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Salt Lake City, Utah
June 4, 1981

REPORT OF STABILITY ANALYSES
18-FOOT RAISE OF TAILINGS EMBANKMENT
TO ELEVATION 4076 FEET
MOAB, UTAH
FOR
ATLAS MINERALS

Dames & Moore

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June 4, 1981

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Attention: Mr. Richard R. Weaver,
President

Gentlemen:

Transmitted herewith are 18 copies of our report entitled "Report of Stability Analyses, 18-Foot Raise of Tailings Embankment to Elevation 4076 Feet, Moab, Utah, For Atlas Minerals.

Very truly yours,

DAMES & MOORE

George C. Toland

George C. Toland
Partner

James R. Boddy

James R. Boddy
Project Manager

GCT/JRB/pc

Attachments

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REPORT OF STABILITY ANALYSES
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INTRODUCTION

This report presents the results of our stability evaluation performed for the proposed raise of the tailings disposal embankment system at Atlas Minerals' mill area near Moab, Utah. The proposed embankment raise is to be 18 feet bringing the final crest elevation to 4076 feet. The location of the tailings disposal facility with respect to the existing plant site and surrounding topography is presented on Plate 1, Plot Plan.

Previous stability evaluations have been performed for the embankment of the tailings pond system in engineering design studies performed by Dames & Moore. In these studies evaluation of the subsurface conditions of the existing embankment and the underlying natural strata were performed through extensive field exploration and laboratory testing programs. The studies included performing additional detailed stability analyses of the existing embankment system, and of future embankment extensions to an ultimate embankment crest elevation of 4076 feet. This present study incorporates the data obtained during these previous evaluations along with current piezometric and pond surface information.

PURPOSE AND SCOPE

With submittals to the U.S. Nuclear Regulatory Commission of the tailings impoundment evaluation in the form of engineering design study reports dated February 15, 1978 and February 16, 1979, detailed analyses for three 12-foot high increases to the overall embankment height were performed. In those studies it was concluded that the embankment could be raised from a then-existing elevation of 4040 feet to a new crest elevation of 4076 feet. In December, 1979, construction of a raise was completed in which the embankment crest elevation was increased 18 feet to an elevation of 4058 feet (the present crest elevation of the embankment system). Since it has been established that the increase of the crest elevation of the embankment to 4076 feet may be performed with the embankment remaining in a stable condition, this present study is necessary in order to perform stability calculations in which only minor geometric changes in the previous stability analyses were performed to complete the design of an additional 18-foot raise to an ultimate crest elevation of 4076 feet.

Thus, the purpose of this study is to develop design recommendations based on an embankment expansion from crest elevation 4058 to 4076 feet and to prepare the necessary design documents for the construction of the expansion. In accomplishing this purpose the following scope was performed:

1. A review of the previous studies performed in which the stability of the embankments were analyzed.

2. An engineering analyses based on the geometry of the proposed 18-foot raise and the data obtained during the previous engineering design studies along with current and projected design piezometric information.

3. Presenting operational requirements including freeboard, beach widths, water level monitoring, and general tailings area surveillance recommendations.

4. The presentation of this final report.

PREVIOUS STUDIES

The study as presented herein is a re-evaluation of the overall stability of the future tailings disposal system under static and seismic loading. The basis of the re-evaluation is the extensive field investigations, results of the laboratory testing programs, and the earlier stability analyses as reported in engineering design studies dated February 15, 1978 and February 16, 1979. These reports plus other reports which summarize engineering design, construction inspection, and remedial construction activities of pertinent construction and design studies are listed below. Copies of the reports as listed appear in Appendix A.

Report of Remedial Construction Activities, Tailings Pond - Including the Western Embankment Improvements and the Northern Embankment Subdrain, Moab, Utah, For Atlas Minerals. Dames & Moore Job No. 05467-018-06, Salt Lake City, Utah, dated November 18, 1977.

Report of Engineering Design Study, Additions to Tailings Pond-Embankment System, Moab, Utah, For Atlas Minerals. Original submittal - Dames & Moore Job No. 05467-018-06, Salt Lake City, Utah, dated February 15, 1978. New printing with revisions dated May 26, 1981 (not reproduced in Appendix A).

Report of Earthwork Observations and Field Control Testing Alteration of Tailings Dam - Six-Foot Embankment Raise, Moab Mill, Moab, Utah, For Atlas Minerals Corporation. Dames & Moore Job No. 05467-022-06, Salt Lake City, Utah, dated January 15, 1979.

Report of Supplementary Study, Geotechnical Evaluation of Tailings Pond - Embankment System, Moab, Utah, For Atlas Minerals. Dames & Moore Job No. 05467-023-06, Salt Lake City, Utah, dated February 16, 1979 (not reproduced in Appendix A).

Plans and Specifications, Tailing Embankment Expansion Project, 12-Foot Raise, For Atlas Minerals, Moab, Utah, dated August 24, 1979.

Technical Questions, Tailings Pond-Embankment System, Atlas Minerals Milling Operation, Moab, Utah, Docket No. 40-3453, dated September 14, 1979.

Amendment No. 1 to Source Material, License SUA-917, Atlas Minerals, Moab Uranium Mill, Docket No. 40-3453, dated October 29, 1979.

Report or Construction Inspection and Embankment Monitoring Program, Tailings Dam Expansion Project, Moab Mill, Moab, Utah, For Atlas Minerals. Dames & Moore Job No. 05467-027-06, Salt Lake City, Utah, dated February 22, 1980.

Other earlier studies for the project have been on-going since 1973. The results of this early work is summarized in the February 15, 1978 Dames & Moore report.

As stated in the introduction of this report, the Dames & Moore reports of February 15, 1978 and February 16, 1979 summarize the detailed geotechnical study and stability analysis of the tailings embankment system. It was concluded in the reports that embankment extensions with factors of safety in excess of those required by the NRC Regulatory Guide 3.11 could be constructed to the embankment crest elevation of 4076 feet. In 1979, Atlas Minerals had requested to NRC that a raise be made to increase the embankment crest elevation to 4058 feet. Following this request a geotechnical review of the 1978 and 1979 studies were performed and submitted to the NRC and on October 29, 1979 a license amendment

was issued to Atlas Minerals allowing the construction of a lift for the tailings embankment system to the elevation of 4058 feet.

FIELD EXPLORATION AND LABORATORY TESTING PROGRAMS

FIELD EXPLORATION PROGRAM

The site conditions are described in detail in the February 15, 1978 and the February 16, 1979 reports. A summary of site conditions appear in the following section of this report. These site descriptions are based on the data obtained during the field exploration and laboratory testing programs performed in conjunction with the 1978 and 1979 studies as well as the previous studies reported in 1973, 1974, 1975, and 1977. Locations of the borings drilled as part of the 1978 and 1979 studies are shown on Plate 1.

In the February 15, 1978 report, logs of exploration borings and test pits were included. The borings range in depth from 19.5 feet up to 100.0 feet. Borings penetrated the tailings material and were extended into the underlying natural sands and silts. The borings were further utilized for the installation of piezometers and for the installation of open standpipes to measure water levels. All borings were drilled with truck-mounted rotary wash drilling equipment.

The February 16, 1979 report contains the logs of 28 additional exploratory borings which extend to depths of up to 130.0 feet. These borings were also advanced utilizing truck-mounted

rotary drilling equipment and 16 of the borings were utilized to install piezometers or standpipes. With the addition of these 18 borings, the spacing along the northeast and southern embankments is a minimum of 250 feet between any two borings and the spacing on the extreme northwest embankment is approximately 500 feet between any two borings.

Sampling was conducted in each of the test borings by a Dames & Moore soils engineer. The samplers used for obtaining representative samples to be used for identification and laboratory testing included Dames & Moore Type-U, standard penetration, Pitcher, Shelby-tube, and piston samplers. The standard split spoon sampler was used to obtain standard penetration data. Penetration data obtained by the Dames & Moore sampler was correlated to the standard penetration values. Field samples were collected and shipped to the Dames & Moore laboratory by conventional means during the field work contained in the 1978 report; samples obtained during the 1979 work were collected, allowed to drain, and then quickly frozen for shipment to the Dames & Moore San Francisco laboratory. The freezing process was performed to limit sample disturbance during the shipment process.

LABORATORY TESTING

Laboratory testing performed on the samples included moisture and density determination, gradation analyses, permeability determination, Atterberg limit determination, consolidation testing, static trixial compression testing, and cyclic triaxial compression

testing. The purpose of the laboratory testing was to obtain data for determining the strength and deformation characteristics of the soils and tailings within the embankment section. A total of 30 consolidated, undrained triaxial compression tests with pore pressure measurements were performed on the slime and sand tailings. Test results were interpreted in the normal procedure by plotting shear stress and failure versus the effective or total stress at failure. Cyclically loaded triaxial tests were also performed to evaluate the liquefaction potential of the tailings. Both Dames & Moore and the Corps of Engineers performed such analyses. The results of the Dames & Moore liquefaction tests were interpreted in the direction toward that of conservatism and were determined to be in reasonable agreement with those results from tests performed by the Corps of Engineers.

SITE CONDITIONS

INTRODUCTION

The existing tailings disposal site of Atlas Minerals' uranium processing mill is located directly southwest of the mill area. The disposal area occupies about 130 acres and is bordered on the southeast by the Colorado River and its floodplain and to the west, southwest, and northwest by roughly formed cliffs rising abruptly to about 800 feet above the floodplain elevation. Also, along the west and southwest of the pond, Utah State Highway 279 and a Utah Power & Light Company right-of-way lie between the base of these cliffs and the tailings disposal area. Moab Wash

and U.S. Highway 160 lie between the cliffs and the north side of the disposal area.

The detailed description of the site conditions is presented in the February 15, 1978 and February 16, 1979 reports. The information presented in those reports, as well as site condition descriptions presented herein, is based on the data obtained during the field exploration and laboratory testing programs performed in conjunction with those studies. The site conditions described in the following subsections briefly summarize those detailed descriptions as well as supplementing the discussions with recent information.

GEOLOGY

Descriptions and discussions of the physiographic setting, regional stratigraphy, regional structure, and the site and vicinity geology are presented in detail in the Safety Analysis Report (SAR) of Moab Mill. The SAR has been submitted by Atlas Minerals to the NRC as a pertinent document for re-licensing of the mill.

SEISMIC CONSIDERATIONS

In the February 16, 1979 report the seismic design evaluation was presented with discussions pertaining to seismo-techtonic setting, and a seismic risk assessment. Based on these results and for a design mean reoccurrence interval of 500 years, the postulated earthquake may be taken as a Magnitude VI event with hypocentral distance of approximately 50 kilometers and a maximum ground surface acceleration of 0.08g.

NATURAL SOIL AND BEDROCK

The natural soils which make up the foundation material beneath the tailings pond embankments at the site consist of a combination of (1) slope wash from the nearby cliffs, (2) soil deposited by the Moab Wash, (3) windblown sands, and (4) alluvial soils deposited by the Colorado River. To investigate the natural foundation materials, Borings B-1 through B-19 were drilled in conjunction with the 1979 study. These borings penetrated into the natural occurring material below the embankment to depths of up to 103 feet below the original ground surface. The results of these borings indicated that the soil-bedrock contact varies considerably within the site area. Sandstone bedrock encountered along the southeast embankment is found to be about 27 feet below the natural ground surface. Along the north embankment the depth to sandstone is 55 feet and along the southwest embankment the depth to sandstone is 103 feet. This was verified by 5 of the 19 borings drilled to investigate the natural materials. Bedrock was not encountered in any of the other borings which extended to depths below ground surface of up to 56 feet.

Above the bedrock the natural soils underlying the tailings disposal area are composed of medium dense to dense random layers and zones of silt, fine sandy silt, silty fine sand, fine to medium sand with traces of silt, and silty sand with gravel. The near-surface sandy material adjacent to, but outside the area occupied by the tailings impoundment, is loose to medium dense in

some locations. The higher densities found in the natural soils directly underlying the tailings pond are partially the result of consolidation by the weight of the tailings.

DESCRIPTION OF THE EXISTING TAILINGS IMPOUNDMENT EMBANKMENTS

EMBANKMENTS

The existing main embankment sections are defined as those embankments on the north, northeast, southeast, and south sides of the tailings ponds as shown on Plate 1. The remaining embankment along the western side is referred to as the Western Embankment. The geometry of these embankments are described in detail in the reports of the previous studies listed in a subsequent section of the report.

In general, the main embankment sections were formed by the construction of a compacted starter dike of natural alluvium fill on which a series of supplemental sand tailings dikes have been placed by the upstream method of construction. In general, this construction has resulted in an overall slope of the embankment of about 2.4 horizontal to 1.0 vertical. The existing supplemental sand tailings dikes above the starter dike were constructed directly upon the hydraulically deposited beach tailings.

The present configuration along the western embankment includes a 30-foot wide embankment of compacted natural red silty sand. The downstream method of construction was utilized to form this embankment section. For a period of time during which the

tailings pool level was at and below elevation 4036 feet, water was allowed to pond directly against the western embankment. At that time the embankment section was modified to incorporate a sand tailings chimney filter and blanket drain with a toe drain of gravel.

The most recent two embankment additions placed August-September, 1978 and October-December, 1979, respectively, increased the height of the embankment by 18 feet to the present elevation of 4058 feet. Documentation of these latter two raises are reported in (1) "Report of Earthwork Observations, Field Control Testing, Alteration of Tailings Dam - Six-Foot Embankment Raise," dated January 15, 1979, and (2) "Report on Construction Inspection and Embankment Monitoring Program, Tailings Dam Expansion Project," dated February 22, 1980. The two expansions were performed utilizing the locally available sandy silt and silty sand natural near-surface soils as fill material for both the main embankment and western embankment sections.

TAILINGS

The tailings from the mill process are discharged from a pipeline located along the entire perimeter of the tailings impoundment. In general, spigots are placed approximately 100 feet apart and the normal discharge is such that about four spigots are in operation at any one time. The slurry discharge results in a beach wedge of tailings sand between the dam embankment and the ponded water. The tailings slurry flows toward the ponded water

at the center of the pond, and the heavier, coarser tailings sands drop out of suspension first resulting in the sand tailings beach area. The lighter, finer slimes particles are carried to the ponded water area where they settle out of suspension. Thus, in general, the tailings slimes are located within the center of the pond area.

Most of the slurry deposited tailings adjacent to the pond's embankments may be classified as sandy tailings material of medium dense, brownish-gray to gray, silty fine sand. In some of the areas adjacent to the embankment, layers of from several inches to 6 to 10 feet of the slimes tailings have been encountered in borings. Along the area of the western embankment as much as 40 to 50 feet of slimes tailings may be found against the downstream construction embankment section. The slimes material encountered in the borings is in general described as stiff to very stiff, grayish-brown to brown silt with a trace to some fine sand and/or clay.

PONDED WATER

The present requirements for the ponded liquid within the tailings impoundment area are that a minimum beach distance must be maintained of at least 150 feet and the elevation of the ponded liquid must be at least six feet below the main embankment crest elevation. A reconnaissance survey of the distance from the edge of the embankment crest to the edge of ponded water has been made at 200-foot intervals along the crest alignment. At that time the existing surface pond elevation was also determined. The

approximate existing pond surface is shown on Plate 1. This pond configuration indicates the approximate edge of the ponded water as recorded by Atlas personnel on April 11, 1981. At that date, the ponded water surface was recorded at approximate elevation 4046 feet.

WATER LEVELS WITHIN THE TAILINGS IMPOUNDMENT

During the field exploration programs for the 1978 and 1979 studies, the exploratory borings were equipped with either isolated piezometer tips or open standpipes. Recorded levels within 26 of these piezometers were reported in the February 16, 1979 report. The latest reading, as presented in that report, is January 26, 1979. Ground water levels have been recorded since that time on a monthly basis in each of the standby pipes and piezometers. A record of the most recent water levels is presented as Table 1 on the following page and compared to the design phreatic surface where applicable. Also, the April 21, 1981 ground water levels have been shown in Sections A-A, B-B, and E-E on Plates 3A, 3B, and 3D of the reprinted copies of the February 15, 1978 report.

SEEPAGE

As reported during our 1978 and 1979 studies, small amounts of seepage have been observed in three locations within the tailings embankments. One of these seeps was observed along the north embankment at an elevation just above that of the starter dam crest; a second seep along the toe of the western embankment; and a third at the extreme south corner of the pond. The seepage at

TABLE 1

WATER LEVELS

LOCATION BY BORING NUMBER*	PIEZOMETER OF STANDPIPE TIP INSTALLATION, FEET**	WATER LEVEL DEPTH BELOW GROUND SURFACE, FEET APRIL 21, 1981 DATE OF READING	DESIGN LEVEL
A-1	65 (S)	40.29	21
A-2	59.5 (S)	22.23	16
A-3	42.0 (S)	17.91	11
A-4	69.5 (S)	49.22	-
A-5	81.0 (S)	60.45	39
A-6	61.0 (S)	destroyed	-
A-7	29.0 (S)	17.12	-
A-8	20.0 (S)	15.48	-
A-9	49.0 (S)	28.53	15
A-10	19.5 (S)	17.44 dry	12
B-1	60.0 (S)	54.32	28
B-2	40.0 (S)	27.54	26
B-4	80.0 (S)	25	24
B-5	80.0 (S)	49.12	24
B-6	82.0 (P)	80.38	26
B-8	68.0 (P)	52.34 dry	22
B-9	15.0 (P)	14.57 dry	0
B-10	81.0 (P)	79.80	31
B-11	50.3 (P)	41.98	18
B-12	26.0 (P)	22.00	11
B-13	82.5 (P)	86.14 dry	32
B-14	30.0 (P)	29.51 dry	5
B-15	61.0 (P)	67.84	29
B-16	22.5 (P)	18.18	5
B-17	8.5 (P)	8.31 dry	0
B-28	55.0 (P)	53.76	24
D-1	38.0	37.48 dry	30
D-2	34.0	33.59 dry	30
D-3	34.0	34.03 dry	30

*For location, see Plate 1, Plot Plan
**(S) indicates standpipe
(P) indicates isolated piezometer tip

these locations is believed to be a result of the perched water above localized slimes layers known to be present at these locations. Collection systems were constructed at all three locations and are described in the 1978 report. Each system has been inspected regularly by Atlas Minerals' personnel. On random occasions a Dames & Moore engineer has observed the seepage from these collection systems. The rate of seepage has in general been constant and is noted as being less than two to three gallons per minute at each location.

PROPOSED EMBANKMENT ADDITION

It is proposed that the crest elevation of the existing tailings pond be raised 18 feet to a final elevation of 4076 feet. The western embankment is to be constructed using the downstream construction method. The remaining embankment sections, along the east, north, and south borders is to be raised by the upstream method of construction.

LIQUEFACTION STUDIES

A liquefaction study is reported in the February 16, 1979 submittal. For this study the postulated design earthquake is a Magnitude VI event with a hypercentral distance of approximately 50 kilometers and a maximum ground surface eccelerɑtion of 0.08g. To assess liquefaction potentials field observations combined with laboratory and analytical studies are presently available in well defined procedures to identify conditions of possible liquefac ion. In the referenced report, two approaches to assessing

liquefaction potential of the tailings dam were explored. The first is an empirical method based on observations of sites where liquefaction has or has not occurred and uses standard penetration tests as the index of in situ soil conditions. The second approach involves laboratory determinations of the number of cycles required to cause liquefaction for various stress levels, and a comparison of this data with that experienced by the soil profile during the course of the design earthquake.

The general conclusion from the empirical method of liquefaction analysis is that the design earthquake will not develop dynamic stress ratios sufficient to liquefy the retaining structure. Likewise, factors of safety against liquefaction based on the laboratory test data and as calculated for the tailings deposit are on the order of 1.90 or greater. Thus, factors of safety obtained from both methods are well over 1.5 which has been used by many earthquake engineers as the criteria to indicate suitability of the site. Based on the analyses presented in the 1979 report, it is our opinion that no major problem related to liquefaction would occur at the proposed embankment during the postulated seismic event.

STABILITY ANALYSIS

GENERAL

A stability analysis was performed for steady-state, seismic, and end-of-construction loading conditions on two cross-sections of the tailings embankment. The analysis of these sections was

performed as a supplement to the determination of the stability as performed during the studies reported February 15, 1978 and February 16, 1979. The analyses performed during the 1978 and 1979 studies consisted of performing stability computations on seven different sections of the embankment. The purpose for performing the supplemental stability computations as described herein is to varify the factors of safety calculated in the earlier studies. The cross-sections used for the computations presented in this report reflect the geometry of the proposed new raises. This geometry is slightly different than that in the earlier cross-sections used. In the subsequent sections of this report we present our discussions pertaining to the design assumptions utilized in our analysis and final conclusions regarding the embankment stability.

EMBANKMENT SECTIONS ANALYZED

A stability analysis was performed on two sections of the tailings impoundment embankment. Each of these sections had been previously analyzed in the earlier studies. One section, Section C-C, is located through the western embankment. The section selected is considered to be a critical section in the embankment placed by the downstream method of construction. The second section, Section J-J, is located in the extreme south corner of the impoundment in an area where the upstream method of construction was utilized. Each of these sections were analyzed for the ultimate embankment raise of 4076 feet. It should be noted that

Section C-C was previously analyzed in the study reported February 15, 1978 and Section J-J in the study reported February 16, 1979.

The location of the sections analyzed is shown on Plate 1, Plot Plan. The geometry of the sections is presented on Plates 2A, 2B, 3A and 3B, Results of Slope Stability Analysis.

SOIL PARAMETERS

The soil parameters used in our analysis were developed in laboratory testing of undisturbed as well as reconstituted and recompacted samples as reported in our previous studies of 1978 and 1979. A summary of the evaluation of the soil parameters is presented in Appendix B of the February 16, 1979 report.

DESIGN WATER LEVELS

The design phreatic lines utilized in our analysis are presented on Plates 2A, 2B, 3A, and 3B. These phreatic conditions are primarily based upon the data obtained from the existing piezometers and general operational recommendations. For the purpose of this analysis, it was assumed that the ponded water within the storage area will be maintained at a minimum distance of 150 feet from the embankment crest. A recent series of piezometric readings is presented in a previous section of this report. In all cases the design phreatic location is well above these readings.

METHOD OF ANALYSIS

GENERAL

As stated, the soil parameters used in this analysis were based on laboratory results presented in the earlier embankment studies of 1978 and 1979. For each of the two embankment sections analyzed, the proposed ultimate configurations were evaluated under static and seismic loading considerations for the steady-state seepage and end-of-construction cases. Stability was calculated by the Simplified Bishop method using a computer and the certified Dames & Moore Program EP-5A (EP-1). This Simplified Bishop technique is identical to the method of analyses as used for the earlier studies.

STEADY-STATE SEEPAGE CASE

For steady-state seepage conditions and maximum pool level, effective stress strength parameters were used in the analysis based on the results of consolidated-drained (consolidated-undrained with recorded pore pressure) laboratory tests. These parameters are shown on Plates 2A and 3A.

END-OF-CONSTRUCTION CASE

The analysis for the end-of-construction case considers the conditions where an 18-foot embankment raise is applied to the existing embankment sections. For these conditions, it has been assumed that excess pore pressure equal to the stresses induced

by the dike weight may occur in the fill and deposited tailings materials below the design phreatic line. In the analysis, the excess pore pressures were added to the design steady-state pore pressure conditions. The embankments were then analyzed using effective stress strength parameters.

EARTHQUAKE (SEISMIC) CONDITION

The earthquake (seismic) condition has been analyzed with a seismic load applied to the steady-state and end-of-construction cases. The seismic load is represented by the application of a horizontal force, equal to an assumed percent of the gravity acceleration, to the weight of the soil within the failure circle. As discussed earlier, a value of 0.08g was utilized in the analysis. The postulated earthquake is a Magnitude VI event with a hypocentral distance of approximately 50 kilometers. For Magnitude VI event, the average number of significant stress cycle is about five based on a statistical study of the strongest components of ground motion. For this rather small event, pore water buildup in the sand or slimes tailings within the embankment will not be excessive, based on the cyclic triaxial tests performed on the sand and slimes tailings. A ratio of the excess pore pressure/effective overburden can be determined for the average number of significant stress cycles. For sands below the water table, a ratio of .12 was established from the cyclic tests. For slimes below the water table, a ratio of 0.03 was estimated.

The analysis conducted under seismic loadings was the same as that used in the 1979 study. That is, two approaches were utilized. The first and more standard approach, total stress analysis, used the water levels generally found under static loading and total stress (undrained) strength parameters based on consolidated-undrained triaxial tests. The second approach, effective stress analysis, used the same water levels and excess pore pressures of 0.12 or 0.03 times the effective overburden stress, as discussed above, were applied to the saturated tailings. Effective stress strength parameters of the soils and tailings were used in this approach.

To obtain the most conservative results, the total stress analysis was utilized for the Section J-J and effective stress analysis for Section C-C.

GENERAL CERTIFICATION

Dames & Moore has formalized its quality assurance procedures in a form of a centralized quality assurance organization completely independent of any project responsibilities. As discussed in detail in the previous studies, varification, documentation, certification, and control of the computer soft ware such as the EP-5A Computer Program (recently renamed as the EP-1 Program) has been given a general certification under the Quality Assurance Program.

STABILITY RESULTS

The geometry, soil parameters and ground water conditions used in this analysis, and the resulting stability factors of safety are shown graphically on Plates 2A, 2B, 3A, and 3B. The results of our analyses for embankment Sections C-C and J-J are summarized on Table 2. The results are in general agreement with the results of the analyses performed in our 1978 and 1979 studies and show factors of safety to be in excess of those required by NRC criteria. All factors of safety determined by this study meet regulatory guidelines presented in NRC Regulatory Guide 3.11, December, 1977.

TABLE 2

SUMMARY OF RESULTS OF SLOPE STABILITY ANALYSIS
MINIMUM FACTORS OF SAFETY

	END-OF-CONSTRUCTION		STEADY-STATE SEEPAGE	
	STATIC	SEISMIC	STATIC	SEISMIC
Section C-C	1.52	1.26	1.52	1.26
Section J-J	1.65	1.23	1.64	1.20

DESIGN RECOMMENDATIONS

RECOMMENDED EMBANKMENT RAISES

A total height increase of the embankment of 18 feet has been proposed. Stability analyses were performed to evaluate the effects of the construction of the additional supplemental dike on the tailings pond embankment system. Results of these analyses have shown that the factors of safety of the embankment against

failure are adequate and the proposed embankment addition may be made without endangering the stability of the tailings pond embankment system. The western embankment of the impoundment is recommended to be raised by the use of downstream method of construction; the remaining embankments to be raised through the upstream method of construction. The freeboard and minimum beach width criteria as used for the preceding raises should be continued to be enforced. A minimum freeboard of six feet and a minimum crest-to-ponded-water distance of 150 feet should be maintained for all embankments, including the western embankment, after the construction of this 18-foot raise. It should be noted that during and directly after completion of this embankment raise, the 150 feet minimum beach width in all likelihood will not immediately exist. A period of time should be allowed for the buildup of tailings and the receding of the ponded water edge until the 150 foot beach width criteria is met.

Included as Appendix B of this report is the plans and specifications for the construction of the proposed 18-foot embankment raise. Along the western embankment the addition will be placed by means of the downstream method of construction. The upstream and downstream slopes will each be at two horizontal to one vertical. The crest width is to be 20 feet. Along the main embankments comprising all the tailings pond embankments other than the existing western embankment, the 18-foot raise may be accomplished by means of the upstream method of construction. This raise also will have upstream and downstream slopes of two horizontal to one

vertical with an embankment crest width of 20 feet. The location of the upstream constructed addition is to be such that the proposed dike's downstream toe will abut the upstream-most edge of the existing crest. The configuration of this is shown on Plates B-3A through B-3E of Appendix B - Plans and Specifications. This configuration provides for an overall downstream slope of 3.25 horizontal to 1.0 vertical. It is recommended that the crest surface of all the proposed additions be constructed to tilt toward the pond area. The configuration of the crest should be such that the elevation of the downstream-most point of the crest is two to three feet higher than that at the upstream-most point. Thus, if any slurry should flow onto the crest area, it will drain into the pond area.

EMBANKMENT MATERIALS AND PLACEMENT

It is recommended that the embankment addition be constructed with the materials and configuration as described in the PLANS AND SPECIFICATIONS in Appendix B of this report. Specifications for site preparation materials and material placement and compaction are given in the Appendix. It is recommended that an experienced soils engineer be present during all site preparation, excavation, placement and compaction of earth fills. The purpose of the soils engineer will be to inspect the new embankment foundations and control the quality of the fill materials and their compaction. It is recommended that an inspection report containing all field

density test results and descriptions of the earth work be performed to provide proper documentation and assure the quality of construction.

OPERATIONAL PROCEDURES AND POST-CONSTRUCTION INSPECTION

In order to control the phreatic surface, a minimum distance between the crest of the embankment and the nearest point of the ponded water must be obtained. It is recommended and assumed in our design that a minimum beach distance of 150 feet will be maintained at all times along the entire perimeter of the tailings pond. Further, a well maintained beach will protect the upstream face of the embankment from possible effects of wave erosion. To insure against the possibility of such erosion occurring, it is recommended that an elevation difference of six feet between the ponded water surface and the embankment crest be maintained at all times.

In order to maintain a proper beach area and satisfy the above conditions of the minimum required distance to the ponded water, the deposition of tailings must be performed by a properly regulated discharge operation. Correct maintenance of the tailings discharge will result in a sloped beach on the tailings pond surface. With continuously regulated discharge the overall slope from the embankment to the water pool area should be expected to approach an overall gradiant of slightly above two percent.

FUTURE MONITORING

In order to maintain surveillance of the phreatic surface, it is recommended that observation of the 28 existing piezometers, as listed in Table 1, be continued on a regular basis. Should any of these piezometers be damaged or covered by construction and/or maintenance operations, they should be replaced. Since the time of the installation of the piezometers, readings have been taken on a monthly basis. It is recommended that these readings be continued at monthly intervals. The data should be transmitted to a qualified soils engineer for the purpose of review. Such reviews should be undertaken continuously in order to detect any gross changes which may have occurred. Comparative reviews should be made periodically to dictate any general trends.

EMBANKMENT SURVEILLANCE

It is recommended that the tailings pond be subjected to a regular program of continuing visual surveillance during the complete life of the pond to that time when the deposited tailings reach the ultimate embankment elevation. During such surveillance, attention should be paid to any signs of tension cracking, sloughing, erosion, and seepage, and records should be maintained of the observations made for each surveillance. Immediate remedial measures should be undertaken to repair any points of distress noted. We understand that Atlas Minerals has an on-going surveillance program which is in accordance to the above recommendations.

oOo

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

Plate 1	-	Plot Plan
Plates 2A and 2B	-	Results of Slope Stability Analysis
Plates 3A and 3B	-	Results of Slope Stability Analysis
Appendix A	-	Previous Studies
Appendix B	-	Plans and Specifications

Respectfully submitted,

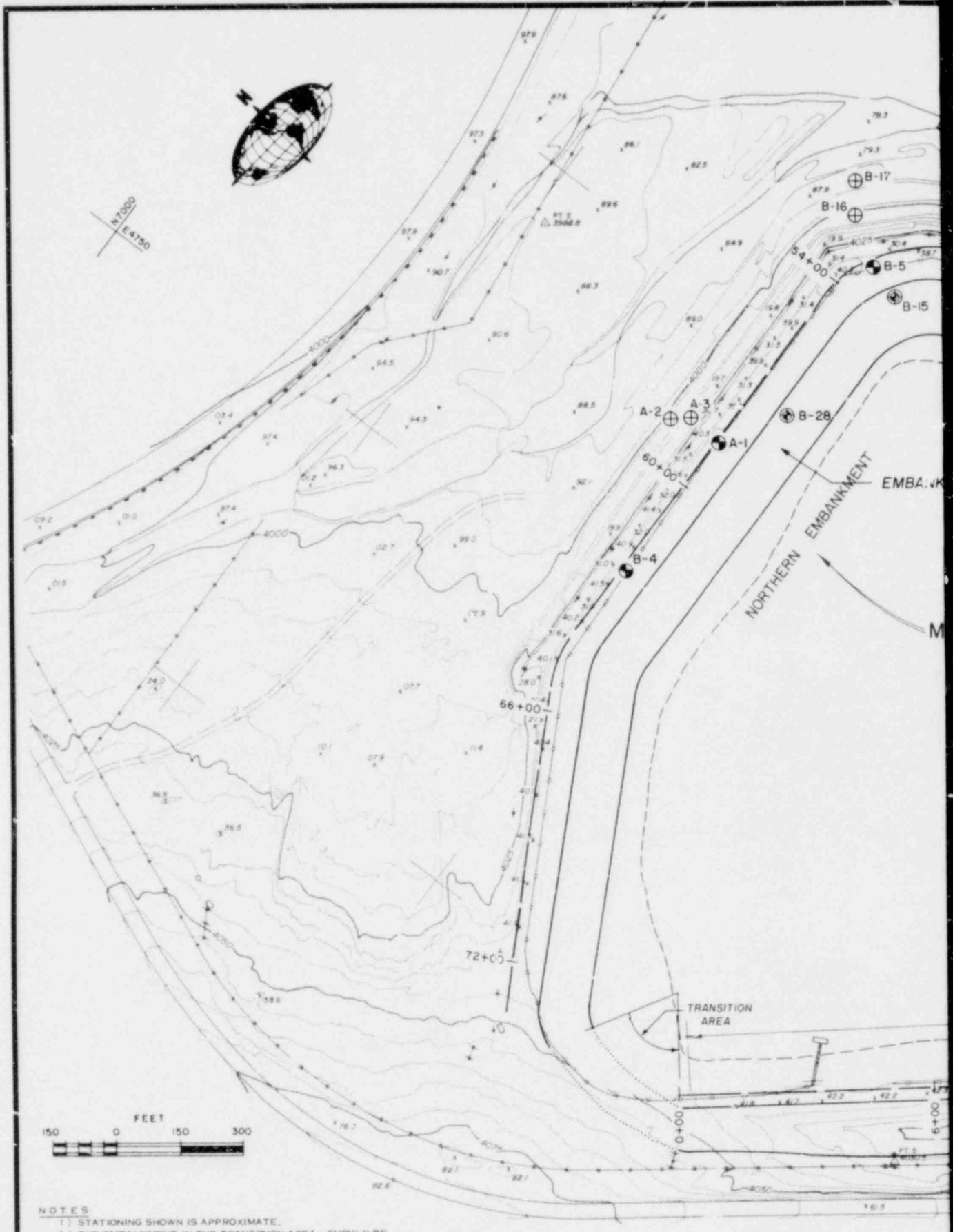
DAMES & MOORE

George C. Toland
Partner
Professional Engineer No. 2311
State of Utah

James R. Boddy
Project Engineer
Professional Engineer No. 4445
State of Utah

GCT/JRB/pc

Attachments

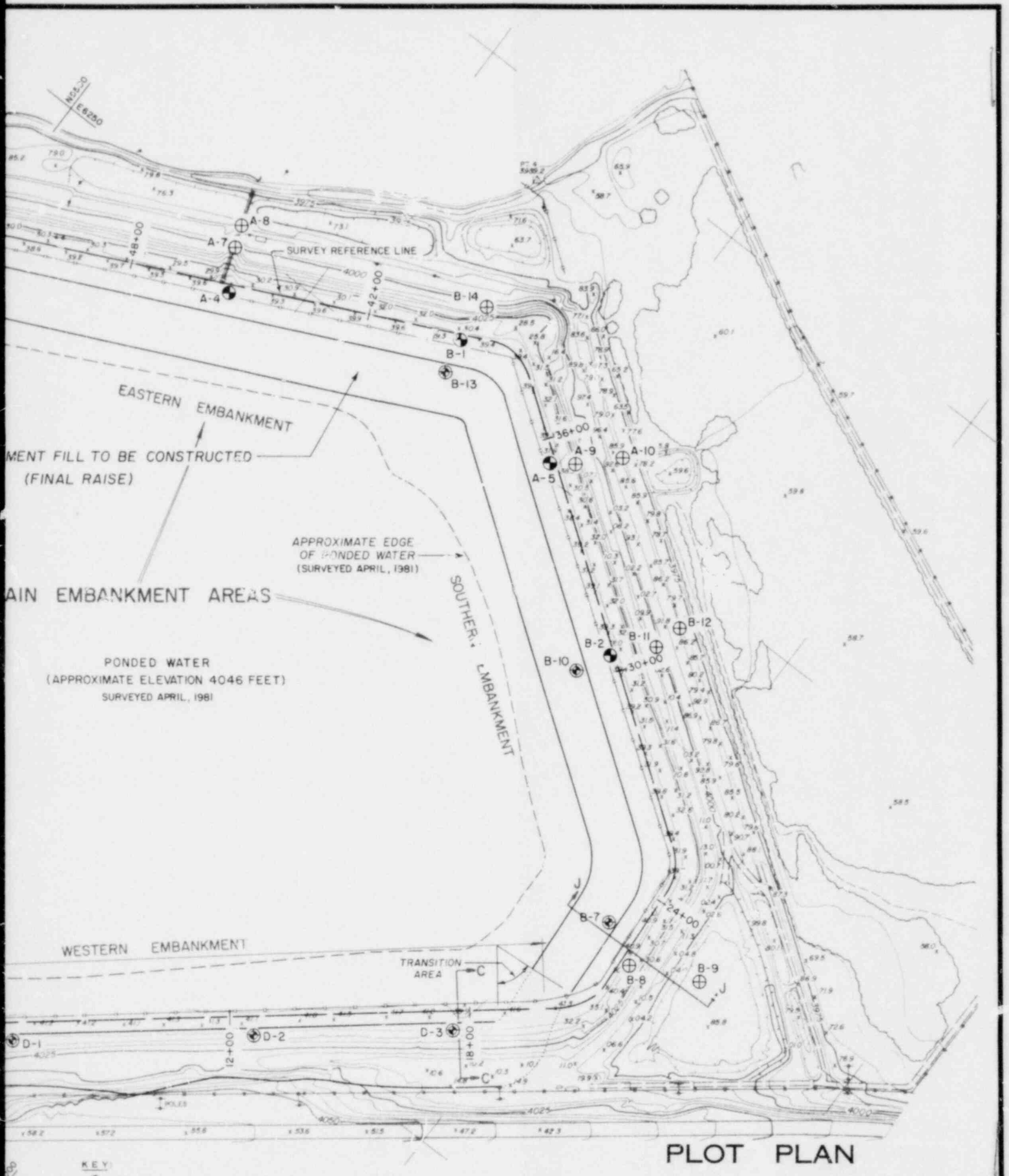


NOTES

1) STATIONING SHOWN IS APPROXIMATE.
2) THE EMBANKMENT IN THE TRANSITION AREA SHOULD BE CONSTRUCTED TO SMOOTHLY CONNECT THE ADJOINING EMBANKMENTS.
3) CONTOUR INTERVAL 5 FT. THE CONTOUR LINES IN THE VICINITY OF THE BORROW AREAS AND THE EXISTING EMBANKMENT CREST DO NOT REPRESENT EXISTING CONDITIONS.
4) EMBANKMENT FILL OUTLINES ARE APPROXIMATE. REFER TO CROSS-SECTIONS FOR ACTUAL FILL LAYOUT.

REFERENCE:

DRAWING ENTITLED, "ATLAS MINERAL TAILINGS POND", BY AEROGRAPHICS, INC., SALT LAKE CITY, UTAH, FROM PHOTOGRAPHY FLOWN 4-11-78.



PLOT PLAN

KEY

- EXISTING PIEZOMETER TO BE RAISED
- EXISTING PIEZOMETER TO BE PROTECTED DURING CONSTRUCTION
- EXISTING PIEZOMETER

DAMES & MOORE

PLATE 1

DOCUMENT/ PAGE PULLED

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APPENDIX A

APPENDIX A

PREVIOUS STUDIES

REPORT OF REMEDIAL CONSTRUCTION ACTIVITIES TAILINGS POND - INCLUDING THE WESTERN EMBANKMENT IMPROVEMENTS AND THE NORTHERN EMBANKMENT SUBDRAIN MOAB, UTAH FOR ATLAS MINERALS

Dames & Moore Job No. 05467-018-06
Salt Lake City, Utah
November 18, 1977

November 18, 1977

Atlas Minerals
P. O. Box 48
Moab, Utah 84532

Attention: Mr. William Badger

Gentlemen:

Ten copies of our construction surveillance report entitled "Report Of Remedial Construction Activities, Tailings Pond - Including The Western Embankment Improvements And The Northern Embankment Subdrain, Moab, Utah, For Atlas Minerals," are herewith submitted. Our surveillance activities pertained to construction of the western tailings pond embankment and the northern and western seepage subdrains.

Yours very truly,

DAMES & MOORE

George C. Toland

George C. Toland
Partner
Professional Engineer No. 2311
State of Utah

GCT/nb

Attachments

REPORT OF REMEDIAL CONSTRUCTION ACTIVITIES
TAILINGS POND - INCLUDING THE
WESTERN EMBANKMENT IMPROVEMENTS AND
THE NORTHERN EMBANKMENT SUBDRAIN
MOAB, UTAH
FOR ATLAS MINERALS

INTRODUCTION

This report summarizes the construction of Atlas Minerals' remedial measures carried out from June 24, 1977 through October 1977, including upgrading of the western embankment and construction of the northern embankment subdrain. A description of the existing tailings pond system and the methods of operations are contained in previous Dames and Moore reports, and are not repeated in this report.

PURPOSE AND SCOPE

The purpose of this report is to summarize the field surveillance conducted during the construction of remedial measures. In accomplishing this purpose, our scope included:

1. To provide engineering guidance to the construction of the remedial measures including:
   a. Estimated quantities,
   b. Weekly site progress inspections,
   c. Compaction and gradation requirements,
   d. Conformance of placed material as to gradation and compaction standards,
   e. Documentation of field operations.

2. Prepare this report summarizing the objectives obtained.

HISTORY OF EVENTS

Prior to June 23, 1977, Atlas Minerals was operating under the then existing conditions using an extension of their Source Material License No. SUA-917. On June 19 or 20, 1977, following a site inspection by NRC personnel, operations at the Moab Plant were suspended to adjust areas of non-compliance with the License. Several of the points of non-compliance were related to the operation and existing conditions of the tailings pond; specifically, a) the stability of the temporary western embankment and, b) two seepage areas, one located along the temporary western embankment and the second along the northern embankment. These areas are shown on Plate 1, Plot Plan.

A temporary remedial program was begun immediately to raise the western dike to elevation 4,040 feet, and to provide a minimum crest width of 20 feet. Other geometry including slopes was not affected. While this temporary action was being advanced, a series of meetings and communications between Atlas Minerals, NRC and Dames and Moore transpired in which it was agreed to institute remedial measures consisting of the construction of a permanent, engineered western embankment capable of water retention, and construction of a drain and pump-back system to control seepage along the northern and western dikes.

DESIGN DETAILS

WESTERN EMBANKMENT

Remedial measures for the western embankment include construction of a downstream embankment capable of acting as a water retention dam. It is necessary to build a water retention type of structure because water and unconsolidated slime tailings are presently resting against the upstream face of the existing embankment and a period of time may elapse before planned discharge of tailings along the western embankment could build a permanent sand tailings beach. The embankment as it existed following temporary remedial construction, was to be upgraded by constructing a widened section downstream of the existing embankment, including a sand tailings filter chimney and blanket drain, a sand and gravel toe drain, a silty sand shell and an upstream layer of rip-rap. The zoned configuration is shown on Plate 2, Western Embankment Typical Sections.

Seepage through the embankment is controlled by the internal chimney and blanket drain system which intercepts the seepage and channels it out the toe of the embankment. Where seepage exits the embankment toe, a subdrain and sump system will collect the seepage for return to the tailings pond. Details of this subdrain system are shown on Plates 1 and 3.

As shown on Plate 2, the embankment was designed with a downstream slope of 2.5 horizontal to 1.0 vertical. Eight feet of cover was maintained above the sand tailings filter

drain, and resulted in a minimum total crest width in excess of 40 feet. In addition, a sand and gravel toe drain would keep the sand tailings from being exposed at the embankment toe. Specific compaction and gradation requirements were placed on the embankment materials. The beach sand tailings chimney and blanket drain with a gradational requirement is shown on Plate 4. Compaction of the material would not be required. The sand and gravel toe drain would also be placed in an uncompacted condition and have a gradation range as specified on Plate 5. The red silty sand shell would be ungraded and have a compaction requirement of 95 percent of the maximum dry density as determined by the ASTM* D-698 Method of Compaction. The only requirement specified for the rip-rap zone was a maximum particle size of one foot. The material requirements of the embankment are summarized below:

EMBANKMENT ZONE	MATERIAL TYPE	GRADATION REQUIREMENTS	COMPACTED REQUIREMENTS
Chimney and Blanket Filter	Beach Sand Tailings	Shown on Plate 4	None
Toe Drain	Sand and Gravel	Shown on Plate 5	None
Shell	Red Silty Sand	None	95 Percent of ASTM D-698
Rip-Rap	Sand, Gravel and Cobbles	Maximum Particle Size - One Foot	None

Based on the proposed embankment geometry and materials, computerized stability analyses were performed on critical

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* American Society For Testing And Materials.

sections. This analysis and the procedures used are detailed in our report entitled "Report Of Engineering Design Study, Addition To Tailings Pond-Embankment System, Moab, Utah, For Atlas Minerals," presently being prepared.

NORTHERN EMBANKMENT SUBDRAIN

To control seepage along the northern embankment, a subdrain was designed for installation along the first bench. The design was based on a standard two filter pipe drain as presented in NAVFAC's* manual DM-7. A typical section of the subdrain and the gradational requirements of the filter materials are shown on Plates 6 and 7, respectively.

PLANS OF QUALITY CONTROL

Quality control of construction activities was implemented by Dames and Moore during construction of the remedial measures. The intent of our control was to maintain the quality of the materials placed including construction to specified lines and grades, and compaction and gradational criteria. In addition, our construction expertise was provided to the Atlas personnel supervising the construction operations.

Gradational controls of the various zones were provided by Dames and Moore. Daily density-compaction control of the Zone 3 material was being provided by an outside, independent consultant with weekly compaction density checks provided by Dames and Moore. A complete record of as constructed lines and grades and pre-construction cross sections were compiled

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* Naval Facilities Engineering Command.

by an independent surveyor. All areas of construction activities were inspected on a weekly basis by qualified Dames and Moore engineering personnel. Reports of each site visit conducted are presented in the Appendix following this report.

PRE-CONSTRUCTION SURVEY

Prior to commencing construction activities, a cross section survey of the existing western embankment was made at 100 foot stations by John Keogh, a registered Utah land surveyor. Using this survey, sections of the proposed construction were prepared at 100 foot stations, and the estimated quantity of in-place construction material was calculated. These sections are shown on Plate 8, and the list of material quantities is presented below:

MATERIAL TYPE	QUANTITY IN CUBIC YARDS
Sand Tailings Chimney and Blanket Filter	10,500
Sand and Gravel Toe Drain	1,000
Red Silty Sand Shell	36,000
Upstream Rip-Rap	Not Calculated

CONSTRUCTION DETAILS

WESTERN EMBANKMENT

Construction on the remedial western embankment was accomplished using the outside construction firm of C&W Construction, and was completed on September 4, 1977. The

three zones of material were placed by heavy earth moving equipment.

CHIMNEY AND BLANKET FILTER

Material for the chimney and blanket drain filter was obtained from the tailings pond beach area. No compactive effort was applied during placement. Gradation test samples were obtained to check compliance to the gradational requirement. The results of these tests, shown on Plate 9, show that the average percent finer than the No. 200 sieve is 13.0 percent rather than the maximum of 7.0 percent. In order to determine the effect of this increased percentage of fines, permeability tests were conducted on the filter material. These tests indicate that a permeability of at least 10^{-3} centimeters per second is capable of being obtained through this material. Such permeability is considered suitable for the filter drain.

TOE DRAIN

Material for the toe drain was imported from off-site and screened to separate the -3 inch material. This -3 inch material was placed in a three-foot thick layer as the toe drain without compactive effort. Results of our gradation test samples as shown on Plate 10 indicate that the material, being gap-graded, does not conform to the desired gradational limits; however, again this will not adversely affect the performance of the filter drains.

SHELL

The red silty sand shell material, borrowed from an area adjacent to the tailings pond (Plate 1), was placed and compacted to the required 95 percent by the passage of the hauling and spreading equipment. Compaction tests were performed by Dames and Moore on samples obtained from the borrow pit. For correlation purposes, periodic compaction tests were performed by Global engineers during embankment construction. The results of Dames and Moore compaction tests are shown on Plates 11A and 11B. The results of the in-place density tests performed by Air Photo Surveys and Global Engineering, Inc. of Grand Junction, Colorado, indicate that adequate compaction was obtained. The daily field density tests were performed using a Troxler Nuclear Density gage. In-place sand cone density tests were performed by Dames and Moore on a weekly basis to confirm the nuclear test gage results. These correlation tests indicate the adequacy of the daily test results. The results of all in-place density tests performed on the embankment by both firms are shown on Plates 12A through 12G. The detailed inspection report prepared by Air Photo Surveys and Global Engineering, Inc. is not presented as part of this report. The locations of these tests are shown on Plates 13A through 13H.

RIP-RAP

The rip-rap material was obtained from an off-site borrow source and consisted of sand, gravel and cobbles. In addition, some of the +3 inch material obtained from the Zone 2 screening process was used as rip-rap. The rip-rap was

end dumped and graded into place. The minimum thickness of rip-rap is two feet.

SUBDRAIN SYSTEMS

The northern embankment drain was placed as designed. The filter material was obtained from a local supplier's stockpile of prepared sand and gravel concrete aggregates. Layout and control of grade was provided by John Keogh, Land Surveyor, while installation, which was completed in October, was performed by Atlas Minerals' personnel. The subdrain drains westerly where it is collected in a fiberglass sump, and pumped back into the tailings pond.

Shortly following completion of the western embankment, seepage was noted at the toe drain near stations 18+00 to 20+00. The subdrain system as shown on Plate 1, was installed and leads to a fiberglass sump where the seepage is pumped back into the tailings pond. The installation of the drains was completed in October, 1977.

POST CONSTRUCTION SURVEYS

Two additional surveys were conducted by John Keogh in addition to those previously mentioned. These were 1) a survey by station sections of the completed filter drain system and 2) a final post construction survey of the completed embankment. These surveys have been used to determine the as built sections of the western embankment, which are shown on Plate 14.

SUMMARY

Based on our construction surveillance, the western embankment construction and the northern embankment subdrain have been adequately constructed (except for minor variations) to the lines, grades and materials as originally specified. The small variations in lines and grades, and the previously mentioned variation of the filter materials should not be detrimental to the overall performance of the project.

oOo

We appreciate the opportunity of performing this service for you. If you have any questions regarding this report, or require additional information, please contact us.

Very truly yours,

DAMES & MOORE

George C. Toland
Partner
Professional Engineer No. 2311
State of Utah

Ronald E. Rager
Project Engineer
Professional Engineer No. 4522
State of Utah

GCT/RER/nb

Attachments:

Plate 1	- Plot Plan
Plate 2	- Western Embankment Typical Sections
Plate 3	- Western Embankment Subdrain Collector - Typical
Plate 4	- Gradational Criteria - Sand Tailings Filter

Plate 5	- Gradational Criteria - Sand and Gravel Toe Drain
Plate 6	- Northern Embankment Seepage Subdrain - Typical
Plate 7	- Northern Embankment Seepage Drain Filter Criteria
Plate 8	- Western Embankment - Design Sections
Plate 9	- Gradational Test Data - Sand Tailings Filter
Plate 10	- Gradational Test Data - Sand and Gravel Toe Drain
Plates 11A and 11B	- Compaction Test Data
Plates 12A through 12G	- Summary of In-Place Density Tests
Plates 13A through 13H	- In-Place Density Test Locations
Plate 14	- Western Embankment - Post Construction Sections
Appendix	- Dames and Moore Site Inspection Reports

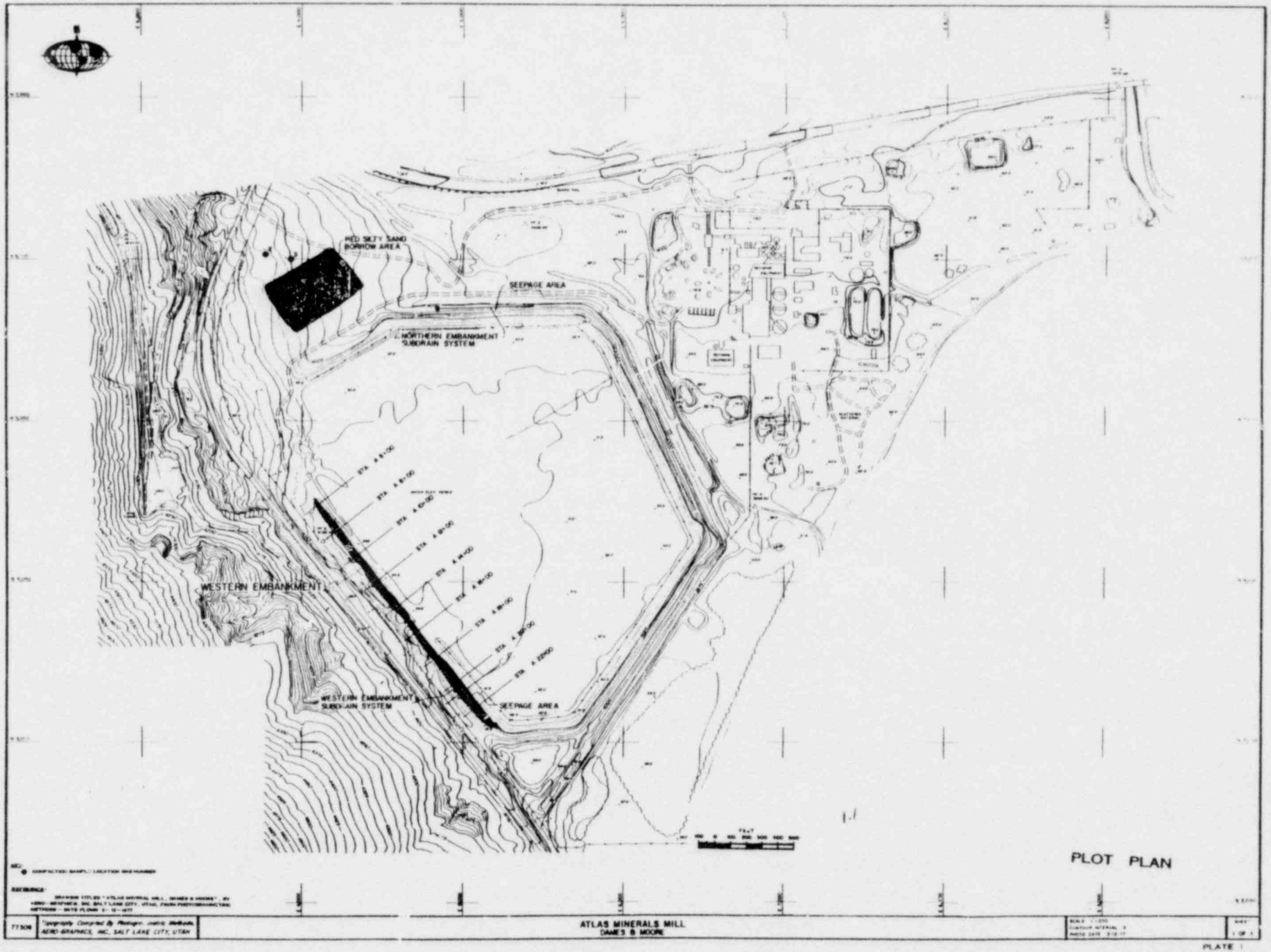
RED SILTY SAND BORROW AREA
SEEPAGE AREA
NORTHERN EMBANKMENT SUBDRAIN SYSTEM
WESTERN EMBANKMENT
WESTERN EMBANKMENT SUBDRAIN SYSTEM
SEEPAGE AREA
PLOT PLAN
ATLAS MINERALS MILL
DAMES & MOORE
AERO-GRAPHICS, INC, SALT LAKE CITY, UTAH

PLATE 1

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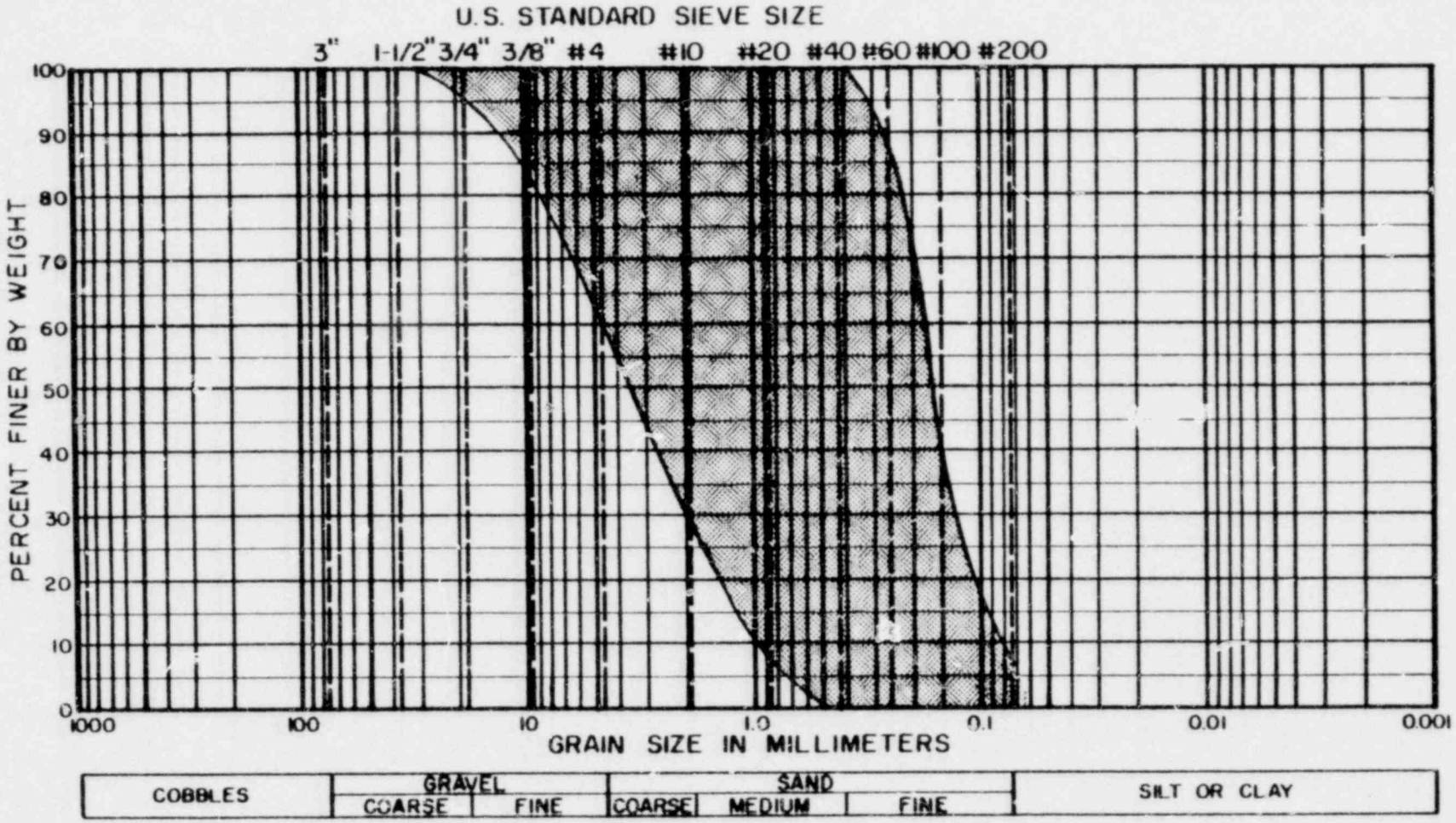
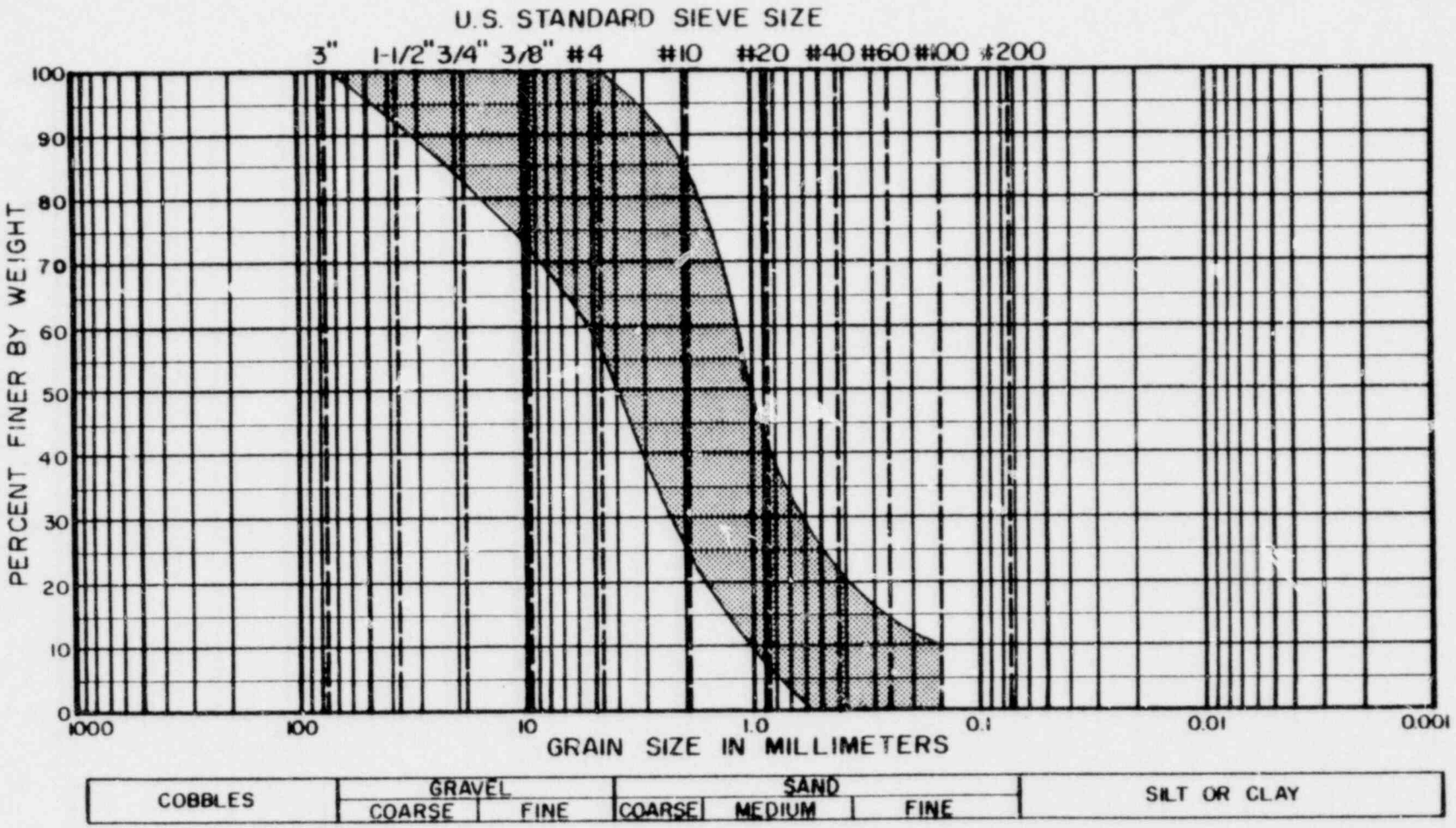


