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Design Analysis Cover Sheet
Advanced Mixed Waste Treatment Project
W.O. 4875
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PHASE 2 GEOTECHNICAL DESIGN REPORT

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ADVANCED MIXED WASTE TREATMENT PROJECT PHASE 2 GEOTECHNICAL DESIGN REPORT

1.0 INTRODUCTION

Morrison Knudsen Corporation (MK), under contract to British Nuclear Fuels Limited, Inc. (BNFL), is performing engineering and design for the Advanced Mixed Waste Treatment Project (AMWTP) at the Idaho National Engineering and Environmental Laboratory (INEEL). MK has performed site geotechnical engineering investigations and analysis, and has developed geotechnical design recommendations as part of the AMWTP Phase 2 Detailed Design activities.

2.0 PURPOSE AND SCOPE

The purpose of this Geotechnical Design Report is to present data and findings from the site geotechnical engineering investigation and to provide geotechnical design values and recommendations for use by MK in Phase 2 Detailed Design of the AMWTP. The scope of the site investigation, analysis, and report are defined in Specification Section 02010 - Geotechnical Engineering Services (MK, 1998b). The geotechnical activities and report address the following project features:

- Advance Mixed Waste Treatment Facility (AMWTF) Building and Utility Building
- Liquid Propane Gas (LPG) Tank Concrete Pad
- Electrical Substation
- Sewage Lagoon Expansion

Although borrow source investigation, sampling, and testing are beyond the scope of this investigation and report, existing on-site borrow material data have been obtained and are summarized herein.

3.0 PROJECT LOCATION AND FEATURES

3.1 Project Location

The AMWTP site is located within the Transuranic Storage Area (TSA) at the INEEL Radioactive Waste Management Complex (RWMC). The TSA is a 56-acre area located in the southeastern section of the RWMC. The AMWTF Building site is to be located near the center of the TSA, between building WMF-636 to the west and buildings WMF-632 and WMF-633 to the east. The Utility Building site is to be located approximately 70 feet south of the AMWTF Building. The LPG Tank Concrete Pad is to be located approximately 300 feet to the south of the AMWTF, at the northwest corner of the intersection of Road #5 and Road #3. The Electrical Substation is to be located to the east of the LPG Tank Concrete Pad at the northwest corner of the intersection of Road #5 and Road #4. The Sewage Lagoon Expansion

is to be located approximately 1,000 feet to the south of the AMWTF, adjacent to the existing RWMC sewage lagoons.

3.2 Project Feature Descriptions

The project feature descriptions are based on information from Specification Section 02010 (MK, 1998b) and verbal descriptions provided by MK design engineers. Conceptual plans are shown on Sketch GSK-002 attached to this report.

The AMWTF Building is a steel-framed structure with metal siding, cast-in-place concrete interior walls, and a finish floor elevation of 5018 feet. The building height is approximately 60 feet, with plan dimensions of approximately 288 feet by 210 feet. Column loads are 500 kips maximum. The building will house numerous pieces of heavy mechanical equipment, including a 62-ton supercompactor, shredders, a microencapsulator, and an incinerator. The supercompactor differential settlement must be minimized to accommodate its operational requirements and tolerances. Similar settlement restrictions apply to the other equipment.

The Utility Building is a steel-framed structure with metal siding and a finish floor elevation of 5018 feet. The building is approximately 70 feet south of the AMWTF Building. The building will house a boiler and other pieces of heavy equipment. Settlement restrictions for the AMWTF Building also apply to the Utility Building.

The LPG Tank Concrete Pad is a 2-foot-thick, 38.5-foot by 77-foot concrete pad with a top-of-concrete elevation of 5,028 feet. One 30,000-gallon LPG tank and one 15,000-gallon LPG tank will be placed on the pad.

The Electrical Substation comprises a dead-end structure with disconnect switches, a power circuit breaker, a transformer, a grounding resistor unit, and switchgear. Switchgear will be enclosed in a single-story structure with plan dimensions of approximately 20 feet by 26 feet.

The Sewage Lagoon Expansion is a lined pond of approximately ½ acre with a total depth of 9 feet, measured from top of berm to bottom of pond. The pond will be partially excavated into the subgrade, and a containment berm will be constructed above grade to achieve the required storage capacity. One side of the lagoon expansion abuts an existing lagoon berm.

4.0 SITE INVESTIGATION

A site investigation was conducted from May 12 through June 3, 1998. The site investigation was performed under the direction and supervision of an on-site MK geotechnical engineer in accordance with the scope of work outlined in Specification Section 02010 (MK, 1998b). Lockheed Martin Idaho Technologies Company (LMITCO) services were procured by BNFL to perform drilling, trenching, and surveying under MK direction. MK performed field logging of all boreholes and the test trench.

4.1 Site Geology and Hydrogeology

The site is located in the southwestern part of the INEEL in southeast Idaho, and lies in the eastern Snake River Plain. The eastern Snake River Plain is a northeast-trending structural

basin approximately 200 miles long and 50 to 70 miles wide. The site is underlain by a complex layered sequence of volcanic rocks and sedimentary deposits thousands of feet thick. The upper portion of the subsurface sequence is composed primarily of basalt flows and cinder beds with soil interbeds. Individual flows are as thick as 114 feet and are primarily vesicular to dense olivine basalt. Soil interbeds are up to 40 feet in thickness and can contain fine- and coarse-grained soils (Anderson and Lewis, 1989).

The site overlies the Snake River Plain aquifer. Depth to the saturated zone (groundwater) below the site is approximately 600 feet. Perched groundwater beneath RWMC has been encountered by others at depths of about 80 and 210 feet below ground surface (DOE, 1993).

4.2 Drilling and Sampling

The drilling program consisted of 37 boreholes:

- 9 conventional auger and coring holes with soil and rock sampling to depths ranging from 12.0 to 29.0 feet
- 28 air-hammer holes to probe for voids and cavities without sampling to depths ranging from 7.0 to 35.8 feet

The bases for the borehole locations, target depths, and the drilling methods are provided in Specification Section 02010 (MK, 1998b). Table 1 lists actual depths, ground surface elevations, top-of-rock elevations, and locations of the boreholes. The borehole locations, coordinates, and ground surface elevations are also shown on Sketch GSK-002. All boreholes were drilled using an Acker Soil Max drill rig. All boreholes were field-logged by an MK geotechnical engineer in accordance with Quality Assurance Procedure 5.2, Rev. 0 (MK, 1998c). The final borehole logs are provided in Appendix A.

The nine conventional borings were advanced using 7 $\frac{5}{8}$ -inch outside diameter (O.D.) hollow-stem augers in soil and an H-size diamond coring bit in rock. Water was used as the drilling fluid during coring. Soil samples were collected using a 2-inch O.D. split spoon driven with a 140-lb hammer in accordance with ASTM D 1586 at 5-foot depth intervals. Rock was cored to a depth of approximately 20 feet below the top of rock at the AMWTF Building and Utility Building sites, and to a depth of approximately 5 feet below the top of rock at the other sites. Rock core was retrieved in 5-foot runs using a wire line.

Soil samples and rock core were scanned by a LMITCO Radiation Control Technician for alpha, beta, and gamma contamination prior to transport from RWMC. All soil samples and rock core were cleared for transport from RWMC as clean, non-contaminated materials. MK will maintain custody of all samples off site until AMWTF construction is completed. Following completion of project construction, the samples and core can be disposed of off site as clean soil and rock.

The 28 air-hammer borings were advanced into rock using a 3.5-inch hammer bit and compressed air as the circulation fluid. Some air-hammer borings were advanced from ground surface to top of rock using hollow-stem augers while the remainder were advanced through soil and rock using the air hammer, depending on the anticipated depth to top of rock and the anticipated ability of the soil to stand without caving or eroding. Air-hammer borings were typically advanced to depths ranging from approximately 20 feet to 30 feet into rock at the AMWTF Building and Utility Building sites. In some cases, the holes were terminated at

shallower depths due to loss of circulation air. Air-hammer borings were advanced approximately 5 feet into rock at the LPG Tank Concrete Pad, the Electrical Substation, and the Sewage Lagoon Expansion sites. Sampling was not performed in the air-hammer borings, except for a single grab sample of the surficial soils at borehole T-25 at the west end of the Electrical Substation site.

After drilling was completed, all boreholes were abandoned, in accordance with State of Idaho requirements, by grouting to top of rock with portland cement-based grout and backfilling from the top of rock to the ground surface with soil cuttings.

Table 1. Borehole Depths, Elevations, and Locations

Borehole No.	Ground Surface Elevation (ft)	Depth to Top of Rock (ft)	Top of Rock Elevation (ft)	Total Borehole Depth (ft)	Location Description
B-1	5013.11	6.5	5006.61	26.5	AMWTF Bldg. NE Corner
B-2	5012.20	3.3	5008.90	23.3	AMWTF Bldg. SW Corner
B-3	5012.23	4.5	5007.73	24.5	AMWTF Bldg. NW Corner
B-4	Borehole number not used				
B-5	5013.67	2.5	5011.17	22.4	AMWTF Bldg. Center – Supercompactor
B-6	5014.40	4.9	5009.50	24.6	Utility Bldg. Center
B-7	5014.15	9.2	5004.95	29.0	AMWTF Bldg. SE Corner
B-8	5022.08	7.0	5015.08	12.0	LPG Tank Pad Center
B-9	5023.16	15.5	5007.66	20.5	Electrical Substation East End
B-10	5010.82	7.8	5003.02	12.8	Sewage Lagoon Expansion Center
T-1	5013.97	8.0	5005.97	28.0	Utility Bldg. NW Corner
T-2	5013.00	10.8	5002.20	24.8	AMWTF Bldg. Stack
T-3	Borehole number not used				
T-4	5014.84	4.8	5010.04	24.8	Utility Bldg. NE Corner
T-5	5013.37	2.9	5010.47	22.9	AMWTF Bldg. Filter Room
T-6	5013.71	3.5	5010.21	23.5	AMWTF Bldg. Drum Cure Area
T-7	5013.34	3.2	5010.14	33.2	AMWTF Bldg. Microencapsulator
T-8	5011.96	3.8	5008.16	23.8	AMWTF Bldg. West Wall, ~50' S of NW Corner
T-9	5013.90	3.8	5010.10	18.8	AMWTF Bldg. Waste Box Fill Station
T-10	5013.40	1.3	5012.10	21.3	AMWTF Bldg. Brine Moving Tanks
T-11	5014.05	2.9	5011.15	21.0	AMWTF Bldg. East Wall, ~125' S of NE Corner
T-12	5013.51	4.6	5008.91	34.6	AMWTF Bldg. Zone 1 Electrical Room
T-13	5013.80	2.0	5011.80	22.0	AMWTF Bldg. Box Line Conveyor
T-14	5013.37	1.6	5011.77	21.6	AMWTF Bldg. Shredder
T-15	5012.76	1.1	5011.66	21.1	AMWTF Bldg. Incinerator
T-16	5012.25	1.6	5010.65	21.6	AMWTF Bldg. West Wall, ~100' N of SW Corner

Borehole No.	Ground Surface Elevation (ft)	Depth to Top of Rock (ft)	Top of Rock Elevation (ft)	Total Borehole Depth (ft)	Location Description
T-17	5014.09	10.8	5003.29	20.8	AMWTF Bldg. East Wall ~90' N of SE Corner
T-18	5014.33	5.8	5008.53	35.8	Utility Bldg. SW Corner
T-19	5013.46	3.3	5010.16	23.3	AMWTF Bldg. Drum Staging Area
T-20	5013.43	2.2	5011.23	21.2	AMWTF Bldg. Future Shredder
T-21	Borehole number not used				
T-22	5015.05	5.8	5009.25	25.8	Utility Bldg. SE Corner
T-23	5013.42	5.0	5008.42	25.0	AMWTF Bldg. South Wall Mid-Point
T-24	5024.14	7.5	5016.64	13.5	LPG Tank Pad East End
T-25	5020.46	4.6	5015.86	9.6	LPG Tank Pad West End
T-26	Borehole number not used				
T-27	Borehole number not used				
T-28	Borehole number not used				
T-29	5024.69	2.0	5022.69	7.0	Electrical Substation West End
T-30	5012.16	6.0	5006.16	11.0	Sewage Lagoon Expansion NW Side
T-31	5011.15	6.1	5005.05	12.0	Sewage Lagoon Expansion NE Side
T-32	5011.30	6.5	5004.80	12.0	Sewage Lagoon Expansion SW Side
T-33	Borehole number not used				
T-34	Borehole number not used				
T-35	5011.95	6.0	5005.95	11.0	Sewage Lagoon Expansion SE Side
B- : Auger/core hole T- : Air-hammer hole					

4.3 Trenching

A test trench near the center of the AMWTF Building was excavated to the top of rock with a Case 590 Turbo backhoe. The test trench measured approximately 2 feet wide by 36 feet long, with a maximum depth of 3.5 feet. The test trench was field logged by an MK geotechnical engineer and was backfilled the same day. The test trench log is provided in Appendix A.

