0055

UNC PLATEAU MINING

Subsidiary of United Nuclear Corporation
A UNC RESOURCES Company

P.O. Drawer PMC
Price, Utah 84501

Telephone 801/637-2875

May 14, 1980

RECEIVED
MAY 15 1980
DIVISION OF
OIL, GAS & MINING

Mr. Ron Daniels
State of Utah
Division of Oil, Gas & Mining
1588 West North Temple
Salt Lake City UT 84116

Re: Addendum to
Refuse Pile Extension Site
ID No. 1211-UT-9-008
Star Point #1 & #2 Mines

Dear Mr. Daniels:

Enclosed you will find five copies of the above Addendum to Refuse Pile Extension Site. You will also find seven copies of the addendum and seven copies of original request, which we understand you will forward to the OSM office in Denver.

We have addressed the areas of concern in the original request, by preparing the Addendum. We would appreciate your prompt attention in reviewing and approving this request. I am sure you understand the urgency concerning this matter.

If you require further information, please feel free to contact us.

Sincerely,

Mike Dmitrich
Public Affairs

MD:ajc

cc: S. W. Rigby

PROPOSED REFUSE PILE EXTENSION

ADDENDUM

Active Refuse Pile No. 1211-UT-9-0008

UNC PLATEAU MINING COMPANY

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A. Information of Reject Material
- Analysis of Refuse
- Physical Properties of Refuse

B. Top Soil
- Commitment on the part of UNC Plateau Mining Company to conserve topsoil
- Map locating proposed topsoil stockpile locations (Map No. 5)

C. Stability Analysis of Refuse Pile
- Dames & Moore report detailing lift thickness, slope requirements, constituients of refuse material

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APPENDICES

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Appendix No. 2 - Design Details of Sedimentation Pond

Appendix No. 3 - Price River Coal Company Analysis

MAPS

Map No. 5 (Submitted April 23, 1980)

Maps 1 of 4; 2 of 4; 3 of 4; 4 of 4.

A. INFORMATION OF REJECT MATERIALS

UNC Plateau Mining Company has not received a copy of the reject analysis from the lab as of this submittal.

We have enclosed a copy of Price River Coal Company analysis, which represents a similar analysis of rejects from the Wasatch Coal Field. This analysis is attached as Appendix No. 3. can this data be extrapolated?

B. TOP SOIL

To prevent suitable topsoil from being wasted or contaminated by spoil or other waste materials, UNC Plateau Mining Company will remove topsoil from the designated area. The topsoil will be stockpiled and protected from water erosion and contamination which might lessen its capacity to support vegetation.

Topsoil will be collected from refuse pile extension site prior to excavation or other surface disturbance operations within the affected area. Soils are of a very fine sandy loam, dark brown when moist; moderate coarse granular structure; soft very friable, slightly sticky, slightly plastic; common very fine roots; common very fine and fine pores; moderately calcareous, carbonates are disseminated; strongly alkaline (pH8.6). In a representative profile the surface layer is brown very fine sandy loam about 3 inches thick.

Present vegetation is dominantly big Sagebrush, Western Wheatgrass, Blue Grama, and Needle and Thread. This soil is used for rangeland and wildlife habitat.

In general, the topsoil to be removed in these areas consists of 1 to 4 inches of A horizon quality material and 6 to 12 inches of B horizon quality material. The C horizon material will not be removed since it is not sufficiently capable of supporting diverse vegetation. Additional soils information is presented in UNC Plateau Mining Company's Underground Mine Permit Application 30 CFR Part 782, 783, 784, Appendix No. 14.

The equipment used for topsoil removal will consist of bulldozers, front-end loaders, and dump trucks. UNC Plateau Mining Company will have present at the time of topsoil removal adequate supervisory personnel to instruct the equipment operators in the proper techniques of topsoil removal and to ensure that required horizons are removed and stored. Div. will determine what to remove & segregate

Topsoil will be stored within the designated area which will not be ? routinely disturbed. During stockpiling operations, unnecessary compaction will be prevented by limiting the equipment traffic over the stockpiles.

what is volume?

There will be two topsoil stockpiles covering an area of approximately 0.25 surface acre. The stockpiles will be established in the draws on the south side of the site. The stockpiled topsoil will not be removed or otherwise disturbed until required for the redistribution operation on a prepared, regraded disturbed area. (See Proposed Topsoil Locations, Map No. 5)

C. STABILITY ANALYSIS OF REFUSE PILE

The stability analysis of refuse pile is contained in the Dames & Moore report. This report details lift thickness, slope requirements, and constituients of refuse material. This report is attached as Appendix No. 1.

D. LAND OWNERSHIP

The proposed refuse extension site is an area owned in fee by UNC Plateau Mining Company. The location of this designated area is shown on Map No. 5, attached in this addendum.

E. SEDIMENT POND LOCATED AT UPPER END OF EXISTING REFUSE PILE

The sedimentation pond located at upper end of the existing refuse pile will be identified as "Wattis South Sedimentation Pond".

The design details of the sedimentation ponds, prepared by Vaughn Hansen Associates, are presented in Underground Mine Permit Application 30 CFR Part 782, 783, 784, ~~Appendix~~ Attachment 4B. Is it adequate?

The design details of the Wattis South Sedimentation Pond are attached to this addendum as Appendix No. 2.

what about sed. control below refuse pile?

F. REFUSE PILE CONSTRUCTION

Attached Map No. 5, details the existing contour lines of the designated refuse pile area, prior to construction.

A system of underdrains will be constructed of durable rock in the refuse pile area. Underdrains will consist of natural rock obtained from this area. How? Where? Details?

G. INSPECTION REQUIREMENTS

UNC Plateau Mining Company will have qualified personnel inspect the fill for stability at least quarterly. Inspection will also be done during the critical construction periods, i.e., removal of all organic material and topsoil, placement of underdrainage systems, installation of surface drainage systems, placement and compaction of fill material, and revegetation. UNC Plateau Mining Company will provide the Regulatory Authority a certified report within 2 weeks after each inspection that the fill has been constructed as specified in the design approved by the Regulatory Authority.

H. DIVERSION CHANNEL DESIGN

UNC Plateau Mining Company will control discharge from sedimentation ponds and coal processing waste drains by the use of riprap channels to reduce erosion, and to prevent deepening or enlargement of stream channels. These discharge structures will be designed according to standard engineering-design procedures. Plans ?

?

A cross section view of a typical discharge channel is presented on Map 3 of 4, which has been submitted with the Request for Refuse Pile Extension on April 23, 1980.

DAMES & MOORE

ENVIRONMENTAL AND
APPLIED EARTH SCIENCES

REPORT OF ENGINEERING STUDIES
STABILITY AND CONSTRUCTION METHOD
STUDY
ACTIVE COAL REFUSE PILE,
NO. 1211-UT-9-0008
WATTIS, UTAH
FOR PLATEAU MINING COMPANY
A SUBSIDIARY OF UNITED NUCLEAR CORP.

Dames & Moore Job No. 10051-001-06
Salt Lake City, Utah

SUITE 200, 250 EAST BROADWAY · SALT LAKE CITY, UTAH 84111 · (801) 359-8764
CABLE: DAMEMORE TWX: 910-925-5692

January 17, 1977

Plateau Mining Company
Post Office Box 539
Price, Utah 84501

Attention: Mr. Tom Bailey,
General Manager

Gentlemen:

Four copies of our report entitled "Report of Engineering Studies, Stability and Construction Method Study, Active Coal Refuse Pile, No. 1211-UT-9-0008, Wattis, Utah, For Plateau Mining Company, A Subsidiary of United Nuclear Corporation" are herewith submitted.

The purpose and scope of our studies were planned in discussions between Mr. Tom Bailey and Mr. Mark Robinson of Plateau Mining Company and Mr. William Gordon of Dames & Moore. An outline of our purpose and scope was presented in our proposal dated October 8, 1976.

We appreciate the opportunity of performing this service for you. If you have any questions with regard to the enclosed report, please contact us.

Yours very truly,

DAMES & MOORE

William J. Gordon
Associate
Professional Engineer No. 3457
State of Utah

WJG/RLO/pc
Attachments

cc: Earnal Shaw
Mark Robinson
Dan Price

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REPORT OF ENGINEERING STUDIES
STABILITY AND CONSTRUCTION METHOD STUDY
ACTIVE COAL REFUSE PILE
NO. 1211-UT-9-0008
WATTIS, UTAH
FOR PLATEAU MINING COMPANY
A SUBSIDIARY OF
UNITED NUCLEAR CORPORATION

INTRODUCTION

This report presents the results of our engineering studies pertaining to Plateau Mining Company's active coal refuse pile, designated as No. 1211-UT-9-0008 in Wattis, Utah. The location of the site is shown with respect to surrounding roads, Price, Utah, and major topographic features on Plate 1, Vicinity Map. A more detailed map of the site showing the location of the active coal refuse pile and an abandoned coal refuse pile are shown on Plate 2, Site Plan. Presented on Plate 3, Plot Plan, is a detailed topographic map of the active coal refuse pile showing locations of the exploration borings and exploration test pits, except Test Pit No. 1. Test Pit No. 1 was excavated in the abandoned refuse pile, No. 1211-UT-9-0009. The location of Test Pit No. 1 is shown on Plate 2.

SUMMARY

Based upon the results of this study, it is our conclusion that subsequent portions of the active coal refuse pile, No. 1211-UT-9-0008, may be safely constructed in a manner similar to that employed prior to September, 1976. This assumes that (1) the gradation of subsequent coal refuse will remain similar

to that obtained from the existing pile, (2) that the pile embankment will remain, from a geotechnical standpoint, a non-water retention system, (3) that lift thickness will be restricted to 10 feet, and (4) the major slopes (over 20 feet high) will be constructed no steeper than 1.75 horizontal to 1.0 vertical. Under these restrictions, the factors of safety against a deep seated massive failing under both static and dynamic loading conditions will be in excess of 1.5. Even though the factor of safety against a controlling deep seated failure is in excess of 1.5 the factor of safety against non-controlling slow moving shallow "slough" type movements, infinite slope failures, of the sideslope materials would be lower. Failures of this type were observed at the crest of the abandoned coal refuse pile.

PURPOSE AND SCOPE

The purpose and scope of this study were developed in discussions between Messrs. Tom Bailey and Mark Robinson of Plateau Mining Company and Mr. William Gordon of Dames & Moore. A detailed outline of the purpose and scope is presented in our proposal dated October 8, 1976.

In general, the purposes of our study were:

1) To determine the most likely slope failure mechanism for the existing and to be expanded active coal refuse pile under static and dynamic loading conditions.
2) Determine the minimal construction (compaction and slope) effort which will be required to maintain an acceptable factor of safety against instability.

In accomplishing these purposes, the scope as outlined below was followed:

1) A field program consisting of a general site reconnaissance, the drilling of six borings, the excavation of five test pits, and the performance of a series of in-place density tests.

2) A laboratory testing program.

3) An office program consisting of the correlation of existing data, engineering analysis, and the preparation of this final summary report which includes the following:

   a. A vicinity map.

   b. A site plan showing the location and general configuration of the coal refuse piles with respect to other site facilities.

   c. A plot plan showing the active coal refuse pile and the locations of the exploration borings and test pits extended.

   d. Logs of the exploration borings and test pits.

   e. A detailed description and discussion of the surface and subsurface conditions encountered.

   f. A detailed discussion of the previous and present coal refuse pile construction methods.

g. A summary of the laboratory test data obtained in conjunction with this study plus a correlation of these data with available published data for similar materials.

h. Results of our stability analysis.

i. Recommended future construction (compaction and slope) methods.

SITE CONDITIONS

SURFACE

GENERAL

The Plateau Mining Company site, consisting of mines, mining facilities, and two coal refuse piles, is located 18 miles, by road, southwest of Price, Utah. The location of the site is shown on Plate 1, Vicinity Map. Plate 2 shows the general site layout.

ABANDONED COAL REFUSE PILE

The oldest refuse pile, designated as No. 1211-UT-9-0009, is located approximately 450 feet northeast of the Plateau Mining Company offices in an intermittent stream gully. This pile has been inactive for two years other than its present temporary use as a coal storage area. During the field portion of our study, a nine-foot high near-vertical road cut in the upper portion of the coal refuse pile was observed. The cut was dry and appeared to have undergone some secondary cementation. The only signs of instability were noted at the east crest of the pile. At this location a series of tension cracks three to four inches wide and with six to eight inches of vertical displacement were noted in a zone extending no more than 10 feet back from the slope crest. The slope of the coal refuse pile at this location is approximately 1.4 horizontal to 1.0 vertical and over 100 feet high. The tension cracks are indicative of a relatively slow movement "infinite slope" failure.

It should be noted that other signs of instability or of spontaneous combustion of the coal refuse, due to the lack of density, have not been observed.

ACTIVE COAL REFUSE PILE

The active coal refuse pile, designated as No. 1211-UT-9-0008, is located adjacent to and extending approximately 1,500 feet southwest of the mine office facilities. This pile is on ground which gently slopes to the northeast. Areas of this pile, at the time of this investigation, were also being used to stockpile coal.

Coal refuse pile No. 1211-UT-9-0008 retains an intermittent discharge flow from the wash plant and natural runoff from a very small drainage area. This resulting pond is relatively small in comparison to the overall size of the coal refuse pile. It is located on the west side of the pile and can be seen on both Plates 2 and 3. Maximum capacity of the pond is approximately 10.10 acre-feet. The pond itself has a maximum area of 2.45 acres. At capacity, the maximum water depth would be seven feet. An emergency spillway has been constructed from the retention area around the south perimeter of the coal refuse pile and outlets into a natural drainage which forms the eastern and southern limits of the area.