GRADATIONAL CRITERIA - SAND TAILINGS FILTER

DAMES & MOORE

PLATE 4



GRADATIONAL CRITERIA - SAND AND GRAVEL TOE DRAIN

PLATE 5

DAMES & MOORE

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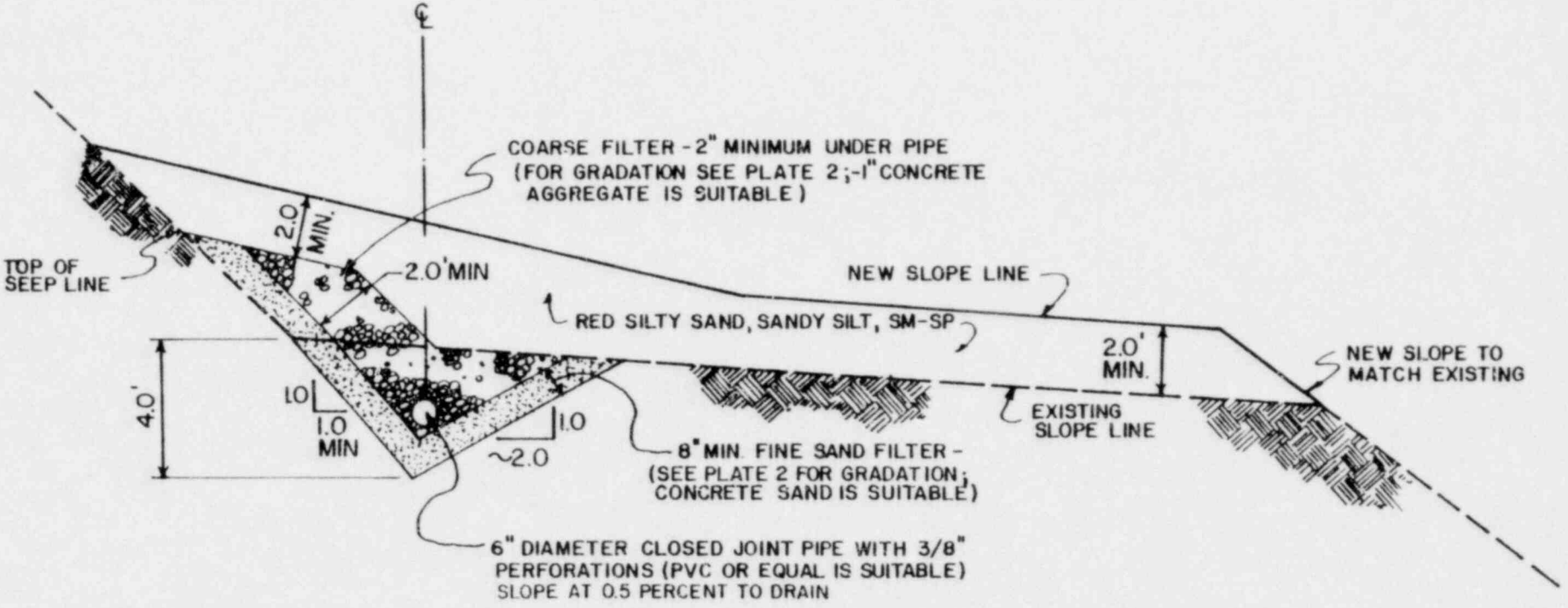
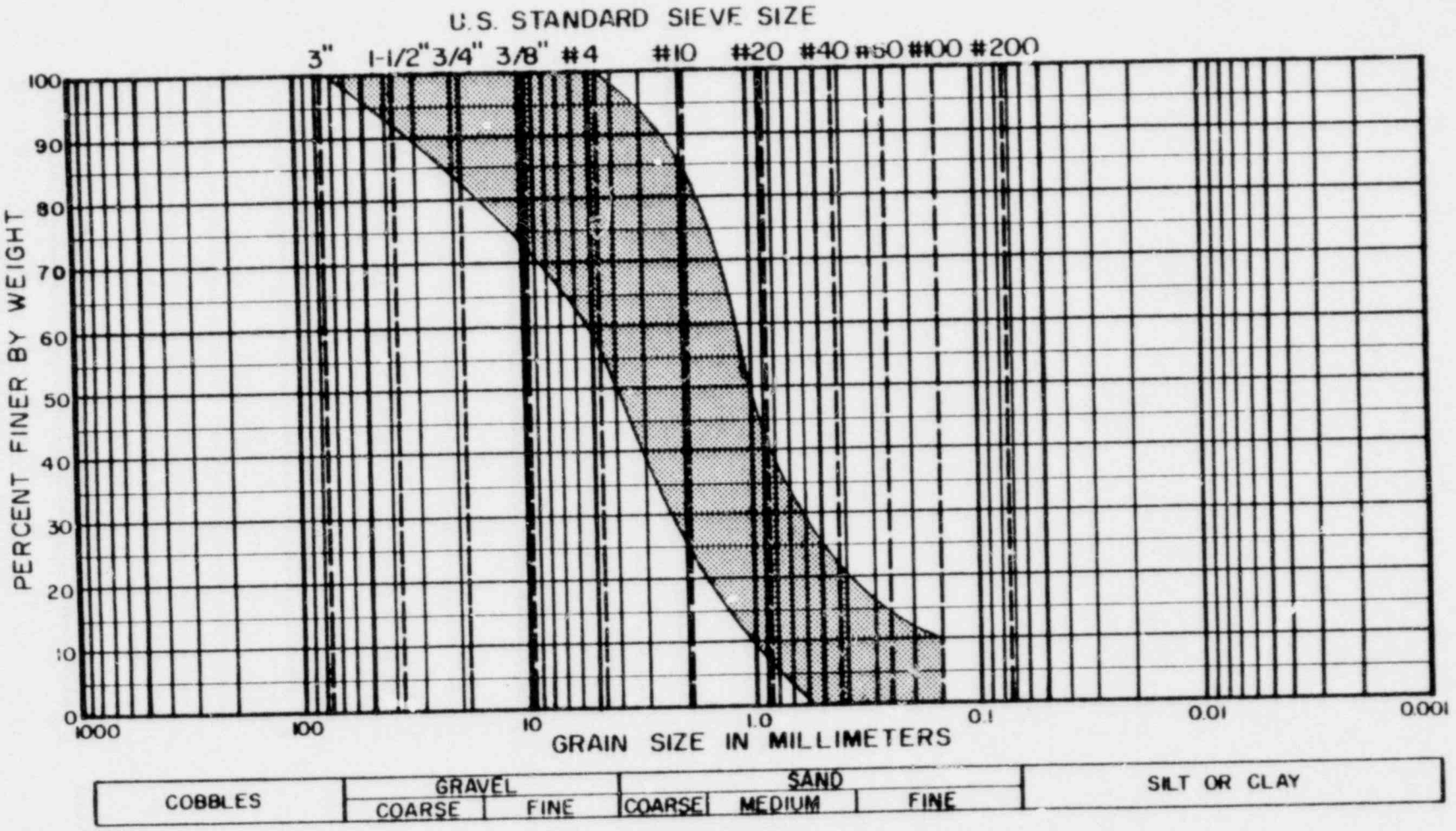


NORTH EMBANKMENT SEEPAGE
SUB-DRAIN - TYPICAL

PLATE 6

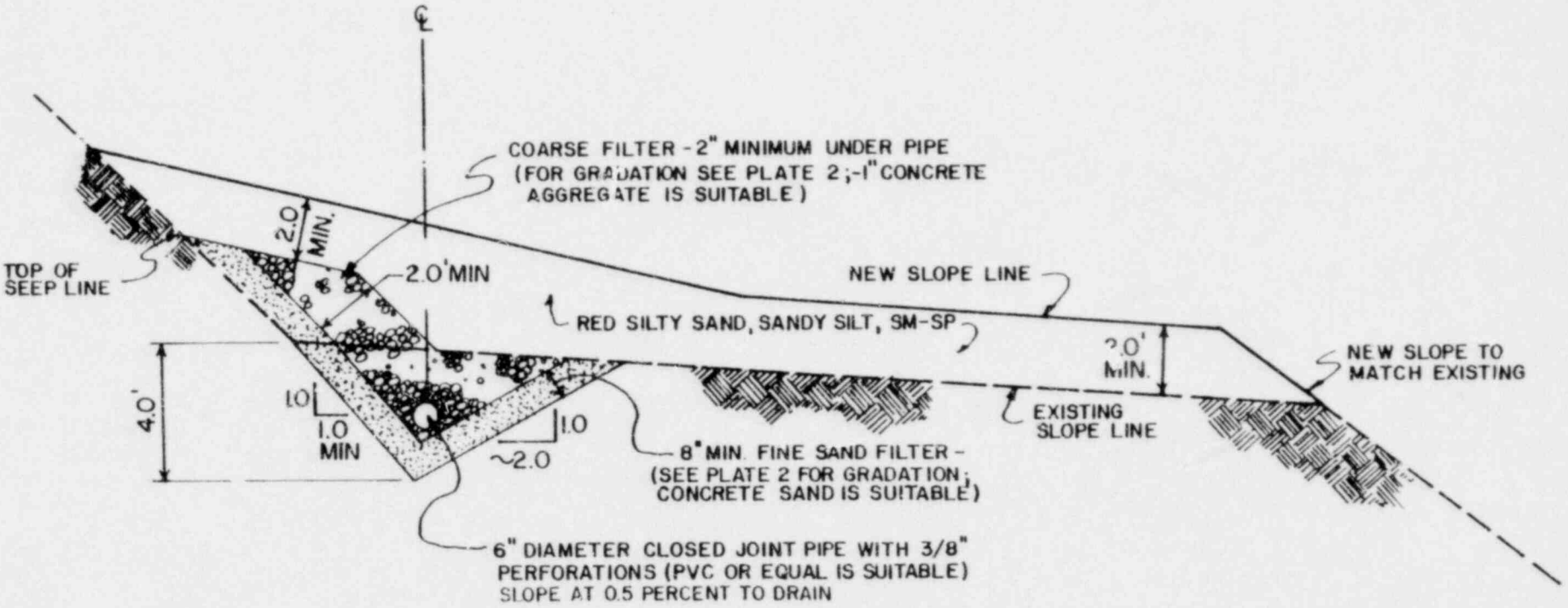
DAMES & MOORE



GRADATIONAL CRITERIA - SAND AND GRAVEL TOE DRAIN

PLATE 5

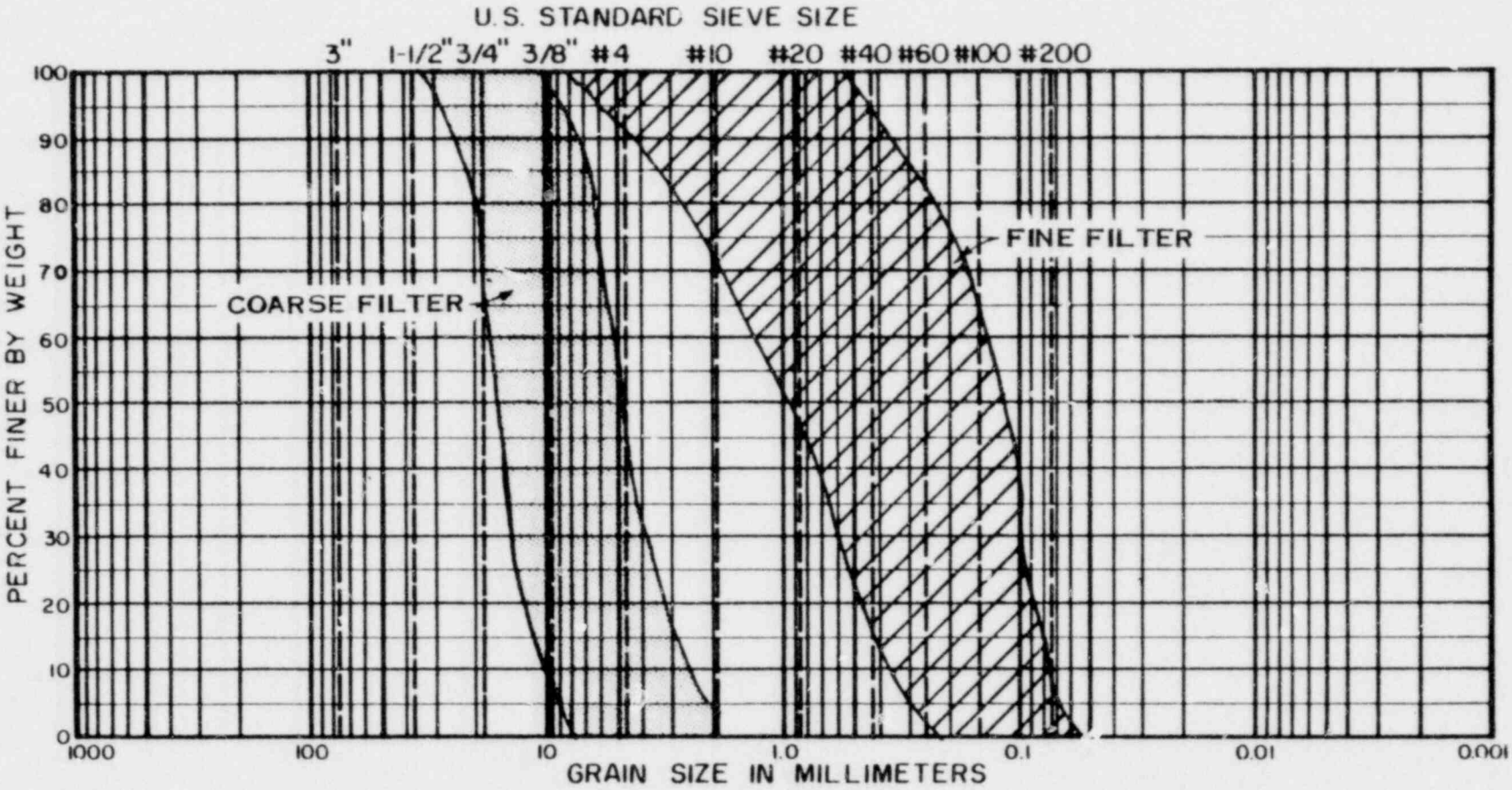
DAMES & MOORE



NORTH EMBANKMENT SEEPAGE SUB-DRAIN - TYPICAL

PLATE 6

DAMES & MOORE

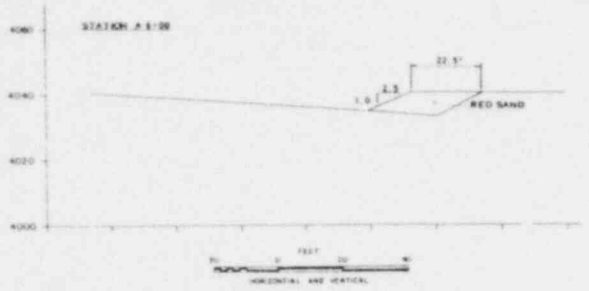


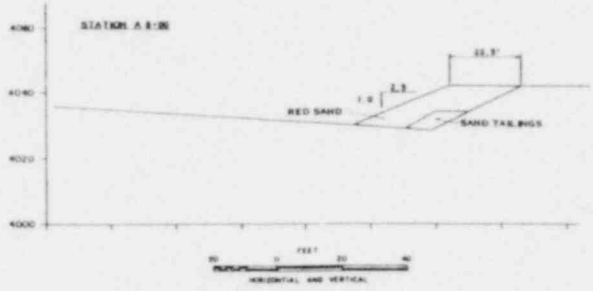
FINE AND COURSE FILTER GRADATION LIMITS

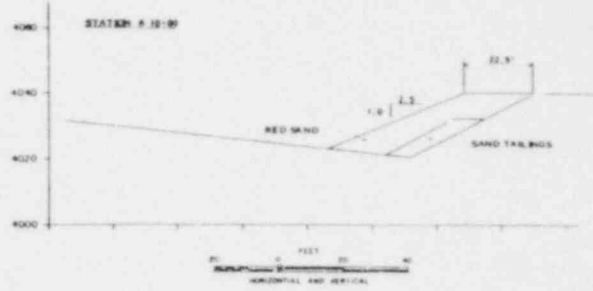
NORTH EMBANKMENT SEEPAGE DRAIN FILTER CRITERIA

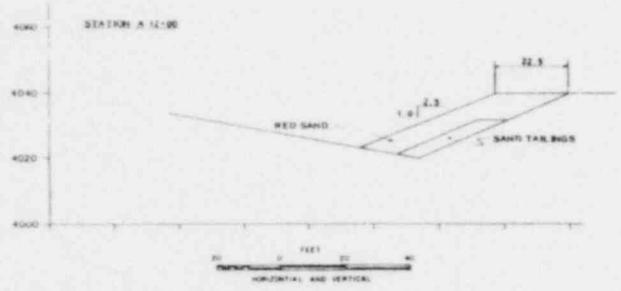
DAMES & MOORE

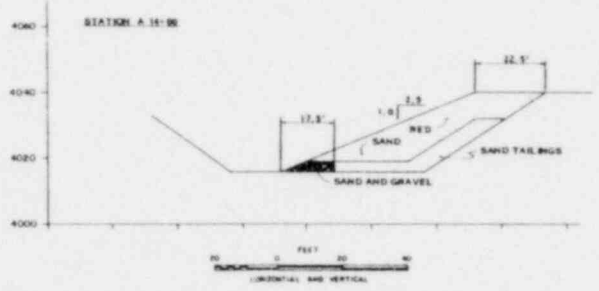
PLATE 7

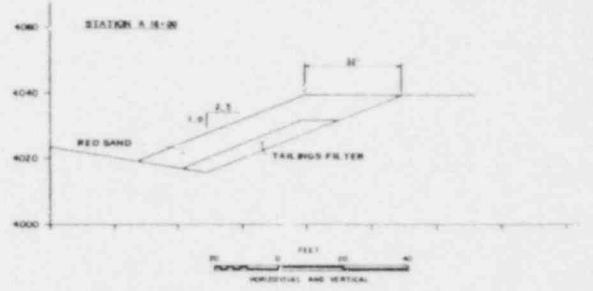


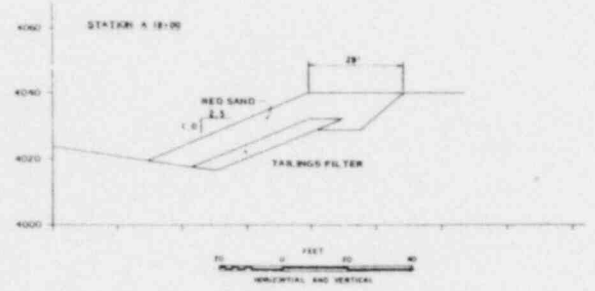


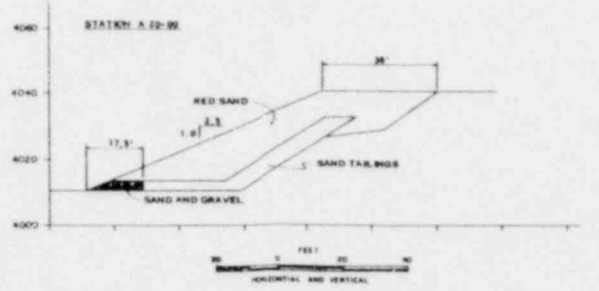


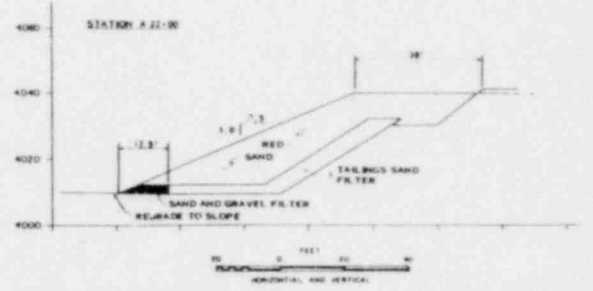










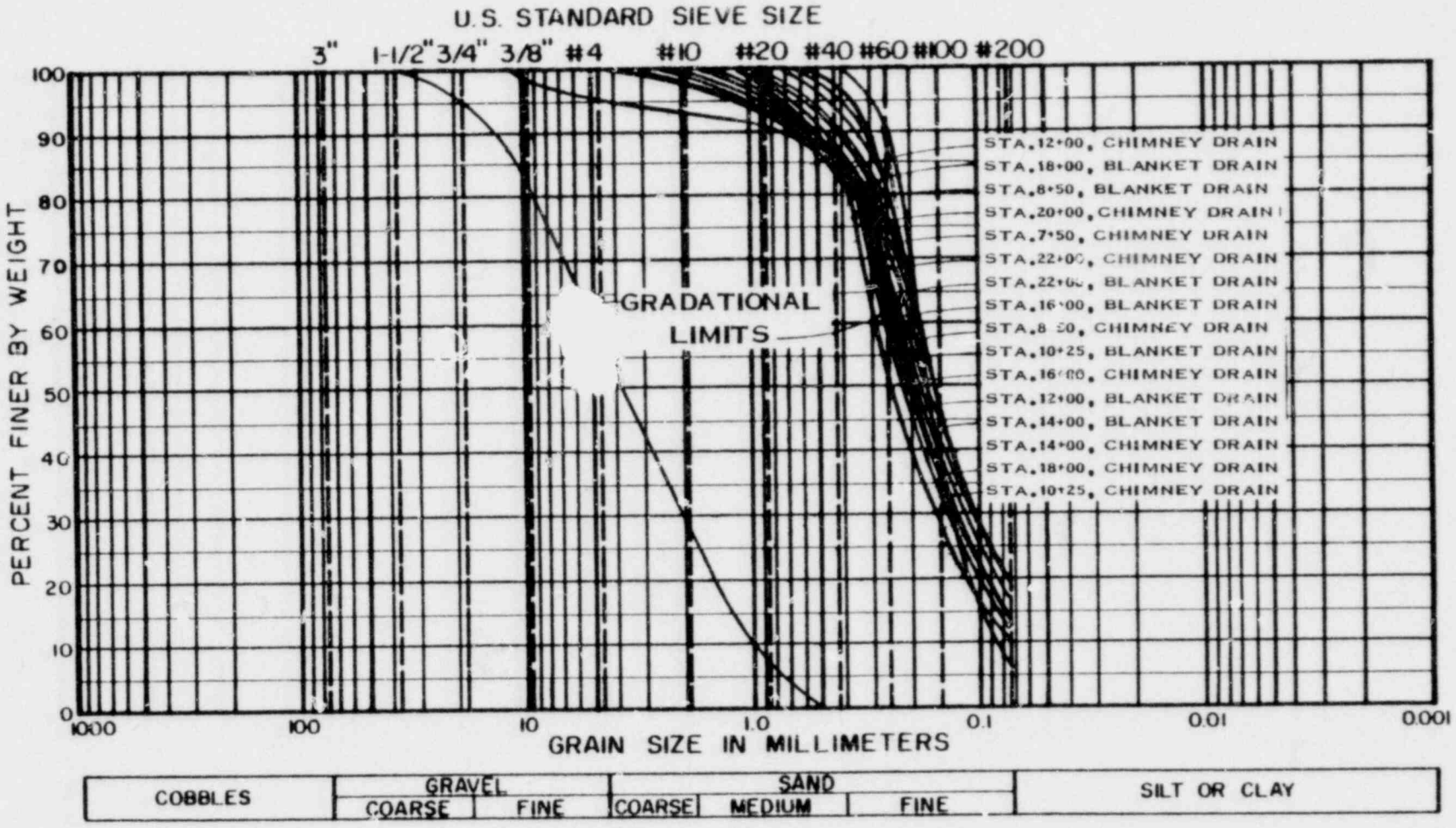


NOTE STATION A 21+00 IS A TIE IN LOCATION TO ORIGINAL EMBANKMENT, THIS SECTION WILL BE PREPARED IN THE FIELD.

WESTERN EMBANKMENT DESIGN SECTIONS

DAMES & MOORE

PLATE 8



GRADATIONAL TEST DATA - SAND TAILINGS FILTER

PLATE 9

DAMES & MOORE

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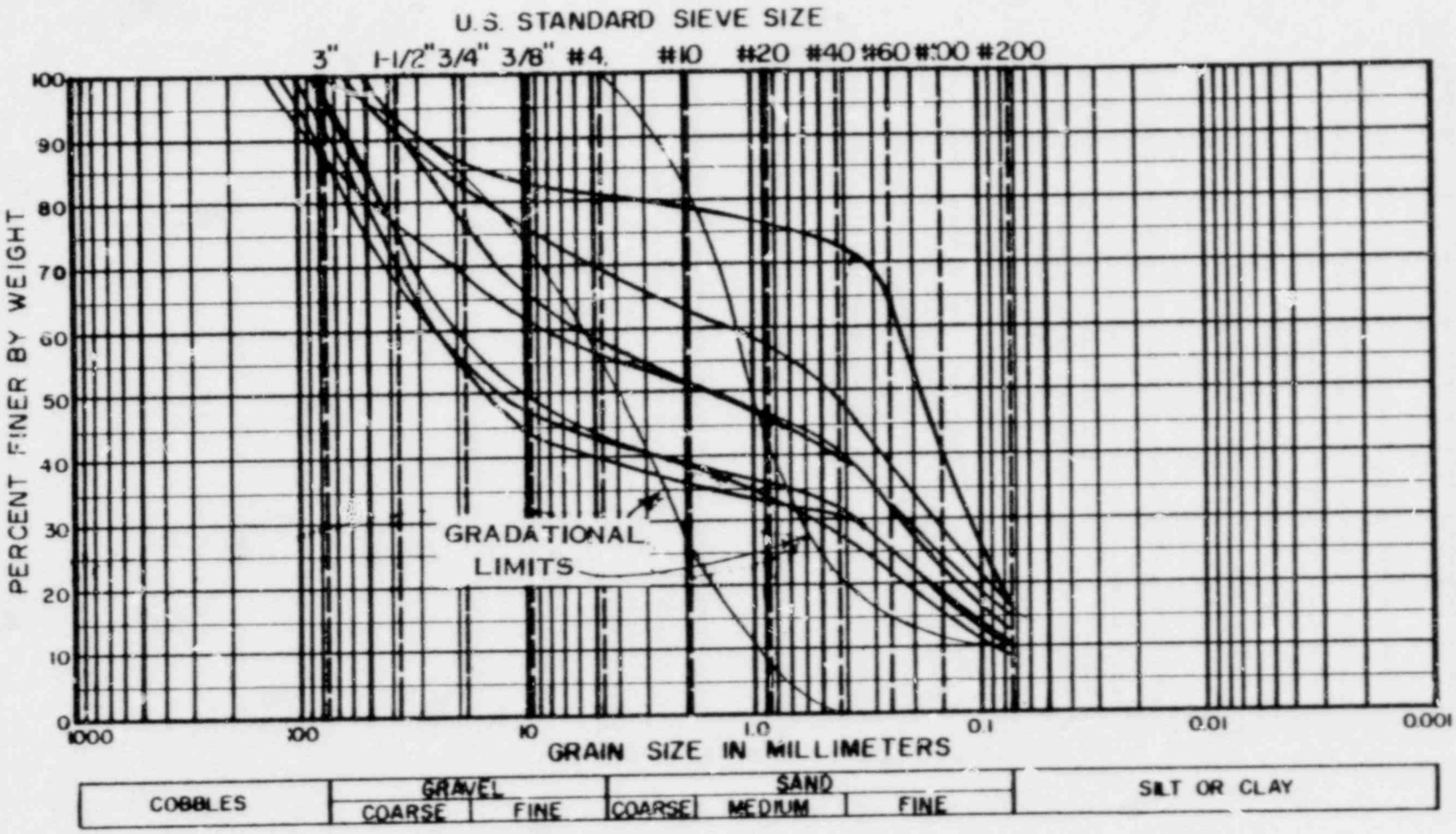
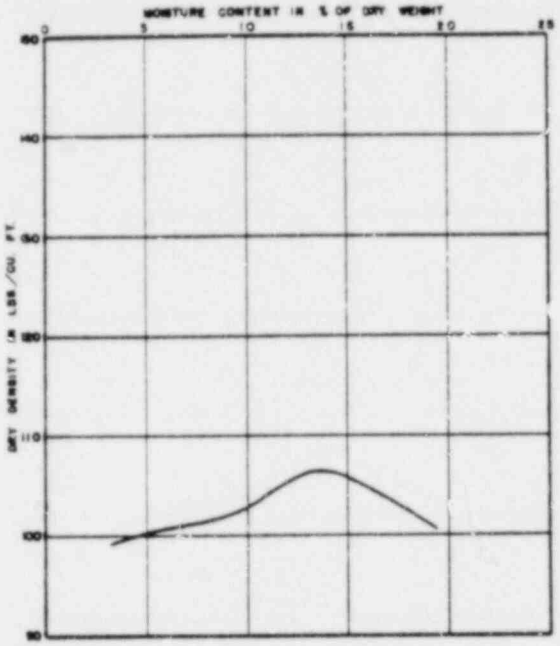


GRADATIONAL TEST DATA - SAND AND GRAVEL TOE DRAIN

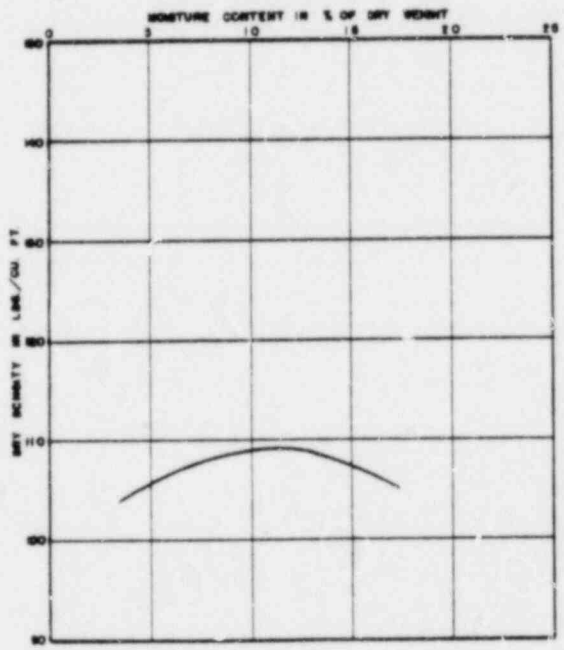
PLATE 10

BARNES & MCCORE

SAMPLE NO. 1
SOIL BROWN SILTY FINE SAND
LOCATION RED SILTY SAND BORROW AREA
OPTIMUM MOISTURE CONTENT 13.5 PERCENT
MAXIMUM DRY DENSITY 107 LBS. PER CUBIC FOOT
METHOD OF COMPACTION ASTM 698



SAMPLE NO. 3
SOIL BROWN SILTY FINE SAND WITH TRACE OF FINE GRAVEL
LOCATION R&O SILTY SAND BORROW AREA
OPTIMUM MOISTURE CONTENT 12 PERCENT
MAXIMUM DRY DENSITY 108 LBS. PER CUBIC FOOT
METHOD OF COMPACTION ASTM-698

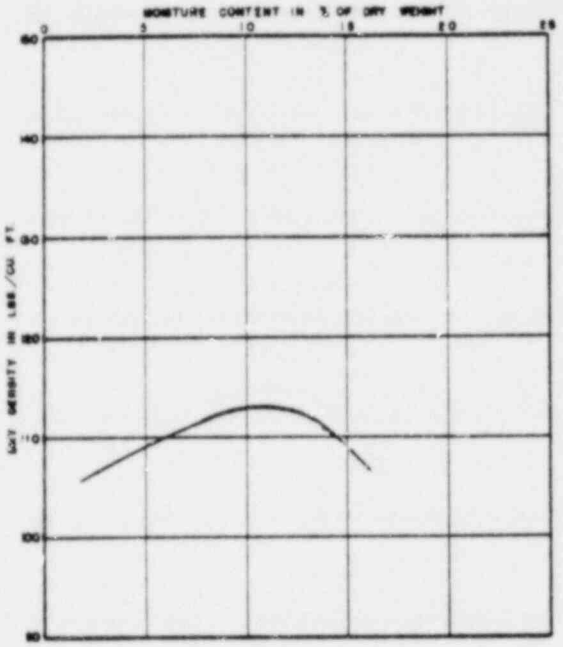


COMPACTION TEST DATA

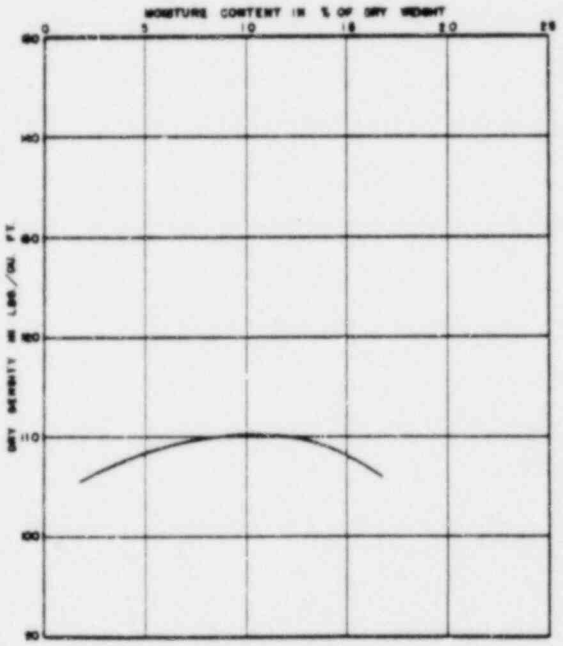
DAMES & MOORE

PLATE IIA

SAMPLE NO. 4
SOIL BROWN SILTY FINE SAND WITH TRACE OF FINE GRAVEL
LOCATION RED SILTY SAND BORROW AREA
OPTIMUM MOISTURE CONTENT 11.5 PERCENT
MAXIMUM DRY DENSITY 113 LBS. PER CUBIC FOOT
METHOD OF COMPACTION ASTM 698



SAMPLE NO. 5
SOIL BROWN SILTY FINE SAND WITH TRACE OF FINE GRAVEL
LOCATION RED SILTY SAND BORROW AREA
OPTIMUM MOISTURE CONTENT 11 PERCENT
MAXIMUM DRY DENSITY 110 LBS. PER CUBIC FOOT
METHOD OF COMPACTION ASTM D698



COMPACTION TEST DATA

DAMES & MOORE

PLATE 118

TEST NO.	DATE	LOCATION	APPROX. ELEVATION IN FEET	MAX. DRY DENSITY IN P.C.F.	REQ'D. DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
1	8-5	8+20, 40'W	4,030	115	90	9.5	131	114	
2	8-5	10+70, 30'W	4,020	115	90	9.6	124	108	
3	8-5	13+00, 30'W	4,017	115	90	8.8	127	110	
4	8-5	17+00, 30'W	4,020	115	90	8.0	139	121	GVL IN SAMPLE
5	8-5	21+00, 65'W	4,020	115	90	7.8	149	130	GRAVEL IN SAMPLE
6	8-12	10+00, 12'W	4,032	115	90	11.4	124	108	
7	8-12	15+50, 38'W	4,024	115	90	9.3	113	98	
8	8-12	21+60, 55'W	4,020	115	90	10.0	126	110	
9	8-17	22+00, 70'W	4,026	115	90	10.5	122	106	
10	8-17	19+90, 50'W	4,026	115	90	9.6	125	109	
11	8-17	12+20, 18'W	4,032	115	90	14.3	121	105	
12	8-29	14+00, 15'W	4,036	115	90	10.3	107	93	AREA REWORKED
13	8-29	18+00, 20'W	4,030	115	90	10.7	106	92	AREA REWORKED
14	8-29	23+00, 35'W	4,027	115	90	10.0	118	102	
15	9-9	16+75, 18'W	4,039	115	90	6.9	119	103	
16	9-9	21+00, 15'W	4,038	115	90	8.3	123	107	
17	9-9	23+40, 20'W	4,034	115	90	9.6	132	115	

SUMMARY OF IN-PLACE DENSITY TESTS

DAMES & MOORE TESTS

DAMES & MOORE

PLATE 12A

REVISIONS BY DATE

FILE

CHECKED BY DATE

TEST NO.	DATE	LOCATION	APPROX. ELEVATION IN FEET	MAX. DRY DENSITY IN P.C.F.	REQ'D. DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
1	7-30	A10+00, 40'W	4,020	115	95	8.4	114	99	
2	7-30	A14+00, 50'W	4,013	115	95	7.1	116	101	
3	7-30	A18+00, 60'W	4,012	115	95	7.7	114	99	
4	7-30	A22+00, 70'W	4,008	115	95	7.3	116	101	
5	7-31	A8+00, 40'W	4,025	115	95	7.8	115	100	
6	7-31	A12+00, 40'W	4,010	115	95	5.6	117	102	
7	7-31	A16+00, 60'W	4,011	115	95	5.6	116	101	
8	7-31	A20+00, 60'W	4,007	115	95	8.1	115	100	
9	8-1	A20+00, 70'W	4,011	115	95	8.4	124	108	
10	8-1	A19+00, 60'W	4,010	115	95	10.6	120	104	
11	8-1	A18+00, 50'W	4,012	115	95	10.2	127	110	
12	8-1	A13+00, --	4,014	115	95	5.8	122	106	
13	8-1	A10+00, 40'W	4,016	115	95	9.0	111	97	
14	8-2	A22+00, 60'W	4,009	115	95	10.6	116	101	
15	8-2	A20+00, 60'W	4,010	115	95	10.7	130	113	GRAVEL NEAR TEST
16	8-3	A12+00, 30'W	4,015	115	95	7.1	114	99	
17	8-3	A14+00, 40'W	4,014	115	95	12.1	122	106	
18	8-3	A18+00, 50'W	4,014	115	95	7.1	123	107	
19	8-3	A20+00, 70'W	4,012	115	95	13.9	120	104	
20	8-3	A22+00, 60'W	4,012	115	95	5.4	115	100	
21	8-4	A6+00, 15'W	4,037	115	95	5.2	120	104	
22	8-4	A8+00, 20'W	4,033	115	95	9.6	117	102	
23	8-4	A10+00, 20'W	4,023	115	95	6.9	119	103	
24	8-4	A12+00, 30'W	4,022	115	95	8.3	126	110	

SUMMARY OF IN-PLACE DENSITY TESTS

AIR PHOTO SURVEYS AND GLOBAL ENGINEERING TESTS

DAMES & MOORE

PLATE 12B

REVISIONS BY DATE

FILE

CHECKED BY DATE

TEST NO.	DATE	LOCATION	APPROX. ELEVATION IN FEET	MAX. DRY DENSITY IN P.C.F.	REQ'D. DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
25	8-4	A14+00, 40'W	4,020	115	95	8.3	121	105	
26	8-4	A16+00, 40'W	4,020	115	95	6.7	120	104	
27	8-4	A18+00, 50'W	4,019	115	95	6.7	123	107	
28	8-4	A20+00, 60'W	4,014	115	95	6.8	128	111	
29	8-5	A10+70, 30'W	4,020	115	95	10.1	122	106	
30	8-5	A13+00, 30'W	4,020	115	95	9.4	125	109	
31	8-5	A17+00, 60'W	4,020	115	95	8.2	122	106	
32	8-5	A22+00, 80'W	4,015	115	95	7.8	125	109	
33	8-5	A10+00, 20'W	4,024	115	95	8.0	116	101	
34	8-5	A12+00, --	--	115	95	9.2	122	106	
35	8-5	A14+00, --	--	115	95	7.8	124	108	
36	8-5	A16+00, --	--	115	95	7.8	124	108	
37	8-5	A18+00, --	--	115	95	7.8	125	109	
38	8-5	A22+00, --	--	115	95	7.7	124	108	
39	8-5	A22+00, --	--	115	95	7.8	124	108	
40	8-8	A 8+00, 30'W	4,031	115	95	7.9	127	110	
41	8-8	A12+00, 30'W	4,024	115	95	8.5	124	108	
42	8-8	A14+00, 50'W	4,024	115	95	8.2	125	109	
43	8-8	A18+00, 60'W	4,020	115	95	8.3	126	110	
44	8-8	A22+00, 70'W	4,020	115	95	7.9	127	110	
45	8-9	A 6+00, 15'W	4,037	115	95	9.1	124	108	
46	8-9	A 8+00, 20'W	4,032	115	95	10.3	128	111	
47	8-9	A10+00, 25'W	4,026	115	95	9.6	123	107	
48	8-9	A12+00, 35'W	4,025	115	95	9.2	123	107	
49	8-9	A14+00, 50'W	4,025	115	95	7.0	124	108	

SUMMARY OF IN-PLACE DENSITY TESTS

AIR PHOTO SURVEYS & GLOBAL ENGINEERING TESTS

DAMES & MOORE

PLATE 12C

REVISIONS BY DATE

FILE

CHECKED BY DATE

TEST NO.	DATE	LOCATION	APPROX. ELEVATION IN FEET	MAX. DRY DENSITY IN P.C.F.	REQ'D. DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
50	8-9	A18+00, 50'W	4,022	115	95	8.0	132	115	
51	8-9	A20+00, 60'W	4,022	115	95	9.2	122	106	
52	8-10	A8+00, 30'W	4,033	115	95	8.4	123	107	
53	8-10	A12+00, 30'W	4,026	115	95	8.5	124	108	
54	8-10	A14+00, 40'W	4,026	115	95	8.3	127	110	
55	8-10	A18+00, 70'W	4,023	115	95	8.1	124	108	
56	8-10	A20+00, 65'W	4,023	115	95	8.3	123	107	
57	8-11	A8+00, 25'W	4,034	115	95	9.6	124	108	
58	8-11	A10+00, 55'W	4,027	115	95	9.5	126	110	
59	8-11	A12+00, 25'W	4,027	115	95	8.6	125	109	
60	8-11	A14+00, 50'W	4,027	115	95	8.2	125	109	
61	8-11	A18+00, 60'W	4,024	115	95	8.4	126	110	
62	8-11	A20+00, 60'W	4,024	115	95	8.7	123	107	
63	8-11	A22+00, 75'W	4,024	115	95	8.5	124	108	
64	8-12	A8+00, 20'W	4,034	115	95	8.4	126	110	
65	8-12	A12+00, --	4,028	115	95	8.7	124	108	
66	8-12	A16+00, --	4,028	115	95	8.4	126	110	
67	8-12	A18+00, --	4,025	115	95	10.0	122	106	
68	8-12	A22+00, --	4,025	115	95	9.0	123	107	
69	8-15	A8+00, 15'W	4,036	115	95	8.6	122	106	
70	8-15	A11+00, 30'W	4,030	115	95	9.1	121	105	
71	8-15	A15+00, 45'W	4,024	115	95	8.4	123	107	
72	8-15	A18+00, 60'W	4,017	115	95	9.4	119	103	
73	8-15	A23+00, 80'W	4,017	115	95	8.8	119	103	
74	8-16	A10+00, 20'W	4,032	115	95	11.5	118	103	

SUMMARY OF IN-PLACE DENSITY TESTS

AIR PHOTO SURVEYS AND GLOBAL ENGINEERING TESTS

DAMES & MOORE

PLATE 120

REVISIONS BY DATE

FILE

CHECKED BY DATE

TEST NO.	DATE	LOCATION	APPROX. ELEVATION IN FEET	MAX. DRY DENSITY IN P.C.F.	REQ'D DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
75	8-16	A14+00, 40'W	4,026	115	95	9.6	120	104	
76	8-16	A16+00, 40'W	4,023	115	95	7.2	118	103	
77	8-16	A18+00, 75'W	4,018	115	95	9.9	118	103	
78	8-16	A22+00, 70'W	4,018	115	95	10.0	121	105	
79	8-17	A10+00, 40'W	4,031	115	95	8.2	118	103	
80	8-17	A12+00, 42'W	4,030	115	95	8.4	118	103	
81	8-17	A14+50, 55'W	4,025	115	95	8.3	118	103	
82	8-17	A17+00, 67'W	4,020	115	95	8.7	118	103	
83	8-17	A21+00, --	4,019	115	95	8.4	116	101	
84	8-18	A12+00, 35'W	4,031	115	95	8.9	118	103	
85	8-18	A16+00, 57'W	4,022	115	95	8.8	120	104	
86	8-18	A19+00, 50'W	4,020	115	95	9.1	118	103	
87	8-18	A21+00, 75'W	4,020	115	95	8.7	117	102	
88	8-19	A10+00, 20'W	4,034	115	95	9.1	122	106	
89	8-19	A14+00, 40'W	4,027	115	95	9.0	120	104	
90	8-19	A18+00, 55'W	4,021	115	95	9.6	120	104	
91	8-19	A21+00, 45'W	4,021	115	95	8.8	120	104	
92	8-19	A23+00, 45'W	4,020	115	95	9.3	121	105	
93	8-20	A12+00, 15'W	4,033	115	95	9.0	125	109	
94	8-20	A15+00, 55'W	4,025	115	95	8.0	122	106	
95	8-20	A17+00, 65'W	4,023	115	95	6.1	123	107	
96	8-20	A19+00, 70'W	4,023	115	95	8.7	119	103	
97	8-20	A22+00, 75'W	4,023	115	95	9.9	116	101	
98	8-22	A14+00, 20'W	4,031	115	95	9.2	118	103	

SUMMARY OF IN-PLACE DENSITY TESTS

AIR PHOTO SURVEYS AND GLOBAL ENGINEERING TESTS

DAMES & MOORE

PLATE 12E

REVISIONS BY DATE

FILE

CHECKED BY DATE

TEST NO.	DATE	LOCATION	APPROX. ELEVATION IN FEET	MAX.DRY DENSITY IN P.C.F.	REQ'D. DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
99	8-22	A17+00, 55'W	4,024	115	95	8.4	117	102	
100	8-22	A20+00, 55'W	4,024	115	95	8.4	118	103	
101	8-22	A23+00, 30'W	4,024	115	95	9.0	117	102	
102	8-23	A12+00, 8'W	4,035	115	95	8.8	119	103	
103	8-23	A16+00, 45'W	4,030	115	95	9.0	119	103	
104	8-23	A19+00, 35'W	4,024	115	95	9.1	117	102	
105	8-23	A23+00, 60'W	4,024	115	95	8.3	120	104	
106	8-24	A12+00, 10'W	4,036	115	95	8.2	119	103	
107	8-24	A16+00, 30'W	4,031	115	95	9.0	118	103	
108	8-24	A20+00, 55'W	4,025	115	95	7.8	118	103	
109	8-24	A23+00, 48'W	4,025	115	95	7.6	121	105	
110	8-26	A13+00, 20'W	4,034	115	95	9.2	120	104	
111	8-26	A16+00, 30'W	4,033	115	95	8.5	121	105	
112	8-26	A20+50, 50'W	4,026	115	95	10.6	117	102	
113	8-26	A23+00, 50'W	4,026	115	95	7.9	117	102	
114	8-27	A13+00, 20'W	4,037	115	95	8.3	124	108	
115	8-27	A19+00, 50'W	4,027	115	95	9.8	121	105	
116	8-27	A22+00, 50'W	4,027	115	95	8.7	120	104	
117	8-29	A14+00, 15'W	4,036	115	95	7.6	118	103	
118	8-29	A23+00, 35'W	4,027	115	95	8.2	116	101	
119	8-29	A18+00, 20'W	4,030	115	95	8.4	114	99	
120	8-30	A16+00, 30'W	4,030	115	95	9.1	116	101	
121	8-30	A19+00, 20'W	4,030	115	95	9.8	118	103	
122	8-30	A23+50, 30'W	4,028	115	95	9.4	116	101	

SUMMARY OF IN-PLACE DENSITY TESTS

AIR PHOTO SURVEYS AND GLOBAL ENGINEERING TESTS

DAMES & MOORE

PLATE 12F

REVISIONS BY DATE

FILE

BY CHECKED DATE

TEST NO.	DATE	LOCATION	APPROX. ELEVATION IN FEET	MAX. DRY DENSITY IN P.C.F.	REQ'D. DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
123	9-1	A23+00, 50'W	4,030	115	95	14.9	114	99	
124	9-1	A18+00, 30'W	4,032	115	95	8.8	120	104	
125	9-1	A15+00, 10'W	4,033	115	95	8.5	123	107	
126	9-2	A17+50, 20'W	4,035	115	95	8.8	117	102	
127	9-2	A19+00, 30'W	4,033	115	95	4.3	122	106	
128	9-2	A22+50, 30'W	4,031	115	95	9.7	122	106	
129	9-6	A22+50, 40'W	4,032	115	95	10.5	110	96	
130	9-6	A17+50, 25'W	4,033	115	95	10.0	109	95	
131	9-6	A15+00, 15'W	4,040	115	95	7.5	109	95	
132	9-7	A18+00, 30'W	4,036	115	95	8.9	111	97	
133	9-7	A22+50, 30'W	4,034	115	95	8.3	119	103	
134	9-7	A18+50, 20'W	4,036	115	95	11.8	112	97	
135	9-7	A16+50, 20'W	4,038	115	95	9.5	117	102	
136	9-8	A18+00, 30'W	4,037	115	95	11.7	122	109	
137	9-8	A22+00, 30'W	4,036	115	95	15.7	121	105	
138	9-8	A23+50, 30'W	4,035	115	95	10.4	118	103	
139	9-8	A19+50, 30'W	4,037	115	95	10.2	119	103	

SUMMARY OF IN-PLACE DENSITY TESTS

AIR PHOTO SURVEYS AND GLOBAL ENGINEERING TESTS

DAMES & MOORE

PLATE 12G

REVISIONS BY DATE

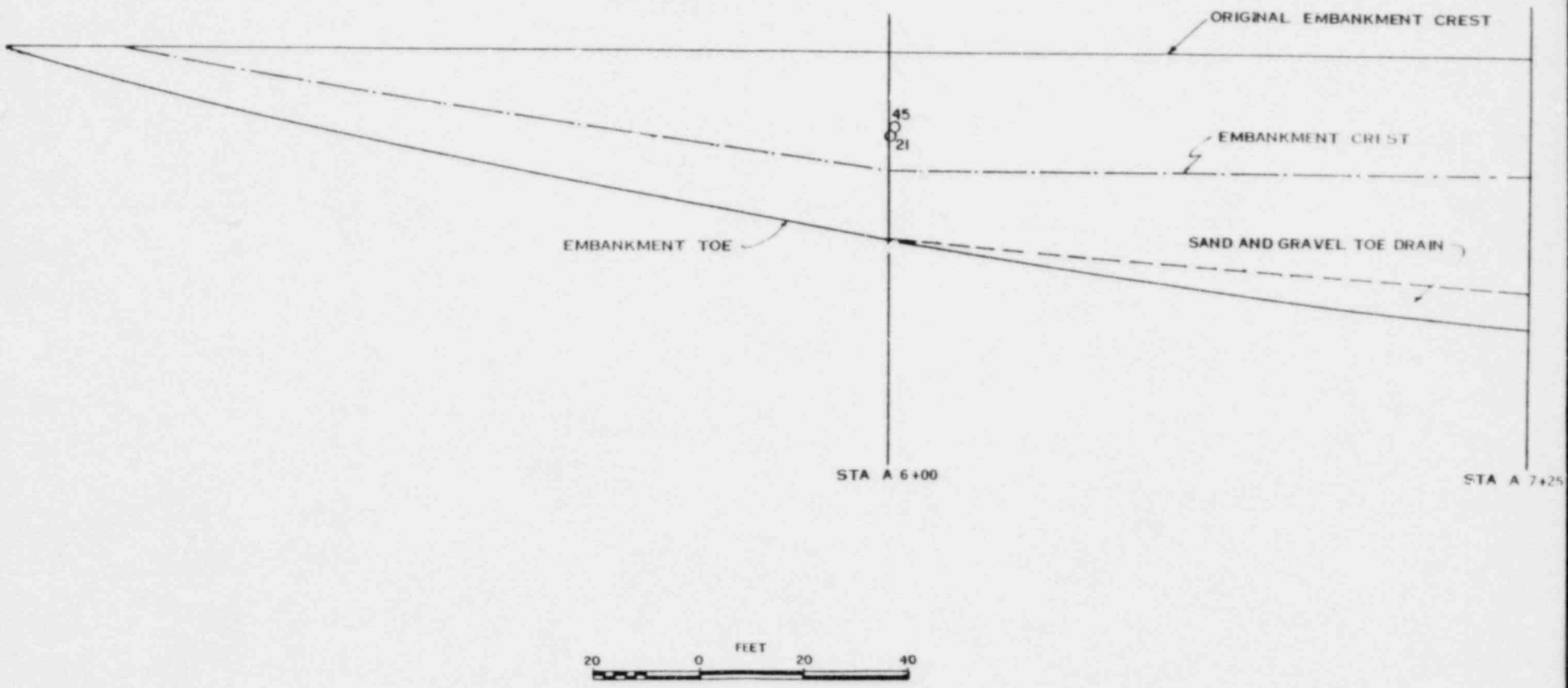
FILE

DATE BY CHECKED BY

KEY

○ INDICATES NUCLEAR DENSITY TEST LOCATION BY GLOBAL ENGINEERING

△ INDICATES SAND CONE DENSITY TEST LOCATION BY DAMES & MOORE



NOTE:
PLAN DERIVED FROM AS - BUILT PROFILES

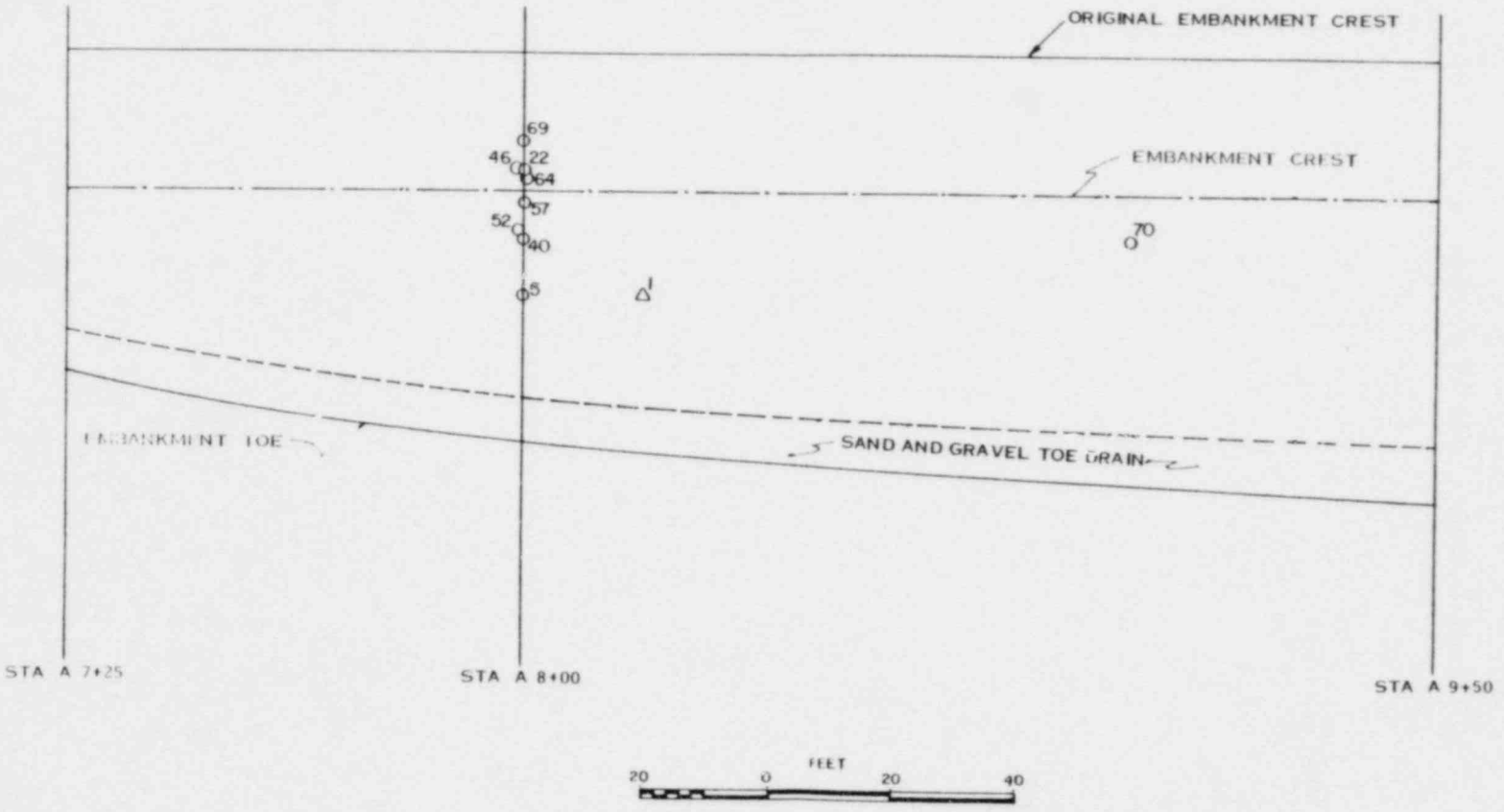
DAMES & MOORE

PLATE 13 A

KEY:

○ INDICATES NUCLEAR DENSITY TEST LOCATION BY GLOSAL ENGINEERING

△ INDICATES SAND CONE DENSITY TEST LOCATION BY DAMES & MOORE



NOTE:
PLAN DERIVED FROM AS BUILT PROFILES

DAMES & MOORE

PLATE 13_B

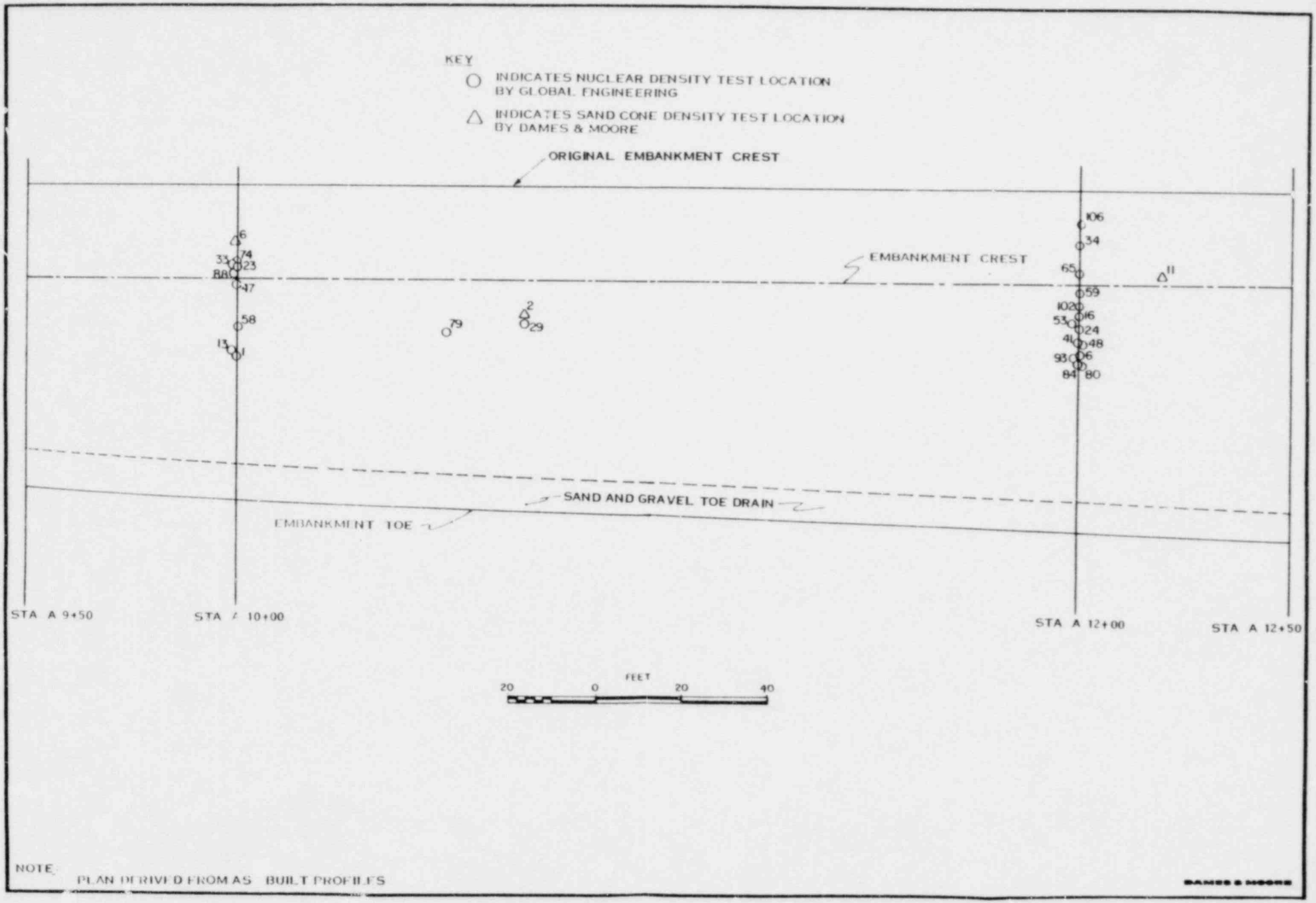
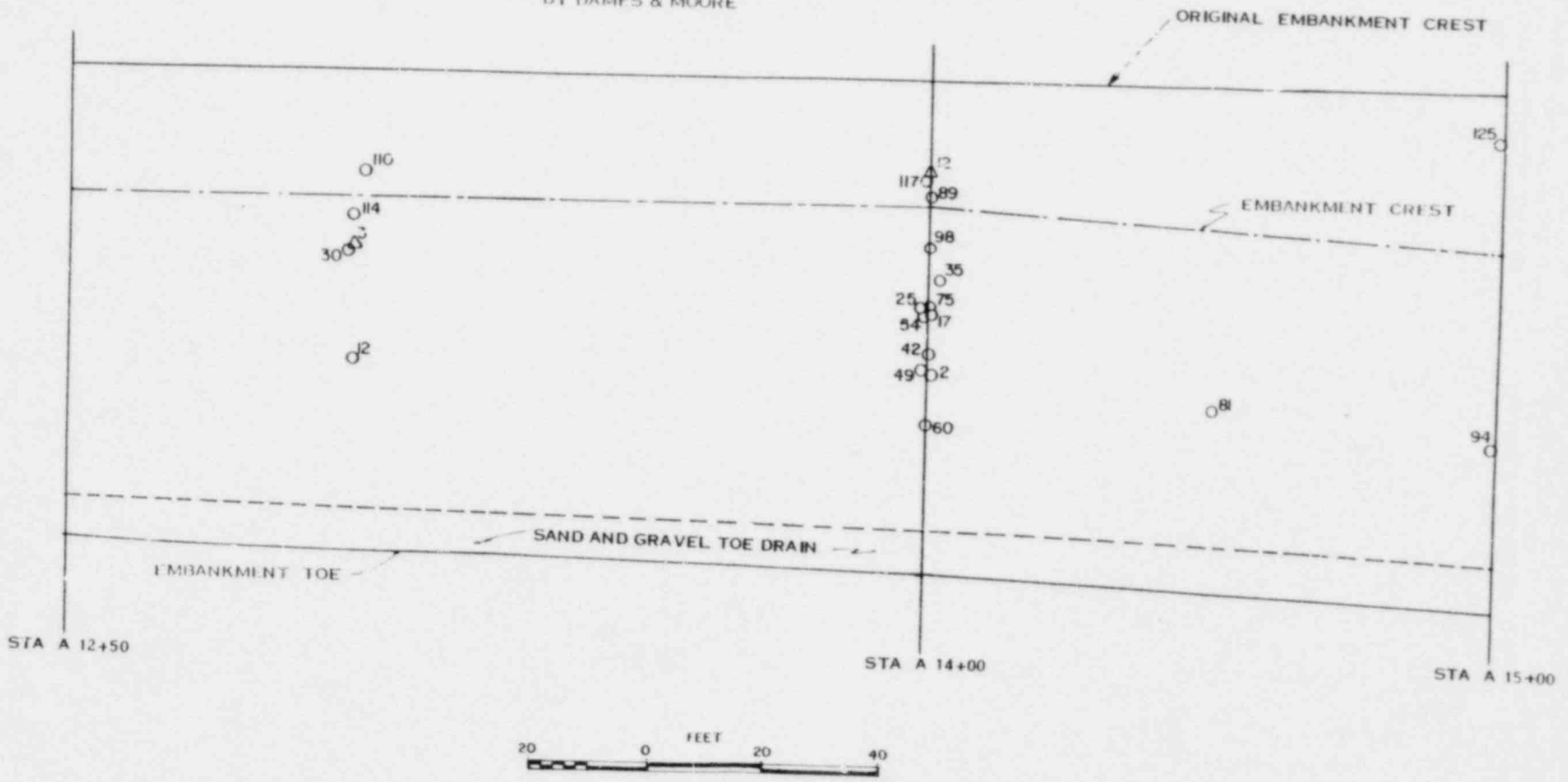

