PART D
OPERATION AND RECLAMATION PLAN

APPENDICES

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APPENDIX A
E-10 FLOCCULENT
SPECIFICATION SHEET

Allied Colloids

Technical and Processing Data

TPD 1025

PERCOL E10

ANIONIC FLOCCULANT

DESCRIPTION

PERCOL E10 is a very high molecular weight slightly anionic polyacrylamide flocculant supplied as a free flowing granular powder.

PRINCIPAL USES

PERCOL E10 has found application in a wide variety of mineral processing operations including the following:

1. Acid leach CCD (Uranium)
2. Potash slimes clarification and dewatering
3. Acid leach CCD (Copper)
4. Acid leach (Zinc)
5. Iron ore tailings clarification
6. Base metal concentrate thickening and filtration.
7. Deep cone thickening of coal tailings

Dosage depends upon the application but normally lies in the range 2 gm to 200 gm per tonne of dry substrate flocculated.

TYPICAL PROPERTIES

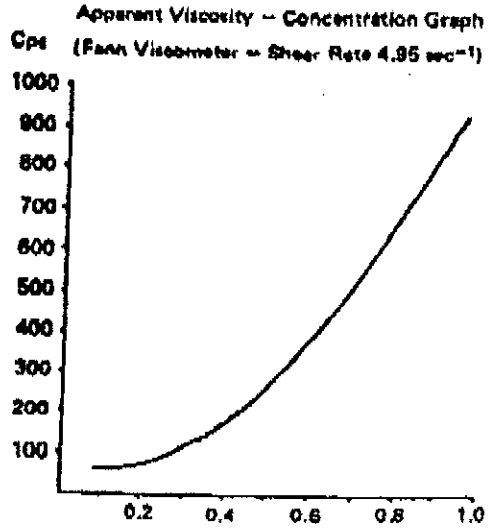
Physical form.....white granular powder
Particle size.....98%< 750 µ
Bulk density.....0.5–0.6
pH of 1% solution @ 25°C.....3.0–4.0
Viscosity at 25°C.....see graph and table overleaf

APPLICATION AND STORAGE

Recommended solution concentrations:
Stock solution.....0.25 to 0.5% max.
Feed solution .....0.025 to 0.05% max.
Recommended storage periods:
Solid.....up to two years
Stock solution.....3 to 6 days

Storage of polymer should be in a cool, dry place.

Details on preparation and feeding can be obtained from an Allied Colloids representative.



ALLIED COLLOIDS (CANADA) INC
11 AUTOMATIC ROAD
TEL (416) 793-9473
FAX (416) 793-9447

SOLUTION VISCOSITY DATA

(Fann Viscometer — 25°C – solvent — deionised water)

PERCOL E10 concentration (%)	Shear rate (sec^{-1}) / Viscosity (Cps)	4.96	9.90	165	330	495	989
1.0		800	620	117	85	69	62
0.5		250	175	39	33	34	32
0.25		80	50	18	14	12	12
0.10		50	50	9	7	6	5

SHIPPING AND HANDLING

PERCOL E10 is supplied in 25kg polyethylene-lined, multi-walled bags. PERCOL E10 has a low order of toxicity and no special precautions are necessary in handling.

Corrosivity towards most standard material of construction is low, but aluminum and galvanized equipment should be avoided.

TECHNICAL SERVICE

Advice and assistance in the running of laboratory and plant tests to select the correct flocculant and determine the best application is given by representatives of Allied Colloids, who are experienced in mineral processing applications.

PERCOL is the registered trade name of Allied Colloids.

HEALTH AND SAFETY INFORMATION

PERCOL E10 exhibits a very low order of oral toxicity and does not present any abnormal problems in its handling or general use.

Full details on Health and Safety aspects are available on request.

WARRANTY

The information contained in this leaflet is given in good faith, but no liability is assumed nor is freedom from any patent owned by Allied Colloids or others implied.

I. PRODUCT IDENTIFICATION

Manufacturer:
ALLIED COLLOIDS LTD.
P.O. Box 38,
Low Moor, West Yorkshire,
Bradford, BD12 0JZ
ENGLAND Tel.: 011-44-274-671267

Distributor:
ALLIED COLLOIDS (CANADA) INC.
11 Automatic Road,
Brampton, Ontario
L6S 4K6
Emergency Tel.: (416) 793-9473

Product Name: PERCOL E10
Product Type: Copolymer of sodium acrylate and acrylamide

II. HAZARDOUS INGREDIENTS

INGREDIENTS	CAS NUMBER	CONCENTRATION	LD50/LC50

No hazardous ingredients as per regulations

III. PHYSICAL PROPERTIES

Appearance and Odour: White free flowing powder

Density: 0.8 g/cm³
Specific Gravity: not available
Vapour Density: not available
Boiling Point: not available
pH Value: not available

Odour Threshold: not available
Vapour Pressure: not available
Evaporation Rate: not available
Freezing Point: not available
Coeff. of water/oil dist.: not available

IV. FIRE AND EXPLOSION HAZARD

Conditions of Flammability: Very low risk.
Flash Point (method of determination) - none exhibited
LEL, UEL - not applicable
Auto-ignition temperature: not available
Flammability Classification: not applicable
Hazardous Combustion Products: none
Explosion Data: not applicable

EXTINGUISHING MEDIA and SPECIAL FIRE FIGHTING PROCEDURES
Carbon dioxide, dry chemical, foam

V. REACTIVITY

Materials to Avoid:
Avoid contact with strong oxidants.

Stability:
This product is stable and will not react violently with water. Hazardous polymerization will not occur.

Hazardous Decomposition Products:
none

VI. TOXICOLOGICAL PROPERTIES OF PRODUCT

HAZARD STATEMENTS

Nature of Hazard:
This product has been determined to be non-hazardous in accordance with 29CFR 1910.1200; however, as with any chemical this product should be handled with good industrial hygiene and safety practices as set forth in the material safety data sheet.

Primary routes of entry:
Ingestion, inhalation

Effects of Acute Exposure: (Signs and symptoms of exposure)
Not applicable.

Effects of Chronic exposure:
None

Exposure Limit:
ACGIH: none OSHA PEL: none MFRS Recommended: none

Carcinogenicity Determination by NTP, IARC, OSHA: None

Sensitization of Product: not as sensitizer
Synergistic Materials: none reported
Reproductive Toxicity: not available
Teratogenicity: not available
Mutagenicity: not available

VII. PREVENTIVE MEASURES

1. PROTECTIVE EQUIPMENT

Eye Protection:
Use splash goggles or face shield when eye contact may occur.

Skin Protection:
Use gloves, if needed, to avoid prolonged or repeated skin contact.

Respiratory Protection:
Normally not needed, use dust mask if needed to prevent inhalation of airborne particles.

Ventilation:
Provide adequate ventilation to minimize dust inhalation.

2. PERSONAL HYGIENE

Minimize breathing dust. Avoid prolonged or repeated breathing of dust and contact with skin. Remove contaminated clothing; launder or dry-clean before reuse. Cleanse skin thoroughly after contact, before breaks and meals and at end of work period. Product is readily removed from skin by washing thoroughly with soap and water.

3. PRECAUTIONARY STATEMENTS

Dust generated in handling of this product can be explosive if sufficient quantities are mixed in air in which case ignition sources should be avoided.

4. SPILLS, LEAKS

Product may create a slip hazard when mixed with water. Spills should be dealt with immediately. Spills of dry product present a slip hazard when wet and should be cleaned up immediately. Do not wet spills of dry product. Sweep up dry and flush spill area with water. Spills of dilute solutions may be flushed with copious amounts of water, or alternatively, they may be absorbed with an inert material such as earth or speedi-dry and contained for disposal. The product or its solutions should not be allowed to enter waterways without treatment. Product should be disposed of in accordance with applicable federal, provincial and local regulations.

VIII. EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT

If splashed into the eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists, call a physician.

INGESTION

If ingested, give emetic and seek medical advice.

IX. PREPARATION INFORMATION

Person to contact: Trixie Schultz, Occupational Health and Safety Department

Prepared By: [signature] Date Revised: 11-03-88

The information and recommendations contained herein are, to the best of Allied Colloids' knowledge and belief, accurate and reliable as of the date issued. Allied Colloids does not warrant or guarantee their accuracy or reliability, and Allied Colloids shall not be liable for any loss or damage arising out of their use thereof.

The information and recommendations are offered for the users' consideration and examination, and it is the users' responsibility to satisfy itself that they are suitable and complete for its particular use.

APPENDIX B
CLIMATOLOGICAL DATA

APPENDIX B - CLIMATOLOGICAL DATA

This appendix contains the climatologic data derived for the site and used in assessing project water balance and hydrologic design of facilities.

Mean annual precipitation was derived using data for Palmer, Alaska obtained via computer modem through the Soil Conservation Service (SCS) in Portland, Oregon and applying an elevation correction to extrapolate to the site.

Mean annual evaporation was derived using data from Matanuska Agriculture Experimental Station and Palmer and regional information obtained from the National Weather Service (Technical Publications NWS 33 and NWS 34).

Site runoff was derived using data obtained from the SCS database for the Little Susitna River and regional atlases of Alaska and Canada for developing precipitation/runoff relationship.

Recurrence interval storm events, including the 100-yr storm, were derived using daily precipitation data for Palmer obtained from the SCS database. These data were analyzed using a Pearson Type 1 Extremal Distribution technique (Chow, 1964) to produce a storm precipitation depth versus recurrence interval curve.

TABLE B-1

PRECIPITATION AT PALMER

TAPS Station : PALMER IAS, 6870
start yr. - 1949 end yr. - 1988

Month	Temperature						Precipitation			
				2 years in 10 will have				2 yrs in 10 will have		
	avg daily max	avg daily min	avg	max temp. >than	min temp. <than	avg no. of grow'n degree days*	avg (in.)	less than (in.)	more than (in.)	average number of days with 0.10 inch or more
January	20.0	3.9	11.9	47	-29	1	0.91	0.25	1.49	2
February	26.4	8.9	17.7	47	-21	1	0.68	0.21	1.10	2
March	34.0	15.1	24.6	53	-15	2	0.53	0.25	0.87	2
April	45.1	27.1	36.1	60	8	21	0.61	0.16	1.03	2
May	56.9	36.5	46.7	74	24	210	0.67	0.24	1.06	2
June	64.2	44.6	54.4	80	35	419	1.37	0.75	1.92	4
July	66.4	48.1	57.2	81	39	537	2.20	1.26	3.04	6
August	64.3	46.7	55.5	78	32	463	2.37	1.10	3.46	6
September	56.4	38.9	47.6	68	22	228	2.34	1.10	3.41	6
October	41.7	26.2	34.0	59	1	35	1.48	0.72	2.14	4
November	28.2	13.1	20.7	51	-13	4	1.01	0.32	1.68	3
December	21.1	6.2	13.7	47	-26	1	1.01	0.46	1.49	3
Yearly :										
Average	43.7	26.3	35.0	----	----	----	---	---	---	---
Extreme	87	-38	---	84	-32	----	---	---	---	---
Total	---	---	---	----	----	1922	15.20	7.94	18.28	42

*A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minumum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (Threshold : 40.0 deg. F)

TABLE B-2

ESTIMATED MONTHLY PRECIPITATION FOR THE MINE SITE, BUFFALO CREEK, AND THE LITTLE SUSITNA RIVER BASED ON DATA FOR PALMER AND ELEVATION CORRELATIONS

MONTH	% MEAN ANNUAL PRECIPITATION	PRECIP* MONTHLY BUFFALO CREEK (28")	PRECIP* MONTHLY SITE (24")	LITTLE SUSITNA
Jan	.06	1.68	1.44	3.00
Feb	.045	1.26	1.08	2.25
Mar	.035	0.98	0.84	1.75
Apr	.04	1.12	0.96	2.00
May	.044	1.23	1.06	2.20
Jun	.09	2.52	2.16	4.50
Jul	.145	4.06	3.48	7.25
Aug	.156	4.37	3.74	7.80
Sep	.154	4.31	3.70	7.70
Oct	.097	2.72	2.33	4.85
Nov	.066	1.85	1.58	3.30
Dec	.066	1.85	1.58	3.30

*Elevation correlations from Palmer Site.

B.C. Area = 446 acres = 19.4×10^6 ft^2

		Mean Annual Precipitation (in inches)
Palmer Elevation	225 ft	15.2
Site Elevation	1000 ft	24
Buffalo Creek Elevation	1400 ft	28
Little Susitna Elevation	3700 ft	50

TABLE B-3

PAN EVAPORATION DATA FROM PALMER AND THE MATANUSKA AGRICULTURAL EXPERIMENT STATION

MONTH	PAN EVAPORATION (INCHES) MATANUSKA	PALMER
May	4.62 (.232)	5.05 (.259)
Jun	4.38 (.220)	4.77 (.245)
Jul	4.16 (.209)	4.66 (.239)
Aug	3.16 (.159)	3 (.154)
Sep	1.95 (.098)	2 (.103)
Oct	1.61 (.081)	-
	19.88 (1.000)	19.48 (1.000)

For the site, say May through October, pan evaporation = 20 inches.

Typical ratio of May through October evaporation to annual is approximately 80% (based on rough regional evaporation mapping in some of the colder U.S. states National Weather Service Technical Reports 33 and 34, 1982).

Mean annual pan evaporation is approximately 25 inches.

Assuming a pan coefficient of 80% ---> mean annual FWS evaporation = 20 inches.

TABLE B-4

WISHBONE HILL SITE EVAPORATION

MONTH	PAN EVAPORATION (INCHES)	LAKE EVAPORATION (INCHES)
Jan	0.8	0.6
Feb	0.8	0.6
Mar	0.8	0.6
Apr	0.9	0.7
May	4.6	3.8
Jun	4.4	3.5
Jul	4.2	3.4
Aug	3.2	2.6
Sep	2.0	1.6
Oct	1.6	1.3
Nov	0.9	0.7
Dec	0.8	0.6
TOTAL	25.0	20.0

May through October based on Matanuska Dist. and 20-inch pan evaporation. November through April evaporation assumed relatively uniform.

TABLE B-5

STORM CALCULATION SPREADSHEET

DAILY PRECIP DEPTHS(INCHES)
PALMER IAS RECORDING GAUGE
P.O.R.=1949-1988

EST.NO.DAYS NO DATA	1,072	P.O.R.		31-Aug-49
EST.NO.DAYS 0 PREC	9,990			31-Dec-88
ABBREVIATED SPREADSHEET VER.		NO. DAYS		14,367.000

R.I.(yr)	T	K	(FOR PLOTTING ONLY)	
100	36525	7.7	0	1
50	18263	7.2	0	1
25	9131	6.7	0	1
10	3653	5.9	0	1
		4		

SORT.PREC.	RANK	T	LOG PREC	K
2.67	1	13,296	0.43	7.0
2.50	2	6,648	0.40	6.4
2.21	3	4,432	0.34	6.1
1.60	4	3,324	0.20	5.9
1.57	5	2,659	0.20	5.7
1.45	6	2,216	0.16	5.6
1.42	7	1,899	0.15	5.4
1.40	8	1,662	0.15	5.3
1.37	9	1,477	0.14	5.2
1.35	10	1,330	0.13	5.2
1.35	11	1,209	0.13	5.1
1.30	12	1,108	0.11	5.0
1.26	13	1,023	0.10	5.0
1.25	14	950	0.10	4.9
1.22	15	886	0.09	4.8
1.22	16	831	0.09	4.8
1.20	17	782	0.08	4.7
1.14	18	739	0.06	4.7
1.13	19	700	0.05	4.7
1.12	20	665	0.05	4.6
1.10	21	633	0.04	4.6
1.10	22	604	0.04	4.5
1.08	23	578	0.03	4.5
1.08	24	554	0.03	4.5
1.07	25	532	0.03	4.4
1.06	26	511	0.03	4.4
1.02	27	492	0.01	4.4
1.01	28	475	0.00	4.4
1.00	29	458	0.00	4.3
1.00	30	443	0.00	4.3
1.00	31	429	0.00	4.3

LIN REG

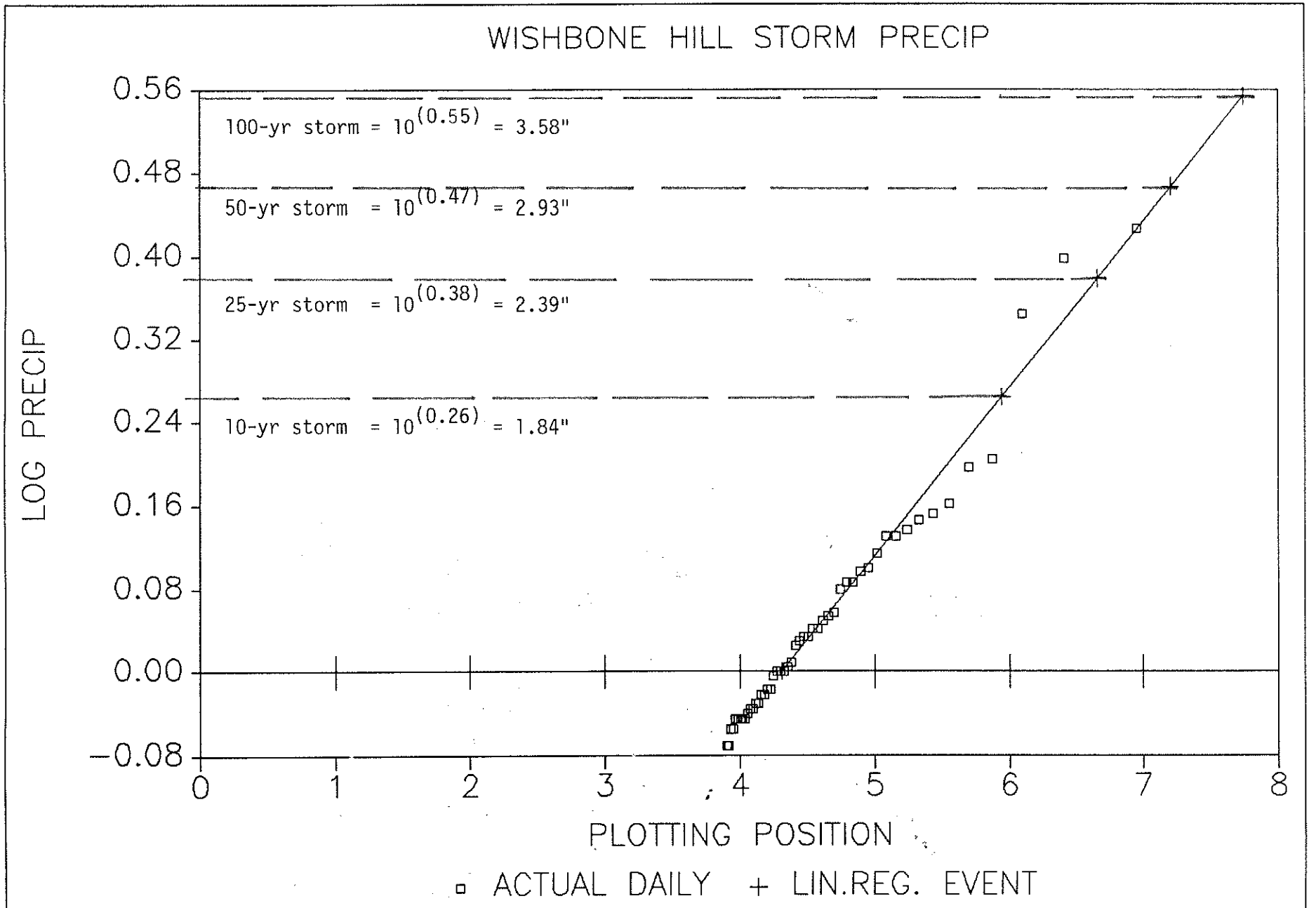
-0.696	b
0.161	m

SUMMARY

****

EVENT	PRECIP	LOG PREC
100	3.58	0.55
50	2.93	0.47
25	2.39	0.38
10	1.84	0.26
	1	0.00

Based on daily data for Palmer obtained from the Soil Conservation Service computer database via computer modem. Attached graph shows plot of storm events.



BASED ON DATA RECORDED AT PALMER IAS

APPENDIX C
PROJECT WATER BALANCE CALCULATIONS

APPENDIX C - PROJECT WATER BALANCE CALCULATIONS

This appendix contains the facilities water balance spreadsheets, slurry pond sizing calculations, and sediment pond gross annual mass balance spreadsheets for all sediment control ponds.

The water balance was evaluated for normal, wet, and dry years to assess pond sizing and water supply needs for the facilities area ponds. The water balance was derived using a SMART spreadsheet with calculations developed by SRK.

The sediment pond mass balance was evaluated to assess pond sizing and maintenance (sediment removal) needs utilizing normal climate, the SECAD results of Appendix D, and the infiltration results of Appendix I.

The slurry pond sizing calculations were based on plant operating criteria provided by McKinley Mining Consultants Inc. (MMCI) and laboratory column settling tests and consolidation testing (Appendix K).

APPENDIX C.1
SUPPORT FACILITIES WATER BALANCE

CALCULATIONS FOR SLURRY POND CAPACITY

1. Total hours plant operation - 70,365 (from McKinley Mining Consultants, Inc. (MMCI)).

2. Fines production: 210 TPD (from MMCI - based on 20-hr day)
   = 10.5 ton/hr

3. Total fines production (1) x (2) = 738,832.5 tons.

4. Assume 63 pcf for average deposited density based on lab test results ranging from 58 to approximately 70 pcf (see Appendix K for column settling and consolidation testing).

5. Volume of fines = (3)/(4) x C; C = 2,000
   = 23,455,000 cu ft

6. Storage elevation for estimated fines production: from height-capacity curve ---> 855.5 ft.

7. Maximum storage elevation for surplus water is approximately 863 ft.

8. Total storage at elevation 863 ft is approximately 30,551,134 cu ft.

9. Net available water storage is approximately (8) - (5) = 7,096,134 cu ft.

10. Slurry pond catchment area is approximately 72 ac ±.

EXPLANATION OF SPREADSHEET COLUMNS

Slurry Pond Water Balance

1. DATE - The month and year under consideration.
2. SOLIDS/cum. - Cumulative tally of the fine coal waste deposited into the slurry pond. Rates are based on a production rate of 210 tons/day and a deposited density of 63 pounds/ft^3.
3. FREEWATER - Slurry water minus the moisture retained in the voids of the fine coal waste.
4. PRECIP - Direct precipitation for the month on the slurry impoundment area.
5. RUNOFF - Runoff from the catchment area tributary to the pond from precipitation for the month (assuming 50% runoff rate).
6. INITIAL STORAGE - Calculation of monthly water inflow for determination of water pool area for loss calculation. Determined by adding columns 3, 4 and 5.
7. INITIAL POND AREA - Area of water pool based on column 6 (initial storage) and slurry pond height-capacity data for use in seepage and evaporation loss calculations.
8. SEEPAGE - Potential seepage loss from the slurry pond based on subsoil and coal slurry infiltration rates (subsoil rates were used for the first year and slurry rates were used for following years).
9. EVAPORATION - Evaporation from the slurry pond water pool based on initial pond area and monthly evaporation data.
10. POND RECLAIM - Water available from the slurry pond for recycling.
11. RECOVER AND RECYCLE - Not applicable since column 10 always is zero.
12. NET STORAGE - End of month water storage.

Fresh Water Pond Balance

1. DATE - The month and year under consideration.
2. WATER FRM BUFF CR - Estimated Buffalo Creek flow at the diversion intake (see CK RO under Climate/Hydrology parameters.
3. PRECIP - Direct precipitation for the month on the lined pond area of both ponds.
4. RUNOFF - Runoff from the catchment area tributary to the ponds from precipitation for the month (assuming 50% runoff rate).
5. EVAP - Evaporation over the lined pond areas. Based on monthly evaporation data.
6. WASH CIRC - Make-up water to be pumped to the coal wash circuit.
7. BUFF CR MAKEUP - Additional makeup water required to maintain storage in the ponds.
8. STORAGE - Total end of month storage at both ponds.
9. WASH PLANT DEFICIT - Calculated shortage at the wash plant (if any).

Wash Down Water Pond

1. PRECIP - Monthly precipitation over the lined pond area.
2. RUNOFF - Runoff from the catchment area tributary to the pond from precipitation for the month (assuming 50% runoff rate).
3. EVAP - Monthly evaporation over the lined pond area.
4. SEEPAGE - Pond seepage (since pond is lined seepage is always equal to zero).
5. BALANCE - Sum of inflows and losses.
6. DUST SUPP'N - Water taken from the wash down water pond as needed for dust control and to maintain pond level below freeboard level (estimated at 14 gpm).
7. POND STORAGE - Wash down water pond storage volume after summing all inflows and losses.

REVISED TABLE C.1
WISHBONE HILL PROJECT WATER BALANCE 05/23/90
1991-2001 PERIOD OF OPERATION
NORMAL OPERATING/NORMAL CLIMATE

OPERATING PARAMETERS

FRESH WATER POND NO. 1(FWP1)

ELEV	AREA	CAPACITY
ft	acres	acre ft
840	0	
850	1	2
865	2	24

CATCHMENT AREA	4	ACRES		
INFILTRATION RATE	1.0E-07	CM/SEC OR	0	FT/MO
INITIAL STORAGE	0	ACRE FT		
POTABLE REQUIREMENT	0.0	GPM		
DUST SUPPRESSION	42	GPM		
WASHDOWN RECYCLE	1	GPM		

FRESH WATER POND NO. 2(FWP2)

CAPACITY	51	AC FT
CATCHMENT	10	ACRES
SURFACE	6	ACRES

SLURRY POND(SP)

ELEV	AREA	CAPACITY
ft	acres	acre ft
825	10	72
850	21	427
865	27	785

CATCHMENT AREA	51	ACRES		
INFILTRATION RATE	1.0E-02	CM/SEC OR	850	FT/MO
(" " AFTER YR1):	1.0E-03	CM/SEC OR	85	FT/MO

TAILINGS PARAMETERS				
SLURRY DENSITY	23%			
SPECIFIC GRAVITY	2.6			
DEGREE SATURATION	75%			
DEPOSITED DENSITY	63	PCF		
VOIDS WATER RETAINED	45%	OR IN GPM:	16	
MINIMUM POND VOLUME	10	ACRE FT		
MILL/PROCESS PARAMETERS				
TAILINGS PRODUCTION	210	TPD		
INITIAL ORE MOISTURE	4%			
SLURRY WATER	120	GPM:	55.7	GPM
MINIMUM FRESHWATER	4	GPM	COARSE WASH FLOW	
SP RECOVER & RECYCLE	0	GPM	0%	
			OF FREEWATER	

CLIMATE/HYDROLOGY PARAMETERS

MONTH	MEAN PPT	MEAN EVAP	MEAN ROV	CK RO DIST	CK RO**
	in	in	in	%	in
JAN	1.4	0.6	0.7	1%	0.1

SLURRY POND BALANCE

DATE	INFLOWS				INITIAL	INITIAL	LOSSES		POND	RECOVER&	NET
YR/MO	SOLIDS/cum	FREEWATER	PRECIP	RUNOFF	STORAGE	POND AREA	SEEPAGE	EVAP	RECLAIM	RECYCLE	STORAGE
	acre ft	gpm	gpm	gpm	acre ft	acre	gpm	gpm	gpm	gpm	acre ft
1990/SEP					0	0					
OCT	0	0	0	37	5	1	-4,179	-1	0	0	0
NOV	0	0	1	25	3	0	-2,944	0	0	0	0
DEC	0	0	0	25	3	0	-2,933	0	0	0	0
1991/JAN	0	0	0	22	3	0	-2,566	0	0	0	0
FEB	0	0	0	17	2	0	-2,014	0	0	0	0
MAR	0	0	0	13	2	0	-1,462	0	0	0	0
APR	0	0	0	16	2	0	-1,825	0	0	0	0
MAY	0	0	0	18	2	0	-2,010	-1	0	0	0
JUN	0	0	0	35	5	1	-4,022	-1	0	0	0
JUL	0	0	1	55	8	1	-6,437	-2	0	0	0
AUG	0	0	2	58	8	1	-6,855	-2	0	0	0
SEP	0	0	2	58	8	1	-6,863	-1	0	0	0
OCT	5	104	2	36	19	3	-16,094	-2	0	0	0
NOV	9	104	3	24	17	2	-14,878	-1	0	0	0
DEC	14	104	2	24	17	2	-14,867	-1	0	0	0
1992/JAN	18	104	2	21	17	2	-1,449	-1	0	0	0
FEB	23	104	2	17	16	2	-1,392	-1	0	0	0
MAR	27	104	1	12	16	2	-1,334	-1	0	0	0
APR	32	104	1	15	16	2	-1,372	-1	0	0	0
MAY	37	104	1	17	16	2	-1,391	-5	0	0	0
JUN	41	104	3	34	19	2	-1,600	-5	0	0	0
JUL	46	104	5	53	22	3	-1,850	-6	0	0	0
AUG	50	104	7	56	22	3	-1,893	-5	0	0	0
SEP	55	104	7	56	22	3	-1,894	-3	0	0	0
OCT	60	104	4	35	19	3	-1,625	-2	0	0	0
NOV	64	104	3	24	17	2	-1,488	-1	0	0	0
DEC	69	104	2	24	17	2	-1,487	-1	0	0	0
1993/JAN	73	104	2	21	17	2	-1,449	-1	0	0	0
FEB	78	104	2	17	16	2	-1,392	-1	0	0	0
MAR	82	104	1	12	16	2	-1,334	-1	0	0	0
APR	87	104	1	15	16	2	-1,372	-1	0	0	0
MAY	92	104	1	17	16	2	-1,391	-5	0	0	0
JUN	96	104	3	34	19	2	-1,600	-5	0	0	0
JUL	101	104	5	53	22	3	-1,850	-6	0	0	0
AUG	105	104	7	56	22	3	-1,893	-5	0	0	0
SEP	110	104	7	56	22	3	-1,894	-3	0	0	0
OCT	115	104	4	35	19	3	-1,625	-2	0	0	0
NOV	119	104	3	24	17	2	-1,488	-1	0	0	0
DEC	124	104	2	24	17	2	-1,487	-1	0	0	0
1994/JAN	128	104	2	21	17	2	-1,449	-1	0	0	0
FEB	133	104	2	17	16	2	-1,392	-1	0	0	0
MAR	137	104	1	12	16	2	-1,334	-1	0	0	0
APR	142	104	1	15	16	2	-1,372	-1	0	0	0
MAY	147	104	1	17	16	2	-1,391	-5	0	0	0
JUN	151	104	3	34	19	2	-1,600	-5	0	0	0
JUL	156	104	5	53	22	3	-1,850	-6	0	0	0
AUG	160	104	7	56	22	3	-1,893	-5	0	0	0
SEP	165	104	7	56	22	3	-1,894	-3	0	0	0

FEB	1.1	0.6	0.6	1%	0.1
MAR	0.8	0.6	0.4	1%	0.1
APR	1.0	0.7	0.5	1%	0.1
MAY	1.1	3.8	0.6	8%	1.0
JUN	2.2	3.5	1.1	27%	3.2
JUL	3.5	3.4	1.6	22%	2.6
AUG	3.7	2.6	1.9	18%	2.2
SEP	3.7	1.6	1.9	12%	1.4
OCT	2.3	1.3	1.2	5%	0.6
NOV	1.6	0.7	0.6	2%	0.2
DEC	1.6	0.6	0.8	2%	0.2
ANNUAL	24.0	20.0	12.0		12.0

*MEAN RO=BASIN RUNOFF=PRECIPx 50%
**CK RO=CREEK FLOW-CK RO DISTx H.A.R.

BUFFALO CREEK DIVERSION
CATCHMENT AREA 446 ACRES

WET YR PPT 157%
DRY YR PPT 56%
DRY YR RO 0

OCT	170	104	4	35	19	3	-1,625	-2	0	0	0
NOV	174	104	3	24	17	2	-1,488	-1	0	0	0
DEC	179	104	2	24	17	2	-1,487	-1	0	0	0
1995/JAN	183	104	2	21	17	2	-1,449	-1	0	0	0
FEB	188	104	2	17	16	2	-1,392	-1	0	0	0
MAR	192	104	1	12	16	2	-1,334	-1	0	0	0
APR	197	104	1	15	16	2	-1,372	-1	0	0	0
MAY	202	104	1	17	16	2	-1,391	-5	0	0	0
JUN	206	104	3	34	19	2	-1,600	-5	0	0	0
JUL	211	104	5	53	22	3	-1,850	-6	0	0	0
AUG	215	104	7	56	22	3	-1,893	-5	0	0	0
SEP	220	104	7	56	22	3	-1,894	-3	0	0	0
OCT	225	104	4	35	19	3	-1,625	-2	0	0	0
NOV	229	104	3	24	17	2	-1,488	-1	0	0	0
DEC	234	104	2	24	17	2	-1,487	-1	0	0	0
1996/JAN	238	104	2	21	17	2	-1,449	-1	0	0	0
FEB	243	104	2	17	16	2	-1,392	-1	0	0	0
MAR	247	104	1	12	16	2	-1,334	-1	0	0	0
APR	252	104	1	15	16	2	-1,372	-1	0	0	0
MAY	257	104	1	17	16	2	-1,391	-5	0	0	0
JUN	261	104	3	34	19	2	-1,600	-5	0	0	0
JUL	266	104	5	53	22	3	-1,850	-6	0	0	0
AUG	270	104	7	56	22	3	-1,893	-5	0	0	0
SEP	275	104	7	56	22	3	-1,894	-3	0	0	0
OCT	280	104	4	35	19	3	-1,625	-2	0	0	0
NOV	284	104	3	24	17	2	-1,488	-1	0	0	0
DEC	289	104	2	24	17	2	-1,487	-1	0	0	0
1997/JAN	293	104	2	21	17	2	-1,449	-1	0	0	0
FEB	298	104	2	17	16	2	-1,392	-1	0	0	0
MAR	302	104	1	12	16	2	-1,334	-1	0	0	0
APR	307	104	1	15	16	2	-1,372	-1	0	0	0
MAY	312	104	1	17	16	2	-1,391	-5	0	0	0
JUN	316	104	3	34	19	2	-1,600	-5	0	0	0
JUL	321	104	5	53	22	3	-1,850	-6	0	0	0
AUG	325	104	7	56	22	3	-1,893	-5	0	0	0
SEP	330	104	7	56	22	3	-1,894	-3	0	0	0
OCT	335	104	4	35	19	3	-1,625	-2	0	0	0
NOV	339	104	3	24	17	2	-1,488	-1	0	0	0
DEC	344	104	2	24	17	2	-1,487	-1	0	0	0
1998/JAN	348	104	2	21	17	2	-1,449	-1	0	0	0
FEB	353	104	2	17	16	2	-1,392	-1	0	0	0
MAR	357	104	1	12	16	2	-1,334	-1	0	0	0
APR	362	104	1	15	16	2	-1,372	-1	0	0	0
MAY	367	104	1	17	16	2	-1,391	-5	0	0	0
JUN	371	104	3	34	19	2	-1,600	-5	0	0	0
JUL	376	104	5	53	22	3	-1,850	-6	0	0	0
AUG	380	104	7	56	22	3	-1,893	-5	0	0	0
SEP	385	104	7	56	22	3	-1,894	-3	0	0	0
OCT	390	104	4	35	19	3	-1,625	-2	0	0	0
NOV	394	104	3	24	17	2	-1,488	-1	0	0	0
DEC	399	104	2	24	17	2	-1,487	-1	0	0	0
1999/JAN	403	104	2	21	17	2	-1,449	-1	0	0	0

FEB	408	104	2	17	16	2	-1,392	-1	0	0	0
MAR	412	104	1	12	16	2	-1,334	-1	0	0	0
APR	417	104	1	15	16	2	-1,372	-1	0	0	0
MAY	422	104	1	17	16	2	-1,391	-5	0	0	0
JUN	426	104	3	34	19	2	-1,600	-5	0	0	0
JUL	431	104	5	53	22	3	-1,850	-6	0	0	0
AUG	435	104	7	56	22	3	-1,893	-5	0	0	0
SEP	440	104	7	56	22	3	-1,894	-3	0	0	0
OCT	445	104	4	35	19	3	-1,625	-2	0	0	0
NOV	449	104	3	24	17	2	-1,488	-1	0	0	0
DEC	454	104	2	24	17	2	-1,487	-1	0	0	0
2000/JAN	458	104	2	21	17	2	-1,449	-1	0	0	0
FEB	463	104	2	17	16	2	-1,392	-1	0	0	0
MAR	467	104	1	12	16	2	-1,334	-1	0	0	0
APR	472	104	1	15	16	2	-1,372	-1	0	0	0
MAY	477	104	1	17	16	2	-1,391	-5	0	0	0
JUN	481	104	3	34	19	2	-1,600	-5	0	0	0
JUL	486	104	5	53	22	3	-1,850	-6	0	0	0
AUG	490	104	7	56	22	3	-1,893	-5	0	0	0
SEP	495	104	7	56	22	3	-1,894	-3	0	0	0
OCT	500	104	4	35	19	3	-1,625	-2	0	0	0
NOV	504	104	3	24	17	2	-1,488	-1	0	0	0
DEC	509	104	2	24	17	2	-1,487	-1	0	0	0
2001/JAN	513	104	2	21	17	2	-1,449	-1	0	0	0
FEB	518	104	2	17	16	2	-1,392	-1	0	0	0
MAR	522	104	1	12	16	2	-1,334	-1	0	0	0
APR	527	104	1	15	16	2	-1,372	-1	0	0	0
MAY	532	104	1	17	16	2	-1,391	-5	0	0	0
JUN	536	104	3	34	19	2	-1,600	-5	0	0	0

AVAIL. FRESH WATER POND BALANCE

DATE	WATER FRM	******INFLOWS******			**********	**********	LOSSES	**********	BUFF CR		WASH PLANT
YR/MO	BUFF CR	PRECIP	RUNOFF	EVAP	POTABLE	WASH CIRC	DUST SUPN	WASHDOWN	MAKEUP	STORAGE	DEFICIT
	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	acre ft	gpm
1990/SEP											
OCT	168	11	2	-6	0	0	0	0	168	23	0
NOV	67	8	1	-3	0	0	0	0	67	33	0
DEC	67	8	1	-3	0	0	0	0	67	43	0
1991/JAN	34	7	3	-3	0	0	0	0	34	48	0
FEB	34	5	2	-3	0	0	0	0	34	53	0
MAR	34	4	2	-3	0	0	0	0	34	58	0
APR	34	5	2	-3	0	0	0	0	34	63	0
MAY	269	5	2	-19	0	0	0	0	269	97	0
JUN	908	11	4	-17	0	0	-42	0	105	105	0
JUL	740	17	7	-17	0	0	-42	0	34	105	0
AUG	605	18	8	-13	0	0	-42	0	29	105	0
SEP	404	18	8	-8	0	0	-42	0	24	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1992/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1993/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1994/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0

OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1995/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	19	8	-13	0	-176	-42	-1	206	105	0
SEP	401	18	5	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1996/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	165	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1997/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	710	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1998/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	19	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	165	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1999/JAN	34	7	3	-3	0	-176	0	-1	34	57	0

FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	15	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
2000/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	15	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
2001/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0

REVISED TABLE C.2

WISHBONE HILL PROJECT WATER BALANCE 06/06/90

1991-2001 PERIOD OF OPERATION

NORMAL OPERATING/DRY YEAR IN 1995

OPERATING PARAMETERS

FRESH WATER POND NO. 1(FWP1)

ELEV ft	AREA acres	CAPACITY acre ft
840	0	
850	1	2
865	2	24

CATCHMENT AREA	4	ACRES		
INFILTRATION RATE	1.0E-07	CM/SEC OR	0	FT/MO
INITIAL STORAGE	0	ACRE FT		
POTABLE REQUIREMENT	0.0	GPM		
DUST SUPPRESSION	42	GPM		
WASHDOWN RECYCLE	1	GPM		

FRESH WATER POND NO. 2(FWP2)

CAPACITY	81	AC FT
CATCHMENT	10	ACRES
SURFACE	6	ACRES

SLURRY POND(SP)

ELEV ft	AREA acres	CAPACITY acre ft
825	10	72
850	21	127
865	27	785

CATCHMENT AREA	51	ACRES		
INFILTRATION RATE	1.0E-02	CM/SEC OR	850	FT/MO
(" " AFTER YR1):	1.0E-03	CM/SEC OR	85	FT/MO

TAILINGS PARAMETERS

SLURRY DENSITY	23%			
SPECIFIC GRAVITY	2.6			
DEGREE SATURATION	75%			
DEPOSITED DENSITY	63	PCF		
VOIDS WATER RETAINED	45%	OR IN GPM=	16	
MINIMUM POND VOLUME	10	ACRE FT		

MILL/PROCESS PARAMETERS

TAILINGS PRODUCTION	210	TPD		
INITIAL ORE MOISTURE	4%			
SLURRY WATER	120	GPM+	55.7	GPM
MINIMUM FRESHWATER	4	GPM	COARSE WASH FLOW	
SP RECOVER & RECYCLE	0	GPM	0%	
			OF FREEWATER	

CLIMATE/HYDROLOGY PARAMETERS

MONTH	MEAN PPT in	MEAN EVAP in	MEAN RO* in	CK RO DIST %	CK RO** in
JAN	1.4	0.6	0.7	1%	0.1

SLURRY POND BALANCE

DATE YR/MO	INFLOWS SOLIDS/cum acre ft	INFLOWS FREEWATER gpm	INFLOWS PRECIP gpm	INFLOWS RUNOFF gpm	INITIAL STORAGE acre ft	INITIAL POND AREA acre	LOSSES SEEPAGE gpm	LOSSES EVAP gpm	POND RECLAIM gpm	RECOVER& RECYCLE gpm	NET STORAGE acre ft
1990/SEP					0	0					
OCT	0	0	0	37	5	1	-4,179	-1	0	0	0
NOV	0	0	1	25	3	0	-2,944	0	0	0	0
DEC	0	0	0	25	3	0	-2,933	0	0	0	0
1991/JAN	0	0	0	22	3	0	-2,566	0	0	0	0
FEB	0	0	0	17	2	0	-2,014	0	0	0	0
MAR	0	0	0	13	2	0	-1,462	0	0	0	0
APR	0	0	0	16	2	0	-1,825	0	0	0	0
MAY	0	0	0	18	2	0	-2,010	-1	0	0	0
JUN	0	0	0	35	5	1	-4,022	-1	0	0	0
JUL	0	0	1	55	8	1	-6,437	-2	0	0	0
AUG	0	0	2	58	8	1	-6,855	-2	0	0	0
SEP	0	0	2	58	8	1	-6,863	-1	0	0	0
OCT	5	104	2	36	19	3	-16,094	-2	0	0	0
NOV	9	104	3	24	17	2	-14,878	-1	0	0	0
DEC	14	104	2	24	17	2	-14,867	-1	0	0	0
1992/JAN	18	104	2	21	17	2	-1,449	-1	0	0	0
FEB	23	104	2	17	16	2	-1,392	-1	0	0	0
MAR	27	104	1	12	16	2	-1,334	-1	0	0	0
APR	32	104	1	15	16	2	-1,372	-1	0	0	0
MAY	37	104	1	17	16	2	-1,391	-5	0	0	0
JUN	41	104	3	34	19	2	-1,600	-5	0	0	0
JUL	46	104	5	53	22	3	-1,850	-6	0	0	0
AUG	50	104	7	56	22	3	-1,893	-5	0	0	0
SEP	55	104	7	56	22	3	-1,894	-3	0	0	0
OCT	60	104	4	35	19	3	-1,625	-2	0	0	0
NOV	64	104	3	24	17	2	-1,488	-1	0	0	0
DEC	69	104	2	24	17	2	-1,487	-1	0	0	0
1993/JAN	73	104	2	21	17	2	-1,449	-1	0	0	0
FEB	78	104	2	17	16	2	-1,392	-1	0	0	0
MAR	82	104	1	12	16	2	-1,334	-1	0	0	0
APR	87	104	1	15	16	2	-1,372	-1	0	0	0
MAY	92	104	1	17	16	2	-1,391	-5	0	0	0
JUN	96	104	3	34	19	2	-1,600	-5	0	0	0
JUL	101	104	5	53	22	3	-1,850	-6	0	0	0
AUG	105	104	7	56	22	3	-1,893	-5	0	0	0
SEP	110	104	7	56	22	3	-1,894	-3	0	0	0
OCT	115	104	4	35	19	3	-1,625	-2	0	0	0
NOV	119	104	3	24	17	2	-1,488	-1	0	0	0
DEC	124	104	2	24	17	2	-1,487	-1	0	0	0
1994/JAN	128	104	2	21	17	2	-1,449	-1	0	0	0
FEB	133	104	2	17	16	2	-1,392	-1	0	0	0
MAR	137	104	1	12	16	2	-1,334	-1	0	0	0
APR	142	104	1	15	16	2	-1,372	-1	0	0	0
MAY	147	104	1	17	16	2	-1,391	-5	0	0	0
JUN	151	104	3	34	19	2	-1,600	-5	0	0	0
JUL	156	104	5	53	22	3	-1,850	-6	0	0	0
AUG	160	104	7	56	22	3	-1,893	-5	0	0	0
SEP	165	104	7	56	22	3	-1,894	-3	0	0	0

FEB	1.1	0.6	0.6	1%	0.1
MAR	0.8	0.6	0.4	1%	0.1
APR	1.0	0.7	0.5	1%	0.1
MAY	1.1	3.8	0.6	8%	1.0
JUN	2.2	3.5	1.1	27%	3.2
JUL	3.5	3.4	1.8	22%	2.6
AUG	3.7	2.6	1.9	18%	2.2
SEP	3.7	1.6	1.9	12%	1.4
OCT	2.3	1.3	1.2	5%	0.6
NOV	1.6	0.7	0.8	2%	0.2
DEC	1.6	0.6	0.8	2%	0.2
ANNUAL	24.0	20.0	12.0		12.0

*MEAN RO=BASIN RUNOFF-PRECIPx 50%
**CK RO=CREEK FLOW-CK RO DISTx M.A.R.

BUFFALO CREEK DIVERSION
CATCHMENT AREA 446 ACRES

WET YR PPT 157%
DRY YR PPT 56%
DRY YR RO 0

OCT	170	104	4	35	19	3	-1,625	-2	0	0	0
NOV	174	104	3	24	17	2	-1,488	-1	0	0	0
DEC	179	104	2	24	17	2	-1,487	-1	0	0	0
1995/JAN	183	104	1	0	14	2	-1,196	-1	0	0	0
FEB	188	104	1	0	14	2	-1,191	-1	0	0	0
MAR	192	104	1	0	14	2	-1,189	-1	0	0	0
APR	197	104	1	0	14	2	-1,190	-1	0	0	0
MAY	202	104	1	0	14	2	-1,191	-4	0	0	0
JUN	206	104	1	0	14	2	-1,199	-4	0	0	0
JUL	211	104	2	0	14	2	-1,209	-4	0	0	0
AUG	215	104	2	0	14	2	-1,210	-3	0	0	0
SEP	220	104	2	0	14	2	-1,210	-2	0	0	0
OCT	225	104	2	0	14	2	-1,200	-2	0	0	0
NOV	229	104	1	0	14	2	-1,195	-1	0	0	0
DEC	234	104	1	0	14	2	-1,195	-1	0	0	0
1996/JAN	238	104	2	22	17	2	-1,446	-1	0	0	0
FEB	243	104	2	17	16	2	-1,391	-1	0	0	0
MAR	247	104	1	12	16	2	-1,334	-1	0	0	0
APR	252	104	1	15	16	2	-1,372	-1	0	0	0
MAY	257	104	1	17	16	2	-1,391	-5	0	0	0
JUN	261	104	3	34	19	2	-1,600	-5	0	0	0
JUL	266	104	5	53	22	3	-1,850	-6	0	0	0
AUG	270	104	7	56	22	3	-1,893	-5	0	0	0
SEP	275	104	7	56	22	3	-1,894	-3	0	0	0
OCT	280	104	4	35	19	3	-1,625	-2	0	0	0
NOV	284	104	3	24	17	2	-1,488	-1	0	0	0
DEC	289	104	2	24	17	2	-1,487	-1	0	0	0
1997/JAN	293	104	2	21	17	2	-1,449	-1	0	0	0
FEB	298	104	2	17	16	2	-1,392	-1	0	0	0
MAR	302	104	1	12	16	2	-1,334	-1	0	0	0
APR	307	104	1	15	16	2	-1,372	-1	0	0	0
MAY	312	104	1	17	16	2	-1,391	-5	0	0	0
JUN	316	104	3	34	19	2	-1,600	-5	0	0	0
JUL	321	104	5	53	22	3	-1,850	-6	0	0	0
AUG	325	104	7	56	22	3	-1,893	-5	0	0	0
SEP	330	104	7	56	22	3	-1,894	-3	0	0	0
OCT	335	104	4	35	19	3	-1,625	-2	0	0	0
NOV	339	104	3	24	17	2	-1,488	-1	0	0	0
DEC	344	104	2	24	17	2	-1,487	-1	0	0	0
1998/JAN	348	104	2	21	17	2	-1,449	-1	0	0	0
FEB	353	104	2	17	16	2	-1,392	-1	0	0	0
MAR	357	104	1	12	16	2	-1,334	-1	0	0	0
APR	362	104	1	15	16	2	-1,372	-1	0	0	0
MAY	367	104	1	17	16	2	-1,391	-5	0	0	0
JUN	371	104	3	34	19	2	-1,600	-5	0	0	0
JUL	376	104	5	53	22	3	-1,850	-6	0	0	0
AUG	380	104	7	56	22	3	-1,893	-5	0	0	0
SEP	385	104	7	56	22	3	-1,894	-3	0	0	0
OCT	390	104	4	35	19	3	-1,625	-2	0	0	0
NOV	394	104	3	24	17	2	-1,488	-1	0	0	0
DEC	399	104	2	24	17	2	-1,487	-1	0	0	0
1999/JAN	403	104	2	21	17	2	-1,449	-1	0	0	0

FEB	408	104	2	17	16	2	-1,392	-1	0	0	0
MAR	412	104	1	12	16	2	-1,334	-1	0	0	0
APR	417	104	1	15	16	2	-1,372	-1	0	0	0
MAY	422	104	1	17	16	2	-1,391	-5	0	0	0
JUN	426	104	3	34	19	2	-1,600	-5	0	0	0
JUL	431	104	5	53	22	3	-1,850	-6	0	0	0
AUG	435	104	7	56	22	3	-1,893	-5	0	0	0
SEP	440	104	7	56	22	3	-1,894	-3	0	0	0
OCT	445	104	4	35	19	3	-1,625	-2	0	0	0
NOV	449	104	3	24	17	2	-1,488	-1	0	0	0
DEC	454	104	2	24	17	2	-1,487	-1	0	0	0
2000/JAN	458	104	2	21	17	2	-1,449	-1	0	0	0
FEB	463	104	2	17	16	2	-1,392	-1	0	0	0
MAR	467	104	1	12	16	2	-1,334	-1	0	0	0
APR	472	104	1	15	16	2	-1,372	-1	0	0	0
MAY	477	104	1	17	16	2	-1,391	-5	0	0	0
JUN	481	104	3	34	19	2	-1,600	-5	0	0	0
JUL	486	104	5	53	22	3	-1,850	-6	0	0	0
AUG	490	104	7	56	22	3	-1,893	-5	0	0	0
SEP	495	104	7	56	22	3	-1,894	-3	0	0	0
OCT	500	104	4	35	19	3	-1,625	-2	0	0	0
NOV	504	104	3	24	17	2	-1,488	-1	0	0	0
DEC	509	104	2	24	17	2	-1,487	-1	0	0	0
2001/JAN	513	104	2	21	17	2	-1,449	-1	0	0	0
FEB	518	104	2	17	16	2	-1,392	-1	0	0	0
MAR	522	104	1	12	16	2	-1,334	-1	0	0	0
APR	527	104	1	15	16	2	-1,372	-1	0	0	0
MAY	532	104	1	17	16	2	-1,391	-5	0	0	0
JUN	536	104	3	34	19	2	-1,600	-5	0	0	0

AVAIL. FRESH WATER POND BALANCE

DATE	WATER FRM	******INFLOWS******			**********	**********	LOSSES	**********	**********	BUFF CR		WASH PLANT
YR/MO	BUFF CR	PRECIP	RUNOFF	EVAP	POTABLE	WASH CIRC	DUST SUPN	WASHDOWN		MAKEUP	STORAGE	DEFICIT
	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm		gpm	acre ft	gpm
1990/SEP												
OCT	168	11	2	-6	0	0	0	0		168	23	0
NOV	67	8	1	-3	0	0	0	0		67	33	0
DEC	67	9	1	-3	0	0	0	0		67	43	0
1991/JAN	34	7	3	-3	0	0	0	0		34	48	0
FEB	34	5	2	-3	0	0	0	0		34	53	0
MAR	34	4	2	-3	0	0	0	0		34	58	0
APR	34	5	2	-3	0	0	0	0		34	63	0
MAY	269	5	2	-19	0	0	0	0		269	97	0
JUN	908	11	4	-17	0	0	-42	0		105	105	0
JUL	740	17	7	-17	0	0	-42	0		34	105	0
AUG	605	18	8	-13	0	0	-42	0		29	105	0
SEP	404	18	8	-8	0	0	-42	0		24	105	0
OCT	168	11	5	-6	0	-176	-28	-1		168	102	0
NOV	67	8	3	-3	0	-176	0	-1		67	88	0
DEC	67	8	3	-3	0	-176	0	-1		67	75	0
1992/JAN	34	7	3	-3	0	-176	0	-1		34	57	0
FEB	34	5	2	-3	0	-176	0	-1		34	38	0
MAR	34	4	2	-3	0	-176	0	-1		34	20	0
APR	34	5	2	-3	0	-176	0	-1		34	1	0
MAY	269	5	2	-19	0	-176	0	-1		269	12	0
JUN	908	11	4	-17	0	-176	-42	-1		908	103	0
JUL	740	17	7	-17	0	-176	-42	-1		228	105	0
AUG	605	18	8	-13	0	-176	-42	-1		206	105	0
SEP	404	18	8	-8	0	-176	-42	-1		201	105	0
OCT	168	11	5	-6	0	-176	-28	-1		168	102	0
NOV	67	8	3	-3	0	-176	0	-1		67	88	0
DEC	67	8	3	-3	0	-176	0	-1		67	75	0
1993/JAN	34	7	3	-3	0	-176	0	-1		34	57	0
FEB	34	5	2	-3	0	-176	0	-1		34	38	0
MAR	34	4	2	-3	0	-176	0	-1		34	20	0
APR	34	5	2	-3	0	-176	0	-1		34	1	0
MAY	269	5	2	-19	0	-176	0	-1		269	12	0
JUN	908	11	4	-17	0	-176	-42	-1		908	103	0
JUL	740	17	7	-17	0	-176	-42	-1		228	105	0
AUG	605	18	8	-13	0	-176	-42	-1		206	105	0
SEP	404	18	8	-8	0	-176	-42	-1		201	105	0
OCT	168	11	5	-6	0	-176	-28	-1		168	102	0
NOV	67	8	3	-3	0	-176	0	-1		67	88	0
DEC	67	8	3	-3	0	-176	0	-1		67	75	0
1994/JAN	34	7	3	-3	0	-176	0	-1		34	57	0
FEB	34	5	2	-3	0	-176	0	-1		34	38	0
MAR	34	4	2	-3	0	-176	0	-1		34	20	0
APR	34	5	2	-3	0	-176	0	-1		34	1	0
MAY	269	5	2	-19	0	-176	0	-1		269	12	0
JUN	908	11	4	-17	0	-176	-42	-1		908	103	0
JUL	740	17	7	-17	0	-176	-42	-1		228	105	0
AUG	605	18	8	-13	0	-176	-42	-1		206	105	0
SEP	404	18	8	-8	0	-176	-42	-1		201	105	0

OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1995/JAN	19	4	0	-3	0	-176	0	-1	19	54	0
FEB	19	3	0	-3	0	-176	0	-1	19	33	0
MAR	19	2	0	-3	0	-176	0	-1	19	12	0
APR	19	3	0	-3	0	-176	0	-1	19	0	-62
MAY	150	3	0	-19	0	-176	0	-1	150	0	-4
JUN	505	6	0	-17	0	-176	-42	-1	505	36	0
JUL	411	10	0	-17	0	-176	-42	-1	411	61	0
AUG	337	10	0	-13	0	-176	-42	-1	337	76	0
SEP	224	10	0	-8	0	-176	-42	-1	224	77	0
OCT	94	6	0	-6	0	-176	-28	-1	94	63	0
NOV	37	4	0	-3	0	-176	0	-1	37	44	0
DEC	37	4	0	-3	0	-176	0	-1	37	26	0
1996/JAN	34	7	3	-3	0	-176	0	-1	34	8	0
FEB	34	5	2	-3	0	-176	0	-1	34	0	-73
MAR	34	4	2	-3	0	-176	0	-1	34	0	-134
APR	34	5	2	-3	0	-176	0	-1	34	0	-132
MAY	269	5	2	-19	0	-176	0	-1	269	11	0
JUN	908	11	4	-17	0	-176	-42	-1	908	102	0
JUL	740	17	7	-17	0	-176	-42	-1	236	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	401	15	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	5	3	-3	0	-176	0	-1	67	75	0
1997/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	15	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1998/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	15	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1999/JAN	34	7	3	-3	0	-176	0	-1	34	57	0

FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	5	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
2000/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	5	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
2001/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0

REVISED TABLE C.3
WISHBONE HILL PROJECT WATER BALANCE 06/06/90
1991-2001 PERIOD OF OPERATION
NORMAL OPERATING/WET YEAR IN 1995

OPERATING PARAMETERS

FRESH WATER POND NO. 1(FWP1)

ELEV	AREA	CAPACITY
ft	acres	acre ft
840	0	
850	1	2
868	2	24

CATCHMENT AREA	4	ACRES		
INFILTRATION RATE	1.0E-07	CM/SEC OR	0	FT/MO
INITIAL STORAGE	0	ACRE FT		
POTABLE REQUIREMENT	0.0	GPM		
DUST SUPPRESSION	42	GPM		
WASHDOWN RECYCLE	1	GPM		

FRESH WATER POND NO. 2(FWP2)

CAPACITY	81	AC FT
CATCHMENT	10	ACRES
SURFACE	6	ACRES

SLURRY POND(SP)

ELEV	AREA	CAPACITY
ft	acres	acre ft
825	10	72
850	21	427
865	27	785

CATCHMENT AREA	51	ACRES		
INFILTRATION RATE	1.0E-02	CM/SEC OR	850	FT/MO
(" " AFTER YR1)=	1.0E-03	CM/SEC OR	85	FT/MO

TAILINGS PARAMETERS				
SLURRY DENSITY	23%			
SPECIFIC GRAVITY	2.6			
DEGREE SATURATION	75%			
DEPOSITED DENSITY	63	PCF		
VOIDS WATER RETAINED	45%	OR IN GPM	16	
MINIMUM POND VOLUME	10	ACRE FT		
MILL/PROCESS PARAMETERS				
TAILINGS PRODUCTION	210	TPD		
INITIAL ORE MOISTURE	1%			
SLURRY WATER	120	GPM	55.7	GPM
MINIMUM FRESHWATER	4	GPM	COARSE WASH FLOW	
SP RECOVER & RECYCLE	0	GPM	0%	
			OF FREEWATER	

CLIMATE/HYDROLOGY PARAMETERS

MONTH	MEAN PPT	MEAN EVAP	MEAN RO*	CK RO DIST	CK RO**
	in	in	in	%	in
JAN	1.4	0.6	0.7	1%	0.1

SLURRY POND BALANCE

DATE YR/MO	INFLOWS SOLIDS/cum acre ft	INFLOWS FREEWATER gpm	INFLOWS PRECIP gpm	INFLOWS RUNOFF gpm	INITIAL STORAGE acre ft	INITIAL POND AREA acre	LOSSES SEEPAGE gpm	LOSSES EVAP gpm	POND RECLAIM gpm	RECOVER& RECYCLE gpm	NET STORAGE acre ft
1990/SEP					0	0					
OCT	0	0	0	37	5	1	-4,179	-1	0	0	0
NOV	0	0	1	25	3	0	-2,944	0	0	0	0
DEC	0	0	0	25	3	0	-2,933	0	0	0	0
1991/JAN	0	0	0	22	3	0	-2,566	0	0	0	0
FEB	0	0	0	17	2	0	-2,014	0	0	0	0
MAR	0	0	0	13	2	0	-1,462	0	0	0	0
APR	0	0	0	16	2	0	-1,825	0	0	0	0
MAY	0	0	0	18	2	0	-2,010	-1	0	0	0
JUN	0	0	0	35	5	1	-4,022	-1	0	0	0
JUL	0	0	1	55	8	1	-6,437	-2	0	0	0
AUG	0	0	2	58	8	1	-6,855	-2	0	0	0
SEP	0	0	2	58	8	1	-6,863	-1	0	0	0
OCT	5	104	2	36	19	3	-16,094	-2	0	0	0
NOV	9	104	3	24	17	2	-14,878	-1	0	0	0
DEC	14	104	2	24	17	2	-14,867	-1	0	0	0
1992/JAN	18	104	2	21	17	2	-1,449	-1	0	0	0
FEB	23	104	2	17	16	2	-1,392	-1	0	0	0
MAR	27	104	1	12	16	2	-1,334	-1	0	0	0
APR	32	104	1	15	16	2	-1,372	-1	0	0	0
MAY	37	104	1	17	16	2	-1,391	-5	0	0	0
JUN	41	104	3	34	19	2	-1,600	-5	0	0	0
JUL	46	104	5	53	22	3	-1,850	-6	0	0	0
AUG	50	104	7	56	22	3	-1,893	-5	0	0	0
SEP	55	104	7	56	22	3	-1,894	-3	0	0	0
OCT	60	104	4	35	19	3	-1,625	-2	0	0	0
NOV	64	104	3	24	17	2	-1,488	-1	0	0	0
DEC	69	104	2	24	17	2	-1,487	-1	0	0	0
1993/JAN	73	104	2	21	17	2	-1,449	-1	0	0	0
FEB	78	104	2	17	16	2	-1,392	-1	0	0	0
MAR	82	104	1	12	16	2	-1,334	-1	0	0	0
APR	87	104	1	15	16	2	-1,372	-1	0	0	0
MAY	92	104	1	17	16	2	-1,391	-5	0	0	0
JUN	96	104	3	34	19	2	-1,600	-5	0	0	0
JUL	101	104	5	53	22	3	-1,850	-6	0	0	0
AUG	105	104	7	56	22	3	-1,893	-5	0	0	0
SEP	110	104	7	56	22	3	-1,894	-3	0	0	0
OCT	115	104	4	35	19	3	-1,625	-2	0	0	0
NOV	119	104	3	24	17	2	-1,488	-1	0	0	0
DEC	124	104	2	24	17	2	-1,487	-1	0	0	0
1994/JAN	128	104	2	21	17	2	-1,449	-1	0	0	0
FEB	133	104	2	17	16	2	-1,392	-1	0	0	0
MAR	137	104	1	12	16	2	-1,334	-1	0	0	0
APR	142	104	1	15	16	2	-1,372	-1	0	0	0
MAY	147	104	1	17	16	2	-1,391	-5	0	0	0
JUN	151	104	3	34	19	2	-1,600	-5	0	0	0
JUL	156	104	5	53	22	3	-1,850	-6	0	0	0
AUG	160	104	7	56	22	3	-1,893	-5	0	0	0
SEP	165	104	7	56	22	3	-1,894	-3	0	0	0

FEB	1.1	0.6	0.6	1%	0.1
MAR	0.9	0.6	0.4	1%	0.1
APR	1.0	0.7	0.5	1%	0.1
MAY	1.1	3.8	0.6	8%	1.0
JUN	2.2	3.5	1.1	27%	3.2
JUL	3.5	3.4	1.8	22%	2.6
AUG	3.7	2.6	1.9	18%	2.2
SEP	3.7	1.6	1.9	12%	1.4
OCT	2.3	1.3	1.2	5%	0.6
NOV	1.6	0.7	0.8	2%	0.2
DEC	1.6	0.6	0.8	2%	0.2
ANNUAL	21.0	20.0	12.0		12.0

*MEAN RO=BASIN RUNOFF=PRECIPx 50%
**CK RO=CREEK FLOW-CK RO DISTx M.A.R.

BUFFALO CREEK DIVERSION
CATCHMENT AREA 446 ACRES

WET YR PPT 157%
DRY YR PPT 56%
DRY YR RO 0

OCT	170	104	4	35	19	3	-1,625	-2	0	0	0
NOV	174	104	3	24	17	2	-1,488	-1	0	0	0
DEC	179	104	2	24	17	2	-1,487	-1	0	0	0
1995/JAN	183	104	3	34	19	2	-1,600	-1	0	0	0
FEB	188	104	3	28	18	2	-1,527	-1	0	0	0
MAR	192	104	2	19	17	2	-1,421	-1	0	0	0
APR	197	104	2	24	17	2	-1,479	-1	0	0	0
MAY	202	104	3	26	18	2	-1,511	-6	0	0	0
JUN	206	104	5	53	22	3	-1,840	-6	0	0	0
JUL	211	104	10	84	26	4	-2,247	-7	0	0	0
AUG	215	104	13	88	27	4	-2,323	-6	0	0	0
SEP	220	104	13	87	27	4	-2,315	-4	0	0	0
OCT	225	104	8	54	22	3	-1,885	-2	0	0	0
NOV	229	104	5	37	19	3	-1,659	-1	0	0	0
DEC	234	104	4	38	19	3	-1,659	-1	0	0	0
1996/JAN	238	104	2	21	17	2	-1,450	-1	0	0	0
FEB	243	104	2	17	16	2	-1,392	-1	0	0	0
MAR	247	104	1	12	16	2	-1,334	-1	0	0	0
APR	252	104	1	15	16	2	-1,372	-1	0	0	0
MAY	257	104	1	17	16	2	-1,391	-5	0	0	0
JUN	261	104	3	34	19	2	-1,600	-5	0	0	0
JUL	266	104	5	53	22	3	-1,850	-6	0	0	0
AUG	270	104	7	56	22	3	-1,893	-5	0	0	0
SEP	275	104	7	56	22	3	-1,894	-3	0	0	0
OCT	280	104	4	35	19	3	-1,625	-2	0	0	0
NOV	284	104	3	24	17	2	-1,488	-1	0	0	0
DEC	289	104	2	24	17	2	-1,487	-1	0	0	0
1997/JAN	293	104	2	21	17	2	-1,449	-1	0	0	0
FEB	298	104	2	17	16	2	-1,392	-1	0	0	0
MAR	302	104	1	12	16	2	-1,334	-1	0	0	0
APR	307	104	1	15	16	2	-1,372	-1	0	0	0
MAY	312	104	1	17	16	2	-1,391	-5	0	0	0
JUN	316	104	3	34	19	2	-1,600	-5	0	0	0
JUL	321	104	5	53	22	3	-1,850	-6	0	0	0
AUG	325	104	7	56	22	3	-1,893	-5	0	0	0
SEP	330	104	7	56	22	3	-1,894	-3	0	0	0
OCT	335	104	4	35	19	3	-1,625	-2	0	0	0
NOV	339	104	3	24	17	2	-1,488	-1	0	0	0
DEC	344	104	2	24	17	2	-1,487	-1	0	0	0
1998/JAN	348	104	2	21	17	2	-1,449	-1	0	0	0
FEB	353	104	2	17	16	2	-1,392	-1	0	0	0
MAR	357	104	1	12	16	2	-1,334	-1	0	0	0
APR	362	104	1	15	16	2	-1,372	-1	0	0	0
MAY	367	104	1	17	16	2	-1,391	-5	0	0	0
JUN	371	104	3	34	19	2	-1,600	-5	0	0	0
JUL	376	104	5	53	22	3	-1,850	-6	0	0	0
AUG	380	104	7	56	22	3	-1,893	-5	0	0	0
SEP	385	104	7	56	22	3	-1,894	-3	0	0	0
OCT	390	104	4	35	19	3	-1,625	-2	0	0	0
NOV	394	104	3	24	17	2	-1,488	-1	0	0	0
DEC	399	104	2	24	17	2	-1,487	-1	0	0	0
1999/JAN	403	104	2	21	17	2	-1,449	-1	0	0	0

FEB	408	104	2	17	16	2	-1,392	-1	0	0	0
MAR	412	104	1	12	16	2	-1,334	-1	0	0	0
APR	417	104	1	15	16	2	-1,372	-1	0	0	0
MAY	422	104	1	17	16	2	-1,391	-5	0	0	0
JUN	426	104	3	34	19	2	-1,600	-5	0	0	0
JUL	431	104	5	53	22	3	-1,850	-6	0	0	0
AUG	435	104	7	56	22	3	-1,893	-5	0	0	0
SEP	440	104	7	56	22	3	-1,894	-3	0	0	0
OCT	445	104	4	35	19	3	-1,625	-2	0	0	0
NOV	449	104	3	24	17	2	-1,488	-1	0	0	0
DEC	454	104	2	24	17	2	-1,487	-1	0	0	0
2000/JAN	458	104	2	21	17	2	-1,449	-1	0	0	0
FEB	463	104	2	17	16	2	-1,392	-1	0	0	0
MAR	467	104	1	12	16	2	-1,334	-1	0	0	0
APR	472	104	1	15	16	2	-1,372	-1	0	0	0
MAY	477	104	1	17	16	2	-1,391	-5	0	0	0
JUN	481	104	3	34	19	2	-1,600	-5	0	0	0
JUL	486	104	5	53	22	3	-1,850	-6	0	0	0
AUG	490	104	7	56	22	3	-1,893	-5	0	0	0
SEP	495	104	7	56	22	3	-1,894	-3	0	0	0
OCT	500	104	4	35	19	3	-1,625	-2	0	0	0
NOV	504	104	3	24	17	2	-1,488	-1	0	0	0
DEC	509	104	2	24	17	2	-1,487	-1	0	0	0
2001/JAN	513	104	2	21	17	2	-1,449	-1	0	0	0
FEB	518	104	2	17	16	2	-1,392	-1	0	0	0
MAR	522	104	1	12	16	2	-1,334	-1	0	0	0
APR	527	104	1	15	16	2	-1,372	-1	0	0	0
MAY	532	104	1	17	16	2	-1,391	-5	0	0	0
JUN	536	104	3	34	19	2	-1,600	-5	0	0	0

AVAIL. FRESH WATER POND BALANCE

DATE YR/MO	WATER FRM BUFF CR	******INFLOWS****** PRECIP	RUNOFF	EVAP	POTABLE	**********	**********	LOSSES	**********	BUFF CR MAKEUP	STORAGE	WASH PLANT DEFICIT
						WASH CIRC	DUST SUPN	WASHDOWN				
	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm		gpm	acre ft	gpm
1990/SEP												
OCT	168	11	2	-6	0	0	0	0		168	23	0
NOV	67	8	1	-3	0	0	0	0		67	33	0
DEC	67	5	1	-3	0	0	0	0		67	43	0
1991/JAN	34	7	3	-3	0	0	0	0		34	48	0
FEB	34	5	2	-3	0	0	0	0		34	53	0
MAR	34	4	2	-3	0	0	0	0		34	58	0
APR	34	5	2	-3	0	0	0	0		34	63	0
MAY	269	5	2	-19	0	0	0	0		269	97	0
JUN	909	11	4	-17	0	0	-42	0		105	105	0
JUL	740	17	7	-17	0	0	-42	0		34	105	0
AUG	605	18	5	-13	0	0	-42	0		29	105	0
SEP	404	18	8	-8	0	0	-42	0		24	105	0
OCT	168	11	5	-6	0	-176	-28	-1		168	102	0
NOV	67	8	3	-3	0	-176	0	-1		67	88	0
DEC	67	8	3	-3	0	-176	0	-1		67	75	0
1992/JAN	34	7	3	-3	0	-176	0	-1		34	57	0
FEB	34	5	2	-3	0	-176	0	-1		34	38	0
MAR	34	4	2	-3	0	-176	0	-1		34	20	0
APR	34	5	2	-3	0	-176	0	-1		34	1	0
MAY	269	5	2	-19	0	-176	0	-1		269	12	0
JUN	908	11	4	-17	0	-176	-42	-1		908	103	0
JUL	740	17	7	-17	0	-176	-42	-1		228	105	0
AUG	605	18	8	-13	0	-176	-42	-1		206	105	0
SEP	404	18	8	-8	0	-176	-42	-1		201	105	0
OCT	168	11	5	-6	0	-176	-28	-1		168	102	0
NOV	67	8	3	-3	0	-176	0	-1		67	86	0
DEC	67	8	3	-3	0	-176	0	-1		67	75	0
1993/JAN	34	7	3	-3	0	-176	0	-1		34	57	0
FEB	34	5	2	-3	0	-176	0	-1		34	38	0
MAR	34	4	2	-3	0	-176	0	-1		34	20	0
APR	34	5	2	-3	0	-176	0	-1		34	1	0
MAY	269	5	2	-19	0	-176	0	-1		269	12	0
JUN	908	11	4	-17	0	-176	-42	-1		908	103	0
JUL	740	17	7	-17	0	-176	-42	-1		228	105	0
AUG	605	18	8	-13	0	-176	-42	-1		206	105	0
SEP	404	18	8	-8	0	-176	-42	-1		201	105	0
OCT	168	11	5	-6	0	-176	-28	-1		168	102	0
NOV	67	8	3	-3	0	-176	0	-1		67	88	0
DEC	67	8	3	-3	0	-176	0	-1		67	75	0
1994/JAN	34	7	3	-3	0	-176	0	-1		34	57	0
FEB	34	5	2	-3	0	-176	0	-1		34	38	0
MAR	34	4	2	-3	0	-176	0	-1		34	20	0
APR	34	5	2	-3	0	-176	0	-1		34	1	0
MAY	269	5	2	-19	0	-176	0	-1		269	12	0
JUN	908	11	4	-17	0	-176	-42	-1		908	103	0
JUL	740	17	7	-17	0	-176	-42	-1		228	105	0
AUG	605	18	8	-13	0	-176	-42	-1		206	105	0
SEP	404	18	5	-8	0	-176	-42	-1		201	105	0

OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1995/JAN	53	11	4	-3	0	-176	0	-1	53	60	0
FEB	53	9	4	-3	0	-176	0	-1	53	45	0
MAR	53	6	3	-3	0	-176	0	-1	53	29	0
APR	53	8	3	-3	0	-176	0	-1	53	13	0
MAY	422	9	4	-19	0	-176	0	-1	422	45	0
JUN	1,425	17	7	-17	0	-176	-42	-1	665	105	0
JUL	1,161	27	11	-17	0	-176	-42	-1	197	105	0
AUG	950	29	12	-13	0	-176	-42	-1	191	105	0
SEP	633	29	12	-8	0	-176	-42	-1	186	105	0
OCT	264	18	7	-6	0	-176	-28	-1	186	105	0
NOV	106	12	5	-3	0	-176	0	-1	106	98	0
DEC	106	12	5	-3	0	-176	0	-1	106	90	0
1996/JAN	34	7	3	-3	0	-176	0	-1	34	72	0
FEB	34	5	2	-3	0	-176	0	-1	34	54	0
MAR	34	4	2	-3	0	-176	0	-1	34	35	0
APR	34	5	2	-3	0	-176	0	-1	34	16	0
MAY	269	5	2	-19	0	-176	0	-1	269	27	0
JUN	908	11	4	-17	0	-176	-42	-1	509	105	0
JUL	740	17	7	-17	0	-176	-42	-1	211	105	0
AUG	605	15	5	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1997/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	15	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1998/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	19	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
1999/JAN	34	7	3	-3	0	-176	0	-1	34	57	0

FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
2000/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0
JUL	740	17	7	-17	0	-176	-42	-1	228	105	0
AUG	605	18	8	-13	0	-176	-42	-1	206	105	0
SEP	404	18	8	-8	0	-176	-42	-1	201	105	0
OCT	168	11	5	-6	0	-176	-28	-1	168	102	0
NOV	67	8	3	-3	0	-176	0	-1	67	88	0
DEC	67	8	3	-3	0	-176	0	-1	67	75	0
2001/JAN	34	7	3	-3	0	-176	0	-1	34	57	0
FEB	34	5	2	-3	0	-176	0	-1	34	38	0
MAR	34	4	2	-3	0	-176	0	-1	34	20	0
APR	34	5	2	-3	0	-176	0	-1	34	1	0
MAY	269	5	2	-19	0	-176	0	-1	269	12	0
JUN	908	11	4	-17	0	-176	-42	-1	908	103	0

APPENDIX C.2

SEDIMENT POND MASS BALANCE SUMMARY

WISHBONE HILL MINE PROJECT 07/31/89
SEDIMENT POND MASS BALANCE SUMMARY 17202

SEDIMENT POND 1

CATCHMENT AREA	114	ACRES
POND SURFACE AREA	8	ACRES
POND STORAGE CAPACITY	46	ACRE FT
MEAN ANNUAL PRECIP	24	IN
MEAN ANNUAL RUNOFF	12	IN
MEAN ANNUAL SEDIMENT	15	ACRE FT
100YR STORM SEDIMENT	22	ACRE FT
100YR STORM RUNOFF	10	ACRE FT
POND INFILTRATION	1.E-04	CM/SEC
	103	FT/YR

YR	POND SED STORAGE ACRE FT	POND WATER STORAGEi ACRE FT	SEEPAGE ACRE FT	POND WATER STORAGEf ACRE FT	WATER+SED STORAGEf ACRE FT	STORAGEf+ 100YR STORM ACRE FT	SEDIMENT REMOVAL ACRE FT
1991	15	12	816	0	15	46	15
1992	15	12	816	0	15	46	15
1993	15	12	816	0	15	46	15
1994	15	12	816	0	15	46	15
1995	15	12	816	0	15	46	15
1996	15	12	816	0	15	46	15
1997	15	12	816	0	15	46	15
1998	15	12	816	0	15	46	15
1999	15	12	816	0	15	46	15
2000	15	12	816	0	15	46	15
2001	15	12	816	0	15	46	15

WISHBONE HILL MINE PROJECT 07/31/89
SEDIMENT POND MASS BALANCE SUMMARY 17202

SEDIMENT POND 2

CATCHMENT AREA	175	ACRES
POND SURFACE AREA	7	ACRES
POND STORAGE CAPACITY	31	ACRE FT
MEAN ANNUAL PRECIP	24	IN
MEAN ANNUAL RUNOFF	12	IN
MEAN ANNUAL SEDIMENT	10	ACRE FT
100YR STORM SEDIMENT	5	ACRE FT
100YR STORM RUNOFF	16	ACRE FT
POND INFILTRATION	1.E-04	CM/SEC
	103	FT/YR

YR	POND SED STORAGE ACRE FT	POND WATER STORAGEi ACRE FT	SEEPAGE ACRE FT	POND WATER STORAGEf ACRE FT	WATER+SED STORAGEf ACRE FT	STORAGEf+ 100YR STORM ACRE FT	SEDIMENT REMOVAL ACRE FT
1991	10	12	679	0	10	31	10
1992	10	12	679	0	10	31	10
1993	10	12	679	0	10	31	10
1994	10	12	679	0	10	31	10
1995	10	12	679	0	10	31	10
1996	10	12	679	0	10	31	10
1997	10	12	679	0	10	31	10
1998	10	12	679	0	10	31	10
1999	10	12	679	0	10	31	10
2000	10	12	679	0	10	31	10
2001	10	12	679	0	10	31	10

WISHBONE HILL MINE PROJECT 07/31/89
SEDIMENT POND MASS BALANCE SUMMARY 17202

SEDIMENT POND 3

CATCHMENT AREA	13	ACRES
POND SURFACE AREA	1	ACRES
POND STORAGE CAPACITY	4	ACRE FT
MEAN ANNUAL PRECIP	24	IN
MEAN ANNUAL RUNOFF	12	IN
MEAN ANNUAL SEDIMENT	2	ACRE FT
100YR STORM SEDIMENT	2	ACRE FT
100YR STORM RUNOFF	1	ACRE FT
POND INFILTRATION	1.E-04	CM/SEC
	103	FT/YR

YR	POND SED STORAGE ACRE FT	POND WATER STORAGEi ACRE FT	SEEPAGE ACRE FT	POND WATER STORAGEf ACRE FT	WATER+SED STORAGEf ACRE FT	STORAGEf+ 100YR STORM ACRE FT	SEDIMENT REMOVAL ACRE FT
1991	2	12	62	0	2	4	2
1992	2	12	62	0	2	4	2
1993	2	12	62	0	2	4	2
1994	2	12	62	0	2	4	2
1995	2	12	62	0	2	4	2
1996	2	12	62	0	2	4	2
1997	2	12	62	0	2	4	2
1998	2	12	62	0	2	4	2
1999	2	12	62	0	2	4	2
2000	2	12	62	0	2	4	2
2001	2	12	62	0	2	4	2

WISHBONE HILL MINE PROJECT 07/31/89
SEDIMENT POND MASS BALANCE SUMMARY 17202

SEDIMENT POND 4

CATCHMENT AREA	5	ACRES
POND SURFACE AREA	0.2	ACRES
POND STORAGE CAPACITY	0.42	ACRE FT
MEAN ANNUAL PRECIP	24	IN
MEAN ANNUAL RUNOFF	12	IN
MEAN ANNUAL SEDIMENT	0.02	ACRE FT
100YR STORM SEDIMENT	0.00	ACRE FT
100YR STORM RUNOFF	0.4	ACRE FT
POND INFILTRATION	1.E-04	CM/SEC
	103	FT/YR

YR	POND SED STORAGE ACRE FT	POND WATER STORAGEi ACRE FT	SEEPAGE ACRE FT	POND WATER STORAGEf ACRE FT	WATER+SED STORAGEf ACRE FT	STORAGEf+ 100YR STORM ACRE FT	SEDIMENT REMOVAL ACRE FT
1991	0.02	12	19	0	0.02	0.42	0.02
1992	0.02	12	19	0	0.02	0.42	0.02
1993	0.02	12	19	0	0.02	0.42	0.02
1994	0.02	12	19	0	0.02	0.42	0.02
1995	0.02	12	19	0	0.02	0.42	0.02
1996	0.02	12	19	0	0.02	0.42	0.02
1997	0.02	12	19	0	0.02	0.42	0.02
1998	0.02	12	19	0	0.02	0.42	0.02
1999	0.02	12	19	0	0.02	0.42	0.02
2000	0.02	12	19	0	0.02	0.42	0.02
2001	0.02	12	19	0	0.02	0.42	0.02

WISHBONE HILL MINE PROJECT 07/31/89
SEDIMENT POND MASS BALANCE SUMMARY 17202

SEDIMENT POND 5

CATCHMENT AREA	105	ACRES
POND SURFACE AREA	1.6	ACRES
POND STORAGE CAPACITY	12.7	ACRE FT
MEAN ANNUAL PRECIP	24	IN
MEAN ANNUAL RUNOFF	12	IN
MEAN ANNUAL SEDIMENT	1.6	ACRE FT
100YR STORM SEDIMENT	1.8	ACRE FT
100YR STORM RUNOFF	9.3	ACRE FT
POND INFILTRATION	1.E-04	CM/SEC
	103	FT/YR

YR	POND SED STORAGE ACRE FT	POND WATER STORAGEi ACRE FT	SEEPAGE ACRE FT	POND WATER STORAGEf ACRE FT	WATER+SED STORAGEf ACRE FT	STORAGEf+ 100YR STORM ACRE FT	SEDIMENT REMOVAL ACRE FT
1991	1.6	12	165	0	1.6	12.7	1.6
1992	1.6	12	165	0	1.6	12.7	1.6
1993	1.6	12	165	0	1.6	12.7	1.6
1994	1.6	12	165	0	1.6	12.7	1.6
1995	1.6	12	165	0	1.6	12.7	1.6
1996	1.6	12	165	0	1.6	12.7	1.6
1997	1.6	12	165	0	1.6	12.7	1.6
1998	1.6	12	165	0	1.6	12.7	1.6
1999	1.6	12	165	0	1.6	12.7	1.6
2000	1.6	12	165	0	1.6	12.7	1.6
2001	1.6	12	165	0	1.6	12.7	1.6

WISHBONE HILL MINE PROJECT 07/31/89
SEDIMENT POND MASS BALANCE SUMMARY 17202

SEDIMENT POND 6

CATCHMENT AREA	6	ACRES
POND SURFACE AREA	1.1	ACRES
POND STORAGE CAPACITY	4.6	ACRE FT
MEAN ANNUAL PRECIP	24	IN
MEAN ANNUAL RUNOFF	12	IN
MEAN ANNUAL SEDIMENT	0.8	ACRE FT
100YR STORM SEDIMENT	3.3	ACRE FT
100YR STORM RUNOFF	0.5	ACRE FT
POND INFILTRATION	1.E-04	CM/SEC
	103	FT/YR

YR	POND SED STORAGE ACRE FT	POND WATER STORAGEi ACRE FT	SEEPAGE ACRE FT	POND WATER STORAGEf ACRE FT	WATER+SED STORAGEf ACRE FT	STORAGEf+ 100YR STORM ACRE FT	SEDIMENT REMOVAL ACRE FT
1991	0.8	12	119	0	0.8	4.6	0.8
1992	0.8	12	119	0	0.8	4.6	0.8
1993	0.8	12	119	0	0.8	4.6	0.8
1994	0.8	12	119	0	0.8	4.6	0.8
1995	0.8	12	119	0	0.8	4.6	0.8
1996	0.8	12	119	0	0.8	4.6	0.8
1997	0.8	12	119	0	0.8	4.6	0.8
1998	0.8	12	119	0	0.8	4.6	0.8
1999	0.8	12	119	0	0.8	4.6	0.8
2000	0.8	12	119	0	0.8	4.6	0.8
2001	0.8	12	119	0	0.8	4.6	0.8

WISHBONE HILL MINE PROJECT 07/31/89
SEDIMENT POND MASS BALANCE SUMMARY 17202

SEDIMENT POND 7

CATCHMENT AREA	0.75	ACRES
POND SURFACE AREA	0.47	ACRES
POND STORAGE CAPACITY	0.57	ACRE FT
MEAN ANNUAL PRECIP	24.00	IN
MEAN ANNUAL RUNOFF	12.00	IN
MEAN ANNUAL SEDIMENT	0.10	ACRE FT
100YR STORM SEDIMENT	0.40	ACRE FT
100YR STORM RUNOFF	0.07	ACRE FT
POND INFILTRATION	1.E-04	CM/SEC
	103	FT/YR

YR	POND SED STORAGE ACRE FT	POND WATER STORAGEi ACRE FT	SEEPAGE ACRE FT	POND WATER STORAGEf ACRE FT	WATER+SED STORAGEf ACRE FT	STORAGEf+ 100YR STORM ACRE FT	SEDIMENT REMOVAL ACRE FT
1991	0.10	12.00	48.60	0.00	0.10	0.57	0.10
1992	0.10	12.00	48.60	0.00	0.10	0.57	0.10
1993	0.10	12.00	48.60	0.00	0.10	0.57	0.10
1994	0.10	12.00	48.60	0.00	0.10	0.57	0.10
1995	0.10	12.00	48.60	0.00	0.10	0.57	0.10
1996	0.10	12.00	48.60	0.00	0.10	0.57	0.10
1997	0.10	12.00	48.60	0.00	0.10	0.57	0.10
1998	0.10	12.00	48.60	0.00	0.10	0.57	0.10
1999	0.10	12.00	48.60	0.00	0.10	0.57	0.10
2000	0.10	12.00	48.60	0.00	0.10	0.57	0.10
2001	0.10	12.00	48.60	0.00	0.10	0.57	0.10

APPENDIX D
SEDIMENT POND DESIGN CALCULATIONS

APPENDIX D – SEDIMENT POND DESIGN CALCULATIONS

This Appendix contains the calculations used for designing the proposed sediment ponds for the life of the project. Materials included in this Appendix are:

- SEDCAD summary printouts;
- Average annual sediment generation calculations;
- Watershed data including areas, slopes, distances, etc.;
- Pond emergency overflow channel sizing calculations; and
- Sediment control ditch sizing calculations.

