UNITED STATES DEPAR
Albuquerque, New Mexic

Uranium Mill Tailings Remedial Action Project (UMTRAP)

Grand Junction, Colorado

GRJ-PH-II
Calculations

Preliminary Final

Volume III

August 1990

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

VOL 3

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Attachment
Letter 91-3050-388
May 9, 1991

PHASE II CONSTRUCTION
GRAND JUNCTION
CALCULATION INDEX

Calculation No.	Title
	VOLUME I
05-622-01-00	Dewatering
05-626-01-03	Tailings Excavation - Tailings Pile Limits and Quantities
05-626-02-04	Tailings Excavation - Off-Pile Excavation Limits and Quantities
05-628-01-00	Site Drainage - Hydrology Parameters
05-631-01-01	Access Road - Culvert at Indian Creek
05-631-02-01	Access and Haul Roads - Culvert Placement and Protection at Indian Creek
✓ 05-631-03-01	Access and Haul Roads - Culvert Outlet Revision
	VOLUME II
05-633-01-01	Site Grading - Restoration Quantity for Grand Junction Processing Site
05-504-01-02	Erosion Protection - Top and Sideslopes of Tailings Embankment
05-504-02-00	Erosion Protection - Time of Concentration, Cheney Disposal Site Embankment
05-504-07-00	Permanent Site Drainage - Off-Pile Drainage Swale
05-504-04-00	Disposal Site Drainage During Construction - Retention Basin and Emergency Spillway
05-504-05-02	Riprap Toe Protection

PHASE II CONSTRUCTION
GRAND JUNCTION
CALCULATION INDEX

Calculation No.	Title
	VOLUME III
05-505-02-02	Rock Quality for the Erosion Protection - Cheney Disposal Site
05-505-03-02	Availability and Suitability of Materials
05-654-01-02	Hydrogeology - Dewatering
05-654-02-00	Slurry Trench at Processing Site - Quantities
05-654-03-00	Hydrogeology - Slurry Trench Seepage Windows
05-655-01-00	Surface Water Runoff Accumulation and Discharge
05-666-01-02	Construction Sequence
05-667-04-02	Quantity Estimate Summary - Phase II Construction
05-670-01-05	Radon Barrier Design - Thickness
05-670-02-03	Radon Barrier Design - Average Ra-226 Concentrations
	VOLUME IV
05-670-05-03	Embankment Design - Material Properties
05-670-06-02	Embankment Design - Settlement and Cover Cracking
	VOLUME V
05-670-07-05	Embankment Design - Slope Stability
05-670-08-01	Embankment Design - Drain Layer/Bedding Layer
05-670-09-02	Embankment Design - Depth of Frost Penetration
05-670-11-00	Radon Barrier - Ra-226 Concentrations in DOE Compound
05-670-12-00	Embankment Design - Paleochannel Remediation
05-670-13-00	Embankment Design - Infiltration

Calculation Cover Sheet

Contract No. 5025-16 **Discipline** ENV. UMTRA **Calc. No.** 05-505-03-00 **No. of Sheets** 46

Project
UMTRA– GRAND JUNCTION

Feature
EMBANKMENT DESIGN

Item
AVAILABILITY AND SUITABILITY OF MATERIALS

Sources of Data

SEE SHEET i

Sources of Formulae & References

SEE SHEET i

Preliminary Calc. ☒ **Final Calc.** ☐ **Supersedes Calc. No.** 05-618-03

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0		P. SIRCAR J. LUBIS	7/3/90	S.E. Botsford	7/3/90	S.E. Botsford	7/2/90

Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA - GRAND JUNCTION
Feature EMBANKMENT DESIGN
Item AVAILABILITY AND SUITA.
Sheet 2
Contract No. 5025-16
File No.
Designed H.L.
Date 7|02|90
Checked GHB
Date 7·3·90

REFERENCES

1. "QUANTITY ESTIMATE SUMMARY - PHASE II CONSTRUCTION" MKE CALC. NO. 05-667-04-02

2. "SUBCONTRACT DOCUMENTS PHASE II, REV. 0, FINAL DESIGN FOR CONSTRUCTION", MKE DOC. NO. 5025-GRJ-R-01-02091-00

3. "ROCK QUALITY FOR THE EROSION PROTECTION - CHENEY DISPOSAL SITE", MKE CALC. NO. 05-505-02-00

4. "EROSION PROTECTION - TOP AND SIDESLOPES OF TAILINGS EMBANKMENT", MKE CALC. No. 05-504-01-00

5. "RIPRAP TOE PROTECTION", MKE CALC. No. 05-504-05-

6. "EMBANKMENT DESIGN - MATERIAL PROPERTIES", MKE CALC. NO. 05-670-05-01

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Project UMTRA - GRJ Contract No. 9025-16 File No.
Feature EMBANKMENT DESIGN Designed H.L. Date 7/3/90
Item Availability Checked Shs Date 7.3.90

TABLE OF CONTENTS

Sheet 1
Project UMTRA-GRJ
Contract No. 5025-16
File No.
Feature Embankment Design
Designed P.S.
Date 1/17/90
Item Availability and Suitability of Mat'ls.
Checked H.L.
Date 7/2/90

I. BACKGROUND AND PURPOSE

Approximately 3 million cubic yards of soil will be excavated for the proposed tailings embankment foundation at the Cheney Reservoir Disposal Site (Reference 1). The present plans, as noted in the Specifications (Reference 2) are to obtain the erosion protection rip rap, radon barrier, Mancos Protection Barrier rooting medium and frost barrier soils (if needed) from the excavated materials, to the maximum extent possible. In addition, plans are, to use excess excavated material from the disposal site for the restoration of the excavation at the processing site.

Soil borings and test pits in the area of the excavation have shown the existence of good quality clay for potential radon barrier material and gravels or boulders of appropriate size and quality (Ref 3). The materials will have to be selectively excavated, and for the erosion protection material, appropriately processed, and then stockpiled for later use.

The purpose of these calculations is to investigate whether the volumes of available materials are satisfactory, with sufficient safety margin. A summary of the findings and conclusions is presented in Sheet 2.

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Project UMTRA - GRJ
Contract No. 5025-V File No.
Feature EMBANKMENT DESIGN
Designed H.L. Date 7/2/90
Item AVAILABILITY AND SUITAB.
Checked SWB Date 7.3.90

I. SUMMARY OF AVAILABILITY AND SUITABILITY OF MATERIALS

THE AVAILABILITY OF MATERIALS	THE REQUIRED MATERIALS (From Ref. 1)
Ⓐ TOP SOIL	Ⓐ ROOTING SOIL
228,367 c.y. (Sh. 6)	173,370 c.y. (REF. 1)
Ⓑ GRAVELLY LAYER	Ⓑ EROSION PROTECTION
727,467 c.y. (Sh. 38)	154,800 c.y.
Gravel : 1"-4" : 140,000 c.y.	Type A : 105,300 c.y.
4"-9" : 70,000 c.y.	Type B : 26,600 c.y.
5"-11" : 49,000 c.y.	Type C : 12,010 c.y.
11"+ : 21,000 c.y.	Type D : 10,890 c.y.
Ⓒ CLAYEY LAYER	Ⓒ RADON BARRIER
348,763 c.y. (Sh. 8)	295,630 c.y.
Ⓓ GRAVELLY LAYER (-1" MATERIAL COMES OUT OF GRAVELLY LAYER)	Ⓔ Clean-Fill Dike Above Ground
400,000 c.y. (Sh. 9)	600,300 c.y.
Ⓔ MANCOS SHALE	Ⓔ Clean-Fill Dike Above Ground
772,476 c.y. (Sh. 10)	283,500 c.y.

Project UMTRA-GRJ
Contract No. 5025-16
Sheet 2
File No.
Feature EMBANKMENT DESIGN
Designed PS
Date 1/19/90
Item AVAILABILITY AND SUITAB
Checked H.L.
Date 7/02/9

III. SITE SOIL CONDITIONS AND PLANNED USAGE

Site soils in the area of the excavation consist of Mancos Shale bedrock overlain by an average of 20 feet of alluvium/colluvium overburden soils. A fence diagram showing the several different soil types is presented on Sheet 11. Major soil zones are indicated on the fence diagram.

Present plans are to use:

(i) Processed (selectively excavated and sieved) gravels from the gravelly soil layer (Layer no. 2) for erosion protection rock

(ii) Selectively excavated clays from Layer 3 for radon barrier. The clays pinch out in the Northwest part of the site.

(iii) The top 1-foot for essentially the entire fenced area, including the excavation area as (a) 2-foot thick rooting medium for the embankment cover and (b) as topsoil for all disturbed areas for the disposal site.

(iv) Ideally, the rest of the soils indiscriminately as general fill for (a) processing site restoration, (b) clean fill dikes at disposal site, and (c) disposal site restoration (excess oversize material, not usable as general fill will be disposed of in Area A (see Sheet 12)), and (d) geoden barrier

However, (1) there is some question as to whether Mancos Shale will be permitted for use in processing site restoration, (2) the strength requirements for side slopes of the clean fill dikes may render Mancos Shale unsuitable - maybe -1" material after sieving for erosion protection in (i) will be required, (3) a shortfall in radon barrier material in (ii) may be made up by the -1" material or very weathered

Mancos Shale, and (d) only some materials may be usable as geochemical barrier.

IV CALCULATIONS PERFORMED

Calculations were performed for computing the volumes of available materials as follows:

(a) Topsoil (Sheet 6)

(b) Erosion Protection Rock (Sheets 7 through 7A)

(c) Radon Barrier Material (Sheets 8)

(d) Minus 1-inch material (Sheets 9.2)

(e) Mancos Shale (i) Total (Sheet 10).

(ii) Very Weathered (Sheet 10).

A summary of the available quantities is presented in Sheet 2. Also included in Sheet 2 is the volume of the quantities of each type of material required.

A MORRISON KNUDSEN COMPANY

Project UMTRA-GRJ Contract No. 5025-16 File No.
Feature Embankment Design Designed P.S. Date 5-26-90
Item Availability and Suitability of Matls. Checked H.L. Date 7/3/90

V. COMPUTATION PROCEDURES AND RESULTS

General

The excavation plan is presented on sheet 12. The stockpile plan as from INDUSTRIAL CONST. (Subcontractor) is presented on Sh. 13. Presented on Sheets 14 through 26 are sections through the excavation area in both directions. The sectio show the boring log locations along and near the sections and the soils noted in the boring logs. The sections also note the zones of (a) gravelly soils from which the erosion protection material will be processed, and (b) clays judged suitable for use as radon barrier. These sections have been of great help during the ongoing excavations. It should be noted that consistent with the instructions given to the Subcontractors during excavation, material within 3 feet of the surface was not included for use as radon barrier or erosion protection material.

Topsoil volume was computed as the volume of 1-ft of Topsoil stripped over the entire fenced area (see Sheet 12).

Detailed calculations and results for each of the soil categories is presented in the following sheets.

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Project UMTRA-GRJ
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Feature Embankment Design
Designed P.S.
Date 5-26-90
Item Availability & Suitability of Materials
Checked H.L.
Date 7-3-90

ⓐ Topsoil

Total Fenced Area = 6,165,912 sq.ft.

Depth of Topsoil = 1 ft

∴ Volume of Topsoil Stripped = 6,165,912 ft^3

= 228,367 cy

Volume of Topsoil Required = 173,370 cy

(from Reference 1, for Rooting Soil)

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Project UMTRA-GRJ
Feature Embankment Design
Item Availability
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Sheet 1
File No.
Date 5-26-90
Date 7|3|90

(b) Erosion Protection Material

① Presented in Sheets 27 and 38 are the gradations required for each type of erosion protection material, as calculated from References 4 and 5. Volume of each type of material, [illegible]

② The volume of gravelly material to be stockpiled from the excavation for subsequent processing for erosion protection material is computed in Sheet 38. The volume is based on geologic sections on Sh. 14 - 26, described earlier. The total volume of the gravelly soils available as source of the erosion protection materials is 727,467 cy. (Use 700,000 c.y., See Sh. 39)

③ Grain size distribution data for the gravelly materials are presented in Sh. 27-29. There are 2 classes of data:

(a) 5 samples tested from combined test pit samples tested prior to start of construction (Sh. 27 and 28)

(b) Additional 20 samples tested from the gravelly soil (sheet 29) stockpile during excavation.

An examination is made of the 2 sets of data. They appear to be generally similar. See sheets 27-28 and 29. Only, there appears to be some discrepancy in the 1" to 3" range. It should be noted that the second data set has a maximum grain size of 14", and does not have as many sieve sizes. Thus, for further analyses, only the

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Project CEMTRA - GRJ Contract No. 5025-16 File No.
Feature Embankment Design Designed H. L. Date 7/3/90
Item Availability Checked SHB Date 7.3.90

first data set was used, (since it appeared that for Type B materials between 4" and 9$\frac{1}{2}$" and for Type C, materials between 5" and 11" will yield the required gradations on Sh. 36 and 37. Data for 4" and 9" is not available for the second set.

Presented on Sheet 39 are the conservatively estimated percentages and volumes available, based on 700,000 cy of stockpiled gravelly soil (this is slightly less than the computed 727,467 cy, since only -14-inch material is stockpiled.)

④ Presented in Sheets 35, 36, 37, and 38 are the grain size distribution curves that will be obtained by selected sieving, to produce Type A, Type B, Type C, and Type D riprap materials, respectively. Presented also are the gradation limits required. The backup calculations are presented in Sheets through .

⑤ It is recommended that, to make the best use of the situation, approximately 250,000 cy should be sieved for 5" to 11" material, and the remaining sieved for 4" to 9" material.

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Project UMTRA-GRJ
Feature Embankment Design
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Sheet 75
File No.
Date 5-26-90
Date 7|3|90

(c) Radon Barrier Clay

Volume of available Radon Barrier Clay is computed from the geologic sections on Sh. 14 to 26. The computations are presented in Sheet 40. The computations indicate an approximate volume of radon barrier clay = 348,763 cy

Volume of radon barrier clay required (from Ref. 1) = 295,630 cy

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Project UMTRA - GRJ Contract No. 5025-16 File No.

Feature Embankment Design Designed HL for PS Date 7/3/90

Item Availability Checked HL Date 7/3/90

ⓓ Minus 1-inch Material

From Sheet: 39, a conservative value of 60 pct is chosen for the available minus 1-inch material.

Using 700,000 cy,

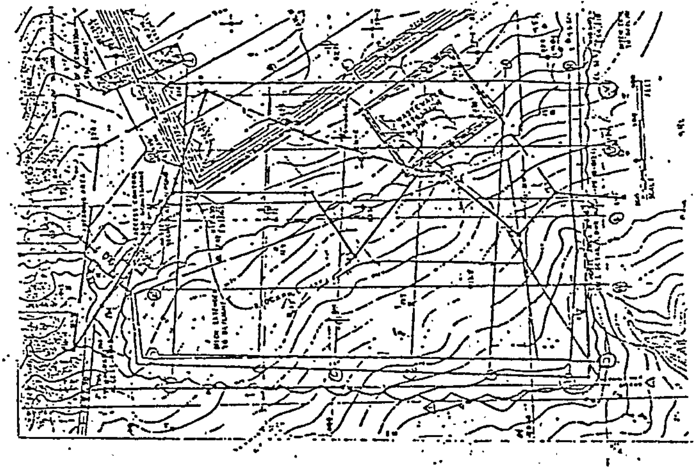
Available −1" material: 420,000 cy ≈ 400,000 cy

Sh. 11

UMTRA-GRJ
5025-16
Availability & similarity

H.L. 7/3/90

LOCATION MAP SLB 7·3·90



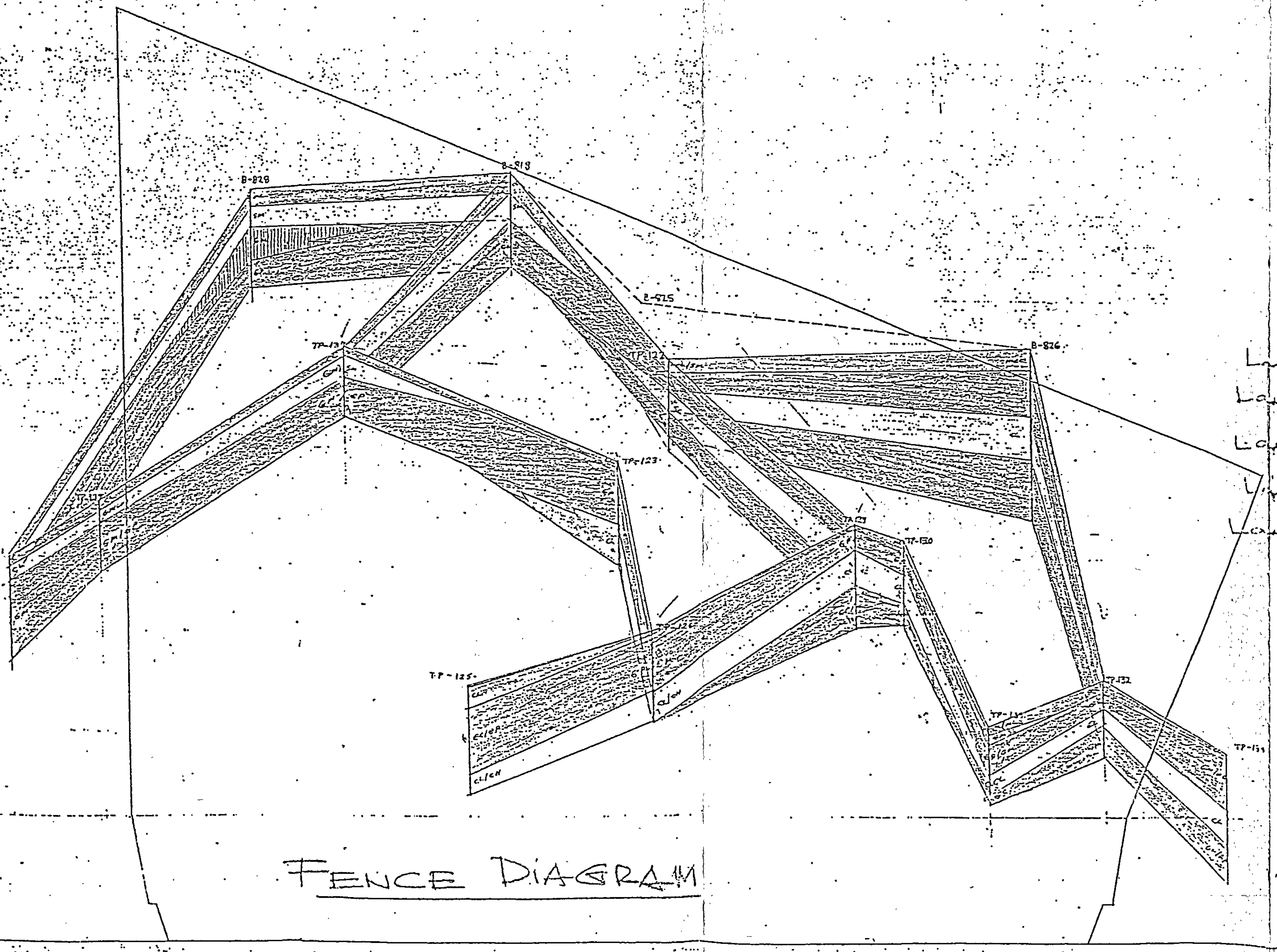
LEGEND

Layer ①	CL/ML	TOP SOIL - SILTY CLAY TO CLAYEY SILT — REDDISH BROWN, MEDIUM PLASTICITY, FIRM TO STIFF
Layer ⑤	SM	SILTY SAND-TO-CLAY-SILT-GRAVEL LIGHT BROWN, INTERSPERSE GYPSUM, ABUNDANT LIME (CALICHE)
Layer ②	GM/GC	GRAVEL-SAND-SILT (UPPER GRAVEL) GRAY-BROWN, POORLY GRADED, DENSE, SLIGHTLY MOIST, SOME CLAY, SOME GYPSUM, SOME LIME (CALICHE)
Layer ③	CL/CH	CLAY - GRAY-BROWN, LOW TO HIGH PLASTICITY, STIFF TO VERY STIFF, TRACE SMALL SIZE GRAVEL, SAND LENSES
Layer ②	GP/GC	GRAVEL TO GRAVEL-SAND-SILT-CLAY MIXTURES LIGHT BROWN TO REDDISH BROWN VERY DENSE, MOIST SOME [illegible] COATING

SCALE

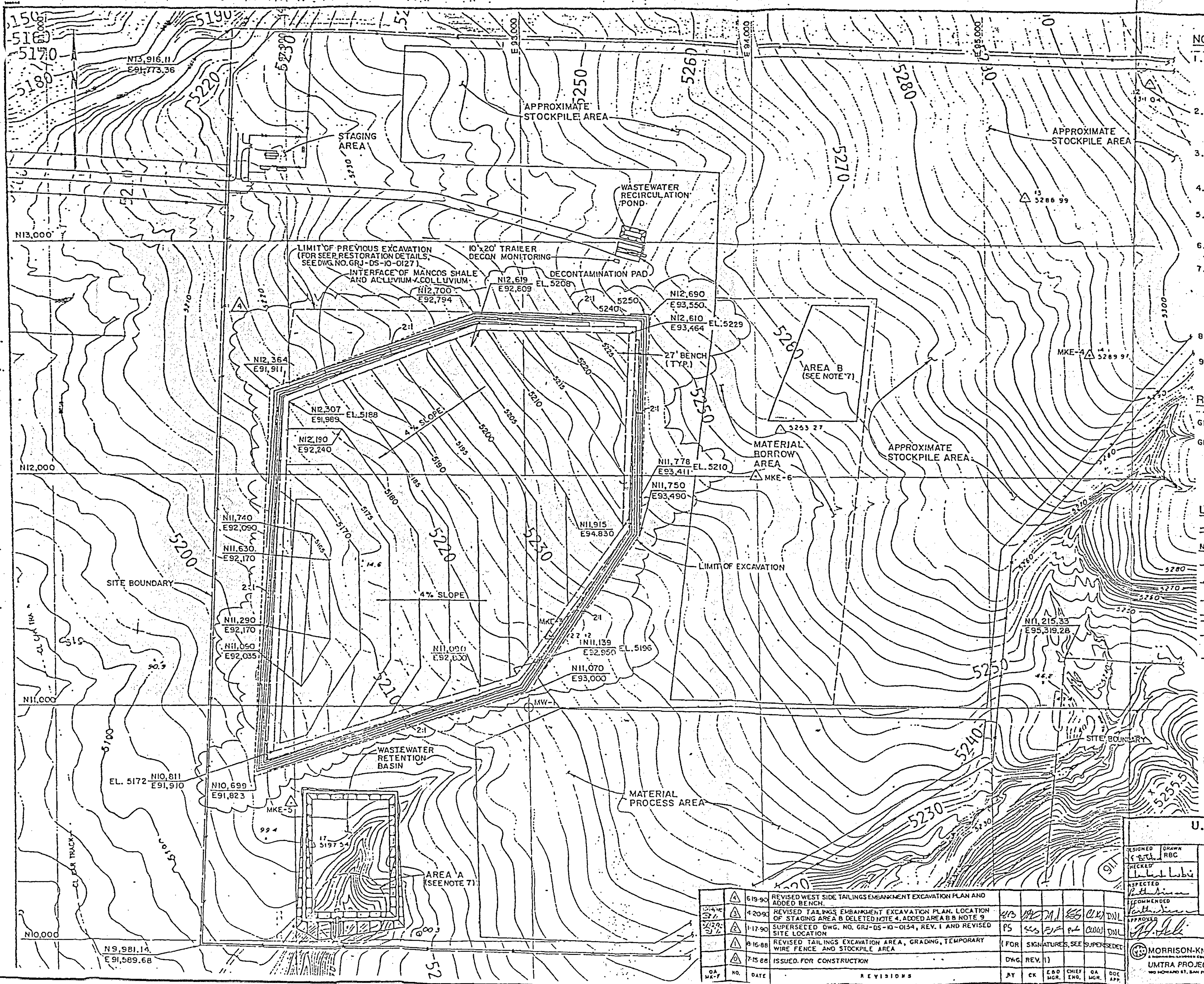
0 100 200 300
HORIZONTAL

0 10 20 30
VERTICAL



FENCE DIAGRAM

UMTRA – GRJ Sh. 12
F025-16
Availability and Sensitivity



NOTES:

1. ALL UNCONTAMINATED MATERIAL EXCAVATED FROM THE SITE DURING CONSTRUCTION SHALL BE PLACED TEMPORARILY WITHIN THE AREAS INDICATED WITH STABLE SLOPES NO STEEPER THAN 2(H) TO 1(V), MAXIMUM HEIGHT OF THE PILE SHALL BE 30 FEET.
2. THE SUBCONTRACTOR SHALL PROVIDE SUMP AND PUMP TO DRAIN THE PONDED NON-CONTAMINATED WATER FROM RAINSTORM AND SNOW MELT FROM THE TAILINGS EMBANKMENT AREA INTO THE NATURAL DRAIN.
3. THE SUBCONTRACTOR SHALL NOT EXCAVATE INTO THE MANCOS SHALE PRIOR TO THE ISSUANCE OF SUCH INSTRUCTIONS BY THE CONTRACTOR.
4. (DELETED)

H.L. 7/3/90
7-3-90

5. THE LOCATION OF THE INTERFACE OF MANCOS SHALE WITH ALLUVIUM/COLLUVIUM IS APPROXIMATE ONLY AND IS BASED ON SOIL BORING LOGS. ACTUAL LOCATION MAY VARY IN THE FIELD.
6. THE DESIGNATED MATERIAL BORROW AREA SHALL NOT BE USED AS STOCKPILE AREA WITHOUT THE CONTRACTOR'S APPROVAL.
7. THE SUBCONTRACTOR MAY SPOIL OVERSIZE ROCK FROM THE DISPOSAL CELL EXCAVATION INTO THE DRAINAGE GULLY UNDER THE PROPOSED WASTEWATER RETENTION BASIN (AREA A) IF, AND AS AVAILABLE. IF THIS AREA IS NOT AVAILABLE, THE SUBCONTRACTOR SHALL TEMPORARILY STOCKPILE THE OVERSIZE MATERIAL IN THE DESIGNATED AREA B. HE SHALL DISPOSE OF THIS MATERIAL AS REQUIRED BY THE CONTRACTOR.
8. LOCATIONS OF WASTEWATER RECIRCULATION POND AND DECONTAMINATION PAD ARE APPROXIMATE.
9. A WORKING BENCH APPROXIMATELY 27' WIDE SHALL BE PLACED BELOW THE TRANSITION BETWEEN MANCOS SHALE AND ALLUVIUM. THE SIDESLOPE IN THE MANCOS MAY VARY AS APPROVED BY THE CONTRACTOR.

REFERENCE DRAWINGS:

GRJ-DS-10-0125,	CONSTRUCTION FACILITIES AND SITE DRAINAGE
GRJ-DS-10-0223,	BORINGS AND TEST PITS LOCATION PLAN

LEGEND:

5240	EXISTING SITE FEATURES AND CONTOURS
N 12,000	CONSTRUCTION GRID COORDINATE
—5250—	CONTOURS OF EXCAVATION
	TEMPORARY CHAIN LINK FENCE AND GATE
	TEMPORARY WIRE FENCE
	ACCESS ROAD
	EXCAVATION
	EMBANKMENT
△MKE-3	EXISTING PERMANENT SURVEY MONUMENT
⊕MW-1	EXISTING WATER SUPPLY WELL

EDWIN S. SMITH 14364

QA REVIEWED FOR QUALITY REQUIREMENTS 3/12/90

200 0 200 400
SCALE FEET

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	4	6-19-90	REVISED WEST SIDE TAILINGS EMBANKMENT EXCAVATION PLAN AND ADDED BENCH.						
	3	4-20-90	REVISED TAILINGS EMBANKMENT EXCAVATION PLAN. LOCATION OF STAGING AREA B DELETED NOTE 4. ADDED AREA B & NOTE 9					CLX	DNL
	2	1-17-90	SUPERSEDED DWG. NO. GRJ-DS-10-0134, REV. 1 AND REVISED SITE LOCATION	PS				CWW	DNL
	1	8-16-88	REVISED TAILINGS EXCAVATION AREA, GRADING, TEMPORARY WIRE FENCE AND STOCKPILE AREA	(FOR SIGNATURES, SEE SUPERSEDED DWG. REV. 1)					
	0	7-15-88	ISSUED FOR CONSTRUCTION						

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

CHENEY RESERVOIR DISPOSAL SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

TAILINGS EMBANKMENT AREA EXCAVATION PLAN

DESIGNED	DRAWN RBC
CHECKED	
INSPECTED	
RECOMMENDED	
APPROVED	DATE 1/19/90

E.S. Smith 1/19/90

DOE PROJECT ENGINEER	DATE
Donald N.	2-2-90

MORRISON-KNUDSEN ENGINEERS, INC.
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UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. GRJ-DS-10-0134

REV. 4

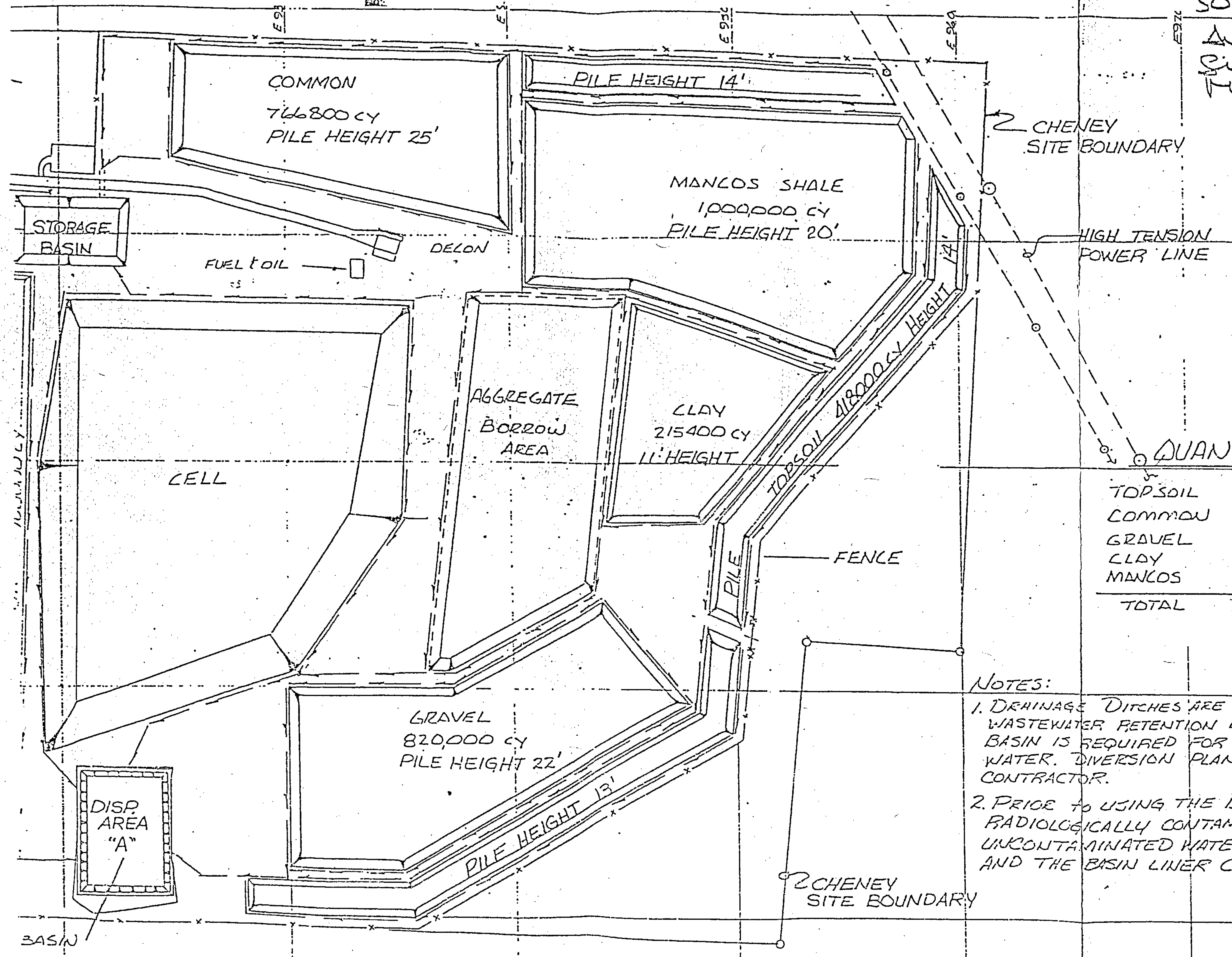
UMTRA - GRJ
5025 _ 16

Sh. 13

Availability and
Suitability of
Materials

H. L 7/3/90

7.3.90

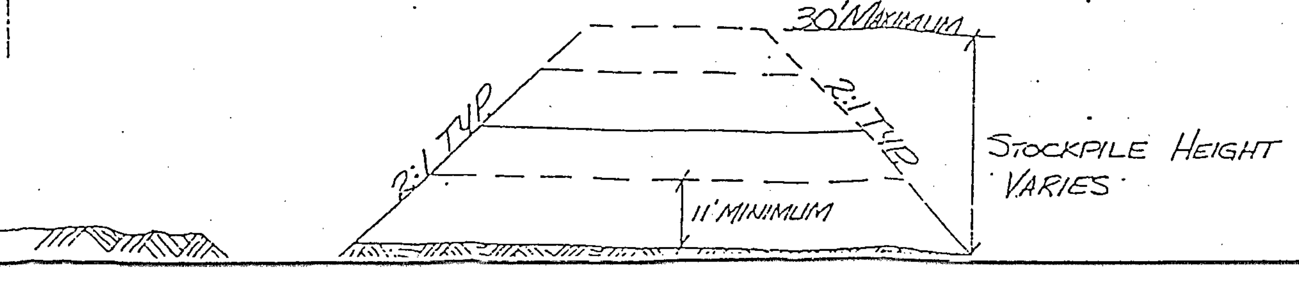


QUANTITIES

TOPSOIL	518000 CY
COMMON	766800 CY
GRAVEL	820.000 CY
CLAY	215.400 CY
MANCOS	1000.000 CY
TOTAL	3,320,200 CY

NOTES:

1. DRAINAGE DITCHES ARE TO BE DIVERTED FROM THE WASTEWATER RETENTION BASIN AT SUCH TIME THE BASIN IS REQUIRED FOR RADIOLOGICALLY CONTAMINATED WATER. DIVERSION PLAN SHALL BE APPROVED BY THE CONTRACTOR.
2. PRIOR to USING THE BASIN FOR STORAGE OF RADIOLOGICALLY CONTAMINATED WATER, ALL UNCONTAMINATED WATER WILL BE REMOVED AND THE BASIN LINER CHECKED FOR DEFECTS



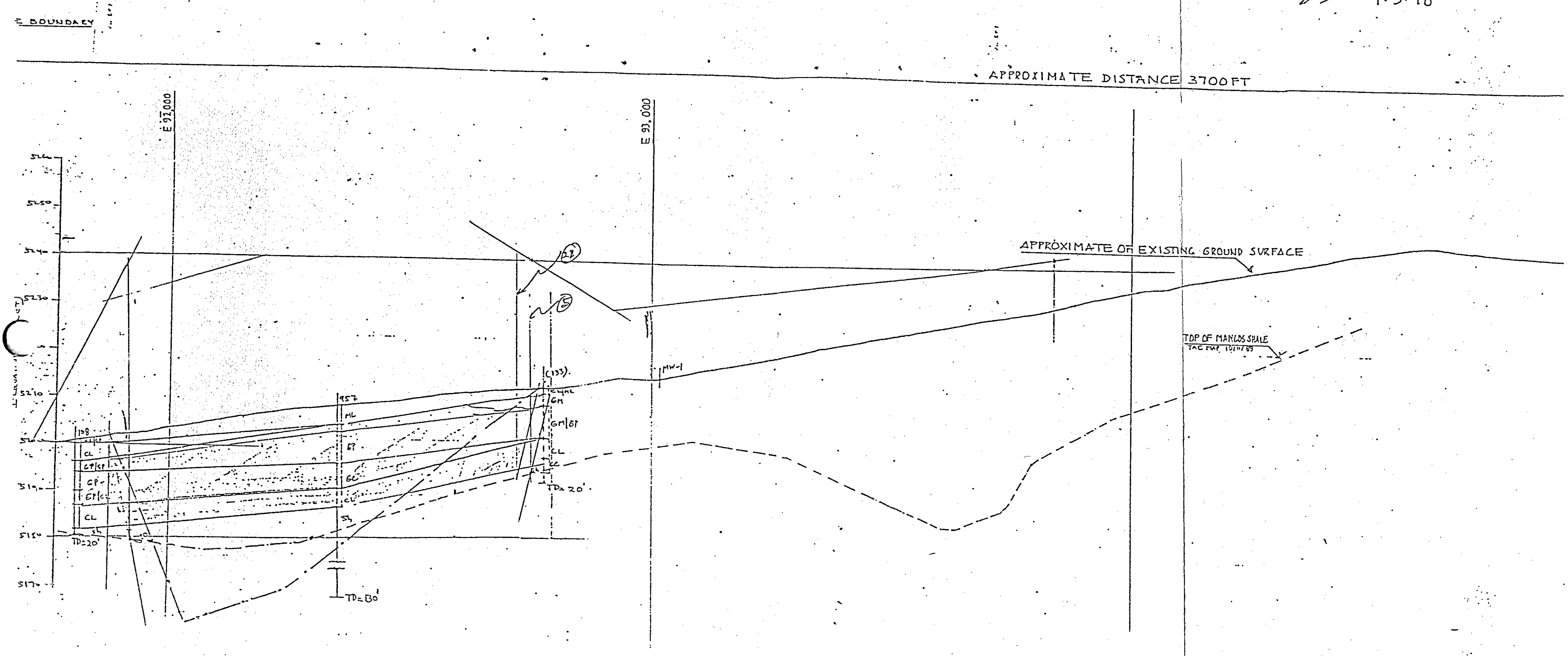
STOCKPILE HEIGHT VARIES

STOCKPILE PLAN

UMTRA	SCALE 1=400	DRAWN BY DLC REVISED TJD

Sh. 14

UMTRA-GRJ
5025-16
H.L. 7/3/90
Shs 7.3.90



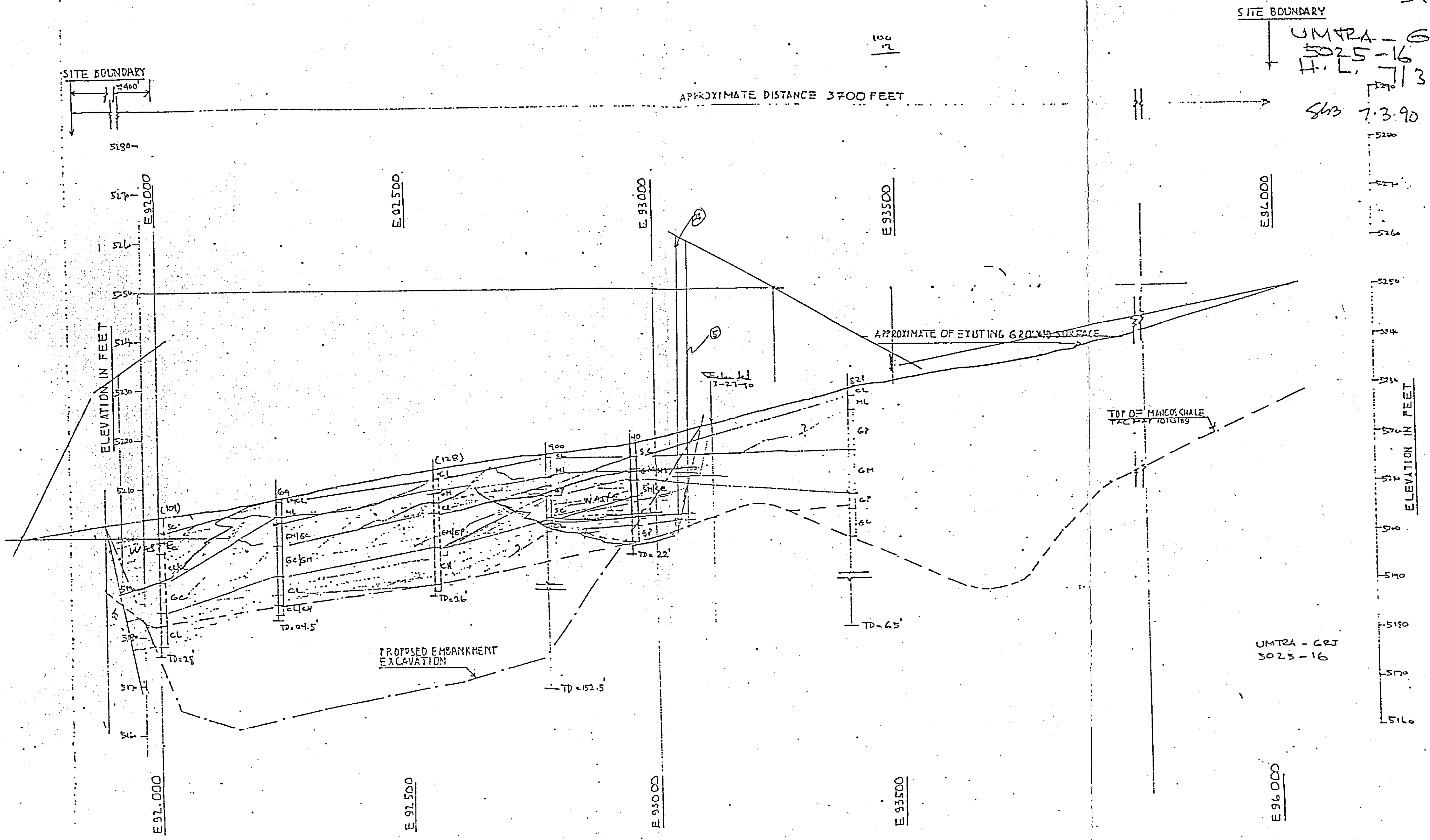
CROSS-SECTION @ N 11,000 - 11,000

SCALE HOR. : 1" = 100'
VER. : 1" = 10'

Sh 15

UMTRA - GRJ
5025-16
H. L. 7/3/90

SGB 7.3.90

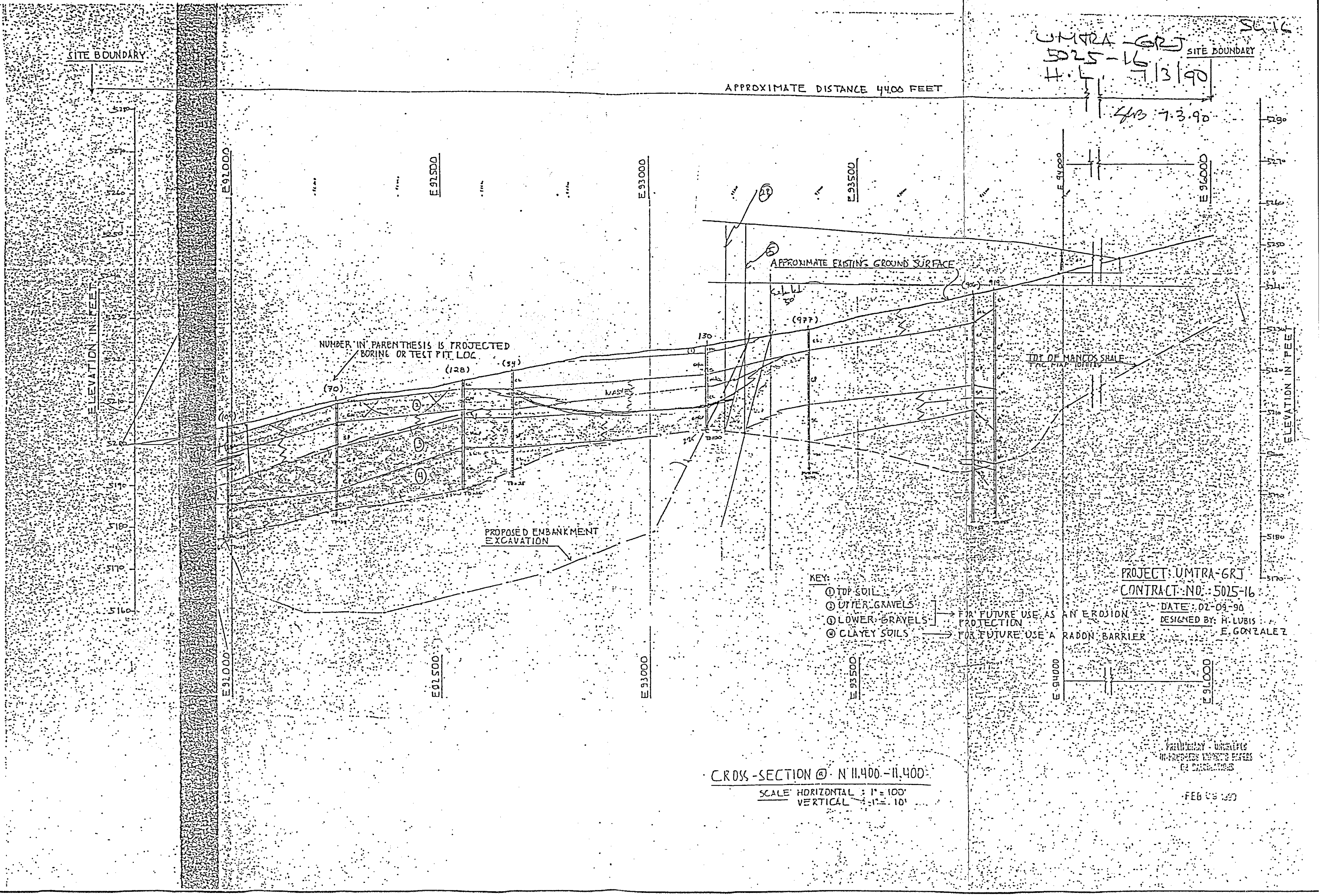


UMTRA - GRJ
5025-16

CROSS-SECTION @ N 11,200-11,200

SCALE HORIZONTAL : 1" = 100'
VERTICAL : 1" = 10'

PRELIMINARY - UNCHECKED
IN-PROCESS WORKING PAPERS
OR CALCULATIONS



SG-16

UMTRA-GRJ
5025-16
H. L. 7|3|90

SAB 7.3.90

KEY:
① TOP SOIL
② UPPER GRAVELS
③ LOWER GRAVELS → FOR FUTURE USE AS AN EROSION PROTECTION
④ CLAYEY SOILS → FOR FUTURE USE A RADON BARRIER

PROJECT: UMTRA-GRJ
CONTRACT NO.: 5025-16
DATE: 02-09-90
DESIGNED BY: H. LUBIS
E. GONZALEZ

CROSS-SECTION @ N 11,400 - 11,400

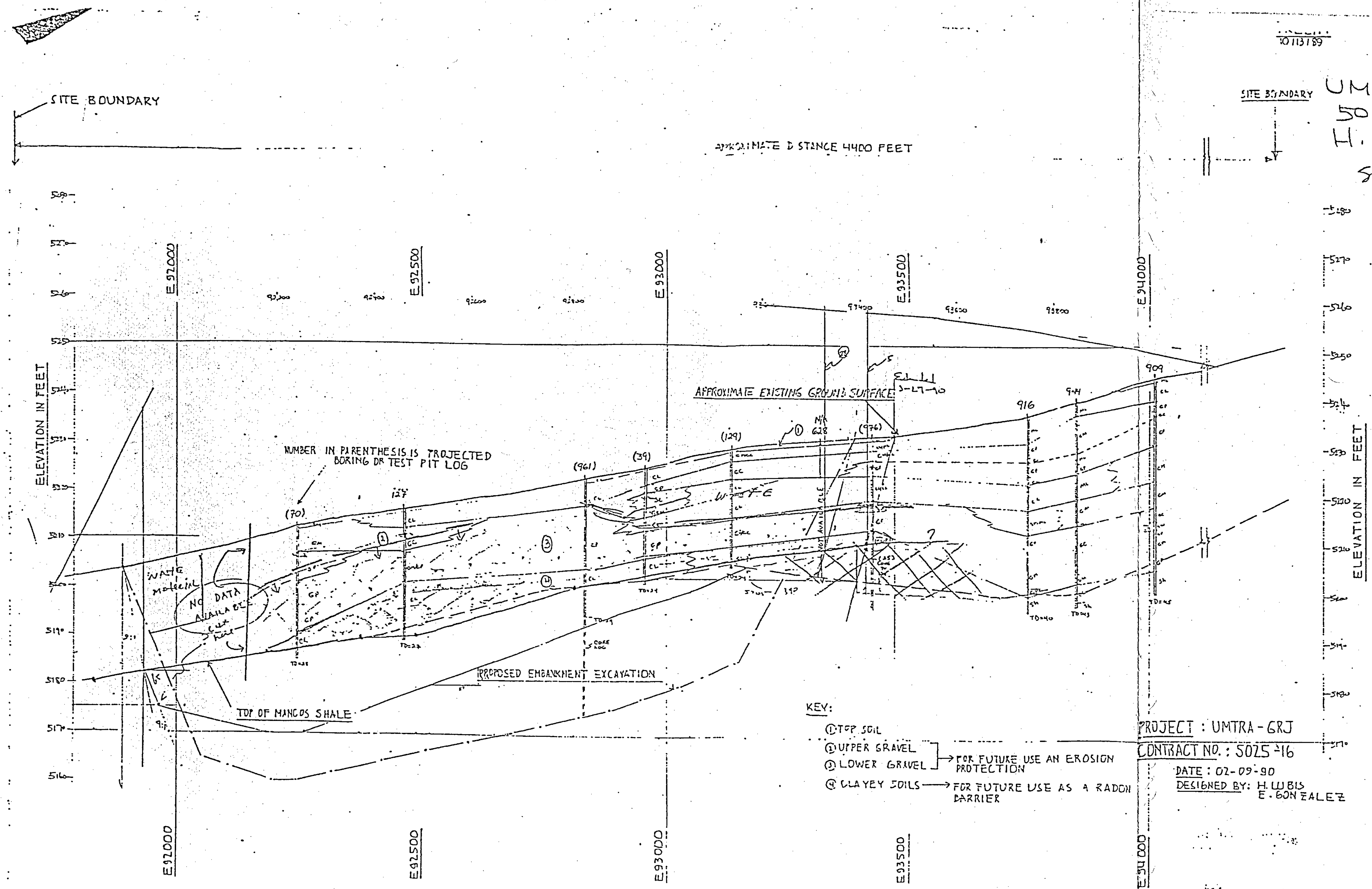
SCALE HORIZONTAL : 1" = 100'
VERTICAL : 1" = 10'

PRELIMINARY - UNCHECKED
[illegible]
OR CALCULATIONS
FEB 08 1990

10/13/89

Sh. 1

UMTRA-GRJ
5025-16
H.L. 7/3/90
SB 7.3.90



KEY:

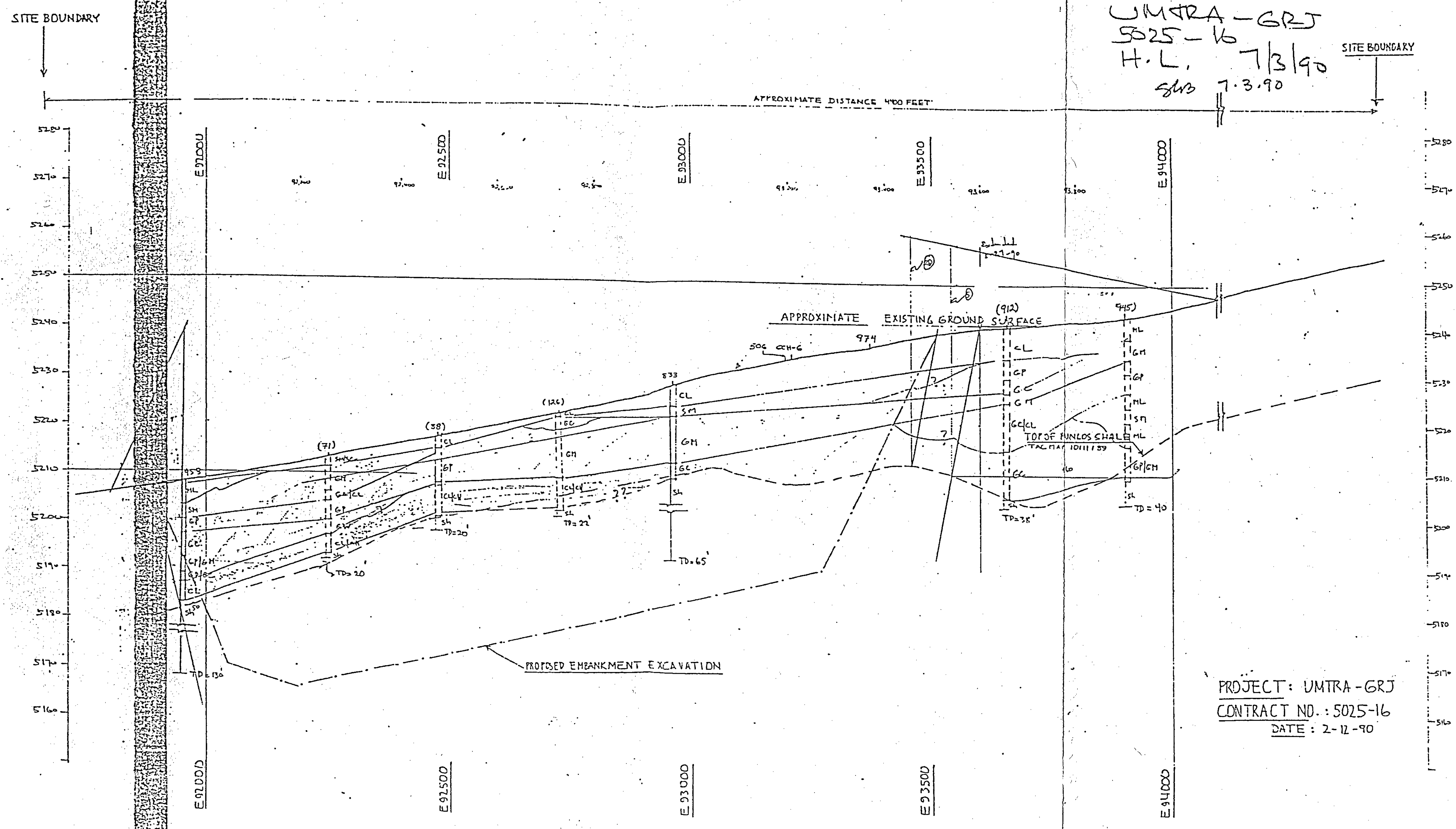
① TOP SOIL
② UPPER GRAVEL ⎤
③ LOWER GRAVEL ⎦ → FOR FUTURE USE AN EROSION PROTECTION
④ CLAYEY SOILS → FOR FUTURE USE AS A RADON BARRIER

PROJECT : UMTRA - GRJ
CONTRACT NO. : 5025-16
DATE : 02-09-90
DESIGNED BY: H. LUBIS
E. GONZALEZ

CROSS-SECTION @ N 11,600 - 11,600
SCALE HORIZONTAL : 1" = 100'
VERTICAL : 1" = 10'

Sh. 18 PRELIM
10/3/89

UMTRA - GRJ
5025 - 16
H.L. 7/3/90
SLB 7.3.90



PROJECT: UMTRA-GRJ
CONTRACT NO.: 5025-16
DATE: 2-12-90

CROSS-SECTION @ N 11,300 - 11,300
SCALE HORIZONTAL: 1" = 100'
VERTICAL : 1" = 10'

Sk-19

UMTRA-GRJ
5025-16
H.L. 7/3/90

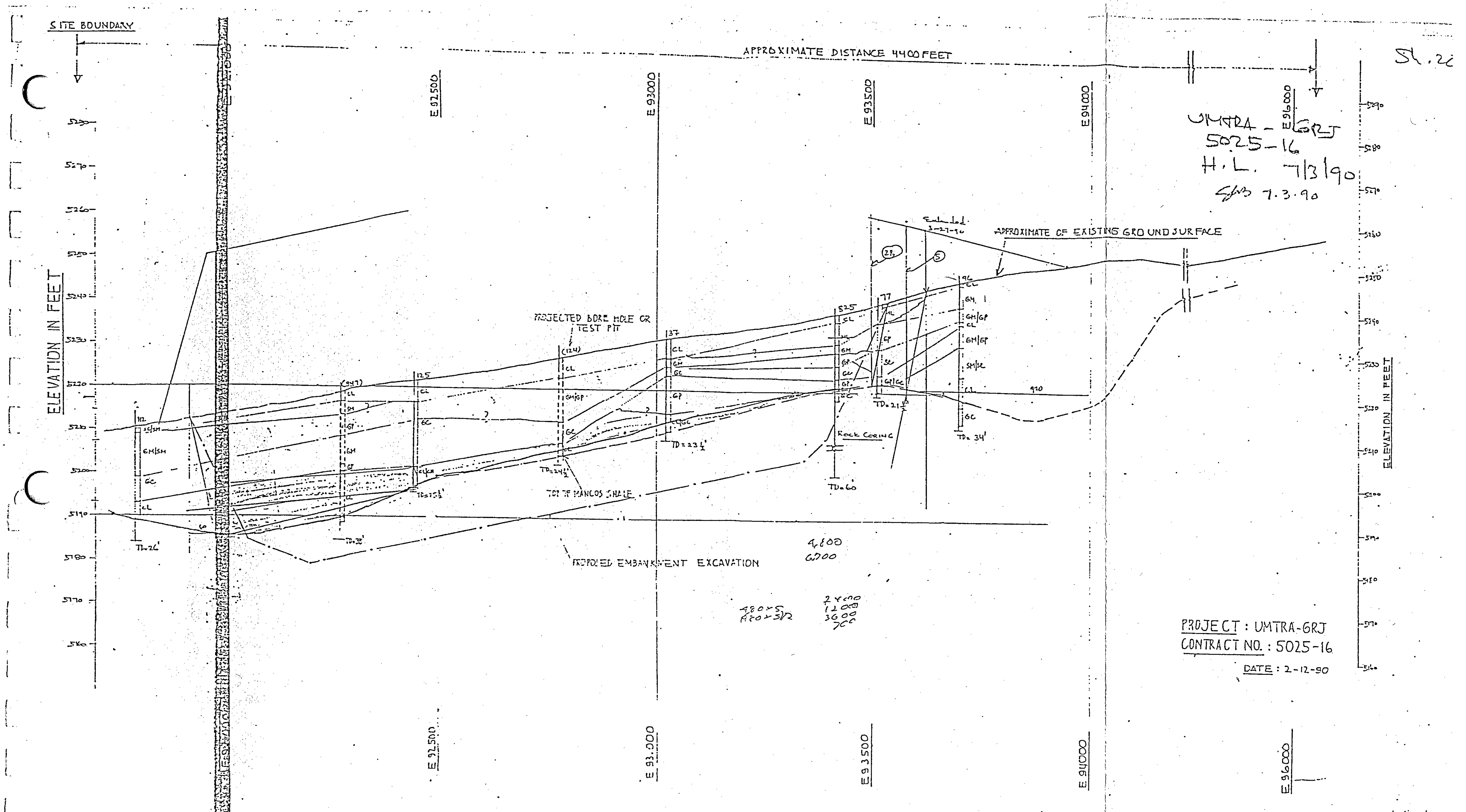
SWB 7.3.90

KEY
① TOP SOIL
② UPPER GRAVELS] → FOR FUTURE USE AS AN EROSION PROTECTION
③ LOWER GRAVELS]
④ CLAYEY SOILS → FOR FUTURE USE AS A RADON BARRIER

CROSS-SECTION @ N 12,000-12,000

Sh. 2i

UMTRA - GRJ
5025-16
H.L. 7/3/90
SAB 7.3.90



PROJECT : UMTRA-GRJ
CONTRACT NO. : 5025-16
DATE : 2-12-90

CROSS-SECTION @ N 12,200 - 12,200

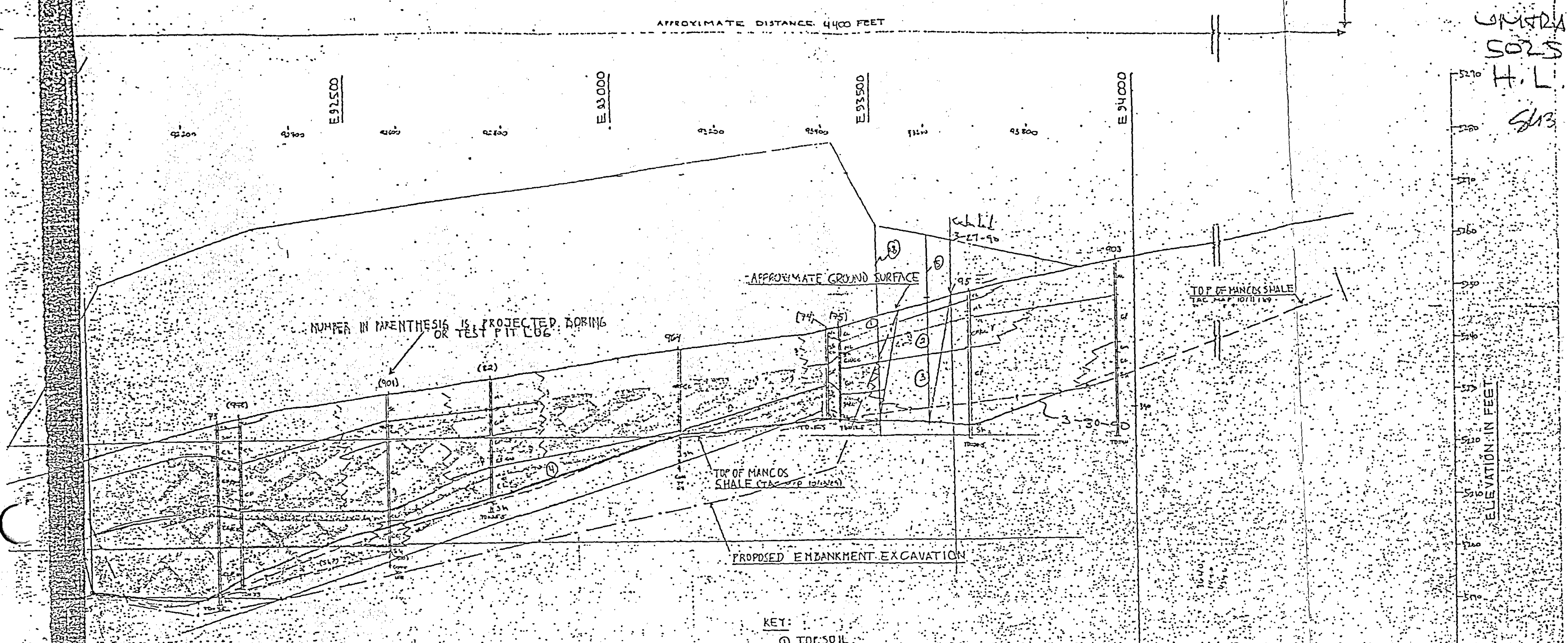
SCALE HORIZONTAL : 1" = 100'
VERTICAL : 1" = 10'

PRELIMINARY - UNCHECKED
UNAPPROVED WORKING PAPERS
OR CALCULATIONS

PRELIMINARY
10/13/89

Sh. 21

UMTRA - GRJ
5025 - 16
H.L. 7/3/90
SH3 7.3.90



KEY:
① TOP SOIL
② UPPER GRAVELS
③ LOWER GRAVELS
④ CLAYEY SOILS

① UPPER GRAVELS and ③ LOWER GRAVELS → FOR FUTURE USE AS AN EROSION PROTECTION
④ CLAYEY SOILS → FOR FUTURE USE AS A RADON BARRIER

PROJECT : UMTRA - GRJ
CONTRACT NO. : 5025-16
DATE : 02-09-90
DESIGNED BY: H. LUBIS
E. GONZALEZ

E 92500
E 93000
E 93500
E 94000

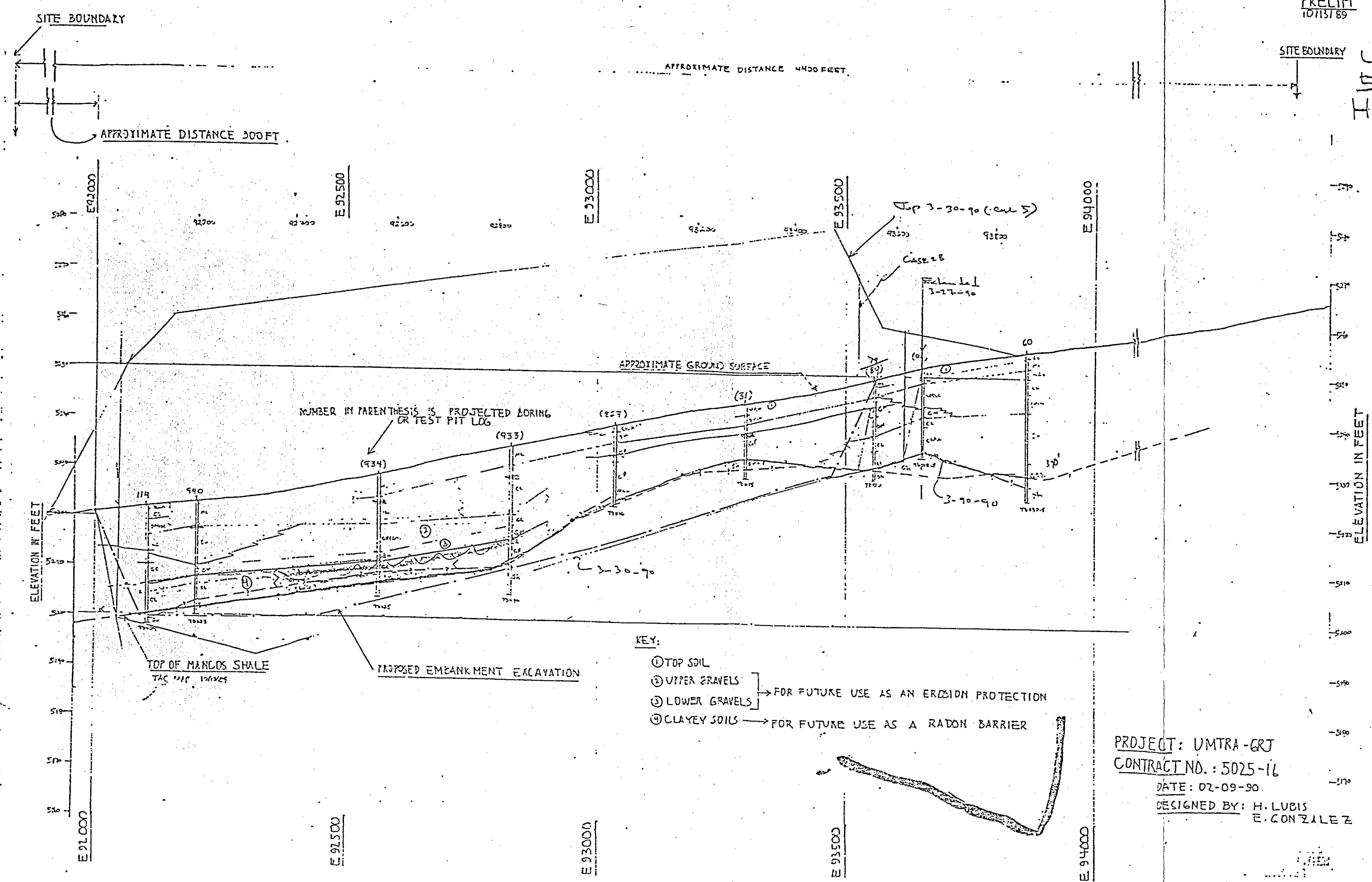
FEB 09 1990

CROSS-SECTION @ N 12,400 - 12,400
SCALE HORIZONTAL : 1" = 100'
VERTICAL : 1" = 10'

PRELIM
10/13/89

Sl 22

UMTRA - GRJ
5025 - 16
H.L. 7/3/90
7.3.90



KEY:

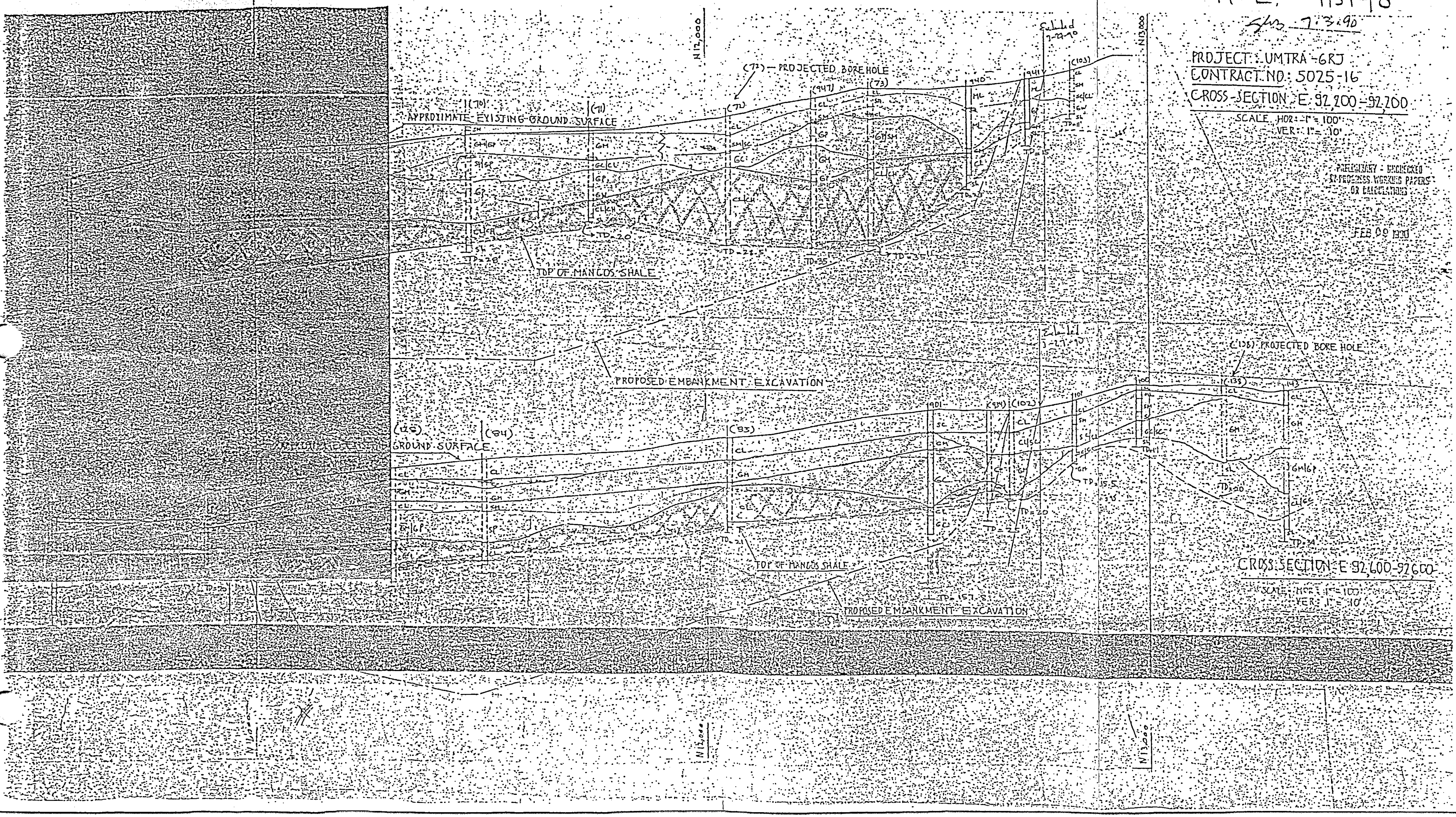
①TOP SOIL
②UPPER GRAVELS ⎤
③LOWER GRAVELS ⎦ → FOR FUTURE USE AS AN EROSION PROTECTION
④CLAYEY SOILS → FOR FUTURE USE AS A RADON BARRIER

PROJECT: UMTRA-GRJ
CONTRACT NO.: 5025-16
DATE: 02-09-90
DESIGNED BY: H. LUBIS
E. GONZALEZ

CROSS-SECTION ⑥ N 12,600 - 12,600
SCALE HORIZONTAL: 1" = 100'
VERTICAL: 1" = 10'

Sh. 23

UMTRA - GRJ
5025 - 16
H.L. 7/3/90



SHB 7.3.90

PROJECT: UMTRA - GRJ
CONTRACT NO: 5025-16
CROSS-SECTION E 92,200 - 92,200
SCALE HOR: 1" = 100'
VER: 1" = 10'

PRELIMINARY - UNCHECKED
IN-PROGRESS WORKING PAPERS
OR CALCULATIONS

FEB 09 1990

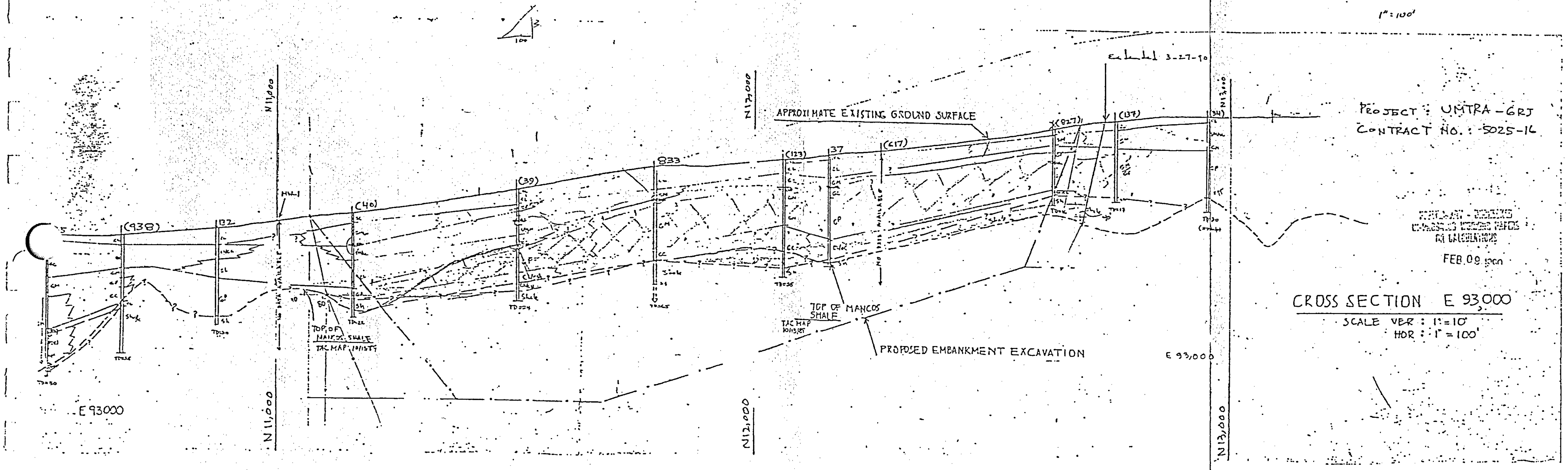
CROSS SECTION E 92,600 - 92,600
SCALE HOR: 1" = 100'
VER: 1" = 10'

UMTRA - GRJ
5025-16
7/3/90
SLB 7.3.90

PRELIMINARY - UNCHECKED
IN-PROGRESS WORKING PAPERS
OR CALCULATIONS

Sh. 25

UMTRA - GRJ
5025-16
H-L 7/3/90
Shb 7.3.90

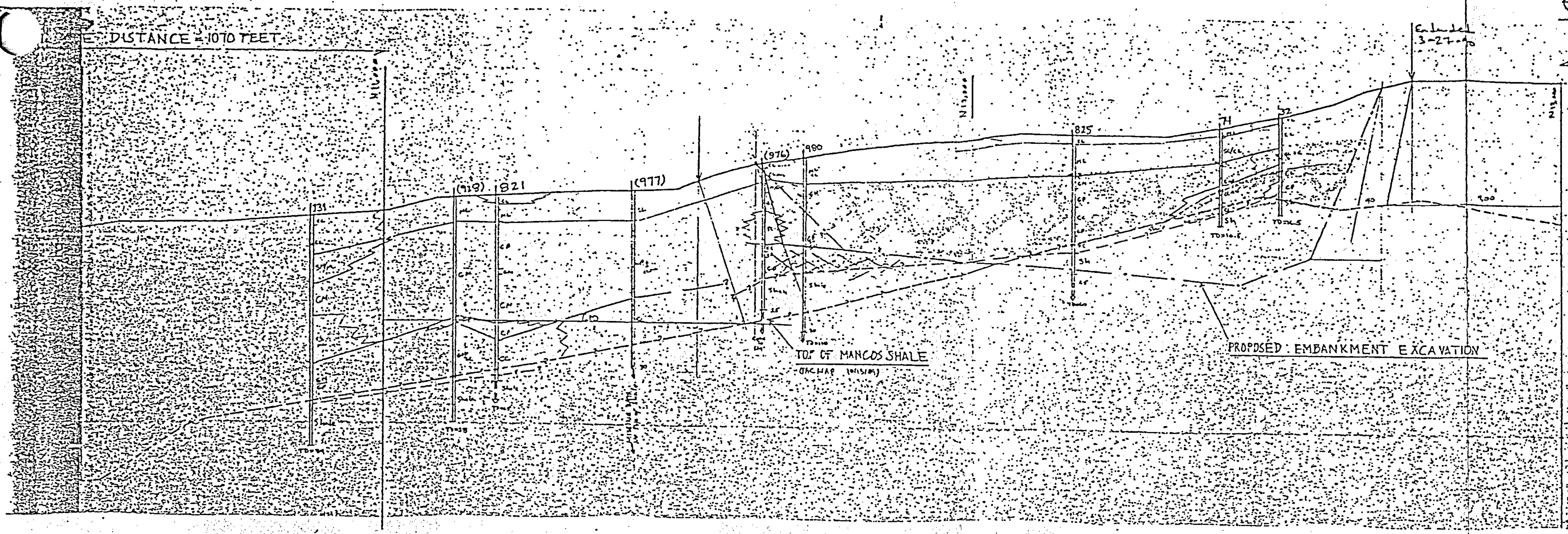


PROJECT: UMTRA - GRJ
CONTRACT NO.: 5025-16

CROSS SECTION E 93,000
SCALE VER: 1"=10'
HOR: 1"=100'

OK

UMTRA - GRJ SL. 26
5025-16 H.L. 7.3.90



APPROXIMATE DISTANCE TO SITE BOUNDARY 670 FEET

SITE BOUNDARY

SWB 7.3.90

SCALE: 1" = 10' (V)
~~1" = 100' (H)~~ ?
1" = 200

CROSS SECTION E 93,400 - 93,400

PROJECT : UMTRA - GR
CONTRACT NO. : 5025-

PRELIMINARY - UNCHECKED
IN-PROGRESS WORKING PAPERS
OR CALCULATIONS

FEB 09 1991

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

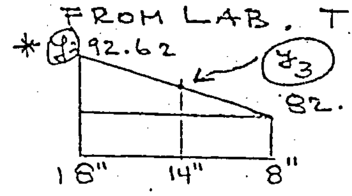
Project UMTRA - GRJ
Feature CHENEY DISPOSAL SITE
Item GRADATIONS
Contract No. 5025-16
Designed H. L.
Checked SWB
Sheet ZA7.3
File No.
Date 4-26-90
Date 7.3.90

ORIGINAL PASSING (%) (DATA FROM REF. 3)

	(14")*	(12")	8"	6"	5"	4"	3"	2"	1"	(9")
SAMPLE 1	(89.4)	(87.5)	82.29	83.48	80.88	71.76	72.2	64.2	52.45	(83.79)
SAMPLE 2	(91.2)	(90.9)	90.33	87.19	80.81	76.22	71.27	66.63	58.38	(90.50)
SAMPLE 3	(93.1)	(91.9)	88.69	84.61	82.5	79.34	76	68.84	60.37	(89.61)
SAMPLE 4	(96.6)	(95.7)	93.35	90.21	86.64	81.28	76.47	66.1	52.42	(94.02)
SAMPLE 5	(96.8)	(95.8)	92.96	91.34	89.64	86	81.59	75.33	64.8	(93.77)

KEY

FROM LAB. TEST



$$y_3 = 82.29 + \frac{\log 14 - \log 8}{\log 18 - \log 8}(y_2 - y_1$$

** CONVERT 14" ≒ 100%

FOR 12" = $\frac{87.5}{89.4} \times 100\% = 97.$

*** RANGE 1"-3"

% = 80.8 - 58.7 = 22.1

CONVERTED PASSING

	14"	12" **	8"	6"	5"	4"	3"	2"	1"	1"-3" ***	3"-8"	5"-12"	1"-4"	9"	4"-9"
SAMPLE 1	(100)	(97.9)	92	93.4	90.5	80.3	80.8	71.8	58.7	22.1	11.2	7.4	21.6	93.72	13.47
SAMPLE 2	(100)	(99.7)	99	95.6	88.6	83.6	78.1	73.1	64.	14.1	20.9	11.1	19.6	99.23	15.6
SAMPLE 3	(100)	(98.7)	95.3	90.9	88.6	85.2	81.6	73.9	64.8	16.8	13.7	10.1	20.4	96.25	11.05
SAMPLE 4	(100)	(99.1)	96.6	93.4	89.7	84.1	79.2	68.4	54.3	24.9	17.4	9.4	29.8	91.33	13.23
SAMPLE 5	(100)	(99)	96	94.4	92.6	88.8	84.3	77.8	66.9	17.4	11.7	6.4	21.9	96.87	8.07
RANGE	100	97.9 To 99.7	92 To 99	90.9 To 95.6	88.6 To 92.6	80.3 To 88.8	78.1 To 84.3	68.4 To 77.8	54.3 To 66.9	14.1 To 24.9	1.2 To 20.9	6.4 TO 11.1	19.6 TO 29.8	93.72 TO 99.23	8.0 TO 15.6
MEAN	100	98.88	95.78	93.54	90	84.4	80.8	73	61.74	19.06	14.98	8.88	22.66	96.69	12.28
STD DEV. (S.D.)	0	0.66	2.53	1.73	1.66	3.06	2.38	3.41	5.14	4.35	4.11	1.94	4.10	1.99	2.86
MEAN ± S.D.	100	98.22 TO 99.54	93.25 TO 98.31	91.81 TO 95.27	88.34 TO 91.66	81.34 TO 87.46	78.42 TO 83.18	69.59 TO 76.41	56.6 TO 66.88	14.71 TO 23.41	10.87 TO 19.09	6.94 TO 10.82	18.56 TO 26.76	94.69 TO 98.67	9.42 TO 15.1
MEAN - SEM	100	98.58	94.65	92.77	89.26	83.03	79.74	71.48	59.44	17.11	13.14	8.01	20.83	95.79	11.00

$$SEM = \frac{SD}{\sqrt{n}} = \frac{SD}{\sqrt{5}} = 0.4472 \times SD$$

NOTE: THE PORTION OF THE SOIL LARGER THAN 14" SIEVE WILL BE DISCARDED PRIOR TO USE. IT IS NECESSARY TO CONVERT THE % PASSING FOR ALL OF THE SIEVES.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature CHENEY DISPOSAL SITE
Item GRADATIONS

Contract No. 5025-16
Designed H. L.
Checked SGB

Sheet 28
File No.
Date 5-3-90
Date 7.3.90

DATA FROM : REF. 3

ORIGINAL PASSING (%)

SEE PREVIOUS CALCULATION

	(11")	8"	6"	5"	(14")
SAMPLE 1	(86.34)	82.29	83.48	80.88	(89.4)
SAMPLE 2	(90.80)	90.33	87.19	80.81	(91.2)
SAMPLE 3	(91.20)	88.69	84.61	82.50	(93.1)
SAMPLE 4	(95.2)	93.35	90.21	86.64	(96.6)
SAMPLE 5	(95.2)	92.96	91.34	89.64	(96.8)

CONVERTED PASSING (%)

	(14")	(11")	8"	6"	5"	5" – 11"
SAMPLE 1	(100)	(96.6)	92	93.4	90.5	6.1
SAMPLE 2	(100)	(99.6)	99	95.6	88.6	11
SAMPLE 3	(100)	(98)	95.3	90.9	88.6	9.4
SAMPLE 4	(100)	(98.6)	96.6	93.4	89.7	8.9
SAMPLE 5	(100)	(98.3)	96	94.4	92.6	5.7
RANGE	100	96.6 To 99.6	92 To 99	90.9 To 95.6	88.6 To 92.6	5.7 To 11
MEAN	100	98.2	95.8	93.5	90	8.22
S.D.	0	1.09	2.53	1.73	1.66	2.26
MEAN ± S.D.	100	99.29 TO 97.11	98.33 TO 93.27	95.23 TO 91.77	91.66 TO 88.34	10.48 TO 5.96
MEAN – SEM	100	97.71	94.67	92.73	89.26	7.21

SEM = 0.4472 × S.D.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature CHENEY DISPOSAL SITE
Item GRADATIONS

Contract No. 5025-16 Sheet 29
File No.
Designed P.S. Date 1-25-90
Checked SWS Date 1-3-90

SOURCE OF DATA: ADDITIONAL 20 GRADATION TESTS (REF. 6)

% PASSING

LINEAR INTERPOLATION ↓

P.	14"	(12")	8"	5"	3"	1"	1" to 3"	3" to 8"	5" to 12"
EP-G-01	100	(99.2)	97.6	85.5	76.7	57.6	19.1	20.9	13.7
EP-G-02	100	(99.6)	98.7	92.8	84.9	67.4	17.5	13.8	6.8
EP-G-03	100	(98.5)	95.5	90.6	82.8	67.6	15.2	12.7	7.9
EP-G-04	100	(97.2)	91.6	85.2	77.5	65.0	12.5	14.1	12.0
EP-G-05	100	(97.8)	93.4	86.7	77.9	64.2	13.7	15.5	11.0
EP-G-06	100	(97.2)	91.7	87.1	80.2	67.9	12.3	11.5	10.1
~~EP-G-07~~	~~100~~	~~(96.8)~~	~~90.4~~	~~85.2~~	~~79.3~~	~~65.9~~	~~13.4~~	~~11.1~~	~~11.6~~
EP-G-08	100	(98.4)	95.2	91.4	85.2	71.7	13.5	10.0	7.0
EP-G-09	100	(99.5)	98.5	93.0	88.2	75.9	12.3	10.3	6.5
EP-G-10	100	(99.4)	98.1	92.3	84.3	69.8	14.5	13.8	7.1
EP-G-11	100	(95.5)	86.5	76.6	67.4	55.4	12.0	19.1	18.9
EP-G-12	100	(98.5)	95.4	90.4	84.7	67.0	17.7	10.7	8.1
EP-G-13	100	(98.8)	96.5	87.4	79.0	61.7	17.3	17.5	11.4
EP-G-14	100	(99.2)	97.7	91.8	84.7	68.5	16.2	13.0	7.4
EP-G-15	100	(99.3)	97.8	92.3	86.5	71.7	14.8	11.3	7.0
EP-G-16	100	(99.4)	98.3	94.6	87.2	72.5	14.7	11.1	4.8
EP-G-17	100	(98.9)	96.8	89.9	81.7	64.4	17.3	15.1	9.0
EP-G-18	100	(96.5)	89.6	84.5	75.3	60.8	14.5	14.3	12.0
EP-G-19	100	(99.3)	97.8	89.7	82.6	68.0	14.6	15.2	9.6
EP-G-20	100	(98.4)	95.2	90.2	81.6	69.0	12.6	13.6	8.2
Range	100		86.5 to 98.7	76.6 to 94.6	67.4 to 88.2	55.4 to 75.9	12.0 to 19.1	10.0 to 20.9	4.8 to 18.9
Mean	100		95.12	88.86	81.39	66.6	14.79	13.73	9.53
Std. Dev.	0		3.47	4.17	4.92	5.01	2.11	2.93	3.30
Mean ± S.D.	100		91.65 to 98.59	84.69 to 93.03	76.47 to 86.31	61.59 to 71.61	12.68 to 16.90	10.80 to 16.66	6.23 to 12.83
Mean - SEM							14.34	13.07	8.79

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature CHENEY DISPOSAL SITE
Item GRADATIONS

Contract No. 5025-16
Designed H.L.
Checked SHB

Sheet 30
File No.
Date 5-02-90
Date 7-3-90

PROPOSED GRADATION (~~DATA~~ FROM REF. 3)
(4" - 9")

SAMPLE	SIEVE SIZE	% RETAINED	RETAINED PERCENT.	PASSING PERCENTAGE
	9"	0	0	100
	8"	7.33	46*	54**
S-1	6"	1.81	12	42
	5"	2.60	16	26
	4"	4.12	26	0
		Σ = 15.86		
	9"	0	0	100
	8"	1.2	8	92
S-2	6"	3.14	20	72
	5"	6.38	42	30
	4"	4.59	30	0
		Σ = 15.31		
	9"	0	0	100
	8"	6.38	41	59
S-3	6"	4.08	26	33
	5"	2.11	13	20
	4"	3.16	20	0
		Σ = 15.73		

KEY:

* $\frac{7.33}{15.86} \times 100\% = 46\%$ ⟶ % RETAIN

** % PASSING = 100 - 46 = 54%

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 31
Project UMTRA - GJT
Contract No. 5025-16
File No.
Feature CHENEY DISPOSAL SITE
Designed H.L.
Date 5-02-9
Checked SLR
Date 7-3-90
Item GRADATIONS

SAMPLE	SIZE	% RETAINED	RETAINED PERCENT	PASSING PERCENTAGE
S-4	9"	0	0	100
	8"	4.65	28	72
	6"	3.14	19	53
	5"	3.57	21	32
	4"	5.36	32	0
		16.72		
S-5	9"	0	0	100
	8"	5.58	44	56
	6'	1.62	13	43
	5"	1.70	14	29
	4"	3.64	29	0
		12.54		

PROPOSED GRADATION

(5" – 11")

SAMPLE	SIEVE	% RETAINED	RETAINED PERCENT.	PASSING PERCENTAGE
S-1	11"	0	0	100
	8'	7.33	63	37
	6"	1.81	15	22
	5"	2.6	22	0
		11.74		
S-2	11"	0	0	100
	8"	1.2	11	89
	6"	3.14	29	60
	5"	6.38	60	0
		10.72		

Project UMTRA - GRJ
Feature CHENEY DISPOSAL SITE
Item GRADATIONS

Contract No. 5025-16
Designed H.L.
Checked SWB

Sheet -32
File No.
Date 5-2-90
Date 7.3.90

5"–11" CONT'D

SAMPLE	SIZE	% RETAINED	RETAINED PERCENT.	PASSING PERCENTAG
	11"	0	0	100
S-3	8"	6.38	51	49
	6"	4.08	32	17
	5"	2.11	17	0
	Σ =	12.57		
	11"	0	0	100
S-4	8"	4.65	41	59
	6"	3.14	28	31
	5"	3.57	31	0
	Σ =	11.36		
	11"	0	0	100
S-5	8"	5.58	63	37
	6"	1.62	18	19
	5"	1.70	19	0
	Σ =	8.90		

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 33
Project UMTRA - GRJ
Contract No 5025-16
File No.
Feature CHENEY DISPOSAL SITE
Designed H.L.
Date 5-3-90
Item GRADATIONS
Checked
Date 7.3.90

PROPOSED GRADATION
(1" - 4")

SAMPLE	SIEVE SIZE	% RETAINED	RETAINED PERCENT	PASSING PERCENTAGE
S-1	4"	0	0	100
	3"	4.56	19	81
	2"	8	33	48
	1"	11.75	48	0
		Σ = 24.31		
S-2	4"	0	0	100
	3"	4.95	28	72
	2"	4.64	26	46
	1"	8.24	46	0
		Σ = 17.83		
S-3	4"	0	0	100
	3"	3.34	18	82
	2"	7.16	38	44
	1"	8.46	44	0
		Σ = 18.96		
S-4	4"	0	0	100
	3"	4.81	17	83
	2"	10.37	36	47
	1"	13.68	47	0
		Σ = 28.86		

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

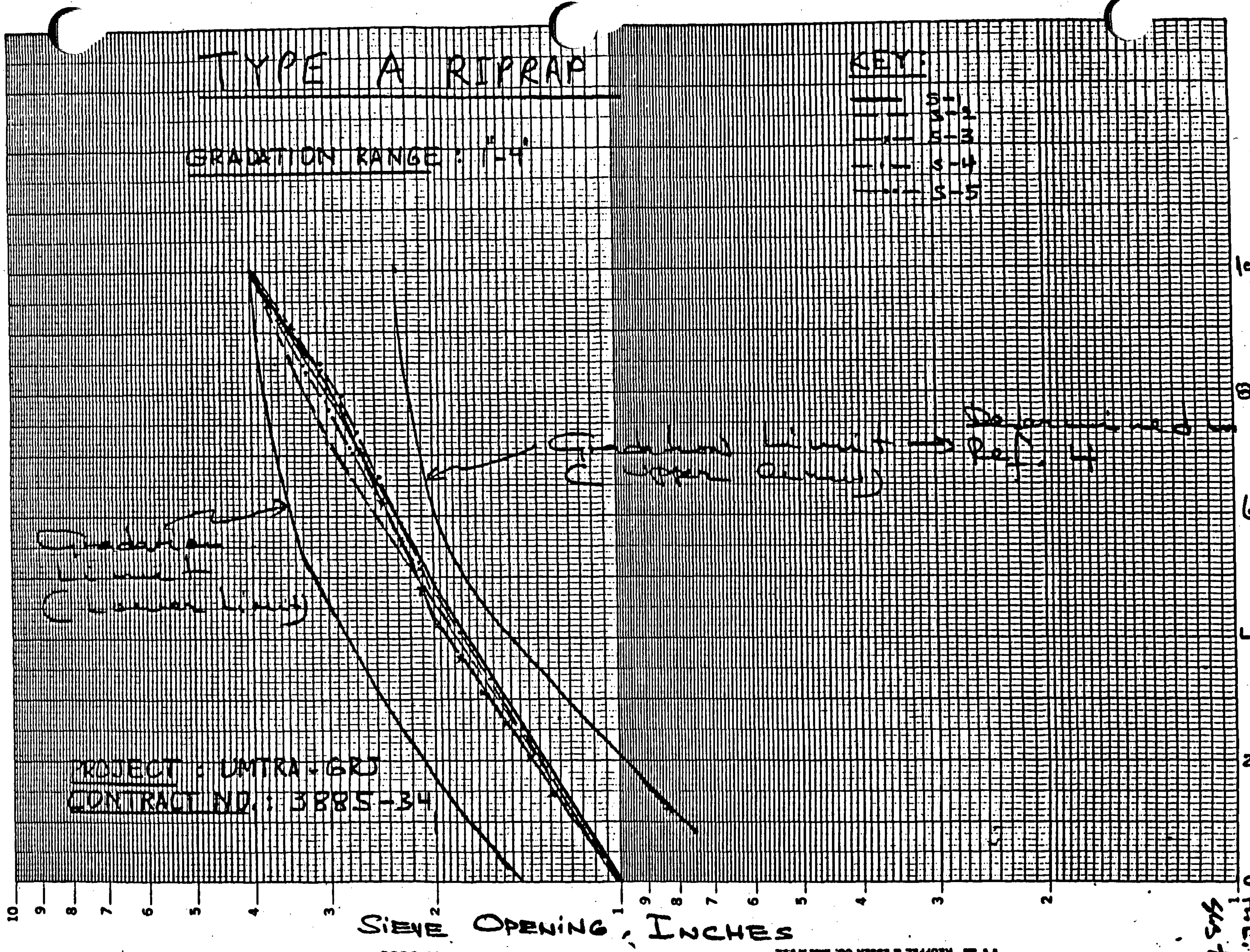
Project UMTRA - GRJ
Feature CHENEY SITE
Item GRADATIONS

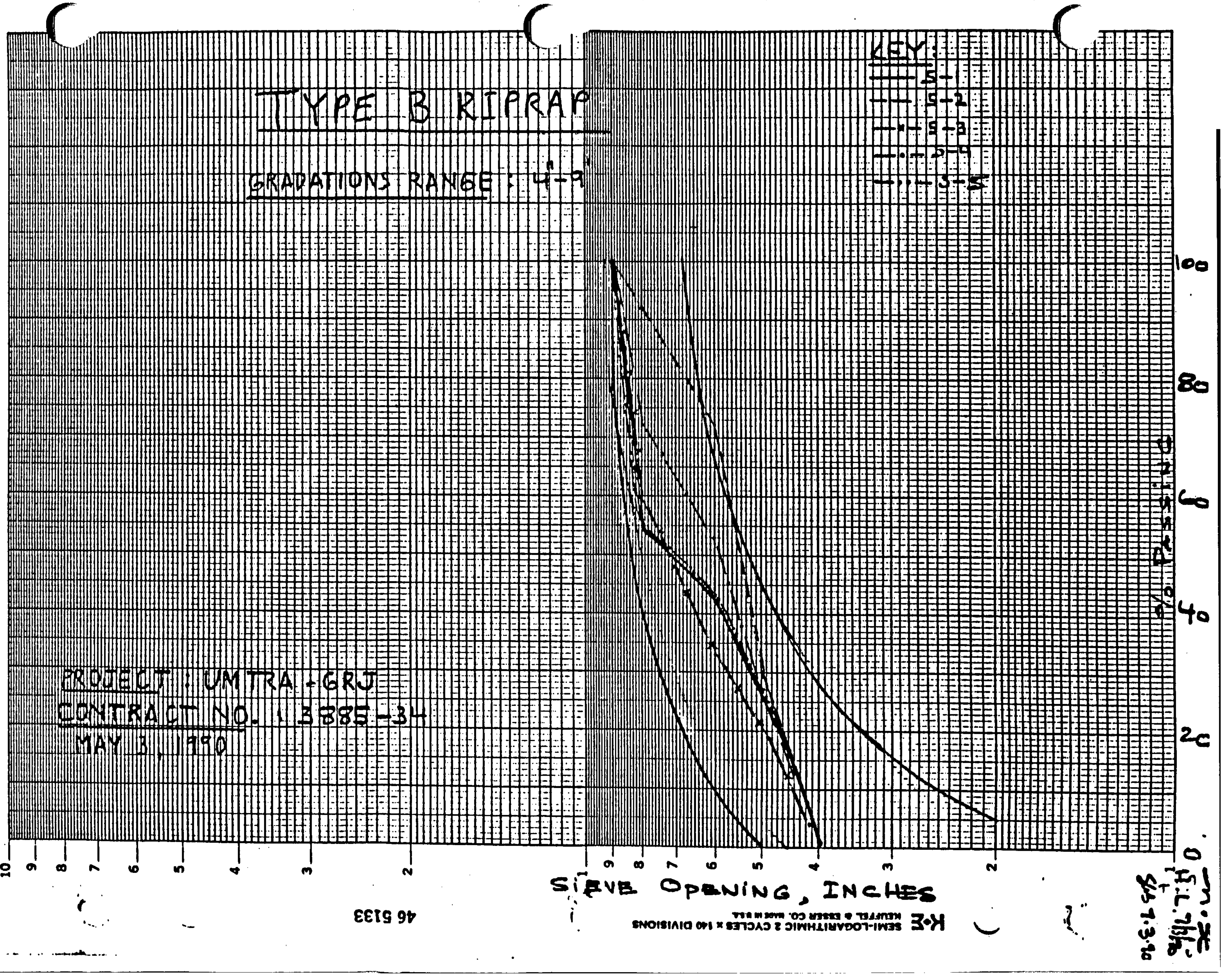
Contract No. 5025-16
Designed H.L.
Checked SWS
Sheet 34
File No.
Date 7/3/90
Date 7.3.90

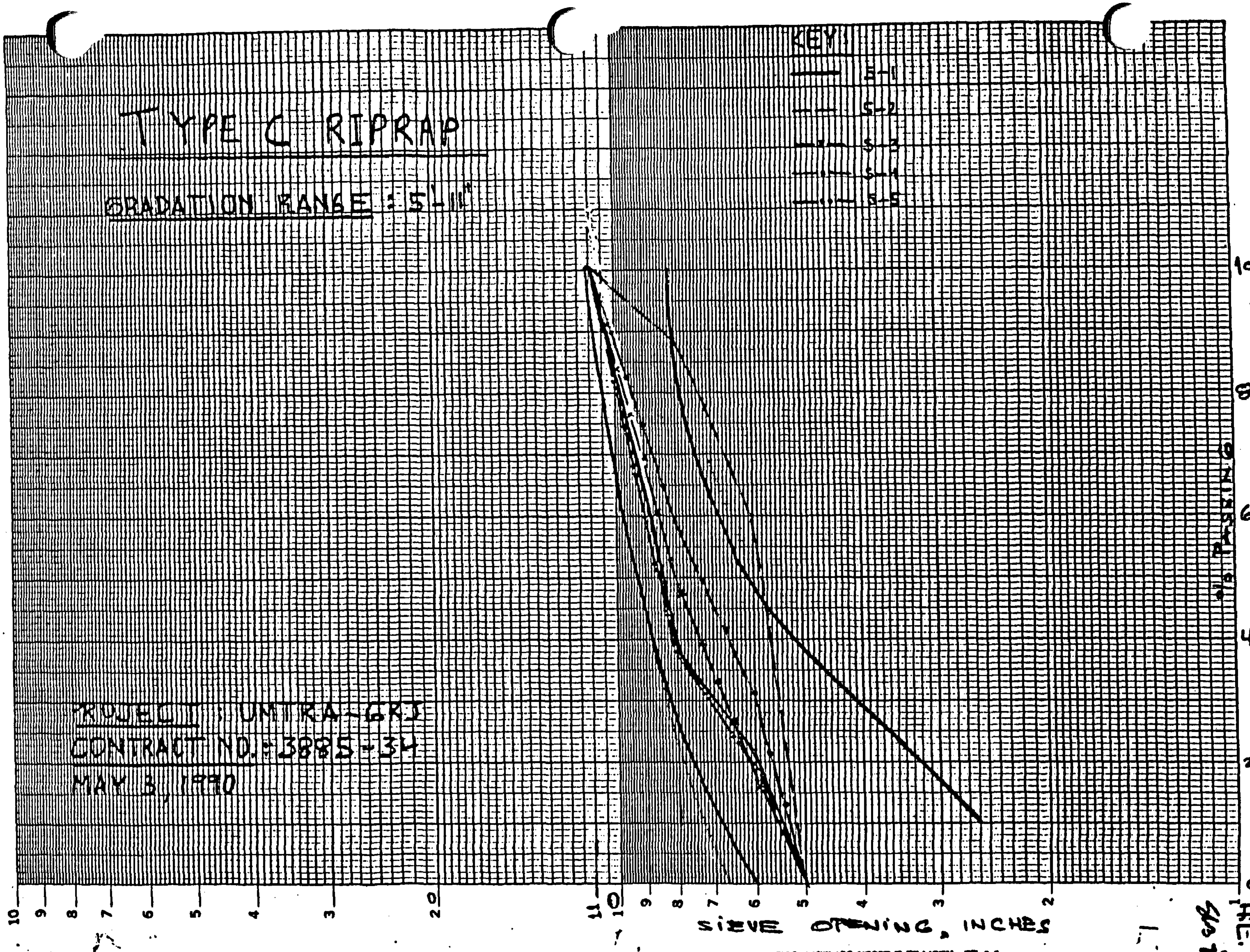
Gradation 1"–4" Continued

SAMPLE	SIEVE SIZE	% RETAINED	RETAINED PERCENT.	PASSING PER
	4"	0	0	100
S-5	3"	4.41	21	79
	2"	6.26	30	49
	1"	10.53	49	0
		Σ= 21.2		

The passing percentages are then plotted on Sheets 35, 36, and 37.