KEY
INDICATES NUCLEAR DENSITY TEST LOCATION BY GLOBAL ENGINEERING
INDICATES SAND CONE DENSITY TEST LOCATION BY DAMES & MOORE
ORIGINAL EMBANKMENT CREST
EMBANKMENT CREST
SAND AND GRAVEL TOE DRAIN
EMBANKMENT TOE
STA A 9+50
STA A 10+00
STA A 12+00
STA A 12+50
FEET
20 0 20 40
NOTE
PLAN DERIVED FROM AS BUILT PROFILES
DAMES & MOORE

PLATE 13 C

KEY

○ INDICATES NUCLEAR DENSITY TEST LOCATION BY GLOBAL ENGINEERING

△ INDICATES SAND CONE DENSITY TEST LOCATION BY DAMES & MOORE

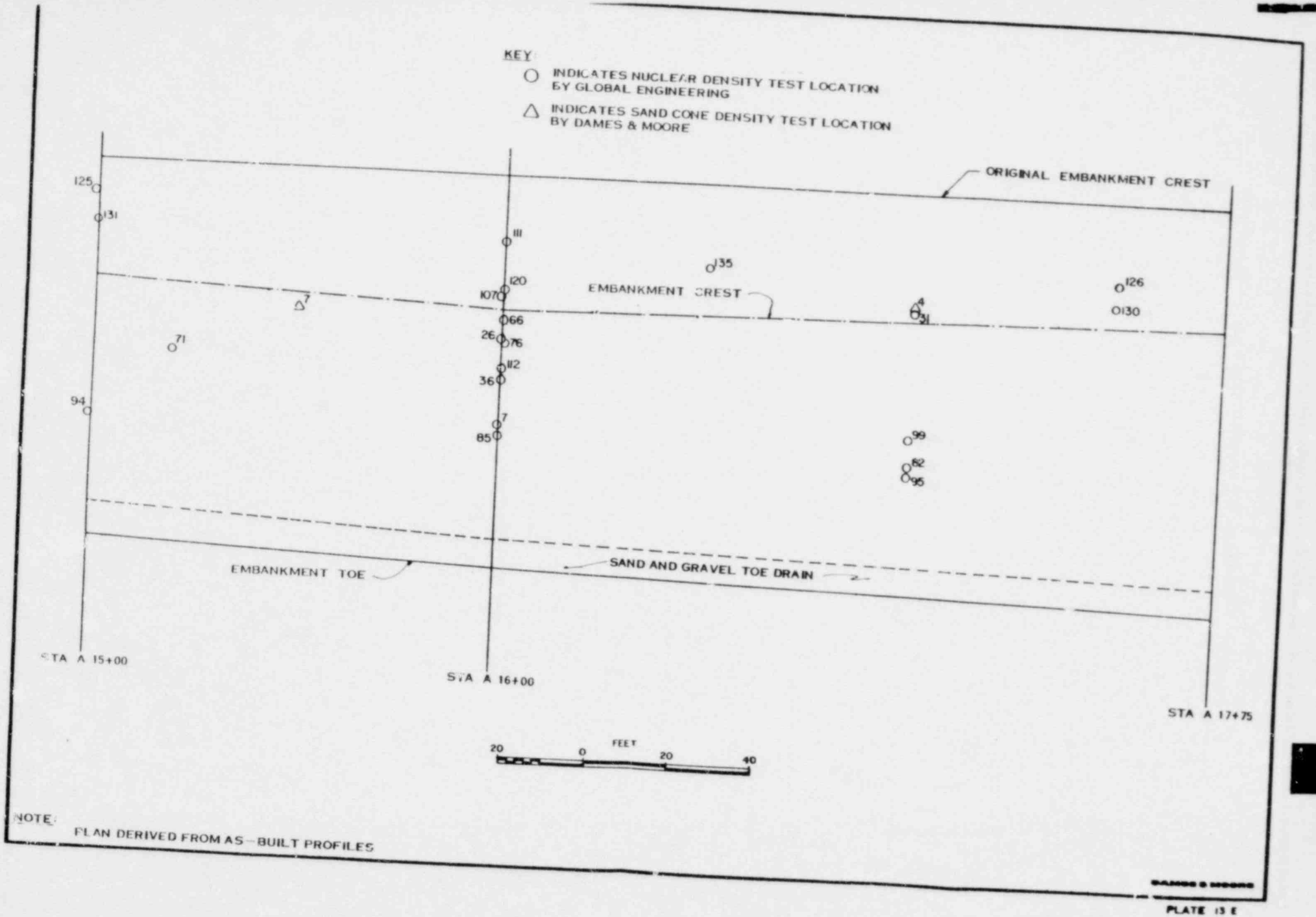


NOTE:

PLAN DERIVED FROM AS-BUILT PROFILES

DAMES & MOORE

PLATE 13 D



NOTE:
PLAN DERIVED FROM AS-BUILT PROFILES

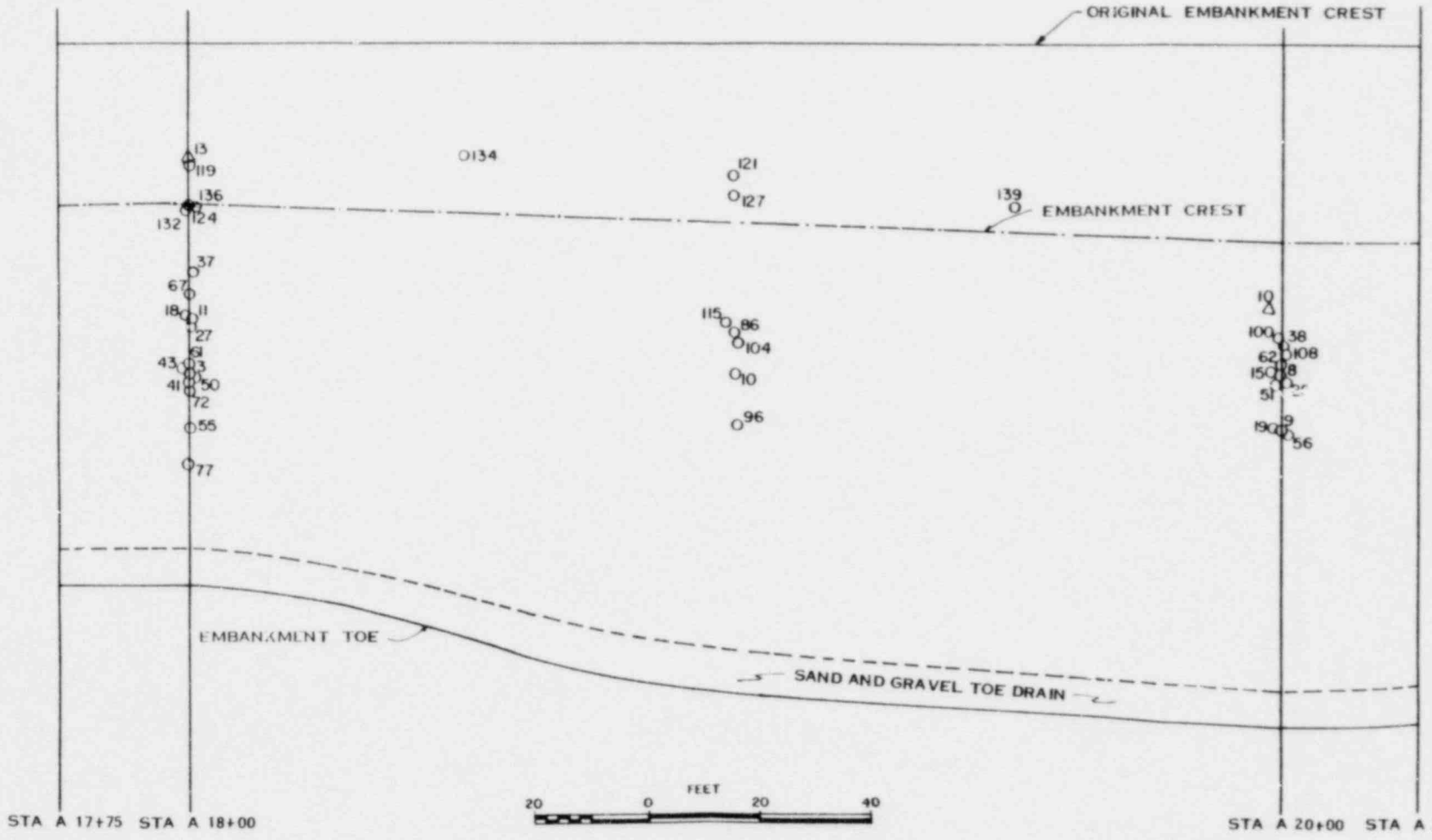
DAMES & MOORE

PLATE 13 E

KEY

○ INDICATES NUCLEAR DENSITY TEST LOCATION BY GLOBAL ENGINEERING

△ INDICATES SAND CONE DENSITY TEST LOCATION BY DAMES & MOORE



NOTE:
PLAN DERIVED FROM AS-BUILT PROFILES

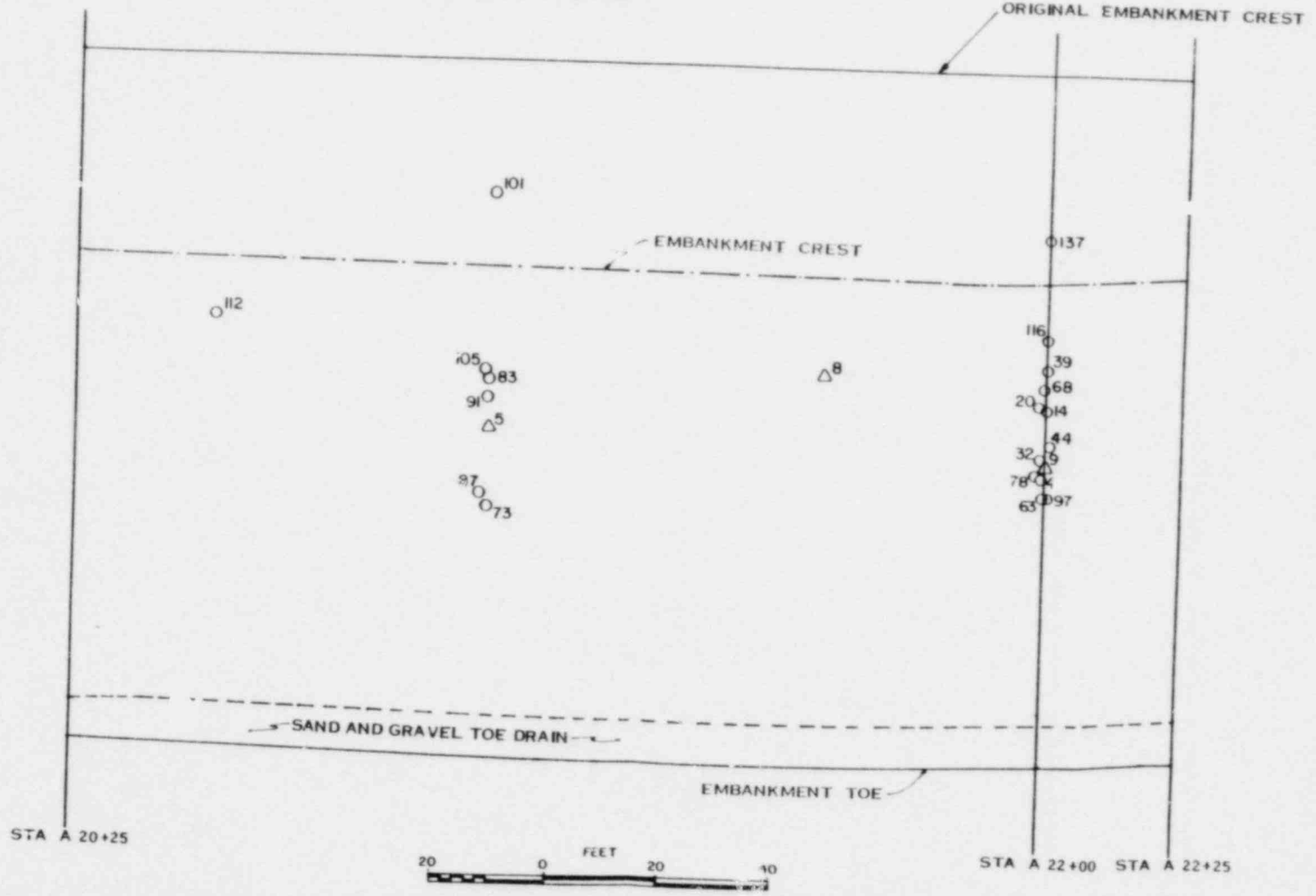
DAMES & MOORE

PLATE 13 F

KEY

○ INDICATES NUCLEAR DENSITY TEST LOCATION BY GLOBAL ENGINEERING

△ INDICATES SAND CONE DENSITY TEST LOCATION BY DAMES & MOORE

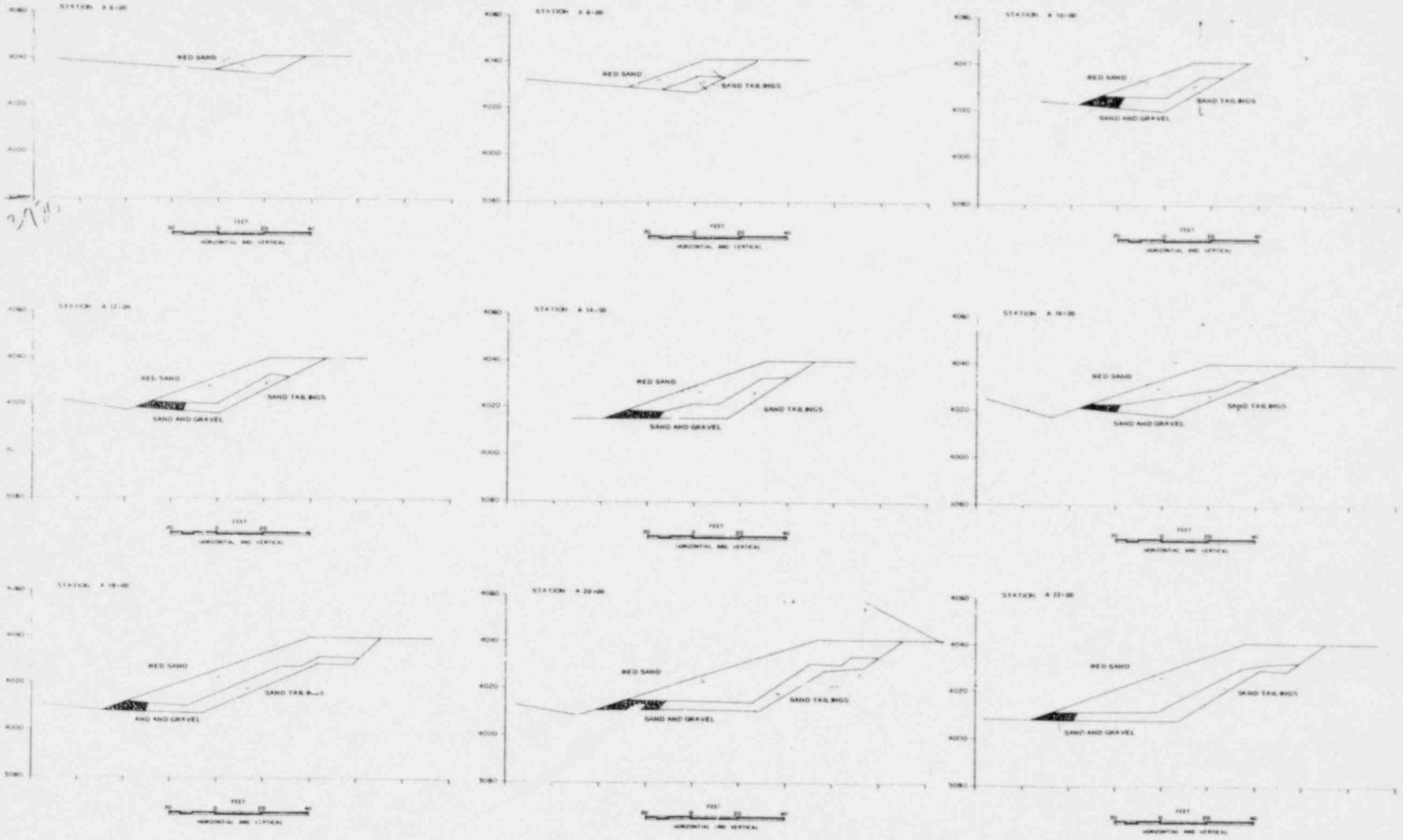


NOTE:

PLAN DERIVED FROM AS-BUILT PROFILES

DAMES & MOORE

PLATE 13 6



WESTERN EMBANKMENT
POST CONSTRUCTION SECTIONS

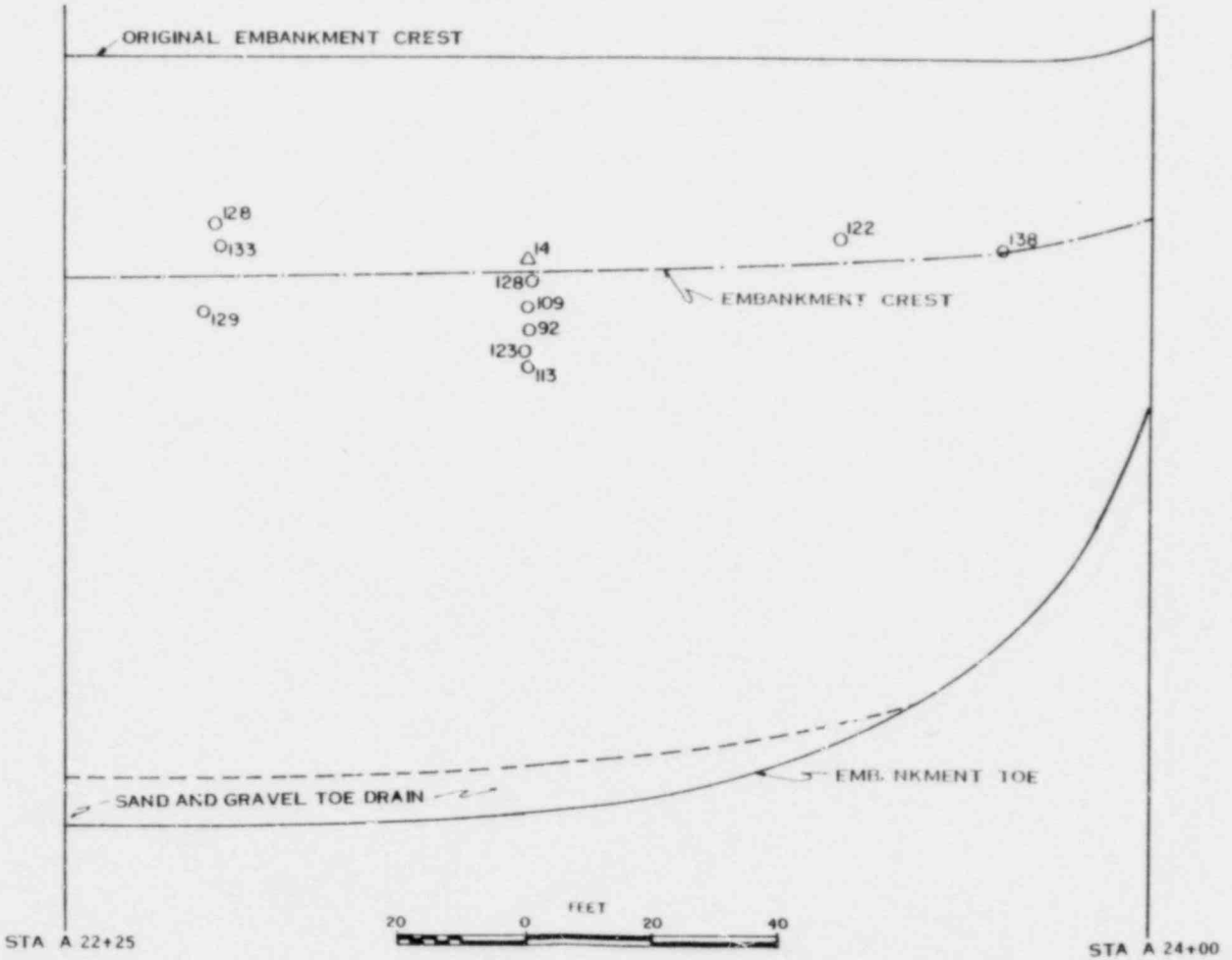
DAMES & MOORE

PLATE 14

KEY

○ INDICATES NUCLEAR DENSITY TEST LOCATION BY GLOBAL ENGINEERING

△ INDICATES SAND CONE DENSITY TEST LOCATION BY DAMES & MOORE



NOTE:
PLAN DERIVED FROM AS-BUILT PROFILES

DAMES & MOORE

PLATE 13 H

ACTION	INFO	
To: George Toland	Bill Badger	File: Atlas Minerals
Jim Boddy		05467-018-06
		X-Ref:
		Date: July 8, 1977

From: R. E. Rager — Reply Required By:

Subject: Site Inspection #2

Reference(s):

The writer visited the site of the remedial construction work located on the west side of the existing tailings pond at Atlas Minerals in Moab, Utah.

During the period since Jim Boddy's inspection on July 1, 1977 to the writer's visit on July 8, 1977, the existing dike crest was finish graded to Elevation 4040 feet. The sloughing noted by Jim Boddy in his memo of July 7, 1977 has been corrected. Approximately 150 feet of rip rap has been placed on the pond side of the embankment. However, this material is not to final grade.

The writer instructed the surveyor, John Keogh, to lay out the toe of the embankment to conform to the lines and the grades shown on the attached typical section. The writer told Bill Badger that the site would have to be cleared in such a manner that drainage would be toward the deepest embankment section and out and away from the toe of the new embankment. In addition, placement of the tailings sand drain, gravel drain and red sand shell would be accomplished in a manner such that the entire embankment section is raised uniformly to prevent weaknesses at the interfaces of the various material types.

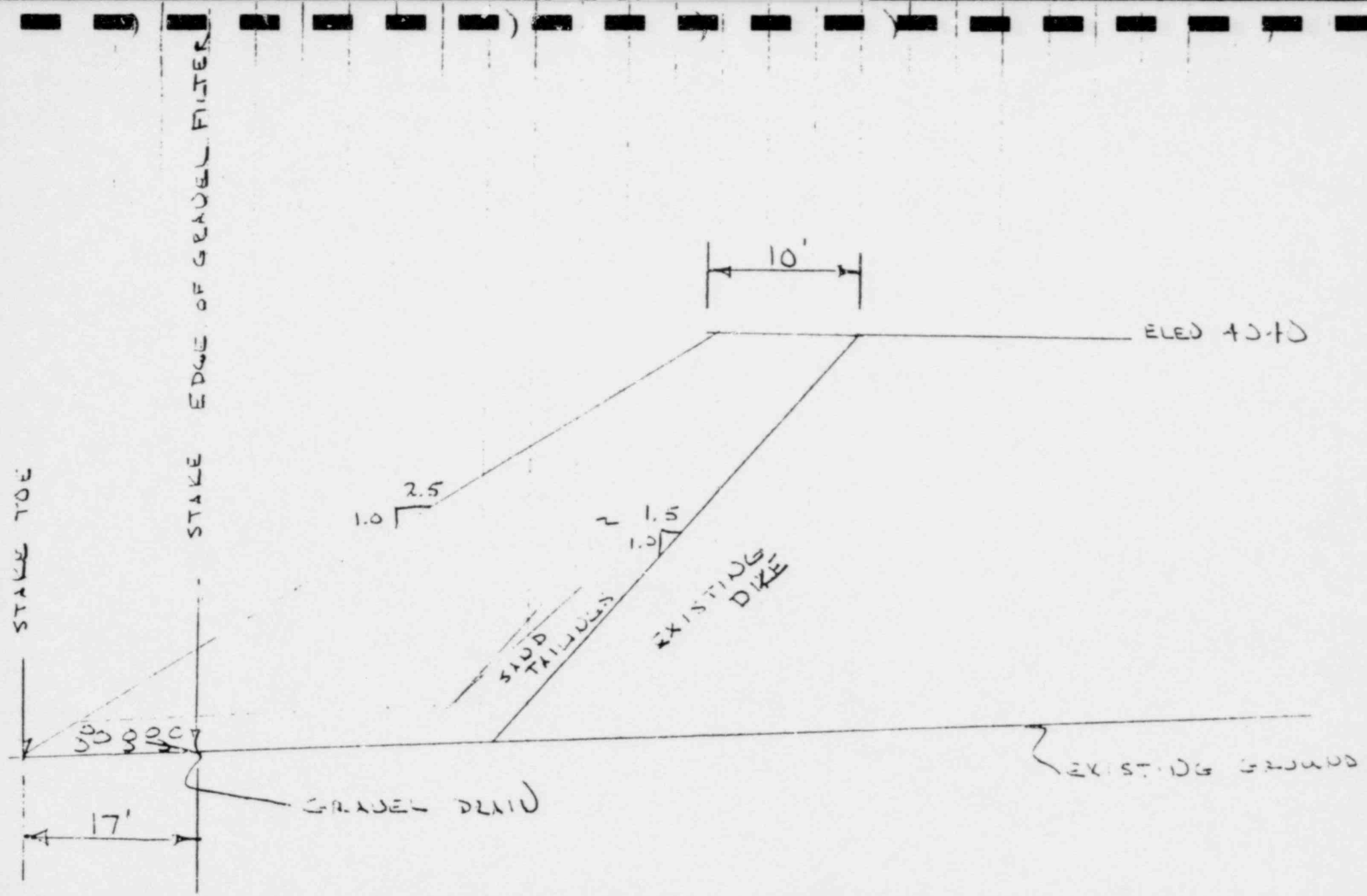
The stockpiling of the gravel drain material was being accomplished to the north of the embankment. Bulk samples of the gravel were taken along with a bulk surface sample of the beach tailings obtained from the proposed borrow area.

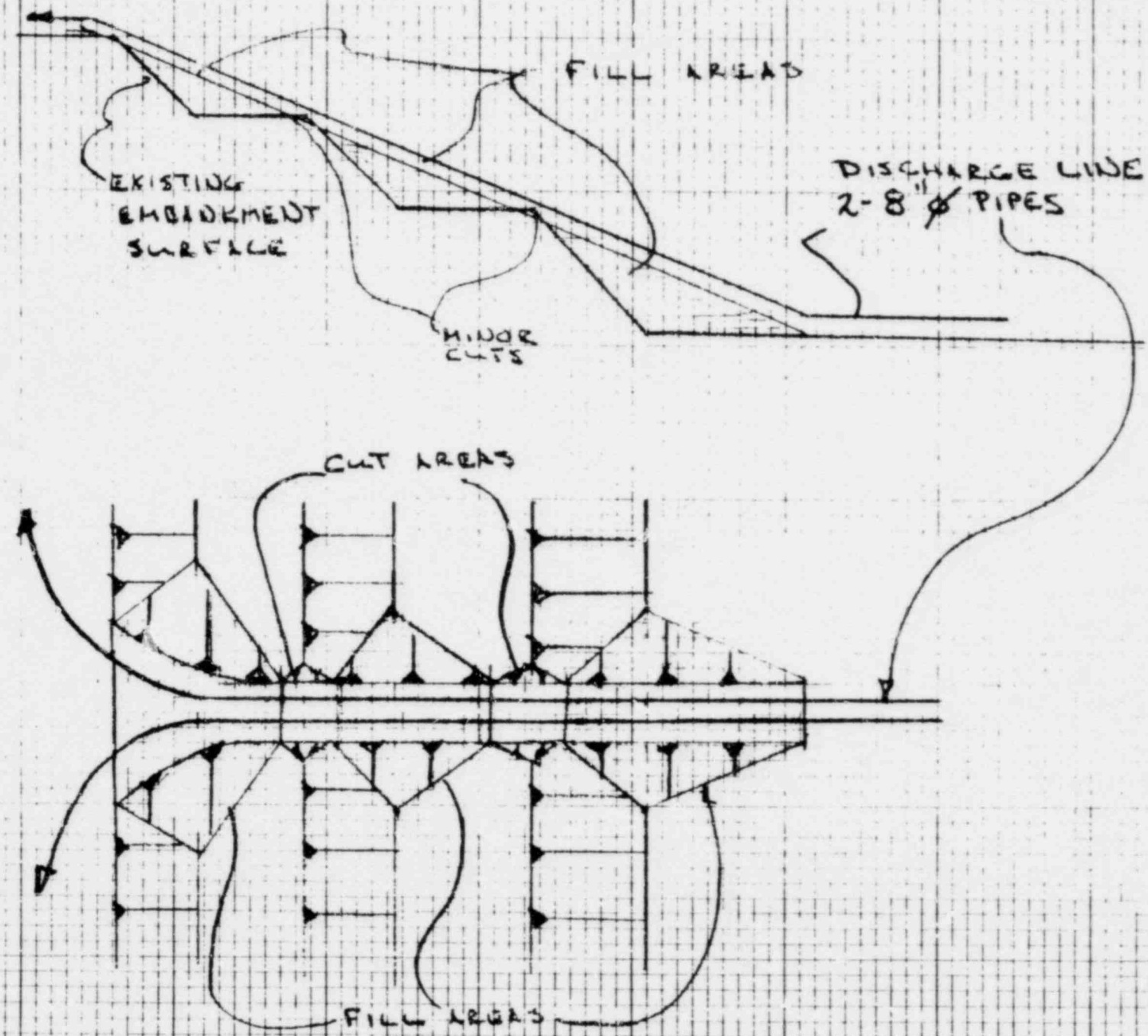
A section of the east tailings embankment was examined where a new tailings discharge line will mount the slope. It is proposed to build a uniform slope on which to lay the pipe, rather than to conform to the existing bench contours. The attached sketch shows the method proposed. This addition will not adversely effect the pond embankment stability and was approved for construction. The new construction will utilize the red sand tailings and will be covered with a protective layer of red sand-sandstone mixture where beach tailings are explosed.

ROUTING

Ron E. Rager

Ronald E. Rager


STAKE TOE
STAKE EDGE OF GRAVEL FILTER
10'
ELEV 43.0
2.5
1.0
1.5
1.0
SAND TAILINGS
EXISTING DIKE
EXISTING GROUND
GRAVEL DRAIN
17'



ACTION	INFO	
To: George Toland Jim Boddy	Bill Badger	File: Atlas Minerals 05467-018-03
		X-Ref:
		Date: July 12, 1977

From: R. E. Rager

Reply Required By:

Subject: Site Inspection #3

Reference(s):

The writer upon further examination of existing and required typical cross sections, visited the site of the Atlas Minerals Tailings Pond remedial construction to clarify details. The final design section is attached. This section was explained to the surveyor John Keogh in a previous telephone conversation and upon the writers arrival the toe of the embankment was laid out in the field. Copies of this cross section were presented to Mr. Oliver of Atlas Minerals. The subgrade under the new embankment has been partially smoothed and graded to provide adequate drainage, however, more work is required including the removal of some boulders, a ramp type road toward the south central portion of the embankment, and some miscellaneous pipe sections and chalk blocks left from an old tailings discharge line. The writer reiterated construction procedures and pointed out the approximate limits of each material type.

Additional rip rap had been placed near the north end of the embankment making a total of approximately 300 feet of placed rip rap. Thickness of the rip rap varied as final grade had not been established. Where the rip rap was covered by tailings pond water, no erosion was present in this rip rap.

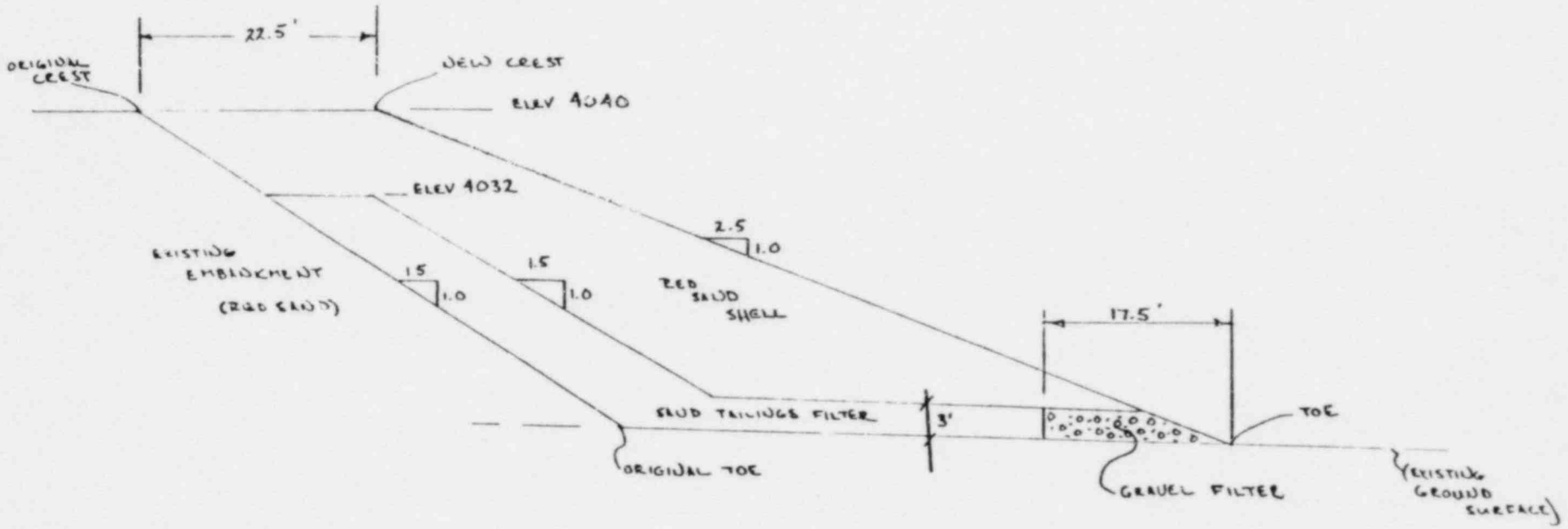
ROUTING

Ron E. Rager

Ronald E. Rager

FILE ATLAS MINERALS

SUBJECT WEST T.P. EMBANKMENT X-SEC (TYP) SHEET 1 OF 1



TYPICAL EMBANKMENT SECTION

BY _____ DATE _____ TO EO _____

CHECKED BY _____ COPY TO EO _____

DAMES & MOORE

ACTION	INFO	
To: George Toland Jim Boddy Jerry Wang	Bill Badger	File: 05467-018 Atlas Minerals
		X-Ref:
		Date: July 22, 1977

From: Ron E. Rager

Reply Required By:

Subject: Site Inspection #4

Reference(s):

The writer visited the site in the company of Jerry Wang (D&M). Construction of the widened western dike continued. Sand tailings had been placed as designated for the filter blanket and the chimney drain. Sand tailings were still being hauled in these areas with the entire chimney drain requiring an additional two to six feet of material. The filter blanket was complete except for from Sta 16+00 to 22+00^{+} where the toe of the new widened embankment was staked in error.

The sand and gravel toe drain had been placed from approximately Sta 8+00 to 15+00 with the remainder to be placed the following week. Two bulk samples were obtained of the as-placed sand and gravel for laboratory sieve analysis.

Survey data of the original dike sections (July 1977) was obtained from John Keogh. The sections from Station 16+00 to 22+00 were re-plotted to show the proposed widened sections. The toe of the new sections were rough staked in the field by the writer and copies of the design sections were presented to L. Oliver (Atlas). Copies of these sections are attached.

ROUTING

ACTION	INFO	
To:		File:
		X-Ref:
		Date: July 22, 1977

From: Reply Required By:

Subject: Site Inspection #4

Reference(s):

The entire embankment is not being raised uniformly as instructed, but rather all of the sand tailings filter material is being placed prior to hauling of sand and gravel and the red sandstone. The reason for specifying a uniform raising of the embankment sections was to provide a better bond between the various material zones. The bond of the dike materials as placed was examined closely during this site visit and found to be adequate. Construction will continue in this manner with the red sand material being placed last.

Rip-rap on the east side of the west embankment was extended to approximately Station 18+00 during the week.

The tailings borrow area was examined. Tailings had been borrowed until a fairly deep excavation (estimated to be 8 feet deep) had been opened adjacent to the south dike. Tailings were being discharged in this area to reestablish a sand beach. At the time of our inspection, a beach was established approximately 100 feet wide. Examination of the tailings effluent showed few -#200 sieve suspended particles. The liquid effluent was not ponding in the borrow area depression, but had formed a channel whereby it flowed to the existing main pond.

ROUTING

FIELD MEMORANDUM

ACTION	INFO	
To:		File:
		X-Ref:
		Date: July 22, 1977

From: Reply Required By:

Subject: Site Inspection #4

Reference(s):

Construction of the new discharge line ramp up the southeast embankment face had begun. Red sand was being hauled from north of the tailings pond and was being pushed from the top by a bull dozer into the ramp configuration, although little compactive effort is able to be applied to the deeper pushed-in-place soil. The upper two feet will be well compacted to lessen the surface erosion potential.

The seep located on the north embankment was examined. It was found to be located on the first bench and is approximately 150 feet long.

Ron E. Rager

Ron E. Rager (gw)

ROUTING

BY _____ DATE _____
CHECKED BY _____
COPY TO EO _____

REVISIONS
BY _____ DATE _____ TO EO _____
BY _____ DATE _____ TO EO _____

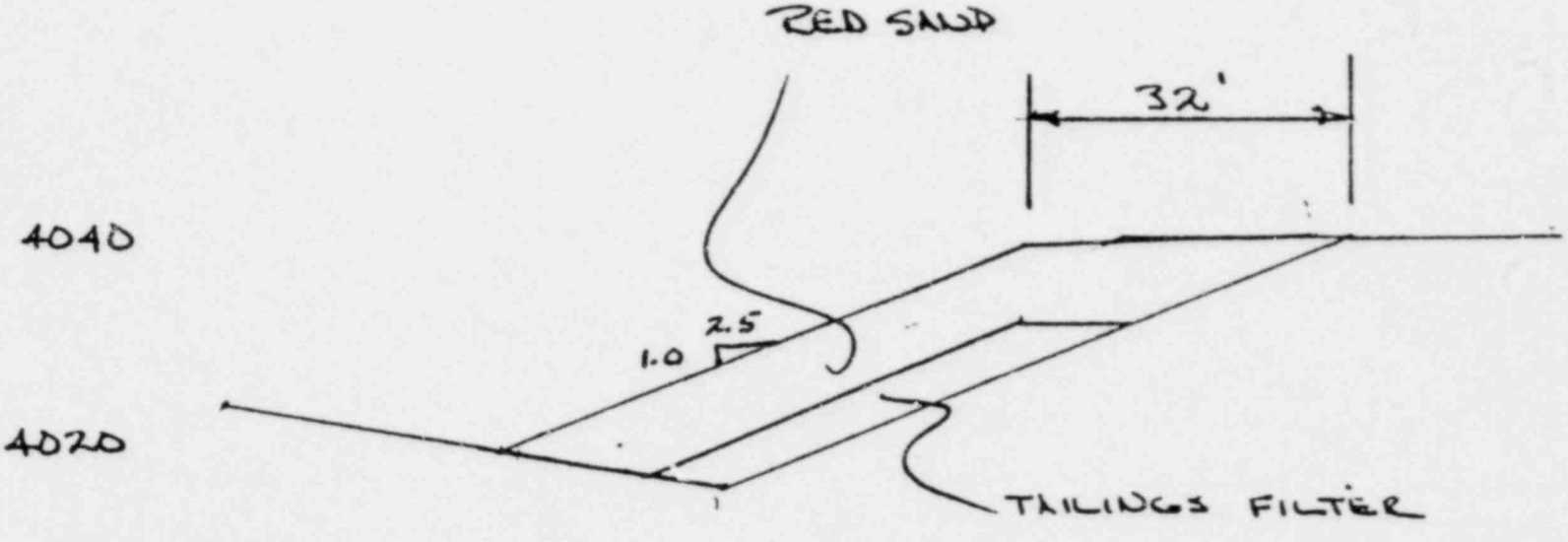
SUBJECT _____

SHEET ___

DAMES & MOORE

PRINTED IN U.S.A.

STA 16+00

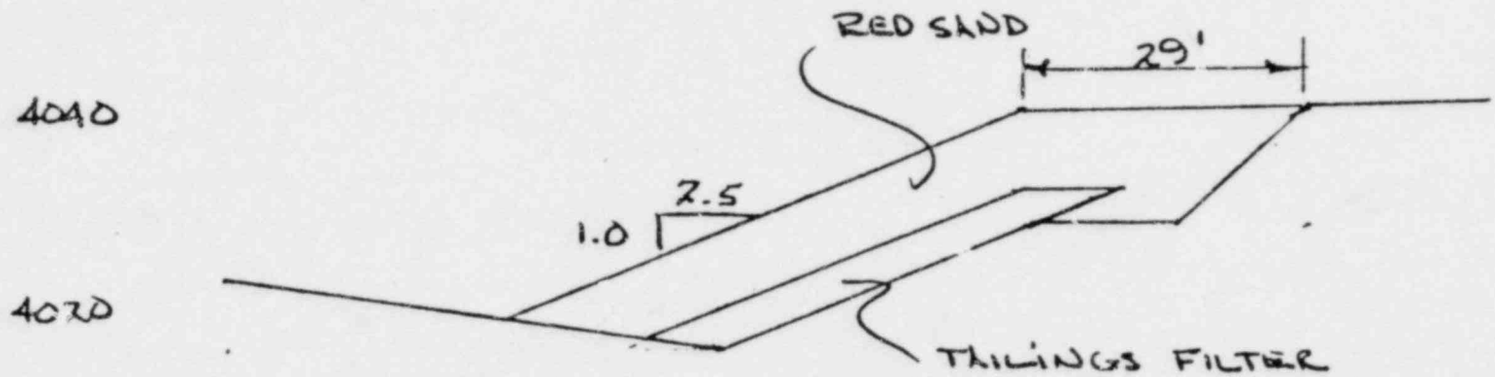


SCALE 1" = 20' HEV

BY _____ DATE _____
CHECKED BY _____
COPY TO EO _____

REVISIONS
BY _____ DATE _____ TO EO ____
BY _____ DATE _____ TO EO ____

STA 18+00



4040
4020
4000

SCALE 1" = 20' HEV

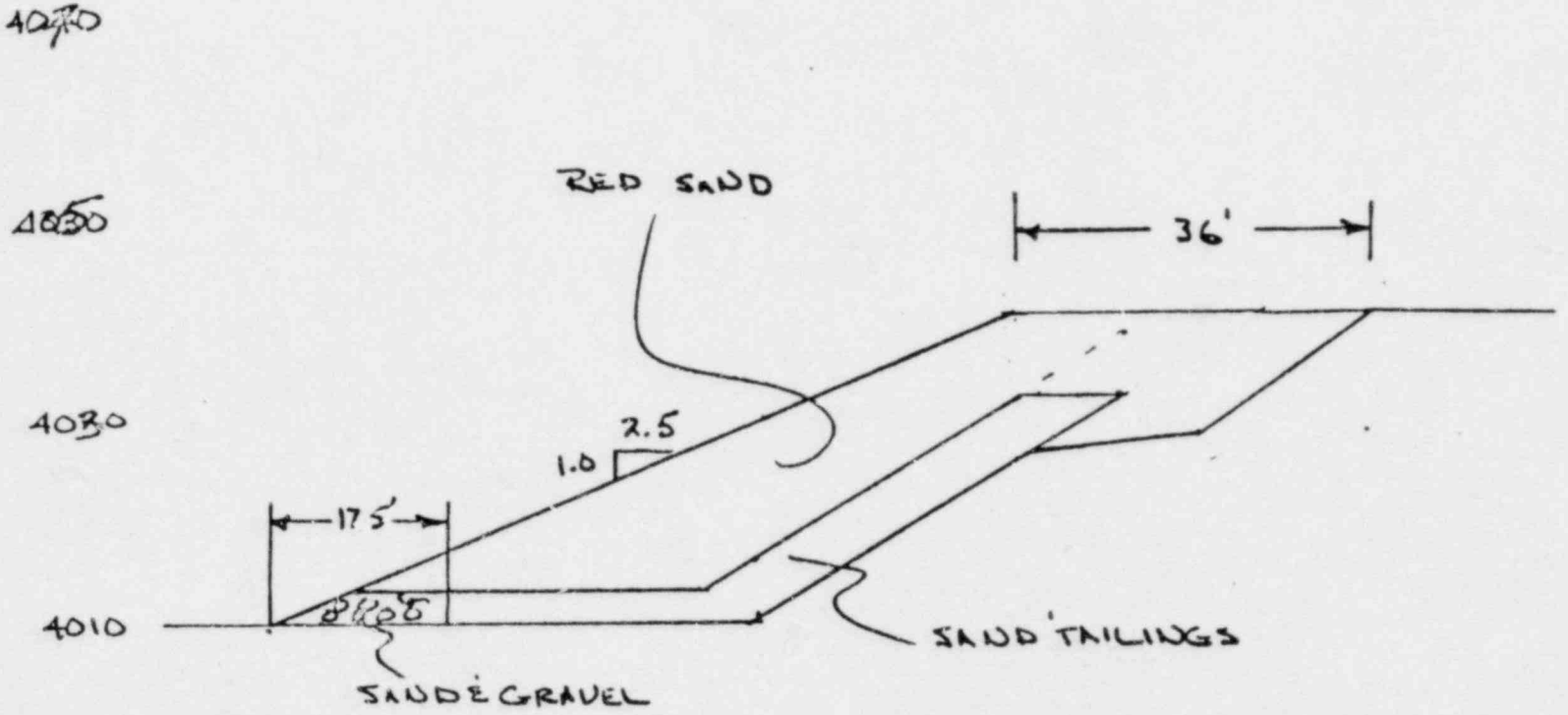
SUBJECT _____ SHEET ____

BY _____ DATE _____
CHECKED BY _____
COPY TO EO _____

REVISIONS
BY _____ DATE _____ TO EO ____
BY _____ DATE _____ TO EO ____

PRINTED IN U.S.A.

STA 20+00



SCALE 1"=20' H&V

SUBJECT _____

SHEET ____ OF ____

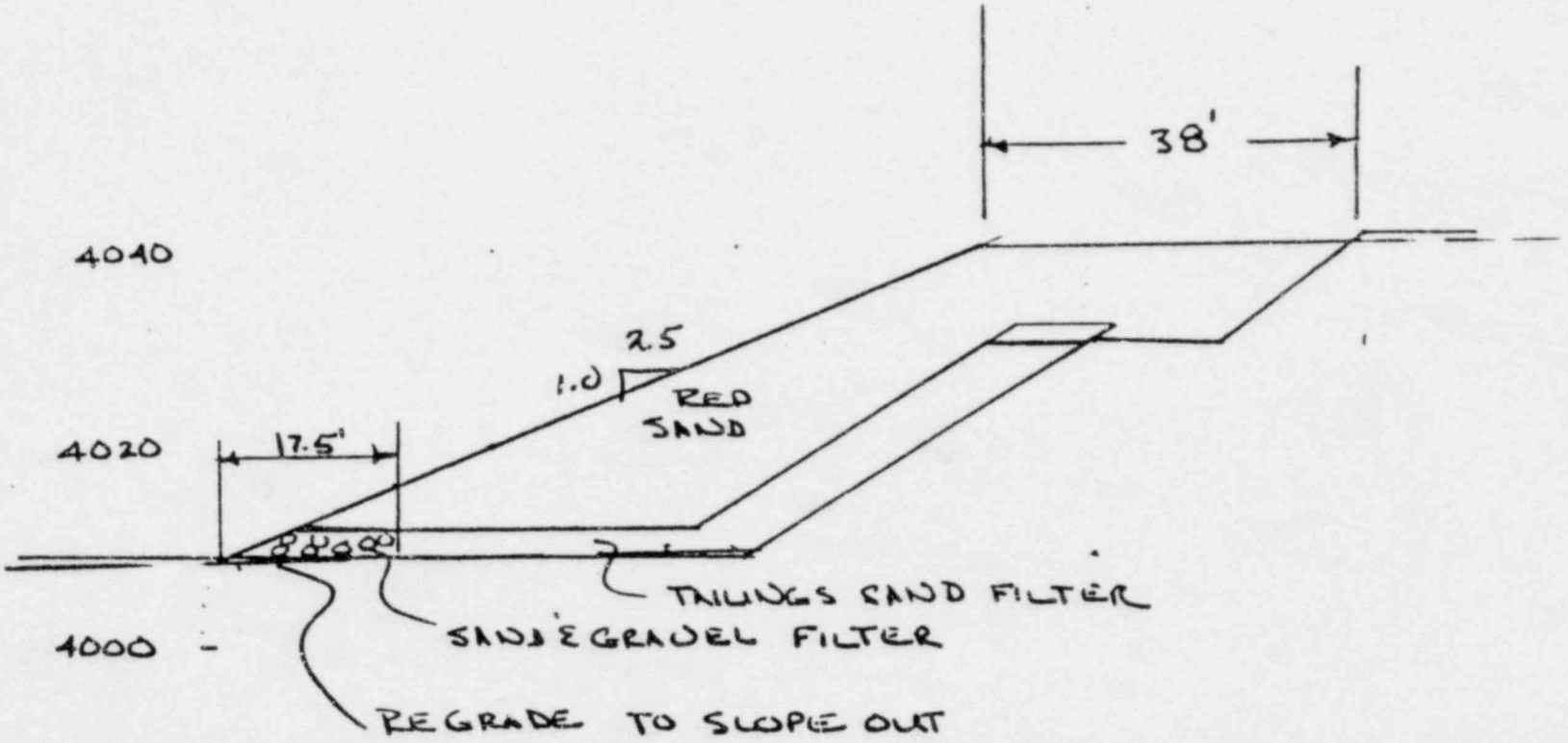
DAMES & MOORE

BY _____ DATE _____
CHECKED BY _____
COPY TO EO _____

REVISIONS
BY _____ DATE _____ TO EO ____
BY _____ DATE _____ TO EO ____

SUBJECT _____ SHEET ____ OF ____

Sta 22+00



SCALE 1"=20' HEV

NOTE: STATION 24+00 IS A TIE IN LOCATION TO ORIGINAL

DAMES & MOORE

PRINTED IN U.S.A.

ACTION	INFO	
To: George Toland	Bill Badger	File: Atlas Minerals
Jim Boddy		05467-018
Jerry Wang		
		X-Ref:
		Date: July 28 and 29, 1977

From: Ron E. Rager

Reply Required By:

Subject: Site Inspection #5

Reference(s):

The writer visited the site and inspected construction progress. To date, all sand and gravel toe drain material and all sand tailings filter material are in-place. The surveyor has obtained cross sections of the as-placed material. The writer has obtained samples of the in-place sand and gravel and sand tailings at approximately 200 feet on station for gradational analyses. Hauling and placing of the red sand shell was begun on July 29. Daily inspection and density testing of the placement of this material will be conducted by Air Photo Surveys and Global Engineering, Inc. of Grand Junction, Colorado. Weekly supervision and site visits by Dames & Moore will continue. No further rip-rap had been placed.

Recent rains have washed approximately one foot of natural slope material against the toe of the new construction.

The sand tailings borrow area was inspected. Approximately eight feet of tailings was borrowed adjacent to the dike. A bull dozer was being used to regrade and establish a 100 foot beach prior to tailings discharge.

ROUTING

ACTION	INFO	
To:		File:
		X-Ref:
		Date: July 28 and 29, 1977

From: Reply Required By:

Subject: Site Inspection #5

Reference(s):

The discharge line ramp was completed. The seep along the north embankment was inspected and found to have enlarged tc approximately 300 feet in length, or the entire north side.

Rip-rap consisting of +3" to 2 foot gravel and cobbles obtained from the west embankment toe drain screening process was being placed along the east embankment toe in the Moab Wash.

Ron E. Rager

Ron E. Rager

(gw)

ROUTING

ACTION	INFO	
To: George Toland	Bill Badger	File: 05467-018
Jim Boddy		Atlas Minerals
Jerry Wang		
		X-Ref: Page 1 of 1
		Date: August 5, 1977

From: Ronald E. Rager

Reply Required By:

Subject: Site Inspection #6

Reference(s):

The writer, accompanied by Larry Cordner (Senior Lab Technician, D & M, SLC) arrived at the site at 9 A.M. While Larry set up a temporary soils laboratory in the Atlas Mill Laboratory, the writer sampled and logged three test pits in the seepage area along the northeast tailings pond embankment. Logs of these test pits and their approximate location are attached.

At approximately 11:30 A.M. Larry Cordner and the writer began taking sand cone density tests of the red sand shell for the western embankment. Approximately 3 to 4 feet of the red sand material had been placed and compacted. The daily inspection and testing services provided by Air Photo Surveys and Global Engineering, Inc. indicate that adequate compaction of the material is being obtained.

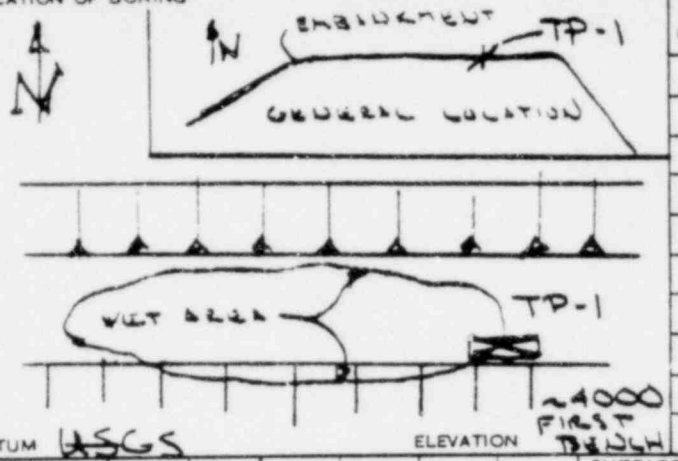
Nuclear density tests were performed adjacent to the sand cone density tests for correlation purposes. This comparison shows good correlation between the two tests with the nuclear machine consistantly showing slightly lower test densities. Since the results of the nuclear machine are conservative, no correction factor to the test results will be applied.

The writer inspected the sand tailings borrow area and found that subsequent to borrow operations an inadequate beach had been regraded inside the dikes. Mr. Oliver was infored that a graded beach with a minimum width of 100 feet would have to be provided before tailings were again discharged in the borrow area.

Ron E. Rager

REROUTING

LOCATION OF BORING



JOB NO.	CLIENT	LOCATION
05467-018	ATLAS MINERALS	MOAB, UT

DRILLING METHOD: BACKHOE

SAMPLING METHOD: HAND

BORING NO. TP-1

SHEET 1 OF 1

	DRILLING START	DRILLING FINISH
WATER LEVEL		
TIME	TIME 9 30	TIME 10 20
DATE	DATE 8-5-77	DATE 8-5-77
CASING DEPTH		

DATUM USGS ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH
						0	ML
						1	
						2	SM
			SAMPLE 1 @ 2.5-3.5'			3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

REDDISH BROWN SANDY SILT WITH COBBLES & OCCASIONAL BOULDER

SEEPING WATER BELOW BOULDER GRAY COLORATION

MOTTLED REDDISH BROWN AND GRAY SILTY FINE SAND TAILINGS MIXED WITH RED SAND

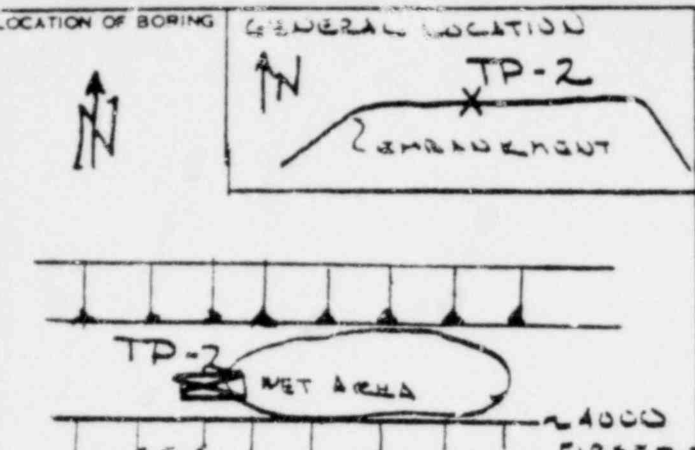
TEST PIT COMPLETED TO A DEPTH OF 8.0 FEET ON 8-5-77

CHK'D BY

DATE 8-5-77

0251 (3) (REV. 11-6)

LOCATION OF BORING	GENERAL LOCATION	JOB NO.	CLIENT	LOCATION
		05467-018	ATLAS MINERALS	MOAB UT



DRILLING METHOD: BACKHOE

SAMPLING METHOD: HAND

BORING NO. TP-2

SHEET 1 OF 1

DRILLING	START	FINISH
TIME	10:15	10:45
DATE	8/5	8/5

WATER LEVEL / TIME / DATE

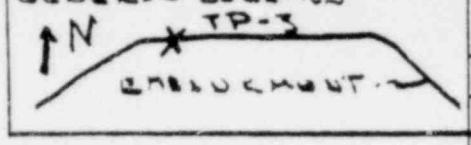
DATUM USGS ELEVATION FIRST ENCOUNTERED DEPTH

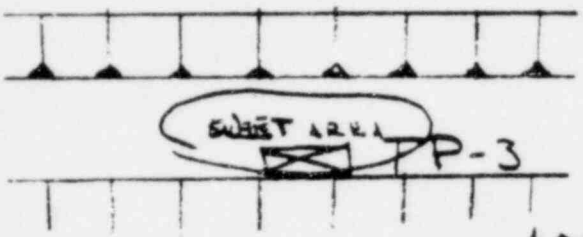
SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						0	SM-ML	REDDISH BROWN SILTY FINE TO COARSE SAND
						1		
SPL 1 @ 2.1 TO 2.8'						2		
						3		
						4	SM	GRAY FINE SAND WITH SOME SILT (SAND TAILINGS)
SPL 2 @ 4.7 TO 5.4'						5		- SATURATED
						6		
						7		
SPL 3 @ 7.5 TO 8.0'						8		TEST PIT COMPLETED TO A DEPTH OF 8.0 FEET ON 8-5-77.
						9		
						10		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

LOCATION OF BORING

GENERAL LOCATION





JOB NO.	CLIENT	LOCATION
05467-01B	ATLAS MINERALS	MOAB UT

DRILLING METHOD: BACKHOE

BORING NO. TP-3

SHEET 1 OF 1

SAMPLING METHOD: HAND

DRILLING

	START	FINISH
WATER LEVEL		
TIME	TIME 11:00	TIME 11:30
DATE	DATE 8/5	DATE 8/8

DATUM USGS ELEVATION 4000 FIRST BEARING

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	SM GM ML
						1	
						2	
						3	SM ML
SPL 1 @ 3.0-3.5'						4	
						5	
SPL 2 @ 5.5 TO 6.0'						6	
SPL 3 @ 4.2 TO 6.0 FEET						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

REDDISH BROWN SILT, GRAVEL AND SAND

SEEPING WATER

GRAY SILTY FINE SAND (SAND TAILINGS AND SLIMES)

TEST PIT COMPLETED TO A DEPTH OF 6.0 FEET ON 8-5-77

ACTION	INFO	
To: George Toland	Bill Badger	File: ✓ Atlas Minerals
Jim Boddy		05467-018
Jerry Wang		
		X-Ref: Page 1 of 1
		Date: August 12, 1977

From: R. E. Rager

Reply Required By:

Subject: Site Inspection #7

Reference(s):

The writer inspected the site of the western embankment. Sand Cove density tests were performed to verify correlation of the nuclear density machine used by Global Engineers. The elevation of red silty sand fill placement ranged from 4032 on the north to 4020 on the south.

