DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			D 5°						Qtz-healed fracture oblique to bedding		
				C 5°						Interbedded siltite/Argillite/meta-Ss, as above but w/ some thin, black shaley layers, yellowish tan, mod-highly weathered,		
	62									2-4 fractures/ft		
						Box 6						
				37	100							
	64											
				RUN	18							
				D	28							
				C	2°							
	66											
				25	96							
				RUN	19							
				D	2°							
	68			C	2°		HB					
				LP.	13		HB					
				77	100					v. hard, ~qtzite (meta-Ss), dk grey, ~1 fracture/ft, some qtzite veins (up to 1/5" thick) mostly parallel to bedding, sl-mod. weathered.		Piezometer installation: 20-ft slots 58-78° sand 40-79° Bentonite seal 37-40°
				RUN	20							
	70			D	5°							
				C	3°							
										soft clayey zone (intensely weathered bedrock) w/several brecciated zones, dk orange-brn		
	72											
						Box 7						
				26	62							
	74											
				RUN	21							
				D	5°							Small amount of artesian flow starting to occur
				C	4°					Siltite/meta-Ss. (~Qtzite) v. hard, contains v. contorted qtzite veins up to 1/10" thick, vuggy, sl.-mod. weathered.		
	76											
										open, qtz(?)-coated fracture		
	78						HB					Packer Test 3 (61 - 79')
				74	92					broken zone		
										Bottom of Hole 79°		Piezometer flowing 2° above GL (~4 psi)
	80											

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-47
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 9/29 - 9/30/90	HOLE SIZE: 8" / HQ	ORIENTATION: VERTICAL
LOCATION: NEW DIVERSION DAM L. ABUT'T	ELEVATION: 3682.9	DEPTH TO WATER: Artesian	DEPTH TO ROCK: —
DRILLING CONTRACTOR: J.D. WELSH (Driller - S. Corn)	SAMPLES	CORE BOXES: 4	DEPTH OF HOLE: 55'
DRILL MAKE - MODEL: ACKER AD-II	LOGGED BY: E. Rennet		REVIEWED BY: DF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Lt brn SILT (ML) w/ occ'l subangular cobbles & boulders; Roots (dry)		Dense conifers up to ~70' high
	2		8" OD AUGER									- auger grinding on cobbles, boulder
	4									← boulder / cobble		
	6	SPT 1		20 27 36						Sandy SILT w/ Gravel (ML), Dry, Lt. brn. ~55% SILT (T clay?) ~25% Sand ~20% Gravel - mostly med. to cse, lt gray, weathered SILTITE / metass - dry, except top 1" of SPT is wet - gravel is ~ subangular		SPT 1 20-27-36 (17" Rec.) - hole has wandered >1' due to boulders - reset rig
	8											
	10	SPT 2		18 18 30						As Above; sltly less sand & gravel sltly moist, top 2" of SPT is wet		SPT 2 18-18-30 (18" Rec)
	12											
	14											
	16	SPT 3		25 44 38						A.A. more gravel; ~40% gray, ~unweathered siltite - sltly moist, top 1" is wet		SPT 3 25-44-38 (15" Rec.) - change to HQ coring - hole is too crooked to use; backfill; offset ~3' to SE
	18											
	20											

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-47

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
			VERTICAL

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
	ER	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0		8" O.D. AUGER							OFFSET HOLE - offset 3' from previous auger hole		Re-auger the first 16 feet. Auger to 50'
	2											
	4											
	6			RUN 1 D 4 5 C 3 2						Lt gray-brn Sandy SILT w/ GRAVEL (ML) ~ 50% Silt ~ 25% Sand ~ 25% Gravel gravel is angular/subangular, lt gray siltite and whitish quartzites; ~ unweathered - matrix mat'l is stiff, core holds together - color is lt. brn — more gravel (~30%), cobbles (~20%) - mostly gray siltite (GM)		HQ coring using ~ 1:1000 "Clear-Mud" in drilling water
	8											
				- 71		BOX 1						
	10			RUN 2 D 5 5 C 4 3								
	12									10" siltite cobble		
	14											
				- 79								
	16			RUN 3 D 5 0 C 4 0								
	18											
						BOX 2						
	20			- 80								Hole collapsed - can't get SPT at 20'

PROJECT		JOB NO.	HOLE NO. DH-47
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY SR	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE	WATER DATA	REMARKS SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS
	20			RUN4 D5º C4º						(ct'd) SILTY GRAVEL w/ SAND & COBBLES (GM) ~40% Gravel ~15% Cobbles ~15% Sand ~30% Silt		
	22											Drill Rate 0.42 ft/min
	24					BOX 2						
				-92 RUN5 D5º C3º						18" Gray Siltite Boulder		25º no SPT - in Cobble
	26											- Drill Fluid coming up in road - ~35' away from hole
	28											Packer Test 1 (12º - 30º) 0 take at 10 psi
	30			-68 RUN6 D5º C4º						~40% Cobbles, ~40% Gravel } lt gray Siltite, angular ~10% Sand ~10% Silt		
	32											V. hard drilling - hole is collapsing onto rods
	34											
		SPT4		-94 50/3" RUN7 D3º C2º		BOX 3						SPT 4 50/3" (2" Rec) Sand & Gravel - Wet
	36											Drill Water Return ~10%
	38			-90 RUN8 D3º C2º								
	40											

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PROJECT			JOB NO.	HOLE NO. DH-47
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			(RUN 8)						(ctd) SILTY GRAVEL w/ COBBLES (GM)		- 0 Drill Water Return
				-	83							- some drill water emerging from ground up to 35' away
				RUN 9								
	42			D	2 15					- Sandy Silt is orange-brown		
				C	2 2							
	44			-	88							
				RUN 10								
				D	3 10							
				C	3 10	BOX 4						
	46									- Silty Sand is grayish brown		
					100							
				RUN 11								
				D	3 10							
	48			C	2 13							
	50			-	77							
				RUN 12								
				D	2 7							
				C	2 6							
	52			-	96							
				RUN 13								
				D	1 3							
				C	0 9	BOX 5						
	54			-	64							
				RUN 14								
				D	1 8							
				C	0 2							
				-	70							
										BOH = 55'		Install piezometer
	56											- 20' #20 Slotted 1" PVC
												- 34' #8 Sand (hole is collapsing, only ~ 1/2 of est'd sand is used)
	58											- 3' Bentonite
	60											

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SHEET 4 OF 4 | HOLE NO. DH-47

PROJECT	JOB NO.	HOLE NO.
MONTANORE	8029	DH-48

SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LITTLE CHERRY	9/24 - 9/26/90	8"/HQ	VERTICAL

LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
NEW DIVERSION DAM	3655.2	Artesian	~49'

DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
J.D. WELSH (Driller: S. Corn)		2	63'

DRILL MAKE - MODEL	LOGGED BY	REVIEWED BY
ACKER AD-II	E. RENNAT	JF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0								Lt brown SILT (ML) w/Cobbles & roots; dry to sltly moist, ~10% Cobbles - gray siltite, subangular, ~unweathered		Dense conifers, ~50' high Begin w/ 8" O.D. Auger
	2										
	4										
	6	SPT 1	8" OD. AUGER	9 13 18					Lt brn SANDY SILT (ML) 10% Subangular Gravel - sltly moist		SPT #1 9 - 13 - 18 12" Recovery - considerable 'grinding' of auger on gravel/cobbles
	8										
	10	SPT 2		50/2"					Lt brn Sandy SILT w/ small root pieces (~10% to 10% : cobble of gray siltite)		SPT 2 50/2" ~1/2" recovery
	12								Lt brn Sandy Silt (ML) - moist - ~30% Sand ~60% Silt - trace clay(?) ~10% Gravel		
	14										
	16	SPT 3		8 12 13							SPT 3 8 - 12 - 13 16" Rec. ~20% gravel in SPT - grinding on gravel/cobbles
	18										
	20										

PROJECT			JOB NO.	HOLE NO. DH-48
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY SR		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	BPT/RQD	RECOVERY	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20	SPT4	8" OD AUGER	50/2"					(ctd) Lt brn Sandy Silt w/ Gravel (ML)		SPT 4 50/2" (0 rec)
	22										20'-~29' V. slow augering - cobbles(?)
	24	SPT 5		13 22 18					~10% clay 25% sand 35% silt 30% gravel & cobbles - subangular - angular - lt gray siltite; occ'l lt brn siliceous siltite		SPT 5 13-22-18 (11" Rec) sltly moist; ~30% gravel
	26										
	28										
	30	SPT 6		6 10 14					As Above, but moist; less sand (~10%) & gravel (~15%)		SPT 6 6-10-14 18" Rec.
	32	SHELBY #1									Shelby #1 pushed 6" - crumpled - no recovery
	34										
	36	SPT 7		10 19 23					Lt brn Sandy Silt w/ Gravel ~10% clay? - moist ~50% silt - occ'l iron stains ~30% sand ~10% gravel - angular		SPT 7 10-19-23 (12" Rec.) slow augering - pour water in hole to help bring up cuttings (~3 gal)
	38										
	40										