Table D.1-1 provides a summary of the 100-yr storm runoff and sediment load and average annual sediment yield for each proposed sediment pond.

SEDCAD, which was largely developed at the Agricultural Engineering Department of the University of Kentucky, is a widely accepted standard for sediment pond design for coal mines. Updates to SEDCAD program have been made and 2010 build of the SEDCAD4 model was used for the permit update. SEDCAD4 is a licensed product of Civil Software Design of Lexington, Kentucky.

Input parameters for SEDCAD include catchment areas, lengths and slopes, SCS curve number, storm type and storm precipitation, soil characteristics including grain size distribution, specific gravity, soil erodibility factor and control practice factor, and Muskingum routing parameters. The program calculates various runoff and sediment load information including runoff volume, peak discharge, and sediment yield.

Average annual sediment calculations were done using the Universal Soil Loss Equations (Barfield et al, 1981).

Emergency overflow channel design calculations are based on the broad-crested weir formula.

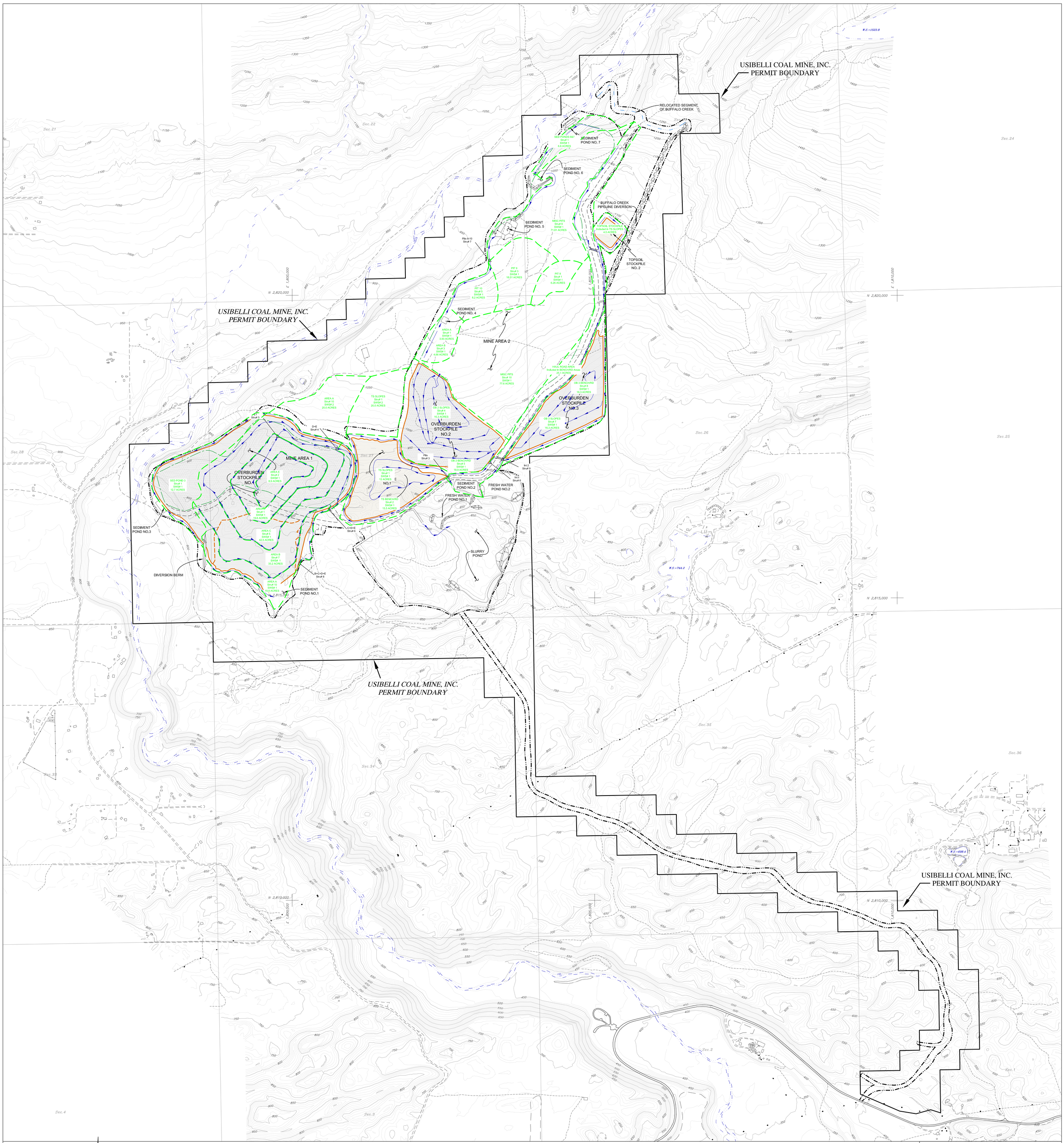
Sediment control ditch sizing utilizes the Bentley FLOWMASTER program assuming Manning's equation to calculate flow depth.

All flood runoff calculations are based on hydrologic condition AMC II (USBR Design of Small Dams).

The predominant soil types throughout the project area are alluvial sands and gravels, and glacial tills. Based on field observation and laboratory testing, a USCS classification of SP to GW is common for the in-situ materials which are anticipated to be exposed in the disturbed (stripped) project areas. As such, the general classification for the site soils would be Group A – high infiltration/low runoff potential. These soils would be classified as poor in terms of hydrologic condition for infiltration, and thus merit a runoff curve number of 68 for pasture or rangeland use. For simplicity, a conservative curve number of 70 has been assumed throughout the disturbed project area. An updated CP factor was used for permit renewal. Based on the Guidelines for the Use of the Revised Soil Loss Equation(RUSLE) on Mined Lands, Construction Sites and Reclaimed Lands, a CP of 0.95 was used for fill areas(i.e., stockpiles) and 0.45 was used for cut areas(i.e., pits).

Attached is a working map which delineates the catchment areas for each of the sediment ponds for the sediment and runoff calculations contained in this Appendix.

SEDCAD was used to analyze peak flow and sedimentation. The design features of the program were not utilized on this project. As a result, structural component entries are identified as “null” in the program output. For clarification, the watersheds and sub-watersheds identifiers within the program are label with corresponding identifiers on drainage area map. (For example: Wishbone Hill Pond 1 is SED Pond 1) “NULL” structures were selected in SEDCAD because the design of the sediment ponds was done outside of the program. Structures within SEDCAD do not always refer to a drainage feature, and in this case were used to identify sub-watersheds.



LEGEND

- PERMIT BOUNDARY
- DISTURBANCE BOUNDARY
- LIMITS OF MINING
- STOCKPILE LIMITS
- FACILITIES AREAS
- ROADS - UNPAVED
- ROADS - PAVED
- DIVERSION DITCHES
- PIPELINE
- SECTIONS LINES
- EXISTING CONTOURS
- MINE ROADWAYS
- TRAIL
- BUFFALO CREEK RELOCATION
- WATERSHED
- FENCE
- TOPSOIL STOCKPILES
- OVERBURDEN STOCKPILES
- OVERBURDEN STOCKPILES CONSTRUCTED ON BACKILLED PIT AREAS

SCALE
0 500' 1000'
CONTOUR INTERVAL: 10FT.

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

5/6/2014
Date

Thomas E. Leidich, AK EM 12365

STATE OF ALASKA 49th THOMAS E. LEIDICH EM 12365 REGISTERED PROFESSIONAL ENGINEER

NOTES:
1. HORIZONTAL DATUM IS ALASKA STATE PLANE, NAD83.
2. VERTICAL DATUM IS NAVD 88.
3. MAPPED FOR 1" = 200 FEET, 10 FOOT CONTOUR INTERVAL.
4. DATE OF PHOTOGRAPHY: 10–12–1997
5. THIS MAP CONFORMS TO ASPRS CLASS I MAP STANDARDS.
6. THE VERTICAL ACCURACY IS APPROXIMATELY ONE HALF OF THE CONTOUR INTERVAL SHOWN IN ANY GIVEN AREA ON THE MAP. CONTOURS IN VEGETATED AREAS MAY BE LESS ACCURATE. CONTOURS IN DENSE VEGETATION ARE LIKELY TO BE LESS ACCURATE.
7. THIS MAP WAS PREPARED TO CLARIFY THE WATERSHEDS USED IN THE SEDCAD RUNS

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	1/14	BAC	SEDCAD WATERSHED CLARAFICATION

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN:

WISHBONE HILL MINE

USIBELLI COAL MINE, INC. UCM

PERMIT NUMBER 01–89–796

MINE AREA 1 & 2
SEDCAD WATERSHEDS

WISHBONE HILL MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683–2226

PLATE No. X–X
SHEET No. 1 OF 1
REV. 0

APPENDIX D.1
SEDCAD PRINTOUTS

TABLE D.1-1
SEDIMENT POND DESIGN SUMMARY

	VOLUMES IN ACRE-FT			
	100-YR STORM			
SEDIMENT POND NUMBER	**SEDIMENT LOAD**	**WATER**	**AVERAGE ANNUAL SEDIMENT YIELD**	**TOTAL**
1	4.69	14.31	14.5	33.5
2	2.28	18.04	10	30.32
3	0.36	1.28	1.6	3.24
4	0.005	0.37	0.02	0.4
5	0.89	10.26	1.6	12.78
6	0.47	0.63	0.8	1.89
7	0.04	0.05	0.1	0.19

Notes:

1. Assumes soil density of 65 pcf.
2. Ponds 6 and 7 were sized based on an area ratio.

TABLE D.1-2
100-YR FLOOD PEAKS FOR SEDIMENT AND FRESHWATER PONDS

POND NO.	100-YR PEAK FLOW* (CFS)
1	30.53
2	87.58
3	6.09
4	1.66
5	43.75
6	3.97
7	3.97
Fresh Water Pond No. 1	43
Fresh Water Pond No. 2	8

* Assume No attenuation at pond.

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Wishbone Hill Pond 1

This model is designed to replicate model results from the 1990 permit for Wishbone Hill. This model will be used as a check and for updating of the permit.

The model files from the permit are not available so they must be re-created.

Brandon A Coleman

General Information

Storm Information:

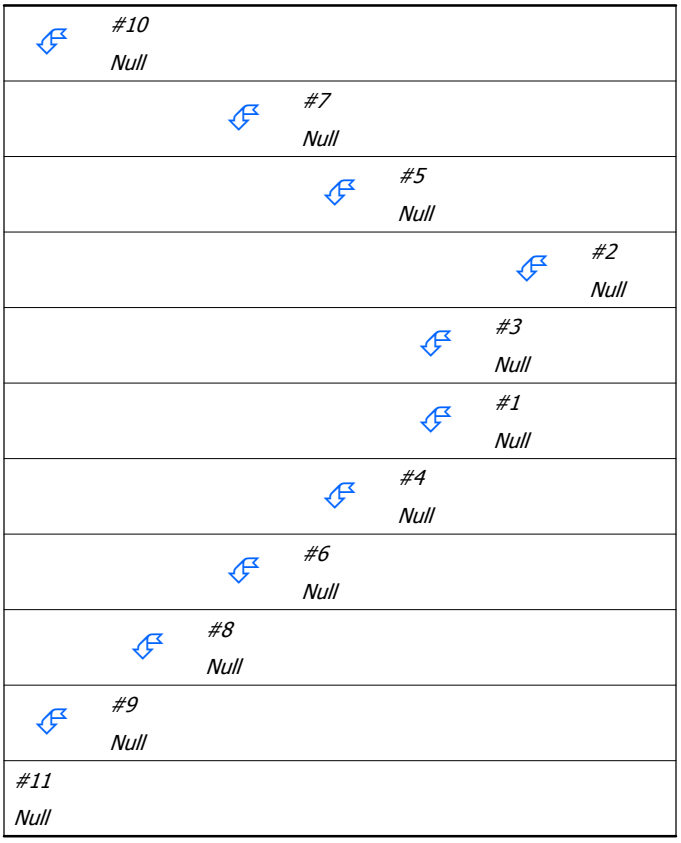
Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Particle Size Distribution:

Size (mm)	Wishbone Hill
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#4	0.089	0.333	D
Null	#2	==>	#3	0.078	0.333	E
Null	#3	==>	#4	0.089	0.333	E1
Null	#4	==>	#6	0.080	0.333	D+E
Null	#5	==>	#6	0.080	0.333	C
Null	#6	==>	#8	0.008	0.333	C+D+E
Null	#7	==>	#8	0.008	0.333	B
Null	#8	==>	#9	0.372	0.185	B+C+D+E
Null	#9	==>	#11	0.000	0.000	SED Pond 1
Null	#10	==>	#11	0.000	0.000	A
Null	#11	==>	End	0.000	0.000	END



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#10	39.800	39.800	15.18	3.94	1,532.4	437,181	298.96	172.96
#7	33.200	33.200	7.89	3.30	1,674.3	469,969	305.48	208.41
#5	42.500	42.500	10.23	4.23	2,274.0	494,365	321.81	219.48
#2	8.900	8.900	3.83	0.88	7.3	11,816	8.17	4.20
#3	0.000	8.900	3.76	0.88	7.3	11,899	8.23	4.20
#1	19.600	19.600	5.95	1.95	1,144.8	566,163	378.48	242.21
#4	0.000	28.500	8.68	2.83	1,152.1	446,423	298.50	176.60
#6	0.000	71.000	17.53	7.06	3,426.1	473,055	310.74	202.68
#8	0.000	104.200	25.35	10.36	5,100.4	472,891	309.56	204.51
#9	0.000	104.200	25.02	10.36	5,100.4	473,557	310.00	204.50
#11	0.000	144.000	30.53	14.31	6,632.8	442,037	292.32	196.43

Particle Size Distribution(s) at Each Structure

Structure #10 (A):

Size (mm)	In/Out
25.0000	100.000%
4.7500	95.172%
2.0000	82.482%
0.2500	63.448%
0.0750	25.379%
0.0010	0.000%

Structure #7 (B):

Size (mm)	In/Out
25.0000	100.000%
4.7500	100.000%
2.0000	100.000%
0.2500	82.669%
0.0750	33.068%
0.0010	0.000%

Structure #5 (C):

Size (mm)	In/Out
25.0000	100.000%
4.7500	100.000%
2.0000	100.000%
0.2500	82.116%
0.0750	32.847%
0.0010	0.000%

Structure #2 (E):

Size (mm)	In/Out
25.0000	100.000%
4.7500	88.912%
2.0000	77.057%
0.2500	59.275%

Size (mm)	In/Out
0.0750	23.710%
0.0010	0.000%

Structure #3 (E1):

Size (mm)	In/Out
25.0000	100.000%
4.7500	88.912%
2.0000	77.057%
0.2500	59.275%
0.0750	23.710%
0.0010	0.000%

Structure #1 (D):

Size (mm)	In/Out
25.0000	100.000%
4.7500	100.000%
2.0000	93.719%
0.2500	72.091%
0.0750	28.836%
0.0010	0.000%

Structure #4 (D+E):

Size (mm)	In/Out
25.0000	100.000%
4.7500	100.000%
2.0000	93.614%
0.2500	72.010%
0.0750	28.804%
0.0010	0.000%

Structure #6 (C+D+E):

Size (mm)	In/Out
25.0000	100.000%
4.7500	100.000%
2.0000	97.853%
0.2500	78.718%
0.0750	31.487%
0.0010	0.000%

Structure #8 (B+C+D+E):

Size (mm)	In/Out
25.0000	100.000%
4.7500	100.000%
2.0000	98.557%
0.2500	80.015%
0.0750	32.006%
0.0010	0.000%

Structure #9 (SED Pond 1):

Size (mm)	In/Out
25.0000	100.000%
4.7500	100.000%
2.0000	98.557%
0.2500	80.015%
0.0750	32.006%
0.0010	0.000%

Structure #11:

Size (mm)	In/Out
25.0000	100.000%
4.7500	98.885%
2.0000	94.844%
0.2500	76.188%
0.0750	30.475%
0.0010	0.000%

Structure Detail:

Structure #10 (Null)

A

Structure #7 (Null)

B

Structure #5 (Null)

C

Structure #2 (Null)

E

Structure #3 (Null)

E1

Structure #1 (Null)

D

Structure #4 (Null)

D+E

Structure #6 (Null)

C+D+E

Structure #8 (Null)

B+C+D+E

Structure #9 (Null)

SED Pond 1

Structure #11 (Null)

END

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	1	19.800	0.551	0.000	0.000	70.000	TR55	7.55	1.961
	2	20.000	0.551	0.000	0.000	70.000	TR55	7.63	1.981
	Σ	**39.800**						**15.18**	**3.942**
#7	1	33.200	1.472	0.000	0.000	70.000	TR55	7.89	3.305
	Σ	**33.200**						**7.89**	**3.305**
#5	1	42.500	1.440	0.000	0.000	70.000	TR55	10.23	4.233
	Σ	**42.500**						**10.23**	**4.233**
#2	1	8.900	0.389	0.000	0.000	70.000	TR55	3.83	0.876
	Σ	**8.900**						**3.83**	**0.876**
#3	Σ	**8.900**						**3.76**	**0.876**
#1	1	19.600	0.922	0.000	0.000	70.000	TR55	5.95	1.951
	Σ	**19.600**						**5.95**	**1.951**
#4	Σ	**28.500**						**8.68**	**2.827**
#6	Σ	**71.000**						**17.53**	**7.059**
#8	Σ	**104.200**						**25.35**	**10.364**
#9	Σ	**104.200**						**25.02**	**10.364**
#11	Σ	**144.000**						**30.53**	**14.306**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#10	1	0.240	158.00	33.00	0.9500	1.0000	1	761.9	436,963	298.81	172.87
	2	0.240	158.00	33.00	0.9500	1.0000	1	770.5	437,398	299.11	173.06
	Σ							**1,532.4**	**437,181**	**298.96**	**172.96**
#7	1	0.240	288.00	37.00	0.9500	1.0000	1	1,674.3	469,969	305.48	208.41
	Σ							**1,674.3**	**469,969**	**305.48**	**208.41**
#5	1	0.240	275.00	39.00	0.9500	1.0000	1	2,274.0	494,365	321.81	219.48
	Σ							**2,274.0**	**494,365**	**321.81**	**219.48**
#2	1	0.240	980.00	0.50	0.9500	1.0000	1	7.3	11,816	8.17	4.20
	Σ							**7.3**	**11,816**	**8.17**	**4.20**

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#3	Σ							**7.3**	**11,899**	**8.23**	**4.20**
#1	1	0.240	248.00	44.00	0.9500	1.0000	1	1,144.8	566,163	378.48	242.21
	Σ							**1,144.8**	**566,163**	**378.48**	**242.21**
#4	Σ							**1,152.1**	**446,423**	**298.50**	**176.60**
#6	Σ							**3,426.1**	**473,055**	**310.74**	**202.68**
#8	Σ							**5,100.4**	**472,891**	**309.56**	**204.51**
#9	Σ							**5,100.4**	**473,557**	**310.00**	**204.50**
#11	Σ							**6,632.8**	**442,037**	**292.32**	**196.43**

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Wishbone Hill Pond 2

This model is designed to replicate model results from the 1990 permit for Wishbone Hill. This model will be used as a check and for potential updating of the permit.

The model files from the permit are not available so they must be re-created.

Brandon A Coleman

General Information

Storm Information:

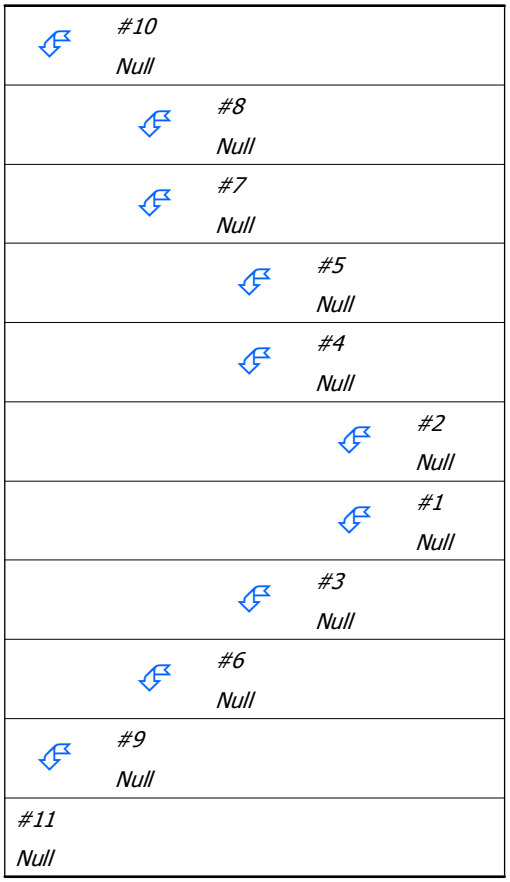
Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Particle Size Distribution:

Size (mm)	Wishbone Hill
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#3	0.000	0.000	TS Slopes
Null	#2	==>	#3	0.000	0.000	TS Bench/Rd
Null	#3	==>	#6	0.000	0.000	Pits
Null	#4	==>	#6	0.000	0.000	OB 2 Slopes
Null	#5	==>	#6	0.000	0.000	OB 2 Bench/Rd
Null	#6	==>	#9	0.000	0.000	Int I
Null	#7	==>	#9	0.000	0.000	OB 3 Slopes
Null	#8	==>	#9	0.000	0.000	OB 3 Bench/Rd
Null	#9	==>	#11	0.000	0.000	Int 2
Null	#10	==>	#11	0.000	0.000	Misc Pits
Null	#11	==>	End	0.000	0.000	SED Pond 2



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#10	77.600	77.600	23.89	6.23	795.9	163,917	109.74	60.26
#8	16.300	16.300	9.51	1.63	58.8	56,367	39.91	18.49
#7	16.300	16.300	9.51	1.63	497.2	408,300	289.11	143.21
#5	18.900	18.900	11.03	1.89	69.3	57,354	40.61	18.82
#4	18.800	18.800	10.97	1.88	583.4	414,183	293.28	145.45
#2	15.500	15.500	9.04	1.55	55.5	56,035	39.68	18.38
#1	32.000	32.000	18.67	3.21	1,162.4	471,493	333.86	167.51
#3	0.000	47.500	27.72	4.76	1,217.9	352,374	249.51	122.23
#6	0.000	85.200	49.72	8.54	1,870.7	307,984	218.08	105.90
#9	0.000	117.800	68.74	11.80	2,426.7	291,175	206.18	99.80
#11	0.000	195.400	87.58	18.04	3,222.6	261,607	182.72	86.32

Particle Size Distribution(s) at Each Structure

Structure #10 (Misc Pits):

Size (mm)	In/Out
25.0000	100.000%
4.7500	100.000%
2.0000	93.001%
0.2500	71.539%
0.0750	28.616%
0.0010	0.000%

Structure #8 (OB 3 Bench/Rd):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #7 (OB 3 Slopes):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #5 (OB 2 Bench/Rd):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%

Size (mm)	In/Out
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #4 (OB 2 Slopes):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #2 (TS Bench/Rd):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #1 (TS Slopes):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #3 (Pits):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%

Size (mm)	In/Out
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #6 (Int I):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #9 (Int 2):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #11:

Size (mm)	In/Out
25.0000	92.470%
4.7500	81.175%
2.0000	71.916%
0.2500	55.320%
0.0750	22.128%
0.0010	0.000%

Structure Detail:

Structure #10 (Null)

Misc Pits

Structure #8 (Null)

OB 3 Bench/Rd

Structure #7 (Null)

OB 3 Slopes

Structure #5 (Null)

OB 2 Bench/Rd

Structure #4 (Null)

OB 2 Slopes

Structure #2 (Null)

TS Bench/Rd

Structure #1 (Null)

TS Slopes

Structure #3 (Null)

Pits

Structure #6 (Null)

Int I

Structure #9 (Null)

Int 2

Structure #11 (Null)

SED Pond 2

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	1	77.600	0.335	0.000	0.000	70.000	M	23.89	6.234
	Σ	**77.600**						**23.89**	**6.234**
#8	1	16.300	0.077	0.000	0.000	70.000	TR55	9.51	1.633
	Σ	**16.300**						**9.51**	**1.633**
#7	1	16.300	0.003	0.000	0.000	70.000	TR55	9.51	1.633
	Σ	**16.300**						**9.51**	**1.633**
#5	1	18.900	0.077	0.000	0.000	70.000	TR55	11.03	1.894
	Σ	**18.900**						**11.03**	**1.894**
#4	1	18.800	0.003	0.000	0.000	70.000	TR55	10.97	1.884
	Σ	**18.800**						**10.97**	**1.884**
#2	1	15.500	0.077	0.000	0.000	70.000	TR55	9.04	1.553
	Σ	**15.500**						**9.04**	**1.553**
#1	1	12.000	0.004	0.000	0.000	70.000	TR55	7.00	1.202
	2	20.000	0.004	0.000	0.000	70.000	TR55	11.67	2.004
	Σ	**32.000**						**18.67**	**3.206**
#3	Σ	**47.500**						**27.72**	**4.759**
#6	Σ	**85.200**						**49.72**	**8.537**
#9	Σ	**117.800**						**68.74**	**11.803**
#11	Σ	**195.400**						**87.58**	**18.037**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#10	1	0.240	1,320.00	8.90	0.4500	1.0000	1	795.9	163,917	109.74	60.26
	Σ							**795.9**	**163,917**	**109.74**	**60.26**
#8	1	0.240	500.00	3.00	0.9500	1.0000	1	58.8	56,367	39.91	18.49
	Σ							**58.8**	**56,367**	**39.91**	**18.49**
#7	1	0.240	75.00	33.00	0.9500	1.0000	1	497.2	408,300	289.11	143.21
	Σ							**497.2**	**408,300**	**289.11**	**143.21**

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#5	1	0.240	500.00	3.00	0.9500	1.0000	1	69.3	57,354	40.61	18.82
	Σ							**69.3**	**57,354**	**40.61**	**18.82**
#4	1	0.240	75.00	33.00	0.9500	1.0000	1	583.4	414,183	293.28	145.45
	Σ							**583.4**	**414,183**	**293.28**	**145.45**
#2	1	0.240	500.00	3.00	0.9500	1.0000	1	55.5	56,035	39.68	18.38
	Σ							**55.5**	**56,035**	**39.68**	**18.38**
#1	1	0.240	100.00	33.00	0.9500	1.0000	1	419.3	456,850	323.49	161.83
	2	0.240	100.00	33.00	0.9500	1.0000	1	743.1	480,179	340.01	170.91
	Σ							**1,162.4**	**471,493**	**333.86**	**167.51**
#3	Σ							**1,217.9**	**352,374**	**249.51**	**122.23**
#6	Σ							**1,870.7**	**307,984**	**218.08**	**105.90**
#9	Σ							**2,426.7**	**291,175**	**206.18**	**99.80**
#11	Σ							**3,222.6**	**261,607**	**182.72**	**86.32**

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Wishbone Hill Pond 3

This model is designed to replicate model results from the 1990 permit for Wishbone Hill. This model will be used as a check and for potential updating of the permit.

The model files from the permit are not available so they must be re-created.

Brandon A Coleman

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Particle Size Distribution:

Size (mm)	Wishbone Hill
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Sed Pond 3

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	12.700	12.700	6.09	1.28	510.7	478,384	333.71	180.14

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In/Out
25.0000	100.000%
4.7500	83.695%
2.0000	72.535%
0.2500	55.797%
0.0750	22.319%
0.0010	0.000%

Structure Detail:

Structure #1 (Null)

Sed Pond 3

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	12.700	0.260	0.000	0.000	70.000	TR55	6.09	1.280
	Σ	**12.700**						**6.09**	**1.280**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.240	150.00	33.00	0.9500	1.0000	1	510.7	478,384	333.71	180.14
	Σ							**510.7**	**478,384**	**333.71**	**180.14**

Wishbone Hill Pond 4

This model is designed to replicate model results from the 1990 permit for Wishbone Hill. This model will be used as a check and for potential updating of the permit.

The model files from the permit are not available so they must be re-created.

Brandon A Coleman

General Information

Storm Information:

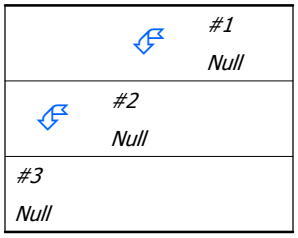
Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Particle Size Distribution:

Size (mm)	Wishbone Hill
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.057	0.270	A
Null	#2	==>	#3	0.000	0.000	A'
Null	#3	==>	End	0.000	0.000	B



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	3.930	3.930	2.29	0.39	16.9	67,118	47.53	22.06
#2	0.000	3.930	2.15	0.39	16.9	74,300	52.61	22.08
#3	4.660	8.590	3.67	0.77	23.6	52,700	36.89	15.62

Particle Size Distribution(s) at Each Structure

Structure #1 (A):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #2 (A'):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #3:

Size (mm)	In/Out
25.0000	92.811%
4.7500	81.698%
2.0000	70.805%
0.2500	54.465%
0.0750	21.786%
0.0010	0.000%

Structure Detail:

Structure #1 (Null)

A

Structure #2 (Null)

A'

Structure #3 (Null)

B

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	3.930	0.050	0.000	0.000	70.000	TR55	2.29	0.394
	Σ	**3.930**						**2.29**	**0.394**
#2	Σ	**3.930**						**2.15**	**0.394**
#3	1	4.660	0.200	0.000	0.000	70.000	M	1.66	0.374
	Σ	**8.590**						**3.67**	**0.767**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.240	380.00	4.00	0.9500	1.0000	1	16.9	67,118	47.53	22.06
	Σ							**16.9**	**67,118**	**47.53**	**22.06**
#2	Σ							**16.9**	**74,300**	**52.61**	**22.08**
#3	1	0.240	720.00	1.50	0.9500	1.0000	1	6.6	25,492	17.32	8.80
	Σ							**23.6**	**52,700**	**36.89**	**15.62**

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Wishbone Hill Pond 5

This model is designed to replicate model results from the 1990 permit for Wishbone Hill. This model will be used as a check and for potential updating of the permit.

The model files from the permit are not available so they must be re-created.

Brandon A Coleman

General Information

Storm Information:

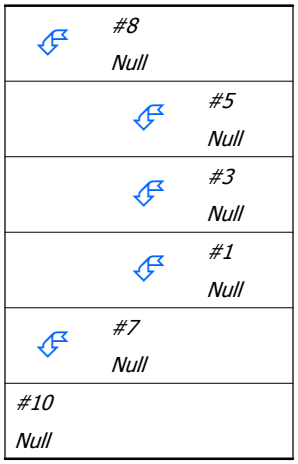
Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Particle Size Distribution:

Size (mm)	Wishbone Hill
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#7	0.142	0.320	Pit 8
Null	#3	==>	#7	0.330	0.230	Pit 9
Null	#5	==>	#7	0.125	0.270	Pit 10
Null	#7	==>	#10	0.000	0.000	Pits 8-10
Null	#8	==>	#10	0.194	0.234	Misc Pits
Null	#10	==>	End	0.000	0.000	SED Pond 5



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#8	71.810	71.810	34.79	6.98	736.1	149,521	104.39	52.19
#5	8.200	8.200	4.79	0.82	289.5	460,678	326.20	163.31
#3	18.510	18.510	10.80	1.85	210.7	169,723	120.18	56.84
#1	6.260	6.260	3.65	0.63	22.8	57,026	40.38	18.71
#7	0.000	32.970	15.17	3.30	523.0	1,012,849	717.19	77.96
#10	0.000	104.780	43.75	10.29	1,259.1	1,012,849	711.28	60.58

Particle Size Distribution(s) at Each Structure

Structure #8 (Misc Pits):

Size (mm)	In/Out
25.0000	99.881%
4.7500	83.234%
2.0000	72.136%
0.2500	55.489%
0.0750	22.196%
0.0010	0.000%

Structure #5 (Pit 10):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #3 (Pit 9):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #1 (Pit 8):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%

Size (mm)	In/Out
0.0750	20.000%
0.0010	0.000%

Structure #7 (Pits 8-10):

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure #10:

Size (mm)	In/Out
25.0000	95.777%
4.7500	79.814%
2.0000	69.172%
0.2500	53.209%
0.0750	21.284%
0.0010	0.000%

Structure Detail:

Structure #8 (Null)

Misc Pits

Structure #5 (Null)

Pit 10

Structure #3 (Null)

Pit 9

Structure #1 (Null)

Pit 8

Structure #7 (Null)

Pits 8-10

Structure #10 (Null)

SED Pond 5

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#8	1	71.810	0.211	0.000	0.000	70.000	TR55	34.79	6.982
	Σ	**71.810**						**34.79**	**6.982**
#5	1	8.200	0.052	0.000	0.000	70.000	TR55	4.79	0.822
	Σ	**8.200**						**4.79**	**0.822**
#3	1	18.510	0.107	0.000	0.000	70.000	TR55	10.80	1.855
	Σ	**18.510**						**10.80**	**1.855**
#1	1	6.260	0.094	0.000	0.000	70.000	TR55	3.65	0.627
	Σ	**6.260**						**3.65**	**0.627**
#7	Σ	**32.970**						**15.17**	**3.303**
#10	Σ	**104.780**						**43.75**	**10.286**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#8	1	0.240	1,543.00	6.80	0.4500	1.0000	1	736.1	149,521	104.39	52.19
	Σ							**736.1**	**149,521**	**104.39**	**52.19**
#5	1	0.240	750.00	22.50	0.4500	1.0000	1	289.5	460,678	326.20	163.31
	Σ							**289.5**	**460,678**	**326.20**	**163.31**
#3	1	0.240	1,160.00	8.80	0.4500	1.0000	1	210.7	169,723	120.18	56.84
	Σ							**210.7**	**169,723**	**120.18**	**56.84**
#1	1	0.240	680.00	4.30	0.4500	1.0000	1	22.8	57,026	40.38	18.71
	Σ							**22.8**	**57,026**	**40.38**	**18.71**
#7	Σ							**523.0**	**1,012,849**	**717.19**	**77.96**
#10	Σ							**1,259.1**	**1,012,849**	**711.28**	**60.58**

Wishbone Hill Ponds 6&7

This model is designed to replicate model results from the 1990 permit for Wishbone Hill. This model will be used as a check and for potential updating of the permit.

The model files from the permit are not available so they must be re-created.

Brandon A Coleman

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Particle Size Distribution:

Size (mm)	Wishbone Hill
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	SED Pond 6 & 7

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	6.800	6.800	3.97	0.68	711.5	1,002,334	709.74	401.53

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure Detail:

Structure #1 (Null)

SED Pond 6 & 7

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	6.800	0.009	0.000	0.000	70.000	TR55	3.97	0.681
	Σ	**6.800**						**3.97**	**0.681**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.240	290.00	59.00	0.9500	1.0000	1	711.5	1,002,334	709.74	401.53
	Σ							**711.5**	**1,002,334**	**709.74**	**401.53**

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Facilities Pond

This model is designed to replicate model results from the 1990 permit for Wishbone Hill. This model will be used as a check and for potential updating of the permit.

The model files from the permit are not available so they must be re-created.

Brandon A Coleman

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Particle Size Distribution:

Size (mm)	Wishbone Hill
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Facilities Pond

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	33.500	33.500	19.55	3.36	91.4	42,908	30.38	14.04

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Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In/Out
25.0000	90.000%
4.7500	75.000%
2.0000	65.000%
0.2500	50.000%
0.0750	20.000%
0.0010	0.000%

Structure Detail:

Structure #1 (Null)

Facilities Pond

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	33.500	0.050	0.000	0.000	70.000	TR55	19.55	3.357
	Σ	**33.500**						**19.55**	**3.357**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.240	500.00	2.00	0.9500	1.0000	1	91.4	42,908	30.38	14.04
	Σ							**91.4**	**42,908**	**30.38**	**14.04**

APPENDIX D.2
USLE CALCULATIONS

TABLE D.2-1

APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS
Barfield et al, 1981

USLE A = RK LS CP
R = rainfall erosivity factor

- 6 hr storm is typically 2/3 of the 24-hr event for a given event (based on a cursory review of U.S. Department of Commerce publication, Technical Paper No. 40, 1961).

  2-yr, 24-hr event 1.15" (from Buffalo Creek analysis spreadsheet)

  2-yr, 6-hr event 0.76" say (1.0")

  Average annual R (Type I storm) = 16.55 $P_{2,6}^{2.2}$ = 16.6 say 20.

K - Soil Erodibility factor

See nomograph (attached)
use K 0.15 to 0.27
gravelly sand - silt, use 0.21 as an average

LS - Length Slope factor

Dependent upon location, i.e., to be determined separately for each pond:

<u>Sed Pond 1</u> - Main purpose is to control sed from overburden Area 1

assume 3:1 slope ---> 33%
maximum height = say 300 ft
slope length = 950 ft

from nomograph ---> LS ≥ 20
using equation ---> LS = 28.5

<u>Sed Pond 2</u> - Overburden Area 2 Sed

assume 3:1 slope
maximum height = say 150 ft
slope length - 475 ft

from nomograph ---> LS = 20

<u>Sed Pond 3</u> - Portion of overburden Area 1

LS = 28.5 (see Sed Pond 1)

CP - Control Practice factor

From Table 5.8 ---> C = say, 1.5

A - Soil Loss (tons/acre) - Annual

Sed Pond 1

A = RK LS CP
= (20) (0.21) (28.5) (1.5)
= 180 tons/acre

Sed Pond 2

A = (20) (0.21) (20) (1.5)
= 126 tons/acre

Sed Pond 3

A = 180 tons/acre (see Sed Pond 1 calculation)

Annual Sediment Yield

Sed Pond 1

Dump area 114 acres ---> 20,520 tons @ 65 pcf ---> 14.5 acre ft

Sed Pond 2

Stockpiles: Use LS = 20

A_1 = (20) (.21) (20) (1.5)
= 126 tons/acre
Total Acre = 27.5 + 37.7 + 32.6 = 97.8
Sed_1 = 12,323 tons

Pit Areas: L = 1,320
S = 8.9, LS = 4

A_2 = (20) (.21) (4) (1.5)
= 25.2 tons/acre
Sed_2 = 1,956 tons

Total Sed (average annual) = 14,279 tons @ 65 pcf ---> 10.0 ac ft

Sed Pond 3

Catchment = 127 acres
180 tons/acre x 127 acres = 2,286 tons
2,286tons at 65 pcf = 1.6 acre-feet

Sed Pond 4

Areas:

A) 3.93 ac @ 4% LS = 380 ft
4% ditch = 410 ft
B) 4.66 ac @ 1.5% LS = 720 ft

Annual yield ---> take 4% for slope and 500 ft for length
yields .75 for LS

A = RK LS CP
= (20) (.21) (.75) (1.5)
= 4.7 tons/acre
Annual Sed = 4.7 x 4.66 = 22 tons ---> 0.016 ac ft

Sed Pond 5

Area = 104.8 acres

Component Area:

Pit 8	6.26 ac	4.26% 680 ft
		6.98% 1,553 ft
Pit 9 (partial)	18.51 ac	8.8% 1,160 ft
		2.3% 1,780 ft
Pit 10 (partial)	8.2 ac	14.1% 750 ft
		2.9% 600 ft

Pits 6, 7, 11, 12, 13, and 16 = 71.81
slope (average by area) 6.8%

Annual (average) Sed

A = RK LS CP
as before
R = 20
K = .21
CP = 1.5

LS: say, representative slope 7.6% (area weighted average)
length 1,361 ft (area weighted average)
LS (Figure 5.15) = 3.5

A = (20) (.21) (3.5) (1.5) = 22 tons/acre/year
* for 104.8 acres ---> A = 2,311 tons or 1.6 acre-feet

Sed Pond 6 - Use area ratio method to factor Sed Pond 1 yield

$$\left(\frac{\text{6.0 acres catchment}}{\text{114 acres catchment (for Sed Pond 1)}}\right) \times \text{14.5 acre ft sediment yield for Sed Pond 1}$$

0.8 acre-ft sediment

Sed Pond 7 – Use area ratio method to factor Sed Pond 1 yield

$$\left(\frac{1.0\ acres\ catchment}{114\ acres\ catchment}\right) \times 14.5\ acre \cdot ft\ sediment$$

(for Sed Pond 1)

0.1 acre-ft of sediment

Slurry Pond Sediment Loading

1. Total catchment area = 72 acres
2. Pond basin area = 27 acres
3. Net external catchment = 45 acres
   (1) – (2)

Catchment geometry includes part of Topsoil Stockpile No. 1 and is similar to mine Area 2/Sediment Pond 2 catchment. Use area ratio method for sediment yield:

	Sed Pond 2	Slurry Pond
Catchment Area	175 (acres)	45 (acres)
Area ratio	------	0.26
100-yr sediment yield	2.28 (acre-ft)	0.59 (acre-ft)
Average annual sediment yield	10.0 (acre-ft)	2.6 (acre-ft)

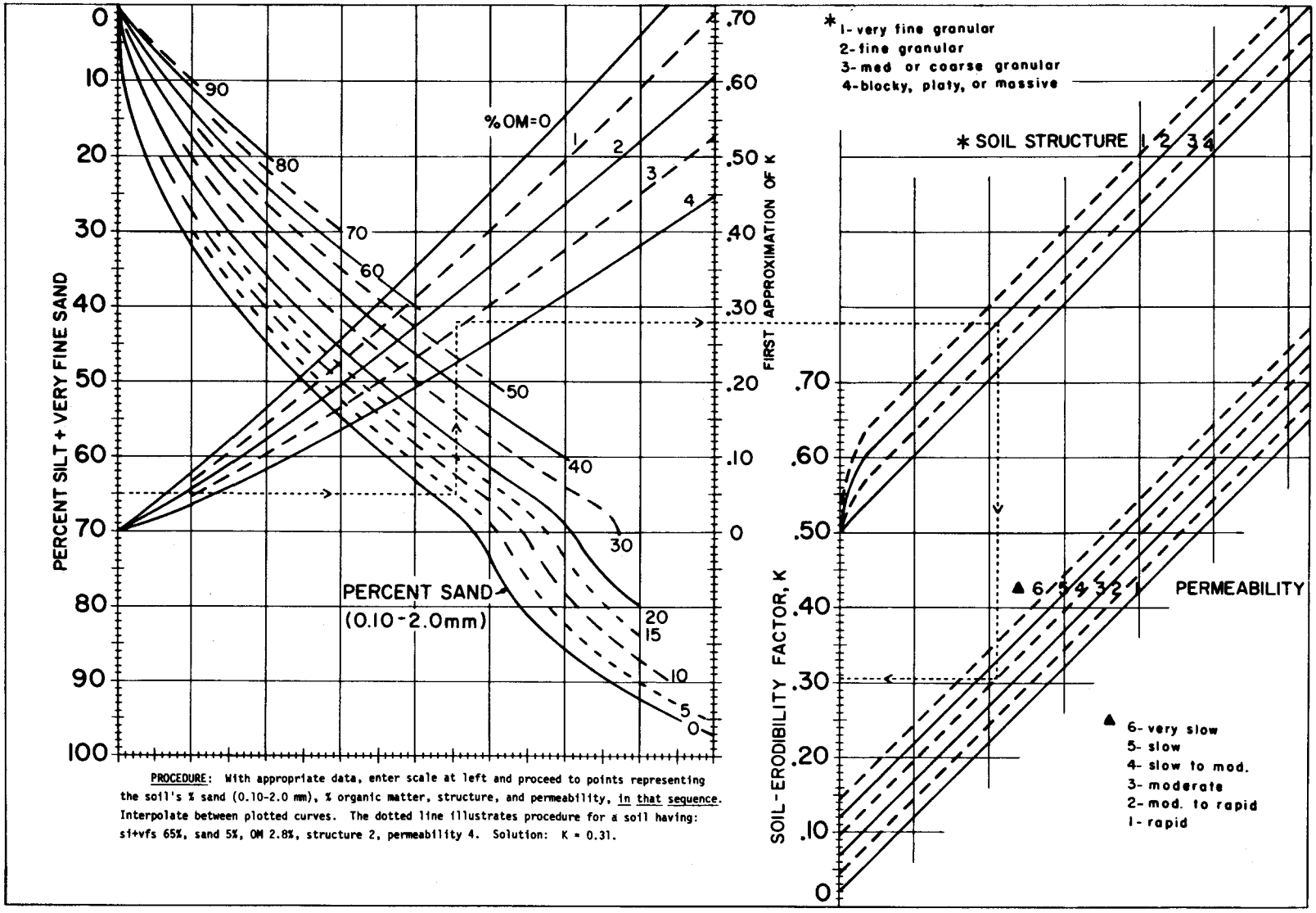

FIGURE 3.—The soil-erodibility nomograph. Where the silt fraction does not exceed 70 percent, the equation is $100\ K = 2.1\ M^{1.14}\ (10^{-4})\ (12 - a) + 3.25\ (b - 2) + 2.5\ (c - 3)$ where M = (percent si + vfs) (100 — percent c), a = percent organic matter, b = structure code, and c = profile permeability class.

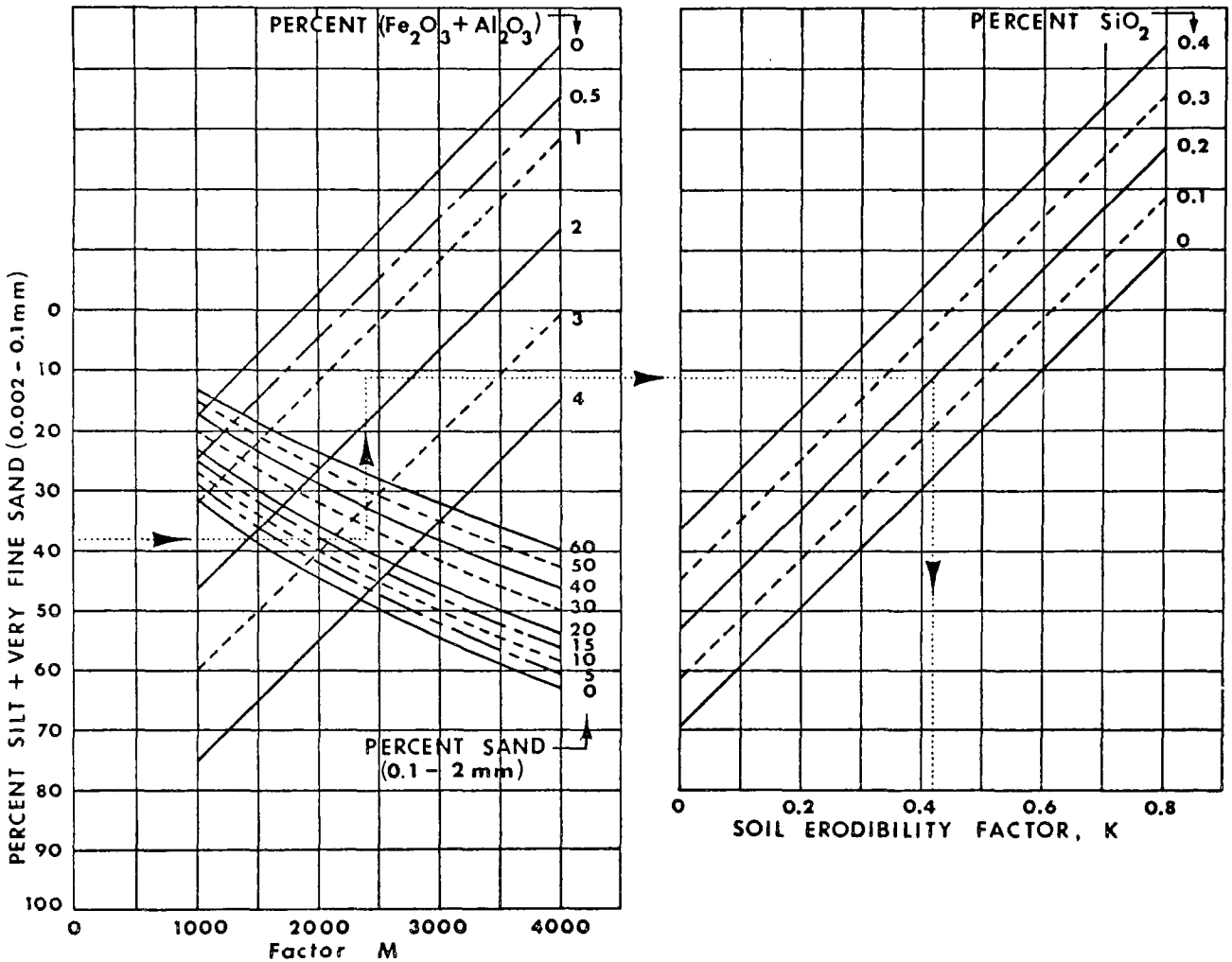

Figure 55. Nomograph for Estimating the Erodibility Factor, K, of High Clay Subsoils

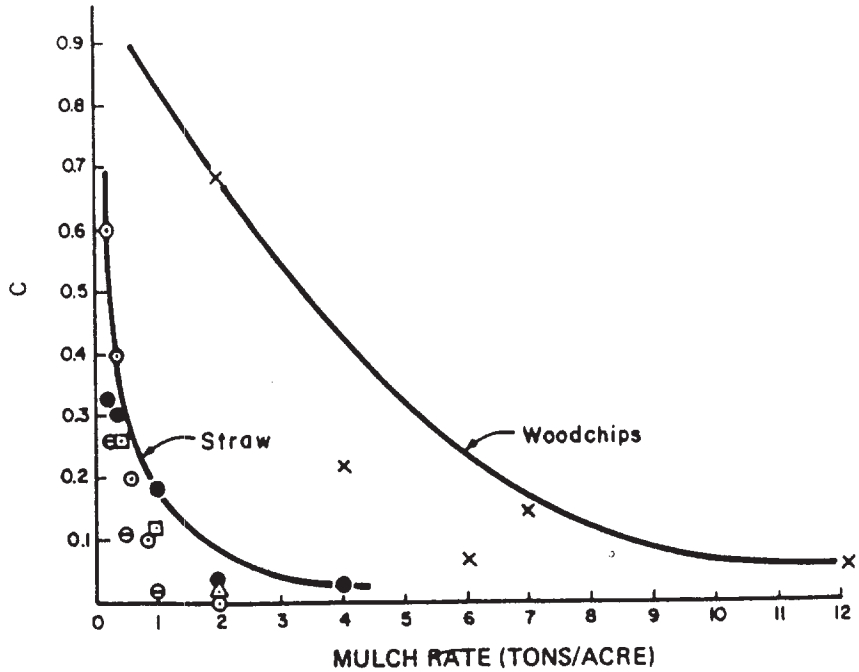

Figure 5.16b. Control factor, C, of surface mulching. (Chen, 1974)

Chemicals are also available for stabilizing the soil surface. C values for selected chemicals are tabulated in Table 5.8. A more complete listing can be found in Table 5.A.1.

Table 5.8 Selected C Values reported in the literature. A comprehensive list is given in Appendix 5A.

Condition	C factor
1. Bare soil conditions	
compacted bulldozer scraped up and down	1.30
compacted fill	1.24 – 1.71
2. Asphalt emulsion	
1250 gallons/acre	0.02
151 gallons/acre	0.65 – 0.70
3. Other chemicals	
Petroset SB	0.40 – 0.66
wood fiber slurry, 1000 lb/acre fresh	0.05
4. Seedings[1]	
permanent, 0 to 60 days[2]	0.40
permanent, after 12 months	0.01
5. Excelsior blanket with plastic net	0.04 – 0.10

1. If plantings are used with mulches, use the minimum C values.
2. If dry weather occurs at planting and emergence is a problem, extend the 0-60 days to a period when rainfall normally occurs.

APPENDIX D.3
DITCH DESIGNS

APPENDIX D.3 – DITCH DESIGNS

The various diversion ditches which are required to control site runoff are shown on Plats 11-8 and 11-11 for Mine Areas 1 and 2, respectively. Peak flood flows for these ditches have been taken from the SEDCAD runs for the appropriate sediment ponds (Appendix D.1). Design information and parameters for the flood peak determinations are discussed in the introductory text of Appendix D. AMC II and a runoff curve number of 70 were assumed for the hydrograph calculations.

Manning's equation was set up in FLOWMASTER, a ditch sizing spreadsheet to design the ditch cross sections for the required diversion structures. Table D.3-1 presents the results for the ditch sizing. The general categorized ditch types on Table D.3-1 have been established based on the minimum calculated cross sections and are detailed on Plate 11-4. The dimensions on Plate 11-4 are to be superseded by the dimensions shown in this Appendix. The ditch sizing spreadsheets are included also for reference.

TABLE D.3-1

SEDIMENT CONTROL DITCH DESIGNATION	DITCH TYPE
No. 1-EAST	7
No. 1-WEST	4
No. 2-NORTH	7
No. 2A-NORTH	7
No. 2B-NORTH	4
No. 2C-NORTH	4
No. 2-WEST	4
No. 3-NORTH	5
No. 3-SOUTH	5
No. 4	4
No. 5-NORTH	6
No. 5-SOUTH	7
No. 6	4
No. 7	4
No. S-WEST	4
BENCH DTICHES	4
RAMP DITCHES	7

SUPERCEEDS DIMENSIONS SHOWN ON PLATE 11-4

Ditch Type	(B) Base Width (ft)	(H) Ditch Depth (ft)	(F.B.) Min. Freeboard (ft)	Design Flow (cfs)	Flow Velocity (ft/s)	Gradient (%)	D50 Riprap (in)	(T) Thickness (in)	Section Detail
4	10	2	1	1-15	1-4	<8	NONE	NONE	DETAIL 4
5	10	2	1	1-15	4-6	12-15	6	12	DETAIL 5
6	10	2.2	1	15-69	3-4	<5	NONE	NONE	DETAIL 4
7	10	2.2	1	15-69	<7	10	6	12	DETAIL 5

Worksheet for Channel 1-East

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	3.30000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	30.53	ft^3/s

Results

Normal Depth	0.61	ft
Flow Area	6.84	ft^2
Wetted Perimeter	12.73	ft
Hydraulic Radius	0.54	ft
Top Width	12.44	ft
Critical Depth	0.63	ft
Critical Slope	0.02903	ft/ft
Velocity	4.46	ft/s
Velocity Head	0.31	ft
Specific Energy	0.92	ft
Froude Number	1.06	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.61	ft
Critical Depth	0.63	ft
Channel Slope	3.30000	%

Worksheet for Channel 1-East

GVF Output Data

Critical Slope	0.02903	ft/ft

Worksheet for Channel 1-East UPPER REACH

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	7.70000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	25.35	ft^3/s

Results

Normal Depth	0.43	ft
Flow Area	4.62	ft^2
Wetted Perimeter	11.90	ft
Hydraulic Radius	0.39	ft
Top Width	11.70	ft
Critical Depth	0.56	ft
Critical Slope	0.03002	ft/ft
Velocity	5.49	ft/s
Velocity Head	0.47	ft
Specific Energy	0.89	ft
Froude Number	1.54	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.43	ft
Critical Depth	0.56	ft
Channel Slope	7.70000	%

Worksheet for Channel 1-East UPPER REACH

GVF Output Data

Critical Slope	0.03002	ft/ft

Worksheet for Channel 1-West

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	1.00000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	15.18	ft^3/s

Results

Normal Depth	0.57	ft
Flow Area	6.41	ft^2
Wetted Perimeter	12.57	ft
Hydraulic Radius	0.51	ft
Top Width	12.30	ft
Critical Depth	0.40	ft
Critical Slope	0.03302	ft/ft
Velocity	2.37	ft/s
Velocity Head	0.09	ft
Specific Energy	0.66	ft
Froude Number	0.58	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.57	ft
Critical Depth	0.40	ft
Channel Slope	1.00000	%

Worksheet for Channel 1-West

GVF Output Data

Critical Slope	0.03302	ft/ft

Worksheet for Channel 2-North

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	2.00000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	68.74	ft^3/s

Results

Normal Depth	1.13	ft
Flow Area	13.84	ft^2
Wetted Perimeter	15.05	ft
Hydraulic Radius	0.92	ft
Top Width	14.52	ft
Critical Depth	1.06	ft
Critical Slope	0.02529	ft/ft
Velocity	4.97	ft/s
Velocity Head	0.38	ft
Specific Energy	1.51	ft
Froude Number	0.90	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.13	ft
Critical Depth	1.06	ft
Channel Slope	2.00000	%

Worksheet for Channel 2-North

GVF Output Data

Critical Slope	0.02529	ft/ft

Worksheet for Channel 2A-North

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	4.30000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	68.74	ft^3/s

Results

Normal Depth	0.91	ft
Flow Area	10.70	ft^2
Wetted Perimeter	14.05	ft
Hydraulic Radius	0.76	ft
Top Width	13.62	ft
Critical Depth	1.06	ft
Critical Slope	0.02529	ft/ft
Velocity	6.42	ft/s
Velocity Head	0.64	ft
Specific Energy	1.55	ft
Froude Number	1.28	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.91	ft
Critical Depth	1.06	ft
Channel Slope	4.30000	%

Worksheet for Channel 2A-North

GVF Output Data

Critical Slope	0.02529	ft/ft

Worksheet for Channel 2B-North

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	4.20000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	9.51	ft^3/s

Results

Normal Depth	0.28	ft
Flow Area	3.01	ft^2
Wetted Perimeter	11.27	ft
Hydraulic Radius	0.27	ft
Top Width	11.14	ft
Critical Depth	0.30	ft
Critical Slope	0.03615	ft/ft
Velocity	3.16	ft/s
Velocity Head	0.15	ft
Specific Energy	0.44	ft
Froude Number	1.07	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.28	ft
Critical Depth	0.30	ft
Channel Slope	4.20000	%

Worksheet for Channel 2B-North

GVF Output Data

Critical Slope	0.03615	ft/ft

Worksheet for Channel 2C-North LOWER REACH

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.50000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	9.51	ft^3/s

Results

Normal Depth	0.54	ft
Flow Area	5.92	ft^2
Wetted Perimeter	12.39	ft
Hydraulic Radius	0.48	ft
Top Width	12.14	ft
Critical Depth	0.30	ft
Critical Slope	0.03615	ft/ft
Velocity	1.61	ft/s
Velocity Head	0.04	ft
Specific Energy	0.58	ft
Froude Number	0.41	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.54	ft
Critical Depth	0.30	ft
Channel Slope	0.50000	%

Worksheet for Channel 2C-North LOWER REACH

GVF Output Data

Critical Slope	0.03615	ft/ft

Worksheet for Channel 2C-North UPPER REACH

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	7.20000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	9.51	ft^3/s

Results

Normal Depth	0.24	ft
Flow Area	2.55	ft^2
Wetted Perimeter	11.09	ft
Hydraulic Radius	0.23	ft
Top Width	10.97	ft
Critical Depth	0.30	ft
Critical Slope	0.03615	ft/ft
Velocity	3.74	ft/s
Velocity Head	0.22	ft
Specific Energy	0.46	ft
Froude Number	1.37	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.24	ft
Critical Depth	0.30	ft
Channel Slope	7.20000	%

Worksheet for Channel 2C-North UPPER REACH

GVF Output Data

Critical Slope	0.03615	ft/ft

Worksheet for Channel 2-West

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	5.20000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	9.04	ft^3/s

Results

Normal Depth	0.26	ft
Flow Area	2.73	ft^2
Wetted Perimeter	11.16	ft
Hydraulic Radius	0.24	ft
Top Width	11.04	ft
Critical Depth	0.29	ft
Critical Slope	0.03651	ft/ft
Velocity	3.31	ft/s
Velocity Head	0.17	ft
Specific Energy	0.43	ft
Froude Number	1.17	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.26	ft
Critical Depth	0.29	ft
Channel Slope	5.20000	%

Worksheet for Channel 2-West

GVF Output Data

Critical Slope	0.03651	ft/ft

Worksheet for Channel 3-North LOWER REACH

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	16.00000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	6.09	ft^3/s

Results

Normal Depth	0.15	ft
Flow Area	1.51	ft^2
Wetted Perimeter	10.66	ft
Hydraulic Radius	0.14	ft
Top Width	10.59	ft
Critical Depth	0.22	ft
Critical Slope	0.03952	ft/ft
Velocity	4.03	ft/s
Velocity Head	0.25	ft
Specific Energy	0.40	ft
Froude Number	1.88	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.15	ft
Critical Depth	0.22	ft
Channel Slope	16.00000	%

Worksheet for Channel 3-North LOWER REACH

GVF Output Data

Critical Slope	0.03952	ft/ft

Worksheet for Channel 3-North UPPER REACH

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	5.20000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	6.09	ft^3/s

Results

Normal Depth	0.21	ft
Flow Area	2.14	ft^2
Wetted Perimeter	10.92	ft
Hydraulic Radius	0.20	ft
Top Width	10.82	ft
Critical Depth	0.22	ft
Critical Slope	0.03952	ft/ft
Velocity	2.85	ft/s
Velocity Head	0.13	ft
Specific Energy	0.33	ft
Froude Number	1.13	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.21	ft
Critical Depth	0.22	ft
Channel Slope	5.20000	%

Worksheet for Channel 3-North UPPER REACH

GVF Output Data

Critical Slope	0.03952	ft/ft

Worksheet for Channel 3-South

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	12.00000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	2.00	ft^3/s

Results

Normal Depth	0.08	ft
Flow Area	0.83	ft^2
Wetted Perimeter	10.37	ft
Hydraulic Radius	0.08	ft
Top Width	10.33	ft
Critical Depth	0.11	ft
Critical Slope	0.04980	ft/ft
Velocity	2.40	ft/s
Velocity Head	0.09	ft
Specific Energy	0.17	ft
Froude Number	1.49	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.08	ft
Critical Depth	0.11	ft
Channel Slope	12.00000	%

Worksheet for Channel 3-South

GVF Output Data

Critical Slope	0.04980	ft/ft

Worksheet for Channel 4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	1.50000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	3.67	ft^3/s

Results

Normal Depth	0.22	ft
Flow Area	2.29	ft^2
Wetted Perimeter	10.98	ft
Hydraulic Radius	0.21	ft
Top Width	10.88	ft
Critical Depth	0.16	ft
Critical Slope	0.04386	ft/ft
Velocity	1.60	ft/s
Velocity Head	0.04	ft
Specific Energy	0.26	ft
Froude Number	0.61	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.22	ft
Critical Depth	0.16	ft
Channel Slope	1.50000	%

Worksheet for Channel 4

GVF Output Data

Critical Slope	0.04386	ft/ft

Worksheet for Channel 5-North

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	2.20000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	25.27	ft^3/s

Results

Normal Depth	0.61	ft
Flow Area	6.91	ft^2
Wetted Perimeter	12.75	ft
Hydraulic Radius	0.54	ft
Top Width	12.46	ft
Critical Depth	0.56	ft
Critical Slope	0.03003	ft/ft
Velocity	3.66	ft/s
Velocity Head	0.21	ft
Specific Energy	0.82	ft
Froude Number	0.87	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.61	ft
Critical Depth	0.56	ft
Channel Slope	2.20000	%

Worksheet for Channel 5-North

GVF Output Data

Critical Slope	0.03003	ft/ft

Worksheet for Channel 5-South UPPER REACH

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	12.50000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	25.27	ft^3/s

Results

Normal Depth	0.37	ft
Flow Area	3.95	ft^2
Wetted Perimeter	11.65	ft
Hydraulic Radius	0.34	ft
Top Width	11.47	ft
Critical Depth	0.56	ft
Critical Slope	0.03003	ft/ft
Velocity	6.39	ft/s
Velocity Head	0.63	ft
Specific Energy	1.00	ft
Froude Number	1.92	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.37	ft
Critical Depth	0.56	ft
Channel Slope	12.50000	%

Worksheet for Channel 5-South UPPER REACH

GVF Output Data

Critical Slope	0.03003	ft/ft

Worksheet for Channel 5-South DIVERSION

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	1.90000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	25.27	ft^3/s

Results

Normal Depth	0.64	ft
Flow Area	7.24	ft^2
Wetted Perimeter	12.87	ft
Hydraulic Radius	0.56	ft
Top Width	12.57	ft
Critical Depth	0.56	ft
Critical Slope	0.03003	ft/ft
Velocity	3.49	ft/s
Velocity Head	0.19	ft
Specific Energy	0.83	ft
Froude Number	0.81	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.64	ft
Critical Depth	0.56	ft
Channel Slope	1.90000	%

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Worksheet for Channel 5-South DIVERSION

GVF Output Data

Critical Slope	0.03003	ft/ft

Worksheet for Channel 6

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	4.20000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	3.97	ft^3/s

Results

Normal Depth	0.17	ft
Flow Area	1.75	ft^2
Wetted Perimeter	10.76	ft
Hydraulic Radius	0.16	ft
Top Width	10.68	ft
Critical Depth	0.17	ft
Critical Slope	0.04314	ft/ft
Velocity	2.27	ft/s
Velocity Head	0.08	ft
Specific Energy	0.25	ft
Froude Number	0.99	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.17	ft
Critical Depth	0.17	ft
Channel Slope	4.20000	%

Worksheet for Channel 6

GVF Output Data

Critical Slope	0.04314	ft/ft

Worksheet for Channel 7

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	1.30000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	3.97	ft^3/s

Results

Normal Depth	0.24	ft
Flow Area	2.52	ft^2
Wetted Perimeter	11.07	ft
Hydraulic Radius	0.23	ft
Top Width	10.96	ft
Critical Depth	0.17	ft
Critical Slope	0.04315	ft/ft
Velocity	1.58	ft/s
Velocity Head	0.04	ft
Specific Energy	0.28	ft
Froude Number	0.58	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.24	ft
Critical Depth	0.17	ft
Channel Slope	1.30000	%

Worksheet for Channel 7

GVF Output Data

Critical Slope	0.04315	ft/ft

Worksheet for Channel S-West

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	2.00000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	6.53	ft^3/s

Results

Normal Depth	0.28	ft
Flow Area	3.00	ft^2
Wetted Perimeter	11.27	ft
Hydraulic Radius	0.27	ft
Top Width	11.14	ft
Critical Depth	0.23	ft
Critical Slope	0.03897	ft/ft
Velocity	2.18	ft/s
Velocity Head	0.07	ft
Specific Energy	0.36	ft
Froude Number	0.74	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.28	ft
Critical Depth	0.23	ft
Channel Slope	2.00000	%

Worksheet for Channel S-West

GVF Output Data

Critical Slope	0.03897	ft/ft

Worksheet for Channel Bench Ditches

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.50000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	25.35	ft^3/s

Results

Normal Depth	0.95	ft
Flow Area	11.27	ft^2
Wetted Perimeter	14.24	ft
Hydraulic Radius	0.79	ft
Top Width	13.79	ft
Critical Depth	0.56	ft
Critical Slope	0.03002	ft/ft
Velocity	2.25	ft/s
Velocity Head	0.08	ft
Specific Energy	1.03	ft
Froude Number	0.44	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.95	ft
Critical Depth	0.56	ft
Channel Slope	0.50000	%

Worksheet for Channel Bench Ditches

GVF Output Data

Critical Slope	0.03002	ft/ft

Worksheet for Channel Ramp Ditches

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	10.00000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	25.35	ft^3/s

Results

Normal Depth	0.39	ft
Flow Area	4.25	ft^2
Wetted Perimeter	11.76	ft
Hydraulic Radius	0.36	ft
Top Width	11.58	ft
Critical Depth	0.56	ft
Critical Slope	0.03002	ft/ft
Velocity	5.97	ft/s
Velocity Head	0.55	ft
Specific Energy	0.95	ft
Froude Number	1.74	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.39	ft
Critical Depth	0.56	ft
Channel Slope	10.00000	%

Worksheet for Channel Ramp Ditches

GVF Output Data

Critical Slope	0.03002	ft/ft

Worksheet for Channel 2-South

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	6.00000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	2.00	ft^3/s

Results

Normal Depth	0.10	ft
Flow Area	1.03	ft^2
Wetted Perimeter	10.45	ft
Hydraulic Radius	0.10	ft
Top Width	10.40	ft
Critical Depth	0.11	ft
Critical Slope	0.04982	ft/ft
Velocity	1.94	ft/s
Velocity Head	0.06	ft
Specific Energy	0.16	ft
Froude Number	1.09	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.10	ft
Critical Depth	0.11	ft
Channel Slope	6.00000	%

Worksheet for Channel 2-South

GVF Output Data

Critical Slope	0.04982	ft/ft

APPENDIX D.4
CULVERT SIZING

APPENDIX D.4 – CULVERT SIZING

Mine Area Culverts

Based on the completed 100-yr storm flows (see SEDCAD Printouts, Appendix D.1), and the attached nomograph, (American Iron and Steel Institute, 1971) 24 inch diameter CMP should suffice at all culvert installation locations. Design parameters for peak flow calculations are discussed in Appendix D.1. Road swales can be constructed to provide additional capacity if desired.

