APPENDIX H

SLOPE STABILITY STUDY
PLANT REFUSE PILE
SLOPE STABILITY STUDY

COAL REFUSE PILE

WELLINGTON COAL PREPARATION PLANT

WELLINGTON, UTAH

PREPARED FOR:

MT NEBO SCIENTIFIC
330 EAST 400 SOUTH, SUITE 6
PO BOX 337
SPRINGVILLE, UTAH 84663

ATTENTION: PATRICK D COLLINS, PHD

PROJECT NO. 34095 JUNE 27, 1995
SLOPE STABILITY STUDY
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CONCLUSIONS

1. The subsoils encountered at the site consist of clay overlying interlayered silt and clay overlying sand and gravel. The sand and gravel was encountered at depths ranging from approximately 24 to 30 feet below the ground surface at the base of the refuse pile.

2. The existing coal refuse pile is approximately 18 to 30 feet in height and consists of silty gravel with sand, cobbles and occasional small boulders. The exterior side slopes range from approximately 1.4 to 5:1 (horizontal to vertical).

3. The refuse pile in its present condition is stable and has a safety factor against failure through the foundation soils of greater than 1.5. The safety factor against failure through the refuse is approximately 1.1. Failure through the refuse pile would be shallow failures of the exterior steep slopes and would not jeopardize the overall stability of the refuse pile.
SCOPE

This report presents the results of a Geotechnical Investigation for the existing condition and potential expansion of a coal refuse pile located at the U.S. Steel Coal Cleaning Facility near Wellington, Utah. The purpose of this investigation was to determine the subsurface conditions in the area of the coal refuse pile, determine the factor of safety of the existing refuse pile with respect to failure and to provide recommendations to obtain adequate slope stability factors of safety for the existing pile and potential expanded configuration.

Borings and test pits were excavated to obtain information on the subsurface conditions and to obtain samples for laboratory testing. Information obtained from the field and laboratory was used to define conditions at the site and to develop recommendations for the refuse pile.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered.

SITE CONDITIONS

At the time of our field investigation, there was an existing coarse refuse pile approximately 350 feet wide and 1,200 feet in length. It extends approximately 30 feet above the original ground surface at its maximum point. Side slopes of the pile range from approximately 1.4 to 5:1 (horizontal to vertical). Somewhat flatter slopes exist on the western end of the pile for access to the top of the pile. There is a reclamation test plot at the northeast end of the pile which is approximately 450 feet in length. This area has been graded to approximately 4 to 5:1 (horizontal to vertical), planted and fenced off. The steepest exterior slopes are at the northwest and south-central portions of the refuse pile. Slopes in these areas appear to be near the angle of repose for the material.

There is some clay which has been piled along the western one-third of the refuse pile.
The surrounding ground surface slopes gently down toward the north/northeast. There are hills to the south of the site and relatively flat ground to the north, east and west.

There is an existing railroad north/northeast of the refuse pile and a coal handling facility to the northwest of the pile.

Vegetation at the site consists of grass and brush. There is very little vegetation on the refuse pile, except at the reclamation test plot.

FIELD STUDY

The field study was conducted on May 30 and 31, 1995. Four borings were drilled around the exterior of the existing refuse pile and 7 test pits were excavated in the refuse pile. The borings were drilled with 8-inch diameter hollowstem auger powered by a truck-mounted drill rig. The test pits were excavated with a rubber-tired backhoe. The borings and test pits were logged and soil samples obtained by a geologist from AGEC. Logs of the subsurface conditions encountered in are graphically shown on Figures 2 and 3 with Legend and Notes on Figure 4.

SUBSURFACE CONDITIONS

The natural soils at the site generally consist of clay and silt overlying sand and gravel. The sand and gravel was encountered at depths ranging from approximately 14 to 30 feet below the original ground surface. Approximately 8 and 4 feet of fill was encountered in Borings B-2 and B-4, respectively. The test pits were excavated entirely within the refuse pile and encountered fill the full depth investigated.

A description of the various materials encountered in the borings and test pits follows:
Fill - Two distinct types of fill were encountered at the site. Laboratory tests conducted on the refuse material indicate it contains a small amount of low plastic fines. The refuse pile generally consists of silty gravel with sand and cobbles up to approximately one foot in size. The refuse is moist, dark brown to black in color and contains pieces of coal and sandstone.