PROJECT			JOB NO.	HOLE NO. DH-48
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY SR		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40	SPT8	3" O.D. AUGER	2 7 14						(ctd) Lt brn sandy SILT (ML) - more clayey; plastic - less gravel (~5%), mostly weathered - slitly moist to moist		SPT #8 2-7-14 (12" Rec.)
	42											
	44											
	46	SPT9		16 34 50/4"						Lt. brn silty SAND w/ Gravel (SM) ~ Trace clay(?) - some orange iron staining - 30% silt ~ 40% sand - moist ~ 30% gravel - subangular - mostly weathered		SPT #9 16-34-50/4" (15" Rec.) - hard augering
	48											
	50	SPT10		50/1"						Approx. Bedrock - SILTITE; lt orange-brown and greenish gray moderately hard; greenish gray portions have small ~1/8" calcite blebs; calcite cementing; breaks often along ~regular relict bedding at ~15° ∠; ~regular, near vertical joints/fractures, some healed w/ ~1/16" calcite; occl small (~1/8") weathered pyrite cubes - slight overall weathering		SPT #10 50/1" begin HQ coring at 50°; using "Clear Mud" ~1:1000 in drill water - no evidence of GW to 50° depth
	52			RU W1 D 3° C 2.8 LP 10"								
				40 94 RU W2 D 5° C 4.9 LP 11"		BOX 1	HB					
	54											
	56											Drill Rate: 0.25 ft/min (bit is worn)
	58			48 98 RU W3 D 5° C 5° LP 10"		BOX 2						
	60											

PROJECT			JOB NO.	HOLE NO. DH-48
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			(R4 N3)		Box 2				(cont'd) Lt orange-brown SILTITE		PACKER TEST 1 (53º - 63º) 0.03 gpm at 40 psi
	62			36	100					~61º → BOH Lt Gray Siltite w/ ~ no calcite		
										63º = BOH		Piezometer:
	64											10' #20 Slotted 1" PVC pipe (49'-59': muck has settled from 59' to 63')
	66											11' #8 Sand (to 48')
												2 1/2' Bentonite plug
	68											
	70											

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

SHEET 4 OF 4 | HOLE NO. DH-48

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-49
SITE: LITTLE CHERRY	DATE - STARTED FINISHED 9/30	HOLE SIZE 8"/HQ	ORIENTATION VERTICAL
LOCATION: NEW DIVERSION DAM - U/S TOE	ELEVATION 3642.6	DEPTH TO WATER Artesian	DEPTH TO ROCK 60.8
DRILLING CONTRACTOR: J.D. WELSH (Driller - S. Corn)	SAMPLES	CORE BOXES	DEPTH OF HOLE 69.0
DRILL MAKE - MODEL: ACKER AQ-II	LOGGED BY E. RENNAT		REVIEWED BY J. FISHER

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0		8" OD AUGER							Lt brown SILT (ML); occ'l cobbles; Roots		Dense conifers ~50' high. Front end of drill rig in soft mud from seeps
	2									occ'l cobble / boulder during augering		
	4											
	6	SPT 1		10 11 15						Lt gray & brown SANDY SILT w/ GRAVEL (ML) ~10% clay(?) ~60% Silt ~15% Sand ~15% Gravel - subangular siltite, mostly gray - moist - orange iron staining		SPT 1 10-11-15 (18" Rec)
	8											
	10	SPT 2		4 6 13						As Above mostly orange colored, more clayey - moist		SPT 2 4-6-13 (13" Rec.)
	12	SHELBY 1										SHELBY #1 (12.0 - 12.5) - refusal 6½" Rec.; tube is slightly crimped
	14											
	16	SPT 3		1 2 2						Lt orange brown SANDY SILT / SILTY SAND (ML/SM) - v. soft, plastic - damp to wet		SPT 3 1-2-2 (19" Rec.)
	18	SHELBY 2		RUN 1 (0 Rec.)						Lab Tests: LL = 26, PI = 8; 12% Gravel, 39% Sand, 49% Fines		Auger hole is crooked - pull 5' of auger, shift to HQ Coring. SHELBY 2 (17.0 - 19.0) 24" Rec.; top mat'l is prob'y cave. Hole collapsed - redrill to 20.0
	20											

MORRISON-KNUDSEN ENGINEERS, INC.
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SHEET 1 OF 4 | HOLE NO. DH-49

PROJECT			JOB NO. 8029	HOLE NO. DH-49
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20	SPT 4		1 1 1					(ctd) Orange-brn SANDY SILT (ML) - v. soft		SPT 4 1-1-1 Recovery: ~12" of watery mud - sandy clayey silt
	22			RUN 2 0 Rec					SIGNIFICANT CORE LOSSES FROM ~15 TO 38 FT		(can't take Shelbys due to collapsing hole)
	24	SPT 5		5 3 12							SPT 5 5-3-12 Rec. 18" - v. soft orange clayey sandy silt, wet - top 4-6" may be cave
	26			RUN 3 D 4.5 C 0.5 CL 4.9							
				- 71					- gray siltite cobble - 3"		
	28			RUN 4 D 4.5 C 1.3							in cobble - no SPT - drill fluid seeping from road ~8' from hole
	30			CL 3.2					- 7" siltite piece		
	32	SPT 6		- 29 7 8 6							SPT 6 7-8-6 no Rec - check valve is plugged
	34			RUN 5 D 5.0 C 0.5					matrix mat'l (sandy silt) is lt grayish brown		only lge gravel pieces, w/ minor matrix mat'l recovered
	36			- 10							
	38	SPT 7		5 27 37							SPT 7 5-27-37 ~2" Rec - watery mud
	40			RUN 6 D 5.5 C 4.3					SILTY GRAVEL w/ SAND (GM) ~65% Gravel & cbl Cobble angular, ~hard siltite ~20% Sand, 15% Silt - orange		

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET ~ OF ~ | HOLE NO. DH-49

PROJECT			JOB NO. 8029	HOLE NO. DH-49
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INJ-ITIES TYPE	DISCONT INJ-ITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			RUN6						(ctd) SILTY GRAVEL w/ SAND (GM)		
	42			-	79					- most fines & sand apparently washing out of cores (core loss)		
		SPT 8		11 12 28								SPT 8 11-12-28 12" Rec - stiff sandy silt w/ Gravel
	44			RUN7 D 5.5 C 2.9		BOX 1						
	46											
	48			-	53							
		SPT 9		21 16 25								SPT 9 21-16-25 2" Rec - Qtzite gravel pieces w/ silty Sand
	50			RUN8 D 5.0 C 2.7								
	52											
				-	54							
				RUN9 D 2.5 C 2.1		BOX 2						
	54											
				-	84							
	56			RUN10 D 3.5 C 3.0								Drill Rate 0.42 ft/min
	58											
				-	86							
				RUN11								
	60											

PROJECT		JOB NO.	HOLE NO. DH-49
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INJ-ITIES TYPE	DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	60			(RUN 11)		2				(ctd) SILTY GRAVEL w/ SAND (GM)		
				D 5°								
				C 5°								
				LP 12"						BEDROCK - Lt Orange SILTITE - most breaks are along ~regular relict bedding (~15° ∡) - some near-vertical regular joints, - top 1' is v. fractured, weathered - occ'l weathered pyrite cubes (~1/16"-1/8") -65' to BOH - mostly lt grey & lt pink		
	62											
				54	100							Packer Test 1 (63°-69°)
	64			RUN 12		3						
				D 5°								
				C 5°								0.5 gpm at 60 psi
	66			LP 8"								
	68											
				30	100							
										69' = BOH		
	70											Install Piezometer: - 10' #20 Slotted PVC 1" pipe on bottom - 12' No. 8 Sand - 2' Bentonite
	72											
	74											
	76											
	78											
	80											

MORRISON-KNUDSEN ENGINEERS, INC. SHEET ... OF ... HOLE

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-50
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 9/28 -	HOLE SIZE: 8" / HQ	ORIENTATION: VERTICAL
LOCATION: NEW DIVERSION DAM	ELEVATION: 3675.3	DEPTH TO WATER: Artesian	DEPTH TO ROCK: 45.0'
DRILLING CONTRACTOR: J.D. WELSH (Driller: S. Corn)	SAMPLES	CORE BOXES: 4	DEPTH OF HOLE: 60.0'
DRILL MAKE - MODEL: ACKER AD-II	LOGGED BY: E. [illegible]	REVIEWED BY: C. F. Slater	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0									Lt brn SILT (ML) w/occ'l subangular cobbles; roots		Dense conifers ~50' high - using 8" O.D. Auger - frequent grinding on gravel/cobbles
	2											
	4											
	6	SPT 1	8" O.D. Auger	6 11 12						Lt gray & lt brn Sandy SILT w/ Gravel (ML) - sltly moist ~ T clay(?) - some orange iron staining ~ 60% silt ~ 15% Sand ~ 20% Gravel - Subangular, siltite, mostly fine, ~unweathered		SPT 1 6-11-12 (18" Rec.)
	8											
	10	SPT 2		15 18 31						As Above - sltly more gravel, one larger piece		SPT 2 15-18-31 (16" Rec)
	12			RUN 1 D 5.0 C ~4.3						(Gray siltite) SILTY GRAVEL w/ SAND (GM) - lt brn silt ~ 50% Gravel, subangular, mostly fine ~ 30% silt ~ 15% sand ~ 5% clay ? - occ'l siltite cobble		begin HQ coring at 10.0' - using "clear Mud" ~ 1:1000 in drill water Drill Rate: 0.58 ft/min
	14			- 86		BOX 1						
	16	SPT 3		3 7 9								SPT 3 3-7-9 - mat'l is wet (14" Rec.)
				RUN 2 - -30								
	18	SHELBY #1		RUN 3 D ~3.0 C 2.0						- sltly less gravel (~35%) more silt (~45%) ⇒ GRAVELLY SILT w/ SAND (ML)		SHELBY #1 (17" Rec.) Hole caved - ~top 1' is caved mat'l - bottom of tube is crushed
	20			- 67								

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 1 OF 2 | HOLE NO.