During the field portion of this study, some small tension cracks were observed near the crest of the active refuse pile just above the pond. The locations of the cracks are shown on Plate 3. These cracks are generally one and one-half to two feet from the crest and show horizontal movement of about four inches and vertical movement of six to eight inches. The depth of these cracks was not readily determinable but is estimated to be in excess of four feet. The cause of these cracks is thought to be a result of end dumping refuse over the crest onto the pond area. The cracks represent an infinite slope "failure" and do not represent a major slope stability problem. No other signs of instability were observed. It is our understanding that instability of the slopes or spontaneous combustion of the coal refuse have never occurred.

CONSTRUCTION METHODS

PRIOR TO SEPTEMBER, 1976

Prior to September, 1976, refuse pile No. 1211-UT-9-0008 was constructed by (1) end-dumping wash plant and mine waste materials on and/or over the crest of the previously placed refuse, (2) allowing the placed material to dry sufficiently so that it could be worked, and (3) levelling the refuse. Generally, the lift thickness would be on the order of 5 to 10 feet; however, greater lift thicknesses were developed at times. The compactive effort applied to the coal refuse would be that imposed by the spreading dozer and hauling trucks. Those portions of the active refuse pile constructed in this manner are shown on Plate 3. This method was also used in the construction of the abandoned refuse pile, designated as No. 1211-UT-9-0009.

CURRENT METHODS

On September 15, 1976, Plateau Mining Company was cited by MESA* for failure to comply with Section 77.215(h) of Part 77, Title 30 of the MESA regulations. This regulation states that "After October 31, 1975, new refuse piles and additions to existing refuse piles, shall be constructed in compacted lifts not exceeding two feet in thickness and shall not have any slope exceeding two horizontal to one vertical (approximately 27°) except that the District Manager may approve construction of a

*Mining Enforcement and Safety Administration refuse pile in compacted layers exceeding two feet in thickness and with slopes exceeding 27° where engineering data substantiates that a minimum factor of safety of 1.5 for the refuse pile will be attained."

Since the MESA citation, sideslopes in the active coal refuse pile have been flattened to approximately two horizontal to one vertical. In addition, the mine coal refuse has been placed in two foot compacted layers in an area east of the original area where the refuse was placed in 5 to 10 foot thick lifts. This new area is shown on Plate 3 and is designated "compacted two foot lift area." It should be noted that prior to placement of mine coal refuse in the new area, the original ground surface was stripped and prepared in accordance with MESA guidelines.

Because of the wet nature of the mine refuse, the material is end dumped and then allowed to dry for two to seven days before spreading and compaction.

SUBSURFACE COAL REFUSE AND NATURAL SOILS

The wash plant and mine waste materials used to construct the refuse piles are composed of mudstone, shale and coal in varying proportions. Gradationally, the refuse can be generally classified as a well graded silty fine to coarse sand with fine and coarse gravel and occasional cobbles. Correlations between blow counts and relative density would tend to indicate the refuse is generally loose. However, these correlations were derived based upon sands and gravels with much higher unit weights than the coal refuse, and consisting of much harder materials. Based upon the unit weights obtained in conjunction with this study, the coal refuse has generally been classified as medium dense, except immediately beneath haul roads where the coal refuse is dense for a vertical distance of two to three feet. The new method of construction with two foot lifts produces a more uniformly dense pile. It should be noted that although the in-place gradations and densities of the coal refuse varies both laterally and vertically, no zones or layers of very loose coal refuse or coal refuse consisting of low strength fine-grained materials were encountered.

The underlying natural soils encountered in the borings and test pits were very similar gradationally to the refuse, consisting of light brown to brown silty fine to coarse sand with fine and coarse gravel and occasional cobbles, with some small roots. This natural soil is probably alluvial or colluvial in origin and is generally dense to very dense. Although bedrock was not definitely encountered in any of the borings or test pits, it is anticipated to be at very shallow depths beneath the surface at the refuse pile location.

A more detailed description of the materials encountered is presented graphically on Plates A-1A and A-1B, Log of Borings, and Plate A-1C, Log of Test Pits.

GROUND WATER

A static ground water table was not encountered in any of the exploration borings or test pits. To monitor ground water conditions, piezometers were installed in Borings 1, 2, and 3 following drilling operations.

It should be noted that some small layers and zones of nearly saturated coal refuse were encountered. These perched zones are related to variations in the permeability of the coal refuse material. The primary source of water is the coal refuse which is placed at the site in a very moist condition. (Proof ?)

GEOLOGY

The site lies at the base of an erosional escarpment which forms the eastern face of the Wasatch Plateau, a subdivision of the Colorado Plateau physiographic province. East of the Wasatch Plateau is Castle Valley, a northeast-southwest trending relatively flat area over 80 miles in length and 10 miles in width. The San Rafael Swell lies east of Castle Valley and is a great upfold marked by rings of hogback hills and intervening valleys.

The Wasatch Plateau is characterized by a high, broad, flat area which has been disected by numerous streams. The high plateaus of Utah, which include the Wasatch Plateau, are thought to be a transition zone that contains geologic structures common to both the Colorado Plateau Province and the Basin and Range Province to the west.

The Plateau Mining Company site is located near the northeastern edge of what is known as the Wasatch Plateau coal field. The plateau edge is a steep cliff with a maximum relief of about 1,000 feet. Coal measures are exposed in the canyon walls and along the cliffs. Rock types at the site are late Cretaceous in age and are generally composed of gray fine to medium grained sandstone, interbedded with subordinate gray and dark gray carbonaceous shale and coal seams.

SEISMICITY

The Wattis area is one of moderate seismic activity. The site is located within a "Zone 2 Area" as defined by the seismic risk map of the United States in the Uniform Building Code (UBC), 1976 Edition. The "Zone 2 Area" is defined as follows: "Moderate damage, which corresponds to Intensity VII on the MM* scale.

DISCUSSIONS AND RECOMMENDATIONS

GENERAL

Supporting data upon which our conclusions and recommendations are based are presented in the Appendices of this report.

Based upon the results of this study, it is our conclusion that subsequent portions of the active coal refuse pile, No.

*Modified Mercalli

1211-UT-9-0008, may be safely constructed in a manner similar to that employed prior to September, 1976. This assumes that (1) the gradation of subsequent coal refuse will remain similar to that obtained from the existing pile, (2) that the pile embankment will remain, from a geotechnical standpoint, a non-water retention system, (3) that lift thickness will be restricted to 10 feet, and (4) the major slopes (over 20 feet high) will be constructed no steeper than 1.75 horizontal to 1.0 vertical. Under these restrictions, the factors of safety against a deep seated massive failure under both static and dynamic loading conditions will be in excess of 1.5.

Even though the factor of safety against a controlling deep seated failure is in excess of 1.5, the factor of safety against non-controlling slow moving shallow "slough" type movements, infinite slope "failures" of the sideslope materials would be lower. Failures of this type were observed at the crest of the abandoned coal refuse pile.

More detailed discussions pertaining to the characteristics of the coal refuse pile, the projected failure mechanisms, stability analysis, and recommended future construction methods are presented in the following sections.

EMBANKMENT CHARACTERISTICS

CLASSIFICATION

Although a small retention pond is located above the active coal refuse pile, the pile should not be considered as a water retention embankment. This conclusion is based upon the facts that (1) the area and volume of the retained water is very small when compared to the width of the existing pile, (2) the width of the coal refuse pile will increase in the future while the size of the water retention area will remain fairly constant, (3) an overflow spillway has been constructed in natural soil-bedrock around the coal refuse pile, and (4) a ground water table was not encountered within the coal refuse pile. Of the above, the fact that a ground water table was not encountered within the pile is most significant.

In order to monitor the ground water conditions within the coal refuse pile, piezometers were installed in Borings 1, 2, and 3 following drilling operations. Readings taken by representatives of Plateau Mining Company subsequent to our field program have not encountered ground water.

It is strongly recommended that the piezometers be maintained as the height of the coal refuse pile is increased. Indications of a ground water table developing within the pile could alter the recommendations presented herein.

MATERIALS

The results of our field and laboratory studies showed that the coal refuse materials are granular and non-cohesive. The coal refuse material can generally be gradationally classified as a silty fine to coarse sand with fine and coarse gravel and some cobbles. Although graditional variations occur no zones or layers of low strength fine grained materials were encountered.

Although a ground water table was not encountered, the in situ coal refuse is moist.

Because of gradational variations the degree of saturation varies; however, specific zones of saturated coal refuse were not encountered.

STRENGTH

After review of the initial field data, it was decided to perform strength tests upon samples of coal refuse which would have gradations and density characteristics lower than the average conditions encountered in those portions of the active refuse pile constructed prior to September, 1976. This required the gradational preparation and recompaction of samples as described in Appendix A. In addition, the prepared samples were tested at saturated moisture conditions. By following these procedures the determined strength data, which was ultimately utilized in our analyses, was conservative when compared with actual conditions.

The results of the strength tests are presented and discussed in detail in Appendix A. It should be noted that the results of the tests performed in conjunction with this study compare extremely well with data obtained by the Bureau of Mines for similar materials.

FAILURE MECHANISM

Being a granular non-saturated system, the mechanism of failure which would occur first would be a "infinite slope" failure. This type of failure is best described as a slow moving shallow "slough" movement of the sideslope materials. The distress noted at the crest of the abandoned coal refuse pile is typical of an "infinite slope" failure. Because this type of failure is slow moving and does not involve a large mass of material, it should not be considered as the controlling stability mechanism.

The controlling failure mechanism would be a deep seated failure which would involve a relatively large mass of material.

STABILITY ANALYSES

STATIC STABILITY

The factor of safety for an "infinite slope" failure is defined as $\frac{\tan \phi}{\tan B}$ where ϕ is the angle of friction of the coal refuse material and B the slope angle. The determined factor of safety for various slope angles are tabulated below:

Slope Angle B	Slope	Angle of Friction	Factor of Safety
35°	1.4h to 1.0v	35°	1.0
30°	1.75h to 1.0v	35°	1.2
26°	2.0h to 1.0v	35°	1.4

For a controlling deep seated circular failure, the factor of safety of a coal refuse pile with a slope of 1.75 horizontal to 1.0 vertical would be on the order of 2.

DYNAMIC STABILITY

In our dynamic analysis a design effective peak acceleration of 0.12* was utilized. The probability that the design effective peak acceleration will not be exceeded during a 50 year period is estimated to be 90 percent.

Applying the design acceleration to an "infinite slope" model as discussed by Newmark**, the following factors of safety were determined:

Slope Angle B	Slope	Factor of Safety
35^{o}	1.4h to 1.0v	<1
30^{o}	1.75h to 1.0v	1
26^{o}	2.0h to 1.0v	1.46

For a controlling deep seated circular failure, the factor of safety of a coal refuse pile with a slope of 1.75 horizontal to 1.0 vertical would be in excess of 1.5.

Because the coal refuse materials are not saturated, liquifaction will not be a problem.

*Donovan, N.C., Bolt, B.A. and Whitman, R.V, Development of Expectancy Maps and Risk Analysis, Preprint 2805, ASCE Annual Convention and Exposition, Philadelphia,PA, Sept. 27-Oct.1,1976.

**Newmark, N.M., Effects of Earthquakes on Dams and Embankments, Fifth Rankine Lecture, Geotechnique, Vol.XV, No. 2, June, 1965.

CONCLUSIONS

The above analyses show that subsequent portions of the active coal refuse pile can be constructed safely with slopes of 1.75 horizontal to 1.0 vertical or flatter in a manner similar to that utilized prior to September, 1976. The factors of safety as presented are somewhat conservative, having been determined utilizing conservative strength data.

It should be noted that the strength data is applicable for a coal refuse pile no higher than approximately 150 feet. At greater heights particle crushing could occur. The affect of particle crushing has not been evaluated as part of this study.

CONSTRUCTION METHOD

Subsequent sections of the active pile should be constructed in a manner similar to that employed prior to September, 1976 except that:

1) Maximum lift thickness should not exceed 10 feet.