Ditch Designation	**Peak Flows (cfs)**	**Min – Culvert Size (in)**	**# of Culverts**
Ditch 1 – East	30.53	24	2
Ditch S- West	6.53	18	1
Ditch 2C – North	9.51	21	1
Ditch 2 –North	68.74	24	3
Culvert under Coal Stockpile to Slurry Pond	6	15	1

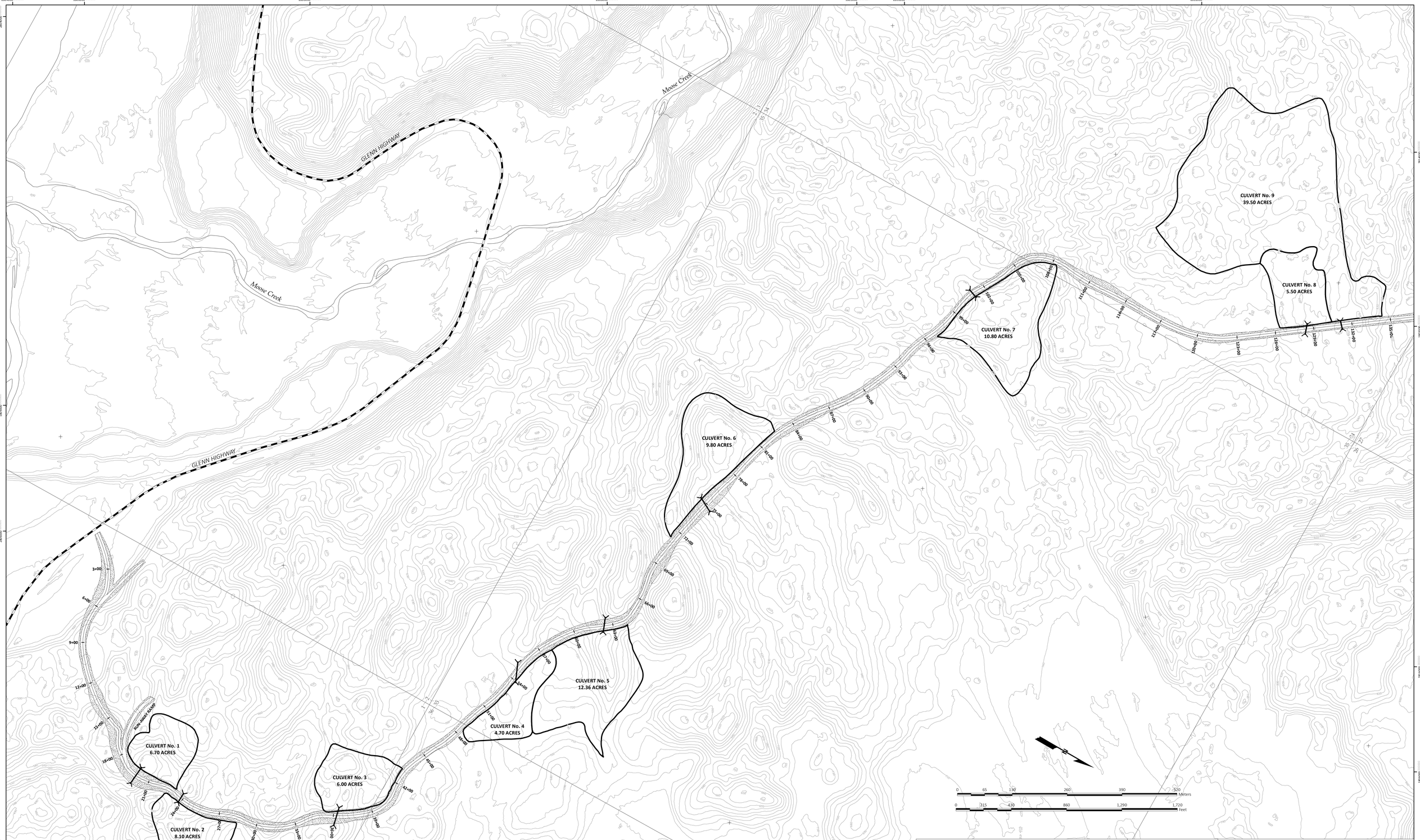
Culverts must be installed at a minimum 1% grade to ensure self-cleaning.

Access Road Culverts

For design purposes, it is assumed that the predominant soil types throughout the access road alignment are equivalent to those located in the mine area. Accordingly, a conservative runoff curve number of 70 has been used in the flood routing to size the haul road culverts. The condition modeled represents antecedent moisture condition (AMC) II. It is further pointed out that haul road culvert catchment areas are generally undisturbed, thus an additional conservatism exists in the curve number selection. Additional descriptive soil information for the SEDCAD4 modeling is contained in Appendix D.1.

Culvert sizes have been based on 100 yr storm flood routing using the SEDCAD4 computer program. Culvert locations are shown on Plat 9-2. A revised figure based on Plate 9-2 is attached, which enumerates the culverts and delineates their respective catchment areas.

From this revised figure, culvert Nos. 5 and 9 were selected as the critical design cases as No. 9 has the largest catchment area (39.5 acres) and No. 5 the steepest overall catchment (30% slopes). Based on the attached SEDCAD4 runs for the these culverts, peak design flood flows of 7.21 and 20.48 cfs have been calculated for culvert No. 5 and No. 9, respectively. The SEDCAD4 runs calculated a culvert size of 18” and 24”culverts for culverts No.5 and No. 9, respectively. Accordingly, all culverts along the access road have been designated 24” diameter CMP installations.



SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS
2	2/2014	CTW	NEW CONTOURS, CONVERT DRAWING TO GIS

FILE NAME: CULVERT DRAINAGE MINE ACCESS.MXD

DESIGN BY:
DRAWN BY:
CHECK BY:
DATE DRAWN: 7/1990
NAD83/AK STATE PLANE ZONE 4

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

CULVERT DRAINAGE AREAS
WISHBONE HILL MINE ACCESS ROAD

USIBELLI COAL MINE, INC.
PO BOX 1000 HEALY, ALASKA 99743
(907) 683-2226

PLATE NO. D-D1

SCALE: 1:3,750

REV. 2

Ditch 1-East (Flow 30.53 cfs/2)

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.00	0.0150	2.50	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 15.27 cfs

Maximum Headwater = 2.50 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (21 in)	**Discharge (cfs) (24 in)**	Discharge (cfs) (30 in)
0.25	0.47	**0.54**	0.67
0.50	1.30	**1.48**	1.85
0.75	2.38	**2.72**	3.40
1.00	3.67	**4.19**	5.24
1.25	5.12	**5.85**	7.32
1.50	6.73	**7.69**	9.62
1.75	8.48	**9.70**	12.12
2.00	10.36	**11.84**	14.81
2.25	11.91	**14.13**	17.67
2.50	13.33	**16.09**	20.69
2.75	14.61	**17.89**	23.87
3.00	15.53	**19.52**	26.90
3.25	16.29	**21.02**	29.41
3.50	17.01	**22.36**	31.84
3.75	17.70	**23.35**	34.10

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Ditch S-West Culvert

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.00	0.0150	2.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 6.53 cfs

Maximum Headwater = 2.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (15 in)	**Discharge (cfs) (18 in)**	Discharge (cfs) (21 in)
0.20	0.24	**0.28**	0.33
0.40	0.68	**0.81**	0.93
0.60	1.22	**1.46**	1.71
0.80	1.88	**2.25**	2.62
1.00	2.62	**3.14**	3.67
1.20	3.44	**4.13**	4.82
1.40	4.34	**5.20**	6.07
1.60	5.10	**6.36**	7.42
1.80	5.72	**7.46**	8.85
2.00	6.13	**8.43**	10.36
2.20	6.44	**9.30**	11.60
2.40	6.73	**9.92**	12.78
2.60	7.02	**10.39**	13.85
2.80	7.29	**10.83**	14.85
3.00	7.55	**11.25**	15.54

Ditch 2C-North Culvert

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.00	0.0150	2.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 9.51 cfs

Maximum Headwater = 2.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (18 in)	**Discharge (cfs) (21 in)**	Discharge (cfs) (24 in)
0.20	0.28	**0.33**	0.38
0.40	0.81	**0.93**	1.06
0.60	1.46	**1.71**	1.95
0.80	2.25	**2.62**	3.00
1.00	3.14	**3.67**	4.19
1.20	4.13	**4.82**	5.50
1.40	5.20	**6.07**	6.94
1.60	6.36	**7.42**	8.48
1.80	7.46	**8.85**	10.11
2.00	8.43	**10.36**	11.85
2.20	9.30	**11.60**	13.67
2.40	9.92	**12.78**	15.36
2.60	10.39	**13.85**	16.83
2.80	10.83	**14.85**	18.23
3.00	11.25	**15.54**	19.52

Ditch 2- North Culvert (Flow 68.74cfs/3)

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.00	0.0150	4.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 23.00 cfs

Maximum Headwater = 4.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (21 in)	**Discharge (cfs) (24 in)**	Discharge (cfs) (30 in)
0.40	0.94	**1.07**	1.33
0.80	2.62	**3.00**	3.75
1.20	4.82	**5.51**	6.88
1.60	7.42	**8.48**	10.59
2.00	10.36	**11.85**	14.81
2.40	12.77	**15.35**	19.46
2.80	14.81	**18.22**	24.53
3.20	16.14	**20.74**	28.90
3.60	17.29	**22.77**	32.77
4.00	18.36	**24.28**	36.22
4.40	19.38	**25.72**	39.37
4.80	20.35	**27.07**	42.29
5.20	21.27	**28.36**	44.94
5.60	22.16	**29.59**	47.09
6.00	23.01	**30.78**	49.15

Slurry Pond Culvert

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.00	0.0150	2.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 6.00 cfs

Maximum Headwater = 2.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (12 in)	**Discharge (cfs) (15 in)**	Discharge (cfs) (18 in)
0.20	0.19	**0.24**	0.28
0.40	0.53	**0.68**	0.81
0.60	0.98	**1.22**	1.46
0.80	1.50	**1.88**	2.25
1.00	2.05	**2.62**	3.14
1.20	2.41	**3.44**	4.13
1.40	3.11	**4.34**	5.20
1.60	3.35	**5.10**	6.36
1.80	3.57	**5.72**	7.46
2.00	3.74	**6.13**	8.43
2.20	3.92	**6.44**	9.30
2.40	4.08	**6.73**	9.92
2.60	4.24	**7.02**	10.39
2.80	4.39	**7.29**	10.83
3.00	4.54	**7.55**	11.25

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Culvert No. 5 UPDATED Design

Culvert No. 5 was selected as the critcal design case for Wishbone Hill based on overall slope steepness (30% slopes).

Brandon A Coleman

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	Culvert No. 5

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	12.360	12.360	7.21	1.24

Structure Detail:

Structure #1 (Culvert)

Culvert No. 5

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.00	0.0150	2.00	0.00	0.90

Culvert Results:

Design Discharge = 7.21 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	12.360	0.050	0.000	0.000	70.000	TR55	7.21	1.238
	Σ	**12.360**						**7.21**	**1.238**

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Culvert No. 9 UPDATED Design

Culvert No. 9 was selected as the critcal design case for Wishbone Hill based on catchment area (39.5 acres).

Brandon A Coleman

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	100 yr - 24 hr
Rainfall Depth:	3.810 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	Culvert No. 9

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	39.500	39.500	20.48	4.03

Structure Detail:

Structure #1 (Culvert)

Culvert No. 9

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.00	0.0150	3.25	0.00	0.90

Culvert Results:

Design Discharge = 20.48 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	39.500	0.150	0.000	0.000	70.000	TR55	20.48	4.027
	Σ	**39.500**						**20.48**	**4.027**

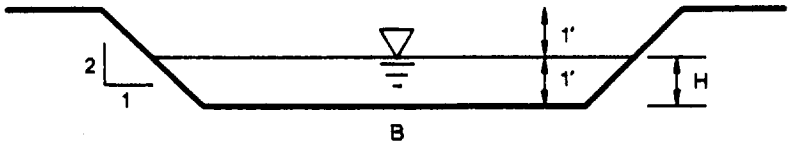
APPENDIX D.5
SPILLWAY SIZING

TABLE D.5-1 SPILLWAY SIZING SUPERCEEDS DIMENSIONS SHOWN ON FIGURE D-1

Sediment Pond Number	UPDATED Peak Flow (cfs)	Flow Depth (ft)	Minimum Bottom Width (ft)
1	30.53	1.00	10.18
2	87.58	1.00	29.19
3	6.09	1.00	2.03
4	1.66	1.00	0.55
5	43.75	1.00	14.58
6	3.97	1.00	1.32
7	3.97	1.00	1.32
FRESH WATER POND NO. 1	43	1.00	15
FRESH WATER POND NO. 2	8	1.00	2.7

CRITERIA

NOT TO EXCEED 1 FT OF FLOW DEPTH THRU CHANNEL



USE: $Q = 3 \times BH^{3/2}$ $B = Q / (3 \times H^{3/2}) = Q/3$

WHERE Q = PEAK FLOW FROM TABLE D-1-2

B = CHANNEL BOTTOM WIDTH

H = HEIGHT OF FLOW IN CHANNEL

POND	Q	H	MIN. B×
SED. POND 1	21	1	7
SED. POND 2	33	1	11
SED. POND 3	5	1	1.7
SED. POND 4	2	1	0.7
SED. POND 5	32	1	11
SED. POND 6	3	1	1
SED. POND 7	3	1	1
FRESH WATER POND NO. 1	43	1	15
FRESH WATER POND NO. 2	8	1	2.7

× USE B=5' OR MIN B, WHICHEVER IS GREATER.

CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

David E. Germer

PROJECT NO. 17202	IDEMITSU ALASKA, INC. c/o McKINLEY MINING CONSULTANTS, INC. 634 South Bailey, Suite 205, Palmer AK 99645	FIGURE D-1
DATE 08/89	WISHBONE HILL MINE MATANUSKA-SUSITNA BOROUGH, ALASKA	POND EMERGENCY OVERFLOW INLET DESIGNS
REVISION 0	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN (U.S.) Consulting Engineers & Scientists	

RECEIVED JUL 31 1990

DITCH DESIGN SPREADSHEET
USING MANNINGS EQUATION
FOR TRAPEZOIDAL OR V-SHAPED DITCHES DATE: 29-Aug-89

GENERAL INFORMATION

PROJECT OR BILLING NO.	WISHBONE HILL PROJECT	17202
FEATURE	FRESH WATER POND NO. 2	SPILLWAY
DESIGN EVENT: RETURN PERIOD AND DURATION	100.0 YR	24 HR
FREEBOARD REQUIREMENT (FT)	1.0	

SIZING CRITERIA (INPUT)

DESIGN FLOW (CFS)	8.0	INTERIM CALCS	
TRIAL WIDTH (CHANNEL BOTTOM,FT)	5.0		
TRIAL FLOW DEPTH (FT)	0.6	AREA	3.72 SQ FT
CHANNEL SIDE SLOPE (H:1), H=	2.0	WET PERIM	7.68 FT
CHANNEL LONGITUDINAL SLOPE (%)	0.9	HYD RADIUS	0.48 FT
MANNINGS "n" VALUE	0.035		

CALCULATIONS (OUTPUT)

		COMMENT
FLOW CAPACITY (CFS)	9.3	OK
MEAN FLOW VELOCITY (FPS)	2.5	
REE SURFACE WIDTH (TOP WIDTH, FT)	7.4	
TOTAL DEPTH OF CHANNEL (FT)	1.6	
FROUDE NUMBER	0.6	

RIPRAP REQUIREMENT

d50 OF REQUIRED RIPRAP (IN) NO RIPRAP REQUIRED

*NOTE: ASSUMED SPECIFIC GRAVITY OF ROCK
USED FOR RIPRAP = 2.65

DITCH DESIGN SPREADSHEET
USING MANNINGS EQUATION
FOR TRAPEZOIDAL OR V-SHAPED DITCHES DATE: 29-Aug-89

GENERAL INFORMATION

PROJECT OR BILLING NO.	WIShBONE HILL PROJECT	17202
FEATURE	FRESh WATER POND NO. 1	SPILLWAY
DESIGN EVENT: RETURN PERIOD AND DURATION	100.0 YR	24 HR
FREEBOARD REQUIREMENT (FT)	1.0	

SIZING CRITERIA (INPUT)

DESIGN FLOW (CFS)	42.6	INTERIM CALCS	
TRIAL WIDTH (CHANNEL BOTTOM,FT)	10.0		
TRIAL FLOW DEPTH (FT)	0.7	AREA	8.11 SQ FT
CHANNEL SIDE SlOPE (H:1), H=	2.0	WET PERIM	13.18 FT
CHANNEL LONGITUDINAL SlOPE (%)	3.0	HYD RADIUS	0.62 FT
MANNINGS "n" VALUE	0.035		

CALCULATIONS (OUTPUT)

		COMMENT
FLOW CAPACITY (CFS)	43.3	OK
MEAN FLOW VELOCITY (FPS)	5.3	
REE SURFACE WIDTH (TOP WIDTH, FT)	12.8	
TOTAL DEPTH OF CHANNEL (FT)	1.7	
FROUDE NUMBER	1.2	**SUPERCRITICAL FLOW!**

RIPRAP REQUIREMENT

d50 OF REQUIRED RIPRAP (IN) **SUPERCRITICAL FLOW!**

*NOTE: ASSUMED SPECIFIC GRAVITY OF ROCK
USED FOR RIPRAP = 2.65

APPENDIX E

DESIGN CALCULATIONS FOR BUFFALO CREEK DIVERSION
AND CHANNEL RELOCATION

APPENDIX E - DESIGN CALCULATIONS FOR BUFFALO CREEK DIVERSION AND CHANNEL RELOCATION

This Appendix contains the design calculations for the Buffalo Creek diversion structure, relocated channel, and diversion pipeline.

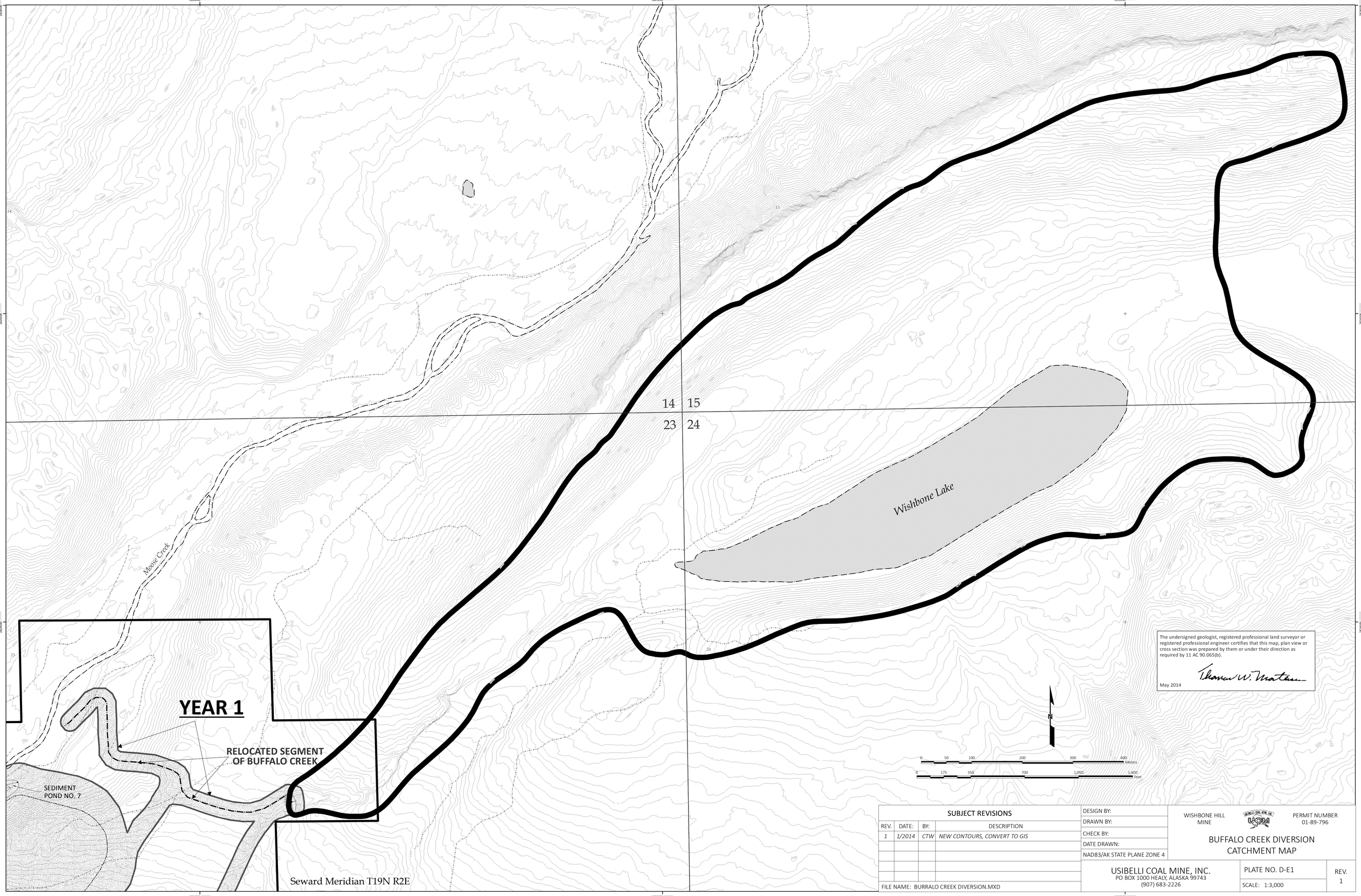
Calculation of the 100-yr stream flow was done using WASHED, an adaptation of WASHMO which utilizes SCS hydrograph techniques, developed by SRK for the IBM PC. Input parameters for WASHED include catchment areas, lengths and slopes, SCS curve number, and storm type and storm precipitation. The program calculates the runoff hydrograph for the catchment areas based on one of three hydrograph techniques, including double triangle, which was the technique used for these calculations. AMC II and a runoff curve number of 80 were assumed for the hydrograph calculation. The lead-in text of Appendix D gives further information on the site soil types and design assumptions. The higher curve number has been selected to reflect the likelihood of more predominant near-surface bedrock or bedrock outcrop in the catchment area as compared to the mine area. A working sketch is attached which shows the catchment boundary for the diversion.

The relocated channel segment was sized using the 100-yr peak flow and Manning's equation.

Riprap sizing was based on conservative urban design techniques (Wright-McLaughlin Engineers, 1969).

Sizing of the diversion pipeline was based on plant requirements provided by MMCI and anticipated creek flow based on the runoff assessment (Appendix B).

Depth of cover for the pipeline was based on estimated freezing depth for the materials anticipated along the alignment using the Stefan equation and regional information on Alaska climate (Andersland and Anderson, 1978 and Cold Regions Engineering Short Course, 1984).



The undersigned geologist, registered professional land surveyor or registered professional engineer certifies that this map, plan view or cross section was prepared by them or under their direction as required by 11 AC 90.065(b).

May 2014

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	1/2014	CTW	NEW CONTOURS, CONVERT TO GIS

FILE NAME: BURRALO CREEK DIVERSION.MXD

DESIGN BY:
DRAWN BY:
CHECK BY:
DATE DRAWN:
NAD83/AK STATE PLANE ZONE 4

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

BUFFALO CREEK DIVERSION CATCHMENT MAP

USIBELLI COAL MINE, INC.
PO BOX 1000 HEALY, ALASKA 99743
(907) 683-2226

PLATE NO. D-E1

SCALE: 1:3,000

REV. 1

```
*****************************************************
*                                                   *
*      H Y D R O L O G I C A L   S Y S T E M S      *
*                                                   *
*****************************************************
*                                                   *
*            PROGRAM   -   WASHED                   *
*                                                   *
*            WATERSHED MODELLING                    *
*                                                   *
*       PROGRAM TO DETERMINE RUNOFF HYDROGRAPHS     *
*       AND SEDIMENTGRAPHS FOR SMALL CATCHMENTS     *
*                                                   *
*****************************************************
```

```
COMPANY DOING ANALYSIS :   SRK
ENGINEER               :   RJF
DATE                   :   30-MAY-89
CLIENT                 :   MMC
PROJECT DESCRIPTION    :   WISHBONE HILL
MAJOR WATERSHED NAME   :   BUFFALO CREEK CHANNEL RELOCATION

THE INPUT DATA FILE IS                    :A:BUFFDIV.
THE FLOOD HYDROGRAPH AND SEDIMENTGRAPH IS NOT STORED
```

```
==================================================================

          ***************************************************************
          WATERSHED CONDITIONS AT  BUFFALO CREEK DIVERS
          ***************************************************************

          GLOBAL PARAMETERS
          -----------------

          RAINFALL                                    (mm.)    :     90.93
          INITIAL ABSTRACTION                         (mm.)    :       .00
            -- will default to the SCS method
          TIME INCREMENT OF HYDROGRAPH FROM START OF RUNOFF  :       .10

          RAINFALL DISTRIBUTION SELECTED                 :SCS TYPE 1 CURVE
==================================================================

          ****************************************************************
          SUBWATERSHED CONDITIONS AT BUFF CR DIV
          ****************************************************************

          RAINFALL PARAMETERS
          -------------------

          SCS CURVE NUMBER                            :  80.00
          UNIT HYDROGRAPH SELECTED                    :  DOUBLE TRIANGLE

          MAP PARAMETERS
          --------------

          AREA                                 (ha.)    :    110.00
          HYDRAULIC LENGTH                      (m.)    :   2286.00
          PERCENT FOREST                         (%)    :     10.00
          PERCENT AGRICULTURE                    (%)    :       .00
          PERCENT GRASSLAND                      (%)    :       .00
          OVERLAND FLOW SLOPE                    (%)    :     25.00
          CHANNEL SLOPE                          (%)    :     10.00
          CHANNEL LENGTH FROM SUBWATERSHED       (m.)   :       .00
          TYPE OF CHANNEL FROM SUBWATERSHED             :AN UNLINED CHANNEL
          CORRECTION FACTOR FOR IMPERVIOUS AREA         :      1.00
          CORRECTION FACTOR FOR CHANNEL IMPROVEMENTS    :      1.00
          AREAL REDUCTION FACTOR                        :      1.00



          SEDIMENT PARAMETERS
          -------------------

          THERE IS NO SEDIMENT DATA FOR THIS SUBWATERSHED

==================================================================
```

********** STORM HYDROGRAPH GENERATED FROM START OF RAINFALL **********

TIME *	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7.0 *	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
8.0 *	.1	.1	.3	.5	.5	.4	.4	.3	.3	.3
9.0 *	.3	.3	.4	.5	.7	.9	1.3	1.8	2.5	3.2
10.0 *	4.3	5.0	3.9	3.1	3.0	2.9	2.7	2.5	2.4	2.2
11.0 *	2.0	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1
12.0 *	1.0	1.0	.9	.9	.8	.8	.7	.7	.7	.7
13.0 *	.7	.6	.6	.6	.7	.7	.7	.7	.8	.8
14.0 *	.8	.9	.9	.9	.9	.9	.8	.8	.8	.8
15.0 *	.8	.8	.7	.7	.7	.7	.7	.6	.6	.6
16.0 *	.6	.6	.6	.5	.5	.5	.5	.5	.5	.5
17.0 *	.5	.4	.4	.4	.4	.4	.4	.4	.4	.4
18.0 *	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
19.0 *	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5
20.0 *	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
21.0 *	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
22.0 *	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
23.0 *	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
24.0 *	.5	.4	.3	.2	.1	.1	.1	.1	.0	.0

INITIAL ABSTRACTION	=	12.70	mm.
ROUTED FLOW TIME FROM THE SUBWATERSHED	=	.00	hours.
TIME TO PEAK OF UNIT HYDROGRAPH	=	.15	hours.
THE DEPTH OF WATER ON WATERSHED	=	43.11	mm.
VOLUME OF RUNOFF	=	47.40	thousand cu.m.
PEAK RUNOFF RATE	=	5.00	cu. m./sec.
TIME TO PEAK RUNOFF	=	10.10	hours.

==========

THERE IS NO SEDIMENT CONTAINED IN THE STORM RUNOFF FROM THIS WATERSHED

==========

STORM HYDROGRAPH FOR WATERSHED BUFFALO CREEK DIVERS

TOTAL AREA OF THE WATERSHED	=	110.00	ha.
THE DEPTH OF WATER ON WATERSHED	=	43.11	mm.
VOLUME OF RUNOFF	=	47.39	thousand cu.m.
PEAK RUNOFF RATE	=	5.00	cu. m./sec.
TIME TO PEAK RUNOFF	=	10.10	hours.
TIME INCREMENT OF NEW HYDROGRAPH	=	.10	hours.
NUMBER OF RUNOFF VALUES	=	186	

******* STORM HYDROGRAPH GENERATED FROM START OF RUNOFF *******

.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
.1	.1	.1	.1	.1	.1	.1	.3	.5	.5
.4	.4	.3	.3	.3	.3	.3	.4	.5	.7
.9	1.3	1.8	2.5	3.2	4.3	5.0	3.9	3.1	3.0
2.9	2.7	2.5	2.4	2.2	2.0	1.8	1.7	1.6	1.5
1.4	1.3	1.2	1.2	1.1	1.0	1.0	.9	.9	.8
.8	.7	.7	.7	.7	.7	.6	.6	.6	.7
.7	.7	.7	.8	.8	.8	.9	.9	.9	.9
.9	.8	.8	.8	.8	.8	.8	.7	.7	.7
.7	.7	.6	.6	.6	.6	.6	.6	.5	.5
.5	.5	.5	.5	.5	.5	.4	.4	.4	.4
.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
.4	.4	.4	.4	.4	.4	.4	.4	.4	.5
.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
.5	.5	.5	.5	.5	.5	.4	.3	.2	.1
.1	.1	.1	.0	.0	.0				

DITCH DESIGN SPREADSHEET
USING MANNINGS EQUATION
FOR TRAPEZOIDAL OR V-SHAPED DITCHES DATE: 29-Jul-89

GENERAL INFORMATION

PROJECT OR BILLING NO.	WISHBONE HILL PROJECT 17202
FEATURE	BUFFALO CREEK RELOCATED SEGMENT- TYPE 1
DESIGN EVENT: RETURN PERIOD AND DURATION	100.0 YR 24 HR
FREEBOARD REQUIREMENT (FT)	1.0

SIZING CRITERIA (INPUT)

DESIGN FLOW (CFS)	180.0	INTERIM CALCS	
TRIAL WIDTH (CHANNEL BOTTOM,FT)	10.0		
TRIAL FLOW DEPTH (FT)	2.5	AREA	37.50 SQ FT
CHANNEL SIDE SLOPE (H:1), H=	2.0	WET PERIM	21.18 FT
CHANNEL LONGITUDINAL SLOPE (%)	0.5	HYD RADIUS	1.77 FT
MANNINGS "n" VALUE	0.030		

CALCULATIONS (OUTPUT)

		COMMENT
FLOW CAPACITY (CFS)	192.7	OK
MEAN FLOW VELOCITY (FPS)	5.1	
FREE SURFACE WIDTH (TOP WIDTH, FT)	20.0	
TOTAL DEPTH OF CHANNEL (FT)	3.5	
FROUDE NUMBER	0.7	

RIPRAP REQUIREMENT

d50 OF REQUIRED RIPRAP (IN)	1.3

*NOTE: ASSUMED SPECIFIC GRAVITY OF ROCK
USED FOR RIPRAP = 2.65

DITCH DESIGN SPREADSHEET
USING MANNINGS EQUATION
FOR TRAPEZOIDAL OR V-SHAPED DITCHES DATE: 29-Jul-89

GENERAL INFORMATION

PROJECT OR BILLING NO.	WISHBONE HILL PROJECT 17202
FEATURE	BUFFALO CREEK RELOCATED SEGMENT- TYPE 2
DESIGN EVENT: RETURN PERIOD AND DURATION	100.0 YR 24 HR
FREEBOARD REQUIREMENT (FT)	1.0

SIZING CRITERIA (INPUT)

DESIGN FLOW (CFS)	180.0	INTERIM CALCS	
TRIAL WIDTH (CHANNEL BOTTOM,FT)	10.0		
TRIAL FLOW DEPTH (FT)	0.9	AREA	10.62 SQ FT
CHANNEL SIDE SLOPE (H:1), H=	2.0	WET PERIM	14.02 FT
CHANNEL LONGITUDINAL SLOPE (%)	33.0	HYD RADIUS	0.76 FT
MANNINGS "n" VALUE	0.040		

CALCULATIONS (OUTPUT)

		COMMENT
FLOW CAPACITY (CFS)	188.8	OK
MEAN FLOW VELOCITY (FPS)	17.8	
FREE SURFACE WIDTH (TOP WIDTH, FT)	13.6	
TOTAL DEPTH OF CHANNEL (FT)	1.9	
FROUDE NUMBER	3.5	**SUPERCRITICAL FLOW!**

RIPRAP REQUIREMENT

d50 OF REQUIRED RIPRAP (IN) **SUPERCRITICAL FLOW!**

*NOTE: ASSUMED SPECIFIC GRAVITY OF ROCK
USED FOR RIPRAP = 2.65

DITCH DESIGN SPREADSHEET
USING MANNINGS EQUATION
FOR TRAPEZOIDAL OR V-SHAPED DITCHES DATE: 29-Jul-89

GENERAL INFORMATION

PROJECT OR BILLING NO.	WISHBONE HILL PROJECT 17202
FEATURE	BUFFALO CREEK RELOCATED SEGMENT- TYPE 3
DESIGN EVENT: RETURN PERIOD AND DURATION	100.0 YR 24 HR
FREEBOARD REQUIREMENT (FT)	1.0

SIZING CRITERIA (INPUT)

DESIGN FLOW (CFS)	180.0	INTERIM CALCS	
TRIAL WIDTH (CHANNEL BOTTOM,FT)	10.0		
TRIAL FLOW DEPTH (FT)	2.0	AREA	28.00 SQ FT
CHANNEL SIDE SLOPE (H:1), H=	2.0	WET PERIM	18.94 FT
CHANNEL LONGITUDINAL SLOPE (%)	1.5	HYD RADIUS	1.48 FT
MANNINGS "n" VALUE	0.035		

CALCULATIONS (OUTPUT)

		COMMENT
FLOW CAPACITY (CFS)	189.4	OK
MEAN FLOW VELOCITY (FPS)	6.8	
FREE SURFACE WIDTH (TOP WIDTH, FT)	18.0	
TOTAL DEPTH OF CHANNEL (FT)	3.0	
FROUDE NUMBER	1.0	

RIPRAP REQUIREMENT

d50 OF REQUIRED RIPRAP (IN)	3.4

*NOTE: ASSUMED SPECIFIC GRAVITY OF ROCK
USED FOR RIPRAP = 2.65

TABLE E-1

BUFFALO CREEK PIPELINE DIVERSION

Length = 6,700 ft (scaled from Plate 3-1)
Elevation difference = 1,217 - 890 = 327 ft

Slope (overall average) = $\Delta E/L$ = 4.9%

Pipe-full flow for various dia. pipes @ 4.97%*

Pipe Diameter	Flow (GPM)
8 inches	1,775
12 inches	5,000
18 inches	15,000

*Reference: Driscopipe Design Manual produced by Phillips 66. See attached nomograph.

Est peak monthly average flow for Buffalo Creek is 908 gpm

Est 100-yr storm flow $\leq$ 180 cfs (81,000 gpm)
Est 10-yr storm flow is 3.5 cfs (16,000 gpm)

8 inch diameter pipe will work.

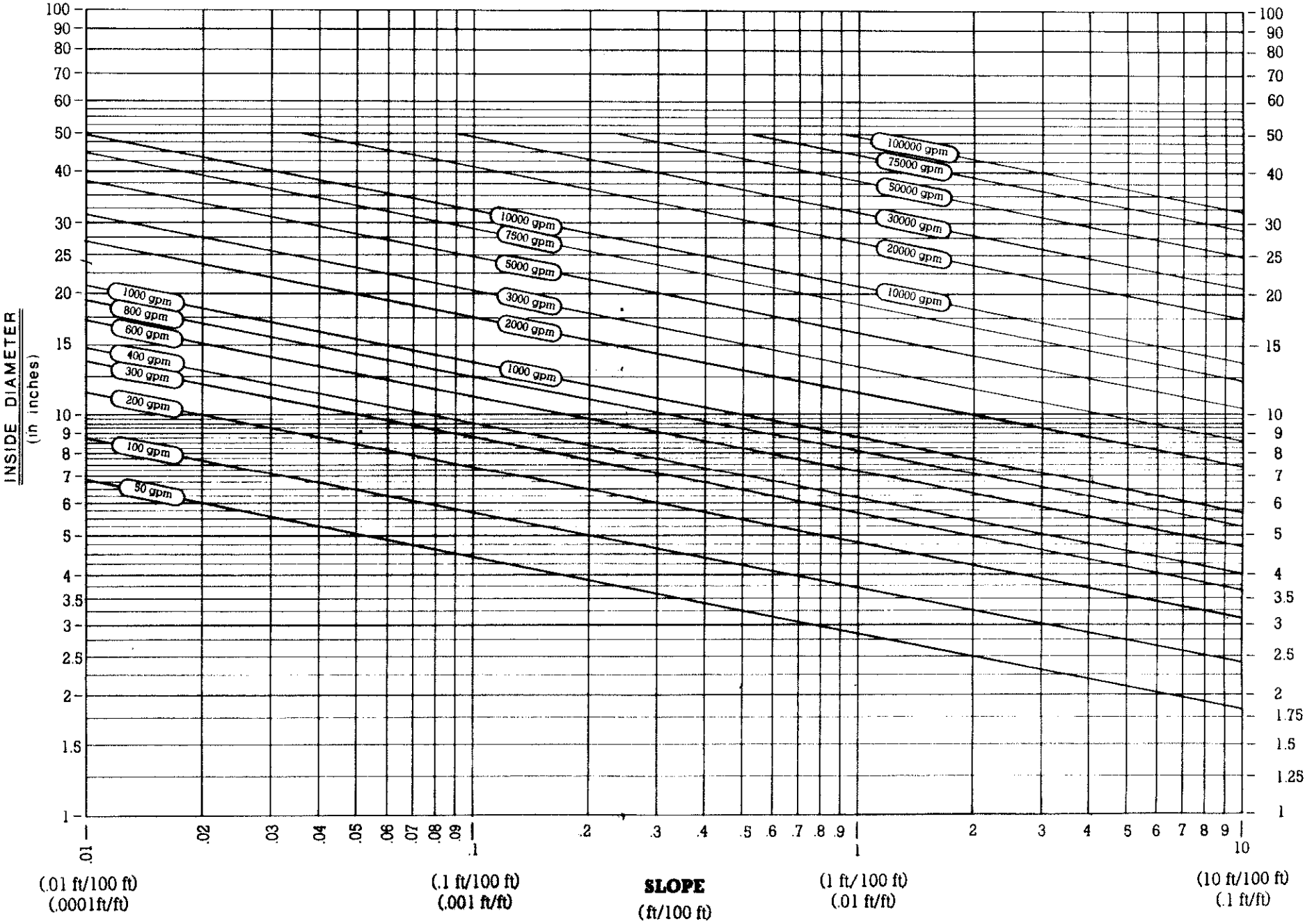
8 inch diameter gate valve should pass approximately 5 cfs or 2,000 gpm with outlet control.

FIGURE E-1

CHART 7

INSIDE DIAMETER VERSUS FLOW RATE AT A GIVEN SLOPE

GRAVITY FULL FLOW: WATER



From: Phillips 66, Driscopipe Systems Design, 1981.

TABLE E-2

RIPRAP SIZING

- Assume
  Q = 180 cfs
  channel width = 10 ft
  Max slope = 33% (3:1)
  Take n = 0.04

- Using Manning's Eqn:

  Depth of flow = 0.9 ft
  velocity = 18 fps

- From the Urban Storm Drainage Criteria Manual (Vol. 2):

$$d_{50} = \left[\frac{V \times S^{0.17}}{4.5 \times (Ss-1)^{0.66}}\right]^2$$

$$= \left[\frac{18 \times 0.33^{0.17}}{4.5 \times (2.65-1)^{.66}}\right]^2$$

$$= 2.4 \text{ ft } (29")$$

Blanket thickness = 1.75 x d_{50} = 4 ft

Granular bedding 8" of Type II material
Type II material gradation specification:

Sieve size or dia. (in)	% Passing
3"	90-100
3/4"	20-90
#4	0-20
#200	0-3

Riprap Gradation: (VH)

Dia. (in)	% Smaller
42	100
33	50-70
24	35-50
9	2-10

TABLE E-3

BUFFALO CREEK PIPELINE DIVERSION
ESTIMATION OF FREEZING DEPTH

FI* = freezing index 3,000 degree days for Palmer

$u^* = \frac{\text{Surface freezing index}}{\text{air freezing index}}$ = 0.5 ft for turf
0.33 for stripped soil
use 0.50

L* = latent heat = 144 (w) (xd)

sandy soils - L = (144) (0.07) (125) = 1,260 btu/ft^3

silty soils - L = (144) (0.35) (80) = 4.032 btu/ft^3

K_f** = thermal conductivity

sandy soils - k_f = 2.5

silty soils - k_f = 1.05

Stefan Formula*

$$x = \text{freezing depth} = \left(\frac{48\ k_f\ uFI}{L}\right)^{1/2}$$

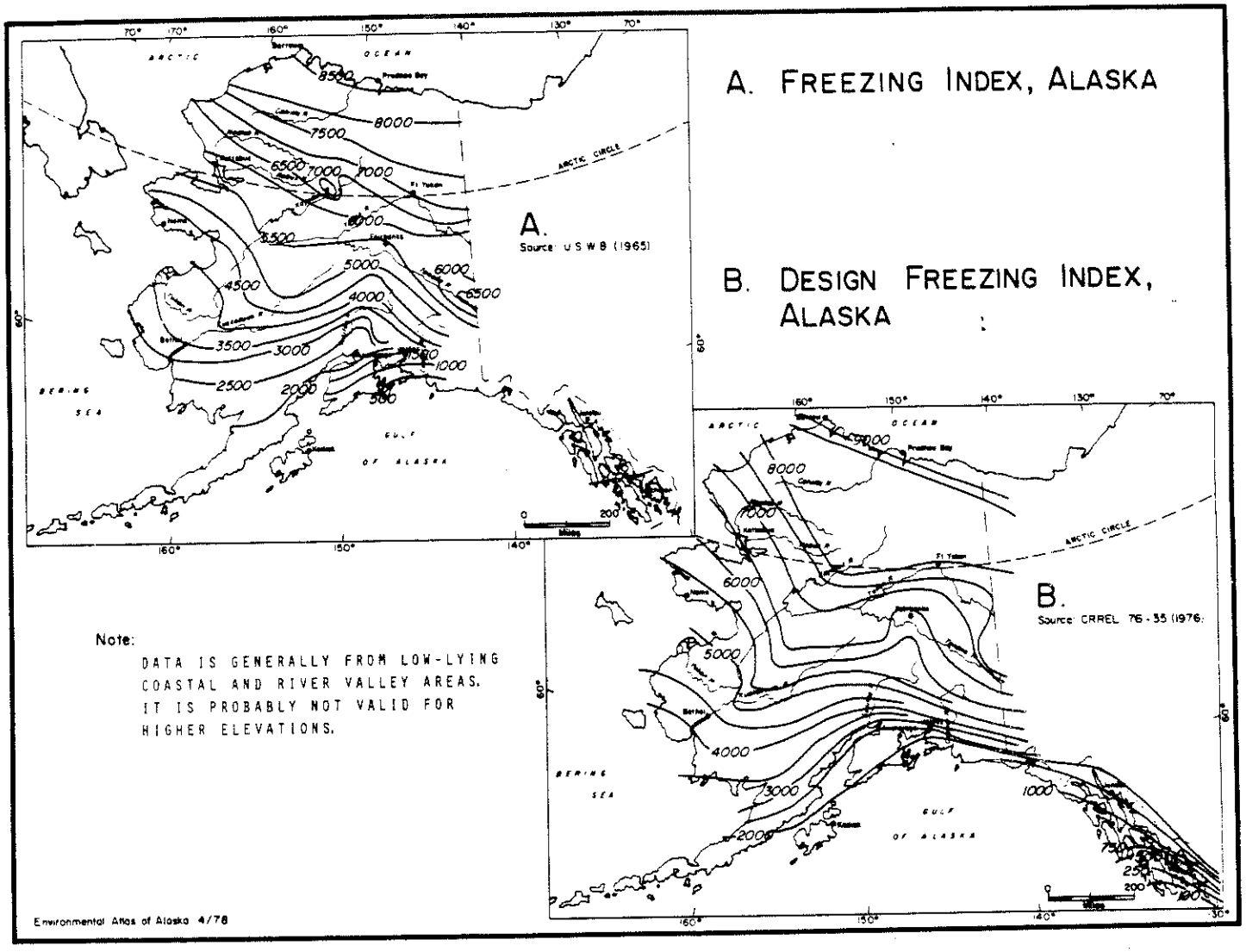
$$\text{sandy soils - } x = \left[\frac{(48)\ (2.5)\ (0.50)\ (3000)}{1260}\right]^{1/2} = 12.0 \text{ ft}$$

$$\text{silty soils - } x = \left[\frac{(48)\ (1.05)\ (0.50)\ (3000)}{4032}\right]^{1/2} = 4.3 \text{ ft}$$

* Cold Regions Engineering Short Course, June 14-17, 1984, Denver, Colorado, by University of Alaska and University of Washington.

** Geotechnical Engineering for Cold Regions, by G.B. Anderstand and D.M. Anderson, McGraw-Hill Book Company, New York, 1978.

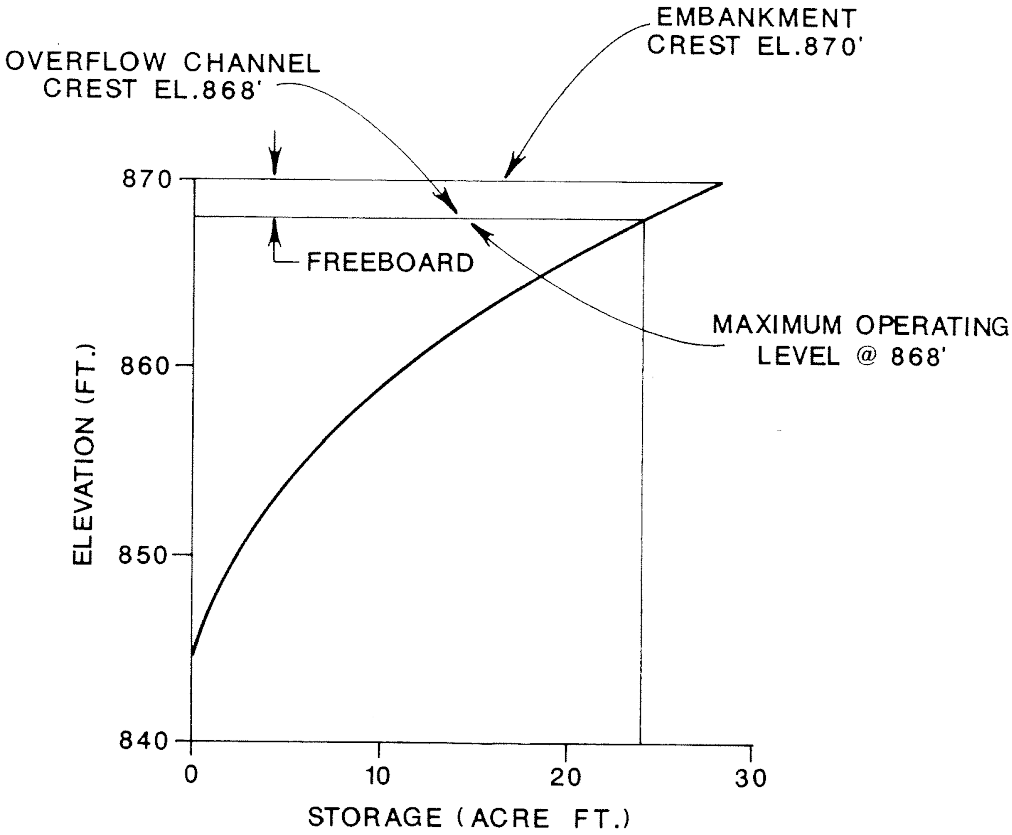
FIGURE E-2



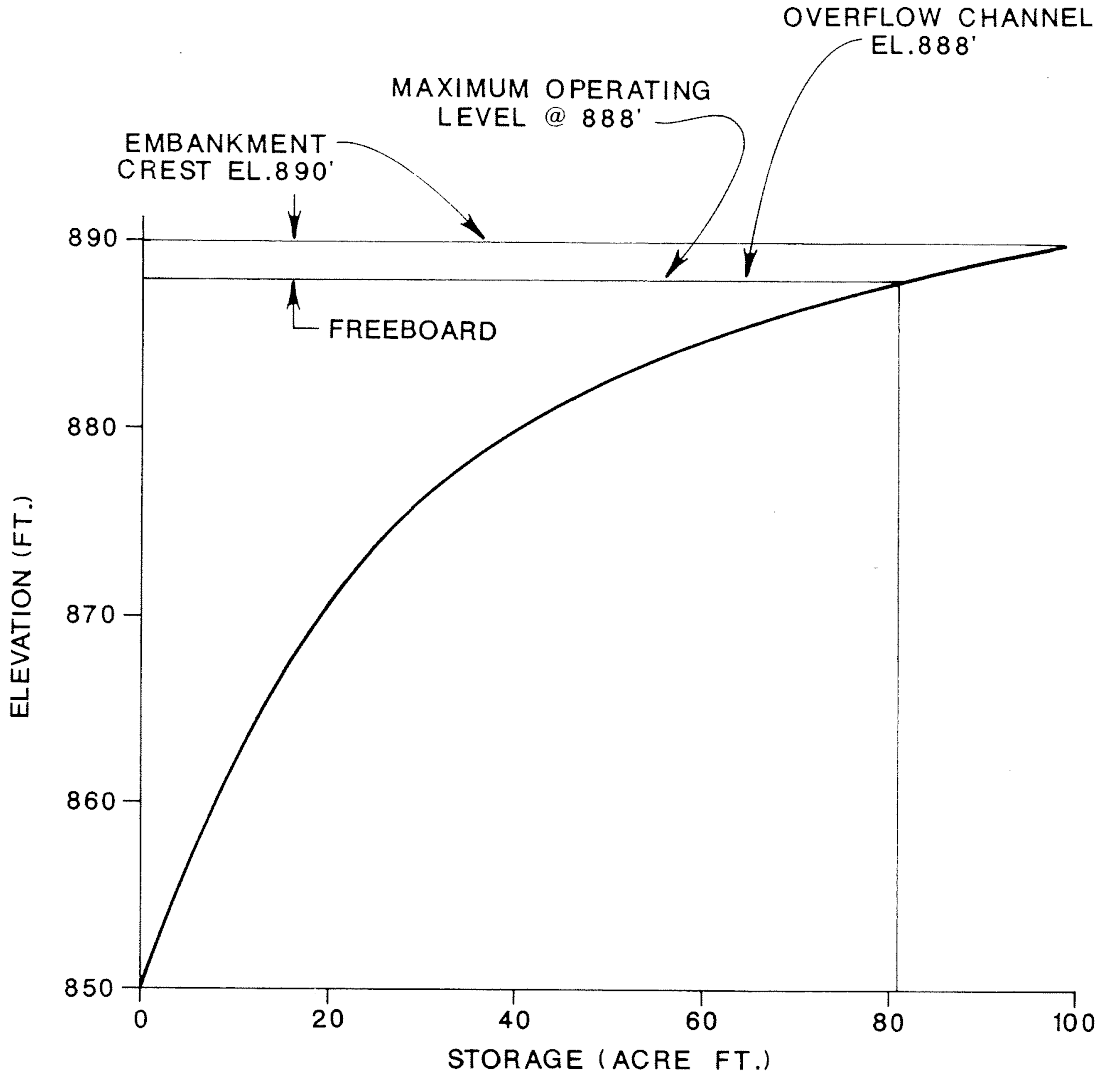
FREEZING INDICES FOR ALASKA

From Cold Regions Engineering Short Course, June 14-17, 1984, Denver, Colorado.

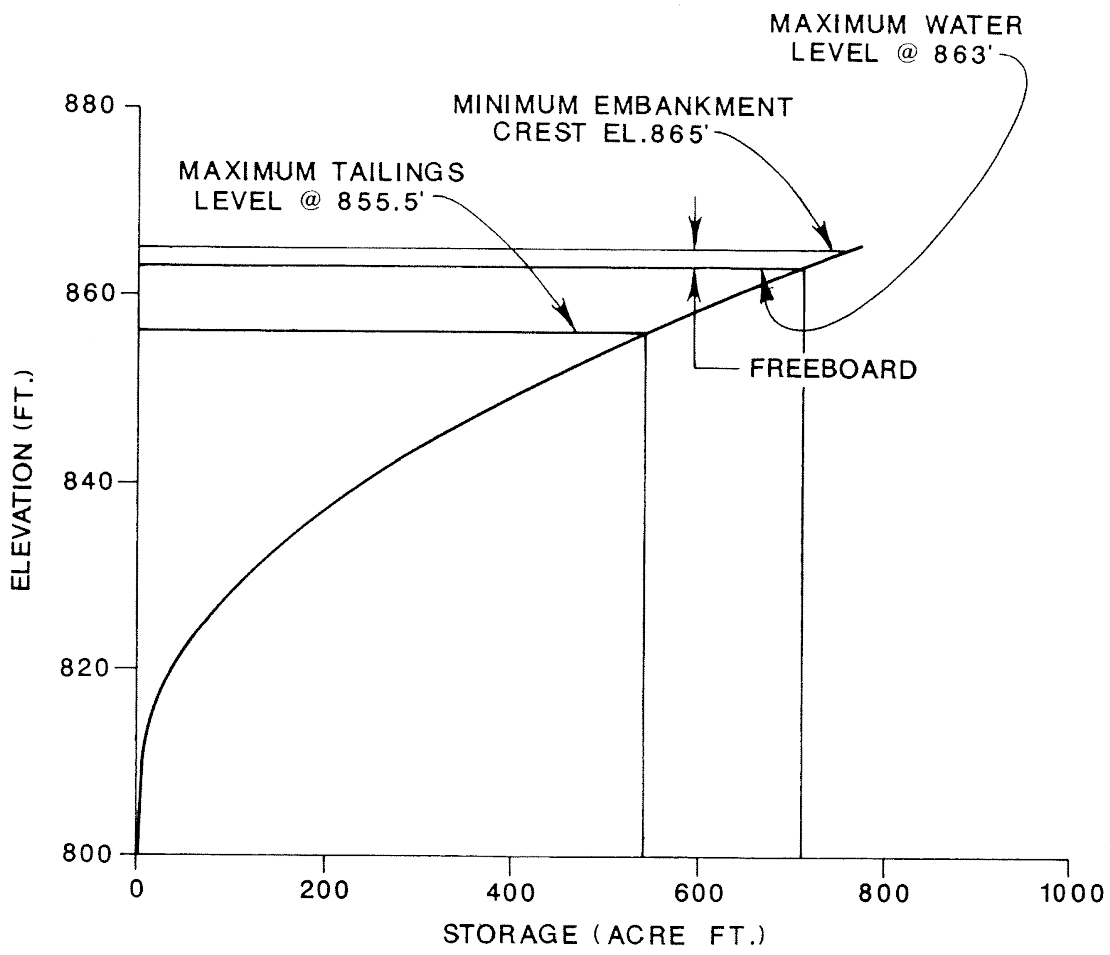
APPENDIX F
HEIGHT CAPACITY CURVES



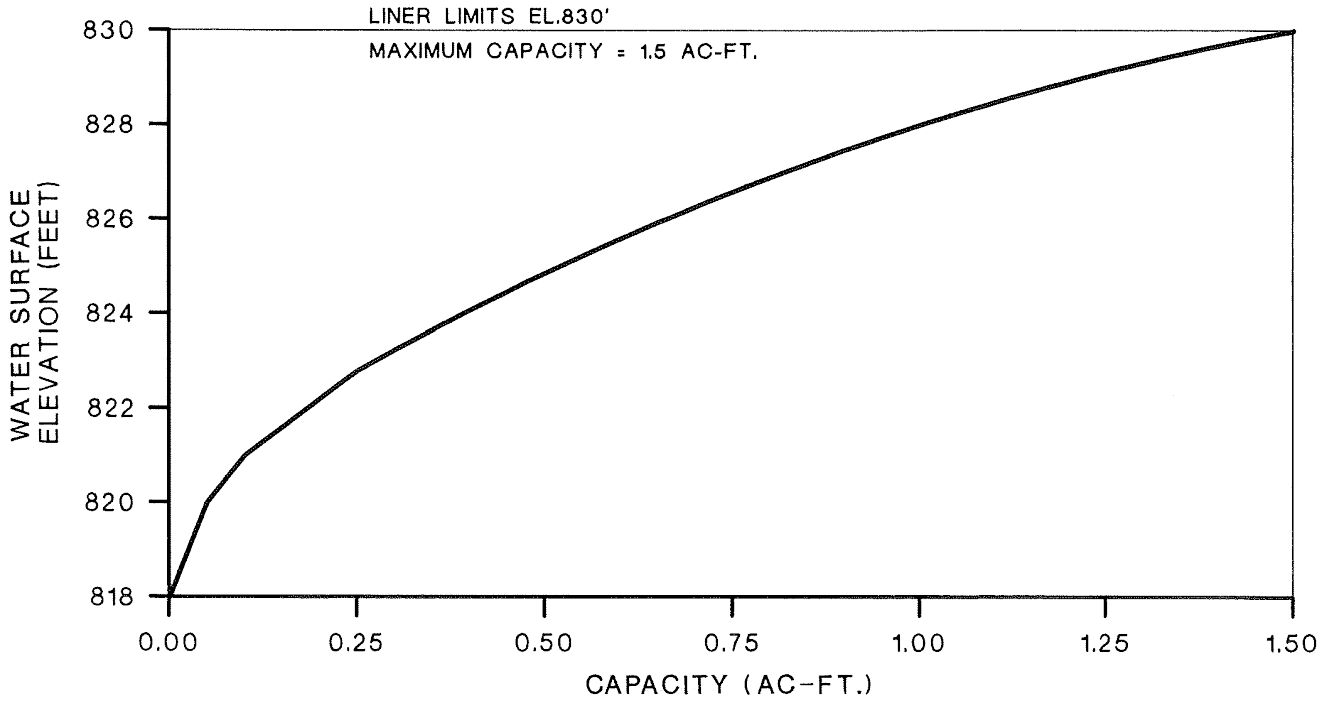
DESIGN BY:	HEIGHT CAPACITY CURVE FRESH WATER POND No. 1	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-1 — REV. 0
DATE DRAWN: 8/89		SCALE: AS SHOWN



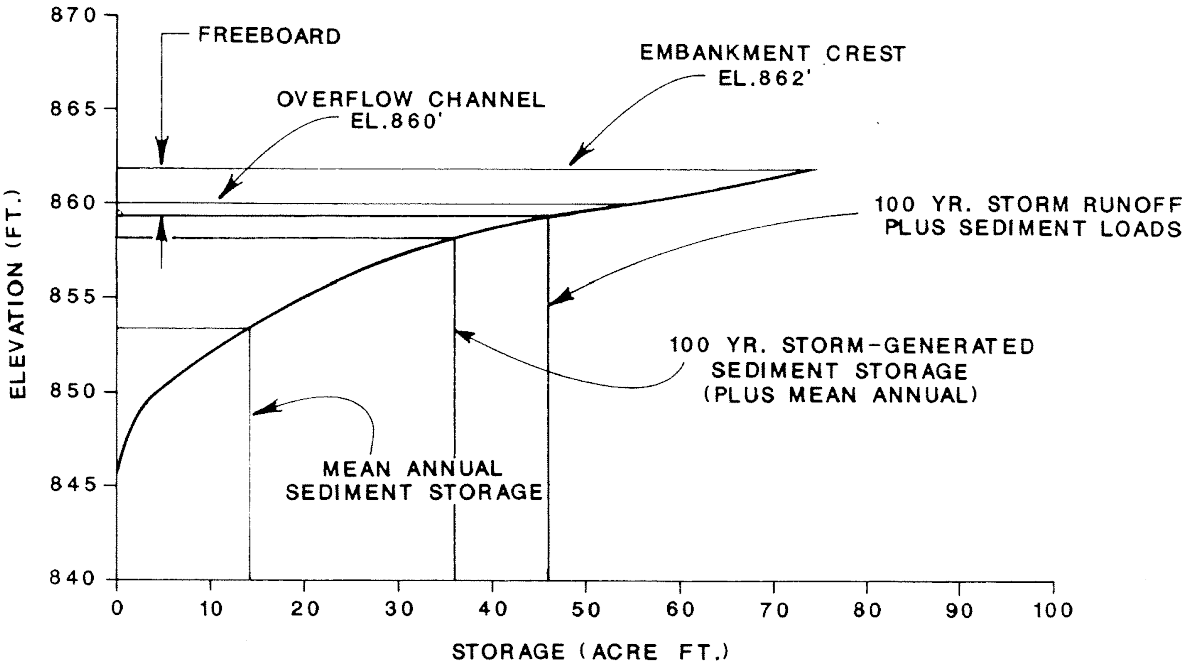
DESIGN BY:	HEIGHT CAPACITY CURVE FRESH WATER POND No. 2	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-2 — REV. 0
DATE DRAWN: 8/89		SCALE: AS SHOWN



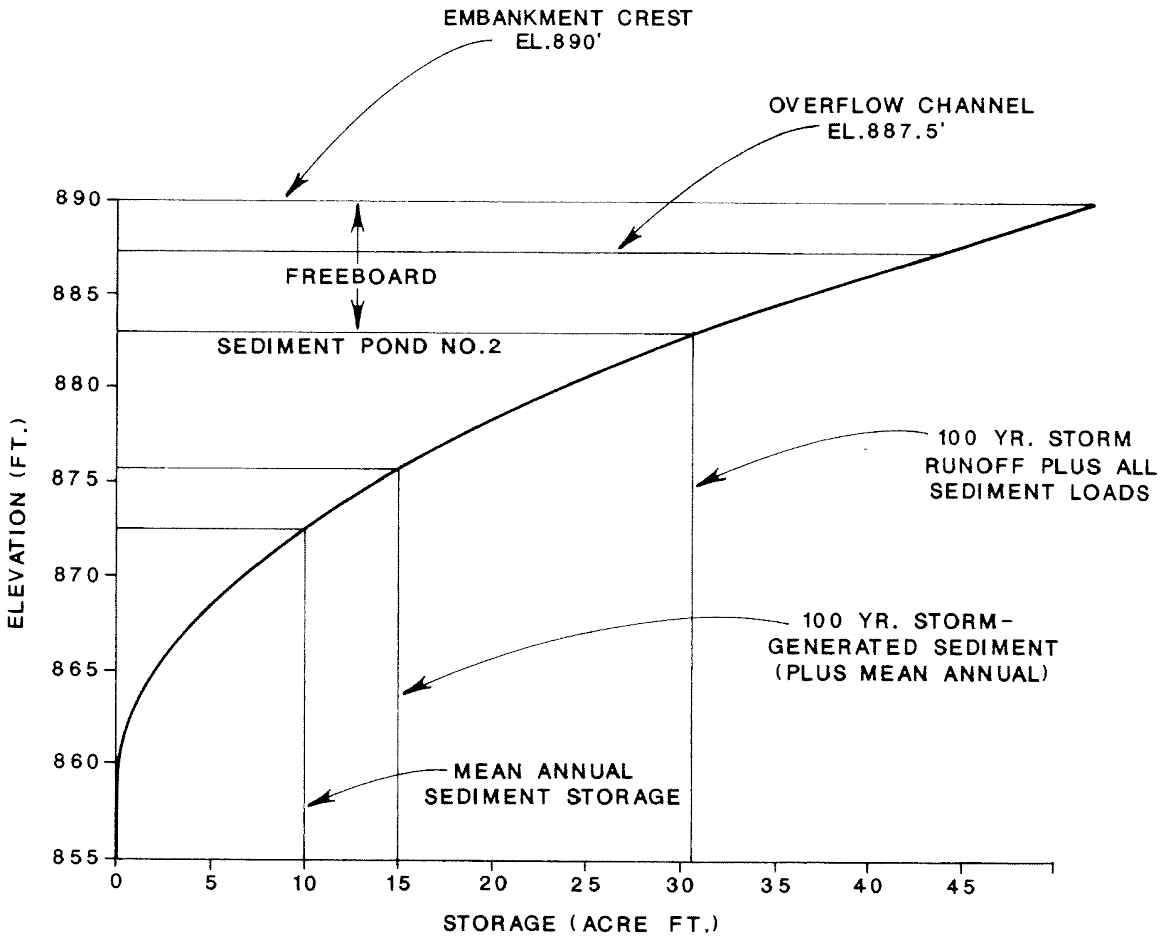
DESIGN BY:	HEIGHT CAPACITY CURVE SLURRY POND	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-3 — REV. 0
DATE DRAWN: 8/89		SCALE: AS SHOWN



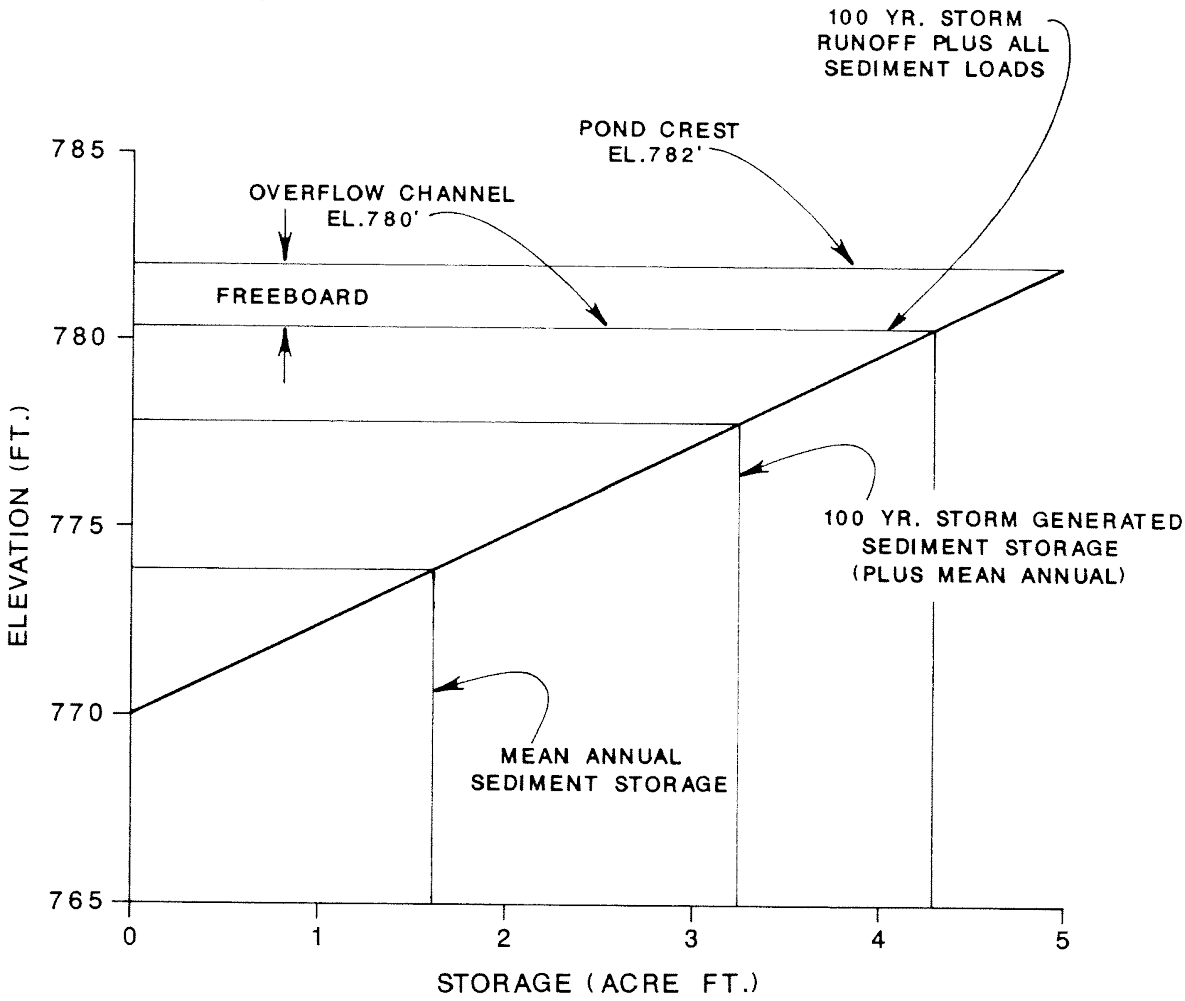
DESIGN BY:	HEIGHT CAPACITY CURVE WASH DOWN WATER RECYCLE POND	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-4	REV. 0
DATE DRAWN: 7/90		SCALE: AS SHOWN	



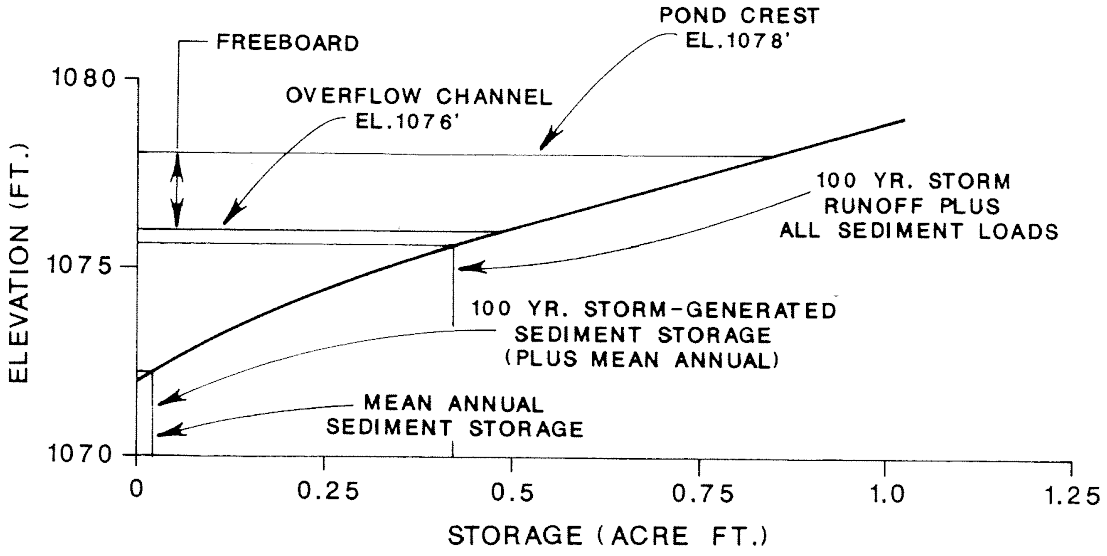
DESIGN BY:	HEIGHT CAPACITY CURVE SEDIMENT POND No. 1	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-5 — REV. 0
DATE DRAWN: 8/89		SCALE: AS SHOWN



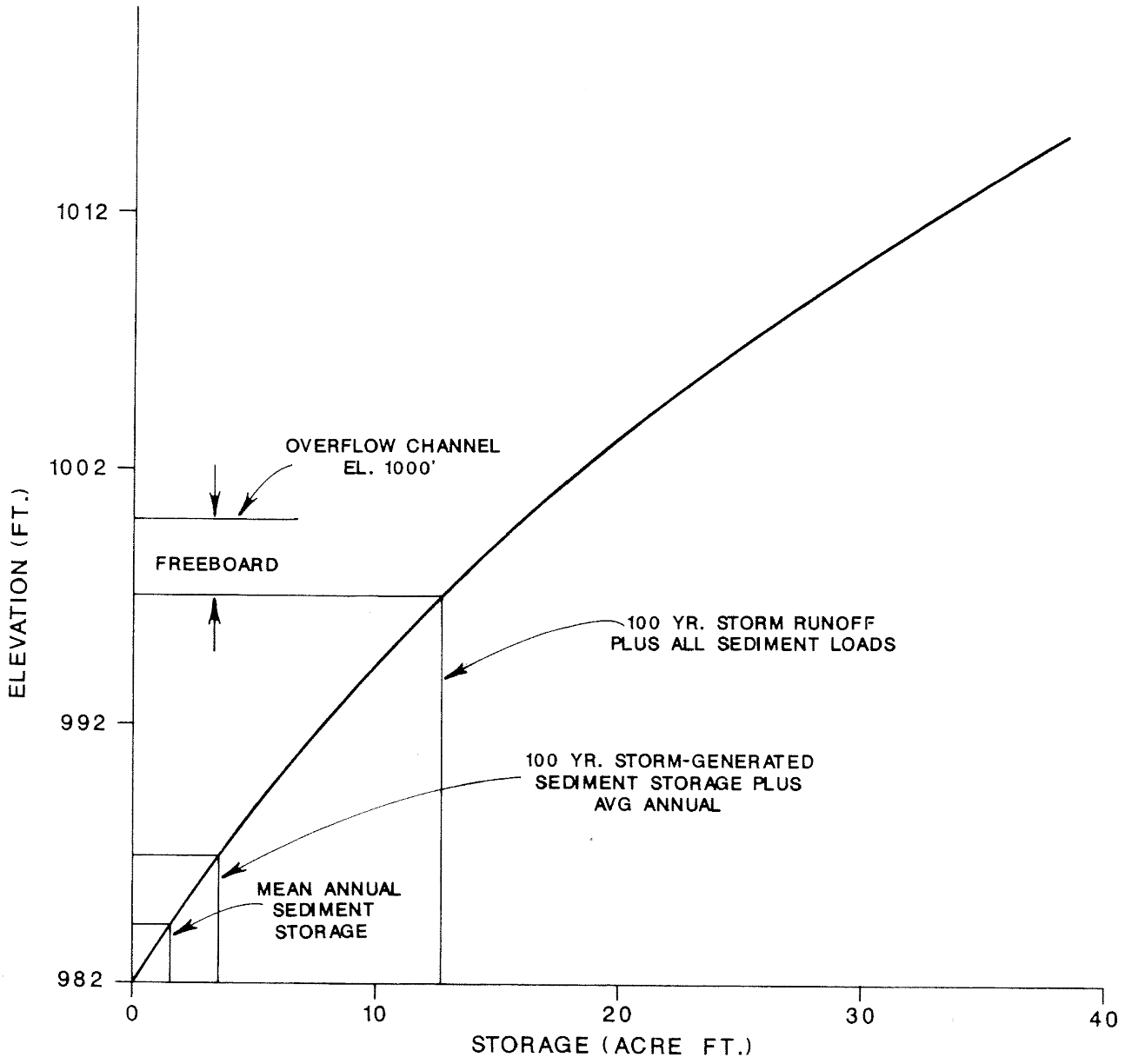
DESIGN BY:	HEIGHT CAPACITY CURVE SEDIMENT POND No. 2	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-6 — REV. 0
DATE DRAWN: 8/89		SCALE: AS SHOWN