The writer presented L. Oliver (Atlas) with preliminary plans for a drain to be installed along the seepage area of the north embankment. Construction began immediately with the excavation of a drainage ditch at this location.

Samples of the slime tailings were obtained from the pond area.

R. E. Rager

ROUTING

ACTION	INFO	
To: George Toland	Bill Badger	File ✓ Atlas Minerals
Jim Boddy		05467-018
Jerry Wang		
		X-Ref: Page 1 of 1
		Date: August 17, 1977

From: R. E. Rager

Reply Required By:

Subject: Site Inspection #8

Reference(s):

The writer inspected the western embankment. Additional sand cone densities of the red silty sand shell were obtained. Construction continues with the fill reaching elevations ranging from 4040 on the north to 4026 on the south.

A final drain section was presented to Atlas for the north embankment seepage area. No further progress has been made in this area since the last visit.

R. E. Rager

ROUTING

ACTION	INFO	
To: George Toland	Bill Badger	File: Atlas Minerals
Jim Boddy		05467-018
Jerry Wang		
		X-Ref: Page 1 of 1
		Date: August 26, 1977

From: R. E. Rager

Reply Required By:

Subject: Site Inspection No. 9

Reference(s):

The writer arrived at the Salt Lake City Airport at 7:00 A.M. for a charter flight to Moab. Due to severe thunderstorms the flight was cancelled. The writer will attempt to visit the site the following Monday.

R. E. Rager

RER/ph

ROUTING

FIELD MEMORANDUM

ACTION	INFO	
To: George Toland	Bill Badger	File: Atlas Minerals
Jim Boddy		05467-018
Jerry Wang		
		X-Ref: Page 1 of 1
		Date: August 26, 1977

From: R. E. Rager

Reply Required By:

Subject: Site Inspection #10

Reference(s):

The writer inspected the western embankment construction and the north embankment seepage drain installation. Construction of the western embankment is complete from stations 6+00 to 12+00 with the height of fill decreasing to elevation 4027 feet at station 24+00. Density tests continue to indicate that adequate compaction is being obtained.

The north embankment seepage drain trench has been excavated to final grade. Hand cleaning of the excavation is underway.

R. E. Rager

RER/ph

ROUTING

FFICE MEMORANDUM

ACTION	INFO	
George Toland	Bill Badger (Atlas)	File: 05467-018 Atlas Minerals Moab, Utah
		X-Ref: Page 1 of 1
		Date: September 9, 1977

om: Ronald Rager

Reply Required By:

bject: Site Inspection #11

Reference(s):

The writer inspected the tailings pond embankment remedial construction activities today. The western embankment is completed to Station 16+00, and decreases to approximately six feet below grade at Station 23+40. In-place density tests continue to indicate good compaction. Global Engineers has removed their nuclear tester and are using Dames & Moore's sand cone. Construction of the western embankment should be completed in one or two days.

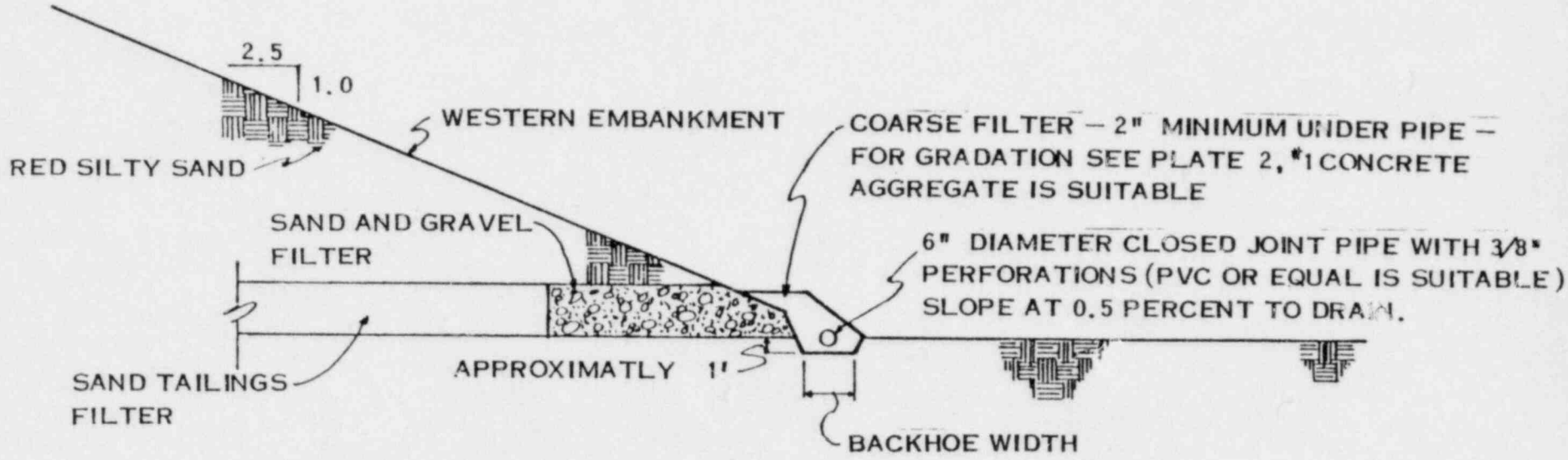
Construction on the north embankment subdrain is 50% complete. Progress is slow, but the final product will conform to our specifications.

Ronald E. Rager

ROUTING

1:4.7L (REV. 5/68)

DAMES & MOORE



WESTERN EMBANKMENT
SUB-DRAIN COLLECTOR - TYPICAL

FIELD MEMORANDUM

ACTION	INFO	
To: George Toland Ron Rager		File: Atlas Minerals 05467-018-06
		X-Ref:
		Date: July 7, 1977

From: Jim Boddy

Reply Required By:

Subject: Site Inspection

Reference(s):

The purpose of this memorandum is to document the items discussed and describe the field work pertaining to the remedial construction work. Reference is made to Atlas Minerals' letter to NRC of June 24, 1977, containing the Design Criteria for Improvements of Tailings Disposal System at Atlas Minerals Milling Operations, Moab, Utah.

The writer inspected the construction work that had been accomplished from the period starting June 21 and continuing at the time of the site visit. During this time the dike along the west side of the tailings pond had been built up with material taken from the near surface at the northwest corner of Atlas' property. The material is a reddish brown silty sand/sandy silt containing an estimated 40 to 60 percent of particles passing the No. 200 sieve size. The embankment material was placed by end dumping from trucks and by large scraper units. A track type dozer leveled off the material and compacted it by its own weight. The side slopes (both upstream and downstream) were being placed at one and one-half to one (horizontal to vertical). Some slumping was noted over a section of about 100 feet where the dike material was being placed directly on the slime materials. The writer felt this was not effecting the overall stability and with time the underlying slime will consolidate. This area is to be compacted and smoothed off.

ROUTING

FIELD MEMORANDUM

ACTION	INFO	
To: George Toland Ron Rager		File: Atlas Minerals 05467-018-06
		X-Ref:
		Date: July 7, 1977

From: Jim Boddy

Reply Required By:

Subject: Site Inspection

Reference(s):

At the time of inspection the crest elevation was near 4,040 feet (the desired elevation of the crest). During the week ending July 8, grade stakes will be placed and the crest will be finished off smooth. The surveying will be done by John Keogh, Registered Land Surveyor. Further, cross-sections will be surveyed to determine the configuration of the embankment section.

On July 5, it was determined that placement of gravel rip-rap material would begin on the upstream face of the embankment. The material will come from a borrow pit in Moab. The material is estimated to have 10 to 15 percent passing the No. 200 sieve and any pieces larger than one foot in diameter will be removed.

Some in place moisture-density tests were performed prior to the writer's visit. Results of the tests are presented in the attached letter.

The contractor will be hauling a stockpile of the river run gravel material and setting up a screen. The attached gradation curve shows the gradational limits of the gravel blanket drain material to be placed at the toe of the downstream embankment slope. It is believed that gravel from the Eldon Ray gravel pit just east of Moab will fall within the limits, provided a three inch screen is used to screen off the larger cobble size pieces.

ROUTING

FIELD MEMORANDUM

ACTION	INFO	
To: George Toland Ron Rager		File: Atlas Minerals 05467-018-06
		X-Ref:
		Date: July 7, 1977

From: Jim Boddy

Reply Required By:

Subject: Site Inspection

Reference(s):

It was agreed that once the cross-sections were surveyed, Dames and Moore would provide Atlas with a relatively accurate quantity estimate. Further, Dames and Moore would provide Atlas with more detailed recommendations pertaining to tailings placement.

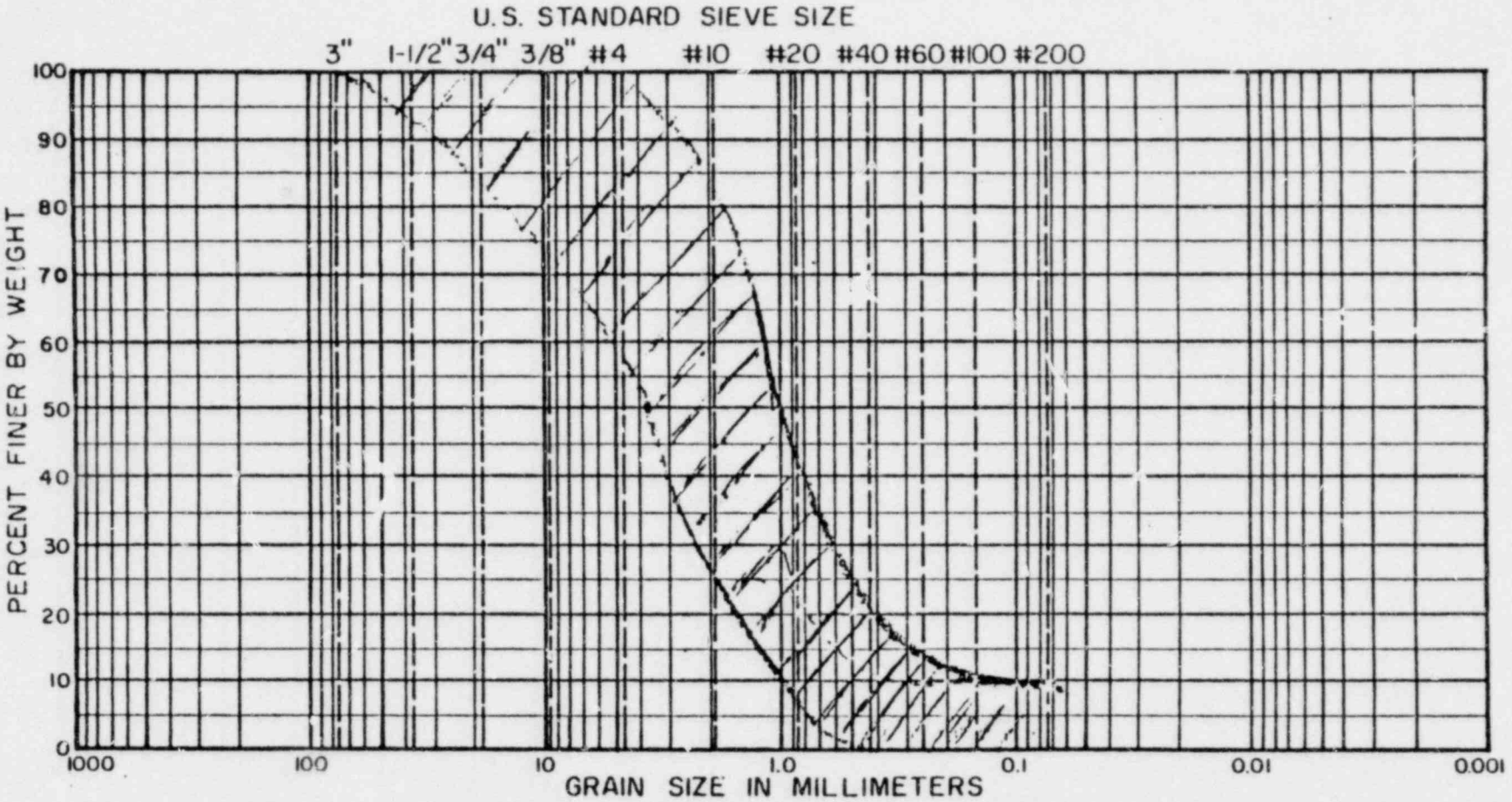
Jim Boddy

JB/nb

Attachments

cc: Bill Badger

ROUTING



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LOCATION	DEPTH	CLASSIFICATION
		SPECIFICATIONS FOR GRAUEL TOE DRAIN

NOTE :- MATERIAL IS TO BE WELL GRADED

PLATE

DAMES & MOORE

Atlas Minerals
Division of Atlas Corporation
P.O. Box 1207 Moab, Utah 84532

June 24, 1977

United States Nuclear Regulatory
Commission
Washington, D.C. 20555

Attention: Leland C. Rouse, Chief
Fuel Processing & Fabrication Branch
Division of Fuel Cycle and
Material Safety

Gentlemen:

Atlas Minerals is hereby requesting that Source Material License SUA-917, Docket No. 40-3453, be amended to incorporate the enclosed tailings pond design modifications and changes in operating controls. Modifications to the embankment system will begin immediately and be complete within 90 days. A qualified geotechnical engineer will inspect the construction of the embankment modifications on a weekly basis.

Further, operation of the resin-in-pulp circuit will be discontinued and there will be no discharge of tailings effluent to the Colorado River.

Very truly yours,

William P. Badger
General Superintendent

WPB:mb

Enclosure

DESIGN CRITERIA FOR IMPROVEMENTS OF TAILINGS DISPOSAL SYSTEM AT ATLAS MINERALS MILLING OPERATIONS, MOAB, UTAH

The design criteria for the improvements of tailings pond is to include (1) modifications of the embankment section along the western edge of the tailings pond; (2) construction of an overburden fill to be placed at the seepage area located along the north embankment toe; and (3) a freeboard requirement for the entire embankment perimeter and a minimum crest-to-pond-water-edge distance at all embankment areas other than the western embankment area.

Western Embankment Section

Along the western embankment area of the tailings pond the design criteria for improvements are shown on Figure 1 and include the following:

1. A minimum freeboard requirement of 6 feet must be met at all locations.

2. A 2-foot minimum cover of rip-rap material is required for wave-erosion protection over the entire upstream slope. The material will consist of well-graded river run gravel with pieces of a maximum size of one foot.

3. A crest width of 20 feet must exist at all embankment sections.

4. Beach sand tailings will be placed against the upstream slope and along the natural ground surface adjacent to the existing toe of embankment slope with the dimensions as shown on Figure 1. The tailings fill material will have particle sizes such that there will be no greater than 7% by weight passing the No. 200 sieve.

5. Filter material of river run gravel with gradation sizing designed in accordance with U.S. Corp of Engineers criteria. The dimensions of placement will be as shown on Figure 1.

6. Overburden material will be placed over the beach sand with minimum cover of 8 feet. The overburden will be of natural near-site sand and silt and will be placed to the dimensions shown on Figure 1. The fill should be placed in 12 inch lifts (loose state) and compacted to a dry density of at least 90% of the maximum density as determined by the AASHTO T-99 method of compaction.

Seep Area at North Embankment Area

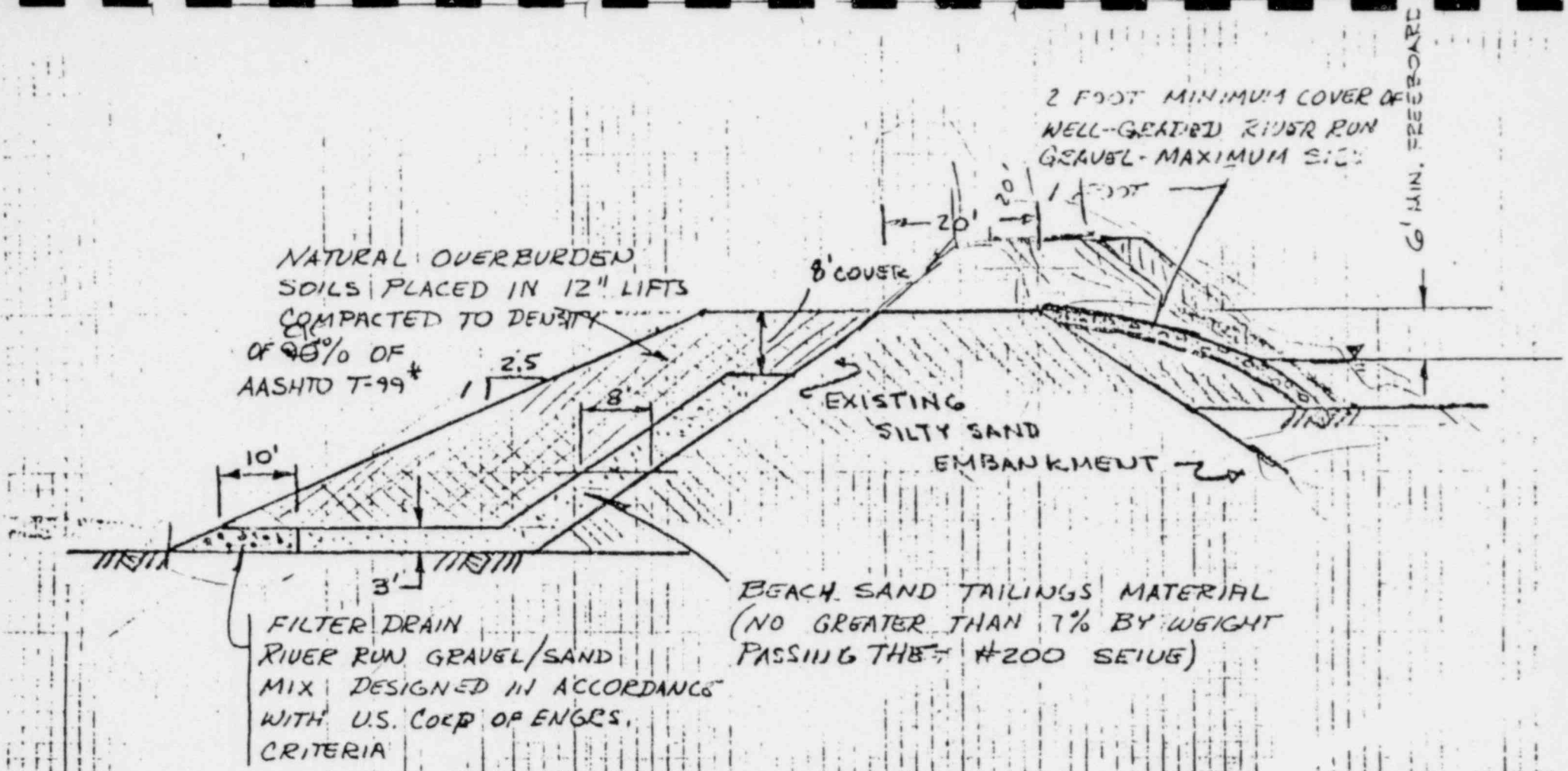
Construction of an overburden fill will be placed over the seepage area located at the north embankment toe. The construction requirements and dimensions are shown on Figure 2 and include the following:

1. An overburden fill of well-graded river run gravel will be placed over the seep area a distance of at least 50 feet in all directions from the seep. The minimum fill thickness of 5 feet will be met over the above stated area. The maximum particle size of the material will be one foot.

2. A perforated drain pipe will be placed as shown on Figure 2 and drained by pipe to a sump pumpback system located near the downstream toe of slope.

Operational Requirements for Ponded Liquids

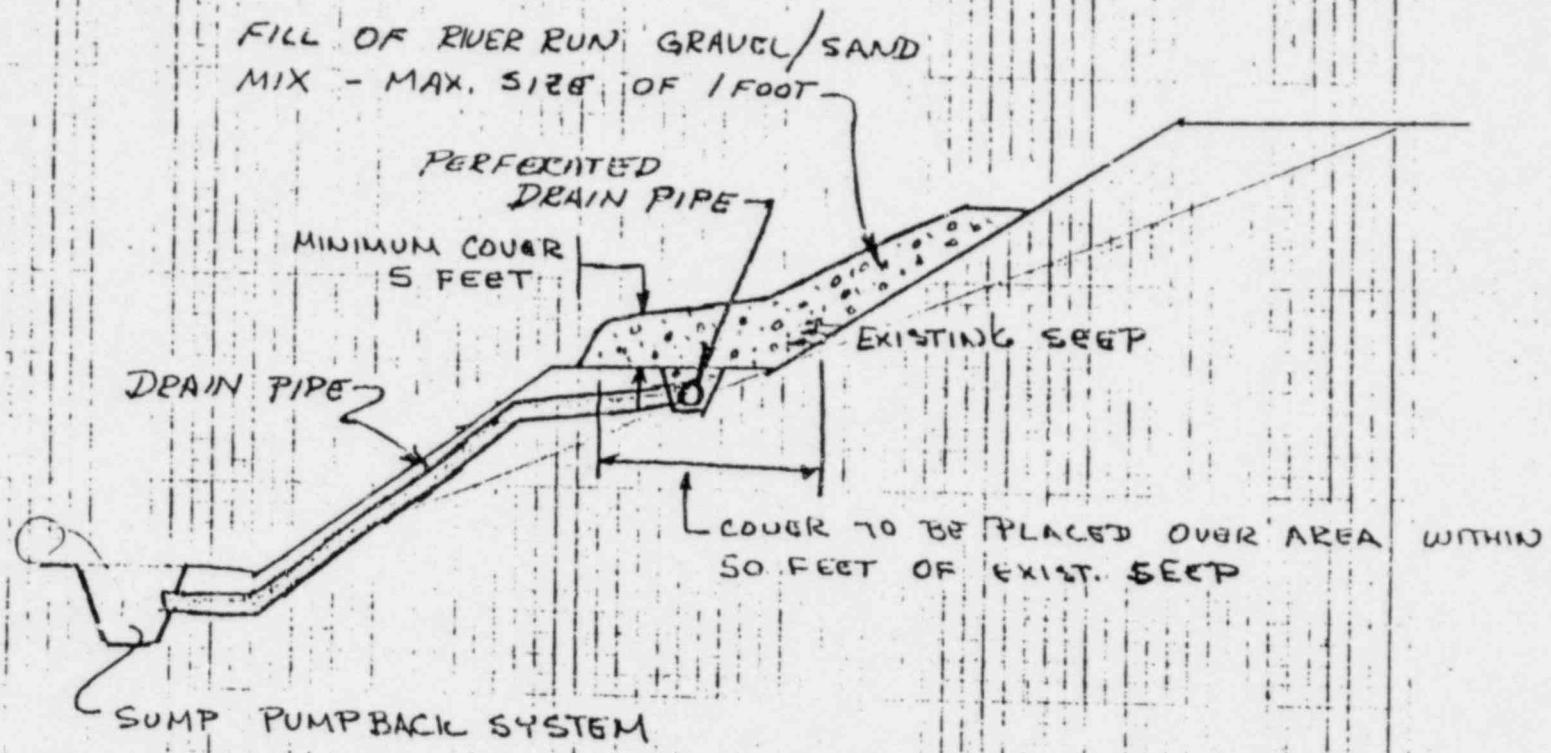
The operational requirements for the ponded liquids will be such that a minimum freeboard of 6 feet must be maintained at all locations along the embankment crest. Along the embankment other than the west embankment area a minimum distance of 150 feet from the crest-of-the-embankment to the edge-of-water must be maintained. The rip-rap material along the western embankment must extend at least 50 feet into the beach areas on either side of the water retention embankment.



AASHTO T-99 METHOD OF COMPACTION

TYPICAL SECTION -
WEST EMBANKMENT AREA

Figure 1



OVERBURDEN CONSTRUCTION TO BE PLACED AT SEEP - NORTH EMBANKMENT AREA

Figure 2

PHOTOGRAMMETRY & ENGINEERING

P.O. Box 491 Grand Junction, Colorado 81501 / Ph. 242 5354

July 1, 1977

Mr. Bill Badger
Atlas Minerals
Moab, Utah 84532

Attached is a summary of test results taken at the Settling Pond Dike.

The in-place moisture-density tests were done with a Troxler, Model 3401, Moisture-Density Gauge. All tests were performed using a 8" probe depth. All tests were done by me.

Frank A. Brown
Professional Engineer

FB/ch

SUMMARY & CONCLUSIONS

The native material being used to compact the dike is typical of the soil found around the plant site. It is readily compacted by a combination of vibratory compaction equipment and rubber tire rollers. The material is very sensative to moisture and considerable less compactive effort is needed if the moisture is brought to the optimum level. Therefore it behooves both the owner and contractor to apply enough water for compaction.

The native soil will show considerably greater density than laboratory tests indicate it even a small portion of rock or gravel is present.

The author was not present to observe the placement of materials in the lower levels of the dike and therefore can reach no conclusions as to stability, etc.

SUMMARY OF TEST RESULTS

Test Location	In-Place Density (lbs.per cu. ft.)		In-Place Moisture Content		Percent Relative Compaction
	Wet	Dry	lbs.per cu.ft.	Percent	
1. Sta 1+00 at Center Line	137.25	128.75	8.5	6.6	116
Sta 2+00 at 7' L. Center Line	140.25	128.50	11.75	9.1	116
Sta 3+00 at 6' RT Center Line	137.00	130.50	6.50	5.0	118
Sta 4+00 at Center Line	127.00	117.25	9.75	8.3	105
Sta 5+00 at 5 lt. Center Line	125.5	121.00	4.50	3.7	109

1. Stationing starts at boot ramp and goes in a southerly direction along dike.

2. The laboratory standard for optimum density and moisture supplied by others.

REPORT OF EARTHWORK OBSERVATIONS AND FIELD CONTROL TESTING ALTERATION OF TAILINGS DAM - SIX-FOOT EMBANKMENT RAISE MOAB MILL MOAB, UTAH FOR ATLAS MINERALS CORPORATION

Dames & Moore Job No. 05467-022-06
Salt Lake City, Utah
January 15, 1979

January 15, 1979

Atlas Minerals
P. O. Box 48
Moab, Utah 84532

Attention: Mr. Richard Adrian

Gentlemen:

Report of Earthwork Observations
And Field Control Testing
Alteration of Tailings Dam -
Six-Foot Embankment Raise
Moab Mill
Moab, Utah
For Atlas Minerals Corporation

INTRODUCTION

This report summarizes our field observations and control testing and presents our conclusions regarding construction of the six-foot embankment raise. The tailings dam is shown on Plate 1, Plot Plan, with the new embankment and the location of 12 post-construction sections. The approximate limits of the borrow area are also shown on Plate 1.

Dames & Moore prepared the plans and specifications* for the project. Significant departures from the plans and specifications are discussed herein.

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* "Specifications for Atlas Minerals, Alterations of Tailings Dam, Six-Foot Embankment Raise, Moab Mill, Moab, Utah," dated July 11, 1978.

EARTHWORK OBSERVATION AND FIELD CONTROL TESTING SERVICES

The full-time earthwork technician for the project was Mr. Brad Shepherd of American Testing Laboratories, Inc., of Salt Lake City. American Testing was under subcontract to Dames & Moore. American Testing's services began with the commencement of earthwork operations on August 1, 1978 and extended through to the completion of construction on September 8 1978.

Mr. Shepherd's responsibilities were outlined in discussions between representatives of Atlas Minerals and Dames & Moore. Mr. Shepherd's purpose was to observe the construction activities and make the necessary field control tests to determine if the embankment raise was being constructed in accordance with the plans and specifications. Daily written reports summarizing the field control test results and the project status were prepared by Mr. Shepherd. The reports were distributed to Atlas Minerals Corporation, Dames & Moore and the contractor, H-E Lowdermilk Company.

Mr. Robert Owen was Dames & Moore's project engineer. Mr. Owen made approximately weekly site visits during construction to answer technical questions and to review the results of the field control tests and observations made by Mr. Shepherd. Weekly progress reports were prepared by Mr. Owen and submitted to Atlas Minerals Corporation.

CONCLUSIONS

Based upon our observations and materials testing, we conclude that the six-foot embankment raise was constructed in accordance with good construction practices and in accordance with the intent of the plans and specifications. The post-construction sections on Plate 2 show that the embankment

sideslopes, crest width and location are generally as called for in the plans and specifications. The fill material used to construct the embankment was as specified and was placed meeting the compaction requirements.

EMBANKMENT CONSTRUCTION

SURVEYING

A stationing system was established by the contractor to provide survey control for the embankment construction. Initially, the toes of the embankment addition (both inboard and outboard toes) were staked at least every 100 feet and fill requirements were written on the stakes. To monitor the fill progress and to establish additional fill requirements, periodic surveys were performed during construction. All field control tests were located using this survey reference.

FOUNDATION PREPARATION, FILL PLACEMENT AND COMPACTION

Between approximately Station 0+00 and 20+00, the reddish-brown, silty sand foundation (existing embankment) was scarified and compacted to the requirements for compacted fill. The remainder of the embankment raise was constructed on the tailings sand beach where scarification and compaction prior to fill placement was not possible due to the inability of the tailings sand to support the construction equipment. To construct the embankment addition on the beach, scrapers would haul and dump fill material on nearby firm ground and dozers would push the fill out onto the beach. This process resulted in an initial lift which varied from 8 to 24 inches.

The fill material was brought to near-optimum moisture content by sprinkling in the borrow pit. Scrapers transported

the fill to the tailings pond where it was spread generally in eight-inch loose lifts. Additional moisture was added if needed by sprinkling the placed fill with a water truck. The compactive effort was generally accomplished by running loaded and unloaded scrapers across the fill. A sheeps-foot roller was used when the embankment crest became so narrow that the scrapers were unable to cover the entire fill surface effectively.

Where the embankment abuts the natural red sandy surface soils near Station 73+00, the existing steep slopes were benched and the fill material was well keyed into the abutment for each lift such that no loose zones remained. This was to provide an adequate tie between the natural soils and the new construction.

FIELD CONTROL TEST RESULTS

GENERAL

Four types of soil tests were used for the technical control to check for compliance with the material and compaction specifications given in the project plans. The four tests are:

1. Sieve analyses.
2. Compaction tests.
3. Nuclear Meter Method of determining in-place moisture and density.
4. Sand Cone Method of determining in-place moisture and density.

SIEVE ANALYSES

The project plans specify that the fill material should be a reddish-brown, fine to coarse sand with 0 to 40 percent silt or clay size particles and 0 to 5 percent gravel size particles.

The results of the sieve analyses performed on material used for embankment construction are tabulated below.

Test Number	Percent Silt Or Clay Size Particles Passing The No. 200 Sieve	Percent Passing The 3/4-Inch Sieve
1	7.4	98.6
2	8.0	99.4
3	7.1	95.5
4	7.3	97.1
5	6.3	95.1

COMPACTION TESTS

The project plans specify that the foundation soils and embankment fill should be compacted to 95 percent of the maximum dry density as defined by the AASHTO* T-99 Method of Compaction. A total of nine compaction tests were performed during the course of construction. The tests were distributed among the three materials as follows:

- Five Compaction Tests - Red Silty Sand Embankment Fill
- Two Compaction Tests - Red Silty Sand Foundation Soils
- Two Compaction Tests - Tailings Sand Foundation Soils

The compaction curves resulting from these tests are shown on Plates 3A through 3C.

NUCLEAR AND SAND CONE IN-PLACE MOISTURE AND DENSITY TESTS

The in-place moisture and density of the compacted soil was measured using a nuclear moisture and density meter, with

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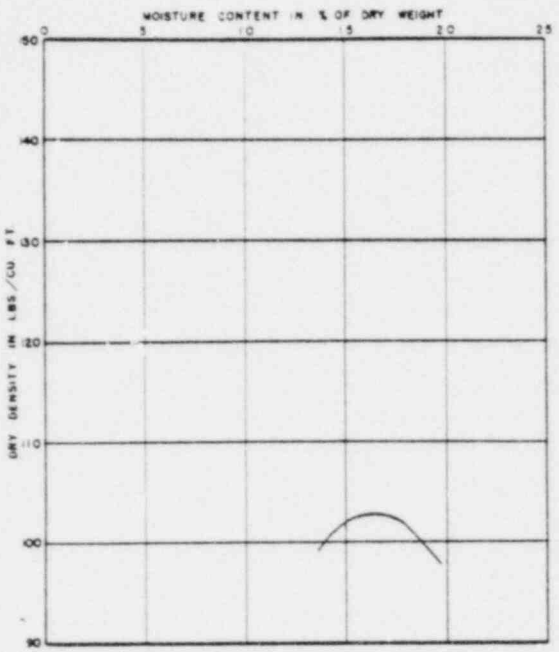
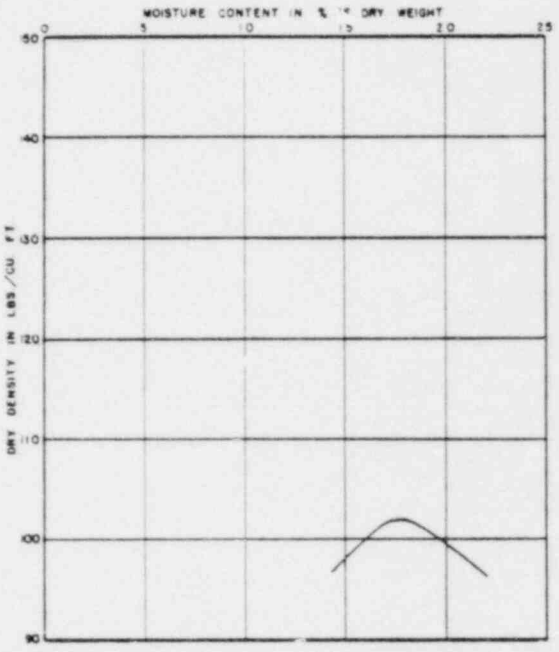
* American Association of State Highway and Transportation Officials.

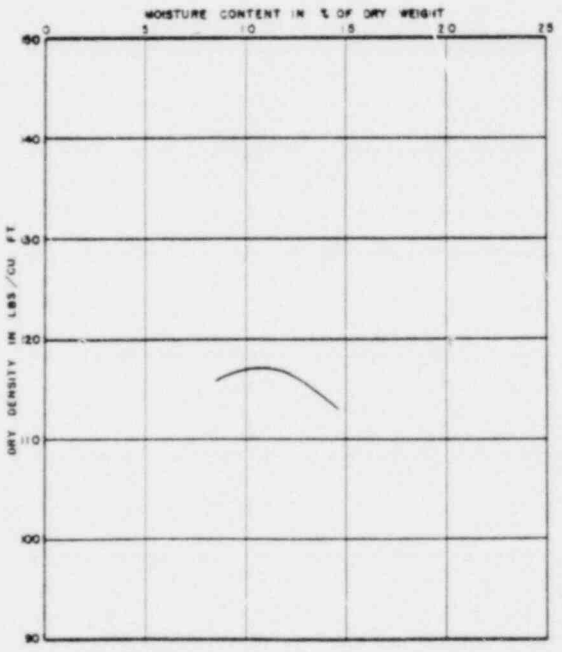
SOIL GRAY TAILINGS SAND
LOCATION BEACH, NEAR STATION 26+50
OPTIMUM MOISTURE CONTENT 16.5 PERCENT
MAXIMUM DRY DENSITY 103 LBS. PER CUBIC FOOT
METHOD OF COMPACTION A.A.S.H.T.O. T-99



SOIL GRAY TAILINGS SAND
LOCATION BEACH, NEAR STATION 43+50
OPTIMUM MOISTURE CONTENT 17.5 PERCENT
MAXIMUM DRY DENSITY 102 LBS. PER CUBIC FOOT
METHOD OF COMPACTION A.A.S.H.T.O. T-99



SOIL REDDISH-BROWN SILTY SAND
LOCATION FOUNDATION, NEAR STATION 43+00
OPTIMUM MOISTURE CONTENT 11.0 PERCENT
MAXIMUM DRY DENSITY 117 LBS. PER CUBIC FOOT
METHOD OF COMPACTION A.A.S.H.T.O. T-99



COMPACTION TEST DATA

DAMES & MOORE

PLATE 30

SUMMARY OF IN-PLACE DENSITY TESTS

TEST NUMBER 3/	DATE 1978	LOCATION 1/	ELEVATION	MAX. DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS 2/
Red Silty Sand Foundation									
1	8/2	6+04 (25)	4039.5	128.0	95	9.8	123.5	97	P
2	"	2+04 (30)	4039.0	"	"	8.5	125.8	99	P
3	"	11+00 (18)	4039.5	"	"	6.6	123.8	97	P
4	"	16+02 (20)	4038.5	"	"	7.7	122.0	96	P
5	"	19+06 (35)	4039.0	"	"	8.2	127.5	100	P
Tailings Sand Foundation									
1	2/3	24+90 (25)	4037.0	103.0	95	7.8	98.2	95	P
2	"	28+80 (15)	"	"	"	4.3	98.2	95	P
3		[illegible]70 (10)	4038.0	"	"	5.6	98.5	96	P
4		[illegible]+30 (20)	"	"	"	7.6	88.8	86	F-R
5	2/16	43+00 (30)	4038.5	"	"	10.0	92.5	90	F-R
6	9/5	49+50 (30)	4037.0	"	"	9.6	95.0	92	F-R
Red Silty Sand Embankment Fill									
1	8/3	4+02 (25)	4040.0	117.3	95	9.7	119.2	100	P
2	"	8+12 (15)	4039.5	"	"	8.6	116.2	99	P
3	"	12+09 (35)	4040.0	"	"	8.9	118.0	100	P
4	"	16+21 (20)	4039.5	"	"	9.1	120.0	100	P
5	"	19+16 (30)	"	"	"	8.6	116.0	99	P
6	"	24+90 (25)	4038.0	"	"	10.0	121.0	100	P
7	"	26+40 (25)	4037.5	"	"	4.3	118.2	100	P
8	"	26+40 (25)	4037.0	"	"	8.7	114.8	98	P
9	"	28+80 (15)	4039.5	"	"	6.2	121.3	100	P
10	"	31+02 (15)	4038.0	"	"	7.8	118.7	100	P
11	"	32+20 (12)	4039.0	"	"	6.3	115.0	98	P
12	"	32+25 (26)	4038.5	"	"	7.6	120.3	100	P
13	8/4	32+80 (16)	4039.0	"	"	6.4	123.2	100	P
14 *	"	32+80 (16)	"	"	"	6.4	123.6	100	P
15	8/7	2+04 (35)	4041.5	"	"	9.9	115.5	98	P
16 *	"	2+04 (35)	"	"	"	9.5	116.7	99	P
17	"	7+01 (15)	4042.0	"	"	8.1	114.5	98	P
18	"	11+20 (25)	4041.4	"	"	9.1	118.3	100	P

1/ 6+04 is the station number and (25) is the approximate distance in feet from the inside toe of the completed embankment.

2/ P-Passed F-Failed R-Received additional working and compaction.

3/ Tests performed using nuclear moisture & density meter except those with an * which were using the sand cone method.

DAMES & MOORE

Plate 4A

SUMMARY OF IN-PLACE DENSITY TESTS

TEST NUMBER	DATE 1978	LOCATION	ELEVATION	MAX. DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
19	8/7	19+20 (45)	4041.0	117.3	95	8.6	118.3	100	P
20	"	26+50 (10)	4040.0	"	"	10.1	116.8	99	P
21	"	31+50 (50)	"	"	"	10.5	117.8	100	P
22	"	3+90 (20)	4042.0	"	"	8.3	116.8	99	P
23	"	12+10 (40)	"	"	"	9.6	118.6	100	P
24	"	26+20 (30)	4040.5	"	"	8.9	116.3	99	P
25	"	30+45 (45)	4040.0	"	"	10.3	117.0	100	P
26	8/8	6+80 (45)	4042.0	"	"	11.3	115.0	98	P
27	"	18+20 (20)	"	"	"	9.9	116.5	99	P
28	"	31+00 (10)	4041.0	"	"	8.0	115.3	98	P
29	"	1+70 (15)	4043.0	"	"	9.4	120.3	100	P
30 *	"	1+70 (15)	"	"	"	9.2	119.5	100	P
31	"	17+30 (40)	4042.5	"	"	8.8	117.5	100	P
32	"	30+00 (10)	4041.0	"	"	10.1	119.5	100	P
33	"	4+04 (25)	4043.0	"	"	11.8	118.5	100	P
34	"	19+00 (10)	4042.5	"	"	9.5	119.5	100	P
35	"	28+00 (35)	4041.5	"	"	9.2	114.0	97	P
36	8/9	2+50 (40)	4043.5	"	"	8.9	124.5	100	P
37	"	18+08 (30)	"	"	"	8.5	121.0	100	P
38	"	31+02 (30)	4042.0	"	"	8.6	122.5	100	P
39*	"	31+02 (30)	"	"	"	8.3	125.3	100	P
40	"	6+04 (25)	4044.0	"	"	8.4	124.5	100	P
41	"	17+50 (50)	"	"	"	10.2	115.3	99	P
42	"	3+90 (10)	4042.5	"	"	11.5	120.0	100	P
43	"	2+20 (40)	4044.3	"	"	8.8	117.7	100	P
44	"	17+90 (25)	"	"	"	7.9	121.0	100	P
45	"	32+20 (30)	4043.8	"	"	8.6	123.0	100	P
46	8/10	2+90 (15)	4044.4	"	"	8.6	119.3	100	P
47	"	17+00 (10)	4044.0	"	"	8.2	119.5	100	P
48	"	32+50 (35)	4043.5	"	"	9.1	120.5	100	P
49	"	2+00 (30)	4044.5	"	"	8.6	117.5	100	P
50*	"	2+00 (30)	"	"	"	8.9	118.3	100	P
51	"	19+20 (20)	"	"	"	9.2	117.6	100	P
52	"	31+80 (35)	4043.7	"	"	8.3	115.5	98	P

SUMMARY OF IN-PLACE DENSITY TESTS

TEST NUMBER	DATE 1978	LOCATION	ELEVATION	MAX. DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
53	8/10	6+50 (30)	4044.8	117.3	95	7.9	116.6	100	P
54	"	18+50 (15)	4044.5	"	"	10.0	116.9	100	P
55	"	32+80 (50)	4044.0	"	"	8.9	117.0	100	P
56	8/11	2+50 (35)	4044.8	"	"	8.9	120.0	100	P
57	"	17+20 (20)	4044.8	"	"	9.2	116.8	100	P
58	"	32+30 (30)	4044.0	"	"	7.9	117.0	100	P
59 *	"	32+30 (30)	"	"	"	8.3	117.9	100	P
60	"	24+40 (40)	4044.1	"	"	8.6	108.6	93	F-R
61	"	24+10 (35)	4044.1	"	"	8.4	116.8	100	P
62	"	22+10 (30)	4044.2	"	"	9.9	106.0	91	F-R
63	8/14	6+00 (10)	4044.4	"	"	8.3	115.9	99	P
64	"	17+40 (30)	4044.6	"	"	8.6	166.3	99	P
65	"	22+95 (20)	4043.6	"	"	8.5	117.0	100	P
66 *	"	22+95 (20)	4043.6	"	"	8.3	117.7	100	P
67	"	32+00 (35)	4043.3	"	"	7.6	112.5	96	P
68	"	25+20 (40)	4043.0	"	"	7.3	114.8	98	P
69	"	31+00 (25)	4043.0	"	"	10.0	114.5	98	P
70	"	23+10 (35)	4043.8	"	"	9.5	119.3	100	P
71	"	31+50 (25)	4044.0	"	"	7.9	115.8	99	P
72	8/15	22+20 (30)	4044.5	"	"	6.6	119.8	100	P
73	"	26+25 (35)	4044.0	"	"	6.9	121.8	100	P
74 *	"	26+25 (35)	4044.0	"	"	6.4	123.4	100	P
75	"	30+00 (25)	4044.0	"	"	8.4	115.8	99	P
76	8/16	37+00 (40)	4040.5	"	"	10.2	119.5	100	P
77	"	37+00 (40)	4039.5	"	"	7.0	115.5	99	P
78	"	43+00 (30)	4039.5	"	"	10.2	115.3	98	P
79	"	4+30 (25)	4045.0	"	"	8.4	115.5	99	P
80	"	17+10 (30)	4045.0	"	"	9.9	116.8	100	P
81	"	17+15 (30)	4045.0	"	"	9.8	115.5	99	P
82	"	28+60 (35)	4044.0	"	"	8.7	116.5	99	P
83	"	37+50 (30)	4041.0	"	"	9.8	120.8	100	P
84	"	43+90 (25)	4040.5	"	"	9.6	118.3	100	P
85	"	36+20 (15)	4041.0	"	"	8.9	119.8	100	P
86	"	40+25 (30)	4040.8	"	"	9.1	117.6	100	P

SUMMARY OF IN-PLACE DENSITY TESTS

TEST NUMBER	DATE 1978	LOCATION	ELEVATION	MAX. DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
87	8/17	4+50 (30)	4045.0	117.3	95	6.9	118.3	100	P
88	"	16+60 (25)	4045.0	"	"	7.1	119.5	100	P
89	"	22+80 (30)	4045.0	"	"	8.8	120.5	100	P
90	"	31+30 (25)	4044.8	"	"	8.8	117.7	100	P
91	"	38+50 (26)	4041.6	"	"	7.9	114.0	97	P
92	"	[illegible]+50 (40)	4040.9	"	"	9.0	115.2	98	P
93	"	23+10 (35)	4045.4	"	"	9.2	113.5	97	P
94	"	31+90 (35)	4045.4	"	"	7.4	114.5	98	P
95	"	39+30 (30)	4042.0	"	"	8.4	119.8	100	P
96 *	"	39+30 (30)	4042.0	"	"	8.1	120.9	100	P
97	"	42+20 (30)	4041.2	"	"	8.6	117.6	100	P
98	"	37+50 (25)	4040.6	"	"	7.0	118.3	100	P
99	"	41+30 (20)	4041.6	"	"	7.4	117.2	100	P
100	"	25+00 (25)	4042.8	"	"	8.2	118.0	100	P
101	"	30+56 (36)	4041.9	"	"	7.9	116.9	99	P
102	8/13	38+50 (30)	4042.9	"	"	8.4	120.3	100	P
103	"	43+20 (20)	4041.9	"	"	7.9	119.8	100	P
104	"	43+20 (20)	4041.9	"	"	7.9	120.9	100	P
105	"	6+50 (25)	4045.3	"	"	9.4	116.8	100	P
106	"	16+10 (30)	4045.0	"	"	10.1	119.3	100	P
107	"	28+00 (40)	4045.3	"	"	7.6	115.9	99	P
108	"	39+00 (38)	4043.1	"	"	8.3	114.8	98	P
109	"	42+00 (10)	4042.1	"	"	8.7	118.0	100	P
110	"	38+50 (30)	4043.0	"	"	9.3	116.0	99	P
111	"	42+75 (40)	4043.0	"	"	8.4	117.4	100	P
112	8/21	8+00 (20)	4046.0	"	"	9.9	119.6	100	P
113 *	"	8+00 (20)	4046.0	"	"	9.1	121.3	100	P
114	"	28+30 (25)	4045.0	"	"	8.6	117.6	100	P
115	"	31+00 (35)	4045.4	"	"	10.0	118.9	100	P
116	"	24+00 (30)	4045.8	"	"	9.4	116.9	100	P
117	"	39+50 (30)	4043.6	"	"	9.0	118.3	100	P
118	"	42+30 (35)	4043.8	"	"	8.9	117.3	100	P
119	"	40+10 (40)	4044.2	"	"	8.3	116.5	99	P
120	8/22	36+80 (30)	4043.9	"	"	8.9	117.2	100	P

SUMMARY OF IN-PLACE DENSITY TESTS

TEST NUMBER	DATE 1978	LOCATION	ELEVATION	MAX. DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
121	8/22	42+30 (35)	4044.0	117.3	95	9.5	118.3	100	P
122 *	"	42+30 (35)	4044.0	"	"	9.0	118.9	100	P
123	"	37+10 (25)	4044.2	"	"	9.6	117.6	100	P
124	"	43+50 (30)	4044.3	"	"	8.3	116.9	100	P
125	"	39+10 (40)	4044.6	"	"	10.0	117.5	100	P
126	"	43+10 (35)	4044.8	"	"	8.9	119.6	100	P
127	8/23	38+00 (30)	4044.9	"	"	10.0	119.6	100	P
128 *	"	38+00 (30)	4044.9	"	"	9.6	121.3	100	P
129	"	43+00 (25)	4045.0	"	"	11.0	118.7	100	P
130	"	39+50 (35)	4045.2	"	"	8.9	117.6	100	P
131	"	42+10 (30)	4045.3	"	"	9.3	118.9	100	P
132	8/24	37+00 (25)	4045.7	"	"	9.3	117.6	100	P
133	"	43+00 (35)	4045.7	"	"	8.7	118.3	100	P
134 *	"	43+00 (35)	4045.7	"	"	8.6	118.9	100	P
135	"	4+00 (20)	4046.0	"	"	10.0	119.6	100	P
136	"	18+50 (30)	4046.0	"	"	8.9	118.3	100	P
137	"	24+90 (35)	4046.0	"	"	9.2	117.9	100	P
138	"	30+10 (20)	4046.0	"	"	8.3	119.0	100	P
139	8/25	36+10 (30)	4046.0	"	"	9.3	117.4	100	P
140	"	41+50 (25)	4046.0	"	"	9.6	118.6	100	P
141	"	41+50 (25)	4046.0	"	"	9.0	119.3	100	P
142	8/28	70+50 (40)	4040.0	"	"	8.3	118.5	100	P
143	"	64+50 (30)	4039.5	"	"	8.1	121.0	100	P
144	"	59+10 (25)	4039.5	"	"	8.8	119.8	100	P
145	"	59+10 (25)	4039.5	"	"	8.1	121.3	100	P
146	"	56+80 (15)	4041.0	"	"	8.9	117.3	100	P
147	"	69+50 (25)	4040.4	"	"	8.2	118.3	100	P
148	"	69+70 (20)	4040.0	"	"	8.3	117.5	100	P
149	8/29	68+80 (40)	4039.6	"	"	8.9	115.6	100	P
150	"	68+80 (40)	4038.9	"	"	9.3	126.4	100	P
151	"	68+80 (40)	4038.0	"	"	6.9	95.5	93	F-R
152	"	58+50 (15)	4039.3	"	"	8.2	117.9	100	P
153	"	58+50 (15)	4038.4	"	"	8.6	118.6	100	P
154	"	58+50 (15)	4039.4	"	"	11.3	94.3	92	F-R

SUMMARY OF IN-PLACE DENSITY TESTS

TEST NUMBER	DATE 1978	LOCATION	ELEVATION	MAX. DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
155	8/29	68+20 (35)	4047.7	117.3	95	9.3	117.2	100	P
156 *	"	63+20 (45)	4040.7	"		10.0	118.0	100	P
157	"	54+50 (30)	4041.2	"	"	10.1	118.4	100	P
158	"	64+20 (20)	4041.3	"	"	8.6	117.0	100	P
159	"	71+30 (40)	4041.0	"		8.1	117.9	100	P
160	"	59+60 (35)	4041.9	"	"	9.5	117.3	100	P
161	"	64+30 (15)	4042.5	"	"	7.9	116.6	99	P
162	"	69+40 (25)	4042.9	"	"	8.4	117.6	100	P
163	8/30	71+30 (40)	4043.3	"	"	8.9	117.9	100	P
164 *	"	71+30 (40)	4043.3	"	"	8.2	117.3	100	P
165	"	59+50 (10)	4043.2	"	"	9.4	118.0	100	P
166	"	68+20 (80)	4043.8		"	9.6	116.9	100	P
167	"	58+00 (20)	4043.9	"	"	8.9	117.1	100	P
168	"	66+10 (40)	4044.3	"	"	8.3	117.6	100	P
169	"	61+00 (35)	4044.5	"	"	9.0	117.3	100	P
170	8/31	59+50 (30)	4044.7	118.7	"	8.9	117.8	99	P
171	"	70+00 (40)	4044.8	"	"	9.4	118.5	100	P
172 *	"	70+00 (40)	4044.8	"	"	9.2	118.3	100	P
173	"	67+40 (35)	4045.1	"	"	8.8	119.6	100	P
174	"	60+10 (35)	4045.2	"	"	9.6	118.8	100	P
175	9/1	67+50 (30)	4045.5	"	"	9.4	119.3	100	P
176 *	"	67+50 (30)	4045.5	"	"	9.0	119.9	100	P
177	"	59+00 (20)	4045.4	"	"	9.6	118.6	100	P
178	"	65+50 (30)	4045.8	"	"	9.3	119.0	100	P
179	"	60+10 (25)	4045.6	"	"	10.0	118.3	100	P
180	"	70+40 (35)	4046.0	"	"	9.6	117.9	100	P
181	"	61+30 (20)	4046.0	"	"	9.5	118.8	100	P
182	"	59+50 (45)	4041.5	"	"	9.6	119.6	100	P
183	"	53+90 (30)	4041.0	"	"	10.3	120.0	100	P
184	"	48+10 (15)	4040.0	"	"	8.9	118.9	100	P
185	9/5	0+50 (30)	4039.5	"	"	9.0	127.6	100	P
186	"	49+50 (30)	4038.5	"	"	9.8	124.3	100	P
187	"	49+50 (30)	4038.0	"	"	11.4	118.9	100	P
188	"	49+50 (30)	4037.5	"	"	11.5	115.1	97	P

SUMMARY OF IN-PLACE DENSITY TESTS

TEST NUMBER	DATE 1978	LOCATION	ELEVATION	MAX. DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN %	FILL MOISTURE IN %	FILL DRY DENSITY IN P.C.F.	% COMPACTION	REMARKS
189	9/5	47+50 (20)	4040.5	118.7	95	9.6	118.3	100	P
190	"	53+00 (40)	4041.1	"	"	9.2	117.6	99	P
191	"	46+10 (30)	4041.6	"	"	8.9	117.9	99	P
192	"	47+00 (45)	4042.0	"	"	9.4	118.9	100	P
193	"	47+00 (45)	4042.4	"	"	9.1	119.6	100	P
194	9/6	58+50 (30)	4042.9	"	"	9.4	118.9	100	P
195	"	49+10 (40)	4043.4	"	"	9.7	119.6	100	P
196 *	"	49+10 (40)	4044.0	"	"	9.4	118.4	100	P
197	"	46+50 (25)	4044.5	"	"	9.0	118.8	100	P
198	"	50+00 (35)	4045.0	"	"	10.2	116.9	99	P
199	"	66+00 (20)	4046.0	"	"	9.7	118.2	100	P
200	"	59+50 (30)	4046.0	"	"	9.3	117.9	98	P
201	9/7	49+50 (40)	4045.4	"	"	9.6	118.7	100	P
202	"	49+50 (40)	4045.4	"	"	9.2	119.2	100	P
203	"	52+30 (30)	4045.4	"	"	9.6	118.6	100	P
204	"	46+10 (20)	4045.8	"	"	8.7	118.9	100	P
205	"	50+00 (35)	4045.7	"	"	8.9	118.6	100	P
206	"	46+40 (25)	4046.0	"	"	9.1	117.9	99	P
207	9/8	46+50 (20)	4046.0	"	"	8.6	118.9	100	P
208 *	"	46+50 (20)	4046.0	"	"	9.3	119.9	100	P
209	"	50+10 (30)	4046.0	"	"	8.9	120.3	100	P
210	"	55+00 (25)	4046.0	"	"	9.2	119.6	100	P
211	"	44+00 (35)	4046.0	"	"	9.5	120.6	100	P

DAMES & MOORE

August 24, 1979

Atlas Minerals
2506 Prudential Plaza
1050 - 17th Street
Denver, CO 80265

Attention: Mr. Gordon Swanby, Vice President
Engineering and Environment

Gentlemen:

Plans and Specifications
Tailings Embankment Expansion Project
12-Foot Raise
For Atlas Minerals
Moab, Utah

The purpose of this letter is to transmit to you the plans and specification documents for the referenced project.

Prior to the finalization of these documents, a preliminary draft was prepared and submitted to you for review. In turn, the preliminary draft was submitted to the U.S. Nuclear Regulatory Commission for its review of the documents. The NRC review was performed by Dr. Terry Howard, engineering consultant and associate professor of geological and civil engineering at the University of Idaho. Recently, through authorization of both Atlas Minerals and the NRC, Mr. James Boddy of Dames & Moore and Dr. Howard have held telephone conversations and a meeting discussing the project. It is our understanding that the final plans and specification documents as submitted herewith are in a condition acceptable to Dr. Howard. Further, it is our understanding that Dr. Howard is informing the NRC of his finding

Based on the discussions with Dr. Howard, Dames & Moore has performed a stability analysis of the critical cross-section along the western embankment for an end-of-construction condition for the new embankment raise. The slope stability analysis was performed on the embankment section C-C as presented on Plate 3-C of the Engineering Design Study submitted February 15, 1978. The end-of-construction condition was performed in a similar manner as

presented in that report. Based on this slope stability analysis it was found that the minimum factor of safety for the western embankment with a raise of the embankment crest to elevation 4058 feet is 1.58 and 1.24 for the static and seismic conditions, respectively. The factors of safety meet regulatory guidelines presented in USNRC Regulatory Guide 3.11.

If you have any questions or require additional information, please contact us.

Yours very truly,

DAMES & MOORE

George C. Toland

George C. Toland
Partner

James R. Boddy

James R. Boddy
Project Manager

GCT/JRB/pc

Attachments

cc: Dr. Terry Howard

CONTRACT SPECIFICATIONS

AND DRAWINGS

FOR

TAILINGS EMBANKMENT EXPANSION PROJECT

Twelve-foot Raise

FOR

ATLAS MINERALS

MOAB, UTAH

PREPARED BY

DAMES & MOORE

Consultants in the Environmental and Applied Earth Sciences

AUGUST, 1979

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BID DOCUMENTS

1.0 INVITATION TO BID

1.1 GENERAL

Atlas Minerals is planning to construct an earthfill embankment addition to its tailings pond dike. You are invited to submit your bid to furnish all labor, supervision, equipment and materials required for the complete construction of the embankment addition in accordance with the specifications and drawings attached hereto. Bidders shall confirm by mail the receipt of this "Invitation to Bid". The contract shall be awarded on the basis of lowest firm-price bid for the complete construction of the earthfill embankment addition. Unit prices will be included in the bid to provide for deletions or additions to the work scope.

1.2 BASIS OF BID

Bidders are urged to visit the site of the work and by their own investigation satisfy themselves as to the existing conditions affecting the work to be done under these specifications. If the bidder chooses not to visit the site, he will nevertheless be charged with knowledge of conditions which a reasonable inspection would have disclosed and shall assume all responsibility for deductions and conclusions made therefrom as to the difficulties in performing the work. The construction site may be inspected during regular office hours by contacting Mr. Gene Ciarus of Atlas Minerals at the Moab Mill near Moab, Utah (801) 259-5131.

Selected samples recovered in the subsurface investigations may be inspected by bidders at the Atlas Minerals' Moab office. Solely for the convenience of the bidders, they may obtain logs of borings and test pits from subsurface investigations upon request to Dames & Moore in Salt Lake City, Utah. Atlas Minerals does not represent that the

available records show conditions that will be encountered in performing the work and represents only that such records show conditions encountered at the particular point and time for which such logs were obtained.

1.3 PREPARATION OF BID

Each bid must be submitted on the prescribed bid form. All blank spaces must be filled in, in ink or typewritten. For the convenience of the bidder, an additional Bid Schedule is attached. All bids must be prepared in triplicate on and submitted under bidder's letterhead. They must be delivered in good order and enclosed in a sealed envelope prior to the due date and time specified below. All bid documents are to be returned, whether or not a bid is submitted.

1.4 RECEIPT AND OPENING OF BIDS

Bids will be received by Atlas Minerals, a division of Atlas Corporation, at Post Office Box 1207, Moab, Utah, 84532, under the attention of Mr. Gene Ciarus, until _____ p.m. on _____. The results of the bidding will be made available on _____. There will be no public opening.

The owner reserves the right to reject any or all bids, to waive technicalities, to advertis for new bids or proceed to do the work otherwise. Only one bid will be accepted per bidder, and rebids will not be accepted unless requested by the owner as a result of a significant design or specification alteration. Any bid may be withdrawn prior to the above scheduled time for the opening of bids or authorized postponement thereof. Late bids will not be accepted.

1.5 COMMENCEMENT, PROSECUTION AND COMPLETION OF THE WORK

Bidders must agree to begin work within ten (10) days after date of receipt of notice to proceed and complete all of the work within 75 calendar days of said date. Bidders shall

include in their proposals an estimate indicating their best start and finish dates for the total scope of work. The capacity of the successful bidder's construction plan, sequence of operations, methods of operation and the forces employed will at all times during the continuance of the contract be subject to the approval of the engineer and shall be such as to insure completion of the work within the specified period of time. The successful bidder shall plan and schedule his work as directed by the owner in order to coordinate said work with the work of the owner or other contractors.

1.6 PRE-CONSTRUCTION CONFERENCE

Within five (5) days after notification of the contract award, the successful bidder, together with any known sub-contractors, will be required to attend a Pre-Construction Conference at a time and place designated by the owner. The purpose of the Pre-Construction Conference will be to discuss, among other considerations, the responsibilities of the successful bidder and his sub-contractors.

2.0 BID FORM AND BID SCHEDULE

The _____ (Contracting Company), having examined the construction site and studies and now comprehending the plans and specifications, proposes to furnish all materials, labor, tools and equipment required to complete all work called for in the plans and specifications prepared for or by Altas Minerals for the construction of the earthfill embankment addition for the sums and totals quoted on the following Bid Schedule. Estimated earthwork quantities shown on the Bid Schedule are for required in-place compacted embankment quantities; final payment will be made on measured quantities.