2) Coal refuse should not be pushed over the outside slope of the working lift.

oOo

The following plates and appendices are attached and complete this report:

Plate 1	Vicinity Map
Plate 2	Site Plan
Plate 3	Plot Plan
Plate A-1A & A-1B	Log of Borings
Plate A-1C	Log of Test Pits
Plate A-2	Soil Sampler Type D
Plate A-3	Unified Soil Classification System
Plate A-4A & A-4B	Gradation Curves
Plate A-5	Method of Performing Compaction Tests (Standard and Modified AASHTO Methods)
Plate A-6A & A-6B	Compaction Test Data
Plate A-7	Method of Performing Direct Shear and Friction Tests
Plate A-8	Method of Performing Unconfined Compression and Triaxial Compression Tests
Appendix A	Field Exploration and Field and Laboratory Testing
Appendix B	Technical Reference, Bureau of Mines Report of Investigations 1974

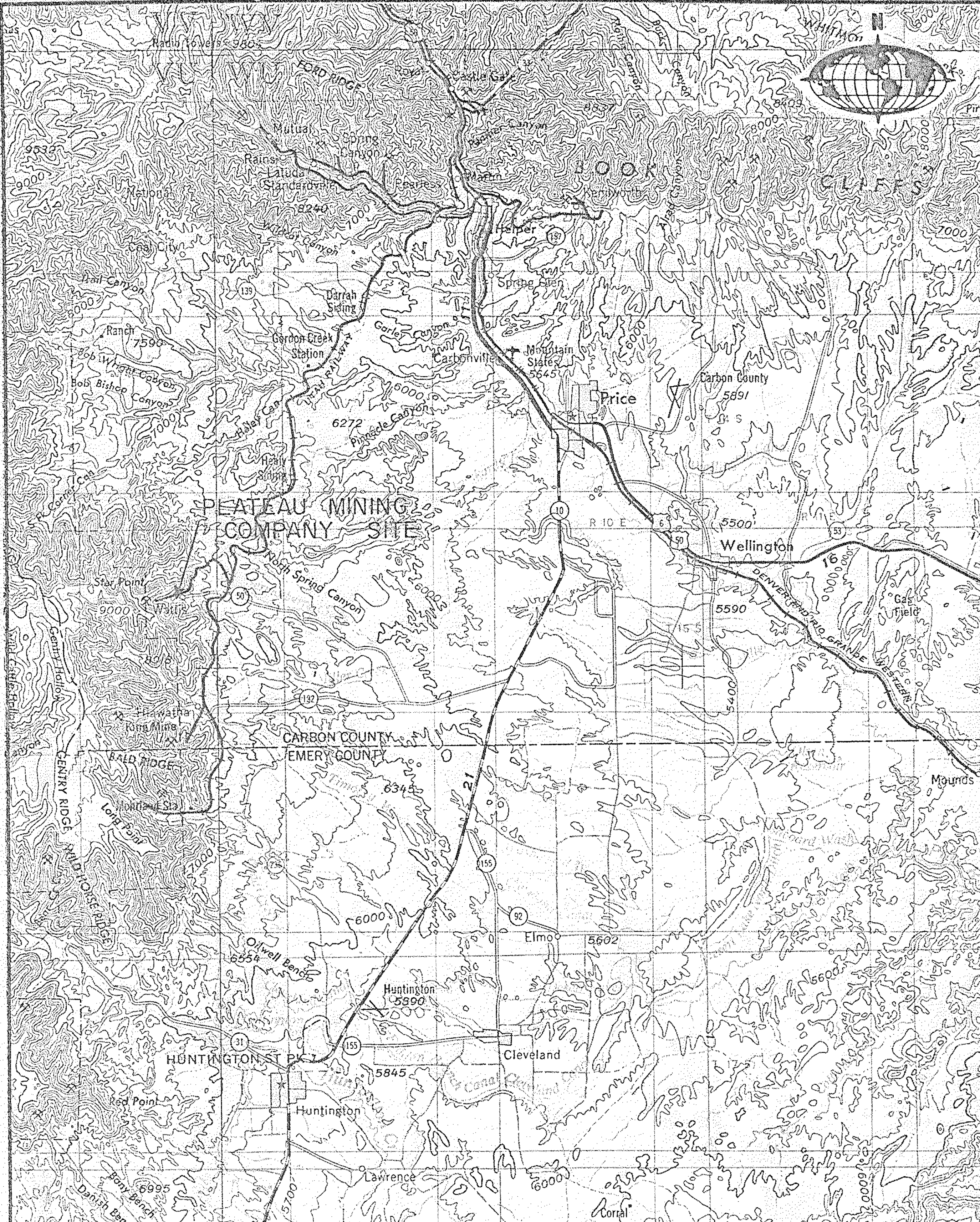
Respectfully submitted,

DAMES & MOORE

William J. Gordon
Associate
Professional Engineer No. 3457
State of Utah

Robert L. Owen
Staff Engineer

WJG/RLO/pc
Attachments



REFERENCE:

TOPOGRAPHIC MAP ENTITLED "PRICE, UTAH" PREPARED BY U.S. ARMY TOPOGRAPHIC COMMAND, DATED 1956, REVISED 1970.

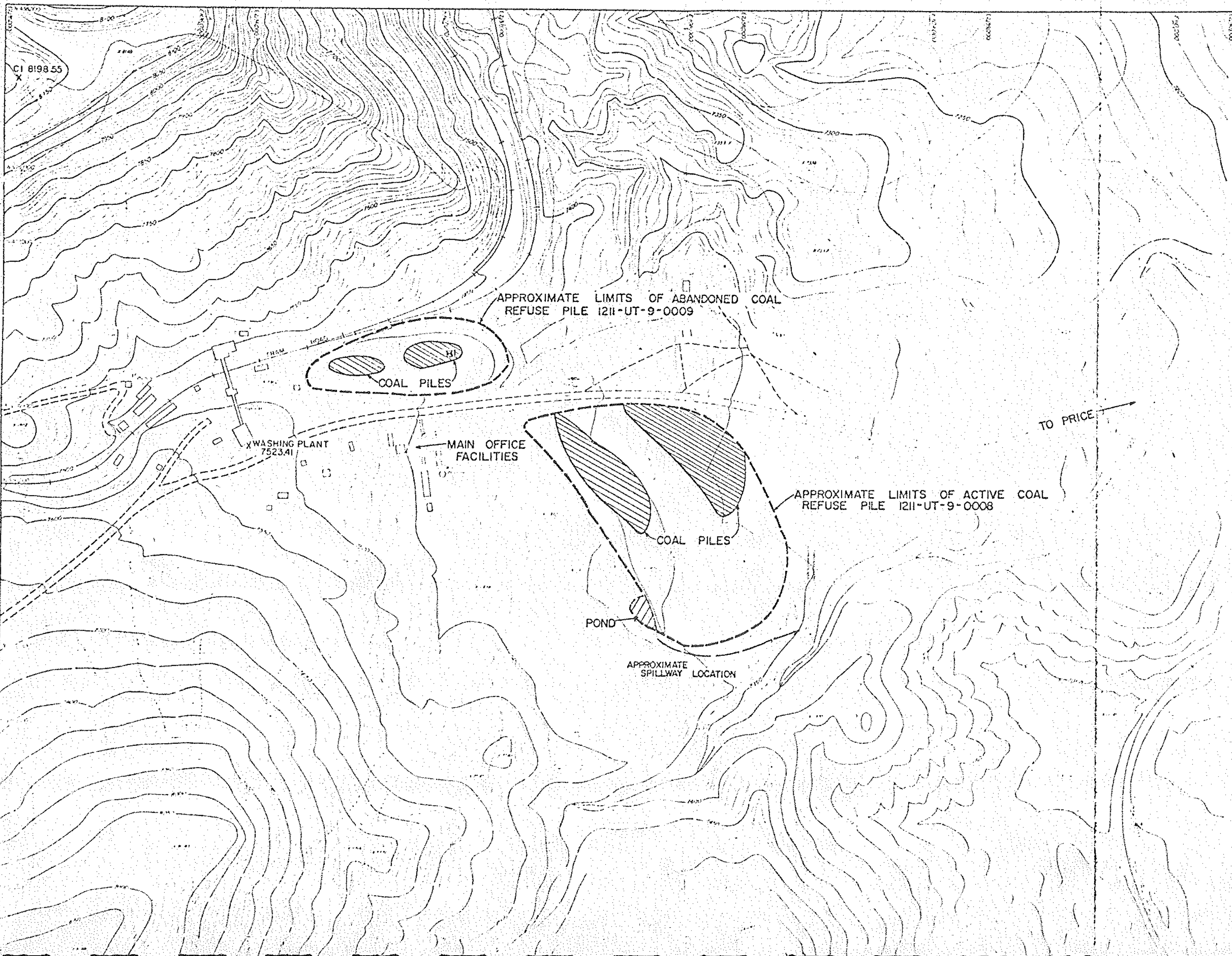
VICINITY MAP

5 0 5 MILES

DAMES & MOORE

PLATE 1

CHECKED BY RCO 1-14-77 FILE 10051-001 BY DATE



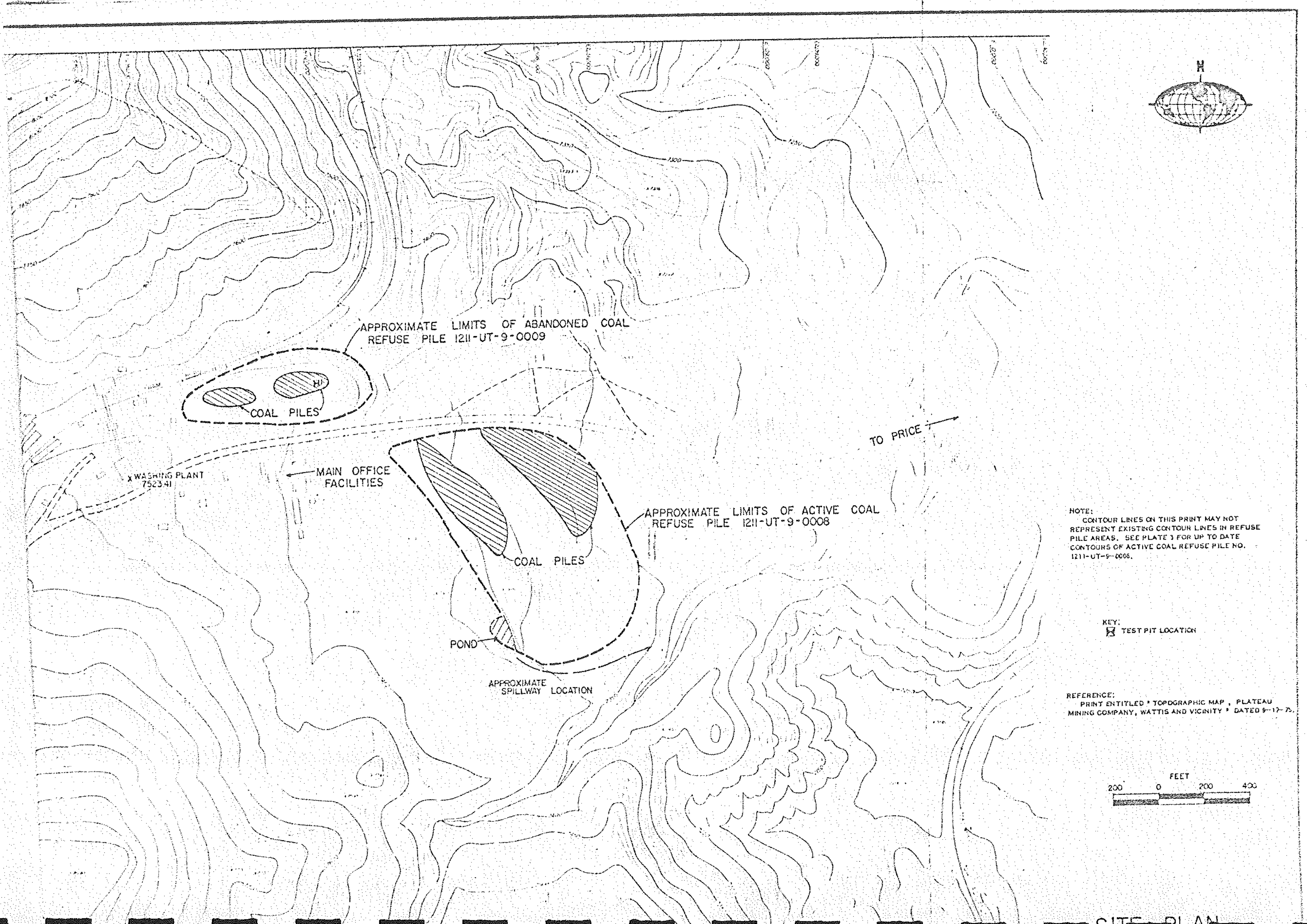
NOTE:
CONTOUR LINES ON THIS PRINT MAY NOT REPRESENT EXISTING CONTOUR LINES IN REFUSE PILE AREAS. SEE PLATE 3 FOR UP TO DATE CONTOURS OF ACTIVE COAL REFUSE PILE NO. 1211-UT-9-0008.

KEY:
TEST PIT LOCATION

REFERENCE:
PRINT ENTITLED "TOPOGRAPHIC MAP, PLATEAU MINING COMPANY, WATTIS AND VICINITY" DATED 9-17-75.