TYPE A RIPRAP
GRADATION RANGE: 1"-4"
KEY:
S-1
S-2
S-3
S-4
S-5
Gradation Limit (Lower Limit)
Gradation Limits (Upper Limit) → Determined by Ref. 4
PROJECT: UMTRA-GRJ
CONTRACT NO.: 3885-34
100
80
60
40
20
0
10
9
8
7
6
5
4
3
2
1
9
8
7
6
5
4
3
2
1
SIEVE OPENING, INCHES
46 5133
K+E SEMI-LOGARITHMIC 2 CYCLES × 140 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
S/S 7.3.9
H.L. 7/1/86
5.3


TYPE B RIPRAP
GRADATIONS RANGE : 4"-9"
KEY:
S-1
S-2
S-3
S-4
S-5
PROJECT : UMTRA - GRJ
CONTRACT NO. : 3885-34
MAY 3, 1990
100
80
60
40
20
0
% PASSING
10
9
8
7
6
5
4
3
2
1
9
8
7
6
5
4
3
2
1
SIEVE OPENING, INCHES
46 5133
K+E SEMI-LOGARITHMIC 2 CYCLES × 140 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
H.S.L. 7/3/90
SA 7.3.90

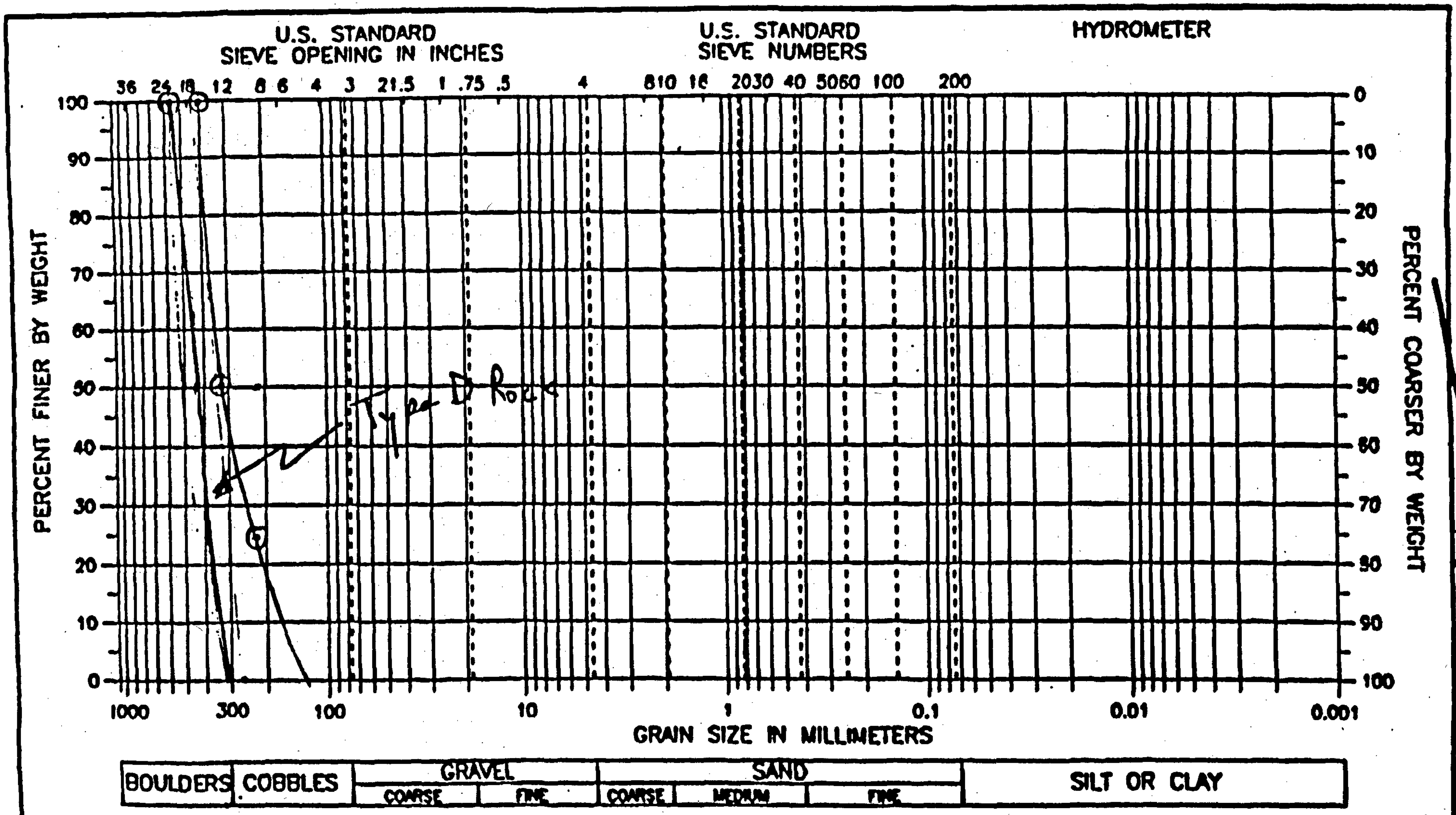


TYPE C RIPRAP

GRADATION RANGE: 5"-11"

PROJECT: UMTRA-GRJ
CONTRACT NO.: 3885-34
MAY 3, 1990

1.HL.7.RP
SAS 7.3.96



SAMPLE NO.	DEPTH	CLASSIFICATION	W %	LL	PL	PI

From REF. 5

SAS 7.13.90

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 38A
Project UMTRA GRT
Contract No. 5025-16
File No.
Feature CHENEY II SITE
Designed SGB
Date 5/4/90
Item EXCAVATION QUANTITY
Checked JAE.
Date 5/4/90

GRAVEL QUANTITY

SECTION	AREA	AVE AREA	DISTANCE	VOLUME
92200	16585			
		16725	200	3345000
92400	16864			
		17337	200	3467400
92600	17809			
		15825	200	3165000
92800	13841			
		14345	200	2869000
93000	14849			
		16988	400	6795200
CHANGE SCALE * 93400	19127			
				19641600 FT³
				727,467 CY

OR

SECTION	AREA	AVE AREA	DISTANCE	VOLUME
11000	8602			
		7641	200	1528200
11200	6680			
		8463	200	1692600
11400	10245			
		9223	200	1844600
11600	8200			
		12377	200	2475400
11800	16554			
		15500	200	3100000
12000	14446			
		17670	200	3534000
12200	20894			
		18484	200	3696800
12400	16073			
		14609	200	2921800
12600	13144			
				20793400 FT³
				770,126 CY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-GRJ Contract No. 5025-16 Sheet 39 File No.
Feature CHENEY DISPOSAL SITE Designed PS Date 4/25/90
Item GRADATIONS Checked GWB Date 7-3-90

Assume available volume of gravelly soil (upto 14-inch) = 700,000 cy).

1"-3" — Use 14 pct ---- 98,000 cy
(From Sh. 27, use 14% instead of 17%, due to discrepancy explained on Sh. 7)

3"-8" — Use 13 pct - - - - 91,000 cy
(From Sh. 27)

5"-12" - Use 8 pct - - - - - 56,000 cy
(From Sh. 27)

1"-4" — Use 20 pct ---- 140,000 cy
(From Sh. 27)

4"-9" — Use 10 pct ----- 70,000 c.y.
(From Sh. 27, use 10% instead of 11%)

5"-11" — USE 7 PCT ----- 49,000 c.y.
(From Sh. 28)

11"(+) — For Type D Riprap
Assume 3% . ---- 21,000 c.y.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA [illegible]
Feature [illegible] SITE
Item EXCAVATION QUANTITY

Contract No. 5025-16
Designed She
Checked JLe.

Sheet 40
File No.
Date 5/4/90
Date 5/4/90

LOWER CLAY VOLUME

SECTION	AREA	AVE. AREA	DISTANCE	VOLUME
92200	19731			
		15748	200	3149600
92400	11764			
		10765	200	2153000
92600	9765			
		8587	200	1717400
92800	7409			
		5379	200	1075800
93000	3348			
		3302	400	1320800
(CHANGE SCALE) * 93400	3255			
				9416600 FT³
				348,763 CY

OR

11000	3673			
		4758	200	951600
11200	5843			
		6037	200	1207400
11400	6231			
		6092	200	1218400
11600	5952			
		5611	200	1122200
11800	5270			
		6890	200	1378000
12000	8509			
		7657	200	1531400
12200	6804			
		9517	200	1903400
12400	12230			
		7588	200	1517600
12600	2945			
				10830000 FT³
				401111 CY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GCJ
Feature MANKOS SHALE QUANTITY
Item

Sheet
Contract No. 5025
File No.
Designed [illegible] Date 4/30/9
Checked [illegible] Date 5-1-9

MANCOS SHALE

ELEVATION	AREA	AVE. AREA	DISTANCE	VOLUME
5165	38440			
		158100	5	790500
5170	277760			
		377580	5	1887900
5175	477400			
		543740	5	2718700
5180	610081			
		652241	5	3261205
5185	694401			
		562030	5	2810150
5190	429660			
		453220	5	2266100
5195	476781			
		465311	5	2326555
5200	453841			
		362550	5	1812750
5205	271260			
		219020	5	1095100
5210	166780			
		146320	5	731600
5215	125860			
		101370	5	506850
5220	76880			
		73470	5	367350
5225	70060			
		56420	5	282100
5230	42780			

20,856,860 FT^3

772476 cy

Calculation Cover Sheet

MKE DOCUMENT NO. 5025-GRJ-C-01-01006-02

Contract No. 5025

Discipline Earth Sci

Calc. No. 05-654-01-02

No. of Sheets 15

Project

UMTRA / GRAND JUNCTION

Feature

HYDROGEOLOGY

Item

DEWATERING

Sources of Data

Sources of Formulae & References

1. U.S. Dept. of Energy, "Draft Environmental Impact Statement, Remedial Actions at the Former Climax Uranium Company, Uranium Mill Site, Grand Junction, Mesa County, Colorado." Vol. I – Text. March, 1986
2. U.S. Dept. of Energy, "Draft Environmental Impact Statement, Remedial Actions at the Former Climax Uranium Company, Uranium Mill Site, Grand Junction, Mesa County, Colorado." Vol. II – Appendices, March, 1986.
3. MKE Calculation No. 05-622-01-00, UMTRA / GRAND JUNCTION, DEWATERING, 1986

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. 05-654-01-00

2		Jim Kaan	5/2/88	G E Kroth	5/2/88		5/2/88
1		Jim Kaan	1/5/88	G E Kroth	1/6/88		1/14/8
0		Jim Kaan	3/26/87	G E Kroth	3/31/87		4/6/87
Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date

Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 1A
Project UMTRA
Contract No. 5025
File No.
Feature Hydrogeology
Designed JTK
Date 3/18/87
Item Dewatering
Checked GEK
Date 3/30/87

Purpose :- To determine the maximum dewatering rate required during removal of contaminated material in an excavation completely enclosed by slurry wall.

Based on the estimated maximum dewatering rate, the justification of discharging NH_3 and TDS to the Colorado River will be assessed through water quality consideration

Approach :- 4 components of inflow into the excavation are estimated separately and are shown on figures on sh. 1 and 5 as Q_1, Q_2, Q_3 and Q_4. The maximum size of excavation at any given time in the contaminated area bounded by slurry wall is assumed to be 500' x 300'. The excavation depths are shown on fig. 1

The perimeter of the area to be excavated coincides approximately with the alignment of the proposed slurry wall. It is divided into segments with different groundwater and bedrock elevations for purpose of analysis.

Sheet 18
Project UMTRA
Contract No. 5025
File No.
Feature Hydrogeology
Designed JTK
Date 3/10/87
Item Dewatering
Checked GEK
Date 3/30/87

To minimize the inflow rate into the excavation, it is recommended that the 500'x300' excavation be started from the eastern side where the excavation depths are shallower and consequently moving to deeper depths at the west so that the release of groundwater storage from the contaminated material is gradual. Preferably, the excavation will be configured to have its long side parallel and as close as possible to the slurry wall, if feasible. Inflows will be computed for different times when the excavation occupies different segments of the area of contaminated material.

Summary of results:

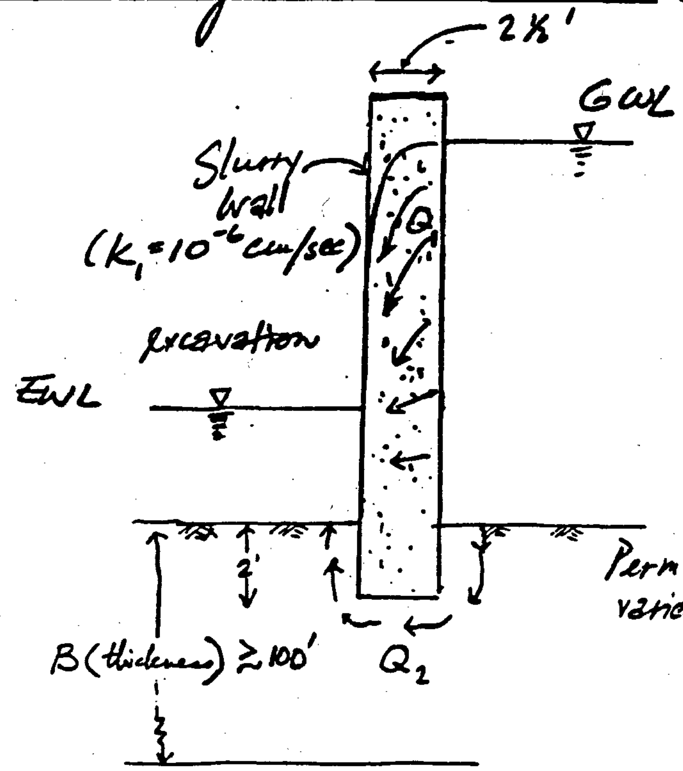
GEK 5/2/88
JTK 5/2/88

~~The maximum dewatering rate is estimated to be 51 gpm in the southeast corner of the excavation. Elsewhere in the excavation, the maximum rate is expected to be lower than 40 gpm. Thus, water quality problems for NH_3 and TDS are not anticipated.~~

The maximum dewatering rate is estimated to be 73 gpm in the northwest corner of the excavation. Elsewhere in the excavation the maximum rate is expected to range from 21 to 65 gpm.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - Grand Junction
Contract No. 5025
Sheet 1
File No.
Feature Hydrogeology
Designed JTK
Date 3/18/87
Item Dewatering
Checked GEK
Date 3/30/87



Note: GWL, EWL BRE & BEA are shown on attached Sheet 10

Permeability of Shale (k_2) varies from 2×10^{-7} to 5×10^{-4} cm/sec (ref. 2)

Segment	GWL	EWL *	Δh (ft) (GWL - EWL)	k_2 (cm/sec)
AB	4563	4554	9	2×10^{-7}
BC	4565	4554	11	2×10^{-7}
CD	4565	4554	11	6×10^{-5}
DE	4566	4560	6	6×10^{-5}
EF	4567	4554	13	6×10^{-5}
FG	4568	4564	4	6×10^{-5}
GH	4567	4562	5	5×10^{-4}
HI	4565	4560	5	5×10^{-4}
IJ	4564	4560	4	6×10^{-5}
JA	4564	4554	10	6×10^{-5}

* Equal to estimated average excavation depth for the entire excavation segment.

Sheet 2
Project UMTRA
Contract No. 5025
File No.
Feature Hydrogeology
Designed JTK
Date 3/18/87
Item Dewatering
Checked GEK
Date 3/20/87

Q_1 computation (Seepage through slurry wall)

Assume K_1 for slurry wall $= 1 \times 10^{-6}$ cm/sec
$= 2 \times 10^{-6}$ ft/min

$$Q_1 = K_1 \cdot b \cdot \frac{\Delta h}{2.5}$$ per unit length of wall

where b = saturated thickness in wall $\simeq \Delta h$

$$= K_1 \cdot \frac{(\Delta h)^2}{2.5}$$

$$= 2 \times 10^{-6} \times \frac{(\Delta h)^2}{2.5} \times L_1 \times 7.48 \text{ gpm}$$

$$= 6 \times 10^{-6} \times L_1 \times (\Delta h)^2 \text{ gpm}$$ where L_1 = Total length of sides bounded by slurry wall

Segment	Δh (ft)	L_1 (ft)	Q_1 (gpm)
AB	9	800	0.4
BC	11	800	0.6
CD	11	800	0.6
DE	6	500	0.1
EF	13	500	0.5
FG	4	800	0.1
GH	5	500	0.1
HI	5	1000	0.2
IJ	4	1000	0.1
JA	10	500	0.3

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 3
Project UMTRA
Contract No. 5025
File No.
Feature Hydrogeology
Designed FTK
Date 3/19/87
Item Dewatering
Checked GEK
Date 3/30/87

Q_2 computation (Underseepage through shale beneath slurry wall)

shortest flow length = 6.5' ✓

longest flow length = 2(2+B) + 6.5   where B = assumed thickness of shale

$$\text{Ave. flow length} = \frac{\cancel{2}(6.5+2+B)}{\cancel{2}}$$

$$= 8.5 + B$$

$$\text{Ave. hydraulic gradient } i = \frac{\Delta h}{8.5+B}$$

$$\text{Ave. velocity through shale} = \frac{\Delta h \cdot k_2}{8.5+B}$$

$$Q_2 = \frac{\Delta h \cdot k_2 \cdot B}{8.5+B} \quad \left[\text{when } B \gg 8.5 \quad \frac{B}{8.5+B} = 1\right]^{*}$$ ✓

$\Rightarrow Q_2 = \Delta h \cdot K_2$ under per unit length of wall

$= \Delta h \cdot K_2 (1.97)(7.48)$ gpm under per unit length of wall

where K_2 is in cm/sec.
Δh is in ft.

$= \underline{14.7 \times \Delta h \times K_2}$ under per unit length of wall

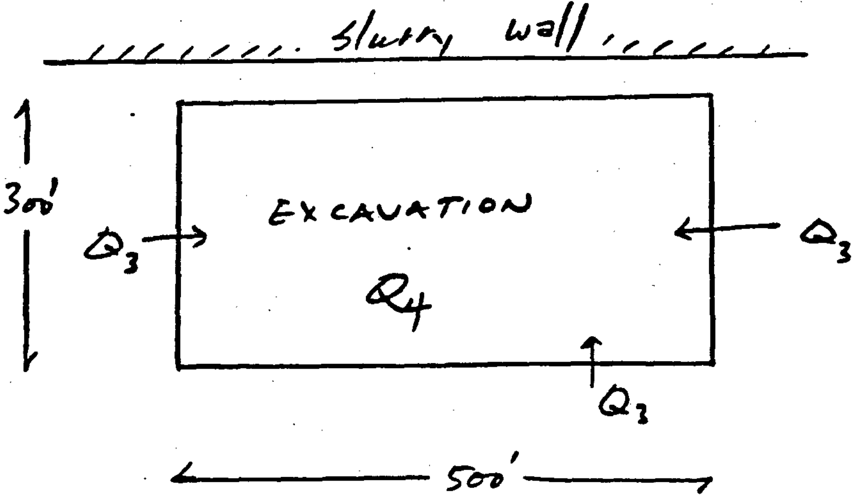
* The thickness of Mancos shale at the vicinity of the tailings site is at least 100 ft according to the RAP (ref. 2)

Project UMTRA Contract No. 5025 File No.
Feature Hydrogeology Designed JTK Date 3/19/87
Item Dewatering Checked GEK Date 3/30/87

Segment	L_1 (ft) Sh.2	Δh (ft)	K_2 (cm/sec) $\times 10^{-7}$ *	$Q_2 = 14.7 \times \Delta h \times K_2 \times L_1$ gpm (eq. from p.3)
AB	800	9	2	0.02
BC	800	11	2	0.03
CD	800	11	600	8.
DE	500	6	600	3.
EF	500	13	600	6.
FG	800	4	600	3.
GH	500	5	5,000	18.
HI	1000	5	5,000	37.
IJ	1000	4	600	4.
JA	500	10	600	4.

* K_2 values are obtained from Table F.3.2 ref. 2

Project UMTRA
Feature Hydrogeology
Item Dewatering
Contract No. 5025
File No.
Designed FTK
Date 3/19/87
Checked GEK
Date 3/30/87



Q_3 = inflow into the excavation from sides not bounded by slurry wall

Hydraulic gradient (i) of groundwater flowing into excavation $\simeq 0.0035$

Ave transmissivity = $(GWL - BRE) \times k_3$

where BRE = ave. bedrock elevation

k_3 = permeability of alluvium

= 0.014 cm/sec. = 39.69 ft/day

(obtained among conservative K values from field testing, ref. 3)

$$\therefore \quad Q_3 = k_3 \times (GWL - BRE) \times i \times L_2$$

$$= 39.69 \times (GWL - BRE) \times 0.0035 \times L_2 \times 7.48 / 1440$$

$$= 7.22 \times 10^{-4} \times L_2 \times (GWL - BRE) \text{ gpm} \checkmark$$

where L_2 = Total length of sides of excavation not bounded by slurry wall

A MORRISON KNUDSEN COMPANY

Project UMTRA — Contract No. 5025 — File No. ____
Feature Hydrogeology — Designed JTK — Date 3/23/87
Item Dewatering — Checked GEK — Date 3/30/87

Q_4 = Drainage from contaminated material being removed out of excavation

$$= (GWL - BEA) \times 300' \times 500' \times 0.03 \quad ft^3 \text{ in 10 days}$$

$$= 4500 \times (GWL - BEA) \times 7.48 / (10 \times 1440) \text{ gpm}$$

$$= 2.34 \times (GWL - BEA) \text{ gpm.}$$

Where BEA = Ave. elev. of bottom excavation

0.03 = specific yield of contaminated material consisting mostly of slime or slime/sand mixture

A MORRISON KNUDSEN COMPANY

Project UMTRA
Feature Hydrogeology
Item Dewatering

Contract No. 5025
Designed JTK
Checked GEK

File No.
Date 3/23/87
Date 3/31/87

Segment	GWL	BRE	BEA	L_2(ft)	Q_3*	Q_4*
					(gpm)	
AB	4563	4553	4556	800	6	16
BC	4565	4553	4556	800	7	21
CD	4565	4554	4555	800	6	23
DE	4566	4557	4560	1100	7	14
EF	4567	4558	4561	1100	7	14
FG	4568	4557	4564	800	6	9
GH	4567	4554	4563	1100	10	9
HI	4565	4553	4561	600	5	9
IJ	4564	4552	4562	600	5	5
JA	4564	4552	4552	1100	10	19

SUPERSEDED

JTK 1/14/88
GEK 1/14/88

* Q_3 and Q_4 are determined by equation on sh. 5 and 6 respectively

MK

Segment	GWL	BEA	V_4* (gal.)	Q_4** (gpm)
AB	4563	4556	1,570,800	40
BC	4565	4556	2,019,600	52
CD	4565	4555	2,244,000	58
DE	4566	4560	1,346,400	35
EF	4567	4561	1,346,400	35
FG	4568	4564	897,600	23
GH	4567	4563	897,600	23
HI	4565	4561	897,600	23
IJ	4564	4562	448,800	12
JA	4564	4556	1,795,200	46

A specific yield of .2 is typical of a silty gravel material /silty sand

* V_4 = Drainable volume in 300'×500' excavation

$= (GWL - BEA) \times .2$ (specific yield) $\times 7.48 \times 300 \times 500$

$= [224,400 \times (GWL - BEA)]$ gal.

** $Q_4 = V_4 / 27 \times 1440$ gpm assuming it takes 27 days to excavate the 300'×500' pit

Project UMTRA
Feature Hydrogeology
Item Dewatering
Contract No. 5025
Designed JTK
Checked GEK
Sheet 8
File No.
Date 3/23/87
Date 3/31/87

Segment	Q_1	Q_2	Q_3 (gpm)	Q_4	ΣQ
AB	0.4	0.02	6	16	22
BC	0.6	0.03	7	21	29
CD	0.6	8.	6	23	38
DE	0.1	3.	7	14	24
EF	0.5	6.	7	14	28
FG	0.1	3.	6	9	18
GH	0.1	18.	10	9	37
HI	0.2	37.	5	9	51
IJ	0.1	4.	5	5	14
JA	0.3	4.	10	19	33

SUPERSEDED

JTK 1/14/88
GEK 1/14/88

A MORRISON KNUDSEN COMPANY

Project UMTRA
Feature Hydrology
Item Dewatering

Contract No. 5025
Designed JTK
Checked GEK
File No.
Date 10/28/87
Date 11/3/87

Segment	Q_1	Q_2	Q_3	Q_4	ΣQ
AB	0.4	0.02	6	40	46
BC	0.6	0.03	7	52	60
CD	0.6	8	6	58	73
DE	0.1	3	7	35	45
EF	0.5	6	7	35	49
FG	0.1	3	6	23	32
GH	0.1	18	10	23	51
HI	0.2	37	5	23	65
IJ	0.1	4	5	12	21
JA	0.3	4	10	46	60

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA
Feature Hydrogeology
Item Water Quality
Contract No. 5025
Designed JTK
Checked GEK
Sheet 9
File No.
Date 3/25/87
Date 3/31/87

Max. discharge rate from excavation (from sh. 8)
= 51 gpm = 0.11 cfs ✓

7-day 10-yr. low flow in the Colorado River near DeBeque
= 1,140 cfs (RAP, ref 1)

NH_3 Concentration in Ground Water @ tailings site = 393 mg/l (RAP, ref 2)

NH_3 concentration in the mixing stream = $\frac{0.11 \text{cfs} \times 393}{1140 \text{cfs}}$

= 0.04 mg/l
< 0.06 mg/l stream standard
(Table F2.2 ref. 2)

TDS concentration in Groundwater @ tailings site = 6,000 mg/l

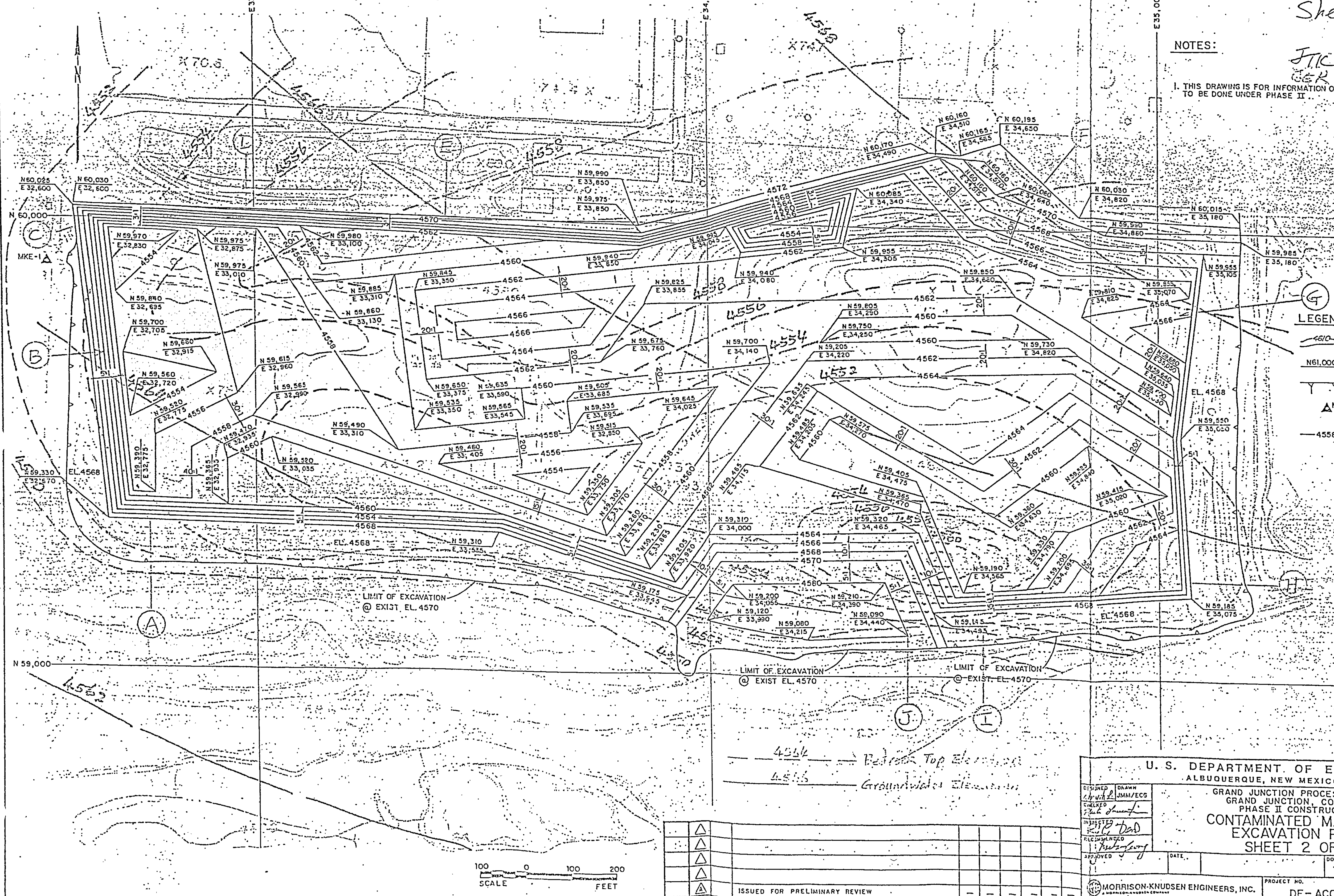
TDS concentration in the mixing stream = $\frac{0.11 \times 6{,}000}{1140}$

= 0.58 mg/l
<< 500 mg/l
(Table F.2.1 ref. 2)

SUPERSEDED

JTK 1/14/88
GEK 1/14/88

Sheet 1.0



NOTES:

JTC 3/25/87
GEK 3/31/87

1. THIS DRAWING IS FOR INFORMATION ONLY. EXCAVATION TO BE DONE UNDER PHASE II.

LEGEND:

4610	EXISTING SITE FEATURES & CONTOURS
N61,000	CONSTRUCTION GRID COORDINATE
⊤ ⊤	EXCAVATION
▲ MKE-1	PERMANENT SURVEY MONUMENT
—4558—	APPROX. ELEVATION CONTOUR OF THE BOTTOM CONTAMINATED MATERIAL TO BE EXCAVATED

— — 4554 — — → Bedrock Top Elevation
——— 4556 ——— Groundwater Elevation

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	TAC REV.	DOE APP
	△								
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	△								
	△								
	A		ISSUED FOR PRELIMINARY REVIEW	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

CONTAMINATED MATERIAL EXCAVATION PLAN
SHEET 2 OF 2

DESIGNED
DRAWN JMM/ECG
CHECKED
INSPECTED
RECOMMENDED
APPROVED
DATE
DOE PROJECT ENGINEER
DATE

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. GRJ-PS-10-
REV.

Calculation Cover Sheet

Calc. No. 05-654-02-00

Contract No. 5025 **Discipline** ESCUP **No. of Sheets** 8

Project

UMTRA - GRAND JUNCTION

Feature

SLURRY TRENCH AT PROCESSING SITE

Item

QUANTITIES

Sources of Data

MKE DWG NO. GRJ-PS-10-0218 "SLURRY TRENCH PROFILES"
MKE DWG NO. GRJ-PS-10-0209 "SLURRY TRENCH PLAN
MKE DWG NO. GRJ-PS-10-0210 "CONSTRUCTION FACILITIES SECTIONS AND DETAILS"

Sources of Formulae & References

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. 05-622-01

0		S.E. Botsford	12/30/87	WY Lin	1/13/88		1/13/88
Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ Contract No. 5025 Sheet 1
Feature SLURRY TRENCH AT PROCESSING SIT Designed SKB Date 12/30/87
Item Checked WYL Date 1/13/88
File No.

PURPOSE: THE PURPOSE OF THIS CALCULATION IS TO CALCULATE THE WALL AREA OF THE SLURRY TRENCH AND TO ESTIMATE THE AMOUNT OF FILL REQUIRED TO MAINTAIN THE WORKING SURFACE OF THE SLURRY TRENCH.

RESULTS:

SLURRY TRENCH AREA = 117,460 SF

FILL REQUIRED TO RAISE
WORKING SURFACE = 22,141 CY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 2
Project UMTRA - GRJ
Contract No. E025
File No.
Feature SLURRY TRENCH QUANTITIES
Designed SGB
Date 12/9/87
Item
Checked WYL
Date 1/13/88

WALL AREA OF SLURRY TRENCH

SEGMENT	LENGTH (FT)	AVE. TOP ELEVATION	AVE. BOTTOM ELEVATION	AVE. WALL HEIGHT (FT)	WALL AREA (FT^2)
AB	800	4570	4552	18	14400
BC	1360	4570	4554	16	21760
CD	480	4570	4554	16	7680
DE	420	4570	4554	16	6720
EF	330	4570	4554	16	5280
FG	850	4570	4552	18	15300
GH	1240	4570	4552	18	22320
HI	480	4570	4552	18	8640
IJ	760	4570	4552	18	13680
JA	80	4570	4549	21	1680
					117,460 FT^2

Sheet 3
Project UMTRA - GRJ
Contract No. 5025
File No.
Feature SLURRY TRENCH QUANTITIES
Designed SLB
Date 12/9/87
Item
Checked WYL
Date 1/13/88

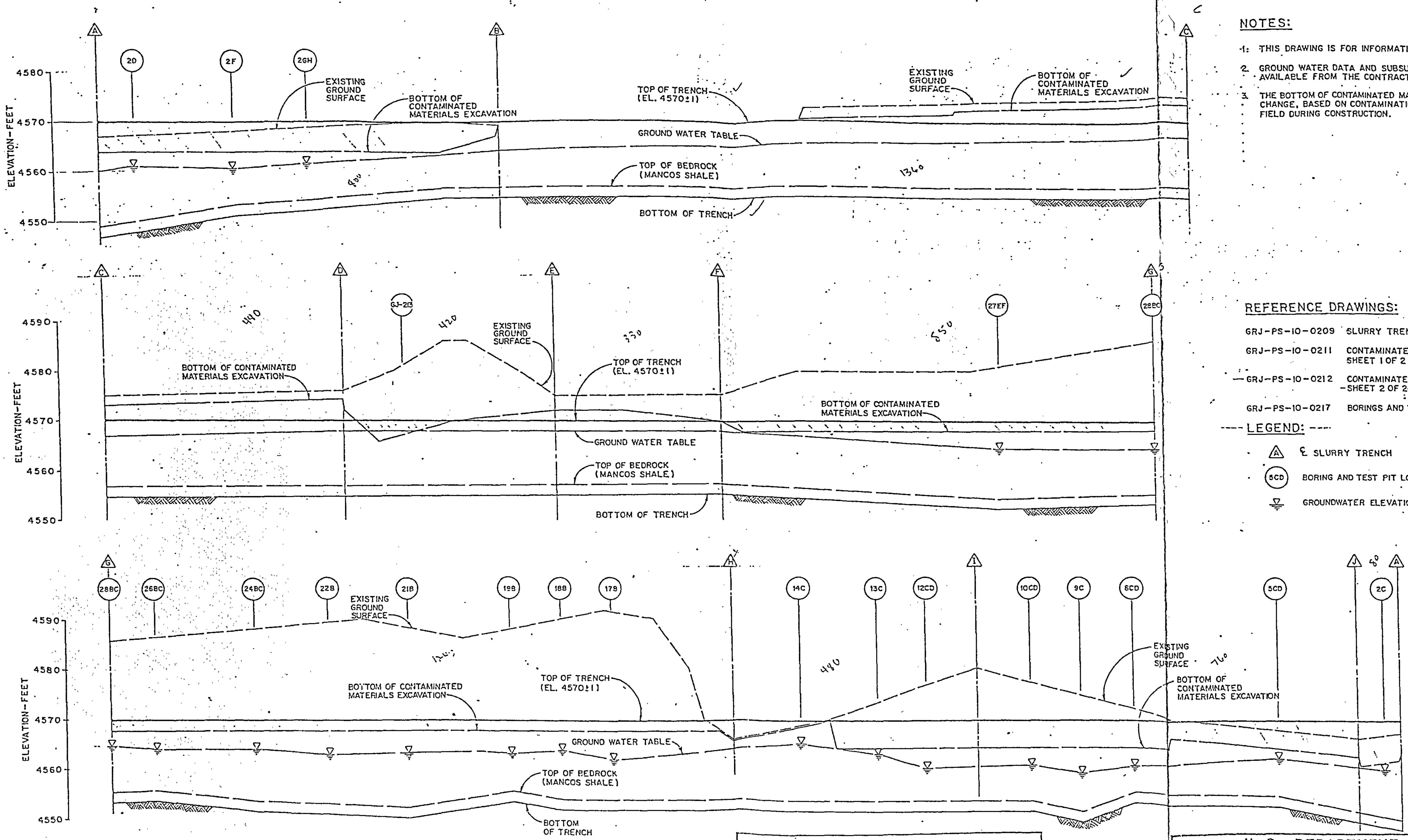
FILL FOR RAISING WORKING SURFACE OF SLURRY TRENCH

SEGMENT	LENGTH (FT)	AVE. FILL HEIGHT FOR RAISING 30' WIDE WORKING SURFACE (FT)	FILL VOLUME (CY)
AB	800	6	7467
DE	180	2	453
FG	850	2	2141
GH	1200	2	3022
HI	290	5	2148
IJ	760	5	5630
JA	80	9	1280
			22,141 CY

NOTES: 1. THE WALL EXTENDS 2' BELOW TOP OF ROCK

2. CONSTRUCTION SHALL BEGIN AFTER THE AREA ALONG THE SLURRY TRENCH ALIGNMENT HAS BEEN EXCAVATED TO ITS FINAL DEPTH TO REMOVE ALL CONTAMINATION.

3. ADDITIONAL FILL WILL BE CONSIDERED AT LOCATIONS WHERE THE WORKING SURFACE WILL BE RAISED TO ELEV. 4570 FROM THE FINAL GRADE.



SHT 4

NOTES:

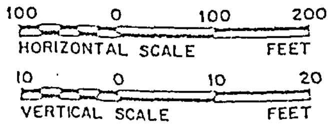
1. THIS DRAWING IS FOR INFORMATION ONLY.
2. GROUND WATER DATA AND SUBSURFACE EXPLORATION LOGS ARE AVAILABLE FROM THE CONTRACTOR.
3. THE BOTTOM OF CONTAMINATED MATERIALS EXCAVATIONS MAY CHANGE, BASED ON CONTAMINATION MEASUREMENTS IN THE FIELD DURING CONSTRUCTION.

REFERENCE DRAWINGS:

GRJ-PS-10-0209	SLURRY TRENCH PLAN
GRJ-PS-10-0211	CONTAMINATED MATERIAL EXCAVATION PLAN SHEET 1 OF 2
GRJ-PS-10-0212	CONTAMINATED MATERIAL EXCAVATION PLAN SHEET 2 OF 2
GRJ-PS-10-0217	BORINGS AND TEST PITS LOCATION PLAN

LEGEND:

△A	℄ SLURRY TRENCH
(5CD)	BORING AND TEST PIT LOCATIONS
▽	GROUNDWATER ELEVATION MEASURED IN BORING



FINAL REVIEW

E&D MANAGER	CHIEF ENGINEER	QA MANAGER

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	TAC REV	DOE APP
	△								
	△								
	△								
	△								
	△		ISSUED FOR FINAL REVIEW						

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED UE Wehl. | DRAWN J.M.M.
CHECKED
INSPECTED
RECOMMENDED
APPROVED | DATE | DOE PROJECT ENGINEER | DATE

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

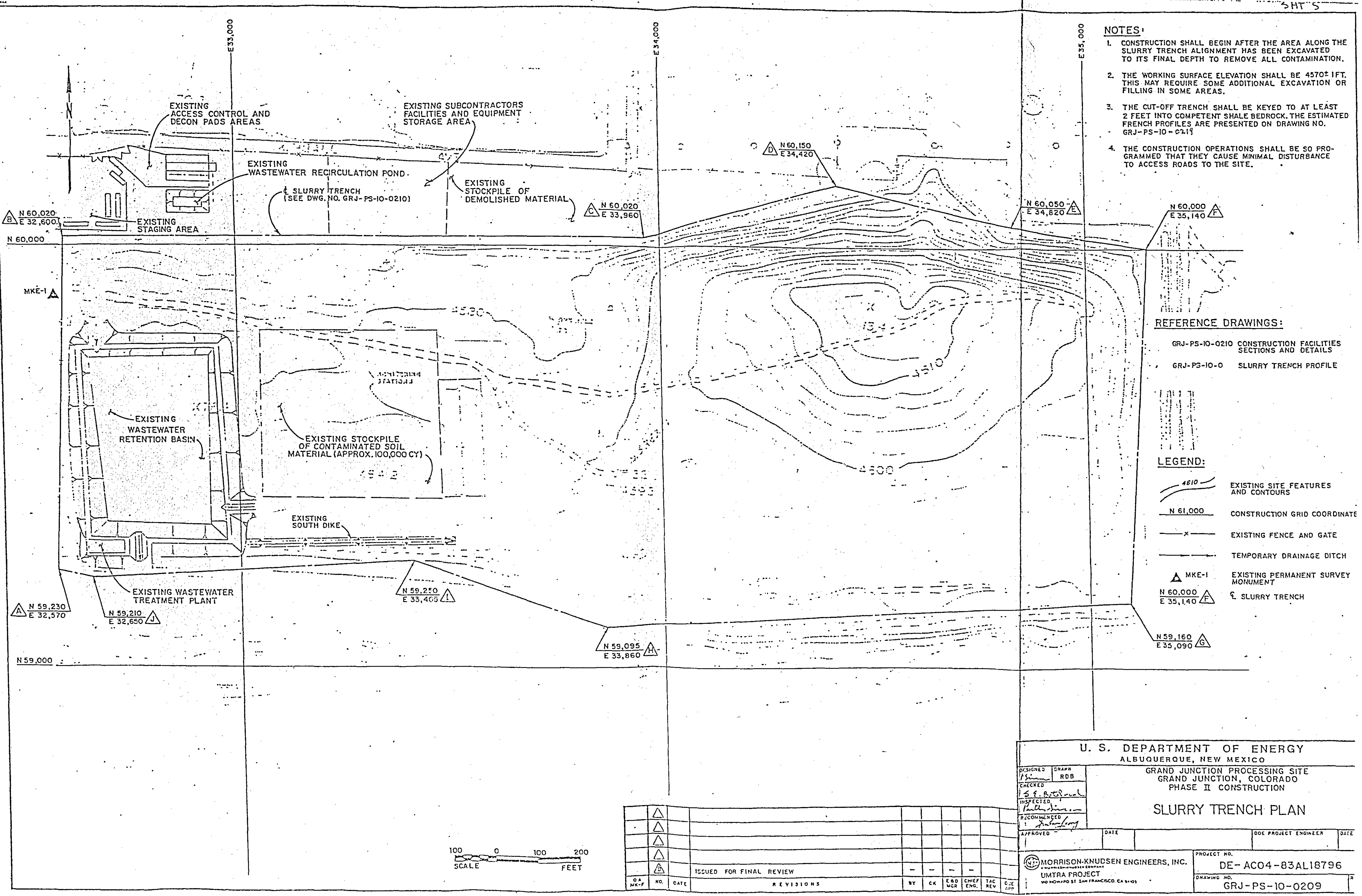
SLURRY TRENCH PROFILES

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. GRJ-PS-10-0218

SHT 5



NOTES:

1. CONSTRUCTION SHALL BEGIN AFTER THE AREA ALONG THE SLURRY TRENCH ALIGNMENT HAS BEEN EXCAVATED TO ITS FINAL DEPTH TO REMOVE ALL CONTAMINATION.
2. THE WORKING SURFACE ELEVATION SHALL BE 4570± 1FT. THIS MAY REQUIRE SOME ADDITIONAL EXCAVATION OR FILLING IN SOME AREAS.
3. THE CUT-OFF TRENCH SHALL BE KEYED TO AT LEAST 2 FEET INTO COMPETENT SHALE BEDROCK. THE ESTIMATED FRENCH PROFILES ARE PRESENTED ON DRAWING NO. GRJ-PS-10-0219
4. THE CONSTRUCTION OPERATIONS SHALL BE SO PROGRAMMED THAT THEY CAUSE MINIMAL DISTURBANCE TO ACCESS ROADS TO THE SITE.

REFERENCE DRAWINGS:

GRJ-PS-10-0210	CONSTRUCTION FACILITIES SECTIONS AND DETAILS
GRJ-PS-10-0	SLURRY TRENCH PROFILE

LEGEND:

4610	EXISTING SITE FEATURES AND CONTOURS
N 61,000	CONSTRUCTION GRID COORDINATE
—×—	EXISTING FENCE AND GATE
—·—·→	TEMPORARY DRAINAGE DITCH
▲ MKE-1	EXISTING PERMANENT SURVEY MONUMENT
N 60,000 E 35,140 F	℄ SLURRY TRENCH

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR	CHIEF ENG.	TAC REV	CJE APP
	△								
	△								
	△								
	△								
	5		ISSUED FOR FINAL REVIEW	–	–	–	–		

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED
DRAWN ROB
CHECKED S. E. B
INSPECTED
RECOMMENDED
APPROVED
DATE
DOE PROJECT ENGINEER
DATE

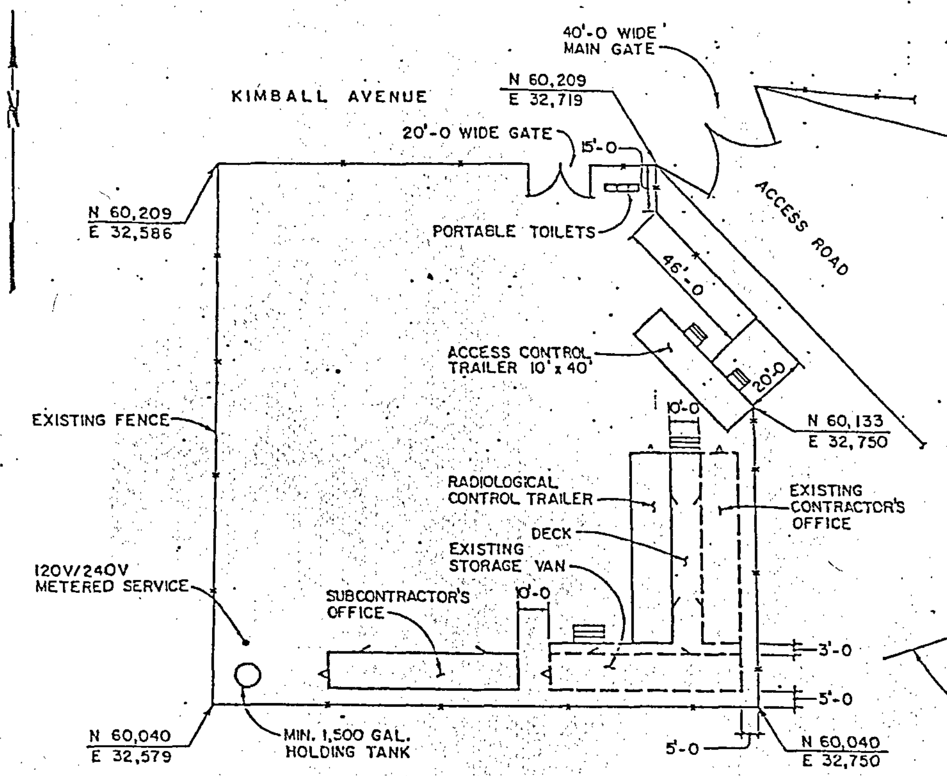
GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

SLURRY TRENCH PLAN

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. GRJ-PS-10-0209

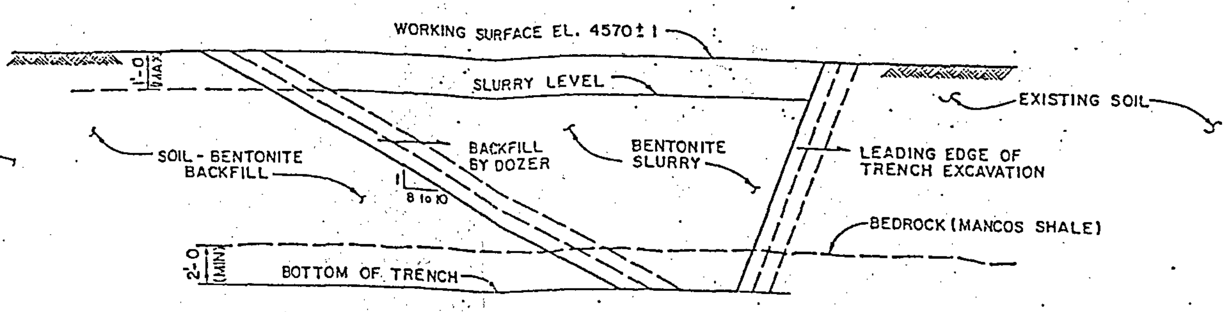
SHT 6



STAGING AREA

DWG. NO. GRJ-PS-10-0208

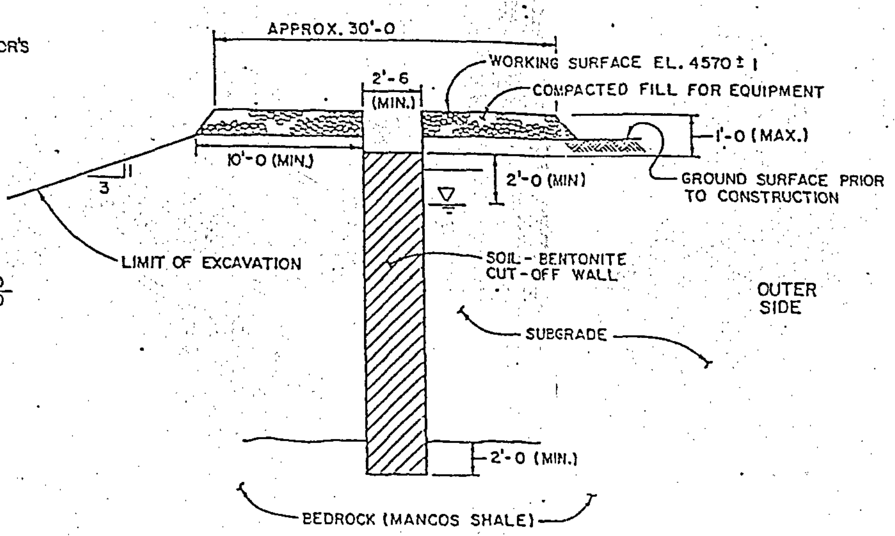
30 0 30 60
SCALE FEET



TYPICAL SLURRY TRENCH ELEVATION

DWG. NO. GRJ-PS-10-0209

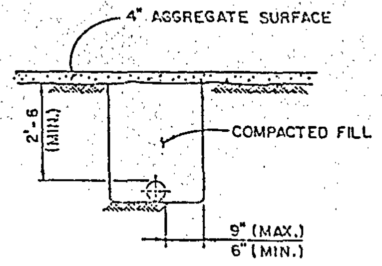
(NOT TO SCALE)



TYPICAL SLURRY TRENCH CROSS-SECTION

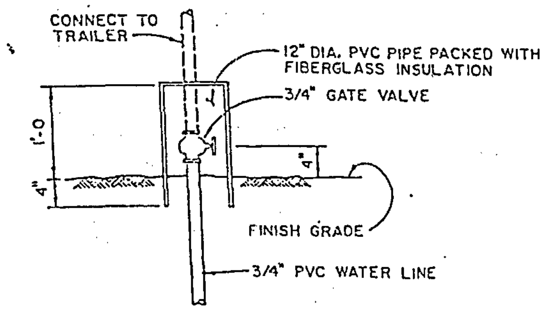
DWG. NO. GRJ-PS-10-0209

(NOT TO SCALE)



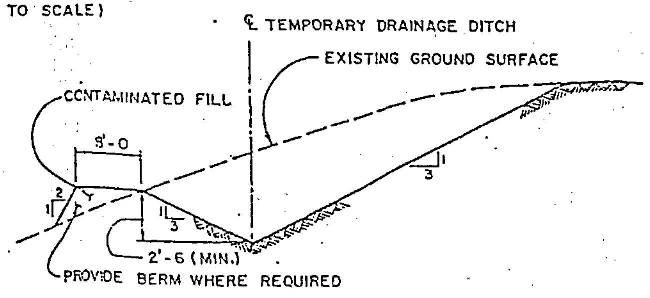
TYPICAL BEDDING AND BACKFILL FOR UTILITIES

(NOT TO SCALE)



TYPICAL STUB DETAIL

(NOT TO SCALE)



TYPICAL TEMPORARY DRAINAGE DITCH CROSS-SECTION

DWG. NO. GRJ-PS-10-0208

(NOT TO SCALE)

NOTES:

1. SEE NOTES ON DRAWING NO. GRJ-PS-10-0209 FOR SLURRY WALL.

REFERENCE DRAWINGS:

GRJ-PS-10-0208	CONSTRUCTION FACILITIES AND SITE DRAINAGE
GRJ-PS-10-0209	SLURRY TRENCH PLAN

FINAL REVIEW

E&D MANAGER	CHIEF ENGINEER	QA MANAGER

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	TAC REV.	DOE APP.
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	△								
	B		ISSUED FOR FINAL REVIEW	–	–	–	–		

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

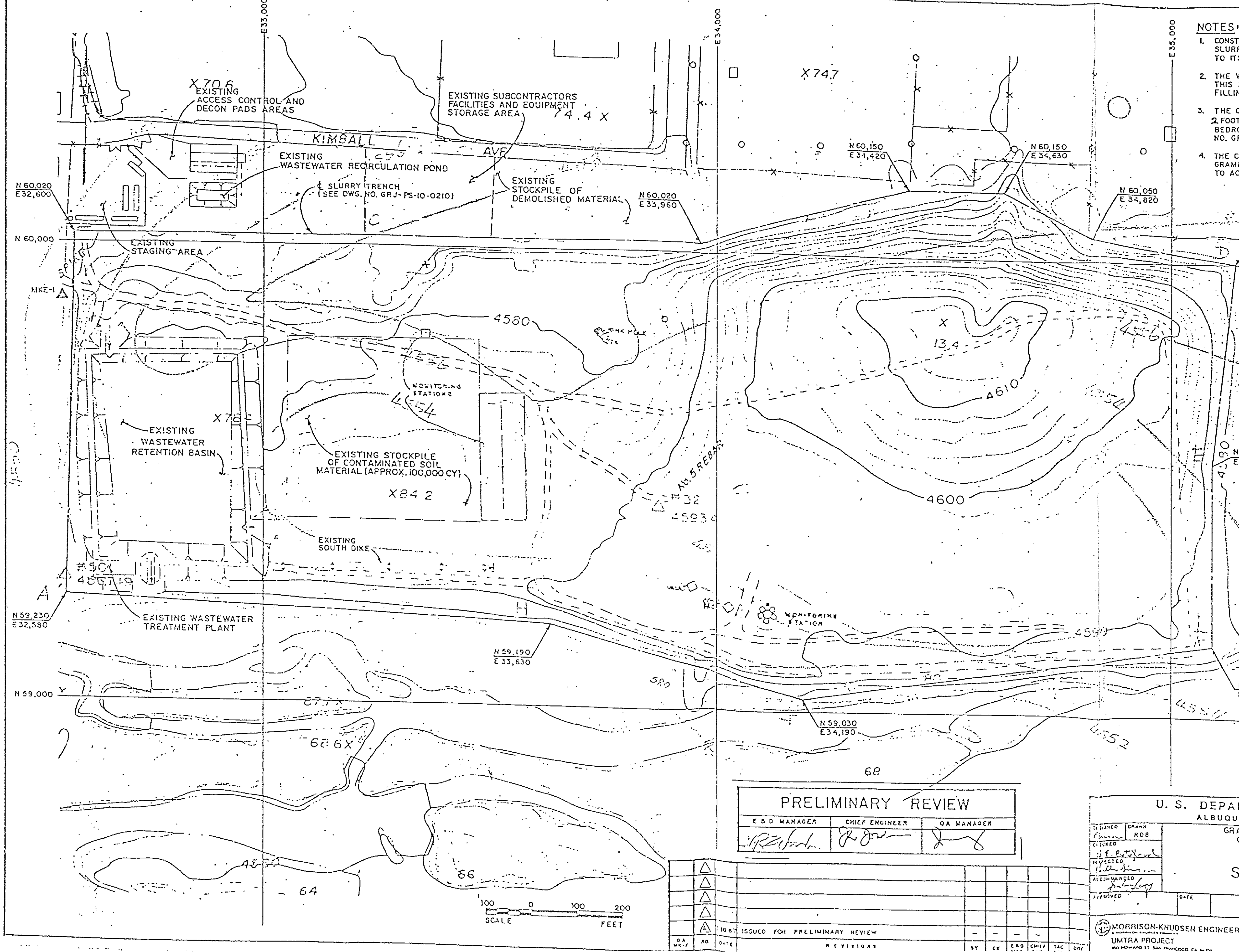
CONSTRUCTION FACILITIES SECTIONS AND DETAILS

DESIGNED: | DRAWN: AMC
CHECKED:
INSPECTED:
RECOMMENDED:
APPROVED: | DATE: | DOE PROJECT ENGINEER: | DATE:

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. GRJ-PS-10-0210
REV. B

SHT 7



NOTES:

1. CONSTRUCTION SHALL BEGIN AFTER THE AREA ALONG THE SLURRY TRENCH ALIGNMENT HAS BEEN EXCAVATED TO ITS FINAL DEPTH TO REMOVE ALL CONTAMINATION.
2. THE WORKING SURFACE ELEVATION SHALL BE 4570± 1FT. THIS MAY REQUIRE SOME ADDITIONAL EXCAVATION OR FILLING IN SOME AREAS.
3. THE CUT-OFF TRENCH SHALL BE KEYED TO AT LEAST 2 FOOT INTO BEDROCK (SHALE). THE ESTIMATED BEDROCK CONTOURS ARE PRESENTED ON DRAWING NO. GRJ-PS-10-0215.
4. THE CONSTRUCTION OPERATIONS SHALL BE SO PROGRAMMED THAT THEY CAUSE MINIMAL DISTURBANCE TO ACCESS ROADS TO THE SITE.

REFERENCE DRAWINGS:

GRJ-PS-10-0210	CONSTRUCTION FACILITIES SECTIONS AND DETAILS
GRJ-PS-10-0215	BEDROCK ELEVATIONS CONTOUR MAP

LEGEND:

4610	EXISTING SITE FEATURES AND CONTOURS
N 61,000	CONSTRUCTION GRID COORDINATE
—x—	EXISTING FENCE AND GATE
—·—·	TEMPORARY DRAINAGE DITCH
△ MKE-1	PERMANENT SURVEY MONUMENT

PRELIMINARY REVIEW

E&D MANAGER	CHIEF ENGINEER	QA MANAGER

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D	CHIEF	TAC	DOE
	△								
	△								
	△								
	△								
	△	7 16 87	ISSUED FOR PRELIMINARY REVIEW	—	—	—	—		

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED
DRAWN ROB
CHECKED J.F. Petty
INSPECTED
ASSIGNMENT
APPROVED
DATE

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

SLURRY TRENCH PLAN

DOE PROJECT ENGINEER
DATE

MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT

PROJECT NO.
DE-AC04-83AL18796
DRAWING NO.
REV

MKE DOCUMENT NO.5025-GRJ-C-01-01568-00

Calculation Cover Sheet

Contract No. 5025 **Discipline** ESCI **Calc. No.** 05-654-03-00 **No. of Sheets** 4

Project
UMTRA – Grand Junction

Feature
Hydrogeology

Item
Slurry Trench
Seepage Windows

Sources of Data

Sources of Formulae & References

1. MKE Calc. No. 05-654-01-01 Document No. 5025-GRJ-C-01-0106-00 "UMTRA - Grand Junction, Hydrogeology, Dewatering"
2. DOE, UMTRAP, Phase II Construction Drawings, Grand Junction, Colorado

Preliminary Calc. ☒ **Final Calc.** ☐ **Supersedes Calc. No.** ______

0		James T. Kar	1/11/88	WY Lin	1/12/88		1/15/88
Rev. No.	**Revision**	**Calculation By**	**Date**	**Checked By**	**Date**	**Approved By**	**Date**

Form 42-110

Project UMTRA – Grand Junction
Feature Hydrogeology
Item Seepage window
Contract No. 5025
Designed FTK
Checked WYL
Sheet 1
File No.
Date 1/11/88
Date 1/12/88

To restore the groundwater contours, seepage windows will be constructed through the slurry wall during reclamation. The number and size of the seepage windows will be such that the groundwater flux through the reclaimed area will be equal to the flux coming in.

With reference to the groundwater contours on pg. 3 (from ref. 2), the hydraulic gradient is fairly uniform throughout the area. Thus, equating the flux coming into the window and that through the window by Darcy's Law,

$$K_1 A_1 i = k_2 A_2 i$$

where K_1 = permeability of gravel backfill for window (at least 100 times k_2)

k_2 = permeability of alluvium (1.4×10^{-2} cm/sec from ref. 1)

A = $W \cdot T$ (W=width ; T=thickness of flow section)

Assume all windows will go through the entire thickness of the alluvium aquifer (i.e. into bedrock Dwg. # GRJ-PS-10-0210, ref. 2)

$\therefore T_1 = T_2$

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 2
Project UMTRA - Grand Junction
Contract No. 5025
File No.
Feature Hydrogeology
Designed JTK
Date 1/11/88
Item Seepage Window
Checked WYL
Date 1/12/88

$$k_1 W_1 = k_2 W_2$$

$$100\ W_1 = W_2$$

$$W_1 = \frac{W_2}{100}$$

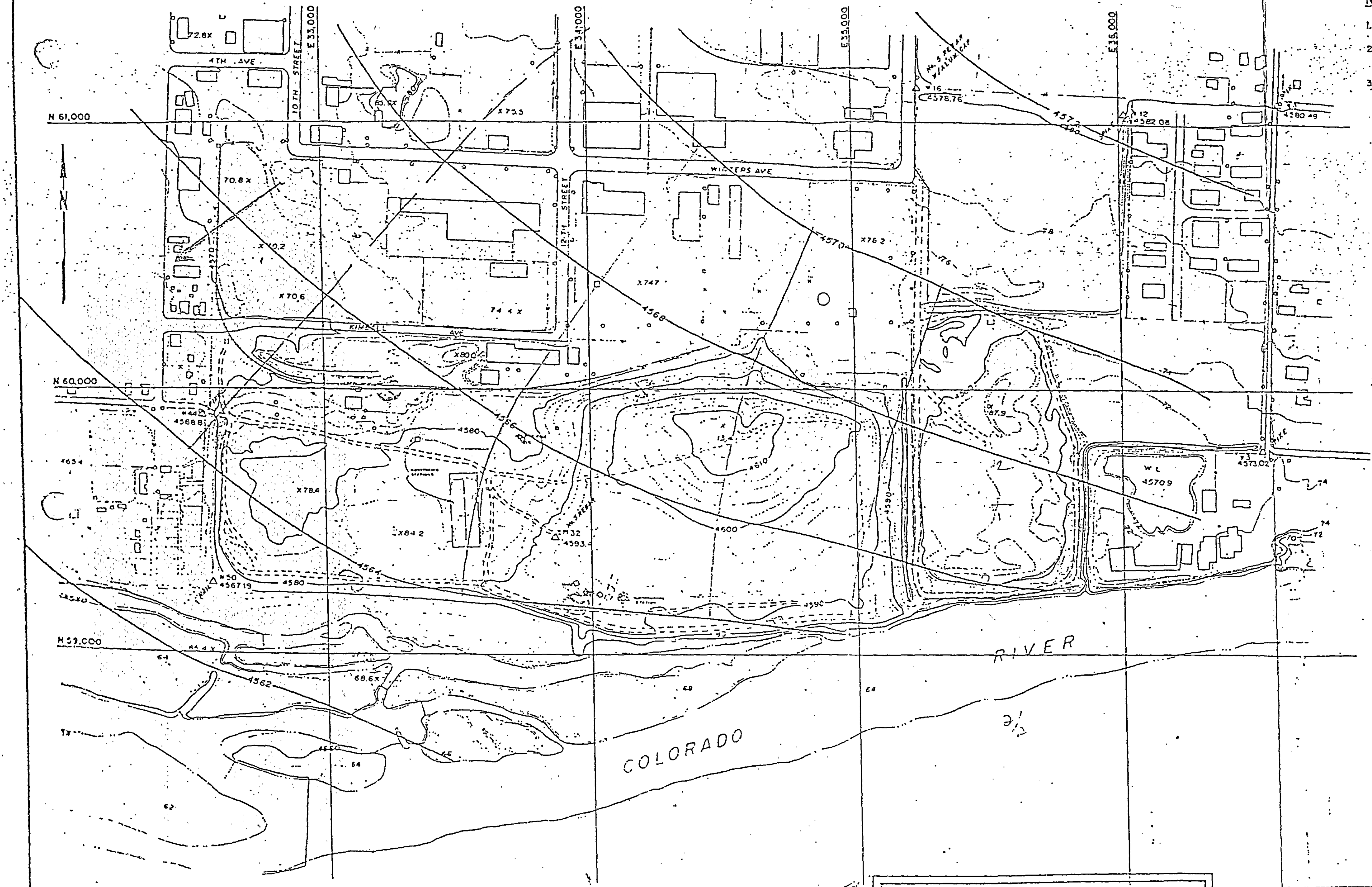
$W_2 = 2600$ ft (width of reclaimed excavation pg. 3)

$$= \frac{2600}{100} = 26 \text{ ft}$$

Thus, a total width of 26 ft. of window is required to pass the flux coming from the upstream direction.

To configure the seepage windows, a flow net is presented on pg. 2 indicating the distribution of flux into and out of the reclaimed excavation area

Assuming width of window to be at least 10 ft each, 3 windows will be required on each side of the reclaimed area (see pg. 3)



NOTES:

1. THIS DRAWING IS FOR INFORMATION ONLY.
2. EXISTING GROUND CONTOURS AND FEATURES SHOWN ARE THOS WHICH EXISTED PRIOR TO PHASE I CONSTRUCTION.
3. GROUNDWATER ELEVATION CONTOUR LINES SHOWN ARE THE COMPOSITE OF READINGS TAKEN AT VARIOUS TIME OF THE YEAR AND WILL VARY SEASONALLY.

ck'd WYL 1/12/88

REFERENCE DRAWINGS:

GRJ-PS-10-0209	SLURRY TRENCH PLAN
GRJ-PS-10-0211	CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 1 OF 2)
GRJ-PS-10-0212	CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 2 OF 2)

LEGEND:

4610	EXISTING SITE FEATURES AND CONTOURS
N 61,000	CONSTRUCTION GRID COORDINATE
	EXISTING FENCE AND GATE
4572	ESTIMATED HIGH GROUNDWATER ELEVATION CONTOUR LINE

PRELIMINARY REVIEW

E & D MANAGER	CHIEF ENGINEER	QA MANAGER

QA MNGR	NO.	DATE	REVISIONS	ST	CK	E & D MGR.	CHIEF ENG.	TAC REV	DOE APP
	△								
	△								
	△								
	△								
	A	7-18-87	ISSUED FOR PRELIMINARY REVIEW	–	–	–	–	–	–

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

GROUNDWATER ELEVATIONS CONTOUR MAP

DESIGNED
DRAWN WSO
CHECKED
INSPECTED
RECOMMENDED
APPROVED
DATE
DOE PROJECT ENGINEER
DATE

MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT
180 HOWARD ST SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. GRJ-PS-10-0216

Calculation Cover Sheet

Contract No. 5025

Discipline CIVIL

Calc. No. 05-655-01-00

No. of Sheets 22

Project

UMTRA

Feature

GRAND JUNCTION

Item

SURFACE WATER RUNOFF
. ACCUMULATION AND DISHARGE

Sources of Data

Sources of Formulae & References

SEE REFERENCES PAGE 3

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. ______

Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0		DWPeppard	02/08/88	TR / HM	Feb 08/88		2/08/88

Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA
Feature GRAND JUNCTION
Item GENERAL SITE DATA

Sheet 1
Contract No. 5025
File No.
Designed D. Rappond
Date 9-14-87
Checked HM
Date 10/02/87

PROBLEM: DETERMINE THE ESTIMATED MONTHLY SURFACE WATER RUNOFF TO STREAMS AT PROCESS SITE AND DISPOSAL SITE FOR NPDES DISCHARGE PERMITS.

GIVEN:

DISPOSAL SITE (CHENEY RESERVOIR SITE)

① Soil material — CH and MC per uniform Soil Classification } Ref. DRAP June 1986
Silty Clay — MKE Calc 05-628-~~03~~-01
Select SCS Soil Group C — Curve No. 88

② (REF: FINAL EIS Dec 1986)
AVG. ANNUAL PRECIPITATION = 10.0 INCHES/YR

③ (REFERENCE MKE CALC. No. 05-628-03-01)

Drainage Area	Area	
(See calc 05-628-03-01 Pg. 23 16.74) TAK 12/21/87	~~82.3~~ Ac.	{ ~~Measured from Drawing~~ 7/20/87
	0.129 sq mi	} REF. #8

WATER TO BE STORED 9.18 Ac-FT (runoff for 10yr-24hr storms —
Pg. 4 — Dimensions of Basin ~ 350' x 500' (4.02 Ac)
Retention Basin Designed to handle 115 Acres.

PROCESS SITE (GRAND JUNCTION)

① (REF: FINAL EIS Dec 1986)
AVG ANNUAL PRECIPITATION ≈ 8.41 INCHES
MAX MONTHLY " = 3.48" Oct. 1957
SNOWFALL (AVG) = 265"/year

② (REF: MKE CALC No, 05-~~625-02-01~~ 628-02-01)

DRAINAGE AREA	(Acres)	use Tc
ON-PILE	60.6	↳ 30 min
OFF PILE	21.8	14 min
	~~81.4~~ 85.4 (See pg. 19 Calc #628-02-01)	
	(0.~~127~~ .133 sq mi)	Lapse Time = 0.3 hrs

WATER STORED NEEDS; 5.56 Ac-FT G
Dimensions 400' x 270' (Avg) = 2.48 Ac

[illegible] by TAK 12/2/87
DAK 1/14/87

③ Soil Material
OFF Pile and Tailings Cover — Clayey Loam
(Ref Calc # 05-628-02-01)
Select SCS Soil Group C
SCS Curve No. 88
(Use group D as referred by Ref #3)

Sheet 2
Project UMTRA
Contract No. 5025
File No.
Feature Grand Junction
Designed D Raymond
Date 7-15-87
Item General Data
Checked HM
Date 12/04/87

Evaporation ~~(Reference 4)~~

Average annual lake evaporation = 36 inches (Ref. 1)

~~Monthly Distribution of Evaporation is assumed to be Similar to Newark, CA.~~ △1 DW 11/25/87

TAK 12/21/87

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 2
Project UMTRA
Contract No. 5025
File No.
Feature GRAND JUNCTION
Designed D. Kyyrod
Date 7-15-87
Item REFERENCES
Checked HM
Date 10/04/87

REFERENCES

1) MKE CALC. NO. 05-628-03-01

2) MKE CALC. NO. 05-628-02-0

3) URBAN STORM DRAINAGE Management, JR Sheaffer, KR Wright, W.C. Taggart and R.M. Wright, MARCEL DEKKER INC 1982

4) HYDROLOGY FOR ENGINEERS, LINSLEY, KOHLER, PAULUS McGraw-Hill 1975

5) HEC-1 FLOOD HYDROGRAPH PACKAGE, US ARMY CORPS OF ENGINEERS, SEPT. 1981 Rev JAN 1985, USERS MANUAL

6) Historical Daily Precipitation Data for Grand Junction w/ High/Low Temp.

7) FINAL ENVIRONMENTAL IMPACT STATEMENT GRAND JUNCTION CO VOLUME 1 DEC 1986

8) PROJECT DRAWING NO. GRJ-DS-10-0125, 'Construction Facilities and Site Drainage'

9) CALC. No. 5-623-01-00 "Water Consumption - Grand Jct. site"

10) WATER RESOURCES ENGINEERING, LINSLEY AND FRANZINI, McGraw-Hill 1964

11) NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), CLIMATOGRAPHY OF THE UNITED STATES NO. 20, 1951-80, COLORADO

JWR △1 11-25-87 12) MKE CALCULATION NO. 05-654-01-01 Hydrology - Dewatering

13) MEAN MONTHLY, SEASONAL, AND ANNUAL PAN EVAPORATION FOR THE U.S. DEC, 1982. NOAA TECH REPORT NWS 34.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 4
Project UMTRA Contract No. 5025 File No.
Feature GRAND JUNCTION Designed D. Repond Date 9-28-87
Item EVAPORATION DATA Checked HM Date 10/02/87

MONTHLY EVAPORATION

THE MONTHLY EVAPORATION IS BASED ON DISTRIBUTING THE KNOWN AVERAGE ANNUAL EVAPORATION USING A KNOWN RELATIVE DISTRIBUTION ~~OF ANOTHER LOCATION~~. FOR PAN EVAPORATION FROM METEOROLOGICAL MEASUREMENTS USING THE PENMAN EQUATION.

THE MONTHLY DISTRIBUTION PERCENTAGE IS ASSUMED TO BE SIMILAR TO ~~NEWARK~~ GR J WS. , ~~CALIFORNIA~~. ~~(REF # 10)~~ (REF #13)
Pg. 4

MONTH	AVERAGE MEAN MONTHLY PAN EVAP. (IN.) ~~NEWARK CA~~	Fraction
JAN	~~1.36~~ 1.86	~~.02~~ .02
FEB	~~1.40~~ 2.11	~~.03~~ .03
MAR	~~3.12~~ 4.26	~~.06~~ .06
APR	~~5.05~~ 6.40	~~.10~~ .08
MAY	~~7.19~~ 9.89	~~.12~~ .13
JUN	~~8.27~~ 12.49	~~.14~~ .16
JUL	~~8.75~~ 12.98	~~.15~~ .16
AUG	~~7.73~~ 11.10	~~.13~~ .14
SEP	~~6.60~~ 8.20	~~.12~~ .10
OCT	~~4.52~~ 5.37	~~.09~~ .07
NOV	~~2.55~~ 2.53	~~.04~~ .03
DEC	~~1.26~~ 1.34	~~.02~~ .02
	78.13"	1.00

DWR 11/25/87

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA
Feature GRAND JUNCTION
Item CONSTRUCTION WATER REQUIREMENTS

Contract No. 5025
Designed D. Reppond
Checked HM

Sheet 5
File No.
Date 9-25-87
Date 10/04/87

CONSTRUCTION WATER REQUIREMENTS

VOID SEE PG 5A

~~ASSUME CONTAMINATED WATER AT PROCESS SITE CANNOT BE USED FOR PLACING EMBANKMENT. THEREFORE WATER USED FOR CONSTRUCTION IS TAKEN AS ZERO AT PROCESS SITE.~~

ALL WATER FOR CONSTRUCTION WILL BE USED AT DISPOSAL SITE. (REF CALC NO. 5-623-01-00) REF. #9

- - 1945

$$\text{WATER VOLUME REQ'D.} = \frac{(61875 - 3682 - 7103) \times 10^3 \text{ GALLONS}}{7.5 \text{ gal/CF} \times 43560 \text{ SF/ACRE}}$$

= ~~156~~ AC-FT
136

CONSTRUCTION PERIOD
SEPT 1989 THRU AUG 1993

WORK TIME = 48 ~~months~~ WORK SCHEDULE − 12 MO Shutdown = 36 ~~months~~ ACTUAL WORK

MONTHLY ~~WATER USAGE = 156 AC-FT / 36 MO~~

~~= 4.33 AC-FT/MO~~

From Sept 1989 − Nov. 1991
21 months total

Monthly water usage $\frac{136}{21}$ = [illegible] ac-ft/mo

Corrections by
THR 12/21/87
DWK 1/14/88

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ
Feature Wastewater Handling — Process Site
Item Water Required for Dust Control
Contract No. 5025
Designed HM
Checked TAK
Sheet 6
File No.
Date Jan 12, 198
Date 1-12-88

Estimate of Water Required for Dust Control at Grand Junction Process Site:

Assumptions —

1. Unit water usage = 0.2 gallons / Yd² (Ref. 9)
2. Two applications of water / day
3. 26 working days for 31-day months (Jan, Mar, May, Jul, Aug, Oct, De
   25 working days for 30-Day months (Apr, Jun, Sept, Nov)
   24 " " " 28-Day month (Feb)
4. 5 Acres of tailings area will be open during any given construction day (Ref. 9)

Total volume of dust control water needed per construction day

$$= 5 \text{ acres} \otimes \frac{4840 \text{ Yd}^2}{\text{Acre}} \otimes 0.2 \frac{\text{gallons}}{\text{Yd}^2} \otimes \frac{2 \text{ applications}}{\text{Day}}$$

= 9680 gallons / day

= 0.02969 AF/day

~~Jan~~, Mar, May, Jul, Aug, Oct, ~~Dec~~ V = 0.02969 ⊗ 26
= <u>0.77</u> AF/month

Apr, Jun, Sept, Nov, V = 0.02969 ⊗ 25 days
= <u>0.74</u> AF/month

Dec, Jan, Feb = <u>0.0</u> (no construction)

CLIMATOGRAPHY OF THE UNITED STATES NO. 20 (REF # 11)

PALISADE, CO LAT. 39° 07N ELEV. 4780 FT.
LONG. 108° 21W

PERIOD: 1951-80
ELEVATION: 4780 FT

CLIMATOLOGICAL SUMMARY

	TEMPERATURE (F)																PRECIPITATION TOTALS (INCHES)											
	MEANS			EXTREMES						MEAN NUMBER OF DAYS				DEGREE DAYS		*	*					SNOW			MEAN NUMBER OF DAYS		
										MAX		MIN															
	* DAILY MAXIMUM	* DAILY MINIMUM	* MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	90 AND ABOVE	32 AND BELOW	32 AND BELOW	0 AND BELOW	* HEATING BASE 65	* COOLING BASE 65	MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	MEAN	MAXIMUM MONTHLY	YEAR	.10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	38.8	17.6	28.2	64+	56	8	-20+	63	12	0	7	30	2	1141	0	.52	1.41	57	.73	56	16	5.3	28.3	57	2	0	0
FEB	46.8	24.2	35.6	73+	61	12	-12	51	1	0	1	24	0	823	0	.56	1.76	62	.90	62	13	3.2	18.5	55	2	0	0
MAR	55.7	31.4	43.6	80+	78	31	9+	71	6	0	0	16	0	663	0	.88	2.72	70	.87	53	30	3.1	14.0	64	3	0	0
APR	66.2	40.1	53.2	88+	80	21	16+	75	2	0	0	5	0	361	7	.82	2.25	65	1.30	65	27	.4	9.2	75	3	0	0
MAY	77.0	49.0	63.0	96	56	31	30+	75	6	2	0	0	0	129	67	.87	2.26	57	.75	79	08	.1	2.0	79	3	0	0
JUN	88.3	57.5	72.9	105+	54	23	34+	74	8	15	0	0	0	14	251	.50	2.46	69	1.04	69	24	.0	.0		1	0	0
JUL	94.8	63.8	79.4	105+	78	14	45	69	01	27	0	0	0	0	446	.60	1.42	65	.66	74	18	.0	.0		2	0	0
AUG	91.4	61.5	76.5	106+	79	6	45+	76	13	21	0	0	0	0	357	.97	2.80	57	1.16	57	30	.0	.0		3	0	0
SEP	83.4	53.1	68.3	100+	78	5	29	68	17	7	0	0	0	48	147	.98	3.47	61	1.76	58	13	.0	.0		2	0	0
OCT	70.9	42.4	56.7	90+	80	2	24+	75	25	0	0	3	0	272	15	1.06	3.68	72	1.80	57	13	.3	5.0	75	2	0	0
NOV	53.4	30.3	41.9	76+	78	3	5+	76	27	0	1	18	0	693	0	.73	1.75	53	.85	53	18	1.6	10.5	64	2	0	0
DEC	41.7	20.4	31.1	69+	73	2	-7+	62	28	0	4	29	1	1051	0	.57	1.41	78	.70	66	07	4.5	18.5	67	2	0	0
YEAR	67.4	40.9	54.2	106	AUG 79	6	-20	JAN 63	12	72	13	125	3	5195	1290	9.06	3.68	OCT 72	1.80	OCT 57	13	18.5	28.3	JAN 57	27	0	0

*FROM 1951-80 NORMALS

ESTIMATED VALUE BASED ON DATA FROM SURROUNDING STATIONS

+ ALSO ON EARLIER DATES.

DEGREE DAYS TO SELECTED BASE TEMPERATURES (F)

BASE	HEATING DEGREE DAYS												
BELOW	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
65	1141	823	663	361	129	14	0	0	48	272	693	1051	5195
60	986	683	508	228	54	0	0	0	13	154	543	896	4065
57	893	606	423	163	26	0	0	0	6	102	453	803	3475
55	831	552	365	128	15	0	0	0	0	72	398	741	3102
50	689	423	235	56	0	0	0	0	0	22	260	593	2278

BASE	COOLING DEGREE DAYS												
ABOVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
55	0	9	12	74	263	537	756	667	399	125	0	0	2842
57	0	6	8	49	212	477	694	605	345	93	0	0	2489
60	0	0	0	24	147	387	601	512	262	51	0	0	1984
65	0	0	0	7	67	251	446	357	147	15	0	0	1290
70	0	0	0	0	20	139	291	206	68	0	0	0	724

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

MONTHLY PRECIPITATION (INCHES)

PROBABILITY LEVELS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.05	.06	.00	.04	.20	.00	.00	.08	.17	.00	.00	.13	.05
.10	.12	.00	.09	.28	.06	.01	.15	.25	.07	.00	.19	.11
.20	.21	.19	.20	.40	.20	.06	.25	.39	.22	.30	.30	.20
.30	.28	.29	.31	.51	.33	.12	.34	.53	.37	.48	.40	.29
.40	.36	.38	.45	.61	.48	.20	.42	.66	.53	.66	.50	.37
.50	.44	.48	.61	.72	.64	.30	.51	.81	.72	.86	.61	.47
.60	.53	.59	.80	.85	.83	.42	.61	.98	.94	1.08	.74	.58
.70	.64	.72	1.06	.99	1.07	.59	.74	1.19	1.21	1.34	.89	.71
.80	.79	.88	1.42	1.18	1.40	.83	.89	1.46	1.59	1.69	1.09	.88
.90	1.03	1.15	2.03	1.49	1.96	1.26	1.15	1.91	2.22	2.26	1.42	1.16
.95	1.25	1.41	2.64	1.77	2.51	1.69	1.39	2.33	2.85	2.80	1.73	1.44

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION.

P.N. 11111
Facility: Grand Junction
Item: Climate DATA

CONTRACT NO. 3965
DESIGNED BY: D. Rygrand 9-29-87
CHECKED BY: KM 10/04/87

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA
Feature GRAND JUNCTION
Item Water Balance

Contract No.
Designed DWK
Checked TAL

Sheet 8
File No.
Date 11/25/87
Date 12/21/87

De-Watering at Process Site

(From Ref 12)

There are ten Segments of Excavation:

Segment	Pump Rate (GPM)
AB	46
BC	60
CD	73
DE	45
EF	49
FG	32
GH	51
HI	65
IJ	21
JA	60

All segments are taken to be about the same volume of excavation work requiring one month,

Then the average Pumping Rate is 50.2 gpm.

However the present schedule is only 9 months.
([illegible])
This requires an average pumping rate

of $\frac{10}{9} \times 50.2$ gpm = 55.8 gpm $\left(0.25 \frac{\text{Ac-FT}}{\text{Day}}\right)$

For a 30 Day month the De-Watering

Rate = $30 \times 0.25 \frac{\text{Ac-FT}}{\text{Day}} = 7.5 \frac{\text{Ac-FT}}{\text{month}}$

SHEET 9
PROJECT UMTRA CONTR. NO. 5025 FILE NO.
FEATURE GRJ DESIGNED DWR DATE 11-25-87
ITEM Water Balance CHECKED HM DATE Jan 14/88

RATIONAL APPROACH FOR ESTIMATING RETENTION BASIN DESIGN WATER VOLUME USING MEAN CLIMATIC DATA

(REVISION B DATE 11-16-87)

A. INTRODUCTION

THIS PROCEDURE PROVIDES THE DETAILS PRIMARILY FOR DETERMINING THE AVERAGE TOTAL MONTHLY RUNOFF VOLUME THAT SHOULD BE EXPECTED IN RETENTION BASIN(S) USING LONG TERM AVERAGE CLIMATIC DATA WITH CONSIDERATION FOR SNOWMELT CARRY-OVER. A SPREADSHEET USING LOTUS 1-2-3 SOFTWARE TO COMPUTE THE TOTAL RUNOFF VOLUME IS AVAILABLE. THE AMOUNT OF RUNOFF IS CALCULATED USING THE SOIL CONSERVATION SERVICE METHOD. SNOWMELT LESS SUBLIMATION IS COMBINED WITH RAINFALL TO ESTIMATE THE MONTHLY TOTAL RUNOFF.

THE SPREADSHEET ALSO CALCULATES THE MONTHLY NET WATER BALANCE WITH ALLOWANCE FOR EVAPORATION AND TAILINGS CONSTRUCTION WATER USE, ALONG WITH THE TOTAL ANTICIPATED WATER ACCUMULATION WHICH COULD OCCUR IF WATER IS NOT DISPOSED OF MONTHLY.

THE SPREADSHEET MUST BE MODIFIED TO REFLECT THE LATEST CONSTRUCTION SCHEDULE DURING WHICH THE RETENTION BASIN WILL BE OPERATING. THE THIS PRIMARILY AFFECTS THE CALCULATED AMOUNTS OF EVAPORATION AND THE ANTICIPATED ACCUMULATED WATER VOLUMES.

B. INPUT DATA

THE REQUIRED DATA INPUT TO THE SPREADSHEET INCLUDES:

1. RUNOFF DRAINAGE AREA (ACRES): USED TO COMPUTE RUNOFF
2. RETENTION BASIN(S) CAPACITY (AC-FT): USED FOR COMPARISON PURPOSES ONLY.
3. POND EVAPORATION AREA (ACRES): FOR COMPUTING EVAPORATION
4. AVERAGE ANNUAL LAKE EVAPORATION(INCHES): USED TO DETERMINE EVAPORATION.
5. SOIL SCS CURVE NUMBER (CN): WHEN MONTHLY MEAN TEMPERATURE IS BELOW FREEZING, A MINIMUM CN=95 IS RECOMMENDED.
6. MEAN NUMBER OF DAYS PRECIPITATION IS GREATER THAN 0.1 INCHES WATER.*
7. MEAN TEMPERATURE, DEGREES FAHRENHEIT*
8. MEAN PRECIPITATION, INCHES*
9. MEAN SNOW DEPTH, INCHES*
10. TAILINGS CONSTRUCTION WATER DEMAND- MONTHLY AVERAGE (AC-FT). THOSE MONTHS OF NO-CONSTRUCTION MUST SHOW 'ZERO', USUALLY, DECEMBER, JANUARY, AND FEBRUARY.
11. EVAPORATION DISTRIBUTION FACTORS (DECIMALS) FOR EACH MONTH OF THE YEAR.

THE FOLLOWING INFORMATION IS USED TO COMPUTE THE TOTAL RUNOFF VOLUME: THE MEAN TEMPERATURE, MEAN SNOW DEPTH, MEAN PRECIPITATION AND THE MEAN NUMBER OF DAYS PRECIPITATION IS GREATER THAN 0.1 INCHES ARE AVAILABLE FROM THE NOAA CLIMATOGRAPHY OF THE UNITED STATES NO. 20, 1951-1980 USING THE CLOSEST RECORDING STATION TO THE SITE(S).

*Input taken from Ref #11

Changed by TK 12/21/89

SHEET 10
PROJECT UMTRA CONTR. NO. 5025 FILE NO.
FEATURE GRJ DESIGNED DWR DATE 11-25-87
ITEM Water Balance CHECKED HM DATE Jan 14/88

ADDITIONAL INPUT FOR OVERALL WATER BALANCE ARE:

AVERAGE MONTHLY TAILINGS CONSTRUCTION WATER DEMAND: (to meet compaction requirement; USED IN PLACING CONTAMINATED EMBANKMENT MATERIAL. APPLIES ONLY TO DISPOSAL SITE WHICH IS BEING EVALUATED, OR WHEN PROCESS SITE WATER CAN BE TRANSPORTED TO DISPOSAL SITE. TRANSPORTING OF CONTAMINATED WATER OVER PUBLIC ROADS IS NOT CONSIDERED PRACTICAL BECAUSE ADDITIONAL PERMITS MAY BE REQUIRED. DURING MONTHS OF NO ~~CONSTRUCTION~~ TAILINGS PLACEMENT THIS EQUALS ZERO.

MONTHLY EVAPORATION DISTRIBUTION FACTORS: USED TO DISTRIBUTE THE TOTAL ANNUAL LAKE EVAPORATION. AVAILABLE FROM THE NOAA TECHNICAL REPORT OR USE AVERAGE MONTHLY EVAPORATION DATA FROM OTHER SOURCES AND LOCALS WHICH CAN BE ASSUMED TO BE REPRESENTATIVE OF THE PRESENT SITE. STATIONS OF SIMILAR LATITUDE ARE MORE LIKELY TO BE REPRESENTATIVE.

AVERAGE ANNUAL LAKE EVAPORATION: AVAILABLE FROM CLIMATIC ATLAS OF THE UNITED STATES.

POND EVAPORATION AREA: FOR RECTANGULAR PONDS, USE THE POND BOTTOM AREA.

WHERE DIKED DRAINAGE AREAS ARE USED, THE WATER SURFACE AREA MAY BE EXPRESSED AS A VARIABLE FUNCTION DEPENDENT ON POND VOLUME(SEE ATTACHED EXAMPLE). DIKED RETENTION AREAS MAY BE MODELED AS CONICAL VOLUMES. THE AVERAGE SURFACE AREA WHEN THE POND IS LESS THAN FULL IS APPROXIMATED BY:

$$A_{AVG}=KA_F(V_P/V_F)^{2/3}$$

WHERE: A_F=MAXIMUM WATER SURFACE AREA ASSOCIATED WITH V_F=VOLUME OF WATER WHEN FULL(EXCLUDING SEDIMENT)
V_P=TOTAL RUNOFF VOLUME FOR THAT MONTH
K=0.5 CONVERTS THE AREA TO AVERAGE END AREA AS THE EVAPORATION AREA GOES FROM A2 TO ZERO (CONSERVATIVE).

NUMBER DAYS RAIN PER STORM: AN EVALUATION OF HISTORICAL DAILY PRECIPITATION RECORDS OF THE SITE SHOULD BE MADE TO DETERMINE THE 'NORMAL' NUMBER OF DAYS ASSOCIATED WITH RAINFALL EVENTS WHEN DAILY PRECIPITATION IS GREATER THAN 0.1 INCHES. THE MINIMUM IS TWO. THIS DATA IS USED TO SIMULATE BACK-TO-BACK 24-HOUR STORMS.

SHEET 11
PROJECT UMTRA CONTR. NO. 5025 FILE NO.
FEATURE GRJ DESIGNED DWR DATE 11-25-87
ITEM WATER BALANCE CHECKED HM DATE Jan 14/88

C. CALCULATIONS

CALCULATION OF TERMS ARE AS FOLLOWS:

DESIGN SNOW: IF AVERAGE TEMPERATURE IS LESS THAN 33 DEGREE F, SNOW IN INCHES WATER IS THE LESSER OF MEAN SNOW (INCHES OF WATER) OR MEAN PRECIPITATION. CONVERSION OF INCHES OF SNOW TO INCHES OF WATER IS BASED ON 8 INCHES SNOW EQUAL ONE INCH WATER.

RAINFALL: MEAN PRECIPITATION MINUS DESIGN SNOW (INCHES OF WATER).

SUBLIMATION: WHEN SNOW IS AVAILABLE AND THE MONTHLY MEAN TEMPERATURE IS BELOW 32 DEGREES FAHRENHEIT, 0.5 INCHES OF WATER EQUIVALENT OF SNOW IS ASSUMED TO BE LOSS TO EVAPOTRANSPIRATION.

ACCUMULATED SNOWPACK: IF AVERAGE TEMPERATURE IS LESS THAN 33 DEGREES F., THE SUM OF PREVIOUS MONTH SNOW PLUS NEW SNOW LESS previous month's SUBLIMATION.

SNOWMELT: IF MEAN DAILY TEMPERATURE IS GREATER THAN 32 DEGREES F., ALL THE ACCUMULATED SNOWPACK BECOMES SNOWMELT.

TOTAL RAINFALL AND SNOWMELT: RAINFALL AND SNOWMELT ARE COMBINED TO CONSERVATIVELY SIMULATE POSSIBLE RUNOFF DURING SNOWMELT CONDITIONS.

NUMBER OF EVENTS: AVERAGE NUMBER OF BACK-TO-BACK STORMS PER MONTH DETERMINED BY DIVIDING THE TOTAL NUMBER OF DAYS PRECIPITION GREATER THAN 0.1 INCHES BY TWO DAYS RAIN PER EVENT AND ROUNDING TO THE NEAREST WHOLE NUMBER WITH A MINIMUM OF ONE.

WATER PER EVENT: TOTAL RAINFALL PLUS SNOWMELT DIVIDED BY THE NUMBER OF EVENTS.

'S': CALCULATED FROM SCS EQUATION WHERE $S=(1000/CN)-10$
(From Ref#3 pg 126-127)

TOTAL RUNOFF VOLUME: CALCULATED FROM SCS EQUATION

$$I(E)=(P-.2S)^2/(P+.8S)$$

WHERE P EQUALS THE WATER PER EVENT WHEN (P-.2S) IS GREATER THAN OR EQUAL TO ZERO, OTHERWISE EQUALS ZERO.

<u>WATER BALANCE (NON ACCUMULATING)</u> - WATER IS DISPOSED OF ON A REGULAR BASIS.

EVAPORATION: THE LESSER VALUE OF (1) MAXIMUM POSSIBLE EVAPORATION DIVIDED BY A FACTOR OF SAFETY OF 2.0 OR (2) THE MONTHLY WATER VOLUME.

SHEET 12
PROJECT UMTRA CONTR. NO. 5025 FILE NO.
FEATURE GW DESIGNED DWR DATE 11-25-87
ITEM WATER BALANCE CHECKED HM DATE JAN 14/88

NOTES:
1. THE FACTOR OF SAFETY INCLUDED TO ACCOUNT FOR LIKELIHOOD THAT THERE MAY BE INSUFFICIENT TIME FOR MAXIMUM EVAPORATION.
2. THE MAXIMUM POSSIBLE EVAPORATION IS THE EVAPORATION AREA TIMES THE AVERAGE ANNUAL LAKE EVAPORATION TIMES THE MONTHLY EVAPORATION DISTRIBUTION FACTOR.

ACTUAL CONSTRUCTION WATER USAGE: TOTAL MONTHLY RUNOFF PLUS ANY DE-WATERING INFLOW LESS EVAPORATION, LIMITED TO THE MAXIMUM CONSTRUCTION WATER VOLUME.

SURPLUS WATER: TOTAL MONTHLY RUNOFF MINUS EVAPORATION AND TAILINGS CONSTRUCTION WATER REQUIRED PLUS ANY DE-WATERING INFLOW.

WATER BALANCE (ACCUMULATING) -

EVAPORATION: THE LESSER VALUE OF THE MAXIMUM POSSIBLE EVAPORATION OR (2) THE MONTHLY WATER VOLUME.

NOTES:
1. THE FACTOR OF SAFETY INCLUDED TO ACCOUNT FOR LIKELIHOOD THAT THERE MAY BE INSUFFICIENT TIME FOR MAXIMUM EVAPORATION.
2. THE MAXIMUM POSSIBLE EVAPORATION IS THE EVAPORATION AREA TIMES THE AVERAGE ANNUAL LAKE EVAPORATION TIMES THE MONTHLY EVAPORATION DISTRIBUTION FACTOR.