PROJECT			JOB NO.	HOLE NO. DH-50
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20			RUN 4						(cont'd) GRAVELLY SILT w/ SAND (ML)		Attempt SPT 4 at 20.0' but hole has caved ~4'
				D	5.0							
				C	3.7							
	22			CL	1.3	BOX 1						
	24											
					74							
				RUN 5								
	26			D	5.0							
				C	2.8							
				CL	2.2							
	28					BOX 2						
					56							
	30			RUN 6								Attempt SPT at 30.0 - hole has caved 2½'
				D	5.0							
				C	3.1							
	32			CL	1.9							Drill Rate: 0.58 ft/min
	34									more sandy, orange iron staining		
					62							
				RUN 7						~35.0 - 38.0 Lt orange SILTY GRAVEL w/ SAND (GM)		
	36			D	5.0					~40% silt, slt clay?		
				C	3.0					~20% sand		
										~35% angular, mostly weathered gravel		~70% Drill Water return - lt. brown color
	38											
	40				60							

PROJECT			JOB NO.	HOLE NO. DH-50
SITE	DATE - STARTED FINISHED		HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER		DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES		DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER		REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			RUN 8						(ctd) Lt. orange GRAVELLY SILT w/ SAND (ML)		
				D 5°								
				C 3°								
	42			CL 1'								
										BEDROCK - Lt greenish brown and lt pink SILTITE - occly v. weathered to 45°' - ~hard, smooth core - most breaks along relict bedding (~20° ∡) - some regular n. vertical fractures		
	44											
				-	78	BOX 3						
				RUN 9								
	46			D 5°								
				C 5°								
	48			LP 8"								Drill Rate ~0.50 ft/min Packer Test 1 (45° - 60°) 2.9 gpm at 30 psi (~10 psi artesian pressure)
	50			30	100							
				RUN 10								
				D 5°								
				C 3.5								
	52									← med gray piece ~52.5° - 55° Weathered, v. broken, orange iron staining - core loss		
				CL 1.5								
				LP 6"								
	54											
				40	70							
				RUN 11								
				D 5°		BOX 4						
	56			C 5°								
				LP 16"								Install Piezometer: - 10' No 10 Slotted Sched. 80 PVC (1" Diam) on Bottom - 15' No. 8 Sand - 3' Bentonite
	58											
				62	100					60° (BOH)		
	60											

MORRISON-KNUDSEN ENGINEERS, INC.

SHEET 2 OF 2 | HOLE NO. DH-50

PROJECT: MONTANORE		JOB NO. 8029	HOLE NO. DH-51
SITE: LITTLE CHERRY	DATE - STARTED FINISHED: 9/26 - 9/27/90	HOLE SIZE: 8"/HQ	ORIENTATION: VERTICAL
LOCATION: NEW DIVERSION DAM	ELEVATION: 3671.1	DEPTH TO WATER: Artesian	DEPTH TO ROCK: ~20'
DRILLING CONTRACTOR: J.D. WELSH (Driller - S. Corn)	SAMPLES	CORE BOXES: 2	DEPTH OF HOLE: 45'
DRILL MAKE - MODEL: ACKER AD-II	LOGGED BY: E. RENNAT		REVIEWED BY: CF Slater

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	0								Lt brn SILT(ML) w/occ'l subangular cobbles; dry; roots		Dense conifers ~50' high; can't go farther E because of soft ground - seeping
	2										
	4										
	6	SPT 1		3 12 9					V light gray Gravelly SILT (ML) - damp to wet		SPT 1 3-12-9 11" Rec.
	8	SHELBY #1	8" O.D. AUGER						Sieve Analysis: 29% Gravel 18% Sand 53% Fines		SHELBY #1 (7'-9') - pushed 2' - 9½" Rec.
	10	SPT 2		9 8 17					Orange brown Silty SAND w/ Gravel (SM) 10% clay? 20% Silt 40% Sand 30% Gravel - subangular to angular, weathered - orange iron staining - damp to wet		SPT 2 9-8-17 18" Rec
	12										
	14	SPT 3		50/5"					Orange GRAVEL w/ SILT & SAND (GP-GM) - wet - iron stained - angular gravel - 10% Silt - 20% Sand - 70% Gravel		SPT 3 50/5" Rec. ~4"
	16										
	18								— possible weathered bedrock		~17'-19' cuttings are sandy silt; soft, wet
	20										

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SHEET 1 OF 3 | HOLE NO. DH-51

PROJECT		JOB NO.	HOLE NO. DH-51
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/RQD	RECOVERY	BOX	DISCONTINUITIES TYPE	DISCONTINUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS, STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	20	SPT 4	8" O.D. AUGER	50/4½"						Orange GRAVEL w/ SILT (GW-GM) ~ T clay ? -wet ~ 10% silt ~ 10% sand ~ 80% Gravel: angular, weathered - may be weathered bedrock		SPT 4 50/4½" - 4" Rec hard augering
	22											
	24											
	26	SPT 5		37 50/5½"								SPT 5 37 - 50/5½" (~11" Rec)
	28											
	30	SPT 6		50/3" RUN 1 D 5° C 4° LP 10"						Lt orange SILTITE (bedrock) ~ hard, smooth - most breaks along fairly regular relict bedding (~20° ∡) - more weathering & iron staining along some breaks, softer mat'l		SPT 6 50/3" 3" Rec. (30° - Begin HQ Coring) Using "Clear Mud" ~ 1:1000 in drill water
	32											
	34						HB			34° - 36⁴ Lt gray & lt purplish color harder - more siliceous		- 34° drill fluid changes color from lt orange-tan to lt gray
	36			70 98 RUN 2 D 5° C 4° LP 9"		BOX				36⁵ - 39° soft, orange broken siltstone; some clay/silt material especially in joints/fractures		~ 37° - 39⁵ drill water turns darker orange-brown increased drill rate
	38											
	40			26 98		BOX 2						

PROJECT		JOB NO.	HOLE NO. DH-51
SITE	DATE - STARTED FINISHED	HOLE SIZE	ORIENTATION
LOCATION	ELEVATION	DEPTH TO WATER	DEPTH TO ROCK
DRILLING CONTRACTOR	SAMPLES	CORE BOXES	DEPTH OF HOLE
DRILL MAKE - MODEL	LOGGED BY ER	REVIEWED BY	

ELEV.	DEPTH	SAMPLER	CASING	SPT/ROD	RECOVERY	Box	DISCONT INUITIES TYPE	DISCONT INUITIES DIP	SYMBOL	MATERIAL DESCRIPTION (NAME, COLOR, CONSISTENCY, GRAIN SIZE, PLASTICITY, CLASSIFICATION, WEATHERING, HARDNESS, STRUCTURE)	WATER DATA	REMARKS (SAMPLING, DRILL ACTION, WATER LOSS, CORE LOSS; STANDARD PENETRATION, WATER PRESSURE TEST, LAB CLASSIFICATION, PIEZOMETERS)
	40			RUN 3						(ct'd) Lt orange SILTSTONE, occ'l thin (~1/4") gray layers; some irreg. fractures, some regular fractures along relict bedding		Drill Rate: 0.42 ft/min
				D 5°								
				C 4 1/2								
	42			LP 3 1/2"		Box 2						Packer Test 1 (33° - 45°) 0.7 gpm at 30 psi
	44											
				0	96							
										BOH - 45°		
	46											
										Install Piezometer: - 10' No. 10 Slotted Sched. 80 PVC on bottom - 12' No. 8 Sand - 2.5' Bentonite		