4.4 Surveying

Prior to commencing the drilling program, all borehole locations were surveyed and staked using the coordinates on Sketch GSK-001 in Specification Section 02010. Following completion of drilling and trenching, as-built locations of all boreholes and the test trench were surveyed under the direction of a Professional Land Surveyor registered in the State of Idaho. Coordinates and ground surface elevations were recorded using the site-specific grid system modified from the Idaho East State Plane coordinate system.

4.5 Quality Assurance

All drilling, trenching, and surveying work by LMITCO was performed in accordance with the technical procedures submitted by LMITCO and approved by MK and BNFL. Field-logging of the soils and rock encountered in the boreholes and test trench was performed by MK in accordance with MK *Quality Assurance Procedure (QAP) 5.2, Rev. 0* (MK, 1998c).

4.6 Safety

Safety meetings, logs, and records were kept daily in accordance with the requirements of the *Geotechnical Investigation Site Safety and Health Plan* (MK, 1998a). No safety incidents or accidents occurred.

5.0 FINDINGS

5.1 General

The as-built locations of the boreholes and test trench are shown in Sketch GSK-002. Table 1 lists the boreholes, the depth to rock, the elevation of top of rock, and the borehole location description. Groundwater was not encountered in any of the boreholes. Additionally, no lava tubes, caves, large voids, or other potentially problematic cavities were encountered in any of the boreholes.

Previously placed fill was encountered in all boreholes. The method by which the fill was placed and degree of compaction (if any) is unknown. Although not encountered in the boreholes, rubble and debris may exist within the fill below the surface. Because of the critical nature of the project structures and to minimize the potential for settlement or subsidence problems, all previously placed fill should be removed and replaced with controlled and compacted fill. The previously placed fill is not suitable for support of foundations or floor slabs

Overall, the site is expected to satisfactorily support the project structures upon implementation of the site preparation activities recommended in this report.

5.2 Surface and Subsurface Conditions

5.2.1 AMWTF Building and Utility Building

The AMWTF Building and Utility Building site is relatively flat with scattered vegetation. The surface drains to the perimeter, but localized depressions create some areas of ponding following precipitation. RWMC facility personnel report that the entire site has been filled and graded on several occasions. The ground surface shows evidence of past grading activities, and the north end of the site has a gravel layer a few inches thick.

The AMWTF Building subsurface profile consists of clay and silt soils overlying basalt. Most, if not all, of the soils are fill. Depth to top-of-rock measurements at multiple points within the building footprint were gathered from the Phase 2 site investigation and from a Lockheed Idaho Technologies Company (LITCO) investigation in 1994 (LITCO, 1994). Based on these two

investigations, depth to rock at boring locations ranges from less than 1 foot to approximately 11 feet below the existing ground surface, typical depth being less than 5 feet. The highest rock surface elevation is near the center of the building and the lowest rock elevations occur at the stack and along the east wall. At boring locations within the Utility Building site, the soil thickness ranges from approximately 5 to 8 feet. The consistency of the soils at both building sites ranges from medium dense/firm to hard. At the time of the site investigation, the soils were moist but the soils are expected to be dry during the summer months. RWMC Facility personnel report that the soil surface becomes extremely soft and muddy during the spring thaw.

The basalt surface is fractured and vesicular. Fracture spacing and vesicle pore size decrease with depth. The test trench near the center of the AMWTF Building allowed a closer examination of the basalt surface, which was found at this location to be relatively smooth with moderately spaced vertical fracturing. Cemented silts and clays fill the vertical fractures, and the vertical fracture opening is approximately ½ inch. Attempts to excavate the basalt surface with a small backhoe demonstrated the fractured basalt blocks can be excavated to a depth of about 2 feet into the rock surface. It is expected that the upper 2 to 3 feet can be excavated without blasting during construction. However, ripping may be required and excavation may be slow.

Loss of circulation air and water during drilling in several holes indicates the fractures and pores in the near-surface vesicular basalt are connected and continuous in some areas. The basalt is relatively young rock, and the near-surface rock in most holes exhibited only moderate weathering. However, in one core hole and in a few of the air-hammer holes, the uppermost 2 to 3 feet of the basalt was very fractured and severely weathered. Lava tubes, large open voids, or other potentially problematic cavities were not encountered in any of the holes.

5.2.2 LPG Tank Concrete Pad

The LPG Tank Concrete Pad site is located on a fill area which slopes downward to the north and west. Gravel fill up to 2 inches thick is visible over much of the surface. The depth to rock varies from approximately 4.5 to 7.5 feet. The soils overlying rock are silts and lean clays with sand. An old aerial photograph of the LPG Tank Concrete Pad site on display at RWMC indicates the northern portion of the Pad site used to be a construction access ramp. Based on this photo, the assumption is that all of the soils are fill.

Rock beneath the LPG Tank Concrete Pad site is basalt. The basalt surface is fractured and vesicular, with the uppermost 2 to 5 feet of the basalt being moderately to highly fractured with soil in-filling. Fracture spacing and vesicle pore size decrease with depth. In borehole T-24 at the east end of the site, a 3-foot-thick soil zone was encountered 3 feet into the rock. Although it is possible that the soil zone is a horizontal interbed, it is probably a vertical crack or crevice which has filled with soil. This conclusion is based on the absence of the soil zone in the other two boreholes at the LPG Tank Concrete Pad site. The excavation should be inspected by a geotechnical engineer during construction.

5.2.3 Electrical Substation

The Electrical Substation site slopes to the east and north. Gravel fill, and scattered cobbles and small boulders are visible at the ground surface. The site has been disturbed and graded in the past. An open void, in what appears to be partially buried basalt rubble, is visible at the ground surface.

The soils overlying rock are sandy silt fill to silty sand fill and lean clay fill. The soil consistency measured in borehole B-9 at the east end decreases from dense to medium dense with depth. This decrease may be due to desiccation of the surface or may be indicative of inadequate compaction of the lower fill materials.

The depth to basalt varies widely. Rock was encountered at a depth of 2 feet at the west end and at 15.5 feet approximately 40 feet away at the east end. The abrupt change in depth to rock may be indicative of the edge of a lava flow or may be the result of previous excavation activities. The uppermost 1 to 2 feet of the basalt is vesicular and moderately fractured with soil in-filling. Fracture spacing and vesicle pore size decrease with depth.

5.2.4 Sewage Lagoon Expansion

The Sewage Lagoon Expansion site is in a local depression adjacent to an existing lagoon, and is bounded on the northeast by an access ramp embankment and on the southeast by a lagoon berm. The embankment and berm slopes are vegetated. The Expansion site bottom has some sparse vegetation and a partial gravel surface with scattered debris and trash. The site has been disturbed and graded in the past.

Total soil depth ranges from approximately 6 to 8 feet, with approximately 1 foot of silt fill at the surface. Below a depth of 1 foot, the soil is lean clay fill. A soft native silt was encountered in one boring below 6 feet.

Rock underlying the site is basalt; the uppermost zone is vesicular and moderately fractured with soil in-filling. No voids or cavities were encountered.

6.0 RECOMMENDATIONS

6.1 Site Preparation and Foundations

6.1.1 AMWTF Building and Utility Building

All soils within the footprints of the AMWTF Building and Utility Building and appurtenant structures should be excavated down to the rock surface to minimize potential differential settlement. All foundation excavations should be inspected by a geotechnical engineer during construction. It is not necessary to remove all in-place or undisturbed fractured rock because much of the fracturing appears to be vertical. Vertical fracturing should not impact vertical load bearing capacity of the rock.

Because the process equipment cannot tolerate differential settlement, reinforced-concrete mat foundations are recommended for both buildings. Each mat foundation should be placed on compacted gravel fill with a 1-foot-thick layer of compacted $\frac{3}{4}$ -inch minus aggregate base course material constructed directly beneath the concrete mat. The combination of the mat foundation and the compacted gravel fill is expected to adequately distribute the building loads across the uneven rock surface, to bridge across any undetected small cavities or voids, and to minimize the potential for differential settlement. As determined by the structural analysis for the mat, individual isolated mass concrete foundations bearing directly on the bedrock surface may need to be considered for particularly heavy and critical pieces of process equipment.

A minimum thickness of 2 feet of compacted gravel fill should be placed between rock and mat to reduce stress concentrations in the mat. The 1-foot-thick layer of aggregate base course material directly beneath the mat comprises part of the 2-foot minimum thickness. As noted above, it is expected that the uppermost 2 to 3 feet of rock can be excavated without blasting. However, excavation of rock may be slow and could require ripping.

The compacted gravel fill beneath the mat foundation should extend past the perimeter of the building a minimum of 5 feet at the ground surface and project down to the rock surface at a slope no steeper than 0.5H:1V to ensure the building load is adequately distributed.

Prior to the site investigation, some consideration had been given to a drilled pier foundation for the AMWTF Building to allow foundation construction activities to proceed during winter. Based on the site investigation findings, a drilled pier foundation may not be an economical alternative. The depth to rock over the majority of the AMWTF Building footprint area is generally between 1 and 5 feet. The uppermost foot of in situ fill soil will be stripped to remove topsoil, vegetation, and trash, regardless of the foundation type used, leaving a minimal thickness of between 0 and 4 feet of in situ fill soil. The in situ fill soil is not suitable for support of floor slabs and will need to be replaced with compacted fill unless a structural slab is used. Additionally, the in situ fill may not have adequate shear strength to provide sufficient lateral resistance for drilled piers. Consequently, drilled piers would have to be socketed into the basalt and the cost may be prohibitive.

6.1.2 LPG Tank Concrete Pad

Spread footings are an acceptable foundation type for the LPG tank support saddles. All soils beneath the bottom of footing elevation should be excavated and replaced with compacted cohesionless fill to the desired footing elevation. Footings may also bear directly on the rock surface. Alternately, the LPG tanks may be supported on the 2-foot-thick structural concrete slab.

Prior to constructing the 2-foot-thick slab, all fill soils should be removed and replaced with compacted cohesionless or cohesive fill. Compacted fill should be placed as needed to bring the subgrade to design elevation beneath the slab. A minimum 1-foot-thick compacted $\frac{3}{4}$ -inch minus aggregate base course layer should be placed immediately below the slab.

6.1.3 Electrical Substation

The conceptual design for the Substation locates the dead-end structure to the east over the deeper rock and the switchgear building over the shallow rock. Consideration should be given to shifting the Substation site approximately 30 feet to the west (or as needed) to find shallower depths to rock. During construction, the areal extent of the shallow rock encountered at the west end of the Substation site can be confirmed with a backhoe to optimize the siting of the Substation features.

All soils beneath the switchgear building should be stripped to expose the rock surface. The recommended switchgear building foundation type is a perimeter stemwall continuous footing bearing directly on rock or on compacted fill brought up to the design grade.

The fill soils beneath the dead-end structure should be excavated and replaced with compacted fill prior to constructing the dead-end structure foundation. Either cohesionless or cohesive fill may be used. Any of a variety of foundation types may be used for the dead-end structure, including spread footings or a mat foundation. A drilled shaft/cast-in-place concrete foundation extended to rock could also be considered for the dead-end structure and would eliminate the need to remove the fill soils. Overturning moments on the dead-end structure can be resisted by the weight of the foundation and overlying soils, buried deadmen with guy wires, rock anchors, or tendons in cast-in-place drilled shafts. Lateral load – deflection curves can be developed for drilled shafts during detailed design if drilled shafts are the foundation of choice for the dead-end structure.