ACTUAL CONSTRUCTION WATER USAGE: THAT WATER REMAINING AFTER ADDING THAT MONTHS RUNOFF TO THE PREVIOUS MONTHS ACCUMULATED WATER LESS EVAPORATION PLUS ANY DE-WATERING INFLOW, LIMITED TO THE MAXIMUM REQUIRED CONSTRUCTION WATER VOLUME.

REFERENCES:

1. URBAN STORM DRAINAGE MANAGEMENT, J.R. SHEAFFER, K.R. WRIGHT, W.C. TAGGART, & R.M. WRIGHT, 1982, BY MARCEL DEKKER INC., N.Y., NEW YORK.

2. HYDROLOGY, O.E. MEINZER, MCGRAW-HILL, 1942, DOVER PUBLICATIONS, NEW YORK.

3. HANDBOOK OF APPLIED HYDROLOGY, V.T. CHOW, MCGRAW-HILL, 1964.

PROJECT UMTRA
FEATURE Grand Junction
ITEM Water Balance

CONTR.NO. 5025
DESIGNED TMR
CHECKED DWR

FILE NO.
DATE 1-8-88
DATE 1-14-88

SHEET

"GRAND JUNCTION" DISPOSAL SITE
RUNOFF AREA (ACRES)= 115
RETENTION BASIN CAPACITY(AC-FT)= 9.18
POND EVAP. AREA (ACRES)= 4.02
AVG ANN. LAKE EVAPORAT'N (IN.)= 55

DATE: 01/08/88

********************INPUT**************

<-----------------WATER BALANCE----------------->
<---"NON-ACCUMULATING"--><----"ACCUMULATING"----->

	MONTH	SOIL SCS NO. (NOTE A)	MEAN NO. DAYS PRECIP.)0.1" (EACH)	MEAN TEMP. DEG. F	MEAN PRECIP. (IN.)	MEAN SNOW (IN.)	SNOW (IN. WTR.)	RAIN-FALL (IN. WTR.)	SUBLIM-ATION (IN.)	ACCUM. SNOWPACK (NOTE B) (INCHES OF WTR.)	SNOW-MELT (IN. WTR.)	TOTAL RAINFALL & SNWMLT. (IN. WTR.)	NUMBER OF EVENTS	WATER PER EVE (IN. WTR.)	"S" -SCS- (IN.)	TOTAL RUNOFF VOLUME (AC-FT)	*INPUT* ASSUMED TAILINGS CONSTR. WATER REQ'D (AC-FT)	*INPUT* ASSUMED DE-WATERING INFLOW (AC-FT)	EST. EVAPTN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	SURPLUS WATER (AC-FT)	EST. EVAPTN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR.
1989	SEP	88	2	68.3	0.98	0	0	0.98	0	0.000	0.000	0.98	1	0.98	1.364	2.315	6.7	0	0.921	1.394	0.000	1.842	0.472	0.000	0.100
	OCT	88	2	56.7	1.06	0.3	0	1.06	0	0.000	0.000	1.06	1	1.06	1.364	2.761	6.7	0	0.645	2.117	0.000	1.290	1.472	0.000	0.070
	NOV	88	2	41.9	0.73	1.6	0	0.73	0	0.000	0.000	0.73	1	0.73	1.364	1.100	6.7	0	0.276	0.824	0.000	0.553	0.548	0.000	0.030
	DEC	95	2	31.1	0.57	4.5	0.562	0.01	0.5	0.563	0.000	0.01	1	0.01	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
1990	JAN	95	2	28.2	0.52	5.3	0.52	0.00	0.5	0.583	0.000	0.00	1	0.00	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
	FEB	95	2	35.6	0.56	3.2	0	0.56	0	0.083	0.083	0.64	1	0.64	0.526	2.601	0	0	0.276	0.000	2.324	0.553	0.000	2.048	0.030
	MAR	88	3	43.6	0.88	3.1	0	0.88	0	0.000	0.000	0.88	2	0.44	1.364	0.350	6.47	0	0.350	0.000	0.000	1.106	1.293	0.000	0.060
	APR	88	3	53.2	0.82	0.4	0	0.82	0	0.000	0.000	0.82	2	0.41	1.364	0.241	6.47	0	0.241	0.000	0.000	0.241	0.000	0.000	0.080
	MAY	88	3	63.0	0.87	0.1	0	0.87	0	0.000	0.000	0.87	2	0.44	1.364	0.331	6.47	0	0.331	0.000	0.000	0.331	0.000	0.000	0.130
	JUN	88	1	72.9	0.50	0	0	0.50	0	0.000	0.000	0.50	1	0.50	1.364	0.311	6.47	0	0.311	0.000	0.000	0.311	0.000	0.000	0.160
	JUL	88	2	79.4	0.60	0	0	0.60	0	0.000	0.000	0.60	1	0.60	1.364	0.607	6.47	0	0.607	0.000	0.000	0.607	0.000	0.000	0.160
	AUG	88	3	76.5	0.97	0	0	0.97	0	0.000	0.000	0.97	2	0.49	1.364	0.548	6.47	0	0.548	0.000	0.000	0.548	0.000	0.000	0.140
	SEP	88	2	68.3	0.98	0	0	0.98	0	0.000	0.000	0.98	1	0.98	1.364	2.315	6.47	0	0.921	1.394	0.000	1.842	0.472	0.000	0.100
	OCT	88	2	56.7	1.06	0.3	0	1.06	0	0.000	0.000	1.06	1	1.06	1.364	2.761	6.47	0	0.645	2.117	0.000	1.290	1.472	0.000	0.070
	NOV	88	2	41.9	0.73	1.6	0	0.73	0	0.000	0.000	0.73	1	0.73	1.364	1.100	6.47	0	0.276	0.824	0.000	0.553	0.548	0.000	0.030
	DEC	95	2	31.1	0.57	4.5	0.562	0.01	0.5	0.563	0.000	0.01	1	0.01	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
1991	JAN	95	2	28.2	0.52	5.3	0.52	0.00	0.5	0.583	0.000	0.00	1	0.00	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
	FEB	95	2	35.6	0.56	3.2	0	0.56	0	0.083	0.083	0.64	1	0.64	0.526	2.601	0	0	0.276	0.000	2.324	0.553	0.000	2.048	0.030
	MAR	88	3	43.6	0.88	3.1	0	0.88	0	0.000	0.000	0.88	2	0.44	1.364	0.350	6.7	0	0.350	0.000	0.000	1.106	1.293	0.000	0.060
	APR	88	3	53.2	0.82	0.4	0	0.82	0	0.000	0.000	0.82	2	0.41	1.364	0.241	6.7	0	0.241	0.000	0.000	0.241	0.000	0.000	0.080
	MAY	88	3	63.0	0.87	0.1	0	0.87	0	0.000	0.000	0.87	2	0.44	1.364	0.331	6.7	0	0.331	0.000	0.000	0.331	0.000	0.000	0.130
	JUN	88	1	72.9	0.50	0	0	0.50	0	0.000	0.000	0.50	1	0.50	1.364	0.311	6.7	0	0.311	0.000	0.000	0.311	0.000	0.000	0.160
	JUL	88	2	79.4	0.60	0	0	0.60	0	0.000	0.000	0.60	1	0.60	1.364	0.607	6.7	0	0.607	0.000	0.000	0.607	0.000	0.000	0.160
	AUG	88	3	76.5	0.97	0	0	0.97	0	0.000	0.000	0.97	2	0.49	1.364	0.548	6.7	0	0.548	0.000	0.000	0.548	0.000	0.000	0.140
	SEP	88	2	66.3	0.98	0	0	0.98	0	0.000	0.000	0.98	1	0.98	1.364	2.315	6.7	0	0.921	1.394	0.000	1.842	0.472	0.000	0.100
	OCT	88	2	56.7	1.06	0.3	0	1.06	0	0.000	0.000	1.06	1	1.06	1.364	2.761	6.7	0	0.645	2.117	0.000	1.290	1.472	0.000	0.070
	NOV	88	2	41.9	0.73	1.6	0	0.73	0	0.000	0.000	0.73	1	0.73	1.364	1.100	6.7	0	0.276	0.824	0.000	0.553	0.548	0.000	0.030
	DEC	95	2	31.1	0.57	4.5	0.562	0.01	0.5	0.563	0.000	0.01	1	0.01	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
1992	JAN	95	2	28.2	0.52	5.3	0.52	0.00	0.5	0.583	0.000	0.00	1	0.00	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
	FEB	95	2	35.6	0.56	3.2	0	0.56	0	0.083	0.083	0.64	1	0.64	0.526	2.601	0	0	0.276	0.000	2.324	0.553	0.000	2.048	0.030
	MAR	88	3	43.6	0.86	3.1	0	0.88	0	0.000	0.000	0.88	2	0.44	1.364	0.350	0	0	0.350	0.000	0.000	1.106	0.000	1.293	0.060
	APR	88	3	53.2	0.82	0.4	0	0.82	0	0.000	0.000	0.82	2	0.41	1.364	0.241	0	0	0.241	0.000	0.000	1.474	0.000	0.059	0.080
	MAY	88	3	63.0	0.87	0.1	0	0.87	0	0.000	0.000	0.87	2	0.44	1.364	0.331	0	0	0.331	0.000	0.000	0.390	0.000	0.000	0.130
	JUN	88	1	72.9	0.50	0	0	0.50	0	0.000	0.000	0.50	1	0.50	1.364	0.311	0	0	0.311	0.000	0.000	0.311	0.000	0.000	0.160
	JUL	88	2	79.4	0.60	0	0	0.60	0	0.000	0.000	0.60	1	0.60	1.364	0.607	0	0	0.607	0.000	0.000	0.607	0.000	0.000	0.160
	AUG	88	3	76.5	0.97	0	0	0.97	0	0.000	0.000	0.97	2	0.49	1.364	0.548	0	0	0.548	0.000	0.000	0.548	0.000	0.000	0.140
	SEP	88	2	68.3	0.98	0	0	0.98	0	0.000	0.000	0.98	1	0.98	1.364	2.315	0	0	0.921	0.000	1.394	1.842	0.000	0.472	0.100
	OCT	88	2	56.7	1.06	0.3	0	1.06	0	0.000	0.000	1.06	1	1.06	1.364	2.761	0	0	0.645	0.000	2.117	1.290	0.000	1.944	0.070
	NOV	88	2	41.9	0.73	1.6	0	0.73	0	0.000	0.000	0.73	1	0.73	1.364	1.100	0	0	0.276	0.000	0.824	0.553	0.000	2.492	0.030
	DEC	95	2	31.1	0.57	4.5	0.562	0.01	0.5	0.563	0.000	0.01	1	0.01	0.526	0.000	0	0	0.000	0.000	0.000	0.369	0.000	2.123	0.020
1993	JAN	95	2	28.2	0.52	5.3	0.52	0.00	0.5	0.583	0.000	0.00	1	0.00	0.526	0.000	0	0	0.000	0.000	0.000	0.369	0.000	1.755	0.020
	FEB	95	2	35.6	0.56	3.2	0	0.56	0	0.083	0.083	0.64	1	[illegible]	[illegible]	[illegible]									

UMTRA 5025
Grand Junction TMR 1-6-88
Water Balance Chkd DWR 1-14-88

DISPOSAL SITE

MAR	88	3	43.6	0.88	3.1	0	0.88	0	0.000	0.000	0.88	2	0.44	1.364	0.350	0	0	0.350	0.000	0.000	1.106	0.000	3.048	0.060
APR	88	3	53.2	0.82	0.4	0	0.82	0	0.000	0.000	0.82	2	0.41	1.364	0.241	0	0	0.241	0.000	0.000	1.474	0.000	1.814	0.080
MAY	88	3	63.0	0.87	0.1	0	0.87	0	0.000	0.000	0.87	2	0.44	1.364	0.331	0	0	0.331	0.000	0.000	2.145	0.000	0.000	0.130
JUN	88	1	72.9	0.50	0	0	0.50	0	0.000	0.000	0.50	1	0.50	1.364	0.311	0	0	0.311	0.000	0.000	0.311	0.000	0.000	0.160
JUL	88	2	79.4	0.60	0	0	0.60	0	0.000	0.000	0.60	1	0.60	1.364	0.607	0	0	0.607	0.000	0.000	0.607	0.000	0.000	0.160
AUG	88	3	76.5	0.97	0	0	0.97	0	0.000	0.000	0.97	2	0.49	1.364	0.548	0	0	0.548	0.000	0.000	0.548	0.000	0.000	0.140
SEP	88	2	68.3	0.98	0	0	0.98	0	0.000	0.000	0.98	1	0.98	1.364	2.315	0	0	0.921	0.000	1.394	1.842	0.000	0.472	0.100
OCT	88	2	56.7	1.06	0.3	0	1.06	0	0.000	0.000	1.06	1	1.06	1.364	2.761	0	0	0.645	0.000	2.117	1.290	0.000	1.944	0.070
NOV	88	2	41.9	0.73	1.6	0	0.73	0	0.000	0.000	0.73	1	0.73	1.364	1.100	0	0	0.276	0.000	0.824	0.553	0.000	2.492	0.030

PROJECT UMTRA
FEATURE Grand Junction
ITEM Water Balance

CONTR.NO. 5025
DESIGNED THR
CHECKED DWR

FILE NO.
DATE 1-12-88
DATE 1-14-88

SHEET 20

"GRAND JUNCTION" PROCESS SITE
DATE: 01/12/88
RUNOFF AREA -PHASE A (ACRES)= 71.5 PHASE B= 40.4 (TOTAL RUNOFF VOLUME FORMULA MODIFIED TO REFLECT AREA CHANGE DURING CONSTR. START DEC. 1991)
RETENTION BASIN CAPACITY(AC-FT)= 5.56
POND EVAP. AREA (ACRES)= 2.48
AVG ANN. LAKE EVAPORAT'N (IN.)= 55

<------------------------------WATER BALANCE------------------------->
<--"NON-ACCUMULATING"---<-----"ACCUMULATING"----->

********************INPUT**************

		MONTH	SOIL SCS NO. (NOTE A)	MEAN NO. DAYS PRECIP. >0.1" (EACH)	MEAN TEMP. DEG. F	MEAN PRECIP. (IN.)	MEAN SNOW (IN.)	SNOW (IN. WTR.)	RAIN-FALL (IN. WTR.)	SUBLIM-ATION (IN.)	ACCUM. SNOWPACK (NOTE B) (INCHES OF WTR.)	SNOW-MELT (IN. WTR.)	TOTAL RAINFALL & SNWMLT. (IN. WTR.)	NUMBER OF EVENTS	WATER PER EVE (IN. WTR.)	"S" -SCS- (IN.)	TOTAL RUNOFF VOLUME (AC-FT)	*INPUT* ASSUMED TAILINGS CONSTR. WATER REQ'D (AC-FT)	*INPUT* ASSUMED DE-WATERING INFLOW (AC-FT)	EST. EVAPTN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	SURPLUS WATER (AC-FT)	EST. EVAPTN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR.
PHASE 1	1989	SEP	88	2	68.3	0.98	0	0	0.98	0	0.000	0.000	0.98	1	0.98	1.364	1.439	0.74	0	0.568	0.740	0.131	1.137	0.303	0.000	0.100
		OCT	88	2	56.7	1.06	0.3	0	1.06	0	0.000	0.000	1.06	1	1.06	1.364	1.717	0.77	0	0.398	0.770	0.549	0.796	0.770	0.151	0.070
		NOV	88	2	41.9	0.73	1.6	0	0.73	0	0.000	0.000	0.73	1	0.73	1.364	0.684	0.74	0	0.170	0.514	0.000	0.341	0.494	0.000	0.030
		DEC	95	2	31.1	0.57	4.5	0.562	0.01	0.5	0.563	0.000	0.01	1	0.01	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
	1990	JAN	95	2	28.2	0.52	5.3	0.52	0.00	0.5	0.583	0.000	0.00	1	0.00	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
		FEB	95	2	35.6	0.56	3.2	0	0.56	0	0.083	0.083	0.64	1	0.64	0.526	1.617	0	0	0.170	0.000	1.446	0.341	0.000	1.276	0.030
		MAR	88	3	43.6	0.88	3.1	0	0.88	0	0.000	0.000	0.88	2	0.44	1.364	0.218	0.77	0	0.218	0.000	0.000	0.682	0.770	0.042	0.060
		APR	88	3	53.2	0.82	0.4	0	0.82	0	0.000	0.000	0.82	2	0.41	1.364	0.150	0.74	0	0.150	0.000	0.000	0.191	0.000	0.000	0.080
		MAY	88	3	63.0	0.87	0.1	0	0.87	0	0.000	0.000	0.87	2	0.44	1.364	0.206	0.77	0	0.206	0.000	0.000	0.206	0.000	0.000	0.130
		JUN	88	1	72.9	0.50	0	0	0.50	0	0.000	0.000	0.50	1	0.50	1.364	0.193	0.74	0	0.193	0.000	0.000	0.193	0.000	0.000	0.160
		JUL	88	2	79.4	0.60	0	0	0.60	0	0.000	0.000	0.60	1	0.60	1.364	0.377	0.77	0	0.377	0.000	0.000	0.377	0.000	0.000	0.160
		AUG	88	3	76.5	0.97	0	0	0.97	0	0.000	0.000	0.97	2	0.49	1.364	0.341	0.77	0	0.341	0.000	0.000	0.341	0.000	0.000	0.140
		SEP	88	2	68.3	0.98	0	0	0.98	0	0.000	0.000	0.98	1	0.98	1.364	1.439	0.74	0	0.568	0.740	0.131	1.137	0.303	0.000	0.100
		OCT	88	2	56.7	1.06	0.3	0	1.06	0	0.000	0.000	1.06	1	1.06	1.364	1.717	0.77	0	0.398	0.770	0.549	0.796	0.770	0.151	0.070
		NOV	88	2	41.9	0.73	1.6	0	0.73	0	0.000	0.000	0.73	1	0.73	1.364	0.684	0.74	0	0.170	0.514	0.000	0.341	0.494	0.000	0.030
		DEC	95	2	31.1	0.57	4.5	0.562	0.01	0.5	0.563	0.000	0.01	1	0.01	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
	1991	JAN	95	2	28.2	0.52	5.3	0.52	0.00	0.5	0.583	0.000	0.00	1	0.00	0.526	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.020
		FEB	95	2	35.6	0.56	3.2	0	0.56	0	0.083	0.083	0.64	1	0.64	0.526	1.617	0	0	0.170	0.000	1.446	0.341	0.000	1.276	0.030
		MAR	88	3	43.6	0.88	3.1	0	0.88	0	0.000	0.000	0.88	2	0.44	1.364	0.218	0.77	7.5	0.218	0.770	6.730	0.682	0.770	7.542	0.060
		APR	88	3	53.2	0.82	0.4	0	0.82	0	0.000	0.000	0.82	2	0.41	1.364	0.150	0.74	7.5	0.150	0.740	6.760	0.909	0.740	13.542	0.080
		MAY	88	3	63.0	0.87	0.1	0	0.87	0	0.000	0.000	0.87	2	0.44	1.364	0.206	0.77	7.5	0.206	0.770	6.730	1.478	0.770	19.000	0.130
		JUN	88	1	72.9	0.50	0	0	0.50	0	0.000	0.000	0.50	1	0.50	1.364	0.193	0.74	7.5	0.193	0.740	6.760	1.819	0.740	24.135	0.160
		JUL	88	2	79.4	0.60	0	0	0.60	0	0.000	0.000	0.60	1	0.60	1.364	0.377	0.77	7.5	0.377	0.770	6.730	1.819	0.770	29.424	0.160
		AUG	88	3	76.5	0.97	0	0	0.97	0	0.000	0.000	0.97	2	0.49	1.364	0.341	0.77	7.5	0.341	0.770	6.730	1.591	0.770	34.903	0.140
		SEP	88	2	68.3	0.98	0	0	0.98	0	0.000	0.000	0.98	1	0.98	1.364	1.439	0.74	7.5	0.568	0.740	7.631	1.137	0.740	41.966	0.100
		OCT	88	2	56.7	1.06	0.3	0	1.06	0	0.000	0.000	1.06	1	1.06	1.364	1.717	0.77	7.5	0.398	0.770	8.049	0.796	0.770	49.617	0.070
		NOV	88	2	41.9	0.73	1.6	0	0.73	0	0.000	0.000	0.73	1	0.73	1.364	0.684	0.74	7.5	0.170	0.740	7.274	0.341	0.740	56.720	0.030
PHASE 2		DEC	95	2	31.1	0.57	4.5	0.562	0.01	0.5	0.563	0.000	0.01	1	0.01	0.526	0.000	0	0	0.000	0.000	0.000	0.227	0.000	56.493	0.020
	1992	JAN	95	2	28.2	0.52	5.3	0.52	0.00	0.5	0.583	0.000	0.00	1	0.00	0.526	0.000	0	0	0.000	0.000	0.000	0.227	0.000	56.265	0.020
		FEB	95	2	35.6	0.56	3.2	0	0.56	0	0.083	0.083	0.64	1	0.64	0.526	0.914	0	0	0.170	0.000	0.743	0.341	0.000	56.838	0.030
		MAR	88	3	43.6	0.88	3.1	0	0.88	0	0.000	0.000	0.88	2	0.44	1.364	0.123	0.77	0	0.123	0.000	0.000	0.682	0.770	55.509	0.060
		APR	88	3	53.2	0.82	0.4	0	0.82	0	0.000	0.000	0.82	2	0.41	1.364	0.085	0.74	0	0.085	0.000	0.000	0.909	0.740	53.944	0.080
		MAY	88	3	63.0	0.87	0.1	0	0.87	0	0.000	0.000	0.87	2	0.44	1.364	0.116	0.77	0	0.116	0.000	0.000	1.478	0.770	51.813	0.130
		JUN	88	1	72.9	0.50	0	0	0.50	0	0.000	0.000	0.50	1	0.50	1.364	0.109	0.74	0	0.109	0.000	0.000	1.819	0.740	49.363	0.160

