40-8903

HOMESTAKE

RECLAMATION PLAN

REVISION 10/93

HOMESTAKE MINING COMPANY

OF CALIFORNIA

GRANTS OPERATION

VOLUME 2

APPENDICES

OCTOBER, 1993

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PREPARED BY AK GEOCONSULT, INC.
WITH JENKINS ENVIRONMENTAL, INC.

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APPENDIX A

HEALTH AND SAFETY RADIATION AND SURVEY PROCEDURES

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Table 3 Homestake Occupational Monitoring Program (7-93)

Type of Sample	Number	Locations	Method	Frequency	Analytical Parameters
Work Area Air Sample	As required by RWO	As required by RWO	HP-1 (50/L/min or eq.)	As required by RWO	Alpha, U-nat
Work Area Sampler Calib.	All in use	na	HP-1	Quarterly	Flow rate
Lapel Personal Air Sample	As required by RWO	As required by RWO (2 L/min or eq.)	HP-1	As required by ROW	Alpha, U-nat
Lapel Personal Air Sampler Calibration	All in use	na	HP-1	Monthly	Flow rate
Removable Alpha	Variable	Lunch Rms, Change Rms in Use	HP-2	Weekly	Removable Alpha
Release of Equip.	na	Potentially Contam. Equipment and Materials	HP-4	As needed	Alpha, gamma
Mill Gamma Survey	None	None	See Personnel Gamma (TLD)	none	none
ALARA	na	As required by RPA	HP-6	na	As required by RPA
Respiratory Protection	As required by RWO	As required by RWO	HP-7	na	na
Bioassay	As required by RWO	As required by RWO	HP-8	Baseline, Monthly during mill decommissioning, termination Semi-annual after mill decommissioning	U-nat in urine
Radon in Mill	As required	As required by RWO	HP-9	As required by RWO	Rn Daughters
Instrument Calibration	Variable	Radiation Detection Instruments in use	HP-10	6 months or less	na
Personnel Gamma (TLD)	Variable	Personnel	HP-11	Quarterly	Gamma
Personnel Contam.	Variable	Personnel from process buildings	HP-12	Every work day	alpha
Mill Inspection	na	Process buildings	HP-13	Daily under RWO's, Quarterly when no RWO's	visual
Radiation Protection Training	As required	Mill Site	HP-14	As required	Training Class & Test

HP-# = Homestake procedure number; RPA = Radiation Protection Administrator; RWO = Radiation Work Order; TLD = Thermoluminescent Dosimeter

PROCEDURES FOR SOIL SAMPLING AND FIELD GAMMA SURVEYS FOR DETERMINATION OF RA-226 CONCENTRATIONS IN SOILS

EQUIPMENT

1. Shovel/trowel
2. 30 mL plastic bag or the equivalent
3. MicroR meter
4. Compass, map, survey stakes
5. Tractor with hydraulic soil sampler or hand soil sampler
6. Balance
7. Rolling pin, ceramic grinder, or pulverizer
8. Trays
9. Drying oven
10. Two quart plastic bag or the equivalent and marking pins
11. Quart "pint" cans
12. Multichannel analyzer

GAMMA-SOIL SURVEY GRID

Gamma survey measurements points and soil sampling locations are taken at 600-foot intervals, beginning approximately at the toe of the tailings pile and extending away from the pile, on radial lines extending out from the center of the pile. The grid consists of 16 radial lines beginning at north and plotted clockwise every 12.5 degrees. Use the existing grid locations, sample locations, and sample numbers where possible.

Using the compass, map of the tailings/mill area, survey stakes, etc. confirm and/or establish the survey grid around the tailings area.

SOIL SAMPLING PROCEDURES

The soil sampler is mounted on the back of a farm tractor and extracts a plug of soil 6.00" x 5.25" diameter. The first plug of soil is used to measure surface activity, i.e., in the top 15 cm of soil. Deeper soil samples from the same hole are used to determine activity is successive 15 cm depths. The sampler requires two operators equipped with a radio for emergencies. Soil samples are collected as follows:

1. Drive the tractor to the first grid point to be sampled. If the grid point falls on a building, concrete pad, or other entity such as large rocks that would preclude soil sampling, find a suitable sampling point in the area. If none are available such as in the middle of a pond,

delete that gird location and proceed to the next grid location. Be sure the soil sampler is clean as specified in item 7 below. Position the soil sampler over the location to be sampled. Install the soil sampler with a push plate on the hydraulic cylinder which activates the sampler

2. Lower the tractor bucket to stabilize the tractor and place the tractor in PARK.

3. With the tractor running at near idle speeds disengage the soil-sampler hydraulic lock-out mechanism and lower the soil sampler completely to fill the sampler with soil. If a rock or very hard soil in encountered which precludes filling the soil sampler, retract the sampler, move to an adjacent location, clean the sampler, and repeat the sampling procedure.

4. DO NOT MOVE the tractor when the hydraulic soil sampler is extended because this could damage the hydraulic cylinder.

5. Label a 2 quart plastic bag with a sample number that identifies the sampling location or can be keyed to the location. Record the sample number (location), the date sampled and the technicians collecting the sample on the soil sampling data sheet EDF-1. Retract the sampler from the ground, place the plastic bag under the sampler, and eject the sample from the sampler placing the sample in the labeled plastic bag. Close the plastic bag. Release the hydraulic pressure on the soil sampler.

6. Raise the tractor bucket, move the tractor to obtain a second soil sample at the same location, and follow steps 2-5 to obtain a second soil sample. Place the second sample in the same labeled bag used for the first sample collected.

7. Measure the gamma radiation levels as specified in the following section.

8. Engage the soil-sampler hydraulic lock-out mechanism and clean the soil sampler of potentially contaminated soil that may remain in the sampler from the last soil sample obtained. A brush, "puddy" knife, or metal rod may assist cleaning the sampler. Be certain that the sampler is clean before sampling to prevent cross contamination between samples. If the tractor or hydraulic mechanism leaks oil, fix the leak before sampling to avoid

contaminating the soil sample with oil.

9. Fill in the sampling hole before proceeding to the next sampling location.

10. As an alternative to using the hydraulic soil sampler, a hand soil sampler (6" x 2" diameter) and a 2 lb. hammer can be used to collect soil samples.

11. At the end of sampling each day verify that the soil samples have been properly labeled. Deliver the samples to the Environmental Department for analysis.

FIELD GAMMA SURVEY

1. Verify that the microR gamma survey meter has been calibrated in the last 6 months. Check the batteries and replace if necessary. Use a check source to verify the instrument is operating properly.

2. At each soil sampling location measure the gamma radiation levels at ground level. Check with the Environmental Department as to whether a lead shield is to be used around the NaI probe to minimize the detection of "shine" from the pile. Record the gamma level on the soil sampling data sheet EDF-1.

SAMPLE PREPARATION PROCEDURES

1. Grind or crush the soil samples to a uniform consistency with a rolling pin, ceramic ball mill, or pulverizer.

2. Mix the sample thoroughly and record the sample number on form EDF-1.

3. Weigh an empty 1 quart "paint" can and lid and record on Form EDF-1.

4. Dry the sample in the drying oven and place the sample in the weighed 1 quart can. Cap the can, weight it, and record on form EDF-1. Calculate and record on EDF-1 the weight of the sample.

5. For 10% of the samples fill a 30 mL plastic bag, or the equivalent, with the ground and dried soil and ship to a commercial laboratory for analysis of Ra-226 as pCi/g.

SAMPLE ANALYSIS

1. Set the multichannel analyzer to count gamma disintegrations from the Ra-226 daughter Bi-214 (609 KEV), Th-230 (911 KEV), and K-40 (1460 KEV).

2. Each day before counting soil samples on the multichannel analyzer count the background gamma levels overnight from an empty 1 quart "paint" can with its lid. Each day soil samples are to be counted, count the Ra-226, Th-230, and K-40 standards to accumulate approximately 10,000 cpm for each standard.

3. Fifteen days or more after sealing each quart can of soil, place the can in the NaI crystal counting chamber, close the shield, and count the gamma emissions until approximately 10,000 counts are obtained.

4. Calculate and record on form EDF-1 the sample activity for each radionuclide as follows:

$$\frac{(SC - BC)\ RA}{(RC - BC)\ (SWT)} = pCi/g$$

Where:
SC = count rate for the radionuclide of interest.
BC = count rate for background.
RC = count rate for standard (same radionuclide).
RA = activity of standard.
SWT = weight of sample in grams.

5. Use the previously established correlation between Ra-226 concentrations determined by counting the Bi-214 gamma rays and the Ra-226 concentrations determined by wet chemistry, to calculate the Ra-226 concentrations equivalent to wet chemical determinations. Record on form EDF-1.

6. Plot the calculated Ra-226 concentrations (wet chemical) on a map of the site.

QUALITY CONTROL

The Environmental Technicians assigned to soil sampling are to verify that the soil samples and gamma measurements are taken at the designated grid points, that the soils samples are not cross contaminated and that the samples are properly labeled.

The Environmental Technician assigned to preparing and counting the soil samples is to verify that the analytical procedures are followed, that the multichannel analyzer is properly functioning, and that the results are recorded and filed in the Environmental Department.

REFERENCES

None.

APPENDIXES

None.

REVISIONS

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DISTRIBUTION

Resident Manager
Environmental Department.

APPROVALS

Fred Craft
Resident Manager

Noel Savignac
Radiation Protection Administrator

B-WESTAR G CO.

RRA MULT-CHANNEL ANALYZER SERIES 35
SN. # 11871847

FDF - 1 SOIL SAMPLES (06/92)

SAMPLE ID	DATE COLLECTED	GROUND GAMMA READING uR/Hr	GROSS WT.	TARE WT.	SAMPLE WT.	DATE SEALED	DATE COUNTED	RA-226 TOTAL CTS. RA(ROI)609KEV CH549-CH658	TH-230 TOTAL CTS. TH(ROI)911KEV CH861-CH951	K-40 TOTAL CTS. K(ROI)1460KEV CH1338-CH1458	COUNT TIME TIME (SEC.)	RA-226 pCi/g FROM GRAMMA	RA-226 pCi/g WET CHEM EQUI	COMMENTS

Inst. Used ----------
SN. ----------
Date Calb. ----------
SAMPLING TECH_____
SAMPLING TECH_____

CORRELATION: pCi Ra Wet Chem = 1.445 (pCi Ra gamma) - 4.721
g g

Reference Material	DATE	CTS	TIME/CT	CT/SEC
Ra-226				
Th-230				
K-40				
BKG				
SUGER				

ENV. TECHNICIAN_____

HMC NON-ROUTINE AIR SAMPLING PROCEDURE

EQUIPMENT:

1. Filters - Gelman type A/E 50 mm glass fiber
2. Tweezers and envelopes
3. RAS-1 (50 Liter/min) air pumps and a watch
4. Lapel air samplers (2 Liters/min)
5. Glassine envelopes
6. Extension cords
7. Log book
8. Alpha scintillation counter (Eberline SAC-4, or the equivalent)

REGULATORY REQUIREMENTS

Personnel monitoring is required for each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 25 % of the exposure limits, 10 CFR 20.202(a). See reference 1. For soluble uranium the NRC has establish a weekly control limit of 40 hrs work at 1E-10 μ/mL air, 10 CFR 20.103(a)(2) and footnote 4 to Appendix B of 10 CFR 20.

Intakes less than 2 hours in any one day or for 10 hours in any one week at the maximum permissible concentration (1 MPC) need not be included in exposure assessments provided that any assessment in excess of these amounts the entire amount is included in the assessment (10 CFR 20.103(3). (10 hrs/40 hrs) MPC = 25 % MPC.

NON-ROUTINE AIR SAMPLING PROCEDURE

1. Radiation Work Order (Area) Samples - Monitor airborne radioactive material using a calibrated 50 L/min air samplers operated where workers are exposed to airborne radionuclides potentially in excess of the regulatory requirements specified above. See the Radiation Work Order (Permit), Appendix 1, issued for the non-routine work to be done. See Appendix 3 for calibration of air samplers. The samplers are to be operated for the duration of the non-routine work while work is in progress and NOT when work is not being performed. Place the samplers where they sample air breathed by workers as opposed to locations remote from the work location.

2. Personnel Air (Breathing Zone) Samples - Monitor airborne

radioactive material using a calibrated lapel air samplers for potential exposures greater than 10 MPC-hrs, e.g. 10 hrs at 1 MPC. See Appendix 3 for calibration of air samplers. Alternatively, place lapel air samplers on approximately 25% of the workers in a work crew. Place the lapel sampler on the workers with the greatest potential for exposure to airborne radioactive materials. Place the filter head near the breathing zone of the worker. Collect the personnel air sample for the durantion of the job or if not possible for a minimum of 30 minutes at 2 liters per minute to detect 10% of the MPC for uranium in restricted areas. The lower limit of detection for uranium on filter samples is 8E-7 g.

3. Radiation work order samples are sequentially numbered WO-# and the personnel air samples are sequentially numbered A-#. Record the respective sample numbers on the glassine envelopes and on the non-routine work-order sample data sheets and on the personnel air sample data sheets, Appendix 2.

4. Using the tweezers place filters in the air samplers, record the start time, date, location, flow rate, and other information needed on the data sheets. Start the pump.

5. At the end of sampling record the stop time. Using the tweezers remove the filter and place in the glassine envelope.

6. To allow for the decay of the radon daughters collected on the filters hold the filters a minimum of 3 hours and preferably overnight before counting. Calibrate the Eberline DP-13 alpha scintillation counter using a calibrated Th-230 source. Determine the counting efficiency and record on form EDF-2 for work order samples and on form EPF-3 for personnel air samples. Count the radiation work order filters and personnel air filters in the alpha scintillation counter or the equivalent for 10 minutes. Count the background for 10 minutes using an unused filter, calculate the background count rate, and subtract from the count rates for air samples. Divide by the counting efficiency to obtain DPM for the filter and record on the data sheets. 1 MPC sampled at 2 L/min for 8 hrs. will have an activity of 213 DPM. Alternatively 1MPC sampled at 50 L/min for 8 hrs will have an activity of 5,330 DPM. If the sample exceed the DPM for the type of sampling performed, obtain the chemical analytical results as soon as practical and analyze the workers potential exposure.

7. After initial counting of the samples, have both the radiation work order filters and the personnel air filter analyzed chemically for natural uranium.

8. Convert the chemical determinations of soluble natural uranium in grams to μCi using 6.77E-1 μ/g and determine the workers exposure each week exposures have occurred. For exposures to non-soluble uranium, such as calcined yellowcake, evaluate exposures to greater than 40 hrs at 1 MPC and take appropriate action to avoid recurrence. See NRC Regulatory Guide 8.30 for further guidance (reference 2). For exposures to airborne insoluble uranium and to ore dusts determine the exposures quarterly.

QUALITY CONTROL

The Environmental Technician assigned to non-routine air sampling is to verify that the personnel air samples are representative of the air breathed by the workers conducting the non-routine work in air containing radioactive materials and that the radiation work order samples are in the general area of the non-routine work. The Environmental Technician is to verify that the data sheets are properly filled in and that the radiation exposure determinations are done weekly for soluble uranium and quarterly for insoluble yellowcake and ore dust.

REFERENCES

1. 10 CFR 20, Standards for Protection Against Radiation.
2. USNRC Regulatory Guide 8.30, Health Physics Surveys in Uranium Mills.

APPENDIXES

1. Radiation Work Order.
2. Radiation Work Order Data Sheet & Personnel Air Sampler Data Sheet.
3. Air Sampler Calibration.

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DISTRIBUTION

Resident Manager/Radiation Protection Administrator

APPROVAL

Fred Craft
Resident Manager/
Radiation Protection
Administrator

APPENDIX 1
RADIATION WORK ORDER

HOMESTAKE MINING COMPANY - GRANTS

RADIATION WORK ORDER
FORM EDF-18

Non-routine Work Order No. _____ Date of Issue: _____

Requested by: _____ Work Location: _____

Description of Work to be Performed: Name(s) of Personnel Performing Work:

Required Radiological Surveys and Work Precautions:

___	Coveralls	___	Respirator Use Without Credit	___	Air Quality Monitoring
___	Rubber Boots	___	Powered Air Respirator	___	Urine Sample(s) Required
___	Gloves	___	Dual Cartridge Respirator With Credit	___	Additional Ventilation
___	Shower	___	Other _____		

Supervisors Signature: _____

Special Instructions: _____

Radiological survey results, if required, are attached.

General rules for non-routine maintenance work for which a work order is issued:

1. All protective requirements checked above must be followed.
2. Eating, drinking, smoking and chewing are prohibited during the performance of non-routine work.
3. The name of each individual engaged in non-routine work is required to be listed in the space provided above.

Supervisor will notify the Environmental Department personnel of the non-routine work to be done.

Approved By Signature: _____ Date: _____

RAD_WP.FRM 070293

APPENDIX 2

EDF-2 NON-ROUTINE WORK-ORDER AIR SAMPLE

EDF-3 NON-ROUTINE PERSONNEL AIR SAMPLE

N :OUTINE WORK-ORDER AIR SAMPLE
RM EDF-2 (7-15-92)

WORK ORDER #_____

DATE_____

TECHNICIAN_____

WORK DONE_____
_____
_____
_____

EMPLOYEES_____
_____
_____
_____

STOP TIME_____

START TIME_____

SAMPLING TIME_____

('LING TIME)(ave. L/min)(efficiency)
_____)(_____)(_____)=_____L

PUMP SERIAL #_____

CPM-BKG_____EFFICIENCY_____
DPM_____

COLORIMETRIC ANALYSIS

_____g U_3O_8E-7 on sample

6.77E-1 μCi/g

CONC._____μCi/mL

COMMENTS_____
_____
_____

NON-ROUTINE PERSONNEL AIR SAMPLE
FORM EDF-3 (7-15-92)

FILTER #_____

DATE_____

TECHNICIAN_____

EMPLOYEE_____

JOB_____

PUMP SERIAL #_____

STOP TIME_____

START TIME_____

SAMPLING TIME_____

LPM @ 2 L/MIN_____

CPM-BKG_____EFFICIENCY_____

DPM_____

COLORIMETRIC ANALYSIS

_____g U_3O_8E-7 on sample
6.77E-1 μCi/g

CONC._____μCi/mL

COMMENTS_____
_____
_____

APPENDIX 3

CALIBRATION OF AIR SAMPLERS

1. Work Order (Area) Air Samplers

A. Quarterly calibrate the work order (area) air samplers that are to be used during the quarter. With a new glass fiber filter in place connect the mass flow meter model NAHL-S to the inlet of the 50 L/min sampler. Measure the flow rate in cubic feet per minute and record on Form EDF-17. Convert cubic feet per minute to liters by:

$$\frac{ft^3}{min}\left(\frac{28.321L}{ft_3}\right) = \frac{L}{min}$$

B. Record on EDF-17 the corresponding air sampler rotameter measurement.

C. Repeat steps A. and B. for a different flow rate.

Calculate the rotameter correction factor by:

$$\frac{L/min}{\text{rotameter reading}} = \text{Rotameter correction factor}$$

Calculate the correction factor to convert the temperature and pressure at which the volume measurements were made to "standard" temperature (32° F) and "standard" pressure (760 mm of Hg) by:

$$\frac{(Pm)}{Ps}\frac{(Ts)}{Tm} = \text{Temp-Pressure correction factor}$$

Where:

Pm = Measured barometric pressure in inches or mm of Hg.
Ps = Standard barometric pressure = 29.2 inches of Hg = 760 mm of Hg. Pm and Ps must both be in the same units.
Ts = 32° F = 459° R.
Tm = Measured temperature = ° F + 459.7° = ° R

D. To use the rotameter correction factor and the pressure-temperature correction factor to calculate the L/min for any rotameter reading:

(rotameter reading)(rotameter correction factor)(temp-pressure correction factor) = L/min

E. Attempt to set the flow rate of each work order (area) air pump to 50 L/min.

F. On each pump attach a calibration sticker that specifies the pump number, the calibration date, the rotameter correction factor, the initials of the technician calibrating the pump. File Form EDF-17 in the Environmental Department Files.

G. Send the mass flow meter to commercial calibration facility for calibration every 6 months.

EDF-17 Work Order (Area) Air Sampler Calibration Record

Pump Model:_____ Date:_____
Pump Serial No.:_____ Technician:
Mass Flow Meter NASL-S, Ser. No. 11782, Calibrated:_____

MASS FLOW METER		WORK ORDER (AREA) PUMP	
FT^3/MIN	LITERS/MIN	MEASURED L/MIN	ROTAMETER CORRECTION FACTOR
			AVE.

$$\frac{ft^3}{min}\ \frac{(28.321L)}{ft_3} = \frac{L}{min}$$

Calculate the rotameter correction factor by:

$$\frac{L/min}{\text{rotameter reading}} = \text{Rotameter correction factor}$$

$$\frac{(Pm)}{Ps}\ \frac{(Ts)}{Tm} = \text{Temp-Pressure correction factor} =$$

Where:

Pm = Measured barometric pressure in inches or mm of Hg.
Ps = Standard barometric pressure = 29.2 inches of Hg = 760 mm of Hg. Pm and Ps must both be in the same units.
Ts = 32° F = 459° R.
Tm = Measured temperature = ° F + 459.7° = ° R

The standard L/min for any rotameter reading is:

(rotameter reading)(rotameter correction factor)(temp-pressure correction factor) = L/min

2. Breathing zone air sampler calibration

A. Monthly calibrate the breathing zone air samplers that will be used during that month. With the glass fiber filter installed on the portable air pump connect the pump to the wet test meter. Start the pump and observe the number of liters pumped in 1 minute. Convert a measured 2 L/min to a standard 2 L/min by:

$$\frac{2\ L}{} \frac{(Pm)}{Ps} \frac{(Ts)}{Tm} = \text{Standard 2 L/min}$$

Where:

Pm = Measured barometric pressure in inches or mm of Hg.
Ps = Standard barometric pressure = 29.2 inches of Hg = 760 mm of Hg. Pm and Ps must both be in the same units.
Ts = 32° F = 459° R.
Tm = Measured temperature = ° F + 459.7° = ° R

Adjust the pump to pump a <u>standard</u> 2 liters per minute and mark the location of the rotameter ball on the rotameter.

B. On each pump attach a calibration sticker that specifies the pump number, the calibration date, and the initials of the technician calibrating the pump.

C. Maintain a list of the pumps calibrated, the date calibrated, and who calibrated the pumps. File the list in the Environmental Department files.

D. Send the wet test meter back to the manufacturer every 5 years for calibration.

HMC PROCEDURE FOR THE SURVEY OF EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE

EQUIPMENT:

1. Alpha scintillation survey meter.
2. GM survey meter or μR/hr survey meter.
3. Gelman type A/E 50 mm glass fiber wipes (wipe label RC-5R) or the equivalent.

REGULATORY REQUIREMENTS

HMC Source Material License SUA-1471 condition 14 states "Release of equipment or packages from the restricted area shall be in accordance with the attachment to SUA-1471 entitled, 'Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials,' dated September 1984."

PROCEDURE FOR SURVEYING EQUIPMENT

1. Fill out and obtain the required signatures on the "Property and Material Removal Permit" in Appendix 1 or the equivalent.

2. All equipment or materials that have potentially been contaminated with uranium or any of its decay products must be surveyed for surface contamination and evaluated against the release criteria as specified below. Potentially contaminated equipment and materials includes but is not limited to process equipment from inside the mill, and equipment that has been on the tailings pile. Potentially uncontaminated equipment and materials include but are not limited to mill office equipment, and unused warehouse supplies. When in doubt, survey prior to release.

3. Schedule the survey with the Environmental Department at least one day before the survey is needed to allow time for calibration and operational checks of the survey equipment prior to monitoring. If equipment has been washed prior to surveying, make sure equipment is dry. Alpha particles will not penetrate a layer of water on the equipment.

4. On form EDF-5 in Addendum 2, or the equivalent, document the location where the equipment was obtained, the type of equipment, the technician conducting the survey, the date, the specific pieces of equipment, and the quantity. In addition document the serial number of the survey instrument, the date calibrated, the

instrument efficiency, and the background.

5. Survey the alpha activity on the surface and on the inside of potentially contaminated items by placing the probe of the alpha scintillation counter within approximately 1/4 inch of the surface and recording the observed counts per minute (CPM) on form EDF-5. Convert the CPM to disintegrations per minute (DPM) per 100 cm^2 by:

a. Converting the actual probe size, usually 50 cm^2, to 100 cm^2 by multiplying by 2, e.g $\frac{(20\ CPM)}{50\ cm^2}(2) = \frac{40\ CPM}{100\ cm^2}$

b. Converting from CPM/100 cm^2 to DPM by dividing by the counting efficiency, of approximately 0.3, e.g.

$$\frac{(40\ CPM)}{100\ cm^2}\left(\frac{1}{3}\right) = \frac{133\ DPM}{100\ cm^2}.$$

Record the DPM per 100 cm^2 under the column for total alpha (fixed plus removable) on form EDF-5.

6. If the total alpha is less than 500 DPM/100 cm^2 no further alpha surveys are necessary. If not smear an area of 100 cm^2, approximately 6" x 6", with a wipe and count the smear with the alpha survey instrument or a laboratory alpha scintillation counter. Convert the results to DPM as done in step 5b above.

7. Using the μR/hr survey meter measure the gamma surface contamination levels and record on EDF-5. In HP-3 procedure 7, the beta exposure rate was determined to be equal to the gamma exposure rate for old yellowcake. Thus to account for <u>both</u> beta and gamma exposure rates double the gamma exposure rate determined with the μR/hr meter and subtract the background, i.e.

$$(2)(\mu R/hr\ measured) - (background\ \mu R/hr) = beta\text{-}gamma\ exposure\ rate$$

Compare the beta-gamma exposure rate with the limits of 200 ave and 1000 max specified on EDF-5 to determine if the item can be released.

As an alternative a GM counter may be used.

8. If the total alpha, removable alpha, and gamma levels respectively are smaller than the limits specified on EDF-5, the piece of equipment being surveyed may be released for unrestricted use. See reference 1 in Appendix 3 for additional information.

Use your professional judgement in releasing equipment and materials. If you know or suspect some unusual circumstance that could cause a radiation problem with the release of an item, consult the Radiation Protection Administrator before releasing the equipment or material. On form EDF-5 check the release column yes or no.

9. If the survey results indicate an item is not to be released, the item may be decontaminated using a pressurized soapy-water cleaner and resurveyed.

RECORD RETENTION

The Environmental Technician is to file the HMC Property and Materials Removal Permit and the HMC Equipment Release Survey Form EDF-5 in the Environmental Department files.

QUALITY CONTROL

The Environmental Technician assigned and trained to monitor equipment and materials for unrestricted release is to verify that all potentially contaminated items have been monitored, that the results have been documented on form EDF-5 or the equivalent, and that the item meets the release criteria specified in reference 1.

REFERENCES

1. "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials,' dated September 1984."
2. USNRC Regulatory Guide 8.30, Health Physics Surveys in Uranium Mills.
3. 10 CFR 20, Standards for Protection Against Radiation.

APPENDIXES

1. Property and Materials Removal Permit.
2. Equipment Release Survey form EDF-5.
3. "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use of Termination of Licenses for Byproduct or Source Materials,' dated September 1984."

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DISTRIBUTION

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Resident Manager/Radiation Protection Administrator

APPENDIX 1
HMC PROPERTY AND MATERIALS REMOVAL PERMIT

HOMESTAKE MINING COMPANY

Property and Material Removal Permit

Prepare in duplicate, Guard retain original, Employee retain copy.

Name	Classification & Dept.	Vehicle or License #

Material Removed From (bldg. or area)	Destination	Date

Description of Material: _____

_____

_____

NO ERASURES PERMITTED ON THIS FORM - LINE UNUSED SPACE

Signature Of Supervisor Authorizing Removal	Date		
Checked Out By Environmental Department (signature)	Date		
Passed Out By (signature of Guard)	Date	Time	A.M. P.M.

APPENDIX 2
HMC EQUIPMENT RELEASE SURVEY FORM EDF-5

HMC EQUIPMENT RELEASE S EY FORM EDF-5 (07-12-93)

Location (Source of equipment)_____ Surveyed by:_____
Equipment being surveyed_____ Date:_____

EQUIPMENT DESCRIPTION	#	GAMMA μR/HR METER READ-ING	GAMMA/ BETA [(2)μR/HR -BACK-GROUND]	TOTAL ALPHA CPM	DPM / 100CM²	REMOV. ALPHA CPM	DPM / 100CM²	RELEASE YES	NO
INSTRUMENT SERIAL NO:									
DATE CALIBRATED									
EFFICIENCY									
BACKGROUND									
LIMITS			μR/HR 200 AVE 1000 MAX	5000 DPM / 100 CM² AVE 15000 DPM / 100 CM² MAX		1000 DPM / 100 CM² MAX			

APPENDIX 3

"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials,' dated September 1984."

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT

PRIOR TO RELEASE FOR UNRESTRICTED USE

OR TERMINATION OF LICENSES FOR

BYPRODUCT OR SOURCE MATERIALS

U. S. Nuclear Regulatory Commission
Uranium Recovery Field Office
Region IV
Denver, Colorado 80225

SEPTEMBER 1984

The instructions in this guide in conjunction with Table I specify the radioactivity and radiation exposure rate limits which should be used in accomplishing the decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table I prior to applying the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table I. A copy of the survey report shall be filed with the Uranium Recovery Field Office, Region IV, P.O. Box 25325, Denver, CO 80225. The survey report shall:

   a. Identify the premises.

   b. Show that reasonable effort has been made to eliminate residual contamination.

   c. Describe the scope of the survey and general procedures followed.

   d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey. The licensee shall not release the premises for unrestricted use without the written approval of the USNRC staff.

TABLE I

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b c f]	MAXIMUM[b d f]	REMOVABLE[b e f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm /100 cm^2	15,000 dpm /100 cm^2	1,000 dpm /100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-118, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except SR-90 and others noted above.	5,000 dpm /100 cm^2	15,000 dpm /100 cm^2	1,000 dpm /100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d]The maximum contamination level applies to an area of not more than 100 cm^2.

TABLE I

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

HMC ALARA PROCEDURE

REGULATORY REQUIREMENTS

10 CFR 20.1(c) states "[A licensee should], in addition to complying with the requirements set forth in this part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable [ALARA] taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations , and in relation to the utilization of atomic energy in the public interest."

HMC Policy

HMC will maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations , and in relation to the utilization of atomic energy in the public interest.

ALARA PROCEDURE

The Radiation Protection Administrator will designate actions to maintain radiation exposures as low as reasonably achievable.

The Environmental Technicians will implement the designated ALARA actions.

RECORDS

ALARA actions are to be documented in an ALARA file.

QUALITY CONTROL

The Environmental Technicians are to verify that ALARA actions are implemented and the Radiation Protection Administrator is to update the ALARA file and have an ALARA audit conducted annually as specified in SUA-1471, license condition 32C.

REFERENCES

10 CFR 20, "Standards for Protection Against Radiation."

APPENDIXES

none.

REVISIONS

Original 11/18/92
Revision 1: 07/12/93

DISTRIBUTION

Resident Manager/Radiation Protection Administrator

APPROVALS

Fred Craft
Resident Manager/Radiation Protection Administrator

HMC RESPIRATORY PROTECTION PROCEDURES FOR MILL DECOMMISSIONING

EQUIPMENT

MSA Comfo II with a Type H filter and a half-mask or full mask, powered-air (positive pressure air-purifying) respirators, spare parts, and battery charger .

Norton 7500 series half-mask (negative-pressure air purifying) respirators and spare parts.

North 7700 series half-mask (negative pressure air purifying) respirators and spare parts.

MSA half-mask (negative pressure air purifying) respirators and spare parts.

Irritant smoke and dispenser.

REGULATORY BASIS

10 CFR 20.103(3)(b) & (c) present the requirements for respiratory protection programs. Highlights of those regulations are presented below:

"(b)(2) When it is impractical to apply process or other engineering controls to limit concentrations of radioactive materials in air below those defined in §20.203(d)(1)(ii) [25% of Appendix B Table 1, Column 1], other precautionary procedures, such as ... respiratory protection equipment shall be used ...

"(c) ...the licensee shall use [respiratory protection] equipment that is certified or had certification extended by the National Institute of Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA).

"(c)(1) The licensee selects respiratory protective equipment that provides a protection factor greater than the multiple by which peak concentrations of airborne radioactive materials in the working area are expected to exceed the values specified in Appendix B, Table 1, Column 1 of this part.

"(c)(2) The licensee maintains and implements a respiratory protection program that includes, at a

minimum: air sampling sufficient to identify the hazard, permit proper equipment selection and estimate exposures; surveys and bioassays as appropriate to evaluate actual exposures; written procedures regarding selection, fitting, and maintenance of respirators, and testing of respirators for operability immediately prior to each use; written procedures regarding supervision and training of personnel and issuance records; and determination by a physician prior to initial use of respirators, and at least every 12 months thereafter, that the individual user is physically able to use the respiratory protective equipment.

"(c)(3) A written policy statement on respirator usage shall be issued covering such things as: use of practicable engineering controls instead of respirators; routine, nonroutine, and emergency use of respirators; and periods of respirator use and relief from respirator use. The licensee shall advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other condition that might require such relief."

HMC RESPIRATORY PROTECTION POLICIES

HMC will use process or engineering controls to the extent reasonably achievable to limit airborne concentrations of radioactive materials, that cause employee exposures, to levels below the concentrations defined in 10 CFR 20.203(d)(1)(ii) [25% of Appendix B Table 1, Column 1]. When it is impractical to apply process or other engineering controls to limit airborne radionuclide concentrations that cause employee exposures, respiratory protection equipment may be used to maintain employee exposures to levels that are as low as reasonably achievable (ALARA). Nonroutine work that requires the use of respirators will be controlled by the use of Radiation Work Permits (RWPs) or Work Orders issued by the Environmental Department and signed by the Radiation Protection Administrator or his designee. Environmental Department personnel will evaluate airborne hazards. RWPs are not required for emergency use of respirators.

Respirator use should be kept to a minimum. Respirator users may leave the area at any time for relief from the respirator use.

The respiratory protection program will be managed by the Environmental Department using written procedures that conform to 10 CFR 20.203 regulations. Contractor respiratory protection programs are to be equivalent to the HMC respiratory protection program.

RESPONSIBILITIES

A. The respirator user will:

1. Use the respirator in accordance with training and fit testing provided.
2. Report any malfunctions of the respirator to the supervisor.
3. Inform the supervisor of any health problems that could affect the use of the respirator.
4. Will not damage the respirator.
5. Will not disassemble or alter the respirator.
6. Use only respirators provided by HMC .
7. Shave facial hair to ensure a proper fit of the respirator.
8. Return the respirator to the Environmental Department for repair and maintenance.

B. The supervisor will:

1. Insure that respirators are used when required.
2. Submit RWPs (work orders) to the Environmental Department for all work in areas of airborne radionuclides.
3. Notify the Radiation Protection Administrator of any respirator user that is not fit to use a respirator for medical reasons.

C. Environmental Department personnel will:

1. Maintain and repair respirators.
2. Maintain and provide adequate supplies of clean functional respirators.
3. Maintain a record of the issuance of respirators.
4. Conduct random inspections of respirator use.
5. Conduct air sampling to identify airborne radionuclide concentrations.
6. Evaluate RWPs (work orders) and determine the need for respirators.
7. Conduct a bioassay program for individuals using respirators.
8. Determine radiation exposures for respirator users.

9. Maintain records required by this procedure.
10. Respirator training and fit testing.

D. Safety Department personnel will:

1. Schedule respirator users' physical examinations.

EVALUATION OF AIRBORNE HAZARDS

The Environmental Technicians are to evaluate airborne radionuclide concentrations in work areas or have process knowledge of the airborne concentrations to assess the need for respiratory protection. Use the air-sampling procedures in HP-1 , "Nonroutine Air Sampling Procedure".

Calculate the multiple by which the peak concentrations of airborne radioactive materials in the work area are expected to exceed the MPCs in Appendix B Table 1 column 1.

MEDICAL EVALUATION OF RESPIRATOR USERS

A physician is to determine prior to initial use of a respirator, and at least every 12 months thereafter, the physical ability of the individual to use a respirator. Obtain documentation of the physician's evaluation and file in the Environmental Department files.

SELECTION AND ISSUANCE OF EQUIPMENT

Select and issue a respirator that provides a respirator protection factor that exceeds the "multiple" calculated above. The type of respirators commonly used at HMC are:

MSA Comfo II with a Type H filter and a half-mask or full mask, powered-air (positive pressure air-purifying) respirator with a protection factor of 1000.

Norton 7500 series half-mask (negative-pressure air purifying) respirator with a protection factor of 10. NOTE: 10 CFR 20 Appendix A, footnote (g) states "The mask shall be tested with irritant smoke, prior to use, each time it is donned." Large or medium sizes are available.

North 7700 series half-mask (negative pressure air purifying) respirator with a protection factor of 10. NOTE: 10 CFR 20

Appendix A, footnote (g) states "The mask shall be tested with irritant smoke, prior to use, each time it is donned." Large or medium sizes are available.

MSA half-mask (negative pressure air purifying) respirator with a protection factor of 10. NOTE: 10 CFR 20 Appendix A, footnote (g) states "The mask shall be tested with irritant smoke, prior to use, each time it is donned." The small size is available.

For other types of respirators see 10 CFR 20 Appendix A. Paper dust masks are NOT to be used to provide protection against radionuclides at HMC.

The respirator distribution and maintenance center is located inside the restricted area of the mill. Contact the Environmental Department to obtain or exchange a respirator. Document the issuance of respirators on form EDF-6, "Respirator Use Log" .

TRAINING

The Radiation Protection Administrator or his designee is to train respirator users is the following topics or their equivalents:

1) Airborne contaminants to be encountered in the mill.
2) Construction, operation, limitations, and type of respirator to be used.
3) Engineering controls used to minimize airborne radionuclides and reasons for use of respirators.
4) Respirator operational checks.
5) Fit testing.
6) Use and maintenance of respirators.
7) Types and use of cartridges and canisters.
8) Relief from respirator use including emergencies.
9) Respirator users responsibilities.

Document respirator user training on form EDF-7, "Respirator User Training, Respirator Fit Test, and Relief from Respirator Use Record" and file in the Safety Department files.

SUPERVISION

Supervisors are to observe respirator use and report improper use to the Radiation Protection Administrator for corrective action.

FIT TESTING

Select the size of Norton, North, or MSA negative pressure respirator that best fits the user. If a Comfo II respirator is to be used turn on the air pump.

Put on the respirator and adjust the straps to provide a snug and comfortable fit.

Conduct both the Negative Pressure Test and the Irritant Smoke Test as follows to determine if the respirator fits the user:

1. Negative Pressure Test. Close off the inlet of the canister or cartridges(s) by covering with the palm of your hand(s), inhale gently so that the facepiece collapses slightly, and hold your breath for ten seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the negative pressure test is passed.

2. Irritant Smoke Test. The Environmental Technician is to discharge an irritant smoke into the face of the individual wearing the respirator. The respirator user is to perform the following movements or the equivalent:
   a) Normal breathing
   b) Deep breathing
   c) Moving head from side to side slowly
   d) Moving head up and down
   e) Frown (for full face masks)
   f) Talking
   g) Running in place
   h) Normal breathing for seal recheck

   If the respirator user can remain in this test atmosphere without detecting the irritant smoke, the irritant smoke test is passed. If he detects the irritant, he should retreat to fresh air, readjust the facepiece, and then repeat the test. If leakage is still noted, this particular respirator does not fit the user and the irritant smoke test is failed. The user should not continue to tighten the headband straps until they are uncomfortably tight, simply to achieve a gas-tight face fit. To avoid eye irritation the user is to keep his/her eyes closed during this test.

Document the results of the respirator fit test on form EDF-7, "Respirator User Training, Respirator Fit Test, and Relief from Respirator Use Record" and file the form in the Safety Department files.

RESPIRATOR USE

Respirator use should be kept to a minimum. Most respirator users will wear the Comfo II powered air respirator which is available in one size. If a Norton, North, or MSA negative-pressure, half-mask respirator is to be worn, the respirator fit test will determine which size best fits the user. For either type of respirator adjust the straps as was done in the fit test.

When using the powered-air respirator turn on the air pump. Turn the air pump off when not using. Replace the filter as the filter becomes clogged sufficiently to make breathing difficult. Replace the battery module after 8 hours of continuous operation and return the expended batteries to the Environmental Department for recharging which requires 16 hours.

When using the Norton, NORTH, or MSA negative-pressure respirators replace the filters when clogged sufficiently to make breathing difficult or when excessively dirty.

Respirator users are to store their respirator in a zip-lock plastic bag or the equivalent which is stored in cabinets or locations to be designated by the Environmental Department. The users are to be kept the respirators clean to prevent the inside of the respirators from becoming contaminated with removable radioactive materials. Whenever the respirator becomes visually dirty, or end of work shift, turn the respirator into the Environmental Department for a clean unit. The respirators being used are to be checked after each respirator is cleaned for removable contamination (wipe test). If the removable contamination exceeds 50 dpm/100cm^2, reclean the respirator. Record the results of the contamination survey on EDF-8. File EDF-8 in the Environmental Department files.

Respirator users may leave the area at any time for relief from the respirator use. Reasons for relief include: equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, emergencies, or any other condition that might require such relief. Respirator users are to sign form EDF-7, "Respirator User Training, Respirator Fit Test, and Relief from Respirator Use Record" acknowledging their awareness of relief from respirator use. File EDF-7 in the Environmental Department files.

Prior to each use of a respirator the user is to perform the following tests of the operability of the respirator:

For the MSA Comfo II powered-air respirator determine that filtered air is being supplied to the face piece by feeling the air flow and inspecting the air pump and filter for leaks.

For the Norton, North, or MSA half-mask (negative-pressure air purifying) respirator perform the negative pressure test and the irritant smoke.

Nonroutine use of respirators will be controlled by the use of Radiation Work Permits (RWPs) or Work Orders issued by the Environmental Department and signed by the Radiation Protection Administrator or his designee. RWPs are not required for emergency use of respirators. Routine work is no longer conducted at the HMC mill because the mill is being decommissioned.

RESPIRATOR MAINTENANCE PROCEDURE

The Environmental Technicians are to:

1. Remove any filters, cartridges, or canisters.
2. Wash facepiece and breathing tube in cleaner-disinfectant or detergent solution. Use a hand brush to facilitate removal of dirt.
3. Rinse completely in clean, warm water.
4. Air dry in a clean area.
5. Clean other respirator parts as recommended by manufacturer.
6. Inspect valves, headstraps, and other parts; replace with new parts if defective.
7. Replace filters, cartridges, or canisters as required by dust loading; make sure seal is tight.
8. Perform an alpha wipe test. If high alpha wipe test (over 50 dpm/100cm^2), clean and perform wipe test again. (See Removable Alpha Survey Procedure). Record all the monitoring results on EDF-8.
9. Place in plastic bag or container for storage.
10. Recharge the Comfo II batteries for 16 hours before reissuing the batteries.

QUALITY ASSURANCE

The Radiation Protection Administrator is to verify that the Environmental Technicians are implementing the HMC Respiratory Protection Program as specified in this procedure. The Environmental Technicians are to verify that all documentation required by this procedure is accurately completed and filed in the Environmental Department files.

REFERENCES

1. 10 CFR 20, "Standards for Protection Against Radiation."

2. NUREG-0041, Manual of Respiratory Protection Against Airborne Radioactive Materials."

3. Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection."

APPENDIXES

A. Respiratory Protection Program Forms

EDF-6	Respirator Use Log.
EDF-7	Respirator User Training, Respirator Fit Test, and Relief from Respirator Use Record.
EDF-8	Respirator Face Piece Removable Alpha Survey.

REVISIONS

Original	12-15-86
Revision 1	07-15-87
Revision 2	12-18-87
Revision 3	12-05-88
Revision 4	09-01-89
Revision 5	02-01-90
Revision 6	12-11-92
Revision 7	07-12-93

DISTRIBUTION

Resident Manager/Radiation Protection Administrator
Environmental Office

APPROVALS

Fred Craft
Resident Manager/Radiation Protection Administrator

APPENDIX A
RESPIRATORY PROTECTION FORMS

EDF-6	Respirator Use Log
EDF-7	Respirator User Training, Respirator Fit Test, and Relief from Respirator Use Record

EDF-6 Respirator Use Log (12-92)

		RESPIRATOR					USER SIGNATURE
IN	OUT	TYPE				ID #	
		PP	NP	HF	FF		

PP = POSITIVE PRESSURE NP = NEGATIVE PRESSURE
HF = HALF FACE FF = FULL FACE

EDF-7 Respirator User Training, Respirator Fit Test, and Relief from Respirator Use Record (12-92)

I have received the following instruction on the use of respirators and understand the materials presented:

1) Airborne contaminants to be encountered in the mill.
2) Construction, operation, limitations, and type of respirator to be used.
3) Engineering controls used to minimize airborne radionuclides and reasons for use of respirators.
4) Respirator operational checks.
5) Fit testing.
6) Use and maintenance of respirators.
7) Types and use of cartridges and canisters.
8) Relief from respirator use including emergencies.
9) Respirator users responsibilities.

I have passed the following respirator fit tests:

1. Negative Pressure Test.
2. Irritant Smoke Test.

I have been informed and understand that respirator users may leave an area at any time for relief from the respirator use. Reasons for relief include: equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, emergencies, or any other condition that might require such relief.

Respirator User_____ Soc. Sec. No.___-___-____

Instructor_____ Date_____

Env. Technician_____

EDF-8 HOMESTAKE MINING COMPANY
RESPIRATOR FACE PIECE REMOVABLE ALPHA SURVEY (07-93)

Detector Efficiency:_____ Instrument Efficiency:_____
Instrument Background:_____ Serial No.:_____
Date Calibrated:_____ Technician:_____

Date	Face Piece ID	CPM	DPM/100 cm^2

Maximum Permissible Level
100 DPM/100 cm^2
ALARA, Resample if above 50 dpm/100cm^3
Document resample on this form.

HMC URANIUM MILL BIOASSAY PROCEDURES FOR MILL DECOMMISSIONING

EQUIPMENT

120 mL wide-mouth plastic bottles with caps and labels

REGULATORY BASIS

Regulatory Guide 8.22, "Bioassay at Uranium Mills" states:

> "[10 CFR]20.103(b)(2) permits licensees to make allowances for the use of respiratory protection equipment in determining the magnitude of intake provided such equipment is used as stipulated in §20.103(c)-(g). These paragraphs require the licensee to perform bioassays, as appropriate, to evaluated individual exposures and to assess the protection actually provided.
>
> "[Urine] specimens from workers, regardless of whether or not respiratory protection devices were used, should be collected at least once per month, and additional special specimens should be collected and evaluated if there is any reason to suspect an inhalation exposure exceeding that resulting from exposure to an average yellowcake concentration of 10^{-10} µCi/mL...for a 40-hour workweek [or to an average ore-dust concentration of 10^{-10} µCi/mL...(based on the concentration of gross alpha activity in air) for a period of 1 calendar quarter] is suspected..."

Material License SUA-1471, amendment No. 12, condition 32B states:

> "Analysis of urine samples shall utilize an LLD of at least 5 µg/L."

Material License SUA-1471, amendment No. 12, Condition 33 states:

> "...all laboratory surfaces used for preparation of bioassay samples shall be spot-checked prior to sample analysis and decontaminated if removable contamination levels exceed 200 dpm/100 cm^2.

PROCEDURES

1. All HMC employees or contractors that have potential exposures to yellowcake, or uranium ore dust in excess of 40 MPC-Hours are to submit a baseline urine sample before working in the mill. MPC for

yellowcake or ore dust is 1E-10 μCi/mL.

2. Urine samples are to be at least 25 mL and are to be collected in the 120 mL wide-mouth plastic bottle provided by HMC.

3. Individuals submitting urine samples are to wash their hands BEFORE submitting the sample, are to submit the samples in a location that is not contaminated with yellowcake or uranium ore, and submit the sample in manner that will not contaminate the sample. Clean rest rooms at the mill or rest rooms at home are examples of clean locations for submitting urine samples. Contaminated cloths should not be worn when submitting the urine samples. Even small particles of uranium ore or yellowcake dust in the urine sample will cause false positive results and could result in work limitations.

4. The Radiation Safety Administrator or the Environmental Technicians are to instruct individuals on the importance of avoiding contamination in the urine samples.

5. During mill decommissioning all workers that work with yellowcake or ore dust are to submit a urine sample monthly. After mill decommissioning bioassays will be collected on a semi-annual frequency. Urine samples are to be submitted at least 48 hours but not more than 96 hours following the end of exposure. All work done in the mill with radioactive materials is "non-routine" work that requires a Radiation Work Order (RWO), also referred to as a work order. Infrequent inspections in the mill usually do not require an RWP. The RWP will specify the radiation protection measures required for the job. As general guidance if there is any reason to suspect an inhalation exposure might approach 40 MPC-Hours, send the worker home with a urine collection bottle and instructions to collect a urine sample the following morning. If the worker is not returning to work the following morning, instruct the worker to submit the urine sample as close as possible to the 48-96 hour time interval after exposure. Daily urine samples are usually required when respirators are used. However when a respirator is required by the RWP for short-duration jobs in atmospheres of only a few percent of the MPC, monthly urine samples are adequate.

6. Collect a urine sample from a person who is known to have no exposure to yellowcake or uranium ore, split the sample into 2 aliquots of at least 25 mL each, and spike one of the aliquots with a known amount of uranium or U_3O_8 in the range of 10-20 μg/L of urine or alternately in the range of 40-60 μg/L. These samples become the blank and spike samples respectively. A 25 mL sample from two people who have no uranium exposure may also be used to

prepare the blank and spike samples. Send a blank and a spike sample to the analytical laboratory with each shipment of urine samples. If the results from the blank sample indicate contamination, attempt to find and correct the cause. If the analytical results from the spike sample are not within 30 % of the known amount of radionuclide added to the aliquot, contact the analytical laboratory for resolution of the problem.

7. The Environmental Technicians are to collect the urine samples, add 5 mL concentrated HNO_3, secure the caps on the bottles, and ship the samples, usually by UPS, to the analytical laboratory. With each batch of urine samples prepared for shipment, spot check the removable contamination levels on all laboratory surfaces used for the preparation of bioassay samples. Decontaminate if removable contamination levels exceed 200 dpm alpha/100 cm^2. See HP-2, "HMC Removable Alpha Survey Procedures. Record results on EDF-9, "Contamination Survey Record for Bioassay-Sample Preparation Area", or the equivalent. Try and ship the samples on the day of collection, otherwise store the samples in the refrigerator until shipment. The samples need not be refrigerated during shipment. Instruct the laboratory to analyze the uranium in urine samples using the method in Appendix A or its equivalent and a lower limit of detection of at least 5 μg/L. The laboratory is to call the Environmental Department and report all results greater than 15 μg/L. A written report is to follow.

8. Implement the corrective actions specified in Table 1 and Figures 1, 2, and 3 from Regulatory Guide 8.22 based on the concentrations of uranium in the urine.

9. The Environmental Technician is to fill in form EDF-10, "Radiation Work Permit and Bioassay Log", or the equivalent. The form facilitated correlation between the RWP and the urinalysis results.

10. If a large (> 9 nCi) acute exposure occurs consider sending the worker to a facility for whole body counting and consult Table 2 of Regulatory Guide 8.22 for corrective actions to be implemented.

QUALITY ASSURANCE

The Environmental Technicians are to verify that the urinalysis program is implemented as specified in this procedure. The Radiation Protection Administrator is to verify that corrective actions are implemented by the Environmental Technicians as specified in Table 1.

Table 1

CORRECTIVE ACTIONS BASED ON MONTHLY URINARY URANIUM RESULTS[a]

Urinary Uranium Concentration	Interpretation	Actions
Less than 15 μg/L	Uranium confinement and air sampling programs are indicated to be adequate.[b]	None. Continue to review further bioassay results.
15 to 35 μg/L	Uranium confinement and air sampling may not provide an adequate margin of safety.[b]	1. Confirm results (repeat urinalysis). 2. Identify the cause of elevated urinary uranium and initiate additional control measures if the result is confirmed. 3. Examine air sampling data to determine the source and concentration of intake. If air sampling results are anomalous, investigate sampling procedures. Make corrections if necessary. 4. Determine whether other workers could have been exposed and perform bioassay measurements for them. 5. Consider work assignment limitations until the worker's urinary uranium concentration falls below 15 μg/L. 6. Improve uranium confinement controls or respiratory protection program as investigation indicates.
Greater than 35 μg/L	Uranium confinement and perhaps air sampling programs are not acceptable.[c]	1. Take the actions given above. 2. Continue operations only if it is virtually certain than no other worker will exceed a urinary uranium concentration of 35 μg/L. 3. Establish work restrictions for affected employees or increase uranium confinement controls if ore dust or high-temperature-dried yellowcake are involved. 4. Analyze bioassay samples weekly.
Confirmed to be greater than 35 μg/L for two consecutive specimens, confirmed to be greater than 130 μg/L for any single specimen, or air sampling indication of more than a quarterly limit of intake	Worker may have exceeded regulatory limit on intake.	1. Take the actions given above. 2. Have urine specimen tested for albuminuria. 3. Obtain an in vivo count if worker may have been exposed to Class Y material or ore dust. 4. Evaluate exposures. 5. Establish further uranium confinement controls or respiratory protection requirements as indicated. 6. Consider continued work restrictions on affected employees until urinary concentrations are below 15 μg/L and laboratory tests for albuminuria are negative.

[a] Use Figures 1-3 to adjust action levels for other frequencies of bioassay sampling. The model used in NUREG-0874 (Ref. 1) employs fractional composition values (F_1, F_2, F_3) for Class D, Class W, and Class Y components of yellowcake compounds. The assigned values in NUREG-0874 are based on data from available literature. The use of alternative values of F_1, F_2, and F_3 specific for a particular operation are acceptable provided (1) details regarding their determination are described and mentioned in employee exposure records (see paragraph 20.401(c)(1) of 10 CFR Part 20) and (2) the model as published in NUREG-0874 is then used in the determination of alternative urinalysis frequencies and action levels.

[b] However, if a person is exposed to uranium ore dust or other material of Class W or Y alone, refer to Section 6 of NUREG-0874 about the possibility of the need for conducting in vivo lung counts on selected personnel or about using alternative urine sampling times and associated action levels computed using NUREG-0874.

[c] Unless the result was anticipated and caused by conditions already corrected.

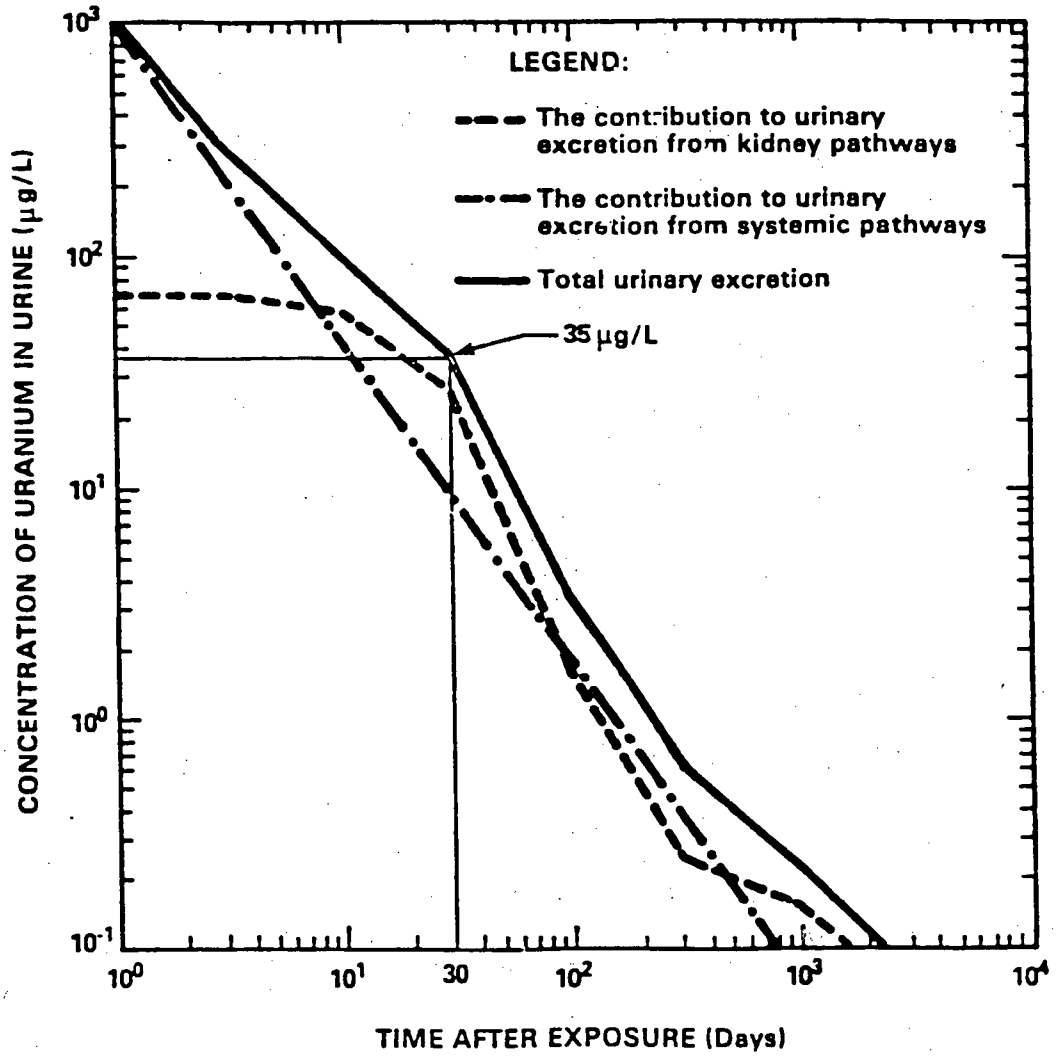

Figure 1 Uranium Concentration in Urine Following Single Exposure to High-Fired Yellowcake (Intake = 160,000 µg U = 1 ALI) (from NUREG-0874, Ref. 1)

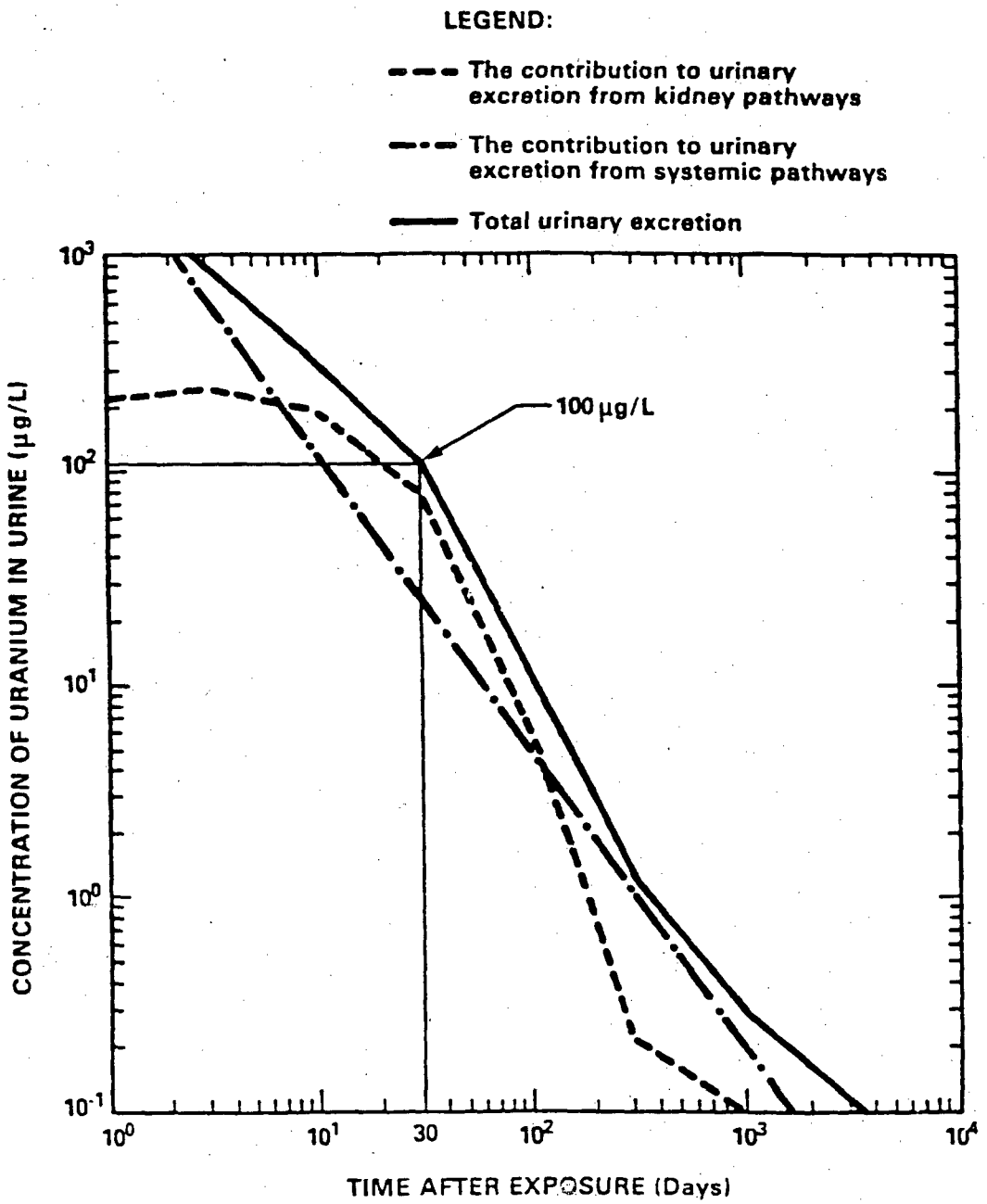

Figure 2 Uranium Concentration in Urine Following Single Exposure to Low-Fired Yellowcake (Intake = 260,000 µg U = 1 ALI) (from NUREG-0874, Ref. 1)

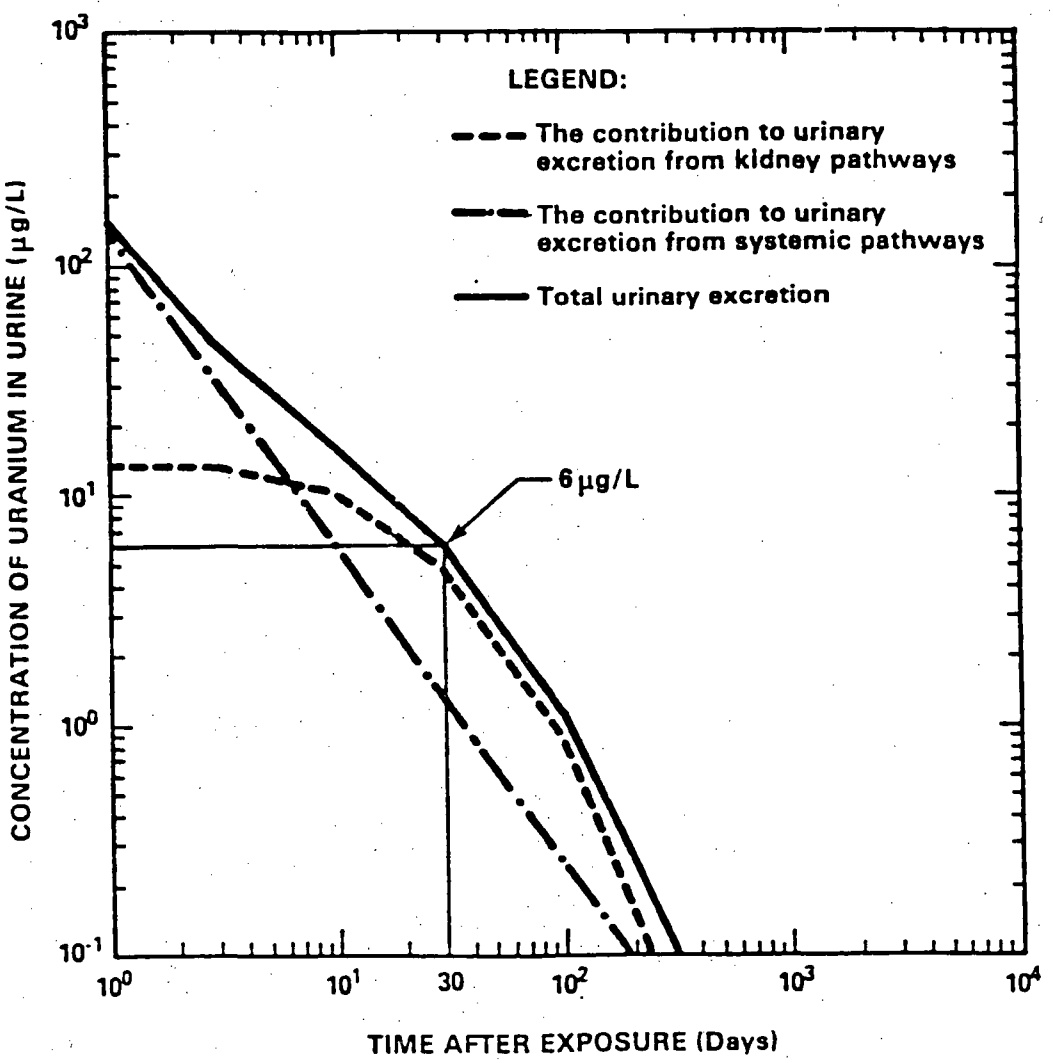

Figure 3 Uranium Concentration in Urine Following Exposure to Ore Dust (from NUREG-0874, Ref. 1)

REFERENCES

1. 10 CFR 20, "Standards for Protection Against Radiation."
2. Regulatory Guide 8.22, "Bioassay at Uranium Mills."

APPENDIXES

A. Bioassay forms

EDF-9	Contamination Survey Record for Bioassay-Sample Preparation Area.
EDF-10	Radiation Work Permit and Bioassay Log.

REVISIONS

Original	12-15-86
Revision 1:	06-30-87
Revision 2:	06-18-87
Revision 3:	01-09-88
Revision 4:	01-11-89
Revision 5:	09-01-89
Revision 6:	01-15-93
Revision 7:	05-17-93
Revision 8:	07-12-93

DISTRIBUTION

Resident Manager/Radiation Protection Administrator
Environmental Department

APPROVALS

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APPENDIX A
BIOASSAY FORMS

EDF-9	Contamination survey Record for Bioassay-Sample Preparation Area.
EDF-10	Radiation Work Permit & Bioassay Log

EDF-9 Contamination Survey Record for Bioassay-Sample Preparation Area.(1-93)

Date:_____ Instrument:_____

Instrument Efficiency:_____ Serial No.:_____

Background:_____ Technician:_____

LOCATION	CPM	DPM/100 CM^2

Maximum removable contamination: 200 dpm/100 cm^2

Decontamination needed for:_____

EDF-10 RADIATION WORK PERMIT & BIOASSAY LOG (07-93)

RWO No. RWO Date _____	Name	Date Urine Collected (On-site)	Date Urine Shipped	Date Lab Called in Result	µg/L	Comments

APPENDIX B
FLUOROMETRIC DETERMINATION OF URANIUM

INTRODUCTION:

This method has proven to be very dependable, quick, and accurate provided proper care is taken to eliminate sources of contamination and to set up standard procedures for keeping out all possible variations. The fluorometric method of analysis a few years ago were not good but modifications on the Fletcher burner were designed and the development of the superior flux (2% lithium fluoride and 98% sodium fluoride) have improved the sensitivity, precision, and convenience.