ITEM	DESCRIPTION	UNITS	AMOUNT
1	Mobilization and Demobilization	Lump Sum	$_____
2	Embankment Fill		
	Red silty sand fill: Required stripping, excavation from borrow area or obtainment from stockpile area, transportation, preparation, placement and compaction	286,000 cu yds in-place @_____/cu yd	$_____
3	Surveying:	Lump Sum	$_____

TOTAL FIRM-PRICE BID EARTHFILL EMBANKMENT ADDITION $_____

GENERAL SPECIFICATIONS

1.0 GENERAL CONDITIONS

1.1 DEFINITIONS

1.1.1 Contract. The written agreement between the CONTRACTOR and the buyer of the Contractor's services setting forth the terms and conditions under which the work is to be performed and/or material is to be furnished. It includes all the contract documents.

1.1.2 Contractor. Party of the second part to the contract acting directly or through his agents or employees, hereinafter call CONTRACTOR.

1.1.3 Owner. Atlas Minerals, a division of Atlas Corporation, and party of the first part, hereinafter called OWNER.

1.1.4 Engineer. The authorized representative assigned by the part of the first part of the contract to supervise and direct the technical aspects of the work called for in the contract to insure that the work and materials are in accordance with the plans and specifications.

1.1.5 Technician. The authorized representative of the ENGINEER who will perform the day-to-day inspection as directed by the ENGINEER

1.1.6 Design Engineer. The authorized representative of the OWNER responsible for the design and preparation of the plans and specifications.

1.1.7 Employee. Any person working on the project who is under the direction or control of, or receives compensation from, the CONTRACTOR or sub-contractor.

Employees shall be personnel skilled and experienced in their trades.

1.1.8 Plans. The drawings or reproductions thereof which show the locations and detailed design of the contemplated improvements outlined in the specifications. Part of the contract documents.

1.1.9 Specifications. The statement containing a minute description of the WORK. Part of the contract documents.

1.1.10 Work. (The Work). The materials and operations necessary for the construction of the specified improvements as indicated on the PLANS, or as set forth in the specifications.

1.1.11 Item. A specified class of WORK on which definite prices are set forth in the CONTRACT.

1.2 CONSTRUCTION CONTROL SURVEYING

The OWNER will establish baselines and bench marks required for proper execution of the work. The CONTRACTOR will furnish competent and qualified survey control during the course of construction to assure adherence to lines and grades. See Section 4.0 for the outlined scope of work.

1.3 CONSTRUCTION INSPECTION

Full-time control inspection of all construction activities under this contract will be provided by the OWNER and ENGINEER, at no cost to the CONTRACTOR.

1.4 WATER, SANITARY AND OTHER FACILITIES

Water for construction will be available at the Moab Mill from the OWNER. Means of obtaining this water and conveying it to the construction site will be left up to the CONTRACTOR with the approval of the ENGINEER. Drinking water and sanitary facilities shall be provided by the CONTRACTOR. Other facilities of the OWNER will not be available to the CONTRACTOR. All storage and disposal areas used by the

CONTRACTOR shall be subject to prior approval by the OWNER's representative.

1.5 SUPERVISION OF WORK

The CONTRACTOR shall provide a competent foreman or superintendent, satisfactory to the ENGINEER, on the work at all times with the authority to act for him. The superintendent or foreman shall give personal supervision to the work, including coordinating, directing and expediting of all subsequent work until completion of all work under the contract. All directions given to such superintendent or foreman shall be considered as given to the CONTRACTOR and shall be binding on the CONTRACTOR.

1.6 LOCATION AND MAINTENANCE OF ROADS

The OWNER will provide a contractor's entrance located approximately 450 yards west of the scale house gate for the sole use of the CONTRACTOR and his employees. All access to the site by the CONTRACTOR shall be through this entrance. Access to the site is available by a non-surfaced road which joins the tailings disposal area to the entrance. Improvement of existing roads and construction of new roads must be approved by the ENGINEER. If such new roads are constructed, they shall be done in such a manner as to be free-draining and shall be maintained in good condition throughout the contract period unless otherwise directed by the ENGINEER. Moisture shall be sprayed on all roads being used by the CONTRACTOR in order to maintain a dust-free condition. All roads are to be considered of a temporary nature unless designated as permanent by the OWNER at some time during the period of this contract.

DETAILED SPECIFICATIONS

1.0 MOBILIZATION AND DEMOBILIZATION

1.1 SCOPE OF WORK

This work item covers the transportation and delivery of all equipment and materials required for the complete construction of the earthfill embankment addition. The removal of the aforementioned equipment and unused materials from the site at the completion of construction shall also be included in this portion of the work.

1.2 PAYMENT

Payment for this work item is based on a lump sum bid and is covered under Item 1 of the Bid Schedule.

2.0 EXCAVATION AND OBTAINMENT OF FILL MATERIALS FROM STOCKPILE AND BORROW AREAS

2.1 SCOPE OF WORK

This specification covers the required excavation of fill material from the borrow areas, the obtainment of fill from on-site stockpile areas and the designation of the borrow and stockpile areas.

2.2 DEFINITION OF MATERIALS

2.2.1 Red Silty Sand Fill. This material is to be excavated from the designated borrow area or obtained from the stockpile area and will be reddish-brown, fine to coarse, sand material with 10 to 40 percent silt- and clay-size particles and 0 to 10 percent gravel-size particles.

2.3 BORROW AREAS

2.3.1 General. It is anticipated that all the material required for the embankment construction shall be obtained from the borrow area or from the stockpile area as designated in the plans. The location and extent of borrow pits other than in the areas designated and to the depths designated shall be subject to the approval of the ENGINEER.

2.3.2 Borrow Area. The designated borrow area as shown on the plans is located immediately northwest of the existing embankment in an area that has previously been used as a borrow area. The ENGINEER estimates that 286,000 cubic yards of red silty sand fill are available within the designated limits of this borrow area. The depth of borrow is limited to the extent that it conforms to the material specification of Sections 2.2.1 and 2.2.2 and is approved by the ENGINEER. Upon completion of the use of the borrow

area, the lowest elevation of the borrow area shall be no lower than 4,003 feet along the area's eastern boundary and the surface shall be smoothed and sloped such that all disturbed areas within the borrow area are graded to drain. Under no circumstances shall permanent cut slopes be made steeper than two horizontal to one vertical.

2.4 STOCKPILE AREA

Should there not be a sufficient quantity of red silty sand fill material in the designated borrow area, additional fill shall be available to the CONTRACTOR from the on-site stockpile area as designated in the PLANS. It will be the responsibility of the OWNER to inform the CONTRACTOR of the changes in the location of the stockpile areas and to provide necessary access to them.

2.5 MOISTURE

The earthfill material prior to and during compaction shall be such that the moisture content shall be in accordance with Section 3.5.3 of these specifications. Should additional moisture be needed, it may be introduced into the borrow or stockpile areas by irrigation or sprinkling in advance of excavation operations. When moisture is introduced into the borrow or stockpile areas, both excessive runoff and accumulation of water in depressions should be avoided.

3.0 EMBANKMENT FILL

3.1 SCOPE OF WORK

This section of the specifications covers material placement, spreading, moisture control and compaction requirements for the compacted embankment fill. The design engineer has estimated the dam will require a total of 286,000 cubic yards of in-place compacted embankment fill.

3.2 DEFINITIONS

3.2.1 Embankment. That portion of the construction which comprises the compacted earthfill as designated on the plans by "Embankment Fill to be Constructed - 12 Foot Raise". Embankment fill is defined as red silty sand fill material.

3.2.2 Existing Embankment. The earthfill tailings retention structure present at the site.

3.2.3 Foundation. The existing embankment, of sand tailings and red silty sand soil, or the natural ground surface adjacent to the existing embankment upon which the earthfill embankment is to be placed.

3.2.4 Compaction. The mechanical process whereby the density of the soil is increased.

3.2.5 Optimum Moisture Content. The moisture content at which the specified amount of compaction effort will produce the maximum density of the soil.

3.2.6 Maximum Dry Density. The dry density of the soil obtained after a specified amount of compaction at the optimum moisture content.

3.3 GENERAL PROVISIONS

3.3.1 Lines and Grades. All fills should be constructed to the lines, grades and cross-sections indicated on the drawings unless otherwise directed in writing by the ENGINEER. All finished surfaces shall be generally smooth.

3.3.2 Conduct of Work. The CONTRACTOR shall maintain and protect all fill in a satisfactory condition at all times until all work under the CONTRACT is complete and final. Any previously approved fill which is not maintained and protected to the satisfaction of the ENGINEER until final acceptance of the work, shall be replaced or reworked by the CONTRACTOR in a satisfactory manner and no additional payment will be made therefore. The CONTRACTOR may be required to remove at his own expense any fill material placed outside of the prescribed lines and grades.

3.4 MATERIALS

3.4.1 General. The suitability of materials and their deposition in the fills will at all times be subject to the approval of the ENGINEER. The compacted dam embankment shall be constructed using the red silty sand borrow material. All material shall be free from any perishable or otherwise undesirable materials. Should any undesirable material be hauled onto the fill, it should be removed prior to compaction operations.

3.4.2 Source. Suitable fill material shall be obtained from the designated borrow area and stockpile area.

3.5 CONSTRUCTION

3.5.1 Foundation Preparation. The entire surface of the dam foundation areas shall be stripped and leveled where necessary, scarified to a depth of at least six (6) inches, moistened (if required), and compacted as herein specified for the compacted fill.

3.5.2 Placement and Spreading. Embankment fill shall be placed in approximately horizontal layers not to exceed eight (8) inches in loose thickness. Fill

materials shall not be placed and compacted until the exposed foundation areas have been inspected and approved by the ENGINEER. The CONTRACTOR shall keep the foundation area free from ponded water or unacceptable material after filling operations have started. Fill shall not be placed upon a frozen surface nor shall snow, ice or frozen material be incorporated in the fill.

Unless otherwise directed, fill material shall be maintained at approximately the same level. The distribution of materials throughout the fill shall be such that there will be no lenses, pockets or streaks of material differing substantially in texture or gradation from the surrounding material in the fill. After placement of each layer of material, the fill shall be spread by motor grader or other approved equipment. Compacted fill shall not be placed against a slope steeper than one horizontal to one vertical unless otherwise shown on the plans or approved by the ENGINEER.

Where the embankment abuts the natural surface soils near the downstream toe of the western embankment, the existing steep surfaces should be benched and the fill material should be well keyed into the slope for each lift so that no loose zones remain and that an adequate tie is provided between the natural soils and the new construction. Where the embankment abuts the steep slopes of the existing embankment, the fill should be likewise well keyed into the slope. Care must be given to the existing sand and gravel drain at the toe of the existing embankment from Stations 0+00 to 21+00.

3.5.3 Moisture Control. During the compaction operations, the surface of the fill and the materials being

placed shall be maintained within the moisture content range required to permit compaction to the specified density with the equipment used. The water content of the earthfill material prior to and during compaction shall be distributed uniformly throughout each layer of the material. Allowable ranges of placement water content are based on design considerations, but the required degree of compaction can be secured with a reasonable effort within the moisture range defined by the ENGINEER. In general, the average placement water content will be required to be maintained at or near the optimum condition.

This optimum water content is defined as the water content which will result in a maximum dry unit weight of the soil when subjected to the ASTM* D-698 method of compaction. Compaction tests will be made by the TECHNICIAN under supervision of the ENGINEER during placing of the fill. Water, if required, may be added to the material at the borrow or stockpile areas or by sprinkling on the placed earthfill. The water shall be uniform throughout the layer immediately prior to compaction.

3.5.4 Compaction

3.5.4.1 Equipment. Rollers (preferably vibratory) of sufficient size and number to maintain the progress of the work may be required to obtain the specified compaction and should be made available. All compaction equipment used shall be in good working order, of a capacity, weight, and/or power necessary to perform the required operations in a workmanlike manner and must be approved for use by the ENGINEER.

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* American Society for Testing and Materials.

3.5.4.2 Compaction Methods. After each layer of fill material has been placed and spread and contains the required moisture content as specified in Subsection 3.5.3, it shall be compacted by making a sufficient number of passes with the compaction equipment over the entire surface of the layer to obtain the density specified for compacted embankment fill.

3.5.5 Density Requirements. All embankment earthfill under these specifications will be classified as compacted fill. Compacted fill shall consist of and include all fills deposited in layers and compacted by rolling and tamping. Embankment fill will be compacted under these specifications to at least 95 percent of the maximum dry density obtained from the performance of a compaction test in accordance with the ASTM D-698 method of compaction. In-place density tests will be performed by the TECHNICIAN to insure that the compaction procedure as outlined in Section 3.5.4.2 is adequate to achieve the required density specifications for embankment fill. The number of density tests to be performed is detailed in Section 5.0. The percent compaction of the compacted fill will be determined by comparing field densities to the densities obtained by compacting the same type of soil in laboratory compaction tests described above. If density tests indicate the fill to be of insufficient compaction, modifications to the procedural compaction method as outlined in Section 3.5.4.2 must be made by the CONTRACTOR. Each layer of fill will be accepted by the ENGINEER before additional layers are placed. Acceptance or rejection of any portion of the compacted embankment fill shall be based on tests conducted during the actual fill placement.

3.6 PAYMENT

Payment for placement, spreading, moisture control and compaction of the embankment fill is based on a firm-price bid. Unit prices for the in-place quantities will be included under Item 2 of the Bid Schedule to provide for deletions and additions to the work scope.

4.0 SURVEYING

4.1 SCOPE OF WORK

This specification covers the surveying required to commence construction, to maintain the progress of the work and determine the final in-place compaction earthwork quantities and excavation volumes.

4.2 REQUIRED SURVEYING

The OWNER will establish baselines and bench marks required for the proper execution of the work. The following subsections outline the minimum required surveying services to be provided by the CONTRACTOR.

4.2.1 Initial Layout. This portion of the work covers the coordination of existing survey control and the initial layout of the embankment addition. The "downstream" edge of the bench at the approximate elevation 4,040 feet shall be the reference for the survey along all but the western segment of the embankment. Along the western length of the embankment, the "upstream" edge of the existing embankment crest at the approximate elevation 4,046 feet shall control.

4.2.2 Determination of Foundation Grade. After completion of the foundation area stripping and leveling work, and prior to scarifying the foundation, the foundation area shall be surveyed for grade at the station sections to facilitate determination of earthwork volumes.

4.2.3 Sectioning the Complete Embankment Addition. This portion of the work covers the surveying required to determine the volumes of embankment fill above foundation grade. Volumes shall be determined by sectioning the embankment at the same 100-foot

stations after fill placement as those surveyed before fill placement.

4.2.4 Miscellaneous Surveying. Additional surveying services may be required to maintain the progress of the work and is the responsibility of the CONTRACTOR. This said additional surveying service shall be supplied by and at the expense of the CONTRACTOR.

4.3 SUPERVISION OF WORK

The above outlined scope of work performed by the CONTRACTOR or his Sub-contractor shall be supervised by a qualified and licensed surveyor. Required surveying and related volume determinations will at all times be subject to review and approval of the ENGINEER.

4.4 PAYMENT

Payment for the required surveying services outlined above shall be based on a lump sum as part of the fixed-price bid and is covered under Item 3 of the Bid Schedule.

5.0 CONSTRUCTION INSPECTION

5.1 SCOPE OF WORK

The ENGINEER will be responsible for field inspection and testing, final quality of earthwork and foundation soil preparation, and advising the OWNER of inadequacies in the event they are not or cannot be corrected during the course of work.

5.2 GENERAL

The ENGINEER will provide all labor, material, and testing equipment, technical and supervisory services necessary to perform all the soil tests, inspections and certifications required by the specifications.

The ENGINEER and the TECHNICIAN will have copies of:

- The project plans and specifications
- The applicable ASTM specifications
- The results of pertinent laboratory tests previously made on the construction materials.

In addition to performing all required field tests and inspection during placement, the TECHNICIAN will also conduct any tests necessary to confirm that the material within the specified borrow area and stockpiles meet the appropriate project specifications for soil type, gradation, or limits on deleterious materials.

The TECHNICIAN will be present each day before any earthwork is started, and remain on the site during the course of the work. He will also make himself available at all reasonable times as requested by the CONTRACTOR.

5.3 INSPECTION DETAILS

5.3.1 Frequency and Location of Tests. Visual inspection of the work and field testing of the soils are the primary means of assuring proper materials and

adequate density in controlled fills. Frequency of tests and the test locations are at the option of the TECHNICIAN unless additional tests are requested by the ENGINEER, CONTRACTOR or the OWNER.

Density tests will be made in the following areas:

- Where the degree of compaction is doubtful.
- Where embankment construction operations are concentrated.
- For every 1,000 yd^3 of embankment when no doubtful or concentrated areas occur.

5.3.2 Verification. The TECHNICIAN will notify the CONTRACTOR's personnel, directly, of any fill material that is below the required density, of improper moisture content for efficient compaction, unapproved borrow materials, or fills that have been improperly placed so that immediate corrections will be made during the course of work.

It will be the responsibility of the TECHNICIAN to notify the ENGINEER and OWNER if the fill material, the placement method, or the soil density or moisture consistently fail to meet the required specifications. His report will include the reasons for such conditions. The TECHNICIAN will report such problems both verbally and subsequently in writing.

On each day in which any earthwork is performed, the TECHNICIAN will submit to the OWNER and to the CONTRACTOR a daily report which will include, but not be limited to, the following information:

- Areas and elevations of completed earthfill placements.
- Type of earthfill materials placed.
- Test densities obtained.
- Soil moisture conditions.
- List of all construction equipment used.

- Deviations from specifications.
- Final disposition of problem areas.

The TECHNICIAN will maintain a personal field file with the above information, plus any unusual conditions, suggestions or recommendations made to the CONTRACTOR and will have such a file on the site at all times.

The ENGINEER will visit the job with sufficient frequency to be thoroughly familiar with:

- The earthwork, excavation, backfill, and foundation construction of the CONTRACTOR.
- The quality and scope of testing and inspection by the TECHNICIAN, during the course of work.

5.3.3 Testing Methods. The ASTM methods that will be used in performing the required tests are as follows:

Type of Test	ASTM Standard Method
Compaction Test	D 698
Gradation Test	D 422
Density Test	D 2922 and D 1556
Moisture Content Test	D 3017 and D 2216

It should be noted that ASTM methods D 2922 and D 3017 involve the use of nuclear methods. The purpose of the ASTM D 1556 and D 2216 tests are to provide a check on the accuracy of these nuclear methods.

6.0 MISCELLANEOUS CONSTRUCTION (NOT A PART OF THIS CONTRACT)

6.1 PIEZOMETERS

6.1.1 Scope of Work. The CONTRACTOR shall construct three new piezometers and extend six existing piezometers in accordance with these Specifications and as shown on the PLANS or as directed by the ENGINEER.

6.1.2 General Description

6.1.2.1 New Piezometer Installation. Three new piezometers shall be installed at the three locations labeled as piezometer locations D-1, D-2 and D-3 as shown in the plans on the Plot Plan. The new piezometers shall be placed in individual boreholes. The boreholes shall be advanced by drilling a four and three-quarter-inch diameter hole below the final grade and casing the hole with four-inch nominal diameter steel pipe. The casing shall be withdrawn as piezometer installation progresses upward. To provide a protective cover, a five-foot length of eight-inch diameter steel casing and three-quarter-inch steel cover plates shall be installed.

6.1.2.2 Existing Piezometers. Six existing piezometers have been established along the existing embankment at the locations labeled as piezometer locations B-7, B-10, B-13, B-16 and B-28 on the Plot Plan in the PLANS. The casing and piezometers shall be extended upward to where the top of the eight-inch PVC casing is at least eight feet above the existing embankment surface at the piezometer location. At

most piezometer locations, compacted fill must be placed adjacent to the piezometer. In these areas, hand-compaction using mechanical tampers will be required to obtain the necessary densities and to prevent damage to the casing and piezometers by heavy compaction or other construction equipment.

Along the first bench of the existing embankment, eight additional existing piezometers (the locations of which are shown on the Plot Plan as A-1, A-4, A-5, B-1, B-2, B-4, B-5, and B-8) have been established and are functional. Care must be taken by the CONTRACTOR not to damage or cover these piezometers.

6.1.3 Materials

6.1.3.1 General. Materials to be used in piezometer construction are described below. The CONTRACTOR shall submit samples of and/or specifications for the various materials to be used in piezometer construction to the ENGINEER for approval before said materials are acquired or piezometer construction begins. The suitability of all materials and methods used for piezometer construction shall be subject to approval of the ENGINEER.

6.1.3.2 Casing. Casing used to install piezometers below the existing ground line shall be nominal four-inch diameter steel pipe.

Casing which will become a part of the permanent construction shall be nominal eight-inch diameter, Schedule 40 PVC pipe.

6.1.3.3 Piezometer Tips. Piezometer tips shall be "Standard Hydro-Tips", as manufactured by Hydrophilic Industries, Inc., Puyallup, Washington, or equivalent. Said tips are made of 1.5-inch nominal diameter PVC plastic pipe with 0.010-inch wide slots, are 22 inches long, and are adapted to 0.75-inch nominal diameter PVC plastic riser pipe.

6.1.3.4 Riser Pipe. Piezometer riser pipe shall be 0.75-inch nominal diameter schedule 40 PVC plastic pipe.

6.1.3.5 Sand. Sand shall be a typical "concrete sand" with 100 percent by weight passing the U.S. Standard three-eighths-inch sieve and less than five percent passing the U.S. Standard No. 200 sieve.

6.1.3.6 Bentonite. Bentonite shall be introduced into the piezometer holes as dry pellets equivalent to "Peltonite" sold by Roctet, Inc., Plattsburgh, N.Y.

6.1.3.7 Cement-Bentonite Grout. Cement-bentonite grout shall be cement and powdered bentonite mixed in a four-to-one, cement-bentonite ratio. Sufficient water should be added to form a slurry which can be pumped down the borehole.

6.1.4 Construction

6.1.4.1 New Piezometer Installation. Piezometers shall be installed below grade after completion of embankment construction. Casing shall be advanced as the hole is drilled. The casing shall be withdrawn after the tip

and riser pipe are installed and as the sand, bentonite and cement-bentonite grout are installed.

The casing shall be withdrawn to the level of the top of the bentonite zone immediately after placement of the bentonite to prevent the bentonite from seizing to the casing. Care shall be taken to prevent other materials from seizing to the casing and to the tips or riser pipes from being disturbed or withdrawn as the casing is withdrawn. Materials shall not be placed in uncased holes but shall be placed inside the casing and the casing then withdrawn.

During borehole drilling operations, the ENGINEER will observe the drilling operation and maintain a log of the soil profile encountered. Exact elevations of piezometer tips will be determined in the field by the ENGINEER based on the ENGINEER's observation of the soil profile encountered. In general, the piezometers are to be installed with their tips five feet below the bottom of the tailings sand drain material of the existing embankment.

6.1.4.2 Extension of Existing Piezometers. Piezometers above grade shall be installed and extended in advance of compacted fill placement by the addition of casing and piezometer tubes. Special care shall be taken to achieve a water-tight seal when joining PVC pipe sections. Fill placed adjacent to the casing sections shall be

hand-compacted within 24 inches of the casing. Riser tubes shall be fitted with removable caps which shall be kept in place at all times to prevent dirt or other debris from entering the piezometer riser pipes and tips.

6.1.5 Measurement and Payment. Payment for constructing the three new piezometers and extendng the existing six piezometers will be based on time and expense of the CONTRACTOR. Said price shall include the cost of: construction and maintenance of work pads and access roads; drilling and casing the hole below grade; furnishing and installing the various components and materials required to construct the piezometers in accordance with these Specifications and Drawings including withdrawal of casing below grade; furnishing and installing permanent casing; hand-compaction of fill placed adjacent to the casing above ground line after stripping; and, all labor, equipment, and material incident thereto.

6.2 SUB-DRAIN SYSTEM

6.2.1 Scope of Work. This specification covers the materials and work required to modify the existing sub-drain system near the south end of the western embankment (approximately Station 17+00 to 21+00).

6.2.2 General Description. The existing sub-drain system is shown in the plans on the Plot Plan. The system consists of two separate drains, each with a sump, pump and PVC drain pipes. As indicated, the new embankment will cover the area labeled as "Existing Sump (To Be Abandoned)." Therefore, this sump and pump will be removed and the sump hole backfilled. A new section of drain pipe will then be added to

connect the drain pipe at the point where it now enters the sump to the existing drain pipe to the south.

6.2.3 Construction

6.2.3.1 Abandonment of Existing Sump. The existing sump along the western embankment shall be removed. The hole shall be backfilled with coarse filter material compacted to the specifications stated in Section 3.5.4. Sufficient quantities of this material will be available to the CONTRACTOR in the designated stockpile area.

6.2.3.2 Construction of New Sub-Drain Collector. The new sub-drain collector should be constructed in general accordance with the detail shown in the plans on the plate entitled "SUB-DRAIN COLLECTOR-TYPICAL." The invert elevation of the north end of the new drain pipe will be approximately 4,009 feet and the southern end approximately 3,994 feet. The pipe will be constructed to a straight grade between the invert elevations of the two existing pipes it connects. The slope is estimated to be approximately three to three and one-half percent which is adequate for proper drainage.

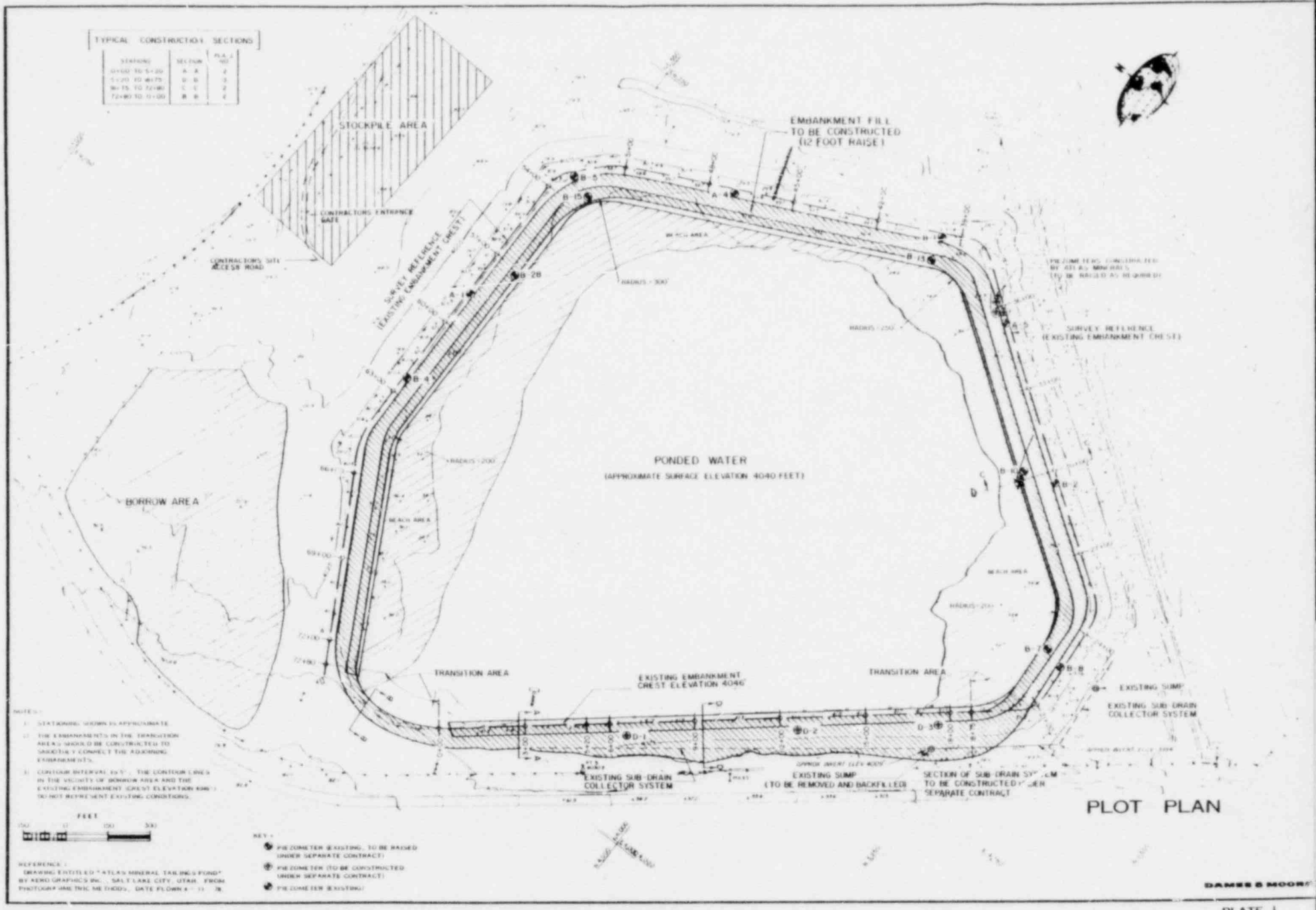
6.2.4 Materials. Materials to be used in sub-drain modification are described in the plans. The CONTRACTOR shall submit samples of the pipe to the ENGINEER for approval before the pipe is acquired or sub-drain construction begins. The suitability of materials and methods used for sub-drain construction shall be subject to approval by the ENGINEER.

BID FORM AND BID SCHEDULE

The _____ (Contracting Company), having examined the construction site and studies and now comprehending the plans and specifications, proposes to furnish all materials, labor, tools and equipment required to complete all work called for in the plans and specifications prepared for or by Altas Minerals for the construction of the earthfill embankment addition for the sums and totals quoted on the following Bid Schedule. Estimated earthwork quantities shown on the Bid Schedule are for required in-place compacted embankment quantities; final payment will be made on measured quantities.

ITEM	DESCRIPTION	UNITS	AMOUNT
1	Mobilization and Demobilization	Lump Sum	$_____
2	Embankment Fill Red silty sand fill: Required stripping, excavation from borrow area or obtainment from stockpile area, transportation, preparation, placement and compaction	286,000 cu yds in-place @_____/cu yd	$_____
3	Surveying:	Lump Sum	$_____

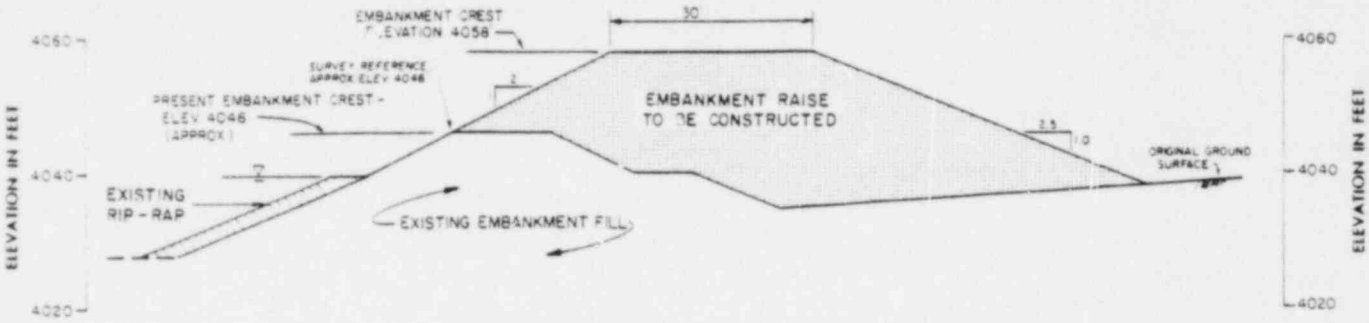
TOTAL FIRM-PRICE BID EARTHFILL EMBANKMENT ADDITION $_____



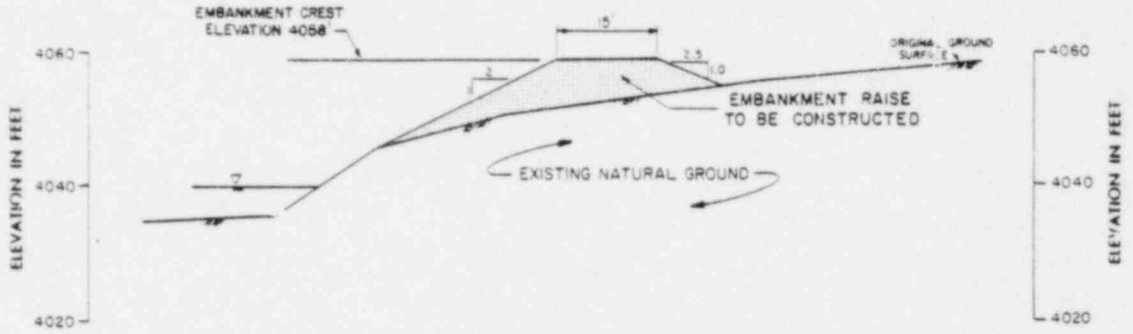
PLOT PLAN

DAMES & MOORE

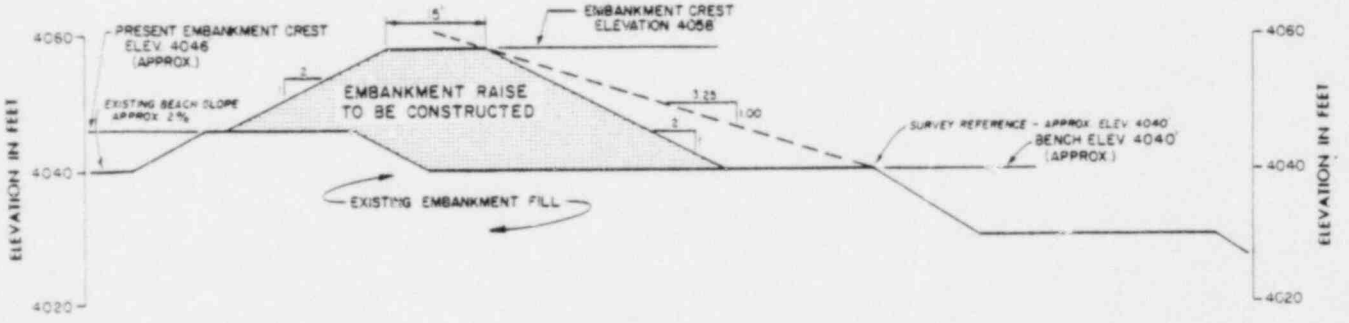
PLATE 1



CONSTRUCTION SECTION A-A



CONSTRUCTION SECTION B-B



CONSTRUCTION SECTION C-C

CONSTRUCTION SECTIONS A-A, B-B, C-C

FEET
10 5 0 10 20 30 40 50

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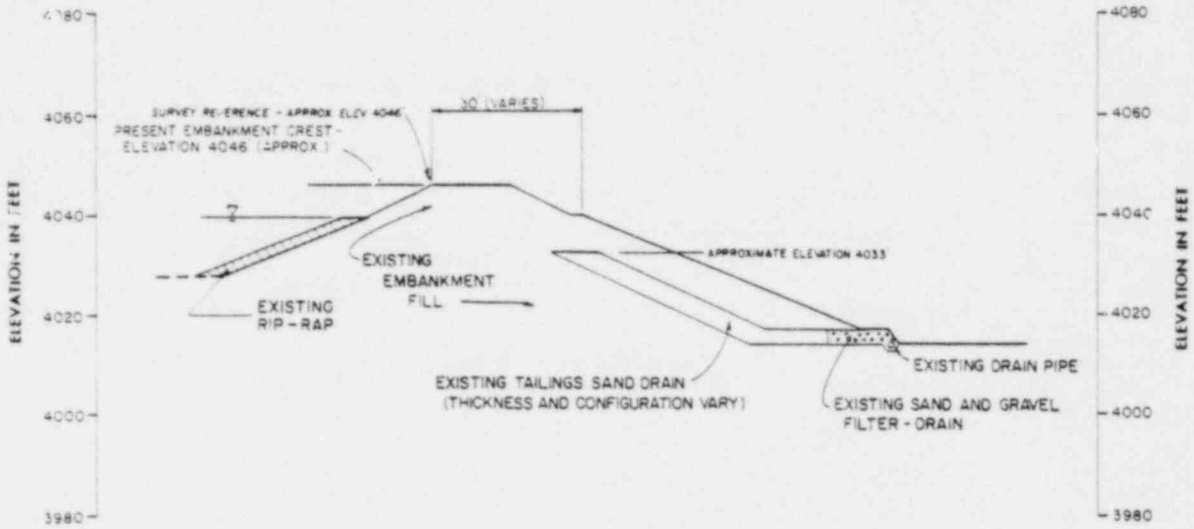
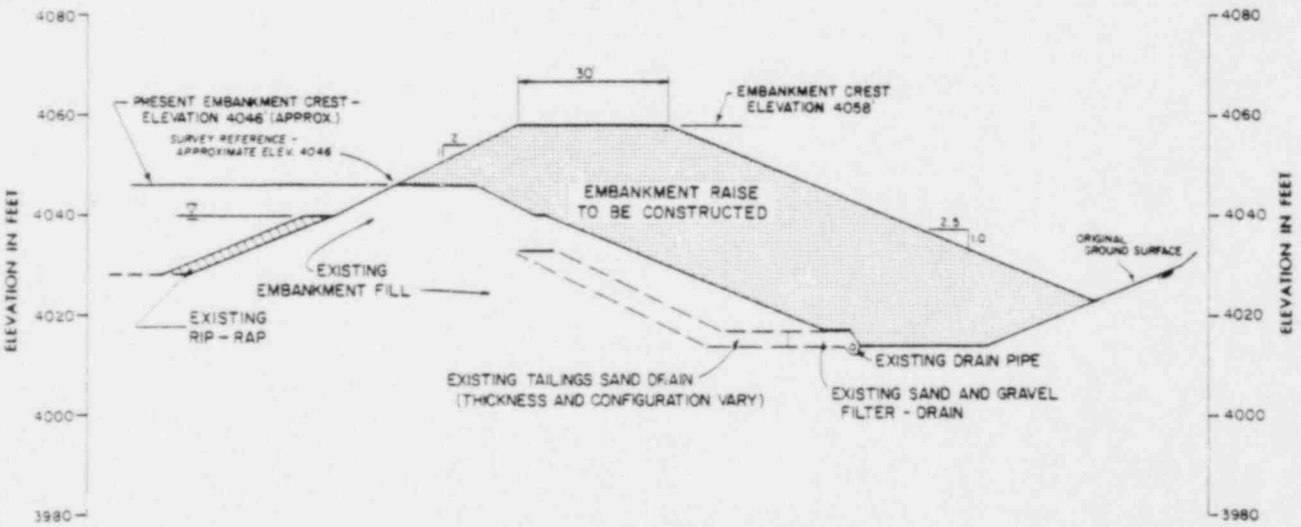
PLATE 2



EXISTING EMBANKMENT



EXISTING EMBANKMENT
AND
EMBANKMENT RAISE

CONSTRUCTION SECTION D-D

FEET
10 5 0 10 20 30 40 50

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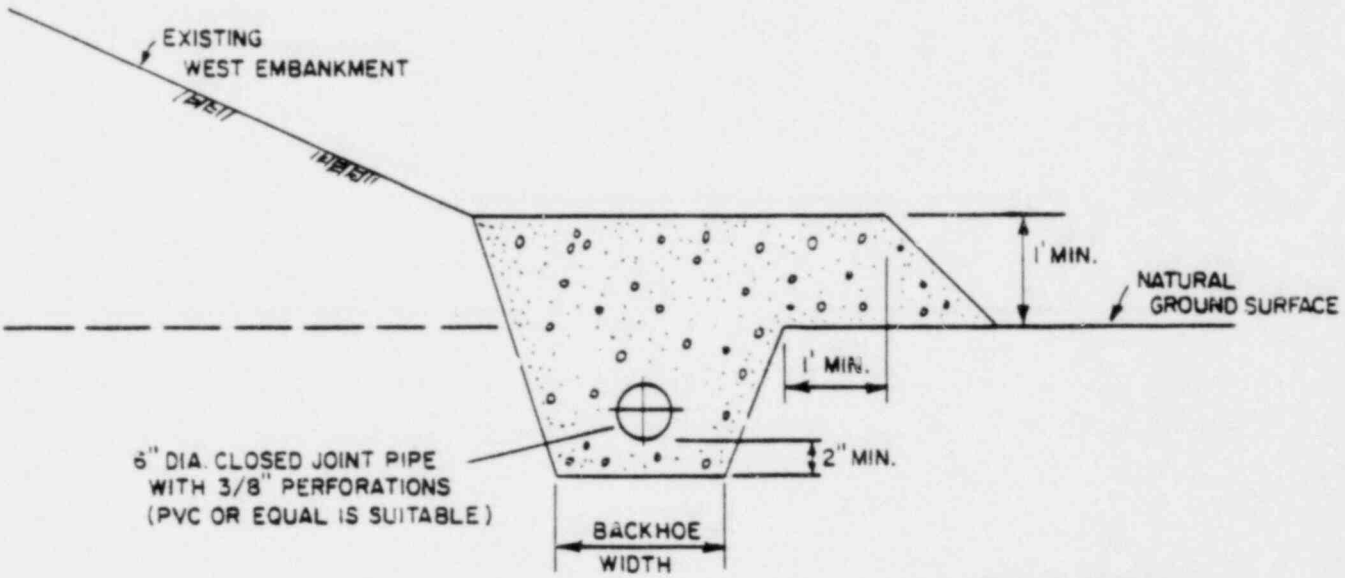
PLATE 3



NOT TO SCALE

U.S. STANDARD SIEVE	% PASSING BY WEIGHT
# 10	0 - 5
# 4	0 - 45
3/8"	10 - 98
3/4"	70 - 100
1 - 1/2"	100

SUB-DRAIN COLLECTOR - TYPICAL

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PLATE 4

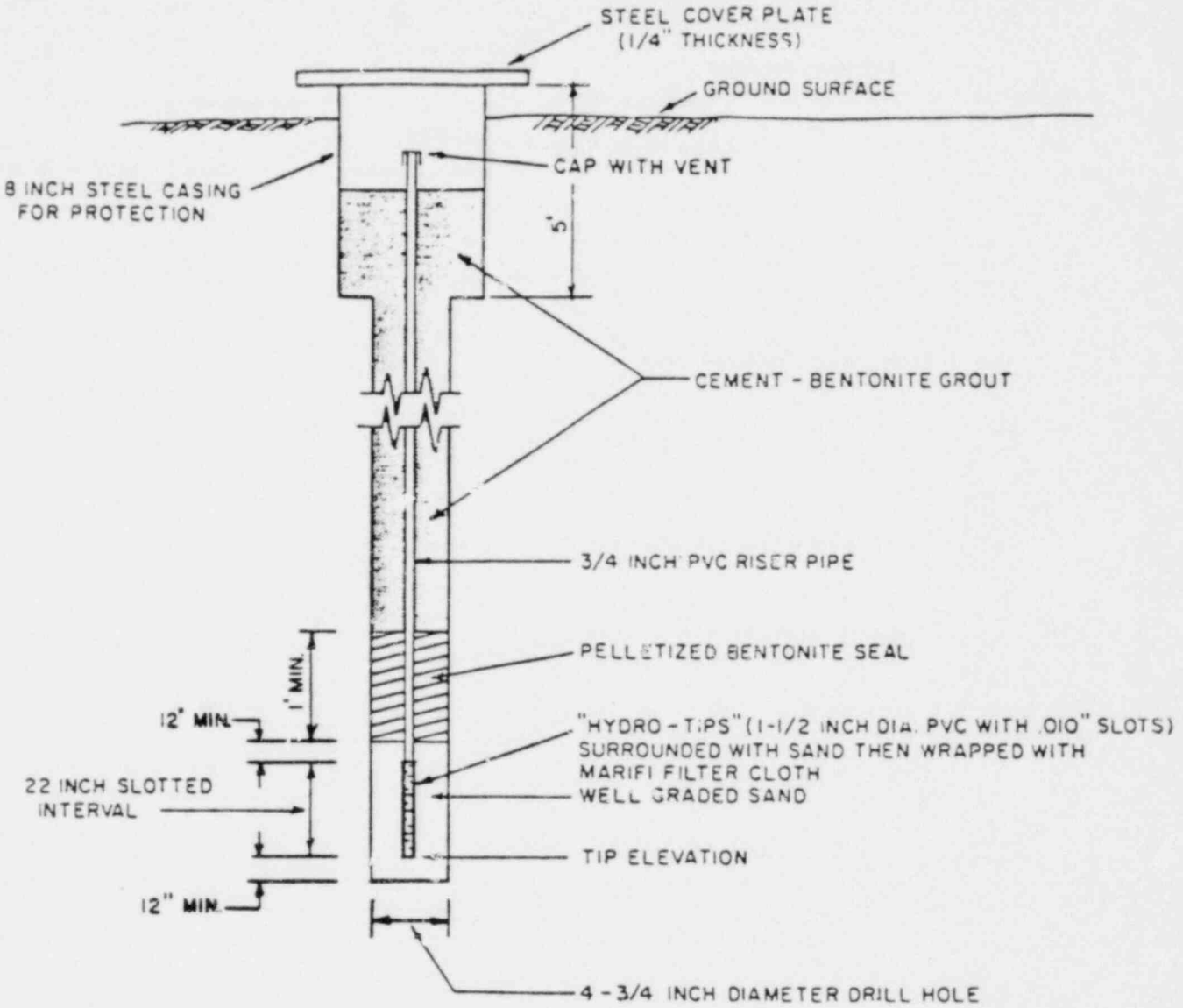

DIAGRAM OF TYPICAL PIEZOMETER

DAMES & MOORE

PLATE 5

September 14, 1979

U. S. Nuclear Regulatory Commission
Uranium Recovery License Branch
7915 Eastern Avenue
Silver Spring, Maryland 20910

Attention: Mr. Peter Garcia
Mail Stop 483-SS

Gentlemen:

Subject: Technical Questions
Tailings Pond-Embankment System
Atlas Minerals Milling Operation
Moab, Utah
Docket No. 40-3453

At the request of Mr. Gordon Swanby of Atlas Minerals, we enclose a copy of our letter to Atlas Minerals of September 14, 1979, which presents responses to the recent questions asked by Mr. Peter Garcia regarding the proposed additions to the Atlas mill tailings pond.

Yours very truly,

DAMES & MOORE

James R. Boody

James R. Boody
Project Manager

JRB/ek

enclosure

cc: Mr. Gordon Swanby, Atlas Minerals

September 14, 1979

Atlas Minerals
2506 Prudential Plaza
1C50 - 17th Street
Denver, CO 80265

Attention: Mr. Gordon, T. Swanby,
Vice President,
Engineering and Environment

Gentlemen:

Evaluation of Tailings Pond-Embankment System
Moab, Utah
For Atlas Minerals

INTRODUCTION

In accordance with recent discussions among Mr. Gordon Swanby of Atlas Minerals, Mr. Peter Garcia of the U.S, Nuclear Regulatory Commission, and with Mr. James Boddy of Dames & Moore, we are presenting herewith our responses to the questions asked by Mr. Garcia regarding the proposed additions to the tailings pond at the Moab mill.

The following discussions should be adequate to answer these questions raised.

TAILINGS BEACH ALONG THE PERIMETER OF THE TAILINGS POND

A question was raised regarding the requirements for the tailings beach that is deposited adjacent to the interior side of the embankment of the tailings pond.

As stated in the February 15, 1978 report of the engineering design study, in order to control the phreatic surface within the tailings pond embankment, a minimum distance between the crest of the embankment and the nearest point of the ponded water must be maintained. It was recommended and assumed in the design that a minimum beach distance of 150 feet be maintained at all times along the entire perimeter of the tailings pond. Further, it is stated in Item 19 of Materials License SUA-917 issued to Atlas Minerals, that notwithstanding the provisions of Section 4.2 of the licensee's submittals specified in Condition 12 of the license, the licensee shall operate the tailings impoundment system in accordance with statements, representations, and conditions

specified in the licensee's application and enclosure of July 11, 1978. In the July 11, 1978 enclosure it is stated that the freeboard requirement for the entire embankment perimeter and the minimum crest-to-pond-water-edge distance along the embankment that had been used up until that time will essentially remain unchanged. Thus, a minimum freeboard requirement of six feet must be met at all locations. And, along the embankment, other than the west embankment area, an ultimate minimum distance of 150 feet from the crest of the embankment to the edge of the water must be maintained. At that time the 150-foot beach was measured from the existing embankment crest. Thus, the sand beach width measured from the new six-foot dike crest was only about 40 feet immediately following construction (in July, 1978) and an allowance of an initial period of time was made for reestablishing the 150-foot-wide beach as quickly as possible after the end of construction.

With the addition to the tailings pond of the new embankment raise it is Atlas's intent that a minimum distance of 150 feet from the crest of the embankment to the edge of the water be maintained at all times along the entire embankment perimeter, including the western embankment. Immediately following the end of construction of the new embankment raise, this criteria may not be met along the western embankment. However, the tailings discharge will be managed as to establish a 150-foot-wide beach as quickly as possible after the construction of the raise.

PROBABLE MAXIMUM FLOOD (PMF) CONDITIONS AT ATLAS MINERALS TAILINGS POND

INTRODUCTION

A question was asked by the NRC in regards to the flood storage capacity of the tailings pond system. The following discussion pertains to the Probable Maximum Flood for the tailings pond drainage area. For discussion pertaining to upstream or interior embankment slope protection against erosion and the capability of the tailings beach and embankment to resist sustained wind-wave activity, reference is made to the response to NRC's Question 5 in Atlas' May 4, 1978 submittal to the NRC.

PMF FOR TAILINGS POND DRAINAGE AREA

In accordance with the criteria recommended by the U.S. NRC[1/], surface runoff into a tailings pond containing toxic materials should be stored for

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1/ U.S. Nuclear Regulatory Commission, December, 1977, Design, Consturction, and Inspection of Embankment Retention Systems for Uranium Mills, Regulatory Guide 3.11.

evaporation. The tailings pond and retention system must be designed to provide the required storage at any particular time. The surcharge capacity of the pond should provide for storage of a PMF series, defined as the Probable Maximum Flood (PMF) and an antecedent flood equivalent to about 40 percent of the PMF, preceded or followed by a 100-year flood, assuming a tailings pond elevation at the start of the flood equivalent to that resulting from the average annual runoff. Also, adequate freeboard must be provided to include the prevention of overtopping by wind-generated waves.

The criteria used in a hydrological analysis of the stored storm water in the tailings pond are noted below:

1. A 150-foot minimum distance from the tailings embankment crest to the ponded water and a six-foot freeboard requirement under normal pool conditions is to be maintained.

2. A tailings beach wedge surface is to be maintained at an approximate slope of 2.4 percent from the sand beach elevation at the tailings embankment crest to the edge of the ponded water.

3. After construction of the new embankment raise, the tailings disposal system will have a continuous embankment along the entire perimeter of the area. Thus, the drainage area will be limited to the interior of the tailings disposal only.

Since extended storm rainfall periods are particularly important when runoff is to be controlled by storage, the PMF series considering the general type Probable Maximum Precipitation (PMP) storm would be more severe than the Probable Maximum Thunderstorm (PMTS) in determining inflow volume to the tailings pond. Estimated PMP amounts for the general storm and thunderstorm conditions for a six-hour duration from Hydrometeorological Report No. 49 2/ are 5.40 and 9.13 inches, respectively. However, the general-type PMP storm extended to a recommended 72-hour duration would be 13.63 inches, whereas, no extension for a duration longer than six hours is considered for the PMTS. In addition, the 100-year rainfall for a duration of six hours was estimated from Technical Paper No. 40 3/ to be 2.20 inches. Based on recommendations by the U.S. Soil Conservation Service, this value extended to a 36-hour duration (considered maximum) would be 3.67 inches. The combined design storm rainfall over the drainage area over the tailings pond would then be an estimated 22.75 inches, conservatively assuming no rainfall losses to evaporation or to ground water percolation. These assumptions are considered valid because the drainage area is nearly all water surface, with very little tributary drainage area

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2/ U.S. Dept. of Commerce & U.S. Dept. of Army, Sept., 1977, Probable Maximum Precipitation Estimates, Colorado River & Great Basin Drainages, Hydrometeorological Report No. 49.

3/ U.S.Dept. of Commerce, Weather Bureau, Jan., 1963, Rainfall Frequency Atlas of the U.S. for Duration of 30 Minutes to 24 Hours and Return Periods of 1 to 100 years, Technical Paper No. 40.

and evaporation during the storm sequence would be very small. The maximum water surface elevation of the pond under this design storm condition, would be about 1.9 feet above the existing ponded water under normal pond conditions. Under the proposed conditions of maintaining a six-foot minimum elevation difference from the embankment crest to the ponded water, adequate storage for total storm runoff from the Probable Maximum Flood series will be provided.

Yours very truly,

DAMES & MOORE

James R. Boddy

James R. Boddy
Project Manager

JRB/pc

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OCT 2 0 1979

DOCKET NO.: 40-3453

LICENSEE: Atlas Minerals

FACILITY: Moab Uranium Mill

SUBJECT: AMENDMENT NO. 1 TO SOURCE MATERIAL LICENSE SUA-917

1.0 INTRODUCTION

1.1 Background

By letter dated March 21, 1978, Atlas Minerals requested that Source Material License SUA-917 be amended to authorize the raising of the existing tailings retention system at their Moab Uranium Mill by constructing three separate 12 foot lifts. By amendment dated July 25, 1978, Atlas was given authorization to construct an interior embankment to provide tailings storage capacity while the March 21, 1978 amendment request was being evaluated. To make optimum use of the interior embankment constructed in spring 1978, Atlas requested, by letter dated August 23, 1979, that construction details presented in the original amendment request be revised. The revised specifications call for the construction of a single 12 foot lift on top of the interior embankment.

1.2 Proposed Action

The proposed action is the amendment of Source Material License SUA-917 to authorize modification of the existing tailings retention system as described in the licensee's submittal accompanying the August 23, 1979, request for revision of the original amendment request.

2.0 REVIEW SCOPE

The amendment request and accompanying enclosures were reviewed to evaluate the safety and environmental impacts associated with the proposed modification.

2.1 Safety Impacts

Safety impacts associated with the proposed modification were reviewed by the staff, with technical assistance being provided by consultants. Hydrologic aspects of the proposed modification were reviewed by NRR, while geotechnical aspects were reviewed by Dr. Terry R. Howard of the University of Idaho. The conclusion reached by the consultants was that the raise will result in safe embankments which meet the criteria of Regulatory Guide 3.11 (see Appendices A & B).

2.2 Environmental Impacts

The proposed raise will result in only a slight increase in seepage over the existing situation. This is because the raise and accompanying modifications will have two opposing effects on seepage. The increase in hydraulic head resulting from the raise will be partially offset by the reduction in pond area occuring as a result of the establishment of a 150 foot beach on the previously riprapped western embankment. The decrease in pond area will act to decrease seepage for two reasons: (1) there will be a corresponding decrease in wetted area through which seepage occurs, and (2) the establishment of the beach on the western embankment will restrict tailings solution to the center of the pond, where tailings slimes act to "seal" the pond bottom. Therefore, the net effect of the proposed raise on seepage is a very slight increase from approximately 92 gpm to 95 gpm. Calculations are presented in Appendix C.

The only effect of the proposed raise on the existing exposed beach area is that, due to the establishment of a beach on the western embankment, an additional 6.5 acres of tailings will be exposed. However, the total resulting beach area of approximately 25 acres will still be considerably less than the conservative estimate of 60 acres assumed in the Final Environmental Statement (FES, NUREG-0453) for assessing radiological airborne releases from the tailings area. In addition, the licensee is required by license condition to take measures to minimize dispersal of blowing tailings in areas not covered by standing water, and to document the effectivenss of the measures by means of a weekly, documented tailings area inspection.

3.0 CONCLUSION

The staff has concluded that issuance of Amendment No. 1 to Source Material License SUA-917 will not constitute an undue risk to the health and safety of the public.

Therefore, based on the insignificant incremental environmental impacts discussed above and pursuant to 10 CFR 51, Section 51.5, an environmental impact statement, negative declaration, or an environmental impact appraisal need not be prepared. Approval of a license amendment authorizing the proposed embankment raise is recommended, subject to the following license condition:

19. (a) The licensee shall construct the lift for the tailings embankment system to a maximum elevation of 4058 feet above mean sea level in accordance with the statements, representations, and commitments contained in the following documents:

1. "Report of Engineering Design Study, Additions to Tailings Pond-Embankment System, Moab, Utah for Atlas Minerals," dated February 15, 1978.

2. "Contract Specifications and Drawings for Tailings Embankment Expansion Project, Twelve-Foot Raise for Atlas Minerals, Moab, Utah," dated August, 1979.

(b) In addition to the compaction testing specified in the above documents, the licensee shall perform field gradation testing at the frequency of one (1) test for every 5,000 cubic yards of material placed.

(c) Should fill material in addition to that from the designated borrow area be required during construction, the licensee shall perform strength and gradation analyses prior to use to ensure that the additional fill material is at least as good as the designated borrow material. If the material is not, the licensee shall perform additional static and pseudo-static stability analyses to ensure that the embankment still meets the criteria of Regulatory Guide 3.11.

(d) Notwithstanding the frequency specified in the above documents, the licensee shall monitor piezometers on a daily basis during construction. Rises in water level shall be reported to the project engineer immediately for evaluation. Following construction, instrumentation monitoring shall be as specified in the documents listed in section (a) above.

(e) The lateral position of the three piezometers to be installed in the western embankment shall be within five feet of the centerline of the embankment. Piezometer spacing and tip elevation shall be as stated in item (2) of section (a) above.

(f) The licensee shall maintain at least six feet of freeboard between the embankment crest and the operating level of the ponded liquid. In addition, the licensee shall maintain a minimum beach of 150 feet between the ponded liquid and the dam embankments.

(g) The results of all quality control testing, as required in sections (a), (b), and (c) above, as well as any additional stability analyses required by section (c) shall be submitted to the Uranium Recovery Licensing Branch, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555 within six (6) months of completion of construction. Piezometer data obtained during construction at the frequency specified in section (d) shall also be submitted at that time.

Pete J. Garcia Jr.

Peter J. Garcia
Uranium Recovery Licensing Branch
Division of Waste Management

Approved by: John J. Linehan
John J. Linehan, Section Leader

Enclosures:

Appendix A - Geotechnical Review
(1) "Review of Expansion of Atlas Tailings Retention System," by Dr. Terry R. Howard, University of Idaho (via letter dated 7/11/79)
(2) "Review of Expansion of Atlas Tailings Retention System - Addendum No. 1," by Dr. Terry R. Howard, University of Idaho + "Contract Specifications and Drawings for Tailings Embankment Expansion Project, 12-Foot Raise for Atlas Minerals," by Dr. Terry R. Howard, University of Idaho (via letter dated 9/20/79)
(3) Letter from Dr. Terry R. Howard, University of Idaho, to Pete Garcia, USNRC, dated October 3, 1979

Appendix B - Hydrological Review
Memorandum for John Linehan from William S. Bivins, dated October 16, 1979

Appendix C - Seepage Analysis

APPENDIX A

Terry R. Howard, P.E.
Consulting Geotechnical Engineer
Route 4, Box 399
Moscow, Idaho 83843

July 11, 1979

Mr. Ross A. Scarano, Chief
Mill Licensing Branch
Waste Management Division
U. S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20555

Dear Mr. Scarano:

Please find enclosed ten (10) copies of my report entitled "Review of Expansion of Atlas Tailings Retention System". This work was completed under a letter agreement from Mr. John J. Wray of Argonne National Laboratory to Dr. Roy E. Williams, University of Idaho.

My review of the Dames and Moore reports as well as my site visit indicates that the results presented by Dames and Moore are acceptable. Specific recommendations for the design and monitoring of the proposed embankments are included at the end of my report.

Should you have any questions, please call.

Yours very truly,

Terry R. Howard

Terry R. Howard, P.E.

TRH:sl

Review of Expansion of Atlas Tailings Retention System

Atlas Uranium Mill

Moab, Utah

Introduction

This report contains the results of my site inspection of the Atlas facilities for tailings retention in Moab, Utah and my review of the written documents that pertain to the proposed expansion. The proposed expansion will involve raising the existing embankment an additional 36 feet in 12 foot increments. My site inspection took place on Tuesday, June 19, 1979, in the company of Mr. Larry Jacobs of Atlas Minerals and Mr. James Boddy from Dames and Moore Consulting Engineers. My review included discussions with these two gentlemen concerning both the operation of the tailings structure and the inspection program that is associated with the operation of that structure. We also discussed the program carried out by Dames and Moore to evaluate the stability of the structure both prior to and after construction of the new enclosure dikes.

The scope of work to be performed during this review was set forth in an attachment to a letter from John J. Wray from Argonne National Laboratories to Dr. Roy E. Williams at the University of Idaho. The review was to include but not be limited to:

a) Detailed assessment of site conditions including geology and seismology to evaluate their impact on the proposed tailing retention system.

b) Evaluation of detailed data concerning foundation and embankment materials, physical and mechanical properties

such as classification, shear strength, consolidation, permeability, compaction, piping and cracking susceptibility, and wind-water erosion characteristics in order to assess the adequacy of impoundment design.

c) Evaluation of the applicants assessments of settlement and acceleration value (percent g) corresponding to five hundred year recurrence interval earthquake which is to be the basis for all non static stability analyses.

d) Review of the static, psuedo-static, and dynamic stability analyses prepared by the applicant to insure that the requirements of Regulatory Guide 3.11 are met.

Submitted for the review by Argonne National Laboratories were the following:

1. "Report of Engineering Design Study Additions to Tailings Pond Embankment System, Moab, Utah, for Atlas Minerals", Dames and Moore Job Number 05467-018-06 dated February 15, 1978.
2. "Report of Supplementary Study, Geotechnical Evaluation of Tailings Pond - Embankment System, Moab, Utah, for Atlas Minerals", Dames and Moore Job Number 05467-023-06 dated February 16, 1979.
3. A copy of a report entitled, "Cyclic Triaxial Test Results, Atlas Minerals Company, Moab, Utah", attached to a letter to Mr. Richard P. Dennise from F. R. Brown, Technical Director, Department of the Army Waterways Experiment Station, Corps of Engineers, dated April 10, 1979.