UMTRA - Grand Junction
Water Balance

5025
by TAR 1-12-88
ck DWR 1-14-88

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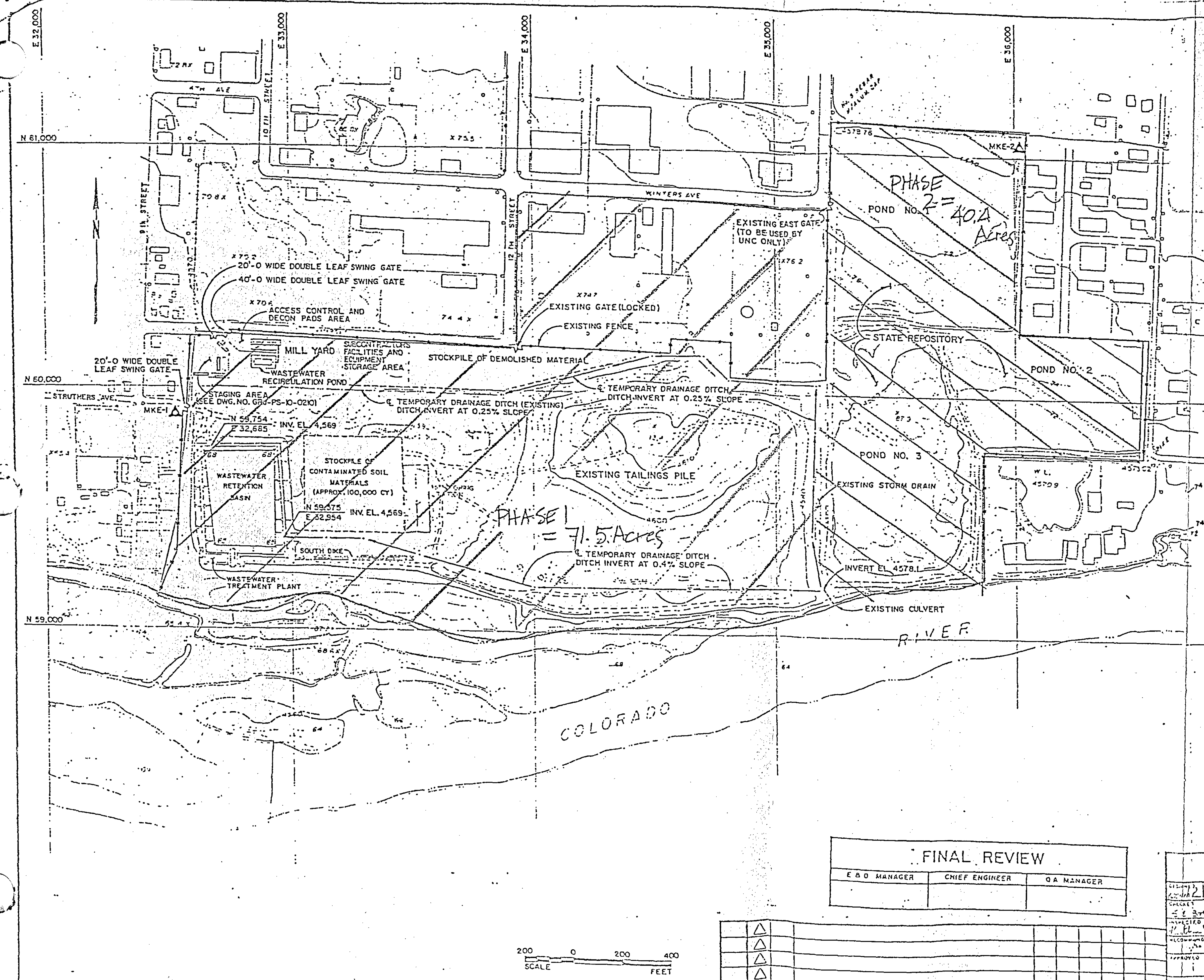
JUL   88   2  79.4  0.60  0    0  0.60   0  0.000  0.000  0.60   1  0.60  1.364  0.213  0.77  0  0.213  0.000  0.000  1.819  0.770  46.988  0.160
AUG   88   3  76.5  0.97  0    0  0.97   0  0.000  0.000  0.97   2  0.49  1.364  0.193  0.77  0  0.193  0.000  0.000  1.591  0.770  44.819  0.140
SEP   88   2  68.3  0.98  0    0  0.98   0  0.000  0.000  0.98   1  0.98  1.364  0.813  0.74  0  0.568  0.245  0.000  1.137  0.740  43.756  0.100
OCT   88   2  56.7  1.06  0.3  0  1.06   0  0.000  0.000  1.06   1  1.06  1.364  0.970  0.77  0  0.398  0.572  0.000  0.796  0.770  43.160  0.070
NOV   88   2  41.9  0.73  1.6  0  0.73   0  0.000  0.000  0.73   1  0.73  1.364  0.387  0.74  0  0.170  0.216  0.000  0.341  0.740  42.466  0.030
```

UMTRA
GRAND JUNCTION
WATER BALANCE

5025
TAR
Chk'd DWR

17
1-6-88
1-14-88

4. ALL CONTAMINATED WATER SHALL BE TREATED BY THE WASTEWATER TREATMENT PLANT BEFORE BEING DISCHARGED INTO THE COLORADO RIVER.



REFERENCE DRAWINGS:

GRJ-PS-10-0203	SITE PLAN AND DEMOLITION
GRJ-PS-10-0209	SLURRY TRENCH PLAN
GRJ-PS-10-0211	CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 1 OF 2)
GRJ-PS-10-0212	CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 2 OF 2)
GRJ-PS-10-0214	EXISTING UTILITIES PLAN
GRJ-PS-10-0217	BORINGS AND TEST PITS LOCATION PLAN

LEGEND:

4610	EXISTING SITE FEATURES AND CONTOURS
N 61,000	CONSTRUCTION GRID COORDINATE
	EXISTING FENCE AND GATE
	TEMPORARY DRAINAGE DITCH
△MKE-1	EXISTING PERMANENT SURVEY MONUMENT

FINAL REVIEW

E & O MANAGER	CHIEF ENGINEER	QA MANAGER

QA [illegible]	NO	DATE	REVISIONS	BY	CK	E&O MGR	CHIEF ENG	TAC [illegible]	CGE [illegible]
	△								
	△								
	△								
	△								
	R		ISSUED FOR FINAL REVIEW	–	–	–	–		

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED:
DRAWN: AMC
CHECKED:
INSPECTED:
RECOMMENDED:
APPROVED:
DATE:
DOE PROJECT ENGINEER:
DATE:

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

CONSTRUCTION FACILITIES AND SITE DRAINAGE

MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT
SAN FRANCISCO, CA

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. GRJ-PS-10-0208
REV. B

Sheet 18
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature WASTEWATER HANDLING
Designed HM
Date Jan 12, 1988
Item Wastewater Retention and Treatment Requirement
Checked DWR
Date 1-14-88

Retention Basin Size and Treatment Requirement: For retention basin design and treatment rate design criteria, see Sheets 25 and 26.

Cheney Resv Disposal Site:

See Sheets 13 and 14 of this calc...
Maxm. accumulated volume = 3.803 AF
Hence enlarge retention basin capacity by 3.803 AF, over and above the capacity required by the 10-year, 24-hour storm. The enlarged basin will contain all the surface runoff upto the end of construction, at which time this accumulated runoff may be treated, if necessary, and released.

Grand Junction Process Site:

See Sheets 15 and 16 of this calc..
A very large retention basin will be required if the "Accumulated Design" method is considered. Hence the "Non-accumulated Design" method is considered, for which the maxm. surplus water = 8.049AF (October, 1991).

But this surplus water also includes the total dewatering inflow of 7.5AF for that month (oct, 1991), which is primarily uniformly distributed, at approximately 7.5/30 = 0.25 AF/day. This water will be withdrawn from the retention basin (treated, if necessary and released) on a daily basis. Thus, when the storm runoff resulting from either the 10-year 24-hour storm or the mean monthly storm occurs, the retention basin will not contain any dewatering volume from previous days. Thus, the monthly dewatering volume of 7.5 AF is subtracted from the net surplus water of 8.049 AF in the retention basin.

Thus net volume in the retention basin during that month resulting from all the storms in that month = (8.049 − 7.5) AF = 0.549 AF, which should be divided by the number of storm events (=1, in this case) to obtain runoff per event. The runoff volume resulting from the 10-year 24-hour storm (= 5.56 AF) being greater than 0.549 AF, will govern sizing of the pumps and treatment plant. The pump and the treatment plant should be able to handle the greater volume in 10 days.

∴ It is assumed that treatment will be necessary — as a worst case. If the water does not require treatment, it can simply go over the

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Feature WASTEWATER HANDLING
Designed HM
Date Jan 13, 1988
Item Wastewater Retention and Treatment.
Checked DWM
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spillway into the natural drainage system. In such a situation, no pumps will be necessary. Assuming that treatment will be required, pump capacity

$$Q = \frac{5.56 \text{ AF}}{10 \text{ Days}} = 0.556 \text{ AF/Day} = 0.28 \text{ CFS}$$

$$= 125 \text{ gpm}$$

Actually during this 10 days the pump also has to pump the dewatering inflow, plus any accumulated dewatering inflow due to 2 days of downtime. Thus, total volume to be pumped in 10 days,

$$V = 5.56 \text{ AF } (\text{10-yr 24-hr storm}) + 0.25 \text{ AF/day} \otimes 10 \text{ day.}$$
$$+ 0.25 \text{ AF/day} \otimes 2 \text{ days downtime}$$
$$= 8.56 \text{ AF}$$

$$\therefore Q = \frac{8.56 \text{ AF}}{10 \text{ Days}} = 0.856 \text{ AF/Day}$$
$$= 0.428 \text{ CFS}$$
$$= 192.6 \text{ gpm, say } 200 \text{ gpm},$$

which is the required pumping capacity at the process site.

This pumping capacity should be available at the process site at all times during the construction months.

DES. BY: 1/14/88 20/
CHK HM Jan 14, 1988

RETENTION BASIN DESIGN

14 JAN 88

RETENTION BASINS COLLECT CONTAMINATED SURFACE WATER WHICH MAY BE EITHER, ACCUMULATED TO AVOID OFFSITE DISCHARGE OR, TREATED AND DISCHARGED TO OFFSITE ON A REGULAR BASIS IN AN EFFORT TO KEEP THE BASIN RELATIVELY EMPTY.

THE MINIMUM DESIGN VOLUME OF A RETENTION BASIN IS THAT DUE TO A 10-YEAR 24-HOUR STORM.

A SEPARATE RATIONAL ANALYSIS OF THE RETENTION BASIN WATER VOLUMES SHOULD BE MADE WHICH WOULD CONSIST OF AN EVALUATION OF SURFACE WATER RUNOFF DURING THE LIFE OF THE PROJECT USING MEAN MONTHLY CLIMATIC DATA WITH ADJUSTMENTS FOR BASIN EVAPORATION, SNOWMELT, INFILTRATION, WATER USED FOR CONSTRUCTION, AND INFLOW DUE TO POSSIBLE DE-WATERING. THE SAME BASIC INFORMATION IS UTILIZED TO (1) ESTIMATE THE VOLUME OF WATER THAT MIGHT ACCUMULATE OVER THE LIFE OF THE PROJECT WHEN NO OFFSITE DISCHARGE IS DESIRED, AND/OR (2) TO SUBSTANTIATE DATA FOR DISCHARGE PERMITS. A MICROCOMPUTER MODELING PROGRAM IS AVAILABLE FOR PERFORMING SUCH A RATIONAL ANALYSIS.

THE TEN YEAR 24-HOUR STORM VOLUME WILL USUALLY EXCEED THE MONTHLY RUNOFF CALCULATED BY A RATIONAL ANALYSIS USING MEAN CLIMATIC DATA. HOWEVER, THE RATIONAL ANALYSIS MAY HAVE HIGHER MONTHLY RUNOFF AT THOSE SITES WHERE SNOW ACCUMULATION FROM MONTH-TO-MONTH OCCURS AND EVENTUALLY MELTS.

THE DESIGN VOLUME FOR THE RETENTION BASIN SHALL BE:

ACCUMULATING DESIGN IF THE CONTAMINATED WATER IS TO BE ACCUMULATED OVER THE LIFE OF THE PROJECT TO AVOID/MINIMIZE OFFSITE DISCHARGE, THE DESIGN WATER VOLUME IS THE SUM OF A 10-YEAR 24-HOUR STORM VOLUME PLUS THAT MAXIMUM VOLUME ATTRIBUTABLE TO 'NORMAL' WATER ACCUMULATION BASED ON A RATIONAL ANALYSIS OF WATER USAGE WITH CONSIDERATION FOR EVAPORATION, CONSTRUCTION WATER, DE-WATERING, SNOWMELT AND INFILTRATION.

NON-ACCUMULATING DESIGN

CASE I.

IF THE MAXIMUM MONTHLY NET INFLOW VOLUME BY A RATIONAL ANALYSIS OCCURS DURING A NORMAL CONSTRUCTION MONTH, THE DESIGN WATER VOLUME SHALL BE THE LARGER VOLUME DUE TO A 10-YEAR 24-HOUR STORM OR AS DETERMINED BY A RATIONAL ANALYSIS PROVIDING THE PUMPING CAPACITY IS LARGE ENOUGH TO EMPTY THE BASIN (TREATED IF NECESSARY) WITHIN TEN DAYS. IF NOT, THE BASIN SHOULD BE DESIGNED FOR THE SUM OF A 10-YEAR STORM PLUS THE MAXIMUM MONTHLY VOLUME FROM A RATIONAL ANALYSIS. AREAS WHERE THE NUMBER OF STORM EVENTS (MULTIPLE DAY STORMS) PER MONTH DOES NOT EXCEED 3 EACH, IT IS ASSUMED THAT THERE WILL BE 10 DAYS (30 DAYS/3 STORMS) MINIMUM BETWEEN ANY MEAN STORM AND A POSSIBLE 10-YEAR STORM.

CASE II.

IF THE MAXIMUM MONTHLY NET INFLOW VOLUME BY A RATIONAL ANALYSIS OCCURS DURING A NON-CONSTRUCTION MONTH, THE DESIGN VOLUME SHALL BE THE SUM OF A 10-YEAR 24-HOUR STORM PLUS THAT MAXIMUM VOLUME BY A RATIONAL ANALYSIS, UNLESS ADEQUATE WATER TREATING CAPACITY IS MADE AVAILABLE DURING THAT MONTH.

Design By: DW Reppond 1/14/88
HM Jan 14, 1988
14 JAN 88

WHERE HIGH GROUNDWATER LEVELS AND/OR SPACE LIMITATIONS RESTRICT ADHERENCE TO THE ABOVE, ADDITIONAL WATER TREATING CAPACITY MAY BE SUBSTITUTED.

THE SELECTION OF WATER TREATMENT RATES WHEN IT EFFECTS RETENTION BASIN SIZING SHOULD BE COORDINATED WITH PROJECT MANAGEMENT BECAUSE OF HIGH WATER TREATMENT PLANT COSTS AND POSSIBLE AVAILABILITY PROBLEMS.

FINAL DETERMINATION OF WHETHER OR NOT TREATING OF WATER WILL ACTUALLY BE REQUIRED IS DEPENDENT ON THE DEGREE OF CONTAMINATION IN RUNOFF WATER. THE DEGREE OF CONTAMINATION WILL LIKELY VARY WITH TIME OF YEAR (LESS WITH HIGH VOLUMES OF SNOWMELT) AND EXTENT OF DISTURBED SOIL DUE TO CONSTRUCTION.

Calculation Cover Sheet

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Project

UMTRA - GRAND JUNCTION

Feature

CONSTRUCTION SEQUENCE

Item

Sources of Data

Sources of Formulae & References

Preliminary Calc. ☐ **Final Calc.** ☒ **Supersedes Calc. No.** 05-666-01-0

0		SE B[illegible]	1-5-88	P. Sircar	1-6-88		1/21/88
Rev. No.	**Revision**	**Calculation By**	**Date**	**Checked By**	**Date**	**Approved By**	**Date**

Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 1
Project UMTRA - GRJ
Contract No. 5025
File No.
Feature CONSTRUCTION SEQUENCE
Designed SGA
Date 12/31/87
Item
Checked PS
Date 1/6/88

I. PURPOSE

THE PURPOSE OF THIS CALCULATION IS TO OUTLINE A POSSIBLE CONSTRUCTION SEQUENCE FOR THE EXCAVATION & TRANSPORT OF CONTAMINATED MATERIAL FROM THE PROCESSING SITE TO THE DISPOSAL SITE, CONSTRUCTION OF THE EMBANKMENT AND RESTORATION AT THE SITES.

II APPROACH

WORK WAS SEPARATED INTO PHASES IA AND II. PHASE IA INCLUDED CONSTRUCTION OF TEMPORARY FACILITIES AT THE PROCESSING SITE. ALL OTHER WORK INCLUDING TEMPORARY FACILITIES AT THE DISPOSAL SITE, TRANSPORT FACILITIES, CONSTRUCTION OF THE EMBANKMENT, AND RESTORATION OF THE SITES WILL BE DONE UNDER PHASE II.

AT THIS TIME TWO ALTERNATIVES ARE CONSIDERED FOR TRANSPORTING THE TAILINGS; BY TRUCK ~~ALONE~~ ONLY (ALT. I) OR BY TRUCK AND RAILROAD (ALT. II)

THE SUGGESTED SEQUENCE LISTS A NUMBER OF EVENTS THAT SHALL OCCUR IN ORDER TO MEET THE DESIGN OBJECTIVES. IT IS ANTICIPATED THAT THERE WILL BE SOME DESIGN MODIFICATIONS DURING CONSTRUCTION AND THAT SEVERAL OPERATIONS MAY BE PERFORMED SIMULTANEOUSLY.

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A MORRISON KNUDSEN COMPANY

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III CONSTRUCTION SEQUENCE

A. PHASE I-A CONSTRUCTION (BY OTHERS)

PROCESSING SITE ONLY

a. REPAIR EXISTING CHAIN LINK AND WIRE FENCES AND CHAIN LINK GATE ON THE WEST SIDE OF THE SITE

b. INSTALL NEW CHAIN LINK FENCE AND GATES

c. SEAL EXISTING ABANDONED WELLS

d EXCAVATE AND STOCKPILE CONTAMINATED MATERIALS FROM ACCESS CONTROL, MONITORING AND DECONTAMINATION PAD AREAS, STAGING AREA, WASTEWATER RETENTION BASIN, WATER TREATMENT PLANT PAD AREA AND WASTEWATER RECIRCULATION POND.

e. CONSTRUCT ACCESS CONTROL, MONITORING AND DECONTAMINATION PAD AREAS AND STAGING AREA FOR TEMPORARY FACILITIES.

f. CONSTRUCT WASTEWATER RETENTION BASIN AND TEMPORARY DRAINAGE DITCHES AND WASTEWATER TREATMENT PLANT PAD FACILITIES.

g. REMOVE EXISTING FENCE WITHIN THE SITE.

h. DEMOLISH THE EXISTING STRUCTURES AND UTILITIES WITHIN THE SITE.

i. INSTALL POWER FOR PHASE II CONSTRUCTION

MORRISON-KNUDSEN ENGINEERS, INC.
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B. PHASE II CONSTRUCTION

1. TRANSPORTATION SYSTEM

ALTERNATIVE 1 (TRUCK ONLY)

a. REHABILITATE OR RECONSTRUCT SPECIFIED STREETS IN GRAND JUNCTION ALONG HAUL ROUTE TO AND FROM THE PROCESSING SITE

b. CONSTRUCT TURNOUT FOR US HIGHWAY 50 AT THE ACCESS ROAD TO CHENEY RESERVOIR DISPOSAL SITE

c. CONSTRUCT ACCESS ROAD TO DISPOSAL SITE

ALTERNATIVE 2 (TRUCK AND RAILROAD ONLY)

a.) INCLUDES b, AND C ABOVE PLUS THE FOLLOWING

b) CONSTRUCT LOADING/ UNLOADING FACILITIES AT THE PROCESSING SITE

C.) CONSTRUCT DECONTAMINATION FACILITIES AT THE PROCESSING SITE

d.) CONNECT RAIL SYSTEM TO PROCESSING SITE

e.) CONSTRUCT TURNOUT ONTO US HIGHWAY 50 NEAR WHITEWATER

f.) CONSTRUCT HAUL ROUTE BETWEEN LOADING FACILITY AND US HIGHWAY 50 NEAR WHITEWATER

g.) CONSTRUCT LOADING/UNLOADING AND DECONTAMINATION FACILITIES NEAR WHITEWATER

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2. TEMPORARY FACILITY CONSTRUCTION

PROCESSING SITE

a) COMPLETE CONSTRUCTION OF TEMPORARY DRAINAGE DITCHES SURROUNDING THE MAIN TAILINGS PILE.

DISPOSAL SITE

a) INSTALL SECURITY FENCES AND GATES

b) SEAL EXISTING ABANDONED WELLS.

c.) CONSTRUCT ACCESS CONTROL, STAGING, MONITORING AND DECONTAMINATION PAD AREAS FOR TEMPORARY FACILITIES

d.) CONSTRUCT WASTEWATER RETENTION BASIN, WASTEWATER RECIRCULATION POND, TEMPORARY DRAINAGE DITCHES AND TEMPORARY INTERCEPT DITCHES. SEED DITCHES.

e.) CONSTRUCT WATER SUPPLY WELL (OPTIONAL)

3. EXCAVATION AND RELOCATION OF TAILINGS MATERIALS AND CONSTRUCTION OF TAILINGS EMBANKMENT.

a) EXCAVATE TAILINGS EMBANKMENT AREA.

b) PROCESS AND STOCKPILE THE EXCAVATED MATERIAL INTO RADON BARRIER AND EROSION PROTECTION MATERIALS AND TRANSFER THE MATERIAL TO SPECIFIED STORAGE AREAS.

c) PREPARE FOUNDATION FOR THE TAILINGS EMBANKMENT INCLUDING RIPPING, REPLACING AND RECOMPACTING THE SUBGRADE.

d.) COMPLETE CONSTRUCTION OF TEMPORARY DRAINAGE DITCHES SURROUNDING THE TAILINGS EMBANKMENT WHILE THE TAILING

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e) EXCAVATE AND TRANSPORT TAILINGS AND DEMOLISHED MATERIALS FROM THE PROCESSING SITE AND PLACE THEM ONTO THE PREPARED FOUNDATION OF THE EMBANKMENT AT THE DISPOSAL SITE.

f.) CONSTRUCT SLURRY TRENCH SURROUNDING THE MAIN PILE WHILE THE PILE IS EXCAVATED TO EL. 4570 ±

g) DISPOSE OF TAILINGS AND CONTAMINATED SEDIMENTS FROM THE WASTEWATER RETENTION BASIN OF THE PROCESSING SITE ONTO THE TAILINGS EMBANKMENT AT THE DISPOSAL SITE. DECONTAMINATE AND DISPOSE OF THE SYNTHETIC MEMBRANE LINER OF THE BASIN.

h) RESTORE THE TAILINGS PILE EXCAVATION AT THE PROCESSING SITE TO THE FINAL GRADE WITH MATERIALS EXCAVATED FROM THE DISPOSAL SITE, FOLLOWED BY PERMANENT SEEDING

i) EXCAVATE CONTAMINATED MATERIALS FROM THE PONDS AT THE PROCESSING SITE AND PLACE THEM ONTO THE RELOCATED COMPACTED TAILINGS ON THE TAILINGS EMBANKMENT.

j) RESTORE THE PONDS AREA EXCAVATION AT THE PROCESSING SITE TO THE FINAL GRADE WITH MATERIALS EXCAVATED FROM THE DISPOSAL SITE, AND SEED POND AREA

k) REMOVE ACCESS CONTROL, MONITORING AND DECONTAMINATION PAD AREAS, INCLUDING THE WASTEWATER RECIRCULATION POND, STAGING AREA AND WASTEWATER TREATMENT PLANT AT THE PROCESSING SITE AND DISPOSE CONTAMINATED MATERIALS FROM THESE FACILITIES IN THE EMBANKMENT. RECONTOUR THE SITE TO FINAL GRADE.

l) DISPOSE OF CONTAMINATED SEDIMENT FROM THE TEMPORARY DRAINAGE DITCHES AND WASTEWATER RETENTION BASIN AT THE DISPOSAL SITE ONTO THE TAILINGS EMBANKMENT, IF REQUIRED. DECONTAMINATE AND DISPOSE OF SYNTHETIC MEMBRANE BASIN LINER.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

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m) PLACE RADON BARRIER ON EMBANKMENT, CONSTRUCT PERMANENT DRAINAGE DITCHES, THEN INSTALL EROSION PROTECTION (RIPRAP) ON THE EMBANKMENT AND DITCHES AT THE DISPOSAL SITE.

n.) REMOVE ACCESS CONTROL, MONITORING AND DECONTAMINATION PAD AREAS INCLUDING THE WASTEWATER RECIRCULATION POND, STAGING AREA AND SECURITY FENCING AT THE DISPOSAL SITE. DECONTAMINATE AND DISPOSE OF SYNTHETIC MEMBRANE POND LINER.

o) RESTORE THE WASTEWATER RETENTION BASIN AREA AND COMPLETE FINAL GRADING AND PERMANENT SEEDING OF THE DISPOSAL SITE OUTSIDE THE EMBANKMENT.

p.) DISPOSE OF EXCESS MATERIAL, IF ANY.

Calculation Cover Sheet

Calc. No. 05-667-04-~~00~~ 02

Contract No. 5025-06 **Discipline** ESCUP **No. of Sheets** ~~15~~ 132

Project
UMTRA - GRAND JUNCTION

Feature
QUANTITY ESTIMATE SUMMARY

Item
PHASE II

Sources of Data 1. PHASE II CONSTRUCTION DRAWINGS FOR FINAL REVIEW UMTRA/GRJ

Sources of Formulae & References

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. Nos 05-667-03-00
05-635-13-00

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
2	REVISE QUANTITIES DUE TO CHANGE IN EXCAVATION AND FINAL GRADING PLAN	G. RICHARDSON	6-28-90	LUBIS, H	7/6/90	S.E. Botsford	7/9/90
1	REMOVE TURNOUT, UPDATE QTY'S	S.E. Botsford	7/13/88	P. Sircar	7/14/88		7/14/88
0		S.E. Botsford	1/11/88	WY Lin	1/28/88		1/29/88

Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 1
Project UMTRA -GRJ
Contract No. 5025-06
File No.
Feature QUANTITY ESTIMATE
Designed SHS
Date 1-11-88
Item PHASE II CONSTRUCTION
Checked WYL
Date 1/28/88

SUMMARY OF QUANTITIES

PROCESSING SITE

- EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL

MAIN PILE (MKE CALC. NO. 5-626-01-01)	2,441,860 cy
OFF PILE (MKE CALC NO. 5-626-02-01)	399,300 cy
VICINITY PROPERTIES (MKE. Doc. NO. 5026-GRJ-I-01-01565-00)	1,219,000 cy

- SLURRY TRENCH (MKE CALC. NO. 05-654-02-00) (TOP EL.4570)

FILL REQUIRED TO RAISE WORKING SURFACE	22,141 cy
SLURRY TRENCH AREA	117,460 SF

- RESTORATION (MKE CALC. NO. 05-633-01-01)

FILL	738,918 cy
EXCAVATION	6,737 cy
SEEDING	105 Ac.

- REHABILITATION OF CITY STREETS (MKE CALC. NO. 05-635-13-00)

EXCAVATION	+183 cy (KIMBALL 9th +)	= ~~3711~~ 3894 cy
ASPHALT CONCRETE	+56 T (KIMBALL 9th +)	= ~~2790~~ 2846 TONS
AGGREGATE BASE COURSE	+ 28 cy (Kim + 9th)	= ~~675~~ 703 cy
NONREINFORCED CONCRETE PIPE 8" Φ		= 360 FT
AGGREGATE SUBBASE COURSE	+ 126 cy (K + 9th)	= ~~3036~~ 3162 cy
ROADWAY SUBGRADE LINER	(+2286 SF ")	= ~~6080~~ 8366 SY
PAINT		= 1 GAL

SHB 7/13/88 Add quantities for Kimball and 9th St intersection See p 115

PS 7/13/88

DWG NO. GRJ-PS 16-0205

A MORRISON KNUDSEN COMPANY

Sheet 2

Project UMTRA -GRJ

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Date 1/28/88

- TEMPORARY DITCHES (MKE CALC. NO. 05-635-12-01)

EXCAVATION	57,928 cy ✓
FILL	9,630 cy ✓

REV 1. ADD

○ WOVEN WIRE FENCE AROUND BESS PROPERTY.	1985 LF	SGB 7/13/88 PS 7/13/88

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DISPOSAL SITE

• SITE STRIPPING 6"	165 AC.	SLB 7/13/88
• WELLS TO BE SEALED (delete GCH2)	~~248~~ 195'	PS 7/14/88
• TEMPORARY FACILITIES		

SECURITY FENCE

- CHAIN LINK	771'
- WIRE	~~9502'~~ - 10670' -
- GATES	1 @ 20', 30' & 40' ✓

STAGING AREA

- SURFACE COURSE	333 CY ✓

DECON PAD AREA AND ROAD

- FILL	296 CY ✓
- Concrete pavement	220 Tons ✓
- SURFACE COURSE	162 CY ✓
- BASE COURSE	111 CY ✓
- SUBBASE COURSE	361 CY ✓

WASTEWATER RECIRCULATION POND

- EXCAVATION	220 CY ✓
- FILL	551 CY ✓
- SYNTHETIC MEMBRANE	805 SY ✓
- PVC PIPE (6"ϕ)	70' ✓

WASTEWATER RETENTION BASIN

- EXCAVATION	42,891 CY ✓
- FILL	3581 CY ✓
- RIPRAP TYPE B	36 CY ✓
- SYNTHETIC MEMBRANE	24,364 SY ✓

Superseded
SLB 7/9/90

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 4
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- TEMPORARY DRAINAGE DITCH (MKE CALC. NO 05-635-12-01)

- EXCAVATION	8932 cy
- SEEDING	2.00

- TEMPORARY INTERCEPTOR DITCH (MKE CALC. NO. 05-635-12-01)

- EXCAVATION	4881 cy
- SEEDING	2.69 AC.

- TAILINGS EMBANKMENT (MKE CALC. NO. 05-635-03-0~~1~~2)

- EXCAVATION	~~1,517,990~~ 1627,000 cy	
- RIPRAP TYPE A (TOPSLOPE)	~~67,832 cy~~	58887
- RIPRAP TYPE ~~A~~ (SIDE SLOPE)	~~29,855~~ cy	42915
- RIPRAP TYPE B (APRON)	12,548 cy	
- BEDDING	~~50,407~~ cy	1572
- RADON BARRIER	~~192,653~~ cy	267975

- PERMANENT DITCH (MKE CALC NO. 05-660-01-00)

- RIPRAP TYPE B FOR DITCHES	17482 cy
- RIPRAP TYPE C FOR DITCHES	1426 cy
- BEDDING	7997 cy

- EXCAVATION & FILL IS INCLUDED IN RESTORATION

superseded Sls 7/9/90

- ACCESS ROAD TO DISPOSAL SITE

- EXCAVATION	55,342 cy
- FILL	19,912 cy
- SURFACE AGGREGATE	4,615 cy
- SUBBASE	17,252 cy
- SEEDING (side ditches)	4.3 AC.
- CULVERT PIPE 96" φ	100
- RIPRAP TYPE B	57 cy
- FILTER FABRIC	72 sy
- REVET MATTRESS	9
- BEDDING	15 cy

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA -GRJ
Feature QUANTITY ESTIMATE
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Sheet 5
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SLB 7/13/88
PS 7/14/88

- US 50 TURNOUT TO DISPOSAL SITE

NIC

-FILL	5732 cy	✓
-AC PAVEMENT	895 cy = 1752 T	✓
-SURFACE COURSE	747 cy	✓
-SUBBASE COURSE	1774 cy	✓
- CULVERT (24" φ)	78'	✓
- SEEDING	.75 AC.	✓
✓ - STRIPING		

- RESTORATION (MKE CALC. NO. 05-665-01-00)

SLB 7/13/88
PS 7/14/88

EXCAVATION	109,280	
FILL	~~92,173~~	✓ 136064

- ADDITIONAL QUANTITIES FOR EMBANKMENT COVER (MKE CALC. NO. 05-635-03-03)

- VEGETATION	41.8 AC
- ROOTING SOIL	117,869 cy
- CHOKED ROCK	14,722 cy
- DRAIN LAYER	80,344 cy
- CLAYMAX	176,660 SY

superseded
SLB 7/9/90

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature QUANTITY ESTIMATE
Item PHASE II CONSTRUCTION
Contract No. 3885-34
Designed SLB
Checked GAR
Sheet 1 A
File No.
Date 7·9·90
Date 7·9·90

REVISION 2

DISPOSAL SITE

- SITE STRIPPING 6" — 165 AC.
- WELLS TO BE SEALED — 195'
- TEMPORARY FACILITIES
  - WASTEWATER RETENTION BASIN — MKE CALC. # 05-504-04-00
    - EXCAVATION — 24,700 CY
    - FILL — 28,300 CY
    - RIPRAP TYPE B — 36 CY
    - SYNTHETIC MEMBRANE — 24,364 SY
- SECURITY FENCE
  - CHAIN LINK — 950 L.F.
  - WIRE FENCE — 15803 LF.
  - GATES — 1 - 40', W.DB SWING
    1 - 20'
    1 - MAN GATE

    2 - ACCESS GATES
- TAILINGS EMBANKMENT

REV. 3
H.L. 8/1/90
SLB

- CAPACITY	5,642,242 CY ~~5,173,612~~ CY
- EXCAVATION ALLUVIUM	1,991,334 CY
- EXCAVATION MANCOS	1,164,185 C.Y ~~707,057~~ CY
- RADON BARRIER CLAY	305,611 CY ~~295,630~~ CY
- DRAIN LAYER	17,121 ~~15,700~~ CY
- BEDDING	49,146 CY ~~47,720~~ CY
- RIPRAP A	133,059 ~~131,566~~ CY
B	59,595 ~~52,829~~ CY
C	12,677 ~~12,010~~ CY
D	11,978 ~~10,890~~ CY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature Cheney Embankment
Item PRELIM QUANTITY
Contract No 3885-34
Designed H. L.
Checked SLB
Sheet 2A
File No.
Date 8/1/90
Date 8.2.90

REV. 3

Summary < 6' Deeper excavated to Mancos>

- Tailings Embankment capacity = 5,642,242 c.y.
- Total Excavated Alluvium = 1,991,334 c.y.
- Total Excavated Mancos = 1,164,185 c.y.

MATERIAL REQUIRED

- Radon Barrier Clay = 305,611 c.y.
- Drain Layer = 17,121 cy
- Bedding Layer = 49,016 cy
- Riprap A = 133,059 c.y.
- Riprap B = 59,595 c.y.
- Riprap C = 12,677 c.y.
- Riprap D = 11,978 c.y.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature QUANTITY ESTIMATE
Item PHASE II CONSTRUCTION

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Contract No. 3885-34
File No.
Designed SMB
Date 7·9·90
Checked GAR
Date 7·9·90

o TAILINGS EMBANKMENT

- CHOKED ROCK		21,670 CY
- ROOTING SOIL		173,370 CY
- CLEAN FILL DIKE (ABOVE GRADE)		606,080 ~~600,396~~ CY
- CLEAN FILL DIKE (BELOW GRADE)		283,500 CY
- SWALE RESTORATION		170,060 CY
- NON-ESSENTIAL RESTORATION		
	EXCAVATION	14,632 CY
	FILL	242,339 CY

o ACCESS ROAD TO DISPOSAL SITE

- EXCAVATION	55,342 CY
- FILL	19,912 CY
- SURFACE AGGREGATE	4,615 CY
- SUBBASE	17,252 CY
- SEEDING (SIDE DITCHES)	4.3 AC
- CULVERT PIPE 96" φ	100'
- RIPRAP TYPE B	57 CY
- FILTER FABRIC	72 SY
- REVET MATTRESS	9
- BEDDING	15 CY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature QUANTITIES
Item CELL CAPACITY CALC.
Contract No. 3885-34
Designed GAR
Checked H.L.
Sheet 4A
File No.
Date 7-3-90
Date 7-5-90

CONTOUR	AREA	AVG. AREA	CONTOUR INTERVAL	VOLUME (YD^3)
5202	12400 FT^3			
		64480	3	7164
5205	116560			
		241180	5	44663
5210	365,800			
		517400	5	95815
5215	669,000			
		848171	5	157,069
5220	1,027,342			
		1182032	5	218,895
5225	1336722			
		1457623	5	269,930
5230	1578523			
		1,718,643	5	318,267
5235	1858763			
		1921384	5	355,812
5240	1,984,004			
		1922002	5	355,926
5245	1860000			
		1727,322	5	319,874
5250	1594643			
		1397,432	5	258,793
5255	1200322			
		1009,362	5	186,919
5260	818402			
		636,122	5	117,800
5265	453841			
		322091	5	59.646
5270	190340			
		121520	5	22504
5275	52700			
		26350	5	4880
5280	0			$\Sigma = 2,793,957$ YD^3

TOTAL AREA OF COVER = 221216 4 FT^2

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-GRJ
Contract No. 3825-34
Sheet ~~2~~/2 5A
File No.
Feature QUANTITIES
Designed GAR
Date 7-3-90
Item CELL CAPACITY CALC
Checked H.L.
Date 7-5-90

VOLUME OF COVER = (2212164 FT^2)(5.75FT) = 12,719,943 FT^3
= 471,109 YD^3

VOLUME OF EXCAVATION = 2,698,382 YD^3
VOLUME OF FILL = 2,793,957 - 471,109 = 2,322,848 YD^3

TOTAL CELL CAPACITY = 5,021,230 YD^3 (% MANCOS PROTECTIONAL BARRIER)

MANCOS BARRIER = 2057164$\left(\frac{2.0}{27}\right)$ = 152,383 YD^3 (2' THICK MANCOS PROTECT. BARR.)

NET CELL CAPACITY = 5,021,230 - 152,383
= 4,868,847 YD^3 ◀

REV. 3
H.L. 8/1/90
GWB 8·2·90

ADDITIONAL VOLUME BY RAISING TOP OF GRADE 2'0"
= 2212164$\left(\frac{2.0}{27}\right)$ = 163,864 YD^3

ADDITIONAL VOLUME BY EXCAVATING AN ADDITIONAL ~~4'~~ 6'
~~= 2057164 (4/27) = 304,765 YD^3~~
= 2057164 $\left(\frac{6}{27}\right)$ = 457,148

TOTAL POTENTIAL STORAGE VOLUME = 4,868,847 + 163,864 + ~~304,765~~ 457,148 + 152,383
= ~~5,489,859~~ YD^3
5,642,242 CY
(W/ 2' ABOVE, ~~4'~~ 6' DOWN : NO PROTECTION)

TOTAL POTENTIAL STORAGE VOLUME (W/ PROTECTION) = ~~5,489,859~~ 5,642,242 - 152,383
= ~~5,337,476~~ YD^3
5,489,859 CY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRAND JNCT
Contract No. 5026
Sheet X 6A
File No.
Feature QUANTITY ESTIMATE
Designed GAR
Date 6-6-90
Item PHASE II CONSTRUCTION
Checked H. L.
Date 7-6-90

CHAIN LINK FENCING

I ACCESS CONTROL & STAGING AREA (DRW # GRJ-DS-10-0127)
= 250 + 130 + 160 + 20 + 70 + 40 + 140
= 810 L.F.

II MISC (DRW # GRJ-DS-10-0125)
= 80 + 60
= 140 L.F.

TOTAL = 950 L.F.

WIRE FENCING

I PERIMETER FENCING (DRW # GRJ-DS-10-0125)
= 3270 + 1273 + 148 + 1475 + 1685 + 1950 + 3700 + 282
= 13,783 L.F.

II ACCESS ROAD (DRW # GRJ-DS-10-0128)
= 490 + 305 + 300 + 475
= 1570 L.F.

III MISC (DRW # GRJ-DS-10-0134)
= 450 L.F.

TOTAL = 15,803 L.F.

GATES

I ACCESS CONTROL AREA (DRW # GRJ-DS-10-0127)
→ 1 - 40' WIDE DOUBLE LEAF SWING GATE
→ 1 - 20' WIDE DOUBLE LEAF SWING GATE
→ 1 - MANGATE

II ACCESS ROAD (DRW # GRJ-DS-10-0128)
→ 2 - GATES

TOTAL = 5 GATES

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 27A
Project UMTRA - GRJ
Contract No. 3125
File No.
Feature QUANITY ESTIMATE
Designed GAR
Date 6-12-90
Item
Checked GBS
Date 6-13-9

I EXCAVATION OF MANCOS SHALE

CONTOUR	AREA (ft^2)	AVG. AREA	DEPTH (FT)	VOLUME (ft^3)
5165	58400			
		182960 ✓	5	914800 ✓
5170	307520			
		405800 ✓	5	2029000 ✓
5175	504080			
		548440 ✓	5	2742200 ✓
5180	592800			
		504800 ✓	10	5048000 ✓
5190	416800			
		416000 ✓	10	4160000 ✓
5200	415200			
		293800 ✓	10	2938000 ✓
5210	172400			
		125800 ✓	10	1258000 ✓
5220	79200			

Σ = 19,090,000 ft^3 ✓
= 707,037 yd^3 ✓

6' Mancos deeper

$2,057,164 \left(\frac{6}{27}\right) = 457,148$ CY

Total = 707,037 + 457,148
= 1,164,185 CY

REV. 3
H.L. 8/1/90
GBS 8.2.90

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA- Grand Jnct. | Contract No. 5026 | Sheet ~~8~~ 8A
Feature Quantity Estimate | Designed GAR | Date 6-6-90
Item Phase II Construction | Checked GBG | Date 6-14-90
File No.

I Excavation

CONTOUR	AREA	AVE. AREA	CONTOUR INTERVAL	VOLUME
5165	51,600 ✓			
		180,800	5	904,000
5170	310,000			
		406400	5	2,032,000
5175	502,800 ✓			
		613,800 ✓	5	3069000 ✓
5180	724,800 ✓			
		845,600 ✓	5	4,228,000 ✓
5185	966,400 ✓			
		1,074,400 ✓	5	5,372,000 ✓
5190	1,182,400 ✓			
		1,296,400 ✓	5	6,482,000 ✓
5195	1,410,400 ✓			
		1,511,800 ✓	5	7,559,000 ✓
5200	1,613,200 ✓			
		1,627,800 ✓	5	8,139,000 ✓
5205	1,642,400 ✓			
		1,610,400 ✓	5	8,052,000 ✓
5210	1,578,400 ✓			
		1480800 ✓	5	7,404,000 ✓
5215	1,383,200 ✓			
		1262400 ✓	5	6,312,000 ✓
5220	1,141,600 ✓			
		1019600 ✓	5	5,098,000 ✓
5225	897,600 ✓			
		791,600 ✓	5	3,958,000 ✓
5230	685,600 ✓			
		551,200 ✓	5	2,756,000 ✓
5235	416,800 ✓			
		287800 ✓	5	1,439,000 ✓
5240	158,800 ✓			
		990.00 ✓	5	495,000 ✓
5245	39,200 ✓			
		21,460 ✓	5	107,300 ✓
[illegible]	3720 ✓			

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet #9A
Project UMTRA - GRAND JNCT
Contract No. 5026
File No.
Feature QUANITY ESTIMATE
Designed GAR
Date 6-6-90
Item PHASE II CONSTRUCTION
Checked LBS
Date 6-4-90

TOTAL VOLUME OF Alluvium EXCAVATION = 72,856,300 FT³ − 19,090,000 = 53,766,300 FT³ = 1,991,334 YD³

RADON BARRIER CLAY

1/ Top Layer (24" THICKNESS) CONTOURED @ GRADE BREAK FROM 2% → 20%

- AREA = 261405 FT²
- THICKNESS = 2'0"

VOLUME = 182,326 YD³

2/ SIDE SLOPES

- AREA = 871722, 823361 } 847,542 FT²
- THICKNESS 3'6"

VOLUME = 109,870 YD³

3/ MISC. SIDE SLOPE

- AREA = 1.5(3.5) + ½(4)(4) = 13.25
- LENGTH = 7000 FT

VOLUME = 3435 YD³

REV. 3
A.L. 8/1/90
SAB 8.2.90

Add up: $\frac{7700 \times 10 \times 3.5}{27} = 9,981$

Σ = 295,630 YD³ ◀
9,981 +
Σ 305,611 cy

DRAIN LAYER

- AREA (FROM RADON CALC) = 847,542
- THICKNESS = 0'6"

Add 77,000 +
924,542

$\frac{924,542 \times \frac{1}{2}}{27} = 17,121$

VOLUME = ~~15,700~~ YD³ ◀

BEDDING LAYER

1/ Top Slope

- AREA (FROM 24" RADON TOP SLOPE) = 261405 FT²
- THICKNESS = 0'6"

VOLUME = 45,580 YD³

2/ TOE PROTECTION

- AREA = (0.5)(16.5) = 8.25 FT²
- LENGTH = 7000 FT

Add-up $\frac{7700 \times 10 \times 0.5}{27} = 1426$

VOLUME = 2140 YD³

Σ = ~~47,720~~ YD³ ◀

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature RIPRAP QUANTITIES
Item
Contract No. 3885-34
Designed GAR
Checked H.L.
Sheet 6 10A
File No.
Date 6-25-90
Date 7-6-90

RIPRAP QUANTITIES

I TYPE A

REV. 3
H.L. 8/1/90
GWB 8.2.90

1/ APRON - 1'0" THICK
- AREA = $\frac{1}{2}(1)(3) + 5(1) + 1(8) = 14.5$ FT^2
- APRON LENGTH = 7000 FT

Add up 1493

VOLUME = 3760 YD^3

2/ TOP SLOPE
- AREA (BY PLANIMETER) = 2,543,245
(10' OUTSIDE OF TOP SLOPE BREAK) 2,552,545 = 2,547,895 FT^2
- THICKNESS = 1'0"

VOLUME = 94,366 YD^3

3/ MISC. TOP SLOPE
- AREA = $2.25(5)(2.25)/2 + 2.25(20) = 57.7$ FT^2
- LENGTH = 5870

4/ SWALE = AREA = 282100 => VOLUME = $282100\left(\frac{2}{27}\right)$
= 20896

VOLUME = 12,544 YD^3

Σ = 110,670 YD^3
+ 20,896
= 131,566 YD^3
1,493
133,059 ◀

II TYPE B

1/ TOP SLOPE AREA = 458180
462521 } 460351
(CONTOURED 21' INSIDE OF TOP SLOPE LINE)
253581
261641 } 257,611

> Σ = 717,962 FT^2

THICKNESS = 1'0"

2/ SWALE = $354020\left(\frac{2}{27}\right) = 26,224$ YD^3

Add up 4937

VOLUME = 52,826 YD^3 ◀
4,937
12,677

III TYPE C

1/ TOP SLOPE AREA = 311241
337280 } 324,260 FT^2

THICKNESS = 1'0"

VOLUME = 12,010 YD^3 ◀

IV TYPE D (TOE OF APRON)

1/ AREA = 4417
4456 } 420 FT^2

2/ LENGTH = ~~7000 FT~~ 7700

VOLUME = ~~10,890~~ YD^3 ◀
11,978

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature QUANTITY ESTIMATES
Item

Sheet 6 IIA
Contract No. 3885-34
File No.
Designed GAR
Date 6-26-90
Checked H.L.
Date 7-6-90

CHOKED ROCK

- AREA (20' UP FROM GRADE BREAK) = 2,340,505 FT^2
- THICKNESS = 3"

VOLUME = 21,670 YD^3 ◀

ROOTING SOIL

- AREA (FROM CHOKED ROCK CALC) = 2,340,505 FT^2
- THICKNESS = 2'0"

VOLUME = 173,370 YD^3 ◀

RESTORATION

1/ EAST SWALE (ESSENTIAL FILL)

CONTOUR FT	AREA FT^2	AVG. AREA FT^2	CONTOUR INTERVAL FT	VOLUME YD^3
5240	55,800	- 84,630	2	6269
42	113,460	- 144,460	2	10700
44	175,460	- 214,830	2	15,913
46	254,200	- 303800	2	22,500
48	353,400	- 376,340	2	27,880
50	399,280	- 375,720	2	27,831
52	352,160	- 320,540	2	23,745
54	288,920	- 254,510	2	18,850
56	220,100	- 165,540	2	12,262
58	110,980	- 55,490	2	4110
60	0			

Σ = 170,060 YD^3

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~7~~ 12A
Project UMTRA-GRJ
Contract No. 3885-34
File No.
Feature Quantity Calcs
Designed GAR
Date 6-26-90
Item
Checked H.L.
Date 7-6-90

Restoration (Non-Essential)

Contour FT	Area FT²	Avg. Area FT²	Contour Interval FT	Volume YD³
5250	8680 C			
	0 F	5580 C	2	413 C
5248	2480 C	6820 F	2	505 F
	13640 F	1860 C	2	138 C
5246	1240 C	13950 F	2	1033 F
	14260 F	620 C	2	46 C
5244	0 C	21390 F	2	1584 F
	28520 F	250 C	2	19 C
5242	500 C	34410 F	2	2549 F
	40300 F	1490 C	2	110 C
5240	2480 C	49910 F	2	3697 F
	59520 F	4030 C	2	298 C
5238	5580 C	72850 F	2	5396 F
	86180 F	4960 C	2	367 C
5236	4340 C	94240 F	2	6981 F
	102300 F	4030 C	2	299 C
5234	3720 C	121830 F	2	9024 F
	141360 F	1860 C	2	138 C
5232	0 C	132370 F	2	9805 F
	123380 F	0 C	2	0 C
5230	0 C	134540 F	2	9966 F
	145700 F	0 C	2	0 C
5228	0 C	123690 F	2	9162 F
	101680 F	0 C	2	0 C
5226	0 C	79670 F	2	5901 F
	57660 F	0 C	2	0 C
5224	0 C	44020 F	2	3261 F
	30380 F	0 C	2	0 C
5222	0 C	22320 F	2	1653 F
	14260 F	0 C	2	0 C
5220	0 C	7130 F	2	528 F
	0 F	0 C	2	0 C

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~8~~ 13A
Project UMTRA - GRJ
Contract No. 3885-34
File No.
Feature
Designed GAR
Date 6-26-90
Item
Checked H. L.
Date 7-6-90

RESTORATION (NON-ESSENTIAL CONT.)

CONTOUR	AREA	AVG. AREA	CONTOUR INTERVAL	VOLUME YD³
5218	0 C	250 F	2	19 F
	500 F	1860 C	2	138 C
5216	3720 C	1180 F	2	87 F
	1860 F	4960 C	2	367 C
5214	6200 C	2480 F	2	184 F
	3100 F	9920 C	2	735 C
5212	13640 C	6510 F	2	482 F
	9920 F	16740 C	2	1240 C
5210	19840 C	11780 F	2	873 F
	13640 F	9920 C	2	735 C
5208	0 C	15190 F	2	1125 F
	16740 F	0 C	2	0 C
5206	0 C	16120 F	2	1194 F
	15500 F	250 C	2	19 C
5204	500 C	15500 F	2	1148 F
	15500 F	870 C	2	64 C
5202	1240 C	18910 F	2	1401 F
	22320 F	4960 C	2	367 C
5200	8680 C	25730 F	2	1906 F
	29140 F	4340 C	2	321 C
5298	0 C	52080 F	2	3858 F
	75020 F	620 C	2	46 C
5296	1240 C	74710 F	2	5534 F
	74400 F	2480 C	2	184 C
5294	3720 C	67890 F	2	5029 F
	61380 F	10540 C	2	781 C
5292	17360 C	49910 F	2	3697 F
	38440 F	8680 C	2	643 C
5290	0 C	19220 F		1424 F
	0 F			

NORTH : WEST SIDES: Σ = 7468 yd³ CUT
= 99,006 yd³ FILL

Project VMTRA - GRJ
Feature Quantity Calcs
Item
Contract No. 3885-34
Designed GAR
Checked H.L.
Sheet ~~8~~ 14A
File No.
Date 6-26-90
Date 7-6-90

Restoration (Non-Essential Cont.)

CONTOUR FT	AREA FT²	AVG. AREA FT²	CONTOUR INTERVAL FT	VOLUME YD³
5240	0 C			
	14260 F	0 C	2	0 C
5238	0 C	18910 F	2	1401 F
	23560 F	3410 C	2	253 C
5236	6820 C	29760 F	2	2204 F
	35960 F	7130 C	2	528 C
5234	7440 C	37510 F	2	2779 F
	39060 F	7440 C	2	551 C
5232	7440 C	41850 F	2	3100 F
	44640 F	6200 C	2	459 C
5230	4960 C	44640 F	2	3307 F
	44640 F	5580 C	2	413 C
5228	6200 C	50840 F	2	3766 F
	57040 F	7440 C	2	551 C
5226	8680 C	60760 F	2	4501 F
	64480 F	10540 C	2	781 C
5224	12400 C	71300 F	2	5281 F
	78120 F	13020 C	2	964 C
5222	13640 C	88040 F	2	6521 F
	97960 F	10540 C	2	781 C
5220	7440 C	107880 F	2	7991 F
	117800 F	8370 C	2	620 C
5218	9300 C	125240 F	2	9277 F
	132680 F	7440 C	2	551 C
5216	5580 C	139810 F	2	10356 F
	146940 F	6200 C	2	459 C
5214	6820 C	154690 F	2	11459 F
	162440 F	3410 C	2	253 C
5212	0 C	165230 F	2	12239 F
	168020 F	0 C	2	0 C
5210	0 C	176080 F	2	13043 F
	184140 F	0 C	2	0 C

— 7.64

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~10~~ 15A
Project UMTRA - GRJ
Contract No. 3825-34
File No.
Feature QUANTITY CALCS.
Designed GAR
Date 6-27-90
Item
Checked H.L.
Date 7-6-90

RESTORATION (NON- ESSENTIAL CONT.)

CONTOUR FT.	AREA FT^2	AVG. AREA FT^2	CONTOUR INTERVAL FT	VOLUME YD^3
5208	0 C	172360 F		12767 F
	160580 F	0 C	2	0 C
5206	0 C	148180 F	2	10976 F
	135780 F	0 C	2	0 C
5204	0 C	128960 F	2	9552 F
	122140 F	0 C	2	0 C
5202	0 C	106640 F	2	7899 F
	91140 F	0 C	2	0 C
5200	0 C	66340 F	2	4914 F
	41540 F			

SOUTH SIDE : Σ = 7164 CUT
= 143,333 FILL
N & W SIDES = 7468 CUT
= 99,006 FILL

TOTAL CUT = 14632 YD^3

TOTAL FILL = 242,339 YD^3

Project UMTRA - GRJ Contract No. 3885-34 Sheet H 16A
Feature QUANTITY CALC. Designed GAR File No.
Item Checked H. L. Date 6-28-90
Date 7-6-90

CLEAN FILL DIKE - ABOVE ORIGINAL GRADE

CONTOUR FT.	AREA FT²	AVG AREA FT²	CONTOUR INTERVAL FT	VOLUME YD³
5198	7440			
		25420	2	1883
5200	43400			
		82150	2	6085
02	120900			
		168640	3	18,737
05	216380			
		264,120	5	48,911
10	311860			
		317440	5	58,785
15	323020			
		327,980	5	60,737
20	332940			
		347,820	5	64,411
25	362700			
		395,870	5	73,309
30	429040			
		439,890	5	81,461
35	450,740			
		453,220	5	83,930
40	455,700			
		455080	5	84,274
45	454,460			
		448,880	5	83,126
50	443,300			
		349,990	5	64,813
55	252680			
		196,540	5	36,396
60	136400			
		115,320	5	21,356
65	94240			
		70,990	5	13,146
70	47740			
		33480	5	6200
75	19220			
		10850	5	2009
80	2480			

Σ = 809,569 YD³

COVER AREA = 3329406 - 2199764 FT²
= 1,129,642 FT²

COVER THICKNESS = 5'0"

VOLUME = 209,193 YD³

TOTAL CLEAN FILL DIKE ABOVE GRADE = 600,376 YD³

REV. 3
8/1/90 H.L.
GAB 8.2.90

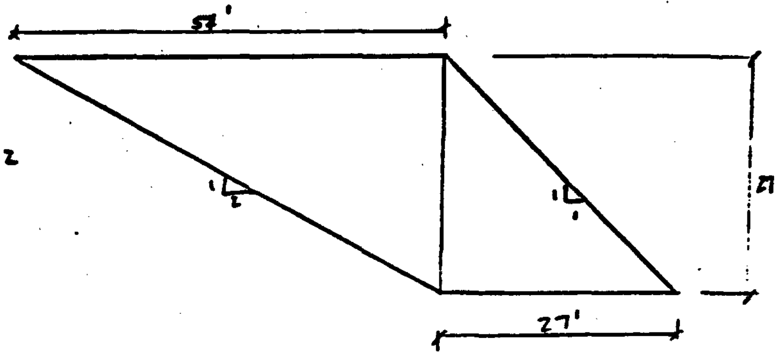
Add up: $\frac{7700 \times 10 \times 2}{27}$ = 5,704 C.Y.

Total = 606,080 CY

Project UMTRA- GRJ
Feature QUANTITY CALC.
Item
Contract No. 3805-34
Designed GAR
Checked H.L.
Sheet ~~12~~ 17A
File No.
Date 6-28-90
Date 7-6-92

CLEAN FILL DIKE - BELOW GRADE

ASSUME X-SECTION



$$AREA = \tfrac{1}{2}(54)(27) + \tfrac{1}{2}(27)^2$$
$$= 1093.5 \text{ FT}^2$$

APRON LENGTH = 7000 FT

TOTAL CLEAN FILL DIKE - BELOW GRADE = 283,500 YD^3 ◀

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ Contract No. 5025 Sheet 46
Feature Quantity Estimate / Phase I Designed WYL Date 3/16/87 File No.
Item Processing Site Checked SWB Date 3/20/87

3. Access Road (DWG No. GRJ-PS-10-~~0108~~ 0109 and 0110)

ACCESS ROAD REHABILITATION, PROCESSING SITE

Location	From	To	Approx. Length (ft)	Width (ft)	Cross Section (in)	A/C (ft³)	Aggregate Base (ft³)	Aggregate Sub-Base (ft³)
US 50 On Ramp	On Ramp Intersection		725 30	17 45	A/C 4" Base 4" Sub-Base 18"	4,558	4,558	20,513
US 50 Off Ramp	—	—	—	—	Maintan	—	—	—
4th Ave	US 50	So 9th St.	1,725	30	Overlay A/C 3.5"	15,094		
So 9th St. 4th Ave	Winters Ave 9th St.	4th Ave. Sta. 2+75	410 275	30	A/C 4" Base 4" Sub-Base 18"	6,850	6,850	30,825
So 9th St.			1035 ~~740~~	30	Overlay " 4½' wide A/C 2.0 ~~1.5"~~	5175 ~~2,775~~		
Kimball Ave	So. 9th St.	Main Gate	400	40	A/C 4" Base 4" Sub-Base 18"	5,333	5,333	24,000
~~So 9th St.~~	~~Struthers Ave~~	~~Kimball Ave~~	~~295~~	~~30~~	~~Maintan~~	—	—	—
Struthers Ave	So. 9th St.	Exist. Gate	185	24	A/C 4" Base 4" Sub-Base 18"	1,480	1,480	6,660
						38490 ~~36,090~~ ft³ 1426 ~~1,337~~ cy 2790 ~~2,616~~ Tons	18,221 ft³ 675 cy	81,998 ft³ 3,036 cy

SWB 11/20/87

Summary

1. Asphalt Concrete needed 1,337 cy (2,616 Tons based on 145 pcf)
2 Aggregate Base Course (3/4") needed 675 cy
3 Aggregate Sub-Base Course (Passing 3" sieve) needed 3,036 cy
4. Excavation 675 + 3,036 = 3,711 cy

SUBGRADE LINER:

725(17) + 30(45) + 685(30) + 400(40) + 185(24)

12325 + [illegible] + [illegible] + 16000 + [illegible] = 54665 SF

= 6074 SY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 67
Project UMTRA - GJ.T
Contract No. 5025
File No.
Feature CONSTRUCTION FACILITIES
Designed SG
Date 11-25-86
Item PAVEMENT DESIGN
Checked ROR
Date 12-15-86

WYL 4/22/87

PAVEMENT DESIGN FOR ACCESS ROAD ~~AND DECON PA~~

DECON PADS WILL BE
CONCRETE SGB 4-6-87
SEE CALC. 05-650-01-0

LOADING

ASSUME 18 CY TRUCKS WILL BE USED TO HAUL MATERIALS
MAXIMUM LEGAL GROSS WEIGHT = 78.000 lbs. (REF.
pg 57

- FULL WT = 78,000 lbs.

EMPTY WT = 78000 lb - (18 cy) 3000 lb/cy ≈ 24 000 lbs.

ASSUME 3.1×10^6 CY MATERIAL WILL BE MOVED TO CHENEY (REF 4) pg 17

$\therefore$ NUMBER TRIPS = $\frac{3.1 \times 10^6}{18}$ = 1.72×10^5

ASSUME 3 YEAR CONSTRUCTION PERIOD @ 9 MONTHS / YEAR
22 DAYS / MONTH (REF. 5)

3 (9) 22 = 594 days

AVERAGE DAILY TRAFFIC = $\frac{172000}{594}$ = 290

18^k EDLA

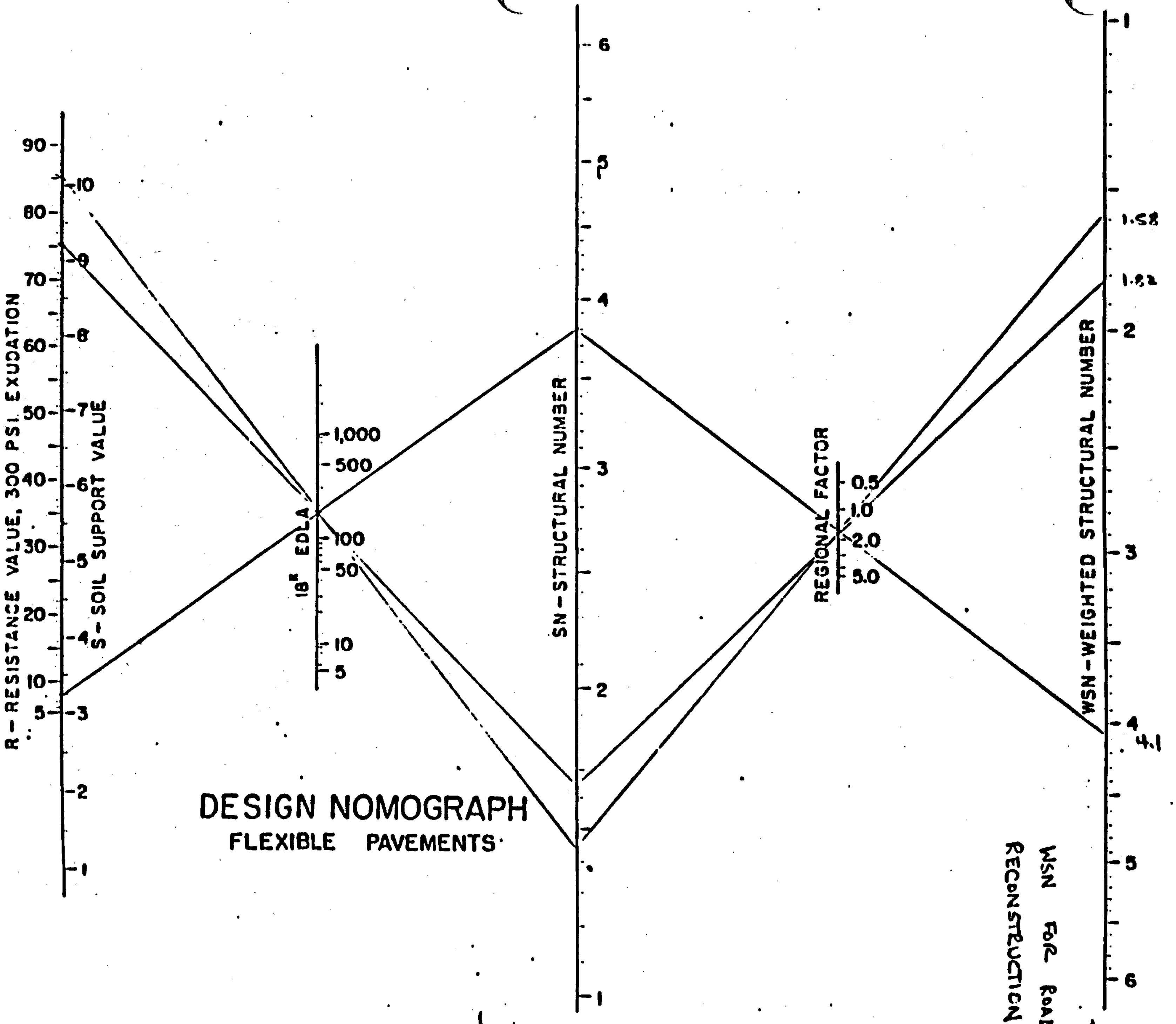
1. TRUCKS WILL LEAVE PROCESSING SITE FULL

$$\therefore \left(18^k \text{ EDLA}\right)_{PS} = \frac{78}{12}(290) = 1257 \underbrace{(3)(.05)}_{\text{PROJECT LIFE FACTOR}} \text{(REF. 3 pg 18)}$$
= 189

2. TRUCKS WILL LEAVE DISPOSAL SITE EMPTY

$$\therefore \left(18^k \text{ EDLA}\right)_{DS} = \frac{24}{12}(290) = 387 (3)(.05)$$
= 58

SERVICE TY INDEX = 2.0
TO BE USED ON MIN GHWAYS - (CURRENT ADT < 750)



DESIGN NOMOGRAPH
FLEXIBLE PAVEMENTS

FROM REF 1
SHS 5/14/87
[illegible] 7/10/87

WSN FOR ROAD
RECONSTRUCTION

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature CONSTRUCTION FACILITIES
Item
Contract No. 5025
Designed slp
Checked PS
Sheet 9
File No.
Date 5/14/87
Date 7/16/87

REVISED PAVEMENT DESIGN FOR GRAND JUNCTION PROCESSING SITE ROAD RECONSTRUCTION
(Based on Reference 1, Section 603)

A. SERVICEABILITY INDEX = 2.0

B. REGIONAL FACTOR:

ANNUAL	PRECIP	-0.5
ELEVATION	~4590	0.25
DRAINAGE		1.00
FROST		1.00
		1.75

C. R-VALUE OF ASPHALT = 90
BASE COURSE = 85
SUBBASE = 75
SUBGRADE = 8 ✓
(See Sheet 10)

D. STRENGTH COEFFICIENTS AND WEIGHTED STRUCTURAL N:

ASPHALT ; $a_1 = .40$
BASE COURSE ; $a_2 = .14$ $WSN_2 = 1.58$
SUBBASE ; $a_3 = .11$ $WSN_3 = \cancel{2.1}$ 1.
SUBGRADE ; $a_4 = .10$ $WSN_4 = 4.1$

E. $WSN = a_1 D_1 + a_2 D_2 + a_3 D_3 + a_4 D_4$

$D_1 = 1.58 \div .40 = 3.95 \rightarrow$ 4" ASPHALT

$D_2 = (\overset{1.22}{\cancel{2.1}} - .4(4)) \div .14 = \overset{-1.57}{\cancel{3.57}} \rightarrow$ 4" BASE COURSE
(minimum value)

$D_3 = (4.1 - .4(4) - .14(4)) \div .11 = 17.6 \rightarrow$
18" SUBBASE

USE: 4" ASPHALT
4" BASE COURSE
18" SUBBASE

SUMMARY OF PRIMARY RECOMMENDATIONS

SECTION #	STREET	FROM	TO	RECOMMENDATION
1195	4th Avenue	Highway 50	7th Street	3.5 Inch Overlay
1210	4th Avenue	7th Street	9th Street	3.5 Inch Overlay
1732	S. 9th Street	Struthers Ave.	Kimball Ave.	Routine Maintenance
1734	S. 9th Street	Kimball Ave.	4th Avenue	Reconstruct Intersection at 4th Ave.
6050	Hwy. 50 on Ramp	4th Avenue	Highway 50	Reconstruct
6060	Hwy. 50 ~~on~~ off Ramp	Highway 50	4th Avenue	Routine Maintenance
6520	Kimball Avenue	S. 9th Street	S. 12th Street	4.0 Inch Overlay on Affected Segment
9070	Struthers Ave.	5th Avenue	S. 9th Street	2.5 Inch Overlay

From An Engineering Report On Pavement Evaluation And Rehabilitation Analysis, Pavement Management Systems, Denver, Dec. 198

WRL 8/5/81

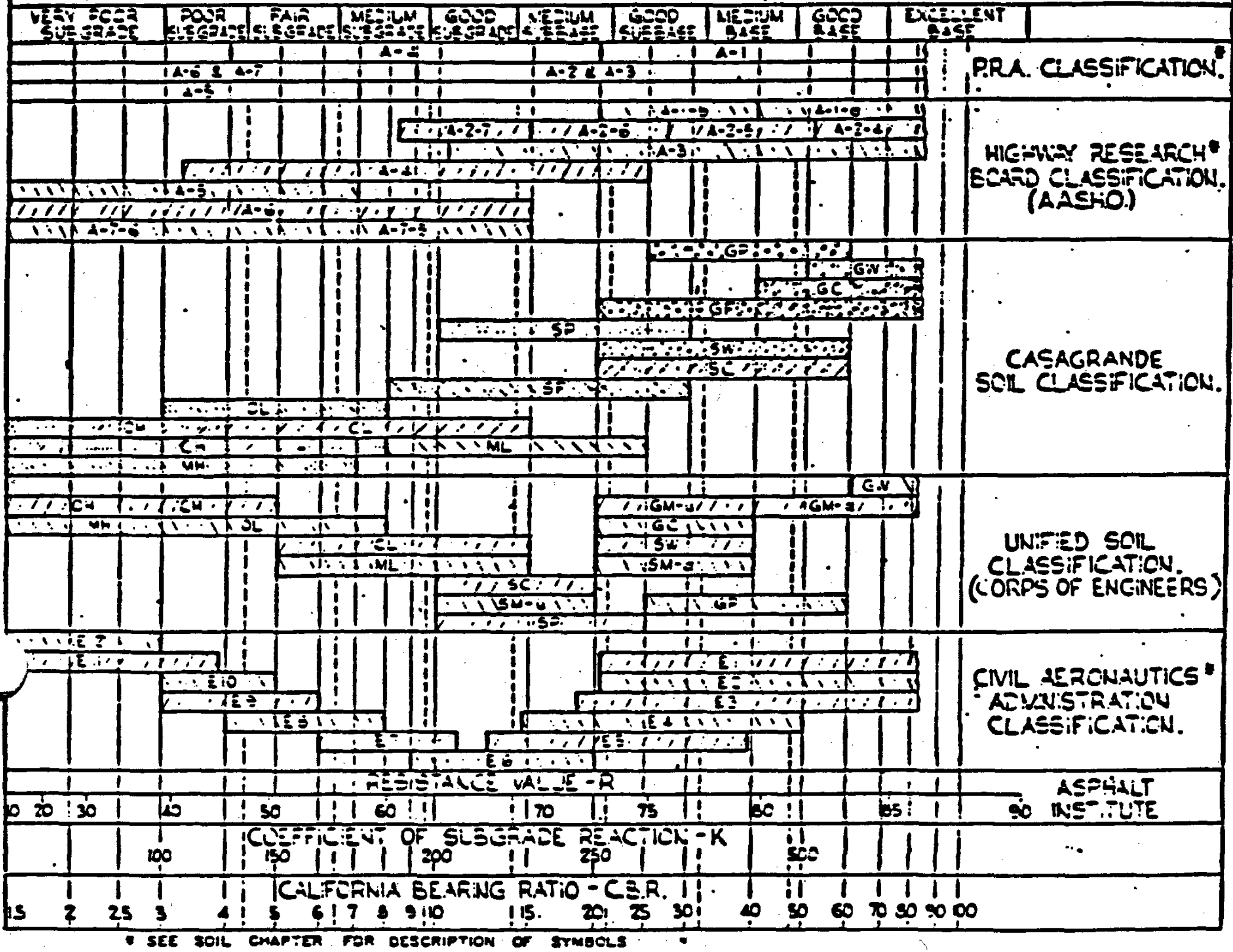
Sec 4/17/2

(Ref. 2) From Elwyn Seelye "Design" Vol. 1
1st ~~10/5/65~~

ROADS & AIRFIELDS-GENERAL SOIL RATINGS

4-5-20 R-12 SPEC

FIG. A GENERAL SOIL RATINGS AS SUBGRADE, SUBBASE OR BASE.



* SEE SOIL CHAPTER FOR DESCRIPTION OF SYMBOLS

AASHO	BOULDERS	COARSE GRAVEL	MEDIUM GRAVEL	FINE GRAVEL	COARSE SAND	FINE SAND	SILT	CLAY	COLLOIDS
CAA	GRAVEL	COARSE SAND	FINE SAND	SILT	CLAY				
UNIFIED (C of E)	COBBLES	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES (SILT OR CLAY)		
SIEVE SIZES	3" 1-1/2" 3/4" 1/2" 4 10 20 40 60 100 200 270								
PARTICLE SIZE mm	100.0 80.0 60.0 40.0 30.0 20.0 10.0 8.0 6.0 4.0 3.0 2.0 1.0 0.8 0.6 0.4 0.3 0.2 0.1 0.08 0.06 0.04 0.03 0.02 0.01 0.008 0.006 0.004 0.003 0.002 0.001								

FIG. B TEXTURAL CLASSIFICATION FOR SOILS

USE IDENTIFY SOIL AND SELECT BEARING VALUE FOR PAVEMENT. DESIGN FROM DIAGRAM.

EXAMPLE GIVEN HIGHLY COMPRESSIBLE CLAY SUBGRADE.
CLASSIFICATION IS CH. A-7 C* A-6
CBR = 4 TO 6
K = 125 TO 160
R = 45 TO 60

NOTE: BEARING VALUES ARE APPROXIMATE AND SHOULD NOT BE USED AS A SUBSTITUTE FOR ACTUAL SOIL TESTS.

LEGEND OF SYMBOLS

G—gravel
S—sand
M—mo, very fine sand, silt, rock flour
C—clay
F—fines (-0.1 mm)
O—organic
W—well graded
P—poorly graded
L—low to medium compressibility
H—high compressibility;
u—unfavorable
d—desirable

PAD PAVEMENT DESIGN ~~A.3.5~~ 5025 5-4

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GR I
Feature CONSTRUCTION FACILITIES
Item

Sheet K 12
Contract No. 5025
File No.
Designed [illegible]
Date 11-21-86
Checked RJB
Date 12-15-86

REFERENCES

1. DIVISION OF HIGHWAYS, STATE OF COLORADO "DESIGN MANUAL", SUPPLEMENTAL SPECIFICATIONS TO THE 1981 STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, OCTOBER 1, 1984

2. SEELYE, ELWYN E. DATA BOOK FOR CIVIL ENGINEERS DESIGN, VOL 1, 3rd ED, JOHN WILEY & SONS, INC, NEW YORK, 1968

3. THE ASPHALT INSTITUTE, THICKNESS DESIGN - ASPHALT PAVEMENT STRUCTURES FOR HIGHWAYS AND STREETS MS-1 7th ED 1963 p48

4. U.S. D.O.E, REMEDIAL ACTION PLAN AND SITE CONCEPTUAL DESIGN FOR STABILIZATION OF THE INACTIVE URANIUM MILL TAILINGS AT GRAND JUNCTION, COLORADO, DRAFT, JUNE 1986

5 M-K COMPANY, PROJECT COST ESTIMATE GRAND JUNCTION, COLORADO RELOCATION TO CHENEY RESERVOIR AUGUST 30, 1985

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

		Sheet	109
Project	UMTRA - GEJ	Contract No. 5625	File No.
Feature	QUANTITY ESTIMATE / PHASE I	Designed SEB	Date 6/1/87
Item	SEALING ABANDONED WELLS	Checked WYL	Date 6/9/87

8.0 SEALING ABANDONED WELLS

DISPOSAL SITE

WELL NOS. GWCH-1, GWCH-2, GWCH-3, and 702 ARE TO BE SEALED, TOTAL FOOTAGE IS 248 FT.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY

Project [illegible]
Feature [illegible] / Phase I
Item Disposal site
Contract No. [illegible]
Designed WVL
Checked [illegible]
Sheet 14
File No.
Date [illegible]
Date 4/17/87

Well No.	Depth of Well (feet)	Well Dia. (in)	Casing Dia. & Type (in)	Casing Depth (ft)	Screen Interval (feet)	Approximate Coordinates North	Approximate Coordinates East	Remarks
GWCH-1	53.4	?	2" PVC	53.4	32.4 - 53.4	11,902.9	93,261.4	To be abandoned and sealed as indicated by TAC 4/15/87
GWCH-2	52.6	?	2" PVC	52.6	32.6 - 52.6	14,169.1	96,180.2	To be abandoned and sealed as indicated by TAC 4/15/87
GWCH-3	102.5	?	4" PVC	102.5	82.5 - 102.5	14,336.4	94,130.7	To be abandoned and sealed as indicated by TAC 4/15/87
(JEG 1982)								
701	40	?	2" PVC	40	28 - 38	14,463.1	95,021.4	To be saved for monitor well as indicated by TAC 4/15/87
702	39.5	?	2" PVC	39.5	27.5 - 32.5	13,412.9	93,568.3	To be abandoned and sealed as indicated by TAC 4/15/87
(JEG 1985)								
526	offsite at Section 15							To be saved for monitor well as indicated by TAC 4/15/87
527	offsite at section 13							To be saved for monitor well as indicated by TAC 4/15/87
(JEG 1986)								

MKE DOCUMENT NO. 5025-GRJ-L-04-00754-00 JL

rYL
110A
109
15

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS
JEG/UMT/0487-0108
5301 CENTRAL AVENUE N.E. — SUITE 1700, ALBUQUERQUE, NEW MEXICO 87108
TELEPHONE (505) 262-1505

April 10, 1987

Mr. James R. Anderson
UMTRA Project Manager
U.S. Department of Energy
Uranium Mill Tailings Project Office
5301 Central Avenue, N.E., Suite 1700
Albuquerque, New Mexico 87108

Attn: Rich Sena

RE: Retention of Ground-water
Monitoring Wells at
Grand Junction Mill Site
Contract No. DE-AC04-82AL14086

Dear Jim:

In response to a request from MK-E during Grand Junction Phase I design review, we have reviewed the wells that were suggested for retention in Colorado Geologic Survey letter of March 9. The value of retaining on-site well numbers 582, 583, 584, 585, and 586 is small compared to the effort required to avoid damaging them during construction, so it is recommended they be properly abandoned. Continued monitoring of the off-site background wells 711 and 712 during construction serves no useful purpose; however, since they are Bureau of Reclamation wells, DOE has no control or responsibility over their retention or abandonment. The remaining eight wells listed (724, 727, 728, 733, 737, 741, 745, and 746) may be useful in monitoring impacts during remedial action and after, if that is deemed appropriate. Therefore, their retention is recommended.

If you have questions, please contact Larry Coons or Bill Deutsch or me.

Very truly yours,
JACOBS ENGINEERING GROUP INC.

Donald P. Dubois, Manager
Albuquerque Operations Office

DPD/LS/vk

cc: Jim Williams (MK-F)
Judd Leong (MK-E)

RECEIVED-MKE
APR 14 1987
UMTRA-S.F.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 14 of 3 16
Project UMTRA / GRJ
Contract No. 5026
File No.
Feature Quantity Estimate / phase I
Designed WYL
Date 3/25/86
Item Disposal site
Checked Sbs
Date 4/17/87

1.16 Temporary Security Fences And Gates (DWG Nos GRJ-DS-10 ~~0116, 0118 And 0120~~ 0125, 0127 AND 0129)

Fences And Gates To Be Installed

Chain-Link Fence

$\sqrt{(13226-12985)^2+(92768-92572)^2}-20-40$	$= 251'$	North
$\sqrt{(13226-13100)^2+(92923-92768)^2}$	$= 200'$	Staging Area
$130+120+20+50$	$= 320'$	Staging Area
	$771'$	

Chain-Link Gates

1 - 40' wide double leaf swing gate (New)	Monitoring Area
1 - 20' wide double leaf swing gate (New)	Staging Area
1 - 30' wide double leaf swing gate (New)	U.S. 50 / Access Road

Wire Fence

$\sqrt{(14080-12050)^2+(95430-94770)^2}$	$= 2135'$	East
$\sqrt{(12050-10760)^2+(95430-94640)^2}$	$= 1513'$	South-East
$\sqrt{(10760-10710)^2+(94640-94145)^2}$	$= 498'$	South
$\sqrt{(11000-10710)^2+(94145-93430)^2}$	$= 772'$	South
$\sqrt{(11660-11000)^2+(93430-93000)^2}$	$= 788'$	South-West
$\sqrt{(12985-11660)^2+(93000-92572)^2}$	$= 1392'$	West
$\sqrt{(13490-13226)^2+(92768-92768)^2}$	$= 264'$	North-East
$\sqrt{(14090-13490)^2+(92330-92768)^2}$	$= 1370'$	North
$\sqrt{(14090-14090)^2+(92770-92000)^2}$	$= 770'$	North-East
	$9502' + 1170'$ AROUND STOCKPILE	

Superseded by REV 2
Sbs 7.10.90

Sbs 7/13/88
PS 7/14/88

Project UMTRA / GRJ
Feature Quantity Estimate / Phase I
Item Disposal site
Contract No. 5225
Designed WYL
Checked ssA
Sheet 17/15/4
File No.
Date 3/25/87
Date 4/17/87

2 ~~7~~. Access Control, Monitoring And Staging Areas (DWG NO GRJ-DS-10-0127 ~~0118~~ And Fig 4)

Excavation (Fig 4)

Stripping (6" topsoil and spoil materials)

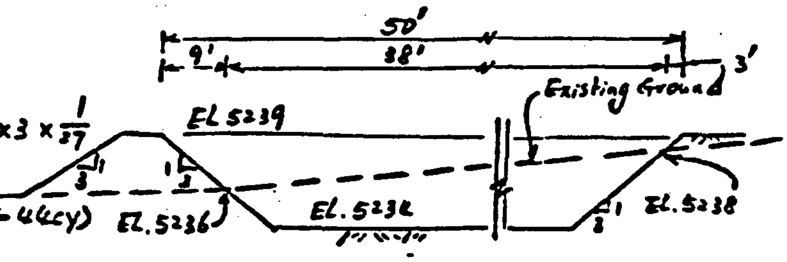
$$Vol. = 0.5 \times [200 \times (130+32+60+20) + (50 \times 100)] \times \frac{1}{27} = 989 \text{ cy}$$

Wastewater Recirculation Pond

$$\text{Ave. excavated depth} = \frac{2+4}{2} = 3'$$

$$Vol. = \frac{(50-12) \times (100-12) + (70 \times 20)}{2} \times 3 \times \frac{1}{27}$$

$$= 264 \text{ cy} \quad (\text{including } 6'' \text{ topsoil} = 44 \text{cy})$$



Wastewater Recirculation Pond (A)
(NOT TO scale)

Fill For Subgrade Preparation (Fig 4)

Staging Area

Vol. = 0 no fill needed

Access Control And Monitoring Areas

South-East Corner Area needs 2' of fill

$$Vol. = \frac{1}{4} \times (80 \times 200) \times 2 \times \frac{1}{27} = 296 \text{ cy}$$

superseded by REV 2 gbs 7/10/90

Wastewater Recirculation Pond

Ave height of dike to be built is about $\frac{3.5+1.5}{2} = 2.5'$ (0.5' of topsoil)