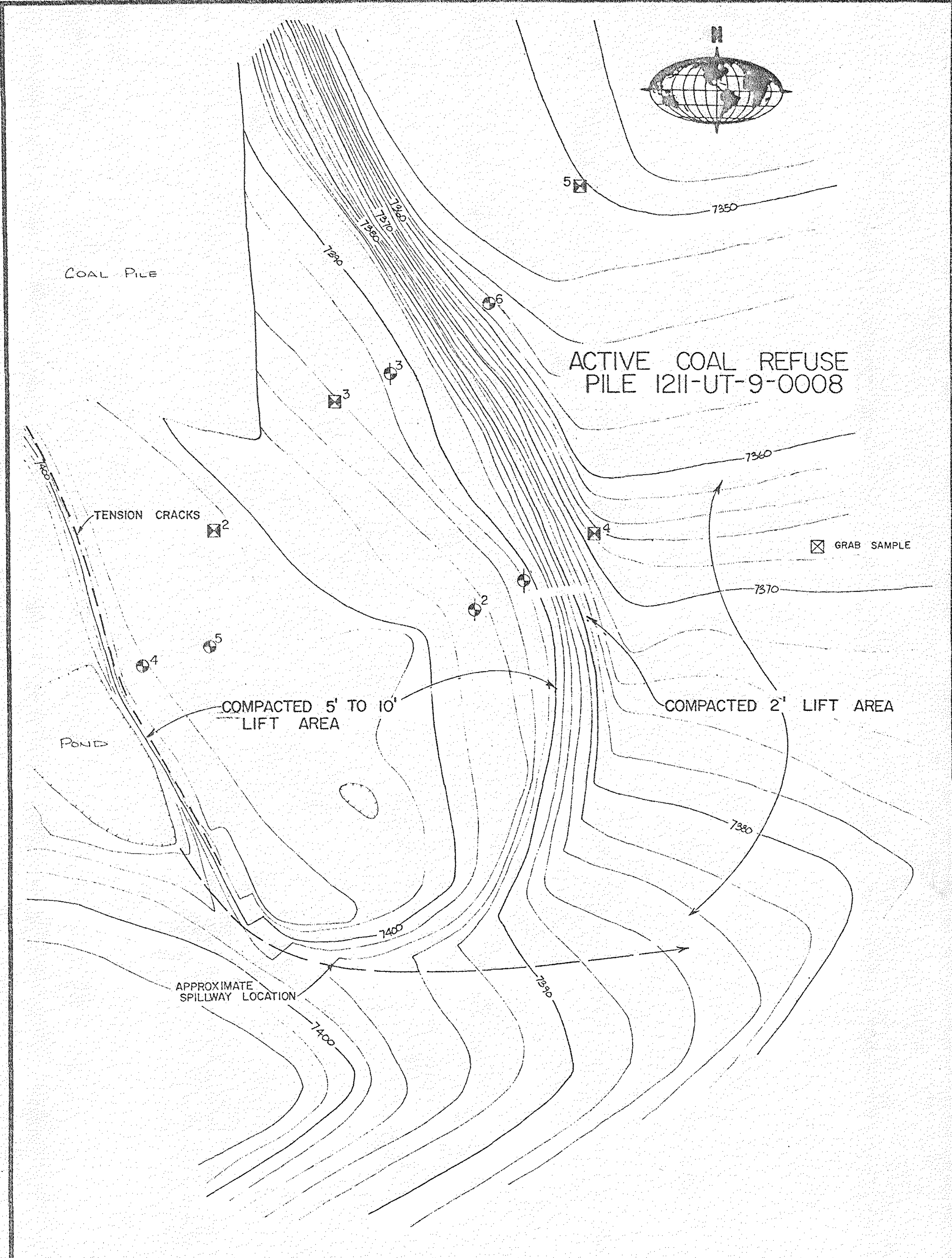
FEET
200 0 200 400

SITE PLAN


N
APPROXIMATE LIMITS OF ABANDONED COAL REFUSE PILE 1211-UT-9-0009
COAL PILES
X WASHING PLANT 7523.41
MAIN OFFICE FACILITIES
TO PRICE
APPROXIMATE LIMITS OF ACTIVE COAL REFUSE PILE 1211-UT-9-0008
COAL PILES
POND
APPROXIMATE SPILLWAY LOCATION
NOTE:
CONTOUR LINES ON THIS PRINT MAY NOT REPRESENT EXISTING CONTOUR LINES IN REFUSE PILE AREAS. SEE PLATE 3 FOR UP TO DATE CONTOURS OF ACTIVE COAL REFUSE PILE NO. 1211-UT-9-0008.
KEY:
TEST PIT LOCATION
REFERENCE:
PRINT ENTITLED " TOPOGRAPHIC MAP , PLATEAU MINING COMPANY, WATTIS AND VICINITY " DATED 9-17-75.
FEET
200 0 200 400

SITE PLAN

APPENDICES



REFERENCE:
MAP ENTITLED "REFUSE PILE NO. 1211 – UT – 9 – 0008"
PREPARED BY PLATEAU MINING COMPANY DATED NOVEMBER 1976.

NOTE:
LOCATIONS SHOWN OF BORINGS AND TEST PITS ARE BY REPRESENTATIVES OF PLATEAU MINING COMPANY.

KEY:
- BORING LOCATIONS
- TEST PIT LOCATIONS
- BORINGS WITH PIEZOMETERS

PLOT PLAN

50 0 50 100 FEET

DAMES & MOORE

PLATE 3

APPENDIX A

FIELD EXPLORATIONS AND FIELD AND LABORATORY TESTING

FIELD STUDIES

GENERAL

The field portion of this study included a general reconnaissance of the site area, the drilling of six exploration borings, the excavation of five test pits, the installation of piezometers, the performance of a series of in-place density tests, and a partial topographic survey of the active refuse pile (No. 1211-UT-9-0008). The field studies, with the exception of the survey, were supervised by an experienced soils engineer from our staff. The partial survey was performed by representatives of Plateau Mining Company.

SITE RECONNAISSANCE

Prior to and during our field exploration program, a general site reconnaissance was performed. The reconnaissance was performed to aid in evaluating the geology of the site and the performance and construction of the existing refuse piles. The data obtained in conjunction with the reconnaissance was utilized to help in selecting the number, locations, and depths of the test pits and borings extended.

FIELD EXPLORATIONS

The subsurface soil, refuse pile, and ground water conditions were investigated by drilling six exploration borings, excavating five test pits, and installing three piezometers. The locations of the borings, test pits, and piezometers are presented on Plate 3, Plot Plan.

The borings were drilled with a truck-mounted rotary drilling rig and extended to depths ranging from 3.0 to 38.0 feet. The test pits were excavated with a tractor-mounted backhoe and extended to depths from 2.0 to 10.0 feet. A piezometer consisting of slotted two inch diameter PVC pipe was installed in Borings 1, 2, and 3 following drilling for the purpose of monitoring ground water conditions.

Undisturbed samples of the coal refuse and underlying natural soils were obtained from the exploration borings by utilizing a Dames & Moore sampler as illustrated on Plate A-2, Soil Sampler Type D. From the test pits disturbed bulk samples were obtained. The coal refuse and soils were classified by visual and textural examination in the field and a complete log was maintained of each boring and test pit. These classifications were supplemented by subsequent inspection and testing in our laboratory. Graphical representation of the coal refuse and natural soils encountered in the exploration borings and test pits are shown on Plates A-1A and A-1B, Log of Borings and Plate A-1C, Log of Test Pits. The nomenclature utilized in describing the soil types appears on Plate A-3, Unified Soil Classification System.

FIELD TESTING

In order to determine the in situ moisture and density of the mine refuse, five in-place density tests were performed during the test pit excavation operations. The tests were performed in accordance with the ASTM* 1556 designation.

Results of the tests are presented to the left of the test pit logs on Plate A-1C.

SURVEYING

In order to accurately define the existing geometry of the active refuse pile, as well as locate and give elevations of borings and test pits associated with this study, representatives of Plateau Mining Company performed a ground survey. This survey formed the basis for the development of the map presented as Plate 3, Plot Plan.

LABORATORY TESTING

GENERAL

Laboratory tests were performed in order to develop appropriate data upon which to base our recommendations. The laboratory testing program included the following:

*American Society for Testing and Materials

1. Moisture and Density Tests
2. An Atterberg Limits Test
3. Gradation Tests
4. Compaction Tests
5. Direct Shear Tests
6. Triaxial Compression Tests
7. Specific Gravity Tests

MOISTURE AND DENSITY TESTS

Moisture and density determinations were performed on various representative relatively undisturbed samples of the coal refuse material in order to help correlate other test data and to aid in classification.

The results of the moisture and density tests are presented to the left of the borings logs on Plates A-1A through A-1C.

ATTERBERG LIMITS TEST

An Atterberg Limits test was performed to classify the fine-grained fraction of the coal refuse. The test showed the fine-grained fraction to be non-plastic.

GRADATION TESTS

Gradation tests were performed for the purposes of classifying the coal refuse as well as correlating other test data. In addition, the data were utilized for the selection of representative samples of the coal refuse for Direct Shear and Triaxial

Compression testing. The results of the various gradation tests performed in conjunction with this study are presented on Plates A-4A and A-4B, Gradation Curves. The results of gradation tests performed upon mine refuse from other piles in the United States (see Appendix B) are also presented on Plate A-4A.

COMPACTION TESTS

Two compaction tests were performed upon mine refuse materials as part of the testing program.

The first test was performed upon a representative "grab sample" of recently placed mine refuse in accordance with the AASHTO T-180, Method C, criteria, as described on Plate A-5, Method of Performing Compaction Tests. The results of this test are presented on Plate A-6A, Compaction Test Data. The original gradation of the "grab sample" is shown on the lower portion of Plate A-4B.

The second test was performed upon a sample of mine waste which was gradationally prepared to limit the maximum particle size to three-eighths of an inch and to have approximately 30 percent by weight passing the No. 200 sieve. The compaction test was performed in accordance with the AASHTO T-180, Method C, criteria, except that the maximum particle size was three-eighths of an inch. The results of this test are presented on Plate A-6B, Compaction Test Data. The gradation of this sample, Sample A, prior to performing the compaction test, is also presented on the lower portion of Plate A-4B. Following the compaction test, the percentage of material passing the No. 200 sieve was measured to be 29 percent.

DIRECT SHEAR TESTS

Strength tests were performed upon recompacted samples of Sample A material. Sample A material was gradationally prepared to represent a refuse pile material which would have lower than average strength characteristics. The samples were recompacted to a dry density of 70 pounds per cubic foot at moisture contents slightly above optimum. This density represents a lower average density of the in situ refuse material that was placed under uncontrolled conditions. The tests were performed at approximate saturated moisture content in accordance with the method described on Plate A-7, Method of Performing Direct Shear and Friction Tests. The tests were run at a strain rate of 0.005 inches per minute in order to approximate drained conditions.

The results of the direct shear tests are tabulated below:

Sample Identification	Initial Dry Density in PCF	Test Moisture Content in %	Normal Pressure in PSF	Peak Shearing Strength in PSF
Sample A - Coal Refuse	70	26.2	2,000	1,600
"	70	24.6	4,000	2,800
"	70	24.1	6,000	4,150

When plotted the data indicates a ϕ' (effective friction angle) of 33° and a c' (effective cohesion) of 200 psf. The range of ϕ' and c' values obtained by the Bureau of Mines (see Appendix B) for similar materials ranged from 31° to 36° and 0 to 490 psf, respectively.

TRIAXIAL COMPRESSION TESTS

In order to further define the strength characteristics of the Sample A, coal refuse, a multi-phase consolidated undrained (CU) triaxial compression test was performed. A general description of the procedures followed in performing the test are described on Plate A-8, Method of Performing Unconfined Compression and Triaxial Compression Test. During the course of this test, pore pressures were recorded.

The results of the tests are presented below:

Sample Identification	Initial Dry Density in PCF	Initial Saturated Moisture Content in %	Effective Friction Angle (ϕ') in Degrees	Effective Cohesion (c') in PSF
Sample A - Coal Refuse	70	26.1	35	0

The range of ϕ' and c' values obtained by the Bureau of Mines (see Appendix B) for similar materials ranged from 31° to 37° and 29 to 1,555 psf, respectively.

SPECIFIC GRAVITY TESTS

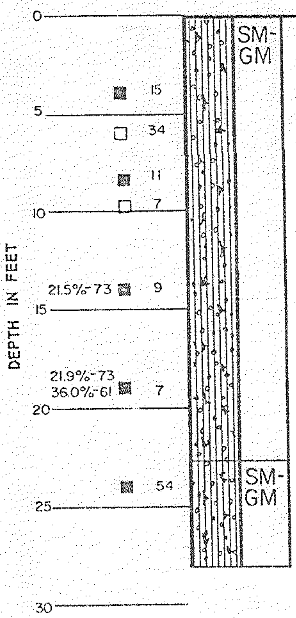
Specific gravity tests were performed in order to provide data utilized in determining the degree of saturation of the coal refuse.

The results of the specific gravity tests are presented below:

Boring No.	Depth	Specific Gravity
4	6.5 feet	1.63
Fresh Coal Refuse	Surface	1.46

BORING 1

ELEVATION 7392.1'



COAL REFUSE (MUDSTONE, SHALE AND COAL) – BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES – MEDIUM DENSE
GRADING DENSE

GRADING MEDIUM DENSE

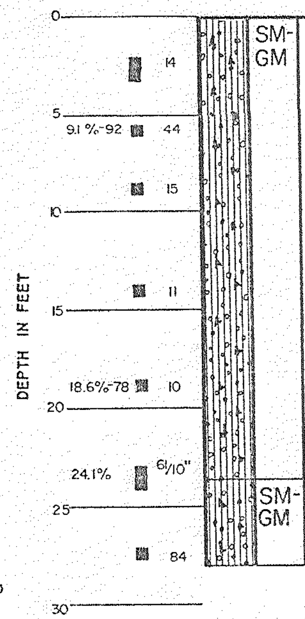
GRADING LESS GRAVEL AND MOIST

BROWN SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND SOME SMALL ROOTS (NATURAL SOIL) – DENSE
GRADING VERY DENSE

BORING COMPLETED AT 28.0' ON 11-1-76
2" DIAMETER SLOTTED PVC PIPE INSTALLED TO A DEPTH OF 28.0'.

BORING 2

ELEVATION 7396.2'



COAL REFUSE (MUDSTONE, SHALE, AND COAL) – BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES – MEDIUM DENSE
GRADING MEDIUM DENSE

GRADING LOOSE

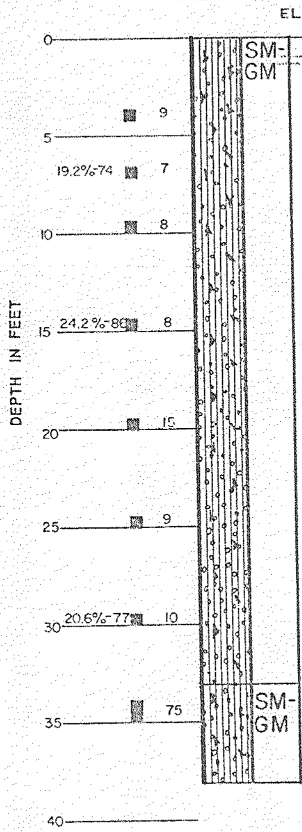
GRADING MOIST

LIGHT BROWN, YELLOWISH – BROWN, AND BROWN SILTY FINE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLES AND SMALL ROOTS (NATURAL SOIL) – DENSE

BORING COMPLETED AT 28.0' ON 11-2-76
2" DIAMETER SLOTTED PVC PIPE INSTALLED TO A DEPTH OF 28.0'.