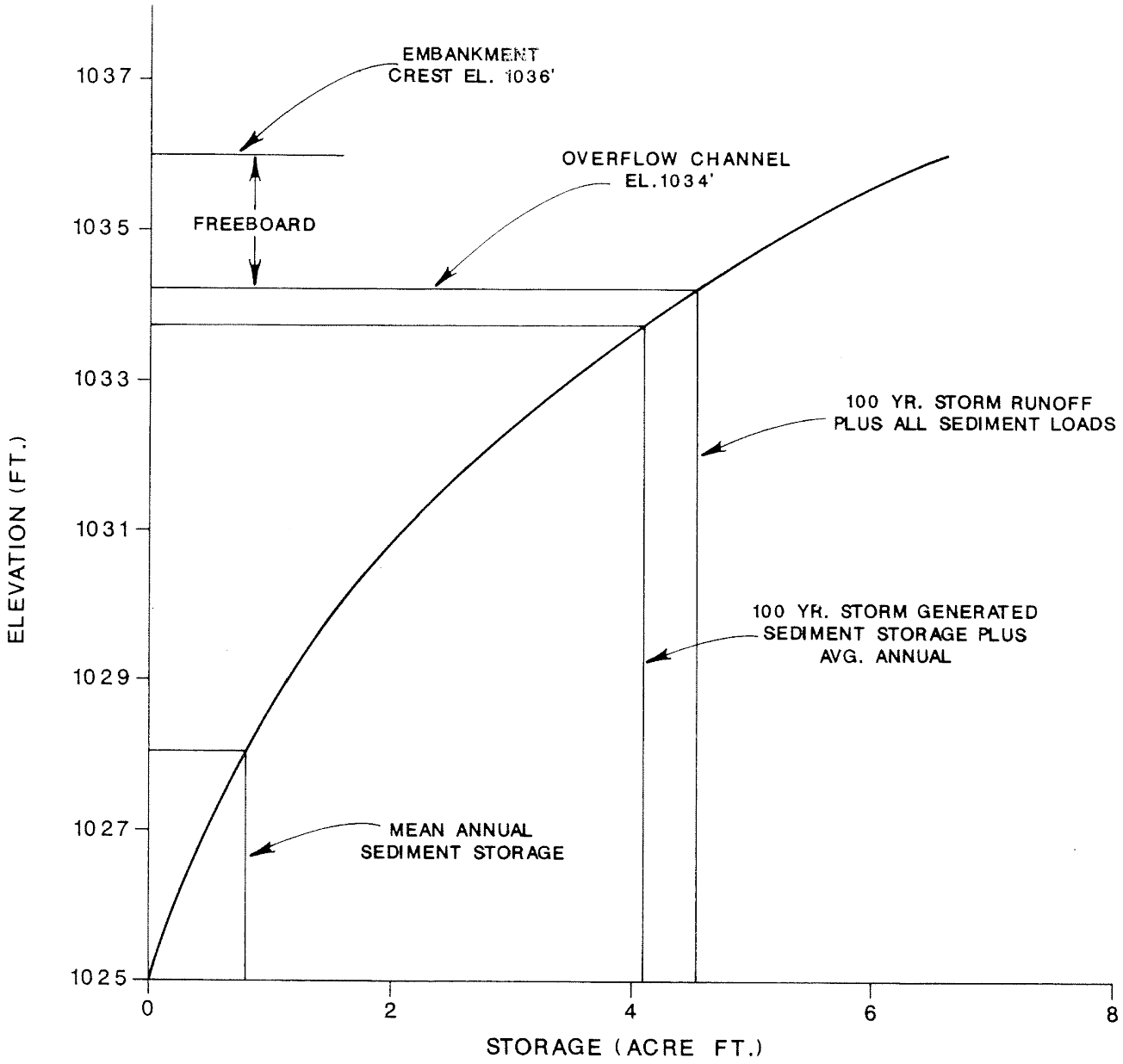
DESIGN BY:	HEIGHT CAPACITY CURVE SEDIMENT POND No. 3	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-7 — REV. 0
DATE DRAWN: 8/89		SCALE: AS SHOWN



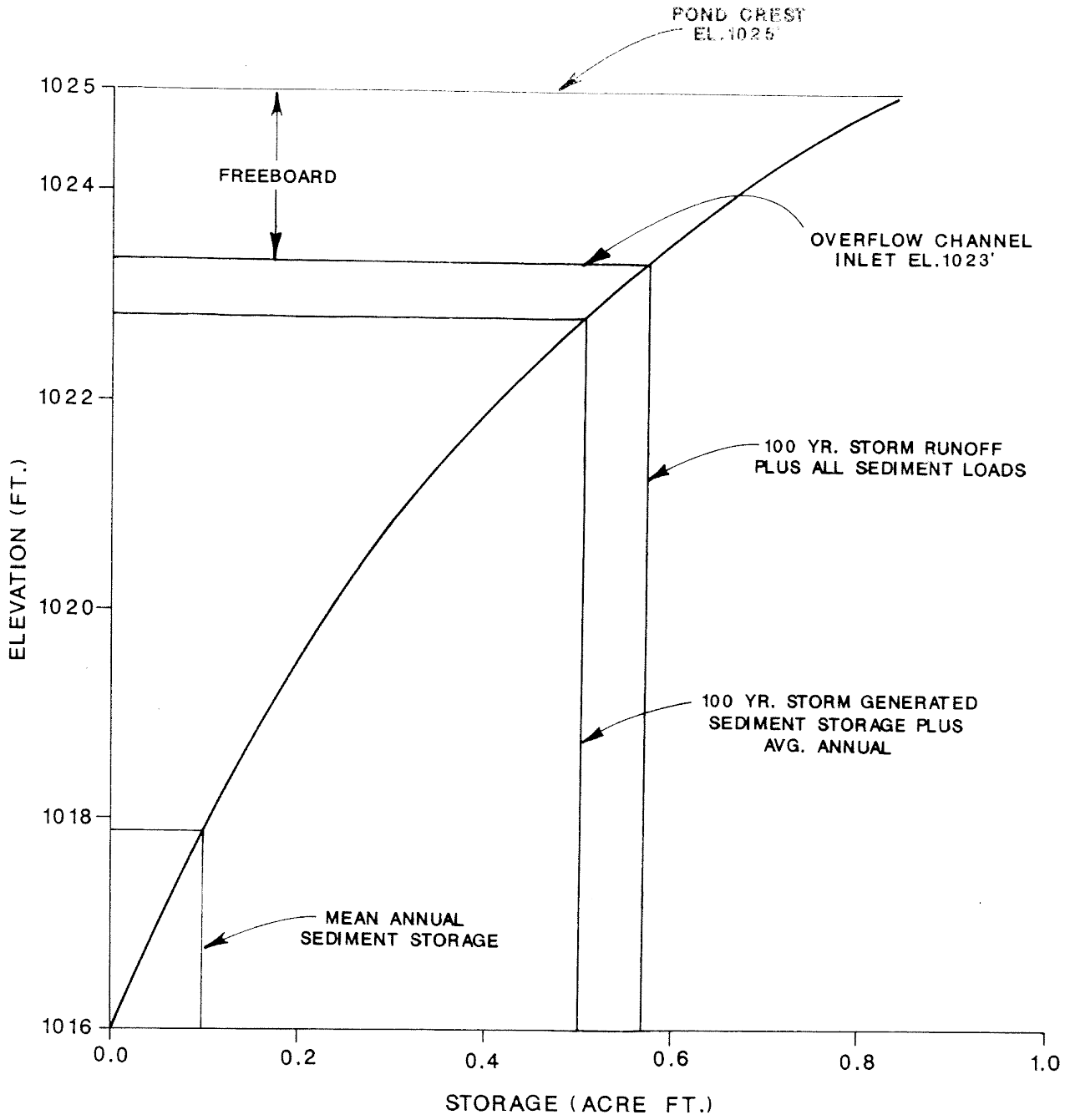
DESIGN BY:	HEIGHT CAPACITY CURVE SEDIMENT POND No. 4	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-8 — REV. 0
DATE DRAWN: 8/89		SCALE:



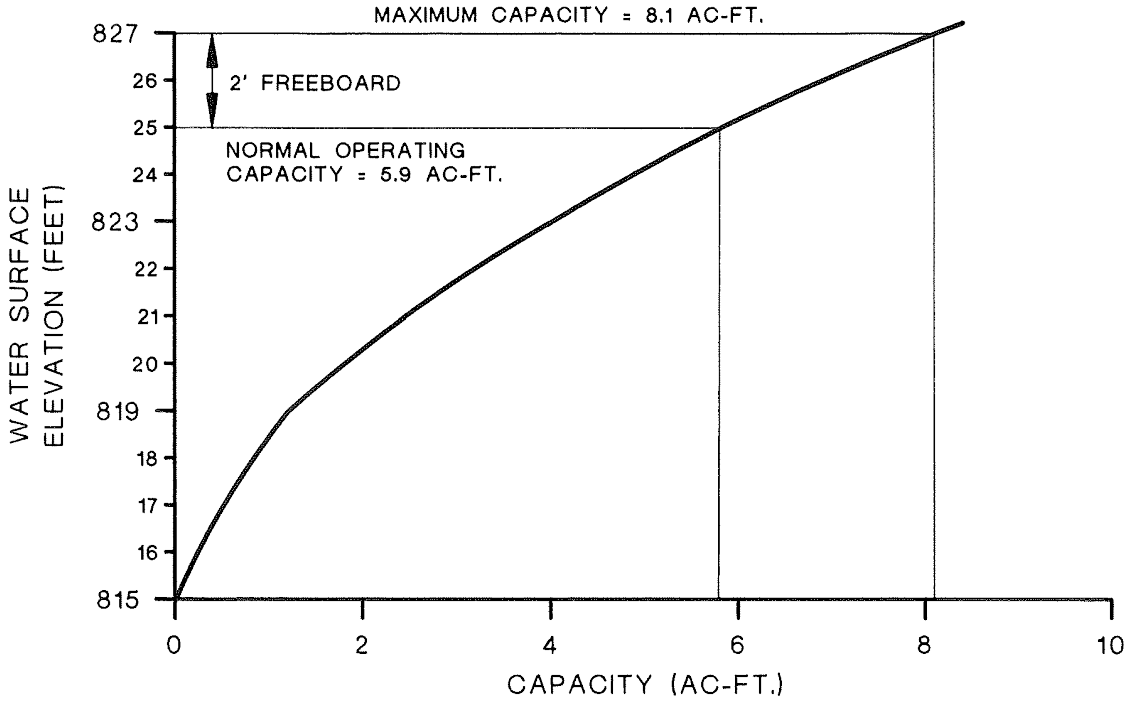
DESIGN BY:	HEIGHT CAPACITY CURVE SEDIMENT POND No. 5	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-9	REV. 0
DATE DRAWN: 8/89		SCALE:	



DESIGN BY:	HEIGHT CAPACITY CURVE SEDIMENT POND No. 6	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-10	REV. 0
DATE DRAWN: 8/89		SCALE:	



DESIGN BY:	HEIGHT CAPACITY CURVE SEDIMENT POND No. 7	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-11	REV. 0
DATE DRAWN: 8/89		SCALE:	



DESIGN BY:	HEIGHT CAPACITY CURVE FACILITIES AREA SEDIMENT POND	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. F-12	REV. 0
DATE DRAWN: 8/89		SCALE:	

APPENDIX G
STABILITY CALCULATIONS

APPENDIX G - STABILITY CALCULATIONS

G.1 General

Slope stability analyses were performed in accordance with the Alaska Surface Coal Mining Control and Reclamation Regulations, Mine Safety and Health Administration (MSHA) requirements and proposed State of Alaska Dam Safety requirements. The most conservative combination of these regulations required that a stability analysis be performed on any structure impounding more than 20 acre feet of water or having an embankment height of 20 feet or greater as measured from the embankment centerline to either the upstream or downstream toe, whichever provides the higher height. The stability of each berm was evaluated at the maximum cross-section utilizing two-dimensional force-equilibrium techniques. Conditions that were considered in the stability analyses included static and pseudostatic loading, rapid drawdown from a maximum pool elevation, and critical pool elevations which could potentially adversely influence the stability of upstream and downstream embankment slopes. The stability of each overburden stockpile and Topsoil Stockpile No. 1 were also evaluated. These structures were evaluated for static and pseudostatic conditions only since they will not impound water.

G.2 Material Properties

The material properties utilized for the stability analyses were based on results of geotechnical laboratory testing, field observations, and interpretations of probable strength characteristics obtained from engineering literature. The material properties are tabulated on each stability figure.

G.3 Seismological Considerations

The seismicity of the Wishbone Hill Project site was evaluated on a preliminary basis using a seismic zone map of Alaska presented in Safety of Existing Dams, Evaluation and Improvement, published by National Academy Press in 1983. The map indicates that the site is located in seismic zone 3 which incorporates most of south-central Alaska between Fairbanks and Anchorage. An accompanying table indicates that the peak ground accelerations in this seismic zone are 0.4g and 0.2g for the Maximum Credible Earthquake (MCE) and Operating Basis Earthquake (OBE), respectively.

The peak ground accelerations for the Wishbone Hill Project site were converted to pseudostatic earthquake coefficients using correlations presented in the paper titled "Evaluation of Seismic Effects on Embankment Dams" by Robert B. Jansen, presented at the Hawaii Dam Safety Conference in Honolulu on December 5, 1989. The resultant pseudostatic coefficients range from 0.16g to 0.28g for the MCE and 0.08g to 0.14g for the OBE. Intermediate values of 0.2g and 0.1g were selected for use in stability analyses in their long-term, post-reclamation and operational configurations, respectively.

For the stability analysis, a pseudostatic method of analysis was employed to assess the performance of structures under dynamic earthquake loads. A peak Operational Basis Earthquake (OBE) of 0.1 g was chosen as the pseudostatic coefficient. The use of this pseudostatic coefficient is reasonable considering the hazard class and relatively short life-span of the impounding structures.

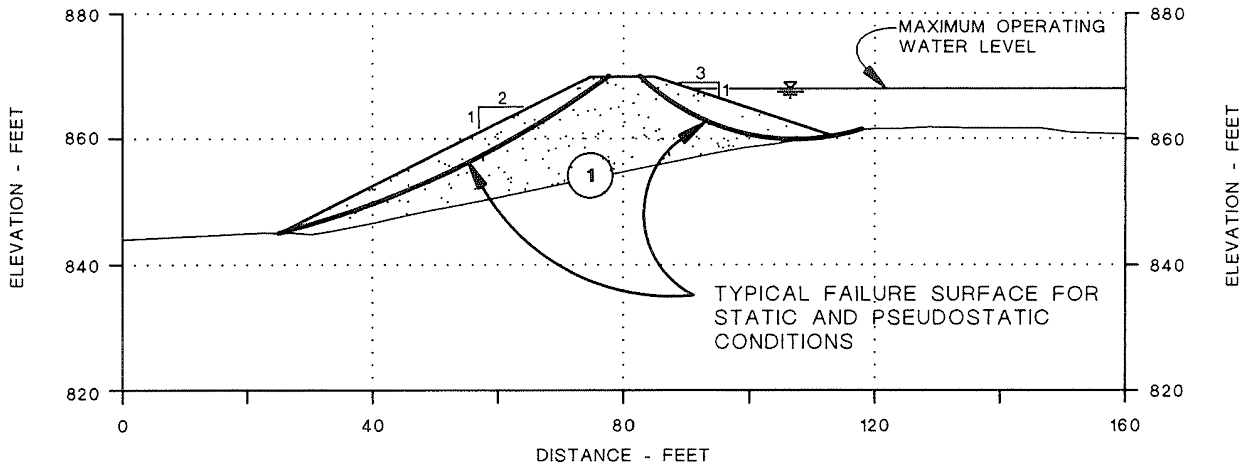
G.4 Stability Analyses Results and Conclusions

The stability was evaluated using judgement based on past experience with similar facilities in conjunction with computerized slope stability analytical methods. The computer program used, PCSTABL4, was developed at Purdue University and is described in detail by Carpenter in the PCSTABL4 User Manual published by Purdue University in 1985. The circular (CIRCLE2) subroutine was used to evaluate the stability of each facility. Each facility was evaluated for static and pseudostatic loading conditions.

The results of the stability analyses indicate that all pond embankment structures will be stable under each condition evaluated. The analyses also indicate that the overburden and topsoil stockpiles will be stable under the anticipated static and pseudostatic loading conditions. As these facilities do not impound water the rapid drawdown and critical pool conditions do not apply and have not been evaluated for the stockpiles. The factors of safety achieved for the static and pseudostatic analyses on the overburden and topsoil stockpiles compare favorably with the minimum values of 1.2 and 1.0, respectively, as recommended by the U.S. Forest Service in their document titled Dump Stability Performance Objectives and Evaluation Standards. Summaries of calculated factors of safety are presented on Figure G-1 through G-12.

The factors of safety achieved for static and pseudostatic analyses compare favorably with the minimum values of 1.5 and 1.0 recommended by the U.S. Army Corps of Engineers for static and pseudostatic embankment stability, respectively (Corps of Engineers, 1970). The minimum recommended safety factor of 1.2 for rapid drawdown was met or exceeded by all but one of the embankment structures. The exception was the upstream face of the large berm on the east perimeter of the slurry pond, which achieved a minimum static factor of safety of 1.1 for drawdown conditions. This factor of safety was determined to be acceptable for this structure

based on the very low probability of occurrence of any significant drawdown during operation of the slurry pond. The presence of settled coal fines behind the embankment further reduces the potential for rapid drawdown conditions and acts to buttress the upstream faces of all the slurry pond embankments.



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	COARSE EMBANKMENT FILL	138	143	38°	0

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	UPSTREAM - STATIC	2.6
2	DOWNSTREAM - STATIC	1.5
3	UPSTREAM - PSEUDOSTATIC *	1.8
4	DOWNSTREAM - PSEUDOSTATIC*	1.1
5	UPSTREAM - DRAWDOWN	1.8

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

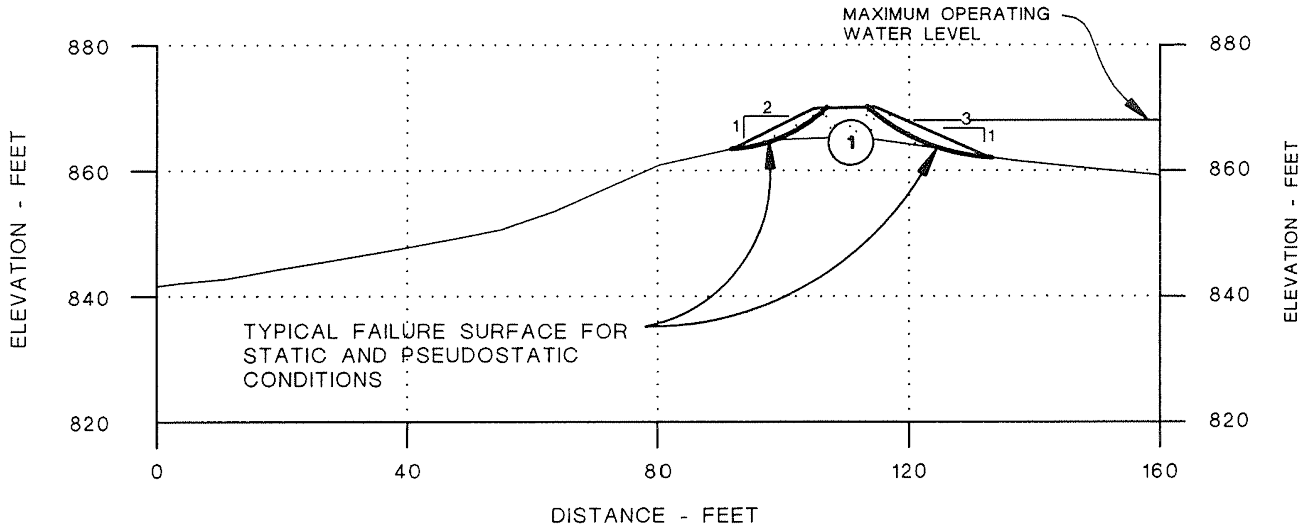
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

SLOPE STABILITY SUMMARY
S5 - FRESH WATER POND No. 1

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. G-1
REV. 0
SCALE:



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	COARSE EMBANKMENT FILL	138	143	38°	0

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	UPSTREAM - STATIC	2.2
2	DOWNSTREAM - STATIC	1.7
3	UPSTREAM - PSEUDOSTATIC *	1.5
4	DOWNSTREAM - PSEUDOSTATIC *	1.1
5	UPSTREAM - DRAWDOWN	1.3

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

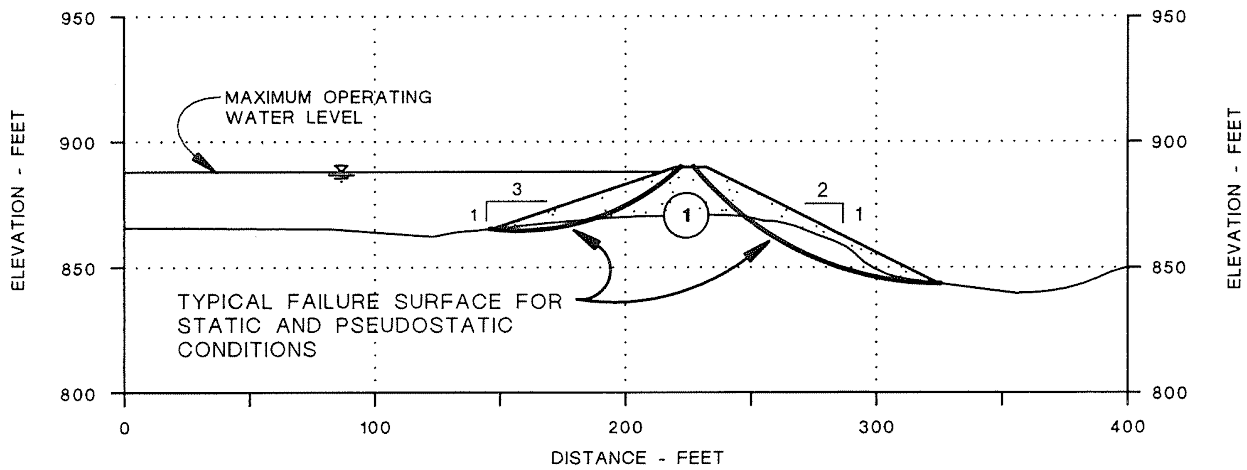
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

SLOPE STABILITY SUMMARY
S4 – SLURRY POND & FRESH WATER POND No. 1

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. G-2
REV. 0
SCALE:



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	COARSE EMBANKMENT FILL	138	143	38°	0

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	UPSTREAM - STATIC	2.3
2	DOWNSTREAM - STATIC	1.6
3	UPSTREAM - PSEUDOSTATIC *	1.7
4	DOWNSTREAM - PSEUDOSTATIC*	1.1
5	UPSTREAM - DRAWDOWN	1.2

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

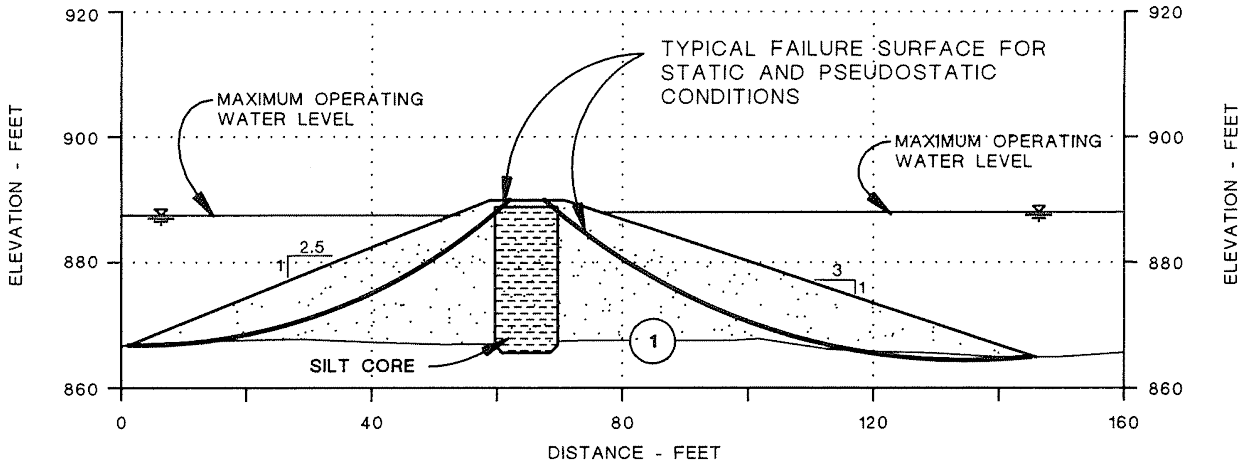
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

SLOPE STABILITY SUMMARY
S7 - FRESH WATER POND No. 2

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. G-3
REV. 0
SCALE:



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	COARSE EMBANKMENT FILL	138	143	38°	0

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	UPSTREAM - STATIC	2.4
2	DOWNSTREAM - STATIC	2.0
3	UPSTREAM - PSEUDOSTATIC *	1.5
4	DOWNSTREAM - PSEUDOSTATIC*	1.3
5	UPSTREAM - DRAWDOWN	1.3
6	DOWNSTREAM - DRAWDOWN	1.2

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

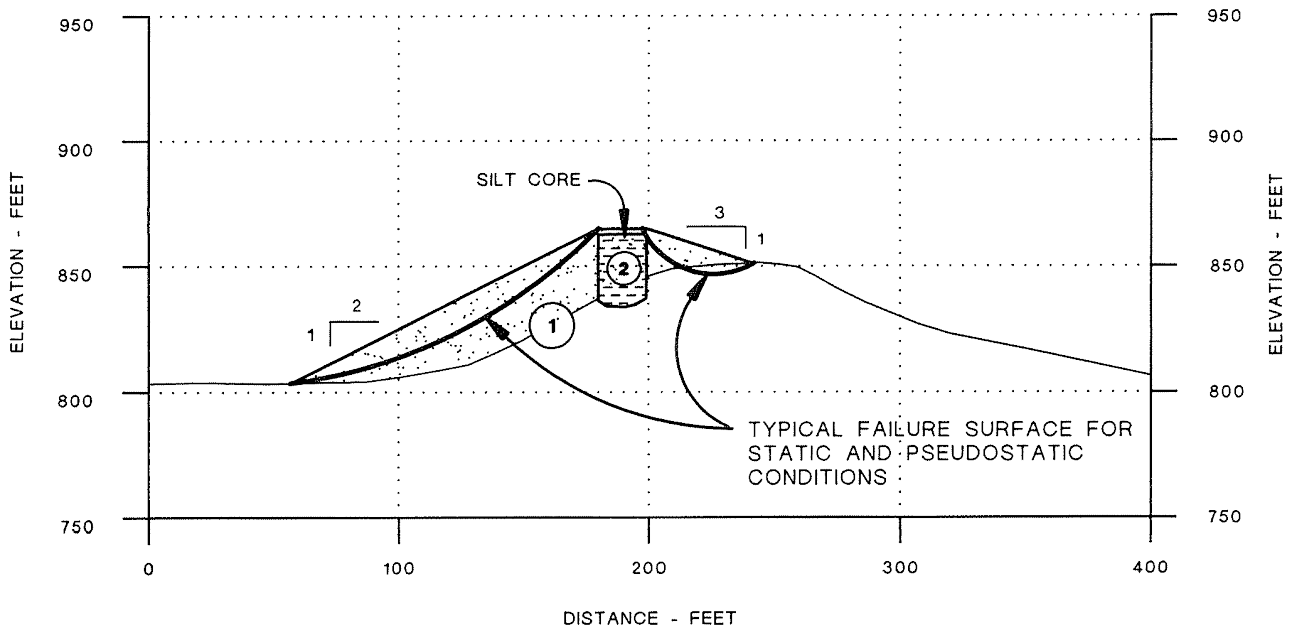
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

SLOPE STABILITY SUMMARY
S6 - SEDIMENT POND No. 2 & FRESH WATER POND No. 2

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. G-4
SCALE:
REV. 0



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	COARSE EMBANKMENT FILL	138	143	38°	0
2	EMBANKMENT SILT CORE	108	111	34°	0

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	UPSTREAM - STATIC	1.6
2	DOWNSTREAM - STATIC	2.1
3	UPSTREAM - PSEUDOSTATIC *	1.3
4	DOWNSTREAM - PSEUDOSTATIC *	1.5
5	UPSTREAM - DRAWDOWN	1.1

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

SLOPE STABILITY SUMMARY
S1 - SLURRY POND

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

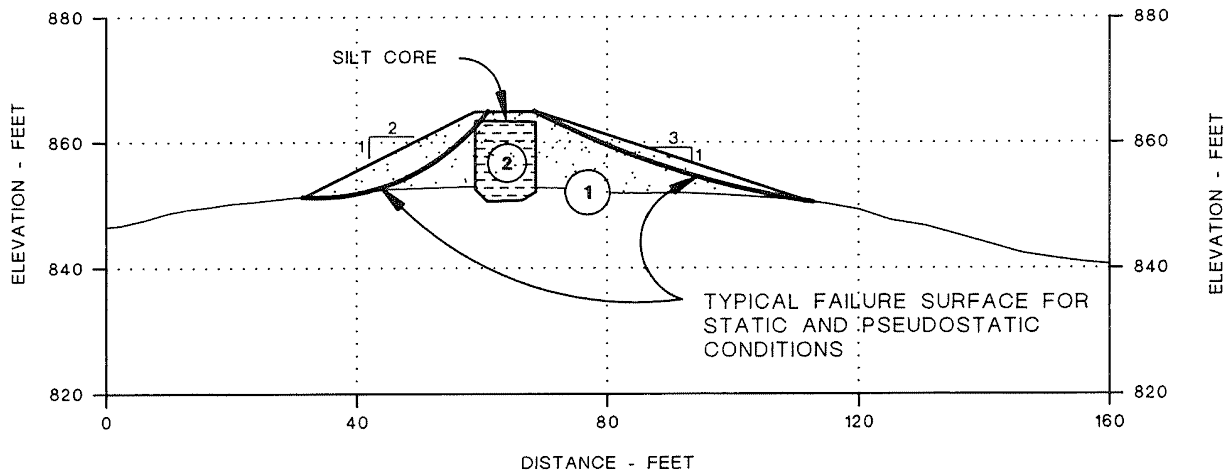
WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. G-5

REV. 0

SCALE:



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	COARSE EMBANKMENT FILL	138	143	38°	0
2	EMBANKMENT SILT CORE	108	111	34°	0

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	UPSTREAM - STATIC	2.2
2	DOWNSTREAM - STATIC	1.6
3	UPSTREAM - PSEUDOSTATIC *	1.7
4	DOWNSTREAM - PSEUDOSTATIC *	1.2
5	UPSTREAM - DRAWDOWN	1.4

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

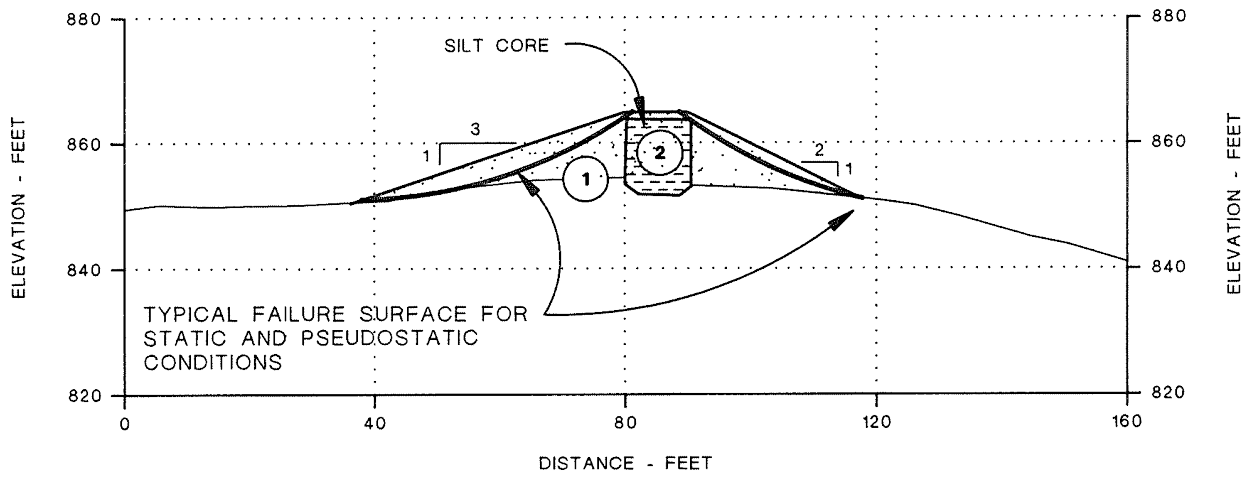
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

SLOPE STABILITY SUMMARY
S2 - SLURRY POND

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. G-6
REV. 0
SCALE:



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	COARSE EMBANKMENT FILL	138	143	38°	0
2	EMBANKMENT SILT CORE	108	111	34°	0

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	UPSTREAM - STATIC	1.8
2	DOWNSTREAM - STATIC	1.5
3	UPSTREAM - PSEUDOSTATIC *	1.2
4	DOWNSTREAM - PSEUDOSTATIC *	1.2
5	UPSTREAM - DRAWDOWN	1.7

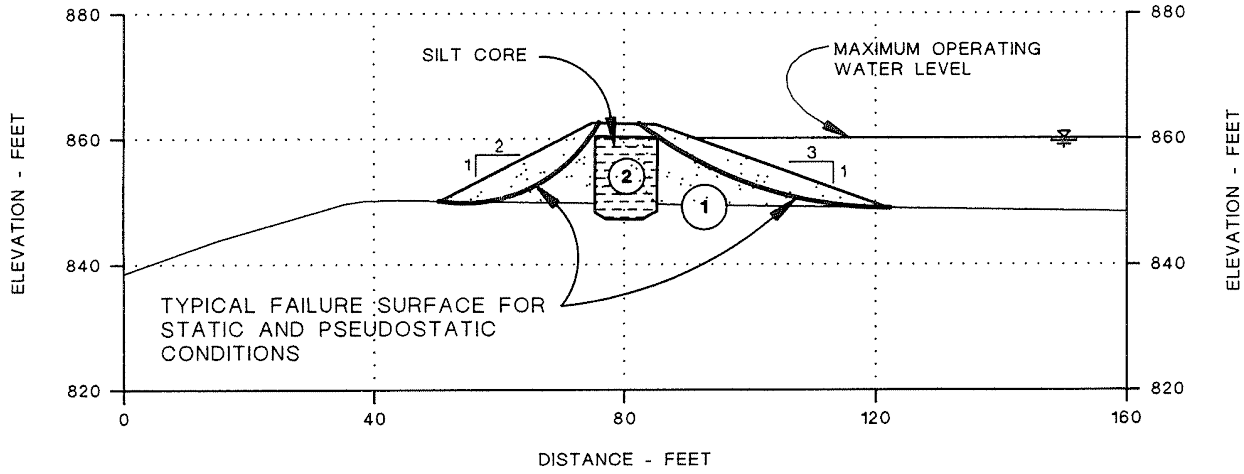
* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

SLOPE STABILITY SUMMARY
S3 - SLURRY POND

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE
PERMIT No. 01-89-796
FIGURE No. G-7
REV. 0
SCALE:



MATERIAL PROPERTIES

MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	COARSE EMBANKMENT FILL	138	143	38°	0
2	EMBANKMENT SILT CORE	108	111	34°	0

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS

CASE	DESCRIPTION	SAFETY FACTOR
1	UPSTREAM - STATIC	2.4
2	DOWNSTREAM - STATIC	1.5
3	UPSTREAM - PSEUDOSTATIC *	1.5
4	DOWNSTREAM - PSEUDOSTATIC *	1.1
5	UPSTREAM - DRAWDOWN	1.4

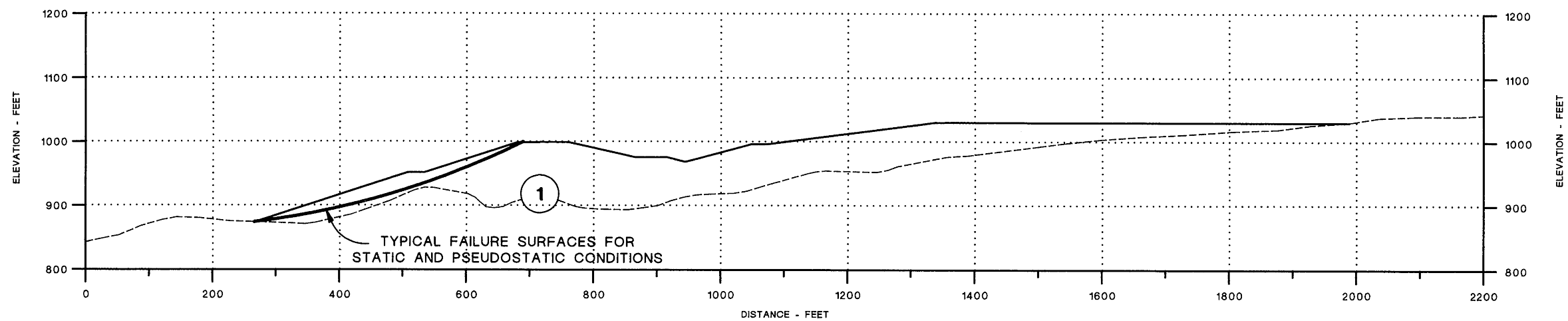
* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

SLOPE STABILITY SUMMARY
S8 – SEDIMENT POND No. 1

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE
PERMIT No. 01-89-796
FIGURE No. G-8
REV. 0
SCALE:



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	TOPSOIL	100	110	33°	--

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	STATIC	2.1
2	PSEUDOSTATIC *	1.6

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

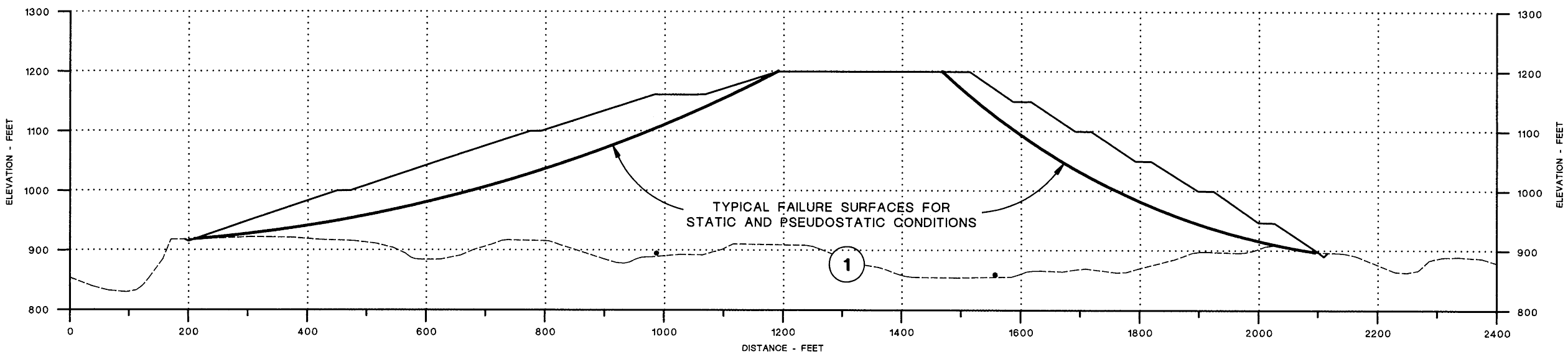
SLOPE STABILITY SUMMARY
TOPSOIL STOCKPILE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. G-9

SCALE: N/A

REV. 1



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	GRANULAR OVERBURDEN	110	125	36°	--

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	STATIC - LEFT SLOPE	2.5
2	STATIC - RIGHT SLOPE	1.3
3	PSEUDOSTATIC * - LEFT SLOPE	1.8
4	PSEUDOSTATIC * - RIGHT SLOPE	1.0

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

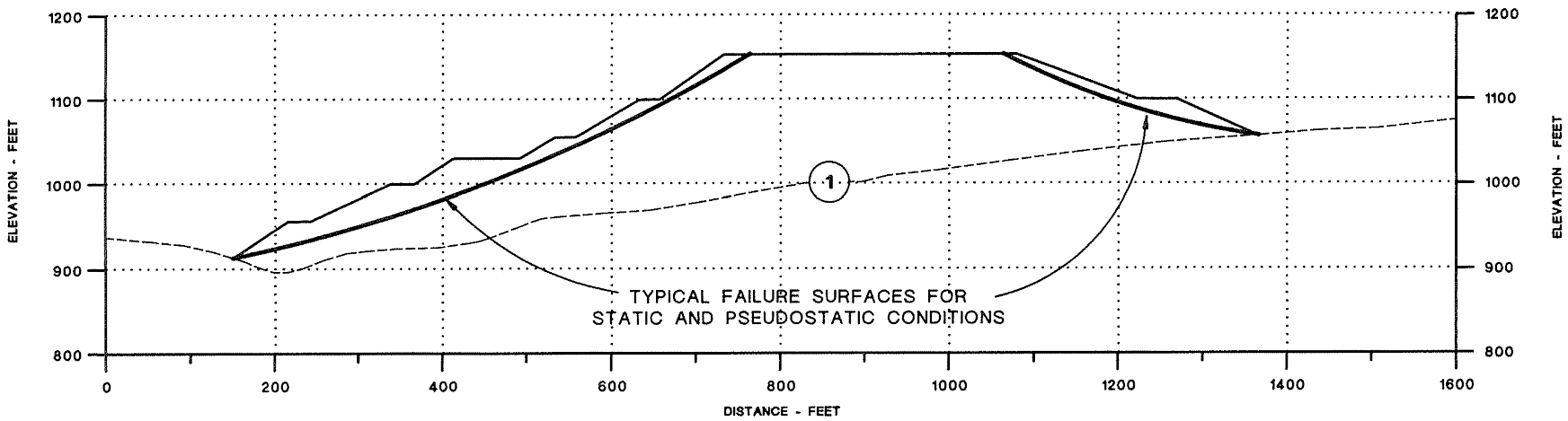
SLOPE STABILITY SUMMARY
OVERBURNDEN STOCKPILE No. 1

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. G-10

SCALE: N/A

REV. 1



MATERIAL PROPERTIES					
MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	GRANULAR OVERBURDEN	110	125	36°	--

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS		
CASE	DESCRIPTION	SAFETY FACTOR
1	STATIC - LEFT SLOPE	1.8
2	STATIC - RIGHT SLOPE	2.2
3	PSEUDOSTATIC* - LEFT SLOPE	1.4
4	PSEUDOSTATIC* - RIGHT SLOPE	1.7

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

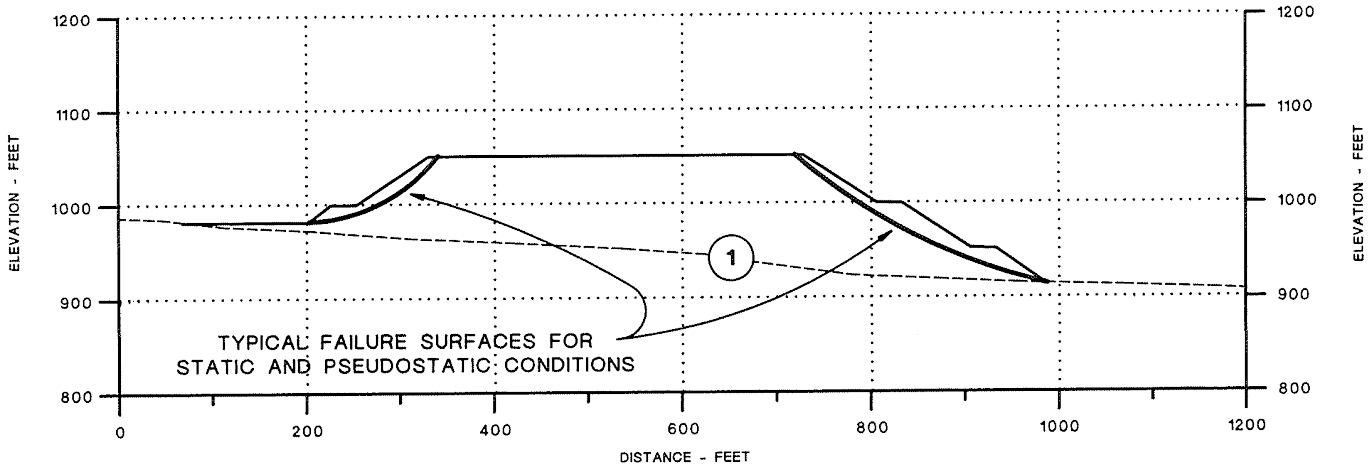
DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

SLOPE STABILITY SUMMARY
OVERBURDEN STOCKPLIE No. 2

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. G-11
REV. 0
SCALE:



MATERIAL PROPERTIES

MATERIAL TYPE	MATERIAL DESCRIPTION	γ (PCF)	γ_{SAT} (PCF)	ϕ (DEG)	c (PSF)
1	GRANULAR OVERBURDEN	110	125	36°	--

NOTE: FOUNDATION MATERIAL ASSUMED TO BE SIMILAR TO MATERIAL TYPE 1.

RESULTS OF STABILITY ANALYSIS

CASE	DESCRIPTION	SAFETY FACTOR
1	STATIC - LEFT SLOPE	2.3
2	STATIC - RIGHT SLOPE	1.4
3	PSEUDOSTATIC* - LEFT SLOPE	1.7
4	PSEUDOSTATIC* - RIGHT SLOPE	1.1

* PSEUDOSTATIC COEFFICIENT OF 0.1g USED

SLOPE STABILITY SUMMARY
OVERBURDEN STOCKPLIE No. 3

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE
PERMIT No. 01-89-796

FIGURE No. G-12
REV. 0
SCALE:

APPENDIX H
FIELD INVESTIGATION PROGRAM

APPENDIX H - FIELD INVESTIGATION PROGRAM

A site investigation program was conducted from June 6 to 13, 1989 to assess the site subsoils with regard to their suitability as construction materials and infiltration characteristics within the proposed water-related mine facilities.

During the field program, a total of 20 backhoe test pits were excavated on site using a caterpillar 416 backhoe and a case 450 bulldozer. The locations of the test pits are shown on Plate H-1. The test pits were excavated to 8 to 11 ft depth and logged by an SRK engineer. Infiltration test results are contained in Appendix I. Test pit logs are summarized on Plate H-2.

Sample were retrieved from the test pits and shipped to SRK's geotechnical laboratory for further classification and testing. Lab testing is summarized in Appendix J.

R 2 E

PERMIT BOUNDARY

MINE AREA 2

SEDIMENT POND NO.4

SEDIMENT POND NO.5

SEDIMENT POND NO.6

SEDIMENT POND NO.7

RELOCATED SEGMENT OF BUFFALO CREEK

TOPSOIL STOCKPILE NO.2

OVERBURDEN STOCKPILE NO.3

TOPSOIL STOCKPILE NO.1

FRESH WATER POND NO.2

RUN OF MINE STOCKPILES

FACILITIES AREA SEDIMENT POND

EXPLOSIVES STORAGE AREA

WASH DOWN WATER RECYCLE POND

LEACH FIELD

PREP PLANT

SLURRY POND

PLANT AREA

SHOP/WAREHOUSE OFFICE AREA

SEWAGE TREATMENT

MAIN SUBSTATION

GUARD HOUSE

OVERBURDEN STOCKPILE NO.1

OVERBURDEN STOCKPILE NO.1 EXTENSION

DIVERSION BERM

SEDIMENT POND NO.1

R.O.W. 52715

R.O.W. 216234

RELOCATED SEGMENT OF R.O.W. 52715

RELOCATED SEGMENT OF R.O.W. 216234

ACCESS ROAD LIMITS OF DISTURBANCE

T 19 N

T 18 N

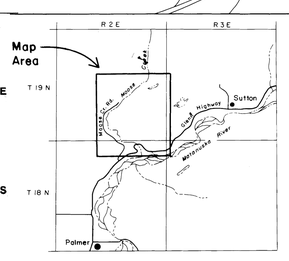
The core map area was photogrammetricaly mapped from photography of 5/8/84, 5/8/83, 6/22/85 by Air Photo Tech, Inc. of Anchorage, Alaska.
The core map area meets National Map Accuracy Standards at 1" = 200' and smaller scales.
Topographic and Planimetric features outside of the core area were taken from a photo enlarged 1" = 1 mile USGS Anchorage C-6 quad map of 1987.
Horizontal datum is Alaska State Plane, zone 4.
Vertical datum is based on USC & GS monumentation.

STATE OF ALASKA 49th
IAN P. G. HUTCHISON
CE-6817
REGISTERED PROFESSIONAL ENGINEER

I HEREBY CERTIFY THAT THESE DRAWINGS FOR THE DESIGN OF THE WISHBONE HILL MINE PROJECT, WERE PREPARED BY STEFFEN ROBERTSON AND KIRSTEN (U.S.) INC. UNDER MY DIRECT SUPERVISION FOR IDEMITSU ALASKA, INC.

LEGEND

- PERMIT BOUNDARY
- x——x FENCE
- FACILITIES AREAS
- ACCESS ROAD
- DIVERSION DITCHES
- PIPELINE
- MINE ROADWAYS
- OVERBURDEN STOCKPILES CONSTRUCTED ON BACKFILLED PIT AREAS
- BUFFALO CREEK RELOCATION
- TEST PIT LOCATION
- INFILTRATION TEST LOCATION



North

500 250 0 500 1000 1500

SCALE IN FEET
1" = 500'
CONTOUR INTERVAL
5 FEET

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
	2009	JEN	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN:

WISHBONE HILL MINE

USIBELLI COAL MINE, INC.

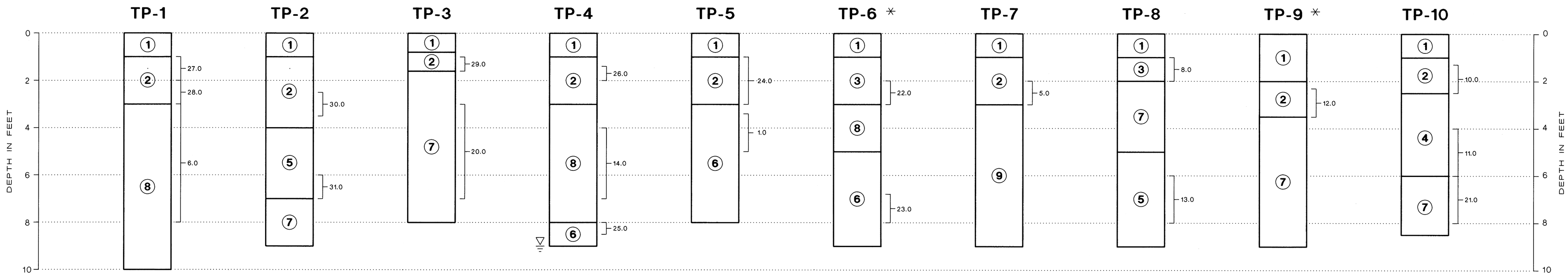
PERMIT NUMBER 01-89-796

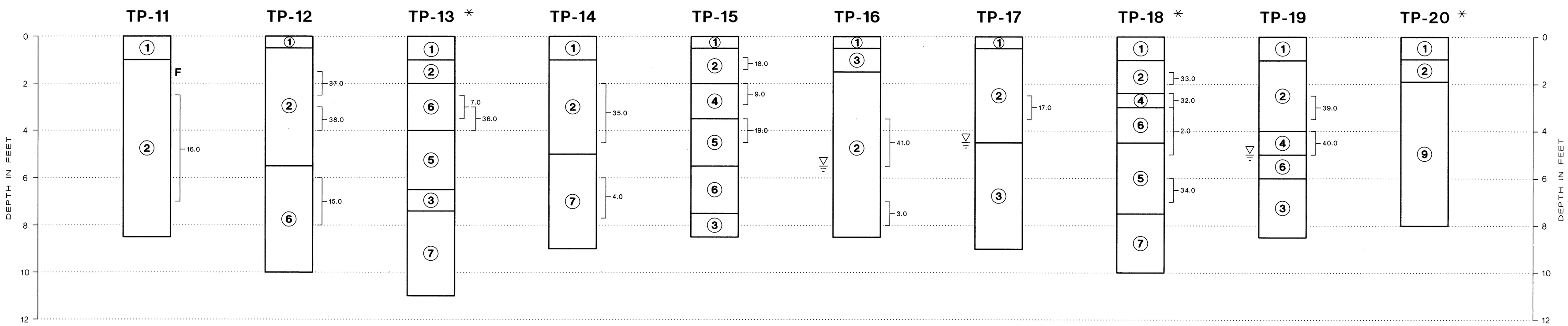
GEOTECHNICAL TEST LOCATIONS FOR THE DRAINAGE CONTROL PLAN

WISHBONE HILL MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

PLATE No. H-1
SHEET No. 1 OF 1
REV. 1





DESCRIPTION OF SOIL TYPES

(1) TOPSOIL - GREY BLACK, HUMUS, CONTAINS ABUNDANT VEGETAL MATERIAL AND LITTER, SOME LOGS AND BOULDERS (HUMOCKY APPEARANCE).

(2) SILT - LIGHT REDDISH BROWN TO ORANGE BROWN TO GREY BROWN TO MEDIUM BROWN COLOR, CONTAINS VARYING AMOUNTS OF SAND, GRAVEL AND COBBLES TO BOULDER SIZED MATERIAL, COBBLES AND BOULDERS (TO >12" DIA.) ARE GENERALLY LOCATED ALONG THE BASE OF THIS ZONE OF MATERIAL, GENERALLY MOIST TO VERY MOIST AND SLIGHTLY SOFT TO MEDIUM DENSE.

(3) SANDY SILT - REDDISH BROWN TO GREY BROWN, CONTAINS VARYING AMOUNTS OF SAND AND SOME GRAVEL TO BOULDER SIZE (TO >12" DIA.) MATERIAL, TYPICALLY MOIST, GENERALLY LOOSE BUT CAN BE UP TO MEDIUM DENSE WHEN FOUND IN THINNER LAYERS (LENSES).

(4) SILTY SAND - GREY BROWN TO BROWN, CONTAINS SOME GRAVEL AND COBBLES WHICH ARE GENERALLY IN LENSES AND POCKETS, TYPICALLY MOIST AND MEDIUM DENSE.

(5) SAND - GREY BROWN TO GREY BLACK WITH "SALT AND PEPPER" APPEARANCE, FAIRLY CLEAN, SOME GRAVEL AND COBBLE TO BOULDER SIZE (TO >12" DIA.) MATERIAL GENERALLY IN LENSES AND POCKETS, TYPICALLY MOIST AND LOOSE.

(6) GRAVELLY SAND - FAIRLY CLEAN, CONTAINS COBBLE TO BOULDER SIZE (TO >24" DIA.) MATERIAL GENERALLY IN LENSES AND POCKETS, TYPICALLY MOIST AND MEDIUM DENSE.

(7) GRAVEL/SAND MIXTURE - GRAVEL TO BOULDER SIZE (TO >24" DIA.) MATERIAL IN A MATRIX, SAND IS GENERALLY CLEAN, TYPICALLY MOIST AND MEDIUM DENSE.

(8) SANDY GRAVEL - FAIRLY CLEAN, CONTAINS COBBLE TO BOULDER SIZE (TO >24" DIA.) MATERIAL GENERALLY IN LENSES AND POCKETS, SOMETIMES CONTAINS SOME SILT, TYPICALLY MOIST AND MEDIUM DENSE, BUT OCCASIONALLY LOOSE.

(9) SLOPE WASH - HIGHLY VARIABLE DEPOSIT, CONTAINS MOST OF THE ABOVE SOIL TYPES AS A MIXTURE OR IN POCKETS AND LENSES, BOULDERS ARE TO >36" DIA, TYPICALLY MOIST AND LOOSE TO MEDIUM DENSE.

KEY TO SYMBOLS:

* NOTEWORTHY VARIABILITY IN LITHOLOGIC TYPES, THICKNESSES AND POSITION WITHIN TEST PIT.

]-6.0 INTERVAL SAMPLED AND SAMPLE NO. FOR LABORATORY REFERENCE

SEEP NOTED IN TEST PIT

F NOTEWORTHY DEGREE OF FROZEN SOIL IN TEST PIT.

(3) SOIL TYPE IDENTIFIED DURING TEST PIT LOGGING (SEE DESCRIPTION OF SOIL TYPES).

STATE OF ALASKA
49th
IAN P. G. HUTCHISON
CE-6817
REGISTERED PROFESSIONAL ENGINEER

NOTE:

SEE PLATE H-1 FOR TEST PIT LOCATIONS.

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
A	5/89	RF	CHECK BY: RF; APPROVED BY: IH
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY: RL
CHECK BY: WMC
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

USIBELLI COAL MINE INC.

PERMIT NUMBER 01-89-796

TEST PIT LOGS

WISHBONE HILL MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

PLATE No. H-2
SHEET No. 1 OF 1
REV. 1

APPENDIX I

FIELD PERMEABILITY TEST RESULTS

APPENDIX I - FIELD PERMEABILITY TEST RESULTS

This Appendix contains the field data and interpretation for the well permeameter field infiltration testing performed during the field site investigation program of June 1989.

Field testing to determine foundation permeability was conducted during the June 1989 site investigation program. The test procedure and apparatus complied with the USBR Field Permeability Test (Well Permeameter Method) Designation E-19 which is documented in Earth Manual (U.S. Department of the Interior, 2nd Edition, 1974).

In short, the testing for the Wishbone Hill Project consisted of excavating a borehole or well into the material to be tested, backfilling with coarse gravel brought onsite from Palmer to stabilize the hole and running water from Moose Creek at a constant head into the hole through the test apparatus while measuring flow rate.

This test procedure was conducted at seven locations within the areas of the proposed Wishbone Hill facilities. Test locations are shown on the field exploration program map (Plate H-1).

In general, the depth interval tested ranged from about 2 to 2 1/2 ft within an 8 to 12 inch diameter hole. Most of the tests were conducted in the coarser foundation materials which are prevalent onsite, sand to sandy gravel. One test (Test No. 6) was conducted within a deposit of silt.

The results of the testing indicate a range of foundation permeabilities of approximately 10^{-2} to 10^{-4} cm/sec. The test results are documented and summarized on the following pages.

TABLE I-1

WELL PERMEAMETER TEST RESULTS

TEST NO.	cm/sec
1	$> 2 \times 10^{-3}$
2	10^{-2}
3	4×10^{-3}
4	2×10^{-3}
5	2×10^{-2}
6	2×10^{-4}
7	2×10^{-2}

See Plate H-1 for test site locations.

INFILTRATION TEST NO. 1

Test Location: Sed Pond 1: Near Test Pit No. 10

Augering Information

Depth Interval	Strata	Notes
0 to 6-12	Topsoil	
6-12 to 18"	Reddish brown silt	

1.	Depth to water table (in) Well dimensions (depths measured from string baseline or other).	NA
2.	Depth to ground surface (in)	9.625"
3.	Depth ot bottom of well (in)	46.0625"
4.	Depth to top of gravel (in)	~10" (est.)
5.	Depth of gravel (3)-(4) (in)	~36"
6.	Depth to water surface in well (in)	~4" (est.)
7.	Depth of water in well, h=(3)-(6) (in)	~42"

Determination of well radius

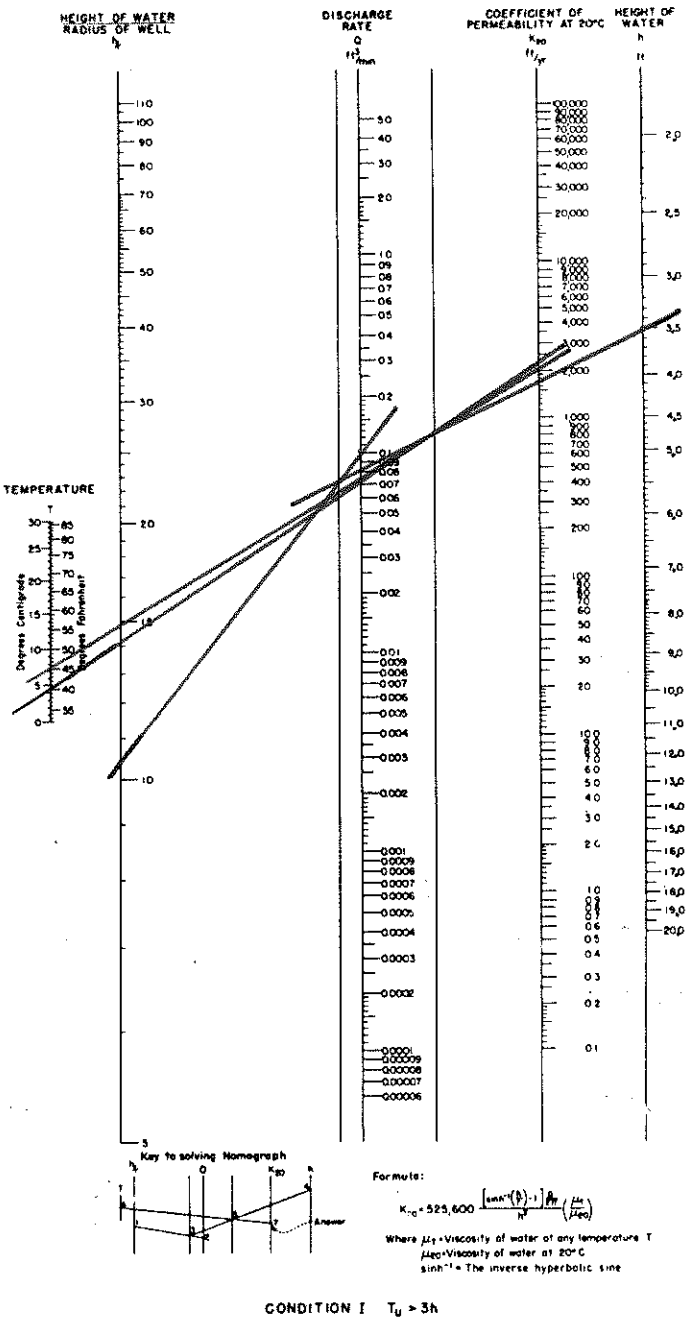
8.	Density of calibrated gravel (pcf)	95
9.	Weight of gravel used to fill well (total weighed out) (LB) 67.52 + 35.31 - 1.72	101.11
10.	Weight of excess gravel (not used) (LB)	---
11.	Weight of gravel actually used (9)-(10) (LB)	101.11
12.	Volume of well (11)÷(8) (cu ft)	1.064
13.	Radius of well. $=\sqrt{\frac{(12)}{(s)\ \pi}}$ (ft)	0.336 ft

INFILTRATION TEST NO. 1 (Con't)

Infiltration Test Readings

Time		Water Volume		
Clock	Accum (min.)	Reading (cu ft)	Difference (cu ft)	Accum (cu ft)
4:14:15	0	0.87	0	0.18
:40	0.42	1.05	0.18	0.18
:50	0.58	1.18	0.13	0.31
:15:00	0.75	1.25	0.07	0.38
:10	0.92	1.32	0.07	0.45
:20	1.08	1.42	0.10	0.55
:30	1.25	1.52	0.10	0.65
:16:00	1.75	1.90	0.38	1.03
:20	2.08	2.30	0.40	1.43
:40	2.42	2.75	0.45	1.88
:17:00	2.75	3.16	0.41	2.29
:30	3.25	3.73	0.57	2.86
:18:00	3.75	4.30	0.57	3.43
:30	4.25	4.80	0.50	3.93
:19:00	4.75	5.35	0.55	4.48
:30	5.25	5.90	0.55	5.03
:20:00	5.75	6.30	0.40	5.43
:30	6.25	6.80	0.50	5.93

TEST NO. 1



K = 2,000 ft/year or

2×10^{-3} cm/sec

Figure from Earth Manual, U.S. Department of the Interior, 1974.

Figure 19-6

INFILTRATION TEST NO. 2

Test Location: Slurry Pond-Adjacent to Test Pit No. 5

Augering Information

Depth Interval	Strata	Notes
0 to 31"	1 ft Topsoil Sandy silt, gravel to boulders to 36"	Stripped with dozer
0 ft to 2.5 ft	Gravel to cobbles in a slightly silty sand material	Rough augering - basically at refusal

1.	Depth to water table (in)	NA
	Well dimensions (depths measured from string baseline or other).	
2.	Depth to ground surface (in)	0
3.	Depth ot bottom of well (in)	24-26"
4.	Depth to top of gravel (in)	9"
5.	Depth of gravel (3)-(4) (in)	~ 16"
6.	Depth to water surface in well (in)	~ 3"
7.	Depth of water in well, h=(3)-(6) (in)	~ 22"

Determination of well radius

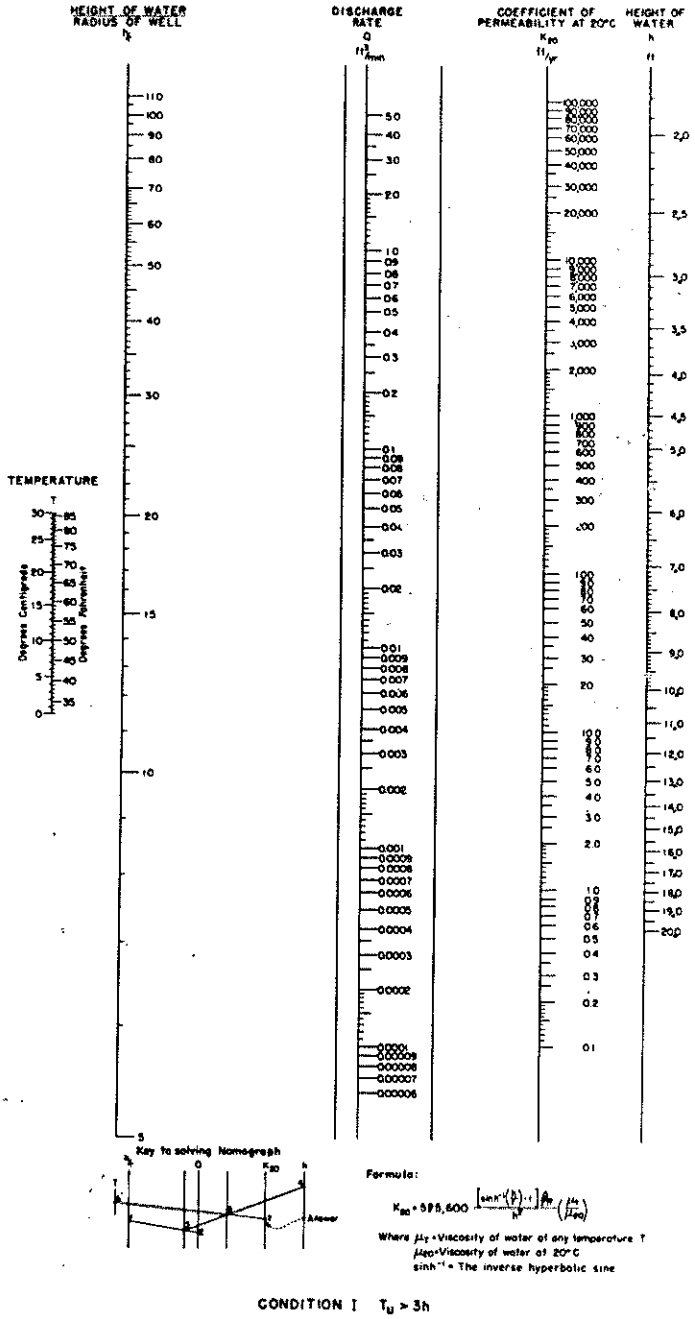
8.	Density of calibrated gravel (pcf)	95
9.	Weight of gravel used to fill well (total weighed out) (LB) 35.84 - 1.71 + 35.97 - 1.72 + 35.75 - 1.7 (?) 67.52 + 35.31 - 1.72	102.43
10.	Weight of excess gravel (not used) (LB)	0
11.	Weight of gravel actually used (9)-(10) (LB)	102.43
12.	Volume of well (11)÷(8) (cu ft)	1.078
13.	Radius of well $= \sqrt{\frac{(12)}{(5)\ \pi}}$ (ft)	0.507 12" (meas.)

INFILTRATION TEST NO. 2 (Con't)

Infiltration Test Readings

Time		Water Volume		
Clock	Accum (min.)	Reading (cu ft)	Difference (cu ft)	Accum (cu ft)
11:03	0	0.0	0	0
:10	0.17	0.1	0.1	0.1
:20	0.33	0.17	0.07	0.17
:30	0.5	.25	0.08	0.25
:40	0.67	.35	0.10	0.35
:50	0.83	.47	0.12	0.47
:04:00	1.0	.6	0.13	0.60
:10	1.17	.68	0.08	.68
:20	1.33	.78	.10	.78
:30	1.5	.9	.12	.9
:40	1.67	1.0	.10	1.0
:05:00	2.0	1.22	.22	1.22
:30	2.5	1.5	.28	1.5
:06:00	3.0	1.7	.2	1.7
:30	3.5	1.9	.2	1.9
:07:00	4.0	2.08	.18	2.08
:30	4.5	2.28	.2	2.28
:08:00	5.0	2.45	.17	2.45
:30	5.5	2.6	.15	2.6
:09:00	6.0	2.8	.2	2.8
:30	6.5	2.98	.18	2.98
:10:00	7.0	3.12	.14	3.12
:30	7.5	3.3	.18	3.3
:11:00	8.0	3.45	.15	3.45
:30	8.5	3.6	.15	3.6
:12:00	9.0	3.78	.18	3.78
:13:00	10.0	4.1	.32	4.1
:14:00	11.0	4.4	.3	4.4
:15:00	12.5	4.9	.5	4.9
:16:00	13.0	5.05	.15	5.05
:17:00	14.0	5.35	.3	5.35
:19:00	16.0	5.92	.57	5.92
:21:00	18.0	6.35	.43	6.35

TEST NO. 2



h = 1.83 ft
h/r = 3.62
h/r too small for use of figure
From equation:
Assuming UT/U20 = 1.54 for a temperature of 40°F
q = 0.3 cfm
k = 11,519 ft/year or
10^{-2} cm/sec

Figure from Earth Manual, U.S. Department of the Interior, 1974, Figure 19-6.

INFILTRATION TEST NO. 3

Test Location: Slurry Pond: Near Test Pit No. 7

Augering Information

Depth Interval	Strata	Notes
0 to 12-18"	Topsoil	
18 to 35"	Boulders/gravel in sandy silt matrix	

R.P. = Rebar Stake: Top @ MNGL

1.	Depth to water table (in)	NA
	Well dimensions (depths measured from string baseline or other).	
2.	Depth to ground surface (in)	35"
3.	Depth ot bottom of well (in)	65.25"
4.	Depth to top of gravel (in)	41.25"
5.	Depth of gravel (3)-(4) (in)	24"
6.	Depth to water surface in well (in)	35.25" (est.)
7.	Depth of water in well, h=(3)-(6) (in)	30"

Determination of well radius

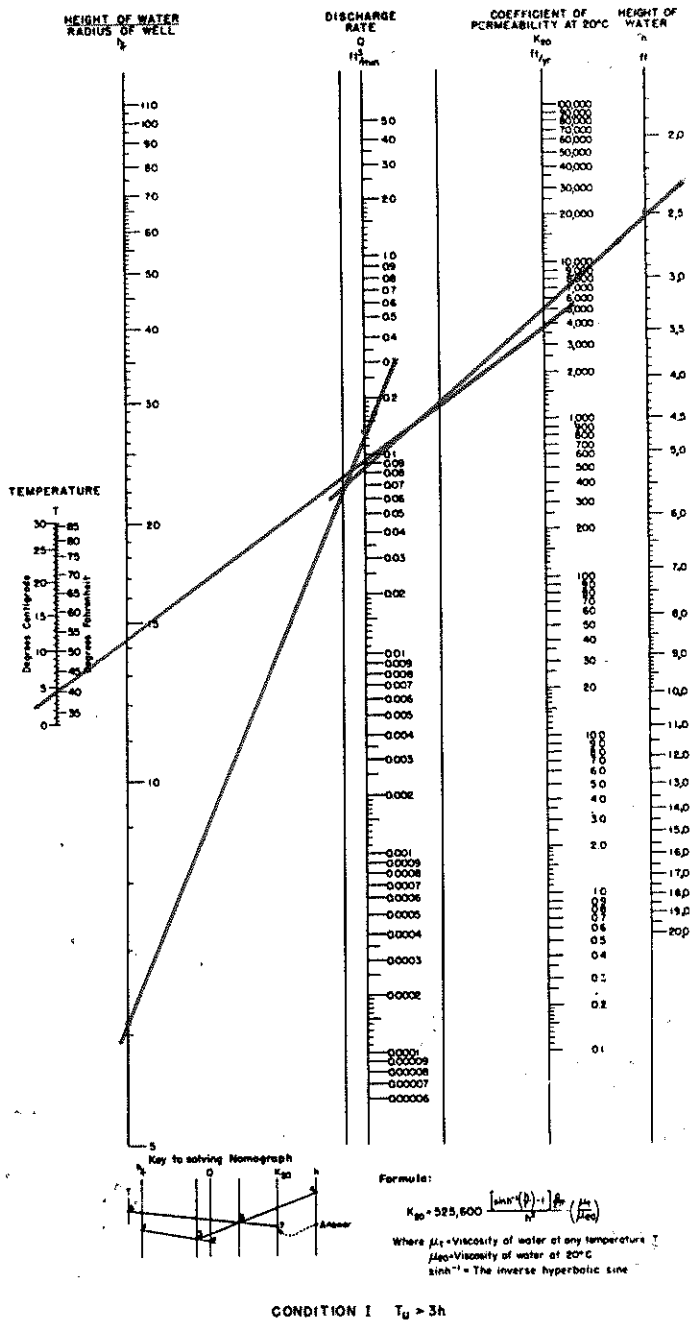
8.	Density of calibrated gravel (pcf)	96.4
9.	Weight of gravel used to fill well (total weighed out) (LB) 67.52 + 35.31 - 1.72	102.54
10.	Weight of excess gravel (not used) (LB)	---
11.	Weight of gravel actually used (9)-(10) (LB)	102.54
12.	Volume of well (11)÷(8) (cu ft)	1.064
13.	Radius of well $= \sqrt{\frac{(12)}{(5)\ \pi}}$ (ft)	0.411 9" (meas.)

INFILTRATION TEST NO. 3 (Con't)

Infiltration Test Readings

Time		Water Volume		
Clock	Accum (min.)	Reading (cu ft)	Difference (cu ft)	Accum (cu ft)
2:05:00	0.00			
:10	0.17			
:20	.39			
:30	.60			
:40	.80			
Stop water flowing out of hole				
Restart				
2:08:30	0	1.00	0	0
:40	0.17	1.05	.05	.05
:50	0.33	1.10	.05	.10
:09:00	0.50	1.15	.05	.15
:10	0.67	1.22	.07	.22
:30	1.0	1.35	.13	.35
:10:00	1.5	1.48	.13	.48
:30	2.0	1.55	.07	.55
:11:00	2.5	1.63	.08	.63
:30	3.0	1.72	.09	.72
:12:20	3.83	1.85	.13	.85
:13:00	4.5	1.95	.10	.95
:14:00	5.5	2.13	.18	1.13
:15:00	6.5	2.28	.15	1.28
:16:00	7.5	2.42	.14	1.42
:18:00	9.5	2.71	.29	1.71
:20:00	11.5	3.00	.29	2.00
:22:00	13.5	3.27	.27	2.27
:24:00	15.5	3.52	.25	2.52
:26:00	17.5	3.80	.28	2.80
:28:00	19.5	4.08	.28	3.08
:30:00	21.5	4.30	.22	3.30
:35:00	26.5	4.87	.57	3.87
:40:00	31.5	5.58	.71	4.58
:45:00	36.5	6.2	.62	5.2
:48:30	40.0	6.6	.4	5.6

TEST NO. 3



h/r = 6.1
q = 0.13 cfm
k = 4,000 ft/year or
10^{-3} cm/sec

Figure from Earth Manual, U.S. Department of the Interior, 1974, Figure 19-6.