$$Vol. = 2 \times [(100+10)+(50+10)] \times \frac{10+(2 \times 3 \times 2.5+10)}{2} \times 2.5 \times \frac{1}{27} = 551 \text{ cy}$$

PVC pipe At Wastewater Recirculation Pond (Fig 4)

70' - 6" ϕ

Synthetic Membrane Liner (Fig 4)

Wastewater Recirculation Pond

$$Area = 2 \times (50+100) \times 5 \times \frac{1}{9} + \frac{2 \times (50+100) + 2 \times (70+20)}{2} \times 15 \times \frac{1}{9} + 70 \times 20 \times \frac{1}{9}$$

= [illegible]

Project UMTRA / GRJ
Feature Quantity Estimate / phase I
Item Disposal site

Contract No. 5025
Designed WYL
Checked SIA

Sheet ~~15~~ ~~8~~ 18
File No.
Date 3/25/87
Date 4/17/87

Aggregate Base Course (DWG NO GRJ-DS-10-~~one~~ 0127)

Decon Pads And Swale

Vol. $= 60 \times 100 \times \frac{6}{12} \times \frac{1}{27} = 111$ cy

Aggregate Sub-Base Course (DWG NO GRJ-DS-10-~~one~~ 0127)

Access Road

Vol. $= (15 \times 100 + 75 \times 100) \times \frac{13}{12} \times \frac{1}{27} = 361$ cy

~~Aggregate Base Course~~

~~Decon Pads And Swale~~

~~Vol. $= 60 \times 100 \times \frac{4}{12} \times \frac{1}{27} = 74$ cy~~

Aggregate Surface (DWG NO. GRJ-DS-10-~~one~~ 0127)

Staging Area

Vol. $= (200 \times 130 + 20 \times 50) \times \frac{4}{12} \times \frac{1}{27} = 333$ cy

Access Road

Vol. $= 75 \times 100 \times \frac{7}{12} \times \frac{1}{27} = 162$ cy

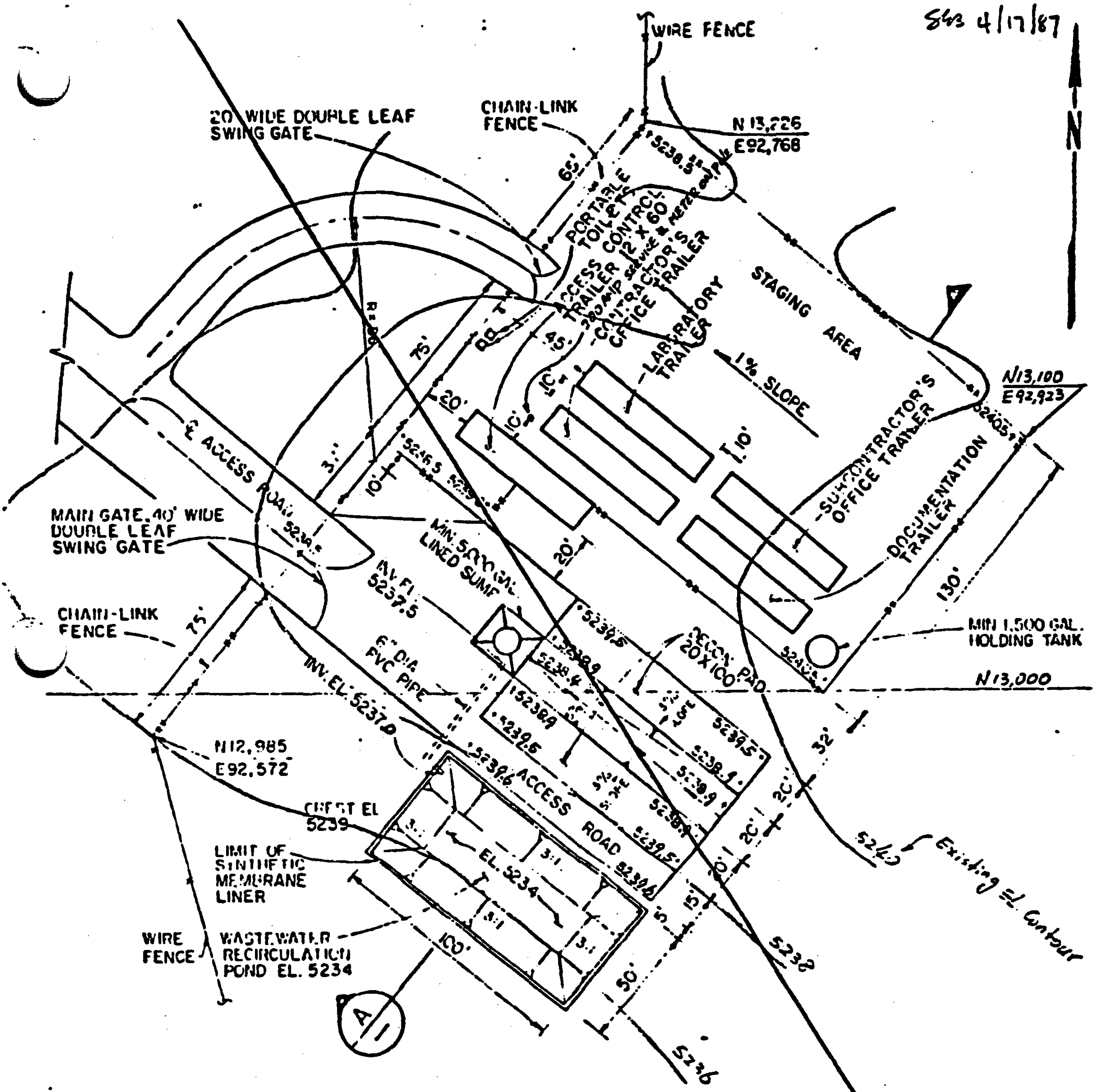
Concrete Pavement (DWG NO GRJ-DS-10-~~one~~ 0127)

Decon Pads And Swale

Vol $= 60 \times 100 \times \frac{6}{12} \times \frac{1}{27} = 112$ cy $= 220$ Tons

Superseded by REV2
GWB 7.10.90

WYL 3/25/87
SWS 4/17/87



ACCESS CONTROL MONITORING AND STAGING AREAS

(Disposal Site)

40 0 40 80
SCALE FEET

Superseded by Rev 2 SWS 7.10.92

Fig 4

Sheet ~~18~~ 7
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature Quantity Estimate / phase I
Designed WYL
Date 3/18/87
Item Disposal site
Checked SHB
Date 3/20/87

WYL 1/27/88
SHB 1/27/88

3 ~~8~~. Wastewater Retention Basin (Fig 5 and DWG No. GRJ-DS-10-~~0117~~ 0126)

1. Excavation (Fig 5)

Basin

Ave depth of Cut $d_1 = \frac{\Sigma \text{ depth of cut}}{25} = \frac{116}{25} = 4.64'$

Area @ El. 5227.5 $A_1 = 340 \times 490 = 166,600 \text{ ft}^2$

Area @ top of basin Cut $A_2 \simeq 530 \times 370 = 196,100 \text{ ft}^2$

Vol. of Cut $V_1 = \frac{166,600 + 196,100}{2} \times 4.64 \times \frac{1}{27} = 31,165 \text{ cy}$

Total Vol. of cut $V = V_1 + \Delta V = 31,165 + 11,888 = 43,053 \text{ cy}$

To deepen 2' at the bottom for accomodating surface runoff water (final El. 5225.5)

Area @ El. 5225.5

$A_3 = 325 \times 475 = 154,375 \text{ ft}$

Additional cut of 2'

$\Delta V = \frac{A_1 + A_3}{2} \times 2 \div 27$

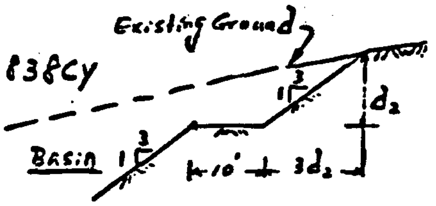
$= \frac{154375 + 166600}{2} \times 2 \div 27$

$= 11,888 \text{ cy}$

Upper Dike

Ave depth of Cut $d_2 = \frac{0.5 + 2 \times (3.5 + 0.5 + 3.5) + 0.5}{8} = 2.0'$

Vol. of Cut $V_2 = \frac{(10 + 3 \times 2) + 10}{2} \times 2 \times (190 + 550 + 130) \times \frac{1}{27} = 838 \text{ cy}$



Upper Dike

Total Excavation $= \overset{43,053}{\cancel{31,165}} + 838 = \overset{43,891}{\cancel{32,003}} \text{ cy}$

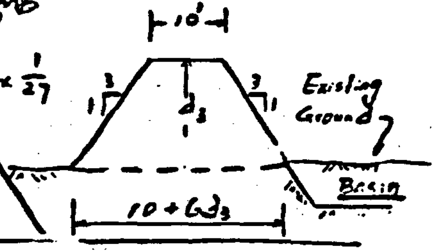
Superseded by REV 2 SHB 7.10.90

2. Fill For The Lower Dike (Fig 5)

Ave depth of fill $d_3 = \frac{0.5 + 2 \times (5.0 + 6.5 + 5.0) + 0.5}{8} = 4.25'$

Vol of fill $V_3 = \frac{(10 + 6 \times 4.25) + 10}{2} \times 4.25 \times (260 + 550 + 90) \times \frac{1}{27}$

$= 3581 \text{ cy}$



Lower Dike

3. Synthetic Membrane Liner (Fig 5)

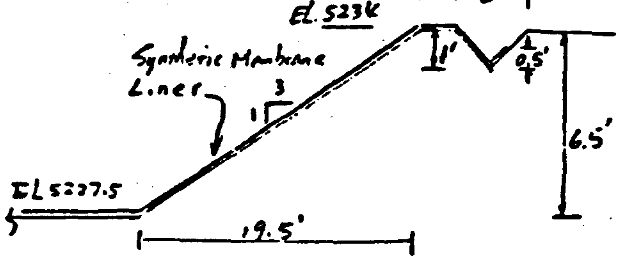
Area $\simeq [2 \times (19.5 + 5) + 340] \times [2 \times (19.5 + 5) + 490] \times \frac{1}{9} = 23,297 \text{ sy}$

$\Delta A = (325 + 475) \times 2 \times 6 \div 9 = 1,067 \text{ sy}$

Total Area $= 23,297 + 1,067 = 24,364 \text{ sy}$

4. Riprap Type B at Toe of Spillway

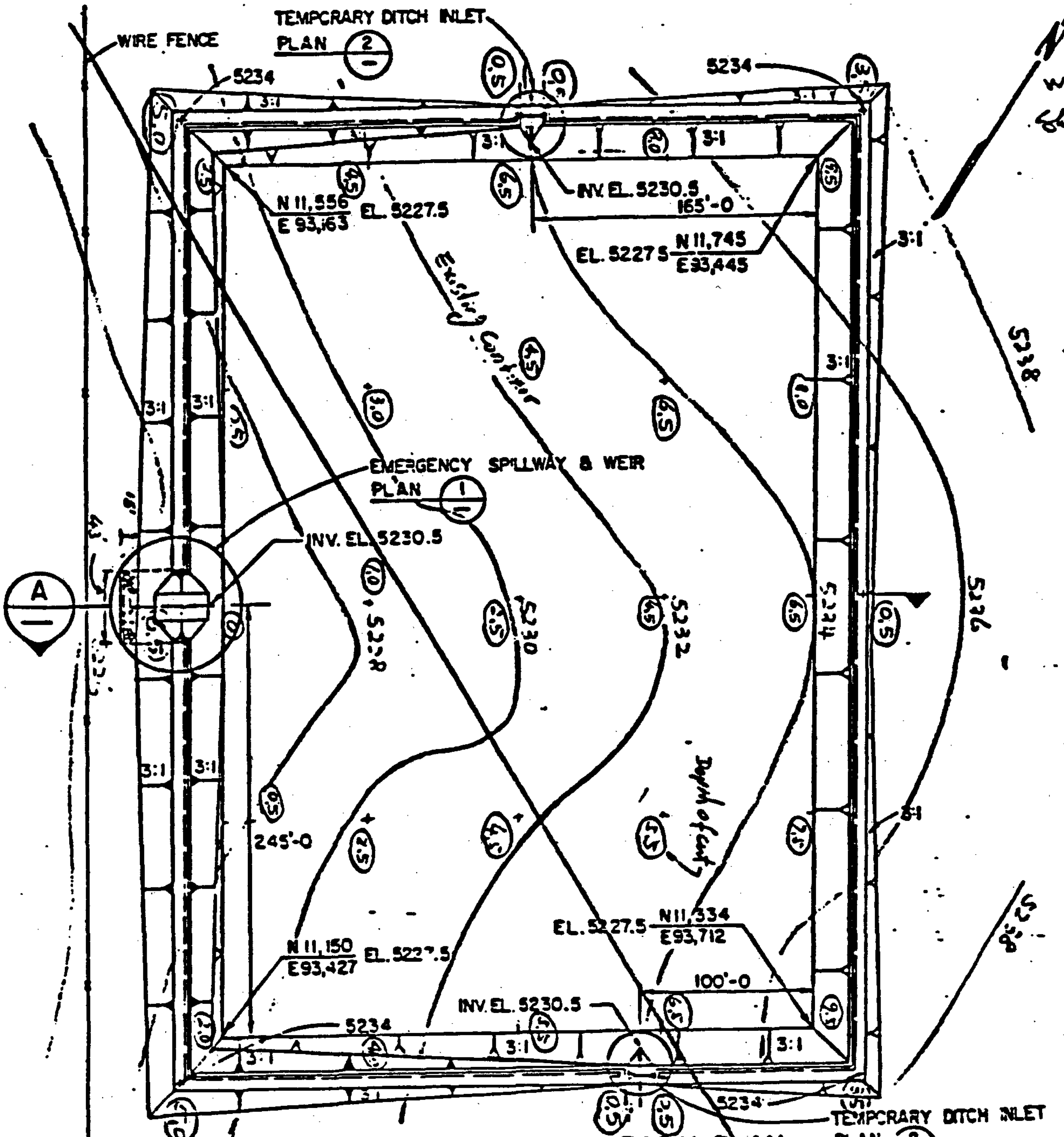
Vol $\simeq 15 \times 43 \times 1.5 \times \frac{1}{27} = 36 \text{ cy}$



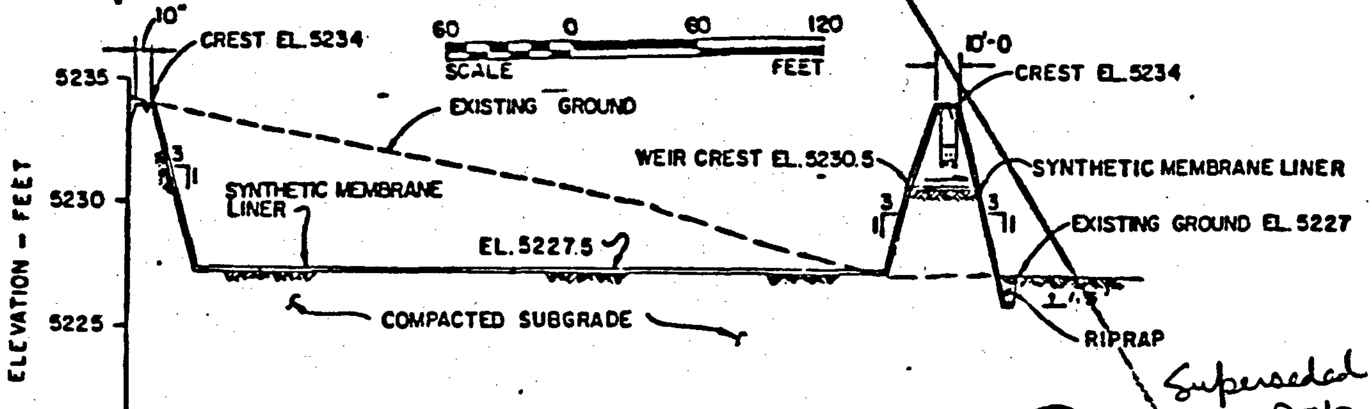
21 ~~17~~/8

WYL 3/18/

SLB 4/17/



WASTEWATER RETENTION BASIN PLAN



WASTEWATER RETENTION BASIN-SECTION A

Superseded by REV2 SHS 7-10-9

Fig 5

Project UMTRA / GRJ
Feature Quantity Estimate / Phase I
Item Disposal site
Contract No. 5225
Designed WYL
Checked SLW
Sheet ~~21~~ 22 10
File No.
Date 4/9/87
Date 4/17/87

10. US 50 TURNOUT LANE AND ACCESS ROAD DWG NO GRJ-DS-10-~~0119~~ thru ~~0123~~)

Summary

US 50 TURNOUT LANE

N/C SLW 7/1/87

~~Asphalt Concrete~~	~~= 894.76 cy = 1752 Tons~~	~~(Unit weight 145 pcf)~~
~~Aggregate Base Course~~	~~= 746.80 cy~~	
~~Aggregate Sub-Base Course~~	~~= 1,723.46 cy~~	
~~Fill~~	~~= 5,731.90 cy~~	~~(compacted)~~
~~Seeding for slopes~~	~~= 0.75 Acres~~	
~~24" ϕ Culvert~~	~~= 78'~~	

PJ 7/1/87

Access Road To Disposal Site

Aggregate Surface	= 4,545 + 70 = 4,615 cy	
Aggregate Sub-Base Course	= 17,043 + 209 = 17,252 cy	
Cut	= 55,362 cy	
Fill	= 19,634 + 278 = 19,912 cy	(compacted)
~~90" ϕ Culvert~~	~~= 120'~~	
~~Riprap Type B For Indian Creek =~~		

Indian Creek

96" ϕ Culvert	= 100'
Riprap, Type B	= 57 cy
Bedding	= 15 cy
Concrete	= 50 cy
Filter Fabric	= 72 sy
[illegible] 12'×6'×9"	= 9

WYL 6/9/87
SB 6/9/87

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 22 23
Project UMTRA GRJ
Contract No. 5025
File No. /
Feature HAUL ROAD
Designed SLB
Date Mar 13 87
Item TURNOUT VOLUME ESTIMATE
Checked PS
Date 4/1/87

FILL FOR US 50 TURNOUT LANE

STATION	AREA FILL	AVE AREA FILL	LENGTH	CY VOLUME
6+00	0			
		0	50	0
6+50	0			
		3	50	5.6
7+00	6			
		7	50	13.0
7+50	8			
		18	50	33.3
8+00	28			
		31	50	57.4
8+50	34			
		44	50	81.5
9+00	54			
		63.5	50	117.6
9+50	73			
		105	50	194.4
10+00	137			
		119.5	50	221.3
10+50	102			
		90.5	50	167.6
11+00	79			
		94	50	174.1
11+50	109			
		110	50	203.7
12+00	111			
		119.5	50	221.3
12+50	128			
		132.5	50	245.3
13+00	137			
		136	50	251.9
13+50	135			
		134.5	50	247.1
14+00	134			
		137	50	253.7
14+50	140			

SWB 7/13/88

NIC

PS 7/14/87

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA GRJ
Feature HAUL ROAD
Item TURNOUT VOLUME ESTIMATE
Contract No. 5025
Designed SLA
Checked PS
Sheet 23 12
File No.
Date Mar 3'87
Date 4/2/87

STATION	AREA FILL	AVE. AREA FILL	LENGTH	CY VOLUME
14+50	140			
		141	50	261.1
15+00	142			
		144.5	50	267.6
15+50	147			
		143.5	50	265.7
16+00	140			
		153	50	283.3
16+50	166			
		159.5	50	295.4
17+00	153			
		136	50	251.9
17+50	119			
		130.5	50	241.7
18+00	142			
		125.5	50	232.4
18+50	109			
		103	50	190.7
19+00	97			
		84	50	155.6
19+50	71			
		74.5	50	138.0
20+00	78			
		68	50	125.9
20+50	58			
		52.5	50	97.2
21+00	47			
		48.5	50	89.8
21+50	50			
		48	50	88.9
22+00	46			
		39.5	50	73.1
22+50	33			
		34	50	63.0
23+00	35			

SWB 7/13/88
PS 7/14/88

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA GR.J
Feature HAUL ROAD
Item TURNOUT VOLUME ESTIMATE

Contract No. 5025
Designed SLB
Checked PS

Sheet 24 13
File No.
Date [illegible] 3 '87
Date [illegible]

STATION	AREA FILL	AVE. AREA FILL	LENGTH	CY VOLUME
23+00	35			
		30	50	55.6
23+50	25			
		17.8	50	33.0
24+00	10.5			
		6.8	50	12.6
24+50	3			
		4.2	50	7.8
25+00	5.5			
		3.3	50	6.1
25+50	1			
		1	50	1.9
26+00	1			
		.9	50	1.7
26+50	.7			
		.6	50	1.1
27+00	.5			

TOTAL = 5731.9 CY
COMPACTED

SLB 7/13/88
PS 7/14/88

5731.9 (1.15) = 6591 CY
LOOSE CY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ
Feature Quantity Estimate / phase I
Item US 50 Turnout Lane / Disposal site
Contract No. 5025
Designed WYL
Checked PS
Sheet 25 14
File No.
Date 4/8/87
Date 4/ /87

Acceleration Lane and Through Lane of US 50 Turnout

7/13/88
PS 7/[illegible]

Station	4" Pavement		6" Aggregate Base Course		13" Aggregate Sub-Base Course	
	Width (ft)	Vol. (cy)	Width (ft)	Vol (cy)	Width (ft)	Vol (cy)
6+50	0		0		0	
		1.85		4.63		12.04
7+00	6		10		12	
		4.32		10.19		26.08
7+50	8		12		14	
		5.86		12.50		31.10
8+00	11		15		17	
		7.72		15.28		37.11
8+50	14		18		20	
		8.64		16.67		42.12
9+00	14		18		20	
		9.26		17.59		42.13
9+50	16		20		22	
		14.81		25.93		62.19
10+00	32		36		38	
		18.52		31.48		72.22
10+50	28		32		34	
		17.28		29.63		68.21
11+00	28		32		34	
		17.28		29.63		68.21
11+50	28		32		34	
		16.67		28.70		66.20
12+00	26		30		32	
		16.36		28.24		65.20
12+50	27		31		33	
		16.36		28.24		65.20
13+00	26		30		32	
		16.05		27.78		64.20
13+50	26		30		32	
		16.05		27.78		64.20
14+00	26		30		32	
		16.05		27.78		64.20
14+50	26		30		32	
		16.05		27.78		64.20
15+00	26		30		32	
		16.05		27.78		64.20
15+50	26		30		32	
		16.05		27.78		64.20
16+00	26		30		32	
		16.05		27.78		64.20
16+50	26		30		32	
		16.05		27.78		64.20
17+00	26		30		32	
		15.43		26.85		62.19
17+50	24		28		30	
		14.20		25.00		58.18
18+00	22		26		28	
		12.96		23.15		54.17
18+50	20		24		26	
		11.73		21.30		50.15
19+00	18		22		24	
		9.88		18.52		44.14
19+50	14		18		20	
		8.64		16.67		42.12
20+00	14		18		20	
		7.41		14.81		36.11
20+50	10		14		16	
		6.17		12.96		32.10
21+00	10		14		16	
		5.56		12.04		30.09
21+50	8		12		14	
		4.94		11.11		28.09
22+00	8		12		14	
		4.32		10.19		26.08
22+50	6		10		12	
		3.70		9.26		24.07
23+00	6		10		12	
		3.70		9.26		24.07
23+50	6		10		12	
		3.09		8.33		22.07
24+00	4		8		10	
		2.47		7.41		20.06
24+50	4		8		10	
		1.85		6.48		18.06
25+00	2		6		8	
		0.93		4.17		12.04
25+50	1		3		4	
		0.62		2.78		8.02
26+00	1		3		4	
		0.62		2.78		8.02
26+50	1		3		4	
		0.62		2.78		8.02
27+00	1		3		4	

NIC

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 26 VS
Project UMTRA / GRJ
Contract No. 5325
File No.
Feature Quantity Estimate / phase I
Designed WYL
Date 4/8/87
Item US 50 Turnout Lane / Disposal site
Checked P.
Date 4/[illegible]87

1-½" overlay of existing pavement over 40' width from sta. 0+00 to sta. 26+60

$$Vol. = \frac{1.5}{12} \times 40 \times 2660 \times \frac{1}{27} = 492.59 \text{ cy}$$

Subtotal.

Asphalt Concrete Pavement = 402.17 + 492.59 = 894.76 cy

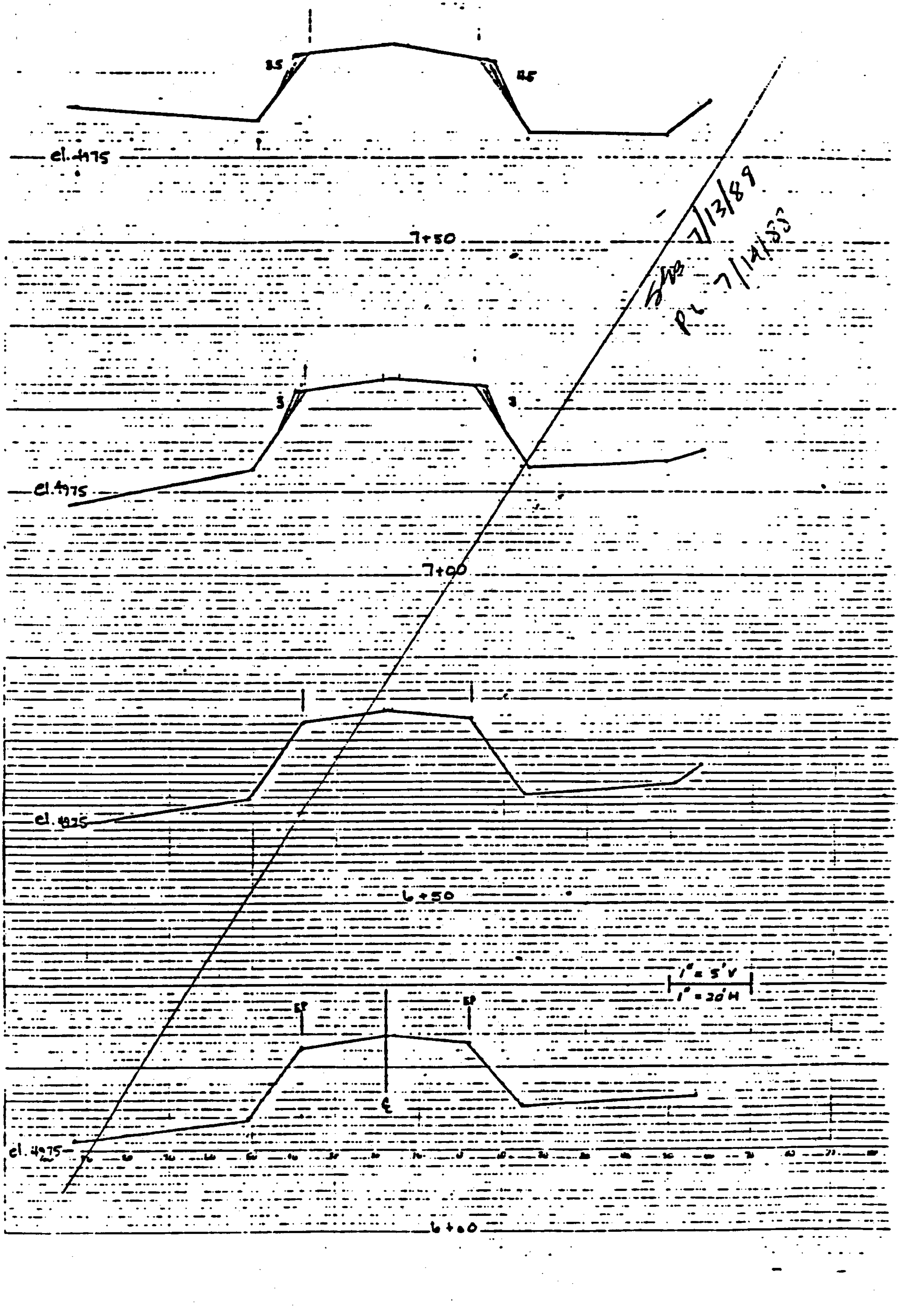
Aggregate Base Course = 746.80 cy

Aggregate Sub-Base Course = 1,773.46 cy

SLW 7/13/88

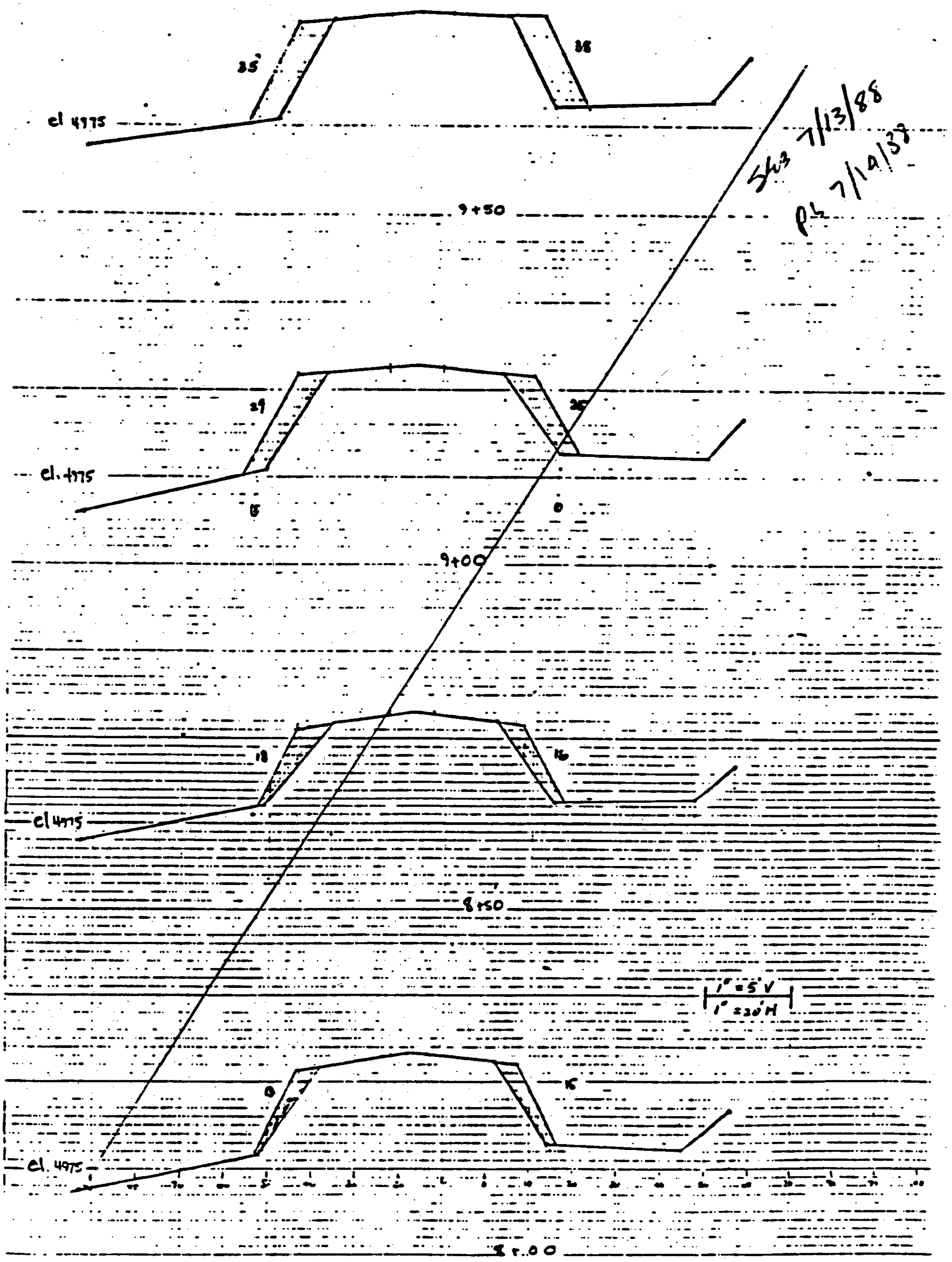
PS 7/14/88

SWB 4/17/87 16
PS 4/24/87



SWB 7/13/89
PC 7/14/89

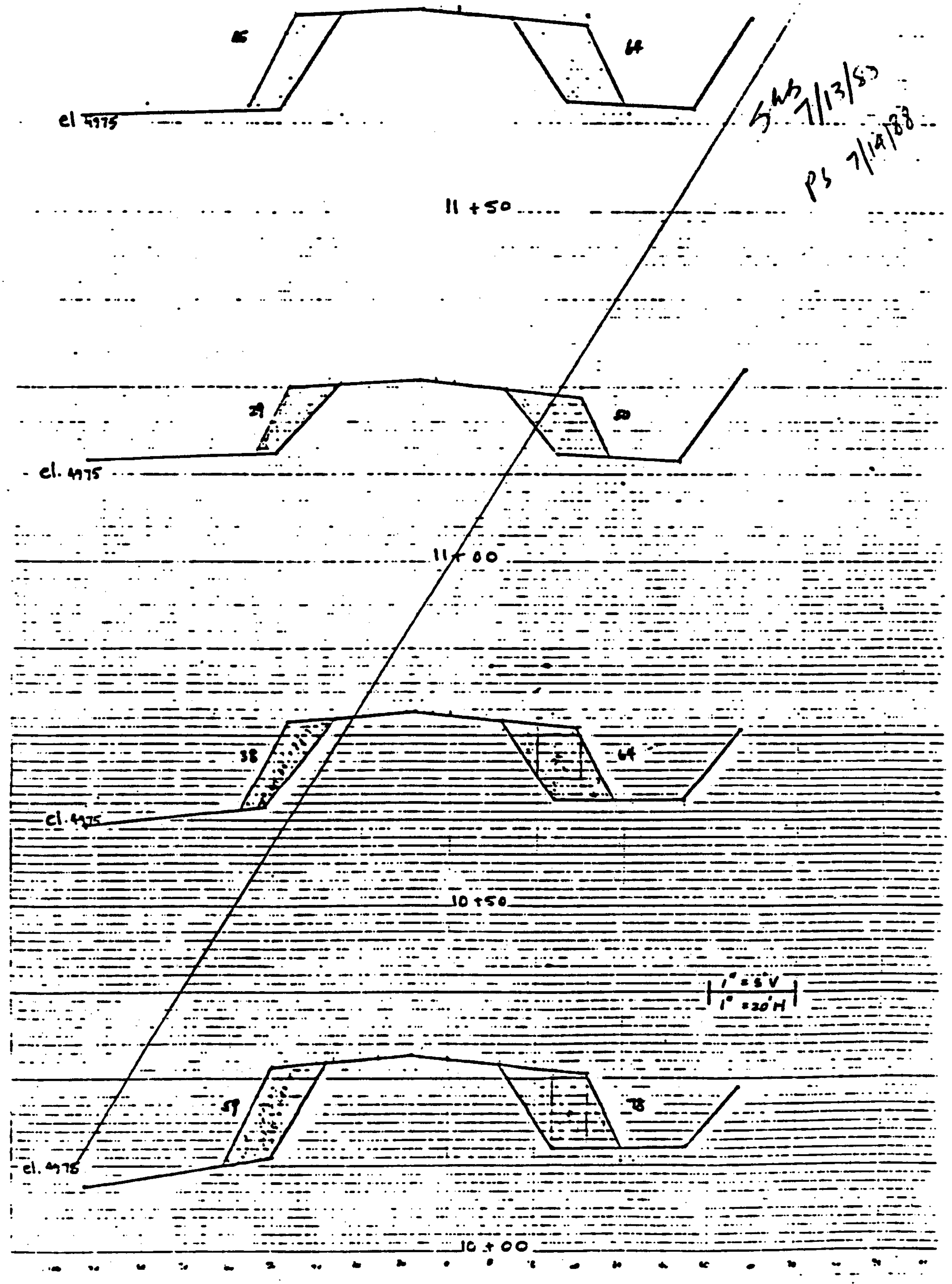
SHB 4/17/87
PS 4/24/87



SHB 7/13/88
PS 7/19/88

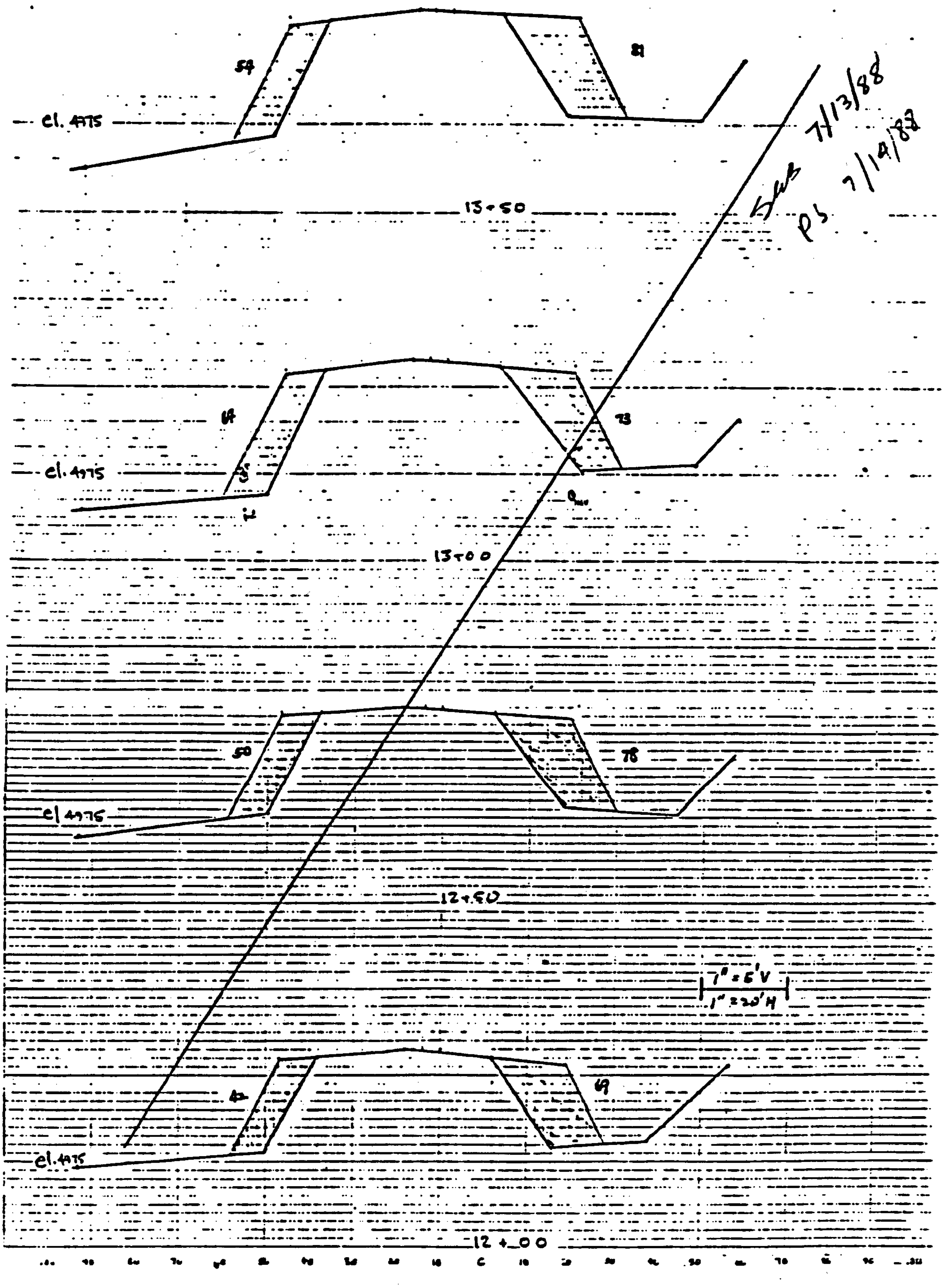
SWS 4/17/87 3
PS 4/24/87

SHT 18



SWS 7/13/88
PS 7/14/88

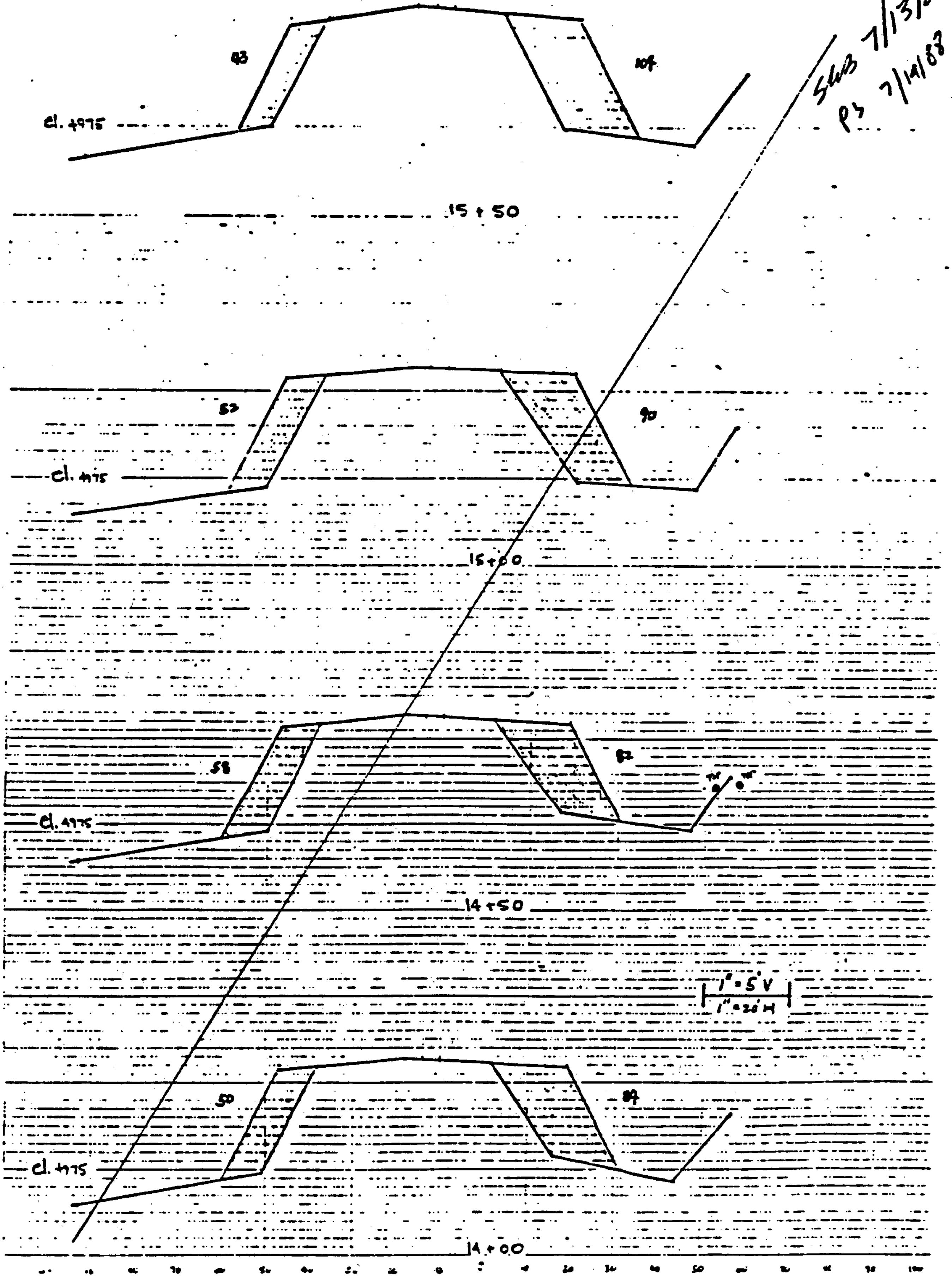
SHT 31 VS
SWS 4/17/87
PS 4/24/87



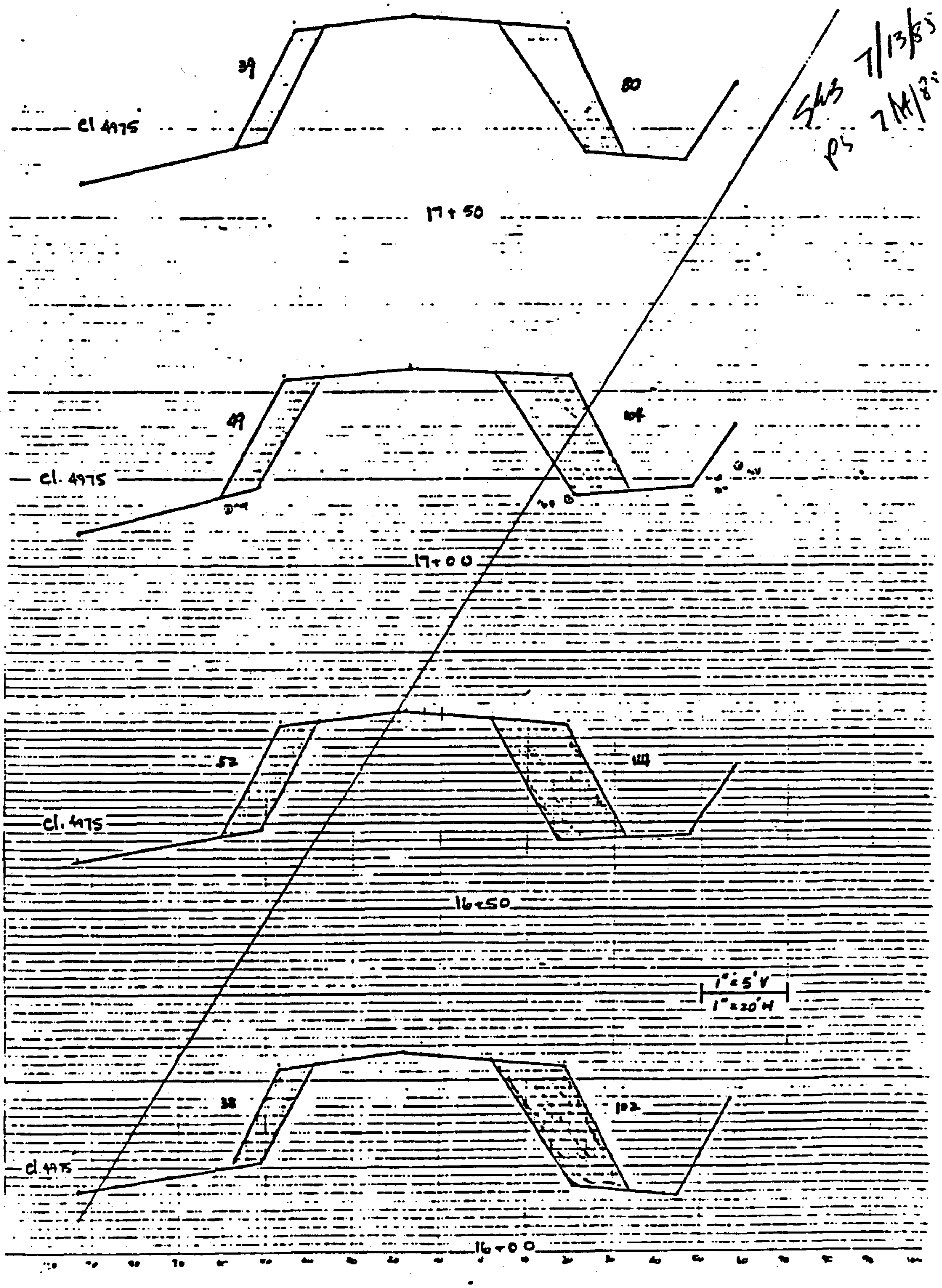
SWS 7/13/88
PS 7/14/88

Sls 4/17/87
PS 4/24/87

Sls 7/13/88
PS 7/14/88

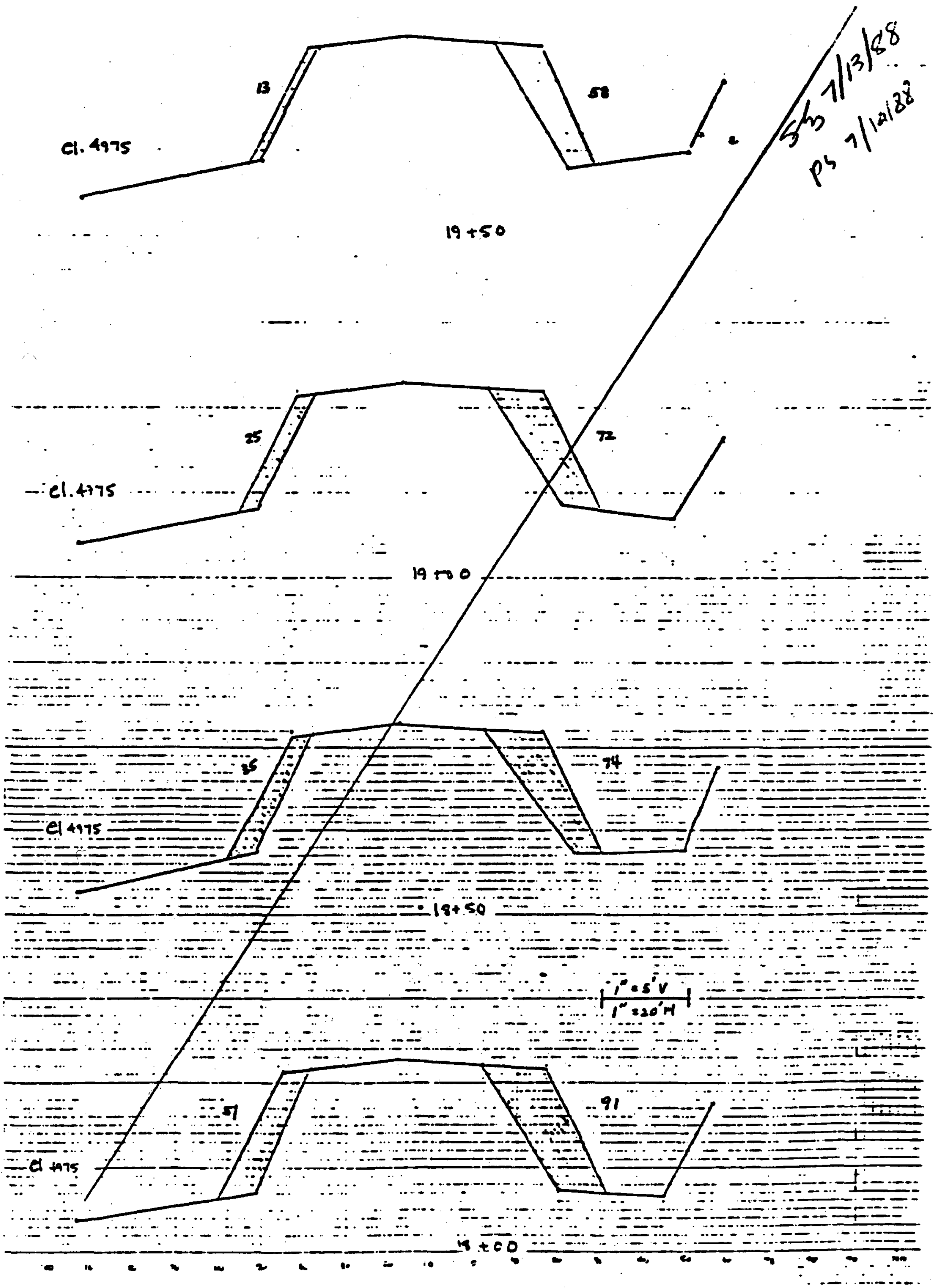


SLS 4/17/87
PS 4/24/87



SLS 7/13/85
PS 7/14/85

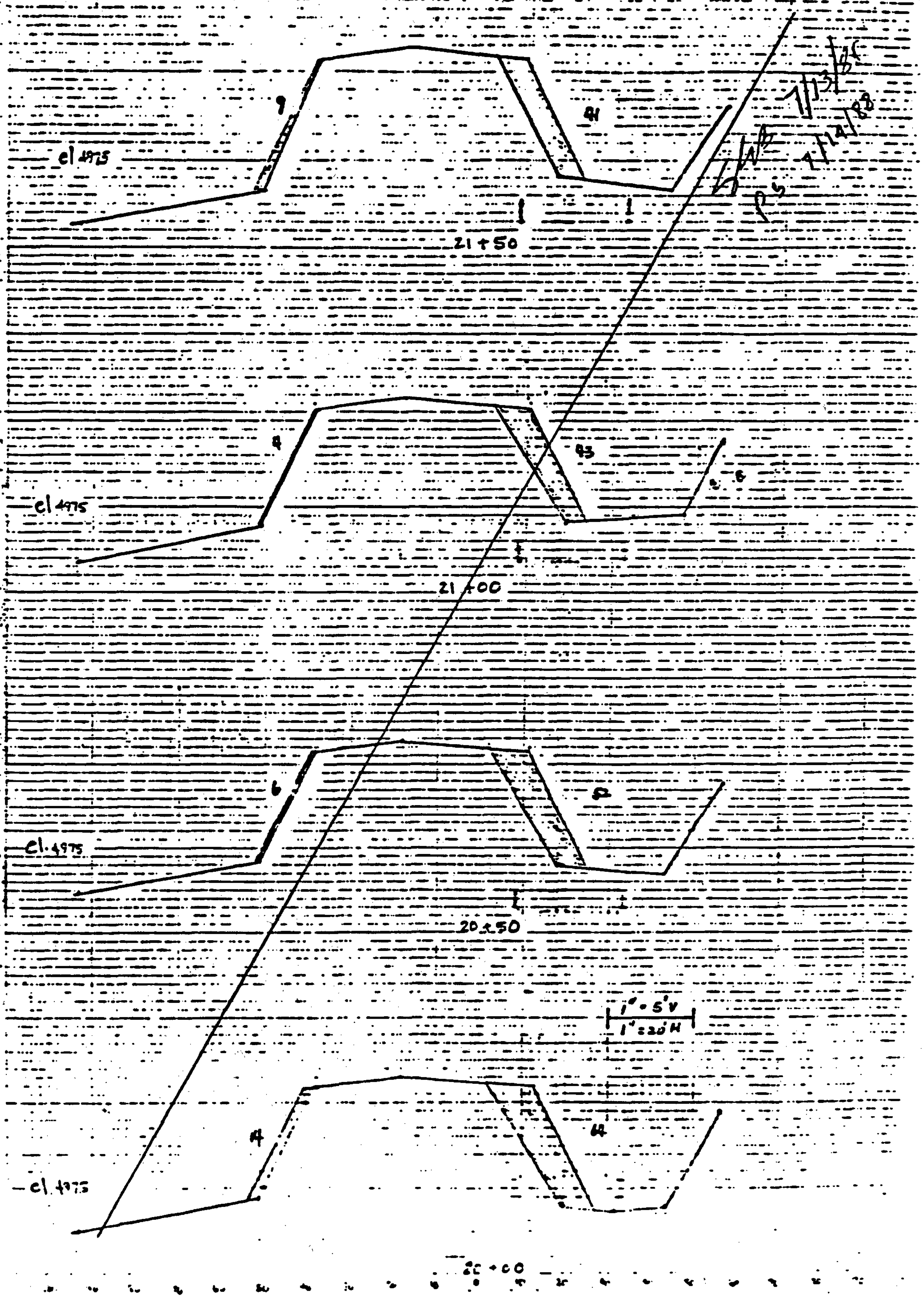
Shs 4/17/87
PS 4/21/87



Shs 7/13/88
PS 7/12/88

SLB 4/17/87

PS 4/24/87



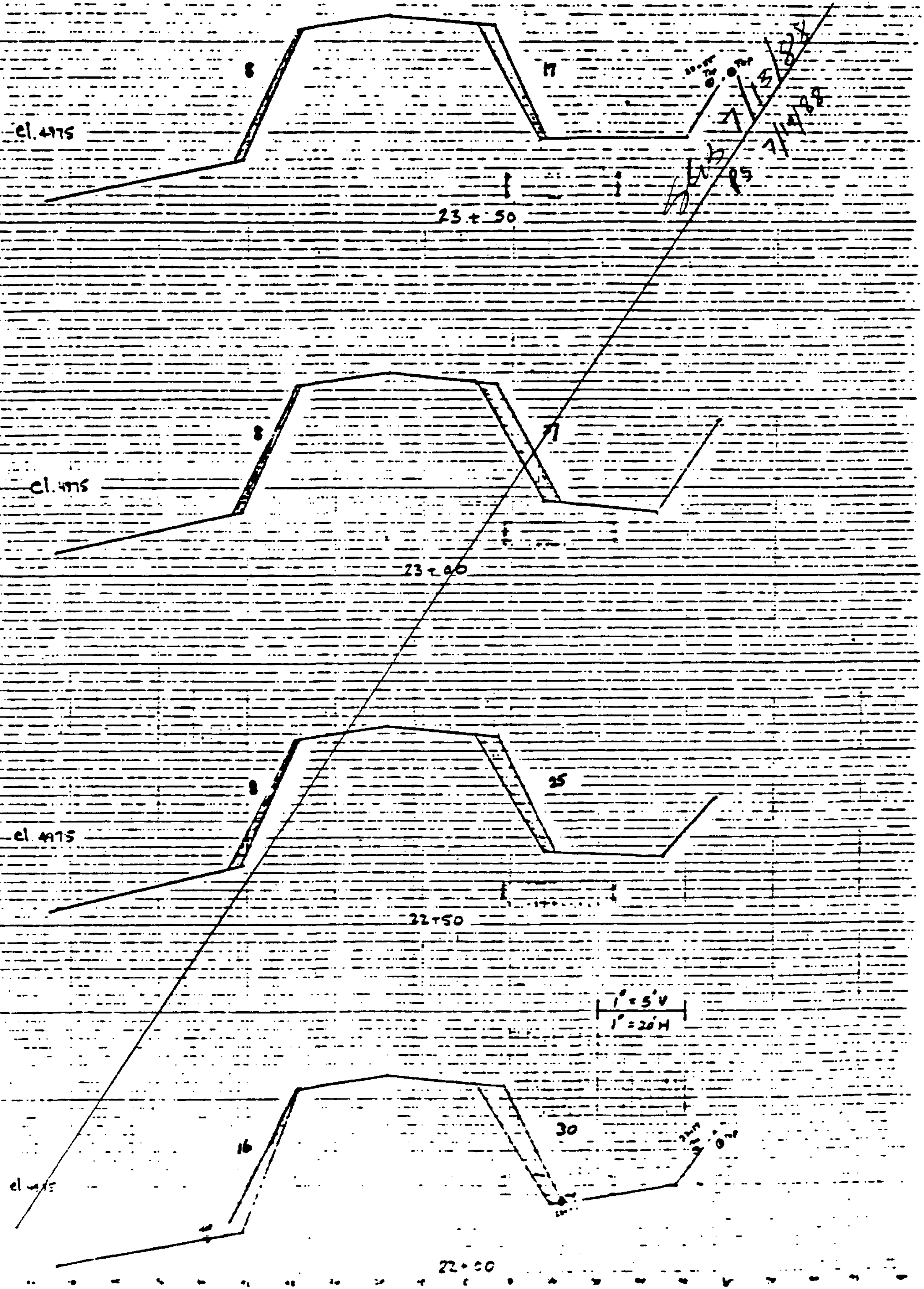
7/13/88

4/14/88

PS

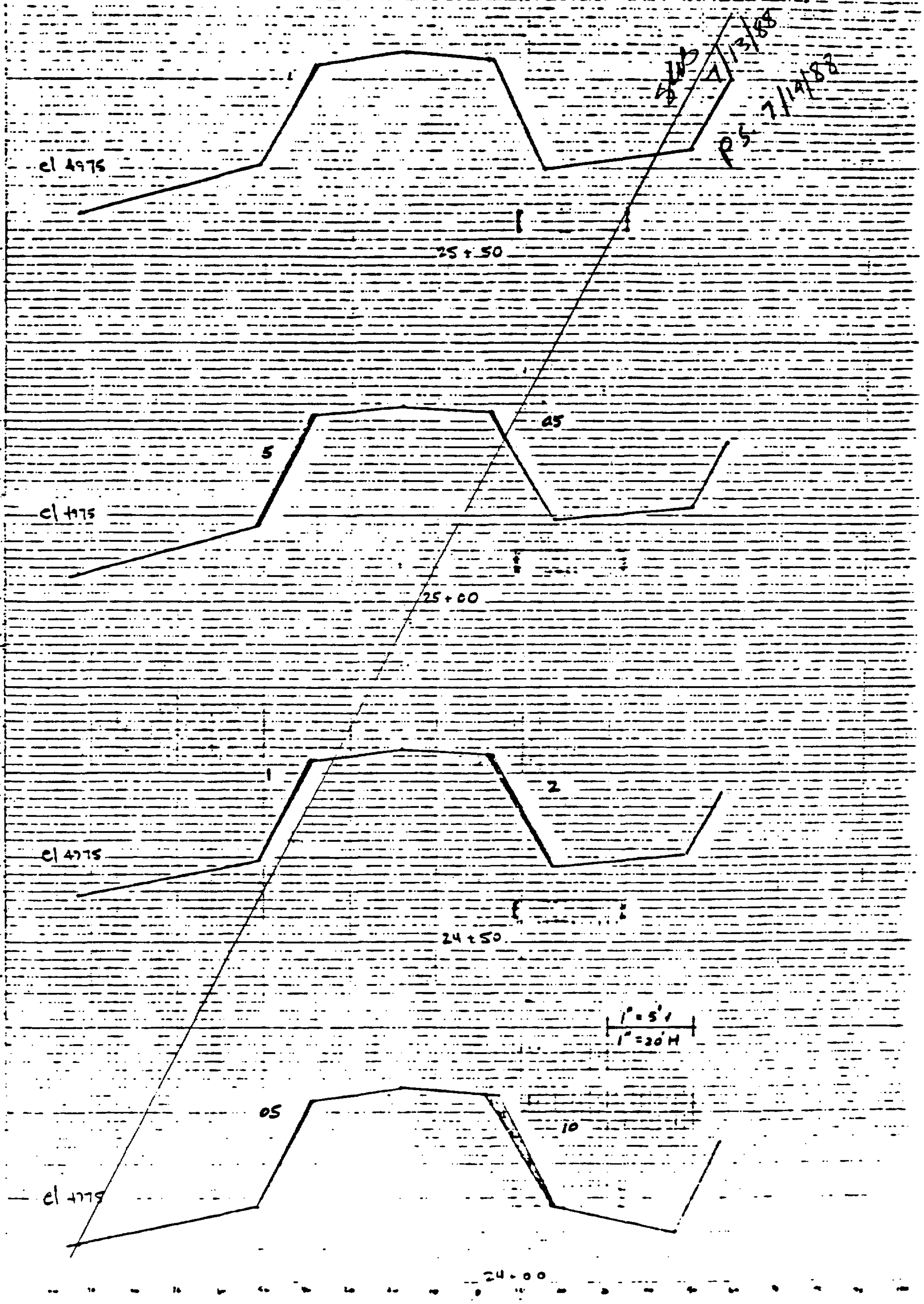
Slub 4/17/87

PS 4/24/87



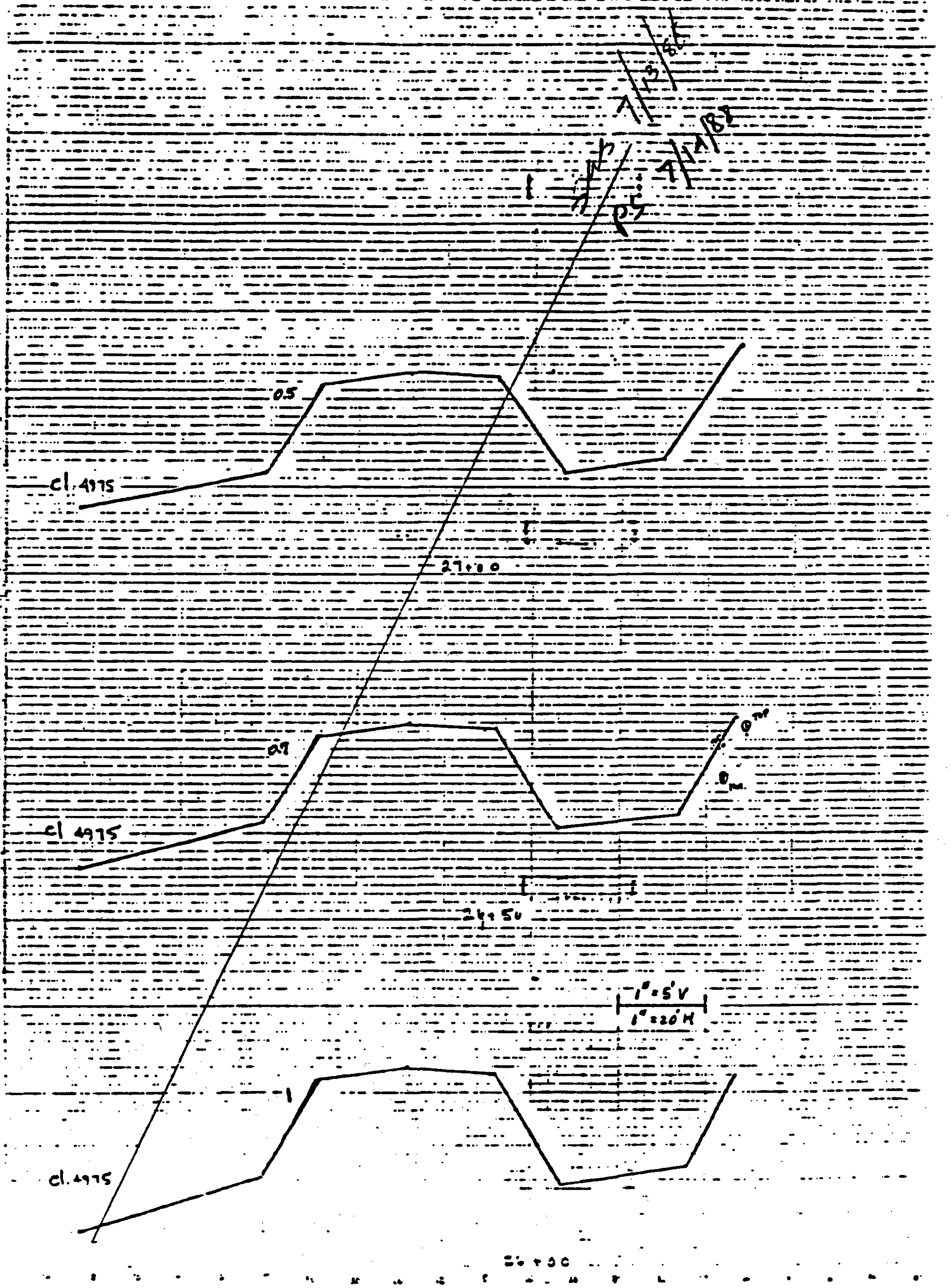
SH3 4/17/87

PS 9/24/82



SLB 4/17/87

PS 9/24/87



MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature ACCESS AND HAUL ROADS
Item ACCESS ROAD VERTICAL CURVES
Contract No. 5025
Designed MDL
Checked PS
Sheet ~~1/2~~ 39/31
File No.
Date 3/20/87
Date 7/8/87

ACCESS ROAD TO DISPOSAL SITE

VERTICAL CURVES

P.I. STATION	P I. ELEVATION	V.C. LENGTH	INITIAL GRADE	FINAL GRADE
184+10	4979.54	100'	-2%	6%
178+00	5016.14	100'	6%	3%
171+00	5037.14	100'	3%	8%
160+66	5119.86	100'	8%	0.75%
156+50	5122.98	100'	0.75%	1.5%
149+00	5134.23	100'	1.5%	2%
142+00	5148.23	100'	2%	3%
138+00	5160.23	100'	3%	1.75%
119+50	5192.61	100'	1.75%	2.25%
113+00	5207.23	100'	2.25%	2%

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ
Feature ACCESS AND HAUL ROADS
Item ACCESS ROAD CUT AND FILL

Contract No. 5025
Designed MDL
Checked PS

Sheet ~~45~~ ~~28~~ 40
File No.
Date 3/20/87
Date 4/8/87

CUT AND FILL QUANTITIES

STATION	AREA (SF) CUT	AREA (SF) FILL	AVE AREA (SF) CUT	AVE AREA (SF) FILL	LENGTH	VOLUME (CY) CUT	VOLUME (CY) FILL
184 + 91	109						
			54.5	59.5	15'	30	33
184 + 76		119					
				91	36'		121
184 + 40		63					
			32.5	31.5	10'	12	12
184 + 30	65						
			73		30'	81	
184 + 00	81						
			66		50'	122	
183 + 50	51						
			36	7.5	50'	67	14
183 + 00	21	15					
			11	37	50'	20	69
182 + 50	1	59					
			0.5	71.5	50'	1	132
182 + 00		84					
			0.5	84.5	50'	1	156
181 + 50	1	85					
			30	44.5	50'	56	82
181 + 00	59	4					
			44.5	4	50'	82	7
180 + 50	30	4					
			146.5	2	50'	271	4
180 + 00	263						
			378.5		50'	701	
179 + 50	494						
			419.5		50'	777	
179 + 00	345						
			562		50'	1041	
178 + 50	779						

Project UMTRA / GRJ
Feature ACCESS AND HAUL ROADS
Item ACCESS ROAD CUT AND FILL

Contract No. 5025
Designed MDL
Checked PS

Sheet ~~45~~ ~~2[illegible]~~ 41
File No.
Date 3/20/87
Date 9/3/87

STATION	AREA (SF) CUT	AREA (SF) FILL	AVE. AREA (SF) CUT	AVE. AREA (SF) FILL	LENGTH	VOLUME (CY) CUT	VOLUME (CY) FILL
178 + 00	667						
			694		50'	1285	
177 + 50	721						
			458.5		50'	849	
177 + 00	196						
			191.5		9'	64	
176 + 91	187						
			333		41'	506	
176 + 50	479						
			546		50'	1011	
176 + 00	613						
			540.5		50'	1001	
175 + 50	468						
			386		50'	715	
175 + 00	304						
			239		50'	443	
174 + 50	174						
			119		50'	220	
174 + 00	64						
			41.5		50'	77	
173 + 50	19						
			10	16	50'	19	30
173 + 00	1	32					
			1	34	50'	2	63
172 + 50	1	36					
			0.5	96.5	9'	0	32
172 + 41		157					
				314.5	23'		268
172 + 18		472					
				529	10'		196
172 + 08		586					
				465	35'		603
171 + 73		344					
				[illegible]	[illegible]		[illegible]

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~45~~ 30
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature ACCESS AND HAUL ROADS
Designed MDL
Date 3/20/87
Item ACCESS ROAD CUT AND FILL
Checked PS
Date 4/21/87

STATION	AREA (SF)		AVE. AREA (SF)		LENGTH	VOLUME (CY)	
	CUT	FILL	CUT	FILL		CUT	FILL
171 + 70		468					
				424.5	18'		283
171 + 52		381					
				419	2'		31
171 + 50		457					
				532	19'		374
171 + 31		607					
				484	11'		197
171 + 20		361					
				367.5	20'		272
171 + 00		374					
				460	50'		852
170 + 50		546					
				694.5	50'		1286
170 + 00		843					
				918.5	50'		1701
169 + 50		994					
				1069	50'		1980
169 + 00		1144					
				1212	50'		2244
168 + 50		1280					
				1307	50'		2420
168 + 00		1334					
				1124.5	50'		2082
167 + 50		915					
			38	518.5	50'	70	960
167 + 00	76	122					
			577.5	61	50'	1069	113
166 + 50	1079						
			1923		50'	3561	
166 + 00	2767						
			2988		50'	5533	
165 + 50	3209						
			[illegible]		[illegible]	[illegible]	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature ACCESS AND HAUL ROADS
Item ACCESS ROAD CUT AND FILL
Contract No. 5025
Designed MDL
Checked PS
Sheet ~~46~~ 47 of 31
File No.
Date 3/20/87
Date 4/8/87

STATION	AREA (SF) CUT	AREA (SF) FILL	AVE. AREA (SF) CUT	AVE. AREA (SF) FILL	LENGTH	VOLUME (CY) CUT	VOLUME (CY) FILL
165+00	2960						
			2845		50'	5269	
164+50	2730						
			2553		50'	4728	
164+00	2376						
			2131.5		50'	3947	
163+50	1887						
			1626.5		50'	3012	
163+00	1366						
			1174.5		50'	2175	
162+50	983						
			805		50'	1491	
162+00	627						
			505.5		50'	936	
161+50	384						
			263.5		50'	488	
161+00	143						
			81	15	50'	150	28
160+50	19	30					
			15.5	42.5	50'	29	79
160+00	12	55					
			9	58.5	50'	17	108
159+50	6	62					
			4	57.5	50'	7	106
159+00	2	53					
			8.5	37.5	50'	16	69
158+50	15	22					
			28	15	50'	52	28
158+00	41	8					
			55	5	50'	102	9
157+50	69	2					
			48.5	8	50'	90	15
157+00	28	14					

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 47 44 37
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature ACCESS AND HAUL ROADS
Designed MDL
Date 3/20/87
Item ACCESS ROAD CUT AND FILL
Checked PS
Date 4/9/87

STATION	AREA (SF)		AVE. AREA (SF)		LENGTH	VOLUME (CY)	
	CUT	FILL	CUT	FILL		CUT	FILL
156 + 50	18	13					
			24	7	50'	44	13
156 + 00	30	1					
			31.5	0.5	50'	58	1
155 + 50	33						
			30.5		42'	47	
155 + 08	28						
			22		58'	47	
154 + 50	16						
			15		50'	28	
154 + 00	14						
			13.5		50'	25	
153 + 50	13						
			13		50'	24	
153 + 00	13						
			9	0.5	50'	17	1
152 + 50	5	1					
			4.5	5	50'	8	9
152 + 00	4	9					
			3.5	11	50'	6	20
151 + 50	3	13					
			2.5	19	50'	5	35
151 + 00	2	25					
			2.5	20.5	50'	5	38
150 + 50	3	16					
			9.5	8	50'	18	15
150 + 00	16						
			20		100'	74	
149 + 00	24						
			32		100'	119	
148 + 00	40						
			48		100'	178	
147 + 00	56						
			[illegible]		[illegible]	[illegible]	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Contract No. 5025
Sheet ~~42~~ 45 33
File No.
Feature ACCESS AND HAUL ROADS
Designed MDL
Date 3/20/87
Item ACCESS ROAD CUT AND FILL
Checked PS
Date 4/8/87

STATION	AREA (SF)		AVE. AREA (SF)		LENGTH	VOLUME (CY)	
	CUT	FILL	CUT	FILL		CUT	FILL
146 + 00	48						
			68.5		100'	254	
145 + 00	89						
			66.5		100'	246	
144 + 00	44						
			36.5		100'	135	
143 + 00	29						
			49		100'	181	
142 + 00	69						
			71		100'	263	
141 + 00	73						
			49.5		100'	183	
140 + 00	26						
			14.5	9	100'	54	33
139 + 00	3	18					
			2	23.5	100'	7	87
138 + 00	1	29					
			1.5	22.5	100'	6	83
137 + 00	2	16					
			3	10.5	100'	11	39
136 + 00	4	5					
			3.5	10	100'	13	37
135 + 00	3	15					
			2	24	100'	7	89
134 + 00	1	33					
			2	24	100'	7	89
133 + 00	3	15					
			8	7.5	100'	30	28
132 + 00	13						
			10	8.5	100'	37	31
131 + 00	7	17					
			3.5	40	100'	13	148
130 + 00		63					

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~45~~ ~~34~~ 46
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature ACCESS AND HAUL ROADS
Designed MDL
Date 3/20/87
Item ACCESS ROAD CUT AND FILL
Checked PS
Date 4/8/87

STATION	AREA (SF) CUT	AREA (SF) FILL	AVE. AREA (SF) CUT	AVE. AREA (SF) FILL	LENGTH	VOLUME (CY) CUT	VOLUME (CY) FILL
129 + 00		79					
				92	100'		341
128 + 00		105					
				101.5	100'		376
127 + 00		98					
				76	100'		281
126 + 00		54					
			1.5	30.5	100'	6	113
125 + 00	3	7					
			3	6	100'	11	22
124 + 00	3	5					
			4	3	100'	15	11
123 + 00	5	1					
			7.5	0.5	100'	28	2
122 + 00	10						
			27		100'	100	
121 + 00	44						
			36.5		100'	135	
120 + 00	29						
			16	6.5	100'	59	24
119 + 00	3	13					
			2.5	19	100'	9	70
118 + 00	2	25					
			6	13.5	100'	22	50
117 + 00	10	2					
			20.5	1	100'	76	4
116 + 00	31						
			29		100'	107	
115 + 00	27						
			22.5		100'	83	
114 + 00	18						
			11	2.5	100'	41	9
113 + 00	4	5					

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 41 ~~56~~ 35
Project UMTRA / GRJ
Contract No. 5025
File No.
Feature ACCESS AND HAUL ROADS
Designed MDL
Date 3/20/87
Item ACCESS ROAD CUT AND FILL
Checked PS
Date 4/10/87

STATION	AREA (SF) CUT	AREA (SF) FILL	AVE. AREA (SF) CUT	AVE. AREA (SF) FILL	LENGTH	VOLUME (CY) CUT	VOLUME (CY) FILL
112+00	37						
			55.5		100'	206	
111+00	74						
			96		100'	356	
110+00	118						
			101.5		100'	376	
109+00	85						
			72.5		100'	269	
108+00	60						
			52		100'	193	
107+00	44						
			24	10	100'	89	37
106+00	4	20					
			4	15	100'	15	56
105+00	4	10					
			9	8	100'	33	30
104+00	14	6					
			18	3	100'	67	11
103+00	22						
			27.5		100'	102	
102+00	33						
			36.5		100'	135	
101+00	40						
			50		100'	185	
100+00	60						
			77.5		100'	287	
99+00	95						
			97		100'	359	
98+00	99						
			95.5		76'	269	
97+24	92						
						55,342 cy	19,634 cy

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ
Feature ACCESS AND HAUL ROADS
Item ACCESS ROAD CUT AND FILL

Contract No. 5025
Designed MDL
Checked SLB

Sheet ~~51~~ ~~36~~ 48
File No.
Date 4/3/87
Date 4/17/87

CUT FOR ROAD TO STAGING AREA = 40 sf × 187.8' = 7512 cf = 278 cy

CUT = 55,342 cy
FILL = 19,634 cy (+ 15% FOR SHRINKAGE) = 22,579 cy

FILL NEEDED FOR TURNOUT = 5732 cy (+ 15% FOR SHRINKAGE) = 6592 cy

NET CUT FOR ACCESS ROAD = 26,449 cy

Sheet ~~52~~ 44 ~~37~~

Project UMTRA / GRJ
Contract No. 5025
File No.
Feature ACCESS AND HAUL ROADS
Designed MDL
Date 4/3/87
Item AGGREGATE QUANTITIES FOR ACCESS ROAD
Checked PS
Date 4/8/87

ACCESS ROAD TO DISPOSAL SITE

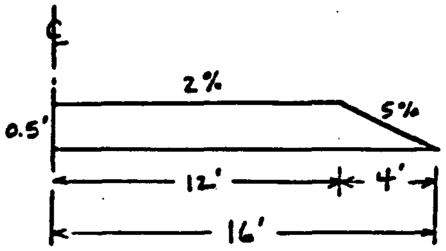
AGGREGATE QUANTITIES

ACCESS ROAD Sta. 184+89 to Sta. 97+24

LENGTH OF ACCESS ROAD = 8765 ft

AGGREGATE SURFACE

SYMMETRY ABOUT ℄



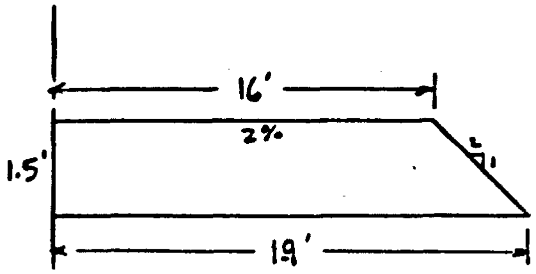
$0.5' \times 12' = 6 \text{ ft}^2$

$\frac{1}{2}(4' \times 0.5') = 1 \text{ ft}^2$

$7 \text{ ft}^2 \times 2 \text{ sides} = 14 \text{ ft}^2 \times 8765 \text{ ft}$

$= 122{,}710 \text{ ft}^3 = \underline{4545 \text{ cy}}$ (6" AGGREGATE SURFACE

AGGREGATE SUB-BASE COURSE



$17.5' \times 1.5' = 26.25 \text{ ft}^2 \times 2 \text{ sides} = 52.5 \text{ ft}^2 \times 8765 \text{ ft}$

$= 460{,}162.5 \text{ ft}^3$

$= \underline{17{,}043 \text{ cy}}$ (18" AGGREGATE SUB-BASE COURSE)

Sheet 55 ~~36~~ 56
Project UMTRA / GRT
Contract No. 5026
File No.
Feature Quantity Estimate / phase I
Designed WYL
Date 4/8/87
Item Access Road To Staging Area / Disposal site
Checked PS
Date 4/8/87

Access Road To Staging Area

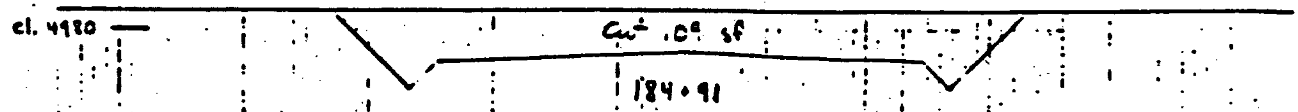
Road width = 20'   Length = 187.8'

6" Aggregate Surface . 18" Aggregate Sub-Base Course

Aggregate Surface $= 20 \times 187.8 \times \frac{6}{12} \times \frac{1}{27} = 70$ cy

Aggregate Sub-Base Course $= 20 \times 187.8 \times \frac{18}{12} \times \frac{1}{27} = 209$ cy

51
SHT ~~39~~
51

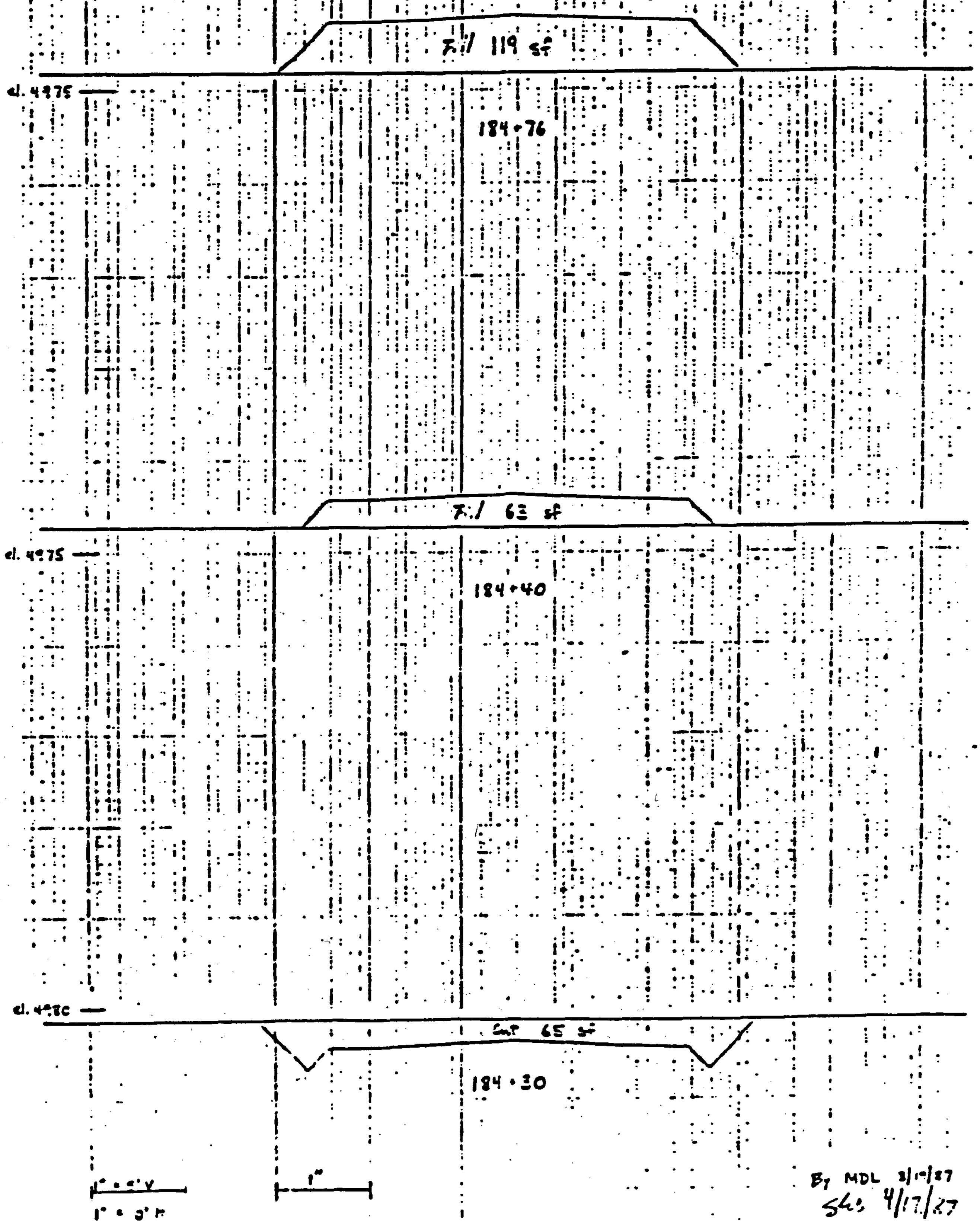


1" = 5' V
1" = 10' H

1"

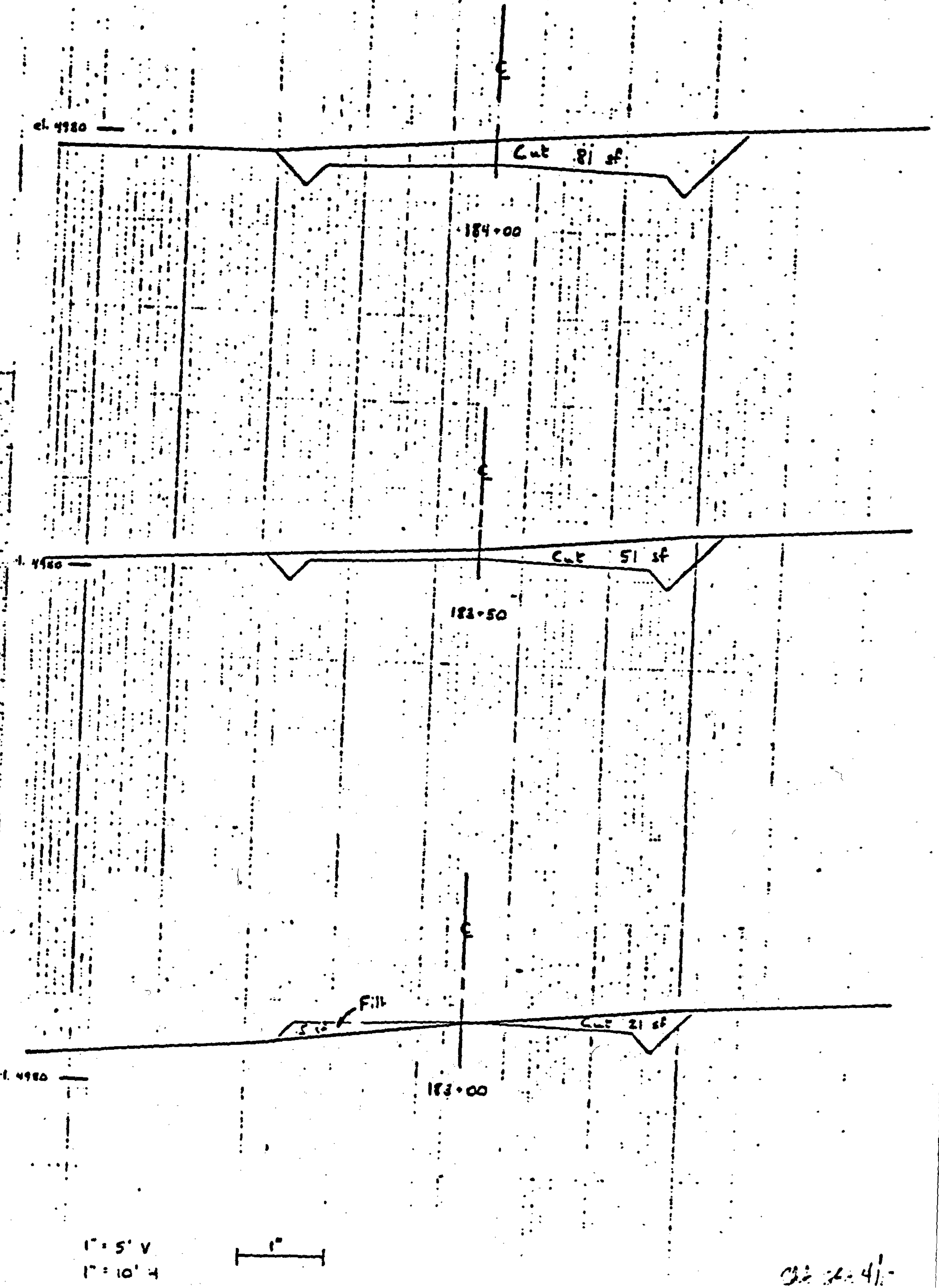
By MDL 3/19/87

SHT 55 ~~48~~ 52

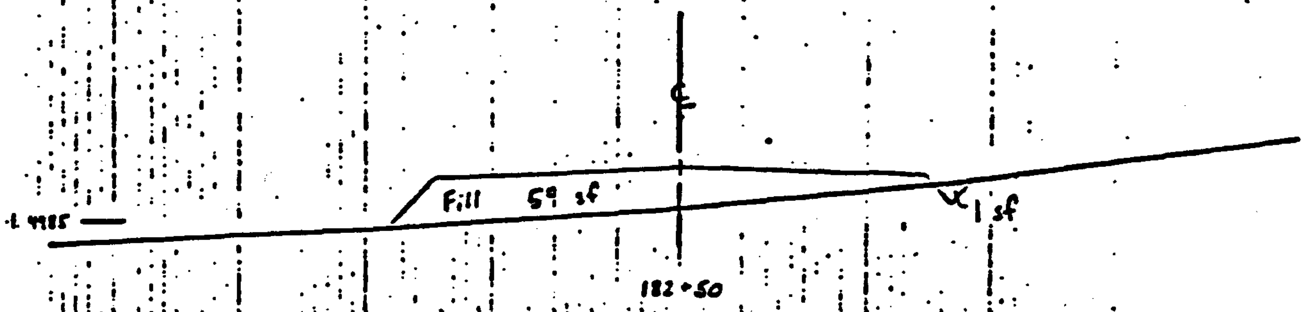


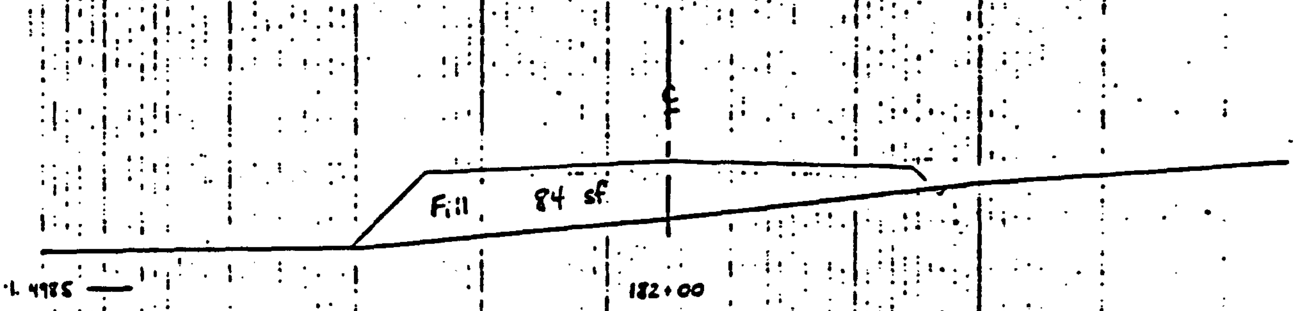
By MDL 3/19/87
Chk 4/17/87

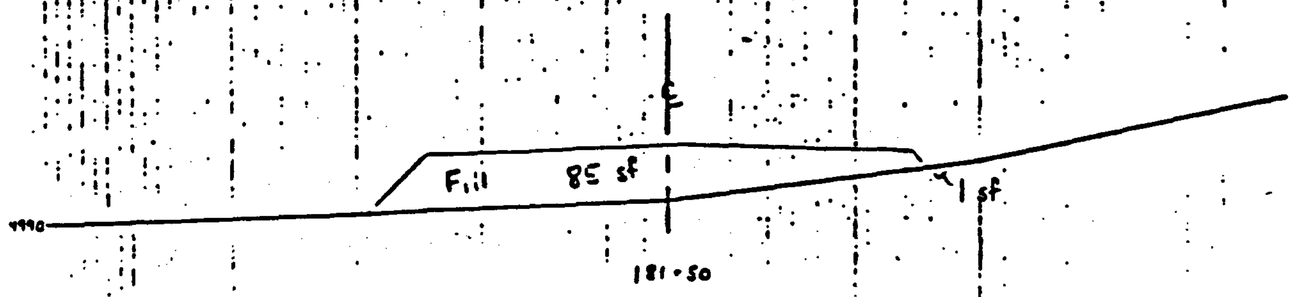
~~56~~
SHT ~~54~~
53


℄
el. 4980
Cut 81 sf
184+00
℄
l. 4980
Cut 51 sf
183+50
℄
Fill
5 sf
Cut 21 sf
l. 4980
183+00
1" = 5' V
1" = 10' H
1"

~~57~~
SHT ~~42~~
54



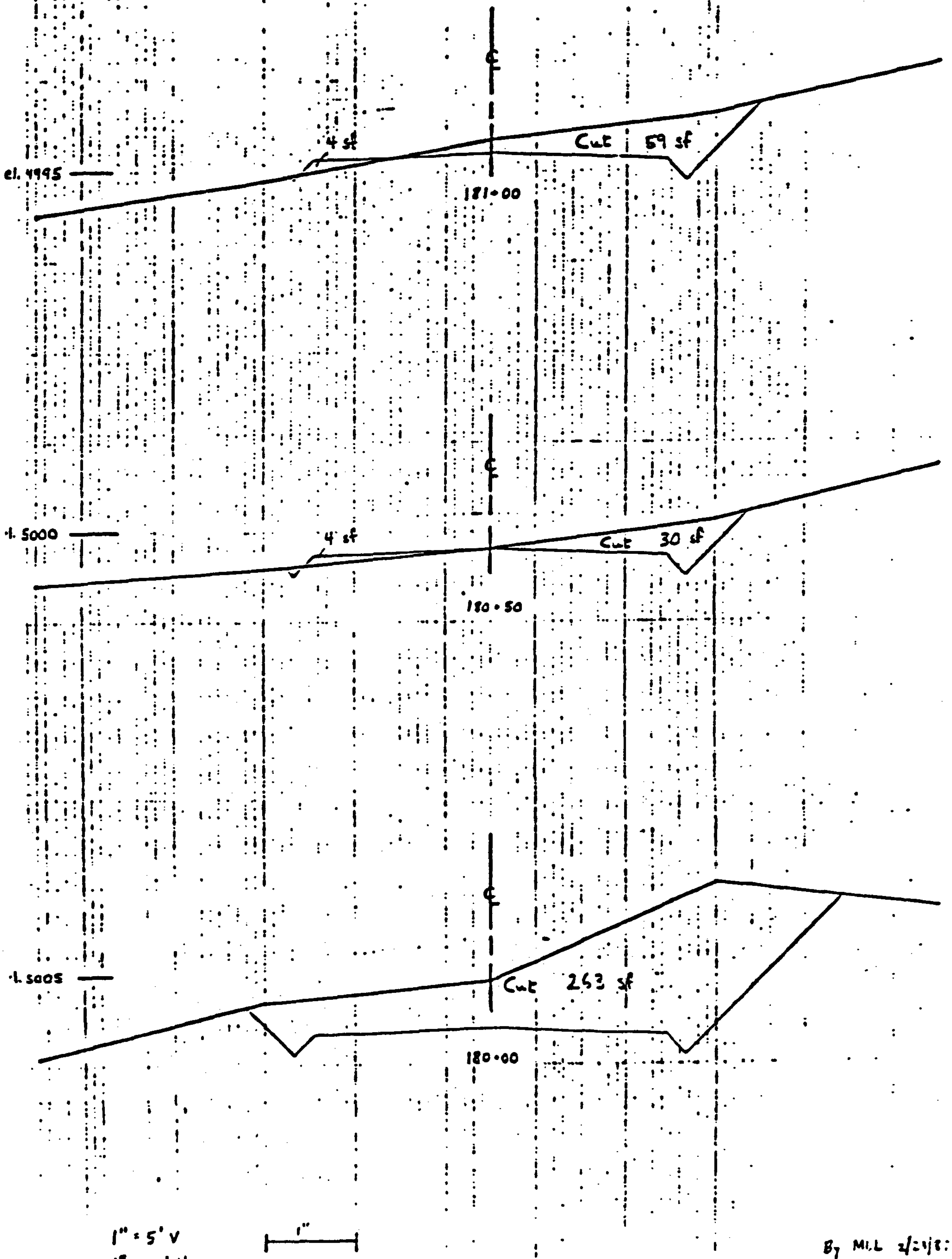




1" = 5' V
1" = 10' H

1"

~~58~~
SHT ~~43~~
55



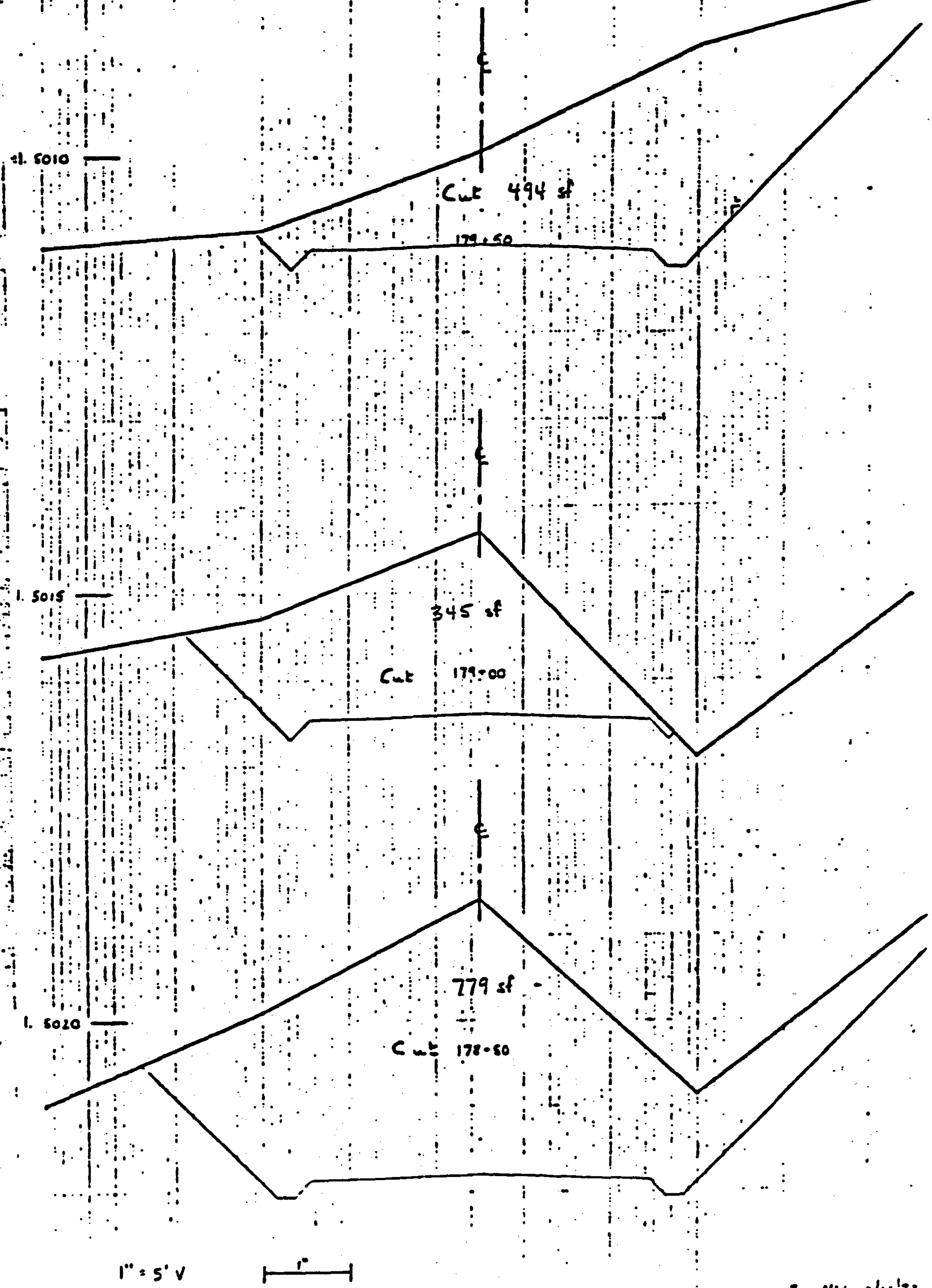
1" = 5' V
1" = 10' H

By MLL 2/21/81

59

SHT ~~44~~

56

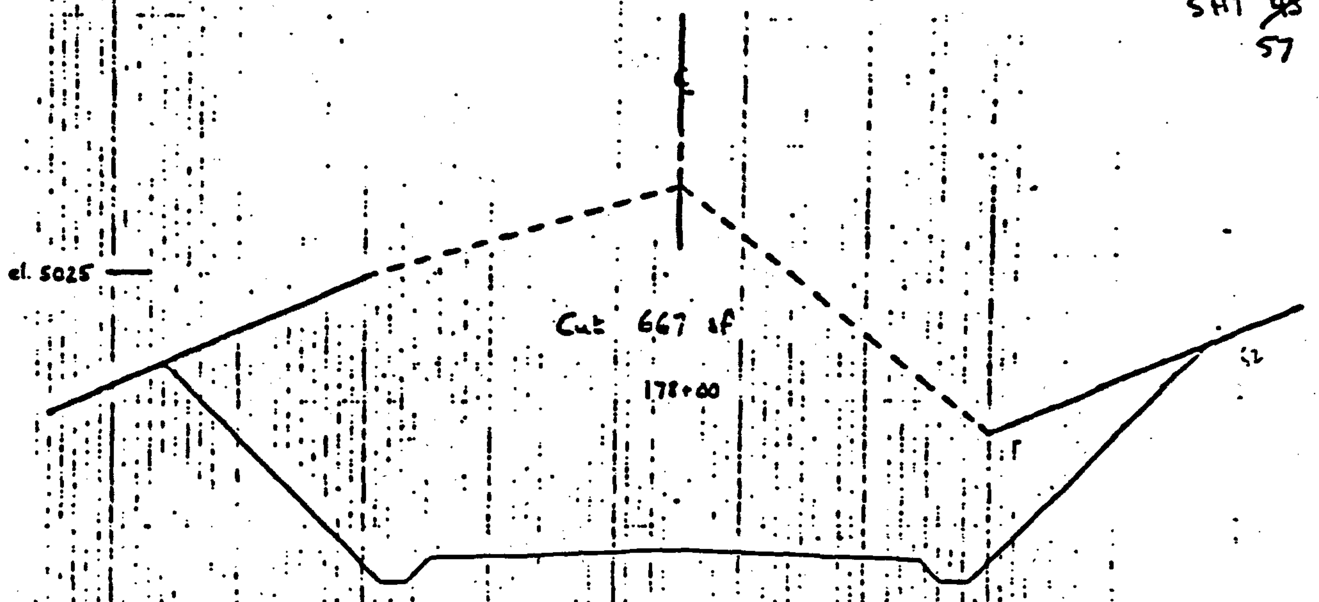


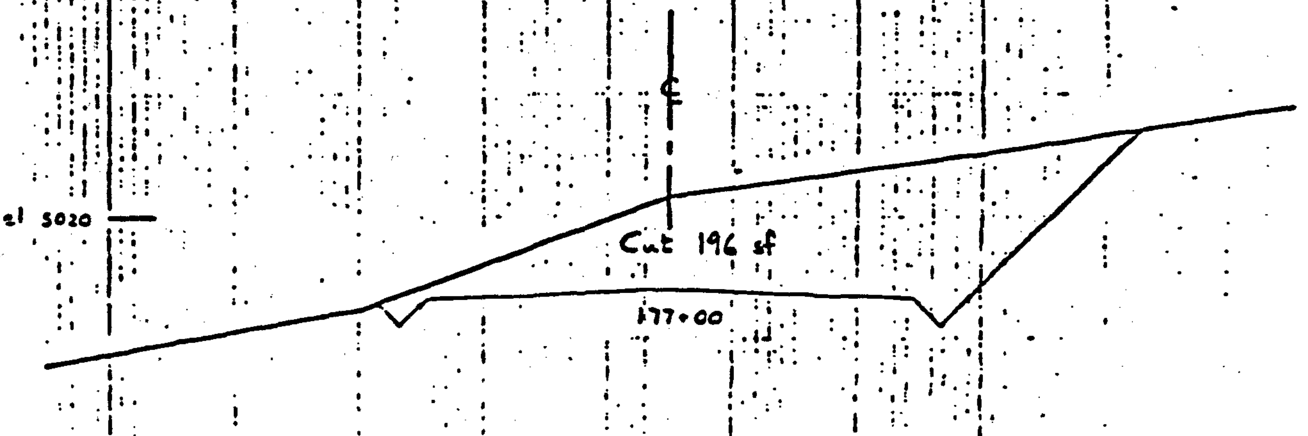
1" = 5' V

1" = 10' H

By M.L. 2/[illegible]/77

~~60~~
SHT ~~45~~
57

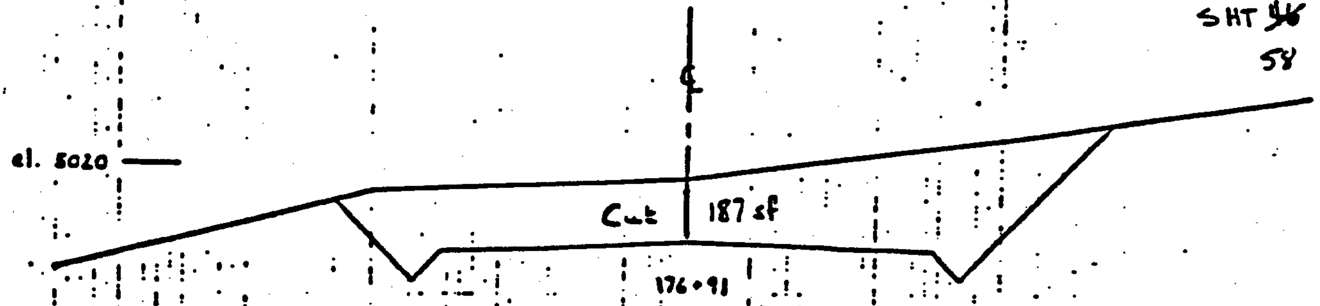


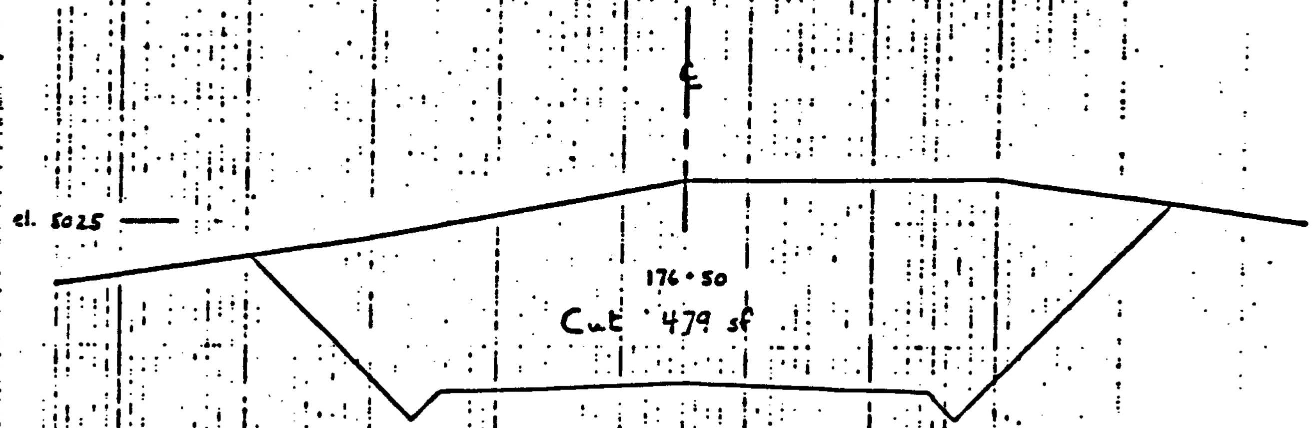


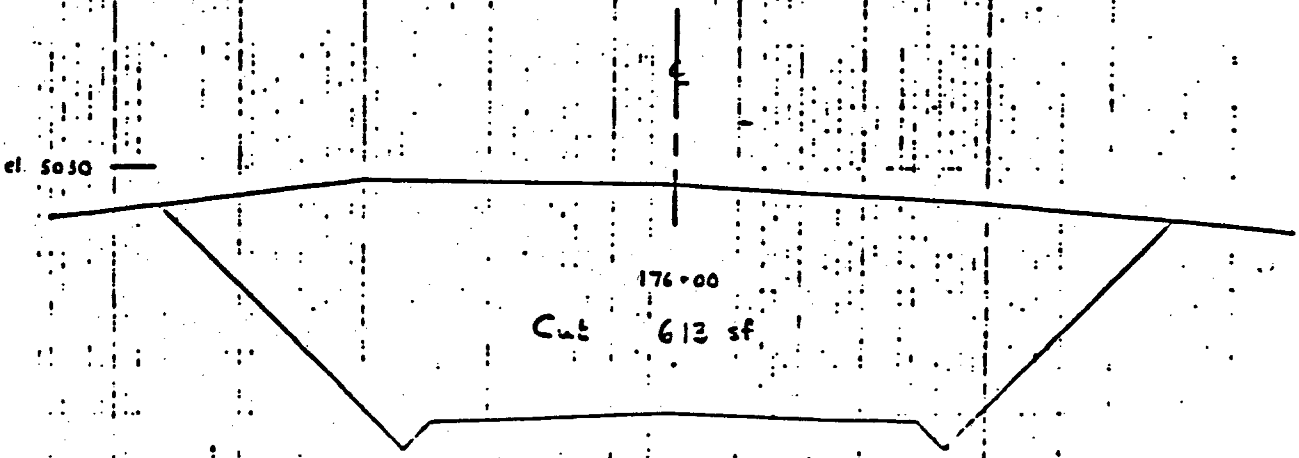
1" = 5' V
1" = 10' H

1"

By MJL 2/23/8[illegible]
[illegible] 2/[illegible]



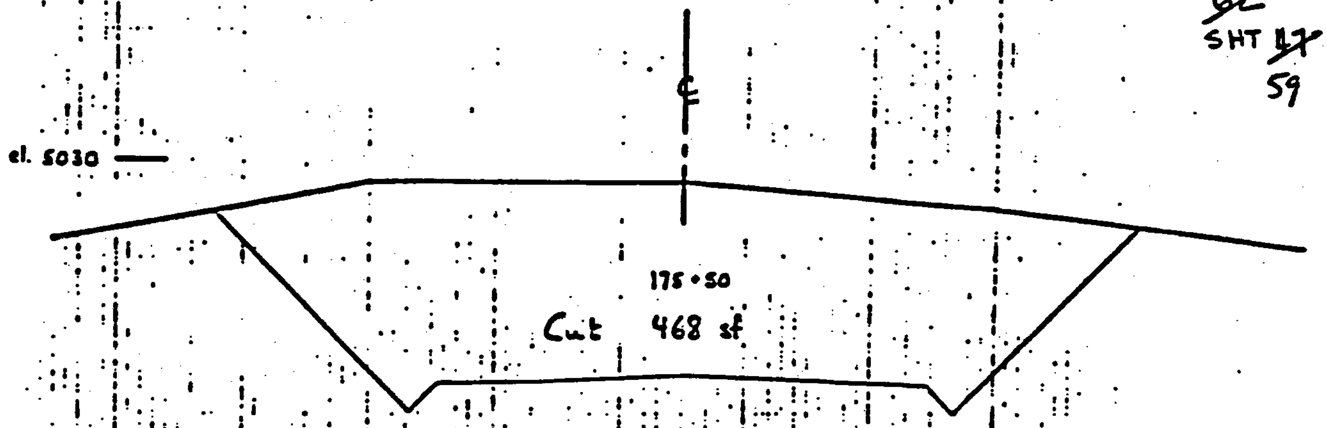


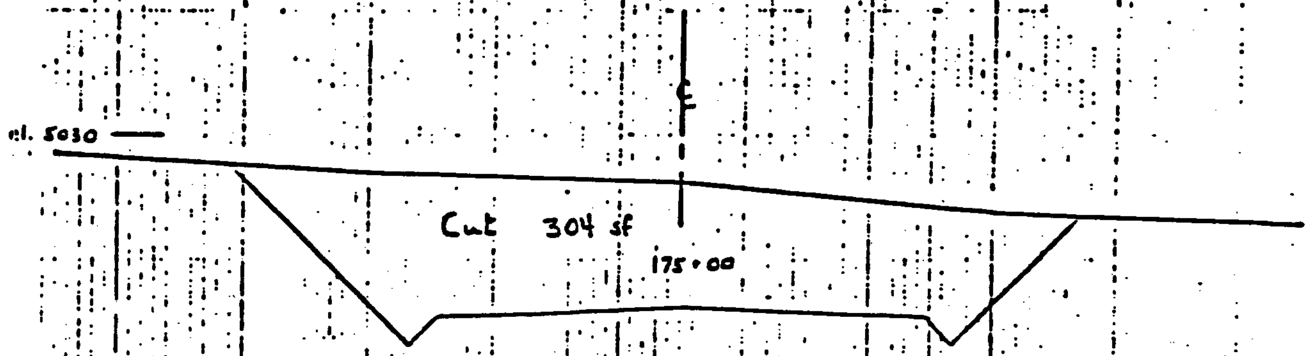


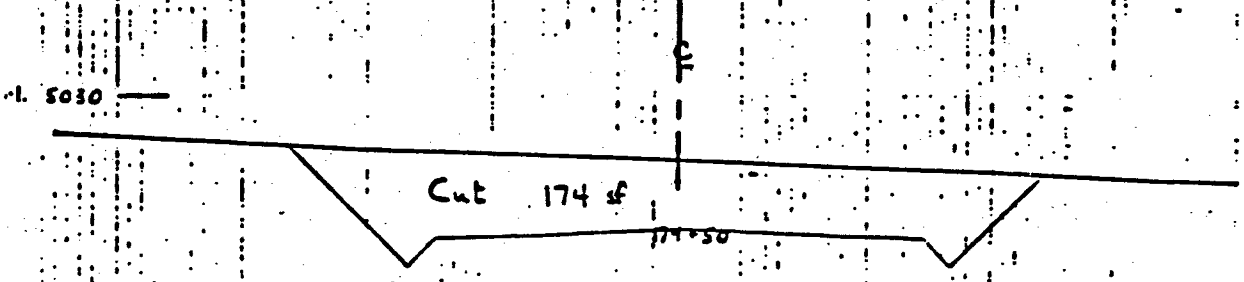
1" = 5' V
1" = 10' H

1"

E. [illegible] 2/28/[illegible]





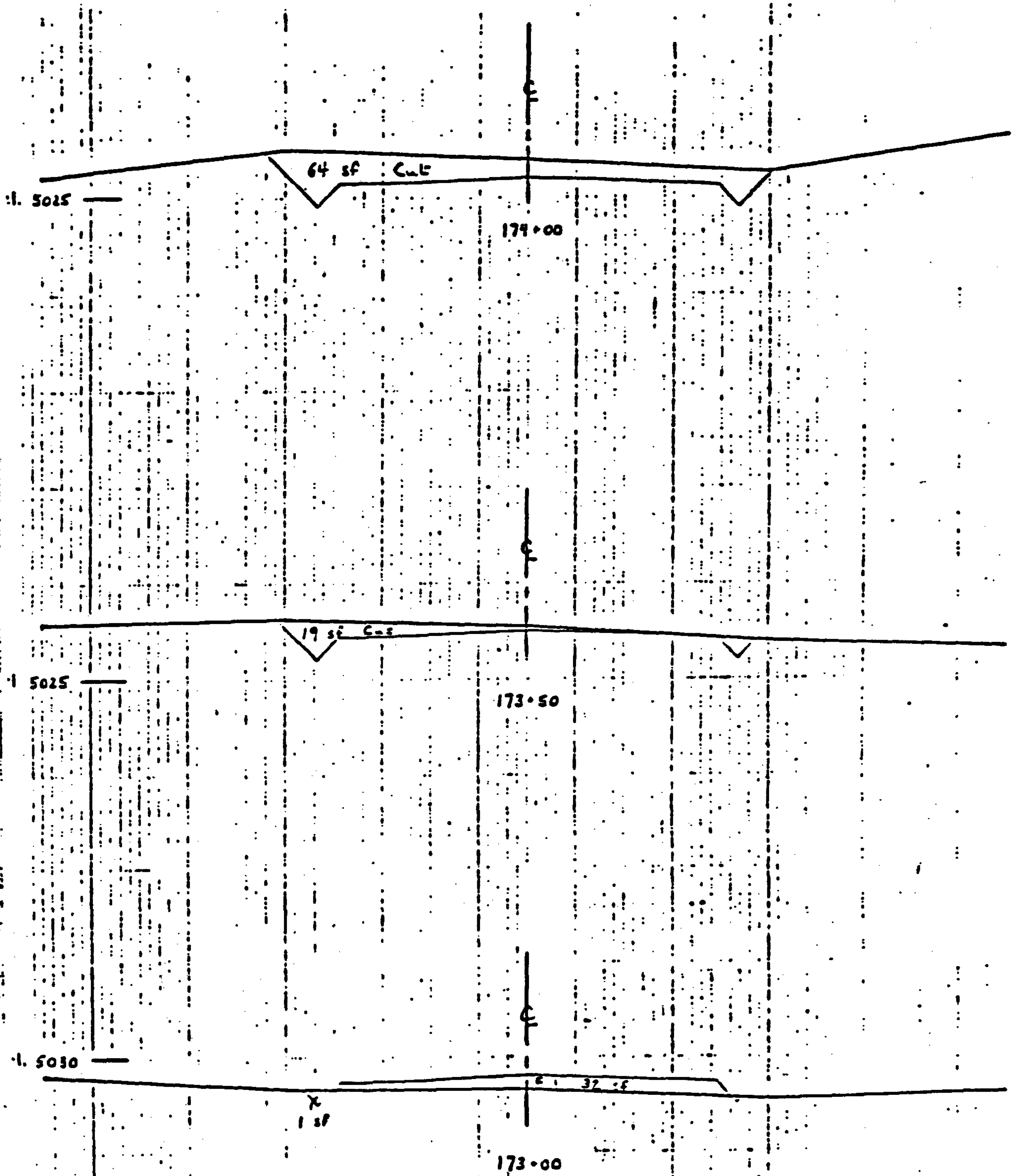


1" = 5' V
1" = 10' H

1"

By MDL 2/23/87
[illegible]

~~63~~
SHT ~~98~~
00

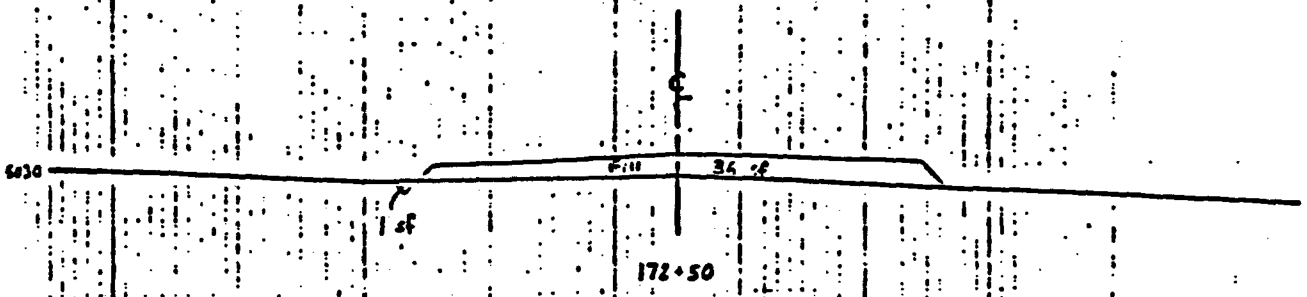


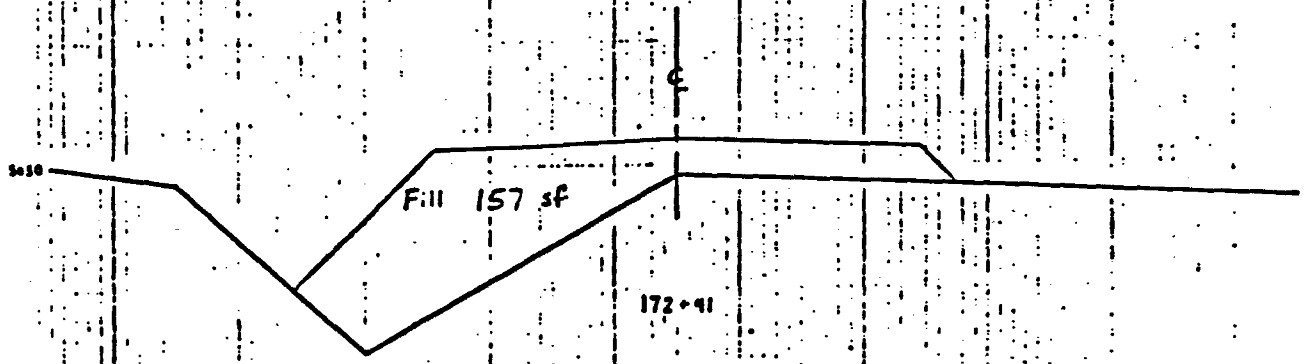
1" = 5' V
1" = 10' H

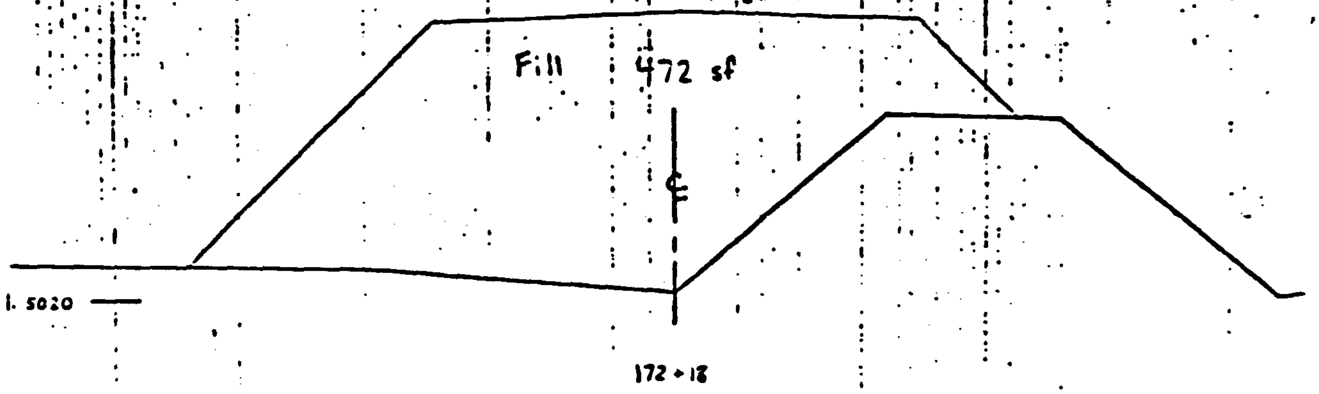
1"

R. MCL [illegible]

~~64~~
SHT ~~49~~
61



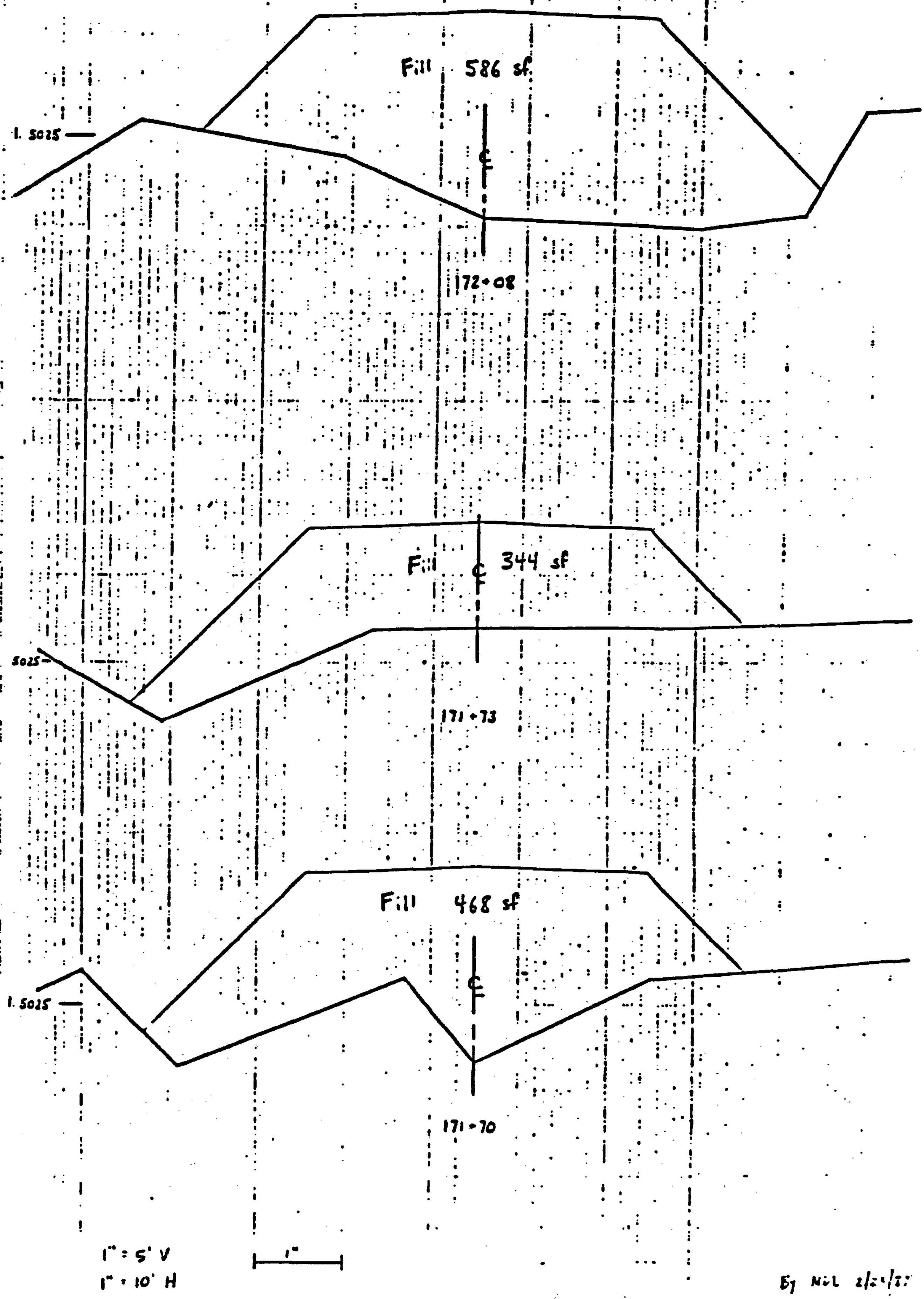




1" = 5' V
1" = 10' H

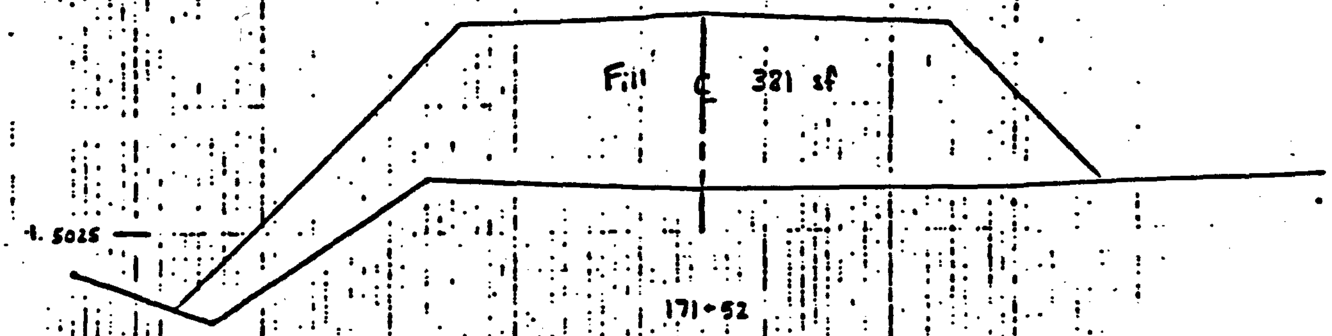
1"

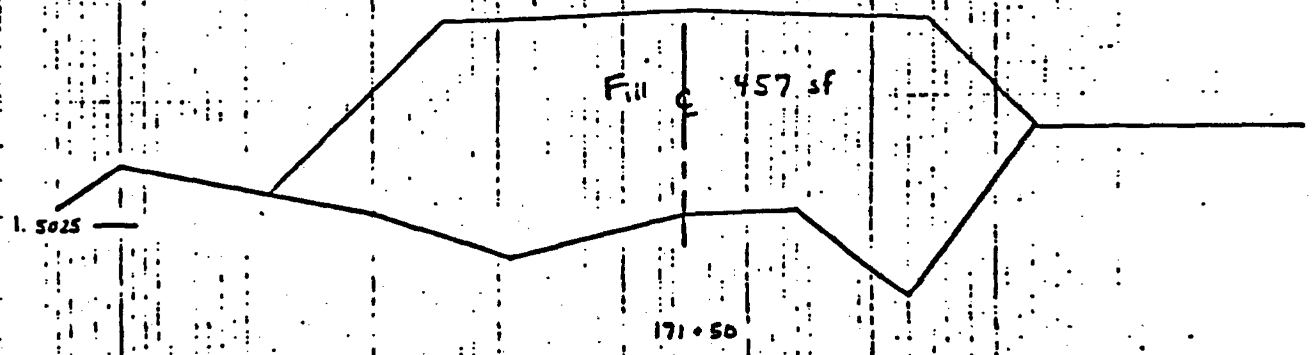
By MDL 2/23/87

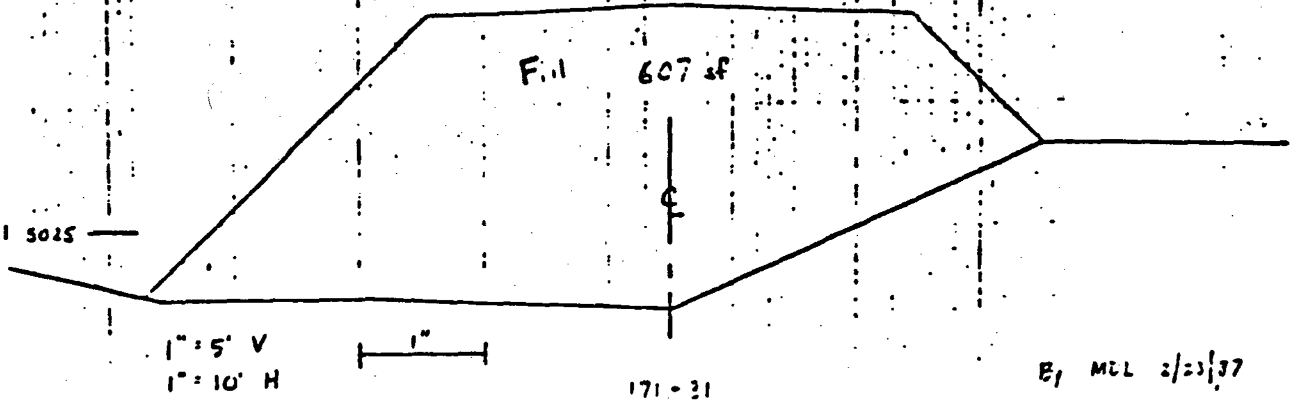

Fill 586 sf
1. 5025
℄
172+08
Fill ℄ 344 sf
5025
171+73
Fill 468 sf
1. 5025
℄
171+70
1" = 5' V
1" = 10' H
1"

By NiL [illegible]

~~66~~
SHT 5~~1~~
63

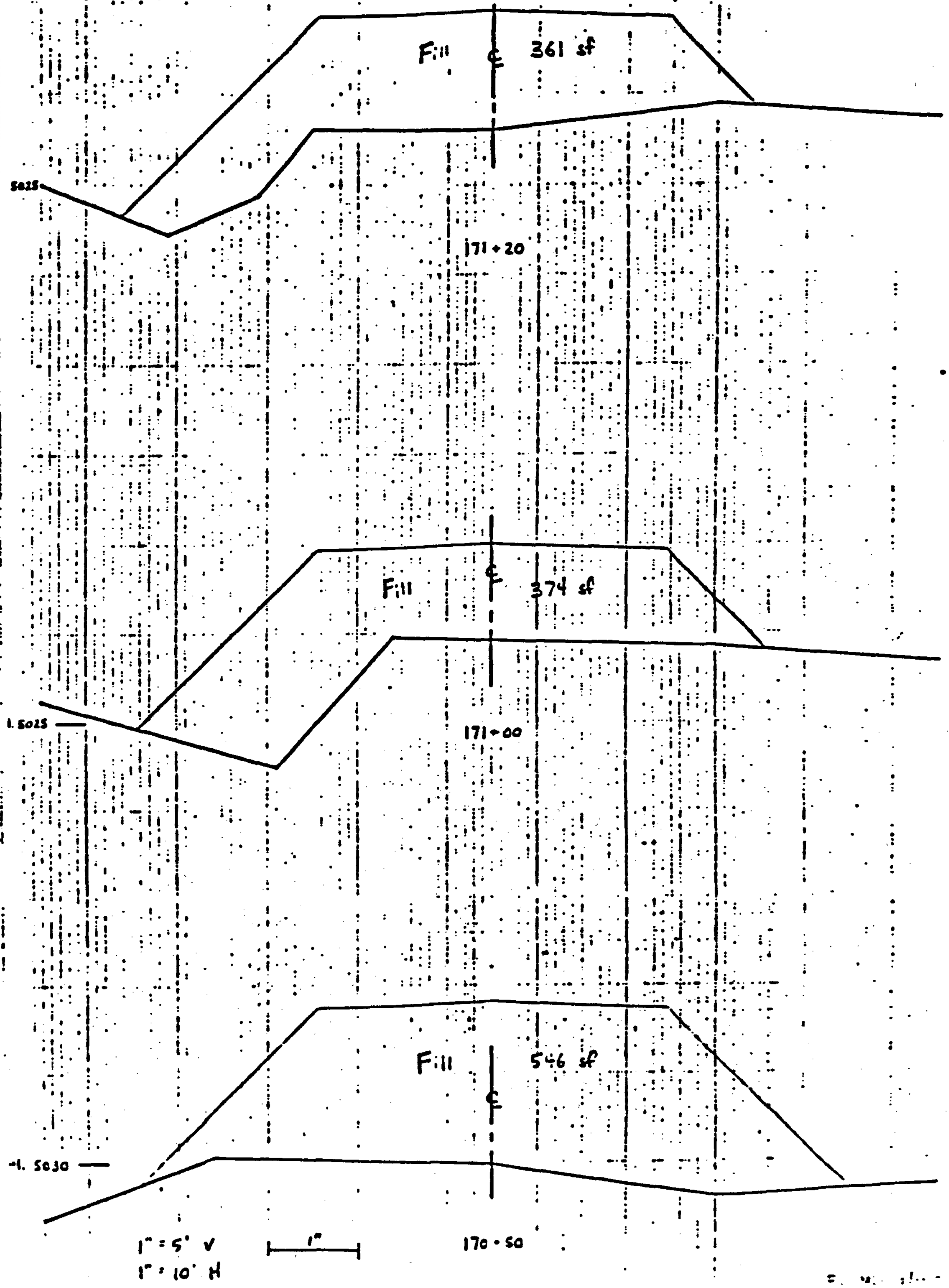




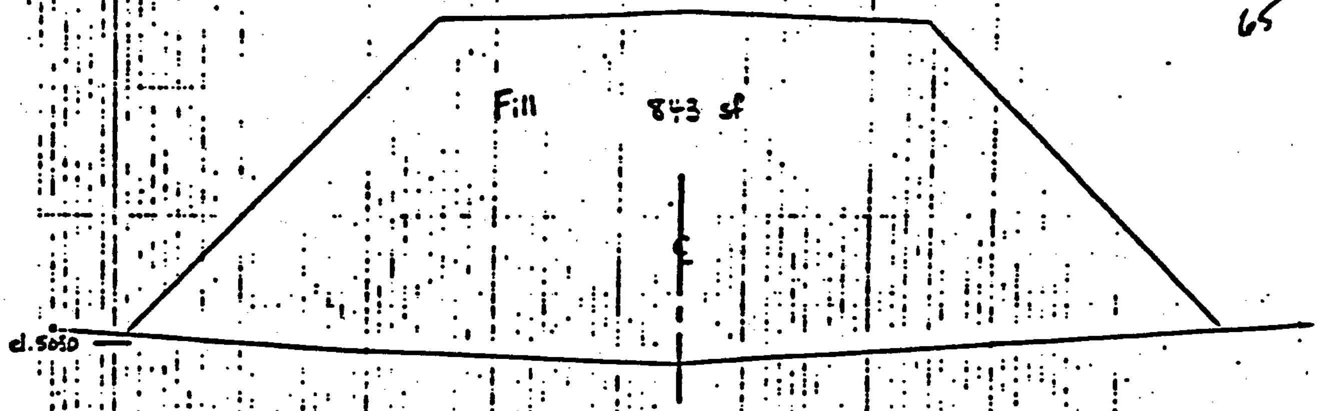


By MLL 2/23/37

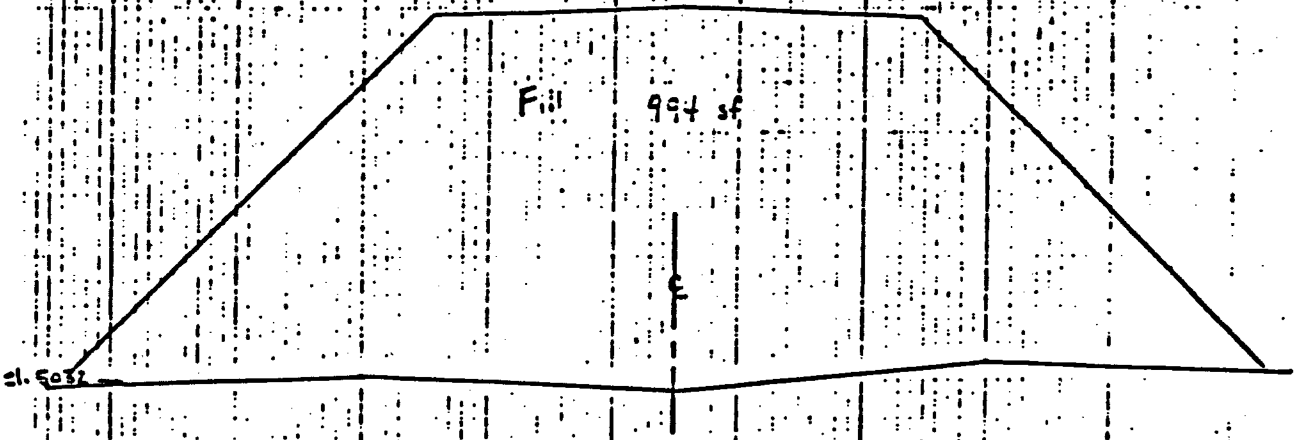
ST
SHT 52
64


Fill
℄
361 sf
5025
171+20
Fill
℄
374 sf
1.5025
171+00
Fill
546 sf
℄
-1.5030
170+50
1" = 5' V
1" = 10' H
1"

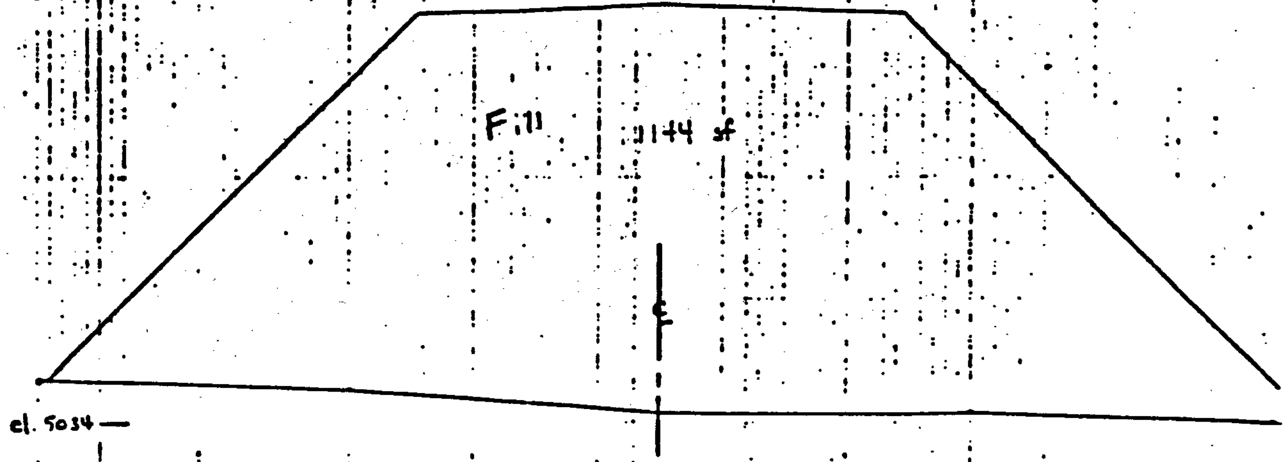
~~68~~
SHT ~~53~~
65



170+00



169+50

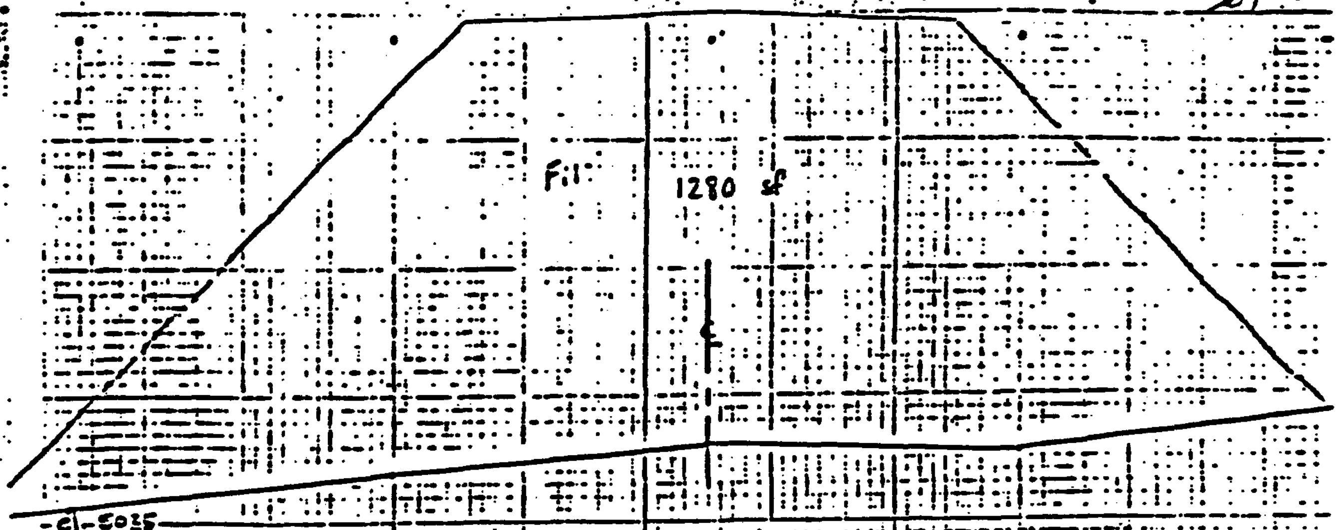


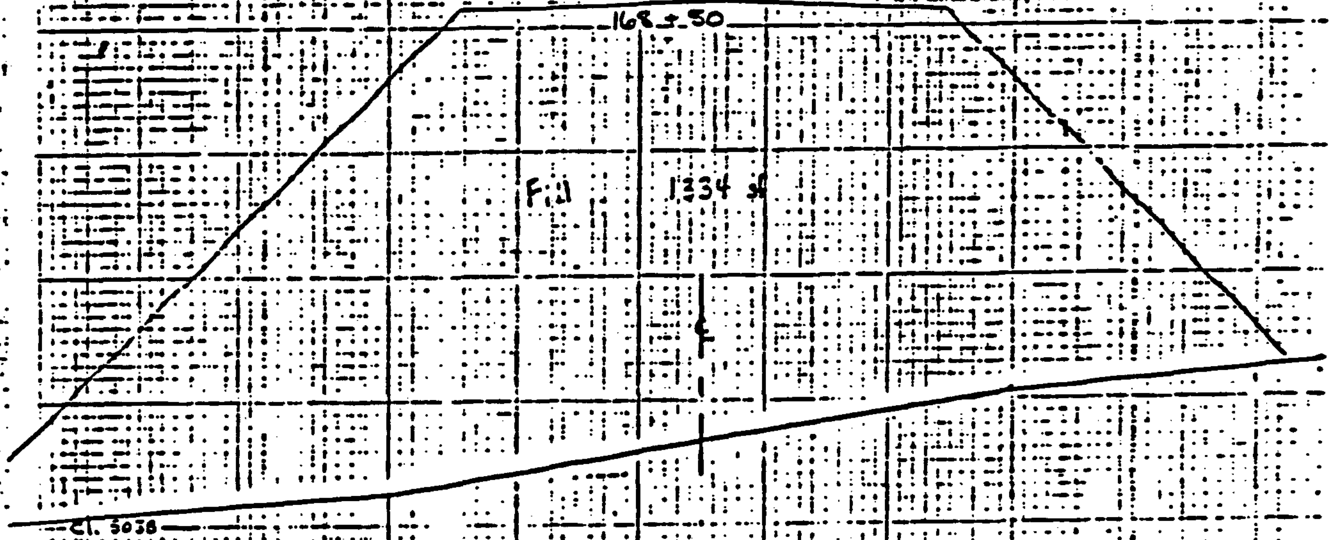
1" = 5' V
1" = 10' H

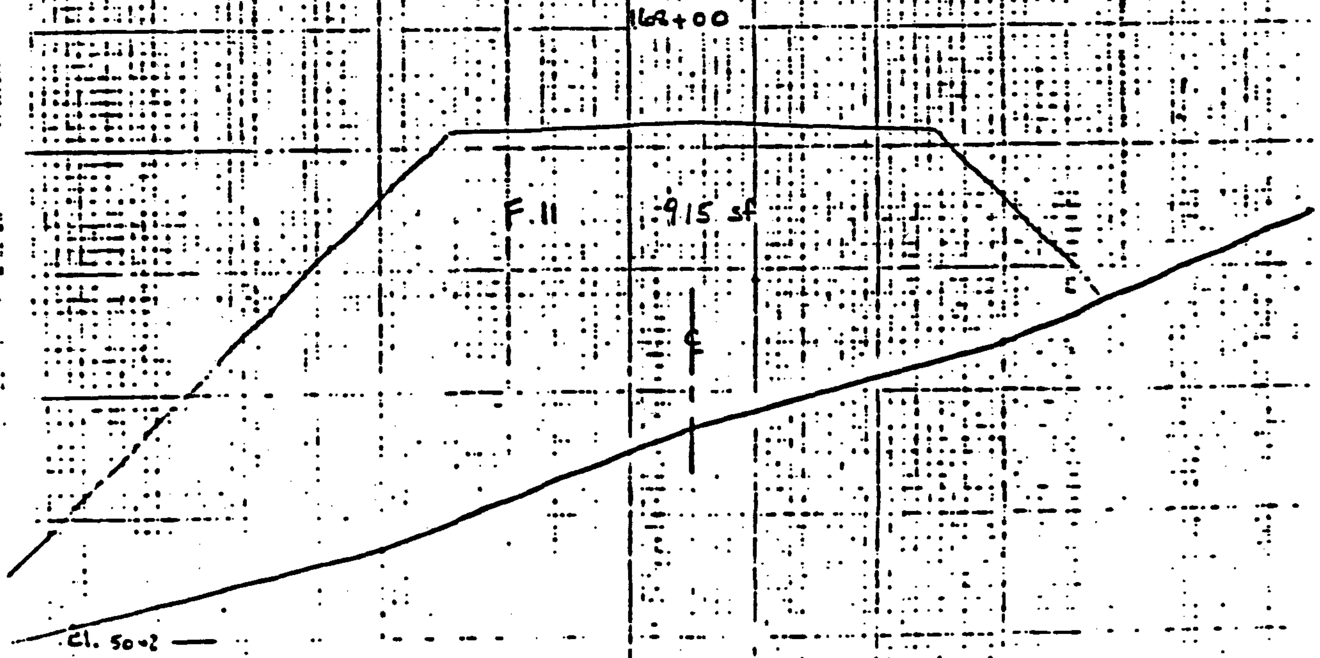
1"

169+00

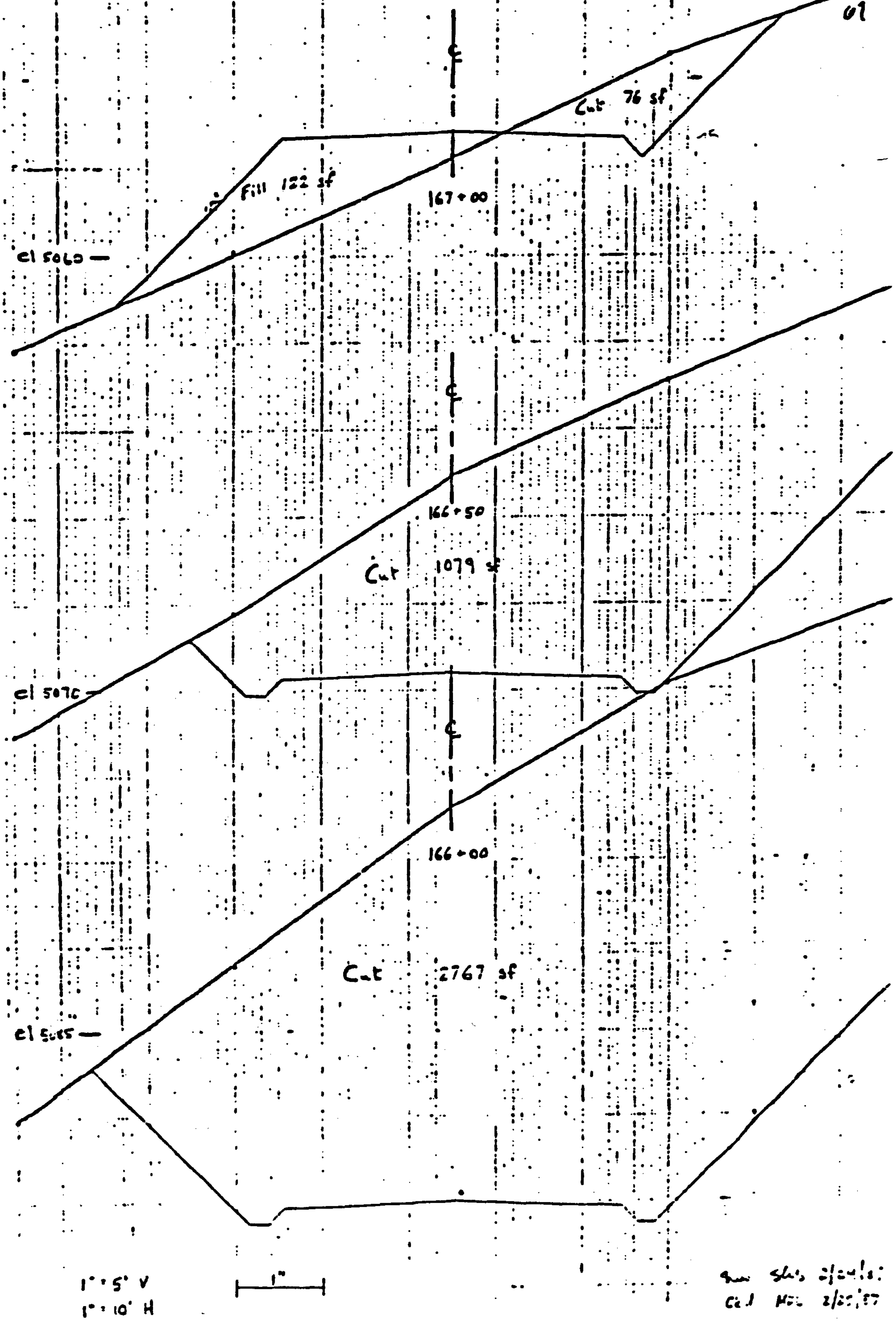
[illegible] [illegible] [illegible]/87
[illegible] MLL [illegible]


Fill
1280 sf
℄
El. 5035

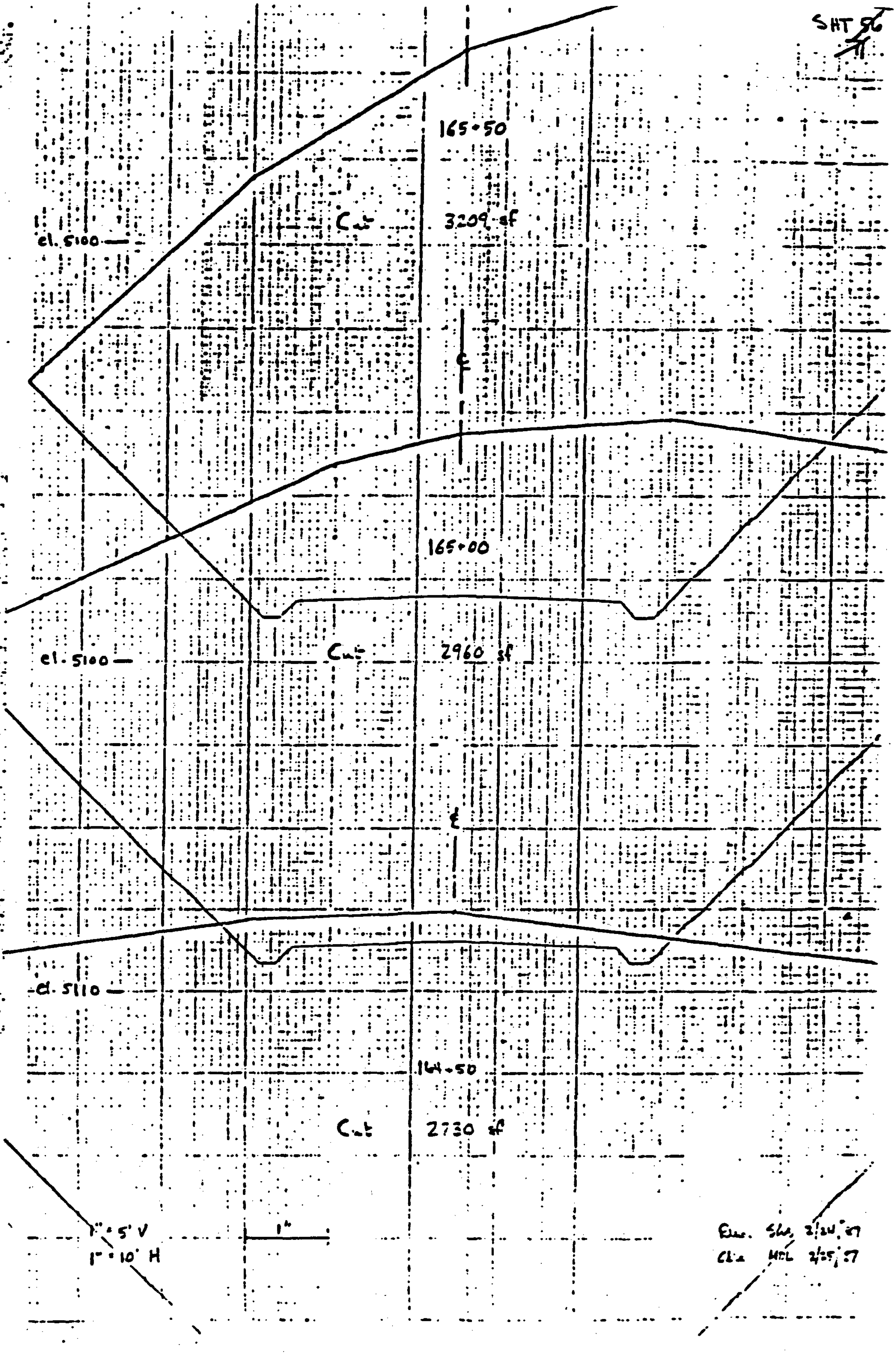

168+50
Fill
1334 sf
℄
El. 5038

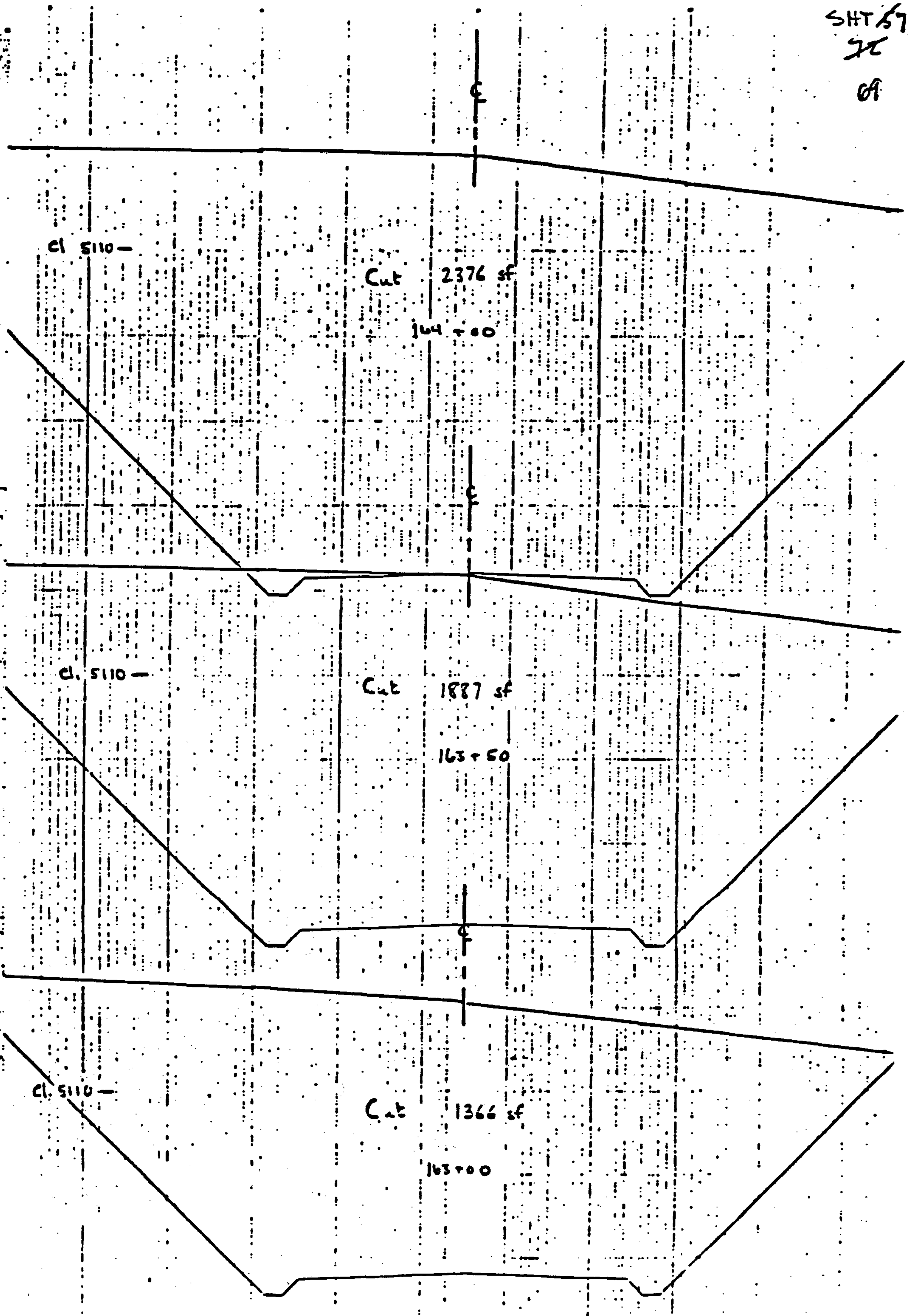

168+00
Fill
915 sf
℄
El. 5042

76
SHT ~~85~~
01



[illegible] [illegible] [illegible]
Cal [illegible] 2/[illegible]/57


SHT 56/71
165+50
Cut 3209 sf
el. 5100
℄
165+00
Cut 2960 sf
el. 5100
℄
el. 5110
164+50
Cut 2730 sf
1" = 5' V
1" = 10' H
1"
Clc. SHS, 2/24/87
Chk MEL 2/25/87

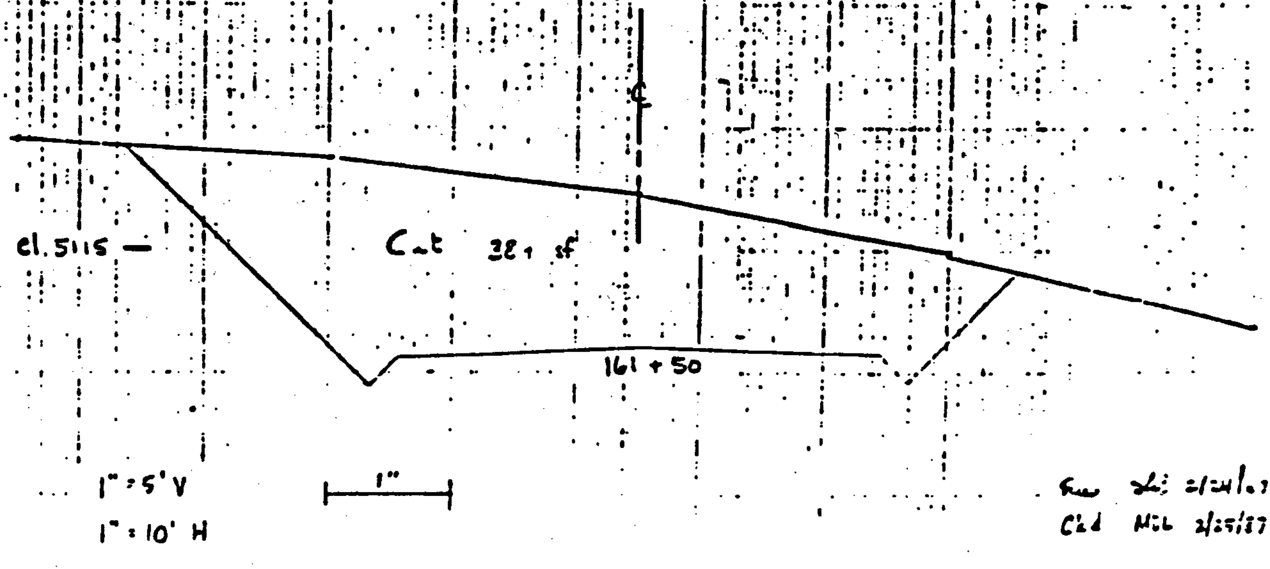


1" = 5' V
1" = 10' H

Enc. SGW. 2/24/77
Ckd MUL 2/25/77

SHT 56

~~73~~ 10



1" = 5' V

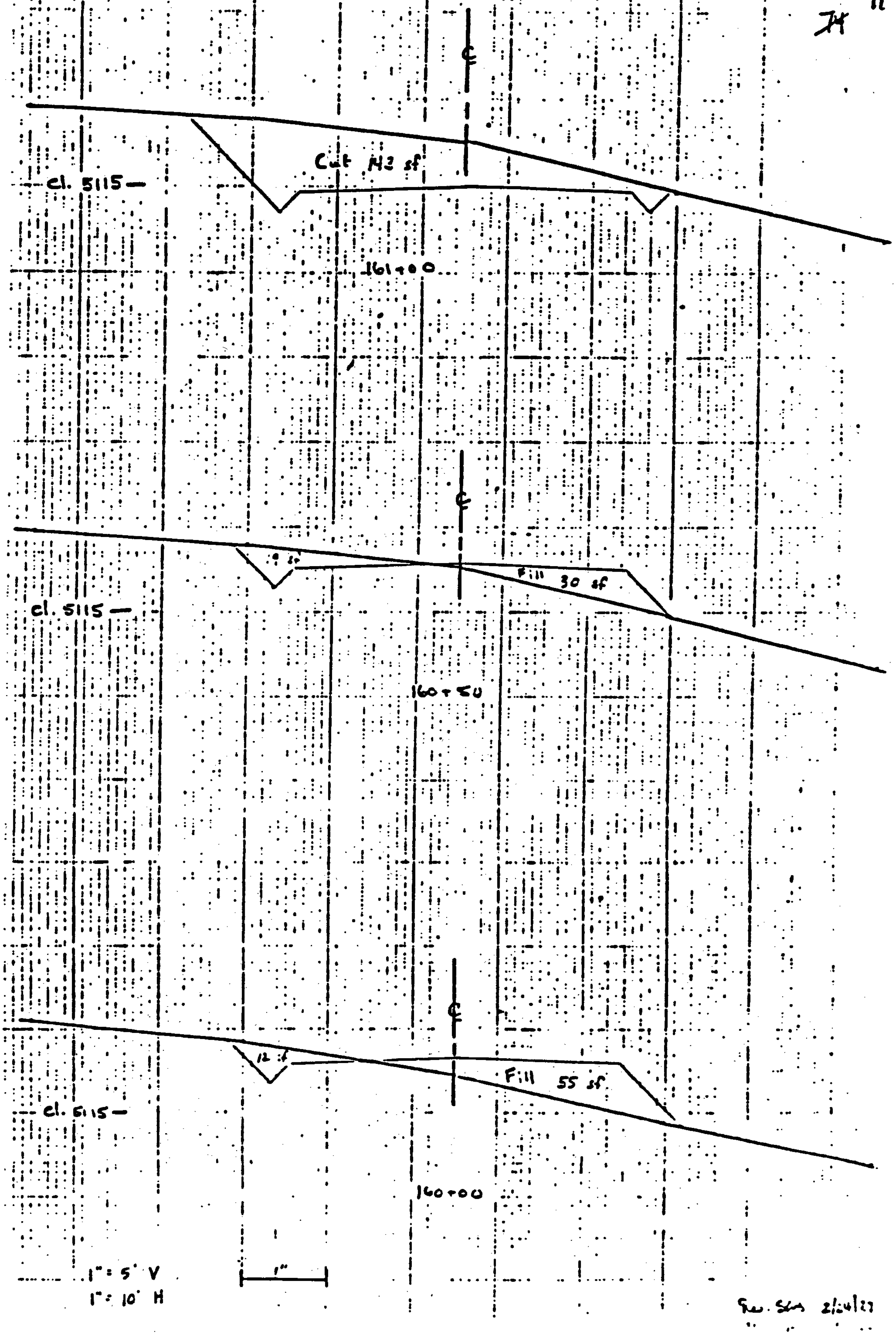
1" = 10' H

1"

Sur [illegible] 2/24/87

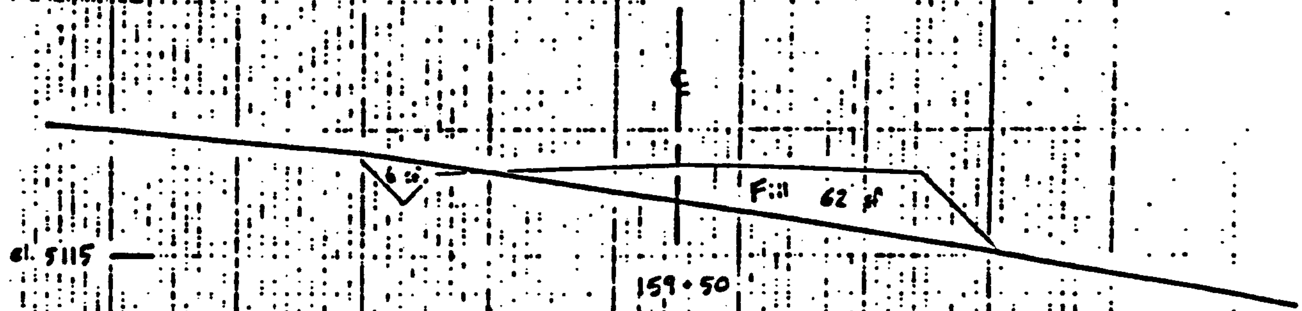
Ckd MIL 2/25/87

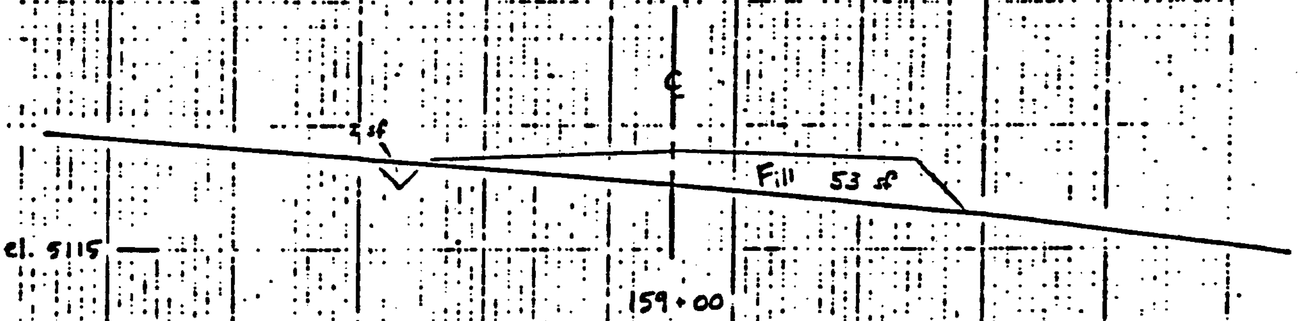
SHT ~~59~~ 71 ~~74~~

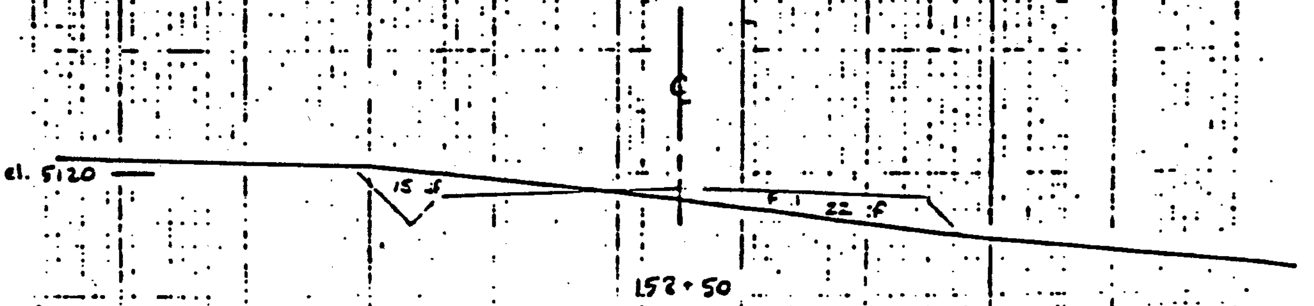


Rev. Sms 2/24/23

SHT ~~60~~ ~~75~~ 72





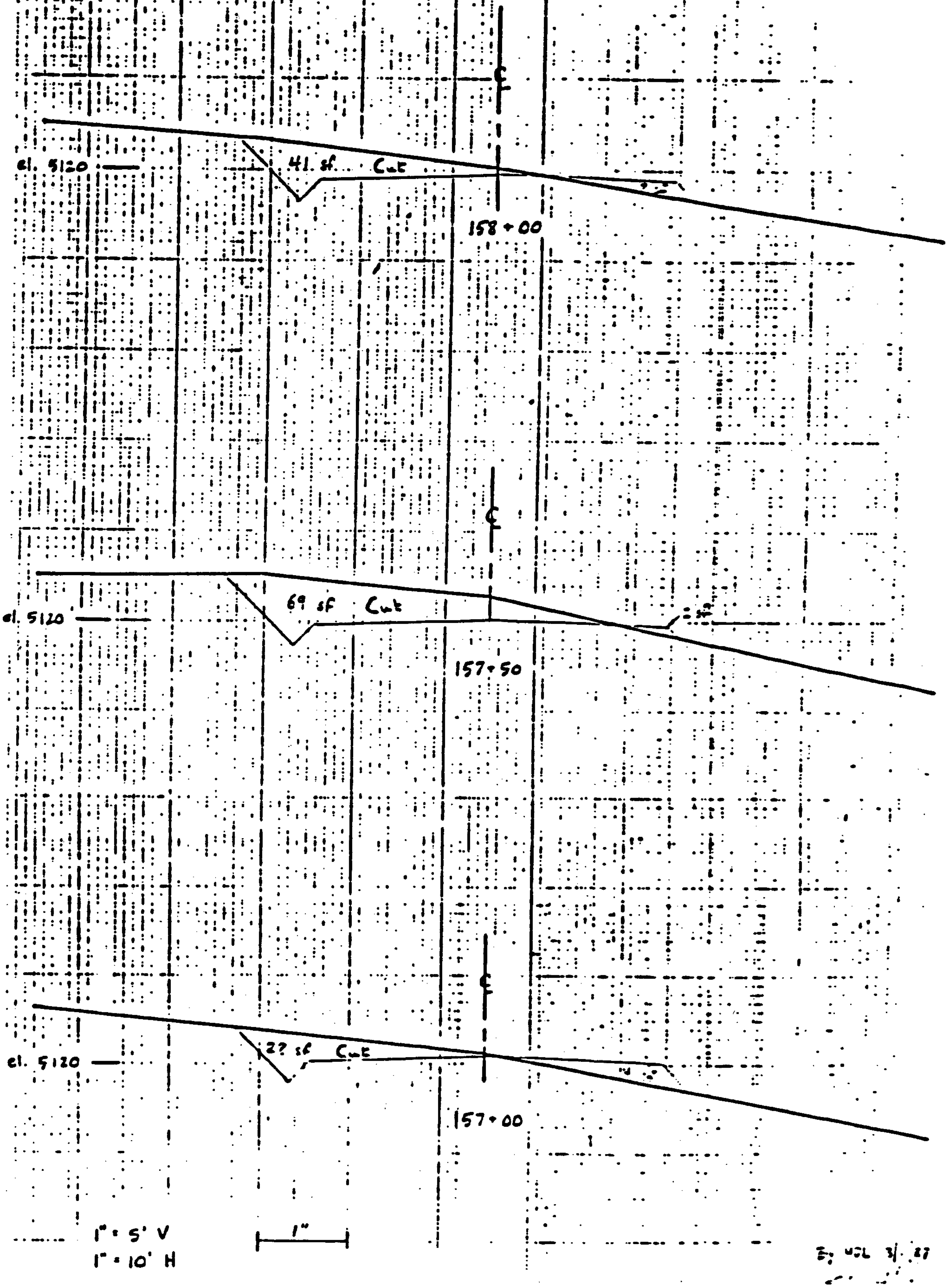


1" = 5' V
1" = 10' H

1"

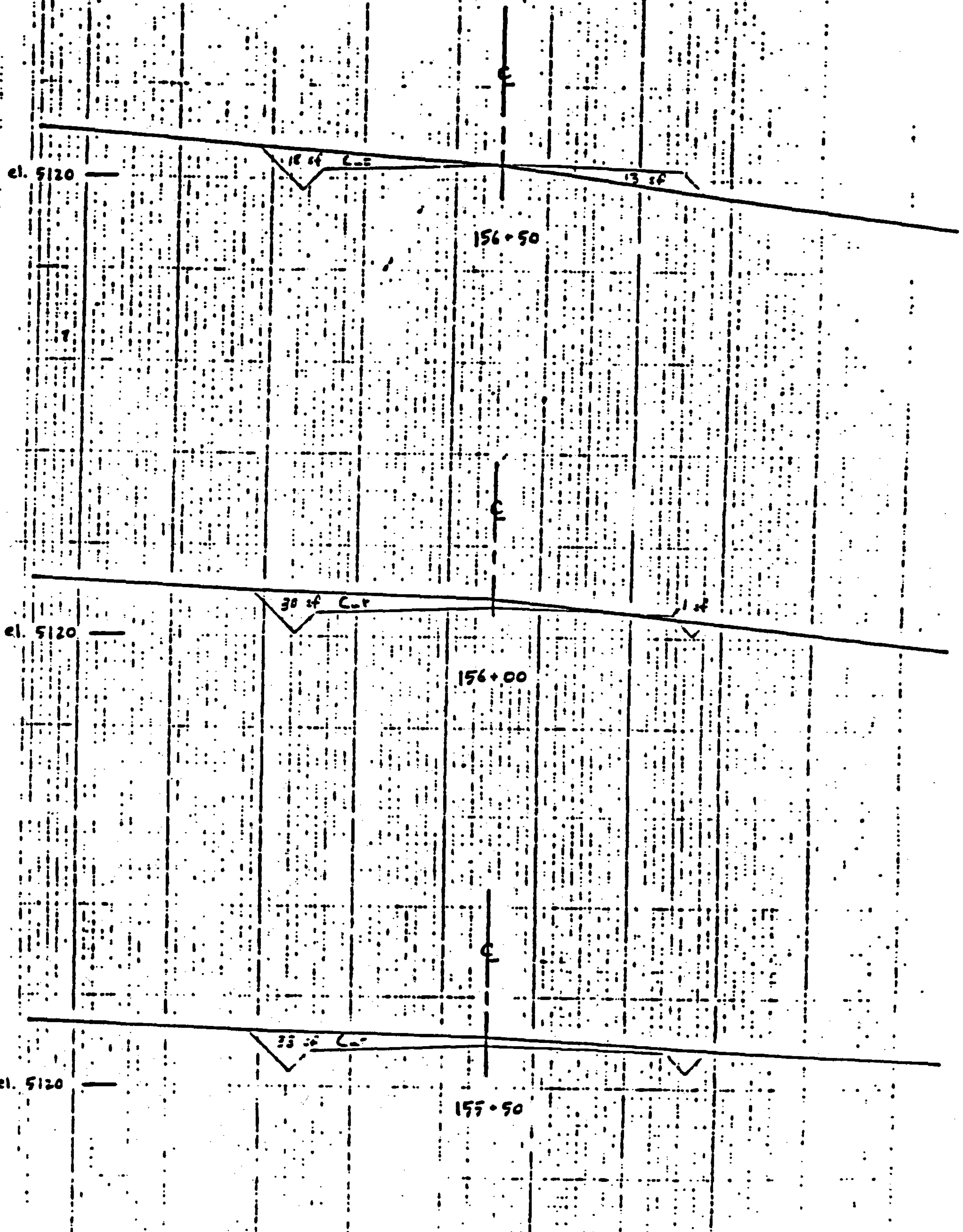
By MDL 3/11/87

SHT ~~14~~ 13
~~16~~



By WJL 3/ 87

SHT. ~~12~~
~~17~~ 14

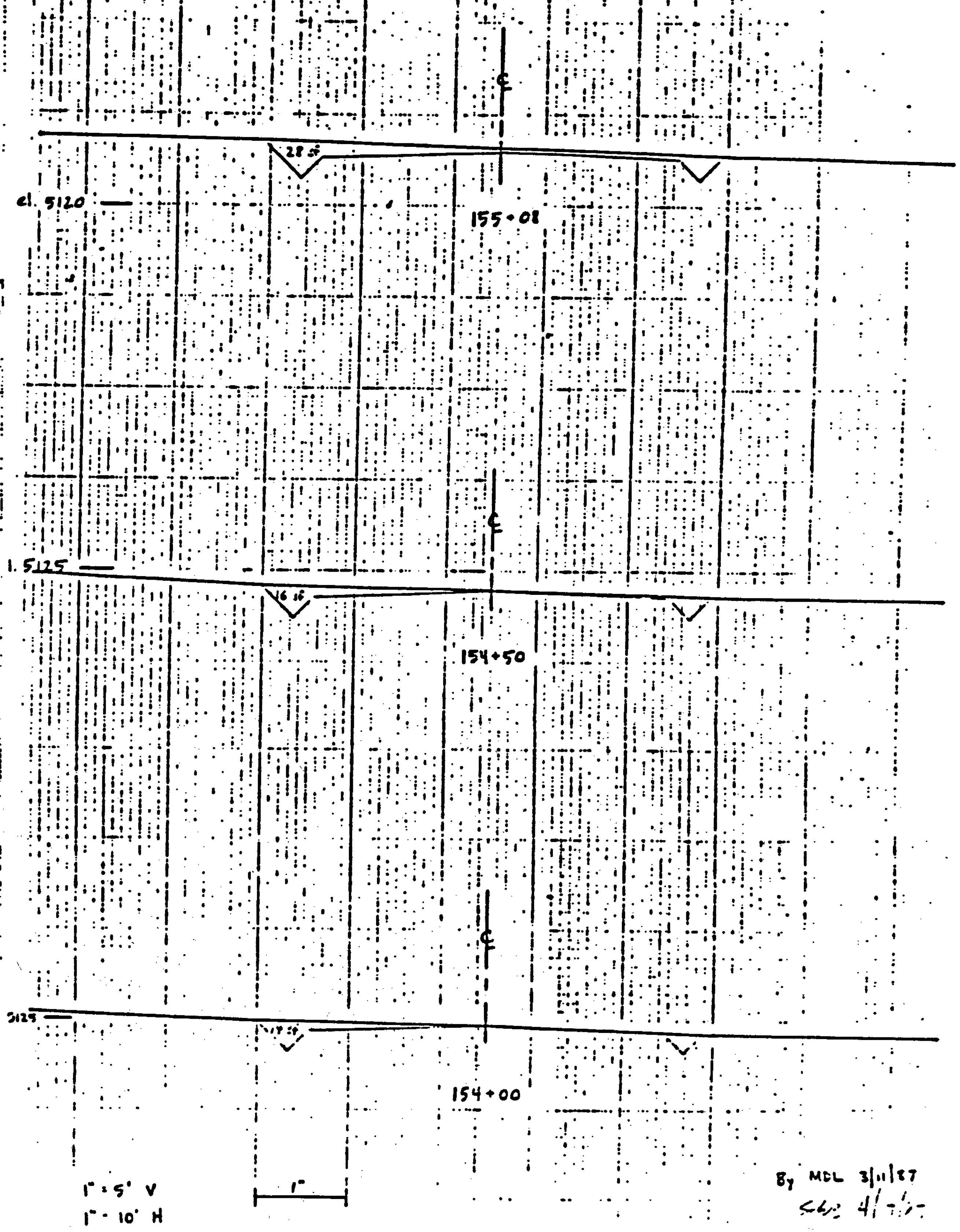


1" = 5' V
1" = 10' H

1"

By MCL 3/../87

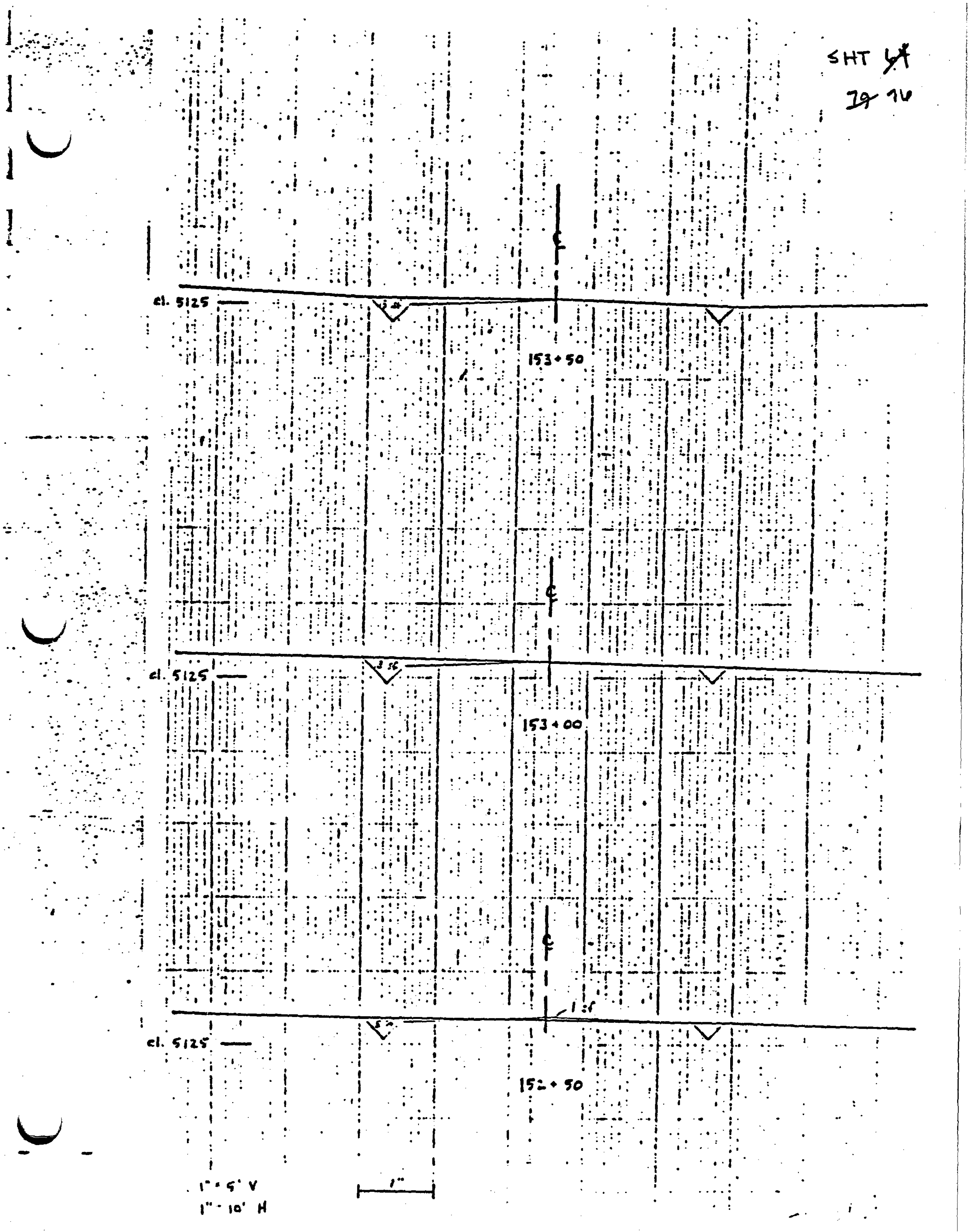
SHT ~~65~~
[illegible] 75



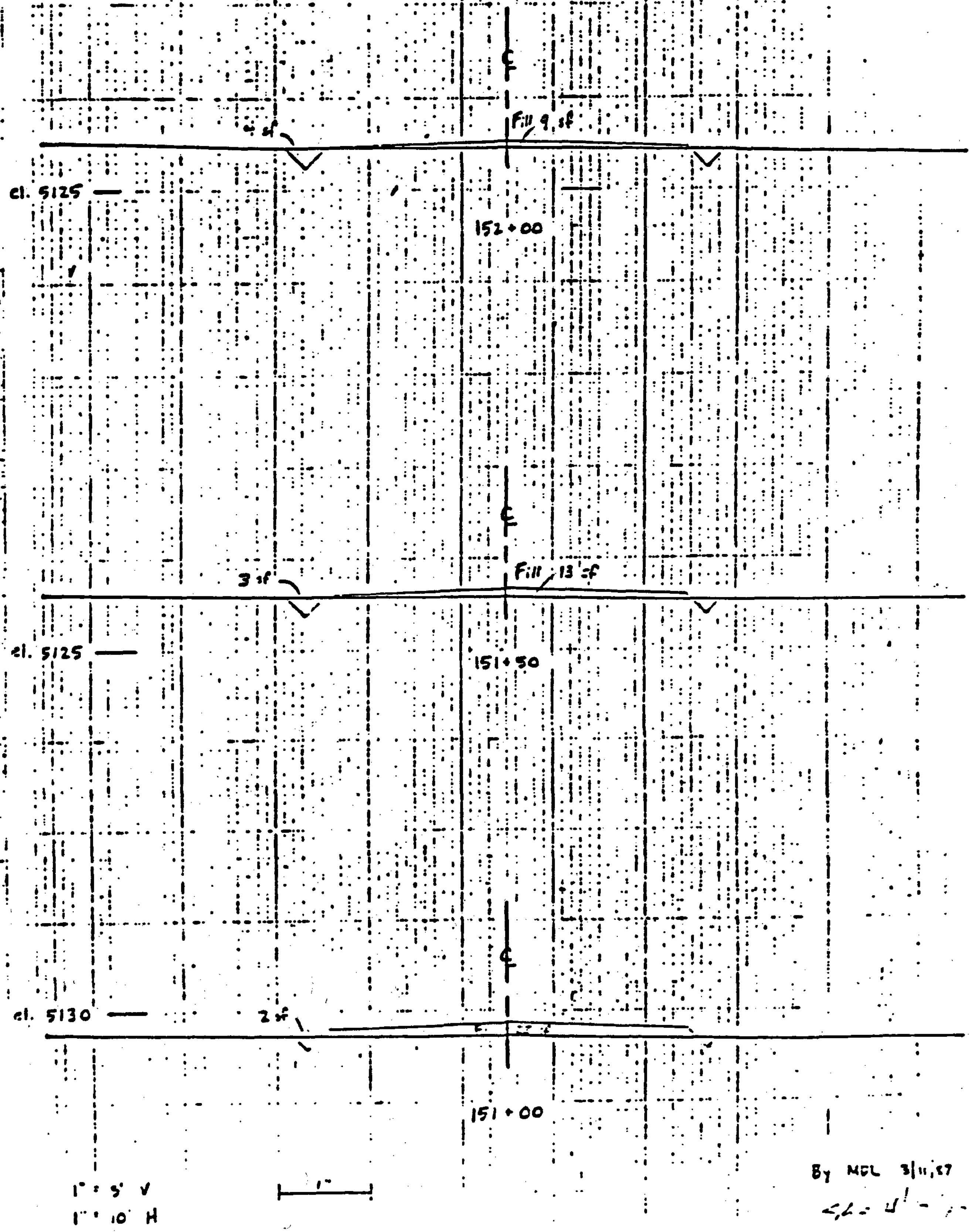
By MDL 3/11/87
[illegible] 4/[illegible]

SHT ~~4~~

~~79~~ 16

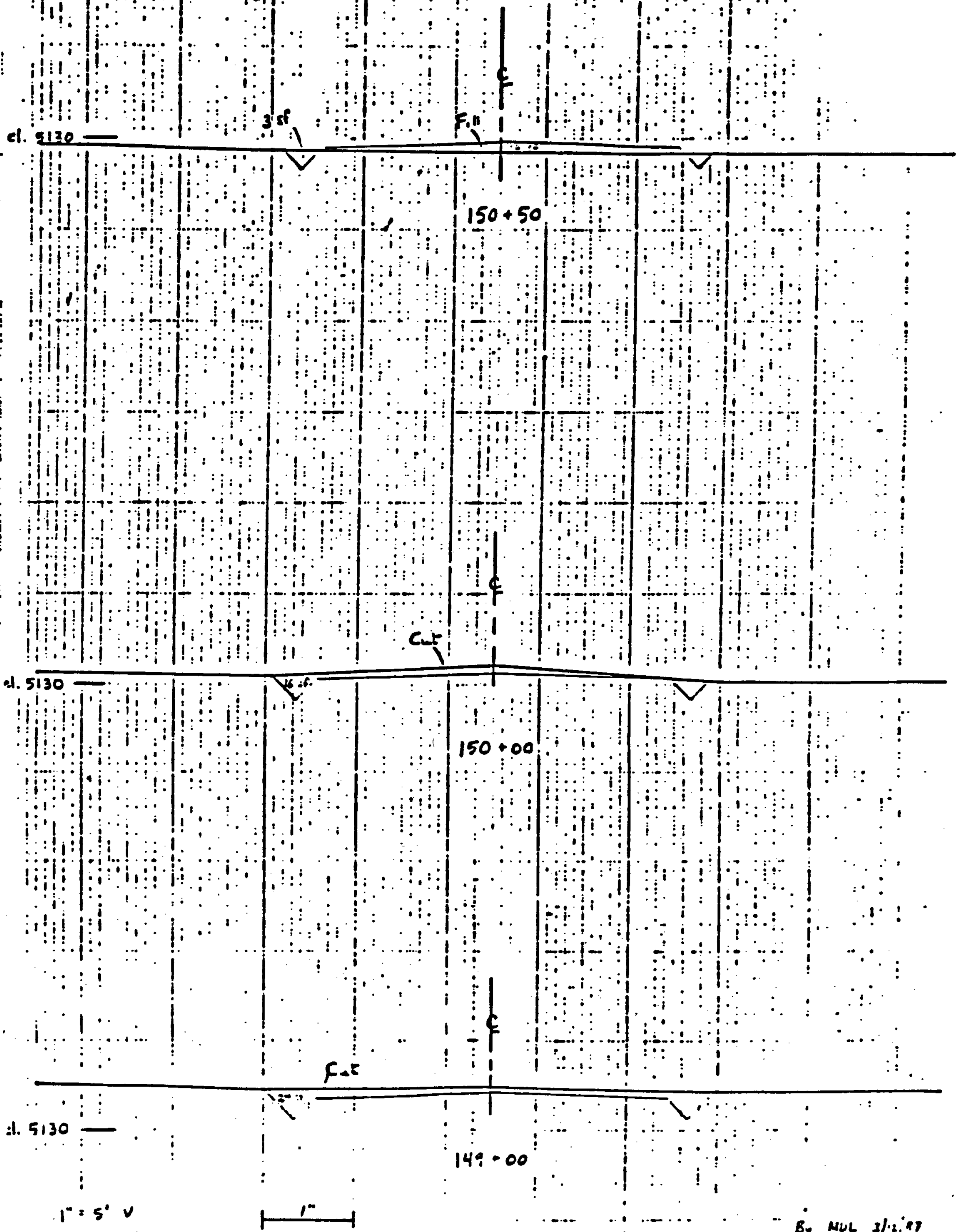


SHT ~~65~~
~~85~~ 11



By MCL 3/11/87

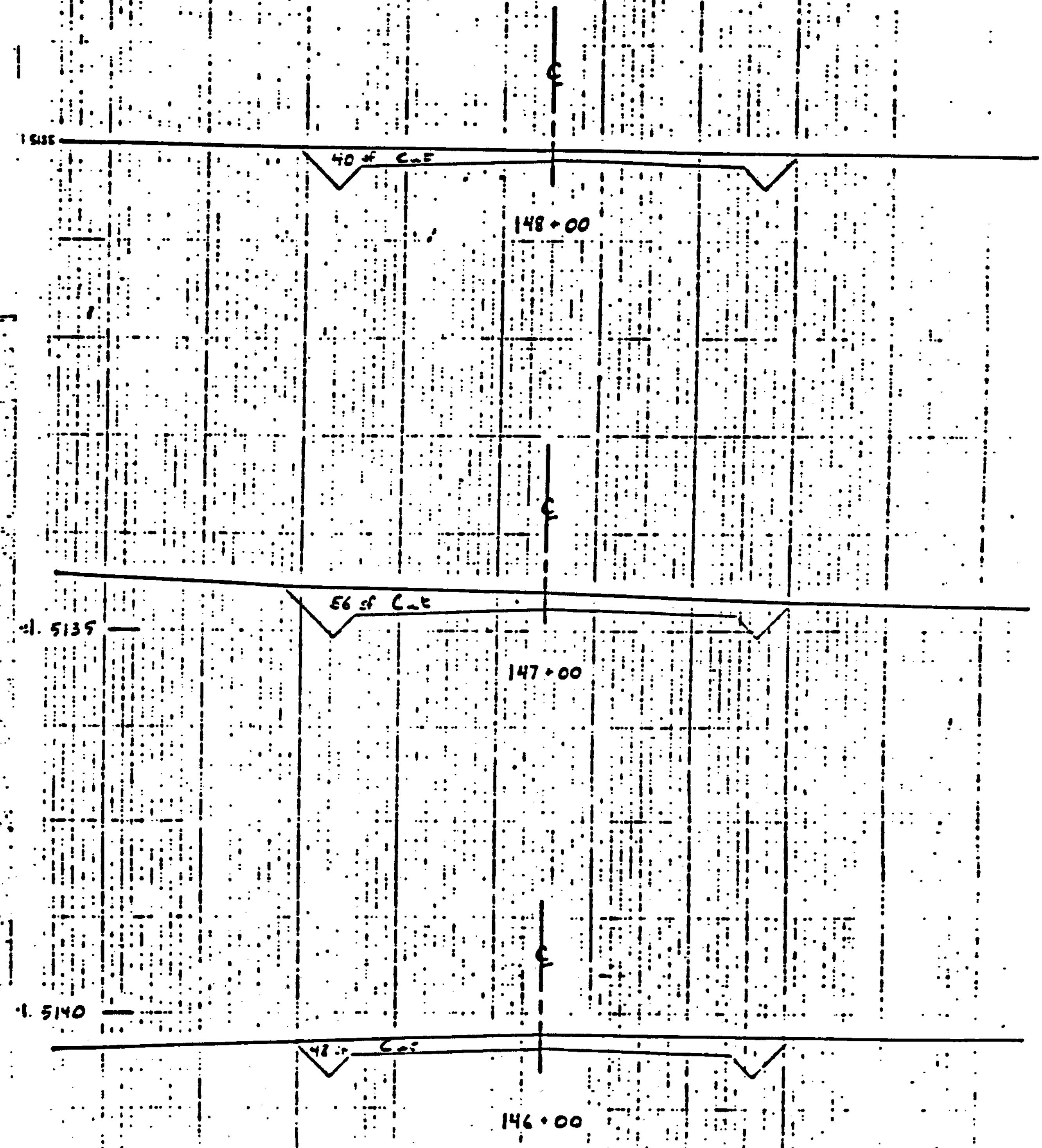
SHT 76
~~81~~ 78



1" = 5' V
1" = 10' H

By NUL 3/12/97

SHT 19

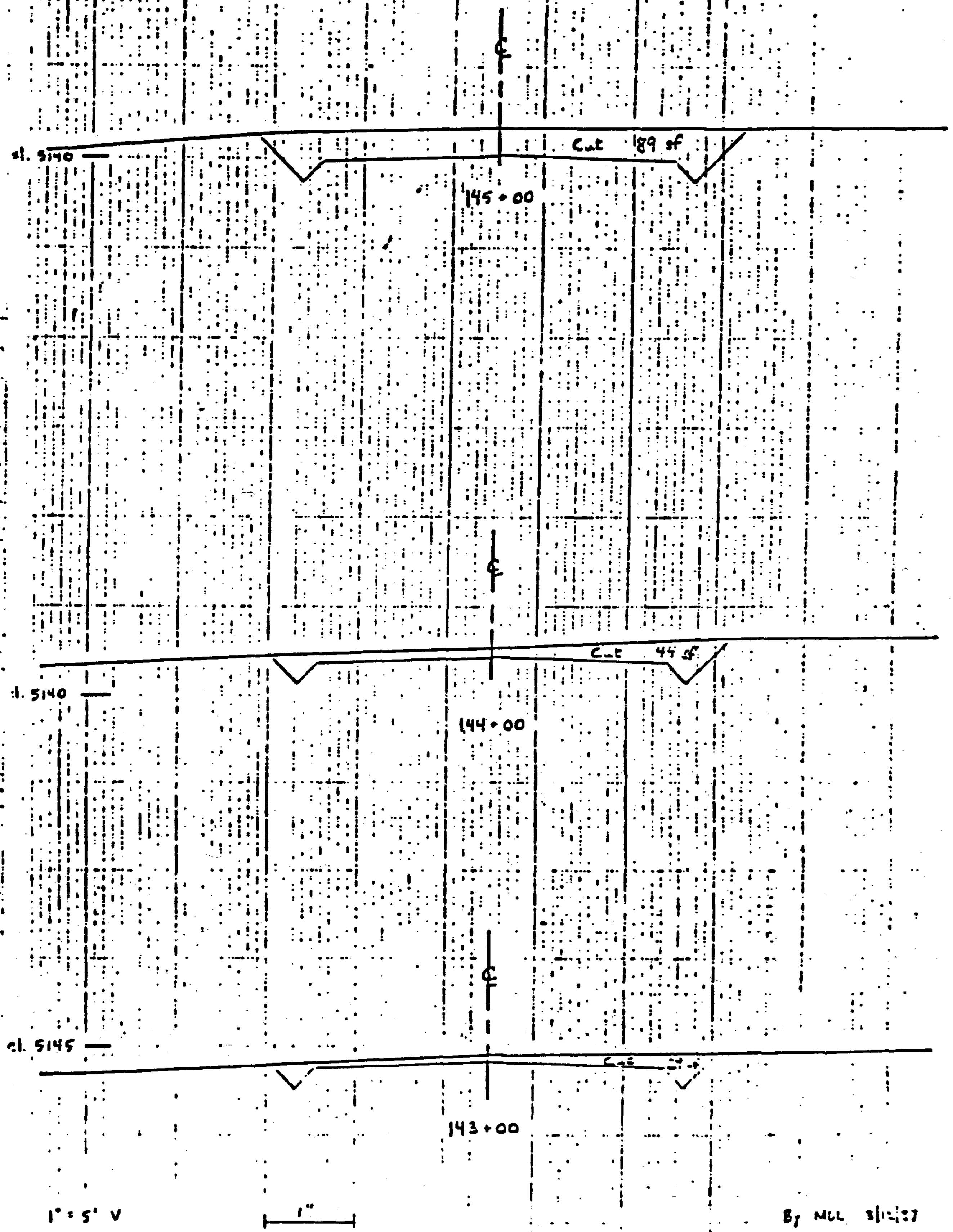


1" = 5' V
1" = 10' H

1"

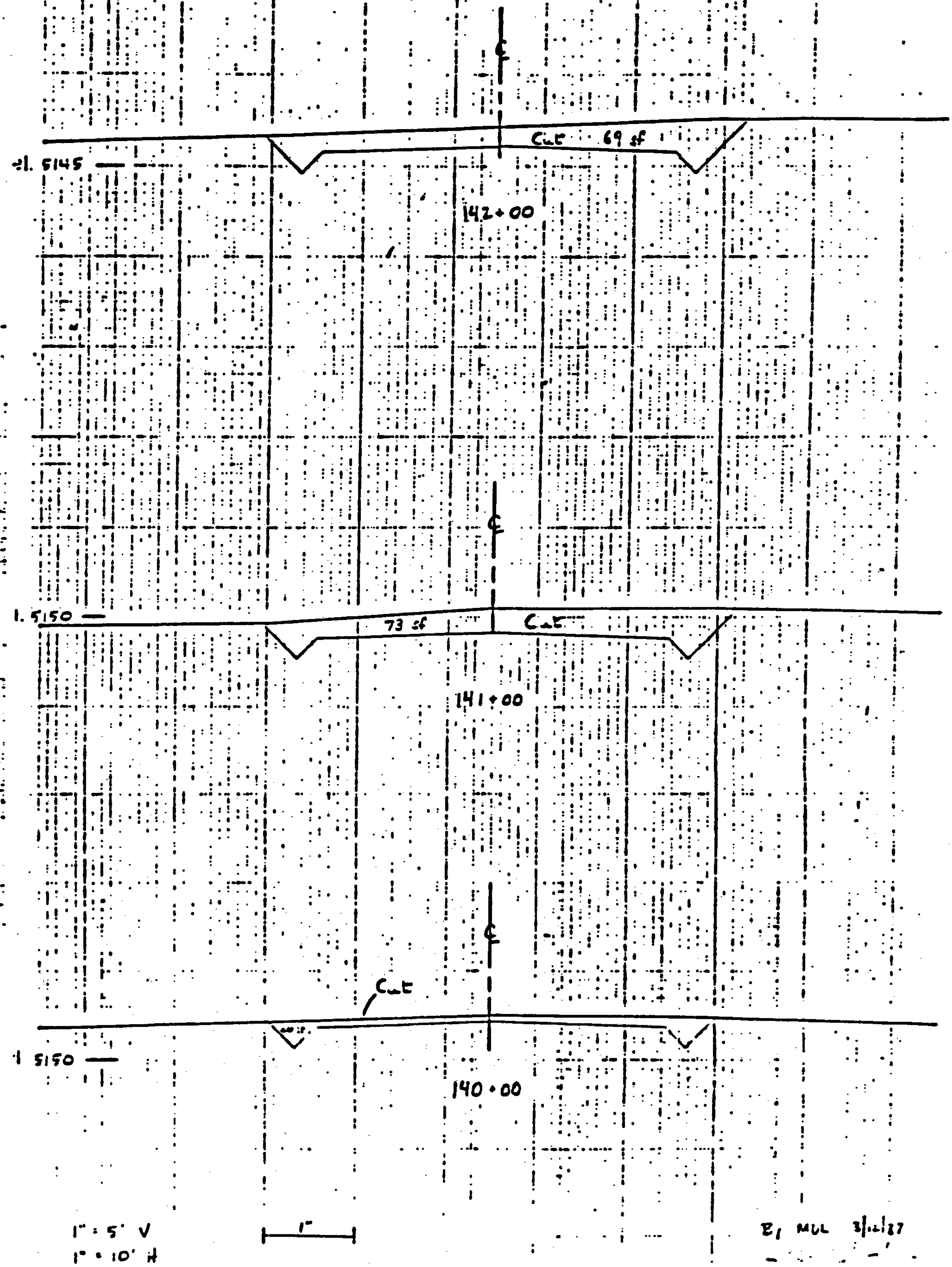
By MCL 3/12/87

SHT 68
~~85~~ 80

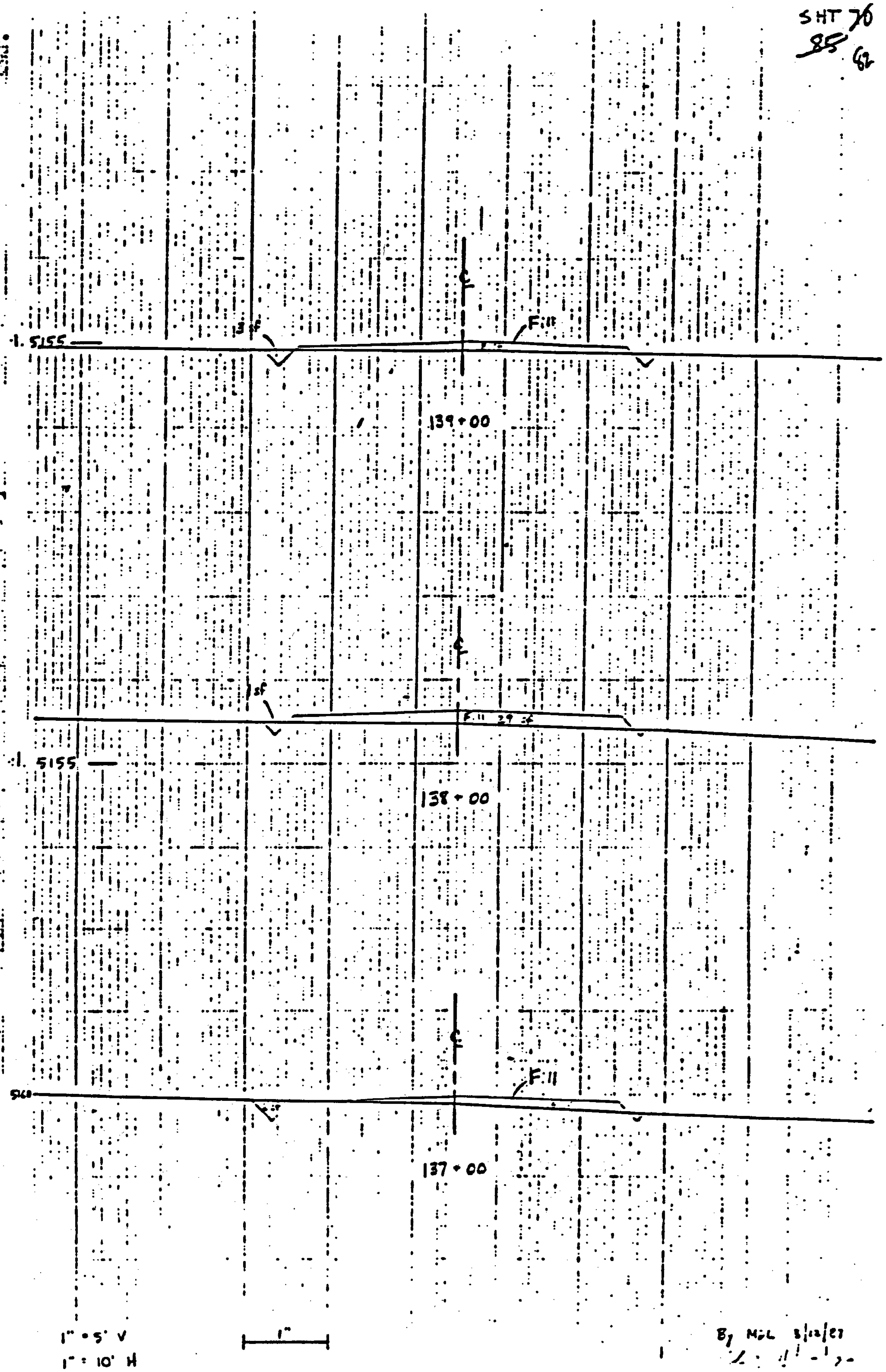


1" = 5' V
1" = 10' H

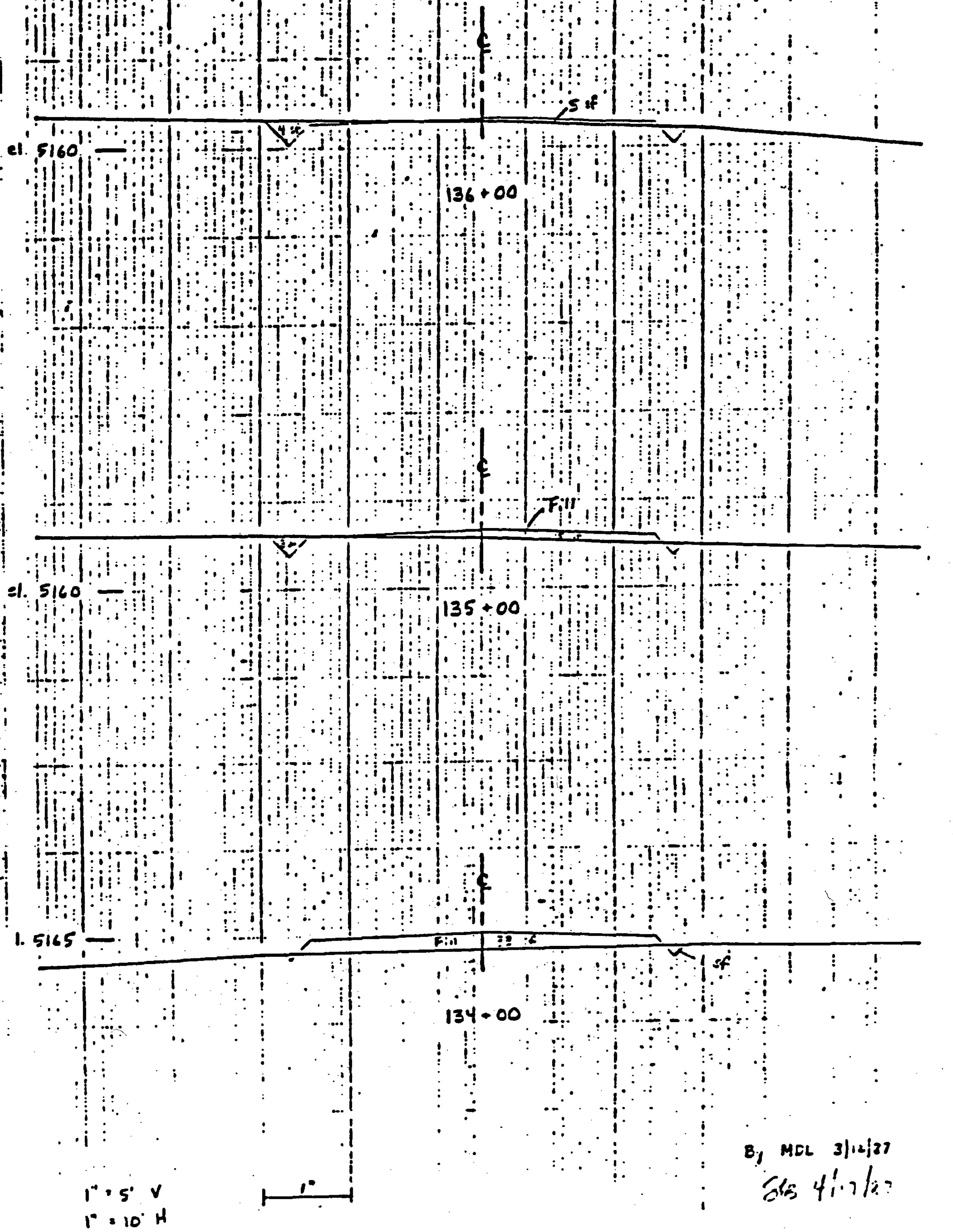
By MLL 3/12/87


℄
1.5145
Cut 69 sf
142+00
℄
1.5150
73 sf
Cut
141+00
℄
Cut
1 5150
140+00
1" = 5' V
1" = 10' H
1"
E, MUL 3/12/87

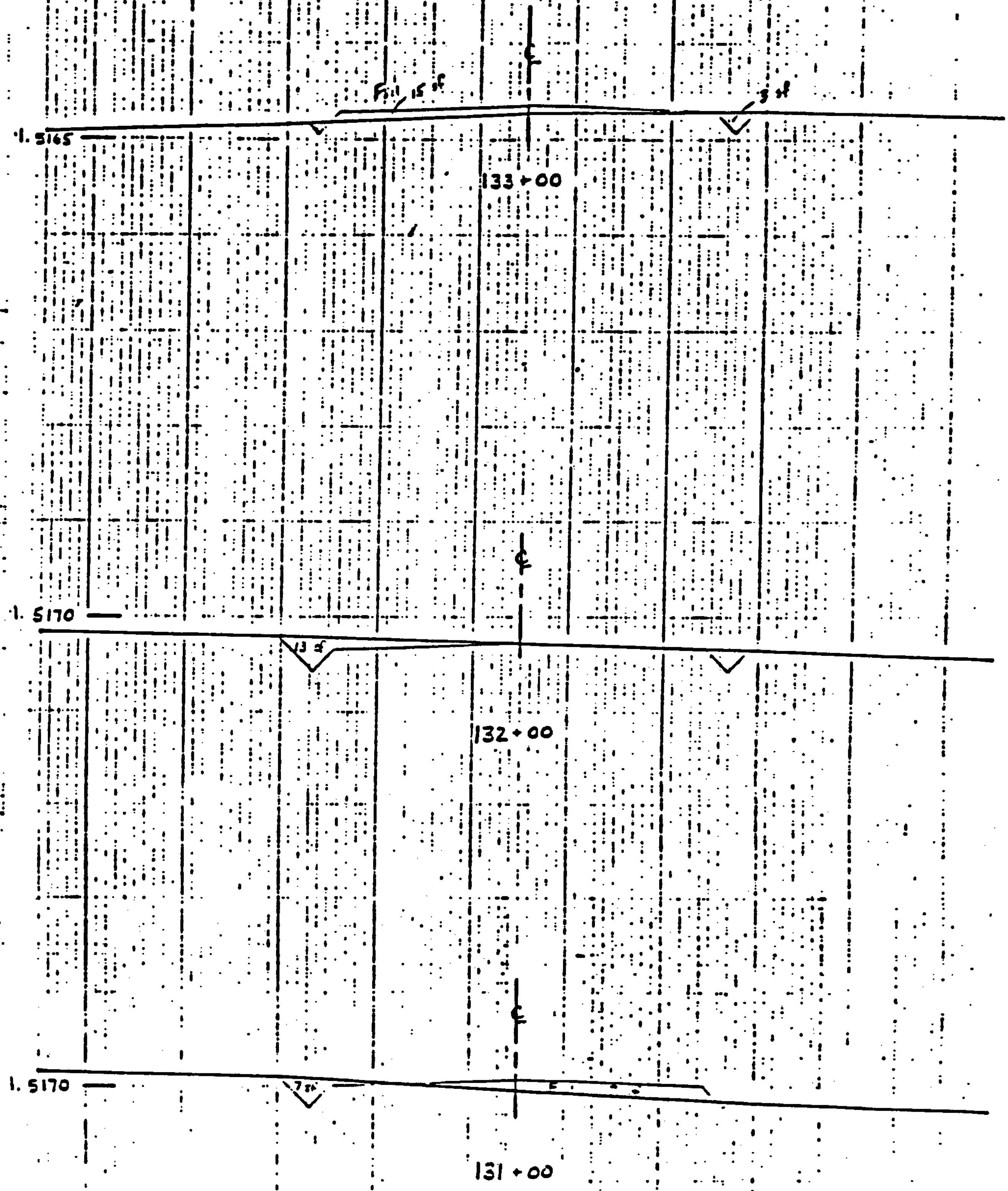
SHT 76
~~85~~ 62


℄
1.5155
3 sf
Fill
139+00
℄
1 sf
F.11 29 sf
1.5155
138+00
℄
Fill
5160
137+00
1" = 5' V
1" = 10' H
1"
By MxL 3/12/87

SHT ~~21~~
~~86~~ 83



By MDL 3/12/87
SGS 4/17/87

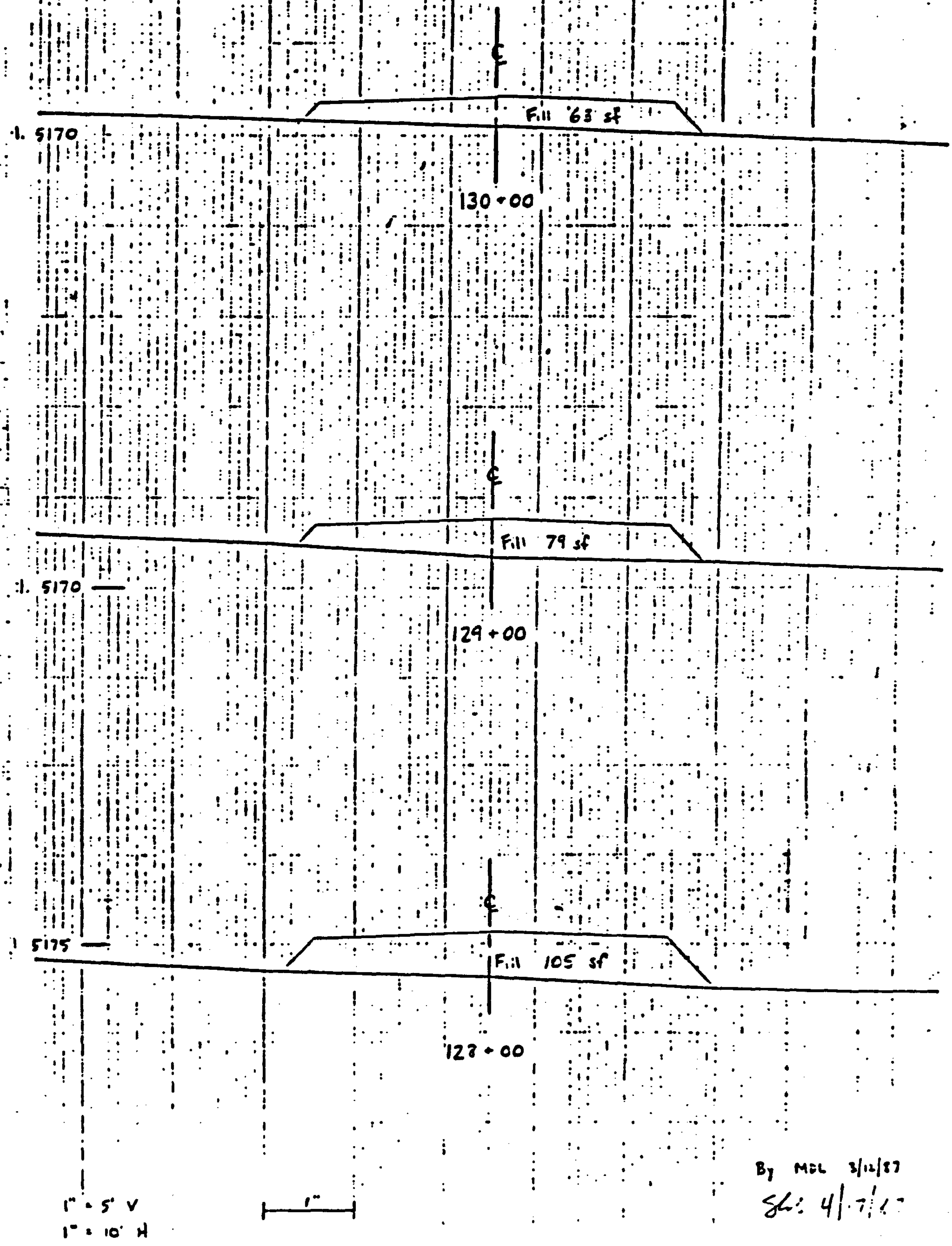


1" = 5' V
1" = 10' H

1"

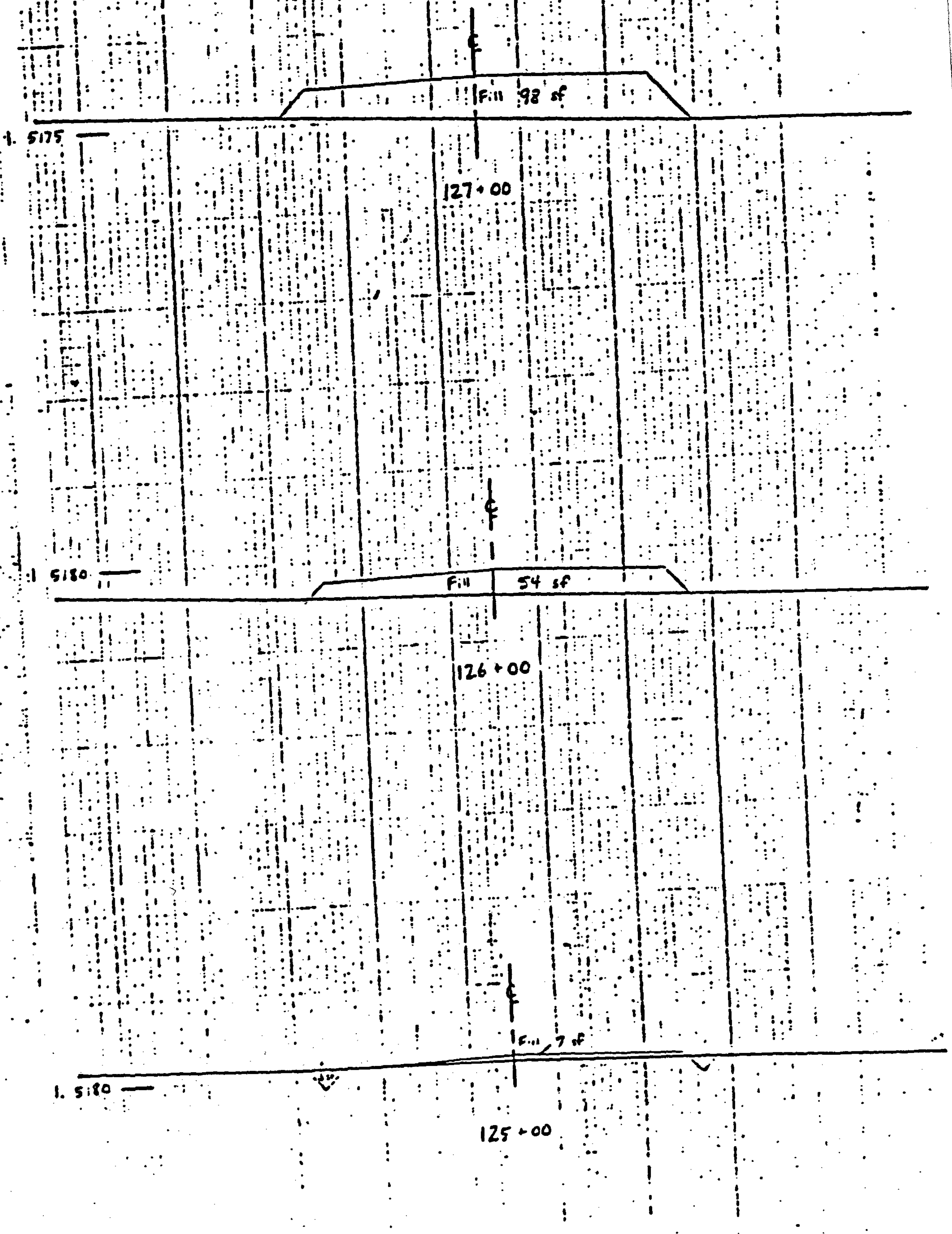
By MDL 3/12/87

SHT ~~78~~ 85 ~~88~~



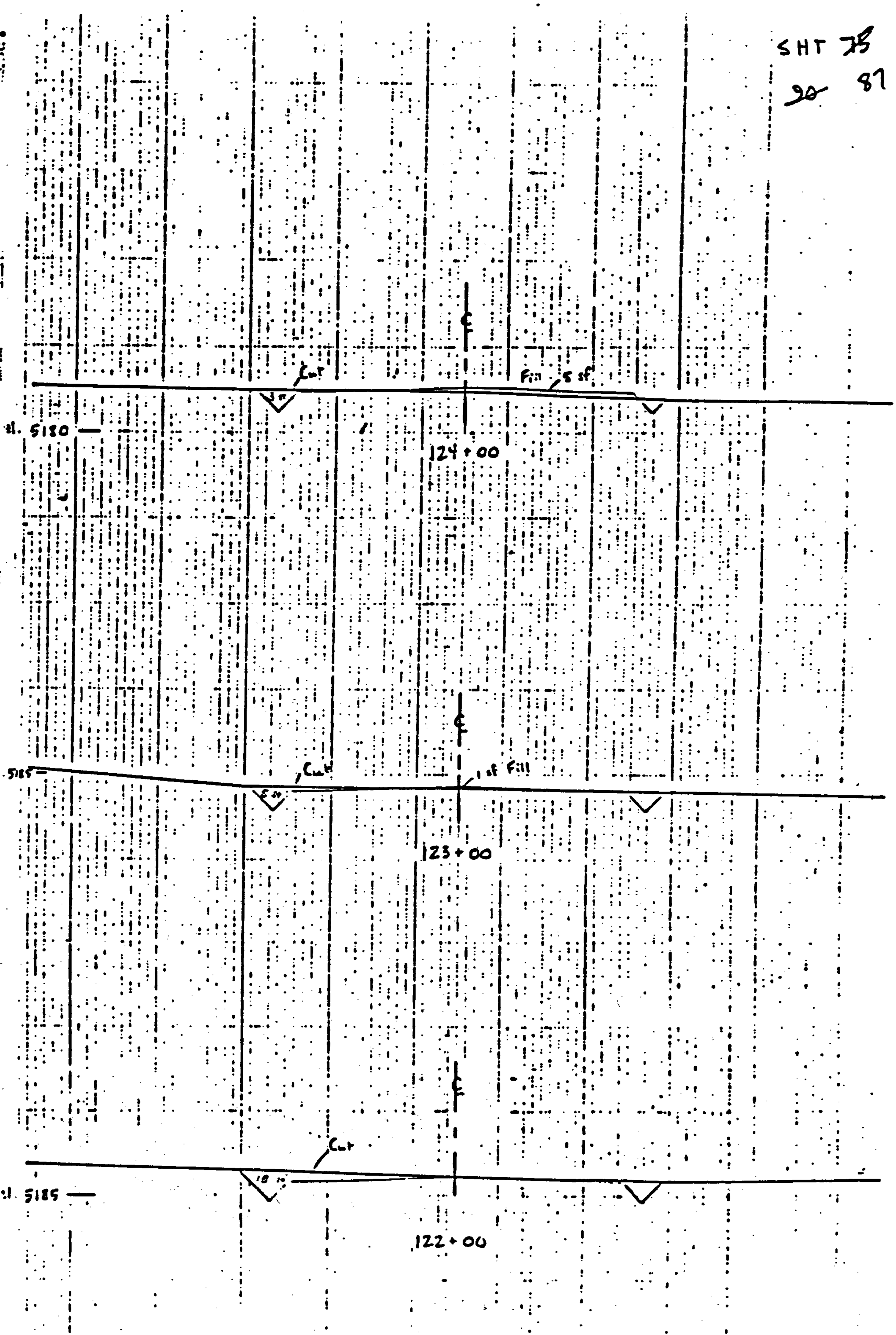
By MDL 3/12/87
Sh: 4/7/1

SHT ~~74~~
~~89~~ 86



1" = 5' V
1" = 10' H

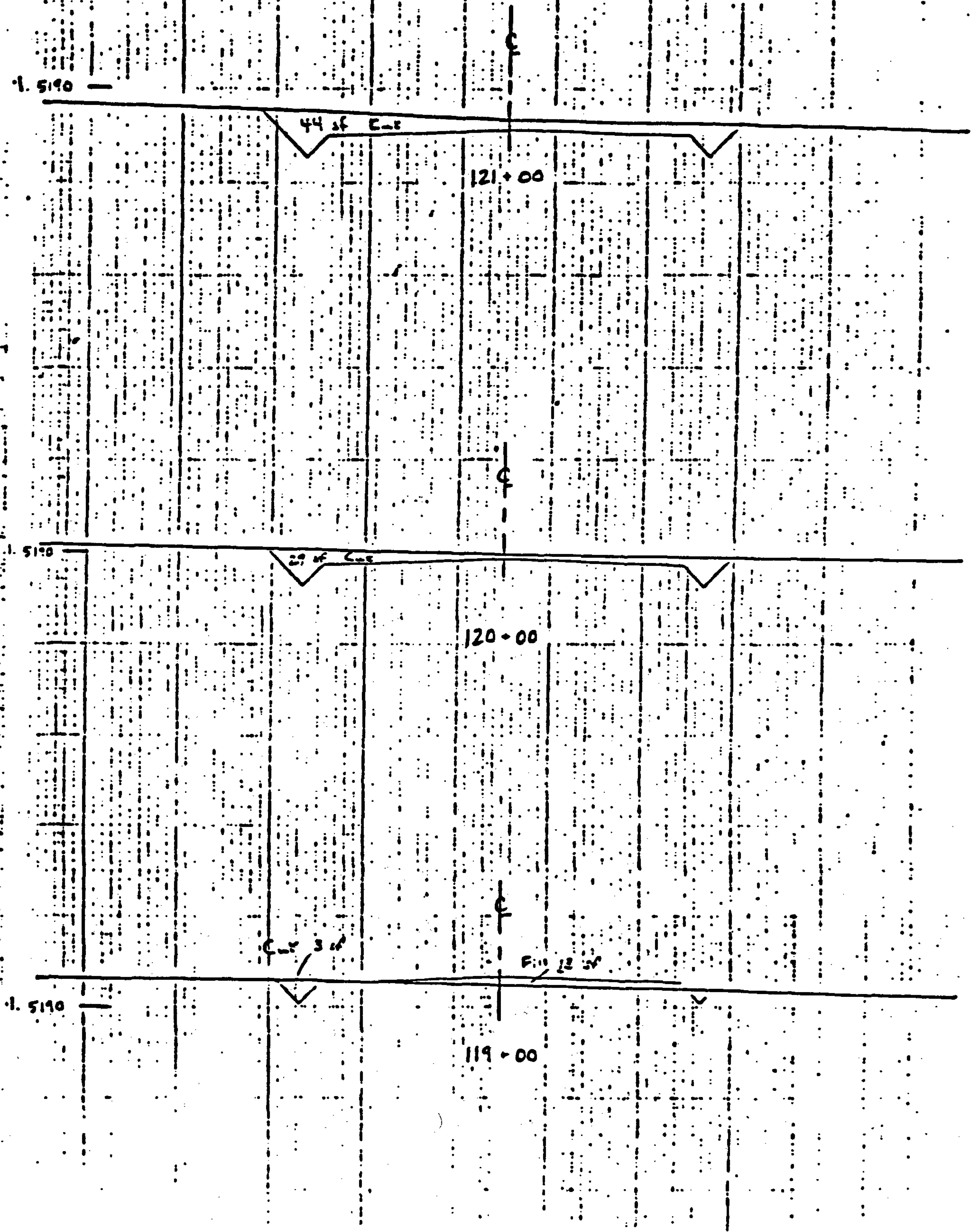
SHT ~~75~~
~~90~~ 87



1" = 5' V
1" = 10' H

By MDL 3/12/87

SHT ~~76~~ ~~91~~ 88

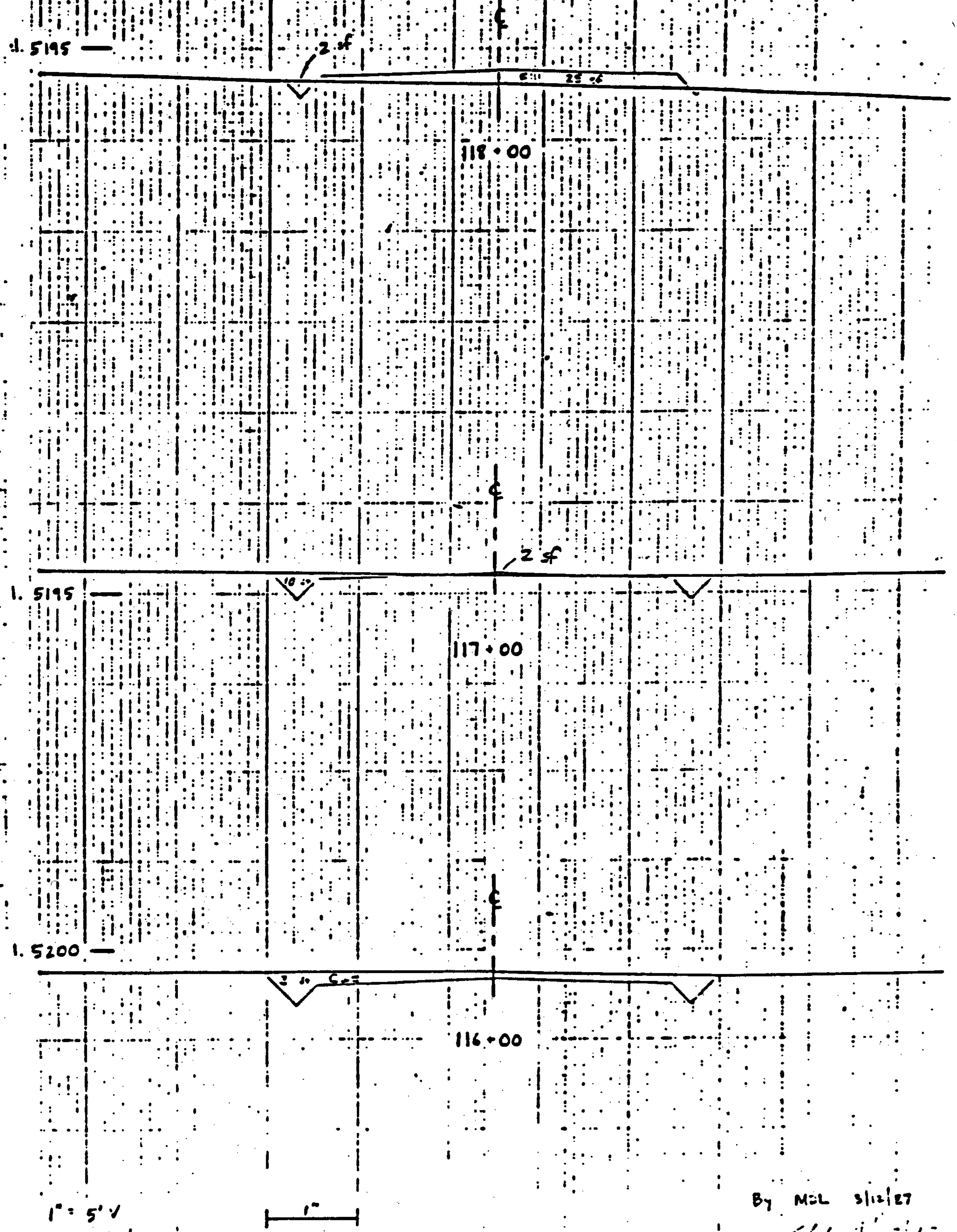


By MDL 3/12/87

1" = 5' V
1" = 10' H

1"

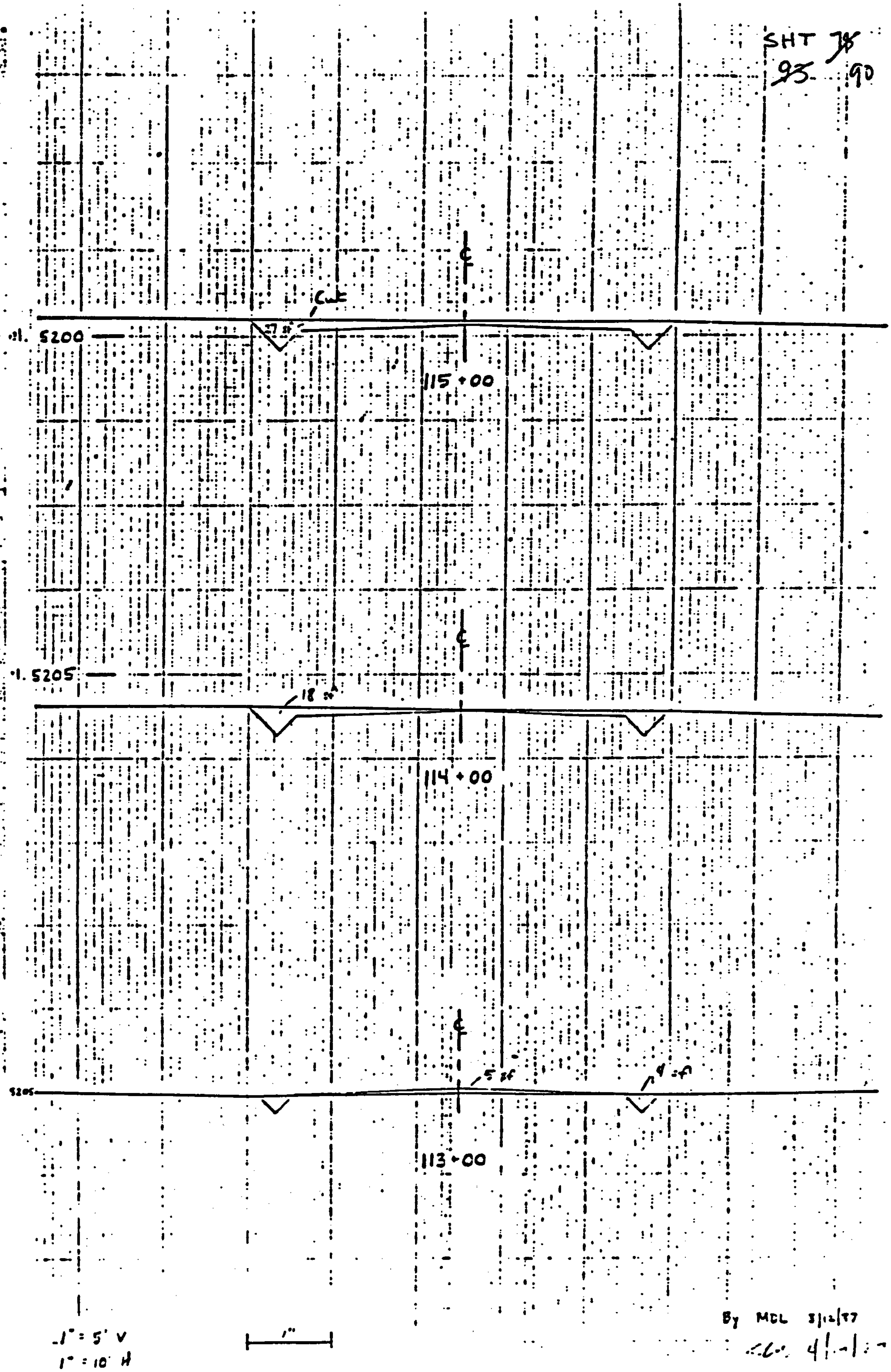
SHT ~~77~~
~~92~~ 89



1" = 5' V
1" = 10' H

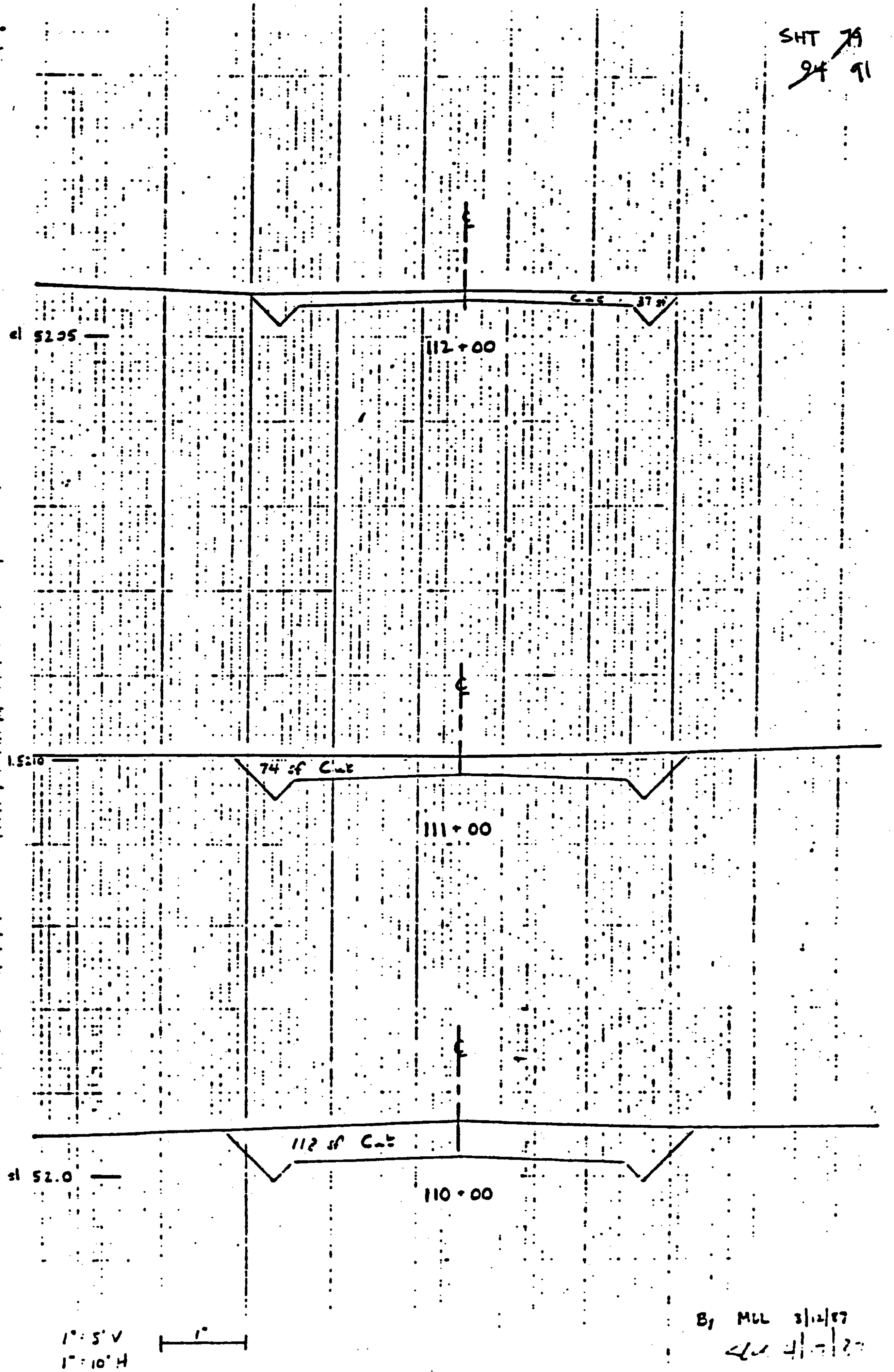
By MCL 3/12/87

SHT ~~78~~ ~~93~~ 90

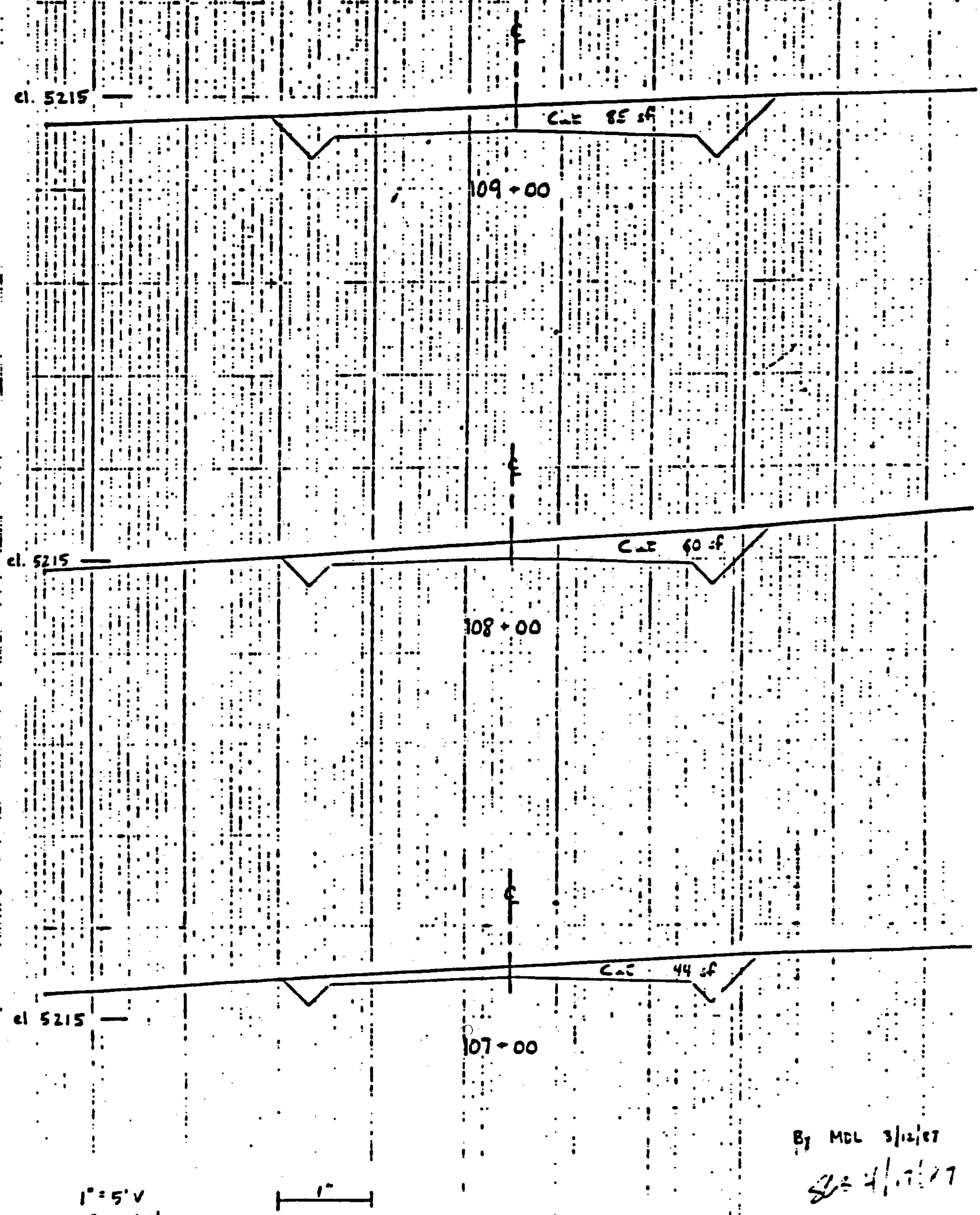


By MDL 3/12/97

SHT ~~79~~
~~94~~ 91



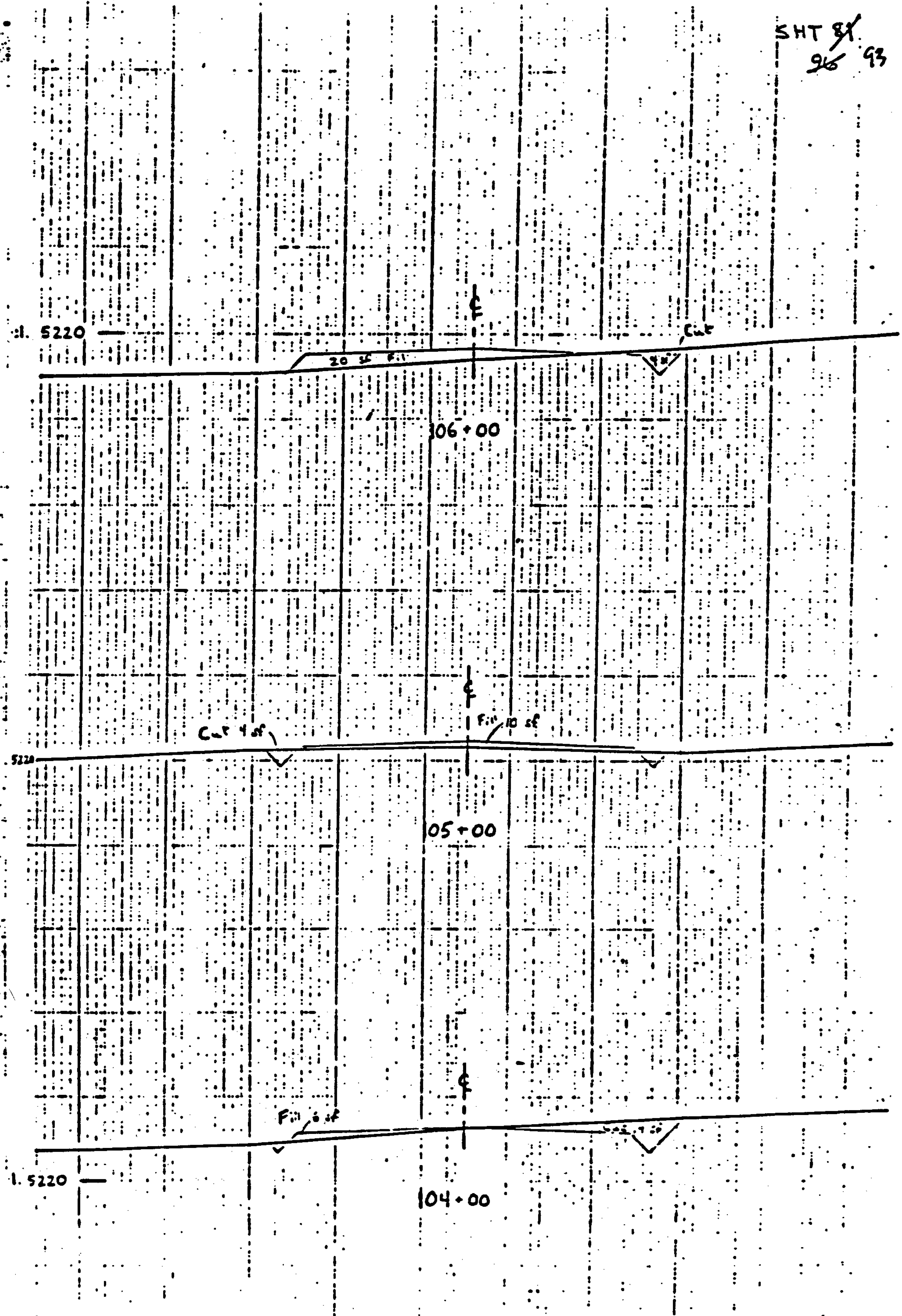
By MLL 3/12/87
4/7/87



1" = 5' V
1" = 10' H

By MCL 3/12/87
4/7/87

SHT ~~81~~ ~~96~~ 93

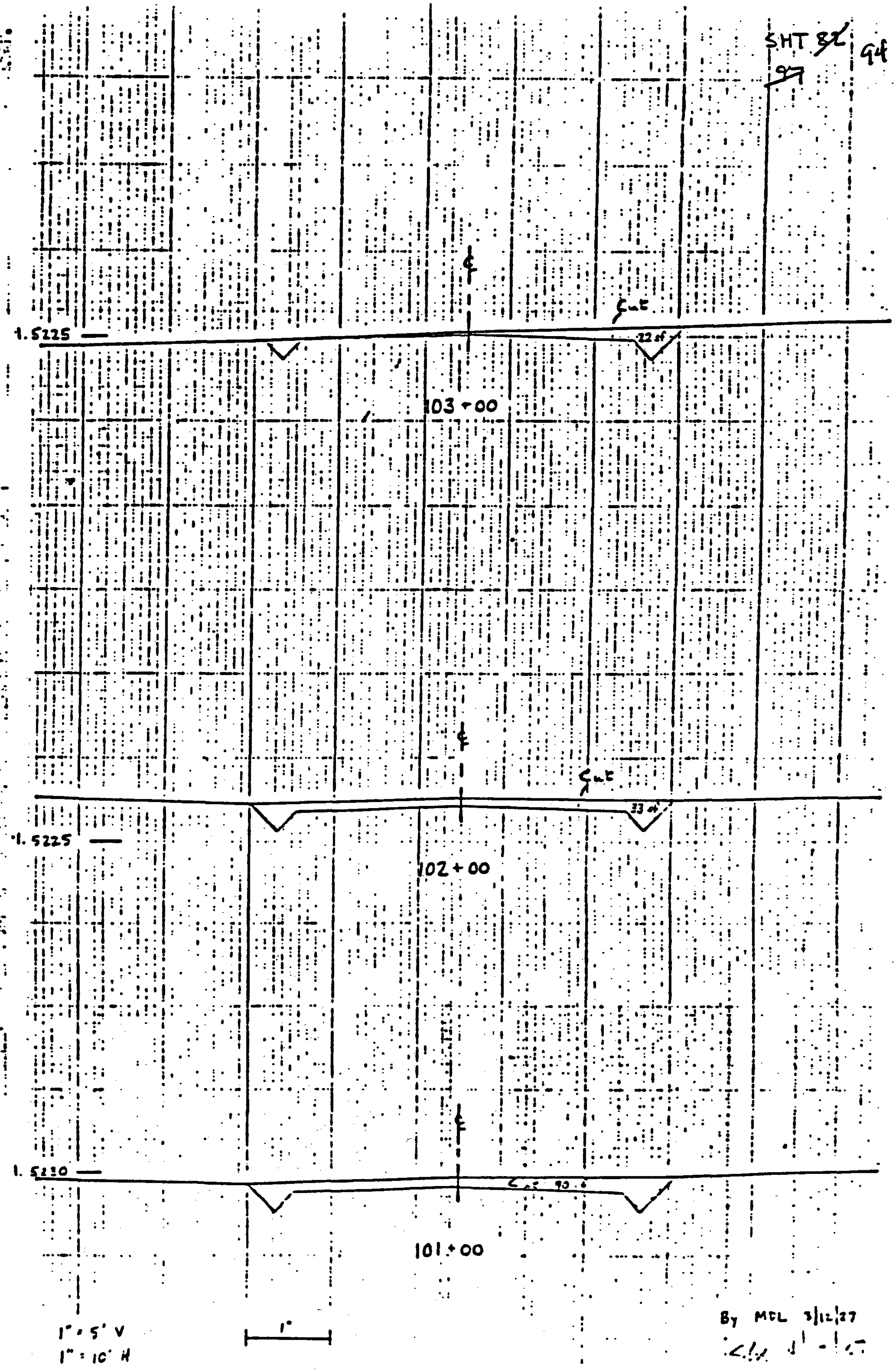


1" = 5' V
1" = 10' H

1"

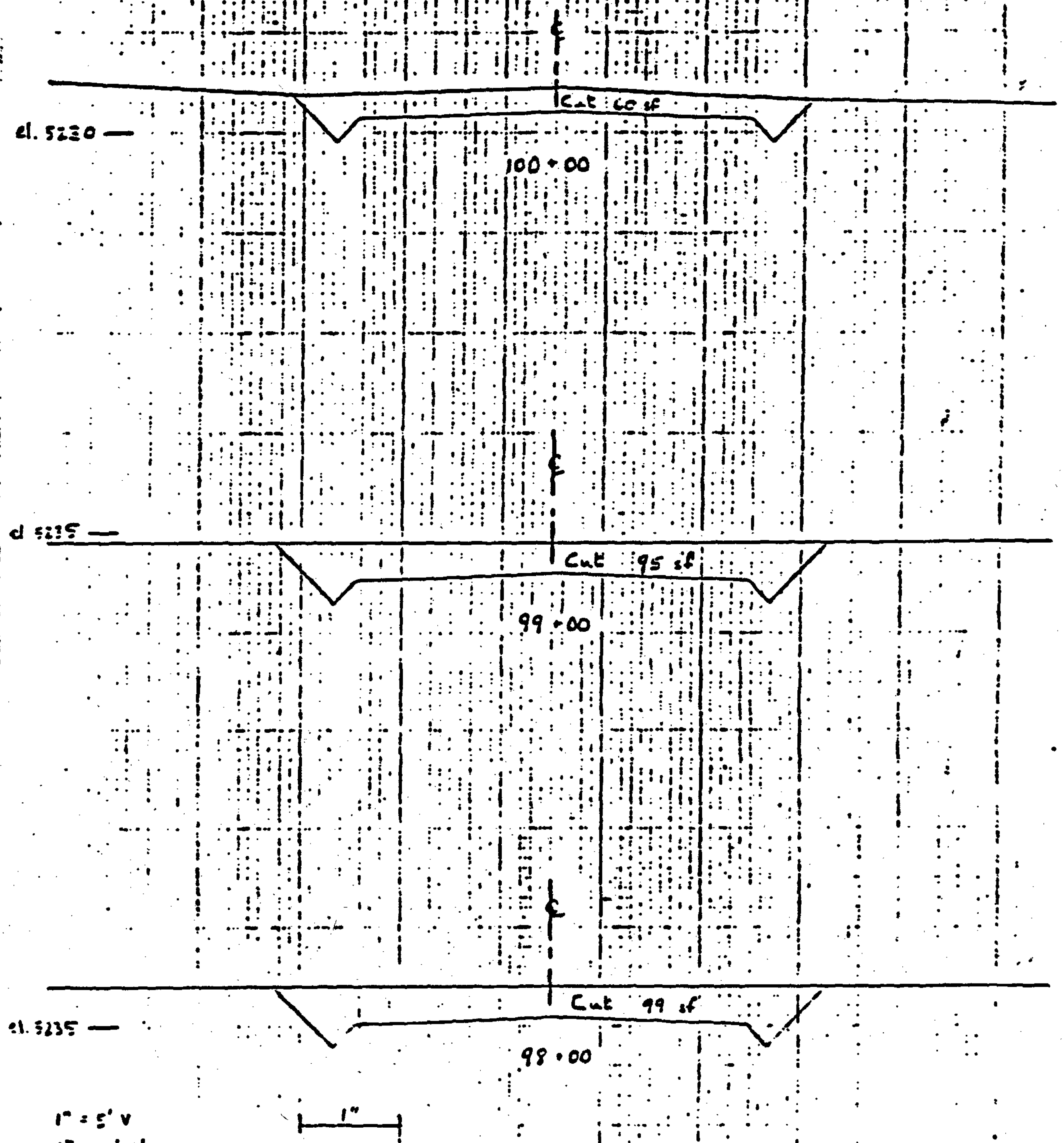
By MDL 3/12/77

SHT ~~82~~ ~~97~~ 94



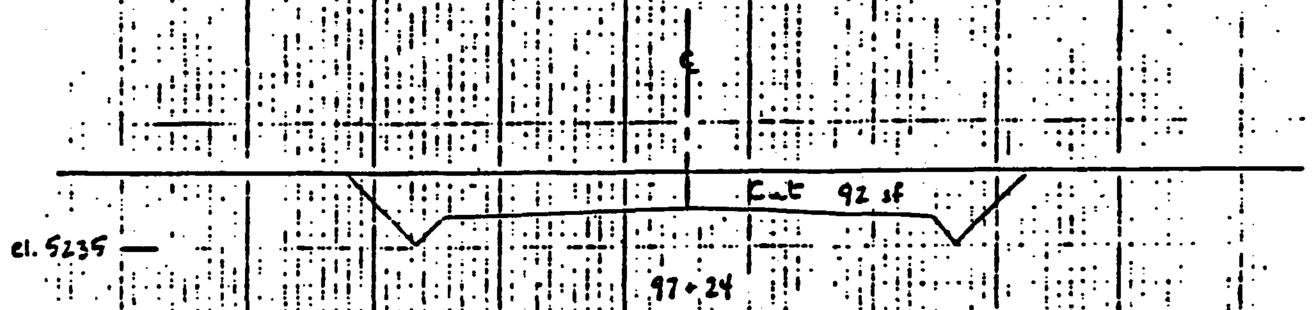
By MCL 3/12/27

SHT ~~93~~ ~~98~~ 95



By MEL 3/12/87

SHT ~~9~~
~~99~~ 96



1" = 5' V
1" = 10' H

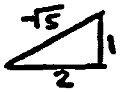
1"

By MDL 4/3/87
Chk 4/[illegible]/87

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature [illegible] ROAD TURNOUT @ HWY 50
Item SEEDING REQUIREMENTS
Contract No. 5025
Designed SLB
Checked PS
Sheet ~~27~~ ~~93~~ 97
File No.
Date 3/4/87
Date 4/[illegible]

SEEDING FOR US 50 TURNOUT LANE SLOPE



STA.	LEFT	RIGHT
7+00	$2.1(\sqrt{5})$	$2.5(\sqrt{5})$
7+50	$2.2(\sqrt{5})$	$3.0(\sqrt{5})$
8+00	$5.0(\sqrt{5})$	$4.6(\sqrt{5})$
8+50	$4.5(\sqrt{5})$	$4.5(\sqrt{5})$
9+00	$5.8(\sqrt{5})$	$4.5(\sqrt{5})$
9+50	$5.7(\sqrt{5})$	$5(\sqrt{5})$
10+00	$5.6(\sqrt{5})$	$4.3(\sqrt{5})$
10+50	$5(\sqrt{5})$	$4.4(\sqrt{5})$
11+00	$3.5(\sqrt{5})$	$3.4(\sqrt{5})$
11+50	$5.3(\sqrt{5})$	$4.5(\sqrt{5})$
12+00	$5.5(\sqrt{5})$	$4.6(\sqrt{5})$
12+50	$6(\sqrt{5})$	$5.3(\sqrt{5})$
13+00	$7.2(\sqrt{5})$	$5.5(\sqrt{5})$
13+50	$6.5(\sqrt{5})$	$5.5(\sqrt{5})$
14+00	$6.2(\sqrt{5})$	$5.7(\sqrt{5})$
14+50	$6.5(\sqrt{5})$	$5.7(\sqrt{5})$
15+00	$6.5(\sqrt{5})$	$6.4(\sqrt{5})$
15+50	$5.7(\sqrt{5})$	$6.5(\sqrt{5})$

SLB 7/13/88
PS 7/14/88

A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature HAUL ROAD TURNOUT @ HWY 50
Item SEEDING REQUIREMENTS

Contract No. 5025
Designed SHB
Checked PS

Sheet 28 [illegible]
File No.
Date 3/4/87
Date 4/1[illegible]/87

STA.	LEFT	RIGHT
16+00	5.6 TS	7.2 TS
16+50	6.5 TS	6.8 TS
17+00	6.7 TS	6.8 TS
17+50	6.5 TS	7.1 TS
18+00	7.5 TS	7.3 TS
18+50	7.2 TS	7.5 TS
19+00	6.7 TS	7 TS
19+50	6.5 TS	6.8 TS
20+00	6.5 TS	7.3 TS
20+50	6.6 TS	6.9 TS
21+00	6.5 TS	6.5 TS
21+50	7.5 TS	6.7 TS
22+00	8.5 TS	6.7 TS
22+50	7.5 TS	6.7 TS
23+00	7.3 TS	6.7 TS
23+50	7 TS	6.4 TS
24+00	3 TS	6.5 TS
24+50	5.3 TS	6.7 TS

SHB 7/13/88
PS 7/14/85

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature HAUL ROAD TURNOUT @ AW/50
Item SEEDING REQUIREMENT
Contract No. 5025
Designed SLB
Checked PS
Sheet ~~29~~ 99 / 2
File No.
Date 3-4-87
Date 4-10/87

SLB 7/13/88
PS 7/14/88

STA	LEFT	RIGHT
25+00	$6.4\sqrt{5}$	$2\sqrt{5}$
25+50	$2\sqrt{5}$	-
26+00	$2.5\sqrt{5}$	-
26+50	$1.7\sqrt{5}$	-
27+00	$1\sqrt{5}$	-

CROSS SECT. AVE. $\frac{227.9\sqrt{5}}{41}$ $\frac{211.5\sqrt{5}}{37}$

= 12.4 ft (2000 ft) 12.8 ft (1800 ft)

= 24859 ft² LEFT = 23007 ft² RIGHT

TOTAL AREA = 47866 ft² = 1.1 ACRE

Note: The seeding will only be below the sub-base level, e.g. 23" (≈1.9') from the top. For left side, area to be seeded is from 7+00 to 26+00 ([illegible]). Total slope area =

$\{227.9\sqrt{5} - 1.7\sqrt{5} - 1\sqrt{5} - \frac{1}{2}(2.5\sqrt{5} + 2.0\sqrt{5})\}$ × 5[illegible]' = 24599 ft²

Area unseeded = 19.00 × $\frac{23}{12}$ × $\sqrt{5}$ = 8143 ft².

∴ Left side area to be seeded = 24599 - 8143 = 16756 ft²

Project UMTRA / GRJ
Feature Quantity Estimate / phase I
Item Seeding Requirements
Contract No.
Designed PS
Checked GWB
Sheet 35/~~85~~ 100
File No.
Date
Date 4/17/89

Similarly, for the right side, the area to be seeded is from 7+00 to 25+00, e.g. (1500 ft).

Total slope area = $\left\{ 211\sqrt{5} - \frac{1}{2}\left(2.5\sqrt{5} + 2\sqrt{5}\right) \right\} 50 = 23331\ ft^2$

Area unseeded = $1800 \times \frac{23}{12} \times \sqrt{5} = 7714\ ft^2$

$\therefore$ Right side area to be seeded = 23331 - 7714 = 15625 ft^2

$\therefore$ Total area to be seeded = 16756 + 15625 = 32351 ft^2 = 0.743 acres

$\simeq$ 0.75 acres

GWB 7/13/88
PS 7/14/88

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~120~~ ~~99~~ 101
Project UMTRA - GRAND JUNCTION
Contract No. 5025
File No.
Feature SEEDING FOR CHENEY HAUL ROA
Designed SLR
Date 5/14/87
Item
Checked MDL
Date 5/18/87

ASSUME CUT SLOPE = FILL SLOPE = 2:1
USE SECTION p. 54-99 OF THIS CALC.

STATION	A VERT. LEFT	A VERT. RIGHT	LENGTH	AREA
97+24	4.5	4.5	76	(4.25 + 4.25)$\sqrt{5}$ (76 = 1444 FT²
98+00	4.0	4.0	100	(2.65+2.71)$\sqrt{5}$ (5200 = 62324 FT²
99+00	4.0	4.0		
100+00	3.5	3.0		
101+00	2.75	3.5		
102+00	2.5	2.75		
103+00	2.0	3.0		
104+00	1.5	3.0		
105+00	2.0	2.0		
106+00	1.0	2.5		
107+00	2.5	3.75		
108+00	2.5	4.0		
109+00	3.5	4.5		
110+00	4.0	4.0		
111+00	3.5	3.75		
112+00	3.0	3.0		
113+00	2.0	2.0		
· : ·	---	- -		

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~121~~ 90
Project UMTRA - GRAND JUNCTION
Contract No. 5025
File No.
Feature SEEDING FOR CHENEY HAUL ROAD
Designed SGA
Date 5/14/87
Item
Checked MDL
Date 5/18/87

STATION	Δ VERT. LEFT	Δ VERT. RIGHT	LENGTH	AREA
115+00	2.75	2.5	100	
116+00	2.75	2.5		
117+00	2.5	2.25		
118+00	2.0	1.5		
119+00	2.5	1.75		
120+00	3.0	2.5		
121+00	3.5	2.5		
122+00	3.0	2.5		
123+00	2.5	2.0		
124+00	2.5	2.0		
125+00	2.0	2.0		
126+00	1.5	1.75		
127+00	1.5	2.75		
128+00	2.0	2.75		
129+00	1.0	2.0		
130+00	1.0	2.0		
131+00	2.5	1.5		
132+00	3.5	2.0		

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRAND JUNCTION
Feature SEEDING FOR CHENEY HAUL ROAD
Item
Contract No. 5025
Designed SLD
Checked MDL
Sheet 107 ~~122~~ 91
File No.
Date 5/14/87
Date 5/18/87

STATION	Δ VERT LEFT	Δ VERT RIGHT	LENGTH	AREA
133+00	3.0	2.0	100	
134+00	2.0	2.0		
135+00	2.0	1.75		
136+00	3.5	2.0		
137+00	2.0	1.5		
138+00	2.0	1.5		
139+00	2.0	2.0		
140+00	2.5	3.5		
141+00	3.0	4.0		
142+00	3.0	4.0		
143+00	2.75	3.5		
144+00	3.0	3.5		
145+00	4.5	4.5		
146+00	3.5	3.0		
147+00	4.0	3.0		
148+00	3.0	3.5		
149+00	3.0	2.5		
150+00	2.75	2.0		

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 107 ~~123~~ ~~92~~
Project UMTRA - GRAND JUNCTION
Contract No. 5025
File No.
Feature SEEDING FOR CHENEY HAUL R
Designed SLF
Date 5/14/87
Item
Checked MDL
Date 5/18/87

STATION	AVERT. LEFT	AVERT RIGHT	LENGTH	AREA
150+50	2.0	1.5	50	$\left(\frac{24.25}{10}+\frac{18.5}{10}\right)$T5(4
151+00	1.5	1.5		= 4307 FT²
151+50	2.0	1.5		
152+00	2.0	2.0		
152+50	2.5	2.0		
153+00	3.5	2.0		
153+50	2.5	2.0		
154+00	3.0	2.0		
154+50	2.5	2.0	58	2.75+2.25 (T5)(
155+08	3 0	2.5		= 648 FT²
155+50	3.5	2.0	42	(3.25+2.25)T5 (4 = 516 FT²
156+00	3.5	2.0	50	$\left(\frac{393}{32}+\frac{386}{32}\right)$T5 (15 = 84369 FT²
156+50	3.0	1.0		
157+00	4.0	1.5		
157+50	5.5	1.5		
158+00	4.0	1.0		
158+50	3.5	1.5		
159+00	2.0	2.0		

SEN ENGINEERS, INC.

[illegible]
[illegible] RD

Contract No. 5025
Designed [illegible]
Checked MDL

Sheet 124 93
File No.
Date [illegible]
Date 5/18/87

ΔV LEFT	ΔV RIGHT	LENGTH
3.0	3.5	50
4.0	4.0	
3.5	2.5	
6.5	2.5	
10.5	5.5	
14.0	9.0	
18.0	12.5	
20.0	15.0	
23.5	20.0	
27.0	23.0	
26.0	27.5	
21.0	29.5	
15.0	34.5	
10.0	43.0	
4 5	30 5	
9.0	9.0	
21.5	7.0	
21 0	14.5	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRAND JUNCTION
Feature SEEDING FOR CHENEY HALL RD.
Item
Contract No. 5025
Designed SGB
Checked MDL
Sheet 126 125 ~~94~~
File No.
Date 5-14-87
Date 5/18/87

STATION	ΔVERT. LEFT	ΔVERT. RIGHT	LENGTH	AREA.
168+50	20.0	16.0	50 ↓	
169+00	15.0	17.0		
169+50	15.0	14.0		
170+00	12.5	12.5		
170+50	10.0	10.5		
171+00	10.0	5.5		
171+20	11.0	5.0	20	$(10.5+5.25)\sqrt{5}(20)$ = 704 FT²
171+31	11.5	5.5	11	$(11.25+5.25)\sqrt{5}(11)$ = 405 FT²
171+50	7.0	4.5	19	$(9.25+5.0)\sqrt{5}(19)$ = 605 FT²
171+52	11.0	6.5	2	$(9.0+5.5)\sqrt{5}(2)$ = 65 FT²
171+70	9.0	6.0	18	$(10.0+6.25)\sqrt{5}(18)$ = 654 FT²
171+73	10.0	6.0	3	$(9.5+6)\sqrt{5}(3)$ = 104 FT²
172+03	6.0	10.0	35	$(8.0+8.0)\sqrt{5}(35)$ = 1252 FT²
172+18	10.0	4.0	10	$(8.0+7.0)\sqrt{5}(10)$ = 335 FT²
172+41	5.5	1.5	23	$(7.75+2.75)\sqrt{5}(23)$ = 540 FT²
172+50	1.0	1.0	9	$(3.25+1.25)\sqrt{5}(9)$ = 91 FT²
173+00	1.5	1.0	50 ↓	$\left(\frac{54}{9}+\frac{47}{9}\right)\sqrt{5}(400)$ = 10037 FT²
173+50	3.0	2.0		

Project UMTRA - GRAND JUNCTION
Feature SEEDING FOR CHENEY HAUL RD.
Item

Contract No. 5025
Designed SLA
Checked MDL

Sheet 107 ~~126 95~~
File No.
Date 5-14-87
Date 5/18/87

STATION	ΔVERT. LEFT	ΔVERT RIGHT	LENGTH	AREA
174+00	4.5	2.5		
174+50	6.0	5.0	50	
175+00	9.0	7.0		
175+50	10.0	8.5		
176+00	11.0	10.0		
176+50	8.0	10.0	41	$(6+8.5)\sqrt{5}(41) = 1329$
176+91	4.0	7.0	9	$(3+8)\sqrt{5}(9) = 221$ FT²
177+00	2.0	9.0	50	$\left(\frac{58.5}{15}+\frac{109.5}{15}\right)\sqrt{5}(700) =$ 17531 FT²
177+50	7.5	16.0		
178+00	10.0	10.0		
178+50	9.0	21.0		
179+00	7.0	1.0		
179+50	3.0	17.0		
180+00	4.0	10.0		
180+50	1.5	4.0		
181+00	1.0	5.0		
181+50	2.0	1.5		
182+00	3.0	1.0		

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA GRAND JUNCTION
Feature SEEDING FOR CHENEY HAUL RD.
Item
Contract No. 5025
Designed SMG
Checked MDL
Sheet 127 ~~86~~
File No.
Date 5/14/87
Date 5/18/87

STATION	Δ VERT. LEFT	Δ VERT. RIGHT	LENGTH	AREA
182+50	2.0	2.0	50 ↓	
183+00	1.0	3.5		
183+50	2.5	4.0		
184+00	3.0	4.5	30	$(3.25+4.0)\sqrt{5}\,(30) =$ 486 FT^2
184+30	3.5	3.5	10	$(2.25+2.25)\sqrt{5}\,(10) =$ 101 FT^2
184+40	1.0	1.0	36	$(1.75+1.75)\sqrt{5}\,(36)$ 282 FT^2
184+76	2.5	2.5	15	$(3.25+3.25)\sqrt{5}\,(15)$ 218 FT^2
184+91	4.0	4.0		

AREA SEEDED = 188568 FT^2

= 4.3 AC.

MORRISON-KNUDSEN ENGINEERS, INC.
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101

Project UMTRA/GRJ
Feature QUANTITY ESTIMATE
Item CULVERT RIPRAP AND BEDDING

Contract No. 5025
Designed MDL
Checked PS

Sheet 44 ~~37~~
File No.
Date 4/21/87
Date 9/21/87

QUANTITY OF RIPRAP

RIPRAP AT OUTLET

9 revet mattresses × 2 cy capacity = 18 cy

RIPRAP AT INLET

$$24'\left[\tfrac{1}{2}(2'\times 2') + (4'\times 2')\right] + \left[\tfrac{1}{2}(\sqrt{1.25}' + 2')1.5' + (6.5'\times 1')\sqrt{1.25}\right]16'$$

$$+ \left[\tfrac{1}{2}(8'\times 8')\sqrt{1.25} + \tfrac{1}{2}(8'\times 8')\sqrt{1.25} + 2(8'\times 4')\sqrt{1.25} + (4'\times 8')\right]1'$$

$$+ \left[2\cdot\tfrac{1}{2}(8'\times 4') + 3(4'\times 8') + (8'\times 8') - \tfrac{\pi}{4}\cdot 8^2\right]1.5'\cdot\sqrt{5}$$

$$= 240 + 154 + 175 + 475 = 1044 \text{ cf} = \underline{39 \text{ cy}}$$

TOTAL RIPRAP AT CULVERT = 57 cy

113

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA / GJ
Feature QUANTITY ESTIMATE
Item CULVERT RIPRAP AND BEDDING
Contract No. 5025
Designed MDL
Checked PS
Sheet ~~115~~ ~~38~~
File No.
Date 4/21/87
Date 4/21/87

QUANTITY OF BEDDING

Bedding will be used only at the inlet to the culvert.

$$\Big[(2'\sqrt{2} \times 24') + (6' \times 24') + (6'\sqrt{1.25} \times 16') + (8' \times 8')\sqrt{1.25}$$

$$+ 2(4' \times 8')\sqrt{1.25} + (4' \times 8') + 2 \cdot \tfrac{1}{2}(8' \times 4')\sqrt{5} + 3(4' \times 8')\sqrt{5}$$

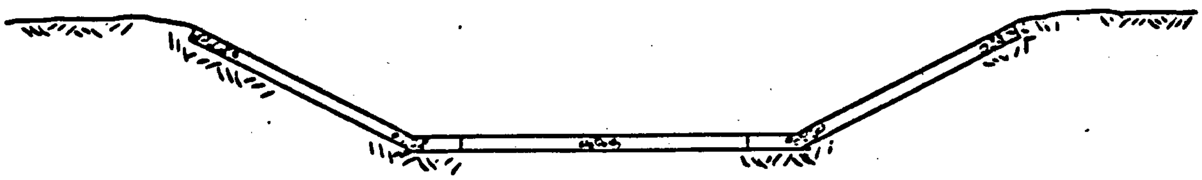
$$+ (8' \times 8')\sqrt{5} - \tfrac{\pi}{4} \cdot 8^2\sqrt{5}\Big]\, 0.5' = 406 \text{ cf} = \underline{\underline{15 \text{ cy}}}$$

FILTER FABRIC

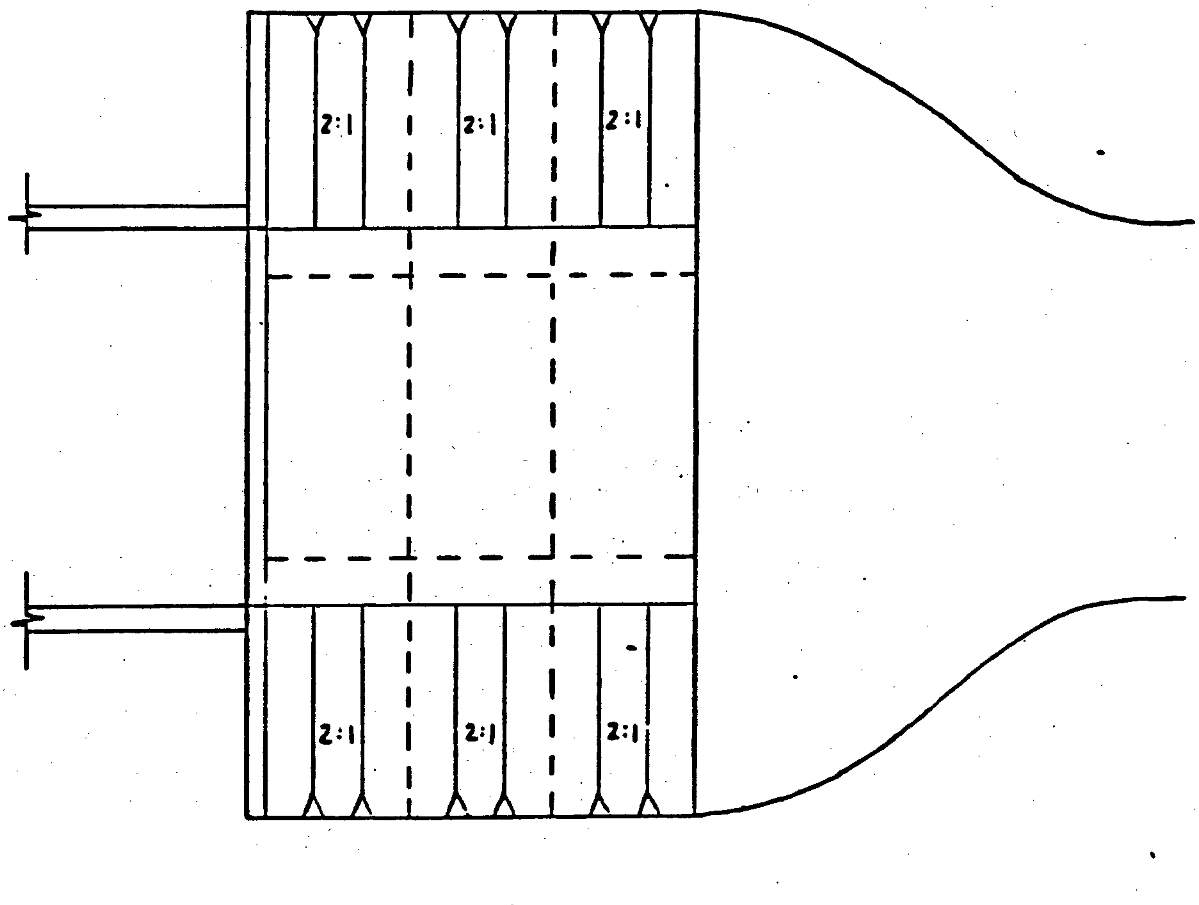
Surface area of each revet mattress = 12' × 6' = 72 sf

9 mattresses × 72 sf = 648 sf = $\underline{\underline{72 \text{ sy}}}$

Sheet 116 ~~97~~
Project UMTRA / GRJ
Contract No. 5025
File No.
Feature QUANTITY ESTIMATE
Designed MDL
Date 5/18/87
Item CULVERT RIPRAP AND BEDDING
Checked PS
Date 4/22/87



CROSS SECTION
OF REVET MATTRESSES

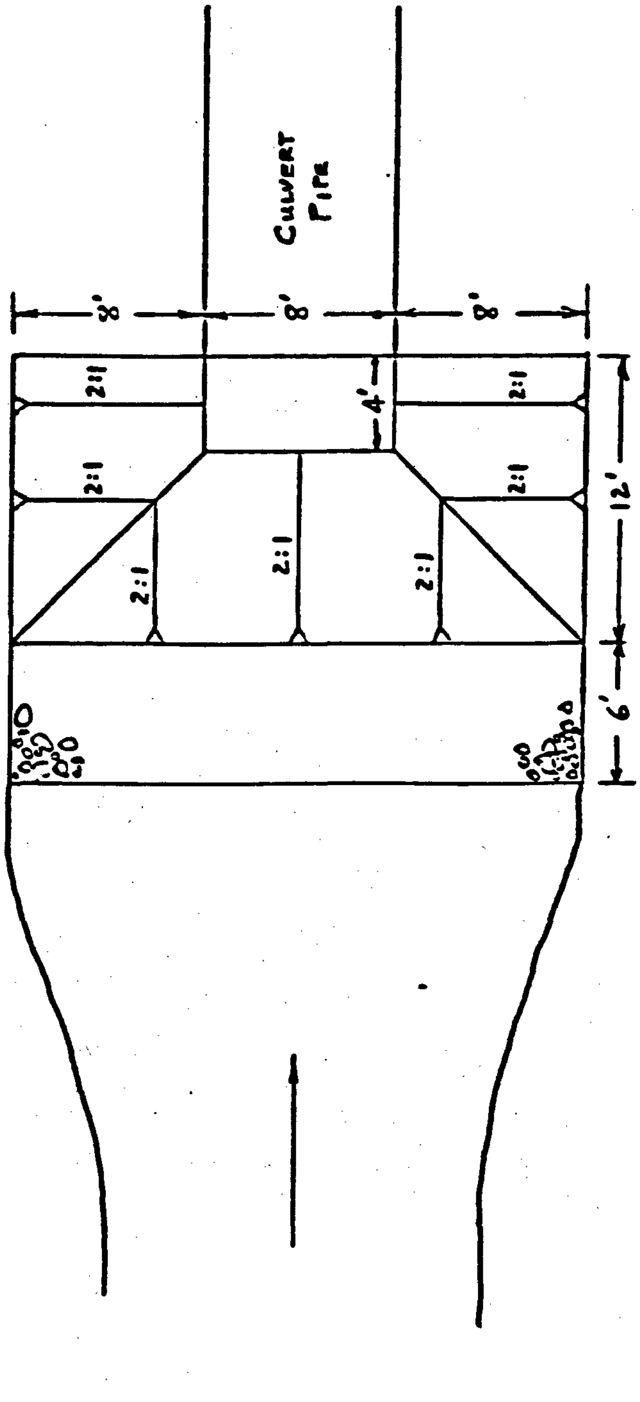


PLAN VIEW
OF REVET MATTRESSES

112

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~117~~ ~~101~~
Project UMTRA: GRJT
Contract No. 5025
File No.
Feature QUANTITY ESTIMATE
Designed MDL
Date 4/22/87
Item CULVERT RIPRAP AND BEDDING
Checked PS
Date 4/22/87

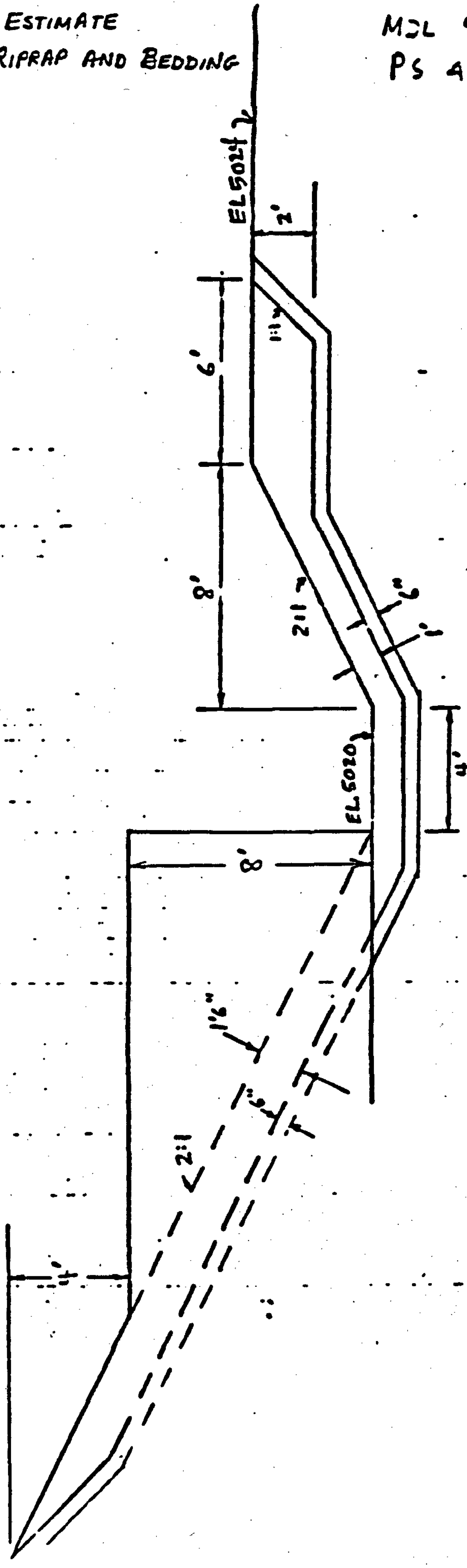


INLET PLAN

UMTRA / GRJ
QUANTITY ESTIMATE
CULVERT RIPRAP AND BEDDING

No. 5025
MJL 4/22/87
PS 4/22/87

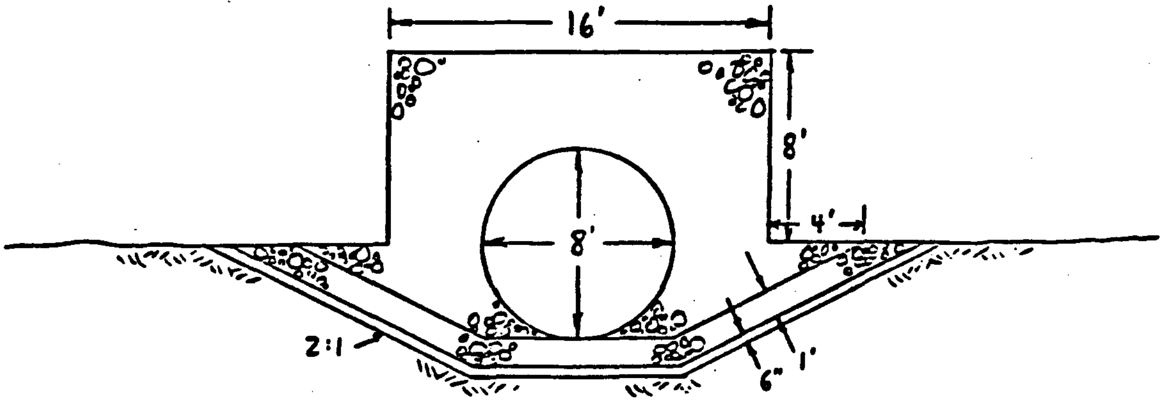
13 118
101



INLET PROFILE

114

Sheet 119 [illegible]
Project UMTRA/GPJ
Contract No. 5025
File No.
Feature QUANTITY ESTIMATE
Designed MDL
Date 4/22/87
Item CULVERT RIPRAP AND BEDDING
Checked PS
Date 4/22/87

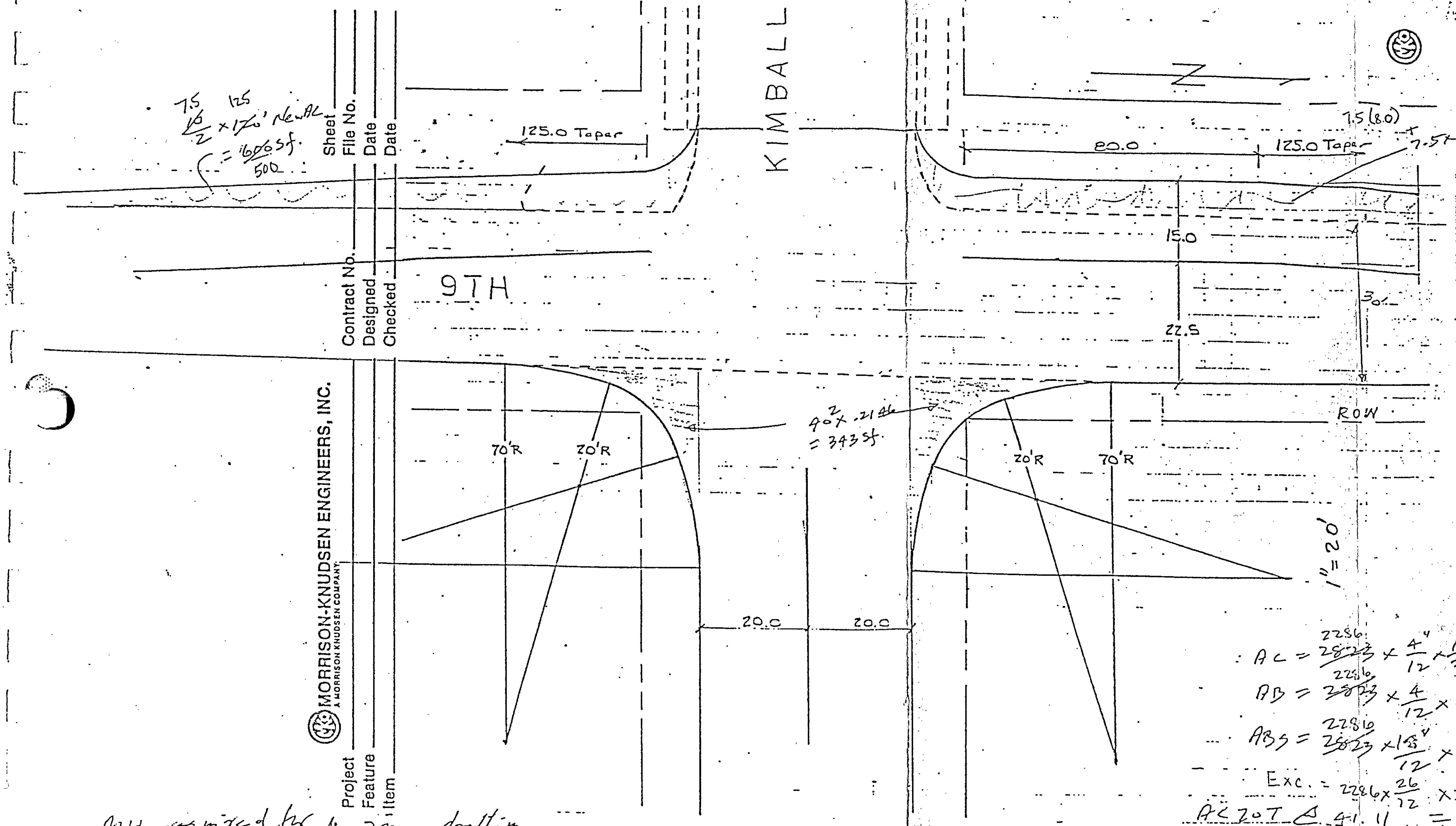


INLET FRONT VIEW

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project
Feature
Item
Contract No.
Designed
Checked
Sheet
File No.
Date
Date

SKB 7/13/86
PS 7/13/8



~~10~~ 7.5 / 2 × ~~120~~ 125' New AC = ~~600~~ 500 sf.

40^2 × .2146 = 343 sf.

7.5 × ~~205~~ 125 = ~~1537~~ 1069 SF

~~1537~~ 1100
343
343
~~600~~ 500
~~2823~~ SF 2286

AC = ~~2823~~ 2286 × 4"/12 × 1/27 = ~~35~~ 28 CY = ~~70~~ 56 Tons
AB = ~~2823~~ 2286 × 4/12 × 1/27 = ~~35~~ 28 CY
ABS = ~~2823~~ 2286 × 18"/12 × 1/27 = ~~157~~ 126 CY
Exc. = 2286 × 26/12 × 1/27 = 183 CY
AC 70T @ 41.11 = 2877
AB 35CY @ 9.53 = 336
ASB 157CY @ 8.00 = 1252
$ 4469

MH required for designing, drafting and administrating = 200 MH

MKE DOCUMENT NO. 5025-GRJ-C-01-01827-02

Calculation Cover Sheet

Contract No. 5025 **Discipline** ESCUP **Calc. No.** 05-670-01-~~03~~ ~~04~~ 05
No. of Sheets ~~110~~ 139

Project UMTRA – Grand Junction

Feature Radon Barrier

Item Thickness

Sources of Data and References

1. U. S. DEPT. OF ENERGY, "REMEDIAL ACTION PLAN AND SITE CONCEPTUAL DESIGN FOR STABILIZATION OF THE INACTIVE URANIUM MILL TAILINGS AT GRAND JUNCTION, COLORADO", DRAFT, JUNE, 1986, MKE DOC. No. 5025-GRJ-R-03-00226-00
2. ROGERS, V.C., ET. AL., "RADON ATTENUATION HANDBOOK FOR URANIUM MILL TAILINGS COVER DESIGN", APRIL, 1984 (RAECOM PROGRAM)
3. MKE CALC. No. 05-670-01-00, "RADON BARRIER DESIGN THICKNESS."
4. MKE CALC. No. 05-670-05-01, "EMBANKMENT DESIGN - MATERIAL PROPERTIES."
5. USSCS COMPUTER PROGRAM, SWRDAT FOR PREDICTING SOIL-WATER RETENTION CAPACITY AT 20 DIFFERENT SUCTION PRESSURES IN THE RANGE OF 0.0 TO 100.0 BARS. DEVELOPED BY OTTO W. BAUMER AND ASSOCIATES AT NSSL, LINCOLN, NEBRASKA, 1985
6. NRC STANDARD REVIEW PLAN FOR UMTRCA TITLE I MILL TAILINGS REMEDIAL ACTION PLANS, OCTOBER, 1985
7. UMTRA DESIGN PROCEDURE MANUAL, MKE DOC. No. 4005-GEN-Q-00571-06, CHAPTER 6

→ CONTINUE TO PAGE i

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. 05-670-01-00

5	TAC's Comments	H. LUBIS	12/21/90	P. Sircar	12/21/90	P. Sircar	12/21/90
4	RESPONDED TO TAC'S & NRC'S COMMENTS	H. LUBIS	11/15/90	S.E. Botsford	11/16/90	P. Sircar	11-16-90
3		H. LUBIS	2/2/90	[illegible]	[illegible]	P. Sircar	5/5/90
2		S.E. Botsford	2/28/89	P. Sircar	2/27/89	P. Sircar	2/27/89
0		P. Sircar	3/28/88	W. Lin	4/5/88		9/6/88
Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date

Form 42-110

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Grand Junction, Colorado Date: December 3, 1990

Document: Preliminary Final Design - August 1990

Commentor: TAC - P. Zelle

Comment: Calculation No. 05-670-01-04

For the layer two vicinity property material, moisture saturations on page 18 and diffusion coefficients on page 33 were not updated for 95 percent compaction. Using 95 percent compaction for the three samples (29-Cr (0'-20'); 29-Cr (20'-30'); and 33-F-B (0'-20')), moisture saturations would be 0.552, 0.548, and 0.484, respectively and diffusion coefficients would be approximately 6 x 10^{-3} cm^2/s, 6 x 10^{-3} cm^2/s, and 1 x 10^{-2} cm^2/s, respectively. It is recognized that these changes will not affect subsequent RAECOM cover thickness calculations since the layer two diffusion coefficient was conservatively increased to 1 x 10^{-2} cm^2/s. The revised calculations only indicate that use of 1 x 10^{-2} cm^2/s is not as conservative as previously thought.

SECTION 2

Response: By: P. Sircar

Date: December 20, 1990

Agreed. The calculations are revised. Please note that additional data on vicinity properties (see Sheet No. 33A) indicate that the material in the diffusion tests represent the VP materials fairly well. So, the need for added conservatism is reduced.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: Date:

Approved by:

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Grand Junction, Colorado Date: December 3, 1990

Document: Preliminary Final Design - August 1990

Commentor: TAC - P. Zelle

Comment: Calculation No. 05-670-01-04

On sheet 25, the first sentence of the Revision 4 discussion should state that the long-term moisture contents calculated by the Rawls and Brakensiak formula are "lower" (rather than "higher") than the moisture contents that were measured by 15-bar capillary moisture tests or calculated by SWRDAT.

SECTION 2

Response: By: P. Sircar

Date: December 20, 1990

Agreed. The word is changed.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: Date:

Approved by:

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA - GRJ
Feature
Item
Contract No. 3885.34
Designed SKD
Checked HL
Sheet
File No.
Date 11.29.90
Date 12/20/90

RADON BARRIER DESIGN - THICKNESS

CALCULATION # 05-670-01-03

<u>NOTE</u>: THE RADON BARRIER DESIGN THICKNESS WILL NOT CHANGE WITH AN INCREASED 6 FOOT DEPTH OF CONTAMINATED MATERIAL. THE SURFACE FLUX WILL NOT BE INFLUENCED BY ADDITIONAL TAILINGS PLACED IN THE BOTTOM OF THE EXCAVATION.

MORRISON-KNUDSEN ENGINEERS, INC.
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Sheet i
Project UMTRA - GRJ
Contract No. 50254-6 File No.
Feature RADON BARRIER
Designed H-L.
Date 5-19-90
Item REFERENCES
Checked G.G
Date 5-22-90

CONTINUATION OF SOURCES OF DATA AND REFERENCES

8. MKE CALC. No. 05-670-02-00, "RADON BARRIER - AVERAGE Ra-226 CONCENTRATIONS."

9. MKE DOC. No. 4005-GEN-R-04-05736-00, "RADON BARRIER DESIGN: STATISTICAL AND SENSITIVITY ANALYSIS."

10. "TECHNICAL APPROACH DOCUMENT", UMTRA-DOE|AL 050425.0002, MKE DOC. NO. 4005-GEN-R-03-02239-05.

11. COMMENTS BY TAC, NOV. 7, 1990, MKE DOC. NO. 3885-GRJ-7-04-04714-00

12 COMMENTS BY NRC, OCT. 11, 1990 (IN THE MEETING NOTES, OCT. 11, 1990, MKE DOC. No. 3885-GRJ-X-01-04709-00)

Sheet ii
Project UMTRA-GRJ
Contract No. 5025
File No.
Feature Radon Barrier
Designed PS
Date 3/28/88
Item Thickness
Checked WYL
Date 4/5/88

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MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

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Project UMTRA - GRJ
Contract No. 5025-16
File No.
Feature RADON BARRIER
Designed H.L
Date 5-26-90
Item LIST OF REVISION #3
Checked GS
Date 5-29-9

REVISION #3

TITLE	SHEET
Elimination of "Layer 3" Term	1
Purpose of Revision #3	1A
"Layer 3" Term	2
Data Base	3
Conclusion	4
Thickness of various layer	6,6A
Dry density and porosity	7
Long Term Moisture contents	14,14
Long Term Moisture Contents of Radon Barrier	22,22 23,23
Suction Curve (15 bar) for R. Barrier	24A
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RAECOM Output Summary	39
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Appendix B	B-1 — B-9
Appendix C	C-1 — C-4
Appendix D	D-7 — D-22
Appendix E	E-1 — E-6
Appendix F	F-1 — F-7

Project UMTRA - GRJ
Feature RADON BARRIER
Item THICKNESS
Contract No. 3885-34
Designed P. Sircar
Checked HL
Sheet iv
File No.
Date 11-19-90
Date 11/19/90

REVISION 4

This revision addresses :

1. Resolution of comments by TAC (See sheets 15A, 25, 33A, 37, 37A, 37B, 37C, 37D, 38, 39), REF. 11.

2. Resolution of comments by NRC, REF. 12

3. A change in the degree of compaction of the Ponds Area material from 100 pct standard compaction, to 95 pct. standard compaction, consistent with the rest of the design (See Sheets 1A, 2, 6, 7, 33A, 38)

Sheet 1A
Project UMTRA-GRJ
Contract No. 5025
File No.
Feature RADON BARRIER
Designed H.L.
Date 2-6-90
Item THICKNESS
Checked G.S.
Date 5-[illegible]-90

PURPOSE OF REVISION #3

The purpose of revision #3 is to compute the radon barrier thickness requirements based on Material Test Data and an Empirical Method called SWRDAT. The material properties for all layers other than the radon barrier are based on the previous design data, however, the radon barrier properties are based on the latest data in Appendix B (Sh. B-3 – B-9), Appendix C (Sh. C-1 – C-4), Appendix D (Sh. D-10 – D-15), and Appendix E (Sh. E-1 – E-6).

SUMMARY OF COMPUTATION

The required radon barrier thickness is summarized as follows:

REV. 4
HL 11/15/90
SHB 11.16.90

A. Based on Material Test Data : ~~1.3~~ 1.1 feet
(See page 40A)

B. Based on SWRDAT Method : ~~1.6~~ 1.4 feet.
(See page 40A)

NOTE:

These calculations were performed for a radon barrier, compacted at 95 percent standard compaction (ASTM D698), since all test data were for that compaction level. However, present plans are to compact the radon barrier to 100 percent standard compaction to attain the required permeabilities. Therefore, the required thicknesses computed herein are conservative.

MORRISON-KNUDSEN ENGINEERS, INC.
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Sheet 1
Project UMTRA - GRJ
Contract No. 5025-16
File No.
Feature EMBANKMENT DESIGN
Designed SKS
Date 2-17-89
Item RADON BARRIER THICKNESS
Checked PS
Date 2-21-89

BACKGROUND AND PURPOSE

THE PURPOSE OF THIS COMPUTATION IS A) TO DEVELOP APPROPRIATE DESIGN PARAMETERS, MOST IMPORTANTLY, LONG-TERM MOISTURE CONTENT AND THE CORRESPONDING RADON DIFFUSION COEFFICIENT, AND B) USE THE DESIGN PARAMETERS TO COMPUTE THE REQUIRED THICKNESS OF THE RADON BARRIER, FROM THE STANDPOINT OF RADON DIFFUSION.

~~THE RADON BARRIER DESIGN IS BASED ON LAYER 3 SOILS AS DEFINED IN MKE CALCULATION 05-670-05-01 p. 95 (VERY STIFF TO HARD SILTY CLAY TO CLAYEY SILT) FOUND AT THE CHENEY RESERVOIR DISPOSAL SITE. IN ADDITION, MINUS 1" FRACTION OF LAYER 2 SOILS WILL BE USED AS NEEDED TO ASSURE 2 FEET OF RADON BARRIER COVER.~~

REV.3 : H.L. 2/2/90 SKS 5/21/90
TERM LAYER 3 WAS NO LONGER USED FOR REVISED RADON BARRIER THICKNESS CALCULATION.

WE REQUIRE A MINIMUM OF 2 FEET THICKNESS OF RADON BARRIER TO SATISFY CRITERIA FOR CONSTRUCTION, SETTLEMENT CRACKING, AND INFILTRATION OF SURFACE WATER.

THE PRESENT CALCULATIONS GENERALLY CONFORM TO THE LATEST GUIDELINES (Reference 9), WHERE ANALYSES ARE PERFORMED FOR 'MEAN' AND 'MEAN ± SEM' CONDITIONS.

OTHER FACTORS OF INTEREST ARE PRESENTED ON THE NEXT PAGE.

- All radon barrier materials shall be compacted to at least 95 percent of the maximum dry density, as standard Proctor compaction (ASTM D-698). Kneading compaction shall be used
- The entire embankment shall be covered with at least 2 lifts of ~~Layer 3 material.~~ radon barrier material

REV. 3 H.L. 5/3/90 SHB 5/21/90

- The tailings material will be compacted to at least 90 of Standard Proctor, and the Ponds Area material to ~~100~~ 95 percent of Standard Proctor.

~~Our estimates indicate that at least 1-foot of Layer 3 material will be available. There appears to be no potential for shortfall of mine-borrow material for Layer 2~~

REV. 3 H.L. 2/2/90 SHB 5/21/90

APPROACH

The cornerstone of this analysis is the use of the RAECOM computer program (Reference 2). The RAECOM program offers a numerical solution to a diffusion equation for radon diffusion. The program requires the following input parameters. The input parameters and the values used are presented in the Sheet nos in parantheses,

- Ambient Radon Concentration (Sheet #5)
- Thicknesses of the various layers (Sheet #6)
- Dry density and porosity for each layer (Sheet #7)
- Avg. Ra-226 concentration for each layer (MKE Calc. No. 05-670-02-00)
- Radon emanation fraction for each layer (Sheet # 8 thru 13)
- Long-term moisture content for each layer (Sheet # 14 - 29)
- Radon diffusion coefficients for each layer corresponding to the long-term moisture content (Sheet #30-43)