As With any other method employed for trace analysis, contamination must be carefully guarded against at all times. The fluorometric method of analysis is not generally used in a laboratory where uranium ore dust or even uranium concentrate dust is present in the atmosphere. A special room supplied with filtered air and equipment which is easily cleaned should be set aside for fluorometric analysis only. Each week all the floors and benches in the room should be washed and once a month the walls and overhead fixtures should be vacuumed . Glassware and other equipment used for this analysis should not be used for other purposes and should be scrupulously cleaned after each use. People working in the fluorimeter room should not use protective hand creams since they usually have a strong ultraviolet fluorescence.

An aliquot of a liquid sample or of a solution of a solid sample is diluted and acidified so that the diluted sample contains approximately 0.01 grams U_3O_8 per liter or 0.01 milligrams U_3O_8 per milliliter in a 5% nitric solution. One milliliter of the diluted sample is salted with saturated aluminum nitrate solution, and the uranium is extracted into 10 milliliter of ethyl acetate. A 0.1 milliliter aliquot of the ethyl acetate solution is and transferred onto pellets of 2% lithium fluoride and 98% sodium fluoride flux in platinum dishes. The pellets are dried, fused, and allowed to cool, forming buttons which slide easily from the dish. The fluorescence of the fluoride button is measured in a Galvanek-Morrison fluorimeter.

RANGE- 1.5 gram/liter to 0.0001 grams/liter.

INTERFERENCES- Rate of fusion, rate of cooling, type and temperature of flame all have a significant bearing on intensity of fluorescence. The uranium must be oxidized and in an acid solution before it can be extracted by ethyl acetate.

APPARATUS

1. 40 milliliter vials with lined caps
2. Machlett autopipet 10 milliliter capacity

3. Platinum dishes
4. Chromolox radiant heater drying unit
5. Pellet maker
6. Fusion burner
7. Automatic timer
8. Propane regulator
9. Air regulator
10. Nichrome wire gauze circular section 4 1/2 inch diameter from 16 gauge 5 mesh screen.
11. Galvenek-Morrison fluorometer obtainable from Jarrell Ash Company
12. Shaking machine

REAGENTS

1. Sodium fluoride
2. Lithium fluoride
3. Ethyl acetate
4. Aluminum nitrate (saturated solution)

OPERATING CONDITIONS

Instrument is to be left on continually.

1. Adjust the phototube voltage to obtain a standard meter reading with a fluoride button containing 0.1 gram or 0.00001 milligrams of uranium. A suggested reading is 0.7 micro amperes.
2. Push the sample slide in and adjust the meter zero by manipulating the zero control.
3. Depress the highest sensitivity scale key and adjust the background current to zero.

PROCEDURE

1. Sample Preparation

A. Aqueous Samples -

Dilute all aqueous samples according to the estimated concentration so that the aliquot contains approximately 0.01 milligrams of U_3O_8. Since the diluted sample should contain 5% (v/v) free nitric acid, samples which are basic must be neutralized before the proper amount of nitric acid is added. Add dropwise 30% hydrogen peroxide to any sample known to contain reduced uranium until the permanent light yellow color characteristic of uranium +6 is obtained.

B. Solid Samples -

Solid samples should be pulverized to minus 120 mesh and well blended. Weigh 3 grams into a 250 milliliter beaker, treat with 15 milliliters perchloric acid, 10 milliliters nitric acid, and 10 milliliters hydrochloric acid, mix well and add 1-2 milliliters hydrofluoric acid. Cover and boil down to 3-5 milliliters, cool, add 25

milliliters water and bring to a boil. Cool to room temperature, then transfer to a 50 milliliter volumetric flask and dilute to the mark. No filtration is necessary.

C. Control Standard -

A control standard and reagent blank should be prepared along with each group of eight samples by pipeting a 1 milliliter sample of 0.01 gram U_3O_8 and follow the same procedure as for the other samples.

2. Extraction

Pipet the desired aliquot of the diluted sample into a 40 milliliter vial, acidify if necessary and add approximately 15 milliliters of saturated aluminum nitrate. Add exactly 10 milliliters ethyl acetate from the automatic pipet. Cap the vial, and agitate on the shaker for 2 minutes.

3. Preparation of Pellets

Place 20 platinum dishes on a nichrome wire gauze according to the pattern shown below. The dishes must be dry to prevent the flux from severely attacking the platinum. Using the pellet maker, prepare and place a pellet of fluoride on each dry dish by the following procedure: Fill a 250 milliliter beaker or other suitable container with flux to a depth of 2-3 inches. While rotating the beaker, pack the barrel of the pellet maker by plunging it vertically through the bed of flux. While the pellet is still in a vertical position, draw it across the bottom of the beaker. Holding the pellet maker about 1/2 inch above the platinum dish, push down the plunger to discharge the pellet. The rotation of the beaker and drawing the pellet across the bottom of the beaker are to assure a uniform pellet size which is necessary to maintain reproducibility.

				std.		I		
	1		2		2		std.	
3		3		4		4		5
5		6		6		std.		7
	7		8		8		std.	

Fill a 0.2 milliliter graduated pipet from the ethyl acetate layer of each extracted sample and drain 0.1 milliliters onto each of two pellets. Volatilize the ethyl acetate from the pellets by placing the wire gauze and dishes under the drying unit. This drying should be done slowly, with the Cramer percentage timer set at no higher than 60 percent.

4. Fusion

The control of atmosphere and temperature are mandatory in the fusion technique in order to obtain accurate results. Transfer the nichrome wire gauze containing the 20 platinum dishes and Pellets to the iron tripod ring on the burner.Both the air and gas regulators are turned on and off by an

automatic timer. Set the timer for 3 minutes and gas will flow to the burner, adjust the propane regulator to give proper flame.The procedure of adjusting the flame to the proper intensity requires experience before it can be done routinely. Periodically, the gas flow rates required to give temperature of 850° to 900° Centigrade should be determined with a thermocouple, until enough experience has been gained to set the flame by visual observation. Fuse at a flame temperature of about 900° Centigrade for two minutes, then decrease the flame temperature to 850° Centigrade by increasing the gas flow. The fusion will continue one more minute and automatically shut off. When the fluoride melts have solidified, remove the gauze and dishes from the burner and allow to cool for at least 15 minutes. (The fluorescence intensity increases for the first 15 minutes and then remains constant for about an hour.) The cooling rate affects the ultimate crystalline structure of the fluoride buttons, which in turn affects the fluorescence of the buttons. Therefore, it is necessary to place the gauze on a heat resistant material away from drafts, and follow the same procedure in cooling each set of dishes.

5. Measurement of Fluorescence

The fluorescence intensities of the first two standards are measured first. Then measure the samples and finish by measuring the last two standards.

A. Pick up a platinum dish with a pair of forceps and tip it so that the fluoride button slides into the polished depression in the slide.

B. Push the slide to the back stop. For buttons of unknown intensity, depress the keys in increasing order of sensitivity so as not to drive the meter needle off scale. Record reading, being careful to get proper decimal.

C. Pull the slide forward, and remove the button with forceps, cleaning any fluoride particles from the slide.

CALCULATIONS

For each set of twenty buttons, average the readings of the four standards and average the readings of all duplicate samples. Subtract the reagent "blank" reading from all average readings. Calculate the uranium content as follows:

$$\frac{\text{Standard 0.01 grams } U_3O_8\text{/liter}}{\text{Corrected Standard Reading}} = \text{Factor}$$

Corrected sample reading x Dilution x Factor =

grams U_3O_8/liter

Reference

1. National Lead Co. , Winchester Laboratory as reported in "Analytical Chemistry," Volume 28, Page 1651, November, 1956.

HMC ALPHA SURVEY PROCEDURE FOR CONTAMINATION ON SKIN AND PERSONAL CLOTHING

EQUIPMENT

Eberline Scaler RM-19 with Alpha Scintillation Probe AC-3 or the equivalent.

REGULATORY BASIS

Materials License SUA-1471 condition 11 states: "The licensee shall determine that employees leaving work are not contaminated with radioactive materials. When an employee has showered and changed clothes prior to leaving work, he may be assumed to be free of contamination."

"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of licenses for Byproduct or Source Materials" states the acceptable surface contamination levels for U-nat, U-238, U-235, and associated decay products are:

5,000 DPM/100 cm^2	average
15,000 DPM/100 cm^2	maximum
1,000 DPM/100 cm^2	removable.

PROCEDURES

1. Each day of use, remove the plastic cover on the alpha scintillation probe and calibrate the alpha scintillation survey meter in the guard house following the HP-10, "HMC Radiological Instrument Calibration." Be sure to schedule the calibration of the alpha survey meter on week ends and holidays when employees or contractors are working with radioactive materials. Use the 2 π Th-230 calibration sources. (Peter Garcia of the Nuclear Regulatory Commission (NRC) Denver Field Office on 6-8-92 interpreted the NRC maximum and average surface contamination limits to be 2 π values expressed as DPM/100 cm^2. He considers the removable contamination limits to be 4 π values expressed as DPM/100 cm^2. The NRC as of 2-93 has not issued an official determination on the 2 π or 4 π definition of their contamination limits.) Record the efficiency on form EDF-12 or the equivalent. Set the alarm point on the scaler at 150

CPM.

2. Personnel leaving the restricted area of the mill who have worked in the process buildings or on the tailing pile, are to scan their clothing, exposed skin, and shoes. Hold the probe approximately 0.25 inches from the surface being scanned and move the probe at approximately 0.5 feet per second.

3. If the alarm sounds push the reset button on the scaler and re-monitor to define the area of contamination. Have the contaminated person go to the mill change room, wash the affected area with soap and water and/or change to clean cloths. If the person showers and changes cloths, that person is assumed to be free of contamination and does not have to re-monitor before leaving the restricted area.

4. Resurvey the contaminated person. If the alarm level is still exceeded, compare the survey results to the contamination limits presented under Regulatory Basis. Do not allow the contaminated person to leave the restricted area with contamination above the contamination limits. Consult the Radiation Protection Administrator for increasingly effective decontamination methods.

5. Record the workers name, and test results on form EDF-12 or the equivalent.

QUALITY CONTROL

The Environmental Technician assigned to the calibration of the alpha scintillation detector used for personnel monitoring is to verify that the instrument is working properly, that the employees are using the survey instrument and filling in EDF-12 according to this procedure. The security guards are to verify that the personnel required to survey for contamination are conducting the survey.

REFERENCES

1. Materials License SUA-1471.

2. "Guidelines for Decontamination of Facilities and

Equipment Prior to Release for Unrestricted Use or Termination of licenses for Byproduct or Source Materials," USNRC, September, 1984

APPENDIXES

A. Personnel Alpha Contamination Survey form EDF-12.

REVISIONS

Original:	Date not available
Revision 1:	02-12-93
Revision 2:	05-14-93

DISTRIBUTION

Resident Manager/Radiation Protection Administrator
Contract Radiation Protection Administrator

APPROVALS

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Administrator

APPENDIX A
EDF-12 HMC PERSONNEL ALPHA CONTAMINATION SURVEY (2-93)

EDF-12 HMC PERSONNEL ALPHA CONTAMINATION SURVEY (2-93)

Date:_____

Name	Contamination NO	Contamination YES	Name	Contamination NO	Contamination YES

Instrument Calibration: Technician:_____

Alpha Source S/N: 7880, Th-230, 360 DPM 2π

Efficiency = $\frac{\text{\_\_\_\_\_ CPM}}{\text{360 DPM}}$ =

Monitoring Spot Check
By:_____ Date:_____

HMC RADIATION PROTECTION TRAINING

REGULATORY BASIS

10 CFR 19.12 states:

> All individuals working in or frequenting any portion of a restricted areas shall be...instructed in the health protection problems associated with exposure to such radioactive materials or radiation, in precautions or procedures to minimize exposure...The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area.

The following NRC Regulatory Guides provide guidance on radiation protection training:

> Regulatory Guide 8.13, "Instructions Concerning Prenatal Radiation Exposure,"
>
> Regulatory Guide 8.29, "Instructions Concerning Risks from Occupational Radiation Exposures."
>
> Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will be as Low As Reasonably Achievable."

PROCEDURE

1. The Radiation Protection Administrator or his designee is to provide the radiation protection training course "Radiation Orientation for New Employees and/or contractors to all new employees and contractors who will be working with or in the presence of radioactive materials at HMC. The only exception are contractors that will be working under the continual supervision of a HMC employee. Visitors are to be accompanied by HMC employees when in the presence of radioactive materials such in inside the precipitation building or on top of the tailings impoundment.

2. The Radiation Protection Administrator or his designee is to present the Radiation Orientation Training course on video tape, as outlined in Appendix A, or its equivalent, and is to be available to answer questions from the

trainees. At the end of the course the trainees are to pass the exam in Appendix A, or its equivalent, to demonstrate their knowledge of the material presented. If the trainee is to be issued a respirator, give the trainee the respirator fit test and training as specified in HP-7, "HMC respiratory Protection Procedures for Mill Decommissioning", and fill out Firms EDF-7, and EDF-8 as specified in that procedure. The exam and applicable forms are to be filed in the Environmental Department files.

3. HMC employees and contractors who have received the Radiation Orientation are to receive Refresher Radiation Protection Training every year that they work with radioactive materials. Document completion of the Refresher Training on form EDF-16, "On-The-Job Radiation Protection Training."

4. The Radiation Protection Administrator is to receive training in radiation protection at least every two years, usually off-site or by a non-HMC trainer. The courses are to be documented by course materials, certificates of satisfactory completion, or the equivalent.

5. The Environmental Technicians are to receive training in radiation protection at least every two years, usually as on-the-job training. The training is to be documented on form EDF-16, or the equivalent.

QUALITY CONTROL

The Radiation Protection Administrator or his designee is to verify that the Radiation Orientation training, the Refresher Radiation Protection training, the Radiation Protection Administrator training, and the Environmental Technician training have been received as described above.

REFERENCES

10 CFR 19.12, "Instructions to Workers."

Regulatory Guide 8.13, "Instructions Concerning Prenatal Radiation Exposure."

Regulatory Guide 8.29, "Instructions Concerning Risks from

Occupational Radiation Exposures."

Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will be as Low As Reasonably Achievable."

APPENDIXES

A. Outline of Introduction to Radiation Protection, exam and answer sheet.

B. EDF-16, On-The-Job Radiation Protection Training.

REVISIONS

Original:	10-07-86 (Alara Radiation Protection)
Revision 1:	12-15-86
Revision 2:	12-18-87
Revision 3:	01-10-89
Revision 4:	04-01-89
Revision 5:	02-01-90
Revision 6:	02- -93

DISTRIBUTION

Resident Manager/Radiation Protection Administrator
Contract Radiation Protection Administrator

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Administrator

APPENDIX A
OUTLINE FOR
RADIATION ORIENTATION FOR NEW EMPLOYEES AND/OR CONTRACTORS
Video tape presentation 8-31-92 by Noel Savignac

What is radiation

Characteristics of

Alpha particles
Beta particles
Gamma rays

Radioactive materials present at HMC

Uranium decay chain emphasizing U, Th, Ra, Rn
Halflife of elements in uranium decay chain

Pathways of Exposure

Inhalation }
Ingestion } may result in internal exposure
Cuts }

Gamma exposure }
U on skin, beta exposure } may result in external exposure (no alpha exposure)

Exposure limits

Whole body	5,000. mrem/yr
Unborn child	500.
General Public	100.

Comparative exposures

NATURAL BACKGROUND

Cosmic	50
Rocks, soil	30
Inside human body (foods	28
Average medical	103.
Jet travel	3.
TOTAL	214.

MEDICAL X RAY EXPOSURES

Chest X ray, or dental	10.
Barium enema	500.
Pelvic X ray	600

ALARA

Exposures to women, Regulatory Guide 8.13

Exposure limited by:

- Time
- Distance
- Shielding
- Clothing, respirators, hygiene

Respirator Use

- Respirator fit testing and medical evaluation
- Powered air respirators
- 1/2 mask respirators

Monitoring Equipment

- TLDs
- Area air samplers
- Personal air samplers
- Gamma survey meters
- Alpha survey meters

Bioassay program

- Urinalysis - cleanliness in providing sample

Sampling/monitoring/survey results available at any time

Precautions at HMC

- Yellowcake - Precipitation building greatest hazard
- Tailing impoundment - hazards

Typical Exposures

- 40 mrem/yr
- < 1% of internal allowable exposure

Handouts - available as supplemental material

EXAM

EXAM

RADIATION ORIENTATION FOR NEW EMPLOYEES AND /OR CONTRACTORS

1. Name three types of radiation._____, _____, _____.

2. Which of the above types of radiation is most easily stopped and absorbed by human tissue?_____.

3. Inhalation of uranium and/or ore dust is a primary exposure pathway. True or False?

4. Alpha particles from uranium on the skin of an employee are stopped and absorbed by _____?

5. The Nuclear Regulatory Commission has a special limitation on exposures to unborn children. True or False?

6. ALARA means _____ _____?

7. Name three methods of limiting an employee's exposure to radiation _____, _____, _____.

8. In the Homestake facility where is the greatest potential for radiation exposure, i.e. which building_____?

9. Name three ways uranium can enter your body _____, _____, _____.

10. A radiation overexposure will automatically result in termination. True or False?

Bonus ? 2 pts Name a city where the Nuclear Regulatory Commission has an office._____.

_____	_____	_____
Name	Date	Social Security No.

EXAM ANSWER SHEET

1. Alpha, beta, gamma.

2. Alpha.

3. True.

4. The dead layer or the skin.

5. True.

6. As low as reasonably achievable.

7. Time, distance, and shielding.

8. Precipitation - yellowcake building.

9. Inhalation, ingestion, cuts, smoking, chewing tobacco or gun, licking lips, etc.

10. False.

Bonus Denver, CO; Washington DC; Silver Springs, MD; King of Prussia, PA; Atlanta, GA; Glen Ellyn, Ill; Arlington, TX; Walnut Creek, CA;

APPENDIX B
EDF-16 ON-THE-JOB RADIATION PROTECTION TRAINING (2-92)

EDF-16 ON-THE-JOB RADIATION PROTECTION TRAINING (2-92)

EMPLOYEE_____ SOC. SEC. NO._____

PROCEDURE #	SUBJECT	TRAINING DATE	DURATION IN HOURS	INSTRUCTOR

APPENDIX B

TECHNICAL SPECIFICATIONS

NO.	TITLE
B1	MILL DEMOLITION
B2	MILL-AREA COVER PLACEMENT
B3	TAILING IMPOUNDMENT RECONTOURING
B4	TAILING IMPOUNDMENT SOIL COVER
B5	SETTLEMENT MONITORING
B6	EROSION PROTECTION - ROCK MATERIALS AND PLACEMENT
B7	DIVERSION LEVEE
B8	SITE GRADING

TECHNICAL SPECIFICATION # B1

TITLE: MILL DEMOLITION

RECLAMATION OF HOMESTAKE MINING COMPANY, GRANTS OPERATION

A) RESPONSIBILITIES

Work under this specification to be performed by mill demolition contractor.

Quality control testing/inspection by Homestake Mill environmental staff and contract soil testing service.

B) PERFORMANCE STANDARDS

1. Dismantle and flatten, crush or cut all metal roofing, siding, and structural material and place on or below ground surfaces near the dismantled structure. Distribute material to minimize residual void space and eliminate protrusions above or depressions below the surface of the debris material.

2. Dismantle metal tanks and distribute and flatten the dismantled pieces to allow burial without excessive void space. Alternatively, place intact tanks in pits or the tailing outslope and fill internal space with sand-cement slurry grout.

3. Cut pipe into lengths that permit easy handling and placement for burial. Crush pipe with heavy equipment or fill the space inside pipe with sand-cement slurry grout.

4. Machinery, pipe, tanks, and any other equipment or material contaminated to levels that could cause the 20 pCi/m^2 sec radon limit at the mill cover surface to be exceeded will be removed to the tailing impoundment for burial. For purposes of determining this level, the gross alpha reading equivalent to the limiting radium activity is conservatively set at 220,000 dpm/ 100 cm^2. The roaster, dryer, and other equipment and materials that cannot reasonably be dismantled and buried in place will be removed to the tailing impoundment for burial.

5. Components that contain more than 10% noncompressible internal void space, by HMC's visual estimate, will be filled with sand-cement slurry grout prior to disposal in the tailing impoundment or burial under the mill area cover.

6. Wood, fiberglass, and other compressible or organic material will be pulverized using a shredder. The pulverized material will be distributed uniformly over the mill area before mill cover placement.

7. After mill components have been dismantled and placed at ground surface or in pits for subsequent burial, void spaces that remain under and within such components will be filled by gravelly sand soil, by sand-cement slurry grout, or other approved method that eliminates void space.

8. Dismantled mill components will be covered with at least two feet of gravelly sand soil. Initial lifts of not more than 12 inches uncompacted thickness shall be placed and thoroughly wetted prior to the subsequent movement of earthwork equipment or placement of additional fill lifts on that surface. Any voids that appear in the surface of the initial fill lifts will be filled with soil and the wetting procedure repeated until no new voids appear. Subsequent lifts not to exceed 12 inches uncompacted thickness will be placed and compacted by the movement of heavy equipment.

C) TESTING AND INSPECTION

1. Inspection of mill demolition by Homestake personnel designated by the Resident Manager.

2. Mill component and equipment surfaces will be scanned for gross alpha to detemine if a component must be removed for burial in the tailing impoundment.

D) DOCUMENTATION AND REPORTING

1. Radiological health and safety documentation and reporting in accordance with relevant procedures in Appendix A of the Reclamation Plan.

2. A log of all gross alpha readings that exceed the limit for burial in-place of mill components, listing the component description, date, reading, and location of burial in the impoundment.

3. All other activities and daily work units recorded in daily activity journal maintained at the direction of Homestake Resident Manager, describing methods of demolition and locations of disposal of all major components described in Figure 3 of the Reclamation Plan.

E) NONCONFORMANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS

1. Nonconformances will be identified or verified by the Homestake Task Manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.

2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.

3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

F) RECORDS

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journals will become a part of the permanent reclamation and contract records.

2. The RM will maintain a permanent file of all testing, measurements, and other records of the work performed under this specification.

TECHNICAL SPECIFICATION # B2

TITLE: MILL-AREA COVER PLACEMENT

RECLAMATION OF HOMESTAKE MINING COMPANY, GRANTS OPERATION

A) RESPONSIBILITIES

Work under this specification to be performed by mill demolition contractor or earthwork contractor.

Quality control testing/inspection by Homestake Mill personnel and contract soil testing service.

B) PERFORMANCE STANDARDS

1. All fill material used to cover the dismantled mill will be gravelly sand or sand soil (USCS Classification SP, SC, ,SM, SW, GW, GP, or SP-SM) that contains not more than 10.5 pCi/g of RA-226. Potential borrow areas for this material are designated on Figure 4 of the Reclamation Plan.

2. Initial soil lifts will be placed directly on exposed surfaces of the dismantled mill components. The initial lift over this debris will be saturated with clean water and continue to be wetted to force the fill material into residual void spaces below and within the mill debris. Additional fill will be placed in voids created by this wetting process, which will be repeated until no more voids are created by this wetting procedure. Components with more than 10% noncompressible internal void space, as determined visually by HMC, will be filled with sand-cement slurry grout, in accordance with Technical Specification B1.b)5, or placed in a subgrade pit than will then be filled with sand-cement slurry grout before placement of mill cover soil.

3. Following the completion of activities described in item #2 above, successive lifts of gravelly sand or sand will be placed not to exceed 12 inches uncompacted thickness.

4. Compaction of all lifts will be achieved by the movement of heavy equipment (scrapers, dozers, etc.).

5. The final surface will be prepared by finished grading to produce the gradients shown in Figure 4 of the Reclamation Plan. The final surface will be compacted to not less than 90% maximum dry density per ASTMD-698 or at least 80% relative density per ASTMD-2049, whichever is appropriate for the fill material being used.

C) TESTING AND INSPECTION

1. Density testing: One test (ASTMD-698 or ASTMD-2049) per 10000 cubic yards of material placed in the topmost 2.0 feet of cover.

2. In-place density: One test (ASTMD-1556 or ASTMD-2922) per 5000 cubic yards of cover soil placed.

3. Grain size/Soil classification (ASTMD-422): One per 5000 cubic yards.

D) DOCUMENTATION AND REPORTING

1. Visual inspection of fill materials and placement procedures at least once daily by HMC personnel. All inspections recorded in daily activity log.

2. Soil testing performed and recorded by contract soil testing laboratory, with written test results submitted weekly to HMC and any results failing specified standards reported immediately to HMC.

E) NONCONFORMANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS

1. Nonconformances will be identified or verified by the Homestake Task Manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.

2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.

3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

F) RECORDS

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journals will become a part of the permanent reclamation and contract records.

2. The RM will maintain a permanent file of all testing, measurements, and other records of the work performed under this specification.

TECHNICAL SPECIFICATION # B3

TITLE: TAILING IMPOUNDMENT RECONTOURING

RECLAMATION OF HOMESTAKE MINING COMPANY, GRANTS OPERATION

A) RESPONSIBILITIES

Work under this specification to be performed by earthwork contractor.

Quality control testing/inspection by HMC/contract soil testing service.

B) PERFORMANCE STANDARDS

1. Excavate, haul and place tailings to create the lines and grades shown on Figure 6 for the large impoundment and on Figure 9 for the small impoundment. Actual recontour elevations may vary but in general will be those shown on the referenced figure less the thicknesses of soil and rock covers.

2. Any tailing material that is visibly saturated (yields free water upon exposure or disturbance) shall be allowed to drain or dry to an unsaturated condition before placement and compaction.

3. No tailing slimes (tailing materials classified as CL, CH, ML or MH) shall be placed within 4.0 feet of final recontoured surfaces. Recontoured surfaces that are created by excavation shall be compacted to achieve 90% maximum dry density per ASTM D-698.

4. At locations where fill placement is required to achieve final recontoured surfaces, all fill placed within 4.0 feet of the final recontoured surface (base for soil cover placement) shall be compacted to not less than 90% of maximum dry density per ASTM D-698.

5. Final recontoured outslopes shall have gradients of 0.20 or flatter. Final recontoured surface elevations can vary, depending on actual excavation and fill volumes and volumes lost to settlements. However, final outslope gradients shall not exceed 0.20, and top surface gradients shall be within 10% of those shown on Figure 6 (large impoundment) and Figure 9 (small impoundment) prior to placement of radon barrier (soil cover).

C) TESTING AND INSPECTION

1. HMC personnel shall perform daily visual inspections of all recontouring activities.

2. Field in-place density tests shall be performed by a contract soil testing service. A minimum of one in-place density per ASTMD-1556 for each 1000 cubic yards of fill placed per section B)4. above shall be performed.

3. A minimum of one Proctor density test per 15,000 cubic yards of tailings fill placed per section B)4 above shall be conducted per ASTMD-698. One-point Proctor tests shall be conducted at a frequency of one per 5000 cubic yards of such fill placed.

4. Final recontoured surfaces shall be surveyed by HMC or a contract surveyor prior to approval of this surface.

D) DOCUMENTATION AND REPORTING

1. HMC personnel shall maintain a daily activity log of tailing recontouring.

2. The contract soil testing service shall document all tests and submit written reports weekly. Failing tests shall be reported immediately to HMC.

E) NONCONFORMANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS

1. Nonconformances will be identified or verified by the Homestake Task Manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.

2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.

3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

F) RECORDS

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journals will become a part of the permanent reclamation and contract records.

2. The RM will maintain a permanent file of all testing, measurements, and other records of the work performed under this specification.

TECHNICAL SPECIFICATION # B4

TITLE: TAILING IMPOUNDMENT SOIL COVER

RECLAMATION OF HOMESTAKE MINING COMPANY, GRANTS OPERATION

A) RESPONSIBILITIES

Construction work under this specification to be performed by earthwork contract.

Quality control testing/inspection by HMC and contract soil testing service.

B) PERFORMANCE STANDARDS

1. Before placement of the initial fill lift, after any rain event that resulted in puddling of water, or after any fill placement activity interruption in excess of two days, the impoundment surface will be scarified prior to subsequent placement of any fill.

2. The soil cover of the large impoundment will consist of 8.0 feet of clayey sand (SC) or a mixture of SC and clay (CL,CH) containing not less than 25% fines (-#200 sieve) by weight and 100% passing 3/4 inch. The cover soil shall be placed in six-inch lifts compacted to not less than 95% Standard Proctor density at a moisture content of -2% to +2% optimum. The soil cover of the small impoundment will be the same as for the large impoundment except that it will be 14 feet thick.

3. The top surface of the large impoundment (that portion of the impoundment not including outslopes) will be covered with one foot of uncontaminated soil as an interim cover to protect against erosion of the recontoured tailings surface during that time between the completion of recontouring and the time when the soil cover can be placed.

4. Soil cover (radon barrier) will be placed as soon as possible after the surface of each impoundment has been recontoured, except that no radon barrier will be placed on the top surface of the large impoundment until 90% of primary-consolidation settlement has been achieved.

4. All fill materials used to construct the impoundment soil covers shall be derived from approved borrow locations shown on Figure 4 of the Reclamation Plan or in other locations approved by Homestake or its engineer.

5. No fill material shall be placed under adverse weather conditions, including freezing temperatures or during or immediately after heavy precipitation events. HMC shall determine when these adverse conditions exist.

6. No fill material shall be used in the soil cover that has contaminated material (concentrations of byproduct-derived Ra-226 in excess of 5.0 pCi/g). With a background radium concentration of 5.5 pCi/g, the maximum total radium content of cover soil will be not more than 10.5 pCi/g unless excess concentrations can be demonstrated by soil tests to be naturally-occurring radium.

7. All final fill surfaces shall have not more than 0.20 gradient on the outslopes and shall not exceed the top surface gradients shown on Figures 6 and 9 by more than 5%.

C) TESTING AND INSPECTION

1. Daily visual inspection of the soil cover construction activity shall be performed by Homestake.

2. The contract soil testing service shall perform the following tests:

   a. Soil gradation and classification: One per 1,000 cy of radon barrier and one per 2000 cy of interim cover placed.

   b. Standard Proctor Density (ASTM D-698): At least one per 7500 cy and one one-point Proctor test for each 2500 cy of radon barrier placed.

   c. In-place density test: For radon barrier soil placement, at least one per 500 cy per ASTM D-1556 ASTM Method D-2922 may be used if the results of this method are within 2% of the results of method D-1556 based on not less than 10 comparative tests.

D) DOCUMENTATION AND REPORTING

1. Homestake shall maintain a daily construction activity log, recording the quantities and locations of fill placed and significant events or conditions that affect the placement and properties of the soil cover.

2. Contract soil testing service shall report all tests, in writing, on a weekly basis and shall report all failing tests immediately to Homestake.

E) NONCONFORMANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS

1. Nonconformances will be identified or verified by the Homestake Task Manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.

2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.

3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

F) RECORDS

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journals will become a part of the permanent reclamation and contract records.

2. The RM will maintain a permanent file of all testing, measurements, and other records of the work performed under this specification.

TECHNICAL SPECIFICATION # B5

TITLE: SETTLEMENT MONITORING

RECLAMATION OF HOMESTAKE MINING COMPANY, GRANTS OPERATION

A) RESPONSIBILITIES

Work under this specification to be performed by Homestake.

Quality control testing/inspection by Homestake.

B) PERFORMANCE STANDARDS

1. Not fewer than 50 settlement monitoring points shall be established on the top surface of the large impoundment at locations shown on Figure 6 of the Reclamation Plan.

2. The monitoring points shall be constructed with materials and dimensions shown on Figure 8 of the Reclamation Plan. Other materials may be substituted if they have equivalent properties, as approved by Homestake.

3. The steel baseplate of each monitoring point shall be placed between two and four feet below the final recontoured tailing surface. The plates may be installed and the construction of the monitoring points completed either immediately after the final recontoured tailing surface has been established or when recontouring fill placement has reached the elevations designated for each steel plate. If constructed according to the latter approach, the tailing fill placed above and around the monitoring point riser and guard pipe shall be hand compacted using hand tampers or hand-guided mechanical compactors. All fill materials excavated for settlement point construction shall be replaced in their original depths and stratigraphic order and compacted to original placement density.

4. The initial construction of each monitoring point shall include:

   a. welding of a threaded coupling to the steel plate
   b. connection of one or more riser pipe sections with appropriate couplings between sections
   c. installation of a protective PVC guard pipe over the riser pipe, with grease placed in the annulus between the PVC pipe and the riser.
   d. placement of the monitor point at its designated location and elevation
   e. backfill of soil above and around the monitor point plate and riser, with the bottom of the PVC guard pipe raised to not more than 18 inches above the elevation of the steel plate

5. Immediately following installation of each monitor point, it shall be surveyed to determine the x, y and z coordinates to a precision of 0.1, 0.1 and 0.01 feet, respectively, and an accuracy of 0.05 feet or better. At least three control points shall be used for these and subsequent surveys. The control points shall be permanently located and protected at positions on the ground surface that will be unaffected by construction on the impoundment surfaces.

6. Subsequent readings shall be made to determine the elevation of each point. The initial subsequent reading shall be made within two weeks of installation, and successive readings after that shall be made biweekly to monthly for six months then at least quarterly thereafter until future settlements can be shown to no longer have the potential to adversely affect the cover, as determined by engineering analysis of settlement data performed by the responsible engineer.

7. The engineering analysis of settlement data shall consist of the recording and plotting of the changes in elevation vs. time for each settlement point and the plotting, comparison, and projection of cumulative elevation changes (settlements) of all settlement monitoring points.

C) TESTING AND INSPECTION

1. Homestake's Resident Manager or his designated representative shall inspect each monitor point after it is assembled and when it is installed prior to backfilling or fill placement around the monitoring point.

2. Each point shall be visually inspected at least weekly during construction activity on the impoundment top surface to determine if any point has been damaged or displaced by construction activity.

D) DOCUMENTATION AND REPORTING

1. The initial x, y and z coordinates of each monitor point shall be surveyed and recorded on both a computer data base and written table. Subsequent changes in elevation shall be monitored on the schedule described in Section B above and added to the computer and written records.

2. Settlements shall be evaluated quarterly by HMC or its engineer and shall be reported at least annually to the NRC until 90% of expected settlements due to primary consolidation have been demonstrated by the data and approved by the NRC.

E) NONCONFORMANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS

1. Nonconformances will be identified or verified by the Homestake Task Manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.

2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.

3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

F) RECORDS

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journals will become a part of the permanent reclamation and contract records.

2. The RM will maintain a permanent file of all testing, measurements, and other records of the work performed under this specification.

TECHNICAL SPECIFICATION # B6

TITLE: EROSION PROTECTION - ROCK MATERIALS AND PLACEMENT

RECLAMATION OF HOMESTAKE MINING COMPANY, GRANTS OPERATION

A) RESPONSIBILITIES

Work under this specification to be performed by earthwork or rock placement contractor.

Quality control testing/inspection by Homestake and its contract soil testing service.

B) PERFORMANCE STANDARDS

1. All rock used for erosion protection shall be basalt developed by drilling, blasting and crushing of the Malpais Lava at its outcrop location in the N 1/2, NE 1/4, Section 28, T 12 N, R 10 W located approximately 1.5 miles west of the large tailing impoundment.

2. The rock shall be quarried and processed to produced those sizes and gradations shown in Calculation C10.3 of Appendix C of the Reclamation Plan.

3. The quality of rock, as determined by the scoring procedure shown in Calculation C10.2 of Appendix C, shall be not less than a weighted score of 80 for all applications of outslope, riprap and toe scour protection. Rock that has received an initial score of <80 may be used for the top rock covers if after crushing to the appropriate sizes the rock is retested and found to have a rating of 80 or more. Alternatively, basalt with a rating less than 80 but more than 50 may be used on any surface of the impoundment if it is oversized by at least (80-rating)%. Rock with a rating less than 50% may not be used for applications covered by this specification.

4. The rock used for covers on the impoundments shall be sized as follows:

large impoundment top	d_{50} = not less than 1.0 inch
large impoundment outslope	d_{50} = 4.7 inches
small impoundment top	d_{50} = 1.0 inch
small impoundment outslope	d_{50} = 4.7 inches

with gradations shown in Calculation C10.3.1. If highly vesicular basalt is used and its quality rating is 50 to 80%, it will be oversized by design $d_{50} \times (1 + (80\text{-rating}))$.

5. Rock covers shall be 90%-125% of the following thicknesses:

large impoundment top	0.5 feet
large impoundment outslope	0.8 feet
small impoundment top	0.5 feet
small impoundment outslope	0.8 feet

6. Rock covers and riprap shall be placed by dumping and spreading the rock with heavy equipment to:

   a) maintain the acceptable gradation ranges listed in Calculation C10.3 and avoid segregation of sizes during transport and placement

   b) create a uniform cover surface free of visible high or low spots so that irregularities in the rock surface do not exceed +/- 1.0 feet vertical difference from the design gradient surface over 100 feet and +/- 0.5 feet vertical difference within any 10-foot segment of a 100-foot survey line.

7. The riprap cover thickness shall be not less than 1.0 feet and shall extend from the elevation on the outslope corresponding to the PMF crest (see Figure 12) to the bottom of the outslope (i.e. the downslope end of the 0.20 gradient outslope).

8. The below-grade scour protection for the north and west sides of the reclaimed large tailing impoundment shall contain rock with the same sizes and gradations as that used for the outslope. The configuration of this scour protection is shown on Figure 8 and shall extend along those portions of the outslope toe as shown on Figure 6. The scour protection shall be constructed by first excavating a trench to at least 7.7 feet below the outslope toe elevation. After the excavation of this trench, which shall have an inside slope of 30 degrees, the trench shall be backfilled initially by dumping rock on this 30 degree slope to form a rockfill on which the top width is at least 5.0 feet and the bottom width is at least 2.0 feet, as shown on Figure 8. The construction of the scour protection shall be completed by backfilling the remaining open space of the trench with soil that was initially excavated from this trench. No specific compaction of this soil is required; however, the soil will be placed by and compacted by dozer.

9. Along the south and east outslope toes of the large impoundment, where no below-grade scour trench is required, the rock cover will be extended 10 feet beyond the toe of the outslope. This toe apron will consist of the same rock sizes and gradations as the outslope rock cover and will be constructed so that the surface of the toe apron slopes away from the toe and the outer edge of the top surface is at the same elevation as the adjacent ground surface.

10. A bedding layer will be placed on all outslope surfaces before placement of rock cover on those surfaces. The bedding layer will be 90%-125% of the design thickness of 0.5 feet. Bedding material may be either crushed basalt fines or sand and gravel satisfying the following size and gradation criteria:

    d_{15} not larger than #10 sieve
    d_{50} not larger than #4 sieve

C) TESTING AND INSPECTION

1. Visual inspection of rock delivered to the site and rock placement will be performed by Homestake at least once daily.

2. Visual inspection of rock cover surfaces to evaluate surface uniformity. If the visual inspection by Homestake results in uncertainty or dispute about adequacy of uniformity at any location, the location shall be surveyed by rod and level, or other method of at least equal accuracy, to determine if allowable limits of surface irregularity are exceeded along 100-foot long horizontal and

slope-gradient lines of a 20-foot square grid covering the location in question. The allowable limits are +/- 1.0 feet vertical difference from the design gradient surface over 100 feet and +/- 0.5 feet vertical difference within any 10-foot segment of a 100-foot survey line. This requirement does not negate or substitute for rock thickness testing required under C3c below.

3. A contract soil testing service shall perform the following tests:

   a. Rock quality testing (sulfate soundness, specific gravity, and absorption): One test on the first 500 cy produced, one test per 10,000 cy produced thereafter, and one test on the last 500 cy produced for each gradation.

   b. Rock and bedding size and gradation: One test per 5000 yards at the screening plant using the appropriate screen stack and one size and gradation test using a portable screen stack for every 5000 cy of rock or bedding placed on the impoundment.

   c. Rock and bedding layer thickness: One measurement per 2000 cy placed.

D) DOCUMENTATION AND REPORTING

1. Homestake will maintain a daily field activity log (journal) of all placement activities, including volumes placed.

2. Homestake will prepare a survey data sheet for each location that is surveyed under C)2. above. The grid location coordinates, grid size, and vertical differences from design surface at 10-foot intervals along each survey line shall be listed.

3. The contract soil testing service shall report all test results, in writing, at least weekly and shall immediately report failing tests to Homestake.

E) NONCONFORMANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS

1. Nonconformances will be identified or verified by the Homestake Task Manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.

2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.

3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

F) RECORDS

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journals will become a part of the permanent reclamation and contract records.

2. The RM will maintain a permanent file of all testing, measurements, and other records of the work performed under this specification.

TECHNICAL SPECIFICATION # B7

TITLE: DIVERSION LEVEE

RECLAMATION OF HOMESTAKE MINING COMPANY, GRANTS OPERATION

A) RESPONSIBILITIES

Work under this specification to be performed by earthwork contractor.

Quality control testing/inspection by Homestake and contract soil testing service.

B) PERFORMANCE STANDARDS

1. A surface water diversion levee shall be constructed in the location shown on Figure 13. The levee shall be a length to be determined by the configuration and location of the east outslope of the large impoundment and by the final reclaimed surface of the mill site in the vicinity of the administration building. The alignment will assure that the levee centerline lies between the Lobo Canyon floodplain and the covered mill area.

2. The levee shall have a crest constructed at the uniform elevation of 6595 and a width of 15 feet. The outslopes shall be constructed at a gradient of 10H:1V.

3. Prior to construction of the diversion levee, all contaminated soils shall be removed from the location of fill placement, and the demolition of all mill facilities shall be completed in accordance with Technical Specification B1. No standing water or saturated soils shall be exposed at the location of the levee at the time of initial fill placement.

4. The levee shall be constructed using the gravelly sand or sand soils (SW, SP, SC, SM, GW, GP and SP-SM) derived from the borrow area east of the mill location, as shown on Figure 4.

5. The diversion levee fill shall be placed in lifts not to exceed 12 inches uncompacted thickness. No particles larger than 2/3 of the uncompacted lift thickness shall be included in the fill. Each lift shall be compacted to not less than 80% relative density or 90% maximum dry density per ASTMD-698. The appropriate compaction testing method will be based on the classification of the soils used for fill.

6. The levee surfaces will be protected from erosion with a 0.5 foot layer of rock meeting the same durability, size and gradation specifications as the rock required for the top of the large impoundment in Technical Specification B6, Rev.10/93.

C) TESTING AND INSPECTION

1. Homestake shall inspect the construction materials and construction activities at least daily.

2. A contract soil testing service shall perform the following tests:

   a. Soil classifications: One test per 2,000 cy.

   b. Relative density or maximum dry density tests: One per 5,000 cy.

c. In-place density testing using method ASTMD-2922 or ASTMD-1556: One test per 2000 cy placed.

d. Rock quality testing (sulfate soundness, specific gravity, and absorption): One test on the first 500 cy produced, one test per 10,000 cy produced thereafter, and one test on the last 500 cy produced for each gradation.

e. Rock size and gradation: One test per 5000 yards at the screening plant using the appropriate screen stack and one size and gradation test using a portable screen stack for every 5000 cy of rock placed on the impoundment.

f. Rock layer thickness: One measurement per 2000 cy placed.

Test requirements d, e, and f above may be satisfied by the testing performed under Technical Specification B6.

D) DOCUMENTATION AND REPORTING

1. Homestake shall maintain a daily activity log of this construction activity.

2. The contract soil testing service shall report all test results at least weekly to Homestake and shall immediately report any failing tests to Homestake.

E) NONCONFORMANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS

1. Nonconformances will be identified or verified by the Homestake Task Manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.

2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.

3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

F) RECORDS

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journals will become a part of the permanent reclamation and contract records.

2. The RM will maintain a permanent file of all testing, measurements, and other records of the work performed under this specification.

TECHNICAL SPECIFICATION # B8

TITLE: SITE GRADING

RECLAMATION OF HOMESTAKE MINING COMPANY, GRANTS OPERATION

A) RESPONSIBILITIES

Work under this specification to be performed by earthwork contractor.

Quality control testing/inspection by Homestake.

B) PERFORMANCE STANDARDS

1. With the exception of the tailing impoundments, each portion of the mill site that is disturbed by reclamation activities, including the borrow areas, shall be graded after all other construction activities have been completed and before revegetation activities on each portion of the affected site.

2. Final site grading shall be performed to establish those gradients that will assure positive drainage of surface water runoff in directions away from tailing impoundments and the reclaimed mill area. To the extent possible the final regraded contours will reestablish or maintain the directions and gradients of ground surfaces that existed prior to the development of the Homestake Grants mill site.

3. The line and grade control for final grading shall be established after the completion of other reclamation work and before each portion of the site is regraded. The final lines and grades will be determined after the completion of those activities that directly affect ground surfaces, such as contaminated soil cleanup, excavation of borrow areas, and burial of demolished mill components.

C) TESTING AND INSPECTION

1. Homestake will visually inspect each discrete area after it has been regraded. After each major rainfall event (i.e any event large enough to cause runoff), Homestake will inspect any regraded surfaces to locate and measure any depressions or other surface features that would prevent positive drainage. Such areas will be regraded and reinspected until final grading has been demonstrated by visual observation to achieve positive drainage.

D) DOCUMENTATION AND REPORTING

1. All activities conducted under Section C above will be recorded, in writing and as appropriate, by photography. If considered appropriate or necessary to complete documentation, an aerial photography survey will be performed of the entire site after all reclamation activities and final site grading have been completed. The resulting topographic map will be submitted as a documentation of the adequacy of final lines and grades.

E) NONCONFORMANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS

1. Nonconformances will be identified or verified by the Homestake Task Manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.

2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.

3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

F) RECORDS

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journals will become a part of the permanent reclamation and contract records.

2. The RM will maintain a permanent file of all testing, measurements, and other records of the work performed under this specification.

APPENDIX C

CALCULATIONS

NO.	TITLE
C1	MILL DEMOLITION VOLUMES AND COSTS
C2	FILL VOLUME - MILL AREA
C3	BORROW SOIL QUANTITIES AVAILABLE
C4	CONTAMINATED SOIL VOLUMES
C5	INTERIM STABILIZATION COVER VOLUMES
C6	RECONTOURING AND SOIL COVER EARTHWORK VOLUMES
C7	"RADON" CODE CALCULATIONS FOR SOIL COVER DESIGN
C8	HEC-2 CALCULATIONS FOR SAN MATEO CREEK, 1/28/88
C9	MAXIMUM AND ALLOWABLE SHEAR STRESSES DUE TO RUNOFF, MILL AREA RECLAMATION
C10	ROCK SIZES FOR EROSION PROTECTION
C11	DEPTH OF SCOUR AT TOE OF LARGE IMPOUNDMENT DUE TO PMF ON SAN MATEO CREEK

HOMESTAKE GRANTS MILL FACILITIES AND MAJOR EQUIPMENT

Facility or Equipment	Map Location Number	Dimensions in feet: Width/ Diameter	Length	Height	Dismantled Volume (1) ft^3	Tonnage (2)
Ore Receiving Section						
Ore receiving scale (steel)	1	15	60	0.5	450	110
concrete supports		10	15	1	150	11
Ore storage pad	2	(to be included in contaminated soil cleanup)				
Crushing and Sampling Section						
Section buildings		30	170	60	17669	4338
Crusher building		50	50	50	7270	1785
Grizzly	3	20	20	10	1200	295
Universal impact breaker	4	9	3	11	89	22
Rotary dryer	5	10	80		628	0
Reciprocating samplers	6	3.5		2	2	0.00
roll crusher		5	5	4	30	7
Fine Ore Storage Section						
Tin shed roof		20	170		469	115
Fine ore bins (4)	7	35		57	43874	3291
conveyor belts		2.5	2337	0.042	245	18
Grinding Section						
Building		60	100	55	18436	4526
Ball mills (2)	8	10	5.5		130	32
2 x 400hp motor						4
10 x 5 ball mill		10	5		118	29
Regrind mill		7	7		81	20
Thickener tanks (2)	9	100		15	23563	5785
Uranium Leaching Section						
Pressure leaching building	10	80	110	50	24294	5964
		90	30	50	7948	1951
		40	60	50	7011	1721
Two circuits with eight 11,000 G autoclaves		12	16		2895	711
Piping (8") to atmospheric leach circuit		0.67	900		25	6
Atmospheric leaching	11	120	160	50	51930	12749
Pachuca tanks (9)		19		38	9697	2381
Building		30	50	50	4522	1110
Filtration buildings	12	80	260	60	67494	16570
		30	50	60	5400	1326
Filtration building	12A	40	60	22	3203	786
a) Three filter stages @ w/ 5-650 sq ft + 2-750 sq ft rotary drums		(material to be cut)			380	93
b) Vacuum filters (21)		11.5		17	3708	910
c) Pipeline (8")		0.67	800		23	6
Solution storage tank	13	100		15	11781	2892
Pipeline to tailing pond (9")		0.75	4000		141	35
Pipeline return (8")		0.67	2500		71	17
Ion exchange building	15	80	140	50	30746	7548
Tanks (2)		70		15	11546	2834
Tanks, fiberglass lined (2)		20		20	1257	309

NOTES:

(1) Estimates of dismantled volumes based on a) buildings - dimensions x 0.05 for interior, + steel wall area x 0.1 or concrete wall area x 0.5, + 0.1 x 1.1 x roof dimensions; b) heavy equipment - volume x 0.3; c) light equipment - volume x 0.1; d) concrete bins - volume x 0.2

(2) Tonnage = volume x a) 490/2000 for steel; b) 150/2000 for concrete and other materials

Facility or Equipment	Map Location Number	Dimensions in feet: Width/ Diameter	Length	Height	Dismantled Volume (1) ft^3	Tonnage (2)
Precipitation Section						
Building		150	170	50	68554	16830
Pregnant solution tank	16	100		15	11781	2892
Precipitation circuit agitation tanks (23)	17, 18	10		18	990	243
		20		30	1885	463
		30		30	10603	2603
		12		8	181	44
		40		8	1005	247
		12		8	90	22
		16		8	161	39
		4		6	8	2
		5		5	10	2
		6		8	158	39
Precipitate thickener tank	19	40		12	1508	370
Feed well		12		8	90	22
Recarbonation		18	27	24	1166	286
Tower (N. of #12)		30		120	4241	1041
Vanadium Removal Section (within Precip. section)						
Roasting Furnace, 6 hearth	20	8.5		20	340	84
Thickener tank		16		10	201	49
Vacuum drum filter		4.5	6		10	2
		6	8		23	6
Agitate tank		6	8		23	6
Tank		6	6		17	4
Yellowcake Packaging, Storage and Shipping Section						
Yellowcake drying furnace	21	8.5	15		85	21
Yellowcake packaging	22	8		14	70	17
Miscellaneous Structures						
Administration building	24	90	140	12	11706	878
Garage	25	40	80	17	5112	383
Shop	26	90	140	30	21113	5183
Warehouses	27	50	100	21	6194	1521
		50	50	21	3181	781
		20	40	17	914	224
Laboratory	28	40	110	12	4924	369
Old facilities	29	50	120	21	7399	1817
		40	50	21	2578	633
		50	130	17	6587	1617
		40	140	32	10374	2547
		50	20	32	2046	502
		40	60	15	3564	267
Electrical shop	30	30	90	15	4122	309
Instrument shop	31	40	80	17	5112	383
Carpenter shop	32	30	80	14	2138	525
Change house	33	40	70	20	5308	398
Old ore pad (only walls will be demolished)		170		1	4900	368
Ore truck shops		150	60	19	9980	2450
		40	80	19	3686	905
		20	30	19	775	190
Floor slabs (#3,4,6,24,26,28)					34727	2605
TOTALS					618118	130499

AREA AND VOLUME CALCULATIONS FOR HOMESTAKE GRANTS RECLAMATION - Revised 10/93

APPENDIX C2 - CALCULATION OF FILL VOLUME, MILL AREA

By planimeter, area to be covered by gravelly sand fill is:

1832000 sq ft, or about 42 acres (see Figure 4)

Volume of fill, using 2 ft. average depth over 42 acres = 1832000 x 2 / 27
= 135703 c.y., say 136,000 c.y.

APPENDIX C3 - BORROW SOIL QUANTITIES AVAILABLE - Revised 10/93

APPENDIX C3.1 ESTIMATED VOLUMES OF RADON BARRIER BORROW SOILS FROM DELINEATED BORROW AREAS

LOCATION VS LARGE IMPOUNDMENT	SOIL TYPE (USCS)	SURFACE AREA ft^2	EST. AVE. THICKNESS IN TOP 5 FT. ft	ESTIMATED VOLUME IN TOP 5 FT. c.y.	AVERAGE DISTANCE TO PILE ft
SOUTH	SM, over clays	1583000	3.2	186882	1600
SOUTH	CL,CH under SM	1583000	1.4	84280	1600
SOUTH	CL,CH at surface	3565000	2.7	356500	1800
WEST	SM, over clays	3365000	2.0	247598	1800
WEST	CL,CH under SM	3365000	2.0	245105	1800
WEST	CL,CH at surface	262000	3.3	31537	600
WEST	SC at surface	1470000	3.6	197361	1100
NORTH	SM, over clays	3533000	2.1	277697	1800
NORTH	CL,CH under SM	3533000	2.0	255888	1800
NORTH	CL,CH at surface	3052000	2.9	331037	2400
NORTH	SC at surface	2002000	3.2	234802	1100

627 acres

TOTALS:	Clay	1304347
	Clayey Sand	712176
	Silty Sand, Sand	432164

These volumes are based on data in Appendix D (Table D1, test pit logs, soil test results) and test pit locations (Figure 4). All volume calculations are for top 5.0 feet of soil. Additional soil is available from depths below 5.0 feet.

APPENDIX C3.2 ESTIMATED VOLUME OF GRAVELLY SAND BORROW SOILS

Area outlined on Figure 4 has existing borrow pits and several test pits that delineate and area of gravelly sand at least 4000′ x 600′ and 8′ minimum thickness. Therefore, known volume is:

4000′ x 600′ x 8′ /27 = 711111 c.y.

****

APPENDIX C4 - CALCULATION OF CONTAMINATED SOIL VOLUMES - Revised 10/93

Area with excessive soil radium content is delineated on Figure 5.

Area Dimensions

County road to south side of large impoundment:

5600′ (county road)
5000′ (south side large impoundment to highway)
2600′ north to south

(5600 + 5000)/2 x 2600 /43560 = 316 acres

less large impoundment, 3700′ x 2000′ /43560 = 170 acres

South side of large impoundment to south edge of small impoundment:

4400′ (north side of area)
4000′ (east-west dimension at south edge brine ponds)
1300′ north to south

(4400 + 4000)/2 x 1300/43560 = 125 acres

less portion of small impoundment south of south edge brine pond, 1800′ x 600′ + 1800′ x 950′ /2, and less brine pond, 550′ x 500′ /43560 = 51 acres

Highway corridor, 3300′ x 300′/ 43560 = 23 acres

TOTAL SOIL CLEAN-UP AREA = 316-170+125-51+23 = 243 acres
TOTAL VOLUME OF SOIL CLEANUP

ore pad and old spill area south of large pile =
400′ x 400′ + 700′ x 800′ = 720000 sq. ft. = 16.5 acres
x ave. 2.5 ft = 66667 c.y.
remainder of area = 243 acres - 16.5 acres = 226.5 acres
assuming 0.5 ft. average depth of contamination, volume =
226.5 acres x 0.5 x 43560/27 = 182687 c.y.

TOTAL VOLUME = 249353 c.y., say 250000 c.y.

****

APPENDIX C5 - CALCULATION OF INTERIM STABILIZATION COVER VOLUMES - Revised 10/93

Interim stabilization cover will be needed only on south end of small impoundment (south of crest of south dike of evaporation pond), a triangular area:

1700′ x 650′ x 1/2 = 552500 sq ft = 12.7 acres

and on top surface of large impoundment, 3540000 sq ft = 81.3 acres

Volumes for 1.0 feet thickness: large pile = 131111 c.y., small pile = 20463 c.y.

APPENDIX C6 - RECONTOURING AND SOIL COVER EARTHWORK VOLUMES - Revised 10/93

RECONTOURING - volume of sand tailings moved to reshape impoundment, c.y.

For Large Impoundment:
Calculations performed by Community Sciences Inc. using PacSoft software and terrain models developed from aerial photography of 1/93 and ground survey data of 8/93. See attached Earthwork Summary, 7 Oct 1993

For Small Impoundment:
Area calculations by AUTOCADD/DCA, checked by planimeter - unchanged from 1/91
Volumes by AUTOCADD/DCA using 20' x 20' grid, unchanged from 1/93

Volumes in c.y. for:	Excavation	Fill
Large impoundment	1467160	1464432
Small impoundment	157000	222000
Excess from evap. pond construction	60000	

Excess large-impoundment excavation, 2728 c.y., reserved for compensating for volumetric loss due to slimes consolidation. Additional excavation to be generated as needed to offset settlements. Deficit of 5000 c.y. fill for small impoundment will come from 2nd phase demolition debris, brine pond liner, and contaminated soil clean-up.

RADON BARRIER AND ROCK COVER

	Large Impoundment		Small Impoundment		TOTALS
	Top	Outslope	Top	Outslope	
Area, sq. ft	3540000	4271658	2031024	334560	
Interim Cover, c.y. (1 ft assumed)	131111	n/a	20463	n/a	151574
Radon Barrier, c.y. (1)	1048889	1265677	1053124	158476 (2)	3526165
Rock, c.y.					
0.5 ft on top	65556		37612		103167
0.8 ft on outslopes		126568		9913	136481
toe apron and riprap		9558		n/a	9558
Bedding, c.y.					
0.5 ft on outslopes		79105		6196	85300

Notes:

(1) Based on thicknesses mandated in License Condition 37A and 37B.
(2) Cover soil was placed on north, east and west outslopes of evaporation evaporation pond at time of 1990 construction. Approximately 15,000 c.y. will remain in place for reclamation.

EARTHWORK SUMMARY

7 Oct 1993

OMESTAKE MINING
% SHRINKAGE "BALANCED SITE"

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<*>>

GROUND SURFACE TNET FILE: 03302ES.TNT
DESIGN SURFACE TNET FILE: 03302F.TNT

GROUND SURFACE COORD FILE:03302ES.CRD
DESIGN SURFACE COORD FILE:03302F.CRD

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<*>>

GROUND SURFACE ADJUSTMENT (ft)	+0.00	PRECISION RATIO	18/1
SWELL FACTOR (ROCK EXCAVATION)	0%	AVERAGE INCREMENTAL AREA (sf)	247
SHRINKAGE FACTOR (COMPACTION)	0%	TOTAL EXCLUDED AREA (ac)	0.000
		COMPUTATION TIME	00:41:28

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<*>>

VOLUME OF BANK CUT (cy)	1467160	TOTAL SURFACE AREA (ac)	179.331
VOLUME OF BANK FILL (cy)	1464432	AREA OF CUT (ac)	78.738
VOLUME OF ADJUSTED CUT (cy)	1467160	AREA OF FILL (ac)	100.593
VOLUME OF ADJUSTED FILL (cy)	1464432	AVERAGE DEPTH OF CUT (ft)	11.550
SITE BALANCE (cy)	2727	AVERAGE DEPTH OF FILL (ft)	9.024

APPENDIX C7

"RADON" CODE CALCULATIONS FOR SOIL COVER DESIGN

TABLE C7.1 A:m58.w84

AVERAGE PROPERTIES FOR BORROW SOILS, 0′ to 5′ HMCCVR.WK3

USCS of Soil	depth to soil ft	soil thickness ft	distance ft	% fines	% clay	% organic	95% ave. Max. dens g/cc	moisture % Calc'd	moisture % test at -15 bar
CL, CH		2.42	1695	73.2	46.4	2.47	1.53	19.4	19.06
(# of samples)				(23)	(20)	(24)	(28)		(3)
61 samples identified as CL, CH									
SC		2.65	2106	34.9	21.8	1.92	1.66	10.0	13.43
(# of samples)				(24)	(20)	(17)	(10)		(3)
36 samples identified as SC									
SM	0-5.0′	3.84	1596	23.3	11.6	1.53	1.65	6.6	8.94
(# of samples)				(24)	(11)	(12)	(8)		(4)
38 samples identified as SM, SC-SM, or SP-SM									

TABLE C7.2

B:a141.i195
HMCCVRW%.wk3

RADON BARRIER DESIGN MODELS

MODEL #	LAYER THICKNESS, cm/ft Slimes	Tlg sand	SM	Clay	SC	VOLUMES NEEDED, cy SM	Clay	SC
TOP 1	500	457	30	30	67	130080	130080	290513
	16.4	15	1.0	1.0	2.2			
TOP 2	500	457	30	45	25	130080	195121	108400
	16.4	15	1.0	1.5	0.8			
TOP 3	500	457	30	50	4	130080	216801	17344
	16.4	15	1.0	1.6	0.1			
TOP 4	500	457	30	51	X	130080	221137	0
	16.4	15	1.0	1.7				
TOP 5	500	457	30	X	142	130080	0	615714
	16.4	15	1.0		4.7			
OS 1	X	457	X	30	93	0	142559	441933
		15		1.0	3.1			
OS 2	X	457	X	45	58	0	213839	275614
		15		1.5	1.9			
OS 3	X	457	X	60	10	0	285118	47520
		15		2.0	0.3			
OS 4	X	457	X	62	X	0	294622	0
		15		2.0				
OS 5	X	457	X	X	164	0	0	779323
		15			5.4			
S1a	213	X	X	102	X	0	251731	0
	7			3.3				
S1b	213	X	76	50	X	187564	123397	0
	7		2.5	1.6				
S1c	213	X	76	30	66	187564	74038	162885
	7		2.5	1.0	2.2			
S3a	X	610	X	96	X	0	236923	0
		20		3.1				
S3b	X	610	76	70	X	187564	172756	0
		20	2.5	2.3				
S3c	X	610	76	30	110	187564	74038	271474
		20	2.5	1.0	3.6			

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - TOP 1

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	5	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 SLIMES

THICKNESS	500	cm
POROSITY	.55	
MEASURED MASS DENSITY	1.19	g cm^-3
MEASURED RADIUM ACTIVITY	582	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.33	
CALCULATED SOURCE TERM CONCENTRATION	8.727D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	41.7	%
MOISTURE SATURATION FRACTION	.902	
CALCULATED DIFFUSION COEFFICIENT	5.168D-04	cm^2 s^-1

LAYER 2 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 3 INTERIM SM

THICKNESS	30	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

LAYER 4 CLAY

THICKNESS	30	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

TOP 1

LAYER 5 SC LAYER

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 7.529D+01 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	5.140D+01	1.318D+05
2	4.570D+02	6.595D+01	1.247D+05
3	3.000D+01	3.483D+01	1.312D+05
4	3.000D+01	2.352D+01	2.310D+04
5	6.746D+01	2.001D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - TOP 2

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	5	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 SLIMES

THICKNESS	500	cm
POROSITY	.55	
MEASURED MASS DENSITY	1.19	g cm^-3
MEASURED RADIUM ACTIVITY	582	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.33	
CALCULATED SOURCE TERM CONCENTRATION	8.727D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	41.7	%
MOISTURE SATURATION FRACTION	.902	
CALCULATED DIFFUSION COEFFICIENT	5.168D-04	cm^2 s^-1

LAYER 2 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 3 INTERIM SM

THICKNESS	30	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

LAYER 4 CLAY COVER

THICKNESS	45	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

LAYER 5 SC LAYER

TOP 2

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 7.529D+01 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	5.139D+01	1.318D+05
2	4.570D+02	6.478D+01	1.262D+05
3	3.000D+01	3.320D+01	1.333D+05
4	4.500D+01	1.950D+01	8.267D+03
5	2.523D+01	2.001D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - TOP 3

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	5	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 SLIMES

THICKNESS	500	cm
POROSITY	.55	
MEASURED MASS DENSITY	1.19	g cm^-3
MEASURED RADIUM ACTIVITY	582	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.33	
CALCULATED SOURCE TERM CONCENTRATION	8.727D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	41.7	%
MOISTURE SATURATION FRACTION	.902	
CALCULATED DIFFUSION COEFFICIENT	5.168D-04	cm^2 s^-1

LAYER 2 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 3 INTERIM SM

THICKNESS	30	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

LAYER 4 CLAY LAYER

THICKNESS	50	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

TOP 3

LAYER 5 SC LAYER

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 7.529D+01 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	5.139D+01	1.318D+05
2	4.570D+02	6.485D+01	1.261D+05
3	3.000D+01	3.329D+01	1.332D+05
4	5.000D+01	1.978D+01	1.247D+03
5	3.750D+00	1.999D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - TOP 4

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	4	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 SLIMES

THICKNESS	500	cm
POROSITY	.55	
MEASURED MASS DENSITY	1.19	g cm^-3
MEASURED RADIUM ACTIVITY	582	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.33	
CALCULATED SOURCE TERM CONCENTRATION	8.727D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	41.7	%
MOISTURE SATURATION FRACTION	.902	
CALCULATED DIFFUSION COEFFICIENT	5.168D-04	cm^2 s^-1

LAYER 2 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 3 INTERIM SM

THICKNESS	30	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5[illegible]	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35[illegible]	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

TOP 4

LAYER 4 CLAY LAYER

THICKNESS	60	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 7.529D+01 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	5.139D+01	1.318D+05
2	4.570D+02	6.490D+01	1.260D+05
3	3.000D+01	3.337D+01	1.331D+05
4	5.061D+01	1.998D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - TOP 5

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	4	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 SLIMES

THICKNESS	500	cm
POROSITY	.55	
MEASURED MASS DENSITY	1.19	g cm^-3
MEASURED RADIUM ACTIVITY	582	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.33	
CALCULATED SOURCE TERM CONCENTRATION	8.727D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	41.7	%
MOISTURE SATURATION FRACTION	.902	
CALCULATED DIFFUSION COEFFICIENT	5.168D-04	cm^2 s^-1

LAYER 2 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 3 INTERIM SM

THICKNESS	30	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

LAYER 4 SC LAYER

TOP 5

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 7.529D+01 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	5.141D+01	1.317D+05
2	4.570D+02	7.742D+01	1.101D+05
3	3.000D+01	5.083D+01	1.102D+05
4	1.424D+02	2.001D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - OS 1

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	3	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 2 CLAY LAYER

THICKNESS	30	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

LAYER 3 SC LAYER

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 1.620D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	4.570D+02	4.530D+01	1.503D+05
2	3.000D+01	2.924D+01	3.410D+04
3	9.261D+01	2.002D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - OS 2

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	3	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 2 CLAY LAYER

THICKNESS	45	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

LAYER 3 SC LAYER

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 1.620D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	4.570D+02	4.266D+01	1.534D+05
2	4.500D+01	2.201D+01	1.935D+04
3	5.760D+01	2.002D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - OS 3

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	3	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 2 CLAY LAYER

THICKNESS	60	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

LAYER 3 SC LAYER

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 1.620D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	4.570D+02	4.194D+01	1.545D+05
2	6.000D+01	1.954D+01	3.472D+03
3	1.051D+01	2.001D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - OS 4

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	2	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	2	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 2 CLAY LAYER

THICKNESS	60	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 1.620D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	4.570D+02	4.208D+01	1.544D+05
2	6.185D+01	2.001D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC LP - OS 5

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	2	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	2	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 TAILING SAND

THICKNESS	457	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.54	g cm^-3
MEASURED RADIUM ACTIVITY	167	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.34	
CALCULATED SOURCE TERM CONCENTRATION	4.372D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.422	
CALCULATED DIFFUSION COEFFICIENT	1.654D-02	cm^2 s^-1

LAYER 2 SC LAYER

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 1.620D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	4.570D+02	6.594D+01	1.239D+05
2	1.636D+02	2.001D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC SP - S1b

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	3	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 slimes

THICKNESS	213	cm
POROSITY	.55	
MEASURED MASS DENSITY	1.19	g cm^-3
MEASURED RADIUM ACTIVITY	732	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.47	
CALCULATED SOURCE TERM CONCENTRATION	1.563D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	41.7	%
MOISTURE SATURATION FRACTION	.902	
CALCULATED DIFFUSION COEFFICIENT	5.168D-04	cm^2 s^-1

LAYER 2 SM layer

THICKNESS	76	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

LAYER 3 clay layer

THICKNESS	60	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 1.349D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	2.130D+02	1.210D+02	7.645D+04
2	7.600D+01	3.303D+01	1.311D+05
3	5.007D+01	1.999D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC SP - S1a

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	2	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	2	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 slimes

THICKNESS	213	cm
POROSITY	.55	
MEASURED MASS DENSITY	1.19	g cm^-3
MEASURED RADIUM ACTIVITY	732	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.47	
CALCULATED SOURCE TERM CONCENTRATION	1.563D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	41.7	%
MOISTURE SATURATION FRACTION	.902	
CALCULATED DIFFUSION COEFFICIENT	5.168D-04	cm^2 s^-1

LAYER 2 clay layer

THICKNESS	60	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 1.349D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	2.130D+02	1.003D+02	1.905D+05
2	9.990D+01	1.998D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC SP - S1c

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	4	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 slimes

THICKNESS	213	cm
POROSITY	.55	
MEASURED MASS DENSITY	1.19	g cm^-3
MEASURED RADIUM ACTIVITY	732	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.47	
CALCULATED SOURCE TERM CONCENTRATION	1.563D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	41.7	%
MOISTURE SATURATION FRACTION	.902	
CALCULATED DIFFUSION COEFFICIENT	5.168D-04	cm^2 s^-1

LAYER 2 SM layer

THICKNESS	76	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

S1c

LAYER 3 clay layer

THICKNESS	30	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

LAYER 4 SC layer

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 1.349D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	2.130D+02	1.211D+02	7.574D+04
2	7.600D+01	3.432D+01	1.289D+05
3	3.000D+01	2.325D+01	2.248D+04
4	6.587D+01	2.002D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC SP - S3a

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	2	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	2	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 tailing sand

THICKNESS	610	cm
POROSITY	.47	
MEASURED MASS DENSITY	1.41	g cm^-3
MEASURED RADIUM ACTIVITY	408	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.39	
CALCULATED SOURCE TERM CONCENTRATION	1.002D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.345	
CALCULATED DIFFUSION COEFFICIENT	2.342D-02	cm^2 s^-1

LAYER 2 clay layer

THICKNESS	60	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 4.961D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	6.100D+02	9.169D+01	3.894D+05
2	9.608D+01	1.999D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC SP - S3b

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	3	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 tailing sand

THICKNESS	610	cm
POROSITY	.47	
MEASURED MASS DENSITY	1.41	g cm^-3
MEASURED RADIUM ACTIVITY	408	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.39	
CALCULATED SOURCE TERM CONCENTRATION	1.002D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.345	
CALCULATED DIFFUSION COEFFICIENT	2.342D-02	cm^2 s^-1

LAYER 2 SM layer

THICKNESS	76	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

LAYER 3 clay layer

THICKNESS	60	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 4.961D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	6.100D+02	2.002D+02	2.853D+05
2	7.600D+01	5.009D+01	2.206D+05
3	6.984D+01	2.001D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

HMC SP - S3c

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	4	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 tailing sand

THICKNESS	610	cm
POROSITY	.47	
MEASURED MASS DENSITY	1.41	g cm^-3
MEASURED RADIUM ACTIVITY	408	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.39	
CALCULATED SOURCE TERM CONCENTRATION	1.002D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	11.5	%
MOISTURE SATURATION FRACTION	.345	
CALCULATED DIFFUSION COEFFICIENT	2.342D-02	cm^2 s^-1

LAYER 2 SM layer

THICKNESS	76	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.64	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.586D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.2	%
MOISTURE SATURATION FRACTION	.268	
CALCULATED DIFFUSION COEFFICIENT	2.786D-02	cm^2 s^-1

S3c

LAYER 3 clay layer

THICKNESS	30	cm
POROSITY	.42	
MEASURED MASS DENSITY	1.53	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.339D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	19.2	%
MOISTURE SATURATION FRACTION	.699	
CALCULATED DIFFUSION COEFFICIENT	3.578D-03	cm^2 s^-1

LAYER 4 SC layer

THICKNESS	60	cm
POROSITY	.36	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	5	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	1.735D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	10	%
MOISTURE SATURATION FRACTION	.472	
CALCULATED DIFFUSION COEFFICIENT	1.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 4.961D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	6.100D+02	2.028D+02	2.827D+05
2	7.600D+01	5.517D+01	2.151D+05
3	3.000D+01	3.490D+01	4.325D+04
4	1.097D+02	2.002D+01	0.000D+00

****

APPENDIX C8 - HEC-2 CALCULATIONS FOR SAN MATEO CREEK, 1/28/88
****

The following five pages are the printout of the HEC-2 calculation of the PMF profiles, defined in Figures 11 and 12, along San Mateo Creek in the vicinity of the mill site. The calculation used input from HMR 55A. It was first submitted to the NRC on 10/31/88 and is reproduced for convenience of reference in this submittal.