INFILTRATION TEST NO. 4

Test Location: Sed Pond 2B, Near Test Pit No. 15

Augering Information

Depth Interval	Strata	Notes
0 to 12"	Topsoil	
12 to 35"	Reddish brown silt	
35 to 60"	Gray brown sand	
≥ 60"	Cobbles	

R.P. = Rebar @ NGL

1.	Depth to water table (in) Well dimensions (depths measured from string baseline or other).	NA
2.	Depth to ground surface (in)	35.25"
3.	Depth ot bottom of well (in)	66.00"
4.	Depth to top of gravel (in)	44" (est.)
5.	Depth of gravel (3)-(4) (in)	22"
6.	Depth to water surface in well (in)	38" (est.)
7.	Depth of water in well, h=(3)-(6) (in)	28"

Determination of well radius

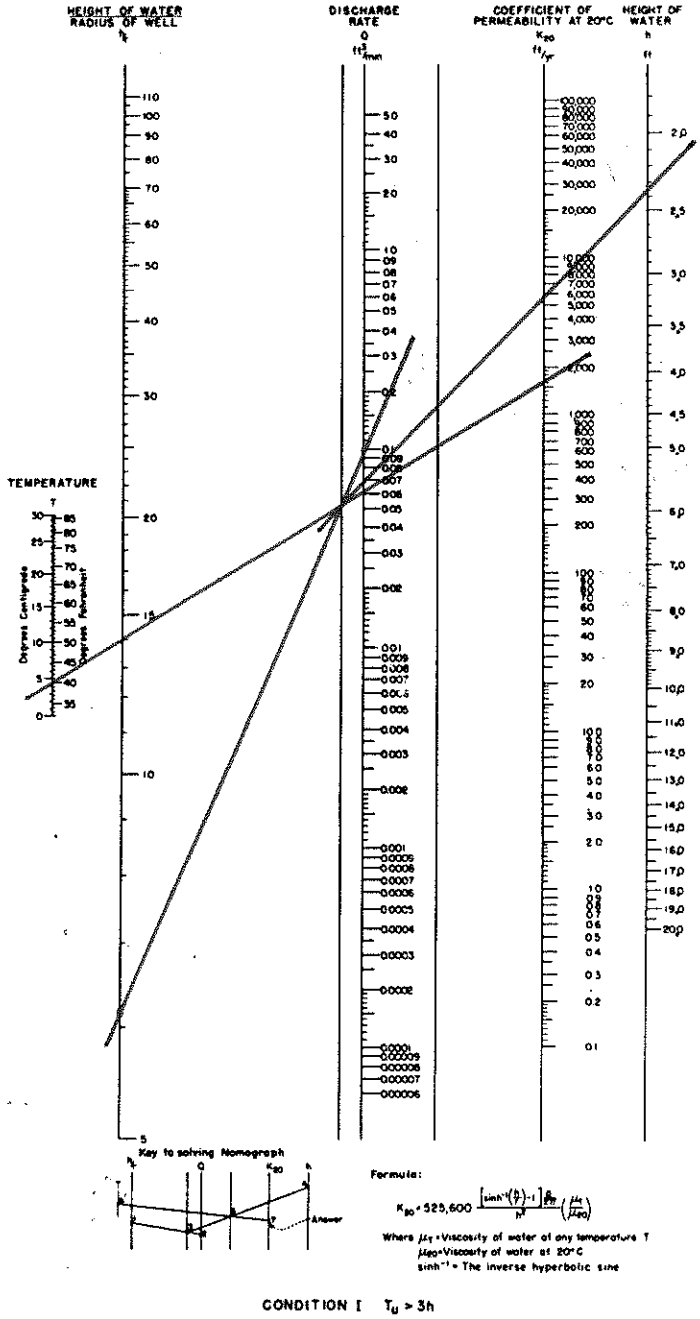
8.	Density of calibrated gravel (pcf)	96
9.	Weight of gravel used to fill well (total weighed out) (LB) 36.00 - 1.72 + 35.73 - 1.72 + 35.85 - 1.72 + 35.39 - 1.72	136.09
10.	Weight of excess gravel (not used) (LB) 23.72 - 1.7 + 35.39 - 1.72	55.69
11.	Weight of gravel actually used (9)-(10) (LB)	80.4
12.	Volume of well (11)÷(8) (cu ft)	0.8375
13.	Radius of well $=\sqrt{\frac{(12)}{(s)\ \pi}}$ (ft)	0.381 8" (meas.)

INFILTRATION TEST NO. 4 (Con't)

Infiltration Test Readings

Time		Water Volume		
Clock	Accum (min.)	Reading (cu ft)	Difference (cu ft)	Accum (cu ft)
6:39:30	0	0.00	0	0
:40	0.17	0.15	0.15	0.15
:50	0.33	0.35	0.2	.35
:40:00	0.5	0.60	.25	.6
:10	0.67	0.70	.1	.7
:20	0.83	0.75	.05	.75
:30	1.10	0.8	.05	.8
:41:00	1.5	0.85	.05	.85
:30	2.0	0.93	.08	.93
:42:00	2.5	1.00	.07	1.0
:30	3.0	1.07	.07	1.07
:43:00	3.5	1.12	.05	1.12
:44:00	4.5	1.23	.11	1.23
:45:00	5.5	1.35	.12	1.35
:46:00	6.5	1.47	.12	1.47
:48:00	8.5	1.67	.2	1.67
:50:00	10.5	1.85	.18	1.85
:55:00	15.5	2.38	.53	2.83
7:00:00	20.5	2.87	.49	2.87
:05:00	25.5	3.37	.5	3.37
:10:00	30.5	3.88	.51	3.88
:15:00	35.5	4.37	.49	4.37
:20:00	40.5	4.89	.52	4.89
:25:00	45.5	5.35	.46	5.35
:30:00	50.5	5.83	.48	5.83

TEST NO. 4



h = 2.33
h/r = 6.12
q = 0.10 cfm
k = 1,700 ft/year
2×10^{-3} cm/sec

Figure from Earth Manual, U.S. Department of the Interior, 1974, Figure 19-6.

INFILTRATION TEST NO. 5

Test Location: Sed Pond 2A: Near Test Pit No. 13

Augering Information

Depth Interval	Strata	Notes
0 to 12"	Topsoil	
12 to 45"	Reddish brown silt	
46 to 63"	Cobbles to boulders in silty sand matrix	Mostly hand dig

R.P. = Rebar = 6" below NGL

1.	Depth to water table (in)	NA
	Well dimensions (depths measured from string baseline or other).	
2.	Depth to ground surface (in)	45.75"
3.	Depth ot bottom of well (in)	63.5"
4.	Depth to top of gravel (in)	48.1875"
5.	Depth of gravel (3)-(4) (in)	15.3125"
6.	Depth to water surface in well (in)	39.75" (est.)
7.	Depth of water in well, h=(3)-(6) (in)	23.75"

Determination of well radius

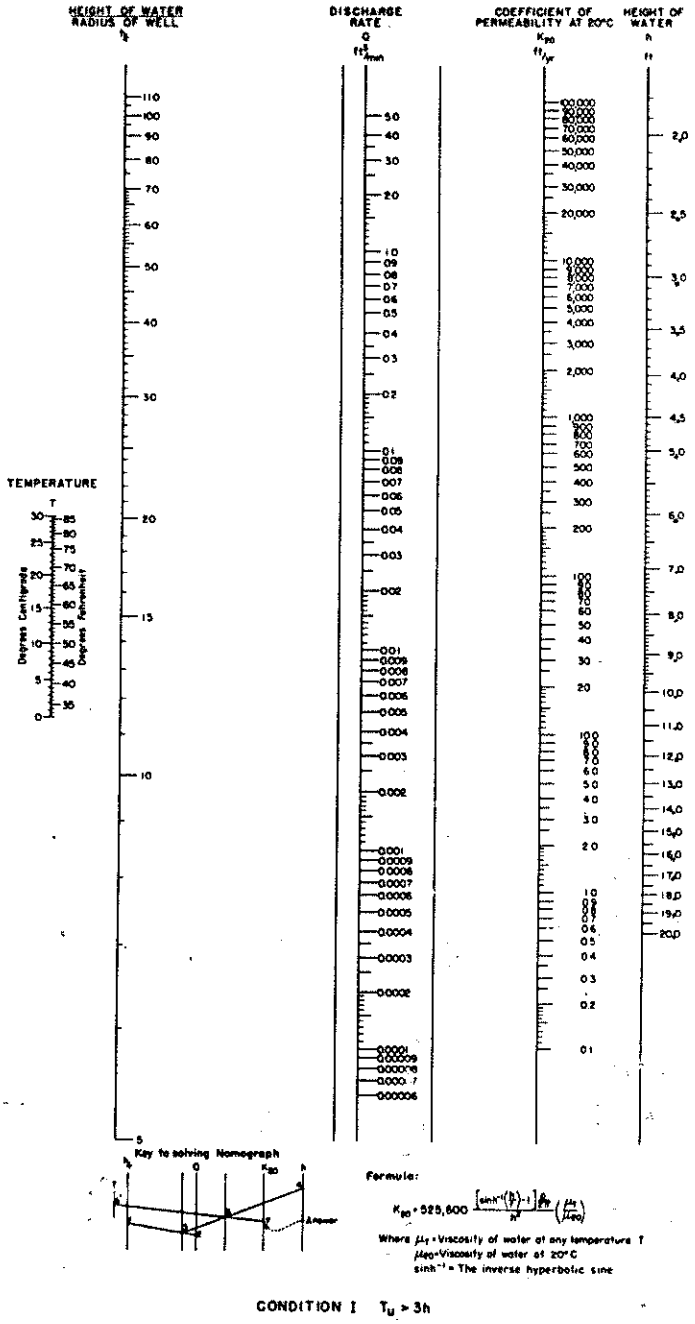
8.	Density of calibrated gravel (pcf)	101.6
9.	Weight of gravel used to fill well (total weighed out) (LB)	136.55
10.	Weight of excess gravel (not used) (LB)	0
11.	Weight of gravel actually used (9)-(10) (LB)	136.55
12.	Volume of well (11)÷(8) (cu ft)	1.343
13.	Radius of well $=\sqrt{\frac{(12)}{(s)\,\pi}}$ (ft)	0.5789 14" (meas.) V. irregular

INFILTRATION TEST NO. 5 (Con't)

Infiltration Test Readings

Time		Water Volume		
Clock	Accum (min.)	Reading (cu ft)	Difference (cu ft)	Accum (cu ft)
11:34:00	0	0.0		
Restart - Discharge too slow				
:35:00	0	0.05	0	0
:10	.13	0.17	.12	.12
:20	.33	0.30	.13	.25
:30	.5	0.48	.18	.43
:36:00	1.0	0.90	.42	.85
:30	1.5	1.30	.4	1.25
:37:00	2.0	1.70	.4	1.65
:30	2.5	2.16	.46	2.11
:38:00	3.0	2.57	.41	2.52
:39:00	4.0	3.38	.81	3.33
:40:00	5.0	4.07	.69	4.02
:41:00	6.0	4.85	.78	4.80
:42:00	7.0	5.50	.65	5.45
:43:00	8.0	6.17	.67	6.12
:43:40	8.67	6.6 (end of barrel)	.49	6.55

TEST NO. 5



h = 1.98 ft
h/r = 3.42
h/r too small to use figure
Using equation:
Assuming UT/U20 = 1.54 at a temperature of 40°F
q = 0.72 cfm
k = 22,323 ft/year
or
2×10^{-2} cm/sec

Figure from Earth Manual, U.S. Department of the Interior, 1974, Figure 19-6.

INFILTRATION TEST NO. 6

Test Location: Fresh Water Pond: Near Test Pit No. 9

Augering Information

Depth Interval	Strata	Notes
0 to 12"	Topsoil	
12 to 49"	Silt medium brown to reddish brown	
49 to 76"	SAA but more cobbles to boulders	

R.P. = Rebar = 8" below NGL

1. Depth to water table (in) — NA
   Well dimensions (depths measured from string baseline or other).
2. Depth to ground surface (in) — 41" (from RP)
3. Depth ot bottom of well (in) — 67.375" (from RP)
4. Depth to top of gravel (in) — 49"
5. Depth of gravel (3)-(4) (in) — 18.375"
6. Depth to water surface in well (in) — 43" (est.)
7. Depth of water in well, h=(3)-(6) (in) — 24.375"

Determination of well radius

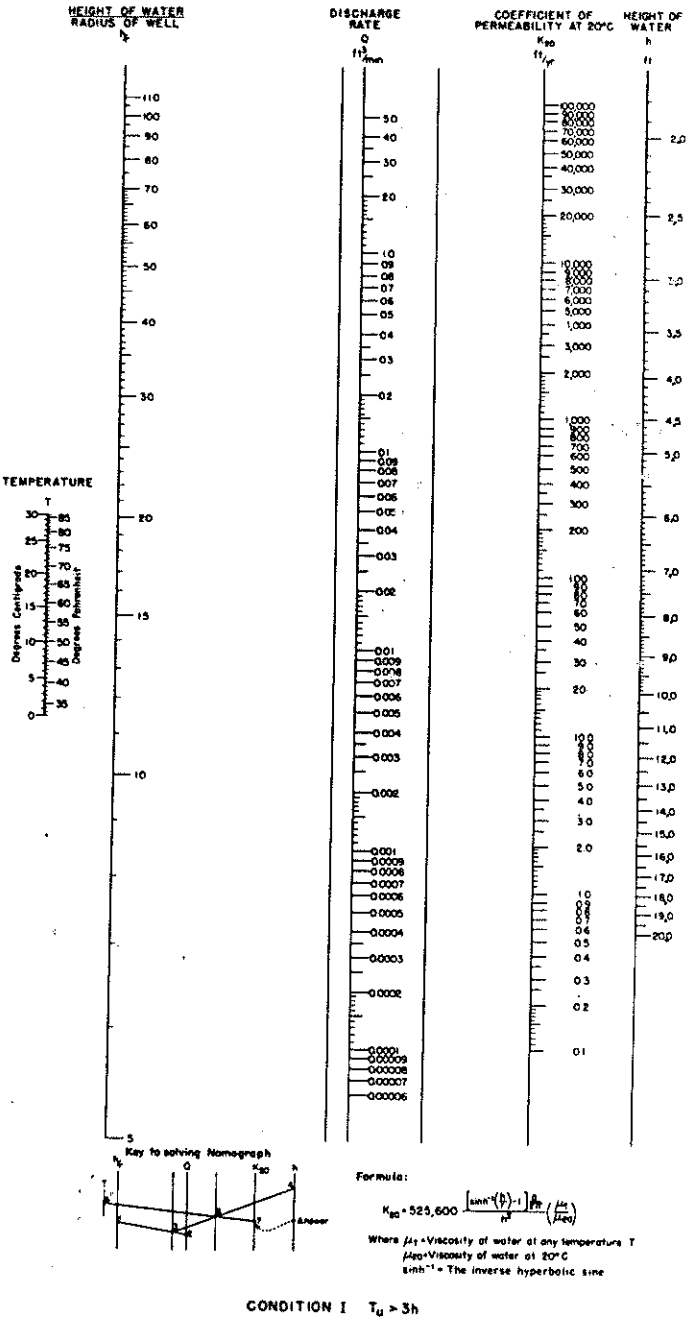
8. Density of calibrated gravel (pcf) — 97.5
9. Weight of gravel used to fill well (total weighed out) (LB) — 136.79
   35.20 - 1.72 + 36.00 - 1.71 + 36.00 - 1.72 + 35.94 - 1.7
10. Weight of excess gravel (not used) (LB) — 34.24
    35.94 - 1.7
11. Weight of gravel actually used (9)-(10) (LB) — 102.55
12. Volume of well (11)÷(8) (cu ft) — 1.052
13. Radius of well $= \sqrt{\frac{(12)}{(s)\ \pi}}$ (ft) — 0.4676
    12" (meas.)

INFILTRATION TEST NO. 6 (Con't)

Infiltration Test Readings

Time		Water Volume		
Clock	Accum (min.)	Reading (cu ft)	Difference (cu ft)	Accum (cu ft)
3:15:00	0	0.35	0	0
:20	0.33	0.55	0.2	.2
:30	0.5	0.69	.14	.34
:40	0.67	0.80	.11	.45
:16:00	1.0	1.05	.25	0.70
:30	1.5	1.16	.11	.81
:18:00	3.0	1.22	.06	.87
:20:00	5.0	1.25	.03	.9
:22:00	7.0	1.30	.05	.95
:24:00	9.0	1.34	.04	.99
:29:00	14.0	1.42	.08	1.07
4:26:00	71.0	2.05	.63	1.70
4:42:00	87.0	2.20	.15	1.85
6:45:00	210.0	3.26	1.06	2.91

TEST NO. 6



h = 2.03 ft
h/r = 4.34
h/r is too small to use figure
Using equation:
Assuming UT/U20 = 1.54 at a temperature of $40^{o}F$
k = 316 ft/year
or
3×10^{-4} cm/sec

Figure from Earth Manual, U.S. Department of the Interior, 1974, Figure 19-6.

INFILTRATION TEST NO. 7

Test Location: Sed Pond No. 4: Near Test Pit No. 18

Augering Information

Depth Interval	Strata	Notes
0 to 6	Topsoil	
6 to 10	Reddish brown silt	
10 to 34	Sand	
≥34	Sandy gravel and cobbles	

R.P. = Rebar = 28" above NGL

1.	Depth to water table (in) Well dimensions (depths measured from string baseline or other).	NA
2.	Depth to ground surface (in)	38" (from RP)
3.	Depth ot bottom of well (in)	67 1/4" (from RP)
4.	Depth to top of gravel (in)	44 3/8" (from RP)
5.	Depth of gravel (3)-(4) (in)	22.875"
6.	Depth to water surface in well (in)	38.375 (est.)
7.	Depth of water in well, h=(3)-(6) (in)	28.875"

Determination of well radius

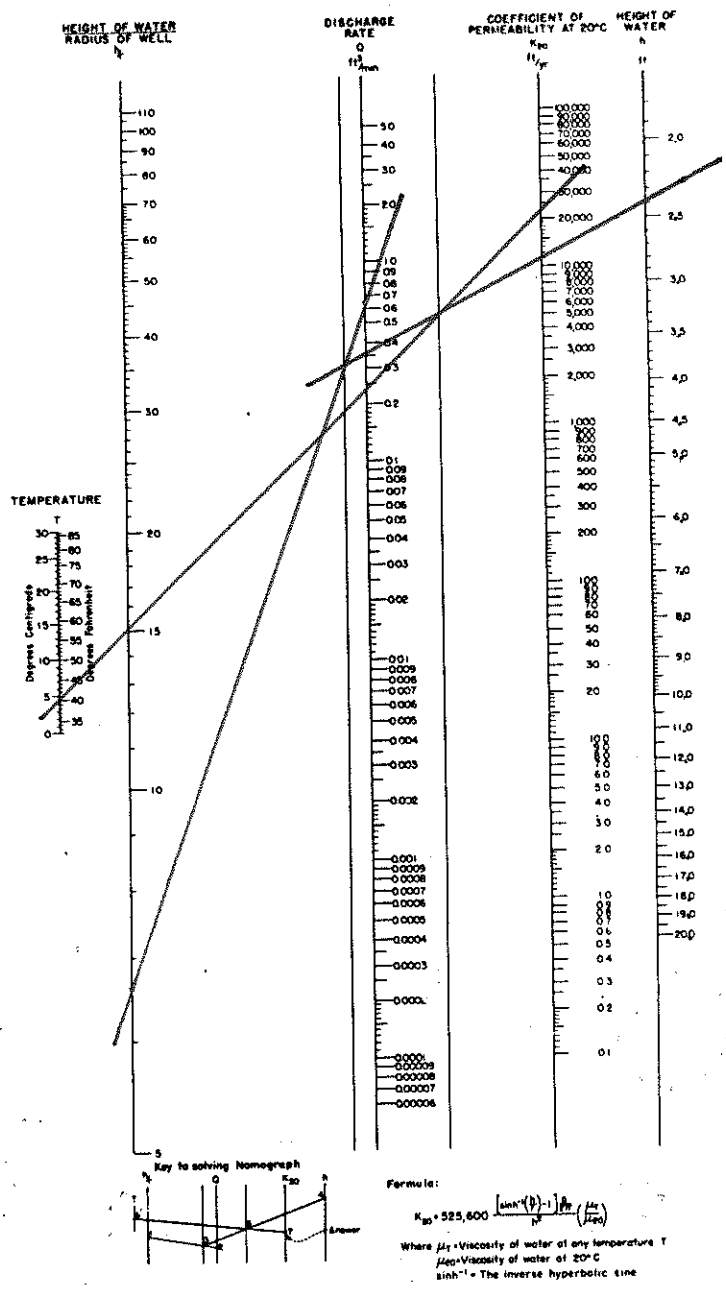
8.	Density of calibrated gravel (pcf)	97.5
9.	Weight of gravel used to fill well (total weighed out) (LB) 36 - 1.7 + 76 - 1.7 + 36 - 1.7 + 36 - 1.7	137.2
10.	Weight of excess gravel (not used) (LB) 36 - 1.7 + 28.03 - 1.7	60.63
11.	Weight of gravel actually used (9)-(10) (LB)	76.57
12.	Volume of well (11)÷(8) (cu ft)	0.785
13.	Radius of well $= \sqrt{\frac{(12)}{(5)\ \pi}}$ (ft)	0.362 7 1/2" (meas.)

INFILTRATION TEST NO. 7 (Con't)

Infiltration Test Readings

Time		Water Volume		
Clock	Accum (min.)	Reading (cu ft)	Difference (cu ft)	Accum (cu ft)
7:37:30	0	0.0	0	0
:40	.17	.18	.18	.18
:50	.33	0.4	.22	.4
:38:00	0.5	0.6	.2	.6
:30	1.0	1.2 stop test	.6	1.2
Restart				
:39:30	0	1.2		
:45	.25	1.5	.3	.3
:40:20	.83	1.9	.4	.7
:30	1.0	2.0	.1	.8
:50	1.33	2.2	.2	1.0
:41:00	1.5	2.3	.1	1.1
:30	2.0	2.55	.25	1.35
:42:00	2.5	2.84	.29	1.64
:30	3.0	3.10	.26	1.90
:43:00	3.5	3.38	.28	2.18
:30	4.0	3.68	.3	2.48
:44:00	4.5	3.95	.27	2.75
:30	5.0	4.24	.29	3.04
:45:00	5.5	4.55	.31	3.35
:30	6.0	4.90	.35	3.70
:46:00	6.5	5.35	.45	4.15
:30	7.0	5.65	.2	4.35
:47:00	7.5	6.04	.39	4.74
:30	8.0	6.38	.34	5.08
:48:00	8.5	6.6	EMPTY .22	5.30

TEST NO. 7



CONDITION I $T_u > 3h$

h = 2.4
h/r = 6.65
q = 0.65 cfm
k = 24,000 ft/year
or
2×10^{-2} cm/sec

Figure from Earth Manual, U.S. Department of the Interior, 1974, Figure 19-6.

APPENDIX J
LABORATORY TESTING OF SITE SOILS

APPENDIX J - LABORATORY TESTING OF SITE SOILS

This Appendix contains the geotechnical lab test results produced for the native soils of the project area. Soils samples were retrieved from backhoe test pits which were excavated as part of the field site investigation program of June 1989 as described in Appendix H.

Grain-size analyses, Atterberg limits testing, and proctor compaction testing were performed on selected samples to characterize the site materials and assess their suitability as construction materials for the proposed facilities.

Table J-1 of this appendix presents a summary of all the lab test results obtained for this program. The subsequent information includes the detailed results including compaction curves and gradation curves.

TABLE J-1.
GEOTECHNICAL LABORATORY TEST RESULTS SUMMARY
NATIVE SITE SUBSOILS

SAMPLE NO.	TEST PIT NO.	LOCATION	SAMPLE INTERVAL FT	MINUS NO. 200 SIEVE %	ATTERBERG LIMITS LL %	PL %	PI %	STANDARD PROCTOR DRY DENSITY PCF	O.M.C. %	CLASSIFICATION USCS
1.0	5	SP	3.5-5	1				134.6	7.2	GW
2.0	18	SED3	3-5	1				122.5	6.8	GW
5.0	7	SP	2-3	76			N/P	77.9	38.5	ML
6.0	1	SED1	3-8	1				132.9	5.7	GP
9.0	15	FWP2	2-3	2				127.9	7.5	GW
10.0	10	SED1	1.5-2.5	79			N/P			ML
11.0	10	SED1	4-6	1						SP
12.0	9	FWP1	2.5-3.5	46						SM
13.0	8	FWP1	6-8	0						SP
14.0	4	SP	4-7	1				129.1	5.5	GW
16.0	11	PD	2.5-7	97	29	20	9			CL
17.0	17	PD	2.5-3.5	43						SC
19.0	15	FWP2	3.5-4.5	2						SP
24.0	5	SP	1-3	80						ML
26.0	4	SP	1.5-2	86			N/P			ML
28.0	1	SED1	2-3	52	31	24	7			ML
30.0	2	WWP	2.5-3.5	2						SP
35.0	14	SED2	2-4.5	83			N/P			ML
39.0	19	BCD	2.5-3.5	75						ML

KEY TO LOCATIONS:

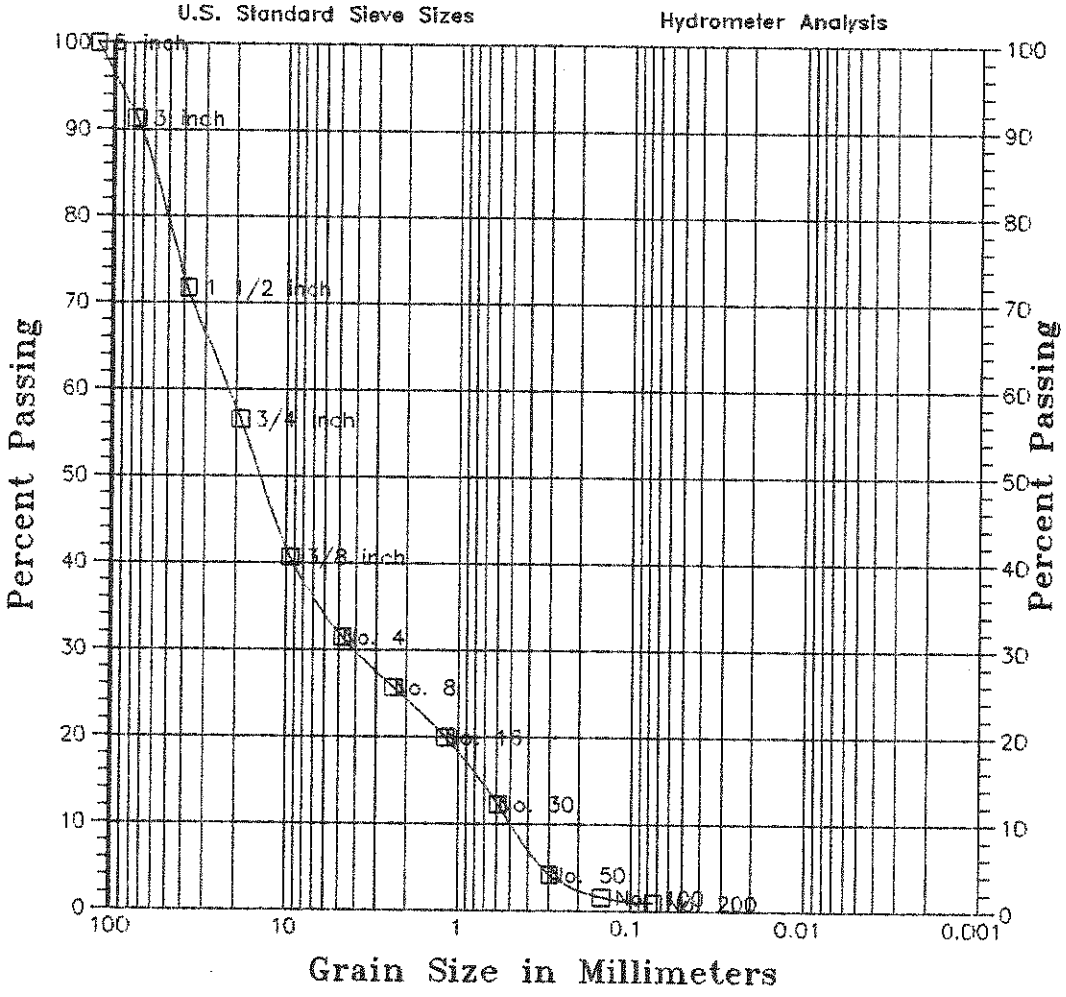
SP SLURRY POND AREA
SED3 SEDIMENT POND NO. 3 AREA
SED1 SEDIMENT POND NO. 1 AREA
FWP2 FRESH WATER POND NO. 2 AREA
FWP1 FRESH WATER POND NO. 1 AREA
PD BUFFALO CREEK PIPELINE DIVERSION ALIGNMENT
WWP WASTE WATER POND AREA
SED2 SEDIMENT POND NO. 2 AREA
BCD BUFFALO CREEK RELOCATION ALIGNMENT

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK - US	LAB NO. L392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 5 DEPTH 3.5-5.0ft	SAMPLE NO. 1.0 DATE TESTED 7-25-89

GRAIN SIZE ANALYSIS



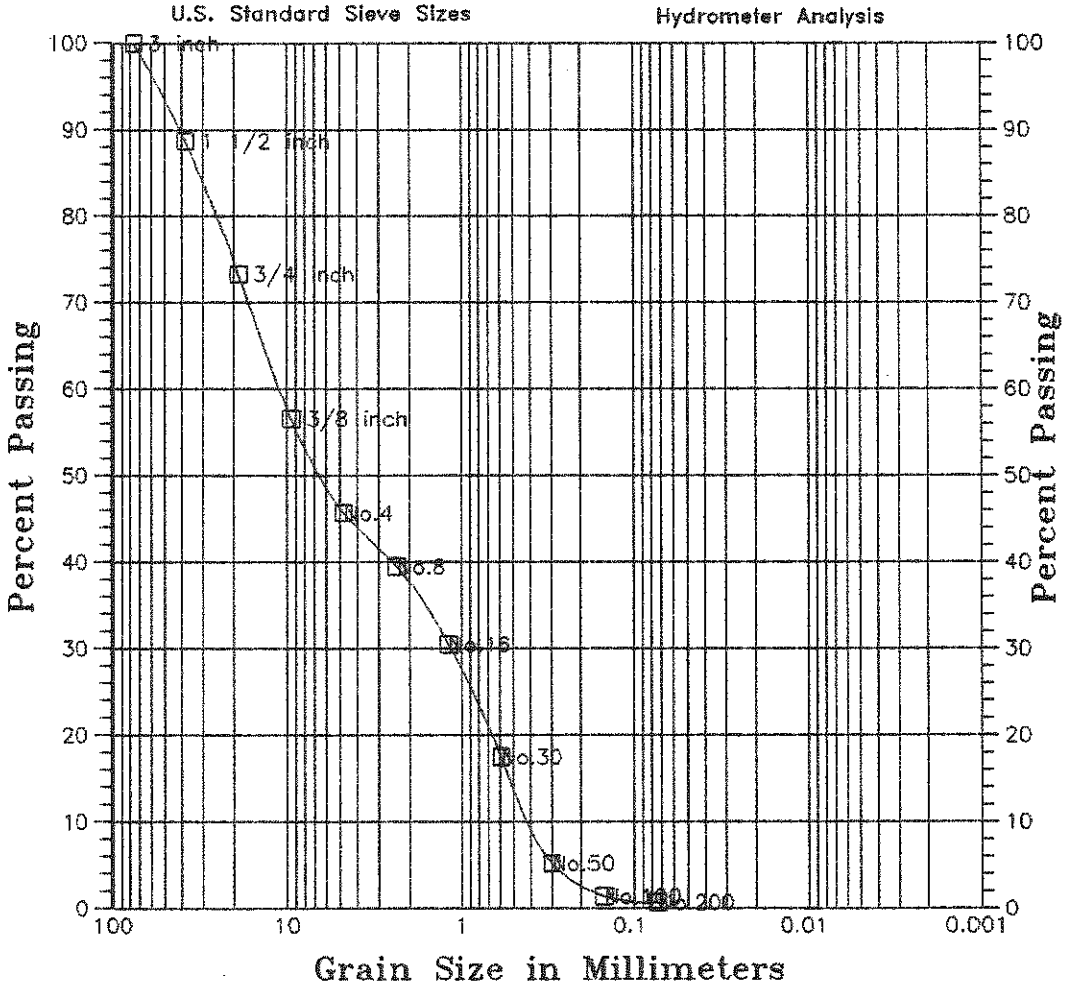
Description - Well Graded Gravel with Sand USCS-GW

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK - US	LAB NO. L392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 18 DEPTH 3.0-5.0ft	SAMPLE NO. 2.0 DATE TESTED 7/25/89

GRAIN SIZE ANALYSIS



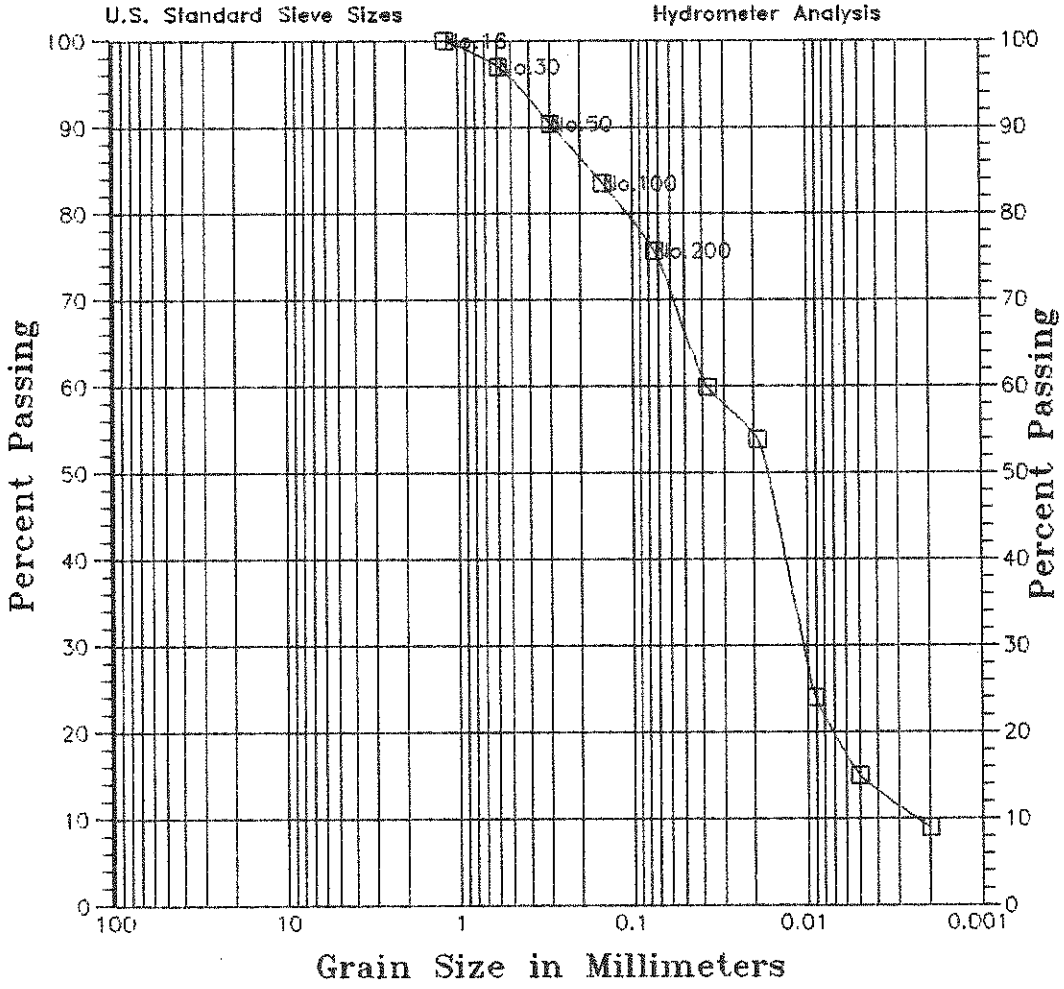
Description - Well Graded Gravel with Sand USCS-GW

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK - US	LAB NO. L392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 7 DEPTH 2.0-3.0 ft	SAMPLE NO. 5.0 DATE TESTED 7/25/89

GRAIN SIZE ANALYSIS



Plasticity Index - Non-plastic

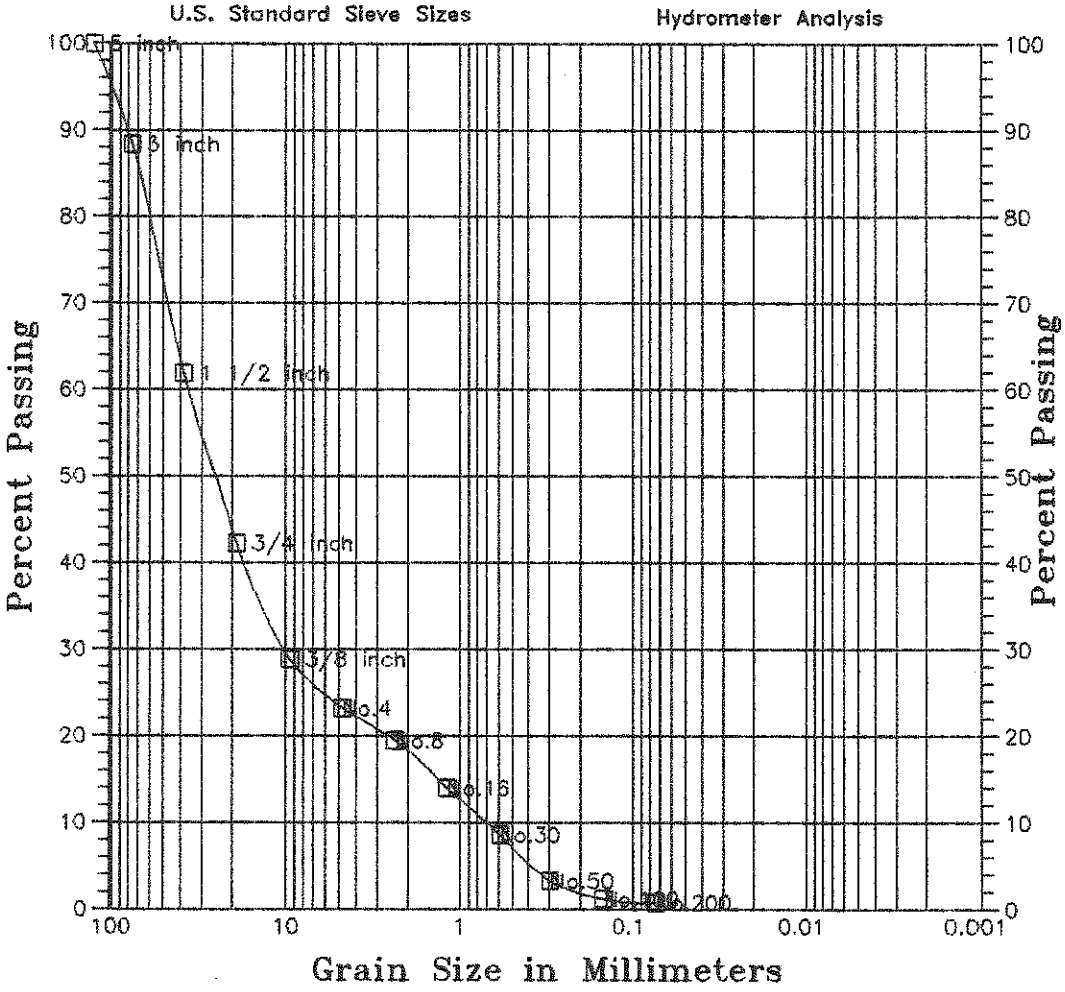
Description - Silt with Sand USCS - ML

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK-US	LAB NO. 1392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 1 DEPTH 3.0-8.0ft	SAMPLE NO. 6.0 DATE TESTED 7/25/89

GRAIN SIZE ANALYSIS



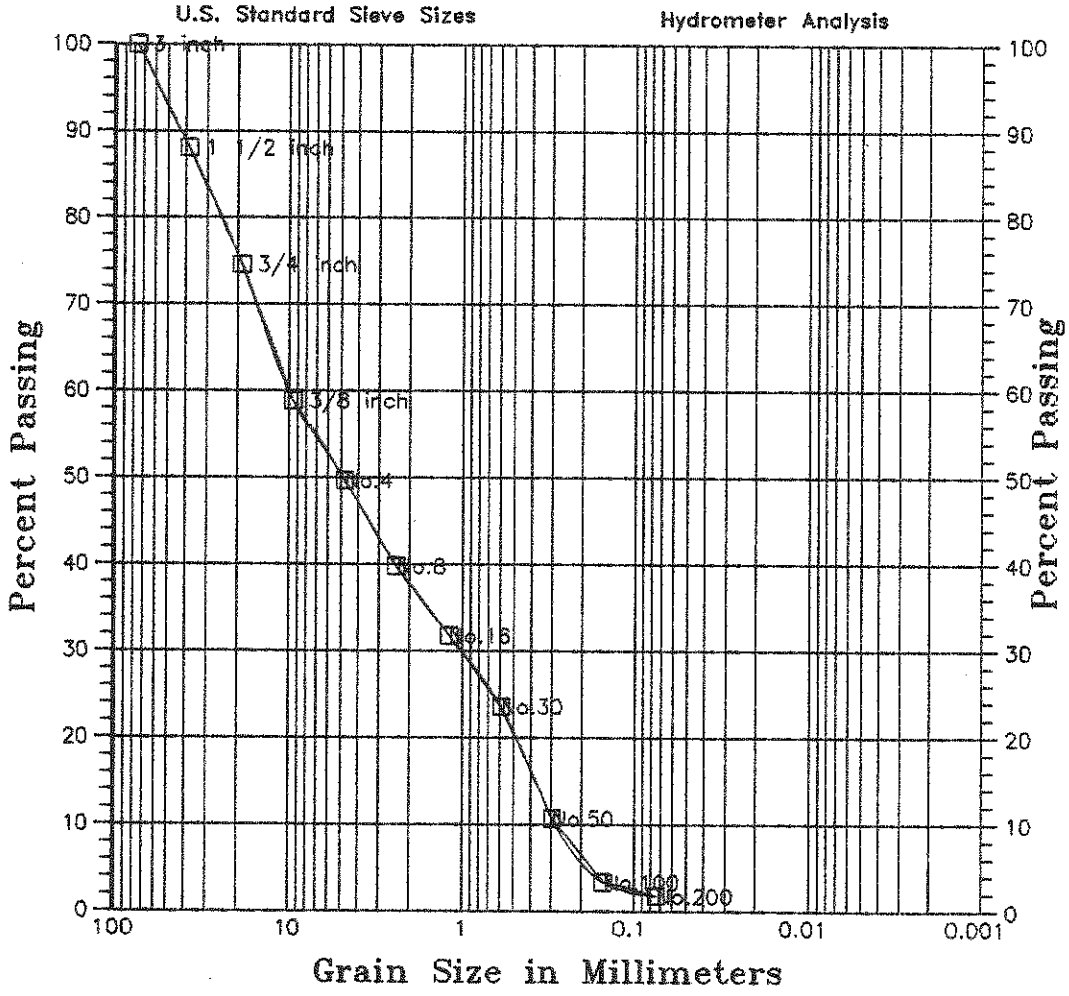
Description - Poorly Graded Gravel With Sand USCS - GP

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK-US	LAB NO. 1392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoil	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 15 DEPTH 2.0-3.0 ft	SAMPLE NO. 9.0 DATE TESTED 7/25/89

GRAIN SIZE ANALYSIS



Description - Well Graded Gravel with Sand USCS-GW

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

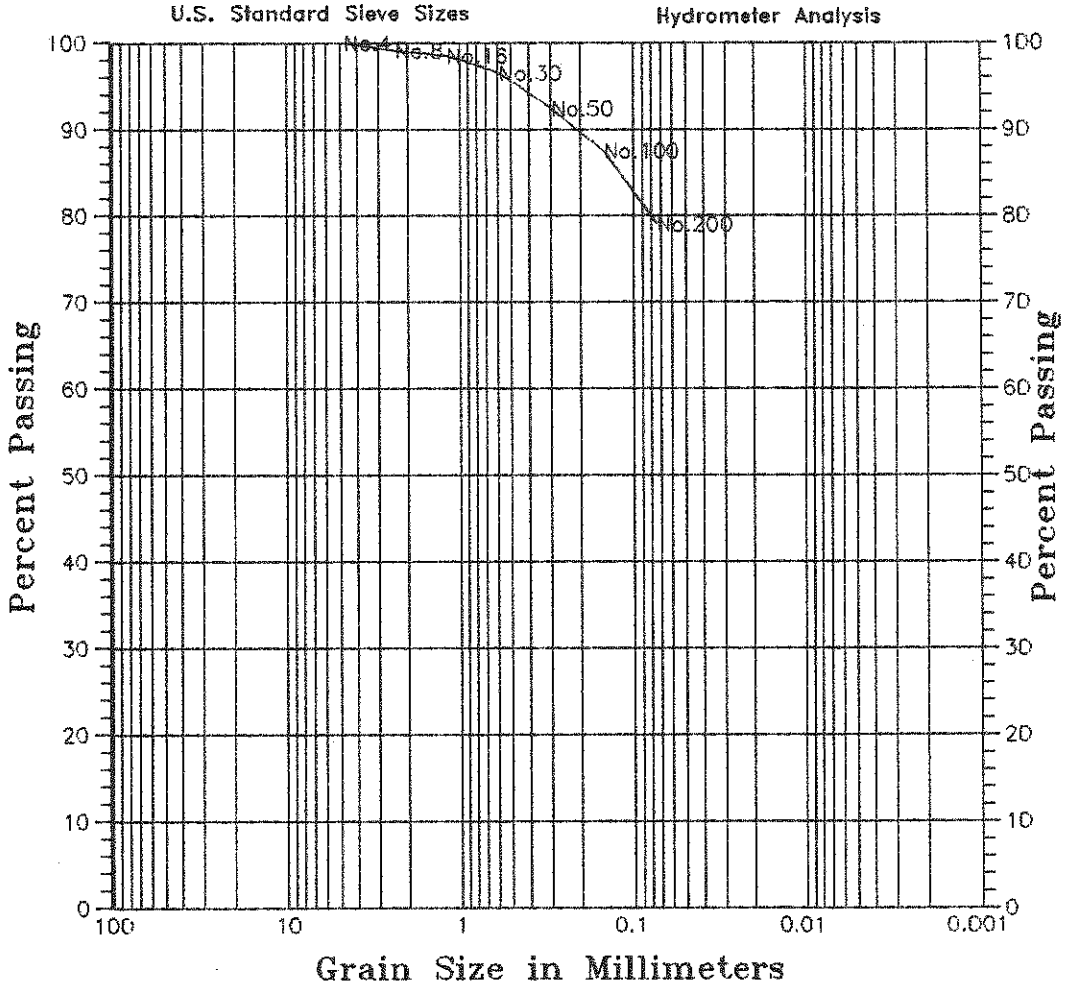
LAB SRK (U.S.),Inc. LAB NO. L-392.0

CLIENT McKinley Mining PROJECT Wishbone Hill

FEATURE Project Area Subsoils PROJECT NO. 17202

BOREHOLE OR TEST PIT NO. 10 DEPTH 1.5-2.5 ft SAMPLE NO. 10.0 DATE TESTED 7-25-89

GRAIN SIZE ANALYSIS



Plasticity Index: Non-Plastic

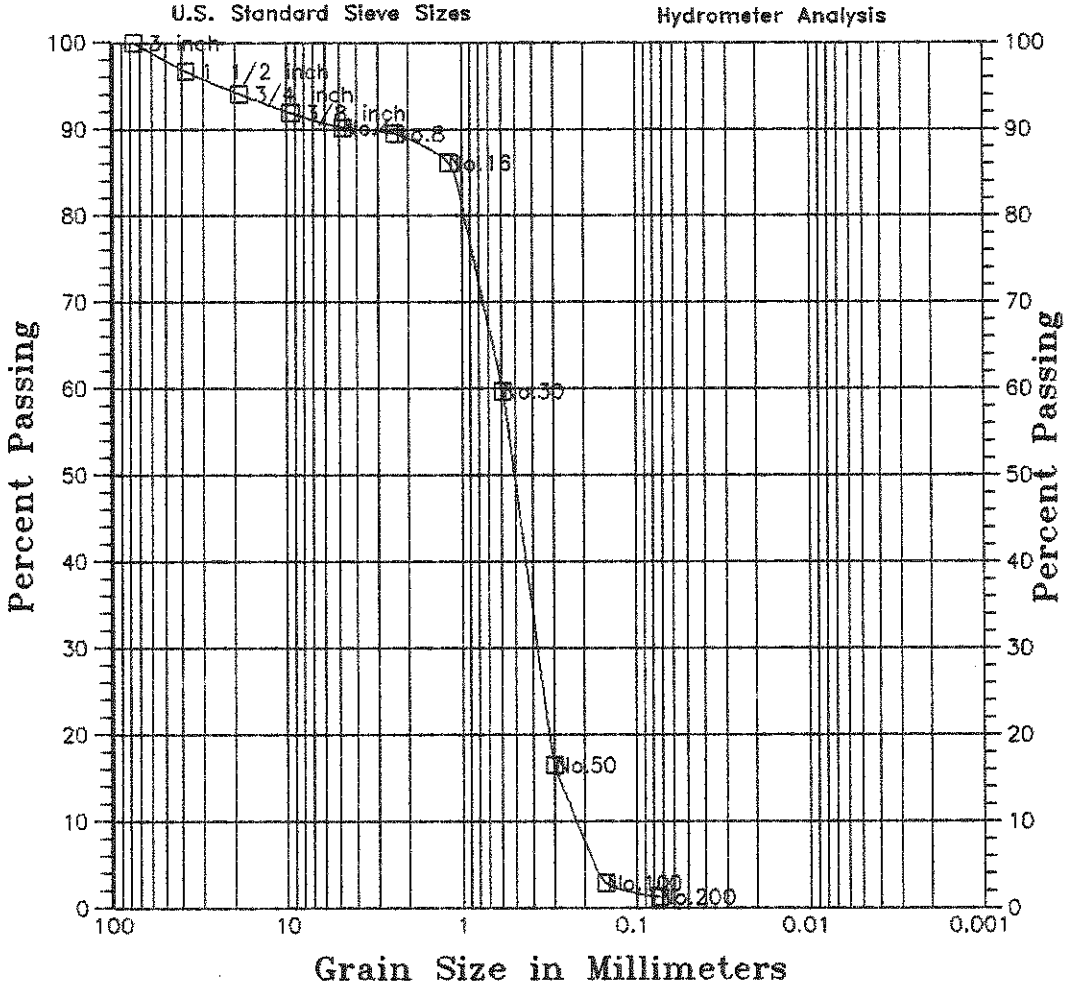
Description: Silt with Sand USCS: ML

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	10	DEPTH	4-6 ft
SAMPLE NO.	11.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



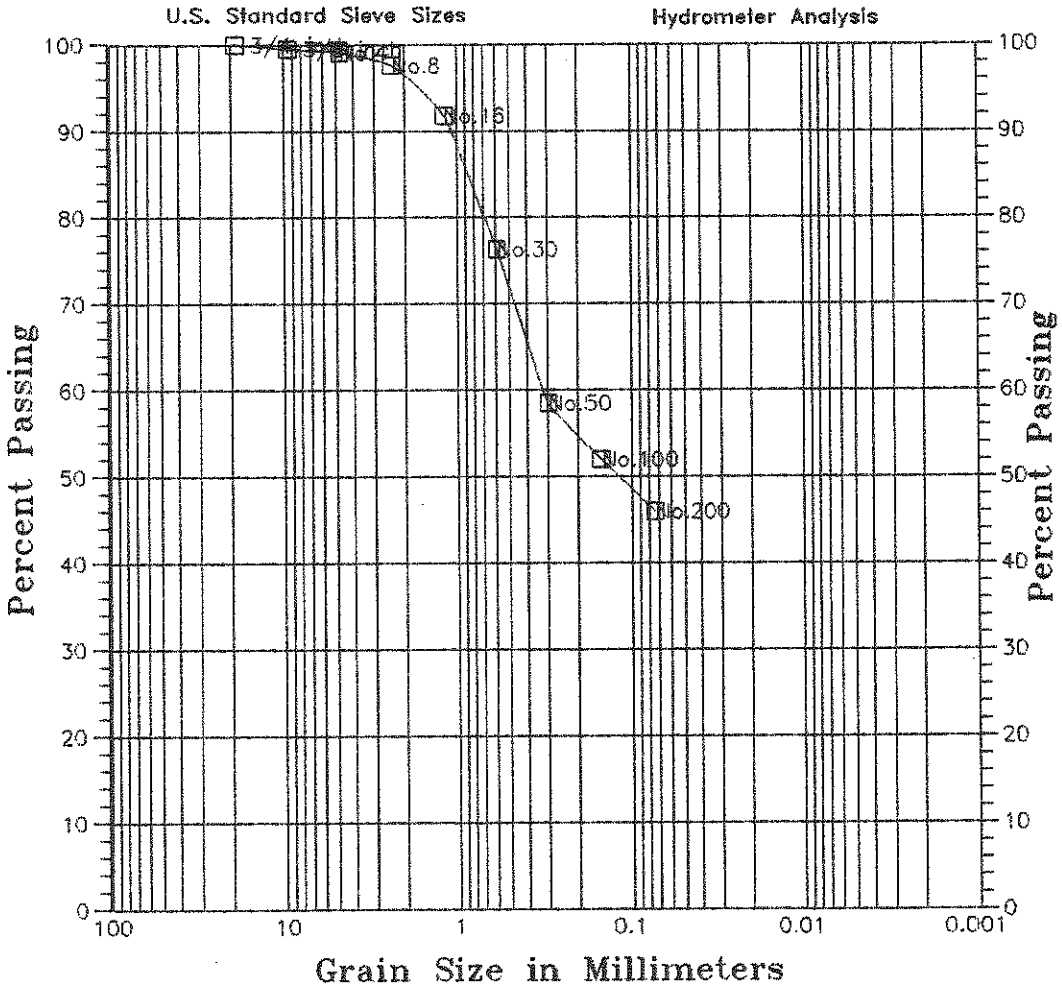
Description: Poorly Graded Sand USCS: SP

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	9	DEPTH	2.5-3.5 ft
SAMPLE NO.	12.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



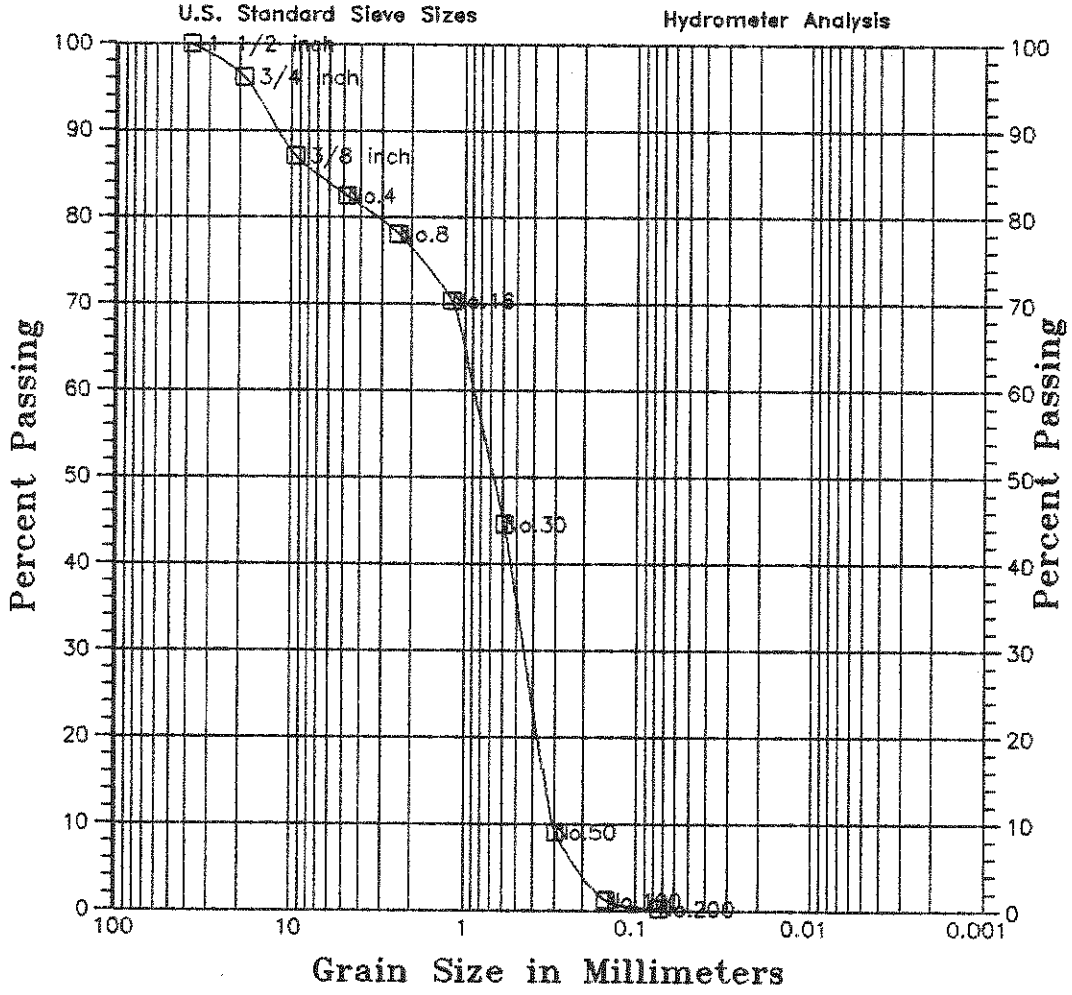
Description: Sand With Silt USCS: SM

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK (U.S.), Inc.	LAB NO. L-392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 8 DEPTH 6-8 ft	SAMPLE NO. 13.0 DATE TESTED 7-25-89

GRAIN SIZE ANALYSIS



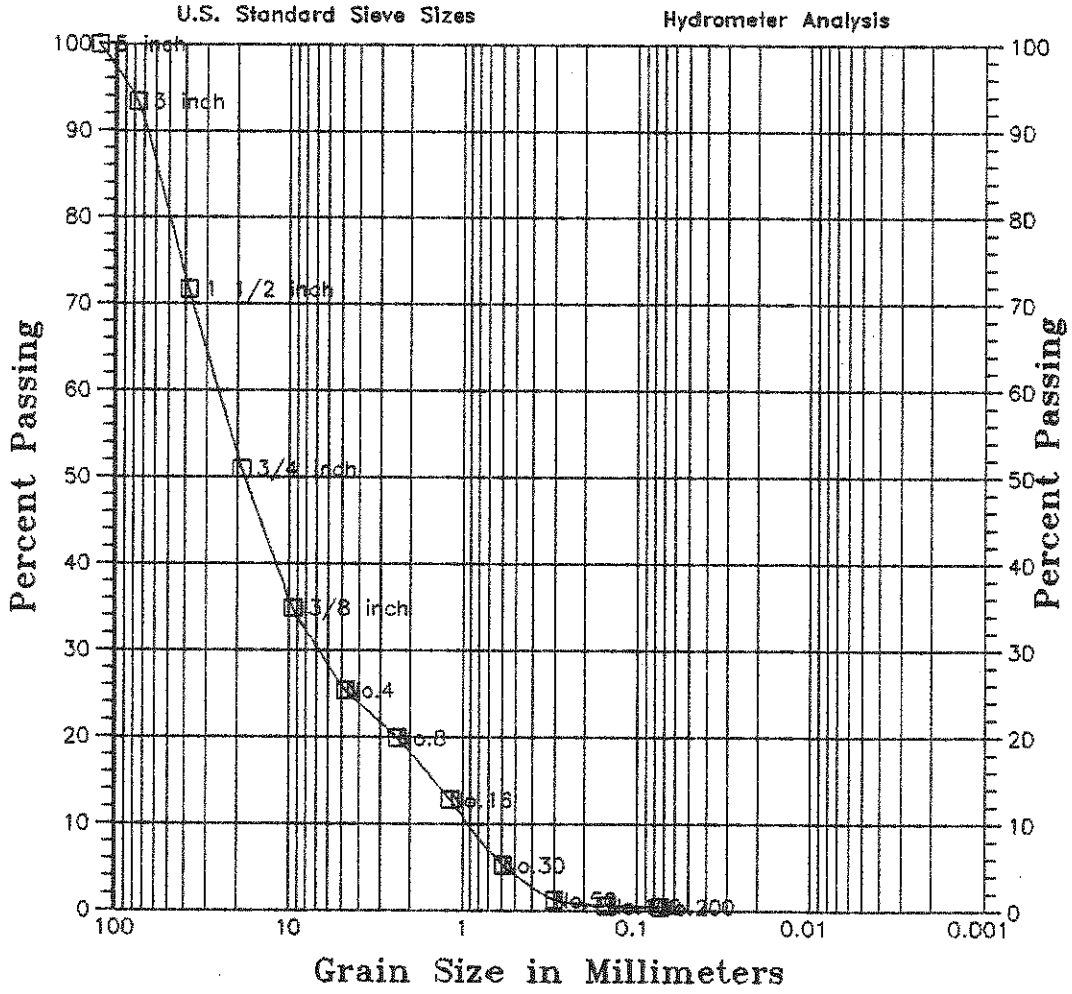
Description: Sand With Gravel USCS: SP

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	4	DEPTH	4-7 ft
SAMPLE NO.	14.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



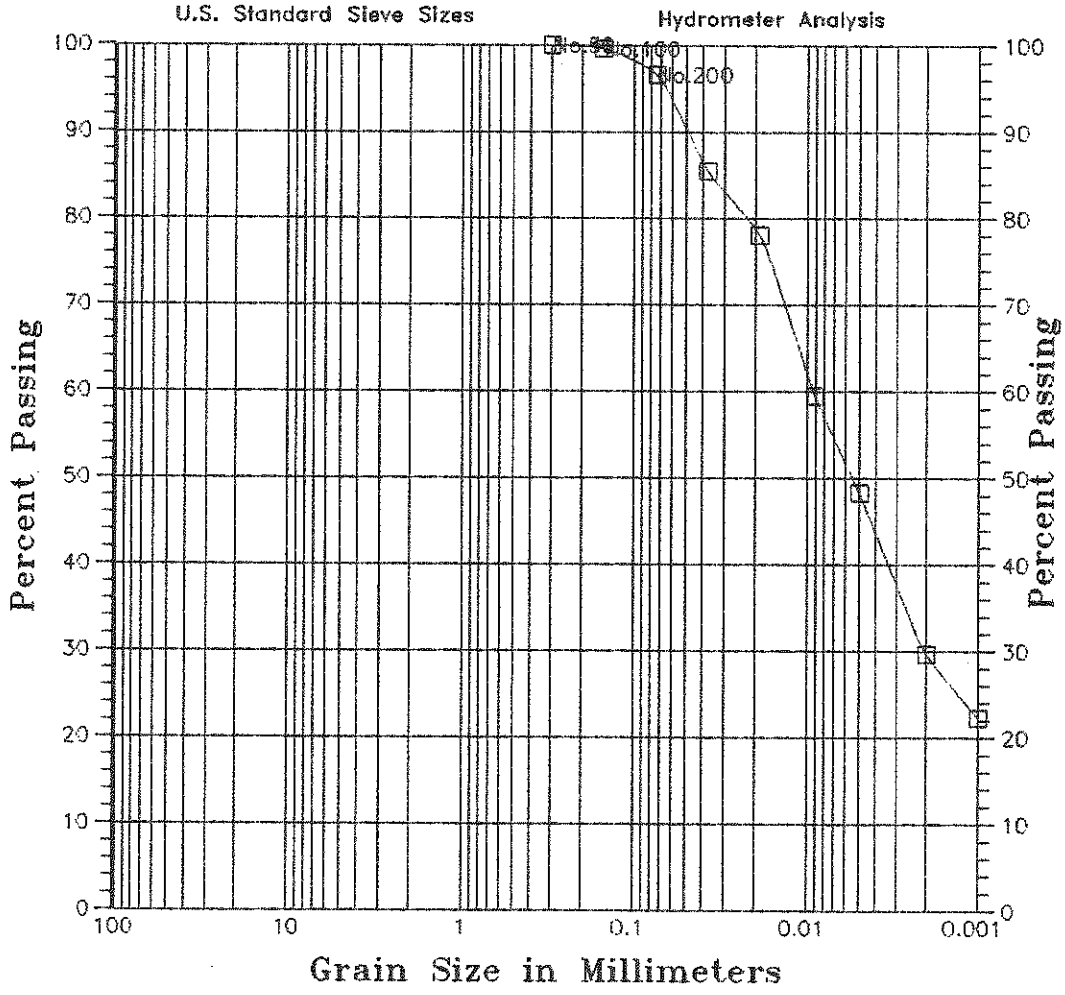
Description: Well graded gravel with sand USCS: GW

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	11	DEPTH	2.5-7 ft
SAMPLE NO.	16.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



Plasticity Index: 9

Liquid Limit: 29

Description: Lean clay

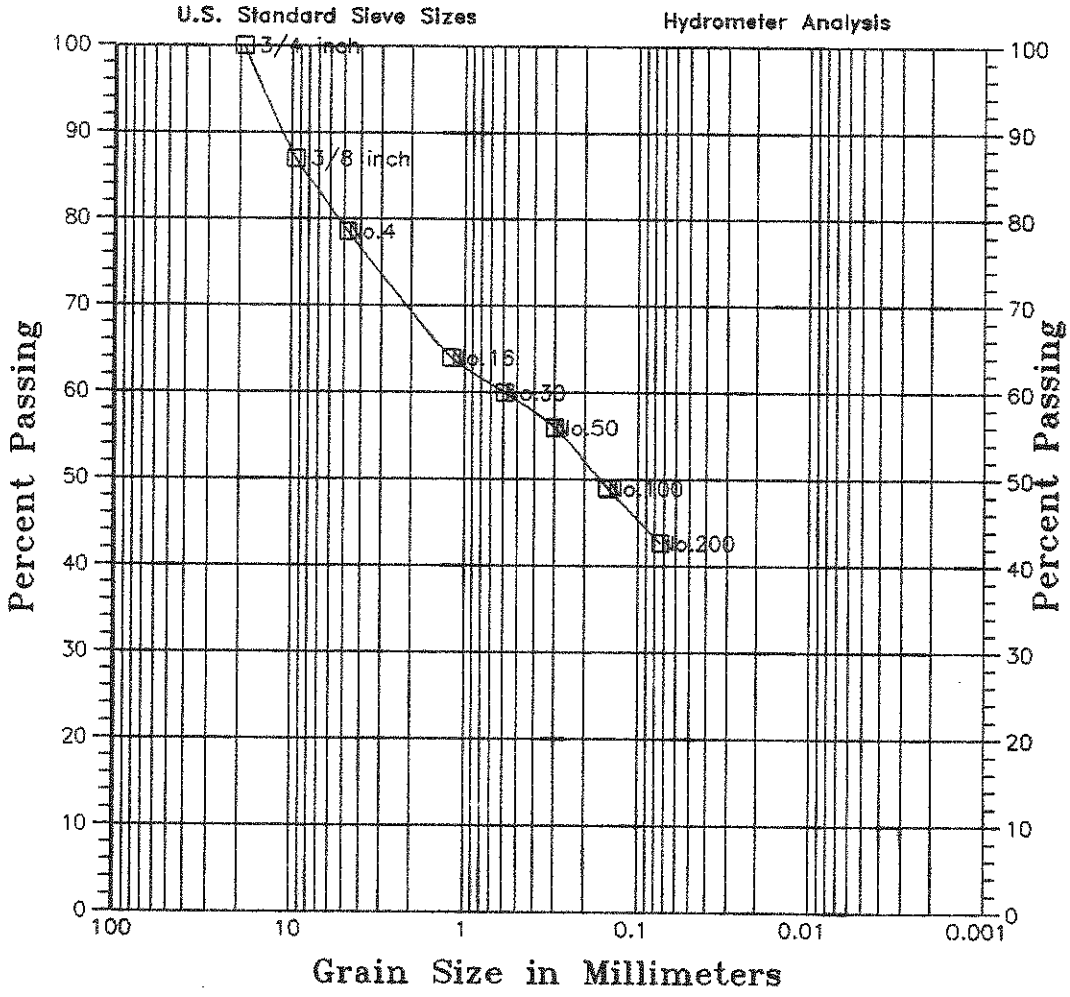
USCS: CL

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	17	DEPTH	2.5-3.5 ft
SAMPLE NO.	17.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



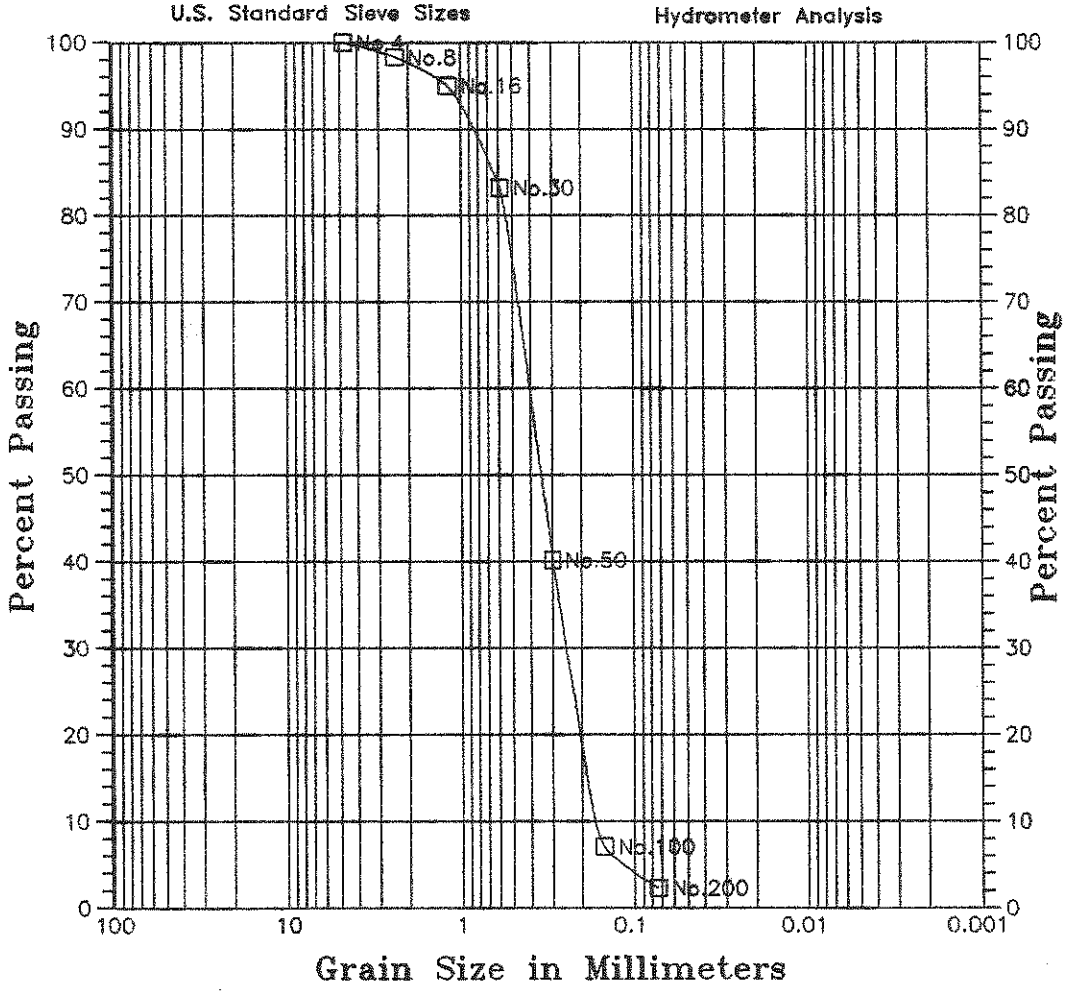
Description: Sand With Gravel and Fines USCS: SM-SC

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	15	DEPTH	3.5-4.5 ft
SAMPLE NO.	19.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



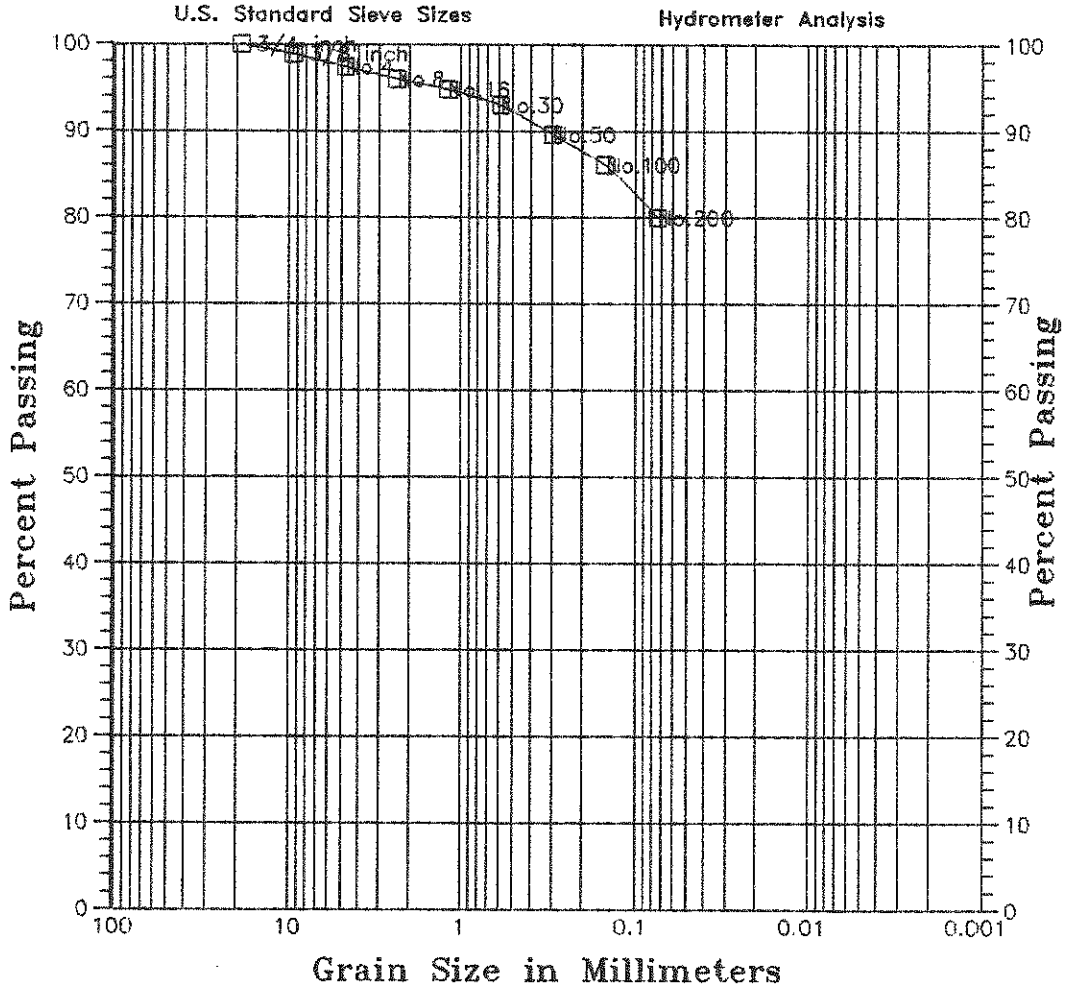
Description: Poorly Graded Sand USCS: SP

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	5	DEPTH	1-3 ft
SAMPLE NO.	24.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



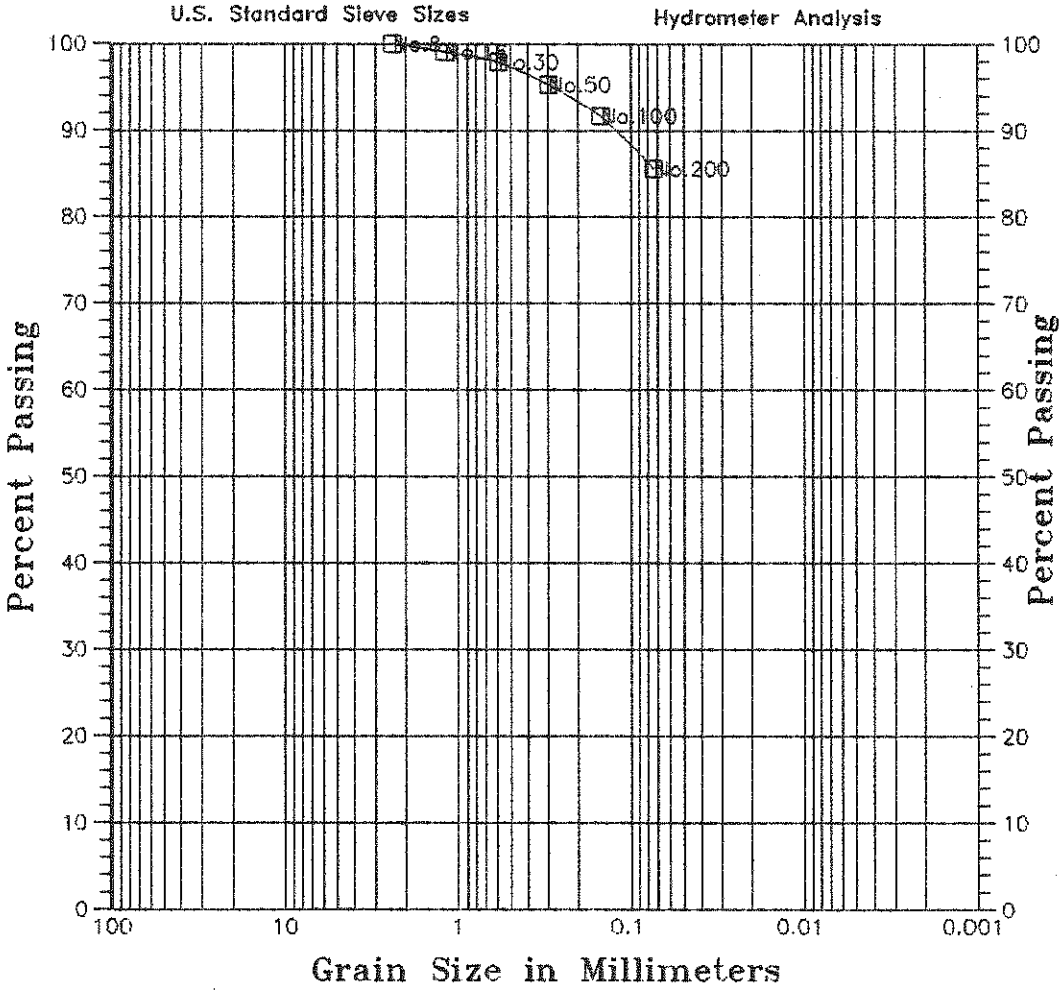
Description: Silt With Sand USCS: ML

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	4	DEPTH	1.5-2 ft
SAMPLE NO.	26.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