The program outputs the exit fluxes and exit concentrations for the top of each layer. In addition, the program has the ability to determine by iteration, the required thickness of a particular layer if the exit concentration is specified for the topmost layer. Thereby, the EPA requirement of 20 pCi/m²/sec is easily input, and the required radon barrier thickness computed.

The program was run for the appropriate input parameters. several cases were run, to examine the sensitivity of the various parameters. The computer runs are presented in Appendix F. The results are discussed in Sheets 44 through 46. Assessment of the radon barrier, as presently designed from the standpoint of radon diffusion could thereby be made.

The Conclusions are presented on Sheet 4.

DATA BASE

The data base utilized in the present analyses, are all included in the Appendices, as discussed below.

Appendix A - Tailings Pile Geometry and Summary of Soil Properties (other than Capillary Moisture and Diffusion test results)

Appendix B - Test Data on Potential Radon Barrier Materials

Appendix C - Capillary moisture test results for ~~all materials~~ radon barrier materials

Appendix D - Radon Diffusion Coefficient test results for ~~all materials~~ radon barrier materials

REV. 3
H.L. 2/2/90
SMB 5/21/90

In general, the emphasis has been placed on the investigations in August, 1987 at Cheney Reservoir Disposal Site. The reasons for this are: (a) The area investigated was the area to be excavated, and (b) a large scale mixing was performed similar to that anticipated during field construction.

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Project UMTRA-GRJ
Feature Embankment Design
Item Radon Barrier

Contract No. 3885-34
Designed PS
Checked HL

Sheet 4
File No.
Date 11-19-90
Date 11-19-90

REV. 4

CONCLUSIONS AND RECOMMENDATIONS

1. A 2-ft thick radon barrier is adequate from the standpoint of radon emanation. This is borne out both by test results and SWRDAT analyses

2. At least 10 feet of Ponds Area (Vicinity Properties) material must be present directly below the radon barrier.

3. The 2-ft thick radon barrier will be adequate for Ra-226 concentrations in the VP material upto 150 pCi/g

4. Additional protection against radon emanation will be provided by the 2-ft of frost protection barrier of compacted Mancos Shale. This is not included in the analyses

Project UMTRA-GRJ
Feature Radon Barrier
Item Thickness
Contract No. 5025
Designed PS
Checked WYL
Sheet 5
File No.
Date 3/24/88
Date 4/5/88

AMBIENT RADON CONCENTRATION:

Section D.2.1.3 of the Draft RAP (Ref 1) reports an annual average radon concentration of 0.83 pCi/l in 1969, and 0.74 pCi/l in 1974 and 1975, for the Grand Junction area. Section E.2.2 of the same document reports measurements of Radon-222 concentrations (ambient) of 0.47 ± 0.06 pCi/l from September 20 through December 20, 1985, at the Cheney Reservoir Disposal Site.

A conservative value of 0.8 pCi/l has been employed in the analyses as the design value.

Project UMTRA-GRJ
Feature Radon Barrier
Item Thickness
Contract No. 5025
Designed PS
Checked WYL
Sheet 6
File No.
Date 3/29/88
Date 4/5/88

THICKNESS OF THE VARIOUS LAYERS

Presented on Sheets A-1 and A-2 in Appendix A, is the layout of the proposed tailings embankment. The pertinent layers for the present analysis are (from bottom up):

(a) Relocated Contaminated Materials from Main Tailings Pile Area (Tailings Material – Layer 1 in RAECOM)

(b) Relocated Contaminated Materials from Evaporation Ponds Area (Ponds Area Material – Layer 2 in RAECOM)

REV. 3 H.L. 2/2/90 SWS 5/21

(c) Radon Barrier (LAYER 3 IN RAECOM)

~~(i) Silty Clays from Foundation Layer 3 (Layer 3 in RAECOM)~~ REV. 3 2/2/90 H.L. SWS 5/21/90

~~(ii) Minus 1 inch fraction of Gravelly Soils from Foundation Layer 2 (Layer 4 in RAECOM).~~ REV. 3 H.L. 2/2/90 SWS 5/21/90

Sheet A-1 in Appendix A indicates a maximum thickness of around 40 feet (1220 cm) for the Tailings Material and 20 ft for the Pond Area Material. The geometry indicates a profound influence of this POND MATERI layer on the required thickness. This, coupled with the uncertainty of the total vicinity property material and the shrinkage factor (this material is compacted to ~~100~~ 95 percent compaction) prompts us to choose a conservative (low) thickness of 15 feet. The radon barrier thickness is discussed earlier. Therefore, the chosen design thicknesses are as follows

REV. 4
HL 11/15/90
PS 11-11-90

~~Layer 1 — 1220 cm (40 ft)~~
~~Layer 2 — 457 cm (15 ft)~~
~~Layer 3 — 30.5 cm (1.0 ft min.)~~
~~Layer 4 — 30.5 cm (1.0 ft max.)~~

REV. 3 2/2/90 H.L.
SEE Sheet 6A
SWS 5/21/90

MORRISON-KNUDSEN ENGINEERS, INC.
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Sheet 6A
Project UMTRA - GRJ
Contract No. 5025-16
File No.
Feature RADON BARRIER
Designed H.L.
Date 2-2-90
Item THICKNESS
Checked
Date 5/21/90

REVISION #3

The design thickness of various layers are :

Layer 1 : 1220 cm (40 feet)
(From Sh. A-1)

Layer 2 : 304.8 cm (10 feet)
(From Sh. A-1)

Layer 3 : 30.5 cm (1 foot MINIMUM)
(From Sh. A-1)

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA-GRJ
Feature Radon Barrier
Item Thickness

Contract No. 5025
Designed PS
Checked WYL

Sheet 7
File No.
Date 3/24/88
Date 4/5/88

DRY DENSITY AND POROSITY FOR EACH LAYER

Except for the top radon barrier layer, e.g. the minus 1-inch fraction for Layer 2 gravelly soils, the design dry densities and void ratios are presented in Sheet A-3 of Appendix A. The porosities are easily determined from the void ratios.

Thus,

Tailings Material (Layer 1)

$\gamma_d = 86.5 \text{ pcf} = \underline{1.39 \text{ gm/cm}^3}$

Void Ratio, $e = 0.970$

$\therefore$ Porosity, $p = \frac{e}{1+e} = \underline{0.492}$

Ponds Area Material (Layer 2)

$\gamma_d = \overset{111}{\cancel{116.8}} \text{ pcf} = \overset{1.78}{\cancel{1.87}} \text{ gm/cm}^3$

Void Ratio, $e = \overset{0.512}{\cancel{0.437}}$

$\therefore$ Porosity, $p = \overset{0.34}{\cancel{0.304}}$

REV. 4
HL 11/15/90
SWB 11.16.90

~~Foundation Layer 3 Silty Clays (Layer 3)~~

REV. 3
H.L. 2/2/90
SWB 5/21/90

$\gamma_d = 109.5 \text{ pcf} = 1.76 \text{ gm/cm}^3$

Void Ratio, $e = 0.555$

$\therefore$ Porosity, $p = \underline{0.356}$

Minus 1-inch Fraction from Foundation Layer 2 Gravelly Soils (Layer 4)

From Sheet B-2 of Appendix B, Average $(\gamma_d)_{max} = \frac{125.5+120.5+126.5}{3} = 124.2 \text{ pcf}$

$\therefore \gamma_d = 0.95 \times 124.2 = 118.0 \text{ pcf} = \underline{1.89 \text{ gm/cm}^3}$

$(G_s)_{ave} = \frac{2.78+2.83+2.81}{3} = 2.81$

$\therefore$ Void Ratio, $e = \frac{G_s \gamma_w}{\gamma_d} - 1 = \frac{2.81 \times 62.4}{118} - 1 = 0.486$; Porosity, $p = \underline{0.327}$

Project UMTRA-GRJ
Feature Radon Barrier
Item Thickness
Contract No. 5025
Designed PS
Checked WYL
Sheet 8
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Date 3/29/88
Date 4/5/88

AVERAGE RA-226 CONCENTRATIONS

Average Ra-226 concentrations are computed for the Tailings Material and the Ponds Area Material, in MKE Calc. No. 05-670-02-01 (Ref 8). They are as follows:

Main Pile Tailings - 570 pCi/g (Avg+SEm= 600 pCi/
Ponds Area Material - 66.5 pCi/g (Avg.+SEm= 81.0 pCi

These value have been used in the subsequent analyses.

The uncertainty in the value of the ponds area material is recognized in the calculation. Therefore, an analysis is also made to determine the maximum value of Ra-226 concentration of the ponds area material, which will still be satisfactory for the present radon barrier design (everything else remaining the same).

Determination
of
Radon Emanation Coefficients

Project UMTRA-GRJ
Feature Radon Barrier
Item Thickness
Contract No. 5025
Designed PS
Checked WYL
Sheet 7
File No.
Date 3/24/88
Date 4/5/88

EMANATING FRACTIONS

Emanating Fractions for Tailings Material

All available emanation fraction data are tabulated on Sheet 10, and plotted on Sheet 11. The plot indicates that there is no significant effect of moisture content on emanation fraction. A slight trend in lower emanation fractions for materials with Ra-226 concentrations of less than 200 pCi/g is noted. This, however, is based on very limited data base. Therefore, and since the average Ra-226 concentration is much higher, e.g. 570 pci/g, the value of 0.359 is chosen for design.

Mean = 0.359 Use 0.36

S = 0.045

PS 2/21/8
5/21/9

SEM = 0.008

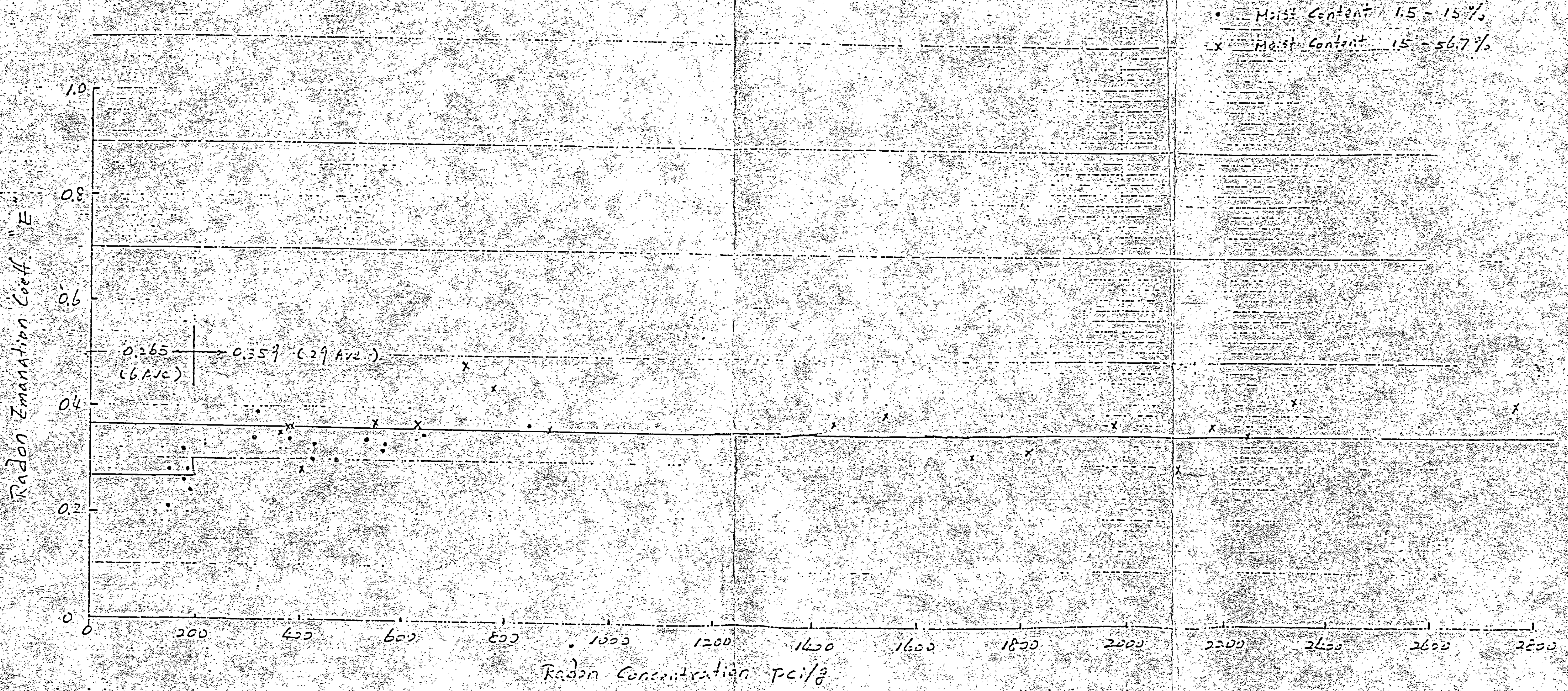
∴ Mean+SEM = 0.359 + 0.008 = 0.367 Use 0.37

[illegible]
WYL 2/11/87

Table B.6.5 Radon emanating fractions for uranium mill tailings: Grand Junction ck PS 2/25/57

Sample number	Moisture content (% dry wt.)	Radon emanating (fraction)	Ra-226 concentration (pCi/g)
GRJ-01-001 4-6'	3.7	0.32	181.0
GRJ-01-001 10-12'	3.8	0.26	181.0
GRJ-01-003 5.25-7.25'	1.5	0.22	191.0
GRJ-01-003 10-12'	3.1	0.28	156.0
GRJ-01-006 6-8'	5.0	0.33	438.0
GRJ-01-006 16-18'	6.9	0.39	322.0
GRJ-01-004 4-6'	3.0	0.21	149.0
GRJ-01-004 10-12'	5.7	0.28	184.0
GRJ-01-007 4-6'	7.2	0.33	572.0
GRJ-01-002 4-6'	8.9	0.34	535.0
GRJ-01-009 8-10'	11.4	0.37	852.0
GRJ-01-009 20-22'	42.1	0.37	635.0
GRJ-01-013 4-6'	35.3	0.36	387.0
GRJ-01-013 16-18'	40.8	0.37	551.0
GRJ-01-013 25-27'	37.4	0.28	404.0
GRJ-01-014 4-6'	28.8	0.36	890.0
GRJ-01-014 12-14'	56.7	0.36	2258.0
GRJ-01-014 14-16'	51.6	0.42	2775.0
GRJ-01-014 16-18'	53.7	0.30	2101.0
GRJ-01-012 4-6'	40.6	0.33	1620.0
GRJ-01-012 16-18'	7.2	0.30	427.0
GRJ-01-012 25-27'	41.2	0.43	2343.0
GRJ-01-011 8-10'	5.9	0.34	386.0
GRJ-01-011 20-22'	9.0	0.32	565.0
GRJ-01-005 4-6'	21.3	0.38	1442.0
GRJ-01-010 6-8'	50.5	0.32	1710.0
GRJ-01-010 16-18'	33.7	0.38	1985.0
GRJ-01-008 8-10'	4.6	0.34	317.0
GRJ-01-008 20-22'	8.1	0.35	644.0
GRJ-01-015 4-6'	15.9	0.35	366.0
GRJ-01-015 19-21'	9.1	0.30	478.0
GRJ-01-015 25-27'	39.0	0.48	725.0
GRJ-01-613 1-4'	42.8	0.44	779.0
GRJ-01-611 3.5-7'	36.5	0.36	380.0
GRJ-01-611 0.5-3'	21.2	0.40	1547.0
	Average	0.34	848.0
	n	35.0	35.0

UHTRA/GEJ
WJL 5/11/87
SGB 2/24/87



RADON AMANATION COEFFICIENT FOR TAILINGS MATERIALS

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA-GRJ
Feature Embankment Design
Item Radon Barrier

Contract No. 5025
Designed PS
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Sheet 12
File No.
Date 3/10/88
Date 4/5/88

Emanating Fractions for Ponds Area Materials

There are no specific measurements for emanation fraction for the ponds area materials in the Draft RAP (Ref 1). Therefore some emanation fraction measurements were made as part of the additional investigations. The new emanation fraction measurements are shown on the next sheet.

The sheet identifies the tailings, and the ponds area materials, (based on the borings they came from, which is also noted. The tailings emanation data are added to the earlier emanation data on Sheet 11. For the pond area materials,

$$\text{Average} = (0.41 + 0.25 + 0.28 + 0.43 + 0.37 + 0.34)/6$$
$$= 0.347$$

Use <u>0.35</u>

Standard Deviation = 0.071
SEM = 0.029
∴ Average + SEM = 0.347 + 0.029 = 0.376
<u>Use 0.38</u>

PS 2/21/89
SHB 2/24/89

PS 3/28/88
WYL 4/5/88

To: Jim Williams
From: Garth Stowe GS
Subject: Grand Junction Soil Radon Emanation Information

Information requested by Bob Heneks, MK-E San Fran regarding the radon emanation from the Grand Junction site characterization samples is presented to you.

The site location of the soil samples used for the radon emanation study was inadvertently not shown on the table presented to you on 9/8/87. The table is presented as follows with all the information requested by Mr. Heneks.

SAMPLE #	LOCATION	BH	WET WEIGHT (grams)		> 20 DAY	+ 8HR (pCi/g)	Radon Emanation
GJ-SS-296	N 59,600 E 35,300	29-G	565	Ponds Area	11.2	6.7	0.41
GJ-SS-495	N 59,500 E 35,700	33-F	530	"	13.6	10.2	0.25
GJ-SS-432	N 59,505 E 35,673	"	562	"	21.3	15.3	0.28
GJ-SS-496	N 59,500 E 35,700	"	381	"	21.6	12.4	0.43
GJ-SS-494	N 59,500 E 35,700	"	511	"	25.4	16.1	0.37
GJ-SS-025	N 59,350 E 32,660		573	Tailings Pile	155.5	127.5	0.18
GJ-SS-437	N 59,505 E 35,673	"	343	Ponds Area	172.3	113.9	0.34
GJ-SS-066	N 59,300 E 33,000		555	Tailings Pile	198.3	131.6	0.34
GJ-SS-016	N 59,500 E 32,627		587	"	255.8	[illegible]	0.59
GJ-SS-158	N 59,250 E 33,400		484	"	268.9	186.1	0.31
GJ-SS-277	N 59,200 E 33,800		597	"	285	184.4	0.36
GJ-SS-150	N 59,800 E 34,500		601	"	299.5	216.3	0.28
GJ-SS-067	N 59,300 E 33,000		574	"	348.6	209.2	0.40

cc: J.E. Purvis
H.R. Meyer

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SEP 28 1987
UMTRA-S.F.

Project ____________ Contract No. ________ Sheet ________
Feature ____________ Designed ________ File No. ________
Item ____________ Checked ________ Date ________
Date ________

Determination

of

Long Term Moisture Contents

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA-GRJ
Feature Radon Barrier
Item Thickness
Contract No. 5025
Designed PS
Checked WYL
Sheet 14
File No.
Date 3/25/88
Date 4/5/88

LONG-TERM MOISTURE CONTENTS FOR EACH LAYER

Long-term moisture contents are computed for the:

- Tailings Material (Sheet 15)
- Ponds Area Material (Sheets 16 - 21)
- Radon Barrier (Sheets 22 - 29)

The assessments are based primarily on capillary moisture tests. However, consideration is also given to empirical correlations, based on the soil gradation, clay activity, etc. Finally, in-situ moisture content is also considered, in the evaluation of long-term moisture content. The diffusion coefficients are determined subsequently, for the appropriate moisture contents.

REV. 3 2/2/90 H.L.
SAS 5/21/90

~~Since the capillary moisture tests are performed on the minus #4 fraction of a soil, the following assumption was made to account for the effect of the gravel fraction, wherever present. The moisture saturation fraction was the same for the whole soil and the minus #4 fraction. This assumption is valid if the gravels 'float' in the minus #4 fraction, and the specific gravities of the two fractions are equal, since the long-term moisture is primarily associated with the clay fraction. This assumption is particularly important for the top radon barrier layer (minus 1-inch fraction)~~

Summary of results is presented in the following page:

Sheet 14A
Project UMTRA - GRJ
Contract No. 5025-16
File No.
Feature EMBANKMENT DESIGN
Designed H.L.
Date 2-2-90
Item RADON BARRIER
Checked Sab
Date 5/21/90

REV. 3

SUMMARY OF MOISTURE CONTENTS FOR RAECOM

	MEAN	MEAN - SEM
LAYER 1	18.0 (From Sh. 15)	18.0 (From Sh. 15
LAYER 2	10.03 (From Sh. 18)	9.74 (Sh. 18
LAYER 3	14.7287 (TEST DATA, Sh. 35C)	14.3365 (TEST DATA, Sh. 35C)
	14.7941 (SWRDAT, Sh. 35E)	13.7918 (SWRDAT, Sh. 35E

Project UMTRA-GRJ
Feature Embankment Design
Item Radon Barrier
Contract No. 5025
File No.
Designed PS
Date 3/17/88
Checked WYL
Date 4/5/88

Long term Moisture Content for the tailings material

The tailings material will be at least 20 feet below the surface. Therefore, and since it is covered by 2 feet of radon barrier and 15 to 20 feet of relatively impermeable ponds area material, it is reasonable to assume that only a minimal amount of drying will take place. The design in-place moisture content is 22 pct (See Sheet A-3 of Appendix A). Therefore we assume a long-term moisture content of <u>18 pct</u>, e.g. 4 pct drying. This may be well justified by the moisture contents for sand-slime tailings in-situ (Sheet A-6 of Appendix A).

$\gamma_d = 86.5$; $G_s = 2.73$

$$\therefore m_r = \frac{0.18 \times 2.73}{\frac{2.73 \times 62.4}{86.5} - 1} = \underline{0.507}$$

Use $m_r = \underline{0.50}$

Note: This parameter is of very minor effect, as seen in the computer analyses, Run # 6 (See Sheet 45)

Project UMTRA-GRJ
Feature RADON BARRIER
Item THICKNESS
REV. 4

Contract No. 3885-34
Designed P.S.
Checked SLB

Sheet 13A
File No.
Date 11-14-90
Date 11-16-90

Additional Clarification for Use of Long-Term Moisture Parameters

The 22 percent initial moisture content is the optimum moisture content for the 'designated average material' as described in Sheet 26B of Reference 4. This material represents a tailings material for which 40 percent passes No. 200 sieve, e.g. a sand-slime. The specifications call for placement of the materials at or below optimum moisture content.

It is not expected that a lot of drying will take place, after the material is placed, as noted in the high in-place moisture contents in Sheet A-6 of Appendix A. Thus, the 18 pct. chosen, e.g. 4 percent drying is not unrealistic.

Also of note is the data obtained from Dan B. Stevens & Associates, which has been used in the Infiltration Analyses (Reference 10). The sand slimes in their analyses, e.g. Samples S-3, S-13, S-15, which are closest to this 'designated average material' (but somewhat coarser) have moisture contents ranging from 16 to 19 percent at 3-bar suction, and 14 to 17 percent at 15-bar suction (which is unlikely to occur). This is further justification for the 18 pct moisture content.

Finally, it should be stressed that an examination of Runs H and I indicates that the the influence of moisture content of the tailings layer is insignificant on the required thickness of the radon barrier (See Sheets F 7B AND F 7C)

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Project UMTRA-GRJ
Feature Embankment Design
Item Radon Barrier
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Designed PS
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Sheet 16
File No.
Date 3/10/88
Date 4/5/88

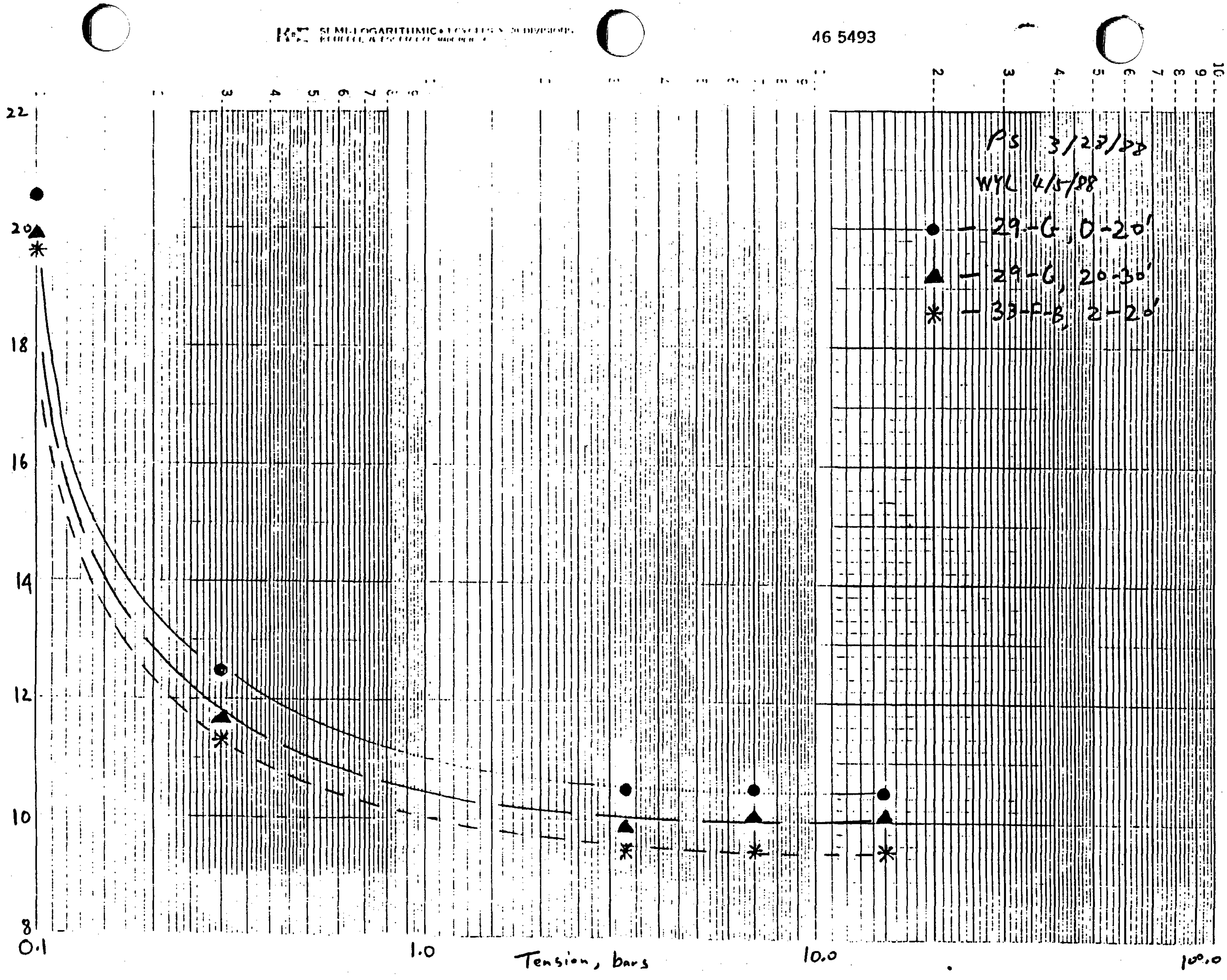
Long-term Moisture Contents on Ponds Area Materials

Since it was determined that the existing ponds area materials (which are predominantly vicinity property materials being continuously deposited on the ponds area) are distinctly different from the tailings from the main piles, additional tests were run on the ponds area materials to determine their long-term moisture contents. The results of the capillary moisture tests for long-term moisture content determinations are presented in Sheets C-1 and C-2. The results are plotted on Sheet 17. Moisture fractions corresponding to the 15-bar moisture test results for the 3 tests are calculated on Sheet 18. Calculated on Sheet 19 are the moisture fractions based on NUREG (Reference 6). The ~~values~~ are fairly close. An average value of $m_r = 0.46$ is deemed appropriate for use.

It should be noted here, that the ponds area materials will be compacted to at least a ~~100~~ 95 percent Standard Proctor, whereas the samples tested ranged from 91 to 93 percent. Test results on a large number of samples indicate only a minor influence of degree of compaction on long-term moisture content (See Reference 5). The SWRDAT runs on radon barrier material (see Appendix E) bear out the same contention. The average $W_{15\text{ bar}}$ from the tests is 10.03 and from NUREG is 9.68. Thus, the test results appear justified.

∴ From next page, $W'_{mean} = 10.03$ pct

$W'_{mean-SEM} = 9.74$ pct



K&E SEMI-LOGARITHMIC
46 5493
PS 3/28/88
WYL 4/5/88
● — 29-G, 0-20'
▲ — 29-G, 20-30'
✳ — 33-F-8, 2-20'
22
20
18
16
14
12
10
8
0.1
1.0
10.0
100.0
Tension, bars

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Project UMTRA-GRJ
Feature Embankment Design
Item Radon Barrier
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Checked WYL
Sheet 18
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Date 3/11/88
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REV. 5
H.L 12/12/90
chk P.S. 12/20/90

BH 29-G (0-20')

γ_d = ~~105.6~~ 110.5 pcf ~~(test result)~~ (0.95×116.3 = 110.5)

γ_d = 116.3 (100 pct compaction)

G_s = 2.67

$W_{15\,bar}$ = 10.50 %

$$\therefore m = \frac{WG_s}{\frac{G_s\gamma_w}{\gamma_d} - 1} = \cancel{0.466}\ 0.552$$

m = 0.648

BH 29-G (20-30')

γ_d = ~~107.3~~ 112.0 ~~(test result)~~ (0.95×117.9 = 112 pcf)

γ_d = 117.9 (100 pct compaction

G_s = 2.68

$W_{15\,bar}$: 10.09 %

$$\therefore m = \frac{.1009 \times 2.68}{\frac{2.68 \times 62.4}{\cancel{107.3}\ 112} - 1} = \cancel{0.484}\ 0.548$$

m = 0.646

BH 33-F-B (0-20')

γ_d = ~~106.1~~ 110.4 ~~(test result)~~ (0.95×116.2 = 110.4 pcf)

γ_d = 116.2 (100 pct compaction)

G_s = 2.71

$W_{15\,bar}$: 9.50

$$\therefore m = \frac{0.0950 \times 2.71}{\frac{2.71 \times 62.4}{\cancel{106.1}\ 110.4} - 1} = \cancel{0.456}\ 0.484$$

m = 0.565

W_{mean} = 10.03
W_{mean} - sem = 10.03 - 0.29 = 9.74

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Sheet 19
Project UMTRA-GRJ
Contract No. 5025
File No.
Feature Embankment Design
Designed PS
Date 3/11/88
Item Radon Barrier
Checked WYL
Date 4/15/88

Correlations using NUREG (Ref. 6)

Equation: $\phi = 0.026 + 0.005x + 0.0158y$

where ϕ = predicted 15 bar soil-water retention value (cm^3/cm^3)

x = percent clay in soil (assumed percent finer than 0.002 mm)

y = percent organic matter in soil (assumed 0 ... conservative)

Moisture saturation fraction, $m_r = \phi / p$, where p = porosity

Sample ID	γ_d, pcf	G_s	p	Clay content total soil	Clay content $-\#4$	ϕ	m_r	w
29-G (0-20')	105.6	2.67	0.366	29	29	0.171	0.467	10.10
29-G (20-30')	107.3	2.68	0.358	19	28	0.166	0.464	9.65
33-F-B (0-20')	108.1	2.71	0.361	23	27	0.161	0.446	9.30
Avg		2.69	0.362				0.459	9.68

Notes:- The clay content for −#4 is used as x, since tests are performed on −#4 soil. The −#4 clay content is computed from the −.002 mm in Sheets 20 and 21, and corrected for the gravel content on Sheet C-1.

$$\left[w = \frac{m_r}{G_s}\left(\frac{p}{1-p}\right) \right]$$

CA-2-79

20

MKE - Grand Junction
PS 3/28/88
WYL 4/5/88

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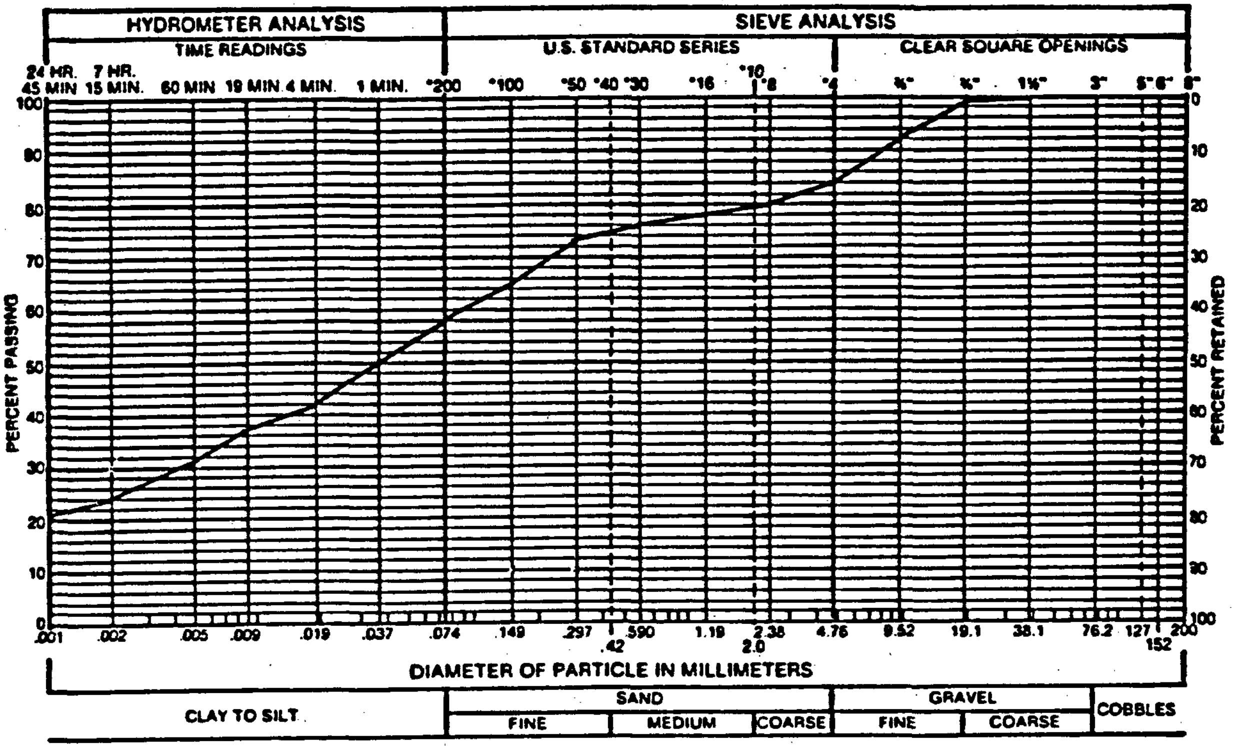
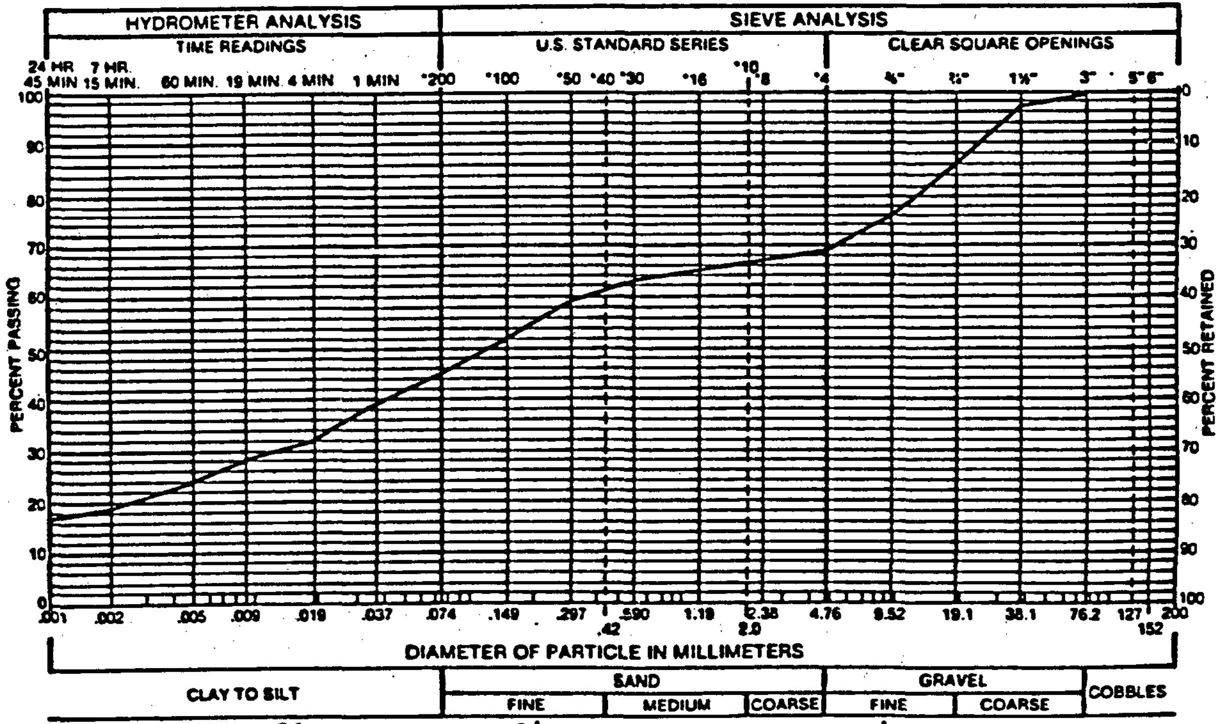


GRAVEL 16 % SAND 26 % SILT AND CLAY 58 %

LIQUID LIMIT 32 % PLASTICITY INDEX 18 %

SAMPLE OF Sandy lean clay with gravel FROM Hole BH6~~-29~~ at depth 0-20'
29-G



GRAVEL 31 % SAND 24 % SILT AND CLAY 45 %

LIQUID LIMIT 32 % PLASTICITY INDEX 18 %

SAMPLE OF Clayey gravel with sand FROM Hole BH6~~-29~~ at depth 20'-30'
29-G

1 343 87

GRADATION TEST RESULTS

Fig. 1

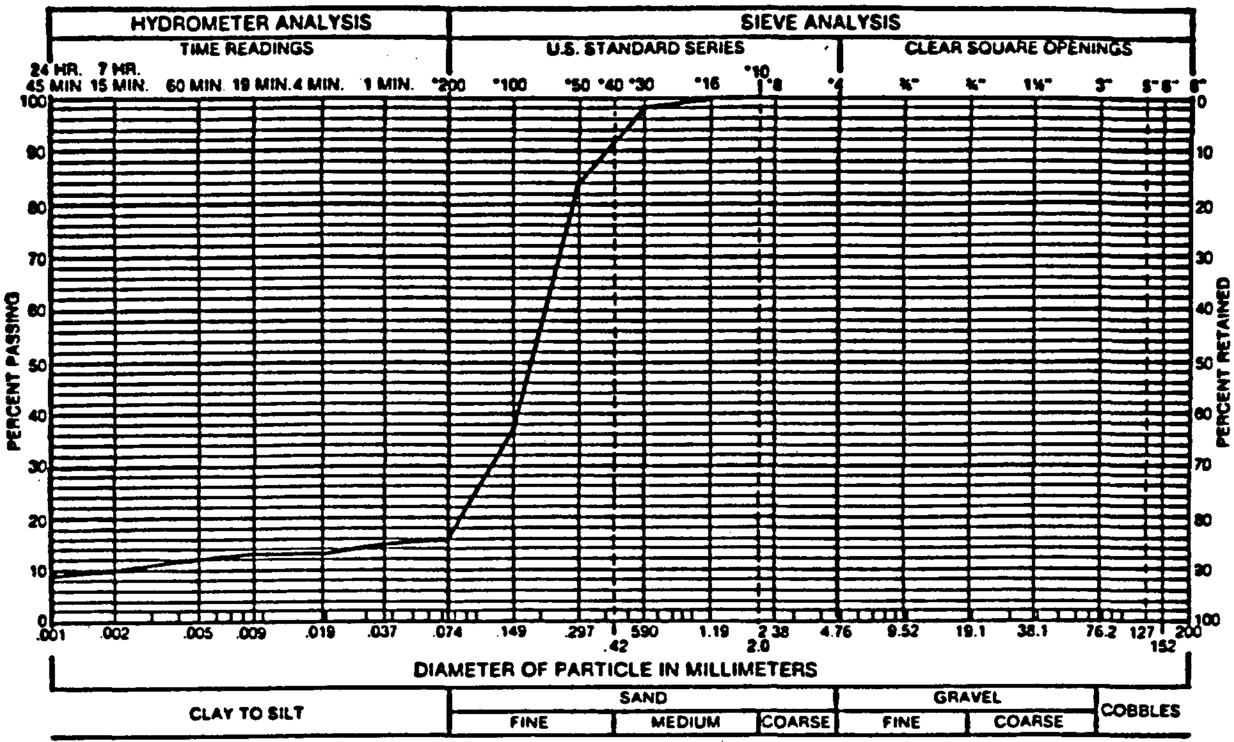
CA-2-79

MKE - Grand Junction 2

PS 3/23/88

WYL 4/5/88

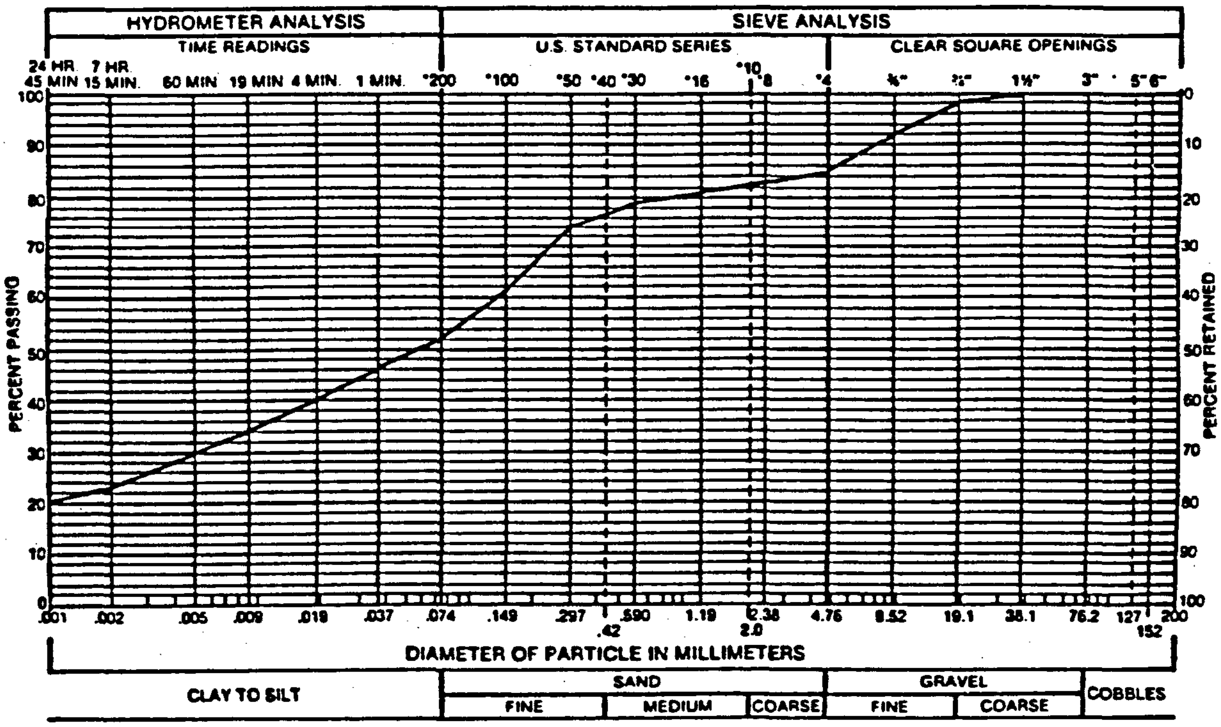
chen and associates, inc.



GRAVEL 0 % SAND 84 % SILT AND CLAY 16 %

LIQUID LIMIT % PLASTICITY INDEX Nonplastic

SAMPLE OF Silty sand FROM Hole 21J at depth 20'-45'



GRAVEL 15 % SAND 33 % SILT AND CLAY 52 %

LIQUID LIMIT 28 % PLASTICITY INDEX 15 %

SAMPLE OF Sandy lean clay with gravel FROM Hole 33F-B at depth 0-20'

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Sheet 22
Project UMTRA-GRJ
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File No.
Feature Radon Barrier
Designed PS
Date 3/23/88
Item Thickness
Checked WYL
Date 4/5/88

Long term Moisture Contents for Radon Barrier Materials

Long-term moisture contents for radon barrier materials were primarily based on the 15-bar tension values from the capillary moisture tests. The results of these tests are presented in Appendix C. The test results are plotted on Sheets 24 and 25, and are discussed on Sheet .

Additionally, two other empirical methods were used to compute the long-term moisture contents:

- NUREG Method (See Sheet 26 and 27)
- SWRDAT Computer Program (See Sheets 28 and 29)

REV. 3
2/2/90 H.L. GSS/28
SEE sheet 22A
chk PS 2/21
4/13 2/24

The results may be summarized as follows

	Long-Term Moisture Saturation Fraction			
Sample	Test	SWRDAT	NUREG	
~~TP-2 (16'-20')~~	~~.702 (13.28)~~	~~0.736 (13.89 pct)~~	~~.511~~	Foundation Layer 3 silty clays
~~TP-3 (15.5'-20')~~	~~.676 (12.82)~~	~~0.519 (9.77 pct)~~	~~.407~~	
~~TP-6 (15.5'-17')~~	~~.834 (18.22)~~	~~1.02 (22.14 pct)~~	~~.783~~	
~~TP-10 (13.5'-20.5')~~	~~.742 (15.57)~~	~~0.577 (11.83 pct)~~	~~.302~~	
~~TP-11 (18.5'-20')~~	~~.825 (18.39)~~	~~0.821 (18.02 pct)~~	~~.564~~	
~~LSS #1~~	~~0.644~~	~~0.300~~	~~0.249~~	-1-in. material from Layer 2 gravelly soils
~~LSS #2~~	~~0.698~~	~~0.402~~	~~0.270~~	
~~LSS #3~~	~~0.640~~	~~0.385~~	~~0.279~~	
~~LSS-X~~	~~0.737~~	~~0.360~~	~~0.304~~	LSS#1 + 5pct bentonite

The test results are GENERALLY higher than the other methods. However, the plots of the data on Sheets 24 and 25 do not reveal any reason to doubt the test results. The curves are generally smooth, and consistently decreasing with tension. Also, lower

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Sheet 22A
Project UMTRA - GRJ
Contract No. 5025-16
File No.
Feature RADON BARRIER
Designed H.L.
Date 2-2-90
Item THICKNESS
Checked SHB
Date 5-21-90

REVISION 3

The results of long-term moisture saturation fraction for radon barrier materials are summarized as follows:

SAMPLE	LONG-TERM MOISTURE SATURATION FRACTION		
	TEST (Sh. 35A	SWRDAT (Sh. 28B)	NUREG (Sh. 26)
TP-123	0.663	0.580	0. 331
TP-125	0.701	0.761	~~0.369~~ 0.608
TP-127	0.702	0.796	~~0.342~~ 0.532
TP-130	0.628	0.546	~~0.241~~ 0.396
TP-131	0.629	0.609	~~0.279~~ 0.438
TP-136	~~0.713~~ .732	0.784	~~0.398~~ 0.633

H.L. 11/2/90

SHB 11/2/90

SHB 5/21/90

REV. 4

Sheet 23
Project UMTRA - GRJ
Contract No. 5025
File No.
Feature Radon Barrier
Designed PS
Date 3/25/88
Item Thickness
Checked WYL
Date 4/5/88

values are generally noted in the test results for lower clay contents.

Mean & Mean - SEM Moisture Contents

	γ_d	G_s	Test Data		SWRPAJ	
			m_r	w	m_r	w
Layer 3 Clays	109.5	2.73	0.736 (1)	15.0	0.735	15.0
			0.709 (2)	14.4	0.645	13.1
-1-inch from Layer 2 w/o Bentonite	124.2	2.81	0.661	9.7	0.362	5.3
			0.642	9.4	0.330	4.8

REV. 3
See Sheet 23A
2/2/90 H.L.
SRS 5/27/90

$$w = \left(\frac{\gamma_w}{\gamma_d} - \frac{1}{G_s}\right) \times m_r \times 100$$

(1) Mean

(2) Mean - SEM

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Project UMTRA-GRJ
Feature RADON BARRIER
Item THICKNESS
Contract No. 5025-16
Designed H.L.
Checked LDG
Sheet 23A
File No.
Date 2-2-90
Date 5-22-91

REVISION 3

MEAN AND MEAN-SEM MOISTURE CONTENTS

	$\overline{\gamma}_D$ (PCF)	$\overline{G}_s$	TEST DATA		SWRDAT	
			m_r	w	m_r	w
LAYER 3 – RADON BARRIER	107.9	2.774	0.676 (1)	14.72869 (1)	0.679 (1)	14.79405 (1)
			0.658 (2)	14.33650 (2)	0.633 (2)	13.79180 (2)

(1) MEAN

$\overline{\gamma}_D$ from sh. C-4

$\overline{G}_s$ from sh. C-3

Test Data

$m_r = 0.676$ (from sh. 35B)

$W = 14.72869$ (from sh. 35C)

SWRDAT

$m_r = 0.679$ (from Sh. 35D)

$W = 14.79405$ (from Sh. 35E)

(2) MEAN – SEM

Test data

$m_r = 0.658$ (from sh. 35B)

$W = 14.33650$ (from sh. 35C)

SWRDAT

$m_r = 0.633$ (from Sh. 35D)

$W = 13.79180$ (from Sh. 35E)

K&E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
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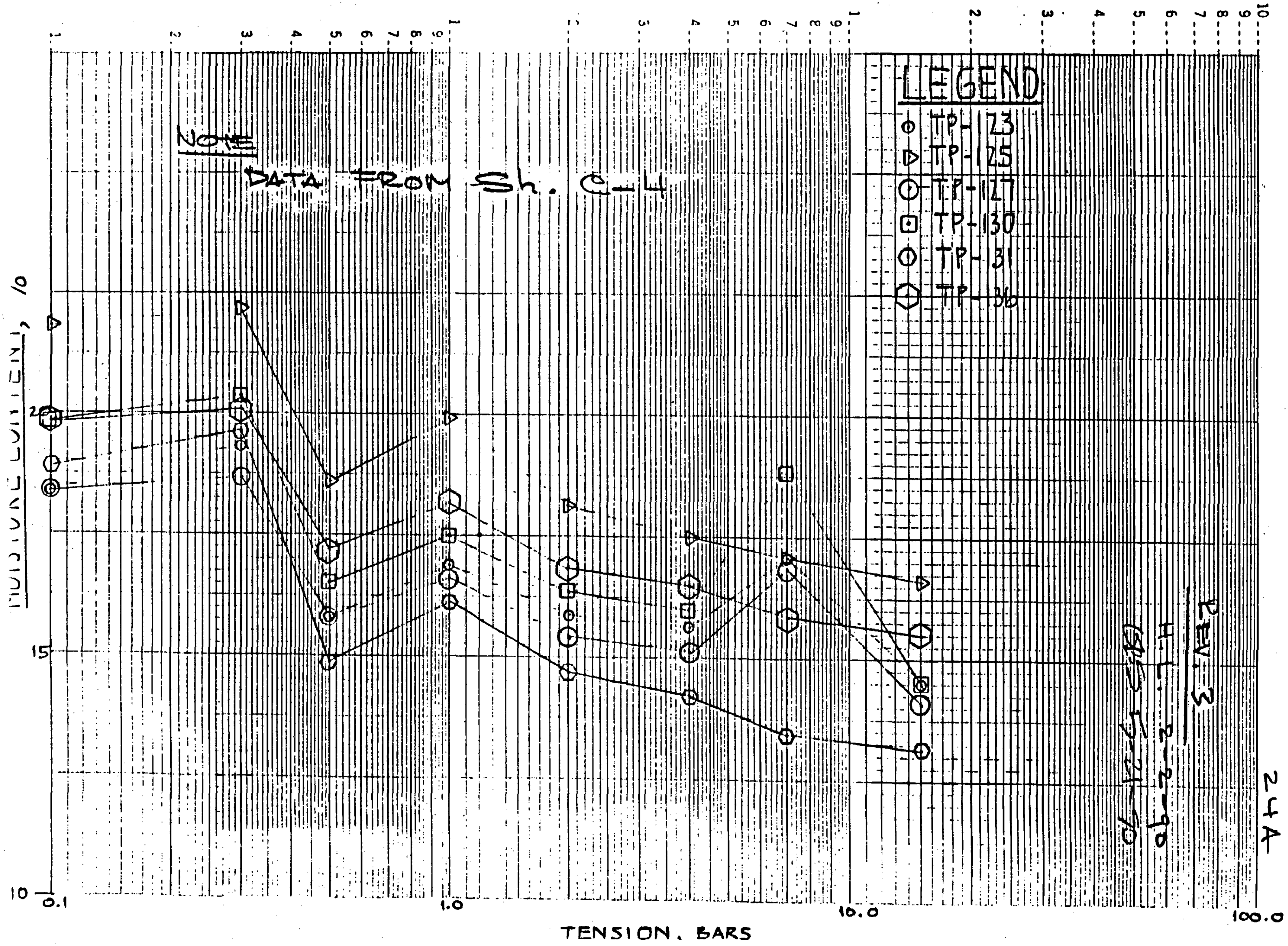
46 5493



NOTE
DATA FROM Sh. C-4

REV. 3
H.L. 2-2-90
[illegible] 5-29-90

24A

Project UMTRA-GRJ Contract No. 5025 Sheet ~~25~~ 2
Feature Radon Barrier Designed PS Date 3/25/88 File No.
Item Thickness Checked WYL Date 4/5/88

SWRDAT Analysis

The SWRDAT computer program (Ref 5) was developed by National Soil Survey Laboratory, based on the model equation between moisture content and suction developed by them. The required input includes grain size distribution, organic matter content and clay activity (defined by cation exchange capacity divided by percent clay). The grain-size distribution is as per SCS classification system. The model is based on data accumulated by NSSL over a period of several decades through which the empirical data is fitted. Output consists of moisture contents for 20 different suction values (including 15-bar). Results are provided for three levels of compaction.

SWRDAT runs were made for 9 soil samples. Input data are presented in Sheet 29. Outputs are presented in Appendix E. Output results are summarized on Sheet 29. As may be noted, the values for moderately high compaction have been used.

For the Layer 3 clays, a moderately high reactivity (Level 3 was used for all cases. This was deemed reasonable, since activity levels (Plasticity Index/percent less than 2μ) ranged from 0.41 to 0.70. The agreement with measured values is quite good. For the minus 1-inch fraction, even for high reactivity, the values are considerably less than measured values, possibly reflecting a limitation in the SWRDAT data base for the type of soils in question.

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Project UMTRA - GRJ
Feature EMBANKMENT DESIGN
Item RADON BARRIER
Contract No. 5025-16
Designed H.L.
Checked GKS
Sheet 26
File No.
Date 2-2-90
Date 5-21-90

REVISION 3

NUREG ANALYSIS (REF. 6, page 3-3)

$$\phi = 0.026 + 0.005x + 0.0158y$$ (See Formula Explanation on Sh. 25)

Data from Appendix B, Sh. B-3 to B-9

SAMPLE	% CLAY (X)	% ORGANIC (Y)	ϕ	n = POROSITY	$m_r = \frac{\phi}{n}$	W
#10 TP-123	19 (Sh. B-4)	0.25 (Sh. C-3)	0.125	0.378	0.331	7.22
#12 TP-125	42 (Sh. B-5)	0.25	0.240	0.396 ~~0.654~~	0.608 ~~0.367~~	14.35 ~~25.66~~
#15 TP-127	32 (Sh. B-6)	0.25	0.190	0.357 ~~0.356~~	0.532 ~~0.342~~	10.66 ~~15.45~~
#17 TP-130	25 (Sh. B-7)	0.25	0.155	0.391 ~~0.643~~	0.396 ~~0.241~~	9.19 ~~15.69~~
#19 TP-131	26 (Sh. B-8)	0.25	0.160	0.365 ~~0.574~~	0.438 ~~0.279~~	9.11 ~~13.61~~
#21 TP-136	41 (Sh. B-9)	0.25	0.235	0.371 ~~0.590~~	0.633 ~~0.398~~	13.39 ~~20.54~~
			AVERAGE =	0.376	0.490	10.65

HL 11/2/90
GKS 11/2/9

EXAMPLE: #10 TP-123

From Sh. C-3

$$e = \text{void ratio} = \frac{G_s \gamma_w}{\gamma_d} - 1 = \frac{(2.188)(62.4)}{108.1} - 1 = 0.609$$

From Sh. C-4

$$n = \text{porosity} = \frac{e}{1+e} = \frac{0.609}{1+0.609} = 0.378$$

$$m_r = \frac{\phi}{n} = \frac{0.125}{0.378} = 0.331$$

$$W = \frac{m_r}{G_s}\left(\frac{n}{1-n}\right) \times 100\% = \frac{0.331}{2.788}\left(\frac{0.378}{1-0.378}\right) \times 100\% = 7.22$$

NOTE: Use the above formula (Ex. #10, TP-123) for the rest of the samples.

REV. 4

NUREG (Ref. 6) Analysis

The reference presents a simple equation (see below) to compute the long-term moisture content.

Equation: $\phi = 0.026 + 0.005\,x + 0.0158\,y$

where ϕ = 15-bar soil-water retention value (cm^3/cm^3)

x = percent clay in soil (assumed percent-finer than 0.002 mm)

y = percent organic matter in soil

Moisture saturation fraction, $m_r = \phi/p$, where p = porosity

Moisture saturation factors for ~~8~~ 6 samples are computed and tabulated on the next sheet. The sheet also includes moisture saturations and moisture contents measured in capillary moisture tests at 15-bar tension.

REVISION 4 PS 11-15-90
HL 11-15-90

Rev. 5
PS 12/21/90
HL 12/21/90

The long term moisture contents calculated by this method (see next page) are generally ~~higher~~ LOWER than the long-term moisture contents measured (Sheet 28B) and those calculated by SWARDAT (Sheet 28B). The agreement between measured results and for SWARDAT are satisfactory.

The above equation was developed by Brakensiek in 1982. According to the Technical Assistance Document (Reference 10), this is more suited to sandy and silty material. In particular, it does not account for the activity levels of the clay (the clays here are generally moderately to highly active, as per Sheet 28A.

Therefore, the long-term moistures computed by this method have not been pursued further in these calculations.

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Sheet 28A
Project UMTRA-GRJ
Contract No. 5025-16
File No.
Feature EMBANKMENT DESIGN
Designed H.L.
Date 1-26-90
Item RADON BARRIER
Checked
Date 5-22-91

REVISION 3

SWRDAT INPUT
(REF. 5)

2 MM 0.05MM 0.002 MM → PARTICLE DIAMETER

SAMPLE	DEPTH	>2MM %WT	%VOL	SAND	SILT	CLAY	ORGANIC MATTER (sh. C-3)	CLAY ACTIVITY ↳FROM REF. 5
TP-123	14-23	26 ↳sh.B-4	16 ↳sh.28B	35	39	26	0.25	HIGH ④
TP-125	18-21	5 ↳sh.B-5	3	11	45	44	0.25	MOD. HIGH ③
TP-127	15-25.5	15 ↳sh.B-6	10	28	34	38	0.25	MOD HIGH ③
TP-130	10.5-14.5	1 ↳sh.B-7	1	42	32	25	0.25	HIGH ④
TP-131	17-25	4 ↳sh.B-8	3	40	33	27	0.25	HIGH ④
TP-136	10-17	2 ↳sh.B-9	1	15	43	42	0.25	LOW ①

EXAMPLE INPUT DATA EVALUATION

TP-123 (SH. B-4)

NOTE: FOLLOW THIS EXAMPLE COMPUTATION FOR THE OTHER SAMPLES.

FROM GRADATION TEST RESULTS (SH. B-4)

PARTICLE DIAMETER	PERCENT PASSING (% WEIGHT)
- >2MM	26
- SAND (2mm - 0.05mm)	26
- SILT (0.05 - 0.002)	29
- CLAY (< 0.002)	19

CONVERT TO % VOLUME

$$\% \text{ SAND, SILT, CLAY} = 100 - 26 = 74$$

$$\% \text{ SAND} = \frac{26}{74} \times 100\% = 35$$

$$\% \text{ SILT} = \frac{29}{74} \times 100\% = 39$$

$$\% \text{ CLAY} = \frac{19}{74} \times 100\% = 26$$

$$\text{TOTAL} = 100.$$

Project UMTRA - GRJ
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File No.
Feature EMBANKMENT DESIGN
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Date 1-26-9
Item RADON BARRIER
Checked
Date 5-2

REVISION 3

FOR ROCK FRAGMENT (% VOL, See Ref. 5)

$\gamma_{D.e}$ 108.1 pcf (CAPILLARY- MOISTURE TEST, Sh.C-4)

% WEIGHT = 26 → % WT, SEE PREVIOUS PAGE. FOR MATERIAL DIAMETER > 2 MM

$$\text{WEIGHT} = \frac{26}{100} \times 108.1$$

$$= 28.1 \text{ PCF}$$

$$\text{VOLUME} = \frac{\gamma_D}{\gamma_W\, G_S}$$

$$= \frac{28.1}{(62.4)(2.788)}$$

$$= 0.16$$

NOTE (FROM REF. 5)
CLAY ACTIVITY, 'A'

A = 0.15 (LOW: 1)
= 0.35 (MOD. LOW: 2)
= 0.55 (MOD. HIGH: 3)
= 0.75 (HIGH: 4)

% VOLUME = 0.16 × 100% = 16

$$\text{ORGANIC MATTER} = \overset{\text{SUMMARY TEST RESULTS (CAPILLARY-MOISTURE (Sh. C-3)}}{\text{ORGANIC CONTENT}} = \frac{(0.28+0.38+0.10)\%}{3} = 0.25\%$$

$$\text{CLAY ACTIVITY} = \frac{\overset{\text{CATION EXCHANGE CAPACITY}}{\text{CEC}}}{\%\text{CLAY}} = \frac{25.5}{26} = 0.98 \text{ (HIGH ④)}$$

From Sh. C-3

(SEE REF. 5)

COMPARISON OF SWRDAT OUTPUT VS LABORATORY TEST

SAMPLE	W- 15 BAR		m_r	
	SWRDAT	CAPILLARY-MOISTURE	SWRDAT	CAP-MOIST. From Sh. 35A
TP-123	12.68 See Sh. E-1	14.5 (Sh. C-4)	0.580 See Sh. 28C	0.663
TP-125	18.02 See Sh. E-2	16.6 (Sh. C-4)	0.761	0.701
TP-127	15.97 See Sh. E-3	14.1 (Sh. C-4)	0.796	0.702
TP-130	12.68 See Sh. E-4	14.6 (Sh. C-4)	0.546	0.628
TP-131	12.68 See Sh. E-5	13.1 (Sh. C-4)	0.609	0.629
TP-136	16.60 See Sh. E-6	15.5 (Sh. C-4)	0.784	.732 0.~~713~~

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Sheet 28C
Project UMTRA - GRJ
Contract No. 5025-16
File No.
Feature EMBANKMENT DESIGN
Designed H. L.
Date 1-29-90
Item RADON BARRIER
Checked
Date 5-22-9

REVISION 3

EXAMPLE INPUT DATA EVALUATION (FRACTION OF SATURATION FOR SWRDAT)

TP-123, FROM SWRDAT OUTPUT (Sh. E-1)

W-15BAR = 12.68 $\longrightarrow m_r = 10^{-2} M \left[\frac{1}{\rho_r} - \frac{1}{g_r}\right]^{-1}$

(see Ref. 2, p. 4-4)

in WHICH: m_r = fraction of saturation

g_r = specific gravity (g cm^{-3})

ρ_r = dry bulk density (g cm^{-3})

M = dry weight ~~percent~~ moisture (gram water/gram dry soil) × 10^2

$$m_r = 12.68 \times 10^{-2} \left[\frac{1}{1.732} - \frac{1}{2.788}\right]^{-1}$$

DATA TAKEN FROM CAPILLARY-MOISTURE TEST (Sh. C-3)

DATA TAKEN FROM CAPILLARY-MOISTURE TEST AFTER CONVERTED FROM $\frac{LB}{FT^3}$ TO $\frac{GRAM}{CM^3}$ (Sh. 35.4)

$m_r = 0.580 \longrightarrow$ Use this as m_r for SWRDAT (see previous Sh. 28B)

<u>NOTE</u>: Follow the above example to compute m_r for the rest of the samples on Sh. 28B. The original formula from Ref. 2, p. 4-4 does not have the subscript r, however, in this computation, the subscript r refers to the radon barrier.

Determination
of
Diffusion Coefficients

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Feature Radon Barrier
Item Thickness
Contract No. 5025
Designed PS
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Sheet 35 29
File No.
Date 3/25/88
Date 4/5/88

DIFFUSION COEFFICIENTS FOR EACH LAYER

Diffusion Coefficient test results are all presented in Appendix D. They are plotted and discussed as follows

- Tailings Material (Sheets 31 and 32) (Layer 1) in one
- Ponds Area Material (Sheets 33 thru 35) (Layer 2)

Radon Barrier { Sheets 36 thru 43 }
- Foundation Layer 3 Silty Clays (Layer 3)
- Minus 1-inch Fraction from Foundation Layer 2 Gravelly Soils (Layer 4)

Diffusion coefficient for each layer was determined for the appropriate long-term moisture contents.

Tests on diffusion coefficients were usually performed on minus #4 material. The same assumption is kept valid as in long-term moisture i.e. the long-term moisture saturation fraction is relatively independent of the gravel content. Thereby the effect of gravel content is not reflected in the chosen diffusion coefficient value. This is a conservative assumption, since, presence of gravels will only deter the flow of radon gas, if the gravels 'float' in the finer material.

Following is a summary of the results for RAECOM:

		Mean		Mean + SEM
Layer 1*	—	1.2×10^{-2}	cm²/sec.	1.2×10^{-2}
Layer 2*	—	1.0×10^{-2}		1.0×10^{-2}
~~Layer 3~~	~~—~~	~~1.18×10^{-3} (Test Data)~~		~~1.95×10^{-3} (Test Data)~~
		4.72×10^{-3} (SWRDAT)		7.40×10^{-3} (SWRDAT)
~~Layer 4~~		~~5.8×10^{-3} (Test Data)~~		~~6.6×10^{-3} (Test Data)~~
		1.97×10^{-2} (SWRDAT)		2.04×10^{-2} (SWRDAT)

REV. 3
N.L. 2/2/93
See Sh. 35C
and Sh. 35E
[illegible]

* For Layers 1 & 2, same values are used for Mean & Mean + SEM

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Feature Embankment Design
Item Radon Barrier

Contract No. 5025
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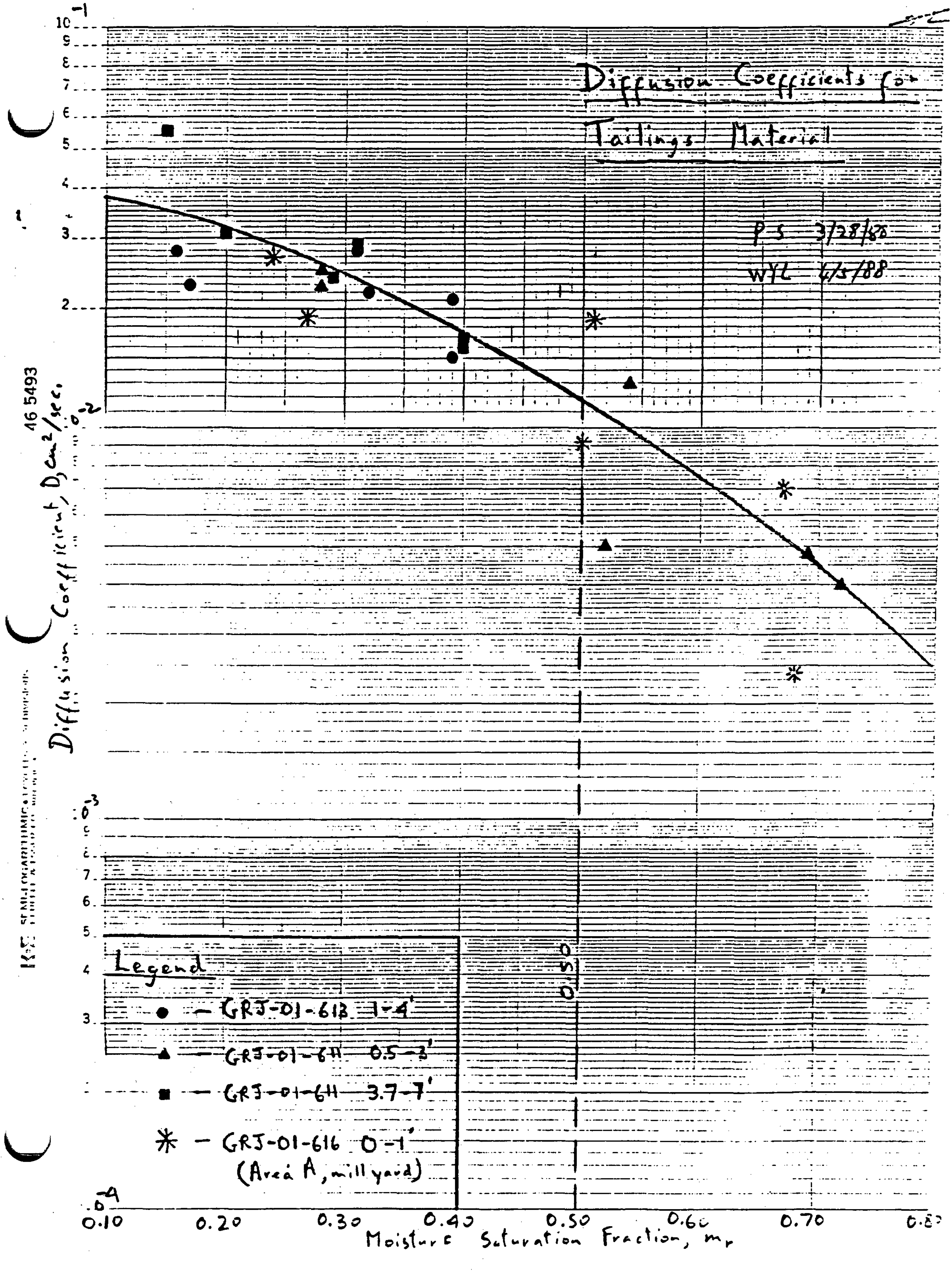
Sheet ~~27~~ 30
File No.
Date 3/17/88
Date 4/5/88

Diffusion Coefficients for Tailings Material

Diffusion coefficients for the main tailings, including mill yard tailings are plotted on the next sheet. The raw data are present in the Appendix (Sheets D-1 & D-2).

The diffusion coefficient corresponding to the long-term moisture saturation fraction of 0.50 is 1.2×10^{-2} cm²/sec.


Diffusion Coefficients for
Tailings Material
P.S. 3/28/88
WYL 4/5/88
Diffusion Coefficient, D, cm²/sec.
Moisture Saturation Fraction, m_r
10^{-1}
9
8
7
6
5
4
3
2
10^{-2}
10^{-3}
9
8
7
6
5
4
3
10^{-4}
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.50
Legend
● – GRJ-01-613 1-4'
▲ – GRJ-01-611 0.5-3'
■ – GRJ-01-611 3.7-7'
✳ – GRJ-01-616 0-1'
(Area A, mill yard)
46 5493
K&E SEMI-LOGARITHMIC

Project UMTRA-GRJ
Feature Embankment Design
Item Radon Barrier
Contract No. 5025
Designed PS
Checked WYL
Sheet 33
File No.
Date 3/11/88
Date 4/5/88

Diffusion Coefficients for Ponds Area Materials

The diffusion coefficient results for the ponds area materials are plotted on Sheet 34. The data are from Sheets D-4 through D-6, and also in D-7 in Appendix D, and are summarized below.

Sample No.	Porosity	Degree of Saturation	Diffusion Coeff.
29-G, 0-20'	0.37	0.25	2.0×10^{-2} cm²/sec
	0.36	0.63	2.2×10^{-3}
	0.37	0.84	4.2×10^{-4}
29-G, 20-30'	0.37	0.43	1.5×10^{-2}
	0.38	0.60	1.2×10^{-3}
	0.37	0.83	2.0×10^{-4}
33-F-B, 2-20'	0.38	0.44	1.3×10^{-2}
	0.37	0.63	1.8×10^{-3}
	0.38	0.74	1.4×10^{-3}
GRJ-01-618 0-5' Pond 3	0.37	0.25	2.6×10^{-2}
	0.38	0.26	2.5×10^{-2}
	0.37	0.50	1.8×10^{-2}
	0.37	0.52	1.5×10^{-2}
	0.37	0.68	1.0×10^{-3}
	0.37	0.67	1.3×10^{-3}
GRJ-01-617 0-5' Ponds 1 and 2	0.43	0.26	2.4×10^{-2}
	0.45	0.31	4.3×10^{-2}
	0.44	0.52	1.7×10^{-2}
	0.44	0.51	1.2×10^{-2}
	0.43	0.67	2.9×10^{-3}
	0.43	0.70	4.8×10^{-3}

The first three samples were collected in March, 1987, when a significant amount of material from the vicinity properties (the material from vicinity properties will overwhelmingly dominate the ponds area materials) had been deposited. Also, these samples represent mixtures over 10 to 20 ft depths. For these reasons, the first three samples are deemed not representative, and therefore emphasized on.

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Item Radon Barrier
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Sheet ~~34~~ 35
File No.
Date 3/11/88
Date 4/5/88

Also presented on Sheet 35 is the empirical curve as per Reference 7. The points for the curve are calculated below:

Empirical Curve:

$$D = 0.07\, e^{-4(m_r - m_r p^2 + m_r^5)}$$

where D = diffusion coefficient in cm²/sec.
m_r = residual fraction of moisture saturation
p = porosity

Assuming p = 0.37

m_r	D
0.2	0.0350
0.4	0.0169
0.6	0.00646
0.8	0.00119

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HL 12/12/90
chk P.S 12/20/90

Diffusion Coefficients

Sample	m_r (1)	D (cm²/sec)
29-G (0-20')	0.552 ~~0.648~~	6.0×10^{-3} ~~1.9×10^{-3}~~
29-G (20-30')	0.548 ~~0.646~~	6.0×10^{-3} ~~1.9×10^{-3}~~
33-F-B (0-20')	0.484 ~~0.565~~	1.0×10^{-2} ~~4.9×10^{-3}~~

D_{mean} = 7.3×10^{-3} ~~2.9×10^{-3}~~
s^e = 2.3×10^{-3} ~~1.73×10^{-3}~~
SEM = 1.3×10^{-3} ~~1.0×10^{-3}~~
Mean + SEM = 8.6×10^{-3} ~~3.9×10^{-3}~~

(1) m_r from Sheet 18

However, due to the potential uncertainty of the actual material that will be placed, we will conservatively use $D = 1.0 \times 10^{-2}$ cm²/sec.

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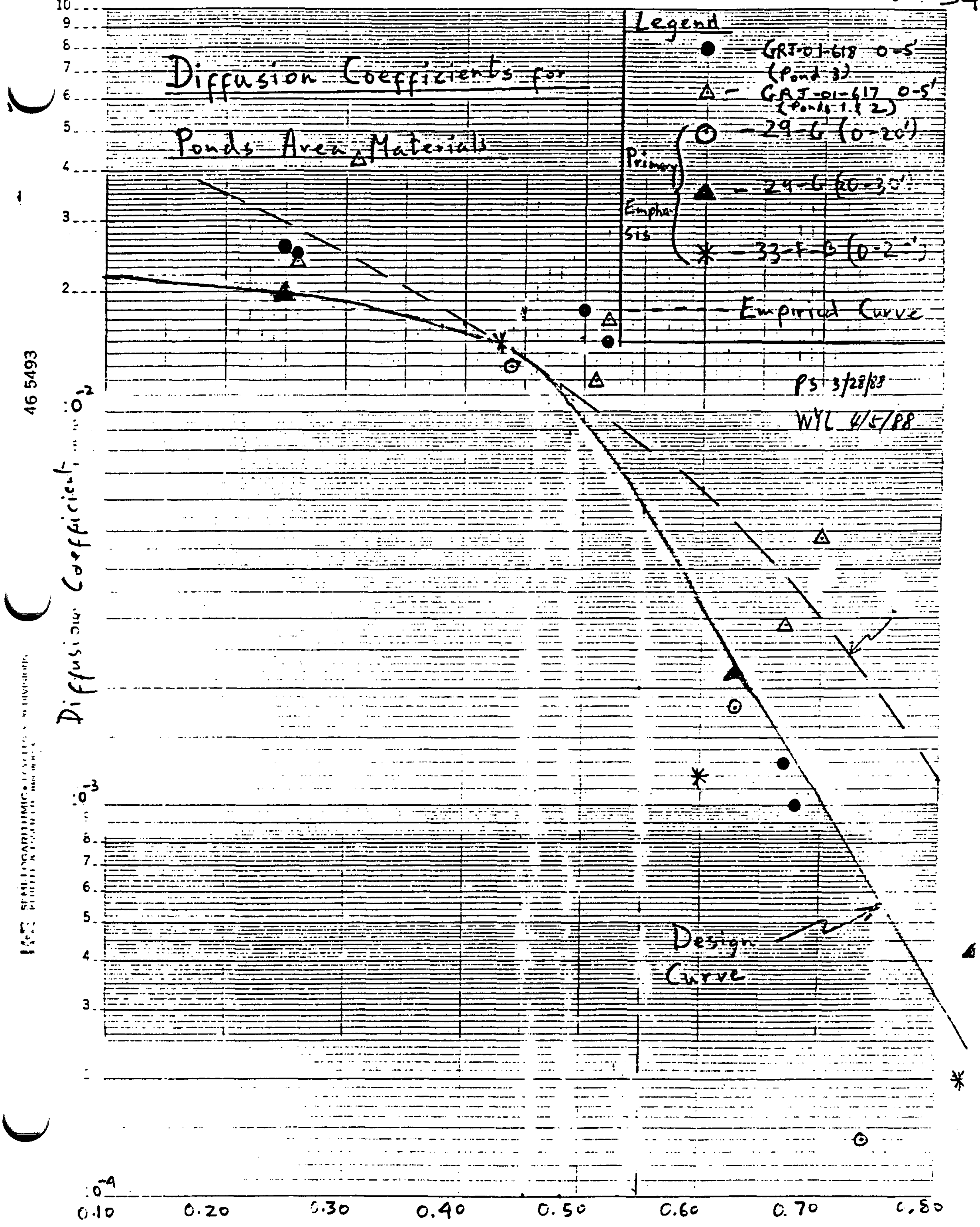
Project UMTRA - GRJ
Feature Embankment Design
Item Radon Barrier
Contract No. 3885-34
Designed P.S.
Checked GWB
Sheet 33A
File No.
Date 11-15-90
Date 11.16.90

REVISION 4

Additional Description of Vicinity Properties Material Type and Placemen

Vicinity properties materials consist of gravelly sandy clays to clayey sandy gravels, mixed in with approximately 15 percent of rubble, primarily concrete (Garth Stowe, CNSI, in telephone conversation, 11-15-90) The test data on long-term moisture contents and diffusion coefficients reported herein are on the soils portion, and perform in 1987. Subsequently, additional gradation tests have been perform on the material in 1990 (see Sheets 73 and 73A in Reference 4). The soils are reasonably similar to the above. Therefore, the diffusion coefficient value of 0.01 cm²/sec should be a good conservative value.

The specifications require that the Vicinity properties material shall be placed at 95 percent standard compaction (ASTM D-698), and shall be compacted dry of optimum moisture content. The specifications require that all demolition debris be broken to be no greater than 10 feet long and not greater than 27 cubic feet in volume. The disposal of this material shall be done evenly in the tailings embankment to avoid nesting and to minimize volume of voids created by the disposal.


Diffusion Coefficients for
Ponds Area Materials
Legend
● – GRJ-01-618 0-5' (Pond 3)
△ – GRJ-01-617 0-5' (Ponds 1 & 2)
⊙ – 29-G (0-20')
▲ – 29-G (20-35')
✱ – 33-F-B (0-2')
Primary Emphasis
– – – – Empirical Curve
PS 3/28/88
WYL 4/5/88
Design Curve
Diffusion Coefficient
10^-1
9
8
7
6
5
4
3
2
10^-2
10^-3
8
7
6
5
4
3
10^-4
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
46 5493

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Project UMTRA - GPJ | Contract No. 5025-16 | Sheet 35A
File No.
Feature EMBANKMENT DESIGN | Designed H.L. | Date 1-29-90
Item RADON BARRIER | Checked | Date 5-22-9

REVISION 3

1 pcf = 1.602×10^{-2} g/c

INPUT DATA FOR RAECOM PROGRAM

(Fraction of saturation is based on 15 bars suction pres

RADON BARRIER MATERIAL

Fraction of saturation is computed by the following equation:

$$m_r = 10^{-2} M \left[\frac{1}{\rho_r} - \frac{1}{g_r} \right]^{-1}$$ (From Ref. 2, p. 4-4)

where

m_r = fraction of saturation

ρ_r = dry bulk density ($g\ cm^{-3}$)

g_r = specific gravity ($g\ cm^{-3}$)

M = dry weight percent moisture (gram water / gram dry soil)

SAMPLE	W-15 BAR (See Sh. C-4)	ρ_r (From Sh. C-4) CONVERT PCF → gr/cc	g_s From Sh. C-3	m_r
#10 TP-123	14.5	108.1×1.602E-2 = 1.732	2.788	0.663
#12 TP-125	16.6	1.672 gr/cc	2.768	0.701
#15 TP-127	14.1	1.781 gr/cc	2.772	0.702
#17 TP-130	14.6	1.684 gr/cc	2.767	0.628
#19 TP-131	13.1	1.754 gr/cc	2.762	0.629
#21 TP-136	15.5	1.753 gr/cc	2.788	0.732
	AVE. =	1.729 gr/cc	2.774	

DATA FROM APPENDIX C, Sh. C-4

MORRISON-KNUDSEN ENGINEERS, INC.
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Sheet 35B
Project UMTRA-GRJ
Contract No. 5025-16
File No.
Feature EMBANKMENT DESIGN
Designed H.L.
Date 1-29-9
Item RADON BARRIER
Checked
Date 6-22-9

REVISION 3

Radon Diffusion Coefficients were obtained by plotting m_r on Fraction of Saturation vs Radon Diffusion Coefficient Graph of Radon Diffusion Test Results (Graph is on Sheet 37). NOTE: D taken within the envelope of test results curves on sh. 37.

SAMPLE	m_r (PLOT TO GRAPH ON Sh. 37)		D (OBTAIN FROM GRAPH on Sh. 37)
TP-123	0.663	from sh. 35-A (for 15 bars Suction pressure Test Data)	2.6×10^{-3}
TP-125	0.701		1.6×10^{-3}
TP-127	0.702		1.5×10^{-3}
TP-130	0.628		4.1×10^{-3}
TP-131	0.629		7.4×10^{-3}
TP-136	0.732		3.3×10^{-4}

~~Based~~ on the data above:

$\overline{m}_r = 0.676$

s_r = standard deviation = 0.043

$$SEM = \frac{s_r}{\sqrt{n}} = \frac{0.043}{\sqrt{6}} = 0.018$$

$\overline{m}_r - SEM = 0.676 - 0.018 = \underline{0.658}$

(Choose $\overline{m}_r - SEM$ as the worst case instead of $\overline{m}_r + SEM$)

$\overline{D} = 0.00292$

s_r = standard deviation = 0.00253

$$SEM = \frac{s_r}{\sqrt{n}} = \frac{0.00253}{\sqrt{6}} = 0.00103$$

$\overline{D} + SEM = 0.00292 + 0.00103$

$= \underline{0.00395}$ ($\overline{D} + SEM$ is the worst case)

Sheet 35c
Project UMTRA - GRJ
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Item RADON BARRIER
Checked
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REVISION 3

$$M = m_r \times 100 \times \left[\frac{1}{\bar{\rho}_r} - \frac{1}{\bar{g}_r} \right]$$ (From Ref. 2, p.4-4)

$\bar{\rho}_r = 1.729$ (From Sh. 35A)

$\bar{g}_r = 2.774$ (From Sh. 35A)

	m_r	$\bar{\rho}_r$	$\bar{g}_r$	M
($\bar{m}_r$)	0.676	1.729	2.774	14.72869
($\bar{m}_r$-SEM)	0.658	1.729	2.774	14.33650

	D	M
RUN Ⓐ → See Sh. F-1	0.00292 (MEAN) → Sh. 35B	14.72869 (MEAN)
RUN Ⓑ → See Sh. F-2	0.00395 (MEAN + SEM) → Sh. 35B	14.33650 (MEAN - SEM)

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Project UMTRA - GRJ
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Sheet 35D
File No.
Date 1-29-90
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REVISION 3

INTUT DATA FOR RAECOM PROGRAM

(Fraction of saturation is based on SWRDAT output from Sh. 28B)

RADON BARRIER MATERIAL

SAMPLE	m_r (PLOT TO GRAPH) (From sh. 28B)	D (OBTAIN FROM GRAPH on Sh. 37)
TP-123	0.580	8.4×10^{-3}
TP-125	0.761	3.6×10^{-4}
TP-127	0.796	2.8×10^{-4}
TP-130	0.546	8.2×10^{-3}
TP-131	0.609	4.8×10^{-3}
TP-136	0.784	2.0×10^{-4}

$\overline{m_r} = 0.679$

S_r = standard deviation = 0.113

$$SEM = \frac{S_r}{\sqrt{n}} = \frac{0.113}{\sqrt{6}} = 0.046$$

$\overline{m_r} - SEM = 0.679 - 0.046 = 0.633$

$\overline{D} = 0.00371$

S_r = Standard deviation = 0.00397

$$SEM = \frac{S_r}{\sqrt{n}} = \frac{0.00397}{\sqrt{6}} = 0.00162$$

$\overline{D} + SEM = 0.00371 + 0.00162$

$= 0.00533$

Project UMTRA - GRJ
Feature EMBANKMENT DESIGN
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File No.
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Checked GBS
Sheet 35E
Date 1-29-9
Date 5-22-

REVISION 3

$$M = m_r \times 100 \times \left[\frac{1}{\bar{\rho}_r} - \frac{1}{\bar{g}_r} \right].$$ (From Ref. 2, p. 4-4)

$\bar{\rho}_r = 1.729$ (From Sh. 35A)

$\bar{g}_r = 2.774$ (From Sh. 35A)

	m_r	$\bar{\rho}_r$	$\bar{g}_r$	M
$(\bar{m}_r)$	0.679	1.729	2.774	14.79405
$(\bar{m}_r - SEM)$	0.633	1.729	2.774	13.79180

	D	M
RUN Ⓒ ↳ See Sh. F-3	0.00371 (MEAN)	14.79405 (MEAN)
RUN Ⓓ ↳ See Sh. F-4	0.00533 (MEAN + SEM)	13.79180 (MEAN - SEM)

Additional runs were performed similar to run Ⓐ except:

RUN Ⓔ: Pond area thickness is equal to 152.4 cm (5 feet)
↳ See Sh. F-5

RUN Ⓕ: Ra - 226 concentration in pond area is ~~100~~ 150 pCi/gr
↳ See Sh. F-6

RUN Ⓖ: Pond area thickness is equal to 457.2 cm (15 feet)
↳ See Sh. F-7

Project UMTRA – GRJ
Feature EMBANKMENT DESIGN
Item RADON BARRIER

Sheet 36.
Contract No. 5025-16 File No.
Designed H. L. Date 2-5-90
Checked GP Date 5-22-90

REV. 3

CALCULATIONS FOR EMPIRICAL CURVE (As per Ref. 7)

Equation:

$$D = 0.07e^{-4(m_r - m_r n^2 + m_r^5)}$$ (Ref. 6, Eq. 6.3)

where:

D = diffusion coefficient in cm²/sec.

m_r = residual fraction of moisture saturation

p = porosity

RADON BARRIER MATERIAL

(Porosity data from Sh. 26)

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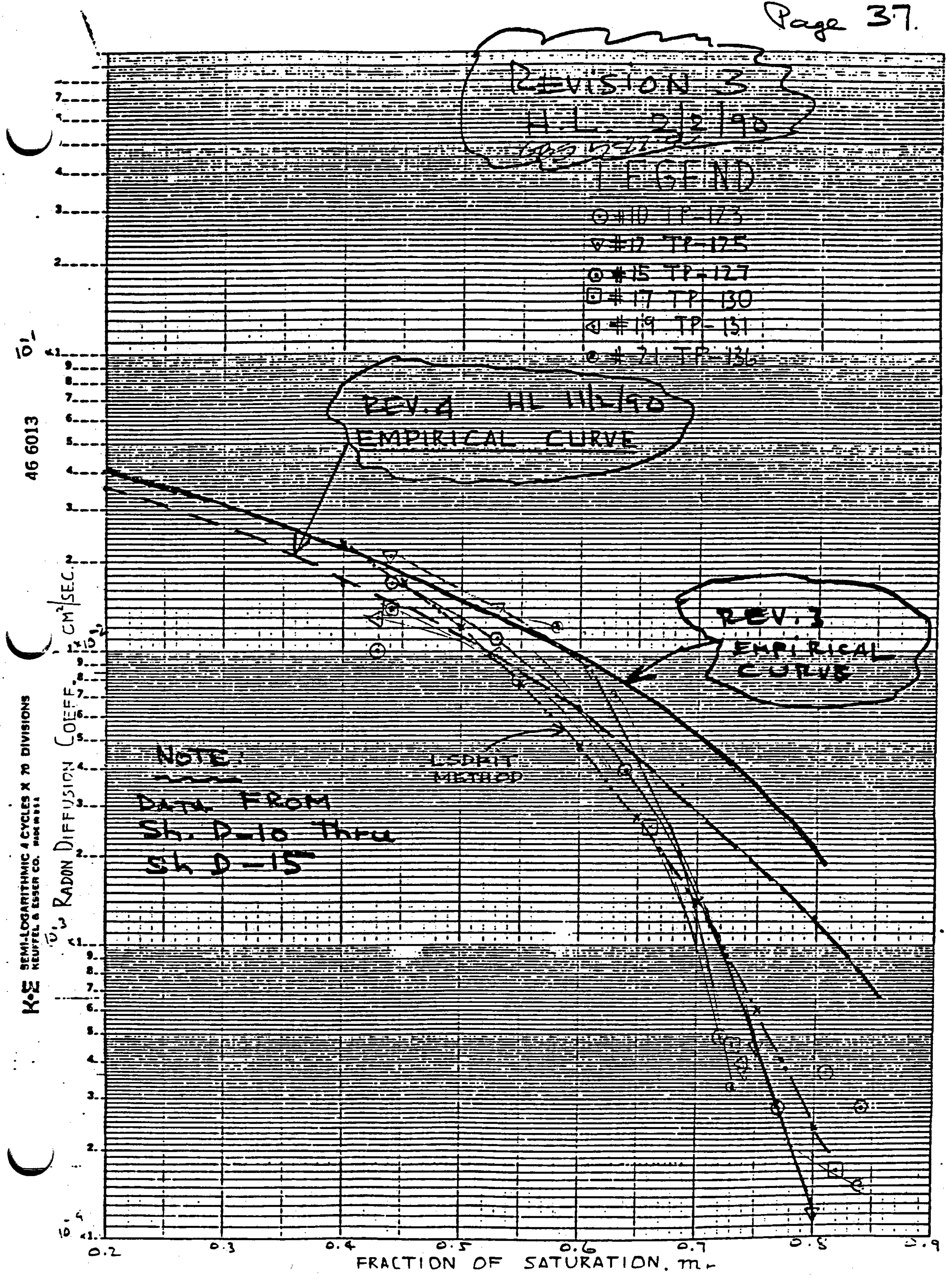
HL
11/2/90
GB 11 16·90

$$\bar{n} = \text{porosity average} = \frac{0.378 + \overset{0.396}{\cancel{0.654}} + \overset{0.357}{\cancel{0.356}} + \overset{0.391}{\cancel{0.643}} + \overset{0.365}{\cancel{0.574}} + \overset{0.371}{\cancel{0.590}}}{6}$$

$= \overset{0.376}{\cancel{0.566}}$

m_r	n	$-4(m_r - m_r n^2 + m_r^5)$	D (cm²/sec.)
0.2	0.376 ~~0.566~~	~~−0.545~~ −0.688	~~4.059×10⁻²~~ 3.51×10^{-2}
0.4	0.376 ~~0.566~~	~~−1.128~~ −1.415	~~2.266×10⁻²~~ 1.70×10^{-2}
0.6	0.376 ~~0.566~~	~~−1.942~~ −2.372	~~1.004×10⁻²~~ 6.53×10^{-3}
0.8	0.376 ~~0.566~~	~~−3.4855~~ −4.058	~~2.140×10⁻³~~ 1.21×10^{-3}

∴ The empirical curve for porosity equal to ~~0.566~~ 0.376 agrees reasonably with the data shown on sheet 37.
(See also Sheet 37A)


REVISION 3
H.L. 2/2/90
LEGEND
⊙ #10 TP-173
▽ #12 TP-175
⊚ #15 TP-127
⊡ #17 TP-130
◁ #19 TP-131
● #21 TP-136
REV. 4 HL 11/2/90
EMPIRICAL CURVE
REV. 3
EMPIRICAL CURVE
LSDFIT METHOD
NOTE:
DATA FROM
Sh. D-10 Thru
Sh D-15
10^{-1}
10^{-2}
10^{-4}
RADON DIFFUSION COEFF. CM²/SEC.
FRACTION OF SATURATION, m
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
K&E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 6013

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

Sheet 37A
Project UMTRA - GRJ
Contract No 3885-34
File No.
Feature EMBANKMENT DESIGN
Designed HL
Date 11|13|90
Item RADON BARRIER
Checked SLB
Date 11.15.90

REV. 4

RADON DIFFUSION COEFFICIENT VS DEGREE OF SATURATION CURVE

(BASED ON LSDFIT METHOD)

The least squares fit of the data points (Data Points obtained from Sh. D-10 -- D-15) for radon barrier material was plotted on page 37. The calculation was based on LSDFIT method, and presented on Sheet 37B through Sheet 37D.

The plot of LSDFIT method curve on Sheet 37 is essentially lower or concurrent with the test data. Therefore, diffusion coefficients based on the test data were used in the calculations

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Sheet 37B
Project UMTRA - GRJ
Contract No. 3885-34
File No.
Feature EMBANKMENT DESIGN
Designed H.L.
Date 11/13/90
Item RADON BARRIER
Checked SHB
Date 11·15·90

UMTRA - GRJ: DIFFUSION COEFFICIENT DETERMINATION (LSDFIT METHOD)