BORING 3

ELEVATION 7391.8'



COAL REFUSE (MUDSTONE, SHALE AND COAL) – BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES – MEDIUM DENSE

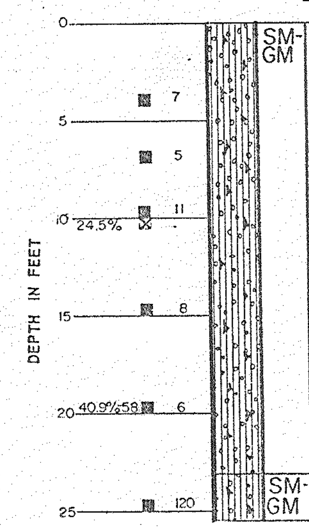
GRADING MOIST

LIGHT BROWN, YELLOWISH BROWN, AND BROWN SILTY FINE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLES (NATURAL SOIL) – DENSE

BORING COMPLETED AT 38.0' ON 11-2-76
2" DIAMETER SLOTTED PVC PIPE INSTALLED TO A DEPTH OF 38.0'

BORING 4

ELEVATION 7404.5'



COAL REFUSE (MUDSTONE, SHALE, AND COAL) – BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES – MEDIUM DENSE

GRADING MOIST

GRADING LESS GRAVEL AND VERY MOIST

BROWN SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL (NATURAL SOIL) – VERY DENSE

BORING COMPLETED AT 25.5' ON 11-2-76

KEY

A – B ▣ C

- A FIELD MOISTURE EXPRESSED AS A PERCENTAGE OF THE DRY WEIGHT OF SOIL
- B DRY DENSITY EXPRESSED IN LBS. PER CUBIC FOOT
- C BLOWS PER FOOT OF PENETRATION USING A 140 LB. HAMMER DROPPING 30 INCHES
- ▣ DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED
- ☒ DEPTH AT WHICH DISTURBED SAMPLE WAS EXTRACTED
- □ SAMPLING ATTEMPT WITH NO RECOVERY
- BULK SAMPLE
- * DEPTH AT WHICH IN PLACE DENSITY AND MOISTURE CONTENT WERE OBTAINED

NOTES

THE DISCUSSION IN THE TEXT UNDER THE SECTION TITLED, "SITE CONDITIONS, SUBSURFACE", IS NECESSARY TO A PROPER UNDERSTANDING OF THE NATURE OF THE SUBSURFACE MATERIALS.

GROUND WATER WAS NOT ENCOUNTERED IN ANY OF THE BORINGS OR TEST PITS.

ELEVATIONS PROVIDED BY PLATEAU MINING COMPANY.

LOG OF BORINGS

DAMES & MOORE

BORING 5

ELEVATION 7402.5'

DEPTH IN FEET

Depth	Sample data	Blows	Description
0			SM-GM: COAL REFUSE (MUDSTONE, SHALE AND COAL) – BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES – DENSE
	16.9%-80	41	
5		13	GRADING MEDIUM DENSE
10	17.1%-71	10	
15		10	
			GRADING MOIST
20	25.6%	9	
25		100	LIGHT BROWN, YELLOWISH-BROWN, AND BROWN SANDSTONE, SLIGHTLY WEATHERED AND MODERATELY HARD WITH SOME SMALL ROOTS

BORING COMPLETED AT 25.5' ON 11-2-76

BORING 6

ELEVATION 7357.0'

DEPTH IN FEET

Depth	Description
0	SM-ML: COAL REFUSE (MUDSTONE, SHALE AND COAL)–BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES – MEDIUM DENSE
	LIGHT BROWN TO BROWN SANDSTONE SLIGHTLY WEATHERED AND MODERATELY HARD WITH SOME SMALL ROOTS.
5	

BORING COMPLETED AT 3.0' ON 11-2-76

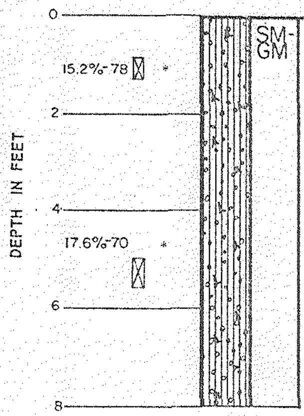
LOG OF BORINGS

DAMES & MOORE

BY ____ DATE ____
BY ____ DATE ____
PLATE ____ OF ____
CHECKED BY ____ DATE ____

TEST PIT 1

ELEVATION 7452.0 (APPROXIMATE)



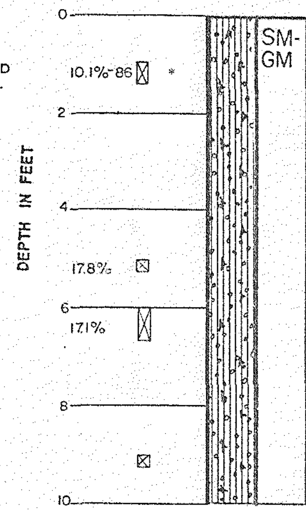
COAL REFUSE (MUDSTONE, SHALE AND COAL)– BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES– MEDIUM DENSE

SIDES OF TEST PIT STAND VERTICAL

TEST PIT COMPLETED AT 8.0' ON 11–3–76

TEST PIT 2

ELEVATION 7402.4'



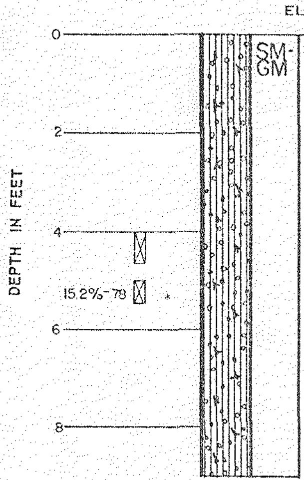
COAL REFUSE (MUDSTONE, SHALE AND COAL)– BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES – DENSE

GRADING MEDIUM DENSE

TEST PIT COMPLETED AT 10.0' ON 11–3–76

TEST PIT 3

ELEVATION 7395.2'



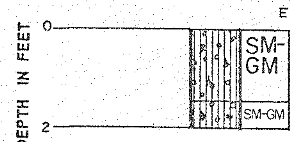
COAL REFUSE (MUDSTONE, SHALE AND COAL) – BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES– MEDIUM DENSE

SIDES OF TEST PIT STAND VERTICAL

TEST PIT COMPLETED AT 9.0' ON 11–3–76

TEST PIT 4

ELEVATION 7567.1'



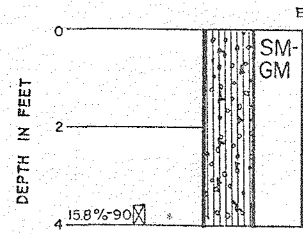
COAL REFUSE(MUDSTONE, SHALE AND COAL) – BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES – DENSE

BROWN SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND COBBLES (NATURAL SOIL)–DENSE

TEST PIT COMPLETED AT 2.0' ON 11–3–76

TEST PIT 5

ELEVATION 7350.2'



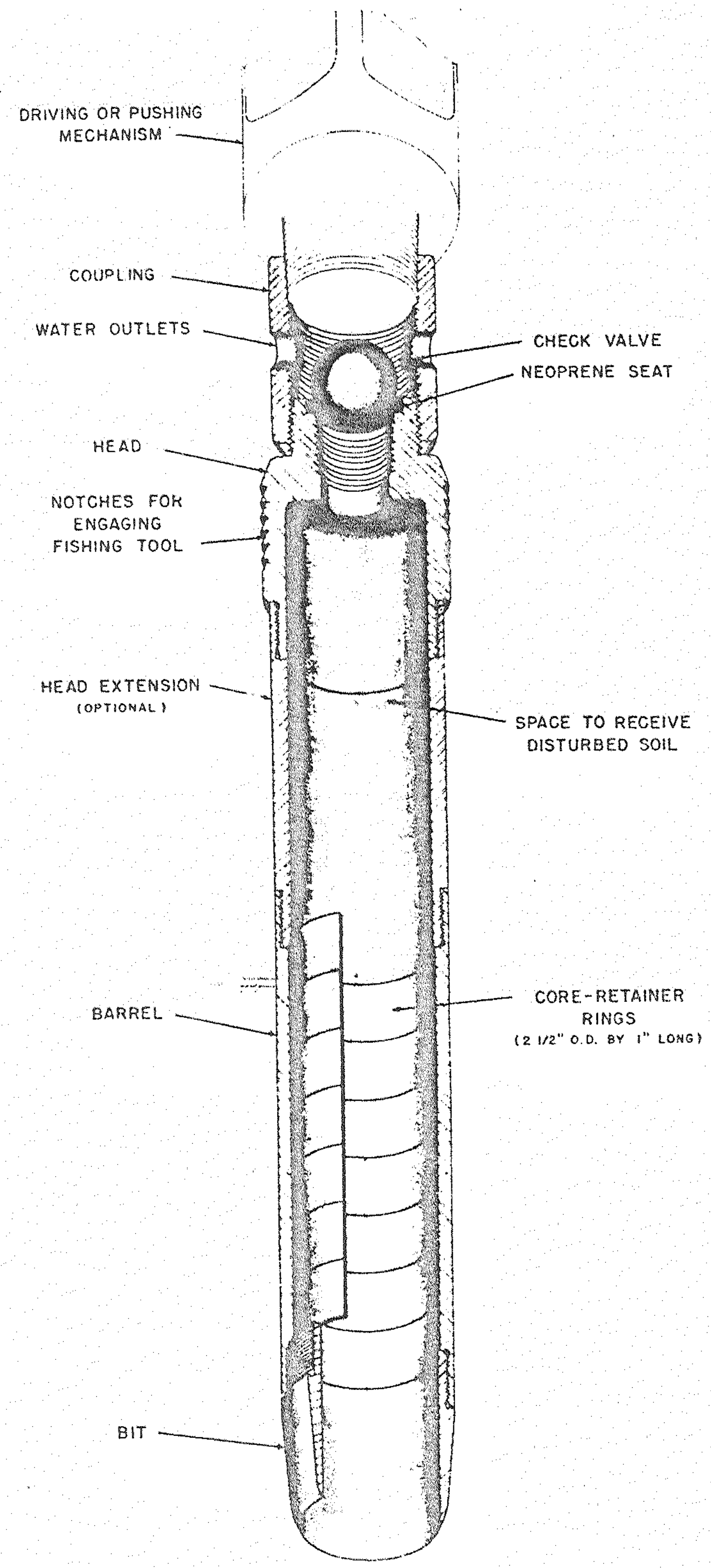
COAL REFUSE (MUDSTONE, SHALE, AND COAL) – BLACK SILTY FINE TO COARSE SAND WITH FINE AND COARSE GRAVEL AND OCCASIONAL COBBLE SIZED PARTICLES– DENSE

TEST PIT COMPLETED AT 4.0' ON 11–3–76

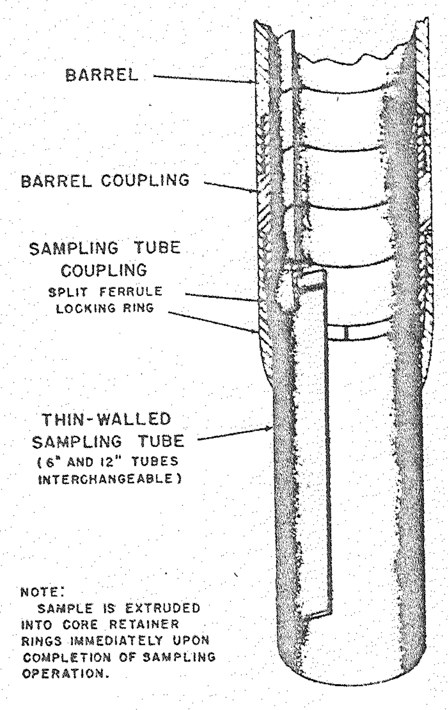
LOG OF TEST PITS

DAMES & MOORE

PLATE A-1C



ALTERNATE ATTACHMENTS



NOTE:
SAMPLE IS EXTRUDED INTO CORE RETAINER RINGS IMMEDIATELY UPON COMPLETION OF SAMPLING OPERATION.

SOIL SAMPLER TYPE D

REVISIONS BY ____ DATE ____

FILE ____

BY ____ DATE ____ CHECKED BY ____

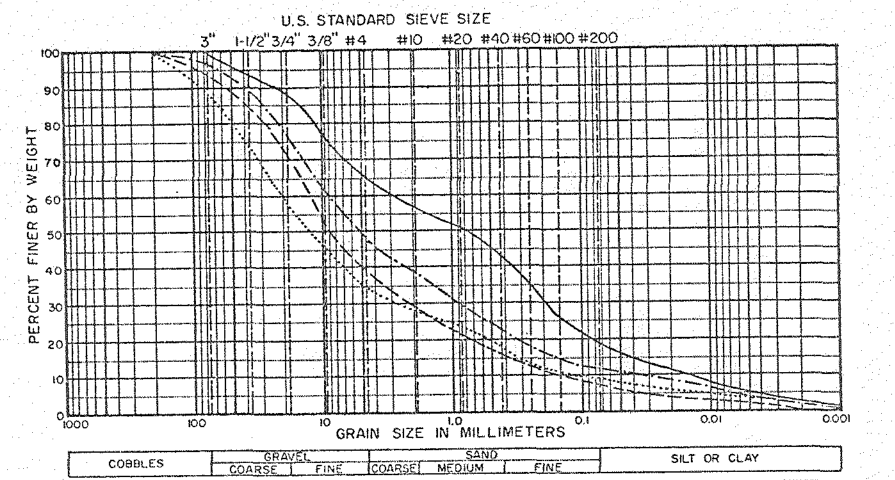
MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO.4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.