The soils beneath the transformer, circuit breaker, and grounding resistor unit locations at the Substation are suspected fill and should be removed to the bedrock surface and replaced with compacted fill. Individual structural slabs or mats are recommended for these features. A minimum thickness of 1 foot of compacted aggregate base course should be placed immediately beneath these slabs and mats. Either cohesive or cohesionless fill may be placed below the 1-foot layer of base course material.

6.1.4 Sewage Lagoon Expansion

Prior to constructing the Sewage Lagoon Expansion, all previously placed fill should be excavated and replaced, with the exception of the existing berm and ramp embankments to the northeast and southeast which may be left in place. Vegetation should be stripped from the existing embankments prior to placing additional fill. Native soil underlying existing fill in the bottom of the Sewage Lagoon Expansion may be left in place but should be proof-rolled and soft spots reworked and recompact. Clayey soils excavated from the AMWTF Building and Utility Building sites are ideal for use as compacted cohesive fill in the Sewage Lagoon Expansion work.

The berms on the existing sewage lagoons have slopes on the order of 2H:1V to 3H:1V and appear to be stable without appreciable erosion. The Sewage Lagoon Expansion berms should have interior and exterior slopes no steeper than 3H:1V to ensure long-term slope stability and to reduce erosion. Where additional fill is to be placed on the existing fill embankments, the new fill should be keyed in.

6.2 Compacted Fill Materials

Several types of fill are recommended, as described in the following subsections. All fill materials should be free of frozen matter, debris, organics, or other deleterious materials.

6.2.1 Gravel Fill

Gravel fill is a mixture of hard, durable aggregates and meets the following gradation:

U.S. Standard Sieve Size	Percent Passing (by weight)
6 inch	100
3 inch	90 - 100
No. 4	25 - 50
No. 40	0-20
No. 200	0-10

Particles larger than 3 inches should be well distributed throughout the fill. Gravel fill should be placed in lifts not exceeding 8 inches in loose thickness and compacted to at least 95 percent of Modified Proctor maximum dry density, in accordance with ASTM D 1557, or to at least 70 percent relative density, in accordance with ASTM D 4253 and D 4354, whichever is appropriate for the specific material used. The relative compaction requirement for aggregate base course is the same as the requirement for gravel fill.

6.2.2 Cohesionless Fill

Cohesionless fill is sand, gravel, or a combination of sand and gravel, and meets the following gradation:

U.S. Standard Sieve Size	Percent Passing (by weight)
6 inch	100
3 inch	90 - 100
No. 4	25 - 100
No. 200	0-10

Gravel fill described in 6.2.1 is one type of cohesionless fill. Particles larger than 3 inches should be well distributed throughout the fill. Cohesionless fill should be placed in lifts not exceeding 8 inches in loose thickness and compacted to at least 95 percent of Modified Proctor maximum dry density, in accordance with ASTM D 1557, or to at least 70 percent relative density, in accordance with ASTM D 4253 and D 4354, whichever is appropriate for the specific material used.

6.2.3 Cohesive Fill

Cohesive fill contains fines, varying percentages of sand and gravel, and meets the following gradation:

U.S. Standard Sieve Size	Percent Passing (by weight)
6-inch	100
3 inch	90 - 100
No. 200	30-95

Clayey soils excavated from the AMWTF Building and Utility Building sites are suitable for use as compacted cohesive fill. Particles larger than 3 inches should be well distributed throughout the fill. The maximum particle size in cohesive fill placed within 6 inches of the Sewage Lagoon geomembrane must not exceed ½ inch. Cohesive fill should be placed in lifts not exceeding 8 inches in loose thickness and compacted to at least 90 percent of Modified Proctor maximum dry density, in accordance with ASTM D 1557, in the Sewage Lagoon Expansion and to at least 95 percent of Modified Proctor maximum dry density elsewhere on the project.

6.3 Borrow Sources and Materials

Based on information provided by LMITCO (AMWTF, 1998), several potential borrow sources have been identified at INEEL, including the RWMC T-12 Pit, the CFA Gravel Pit Expansion, the Borax Pit, the TRA Pit, the Ryegrass Flats Area, Spreading Area A, and the Howe Junction Blown [sic] Sand Pit. Borrow source reserve quantities and availability of materials for use on the project are unknown, and this determination is beyond the scope of this investigation.

Gradation test results provided by LMITCO show the RWMC T-12 Pit, the CFA Gravel Pit Expansion, the Borax Pit, and the TRA Pit materials are predominantly 3-inch minus pit-run gravels with approximately 30 to 40 percent sand and less than 5 percent fines. The Unified Soil Classification System (USCS) group name for these materials is poorly graded to well-graded gravel with sand. These materials are ideally suited for use as gravel fill for the AMWTF Building and Utility Building and for use as cohesionless fill elsewhere. Haul distance to the project site from the T-12 Pit is about 1 mile, from the Borax Pit about 3 miles, and from the CFA Gravel Pit Expansion and the TRA Pit about 7 miles.

The Ryegrass Flats Area and Spreading Area A are potential sources of cohesive fill. The soils to be excavated from the AMWTF Building and Utility Building sites are also suitable for use as cohesive fill provided they are free of debris, vegetation, organics, or other deleterious materials. Haul distance to the project site from the Ryegrass Flats Area is about 10 miles, and from Spreading Area A about 1 mile.

The Howe Junction Blown [sic] Sand Pit has been identified as a source for poorly graded medium to fine sand with approximately 10 percent fines. Haul distance to the project site from the Howe Junction Blown Sand Pit is about 30 miles.

Another gravel pit is located on Highway 20/26 approximately ¼ mile west of the Highway 20/26-Van Buren Boulevard (RWMC Road) intersection. The pit name is unknown, but a large

quantity of material appears to have been removed from the pit. During a site walkover, the pit materials were visually classified as poorly graded to well-graded gravel with sand, similar to the material found in the other gravel pits described above.

6.4 Frost Depth

Frost depth at the site is 5 feet (DOE, 1997).

6.5 Allowable Bearing Pressures and Foundation Design Parameters

The allowable bearing pressures are conservative, presumptive values based on material properties of fill and rock. The design recommendations are conservative due to the critical and sensitive nature of the project structures. The pressures are based on compaction of fill to at least 95 percent of Modified Proctor maximum dry density as determined in accordance with ASTM D 1557 or to at least 70 percent relative density as determined in accordance with ASTM D 4253 and D 4254.

Table 2. Allowable Bearing Pressures

Material Type	Allowable Bearing Pressure
Basalt bedrock	20,000 lbs/ft ²
Compacted gravel fill placed directly on exposed bedrock	8,000 lbs/ft ²
Compacted cohesionless fill placed directly on exposed bedrock	5,000 lbs/ft ²
Compacted cohesive fill placed directly on exposed bedrock	3,000 lbs/ft ²

A least lateral footing dimension of 3 feet is recommended for footings placed on compacted fill. For footings bearing directly on rock, a least lateral dimension of 1 foot is recommended. The minimum depth of exterior spread footings should be the frost depth of 5 feet or depth to top of rock, whichever is shallower. The edges of the AMWTF Building and Utility Building mats also should extend a minimum of 5 feet below the ground surface. Slabs or mats for the transformer and circuit breaker may be constructed above the frost depth, but seasonal movement should be expected.

Allowable bearing pressures may be increased by one-third for transient live load from wind or earthquake.

6.6 Elastic Design Properties

Typical elastic properties recommended for use in design (Bowles, 1982; NAVFAC, 1986; and ASCE, 1977) are listed in Table 3.

Table 3. Elastic Design Properties

Material Type	Modulus of Subgrade Reaction, k_s (lb/in ³)	Young's Modulus, E_s ($\times 10^6$ lb/ft ²)	Poisson's Ratio, μ
Basalt	1000	300	0.3
Compacted Gravel Fill	300	3	0.3
Compacted Cohesionless Fill	200	1.5	0.3
Compacted Cohesive Fill	100	1.5	0.3

6.7 Total and Differential Settlement

The compacted gravel fill under the AMWTF Building and Utility Building will vary in thickness, but the mat foundations will keep differential settlement small. Elastic deformations of the mats under the design loadings and load configurations will be determined during the structural finite element analysis of the mats. Deformations of sufficiently thick mat foundations are anticipated to be very small.

Settlements of all foundations constructed directly on rock or on compacted gravel fill over rock are expected to be immediate and elastic. Plastic and time-dependent settlements are not anticipated for these foundations.

Settlement of LPG Tank support saddle spread footings is expected to be less than ¼ inch on compacted cohesionless fill over rock. Settlement of the support saddle footings is expected to be negligible if the footings are constructed directly on rock. If the LPG tanks are supported on the structural slab, the settlement is expected to be very small.

Settlement of the Substation switchgear building is also expected to be negligible because it will be constructed directly on rock. Settlement of spread footings under the Substation dead-end structure is expected to be less than ¼ inch on compacted fill. Settlement of mats or slabs under the appurtenant Substation features is expected to be less than 1 inch.

Settlement of the Sewage Lagoon Expansion berms could be as much as 2 percent of the embankment height (NAVFAC, 1986), or approximately 3 inches, if the berms are constructed using cohesive fill. The settlement will be due to compression of the compacted fill embankments under self-weight and is expected to occur slowly. However, this settlement should not adversely affect the performance of the berms or geomembrane liner.

6.8 Lateral Earth Pressure Coefficients and Interface Friction

Typical design lateral earth pressure coefficients (Bowles, 1982) are listed in Table 4.

Table 4. Design Lateral Earth Pressure Coefficients

Material Type	Active Earth Pressure, K_a	At-Rest Earth Pressure, K_0	Passive Earth Pressure, K_p
Cohesionless Fill	0.3	0.5	3.0
Gravel Fill	0.3	0.5	3.0
Cohesive Fill	0.8	0.8	1.5
In situ Soils	0.8	0.8	1.5

The recommended design interface friction values for various material combinations (NAVFAC, 1986) are as follows:

- Mass concrete on clean rock: 35°
- Mass concrete on gravel fill: 30°
- Mass concrete on aggregate base course: 30°
- Mass concrete on cohesionless fill: 28°
- Mass concrete on cohesive fill: 18°
- Gravel and cohesionless fill on rock: 30°

6.9 Soil Unit Weights

Typical soil unit weights (NAVFAC, 1986) recommended for use in design are listed in Table 5. The saturated unit weights are not buoyant unit weights.

Table 5. Design Unit Weights

Material Type	Moisture Condition	Compaction (% of Mod. Proctor Max Dry Density)	Design Unit Weight (lb/ft ³)
Basalt	Moist	N/A	160
In Situ Soil / In Situ Fill	Moist	N/A	115
Gravel Fill and Cohesionless Fill	Moist	95	130
	Saturated	95	140
	Moist	90	120
	Saturated	90	130
Cohesive Fill	Moist	95	125
	Saturated	95	130
	Moist	90	115
	Saturated	90	120

6.10 Excavation Slopes

Excavation slopes within the project site must comply with the requirements of OSHA Standards, 29 CFR 1926, Subpart P - Excavations. An excavation slope of 1H:1V is recommended for design layout purposes; however, the soil type and necessary excavation slope configuration must be verified by a competent person during construction as excavation proceeds.