Fill outside and along the top of the refuse pile consists of lean clay to sandy lean clay with occasional gravel. It is slightly moist and ranges from brown to brownish gray in color.

Topsoil - The topsoil consists of lean clay to clay with sand. It is moist, dark brown in color and contains roots and organics.

Lean Clay - The clay contains a small to moderate amount of sand. Silt and clay layers were encountered which generally increased in frequency with depth. The clay ranges from stiff to hard and from moist to wet. Color ranges from brown to grayish brown.

Laboratory tests indicate the clay has a natural moisture content of 13 to 25 percent and a natural dry density of 99 to 107 pounds per cubic foot (pcf). Unconfined compressive strengths of 3,100 to 22,400 pounds per square foot were obtained for the clay.

Interlayered Lean Clay and Sandy Silt - The interlayered soil contains occasional silty sand layers. It is medium stiff to stiff, moist to wet, and ranges from brown to gray in color.

Laboratory tests indicate the interlayered soil has a natural moisture content of 20 to 27 percent and a natural dry density of 98 to 100 pcf.

Silty Sand - The sand contains occasional gravel. It is medium dense, wet, and ranges from brown to grayish brown in color.
Gravel - The gravel ranges from silty to clayey and contains a moderate amount of sand. Sand and silt layers were encountered within the gravel deposit. The gravel ranges from medium to very dense, wet, and brown to brownish gray in color.

Laboratory tests indicate the gravel has a natural moisture content of 8 percent and a natural dry density of 134 pcf.

SUBSURFACE WATER

Subsurface water was encountered at depths ranging from 16-1/2 to 24 feet below the ground surface at the base of the coal refuse pile. The water surface elevation ranges from approximately 5323 to 5326-1/2 based on the topographic map provided as a reference. These water levels are based on measurements taken one day after drilling and may not represent stabilized water levels. Slotted 1-1/2 inch PVC pipe was installed in the borings to facilitate future water level measurements.

LABORATORY TESTING

Laboratory testing was conducted to determine the engineering characteristics of the material obtained during the field investigation. Laboratory testing included natural moisture content, dry density, Atterberg Limits, grain-size distribution and strength tests. The results of the laboratory testing are summarized on Table I and are included on the Logs of Exploratory Borings and Test Pits.

A discussion of the laboratory testing procedures are presented below. The testing procedures are primarily those of the American Society for Testing Materials (ASTM).
Index Properties
The Unified Soil Classification System (ASTM D-2487) was used to classify the soil. This system is based on index property tests including the determination of natural moisture content (ASTM D-2216), liquid and plastic limits (ASTM D-4318) and grain-size distribution (ASTM D-422). Results of the grain-size distribution tests are presented on Figures 10 and 11.

Moisture/Density Relationship
The moisture/density relationship test was performed in general accordance with ASTM D-698. Results of the test are presented on Figure 9.

Triaxial Shear
Triaxial shear tests were performed in general accordance with ASTM D-4767. Samples were prepared by trimming the ends perpendicular to the sample axis and placing them in a latex membrane. The prepared samples were placed in the triaxial cell and saturated using back pressure saturation. Testing continued by placing consolidation loads of 7, 14 and 28 psi and loading the samples to near failure for each consolidation load. Sample strains, loads and pore pressures were monitored throughout each test. Results of the tests are presented on Figure 5 and 6.

Direct Shear
Direct shear tests were conducted in general accordance with ASTM D-3080 on two remolded samples of the coal refuse material which passed the No. 10 sieve. The samples were compacted to approximately 85 to 90 percent of the maximum dry density as determined by ASTM D-698. Each sample was tested to determine the shear strength under normal loads of 1, 2 and 4 ksf. Results of the tests are presented on Figure 7 and 8.

PROPOSED CONSTRUCTION
We understand that the coarse refuse pile is being considered for potential expansion. The area proposed for the expansion is from the railroad south to the hills. This would approximately double
the area of the existing refuse pile. In addition, the refuse pile could be increased in height. We have assumed that the maximum height of the pile will be 50 feet. However, additional testing and analysis could be performed to determine if a greater pile height could be attained and continue to have an adequate safety factor. Our analysis also assumes that the coarse refuse material will continue to be used in expanding the pile.