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SHEET 2 OF 2 HOLE NO. DH-51

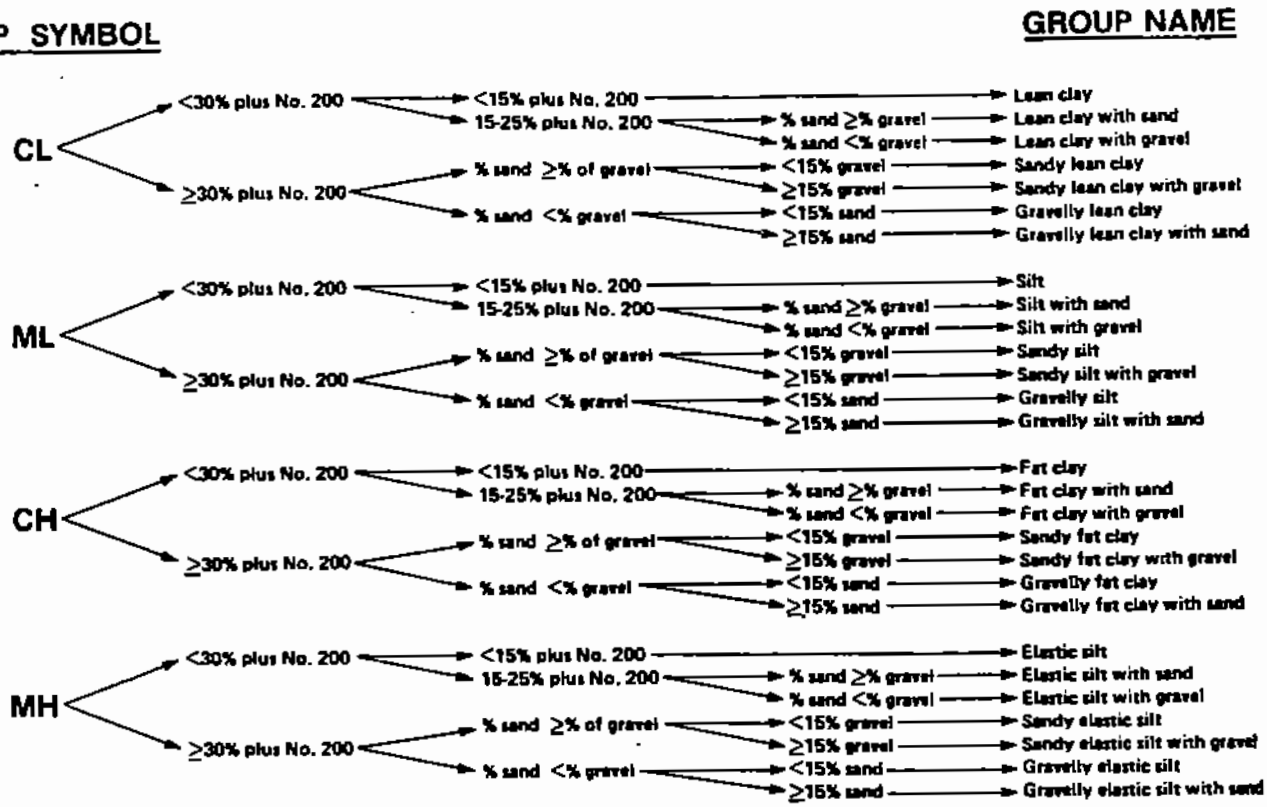
APPENDIX B
TEST PIT LOGS

APPENDIX B
TEST PIT LOGS

The bulk of the 1990 exploration test pits were excavated by a Caterpillar/Mitsubishi E120 trackhoe with a 3-foot-wide bucket and were logged by an MKE geotechnical engineer. Test pits TP-247, -248, -249, and -250 were excavated by a John Deere 410 backhoe with a 2-foot wide bucket and were logged by a Noranda geologist. The pits were one bucket width wide, 10 to 20 feet long and at least 12 feet deep unless refusal on boulders or bedrock occurred. Representative soil samples were taken from each test pit. Generally, 50 to 60 pound samples were taken from the sides of test pits and placed in bags. Boulders and cobbles larger than 4 or 5 inches were not included in the samples. Approximately 1 pound of soil was also sealed in a separate plastic bag for moisture content determination. All pits were backfilled with the deeper soils first and topsoil (if any) last. The ground was then smoothed and compacted by backhoe. Test pit locations were surveyed by others, or were visually located.

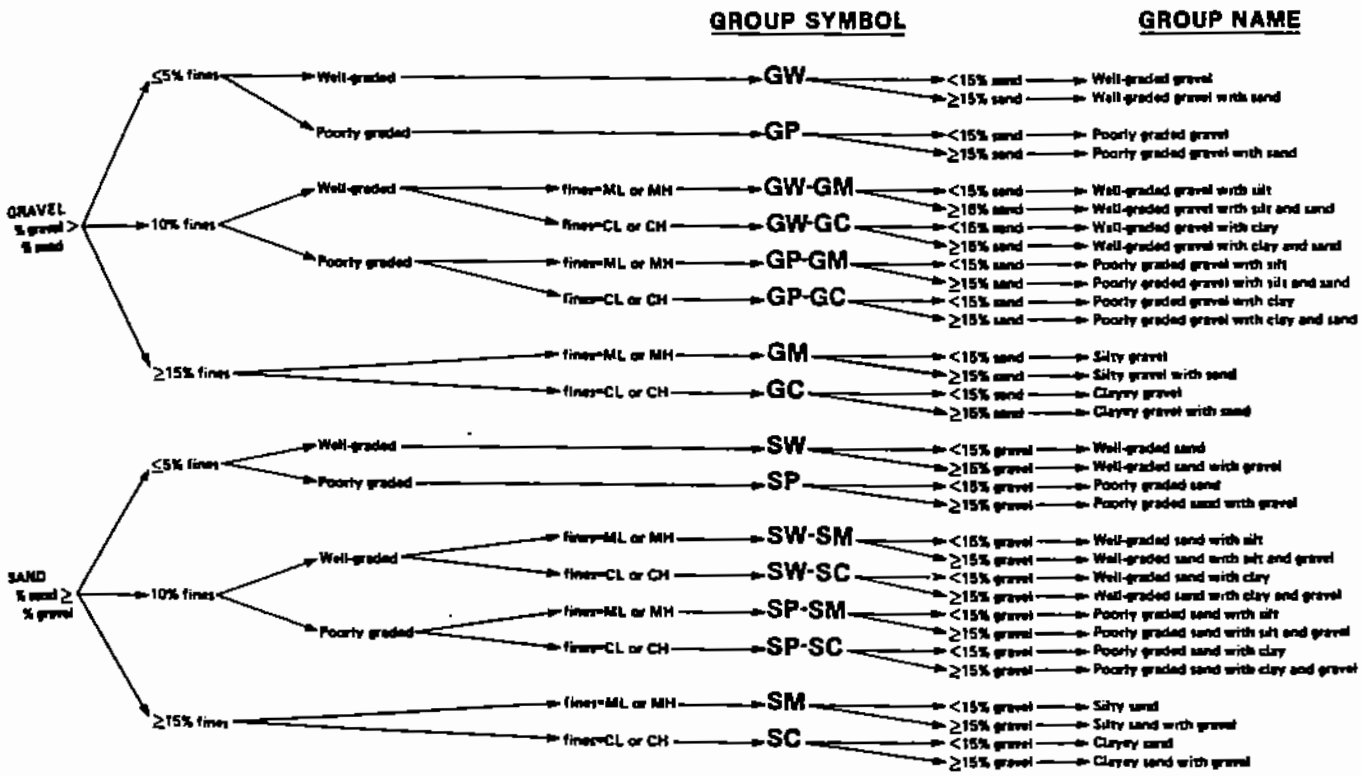
Information entered on the test pit logs included soil type, color, moisture, density or consistency and plasticity. For gravel size material and larger, rock type, angularity and degree of weathering were also noted. Other items such as the presence of roots, the difficulty of excavation and zones of water inflow were noted as well. Estimates were made of the percentages of cobbles, gravel, sand and fines and visual classification of the samples was made in conformance with ASTM D2488 (Figure B-1).

NOTE: Due to difficult access, test pits TP-218, -221, -222, -223 and -232 were not excavated and consequently no logs exist for these test pits.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

Figure B-1 Visual Soil Classification System (ASTM, 1984)

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA A	8029	TP-201

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		8/30/90 16:29	17:22			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - orange-brown, slightly moist - some subrounded cobbles ~10% Clay, 70% Silt, 10% Sand; 10% Gravel & Cobbles	Among spruce & cedar trees to >80' high; duff at surface, little vegetation
1				
2			A.A. lt. tan color ~10% Gravel	All contacts are gradational
3				
4	1		Silty GRAVEL with Sand (GM) - orangish color - subrounded gravel & cobbles; some is v. weathered to v. stiff silt/clay.	Sieve Analysis: 32% Gravel, 20% Sand, 29% Silt, 19% Clay-size (48%) LL = 22 PI = 5
5				
6			A.A. more gravel & cobbles; often broken by excavation	Very hard digging
7				
8	2			
9			T.D. = 8 1/2'	
10				
11				

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-201

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA C	8029	TP-202

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe	3' x 14'	8/31/90 8:21	9:25			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Gravelly SILT with Cobbles (ML) - lt. brown, sltly moist - ~5% clay, 10% sand, 60% silt, 10% Gravel, 15%+ Gravel - Gravel & cobbles are subangular; mostly siltite; some v. weathered	Old clearcut area; bushes & conifer trees, ~8' high
1			A.A. - whitish to lt. tan color; occ'l patch of iron staining - sltly moister - just barely 'clumps' in hand	
2				
3				
4			A.A. - med brown color - more cobbles w/ depth (~30%) - occ'l boulders up to 2' in size, angular	
5				
6				
7				
8	1			
9				
10				
11			TD = 12'	Refusal at 12' on boulders

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-202

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA C	8029	TP-203

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		8/31/90 9:46	11:05			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT (ML) - lt. to med brown ; sltly moist - small roots - occ'l cobble	Old clearcut area : dense bushes, mixed trees up to 20' high
1			Gravelly SILT with Sand and Cobbles (ML) ~ trace clay ~ 40 % silt 10 % Sand 15 % Gravel 25 % Cobbles } subangular to Subrounded 10 % Boulders	V. hard digging
2				
3				
4			grades into Silty GRAVEL with Sand (GM) - up to 50% cobbles & boulders at depth - lt. to med. brown color	
5				
6				
7				
8				- digging is sltly easier at 8'
9				- 2'x2'x3½' gray siltite boulder at 9'
10	1			Sieve Analysis : 7% Cobbles 30% Gravel 28% Sand 35% Fines
14			TD = 14'	