6.11 Uniform Building Code Soil Categories

6.11.1 1994 UBC Soil Categories

The overall site is categorized below in accordance with Section 1627 of the 1994 Uniform Building Code (UBC), based on the soil profile, Standard Penetration Test blow counts and pocket penetration tests in in situ soils, estimated properties of fill materials, and soil depths:

- In situ soils, compacted fill, and rock: Site Coefficient Type S_1

6.11.2 1997 UBC Soil Categories

The site soils and rock are categorized below in accordance with Section 1636 of the 1997 UBC, based on Standard Penetration Test blow counts and pocket penetrometer tests in in situ soils, estimated properties of fill materials, and weathering and fracturing conditions of the rock:

- In situ soils and compacted cohesive fill: Soil Profile Type S_D
- Compacted cohesionless fill, compacted gravel fill, and the uppermost 2 feet of rock: Soil Profile Type S_C
- Rock at a depth greater than 2 feet below the top of rock: Soil Profile Type S_B , based on an estimated shear velocity in excess of 2,500 ft/sec and the degree of fracturing and weathering encountered

The overall project site following site preparation and fill placement as recommended in this report is categorized conservatively as Soil Profile Type S_C .

6.12 Distance to Active Fault

The distance from the project site to the nearest active known fault was scaled from vicinity maps. The distance from the project site to the southernmost known scarp of the Lost River Fault is approximately 11 miles (LITCO, 1996).

6.13 Cement Type

In accordance with *INEL Guide Specifications* (EG&G, 1992), Type I/II portland cement is recommended.

6.14 Soil Corrosion Characteristics

In accordance with *DOE-ID Architectural Engineering Standards*, Section 0260 (DOE, 1997), buried metal piping should be coated or wrapped to protect against corrosion.

6.15 Soil and Rock Resistivities

Design values of soil and rock resistivities (Bowles, 1982; Hunt, 1984) for design of the Substation grounding system are listed in Table 6.

Table 6. Soil and Rock Resistivities

Material Type	Resistivity ($\Omega \cdot \text{cm}$)
Basalt	250,000
Gravel Fill	250,000
Cohesionless Fill	250,000
Cohesive Fill	150,000
In Situ Fill and Native Soils	150,000

6.16 Geotechnical Review and Inspection

Geotechnical review of the Phase 2 Detailed Design drawings and technical specifications is recommended. If project features are revised from the descriptions contained in this report, the recommendations contained herein will need to be reviewed and may require revision. Also, all foundation excavations should be inspected by a geotechnical engineer during construction.

7.0 REFERENCES

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American Society of Civil Engineers (ASCE), 1977. *Rock Engineering for Foundations & Slopes - 1976*, Proceedings of a Specialty Conference. Volume II. ASCE: New York.

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ADVANCED MIXED WASTE TREATMENT PROJECT
PHASE 2 GEOTECHNICAL DESIGN REPORT

Sketch GSK-002

Appendix A

Final Borehole and Test Trench Logs

Borehole and Test Trench Logs

Explanation of Abbreviations and Descriptive Terms

<u>Sample Type</u>	<u>Definition</u>
SS -	Split Spoon sample / Standard Penetration Test. Results recorded as the number of blows of a 140-lb hammer falling 30 inches required to drive the 2.0-inch O.D. split spoon sampler the last 12 inches of an 18-inch sample interval
Core -	Rock core sample obtained by diamond bit coring
Grab -	Sample of disturbed soil obtained manually from cuttings or by shovel

Note: The lines separating soil strata on the logs represent approximate boundaries only. The actual transition between soil strata may be gradual.

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BOREHOLE LOG

BOREHOLE NUMBER:

B-1

F-B
S-INCL

Sheet 2 of 2

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/13/98 12:45 PM	DATE FINISH: 5/13/98 4:45 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG - NE CORNER (N668411.96, E269217.67)		DRILLING METHOD: ACKER SOILMAX HSA & H-SIZE WIRE LINE ROTARY WASH		
SURFACE ELEVATION: 5013.11'		TOTAL DEPTH: 26.5'	ROCK DEPTH: 6.5'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LIMITCO		BOREHOLE DIA: 7 5/8 HSA, 3 1/2" H CORE	CHECKER: MARK CLOUGH	CHECK DATE: 5/26/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RGD (%)	Rock Type	ROCK	
					BASALT		
					26.5		Bottom of hole @ 26.5'
30							
35							
40							
45							
50							

APPROVED BY/DATE:

Mark Clough 6/30/98

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BOREHOLE NUMBER:

B-2

BOREHOLE LOG

F-BR
S-INCEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/15/98 8:20 AM	DATE FINISH: 5/15/98 10:30 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG - SW Corner (N668131.19, E268999.42)		DRILLING METHOD: ACKER SOILMAX HSA & H-SIZE WIRE LINE ROTARY WASH	
SURFACE ELEVATION: 5012.20'	TOTAL DEPTH: 23.3'	ROCK DEPTH: 3.3'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8 HSA, H SIZE CORE	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery					
						FILL	Fill. (Reworked/disturbed native material with some borrow), sandy lean clay (CL), firm to hard, ~40% fine sand, dry, medium plasticity, trace of gravel up to 2".	
5		CORE-1	98%	(98)			(TOP OF ROCK)	fractures at 5.8'
10		CORE-2	100%	(100)			Basalt, black, vesicular (up to 1 cm pore size), carbonate filling in fractures and pores, slightly weathered, moderate fracture spacing, hard, some vertical fractures.	
15		CORE-3	100%	(100)	BASALT		same as above, pore size decreasing with depth to ~1 mm, trace calcite or carbonate in fractures, some FeO staining in fractures, slightly to unweathered, fracture spacing very wide.	
20		CORE-4	100%	(84)			same as above, pore size varies but about 2 mm typical, very wide fracture spacing, unweathered, FeO staining in larger pores.	
25							same as above, fracture spacing is close to wide, unweathered, some FeO staining.	
							Bottom of hole @ 23.3'	

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BOREHOLE NUMBER:

B-3

BOREHOLE LOG

F-83
S-INCEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/14/98 9:05 AM	DATE FINISH: 5/14/98 12:30 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG - NW CORNER (N668418.58, E269008.06)		DRILLING METHOD: ACKER SOILMAX HSA AND WIRE LINE ROTARY WASH		
SURFACE ELEVATION: 5012.23'	TOTAL DEPTH: 24.5'	ROCK DEPTH: 4.5'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8 HSA, H SIZE CORE	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RQD (%)	Rock Type	ROCK	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor. Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.
					FILL		Fill, Gravel, 2" minus (GP) at surface, changing to medium plasticity clay (CL) at ~3 feet.
5		CORE-1	94%	(70)		4.5	(TOP OF ROCK)
10		CORE-2	100%	(100)			Basalt, vesicular black, slightly to moderately weathered, fracture spacing very close to moderate, hard, carbonate deposits in fractures and adjacent pores, pore size 4 to 5 mm, up to > 1 cm, FeO staining near 4.5'. same as above, slightly weathered to unweathered, fracture spacing is moderate, pore size smaller with depth.
15		CORE-3	100%	(100)	BASALT		same as above, very wide fracture spacing. clay filling seam @ 17.8', FeO staining, unweathered.
20		CORE-4	96%	(96)			clay filling seam @ 22.3', unweathered, wide to very wide fracture spacing.
24.5						24.5	Bottom of hole @ 24.5'

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Fiber Oil 6/30/98

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BOREHOLE NUMBER:

B-5

BOREHOLE LOG

F-28
S-1NEEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/14/98 2:00 PM	DATE FINISH: 5/14/98 4:15 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG NEAR CENTER (N668318.16, E269122.86)		DRILLING METHOD: ACKER SOILMAX HSA AND H-SIZE WIRE LINE ROTARY WASH		
SURFACE ELEVATION: 5013.67'	TOTAL DEPTH: 22.4'	ROCK DEPTH: 2.5'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8 HSA, H SIZE CORE	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery		RGD (%)	Rock Type		
					FILL		FILL. Sandy gravely (GP), changing to sandy clay (CL), ~50% fine sand, medium plasticity, moist, firm.	
		CORE-1	90%	(70)		2.5	(TOP OF ROCK)	Circulation loss @ ~4'
5		CORE-2	90%	(22)			Basalt , vesicular, black, some FeO staining, moderately weathered, close to moderate fracture spacing, abundant carbonates and other deposits in seams and fractures, some fractures oriented vertically.	
10		CORE-3	100%	(100)	BASALT		same as above, core is fractured vertically with silty sand and caliche in filling, moderately weathered, moderate fracture spacing.	
15		CORE-4	100%	(82)			same as above, very wide fracture spacing, slightly weathered to unweathered.	
20							same as above.	
							close to very close fracture spacing	
25						22.4	Bottom of hole @ 22.4'	

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BOREHOLE LOG

BOREHOLE NUMBER:

B-6

F-88
S-INCEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/15/98 11:00 AM	DATE FINISH: 5/15/98 2:45 PM	LOGGER: K. OHSIEK
LOCATION: CENTER OF UTILITY BLDG (N668024.08, E269106.69)		DRILLING METHOD: ACKER SOILMAX HSA AND WIRE LINE ROTARY WASH		
SURFACE ELEVATION: 5014.40'	TOTAL DEPTH: 24.6'	ROCK DEPTH: 4.9'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8 HSA, H SIZE CORE	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RQD (%)	Rock Type	ROCK	
5		CORE-1	100%	(87)	FILL	Fill./disturbed material. Sandy Lean Clay (CL), firm to hard, ~40% fine sand to silt, moist, reddish brown.	
10		CORE-2	100%	(100)		(TOP OF ROCK)	left 0.3' in hole.
15		CORE-3	100%	(100)	BASALT	Basalt, vesicular (up to 1 cm pore dia.), black, FeO staining, abundant carbonates in fractures, moderate to wide fracture spacing except for uppermost 0.6' which is very close spacing, hard, moderately weathered, pore size decreasing with depth to ~1 mm.	clayey cuttings plugging top of core-2.
20		CORE-4	98%	(82)		same as above	
22.8						Basalt, andesitic, dark purple-grey, closely spaced fractures, some healed, fractures in all directions, FeO staining, non-vesicular	different basalt flow
24.6						Bottom of hole @ 24.6'	

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BOREHOLE LOG

BOREHOLE NUMBER:

B-7

F- BY
S- INEEL

Sheet 1 of 2

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/15/98 3:25 AM	DATE FINISH: 5/18/98 11:15 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG - SE CORNER (N668123.73, E269207.06)		DRILLING METHOD: ACKER SOILMAX HSA AND WIRE LINE ROTARY WASH	
SURFACE ELEVATION: 5014.15'	TOTAL DEPTH: 29.0'	ROCK DEPTH: 9.2'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8 HSA, H SIZE CORE	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RQD (%)	Rock Type	ROCK	
0 - 1					FILL	FILL	Fill, 0' to 1' is silt to fine sand (SM-ML) and sandy lean clay (CL) from 1', medium plasticity.
3.0							
5 - 10	SS-1	SS-1	13"	(30)	ML	ML	Silt with Sand (ML), hard, moist at bottom, dry at top, ~20% fine sand, non-plastic to slightly plastic, light brown. Blow counts may be inaccurate (too high), rope is new and appears to be catching as hammer falls.
10	CORE-1	CORE-1	94%	(84)			(TOP OF ROCK)
10.5 - 10.7							Basalt, vesicular, grey to black, pore size up to 1 cm, slightly to moderately weathered, carbonates and other deposits in fracture zones, some FeO staining in pores, moderate to wide fracture spacing. 3" void from 10.5' to 10.7'
15	CORE-2	CORE-2	100%	(96)	BASALT	BASALT	same as above, pore size decreasing to ~1mm @ 15', slightly weathered to unweathered, wide fracture spacing.
20	CORE-3	CORE-3	100%	(62)			
21.5	CORE-4	CORE-4	98%	(98)			same as above, moderately weathered below 21.5', Clay filled void @ 21.5', FeO staining below 21.5' with close to moderate fracture spacing, vesicular with pores ~1 cm in diameter. different basalt flow @ 21.5'
25							

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BOREHOLE LOG

BOREHOLE NUMBER:

B-7

Sheet 2 of 2

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/15/98 3:25 AM	DATE FINISH: 5/18/98 11:15 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG - SE CORNER (N668123.73, E269207.06)		DRILLING METHOD: ACKER SOILMAX HSA AND WIRE LINE ROTARY WASH		
SURFACE ELEVATION: 5014.15'	TOTAL DEPTH: 29.0'	ROCK DEPTH: 9.2'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8 HSA, H SIZE CORE	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery		Rock Type			
30					BASALT		same as above, unweathered, very wide fracture spacing, pore size decreasing with depth to ~1 mm diameter.	
							Bottom of hole @ 29.0'	
35								
40								
45								
50								