THIS RUN EXECUTED TUE, JAN 29 1991 00:45:45

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**************************************************
 HEC2 RELEASE DATED NOV 76 UPDATED MAR 1982
 ERROR CORR    01,02,03,04,05
 MODIFICATION    10,51,52,53,54,55
**************************************************

T1      BROWNELL MAXIMUM FLOOD   SAN MATEO CREEK
T2      HOMESTAKE MINING COMPANY     RMBS 005  1/28/88
T3        SAN MATEO CREEK SUBCRITICAL FLOW

J1  IDHCK    INJ      NINV     IDIR     STRT     METRIC   IWRNG    Q        WSEL     TQ

     0.       0.       0.       0.  0.000450     0.00      0.0  169000.  6570.000    0.000


NC     0.050    0.050    0.050    0.000    0.000    0.000    0.000    0.000    0.000    0.000
X1    10.000   15.000  800.000 11410.000    0.000    0.000    0.000    0.000    0.000    0.000
GR  6559.000    0.000 6560.000 3000.000 6559.000 3360.000 6560.000 3700.000 6562.000 4560.000
GR  6560.000 5000.000 6564.000 6000.000 6560.000 6600.000 6559.000 6800.000 6560.000 7000.000
GR  6567.000 8000.000 6560.000 10120.000 6559.000 10900.000 6560.000 11410.000 6559.000 12000.000

X1   100.000   40.000    0.000 11300.000 6000.000 2000.000 4000.000    0.000    0.000    0.000
GR  6590.000    0.000 6573.000  400.000 6567.200  800.000 6563.600 1200.000 6561.000 1600.000
GR  6560.000 1800.000 6562.500 2100.000 6562.500 2400.000 6563.000 2800.000 6564.000 2700.000
GR  6567.200 2900.000 6566.400 3100.000 6566.400 3300.000 6567.200 3500.000 6569.100 3700.000
GR  6567.500 3900.000 6571.000 4100.000 6569.000 4300.000 6569.000 4500.000 6569.000 4700.000
GR  6570.000 4900.000 6568.000 5100.000 6562.000 5300.000 6566.000 5500.000 6572.500 5700.000
GR  6571.100 5900.000 6570.500 6100.000 6571.500 6300.000 6570.500 6500.000 6571.000 6700.000
GR  6571.200 6900.000 6571.000 7100.000 6571.000 7300.000 6572.000 7500.000 6572.000 7700.000
GR  6571.600 7900.000 6571.400 8100.000 6570.900 8300.000 6570.200 8500.000 6570.000 8700.000
GR  6570.000 10000.000 6575.000 11300.000    0.000    0.000    0.000    0.000    0.000    0.000

X1   200.000   20.000  700.000 3260.000 7000.000 2500.000 4600.000    0.000    0.000    0.000
GR  6591.500    0.000 6583.000   90.000 6587.500  330.000 6586.500  470.000 6585.000  700.000
GR  6580.000  760.000 6576.000  960.000 6575.000 1110.000 6575.000 2510.000 6580.000 2710.000
GR  6570.800 2721.000 6580.200 2730.000 6579.500 2800.000 6578.900 2950.000 6576.000 2965.000
GR  6576.000 2985.000 6576.500 3010.000 6578.000 3070.000 6577.700 3085.000 6575.700 3085.000
GR  6577.050 3095.000 6577.500 3170.000 6578.000 3230.000 6578.100 3260.000 6582.000 3285.000
GR  6581.500 3320.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000

X1   300.000   15.000 1300.000 5100.000  950.000 1600.000 1250.000    0.000    0.000    0.000
GR  6580.000    0.000 6582.000 1300.000 6580.000 1400.000 6579.000 1540.000 6578.000 1620.000
GR  6577.000 1695.000 6577.000 2925.000 6578.000 3040.000 6579.000 3195.000 6580.000 3270.000
GR  6580.000 3395.000 6580.000 4200.000 6580.000 4320.000 6582.000 5100.000 6580.000 5150.000

NC     0.050    0.050    0.050    0.000    0.000    0.000    0.000    0.000    0.000    0.000
X1   400.000   14.000 2400.000 6400.000 1600.000 1300.000 1100.000    0.000    0.000    0.000
GR  6617.500    0.000 6595.000  450.000 6600.000  810.000 6595.000 1300.000 6588.000 2800.000
GR  6585.000 3400.000 6585.000 3810.000 6585.500 4050.000 6586.500 4100.000 6581.000 5400.000
GR  6581.000 6000.000 6593.000 7000.000 6597.500 7600.000 6600.000 8000.000    0.000    0.000
```

X1	1000.000	23.000	0.000	0700.000	4000.000	5000.000	8000.000	0.000	0.000	0.000
CR	6416.100	0.000	6442.000	700.000	6500.100	1700.000	6581.000	1700.000	6502.000	1000.000
CR	6503.100	2000.000	6481.000	2120.000	6501.100	2260.000	6601.200	2420.000	6501.500	2600.000
CR	6400.200	2710.000	6481.000	2820.000	6600.500	3000.000	6641.000	3000.000	6642.200	3000.000
CR	6600.000	3050.000	6501.000	6000.000	6503.500	6300.000	6507.300	6330.000	6503.000	7000.000
CR	6400.500	10000.000	6414.000	10000.000	6620.000	9700.000	0.000	0.000	0.000	0.000
E1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

```
 SECND     DEPTH     CWSA     CRWS     WSTK     TG       IN       IB       DROP     RANK ELEV
 Q         QCOR      QTH      QERR     ALFR     NSI      NROR     VAR      IWA      ELEV/SLOPE
 TIME      VCOR      VCH      VERR     XNL      XNBI     XNR      WIN      ELMIN    SSIA
 SLOPE     XCOR      XCOL     XCORR    DIFIAL   IRC      ICONE    CORVR    JOINID   INFO
                     rel.
*****BOX 1

**SECND 140.000  Z - Z')
3200 CROSS SECTION      40.00 EXTENDED      0.84 FEET
   50.00     9.84   6559.84     0.00  6570.00  6568.92     0.00     0.00     0.00  6560.00
  169000.   26171.  190000.     4406.   14500.   50788.    2461.       0.       0.  6560.00
    0.00     1.00     2.33     1.70     0.050    0.050    0.050    0.000  6559.00     0.00
 0.000449       0.       0.       0.        0        0       -1     0.00 11080.50 11050.50
0
**SECND 180.000  ( A - A')

3265 DIVIDED FLOW
  100.00    17.45   6572.45     0.00     0.00  6577.70     0.75     3.70     0.00  6560.00
  169000.       0.  169000.       0.       0.   42362.       0.    5749.    1005.  6575.00
    0.29     0.00     4.01     0.00     0.050    0.050    0.050    0.000  6560.00   461.22
 0.002005    6000.    4000.    2000.        1        0        0     0.00 10423.25 11015.11
0
**SECND 200.000  (B - B')

3001 IN CHANGED REACH BEGIN ENTRY
  200.00    10.46   6546.46     0.00     0.00  6546.28     0.81    13.50     0.00  6546.00
  169000.       0.  169134.      606.       0.   23337.     148.    9222.    1771.  6578.00
    0.46     0.00     7.25     4.49     0.050    0.050    0.050    0.000  6575.00   705.41
 0.001115    7000.    4600.    2500.        4        0        0     0.00  2592.33   329.74
0
**SECND 300.000  (C - C')
  300.00    11.41   6551.41     0.00     0.00  6551.81     0.38     2.53     0.00  6547.00
  169000.       5.  169135.      312.      69.   34313.     129.   10055.    1064.  6582.00
    0.54     0.76     4.90     2.47     0.050    0.050    0.050    0.000  6577.00  1266.83
 0.001422     950.     1250.    1000.        2        0        0     0.00  3873.33  5140.16
0
**SECND 400.000  (D - D')