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-203

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA B	8029	TP-204

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		8/31/90 12:01	12:58			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Gravel and Cobbles (ML) - roots - occ'l boulder, trace clay	Old clearcut area: dense bushes & mixed trees up to 15' high
1			grades into: Silty GRAVEL with Sand & Cobbles (GM) - whitish color with patches of orange iron staining - occ'l small roots	
2				
3			A.A. - lt brown color - slight clay with depth (~10%) - up to 50% cobbles & boulders with depth; subangular, occ'ly tabular	- V. hard digging
4				Sieve Analysis: 3% Cobbles 39% Gravel 18% Sand 40% Fines
5	1			
6				
7				
8				
9				
10			T.D. = 10'	- 2 boulders (~1'x2'x2½') near bottom Refusal on Boulders
11				

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-204

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA A	8029	TP-205

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe	3' x 8'	8/30/90 9:16	10:24			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Gravelly SILT with Sand and Cobbles (ML) - light orange-brown color - small roots - slightly moist	Old clearcut area: grasses, mixed trees up to 20' high, some cobbles at surface
2–5	1		A.A. - light tan color - up to 20% cobbles & small boulders (mostly subrounded)	Sieve Analysis: 24% Gravel 23% Sand 53% Fines
5–9	2		A.A. - med. brown - increased clay content; often as hard clods; est'd up to 30% clay - increased cobbles & boulders (~35%)	Atterberg Limits: LL = 21 PI = 3 v. hard digging
9			T.D. = 9'	Refusal on Boulders
10				
11				

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-205

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA A	8029	TP-206

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY
C. NOBLE	CAT E 120 Trackhoe		9/3/90 8:50	9:53		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - medium orange-brown - occ'l gravel & cobble - roots - dry to sltly moist	Old clearcut area; relatively open; grasses & occ'l bushes; mixed trees up to 15' high
1				
2			A.A. - whitish & orange color - few roots - ~15% Cobbles, 10% Gravel, 15% Sand, 50% Silt, 10% Clay	
3			A.A. - med. brown color - sltly moist - ~25% Cobbles & Boulders, 20% Gravel, 10% Sand, 25% Silt, 20% Clay } subangular, some black stains on surfaces	- hard digging beyond 3' - penetrometer on matrix material: >5 tsf
4				
5				
6				
7	1			
8				
9			- more cobbles & boulders with depth	
10				
11			T.D. = 10½'	

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-206

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA C	8029	TP-207

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/1/90 9:47	10:36		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT (ML) – orange-brown – with Gravel & Cobbles, Roots	Old clearcut area; dense bushes; mixed trees up to 20' high
1			COBBLES & BOULDERS with Silty Gravel with Sand (GM) – mostly gray siltite; subangular – matrix material does not "clump" in hand – ~60% cobbles & boulders	– largest boulder 1½' x 3' x 5'
2				
3				
4				Sieve Analysis (on –5" material): 31% Cobbles 31% Gravel 21% Sand 17% Fines
5	1		A.A. – lt brown color – up to 80% cobbles & boulders	
6			T.D. = 6'	Refusal on Boulders & Cobbles
7				
8				
9				
10				
11				

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-207

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA C	8029	TP-208

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY
C. NOBLE	CAT E 120 Trackhoe		8/31/90 14:26	9/1/90 9:35		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0	1*		Sandy SILT with Gravel & Cobbles (ML) - lt. brown color - slt'ly moist - small roots	Old clearcut area: dense bushes, mixed trees up to 20' high
1			Silty GRAVEL with Sand (GM) (gradational contact) - whitish to lt. tan color - coarse material is subangular to subrounded - ~20% cobbles & occ'l boulder (max size = 2 1/2')	Sieve Analysis (1-3')* 3% Cobbles, 34% Gravel, 27% Sand, 36% Fines ~14:30 Hoe is running out of fuel - continue pit on 9/1/90 8:28 A.M. - new teeth on bucket; digs better than on previous pits
2	2*			
3				
4			A.A. - lt. brown color - more cobbles & boulders with depth (~60% at bottom)	
5				
6				
7				
8				
9	3*			
10				* No +4" material in samples 1 & 2, no +6" material in sample 3
13			TD = 13'	

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-208

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA B	8029	TP-209

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		8/31/90 13:09	14:06			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Gravel & Cobbles (ML) - angular cobbles - small roots - Lt. orange-brown	Old clearcut area: bushes, grasses, mixed trees to 20' high; partly open area; some cobbles at surface
1				
2			grading to: Silty Gravel with Sand (GM) - whitish and orange (iron stained) color - some clay & silt from weathering of rocks	
3			- ~10% cobbles & occ'l boulder (2' maximum size)	- one quartzite cobble - rounded, ~ tabular - ir
4				
5			A.A. - medium brown color	Sieve Analysis: 32% Gravel 27% Sand 41% { 29% Silt, 12% Clay-size }
6				
7	1			Note: Sample contained no cobble size material or larger
8				v. hard digging
9				
10			T.D. = 9½'	Refusal on boulders & cobbles
11				

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-209

EH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA B	8029	TP-210

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe	3' x 13'	8/30/90 11:50	13:09	—		E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT (ML) - small roots - orange color	Old clearcut area: grasses; trees to 20' high
1	1		Silty GRAVEL with Sand & Cobbles (GM) - whitish color - subangular particles (SILTITE) - occ'l boulders - 2 large slabs 8" x 2' x 2½' 7" x 2' x 2'	Sieve Analysis*: 11% Cobbles 19% Gravel 22% Sand 48% Fines * Note: No large cobble or boulder size pieces in sample
2				
3				
4				
5			A.A. - med brown color - more cobbles (~40%) and boulders (~10%) with depth	
6				
7				v. hard digging
8				
9				
10				
11			TD = 11'	

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-210

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA A	8029	TP-211

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe	3'x10'	8/30/90 10:36	11:34		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT (ML) - roots - orange colored	Old clearcut area: mixed trees up to 20' high; grasses
1			Sandy SILT with Gravel & Cobbles (ML) - Whitish to lt. brown color - ~20% angular cobbles - barely 'clumps' in hand	
2				
3				
4	1		Gravelly Lean CLAY with Sand (CL) - med. brown color, some black surfaces - v. stiff	v. hard digging Sieve Analysis: 5% cobbles 18% Gravel 17% Sand 60% Fines LL = 31 PI = 14
5				
6				
7				
8				
9				
10				
11			TD = 11½'	v. hard digging

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-211

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA C	8029	TP-212

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/1/90 11:01	12:00			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - lt. orange-brown - roots - occ'l gravel & cobbles	Small clearing in v. dense bushes & mixed trees (up to 20' high); ferns & grasses at surface
1			A.A. - whitish color Gravelly SILT (ML) - more gravel & cobbles: ~25% cobbles, 15% Gravel, 10% Sand, 40% Silt, 10% Clay	
2				
3			Sandy Lean CLAY with Gravel and Cobbles (CL) - Orange reddish brown color - stiff - ~20% cobbles, occ'l boulder - clay is often from v. weathered rocks, with occasional black stained surface - occ'l boulder	
4				
5				Pocket Penetrometer: all readings >5 tsf
6	1			Sieve Analysis: 18% Gravel 20% Sand 62% {34% Silt, 28% Clay-size} LL = 36 PI = 16
7				
8			A.A. - gradually changes over 2' - brownish color - less clay, more gravel (~20%) & cobbles (~20%)	
9				
10				harder digging at 10'
13	2		T.D. = 13'	Sample 2 : 12'-13'

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-212

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA C	8029	TP-213

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY
C. NOBLE	CAT E 120 Trackhoe		9/1/90 12:16	13:47		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Gravel (ML) - med brown - fine roots - ~dry	At end of overgrown road in dense bushes & mixed trees;
1			Silty GRAVEL with Sand and Cobbles (GM) - White and orange color, some in 2" layers - occ'l boulders - sltly moist - mostly coarse & medium gravels - particles are subrounded to subangular	
2				- subrounded, sltly tabular siltite boulder at 2'-3' (1½ x 3' x 5')
3				
4				- easier digging than previous pits
5			A.A. - med. brown color - more cobbles with depth, up to 40%	- some fines are from v. weathered cobbles & gravel
6				
7	1			Sieve Analysis: 8% Cobbles 33% Gravel 22% Sand 37% Fines
8				
9				
10				- hard digging past 10'
12			TD = 12'	

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-213

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA B	8029	TP-214

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe	3' x 16'	8/30/90 13:20	14:30		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Gravel and Cobbles (ML) - orange color - ~20% subangular, gray siltite cobbles	Old clearcut area : dense bushes & small trees ; ferns
1			Clayey GRAVEL, COBBLES and BOULDERS (GM) - whitish to lt. tan color - ~50% cobbles & boulders	
2				- at ~2½' : 1½' x 3½' x 7' slab
3				V. hard digging
4				breaking of rocks during excavation into hard, angular pieces
5				
6	1*			Sieve Analysis:* 11% Cobbles 32% Gravel 18% Sand 39% { 4% Silt 35% Clay-size }
7			A.A. - med. brown color - 50 to 70% cobbles and boulders	
8				
9				
10			T.D. = 10'	Refusal
11				* No +4" material in sample