SOIL CLASSIFICATION CHART

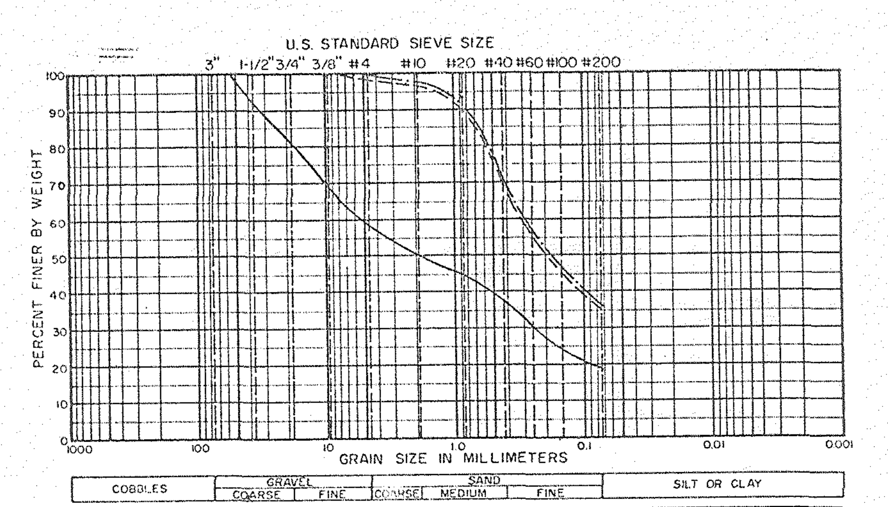
UNIFIED SOIL CLASSIFICATION SYSTEM

DAMES & MOORE



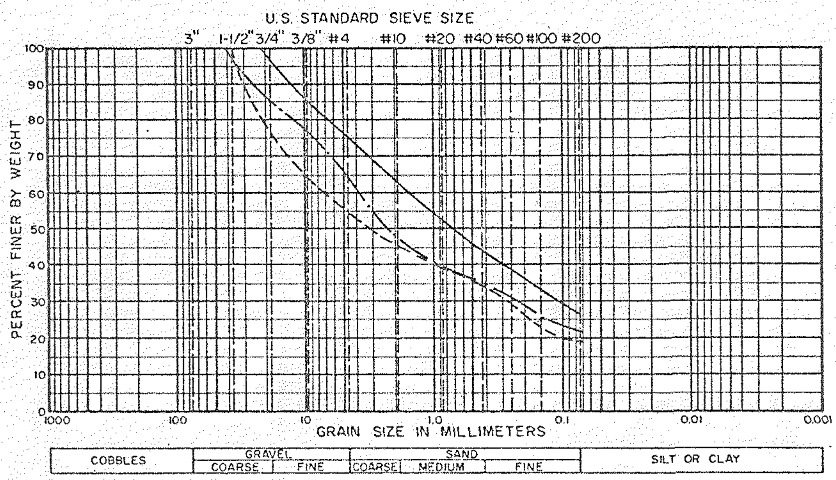
LOCATION	DEPTH	CLASSIFICATION
		TYPICAL COAL REFUSE GRADATION CURVES (SEE APPENDIX B)

REFERENCE: BUSH, RICHARD A., BACKER, RONALD R., AND ATLEINS, LYNN A., (1974) "PHYSICAL PROPERTY DATA ON COAL WASTE EMBANKMENT MATERIALS", UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF MINES, REPORT OF INVESTIGATIONS 7964.

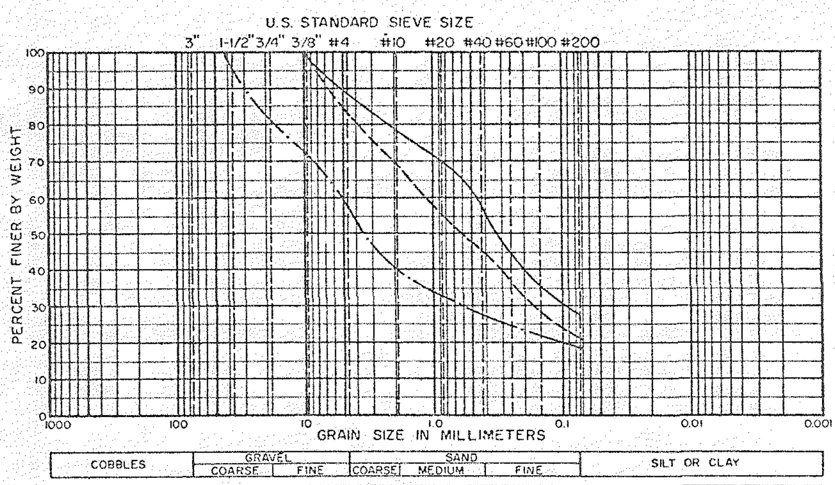


LOCATION	DEPTH	CLASSIFICATION	SYMBOL
B-1, B-2, B-3, B-4.	8.0', 13.5' 19.5', 10'	SM-GM (COAL REFUSE - COMPOSITE SAMPLE)	———
TEST PIT 1	1.0'	SM-GM (COAL REFUSE)	— — —
TEST PIT 1	5.0'	SM-GM (COAL REFUSE)	— · —

GRADATION CURVES



LOCATION	DEPTH	CLASSIFICATION	SYMBOL
TEST PIT 2	1.0'	SM-GM (COAL REFUSE)	———
TEST PIT 3	5.0'	SM-GM (COAL REFUSE)	– – – –
TEST PIT 5	4.0'	SM-GM (COAL REFUSE)	—·—



LOCATION	DEPTH	CLASSIFICATION	SYMBOL
TEST PIT 3	4.0'	SM (COAL REFUSE WITH MATERIAL RETAINED ON 3/8" SIEVE REMOVED)	———
SAMPLE A		SM (COAL REFUSE, GRADATIONALLY PREPARED)	– – – –
"GRAB SMPL" SEE PLOT PLAN	SURF.	SM-GM (FRESH COAL REFUSE)	— · —

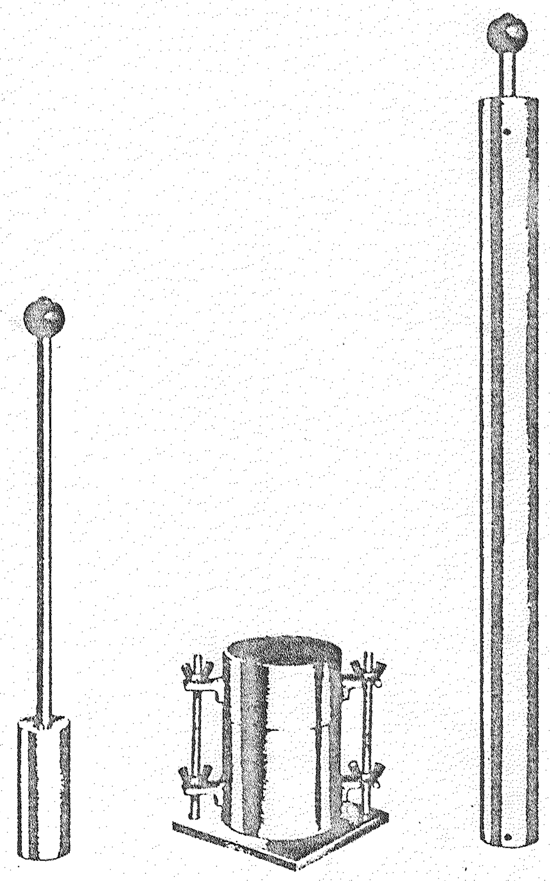
GRADATION CURVES

DAMES & MOORE

CHECKED BY DATE

It has been established that when compacting effort is held constant, the density of a rolled earth fill increases with added moisture until a maximum dry density is obtained at a moisture content termed the "optimum moisture content," after which the dry density decreases. The compaction curve showing the relationship between density and moisture content for a specific compacting effort is determined by experimental methods. Two commonly used methods are described in the following paragraphs.

For the "Standard A.A.S.H.O." (A.S.T.M. D698-58T & A.A.S.H.O. T99-57) method of compaction a portion of the soil sample passing the No. 4 sieve is compacted at a specific moisture content in three equal layers in a standard compaction cylinder having a volume of 1/30 cubic foot, using twenty-five 12-inch blows of a standard 5-1/2 pound rammer to compact each layer.



SOME APPARATUS FOR PERFORMING COMPACTION TESTS
Shows, from left to right, 5-1/2 pound rammer (sleeve controlling 12" height of drop removed), 1/30 cubic-foot cylinder with removable collar and base plate, and 10 pound rammer within sleeve.

In the "Modified A.A.S.H.O." (A.S.T.M. D-1557-58T & A.A.S.H.O. T 180-57) method of compaction a portion of the soil sample passing the No. 4 sieve is compacted at a specific moisture content in five equal layers in a standard compaction cylinder having a volume of 1/30 cubic foot, using twenty-five 18-inch blows of a 10-pound rammer to compact each layer. Several variations of these compaction testing methods are often used and these are described in A.A.S.H.O. & A.S.T.M. specifications.

For both methods, the wet density of the compacted sample is determined by weighing the known volume of soil; the moisture content, by measuring the loss of weight of a portion of the sample when oven dried; and the dry density, by computing it from the wet density and moisture content. A series of such compactions is performed at increasing moisture contents until a sufficient number of points defining the moisture-density relationship have been obtained to permit the plotting of the compaction curve. The maximum dry density and optimum moisture content for the particular compacting effort are determined from the compaction curve.

METHOD OF PERFORMING COMPACTION TESTS (STANDARD AND MODIFIED A.A.S.H.O. METHODS)

SAMPLE NO. BULK DEPTH SURF. ELEVATION 7359.0'