```
LEAST SQUARES FIT OF THE VALUES C1,C2,q and n TO DIFFUSION
COEFFICIENT vs MOISTURE SATURATION DATA ACCORDING TO :

              D = C1*EXP(-C2*(m*(1-P^2)+(m+(1-q))^n))

DATA FROM FILE: grj.FIT

UMTRA GRAND JUNCTION : RADON BARRIER DESIGN
LSDFIT FOR RADON BARRIER

MOIS          POROS.        DIFF.
SAT.                        COEFF
----          ------        -----
 .43           .37           .01
 .54           .37           .012
 .64           .38           .0039
 .72           .37           .00048
 .81           .37           .00027
 .44           .4            .021
 .53           .39           .014
 .61           .39           .0086
 .74           .39           .00037
 .75           .4            .00045
 .8            .4            .00012
 .44           .35           .017
 .53           .35           .011
 .64           .35           .004
 .77           .36           .00028
 .84           .35           .00028
 .44           .39           .014
 .55           .39           .0081
 .66           .39           .0025
 .73           .39           .00046
 .82           .39           .00017
 .43           .37           .013
 .53           .36           .0099
 .6            .36           .011
 .74           .37           .0004
 .84           .36           .00015
 .44           .37           .014
 .58           .38           .012
 .63           .37           .0071
 .73           .37           .00033
 .84           .37           .00015

RESULTS FOR INITIAL VALUE OF n = 4

C1 (NOMINALLY 0.07)               8.318333E-02
C2 (NOMINALLY 4.0)                1.663169
q = BREAKPOINT VALUE              .5625
n = DROPOFF VALUE                 4.875
RESIDUAL:                         8.255016
AVERAGE POROSITY:                 .3748387
```

MK-ENVIRONMENTAL SERVICES
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Sheet 37 c
Project UMTRA - GRJ
Contract No. 3885-34
File No.
Feature EMBANKMENT DESIGN
Designed HL
Date 11/13/90
Item RADON BARRIER
Checked SWB
Date 11·15·90

UMTRA-GRJ: DIFFUSION COEFFIENT DETERMINATION (LSDFIT METHOD)

```
LEAST SQUARES FIT OF THE VALUES C1,C2,q and n TO DIFFUSION
COEFFICIENT vs MOISTURE SATURATION DATA ACCORDING TO :

                    D = C1*EXP(-C2*(m*(1-P^2)+(m+(1-q))^n))

DATA FROM FILE: grj.FIT

UMTRA GRAND JUNCTION : RADON BARRIER DESIGN
LSDFIT FOR RADON BARRIER

MOIS          POROS.        DIFF.
SAT.                        COEFF
----          ------        -----
 .43           .37           .01
 .54           .37           .012
 .64           .38           .0039
 .72           .37           .00048
 .81           .37           .00027
 .44           .4            .021
 .53           .39           .014
 .61           .39           .0086
 .74           .39           .00037
 .75           .4            .00045
 .8            .4            .00012
 .44           .35           .017
 .53           .35           .011
 .64           .35           .004
 .77           .36           .00028
 .84           .35           .00028
 .44           .39           .014
 .55           .39           .0081
 .66           .39           .0025
 .73           .39           .00046
 .82           .39           .00017
 .43           .37           .013
 .53           .36           .0099
 .6            .36           .011
 .74           .37           .0004
 .84           .36           .00015
 .44           .37           .014
 .58           .38           .012
 .63           .37           .0071
 .73           .37           .00033
 .84           .37           .00015

RESULTS FOR INITIAL VALUE OF n = 7

C1 (NOMINALLY 0.07)             .1004747
C2 (NOMINALLY 4.0)              2.830276E-02
q = BREAKPOINT VALUE            -.35
n = DROPOFF VALUE               7
RESIDUAL:                       8.120545
AVERAGE POROSITY:               .3748387
```

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

Sheet 37D
Project UMTRA - GR J
Contract No. 3885-34
File No.
Feature EMBANKMENT DESIGN
Designed H.L.
Date 11/13/90
Item RADON BARRIER
Checked
Date 11.15.90

UMTRA - GRJ: DIFFUSION COEFFICIENT DETERMINATION (LSDFIT METHOD)

```
                    UMTRA-GRJ: MOISTURE SATURATION vs DIFFUSION COEFFICIENT
                                  USING LSDFIT METHOD


                         n=4                          n=7
              C1=      0.08318                      0.10047
              C2=      1.66317                      0.02830
              p=       0.37484                      0.37484
              q=       0.56250                     -0.35000
              n=       4.87500                      7.00000


   DEGREE OF        DIFFUSION                  DIFFUSION
   SATURATION       COEFF.                     COEFF.
                    (CM2/SEC.)                 (CM2/SEC.)