3001 IN CHANGED REACH BEGIN ENTRY
  400.00     7.81   6552.81     0.00     0.00  6553.79     0.98     4.98     0.00  6581.00
  169000.    1198.  190000.    2267.    2095.   18234.    1870.    1120.    2049.  6581.00
    0.00     4.03     5.28     3.99     0.050    0.050    0.050    0.000  6586.00  1767.96
 0.002652     1000.    1000.    1000.        2        0        0     0.00  5186.09  6954.05
0
```

[illegible]	DEPTH	[illegible]	[illegible]	[illegible]	TG	IV	IR	[illegible]	[illegible]
Q	QICE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	THA	[illegible]
TIME	VICE	[illegible]	[illegible]	XNI	[illegible]	XNR	WIN	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	TIRIAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*SEND 500.000

*RAI IN [illegible] MORE THAN INTIN.

500.00	[illegible]	[illegible]	0.00	0.00	[illegible]	0.26	[illegible]	0.00	[illegible]
[illegible]	0.	[illegible]	0.	0.	41583.	0.	[illegible]	[illegible]	6670.00
[illegible]	0.00	4.00	0.00	0.050	0.050	0.000	0.000	[illegible]	[illegible]
0.001[illegible]	[illegible]	[illegible]	[illegible]	6	0	0	0.00	7424.03	7937.03

0

PROFILE FOR [illegible] SAN MATEO CREEK [illegible]

PLOTTED POINTS (BY PRIORITY) I INTAKE,W WATER SURFACE,I INVERT,C CRITICAL W.S.,L LEFT BANK,R RIGHT BANK,M TOMBE END [illegible]

ELEVATION (FEET)	6550.	6560.	6570.	6580.	6590.	6600.	6610.	6620.	6630.	6640.
140.00	0.	I H	M.	.	.	.	.	.	.	.
	500.	I. I	F.	.	.	.	.	.	.	.
	1000.	I. H	I	.	.	.	.	.	.	.
	1500.	I. RI	IM	.	.	.	.	.	.	.
	2000.	I. R	II	.	.	.	.	.	.	.
	2500.	I	R.FL	.	.	.	.	.	.	.
	3000.	I	.RIM I	.	.	.	.	.	.	.
	3500.	I	. FRM L	.	.	.	.	.	.	.
	4000.	I	. WE R I	.	.	.	.	.	.	.
100.00	4500.	I	. WE R L	.	.	.	.	.	.	.
	5000.	. I	. IR M .I	.	.	.	.	.	.	.
	5500.	. I	. WF M.I.	.	.	.	.	.	.	.
	6000.	. I	. RI M I	.	.	.	.	.	.	.
	6500.	. I	. RWF. ML	.	.	.	.	.	.	.
	7000.	. I	. R I IM	.	.	.	.	.	.	.
	7500.	. I	. R .WI I M	.	.	.	.	.	.	.
	8000.	. .I	. R . WI I M .	.	.	.	.	.	.	.
	8500.	. I	. R . WF M.	.	.	.	.	.	.	.
200.00	9000.	. I	. R. WI . M	.	.	.	.	.	.	.
	9500.	. I	. R F .M	.	.	.	.	.	.	.
300.00	10000.	. I	. R IWIM	.	.	.	.	.	.	.
	10500.	. I	. R I F M	.	.	.	.	.	.	.
	11000.	. I	.I R I .WI M	.	.	.	.	.	.	.
	11500.	. I	. I I ..WF M .	.	.	.	.	.	.	.
400.00	12000.	. I	. I IR. WF M	.	.	.	.	.	.	.
	12500.	. I	. I . IR F . M	.	.	.	.	.	.	.
	13000.	. I	. I . IWI . M	.	.	.	.	.	.	.
	13500.	. I	. I WI.R M .	.	.	.	.	.	.	.
	14000.	. I	.I WI I R M.	.	.	.	.	.	.	.
	14500.	. I	. I . F I R.M	.	.	.	.	.	.	.
	15000.	. I	. I . I I R	.	.	.	.	.	.	.
500.00	15500.	. I	. I . WF . I R	.	.	.	.	.	.	.

APPENDIX C9 - MAXIMUM AND ALLOWABLE SHEAR STRESSES DUE TO RUNOFF, RECLAIMED MILL AREA

Cover soil - gravelly sand from alluvial terrace east of Hwy 605, across from mill
d75 = 15.0 mm, = 0.59 inches, based on sieve analysis of 8 samples
d50 = 2.3 mm, = 0.09 inches, based on sieve analysis of 8 samples
Native soil - fine sand (SP) to clay (CL,CH)
Runoff Coefficient, C = 0.7 , upper end of range per NUREG/CR-4620
See APPENDIX C10 for equations and parameters used in the following calculations

****

CALCULATION C9.1 - RUNOFF FROM ON-SITE WATERSHEDS - Mill Area and Vicinity

WATERSHED ELEMENT	ELEMENT LENGTH L	MAX. ELEV.	MIN. ELEV.	GRADIENT S	tc hours	PMP RAINFALL in. (1)	i in/hr	q cfs/ft	y ft	v fps	Runoff Coeff.	Runoff Area, A acres(2)	Runoff from area cfs	PEAK SHEAR(3) psf	ALLOWABLE SHEAR(4) psf
Top from 1 to 3 (a)	809	6686	6674	0.0148	0.14	4.9	35.00	0.52	0.18	2.88	0.8	5.50	154	(see Calculation C10.1A for rock design for protection of covers)	
Outslope 1 to 3 (b)	470	6674	6580	0.2000	0.17	5.5	32.82	0.28	0.06	4.93	0.8	9.10	247		
Levee (5)	140	6595	6582	0.0929	0.04 (6)	1.8	45.00	0.10	0.04	2.60	0.7	3.64	115	0.23	0.24
Mill Area (longest path)	1800	6595	6580	0.0083	0.30	7.3	24.04	0.80	0.28	2.88	0.7	27.00	454	0.14	0.24
Mill Area	1200	6595	6580	0.0125	0.17	5.5	33.32	0.64	0.22	2.98	0.7	27.00	630	0.17	0.24

Notes:
(1) from graph of rainfall vs duration, Figure C10.1
(2) from scaled measurements on plan of recontoured impoundment
(3) Peak shear = 62.4Sy
(4) Based on using gravelly sand with d75 = 0.59", allowable shear = 0.4 d75 (UDSA Handbook 667)
(5) south slope of levee
(6) minimum tc is 2.5 minutes per NUREG/CR-4620

Definitions
(a) Large impoundment top from flow line 1 to flow line 3 (see Figure C10.2)
(b) Large impoundment outslope from flow line 1 to flow line 3 (see Figure C10.2)

****

CALCULATION C9.2 - PEAK DISCHARGE AND HYDRAULIC PARAMETERS FOR LOCAL PMP AT CRITICAL LOCATIONS OF ON-SITE WATERSHED

LOCATION	LOCATION GRADIENT	LOCATION WIDTH	DISCHARGE RATE (1)	UNIT DISCHARGE	FLOW DEPTH	PEAK SHEAR	ALLOWABLE SHEAR (5)
SE corner, large impoundment	0.0083	500	970	1.94	0.47	0.24	0.24
NW corner small impoundment	0.0044	500	1051 (2)	2.10	0.60	0.16	0.24

Note:
(1) Discharge rate = sum of discharges from contributing upstream areas.
(2) Q at SE corner large impoundment + (q along flow line #8 of small impoundment x 900', width of north outslope of small impoundment)

APPENDIX C10 (Rev. 10/93) - ROCK SIZES FOR EROSION PROTECTION

PARAMETERS USED FOR SITE RUNOFF AND EROSION PROTECTION CALCULATIONS

1-HR LOCAL PMP	10.58	inches	unadjusted for elevation above 5000 ft	(Plate VIc, HMR 55A)
1-HR LOCAL PMP	9.94	inches	adjusted for ave. elev. of 6600 on pile	(Fig. 14.3, HMR 55A)
C, runoff coeff.	0.8		from pile surfaces	(NRC-directed value)
	0.7		from other site surfaces	(upper end of range for gravel, Table 4.6, NUREG/CR-4620)
Manning coeff., n,				
of soil cover	0.020			(Table 4.2, NUREG/CR-4620)
of rock cover	n=0.0456(d50 x S)^0.159			(Eqn. 4.8, NUREG/CR-4651)

allowable shear stress, Ta, in psf, of:

alluvial sand =	0.02	for SP with d75=	0.27 mm	= 0.0106 in.	(USDA Ag. Handbook 667, Table 3.3)
gravel =	0.425	for GP with d75=	26.9 mm	1.06 in.	

rock = 0.4*d75 = 0.4*1.25*d50 = 0.5*d50

flow concentration factor, F = 3 assumed based on vegetation over 30 % or less of area

Stephenson factor, Cs = 0.27 for blasted/ crushed basalt (p. 48, NUREG/CR-4620)

rock cover porosity, P = 0.45 (Table B.1, NUREG/CR-4651)

rock spec. gravity, G = 2.57 based on average of 27 tests of samples from 0-50' depth (Rev. 10/93) (see Appendix D)

slope angle, SA (design values)

pile top	varies up to about 8.0 degrees	
outslope	11.31 degrees, 0.1974 radians	

friction angle

of rock, FA =	40 degrees, 0.6981 radians		(Figure 4.8, NUREG/CR-4620)

EQUATIONS

tc, time of concentration = 0.00013*(L^0.77/S^0.385)

i, rainfall intensity = PMP depth * %PMP * 60/tc = rainfall depth/tc (rainfall depth from HMR 55A, Fig.12.10 and Table 12.4; reproduced on Figure C10.1 of this appendix)

q, unit discharge = C*i*a

Q, total runoff = C*i*A

y, max. flow depth = (q*n/1.486*S^.5)^0.6

v, max. flow velocity = (1.486/n)*y^.667*S^.5

Ss, critical slope (limiting value for erosional stability) = ((65*Ta^(5/3))/(i*L*F*n))^(6/7)

d50, mean rock diameter (per rationale of NRC Staff Technical Position on Erosion Protection...)

by Safety Factors Method, Safety Factor, SF = (cos SA)*(tan FA)/((21*y*S/(G-1)*d50)*(tan FA)+sin SA) For slopes with gradients < 0.1

by Stephenson Method, d50 = [(q*(tan SA)^7/6*P^1/6)/(Cs*g^.5*((1-P)*(G-1)*(cosSA)*(tanFA-tanSA))^1.667]^.667*12 For slopes with gradients < 0.1

FIGURE C10.1

DEPTH VS DURATION FOR 1-HR LOCAL PMP

HOMESTAKE GRANTS OPERATION, NEW MEXICO

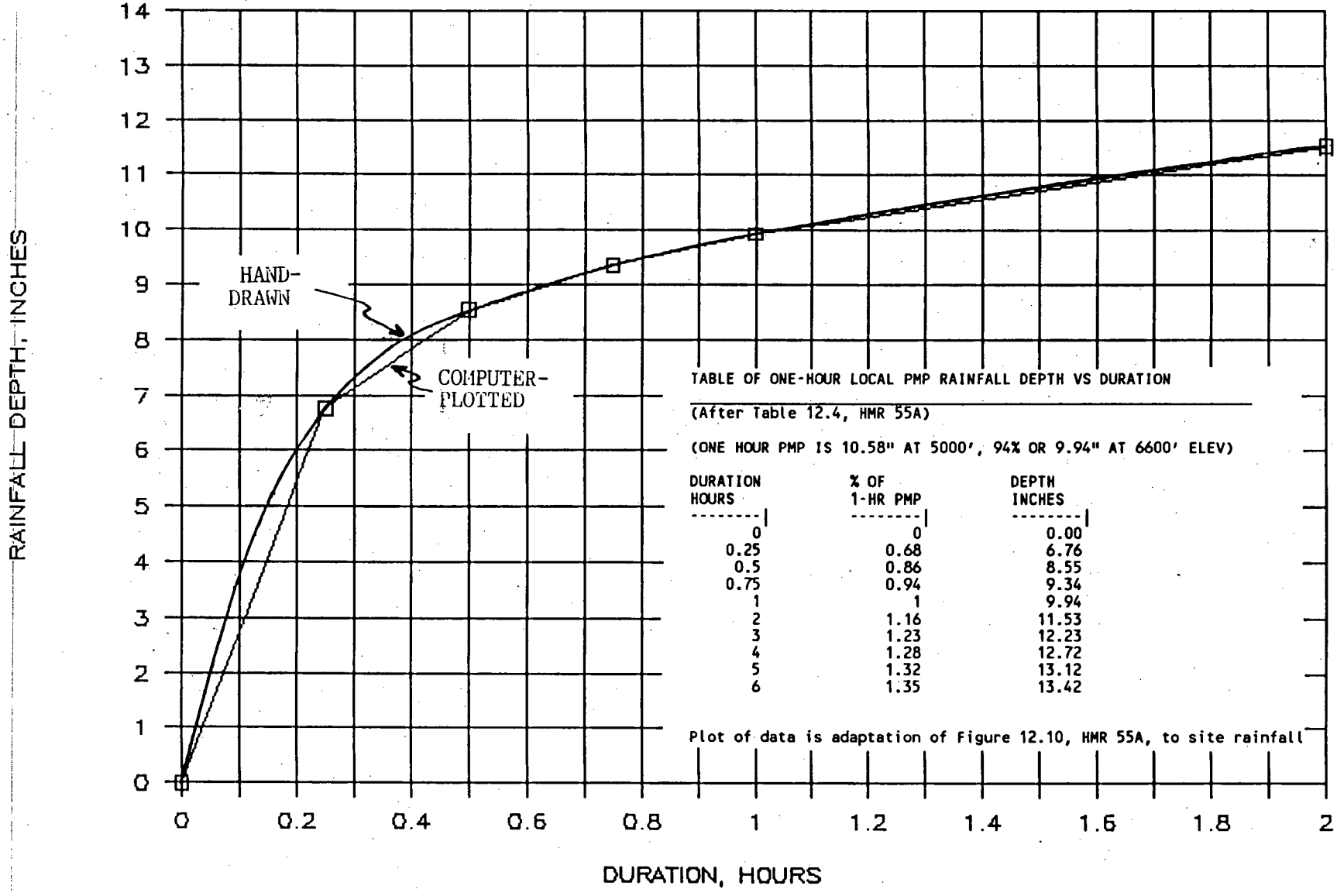


TABLE OF ONE-HOUR LOCAL PMP RAINFALL DEPTH VS DURATION

(After Table 12.4, HMR 55A)

(ONE HOUR PMP IS 10.58" AT 5000', 94% OR 9.94" AT 6600' ELEV)

DURATION HOURS	% OF 1-HR PMP	DEPTH INCHES
0	0	0.00
0.25	0.68	6.76
0.5	0.86	8.55
0.75	0.94	9.34
1	1	9.94
2	1.16	11.53
3	1.23	12.23
4	1.28	12.72
5	1.32	13.12
6	1.35	13.42

Plot of data is adaptation of Figure 12.10, HMR 55A, to site rainfall

FIGURE C10.1

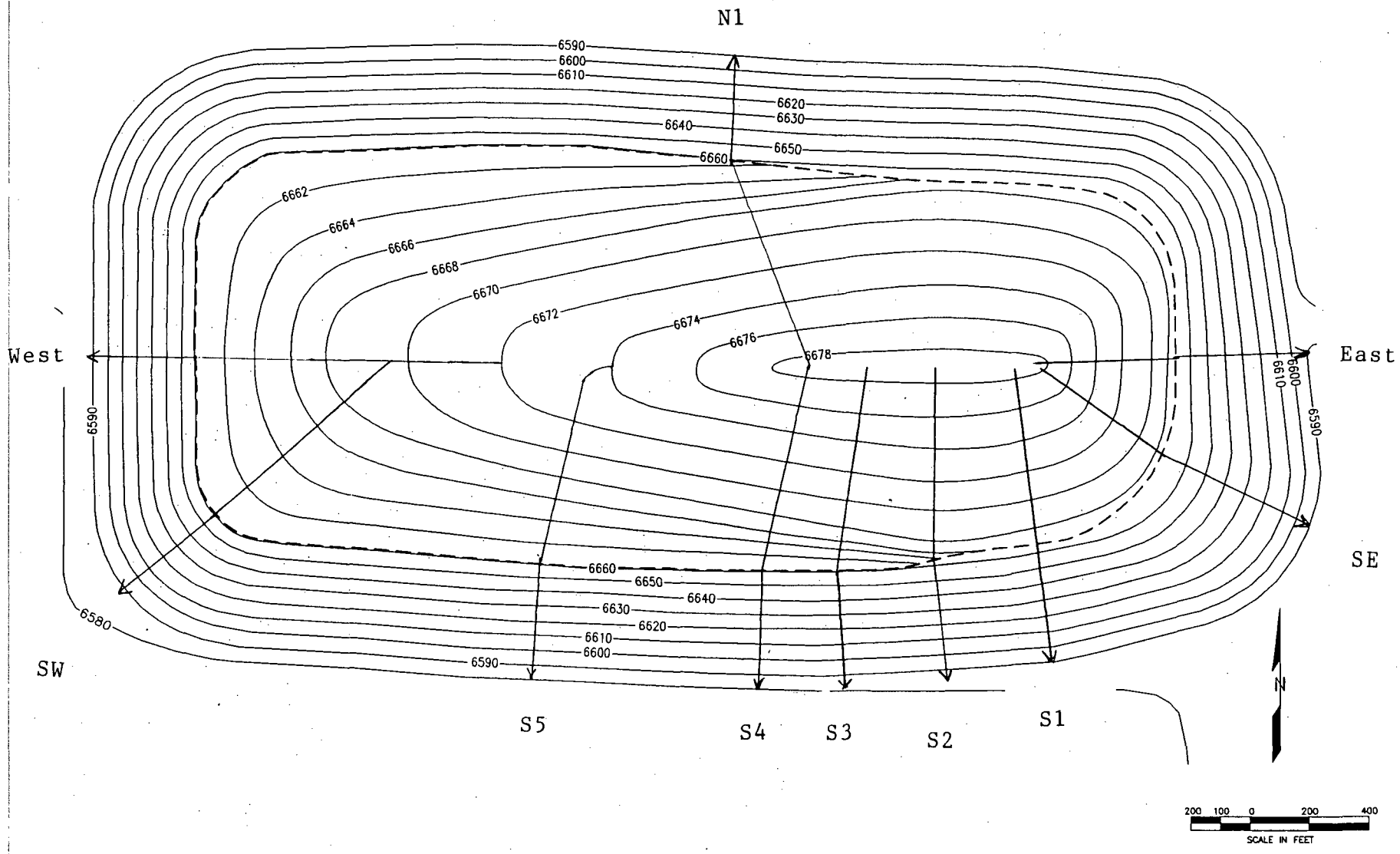


Figure C10.2 - Reclaimed Large Impoundment With Slope Elements Used for Runoff Erosion Analysis

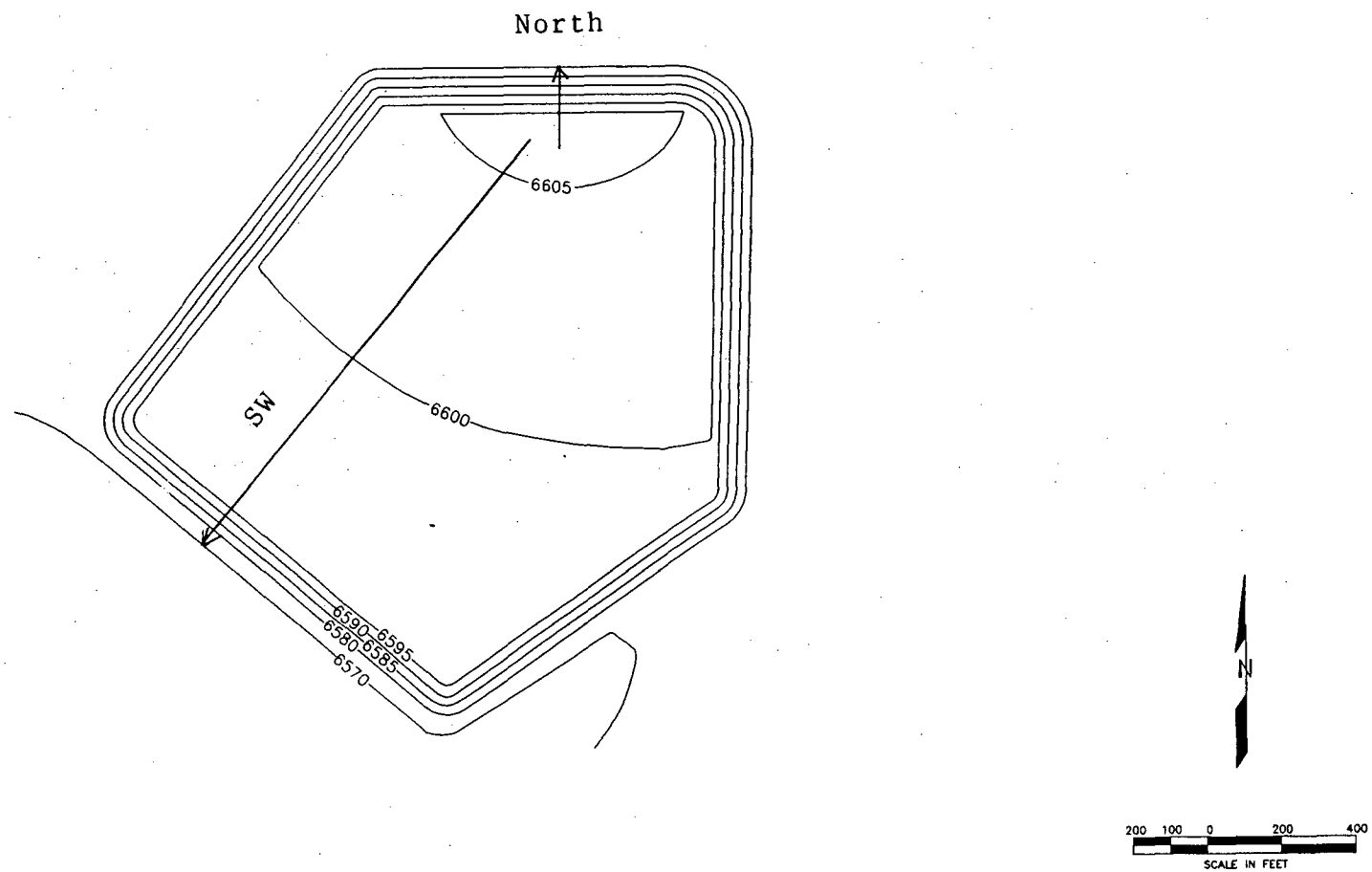


Figure C10.3 - Reclaimed Small Impoundment With Slope Elements Used for Runoff Erosion Analysis

CALCULATION C10.1A.1 - ROCK SIZES FOR EROSION PROTECTION OF LARGE IMPOUNDMENT FROM RAINFALL AND RUNOFF OF 1-HR LOCAL PMRevised 10/93 HMCEROPR.WK3 a61.t120

SLOPE ELEMENT Fig.C10.2	ELEMENT LENGTH L	MAX. ELEV.	MIN. ELEV.	GRADIENT S	SLOPE ANGLE degrees	tc hours	RAINFALL WITHIN tc (1)	i in/hr	q cfs/ft (2)	y ft (2)	v fps (2)	Critical slope, Ss ft/ft	d50 for S>0.1 inches	d50 for S<0.1 inches	Parameters for flow on top of rock n for d50 (3)	y	v	Ss	Safety Factor
east top	483	679	667	0.0248	1.42	0.06	2.40	38.18	0.34	0.12	2.83	0.00033		1.00	0.025	0.14	2.46	0.02671	1.73
east os	450	667	590	0.1711	9.71	0.09	3.50	38.38	0.65	0.10	6.59	0.00035	3.52						
SE top	506	679	667.5	0.0227	1.30	0.07	2.90	43.01	0.40	0.14	2.95	0.00029		1.00	0.025	0.15	2.58	0.02346	1.69
SE os	550	667.5	590	0.1409	8.02	0.10	3.80	36.87	0.77	0.12	6.63	0.00030	3.93						
S1 top	610	679	667	0.0197	1.13	0.08	3.10	37.66	0.42	0.15	2.89	0.00027		1.00	0.024	0.16	2.56	0.02284	1.84
S1 os	400	667	590	0.1925	10.90	0.11	4.00	37.37	0.69	0.10	6.99	0.00039	3.67						
S2 top	650	679	664	0.0231	1.32	0.08	3.10	38.13	0.45	0.15	3.12	0.00026		1.00	0.025	0.17	2.73	0.02094	1.55
S2 os	420	664	585	0.1881	10.65	0.11	4.00	37.32	0.74	0.10	7.12	0.00038	3.83						
S3 top	700	679	660	0.0271	1.55	0.08	3.10	38.34	0.49	0.15	3.38	0.00024		1.00	0.026	0.17	2.91	0.01913	1.30
S3 os	400	660	582	0.1950	11.03	0.11	4.00	37.93	0.77	0.11	7.31	0.00039	3.93						
S4 top	700	679	660	0.0271	1.55	0.08	3.10	38.34	0.49	0.15	3.38	0.00024		1.00	0.026	0.17	2.91	0.01913	1.30
S4 os	400	660	580	0.2000	11.31	0.11	4.00	38.02	0.77	0.10	7.37	0.00039	3.93						
7 apron	10	580	579.9	0.0100	0.57	0.11	4.00	36.46	0.78	0.26	3.01	0.00951	3.95						
S5 top	673	674	660	0.0208	1.19	0.09	3.50	40.27	0.50	0.16	3.13	0.00024		1.00	0.025	0.18	2.77	0.01967	1.60
S5 os	400	660	580	0.2000	11.31	0.11	4.00	35.95	0.76	0.10	7.33	0.00041	3.89						
West top	1034	672	660	0.0116	0.66	0.15	5.10	33.68	0.64	0.22	2.91	0.00019		1.00	0.022	0.24	2.71	0.01718	2.21
West os	371	660	588	0.1941	10.98	0.17	5.50	31.48	0.85	0.11	7.60	0.00049	4.20						
N1 top	750	679	660	0.0253	1.45	0.09	3.50	39.97	0.55	0.16	3.46	0.00022		1.00	0.025	0.18	3.00	0.01757	1.29
N1 os	360	660	590	0.1944	11.00	0.11	4.00	36.28	0.79	0.11	7.37	0.00044	3.99						
SW top	790	669.5	660	0.0120	0.69	0.12	4.40	36.24	0.52	0.19	2.72	0.00023		1.00	0.023	0.21	2.53	0.02023	2.41
SW os	416	660	586	0.1779	10.09	0.15	5.10	34.53	0.79	0.11	7.18	0.00041	3.99						

Notes:
(1) from graph of rainfall vs duration, Figure C10.1
(2) for soils surfaces without (before application of) rock cover
(3) n=0.0456(d50 x S)^0.159

CALCULATION C10.1B.1 - ROCK SIZES NEEDED FOR EROSION PROTECTION OF SMALL IMPOUNDMENT FROM RAINFALL AND RUNOFF OF 1-HR LOCAL PMP HMCEROPR.WK3

SLOPE ELEMENT Fig.C10.3	ELEMENT LENGTH L	MAX. ELEV.	MIN. ELEV.	GRADIENT S	SLOPE ANGLE degrees	tc hours	RAINFALL WITHIN tc (1)	i in/hr	q cfs/ft (2)	y ft (2)	v fps (2)	Critical slope, Ss ft/ft	d50 for S>0.1, inches	d50 for S<0.1, inches	Parameters for flow on top of rock sur n for d50 (3)	y	v	Ss	Safety Factor
North top	90	606	605	0.0111	0.64	0.02	2.5	106.38	0.18	0.10	1.71	0.00058		1.00	0.022	0.11	1.60	0.05228	4.80
North os	124	605	580	0.2016	11.40	0.03	2.5	74.95	0.35	0.06	5.36	0.00059	2.30						
SW top	1293	606	595.5	0.0081	0.47	0.21	6.1	29.56	0.70	0.26	2.71	0.00018		1.00	0.021	0.27	2.62	0.01666	2.79
SW os	152	595.5	570	0.1678	9.52	0.22	6.2	28.34	0.78	0.11	7.02	0.00115	3.96						

Notes:
(1) from graph of rainfall vs duration, Figure C10.1
(2) for soils surfaces without (before application of) rock cover
(3) n=0.0456(d50 x S)^0.159

SUMMARY OF ROCK QUALITY SCORING --- HOMESTAKE'S MALPAIS BASALT QUARRY SITE (NE 1/4, 28/T12N/R10W)

Sample Number	Rock Type (1 = igneous) (2 = limestone) (3 = sandstone)	Weighting Factor (WF)/ Test Value (TV) / Score for: Specific Gravity g/cc	Absorption %	Sulfate Soundness % loss	LA Abrasion % loss	Schmidt Hammer SRU	Tensile Strength psi	
AVERAGES FOR ALL TESTED SAMPLES								
	Numbers of Samples Tested =	27	27	27	15	17	18	
	TV =	2.57	1.81	0.79	26.2	39.7	1059	
	Score =	8.51	3.37	9.87	2.49	5.01	8.26	
	Rating =	74.95	6.75	108.57	2.49	15.0	82.59	ROCK SOURCE COMPOSITE RATING, %, USING ALL ROCK FROM 0' TO 50' =
	Maximum possible rating (MPR)=	90	20	110	10	30	100	
	Rating in % MPR =	83.28	33.74	98.70	24.90	50.10	82.59	80.7
AVERAGES FOR ALL SAMPLES BELOW HIGHLY VESICULAR ZONE (0'--5')								ROCK BELOW ~5'
	Numbers of Samples Tested =	22	22	22	14	16	17	
	TV =	2.60	1.66	0.75	27.71	40.20	1074	
	Score =	9.50	3.66	9.86	2.09	5.07	8.34	
	Rating =	83.48	7.32	108.44	2.09	15.22	83.41	ROCK SOURCE COMPOSITE RATING, %, USING ONLY ROCK FROM 5' TO 50' =
	Maximum possible rating (MPR)=	90	20	110	10	30	100	
	Rating in % MPR =	92.75	36.60	98.58	20.92	50.73	83.4	83.3

Calculation C10.2 - Revised 10/93
****

OVERSIZING FOR HIGHLY VESICULAR ROCK WITH RATING < 80
HOMESTAKE'S MALPAIS BASALT QUARRY SITE (NE 1/4, 28/T12N/R10W)

Sample Number	Rock Type (1 = igneous) (2 = limestone) (3 = sandstone)		Weighting Factor (WF)/ Test Value (TV) / Score for: Specific Gravity(SSD) g/cc	Absorption %	Sulfate Soundness % loss	LA Abrasion % loss	Schmidt Hammer SRU	Tensile Strength psi	TOTALS	COMPOSITE RATING FOR SAMPLE, %
10/1'-6'	1	WF =	9	2	11					
		TV =	2.392	2.6	1.3					
		Score =	2.84	1.8	9.9					
		Rating =	25.56	3.6	108.35				137.5	62.5
		Max. Possible =	90	20	110				220	
11/0'-4'	1	WF =	9	2	11					
		TV =	2.398	2.1	0.6					
		Score =	2.96	2.8	10.0					
		Rating =	26.64	5.6	110				142.2	64.7
		Max. Possible =	90	20	110				220	
12/0'-5'	1	WF =	9	2	11					
		TV =	2.393	2.9	1.30					
		Score =	2.86	1.2	9.9					
		Rating =	25.74	2.4	108.35				136.5	62.0
		Max. Possible =	90	20	110				220	
13/0'-5'	1	WF =	9	2	11					
		TV =	2.390	2.7	1.2					
		Score =	2.8	1.6	9.9					
		Rating =	25.2	3.2	108.9				137.3	62.4
		Max. Possible =	90	20	110				220	
X+Y+Z	1	WF =	9	2	11	1				
		TV =	2.581	2.083	1.5	33.00				
		Score =	6.62	2.8	9.7	0.0				
		Rating =	59.58	5.7	107.09	0.00			172.3	74.9
		Max. Possible =	90	20	110	10			230	
X	1	WF =					3	10		
		TV =					54.60	940		
		Score =					6.9	7.7		
		Rating =					20.76	76.5	97.3	74.8
		Max. Possible =					30	100	130	
Y	1	WF =					3	10		
		TV =					49.80	720		
		Score =					6.4	6.3		
		Rating =					19.2	63.3	82.5	63.4
		Max. Possible =					30	100	130	
Z	1	WF =					3	10		
		TV =					52.90	900		
		Score =					6.8	7.4		
		Rating =					20.53	74.1	94.6	72.8
		Max. Possible =					30	100	130	

% OVERSIZING (80-AVE.) = 12.8 FOR AVERAGE RATING OF 67.2

Calculation C10.3 Revised 10/93
****

ROCK COVER GRADATIONS - BOTH IMPOUNDMENTS
HOMESTAKE GRANTS TAILING RECLAMATION

Area Covered	Design d50 inches	d50 Range minimum	d50 Range maximum	d100 Range minimum	d100 Range maximum	d25 Range minimum	d25 Range maximum
Top	1	1	1.1	1.3	1.7	0.7	1.0
Top using HVB (1)	1.128	1.128	1.3	1.4	1.9	0.8	1.2
Outslope	4.7	4.7	5.4	5.9	8.0	3.3	5.3
Riprap, Toe	4.7	4.7	5.4	5.9	8.0	3.3	5.3

(1) HVB = highly vesicular basalt, from upper 4-6 feet of flow

Gradation criteria, per NUREG/CR-4620, p.53, are:

Design d50 - see calculation c10.1
d50 minimum = design d50
d50 maximum = d100 maximum/1.5
d100 minimum = d50 minimum x 1.26
d100 maximum = d50 minimum x 1.71
d25 minimum = d50 minimum x 0.7
d25 maximum < d50 maximum

****

Calculation C10.4
****

ROCK SIZE FOR OUTSLOPE RIPRAP AND TOE SCOUR PROTECTION

Sizes must be sufficient to resist local boundary shear caused by San Mateo PMF overbank flows along outslope toe. Left overbank velocities (VLOB), channel velocities (VCH) and average water surface gradients (S) at analytical cross sections (Figures 11, 12) from HEC-2 calculation of 1/29/88 (see Appendix C8) are:

Section	VLOB fps	VCH fps	S
Z	1.8	2.33	0.000449
A	*	4.01	0.0028
B	*	7.25	0.0031
C	0.76	4.94	0.0014
D	4.66	8.78	0.0076
E	*	4.08	0.0019

* VLOB calculated as 0.00 by HEC-2, VCH value used for VLOB

1) Allowable shear, Ta

Assuming all soil within top 10' of alluvium is sand (conservative),

From D'Appolonia, 1980, and HMC, 1986, grain size analyses of 23 alluvial sand samples, d75= 0.268 mm = 0.010 in. ave.

Ta = 0.02 psf (USDA Handbook 667, Table 3.3)

2) Peak shear, Tmax = 62.4Sy

depth, y, cannot be taken from HEC-2 because left bank elev. is higher than peak water elev. at A, B, and E, so calculate using VLOB:

y =((VLOB x n)/(1.486 x S^0.5))^1.5
where: n=0.020 (see cover sheet)

Section	y ft.	Tmax. psf	
Z	1.22	0.03	> Ta
A	1.03	0.18	> Ta
B	2.32	0.45	> Ta
C	0.14	0.01	< Ta
D	0.61	0.29	> Ta
E	1.41	0.17	> Ta

All sections except C would have erosion; therefore, entire length of west and north outslopes will be protected with riprap and scour protection

3) Riprap size needed, d50

Tmax = 0.04(unit wt rock - unit wt water)d50 x (1- (sin^2 bank slope/sin^2 angle of repose))^0.5

= 0.04 (1.51 x 62.4) d50 x (1- sin^2(11.3)/sin^2(40))^0.5

d50 = 0.13 feet, = 1.50 inches

APPENDIX C.11 - CALCULATION OF DEPTH OF SCOUR AT TOE OF LARGE IMPOUNDMENT
DUE TO PMF ON SAN MATEO CREEK

References: 1) Pemberton, E.L., and J.M. Lara, 1984, "Computing Degradation and Local Scour", Technical Guideline for Bureau of Reclamation

2) HEC-2 Output for San Mateo Creek, 1988, Canonie Environmental

Estimates of scour depth made by five methods described in Ref.1 using flood parameters from Ref. 2. Estimates made for section B-B' (see Fig. 11 in text) where velocities should be highest.

1) ds = depth of scour = K*q^0.24 (p.32, Ref. 1)

K = 2.45
q = Q/T
where:
Q = 169800 cfs, peak PMF discharge (Ref.2)
T = top width of section B-B' = 2600 ft. (Fig.12 of text)

q = 65.31 cfs/ft

ds = 6.68 ft

2) ds = 0.25 * dm (eqn. 26, Ref. 1)
dm = mean water depth at design discharge = 0.47(Q/f)^0.333

f = Lacey silt factor = 1.76 (Dm)^.5
Dm = mean grain size of bed material = 0.20mm (Table 3 of text)

dm = 28.07 ft.
ds = 7.02 ft.

3) ds = 0.6 * dfo (eqn 27, Ref. 1)
dfo = qf^0.666/Fbo^0.333
qf = unit discharge = 65.31 cfs/ft (see #1 above)
Fbo = zero bed factor, Fig. 9, Ref. 1, for Dm, = 1.0 ft/s^2

dfo = 16.17
ds = 9.70 ft.

4) ds = 0.25 * dma (p.37, Ref. 1)
dma = channel cross section area / water surface width = A/T
= 23485 ft^2 / 2600 ft = 9.03 ft

ds = 2.26 ft

5) ds = dma * ((Vm/Vc)-1) (p. 38, Ref. 1)
dma = 9.03 ft. (see #4 above)
Vm = mean velocity = Q/A = 7.23 fps
Vc = competent mean velocity = 3.0 fps (Fig. 12, Ref. 1)

ds = 12.74 ft

AVERAGE OF ABOVE, ds ave. = 7.68 ft.

APPENDIX D

DOCUMENTATION ON INVESTIGATIONS

OF

TAILING, SOIL, AND ROCK PROPERTIES

D'Appolonia, 1980 - Figure 14, Tailings Grain Size Curves.

D'Appolonia, 1980 - Figure 17, Native Sand Laboratory Test Results.

D'Appolonia, 1980, p.3-4.

Rogers and Associates Engineering Corp., Letter Report, 2/24/89.

Daniel B. Stephens and Associates, Inc., Letter Report, 10/20/89.

Results of Laboratory Tests on Borrow Soils (Summary Table).

Fox and Associates of New Mexico, Inc., Letter Reports of 9/30/87, 10/1/87, 10/12/87, 11/5/87, 12/14/87.

Assaigai Analytical Laboratories, Letter Report, 3/13/89.

Sergent, Hauskins, and Beckwith, Soil Test Reports of 7/28/86, 7/31/86, 8/22/89 and 9/31/86.

Vinyard and Associates, 1990, Summary of Laboratory Test Data, Test Pits in Gravelly Sand.

Vinyard and Associates, 1990, Table of Soundness, Specific Gravity, and Absorption Test Results.

Vinyard and Associates, 1990 and 1993, Logs of Test Holes, M (Malpais) Series.

Homestake Mining Company, 1987-1993, Logs of Test Pits TP-10 through TP-126

Table D1 - Homestake Grants Borrow Soils - Test Pit Evaluation

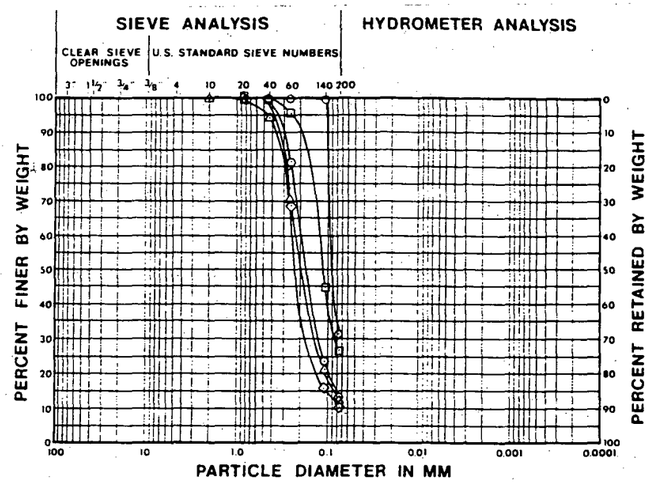
Geochem/ Terra Vac - Report on "Geochemical Analysis of Mill Tailings from Homestake Mining Company's Grants Uranium Mill", 10/1/92

George V. Sabol Consulting Engineers, Inc. letter report on design of rock apron and outslope rock cover, 11/23/92

Water Waste & Land letter report "Radon Barrier Design Homestake Grants Mill Tailing Site", 6/30/93

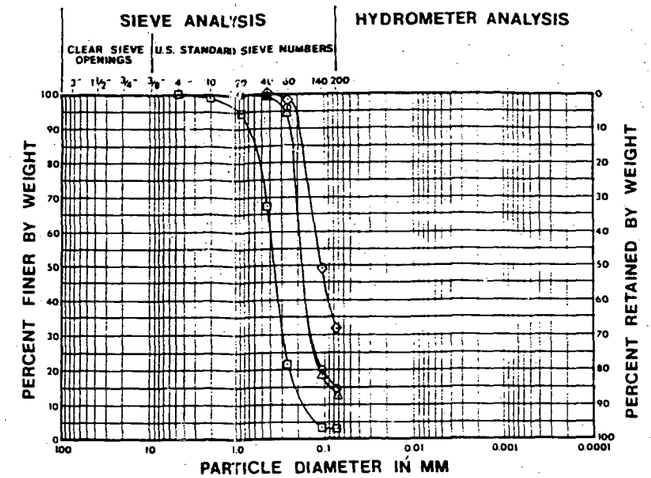
Vinyard & Associates - Laboratory Test Results on Samples from TP-127 through TP-143, 4A, 20A, 21A

DRAWN BY	TEJ 10-22-80	CHECKED BY / APPROVED BY	JWN MST 10-24-80 / 10-24-80	DRAWING NUMBER RM80-311-E3



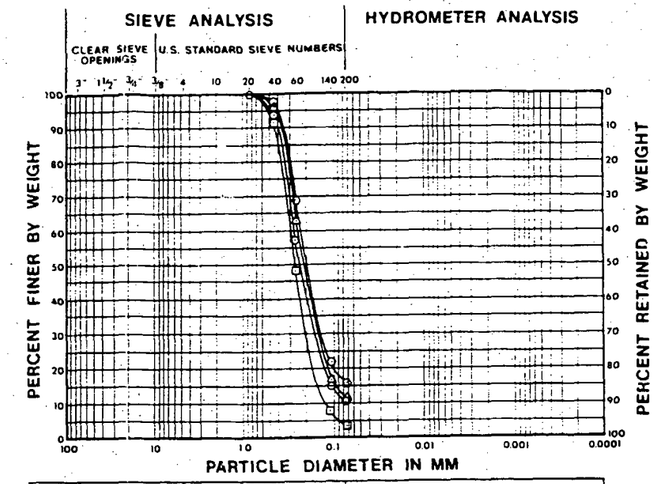
COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT AND CLAY FRACTION

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-2A	S-2	12.5-14.0	BROWN, SILTY FINE SAND	SM	N/A	N/A	30
□	DB80-2A	S-8	40.0-41.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	8
△	DB80-2A	ST-4	41.5-42.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	6
⊙	DB80-12	S-4	20.0-21.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	5
◇	DB80-12	S-13	65.0-66.5	BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	11



COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT AND CLAY FRACTION

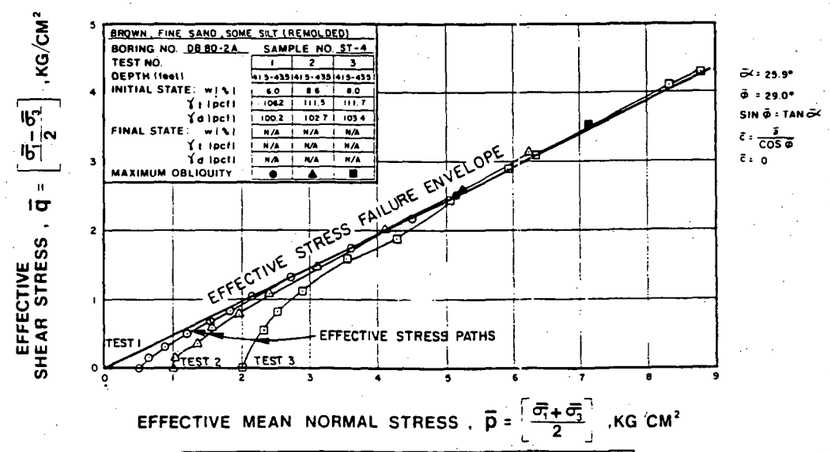
SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-1A	S-18	90.0-91.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	20
□	DB80-1A	S-19	100.0-101.5	TAN, FINE TO MEDIUM SAND, TRACE SILT	SP	0.14	2.9	3
△	DB80-6A	S-5	30.0-31.5	TAN, FINE SAND, SOME SILT	SM	N/A	N/A	7
◇	DB80-6A	S-8	50.0-51.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	16



COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT AND CLAY FRACTION

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-18	S-4	25.0-26.5	BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	7
□	DB80-18	ST-3	35.0-37.0	BROWN, FINE SAND, TRACE SILT	SP	0.9	3.1	N/A
△	DB80-18	S-8	50.0-51.5	GRAY, FINE SAND, SOME SILT	SP-SM	N/A	N/A	21
⊙	DB80-19	S-12	60.0-61.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	24

GRAIN SIZE CURVES



$\bar{\alpha} = 25.9°$

$\bar{\phi} = 29.0°$

$\sin \bar{\phi} = \tan \bar{\alpha}$

$\bar{c} = \frac{\bar{s}}{\cos \bar{\phi}}$

$\bar{c} = 0$

TEST PARAMETERS			
TEST NO	1	2	3
STRAIN RATE (in/min)	0.015	0.017	0.017
BACK PRESSURE (kg/cm²)	2.50	2.50	2.50
CONSOLIDATION TIME (days)	0.21	0.21	0.21

SAMPLE DIMENSIONS			
DIAMETER (inches)	2.88	2.86	2.85
LENGTH (inches)	5.70	5.72	5.72

TRIAXIAL SHEAR TESTS

APERTURE CARD

Also Available on Aperture Card

9810280099-14

FIGURE 17

NATIVE SAND
LABORATORY
TEST RESULTS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

was 96 pounds per cubic foot (pcf). An average undisturbed sample tube density was also calculated from the samples obtained in the D'Appolonia investigations. The average density was also 96 pcf.

As a check on the average density obtained from the tubes, the average in situ relative density was evaluated using the SPT blow counts from the D'Appolonia borings and the results of relative density tests. Figure 11 presents a composite plot of SPT blow counts (N) versus depth in all borings. Using the average N vs. depth relationship, the correlation of Marcuson and Bieganowsky (1977), between relative density (D_r) and N was used to obtain an average in situ relative density of 44 percent. Laboratory relative density tests indicated that the maximum density is 115.5 pcf and the minimum density is 78.4 pcf. Using these maximum and minimum densities, a D_r equal to 44 percent corresponds to a density of 91 pcf. This density correlates well with the 96 pcf from tube densities considering the variability and uncertainty associated with the use of relative density correlations (Selig and Ladd, 1973).

The average density from the tube samples, 96 pcf, was used to obtain a friction angle for stability analysis. Referring to Figure 15, with an average density of 96 pcf, the effective friction angle is 29°. This is the friction angle used in the stability analyses described in Section 4.1.

3.1.3 Permeability

Constant head permeability tests were performed on four samples, the same as those tested for triaxial shear. The results are summarized in Table 3. Remolded samples were used for testing since undisturbed samples could not be prepared. The variation in permeability is quite large, from 1×10^{-6}cm/sec to 1×10^{-4}cm/sec with an average of 2.7×10^{-5}cm/sec. This value is lower than the average permeability of 1.0×10^{-4} cm/sec obtained from piezometer sensitivity tests.

R
A
E

Rogers & Associates Engineering Corporation

Post Office Box 330
Salt Lake City, Utah 84110
(801) 263-1600

February 24, 1989

Mr. Ed Kennedy
Homestake Mining Co. - Grants
P.O. Box 98
Grants, NM 87020

C8900/5

Dear Mr. Kennedy:

Enclosed are the results of the radium and radon emanation fraction tests performed on the 20 samples sent to us in January. If you have any questions please feel free to contact Dr. Kirk Nielson or me.

I will be shipping your samples back to you within 30 days unless otherwise instructed.

Sincerely,

Renee Y. Bowser
Lab Supervisor

RYB/b

515 East 4500 South • Salt Lake City, Utah 84107

Rogers & Associates Engineering Corporation

REPORT OF RADIUM AND EMANATION COEFFICIENT MEASUREMENTS
(LAB PROCEDURE RAE-SQAP-3.1)

REPORT DATE 2/24/89

CONTRACT C8900/5

BY RYB

SAMPLE IDENTIFICATION Homestake Mining Co.

SUBMITTED BY RYB DATE RECEIVED

SAMPLE NUMBER	MOISTURE (DRY WT. %)	RADON EMANATION COEFFICIENT[a]	RADIUM[a] (pCi/gram)	COMMENTS
Inactive Slime #1	17.3	0.56 ± 0.01	602 ± 5	
Inactive Slime #2	7.1	0.48 ± 0.01	545 ± 5	
Inactive Slime #3	14.7 avg 14.9	0.48 ± 0.01	776 ± 6	
Inactive Slime #4	15.7	0.51 ± 0.01	767 ± 6	
Inactive Slime #5	19.7	0.32 ± 0.01	969 ± 7	
Inactive Sand #1	7.8	0.52 ± 0.01	455 ± 4	
Inactive Sand #2	16.1 avg. 9.8	0.31 ± 0.01	557 ± 5	
Inactive Sand #3	3.6	0.36 ± 0.01	419 ± 4	
Inactive Sand #4	3.4	0.38 ± 0.01	250 ± 3	
Inactive Sand #5	18.1	0.40 ± 0.01	359 ± 1	
Active Slime #1	5.1	0.36 ± 0.02	351 ± 3	
Active Slime #2	5.1	0.25 ± 0.02	453 ± 4	
Active Slime #3	748.0	0.29 ± 0.01	* DIDN'T USE 2976 ± 27	

[a]UNCERTAINTIES BASED ON GAMMA-RAY COUNTING STATISTICS ONLY.

RAE

POST OFFICE BOX 330
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(801) 263-1600

Rogers & Associates Engineering Corporation

REPORT OF RADIUM AND EMANATION COEFFICIENT MEASUREMENTS
(LAB PROCEDURE RAE-SQAP-3.1)

REPORT DATE 2/24/89

CONTRACT C8900/5

BY RYB

SAMPLE IDENTIFICATION Homestake Mining Co.

SUBMITTED BY RYB DATE RECEIVED

SAMPLE NUMBER	MOISTURE (DRY WT. %)	RADON EMANATION COEFFICIENT[a]	RADIUM[a] (pCi/gram)	COMMENTS
Active Slime #4	20.5	0.25 ± 0.01	203 ± 2	
Active Slime #5	12.1	0.51 ± 0.01	1320 ± 8	
Active Sand #1	4.1	0.38 ± 0.02	124 ± 1	
Active Sand #2	1.0	0.33 ± 0.02	120 ± 1	
Active Sand #3	3.2	0.34 ± 0.01	346 ± 2	
Active Sand #4	1.0	0.35 ± 0.01	120 ± 1	
Active Sand #5	0.3	0.31 ± 0.01	127 ± 1	
ACTIVE SANDS $\bar{X}$	1.9	0.34 ± 0.03	167 ± 100	
ACTIVE SLIMES $\bar{X}$	10.7	0.33 ± 0.11	582 ± 503	
INACTIVE SANDS $\bar{X}$	9.8	0.39 ± 0.08	408 ± 114	
INACTIVE SLIMES $\bar{X}$	14.9	0.47 ± 0.09	732 ± 167	

[a]UNCERTAINTIES BASED ON GAMMA-RAY COUNTING STATISTICS ONLY.

RAE

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DANIEL B. STEPHENS & ASSOCIATES, INC.
CONSULTANTS IN GROUND-WATER HYDROLOGY

• GROUND-WATER CONTAMINATION • UNSATURATED ZONE INVESTIGATIONS • WATER SUPPLY DEVELOPMENT •

October 20, 1989

Mr. George L. Hoffman
Hydro Engineer
770 E. Magnolia
Casper, WY 82604

Dear Mr. Hoffman:

I have enclosed revised laboratory summary tables (Tables 1 through 4) of the hydraulic properties of the Homestake mill tailings samples. The revised tables include three additional consolidated samples (IP-2/T4/11.5-14.0/C, IP-4/T2/8.5-9.0/C, and IP-4/T4/15.0-15.4/C) delivered from Martin Vineyard and Assoc., Inc. Please replace the laboratory summary tables in the DBS&A report entitled "Laboratory Analysis of Hydraulic Properties of Uranium Mill Tailings from the Homestake Mine in Grants, New Mexico" submitted to you in September, 1989, with these tables.

DBS&A is please to provide this service to AK GeoConsult, Inc., Hydro Engineer, and the Homestake Mining Company. If you have any questions, please do not hesitate to call me. Thank you.

Sincerely,

Daniel B. Stephens & Associates, Inc.

Earl D. Matteson

Earl D. Matteson
Laboratory Manager/Hydrologist

EDM/alm

Enclosures

Disk: 89-L-100
File: Hoffman.020

4415 Hawkins NE Albuquerque, New Mexico 87109 (505) 345-4567 FAX 345-4560

Table 1. Summary of Tests Performed
(revised 10/20/89)

Sample No.	Initial Moisture Content	Dry Bulk Density	Porosity	Moisture Characteristic Pressure Plate
IP-1/T2/5.8-6	X	X	X	X
IP-1/T2/6.0-6.5/C*	X	X	X	X
IP-1/T3/7.6-7.8	X	X	X	X
IP-1/T3/7.8-8.3/C*	X	X	X	X
IP-1/T3/8.3-8.5	X	X	X	X
IP-1/T3/8.5-9.0/C*	X	X	X	X
IP-2/T3/10.1-10.5/C*	X	X	X	X
IP-2/T3/10.8-11.5	X	X	X	X
IP-2/T4/11.5-14.0/C*	X	X	X	X
IP-2/T4/12.2-12.4	X	X	X	X
IP-2/T4/13.0-13.7/C*	X	X	X	X
IP-2/T4/13.7-14	X	X	X	X
IP-3/T2/5.9-6.1	X	X	X	X
IP-3/T3/7.7-7.9	X	X	X	X
IP-3/T5/12.8-13.6	X	X	X	X
IP-4/T2/7.9-8.3	X	X	X	X
IP-4/T2/8.5-9.0/C*	X	X	X	X
IP-4/T3/12.2-12.5	X	X	X	X
IP-4/T4/15.0-15.4/C*	X	X	X	X
IP-4/T4/15.4-15.8	X	X	X	X
IP-4/T5/16.9-17.3	X	X	X	X

Table 1. Summary of Tests Performed
(revised 10/20/89)

Sample No.	Initial Moisture Content	Dry Bulk Density	Porosity	Moisture Characteristic Pressure Plate
IP-5/T2/7.5-7.8	X	X	X	X
IP-5/T3/12.9-13.2	X	X	X	X
IP-5/T6/22.1-22.4	X	X	X	X
IP-5/T7/25.8-26.5	X	X	X	X

/C* = Consolidated sample from Vineyard and Associates, Inc.

Table 2. Summary of Sample Characteristics
(revised 10/20/89)

Sample No.	Depth (ft)	Color	Visual Texture	Comments
IP-1/T2/5.8-6.0	5.8-6.0	olive green and light olive	slime	saturated, moderately dense compaction
IP-1/T2/6.0-6.5/C	6.0-6.5	olive green	slime	consolidated sample from Martin Vineyard and Assoc. Inc.
IP-1/T3/7.6-7.8	7.6-7.8	olive green	slime	saturated, moderately dense compaction
IP-1/T3/7.8-8.3/C	7.8-8.3	olive green	slime	consolidated sample from Martin Vineyard and Assoc. Inc.
IP-1/T3/8.3-8.5	8.3-8.5	olive green	slime	saturated, moderately dense compaction
IP-1/T3/8.5-9.0/C	8.5-9.0	olive green	slime	consolidated sample from Martin Vineyard and Assoc. Inc.
IP-2/T3/10.1-10.5/C	10.1-10.5	olive green	slime	consolidated sample from Martin Vineyard and Assoc. Inc.
IP-2/T3/10.8-11.5	10.8-11.5	olive greenish brown with olive layers	silt	moist, moderately dense compaction
IP-2/T4/11.5-14.0/C*	11.5-14.0	olive green	slime with sand on top, slime on bottom	consolidated sample from Martin Vineyard and Assoc. Inc.
IP-2/T4/12.2-12.4	12.2-12.4	tan	sand	moist, moderately loose compaction, slightly remolded

Table 2. Summary of Sample Characteristics (continued)
(revised 10/20/89)

Sample No.	Depth (ft)	Color	Visual Texture	Comments
IP-2/T4/13.0-13.7/C	13.0-13.7	brown	silty sand	consolidated sample from Martin Vineyard and Assoc. Inc.
IP-2/T4/13.7-14.0	13.7-14	olive green	clay	saturated, moderately dense compaction, odor
IP-3/T2/5.9-6.1	5.9-6.1	olive green brown mottled	silty sand	moist, moderately loose compaction, silty sand on bottom, sand on top, odor
IP-3/T3/7.7-7.9	7.7-7.9	olive green brown	sand	moist, dense compaction, strong odor
IP-3/T5/12.8-13.6	12.8-13.6	light brown	sand	damp, moderately loose compaction, odor
IP-4/T2/7.9-8.3	7.9-8.3	olive gray	silty sand	saturated, moderately dense compaction
IP-4/T2/8.5-9.0/C*	8.5-9.0	olive gray	silty sand	consolidated sample from Martin Vineyard and Assoc. Inc.
IP-4/T3/12.2-12.5	12.2-12.5	olive gray and dark brown mottled	silty sand	saturated, moderately loose compaction, odor
IP-4/T4/15.0-15.4/C*	15.0-15.4	olive gray	silty sand	consolidated sample from Martin Vineyard and Assoc. Inc.
IP-4/T4/15.4-15.8	15.4-15.8	olive gray	clayey silt	saturated, moderately dense compaction, odor

Table 2. Summary of Sample Characteristics (continued)
(revised 10/20/89)

Sample No.	Depth (ft)	Color	Visual Texture	Comments
IP-4/T5/16.9-17.3	16.9-17.3	olive gray	clay w/silt a dark brown mottled	saturated, moderately dense compaction, odor
IP-5/T2/7.5-7.8	7.5-7.8	olive gray	silty sand	saturated, moderately dense compaction
IP-5/T3/12.9-13.2	12.9-13.2	light brown	sand	moist, moderately loose compaction
IP-5/T6/22.1-22.4	22.1-22.4	olive gray and gray mottled	silty sand	moist, moderately loose compaction
IP-5/T7/25.8-26.5	25.8-26.5	dark gray	clayey sand	saturated, moderately loose compaction, odor

/C* = consolidated sample from Martin Vineyard and Associates, Inc.

Table 3. Summary of Initial Moisture Content, Dry Bulk Density, and Porosity (revised 10/20/89)

Sample No.	Initial Moisture Content Gravimetric (%g/g)	Initial Moisture Content Volumetric (%cm^3/cm^3)	Dry Bulk Density (g/cc)	Calculated Porosity (%)
IP-1/T2/5.8-6.0	60.40	64.21	1.06	59.89
IP-1/T2/6.0-6.5/C*	52.19	61.47	1.18	55.56
IP-1/T3/7.6-7.8	76.12	69.56	0.91	65.52
IP-1/T3/7.8-8.3/C*	59.43	77.72	1.31	50.66
IP-1/T3/8.3-8.5	31.98	46.65	1.46	44.95
IP-1/T3/8.5-9.0/C*	46.93	56.25	1.20	54.78
IP-2/T3/10.1-10.5/C*	54.09	58.58	1.08	59.13
IP-2/T3/10.8-11.5	24.87	36.35	1.46	44.85
IP-2/T4/11.5-14.0/C*	45.93	53.45	1.16	56.09
IP-2/T4/12.2-12.4	9.76	12.84	1.32	50.33
IP-2/T4/13.0-13.7/C*	33.69	46.52	1.38	47.89
IP-2/T4/13.7-14.0	58.97	64.21	1.09	58.91
IP-3/T2/5.9-6.1	17.76	25.53	1.44	45.75
IP-3/T3/7.7-7.9	10.03	14.02	1.40	47.28
IP-3/T5/12.8-13.6	6.52	7.90	1.21	54.26
IP-4/T2/7.9-8.3	28.32	44.07	1.56	41.28
IP-4/T2/8.5-9.0/C*	6.99	9.43	1.35	49.08
IP-4/T3/12.2-12.5	30.62	46.82	1.53	42.30
IP-4/T4/15.0-15.4/C*	28.66	41.44	1.45	45.44
IP-4/T4/15.4-15.8	30.69	47.41	1.54	41.71
IP-4/T5/16.9-17.3	47.62	57.43	1.21	54.49

Table 3. Summary of Initial Moisture Content, (continued)
Dry Bulk Density, and Porosity
(revised 10/20/89)

Sample No.	Initial Moisture Content Gravimetric (%g/g)	Initial Moisture Content Volumetric (%cm^3/cm^3)	Dry Bulk Density (g/cc)	Calculated Porosity (%)
IP-5/T2/7.5-7.8	24.31	39.60	1.63	38.54
IP-5/T3/12.9-13.2	7.26	9.37	1.29	51.28
IP-5/T6/22.1-22.4	19.89	26.47	1.33	49.77
IP-5/T7/25.8-26.5	32.51	47.86	1.47	44.44

* Initial gravimetric and volumetric moisture contents of the consolidated samples are measured after the consolidation analysis was completed

Table 4. Summary of Moisture Characteristics
(revised 10/20/89)

Sample No.	Pressure Head (-cm of water)	Moisture Content Gravimetric (% g/g)	Moisture Content Volumetric (% cm^3/cm^3)
IP-1/T2/5.8-6.0	0.0	58.41	62.09
	489.5	54.21	51.14
	15297.0	48.41	45.67
IP-1/T2/6.0-6.5/C*	0.0	52.19	61.47
	305.9	50.07	58.97
	15297.0	46.68	54.98
IP-1/T3/7.6-7.8	0.0	69.07	63.11
	489.5	58.88	53.80
	15297.0	47.09	43.03
IP-1/T3/7.8-8.3/C*	0.0	48.74	63.73
	305.9	43.94	57.46
	15297.0	40.43	52.87
IP-1/T3/8.3-8.5	0.0	28.69	41.86
	489.5	24.86	36.27
	15297.0	21.29	31.06
IP-1/T3/8.5-9.0/C*	0.0	46.93	56.25
	305.9	46.20	55.37
	15297.0	41.77	50.06
IP-2/T3/10.1-10.5/C*	0.0	54.09	58.58
	305.9	53.35	57.78
	15297.0	44.41	48.10
IP-2/T3/10.8-11.5	0.0	31.36	45.84
	489.5	19.73	28.83
	15297.0	9.59	14.01
IP-2/T4/11.5-14.0/C*	Initial	45.94	53.45
	305.9	45.16	52.55
	15297.0	40.58	47.22
IP-2/T4/12.2-12.4	0.0	36.19	47.64
	489.5	4.35	5.73
	15297.0	3.75	4.93
IP-2/T4/13.0-13.7/C*	0.0	33.69	46.52
	305.9	33.15	45.77
	15297.0	24.62	33.99

Table 4. Summary of Moisture Characteristics (continued)
(revised 10/20/89)

Sample No.	Pressure Head (-cm of water)	Moisture Content Gravimetric (% g/g)	Moisture Content Volumetric (% cm^3/cm^3)
IP-2/T4/13.7-14.0	0.0	57.24	62.32
	489.5	52.95	57.65
	15297.0	49.55	53.95
IP-3/T2/5.9-6.1	0.0	29.85	42.91
	489.5	15.28	21.97
	15297.0	9.41	13.52
IP-3/T3/7.7-7.9	0.0	29.82	41.67
	489.5	7.96	11.12
	15297.0	5.23	7.31
IP-3/T5/12.8-13.6	0.0	39.86	48.32
	305.9	5.21	6.31
	15297.0	4.46	5.40
IP-4/T2/7.9-8.3	0.0	28.21	43.90
	305.9	25.18	39.18
	15297.0	18.21	28.34
IP-4/T2/8.5-9.0/C*	Initial	6.99	9.43
	305.9	7.15	9.65
	15297.0	4.65	6.27
IP-4/T3/12.2-12.5	0.0	29.03	44.39
	305.9	20.02	30.61
	15297.0	18.27	27.93
IP-4/T4/15.0-15.4	Initial	28.66	41.44
	305.9	21.95	31.74
	15297.0	16.69	24.13
IP-4/T4/15.4-15.8	0.0	29.82	46.06
	305.9	20.16	31.14
	15297.0	13.92	21.50
IP-4/T5/16.9-17.3	0.0	48.14	58.05
	305.9	42.51	51.26
	15297.0	37.27	44.95
IP-5/T2/7.5-7.8	0.0	25.22	41.08
	305.9	22.37	36.44
	15297.0	14.29	23.28

Table 4. Summary of Moisture Characteristics (continued)
(revised 10/20/89)

Sample No.	Pressure Head (-cm of water)	Moisture Content Gravimetric (% g/g)	Moisture Content Volumetric (% cm^3/cm^3)
IP-5/T3/12.9-13.2	0.0	37.25	48.09
	305.9	4.73	6.11
	15297.0	3.87	5.00
IP-5/T6/22.1-22.4	0.0	37.89	50.43
	305.9	15.18	20.21
	15297.0	14.24	18.95
IP-5/T7/25.8-26.5	0.0	32.86	48.39
	305.9	30.11	44.33
	15297.0	22.66	33.36

/C* = Consolidation sample from Vineyard and Associates, Inc.

RESULTS OF LABORATORY TESTS ON BORROW SOILS

HOMESTAKE MINING COMPANY, GRANTS, NM
TAILINGS STABILIZATION AND RECLAMATION PLAN

TEST PIT SOIL SAMPLE TEST PROGRAM, SEPT 1987

TEST PIT/ SAMPLE NO	SOIL CLASS	WATER CONTENT %	ATTERBERG LIMITS LL/PI	USED IN PROCTOR TEST NO.
TP 10/J1		18.04		
TP 10/B1	CL		46.5/25.4	COMP 1
TP 12/J1		21.91		
TP 12/B1	CH		73.6/48.4	
TP 12/J2		22.97		
TP 12/B2	CL		35.1/19.9	COMP 1
TP 13/J1		15.61		
TP 13/B1	CL		45.9/24.6	COMP 1
TP 13/J2		10.54		
TP 13/B2	CL		30.5/15.4	COMP 1
TP 14/J1		11.34		
TP 14/B1	CH		52.7/29.0	COMP 2
TP 15/J1		12.84		
TP 15/B1	CL-CH		48.7/27.6	COMP 2
TP 17/J1		14.24		
TP 17/B1	CH		56.5/32.3	COMP 3
TP 18/J1		12.15		
TP 18/B1	CL-CH		47.8/25.2	COMP 4
TP 19/J1		12.73		
TP 19/B1	CH-CL		53.4/31.8	COMP 4
TP 20/J1		7.91		
TP 20/B1	CL		28.9/13.5	COMP 5
TP 21/J1		16.24		
TP 21/B1	CH		58.5/34.1	COMP 5
TP 22/J1		14.69		
TP 22/B1	CL-CH		49.8/29.3	COMP 5
TP 23/J1		9.45		
TP 23/B1	CH-CL		50.1/27.4	COMP 6
TP 24/J1		16.35		
TP 24/B1	CH		67.2/41.9	COMP 6
TP 25/J1		8.73		
TP 25/B1	CL		25.5/11.4	COMP 7

RESULTS OF LABORATORY TESTS OF BORROW SOILS

TEST PIT/ SAMPLE NO	SOIL CLASS	WATER CONTENT %	ATTERBERG LIMITS LL/PI	USED IN PROCTOR TEST NO.
TP 26/J1		13.47		
TP 26/B1	CL		45.4/25.1	COMP 7
TP 27/J1		9.75		
TP 27/B1	CL		22.7/8.7	COMP 7
TP 28/J1		15.42		
TP 28/B1	CL-CH		47.2/28.0	COMP 3
TP 30/J1		12.93		
TP 30/B1	CH		54.5/31.4	COMP 4
TP 31/J1		17.06		
TP 31/B1	CL		42.2/24.3	COMP 2
TP 33/B1	CH-CL		53.6/31.7	

GRAIN SIZE	-#4	-#10	-#40	-#80	-#200
TP 33/B2	100	100	95	28	6.0
TP 34/B1	100	100	93	38	13.3

COMPOSITE SAMPLES	GRAIN SIZE SIEVE -#10/-#40/-#200	GRAIN SIZE HYDROMETER -.005/-.001	STD. PROCTOR MAX. DRY DENSITY,PCF	OPTIMUM MOISTURE %	PERMEABILITY (E-08 cm/s)	DISPERSIVITY PINHOLE	DISPERSIVITY CRUMB
COMP 1	100/94.4/84.0	60.2/44.4	102.3	20.3	1.69	D1	2
COMP 2			102.0	19.3			
COMP 3	100/94.9/85.6	66.3/50.0	94.1	20.0	3.84	ND3	1
COMP 4	100/97.3/83.3	71.1/56.6	93.7	13.5	1.59	ND1	1
COMP 5	100/96.2/92.1	77.6/55.8	99.3	20.0	.502	ND2	1
COMP 6			99.5	20.0			
COMP 7	100/96.9/84.2	63.0/49.1	106.3	18.5	1.51	ND1	1

ave - 0.002 = 58.4 ave = 99.6 95% = 94.6 = 18.8

FOX

FOX & ASSOCIATES OF NEW MEXICO, INC.

CONSULTING ENGINEERS AND GEOLOGISTS

ALBUQUERQUE OFFICE 3412 BRYN MAWR DRIVE, NE
ALBUQUERQUE, NEW MEXICO 87107
(505) 884-0900

September 30, 1987

Homestake Mining Company
P.O. Box 98
Grants, New Mexico 87020

Job No. 3-4264-5885-00

Attention: Mr. Edward Kennedy

Subject: Laboratory Results of Atterberg Limits and Sieve Analyses for Homestake Mine Reclamation Project
P.O. # 155-167

Gentlemen:

Transmitted herein is the detailed test data for the subject project.

FOX & ASSOCIATES OF NEW MEXICO, INC.

Martin F. Barker, P.E.
Area Manager

Copies: Addressee (2)

Attached: Data Sheets (3)

bss

Job No.: 3-4265-5885-00

Project: Homestake Mine Reclamation Project
P.O. #155-167

Sample No. F87-1250

Sieve Analysis for Homestake Mine Reclamation Project, sampled by our Client and delivered to our laboratory on September 24, 1987

SIEVE ANALYSIS

Sieve Size	% Passing
No. 4	100
No. 10	100
No. 40	95
No. 80	28
No. 200	6.0

Location: TP-33-B2

Job No. 3-4265-5885-00

Project: Homestake Mine Reclamation Project
P.O. #155-167

Sample No. F87-1251

Sieve Analysis for Homestake Mine Relamation Project, sampled by our Client and delivered to our laboratory on September 24, 1987

SIEVE ANALYSIS

Sieve Size	% Passing
3/8	100
No. 4	100
No. 10	100
No. 40	93
No. 80	38
No. 200	13.3

Location: TP-34-B1

JOB NO.: 3-4265-5885-00

PROJECT: Homestake Mine Reclamation Project
P.O. # 155-167

Atterberg Limits for Homestake Mine Reclamation Project, sampled by our client and delivered to our laboratory on September 24, 1987.

SAMPLE NUMBER	LIQUID LIMITS	PLASTICITY INDEX	LOCATION
F87-1230	46.5	25.4	TP-10
F87-1231-B1	73.6	48.4	TP-12
F87-1231-B2	35.1	19.9	TP-12
F87-1232-B1	45.9	24.6	TP-13
F87-1232-B2	30.5	15.4	TP-13
F87-1233	52.7	29.0	TP-14
F87-1234	48.7	27.6	TP-15
F87-1235	56.5	32.3	TP-17
F87-1236	47.8	25.2	TP-18
F87-1237	53.4	31.8	TP-19
F87-1238	28.9	13.5	TP-20
F87-1239	58.5	34.1	TP-21
F87-1240	49.8	29.3	TP-22
F87-1241	50.1	27.4	TP-23
F87-1242	67.2	41.9	TP-24
F87-1243	25.5	11.4	TP-25
F87-1244	45.4	25.1	TP-26
F87-1245	22.7	8.7	TP-27
F87-1246	47.2	28.0	TP-28
F87-1247	54.5	31.4	TP-30
F87-1248	42.2	24.3	TP-31
F87-1249	53.6	31.7	TP-33-B1

FOX

FOX & ASSOCIATES OF NEW MEXICO, INC.

CONSULTING ENGINEERS AND GEOLOGISTS

ALBUQUERQUE OFFICE 3412 BRYN MAWR DRIVE, NE
ALBUQUERQUE, NEW MEXICO 87107
(505) 884-0900

October 1, 1987

Homestake Mining Co.
P.O. Box 98
Grants, New Mexico 87020

Job No. 3-4264-5885-00

Attention: Mr. Edward Kennedy

Subject: Results of Laboratory Determinations
Moisture-Density Relations of Soils
Homestake Mine Reclamation Project
P.O. #155-167

Gentlemen:

Transmitted herein is the detailed test data for the subject project.

FOX & ASSOCIATES OF NEW MEXICO, INC.

Martin F. Barker, P.E.
Area Manager

Copies: Addressee (2)

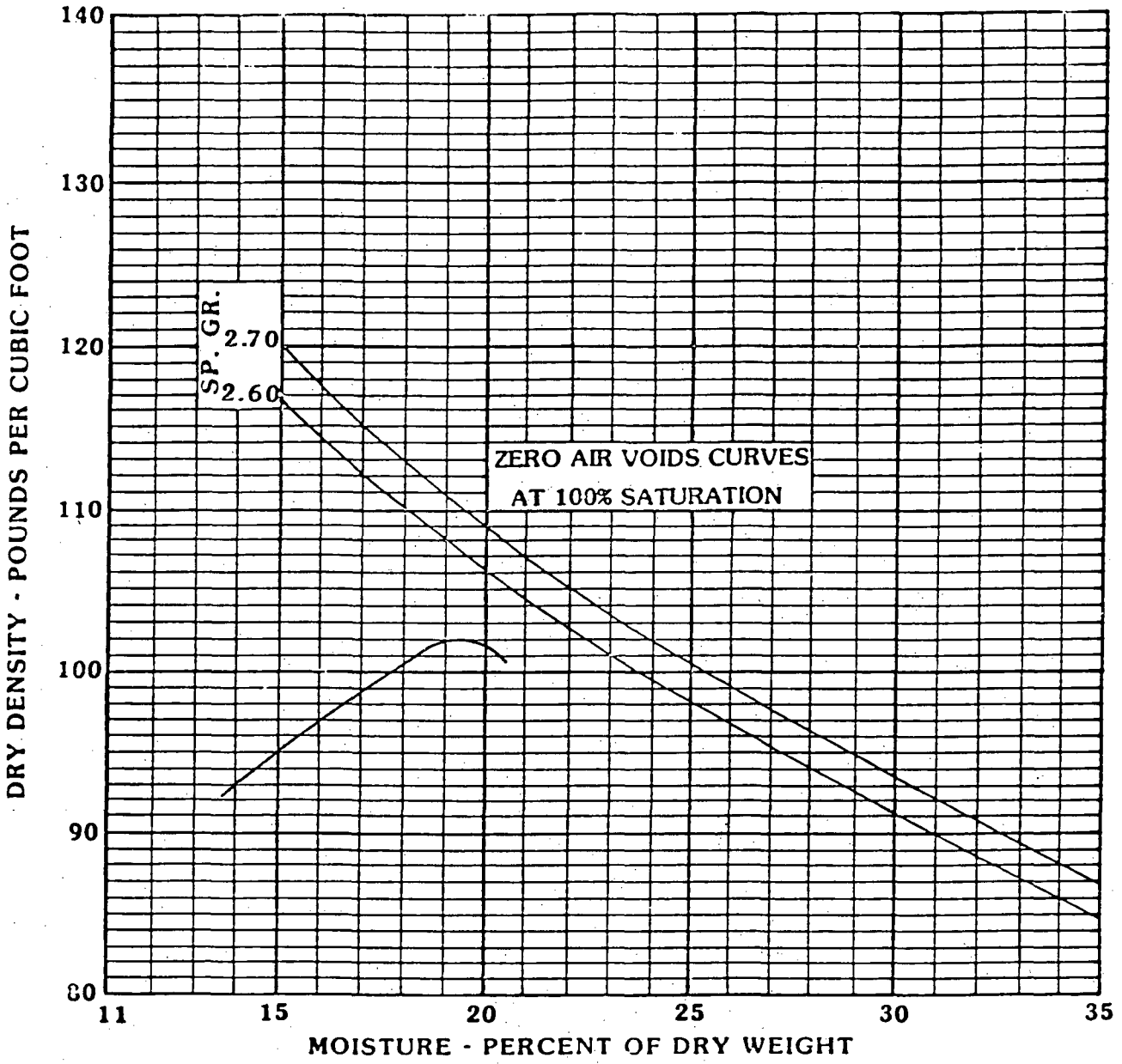
Revised Copy: Moisture Content

Attached: Data Sheets (5)

Revised Copy: 11/2/87-Location

VS

LABORATORY MOISTURE DENSITY TEST RESULTS



MAXIMUM DRY DENSITY : 102.0 pcf OPTIMUM MOISTURE CONTENT : 19.3%

SAMPLE DESCRIPTION : - Composite #2

LOCATION : TP-14-B1, TP-15-B1, TP-31-B1

AMT. OF MAT'L FINER THAN : #4 SIEVE - #10 - #40 - #200 -

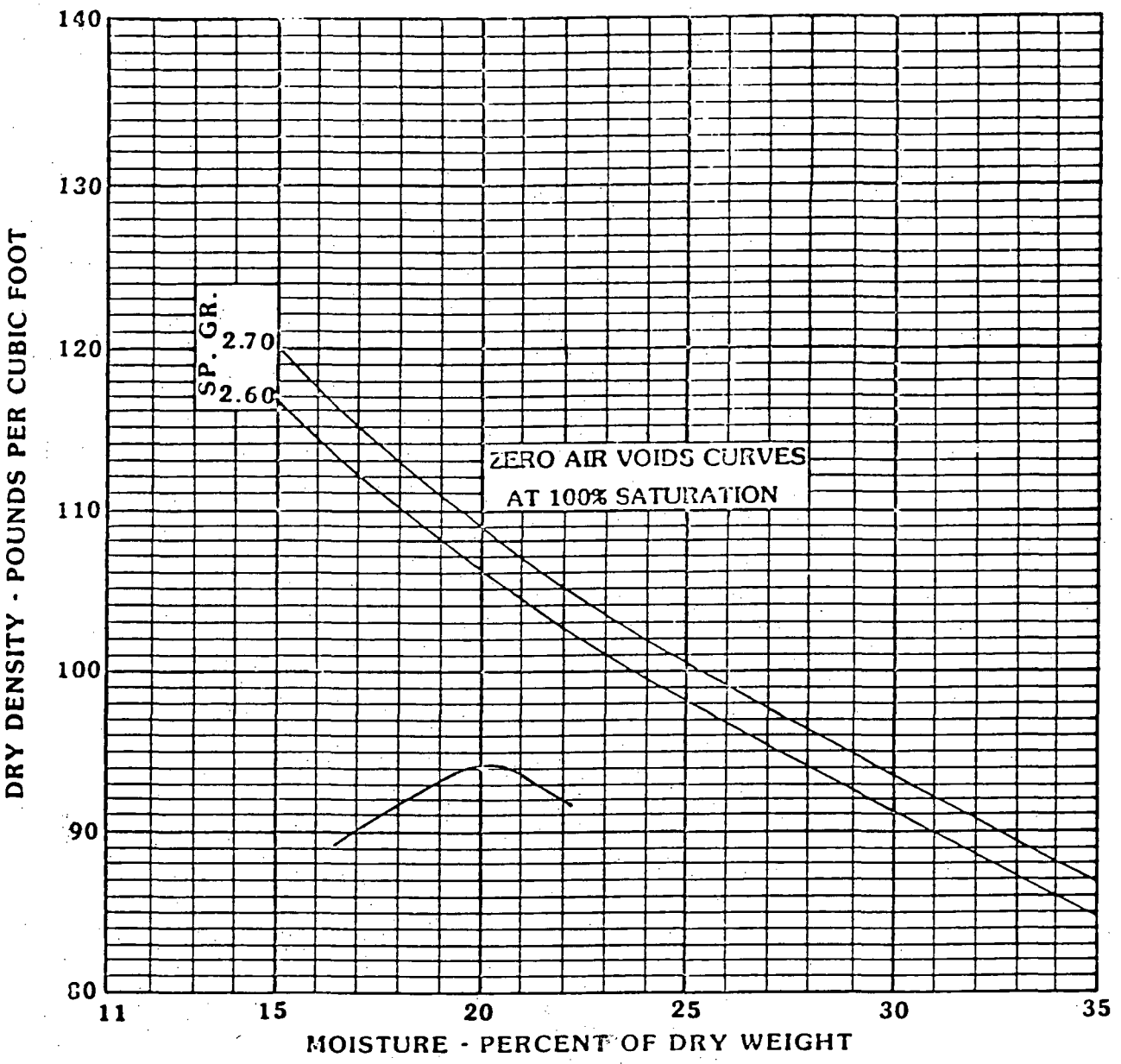
ATTERBERG LIMITS : LL : - PL : - PI : -

REVISED COPY: Moisture Content

LABORATORY MOISTURE DENSITY TEST RESULTS	Proctor No.
FOX Consulting Engineers and Geologists	Comp. Test Proc. ASTM-D-698-
	Figure

SLR-4

LABORATORY MOISTURE DENSITY TEST RESULTS



MAXIMUM DRY DENSITY : 94.1 pcf OPTIMUM MOISTURE CONTENT : 20.0%

SAMPLE DESCRIPTION : - Composite #3

LOCATION : TP-28-B1, TP-17-B1

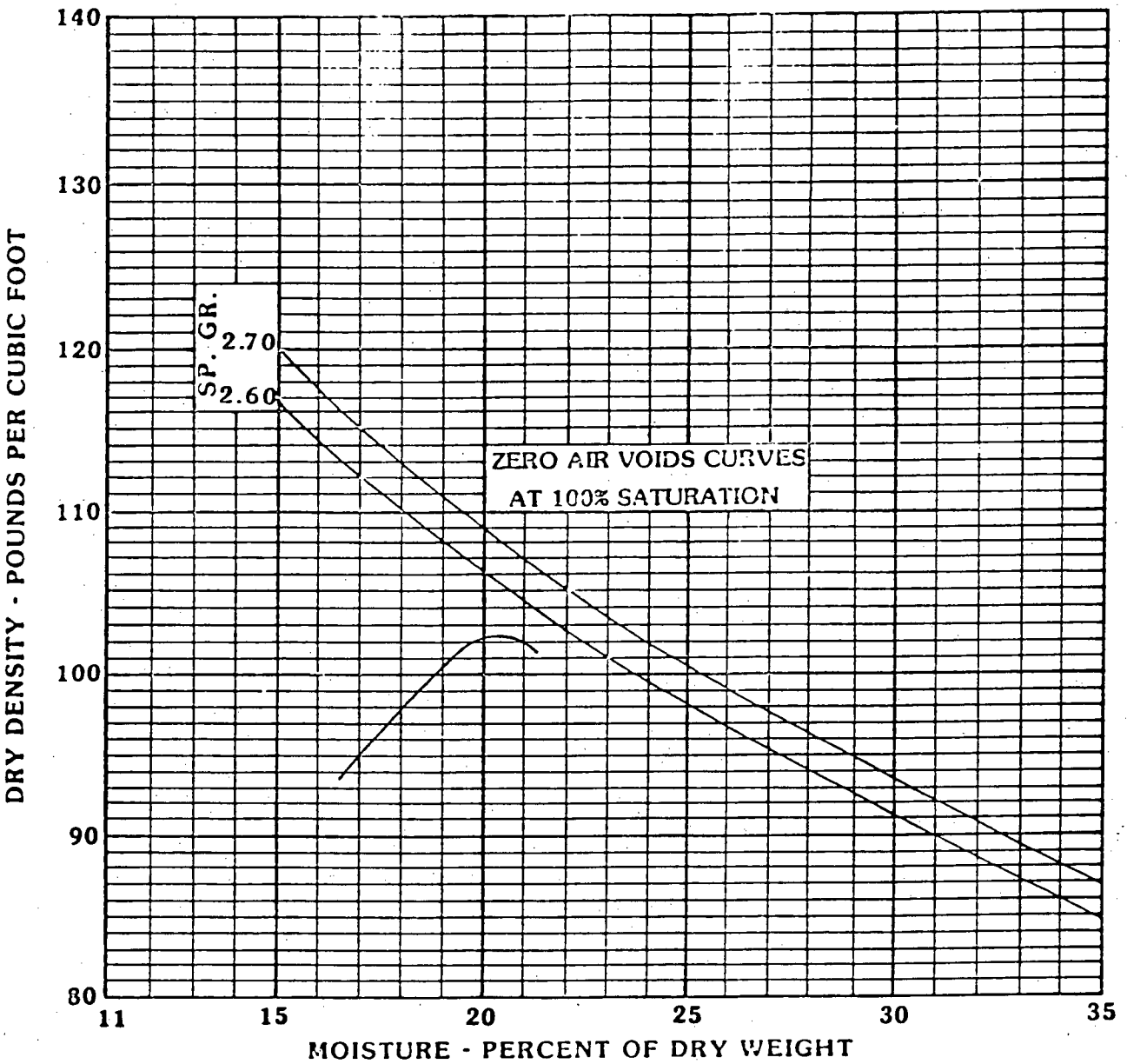
AMT. OF MAT'L FINER THAN : #4 SIEVE - #10 - #40 - #200 -

ATTERBERG LIMITS : LL : - PL : - PI : -

LABORATORY MOISTURE DENSITY TEST RESULTS	Proctor No.
FOX Consulting Engineers and Geologists	Comp. Test Proc. ASTM-D-698-
	Figure

SLR-4

LABORATORY MOISTURE DENSITY TEST RESULTS



MAXIMUM DRY DENSITY : 102.3 pcf OPTIMUM MOISTURE CONTENT : 20.3%

SAMPLE DESCRIPTION : - Composite #1

LOCATION : TP-10-B1, TP-12-B2, TP-13-B1, TP-13-B2

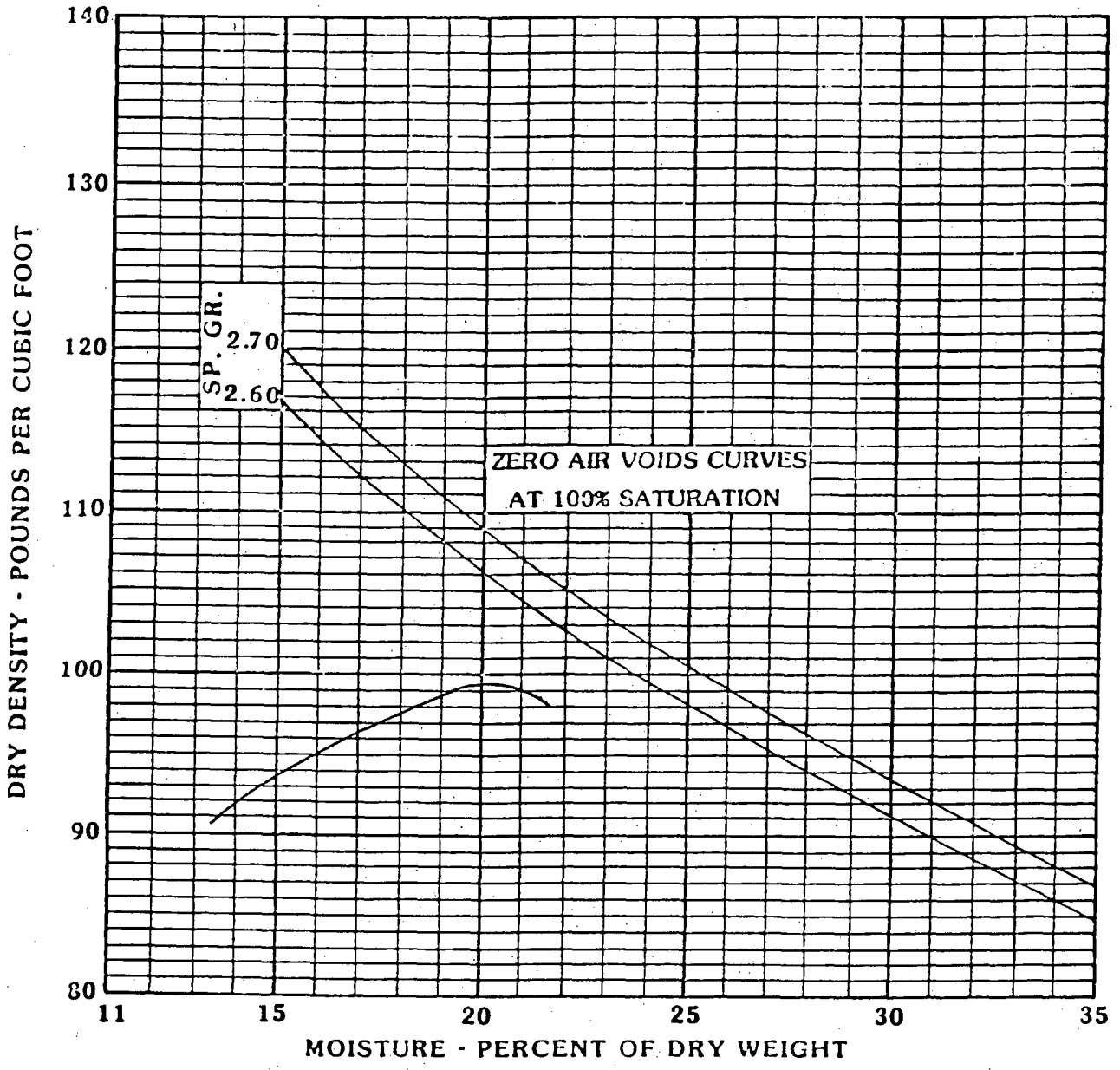
AMT. OF MAT'L FINER THAN : #4 SIEVE - #10 - #40 - #200 -

ATTERBERG LIMITS : LL : - PL : - PI : -

LABORATORY MOISTURE DENSITY TEST RESULTS	Proctor No.
FOX Consulting Engineers and Geologists	Comp. Test Proc. ASTM-D-698
	Figure

SLR-4

LABORATORY MOISTURE DENSITY TEST RESULTS



MAXIMUM DRY DENSITY : 99.3 pcf OPTIMUM MOISTURE CONTENT : 20.0%

SAMPLE DESCRIPTION : - Composite #5

LOCATION : TP-20-B1, TP-21-B1, TP-22-B1

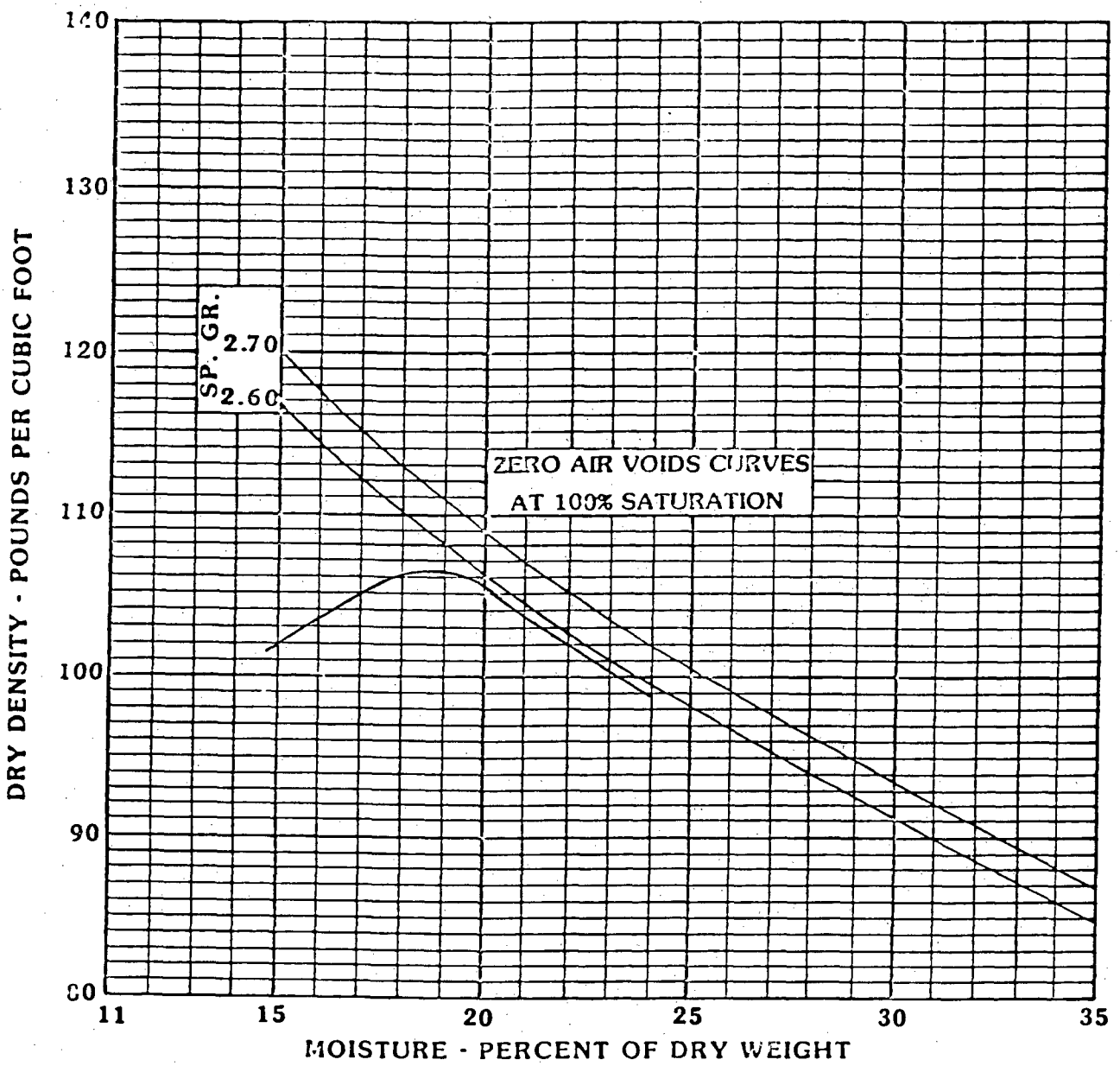
AMT. OF MAT'L FINER THAN : #4 SIEVE - #10 - #40 - #200 -

ATTERBERG LIMITS : LL : - PL : - PI : -

LABORATORY MOISTURE DENSITY TEST RESULTS	Proctor No.
FOX Consulting Engineers and Geologists	Comp. Test Proc. ASTM D-698-A
	Figure

SLR-4

LABORATORY MOISTURE DENSITY TEST RESULTS



MAXIMUM DRY DENSITY : 106.3 pcf OPTIMUM MOISTURE CONTENT : 18.5%

SAMPLE DESCRIPTION : - Composite #7

LOCATION : TP25-B1, TP-26-B1, TP-27-B1

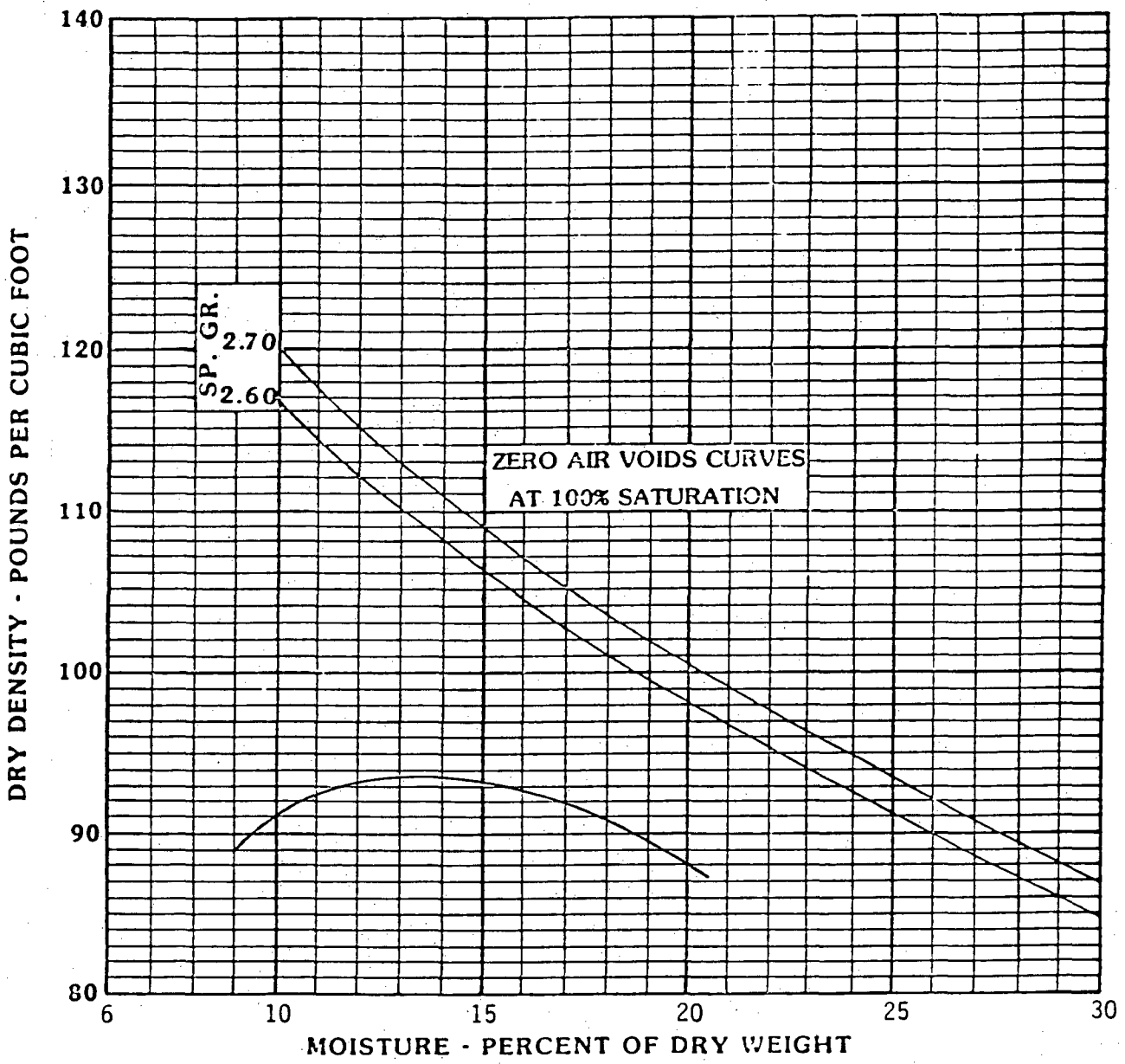
AMT. OF MAT'L FINER THAN : #4 SIEVE - #10 - #40 - #200 -

ATTERBERG LIMITS : LL : - PL : - PI : -

LABORATORY MOISTURE DENSITY TEST RESULTS	Proctor No.
FOX Consulting Engineers and Geologists	Comp. Test Proc ASTMD698-A
	Figure

SLR-4

LABORATORY MOISTURE DENSITY TEST RESULTS



MAXIMUM DRY DENSITY : 93.7 pcf OPTIMUM MOISTURE CONTENT : 13.5%

SAMPLE DESCRIPTION : - Composite # 4

LOCATION : TP-18-B1, TP-19-B1, TP-30-B1

AMT. OF MAT'L FINER THAN : #4 SIEVE - #10 - #40 - #200 -

ATTERBERG LIMITS : LL : - PL : - PI : -

REVISED COPY - 11/2/87 - Location

LABORATORY MOISTURE DENSITY TEST RESULTS	Proctor No.
FOX Consulting Engineers and Geologists	Comp. Test Proc.ASTM D698-A
	Figure

SLR-4

FOX

FOX & ASSOCIATES OF NEW MEXICO, INC.

CONSULTING ENGINEERS AND GEOLOGISTS

ALBUQUERQUE OFFICE 3412 BRYN MAWR DRIVE, NE
ALBUQUERQUE, NEW MEXICO 87107
(505) 884-0900

October 12, 1987

Homestake Mining Co.
P.O. Box 98
Grants, New Mexico 87020

Job No: 3-4264-5885-00

Attention: Mr. Edward Kennedy

Subject: Laboratory Determinations
Moisture-Density Relations of Soils
Homestake Mine Reclamation Project
P.O. #155-167

Gentlemen:

Transmitted herein is the detailed test data for the subject project.

FOX & ASSOCIATES OF NEW MEXICO, INC.

Martin F. Barker, P.E.
Area Manager

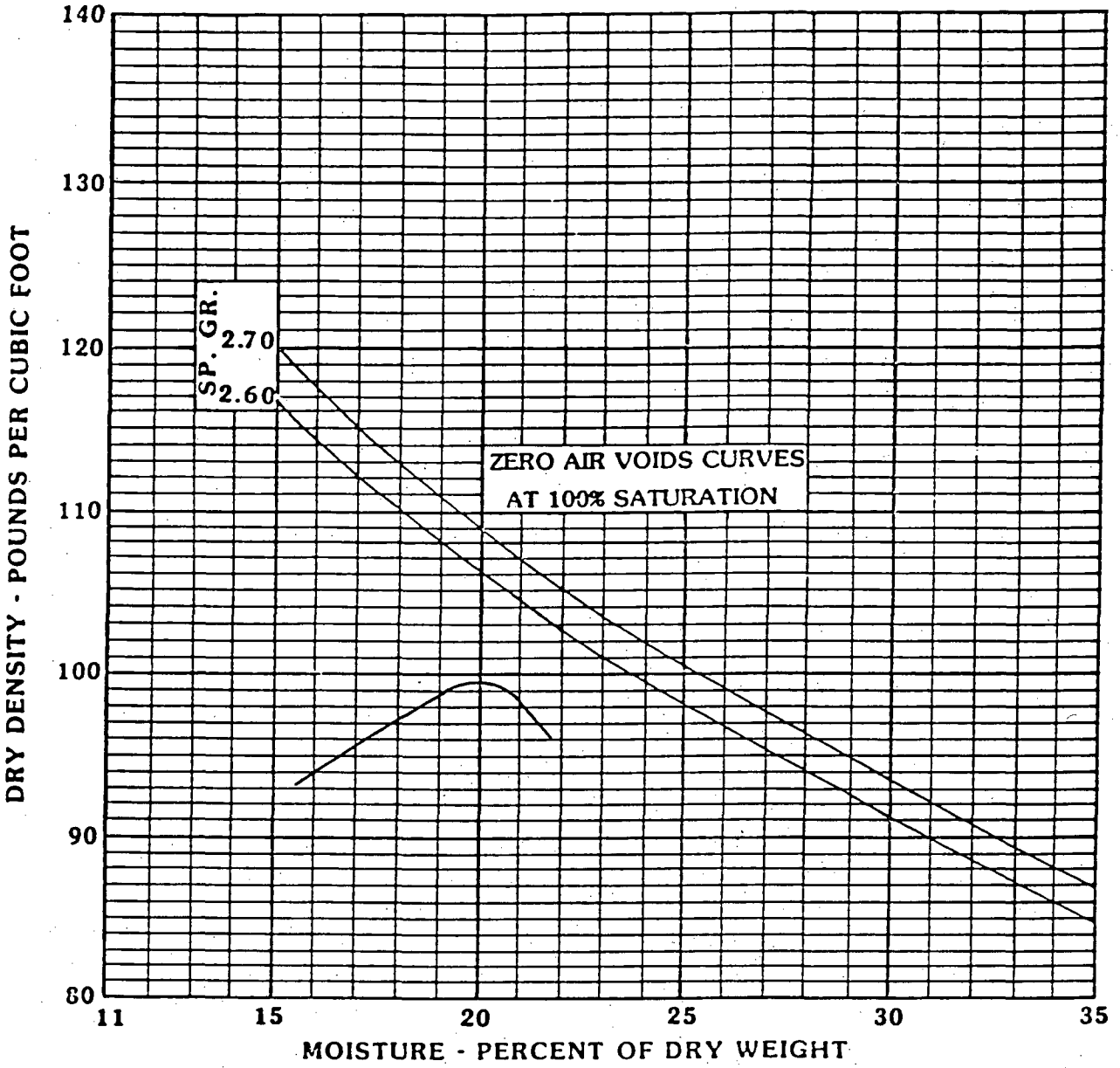
Copies: Addressee (2)

Attached: Data Sheet

ra

Job No: 3-4264-5885-00

LABORATORY MOISTURE DENSITY TEST RESULTS



MAXIMUM DRY DENSITY : 99.5 pcf OPTIMUM MOISTURE CONTENT : 20.0%

SAMPLE DESCRIPTION : - Composite #6

LOCATION : TP - 23 - B1, TP - 24 - B1

AMT. OF MAT'L FINER THAN : #4 SIEVE - #10 - #40 - #200 -

ATTERBERG LIMITS : LL : - PL : - PI : -

LABORATORY MOISTURE DENSITY TEST RESULTS	Proctor No.
FOX Consulting Engineers and Geologists	Comp. Test Proc. AASHTO T-99-A
	Figure

SLR-4

FOX

FOX & ASSOCIATES OF NEW MEXICO, INC.

CONSULTING ENGINEERS AND GEOLOGISTS

ALBUQUERQUE OFFICE 3412 BRYN MAWR DRIVE, NE
ALBUQUERQUE, NEW MEXICO 87107
(505) 884-0900

November 5, 1987

Homestake Mining Co.
P.O. Box 98
Grants, New Mexico 87020

Job No: 3-4264-5885-00

Attention: Mr. Edward Kennedy

Subject: Particle Size Analysis
Homestake Mine Reclamation Project
P.O. # 155-167

Gentlemen:

Transmitted herein is the detailed test data for the subject project.

FOX & ASSOCIATES OF NEW MEXICO, INC.

Martin F. Barker, P.E.
Area Manager

Copies: Addressee (2)

Attached: Data Sheet

ra

Job No: 3-4264-5885-00