In addition to the above reports, Dames and Moore with the permission of Atlas Mineral supplied the following:

1. "Safety Analysis Report" dated August 15, 1975, the Geology and Seismology portion only.
2. "Report of Remedial Construction Activities - Tailings Pond, Including the Western Embankment Improvements and the Northern Embankment Sub-drain", dated November 18, 1977.
3. Users Manual Program, EP1 (SLOPEB) Slope Stability Analysis by the Simplified Bishops Method, dated August 1974.
4. General office records and monitoring procedures were also reviewed in the Dames and Moore Salt Lake City office.

Results of Review

Field Investigation

Field work for the project has been ongoing since 1973. The results of this field work is summarized in the 1978 Dames and Moore report referenced above, and includes logs of test borings and test pits from Dames and Moore reports dated 1973, 1974, 1975 and 1977. The borings ranged in depth from 9½ up to 100 feet. Borings penetrated the tailings material and into the underlying naturally occurring sands and silts. The borings were further utilized for the installation of piezometers and for the installation of open stand pipes to measure water levels. All borings were drilled with truck-mounted rotary wash drilling equipment and sampling appeared to be performed to the general practice of the industry.

The 1979 report contains the logs of 28 additional exploratory borings that extend to depths of up to 130 feet. These borings were also advanced utilizing truck-mounted rotary drilling equipment and 16 of the borings were utilized to install piezometers or stand pipes. With the addition of these 28 borings, the spacing along the northeast and southern

embankments is a minimum of 250 feet between any two borings and the spacing on the extreme northwestern embankment is approximately 500 feet between any two borings.

Sampling was conducted in each of the test borings by a Dames and Moore soils engineer. Typical Dames and Moore samplers were used including an underwater type sampler and various kinds of split barrel samplers and piston samplers. The Standard Penetration test sampler was also used and test results were correlated to the Dames and Moore samplers. Field samples were collected and shipped to the Dames and Moore laboratory by conventional means during the field work contained in the 1978 report; samples for the 1979 field work were collected and then quickly frozen for shipment to the Dames and Moore San Francisco laboratory. The freezing process was meant to limit sample disturbance during the shipping process. This, of course, is extremely important for the fine grained silty and sandy soils involved.

Laboratory Testing

Laboratory testing performed on the site samples included moisture and density determinations, gradation analysis, permeability determination, Atterberg limit determination, consolidation testing, static triaxial compression testing and cyclic triaxial compression testing. The purpose of the laboratory testing was to obtain data for determining the strength and deformation characteristics of the insitu material. In addition compressibility and permeability were also required. The total of 30 consolidated, undrained triaxial compression test with pore pressure measurements were performed on the slime and sand tailings. Test results were interpreted in the normal procedure by plotting shear stress at failure versus the effective or total stress at failure. In all cases the test results

appeared to be interpreted toward the more conservative side.

Cyclic loaded triaxial tests were performed to evaluate the liquifaction potential of the tails. Both Dames and Moore and the Corps of Engineers performed such analyses. The results of the Dames and Moore liquifaction tests plot in reasonable agreement with the results of the Corps of Engineers tests. Again the value used in the analyses for determining liquifaction potential was directed toward the conservative side.

Slope Stability Studies

The slope stability studies for the proposed additional raising of the tailings embankment included studying the embankment stability as it exists during 1978 and then considering the additional 36 feet of embankment in the stability analysis for steady state seepage conditions and the end of construction conditions. Seven cross sections were studied and in each case the existing embankment steady state seepage factor of safety against sliding was determined and then the completed additional raise to the embankment was studied in terms of both "end of construction condition" and "steady state seepage conditions". These cases represent the critical period during the life of the embankment and conform to Regulatory Guide 3.11. For each of these cases both static conditions and dynamic conditions were studied.

Soil conditions were taken from the boring logs and ground water conditions in the embankment were taken from the piezometers and stand pipes established during the previous studies and the 1978-79 study. Water levels from both the piezometers and stand pipes indicate that the ground water system within the tailings embankment is not continuous.

That is, perched water tables exist throughout the embankment. However in the analysis Dames and Moore assumed that the water levels were continuous and that they reached an assumed maximum phreatic surface level. This level ran essentially from the ponding water to the toe of the slope at an elevation of approximately 39 to 80 feet. I believe this to be a relative conservative assumption.

In addition to the ground water levels within the embankment, consideration was also given to a build-up in pore pressure due to the loading caused by raising the embankment. Although consolidation testing indicated that the tails are relatively free draining, that is pore pressures are unlikely to build up, nonetheless Dames and Moore included the build-up of pore pressure equal to the weight of the additional raised section. Again I believe this to be relatively conservative.

In addition to static analysis, dynamic analysis for rigid body response to slope instability was also included. The approach to obtain a factor of safety for seismic conditions was to utilize a pseudo-static seismic loading, considering a horizontal acceleration of 0.08 g. Dames and Moore utilized the standard approach of analysis using the cross sections and water levels that were used for the static analysis. In addition, however, they also analyzed the most critical section, as determined by the above procedure, by the wedge failure analysis.

For most of the analysis the simplified Bishop procedure was employed using the Dames and Moore computer program EP1. This method was used to compute both the static minimum factor of safety for the embankment and also the seismic minimum factor of safety. Although a complete printout of the program was unavailable, I inspected the computer program documentation from Dames and Moore. This inspection plus discussions with

Mr. James Boddy of Dames and Moore indicates that the procedures used to examine the slope stability are within the accepted standards of practice. The program itself evidently corresponds to the Bishop modified method. The static analysis is determined by applying the horizontal g force to the centroid of each slice. In addition the minimum factor of safety for seismic conditions is separated from the static minimum factor of safety; that is a new failure plane and minimum factor of safety is obtained for the seismic event. Both of these items are in agreement with the standard of practice.

The Dames and Moore study indicates that the end of construction, steady state seepage and the static and seismic conditions for both are well within the minimum factors of safety required by the U. S. N. R. C. Regulatory Guide 3.11. It is my opinion that these factors of safety, as presented in the Dames and Moore 1979 report on Tables 1, 2, 3 and 4, have been obtained utilizing good geometric information, a conservative approach to shear strength data and a conservative approach to ground water levels. In addition it would appear that the seismic minimum factor of safety was obtained in a proper manner.

Liquifaction Studies

The postulated earthquake utilized in the Dames and Moore study was one of a Magnitude 6 event with a hypocentral distance of approximately 50 km and a maximum ground surface acceleration of 8 percent g. This postulated earthquake was obtained utilizing the geologic information as presented in the 1975 Dames and Moore "Risk Analysis Study", the Algermissen and Perkins, 1976, procedure for developing the seismic risk map for the contiguous states, and then Donovans, 1973 and 1978, published attenuation

relationships to compute the mean recurrence rate. From the level of effort involved, the personnel involved, and the results of the study, I would judge the design earthquake utilized in the Dames and Moore report to be adequate. This information was, of course, used in the above mentioned seismic minimum factors of safety and will be used in the liquifaction studies as reviewed below.

The potential for liquifaction at the site was studied utilizing two methods. The first method is generally referred to as the imperical liquifaction method and involves determining the standard penetration test values in the field and then a calculation of the induced cyclic stress ratio for the postulated design earthquake. A comparison is then made for equal cyclic stress ratios and an equal magnitude earthquake of the field standard penetration test values at sites where liquifaction has either occurred or not occurred and for the standard penetration test values at the in-question site. Both field and laboratory studies have been used to imperically establish the lower bound of penetration resistance for this kind of approach. The relationship has been established by Seed in his 1976 state of the art paper. The factors of safety calculated by this approach indicate that liquifaction of the material underlying the embankment dams constructed by the upstream method is very unlikely.

In addition to the imperical approach, Dames and Moore performed a liquifaction analysis based upon the results of cyclic triaxial shear testing. This method involves simply computing the cyclic shear stresses that could be produced by the design earthquake and comparing those shear stressess to the laboratory results that represent specific stresses that will cause soil liquifaction at specific depths. This method is again presented in the state of the art paper by Seed in 1976. Utilizing this

technique, factors of safety against liquifaction were computed to be above 1.9 in all cases.

The results of the two procedures utilized by Dames and Moore to determine liquifaction potential at the site indicate that liquifaction is highly unlikely. However the results of this investigation were based upon laboratory samples that were taken from the insitu material. The Dames and Moore analysis then assumes that new material will be as good or better than the insitu material and that the water table assumed for the analysis will raise as assumed. Changes of grind will give different strength parameters for the material and will have to be noted in the inspection program to determine if the design assumptions have been or are continuing to be met.

Conclusions of Review

My review of the Dames and Moore 1978 and 1979 reports to Atlas Minerals have indicated the following:

1. Good field exploration and sampling techniques were utilized.
2. Samples were transported to the laboratory for testing with a minimum of disturbance.
3. The laboratory results of strength testing indicate reasonable values for the materials involved.
4. In all cases Dames and Moore engineers have utilized a conservative approach to obtaining factor of safety values.
5. The state of the art was utilized in the analysis.
6. Enough information was obtained during the field and laboratory portions of the analysis to obtain accurate values or to make reasonable assumptions concerning the

geometry, the water table configuration and the strength parameters involved to calculate factors of safety for slope stability.

7. Both dynamic analysis and liquifaction studies were conducted in a suitable manner and using "State of the Art" procedures.

Based upon the above factors, it is my opinion that the results of the 1979 Dames and Moore report, "Supplementary Study Geotechnical Evaluation of Tailings Pond-Embankment System, Moab, Utah, for Atlas Minerals", can be accepted as reported. Please be advised however that this is only an exploration report for the purpose of design and construction of the proposed three level embankment rise. Once the design is completed, additional review should take place to be assured that the design conforms to the results of the exploration program. In addition construction should also be monitored to provide assurance that the design criteria are being met and that the design assumptions are being met.

Both the design and construction are only as good as the assumptions that are necessary to make the design. A strict monitoring program is necessary in order to evaluate the design assumptions and assure that the design assumptions are in fact being met. My site visit indicated that such a monitoring program is ongoing. In fact, an inspector generally traverses the site every two hours. In addition pore pressure and water level measurements are obtained from 25 piezometers and stand pipes and transmitted to Mr. James Boddy of Dames and Moore for his evaluation. During my office visit in the Dames and Moore Salt Lake City office, I asked Mr. Boddy what he did with this information and he indicated that as soon as it was obtained it was plotted. This seemed to be the case and of course is extremely necessary in order to make the proper evaluation.

The amount of water level information to date is adequate for the north, east and south embankment areas. However, there are no piezometers along the western embankment. I therefore recommend that three piezometers be installed along the western embankment in order to monitor water levels during and after the proposed embankment construction.

In addition the western embankment at present contains a "chimney drain" system to guard against piping. I recommend that the chimney drain be continued upward during the construction of at least the 1st and 2nd raises. The above recommended three piezometers can be used to evaluate the worth of continuing the chimney drain for the 3rd stage.

Present operational plans call for regulating flow points into the pond such that a beach is built along the north, east, and south embankment areas. The objective is to retain the pond water level away from the dike by 150 feet. Provided that this occurs, no erosion protection will be needed. However, the western embankment will be exposed to pond water and must be rip rap protected.

The U. S. Nuclear Regulatory Commission should be assured that the necessary monitoring program be continued both during the construction phase and well after the construction has been completed. A qualified geotechnical engineering firm such as Dames and Moore should be incharge of collecting and evaluating the data. The evaluation should take place immediately upon collection of these data. This is necessary in order to evaluate both the construction and end of construction factors of safety and then to evaluate the steady state seepage factors of safety.

In addition there is evidence of seepage on the present embankment. The seepage should be continually monitored to be assured that the seepage will not result in detrimental effects to the embankment. This is certainly

necessary during the proposed construction activity.

Should you have any questions or require further explanation of the content of this report, please call.

Terry R. Howard, P.E.
Consulting Geotechnical Engineer
Route 4, Box 399
Moscow, Idaho 83843

September 20, 1979

Mr. Ross A. Scarano
Chief
Mill Licensing Branch
Waste Management Division
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20555

Dear Mr. Scarano:

Please find enclosed ten copies of my report entitled, "Review of Contract Specifications and Drawings for Tailings Embankment Expansion Project, 12-foot Raise, for Atlas Minerals, Moab, Utah". This work was completed under a letter of agreement from Mr. John J. Wray of Argonne National Laboratory to Dr. Roy E. Williams, University of Idaho.

My review of the Dames and Moore "Contract Specifications and Drawings" as well as personal discussions with Dames and Moore personnel indicates that this document is generally acceptable. However, several questions as outlined in my report require further amplification. Should you have questions about the content of my review, please feel free to call.

In addition please find enclosed ten copies of my report entitled, "Review of Expansion of Atlas Tailings Retention System, Addendum No. 1". The intent of this report is to add and clarify several points in the original document. Again should you have any questions concerning this report, please call.

Yours very truly,

Terry R. Howard

Terry R. Howard, P.E.

TRH:sl

enc.

Review of Expansion of Atlas Tailings Retention System

Atlas Uranium Mill

Moab, Utah

Addendum No. 1

The objective of this addendum to the original above referenced report is to include in that report items which have been inadvertently left out. These items are listed numerically below.

1. Foundation conditions. The foundation soils for the embankment were tested in borings B-1 through B-19. Each of these borings penetrated into the naturally occurring material below the embankment. The materials range from a red silty sand to clay to sandstone and bedrock. Blow counts for the sandy materials and clay materials are relatively high and the material will be confined by the embankment itself. In addition stability analyses performed by Dames and Moore indicate that base failure will not be a problem. This indication comes from the fact that the minimum factors of safety occur tangent to or slightly into the base materials. Failure, if it were to occur, according to the Dames and Moore stability analyses would then occur in the man deposited materials. It is my conclusion then that the foundation is adequate to support the imposed loading due to the planned 36 feet rise. In addition it is my opinion that the ground water table below the tailings pile will not be affected by the stress increase due to the imposed loading.
2. Laboratory testing. Laboratory testing was performed on both the slime and sand tailings as well as the fill material taken from

on-site. Test results were interpreted in the normal procedure by plotting shear stress of failure versus the effective or total stress of failure. In all cases the test results appear to be interpreted toward the more conservative side.

3. Liquifaction studies. The postulated earthquake utilized in the Dames and Moore study was one of a magnitude 6 event with a hypo-central distance of approximately 50 kilometers and a maximum ground surface acceleration of 8 percent G. This design earthquake acceleration corresponds to the required one in 500 year recurrence interval.

4. Monitoring piezometers. Performance of the embankment tends to be a function of the post-construction monitoring program. I inspected the monitoring program while visiting the site in Moab and also inspected the use of that information by Dames and Moore during my visit in their Salt Lake City office. Atlas Minerals requires one of their people to inspect the site on an hourly basis. Piezometer readings take place on a weekly basis and that information is sent directly to Mr. Jim Boddy of the Dames and Moore Salt Lake City office. Mr. Boddy then immediately plots that information and judges whether a significant change in water level has occurred. This is in my opinion an excellent post-construction monitoring program and is adequate to monitor the stability of the tailings pond at Moab.

Should you have any additional questions or require further explanation of the content of this report or the original report, please call.

Contract Specifications and Drawings for Tailings

Embankment Expansion Project

12-Foot Raise for Atlas Minerals

Moab, Utah

This report contains the results of my review of the above mentioned report. In addition to reviewing this document I also met with Mr. James Boddy of Dames and Moore, project manager for the project. The meeting took place to review the first draft of the contract specifications and drawings and the final design of the embankment expansion. This meeting and subsequent discussion resulted in the finalized and above referenced document.

One of the problems brought out during this discussion was that the initial plan called for a three stage embankment development with each raise 12 feet high beginning at elevation 4040 feet. All preceding stability analyses were performed accordingly. The final plans, however, included one stage of construction for a total raise height of 18 feet based on the 4040 feet elevation. This, of course, is a slight modification to the original study and therefore (I felt) required a further stability study utilizing the 18-foot high embankment.

An indication that this study has been accomplished is contained in a letter of transmittal for the plans and specification to Mr. Gordon Swanby of Atlas Minerals dated August 34, 1979 from Dames and Moore. This letter states that the slope stability analysis was performed and that a minimum factor of safety for the western embankment with a raise of the embankment crest to elevation 4058 feet is 1.58 and 1.24 for the static

and seismic conditions, respectively. Please be advised that I have not reviewed this part of the work.

The second major change in the original design, as a result of our meeting, was in the chimney drain on the western embankment. The original plan called for a continuation of the existing chimney drain into the planned embankment raise. This would have resulted in a very complex construction problem, probably to the extent that the drain, once completed would not have functioned properly. The final plans deleted the chimney drain extension. In my opinion this is a superior design since it will both eliminate construction problems and provide a relatively simple embankment. The deletion of the chimney drain, however, is based on the assumption that the pond water level will be contained back from the embankment 150 feet as it will be on the other three sides of the pond area. This assumption should be detailed in the working plans for the tailings pond, so that the assumption becomes fact.

My review of the Contract Specifications and Drawings indicates that the document in general is acceptable. However, several items need to be clarified.

Item 1

The soils engineer has estimated that approximately 286,000 cubic yards of material will be required to raise the embankment to the plan elevation and that approximately this amount is contained in the designated borrow area. However, assurance that the borrow area material meets the strength requirements for the embankment material should be provided during the excavation process. Since strength is related to the gradation of sandy materials, the strength can be checked by performing gradation

analysis. Therefore field gradation testing should be required for every 4,000 to 5,000 cubic yards of material placed. The level of compaction testing specified is adequate.

Item 2

The contract documents also indicate that should more than 286,000 cubic yards of material be required or should the borrow material not contain a sufficient amount, a stockpile of material will be provided to the contractor. However, no indication of either strength testing or gradational testing has been provided for that material. Therefore should the stockpile material be necessary, strength and gradation analysis should be provided prior to its use.

Item 3

The location of the three new piezometers on the western embankment has not been specified clearly enough. The elevation of the tip has been specified to be five feet below the bottom of the existing chimney drain. This, in my opinion, is a reasonable tip elevation. However, the readings obtained from the piezometer will be dependent upon the lateral position of the tip. Therefore Dames and Moore should specify more clearly the lateral location of each piezometer. It is my recommendation that these three piezometers be located within five feet of the center line of the western embankment and that the tip elevation be as specified in the contract specifications. The spread of the three piezometers along the western embankment, in my opinion, is adequate.

In addition to outlining procedures to correct the above items Dames and Moore should be questioned on their procedure to monitor the existing piezometers to assure that the assumptions made during the design

of the embankment raise are being met. Piezometers should be monitored on a daily basis during the construction program and if a water level raise is encountered, the engineer of the project should be notified immediately. Finally, as mentioned above, some provisions should be made during the construction process to keep the pond water from the western embankment. This will assure that erosion on the newly implaced embankment does not occur and that ground water within the embankment does not reach high levels.

Should you have any questions or require additional information, please contact me.

Terry R. Howard, P. E.
Consulting Geotechnical Engineer
Route 4, Box 399
Moscow, Idaho 83843

October 3, 1979

Mr. Pete Garcia
Mill Liscensing Branch
Waste Management Division
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20555

Dear Mr. Garcia:

This letter is in regard to my report entitled "Review of Contract Specifications and Drawings for Tailings Embankment Expansion Project, 12-foot Raise for Atlas Minerals, Moab, Utah." In this report I pointed out that a further stability study of the proposed 18-foot high embankment should be required, but that I had not reviewed that work. Since then I have received a copy of the computer print out of such a study from Mr. James Boddy of Dames and Moore.

I have reviewed the Dames and Moore stability analysis and find it to be satisfactory. Both the static and seismic stability was obtained for an embankment section judged to be the most critical. The factors of safety for these two conditions are 1.58 and 1.24 respectively. These safety factors meet the requirements of USNRC Regulatory Guide 3.11.

Should you have any questions, please contact me. It has been a pleasure working with you on this project.

Yours very truly,

Terry R. Howard

TRH:sl

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OCT 16 1979

MEMORANDUM FOR: John Linehan, Leader
Uranium Recovery Licensing Branch

THRU: L. G. Hulman, Chief
Hydrology-Meteorology Branch, DSE

FROM: William S. Bivins, Leader
Hydrologic Engineering Section, HMB, DSE

SUBJECT: ATLAS URANIUM MILL - MOAB, UTAH - HYDROLOGIC ENGINEERING SUMMARY

Enclosed is a hydrologic engineering summary for the subject uranium mill, prepared by T. L. Johnson. This report principally addresses the flooding and safety criteria as outlined in Regulatory Guide 3.11, which was issued subsequent to our initial review of this facility in 1974.

William S. Bivins

William S. Bivins, Leader
Hydrologic Engineering Section
Hydrology-Meteorology Branch
Division of Site Safety and
Environmental Analysis

Enclosure:
As Stated

cc: w/enclosure
J. Martin
D. Muller
W. Kreger
R. Jackson
W. Bivins
L. Heller
J. Greeves
P. Garcia
T. Johnson

HYDROLOGIC ENGINEERING SUMMARY
ATLAS URANIUM MILL
MOAB, UTAH

I. Hydrologic Description

The site for the Atlas Uranium Mill tailings dam is located about three miles northwest of Moab, Utah, along the Colorado River. The drainage area of the Colorado River at this location is about 25,000 square miles. The river is regulated by dams that provide irrigation, recreation, power and flood control.

The site is also immediately adjacent to Moab Wash, a relatively steep, perennial stream draining about six square miles of arid canyons. The Moab Wash Canyon terminates in an alluvial fan on which the tailings dam is located.

II. Flood Potential

We have assessed the potential for flooding, overtopping, erosion, and failure of the tailings dam from several sources: (1) a Probable Maximum Flood (PMF) on the Colorado River, (2) a PMF on Moab Wash, (3) local intense precipitation as severe as the Probable Maximum Precipitation (PMP) on the area draining into the tailings pond, and (4) erosion of upstream embankment by wind waves.

(1) Colorado River PMF

We evaluated the licensee's estimate of the PMF on the Colorado River, and found the estimate to be non-conservative. Based on our independent analyses, we calculated the Colorado River PMF at the site to be about 300,000 cfs. This estimate was developed by adjusting the Standard Project Flood (SPF) estimate of the Corps of Engineers. Detailed

estimates of the PMF at this location are unavailable and would require extensive and detailed computations; our estimate, however, is conservative.

Based on independent evaluations of water surface profiles and overbank flow velocities of the Colorado River, we conclude that erosive velocities would not occur at the tailings dam. We conclude that the toe of the dam would be inundated by several feet of water, but due to site topography and the large flood water storage area available on the other side of the river, no damaging velocities would exist at the toe of the tailings dam due to flooding on the Colorado River.

(2) Moab Wash PMF

We reviewed analyses of flooding on Moab Wash submitted by the licensee's consultants and found these analyses to be inadequate. The principal staff concern was long-term protection of the toe of the tailings against the erosive flood velocities produced in Moab Wash by an occurrence of the PMF.

Based on our independent analyses, we conclude that extensive erosion protection will be required to resist erosive velocities created in Moab Wash at the toe of the tailing dam. This protection will be required along the entire northeastern toe, of the dam. Staff requirements for erosion protection were discussed with the licensee several times. The licensee

agreed to accept the staff's recommendations, and has committed to install the required erosion protection within the next three years. The final design will be submitted for our review and approval by January 1, 1980. We conclude that the proposal committted to meet the suggested criteria of Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills".

After cessation of mill operations, continued maintenance and monitoring of the erosion protection will be required to assure its function. The capability of riprap to withstand long-term erosion and degradation cannot be guaranteed over a long period of time. We recommend that provisions be made to have the abandoned tailings pile and erosion protection inspected periodically. If degradation is found, the damaged areas should be repaired to their original design configuration.

(3) Local PMP Into Tailings Reservoir

The licensee proposes to provide six feet of freeboard above maximum pool level at all times to allow for storage of local runoff. We have evaluated the runoff potential for the small watershed draining into the tailings reservoir. Based on these independent evaluations, we conclude that the reservoir will safely impound the entire runoff from a PMF series and that the freeboard meets the suggested criteria of Regulatory Guide 3.11.

(4) Erosion of Upstream Embankment Slope

At our request, the licensee and his consultants provided analyses to document the capability of the proposed tailings beach to resist wave damage during severe storms. We concur with these analyses which indicate that a tailings beach with a width of 150 feet is needed to protect the dam. The 150-foot requirement should be made a license condition. Formation of the tailings beach at this location should be started as soon as practicable and should be inspected by I&E to assure that its formation is being accomplished properly.

APPENDIX C

SEEPAGE ANALYSIS

This seepage analysis is based upon results previously presented in the FES for the Moab mill. The analysis assumes that the seepage rate is proportional to the hydraulic head. Data used in the analysis is as follows:

average pond bottom elevation = 3970

pond water elevation (existing) = 4040

pond water elevation (proposed) = 4052

pond acreage (existing) = 54 acres (FES)

decrease in pond area due to beach on western embankment = 6.5 acres

pond acreage (proposed) = 54-6.5 = 47.5 acres

seepage rate (existing) = 1.7 gpm/acre (FES)

Computations are as follows:

hydraulic head (existing) = 4040 - 3970 = 70 feet

hydraulic head (proposed) = 4052 - 3970 = 82 feet

$$\text{increase in hydraulic head} = \frac{82-70}{70} \times 100 = 17\%$$

$\therefore$ future seepage rate = 1.17 x 1.7 = 2.0 gpm/acre

existing total seepage = 54 (1.7) = 91.8 gpm

future total seepage = 47.5 (2.0) = 95.0 gpm

Radiation Survey of Areas Immediately Surrounding the Atlas Minerals Tailings Pond, Moab, Utah

1.0 Introduction

One of the NRC license conditions for Atlas Minerals' uranium mill at Moab, Utah requires that a special survey be taken to determine the magnitude and location of any tailings materials which may in the past have been deposited away from the tailings pond. Ford, Bacon & Davis Utah Inc. (FBDU) performed this survey for Atlas Minerals September 18-19, 1979.

In accordance with the license conditions, eight traverses were made along the major compass directions away from the tailings pond. In addition, five background readings were made at distances ranging from 1.3 to 3.5 miles from the tailings pond to the measurement location. Charcoal canisters were placed at the five background locations to determine the 24-hour integrated average flux at these locations.

Each traverse was started at the edge of the pond and was aligned using standard surveyor methods. Gamma radiation levels were measured at the edge of the pile and normally at 100 foot intervals horizontally from the pond until exposure rates were below about 20 ur/hr above background at one meter above the soil surface.

2.0 Instrumentation

Two forms of measurement were used simultaneously. Each will be described.

2.1 Micro R Meters

A Ludlum Model 125 Micro R meter was used to determine gamma levels at one meter above the soil surface. This instrument consists of a sodium iodide (NaI) crystal optically coupled to a photomultiplier tube, with appropriate readout. The most sensitive scale on this unit is 0-3 mR/hr, and the highest scale is 0-3000 μR/hr (0-3 mR/hr). Accuracy of the instrument is within ± 10% at higher levels but may be only within ± 50% at levels near background.

2.2 "Delta" Measurements

The second form of measurement used provides a more precise method of determining the presence of radioactive tailings in a particular location. A lead-collimated gamma scintillation probe similar to the detection unit of the micro R meter is connected to a Ludlum Model 2200 portable scaler. The probe

is held about 2-3 inches above the soil surface and a count is made for a predetermined period of time (e.g., 30 seconds). A ½-inch thick lead shield is then inserted between the scintillation probe and the soil, and a new count is taken. The difference in the two counts (called "delta") indicates the presence of radioactive materials. A small "delta" exists even at background locations due to the presence of trace concentrations of uranium and other naturally occuring radionuclides in all soils. The "delta" is produced from the attenuation by the lead shield of the relatively low energy gammas emitted by materials in the uranium decay chain.

3.0 Background Radiation

Background gamma levels were measured at five locations in the general area. Readings ranged from 6 μR/hr to 13 μR/hr, with an average of 10.3 μR/hr. "Delta" measurements averaged about 200 counts per minute, except for one measurement where the count was taken relatively near a brick home. This value may be taken as a reasonably accurate value for the background, and should be considered to be equivalent to about 10 μR/hr.

Radon flux measurements at the five background locations ranged from 0.28pCi/m^2-sec to 0.56pCi/m^2-sec, with an average of 0.41pCi/m^2-sec.

Table I indicates background locations and gamma readings at these sites, together with background radon flux measured at these locations.

4.0 Survey Results

Special situations were observed along each traverse. Each traverse will be discussed separately.

4.1 North Traverse

The north traverse passed through an intermittent stream bed about 400 feet from the pond. Levels in this area were reduced, but still were above background. A reading of 60 μR/hr was measured at the edge of U.S. Highway 163, about 900 feet from the pile. This was the highest reading since the stream bed. This elevated reading is probably due to ore spillage from trucks driving along the highway, rather than from tailings deposition. The north traverse entered Arches National Park at the toe of the cliffs just north of the highway, and readings at background levels were achieved about 1400 feet north of the tailings pond, a short distance up the hill.

4.2 Northeast Traverse

An ore storage pile was located approximately 500 feet from tailings pond along the northeast traverse and the mill was

just beyond the ore pile. No readings were taken in the mill area, since any activity due to tailings deposition would be completely masked by radiation from the ore processing operations. Beyond the mill gamma levels gradually diminished in intensity until background levels were reached about 2200 feet from the pond, an exception was observed at both sides of U.S. Highway 163, where gross gamma levels as high as 190uR/hr were detected.

4.3 East Traverse

The east traverse passed near an inactive evaporation pond. A special measurement taken inside the pond indicated levels of 285uR/hr. This traverse passed near the mill "boneyard" and into tamarack bushes near the Colorado River. Gamma levels remained slightly elevated (35-55uR/hr) for about 900 feet, and then dropped to background near the bank of the Colorado River. The survey was continued on the opposite side of the river, at a distance of 2000 feet, with no readings above background.

4.4 Southeast Traverse

The southeast traverse proved to be the most difficult to complete because of the thick growth of tamarack brush between the tailings pond and the Colorado River. It also had the largest amount of contamination of any traverse, both in intensity and in area. Readings increased steadily from 195uR/hr at the edge of the pond to 1750uR/hr (1.75mR/hr) 400 feet from the pond. From this point readings declined slowly until the protective fence was reached, 860 feet from the tailings pond. Throughout this area white tailings material was present at the soil surface. This did not have the appearance of being windblown, but rather appeared to have been wetted. Beyond the fence readings decreased rapidly, reaching background near the Colorado River. No soil samples were collected in the area for this survey. However, these readings do not exclude the possibility that tailings have reached the river. Although a study of soil samples could be made to check this as a possible contamination pathway, we don't believe such a study is warranted because of the large dilution factor of the river.

4.5 South Traverse

The highest gamma reading detected during this survey was in an old evaporation pond located on the south traverse, about 300 feet from the tailings pond. A reading of 2.8mR/hr was observed. From this point readings decreased steadily without ever reaching background. At a distance of 1700 feet from the tailings pond readings suddenly increased. Visual investigation showed a small surface outcropping of uranium mineral at this point. Radiation from this ore body undoubtedly overshadows any radiation from fugitive tailings in this area.

4.6 Southwest Traverse

Readings along the southwest traverse decreased in general with decreasing distance from the tailings pond. A "hot spot" discovered at 200 feet from the pond, was the only anomaly. This traverse was essentially up the face of a hill with a slope greater than 45 degrees. Background was reached 800 feet from the pond.

4.7 West Traverse

The west traverse was the shortest of the traverses, only 600 feet to background. Levels were low at all points. This probably is due to the very steep slope of the cliff in this area, severely limiting the capability of the wind to carry the tailings up the hill.

4.8 Northwest Traverse

The northwest traverse passed through a borrow pit from which soil for the tailings pond dikes had been taken. Levels were quite low through this shallow pit, increasing to about 40μR/hr beyond the pit. A reading of 75μR/hr was detected at the side of the Potash Road. Levels dropped steadily thereafter, and were at background by 1700 feet from the tailings pond.

4.9 Special Survey

At the request of Atlas Minerals, one measurement was taken at a small evaporation pond just east of the tailings, located between the east and northeast traverse lines. Gamma levels at this pond were found to be 600μR/hr at one meter above the surface.

5.0 Discussion and Summary

Levels measured by FBDU's micro R meter at one meter above the surface were compared with the "delta" counts at each measurement location. In every instance a large "delta" was linked with a higher reading on the micro R meter, while a small "delta" (200-300 counts/minute) was measured at background and very low levels. The direct correspondence at all levels provides assurance that the direct reading gamma levels are reliable.

As a further check the FBDU micro R meter was compared with an Atlas Minerals Eberline micro R meter at different radiation levels. On an average the FBDU meter read higher by a factor of 1.4. FBDU's meter had been calibrated by the manufacturer within the previous month, while the Atlas meter was calibrated by Atlas personnelwithin the same time period. Both instruments were calibrated to 137Cs sources. Table II indicates the different ratios at various radiation levels.

A copy of FBDU's raw data is attached as Appendix A, in response to Atlas Minerals' request.

Figure 1 indicates the results of the survey in the eight compass directions. The pond configuration and Atlas property boundaries were determined from maps furnished by Atlas Minerals. It can be seen that there is very little increase in radiation readings off Atlas property wich can be attributed to migrating tailings, either windblown or from seepage. Consideration should be given to cleaning up or covering areas within Atlas property where contamination is present, such as inactive evaporation ponds or demonstrated seepage areas.

TABLE I

BACKGROUND GAMMA AND RADON SURVEYS

	Location	Scint. Detector No Lead (c/m)	Scint. Detector With Lead (c/m)	"Delta" Measurements	Micro R Meter Reading uR/hr	Rn flux pCi/m^2-sec
1	Small sand dune, 1.3 mi NW of plant entrance	673	505	168	10	0.34
2	~3 mi SW of site, along road to Potash; near Bowtie Arch	903	667	236	10.5	0.56
3	~3 mi E of site, along State 128, near Negro Bill Canyon	576	396	180	6	0.49
4*	425 Huntridge, in Moab, 3 mi SE of site	1208	749	459	13	0.28
5	Motel, ~3.5 mi SE of site	963	745	218	12	0.36

*This reading was taken near a brick home that could have increased the readings taken.

TABLE II

Comparison - FBDU Micro R Meter to Atlas Micro R Meter

FBDU Reading	Atlas Reading	Ratio
160	115	1.4
17	12	1.4
15	10	1.5

FIGURE 1. ATLAS MINERALS FUGITIVE TAILINGS SURVEY, MOAB, UTAH

REPORT ON CONSTRUCTION INSPECTION AND EMBANKMENT MONITORING PROGRAM TAILINGS DAM EXPANSION PROJECT MOAB MILL MOAB, UTAH FOR ATLAS MINERALS

Dames & Moore Job No. 05467-027-06
Salt Lake City, Utah
February 22, 1980

February 22, 1980

Atlas Minerals
Division of Atlas Corporation
2506 Prudential Plaza
1050 17th Street
Denver, Colorado 80265

Attention: Mr. Gordon Swanby

Gentlemen:

Transmitted herewith are six copies of our report entitled "Report on Construction Inspection and Embankment Monitoring Program, Tailings Dam Expansion Project, Moab Mill, Moab, Utah, For Atlas Minerals." It is our understanding that one or two copies of this report will be transmitted to the Nuclear Regulatory Commission for their review. Two additional copies have been sent under separate cover to Larry Jacobs at the Atlas Mill.

We appreciate the opportunity of performing this study for you.

Yours very truly,

JAMES & MOORE

James R. Boddy

James R. Boddy
Project Manager
Professional Engineer No. 4445
State of Utah

JRB/jb

REPORT ON CONSTRUCTION INSPECTION
AND EMBANKMENT MONITORING PROGRAM
TAILINGS DAM EXPANSION PROJECT
MOAB MILL
MOAB, UTAH
FOR ATLAS MINERALS

INTRODUCTION

This report presents the results of our construction inspection and embankment monitoring program performed during the tailings dam expansion project at the Moab Mill for Atlas Minerals. The construction inspection program consisted of supervising the preparation and placement of compacted structural fill required to raise the existing tailings dam crest to elevation 4,058 feet. The embankment monitoring program primarily consisted of monitoring the existing embankment piezometers and the construction of three additional piezometers along the western embankment. The layout of the tailings dam with the approximate location of the borrow area and the new embankment addition is presented on Plate 1, Plot Plan.

The construction inspection and embankment monitoring programs generally conformed to the project specifications and in accordance with an addendum to the Nuclear Regulatory License No. SUA-917 issued to Atlas Minerals on October 29,1979.

DAM DESIGN AND SPECIFICATIONS

Specifications followed for construction of the final dam stages are generally as presented in the following reports:

> "Report of Engineering Design Study Additions to Tailings Pond Embankment System, Moab, Utah, For Atlas Minerals," Dames & Moore, Job No. 05467-018-06, dated February 13, 1978.
>
> "Report of Supplementary Study, Geotechnical Evaluation of Tailing Pond Embankment System, Moab, Utah, For Atlas Minerals," Dames & Moore, Job No. 05467-023-06, dated February 16, 1979.
>
> "Contract Specification and Drawings for Tailings Embankment Expansion Project, Twelve Foot Raise, For Atlas Minerals, Moab, Utah," Dames & Moore, Job No. 05467-026-06, dated August, 1979.

These reports were reviewed by the Nuclear Regulatory Commission with discussions authored by Dr. Terry Howard, Consulting Geotechnical Engineer as follows:

> "Review of Expansion of Atlas tailings Retention System, Atlas Uranium Mill, Moab, Utah," Dr. Terry Howard, P.E., dated July 11, 1979.
>
> "Review of Contract Specifications and Drawings for Tailing Embankment, Atlas Uranium Mill, Moab, Utah," Dr. Terry Howard, P.E., dated September 20, 1979.
>
> "Review of Expansion of Atlas tailings Retention System, Addendum No. 1, Atlas Uranium Mill, Moab, Utah," Dr. Terry Howard, P.E., dated September 1979.

In brief, the design of the embankment addition required the placement of a silty sand fill obtained from an adjacent borrow area outlined on Plate 1. The western portion of the embankment was to be constructed utilizing a "downstream" form of construction with the remaining portion utilizing "upstream" construction.

The crest of the embankment was to be established at elevation 4,058 feet and was to be constructed in accordance with the lines and grades presented in the aforementioned reports.

EARTHWORK OPERATIONS

GENERAL

The general contractor for the earthwork operations was Nielson Incorporation from Cortez, Colorado. Prinicipal construction operations commenced with foundation stripping operations on about October 22, 1979 and extended through final cleanup operations on December 14, 1979. The work was performed basically on an eight hour day, five days a week schedule with an estimated 293,000 cubic yards of fill material placed in a total of approximately 40 working days. Fill placement rates were typically about 6,000 to 9,000 cubic yards per day.

Weather conditions were such that there were only occassional brief delays due to inclement weather. Freezing was not considered a significant problem and no special procedures for removing frost were required.

SURVEYING

A stationing system was established by the contractor to provide survey control for the embankment construction.

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* American Association of State Highway and Transporation Officials.

Initially, the toes of the embankment addition (both inboard and outboard toes) were staked at least every 100 feet and fill requirements were written on the stakes. To monitor the fill progress, periodic surveys were performed during construction. All field control tests were located using this survey reference.

EQUIPMENT

Fill hauling equipment consisted of four to six Caterpillar 633 scrapers. Within the borrow area, one or two Caterpillar D6 dozers were utilized to sort oversized rocks and to maintain proper grades. One or two graders were utilized for the spreading and general grading of the placed fill. One or two 40 ton rubber tire compactors were used to aid the compaction operation. A Caterpillar, 631 B, 10,000 magnum water truck was available on site to provide additional moisture to the fill soils as required.

EARTHWORK PROCEDURES

Foundation preparation for the proposed embankment generally consisted of stripping vegetation and organic soils, scarifying the surficial soils and recompacting them to the specifications for compacted fill. However, in areas where the embankment addition was to be constructed upon the tailings sand beach, scarification and compaction prior to fill placement was not possible due to the inability of the tailings sand to support the construction equipment. To construct the embankment

addition on the beach, scrapers would haul and dump fill material on nearly firm ground and dozers would push the fill out onto the beach. This process resulted in an initial lift which varied from 8 to 24 inches.

The embankment fill was obtained from the adjacent borrow area designated on Plate 1. The fill material was brought to near optimum moisture content by prewetting the borrow area with a system of irrigation sprinklers. Scrapers were utilized to transport the fill to the tailings pond where it was bladed and spread in maximum eight-inch loose lifts. Compaction was generally accomplished through a combination of wheel rolling by scrapers and the systematic routing of the 40 ton compactors. Additional moisture was added as needed by wetting the placed fill with a water truck. Occasionally, oversized rocks were observed within the fill. When encountered, such material was bladed from the fill by available graders.

EARTHWORK OBSERVATIONS AND FIELD CONTROL TESTING

GENERAL

Earthwork operations were performed under the direct supervision of a full time earthwork technician, Mr. Neal Backman of American Testing Laboratories, Inc., of Salt Lake City, Utah. American Testing was under subcontract to Dames & Moore and their services began with the commencement of earthwork operations and extended through to the completion of construction.

Mr. Backman's responsibilities were outlined in discussions between representatives of Atlas Minerals and Dames & Moore. Mr. Backman's main purpose was to observe the construction activities and perform the necessary field control tests to assure conformance with the plans and specifications and the Material Source License No. SUA-917. Daily written reports summarizing the field control test results and the project status were prepared by Mr. Backman.

Mr. James Zitnik was Dames & Moore's project engineer. Mr. Zitnik made approximately weekly site visits during construction to answer technical questions and to review the results of field control tests and observations made by Mr. Backman. Weekly summary reports were prepared by Mr. Zitnik, copies of which appear in the appendix to this report.

FIELD CONTROL TESTING

Field control testing was performed to confirm compliance with the material and compaction specifications given in the project plans. The field control testing basically consisted of three types of tests. The three tests are:

1. Gradation Tests
2. Compaction Tests
3. Field Density Tests

A discussion of these tests and a tabulation of the results are presented in the following sections.

GRADATION TESTS

During construction, gradation tests were performed on representative samples of material obtained from both the borrow and fill areas. The results of the gradation tests were used to confirm the general consistency of the fill. The test results indicate that the gradation of the fill was relatively consistent and conformed to the limits considered in the aforementioned design reports. The tests were performed in accordance with the ASTM* Test designation D-422 (Particle-Size Analysis of Soils, Washed Sieve Method). A summary of the test results is presented in the appendix to this report.

COMPACTION TESTS

Compaction tests were performed on representative samples of the fill during construction operations to evaluate the maximum dry densities and optimum moisture contents. The compaction tests were performed in accordance with the AASHTO T-180 and T-99 Method of Compaction. The results of the tests are presented on Plates 2A and 2B.

FIELD DENSITY TESTS

Field density tests were performed as the fill operations progressed. The field density tests were performed in accordance with the ASTM Designation D-1556-64 (sand-cone method) and D-2922 (nuclear method). The compaction criteria was based upon 95

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* American Society for Testing and Materials.

percent of the maximum dry density as determined by the AASHTO-T180 Method of Compaction. When the results indicated that an area had not been compacted to the specified degree of compaction, the fill material was carefully inspected to determine the limits of the poorly compacted material and the cause of the failure. Generally, the lower density resulted from one or a combination of the following:

1. Excess lift thickness
2. Insufficient or excessive moisture
3. Insufficient compact effort

After the limits of the lower density material had been established, the material was either removed or reworked and compacted until the specified degree of compaction had been achieved. The locations, elevations and results of the field density tests are presented in the attached Summary of In-Place Density Tests presented in the appendix to this report. The stationing system which was used to locate the tests is shown on the attached Plot Plan, Plate 1.

CONCLUSIONS

Based upon the results of the field testing and construction inspection, it is our opinion the embankment construction has been performed in accordance with the specifications set forth in the project specifications and the U.S. Nuclear Regulatory Commission Source Materials License SUA-917.

EMBANKMENT SURVEY

Surveyed embankment cross sections were performed before and after construction operations. The surveys were performed on approximately 100 foot centers along the embankment alignment. The survey work was performed under the supervision of Mr. Tom Phillips of Nielson Inc. The embankment sections on 600 foot centers are presented on Plates 3 and 4.

EMBANKMENT MONITORING PROGRAM

GENERAL

In accordance with the plans and specifications and the Nuclear Regulatory Commission Material Source License No. SUA-917, an embankment monitoring program was undertaken. The program consisted primarily of monitoring the water levels within the existing embankment piezometers during the duration of the construction operation and the installation of three new piezometers along the western embankment.

PIEZOMETER MONITORING

The existing piezometers within the tailings embankment were monitored on a daily basis for the duration of construction operations. The purpose of the monitoring program was to detect any construction induced increase in pore pressure which could result in a lower factor of safety within the embankment. Should

there have been any significant rise in water levels within the piezometers, Dames & Moore was to have been notified and appropriate operational recommendations made.

The piezometers were monitored by Atlas personnel with the daily recordings entered in graphical form as requested by Dr. Howard. Piezometric data recorded during the duration of construction operations are presented on Plates 5 and 6. Available data was reviewed by a Dames & Moore engineer (Mr. Zitnik) during his weekly site inspections. There was no indication of any significant increase in pore pressures within the embankment during the duration of construction operations.

PIEZOMETER INSTALLATION

As dictated in the specifications, three piezometers were installed along the western embankment. The piezometers were established within five feet of the centerline of the final embankment crest with approximate locations as shown on Plate 1. The installation of the piezometers was performed by the Cooper Drilling Company from Moab, Utah under the direct supervision of representatives of Dames & Moore in accordance with the plans and specifications. A cross sectional view of the piezometers as constructed is presented on Plate 7.

oOo

We appreciate being a part of this tailing dam expansion project. If you have any questions regarding this report, please contact us.

Very truly yours,

DAMES & MOORE

James R. Boddy
Project Manager
Professional Engineer No. 4445
State of Utah

James F. Zitnik
Project Engineer

JRB/JFZ/jb

Attachments: Plate 1 - Plot Plan
Plates 2A and 2B - Compaction Test Data
Plates 3 and 4 - Embankment Profiles
Plates 5 and 6 - Piezometer Readings
Plate 7 - Piezometers Along Western Embankment

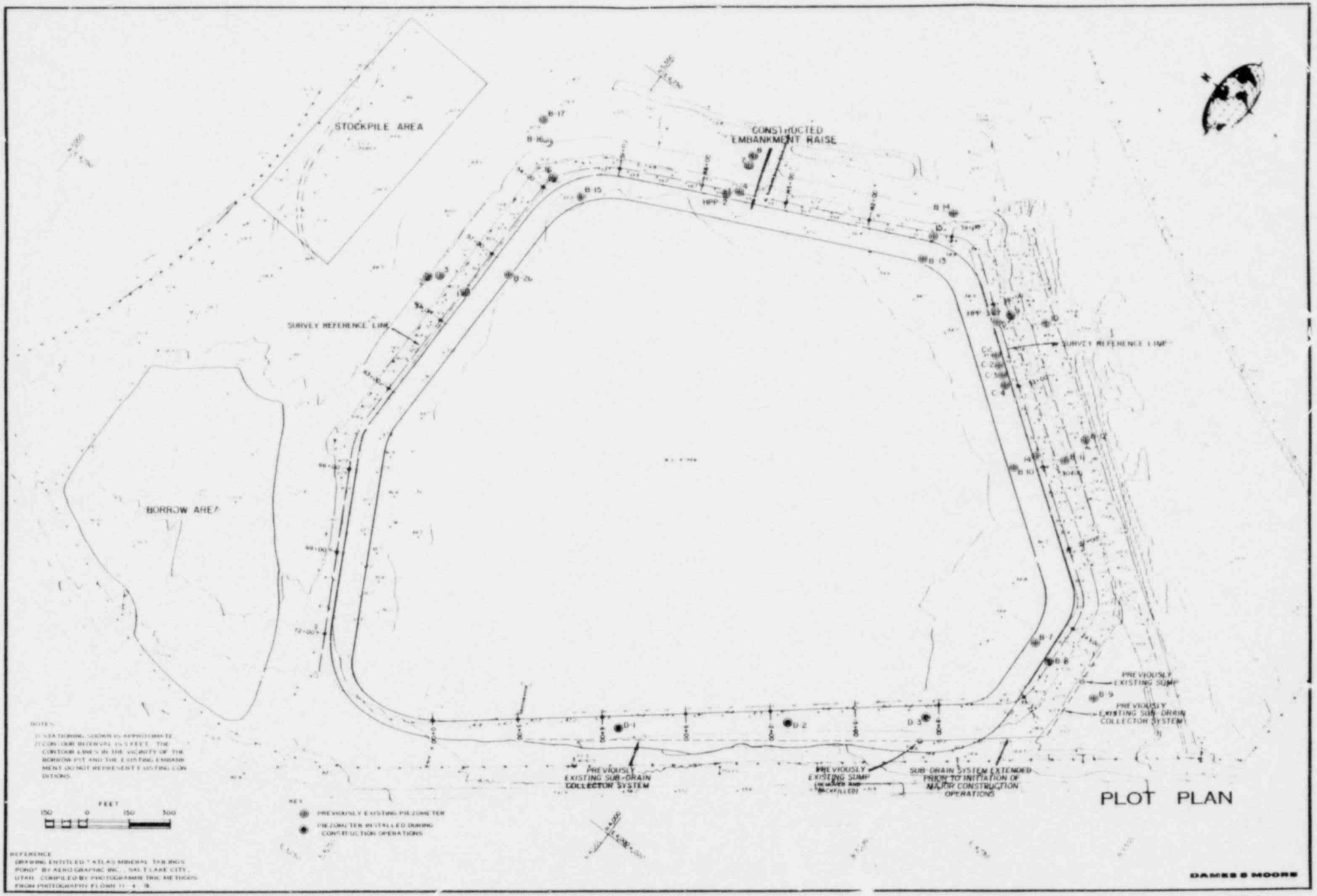
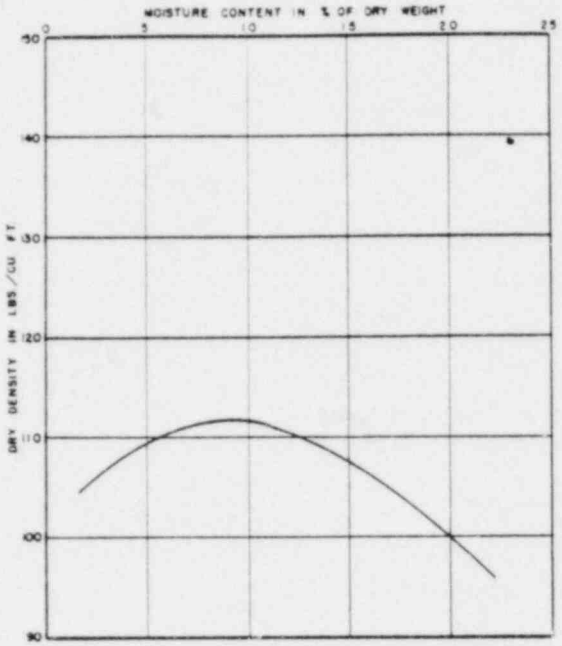
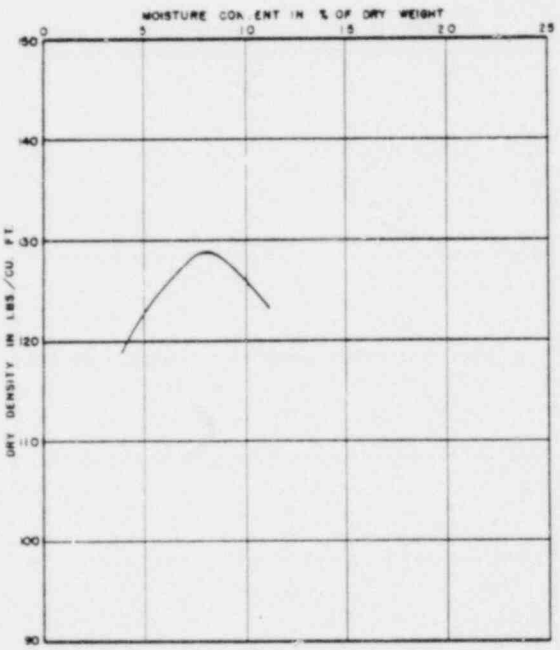

STOCKPILE AREA
CONSTRUCTED EMBANKMENT RAISE
SURVEY REFERENCE LINE
BORROW AREA
SURVEY REFERENCE LINE
PREVIOUSLY EXISTING SUMP
PREVIOUSLY EXISTING SUB-DRAIN COLLECTOR SYSTEM
PREVIOUSLY EXISTING SUB-DRAIN COLLECTOR SYSTEM
PREVIOUSLY EXISTING SUMP (BACKFILLED)
SUB-DRAIN SYSTEM EXTENDED PRIOR TO INITIATION OF MAJOR CONSTRUCTION OPERATIONS
D-1
D-2
D-3
B-15
B-16
B-17
B-14
B-13
B-12
B-11
B-10
B-9
B-8
B-7
NOTES:
1) STATIONING SHOWN IS APPROXIMATE
2) CONTOUR INTERVAL IS 5 FEET. THE CONTOUR LINES IN THE VICINITY OF THE BORROW PIT AND THE EXISTING EMBANKMENT DO NOT REPRESENT EXISTING CONDITIONS.
FEET
150 0 150 300
KEY
PREVIOUSLY EXISTING PIEZOMETER
PIEZOMETER INSTALLED DURING CONSTRUCTION OPERATIONS
REFERENCE
DRAWING ENTITLED "ATLAS MINERAL TAILINGS POND" BY AERO GRAPHIC INC., SALT LAKE CITY, UTAH. COMPILED BY PHOTOGRAMMETRIC METHODS FROM PHOTOGRAPHY FLOWN 11-4-78.
PLOT PLAN
DAMES & MOORE

PLATE 1

SAMPLE NO. ____ DEPTH ____ ELEVATION ____
SOIL REDDISH-BROWN SILTY SAND
LOCATION MOAB
OPTIMUM MOISTURE CONTENT 8.5 PERCENT
MAXIMUM DRY DENSITY 112 LBS. PER CUBIC FOOT
METHOD OF COMPACTION T-99



SAMPLE NO. ____ DEPTH ____ ELEVATION ____
SOIL REDDISH-BROWN SILTY SAND
LOCATION BORROW AREA
OPTIMUM MOISTURE CONTENT 8.0 PERCENT
MAXIMUM DRY DENSITY 129 LBS. PER CUBIC FOOT
METHOD OF COMPACTION T-180

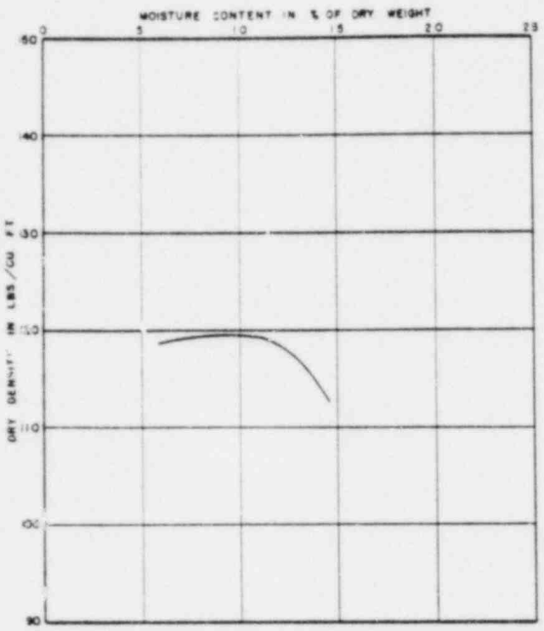


COMPACTION TEST DATA

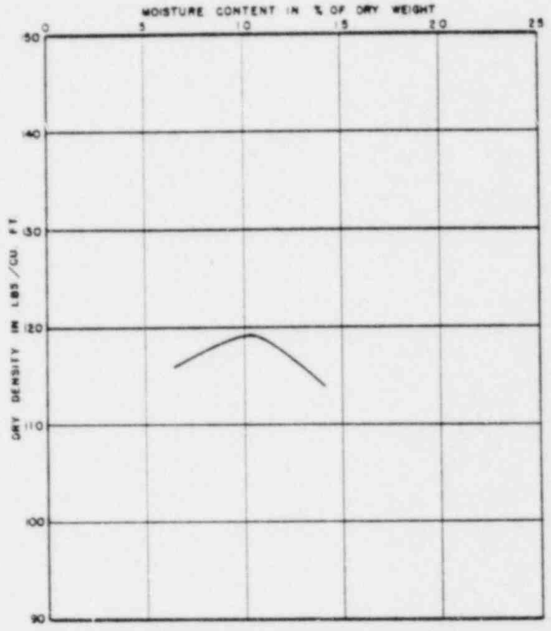
DAMES & MOORE

PLATE 2A

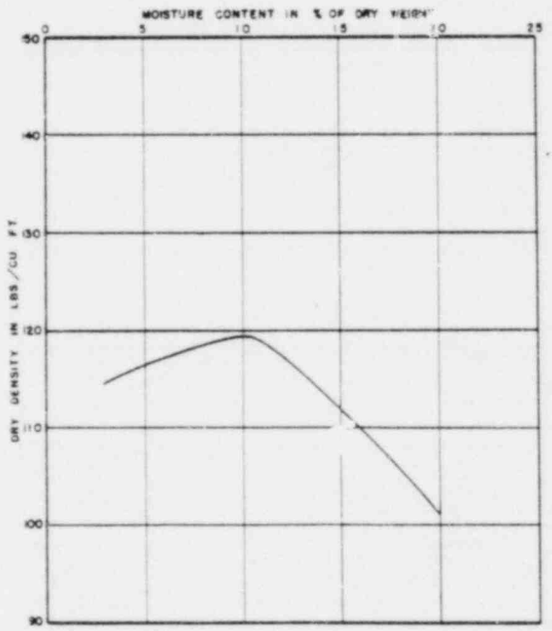
SAMPLE NO. _____ DEPTH _____ ELEVATION _____
SOIL REDDISH-BROWN SILTY SAND
LOCATION BORROW AREA
OPTIMUM MOISTURE CONTENT 9.8 PERCENT
MAXIMUM DRY DENSITY 120 LBS. PER CUBIC FOOT
METHOD OF COMPACTION T-180



SAMPLE NO. _____ DEPTH _____ ELEVATION _____
SOIL REDDISH-BROWN SILTY SAND
LOCATION BORROW AREA
OPTIMUM MOISTURE CONTENT 10.6 PERCENT
MAXIMUM DRY DENSITY 119 LBS. PER CUBIC FOOT
METHOD OF COMPACTION T-180



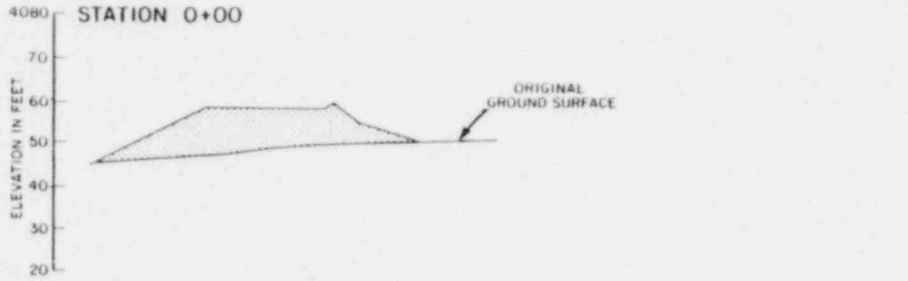
SAMPLE NO. _____ DEPTH _____ ELEVATION _____
SOIL REDDISH-BROWN SILTY SAND
LOCATION MOAB
OPTIMUM MOISTURE CONTENT 10.5 PERCENT
MAXIMUM DRY DENSITY 120 LBS. PER CUBIC FOOT
METHOD OF COMPACTION T-180