STABILITY ANALYSIS

Stability of the existing and proposed expansion of the refuse pile was analyzed under several loading conditions. Factors of safety for the embankment were determined with respect to mass rotational and sliding wedge failures. The shear strength parameters used in the stability analysis were based on consolidated drained shear test information.

The subsurface profile used in the stability analysis was defined from the information obtained from the exploratory borings and laboratory test results. Strength parameters for use in the stability analysis were determined from the field and laboratory test results. The testing consisted of penetration resistance, triaxial shear, direct shear and pocket penetrometer tests. Laboratory tests were conducted on saturated or near-saturated samples. Based on these results and our judgement, strengths of the upper 30 feet of soil below the embankment assume a cohesion of 230 psf and an internal friction angle of 28 degrees. The strengths for the underlying sand and gravel assume an internal friction angle of 36 degrees with no cohesion.

The strength of the refuse material is based on the observed maximum slopes of the refuse pile which presently exist and by testing the refuse in the laboratory to determine its angle of repose. These slopes are approximately 1.4:1 (horizontal to vertical) which is an angle of approximately 36 degrees to the horizontal. Angle of repose values obtained in the laboratory range from approximately 36 to 42 degrees. An internal friction value of 36 degrees was assumed for the refuse material.
Subsurface water was encountered at a depth of approximately 15 feet below the base of the existing coal refuse pile. No free water was observed within excavations in the coal refuse material. Our analysis assumes that drainage will be provided on and around the refuse pile by sloping the top of the pile to drain and diverting any drainages that lead to the pile away from the pile. If water were allowed to build up in the refuse material, flatter slopes would be required.

Slope stability analysis was conducted using the modified Janbu method of analysis. Stability calculations indicate that the refuse pile is stable under its present condition. The foundation soils have a safety factor against failure of greater than 1.5. Refuse slopes of 2:1 (horizontal to vertical) and flatter have a safety factor against failure of 1.5 and greater. Refuse slopes of 1.4 to 2:1 (horizontal to vertical), which represent the steepest existing slopes, have safety factors against failure greater than 1 indicating they are stable. If these slopes were steepened to result in slope failure, the failure would occur as a surface slip. Such a slope failure would be of minimal consequence since it would only involve the outer few feet of the refuse material and would not extend into the foundation soil. Revegetation and erosion concerns may dictate the preferred final slope of the refuse pile.
LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the borings drilled and test pits excavated at the locations indicated on the site plan and the data obtained from laboratory testing.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Reviewed by James E. Nordquist, P.E.

DRH/cs
COAL REFUSE PILE NEAR WELLINGTON, UTAH

Logs of Borings and Tests Pits

Figure 1
Approximate Vertical Scale 1" = 8'

See Figure 4 for legend and Notes

Logs of Exploratory Borings

Figure 2
See Figure 4 for Legend and Notes

Approximate Vertical Scale 1" = 8'

Logs of Test Pits

Figure 3
LEGEND:

- Fill; lean clay to sandy lean clay, occasional gravel, slightly moist, brown to brownish gray.
- Fill; silty gravel with sand and cobbles up to approximately one foot in size, moist, dark brown to black, pieces of coal and sandstone.
- Topsoil; lean clay with sand, moist, dark brown, roots, organics.
- Lean Clay to Sandy Lean Clay (CL); silt and sand layers increasing with depth, stiff to hard, slightly moist to wet, brown to grayish brown.
- Interlayered Lean Clay and Sandy Silt (CL/ML); occasional silty sand layers, medium stiff to stiff, moist to wet, brown to gray.
- Silty Sand (SM); occasional gravels, medium dense, wet, brown to grayish brown.
- Silty Clayey Gravel with Sand (SM-GC); sand and silt layers, medium to very dense, wet, brown to brownish gray.

10/12 California Drive sample taken. The symbol 10/12 indicates that 10 blows from a 140 pound hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates relatively undisturbed hand drive sample taken.

Indicates disturbed sample taken.