Project: Homestake Mine Reclamation Project
P.O. # 155-167

Sieve Size	% Passing Comp. 7 TP-25-B1 TP-26-B1 TP-27-B1	Comp. 4 TP-18-B1 TP-19-B1 TP-30-B1	Comp. 5 TP-20-B1 TP-21-B1 TP-22-B1	Comp. 1 TP-10-B1 TP-12-B2 TP-13-B1 TP-13-B2	Comp. 3 TP-28-B1 TP-17-B1
No. 10	100	100	100	100	100
No. 40	96.9	97.3	96.2	94.4	94.9
No. 200	84.2	83.3	92.1	84.0	85.6
Hydrometer Analysis					
.005 mm	63.0	71.7	77.6	60.2	66.3
.001 mm	49.1	56.6	55.8	44.4	50.0

FOX

FOX & ASSOCIATES OF NEW MEXICO, INC.

CONSULTING ENGINEERS AND GEOLOGISTS

ALBUQUERQUE OFFICE 3412 BRYN MAWR DRIVE, NE
ALBUQUERQUE, NEW MEXICO 87107
(505) 884-0900

December 14, 1987

Homestake Mining Co.
P.O. Box 98
Grants, New Mexico 87020

Job No: 3-4264-5885-00

Attention: Mr. Edward Kennedy

Subject: Results of Laboratory Determinations
Pinhole Dispersivity
Crumb Test
Permeability
Homestake Mine Reclamation Project
P.O. # 155-167

Gentlemen:

Transmitted herein is the detailed test data for the subject project.

FOX & ASSOCIATES OF NEW MEXICO, INC.

Martin F. Barker, P.E.
Area Manager

Copies: Addressee (2)
Alan Kuhn

Attached: Data Sheet

ra

SAMPLE IDENTIFICATION		PROCTOR TEST DATA		PINHOLE TEST DATA SUMMARY									CRUMB TEST	PERMEABILITY		
				PLACEMENT					WATER QUALITY*					CONSTANT HEAD PERMEABILITY	PLACEMENT	
SET NO.	TEST PIT NOS.	MAX. DRY DEN. (PCF)	O.M.C. %	γ (PCF)	W %	HEAD MM	Q1 ML/SEC.	Qf ML/SEC.	INITIAL	FINAL	CLASSIFICATION	REMARKS	GRADE	$\times 10^{-8}$ CM/SEC.	γ (PCF)	W %
1	20, 21 AND 22	99.3	20.0	97.3	18.0	50	0.458	0.233	C	C		REPUNCHED HOLE AT 5 MIN.	1			
						50	0.267	0.142	C	C		REPUNCHED HOLE AT 10 MIN.				
						180	1.200	1.080	C	C						
						380	1.700	1.750	C	SC	ND2			0.502	94.3	20.4
2	25, 26 AND 27	106.3	18.5	104.2	16.6	50	0.250	0.217	C	C			1			
						50	0.233	0.217	C	C						
						180	0.583	0.587	C	C						
						380	1.030	0.987	C	C						
						380	1.030	1.000	C	C	ND1			1.510	101.0	18.6
3	18, 19 AND 30	98.0	21.5	96.0	19.5	50	0.275	0.233	C	C			1			
						50	0.275	0.317	C	C						
						180	0.508	0.533	C	C						
						380	0.883	0.850	C	C	ND1			1.590	93.4	21.6
4	10, 12 AND 13	102.3	20.3	100.3	18.0	50	0.275	2.517	SC	CL/D	D1		2	1.690	97.3	20.4
5	17 AND 28	94.1	20.0	92.2	18.3	50	0.142	0.065	SC/C	SC/C		REPUNCHED HOLE AT 5 MIN.	1			
						50	0.392	0.243	SC/C	SC/C						
						50	0.692	0.148	SC/C	SC/C						
						180	1.630	1.720	SC	SC	ND3			3.84	89.3	19.7

*D = Dark/Distinctly Cloudy CL = Cloudy SC = Slightly Cloudy C = Clear

SUMMARY OF LABORATORY TESTING

FOX Consulting Engineers and Geologists

Job No:

Date:

Figure

E4/02

ASSAIGAI ANALYTICAL LABORATORIES

TO: A.K. GeoConsult, Inc.
13212 Manitoba Dr., NE
Albuquerque, NM 87111

DATE: 13 March, 1989
WORK ORDER NO: 316

SAMPLE SITE: Homestake Mill, Grants, NM
SAMPLES TAKEN: 19 February, 1989
RECEIVED: 27 February, 1989 @ 4:00 PM
ANALYST: Nedene Hennrich
ANALYTE REQUESTED: Organic Content

SAMPLE ID	ANALYTICAL RESULTS
TP 14, Clay	3.15 %
TP 15, Clay	2.94 %
TP 17, Clay, Sand	3.41 %
TP 18, Clay	2.78 %
TP 19, Clay	3.05 %
TP 20, Clay, Sand	2.47 %
TP 22, Clay	3.16 %
TP 23, Clay	2.75 %
TP 24, Clay	3.12 %
TP 25, Clay, Sand	1.63 %
TP 26, Clay	3.16 %
TP 27, Clay, Sand	3.19 %
TP 28, Sand	.94 %
TP 30, Clay	1.45 %
TP 31, Clay	2.73 %

NOMINAL DETECTION LIMIT: .1 %

An invoice for services is included. Thank you for contacting Assaigai Analytical Laboratories.

Sincerely,

Balwant Chauhan, Ph.D.
Laboratory Director

P.O. Box 90430 • Albuquerque, New Mexico 87199-0430 • (505) 345-8964

84-102

SERGENT, HAUSKINS & BECKWITH CONSULTING GEOTECHNICAL ENGINEERS

APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING • HYDROLOGY

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July 28, 1986

Alan K. Kuhn, PhD, P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dr. Kuhn:

The following table lists results of moisture-density relationships, ASTM D698, on samples requested in your letter to this firm dated July 21, 1986. Results of sieve analyses and compaction curves are attached.

Sample	Optimum Moisture Content (%)	Maximum Dry Density (pcf)
BA1-A1	7.8	118.4
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BA5-A3	13.6	116.6
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BA10-A1	12.0	117.2
BA14-A1	13.3	111.0
BA19-A1	12.8	116.2
		ave = 115.8

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

PHOENIX (602) 272-6848 | ALBUQUERQUE (505) 884-0950 | SANTA FE (505) 471-7836 | SALT LAKE CITY (801) 266-0720 | EL PASO (915) 778-3369

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NORMAN H WETZ P E
ROBERT L FREW
ALLON C OWEN JR, P E

Date July 28, 1986

To: Alan Kuhn PhD., PE
13212 Manitoba Dr. N.E.
Albuquerque, N.M. 87111

SHB Job No. E86-1113

Attn: Alan Kuhn

Re: Contract Drilling & Lab Tests
Homestake Mining Company
Grants, New Mexico

We are sending ☐ As requested ☒ For your use ☐ For comment

☐ Enclosed ☐ Under separate cover via _____

Description Moisture content data & calculations on samples recieved today from Homestake Mine.

Remarks Homestake added one more sample to determine Atterberg Limits, BA 11-SA

By Gregory M. Smith
Title Staff Engineer

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

17-21-86

Samples

PAN #		Wet	Dry	TARE
	BA-16			
1	S-1	840	827	665
2	S-2	906	902	636
3	S-3	858	852	630
4	S-4	926	920	674
	BA-17			
5	S-1	962	958	673
6	S-2	881	872	660
7	S-3	909	895	627
8	S-4	926	922	66
9	S-5	905	894	67
	BA-18			
10	S-1	941	921	70
11	S-2	863	857	62
12	S-3	811	799	59
13	S-4 (A)	874	857	63
14	S-4 (B) CL	909	876	66
15	S-5	799	789	60
	BA-19			
16	S-1	878	851	67
17	S-2	947	943	66
18	S-3	966	961	68
19	S-4	915	913	604
	BA-20			
20	S-1	851	831	656
21	S-2	933	930	68
22	S-3	936	928	69
23	S-4	890	884	66

7-22-86

Calculations

BA-16	Wet	Dry	Diff		% moisture $\frac{Wet-Dry}{Wet} \times 100$
S-1	175	162	13	ML-SM	7.43
S-2	270	266	4	SP	1.48
S-3	228	222	6	SP	2.63
S-4	252	246	6	SP	2.38
BA-17					
S-1	289	285	4	SP	1.38
S-2	212	203	9	SM	4.25
S-3	286	272	14	SP	4.90
S-4	260	256	4	SM	1.54
S-5	234	223	11	SM/ML	4.70
BA-18					
S-1	232	212	20	SM/ML	8.62
S-2	236	230	6	SM	2.5
S-3	216	204	12	SM/ML	5.5
S-4(A)	239	222	17	ML	7.11
S-4(B)	241	208	33	CL	3.6
S-5	195	185	10	ML/SM	5.1
BA-19					
S-1	199	172	27	SM	13.5
S-2	282	278	4	SM	1.4
S-3	283	278	5	SM	1.7
S-4	311	309	2	SP	0.6
BA-20					
S-1	195	175	20	ML	10.2
S-2	250	247	3	SM	1.2

SUMMARY OF NATURAL MOISTURE CONTENTS
OF BORROW SOIL SAMPLES
FROM TESTS BY HMC MILL LAB, 7/17/86

BORING NO., BA-	SAMPLE NO., S-		MOISTURE %	SOIL TYPE
1	1		2.55	SM
1	2	11'	8.94	CL
1	3		2.22	SP
1	4		1.67	SP
2	1	6'	13.27	CH
2	2	10'	13.71	CL
2	3		2.67	SM
2	4		2.07	SP
3	1		2.36	SP-SM
3	2		1.84	SM
3	3		0.94	SP
3	4		1.16	SP
4	1		4.48	SM
4	2	11'	14.20	CL
4	3		11.03	ML
4	4		2.02	SP
5	1		5.57	SP-SM
5	2		3.10	SP
5	3		2.21	SP
5	4		2.09	SP
6	1	6'	12.04	CL
6	2		2.42	SM
6	3		2.08	SP-SM
6	4		2.17	SP
7	1	6'	9.96	CL
7	2	11'	12.22	CL-CH
7	3		2.34	SP
7	4		1.67	SP
8	1	6'	13.81	CH
8	2		2.26	SM
8	3		1.59	SP
9	1		4.00	SP-SM
9	2		1.42	SM
9	3		0.48	SP
9	4		1.16	SP
10	1		2.21	SP
10	2		3.10	SP
10	3		1.57	SP
10	4		1.17	SP
11	1		3.26	SP
11	2		6.31	SM
11	3		3.96	SP
11	4	21'	14.64	CH
11	5	26'	14.14	CL
11	6	31'	16.93	CH
11	7		4.79	SM
12	1		0.76	SM
12	2		3.17	SP
12	3		0.79	SP
12	4		2.53	SP
13	1		2.02	SM
13	2		5.70	SM
13	3		1.77	SP
13	4		0.96	SP
14	1		1.18	SP
14	2		1.78	SP
14	3		0.58	SP
14	4		0.80	SP
15	1		3.40	SM
15	2		2.91	SM
15	3		0.29	SP
15	4		1.45	SP

84-102

SERGENT, HAUSKINS & BECKWITH CONSULTING GEOTECHNICAL ENGINEERS

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July 28, 1986

Alan K. Kuhn, PhD, P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

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The following table lists results of moisture-density relationships, ASTM D698, on samples requested in your letter to this firm dated July 21, 1986. Results of sieve analyses and compaction curves are attached.

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Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

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TABULATION OF TEST RESULTS

Job No. E86-1113

Project Contract Drilling & Laboratory Testing

Homestake Mining Company, Grants, NM

Material

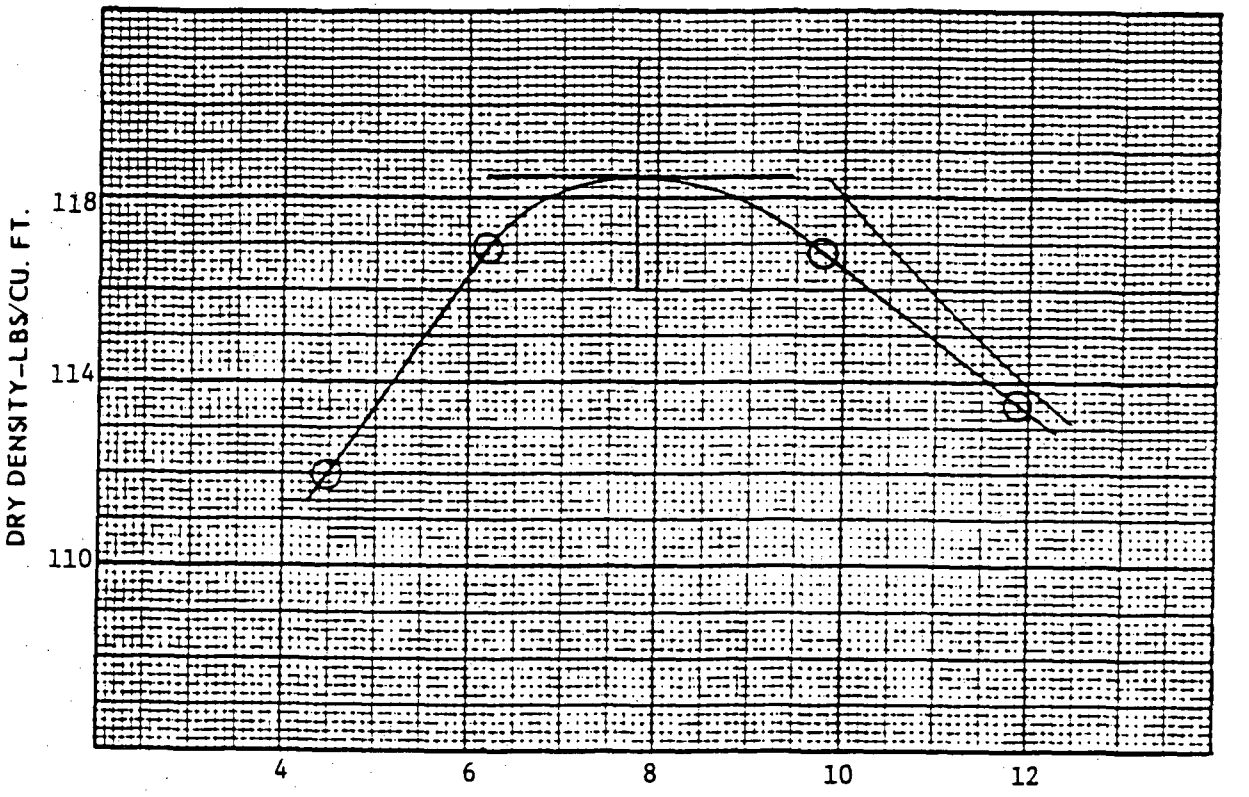
Source

HOLE NO.	LOCATION	DEPTH	UNIFIED CLASS.	LL	PI	SIEVE ANALYSIS – ACCUM. % PASSING												LAB. NO.
						200	100	40	10	4	3/8	1/2	3/4	1	1-1/2	3	MOIST.	
	BA1-A1					13	35	98	100								2	13-1
	BA2-A1					32	56	99	100								5	13-2
	BA3-A1					19	55	100									3	13-3
	BA5-A1					25	45	97	100								4	13-4
	BA5-A3					30	50	98	100								2	13-5
	BA6-A1					17	48	99	100								3	13-6
	BA7-A2					36	55	94	100								5	13-7
	BA8-A1					25	50	98	100								6	13-8
	BA10-A1					18	42	96	100								4	13-9
	BA14-A1					14	35	94	100								3	13-10
	BA19-A1					26	61	99	100								5	13-11

SERGENT, HAUSKINS & BECKWITH

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA1-A1	7.9	118.4	ASTM D698	A	13-1

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12.375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12.317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12.317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12.317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56.250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55.986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55.986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55.986

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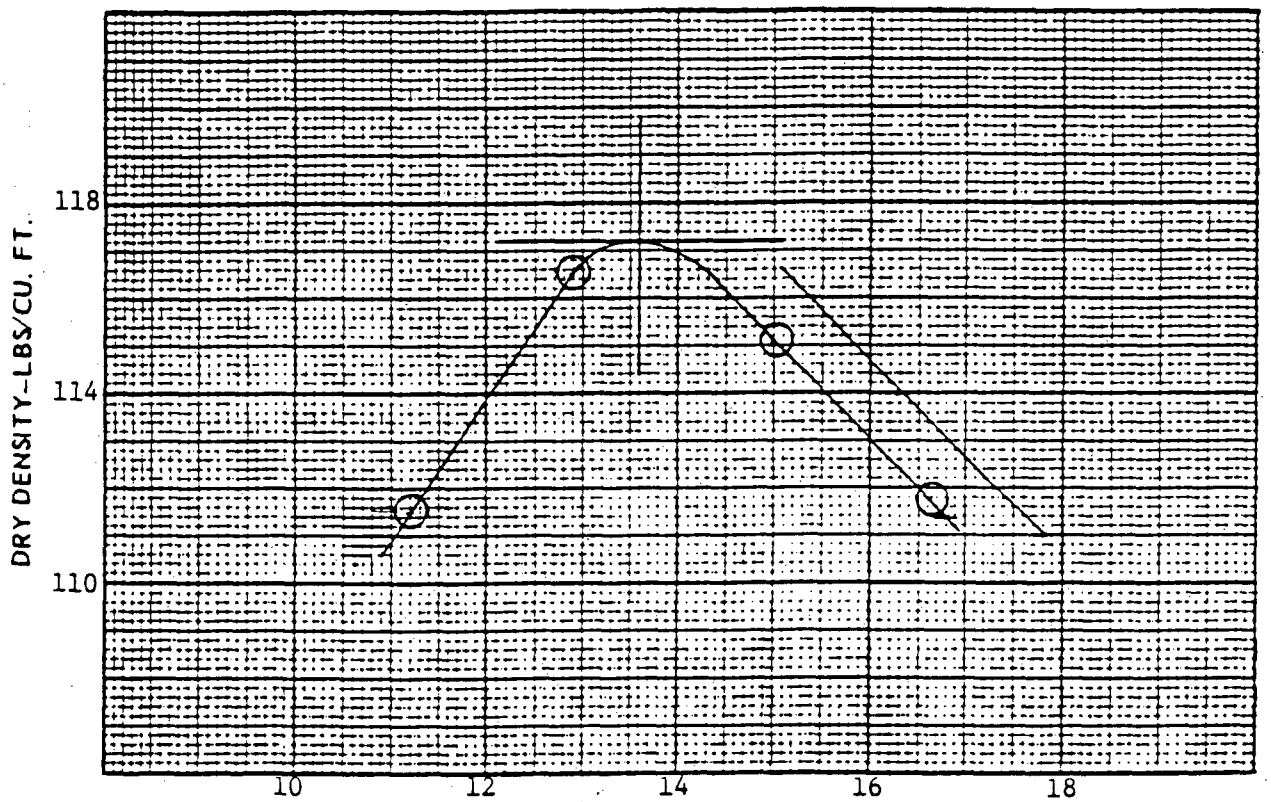
CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE • SALT LAKE CITY

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA2-A1	13.6	117.2	ASTM D698	A	13-2

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
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D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
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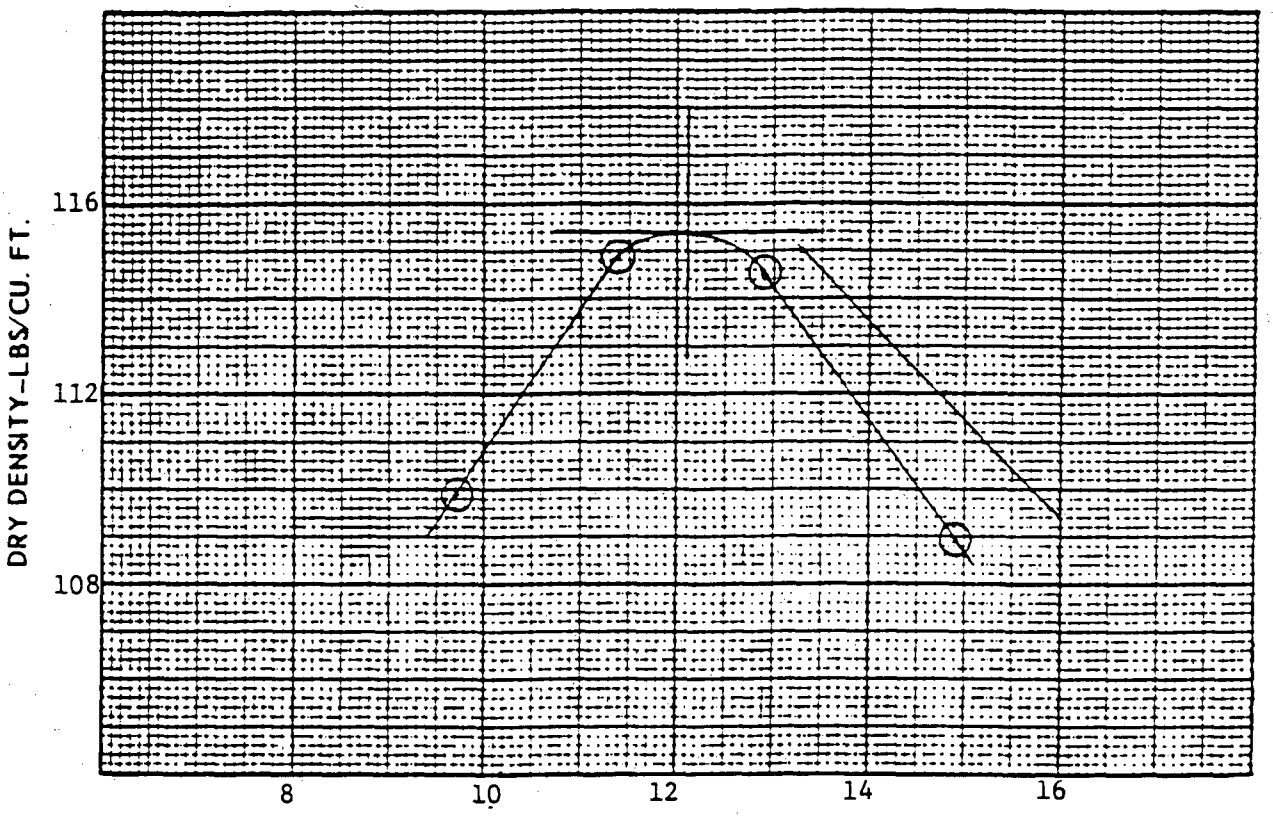
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA3-A1	12.1	115.4	ASTM D698	A	13-3

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

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METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
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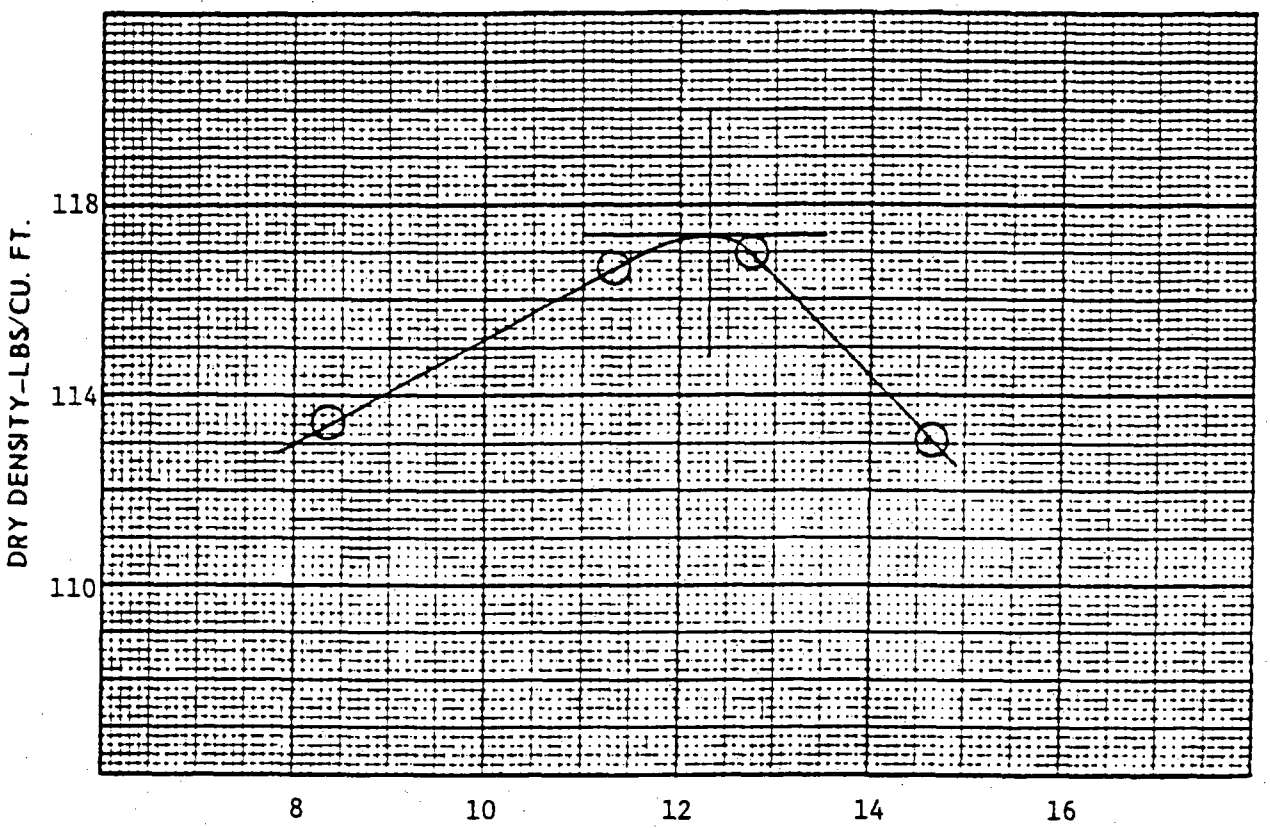
CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE • SALT LAKE CITY

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** 586-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA5-A1	12.3	117.4	ASTM D698	A	13-4

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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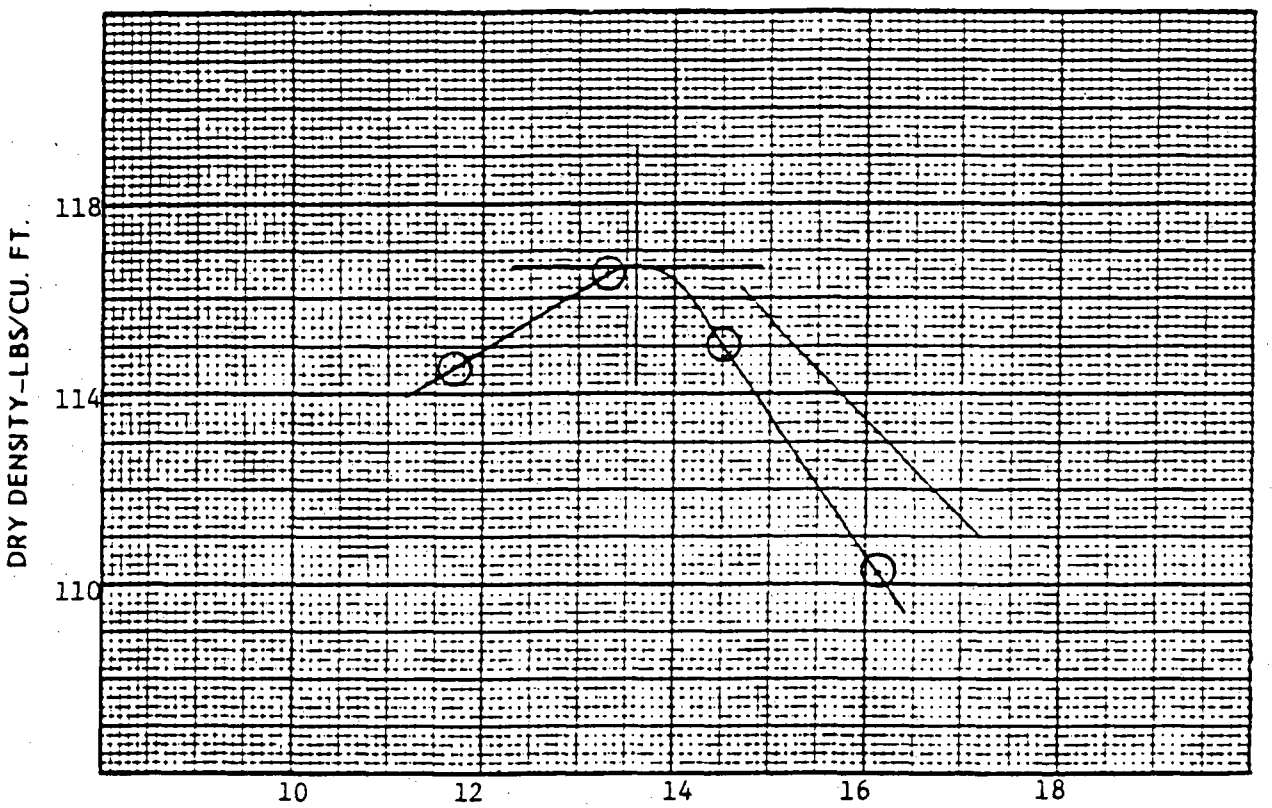
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA5-A3	13.6	116.6	ASTM D698	A	13-5

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
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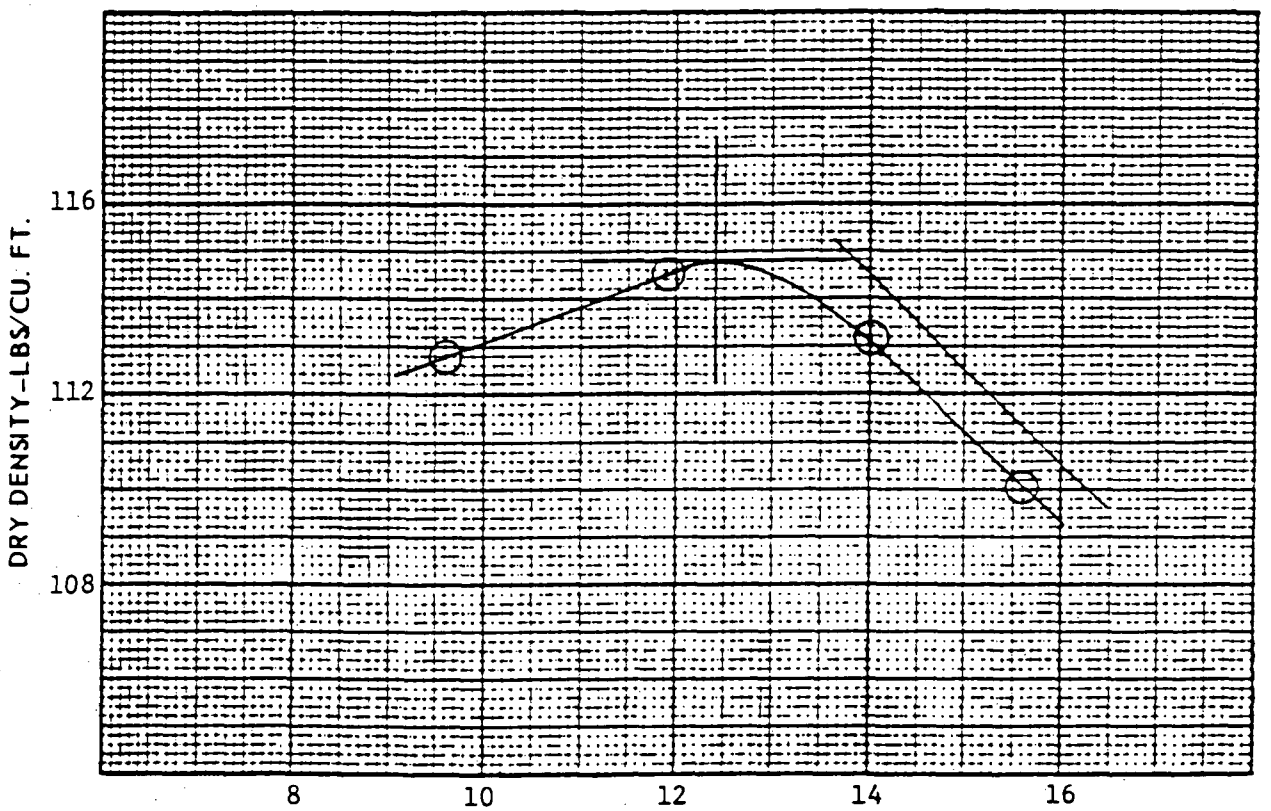
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA6-A1	12.4	114.8	ASTM D698	A	13-6

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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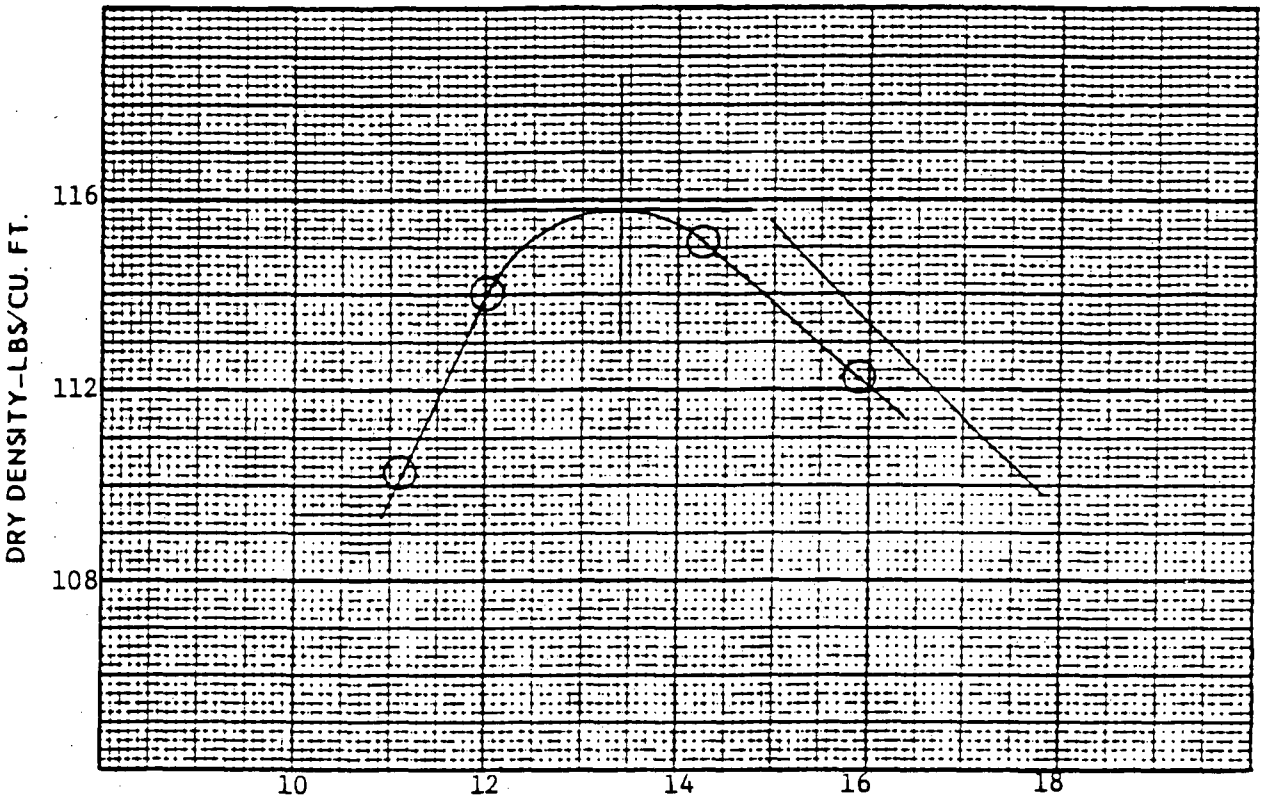
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA7-A2	13.4	115.8	ASTM D698	A	13-7

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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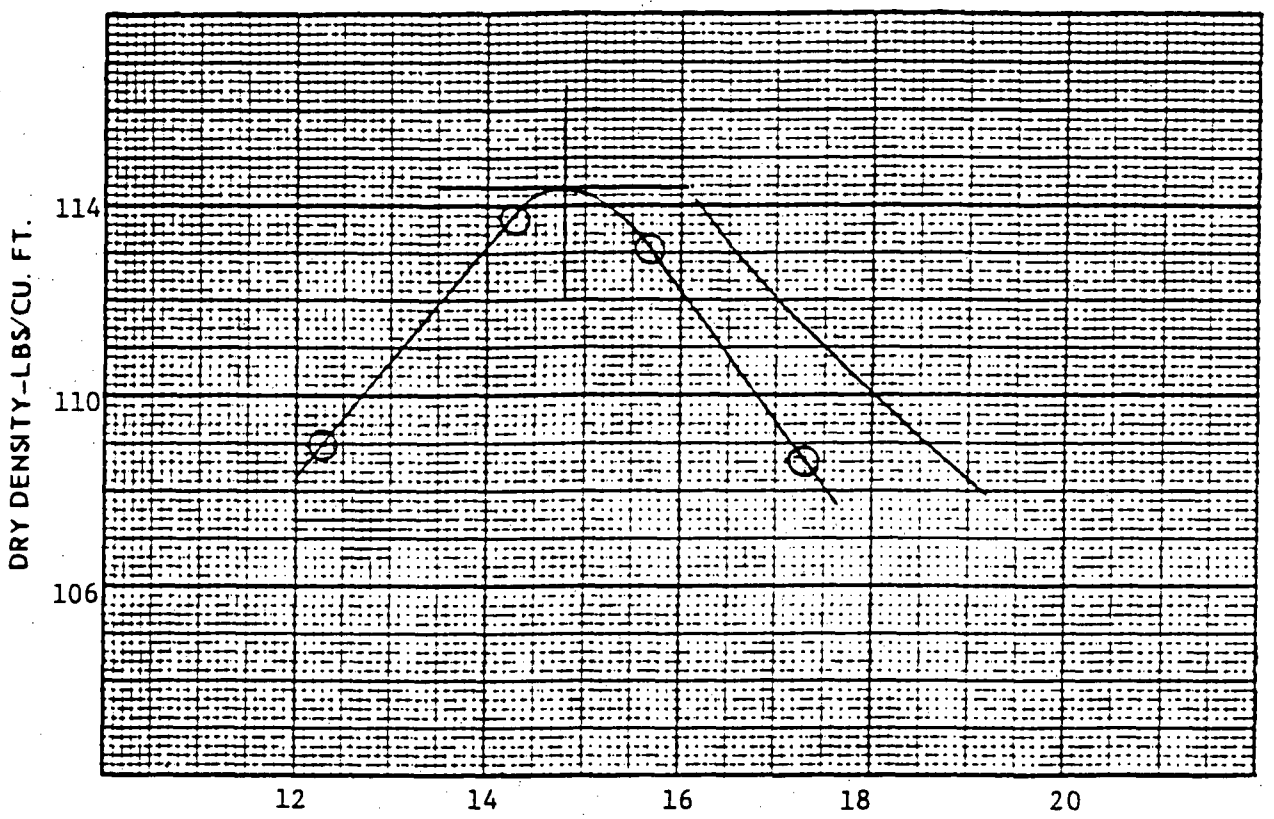
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA8-A1	14.8	114.4	ASTM D698	A	13-8

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
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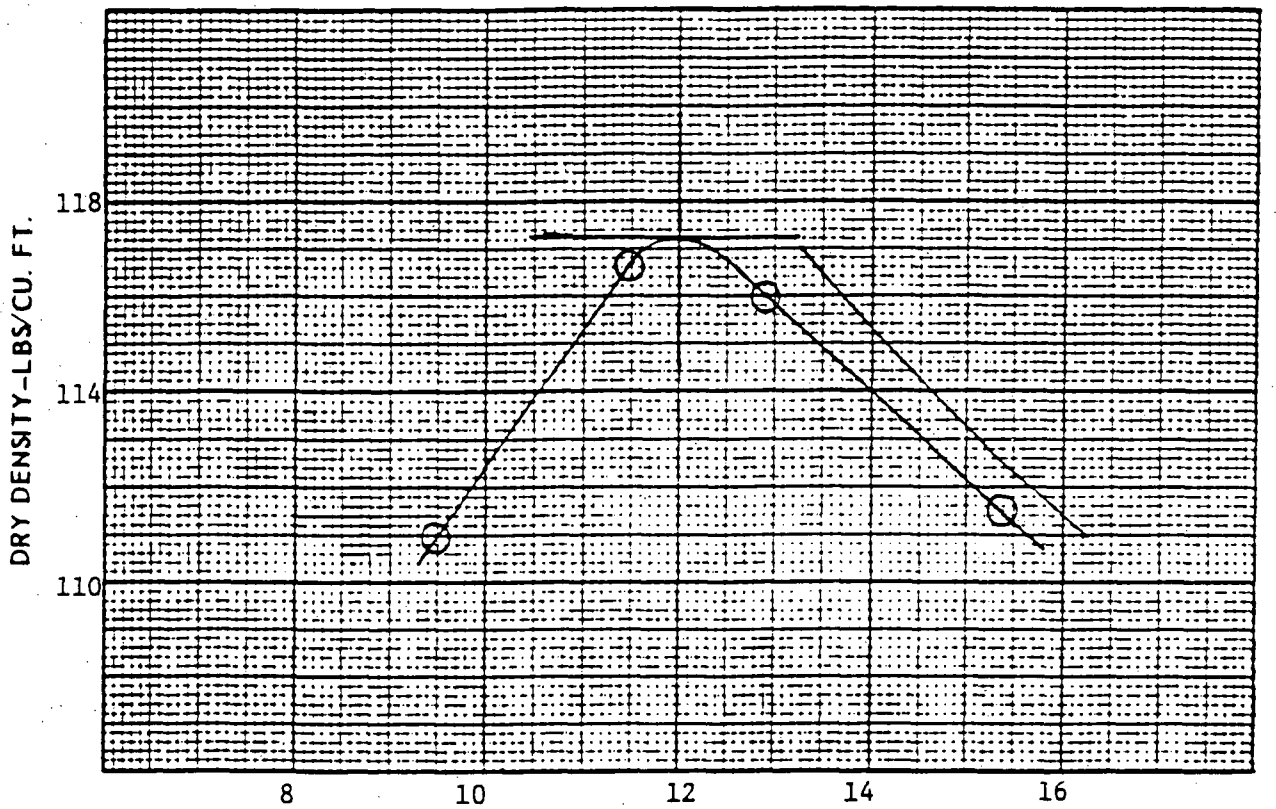
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** F86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA10-A1	12.0	117.2	ASTM D698	A	13-9

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
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D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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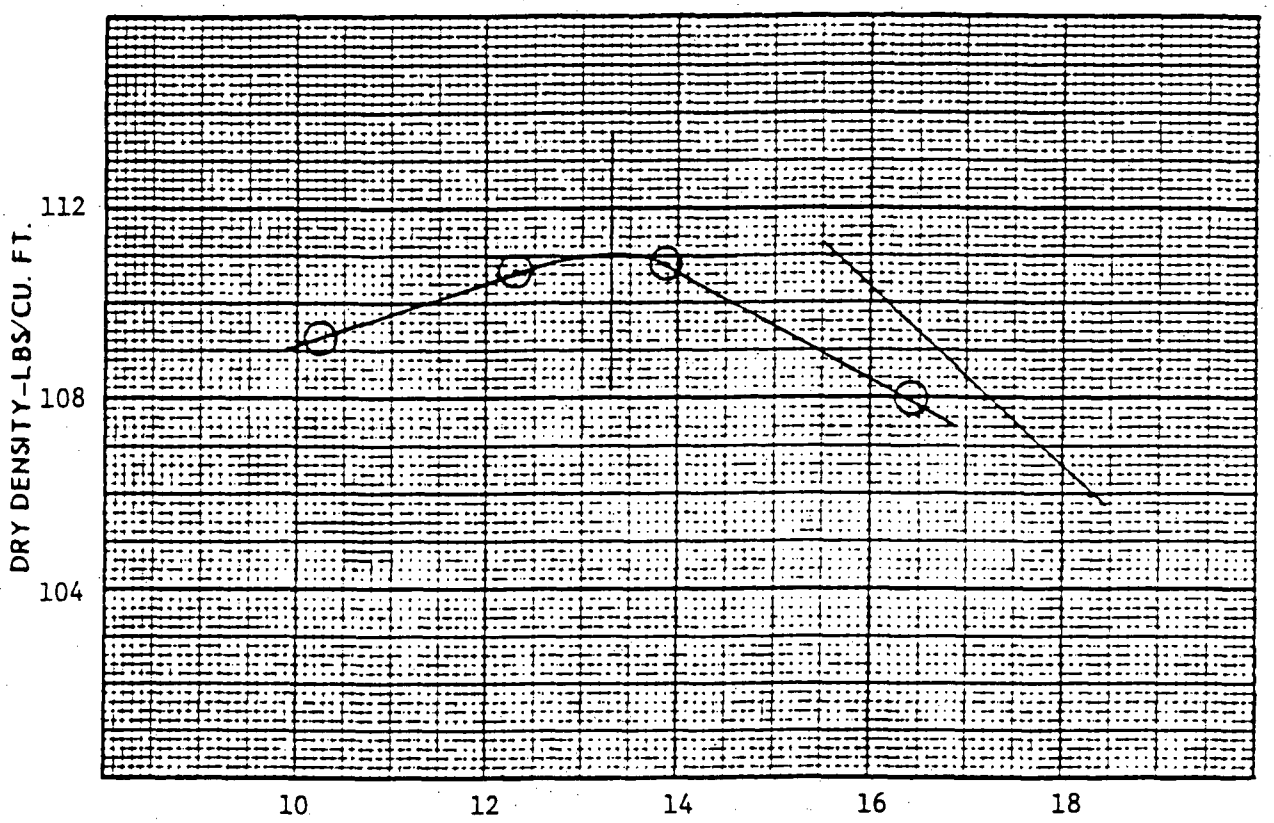
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA14-A1	13.3	111.0	ASTM D698	A	13-10

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
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D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
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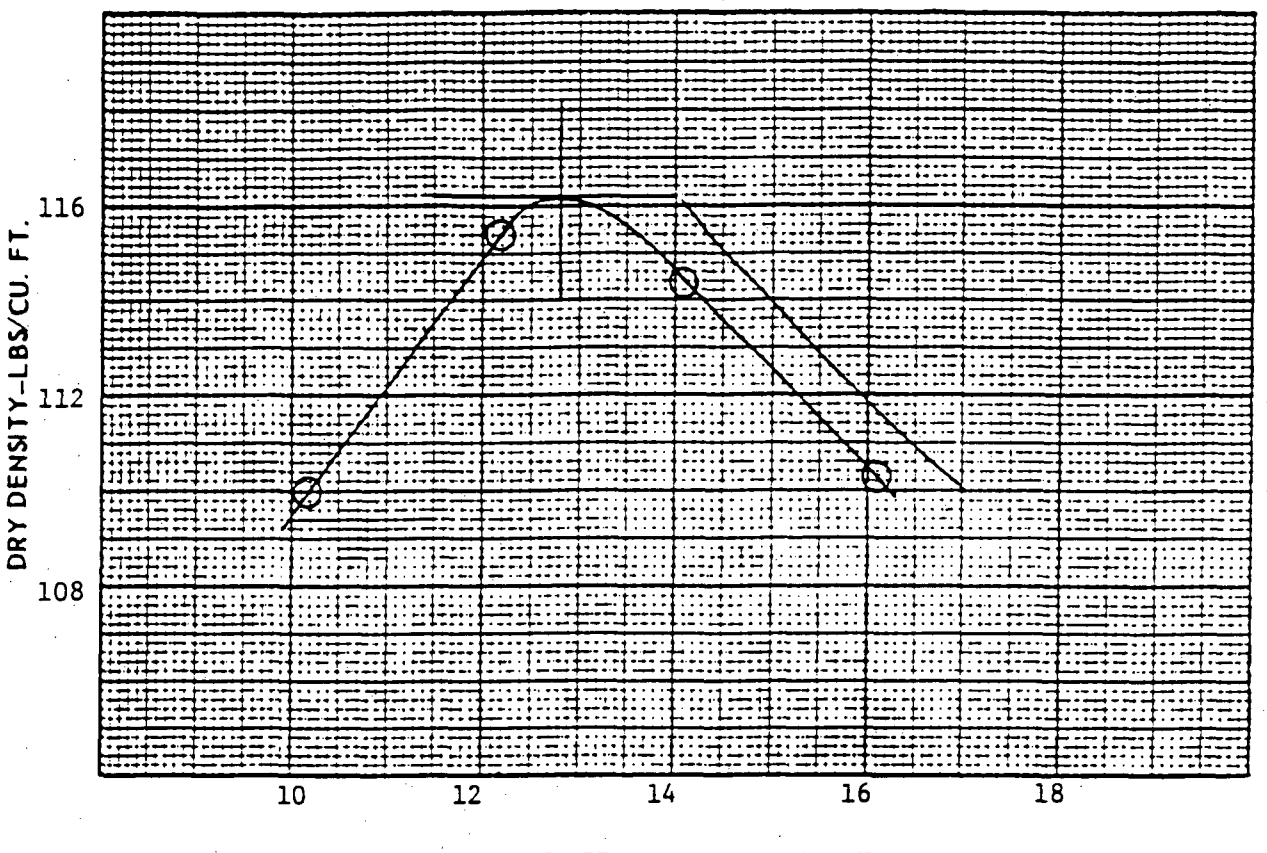
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA19-A1	12.8	116.2	ASTM D698	A	13-11

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
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AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
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APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING • HYDROLOGY

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RALPH E. WEEKS, P.G.
DARREL L. BUFFINGTON, P.E.
DONALD VAN BUSKIRK, P.G.
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DALE V. BEDENKOP, P.E.
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NORMAN H. WETZ, P.E.
ROBERT L. FREW
ALLON C. OWEN, JR., P.E.

July 31, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

Transmitted herewith is a table listing results of liquid limit and plasticity index tests performed in accordance with ASTM D4318, as requested in your letter of July 21, 1986. Also shown are the soil types of the samples according to the Unified Soil Classification System.

If you have any questions regarding these test results or those transmitted in our letter of July 28, please do not hesitate to contact us.

Respectfully submitted
Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

Copies: Addressee (2)

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

PHOENIX (602) 272-6848 | ALBUQUERQUE (505) 884-0950 | SANTA FE (505) 471-7836 | SALT LAKE CITY (801) 266-0720 | EL PASO (915) 778-3369

Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico
SHB Job No. E86-1113

Sample	Depth (feet)	U.S. Class.	Liquid Limit	Plasticity Index
BA1-S2	10-11.5	CL	32	11
BA2-S1	5-6.5	CH	52	31
BA2-S2	10-11.5	CL	48	28
BA4-S2	10-11.5	CL	48	26
BA6-S1	5-6.5	CL	47	27
BA7-S1	5-6.5	CL	42	22
BA7-S2	10-11.5	CL-CH	50	29
BA8-S1	5-6.5	CH	71	52
BA11-S4	20-21.5	CH	56	37
BA11-S5	25-26.5	CL	42	24
BA11-S6	30-31.5	CH	64	45
BA16-S1	5-6.5	CL	30	13
BA18-S4(B)	20-21.5	CL	33	14
BA19-S1	5-6.5	CH	52	32
BA20-S1	5-6.5	CL	39	20

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ROBERT L. FREW
ALLON C. OWEN, JR., P.E.

August 22, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

The table below presents results of moisture-density relationships, as determined by ASTM D698, on samples delivered by you to our lab August 15, 1986. Also listed are results of plastic and liquid limit tests, ASTM D4318. Moisture-density compaction curves are attached.

Sample	Optimum Moisture Content %	Maximum Dry Density (pcf)	Liquid Limit %	Plastic Limit %
TP1, B-1	19	102	40	20
TP2, B-1	13	110.5	23	19
TP4, B-1	16	112	24	19
TP4, B-2	22	102	37	18
TP5, B-1	21	102	45	18
TP7, B-1	16	109	25	18
TP8, B-1	21	100	35	19

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

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If you have any questions regarding these test results, please do not hesitate to contact us.

Respectfully submitted,

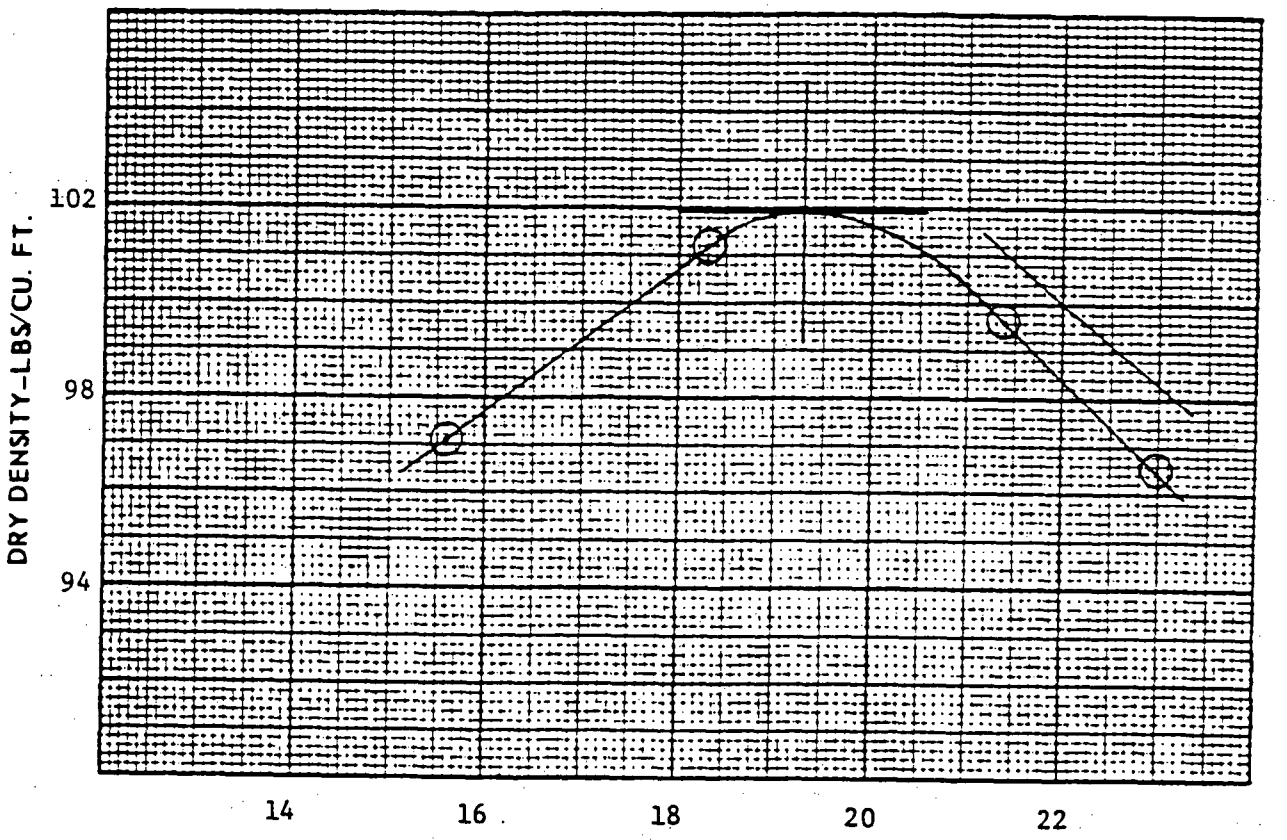
Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

Copies: Addressee (2)

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP1, B-1	19.3	101.9	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12.375
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D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12.317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56.250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55.986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55.986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55.986

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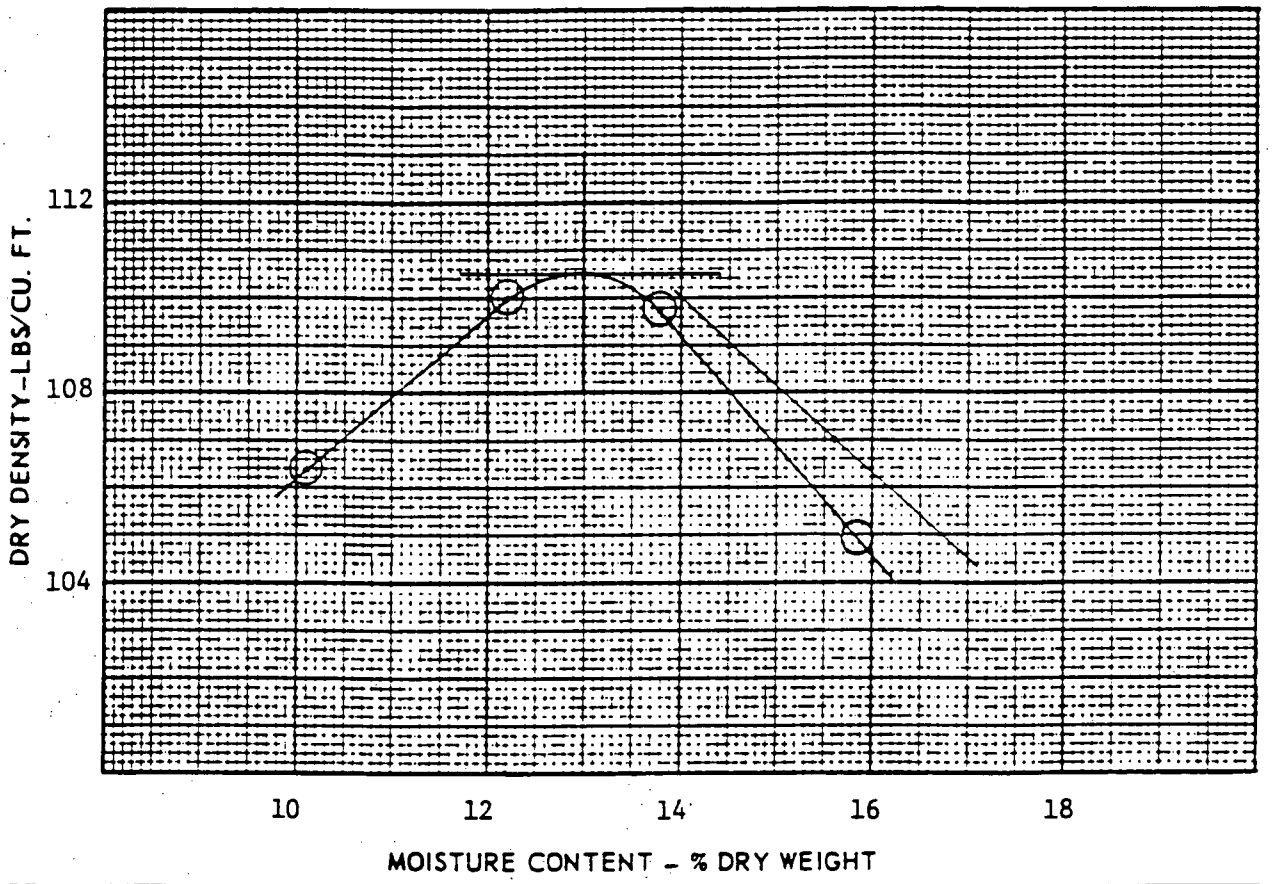
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP2, B-2	13.0	110.5	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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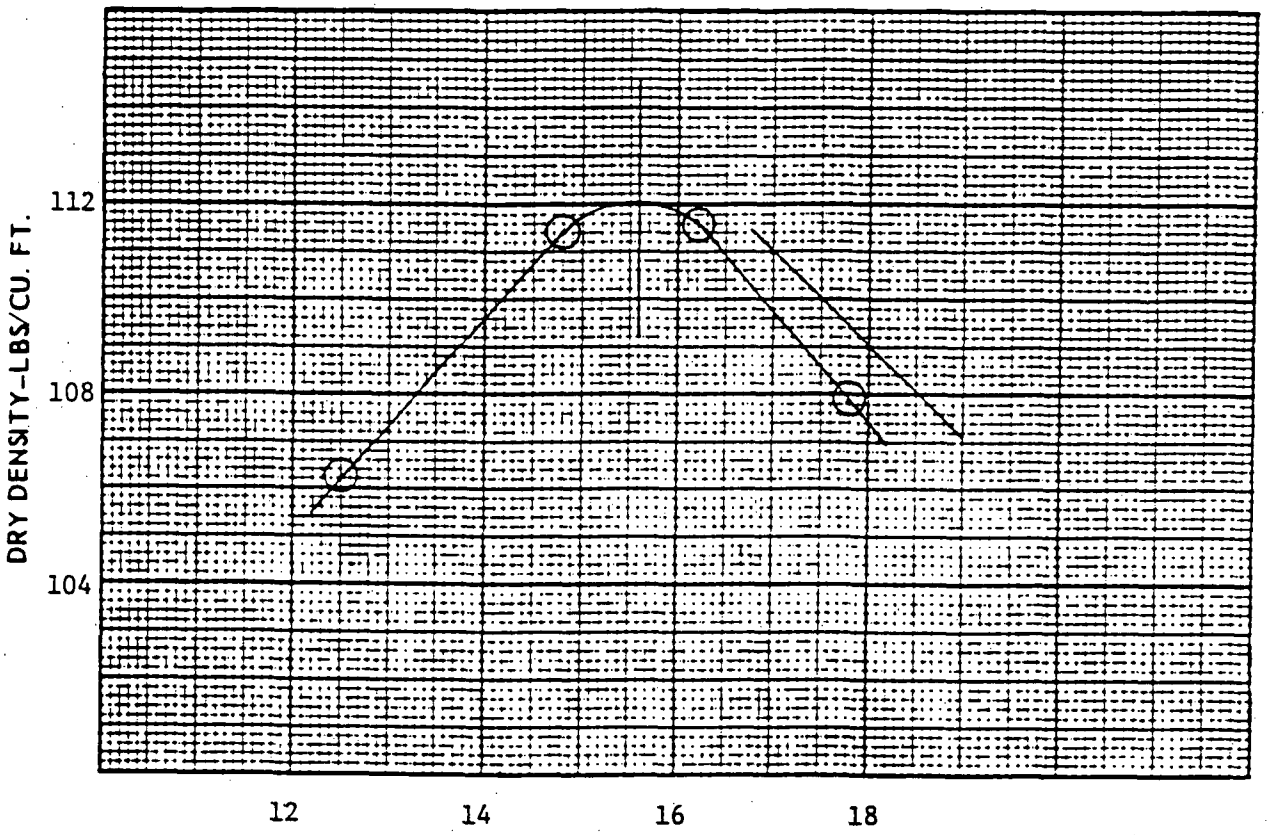
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP4, B-1	15.6	112.0	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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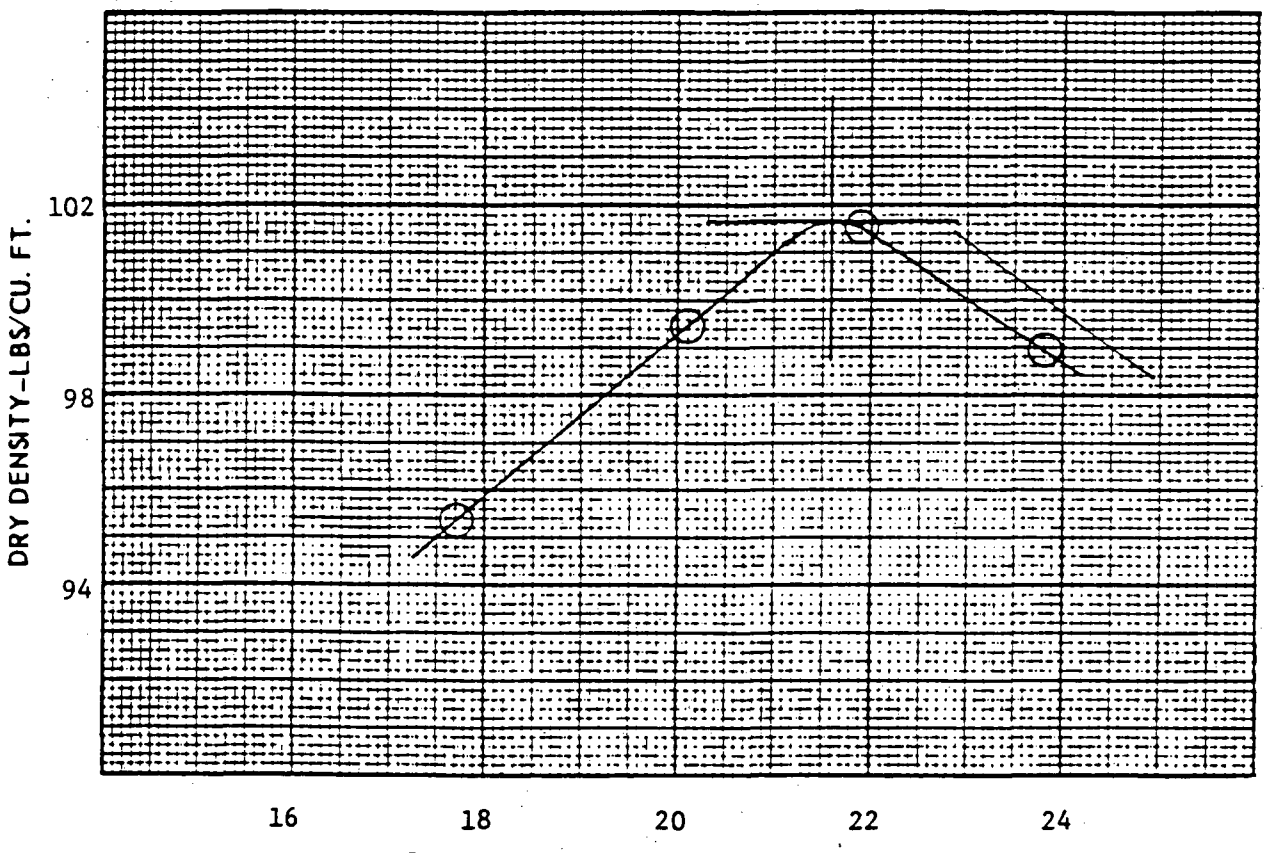
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP4, B-2	21.6	101.7	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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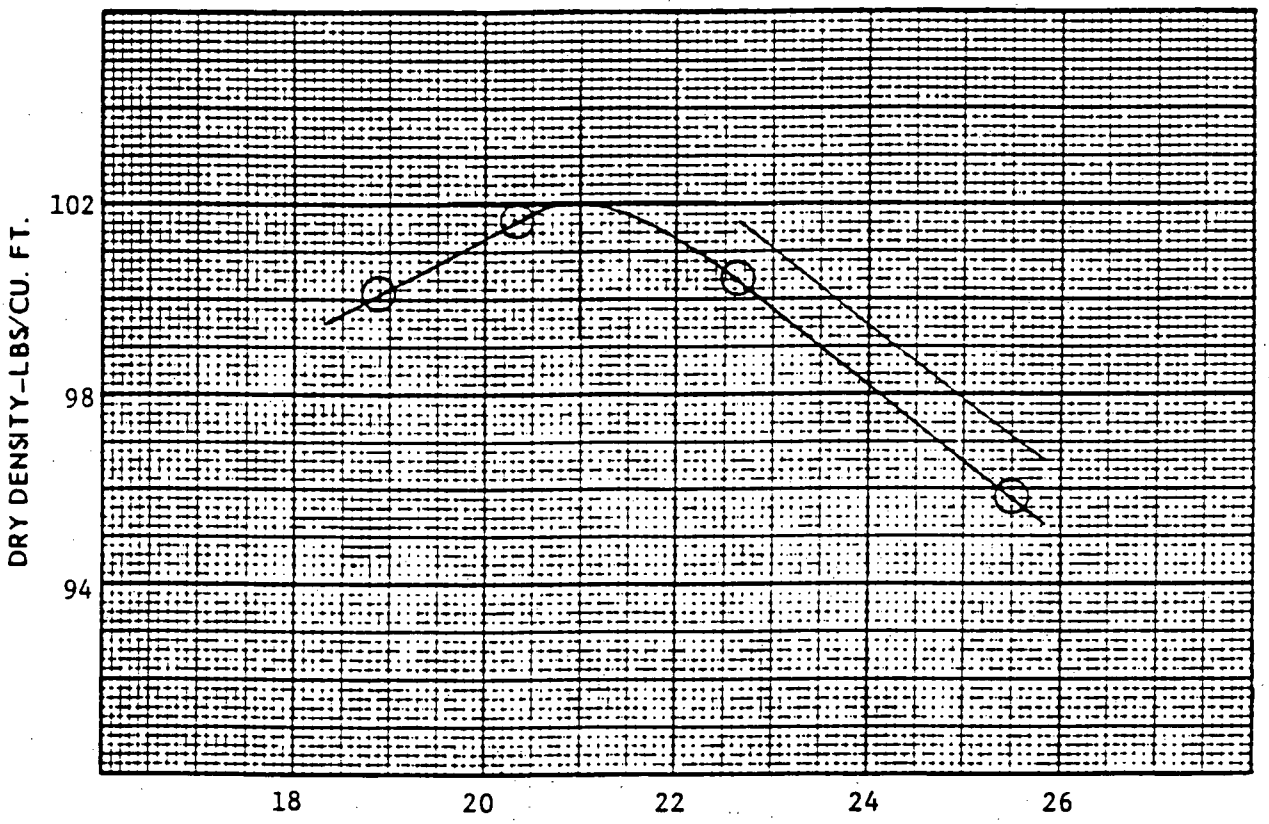
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP5, B-1	21.0	102.0	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
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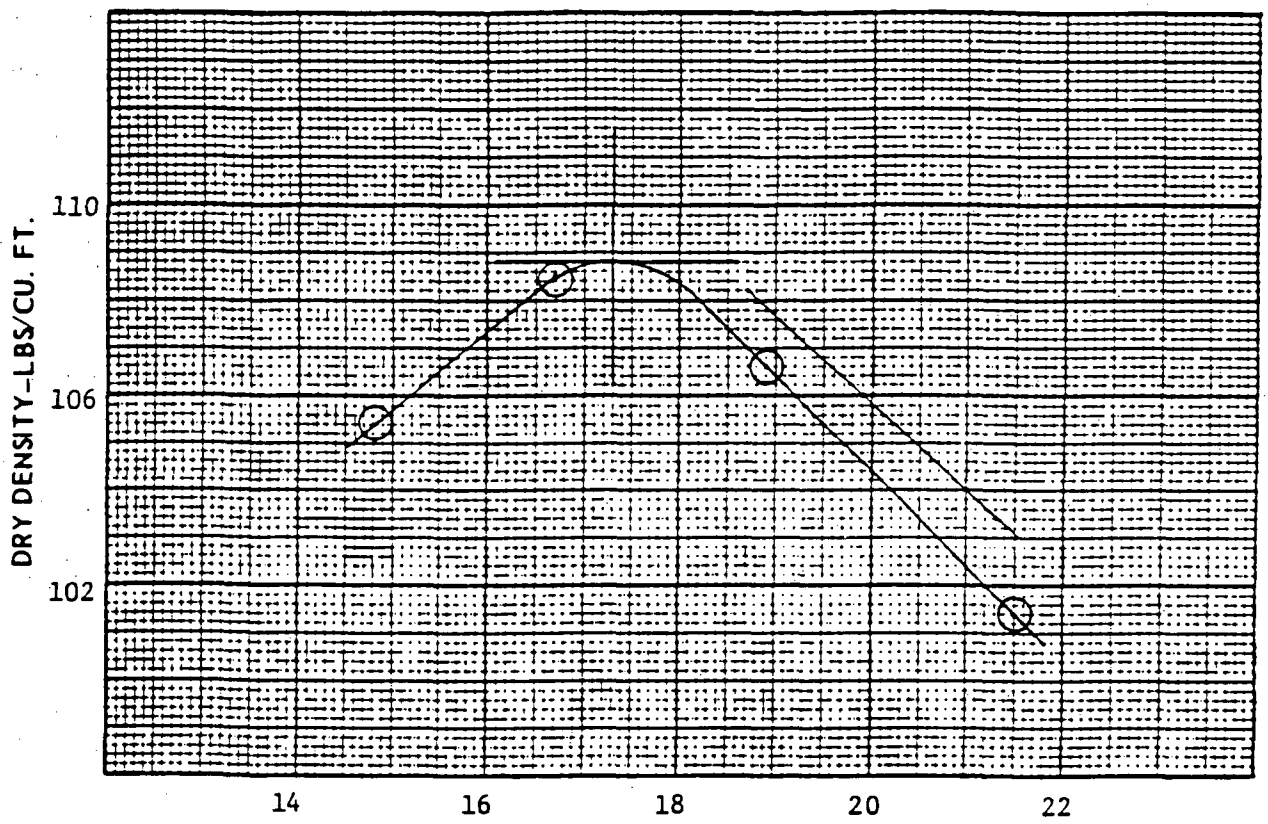
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP7, B-1	16.3	108.8	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
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AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
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C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
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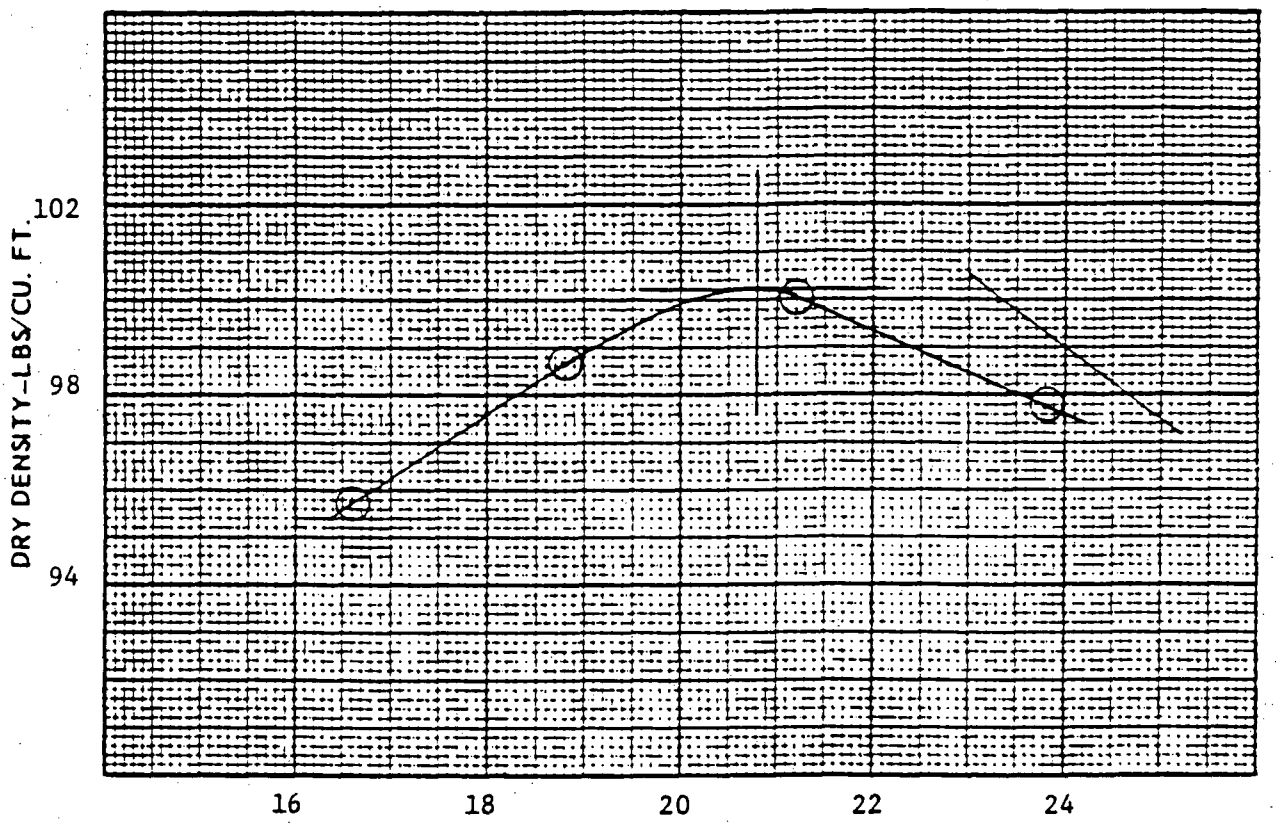
PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP8, B-1	20.8	100.2	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
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D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
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D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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September 3, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

The table below lists results of constant-head permeability testing performed. A constant water head of 11.5 feet was used to determine the hydraulic conductivities. Also presented are dry densities and water contents achieved prior to testing.

Sample	Dry Density (pcf)	Moisture Content (%)	Compaction* (%)	Hydraulic Conductivity (cm/sec)
BA1-A1	112.5	11.9	95.0	5.4×10^{-5}
BA3-A1	109.0	14.2	94.5	4.4×10^{-6}
BA5-A3	110.8	14.0	95.0	7.6×10^{-6}
BA19-A1	112.5	13.0	96.8	4.7×10^{-8}

* Relative to maximum dry density as determined in accordance with ASTM D698.

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

PHOENIX (602) 272-6848 ALBUQUERQUE (505) 884-0950 SANTA FE (505) 471-7836 SALT LAKE CITY (801) 266-0720 EL PASO (915) 778-3369

If you have any questions regarding these results, please do not hesitate to contact us.

Respectfully submitted,

Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

Copies: Addressee (2)

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PAUL KAPLAN, P.E.

November 6, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

Test results for specific gravity absorption, and sodium soundness are enclosed. These analysis were performed on the follwoing samples which were submitted on October 10, 1986.

Sample No. 1 - Massive Limestone, Surface
Sample No. 2 - Laminar Limestone, Surface
Sample No. 3 - Bluff Sandstone
Sample No. 4 - Red Sandstone, Recapture
Sample No. 5 - Limestone at 100 feet
Sample No. 6 - Sandstone at 100 feet

ASTM C-127

Specific Gravity & Absorption

Sample No.	Dry Bulk	SSD Bulk	Apparent	Absorption (%)
1	2.68	2.69	2.71	0.4
2	2.69	2.70	2.72	0.4
3	2.04	2.24	2.54	9.9

ASTM C-127

Specific Gravity & Absorption

Sample No.	Dry Bulk	SSD Bulk	Apparent	Absorption (%)
4	Sample very weathered, decomposed during preparation.			
5	2.64	2.66	2.70	0.9
6	2.11	2.28	2.55	8.1

ASTM C-88

Sodium Soundness (5 cycles)

Sample No.	Sieve Size	Individual Loss (%)	Average Loss (%)
1	-1.5" to +1.0"	0.2	0.2
	-1.0" to +0.75"	0.2	
2	-1.5" to +1.0"	0.1	0.2
	-1.0" to +0.75"	0.3	
3	-1.5" to +1.0"	38.4	44.2
	-1.0" to +0.75"	50.1	
4	Sample very weathered, decomposed during preparation.		
5	-1.5" to +1.0"	1.0	0.6
	-1.0" to +0.75"	0.3	
6	-1.5" to +1.0"	43.8	46.8
	-1.0" to +0.75"	49.8	

Qualitative Examination

Number of Particles

Sample No.	Before Test	Split	Crumbled	Cracked	Flaked	Sound
1	34	---	---	---	4	30
2	34	---	---	---	2	22

Qualitative Examination

Number of Particles

Sample No.	Before Test	Split	Crumbled	Cracked	Flaked	Sound
3	31	---	13	3	2	5
4	Sample very weathered, decomposed during preparation.					
5	24	---	---	1	4	19
6	23	---	5	2	4	6

If you have any questions regarding these results, please do not hesitate to contact us.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By Timothy R. Hyden
Timothy R. Hyden
Assistant Laboratory & Field Supervisor

Copies: Addressee (2)

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July 31, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

Transmitted herewith is a table listing results of liquid limit and plasticity index tests performed in accordance with ASTM D4318, as requested in your letter of July 21, 1986. Also shown are the soil types of the samples according to the Unified Soil Classification System.

If you have any questions regarding these test results or those transmitted in our letter of July 28, please do not hesitate to contact us.

Respectfully submitted
Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

Copies: Addressee (2)

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

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Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico
SHB Job No. E86-1113

Sample	Depth (feet)	U.S. Class.	Liquid Limit	Plasticity Index
BA1-S2	10-11.5	CL	32	11
BA2-S1	5-6.5	CH	52	31
BA2-S2	10-11.5	CL	48	28
BA4-S2	10-11.5	CL	48	26
BA6-S1	5-6.5	CL	47	27
BA7-S1	5-6.5	CL	42	22
BA7-S2	10-11.5	CL-CH	50	29
BA8-S1	5-6.5	CH	71	52
BA11-S4	20-21.5	CH	56	37
BA11-S5	25-26.5	CL	42	24
BA11-S6	30-31.5	CH	64	45
BA16-S1	5-6.5	CL	30	13
BA18-S4(B)	20-21.5	CL	33	14
BA19-S1	5-6.5	CH	52	32
BA20-S1	5-6.5	CL	39	20

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September 3, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

The table below lists results of constant-head permeability testing performed. A constant water head of 11.5 feet was used to determine the hydraulic conductivities. Also presented are dry densities and water contents achieved prior to testing.

Sample	Dry Density (pcf)	Moisture Content (%)	Compaction* (%)	Hydraulic Conductivity (cm/sec)
BA1-A1	112.5	11.9	95.0	5.4×10^{-5}
BA3-A1	109.0	14.2	94.5	4.4×10^{-6}
BA5-A3	110.8	14.0	95.0	7.6×10^{-6}
BA19-A1	112.5	13.0	96.8	4.7×10^{-8}

* Relative to maximum dry density as determined in accordance with ASTM D698. (ave. max. γ_d = 116.7)

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

PHOENIX (602) 272-6848 ALBUQUERQUE (505) 884-0950 SANTA FE (505) 471-7836 SALT LAKE CITY (801) 266-0720 EL PASO (915) 778-3369

If you have any questions regarding these results, please do not hesitate to contact us.

Respectfully submitted,

Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

Copies: Addressee (2)

SUMMARY OF LABORATORY TEST DATA

Location	Unified Classi-fication	Moisture Content (%)	Atterberg Limits LL	Atterberg Limits PI	Sieve Analysis % Passing by Weight 6"	3"	1½"	3/4"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	Description
Pit 2 at 5'	GP	-	-	-	100	70	60	47	38	31	27	25	23	19	10	6.5	GRAVEL, very sandy
Pit 2 at 7'	GP	-	-	-	100	62	62	53	44	36	30	25	22	15	7	3.9	GRAVEL, very sandy
Pit 3 at 8'	SP	-	-	-	-	100	96	88	78	73	67	59	52	27	14	5.3	SAND, very gravelly
Pit 4 at 10'	SP-SM	-	-	-	-	-	100	89	72	55	42	35	31	23	13	5.6	SAND, very gravelly
Pit 5 at 10'	SP-SM	-	-	-	-	-	100	91	75	62	51	43	37	26	14	6.2	SAND, very gravelly
Pit 8 at 5'	SM	-	-	-	-	-	100	97	84	74	69	65	62	53	31	17.8	SAND, very gravelly, silty
Pit 9 at 4'	SP-SM	-	-	-	-	-	100	96	87	78	69	60	52	31	15	8.7	SAND, very gravelly
Southeast Bank of Gravel Pit	SP	1.4	-	-	-	100	77	75	68	61	53	45	38	21	7	2.1	SAND, very gravelly
			ave.		100	82	87	79	68	59	51	45	40	24	14	7	
N-2-11 at 13½'	CH	-	56	35	-	-	-	100	98	96	95	94	93	90	81	67.4	CLAY, very sandy

ave Std. Proctor 111.2 (12 tests), 95% = 105.6 pci

ave −0.002 % IS 29.3 (10 samples)

ave. long term moisture as w% = 16.3

PRELIMINARY

V. NAVARRO, 1990

SOUNDNESS, SPECIFIC GRAVITY AND ABSORPTION TEST RESULTS

HOMESTAKE MINE

Test	Depth	Description	Soundness Loss (%)*	Specific Gravity (SSD)	Bulk Specific Gravity	Apparent Specific Gravity	Absorption (%)
10	1' - 6'	highly vesicular	1.3	2.361	2.392	2.422	2.6
10	6' - 14'	moderately vesicular	0.3	2.652	2.654	2.671	1.6
10	24'- 30'	slightly vesicular	0.2	2.784	2.789	2.807	0.6
11	0' - 4'	highly vesicular	0.6	2.368	2.398	2.426	2.1
11	4' - 14'	moderately vesicular	0.3	2.651	2.657	2.673	1.0
11	24'- 30'	slightly vesicular	0.5	2.782	2.788	2.806	0.7
12	0' - 5'	highly vesicular	1.3	2.362	2.393	2.421	2.9
12	5' - 14'	moderately vesicular	0.8	2.646	2.653	2.669	1.3
12	14'- 24'	slightly vesicular	2.4	2.784	2.801	2.821	0.5
13	0' - 5'	highly vesicular	1.2	2.360	2.390	2.420	2.7
13	5' - 14'	moderately vesicular	1.3	2.649	2.660	2.683	1.2
13	14'- 24'	slightly vesicular	5.0	2.781	2.792	2.811	0.9

* Magnesium Sulfate, Five Cycles)

VINYARD AND ASSOCIATES, 1990

V & A

LOG OF TEST HOLE NO. M-1

Project: Homestake Malpais — Project No. 90-1-60

Elevation - Top of Test Hole: n/a — Date Drilled: 6/25/90

Depth to Groundwater: not encountered — Drilling Method: 6" Rotary

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
							BASALT, dark gray, non crystaline, very vesicular
10							BASALT, gray, 50% plagioclase crystals, 1% olivene crystals, trace of fine pores, fine-grained
20							BASALT, fine-grained, 50% plagioclase crystals, 1% olivene crystals, trace sulfide crystals, trace garnet crystals, harder drilling
30							
40							BASALT, 60% plagioclase crystals, fine-grained, 1% olivene crystals, 1% garnet, 2% light gray-white grains
50							Bottom of Hole at 49'
60							

PRELIMINARY

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST HOLE NO. M-2

Project: Homestake Malpais — Project No. 90-1-60

Elevation - Top of Test Hole: n/a — Date Drilled: 6/25/90

Depth to Groundwater: not encountered — Drilling Method: 6" rotary

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	SAND, silty, fine-grained, gravelly, coarse to fine, slightly moist, brown
						CL	CLAY, very sandy, fine-grained, medium moist, brown
10						SM	SAND, silty, fine-grained, slightly moist, orange brown
20							Bottom of Hole at 19' Hole caved
30							
40							
50							
60							

PRELIMINARY

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST HOLE NO. M-3

Project: Homestake Malpais — Project No. 90-1-60

Elevation - Top of Test Hole: n/a — Date Drilled: 6/25/90

Depth to Groundwater: not encountered — Drilling Method: 6" Rotary

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
							BASALT, dark gray, non crystaline, very vesicular
10							
							Less vesicular, slightly crystaline
20							
30							
							1% olivene crystals
40							
50							Bottom of Hole at 49'
							Bit worn, cones loose
60							

PRELIMINARY

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST HOLE NO. M-4

Project: Homestake Malpais — Project No. 90-1-60

Elevation - Top of Test Hole: n/a — Date Drilled: 6/26/90

Depth to Groundwater: not encountered — Drilling Method: 6" Rotary

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
							BASALT, dark gray, non crystaline, very vesicular
10							BASALT, gray, 25% plagioclase crystals, 1% olivene crystals, less vesicular
						CL	CLAY, very sandy, fine-grained, brown, sli. moist
20							BASALT, 10% plagioclase, 1% olivene crystals, vesicular
30							BASALT, not vesicular, 50% plagioclase crystals, trace olivene,
							65% plagioclase crystals
40							
50							Bottom of Hole at 49'
60							

PRELIMINARY

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST HOLE NO. M-5

Project: Homestake Malpais — Project No. 90-1-60

Elevation - Top of Test Hole: n/a — Date Drilled: 6/26/90

Depth to Groundwater: not encountered — Drilling Method: 6" Rotary

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	SAND, silty, fine-grained, slightly moist, brown
							Occasional clay layers
10							
							Dark brown
							Light brown
						CL	CLAY, very sandy, fine-grained, sli. moist, brown
20							Bottom of Hole at 19'
30							
40							
50							
60							

PRELIMINARY

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST HOLE NO. M-6

Project: Homestake Malpais — Project No. 90-1-60

Elevation - Top of Test Hole: n/a — Date Drilled: 6/26/90

Depth to Groundwater: not encountered — Drilling Method: 6" Rotary

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
							BASALT, dark gray, trace to nil light gray grains, trace olivene, moderately vesicular
10							BASALT, dark gray, 35% light gray crystals, trace olivene
							Slightly vesicular, 50% light gray, trace olivene
20							BASALT, 50% light gray plagioclase, 2% red brown garnet
							Change b
							BASALT, 50% plagioclase, 4% garnet
							BASALT, 50% plagioclase, 4% garnet, 2% olivene
30							
							BASALT, 60% plagioclase, 4% garnet, 2% olivene
40							BASALT, 55% plagioclase, 2% olivene, 1% garnet
							BASALT, 65% plagioclase, 5% garnet, 8% olivene
50							BASALT, 65% plagioclase, 1% garnet, 1% olivene crystals, 1% hematite
							Bottom of Hole at 49'
60							

PRELIMINARY

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

850' N. of Co. Rd.
N. of sink hole

V & A

LOG OF TEST HOLE NO. M-7

Project: Homestake — Project No. 90-1-60

Elevation · Top of Test Hole: — Date Drilled: 6-27-90

Depth to Groundwater: — Drilling Method: 6" Rotary Tricone

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description	
						SM	Sand, silty, fine grained	1.40
		B					Basalt, dark gray-black noncrystaline moderately vesicular	
		B					Basalt, dark gray, 30% plagioclase 2% olivene, less vesicular	
10		B					a.a.	
		B					Basalt, dark gray, 30% plagioclase, 1% olivene 2% garnet (brown)	
Add 20		B						2.12
		B					Basalt, gray, 50% plagioclase, 1% olivene a.a.	2.19
		B					Basalt, gray, 50% plagioclase, 2% olivene	
30		B					Basalt, gray, 50% plagioclase, 3% olivene	
Add		B					Basalt, gray, 50% plag., 2% olivene	2.51
								3.02
40		B					Basalt, dark gray to Black / ~~Rig Down Bearing Broke~~ Very vesicular, some red brown chips	3.4
		B					Basalt, dark red brown, very vesicular (possible pyrite grains?)	4.25
							lost circulation	
50								4.9
60								

PRELIMINARY

BOH @ 49'

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Volumes of Rock 300,000. yds deep 500'

Figure

26 to Rock
275' ~~S.R.~~ Co. Rd.
590' to Pipeline

V & A

LOG OF TEST HOLE NO. M-8

Project: Homestake ~~Rip Rap~~ Malpais Project No. 90-1-60

Elevation - Top of Test Hole: N/A Date Drilled: 6-27-90

Depth to Groundwater: not encountered Drilling Method: 6" Rotary

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	~~New, used bit~~ Material Description ~~Sand~~, silty, fine grained	
		B					Basalt, dark gray, very vesicular, non crystalline	9:45 9:00
		B					Basalt, dark gray, 1% olivene ~~crystals~~, ~~moderately~~ vesicular slightly crystaline	
10		B					aa w 10% plagioclase crystal	
							~~1/2 mm xtals~~	9:18
add 20		B					Basalt, dark gray, 40% plagioclase, 1% olivene, trace biotite, slightly vesicular	9:24 9:3
		B					Basalt, gray, 50% plagioclase, 3% olivene, trace garnet	
		B					Basalt, gray 50% Plagioclase, 4% Garnet, 3% olivene Soft	
30		B					lost air circulation from 29'-31'	9:42
add							Basalt, red brown, non crystalline very vesicular	9:44 9:55
							poor circulation	
40		B					Basalt, dark red brown, 2% Garnet trace vesicular	
		B					Basalt, red brown, 2% Garnet, slight fine no circulation, no returns	10:03 Done
50								
60							PRELIMINARY B.O.H. @ 49'	

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

124 → M8
56° → M6

V & A

LOG OF TEST HOLE NO. M-9

Project: Homestake — Project No. 90-1-60

Elevation - Top of Test Hole: — Date Drilled: 6-27-90

Depth to Groundwater: — Drilling Method: 6" Rotary Tricone

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description	
							Basalt, dark gray, black non xtline, trace olivene crystals, very vesicular	10:45
		B					faster drilling, 6" void @ 2"	
		B					Basalt, dark gray, trace of plagioclase, 3% olivene moderately vesicular	
10		B					Basalt 25% Plagioclase 1% olivene, dark gray	
		B					Soft from 14'-15'	
Add 20							Basalt, gray, 40% plagioclase, 2% garnet 2% olivene, some vesicular fragments	11:16
		B					Basalt, gray, 40% plagioclase, 3% olivene	add oil 11:27 11:30
		B					Soft, Basalt, red brown, vesicular Poor returns	
30								
Add		B					Basalt, brown dark, 4% garnet trace vesicular,	11:41 11:48
		B					Basalt, dark gray + dark brown grains 8% light gray banded grains no gravel size returns	
40		B					Basalt, gray, 40% plagioclase, 2% olivene 6% light gray to white grains	
		B					a.a.	12:15
50							BOH @ 49	
60								

PRELIMINARY

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST HOLE NO. M 10

Project: Homestake — Project No. 90-1-60

Elevation · Top of Test Hole: — Date Drilled: 7-5-90

Depth to Groundwater: not encountered — Drilling Method: Core NX Water

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description	
							6" soil	11:30
							Basalt. lost circulation	
							Basalt, very vesicular 50% plag xtals	11:43 / 11:53
10							less vesicular, few voids < 1/4" ϕ	12:00 / 12:06
							1/2" ϕ voids @ 6" intervals	
								12:19 / 12:25
20								
							vertical fracture in core [go for water →	12:45 / 1:32
							few large voids, porous rock, fine pores 60% plagio clase 1-2% olivene	
30								
							lost 7" of core	1:49 / 2:11
40								
							core stuck in barrel	2:30
							15 min. Rain standby for lightning	2:52
50								3:00

PRELIMINARY

1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

S.E. Corner of Area

V & A

LOG OF TEST HOLE NO. M 11

Project: Homestake

Project No. 90-1-60

Elevation · Top of Test Hole:

Date Drilled: 7-6-90

Depth to Groundwater:

Drilling Method: NX Core

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
							6" Soil cover 8:22
	60%	core					Basalt, very vesicular ½" voids – ⅛" voids non crystaline
							lost circulation @ 2' 8:29
							crystaline 8:45
							less vesicular, few ½" voids per foot, fine pores
10	100%	core					50% plagioclase 1% olivene
							Some horizontal void planes (⅛" voids) ½" voids
							9:02
							Basalt, brown gray color, few ½" voids per foot 9:09
	95%						fine pores, 60% plagioclase, <1% garnet
20		core					
							gray color 60% plagioclas 9:24
							few ½" voids per foot 9:28
							less voids, fine pores
30		core					50% plagioclase, 1% olivene 1% garnet
	100%						9:40
							9:46
40							+ 60% plagioclase
							trace of voids 10:01
	100%						10:12
							Thin dense layer 5" thick after water
50							
							11:12
							~~11~~ 1½/e

PRELIMINARY

1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST HOLE NO. M 12

Project: Homestake Malpais — Project No. 90-1-60

Elevation - Top of Test Hole: — Date Drilled: 7-9-90

Depth to Groundwater: — Drilling Method: NX Core

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
							1 Rig, 1 water Truck, 1 Pickup; 1 Driller, 1 helper — 9:15 Crew @ Rig @ Homestake yard; 9:57
	100% 5'2"	NX					very vesicular; moderately vesicular; 50-60% plagio clase crystals — lost circulation @ 2' — 10:05; 10:15
10	100% 9'8"	NX					slightly vesicular, few ½" voids per foot,
	9'8" 96%	NX					slightly vesicular, brown gray color 14'-20' — 10:25; 10:35; vertical fracture from 14'-19'
20							thin, small ¼" void layers @ 6"-1' intervals; gray color, 60% plagioclase — 10:47; 10:57
	10'1" 100%	NX					gray color; trace of voids — Drill pipe chattering
30							11:15; 11:25
40	100%	NX					11:45; 11:58
50							BOH @ 50'
							PRELIMINARY
							1:00 Rig off

1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST HOLE NO. M 13

Project: Homestake — Project No. 90-1-60

Elevation · Top of Test Hole: — Date Drilled: 7-6-90

Depth to Groundwater: — Drilling Method: NX core

1 Driller 1 Rig, 1 Water Truck, 1 - Pick-up
2 Helpers

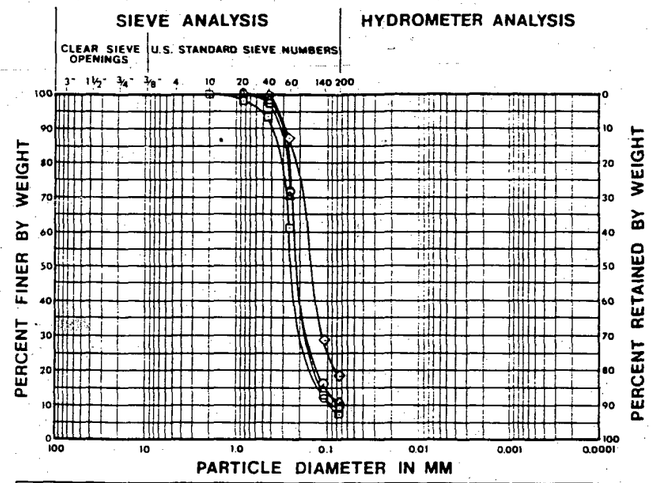
Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description	
								11:29
	100%	5' 2"					Basalt, very vesicular, fine grained crystaline 40% plagioclase crystals	11:38 / 11:46
10	95%	NX core 9"					Basalt, moderately vesicular gray 50% plagioclase fine crystals <2% olivene crystals fine pores	"
							Slightly vesicular	12:57 / 12:05
20	100%							
								12:20 / 12:25
30	100%						gray	
							Dark Gray basalt, vesicular, 1/8" voids 8" thick	12:38 / 1243
40							as above	
50								

PRELIMINARY

1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

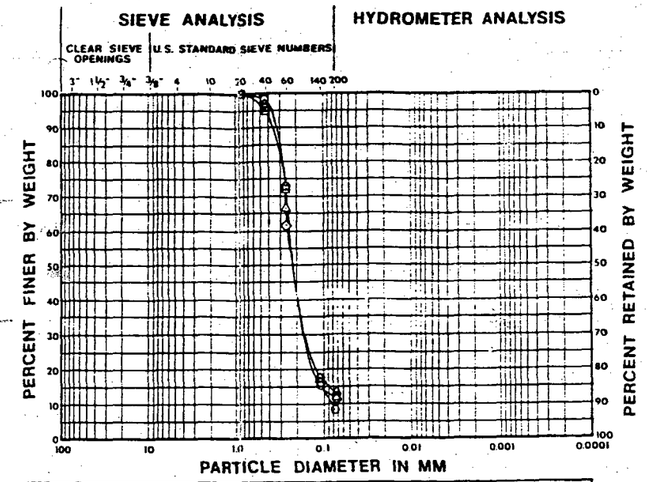
Figure

DRAWN BY	TEJ 10-22-80	CHECKED BY	DWN MST	10-24-80	DRAWING NUMBER RM80-311-E1
		APPROVED BY		10-29-80	



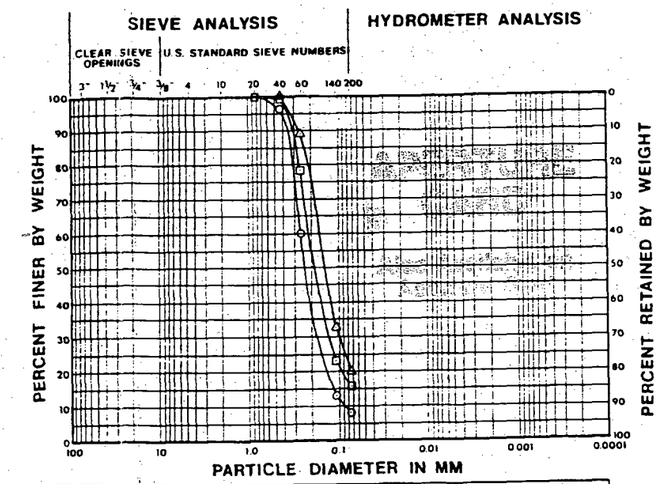
COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-1A	S-5	25.0-26.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.09	2.7	6
△	DB80-1A	S-9	45.0-46.5	BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	13
□	DB80-2A	ST-1	7.5-9.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.095	2.6	20
⊙	DB80-3	ST-5	25.0-26.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.08	3.3	10
◇	DB80-3	S-15	75.0-76.5	BROWN-GRAY, FINE SAND, SOME SILT	SM	N/A	N/A	24



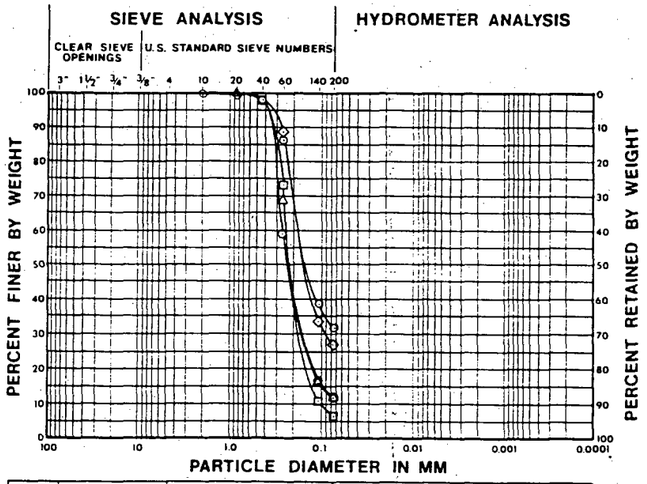
COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
⊙	DB80-5A	S-3	15.0-16.5	LIGHT BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	8
□	DB80-5A	S-13	65.0-66.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	23
△	DB80-6A	S-2	10.0-11.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	18
⊙	DB80-7	S-4	20.0-21.5	TAN, FINE SAND, SOME SILT	SP-SM	0.08	3.0	8
◇	DB80-7	S-8	40.0-41.5	DARK BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	11



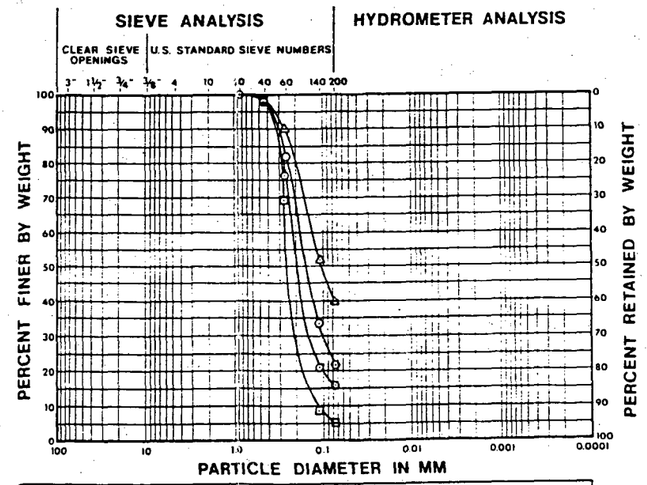
COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
⊙	DB80-16	S-3	15.0-16.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.090	2.3	23
□	DB80-16	ST-1	35.0-37.0	GRAY, FINE SAND, SOME SILT	SM	N/A	N/A	23
△	DB80-16	S-8	45.0-46.5	GRAY, FINE SAND, SOME SILT	SM	N/A	N/A	29



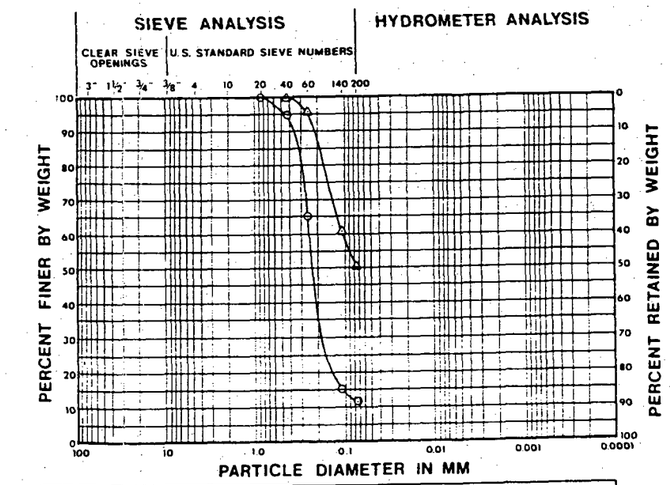
COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-14	S-3	15.0-16.5	BROWN, FINE SAND AND SILT	SM	N/A	N/A	27
□	DB80-14	S-5	25.0-26.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.10	2.4	27
△	DB80-14	ST-1	30.0-32.0	BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	18
⊙	DB80-14	S-8	40.0-41.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	15
◇	DB80-14	S-11	60.0-61.5	GRAY FINE SAND, SOME SILT	SM	N/A	N/A	25



COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-7	S-13	65.0-66.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	22
□	DB80-17	S-4	20.0-21.5	BROWN, FINE SAND, TRACE OF SILT	SP	0.12	2.3	4
△	DB80-17	S-6	30.0-31.5	BROWN, SILTY SAND	SM	N/A	N/A	24
⊙	DB80-19	S-4	20.0-21.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	14



COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	FROM CYCLONE TRUCK	COARSE TAILINGS		BROWN, SILT AND FINE SAND	SM-ML	N/A	N/A	N/A
△		FINE TAILINGS		BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	N/A

FIGURE 14

TAILINGS GRAIN SIZE CURVES

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

9810280099-15

D'APPOLONIA

TP- 10

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-10 Date 9/22/87 Logged by A.K. Kuhn

Location Description S. of SE corner of tailings pile

NM Grid Coordinates 492500 E 1542600 N

Depth	Sample (J=jar, B=bag)	Description
0		CH - Brown clay, plastic, moist, stiff
	← J1 B1	grades downward to less plastic clay with some f. sa or silt
		CL
5		
5.2		SP - tan f. sa, moist, med. to dense mottled with gray
10		bottom

COMMENTS: pit offset 80' south of staked location due to scrap metal

TP-11

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-11 Date 9/22/87 Logged by A.K. Kuhn

Location Description along diversion N. of old pile

NM Grid Coordinates 1492000 E 1542600 N

****

Depth	Sample J=jar B=bag	Description
0		sa. + clay fill
		SP - tan f. sa, loose to med., moist
5		
		SC - dk. gray, mottled sandy clay/clayey sa. moist
		SP - lt. gray f. sa, loose-med, moist bottom
10		

****

COMMENTS:

No samples taken

TP-12

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-12 Date 9/21/87 Logged by A. K. Kuhn

Location Description near NW corner of old pile

NM Grid Coordinates 491500 E 1342600 N

****

Depth	Sample (J=jar, B=bag)	Description
0		Sa. fill,
	← J1 B1	
		CH - gray-brown plastic clay, wet, soft to firm
		SP - lt. tan f. sa., damp
5		
5.5		CH - gray plastic clay, firm to stiff moist
	← J2 B2	
8.5		SP - lt. gray f. sa., moist bottom
10		

****

COMMENTS: both clays are very plastic, look the same

TP- 13

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 13 Date 9/21/82 Logged by A.K. KUHN

Location Description S. of middle of tailings pile

NM Grid Coordinates 491000 E 1542600 N

****

Depth	Sample (J=jar, B=bag)	Description
0	← J1, B	CH – Brown, plastic clay, stiff, damp. grades to CL from 2' to 3'
3.5		SP – tan f. sa., med., damp
5.4	← S2, B2	SC – dark brown to black sa. clay to clayey sa, some organic moist, dense/stiff
10		bottom

****

COMMENTS:

TP-14

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-14 Date 9/21/87 Logged by A.K. KUHN

Location Description along diversion S. of pile

NM Grid Coordinates 490500 E 1542600 N

****

Depth	Sample (J=jar, B=bag)	Description
0		CL - Brown clay, stiff, slightly moist
	← J1	
	B1	
5		SP - tan f. sand, dense, slight moisture
		grades to interbedded lt. gray and dark purplish gray last 3 feet.
		bottom
10		

****

COMMENTS:

Offset 100' east to clear metal scrap area

TP- 15

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 15 Date 9/21/87 Logged by A. K. Kuhn

Location Description S. of west tailings pond

NM Grid Coordinates 490000 E 1542600 N

****

Depth	Sample (J=jar, B=bag)	Description
0	J1 B1	CL - Brown clay, damp, stiff
~~2.8~~ 2.8		SP - tan f. sa, loose to med. moist
5		CH - mottled gray/brown moist clay, firm
		SP/w. cl, to SC - interbedded tan to dark brown fine sand, trace roots, stringers of clay, wet
10		bottom

****

COMMENTS:

Top clay is similar to TP-17

TP- 16

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 16 Date 9/21/87 Logged by A.K. KUHN

Location Description along diversion south of pile

NM Grid Coordinates 1489500 E 1542600 N

****

Depth	Sample J=jar B=bag	Description
0		SM - f. sandy silt/silty sa., lt. brown dense, damp
		grades downward to
		SP - lt. brown f. sa., moist
5		
		SP - same as above but wet to saturated
		bottom
10		

****

COMMENTS: No samples

TP-17

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-17 Date 9/21/87 Logged by A.K. Kuhn

Location Description SW of SW corner of pile, along diversion

NM Grid Coordinates 489000 E 1542600 N

****

Depth	Sample (J=jar, B=bag)	Description
0		CL - Brown clay, moist to damp, stiff, trace roots
	← J1	
	B1	
	A.O	
5		SP - tan f. sand, loose to med., damp
10		bottom

****

COMMENTS: clay at top is not like clay to west or north in appearance. Is less laminated, more massive

TP-18

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-18 Date 9/21/87 Logged by A.K. KUHN

Location Description along S. diversion channel, w. of section line

NM Grid Coordinates 488500 E 1542600 N

****

Depth	Sample (J=jar B=bag)	Description
0		SP – lt. tan loose f. sa., roots
1.3	J1 B1	CL – GR.-BRN. STIFF CLAY, w/roots moist
2.7		SP – lt. tan dense f. sand, moist
4.3	(no sample)	CL – DK. BRN – STIFF CLAY, moist
5		SP to SM – lt. tan dense f. sa, silty sand.
6.3		(<2" streak of dk. brown clay)
		SP to SM – same as above clay streak
10		bottom

****

COMMENTS:

TP- 19

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-19 Date 9/21/87 Logged by A.K. KUHN

Location Description w. end of S. diversion channel

NM Grid Coordinates 488000 E 1542600 N

****

Depth	Sample (J=jar, B=bag)	Description
0		SP lt. tan. f. sa. w/roots, loose
1.0	J1, B1	CL - gr. brn. clay, slightly moist, stiff
3.2		SP - lt. tan. f. sand, dense
5		
8.5		CL-CH - lense of dk. gray-brown clay, moist
9.2		SP - same as above
10		bottom

****

COMMENTS: Shallow clay is visually distinct from clays in TP-20, -21, -22

TP- 20

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 20 Date 9/21/87 Logged by A.K. Kuhn

Location Description ~1/3 mi. w. of N-S country road & of pile

NM Grid Coordinates 487250 E 1544300 N

****

Depth	Sample (J=jar, B=bag)	Description
0		SP - lt. tan f. sand
4.0	J #1, B #1	CL - dk. brn. clay, some sa., some roots, slightly laminated, slightly moist
7.5		SP - lt. tan fine sand
10		Bottom

****

COMMENTS:

TP-21

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-21 Date 9/21/87 Logged by A.K. KUHN

Location Description NW of TP 20, nearly due W. of NW corner pile

NM Grid Coordinates 486800' E 1544600 N

Depth	Sample J=jar B=bag	Description
0		SP - lt. tan f. sand
	2.5	interbedded SP + laminated CL (dk. brown to gray clay), some fine roots slightly moist
	4.5	SP - lt. tan f. sand some fine roots
5		
	J-#1	CL-CH - DK. Brown CLAY trace roots, streaks of red-brown clay
10	B-#1	Bottom

COMMENTS:

Bottom of pit was in clay at max reach of backhoe.

TP- 22

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 22 Date 9/21/87 Logged by A. K. Kuhn

Location Description Center of section near E-W county line

NM Grid Coordinates 487500 E 1545000 N

Depth	Sample J=jar B=bag	Description
0		SP - lt. tan, f. sa., med-dense
5		
6.0	J1 B1	CL-CH - Dark Brown clay, trace fine roots, moist
8.5		SP- f. sand, lt. tan, dense
10		bottom

COMMENTS:

TP-23

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-23 Date 9/21/87 Logged by A.K. Kuhn

Location Description NW of pile

NM Grid Coordinates 487800 E 1546700 N

****

Depth	Sample J=jar B=bag	Description