APPROVED BY/DATE: *Peter Oehl* 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

BOREHOLE LOG

BOREHOLE NUMBER:

B-9

Sheet 1 of 1

F-100
S-1000

PROJECT NAME/NUMBER: AMWTP	DATE START: 4875 5/12/98 4:15 PM	DATE FINISH: 5/13/98 10:40 AM	LOGGER: K. OHSIEK
LOCATION: EAST END OF SUBSTATION (N667795.21, E269536.48)		DRILLING METHOD: ACKER SOILMAX HSA AND WIRE LINE ROTARY WASH	
SURFACE ELEVATION: 5023.16'	TOTAL DEPTH: 20.5'	ROCK DEPTH: 15.5'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8 HSA, H SIZE CORE	CHECKER: MARK CLOUGH	CHECK DATE: 6/4/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery					
5		SS-1	15"	(48)			Fill, lean clay with sand (CL), medium plasticity, moist, brown	
10		SS-2	12"	(16)		FILL	Fill, sandy silt (ML) to silty sand (SM), very hard to dense, non-plastic, slightly moist, some lamination, caliche layers, single 1" minus gravel particle, fill, light brown.	
15		CORE-1	94%	(76)		15.5	(TOP OF ROCK)	
20						20.5	Basalt , black to greenish gray, vesicular, moderately weathered, moderately fractured, calcite in fractures, other precipitate in fractures, hard.	~2" fracture or void at ~16.5', no loss of circulation.
25							Bottom of hole @ 20.5'	

APPROVED BY/DATE: *Miller* 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE LOG

BOREHOLE NUMBER:

B-10

Sheet 1 of 1

F-810
S-1000

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/12/98 11:00 AM	DATE FINISH: 5/12/98 3:00 PM	LOGGER: K. OHSIEK
LOCATION: SEWAGE LAGOON CENTER (N667279.85, E268485.83)		DRILLING METHOD: ACKER SOILMAX HSA AND WIRE LINE ROTARY WASH	
SURFACE ELEVATION: 5010.82'	TOTAL DEPTH: 12.8'	ROCK DEPTH: 7.8'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8 HSA, H SIZE CORE	CHECKER: MARK CLOUGH	CHECK DATE: 6/4/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery					
				RGD (%)	Rock Type	ROCK	Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.	
5		SS-1	11"	(8)	FILL		Fill, silt with sand to lean clay (ML to CL), soft, variable, moist, dark brown, trace of gravel.	
						6.0		
					ML		Silt (ML), soft, slightly moist, low plasticity, no cementation, light tan.	Only 6' - 6.5' portion of sample saved.
		CORE-1	80%	(72)	BASALT	7.8	Basalt, black, vesicular, some carbonate filling in voids, some non-calcite deposits in voids, joints moderately weathered, hard, fracture spacing moderate.	lost circulation @ 9.3'.
10								
						12.8		
							Bottom of hole @ 12.8'	
15								
20								
25								

APPROVED BY/DATE:

Philip O'Neil 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

BOREHOLE NUMBER:

T-1

BOREHOLE LOG

F-11
S-1NEEL

Sheet 1 of 2

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/28/98 8:55 AM	DATE FINISH: 5/28/98 9:55 AM	LOGGER: K. OHSIEK
LOCATION: UTILITY BLDG NW CORNER (N668059.28, E269056.98)	DRILLING METHOD: ACKER SOILMAX AIR HAMMER		
SURFACE ELEVATION: 5013.97'	TOTAL DEPTH: 28.0'	ROCK DEPTH: 8.0'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LIMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery					
5					FILL		Fill, Silt with sand (ML), sand fraction is fine, moist, ~20% fine sand, brown, low plasticity, changing to silt (ML), dry, some (~10%) fine sand, non plastic at 3.8'	boulder @ 2.8'
8.0							(TOP OF ROCK)	
10					BASALT		Basalt, black, vesicular, heavy fracturing of upper 2 to 3 feet of rock soil-filled zone @ ~12' (~1' thick).	
15								
20							small fracture zone @ ~23' and 25' (with some soil infilling).	
25								

APPROVED BY/DATE:

John Chil 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE LOG

BOREHOLE NUMBER:

T-1

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S-11NEEL

Sheet 2 of 2

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/28/98 8:55 AM	DATE FINISH: 5/28/98 9:55 AM	LOGGER: K. OHSIEK
LOCATION: UTILITY BLDG NW CORNER (N668059.28, E269056.98)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER	
SURFACE ELEVATION: 5013.97'	TOTAL DEPTH: 28.0'	ROCK DEPTH: 8.0'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RGD (%)	Rock Type	ROCK	
						soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	
						Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.	
					BASALT	same as above	
30						Bottom of hole @ 28.0'	
35							
40							
45							
50							

APPROVED BY/DATE:

Richard D. ... 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

BOREHOLE NUMBER:

T-2

BOREHOLE LOG

F-12
S-1NEEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/26/98 9:45 AM	DATE FINISH: 5/26/98 11:10 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG STACK (N668425.52, E269122.39)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5013.00'	TOTAL DEPTH: 24.8'	ROCK DEPTH: 10.8'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery	RQD (%)	Rock Type	ROCK	
0 - 10.8					FILL	Fill, poorly graded gravel with sand (GP) to 6" ~20% sand, grading to sandy lean clay (CL), medium plasticity, ~40% fine sand, wet.	
10.8 - 24.8					BASALT	(TOP OF ROCK) Basalt, fractured at shallow depths with soil filling in fracture zones @ 11.8', 13.8', 14.3'. soil zone @ 14.3' to 14.8' fractures @ 15.8', 18.3', 18.8', 24'.	Total air loss into formation @ 14.3' to 14.8' limited air return hole stopped @ 24.8' due to heavy fracturing and shifting of rock and poor air return.
24.8						Bottom of hole @ 24.8'	

APPROVED BY/DATE:

Mark Clough 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE LOG

BOREHOLE NUMBER:

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S-1NEEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/19/98 3:55 PM	DATE FINISH: 5/20/98 8:20 AM	LOGGER: MARK CLOUGH
LOCATION: NE CORNER OF UTILITY BLDG (N668056.98, E269158.37)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5014.84'	TOTAL DEPTH: 24.8'	ROCK DEPTH: 4.8'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: K. OHSIEK	CHECK DATE: 6/4/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery		RQD (%)	Rock Type	
0 - 4.8					FILL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	
4.8						Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.	
4.8 - 24.8					BASALT	Basalt, black, vesicular, fracture zone containing soil at 1.4' to 2.0' into rock (6.2' to 6.8' from ground surface), bedrock slightly fractured from 5.0' to 5.3' into rock (9.8' to 10.1' from ground surface).	
24.8						Bottom of hole @ 24.8'	

APPROVED BY/DATE:

Gene Divil 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE NUMBER:

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BOREHOLE LOG

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S-1MEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/20/98 3:30 PM	DATE FINISH: 5/20/98 4:40 PM	LOGGER: MARK CLOUGH
LOCATION: AMWTF BLDG FILTER ROOM (N668345.33, E269169.32)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5013.37'	TOTAL DEPTH: 22.9'	ROCK DEPTH: 2.9'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LIMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: K. OHSIEK	CHECK DATE: 6/4/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery	RGD (%)	Rock Type	ROCK	
							soil group name, plasticity or gradation, relative density or consistency, particle size percentages; particle shape, moisture content, color, soil structure, odor.
							Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.
					FILL		Fill, Sandy Lean Clay (CL), low plasticity, moist, light brown, ~30% sand.
							2.9 (TOP OF ROCK)
5							Basalt, black, vesicular, fractures noted at 4.9' from ground surface (1" to 2" thick), and at 6.9' from ground surface (~6" thick).
10					BASALT		
15							
20							
25							22.9 Bottom of hole @ 22.9'

APPROVED BY/DATE:

Richard Olm 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE NUMBER:

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BOREHOLE LOG

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S-INCH

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/26/98 8:30 AM	DATE FINISH: 5/26/98 9:30 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG DRUM CURE AREA (N668345.74, E269131.59)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5013.71'	TOTAL DEPTH: 23.5'	ROCK DEPTH: 3.5'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery	RQD (%)	Rock Type	ROCK	
					FILL		Fill, poorly graded gravel with sand (GP) changing to lean clay (CL), medium plasticity, moist, brown, ~20% sand.
5							(TOP OF ROCK)
10					BASALT		Basalt, vesicular, fractured with soil and carbonate filling in fractures, fractures decreasing with depth.
15							
20							
25							Bottom of hole @ 23.5'

APPROVED BY/DATE:

Mark Clough 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

BOREHOLE NUMBER:

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BOREHOLE LOG

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S-INCEL

Sheet 1 of 2

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/26/98 12:25 PM	DATE FINISH: 5/26/98 1:50 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG MELTER (N668339.25, E269054.57)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5013.34'	TOTAL DEPTH: 33.2'	ROCK DEPTH: 3.2'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LIMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RQD (%)	Rock Type		
					FILL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	
						Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.	
						Fill, poorly graded gravel with sand (GP) overlying lean clay with sand (CL), medium plasticity, moist, ~20% sand, brown.	
						(TOP OF ROCK)	
5						Basalt, fractured with soil filling, vesicular	
						3" fracture with soil infilling at 6.5'	
10						no discernable fractures from 8.2' to 23.2'	
15					BASALT		
20							
25							

APPROVED BY/DATE:

Richard Olivo 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

BOREHOLE LOG

BOREHOLE NUMBER:

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S-1NEEL

Sheet 2 of 2

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/26/98 12:25 PM	DATE FINISH: 5/26/98 1:50 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG MELTER (N668339.25, E269054.57)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5013.34'	TOTAL DEPTH: 33.2'	ROCK DEPTH: 3.2'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LIMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
						soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	
				RGD (%)	Rock Type	ROCK	Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.
30					BASALT		same as above fracture zone @ 31' flow break @ 32' with soil fracture filling, baked FeO appearance to cuttings.
35							Bottom of hole @ 33.2'
40							
45							
50							

APPROVED BY/DATE:

John D. Hill 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE NUMBER:

T-8

BOREHOLE LOG

F- TB
S- INEEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/26/98 2:05 PM	DATE FINISH: 5/26/98 3:05 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG WEST WALL (N668339.89, E269005.78)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5011.96'	TOTAL DEPTH: 23.8'	ROCK DEPTH: 3.8'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
						soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	
				RQD (%)	Rock Type	ROCK	Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.
					FILL		Fill, lean clay to lean clay with sand (CL), ~20% sand, medium plasticity, trace of gravel at surface.
5						3.8 (TOP OF ROCK)	
10					BASALT		Basalt, vesicular, some discernable fractures in uppermost 3' of rock, black.
15							
20							
25						23.8 Bottom of hole @ 23.8'	

APPROVED BY/DATE:

John O'Neil 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE LOG

BOREHOLE NUMBER:

T-9

Sheet 1 of 1

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S-1NEEL

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/20/98 2:10 PM	DATE FINISH: 5/20/98 3:20 PM	LOGGER: MARK CLOUGH
LOCATION: AMWTF BLDG WASTE BOX FILL (N668305.45, E269167.60)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5013.90'	TOTAL DEPTH: 18.8'	ROCK DEPTH: 3.8'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LIMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: K. OHSIEK	CHECK DATE: 6/4/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RGD (%)	Rock Type	ROCK	
					FILL	Fill, Sandy Lean Clay (CL), low plasticity, moist, light brown ~30% sand.	
5						3.8 (TOP OF ROCK)	top 5' of rock is very fractured and crumbles into hole.
10					BASALT	Basalt, black, vesicular, very fractured to 8.8'	
15						reduced return air flow and fracture at 12.8', fracture thickness approximately 2 inches.	terminated drilling at 18.8' due to insufficient air return flow.
20						18.8 Bottom of hole @ 18.8'	
25							

APPROVED BY/DATE:

Mark Clough 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE NUMBER:

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BOREHOLE LOG

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S-INCEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/26/98 3:35 PM	DATE FINISH: 5/27/98 8:45 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG BRINE TANKS (N668280.56, E269046.24)	DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5013.40'	TOTAL DEPTH: 21.3'	ROCK DEPTH: 1.3'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery		RQD (%)	Rock Type		
					FILL		Fill, lean clay with gravel (CL) at surface, changing to lean clay (CL), ~10% fine sand, moist, medium plasticity.	
							(TOP OF ROCK)	
5					BASALT		Basalt, vesicular, black, some moderately spaced fractures in upper 3', decreasing fractures with depth.	
10					BASALT		same as above	
15					BASALT		same as above	
20					BASALT		same as above	
21.3							Bottom of hole @ 21.3'	
25								

APPROVED BY/DATE:

Allen O'Neil 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE NUMBER:

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BOREHOLE LOG

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S-1NEEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/28/98 1:55 PM	DATE FINISH: 5/28/98 3:00 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG EAST WALL (N668277.55, E269212.52)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5014.05'	TOTAL DEPTH: 21.0'	ROCK DEPTH: 2.9'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LIMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery	RQD (%)	Rock Type	ROCK		
					FILL		Fill, lean clay (CL), 10% fine sand, medium plasticity, moist, brown.	
							(TOP OF ROCK)	
5					BASALT		Basalt, vesicular, heavily fractured with soil infilling, fractures at ~5', 7' to 8'.	
10								
15								
20							fracture zone and void at 17' caused total air loss; Fracture zone is about 3.5' thick (17' to 20.5')	terminated drilling at 21' due to loss of air return flow
							Bottom of hole @ 21.0'	
25								

APPROVED BY/DATE:

John O'Neil 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

BOREHOLE NUMBER:

T-12

BOREHOLE LOG

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S-INCH

Sheet 1 of 2

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/20/98 8:40 AM	DATE FINISH: 5/20/98 10:22 AM	LOGGER: MARK CLOUGH
LOCATION: AMWTF BLDG ELECTR. ROOM (N668247.87, E269165.02)	DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5013.51'	TOTAL DEPTH: 34.6'	ROCK DEPTH: 4.6'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: K. OHSIEK	CHECK DATE: 6/4/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RQD (%)	Rock Type		
0 - 4.6					FILL	Fill, sandy lean clay (CL), medium plasticity, moist, light brown, ~30% sand.	
4.6						(TOP OF ROCK)	
4.6 - 34.6					BASALT	Basalt, black, vesicular, fractures noted at 5.6' and 6.6' below ground surface, estimate fracture thickness to be 1 to 2 inches.	

APPROVED BY/DATE:

John Phil 5/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

BOREHOLE NUMBER:

T-12

BOREHOLE LOG

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S-1NEEL

Sheet 2 of 2

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/20/98 8:40 AM	DATE FINISH: 5/20/98 10:22 AM	LOGGER: MARK CLOUGH
LOCATION: AMWTF BLDG ELECTR. ROOM (N668247.87, E269165.02)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5013.5'	TOTAL DEPTH: 34.6'	ROCK DEPTH: 4.6'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMTICO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: K. OHSIEK	CHECK DATE: 6/4/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery	RGD (%)	Rock Type	ROCK	
30					BASALT		same as above, apparent flow break at 34.5'
35							Bottom of hole @ 34.6'
40							
45							
50							

APPROVED BY/DATE:

Fisher Olip 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
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BOREHOLE LOG

BOREHOLE NUMBER:

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S-1 INCEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/20/98 10:55 AM	DATE FINISH: 5/20/98 1:55 PM	LOGGER: MARK CLOUGH
LOCATION: AMWTF BLDG BOX CONVEYOR (N668244.59, E269115.71)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5013.80'	TOTAL DEPTH: 22.0'	ROCK DEPTH: 2.0'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: K. OHSIEK	CHECK DATE: 6/4/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery					
				RQD (%)	Rock Type	ROCK	Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.	
					FILL		Fill, sandy lean clay (CL), medium plasticity, moist, light brown, ~30% sand.	
						2.0	(TOP OF ROCK)	
5							Basalt, black, vesicular, 2" fracture zone with sediment encountered at 2.7' from ground surface	rock crumbled into the drill hole often from 4.5' to 16'
10							fracture zones encountered from 2.7' to 14.0' below ground surface range from 1 to 3 inches thick.	
15					BASALT		non-fractured rock from 16.0' to 22.0'	
20						22.0	Bottom of hole @ 22.0'	
25								

APPROVED BY/DATE:

Fisher Oil 6/30/98

MORRISON KNUDSEN CORPORATION

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BOREHOLE NUMBER:

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PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/27/98 12:45 PM	DATE FINISH: 5/27/98 1:35 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG SHREDDER (N688229.77, E269074.17)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5013.37'	TOTAL DEPTH: 21.6'	ROCK DEPTH: 1.6'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LIMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
						soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	
				RGD (%)	Rock Type	ROCK	Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.
					FILL		Fill, lean clay with sand (CL), moist, ~20% sand, medium plasticity, brown.
						1.6	(TOP OF ROCK)
5							Basit, vesicular, fractured in upper zones, ~6" void (soil filled) @ 3.6'
10							small fracture zone @ ~14'
15					BASALT		
20							small fracture zone @ 19.5'
21.6							Bottom of hole @ 21.6'
25							quite hard @ 20'

APPROVED BY/DATE:

John O'Neil 6/30/98

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PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/27/98 10:25 AM	DATE FINISH: 5/27/98 11:25 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG INCINERATOR (N668213.57, E269038.35)	DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5012.76'	TOTAL DEPTH: 21.1'	ROCK DEPTH: 1.1'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LIMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RGD (%)	Rock Type	ROCK	
					FILL		Fill, silt with gravel (ML), low plasticity to non-plastic, ~20% gravel, light brown to tan, trace of sand (< 5%)
							(TOP OF ROCK)
5							Basalt fractured in upper zone, soil infilling from 2.1' to 3.1', vesicular, black
10							no discernable fractures between ~8' and ~19'
15					BASALT		
20							fractured zone between 19' and 20'
21.1							Bottom of hole @ 21.1'
25							

APPROVED BY/DATE:

John D. Hill 6/30/98

MORRISON KNUDSEN CORPORATION

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BOREHOLE NUMBER:

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PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/27/98 9:00 AM	DATE FINISH: 5/27/98 10:10 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG WEST WALL (N668242.47, E269002.80)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5012.25'	TOTAL DEPTH: 21.6'	ROCK DEPTH: 1.6'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" AIR HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery	RGD (%)	Rock Type	ROCK	
					FILL		Fill, sandy silt with gravel (ML), low plasticity to non-plastic, up to 3" gravel, one 8" boulder, brown.
						1.6	(TOP OF ROCK)
5					BASALT		Basalt, very fractured in upper 2 to 3 feet, soil and caliche in fractures, decreasing fractures with depth.
15					BASALT		same as above
21.6						21.6	Bottom of hole @ 21.6'

APPROVED BY/DATE: *Richard D. Hill* 6/30/98

MORRISON KNUDSEN CORPORATION

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PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/28/98 12:30 PM	DATE FINISH: 5/28/98 1:35 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG EAST WALL (N668214.59, E269212.06)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER		
SURFACE ELEVATION: 5014.09'	TOTAL DEPTH: 20.8'	ROCK DEPTH: 10.8'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery		ROD (%)			
5					FILL		Fill, lean clay (CL), moist, ~10% fine sand, medium plasticity, brown.	
10							rock fragments @ 9.5'	
10.8							(TOP OF ROCK)	
15					BASALT		Basalt, vesicular, highly fractured 10' - 12', ~3", void @ 12.2'	lost all air circulation at 12.2', regained very limited air return at ~13'
20							fracture zone @ 18.5'	
20.8							Bottom of hole @ 20.8'	terminated hole @ 20.8' due to inadequate air return
25								

APPROVED BY/DATE:

Ken Ohsiek 6/30/98

MORRISON KNUDSEN CORPORATION

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PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/28/98 10:05 AM	DATE FINISH: 5/28/98 11:25 AM	LOGGER: K. OHSIEK
LOCATION: UTILITY BLDG SW CORNER (N667990.06,E269053.72)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER	
SURFACE ELEVATION: 5014.33'	TOTAL DEPTH: 35.8'	ROCK DEPTH: 5.8'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery		RQD (%)	Rock Type		
5					FILL		Fill, silt with sand (ML), moist, non-plastic, brown, ~20% fine sand	
						5.8	(TOP OF ROCK)	
							Basalt, vesicular, black	fractured up to 6' with soil infilling.
10							no discerable fractures between 6' to 25'	
15					BASALT			
20								
25								

APPROVED BY/DATE: *Richard Olm* 6/30/98

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PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/28/98 10:05 AM	DATE FINISH: 5/28/98 11:25 AM	LOGGER: K. OHSIEK
LOCATION: UTILITY BLDG SW CORNER (N667990.06,E269053.72)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER	
SURFACE ELEVATION: 5014.33'	TOTAL DEPTH: 35.8'	ROCK DEPTH: 5.8'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LIMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery	RGD (%)	Rock Type	ROCK	
30					BASALT	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor. Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.	softer at ~25
35						same as above 32' some fracturing 33' FeO staining (looks burnt/baked) 34' soil/sediments in fractured basalt	interbed/flow break @ ~33'
40						35.8 Bottom of hole @ 35.8'	
45							
50							

APPROVED BY/DATE:

John D. ... 6/30/98

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PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/27/98 2:55 PM	DATE FINISH: 5/27/98 3:40 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG DRUM STAGING (N668182.99, E269120.21)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER	
SURFACE ELEVATION: 5013.46'	TOTAL DEPTH: 23.3'	ROCK DEPTH: 3.3'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMI/TCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RGD (%)	Rock Type	ROCK	
					FILL	Fill, lean clay with gravel (CL), medium plasticity, moist, brown, ~20% gravel, trace sand	
						3.3 (TOP OF ROCK)	
5					BASALT	Basalt, vesicular, moderate to close fracturing to 11' depth with soil filling in fractures.	
10							
15						same as above, no discerable fractures below 11'	
20							
25						23.3 Bottom of hole @ 23.3'	

APPROVED BY/DATE:

Fisher O'Neil 6/30/98

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PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/27/98 1:50 PM	DATE FINISH: 5/27/98 2:40 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG FUTURE SHREDDER (N668198.22, E269072.77)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER	
SURFACE ELEVATION: 5013.43'	TOTAL DEPTH: 21.2'	ROCK DEPTH: 2.2'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
						soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	
				RQD (%)	Rock Type	ROCK	Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.
					FILL		Fill, lean clay with sand (CL), sand is fine (~20% sand), moist, brown, medium plasticity
						2.2	(TOP OF ROCK)
5							Basalt, vesicular, black, heavily fractured in upper zones with up to 6" voids filled with soil, more voids with some soil infilling at 4'
10					BASALT		small fracture zone at ~14'
15							fracture zone at 19.5' to ~20'
20						21.2	Bottom of hole @ 21.2'
25							

APPROVED BY/DATE:

Richard Obiel 6/30/98

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BOREHOLE NUMBER:

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PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/19/98 2:00 PM	DATE FINISH: 5/19/98 3:30 PM	LOGGER: MARK CLOUGH
LOCATION: UTILITY BLDG SE CORNER (N667986.55, E269154.56)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5015.05'	TOTAL DEPTH: 25.8'	ROCK DEPTH: 5.8'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" HAMMER	CHECKER: K. OHSIEK	CHECK DATE: 6/4/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery					
				RGD (%)	Rock Type	ROCK	Rock type, grain size, color, cementation, alteration, weathering, hardness, mineralogy.	
5					FILL		FILL, lean clay with sand (CL), ~25% sand, medium plasticity, moist, light brown	
						5.8	(TOP OF ROCK)	
10							Basalt, black, vesicular, some fracture zones in uppermost 3' of basalt, slight fractures at 21.8', estimate fracture zone to be 1 to 3 inches thick	
15					BASALT			
20								
25								