Indicates slotted 1¼ inch PVC pipe installed in the boring to the depth shown.

Indicates the depth to free water and the number of days after drilling the measurement was taken.

NOTES:

1. Borings were drilled on May 30 and 31, 1995 with 8-inch diameter hollowstem auger. Test pits were excavated on May 31, 1995 with a rubber-tired backhoe.
2. Locations of borings and test pits were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of borings and test pits were determined by interpolating between contours shown on the site plan provided.
4. The boring and test pit locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the logs represent the approximate boundaries between material types and the transitions may be gradual.
6. Water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water level may occur with time.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   -200 = Percent Passing No. 200 Sieve;
   LL = Liquid Limit (%);
   PI = Plasticity Index (%);
   UC = Unconfined Compressive Strength (psf);
   WSS = Water Soluble Sulfate (ppm).
Note: Strength parameters shown for 1.4 to 1.5% strain.

c = 1030 psf \( \phi = 19^\circ \)
c' = 850 psf \( \phi' = 27^\circ \)

Test No. (Symbol) | 1(\( O \)) | 2(\( M \)) | 3(\( \wedge \))
---|---|---|---
Sample Type | Undisturbed | | |
Length, in. | 3.83 | 3.83 | 3.83 |
Diameter, in. | 1.93 | 1.93 | 1.93 |
Dry Density, pcf | 100 | 100 | 100 |
Moisture Content, % | 20 | 20 | 20 |
Consol. Pressure, psi | 7 | 14 | 28 |
"B" Parameter | -95 | -95 | -95 |
Total Conf. Stress(\( \sigma_1 \)), psi | -25.7 | -49.5 | -77.4 |
Total Axial Stress(\( \sigma_3 \)), psi | -18.6 | -45.2 | -66.2 |
Deviator Stress(\( \sigma'_1 - \sigma'_3 \)), psi | -14 | -28 | -28 |
Eff. Lateral Stress(\( \sigma' \)), psi | -7 | -14 | -28 |
Eff. Axial Stress(\( \sigma'_3 \)), psi | -6 | -14 | -28 |
Pore Pressure(\( \psi \)), psi | 7.1 | 4.3 | 11.2 |
Strain(\( \varepsilon \)), % | 1.4 | 1.5 | 1.5 |
Remarks | Staged, consolidated, undrained test with pore pressure measurement. | | |

Sample Index Properties

- Natural Dry Density, pcf: 100
- Natural Moisture Content, %: 20
- Liquid Limit, %: 26
- Plasticity Index, %: 5
- Percent Gravel: -
- Percent Sand: -
- Percent Passing No. 200 Sieve: 98

Sample Description: Silty Clay

From B-2 @ 14 feet

Project No. 34095

TRIAXIAL COMPRESSION TEST RESULTS

Figure 5
c = 340 psf  \( \phi = 17^\circ \)

Note: Strength parameters shown for 2.0 to 2.6% strain.

\( c' = 230 \) psf  \( \phi' = 28^\circ \)

Test No. (Symbol)  
1(\( \square \))  
2(\( \square \))  
3(\( \square \))

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Undisturbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length, in.</td>
<td>4.0</td>
</tr>
<tr>
<td>Diameter, in.</td>
<td>1.93</td>
</tr>
<tr>
<td>Dry Density, pcf</td>
<td>99</td>
</tr>
<tr>
<td>Moisture Content, %</td>
<td>25</td>
</tr>
<tr>
<td>Consol. Pressure, psi</td>
<td>7 14 28</td>
</tr>
<tr>
<td>&quot;B&quot; Parameter</td>
<td>.95 .95 .95</td>
</tr>
<tr>
<td>Total Conf. Stress(( \sigma_z )), psi</td>
<td>7 14 28</td>
</tr>
<tr>
<td>Total Axial Stress(( \sigma_i )), psi</td>
<td>17.9 32.9 56.8</td>
</tr>
<tr>
<td>Deviator Stress(( \sigma_i - \sigma_s )), psi</td>
<td>10.9 18.9 28.8</td>
</tr>
<tr>
<td>Eff. Lateral Stress(( \sigma_s ')), psi</td>
<td>7 14 28</td>
</tr>
<tr>
<td>Eff. Axial Stress(( \sigma_s ')), psi</td>
<td>15.3 26.5 41.6</td>
</tr>
<tr>
<td>Pore Pressure(( \Delta u )), psi</td>
<td>2.6 6.4 15.2</td>
</tr>
<tr>
<td>Strain(( \epsilon )), %</td>
<td>2.0 2.5 2.6</td>
</tr>
<tr>
<td>Remarks</td>
<td>Stepped, consolidated, undrained test with pore pressure measurement</td>
</tr>
</tbody>
</table>