0		SP - lt. brown f. sa, loose to med.
0.8	←J1 B1	CL - Br. to GRAY BR. clay, stiff, slightly moist, w/some roots
3.0		SP - lt. tan f. sa, damp, med. to dense
5		
10		bottom

****

COMMENTS:

TP- 24

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 24 Date 9/21/87 Logged by A.K. KUHN

Location Description NW of tailings pile

NM Grid Coordinates 488300 E 1546500 N

****

Depth	Sample J=jar B=bag	Description
0		SP- lt. brown f. sa, loose to med., roots,
3.5	←J1 B1	CL- Brn. clay, stiff, damp to moist, some roots
5.6		SP- lt. tan f. sa, dense, damp
		bottom
10		

****

COMMENTS:

TP- 25

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 25 Date 9/21/87 Logged by A. K. Kuhn

Location Description NNW of NW corner of tailings pile

NM Grid Coordinates 488900 E 1546700 N

****

Depth	Sample J=jar B=bag	Description
0		SP lt. brown f. sa., loose to med.
1.0	←J1 B1	CL - gr.-Brown & Gray laminated clay, w/ roots, slightly moist, firm to stiff
3.5		SP - lt. tan f. sa., med.
5		
10		bottom

****

COMMENTS:

TP-26

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP-26 Date 9/21/87 Logged by A.K. KUHN

Location Description NW of NW corner of tailings pile

NM Grid Coordinates 488700 E 1547100 N

****

Depth	Sample (J=jar, B=bag)	Description
0		SP - lt. brown f. sa., med. dense, roots
0.8	←J1 B1	CL - Gr.-Brn. clay, stiff, slightly moist, w/roots
2.7		SP - tan f. sand, slightly moist, med. dense
5		
		bottom
10		

****

COMMENTS:

TP- 27

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 27 Date 9/24/87 Logged by H. K. KUHN

Location Description N. of NW corner of tailings pile

NM Grid Coordinates 489500 E 1547200 N

****

Depth	Sample J=jar B=bag	Description
0		SP - lt. brown f. sa, loose - med.
1.4	J1 B1	CL to SC, brown sa. clay to clayey sand, slightly moist, firm
2.7		SP - lt. tan, f. sa, med. dense
5		
10		Bottom

****

COMMENTS:

TP- 28

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 28 Date 9/22/87 Logged by A.K. KUHN

Location Description 200' S. of evap. ponds along N-S ℄

NM Grid Coordinates 489,975 E 1,541,750 N

(coordinates are approximate)

****

Depth	Sample (J=jar, B=bag)	Description
0		
	B1	CL - Brown clay, slightly damp, stiff, w/roots & alkali streaks
2.0	J1	
		SP - lt. tan f. sa, loose-med., w/streaks of ML silt.
4.8		
	B1	CL - same as clay above, less roots
6.5		
		SP - lt. gray f. sa
		bottom
10		

****

COMMENTS:

B1 sample is composite of upper + lower clays

TP- 29

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 29 Date 9/22/87 Logged by AK KUHN

Location Description 30' SE of mon. well B-1, w of evap ponds

NM Grid Coordinates 499400 E 1542000 N

(coordinates are approximate)

****

Depth	Sample J=jar B=bag	Description
0		CL - Brown clay with some roots, slightly damp, stiff
1.9		SP - lt. brown f. sa., dense
		CL - similar to above
5		SP - tan dense f. sa
		bottom
10		

****

COMMENTS: No Samples

TP- 30

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 30 Date 9/22/87 Logged by A.K. Kuhn

Location Description along fence E of N-S county road, 100' NW of (see below)

NM Grid Coordinates V 488850 E 1542925 N

(coordinates are approximate)

****

Depth	Sample J=jar B=bag	Description
0		CL - Brown clay, stiff, slightly damp, some roots
	J1+B1	
4.0		SP - tan f. sand
5		
		bottom
10		

****

COMMENTS: corner of power line, ~ 250' N of diversion ℄

TP- 31

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 31 Date 9/22/87 Logged by A. K. Kuhn

Location Description Midway between #15+16, ~200' N of line between #15+16, 20' S. of power line (coordinates are approximate)

NM Grid Coordinates 489750 E 1542800 N

****

Depth	Sample J=jar B=bag	Description
0		CH - Brown plastic clay, v. stiff, moist
	J1 B1	
2.0		SP - lt. brown f. sand, moist
5		becomes wet ↓
		bottom
10		

****

COMMENTS:

TP- 32

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 32 Date 9/22/87 Logged by A.K. KUHN

Location Description 100' S. of well D-V, between TP 13 + 14

NM Grid Coordinates 491250 E' 1542,710 N

(coordinates are approximate)

****

Depth	Sample (J=jar B=bag)	Description
0		CH - Brown plastic clay, moist, stiff to hard
2.7		SP - lt. brown f. sand, moist to damp, medium dense
5		- becomes dark brown
		SP - lt. gray f. sand
		bottom
10		

****

COMMENTS: Test pit is under power line, N. of diversion ℄

No Samples

TP- 33

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 33 Date 9/22/87 Logged by A. K. KUHN

Location Description NE of pile, ~300' S. of country road (see below)

NM Grid Coordinates _____ E _____ N

Depth	Sample J=jar B=bag	Description
0	B1	CL - Brown clay, w/roots, stiff to hard
	B2	SP - tan grading to lt. gray to pink f. sand
5		bottom
10		

COMMENTS:

- along N-S line of power line in next section north

TP- 34

TEST PIT LOG

HOMESTAKE MINING COMPANY - GRANTS

Test Pit No. TP- 34 Date 9/22/87 Logged by A. K. KUHN

Location Description 100' E of old property line, 150' N. of S. fence

NM Grid Coordinates _____ E _____ N

See below

Depth	Sample J=jar B=bag	Description
0		CL - Brown clay w/ roots, stiff
	B1	SP - lt. brown sand, fine, damp
		- grades to SC with depth
5		CL - gray clay with white blebs of volcanic ash clay
		bottom
10		

COMMENTS: of newly acquired property E. of Hwy 53

TP 35

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 35 Date 1/30/90 Logged by A. Glover

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0			
1			Soil zone - well defined organics
2			Sub-soil zone w/ roots - silty sand
3			buff colored poorly sorted sand
4			sub-rounded grains
5			
6			
7			Dark organic zone - silty sand
8			
9			Dark organic zone - silty/clayey sand more consolidated than material above
10			
11			T.D. - bottom 4"-6" cut into a tan colored clay zone
12			
13			
14			
15			

****

Comments:

TP 36

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 36 Date 1/31/90 Logged by A. Glover

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0-----			Clay with organic and roots
1-----			
2-----			tan colored sand
3-----			
4-----			
5-----			
6-----		gral clay	Brown clay grade to dark brown
7-----			Dark brown sandy clay
8-----			
9-----			light gray to bleached sand with some clay matrix
T.D. 10-----			
11-----			
12-----			
13-----			
14-----			
15-----			

****

Comments:

TP 38

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 38 Date 1/31/90 Logged by A. Glover

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0-----			intake clayey soil zone
1-----			loose buff colored sand
2-----			contains some silt
3-----			shows some laminations
4-----			
5-----			
6-----			
7-----			
8-----			
9-----			lite gray colored fine to med. sand
T.D 10----			
11----			
12----			
13----			
14----			
15----			

****

Comments:

TP 40

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 40 Date 1/30/90 Logged by A. Glover

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0			Soil zone - well defined organics/roots
1			
2			sub-soil zone - silty sand
3			upper clay zone - clay with intermittent sandy lenses
4			
5			
6			
7			loose sand
8			lower clay zone - sand mixed with clay
9			10" of dark (organic) clayey sand
10			T.D. in loose fine colorado sand
11			
12			
13			
14			
15			

****

Comments:

Two pits were dug (6) feet apart and there was a difference in the location of lower clay and the thickness of the clay

TP 43

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 43 Date 1/31/90 Logged by A. Glover

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0-----			Clay with organics and roots.
1-----			~~Brown/Buffalow~~ clay with some organic lamination
2-----			some thin sandy lenses-
3-----			
4-----			
5-----			lt. gray to bleached silty/clayey sand
6-----			
7-----			
8-----			
9-----			lower zone of sand is limonitic
T.D 10----			
11----			
12----			
13----			
14----			
15----			

****

Comments:

TP 45

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 45 Date 1/30/90 Logged by A. Glover

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0-----			soil zone - organics + roots
1-----			
2-----			Buff colored loose sand - very poorly sorted
3-----			
4-----			clay zone
5-----			Organic clayey + silty sand - grade from thin layer of clay to a clayey sand some caliche but spotty
6-----			
7-----			loose buff to yellow colored sand to total depth
8-----			
9-----			
10----			
TD 11----			
12----			
13----			
14----			
15----			

****

Comments:

TP 47

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 47 Date 1/31/90 Logged by A. Clover

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0			well defined soil and subsoil zone
1			
2			loose buff colored sand
3			
4			Clay - dark with some sand + roots
5			
6			Light to buff colored sand med/fine grained poorly sorted
7			
8			
9			
T.D 10			
11			
12			
13			
14			
15			

****

Comments:

TP 49

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 49 Date 1/31/90 Logged by A. Gloven

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0			Soil
1			Sub-soil mostly clay
2			yellow sand
3			Dark brown sand with some clay
4			
5			
6			Lt. Gray bleached sand
7			
8			
9			
T.D. 10			
11			
12			
13			
14			
15			

****

Comments:

TP 51

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 51 Date 1/30/90 Logged by A. GLOVER

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0			no soil profile
			Clay with some sand
1			Buff colored sand
2			
3			
4			Dark gray to black sand with
5			some clay
6			
7			loose light colored sand
8			poorly sorted medium to very fine
9			
T.D 10			
11			
12			
13			
14			
15			

****

Comments:

TP 53

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP-53 Date 1/3/90 Logged by A. Glover

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0			Soil - clayey with roots
1			sub-soil clay (Brown) many roots
2			↓
3			yellow to buff sandy zone with
4			some clay lenses
5			↓
6			
7			Dark brown clayey sand
8			
9			LT. gray bleached sand
T.D 10			↓
11			
12			
13			
14			
15			

****

Comments:

TP 55

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 55 Date 1/31/90 Logged by A. Glover

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0			Dark soil
1			Clay sub-soil with roots
2			Yellow to buff loose sand
3			
4			Dark brown sand with some silt/clay
5			
6			
7			Blended to lt. Gray sand with some limonite staining
8			
9			
T.D. 10			
11			
12			
13			
14			
15			

****

Comments:

TP 57

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 52 Date 1/31/90 Logged by A Clover

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar	USCS Class.	Description
0			
1			
2			tan sand
3			Dark sand - with some clay
4			tan sand
5			clay & one foot
6			SAND - light in color with some clay
7			Loose sand with some limonite staining
8			
9			
T.D 10			Pit bottomed in loose sand
11			
12			
13			
14			
15			

****

Comments:

V & A

LOG OF TEST PIT NO. TP-58

Project: Homestake | Project No. 90-1-60

Elevation · Top of Test Hole: n/a | Date Drilled: 7/24/90

Depth to Groundwater: not encountered | Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
		B				SM	SAND, silty, fine-grained, poorly graded, uniform, dry, light brown
5		B				CL-SC	CLAY, very sandy to sand, very clayey, sand is fine-grained, poorly graded, uniform, slightly moist, dark brown
10		B				SC	SAND, clayey, fine-grained, poorly graded, uniform, slightly moist, light brownish grey Trace clayey
15 20 25 30							Bottom of Pit at 12'

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST PIT NO. TP-59

Project: Homestake | Project No. 90-1-60

Elevation · Top of Test Hole: n/a | Date Drilled: 7/24/90

Depth to Groundwater: not encountered | Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	SAND, very silty, fine-grained, poorly graded, uniform, dry to slightly moist, brown
5		B				SC	SAND, slightly to moderately clayey, fine-grained, poorly graded, uniform, slightly moist, brown to black
						SC	SAND, slightly to moderately clayey, fine-grained, poorly graded, uniform, slightly moist, light grey brown
10		B				SP-SM	SAND, slightly silty, fine-grained, poorly graded, uniform, slightly moist, light grey brown, some rust
15							Bottom of Pit at 11'
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST PIT NO. TP-60

Project: Homestake | Project No. 90-1-60

Elevation - Top of Test Hole: n/a | Date Drilled: 7/24/90

Depth to Groundwater: not encountered | Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
		B				SC	SAND, very silty, clayey, fine-grained, poorly graded, uniform, slightly moist, brown
5		B				SM	SAND, silty, occasional lenses with some clay, fine-grained, poorly graded, uniform, dry, light brown
							Slightly increased clay content
10							Bottom of Pit at 10'
15							
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST PIT NO. TP-61

Project: Homestake Project No. 90-1-60

Elevation · Top of Test Hole: n/a Date Drilled: 7/24/90

Depth to Groundwater: not encountered Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
		B				SM	SAND, very silty, slightly clayey, fine-grained, poorly graded, uniform, slightly moist, brown
5		B				SC	SAND, slightly to moderately clayey, fine-grained, poorly graded, uniform, dry, light brown
10							9' - Lens of clay, slightly sandy, slightly moist, dark brown
							Bottom of Pit at 10½'
15							
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST PIT NO. TP-62

Project: Homestake Project No. 90-1-60

Elevation · Top of Test Hole: n/a Date Drilled: 7/24/90

Depth to Groundwater: not encountered Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
		B				SM-SC	SAND, very silty, clayey, fine-grained, poorly graded uniform, slightly moist, brown
5		B				SM	SAND, silty, fine-grained, poorly graded, uniform, slightly moist, light brown
10							
15							Bottom of Pit at 11'
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST PIT NO. TP-63

Project: Homestake Project No. 90-1-60

Elevation · Top of Test Hole: n/a Date Drilled: 7/24/90

Depth to Groundwater: not encountered Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	SAND, silty, fine-grained, poorly graded, uniform, slightly moist, brown
		B				SM	SAND, silty, fine-grained, poorly graded, uniform, dry, light brown
5						SM & CL	Interbedded silty fine SAND, fine-grained, poorly graded, uniform, dry, light brown and sandy clay, dark brown, slightly moist
		B					
10							
							Bottom of Pit at 10½'
15							
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure

V & A

LOG OF TEST PIT NO. TP-64

Project: Homestake | Project No. 90-1-60

Elevation - Top of Test Hole: n/a | Date Drilled: 7/24/90

Depth to Groundwater: not encountered | Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
		B				SM	SAND, silty, fine-grained, poorly graded, uniform, dry, light brown
5		B				CL	CLAY, very sandy, slightly moist, dark brown
		B				SC	SAND, slightly clayey, fine-grained, poorly graded, uniform, slightly moist, light brown, some rust
10		B				SM	SAND, silty, fine-grained, poorly graded, uniform, dry to slightly moist, light brown-rust
15							Bottom of Pit at 11'
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST PIT NO. TP-65

Project: Homestake | Project No. 90-1-60

Elevation · Top of Test Hole: n/a | Date Drilled: 7/24/90

Depth to Groundwater: not encountered | Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
		B				SM	SAND, silty, fine-grained, poorly graded, uniform, slightly moist, brown
		B				SM	SAND, slightly silty to silty, fine-grained, poorly graded, uniform, dry, light brown
5		B				SC	SAND, clayey, slightly moist, grey brown, porous
10						SM	SAND, silty, fine-grained, poorly graded, uniform, dry, light grey brown 9-10½' - Lenses of sand, trace silt
15 20 25 30							Bottom of Pit at 10½'

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST PIT NO. TP-66

Project: Homestake | Project No. 90-1-60

Elevation - Top of Test Hole: n/a | Date Drilled: 7/24/90

Depth to Groundwater: not encountered | Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
		B				SM	SAND, very silty, fine-grained, poorly graded, uniform, slightly moist, brown
						SC	SAND, silty, clayey, fine-grained, poorly graded, uniform, dry, dark brown-black
5		B				SC	SAND, silty, clayey, fine-grained, poorly graded, uniform, slightly moist, light grey brown
10							Silty, trace clayey to no clay
							Bottom of Pit at 10½'
15							
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST PIT NO. TP-67

Project: Homestake | Project No. 90-1-60

Elevation - Top of Test Hole: n/a | Date Drilled: 7/24/90

Depth to Groundwater: not encountered | Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	SAND, silty, fine-grained, poorly graded, uniform, dry
						SC	SAND, clayey and silty, calcareous, fine-grained, mottled tan-brown
		B				SM	SAND, silty, fine-grained, poorly graded, uniform, slightly moist, golden brown
5							
10							Less silty
							Bottom of Pit at 10½'
15							
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST PIT NO. TP-68

Project: Homestake — Project No. 90-1-60

Elevation - Top of Test Hole: n/a — Date Drilled: 7/24/90

Depth to Groundwater: not encountered — Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SC	SAND, clayey, slightly calcareous, mottled dark brown - white, slightly moist
		B				SM	SAND, silty, trace clay, fine-grained, poorly graded, uniform, slightly moist, golden brown, porous
5							
		B					
10							Bottom of Pit at 9'
15							
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

V & A

LOG OF TEST PIT NO. TP-69

Project: Homestake — Project No. 90-1-60

Elevation - Top of Test Hole: n/a — Date Drilled: 7/24/90

Depth to Groundwater: not encountered — Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	SAND, silty, trace clay, fine-grained, poorly graded, uniform, moist, brown
		B					
							Lenses of sand as above with some clay
5							
		B					
10							
							Bottom of Pit at 10'
15							
20							
25							
30							

ADDITIONAL TESTS: 1 = Sieve Analysis 2 = Atterberg Limits 3 = Direct Shear 4 = R-Value 5 = Other

Figure _____

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 70 Date 11/11/91 Logged by GM

Location Description Between brine pond and evaporation pond
NM Grid Coordinates 490,970 E, 1,541,950 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0	BK	SC	SAND, very clayey, fine-grained, moist, brown
1			
2	B	SM	SAND, silty
3			
4	B Bk	CL	CLAY, very sandy, fine-grained, slightly moist, dark brown-black
5			
6	B	SM	SAND, silty to slightly silty, fine-grained, slightly moist with thin white clay layers, light gray
7			
8	B		Orange stained
9			Bottom of Hole at 8½'
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 71 Date 11/11/91 Logged by GM

Location Description South-southwest of pile, 150' east of road, west of brine pond

NM Grid Coordinates 1,541,850 E, 489,000 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		CL	CLAY, very sandy, fine-grained, moist to medium moist, brown
1	Bk		
2		SM	SAND, silty, fine-grained, slightly moist to dry
3			
4	Bk		
5	B	CL	Clay layer 4"
		SM	SAND, silty, fine-grained, slightly moist, light brown
6			
7	B	CL	Clay layer 6"
		SM	SAND
8	Bk	CL	Clay layer 12"
9	Bk	SM	SAND, silty, fine-grained, slightly moist, dark brown
10			Light grey
			Bottom of Hole at 10'
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 72 Date 11/11/91 Logged by GM

Location Description 40' southwest of WR-9
NM Grid Coordinates 488,200 E, 1,542,090 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		SC	SAND, very clayey, fine-grained, slightly moist, brown
1		SM	SAND, silty to slightly silty, fine-grained, uniform, slightly moist to dry, light brown
2			
3			
4			
5			
6			
7			
8			
9			Silty, dark brown Grey color
10			Bottom of Hole at 9½'
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 73 Date 11/11/91 Logged by GM

Location Description 80' northwest of MW (no number), 200' east of Fork in road

NM Grid Coordinates 487,190 E, 1,542,380 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, fine-grained, slightly moist, brown
1		SC	SAND, very clayey, fine-grained, slightly moist, light brown
2		SM	SAND, silty, fine-grained, slightly moist, brown
3			
4			
5			
6			Very thin clay layer 2" thick
7			Very thin clay layer 2" thick
8			Bottom of Hole at 7½'
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 74 Date 11/11/91 Logged by GM

Location Description 200' northeast of fence angle near west fence

NM Grid Coordinates 486,490 E, 1,542,680 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, fine-grained, moist, brown
1			Slightly moist, light brown
2			
3	B		Thin clay stringer 2" thick
4			Thin clay stringer 2" thick
5			
6	B	ML	SILT, sandy, fine-grained, moist, gray
7		SM	SAND, silty, fine-grained
8			Bottom of Hole at 7½'
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 75 Date 11/11/91 Logged by GM

Location Description Near west fence south of air monitor station
NM Grid Coordinates 486,350 E, 1,543,610 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0-----		SC	SAND, clayey, fine-grained, slightly moist, light brown
1-----	B		
2-----			
3-----	Bk	CL	CLAY, sandy, fine-grained, medium moist, brown
4-----		SM	SAND, silty, fine-grained, slightly moist, light brown
5-----			
6-----			Thin clay layer 2" thick
7-----	B		
8-----			
9-----			Bottom of Hole at 8½'
10----			
11----			
12----			
13----			
14----			
15----			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 76 Date 11/11/91 Logged by GM

Location Description Middle of southwest area
NM Grid Coordinates 487,520 E, 1,543,170 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, fine-grained, moist, light brown
1			Slightly moist
2			
3	B	CL	Clay layer 6" thick
4		SM	Less silty
5			
6			
7	B	CL	Clay layer 6" thick
		SM	as above
8			Bottom of Hole at 8'
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 77 Date 11/11/91 Logged by GM

Location Description 50' south-southwest of St. well ±300' west of southwest corner of pile

NM Grid Coordinates 488,680 E, 1,543,170 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		~~SC~~ CL	~~SAND, very clayey to~~ clay, fine-grained, medium moist, brown
1	Bk		
2			
3		SM	SAND, silty, fine-grained, slightly moist, light brown
4	B	CL	CLAY, sandy, fine-grained, medium moist, 6" thick, dark brown
5	B	SM	as above
6			
7		CL	Clay layer 6" thick
		SM	As above
8			Bottom of Hole at 8'
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 78 Date 11/11/91 Logged by GM

Location Description West side of road west of center of pile
NM Grid Coordinates 488,700 E, 1,544,140 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		~~SC~~ CL	~~SAND, very clayey~~, fine-grained, medium moist, brown
1	B		Less clayey
2	Bk		Very clayey
3			
4		SM	SAND, silty, fine-grained
5			Clay layer 4" thick
6			Clay layer 6" thick
7			
8			
9			Bottom of Hole at 8½'
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 79 Date 11/11/91 Logged by GM

Location Description Northeast corner of west area south of Co. Road
NM Grid Coordinates 488,700 E, 1,545,130 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, fine-grained, moist, brown
1			
2			
3	Bk	CL	CLAY, very sandy, fine-grained, medium moist, brown
4			
5		SM	SAND, silty, fine-grained, slightly moist, light brown
6	B		
7			Thin clay layer
8			Bottom of Hole at 8'
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 80 Date 11/11/91 Logged by GM

Location Description Northwest corner of west area south of Co. Road
NM Grid Coordinates 486,370 E, 1,545,100 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, fine-grained, moist, brown
1	Bk	~~SC~~ CL	~~SAND, very clayey to~~ clay, fine-grained, medium moist, brown
2			
3		SM	SAND, silty, fine-grained, slightly moist, light brown
4			
5			
6	B		Clay layer, red banded 3" thick
7			Clay layer 6" thick
8			Bottom of Hole at 8'
9			
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 81 Date 11/12/91 Logged by GM

Location Description Bottom of pond near west-northwest corner north of Co. Road

NM Grid Coordinates 486,600 E, 1,546,020 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0	B	CL	CLAY, sandy, fine-grained, medium moist, dark brown
1		SM	SAND, silty, fine-grained, slightly moist, brown
2			Thin clay layer, red brown
3			
4			
5			Light brown
6			
7			
8			
9			Bottom of Hole at 9'
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 82 Date 11/12/91 Logged by GM

Location Description North of Co. Road at north-northwest fence corner

NM Grid Coordinates 488,150 E, 1,547,420 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0			
1	Bk	CL	CLAY, very sandy, fine-grained, moist to medium moist, brown
2		SM	SAND, silty, fine-grained, slightly moist, light brown
3			
4			Thin clay layer
5			
6			Thin clay layer
7			
8			
9			Bottom of Hole at 9'
10			
11			
12			
13			
14			
15			

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Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 83 Date 11/12/91 Logged by GM

Location Description North of west end of pile, 1000' north of Co. Road

NM Grid Coordinates 489,550 E, 1,546,180 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, fine-grained, moist, brown
1	B		Slightly moist, light brown
2			
3			
4	B		2 thin clay layers
5			
6			
7			
8			Bottom of Hole at 8'
9			
10			
11			
12			
13			
14			
15			

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Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 84 Date 11/12/91 Logged by GM

Location Description West side of gate north of center of pile, north of Co. Road

NM Grid Coordinates 490,998 E, 1,545,250 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		CL	CLAY, very sandy, fine-grained, medium moist, brown
1			
2	Bk	~~SC~~ CL	~~SAND, very~~ clayey, fine-grained, slightly moist, brown
3			
4		SM	SAND, silty, fine-grained, sli. moist, lt. brown
5			Thin clay layer
6	B		
7			
8			
9			
10			Bottom of Hole at 9½'
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 85 Date 11/12/91 Logged by GM

Location Description North of center of pile, 1200' north of Co. Road

NM Grid Coordinates 491,290 E, 1,546,430 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		~~CL~~ CH	CLAY, sandy, fine-grained, medium moist, brown
1			
	Bk		
2			
3		SM	SAND, silty, fine-grained, slightly moist, light brown
4	Bk	SM	
5			
6			
7	Bk	CL	Clay, 8" thick
8	B	SM	SAND, dark brown
9			Bottom of Hole at 8½'
10			
11			
12			
13			
14			
15			

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Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 86 Date 11/12/91 Logged by GM

Location Description 75' SW of air monitor station near north central gate

NM Grid Coordinates 491,260 E, 1,547,390 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, fine-grained, moist, brown
1	B	SC	clayey sand layer, slightly moist
2		SM	SAND, silty, fine-grained, slightly moist, light brown
3			
4	B		
5			
6			
7			
8			Bottom of Hole at 8'
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 87 Date 11/12/91 Logged by GM

Location Description on line north of east crest of pile, 1200' north of Co. Rd.

NM Grid Coordinates 492,500 E, 1,546,320 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0			
		SM	SAND, silty, fine-grained, moist, brown
1			Slightly moist, light brown
2			
3			
4			
5			
6			
7			
8	B	CL	CLAY, sandy, fine-grained, medium moist, brown
9	B	SM	SAND, silty, fine-grained, sli. moist, dark brown
			Bottom of Hole at 9'
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 88 Date 11/12/91 Logged by GM

Location Description 100' N. of Co. Rd., N. of NE corner of Pile, N. of gate to millsite

NM Grid Coordinates 492,870 E, 1,545,250 N

Depth	Sample B=Bag Bk=Bucket	USCS Class.	Description
0			
1	Bk	SC	SAND, very clayey, fine-grained
2			
3	Bk		Thin clay layer
4		SM	SAND, silty, fine to medium-grained, slightly moist, light brown
5	B		Thin clay layer 2" thick
6	BK	CL	CLAY, sandy, fine-grained, medium moist, brown
7		CL	CLAY, sandy, dark grey to black
8	BK		
9		SM	SAND, silty, fine-grained, weakly cemented
10			Bottom of Hole at 9½'
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 90 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0	BK	SC-CL	CLAYEY SAND TO SANDY CLAY, moist, dark brown
1			
2	Sample 90-A	SC	SAND, clayey, fine-grained, poorly graded, uniform, slightly moist, brown
3		SM-SC	SAND, silty, slightly clayey, fine-grained, poorly graded, uniform, slightly moist, light brown
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 91 Date 9/10/92 Logged by MDV

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SC	SAND, clayey, fine-grained, poorly graded, uniform, slightly moist, brown
1	BK Sample 91-A		
2		SM	SAND, silty, fine-grained, poorly graded, uniform, dry, grey
3			
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 92 Date 9/10/92 Logged by MDV

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CL	SANDY CLAY, slightly moist, brown
1		SM-SC	SAND, silty, sli. clayey, fine-grained, poorly graded, uniform, moist, light brown
2	BK Sample 92-A	SC	SAND, clayey, slightly moist, brown
3			
4		SP	SAND, fine-grained, poorly graded, uniform, slightly moist, light grey brown
5			Bottom of pit at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 93 Date 9/10/92 Logged by MDV

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0			
	BK Sample 93-A	CL	CLAY, sand, moist, dark brown
1			
2			
		SM	SAND, silty, fine-grained, poorly graded, uniform, slightly moist, light brown
3			
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 94 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0			
		SM	SAND, silty, trace clay, fine-grained, poorly graded, uniform, moist, light brown
1			
2			
3			
		CL	CLAY, sandy, moist, dark brown
4			
5			
			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 95 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0	BK Sample 95-A	SC-CL	SAND, very clayey, interbedded with sandy clay, moist, dark brown
1			
2			
3	No Sample	SP	SAND, fine-grained, poorly graded, uniform, moist, light brown
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 96 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0-----		CL	CLAY, sandy, fine-grained, moist, dark brown,
1-----			lenses of clayey sand
2-----			
3-----			
4-----			
5-----			Bottom of pit at 5'
6-----			
7-----			
8-----			
9-----			
10----			
11----			
12----			
13----			
14----			
15----			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 97 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0			
		CL	CLAY, sandy, moist, brown
1		SP	SAND, fine-grained, poorly graded, uniform, moist, light brown
2			
3			
4			
5			4-1/2' - clay lens - free water Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 98 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SM-SC	SAND, silty, clayey, fine-grained, poorly graded, moist, brown
1			
2			
3			
4		SM	SAND, silty, fine-grained, poorly graded, uniform, moist
5			
6			Bottom of pit at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 99 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SC-CL	SAND, very clayey to clay, very sandy, fine-grained, moist, dark brown
1	Bk Sample 99-A		
2		SP	SAND, fine-grained, poorly graded, uniform, moist, light brown
3			
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 100 Date 9/10/92 Logged by MDV

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CL	CLAY, sandy, firm, moist, dark brown
1	BK Sample 100-A		
2		SP-SM	SAND, slightly silty, fine-grained, poorly graded, uniform, slightly moist, light brown
3			
4			
5			Bottom of pit at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 101 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0-----		SM	SAND, silty, trace clay, fine-grained, poorly graded, uniform, slightly moist, light brown
1-----			
2-----			
3-----		SC	2'-2-1/2' - light calcareous cementation, very silty, clayey
4-----			
5-----			Bottom of pit at 5'
6-----			
7-----			
8-----			
9-----			
10----			
11----			
12----			
13----			
14----			
15----			

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 102 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CL	CLAY, very sandy, stiff, moist, dark brown
1	BK 2 Samples 102-A		
2			Becoming sandier
3		SM	SAND, silty, fine-grained, poorly graded, uniform, dry, light brown
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 103 Date 9/10/92 Logged by MDV

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty to slightly silty, fine-grained, poorly graded, uniform, slightly moist, light brown
1	BK Sample 103-A		
2			
3			
4		CL	CLAY, sandy, stiff, moist, dark brown
5		SM	SAND, silty to slightly silty, fine-grained, poorly graded, uniform, slightly moist, light brown
6			
7			Bottom of pit at 5'
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 104 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SC-CL	SAND, very clayey to clay, very sandy, fine-grained, moist, dark brown
1	BK Sample 104-A		
2			
3		SC	Becoming sandier
4		SM	SAND, silty, fine-grained, poorly graded, uniform, slightly moist, light brown
5			
6			Bottom of pit at 5'
7			
8			
9			
10			
11			Sampled 0' - 4-1/2'
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 105 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SM-SC	SAND, silty, slightly clayey, fine-grained, poorly graded, uniform, moist
1	BK		
2	Sample 105-A	SC	SAND, very clayey, fine-grained, poorly graded, uniform, moist, brown
3			
4		SM	SAND, silty, fine-grained, poorly graded, uniform
5		CL	CLAY, sandy, moist, dark brown
6			Bottom of pit at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 106 Date 9/10/92 Logged by MDV

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, trace clay, fine-grained, poorly graded, uniform, dry, light brown
1	BK		
2	Sample 106-A		
3		CL	CLAY, sandy, dark brown, moist
4			
5		SM	SAND, silty, trace clay, fine-grained, poorly graded, uniform, dry, light brown
6			Bottom of pit at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 107 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SP-SM	SAND, slightly silty, fine-grained, poorly graded, uniform, moist
1			
2		CL	CLAY, sandy, moist, dark brown
3		SM	SAND, silty, fine-grained, poorly graded, uniform, slightly moist, light brown
4			4' - lens of clayey sand
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 108 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0-----		SM	SAND, silty, fine-grained, poorly graded, uniform, slightly moist, brown
1-----			18"-lens of sandy clay, moist, dark brown
2-----			
3-----			
4-----		SP-SM	SAND, slightly silty, fine-grained, poorly graded, uniform, slightly moist, light brown
5			Bottom of pit at 5'
6-----			
7-----			
8-----			
9-----			
10----			
11----			
12----			
13----			
14----			
15----			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 109 Date 9/10/92 Logged by MDV

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0-----		SM	SAND, very silty, trace clay, fine-grained, poorly graded, uniform, dry to slightly moist, light brown
1-----			At 18" - 2" caliche lens - light cementation, buff
2-----			
3-----			
4-----			
5-----			
6-----			Bottom of pit at 5-1/2'
7-----			
8-----			
9-----			
10----			
11----			
12----			
13----			
14----			
15----			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 110 Date 9/09/92 Logged by RDG

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SP-SM	SAND, slightly silty, fine to medium-grained, poorly graded, medium dense to dense, slightly moist, lightly cemented, light brown
1	BK		
2			Very thin clay layer
3			Very thin clay layer
4			Very thin clay layer
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 111 Date 9/09/92 Logged by RDG

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SM	SAND, silty, fine-grained, poorly graded, medium dense, slightly moist, light brown
1		SC	SAND, clayey, fine-grained, poorly graded, medium dense, medium moist, light brown
2	BK		
3		SM	SAND, silty, fine-grained, poorly graded, medium dense, slightly moist, light brown
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 112 Date 9/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CL	CLAY, sandy, fine-grained, stiff to very stiff, medium moist, dark brown
1	BK Sample 112-A		
2	BK	SC	SAND, clayey, fine-grained, poorly graded, medium dense, slightly moist, light brown
3		SM	SAND, slightly silty, fine-grained, poorly graded, medium dense, slightly moist, light brown
4			
5			
6			Bottom of pit at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

Initial sample (BK) from 1/2' - 5'

Sample 112-A (BK) from 1/2' - 3'

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 113 Date 9/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SC	SAND, clayey, fine-grained, loose to medium dense, trace moisture, brown
1	BK Sample 113-A	CL	CLAY, sandy, fine-grained, stiff to very stiff, medium moist, dark brown
2	BK	SC	SAND, clayey, fine-grained, poorly graded, medium dense, slightly moist, light brown
3		SM	SAND, slightly silty, fine-grained, poorly graded, medium dense, slightly moist, light brown
4			
5			
6			
7			Bottom of pit at 5'
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

Initial Sample (BK) from 1/2' - 5'

Sample 113-A (BK) from 1/2' - 3-1/4'

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 114 Date 9/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SC	SAND, clayey, fine-grained, poorly graded, loose, trace moisture, light brown
1	BK Sample 114-A	CL	CLAY, trace sand, fine-grained, stiff, slightly moist, brown
2	BK	SM	SAND, silty, fine-grained, poorly graded, medium dense, slightly moist, brown
3			
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Comments:

Initial Sample (BK) from 1/2' - 5'

Sample 114-A (BK) from 1/2' - 2'

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 115 Date 9/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CL	CLAY, trace sand, very stiff, slightly moist to moist, brown
1	BK Sample 115-A		
2			
3			
4		SM	SAND, silty, fine-grained, poorly graded, medium dense, slightly moist, light brown
5			
6			Bottom of pit at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

Initial Sample (BK) from 1/2' - 4'

Sample 115-A (BK) from 1/2' - 5'

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 118 Date 9/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CL	CLAY, trace sand, stiff to very stiff, moist, dark brown
1	BK Sample 118-A		
2			
3	BK Sample 118-B		
4		SM	SAND, silty, fine-grained, poorly graded, medium dense,
5			slightly moist, light brown
6			Bottom of pit at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

Initial Sample (BK) from 1/2' - 5'

Sample 118-A (BK) from 1/2' - 3'

Sample 118-B (BK) from 1/2' - 5'

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 117 Date 9/09/92 Logged by RDG

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SM	SAND, slightly silty to silty, trace clay, fine-grained, loose to medium dense, slightly moist, dark brown
1			
2	BK		
3			
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****
Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 118 Date 9/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CL	CLAY, trace sand, stiff to very stiff, moist, dark brown
1	BK		
2			
3		SM	SAND, silty, fine-grained, poorly graded, medium dense, slightly moist, light brown
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 119 Date 9/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SC	SAND, very clayey, fine-grained, medium dense, poorly graded, slightly moist
1		CL	CLAY, sandy, fine-grained, stiff to very stiff
2	BK	SM	SAND, slightly silty, fine-grained, poorly graded, medium dense to dense, slightly moist, light brown
3			
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Comments:

TEST PIT LOG

HOMESTAKE MINING COMPANY

Test Pit No. TP- 120 Date 9/09/92 Logged by RDG

Location Description _____
NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CL	CLAY, sandy, fine-grained, stiff to very stiff
1			
2			
3			
4			
5			Bottom of pit at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TP 121

TEST ~~PIT~~ HOLE LOG

HOMESTAKE MINING COMPANY

Test ~~Pit~~ Hole No. TP- 121 Date 11/09/92 Logged by RDG

Location Description West side of fence

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0			
1	BK	SC	SAND, clayey, fine-grained, trace medium and coarse, poorly graded, medium dense, trace to slightly moist, light brown
2			
3			Very clayey
4			
5			Bottom of hole at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST ~~PIT~~ HOLE LOG

HOMESTAKE MINING COMPANY

Test ~~Pit~~ Hole No. TP- 122 Date 11/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0	BK	SC	SAND, very clayey, fine-grained, poorly graded, medium dense, slightly moist, brown
1			
2			
3			
4		CH	CLAY, sandy, fine-grained, stiff to very stiff, slightly moist, light brown
5			Bottom of hole at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST ~~PIT~~ HOLE LOG

HOMESTAKE MINING COMPANY

Test ~~Pit~~ Hole No. TP- 123 Date 11/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		CH	CLAY, very sandy, fine-grained, stiff, moist, brown
1	BK		
2			
3		SC	SAND, very clayey, fine-grained, trace medium, coarse, poorly graded, medium dense, slightly moist, light brown
4			
5			Bottom of hole at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST ~~PIT~~ HOLE LOG

HOMESTAKE MINING COMPANY

Test ~~Pit~~ Hole No. TP- 124 Date 11/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SC	SAND, very clayey, fine-grained, poorly graded, medium dense, slightly moist, brown
1			
2	BK		
3			
4		CH	CLAY, very sandy, fine-grained, stiff to very stiff, slightly moist, light brown
5			Bottom of hole at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST ~~PIT~~ HOLE LOG

HOMESTAKE MINING COMPANY

Test ~~Pit~~ Hole No. TP- 125 Date 11/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0			
1	BK	SC	SAND, slightly clayey to clayey, fine-grained, poorly graded, medium dense, slightly moist to moist, brown
2			
3			
4			Thin clay lenses
5			Bottom of hole at 5'
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TEST ~~PIT~~ HOLE LOG

HOMESTAKE MINING COMPANY

Test ~~Pit~~ Hole No. TP- 126 Date 11/09/92 Logged by RDG

Location Description _____

NM Grid Coordinates _____ E, _____ N

Depth	Sample B=Bag J=jar Bk=Bucket	USCS Class.	Description
0		SC	SAND, clayey, fine-grained, poorly graded, medium dense, slightly moist to moist, brown
1			
2	BK		
3		CH	CLAY, sandy, fine-grained, stiff to very stiff, slightly moist, light brown
4			
5		SM	SAND, silty, fine-grained, poorly graded, medium dense, slightly moist, brown
6			Bottom of hole at 5'
7			
8			
9			
10			
11			
12			
13			
14			
15			

****

Comments:

TABLE D1

HOMESTAKE GRANTS BORROW SOILS - TEST PIT SAMPLE EVALUATION
Data sorted by Test Pit Number Updated 6/18/93

BORROW AREA SECTOR	TEST PIT OR BORING	DISTANCE FROM LP CREST ft.	DEPTH TO CL,CH,SC ft.	FT. OF CH,CL, OR SC IN 0'-5'	CH,CL, OR SC IN ONE LAYER?	USCS OF TARGET SOIL IN TOP 5'	% FINES (-#200)	% CLAY	% ORGANIC	-15 BAR GRAVIMETR MOISTURE W%	PROCTOR DENSITY pcf
WEST	001	2900	0.5	3.0	N	CL					
WEST	002	2600	1.0	2.0	Y	CL					
WEST	003	1200	2.5	2.0	Y	CL					
WEST	004	1500	1.5	2.5	Y	CL					
WEST	04A					SM	15.9				
SOUTH	005	2100	0.0	2.5	Y	CL					94.1
NORTH	006	2000	0.0	2.5	Y	CL					
WEST	007	2400	0.0	3.0	Y	CL					111.1
WEST	008	1700	0.5	2.0	Y	CL					
NORTH	009	1300	0.0	0.0		SM					
SOUTH	010	700	0.0	5.0	Y	CL	84	50			
SOUTH	011	700	0.0	5.0		SM					
SOUTH	012	700	1.0	2.0	Y	CH					102.3
SOUTH	013	700	0.0	3.5	Y	CH					102.3
SOUTH	014	700	0.0	4.0	Y	CH-CL			3.15		102
NORTH	015	700	0.0	2.8	Y	CL			2.94		107.2
SOUTH	016	700	0.0	5.0		SM					
SOUTH	017	700	0.0	4.0	Y	CH	85.6	55	3.41		94.1
WEST	018	1000	1.3	2.0	N	CL	83.3	61	2.78		99.8
WEST	019	1600	1.0	2.2	Y	CL			3.05		
WEST	020	2200	4.0	1.0	Y	CL	92.1	63	2.47		102.3
WEST	020A	2200				SM	29.4				
WEST	021A	2500				CL	51.7				
WEST	021	2500	0.0	5.0		SM					99.3
WEST	022	1800	0.0	5.0		SM			3.16		99.3
NORTH	023	2400	0.8	2.2	Y	CH-CL			2.75		99.5
NORTH	024	2200	3.5	1.5	Y	CL			3.12		
NORTH	025	2400	1.0	2.5	Y	CL	84.2	54	1.63		93.7
NORTH	026	2600	0.8	1.9	Y	CL			3.16		106.3
NORTH	027	2600	1.4	1.3	Y	SC			3.19		106.3
NORTH	028	1500	0.0	2.0	Y	CL			0.94		
SOUTH	029	1200	0.0	2.5	N	CL					103.8
WEST	030	600	0.0	4.0	Y	CL			1.45		104.4
SOUTH	031	500	0.0	2.0	Y	CH			2.73		102
SOUTH	032	600	0.0	2.7	Y	CH					
EAST	033	2000	0.0	2.0	Y	CL					
EAST	034	2000	0.0	1.0	Y	CL					
SOUTH	035	1400	0.0	5.0		SM					
SOUTH	036	1400	0.0	1.5	Y	CL					
SOUTH	038	1400	0.0	1.0	Y	CL					
SOUTH	040	1600	3.0	2.0	Y	CL					105.2
SOUTH	043	1800	0.0	5.0	Y	CL					102.3
SOUTH	045	1800	4.0	1.0	Y	CL					
SOUTH	047	1800	4.0	1.0	Y	CL					
SOUTH	049	2000	0.5	1.0	Y	SC					
SOUTH	051	2000	0.0	1.0	Y	CL					
SOUTH	053	2300	0.0	3.0	Y	CL					
SOUTH	055	2300	0.0	2.0	Y	CL					
SOUTH	057	2300	0.0	5.0		SM					
SOUTH	058	900	4.5	0.5	Y	CL					93.7
SOUTH	059	1700	2.5	2.5	Y	SC					
SOUTH	060	2800	0.0	2.0	Y	SC					
SOUTH	061	4200	3.0	2.0	Y	SC					
SOUTH	062	3200	0.0	5.0		SM					
SOUTH	063	2300	0.0	5.0		SM					
SOUTH	064	2400	3.5	1.5	Y	CL					
SOUTH	065	3100	0.0	5.0		SM					
SOUTH	066	3700	3.0	1.0	Y	SC					
SOUTH	067	3700	1.0	1.5	Y	SC					
SOUTH	068	3200	0.0	1.0	Y	SC					
SOUTH	069	3300	0.0	5.0		SM					
SOUTH	070	1300	0.0	3.5	Y	SC					
SOUTH	071	1500	0.0	2.5	N	CL	81	39	2.4		
WEST	072	1600	0.0	1.0	Y	SC					
WEST	073	2400	0.5	1.5	Y	SC					
WEST	074	2900	0.0	0.0		SM					

TABLE D1

BORROW AREA SECTOR	TEST PIT OR BORING	DISTANCE FROM LP CREST ft.	DEPTH TO CL,CH,SC ft.	FT. OF CH,CL, OR SC IN 0'-5'	CH,CL, OR SC IN ONE LAYER?	USCS OF TARGET SOIL IN TOP 5'	% FINES (-#200)	% CLAY	% ORGANIC	-15 BAR GRAVIMETR MOISTURE W%	PROCTOR DENSITY pcf
WEST	075	2900	0.0	3.5	Y	CL	77	44			
WEST	076	1800	3.0	0.5	Y	CL					99.5
WEST	077	600	0.0	3.0	N	CL	71	48	2.3		
WEST	078	600	0.0	3.5	Y	CL	70	44	2.2		98.8
WEST	079	900	2.0	2.5	Y	CL	72	52	2.9		101.6
WEST	080	3000	0.5	1.8	Y	CL	59	21			106.3