APPROVED BY/DATE: *Richard* 6/30/98

MORRISON KNUDSEN CORPORATION

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BOREHOLE NUMBER:

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PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/19/98 2:00 PM	DATE FINISH: 5/19/98 3:30 PM	LOGGER: MARK CLOUGH
LOCATION: UTILITY BLDG SE CORNER (N667986.55, E269154.56)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5015.05'	TOTAL DEPTH: 25.8'	ROCK DEPTH: 5.8'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" HAMMER	CHECKER: K. OHSIEK	CHECK DATE: 6/4/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery	RQD (%)	Rock Type	ROCK	
					BASALT	same as above	
						Bottom of hole @ 25.8'	
30							
35							
40							
45							
50							

APPROVED BY/DATE:

John O'Neil 6/30/98

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BOREHOLE NUMBER:

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PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/27/98 3:50 PM	DATE FINISH: 5/28/98 8:40 AM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG SOUTH WALL (N668127.94, E269103.13)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER		
SURFACE ELEVATION: 5013.42'	TOTAL DEPTH: 25.0'	ROCK DEPTH: 5.0'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery	RQD (%)	Rock Type	ROCK		
0 - 5.0					FILL		FILL, Lean Clay (CL), trace (~5%) of gravel at surface, moist, brown, medium plasticity	
5.0							(TOP OF ROCK)	
5.0 - 25.0					BASALT		Basalt vesicular, black, some fracturing at surface, fractures have soil infilling small fracture zone at 10' and at 13'	
25.0							Bottom of hole @ 25.0'	

APPROVED BY/DATE:

Timothy O'Neil 6/30/98

MORRISON KNUDSEN CORPORATION

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BOREHOLE NUMBER:

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PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/19/98 12:40 PM	DATE FINISH: 5/19/98 1:30 PM	LOGGER: K. OHSIEK
LOCATION: PROPANE TANK PAD EAST END (N667796.56, E269231.54)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER	
SURFACE ELEVATION: 5024.14'	TOTAL DEPTH: 13.5'	ROCK DEPTH: 7.5'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 5/27/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery				
				RGD (%)	Rock Type	ROCK	
5					FILL	Fill, lean clay with sand (CL), medium plasticity, slightly moist, brown, ~20% sand	
7.5						(TOP OF ROCK)	
10					BASALT	Basalt, vesicular, black soil interbed or soil filled vertical fracture (crevice) from ~10.5' to 13.5'	
13.5						hard basalt at 13.5'	
15						Bottom of hole @ 13.5'	
20							
25							

APPROVED BY/DATE:

Paul Divil 6/30/98

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BOREHOLE LOG

BOREHOLE NUMBER:

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PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/19/98 10:00 AM	DATE FINISH: 5/19/98 11:40 AM	LOGGER: K. OHSIEK
LOCATION: PROPANE TANK PAD WEST END (N667813.86, E269156.92)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5020.46'	TOTAL DEPTH: 9.6'	ROCK DEPTH: 4.6'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery		RQD (%)	Rock Type		
5					FILL		Fill, lean clay with sand (CL), medium plasticity, slightly moist, brown, ~20% fine sand	
						4.6	(TOP OF ROCK)	
					BASALT		Basalt, black, vesicular, some fractured zones in uppermost 2'	
						9.6	Bottom of hole @ 9.6'	

APPROVED BY/DATE:

John O'Neil 6/30/98

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PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/28/98 3:30 PM	DATE FINISH: 5/28/98 4:10 PM	LOGGER: K. OHSIEK
LOCATION: ELECT. SUBSTATION WEST END (N667797.26,E269488.26)		DRILLING METHOD: ACKER SOILMAX HSA/AIR HAMMER		
SURFACE ELEVATION: 5024.69'	TOTAL DEPTH: 7.0'	ROCK DEPTH: 2.0'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 7 5/8" HSA 3 1/2" HAMMER	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	Remarks
	Symbol	Sample ID	Recovery		RGD (%)	Rock Type	
					FILL	Fill, gravelly lean clay (CL) 0.0' to 1', 1'-2' lean clay with sand (CL), moist, scattered boulders and cobbles, brown, low plasticity, ~20% sand	
						2.0 (TOP OF ROCK)	
5					BASALT	Basalt, vesicular, black, moderately fractured with soil infilling	
						7.0 Bottom of hole @ 7.0'	
10							
15							
20							
25							

APPROVED BY/DATE: *Robert Phil* 6/30/98

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BOREHOLE NUMBER:

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PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/29/98 10:15 AM	DATE FINISH: 5/29/98 10:35 AM	LOGGER: K. OHSIEK
LOCATION: NW SIDE OF SEWAGE LAGOON (N667332.88, E268460.79)	DRILLING METHOD: ACKER SOILMAX AIR HAMMER		
SURFACE ELEVATION: 5012.16'	TOTAL DEPTH: 11.0'	ROCK DEPTH: 6.0'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery	RGD (%)	Rock Type	ROCK		
5					FILL		Fill, Silt (ML) to lean clay (CL) low to medium plasticity, some gravel on surface to 8" depth, moist, scattered cobbles on surface, brown	
						6.0	(TOP OF ROCK)	
10					BASALT		Basalt, vesicular, black, fracture at 8.7' (~3" thick soil infilling), and at 9.5', and at 10.0'	
						11.0	Bottom of hole @ 11.0'	

APPROVED BY/DATE: *Robert O'Neil* 6/30/98

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PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/29/98 9:40 AM	DATE FINISH: 5/29/98 10:05 AM	LOGGER: K. OHSIEK
LOCATION: NE SIDE OF SEWAGE LAGOON (N687292.63, E268524.10)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER		
SURFACE ELEVATION: 5011.15'	TOTAL DEPTH: 12.0'	ROCK DEPTH: 6.1'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery	RGD (%)	Rock Type	ROCK		
5					FILL		Fill, lean clay (CL) to silt (ML), slightly moist, 3"-minus gravel and trash in upper 1', low plasticity, brown to light tan, ~5% fine sand	
						6.1	(TOP OF ROCK)	
10					BASALT		Basalt, vesicular, black, fracture zones with soil infilling at 8.5', 9.5' (soil infilling ~6" thick), and 11' (soil infilling ~11" thick)	
						12.0	Bottom of hole @ 12.0'	
15								
20								
25								

APPROVED BY/DATE:

John O'Neil 6/30/98

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BOREHOLE LOG

BOREHOLE NUMBER:

T-32

F-112
S-1NEEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP 4875	DATE START: 5/29/98 8:50 AM	DATE FINISH: 5/29/98 9:30 AM	LOGGER: K. OHSIEK
LOCATION: SW SIDE OF SEWAGE LAGOON (N667253.94, E268431.24)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER	
SURFACE ELEVATION: 5011.30'	TOTAL DEPTH: 12.0'	ROCK DEPTH: 6.5'	WATER DEPTH/DATE: NONE ENCOUNTERED
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery		RGD (%)	Rock Type		
5					FILL		Fill, silt with gravel (ML) ~20% 3"-minus gravel, moist, changing to lean clay (CL), moist, brown, low plasticity to non-plastic.	
						6.5	(TOP OF ROCK)	
10					BASALT		Basalt, vesicular, black, fracture zone at 8', 11', 11.5' with some soil infilling	
						12.0	Bottom of hole @ 12.0'	

APPROVED BY/DATE:

John O'Neil 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

BOREHOLE LOG

BOREHOLE NUMBER:

T-35

F-135
S-INCEL

Sheet 1 of 1

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/29/98 8:00 AM	DATE FINISH: 5/29/98 8:40 AM	LOGGER: K. OHSIEK
LOCATION: SE SIDE OF SEWAGE LAGOON (N667229.90, E268501.11)		DRILLING METHOD: ACKER SOILMAX AIR HAMMER		
SURFACE ELEVATION: 5011.95'	TOTAL DEPTH: 11.0'	ROCK DEPTH: 6.0'	WATER DEPTH/DATE: NONE ENCOUNTERED	
CONTRACTOR: LMITCO	BOREHOLE DIA: 3 1/2"	CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98	

Depth (ft)	SAMPLE			SPT (N)	USCS	SOIL	soil group name, plasticity or gradation, relative density or consistency, particle size percentages, particle shape, moisture content, color, soil structure, odor.	Remarks
	Symbol	Sample ID	Recovery					
5					FILL		FILL, silt (ML) to silt with sand (ML) sand is medium to fine grained, trace of 3" minus gravel at surface, brown, low plasticity to non-plastic, lean clay (CL), moist, below ~1', brown, medium plasticity	
						6.0	(TOP OF ROCK)	
10					BASALT		Basalt, vesicular, black, moderately spaced fractures with soil infilling, ~4" fracture zone at 9'	
						11.0	Bottom of hole @ 11.0'	

APPROVED BY/DATE: *Richard Ohsiek* 6/30/98

MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION &
ENVIRONMENTAL GROUP

TEST PIT LOG

TEST PIT ID:

TEST TRENCH

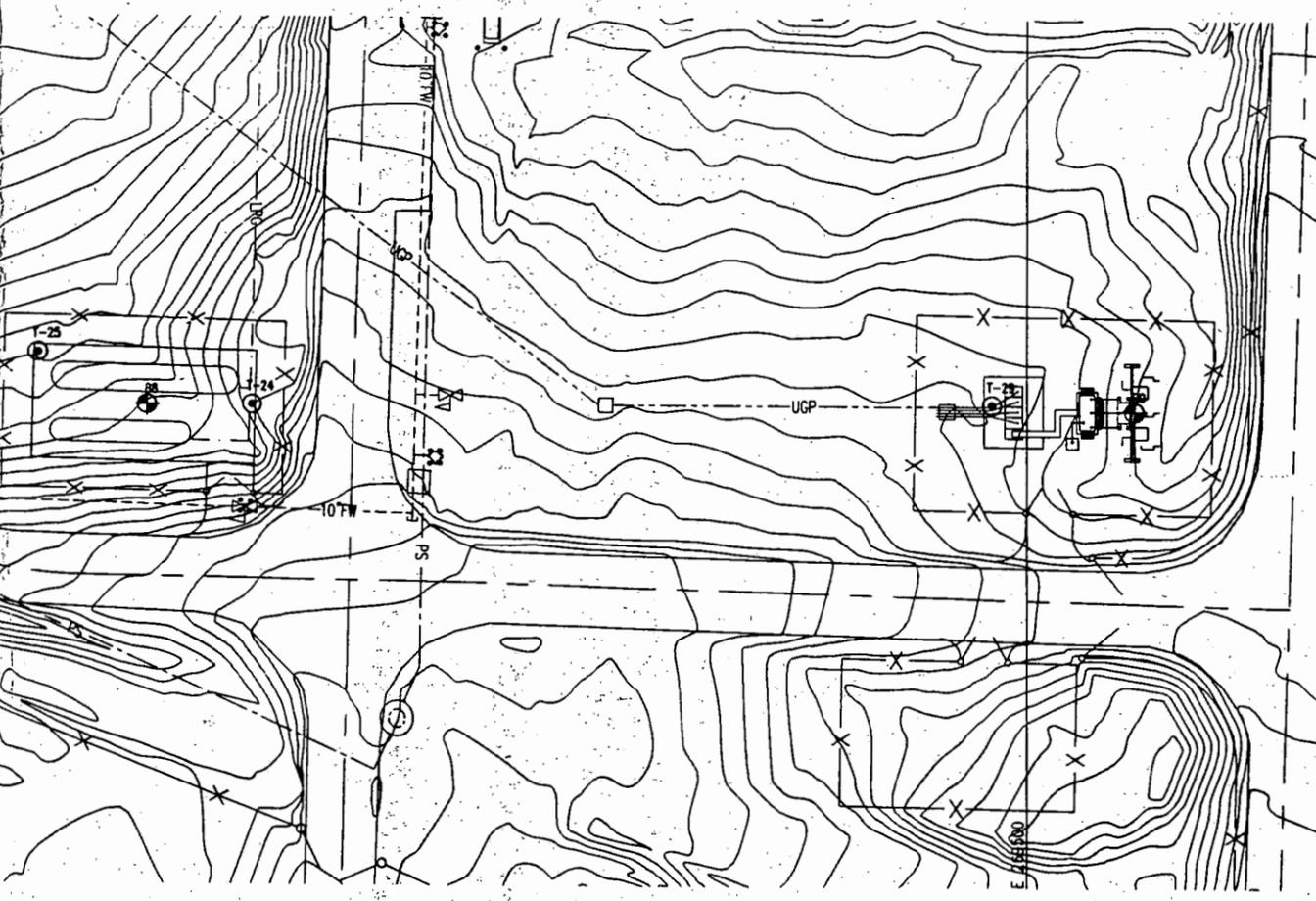
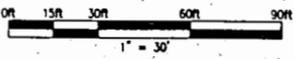
Sheet 1 of 1