Plasticity Index: Non-Plastic

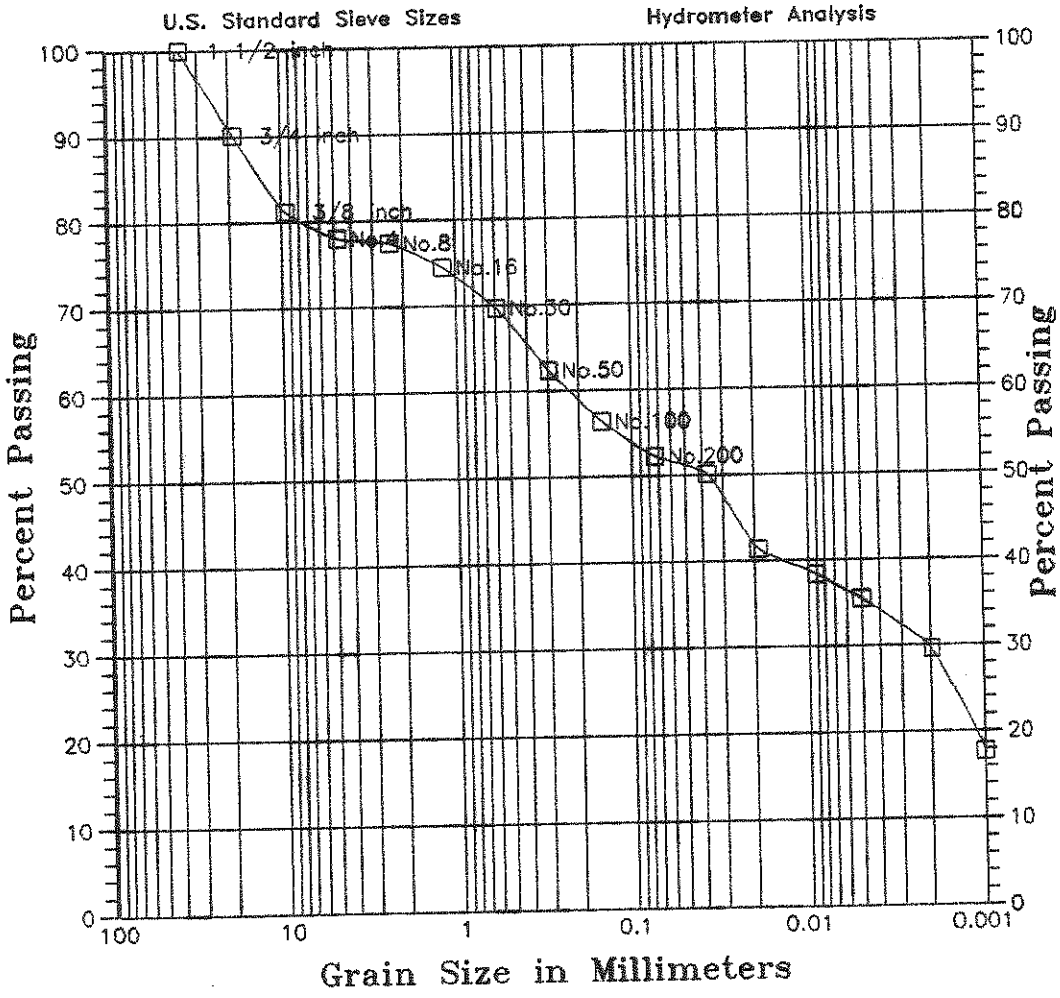
Description: Silt with sand USCS: ML

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK (U.S.), Inc.	LAB NO. L-392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 1 DEPTH 2-3 ft	SAMPLE NO. 28.0 DATE TESTED 7-25-89

GRAIN SIZE ANALYSIS



Plasticity Index: 7 Liquid Limit: 31

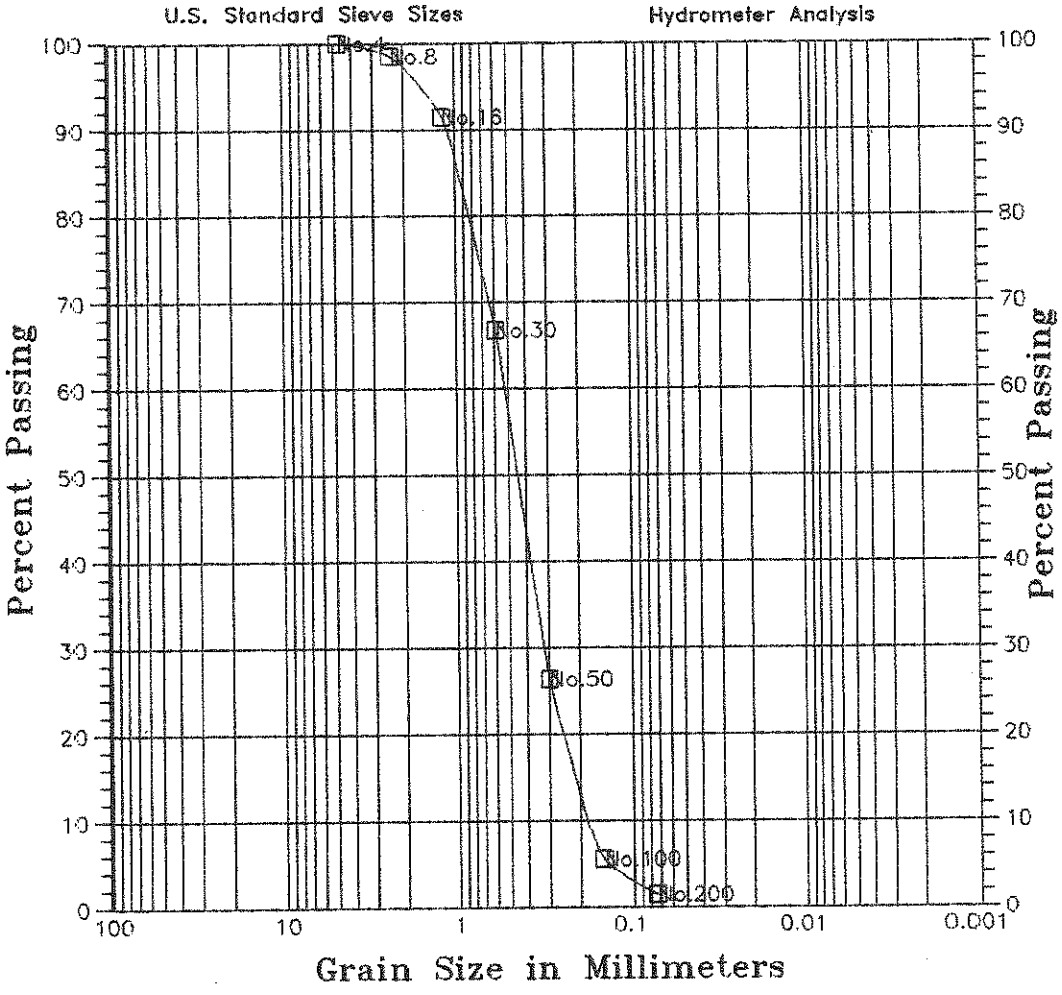
Description: Sandy Clayey Silt With Gravel USCS: ML

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
BOREHOLE OR TEST PIT NO.	2	DEPTH	2.5-3.5 ft
SAMPLE NO.	30.0	DATE TESTED	7-25-89

GRAIN SIZE ANALYSIS



Description: Poorly Graded Sand USCS: SP

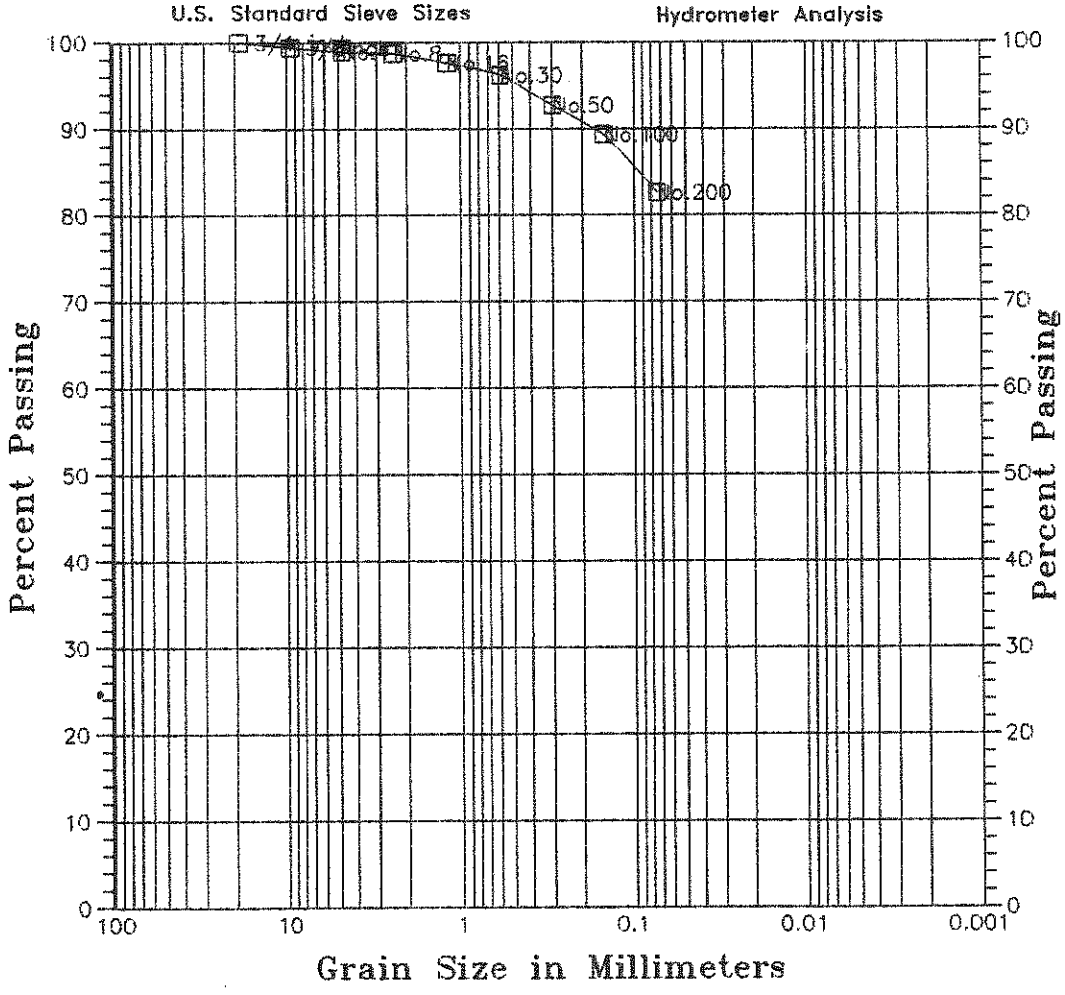
STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK (U.S.), Inc.	LAB NO.	L-392.0
CLIENT	McKinley Mining	PROJECT	Wishbone Hill
FEATURE	Project Area Subsoils	PROJECT NO.	17202
SAMPLE NO.	35.0	DATE TESTED	7-25-89

BOREHOLE OR TEST PIT NO. 14 DEPTH 2-4.5 ft

GRAIN SIZE ANALYSIS



Plasticity Index: Non-Plastic

Description: Sandy silt USCS: ML

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

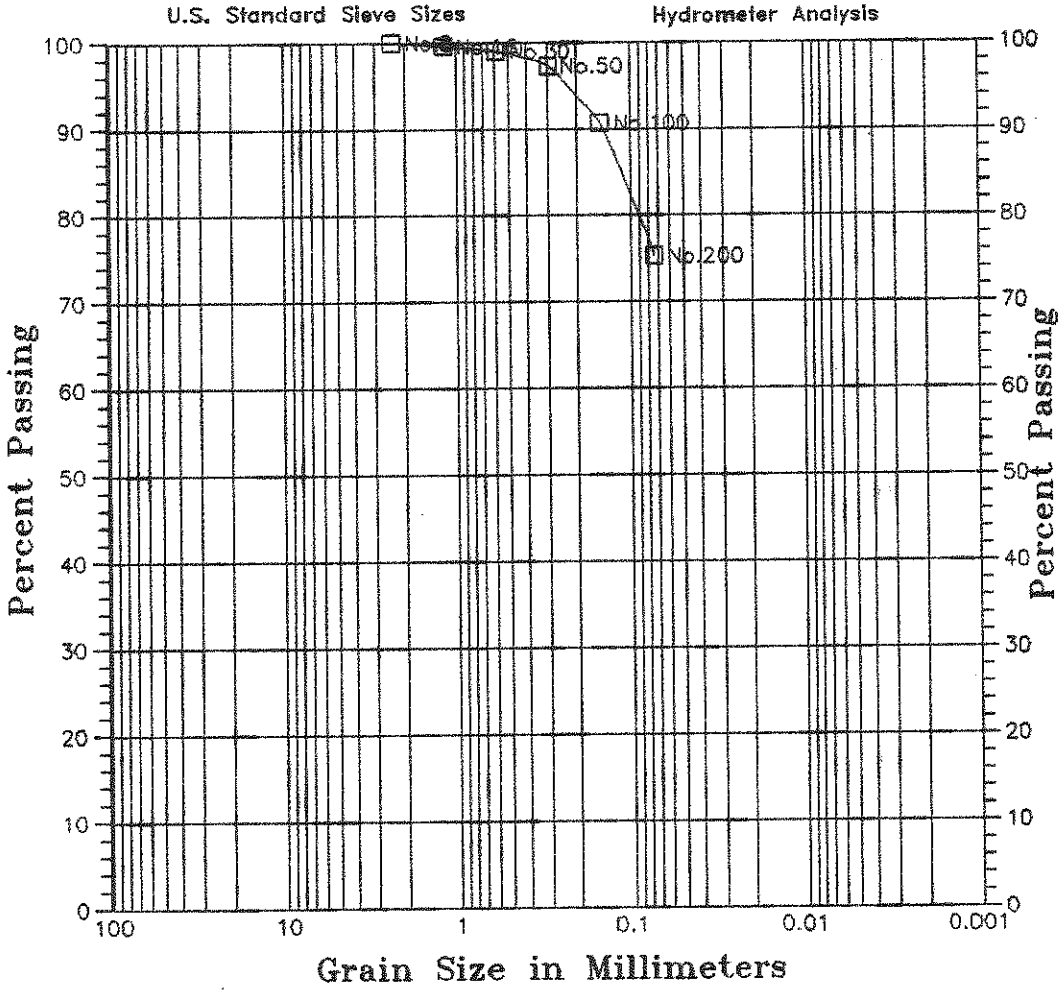
LAB SRK (U.S.), Inc. LAB NO. L-392.0

CLIENT McKinley Mining PROJECT Wishbone Hill

FEATURE Project Area Subsoils PROJECT NO. 17202

BOREHOLE OR TEST PIT NO. 19 DEPTH 2.5-3.5 ft SAMPLE NO. 39.0 DATE TESTED 7-25-89

GRAIN SIZE ANALYSIS



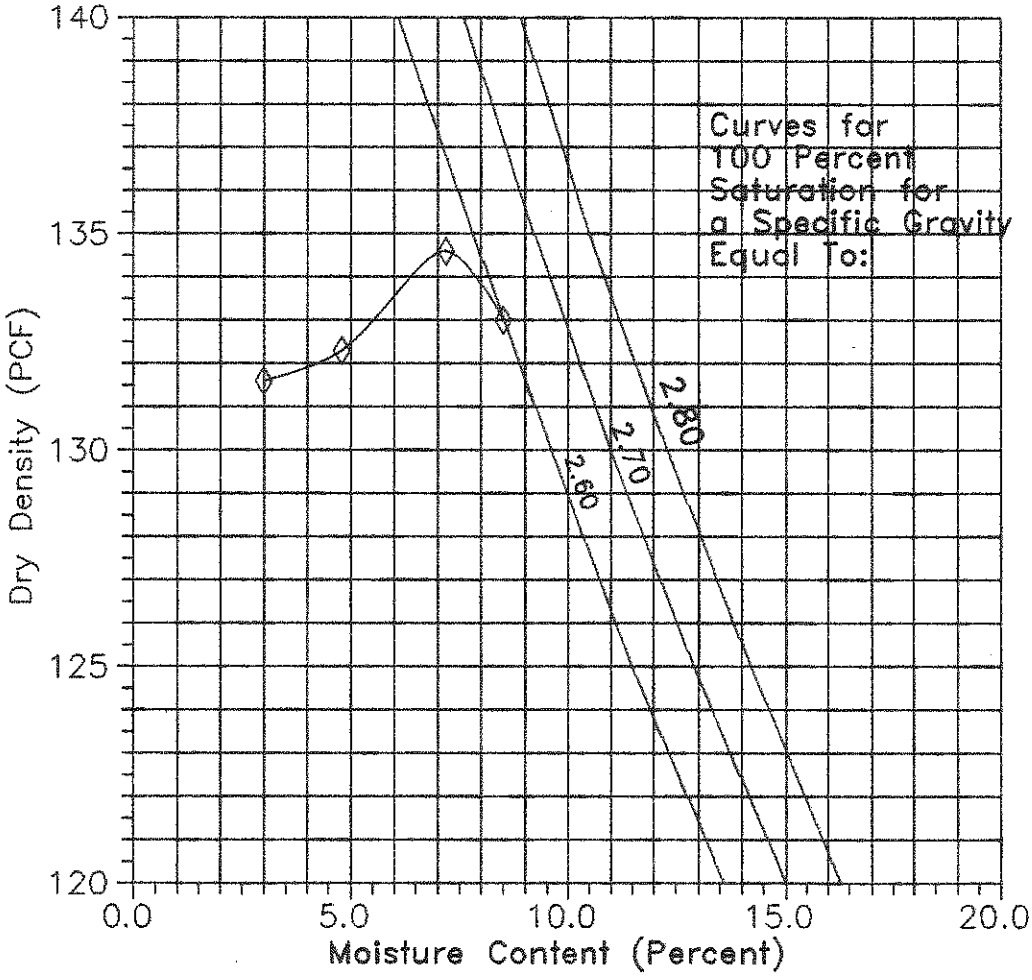
Description: Silt with sand USCS: ML

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK - US	LAB NO. L392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 5 DEPTH 3.5-5 ft	SAMPLE NO. 1.0 DATE TESTED 7-18-89

PROCTOR COMPACTION TEST



ASTM D 698-78 Method C

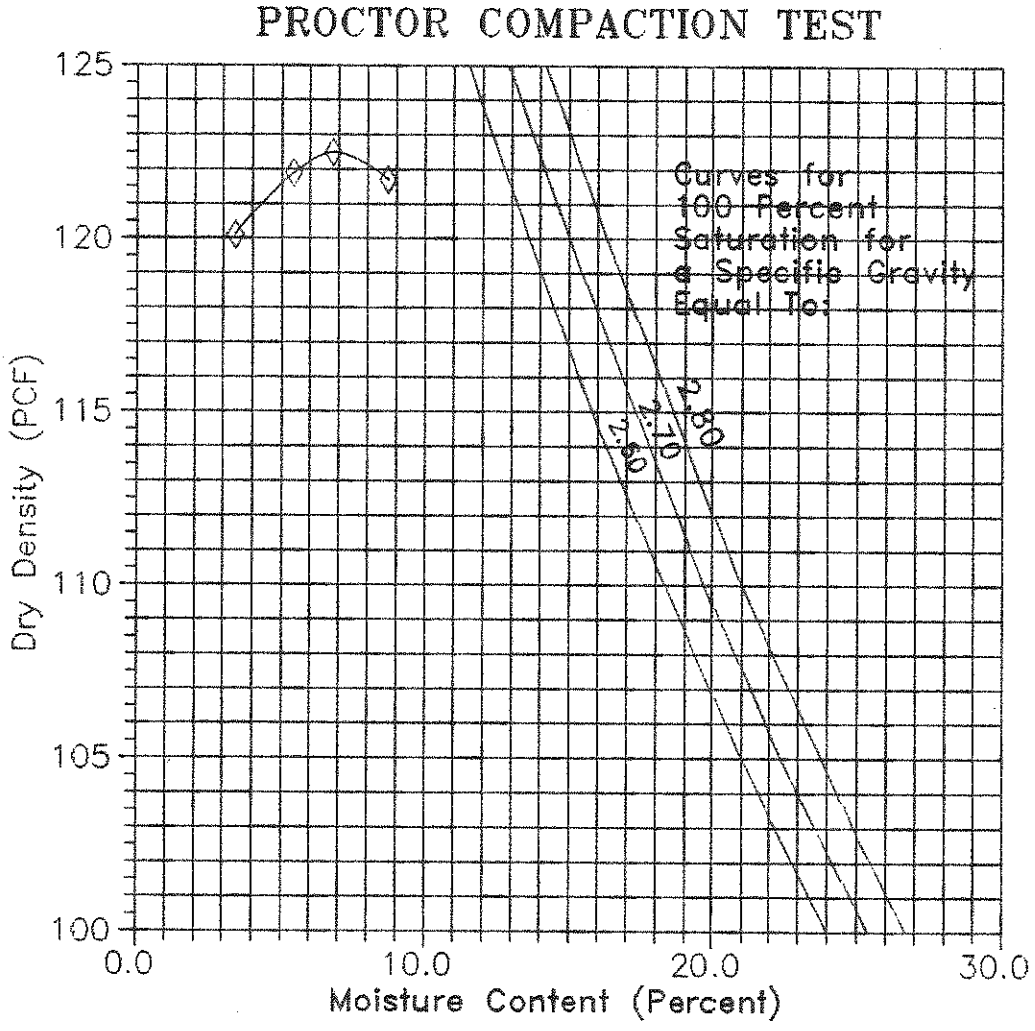
Maximum Dry Density = 134.6 pcf

Optimum Moisture Content = 7.2%

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK-US	LAB NO. L392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 18 DEPTH 3-5 ft	SAMPLE NO. 2.0 DATE TESTED 7-18-89



ASTM D698-78 Method C

Maximum Dry Density = 122.5 pcf

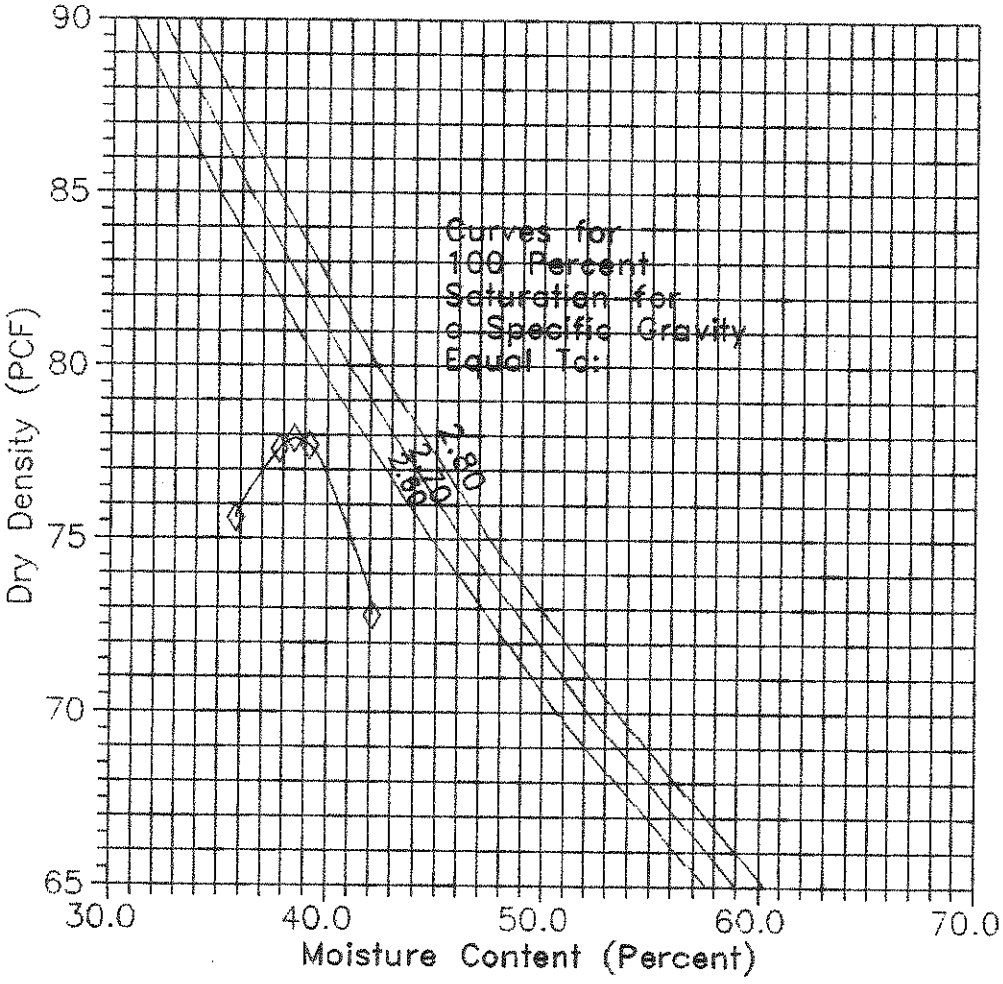
Optimum Moisture Content = 6.8%

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK - US	LAB NO. 1392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 7 DEPTH 2.0-3.0 ft	SAMPLE NO. 5.0 DATE TESTED 7/17/89

PROCTOR COMPACTION TEST



ASTM D 698-78 Method B

Maximum Dry Density = 77.9 pcf

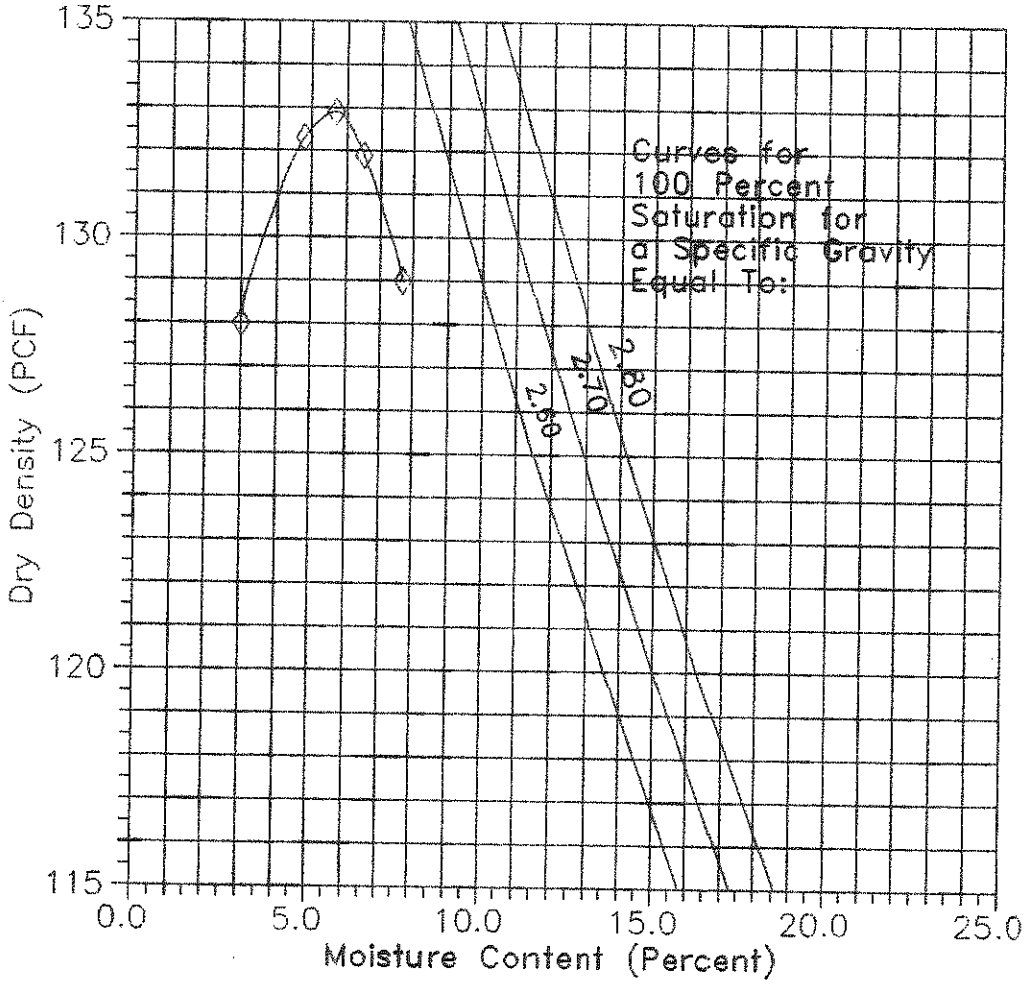
Optimum Moisture Content = 38.5%

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK - US	LAB NO. L392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 1 DEPTH 3.0-8.0 ft	SAMPLE NO. 6.0 DATE TESTED 7-18-89

PROCTOR COMPACTION TEST



ASTM = D 698 - 78 Method B

Maximum Dry Density = 132.9

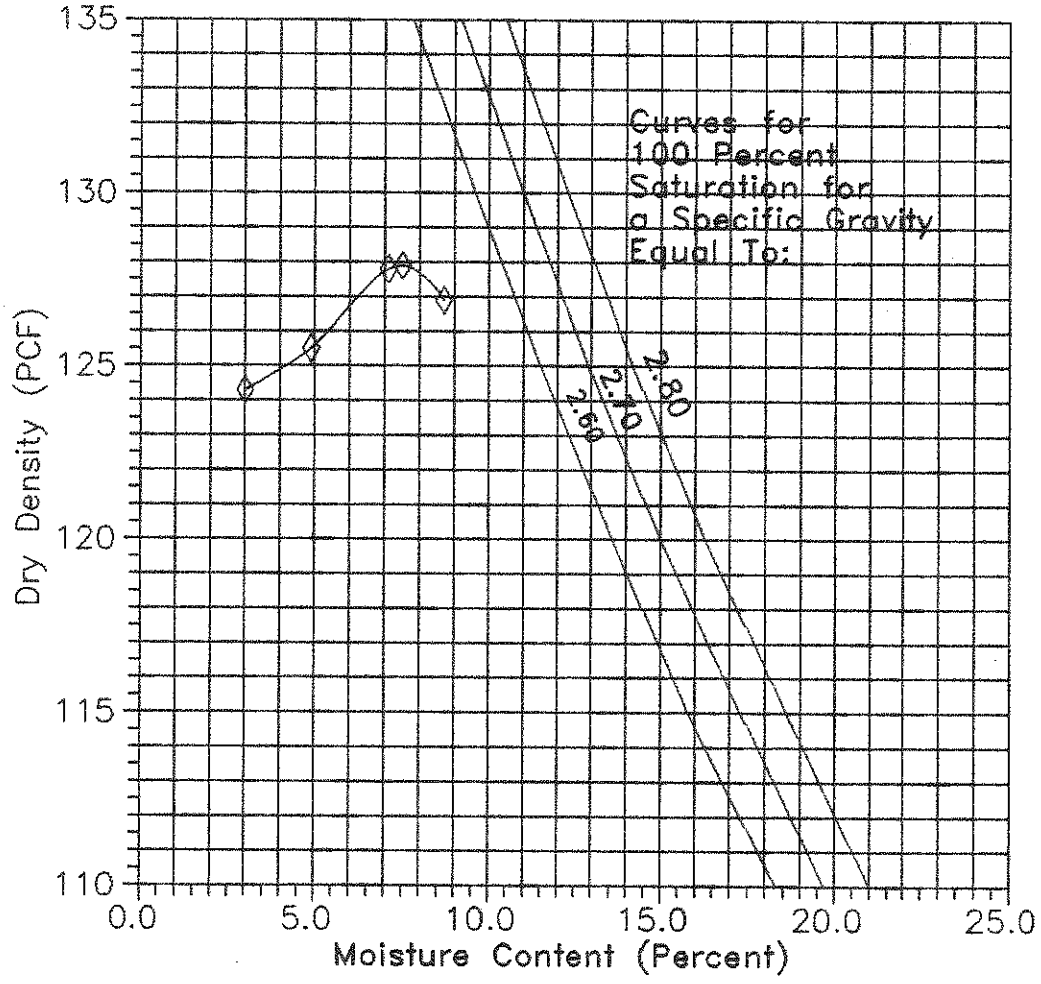
Optimum Moisture content = 5.7%

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK - US	LAB NO. 1392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 15 DEPTH 2.0-3.0 ft	SAMPLE NO. 9.0
	DATE TESTED 7-19-89

PROCTOR COMPACTION TEST



ASTM D 698 - 78 Method B

Maximum Dry Density = 127.9 pcf

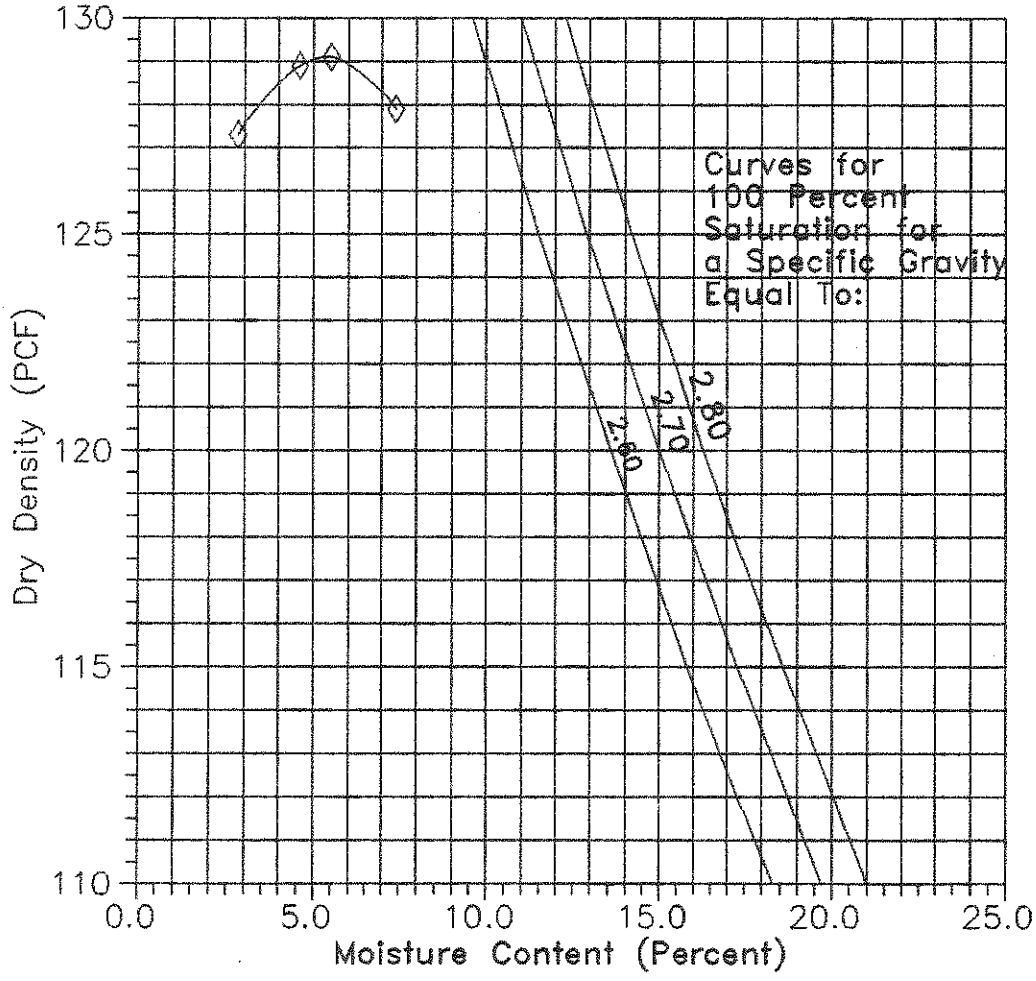
Optimum Moisture Content = 7.5%

STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB SRK - US	LAB NO. L392.0
CLIENT McKinley Mining	PROJECT Wishbone Hill
FEATURE Project Area Subsoils	PROJECT NO. 17202
BOREHOLE OR TEST PIT NO. 4 DEPTH 4.0-7.0ft	SAMPLE NO. 4.0 DATE TESTED 7/19/89

PROCTOR COMPACTION TEST



ASTM D 698-78 Method C
Maximum Dry Density = 129.1 pcf

Optimum Moisture Content = 5.5%

APPENDIX K

LABORATORY TESTING OF COAL SLURRY

APPENDIX K - GEOTECHNICAL LAB TEST RESULTS

This appendix contains the geotechnical lab test results produced for the coal fines which will be disposed in the slurry pond. Test results are included for gradational analysis, column settling tests and consolidation testing. These results were used in the design and sizing of the slurry impoundment. Based on the results of this testing program, a consolidated density of 63 pcf was selected for use in sizing of the slurry pond.

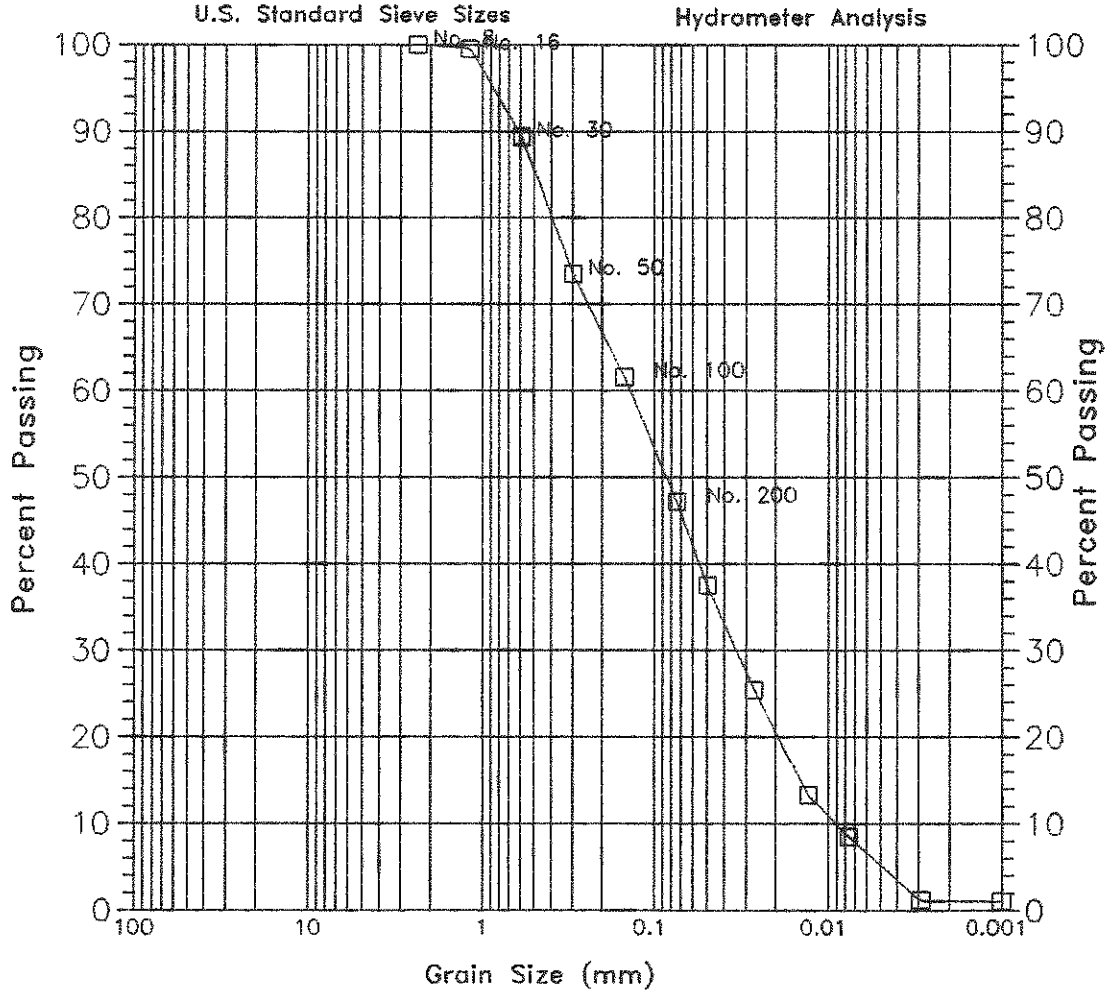
STEFFEN ROBERTSON & KIRSTEN (U.S.)

Consulting Engineers & Scientists

LAB	SRK - U.S.	LAB NO.	L388.0
CLIENT	McKinley Mining Co.	PROJECT	Wishbone Hill
FEATURE	Coal Tailings	PROJECT NO.	17202
SAMPLE NO.	1.0	DATE TESTED	05/15/89

BOREHOLE OR TEST PIT NO. _____ DEPTH _____

GRAIN SIZE ANALYSIS



COLUMN SETTLED DENSITY / PERMEABILITY

Project	WISHBONE HILL	Project No 17202	Lab No.	L388.0	Column No. 51
Lab	SRK - US	Feature COAL TAILINGS	Date	05/15/89	Bottom Drainage YES
Sample No.	1	Specimen No.	3		Lift No. 1

INITIAL SPECIMEN CONDITIONS

WET WT. OF SOLIDS =	482.60 g	M/C % (initial) =	11.60 %	WT. OF DRY SOLIDS =	432.44 g
WT. OF WATER =	50.16 g	WT. OF ADDED WATER =	1,166.76 g	TOTAL WATER =	1,216.92 g
TOTAL WT. OF SLURRY=	1,599.20 g	M/C % (SLURRY) =	281.41 %	SOLIDS CONTENT =	26.2 %
DIAMETER =	12.45 cm	AREA =	121.74 sq cm	HEIGHT =	12.07 cm
VOLUME (t) =	1,469.39 cc	VOLUME (s) =	252.89 cc	VOLUME (v) =	1,216.50 cc
e =	4.810	n % =	82.8 %	So =	100.0 %

AFTER SETTLEMENT AND DRAINAGE SPECIMEN CONDITION

RECOVERED WATER =	941.10 g	RETAINED WATER =	275.82 g	RETAINED M/C % =	63.8 %

END OF TEST SPECIMEN CONDITION

M/C % (final) =	52.00 %	Sf =	87.43 %

SETTLEMENT DATA

Date M D Y 00/00/00	Time (Hrs.)	Total Elapsed Time (Min.)	Total Volume Total (cc)	Void Ratio (e)	Dry Density (PCF)	Saturated Moisture Content %	Permeability Test: Constant	Falling	(Ft./Yr.)	(cm/sec)	Gradient (i)
05/15/89	15.68										
05/15/89	15.70	1.0	1,469.4	4.810	18.4	281.3					
05/15/89	15.72	2.0	1,453.6	4.748	18.6	277.7					
05/15/89	15.73	3.0	1,447.5	4.724	18.7	276.2					
05/15/89	15.77	5.0	1,361.0	4.382	19.8	256.3					
05/15/89	15.83	9.0	1,267.3	4.011	21.3	234.6					
05/15/89	15.95	16.0	525.9	1.080	51.3	63.1		X	859.1	8.3E-04	2.2
05/15/89	16.20	31.0	525.9	1.080	51.3	63.1		X	1,308.3	1.3E-03	1.7
05/15/89	16.70	61.0	525.9	1.080	51.3	63.1		X	1,113.2	1.1E-03	1.1
05/15/89	16.80	67.0	525.9	1.080	51.3	63.1		X	1,043.2	1.0E-03	1.0
05/16/89	9.95	1,096.0	510.1	1.017	52.9	59.5					
05/16/89	16.97	1,517.0	510.1	1.017	52.9	59.5					
05/17/89	8.57	2,453.0	510.1	1.017	52.9	59.5					
05/17/89	13.50	2,749.0	510.1	1.017	52.9	59.5					
05/17/89	13.77	2,765.0	510.1	1.017	52.9	59.5					

COLUMN SETTLED DENSITY / PERMEABILITY

Project	WISHBONE HILL	Project No	17202	Lab No.	L388.0
Lab	SRK - US	Feature	COAL TAILINGS	Date	05/17/89
Sample No.	1	Specimen No.	3		

Column No.	51
Bottom Drainage	YES
Lift No.	2

INITIAL SPECIMEN CONDITIONS

WET WT. OF SOLIDS =	482.70 g	M/C % (initial) =	11.20 %	WT. OF DRY SOLIDS =	434.08 g
WT. OF WATER =	48.62 g	WT. OF ADDED WATER =	1,138.40 g	TOTAL WATER =	1,187.02 g
TOTAL WT. OF SLURRY=	1,572.48 g	M/C % (SLURRY) =	273.45 %	SOLIDS CONTENT =	26.8 %
DIAMETER =	12.45 cm	AREA =	121.74 sq cm		
HEIGHT of 1st LIFT =	4.19 cm	HEIGHT of 2nd LIFT =	15.24 cm	HEIGHT =	11.05 cm
VOLUME (t) =	1,345.21 cc	VOLUME (s) =	253.85 cc	VOLUME (v) =	1,091.36 cc
e =	4.299	n % =	81.1 %	So =	108.8 %

AFTER SETTLEMENT AND DRAINAGE SPECIMEN CONDITION

RECOVERED WATER =	938.00 g	RETAINED WATER =	249.02 g	RETAINED M/C % =	57.4 %
RECOVERED WATER 1&2	1,879.10	RETAINED WATER 1&2	524.84 g	RETAINED M/C% 1&2	60.6 %

END OF TEST SPECIMEN CONDITION

M/C % (final) =	52.00 %	Sf =	107.50 %

SETTLEMENT DATA

Date M D Y 00/00/00	Time (Hrs.)	Total Elapsed Time (Min.)	Volume Total (cc)	Void Ratio (e)	Dry Density (PCF)	Saturated Moisture Content %	Permeability Test: Constant	Falling	(Ft./Yr.)	(cm/sec)	Gradient (i)	Lift Nos. 1&2: Total Volume	Total Void Ratio (e)	Total Dry Density (PCF)	Total Saturated Moisture Content %
05/17/89	13.70		1,345.21	4.299	20.1	251.4						1,855.3	2.661	29.2	155.6
05/17/89	13.72	0.6	1,345.21	4.299	20.1	251.4	X					1,855.3	2.661	29.2	155.6
05/17/89	13.73	1.2	1,329.39	4.237	20.4	247.8	X					1,839.5	2.630	29.4	153.8
05/17/89	13.77	2.4	989.74	2.899	27.4	169.5	X					1,499.8	1.960	36.1	114.6
05/17/89	13.83	4.8	819.30	2.228	33.1	130.3	X					1,329.4	1.623	40.7	94.9
05/17/89	13.95	9.0	504.00	0.985	53.8	57.6	X					1,014.1	1.001	53.3	58.5
05/17/89	14.20	42.0	479.65	0.890	56.5	52.0	X	561.7	5.4E-04		1.4	989.7	0.953	54.7	55.7
05/17/89	14.53	54.0	479.65	0.890	56.5	52.0	X	1,852.0	1.8E-03		1.2	989.7	0.953	54.7	55.7
05/17/89	14.70	60.0	479.65	0.890	56.5	52.0	X	2,073.4	2.0E-03		1.1	989.7	0.953	54.7	55.7
05/17/89	14.85	65.4	479.65	0.890	56.5	52.0	X	1,263.8	1.2E-03		1.1	989.7	0.953	54.7	55.7
05/17/89	14.88	66.6	479.65	0.890	56.5	52.0	X	5,694.2	5.5E-03		1.0	989.7	0.953	54.7	55.7
05/17/89	14.92	67.8	463.82	0.827	58.4	48.4	X	2,549.2	2.5E-03		1.0	973.9	0.922	55.5	53.9
05/17/89	15.05	96.6	463.82	0.827	58.4	48.4						973.9	0.922	55.5	53.9
05/17/89	17.05	216.6	463.82	0.827	58.4	48.4						973.9	0.922	55.5	53.9
05/18/89	9.33	1,186.8	463.82	0.827	58.4	48.4						973.9	0.922	55.5	53.9
05/18/89	14.08	1,477.8	463.82	0.827	58.4	48.4						973.9	0.922	55.5	53.9

COLUMN SETTLED DENSITY / PERMEABILITY

Project	SAN LUIS	Project No	17202	Lab No.	L388.0
Lab	SRK - US	Feature	COAL TAILINGS	Date	05/17/89
Sample No.	1	Specimen No.	3		

Column No.	51
Bottom Drainage	YES
Lift No.	3

INITIAL SPECIMEN CONDITIONS

WET WT. OF SOLIDS =	482.70 g	M/C % (initial) =	11.20 %	WT. OF DRY SOLIDS =	434.08 g
WT. OF WATER =	48.62 g	WT. OF ADDED WATER =	1,138.40 g	TOTAL WATER =	1,187.02 g
TOTAL WT. OF SLURRY=	1,572.48 g	M/C % (SLURRY) =	273.45 %	SOLIDS CONTENT =	26.8 %
DIAMETER =	12.45 cm	AREA =	121.74 sq cm		
HEIGHT of 2nd LIFT =	8.00 cm	HEIGHT of 3rd LIFT =	19.55 cm	HEIGHT =	11.55 cm
VOLUME (t) =	1,406.08 cc	VOLUME (s) =	253.85 cc	VOLUME (v) =	1,152.23 cc
e =	4.539	n % =	81.9 %	So =	103.0 %

AFTER SETTLEMENT AND DRAINAGE SPECIMEN CONDITION

RECOVERED WATER =	950.80 g	RETAINED WATER =	236.22 g	RETAINED M/C % =	54.4 %
RECOVERED H2O 1,2&3	2,829.90	RETAINED H2O 1,2&3	761.06 g	RETAINED M/C% 1,2&3	58.5 %

END OF TEST SPECIMEN CONDITION

M/C % (final) =	52.00 %	Sf =	93.42 %

SETTLEMENT DATA

Date M D Y 00/00/00	Time (Hrs.)	Total Elapsed Time (Min.)	Volume Total (cc)	Void Ratio (e)	Dry Density (PCF)	Saturated Moisture Content %	Permeability Test: Constant	Falling	(Ft./Yr.)	(cm/sec)	Gradient (i)	Lift Nos. 1,2&3: Total Volume	Total Void Ratio (e)	Total Dry Density (PCF)	Total Saturated Moisture Content %
05/18/89	14.08		1,406.08	4.539	19.3	265.4									
05/18/89	14.10	1.0	1,391.47	4.481	19.5	262.1						2,380.0	2.129	34.1	124.5
05/18/89	14.12	2.0	1,361.04	4.362	19.9	255.1						2,365.4	2.110	34.3	123.4
05/18/89	14.15	4.0	1,339.13	4.275	20.2	250.0						2,334.9	2.070	34.8	121.0
05/18/89	14.22	8.0	1,268.52	3.997	21.4	233.7						2,313.0	2.041	35.1	119.4
05/18/89	14.33	15.0	510.09	1.009	53.1	59.0						2,242.4	1.948	36.2	113.9
05/18/89	14.48	24.0	495.48	0.952	54.7	55.7						1,484.0	0.951	54.7	55.6
05/18/89	14.58	30.0	495.48	0.952	54.7	55.7		X	1,014.4	9.8E-04	1.4	1,469.4	0.932	55.3	54.5
05/18/89	14.68	36.0	495.48	0.952	54.7	55.7		X	1,314.2	1.3E-03	1.3	1,469.4	0.932	55.3	54.5
05/18/89	14.78	42.0	495.48	0.952	54.7	55.7		X	1,211.6	1.2E-03	1.3	1,469.4	0.932	55.3	54.5
05/18/89	14.88	48.0	495.48	0.952	54.7	55.7		X	1,324.2	1.3E-03	1.3	1,469.4	0.932	55.3	54.5
05/18/89	14.98	54.0	495.48	0.952	54.7	55.7		X	1,472.3	1.4E-03	1.2	1,469.4	0.932	55.3	54.5
05/18/89	15.08	60.0	495.48	0.952	54.7	55.7		X	1,239.6	1.2E-03	1.2	1,469.4	0.932	55.3	54.5
05/18/89	15.18	66.0	495.48	0.952	54.7	55.7		X	1,285.7	1.2E-03	1.1	1,469.4	0.932	55.3	54.5
05/18/89	15.28	72.0	495.48	0.952	54.7	55.7		X	1,335.4	1.3E-03	1.1	1,469.4	0.932	55.3	54.5
05/18/89	15.37	77.0	495.48	0.952	54.7	55.7		X	1,222.7	1.2E-03	1.0	1,469.4	0.932	55.3	54.5
05/18/89	16.65	154.0	479.65	0.890	56.5	52.0		X	1,452.2	1.4E-03	1.0	1,469.4	0.932	55.3	54.5
05/19/89	9.82	1,184.0	479.65	0.890	56.5	52.0		X	0.0	0.0E+00	1.0	1,453.6	0.911	55.9	53.3
05/19/89	10.83	1,245.0	479.65	0.890	56.5	52.0		X	0.0	0.0E+00	1.0	1,453.6	0.911	55.9	53.3
05/19/89	10.85	1,246.0	479.65	0.890	56.5	52.0		Recharged Column with water and ran a permeability test							
05/19/89	10.93	1,251.0	479.65	0.890	56.5	52.0		X	663.8	6.4E-04	2.1	1,453.6	0.911	55.9	53.3
05/19/89	11.02	1,256.0	479.65	0.890	56.5	52.0		X	518.5	5.0E-04	2.0	1,453.6	0.911	55.9	53.3
05/19/89	11.10	1,261.0	479.65	0.890	56.5	52.0		X	644.7	6.3E-04	2.0	1,453.6	0.911	55.9	53.3
05/19/89	11.18	1,266.0	479.65	0.890	56.5	52.0		X	602.9	5.8E-04	2.0	1,453.6	0.911	55.9	53.3
05/19/89	11.27	1,271.0	479.65	0.890	56.5	52.0		X	541.5	5.3E-04	2.0	1,453.6	0.911	55.9	53.3
05/19/89	11.35	1,276.0	479.65	0.890	56.5	52.0		X	620.1	6.0E-04	1.9	1,453.6	0.911	55.9	53.3
05/19/89	11.52	1,286.0	479.65	0.890	56.5	52.0		X	684.0	6.6E-04	1.9	1,453.6	0.911	55.9	53.3
05/19/89	11.68	1,296.0	479.65	0.890	56.5	52.0		X	607.9	5.9E-04	1.8	1,453.6	0.911	55.9	53.3
05/19/89	11.85	1,306.0	479.65	0.890	56.5	52.0		X	781.2	7.6E-04	1.8	1,453.6	0.911	55.9	53.3
05/19/89	12.02	1,316.0	479.65	0.890	56.5	52.0		X	751.6	7.3E-04	1.7	1,453.6	0.911	55.9	53.3
05/19/89	12.18	1,326.0	479.65	0.890	56.5	52.0		X	790.7	7.7E-04	1.6	1,453.6	0.911	55.9	53.3
05/19/89	12.68	1,356.0	479.65	0.890	56.5	52.0		X	887.9	8.6E-04	1.6	1,453.6	0.911	55.9	53.3
05/19/89	13.18	1,386.0	479.65	0.890	56.5	52.0		X	1,015.6	9.9E-04	1.4	1,453.6	0.911	55.9	53.3
05/19/89	13.42	1,400.0	479.65	0.890	56.5	52.0		X	1,243.6	1.2E-03	1.1	1,453.6	0.911	55.9	53.3
								X	1,389.3	1.3E-03	1.0	1,453.6	0.911	55.9	53.3

COLUMN SETTLED DENSITY / PERMEABILITY

Project	WISHBONE HILL	Project No	17202	Lab No.	L388.0	Column No.	52
Lab	SRK - US	Feature	COAL TAILINGS	Date	05/16/89	Bottom Drainage	NO
Sample No.	1	Specimen No.	4			Lift No.	1

INITIAL SPECIMEN CONDITIONS

WET WT. OF SOLIDS =	482.60 g	M/C % (initial) =	11.20 %	WT. OF DRY SOLIDS =	433.99 g
WT. OF WATER =	48.61 g	WT. OF ADDED WATER =	1,142.80 g	TOTAL WATER =	1,191.41 g
TOTAL WT. OF SLURRY=	1,576.79 g	M/C % (SLURRY) =	274.52 %	SOLIDS CONTENT =	26.7 %
DIAMETER =	12.45 cm	AREA =	121.74 sq cm	HEIGHT =	11.77 cm
VOLUME (t) =	1,432.86 cc	VOLUME (s) =	253.80 cc	VOLUME (v) =	1,179.07 cc
e =	4.646	n % =	82.3 %	So =	101.0 %

AFTER SETTLEMENT AND DRAINAGE SPECIMEN CONDITION

RECOVERED WATER =	830.00 g	RETAINED WATER =	361.41 g	RETAINED M/C % =	83.3 %

END OF TEST SPECIMEN CONDITION

M/C % (final) =	51.3 %	Sf =	57.2 %

SETTLEMENT DATA

Date M D Y 00/00/00	Time (Hrs.)	Total Elapsed Time (Min.)	Total Volume Total (cc)	Void Ratio (e)	Dry Density (PCF)	Saturated Moisture Content %	Permeability Test Constant	Permeability Test Falling	Permeability Test (Ft./Yr.)	Permeability Test (cm/sec)	Gradient (i)
05/16/89	14.15										
05/16/89	14.17	1.0	1,432.9	4.646	18.9	271.7					
05/16/89	14.20	3.0	1,432.9	4.646	18.9	271.7					
05/16/89	14.28	8.0	1,432.9	4.646	18.9	271.7					
05/16/89	14.40	15.0	742.6	1.926	36.5	112.6					
05/16/89	14.42	16.0	726.8	1.864	37.3	109.0					
05/16/89	14.43	17.0	704.9	1.777	38.4	103.9					
05/16/89	14.47	19.0	685.4	1.701	39.5	99.4					
05/16/89	14.53	23.0	674.4	1.657	40.2	96.9					
05/16/89	14.65	30.0	648.9	1.557	41.8	91.0					
05/16/89	14.90	45.0	642.8	1.533	42.2	89.6					
05/16/89	15.40	75.0	630.6	1.485	43.0	86.8					
05/16/89	16.40	135.0	630.6	1.485	43.0	86.8					
05/17/89	8.58	1,106.0	602.6	1.374	45.0	80.4					
05/17/89	14.25	1,446.0	602.6	1.374	45.0	80.4					

COLUMN SETTLED DENSITY / PERMEABILITY

Project	WISHBONE HILL	Project No 17202	Lab No. L388.0	Column No.	52
Lab	SRK - US	Feature COAL TAILINGS	Date 05/16/89	Bottom Drainage	NO
Sample No.	1	Specimen No.	4	Lift No.	2

INITIAL SPECIMEN CONDITIONS

WET WT. OF SOLIDS =	482.60 g	M/C % (initial) =	10.90 %	WT. OF DRY SOLIDS =	435.17 g
WT. OF WATER =	47.43 g	WT. OF ADDED WATER =	1,162.40 g	TOTAL WATER =	1,209.83 g
TOTAL WT. OF SLURRY=	1,597.57 g	M/C % (SLURRY) =	278.02 %	SOLIDS CONTENT =	26.5 %
DIAMETER =	12.45 cm	AREA =	121.74 sq cm		
HEIGHT of 1st Lift =	11.77 cm	HEIGHT of 2nd Lift =	23.70 cm	HEIGHT =	11.93 cm
VOLUME (t) =	1,452.34 cc	VOLUME (s) =	254.48 cc	VOLUME (v) =	1,197.86 cc
e =	4.707	n % =	82.5 %	So =	101.0 %

AFTER SETTLEMENT AND DRAINAGE SPECIMEN CONDITION

RECOVERED WATER =	926.40 g	RETAINED WATER =	283.43 g	RETAINED M/C % =	65.1 %
RECOVERED WATER 1&2	1,756.40 g	RETAINED WATER 1&2	644.84 g	RETAINED M/C% 1&2	74.2 %

END OF TEST SPECIMEN CONDITION

M/C % (final) =	51.30 %	Sf =	82.25 %

SETTLEMENT DATA

Date M D Y 00/00/00	Time (Hrs.)	Total Elapsed Time (Min.)	Volume Total (cc)	Void Ratio (e)	Dry Density (PCF)	Saturated Moisture Content %	Permeability Test Constant (Ft./Yr.)	Permeability Test Falling (Ft./Yr.)	Permeability Test (cm/sec)	Gradient (i)	Lift Nos. 1&2 Total Volume	Lift Nos. 1&2 Total Void Ratio (e)	Lift Nos. 1&2 Total Dry Density (PCF)	Lift Nos. 1&2 Total Saturated Moisture Content %
05/17/89	14.32		2,282.60	7.970	11.9	466.1					2,885.2	4.676	18.8	273.5
05/17/89	14.33	1	2,282.60	7.970	11.9	466.1					2,885.2	4.676	18.8	273.5
05/17/89	14.35	2	2,282.60	7.970	11.9	466.1					2,885.2	4.676	18.8	273.5
05/17/89	14.38	4	2,282.60	7.970	11.9	466.1					2,885.2	4.676	18.8	273.5
05/17/89	14.45	8	1,716.52	5.745	15.8	336.0					2,319.1	3.563	23.4	208.3
05/17/89	14.57	15	1,222.26	3.803	22.2	222.4					1,824.9	2.590	29.7	151.5
05/17/89	14.82	30	634.26	1.492	42.8	87.3					1,236.9	1.433	43.9	83.8
05/17/89	15.32	60	581.91	1.287	46.7	75.2					1,184.5	1.330	45.8	77.8
05/17/89	16.32	120	557.56	1.191	48.7	69.6					1,160.2	1.283	46.8	75.0
05/17/89	17.32	180	550.26	1.162	49.4	68.0					1,152.9	1.268	47.1	74.2
05/18/89	9.25	1,136	525.91	1.067	51.7	62.4					1,128.5	1.220	48.1	71.4
05/18/89	16.12	1,548	525.91	1.067	51.7	62.4					1,128.5	1.220	48.1	71.4

COLUMN SETTLED DENSITY / PERMEABILITY

Project	SAN LUIS	Project No	17202	Lab No.	L388.0
Lab	SRK - US	Feature	COAL TAILINGS	Date	05/16/89
Sample No.	1	Specimen No.	4		

Column No.	52
Bottom Drainage	NO
Lift No.	3

INITIAL SPECIMEN CONDITIONS

WET WT. OF SOLIDS =	482.70 g	M/C % (initial) =	11.00 %	WT. OF DRY SOLIDS =	434.86 g
WT. OF WATER =	47.84 g	WT. OF ADDED WATER =	1,141.10 g	TOTAL WATER =	1,188.94 g
TOTAL WT. OF SLURRY=	1,575.96 g	M/C % (SLURRY) =	273.40 %	SOLIDS CONTENT =	26.8 %
DIAMETER =	12.45 cm	AREA =	121.74 sq cm		
HEIGHT of 2nd Lift =	23.70 cm	HEIGHT of 3rd Lift =	35.47 cm	HEIGHT =	11.77 cm
VOLUME (t) =	1,432.86 cc	VOLUME (s) =	254.31 cc	VOLUME (v) =	1,178.56 cc
e =	4.634	n % =	82.3 %	So =	100.9 %

AFTER SETTLEMENT AND DRAINAGE SPECIMEN CONDITION

RECOVERED WATER =	953.80 g	RETAINED WATER =	235.14 g	RETAINED M/C % =	54.1 %
RECOVERED H2O 1,2&3	2,710.20	RETAINED H2O 1,2&3	879.98 g	RETAINED M/C% 1,2&3	67.5 %

END OF TEST SPECIMEN CONDITION

M/C % (final) =	51.30 %	Sf =	82.14 %

SETTLEMENT DATA

Date M D Y	Time (Hrs.)	Total Elapsed Time (Min.)	Volume Total (cc)	Void Ratio (e)	Dry Density (PCF)	Saturated Moisture Content %	Permeability Test: Constant (Ft./Yr.)	Permeability Test: Falling (Ft./Yr.)	Permeability Test: (cm/sec)	Gradient (i)	Lift Nos. 1,2&3: Total Volume	Lift Nos. 1,2&3: Total Void Ratio (e)	Lift Nos. 1,2&3: Total Dry Density (PCF)	Lift Nos. 1,2&3: Total Saturated Moisture Content %
00/00/00														
05/18/89	16.12		2,056.17	7.085	13.2	414.3					3,184.7	3.176	25.6	185.7
05/18/89	16.13	1.0	2,025.73	6.966	13.4	407.4					3,154.2	3.136	25.8	183.4
05/18/89	16.15	2.0	1,994.08	6.841	13.6	400.1					3,122.6	3.095	26.1	181.0
05/18/89	16.18	4.0	1,963.64	6.722	13.8	393.1					3,092.2	3.055	26.3	178.6
05/18/89	16.25	8.0	1,654.43	5.506	16.4	322.0					2,782.9	2.649	29.3	154.9
05/18/89	16.37	15.0	865.56	2.404	31.4	140.6					1,994.1	1.615	40.8	94.4
05/18/89	16.38	16.0	835.13	2.284	32.5	133.6					1,963.6	1.575	41.5	92.1
05/18/89	16.40	17.0	804.69	2.164	33.7	126.6					1,933.2	1.535	42.1	89.8
05/18/89	16.43	19.0	742.61	1.920	36.6	112.3					1,871.1	1.454	43.5	85.0
05/18/89	16.50	23.0	658.61	1.590	41.2	93.0					1,787.1	1.344	45.6	78.6
05/18/89	16.62	30.0	572.17	1.250	47.4	73.1					1,700.7	1.230	47.9	71.9
05/18/89	16.87	45.0	525.91	1.068	51.6	62.5					1,654.4	1.169	49.2	68.4
05/18/89	17.95	110.0	495.48	0.948	54.8	55.5					1,624.0	1.130	50.1	66.1
05/19/89	9.87	1,065.0	479.65	0.886	56.6	51.8					1,608.2	1.109	50.6	64.8

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PROJECT:	Wishbone Hill	SAMPLE NO.:	1.0
PROJECT NO.:	22401	SPECIMEN	
LAB NO.:	L3880		
FEATURE:	COAL SPOILS		

CONSOLIDATION TEST
SPECIMEN DATA

Moisture Content and Initial Conditions

Consolidometer No.	Units	Before Test Specimen	Before Test Trimmings	After Test Specimen
Tare No.			Cottonwood	C220
Tare Plus Wet Soil	grams	300.5	296.8	324.1
Tare Plus Dry Soil	grams	294.8	289.2	298.7
Moisture	grams	5.8	7.6	25.4
Tare	grams	220.1	190.3	229.4
Dry Soil	grams	74.7	98.9	69.3
Moisture Content	%	7.7	7.7	36.7

Initial Specimen Conditions

	Units			Units	
Initial Height	cm	2.54	Volume of Solids	cm3	43.65
Diameter of Specimen	cm	7.04	Void Ratio	e	1.262
Area of Specimen	cm2	38.88	Saturation	%	10.4
Volume of Specimen	cm3	98.74	Dry Density	PCF	47.2
Specific Gravity	--	1.71			

CONSOLIDATION TEST
Time - Consolidation Readings

Load Placed	Date	Time (Hours, Minutes)	Time (Hrs.)	Total Elapsed Time	Load Elapsed Time	Square Rt Elapsed Time	Log Elapsed Time	Dial Reading	Dial Reading Correction	Corrected Dial Reading	Load Dial Reading	Height of Specimen	Total Volume	Void Ratio	Dry Density (PCF)
Seating Load	07/17/89	10.23	10.38					0.0000							
1.1 Psi	07/17/89	10.23	10.39	0.1	0.1	0.32		0.0000	0.0350			2.54	98.74	1.262	47.2
	07/17/89	10.23	10.39	0.3	0.3	0.50		0.1400	0.0350	0.1050		2.53	98.34	1.253	47.4
	07/17/89	10.24	10.39	0.5	0.5	0.71		0.1450	0.0350	0.1100	0.0050	2.53	98.32	1.252	47.4
	07/17/89	10.24	10.40	1.0	1.0	1.00	0.00	0.1525	0.0350	0.1175	0.0125	2.53	98.29	1.251	47.4
	07/17/89	10.25	10.42	2.0	2.0	1.41	0.30	0.1575	0.0350	0.1225	0.0175	2.53	98.27	1.251	47.4
	07/17/89	10.27	10.45	4.0	4.0	2.00	0.60	0.1625	0.0350	0.1275	0.0225	2.53	98.25	1.251	47.4
	07/17/89	10.31	10.52	8.0	8.0	2.83	0.90	0.1650	0.0350	0.1300	0.0250	2.53	98.24	1.250	47.4
	07/17/89	10.38	10.63	15.0	15.0	3.87	1.18	0.1700	0.0350	0.1350	0.0300	2.53	98.22	1.250	47.4
	07/17/89	10.53	10.88	30.0	30.0	5.48	1.48	0.1725	0.0350	0.1375	0.0325	2.53	98.21	1.250	47.5
	07/17/89	11.23	11.38	60.0	60.0	7.75	1.78	0.1750	0.0350	0.1400	0.0350	2.53	98.20	1.249	47.5
	07/17/89	12.23	12.38	120.0	120.0	10.95	2.08	0.2000	0.0350	0.1650	0.0600	2.52	98.10	1.247	47.5
	07/17/89	14.23	14.38	240.0	240.0	15.49	2.38	0.2100	0.0350	0.1750	0.0700	2.52	98.06	1.246	47.5
Water Added	07/17/89	14.33	14.55	250.0	250.0	15.81	2.40	0.2100	0.0350	0.1750		2.52	98.06	1.246	47.5
	07/17/89	14.33	14.55	250.1	0.1	0.32		1.50	0.0350	1.4650	1.3600	2.39	93.05	1.131	50.1
	07/17/89	14.33	14.55	250.3	0.2	0.50		2.0575	0.0350	2.0225	1.9175	2.34	90.88	1.082	51.3
	07/17/89	14.34	14.56	250.5	0.5	0.71		4.8075	0.0350	4.7725	4.6675	2.06	80.19	0.837	58.1
	07/17/89	14.34	14.57	251.0	1.0	1.00	0.00	5.0700	0.0350	5.0350	4.9300	2.04	79.17	0.814	58.9
	07/17/89	14.35	14.58	252.0	2.0	1.41	0.30	5.0875	0.0350	5.0525	4.9475	2.03	79.10	0.812	58.9
	07/17/89	14.37	14.62	254.0	4.0	2.00	0.60	5.0950	0.0350	5.0600	4.9550	2.03	79.07	0.811	58.9
	07/17/89	14.41	14.68	258.0	8.0	2.83	0.90	5.1000	0.0350	5.0650	4.9600	2.03	79.05	0.811	59.0
	07/17/89	14.48	14.80	265.0	15.0	3.87	1.18	5.1175	0.0350	5.0825	4.9775	2.03	78.99	0.809	59.0
	07/17/89	15.03	15.05	280.0	30.0	5.48	1.48	5.1225	0.0350	5.0875	4.9825	2.03	78.97	0.809	59.0
	07/17/89	15.33	15.55	310.0	60.0	7.75	1.78	5.1275	0.0350	5.0925	4.9875	2.03	78.95	0.808	59.0
	07/17/89	16.33	16.55	370.0	120.0	10.95	2.08	5.1425	0.0350	5.1075	5.0025	2.03	78.89	0.807	59.1
2.15 Psi	07/18/89	6.45	6.75	1,222.0	972.0	31.18	2.99	5.2975	0.0575	5.2400	5.1350	2.02	78.37	0.795	59.5
	07/18/89	6.45	6.75	1,222.1	0.1	0.32		6.1550	0.0575	6.0975	5.9925	1.93	75.04	0.719	62.1
	07/18/89	6.45	6.75	1,222.3	0.3	0.50		6.1725	0.0575	6.1150	6.0100	1.93	74.97	0.717	62.2
	07/18/89	6.46	6.76	1,222.5	0.5	0.71		6.1800	0.0575	6.1225	6.0175	1.93	74.94	0.717	62.2
	07/18/89	6.46	6.77	1,223.0	1.0	1.00	0.00	6.1875	0.0575	6.1300	6.0250	1.93	74.91	0.716	62.2
	07/18/89	6.47	6.78	1,224.0	2.0	1.41	0.30	6.2325	0.0575	6.1750	6.0700	1.92	74.74	0.712	62.4
	07/18/89	6.49	6.82	1,226.0	4.0	2.00	0.60	6.2350	0.0575	6.1775	6.0725	1.92	74.73	0.712	62.4
	07/18/89	6.53	6.88	1,230.0	8.0	2.83	0.90	6.2375	0.0575	6.1800	6.0750	1.92	74.72	0.712	62.4
	07/18/89	7.00	7.00	1,237.0	15.0	3.87	1.18	6.2550	0.0575	6.1975	6.0925	1.92	74.65	0.710	62.4
	07/18/89	7.15	7.25	1,252.0	30.0	5.48	1.48	6.2700	0.0575	6.2125	6.1075	1.92	74.59	0.709	62.5
	07/18/89	7.45	7.75	1,282.0	60.0	7.75	1.78	6.2825	0.0575	6.2250	6.1200	1.92	74.54	0.708	62.5
	07/18/89	8.45	8.75	1,342.0	120.0	10.95	2.08	6.3025	0.0575	6.2450	6.1400	1.92	74.47	0.706	62.6
	07/18/89	10.45	10.75	1,462.0	240.0	15.49	2.38	6.3050	0.0575	6.2475	6.1425	1.92	74.46	0.706	62.6
	07/18/89	14.45	14.75	1,702.0	480.0	21.91	2.68	6.3075	0.0575	6.2500	6.1450	1.92	74.45	0.705	62.6
	07/19/89	10.50	10.83	2,907.0	1,685.0	41.05	3.23	6.3425	0.0575	6.2850	6.1800	1.91	74.31	0.702	62.7

4.3 Psi	07/19/89	10.50	10.84	2,907.1	0.1	0.32		6.7225	0.0900	6.6325	6.5275	1.88	72.96	0.671	63.9
	07/19/89	10.50	10.84	2,907.3	0.2	0.50		6.7500	0.0900	6.6600	6.5550	1.87	72.85	0.669	64.0
	07/19/89	10.51	10.84	2,907.5	0.5	0.71		6.7550	0.0900	6.6650	6.5600	1.87	72.83	0.668	64.0
	07/19/89	10.51	10.85	2,908.0	1.0	1.00	0.00	6.7675	0.0900	6.6775	6.5725	1.87	72.79	0.667	64.0
	07/19/89	10.52	10.87	2,909.0	2.0	1.41	0.30	6.7800	0.0900	6.6900	6.5850	1.87	72.74	0.666	64.1
	07/19/89	10.54	10.90	2,911.0	4.0	2.00	0.60	6.8350	0.0900	6.7450	6.6400	1.87	72.52	0.661	64.3
	07/19/89	10.58	10.97	2,915.0	8.0	2.83	0.90	6.8375	0.0900	6.7475	6.6425	1.87	72.51	0.661	64.3
	07/19/89	11.05	11.08	2,922.0	15.0	3.87	1.18	6.8525	0.0900	6.7625	6.6575	1.86	72.45	0.660	64.3
	07/19/89	11.20	11.33	2,937.0	30.0	5.48	1.48	6.8550	0.0900	6.7650	6.6600	1.86	72.45	0.659	64.3
	07/19/89	11.50	11.83	2,967.0	60.0	7.75	1.78	6.8700	0.0900	6.7800	6.6750	1.86	72.39	0.658	64.4
	07/19/89	12.50	12.83	3,027.0	120.0	10.95	2.08	6.8750	0.0900	6.7850	6.6800	1.86	72.37	0.658	64.4
	07/19/89	14.50	14.83	3,147.0	240.0	15.49	2.38	6.8825	0.0900	6.7925	6.6875	1.86	72.34	0.657	64.4
	07/19/89	18.50	18.83	3,387.0	480.0	21.91	2.68	6.8825	0.0900	6.7925		1.86	72.34	0.657	64.4
	07/20/89	8.55	8.92	4,232.0	1,325.0	36.40	3.12	6.8875	0.0900	6.7975	6.6925	1.86	72.32	0.657	64.4
8.6 Psi	07/20/89	9.02	9.03	4,239.0	1,332.0	36.50	3.12	6.8875	0.1450	6.7425		1.87	72.53	0.661	64.3
	07/20/89	9.02	9.04	4,239.1	0.1	0.32		7.2925	0.1450	7.1475	7.0425	1.83	70.96	0.625	65.7
	07/20/89	9.02	9.04	4,239.3	0.2	0.50		7.3175	0.1450	7.1725	7.0675	1.82	70.86	0.623	65.8
	07/20/89	9.03	9.04	4,239.5	0.5	0.71		7.3250	0.1450	7.1800	7.0750	1.82	70.83	0.623	65.8
	07/20/89	9.03	9.05	4,240.0	1.0	1.00	0.00	7.3450	0.1450	7.2000	7.0950	1.82	70.75	0.621	65.9
	07/20/89	9.04	9.07	4,241.0	2.0	1.41	0.30	7.3575	0.1450	7.2125	7.1075	1.82	70.71	0.620	65.9
	07/20/89	9.06	9.10	4,243.0	4.0	2.00	0.60	7.3625	0.1450	7.2175	7.1125	1.82	70.69	0.619	65.9
	07/20/89	9.10	9.17	4,247.0	8.0	2.83	0.90	7.3725	0.1450	7.2275	7.1225	1.82	70.65	0.618	66.0
	07/20/89	9.17	9.28	4,254.0	15.0	3.87	1.18	7.3850	0.1450	7.2400	7.1350	1.82	70.60	0.617	66.0
	07/20/89	9.32	9.53	4,269.0	30.0	5.48	1.48	7.3925	0.1450	7.2475	7.1425	1.82	70.57	0.617	66.0
	07/20/89	10.02	10.03	4,299.0	60.0	7.75	1.78	7.4025	0.1450	7.2575	7.1525	1.81	70.53	0.616	66.1
	07/20/89	11.02	11.03	4,359.0	120.0	10.95	2.08	7.4100	0.1450	7.2650	7.1600	1.81	70.50	0.615	66.1
	07/20/89	13.02	13.03	4,479.0	240.0	15.49	2.38	7.4150	0.1450	7.2700	7.1650	1.81	70.48	0.615	66.1
	07/20/89	17.02	17.03	4,719.0	480.0	21.91	2.68	7.4225	0.1450	7.2775	7.1725	1.81	70.45	0.614	66.1
	07/21/89	9.02	9.03	5,679.0	1,440.0	37.95	3.16	7.4325	0.1450	7.2875	7.1825	1.81	70.41	0.613	66.2
17.2 Psi	07/21/89	9.16	9.27	5,693.0	1,454.0	38.13	3.16	7.7900	0.2000	7.5900	7.4850	1.78	69.24	0.586	67.3
	07/21/89	9.16	9.27	5,693.1	0.1	0.32		7.8225	0.2000	7.6225	7.5175	1.78	69.11	0.583	67.4
	07/21/89	9.16	9.27	5,693.3	0.3	0.50		7.8275	0.2000	7.6275	7.5225	1.78	69.09	0.583	67.4
	07/21/89	9.17	9.28	5,693.5	0.5	0.71		7.8375	0.2000	7.6375	7.5325	1.78	69.05	0.582	67.5
	07/21/89	9.18	9.30	5,695.0	2.0	1.41	0.30	7.8625	0.2000	7.6625	7.5575	1.77	68.96	0.580	67.6
	07/21/89	9.20	9.33	5,697.0	4.0	2.00	0.60	7.9075	0.2000	7.7075	7.6025	1.77	68.78	0.576	67.8
	07/21/89	9.24	9.40	5,701.0	8.0	2.83	0.90	7.9150	0.2000	7.7150	7.6100	1.77	68.75	0.575	67.8
	07/21/89	9.31	9.52	5,708.0	15.0	3.87	1.18	7.9225	0.2000	7.7225	7.6175	1.77	68.72	0.574	67.8
	07/21/89	9.46	9.77	5,723.0	30.0	5.48	1.48	7.9275	0.2000	7.7275	7.6225	1.77	68.70	0.574	67.8
	07/21/89	10.16	10.27	5,753.0	60.0	7.75	1.78	7.9325	0.2000	7.7325	7.6275	1.77	68.68	0.573	67.9
	07/21/89	11.16	11.27	5,813.0	120.0	10.95	2.08	7.9375	0.2000	7.7375	7.6325	1.77	68.66	0.573	67.9
	07/21/89	13.16	13.27	5,933.0	240.0	15.49	2.38	7.9425	0.2000	7.7425	7.6375	1.77	68.65	0.572	67.9
	07/21/89	17.16	17.27	6,173.0	480.0	21.91	2.68	7.9500	0.2000	7.7500	7.6450	1.77	68.62	0.572	67.9
	07/22/89	13.36	13.60	7,393.0	1,700.0	41.23	3.23	7.9600	0.2000	7.7600	7.6550	1.76	68.58	0.571	68.0
34.4 Psi	07/22/89	13.38	13.63	7,395.0	1,702.0	41.26	3.23	7.9600	0.2700	7.6900		1.77	68.85	0.577	67.7
	07/22/89	13.38	13.64	7,395.1	0.1	0.32		8.0625	0.2700	7.7925	7.6875	1.76	68.45	0.568	68.1
	07/22/89	13.38	13.64	7,395.3	0.2	0.50		8.0675	0.2700	7.7975	7.6925	1.76	68.43	0.568	68.1
	07/22/89	13.39	13.64	7,395.5	0.5	0.71		8.0900	0.2700	7.8200	7.7150	1.76	68.34	0.566	68.2
	07/22/89	13.39	13.65	7,396.0	1.0	1.00	0.00	8.1000	0.2700	7.8300	7.7250	1.76	68.30	0.565	68.2
	07/22/89	13.40	13.67	7,397.0	2.0	1.41	0.30	8.1050	0.2700	7.8350	7.7300	1.76	68.29	0.564	68.2
	07/22/89	13.42	13.70	7,399.0	4.0	2.00	0.60	8.1075	0.2700	7.8375	7.7325	1.76	68.28	0.564	68.3
	07/22/89	13.46	13.77	7,403.0	8.0	2.83	0.90	8.1075	0.2700	7.8375		1.76	68.28	0.564	68.3
	07/22/89	13.53	13.88	7,410.0	15.0	3.87	1.18	8.1100	0.2700	7.8400	7.7350	1.76	68.27	0.564	68.3
	07/22/89	14.08	14.13	7,425.0	30.0	5.48	1.48	8.1100	0.2700	7.8400		1.76	68.27	0.564	68.3
	07/22/89	14.38	14.63	7,455.0	60.0	7.75	1.78	8.1125	0.2700	7.8425	7.7375	1.76	68.26	0.564	68.3
	07/22/89	15.38	15.63	7,515.0	120.0	10.95	2.08	8.1150	0.2700	7.8450	7.7400	1.76	68.25	0.563	68.3
	07/22/89	17.38	17.63	7,635.0	240.0	15.49	2.38	8.1175	0.2700	7.8475	7.7425	1.76	68.24	0.563	68.3
	07/22/89	17.38	17.63	7,635.0	240.0	15.49	2.38	8.1225	0.2700	7.8525	7.7475	1.75	68.22	0.563	68.3
	07/24/89	8.32	8.53	9,969.0	2,574.0	50.73	3.41	8.5750	0.2700	8.3050	8.2000	1.71	66.46	0.522	70.1

APPENDIX L
INFLOW ANALYSIS

APPENDIX L.1

TRANSIENT 1-DIMENSIONAL ANALYSIS OF INFLOW

1. Summary Tables of Computed Inflows
2. Program Output
3. Program Listing

RESULTS OF TRANSIENT 1-D FLOW ANALYSIS
ESTIMATED INFLOWS (GPM) TO MINE AREA 1

END OF YEAR	PIT 1			PIT 2		DEEPEN PITS 1&2				PIT 3			MINE AREA I TOTAL (GPM)
	FLAT	GLAC	TOTAL	FLAT	DIP	FLAT	DIP	GLAC	TOTAL	FLAT	GLAC	TOTAL	
YEAR 1	0.51	15.82	16.33										16.33
	0.90	28.18	29.08										29.08
	1.61	50.02	51.63										51.63
YEAR 2	0.36	11.18	11.54	0.85	0.27	0.07	0.05	15.82	17.06				28.60
	0.64	19.93	20.57	1.51	0.49	0.12	0.10	28.18	30.40				50.97
	1.14	35.37	36.51	2.68	0.87	0.21	0.17	50.02	53.95				90.46
YEAR 3	0.29	9.13	9.42	0.60	0.19	0.05	0.04	11.18	12.06	0.37	15.82	16.19	37.67
	0.52	16.27	16.79	1.07	0.35	0.08	0.07	19.93	21.50	0.66	28.18	28.84	67.13
	0.93	28.88	29.81	1.90	0.61	0.15	0.12	35.37	38.15	1.18	50.02	51.20	119.16
YEAR 4	0.25	7.91	8.16	0.49	0.16	0.04	0.03	9.13	9.85	0.26	11.18	11.44	29.45
	0.45	14.09	14.54	0.87	0.28	0.07	0.06	16.27	17.55	0.47	19.93	20.40	52.49
	0.80	25.01	25.81	1.55	0.50	0.12	0.10	28.88	31.15	0.84	35.37	36.21	93.17

Notes:

Column Headings:
FLAT = flat-lying bedrock
DIP = dipping bedrock
GLAC = glacial deposits

The three entries for each year refer to low, mid and high values for hydraulic conductivity discussed in text.