Sample Index Properties

| Natural Dry Density, pcf | 99 |
| Natural Moisture Content, % | 25 |
| Liquid Limit, % | 43 |
| Plasticity Index, % | 25 |
| Percent Gravel | - |
| Percent Sand | - |
| Percent Passing No. 200 Sieve | 100 |

Sample Description: Lean Clay  
From B-3 @ 19 feet  
Project No. 34095  
TRIAXIAL COMPRESSION TEST RESULTS  
Figure 6
Applied Geotechnical Engineering Consultants, Inc.

Test No.(Symbol) | 1(☐) | 2(■) | 3(△)
---|---|---|---
Sample Type | Remolded | | 
Length, in. | 1.0 | | 
Diameter, in. | 1.93 | | 
Dry Density, pcf | 81 | | 
Moisture Content, % | 16 | | 
Consolidation Load, ksf | 1.0 | 2.0 | 4.0 
Normal Load, ksf | 1.0 | 2.0 | 4.0 
Shear Stress, ksf | 0.47 | 1.14 | 1.99 
Remarks | Remolded to 85% ASTM D-698 | Sample saturated | Strain rate = 0.05 in/min 

Sample Index Properties
- Natural Dry Density, pcf
- Natural Moisture Content, %
- Liquid Limit, %
- Plasticity Index, %
- Percent Gravel
- Percent Sand
- Percent Passing No. 200 Sieve

Type of Test Consolidated
Sample Description Refuse material passed through a No. 10 sieve From TP-1 @ 1 to 3 feet
Project No. 34095 DIRECT SHEAR TEST RESULTS Figure 7
### DIRECT SHEAR TEST RESULTS

**Figure 8**

#### Applied Geotechnical Engineering Consultants, Inc.

**Graph:**
- Normal Stress, ksf vs. Shear Stress, ksf
- The graph shows a linear relationship with a slope of $\phi = 30^\circ$ and $c = 0$.

<table>
<thead>
<tr>
<th>Test No. (Symbol)</th>
<th>1(□)</th>
<th>2(■)</th>
<th>3(△)</th>
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</thead>
<tbody>
<tr>
<td>Sample Type</td>
<td>Remolded</td>
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</tr>
<tr>
<td>Length, in.</td>
<td>1.0</td>
<td></td>
<td></td>
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<tr>
<td>Diameter, in.</td>
<td>1.93</td>
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<tr>
<td>Dry Density, pcf</td>
<td>86</td>
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<tr>
<td>Moisture Content, %</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal Load, ksf</td>
<td>1.0</td>
<td>2.0</td>
<td>4.0</td>
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<tr>
<td>Normal Stress, ksf</td>
<td>0.47</td>
<td>1.33</td>
<td>2.16</td>
</tr>
</tbody>
</table>

**Remarks:**
- Remolded to 90% ASTM D-398
- Sample saturated
- Strain rate = 0.05 in/min

### Sample Index Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Natural Dry Density, pcf</td>
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</tr>
<tr>
<td>Natural Moisture Content, %</td>
<td>-</td>
</tr>
<tr>
<td>Liquid Limit, %</td>
<td>29</td>
</tr>
<tr>
<td>Plasticity Index, %</td>
<td>4</td>
</tr>
<tr>
<td>Percent Gravel</td>
<td>-</td>
</tr>
<tr>
<td>Percent Sand</td>
<td>-</td>
</tr>
<tr>
<td>Percent Passing No. 200 Sieve</td>
<td>-</td>
</tr>
</tbody>
</table>