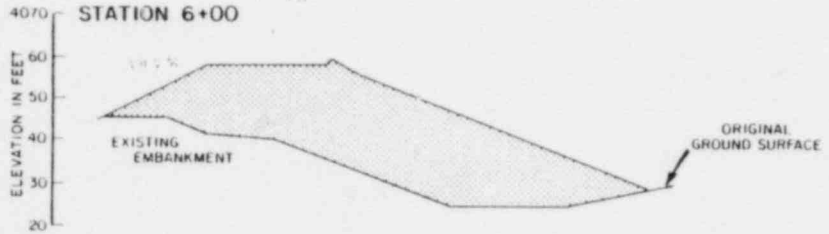


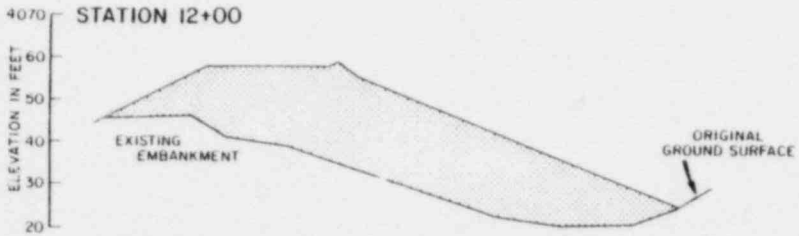
COMPACTION TEST DATA

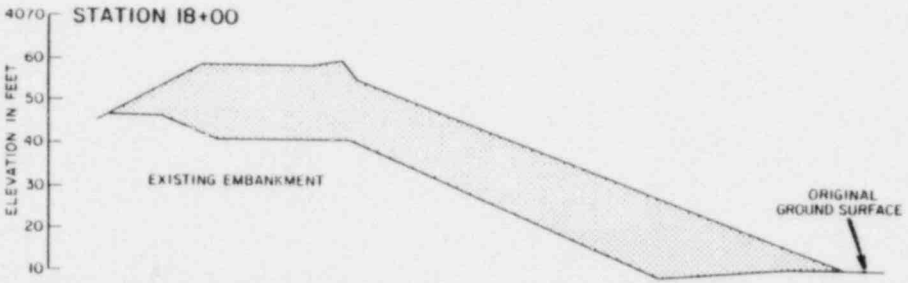
DAMES & MOORE

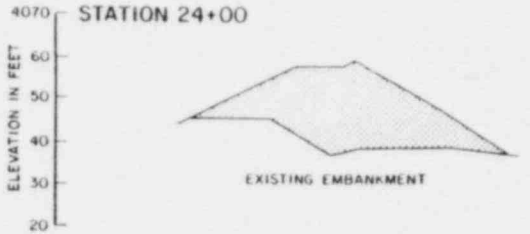
PLATE 28

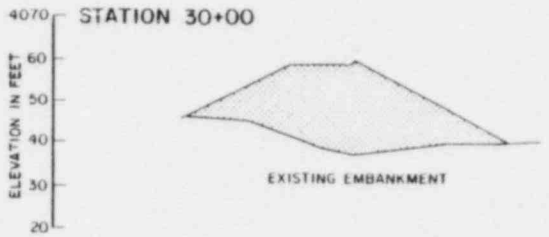


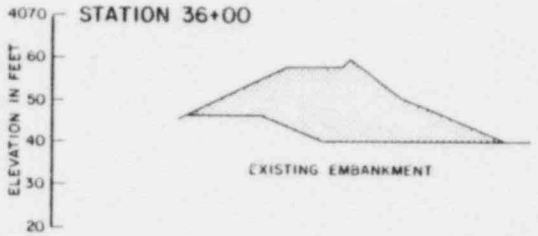


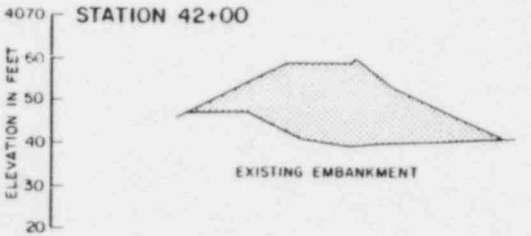








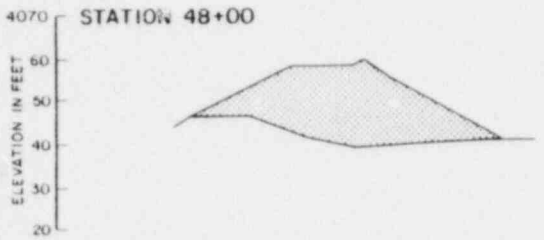


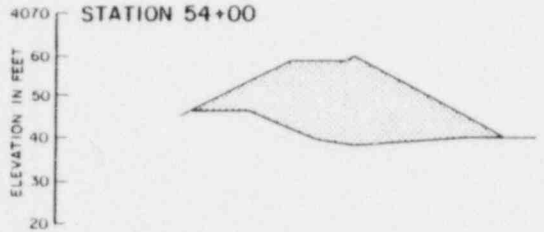


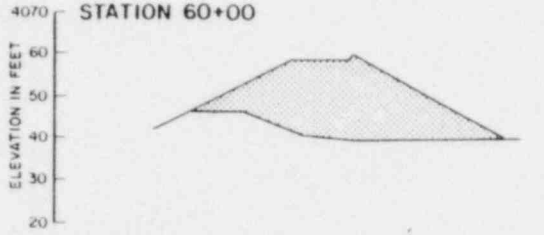
EMBANKMENT PROFILES

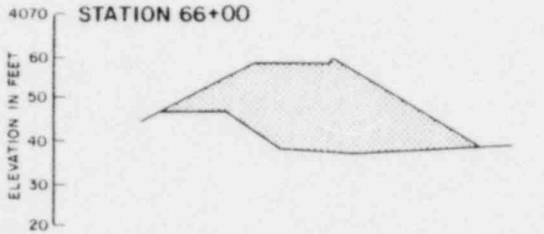
DAMES & MOOR

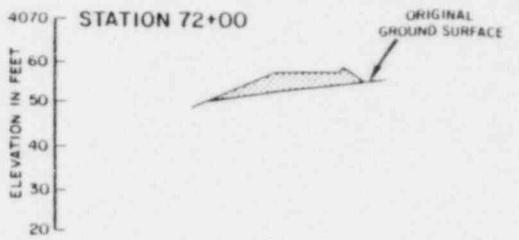
PLATE 3







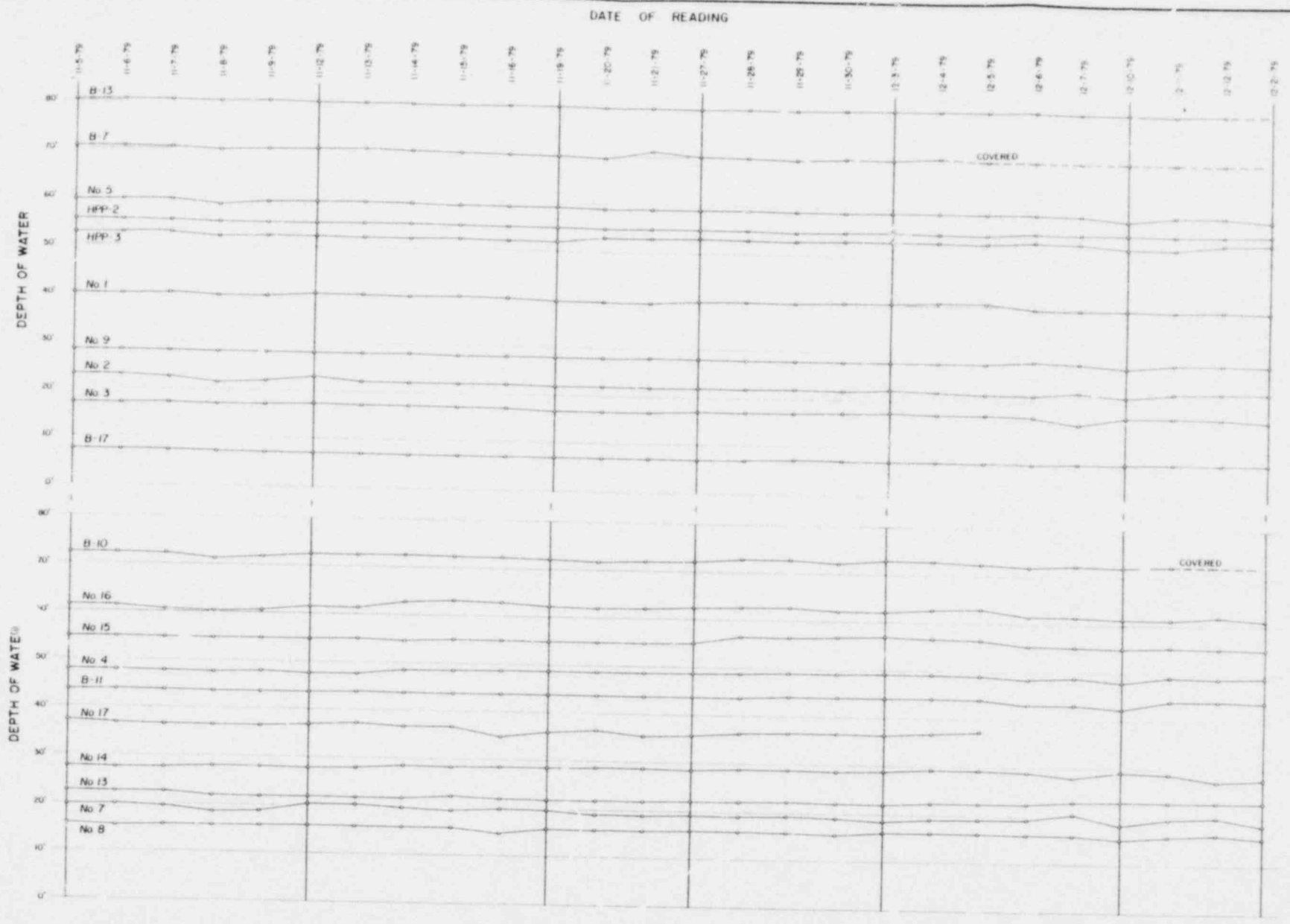




EMBANKMENT PROFILES

DAMES & MOOR

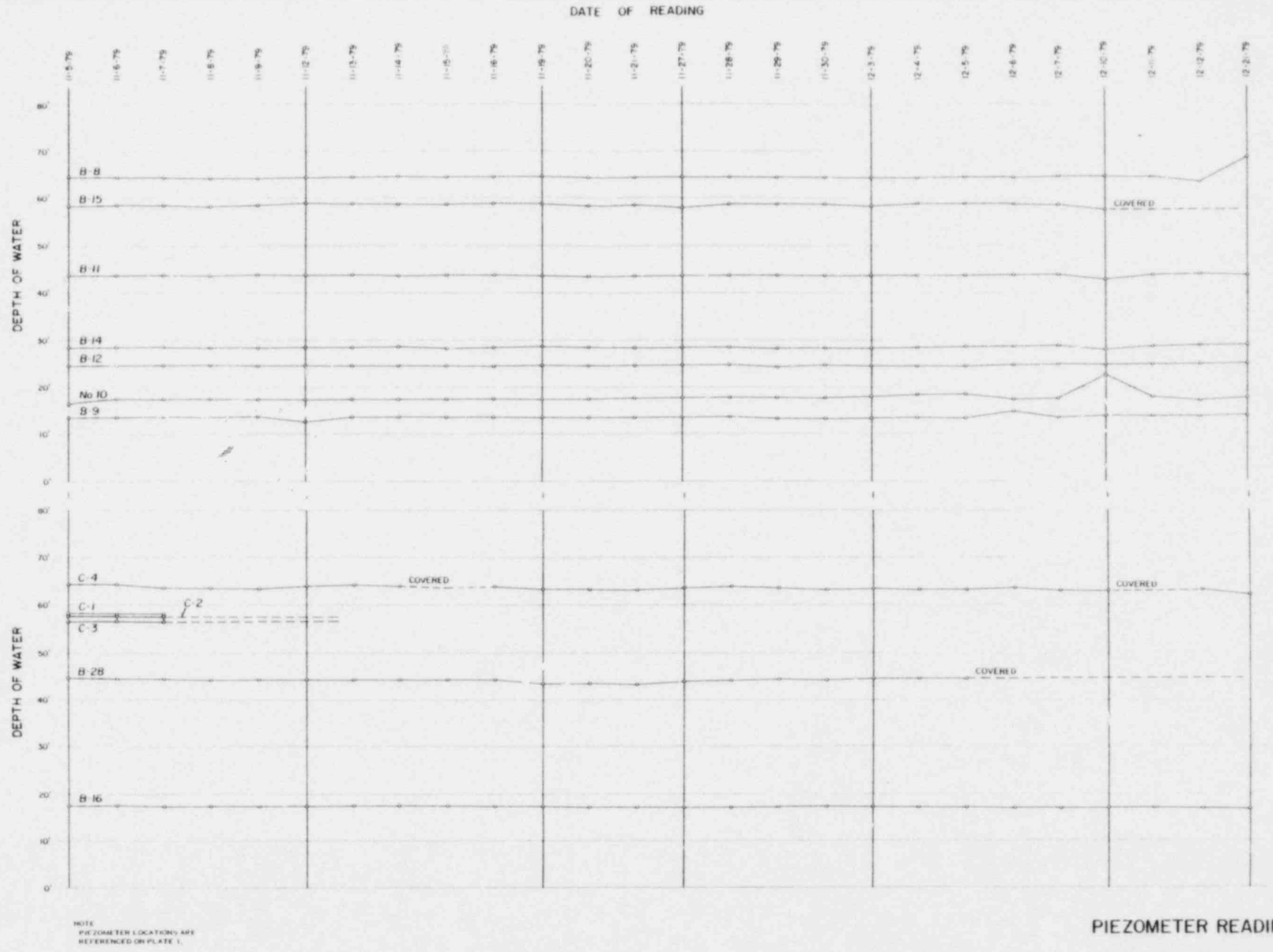
PLATE 4



NOTE
PIEZOMETER LOCATIONS ARE REFERENCED ON PLATE 1.

PIEZOMETER READINGS

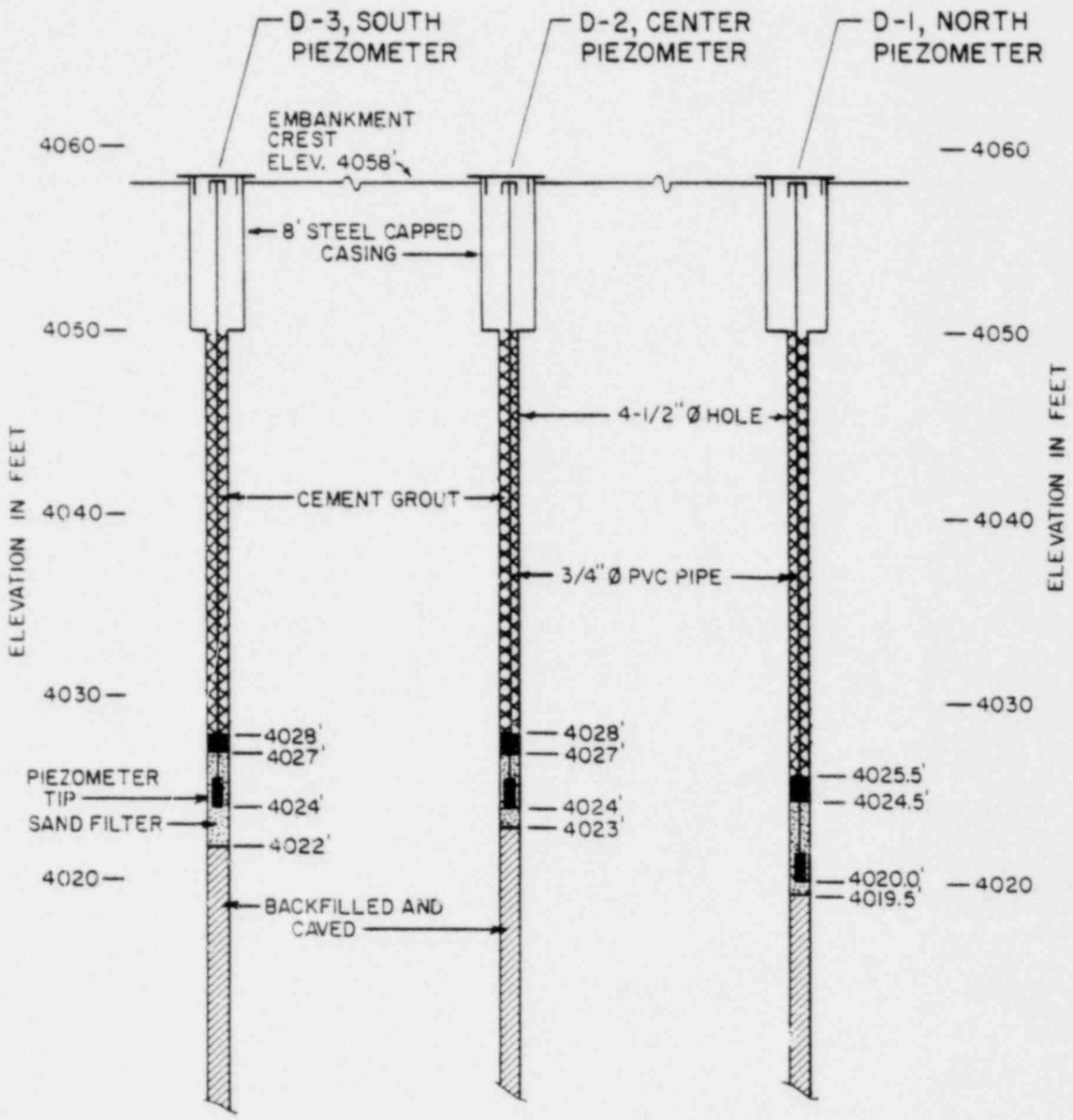
DAMES & MOORE



PIEZOMETER READINGS

DAMES & MOORE

PLATE 6



NOTE
PIEZOMETER LOCATIONS ARE REFERENCED ON PLATE 1.

PIEZOMETERS ALONG WESTERN EMBANKMENT

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PLATE 7

SUMMARY OF GRADATION TEST RESULTS

PERCENT PASSING BY WEIGHT

	U.S. Standard Sieve No.								
	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
12/12/79	98.5	98.1	97.5	96.7	95.3	91.2	81.0	52.5	18.1
12/12/79	-	97.8	93.8	88.2	82.7	81.0	75.5	48.7	20.5
12/05/79	97.3	95.6	91.8	88.5	84.4	74.8	66.7	55.8	25.7
12/03/79	97.9	96.5	93.3	90.2	85.0	82.9	76.9	54.7	18.3
11/28/79	99.1	99.0	98.9	98.6	98.2	96.9	89.7	57.9	15.1
11/26/79	98.0	96.8	90.4	83.1	76.6	70.7	63.6	41.2	20.9
11/21/79	95.9	92.1	87.9	85.0	83.0	78.0	72.0	42.7	18.4
11/18/79	100.0	99.4	99.2	99.0	98.7	98.2	90.4	51.1	14.0
11/15/79	98.2	97.3	95.1	92.5	89.4	86.1	78.6	48.7	19.3
11/15/79	95.5	94.7	91.0	88.2	86.2	82.0	79.2	48.6	17.4
11/13/79	98.2	97.2	93.6	90.7	88.7	84.0	78.0	48.5	20.1
11/09/79	98.4	97.9	95.8	93.1	90.5	87.8	80.7	49.7	18.9
11/06/79	99.4	99.0	97.6	95.9	93.6	91.2	83.6	50.1	18.0
11/05/79	96.6	95.2	92.5	90.1	87.7	85.4	78.2	47.3	16.2
11/01/79	-	98.0	93.1	88.9	84.0	80.3	74.8	51.1	20.8
10/30/79	-	79.5	67.0	51.4	40.4	33.5	28.7	21.3	11.4
10/29/79	-	89.9	83.8	73.9	64.1	58.8	53.9	39.9	28.0
10/26/79	-	-	85.2	75.9	65.5	57.4	51.7	40.6	32.7
10/25/79	-	-	91.7	87.3	82.5	78.3	71.8	41.2	16.5
10/24/79	-	-	87.3	81.8	76.2	71.2	66.2	51.5	31.6
10/23/79	-	-	85.0	78.6	71.7	66.4	62.1	51.3	31.3

SUMMARY OF IN-PLACE DENSITY TESTS

TEST NO.	DATE	LOCATION	ELEVATION	MAXIMUM DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN PERCENT	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN P.C.F.	PERCENT COMPACTION	REMARKS
1	10/22/79	3+50		134.2	95	7.3	129.5	96	
2	"	12+00		"	"	7.1	114.8	86	*
3	"	17+00		"	"	10.8	124.1	92	
4	"	18+75		"	"	9.3	130.8	97	
5	10/23/79	5+25		129.0	"	8.5	125.8	97	
6	"	8+00		"	"	9.6	119.9	93	*
7	"	10+00		"	"	10.0	124.5	97	
8	"	15+00		"	"	9.5	123.2	96	
9	"	18+00		"	"	6.4	126.8	98	
10	"	18+75		"	"	7.9	126.5	98	
11	10/24/79	3+00	4,032	"	"	9.8	123.4	96	
12	"	6+00	4,029	"	"	7.7	126.8	98	
13	"	9+00	4,027	"	"	8.8	128.3	99	
14	"	12+00	4,026	"	"	6.7	130.9	100	
15	10/25/79	72+80	4,043	"	"	6.4	129.8	100	
16	"	70+00	4,042	"	"	9.0	127.5	99	
17	"	66+00	4,044	"	"	8.1	129.0	100	
18	"	64+00	4,044	"	"	8.8	126.8	98	
19	"	12+00	4,032	"	"	8.2	126.8	98	
20	"	12+00	4,031	"	"	8.8	129.4	100	
21	"	17+00	4,018	"	"	8.3	121.6	94	
22	"	18+25	4,017	"	"	7.0	123.3	96	
23	"	12+75	4,017	"	"	9.4	126.0	97	
24	"	7+50	4,020	"	"	9.2	121.7	95	

* Material was reworked and compacted to required specifications.

-Continued-

SUMMARY OF IN-PLACE DENSITY TESTS

-CONTINUED-

TEST NO.	DATE	LOCATION	ELEVATION	MAXIMUM DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN PERCENT	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN P.C.F.	PERCENT COMPACTION	REMARKS
25	10/26/79	65+00	4,040	129.0	95	6.9	122.8	95	
26	"	63+00	4,040	"	"	7.2	124.3	96	
27	"	60+00	4,041	"	"	4.9	122.4	95	
28	"	57+00	"	"	"	6.3	123.7	96	
29	"	54+00	"	"	"	5.7	123.2	96	
30	10/29/79	54+00	"	"	"	4.2	122.8	95	
31		50+00	"	"	"	6.7	121.8	95	
32	"	65+00	4,040	"	"	5.3	120.6	94	*
33	"	3+75	4,046	"	"	4.2	124.2	96	
34	"	9+00	4,030	"	"	5.9	121.8	95	
35	10/29/79	12+00	4,020	"	"	4.6	120.4	93	*
36	"	18+00	4,013	"	"	4.9	122.0	95	
37	10/30/79	6+00	4,025	"	"	7.4	126.4	98	
38	"	7+00	"	"	"	6.8	127.8	99	
39	"	9+00	4,030	"	"	5.7	122.7	95	
40	"	17+00	4,025	"	"	6.1	123.1	95	
41	"	18+75	4,025	"	"	4.9	121.9	95	
42	10/31/79	3+00	4,030	"	"	6.9	123.4	96	
43	"	5+00	"	"	"	7.4	122.7	95	
44	"	12+00	4,028	"	"	7.2	124.0	96	
45	"	18+00	4,020	"	"	6.5	126.2	98	
46**	"	9+00	4,031	"	"	6.8	122.9	95	
47**	"	64+00	4,040	"	"	7.0	121.2	94	*

* Material was reworked and compacted to required specifications.

** Sand cone density tests.

SUMMARY OF IN-PLACE DENSITY TESTS

-CONTINUED-

TEST NO.	DATE	LOCATION	ELEVATION	MAXIMUM DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN PERCENT	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN P.C.F.	PERCENT COMPACTION	REMARKS
48	11/02/79	18+00	4,027	119.6	95	7.8	115.4	96	
49	"	9+00	4,031	"	"	6.9	113.9	95	
50	"	38+00	4,040	"	"	8.4	117.6	98	
51	"	58+00	4,043	"	"	7.8	114.7	96	
52	"	36+00	4,042	"	"	6.7	113.8	95	
53	"	21+00	4,032	"	"	6.0	116.2	97	
54	11/05/79	64+00	4,044	"	"	4.8	108.9	91	*
55	"	60+00	4,042	"	"	5.0	109.5	97	*
56	"	42+00	4,041	"	"	4.5	110.0	92	*
57	"	40+00	4,042	"	"	7.2	112.5	94	*
58	"	62+00	4,043	"	"	5.9	118.5	99	
59	"	40+00	4,042	"	"	5.5	114.2	95	
60	"	38+00	"	"	"	5.0	114.2	95	
61	"	32+00	"	"	"	6.1	114.0	95	
62	11/06/79	14+00	4,032	"	"	5.2	109.8	92	*
63	"	12+00	4,031	"	"	5.4	109.3	91	*
64	"	9+00	4,041	"	"	5.4	106.5	89	*
65	"	6+00	"	"	"	3.5	121.7	101	
66	"	9+00	"	"	"	7.0	126.9	98	
67	"	12+00	4,031	"	"	6.9	128.0	99	
68	"	14+00	4,032	"	"	5.2	119.0	100	
69	11/06/79	16+00	4,029	"	"	4.9	121.0	101	
70	11/07/79	17+00	"	"	"	7.1	114.3	95	

* Material was reworked and compacted to required specifications.

SUMMARY OF IN-PLACE DENSITY TESTS

-CONTINUED-

TEST NO.	DATE	LOCATION	ELEVATION	MAXIMUM DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN PERCENT	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN P.C.F.	PERCENT COMPACTION	REMARKS
71	11/07/79	14+00	4,029	119.6	95	7.3	113.4	95	
72	"	11+00	"	"	"	8.1	112.0	94	*
73	"	9+00	"	"	"	6.5	114.1	95	
74	"	44+00	4,044	"	"	6.5	113.6	95	
75	"	31+00	"	"	"	6.0	117.9	99	
76	"	29+00	"	"	"	6.5	117.8	99	
77	"	22+00	"	"	"	6.1	116.9	98	
78	11/08/79	21+00	4,043	"	"	6.5	116.6	97	
79	"	26+00	"	"	"	5.9	114.8	96	
80	"	36+00	"	"	"	7.4	116.7	98	
81	"	42+00	4,044	"	"	7.3	113.9	95	
82	11/09/79	43+00	4,045	"	"	7.2	114.9	96	
83	"	38+00	"	"	"	6.9	116.2	97	
84	"	30+00	"	"	"	6.7	115.2	96	
85	"	24+00	"	"	"	7.0	114.6	96	
86	11/12/79	68+00	4,046	"	"	5.8	115.7	97	
87	"	59+00	4,047	"	"	6.3	114.3	96	
88	"	57+00	4,046	"	"	6.0	114.8	96	
89	"	51+00	4,045	"	"	7.1	113.6	95	
90	11/13/79	68+00	4,046	"	"	11.8	110.5	92	*
91	"	64+00	"	"	"	6.8	117.9	98	
92	"	68+00	"	"	"	6.6	116.8	98	
93	11/14/79	9+00	4,044	"	"	5.9	114.0	95	

* Material was reworked and compacted to required specifications.

SUMMARY OF IN-PLACE DENSITY TESTS

-CONTINUED-

TEST NO.	DATE	LOCATION	ELEVATION	MAXIMUM DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN PERCENT	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN P.C.F.	PERCENT COMPACTION	REMARKS
94	11/14/79	12+00	4,043	119.6	95	6.5	113.8	95	
95	"	44+00	4,047	"	"	7.0	115.6	97	
96	11/15/79	69+00	"	"	"	7.4	116.7	98	
97	"	18+00	4,042	"	"	6.8	114.3	96	
98	"	44+00	4,050	"	"	7.1	114.9	96	
99	11/16/79	6+00	4,045	"	"	6.9	114.8	96	
100	"	19+00	"	"	"	7.3	115.9	95	
101	"	43+00	4,049	"	"	5.8	114.0	95	
102	"	49+00	4,048	"	"	7.6	114.3	96	
103	11/19/79	46+00	4,051	129.0	"	9.3	120.8	94	*
104	"	49+00	4,050	"	"	8.0	124.5	96	
105	"	58+00	4,048	"	"	8.6	124.3	96	
106	"	67+00	4,047	"	"	7.4	128.0	99	
107	"	17+00	"	"	"	7.7	126.3	98	
108	"	6+00	"	"	"	7.5	124.7	97	
109	11/20/79	39+00	4,048	"	"	8.3	124.6	96	
110	"	9+00	4,047	"	"	8.9	122.9	95	
111	11/2[illegible],79	18+00	"	119.6	"	7.9	116.5	97	
112	11/2[illegible]79	6+00	4,048	"	"	7.4	115.4	96	
113	"	14+00	4,053	"	"	6.9	114.7	96	
114	11/27/79	12+00	4,049	"	"	7.3	115.4	96	
115	"	6+00	4,050	"	"	6.9	116.9	98	
116	11/28/79	49+00	4,054	"	"	7.8	117.9	99	

* Material was reworked and compacted to required specifications.

SUMMARY OF IN-PLACE DENSITY TESTS

-CONTINUED-

TEST NO.	DATE	LOCATION	ELEVATION	MAXIMUM DRY DENSITY IN P.C.F.	REQUIRED DENSITY IN PERCENT	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN P.C.F.	PERCENT COMPACTION	REMARKS
117	11/28/79	51+00	4,051	119.6	95	7.6	117.4	98	
118	11/29/79	18+00	4,050	"	95	7.9	115.2	96	
119	"	36+00	4,054	"	"	6.9	114.7	96	
120	12/03/79	54+00	4,05	"	"	7.8	117.9	99	
121	"	68+00	4,049	"	"	8.2	118.0	99	
122	"	14+00	4,055	"	"	7.5	115.3	96	
123	12/04/79	38+00	4,052	"	"	7.2	115.9	97	
124	"	67+00	4,050	"	"	6.9	117.8	98	
125	"	60+00	"	"	"	7.3	116.2	98	
126	12/05/79	30+00	4,053	129.0	"	7.4	116.8	98	
127	"	59+00	4,052	"	"	7.8	118.3	99	
128	12/06/79	62+00	4,056	"	"	7.3	114.6	96	
129	"	29+00	4,057	"	"	7.9	117.3	99	
130	12/10/79	57+00	"	"	"	7.9	117.9	99	
131	"	5+00	"	"	"	8.3	116.0	97	
132	"	16+00	"	"	"	8.1	117.3	98	
133	12/11/79	56+00	4,058	"	"	7.8	114.0	95	
134	"	54+00	"	119.6	"	8.3	116.2	97	
135	"	18+00	"	"	"	5.0	115.9	97	
136**	"	56+00	"	"	"	8.0	113.9	95	

** Sand cone density tests.

DAMES & MOORE

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

JOB LOCATION: Moab, Utah	JOB NUMBER: 5467-027-0106
CLIENT OR OWNER: Atlas Minerals	REPORT SEQUENCE NUMBER: 1
GENERAL LOCATION OF INSPECTION: Moab, Utah (Tailings Area)	DATE: 10-17-79 / DAY OF WEEK: Wed.
GENERAL CONTRACTOR: Nielsons, Inc. / EARTHWORK CONTRACTOR: Nielsons, Inc.	PAGE: 1 of 3
OWNER'S CONTACT: Larry Jacobs / CONTRACTOR'S CONTACT: Rick Keck	JOB ENGINEER: Jim Boddy
REPORT DISTRIBUTION: Rick Keck, Larry Jacobs	WEATHER: Clear, 75°

SUPPLEMENTARY REPORT (OBSERVATIONS and RECOMMENDATIONS)

On October 16, 1979, Jim Boddy and Jim Zitnik visited the Atlas Mineral Moab mill. The purpose of this site visit was to discuss the placement of the reference line around the entire tailings pond area, as well as agree upon the best location of the dike embankment within the transition zones at the north and south ends of the western embankment. Also, it was necessary to discuss the borrow material quanities and general construction schedules with Atlas Mineral and Nielsons.

Boddy and Zitnik met with Larry Jacobs of Atlas Minerals and Tom Phillips, the surveyor for Nielsons. Phillips has obtained the necessary bench mark and base line data from John Keough, Surveyor. At the time of our visit, Phillips had the lay-out of the reference survey line half completed. Upon inspecting the two transition areas an agreement was reached upon the actual center line for the new embankment within those areas. Also, it was agreed upon that the embankment cross-section will be constructed such that the toe of the in-board slope will not extend beyond the in-board most point along the existing six-foot dike crest (that is no sloughing should occur over the in-board side of the existing six-foot high dike.)

Tom Phillips estimated that it will be approximately two days

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DAMES & MOORE

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

JOB NUMBER	5467-027-0106
REPORT SEQUENCE NUMBER	1
DATE	10-17-79
DAY OF WEEK	Wed.
PAGE	2 of 3
JOB ENGINEER	Jim Boddy
WEATHER	Clear, 75°

to complete the initial pre-construction survey. The cross-sections that are to be taken at 100-foot intervals will be completed before any site preparations work has begun. It was agreed that the stripping foundation preparations would include taking off only a couple of inches of surface material and, therefore, would not drastically effect the before-cross-section survey. Phillips will be contacting either Boddy of Zitnik by October 19, to discuss any problems he might have had during survey work.

At the time of receiving all the survey information from Phillips, we will re-estimate the amount of fill material required during construction-as well as re-estimate the available borrow material quanities in the existing borrow site. Hopefully, Phillips will be able to give us more survey information on the existing borrow site. Thus, we will have a better idea of the amount of material available in the borrow area.

At two locations along the existing embankment(approximately station 23+00 and 60+00) seepage water is carried from sumps located at the downstream toe of the slope, back into the tailings pond, by means of a two-inch PVC pipe extending over the existing embankment. The problem of what to do with these pipes during construction were discussed with Rick Keck and Larry Jacobs. It was decided that these lines would be removed during construction and the seepage water in the sumps would be allowed to discharge into a holding area at station 23+00 and to discharge into a low area in the borrow site near station 60+00. After construction of the new embankment is complete at those stations, new PVC pipe will be extended over the crest of the embank-

DAMES & MOORE

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

JOB NUMBER	5467-027-0106
REPORT SEQUENCE NUMBER	1
DATE	10-17-79
DAY OF WEEK	Wed.
PAGE	3 of 3
JOB ENGINEER	Jim Boddy
WEATHER	Clear, 75°

It was estimated by Rick Keck that the placement of fill would begin in approximately Monday or Tuesday of next week. Jim Zitnik plans to visit the site at that time. Also, our proposed schedule would be to have the American Testing Laboratories' technician on the site sometime on the week-end of October 20th.

Sincerely

DAMES & MOORE

James Boddy

Jim Boddy

Project Manager

cc: Larry Jacobs, Atlas Minerals

Rick Keck, Neilsons, Inc.

DAMES & MOORE

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

JOB LOCATION: Moab, Utah		JOB NUMBER: 05467-027-06	
CLIENT OR OWNER: Atlas Minerals		REPORT SEQUENCE NUMBER: 2	
GENERAL LOCATION OF INSPECTION: Moab, Utah (Tailings Area)		DATE: 10/22/79	DAY OF WEEK: Monday
GENERAL CONTRACTOR: Nielsens, Inc.	EARTHWORK CONTRACTOR: Nielsens, Inc.	PAGE: 1 of 1	
OWNER'S CONTACT: Larry Jacobs	CONTRACTOR'S CONTACT: Rick Keck	JOB ENGINEER: James Zitnik	
REPORT DISTRIBUTION: Rick Keck, Larry Jacobs		WEATHER: Clear, 65°	

SUPPLEMENTARY REPORT (OBSERVATIONS and RECOMMENDATIONS)

On October 22, 1979 Jim Zitnik of Dames & Moore visited the Atlas Minerals Moab mill. The purpose of the visit was to brief the soils technician assigned to the project. The duties of the technician consisted of observing the earthwork operations and to perform field compaction, gradation and density tests to confirm compliance with the design specifications. The technician assigned to the project was Mr. Neal Backman of American Testing Lab.

Mr. Zitnik initially met with Mr. Jacobs of Atlas Minerals and Mr. Rick Keck of Nielsens, Inc. At the time of the inspection, foundation preparation in the vicinity of the western embankment had commenced and some fill had been placed. It was the opinion of the writer that the foundation areas had been properly prepared and that the placement of fill could be continued.

Sincerely,

DAMES & MOORE

James Zitnik

James Zitnik

Project Engineer

CONTINUED ON NEXT PAGE ☐

DAMES & MOORE

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

JOB LOCATION: Moab, Utah			JOB NUMBER: 05467-027-06
CLIENT OR OWNER: Atlas Minerals			REPORT SEQUENCE NUMBER: 3
GENERAL LOCATION OF INSPECTION: Moab, Utah			DATE: 10/25/79 / DAY OF WEEK: Thurs.
GENERAL CONTRACTOR: Nielsen, Inc.	EARTHWORK CONTRACTOR: Nielsens, Inc.		PAGE: 1 of 1
OWNER'S CONTACT: Larry Jacobs	CONTRACTOR'S CONTACT: Rick Keck		JOB ENGINEER: Jim Zitnik
REPORT DISTRIBUTION: Rick Keck, Larry Jacobs			WEATHER: Clear, 65°

SUPPLEMENTARY REPORT (OBSERVATIONS and RECOMMENDATIONS)

At the request of Larry Jacobs of Atlas Minerals, Jim Zitnik visited the Atlas Mineral Moab mill. The purpose of the site visit was to evaluate problems being encountered regarding large cobble and boulder sized rocks being excavated from the borrow area and soft pumping soils within the initial lifts of fill.

Upon arrival at the site Mr. Zitnik met with Larry Jacobs, Rick Keck of Nielsens, Inc. and Neal Backman, the quality control inspector from American Testing Lab. A brief tour of the borrow area indicated the presence of a number of oversized rocks within the borrow source. However it was the opinion of Mr. Zitnik and Mr. Keck that the cobbles and boulders were primarily associated with a number of isolated zones within the borrow source and was not considered a major problem. Mr. Keck stated that he would maintain one or two cats within the borrow area to sort out the larger pieces when encountered. It was agreed that if any oversized rocks were transported to the embankment, they would be removed from the fill during grading operations.

The initial lifts along the western embankment demonstrated a slight tendency to "pump" when traversed by loaded scrapers or the 40 ton rollers. Compaction tests however, indicated that the fill was compacted in excess of the requirements as stated in the specifications. It was recommended that drier material be bladed into the fill to alleviate the problem.

Sincerely,

DAMES & MOORE

James Zitnik

CONTINUED ON NEXT PAGE ☐

DAMES & MOORE

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

JOB LOCATION: Moab, Utah		JOB NUMBER: 05467-027-06	
CLIENT OR OWNER: Atlas Minerals		REPORT SEQUENCE NUMBER: 4	
GENERAL LOCATION OF INSPECTION: Moab, Utah (Tailings Area)		DATE: 11/1/79	DAY OF WEEK: Thurs.
GENERAL CONTRACTOR: Nielsens, Inc.	EARTHWORK CONTRACTOR: Nielsens, Inc.	PAGE: 1 of 1	
OWNER'S CONTACT: Larry Jacobs	CONTRACTOR'S CONTACT: Rick Keck	JOB ENGINEER: Jim Zitnik	
REPORT DISTRIBUTION: Rick Keck, Larry Jacobs		WEATHER: Clear, 60°	

SUPPLEMENTARY REPORT (OBSERVATIONS and RECOMMENDATIONS)

On November 1, 1979, Jim Zitnik visited the Atlas Mineral Moab mill. The purpose of the visit was to observe general earthwork operations and to inspect the test results performed during the quality control program.

Mr. Zitnik initially met with Rick Keck of Nielsens, Inc. and Larry Jacobs of Atlas Minerals. The general earthwork operations were running smoothly. Some large oversized rocks were still being encountered in isolated areas within the borrow area, however, they were effectively being removed prior to the compaction of the fill. Mr. Zitnik then met with Mr. Backman of American Testing Lab. A review of available data indicated that the fill was being compacted in excess of the requirements stated in the specifications and the results of gradation tests indicated that the fill material was relatively uniform and consistent with the materials analyzed in the design reports.

Sincerely,

DAMES & MOORE

James Zitnik

James Zitnik

Project Engineer

CONTINUED ON NEXT PAGE ☐

JOB ENGINEER'S FIELD REPORT OF EARTHWORK AND FOUNDATION INSPECTION

Job Location Moab, Utah		Job Number 05467-027
Client or Owner Atlas Minerals		Report Sequence No. 5
General Location of Inspection Moab, Utah		Date 11/16/79 / Day of Wk Friday
General Contractor Nielsons, Inc	Earthwork Contractor Nielsons, Inc.	Page 1 Of 2
Owner's Contact Larry Jacobs	Contractor's Contact Rick Keck	Job Engineer Jim Zitnik
Report Distribution Jim Zitnik		Weather Clear, 65°

SUPPLEMENTARY REPORT (Observations and Recommendations)

On November 13, 1979, Jim Boddy and Jim Zitnik of Dames & Moore in the company of Dr. Terry Howard, representing the Nuclear Regulatory Commission, visited the Atlas Minerals Moab mill. The purpose of the visit was to inspect the earthwork operations for the tailings dam expansion project which were currently on-going. At the time of the visit approximately one-half of the estimated 286,000 cubic yards of fill had been placed to date.

Prior to the inspection Boddy, Zitnik and Howard met with Larry Jacobs of Atlas Minerals at the site. In addition to his visual inspection of the borrow area and general construction operation, Dr. Howard renewed the available piezometric data and the results of gradation and compaction tests performed during the placement of the fill. In general, Dr. Howard was satisfied that construction operations were being performed according to recommended specifications and that proper control and supervision were being enforced. During his inspection, the installation of the proposed piezometers along the western embankment was discussed. Dr. Howard stated that these piezometers would provide valuable data regarding the development of pore pressures during construction and he was concerned that their installation has been delayed. It seems however, that by the time his official request to NRC regarding their installation is made, construction of the western embankment may be completed.

Dr. Howard also suggested that Atlas record of daily piezometer levels presently being maintained by Larry Jacobs be kept in graphic form and

CONTINUED ON NEXT PAGE ▭

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

JOB NUMBER	5467-027
REPORT SEQUENCE NUMBER	
DATE	11/16/79
DAY OF WEEK	Friday
PAGE	2 of
JOB ENGINEER	Jim Zitnik
WEATHER	Clear, 65°

presented for review to Jim Zitnik, our soils engineer, during his weekly site visits.

Sincerely

DAMES & MOORE

James J. Zitnik

Jim Zitnik

JZ/sb

JOB ENGINEER'S FIELD REPORT OF EARTHWORK AND FOUNDATION INSPECTION

Job Location Moab, Utah		Job Number 05467-027
Client or Owner Atlas Minerals		Report Sequence No. 6
General Location of Inspection Moab, Utah		Date 11-20-79 / Day of Wk. Tuesday
General Contractor Nielsons, Inc.	Earthwork Contractor Nielsons, Inc.	Page 1 Of 1
Owner's Contact Larry Jacobs	Contractor's Contact Rick Keck	Job Engineer Jim Zitnik
Report Distribution Jim Zitnik		Weather Overcast, 35°

SUPPLEMENTARY REPORT (Observations and Recommendations)

On November 20, 1979 Jim Zitnik of Dames & Moore visited the Atlas Minerals Moab mill. The purpose of the visit was to inspect the earthwork operations for the tailings dam expansion project which were currently on-going. At the time of the visit approximately 190,000 cubic yards of fill had been placed.

Mr. Zitnik initially met with Neal Backman of American Testing Labs and Rick Keck of Nielsens, Inc. to discuss general earthwork operations. There was some discussion about the quality of the fill at the back of borrow area. Excavation problems had previously been encountered in conjunction with the numerous cobble and boulder size rocks. However due to the steadily decreasing fill source it was recommended that as much of this material be used as possible. Based upon current tests it appears that the materials encountered in the borrow area are within the specified gradational limits and that the fill is being adequately compacted.

Mr. Zitnik also met with Larry Jacobs of Atlas Minerals. During that meeting the available piezometric data was discussed. In general it appears that there has been no significant upward trend in the readings during the construction operations.

Very truly yours

DAMES & MOORE

Jim Zitnik

JZ/sb

CONTINUED ON NEXT PAGE ☐

JOB ENGINEER'S FIELD REPORT OF EARTHWORK AND FOUNDATION INSPECTION

Job Location Moab, Utah			Job Number 05467-027
Client or Owner Atlas Minerals			Report Sequence No. 7
General Location of Inspection Moab, Utah			Date 11/29/79 / Day of Wk. Thursday
General Contractor Nielsens, Inc.	Earthwork Contractor Nielsens, Inc.		Page 1 Of 2
Owner's Contact Larry Jacobs	Contractor's Contact Rick Keck		Job Engineer Jim Zitnik
Report Distribution Jim Zitnik, Larry Jacobs			Weather Clear, 40°

SUPPLEMENTARY REPORT (Observations and Recommendations)

On November 29, 1979, Jim Zitnik of Dames & Moore visited the Atlas Minerals Moab mill. The purpose of the visit was to inspect the on-going earthwork operations for the tailings dam expansion project. At the time of the visit approximately 236,000 yards of fill had been placed.

Mr. Zitnik initially met with Neal Backman of American Testing Labs and Rick Keck of Nielsens, Inc. to discuss general earthwork operations. Mr. Zitnik reviewed the available gradation and compaction test results and it was apparent that the fill material being excavated from the borrow area was within the specified gradational limits and that the required compaction was being achieved. It was proposed by Atlas Minerals that the current borrow area be leveled to provide a suitable foundation for the construction of an evaporation pond. At the time of the inspection, grade stakes had been placed in the borrow area. It was estimated that a sufficient quantity of fill material will be available to complete construction operations by leveling the borrow area at an elevation of 4002 feet. It was the intention of Atlas Minerals that should the evaporation pond not be constructed, the borrow area will be suitably graded to drain.

Mr. Zitnik also met with Larry Jacobs of Atlas Minerals and reviewed the available piezometric data. Mr. Jacobs had presented the data in graphical form as requested by Terry Howard who is representing NRC on the project. In general, it appears that there has been no significant upward trend in the readings during the construction operations. In a brief tour of the tailings

CONTINUED ON NEXT PAGE

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

impoundment area it was apparent to Mr. Zitnik and to Mr. Jacobs that a water balance problem exists at least during the winter months. In many areas the pond of water had encroached well within the specified minimum beach width of 150 feet.

JOB NUMBER	05467-027
REPORT SEQUENCE NUMBER	
DATE	11/29/79
DAY OF WEEK	Thursday
PAGE	2 of 2
JOB ENGINEER	Jim Zitnik
WEATHER	Clear, 40°

Sincerely

DAMES & MOORE

James Zitnik

JZ/sb

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

JOB LOCATION: Moab, Utah		JOB NUMBER: 5467-027-06	
CLIENT OR OWNER: Atlas Minerals		REPORT SEQUENCE NUMBER: 8	
GENERAL LOCATION OF INSPECTION: Moab, Utah (Tailings Area)		DATE: 12/6/79	DAY OF WEEK: Thurs.
GENERAL CONTRACTOR: Nielsens, Inc.	EARTHWORK CONTRACTOR: Nielsens, Inc.	PAGE: 1 of 1	
OWNER'S CONTACT: Larry Jacobs	CONTRACTOR'S CONTACT: Rick Keck	JOB ENGINEER: Jim Zitnik	
REPORT DISTRIBUTION: Rick Keck, Larry Jacobs		WEATHER: Clear, 60°	

SUPPLEMENTARY REPORT (OBSERVATIONS and RECOMMENDATIONS)

On December 6, 1979, Jim Zitnik of Dames & Moore visited the Atlas Mineral Moab mill. The purpose of this site visit was to observe the on-going earthwork operations and inspect the test results performed during the quality control program and the available piezometer data.

Mr. Zitnik initially met with Larry Jacobs of Atlas Minerals and Rick Keck of Nielsens, Inc. to discuss general earthwork operations. Mr. Zitnik reviewed the available gradation and compaction test results and it was apparent that the fill was being placed in accordance with specifications. Mr. Zitnik also reviewed the available piezometer data. In general it appeared that there has been no significant upward trend in the readings during the construction operations.

Sincerely,

DAMES & MOORE

James Zitnik

James Zitnik

Project Engineer

CONTINUED ON NEXT PAGE ☐

JOB ENGINEER'S FIELD REPORT OF EARTHWORK AND FOUNDATION INSPECTION

Job Location Moab, Utah		Job Number 5467-027-06	
Client or Owner Atlas Minerals		Report Sequence No. 9	
General Location of Inspection Moab, Utah-Tailings Embankment		Date 12/17/79	Day of Wk Monday
General Contractor Nielsens, Inc.	Earthwork Contractor Nielsens, Inc.	Page 1 Of 2	
Owner's Contact Larry Jacobs	Contractor's Contact Rick Keck	Job Engineer Jim Zitnik, Jim Boddy	
Report Distribution Jim Zitnik Larry Jacobs (Atlas Minerals)		Weather Clear, 40°	

SUPPLEMENTARY REPORT (Observations and Recommendations)

On December 17, 1979, Jim Zitnik and Jim Boddy of Dames & Moore visited the Atlas Minerals Moab Mill tailings embankment site. The purpose of the visit was to observe the finished earthwork operation for the tailings dam expansion project and to observe and assist in the installation of the three piezometers to be installed along the western embankment.

At about 8:30 A.M. Mr. Zitnik and Mr. Boddy met with Larry Jacobs and Mr. Cooper of Cooper Drilling Company regarding the placement of the three piezometers on the western embankment. From about 9:00 until 12:00 (noon) Cooper installed the piezometers to the depths and specifications as called for in the contract documents. This was done under the supervision of Boddy and Zitnik. On the attached sketch the various pertinent tip elevations of the piezometers are shown. During the Dames & Moore on-site visit, a reconnaissance was made of the in-place completed embankment raise as well as the borrow source area. It was concluded at the end of the brief tour that the construction of the embankment as well as the final contouring of the borrow area was completed in an acceptable manner. It is Dames & Moore's understanding that a final as-built survey will be performed sometime during the week ending 12/21/79. Upon examining the survey cross-sections of the embankment, it may then be determined that the embankment raise was made to the lines and grades as shown on the contract document plans. It should be noted that during the site visit it was

CONTINUED ON NEXT PAGE

DAMES & MOORE

JOB ENGINEER'S FIELD REPORT
EARTHWORK AND FOUNDATION INSPECTION

observed by Zitnik and Boddy that at several locations along the embankment the edge of ponded water is less than the specified minimum beach width of 150 feet. In several locations along the eastern embankment section the water is up to, or nearly up to, the actual embankment section.

JOB NUMBER	5467-027-06
REPORT SEQUENCE NUMBER	
DATE	12/17/79
DAY OF WEEK	Monday
PAGE	2 of 2
JOB ENGINEER	Jim Zitnik, Jim Boddy
WEATHER	Clear 40°

Sincerely

DAMES & MOORE

James R. Boddy

James R. Boddy

Project Engineer

JRB/sb

attachment

APPENDIX B

APPENDIX B

PLANS AND SPECIFICATIONS

CONTRACT SPECIFICATIONS

AND DRAWINGS

FOR

TAILINGS EMBANKMENT EXPANSION PROJECT

Final Raise

FOR

ATLAS MINERALS

MOAB, UTAH

PREPARED BY

DAMES & MOORE

Consultants in the Environmental and Applied Earth Sciences

APRIL 1981

05467 — 028 — 06

INDEX OF SPECIFICATIONS

INDEX OF SPECIFICATIONS
(Continued)

INDEX OF SPECIFICATIONS
(Continued)

INDEX OF SPECIFICATIONS
(Continued)

BID DOCUMENTS

1.0 INVITATION TO BID

1.1 GENERAL

Atlas Minerals is planning to construct an earthfill embankment addition to its tailings pond dike. You are invited to submit your bid to furnish all labor, supervision, equipment and materials required for the complete construction of the embankment addition in accordance with the specifications and drawings attached hereto. Bidders shall confirm by mail the receipt of this "Invitation to Bid." The bids shall be based on a summation of lump sum and unit priced items. Bids for unit price earthwork items shall be based on estimated in-place compacted quantities. Actual payments for the unit priced earthwork items will be determined from final measured borrow quantities with an appropriate shrink factor applied to determine in-place compacted quantities.

1.2 BASIS OF BID

Bidders are urged to visit the site of the work and by their own investigation satisfy themselves as to the existing conditions affecting the work to be done under these specifications. If the bidder chooses not to visit the site, he will nevertheless be charged with knowledge of conditions which a reasonable inspection would have disclosed and shall assume all responsibility for deductions and conclusions made therefrom as to the difficulties in performing the work. The construction site may be inspected during regular office hours by contacting Mr. Carl Dixon of Atlas Minerals at the Moab Mill near Moab, Utah (801) 259-5131. Solely for the convenience of the bidders, they may obtain logs of borings and test pits from subsurface investigations upon

request to Dames & Moore in Salt Lake City, Utah. Atlas Minerals does not represent that the available records show conditions that will be encountered in performing the work and represents only that such records show conditions encountered at the particular point and time for which such logs were obtained.

1.3 PREPARATION OF BID

Each bid must be submitted on the prescribed bid form. All blank spaces must be filled in, in ink or typewritten. For the convenience of the bidder, an additional Bid Schedule is attached. All bids must be prepared in triplicate on and submitted under bidder's letterhead. They must be delivered in good order and enclosed in a sealed envelope prior to the due date and time specified below. All bid documents are to be returned, whether or not a bid is submitted.

1.4 RECEIPT AND OPENING OF BIDS

Bids will be received by Atlas Minerals, a division of Atlas Corporation, at Post Office Box 1207, Moab, Utah, 84532, under the attention of Mr. Robert Exby, until _____ p.m. on _____. The results of the bidding will be made available on _____. There will be no public opening.

The owner reserves the right to reject any or all bids, to waive technicalities, to advertise for new bids or proceed to do the work otherwise. Only one bid will be accepted per bidder, and rebids will not be accepted unless requested by the owner as a result of a significant design or specification alteration. Any bid may be withdrawn prior to the above scheduled time for the opening of bids or authorized postponement thereof. Late bids will not be accepted.

1.5 COMMENCEMENT, PROSECUTION AND COMPLETION OF THE WORK

Bidders must agree to begin work within ten (10) days after date of receipt of notice to proceed and complete all of the

work within __ calendar days of said date. Bidders shall include in their proposals an estimate indicating their best start and finish dates for the total scope of work. The capacity of the successful bidder's construction plan, sequence of operations, methods of operation and the forces employed will at all times during the continuance of the contract be subject to the approval of the engineer and shall be such as to insure completion of the work within the specified period of time. The successful bidder shall plan and schedule his work as directed by the owner in order to coordinate said work with the work of the owner or other contractors.

1.6 PRE-CONSTRUCTION CONFERENCE

Within five (5) days after notification of the contract award, the successful bidder, together with any known subcontractors, will be required to attend a Pre-Construction Conference at a time and place designated by the owner. The purpose of the Pre-Construction Conference will be to discuss, among other considerations, the responsibilities of the successful bidder and his subcontractors.

2.0 BID FORM AND BID SCHEDULE

The _____ (Contracting Company), having examined the construction site and studies and now comprehending the plans and specifications, proposes to furnish all materials, labor, tools and equipment required to complete all work called for in the plans and specifications prepared for or by Altas Minerals for the construction of the earthfill embankment addition for the sums and totals quoted on the following Bid Schedule. Estimated earthwork quantities shown on the Bid Schedule are for required in-place compacted embankment quantities; final payment will be made on measured borrow quantities with an appropriate shrink factor applied to determine in-place compacted quantities.

ITEM	DESCRIPTION	UNITS	AMOUNT
1	Mobilization and Demobilization	Lump Sum	$_____
2	Embankment Fill Red silty sand fill: Required stripping, excavation from borrow area or obtainment from a stockpile area, transportation, preparation, placement and compaction	509,000 cy yds in-place @____/cu yd	$_____
3	Surveying	Lump Sum	$_____
4	Piezometer Extensions	Lump Sum	$_____
	TOTAL FIRM-PRICE BID EARTHFILL EMBANKMENT ADDITION		$_____

GENERAL SPECIFICATIONS

1.0 GENERAL CONDITIONS

1.1 DEFINITIONS

1.1.1 Contract. The written agreement between the CONTRACTOR and the buyer of the Contractor's services setting forth the terms and conditions under which the work is to be performed and/or material is to be furnished. It includes all the contract documents.

1.1.2 Contractor. Party of the second part to the contract acting directly or through his agents or employees, hereinafter called CONTRACTOR.

1.1.3 Owner. Atlas Minerals, a division of Atlas Corporation, and party of the first part, hereinafter called OWNER.

1.1.4 Engineer. The authorized representative assigned by the party of the first part of the contract to supervise and direct the technical aspects of the work called for in the contract to insure that the work and materials are in accordance with the plans and specifications.

1.1.5 Technician. The authorized representative of the ENGINEER who will perform the day-to-day inspection as directed by the ENGINEER.

1.1.6 Design Engineer. The authorized representative of the OWNER responsible for the design and preparation of the plans and specifications.

1.1.7 Employee. Any person working on the project who is under the direction or control of, or receives compensation from, the CONTRACTOR or subcontractor. Employees shall be personnel skilled and experienced in their trades.

1.1.8 Plans. The drawings or reproductions thereof which show the locations and detailed design of the contemplated improvements outlined in the specifications. Part of the contract documents.

1.1.9 Specifications. The statement containing a minute description of the WORK. Part of the contract documents.

1.1.10 Work. (The Work). The materials and operations necessary for the construction of the specified improvements as indicated on the PLANS, or as set forth in the specifications.

1.1.11 Item. A specified class of WORK on which definite prices are set forth in the CONTRACT.

1.2 CONSTRUCTION CONTROL SURVEYING

The OWNER will establish baselines and bench marks required for proper execution of the work. The CONTRACTOR will furnish competent and qualified survey control during the course of construction to assure adherence to lines and grades. See Section 4.0 for the outlined scope of work.

1.3 CONSTRUCTION INSPECTION

Full-time control inspection of all construction activities under this contract will be provided by the OWNER and ENGINEER, at no cost to the CONTRACTOR.

1.4 WATER, SANITARY AND OTHER FACILITIES

Water for construction will be available at the Moab Mill from the OWNER. Means of obtaining this water and conveying it to the construction site will be left up to the CONTRACTOR with the approval of the ENGINEER. Drinking water and sanitary facilities shall be provided by the CONTRACTOR. Other facilities of the OWNER will not be available to the CONTRACTOR. All storage and disposal areas used by the CONTRACTOR shall be subject to prior approval by the OWNER's representative.

1.5 SUPERVISION OF WORK

The CONTRACTOR shall provide a competent foreman or superintendent, satisfactory to the ENGINEER, on the work at all times with the authority to act for him. The superintendent or foreman shall give personal supervision to the work, including coordinating, directing and expediting of all subsequent work until completion of all work under the contract. All directions given to such superintendent or foreman shall be considered as given to the CONTRACTOR and shall be binding on the CONTRACTOR.

1.6 LOCATION AND MAINTENANCE OF ROADS

The OWNER will provide a contractor's entrance located approximately 450 yards west of the scale house gate for the sole use of the CONTRACTOR and his employees. All access to the site by the CONTRACTOR shall be through this entrance. Access to the site is available by a non-surfaced road which joins the tailings disposal area to the entrance. Improvement of existing roads and construction of new roads must be approved by the ENGINEER. If such new roads are constructed, they shall be done in such a manner as to be free-draining and shall be maintained in good condition throughout the contract period unless otherwise directed by the ENGINEER. Moisture shall be sprayed on all roads being used by the CONTRACTOR in order to maintain a dust-free condition. All roads are to be considered of a temporary nature unless designated as permanent by the OWNER at some time during the period of this contract.

1.7 UTILITIES

All utilities necessary for performing the work shall be supplied by the CONTRACTOR. In addition, it shall be the responsibility of the CONTRACTOR to obtain necessary locations, clearances, and easements with regard to crossing or conducting work on or near the existing buried or overhead utility lines.

DETAILED SPECIFICATIONS

1.0 MOBILIZATION AND DEMOBILIZATION

1.1 SCOPE OF WORK

This work item covers the transportation and delivery of all equipment and materials required for the complete construction of the earthfill embankment addition. The removal of the aforementioned equipment and unused materials from the site at the completion of construction shall also be included in this portion of the work.

1.2 PAYMENT

Payment for this work item is based on a lump sum bid and is covered under Item 1 of the Bid Schedule.

2.0 OBTAINMENT OF FILL MATERIALS FROM STOCKPILE AND/OR BORROW AREAS

2.1 SCOPE OF WORK

This specification covers the obtainment of fill from on-site stockpile and/or borrow areas.

2.2 DEFINITION OF MATERIALS

2.2.1 Red Silty Sand Fill. This material is to be excavated from the borrow areas or obtained from the stockpile area and will be reddish-brown, fine to coarse, sand material with 10 to 40 percent silt- and clay-size particles and 0 to 10 percent gravel-size particles. The areas from which this material may be taken will be on-site and designated by the OWNER's representative.

2.3 BORROW AREAS

2.3.1 General. It is anticipated that all the material required for the embankment construction shall be obtained on-site from the borrow area or from the stockpile area, the location of which will be designated by the OWNER's representative.

2.3.2 Borrow Area. The borrow area is to be located immediately northwest of the existing embankment in an area that has previously been used as a borrow area. The grading and elevations of the final surfaces, after removing borrow material under this contract, will be designated by the OWNER's representative.

2.4 STOCKPILE AREA

Should there not be a sufficient quantity of red silty sand fill material in the designated borrow area, additional fill shall be available to the CONTRACTOR from an on-site stockpile area. It will be the responsibility of the OWNER to

inform the CONTRACTOR of the location of the stockpile area and to provide necessary access to the area.

2.5 MOISTURE

The earthfill material prior to and during compaction shall be such that the moisture content shall be in accordance with Section 3.5.3 of these specifications. Should additional moisture be needed, it may be introduced into the borrow or stockpile areas by irrigation or sprinkling in advance of excavation operations. When moisture is introduced into the borrow or stockpile areas, both excessive runoff and accumulation of water in depressions should be avoided.

3.0 EMBANKMENT FILL

3.1 SCOPE OF WORK

This section of the specifications covers material placement, spreading, moisture control and compaction requirements for the compacted embankment fill. The design engineer has estimated the dam will require a total of 509,000 cubic yards of in-place compacted embankment fill.

3.2 DEFINITIONS

3.2.1 Embankment. That portion of the construction which comprises the compacted earthfill as designated on the plans by "Embankment Fill to be Constructed - (Final Raise)." Embankment fill is defined as red silty sand fill material.

3.2.2 Existing Embankment. The earthfill tailings retention structure present at the site.

3.2.3 Foundation. The existing embankment, of red silty sand soil, the sand beach tailings, or the natural ground surface adjacent to the existing embankment upon which the earthfill embankment is to be placed.

3.2.4 Compaction. The mechanical process whereby the density of the soil is increased.

3.2.5 Optimum Moisture Content. The moisture content at which the specified amount of compaction effort will produce the maximum density of the soil.

3.2.6 Maximum Dry Density. The dry density of the soil obtained after a specified amount of compaction at the optimum moisture content.

3.3 GENERAL PROVISIONS

3.3.1 Lines and Grades. All fills should be constructed to the lines, grades and cross-sections indicated on the

drawings unless otherwise directed in writing by the ENGINEER. All finished surfaces shall be generally smooth.

3.3.2 Conduct of Work. The CONTRACTOR shall maintain and protect all fill in a satisfactory condition at all times until all work under the CONTRACT is complete and final. Any previously approved fill which is not maintained and protected to the satisfaction of the ENGINEER until final acceptance of the work shall be replaced or reworked by the CONTRACTOR in a satisfactory manner, and no additional payment will be made therefor. The CONTRACTOR may be required to remove at his own expense any fill material placed outside of the prescribed lines and grades.

3.4 MATERIALS

3.4.1 General. The suitability of materials and their deposition in the fills will at all times be subject to the approval of the ENGINEER. The compacted dam embankment shall be constructed using the red silty sand borrow material. All material shall be free from any perishable or otherwise undesirable materials. Should any undesirable material be hauled onto the fill, it should be removed prior to compaction operations.

3.4.2 Source. Suitable fill material shall be obtained from the designated borrow area and stockpile area.

3.5 CONSTRUCTION

3.5.1 Foundation Preparation. The entire surface of the dam foundation areas, with the exception of the tailings sand beach area, shall be stripped and leveled where necessary, scarified to a depth of at least six (6) inches, moistened (if required), and compacted as herein specified for the compacted

fill. All topsoil containing vegetation shall be completely removed from the area.