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-214

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA A	8029	TP-215

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		8/30/90 14:39	16:01		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT with Gravel (ML) - orange-brown - roots	On old road in old clearcut area; grass, small mixed trees; subangular cobbles & gravel at surface
1			Sandy SILT with Gravel (ML) - whitish color - sltly moist, barely clumps in hand - ~ 10% Gravel & occ'l Cobble 15% Sand 60% Silt 15% Clay	- hard digging
2	1			
3				
4				
5			Sandy Lean CLAY with Gravel (CL) - orange color, occ'ly reddish - stiff to v. stiff, comes in hard clods - ~10% Cobbles, more toward bottom	Penetrometer: all > 5 tsf Sieve Analysis: * 10% Gravel, 19% Sand, 36% Silt, 35% Clay-Size LL = 33 PI = 16
6				
7				
8	2*			
9				- large boulder at 9½'; back up hoe
10				
12			T.D. = 12'	* No cobble size material in sample Refusal on boulders

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-215

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	SOUTH SADDLE DAM	8029	TP-216

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/3/90 13:01	13:40		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Gravelly SILT (ML) - Tan color, sltly orange in top 16"; some whitish spots from 1' to 3' - sltly moist - ~Trace clay 70% Silt 10% Sand 20% Gravel & Cobbles - angular, tabular	At edge of drill road among dense pine trees, 30' to 40' high; angular & tabular gravel exposed in road
1				
2	1			
3				
4			SILTITE BEDROCK - weathered & iron stained - brown & black, fresher surfaces are gray - v. angular pieces (~1") - some slickensides with black staining	
5				
6			T.D. = 5½'	Refusal at 5½'
7				
8				
9				
10				
11				

MORRISON-KNUDSEN ENGINEERS, INC.
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T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-216

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	DIVERSION DAM	8029	TP-217A

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/1/90 14:34	15:23			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Gravel (ML) - med to dark brown - occ'l cobble - abundant small tree roots - damp	On drill road, ~160' N55E from DH-31; surrounding dense conifers up to 120' high
1				
2			Silty SAND with Gravel & Cobbles (SM) - Lt. tan, occ'ly whitish color; some orange iron stained portions - damp - sand is angular to subrounded, mostly medium to coarse - ~20% cobbles & small boulders - subangular to subrounded	
3				
4				
5				Sieve Analysis: 7% Cobbles 27% Gravel 28% Sand 38% Fines
6				
7			A.A. - no white or orange areas - more gravel & cobbles with depth ~60% at bottom	
8	1			
9				
10				
11			T.D. = 10½'	Refusal

MORRISON-KNUDSEN ENGINEERS, INC.
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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-217A

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	DIVERSION DAM	8029	TP-217 B

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/1/90 15:51	16:38		6½'	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Organic Soil (OL) - Black-brown color - some silt, roots	~150' WSW of DH-46, among dense cedars & spruces up to 150' high; sparse ferns & mosses on spongy ground
1	1		SILT with Gravel & Cobbles (ML) - med. brown, occ'l orange areas - damp - ~10% Clay 50% Silt 5% Sand 10% Gravel - mostly coarse } subangular to sub-rounded 25% Cobbles	~easy digging
2				
3				
4				
5				
6				
7			A.A. - gray-brown color - more cobbles (~40%) & occ'l small boulder	▽ 6½' - ~5 to 10 gpm water flowing in
8				
9	2			
10				
11				-11'
12			AA. - Angular pieces of v. weathered rock; possible clasts of weathered bedrock T.D. = 12'	

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-217 B

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	DIVERSION DAM	8029	TP-217C

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/3/90 10:16	11:22		4'	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0–3	1		SILT/ORGANIC SOIL (ML/OL) - Dark brown-black at top; med brown from 1'-3' - Damp - abundant roots, esp. in top 1' - Soft	60' NE of DH-46 among dense conifers up to 150' high; moss & ferns on spongy ground. - 2½' Penetrometer: 1.0 to 1.5 tsf
3–14	2		Silty Gravel with Sand & Cobbles (GM) - Tan color, some orange iron stains from 3'-6' - fines are often in stiff clods - particles are subrounded to subangular - Color is grayish toward bottom - ~60% gravel, cobbles & sml boulders toward bottom	▽ - ~5 gpm inflow (no inflow below 5') - pit walls are unstable; sides are sloughing into hole Sieve Analysis: 10% Cobbles, 28% Gravel, 31% Sand, 31% Fines Refusal at 14½'

T.D. = 14½'

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T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-217C

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	DIVERSION CHANNEL	8029	TP-219

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe			9/3/90 14:10	15:11	4'	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - med. brown - moist - roots, occ'l cobble	~315' SIOW of DH-32; along drill road among dense pines ~40' high; small spring is ~20' W of site
2	1		Lean Clay with Gravel & Cobbles (CL) - Brown to orange & white - mostly v. weathered rock w/ orange iron staining - ~50% clay 20% silt 10% sand 10% gravel - mostly angular 10% cobbles - some rounded	easy digging
4				~5gpm inflow
5	2		Silty GRAVEL with Sand (GM) - orange color - wet - mostly angular, ~tabular pieces, $D_{50} \approx 1\frac{1}{2}$" - may be v. weathered & broken bedrock - occ'l cobble; mostly subrounded; grayish	sieve Analysis: 62% Gravel 22% Sand 16% Fines
13				- caving back in

TD = 13 1/2'

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T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-219

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-220

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/3/90 15:23	16:28		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			ORGANIC SOIL (OL) - dark brown - ~dry	Edge of road; dense mixed trees up to ~30' high, small bushes; ~3" of duff
1			SILT with Gravel (ML) - lt. brown - ~10% angular gravel & cobbles - abundant roots - dry to sltly moist	
2			Clayey GRAVEL with Sand (GC) - ~dry - orange with some white patches to 4' - ~15% cobbles - pieces are subangular, weathered, some surfaces stained black; often break/crumble under hand pressure	moderate digging
3				
4				Sieve Analysis: 4% Cobbles, 45% Gravel, 29% Sand, 22% {10% Silt, 12% Clay}
5				
6				
7	1			
8			A.A. - still ~dry - sltly more clay	harder digging pit walls are ~smooth
9				
10				
13			TD = 13'	Refusal on hard, shaly material

MORRISON-KNUDSEN ENGINEERS, INC.
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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-220

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-224

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/5/90 11:15	12:48		16 1/2'	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Gravel & Cobbles - med. brn - roots	on old skid path between dense forest (conifers to 50' high) and partially logged area; bushes, grass & lt tan quartzite/meta-SS cobbles at surface
1			Silty GRAVEL with Sand (GM) - orange-brown color - moist	
2			- ~30% cobbles - mostly subangular, often tabular; mostly gray siltstone, some lighter quartzite	moderate digging
3			- occ'l small tabular boulder (~2 1/2' max dimension)	
4			- more clay with depth, often in clods	
5				Sieve Analysis*: 6% Cobbles 40% Gravel 18% Sand 36% Fines
6	1*			
7				
8				pit walls are rough, but stand up well
9				
10				Water at 16 1/2'
11		16'	TD = 17'	* No +4" material in sample 17' = max. reach

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-224

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-225

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/5/90 10:16	11:07			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT/ORGANIC SOIL (ML/OL) - med. brown - moist - roots	On old skid path; dense conifers up to 50' high; bushes, grass at surface
1				
2			Sandy SILT with Gravel & Cobbles (ML) - tan to lt. brown - moist; clumps in hand - ~10% clay 50% silt 15% sand 10% Gravel, mostly coarse } lt. gray, little weathered, subangular to sub-rounded; often ~tabular 15% Cobbles & occ'l boulder }	
3				
4				
5				
6	1			
7				
8				
9			← Bedrock: Hard, gray SILTITE; <1% fresh pyrite in amorphous 1/8" clumps T.D. = 9'	
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-225

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-226

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/5/90 9:05	10:10			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT with Gravel (ML) - lt. brown color - roots - ~15% angular, coarse gravel	on old road; edge of old clearcut; pine trees to 12' high, bushes.
1			Gravelly SILT with Sand and Cobbles (ML) - Whitish - lt. gray color; orange-pink from 2'-3' - ~dry - ~ Trace clay, 40% silt, 15% Sand; 20% Gravel, 25% Cobbles } angular, mostly weathered	
2				
3			Clayey SAND with Gravel (SM) - orange, weathered - most lge. gravel & cobble sized pieces are angular; break/crumble in hand; pieces show weathered out pyrite cubes; some black surfaces - SILTITE is parent rock	~ easy digging Sieve Analysis: 29% Gravel, 34% Sand, 37% Fines LL = 31 PI = 14 pit walls are smooth; stand up well
4				
5				
6				
7	1			
8				
9				
10				
17			TD = 16½'	- maximum reach of hoe

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-226

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-227

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe						E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - med brown - small roots - sltly moist	
1			Sandy SILT with Gravel & Cobbles (ML) - Whitish and orange (iron stained) color - moist - ~ 5% Clay, 55% Silt } mostly as v. weathered rocks 15% Sand 15% Gravel - subangular 10% Cobbles - subrounded } mostly gray siltite	
2				
3				
4				max particle size : 1½' x 1½' x 2½'
5			Gravelly CLAY with Sand & Cobbles (CL) - less weathered than above - lt. brown color - fines often in stiff clods	Sieve Analysis : 20% Gravel 29% Sand 51% { 23% Silt, 28% Clay-size LL = 21 PI = 6
6	1			
7				hard digging
8				
9			℄ Possible bedrock : hard, gray, SILTITE TD = 9'	Refusal
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-227