RESULTS OF TRANSIENT 1-D FLOW ANALYSIS
ESTIMATED INFLOWS (GPM) TO MINE AREA 2

END OF YEAR	PITS 4-7			PITS 8 - 10			PITS 12 & 13			PIT 16			MINE AREA I TOTAL
	DIP	GLAC	TOTAL	DIP	GLAC	TOTAL	DIP	GLAC	TOTAL	DIP	GLAC	TOTAL	
YEAR 3	3.70	35.32	39.02										39.02
	6.57	62.94	69.51										69.51
	11.70	111.70	123.40										123.40
YEAR 4	2.62	24.98	27.60										27.60
	4.65	44.50	49.15										49.15
	8.27	78.99	87.26										87.26
YEAR 5	2.14	20.39	22.53										22.53
	3.80	36.34	40.14										40.14
	6.75	64.49	71.24										71.24
YEAR 6	1.85	17.66	19.51	2.51	20.03	22.54							42.05
	3.29	31.47	34.76	4.45	35.70	40.15							74.91
	5.85	55.85	61.70	7.92	63.35	71.27							132.97
YEAR 7	1.65	15.80	17.45	1.77	14.17	15.94							33.39
	2.94	28.15	31.09	3.15	25.24	28.39							59.48
	5.23	49.95	55.18	5.60	44.80	50.40							105.58
YEAR 8	1.51	14.42	15.93	1.45	11.57	13.02							28.95
	2.68	25.69	28.37	2.57	20.61	23.18							51.55
	4.78	45.60	50.38	4.57	36.58	64.33							114.71
YEAR 9	1.40	13.35	14.75	1.25	10.02	11.27	2.67	13.96	16.63				42.65
	2.48	23.79	26.27	2.23	17.85	20.08	4.75	24.87	29.62				75.97
	4.42	42.22	46.64	3.96	31.68	35.64	8.46	44.14	52.60				134.88
YEAR 10	1.31	12.49	13.80	1.12	8.96	10.08	1.89	9.87	11.76	1.16	8.09	9.25	44.89
	2.32	22.25	24.57	1.99	15.96	17.95	3.36	17.59	20.95	2.05	14.41	16.46	79.93
	4.14	39.49	43.63	3.54	28.33	31.87	5.98	31.21	37.19	3.65	25.57	29.22	141.91
YEAR 11	1.23	11.77	13.00	1.02	8.18	9.20	1.54	8.06	9.60	0.82	5.72	6.54	38.34
	2.19	20.98	23.17	1.82	14.57	16.39	2.74	14.36	17.10	1.45	10.19	11.64	68.30
	3.90	37.23	41.13	3.23	25.86	29.09	4.88	25.48	30.36	2.58	18.08	20.66	121.24

Column headings: DIP = dipping bedrock
GLAC = glacial deposits

The three entries for each year refer to low, mid, and high values for hydraulic conductivity discussed in text.

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 1 FLAT STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0076
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3400
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00015	0.51
2.0	0.00011	0.36
3.0	0.00009	0.29
4.0	0.00007	0.25

***** PIT 1 FLAT STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0240
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3400
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00027	0.90
2.0	0.00019	0.64
3.0	0.00015	0.52
4.0	0.00013	0.45

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 1 FLAT STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0760
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3400
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00047	1.61
2.0	0.00033	1.14
3.0	0.00027	0.93
4.0	0.00024	0.80

***** PIT 2 FLAT STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0076
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2800
Drawdown (ft) = 180
Aquifer thick (ft) = 230

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00030	0.85
2.0	0.00021	0.60
3.0	0.00018	0.49
4.0	0.00015	0.42

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 2 FLAT STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0240
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2800
Drawdown (ft) = 180
Aquifer thick (ft) = 230

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00054	1.51
2.0	0.00038	1.07
3.0	0.00031	0.87
4.0	0.00027	0.75

***** PIT 2 FLAT STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0760
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2800
Drawdown (ft) = 180
Aquifer thick (ft) = 230

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00096	2.68
2.0	0.00068	1.90
3.0	0.00055	1.55
4.0	0.00048	1.34

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 4 - 7 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 6500
Drawdown (ft) = 370
Aquifer thick (ft) = 420

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00057	3.70
2.0	0.00040	2.62
3.0	0.00033	2.14
4.0	0.00028	1.85
5.0	0.00025	1.65
6.0	0.00023	1.51
7.0	0.00022	1.40
8.0	0.00020	1.31
9.0	0.00019	1.23

***** PITS 4 - 7 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 6500
Drawdown (ft) = 370
Aquifer thick (ft) = 420

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00101	6.57
2.0	0.00072	4.65
3.0	0.00058	3.80
4.0	0.00051	3.29
5.0	0.00045	2.94
6.0	0.00041	2.68
7.0	0.00038	2.48
8.0	0.00036	2.32
9.0	0.00034	2.19

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 4 - 7 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 6500
Drawdown (ft) = 370
Aquifer thick (ft) = 420

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00180	11.70
2.0	0.00127	8.27
3.0	0.00104	6.75
4.0	0.00090	5.85
5.0	0.00080	5.23
6.0	0.00073	4.78
7.0	0.00068	4.42
8.0	0.00064	4.14
9.0	0.00060	3.90

***** PITS 4 - 7 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 6700
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00527	35.32
2.0	0.00373	24.98
3.0	0.00304	20.39
4.0	0.00264	17.66
5.0	0.00236	15.80
6.0	0.00215	14.42
7.0	0.00199	13.35
8.0	0.00186	12.49
9.0	0.00176	11.77

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 - 3 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3000
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.01667	50.02
2.0	0.01179	35.37
3.0	0.00963	28.88
4.0	0.00834	25.01

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 - 3 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3000
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00527	15.82
2.0	0.00373	11.18
3.0	0.00304	9.13
4.0	0.00264	7.91

***** PITS 1 - 3 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3000
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00939	28.18
2.0	0.00664	19.93
3.0	0.00542	16.27
4.0	0.00470	14.09

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 3 FLAT STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0240
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00027	0.66
2.0	0.00019	0.47
3.0	0.00015	0.38
4.0	0.00013	0.33

***** PIT 3 FLAT STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0760
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00047	1.18
2.0	0.00033	0.84
3.0	0.00027	0.68
4.0	0.00024	0.59

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 & 2 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 100
Aquifer thick (ft) = 150

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00017	0.17
2.0	0.00012	0.12
3.0	0.00010	0.10
4.0	0.00009	0.09

***** PIT 3 FLAT STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0076
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00015	0.37
2.0	0.00011	0.26
3.0	0.00009	0.22
4.0	0.00007	0.19

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 & 2 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 100
Aquifer thick (ft) = 150

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00005	0.05
2.0	0.00004	0.04
3.0	0.00003	0.03
4.0	0.00003	0.03

***** PITS 1 & 2 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 100
Aquifer thick (ft) = 150

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00010	0.10
2.0	0.00007	0.07
3.0	0.00006	0.06
4.0	0.00005	0.05

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 & 2 FLAT STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0240
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 40
Aquifer thick (ft) = 90

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00005	0.12
2.0	0.00003	0.08
3.0	0.00003	0.07
4.0	0.00002	0.06

***** PITS 1 & 2 FLAT STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0760
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 40
Aquifer thick (ft) = 90

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00008	0.21
2.0	0.00006	0.15
3.0	0.00005	0.12
4.0	0.00004	0.10

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 2 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 250
Aquifer thick (ft) = 300

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00087	0.87
2.0	0.00061	0.61
3.0	0.00050	0.50
4.0	0.00043	0.43

***** PITS 1 & 2 FLAT STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0076
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 40
Aquifer thick (ft) = 90

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00003	0.07
2.0	0.00002	0.05
3.0	0.00002	0.04
4.0	0.00001	0.03

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 2 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 250
Aquifer thick (ft) = 300

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00027	0.27
2.0	0.00019	0.19
3.0	0.00016	0.16
4.0	0.00014	0.14

***** PIT 2 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 250
Aquifer thick (ft) = 300

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00049	0.49
2.0	0.00035	0.35
3.0	0.00028	0.28
4.0	0.00024	0.24

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 4 - 7 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 6700
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00939	62.94
2.0	0.00664	44.50
3.0	0.00542	36.34
4.0	0.00470	31.47
5.0	0.00420	28.15
6.0	0.00383	25.69
7.0	0.00355	23.79
8.0	0.00332	22.25
9.0	0.00313	20.98

***** PITS 4 - 7 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 6700
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.01667	111.70
2.0	0.01179	78.99
3.0	0.00963	64.49
4.0	0.00834	55.85
5.0	0.00746	49.95
6.0	0.00681	45.60
7.0	0.00630	42.22
8.0	0.00589	39.49
9.0	0.00556	37.23

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 8 - 10 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3800
Drawdown (ft) = 400
Aquifer thick (ft) = 450

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00066	2.51
2.0	0.00047	1.77
3.0	0.00038	1.45
4.0	0.00033	1.25
5.0	0.00029	1.12
6.0	0.00027	1.02
7.0	0.00025	0.95
8.0	0.00023	0.89
9.0	0.00022	0.84

***** PITS 8 - 10 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3800
Drawdown (ft) = 400
Aquifer thick (ft) = 450

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00117	4.45
2.0	0.00083	3.15
3.0	0.00068	2.57
4.0	0.00059	2.23
5.0	0.00052	1.99
6.0	0.00048	1.82
7.0	0.00044	1.68
8.0	0.00041	1.57
9.0	0.00039	1.48

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 8 - 10 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3800
Drawdown (ft) = 400
Aquifer thick (ft) = 450

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00208	7.92
2.0	0.00147	5.60
3.0	0.00120	4.57
4.0	0.00104	3.96
5.0	0.00093	3.54
6.0	0.00085	3.23
7.0	0.00079	2.99
8.0	0.00074	2.80
9.0	0.00069	2.64

***** PITS 8 - 10 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3800
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00527	20.03
2.0	0.00373	14.17
3.0	0.00304	11.57
4.0	0.00264	10.02
5.0	0.00236	8.96
6.0	0.00215	8.18
7.0	0.00199	7.57
8.0	0.00186	7.08
9.0	0.00176	6.68

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 8 - 10 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3800
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00939	35.70
2.0	0.00664	25.24
3.0	0.00542	20.61
4.0	0.00470	17.85
5.0	0.00420	15.96
6.0	0.00383	14.57
7.0	0.00355	13.49
8.0	0.00332	12.62
9.0	0.00313	11.90

***** PITS 8 - 10 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3800
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.01667	63.35
2.0	0.01179	44.80
3.0	0.00963	36.58
4.0	0.00834	31.68
5.0	0.00746	28.33
6.0	0.00681	25.86
7.0	0.00630	23.95
8.0	0.00589	22.40
9.0	0.00556	21.12

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 12 & 13 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3700
Drawdown (ft) = 420
Aquifer thick (ft) = 470

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00072	2.67
2.0	0.00051	1.89
3.0	0.00042	1.54
4.0	0.00036	1.34
5.0	0.00032	1.20
6.0	0.00030	1.09
7.0	0.00027	1.01
8.0	0.00026	0.95
9.0	0.00024	0.89

***** PITS 12 & 13 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3700
Drawdown (ft) = 420
Aquifer thick (ft) = 470

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00128	4.75
2.0	0.00091	3.36
3.0	0.00074	2.74
4.0	0.00064	2.38
5.0	0.00057	2.13
6.0	0.00052	1.94
7.0	0.00049	1.80
8.0	0.00045	1.68
9.0	0.00043	1.58

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 12 & 13 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3700
Drawdown (ft) = 420
Aquifer thick (ft) = 470

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00229	8.46
2.0	0.00162	5.98
3.0	0.00132	4.88
4.0	0.00114	4.23
5.0	0.00102	3.78
6.0	0.00093	3.45
7.0	0.00086	3.20
8.0	0.00081	2.99
9.0	0.00076	2.82

***** PITS 12 & 13 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3700
Drawdown (ft) = 40
Aquifer thick (ft) = 20

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00377	13.96
2.0	0.00267	9.87
3.0	0.00218	8.06
4.0	0.00189	6.98
5.0	0.00169	6.24

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 12 & 13 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3700
Drawdown (ft) = 40
Aquifer thick (ft) = 20

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00672	24.87
2.0	0.00475	17.59
3.0	0.00388	14.36
4.0	0.00336	12.43
5.0	0.00301	11.12

***** PITS 12 & 13 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3700
Drawdown (ft) = 40
Aquifer thick (ft) = 20

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.01193	44.14
2.0	0.00844	31.21
3.0	0.00689	25.48
4.0	0.00596	22.07
5.0	0.00534	19.74

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 16 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3200
Drawdown (ft) = 290
Aquifer thick (ft) = 340

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00036	1.16
2.0	0.00026	0.82
3.0	0.00021	0.67
4.0	0.00018	0.58
5.0	0.00016	0.52

***** PIT 16 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3200
Drawdown (ft) = 290
Aquifer thick (ft) = 340

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00064	2.05
2.0	0.00045	1.45
3.0	0.00037	1.19
4.0	0.00032	1.03
5.0	0.00029	0.92

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 16 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3200
Drawdown (ft) = 290
Aquifer thick (ft) = 340

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00114	3.65
2.0	0.00081	2.58
3.0	0.00066	2.11
4.0	0.00057	1.83
5.0	0.00051	1.63

***** PIT 16 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3300
Drawdown (ft) = 30
Aquifer thick (ft) = 15

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00245	8.09
2.0	0.00173	5.72
3.0	0.00141	4.67
4.0	0.00123	4.04
5.0	0.00110	3.62

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 16 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3300
Drawdown (ft) = 30
Aquifer thick (ft) = 15

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00437	14.41
2.0	0.00309	10.19
3.0	0.00252	8.32
4.0	0.00218	7.20
5.0	0.00195	6.44

***** PIT 16 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3300
Drawdown (ft) = 30
Aquifer thick (ft) = 15

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00775	25.57
2.0	0.00548	18.08
3.0	0.00447	14.76
4.0	0.00387	12.78
5.0	0.00347	11.44

```
'PROGRAM PLANEQUE
'ONE-DIMENSIONAL SOLUTIONS TO GROUNDWATER FLOW

WRITTEN BY L. COPE, GOLDER ASSOCIATES, 1989.

'THE EQUATION FOR DISCHARGE (OPTION 9 IN THE MENU) IS THE
'BANK STORAGE EQUATION GIVEN ON PAGE 74 OF "TRANSIENT GROUNDWATER
'HYDRAULICS" BY R.E. GLOVER, 1974.


Defdbl C-H,J-Z: defstr A,B: DEFINT I
SZERO=200:K=.0019:THIC=150:STOR=.05:TIM=365:LENG=1000
NSTEP=10.:ATIT="OUTPUT TABLE":AFLAG="SCREEN"
50 CLS:PRINT "     1-D SOLUTIONS FOR FLOW IN A VERTICAL PLANE"
PRINT "    ***********************************************"
PRINT "    0   TITLE FOR OUTPUT:     ";ATIT
PRINT "    1   DRAWDOWN (So) IN FEET                     ";SZERO
PRINT USING "    2   HYDRAULIC CONDUCTIVITY (K) IN FEET/DAY:#####.####";K
PRINT USING "    3   STORAGE PARAMETER (S/Sya):              #####.####";STOR
PRINT "    4   AVERAGE AQUIFER THICKNESS (b) IN FEET:    ";THIC
PRINT "    5   NUMBER OF TIME STEP (print times):        ";NSTEP
PRINT "    6   NUMBER OF DAYS PER TIME STEPS (t):        ";TIM
PRINT "    7   LENGTH OF PIT WALL (LENG) IN FEET:        ";LENG:PRINT
PRINT "        =======  TRANSIENT STATE SOLUTION ======="
PRINT "    8   SOLVE EQUATION FOR DRWDWN DISTANCE FROM WALL (feet)"
PRINT "    9   SOLVE EQUATION FOR WALL DISCHARGE":PRINT
PRINT "        =======   STEADY STATE SOLUTION   ========"
PRINT "    10  SOLVE FOR INFILTRATION GIVEN (L) AND (H)"
PRINT "    ***********************************************"
PRINT "    11  ACTIVATE OUTPUT TO DISK FILE  =======>   ";AFLAG
PRINT "    12  OUTPUT FILE NAME ====>   ";AFNAM
PRINT "    13  QUIT PROGRAM
PRINT:INPUT "Enter selection:";IN
  IF IN=0 THEN
    input "      Title for output listing";ATIT
  ELSEIF IN=1 THEN
    input "      Drawdown (feet)";SZERO
  ELSEIF IN=2 THEN
    input "      Hydraulic Conductivity (feet/day)";K
  ELSEIF IN=3 THEN
    input "      Storage parameter";STOR
  ELSEIF IN=4 THEN
    input "      Average aquifer thickness (feet)";THIC
  ELSEIF IN=5 THEN
    input "      number of time steps";NSTEP
  ELSEIF IN=6 THEN
    input "      Days per timestep";TIM
  ELSEIF IN=7 THEN
    input "      Length of pit wall (feet)";LENG
  ELSEIF IN=8 THEN :CLS
    PRINT "                ";ATIT:PRINT:PRINT
    input " Enter integral value (From Tab.8, Glover,74)";ERFVAL
    TSALFA=K*SZERO/2/STOR
```

```
      PRINT:PRINT " s = ";SZERO,"K = ";k:PRINT USING "     ALPHA= ###.##";TSALFA
      PRINT:PRINT "  YEAR     DIST (ft.) "
      PRINT "            FROM WALL "
      PRINT " ======================"
      FOR I=1 TO NSTEP
        DAY= I*TIM : YEAR=DAY/365.25
        L= (ERFVAL)*((4*TSALFA*DAY)^.5)
        PRINT USING "####.##   #####,.#";YEAR,L
      NEXT I
      GOTO 40
    ELSEIF IN=9 THEN
      goto 100
    ELSEIF IN=10 THEN
      CLS:PRINT:PRINT:PRINT "                ";ATIT:PRINT
      PRINT:INPUT "  Average annual precipitation";precip
      PRINT:INPUT "  Distance that infiltration is caught by pit";L
      PRINT:PRINT "  Thickness Ho is assumed to be 50 feet.  Enter"
      INPUT "  the saturated thickness plus 50 feet (H1) ";H1
      PRINT:PRINT:PRINT:PRINT
      W=((K*365.25)*(H1^2 - 2500))/L^2
      WIN=W*12.
      PCNT=WIN/PRECIP*100.
      PRINT USING "    HYDRAULIC CONDUCTIVITY (ft/day)= ##.###";K
      PRINT "    ANNUAL PRECIP. (Inches)        = ";PRECIP
      PRINT USING "    ANNUAL INFILTRATION (Inches)   = ##.##";WIN
      PRINT USING "    INFILT/PRECIP (Percent)        = ###.##";PCNT;
      PRINT:PRINT:PRINT
      IF PCNT>100. THEN PRINT "WARNING: INFILTRATION EXCEEDS PRECIPITATION.
      GOTO 40
    ELSEIF IN=11 THEN
     AFLAG="FILE"
    ELSEIF IN=12 THEN
      print:input "   New name of output file  ";AFNAM
    ELSEIF IN=13 THEN
      goto 200
    END IF
  GOTO 50
  100 PI=3.1416 : T=K*THIC
  CLS:PRINT "        *****  ";ATIT;"  *****":PRINT
  PRINT USING "          Hydraulic cond = #.####";K
  PRINT USING "          Storage coef   = #.####";STOR
  PRINT "          Pit wall length=";leng
  PRINT "          Drawdown       =";szero
  PRINT "          Aquifer thick. =";thic:print
  PRINT "                UNIT       TOT. WALL
  PRINT "      YEAR     INFLOW       INFLOW"
  PRINT "                Gpm/ft       Gpm
  PRINT "   ================================"
  IF AFLAG="SCREEN" GOTO 60
  OPEN AFNAM FOR APPEND AS #1
  PRINT #1,:PRINT #1,:PRINT #1,:PRINT #1,:PRINT #1, "          *****   ";ATIT;
  *****":PRINT #1,
  PRINT #1, USING "          Hydraulic cond = #.####";K
  PRINT #1, USING "          Storage coef   = #.####";STOR
```

```
PRINT #1, "          Pit wall length =";leng
PRINT #1, "          Drawdown        =";szero
PRINT #1, "          Aquifer thick.  =";thic:
PRINT #1,
PRINT #1, "                 UNIT       TOT. WALL
PRINT #1, "      YEAR      INFLOW       INFLOW"
PRINT #1, "                 Gpm/ft       Gpm
PRINT #1, "     ==============================="
60 FOR I=1 TO NSTEP
    DAY=I*TIM:YEAR=DAY/365.25
    Q=SZERO*T/((PI*(T/STOR)*DAY)^.5)
    QGPM=(Q*7.48)/1440
    TOTQ=QGPM*LENG
    PRINT USING "########.#    ##.#####   #####.##";YEAR,QGPM,TOTQ
    IF AFLAG="SCREEN" GOTO 70
    PRINT #1, USING "########.#    ##.#####   #####.##";YEAR,QGPM,TOTQ
70 NEXT I
CLOSE #1
40 PRINT:INPUT "        press enter for menu";B
AFLAG="SCREEN"
GOTO 50
200 CLS:END^Z
```

APPENDIX L.2

STEADY-STATE 1-DIMENSIONAL ANALYSIS OF INFLOW

Golder Associates	Subject 1-D STEADY STATE	Made by LEC	Job No. 893-2145
		Checked by	Date 8/11/89
		Approved by	Sheet No. 1/4

CALCULATIONS

USING 1-D STEADY STATE SOLN

Assumptions

- NO RECHARGE FROM PRECIPITATION OR SURFACE WATER
- NO LEAKAGE FROM THE GLACIAL DEPOSITS TO THE BEDROCK
- A CONSTANT HEAD BOUNDARY IS ASSUMED AT SOME DISTANCE FROM THE PITS. DISTANCE TO THE BOUNDARY IS CONTROLLED BY SURFACE TOPOGRAPHY AND BY DISTANCE TO SURFACE WATER.

ESTIMATED DISTANCES (L) ARE:

L = 1000 ft. for mine area 1
L = 1500 ft. for mine area 2

THE EQUATION USED:

$$Q = \frac{K}{2L}\left(h_L^2 - h_o^2\right)$$

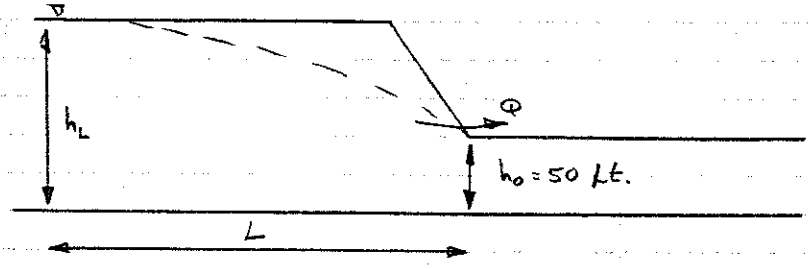
unconfined - steady state, as presented by Sunada & McWhorter, 1977, Groundwater hydrology and hydraulics, pg 147.

L = distance to constant head
h_L = Saturated thickness at distance L
h_o = Saturated thickness at toe of pit wall

Golder Associates	Subject: 1-D STEADY STATE	Made by: LEC	Job No. 893-2145
		Checked by:	Date: 8/11/89
		Approved by:	Sheet No. 2/4

BEDROCK

physical model:



MINE AREA 1

$K = 0.0076,\ 0.024,\ 0.076$ ft/day
$L = 1000$ ft.
$h_L = 250$ ft.

$$Q = \frac{(0.0076)}{2(1000)}(250^2 - 50^2) = 0.228 \text{ ft}^3/\text{day}/\text{ft.}$$

$$Q = \frac{(0.024)}{2(1000)}(250^2 - 50^2) = 0.720 \text{ ft}^3/\text{day}/\text{ft.}$$

$$Q = \frac{(0.076)}{2(1000)}(250^2 - 50^2) = 2.280 \text{ ft}^3/\text{day}/\text{ft.}$$

MINE AREA 2

$K = 0.0019,\ 0.006,\ 0.019$ ft/day
$L = 1500$ ft
$h_L = 450$ ft

$$Q = \frac{(0.0019)}{2(1500)}(450^2 - 50^2) = 0.127 \text{ ft}^3/\text{day}/\text{ft}$$

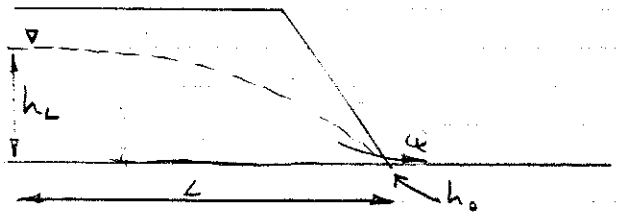
$$Q = \frac{(0.006)}{2(1500)}(450^2 - 50^2) = 0.40 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(0.019)}{2(1500)}(450^2 - 50^2) = 1.27 \text{ ft}^3/\text{day}/\text{ft}$$

Golder Associates	Subject 1-D STEADY STATE	Made by LEC	Job No. 883-2145
		Checked by	Date 8/11/89
		Approved by	Sheet No. 3/4

GLACIAL DEPOSITS

physical model:



MINE AREA 1

$K = 0.126,\ 0.40,\ 1.26$ ft/day
$L = 1000$ ft
$h_L = 50$ ft

$$Q = \frac{(0.126)}{2(1000)}(50^2 - 0^2) = 0.158 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(0.40)}{2(1000)}(50^2 - 0^2) = 0.500 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(1.26)}{2(1000)}(50^2 - 0^2) = 1.58 \text{ ft}^3/\text{day}/\text{ft}$$

MINE AREA 2

$$Q = \frac{(0.126)}{2(1500)}(50^2 - 0^2) = 0.105 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(0.40)}{2(1500)}(50^2 - 0^2) = 0.33 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(1.26)}{2(1500)}(50^2 - 0^2) = 1.05 \text{ ft}^3/\text{day}/\text{ft}$$

Golder Associates	Subject 1-D Steady State	Made by LEC	Job No. 883-2145
		Checked by	Date 8/11/89
		Approved by	Sheet No. 4/4

– Summary of Results –

for

1-D steady-state mine Inflow

	K	INFLOW (GPM) BEDROCK gpm	GLACIAL DEPOSITS gpm	TOTAL gpm
MINE AREA I (Q x 8,100)	LO	9.6	6.6	16.2
	MID	30.3	21.0	51.3
	HI	95.9	66.2	162.1
MINE AREA II (Q x 15,400)	LO	10.2	8.4	18.6
	MID	32.0	26.7	58.7
	HI	101.6	84.0	185.6

APPENDIX L.3
TRANSIENT RADIAL
ANALYSIS OF INFLOW

Golder Associates	Subject: RADIAL TRANSIENT STATE WISHBONE HILL MINE INFLOW	Made by: LEC	Job No. 883-2145
		Checked by:	Date: 8/11/89
		Approved by:	Sheet No. 1/4

CALCULATION OF MINE INFLOW
USING RADIAL TRANSIENT STATE
SOL'N

ASSUMPTIONS

- NO RECHARGE FROM PRECIPITATION, SURFACE WATER, OR INTO BEDROCK FROM GLACIAL DEPOSITS
- A LARGE OPEN PIT BEHAVES HYDRAULICALLY LIKE A LARGE DIAMETER WELL.
- THE USUAL THEIS ASSUMPTIONS OF HORIZONTAL RADIAL FLOW IN AN INFINITE AQUIFER ARE VALID AT THE SITE.
- VALUES FOR (u) ARE ≤ 10.
  SINCE:

$$u = \frac{r^2 S}{4Kt},$$

THE CONDITION FOR $u \leq 10$ IS TRUE WHEN (r) IS THE LARGE RADIUS OF AN OPEN PIT MINE ONLY IF:

STORAGE (S) is VERY SMALL ⇒ CONFINED
and/or HYD. COND. (K) is VERY LARGE
and/or time (t) is Very LARGE

OVER THE LIFE OF THE MINE ($t \leq 10$ YEARS), AND WITH THE GIVEN VALUES OF (r) AND (K), SPECIFIC YIELD VALUES OF 0.05 - 0.20 PRODUCE $u \gg 10$.

CONSEQUENTLY, THE SOLUTION IS ONLY VALID FOR CONFINED FLOW HAVING LOW STORAGE (S_S BEDROCK $\approx 10^{-7}/ft$).

- EQUIVALENT MINE AREA RADII ARE CHOSEN THAT CORRESPOND TO ACTUAL MINE OPEN AREAS:

$$A = \pi r^2 \Rightarrow r = (\pi/A)^{1/2}$$

Golder Associates	Subject: RADIAL TRANSIENT STATE WISHBONE HILL MINE INFLOW	Made by: LEC	Job No. 883-2145
		Checked by	Date 8/11/89
		Approved by	Sheet No. 2/4

FOR:

MINE AREA 1, $r = 950$ ft

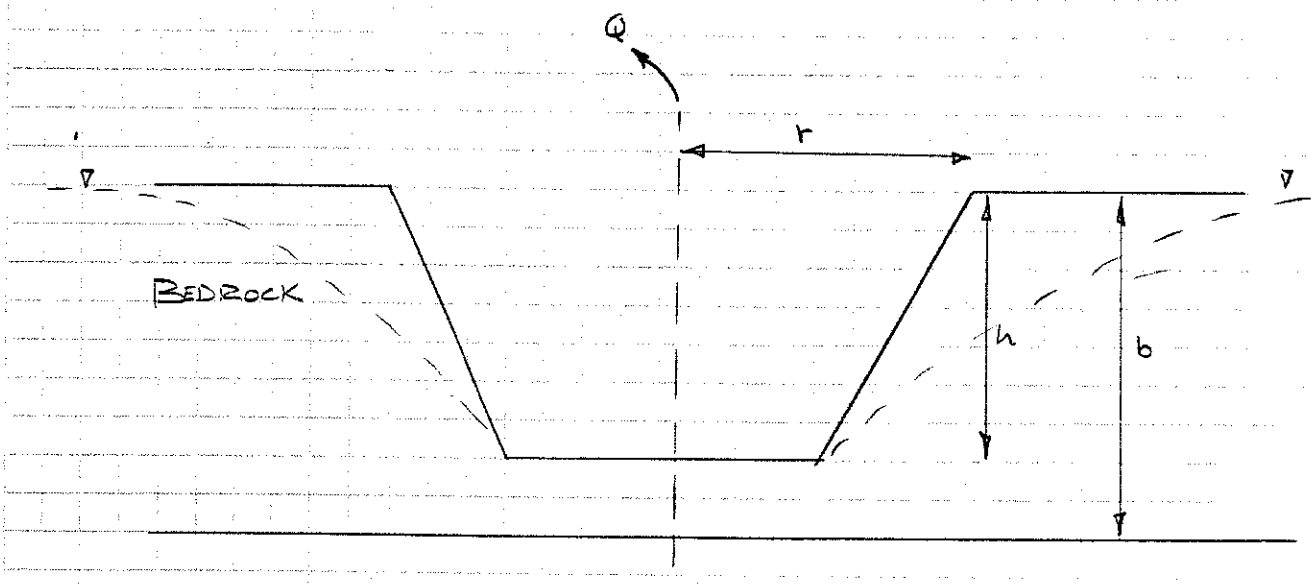
MINE AREA 2, $r = 1700$ ft.

- VALUES FOR MINE INFLOW ARE CALCULATED BY THE THEIS EQUATION:

$$u = \frac{r^2 S}{4Kt}$$

$(u) \Longrightarrow w(u)$ from well function tables

$$Q = \frac{4\pi K b h}{w(u)}$$



Golder Associates	Subject: RADIAL TRANSIENT STATE WISHBONE HILL MINE INFLOW	Made by: LEC	Job No. 883-2145
		Checked by:	Date: 8/11/89
		Approved by:	Sheet No. 3/4

MINE AREA 1

$r = 950$ ft
$K = 0.0076,\ 0.024,\ 0.076$ ft/day
$S_s = 3 \times 10^{-7}$ /ft

$h = 200$
$b = 250$
$t = 1 \rightarrow 3$ YEARS

	K	u	W(u)	Q (gpm)
YEAR 1	LO	2.44×10^{-2}	3.15	7.85
	MID	7.72×10^{-2}	4.3	18.2
	HI	2.44×10^{-3}	5.44	45.58
YEAR 2	LO	1.22×10^{-2}	3.86	6.46
	MID	3.86×10^{-3}	4.98	15.72
	HI	1.22×10^{-3}	6.13	40.44
YEAR 3	LO	8.13×10^{-3}	4.25	5.85
	MID	2.57×10^{-3}	5.40	14.54
	HI	8.13×10^{-4}	6.54	37.94
YEAR 4	LO	6.1×10^{-3}	4.53	5.48
	MID	1.93×10^{-3}	5.67	13.80
	HI	6.1×10^{-4}	6.83	36.34

Golder Associates	Subject: RADIAL TRANSIENT STATE WISHBONE HILL MINE INFLOW	Made by: LEC	Job No. 883-2145
		Checked by:	Date: 8/11/89
		Approved by:	Sheet No. 4/4

MINE AREA 2

	K	(u)	w(u)	Q (gpm)
YEAR 3	LO	3.12×10^{-1}	0.88	25.48
	MID	9.89×10^{-2}	1.83	38.52
	HI	3.12×10^{-2}	2.90	76.98
YEAR 4	LO	1.56×10^{-1}	1.43	15.61
	MID	4.95×10^{-2}	2.48	28.43
	HI	1.56×10^{-2}	3.6	62.01
YEAR 5	LO	1.04×10^{-1}	1.78	12.5
	MID	3.3×10^{-2}	2.87	24.56
	HI	1.04×10^{-2}	4.03	55.40
YEAR 6	LO	7.81×10^{-2}	2.05	10.89
	MID	2.47×10^{-2}	3.14	22.45
	HI	7.81×10^{-3}	4.28	52.12
YEAR 7	LO	6.25×10^{-2}	2.26	9.89
	MID	1.98×10^{-2}	3.35	21.04
	HI	6.25×10^{3}	4.49	49.56
YEAR 8	LO	5.21×10^{-2}	2.43	9.19
	MID	1.65×10^{-2}	3.53	19.97
	HI	5.21×10^{-3}	4.69	47.60
YEAR 9	LO	4.46×10^{-2}	2.58	8.66
	MID	1.41×10^{-2}	3.70	19.05
	HI	4.46×10^{-3}	4.84	46.12
YEAR 10	LO	3.90×10^{-2}	2.70	8.25
	MID	1.24×10^{-2}	3.80	18.55
	HI	3.90×10^{-3}	4.97	44.92
YEAR 11	LO	3.47×10^{-2}	2.82	7.92
	MID	1.10×10^{-2}	3.94	17.89
	HI	3.47×10^{-3}	5.10	43.77

$r = 1700$ ft
$K = 0.0019$
0.006
0.019 ft/day
$S = 3 \times 10^{-7}$/ft
$h = 400$ ft
$b = 450$ ft
$t = 1 \rightarrow 9$ years
(3 → 11 mine years)

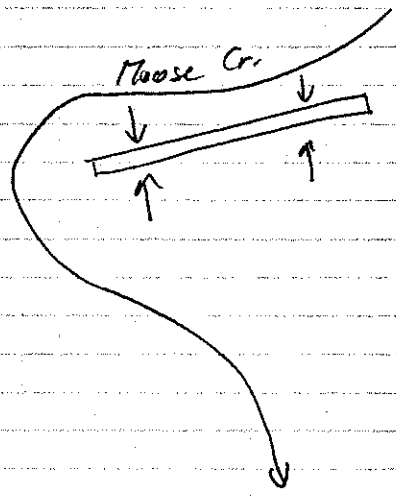
APPENDIX L.4

ANALYSIS OF WATER LEVEL DRAWDOWNS

Golder Associates	Subject: Wishbone Hill Coal - WL Impacts	Made by: [illegible]	Job No. 883-2145.003
		Checked by:	Date: 1/27/96
		Approved by:	Sheet No. 1

Objective: Estimate the distance from the open pits that water level drawdowns caused by pit inflow will occur.

Approach: Idealize open pits as a long trench or slot with axis running NE-SW and 9,000 feet long based on Fig 4-1 from Chap IV.



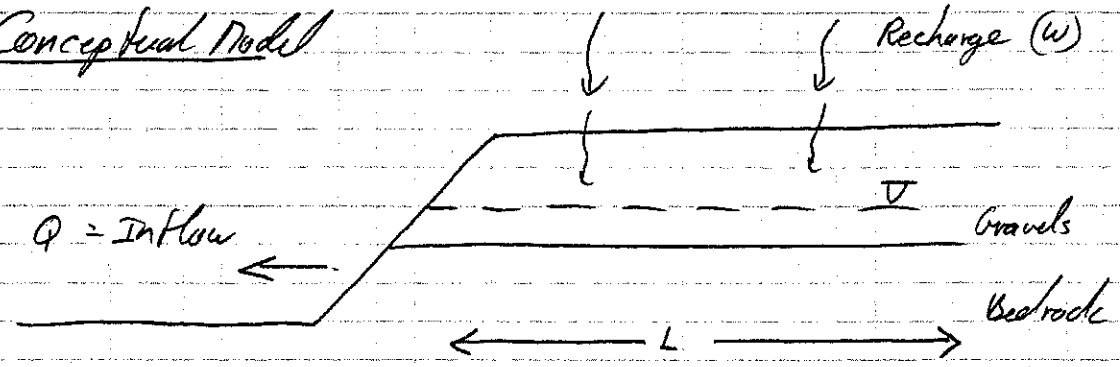
At steady-state, drawdowns will be at maximum around pits. Inflow will be supplied by surface recharge from precipitation + infiltration to water table. Water table aquifer will provide vertical leakage to bedrock.

Estimated Recharge: based on experience, infiltration to groundwater should be 2" per year or greater. Assume 2 values as representative ⇒ 2"/yr = 4.57×10^{-4} ft³/day/ft²

4"/yr = 9.13×10^{-4} ft³/day/ft²

Golder Associates	Subject	Made by	Job No. 883-2245.003
		Checked by	Date 1/27/90
		Approved by	Sheet No. 2

Conceptual Model



Q_{tot} = Total Inflow to pit, based on inflow analysis in Section 2.0 the maximum inflow to the pits is expected to be 200 gpm. Half will come from north (i.e. from area between pits + Moose Creek) and half from South of idealized trench. Inflow per unit length of trench will be

$$Q_{unit} = Q_{tot} / 2 / 9000 \text{ ft}$$

$$Q_{unit} = 200 \text{ gpm} / 18000 = 1.11 \times 10^{-2} \text{ gpm/ft}$$

$$Q_u = 2.14 \text{ ft}^2/\text{day}/\text{ft}$$

At steady state recharge = inflow

$$\text{Recharge} = W \times L$$ where L is perpendicular distance from trench.

$$Q_u = WL \Rightarrow L = Q_u/W$$

for $W = 2''/yr$

$$L = \frac{2.14 \text{ ft}^3/\text{day}/\text{ft}}{4.57 \times 10^{-4} \text{ ft}^3/\text{day}/\text{ft}^2} = 4{,}680 \text{ ft}$$

for $W = 4''/yr$

$$L = \frac{2.14 \text{ ft}^3/\text{day}/\text{ft}}{9.13 \times 10^{-4} \text{ ft}^3/\text{day}/\text{ft}^2} = 2{,}340 \text{ ft}$$

Golder Associates	Subject	Made by J Rowe	Job No. 883-2145.003
		Checked by	Date 1/27/90
		Approved by	Sheet No. 3

Conclusions: Based on steady-state flow the total inflow to the pit from both glacial sediments and bedrock can be sustained by a recharge area from 2,340 to 4,680 ft from the pit. This estimate is conservative since it assumes steady-state conditions (no inflow from aquifer storage) and maximum estimated pit inflows.

APPENDIX M
Golder and Associates Model

Golder Associates Inc.
CONSULTING ENGINEERS

CHAPTER XVI
PROTECTION OF GROUNDWATER RESOURCES

WISHBONE HILL MINE
MATANUSKA - SUSITNA BOROUGH, ALASKA

Prepared for

Idemitsu Alaska, Inc.
c/o McKinley Mining Consultants, Inc.

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1.0 OVERVIEW OF GROUNDWATER PROTECTION

1.1 Protection Goals

This chapter provides information relating to protection of groundwater resources in and near the Proposed Permit Area. Protection standards relating to groundwater resources are established in 11 AAC 90 Sections 321, 323 and 339 of the Alaska Coal Mining Program as listed below.

11 AAC 90.321. HYDROLOGIC BALANCE:

a) Operations must be planned and conducted to prevent long-term adverse changes in the hydrologic balance in both the permit area and adjacent areas.

b) Changes in water quality and quantity, in the depth and flow patterns of ground water, and in the location of surface and subsurface water drainage channels must be minimized so that the approved post-mining land use of the permit area is not adversely affected.

c) The operator shall comply with all applicable federal and state water quality statutes and regulations.

d) Operations must be conducted to prevent or minimize water pollution. The commissioner will, in his or her discretion, require operation of necessary water treatment facilities for as long as treatment is required under this chapter. (Eff. 5/2/83, Register 84)

11 AAC 90.323. WATER QUALITY STANDARDS:

a) All discharges of water from underground workings to surface water and all surface drainage from the disturbed area, including disturbed areas that have been graded, seeded, or planted, must be passed through sedimentation ponds or a treatment facility before leaving the permit area, unless the commissioner finds that conditions such as permafrost or ice-covered ponds will be present and that the drainage will meet the applicable state and

federal water quality laws and regulations without treatment.

b) Sedimentation ponds and other treatment facilities for surface drainage from the disturbed area and discharges from underground workings must be maintained until the vegetation requirements of 11 AAC 90.451 -- 11 AAC 90.457 are met and the untreated drainage from the disturbed area meets, and is expected to permanently meet, the applicable state and federal water quality laws and regulations for the receiving stream.

c) The operator shall meet all applicable federal and state water quality laws and regulations for the mixed drainage from the permit area when there is mixing of drainage from disturbed and undisturbed areas.

d) The commissioner will require installation, operation and maintenance of treatment processes necessary to bring any discharge from an operation into compliance with applicable state water quality laws and regulations. (Eff. 5/2/83, Register 84)

11 AAC 90.339. GROUND WATER PROTECTION

a) Backfilled materials must be placed so as to minimize contamination of ground water systems with acid, toxic, or otherwise harmful mine drainage, to minimize adverse effects of mining on ground water systems outside the permit area, and to support approved post-mining land uses.

b) To control the effects of mine drainage, pits, cuts and other mine excavation or disturbances must be located, designed, constructed, and utilized to prevent or control discharge of acid, toxic or otherwise harmful mine drainage water into ground water systems and to prevent adverse impacts on ground water systems or on approved post-mining land uses. (Eff. 5/2/83, Register 84)

1.2 Water Quality Standards

Water quality criteria for the State of Alaska are promulgated in the Alaska Water Quality Standards, 18 AAC 70. The water quality

criteria are combined with the water use designation to determine the water quality standards for a particular water body. Alaska Water Quality Standards incorporate by reference Federal Primary and Secondary Drinking Water Standards in addition to numerical criteria for other constituents not covered under Federal Standards. Additional information on water quality standards and existing baseline groundwater quality is provided in Part C, Chapter IV.

2.0 MINE INFLOW

2.1 Mine Inflow From Bedrock and Glacial Sediments

The proposed mine excavations will penetrate saturated glacial deposits and sedimentary bedrock resulting in groundwater inflow to the open pits. The pit in Mine Area 1 will be excavated to a maximum depth of approximately 380 feet below ground surface to elevation 605 feet. It is expected to penetrate up to approximately 300 feet of saturated material (i.e. glacial sediments and bedrock). The pit in Mine Area 2 will be excavated to a maximum depth of approximately 550 feet below ground surface to elevation 505 feet. It is expected to penetrate up to approximately 450 feet of saturated material.

The open pits are not expected to intersect saturated alluvial materials. Based on borehole and seismic survey data (see Part C, Chapter IV) the alluvial deposits are confined to an area within several hundred feet or less of the Moose Creek channel and are generally less than 20 feet thick. Alluvial deposits will be separated from the pit slopes by bedrock and glacial deposits that have a relatively low permeability (see Part C, Chapter IV). Therefore, it is not expected that the mine excavation will induce flows of groundwater from the shallow alluvium or cause increased losses of surface water from Moose Creek into the alluvium.

2.1.1 Physical Model

Approximate groundwater inflow rates to the two mine areas were calculated based on the proposed pit configurations and mining sequence as presented in Part D, Chapter 3. Figure 2-1 shows the simplified mining sequence that was used for the inflow computations. A conceptualized diagram of a pit wall and one of the

analytical models used to calculate inflow are shown in Figure 2-2. For each portion of the pit slope the saturated thickness of glacial sediments and bedrock was determined from the hydrogeologic cross-sections (Figures 4-3 to 4-7) and water table contour map (Figure 4-9) presented in Part C, Chapter IV. The maximum drawdown in water level in the bedrock was set at the elevation of the pit floor. The maximum drawdown in the glacial sediments was set at the contact between the glacial sediments and the bedrock.

Pits that are to be developed during any given year were assumed to open instantaneously at the beginning of that year and then stay open during the remaining life of the mine area. In reality, the mine excavation will be backfilled sequentially. However, the backfill will be several of orders of magnitude more permeable than the in-situ bedrock and glacial sediments and, therefore, will not significantly impede inflow to the remaining open areas of the pit. Depending on the bottom profile of the backfilled areas, inflow may tend to pond beneath the backfill in low areas thus reducing the actual inflow into the open areas of the pit. Under such conditions, the resulting inflow into the open (i.e. not backfilled) areas of the pit would be less than that estimated below.

The contribution of pit inflow from the glacial sediments and the bedrock was calculated separately. Because the bedrock is generally one to two orders of magnitude lower in hydraulic conductivity than the overlying glacial sediments (see Part C, Chapter IV) and will have a different storage coefficient, each of these major hydrogeologic units will have a different hydraulic response to the excavation. It is expected that the unconfined groundwater in the glacial sediments will flow laterally towards the open pit on top of the bedrock contact. The groundwater in the bedrock is expected to flow towards the pit under confined conditions except adjacent to the excavation where it may become

unconfined as portions of the bedrock desaturate. Total pit inflow is the sum of the separately calculated inflows from the glacial sediments and the bedrock formations.

Representative values for hydraulic conductivity were determined from aquifer pump tests and slug tests described in Part C, Chapter IV. The values used for the mine inflow estimates are listed below.

Unit	Hydraulic Conductivity Best Estimate (ft/day)	Low (ft/day)	High (ft/day)
Bedrock			
Flat Strata	0.024	0.0076	0.076
Dipping Strata	0.006	0.0019	0.019
Glacial Sediments	0.400	0.1260	1.260

Two "best estimate" values of hydraulic conductivity were used for the bedrock. For relatively flat-lying bedrock, a hydraulic conductivity value of 0.024 ft/day determined from the H88-15 pump test was used. This test was conducted in relatively flat-lying strata in Mine Area 1. For steeply dipping bedrock a value of 0.006 ft/day determined from the H88-16 pump test was used. This pump test was conducted in steeply-dipping strata in Mine Area 2. As discussed in Part C, Chapter IV, the steeply dipping strata is expected to have a lower horizontal hydraulic conductivity than the relatively flat-lying strata because flow will occur across bedding. Inflow from pit walls in flat-lying strata (i.e. portions of Mine Area 1) was calculated using the higher value of hydraulic conductivity and inflow from pit walls in steeply-dipping strata (i.e. portions of Mine Area 1 and all of Mine Area 2) was calculated using the lower value of hydraulic conductivity.

A representative "best estimate" value for hydraulic conductivity for the glacial sediments of 0.4 ft/day was calculated as the geometric mean of the slug tests performed in seven monitoring wells installed in the glacial sediments (see Part C, Chapter IV).

To account for variability in groundwater parameters, a range of inflows was computed using a one-order-of-magnitude envelope about the representative values of hydraulic conductivity. The low and high values of hydraulic conductivity used for the inflow estimates are shown above.

Since pit inflow will vary with time, values for storage coefficient were needed to calculate transient effects. In bedrock, inflow is expected to occur under primarily confined aquifer conditions and the storage coefficient was set equal to the measured specific storage of the bedrock times the thickness of the bedrock over which inflow is assumed to occur. Bedrock specific storage values measured from the pump test in well H88-15 are approximately 2×10^{-7} and 4×10^{-7} ft^{-1} as presented in Part C, Chapter IV. An average value of 3×10^{-7} ft^{-1} was used for the mine inflow calculations for both flat-lying and dipping bedrock. Since specific storage is primarily a function of aquifer compressibility and porosity, there is not expected to be a difference in specific storage between the flat-lying and steeply-dipping strata and it is appropriate to use one value for both. Flow in the glacial sediments will occur under unconfined conditions. Therefore a value of specific yield was used for the transient inflow calculations. Based on the material type a specific yield of 0.15 (see Part C, Chapter IV) was used for the glacial sediments.

2.1.2 Analytical Methods

Three analytical methods were used to estimate the quantity of mine inflow from the bedrock and glacial sediments. Different methods were used to account for a range of possible inflow conditions and as a cross-check. Each of the methods required idealization of the hydrogeology at the site and the resulting inflow numbers should be considered as approximate. As discussed above, a range of parameter values was used to account for the natural variability of the rock.

The first analytical method is based on confined one-dimensional transient inflow to an open excavation. The solution is given by Glover (1974) and is shown in Figure 2-2. This solution assumes that horizontal flow will occur from a confined aquifer of infinite areal extent and no recharge. Although this solution is strictly applicable only to confined conditions, unconfined flow conditions in the glacial deposits were approximated by reducing the effective saturated thickness in the sediments to one half of the total saturated thickness. This reduction compensates for dewatering of the sediments and the associated reduction in transmissivity that will occur near the pit wall. Because this solution assumes no recharge either from vertical leakage or hydrologic boundaries, it represents a minimum estimate of pit inflow for a given set of parameters.

The procedure included solving for inflow from the glacial sediments and bedrock formations separately in one-year intervals for the duration of the mining. Inflows from each formation were then summed by year. A computer program used to run the analytical model is presented in Appendix A. This Appendix also provides the parameter values used for each calculation and summary tables of

inflow from bedrock and glacial sediments to the various pits during each year.

A second analytical method used to estimate inflows is based on one-dimensional steady-state unconfined flow into an excavation from a boundary at which the head is held constant. This method described by McWhorter (1977) is illustrated in Figure 2-3. The assumed constant head boundary could be maintained by a stream (e.g. Moose Creek), by vertical infiltration or by a lateral change to a more permeable hydrogeologic unit (e.g. from bedrock to alluvium). It represents a reasonable maximum estimate of inflow for a given set of parameters. Inflow from both bedrock and glacial units was estimated using this method. The calculations are presented in Appendix A.

A third analytical method was used as an additional check on inflows. This method used the standard Theis solution for confined radial flow to a well (Lohman, 1972) and is illustrated in Figure 2-4. The maximum area of the open pit excavation in each of the two mine areas was idealized as a large diameter well in an aquifer of infinite areal extent. Diameters were calculated based on a large well with the same equivalent area as the pits in each mine area. This method was used only to calculate inflow under confined conditions from the bedrock. The solution is not appropriate to use for a large diameter excavation in an unconfined aquifer (i.e. glacial deposits). Calculations of inflow using this method are presented in Appendix A.

2.1.3 Results

The estimated mine inflows to Mine Areas 1 and 2 over the proposed mine life are plotted in Figure 2-5. For any given point in time a range of inflows is shown. The range reflects the uncertainty

in hydrogeologic parameters (reflected by an order of magnitude variation in hydraulic conductivity) and boundary conditions (reflected by the three different analytical methods) that will influence actual inflows into the pits. As shown in Figure 2-5 inflow is expected to be in the range of approximately 20 to 180 gpm in Mine Area 1 and 30 to 200 gpm in Mine Area 2.

These estimated inflows are relatively small for a large open pit mine. The low permeability of the units comprising the pit slopes limits the amount of inflow that will occur. Observed inflows to the pits may be smaller than those calculated due to evaporation of inflow as it enters the pit.

It is possible that inflows higher than these ranges could be experienced if permeable faults or fractures are encountered during pit excavation. Such permeable features were not detected in the mine areas during the hydrogeological characterization program but cannot be ruled out. It is likely that if such features are encountered during excavation, they would contribute higher inflows over several days to weeks and then flows would decrease as these features drain.

2.2 Inflow from Underground Workings

The proposed bottom of the excavation in Mine Area 1 will be at an elevation of about 605 feet. The open pit excavation will intersect the old underground workings of the Premier Mine based on the mapped location of these workings (Rocky Mountain Energy, 1983). Information obtained from monitoring wells penetrating the old workings indicates that they are saturated up to approximately elevation 710 feet or about 100 feet above the base of the proposed pit (see Part C, Chapter IV). Therefore, dewatering of the old workings will be conducted before the open pit penetrates below

elevation 710 feet to avoid sudden inrushes of water from the old workings into the pit.

A pump test conducted in well H89-29 (see Part C, Chapter IV) indicates that the saturated mine voids behave like a reservoir rather than a porous media. The volume of water contained in the old mine voids was estimated by taking the approximate area of the underground mine perpendicular to dip of the coal (13.6 acres) times the estimated thickness of the unit mined (10 ft) times an estimated extraction ratio of 50 percent. The entire area of the underground workings on both sides of Moose Creek was considered to be interconnected based on the similarity in water levels in the old workings on either side of Moose Creek measured in H89-29 and H89-30 (see Part C, Chapter IV). The location and area at the old workings was taken from a map by Rocky Mountain Energy (1983). The resulting volume of water contained in the workings from elevation 710 feet to elevation 600 feet is approximately 68 acre-ft. This volume of water could be removed by pumping at a rate of 100 gpm for a period of about 150 days assuming no recharge to the old workings.

Groundwater recharge to the old underground workings would have to be pumped in addition to the water currently contained in the mine voids. Direct measurements of recharge to the old workings are not available. An indirect estimate of recharge to the portion of the old workings affected by pumping in well H89-30 is presented in Part C, Chapter IV. A recharge rate of approximately 5 gpm was indicated by the recovery rate in H89-30 after pumping was stopped. Barnes and Payne (1956) reported that in 1933, the removal of pillars in a weakened area of the Premier Mine caused flooding of the lower workings. The depth of the flooding was not reported. However, it is possible that dewatering of the old underground workings could require the pumping of large quantities of water if

renewed flooding in the old workings above the 600 foot level occurs during proposed dewatering operations.

2.3 Mine Dewatering Requirements

Inflow to the open pits from glacial sediments and bedrock is expected to be relatively low as described in Section 2.1 above. Much of this inflow will evaporate as it enters the pit and will therefore not require any special handling. Groundwater inflow and surface precipitation that does not evaporate will be collected in sumps and pumped out of the pit for use as process water.

It is possible that the pits may encounter localized zones of inflow that are higher than predicted in Section 2.1. Such zones in the bedrock could result from open fractures, faults or other features. Increased inflow from the glacial deposits could result from buried stream channels or other localized zones of increased permeability. In general it is anticipated that higher inflows in such zones will decrease within several days to several weeks as the localized features drain. If sustained higher inflows are encountered, additional sumps in the pit, horizontal drains or in extreme cases dewatering wells may be needed to control inflow.

As described in Section 2.2 above, the pits in Mine Area 1 will encounter old underground workings from the Premier Mine. These workings are currently saturated to approximately elevation 710 feet, well above the bottom pit elevation of 605 feet. Therefore, dewatering of the old workings will be required before excavating the western portion of Mine Area 1 below the 710 foot elevation. Dewatering of the old workings will be accomplished by wells completed into the mine voids. Groundwater will be pumped from the old workings and used for process water.

2.4 Quality of Mine Inflow

The chemical quality of groundwater inflow to the open pit mines will be the same as that measured in bedrock and glacial monitoring wells. The average chemical content of mine water will reflect a combination of groundwater from glacial sediments and bedrock units. The chemical characteristics of groundwater inflow to the mine will be similar to the average characteristics provided in Table 4-1 in Part C, Chapter IV. The quality of mine inflow is anticipated to be sufficient for use as process water.

The quality of water in the flooded underground workings is represented by the data from wells H89-29 and 30 in Table 3-2, Part C, Chapter IV. It is very similar in chemical composition to other bedrock waters sampled in wells and is anticipated to be of sufficient quality for use as process water.

Releases of mine inflow to surface streams are not proposed. Any excess mine inflow will be pumped from the pits and used as process water. No degradation of surface water or groundwater quality as a result of the discharge of mine inflow is anticipated.

3.0 MINE FACILITIES

3.1 Slurry Pond

A slurry pond will be constructed for disposal of fine coal refuse. The pond is approximately 26 acres in surface area and will be unlined. The settlement of fine coal refuse out of the slurry is expected to provide a low permeability seal to reduce leakage out of the pond and allow recovery of water off the top. A small initial portion of the pond may be lined with 60 mil HDPE to allow for initial recycling of water.

The materials underlying the slurry pond were investigated in four test pits as described in Section D, Chapter 4. The materials generally consist of approximately one foot of topsoil, two feet of silt or sandy silt, and then gravelly sand or sandy gravel to the maximum test pit depths of 8 to 9 feet. Two infiltration tests were conducted in the shallow (i.e. less than 5 ft deep) materials underlying the slurry pond (see Section D, Chapter 4). Hydraulic conductivity values of 60 and 10 ft/day (2×10^{-2} and 4×10^{-3} cm/sec) were calculated for these tests (see Section D, Chapter 4).

Three monitoring wells designated H88-23, 24A, and 25 are located around the slurry pond area (see Part C, Chapter IV). These wells indicate that glacial deposits of predominantly sand and gravel underlie the slurry pond area to depths of 40 to 100 feet. In well H88-25 the Tsadaka Conglomerate was identified below the glacial deposits at a depth of 40 feet. Hydraulic conductivities measured by slug tests in wells H88-24A and H88-25 were 0.40 and 0.008 ft/day, respectively.

The lowermost elevation in the bottom of the slurry pond is approximately 800 feet. The water table elevation measured in the

surrounding monitoring wells is generally between elevations 790 to 798 feet, or less than 10 feet below the maximum depth of the slurry pond.

Vertical leakage out of the pond into the shallow groundwater will occur. The rate of leakage will depend mainly on the degree of sealing provided by the fine coal refuse. Initially, leakage rates will probably be high until the fine coal refuse settles out and reduces the permeability of the bottom of the pond. Rates were estimated based on the following assumptions:

- A pond area of 26 acres;
- The hydraulic head at the top of the coal slurry is equal the elevation of the top of the coal slurry;
- The hydraulic head at the base of the pond is equal to the elevation of the base of the pond (i.e. free-draining conditions exist below the coal slurry);
- The hydraulic conductivity of the fine coal refuse will be in the range of 0.3 to 0.003 ft/day (10^{-4} to 10^{-6} cm/sec) which is representative of a fine sand to silt; and
- Horizontal leakage out of the pond was ignored.

The Darcy equation was used to estimate vertical leakage as follows:

$$Q = K\ I\ A \qquad (3\text{-}1)$$

where:

Q = vertical leakage (L^3/T)
K = hydraulic conductivity of the fine coal refuse (L/T)
I = hydraulic gradient (L/L)
A = planar area of the pond (L^2).

For the conditions assumed (I = 1 ft/ft, A = 1.13×10^6 ft^2, K = 0.3 to 0.003 ft/day), the leakage rate out of the pond varies from

1,650 to 16.5 gpm. Rates of 165 to 16.5 gpm are considered most likely once the bottom of the pond is covered with several feet of fine coal refuse. A localized groundwater mound may form under and around the slurry pond as a result of leakage. This localized mound should not affect the general regional direction of groundwater flow in the glacial sediments and will not cause any significant adverse impacts to the groundwater regime.

The chemical quality of water leaking from the slurry pond is not expected to result in degradation of groundwater. Based on information in Part C, Chapter III the fine coal waste does not have any geochemical characteristics that are acid or toxic forming or would result in water quality degradation.

3.2 Waste Water Pond

The waste water pond will be fully lined and will have zero discharge. Therefore, no impacts to groundwater are expected during normal operation of the waste water pond. The performance of the liner will be monitored by a groundwater well as described in Section 6 below.

3.3 Fresh Water Pond

The fresh water pond will be lined to prevent leakage and minimize the amount of makeup water required for the mine. Therefore, no impacts to groundwater are expected during normal operation of the fresh water pond. Leakage from the pond would not cause any groundwater quality degradation since only fresh water is stored in the pond.

3.4 Sedimentation Ponds

Sedimentation ponds will temporarily store surface runoff until it evaporates or infiltrates into the ground. Surface runoff will contain sediment from roads, overburden stockpiles, coal stockpiles and other sources. Based on the information provided in Part C, Chapter III potential sources of sediments including overburden and coal do not have any geochemical characteristics that are acid or toxic forming or would degrade the quality of surface water and groundwater.

3.5 Topsoil Stockpile

Precipitation falling on the topsoil stockpile may eventually infiltrate to the groundwater table. No degradation of groundwater quality is anticipated since topsoil does not contain acid or toxic forming substances. Since topsoil stockpiles are temporary, it is likely that during the period they are in operation a significant proportion of available infiltration will be stored in the stockpile as soil moisture rather than percolating through the stockpile into the underlying soils and eventually to the shallow groundwater.

3.6 Overburden Stockpiles

Precipitation falling on the overburden stockpile may eventually infiltrate to the groundwater table. As discussed in Part C, Chapter III the overburden does not have any geochemical characteristics that are acid or toxic forming or would cause degradation of groundwater quality. Since stockpiles are temporary, it is likely that during the period they are in operation a significant proportion of available infiltration will be stored in the stockpile as soil moisture rather than percolating

through the stockpile into the underlying soils and eventually to the shallow groundwater.

3.7 Mine Service Area

Facilities associated with the mine service area and coal processing plant are not expected to cause significant groundwater impacts under normal operating conditions. Mine maintenance activities will be conducted in a maintenance facility with a concrete foundation, therefore minimizing the potential for oils, fuels and degreasers to affect soil and groundwater. No chemicals other than a flocculent will be used in the coal washing process. Therefore, chemical leaks or spills are unlikely.

Fuel storage will be above ground, therefore allowing early detection of any leaks or spills. The area will be bermed to prevent offsite movement in the unlikely event of a spill. Any soils affected by a leak or spill will be immediately removed and treated or properly disposed.

3.8 Septic System

Sewage treatment will include an aerated septic tank, a subsurface tile drainage system, and a leach field and dosing tank. The glacial sediments present on the site should be amenable to leach field operation. Degradation of groundwater quality as a result of leach field operation is not anticipated.

4.0 POST-MINING GROUNDWATER REGIME

4.1 Aquifer Restoration

The open pits will be sequentially backfilled with overburden and coarse coal refuse during the active life of the mine. The backfill material will be significantly more permeable and have a higher porosity than the in-situ bedrock. Therefore, when re-saturated with groundwater, the backfill will comprise a more permeable hydrogeologic unit than the in-situ bedrock. This is not considered to be a significant adverse impact.

Resaturation of mine backfill will occur as a result of lateral inflow of groundwater from the pit walls plus vertical infiltration from precipitation. Based on information presented in Section 2.1 of this chapter, lateral inflows of groundwater are expected to range from 20 to 180 gpm in Mine Area 1 and from 30 to 200 gpm in Mine area 2.

The amount of infiltration from precipitation on the backfill will depend on a number of factors including slope, vegetation and thickness of topsoil. As an estimate of infiltration, it is assumed that 20 percent of the average 15 inches of precipitation infiltrates into the backfill. This results in 3 inches per year of infiltration which yields approximately 10 gpm of inflow over the 65 acres comprising Mine Area 1 and approximately 35 gpm of inflow over the 220 acres comprising Mine Area 2.

Adding infiltration to groundwater inflow results in a total inflow to Mine Area 1 of 30 to 190 gpm and an inflow to Mine Area 2 of 65-235 gpm. It is assumed that these inflow rates occur until the backfill is resaturated. In reality, groundwater inflow will decrease as the water levels in the backfill rise (i.e. as a result

of lower gradients). Therefore, the resaturation times estimated by assuming constant inflow rates are minimum times.

The volume of backfill in Mine Areas 1 and 2 are approximately 25 and 125 MCY (million cubic yards), respectively (see Part D, Chapter 12). Assuming a 40 percent porosity in the backfill, the total void volume to resaturate is 10 MCY and 50 MCY in Mine Areas 1 and 2, respectively. At the inflow rates presented above, it will take 20 to 130 years to resaturate the backfill in Mine Area 1 and 80 to 300 years in Mine Area 2. These times should be considered as order of magnitude estimates. However, they indicate that a relatively long time period may be required to resaturate the backfill and restore groundwater levels to pre-mining conditions.

4.2 Groundwater Quality

Geochemical information discussed in Part C, Chapter III indicates that the overburden and course coal refuse do not contain acid or toxic-forming materials. Therefore, vertical infiltration through and resaturation of the mine backfill is not expected to degrade post-mining groundwater quality.

It is likely that moderate increases in the total dissolved solids (TDS) content of groundwater in the mine backfill will occur as a result of oxidation of backfill materials and subsequent leaching by infiltrating waters. Water in bedrock wells ranged in TDS from 142 to 834 mg/l based on data presented in Part C, Chapter IV. An estimate of the amount of increase in TDS was obtained by developing a relationship between electrical conductivity (EC) and TDS and then using this relationship to estimate TDS content from the overburden geochemistry information presented in Part C, Chapter III. The following data from the first two groundwater

sampling rounds (see Part C, Chapter IV) in bedrock wells were used to develop a relationship between TDS and EC.

Well No	EC (lab) umhos/cm	TDS mg/l
H88-10	301	188
	278	182
H88-11	1200	738
	964	782
H88-12	1180	728
	1085	736
H88-13	4285	2750
	2560	1984
H88-15	255	172
	245	154
H88-16	273	192
	234	164

A linear regression in the form of:

$$TDS = A \times EC + B \qquad (4\text{-}1)$$

where A and B are the slope and intercept of the regression line yielded the equation:

$$TDS = 0.67EC + 13.5 \qquad (4\text{-}2)$$

with a coefficient of correlation, r, equal to 0.99. Ignoring the intercept (which has negligible effect for the range of EC values being considered) yields the equation:

$$TDS = 0.67EC \qquad (4\text{-}3)$$

which is in the form TDS = A x EC suggested by Hem (1970). Hem reports that the coefficient A usually lies between 0.55 and 0.75 for natural waters. The calculated coefficient of 0.67 falls in approximately the middle of this range.

Overburden geochemistry data presented in Part C, Chapter III indicate that the following measured EC values are representative of overburden/interburden material:

Unit	EC (umhos/cm)
Tsadaka Conglomerate	1,000
Wishbone conglomerate	1,300
Shale	1,600
Sandstone	1,500
Siltstone	1,500
Jonesville	700
Premier	1,300
Midway	1,500
Eska	1,800
Sub Eska	2,300
Burning Bed	1,400

The range is from 700 to 2,300 umhos/cm with most values falling between 1,300 to 1,800 umhos/cm. Using equation 4-3 presented above to convert the latter range of EC values to TDS yields expected TDS concentrations in saturated overburden of 870 to 1210 mg/l. These expected ranges of TDS do not constitute a significant groundwater quality impact and are within the range of TDS values acceptable for livestock and agricultural uses.

Minor increases in the TDS content of groundwater baseflow from the mine area to Moose Creek may occur. However, as discussed in Part C, Chapter IV the groundwater baseflow from the mine area is small and potential increases in TDS caused by the mine are not anticipated to degrade the water quality in Moose Creek.

5.0 PROTECTION OF GROUNDWATER USERS

Groundwater rights and uses in and near the Proposed Permit Area are described in Part C, Chapter VI. Three permitted wells and three permitted springs are located within approximately two miles of the Proposed Permit Area (see Figure 1-1 in Part C, Chapter VI). However, all wells and two of the springs are located south of the mine area in the Matanuska Valley. A third spring is located approximately one mile north of Moose Creek. These wells and springs lie well outside the area that could potentially be affected by the proposed mine. No permitted or other groundwater users were identified within the Proposed Permit Area. Therefore, no impacts of mining on existing groundwater users in the area are anticipated.

Process water supplies will be obtained from pit inflow, diversion of surface water from Buffalo Creek, and potentially from dewatering of the old underground workings of the Premier Mine. Development of well fields in glacial or alluvial deposits is not anticipated. Therefore, no significant groundwater impacts are anticipated as a result of mine water supply.

6.0 GROUNDWATER MONITORING

6.1 Pre-Mining Monitoring

Pre-mining groundwater monitoring has been conducted as part of the baseline hydrogeological characterization activities described in Part C, Chapter IV. Table 6-1 provides a list of the pre-mining monitoring installations which include both monitoring wells and pneumatic piezometers. The location of these facilities is shown in Figure 6-1. Water levels have been measured on approximately a monthly basis since the fall of 1988 in both wells and piezometers. Wells have been sampled quarterly. Wells H89-29 and H89-30 were installed in July 1989 to provide additional characterization of the old underground workings of the Premier Mine. They have been sampled once in July 1989.