WEST	081	3200	0.0	1.0	Y	CL					
NORTH	082	3200	0.0	2.0	Y	CL					
NORTH	083	1400	0.0	0.0		SM					
NORTH	084	600	0.0	4.0	Y	CL	74	58	2.4		103.2
NORTH	085	1900	0.0	3.0	Y	CH	88	54	2.4		90.1
NORTH	086	2800	1.0	0.5	Y	SC					
NORTH	087	1700	0.0	0.0		SM					
NORTH	088	800	0.0	3.5	Y	SC	39	22	1.3		120.5
NORTH	089	2200	4.5	0.5	Y	CL	84	53			99.3
SOUTH	090	2800	0.0	3.0	Y	SC	40.4	27	2.1	13.63	102
SOUTH	091	2600	0.0	2.0	Y	SC	26.8	18	1.6		
SOUTH	092	1800	0.0	3.5	Y	SC	34.1	18	2.35		
SOUTH	093	1800	0.0	2.0	Y	CH	92.8	65	1.6	24.42	93.3
SOUTH	094	1100	3.0	2.0	Y	CL	55.4	32	2.65		
SOUTH	095	1000	0.0	2.5	Y	CL	54	34	2.2	14.82	
SOUTH	096	500	0.0	5.0	Y	CL	73	31	2.3		102.2
SOUTH	097	500	0.0	1.0	Y	SM	22.3	5	1.7		112.2
SOUTH	098	900	0.0	4.0	Y	SM-SC	46.5	20	2.2	10.47	110.5
SOUTH	099	600	0.0	2.0	Y	SM	23.6	15	1.75		
WEST	100	1500	0.0	2.0	Y	SC	39.2	27	1.8		
WEST	101	1800	0.0	5.0	Y	SM	15.5	8	1.0	5.31	112.4
WEST	102	1100	0.0	3.0	Y	SC	17.1	12	1.9		
WEST	103	1400	3.5	1.5	Y	SC	38.6	32	2.6	17.40	
WEST	104	500	0.0	3.2	Y	SC	30.5	17.5	2.0		
WEST	105	1000	0.0	3.5	Y	SC	43.1	17	1.9		
WEST	106	1900	0.0	4.0	Y	SC	42.2	28	2.9		
WEST	107	500	0.0	5.0		SM	21.7	12	1.1	5.50	113.4
WEST	108	1000	0.0	5.0		SM	25.2	9	1.7		
WEST	109	1900	0.0	5.0		SM	21.7	13	1.05		
WEST	110	1300	0.0	5.0		SM	17.7	8	0.85		
NORTH	111	1300	0.0	5.0		SM	13.8	7	0.6		
NORTH	112	600	0.0	3.0	Y	SC	39.3	24	1.4		109
NORTH	113	1200	0.0	3.5	Y	SC	35.1	17	2.15	9.25	110.6
NORTH	114	1200	0.0	2.0	Y	SC	32.6	27	1.2		
NORTH	115	600	0.0	4.0	Y	SM	33.0	22.5	2.2	14.46	112.1
NORTH	116	1600	0.0	4.0	Y	SC	38	26	1.1		
NORTH	117	900	0.0	5.0		SM	13.2	8	1.0		106.9
EAST	118	1600	0.0	3.0	Y	SC	37	21	1.7		112.2
EAST	119	1400	0.0	2.0	Y	SC	29.9	23	1.4		
SOUTH	120	2200	0.0	5.0	Y	CL	53.1	43	2.25	17.93	93.7
WEST	121	3100	0.0	5.0	Y	SC	46	25			
WEST	122	3100	0.0	3.5	Y	CH	75	26			
WEST	123	3100	0.0	3.0	Y	CH					
WEST	124	3100	0.0	5.0	Y	SC	49	21			
WEST	125	3100	0.0	5.0	Y	SC	20	10			
WEST	126	3100	0.0	4.2	Y	SC	34	23			
NORTH	127					SP-SM	10.8				
NORTH	128					CL	71.5				
NORTH	129					SM	18.3				
NORTH	130					SM	18.6				
NORTH	131					SC	25.6				105.4
NORTH	132					SM	14				
NORTH	133					SP	4.5				
NORTH	134					SP-SM	10.1				
WEST	135					SC	41.6				101.8
WEST	136					SC	29.4				115.5
WEST	137					SM	34.9				
WEST	138					SC-SM	48.8				
WEST	139					SC-SM	43.3				
WEST	140					CL	51.4				
WEST	141					SC	29.8				105.8
WEST	142					SM	21				
WEST	143					SM	35.7				

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June 30, 1993

WWL #310

Homestake Mining Company
650 California Street, Tenth Floor
San Francisco, California 94108-2788

Attention: Harold Barnes, Director
Environmental, Health, Safety & Governmental Affairs

Subject: Radon Barrier Design
Homestake Grants Mill Tailing Site

Dear Harold,

In accordance with your request, WWL has conducted an independent review and evaluation of the proposed radon barrier design for the large tailings impoundment at the Homestake Grants site. We have evaluated the radon barrier design in accordance with the reclamation standards in 10 CFR 40 Appendix A, applicable NRC design guidelines, and accepted engineering principles for tailings reclamation. The results of our evaluation are presented in the WWL report entitled "Discussion of Radon Barrier Design for the Large Tailings Impoundment at the Grants Uranium Mill, NRC License No. SUA-1471" dated June 30, 1993.

As discussed in the WWL report, two alternative radon barrier systems were evaluated. The first alternative is the three-layer system proposed to the NRC in 1992. The first alternative requires selection of clayey soils from the borrow area to form the clay barrier within the radon barrier system. The second alternative is a two-layer system proposed as an alternate to NRC in 1992, and consists of a controlled mixture of sandy and clayey soils to form the radon barrier. We prefer the second alternative because it meets radon barrier suitability requirements and is compatible with the soil characteristics of the proposed borrow area, allowing the lenses of clayey and sandy soils present in the borrow area to be mixed to form the radon barrier. These alternatives and conclusions are discussed in the WWL report.

Our evaluation has included the following issues outlined in the NRC URFO May 1993 letter and the NRC Region IV June 14, 1993 Demand for Information.

- Suitability of the radon barrier soils (as defined by material specifications) for radon barrier performance in terms of infiltration control, potential for cover cracking, conformance with radon flux requirements, susceptibility to the effects of freeze/thaw cycles, and the potential for intrusion by plant and animal species. The radon barrier design meets these suitability issues, which are discussed in Section 4.4 of the WWL report.

- Accessibility (in terms of excavation depth) of a sufficient volume of radon barrier soil in the borrow area to meet the proposed material specifications. Sufficient volumes of radon barrier material are available, based on the revised material specifications outlined in the WWL report.

- Use of reasonable and supportable long-term moisture contents in the radon barrier design calculations. Reasonable and supportable values have been used (from our experience), which have resulted in a thicker radon barrier than what has been used in previous designs.

The radon barrier calculations presented in the WWL report are based on conservative interpretation of actual data where present and conservative assumptions where the data is not present. The calculated radon barrier is thicker than previous designs presented to NRC, and represents a conservative or upper limit thickness for the radon barrier. In order for HMC to reduce the thickness of the radon barrier, additional testing would be required with measurement of radon attenuation parameters that more closely represent site-specific conditions and actual materials to be used as radon barrier construction materials.

This testing would include measuring radon emanation from the radon barrier after three feet of barrier material (not including interim cover) has been placed and compacted. Measured radon emanation rates would be compared with the calculated radon flux at that level in the radon barrier and with the surface maximum of 20 pCi/m^2-sec. Recommendations are provided in the WWL report for providing this data while meeting the current reclamation schedule.

On behalf of WWL, I affirm that the evaluation of the radon barrier design documented in the WWL report has addressed the issues of suitability and accessibility of radon barrier soils, use of reasonable and supportable parameters in the radon barrier design calculations, and conformance to applicable requirements in Appendix A of 10 CFR 40. If you have questions concerning the information in this letter or in the WWL report, please call me.

Yours sincerely,

Water, Waste & Land, Inc.

Clint Strachan

Clint Strachan, P.E.
Manager, Mining/Geotechnical Division

DISCUSSION OF THE RADON BARRIER DESIGN FOR THE LARGE TAILINGS IMPOUNDMENT AT THE GRANTS URANIUM MILL

NRC LICENSE NO. SUA-1471

Prepared for:

Homestake Mining Company
P.O. Box 98
Grants, New Mexico 87020

Prepared by:

Water, Waste & Land, Inc.
2629 Redwing Road, Suite 200
Fort Collins, Colorado 80526

June 1993

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1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

This report outlines our evaluation of the radon barrier for reclamation of the large tailings impoundment at Homestake Mining Company's (HMC's) Grants uranium mill site near Milan, New Mexico. This evaluation comprises an independent review of previous radon barrier design, as requested by the Uranium Recovery Field Office of the Nuclear Regulatory Commission (NRC) in May 1993 (NRC, 1993a). This evaluation has been conducted by Water, Waste and Land, Inc. (WWL) at the request of HMC in May 1993.

The results of this evaluation reflect our understanding of site conditions, previous site exploration work, and previous radon barrier design calculations. This information includes the following items.

- Review of previous test results, design calculations, and correspondence in HMC files pertinent to radon barrier design.
- Results of additional soil sampling and geotechnical testing conducted for HMC by Vinyard and Associates Inc. in June 1993.
- Informal meeting with NRC staff on June 11, 1993 and informal telephone conversations with NRC staff.

The evaluation conducted by WWL consisted of the following tasks.

- Review of previous documents, especially correspondence between HMC and NRC to identify technical issues associated with the reclamation plan for the large tailings impoundment.
- Review of previous radon barrier thickness calculations, checking values used as input to the calculations, and verifying calculation results using previously used input values.
- Review of previous site exploration work and laboratory testing with focus on availability of materials and parameters affecting radon barrier thickness calculations.
- Preparation of recommendations for revised input values for radon barrier thickness calculations, based on our perception of site and borrow area conditions.

1.2 SCOPE OF REPORT

This report presents the results of the evaluation tasks listed above associated with the radon barrier for the large tailings impoundment at the Grants site. The large impoundment is of primary concern for reclamation plan permitting and reclamation scheduling. Due to the planned use of the small tailings impoundment for ground water evaporation for some period of time, the radon barrier of the small impoundment was not included as part of this evaluation. The erosion protection issues associated with the rock surface of the reclaimed large tailings impoundment are not included in this report.

This report has been organized to present the results of our evaluation in a manner that facilitates NRC review. Background information has been cited by reference, with only new analyses or discussion presented in this report. The following two sections of the report summarize site conditions and radon barrier design parameters. Subsequent sections of the report address specific items in NRC's May letter (NRC, 1993a) and June 14 Demand for Information (NRC, 1993b).

2.0 SUMMARY OF SITE CONDITIONS

The summary of site conditions presented in this section is based on work conducted under the direction of HMC at the Grants site. Evaluation of tailings and borrow materials pertinent to the radon barrier design are summarized in the following subsections.

2.1 TAILINGS IMPOUNDMENT CONDITIONS

As outlined in AK Geoconsult et al. (1991), the large tailings impoundment was operated from 1958 to 1990 for disposal of uranium mill tailings for both Atomic Energy Commission and industry contracts. The ring-dike impoundment contains 20 to 22 million tons of tailings, covers approximately 170 acres, and is 85 to 100 feet high. The impoundment contains two cells. Tailings were discharged into the first cell only from mill startup until 1966. Subsequently the second cell was constructed, and tailings were discharged into both cells until mill shutdown (AK Geoconsult et al., 1991).

Tailings that were discharged into the large impoundment came from the Homestake-Sapin Partners mill, which utilized an alkaline (soda ash) leach and caustic precipitation process. The tailings grind was such that a sufficient amount of sand was produced to allow cyclone separation of tailings for embankment construction. The large impoundment was designed and operated for centerline embankment construction, with the sand fraction used for embankment materials and the fine fraction or slimes discharged within the perimeter of the impoundment. Tailings water was ponded in the center of each impoundment cell prior to decanting and reuse in the mill (AK Geoconsult et al., 1991).

The centerline method of embankment construction was modified in 1981 to include an upstream offset to improve embankment stability. In the later years of mill operation, cyclone separation was stopped due to lower tailings discharge rates, and tailings were spigotted from the tailings embankment (AK Geoconsult et al., 1991).

2.2 PLANNED RECLAMATION SEQUENCE

The planned reclamation sequence for the large tailings impoundment (from AK Geoconsult et al., 1991 and HMC, 1992b) is listed below.

- Evaporation of remaining tailings pond water while minimizing windblown release of tailings.
- Regrading the impoundment surface to meet final slopes by covering the interior of the impoundment with tailings sands excavated from the impoundment perimeter.
- Excavation of windblown tailings and placement of these tailings within the large tailings impoundment. Offsite cleanup is planned to be to radium levels described in Section 4.2.
- Placement of mill debris from mill site cleanup in a specified area on the side of the large tailings impoundment.

- Construction of an interim cover over the regraded surface of the large tailings impoundment, with subsequent monitoring of tailings settlement.

- After acceptable tailings settlement has been achieved, construction of the radon barrier over the interim cover and placement of a rock surface on top of the radon barrier.

2.3 CONSTRUCTION MATERIALS FOR RECLAMATION

The Grants site is situated on alluvial soils within the San Mateo Creek watershed. These soils consist primarily of interbedded sands and clays that are mantled with eolian sands. Areas containing these soils immediately north, south, and west of the large tailings impoundment have been explored and identified as the borrow area for radon barrier construction materials (AK Geoconsult et al., 1991; HMC, 1992b). The identified borrow area shown in HMC (1992b) covers approximately 480 acres. The exploration and testing of the borrow area are outlined in the following subsections.

2.4 BORROW AREA EXPLORATION

Test holes BA-1 through BA-20 were drilled to a typical depth of 22 feet in July, 1986, under the direction of Alan K. Kuhn. Split spoon samples were taken on five foot intervals and bulk samples were collected from the auger cuttings. Backhoe trenches TP-1 through TP-9 were excavated to typical depths of 10 feet in August, 1986, under the direction of Alan K. Kuhn. Selected samples of layers of interest were collected. Logs of trenches TP-1 through TP-9 and borings BA-1 through BA-20 are presented in HMC (1986). Backhoe trenches TP-10 through TP-34 were logged and sampled by AK Geoconsult to a typical depth of 10 feet in September, 1987. Backhoe trenches TP-35 through TP-57 were logged and sampled by AK Geoconsult to a typical depth of 10 feet in January 1990. The results from this work are summarized in AK Geoconsult et al. (1991). Logs of trenches TP-10 through TP-34 are presented in HMC (1988a). The log of trench TP-27 was presented in HMC (1988b).

Backhoe trenches TP-70 through TP-89 were logged and sampled by AK Geoconsult in November, 1991. Backhoe trenches TP-90 through TP-120 were logged and sampled under the direction of AK Geoconsult by Vinyard and Associates in September 1992 (HMC, 1992b). Test holes TP-121 through TP-126 were sampled, using a small auger device during November 1992 to a typical depth of 5 feet (HMC, 1992b).

In June 1993, 20 shallow backhoe trenches were excavated and sampled by Vinyard and Associates in areas of the borrow area needing verification of soil conditions. Index and compaction tests were conducted by Vinyard and Associates (Vinyard and Associates, 1993).

From the exploration work listed above, 129 backhoe trenches and 26 borings have been drilled in potential borrow area materials at the Grants site. From this total, the majority of backhoe trenches (99) and borings (15) present logs and data from the 480-acre borrow area currently under consideration for the radon barrier.

2.5 SOIL BORROW MATERIAL TESTING

Fox and Associates in letter reports dated from September through December, 1987 report data from testing of selected individual and composite samples submitted from test pits TP-10 through TP-34. Testing included Atterberg limits, sieve analyses, hydrometer tests, pinhole dispersivity, crumb tests, and permeability tests. Sergent, Hauskins, and Beckwith (SHB) in letters dated from July through September, 1986 present data from testing of selected samples from borings BA-1 through BA-20 and trenches TP-1 through TP-9. Testing included natural moisture contents, Standard Proctors, sieve analyses, Atterberg limits, and permeabilities. The results from this phase of testing are included in AK Geoconsult et al. (1991). The data from Fox and Associates is also presented in HMC (1987) and the data from SHB is also presented in HMC (1986).

Assaigai Analytical Laboratories in a letter dated 3/13/89 report data from organic matter tests on selected individual samples from test pits TP-10 through TP-34 (AK Geoconsult et al., 1991). Homestake Mining Company's Grants, New Mexico Mill laboratory in a letter dated 7/17/86 presents data from natural moisture tests performed on selected individual samples from borings BA-1 through BA-15 (HMC, 1986, and AK Geoconsult et al., 1991).

Vinyard and Associates, Inc., in a table dated 1990, report data on testing of 9 soil samples. Sieve analyses were performed on seven samples labeled Pit 2 through Pit 9 and one surface grab sample, these samples were gravels and sands. Sieve analyses and Atterberg limits were performed on one sample of clay labeled N-2-11 (AK Geoconsult et al., 1991).

2.6 TAILINGS TESTING

Rogers and Associates Engineering Corporation in a letter dated 2/24/89 report data from testing of 20 tailings samples. Results include moisture, radon emanation coefficient, and radium activity. Daniel B. Stephens & Associates, Inc. in a letter dated 10/20/89 report data from testing of 25 tailings samples. Results include moisture contents at 1/3 and 15-bar suction pressures from pressure plate testing. These results are included in AK Geoconsult et al. (1991).

2.7 SUMMARY OF RADON BARRIER BORROW MATERIAL CONDITIONS

From the borrow site exploration work listed above, materials range from relatively clean fine-grained sands (USCS SP classification) to clays of low to high plasticity (USCS CL to CH classification). The ranges of grain-size distribution of these materials are summarized in Figure 2.2. Atterberg limit test results from clayey samples are summarized in Figure 2.3. Composite samples of the clay soils had measured laboratory permeability values of less than 10^{-7} cm/sec (AK Geoconsult et al., 1991)

From reviews of the backhoe trench and boring logs, considerable interbedding is observed between the materials described as clays and the materials described as sands. Based on these descriptions, the total thickness of clays in the upper 10 feet of backhoe

; and borings within the borrow area ranges from less than 1 to approximately 7 feet. he acre borrow area, approximately 217 acres contain more than 2 feet of clays ppt) feet and approximately 27 acres contain more than 4 feet of clays in the) feet.

COARSE FINE COARSE MEDIUM FINE

FIGURE 2.1
GRAIN-SIZE DISTRIBUTION SUMMARY

Date: JUNE 1993
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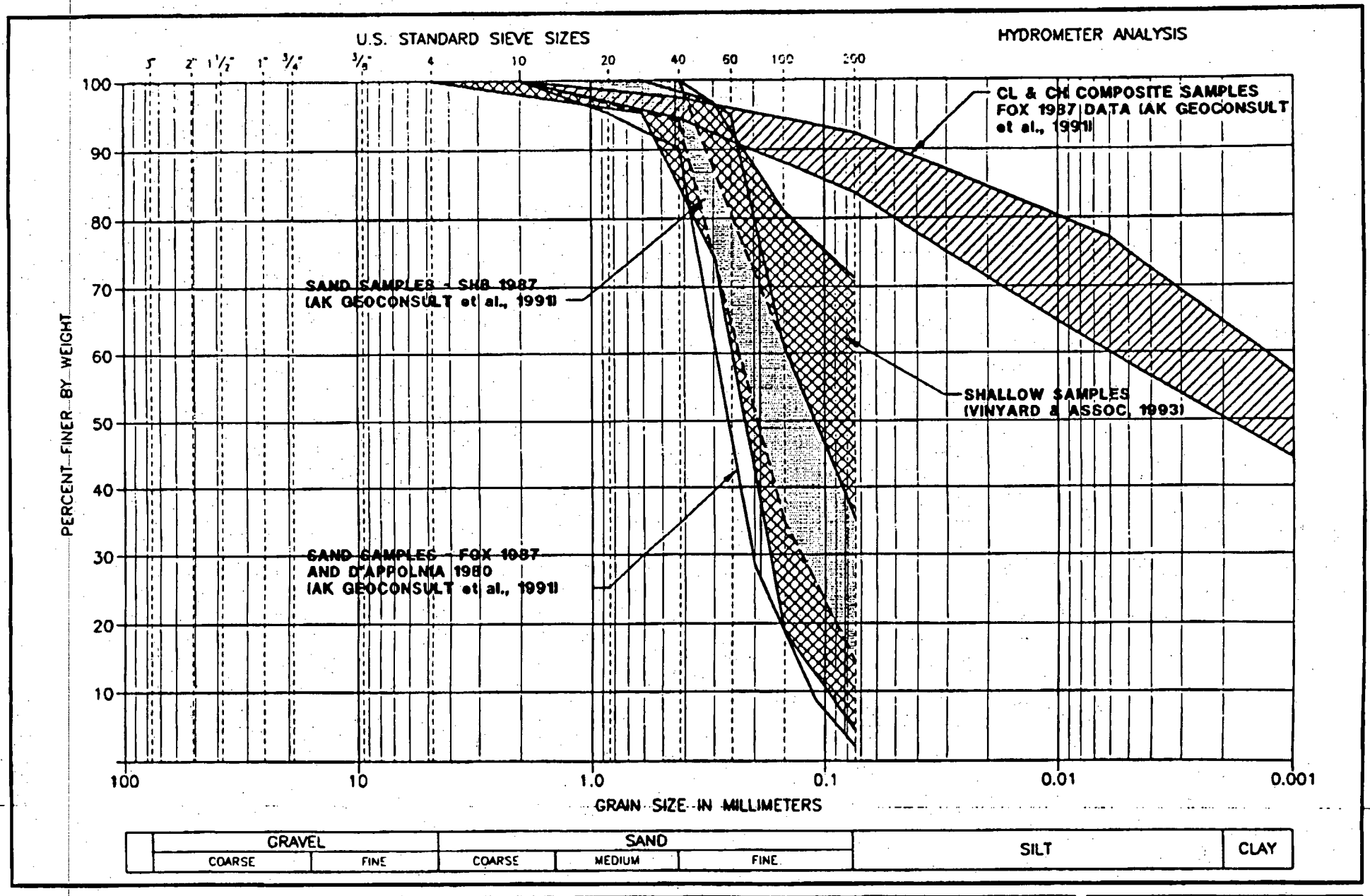

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FIGURE 2.2
GRAIN-SIZE DISTRIBUTION SUMMARY

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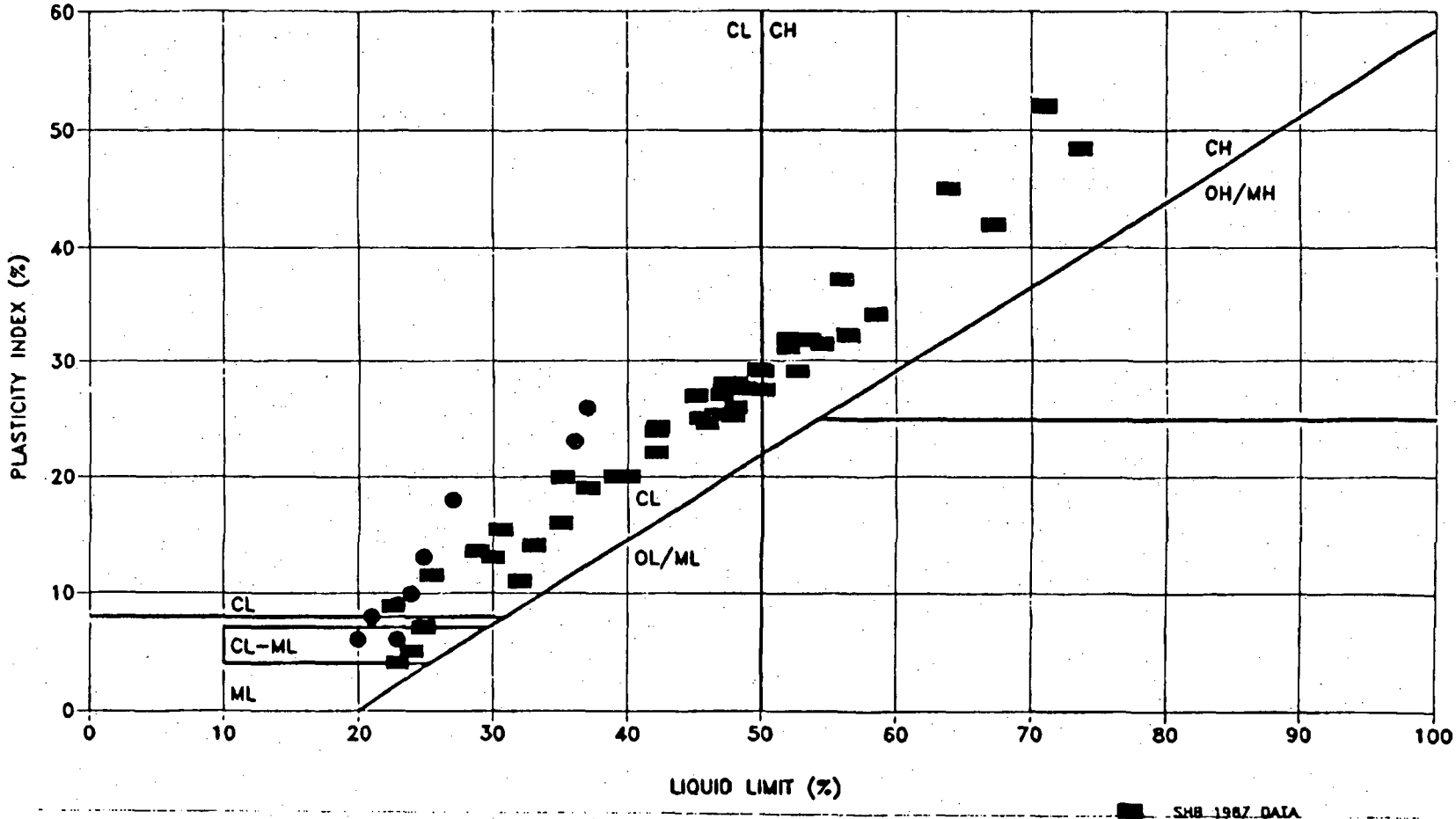


SHB 1987 DATA (FROM AK GEOCONSULT ET AL., 1991)

VINYARD AND ASSOCIATES (1993)

WATER WASTE & LAND INC.

FIGURE 2.3
SUMMARY OF ATTERBERG LIMIT TEST RESULTS

Date: JUNE 1993

Project: 310

3.0 SUMMARY OF RADON BARRIER DESIGN

3.1 GENERAL RADON BARRIER CONCEPT

One of the radon barrier concepts for the large tailings impoundment that has been presented by HMC to the NRC (AK Geoconsult et al., 1991; HMC, 1992b) includes a radon barrier with a compacted clay layer containing approximately 53 percent clay. This radon barrier included an interim cover (SM layer) beneath the clay layer on the top surface of the impoundment and clayey sand (SC) layer on top of the clay layer and on top and side slopes of the impoundment. The clay layer was specified as such to maximize radon attenuation within the layer, minimizing the volume of material required to construct the radon barrier. From our review, this design was based on an appropriate level of detail for site exploration and testing, and radon attenuation calculations were appropriately made based on actual test results for tailings and potential radon barrier soils.

The radon barrier concept summarized in this report is based on a different approach and interpretation of site exploration data than that taken previously presented to the NRC. These differences are listed below.

- The long-term moisture content for the tailings sands and slimes has been represented in the radon barrier calculations in a more conservative manner.

- The long-term moisture content for the clay layer within the radon barrier has been represented in a more conservative manner in radon barrier calculations.

- Material specifications have been revised to reflect the presence of interbedded layers of sands and clays in the borrow area. Excavation and placement of a mixture of these soils would be simpler for construction and quality assurance (Q/A) testing than selection of high clay content materials.

Based on soil moisture content discussion in Criterion 6 of 10 CFR 40 Appendix A, and guidelines in NRC (1989b), this evaluation has focused on natural moisture contents to represent long-term moisture contents in radon attenuation modeling. For long-term moisture content in the radon barrier, the average moisture content from borrow area samples was used (from test results at appropriate depths and from samples meeting anticipated material specifications).

As outlined in NRC (1989b), natural moisture content is appropriate in the long-term water balance is similar to natural conditions. For example, at sites with vegetated surfaces, the long-term runoff, evapotranspiration, and infiltration conditions of the reclamation cover are similar to nearby borrow areas. Therefore, long-term moisture contents in the radon barrier can be represented by natural moisture contents measured form soil samples at reasonable depths.

For the Grants site, reclaimed conditions will differ from natural conditions. The rock surface with underlying layers materials with decreasing particle size would increase the proportion of precipitation that percolates into the radon barrier. The absence of vegetation would reduce the amount of moisture loss from the radon barrier by evapotranspiration.

Therefore, long-term moisture contents in the radon barrier may be higher than natural moisture contents measured from soil samples in the potential borrow areas on site.

3.2 RADON BARRIER COMPONENTS

The radon barrier concept for the large tailings impoundment consists of the multilayered system outlined in HMC (1992b), but with the same layers on both the top surface and side slopes (summarized in Figure 3.1). Descriptions of the individual layers or components used for radon barrier calculations are outlined in the following subsections (listed in order from bottom to top).

3.2.1 Tailings Slimes

The tailings slimes will be covered during impoundment regrading by tailings sands. An average value of radium activity for the slimes was used in the radon barrier calculations (582 pCi/g) based on testing of surface samples (summarized in AK Geoconsult et al., 1991). Due to milling of higher-grade uranium ores during the latter stages of mill operation, the average measured radium activity from surface slimes samples represents a realistic value for radon barrier calculations.

For long-term moisture content, a value of 13 percent was used, which is similar to the upper limit value recommended in NRC (1992b). Moisture content measurements of the tailings slimes from 15-bar suction testing yielded values in excess of 40 percent (AK Geoconsult et al., 1991) and these values were typical (from a geochemical standpoint) of tailings slimes from an alkaline leach process (HMC, 1992). However, a lower value for the slimes was used in this evaluation to conservatively represent long-term conditions in the majority of the slimes and to represent upper layers or isolated zones of well-drained slimes surrounded by tailings sands.

3.2.2 Tailings Sands

The tailings sands excavated from the embankment will cover tailings slimes to form the regraded impoundment surface. HMC estimates indicate that a minimum of 15 feet of tailings sands will cover the tailings slimes. As outlined in HMC (1992), the upper 4 feet of the placed tailings sands will be compacted to 90 percent of Standard Proctor density.

An average value of radium activity for the sands was used in the radon barrier calculations (167 pCi/g) based on testing of surface samples (summarized in AK Geoconsult et al., 1991). Due to milling of higher-grade uranium ores during the latter stages of mill operation and the regrading of considerable volumes of tailings sands, the average measured radium activity from surface samples represents a conservative value for tailings sands in the radon barrier calculations (since excavated tailings sands may have a lower radium activity than those originally at the surface).

For long-term moisture content a value of 6 percent was used, which is the value recommended in NRC (1992b). This value was selected as an average based on the variation in fines fraction of the tailings to be used for regrading (ranging from 5 to 50 percent as shown in Figure 2.1 and listed in D'Appolonia, 1980).

3.2.3 Interim Cover

As outlined in HMC (1992), an interim cover is planned over the regraded tailings surface. Interim cover materials will consist of near-surface materials, primarily windblown sands, compacted to 90 percent of Standard Proctor density. For long-term moisture content, a value of 6 percent was used, representing windblown natural sands or tailings sands. An average radium activity of 5 pCi/g was used.

3.2.4 Clay Barrier

The clay barrier material will be obtained from selected alluvial deposits in the borrow area. In order to facilitate construction (as mentioned in Section 3.1), the clay barrier specifications were modified to allow mixing of sandy and clayey soils to form the clay barrier. The characteristics of the clay barrier in the radon barrier calculations reflect a revised material specification of at least 50 percent fines (passing the No. 200 sieve). The clay barrier will be compacted to 95 percent of Standard Proctor density and within minus 1 to plus 3 percent of optimum moisture content.

For long-term moisture content, a value of 13.8 percent was used in the radon barrier calculations. This value was based on an average natural moisture content from samples at depth (D'Appolonia, 1980; AK Geoconsult et al., 1991). The distribution of these measured values is shown in Figure 3.2. From 15-bar suction tests on clay samples, the measured moisture content averages 29 percent (HMC, 1992), which is significantly higher than Standard Proctor test optimum values. Using the conservative Rawls and Brakensiek equation (NRC, 1989b), the estimated moisture content is 10 percent (based on 2.4 percent organic matter and 30 percent clay). From Standard Proctor tests on potential borrow material samples (summarized in Figure 3.3), optimum moisture content values range from 13 to 22 percent and represent the moisture content at which clays will be compacted in the radon barrier. Plastic limit values show similar values, ranging from 14 to 25 percent (AK Geoconsult et al., 1991). From the range of values discussed above and the fact that the planned cover system without vegetation is likely to have higher long-term moisture contents than surrounding vegetated areas, the value of 13.8 percent was used to conservatively represent the long-term moisture content of the clay layer.

3.2.5 Clayey Sand Layer

The clayey sand layer material will be obtained from mixture of near-surface alluvial deposits in the borrow area. The characteristics of the clayey sand layer in the radon barrier calculations reflect a material specification of at least 25 percent fines (passing the No. 200 sieve). The clayey sand layer will be compacted to 95 percent of Standard Proctor density and within minus 2 to plus 2 percent of optimum moisture content.

For long-term moisture content, a value of 10 percent was used in the radon barrier calculations. This value was based on several methods of estimation. No natural moisture content values or 15-bar suction values are available for the clayey sand material. Using the Rawls and Brakensiek equation (NRC, 1989b), the estimated moisture content is 9 percent (based on 2.4 percent organic matter and 15 percent clay). From Standard Proctor tests on potential borrow material samples, optimum moisture content values range from 11 to 15 percent, with an average of approximately 14 percent (Vinyard and Associates, 1993) and represent the moisture content at which clayey sands will be compacted in the radon barrier. wrong

Plastic limit values show similar values, ranging from 9 to 14 percent (Vinyard and Associates, 1993). From the range of values discussed above and the fact that the planned cover system without vegetation is likely to have higher long-term moisture contents than surrounding vegetated areas, the value of 10 percent was used to conservatively represent the long-term moisture content of the clayey sand layer.

3.2.6 Rock Layers

The rock cover and bedding layer materials were not included in the radon barrier calculations due to their relatively coarse particle size distributions.

3.3 RADON BARRIER THICKNESS

Based on the radon barrier calculations discussed above and using the RADON model (NRC, 1989b), the resulting radon barrier thicknesses are shown in Figure 3.1. These thicknesses and general specifications are summarized below.

- 1 foot of interim cover, compacted in 6-inch lifts to 90 percent of Standard Proctor density.
- 2 feet of clay barrier, consisting of minus 3/4-inch material, at least 50 percent passing the No. 200 sieve, Atterberg limits plotting above the "A" line, and compacted in 6-inch lifts to at least 95 percent of Standard Proctor density within minus 1 to plus 3 percent of optimum moisture content.
- 4.5 feet of clayey sand layer, consisting of minus 3/4-inch material, containing at least 25 percent passing the No. 200 sieve, Atterberg limits plotting above the "A" line; and compacted in 6-inch lifts to at least 95 percent of Standard Proctor density within minus 2 to plus 2 percent of optimum moisture content.
- Covering the clayey sand layer with bedding layer and rock cover layers.

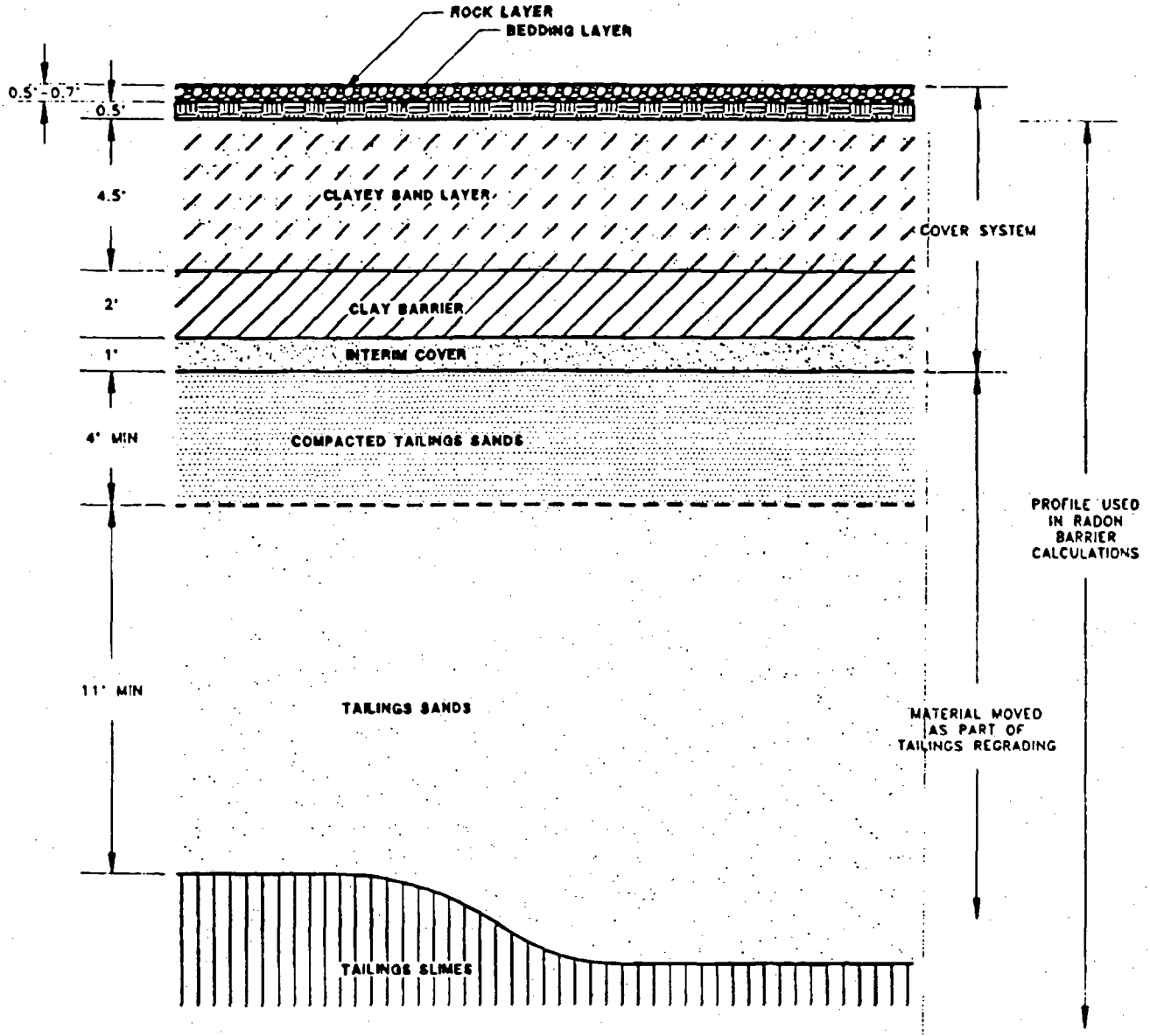
An alternative to the clay barrier system outlined above was evaluated, consisting of a homogeneous radon barrier system with the clay barrier and clayey sand layer replaced entirely with clayey sand layer. This was an alternate radon barrier concept presented in HMC (1992b). This alternative was evaluated for its preferred construction requirements, allowing mixing of sandy and clayey soils from the borrow area as radon barrier without selecting clays. The thicknesses and general specifications of this alternative are summarized below.

- 1 foot of interim cover, compacted in 6-inch lifts to 90 percent of Standard Proctor density.
- 7 feet of clayey sand layer, consisting of minus 3/4-inch material, containing at least 25 percent passing the No. 200 sieve, Atterberg limits plotting above the "A" line; and compacted in 6-inch lifts to at least 95 percent of Standard Proctor density within minus 2 to plus 2 percent of optimum moisture content.
- Covering the clayey sand layer with bedding layer and rock cover layers.

The profile of this alternative radon barrier system is illustrated in Figure 3.4. This alternative is preferred for the radon barrier due to the construction advantages listed above.

TYPICAL RECLAIMED IMPOUNDMENT CROSS-SECTION

NOT TO SCALE



TYPICAL PROFILE

NOT TO SCALE

WATER WASTE & LAND INC.	FIGURE 3.1 COVER SYSTEM PROFILE USED FOR RADON BARRIER CALCULATIONS	Date: JUNE 1993 Project: 310

TABLE 3.1
SUMMARY OF INPUT VALUES USED IN RADON MODEL

PARAMETER / LAYER		TAILINGS SLIMES	TAILINGS SANDS	COMPACTED TAILINGS SANDS	INTERIM COVER	CLAY BARRIER	CLAYEY SAND LAYER
Radium activity	(pCi/g)	582(a)	167(a)	167(a)	5(b)	5(b)	5(b)
Radon emanation coefficient		0.33(a)	0.34(a)	0.34(a)	0.35(b)	0.35(b)	0.35(b)
Radon diffusion coefficient	(cm^2/sec)	0.0273(c)	0.0336(c)	0.0305(c)	0.0291(c)	0.0115(c)	0.0173(c)
Porosity		0.55(d)	0.42(d)	0.39(d)	0.38(d)	0.42(d)	0.40(d)
Void ratio		1.22(d)	0.72(d)	0.52(d)	0.61(d)	0.72(d)	0.67(d)
Density	(g/cm^3)	1.19(d)	1.54(d)	1.62(d)	1.66(d)	1.53(d)	1.63(d)
	(pcf)	74.3(e)	96.1(e)	101.0(f)	103.6(g)	95.5(h)	101.8(i)
Moisture content	(%)	13(j)	6(j)	6(j)	6(j)	13.8(j)	10(j)
Degree of saturation		0.28(k)	0.22(k)	0.31(k)	0.26(k)	0.50(k)	0.40(k)
Layer thickness	(ft)	16.4	11.0	4.0	1.0	2.0	(l)
	(cm)	500	335	122	30	60	(l)

SOURCES FOR VALUES

(a) Average from measurements in 1989 by Rogers and Associates Engineering Corporation (RAEC), given in AK Geoconsult et al. (1991).

(b) Default value given in RAEC (1984).

(c) Value calculated from moisture content using empirical relationships in RAEC (1984).

(d) Calculated from dry density, using a specific gravity of solids of 2.65.

(e) Average from measurements by D'Appolonia given in D'Appolonia (1980) and AK Geoconsult et al. (1991).

(f) Estimated to be 5 percent higher than tailings sand value.

(g) 95% of average maximum density from Standard Proctor tests on sand samples with less than 25% fines (from Figure 3.3). This is close to the value used for the interim layer in HMC (1992).

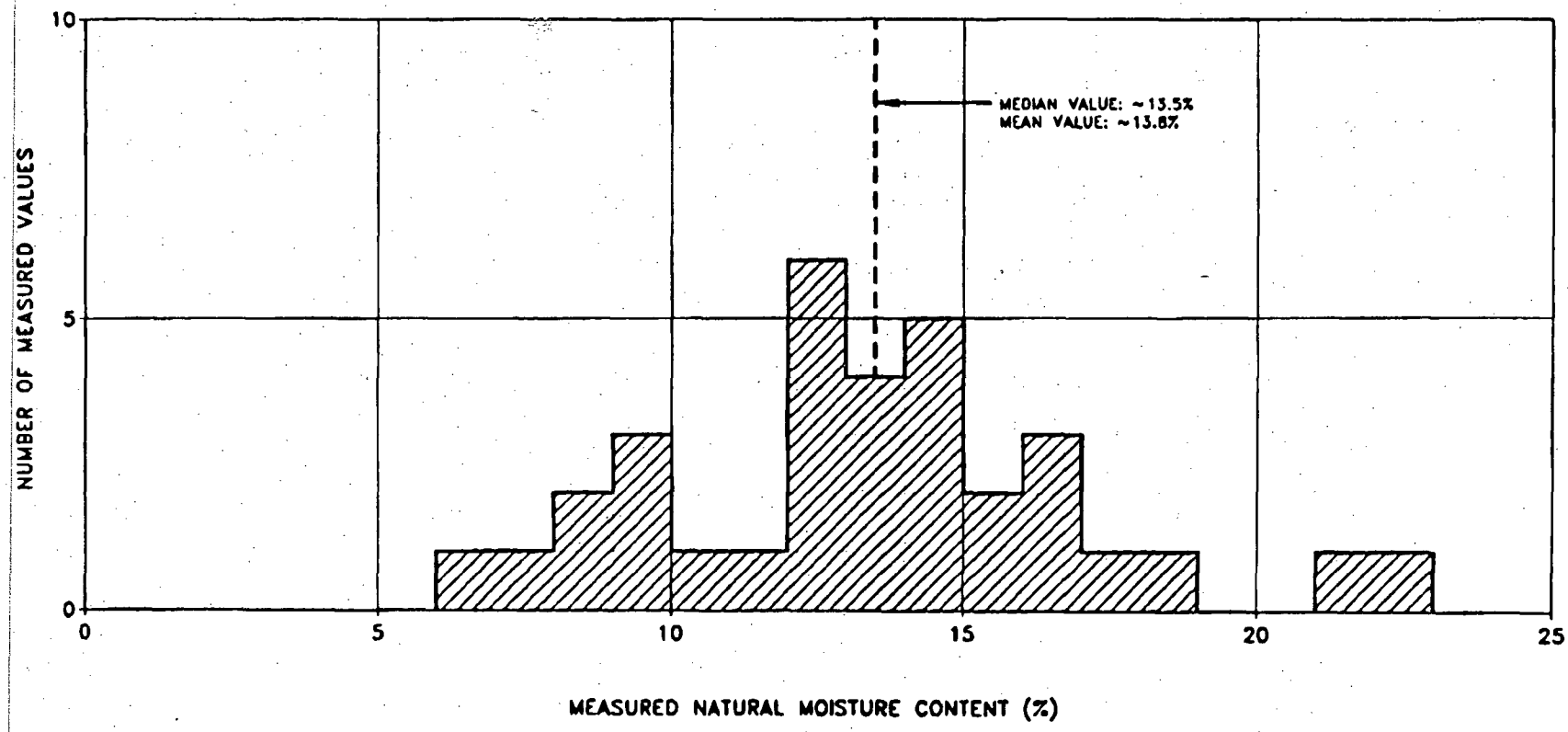
(h) 95% of average maximum density from Standard Proctor tests on clay samples with more than 50% fines (from Figure 3.3). This is the same value used for the clay layer in HMC (1992).

(i) 95% of average maximum density from Standard Proctor tests on clayey sands samples by Vinyard and Associates (1993).

(j) Long-term moisture content, as discussed in report text.

(k) Calculated from density and moisture content, using a specific gravity of solids of 2.65.

(l) Calculated with RADON model (NRC, 1989b).



NOTES

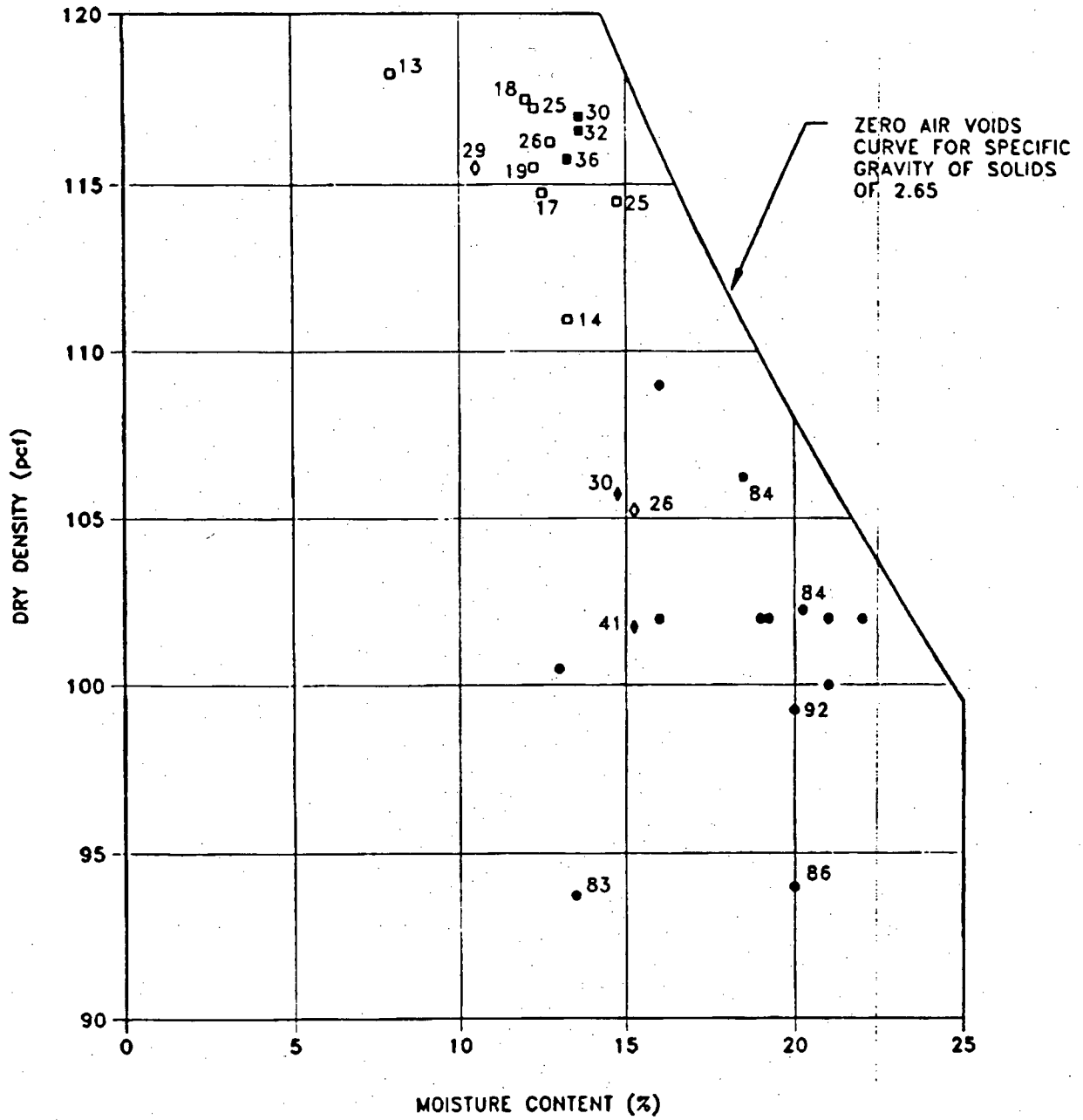
1. TOTAL NUMBER OF SAMPLES - 31.
2. DATA FROM SAMPLES COLLECTED BELOW 5-FOOT DEPTH FROM D'APPLONIA (1980) AND SHB (AK GEOCONSULT et al., 1991)

WATER WASTE & LAND INC.

FIGURE 3.2
DISTRIBUTION OF NATURAL MOISTURE CONTENTS FROM CLAY SAMPLES COLLECTED AT DEPTH

Date: JUNE 1993

Project: 310



LEGEND

■ □ SHB 1987 DATA (AK GEOCONSULT et al., 1991)

♦ ◊ VINYARD & ASSOC (1993)

● FOX 1987 DATA, CL & CH SAMPLES (No. 200 SIEVE VALUES ABOVE 50 PERCENT) (AK GEOCONSULT et al., 1991)

DARKENED SYMBOLS REPRESENT PASSING No. 200 SIEVE VALUES ABOVE 30 PERCENT

NOTES

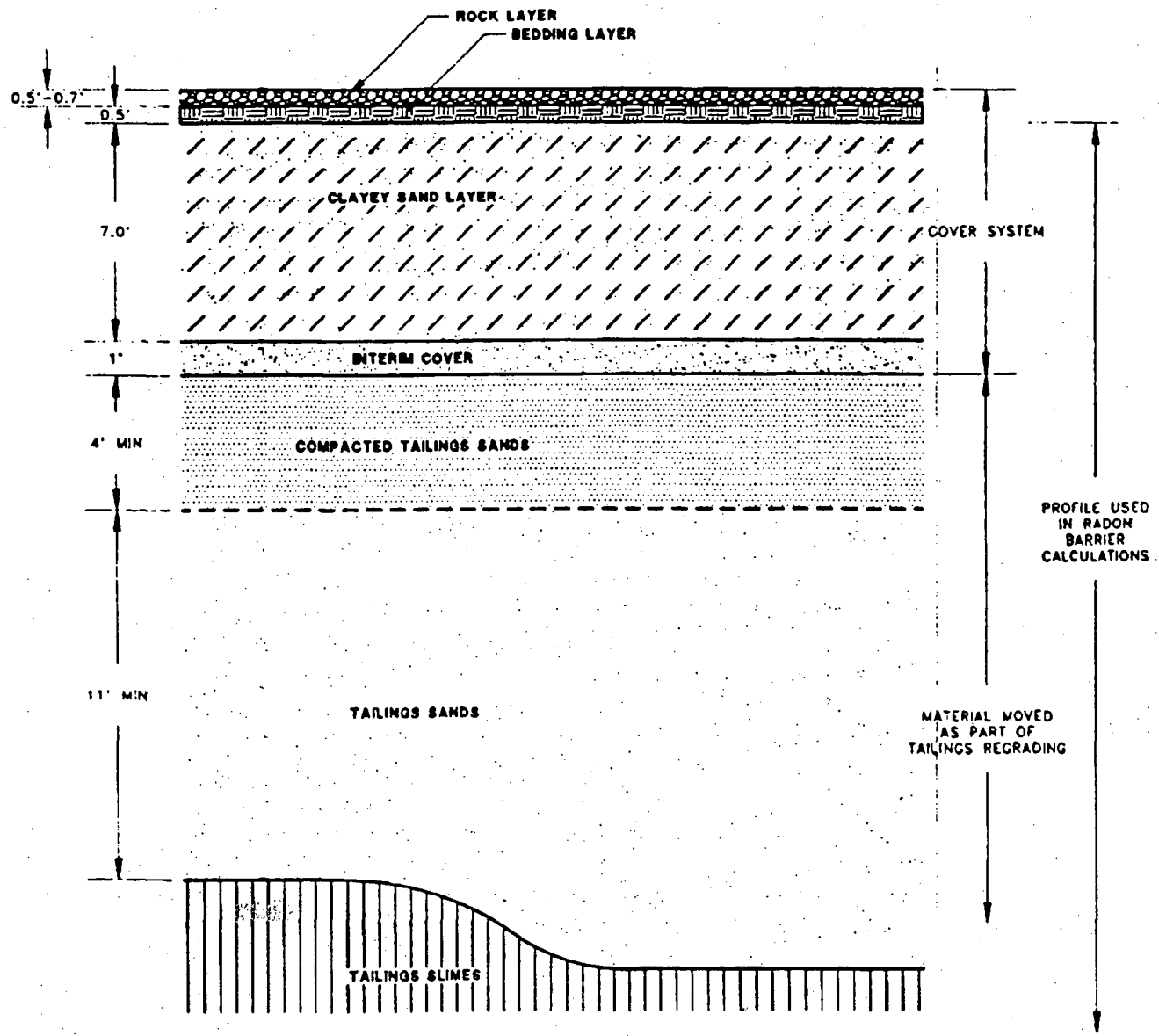
1. POINTS SHOWN ARE MAXIMUM DENSITY/ OPTIMUM MOISTURE CONTENTS FROM STANDARD PROCTOR TESTS (ASTM D 698 METHOD A)

2. NUMBERS SHOWN ARE PERCENT PASSING No. 200 SIEVE VALUES (WHERE AVAILABLE)

WATER WASTE & LAND INC.	FIGURE 3.3 SUMMARY OF COMPACTION TEST RESULTS	Date: JUNE 1993 Project: 310

TYPICAL RECLAIMED IMPOUNDMENT CROSS-SECTION

NOT TO SCALE



TYPICAL PROFILE

NOT TO SCALE

WATER WASTE & LAND INC.

FIGURE 3.4
ALTERNATIVE COVER SYSTEM USED FOR RADON BARRIER CALCULATIONS

Date: JUNE 1993

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4.0 DISCUSSION OF NRC ISSUES

This section addresses issues outlined in NRC (1993a and 1993b), as well as previous NRC correspondence. Many of these issues have been discussed in the previous section of this report, but are summarized in the following subsections to facilitate NRC review.

4.1 LONG-TERM MOISTURE CONTENTS

This subsection addresses Item No. 1 of NRC (1993a) and Section III 1 of NRC (1993b).

The long-term moisture content of tailings is discussed in Section 3.2 above, using more conservative values than those used previously. Values used in the RADON model are listed in Table 3.1. For 15 feet of tailings sands above the tailings slimes, RADON model calculations indicate that the moisture content of the tailings slimes results in an insignificant variation in radon barrier thickness.

The long-term moisture content of radon barrier soils is discussed in Section 3.2 above, using more conservative values than those used previously, and using values representing mixtures of soils to be excavated from the borrow area. Values used in the RADON model are listed in Table 3.1.

Based on calculations provided for HMC by AK Geoconsult Inc., there are sufficient quantities of borrow materials for construction of the radon barrier. These estimated quantities are aided by the revised material specifications listed in Section 3.3, which allow mixing of clayey and sandy soils. The borrow area outlined in HMC (1992b) is approximately 480 acres. For seven feet of clayey sand radon barrier, this would require excavation of materials to an average depth of 2.5 feet (using all of the 480-acre borrow area).

4.2 RADIUM ACTIVITY OF RADON BARRIER SOILS

This subsection addresses Item No. 2 of NRC (1993a) and Section III 2 of NRC (1993b).

HMC is planning to excavate windblown tailings and place these tailings within the large tailings impoundment. Offsite cleanup is planned to the byproduct material radium standards in Criterion 6 of 10 CFR 40 Appendix A, consisting of cleanup to 10.5 pCi/g (5 pCi/g above the measured background value of 5.5 pCi/g). In areas of documented tailings excursion, sampling would be on a 100-foot grid. Areas with measured radium values above 10.5 pCi/g would be removed in 6-inch depth intervals, with the remaining soils sampled and compared with the 10.5 pCi/g level. In areas outside of documented tailings excursion, existing data would be supplemented (if necessary) with sampling and analyses for radium on a 400-foot grid to verify the boundaries of documented tailings excursion.

In order to incorporate byproduct material in the interim cover, radium activity values of 5 to 15 pCi/g (representing 5 to 15 pCi/g above background) were used for the interim cover in the radon barrier calculations. This range of values had an insignificant effect on

radon barrier thickness. For the radon barrier, radium activity values of 5 pCi/g (representing 5 pCi/g above background) were conservatively used in the radon barrier calculations.

In order to distinguish between byproduct material and naturally occurring mineralization, soils in documented areas of tailings excursion will be sampled and analyzed for natural uranium and radium. The ratio of natural uranium to radium from these analyses would be used to distinguish between these materials. Acceptable uranium to radium ratios from this test method would be established prior to initiation of tailings cleanup.

4.3 GEOTECHNICAL CHARACTERISTICS OF RADON BARRIER SOILS

This subsection addresses Item No. 3 of NRC (1993a).

Due to high clay content of the previously planned radon barrier (AK Geoconsult et al., 1991; HMC, 1992), the shrink/swell potential of the radon barrier and the marginally dispersive nature of the soils (based on previous testing) was to be addressed. The revised material specifications for the radon barrier comprise materials with lower clay contents, resulting in a lower shrink/swell potential.

Dispersivity test results summarized AK Geoconsult et al. (1991) indicate non-dispersive to marginally dispersive characteristics. These results were from pinhole tests on samples of higher clay content than the materials included in the current specifications. The alternative with the clay barrier is currently planned at the bottom of the radon barrier, making it less susceptible to fluctuations in moisture content or to dispersive erosion.

4.4 GENERAL SUITABILITY OF RADON BARRIER SOILS

This subsection addresses Section III 1 of NRC (1993b) regarding general suitability of the radon barrier soils.

The radon barrier and cover design for the large tailings impoundment at the Grants site has been designed to meet Criterion 6 and the other applicable criteria in 10 CFR 40 Appendix A. Design features include cover slopes of 5:1 or less with smooth surfaces that avoid areas of flow concentration or abrupt changes in grade and rock cover. The cover has been designed to control tailings releases for the design period and to limit the rate of radon 222 emanation to an average of less than 20 pCi/m^2-sec. Specific items pertaining to general cover and radon barrier suitability are listed below.

- The radon barrier (with clay and clayey sand zones) provides a low-permeability zone to reduce the rate of infiltration and precipitation recharge into the tailings.

- For intrusion from vegetation, the thickness of the radon barrier would preclude vegetation from establishing roots into the underlying tailings.

- For intrusion from animal activity, the rock-covered surface and radon barrier do not provide a habitat or area of cover that indigenous animal species would prefer over surrounding terrain.

- The potential effects of freeze/thaw cycles and the potential to transport excess water to the frost line are low due to the 15 feet of tailings sands and one foot of interim cover beneath the radon barrier, and the thickness of the radon barrier relative to the estimated frost depth in the area (approximately 2 feet).

4.5 CONSTRUCTION QUALITY ASSURANCE TESTING

This subsection addresses Section III 3 of NRC (1993b). Recommended construction quality assurance testing frequencies for the radon barrier are listed in the table below. Testing frequencies are based on the guidelines in NRC, 1989a) and recommendations in NRC (1992a).

CONSTRUCTION Q/A TEST	TAILINGS AND INTERIM COVER (Contaminated Materials)	RADON BARRIER (Uncontaminated Materials)
No. 200 sieve wash	1 per 2,000 cy or 1 per day min.	1 per 2,000 cy or 1 per day min.
Atterberg limits	1 per day	1 per day
Single-point Proctor	Not used	1 per 5,000 cy
Full Proctor	1 per 10,000 cy	1 per 10,000 cy
Field density tests	1 per 2,000 cy or 2 per day min.	1 per 1,000 cy or 2 per day min.
Sand cone correlations	1 per 10 field density tests	1 per 10 field density tests

Field density tests (measuring in-place density and moisture content) at one test per 1000 cubic yards of radon barrier material compacted, with at least two tests per full shift of compaction operations. This modification from requirements in NRC (1989a) was suggested in NRC (1992a). Field density tests for contaminated materials (such as the tailings and interim cover) will be at one test per 2000 cubic yards, as suggested in NRC (1992a).

The use of a nuclear density gauge is planned for field density testing of radon barrier, interim cover, and compacted tailings materials in order to expedite test results. Prior to actual field density testing, the nuclear density gauge will be correlated with sand cone density and oven-dried moisture content measurements. The nuclear density gauge will be used if the correlations meet guidelines in NRC (1989a) and recommendations in NRC (1992a). During construction, sand cone tests will be continued to check the correlation with the nuclear density gauge at a frequency of one test per 10 field density tests, with a maximum of one test per day.

5.0 SUMMARY

5.1 PREFERRED RADON BARRIER ALTERNATIVE

As mentioned in Section 4, two alternative radon barrier systems or concepts were evaluated. The first alternative is a three-layer system consisting of interim cover, clay barrier, and clayey sand layers proposed to the NRC in HMC (1992b). The first alternative requires selection of clayey soils from the borrow area to form the clay barrier within the radon barrier system. The second alternative is a two-layer system consisting of interim cover and clayey sand layers.

From the RADON modeling described in Section 3, the total calculated thickness between the two alternative radon barriers is less than one foot. From an ease-of-construction standpoint, the second or clayey sand barrier alternative is preferred because it allows the lenses of clayey and sandy soils present in the borrow area to be mixed to form the radon barrier. The planned fines content for this mixture is at least 25 percent passing the No. 200 sieve.

5.2 KEY ISSUES FOR CONSTRUCTION OF THE RADON BARRIER

From the review and evaluation of the radon barrier described in this report, several key issues are listed below.

- The focus of previous borrow material testing has been the clayey soil lenses within the alluvial deposits on site. The modified radon barrier described in this report uses a mixture of sandy and clayey soils, which has not been tested as frequently as the clayey soils. Testing directed by HMC in June 1993 has developed more information on the properties of this mixture (Vinyard and Associates, 1993). Because of this lack of data, conservative parameters have been used to represent this layer in the radon attenuation calculations. previous data were adequate