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-228

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/5/90 12:58	14:18			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Cobbles (ML) - lt. orange-brown - dry to sltly moist - small & large roots	On old skid path; surrounding conifers to ~50' high; 2-3' high bushes & trees at surface
1				
2			Silty GRAVEL with Sand, Gravel & Boulders (GM) - tan color, occ'ly orange - moist - ~10% clay 15% silt 20% sand 20% Gravel } subangular & subrounded, some weathered 20% Cobbles } 15% Boulders - mostly subangular, ~tabular siltite; max. size 1½'x3'x4'	
3				
4				- slow digging
5				
6	1			
7				
8				
9				9½' to 14' v. hard digging
10	2		A.A. - orange-brown color - more clay (~30%), often as v. weathered rock - no boulders - most rocks are angular, v. weathered (break in hand)	
14				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-228

HEN420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-229

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/7/90 8:53	9:15			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Cobbles (ML) - lt. to med. brown color - dry - roots	At edge of old clearcut; old growth is mixed conifers to ~50' high; dense pine trees to 15' high, bushes & stumps; ~2" of duff, gray siltite cobbles at surface
1				
2	1		A.A. - whitish-tan color - ~ 40% silt 20% Sand 20% Gravel } gray siltite, subangular to sub- 20% Cobbles } rounded, some weathering	
3			Probable Bedrock - gray siltite	
4			T.D. = 4'	Refusal
5				
6				
7				
8				
9				
10				
11				

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T.D = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-229

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-230

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/7/90 10:19	11:28		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - lt brown - occ'l gravel & cobbles - dry - roots	Old clearcut area; mixed trees up to 20' high; ferns, grasses, stumps & logs ~60' NE of small drainage
1			A.A. - lt tan to whitish - dry - ~15% clay 10% Gravel } weathered siltite 55% silt 5% Cobbles } subrounded to subangular 15% sand - occ'l hard grey siltite boulder (small)	moderate digging
2				
3				
4			A.A. - orangish color - moist	pit walls are smooth (3' to 7½')
5	1			
6				
7				
8			Silty GRAVEL with Sand (GP-GM) - lt. to med. brown - moist - ~5% Cobbles - angular to subangular, slt'ly weathered tan & gray siltite	harder digging
9	2			
10				
14			TD = 14'	

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-230

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-231

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/6/90 15:31	17:10		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT (ML) - lt. brown - roots - occ'l gravel	Old clearcut area; dense mixed trees up to 20' high, bushes, stumps, logs, some grass
1			Silty GRAVEL with Sand & Cobbles - lt tan & whitish color - ~Trace Clay 20% Silt 15% Sand 50% Gravel } angular weathered siltite 15% Cobbles } many pieces break in hand	
2				
3	1			
4			A.A. - orange colored - sltly moist - more weathered, more clay	moderate digging
5				
6			≈ Weathered SILTITE bedrock T.D. = 6 1/2'	Refusal
7				
8				
9				
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-231

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-233

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/5/90 14:35	15:51		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - med. brown & lt. orange-brown - sltly moist - occ'l cobbles - roots	Old clearcut area - dense bushes & small trees to 15' high
1				
2			Sandy SILT with Gravel & Cobbles (ML) - lt. tan & whitish - sltly moist - ~10% clay 40% silt 15% sand 15% Gravel } sltly weathered siltite; subangular to subrounded 20% Cobbles } - occ'l small boulder	
3				V. hard digging
4				
5			A.A. - lt brown color - sltly more clay - more cobbles & boulders - moist	Sieve Analysis*: 17% Gravel 24% Sand 59% Fines
6				
7				
8	1*			
9				
10				* No cobble-size material in sample
14			T.D. = 14'	Virtual Refusal

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-233

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-234

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/6/90 12:58	13:59		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT (ML) - Lt. brown to tan - dry, - occ'l gravel & cobbles - roots	Old clearcut area : dense mixed trees up to 20' high, bushes, stumps, logs 1st attempt stopped by > 9' flat, gray siltite boulder at 1' depth - move back & redig
1				
2			Silty GRAVEL with Sand & Cobbles (GM) - lt tan & whitish color - dry - ~Trace clay, 40% silt, 15% Sand, 40% Gravel, 5% Cobbles } angular, weathered	moderate digging
3				
4			Silty Gravel (GM) - lt orange-brown color - ~70% Gravel, 15% Cobbles } angular, often tabular with even surfaces; weathered siltite/meta-sandstone; lt. pink-tan	Sieve Analysis: 8% cobbles, 67% Gravel, 12% Sand, 13% Fines
5	1			
6				
7				
8				
9				
10				
12			← Possible Bedrock	Refusal

TD = 12½'

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-234

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-235

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/7/90 11:58	13:32		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Silty SAND with Gravel & Cobbles (SM)	On edge of logging road in old clearcut; pine trees up to 20' high, bushes; angular gravel at surface
1			- Lt. tan to whitish color	
			- dry to slitly moist	
2			- gravel & cobbles are angular, mostly weathered siltite	
3			A.A. - orangish color	moderate digging
4			- moist	
			- less gravel (~20%) & cobbles (~10%)	
5				Sieve Analysis: 13% Gravel
6				39% Sand
				48% Fines
7	1			
8				Hoe is down from 12:10 - 12:41 for refueling, cleaning off radiator
9				
10		12'		
15			- less gravel, no cobbles toward bottom	- easier digging beyond 12' max reach of hoe

T.D. = 15½'

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-235

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-236

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/6/90 9:02	10:21		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT with Cobbles (ML) - lt. tan color - roots - dry	Old clearcut area : v. dense mixed conifers up to 15' high & bushes ; stumps & logs
1			Gravelly SILT with Sand & Cobbles (ML) - lt tan & whitish color - ~dry - ~20% cobbles ; subangular, some weathering	moderate digging
2				
3			A.A. - lt. brown color - moist	
4			↙ sharp contact	
5	1*		Silty GRAVEL with Sand & Cobbles (GM) - orange color - moist - V. weathered - most fines are from v. weathered rocks going to silts & clays - most pieces break in hand, often along regular relict bedding	- pit walls are smooth, stand up well Sieve Analysis*: 26% Gravel 24% Sand 50% Fines
6				
7				
8				
9				
10				
15			T.D. = 15' (maximum reach from uphill position)	* No cobbles in sample

MORRISON-KNUDSEN ENGINEERS, INC.
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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-236

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-237

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/6/90 10:48	12:20		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT with Cobbles (ML) - Lt brown to tan color - roots - dry - occ'l tabular boulder (small)	Old clearcut area; v. dense mixed conifers to 15' high, bushes; stumps & logs; some gray tabular siltite boulders (avg. 8"x1½'x2') at surface and in top 2'
1				
2	1		Gravelly SILT with Cobbles (ML) - Lt. tan to whitish color - dry - ~Trace clay 40% silt 10% Sand 35% Gravel - mostly coarse } mostly angular with even surfaces; some weathering 15% Cobbles	
3				
4				
5			Silty SAND with Gravel & Cobbles (SM) - orange color - moist - ~10% cobbles - pieces are v. weathered; most break/crumble in hand; soft, angular	Sieve Analysis: 24% Gravel 36% Sand 40% Fines NOTE: Due to high degree of weathering, material would break down to > 80% fines with extensive handling
6				
7				
8	2			
9				
10				
12				v. hard digging at bottom

TD = 12½'

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-237

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-238

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/8/90 14:42	15:20		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT (ML) - lt. brown color - dry - occ'l cobbles - abundant fine roots	Old clearcut area; Dense mixed trees up to 20' high, bushes; stumps & logs, grass
1			Silty GRAVEL with Cobbles (GM) - lt tan to whitish color - dry - ~ Trace clay 25% Silt 10% Sand 40% Gravel } ~angular, v. weathered, many 25% Cobbles } pieces break in hand	moderate digging
2				
3				
4	1		A.A. - orange color - moist - more weathered, more clayey - pieces often break in hand; some are still competent - may be weathered bedrock	
5				
6				
7			TD = 6 ½'	Refusal on probable siltite bedrock
8				
9				
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-238

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-239

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe			9/6/90 15:56	16:13	—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			SILT (ML) - Lt brown color - dry - occ'l gravel & cobble - roots	old clearcut area : dense mixed trees up to 20' high, bushes, stumps, logs; some grass
1			Silty GRAVEL with Sand & Cobbles (GM) - Lt. tan color - dry - ~Trace clay 35% silt 15% sand 30% Gravel } weathered, angular siltite 20% Cobbles } weathered, angular siltite	
2				
3				
4				
	1		A.A. - orange color - moist - more weathered, more silt/clay from weathered rocks - almost all pieces break/crumble in hand, material would be > 80% fines with handling ↖ Probable Siltite bedrock	4'+ - walls are smooth, stand up well
5				
6				
7			T.D. = 7'	- Refusal
8				
9				
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-239

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-240

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/8/90 10:36	11:19			E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - Lt. to med. brown color - roots - dry - occ'l cobble	Old clearcut area; mixed conifers up to 15' high, bushes, stumps & logs; grass, occ'l angular gravel at surface - near top of gentle hill
1			Sandy SILT with Gravel & Cobbles (ML) - Lt. tan to whitish color - angular pieces	
2			Silty GRAVEL with Cobbles (GM) - Lt. orange-brown color - dry to slty moist - comes out as angular gravel/cobbles (~85%) - pieces are ~hard, ~tabular with even faces	
3				
4	1			
5			may be Weathered Bedrock	
6			A.A. - orange color - more weathered - moist	- hard digging; smooth pit walls Refusal
7			TD = 6½'	
8				
9				
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-240