**Type of Test:** Consolidated

**Sample Description:** Refuse material passed through a No. 10 sieve

**Project No.:** 34095

**From:** TP-1 @ 1 to 3 feet
Applied Geotechnical Engineering Consultants, Inc.

Sample from: TP-1 @ 3 to 4 feet
Description: Fill: Sandy Silty Clay
Note: Original Sample of Silty Gravel was passed through the No. 10 Sieve. Approximately 29% of the sample passed the No. 10 Sieve.
Test Method: ASTM D-698

Maximum Dry Density: 95 pcf
Optimum Moisture Content: 16.5%

Atterberg Limits
Liquid Limit: 29%
Plasticity Index: 4%

Gradation
Gravel: 0%
Sand: 56%
Silt & Clay: 44%

Zero Air Voids Curve for:
- G = 2.8
- G = 2.7
- G = 2.6

Project No. 34095

COMPACATION TEST RESULTS  Figure 9
Applied Geotechnical Engineering Consultants, Inc.

HYDROMETER ANALYSIS

TIME READINGS

24 Hr 7 Hr 2 Min 15 Min 60 Min 19 Min 4 Min 1 Min #200 #100 #50 #40 #30 #16 .05 .04 .00 .10 .20 .30 .40 .50

US STANDARD SERIES

#8 #4 3/8" 3/4" 1-1/2" 3" 5" 6" 8"

CLEAR SQUARE OPENINGS

PERCENT PASSING

PERCENT RETAINED

0 .001 .002 .005 .010 .015 .020 .030 .040 .050 .060 .070 .080 .090 .100

DIAMETER OF PARTICLE IN MILLIMETERS

CLAY TO SILT SAND GRAVEL COBBLES

FINE MEDIUM COARSE FINE COARSE

Gravel 65 % Sand 22 % Silt and Clay 13 %

Liquid Limit 29 % Plasticity Index 4 %

Sample of Refuse Material. Gravel with From TP-1 @ 3' - 4'

Sand

HYDROMETER ANALYSIS

TIME READINGS

24 Hr 7 Hr 45 Min 15 Min 60 Min 19 Min 4 Min 1 Min #200 #100 #50 #40 #30 #16 .05 .04 .00 .10 .20 .30 .40 .50

US STANDARD SERIES

#8 #4 3/8" 3/4" 1-1/2" 3" 5" 6" 8"

CLEAR SQUARE OPENINGS

PERCENT PASSING

PERCENT RETAINED

0 .001 .002 .005 .010 .015 .020 .030 .040 .050 .060 .070 .080 .090 .100

DIAMETER OF PARTICLE IN MILLIMETERS

CLAY TO SILT SAND GRAVEL COBBLES

FINE MEDIUM COARSE FINE COARSE

Gravel 8 % Sand 47 % Silt and Clay 45 %

Liquid Limit 26 % Plasticity Index 8 %

Sample of Fill, Clayey Sand From TP-4 @ 0' - 2'

Project No. 34095 GRADATION TEST RESULTS Figure 10
Gravel 55% Sand 28% Silt and Clay 17%
Liquid Limit % Plasticity Index %
Sample of Clayey Gravel with Sand From B-4 @ 24'

Gravel 0% Sand 6% Silt and Clay 94%
Liquid Limit 33% Plasticity Index 16%
Sample of Fill; Lean Clay From Fill from west-central portion of refuse pile
Project No. 34095

GRADATION TEST RESULTS

Figure 11
# TABLE I
SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>SAMPLE LOCATION</th>
<th>BORING/TEST PIT</th>
<th>DEPTH (FEET)</th>
<th>NATURAL MOISTURE CONTENT (%)</th>
<th>NATURAL DRY DENSITY (PCF)</th>
<th>GRAVITY (%)</th>
<th>SAND (%)</th>
<th>SILT/CLAY (%)</th>
<th>LIQUID LIMIT (%)</th>
<th>PLASTICITY INDEX (%)</th>
<th>UNCONFINED COMPRESSION STRENGTH (PSF)</th>
<th>SAMPLE CLASSIFICATION</th>
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<tbody>
<tr>
<td>B-1</td>
<td>2</td>
<td>13</td>
<td>117</td>
<td>96</td>
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<td>Silt with Sand</td>
</tr>
<tr>
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<td></td>
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<td>Fill; Clayey Sand</td>
</tr>
<tr>
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<td>94</td>
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<td>33</td>
<td>16</td>
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<td>Fill; Lean Clay</td>
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*Sample obtained from fill pile at the west-central portion of the refuse pile.
Sample from: TP-1 @ 3 to 4 feet
Description: Fill: Sandy Silty Clay
Note: Original Sample of Silty Gravel was passed through the No. 10 Sieve. Approximately 29% of the sample passed the No. 10 Sieve.
Test Method: ASTM D-698
Maximum Dry Density: 95 pcf
Optimum Moisture Content: 16.5%
Atterberg Limits
Liquid Limit: 29%
Plasticity Index: 4%
Gradation
Gravel: 0%
Sand: 56%
Silt & Clay: 44%
Zero Air Voids Curve for:
- G = 2.8
- G = 2.7
- G = 2.6
Applied Geotechnical Engineering Consultants, Inc.