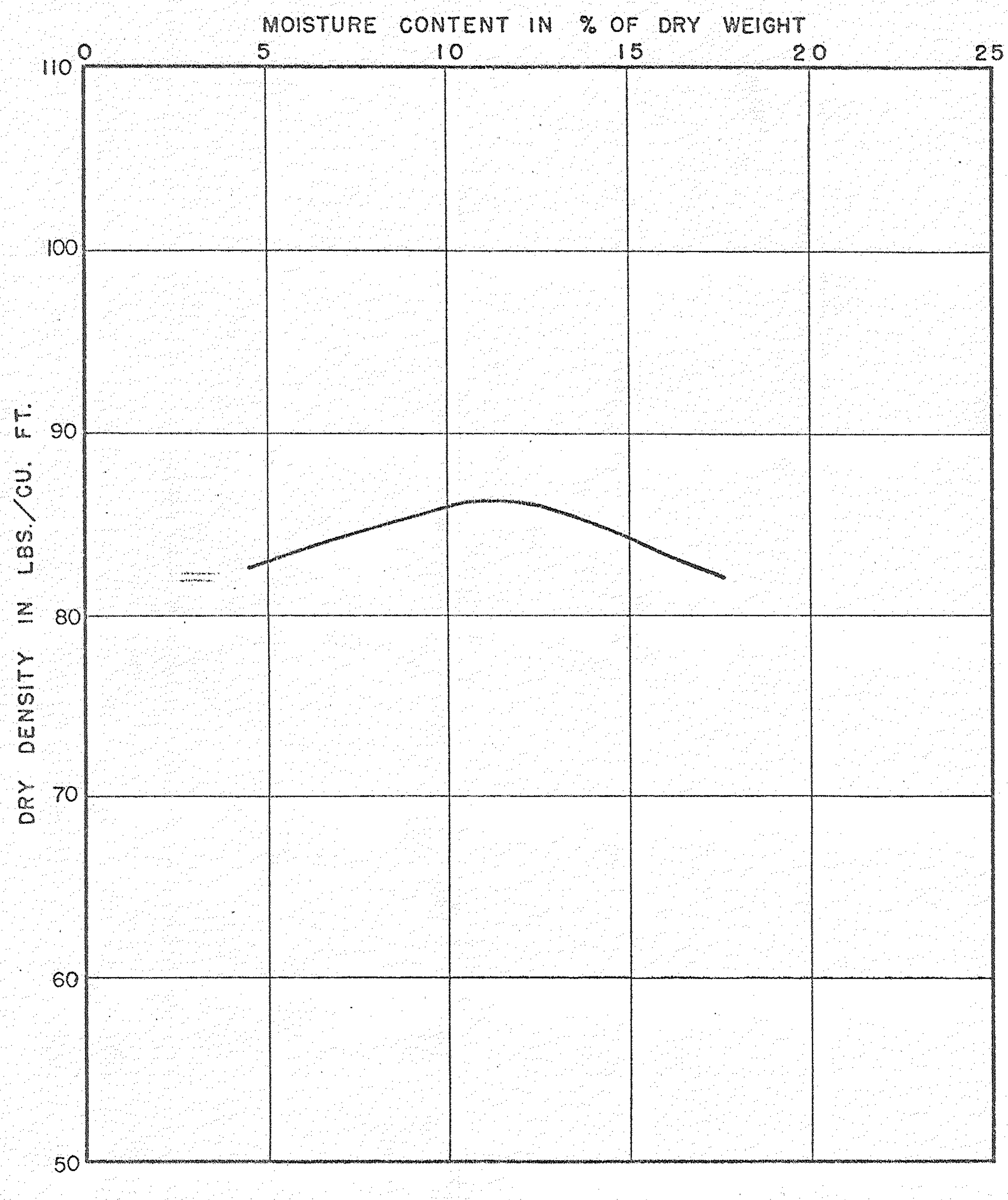
SOIL COAL REFUSE

LOCATION "GRAB SMAPLE"– SEE PLOT PLAN

OPTIMUM MOISTURE CONTENT 11.5 PERCENT

MAXIMUM DRY DENSITY 86.5

METHOD OF COMPACTION AASHTO T – 180 METHOD C



COMPACTION TEST DATA

DAMES & MOORE

CHECKED BY RLO DATE 1-19-77

BY DATE

DATE

Plateau Mining

SAMPLE NO. A DEPTH ______ ELEVATION ______

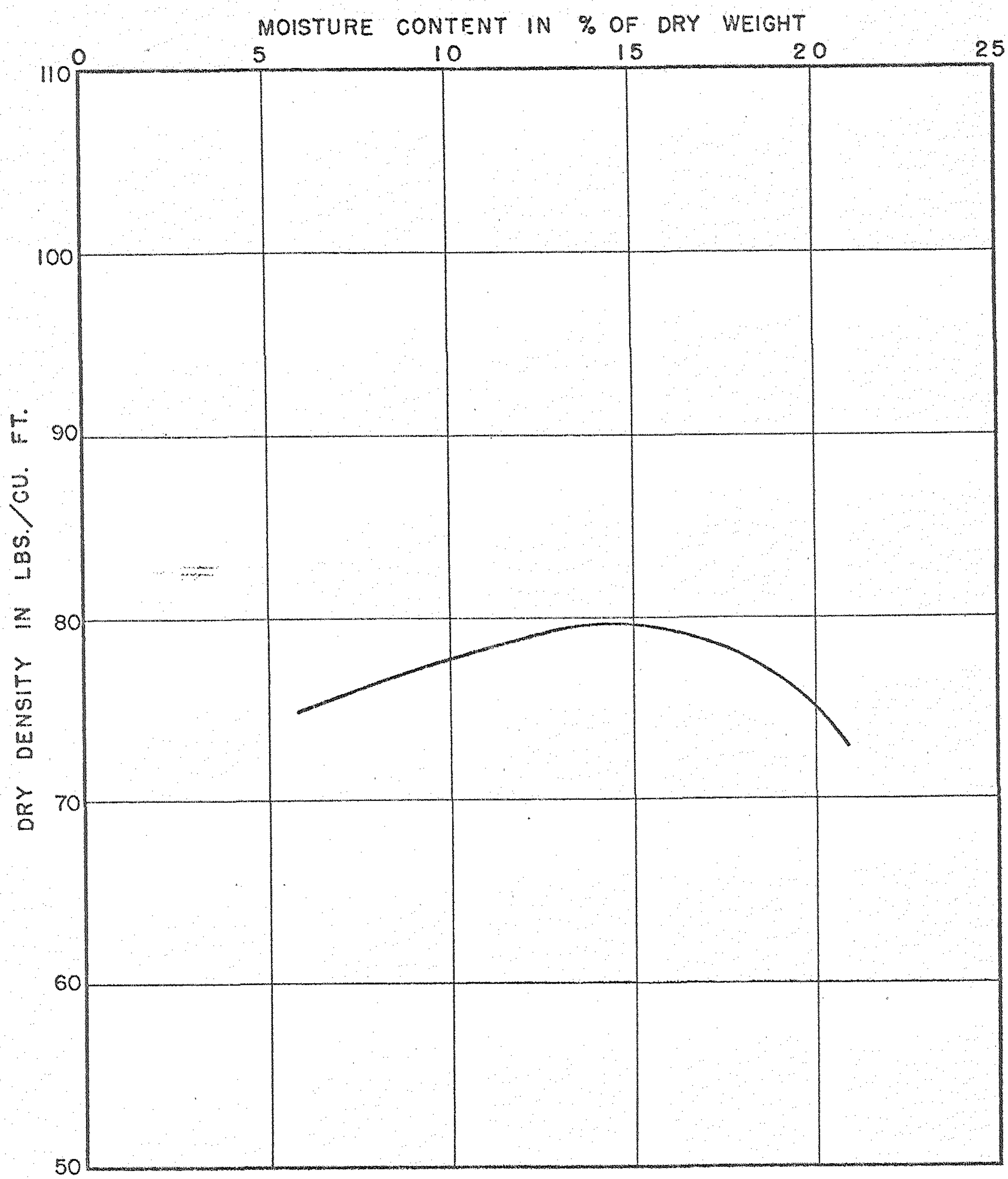
SOIL COAL REFUSE (GRADATIONALLY PREPARED)

LOCATION SAMPLE A

OPTIMUM MOISTURE CONTENT 15 PERCENT

MAXIMUM DRY DENSITY 79.6

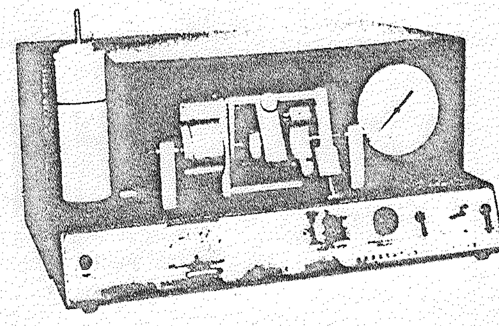
METHOD OF COMPACTION AASHTO T-180 METHOD C (EXCEPT 3/8" MAXIMUM)



COMPACTION TEST DATA

DAMES & MOORE

DIRECT SHEAR TESTS ARE PERFORMED TO DETERMINE THE SHEARING STRENGTHS OF SOILS. FRICTION TESTS ARE PERFORMED TO DETERMINE THE FRICTIONAL RESISTANCES BETWEEN SOILS AND VARIOUS OTHER MATERIALS SUCH AS WOOD, STEEL, OR CONCRETE. THE TESTS ARE PERFORMED IN THE LABORATORY TO SIMULATE ANTICIPATED FIELD CONDITIONS.



DIRECT SHEAR TESTING
& RECORDING APPARATUS

EACH SAMPLE IS TESTED WITHIN THREE BRASS RINGS, TWO AND ONE-HALF INCHES IN DIAMETER AND ONE INCH IN LENGTH. UNDISTURBED SAMPLES OF IN-PLACE SOILS ARE TESTED IN RINGS TAKEN FROM THE SAMPLING DEVICE IN WHICH THE SAMPLES WERE OBTAINED. LOOSE SAMPLES OF SOILS TO BE USED IN CONSTRUCTING EARTH FILLS ARE COMPACTED IN RINGS TO PREDETERMINED CONDITIONS AND TESTED.

DIRECT SHEAR TESTS

A THREE-INCH LENGTH OF THE SAMPLE IS TESTED IN DIRECT DOUBLE SHEAR. A CONSTANT PRESSURE, APPROPRIATE TO THE CONDITIONS OF THE PROBLEM FOR WHICH THE TEST IS BEING PERFORMED, IS APPLIED NORMAL TO THE ENDS OF THE SAMPLE THROUGH POROUS STONES. A SHEARING FAILURE OF THE SAMPLE IS CAUSED BY MOVING THE CENTER RING IN A DIRECTION PERPENDICULAR TO THE AXIS OF THE SAMPLE. TRANSVERSE MOVEMENT OF THE OUTER RINGS IS PREVENTED.

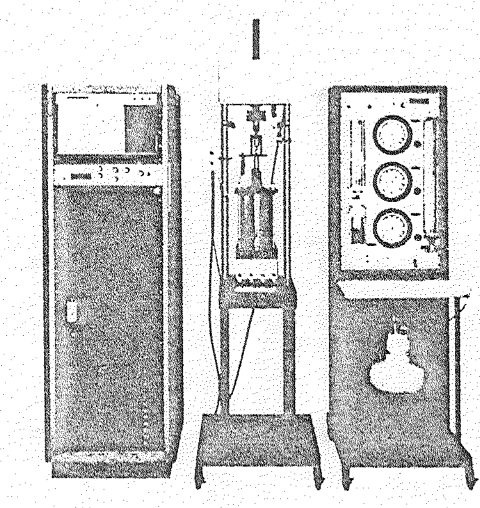
THE SHEARING FAILURE MAY BE ACCOMPLISHED BY APPLYING TO THE CENTER RING EITHER A CONSTANT RATE OF LOAD, A CONSTANT RATE OF DEFLECTION, OR INCREMENTS OF LOAD OR DEFLECTION. IN EACH CASE, THE SHEARING LOAD AND THE DEFLECTIONS IN BOTH THE AXIAL AND TRANSVERSE DIRECTIONS ARE RECORDED AND PLOTTED. THE SHEARING STRENGTH OF THE SOIL IS DETERMINED FROM THE RESULTING LOAD-DEFLECTION CURVES.

FRICTION TESTS

IN ORDER TO DETERMINE THE FRICTIONAL RESISTANCE BETWEEN SOIL AND THE SURFACES OF VARIOUS MATERIALS, THE CENTER RING OF SOIL IN THE DIRECT SHEAR TEST IS REPLACED BY A DISK OF THE MATERIAL TO BE TESTED. THE TEST IS THEN PERFORMED IN THE SAME MANNER AS THE DIRECT SHEAR TEST BY FORCING THE DISK OF MATERIAL FROM THE SOIL SURFACES.

METHOD OF PERFORMING DIRECT SHEAR AND FRICTION TESTS

THE SHEARING STRENGTHS OF SOILS ARE DETERMINED FROM THE RESULTS OF UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS. IN TRIAXIAL COMPRESSION TESTS THE TEST METHOD AND THE MAGNITUDE OF THE CONFINING PRESSURE ARE CHOSEN TO SIMULATE ANTICIPATED FIELD CONDITIONS.



TRIAXIAL COMPRESSION TEST UNIT

UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS ARE PERFORMED ON UNDISTURBED OR REMOLDED SAMPLES OF SOIL APPROXIMATELY SIX INCHES IN LENGTH AND TWO AND ONE-HALF INCHES IN DIAMETER. THE TESTS ARE RUN EITHER STRAIN-CONTROLLED OR STRESS-CONTROLLED. IN A STRAIN-CONTROLLED TEST THE SAMPLE IS SUBJECTED TO A CONSTANT RATE OF DEFLECTION AND THE RESULTING STRESSES ARE RECORDED. IN A STRESS-CONTROLLED TEST THE SAMPLE IS SUBJECTED TO EQUAL INCREMENTS OF LOAD WITH EACH INCREMENT BEING MAINTAINED UNTIL AN EQUILIBRIUM CONDITION WITH RESPECT TO STRAIN IS ACHIEVED.

YIELD, PEAK, OR ULTIMATE STRESSES ARE DETERMINED FROM THE STRESS-STRAIN PLOT FOR EACH SAMPLE AND THE PRINCIPAL STRESSES ARE EVALUATED. THE PRINCIPAL STRESSES ARE PLOTTED ON A MOHR'S CIRCLE DIAGRAM TO DETERMINE THE SHEARING STRENGTH OF THE SOIL TYPE BEING TESTED.

UNCONFINED COMPRESSION TESTS CAN BE PERFORMED ONLY ON SAMPLES WITH SUFFICIENT COHESION SO THAT THE SOIL WILL STAND AS AN UNSUPPORTED CYLINDER. THESE TESTS MAY BE RUN AT NATURAL MOISTURE CONTENT OR ON ARTIFICIALLY SATURATED SOILS.

IN A TRIAXIAL COMPRESSION TEST THE SAMPLE IS ENCASED IN A RUBBER MEMBRANE, PLACED IN A TEST CHAMBER, AND SUBJECTED TO A CONFINING PRESSURE THROUGHOUT THE DURATION OF THE TEST. NORMALLY, THIS CONFINING PRESSURE IS MAINTAINED AT A CONSTANT LEVEL, ALTHOUGH FOR SPECIAL TESTS IT MAY BE VARIED IN RELATION TO THE MEASURED STRESSES. TRIAXIAL COMPRESSION TESTS MAY BE RUN ON SOILS AT FIELD MOISTURE CONTENT OR ON ARTIFICIALLY SATURATED SAMPLES. THE TESTS ARE PERFORMED IN ONE OF THE FOLLOWING WAYS:

<u>UNCONSOLIDATED-UNDRAINED:</u> THE CONFINING PRESSURE IS IMPOSED ON THE SAMPLE AT THE START OF THE TEST. NO DRAINAGE IS PERMITTED AND THE STRESSES WHICH ARE MEASURED REPRESENT THE SUM OF THE INTERGRANULAR STRESSES AND PORE WATER PRESSURES.

<u>CONSOLIDATED-UNDRAINED:</u> THE SAMPLE IS ALLOWED TO CONSOLIDATE FULLY UNDER THE APPLIED CONFINING PRESSURE PRIOR TO THE START OF THE TEST. THE VOLUME CHANGE IS DETERMINED BY MEASURING THE WATER AND/OR AIR EXPELLED DURING CONSOLIDATION. NO DRAINAGE IS PERMITTED DURING THE TEST AND THE STRESSES WHICH ARE MEASURED ARE THE SAME AS FOR THE UNCONSOLIDATED-UNDRAINED TEST.

<u>DRAINED:</u> THE INTERGRANULAR STRESSES IN A SAMPLE MAY BE MEASURED BY PERFORMING A DRAINED, OR SLOW, TEST. IN THIS TEST THE SAMPLE IS FULLY SATURATED AND CONSOLIDATED PRIOR TO THE START OF THE TEST. DURING THE TEST, DRAINAGE IS PERMITTED AND THE TEST IS PERFORMED AT A SLOW ENOUGH RATE TO PREVENT THE BUILDUP OF PORE WATER PRESSURES. THE RESULTING STRESSES WHICH ARE MEASURED REPRESENT ONLY THE INTERGRANULAR STRESSES. THESE TESTS ARE USUALLY PERFORMED ON SAMPLES OF GENERALLY NON-COHESIVE SOILS, ALTHOUGH THE TEST PROCEDURE IS APPLICABLE TO COHESIVE SOILS IF A SUFFICIENTLY SLOW TEST RATE IS USED.

AN ALTERNATE MEANS OF OBTAINING THE DATA RESULTING FROM THE DRAINED TEST IS TO PERFORM AN UNDRAINED TEST IN WHICH SPECIAL EQUIPMENT IS USED TO MEASURE THE PORE WATER PRESSURES. THE DIFFERENCES BETWEEN THE TOTAL STRESSES AND THE PORE WATER PRESSURES MEASURED ARE THE INTERGRANULAR STRESSES.