F- INEPLIT
S- INEEL

PROJECT NAME/NUMBER: AMWTP	4875	DATE START: 5/20/98 10:45 AM	DATE FINISH: 5/20/98 3:45 PM	LOGGER: K. OHSIEK
LOCATION: AMWTF BLDG NORTH-SOUTH NEAR SUPERCOMPACTOR	EQUIPMENT: CASE 590 TURBO BACKHOE/LOADER			WATER DEPTH/DATE: NONE ENCOUNTERED
SURFACE ELEVATION: 5013.87' NORTH END AND 5013.83' SOUTH END	ROCK DEPTH: SEE PROFILE			
CONTRACTOR: LIMITCO	DIMENSIONS	LENGTH: 36'	WIDTH: 2'	DEPTH: 1.6' TO 3.5'
			CHECKER: MARK CLOUGH	CHECK DATE: 6/2/98

Depth (ft)	Sample ID	Soil Class	Description	Remarks																																																																																
		FILL	<p>Fill, poorly graded gravel (GP) at surface up to 3" size silt with sand (ML) to lean clay with sand (CL), hard, moist, trace of roots and organics, approx. 20% fine sand, dark brown.</p> <p>depth to top of rock varies (1.6' to 3.1'), see profile on table below</p>	<p>attempts to excavate into basalt successful to about 2' into the rock (fractured zone), excavated rock coming up in cobble to boulder size blocks (up to ~15").</p>																																																																																
		BASALT	<p>Basalt, black, slightly weathered, fractures at 6" to 1' spacing as viewed from surface, depth of fracturing > 2'</p>																																																																																	
			<table border="1"> <thead> <tr> <th>STATION (FT) (FROM S->N)</th> <th>DEPTH TO TOP OF ROCK ON WEST FACE (FT)</th> <th>NORTHING (FT)</th> <th>EASTING (FT)</th> </tr> </thead> <tbody> <tr><td>0</td><td>1.6</td><td>668338.73</td><td>269133.85</td></tr> <tr><td>2</td><td>1.6</td><td>-</td><td>-</td></tr> <tr><td>4</td><td>1.8</td><td>-</td><td>-</td></tr> <tr><td>6</td><td>1.8</td><td>-</td><td>-</td></tr> <tr><td>8</td><td>1.6</td><td>-</td><td>-</td></tr> <tr><td>10</td><td>2.0</td><td>-</td><td>-</td></tr> <tr><td>12</td><td>2.2</td><td>-</td><td>-</td></tr> <tr><td>14</td><td>2.3</td><td>-</td><td>-</td></tr> <tr><td>16</td><td>2.0</td><td>-</td><td>-</td></tr> <tr><td>18</td><td>2.2</td><td>-</td><td>-</td></tr> <tr><td>20</td><td>2.3</td><td>-</td><td>-</td></tr> <tr><td>22</td><td>2.5</td><td>-</td><td>-</td></tr> <tr><td>24</td><td>2.6</td><td>-</td><td>-</td></tr> <tr><td>26</td><td>2.6</td><td>-</td><td>-</td></tr> <tr><td>28</td><td>2.8</td><td>-</td><td>-</td></tr> <tr><td>30</td><td>2.6</td><td>-</td><td>-</td></tr> <tr><td>32</td><td>3.1</td><td>-</td><td>-</td></tr> <tr><td>34</td><td>2.6</td><td>-</td><td>-</td></tr> <tr><td>36</td><td>2.7</td><td>668302.88</td><td>269131.07</td></tr> </tbody> </table>	STATION (FT) (FROM S->N)	DEPTH TO TOP OF ROCK ON WEST FACE (FT)	NORTHING (FT)	EASTING (FT)	0	1.6	668338.73	269133.85	2	1.6	-	-	4	1.8	-	-	6	1.8	-	-	8	1.6	-	-	10	2.0	-	-	12	2.2	-	-	14	2.3	-	-	16	2.0	-	-	18	2.2	-	-	20	2.3	-	-	22	2.5	-	-	24	2.6	-	-	26	2.6	-	-	28	2.8	-	-	30	2.6	-	-	32	3.1	-	-	34	2.6	-	-	36	2.7	668302.88	269131.07	
STATION (FT) (FROM S->N)	DEPTH TO TOP OF ROCK ON WEST FACE (FT)	NORTHING (FT)	EASTING (FT)																																																																																	
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APPROVED BY/DATE: *Richard Obiel* 6/30/98



LPG PAD

ELECTRICAL SUBSTATION

REV	DATE	DESCRIPTION	BY	LEAD	CHKD	APP'D
0	6/29/98	Issue for Review Use	K-0	W-0	W-0	W-0

NOTES

1. COORDINATES AND ELEVATIONS ARE SITE-SPECIFIC AS MODIFIED FROM IDAHO EAST STATE PLANE.

LEGEND

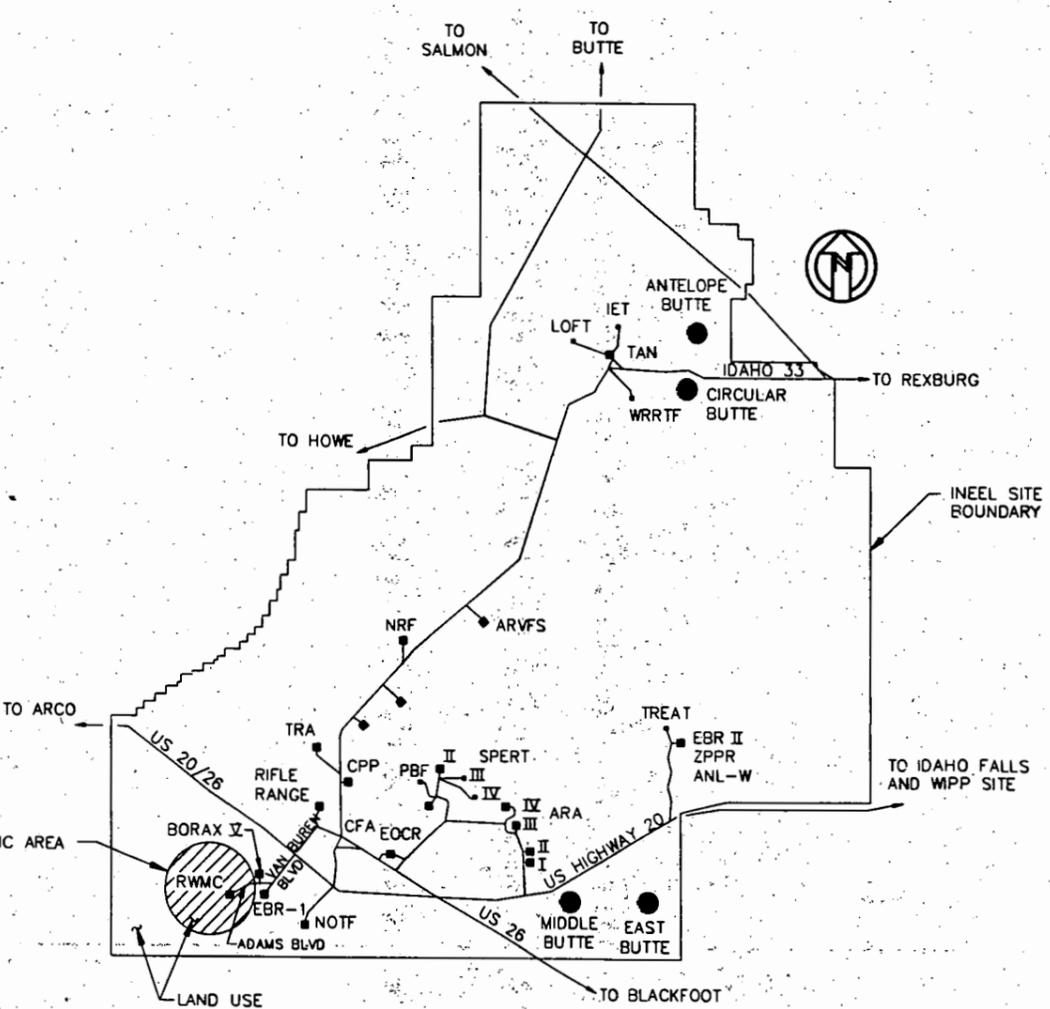
- AUGER BORING AND CORE DRILLING LOCATION
- AIR-HAMMER DRILLING LOCATION
- TEST TRENCH

TABLE OF COORDINATES

LOCATION I.D.	NORTH	EAST	ELEVATION
B1	668411.96	269217.67	5013.11
B2	668131.19	268999.42	5012.20
B3	668418.58	269008.06	5012.23
B4	NOT USED		
B5	668318.16	269122.86	5013.67
B6	668024.08	269106.69	5014.40
B7	668123.73	269207.06	5014.15
B8	667796.34	269195.10	5022.08
B9	667795.21	269536.48	5023.16
B10	667279.85	268485.83	5010.82
T-1	668059.28	269056.98	5013.97
T-2	668425.52	269122.39	5013.00
T-3	NOT USED		
T-4	668056.98	269158.37	5014.84
T-5	668345.33	269169.32	5013.37
T-6	668345.74	269131.59	5013.71
T-7	668339.25	269054.57	5013.34
T-8	668339.89	269005.78	5011.96
T-9	668305.45	269167.60	5013.90
T-10	668280.56	269046.24	5013.40
T-11	668277.55	269212.52	5014.05
T-12	668247.87	269165.02	5013.51
T-13	668244.59	269115.71	5013.80
T-14	668229.77	269074.17	5013.37
T-15	668213.57	269038.35	5012.76
T-16	668242.47	269002.80	5012.25
T-17	668214.59	269212.06	5014.09
T-18	667990.06	269053.72	5014.33
T-19	668182.99	269120.21	5013.46
T-20	668198.22	269072.77	5013.43
T-21	NOT USED		
T-22	667986.55	269154.56	5015.05
T-23	668127.94	269103.13	5013.42
T-24	667796.56	269231.54	5024.14
T-25	667813.86	269156.92	5020.46
T-26	NOT USED		
T-27	NOT USED		
T-28	NOT USED		
T-29	667797.26	269488.26	5024.69
T-30	667332.88	268460.79	5012.16
T-31	667292.63	268524.10	5011.15
T-32	667253.94	268431.24	5011.30
T-33	NOT USED		
T-34	NOT USED		
T-35	667229.90	268501.11	5011.95
TEST TRENCH	668338.73	269133.85	5013.87(END)
	668302.88	269131.07	5013.83(END)

REFERENCE DRAWINGS

DRAWING NO.	DRAWING TITLE



VICINITY MAP
NTS

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ADVANCED MIXED WASTE TREATMENT PROJECT
INEEL - DOE/ID

GEOTECHNICAL BOREHOLE LOCATION PLAN

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL/GOVERNMENT GROUP

DEPT	ARCH	STR/CM	MCH	ELECT	PIPING	HEAT	QA	OS	PSH

BNFL Inc.

SCALE: 1" = 30'-0"
 DRAWN: K.FAHEY
 DESIGNED: K. OHSIEK
 CHECKED: C. A. White
 VERIFIED: N/A

BNFL INC. WORK ORDER NUMBER
BNFL-5232
 QUALITY LEVEL
 DRAWING NUMBER
 REV