- The borrow area for radon barrier materials contains areas of tailings excursion. This requires cleanup of byproduct materials and disposal in the tailings impoundment prior to excavation of radon barrier materials. Because of natural mineralization in the site area, this also requires delineation between byproduct materials and naturally occurring uranium in the borrow area. The proposed testing program for this delineation is outlined in Section 4.2.

- Several of the parameters in the radon attenuation calculations have been selected as model default values or values calculated from general relationships in RAEC (1984) and NRC (1989b). Radon attenuation testing of tailings sands (from samples from the surface and at depth) with clayey sand materials from the borrow area would result in more site-specific values of radium activity, radon emanation coefficient, and radon diffusion coefficient for radon attenuation calculations.

5.3 RECOMMENDATIONS

The radon barrier calculations presented in this report are based on actual data where present and conservative assumptions where the data is not present. The calculated radon barrier is thicker than previous designs presented to NRC, and represents a conservative or upper limit thickness for the radon barrier. This conservative radon barrier design also represents significantly larger earthmoving costs than those estimated with previous designs.

only selected data

In order for HMC to reduce the thickness of the radon barrier, additional testing would be required with measurement of radon attenuation parameters that more closely represent site-specific conditions and actual materials to be used as radon barrier construction materials. These measured values (if appropriate) would be used in place of conservatively assumed parameters in the radon attenuation calculations. A proposed schedule for collecting additional data while maintaining the current reclamation schedule is outlined in the stages listed below.

1. Radon attenuation parameter testing by fall 1993. This work would consist of measurement of radium activity of the sand tailings on the surface and at depth (where tailings excavation will occur), measurement of natural moisture contents for borrow area samples representing clayey sand materials, and measurement of radon emanation coefficient and radon diffusion coefficient from laboratory attenuation tests using representative tailings sands and clayey sand radon barrier material. This testing would be done in the second or third quarter of 1993 in order to be included in the updated, comprehensive reclamation plan for the large tailings impoundment.

2. Radium/uranium analyses in borrow area prior to interim cover placement. This work would consist of measurement of natural uranium and radium in the borrow area to assess the extent of tailings cleanup and to delineate between byproduct material and naturally occurring uranium in the borrow area. In order to allow for analysis time, this work would be done prior to interim cover placement.

3. Radon attenuation measurements partway through radon barrier construction. This would consist of measuring radon emanation from the radon barrier after three feet of barrier material (not including interim cover) has been placed and compacted. Measured radon emanation rates would be compared with the calculated radon flux at that level in the radon barrier and with the surface maximum of 20 pCi/m^2-sec.

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Geotechnical Engineering • Materials Testing • Environmental Engineering

June 17, 1993

Homestake
P. O. Box 98
Grants, NM 87020

Attention: Mr. Fred Kraft

Subject: Homestake Mine
V & A Job No.: 93-1-114

Gentlemen:

Attached are copies of the Laboratory Test Results for the subject project.

Should you have any questions regarding this data, please do not hesitate to call.

Sincerely,
Vinyard & Associates, Inc.

Martin D. Vinyard, PE

MARTIN D. VINYARD
NEW MEXICO
8261
REGISTERED PROFESSIONAL ENGINEER

cc: Addressee (2)

V & A

SUMMARY OF LABORATORY TEST DATA

Test Hole No.	Depth (Feet)	Unified Classi-fication	Natural Dry Density (pcf)	Natural Moisture Content (%)	Atterberg Limits		SIEVE ANALYSIS % PASSING BY WEIGHT										DESCRIPTION
					LL	PI	1½"	3/4"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	
4	0-3	SM	-	-	NV	NP	-	-	-	-	-	-	100	95	47	15.9	SAND, silty
20	0-3	SM	-	-	NV	NP	-	-	-	-	-	-	100	96	60	29.4	SAND, very silty
21	0-3	CL	-	-	23	9	-	-	-	-	-	100	99	96	78	51.7	CLAY, very sandy
127	0-3	SP-SM	-	-	NV	NP	-	-	-	-	-	100	98	80	26	10.8	SAND, slightly silty
128	0-3	CL	-	-	37	26	-	-	-	-	100	99	97	92	81	71.5	CLAY, very sandy
129	0-3	SM	-	-	NV	NP	-	-	-	-	-	100	99	88	39	18.3	SAND, silty
130	0-3	SM	-	-	NV	NP	-	-	-	-	100	99	96	84	39	18.6	SAND, silty
131	0-3	SC	-	-	24	10	-	-	-	100	99	99	98	95	58	25.6	SAND, clayey
132	0-3	SM	-	-	NV	NP	-	-	-	-	-	100	99	85	39	14.0	SAND, silty
133	0-3	SP	-	-	NV	NP	-	-	-	-	-	100	98	78	19	4.5	SAND, trace silt
134	0-3	SP-SM	-	-	NV	NP	-	-	-	-	-	100	98	77	29	10.1	SAND, slightly silty
135	0-3	SC	-	-	36	23	-	-	-	-	-	100	98	92	62	41.6	SAND, very clayey
136	0-3	SC	-	-	27	18	-	-	-	-	-	100	99	93	56	29.4	SAND, very clayey
137	0-3	SM	-	-	NV	NP	-	-	-	-	-	100	99	96	61	34.9	SAND, very silty
138	0-3	SC-SM	-	-	23	6	-	-	-	-	-	-	100	97	79	48.8	SAND, very clayey-silty
139	0-3	SC-SM	-	-	20	6	-	-	-	100	99	98	97	91	61	43.5	SAND, very clayey-silty
140	0-3	CL	-	-	25	13	-	-	-	-	100	99	98	95	77	51.4	CLAY, very sandy
141	0-3	SC	-	-	21	8	-	-	-	-	-	-	100	95	57	29.8	SAND, very clayey
142	0-3	SM	-	-	NV	NP	-	-	-	-	-	-	100	94	48	21.0	SAND, very silty
143	0-3	SM	-	-	NV	NP	-	-	-	-	-	100	99	96	73	35.7	SAND, very silty

NV - Indicates no value

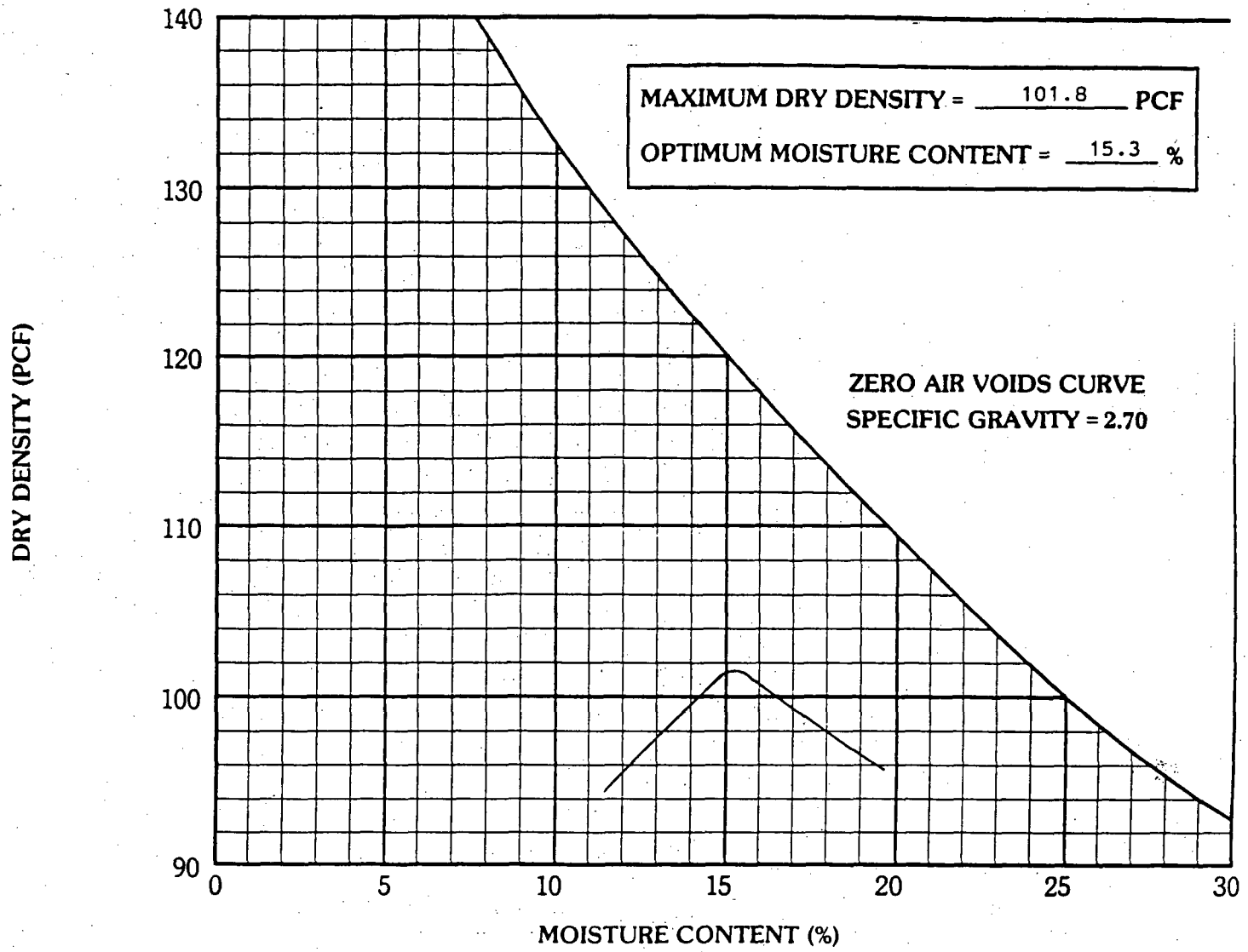
NP - Indicates non-plastic

Project No. 93-1-114

Table 1

V & A

COMPACTION TEST RESULTS



SAMPLE LOCATION: Sample No. 135 (0' - 3')

SOIL DESCRIPTION: SAND, very clayey

UNIFIED SOIL CLASSIFICATION: (SC)

AASHTO SOIL CLASSIFICATION: -

TEST METHOD: ASTM D-698

ATTERBERG LIMITS: LL 36 % PI 23 %

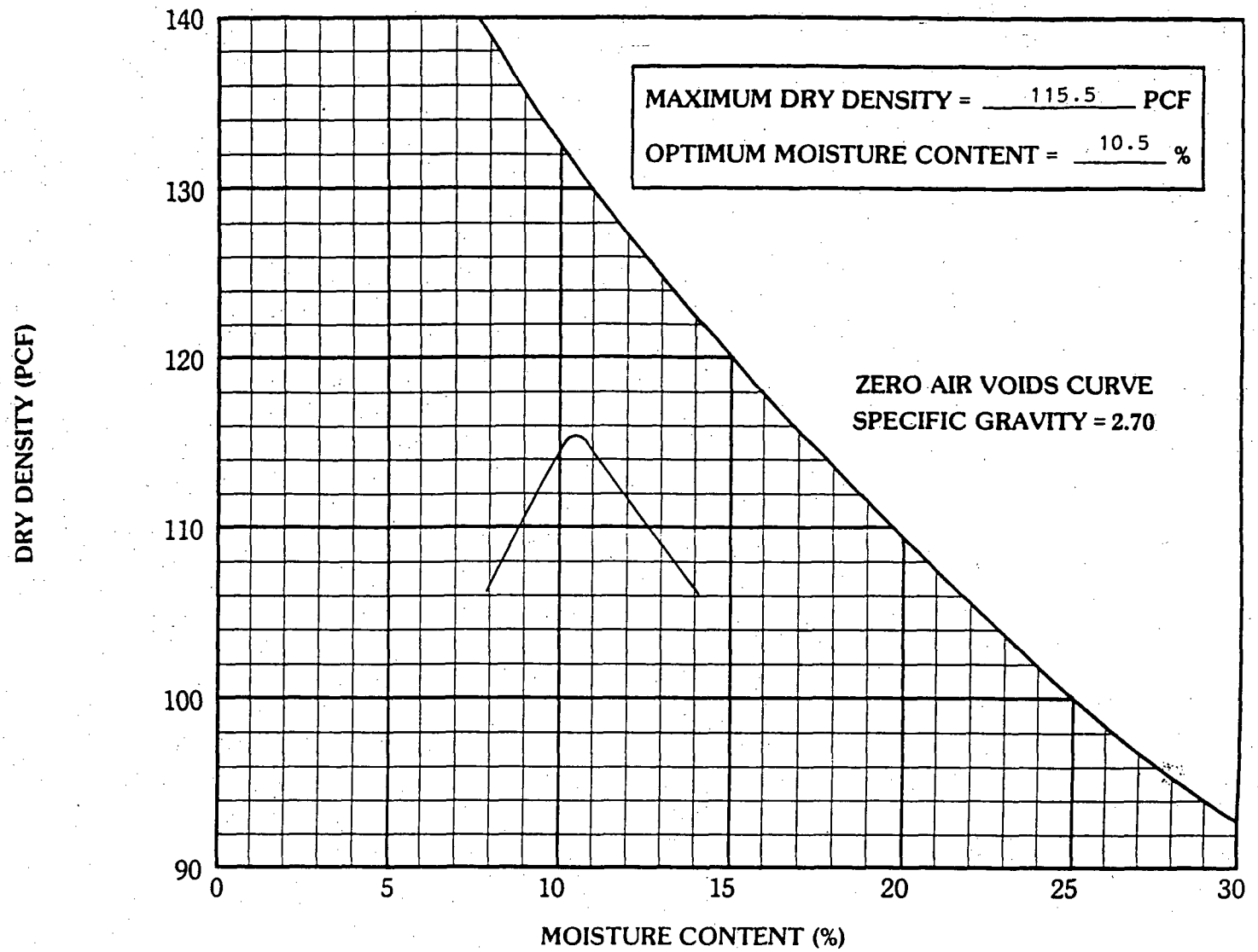
SIEVE ANALYSIS - % PASSING									
1 1/2"	3/4"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
					100	98	92	62	41.6

Project No: 93-1-114

Figure

V & A

COMPACTION TEST RESULTS



SAMPLE LOCATION: Sample No. 136 (0' - 3')

SOIL DESCRIPTION: SAND, very clayey

UNIFIED SOIL CLASSIFICATION: (SC)

AASHTO SOIL CLASSIFICATION: -

TEST METHOD: AST D-698

ATTERBERG LIMITS: LL 27 % PI 18 %

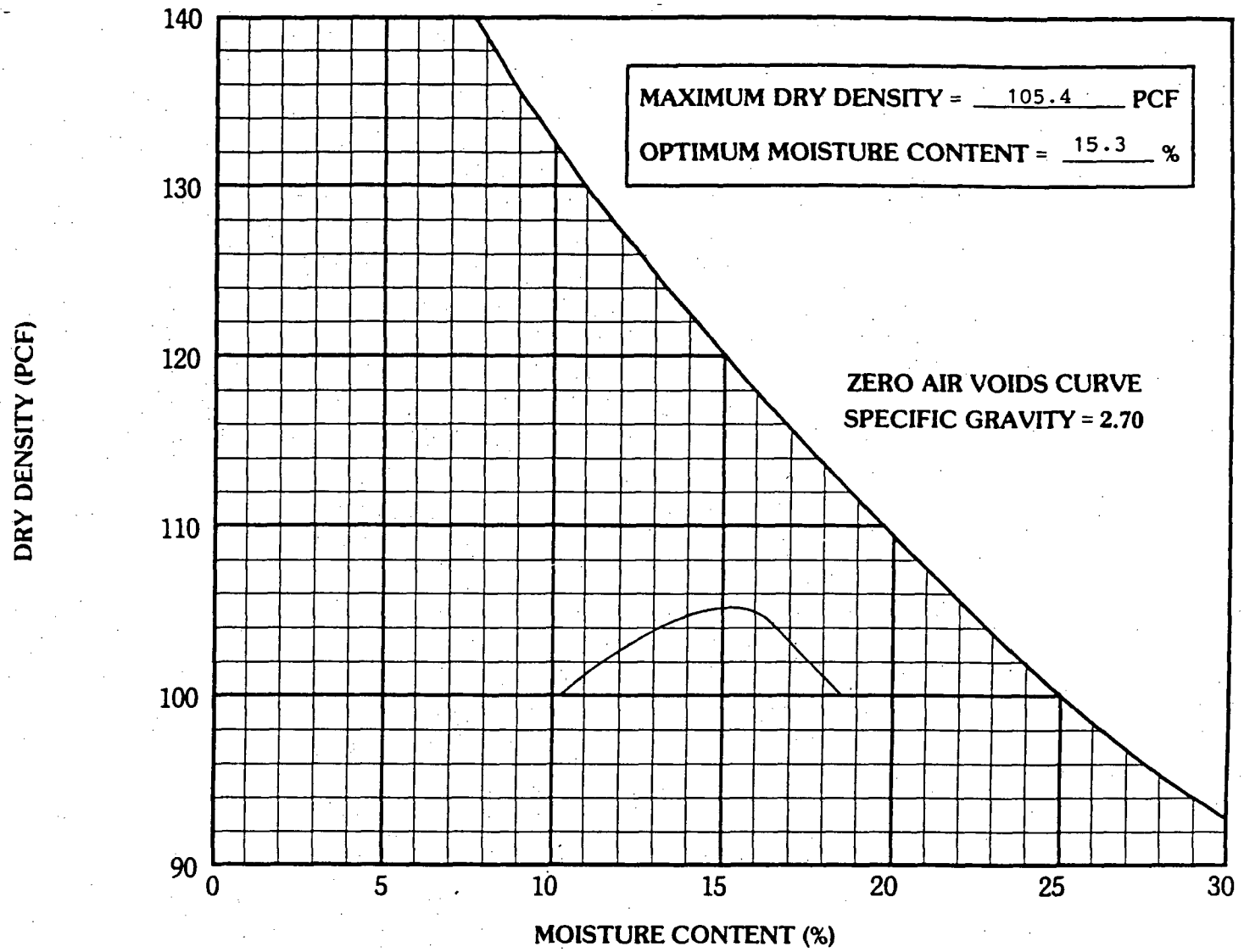
SIEVE ANALYSIS - % PASSING									
1 1/2"	3/4"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
					100	99	93	56	29.4

Project No: 93-1-114

Figure

V & A

COMPACTION TEST RESULTS



SAMPLE LOCATION: Sample No. 131 (0' - 3')

SOIL DESCRIPTION: SAND, clayey

UNIFIED SOIL CLASSIFICATION: (SC)

AASHTO SOIL CLASSIFICATION: -

TEST METHOD: ASTM D-698

ATTERBERG LIMITS: LL 24 % PI 10 %

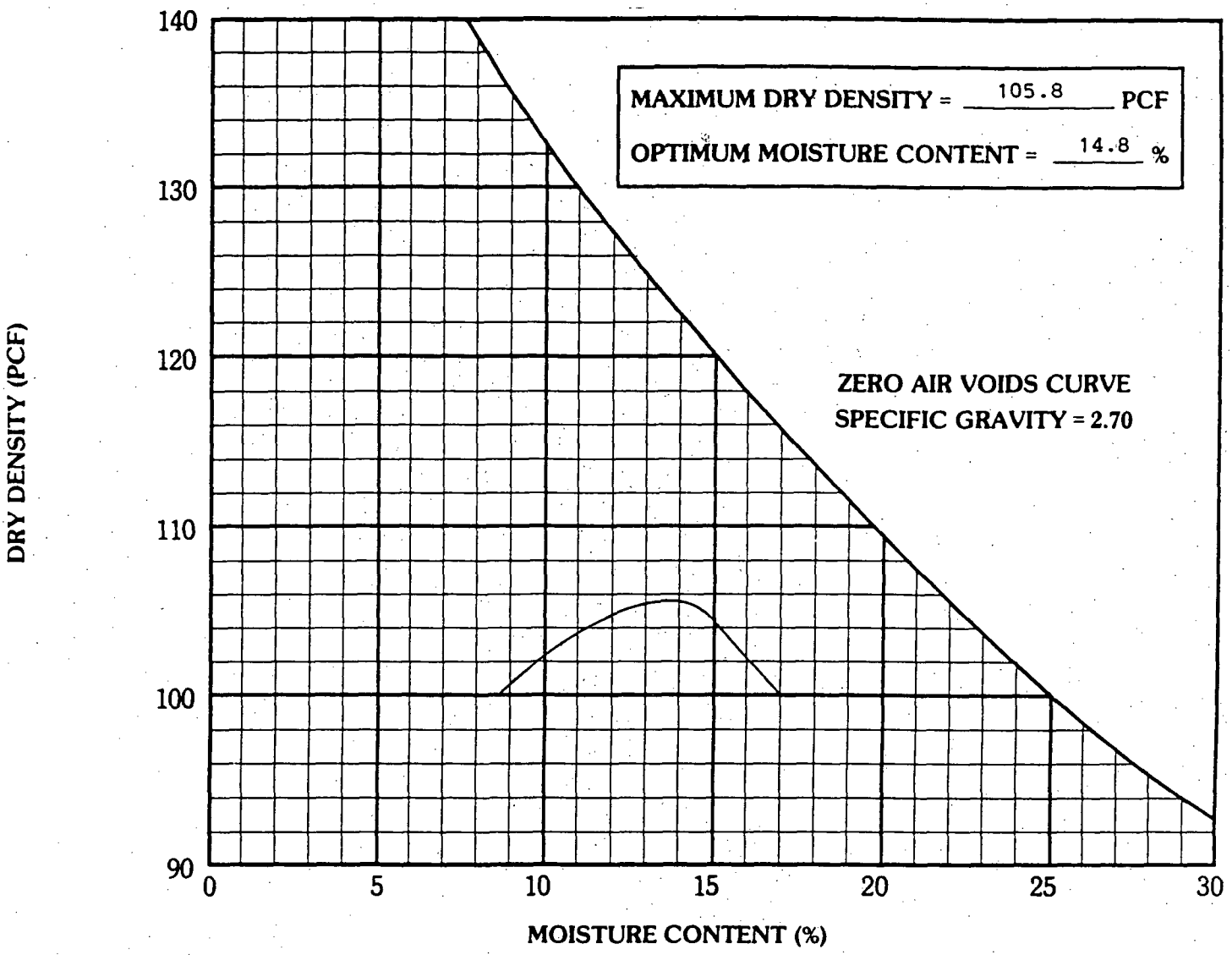
SIEVE ANALYSIS - % PASSING									
1 1/2"	3/4"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
			100	99	99	98	95	58	25.6

Project No: 93-1-114

Figure

V & A

COMPACTION TEST RESULTS



SAMPLE LOCATION: Sample No. 141 (0' - 3')

SOIL DESCRIPTION: SAND, very clayey

UNIFIED SOIL CLASSIFICATION: (SC)

AASHTO SOIL CLASSIFICATION: -

TEST METHOD: ASTM D-698

ATTERBERG LIMITS: LL 21 % PI 8 %

SIEVE ANALYSIS - % PASSING									
1 1/2"	3/4"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
						100	95	57	29.8

Project No: 93-1-114

Figure

GEOCHEMICAL ANALYSIS OF MILL TAILINGS FROM HOMESTAKE MINING COMPANY'S GRANTS URANIUM MILL

Prepared For:

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October 1, 1992

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1.0 INTRODUCTION

As support information for developing the reclamation plan for Homestake Mining Company's Grants Uranium Mill, samples of mill tailings were tested in a soils lab for mechanical and hydrological properties. Included in the testwork were standardized procedures for moisture measurements. The results of this testwork indicated that the moisture content of the mill tailings samples was higher than typical for natural soil material with similar grain size distribution.

Higher-than-typical moisture content is explainable when the effects of the milling process on the ore are considered. This report offers geochemical laboratory data that are supportive of the earlier soils lab testwork and provides a geochemical explanation for the higher-than-typical moisture content of the tailings.

2.0 MILL OPERATION AND TAILINGS DISPOSAL

Homestake Mining Company's Grants Uranium Mill was originally built in 1958. After several expansions, the mill processed up to 3,500 tons of ore per day. The mill was the only alkaline leach (soda ash) operation in the Grants region and, for this reason, received limestone and calcareous sandstone ores from the Ambrosia Lake, Smith Lake, and Crown Point areas of New Mexico.

During typical mill operations, crushed ore was leached with soda ash solutions under very thorough leaching conditions. To maximize uranium dissolution from the ore, leaching was conducted in autoclaves at elevated temperatures (200°F) and air pressures (70 psi). Ore material in which the uranium was less amenable to dissolution underwent additional atmospheric leaching. When operated at maximum leaching efficiency, uranium recovery from the crushed ore was about 95%.

The uranium contained in the leach solution was separated from the leached solids by countercurrent filtration. The uranium-bearing pregnant solution was treated with caustic soda to precipitate an initial uranium product. If necessary, this product was treated and further purified.

The filter cake, which consisted of the pressure-leached solids, was collected after the final washing stage and reslurried with water and recycle tailings solution. This slurry of mill tailings was pumped to the tailings disposal area. The sands fraction of the slurry was utilized in building the sides and internal dikes of the impoundment; the slimes were allowed to flow and collect in the center of the impoundment.

3.0 GEOCHEMICAL ANALYSES OF MILL TAILINGS SAMPLES

Thirty samples of tailings sands and slimes were collected by Vinyard & Assoc., Inc., and were delivered to Core Laboratories, Aurora, CO, for geochemical analyses. The results of the analyses are presented in Table 1, and a copy of the analytical report from Core Laboratories is included as an appendix to this report.

Soil hydrometer tests on dispersed samples of slime and sand material indicated appreciable clay content (<2 microns) in the slimes (ranging between 14 and 50%) and in the sands (ranging between 5 and 14%). The cation-exchange-capacity (CEC) of the slime samples, as measured using the sodium acetate extraction procedure, ranged between 13 and 40 meq/100g; the CEC of the sands samples ranged between 2 and 7 meq/100g.

Both the slime and sands samples indicate appreciable "clay content." The analysis is a textural description measuring material <2 microns in size, and is not necessarily indicative of the amounts of the clay minerals in each sample. The cation-exchange-capacity, on the other hand, is more indicative of the clay-mineral fraction in each sample. Clay minerals make up a significant portion of the material in tailings samples

with a CEC above 15 meq/100g. Tailings samples with a CEC below 3 meq/100g are essentially clean sand with very little clay minerals present, despite what the "clay content" analysis report.

The exchangeable cation result indicate that the clay-mineral fraction in the tailings is sodium-saturated. The anomolously high exchangeable calcium results reported for each of the samples are due to the presence of calcium carbonates in the tailings material. Calcium carbonate tends to dissolve during the CEC analytical procedure, and interferes in the method.

"Sodium saturation" means that the chief cation that is adsorbed on the surface of the clay mineral particles is sodium. Sodium ions sorbed on the clay surface generally serve to repel other clay mineral particles, increasing the distances to which the clay particles remain separated. Separation of the clay particles makes more room for water molecules to enter the network of particles. As a general rule, sodium-saturated clays sorb much more water than clays saturated with calcium or magnesium. Typically, clay-bearing material that is primarily sodium-saturated can be expected to have higher moisture content, irrespective of physical size distribution.

TABLE 1

Geochemical Analysis of Mill Tailings Samples

Sample No.	Description	Clay Content (%)	CEC (meq/100g)	Exchangeable Cations, meq/100g Ca	Mg	Na	K
TSL-1	Tailings Slimes	14.3	13.2	21.5	0.51	9.49	0.19
TSL-2	Tailings Slimes	37.5	40.2	22.8	1.21	19.9	0.45
TSL-3	Tailings Slimes	31.9	39.6	24.2	0.87	19.2	0.39
TSL-4	Tailings Slimes	31.9	36.5	23.2	1.20	24.5	0.39
TSL-5	Tailings Slimes	18.9	17.9	27.2	0.80	10.0	0.26
TSL-6	Tailings Slimes	27.9	26.9	26.2	0.96	14.5	0.25
TSL-7	Tailings Slimes	35.9	32.3	44.4	4.43	21.1	0.34
TSL-8	Tailings Slimes	28.9	33.5	47.4	5.78	32.8	0.30
TSL-9	Tailings Slimes	19.2	36.3	46.2	8.18	44.8	0.40
TSL-10	Tailings Slimes	22.2	36.7	49.5	6.01	39.4	0.36
TSL-11	Tailings Slimes	42.8	29.3	54.4	6.66	40.6	0.47
TSL-12	Tailings Slimes	43.9	32.8	47.2	5.17	63.7	0.37
EP-EDT-N	Tailing Decant Tower Slimes	27.2	29.0	45.5	4.49	38.8	0.47
EP-EDT-S	Tailing Decant Tower Slimes	40.2	45.7	51.8	4.80	52.2	0.54
EP-WDT-N	Tailing Decant Tower Slimes	34.3	27.7	43.8	4.51	47.2	0.37
EP-WDT-S	Tailing Decant Tower Slimes	49.6	27.5	43.3	4.92	70.2	0.43
WP-DT-N	Tailing Decent Tower Slimes	32.6	28.1	39.9	4.96	42.9	0.35
CS-1	Tailings Crest Sands	10.7	2.46	42.3	0.46	1.25	0.06
CS-3	Tailings Crest Sands	4.7	2.28	20.3	0.29	<0.01	0.04
CS-4	Tailings Crest Sands	9.4	2.65	42.4	0.79	1.57	0.05
CS-5	Tailings Crest Sands	7.4	3.66	31.9	1.04	4.13	0.08
CS-6	Tailings Crest Sands	10.4	1.91	50.2	0.75	0.50	0.04
CS-7	Tailings Crest Sands	5.7	1.76	44.8	0.72	<0.01	0.05
CS-8	Tailings Crest Sands	11.4	1.99	54.0	0.50	6.76	0.05
CS-9	Tailings Crest Sands	13.8	2.47	48.7	1.51	<0.01	0.04
CS-10	Tailings Crest Sands	8.8	2.06	50.9	0.88	0.24	0.06
CS-11	Tailings Crest Sands	13.8	1.94	44.6	0.46	0.02	0.06
CS-12	Tailings Crest Sands	7.8	1.89	48.4	0.47	0.06	0.04
TSL-2 Sand	Tailings Slime Sands	9.8	7.38	37.8	7.07	1.70	0.12
TSL-6 Sand	Tailings Slime Sands	9.4	2.94	43.0	2.18	5.35	0.09

4.0 INTERPRETATION OF RESULTS

The geochemical clay analyses completed on the tailings samples offer an explanation for the higher-than-typical moisture content reported by the soils lab. The tailings slimes, which contain most of the clay-mineral phase, are sodium-saturated. Sodium saturation of the clay minerals occurred during the milling of the original uranium ore. Ore material containing various clay minerals was subjected to a very thorough leach with soda ash (Na_2CO_3) solution under elevated temperature and pressure conditions. This sodium-treated spent ore was discharged to disposal as mill tailings. The mill tailings, and especially the slime fraction, would be expected to show a much higher moisture content when compared to a natural soil with similar grain size distribution, but not exposed to the soda ash leaching.

A similar example of this geochemical phenomenon can be found in the Florida phosphate fertilizer industry. The mining and beneficiation of phosphate rock produce tremendous volumes of phosphatic clay wastes, also referred to as "slimes". These clay slimes also retain a high percentage of water for extended periods of time. The phosphate slimes exhibit colloide-like properties that are believed to be largely responsible for their poor dewatering characteristics. Geochemical and mineralogical studies indicate that such colloidal behavior is caused by the sodium-saturated clays that are found in the phosphate slimes. Clay minerals such as montmorillonite and attapulgite may comprise up to one-third of the slime.

APPENDIX A

Analytical Report

Core Laboratories

Western Atlas International
A Litton Dresser Company

CORE LABORATORIES

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A N A L Y T I C A L R E P O R T

Job Number: 920950
Prepared For:

GEOCHEM, Inc.
Roman Pyrih
12265 W. Bayaud
Lakewood, CO 80228

Date: 08/10/92

Signature

Date: 8/10/92

Name: David A. McWharter

Core Laboratories
1300 South Potomac, Suite 130
Aurora, CO 80012

Title: LABORATORY MANAGER

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LABORATORY TESTS RESULTS
08/10/92

JOB NUMBER: 920950 CUSTOMER: GEOCHEM, Inc. ATTN: Roman Pyrih

SAMPLE NUMBER: 1 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-1 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 2 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-2 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 3 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-3 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 4 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-4 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 5 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-5 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 6 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-6 REM: CAUTION: SLIGHTLY RADIOACTIVE!

TEST DESCRIPTION	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5	SAMPLE 6	UNITS OF MEASURE
Cation Exchange Capacity	13.2	40.2	39.6	36.5	17.9	26.9	meq/100gms
Cation, Exchangeable-Calcium	21.5	22.8	24.2	23.2	27.2	26.2	meq/100gms
Cation, Exchangeable-Magnesium	0.51	1.21	0.87	1.20	0.80	0.96	meq/100gms
Cation, Exchangeable-Sodium	9.49	19.9	19.2	24.5	10.0	14.5	meq/100gms
Cation, Exchangeable-Potassium	0.19	0.45	0.39	0.39	0.26	0.25	meq/100gms
Texture, Clay	14.3	37.5	31.9	31.9	18.9	27.9	%

1300 South Potomac, Suite 130
Aurora, CO 80012
(303) 751-1780

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08/10/92

JOB NUMBER: 920950 CUSTOMER: GEOCHEM, Inc. ATTN: Roman Pyrih

SAMPLE NUMBER: 7 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-7 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 8 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-8 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 9 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-9 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 10 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-10 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 11 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-11 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 12 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-12 REM: CAUTION: SLIGHTLY RADIOACTIVE!

TEST DESCRIPTION	SAMPLE 7	SAMPLE 8	SAMPLE 9	SAMPLE 10	SAMPLE 11	SAMPLE 12	UNITS OF MEASURE
Cation Exchange Capacity	32.3	33.5	36.3	36.7	29.3	32.8	meq/100gms
Cation, Exchangeable-Calcium	44.4	47.4	46.2	49.5	54.4	47.2	meq/100gms
Cation, Exchangeable-Magnesium	4.43	5.78	8.18	6.01	6.66	5.17	meq/100gms
Cation, Exchangeable-Sodium	21.1	32.8	44.8	39.4	40.6	63.7	meq/100gms
Cation, Exchangeable-Potassium	0.34	0.30	0.40	0.36	0.47	0.37	meq/100gms
Texture, Clay	35.9	28.9	19.2	22.2	42.8	43.9	%

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08/10/92

JOB NUMBER: 920950 CUSTOMER: GEOCHEM, INC. ATTN: Roman Pyrih

SAMPLE NUMBER: 13 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: 05/14/92 SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: EP-EDT-N REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 14 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: 05/14/92 SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: EP-EDT-S REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 15 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: 05/14/92 SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: EP-WDT-N REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 16 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: 05/14/92 SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: EP-WDT-S REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 17 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: 05/14/92 SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: WP-DT-N REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 19 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-1 REM: CAUTION: SLIGHTLY RADIOACTIVE!

TEST DESCRIPTION	SAMPLE 13	SAMPLE 14	SAMPLE 15	SAMPLE 16	SAMPLE 17	SAMPLE 19	UNITS OF MEASURE
Cation Exchange Capacity	29.0	45.7	27.7	27.5	28.1	2.46	meq/100gms
Cation, Exchangeable-Calcium	45.5	51.8	43.8	43.3	39.9	42.3	meq/100gms
Cation, Exchangeable-Magnesium	4.49	4.80	4.51	4.92	4.96	0.46	meq/100gms
Cation, Exchangeable-Sodium	38.8	52.2	47.2	70.2	42.9	1.25	meq/100gms
Cation, Exchangeable-Potassium	0.47	0.54	0.37	0.43	0.35	0.06	meq/100gms
Texture, Clay	27.2	40.2	34.3	49.6	32.6	10.7	%

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LABORATORY TESTS RESULTS
08/10/92

JOB NUMBER: 920950 CUSTOMER: GEOCHEM, Inc. ATTN: Roman Pyrih

SAMPLE NUMBER: 20 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-3 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 21 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-4 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 22 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-5 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 23 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-6 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 24 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-7 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 25 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-8 REM: CAUTION: SLIGHTLY RADIOACTIVE!

TEST DESCRIPTION	SAMPLE 20	SAMPLE 21	SAMPLE 22	SAMPLE 23	SAMPLE 24	SAMPLE 25	UNITS OF MEASURE
Cation Exchange Capacity	2.28	2.65	3.66	1.91	1.76	1.99	meq/100gms
Cation, Exchangeable-Calcium	20.3	42.4	31.9	50.2	44.8	54.0	meq/100gms
Cation, Exchangeable-Magnesium	0.29	0.79	1.04	0.75	0.72	0.50	meq/100gms
Cation, Exchangeable-Sodium	<0.01	1.57	4.13	0.50	<0.01	6.76	meq/100gms
Cation, Exchangeable-Potassium	0.04	0.05	0.08	0.04	0.05	0.05	meq/100gms
Texture, Clay	4.7	9.4	7.4	10.4	5.7	11.4	%

1300 South Potomac, Suite 130
Aurora, CO 80012
(303) 751-1780

The analyses, opinions or interpretations contained in this report are based upon observations and materials supplied by the client to whom and for whose exclusive and confidential use this report is made. The interpretations or opinions expressed represent the best judgement of Core Laboratories. Core Laboratories [illegible] or any of its officers or employees, or any oil, gas, coal or other mineral property, well or sand in connection with which such report is used or relied upon. [illegible] without the written approval of Core Laboratories.

Western Atlas International
A Litton/Dresser Company

CORE LABORATORIES

LABORATORY TESTS RESULTS
08/10/92

JOB NUMBER: 920950 CUSTOMER: GEOCHEM, Inc. ATTN: Roman Pyrih

SAMPLE NUMBER: 26 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-9 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 27 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-10 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 28 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-11 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 29 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: CS-12 REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 30 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-2 SAND REM: CAUTION: SLIGHTLY RADIOACTIVE!

SAMPLE NUMBER: 31 DATE RECEIVED: 05/22/92 TIME RECEIVED: 12:00 SAMPLE DATE: / / SAMPLE TIME: :
PROJECT: Grants Mill SAMPLE: TSL-6 SAND REM: CAUTION: SLIGHTLY RADIOACTIVE!

TEST DESCRIPTION	SAMPLE 26	SAMPLE 27	SAMPLE 28	SAMPLE 29	SAMPLE 30	SAMPLE 31	UNITS OF MEASURE
Cation Exchange Capacity	2.47	2.06	1.94	1.89	7.38	2.94	meq/100gms
Cation, Exchangeable-Calcium	48.7	50.9	44.6	48.4	37.8	43.0	meq/100gms
Cation, Exchangeable-Magnesium	1.51	0.88	0.46	0.47	7.07	2.18	meq/100gms
Cation, Exchangeable-Sodium	<0.01	0.24	0.02	0.06	1.70	5.35	meq/100gms
Cation, Exchangeable-Potassium	0.04	0.06	0.06	0.04	0.12	0.09	meq/100gms
Texture, Clay	13.8	8.8	13.8	7.8	9.8	9.4	%

1300 South Potomac, Suite 130
Aurora, CO 80012
(303) 751-1780

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Vinyard & Associates, Inc.

4415-D Hawkins, NE
Albuquerque, New Mexico 87109
(505) 345-1937

Geotechnical Engineering • Materials Testing • Environmental Engineering

May 20, 1992

Core Laboratories
1300 S. Potomac Street
Suite 130
Aurora, Colorado 80012

Attention: Mr. Dave McWhorter

Subject: Homestake Mining Company, Grants Mill, Tailings Samples Transmittal

Gentlemen:

Please find enclosed two (2) coolers containing 31 sample jars of tailings slimes, tailings decant tower slimes, tailings slime sands, and tailing crest sands from the large pile at the Homestake Mill in Grants, New Mexico. Samples were collected by Vinyard & Associates on May 14 and May 8, 1992.

The sample jars contained are labelled as follows:

1. Tailings Slimes; TSL 1 through TSL-12;

2. Tailings Decant Tower Slimes; EP-EDT-N, EP-EDT-S, EP-WDT-N, EP-WDT-S, WP-DT-N, and WP-DT-S;

3. Tailings Crest Sands; CS-1, CS-3 through CS-12;

4. Tailings Slime Sands; TSL-2 Sand and TSL-6 Sand.

Samples were transported by U.P.S. Land Shipments on May 20, 1992.

Testing is to be done according to instructions from A.K. GeoConsult.

Please acknowledge receipts of these materials by signing and returning three (3) copies of this letter.

If you have any questions regarding this transmittal, please do not hesitate to contact us.

Sincerely,
Vinyard & Associates, Inc.

Gordon T. Mossberg

Gordon T. Mossberg, P. E.

Received by: David L. Toering DAVID L. TOERING
Title: SAMPLE CUSTODIAN
Organization: CORE LABORATORIES
On This 22ND Day of MAY 1992 12:00

File: 92-1-68.cor

George V. Sabol Consulting Engineers, Inc.
1331 17th Street, Suite 700, Denver, Colorado 80202
(303) 295-7016 FAX (303) 292-2415

23 November 1992

Alan K. Kuhn, Ph.D., P.E.
AK GeoConsult, Inc.
13212 Manitoba Drive, N.E.
Albuquerque, NM 87111-2955

Subject: Homestake Mine-Mill Tailings Impoundment
NRC comment concerning the rock aprons at the toe of the impoundment outslopes

Dear Dr. Kuhn:

We have completed our review and evaluation of the U.S. Nuclear Regulatory Commission's (NRC) comment concerning the design of the rock aprons to be placed at the toes of the impoundment outslopes. A copy of NRC's comment that you supplied is shown in Attachment A. In attempting to better interpret and to appropriately respond to the NRC concern about flow instability at the apron, Dr. Carl F. Nordin, Jr. discussed this with Dr. Steven R. Abt of Colorado State University and with Mr. Ray Gonzales of NRC in Denver. Dr. Nordin received a response from the NRC in a letter from Mr. Ramon Hall (Attachment B). Mr. Hall's letter provides a technical definition of NRC's concern about flow instability on the apron, and we addressed the NRC comment in that context.

In our opinion, the design of the apron should be adequately viewed by the NRC if two conditions can be satisfied by the design of the apron:

1. Adequate energy dissipation is provided at the apron to dissipate the energy of flow that is entering the apron from runoff from the impoundment outslopes.

2. Adequate scour protection of the apron is provided to resist movement of the riprap that comprises the apron.

Furthermore, it is our opinion that the above two conditions are satisfied if the riprap of the apron is sized to resist movement due to outslope runoff. An appropriate technology to apply to this situation is that used by the U.S. Bureau of Reclamation (USBR) (Peterka, 1964, Fig. 165) for sizing riprap downstream from spillways and energy dissipators. That method is presented in the NRC Phase I report (Abt and other, 1987, pgs. 30 and 31) (Attachment C). Supporting documentation of the USBR Method (Peterka, 1964) is provided in Attachment D.

Review of the information contained in Attachments C and D indicates the following:

1. Figure 165 (Peterka, 1964) can be used to determine the stone size in the riprap mixture to resist movement.

2. A well-graded riprap layer containing about 40 percent of the rock pieces smaller than the required size is as stable, or more stable, than a single stone size as determined by Figure 165. Therefore, the stone size from Figure 165 can be used to conservatively set the required D_{50} for the apron riprap layer.

3. The apron riprap thickness should be 1.5 times, or more, the dimension of the large stones in the riprap.

4. The apron riprap should be placed over a granular filter of appropriately sized material and gradation, and filter thickness of at least 6 inches.

5. The lower end of the curve in Figure 165 was empirically derived using river run gravel and smooth stone. The use of crushed rock will add to the conservatism.

6. The NRC Phase I report (Abt and others, 1987, pg. 30) recommends the USBR Method at the toe of outslopes where substantial energy dissipation is required.

7. The NRC Phase I report (Abt and others, 1987, pg. 30) indicates that the resulting stone size is conservative.

We have calculated the apron riprap size (D_{50}) using the USBR Method for the impoundment outslope design condition that you supplied to us with an unit discharge of 0.96 cfs/ft, slope of 0.1976 ft/ft, and riprap D_{50} of 4.74 inches. For these conditions, the outslope n is estimated as 0.045 with a bottom velocity of 4.9 ft/sec (Froude Number = 1.9). From Figure 165, D_{50} equals about 3.6 inches. Calculations are shown in Attachment E.

In this example, and this would probably be the same for most, if not all cases, the apron riprap D_{50} is smaller than the outslope riprap D_{50}. From theoretical considerations, this is not unexpected. The riprap on the outslope must be able to resist both the hydraulic forces of the runoff plus the gravity force on the steep outslope face. The apron, being nearly horizontal, results in only hydraulic forces on the riprap. From a practical standpoint, use of the same riprap material on the outslope and on the apron may be justified, and will be conservative for the apron.

The Froude number is estimated as 1.9 for this case and is outside the range 2.5 to 4.5 where oscillating hydraulic jumps normally occur. The depth of flow (about 0.2 ft) is too small in comparison to the size of the roughness elements (about 0.4 ft) on the apron for a hydraulic jump to occur. Engergy dissipation will be achieved by impact of the water into the larger, protruding rock elements, and by turbulence within the flow. Engergy dissipation should be complete and adequately contained on a 10 ft wide apron.

In conclusion, it is our opinion that the USBR Method (Peterka, 1964), as recommended by the NRC in the Phase I report (Abt and others, 1987), is appropriate to determine the size of riprap for the apron of the impoundment outslopes. The USBR Method yields conservative results, and is even more conservative if crushed rock is used rather than rounded rock. It is my understanding that crushed rock will be used. Use of the USBR Method will result in a riprap design that provides energy dissipation (by impact and turbulence), and a riprap layer that will resist movement of stone and prohibit scour. Furthermore, it is our opinion that use of the Stephenson Method to size the riprap on the impoundment outslopes will result in larger riprap than is needed on the apron. Calculations, such as shown in Attachment E, should be made to confirm this if the final design of the outslope riprap would change. We recommend, from a practical consideration of construction practices, that the apron should contain the same riprap design as is used on the outslopes.

Please contact me if you have any questions or wish to discuss this in more detail. It was our pleasure to be of service to you and to the Homestake Mining Company. Let me know if I can be of service to you in resolving other NRC review comments.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

George V. Sabol

Attachments:
- A - NRC's comment on toe
- B - Letter from Mr. Ramon Hall, NRC, on flow instability
- C - USBR method in Abt and others, (1987)
- D - USBR method documentation (Peterka, 1964)
- E - Calculation sheet

APPENDIX E

RECLAMATION COST ESTIMATE DETAILS AND BACKUP

CONTENTS

Reclamation Cost Estimate Details and Backup

Nielsons Actual Contract Prices for Large Impoundment Recontouring Earthwork

Nielsons Contractor's Equipment Rental Rates

Nielsons Loaded Wage Rates

Olshan Actual Contract Prices for Mill Demolition and Burial

Purchase Order for Producing Crushed Rock

Western States Reclamation revegetation cost estimate

APPENDIX E - RECLAMATION COST ESTIMATE DETAILS AND BACKUP
HOMESTAKE MINING COMPANY - GRANTS OPERATION

SECTION # IN TABLE 6			
I.	COVER AND REGRADE DEMOLISHED MILL AREA		
	a) Prepare borrow area, 1600′ x 600′ (ridge east of mill) using 200 hp dozer at $0.58/cy (1993 RS MEANS, p.30) to strip brush and 0.5 ft soil for 807 cy/acre, $468/acre, 22 acres =	$10,296	
	b) Excavate, haul, and place ave. 2′ soil over 42 acres + 30% for filling voids; 176800 c.y. at $1.20/c.y. (Recontour bid item UP-02) =	$212,160	
	c) Grade covered area with D8, at 245 c.y./hr, 176800 cy, $95/hr =	$68,952	
	d) Compact 136000 cy x $0.50 /cy (RSM,1993, p. 35)=	$68,000	
	Total for cover and regrade mill area =		$359,408
I.	CONTAMINATED SOIL CLEANUP		
	250000 cy (App.C4) x $1.20/cy =		$300,000
I.	SITE RECONTOURING		
	Finish grading with CAT 14G - at 2 mph or 2.4 acres/hr and $56/hr (Nielsons 1993 bid rate) = $23.33/acre, x 700 acres =	$16,331	
	Grade surveying - $530/day (RSM,1993, p.6) x 700/(2.4 x 8hr/day) =	$19,323	
			$35,654
II.	GROUND WATER MONITORING (including well operation and maintenance) (REF: George Hoffman, Hydro Engineering, 1990)		
	$632,000/yr for first 7 years = $4,424,000 $474,000/yr for year 8-15 = $3,792,000		
	Total for ground water monitoring =		$8,216,000
II.	WELL PLUGGING		
	Rig time 2 hrs. x $120/hr. + one bag readi-mix at $5.00 + one bag bentonite at $25 x 260 wells =		$39,000
III.	INTERIM STABILIZATION		
	Excavate and haul (CAT 633 scraper at $121/hr, 100 cy/hr), spread ($1.33) and compact ($0.50) (RSM 1993; p. 39, 42, and 35) for $3.04/cy unit price		
	a) Interim soil cover on top of large impoundment, SM soil, 1800 ft haul 131111 cy (APP C6) x 3.04/cy =	$398,577	
	b) Interim soil cover on small impoundment, south end 20463 cy (APP C6) x 3.04/cy =	$62,208	
			$460,785
IV.	RECONTOURING OF TAILING PILES (see Appendix C6 for volume calculations)		
	a) Large Pile - see attached actual contract price schedule	$3,650,775	
	b) Small Pile - excavate, haul and place 222,000 c.y. of tailing sand and contaminated soil		
	Dozer - 50000 cy, 160 cy/hr, $95/hr (Nielsons 1993)= $29,688 Scraper - 172000 cy, 250 cy/hr, $121/hr (Nielsons 1993)= $83,248		
	Total for small pile recontouring =	$112,936	
	Total all recontouring =		$3,763,711

IV. SETTLEMENT MONITORING - 50 points

Installation - $400 @ per actual contract price schedule, x 50 =	$20,000	
Settlement surveys - 50 x 4 crew-hours @ x $75/hr =	$15,000	
Total cost of monitoring =		$35,000

IV. CONSTRUCTION OF RADON BARRIERS (SOIL COVERS)

a) Borrow Area Preparation - 627 acres

CAT D8L dozer to strip and windrow vegetation and topsoil
Each pass 10 ft wide, for 4362 ft/acre x 627 acres =
2734974 ft., / [2.0 mph (Rust Tractor Co., 1990)
x 5280 ft/mi.] = 259 hrs, x $95/hr = $24,604

b) Excavate, haul ave. 1600 ft, place and compact SC and CL soils
(see App. C6 for volumes) See Interim Cover for unit price.

Large pile	2314566 cy	x	$3.04	/cy =	$7,036,281
Small pile	1211600 cy	x	$3.04	/cy =	$3,683,264
Totals =	3526166 cy				$10,719,545

Radon Barrier Total = $10,744,149

IV. CONSTRUCTION OF ROCK COVER. TOE APRON AND RIPRAP
(see App. C6 for volumes)

a) Produce and stockpile rock: 249206 cy rock + 85300 cy fines
334506 cy x $6.25 /cy (see actual purchase order attached) = $2,090,663

b) Load, haul, and place : 334506 cy x $4.35 /cy (RSM 1993, p.306) = $1,455,101

c) Spread: 320339 cy x $0.76 /cy (RSM 1993, p.38) = $243,458

d) Scour protection trench excavation and backfill

Trench is 5000' long, assume triangular shape 17' across
by 9'deep to accommodate scour-protection rock per Fig.8.
Volume of trench is 17 x 9 x 0.5 x 5000 /27 = 14167 c.y.
Using D8L to excavate and backfill in tandem with rock placement,
cost is 14167cy /240 cy/hr x $95/hr = $5,608

Total rock cost = $3,794,829

IV. REVEGETATION AND FENCING

a) Revegetation - estimate 750 acres x $600/acre (1986 cost x 1.2) =	$450,000	
b) Fencing - three-strand barbed wire for 19500 ft x $1.13/ft (Acme Fence Co., 1990 quote x 1.1) =	$22,035	
Total =		$472,035

IV. LEVEE CONSTRUCTION

Dimensions are length 1775', crest width 15', side slopes 10H:1V maximum height 17' above present ground surface (will change with soil clean-up excavation). Approximate volume = 1775 x (15h+10h^2), where h = ave. ht. = 17/2 = 8.5', = 55880 cy

Est. cost = [1775 x (15h+10h^2)]/27 x $3.04 to excavate, haul and place and spread and compact gravelly sand = $169,875

IV. REMOVAL BRINE POND AND RESTORE AREA

Ponds are 600' x 420', 28000 sq. yd.
Ave. depth below surrounding grade is 3'
Volume of fill in dike = (600 x 2 + 420 x 2) = soil to be replaced x ave. width 20'x ave. ht. 5' = 9111 c.y., say 9500 c.y.

Remove liner - cut into 6' x 10' strips, and roll; (4200 rolls) x 0.5 man hours @ x $30.15/hr (RSM 1993, p.451) =	$63,315	
Load and haul strips to evap.pond by 6 cy truck, 10 rolls/ hr, = 420 hrs., x $73/hr (RSM 1993, p.42) =	$30,660	
Fill in pond basin with D8L, 9500 c.y./ 240 c.y. per hr x $95/hr =	$3,760	
Total =		$97,735

NOTE: For this revision, all contractor mob/ demob, management and supervision, and equipment fueling and servicing are included in unit prices

ESTIMATED PROJECT MANAGEMENT COSTS FOR RECLAMATION revised 10/93

HOMESTAKE GRANTS

Preliminary estimate of active reclamation work period is three years

Project Manager - $50,000/yr x 3 yrs =	$150,000
Deputy Project Manager - $30,000/yr	$90,000
Secretary/Bookkeeper - $20,000/yr	$60,000
Total Direct Labor	$300,000
x multiplier of 3.0 (direct labor, indirect labor, overhead, G & A, profit) =	$900,000

QUALITY CONTROL TESTING COST ESTIMATE

Field Technicians, 2 full-time * - $60/hr x 6000 hr	$360,000
Per Diem, lodging - $100/day x 375 days	$37,500
Equipment and Supplies $100 /day x 375 days	$37,500
TOTAL	$435,000

* Hourly rate includes cost of performing all field and on-site lab testing.

ACTUAL CONTRACT PRICES FOR LARGE
IMPOUNDMENT RECONTOURING EARTHWORK

WORK AND PRICES BID

UNIT PRICE SCHEDULE

ITEM	ACTIVITY	UNITS	ESTIMATED QUANTITY	UNIT COST	EXPANDED COST
UP-01	Mobilization	Lump Sum	N/A		250,000.00
	Demobilization	Lump Sum	N/A		25,000.00
UP-02	Excavation	Total Bank Cubic Yards	1,867,000	1.20	2,240,400.00
UP-03	Fill	Bank Cubic Yards			
	UP-031-Stabilization Lift and Lift Without Specified Compaction		889,000 ~~[illegible]~~ yd.³	0.70	622,300.00
	UP-032-Lifts without specified compaction		~~[illegible]~~ yd.³	N/A	N/A
	UP-033-Lifts within 4.0 ft. of final grade		865,000 yd.³	0.35	302,750.00
UP-04	Settlement Point Installation	Unit Price	50 points	400.00	20,000.00
TOTAL					3,460,450.00
	New Mexico State Gross Receipts Tax		5.5% Rate		190,324.75
GRAND TOTAL					3,650,774.75

NIELSONS, INC.
CONTRACTOR'S EQUIPMENT RENTAL RATES

EQUIPMENT	S/N BRAND/MODEL	BUCKET/BED SIZE OR COMPACTOR WEIGHT & TYPE/WATER TRUCK CAPACITY	HOURLY RATE
Loader(s)	Caterpillar	950	$34.00
	Caterpillar	966	$45.00
Backhoe(s)	John Deere	JD 510	$15.00
Dozer(s)	Caterpillar	D-6	$24.00
	Caterpillar	D-8	$75.00
	Caterpillar	D-9	$84.00
Scraper(s)	Caterpillar	631D	$90.00
	Caterpillar	631E	$146.00
	Caterpillar	633D	$101.00
Haul Truck(s)	Truck & end dump trailer		$29.12
Motor Grader(s)	Caterpillar	14G	$36.00
Compactor(s)	Caterpillar	825	$54.00
	Raygo	Romper	$18.00
	50 Ton Pneumatic		$28.00
Water Truck(s)	Truck	3,000 gallon	$20.00
Water Wagon(s)	Caterpillar	8,000 or 10,000 gallon	$39.00
Service Truck			$17.00
Mechanic Truck			$9.50
Pick-up Truck			$7.50
Other Equipment	Whacker	Tamper	$6.00
	Walk Behind Roller	Compactor	$15.00

NOTE: New Mexico Gross Receipts Tax to be billed seperately.
Labor to be paid at applicable rate from "Loaded Wage Rate Schedule"

NIELSONS, INC • P.O. BOX 1660 • 22419 COUNTY ROAD G • CORTEZ, CO 81321 • 303 565-8461 • FAX 303 565-0188

NIELSONS, INC.
LOADED WAGE RATES

CLASSIFICATION	STRAIGHT TIME	OVERTIME
Supervision:		
Foreman	$30.25	$44.75
Project Superintendent	$47.00	$47.00
(includes Pick-up)		
Operators:		
Operator 1	$18.00	$26.50
Operator 2	$19.70	$29.00
Truck Drivers	$15.70	$23.00
Maintenance:		
Mechanic	$19.70	$29.00
Oiler	$18.00	$26.50
Other:		
Common Laborer	$12.50	$18.00
Grade Checker	$18.00	$26.50
Skilled Labor	$13.00	$19.00

NOTE: New Mexico Gross Receipts Tax to be billed seperately.
No shift differential would apply

NIELSONS, INC. • P.O. BOX 1660 • 22419 COUNTY ROAD G • CORTEZ, CO 81321 • 303/565-8461 • FAX: 303/565-0188

ACTUAL CONTRACT PRICES FOR
MILL DEMOLITION AND BURIAL

WORK AND PRICES BID

ITEM	ACTIVITY	UNITS	BID PRICE
01	Mobilization	Lump Sum	$ 20,000.00
	Demobilization	Lump Sum	$ 20,000.00
02	Cost of Temporary Office, Shop, Sanitary Facilities, etc.		
	03.1 Temporary Office Facilities	Lump Sum	$ 10,000.00
	03.2 Temporary Shop Facilities	Lump Sum	$ 5,000.00
	03.3 Temporary Sanitary Facilities	Lump Sum	$ 5,000.00
03	Dismantling and removal of all above ground structures and equipment of the Mill facility		
	Rubble/Scrap Cleanup and Burial	Lump Sum	$380,000.00
	Disposal of all dismantled Mill components by Burial in below-grade disposal pits, or placement in or on the large tailings impoundment.		$935,000.00
	Encapsulation of buried Mill components by using Slurry Grout.		
	Plan A (Drawing 4153-2A)	Lump Sum	$260,000.00
	Plan B (Drawing 4153-2B)	Lump Sum	N/A
	TOTAL CONTRACT AMOUNT		$1,635,000.00

HOMESTAKE MINING COMPANY—GRANTS

P.O. BOX 98 • GRANTS, NEW MEXICO 87020 • (505) 287-4456 EXT 505

PURCHASE ORDER NO. 161040

VENDOR
GIBBONS & REED COMPANY
P.O. BOX 30429
SALT LAKE CITY UT 67130

SHIP TO:
HOMESTAKE MINING COMPANY
HWY 605
PO BOX 98
GRANTS, NEW MEXICO 87020-0011

DATE OF ORDER	DELIVERY REQUIRED	TERMS	F.O.B. POINT	CARRIER-ROUTING	PAGE
10/6/93	08/31/94	NET 30	DESTINATION	VENDOR DELIVERY	1

CHARGE TO:	REQUISITIONED BY:	REQ. NO.
021-50-42350-5000-51000	F.C. P.S.	035531

ITEM	QUANTITY	STOCK NUMBER	DESCRIPTION	UNIT	UNIT PRICE
	134,000		PRODUCE D50 = 1 INCH ROCK PRODUCT AS PER ATTACHED QUALITY CONTROL SPECIFICATION WITH PLACEMENT OF ROCK IN STOCKPILE NEAR ROCK QUARRY.	CY	6.25
	143,000		PRODUCE D50 = 4.7 INCH ROCK PRODUCT AS PER ATTACHED QUALITY CONTROL SPECIFICATIONS WITH PLACEMENT OF ROCK IN A STOCKPILE NEAR ROCK QUARRY.	CY	6.25
			NO ROCK PRODUCED WILL BE ACCEPTED FOR USE AND PAYMENT UNTIL ALL TEST RESULTS HAVE BEEN REVIEWED AND APPROVED BY HOMESTAKE.		
			ATTACHED ARE SIX PAGES DEALING WITH ROCK QUALITY CONTROL SPECIFICATION (3 PAGES), AND ROCK COVER GRADATIONS (3 PAGES).		

ACTUAL PURCHASE ORDER PRICES
FOR ROCK PRODUCTION AT QUARRY

INVOICES MUST BE MAILED IN DUPLICATE NO LATER THAN THE DAY FOLLOWING SHIPMENT OF ANY PART OF THIS ORDER.

BY: HOMESTAKE MINING COMPANY—GRANTS

IMPORTANT INSTRUCTIONS:

1. OUR PURCHASE ORDER NUMBER MUST APPEAR ON ALL INVOICES, BILLS OF LADING, CARTONS, CASES, BUNDLES, PACKING SLIPS AND CORRESPONDENCE.
2. FURNISH COMPLETE PACKING LIST WITH EACH SHIPMENT AND TAG OR MARK EACH ITEM WITH PART NUMBER.
3. MARK EACH PACKAGE WITH SHIPPING ADDRESS AND ORDER NUMBER.
4. FURNISH SEPARATE ITEMIZED INVOICE IN DUPLICATE CONFORMING TO EACH ORDER FOR EACH SHIPMENT.
5. MAIL ORIGINAL BILL OF LADING ON DAY OF SHIPMENT TO: HOMESTAKE MINING COMPANY—GRANTS P.O. BOX 98, GRANTS, NEW MEXICO 87020.

ORDERS REFERRED TO BRANCH HOUSES OR OTHER VENDORS MUST CARRY ABOVE MENTIONED INSTRUCTIONS. FAILURE TO ADHERE TO THESE INSTRUCTIONS MAY RESULT IN REFUSAL OF SHIPMENT.

PURCHASE ORDER

THIS ORDER IS SUBJECT TO THE TERMS AND CONDITIONS STATED ON THE REVERSE SIDE HEREOF.

ORIGINAL

WESTERN STATES
Reclamation, Inc.

11730 Wadsworth Blvd. • Broomfield, Colorado 80020 • (303) 469-1986

TO: Gene Jenkins ~ Jenkins Environmental, Inc.

FROM: David R. Chenoweth DRC

DATE: January 28, 1991

SUBJECT: Revegetation Estimate Homestake Mining Co.
Grants, New Mexico Uranium Mine

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Provided on the attachment is an estimate of revegetation cost for the project listed above. This quote includes fertilizing based upon an estimate of appropriate Nitrogen and Phosphorus requirements, disking or chisel plowing, drill seeding using specified seed mixture, straw/hay mulching, and crimping.

This estimate was prepared as though it was a competitive bid for the client's comparison with other bids. However, the variables which could impact this bid over time are the price of oil and its impact on mobilization, revegetation machinery operating cost, and price of fertilizer. Also, seed prices could fluctuate between now and project commencement, which will increase or decrease our bid accordingly. However, I do not feel these prices will fluctuate more than 10% above the estimate.

We would appreciate the opportunity to negotiate a contract with Homestake Mining Co. when the time arises to proceed with the actual revegetation. We have numerous examples of revegetation projects to provide as references of our past work performance.

Call me if you should have any further questions.

Revegetation Cost Estimate

Homestake Mining Company - New Mexico Uranium Tailing Site

Mobilization

1 Lump Sum	$5.200
Each Additional Mobilization if more than one is required	$4,000

Revegetation (includes all Labor, Materials, and Mulching)

$424/Acre for an estimated 750 Acres