METHODS OF PERFORMING UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS

DAMES & MOORE

REVISIONS BY ____ DATE ____

FILE ____

BY ____ DATE ____ CHECKED BY ____

946 7 REV.

APPENDIX B

TECHNICAL REFERENCE

BUREAU OF MINES

REPORT OF INVESTIGATIONS

1974*

PURPOSE AND SCOPE OF REPORT

The purpose of the referenced report was to define representative physical property data on typical coal refuse embankment materials. An extensive field sampling and laboratory testing program was carried out which resulted in a basis for establishing guideline parameters for use in design.

DISCUSSION OF RESULTS

The gradation curves for the coarse refuse materials tested show that the refuse materials are mostly well graded, although a considerable difference in the range of sizes was noted. The variety of preparation plants would account for this range in gradation. Typical gradation curves are shown on Plate A-4A, Gradation Curves.

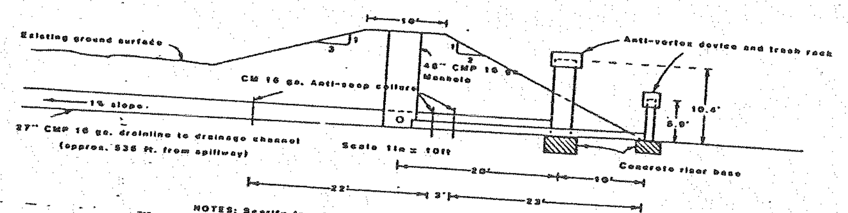
Specific gravity values also varied considerably from site to site reflecting the variation of coal content and rock types in the various dumps and individual samples.

*Busch, Richard A., Backer, Ronald R., and Atkins, Lynn A. (1974), "Physical Property Data on Coal Waste Embankment Materials," United States Department of the Interior, Bureau of Mines, Report of Investigations 7964.

A large variation in field densities was found. Methods of deposition, moisture contents, and proximity to haul roads were cited as variables effecting density.

Much time and effort was expended to establish reliable values for shear strength. Both direct shear and triaxial compression tests were run with extremely good correlation between the two. The values of ϕ' (effective friction angle) and c' (effective cohesion) were found to not change appreciably when tested in a saturated condition versus field conditions.

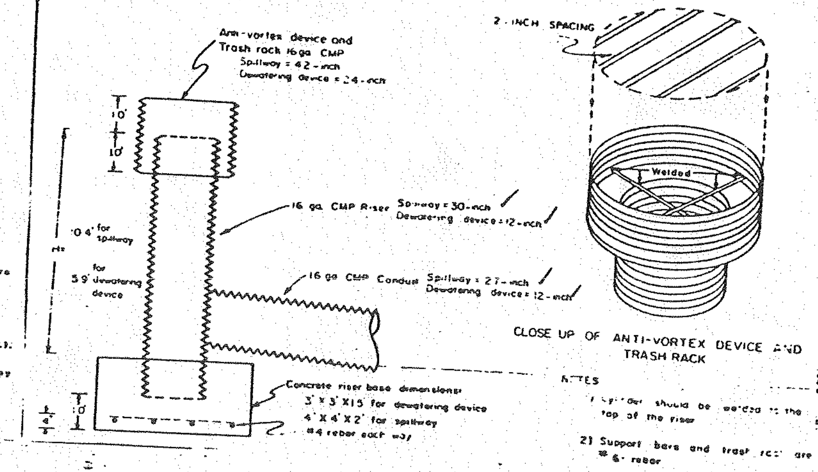
Typical results of direct shear and triaxial compression test obtained by the Bureau of Mines are presented with the direct shear and triaxial test data obtained in conjunction with this study in Appendix A.



NOTES: Scarify foundation prior to embankment construction.

NOTES:

1. Fill material to be laid in 6 to 8 inch continuous layers and machine compacted.
2. Fill material around conduits to be hand compacted.
3. Riprap to be placed at points of inflow and outflow.
4. Revegetate following construction.
5. Reference elevation is bottom of pond (7398.8 ft MSL).
6. All connections are to be watertight.
7. Riprap shall be placed 5 feet on both sides of spillway and dewatering device up full height of dam



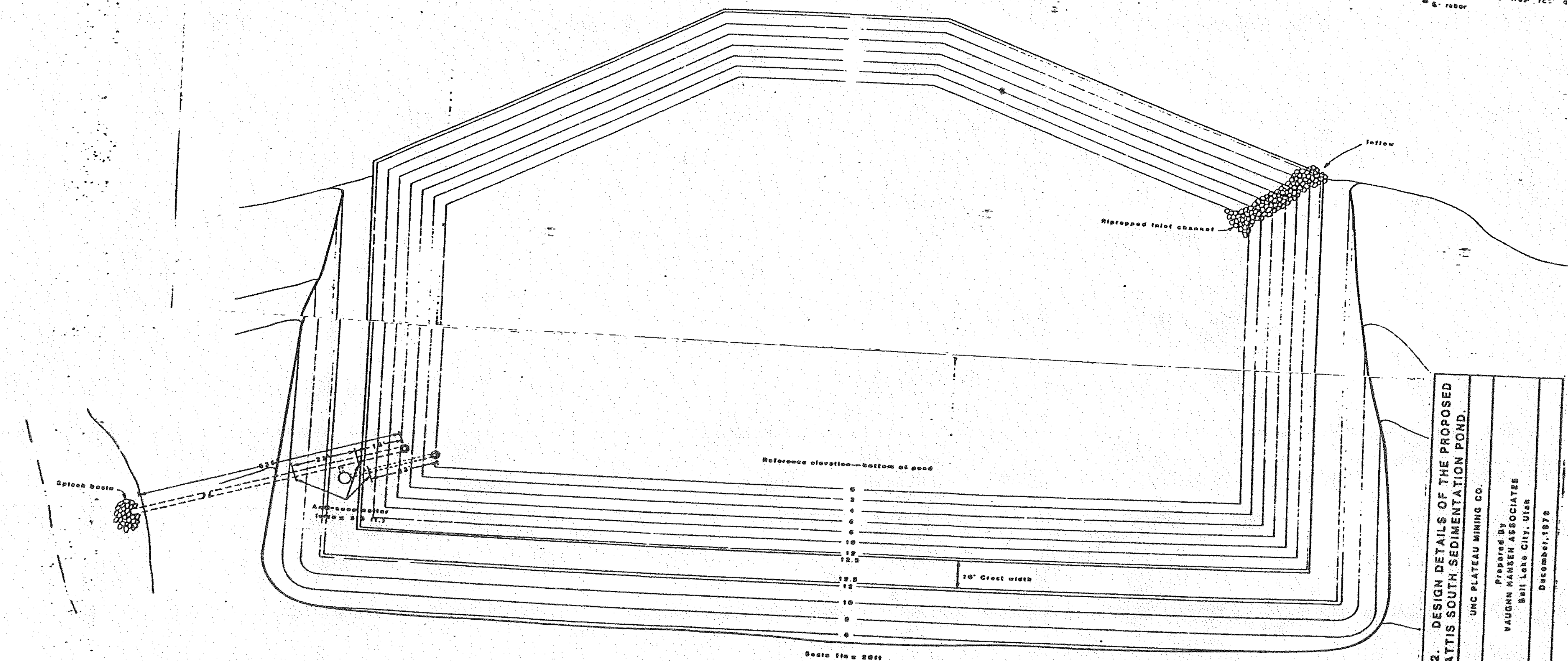


FIGURE 22. DESIGN DETAILS OF THE PROPOSED WATTIS SOUTH SEDIMENTATION POND.

UNC PLATEAU MINING CO.

Prepared By
VAUGHN HANSEN ASSOCIATES
Salt Lake City, Utah

December, 1979

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

ERN DIVISION MANAGER
D W. TAYLOR, JR.

PLEASE ADDRESS ALL CORRESPONDENCE TO:
139 SOUTH MAIN, HELPER, UTAH 84526
OFFICE TEL. (801) 472-3537

SINCE 1908

PRICE RIVER COAL CO.
P.O. Box 629
Helper, Utah 84526

Jan. 25, 1980

Sample identification by: Price River Coal Co.
Refuse Pile
1211-UT-9-0027

Kind of sample reported to us: Coal

Sample taken at: Castle Gate Prep. Plant-Refuse Pile

Sample taken by: Price River Coal Co.

Date sampled: 1-16-80

Date received: 1-16-80

Analysis report no. 57-3329

TOXICITY- Following procedure as outlined in the Federal Register, Part IV. Dec. 18, 1978

Arsenic-	0.011 mg/1
Selenium-	less than or = to 0.002 mg/1
Mercury-	less than or = to 0.04 micrograms/1
Cadmium-	less than or = to 0.004 mg/1
Lead-	less than or = to 0.06 mg/1
Cromium-	less than or = to 0.01 mg/1
Silver-	less than or = to 0.01 mg/1
Barium-	0.8 mg/1

ACIDITY- Sample prepared 1:1 coal-water extraction, following procedures of the U.S. Dept. of Agriculture-Handbook 60. Acidity determined as directed in Standard Methods 14th Edition.

Acidity- 0

JB/gp

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.
Jack Blair,
Jack Blair
Manager, Helper Laboratory

LOCATION: PLATEAU MINING COMPANY ; STARPOINT #1
REFUSE PILE EXTENSION

PRECIPITATION:

10 year-24 hour 2.1 inch; 25 year-6 hour 1.6 inch

100 yr-24 hr = 3.0 inch

AREA:

Disturbed Area 45.016 acres

Undisturbed Area 0 acres

Pond Area ½ A (assumed) acres

CN: Disturbed 78

Undisturbed 100

POND SIZE:

Discharge Disturbed Area ______ acre-feet

Discharge Undisturbed Area ______ acre-feet

Direct Precipitation ______ acre-feet

Sediment Storage ______ acre-feet

Total Storage ______ acre-feet

TIME OF CONCENTRATION: ______ hours

PEAK FLOW:

Farmer Fletcher ______ cfs

SCS ______ cfs

CULVERT PROGRAM FORMATS

* * * * * * * * * * * * * * *

MINE NAME: PLATEAU MINING CO. - Starpoint #1

WATERSHED: Refuse Pile Extension

CURVE NUMBER: ______

TIME OF CONCENTRATION (hour): ______

Y= ______

S= ______

L= ______

AREA (square mile): 0.07 sq. mi.

DURATION OF STORM (hour): 6

RAINFALL DEPTH (inch): 1.6

DISTRIBUTION TYPE (1=SCS, 2=Farmer-Fletcher):

1

PEAK DISCHARGE:

qp= ______ cfs Culvert Sizing: ______ inches

VOLUME:

Q= ______ inches

TIME OF CONCENTRATION DETERMINATION

*

MINE: ____________________

PERMIT: ____________________

STRUCTURE: ____________________

DATE: ____________________

STRUCTURE	CURVE NUMBER	S	l(ft)	H(ft)	y(%)	L(hrs)	Tc(hrs)

KENT'S FORMULA

$Tc = L/0.6$, hours

L = watershed lag, hours

$$L = \frac{l^{0.8} (S + 1)^{0.7}}{1900\ y^{0.5}}$$

l = length of the longest stream channel (ft)

$S = (1000/CN) - 10$, inches

y = average watershed slope in percent

Reference: Kent, K. M. 1973. A method of Estimating Volume and Rate of Runoff in Small Watersheds. U.S.D.A., SCS-TP-149 (Revised April 1973). ca. 80 pp.

To Lonski

LOCATION: Plateau Mining Company
East Sedimentation Pond

PRECIPITATION:

10 year-24 hour 2.1 inch; 25 year-6 hour 1.6 inch
100 yr-24 hr = 3.0

AREA:

Disturbed Area 45.13 acres

Undisturbed Area 0 acres

Pond Area 0.51 acres

CN: Disturbed 78

Undisturbed 100

POND SIZE:

Discharge Disturbed Area 2.036 acre-feet

Discharge Undisturbed Area 0 acre-feet

Direct Precipitation 0.089 acre-feet

Sediment Storage 4.513 acre-feet

Total Storage 6.639 acre-feet

TIME OF CONCENTRATION: ______ hours

PEAK FLOW:

Farmer Fletcher ______ cfs

SCS ______ cfs

ENTER
PRECIP.?
2.1 IN.
AREA UNDISTURBED?
0. AC.
AREA DISTURBED?
45.13 AC.
POND AREA?
0.51 AC.
C N UNDISTURBED?
100.
C N DISTURBED?
78.

DISCHARGE (DIST.):
2.036478111 ACFT
DISCHARGE (UNDIST.):
0. ACFT
SEDIMENT STORAGE:
4.513 ACFT
DIRECT PRECIP.:
0.08925 ACFT
TOTAL STORAGE:
6.638728111 ACFT

To Tomsik

LOCATION: Plateau Mining Company
East Sedimentation Pond

PRECIPITATION:

10 year-24 hour 2.1 inch; 25 year-6 hour 1.6 inch

100 yr-24 hr = 3.0

AREA:

Disturbed Area 45.13 acres

Undisturbed Area 0 acres

Pond Area 0.51 acres

CN: Disturbed 78

Undisturbed 100

POND SIZE:

Discharge Disturbed Area 2.036 acre-feet

Discharge Undisturbed Area 0 acre-feet

Direct Precipitation 0.089 acre-feet

Sediment Storage 4.513 acre-feet

Total Storage 6.639 acre-feet 1.5

TIME OF CONCENTRATION: ____ hours

PEAK FLOW:

Farmer Fletcher ____ cfs

SCS ____ cfs

1051 yd x 0.01 ac =
4513 yd x 0.01 ac =