**HYDROMETER ANALYSIS**

**TIME READINGS**

<table>
<thead>
<tr>
<th>24 Hr</th>
<th>7 Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Min</td>
<td>1 Min</td>
</tr>
</tbody>
</table>

**US STANDARD SERIES**

| #200 | #100 | #50 | #40 | #16 | #8 | #4 | 3/8" | 3/4" | 1-1/2" | 3" | 5" | 8" | 10"
|-------|------|-----|-----|-----|----|----|------|------|-------|----|----|----|-----|

**CLEAR SQUARE OPENINGS**

- 24 Hr
- 7 Hr
- 1 Min
- 4 Min
- 8 Min
- 12 Min
- 30 Min
- 15 Min
- 30 Min
- 18 Min
- 60 Min
- 90 Min
- 120 Min
- 180 Min
- 240 Min

**SIEVE ANALYSIS**

**DIAMETER OF PARTICLE IN MILLIMETERS**

<table>
<thead>
<tr>
<th>CLAY TO SILT</th>
<th>SAND</th>
<th>GRAVEL</th>
<th>COBBLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINE</td>
<td>MEDIUM</td>
<td>COARSE</td>
<td>FINE</td>
</tr>
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</table>

Gravel: 65%  
Sand: 22%  
Silt and Clay: 13%  
Liquid Limit: 29%  
Plasticity Index: 4%

Sample of Refuse Material, Gravel with Sand From TP-1 @ 3' - 4'

**GRADATION TEST RESULTS**

Project No. 34095

**FIGURE 10**
**HYDROMETER ANALYSIS**

TIME READINGS

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<th>0.200</th>
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<th>0.040</th>
<th>0.030</th>
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US STANDARD SERIES

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<th>3/32&quot;</th>
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CLEAR SQUARE OPENINGS

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**SIEVE ANALYSIS**

<table>
<thead>
<tr>
<th>PERCENT PASSING</th>
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</table>

**DIAMETER OF PARTICLE IN MILLIMETERS**

<table>
<thead>
<tr>
<th>CLAY TO SILT</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINE</td>
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<tr>
<td>------</td>
</tr>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINE</td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>GRAVEL</th>
</tr>
</thead>
<tbody>
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<td>FINE</td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COBBLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

Gravel 55 % Sand 28 % Silt and Clay 17 %

Liquid Limit % Plasticity Index %

Sample of Clayey Gravel with Sand From B-4 @ 24'

**GRADATION TEST RESULTS**

Project No. 34095

Figure 11
## TABLE I
### SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>SAMPLE LOCATION</th>
<th>DEPTH (FEET)</th>
<th>NATURAL MOISTURE CONTENT (%)</th>
<th>NATURAL DRY DENSITY (PCF)</th>
<th>GRAVITY (%)</th>
<th>SAND (%)</th>
<th>SILT/CLAY (%)</th>
<th>LIQUID LIMIT (%)</th>
<th>PLASTICITY INDEX (%)</th>
<th>UNCONFINED COMPRESSIVE STRENGTH (PSF)</th>
<th>SAMPLE CLASSIFICATION</th>
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</thead>
<tbody>
<tr>
<td><strong>B-1</strong></td>
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<td>13</td>
<td>117</td>
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*Sample obtained from fill pile at the west-central portion of the refuse pile.