3.5.2 Placement and Spreading. Embankment fill shall be placed in approximately horizontal layers not to exceed eight (8) inches in loose thickness. Fill materials shall not be placed and compacted until the exposed foundation areas have been inspected and approved by the ENGINEER. From Station 19+00 to 76+00 (approximate), embankment fill will be placed on a foundation of sand tailings. In these areas, the initial embankment fill may need to be end-dumped in a thickness of up to 24 inches in order to construct a working pad on which to place the subsequent 8-inch layers of fill.

The CONTRACTOR shall keep the foundation area free from ponded water or unacceptable material after filling operations have started. Fill shall not be placed upon a frozen surface nor shall snow, ice or frozen material be incorporated in the fill.

Unless otherwise directed, fill material shall be maintained at approximately the same level. The distribution of materials throughout the fill shall be such that there will be no lenses, pockets or streaks of material differing substantially in texture or gradation from the surrounding material in the fill. After placement of each layer of material, the fill shall be spread by motor grader or other approved equipment. Compacted fill shall not be placed against a slope steeper than one horizontal to one vertical unless otherwise shown on the plans or approved by the ENGINEER.

Where the embankment abuts the natural surface soils near the downstream toe of the western embankment, the existing steep surfaces should be benched and the

fill material should be well keyed into the slope for each lift so that no loose zones remain and that an adequate tie is provided between the natural soils and the new construction. Where the embankment abuts the sideslopes of the existing embankment, the fill should likewise be well keyed into the slope. Care must be given to the existing sand and gravel drain at the toe of the existing embankment near Station 21+00 (see Plot Plan, Plate B-1).

Care must be exercised to adequately mark, protect, and prevent damage to all existing piezometer pipes which project from the existing embankment.

3.5.3 Moisture Control. During the compaction operations, the surface of the fill and the materials being placed shall be maintained within the moisture content range required to permit compaction to the specified density with the equipment used. The water content of the earthfill material prior to and during compaction shall be distributed uniformly throughout each layer of the material. Allowable ranges of placement water content are based on design considerations, but the required degree of compaction can be secured with a reasonable effort within 4% of optimum moisture content or in the moisture range defined by the ENGINEER.

The optimum water content is defined as the water content which will result in a maximum dry unit weight of the soil when subjected to the ASTM* D-698 method of compaction. Compaction tests will be made by the TECHNICIAN under supervision of the ENGINEER during placing of the fill. Water, if required, may

* American Society for Testing and Materials

be added to the material at the borrow or stockpile areas or by sprinkling on the placed earthfill. The water shall be uniform throughout the layer immediately prior to compaction.

3.5.4 Compaction.

3.5.4.1 Equipment. Compactors of sufficent size and number to maintain the progress of the work may be required to obtain the specified compaction and should be made available. All compaction equipment used shall be in good working order, of a capacity, weight, and/or power necessary to perform the required operations in a workmanlike manner and must be approved for use by the ENGINEER.

3.5.4.2 Compaction Methods. After each layer of fill material has been placed and spread and contains the required moisture content as specified in Subsection 3.5.3, it shall be compacted by making a sufficient number of passes with the compaction equipment over the entire surface of the layer to obtain the density specified for compacted embankment fill.

3.5.5 Density Requirements. All embankment earthfill under these specifications will be classified as compacted fill. Compacted fill shall consist of and include all fills deposited in layers and compacted by rolling and tamping. Embankment fill will be compacted under these specifications to at least 95 percent of the maximum dry density obtained from the performance of a compaction test in accordance with the ASTM D-698 method of compaction. In-place density tests will be performed by the TECHNICIAN to

insure that the compaction procedure as outlined in Section 3.5.4.2 is to achieve the required density specifications for embankment fill. The number of density tests to be performed is detailed in Section 5.0. The percent compaction of the compacted fill will be determined by comparing field densities to the densities obtained by compacting the same type of soil in laboratory compaction tests described above. If density tests indicate the fill to be of insufficient compaction, modifications to the procedural compaction method as outlined in Section 3.5.4.2 must be made by the CONTRACTOR. Each layer of fill will be accepted by the ENGINEER before additional layers are placed. Acceptance or rejection of any portion of the compacted embankment fill shall be based on tests conducted during the actual fill placement.

3.6 PAYMENT

Payment for placement, spreading, moisture control and compaction of the embankment fill is based on a unit priced bid and covered under Item 2 of the Bid Schedule. Pay quantities will be determined by surveying, as described under Section 4.2.

4.0 SURVEYING

4.1 SCOPE OF WORK

This specification covers the surveying required to commence construction, to maintain the progress of the work and determine the final in-place compaction earthwork quantities and excavation volumes.

4.2 REQUIRED SURVEYING

The OWNER will establish baselines and bench marks required for the proper execution of the work. The following subsections outline the minimum required surveying services to be provided by the CONTRACTOR.

4.2.1 Initial Layout. This portion of the work covers the coordination of existing survey control and the initial layout of the embankment addition. The "downstream" or outer edge of the bench at the approximate elevation 4,058 feet shall be the reference for the survey along all but the western segment of the embankment. Along the western length of the embankment, the "upstream" or inner edge of the existing embankment crest at the approximate elevation 4,058 feet shall control.

4.2.2 Determination of Foundation Grade. After completion of the foundation area stripping and leveling work, and prior to scarifying the foundation, the foundation area shall be surveyed for grade at the station sections to determine pre-construction cross-sections.

4.2.3 Sectioning the Completed Embankment Addition. This portion of the work covers the surveying of sections of the embankment at the same 100-foot stations after fill placement as those surveyed before fill placement.

4.2.4 Determination of Borrow Material Volumes. Survey services will be required to (1) survey all areas designated as borrow areas before any material is removed and (2) survey sections of the embankment at the same 100-foot station intervals after removal of all required borrow material. An appropriate shrink factor will be applied to this volume to determine the compacted in-place quantity of embankment fill. From the survey performed under Sections 4.2.2 and 4.2.3, volumes of fill not a part of this contract will be determined. The preceding survey will form the basis in determining payment under Item 2 of the Bid Schedule.

4.2.5 Miscellaneous Surveying. Additional surveying services may be required to maintain the progress of the work and is the responsibility of the CONTRACTOR. This said additional surveying service shall be supplied by and at the expense of the CONTRACTOR.

4.3 SUPERVISION OF WORK

The above outlined scope of work performed by the CONTRACTOR or his subcontractor shall be supervised by a qualified and licensed surveyor. Required surveying and related volume determinations will at all times be subject to review and approval of the ENGINEER.

4.4 PAYMENT

Payment for the required surveying services outlined above shall be based on a lump sum as part of the bid and is covered under Item 3 of the Bid Schedule.

5.0 CONSTRUCTION INSPECTION

5.1 SCOPE OF WORK

The ENGINEER will be responsible for field inspection and testing, final quality of earthwork and foundation soil preparation, and advising the OWNER of inadequacies in the event they are not or cannot be corrected during the course of work.

5.2 GENERAL

The ENGINEER will provide all labor, material, and testing equipment, technical and supervisory services necessary to perform all the soil tests, inspections and certifications required by the specifications.

The ENIGNEER and the TECHNICIAN will have copies of:

- The project plans and specifications.
- The applicable ASTM specifications.
- The results of pertinent laboratory tests previously made on the construction materials.

In addition to performing all required field tests and inspection during placement, the TECHNICIAN will also conduct any tests necessary to confirm that the material within the specified borrow area and stockpiles meet the appropriate project specifications for soil type, gradation, or limits on deleterious materials.

The TECHNICIAN will be present each day before any earthwork is started,and remain on the site during the course of the work. He will also make himself available at all reasonable times as requested by the CONTRACTOR.

5.3 INSPECTION DETAILS

5.3.1 Frequency and Location of Tests. Visual inspection of the work and field testing of the soils are the primary means of assuring proper materials and

adequate density in controlled fills. Frequency of tests and the test locations are at the option of the TECHNICIAN unless additional tests are requested by the ENGINEER, CONTRACTOR or the OWNER.

Density tests will be made in the following areas:

- Where the degree of compaction is doubtful.
- Where embankment construction operations are concentrated.
- For every 1,000 yd^3 of embankment when no doubtful or concentrated areas occur.

5.3.2 Verification. The TECHNICIAN will notify the CONTRACTOR's personnel, directly, of any fill material that is below the required density, of improper moisture content for efficient compaction, unapproved borrow materials, or fills that have been improperly placed so that immediate corrections will be made during the course of work.

It will be the responsibility of the TECHNICIAN to notify the ENGINEER and OWNER if the fill material, the placement method, or the soil density or moisture consistently fail to meet the required specifications. His report will include the reasons for such conditions. The TECHNICIAN will report such problems both verbally and subsequently in writing.

On each day in which any earthwork is performed, the TECHNICIAN will submit to the OWNER and to the CONTRACTOR a daily report which will include, but not be limited to, the following information:

- Areas and elevations of completed earthfill placements.
- Type of earthfill materials placed.
- Test densities obtained.
- Soil moisture conditions.
- List of all construction equipment used.

. Deviations from specifications.

. Final disposition of problem areas.

The TECHNICIAN will maintain a personal field file with the above information, plus any unusual conditions, suggestions or recommendations made to the CONTRACTOR and will have such a file on the site at all times.

The ENGINEER will visit the job with sufficient frequency to be thoroughly familiar with:

. The earthwork, excavation, backfill, and foundation construction of the CONTRACTOR.

. The quality and scope of testing and inspection by the TECHNICIAN, during the course of work.

5.3.3 Testing Methods. The ASTM methods that will be used in performing the required tests are as follows:

Type of Test	ASTM Standard Method
Compaction Test	D-698
Gradation Test	D-422
Density Test	D-2922 and D-1556
Moisture Content Test	D-3017 and D-2216

It should be noted that ASTM methods D-2922 and D-3017 involve the use of nuclear methods. The purpose of the ASTM D-1556 and D-2216 tests are to provide a check on the accuracy of these nuclear methods.

6.0 PIEZOMETER EXTENSIONS

6.1 SCOPE OF WORK

Eight piezometers exist within the area to be covered by fill under this contract. This specification covers extending the piezometers upward through the new fill as it is being placed.

6.2 GENERAL DESCRIPTION

Eight piezometers have been established along the existing embankment at the locations labeled as piezometer locations B-7, B-10, B-13, B-15, B-28, D-1, D-2, and D-3 on the Plot Plan in the PLANS. The casing and piezometers shall be extended upward to where the top of the eight-inch PVC casing is at least eight feet above the existing embankment surface at the piezometer location. At most piezometer locations, compacted fill must be placed adjacent to the piezometer. In these areas, hand-compaction using mechanical tampers will be required to obtain the necessary densities and to prevent damage to the casing and piezometers by heavy compaction or other construction equipment.

Along the first bench of the existing embankment, eight additional piezometers (the locations of which are shown on the Plot Plan as A-1, A-4, A-5, B-1, B-2, B-4, B-5, and B-8) have been established and are functional. Care must be taken by the CONTRACTOR not to damage or cover these piezometers.

6.3 MATERIALS

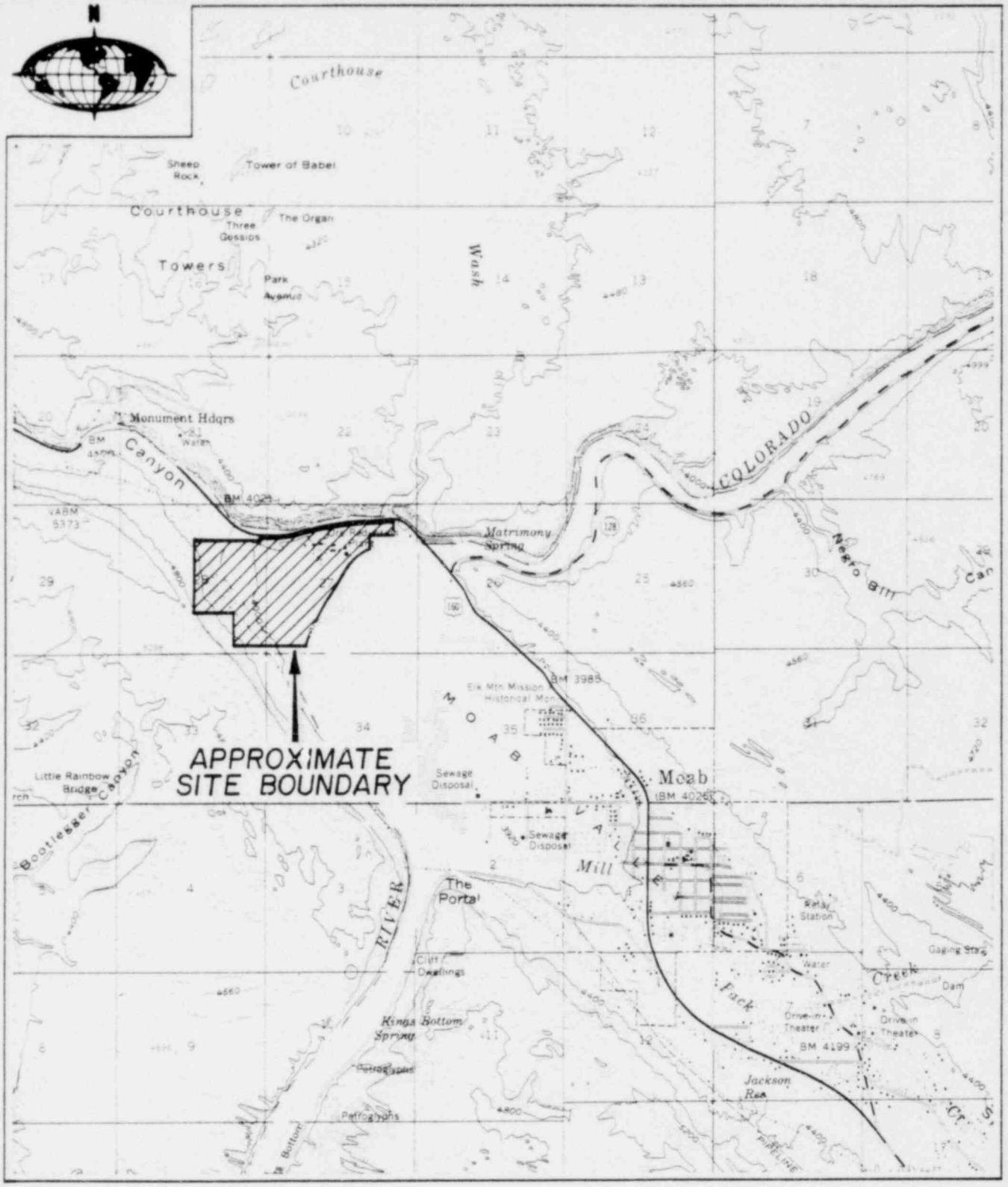
Casing used to protect the piezometers shall consist of nominal 8.0-inch diameter section 40 PVC pipe. Piezometer pipe shall consist of 0.75-inch nominal diameter section 40 PVC plastic pipe.

6.4 INSTALLATION

Piezometers above grade shall be installed and extended in advance of compacted fill placement by the addition of casing and piezometer tubes. Special care shall be taken to achieve a watertight seal when joining PVC pipe sections. Fill placed adjacent to the casing sections shall be hand-compacted within 24 inches of the casing. Riser tubes shall be fitted with removable caps which shall be kept in place at all times to prevent dirt or other debris from entering the piezometer riser pipes and tips.

6.5 PAYMENT

Payment for extending the piezometer including all labor, materials, and supervision incident thereto is covered under Item 4 of the Bid Schedule as a lump sum amount.

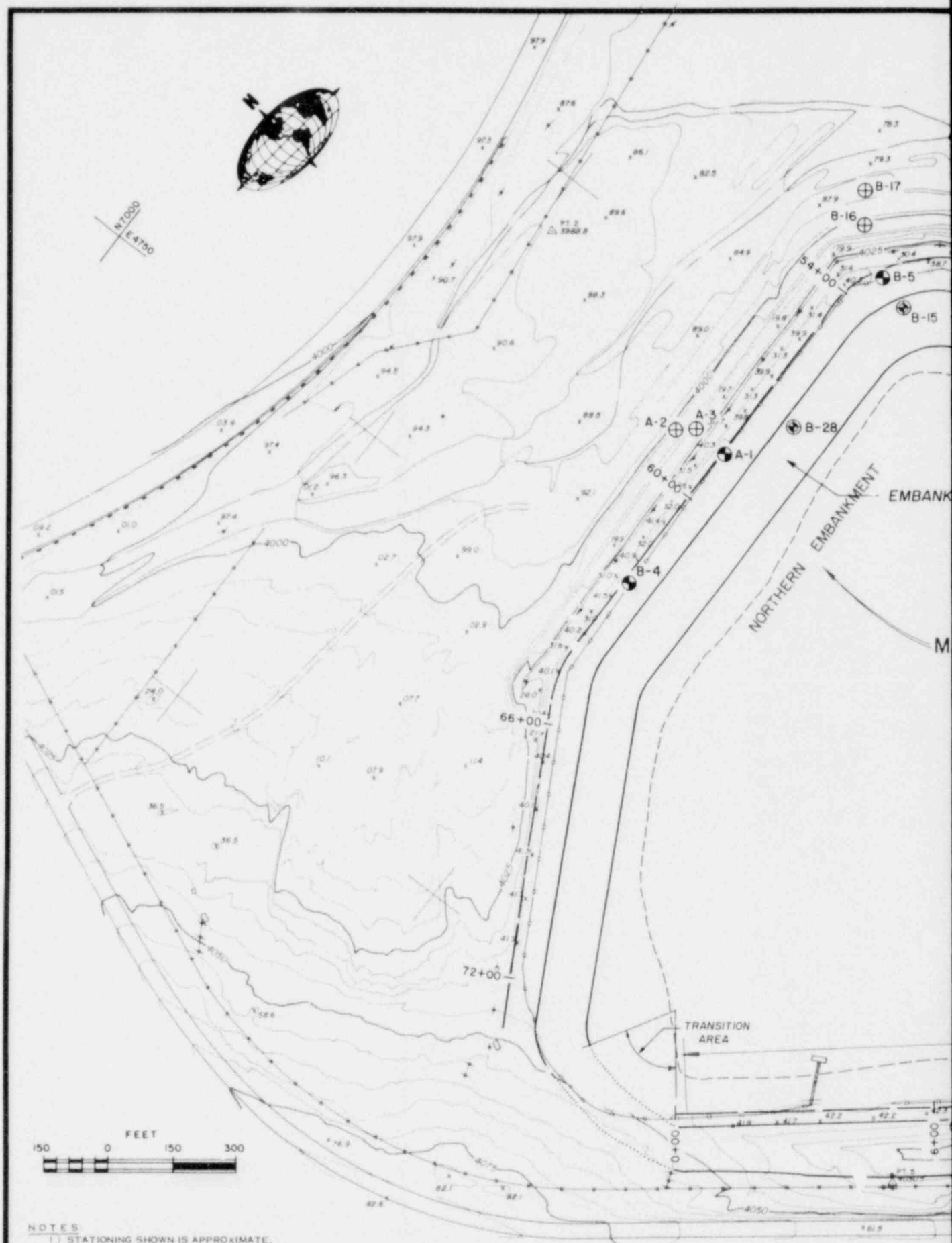


VICINITY MAP

REFERENCE
U.S.G.S. QUADRANGLE SHEET ENTITLED "MOAB, UTAH" DATED 1959 (PR 1968).

DAMES & MOORE

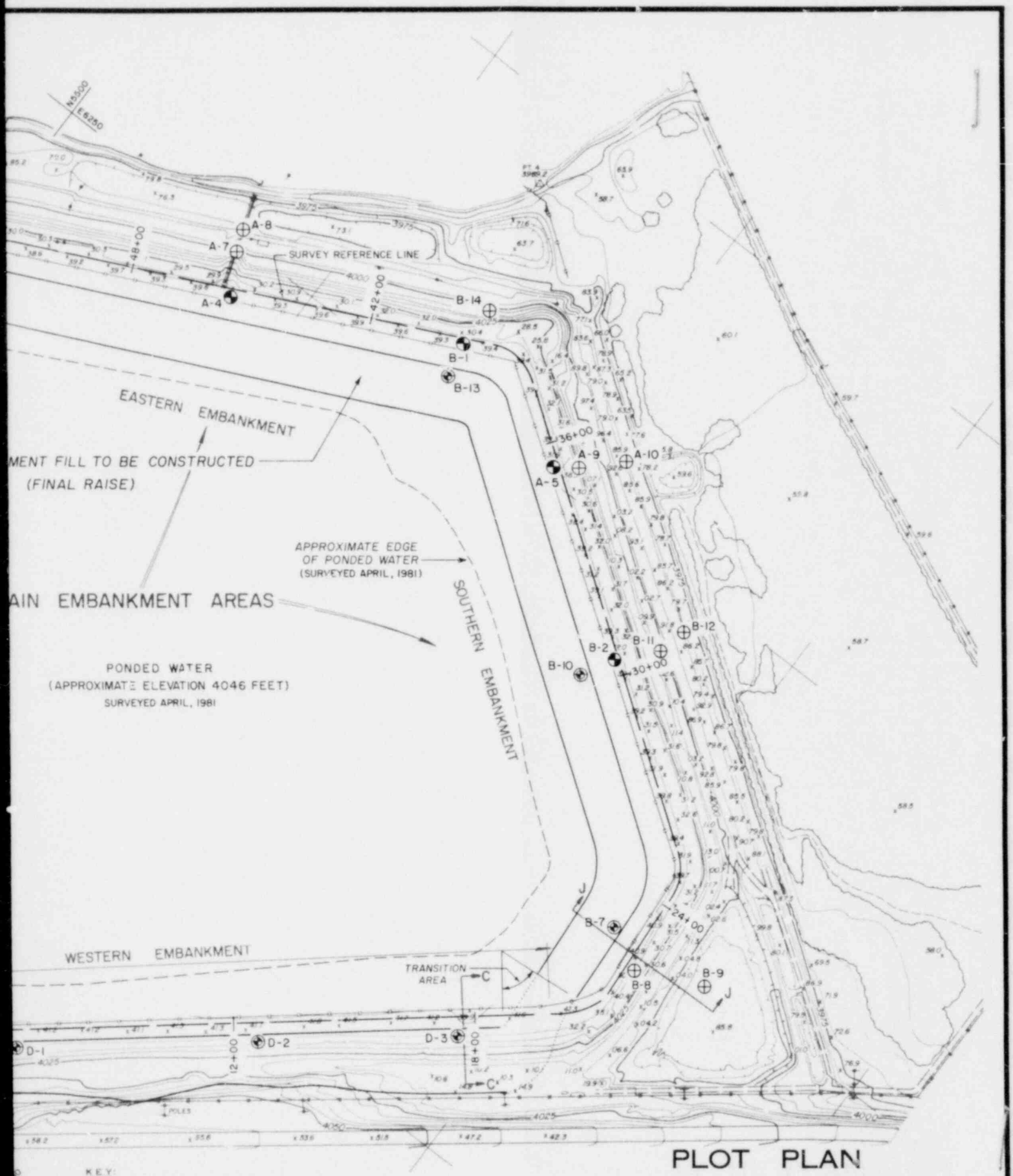
PLATE B-1



NOTES

1) STATIONING SHOWN IS APPROXIMATE.
2) THE EMBANKMENT IN THE TRANSITION AREAS SHOULD BE CONSTRUCTED TO SMOOTHLY CONNECT THE ADJOINING EMBANKMENTS.
3) CONTOUR INTERVAL 5 FT. THE CONTOUR LINES IN THE VICINITY OF THE BORROW AREAS AND THE EXISTING EMBANKMENT CREST DO NOT REPRESENT EXISTING CONDITIONS.
4) EMBANKMENT FILL OUTLINES ARE APPROXIMATE. REFER TO CROSS-SECTIONS FOR ACTUAL FILL LAYOUT.

REFERENCE:
DRAWING ENTITLED, "ATLAS MINERAL TAILINGS POND", BY AEROGRAPHICS, INC., SALT LAKE CITY, UTAH, FROM PHOTOGRAPHY FLOWN 4-11-78.



PLOT PLAN

KEY:

- EXISTING PIEZOMETER TO BE RAISED
- EXISTING PIEZOMETER TO BE PROTECTED DURING CONSTRUCTION
- EXISTING PIEZOMETER

DAMES & MOORE

PLATE B-2

REVISIONS

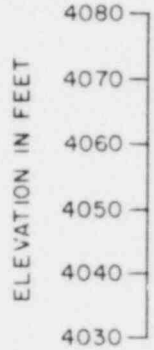
BY _____ DATE _____ TO EO ____

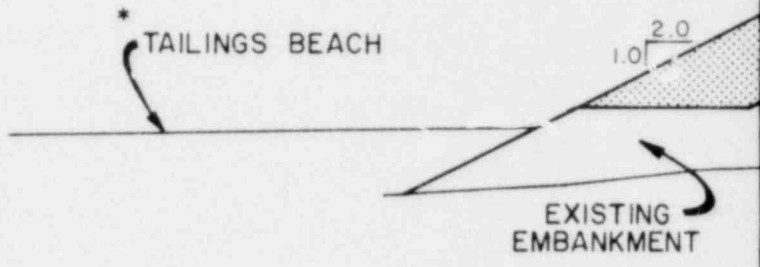
BY _____ DATE _____ TO EO ____

BY _____ DATE _____

CHECKED BY _____

COPY TO EO _____





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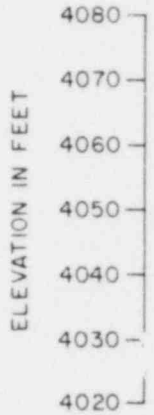

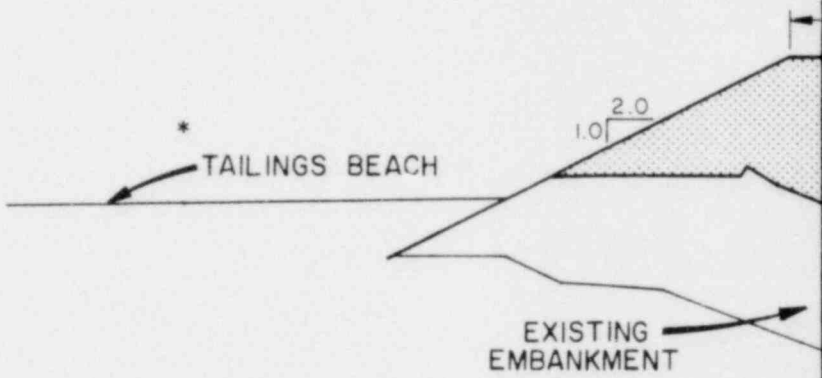

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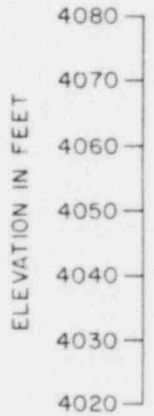

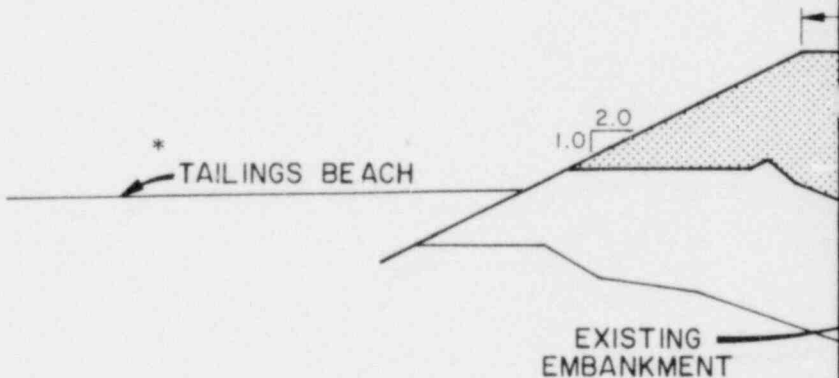

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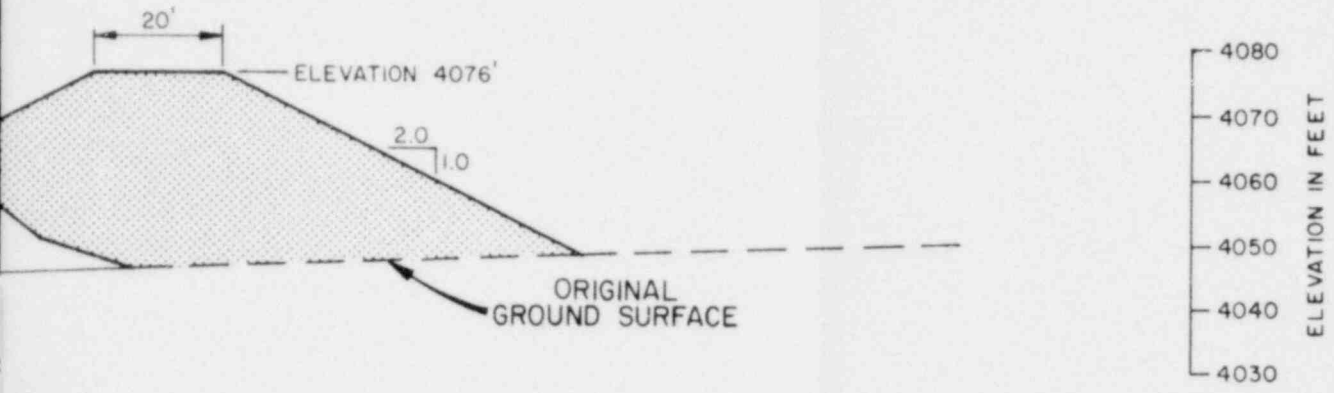
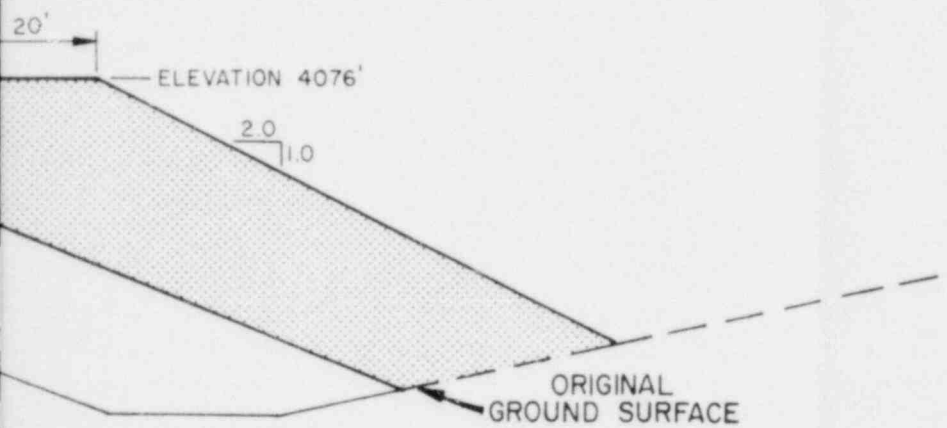
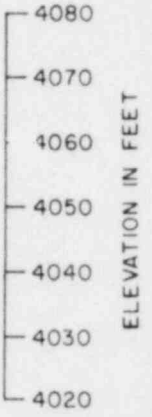
* ANATICIPATED TAILINGS BEACH SURFACE AT TIME OF CONSTRUCTION.

466.12 (4-84)

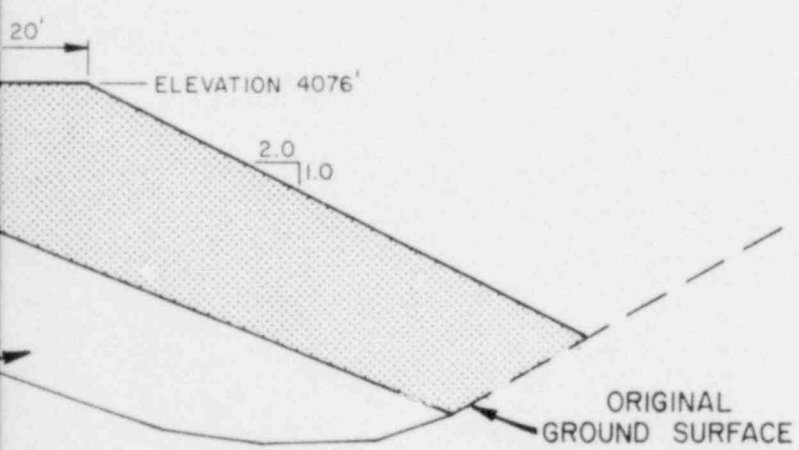


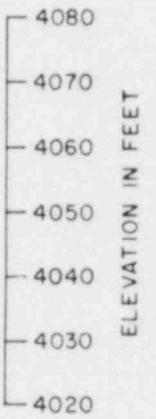
TION 0+00





TION 6+00





TION 12+00

Dames & Moore

PLATE B-3A

REVISIONS

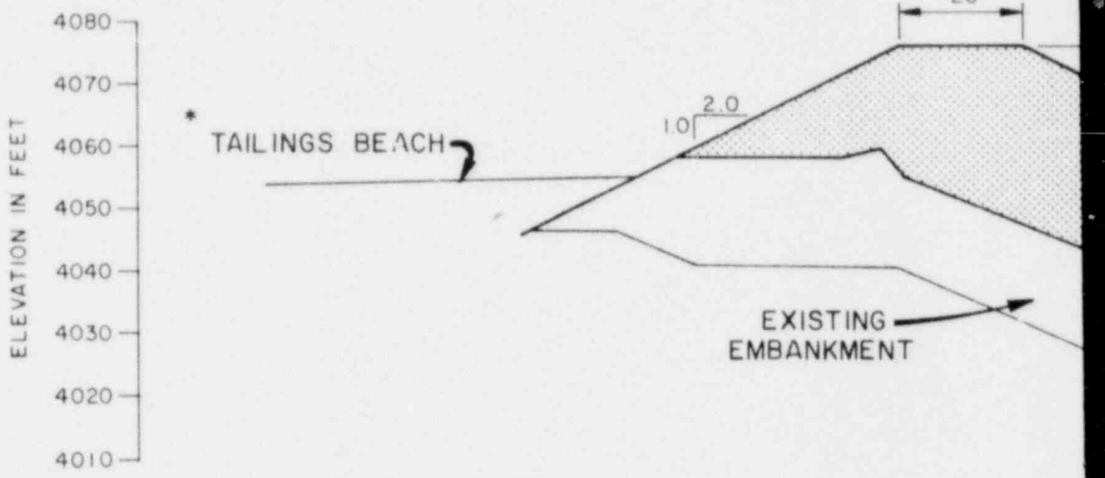
BY _____ DATE _____ TO EO ____

BY _____ DATE _____ TO EO ____

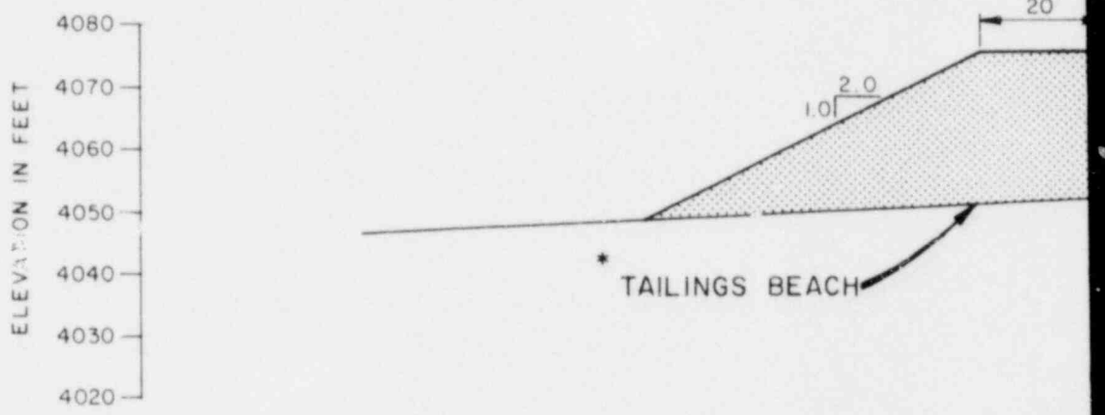
BY _____ DATE 4-6-81

CHECKED BY CS 4-7-81

COPY TO EO _____



STA



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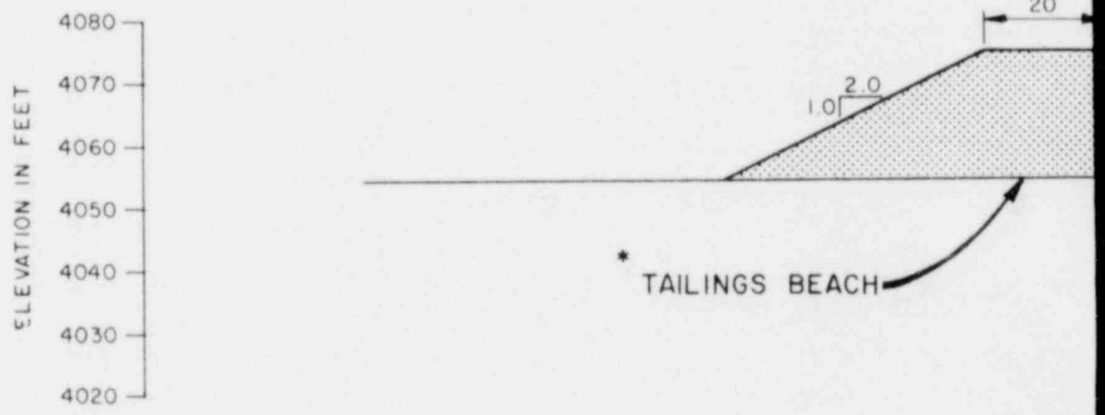
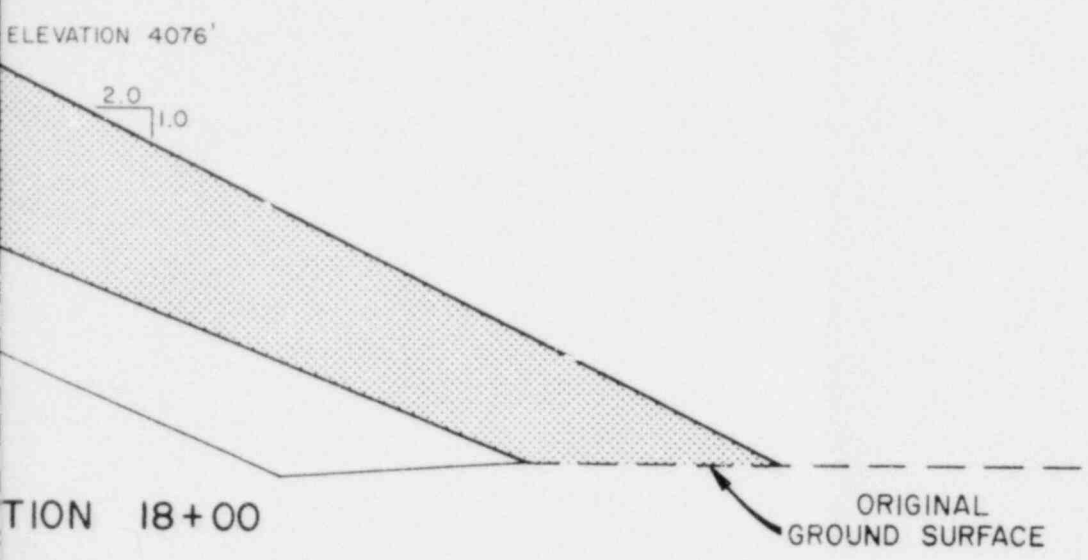


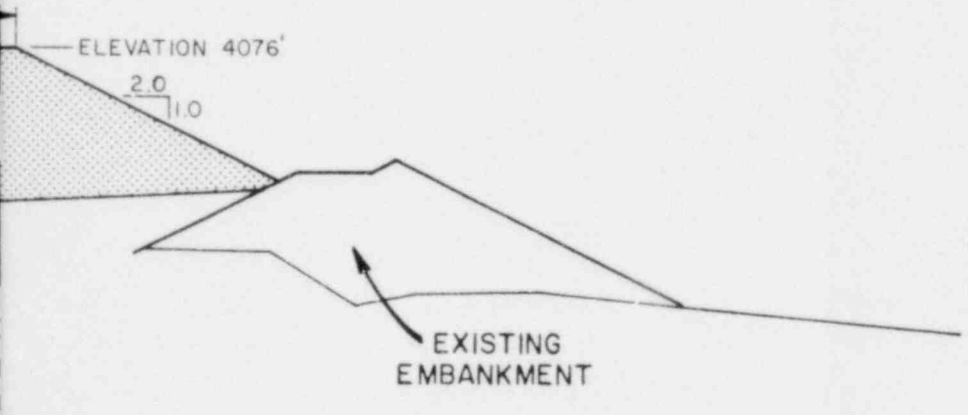
STA

* ANATICIPATED TAILINGS BEACH SURFACE AT TIME OF CONSTRUCTION.

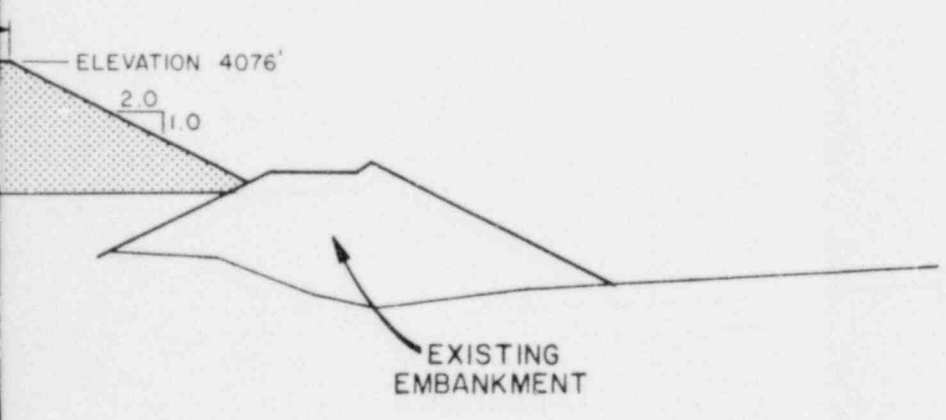
466.12 (4-64)



TION 18+00



TION 24+00



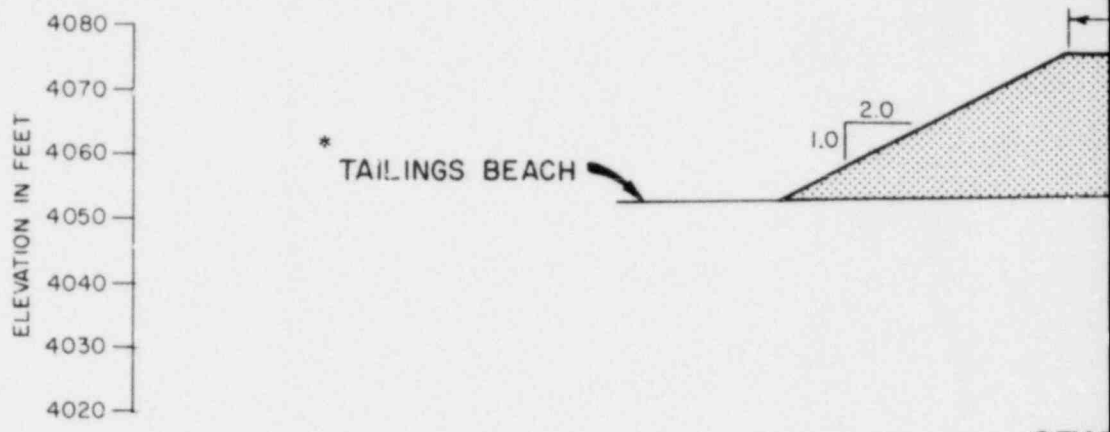
TION 30+00

Dames & Moore

PLATE B-38

REVISIONS
BY _____ DATE _____ TO EO ____
BY _____ DATE _____ TO EO ____

BY _____ DATE 9-6-91
CHECKED BY 05462-0328
COPY TO EO _____



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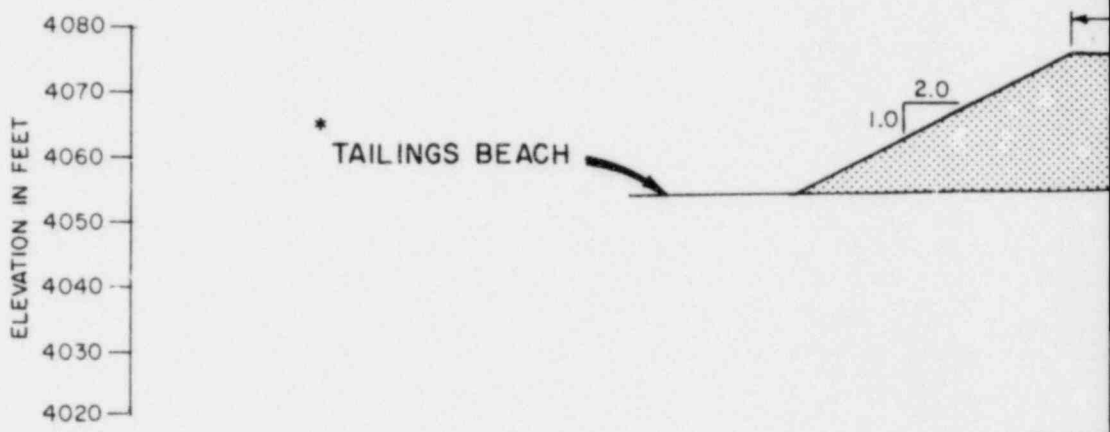

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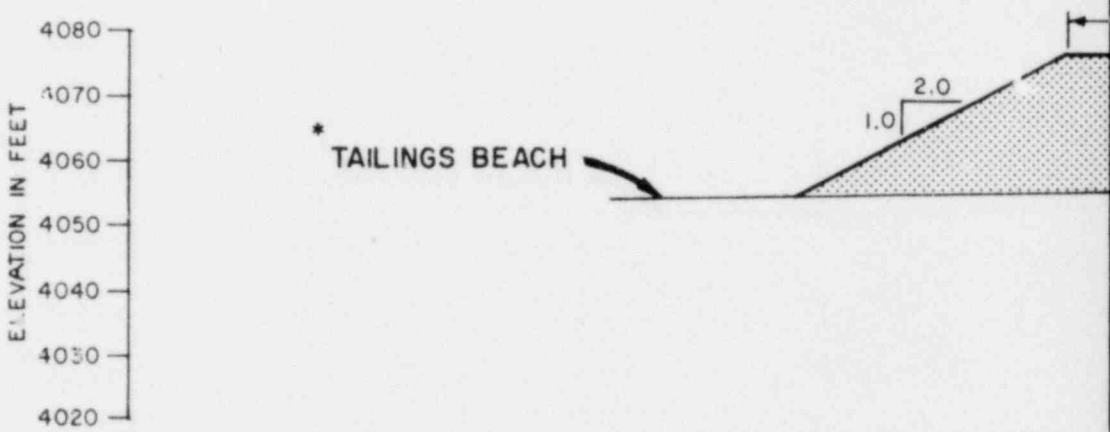
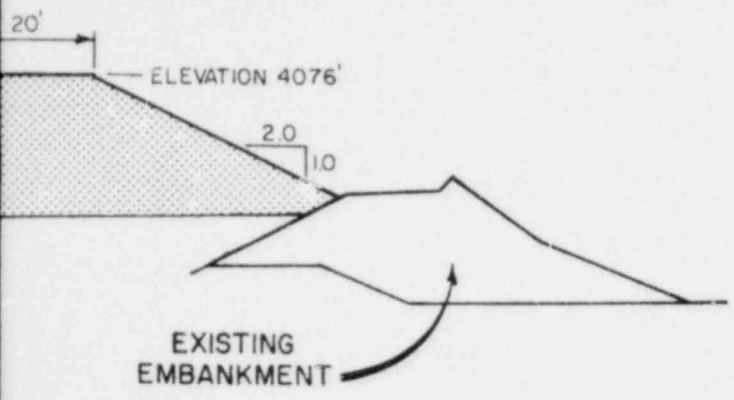
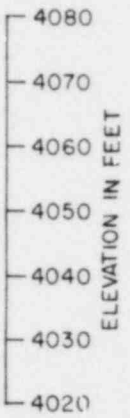


STA

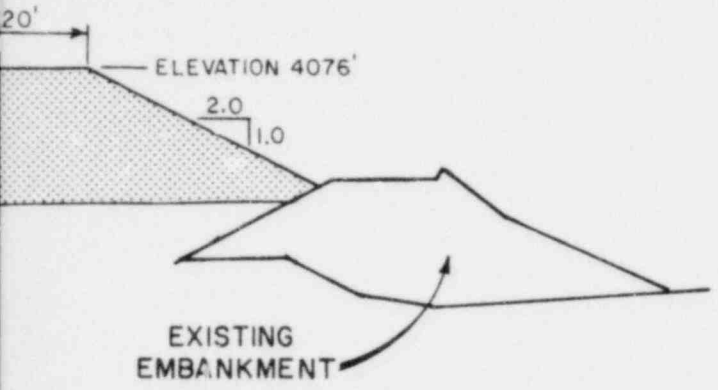
* ANATICIPATED TAILINGS BEACH SURFACE AT TIME OF CONSTRUCTION.

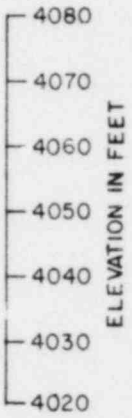
466.12-(4-80)



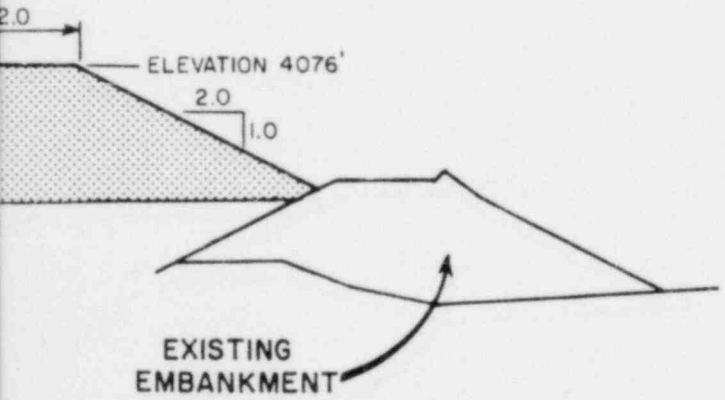


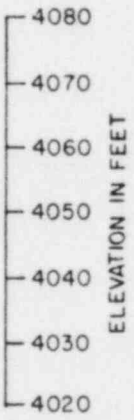
TION 36+00





ION 42+00





TION 48+00

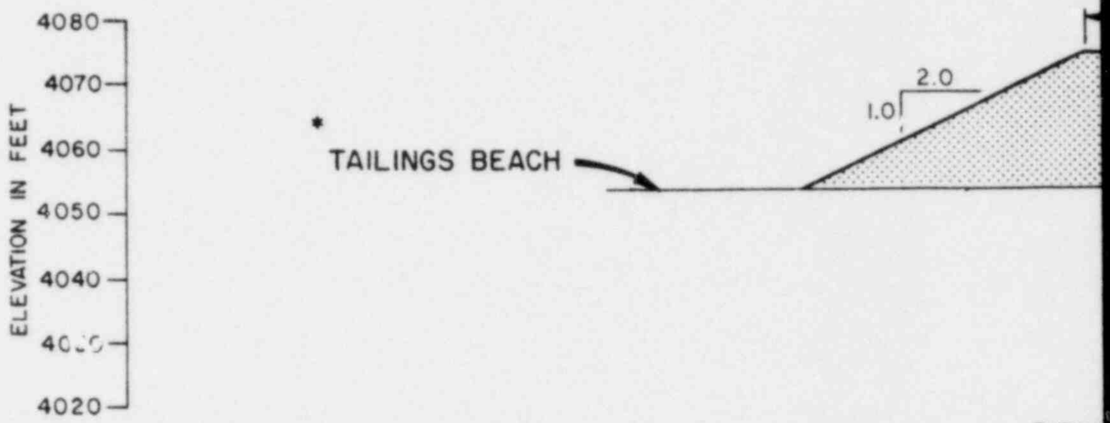
Dames & Moore

PLATE B-3C

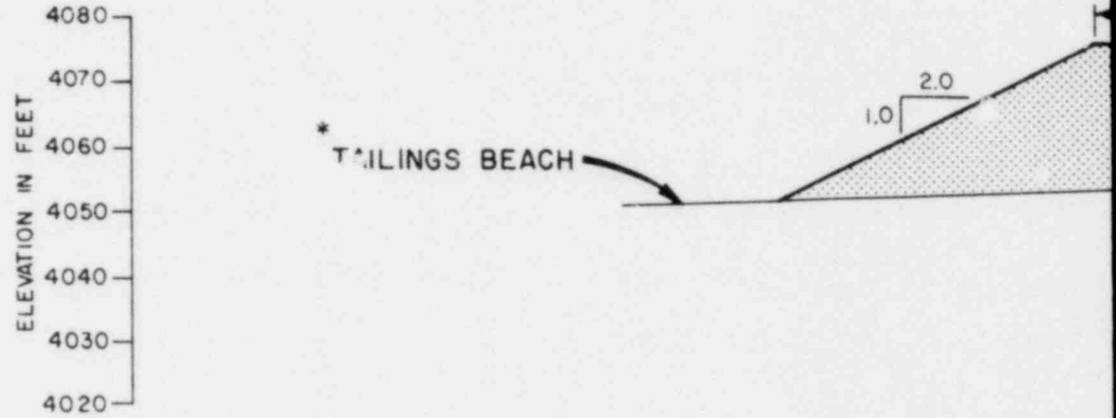
REVISIONS
BY ____ DATE ____ TO EO ____
BY ____ DATE ____ TO EO ____

BY ____ DATE ____
CHECKED BY ____
COPY TO EO ____

466.12 (4-64)

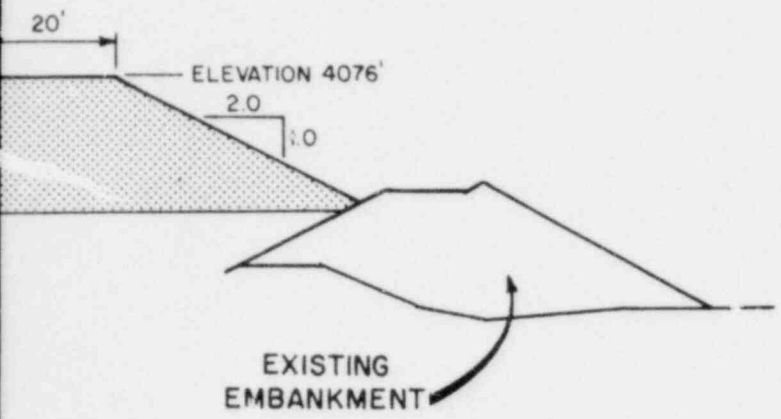


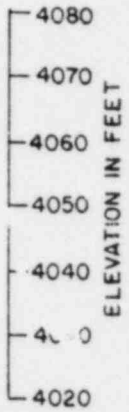
STAT



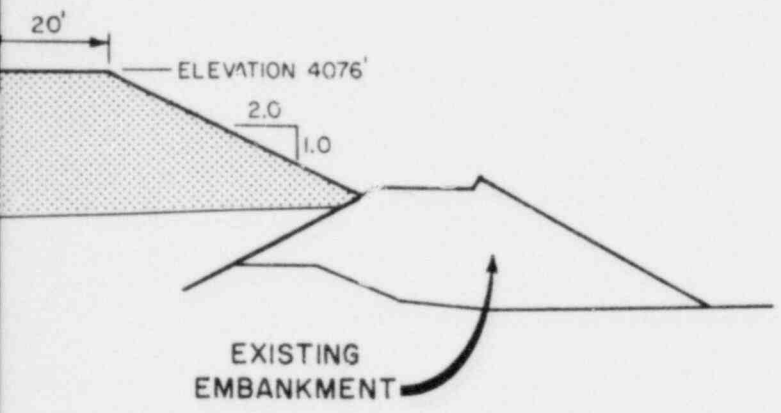
STAT

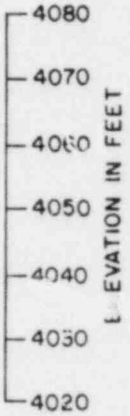
* ANATICIPATED TAILINGS BEACH SURFACE AT TIME OF CONSTRUCTION.





TION 54+00



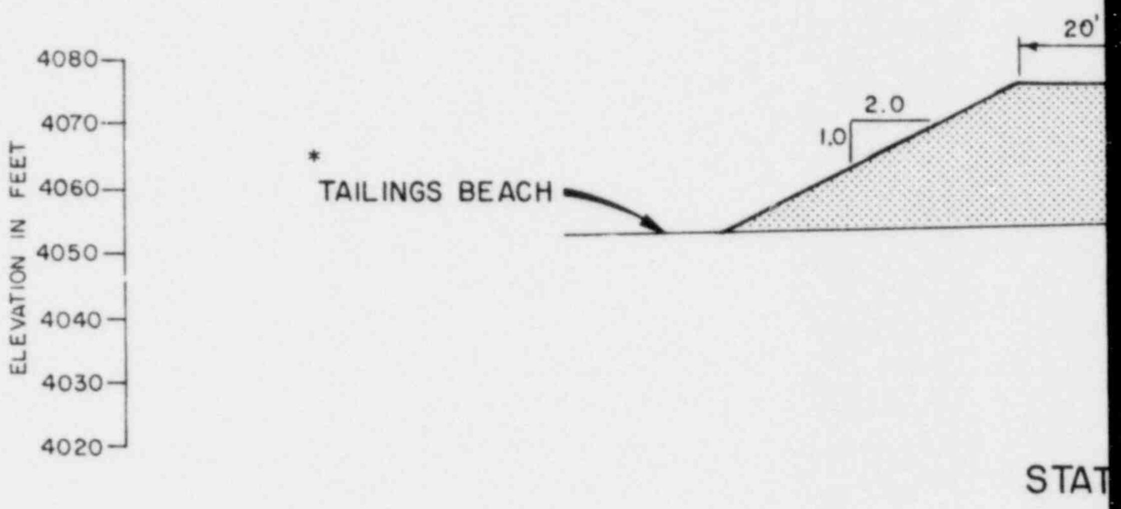


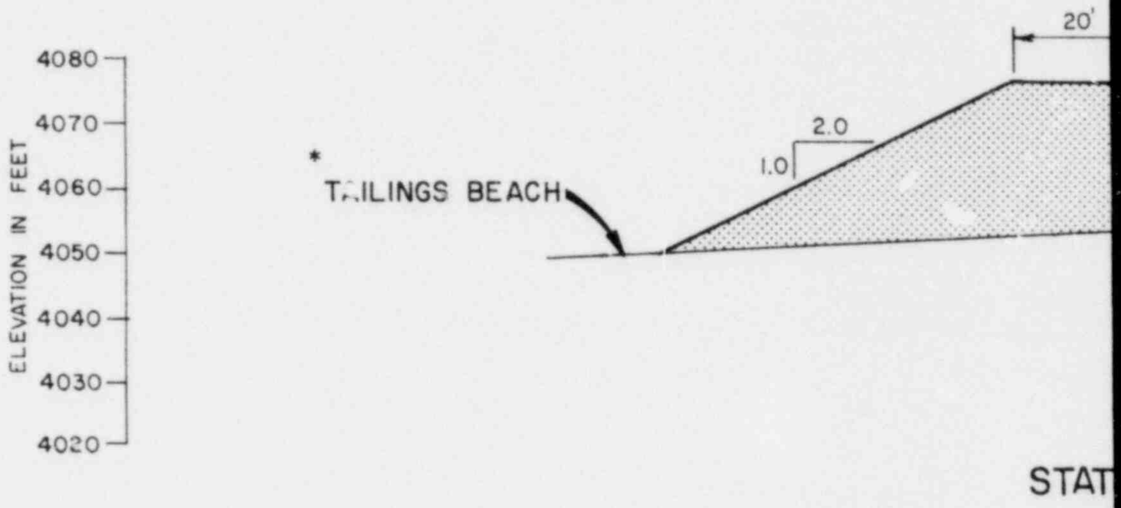
TION 60+00

Dames & Moore

PLATE B-30

REVISIONS
BY ____ DATE ____ TO EO ____
BY ____ DATE ____ TO EO ____

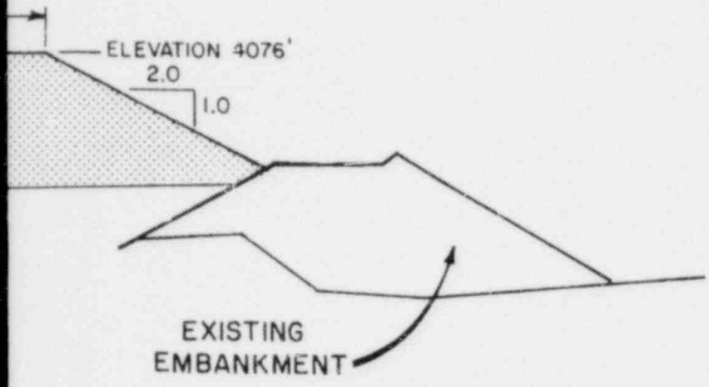




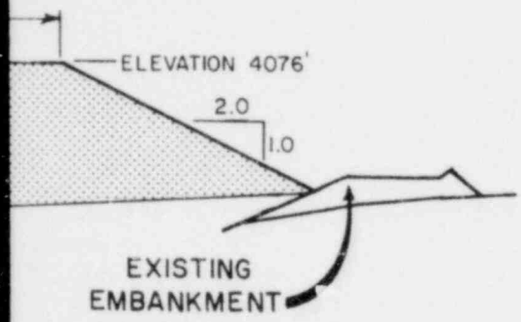
BY ____ DATE ____
CHECKED BY ____
COPY TO EO ____

* ANATICIPATED TAILINGS BEACH SURFACE AT TIME OF CONSTRUCTION.

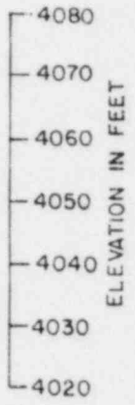
466.12 (1-64)



ION 66+00



ION 72+00



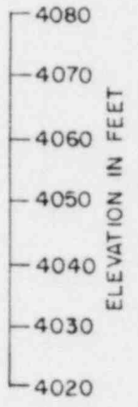


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PLATE B-3E