The suite of chemical parameters analyzed in groundwater samples during the pre-mining monitoring is listed in Tables 3-6 and 3-7 in Part C, Chapter IV. The same suite of parameters will continue to be analyzed during the remainder of the pre-mining monitoring program.

Monthly monitoring of water levels and quarterly water sampling will continue until permit approval. Information from the monitoring activities will be reported quarterly in data supplements to the baseline studies.

6.2 Operational Monitoring

Operational monitoring will commence upon approval of the mine permit and startup of mining activities at the site. Operational groundwater monitoring will be conducted to determine the effect

of the mining activities on groundwater levels and water quality during the active mining period.

A number of the baseline monitoring facilities that are located within the two mine areas will be destroyed by mining. These include wells H88-11, 12, 15, and 16 and essentially all of the pneumatic piezometers. Monthly monitoring of water levels will continue in these facilities until they are destroyed.

In addition to the wells located in the mine areas, three other existing wells are located in areas that will be affected by mine facilities. Well H88-21 will be in an overburden stockpile area, well H88-23 will be in the area of one of the fresh water ponds, and well H88-24A may be covered by an embankment for the slurry pond. These wells will be decommissioned prior to construction of these facilities. Decommissioning will include drilling out the existing well casings and gravel packs and filling the holes with cement/bentonite slurry to provide a seal.

The wells that will be used for operational groundwater monitoring are listed in Table 6-2. Locations are shown in Figure 6-2. They include eleven existing wells and three new wells. New well H-31 will be located immediately south of the waste water pond and will be used to monitor the performance of the pond liner. New well H-32 will be located on the southeast side of the slurry pond and monitor potential impacts of the slurry pond. It will replace well H88-24A which is expected to be decommissioned as described above. New well H-33 will be located down-gradient of the plant area and will be used to monitor groundwater quality near this facility.

All wells used for operational monitoring will be measured monthly to determine water levels. Selected wells will be sampled semi-annually for water quality. The wells selected for water quality

sampling are indicated in Table 6-2 and include wells adjacent to Moose Creek (H88-10, 14A, 17, and 19), wells H88-25 and H-32 around the slurry pond, well H-31 near the waste water pond and well H-33 near the plant area.

The chemical parameters that will be analyzed in groundwater samples during operational monitoring are listed in Table 6-3. The results of monitoring activities will be reported semiannually.

6.3 Post-Mining Monitoring

Post-mining groundwater monitoring will commence upon the termination of mining activities and startup of mine reclamation. Post-mining groundwater monitoring will be conducted to evaluate the re-establishment of the hydrogeologic regime in the mine area. Monitoring will be provided to measure water level recovery in the reclaimed pits and the quality of groundwater in the pits and adjacent down-gradient areas.

The wells that will be used for post-mining monitoring are shown in Figure 6-3 and listed in Table 6-4. They include a number of wells that will be used for pre-mining and operational monitoring plus several new wells. Well H88-10 will be used to monitor bedrock on the west side of Mine Area 1. Wells H88-14A, 17 and 19 will be used to monitor stream alluvium along Moose Creek. Wells H88-25 and H-32 will be used to monitor glacial sediments adjacent to the slurry pond area. Four wells, H-34 to 37, will be installed into the backfilled pits and be used to monitor the water levels and water quality in the backfill.

All other wells that were used for operational monitoring will be appropriately decommissioned as described in Section 6.2 above.

The suite of chemical parameters that will analyzed is included in Table 6-3. Results of post-mining monitoring will be reported annually.

7.0 RESPONSIBLE PARTIES

This report was prepared by Golder Associates Inc., 200 Union Boulevard, Suite 100, Lakewood, Colorado 80228. Individuals conducting technical analyses for this report included the following:

Jerry Rowe, P.E.	Associate
Greg Davis	Project Geochemist
Larry Cope	Project Hydrogeologist
Ed Pottorff	Staff Hydrogeologist

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TABLE 6-1
PRE-MINING GROUNDWATER MONITORING

DESIGNATION	TYPE	UNIT MONITORED	WATER LEVELS	WATER SAMPLES
H88-10	2" Well	Bedrock	Monthly	Quarterly
H88-11	2" Well	Bedrock	Monthly	Quarterly
H88-12	2" Well	Bedrock	Monthly	Quarterly
H88-13	2" Well	Bedrock	Monthly	Quarterly
H88-14A	2" Well	Stream Alluvium	Monthly	Quarterly
H88-15	5" Well	Bedrock	Monthly	Quarterly
H88-16	5" Well	Bedrock	Monthly	Quarterly
H88-17	2" Well	Steam Alluvium	Monthly	Quarterly
H88-19	2" Well	Steam Alluvium	Monthly	Quarterly
H99-21	2" Well	Glacial Sediments	Monthly	Quarterly
H88-22	2" Well	Glacial Sediments	Monthly	Quarterly
H88-23	2" Well	Glacial Sediments	Monthly	Quarterly
H88-24A	2" Well	Glacial Sediments	Monthly	Quarterly
H88-25	2" Well	Glacial Sediments	Monthly	Quarterly
H88-27	2" Well	Glacial Sediments	Monthly	Quarterly
H88-28	2" Well	Glacial Sediments	Monthly	Quarterly
H89-29*	5" Well	Mine Voids	Monthly	Quarterly
H89-30*	2" Well	Bedrock	Monthly	Quarterly
PB-7	Piezometers	Bedrock	Monthly	----
PB-8	Piezometers	Bedrock	Monthly	----
PB-12	Piezometers	Bedrock	Monthly	----
PB-13	Piezometers	Bedrock	Monthly	----
PB-60	Piezometers	Bedrock	Monthly	----
PB-88	Piezometers	Bedrock	Monthly	----
PB-92	Piezometers	Bedrock	Monthly	----
PB-100	Piezometers	Bedrock	Monthly	----
PB-101	Piezometers	Bedrock	Monthly	----
PB-102	Piezometers	Bedrock	Monthly	----
PB-103	Piezometers	Bedrock	Monthly	----
PB-104	Piezometers	Bedrock	Monthly	----
PB-105	Piezometers	Bedrock	Monthly	----

* Wells installed July 1989

TABLE 6-2
OPERATIONAL GROUNDWATER MONITORING

DESIGNATION	TYPE	UNIT MONITORED	WATER LEVELS	WATER SAMPLES
H88-10	2″ Well	Bedrock	Monthly	Semi-annually
H88-13	2″ Well	Bedrock	Monthly	----
H88-14A	2″ Well	Stream Alluvium	Monthly	Semi-annually
H88-17	2″ Well	Stream Alluvium	Monthly	Semi-annually
H88-19	2″ Well	Stream Alluvium	Monthly	Semi-annually
H88-22	2″ Well	Glacial Sediments	Monthly	----
H88-25	2″ Well	Glacial Sediments	Monthly	Semi-annually
H88-27	2″ Well	Glacial Sediments	Monthly	----
H88-28	2″ Well	Glacial Sediments	Monthly	----
H89-29	5″ Well	Mine Voids	Monthly	----
H89-30	2″ Well	Bedrock	Monthly	----
H-31*	2″ Well	Glacial Sediments	Monthly	Semi-annually
H-32*	2″ Well	Glacial Sediments	Monthly	Semi-annually
~~H-33*~~	~~2″ Well~~	~~Glacial Sediments~~	~~Monthly~~	~~Semi-annually~~

* New well to be installed

TABLE 6-3
PARAMETERS FOR OPERATIONAL AND
POST-MINING GROUNDWATER MONITORING

FIELD PARAMETERS

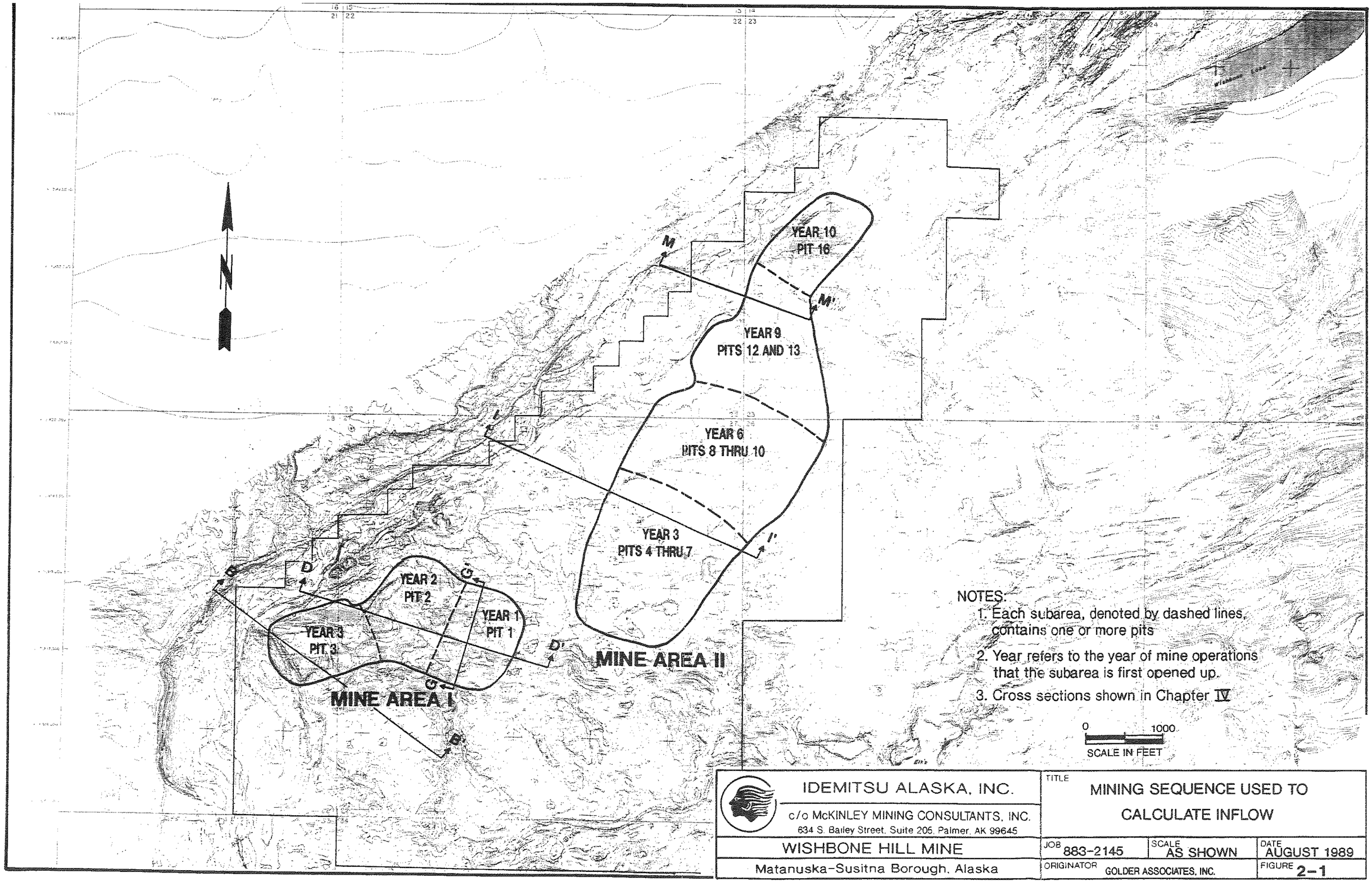
Specific Conductance
Temperature
Alkalinity
pH

LABORATORY PARAMETERS

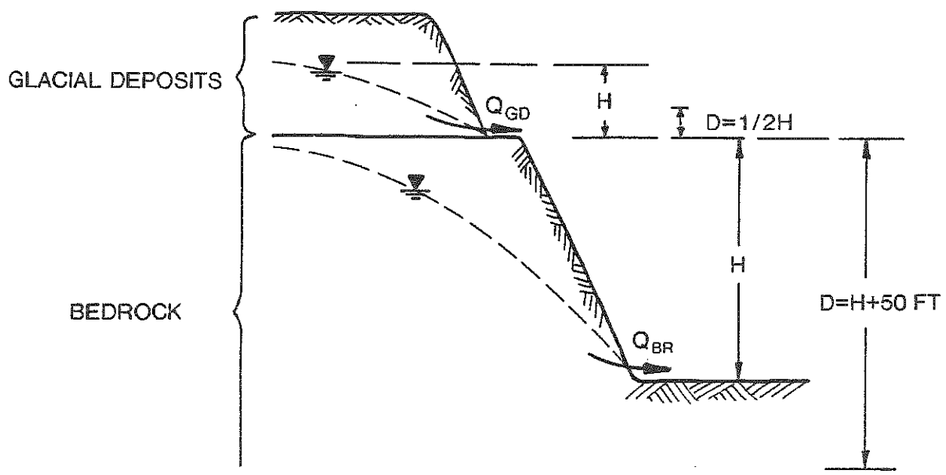
Sodium
Potassium
Magnesium
Calcium
Chloride
Sulfate
Bicarbonate
Nitrate
Barium
Arsenic
Chromium
Lead
Silver
Cadmium
Selenium
Mercury
Fluoride
Copper
Iron (total)
Iron (dissolved)
Manganese
Zinc
Total Dissolved Solids
pH

TABLE 6-4
POST-MINING GROUNDWATER MONITORING

DESIGNATION	TYPE	UNIT MONITORED	WATER LEVELS	WATER SAMPLES
H88-10	2" Well	Bedrock	Quarterly	Annually
H88-14A	2" Well	Stream Alluvium	Quarterly	Annually
H88-17	2" Well	Stream Alluvium	Quarterly	Annually
H88-19	2" Well	Stream Alluvium	Quarterly	Annually
H88-25	2" Well	Glacial Sediments	Quarterly	Annually
H-32* 31	2" Well	Glacial Sediments	Quarterly	Annually
H-34* 33	2" Well	Pit Backfill	Quarterly	Annually
H-35* 34	2" Well	Pit Backfill	Quarterly	Annually
H-36* 35	2" Well	Pit Backfill	Quarterly	Annually
H-37* 36	2" Well	Pit Backfill	Quarterly	Annually


YEAR 10
PIT 16
YEAR 9
PITS 12 AND 13
YEAR 6
PITS 8 THRU 10
YEAR 3
PITS 4 THRU 7
YEAR 2
PIT 2
YEAR 1
PIT 1
YEAR 3
PIT 3
MINE AREA I
MINE AREA II
M
M'
L
L'
I
I'
D
D'
G
G'
B
B'
N
NOTES:
1. Each subarea, denoted by dashed lines, contains one or more pits
2. Year refers to the year of mine operations that the subarea is first opened up.
3. Cross sections shown in Chapter IV
0
1000
SCALE IN FEET
IDEMITSU ALASKA, INC.
c/o McKINLEY MINING CONSULTANTS, INC.
634 S. Bailey Street, Suite 205, Palmer, AK 99645
WISHBONE HILL MINE
Matanuska-Susitna Borough, Alaska
TITLE
MINING SEQUENCE USED TO CALCULATE INFLOW
JOB 883-2145
SCALE AS SHOWN
DATE AUGUST 1989
ORIGINATOR GOLDER ASSOCIATES, INC.
FIGURE 2-1

TYPICAL SECTION THROUGH PIT WALL

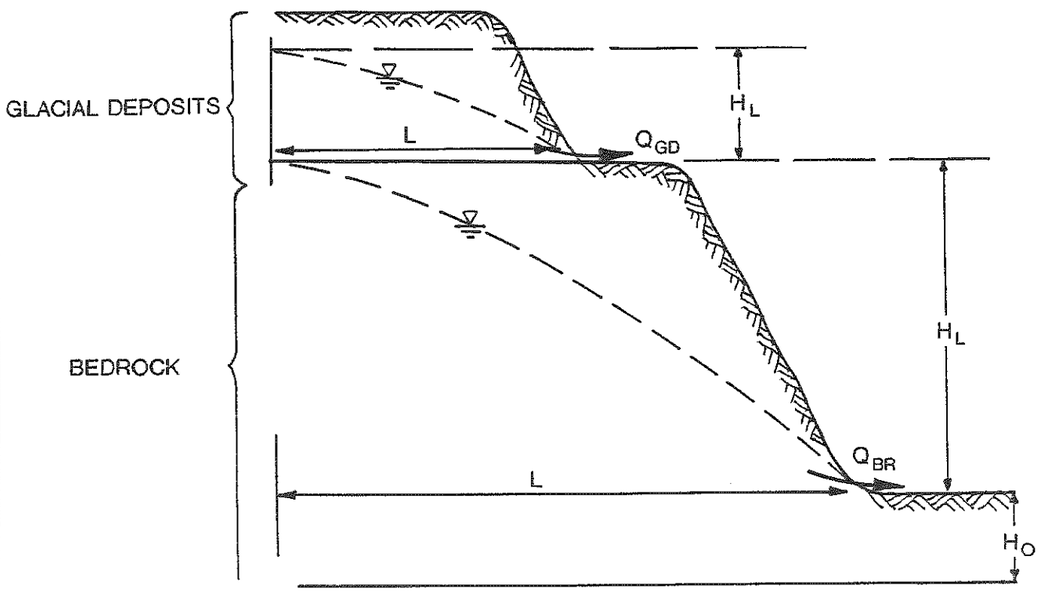


$$Q_{GD,BR} = \frac{2H\ KD}{\sqrt{\frac{4\pi KDt}{S}}} \qquad Q_T = Q_{GD}(W_{GD}) + Q_{BR}(W_{BR})$$

H= DRAWNDOWN AT PIT [L]
D= ASSUMED EFFECTIVE THICKNESS OF AQUIFER [L]
K= HYDRAULIC CONDUCTIVITY [L/T]
S= STORAGE COEFFICIENT
t= ELAPSED TIME SINCE PIT FIRST OPENED [T]
W_{GD}= LENGTH OF GLACIAL TILL PIT WALL [L]
W_{BR}= LENGTH OF BEDROCK FORMATION PIT WALL [L]
Q_{GD}= INFLOW PER UNIT LENGTH FROM GLACIAL TILL [$L^3/T/L$]
Q_{BR} = INFLOW PER UNIT LENGTH FROM BEDROCK [$L^3/T/L$]
Q_T = TOTAL PIT INFLOW [L^3/T]

IDEMITSU ALASKA, INC. c/o McKINLEY MINING CONSULTANTS, INC. 634 S. Bailey Street, Suite 205, Palmer, AK 99645	TITLE CONCEPTUAL MODEL TO APPLY TRANSIENT 1-DIMENSIONAL SOLUTION FOR PIT INFLOW		
WISHBONE HILL MINE	JOB 883-2145	SCALE N/A	DATE AUGUST 1989
Matanuska-Susitna Borough, Alaska	ORIGINATOR GOLDER ASSOCIATES, INC.		FIGURE 2-2

TYPICAL SECTION THROUGH PIT WALL



$$Q_{GD,BR} = \frac{K}{2L}\,(H_L^2 - H_O^2)$$

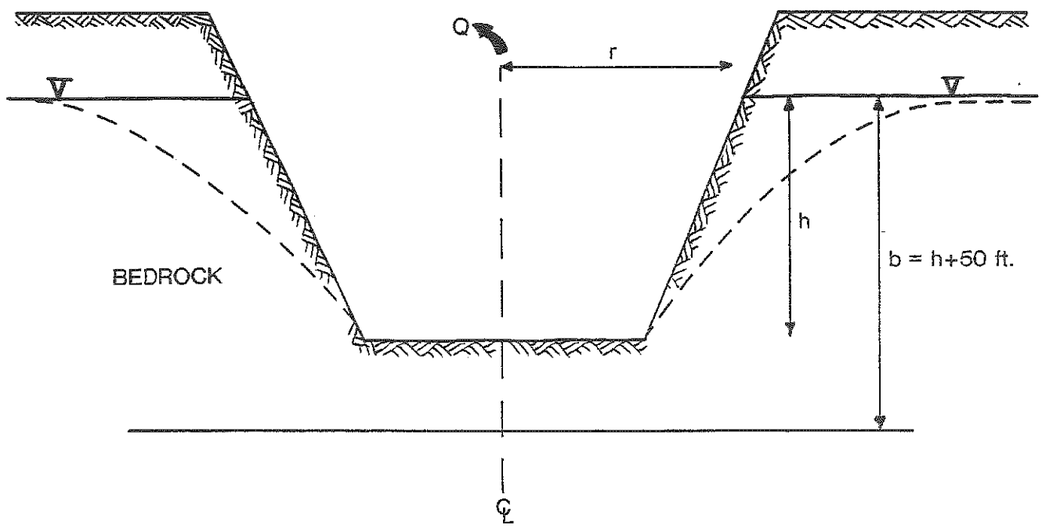
$$Q_T = Q_{GD}(W_{GD}) + Q_{BR}(W_{BR})$$

H_O = ASSUMED AQUIFER THICKNESS AT TOE OF PIT SLOPE [L]
H_L = ASSUMED AQUIFER THICKNESS AT DISTANCE L FROM PIT WALL [L]
L = DISTANCES FROM PIT WALL TO CONSTANT HEAD BOUNDARY
K = HYDRAULIC CONDUCTIVITY [L/T]
$Q_{GD,BR}$ = DISCHARGE PER UNIT LENGTH OF PIT [L^3/T/L]
Q_T = TOTAL FLOW INTO PIT [L^3/T]
W_{GD} = LENGTH OF GLACIAL DEPOSITS PIT WALL [L]
W_{BR} = LENGTH OF BEDROCK PIT WALL [L]

NOTE: FOR GLACIAL DEPOSITS H_O = 0, FOR BEDROCK H_O =50 FT

IDEMITSU ALASKA, INC. c/o McKINLEY MINING CONSULTANTS, INC. 634 S. Bailey Street, Suite 205, Palmer, AK 99645	TITLE CONCEPTUAL MODEL TO APPLY STEADY STATE 1-DIMENSIONAL SOLUTION FOR PIT INFLOW		
WISHBONE HILL MINE	JOB 883-2145	SCALE N/A	DATE AUGUST 1989
Matanuska-Susitna Borough, Alaska	ORIGINATOR GOLDER ASSOCIATES, INC.		FIGURE 2-3

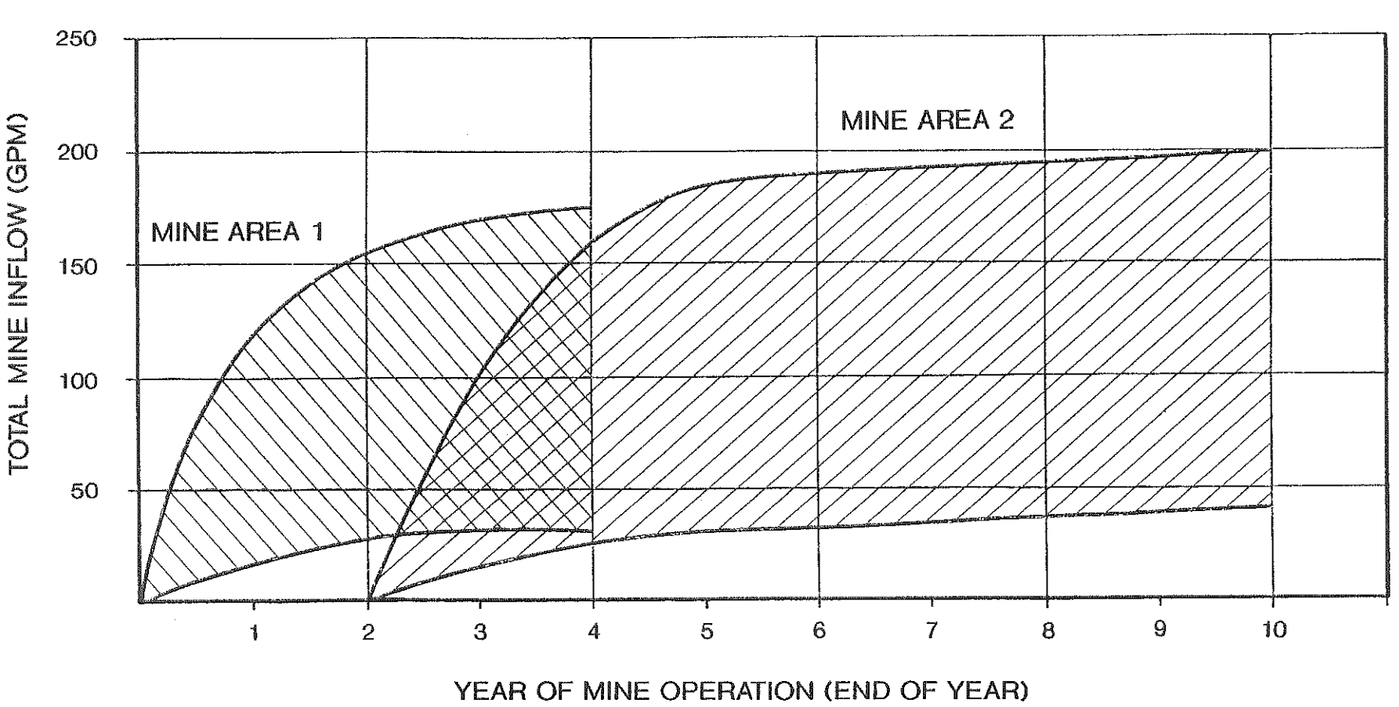
TYPICAL SECTION THROUGH MINE AREA



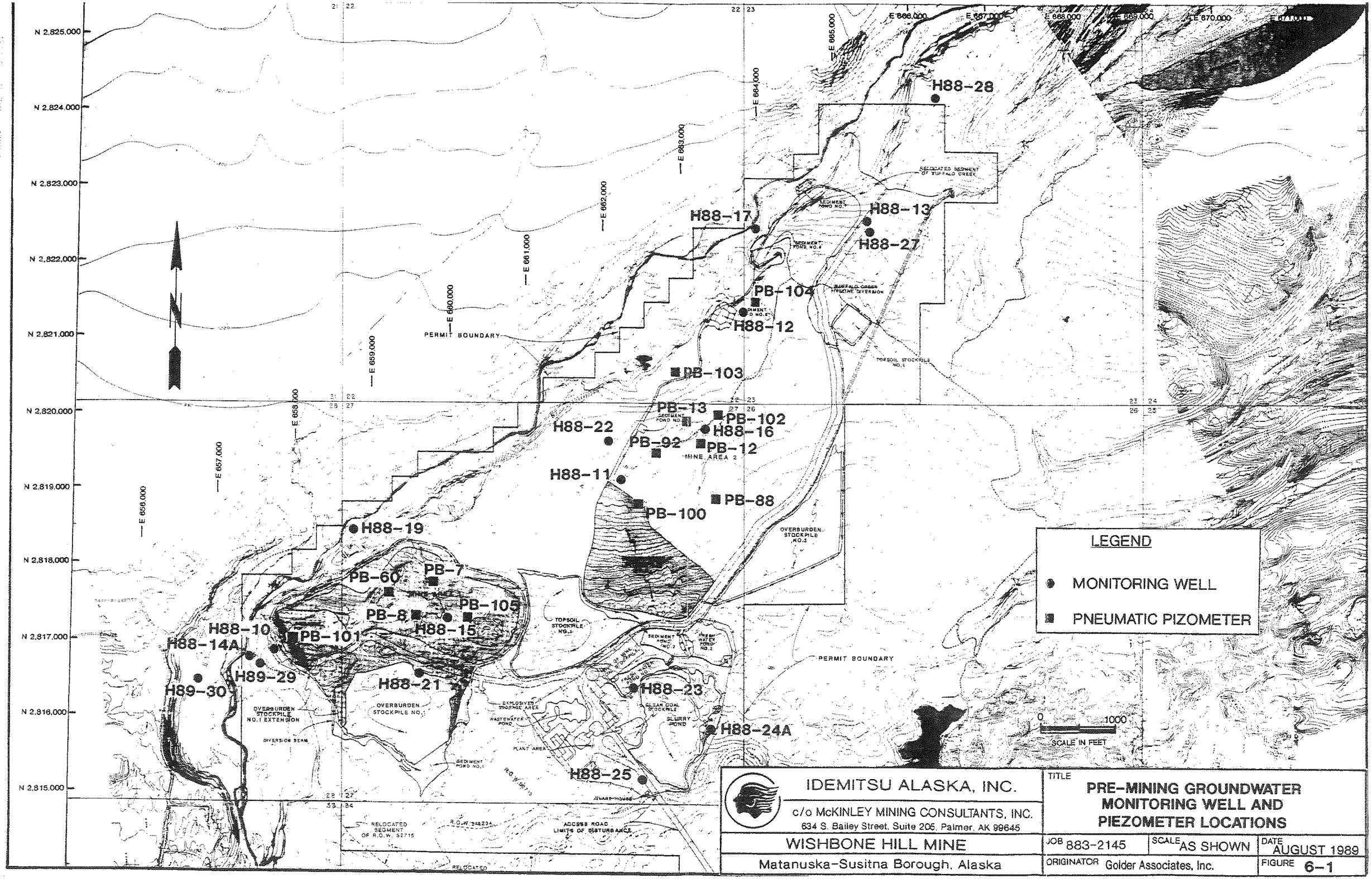
$$Q = \frac{4\pi Kbh}{W(u)} \qquad u = \frac{r^2 Ss}{4Kt}$$

r = EFFECTIVE RADIUS OF MINE AREA (L)
Ss = SPECIFIC STORAGE ($^1/L$)
K = HYDRAULIC CONDUCTIVITY (L/T)
t = ELAPSED TIME FROM INITIAL PIT OPENING (T)
b = THICKNESS OF AQUIFER (L)
h = DRAWDOWN (L)
W(u) = WELL FUNCTION

IDEMITSU ALASKA, INC. c/o McKINLEY MINING CONSULTANTS, INC. 634 S. Bailey Street, Suite 205, Palmer, AK 99645	TITLE CONCEPTUAL MODEL TO APPLY TRANSIENT RADIAL SOLUTION FOR PIT INFLOW		
WISHBONE HILL MINE	JOB 883-2145	SCALE N/A	DATE AUGUST 1989
Matanuska-Susitna Borough, Alaska	ORIGINATOR GOLDER ASSOCIATES, INC.		FIGURE 2-4



IDEMITSU ALASKA, INC. c/o McKINLEY MINING CONSULTANTS, INC. 634 S. Bailey Street, Suite 205, Palmer, AK 99645	WISHBONE HILL MINE Matanuska-Susitna Borough, Alaska			TITLE ESTIMATED RANGE OF GROUNDWATER INFLOWS TO THE OPEN PITS	
	JOB 883-2145	SCALE AS SHOWN	DATE AUGUST 1989	ORIGINATOR Golder Associates, Inc.	FIGURE 2-5



IDEMITSU ALASKA, INC.

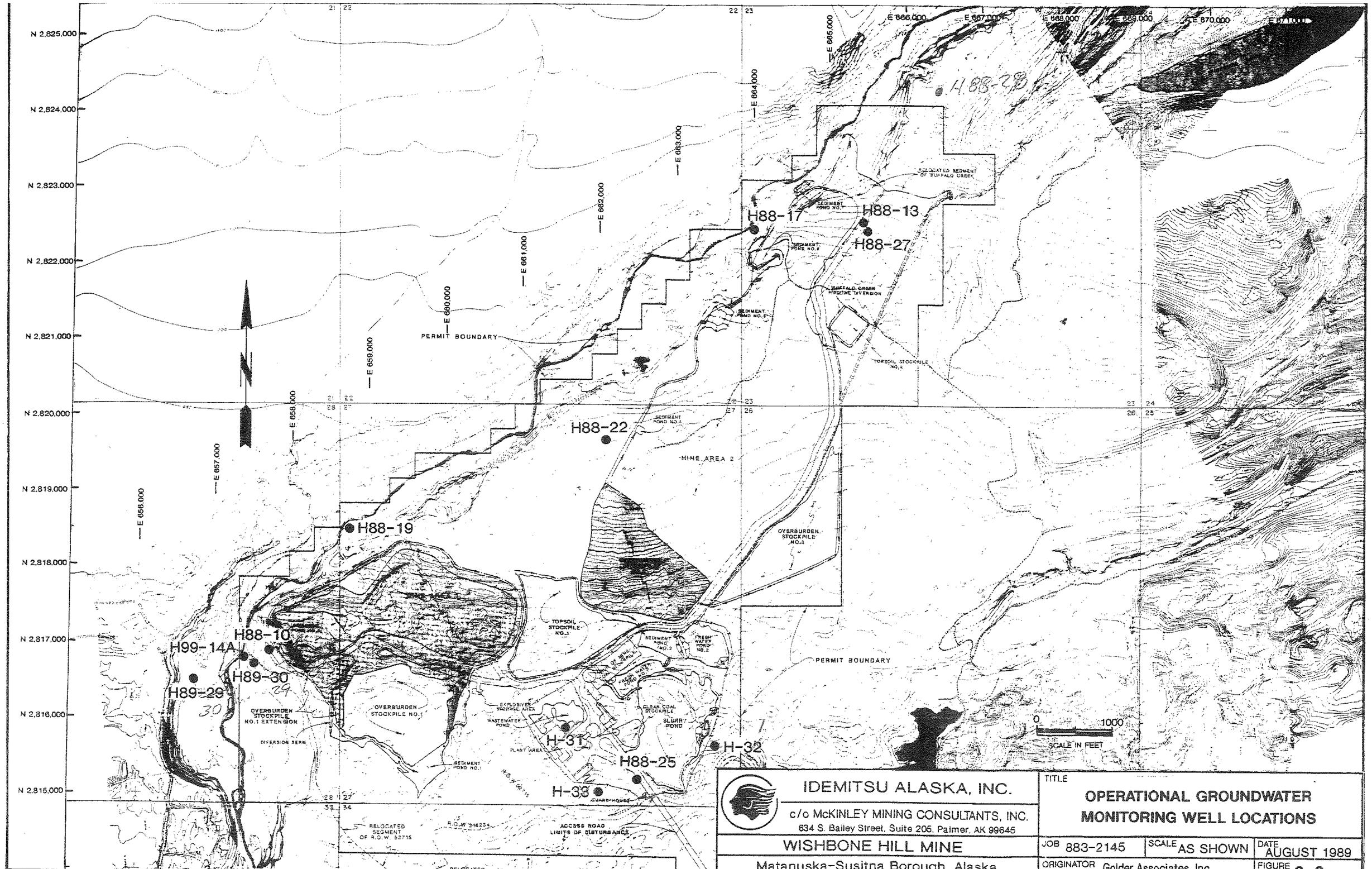
c/o McKINLEY MINING CONSULTANTS, INC.
634 S. Bailey Street, Suite 205, Palmer, AK 99645

WISHBONE HILL MINE

Matanuska-Susitna Borough, Alaska

TITLE
PRE-MINING GROUNDWATER MONITORING WELL AND PIEZOMETER LOCATIONS

JOB	SCALE	DATE
883-2145	AS SHOWN	AUGUST 1989
ORIGINATOR Golder Associates, Inc.		FIGURE 6-1



IDEMITSU ALASKA, INC.

c/o McKINLEY MINING CONSULTANTS, INC.
634 S. Bailey Street, Suite 205, Palmer, AK 99645

WISHBONE HILL MINE

Matanuska-Susitna Borough, Alaska

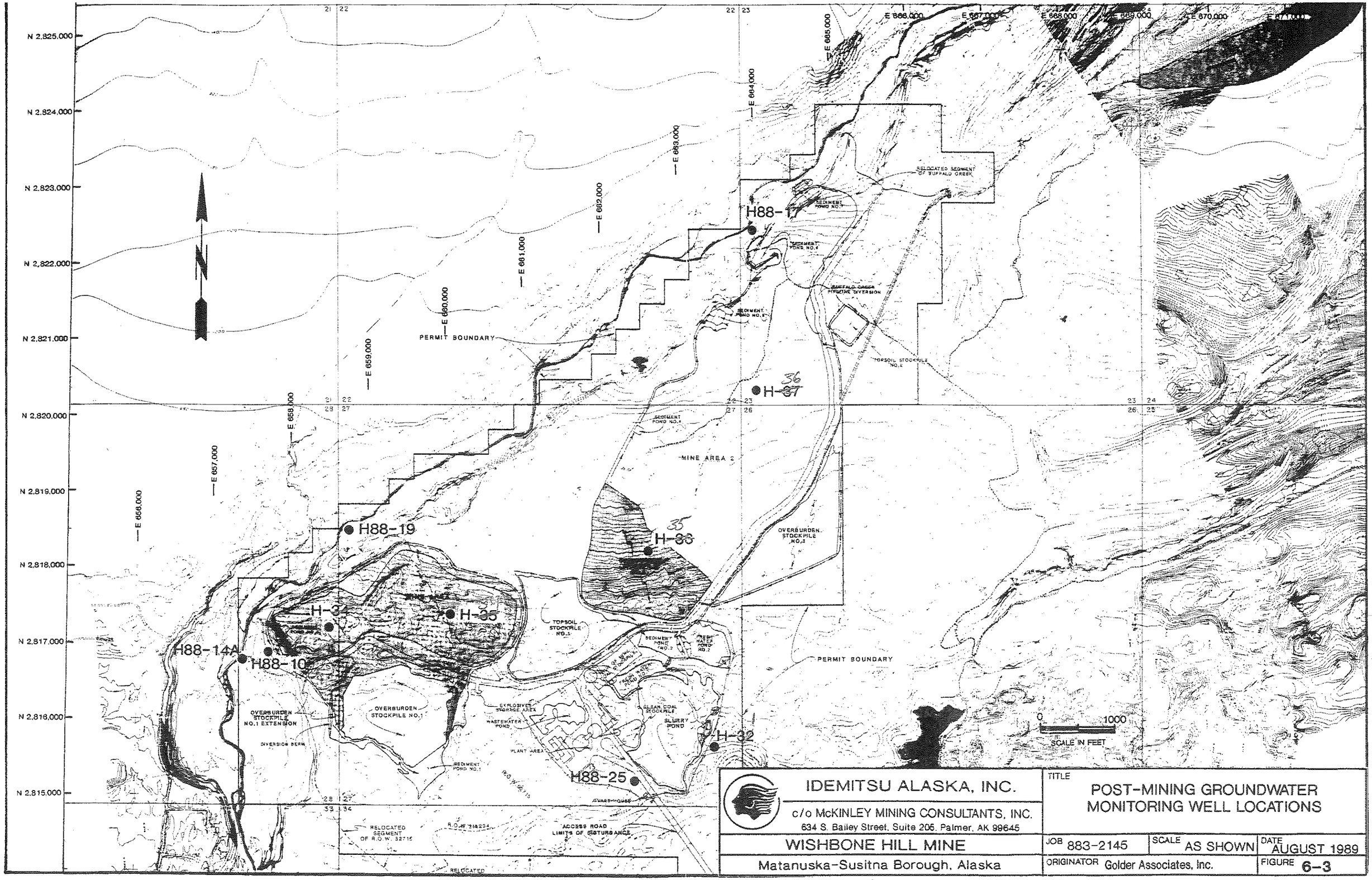
TITLE

OPERATIONAL GROUNDWATER MONITORING WELL LOCATIONS

JOB	SCALE	DATE
883-2145	AS SHOWN	AUGUST 1989

ORIGINATOR Golder Associates, Inc.

FIGURE 6-2



IDEMITSU ALASKA, INC.

c/o McKINLEY MINING CONSULTANTS, INC.
634 S. Bailey Street, Suite 205, Palmer, AK 99645

WISHBONE HILL MINE

Matanuska-Susitna Borough, Alaska

TITLE
POST-MINING GROUNDWATER MONITORING WELL LOCATIONS

JOB	SCALE	DATE
883-2145	AS SHOWN	AUGUST 1989

ORIGINATOR Golder Associates, Inc.

FIGURE 6-3

APPENDIX A

INFLOW ANALYSES

AUGUST 1989

883-2145

Golder Associates

APPENDIX A-1

TRANSIENT 1-DIMENSIONAL ANALYSIS OF INFLOW

1) Summary Tables of Computed Inflows
2) Program Output
3) Program Listing

RESULTS OF TRANSIENT 1-D FLOW ANALYSIS
ESTIMATED INFLOWS (GPM) TO MINE AREA 2

END OF YEAR	PITS 4-7			PITS 8 - 10			PITS 12 & 13			PIT 16			MINE AREA I TOTAL
	DIP	GLAC	TOTAL	DIP	GLAC	TOTAL	DIP	GLAC	TOTAL	DIP	GLAC	TOTAL	
YEAR 3	3.70	35.32	39.02										39.02
	6.57	62.94	69.51										69.51
	11.70	111.70	123.40										123.40
YEAR 4	2.62	24.98	27.60										27.60
	4.65	44.50	49.15										49.15
	8.27	78.99	87.26										87.26
YEAR 5	2.14	20.39	22.53										22.53
	3.80	36.34	40.14										40.14
	6.75	64.49	71.24										71.24
YEAR 6	1.85	17.66	19.51	2.51	20.03	22.54							42.05
	3.29	31.47	34.76	4.45	35.70	40.15							74.91
	5.85	55.85	61.70	7.92	63.35	71.27							132.97
YEAR 7	1.65	15.80	17.45	1.77	14.17	15.94							33.39
	2.94	28.15	31.09	3.15	25.24	28.39							59.48
	5.23	49.95	55.18	5.60	44.80	50.40							105.58
YEAR 8	1.51	14.42	15.93	1.45	11.57	13.02							28.95
	2.68	25.69	28.37	2.57	20.61	23.18							51.55
	4.78	45.60	50.38	4.57	36.58	64.33							114.71
YEAR 9	1.40	13.35	14.75	1.25	10.02	11.27	2.67	13.96	16.63				42.65
	2.48	23.79	26.27	2.23	17.85	20.08	4.75	24.87	29.62				75.97
	4.42	42.22	46.64	3.96	31.68	35.64	8.46	44.14	52.60				134.88
YEAR 10	1.31	12.49	13.80	1.12	8.96	10.08	1.89	9.87	11.76	1.16	8.09	9.25	44.89
	2.32	22.25	24.57	1.99	15.96	17.95	3.36	17.59	20.95	2.05	14.41	16.46	79.93
	4.14	39.49	43.63	3.54	28.33	31.87	5.98	31.21	37.19	3.65	25.57	29.22	141.91
YEAR 11	1.23	11.77	13.00	1.02	8.18	9.20	1.54	8.06	9.60	0.82	5.72	6.54	38.34
	2.19	20.98	23.17	1.82	14.57	16.39	2.74	14.36	17.10	1.45	10.19	11.64	68.30
	3.90	37.23	41.13	3.23	25.86	29.09	4.88	25.48	30.36	2.58	18.08	20.66	121.24

Column headings: DIP = dipping bedrock
GLAC = glacial deposits

The three entries for each year refer to low, mid, and high values for hydraulic conductivity discussed in text.

Golder Associates

RESULTS OF TRANSIENT 1-D FLOW ANALYSIS
ESTIMATED INFLOWS (GPM) TO MINE AREA 1

END OF YEAR	PIT 1			PIT 2		DEEPEN PITS 1&2				PIT 3			MINE AREA I TOTAL (GPM)
	FLAT	GLAC	TOTAL	FLAT	DIP	FLAT	DIP	GLAC	TOTAL	FLAT	GLAC	TOTAL	
YEAR 1	0.51	15.82	16.33										16.33
	0.90	28.18	29.08										29.08
	1.61	50.02	51.63										51.63
YEAR 2	0.36	11.18	11.54	0.85	0.27	0.07	0.05	15.82	17.06				28.60
	0.64	19.93	20.57	1.51	0.49	0.12	0.10	28.18	30.40				50.97
	1.14	35.37	36.51	2.68	0.87	0.21	0.17	50.02	53.95				90.46
YEAR 3	0.29	9.13	9.42	0.60	0.19	0.05	0.04	11.18	12.06	0.37	15.82	16.19	37.67
	0.52	16.27	16.79	1.07	0.35	0.08	0.07	19.93	21.50	0.66	28.18	28.84	67.13
	0.93	28.88	29.81	1.90	0.61	0.15	0.12	35.37	38.15	1.18	50.02	51.20	119.16
YEAR 4	0.25	7.91	8.16	0.49	0.16	0.04	0.03	9.13	9.85	0.26	11.18	11.44	29.45
	0.45	14.09	14.54	0.87	0.28	0.07	0.06	16.27	17.55	0.47	19.93	20.40	52.49
	0.80	25.01	25.81	1.55	0.50	0.12	0.10	28.88	31.15	0.84	35.37	36.21	93.17

Notes:

Column Headings:

FLAT = flat-lying bedrock
DIP = dipping bedrock
GLAC = glacial deposits

The three entries for each year refer to low, mid and high values for hydraulic conductivity discussed in text.

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 1 FLAT STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0076
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3400
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00015	0.51
2.0	0.00011	0.36
3.0	0.00009	0.29
4.0	0.00007	0.25

***** PIT 1 FLAT STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0240
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3400
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00027	0.90
2.0	0.00019	0.64
3.0	0.00015	0.52
4.0	0.00013	0.45

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 1 FLAT STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0760
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3400
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00047	1.61
2.0	0.00033	1.14
3.0	0.00027	0.93
4.0	0.00024	0.80

***** PIT 2 FLAT STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0076
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2800
Drawdown (ft) = 180
Aquifer thick (ft) = 230

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00030	0.85
2.0	0.00021	0.60
3.0	0.00018	0.49
4.0	0.00015	0.42

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 2 FLAT STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0240
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2800
Drawdown (ft) = 180
Aquifer thick (ft) = 230

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00054	1.51
2.0	0.00038	1.07
3.0	0.00031	0.87
4.0	0.00027	0.75

***** PIT 2 FLAT STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0760
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2800
Drawdown (ft) = 180
Aquifer thick (ft) = 230

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00096	2.68
2.0	0.00068	1.90
3.0	0.00055	1.55
4.0	0.00048	1.34

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 2 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 250
Aquifer thick (ft) = 300

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00027	0.27
2.0	0.00019	0.19
3.0	0.00016	0.16
4.0	0.00014	0.14

***** PIT 2 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 250
Aquifer thick (ft) = 300

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00049	0.49
2.0	0.00035	0.35
3.0	0.00028	0.28
4.0	0.00024	0.24

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 2 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 250
Aquifer thick (ft) = 300

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00087	0.87
2.0	0.00061	0.61
3.0	0.00050	0.50
4.0	0.00043	0.43

***** PITS 1 & 2 FLAT STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0076
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 40
Aquifer thick (ft) = 90

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00003	0.07
2.0	0.00002	0.05
3.0	0.00002	0.04
4.0	0.00001	0.03

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 & 2 FLAT STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0240
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 40
Aquifer thick (ft) = 90

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00005	0.12
2.0	0.00003	0.08
3.0	0.00003	0.07
4.0	0.00002	0.06

***** PITS 1 & 2 FLAT STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0760
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 40
Aquifer thick (ft) = 90

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00008	0.21
2.0	0.00006	0.15
3.0	0.00005	0.12
4.0	0.00004	0.10

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 & 2 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 100
Aquifer thick (ft) = 150

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00005	0.05
2.0	0.00004	0.04
3.0	0.00003	0.03
4.0	0.00003	0.03

***** PITS 1 & 2 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 100
Aquifer thick (ft) = 150

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00010	0.10
2.0	0.00007	0.07
3.0	0.00006	0.06
4.0	0.00005	0.05

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 & 2 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 1000
Drawdown (ft) = 100
Aquifer thick (ft) = 150

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00017	0.17
2.0	0.00012	0.12
3.0	0.00010	0.10
4.0	0.00009	0.09

***** PIT 3 FLAT STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0076
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00015	0.37
2.0	0.00011	0.26
3.0	0.00009	0.22
4.0	0.00007	0.19

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 3 FLAT STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0240
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00027	0.66
2.0	0.00019	0.47
3.0	0.00015	0.38
4.0	0.00013	0.33

***** PIT 3 FLAT STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0760
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 2500
Drawdown (ft) = 120
Aquifer thick (ft) = 170

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00047	1.18
2.0	0.00033	0.84
3.0	0.00027	0.68
4.0	0.00024	0.59

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 - 3 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3000
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00527	15.82
2.0	0.00373	11.18
3.0	0.00304	9.13
4.0	0.00264	7.91

***** PITS 1 - 3 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3000
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00939	28.18
2.0	0.00664	19.93
3.0	0.00542	16.27
4.0	0.00470	14.09

MINE AREA 1: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 1 - 3 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3000
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.01667	50.02
2.0	0.01179	35.37
3.0	0.00963	28.88
4.0	0.00834	25.01

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 4 - 7 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 6500
Drawdown (ft) = 370
Aquifer thick (ft) = 420

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00057	3.70
2.0	0.00040	2.62
3.0	0.00033	2.14
4.0	0.00028	1.85
5.0	0.00025	1.65
6.0	0.00023	1.51
7.0	0.00022	1.40
8.0	0.00020	1.31
9.0	0.00019	1.23

***** PITS 4 - 7 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 6500
Drawdown (ft) = 370
Aquifer thick (ft) = 420

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00101	6.57
2.0	0.00072	4.65
3.0	0.00058	3.80
4.0	0.00051	3.29
5.0	0.00045	2.94
6.0	0.00041	2.68
7.0	0.00038	2.48
8.0	0.00036	2.32
9.0	0.00034	2.19

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 4 - 7 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 6500
Drawdown (ft) = 370
Aquifer thick (ft) = 420

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00180	11.70
2.0	0.00127	8.27
3.0	0.00104	6.75
4.0	0.00090	5.85
5.0	0.00080	5.23
6.0	0.00073	4.78
7.0	0.00068	4.42
8.0	0.00064	4.14
9.0	0.00060	3.90

***** PITS 4 - 7 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 6700
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00527	35.32
2.0	0.00373	24.98
3.0	0.00304	20.39
4.0	0.00264	17.66
5.0	0.00236	15.80
6.0	0.00215	14.42
7.0	0.00199	13.35
8.0	0.00186	12.49
9.0	0.00176	11.77

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 4 - 7 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 6700
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00939	62.94
2.0	0.00664	44.50
3.0	0.00542	36.34
4.0	0.00470	31.47
5.0	0.00420	28.15
6.0	0.00383	25.69
7.0	0.00355	23.79
8.0	0.00332	22.25
9.0	0.00313	20.98

***** PITS 4 - 7 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 6700
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.01667	111.70
2.0	0.01179	78.99
3.0	0.00963	64.49
4.0	0.00834	55.85
5.0	0.00746	49.95
6.0	0.00681	45.60
7.0	0.00630	42.22
8.0	0.00589	39.49
9.0	0.00556	37.23

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 8 - 10 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3800
Drawdown (ft) = 400
Aquifer thick (ft) = 450

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00066	2.51
2.0	0.00047	1.77
3.0	0.00038	1.45
4.0	0.00033	1.25
5.0	0.00029	1.12
6.0	0.00027	1.02
7.0	0.00025	0.95
8.0	0.00023	0.89
9.0	0.00022	0.84

***** PITS 8 - 10 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3800
Drawdown (ft) = 400
Aquifer thick (ft) = 450

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00117	4.45
2.0	0.00083	3.15
3.0	0.00068	2.57
4.0	0.00059	2.23
5.0	0.00052	1.99
6.0	0.00048	1.82
7.0	0.00044	1.68
8.0	0.00041	1.57
9.0	0.00039	1.48

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 8 - 10 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3800
Drawdown (ft) = 400
Aquifer thick (ft) = 450

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00208	7.92
2.0	0.00147	5.60
3.0	0.00120	4.57
4.0	0.00104	3.96
5.0	0.00093	3.54
6.0	0.00085	3.23
7.0	0.00079	2.99
8.0	0.00074	2.80
9.0	0.00069	2.64

***** PITS 8 - 10 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3800
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00527	20.03
2.0	0.00373	14.17
3.0	0.00304	11.57
4.0	0.00264	10.02
5.0	0.00236	8.96
6.0	0.00215	8.18
7.0	0.00199	7.57
8.0	0.00186	7.08
9.0	0.00176	6.68

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 8 - 10 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3800
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00939	35.70
2.0	0.00664	25.24
3.0	0.00542	20.61
4.0	0.00470	17.85
5.0	0.00420	15.96
6.0	0.00383	14.57
7.0	0.00355	13.49
8.0	0.00332	12.62
9.0	0.00313	11.90

***** PITS 8 - 10 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3800
Drawdown (ft) = 50
Aquifer thick (ft) = 25

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.01667	63.35
2.0	0.01179	44.80
3.0	0.00963	36.58
4.0	0.00834	31.68
5.0	0.00746	28.33
6.0	0.00681	25.86
7.0	0.00630	23.95
8.0	0.00589	22.40
9.0	0.00556	21.12

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 12 & 13 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3700
Drawdown (ft) = 420
Aquifer thick (ft) = 470

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00072	2.67
2.0	0.00051	1.89
3.0	0.00042	1.54
4.0	0.00036	1.34
5.0	0.00032	1.20
6.0	0.00030	1.09
7.0	0.00027	1.01
8.0	0.00026	0.95
9.0	0.00024	0.89

***** PITS 12 & 13 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3700
Drawdown (ft) = 420
Aquifer thick (ft) = 470

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00128	4.75
2.0	0.00091	3.36
3.0	0.00074	2.74
4.0	0.00064	2.38
5.0	0.00057	2.13
6.0	0.00052	1.94
7.0	0.00049	1.80
8.0	0.00045	1.68
9.0	0.00043	1.58

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 12 & 13 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3700
Drawdown (ft) = 420
Aquifer thick (ft) = 470

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00229	8.46
2.0	0.00162	5.98
3.0	0.00132	4.88
4.0	0.00114	4.23
5.0	0.00102	3.78
6.0	0.00093	3.45
7.0	0.00086	3.20
8.0	0.00081	2.99
9.0	0.00076	2.82

***** PITS 12 & 13 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3700
Drawdown (ft) = 40
Aquifer thick (ft) = 20

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00377	13.96
2.0	0.00267	9.87
3.0	0.00218	8.06
4.0	0.00189	6.98
5.0	0.00169	6.24

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PITS 12 & 13 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3700
Drawdown (ft) = 40
Aquifer thick (ft) = 20

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00672	24.87
2.0	0.00475	17.59
3.0	0.00388	14.36
4.0	0.00336	12.43
5.0	0.00301	11.12

***** PITS 12 & 13 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3700
Drawdown (ft) = 40
Aquifer thick (ft) = 20

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.01193	44.14
2.0	0.00844	31.21
3.0	0.00689	25.48
4.0	0.00596	22.07
5.0	0.00534	19.74

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 16 DIPPING STRATA, LOW K *****

Hydraulic cond (ft/day) = 0.0019
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3200
Drawdown (ft) = 290
Aquifer thick (ft) = 340

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00036	1.16
2.0	0.00026	0.82
3.0	0.00021	0.67
4.0	0.00018	0.58
5.0	0.00016	0.52

***** PIT 16 DIPPING STRATA, MID K *****

Hydraulic cond (ft/day) = 0.0060
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3200
Drawdown (ft) = 290
Aquifer thick (ft) = 340

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00064	2.05
2.0	0.00045	1.45
3.0	0.00037	1.19
4.0	0.00032	1.03
5.0	0.00029	0.92

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 16 DIPPING STRATA, HIGH K *****

Hydraulic cond (ft/day) = 0.0190
Storage (1/ft) = 3.00E-07
Pit wall length (ft) = 3200
Drawdown (ft) = 290
Aquifer thick (ft) = 340

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00114	3.65
2.0	0.00081	2.58
3.0	0.00066	2.11
4.0	0.00057	1.83
5.0	0.00051	1.63

***** PIT 16 GLACIAL DEPOSITS, LOW K *****

Hydraulic cond (ft/day) = 0.1260
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3300
Drawdown (ft) = 30
Aquifer thick (ft) = 15

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00245	8.09
2.0	0.00173	5.72
3.0	0.00141	4.67
4.0	0.00123	4.04
5.0	0.00110	3.62

MINE AREA 2: 1-D TRANSIENT STATE INFLOW RESULTS

***** PIT 16 GLACIAL DEPOSITS, MID K *****

Hydraulic cond (ft/day) = 0.4000
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3300
Drawdown (ft) = 30
Aquifer thick (ft) = 15

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00437	14.41
2.0	0.00309	10.19
3.0	0.00252	8.32
4.0	0.00218	7.20
5.0	0.00195	6.44

***** PIT 16 GLACIAL DEPOSITS, HIGH K *****

Hydraulic cond (ft/day) = 1.2600
Storage (Sya) = 1.50E-01
Pit wall length (ft) = 3300
Drawdown (ft) = 30
Aquifer thick (ft) = 15

YEAR	UNIT INFLOW Gpm/ft	TOT. WALL INFLOW Gpm
1.0	0.00775	25.57
2.0	0.00548	18.08
3.0	0.00447	14.76
4.0	0.00387	12.78
5.0	0.00347	11.44

```
'PROGRAM PLANEQUE
'ONE-DIMENSIONAL SOLUTIONS TO GROUNDWATER FLOW

WRITTEN BY L. COPE, GOLDER ASSOCIATES, 1989.

'THE EQUATION FOR DISCHARGE (OPTION 9 IN THE MENU) IS THE
'BANK STORAGE EQUATION GIVEN ON PAGE 74 OF "TRANSIENT GROUNDWATER
'HYDRAULICS" BY R.E. GLOVER, 1974.


Defdbl C-H,J-Z: defstr A,B: DEFINT I
SZERO=200:K=.0019:THIC=150:STOR=.05:TIM=365:LENG=1000
NSTEP=10.:ATIT="OUTPUT TABLE":AFLAG="SCREEN"
50 CLS:PRINT "     1-D SOLUTIONS FOR FLOW IN A VERTICAL PLANE"
PRINT "    ***********************************************"
PRINT "    0   TITLE FOR OUTPUT:     ";ATIT
PRINT "    1   DRAWDOWN (So) IN FEET                      ";SZERO
PRINT USING "    2   HYDRAULIC CONDUCTIVITY (K) IN FEET/DAY:#####.####";K
PRINT USING "    3   STORAGE PARAMETER (S/Sya):              #####.####";STOR
PRINT "    4   AVERAGE AQUIFER THICKNESS (b) IN FEET:    ";THIC
PRINT "    5   NUMBER OF TIME STEP (print times):        ";NSTEP
PRINT "    6   NUMBER OF DAYS PER TIME STEPS (t):        ";TIM
PRINT "    7   LENGTH OF PIT WALL (LENG) IN FEET:        ";LENG:PRINT
PRINT "        =======  TRANSIENT STATE SOLUTION ========"
PRINT "    8   SOLVE EQUATION FOR DRWDWN DISTANCE FROM WALL (feet)"
PRINT "    9   SOLVE EQUATION FOR WALL DISCHARGE":PRINT
PRINT "        =======   STEADY STATE SOLUTION   ======="
PRINT "    10  SOLVE FOR INFILTRATION GIVEN (L) AND (H)"
PRINT "    ***********************************************"
PRINT "    11  ACTIVATE OUTPUT TO DISK FILE  =======>   ";AFLAG
PRINT "    12  OUTPUT FILE NAME ====>   ";AFNAM
PRINT "    13  QUIT PROGRAM
PRINT:INPUT "Enter selection:";IN
  IF IN=0 THEN
    input "      Title for output listing";ATIT
  ELSEIF IN=1 THEN
    input "      Drawdown (feet)";SZERO
  ELSEIF IN=2 THEN
    input "      Hydraulic Conductivity (feet/day)";K
  ELSEIF IN=3 THEN
    input "      Storage parameter";STOR
  ELSEIF IN=4 THEN
    input "      Average aquifer thickness (feet)";THIC
  ELSEIF IN=5 THEN
    input "      number of time steps";NSTEP
  ELSEIF IN=6 THEN
    input "      Days per timestep";TIM
  ELSEIF IN=7 THEN
    input "      Length of pit wall (feet)";LENG
  ELSEIF IN=8 THEN :CLS
    PRINT "                ";ATIT:PRINT:PRINT
    input " Enter integral value (From Tab.8, Glover,74)";ERFVAL
    TSALFA=K*SZERO/2/STOR
```

```
    PRINT:PRINT " s = ";SZERO,"K = ";k:PRINT USING "     ALPHA= ###.##";TSALFA
    PRINT:PRINT "  YEAR     DIST (ft.) "
    PRINT "            FROM WALL "
    PRINT " ====================="
    FOR I=1 TO NSTEP
      DAY= I*TIM : YEAR=DAY/365.25
      L= (ERFVAL)*((4*TSALFA*DAY)^.5)
      PRINT USING "####.##   #####,.#";YEAR,L
    NEXT I
    GOTO 40
  ELSEIF IN=9 THEN
    goto 100
  ELSEIF IN=10 THEN
    CLS:PRINT:PRINT:PRINT "                ";ATIT:PRINT
    PRINT:INPUT "  Average annual precipitation";precip
    PRINT:INPUT "  Distance that infiltration is caught by pit";L
    PRINT:PRINT "  Thickness Ho is assumed to be 50 feet.  Enter"
    INPUT "  the saturated thickness plus 50 feet (H1) ";H1
    PRINT:PRINT:PRINT:PRINT
    W=((K*365.25)*(H1^2 - 2500))/L^2
    WIN=W*12.
    PCNT=WIN/PRECIP*100.
    PRINT USING "    HYDRAULIC CONDUCTIVITY (ft/day)= ##.###";K
    PRINT "    ANNUAL PRECIP. (Inches)        = ";PRECIP
    PRINT USING "    ANNUAL INFILTRATION (Inches)   = ##.##";WIN
    PRINT USING "    INFILT/PRECIP (Percent)        = ###.##";PCNT;
    PRINT:PRINT:PRINT
    IF PCNT>100. THEN PRINT "WARNING: INFILTRATION EXCEEDS PRECIPITATION.
    GOTO 40
  ELSEIF IN=11 THEN
   AFLAG="FILE"
  ELSEIF IN=12 THEN
    print:input "   New name of output file  ";AFNAM
  ELSEIF IN=13 THEN
    goto 200
  END IF
GOTO 50
100 PI=3.1416 : T=K*THIC
CLS:PRINT "        *****  ";ATIT;"  *****":PRINT
PRINT USING "          Hydraulic cond = #.####";K
PRINT USING "          Storage coef   = #.####";STOR
PRINT "          Pit wall length=";leng
PRINT "          Drawdown       =";szero
PRINT "          Aquifer thick. =";thic:print
PRINT "                UNIT       TOT. WALL
PRINT "      YEAR     INFLOW       INFLOW"
PRINT "                Gpm/ft       Gpm
PRINT "   ================================="
IF AFLAG="SCREEN" GOTO 60
OPEN AFNAM FOR APPEND AS #1
PRINT #1,:PRINT #1,:PRINT #1,:PRINT #1,:PRINT #1, "          *****   ";ATIT;
*****":PRINT #1,
PRINT #1, USING "          Hydraulic cond = #.####";K
PRINT #1, USING "          Storage coef   = #.####";STOR
```

```
PRINT #1, "          Pit wall length =";leng
PRINT #1, "          Drawdown        =";szero
PRINT #1, "          Aquifer thick.  =";thic:
PRINT #1,
PRINT #1, "                UNIT       TOT. WALL
PRINT #1, "      YEAR     INFLOW       INFLOW"
PRINT #1, "                Gpm/ft       Gpm
PRINT #1, "     ==============================="
60 FOR I=1 TO NSTEP
    DAY=I*TIM:YEAR=DAY/365.25
    Q=SZERO*T/((PI*(T/STOR)*DAY)^.5)
    QGPM=(Q*7.48)/1440
    TOTQ=QGPM*LENG
    PRINT USING "########.#    ##.#####   #####.##";YEAR,QGPM,TOTQ
    IF AFLAG="SCREEN" GOTO 70
    PRINT #1, USING "########.#    ##.#####   #####.##";YEAR,QGPM,TOTQ
70 NEXT I
CLOSE #1
40 PRINT:INPUT "        press enter for menu";B
AFLAG="SCREEN"
GOTO 50
200 CLS:END^Z
```

APPENDIX A-2

STEADY-STATE 1-D ANALYSIS OF INFLOW

August 1989

883-2145

Golder Associates

Golder Associates	Subject 1-D STEADY STATE	Made by LEC	Job No. 893-2145
		Checked by	Date 8/11/89
		Approved by	Sheet No. 1/4

CALCULATIONS

USING 1-D STEADY STATE SOL'N

Assumptions

- No Recharge from precipitation or surface water
- No leakage from the glacial deposits to the bedrock
- A constant head boundary is assumed at some distance from the pits. Distance to the boundary is controlled by surface topography and by distance to surface water.

Estimated distances (L) are:

L = 1000 ft. for mine area 1
L = 1500 ft. for mine area 2

The equation used:

$$Q = \frac{K}{2L}\left(h_L^2 - h_o^2\right)$$

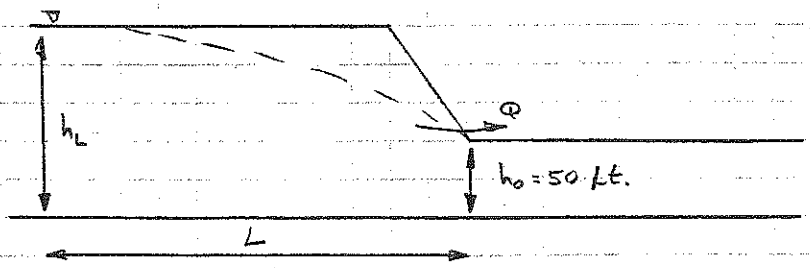
unconfined - steady state, as presented by Sunada & McWhorter, 1977, Groundwater hydrology and hydraulics, pg 147.

L = distance to constant head
h_L = Saturated thickness at distance L
h_o = Saturated thickness at toe of pit wall

Golder Associates	Subject: 1-D STEADY STATE	Made by: LEC	Job No. 893-2145
		Checked by	Date 8/11/89
		Approved by	Sheet No. 2/4

BEDROCK

Physical model:



MINE AREA 1

$K = 0.0076, 0.024, 0.076$ ft/day
$L = 1000$ ft.
$h_L = 250$ ft.

$$Q = \frac{(0.0076)}{2(1000)}(250^2 - 50^2) = 0.228 \text{ ft}^3/\text{day}/\text{ft.}$$

$$Q = \frac{(0.024)}{2(1000)}(250^2 - 50^2) = 0.720 \text{ ft}^3/\text{day}/\text{ft.}$$

$$Q = \frac{(0.076)}{2(1000)}(250^2 - 50^2) = 2.280 \text{ ft}^3/\text{day}/\text{ft.}$$

MINE AREA 2

$K = 0.0019, 0.006, 0.019$ ft/day
$L = 1500$ ft
$h_L = 450$ ft

$$Q = \frac{(0.0019)}{2(1500)}(450^2 - 50^2) = 0.127 \text{ ft}^3/\text{day}/\text{ft}$$

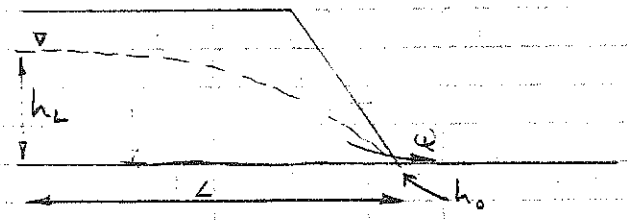
$$Q = \frac{(0.006)}{2(1500)}(450^2 - 50^2) = 0.40 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(0.019)}{2(1500)}(450^2 - 50^2) = 1.27 \text{ ft}^3/\text{day}/\text{ft}$$

Golder Associates	Subject 1-D STEADY STATE	Made by LEC	Job No. 883-2145
		Checked by	Date 8/11/89
		Approved by	Sheet No. 3/4

GLACIAL DEPOSITS

physical model:



MINE AREA 1

$K = 0.126,\ 0.40,\ 1.26$ ft/day
$L = 1{,}000$ ft
$h_L = 50$ ft

$$Q = \frac{(0.126)}{2(1000)}(50^2 - 0^2) = 0.158 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(0.40)}{2(1000)}(50^2 - 0^2) = 0.500 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(1.26)}{2(1000)}(50^2 - 0^2) = 1.58 \text{ ft}^3/\text{day}/\text{ft}$$

MINE AREA 2

$$Q = \frac{(0.126)}{2(1500)}(50^2 - 0^2) = 0.105 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(0.40)}{2(1500)}(50^2 - 0^2) = 0.33 \text{ ft}^3/\text{day}/\text{ft}$$

$$Q = \frac{(1.26)}{2(1500)}(50^2 - 0^2) = 1.05 \text{ ft}^3/\text{day}/\text{ft}.$$

Golder Associates	Subject: 1-D Steady State	Made by: LEC	Job No. 883-2145
		Checked by:	Date: 8/11/89
		Approved by:	Sheet No. 4/4

— SUMMARY OF RESULTS —

for

1-D steady-state mine Inflow

	K	INFLOW (GPM) BEDROCK gpm	GLACIAL DEPOSITS gpm	TOTAL gpm
MINE AREA I (Q x 8,100)	LO	9.6	6.6	16.2
	MID	30.3	21.0	51.3
	HI	95.9	66.2	162.1
MINE AREA II (Q x 15,400)	LO	10.2	8.4	18.6
	MID	32.0	26.7	58.7
	HI	101.6	84.0	185.6

APPENDIX A-3

TRANSIENT RADIAL ANALYSIS OF INFLOW

August 1989

883-2145

Golder Associates

Golder Associates	Subject: RADIAL TRANSIENT STATE WISHBONE HILL MINE INFLOW	Made by: LEC	Job No. 883-2145
		Checked by:	Date: 8/11/89
		Approved by:	Sheet No. 1/4

CALCULATION OF MINE INFLOW USING RADIAL TRANSIENT STATE SOL'N

ASSUMPTIONS

- NO RECHARGE FROM PRECIPITATION, SURFACE WATER, OR INTO BEDROCK FROM GLACIAL DEPOSITS
- A LARGE OPEN PIT BEHAVES HYDRAULICALLY LIKE A LARGE DIAMETER WELL.
- THE USUAL THEIS ASSUMPTIONS OF HORIZONTAL RADIAL FLOW IN AN INFINITE AQUIFER ARE VALID AT THE SITE.
- VALUES FOR (u) ARE ≤ 10.

SINCE:

$$u = \frac{r^2 S}{4Kt},$$

THE CONDITION FOR $u \leq 10$ IS TRUE WHEN (r) IS THE LARGE RADIUS OF AN OPEN-PIT MINE ONLY IF:

STORAGE (S) IS VERY SMALL $\Rightarrow$ CONFINED
and/or HYD. COND. (K) IS VERY LARGE
and/or time (t) IS VERY LARGE

OVER THE LIFE OF THE MINE ($t \leq 10$ YEARS), AND WITH THE GIVEN VALUES OF (r) AND (K), SPECIFIC YIELD VALUES OF 0.05 - 0.20 PRODUCE $u \gg 10$.

CONSEQUENTLY, THE SOLUTION IS ONLY VALID FOR CONFINED FLOW HAVING LOW STORAGE (S_S BEDROCK $\approx 10^{-7}$/ft).

- EQUIVALENT MINE AREA RADII ARE CHOSEN THAT CORRESPOND TO ACTUAL MINE OPEN AREAS:

$$A = \pi r^2 \Rightarrow r = (\pi / A)^{1/2}$$

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FOR:

MINE AREA 1, $r = 950$ ft

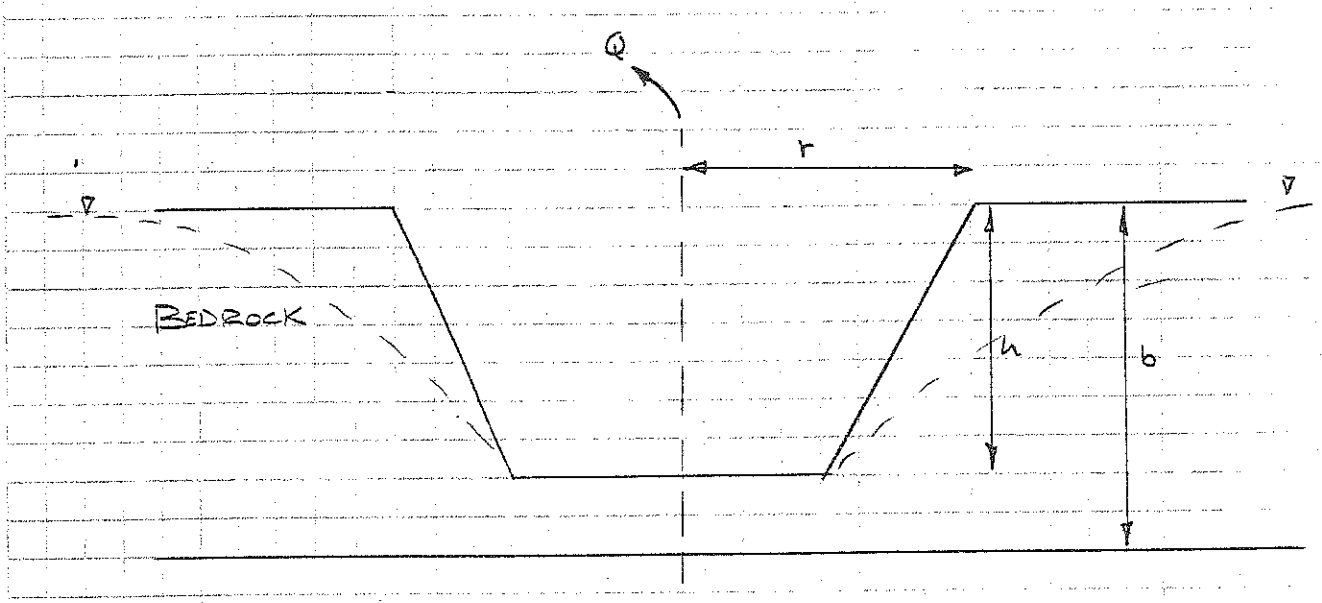
MINE AREA 2, $r = 1700$ ft.

- VALUES FOR MINE INFLOW ARE CALCULATED BY THE THEIS EQUATION:

$$u = \frac{r^2 S}{4Kt}$$

$(u) \Longrightarrow W(u)$ from well function tables.

$$Q = \frac{4\pi K b h}{W(u)}$$



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MINE AREA 1

$r = 950$ ft
$K = 0.0076,\ 0.024,\ 0.076$ ft/day
$S = 3 \times 10^{-7}$ / ft

$h = 200$
$b = 250$
$t = 1 \rightarrow 3$ YEARS

	K	u	W(u)	Q (GPM)
YEAR 1	LO	2.44×10^{-2}	3.15	7.85
	MID	7.72×10^{-2}	4.3	18.2
	HI	2.44×10^{-3}	5.44	45.58
YEAR 2	LO	1.22×10^{-2}	3.86	6.46
	MID	3.86×10^{-3}	4.98	15.72
	HI	1.22×10^{-3}	6.13	40.44
YEAR 3	LO	8.13×10^{-3}	4.25	5.85
	MID	2.57×10^{-3}	5.40	14.54
	HI	8.13×10^{-4}	6.54	37.94
YEAR 4	LO	6.1×10^{-3}	4.53	5.48
	MID	1.93×10^{-3}	5.67	13.80
	HI	6.1×10^{-4}	6.83	36.34

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MINE AREA 2

		K	(u)	w(u)	Q (gpm)
YEAR 3	LO	3.12×10^{-1}	0.88	25.48	
	MID	9.89×10^{-2}	1.83	38.52	
	HI	3.12×10^{-2}	2.90	76.98	
YEAR 4	LO	1.56×10^{-1}	1.43	15.61	
	MID	4.95×10^{-2}	2.48	28.43	
	HI	1.56×10^{-2}	3.6	62.01	
YEAR 5	LO	1.04×10^{-1}	1.78	12.5	
	MID	3.3×10^{-2}	2.87	24.56	
	HI	1.04×10^{-2}	4.03	55.40	
YEAR 6	LO	7.81×10^{-2}	2.05	10.89	
	MID	2.47×10^{-2}	3.14	22.45	
	HI	7.81×10^{-3}	4.28	52.12	
YEAR 7	LO	6.25×10^{-2}	2.26	9.89	
	MID	1.98×10^{-2}	3.35	21.04	
	HI	6.25×10^{3}	4.49	49.56	
YEAR 8	LO	5.21×10^{-2}	2.43	9.19	
	MID	1.65×10^{-2}	3.53	19.97	
	HI	5.21×10^{-3}	4.69	47.60	
YEAR 9	LO	4.46×10^{-2}	2.58	8.66	
	MID	1.41×10^{-2}	3.70	19.05	
	HI	4.46×10^{-3}	4.84	46.12	
YEAR 10	LO	3.90×10^{-2}	2.70	8.25	
	MID	1.24×10^{-2}	3.80	18.55	
	HI	3.90×10^{-3}	4.97	44.92	
YEAR 11	LO	3.47×10^{-2}	2.82	7.92	
	MID	1.10×10^{-2}	3.94	17.89	
	HI	3.47×10^{-3}	5.10	43.77	

$r = 1700$ ft
$K = 0.0019$
0.006
0.019 ft/day
$S = 3 \times 10^{-7}$/ft
$h = 400$ ft
$b = 450$ ft
$t = 1 \rightarrow 9$ years
(3 → 11 mine years)