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-241

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/7/90 13:30	14:38		—	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT with Gravel & Cobbles (ML) - Lt. tan to whitish color	Along logging road in old clearcut area: mixed trees to 20' high, dense bushes; some gravel & cobbles at surface
1				
2			A.A. - lt. orange-brown color - moist - ~15% clay } often as stiff clods with 50% silt } black staining 20% Sand 15% Gravel & occ'l cobble	
3				
4				
5	1		- more cobbles (~15%) with depth, fairly unweathered, tabular	hard digging
6				
7				
8			TD = 8'	Refusal on large boulder, possible bedrock
9				
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-241

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-242

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/7/90 16:07	16:47		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - Lt. to med brown color - dry - roots	Old clearcut area; mixed trees to ~15' high, bushes, stumps, logs; some grass
1				
2			Sandy SILT with Gravel & Cobbles - Lt tan to whitish color - dry - ~Trace Clay, 40% Silt, 20% Sand; 25% Gravel, 15% Cobbles } weathered siltite, subangular to angular	moderate digging
3				
4	1		A.A. - orange color - moist	hard to v. hard digging beyond 4'
5				
6			TD = 6'	- refusal
7				
8				
9				
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-242

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-242

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/7/90 16:07	16:47		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - Lt. to med brown color - dry - roots	Old clearcut area; mixed trees to ~15' high, bushes, stumps, logs; some grass
1				
2			Sandy SILT with Gravel & Cobbles - Lt tan to whitish color - dry - ~Trace Clay, 40% silt, 20% sand; 25% Gravel, 15% Cobbles } weathered siltite, subangular to angular	moderate digging
3				
4	1		A.A. - orange color - moist	hard to v. hard digging beyond 4'
5				
6			TD = 6'	- Refusal
7				
8				
9				
10				
11				

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T.D. = Total Depth
A.A. = As Above

SHEET	TEST PIT NO.
1 OF 1	TP-242

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	BORROW AREA D	8029	TP-244

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/7/90 15:10	15:54		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) – Lt. brown color – dry – roots	Overgrown skid path in old clearcut area; trees up to 20' high, dense bushes
1				
2			Sandy SILT with Gravel – Whitish color – dry – ~ Trace Clay 55% Silt 15% Sand 30% Gravel & occ'l Cobble	moderate digging
3				
4			Silty SAND with Gravel & Cobbles (SM) – Lt. orange-brown – pieces are angular; weathered, but relatively hard – ~15% Cobbles	hard digging beyond 4' Sieve Analysis*: 26% Gravel 37% Sand 37% Fines
5				
6				
7	1*			
8				
9				* No cobbles in sample
10			T.D. = 10'	Refusal
11				

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T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-244

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	SOUTH SADDLE DAM	8029	TP-245

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/4/90 8:57	10:01		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - Lt brown color - some organics - dry - roots, up to 4" diameter	Along drill road, among dense spruces & pines up to 50' high ~ 50' W of small drainage ~ 300' S of DH-14
1	1		Sandy SILT with Gravel (ML) - Tan to orange-tan color - dry to moist - ~Trace clay 45% silt 20% Sand 30% Gravel } mostly v. weathered, going to silts & clays, some break in hand, angular, orange & black surfaces; mostly siltite, occ'l quartzite <5% Cobbles }	- easy digging
2				
3				
4				
5				
6			- some cobbles are unweathered, rounded	
7	2		GRAVEL (GP) - probably v. weathered Bedrock - orange color - moist - comes out as mostly angular, hard gravel $D_{50} \approx 1'$	
8				
9				
10				
13			T.D. = 13'	

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T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-245

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	LITTLE CHERRY	SOUTH SADDLE DAM	8029	TP-246

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
C. NOBLE	CAT E 120 Trackhoe		9/4/90 10:16	11:10		–	E. RENNAT

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
0			Sandy SILT (ML) - med. brown - minor gravel - moist - abundant small roots	Along drill road; Conifer trees up to 30' high; grasses, some ferns at surface ~220' SE of DH-4
1			Silty GRAVEL with Sand (GM) - whitish and orange color - moist - pieces are weathered, subangular to angular Siltite	
2				
3			A.A. - orange color	~ easy digging
4				Sieve Analysis: 41% Gravel 34% Sand 25% Fines
5	1			
6			AA - brownish color	
7				
8			← Probable SILTITE Bedrock	
9			TD = 8 1/2' - gray-black color with orange staining - some argillite - breaks into uneven, ~ tabular pieces	
10				
11				

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A.A. = As Above
T.D. = Total Depth

SHEET	TEST PIT NO.
1 OF 1	TP-246

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
MONTANORE	Little Cherry	Seepage collection dam	8029	TP-247

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
NOBEL EX.	BACK HOE J. Deere 410		10/3/90	10/3/90		–	S. Ungermacher

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
	TP247 2'-12'		-very light tan, silty A-B horizon Brown, fairly compacted & stiff silty clay. Low plasticity to medium/good plasticity deeper. This clay appears fairly weathered and is moderately moist. Silty clay shows good microlaminations. Some minor matrix supported, somewhat weathered, subangular to subrounded clasts of dark gray-green siltstone showing microlaminae and possible reduction spots?	* Took photo of excavated material Lab Results: 28% Gravel 25% Sand 47% Fines (non-plastic) (GM) Silty Gravel with Sand
			* sample taken from 2'-12' by backhoe bucket.	In general, soils are low to moderate in plasticity, color is lt. brown to brown - clays tend to be darker. Texture is dense and stiff from ~2'-7' then soft & loose. * TD = 12'

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SHEET	TEST PIT NO.
1 OF 1	TP 247

FH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
Montanore	Little Cherry	Seepage collection dam	8029	TP-248

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
Nobel	Back hoe J. Deere 410		10/3/90	10/3/90		–	S. Ungemach

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
	TP 248 2'-12'		-light tan, dry, soft silt & clay -tan silty clay, very low plasticity grading downward to moderate plasticity. Clasts are matrix supported, subangular gray/green, cobble sized, laminated siltstone. Some of the silty clay matrix appears weathered, showing iron staining. At ~10', clays become fairly plastic. Soil moisture increases with depth. Occasional clast is purple colored siltstone. Toward bottom of pit, some clasts are tan colored and moderately weathered - possibly carbonate (no acid to test!) * sample taken from 2'-12' by backhoe bucket	* Took photo of excavated material Sieve Analysis: 41% Gravel 22% Sand 37% Fines (Non-plastic) (GM) Silty Gravel with Sand Generally, soils are dry to somewhat moist with depth. Color is brown, texture is loose & soft with plasticity increasing with depth. * TD = 12'

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SHEET 1 OF 1

TEST PIT NO. TP-248

HF1420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
Montanore	Little Cherry	Seepage collection dam	8029	TP-249

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
Nobel	Back hoe J. Deere 410		10/3/90	10/3/90		–	S. Ungemach

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
	TP249 1'-12½'		Fine sands and silts, matrix supported gravels and cobbles. Texture is soft & soil is dry. Color is light tan. Some reddish clay with med. to low plasticity. Otherwise soil is generally brown/tan. Cobbles are somewhat weathered, green/gray siltstone and occasional slightly weathered subrounded quartzite cobble. Matrix soil is moist. Clays have moderate to good plasticity. Soil is reddish brown.	* Took photo of excavated material
				Lab Results: 46% Gravel, 26% Sand, 28% Fines; LL = 21, PI = 2; (GM) Silty Gravel with Sand
				Soil is generally dry grading to moist with depth. Soil is mainly loose & soft, color is tan to redish brown. Clasts are mostly green/gray siltstone with darker clay laminations. Some clasts are quartzite.
			* Sample taken from 1' - 12½' by back hoe bucket	* TD = 12½'

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SHEET	TEST PIT NO.
1 OF 1	TP-249

HEH420

TEST PIT LOG

PROJECT	SITE	LOCATION	JOB NO.	TEST PIT NO.
Montanore	Little Cherry	Seepage Collection dam	8029	TP-250

CONTRACTOR	EXCAVATION METHOD	SIZE	BEGUN	COMPLETED	GROUND ELEV.	GR. WATER DEPTH	LOGGED BY:
Nobel	Backhoe J. Deere 410		10/3/90	10/3/90		—	S. Ungemach

DEPTH	SAMPLE NO.	GRAPHIC LOG	MATERIAL DESCRIPTION AND CLASSIFICATION	REMARKS PHOTOGRAPH
	TP 250 2'-11½'		silts & clay, low plasticity, loose & soft, color = tan, dry to slightly moist silts & clay with slightly weathered, subangular to subrounded greenish gray siltstone with dark mud laminae. Some crossbeds in the clasts observed. Soil is moderately moist and reddish tan in color. hit hard rock at ~11½'	* Took photo of excavated material Sieve Analysis: 29% Gravel 24% Sand 47% Fines (Non-Plastic) (GM) Silty Gravel with Sand Generally, soil is soft & loose, tan to reddish tan, and moderately moist. Clasts are subangular to subrounded, greenish gray laminated siltstone with some crossbedding. * TD = 11½'
			*Sample taken from 2'-11½' by backhoe bucket.	

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SHEET 1 OF 1

TEST PIT NO. TP 250

HEH420