   ===================================================================

    0.00000         0.08076                     0.07973
    0.05000         0.07366                     0.07446
    0.10000         0.06651                     0.06845
    0.15000         0.05927                     0.06172
    0.20000         0.05193                     0.05442
    0.25000         0.04452                     0.04672
    0.30000         0.03716                     0.03887
    0.35000         0.03002                     0.03119
    0.40000         0.02330                     0.02399
    0.45000         0.01726                     0.01757
    0.50000         0.01209                     0.01217
    0.55000         0.00793                     0.00790
    0.60000         0.00482                     0.00476
    0.65000         0.00269                     0.00264
    0.70000         0.00135                     0.00133
    0.75000         0.00061                     0.00060
    0.80000         0.00024                     0.00024
    0.85000         0.00008                     0.00008
    0.90000         0.00002                     0.00003
    0.95000         0.00001                     0.00001
    1.00000         0.00000                     0.00000
```

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

Sheet 39
Project UMTRA-GRJ
Contract No. 3885-34
File No.
Feature Embankment Design
Designed HL
Date 11/19/90
Item Radon Barrier
Checked PS
Date 11-19-90

REV. 4

RAECOM OUTPUT SUMMARY

Ⓐ RAECOM OUTPUTS (From Sh. F-1 -- F7B)

The RAECOM outputs are summarized as follows:

RUN	TYPES OF RUN	TEST DATA OR SWRDAT	RADON BARRIER THICKNESS (LAYER 3)	REMARKS
Ⓐ	MEAN	TEST DATA	30 cm (1 foot)	Sh F-1
Ⓑ	MEAN ± SEM	TEST DATA	49 cm (1.6 feet)	Sh F-2
Ⓒ	MEAN	SWRDAT	36 cm (1.2 feet)	Sh F-3
Ⓓ	MEAN ± SEM	SWRDAT	62 cm (2 feet)	Sh F-4
Ⓔ	SAME AS RUN Ⓐ Layer ② = 152.4 cm	TEST DATA	42 cm (1.4 feet)	Sh F-5
Ⓕ	Same as Run Ⓐ Layer 2, Ra-226=150	TEST DATA	57 cm (1.8 feet)	Sh F-6
Ⓖ	Same as Run Ⓐ Layer 2 = 457.2 cm	TEST DATA	28 cm (0.9 feet)	Sh F-7
Ⓗ	Same as Run Ⓑ except Ra-226 = 800 in Layer 1	TEST DATA	50 cm (1.6 feet)	Sh F-7A
Ⓘ	Same as, Run Ⓑ except in Layer 1, D = 0.02, Ra = 800, and Layer 2 Moisture Content = 8%	TEST DATA	49 cm (1.6 feet)	Sh. F-7B

The radon barrier thickness should be based on "MEAN ± SEM" divided by 1.4 (Reference 9)

	Thickness Requirement
Run Ⓑ (Test Data)	$\frac{1.6}{1.4} = 1.1$ feet
Run Ⓓ (SWRDAT)	$\frac{2.0}{1.4} = 1.4$ feet

or the "MEAN", whichever is higher

Project ____ Contract No. ____ Sheet ____
Feature ____ Designed ____ File No. ____
Item ____ Checked ____ Date ____
Date ____

RAECOM

Computer

Runs

MORRISON-KNUDSEN ENGINEE 5, INC.
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Project UMTRA - GRJ
Feature EMBANKMENT DESIGN
Item RADON BARRIER
Contract No. 5025-16
Designed H. L.
Checked GBG
Sheet 38
File No.
Date 1-31-90
Date 5-27-90

REVISION ~~3~~ 4 HL 11/15/90
PS 11/19/90

RAECOM INPUT SUMMARY (Sheet F-1 thru F-7)

RUN	LAYER	MATERIAL DESCRIPTION	LAYER THICKNESS (CM)	DIFFUSION COEFFIENT (cm²/SEC)	POROSITY FRACTION	Ra-226 CONCENTRATION (pCi/gr)	EMANATING FRACTION	BULK DENSITY (gr/cm³)	MOISTURE % DRY WEIGHT From Sh. 14A	REMARKS
Ⓐ	1	TAILINGS	1220.0 ↳ sh. 6A	0.01200 ↳ sh. 30	0.492 ↳ sh. 7	570.0 ↳ sh. 8	0.36 ↳ See sh. 9	1.39 ↳ sh. 7	18.0000	MEAN AND TEST DATA
	2	POND AREA	304.8 ↳ sh. 6A	0.01000 ↳ sh. 33	~~0.304~~ 0.34 ↳ sh. 7	66.5 ↳ sh. 8	0.35 ↳ sh. 12	~~1.87~~ 1.78 ↳ sh. 7	10.0300	
	3	RADON BARRIER	30.5 ↳ sh. 6A	0.00292 ↳ sh. 35B	0.375 ↳ sh. D-10	0.0	0.00	1.73 ↳ sh. 35A	14.7287	
Ⓑ	1	TAILINGS	1220.0 ↳ sh. 6A	0.01200	0.492	600.0 ↳ sh. 8	0.37 ↳ See sh. 9	1.39	18.0000	MEAN ±SEM AND TEST DATA
	2	POND AREA	304.8 ↳ sh. 6A	0.01000	~~0.304~~ 0.34	81.0 ↳ sh. 8	0.38 ↳ sh. 12	~~1.87~~ 1.78	9.7400	
	3	RADON BARRIER	30.5 ↳ sh. 6A	0.00395 ↳ sh. 35B	0.375	0.0	0.00	1.73	14.3365	
Ⓒ	1	TAILINGS	1220.0 ↳ sh. 6A	0.01200	0.492	570.0	0.36	1.39	18.0000	MEAN AND SWRDAT
	2	POND AREA	304.8 ↳ sh. 6A	0.01000	~~0.304~~ 0.34	66.5	0.35	~~1.87~~ 1.78	10.0300	
	3	RADON BARRIER	30.5 ↳ sh. 6A	0.00371 ↳ sh. 35D	0.375	0.0	0.00	1.73	14.1941	
Ⓓ	1	TAILINGS	1220.0 ↳ sh. 6A	0.01200	0.492	600.0	0.37	1.39	18.0000	MEAN ±SEM AND SWRDAT
	2	POND AREA	304.8 ↳ sh. 6A	0.01000	~~0.304~~ 0.34	~~66.5~~ 81	0.38	~~1.87~~ 1.78	9.7400	
	3	RADON BARRIER	30.5 ↳ sh. 6A	0.00533 ↳ sh. 35D	0.375	0.0	0.00	1.73	13.7918	
Ⓔ	1	TAILINGS	1220.0 ↳ sh. 35E	0.01200	0.492	570.0	0.36	1.39	18.0000	SAME AS RUN Ⓐ, EXCEPT POND AREA THICKNESS IS EQUAL TO 152.4 cm OR 5-FEET.
	2	POND AREA	152.4 ↳ sh. 35E	0.01000	~~0.304~~ 0.34	66.5	0.35	~~1.87~~ 1.78	10.0300	
	3	RADON BARRIER	30.5 ↳ sh. 35E	0.00292 ↳ sh. 35B	0.375	0.0	0.00	1.73	14.7287	
Ⓕ	1	TAILINGS	1220.0 ↳ sh. 35E	0.01200	0.492	570.0	0.36	1.39	18.0000	SAME AS RUN Ⓐ, EXCEPT Ra-226 CONCENTRATION IN POND AREA IS 100 pCi/gr
	2	POND AREA	304.8 ↳ sh. 35E	0.01000	~~0.304~~ 0.34	150.0 ↳ sh. 35E	0.35	~~1.87~~ 1.78	10.0300	
	3	RADON BARRIER	30.5 ↳ sh. 35E	0.00292	0.375	0.0	0.00	1.73	14.7287	
Ⓖ	1	TAILINGS	1220.0 ↳ sh. 35E	0.01200	0.492	570.0	0.36	1.39	18.0000	SAME AS RUN Ⓐ, EXCEPT POND AREA THICKNESS IS EQUAL TO 457.2 cm OR 15-FEET.
	2	POND AREA	457.2 ↳ sh. 35E	0.01000	~~0.304~~ 0.34	66.5	0.35	~~1.87~~ 1.78	10.0300	
REV. 4	3	RADON BARRIER	30.5 ↳ sh. 35E	0.00292	0.375	0.0	0.00	1.73	14.7287	
Ⓗ	1	TAILINGS	THE SAME AS RUN Ⓑ	THE SAME AS RUN Ⓑ	THE SAME AS RUN Ⓑ	800	THE SAME AS RUN Ⓑ	THE SAME AS RUN Ⓑ	THE SAME AS RUN Ⓑ	THE SAME AS RUN Ⓑ
	2, 3	→ THE SAME AS RUN Ⓑ								
Ⓘ	1	TAILINGS	THE SAME AS RUN Ⓑ	0.02000	THE SAME AS RUN Ⓑ	800	THE SAME	THE SAME		THE SAME AS

Sheet 39
Project UMTRA-GRJ
Contract No. 3885-34
File No.
Feature Embankment Design
Designed HL
Date 11/19/90
Item Radon Barrier
Checked PS
Date 11-19-90

REV. 4

RAECOM OUTPUT SUMMARY

Ⓐ RAECOM OUTPUTS (From sh. F-1 -- F7B)

The RAECOM outputs are summarized as follows:

RUN	TYPES OF RUN	TEST DATA OR SWRDAT	RADON BARRIER THICKNESS (LAYER 3)	REMARKS
Ⓐ	MEAN	TEST DATA	30 cm (1 foot)	Sh F-1
Ⓑ	MEAN ± SEM	TEST DATA	49 cm (1.6 feet)	sh F-2
Ⓒ	MEAN	SWRDAT	36 cm (1.2 feet)	Sh F-3
Ⓓ	MEAN ± SEM	SWRDAT	62 cm (2 feet)	Sh F-4
Ⓔ	SAME AS RUN Ⓐ Layer ② = 152.4 cm	TEST DATA	42 cm (1.4 feet)	Sh F-5
Ⓕ	Same as Run Ⓐ Layer 2, Ra-226 = 150	TEST DATA	57 cm (1.8 feet)	Sh F-6
Ⓖ	Same as Run Ⓐ Layer 2 = 457.2 cm	TEST DATA	28 cm (0.9 feet)	Sh F-7
Ⓗ	Same as Run Ⓑ except Ra-226 = 800 in Layer 1	TEST DATA	50 cm (1.6 feet)	Sh F-7A
Ⓘ	Same as, Run Ⓑ except in Layer 1, D = 0.02, Ra = 800, and Long Term Moisture Content = 8%	TEST DATA	49 cm (1.6 feet)	Sh. F-7B

The radon barrier thickness should be based on "MEAN ± SEM" divided by 1.4 (Reference 9)

Thickness Requirement

Run Ⓑ (Test Data) $\frac{1.6}{1.4} = 1.1$ feet

Run Ⓓ (SWRDAT) $\frac{2.0}{1.4} = 1.4$ feet

or the "MEAN", whichever is higher

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Project UMTRA-GRJ
Feature Embankment Design
Item Radon Barrier
Contract No. 5025
Designed PS
Checked SWB
Sheet ~~46~~ 4.
File No.
Date 2-27-89
Date 2-27-89

The following observations may be made:

① In all cases, the 'mean ± SEm' run is less conservative, e.g., varies from the 'mean' run by over 40 percent. Therefore, design radon barrier values should be based on thickness of radon barrier as per 'mean ±SEm' divided by 1.4 (see Sheet 39)

② As is expected, SWRDAT-based runs indicate greater radon barrier thickness requirements

REV. 3
2/2/90 H.L
see sheet 40A
[illegible] 2-2-90

③ ~~Based on test data, a thickness of 0.66 ft~~ of Layer 3 only is sufficient (Run # 2 — 0.92/1.4 = 0.66)

④ Based on SWRDAT data, a thickness of 1.95 ft of Layer 3 only is sufficient (Run # 4 — 2.72/1.4 = 1.95)

⑤ Based on test data, with 1-ft thick layer #3 and 1-ft thick layer # 4, Ra-226 concentrations at least twice the design values are adequately controlled (See Runs 5 & 6)

⑥ If SWRDAT results are used, with 1-ft thick layer #3, we need 2.2 ft thick Layer 2 (see run #6 — 3.08/1.4 = 2.2). Thus, 1-ft of Layer 3 & 2.5 ft of Layer 2 on side slopes is okay.

⑦ The thickness of Layer 2, if reduced to 10 ft (such as can happen on the top-slope due to insufficient material, has only a small influence on the radon barrier thickness (Compare run nos 4 & 9).

⑧ As shown in Run 8A, the required thickness of Layer #1 is considerably reduced, if more realistic values of diffusion coefficient are used.

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA – GRJ
Feature EMBANKMENT DESIGN
Item RADON BARRIER
Contract No. 5025-16
Designed H.L.
Checked SBS
Sheet 40A
File No.
Date 2-6-90
Date 5-22-90

REVISION ~~3~~ 4

OBSERVATIONS

3. Based on test data, a thickness of ~~1.3~~ 1.1 feet radon barrier is sufficient.

4. Based on SWRDAT data, a thickness of ~~1.6~~ 1.4 feet radon barrier is sufficient.

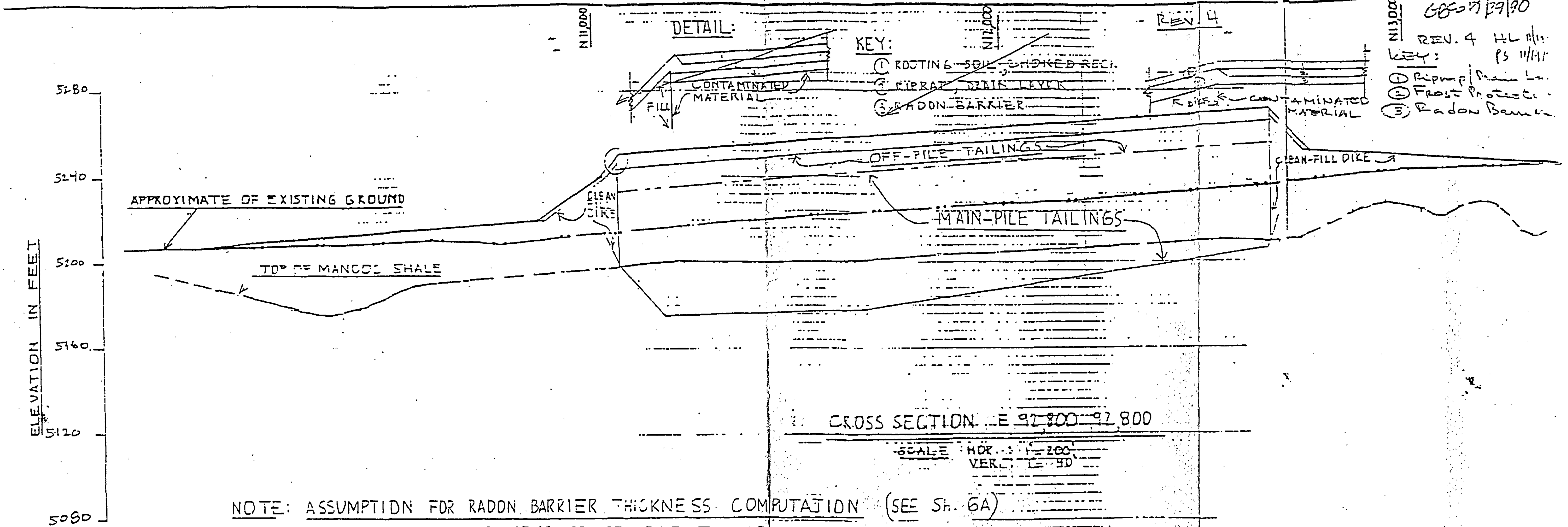
HL 11/16/90
SHB 11.16.90

Sheet ______
Project ______ Contract No. ______ File No. ______
Feature ______ Designed ______ Date ______
Item ______ Checked ______ Date ______

Appendix A

BASIC DATA

Sh. A — 1
H.L. 5-26-90
REV. 3



CROSS SECTION ~~E 92,800~~ 92,800

~~SCALE~~ HOR. : ~~1" = 200'~~
VERT. : 1" = 40'

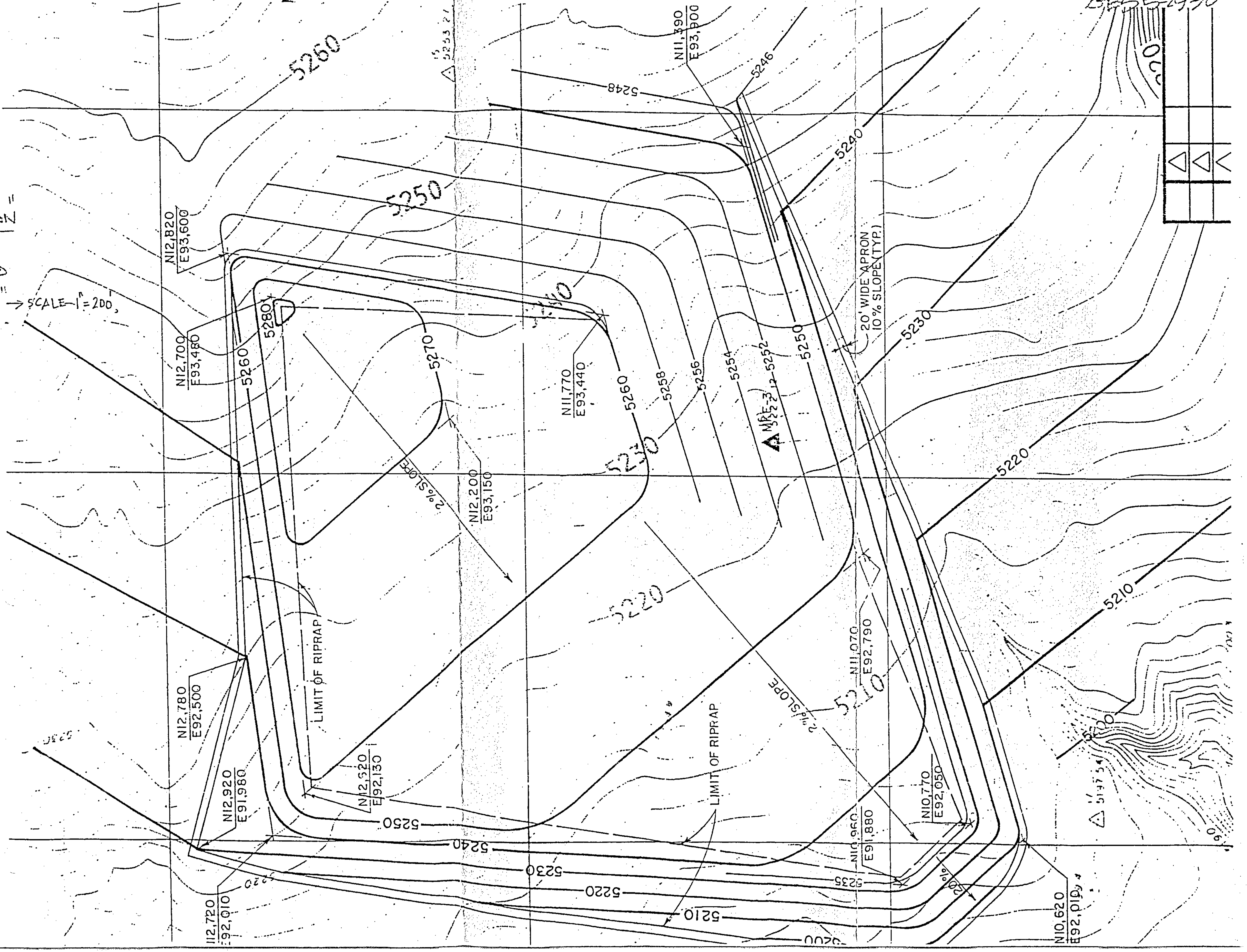
NOTE: ASSUMPTION FOR RADON BARRIER THICKNESS COMPUTATION (SEE Sh. 6A)

1. THE MINIMUM THICKNESS OF OFF-PILE TAILINGS IS 10 FEET
2. THE THICKNESS OF MAIN-PILE TAILINGS IS ESTIMATED TO APPROXIMATELY 40 FEET
3. THE MINIMUM THICKNESS OF RADON BARRIER IS 1 FOOT

PROJECT: UMTRA-GRJ
JOB NUMBER: 5025-16
DATE : APRIL 5, 1990

Sh. A-2
H.L. 5-19-90
REV. 3
GBG 5-23-90

NOTE: THIS IS A
FOTO-COPY OF
"FINAL GRADING PLAN"
DRAWING NO.
GRJ-DS-10-0220
(SOURCE SIZE: 22" x 34" → SCALE 1"=200',
REDUCED 77% TO
PAPER 11" x 17")



MK-F-GIT Settlement & Slope Stability PS. 1/1 A-3 ~~8~~ 3

REV 3
2/2/90 2-29-95
H.L. GDP

rev 3

From Ref 1

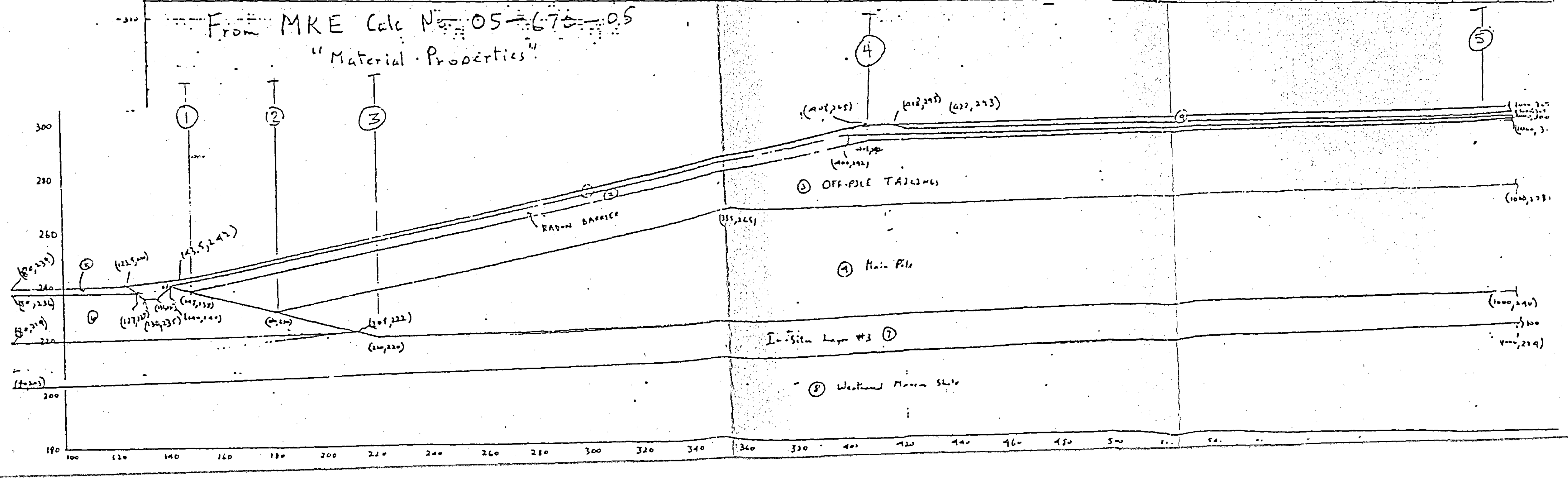
Summary of Design Parameters

ABY 9-20-88
[illegible] 10.25.88

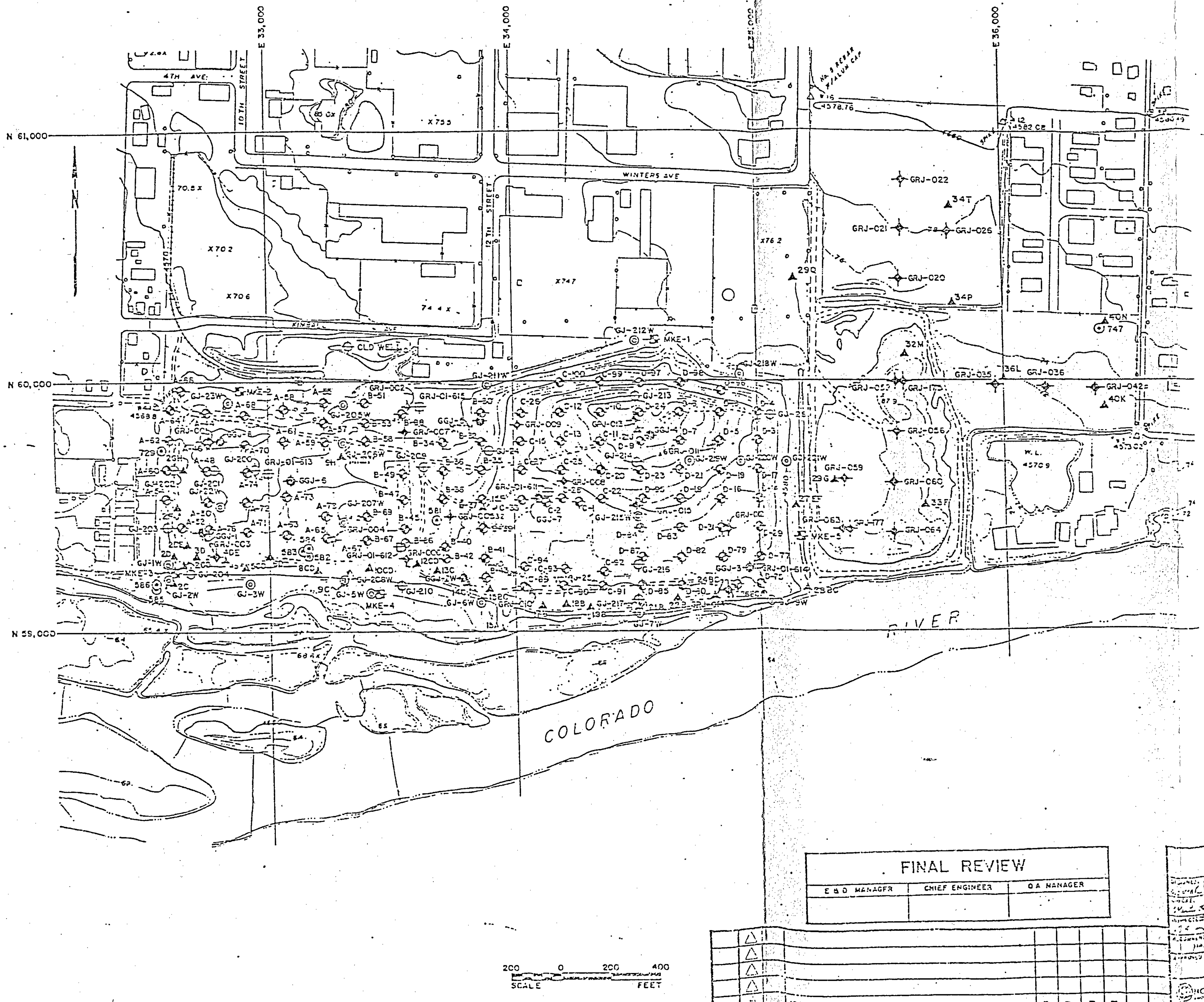
WYL 2/5/88

Layer No.	Description	In-place Dry Den. γ_d pcf	In-place Density/Moist. γ_t pcf	In-place Density/Moist. ω %	Saturated Density/Moist. γ_{sat} pcf	Saturated Density/Moist. ω_{sat} %	Short Term Static/Seismic C psf	Short Term Static/Seismic ϕ Degree	Long Term Static C psf	Long Term Static ϕ Degree	Long Term Seismic C psf	Long Term Seismic ϕ Degree	Consolidation P_p ksf	Consolidation C_v ft²/sec	Consolidation C_c	Consolidation C_r	Consolidation e	Permeab K cm/sec
1	Riprap Layer Including Bedding Layer	125.0	125.0	–	125.0	—	0	38°	0	38°	0	38°	—	—	—	—	—	—
2	Radon Barrier Cover Compacted To At Least 95% Standard Proctor (ASTM D-698) ~~with In-Situ Layer No. 1 Material~~	109.5 ~~102.9~~	~~125.1~~ ~~121.5~~	14.2 ~~12.1~~	131.7 ~~127.8~~	20.6 ~~24.2~~	890 Su = ~~655~~ psf		250	28°	890 Su = ~~655~~ psf		4.0 ~~6.0~~	2.8×10^{-5} ~~3.0×10^{-5}~~	0.178 ~~0.252~~	— ~~0.018~~	0.555 ~~0.665~~	2.2×10^{-6} ~~2.5×10^{-6}~~
3	Off-pile Tailings Materials Compacted To At Least 100% Standard Proctor (ASTM D-698)	116.8	131.3	12.4	135.8	16.2	Su = 800 psf		0	30°	Su = 800 psf		2.2	5.5×10^{-5}	0.230	0.007	0.437	2.0×10^{-6}
4	Main-Pile Tailings Materials Compacted To At Least 90% Standard Proctor (ASTM D-698)	86.5	105.5	22.0	117.2	35.5	0	25°	0	35°	0	25°	1.0	1.0×10^{-3}	0.200	0.020	0.970	7.0×10^{-5}
5	In-Situ Layer No. 1 (CL-ML)	85.4	95.0	12.0	115.4	32.0	Su = 500 psf		0	30°	Su = 500 psf		—	—	—	—	1.050	—
6	In-Situ Layer No. 2 (GM-SM)	121.5	130.0	7.0	142.0	9.3	0	35°	0	35°	0	35°	—	—	—	—	—	7.0×10^{-5}
7	In-Situ Layer No. 3 (CL) And Layer No. 4 (CL-GC)	107.4	116.1	8.1	130.0	23.0	Su = 1500 psf		0	28.8°	0	18.8°	6.0	2.3×10^{-5}	0.116	0.015	0.568	5.7×10^{-5} to 4.1×10^{-6}
8	In-Situ Layer No. 5 Weathered Mancos Shale	133.7	145.0	10.3	145.0	10.3	Su = 5000 psf		0	35°	Su = 5000 psf		—	—	—	—	0.283	Approx. 1×10^{-7}
9	ROOTING SOIL	84.9	95.0	12.0	–	–	Su = 250 psf		0	20°	Su = 250 psf		–	–	–	–	–	–

From MKE Calc No. 05-670-05
"Material Properties"



SH. 33
A-4



NOTES:

1. GROUND WATER DATA AND SUBSURFACE EXPLORATION LOGS ARE AVAILABLE FROM THE CONTRACTOR.
2. JACOBS MONITOR WELLS NUMBERED 581 THROUGH 586 CORRESPOND TO FIELD DESIGNATION GWGJ-1 THROUGH GWGJ-6 RESPECTIVELY.
3. EXISTING CONTOURS AND FEATURES SHOWN ARE THOSE WHICH EXISTED PRIOR TO PHASE I-A CONSTRUCTION.

H.L. 5-26-90
REV. 3 5-29-90

REFERENCE DRAWINGS:

GRJ-PS-10-0208	CONSTRUCTION FACILITIES AND SITE DRAINAGE
GRJ-PS-10-0209	SLURRY TRENCH PLAN
GRJ-PS-10-0211	CONTAMINATED MATERIAL EXCAVATION PLAN SHEET 1 OF 2
GRJ-PS-10-0212	CONTAMINATED MATERIAL EXCAVATION PLAN SHEET 2 OF 2

LEGEND:

4640	EXISTING SITE FEATURES & CONTOURS
N61,000	CONSTRUCTION GRID COORDINATE
⊕GJ-200	AUGER BORINGS DRILLED BY COLORADO STATE UNIVERSITY (1980)
A-66, B-51 C-25, D-27	AUGER BORINGS DRILLED BY SERGENT, HAUSKINS & BECKWITH (1981)
⊕GGJ-1	AUGER BORINGS DRILLED IN 1982, MONITORING WELLS 1982.
◎GJ-205W	MONITOR WELLS INSTALLED BY COLORADO STATE UNIVERSITY (1980)
⊙724	MONITOR WELL INSTALLED BY JACOBS ENGINEERING GROUP, INC. (1985)
GRJ-01-611	TEST PITS DUG BY JACOBS ENGINEERING GROUP, INC. (1985)
MKE-1	TEST PITS DUG BY MORRISON-KNUDSEN ENGINEERS, INC. (1985)
◇GRJ-001	AUGER BORINGS DRILLED BY JACOBS ENGINEERING GROUP (1984)
⊕	OLD WELL WEST OF MILL.
▲3C	AUGER BORINGS DRILLED BY LINCOLN DEVORE (1957)

FINAL REVIEW

E & D MANAGER	CHIEF ENGINEER	Q A MANAGER

NO	DATE	REVISIONS	BY	CK	E&D MGR	CHIEF ENG	TAC REV	DOE APP
△								
△								
△								
△								
△		ISSUED FOR FINAL REVIEW	-	-	-	-		

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

BORINGS AND TEST PITS LOCATION PLAN

DESIGNED: DRAWN: RBC
CHECKED:
APPROVED:
DATE
DOE PROJECT ENGINEER
DATE

MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO CA

PROJECT NO
DE-AC04-83AL18796

DRAWING NO
GRJ-PS-10-0217

A-5

FS 2/4/88 WYL 2/5/88

24

SUMMARY OF SOIL TEST RESULTS

Job No 5025 Project Name UMTRA/GRJ Feature Grand Junction Processing Site Date

Hole or Trench Number	Sample Number	Depth (ft)		Laboratory Classification	Mechanical Analysis			Atterberg Limits		Specific Gravity G	Natural		Compaction			Shear Strength					Permeability		Consolidation			Notes
														Optimum			Initial		C							
		From	To		Gravel	Sand	Fines	LL	PI		w %	γd	Test	w	γd	Test	w	γd	c'/c	φ'/φ	γd (sat)	k	C	C C_c	E e_o	
I Sand Tailings (Less than 30% Passing #200 sieve)																										
GRJ-01 -611		3.5	7.0	SM	0	85	15			2.69	3.1		SP	17.4	101.0											
-612		7.5	11.0	SP/SM	0	89	11			2.69	2.9		SP	15.6	99.6											
-613		0.5	4.0	SM	0	81	19			2.70	8.7		SP	16.1	103.5											
-615		4.5	8.0	SM	0	75	25			2.71	11.2		SP	17.3	103.8											
GJ-213B		0	3.0	SM	0	86	14			2.70			SP	13.0	109.2	DS		98.3		0/30°	99.8 (NA)	1.4 x 10^{-3}	Last	0.10	0.73	Remolded to density of 90% Comp as ASTM D-698
-216B		0	3.0	SP	0	93	7			2.70			SP	10.8	110.0						99.8 (NA)	1.1 x 10^{-3}				Remolded to density of 90% Comp. as ASTM D-698
GJ-419	Undisturb	14.0	16.0	SM	0	71	29			2.70	5.4	86.8														
GJ-22	Undisturb	10.2		SP	0	94	6				3.9	98.2									98.2 (NA)	1.1 x 10^{-2}			0.72	Sat = 18%
GJ-201	Undisturb	14.0		SM	0	77	23				40.6	80.0									80.0 (NA)	3.6 x 10^{-5}			1.11	Sat = 99%
GJ-207	Undisturb	4.0		SP/SM	0	93	7				2.5	84.6									84.3 (NA)	4.3 x 10^{-4}			0.99	Sat = 7%
	Undisturb	19.0		SM	0	85	15				37.5	74.1									74.1 (NA)	1.2 x 10^{-4}			1.27	Sat = 79%
GJ-209 GJ-214	Undisturb Undisturb	4.0 14.0		SM SP	0 0	95 96	5 4				3.5	99.6									99.6 (NA)	1.1 x 10^{-4}			0.70	Sat = 16%
GJ-220	Undisturb	19.0		SM	0	88	12				9.0	89.4									89.4 (NA)	1.3 x 10^{-4}			0.89	Sat = 28%
~~G~~GJ-3	Undisturb	1.0	3.0	SM	0	83	17				5.9	100.9									100.9 (NA)	2.0 x 10^{-3}				
-4	Undisturb	13.0	15.0	SM/SP	0	95	5				4.5	86.4									86.4 (NA)	1.0 x 10^{-3}				
	Undisturb	43.0	45.0	SM/SP	0	95	5				9.7	91.4									91.4 (NA)	8.0 x 10^{-4}				
-6	Undisturb	8.0	10.0	SM/SP	0	95	5				3.0	91.4									91.4 (NA)	6.0 x 10^{-3}				
-7	Undisturb	18.0	20.0	SP	0	96	4				3.2	91.0									91.0 (NA)	3.0 x 10^{-3}				
				Average	0	88	12			2.70	9.7	89.5	SP MD	15.0 10.1	104.5 115.4											
Additional Investigations by MKE (See Sheet 75)																										
9H		5	20'		0	86	14	N	P				SP	14.1	105.5											
21J		5	20		0	88	12	N	P				SP	13.3	102.0											
21J		20	45		0	84	16	N	P				SP	13.2	109.2	CU	14.1	98.0	0.152 0	34.6 20.5						

*Visual Classification

SP = Standard Proctor
MP = Modified Proctor
S = Special - See Text

TC = Triaxial Compression
UC = Unconfined Compression
DS = Direct Shear

UU = Unconsolidated Undrained
CU = Consolidated Undrained
CD = Consolidated Drained

A-6

PS 2/4/88 WYL 2/5/88 ~~25~~

SUMMARY OF SOIL TEST RESULTS

Job No 5025 Project Name UMTRA/GRJ Feature Grand Junction Processing Site Date

Hole or Trench Number	Sample Number	Depth		Laboratory Classification	Mechanical Analysis			Atterberg Limits		Specific Gravity G	Natural		Compaction			Shear Strength					Permeability		Consolidation			Notes
		From	To		Gravel	Sand	Fines	LL	PI		w %	γ_d	Test	Optimum w	Optimum γ_d	Test	Initial w	Initial γ_d	C c/ϕ	$\bar{c}/\bar{\phi}$	γ_d (sat)	k	C_v	C_c	e_o	
II Sand-slime Tailings (30% to 70% Passing #200 Sieve)																										
GRJ-01 -611		0.5	3.5	ML	0	46	54			2.75	24.3		SP	22.0	75.1											
GJ-2176		0	3.0	SM	0	70	30	38	18	2.77			SP	18.8	101.0											
GJ-417	Undisturb	15.0	17.0	ML	0	32	68			2.77						CU	37.2	64.0	0.7/18.5°	0.4/30.2						
GJ-216	Undisturb	14.0		SM	0	59	41				23.6	100.0									100.0 (NA)	4.4×10^{-4}			0.66	Sat=93%
GJ-220	Undisturb	24.0		SM	0	63	37				20.0	91.8									91.8 (60%)	2.6×10^{-4}			0.84	
				Average	0	54	46			2.76	22.6	95.9	SP	23.4	92.1											
III Slime Tailings (More than 70% Passing #200 Sieve)																										
GRJ-01 -614		5.0	7.0	ML	0	15	85			2.80	53.3		SP	42.1	72.8											
GJ-2093		0	3.0	ML.	0	30	70	37	3	2.76			SP	28.6	83.8	DS		75.4		0/45.5°	74.9 (NA)	9.3×10^{-5}	fast	0.26	1.30	
-2168		0	3.0	ML	0	9	91	46	5	2.70			SP	32.7	80.0											
GJ-421	Undisturb	8.0	10.0	ML	0	2	98			2.79	-					CU	62.3	60.6	0.1/31.9°	0.1/30.2°	60.6 (90.9%)	4.2×10^{-6}				
GJ-24	Undisturb	6.5		ML	0	18	82				41.6	65.5									65.5 (NA)	4.6×10^{-5}			1.65	Sat=68%
GJ-200	Undisturb	14.0		ML	0	10	90																			
GJ-209	Undisturb	14.0		ML	0	20	80				22.5	93.9									93.9 (NA)	1.3×10^{-6}			0.79	Sat=72%
GJ-220	Undisturb	14.0		ML	0	22	78				31.0	58.3									58.3 (NA)	6.3×10^{-5}			1.89	Sat=44%
GJ-2	Undisturb	13.0	15.0	ML	0	5	95				37.0	104.1														
-7	Undisturb	33.0	34.0	ML				40	10		39.2															
				Average	0	15	85	41	6		37.4	80.5	SP	39.5	78.9											
IV Mixed Tailings (Man Made)																										
GJ-16M		80% 20%	GJ-2138 GJ-2098	(Sand). SM		84	16			2.71			SP	12.9	109.2	CU		109.2		0/43°	98.6 (NA)	8.5×10^{-5}				
-17M		60% 40%	GJ-2138 GJ-2098	(Sand-Slimes, SM		68	32			2.73			SP	16.1	106.5	DS CU	?	95.3 106.5		0/[illegible] 1.44/[illegible]	93.6 (NA)	4.8×10^{-5}	fast	0.135	0.79	
-18M		40% 60%	GJ-2138 G-2098	Sand-Slimes, SM		60	40			2.76			SP	19.0	99.0	CU		99.0		0/44°	99.2 (NA)	5.6×10^{-5}				

*Visual Classification

SP = Standard Proctor
MP = Modified Proctor
S = Special - See Text

TC = Triaxial Compression
UC = Unconfined Compression
DS = Direct Shear

UU = Unconsolidated Undrained
CU = Consolidated Undrained
CD = Consolidated Drained

SUMMARY OF SOIL PROPERTIES FOR PONDS AREA MATERIALS

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature
Item

Contract No. 5025
Designed PS
Checked WYL

Sheet
File No.
Date 1-27-88
Date 2/5/88

Sample Identification	Laboratory Classification	Mechanical Analysis			Atterberg Limits		Specific Gravity G	Natural		Compaction			Shear Strength					Permeability		Consolidation			Notes
											Optimum			Initial									
		Gravel	Sand	Fines	LL	PI		w %	γ_d	Test	w	γ_d	Test	w	γ_d	C	ϕ	γ_d	k	$C_{c\varepsilon}$	$C_{r\varepsilon}$	$\bar{p}$	
BH 29-G (0-20')	Sandy Lean Clay with gravel	16	26	58	32	18	2.67				12.5	116.3	UU	13.4	104.7	0.210 Ksf	--	104.1	7.4x10⁻⁴ cm/sec	0.160	0.005	2.2 Ksf	
''	}												UU	12.8	110.0	0.415 Ksf							
''	}												UU	12.4	116.1	0.84 Ksf							
''	}												CU	12.9 12.6 12.5	104.2 104.6 104.7	0.149 Ksf 0.110 Ksf	30.3° 17.7°	Effective Total					
BH 29-G (20-30')	Clayey gravel with sand	31	24	45	32	18	2.68				11.6	117.9	UU	11.2	106.4	0.225 Ksf							
''	}												UU	11.7	111.6	0.510 Ksf							
''	}												UU	11.6	118.1	1.15 Ksf							
''	}																						
BH 33-F (0-20')	Sandy Lean Clay with gravel	15	33	52	28	15	2.71				13.2	116.2	UU	12.5	104.5	0.215 Ksf		104.2	2.0x10⁻⁶ cm/sec.				
''	}												UU	13.2	110	110.9 Ksf							
''	}												UU	13.0	116.4	0.875 Ksf							
''	}																						

*Visual Classification

SP = Standard Proctor
MP = Modified Proctor
S = Special - See Text

TC = Triaxial Compression
UC = Unconfined Compression
DS = Direct Shear

UU = Unconsolidated Undrained
CU = Consolidated Undrained
CD = Consolidated Drained

Notes: (1) All UU tests were saturated before shearing
(2) The c & φ values for CU tests are those presented by Chen & Assoc.
our interpretation may be different

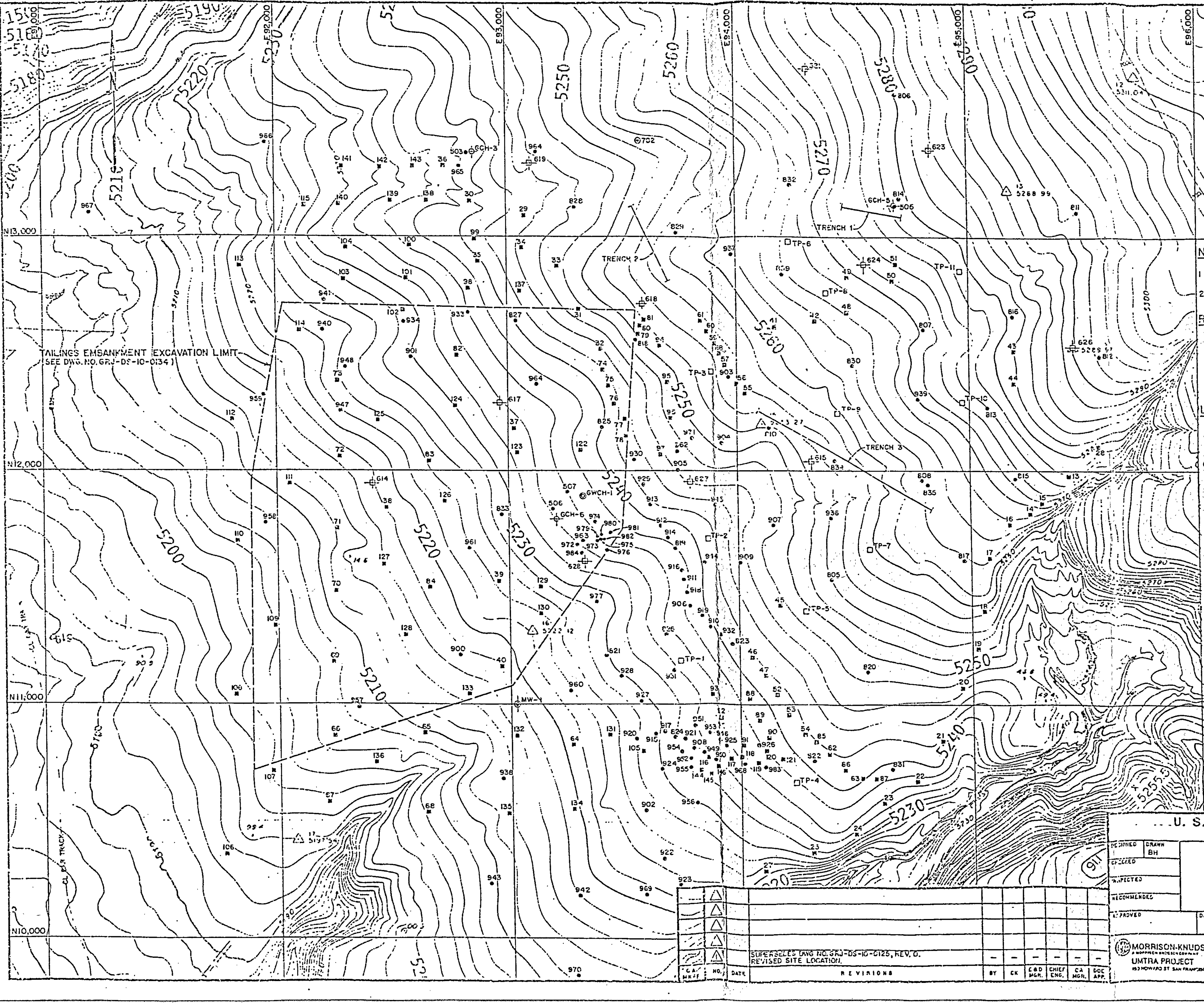
Project
Feature
Item

Contract No.
Designed
Checked

Sheet
File No.
Date
Date

Appendix B

DATA ON RADON BARRIER MATERIALS



BOREHOLES & TEST PITS	COORDINATES	
GWCH-2	N14,170	E96,080
GWCH-3	N14,320	E94,140
GCH-1	N15,220	E95,370
GCH-2	N14,240	E94,150
GCH-4	N14,170	E96,250
815	N13,270	E95,100
701	N14,460	E95,015
26	N10,170	E93,985
935	NOT DRILLED	
978	NOT SURVEYED	

REV. 3 H.L. 2/2/90
GBS 5-22-90

NOTE:

1. GROUND WATER DATA AND SUBSURFACE EXPLORATION LOGS ARE AVAILABLE FROM THE CONTRACTOR.
2. BOREHOLES AND TEST PITS NOT SHOWN ON DRAWING ARE LISTED ON TABLE ABOVE.

REFERENCE DRAWINGS:

GRJ - DS - 10-0125	CONSTRUCTION FACILITIES AND SITE DRAINAGE
GRJ - DS - 10-0134	TAILINGS EMBANKMENT AREA EXCAVATION PLAN

LEGEND:

—5240—	EXISTING SITE FEATURES AND CONTOURS
N12,000	CONSTRUCTION GRID COORDINATE
GCH-6 ⌖	BORINGS DRILLED BY NUS IN 1982
◎ GWCH-3	MONITOR WELLS INSTALLED IN 1982
701 ⊙	MONITOR WELLS INSTALLED BY TAC IN 1985
⌖ 616	TEST PITS DUG BY TAC IN 1984
617 ⌖	TEST PITS DUG BY LINCOLN DEVORE/MKE IN 1985
□ TP-5	TEST PITS DUG BY WESTERN ENG./MKE IN 1987
⌖ MW-1	EXISTING WATER SUPPLY WELL BY MKE IN 1987
■ 41	TEST PIT BY TAC IN 1989
● 930	WELL-BOREHOLE BY TAC IN 1989

ALL RADON BARRIER MATERIAL WILL BE OBTAINED FROM THE EXCAVATION FOR THE TAILINGS EMBANKMENT

200 0 200 400
SCALE FEET

C.A. MK#F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	CA MGR.	DOE APP.
	△								
	△								
	△								
	△								
	△		SUPERSEDES DWG NO. GRJ-DS-10-0125, REV. 0. REVISED SITE LOCATION.	–	–	–	–	–	–

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED
DRAWN BH
CHECKED
INSPECTED
RECOMMENDED
APPROVED
DATE
DOE PROJECT ENGINEER
DATE

CHENEY RESERVOIR DISPOSAL SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

BORINGS AND TEST PITS LOCATION PLAN

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. GRJ-DS-10-0223
REV. 1

MAT. FOR RADON BARRIER

SUMMARY OF SOIL TEST RESULTS

REV. 3
H.L. 2/5/90
GBS 5-22-90

Job No 5025-16
Project Name UMTRA - GRAND JUNCTION
Feature CHENEY DISPOSAL SITE
Date 12/15/89

Hole or Trench Number	Sample Number	Depth		Laboratory Classification	Mechanical Analysis			Atterberg Limits		Specific Gravity G	Natural		Compaction			Shear Strength					Permeability		Consolidation			Notes
		From	To		Gravel	Sand	Fines	LL	PI		w %	γ_d	Test	Optimum w	Optimum γ_d	Test	Initial w	Initial γ_d	C	φ	γ_d	k cm/sec ① ②	C	C	K	
114	5	0	1	SC/SM	4	24	72	23	10																	CLAY CONTENT (HYDROMETER) = 19%
122	9	7	12	SC	6	54	40	23	7				SP	12.5	120.7											CLAY CONTENT = 18%
123	10	14	23	CL	17	34	49	33	18	2.79			SP	15.5	114.3						105.5	4.7×10^{-7}				CLAY CONTENT = 19%
124	11	18.5	23	CL	3	9	88	40	24				SP	16.1	112.2											CLAY CONTENT = 43%
125	12	18	21	CL	4	8	88	40	25	2.77			SP	17.1	109.7						97.6 102.7	3.9×10^{-7} 1.6×10^{-8}				CLAY CONTENT = 42%
126	13	1	4	CL	38	15	47	41	19																	CLAY CONTENT = 31%
126	14	14	21	CL	0	6	94	43	25				SP	16.5	110.2											CLAY CONTENT = 42%
127	15	15	25.5	CL	3	30	67	37	22	2.77			SP	14	117.6							4.7×10^{-8}				CLAY CONTENT = 32%
128	16	16	25	CL	0	5	95	44	27				SP	12.9	109.2											CLAY CONTENT = 47%
130	17	10.5	14.5	CL	0	36	64	33	17	2.77			SP	16	110.6						100.5 106.3	4.0×10^{-7} 2.0×10^{-7}				CLAY CONTENT = 25%
131	18	0	1.5	CL	4	23	73	41	24																	CLAY CONTENT = 42%
131	19	17	25	CL	2	32	66	29	15	2.76			SP	14.2	114.9							1.2×10^{-7}				CLAY CONTENT = 26%
133	20	11	15	CL	4	44	52	28	13				SP	13.9	116.2											CLAY CONTENT = 16%
136	21	10	17	CL	1	11	88	38	24	2.79			SP	15.7	114.9						102.4 109.3	2.4×10^{-7} 1.4×10^{-8}				CLAY CONTENT = 41%
				AVERAGE	6	24	70			2.78				14.95	113.7											

For 95% $k = \frac{3.9 \times 10^{-7} + 4 \times 10^{-7} + 2.4 \times 10^{-7}}{3} = 3.43 \times 10^{-7}$ cm/sec

NOTE: SEE Sh. B-1 FOR HOLE OR TRENCH NUMBER

* Visual Classification

SP = Standard Proctor
MP = Modified Proctor
S = Special - See Text

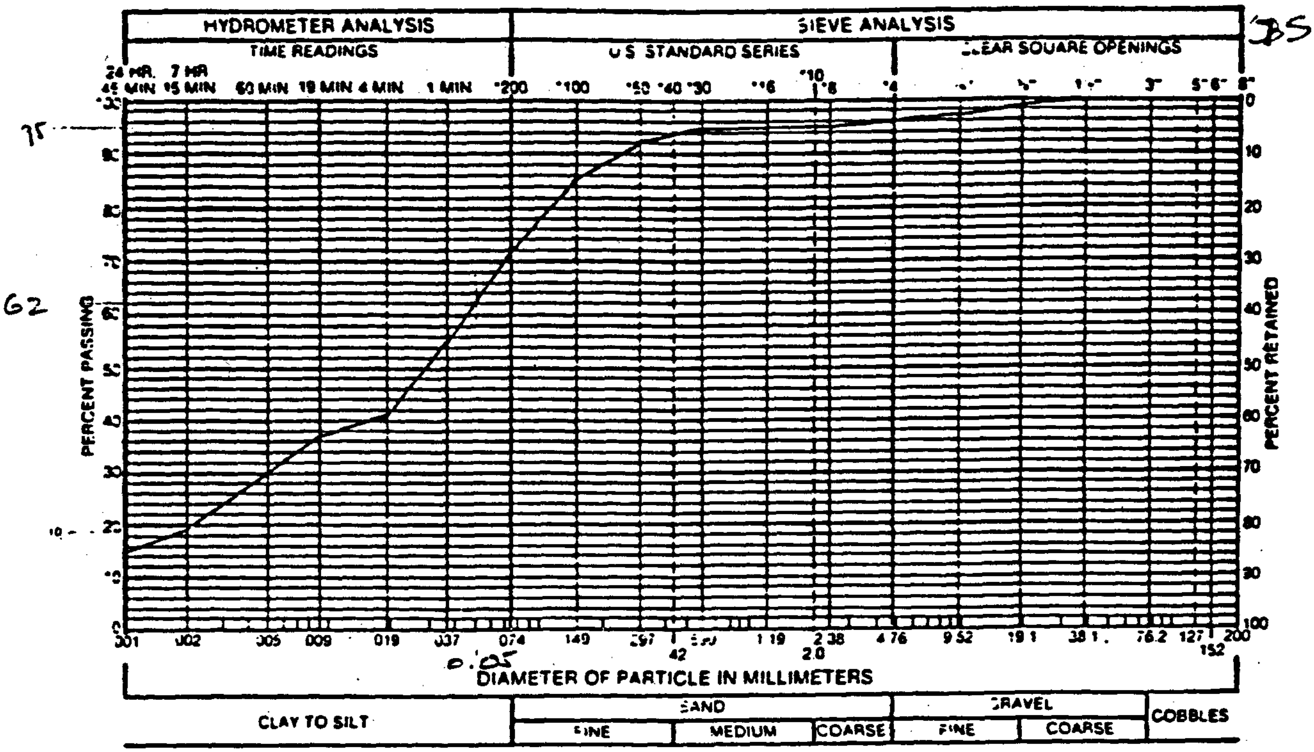
TC = Triaxial Compression
UC = Unconfined Compression
DS = Direct Shear

UU = Unconsolidated Undrained
CU = Consolidated Undrained
CD = Consolidated Drained

① SOIL COMPACTED TO ≅ 95% (STANDARD PROCTOR)
② SOIL COMPACTED TO ≅ 100% (STANDARD PROCTOR

D-5

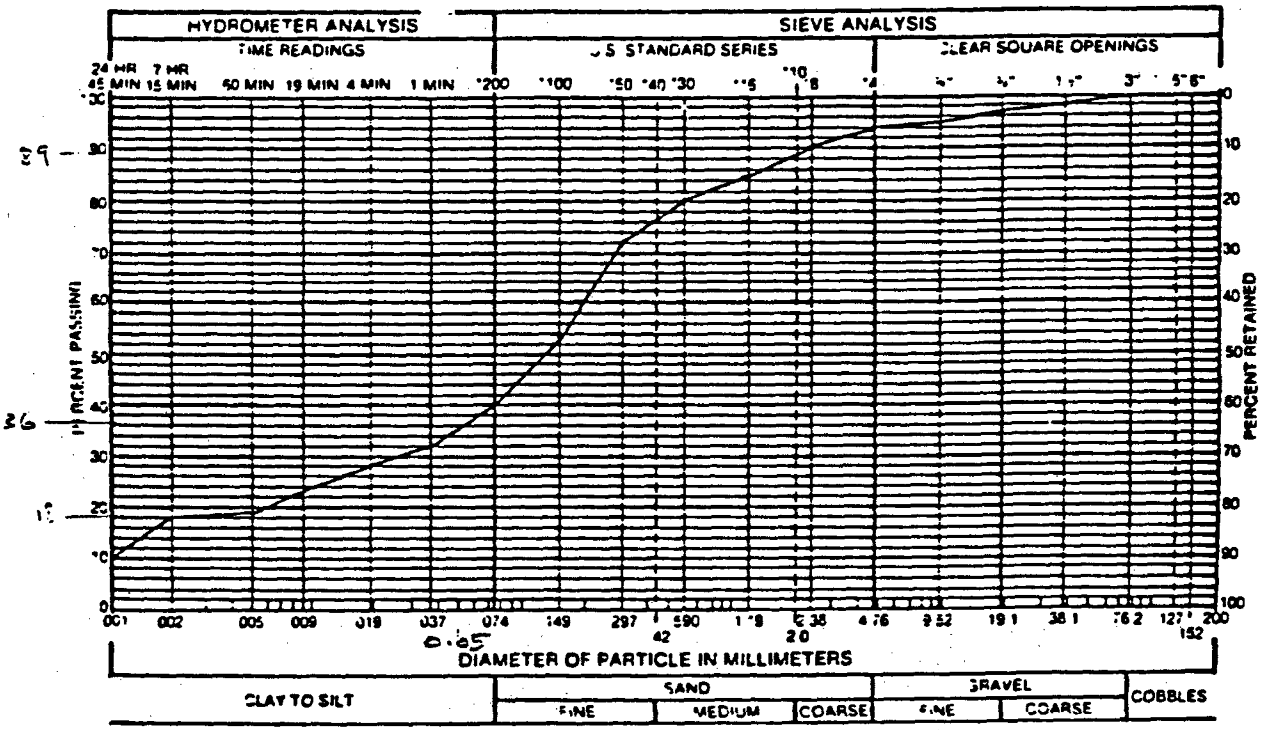
REV. 3
H.L. 2/5/90
855-22-90



GRAVEL 4 % SAND 24 % SILT AND CLAY 72 %

LIQUID LIMIT 23 % PLASTICITY INDEX 10 %

SAMPLE OF Lean clay with sand FROM TP 114 at depth 0-1.0,
Sample No. 5



GRAVEL 6 % SAND 54 % SILT AND CLAY 40 %

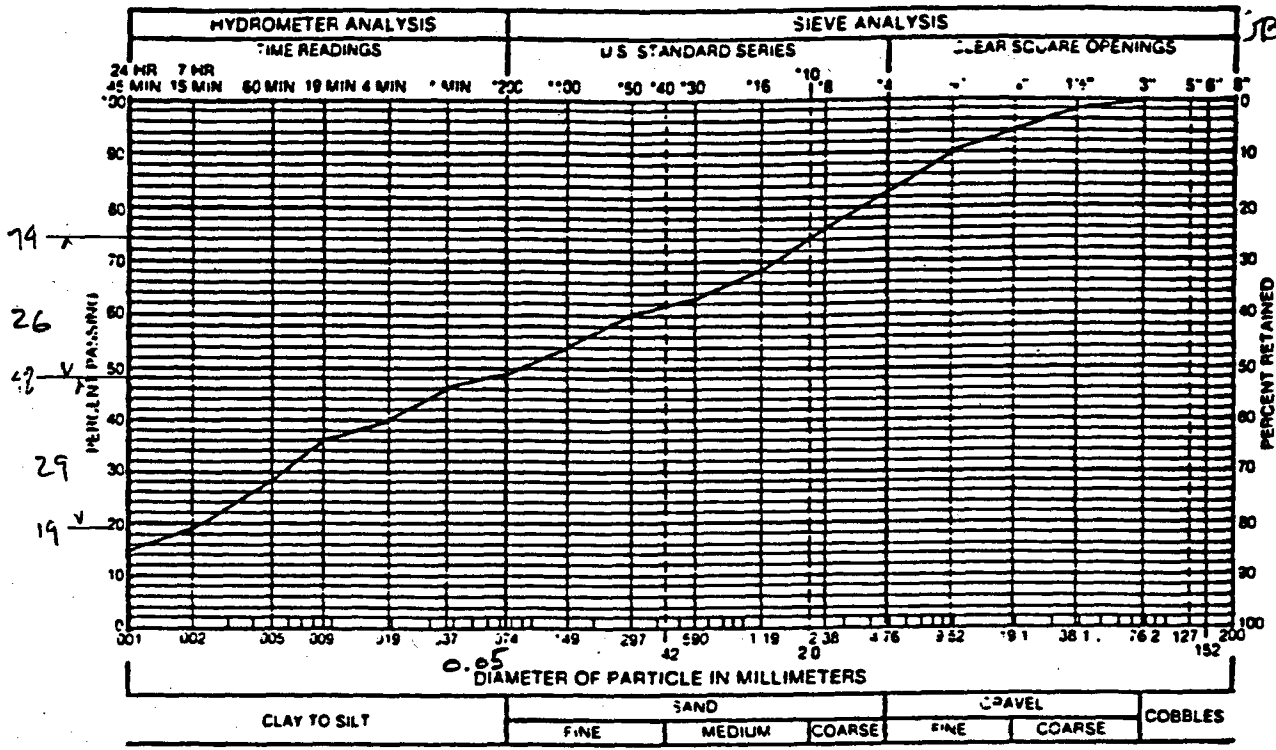
LIQUID LIMIT 23 % PLASTICITY INDEX 7 %

SAMPLE OF Silty, clayey sand FROM TP 122 at depth 7.0-12.0,
Sample No. 9

1 126 90	Chen-Northern, Inc.	GRADATION TEST RESULTS	Fig. 1

5-4

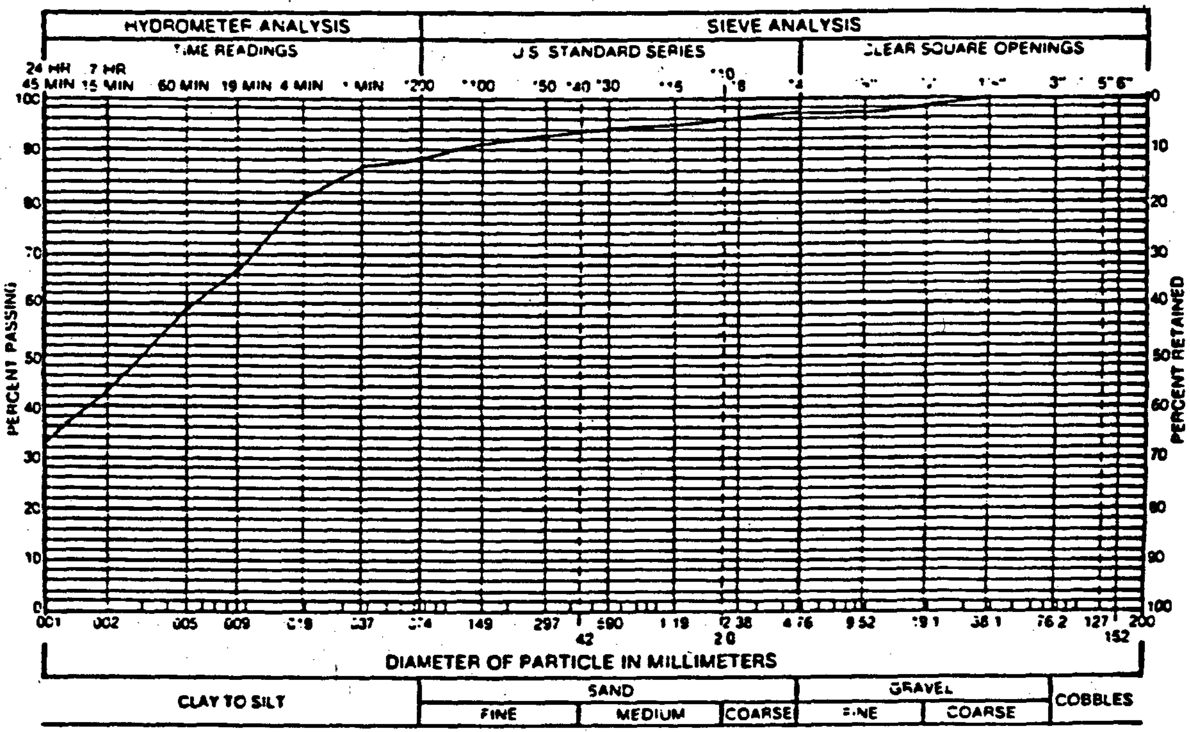
REV. 3
H.L. 2/5/90
JBS5-22-92



GRAVEL 17 % SAND 34 % SILT AND CLAY 49 %

LIQUID LIMIT 33 % PLASTICITY INDEX 18 %

SAMPLE OF Clayey sand with gravel FROM TP 123 at depth 14.0-23.0,
Sample No. 10



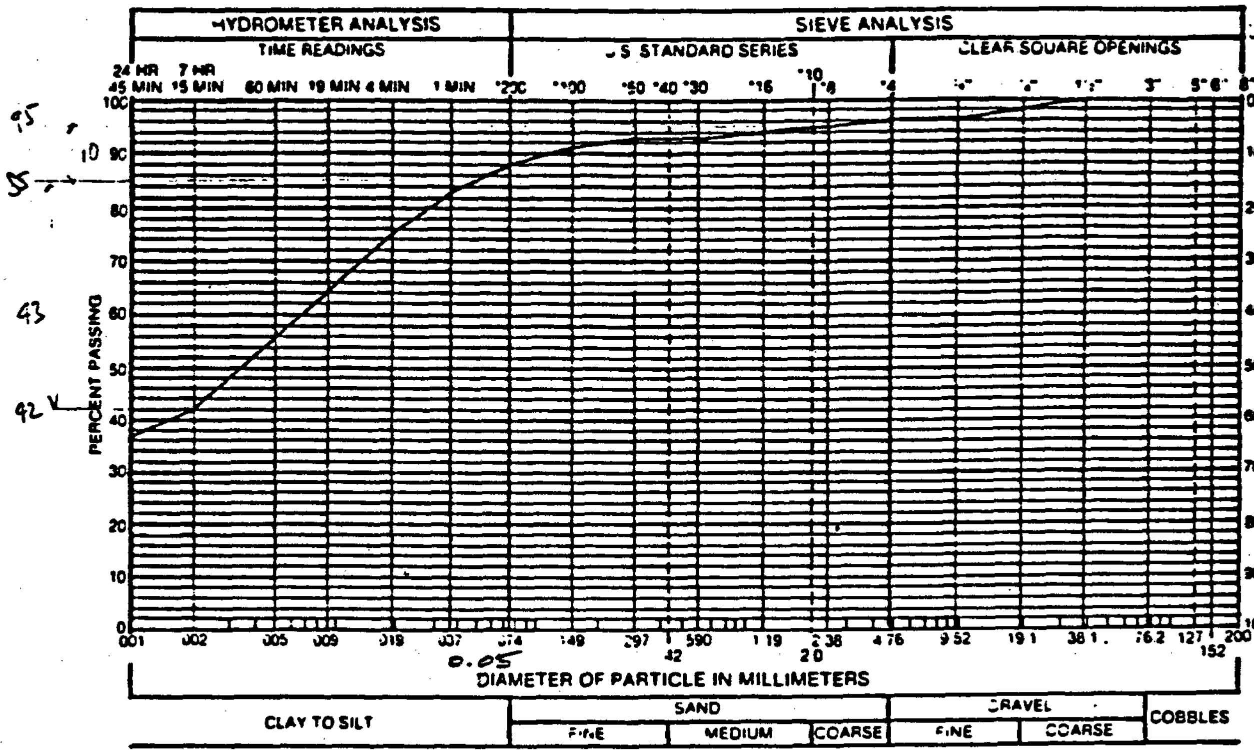
GRAVEL 3 % SAND 9 % SILT AND CLAY 88 %

LIQUID LIMIT 40 % PLASTICITY INDEX 24 %

SAMPLE OF Lean clay FROM TP 124 at depth 18.5-23.0,
Sample No. 11

1 126 90	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 2

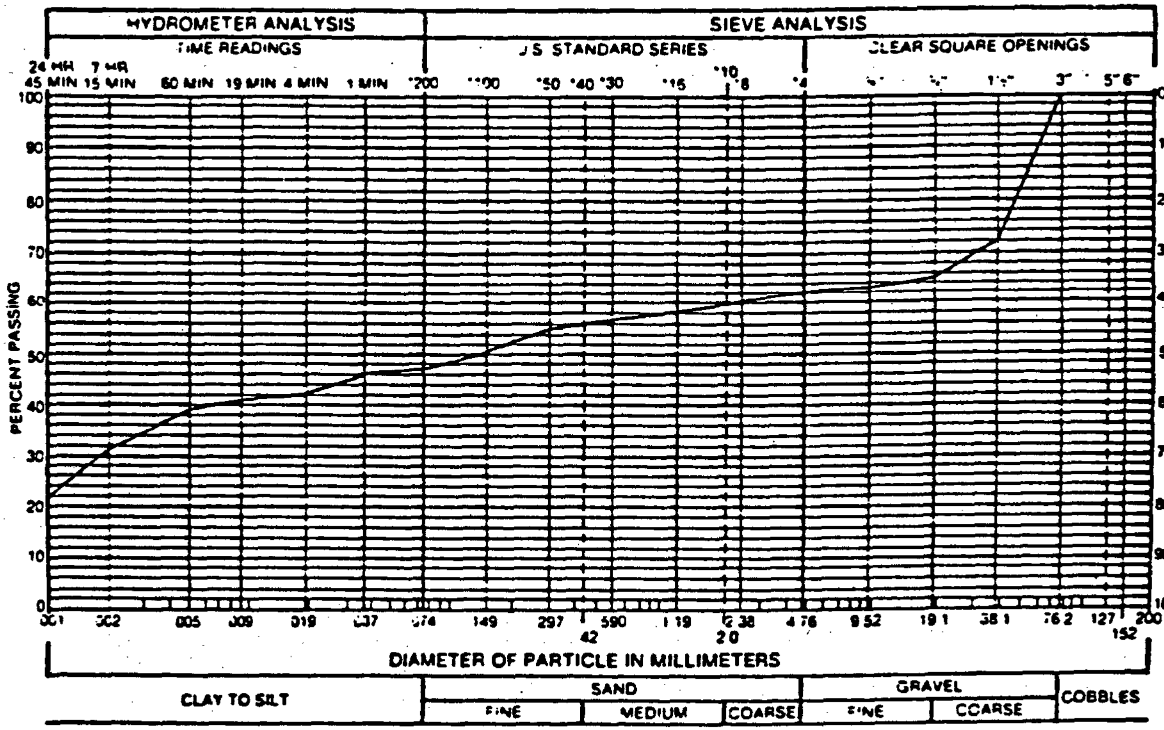
REV. 3
H.L. 2/5/9C
3855-225



GRAVEL 4 % SAND 8 % SILT AND CLAY 88 %

LIQUID LIMIT 40 % PLASTICITY INDEX 25 %

SAMPLE OF Lean clay FROM TP 125 at depth 18.0-21.0,
Sample No. 12



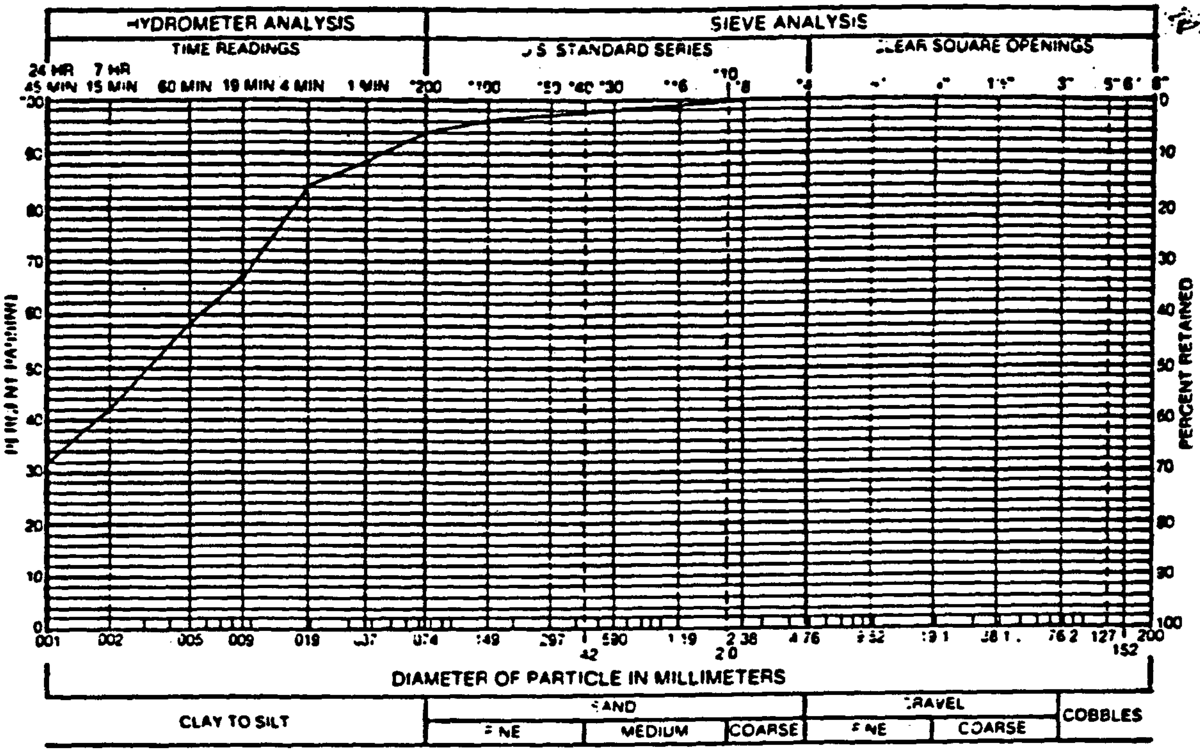
GRAVEL 38 % SAND 15 % SILT AND CLAY 47 %

LIQUID LIMIT 41 % PLASTICITY INDEX 19 %

SAMPLE OF Clayey gravel with sand FROM TP 126 at depth 1.0-4.0,
Sample No. 13

1 126 90	Chen-Northern, Inc.	GRADATION TEST RESULTS	Fig. 3

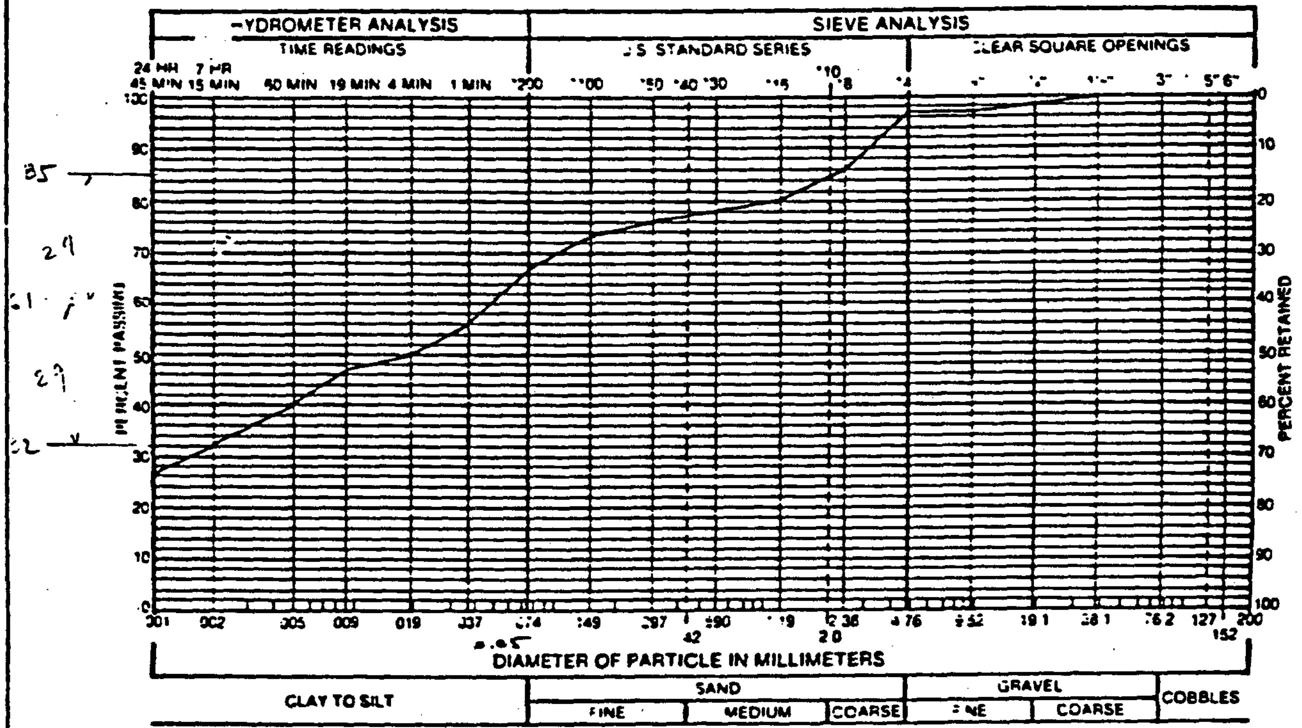
REV. 3
H.L. 2/5/90
#55-22.5)



GRAVEL 0 % SAND 6 % SILT AND CLAY 94 %

LIQUID LIMIT 43 % PLASTICITY INDEX 25 %

SAMPLE OF Lean clay FROM TP 126 at depth 14.0-21.0, Sample No. 14



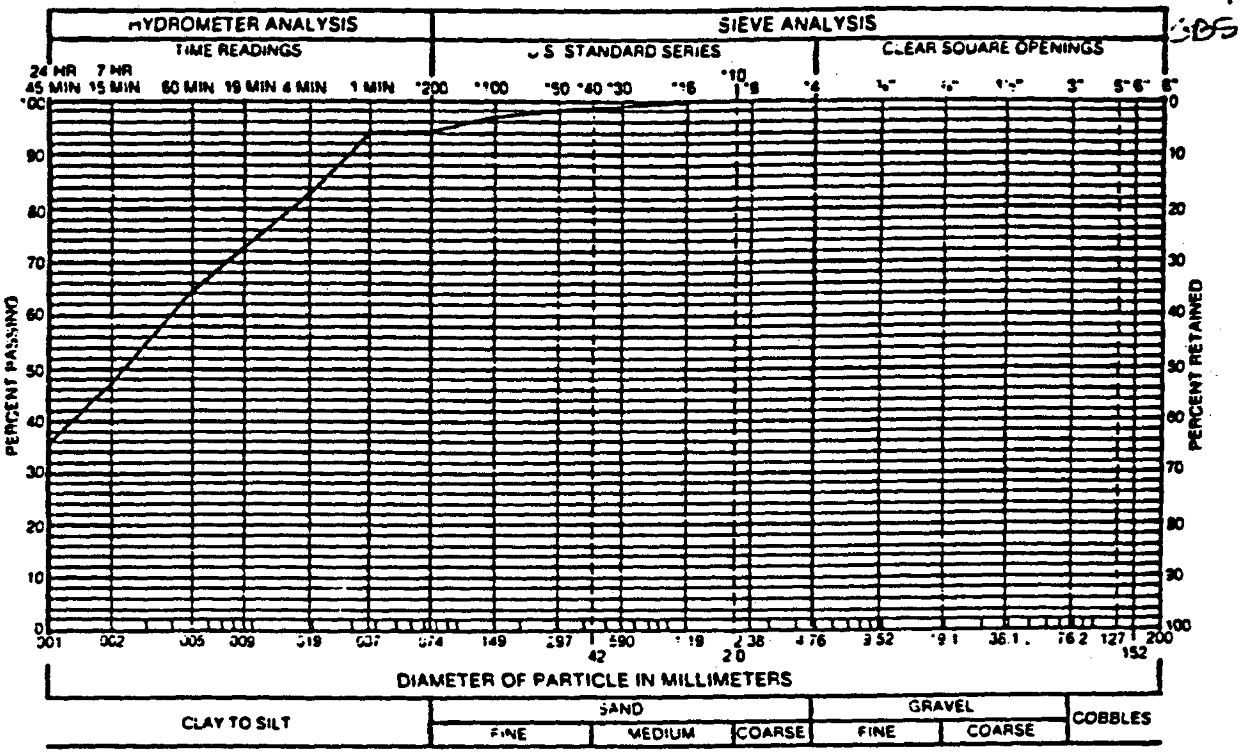
GRAVEL 3 % SAND 30 % SILT AND CLAY 67 %

LIQUID LIMIT 37 % PLASTICITY INDEX 22 %

SAMPLE OF Sandy lean clay FROM TP 127 at depth 15.0-25.5, Sample No. 15

1 126 90	Chen-Northern, Inc.	GRADATION TEST RESULTS	Fig. 4

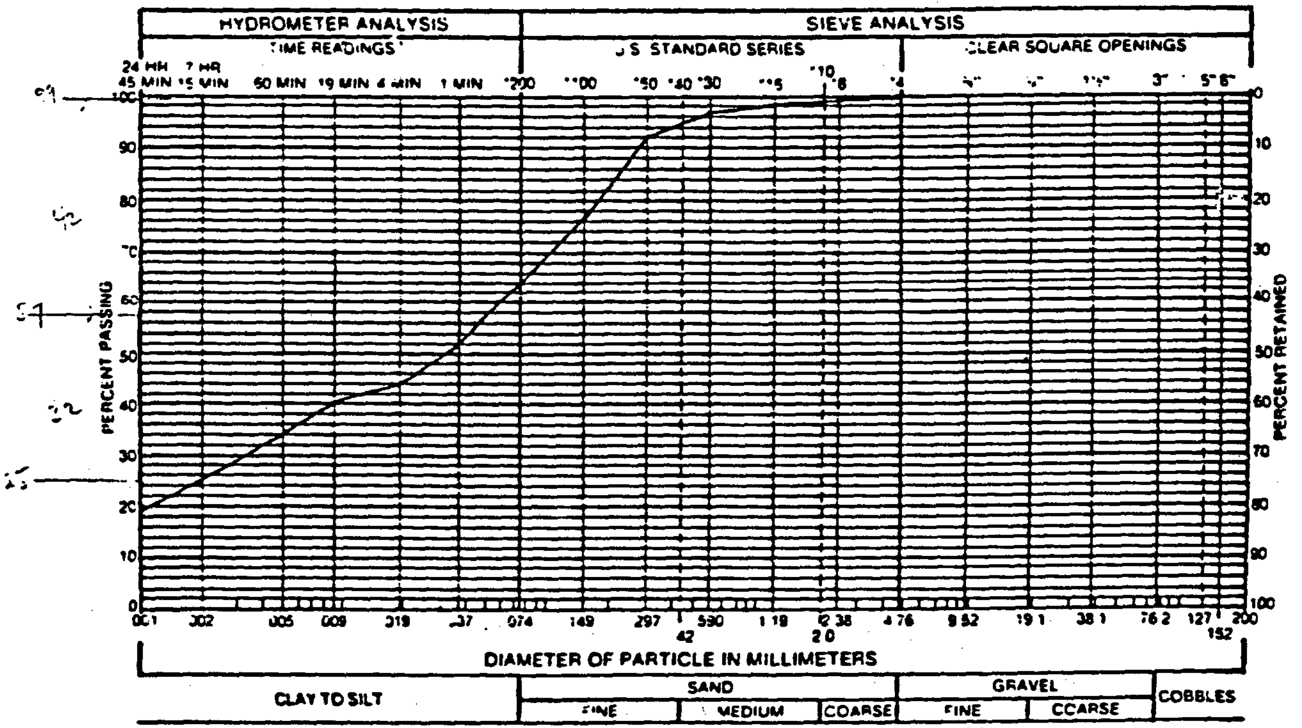
Rev. 3
H.L. 2/5/90
GDSS-22-



GRAVEL 0 % SAND 5 % SILT AND CLAY 95 %

LIQUID LIMIT 44 % PLASTICITY INDEX 27 %

SAMPLE OF Lean clay FROM TP 128 at depth 16.0-25.0, Sample No. 16



GRAVEL 0 % SAND 36 % SILT AND CLAY 64 %

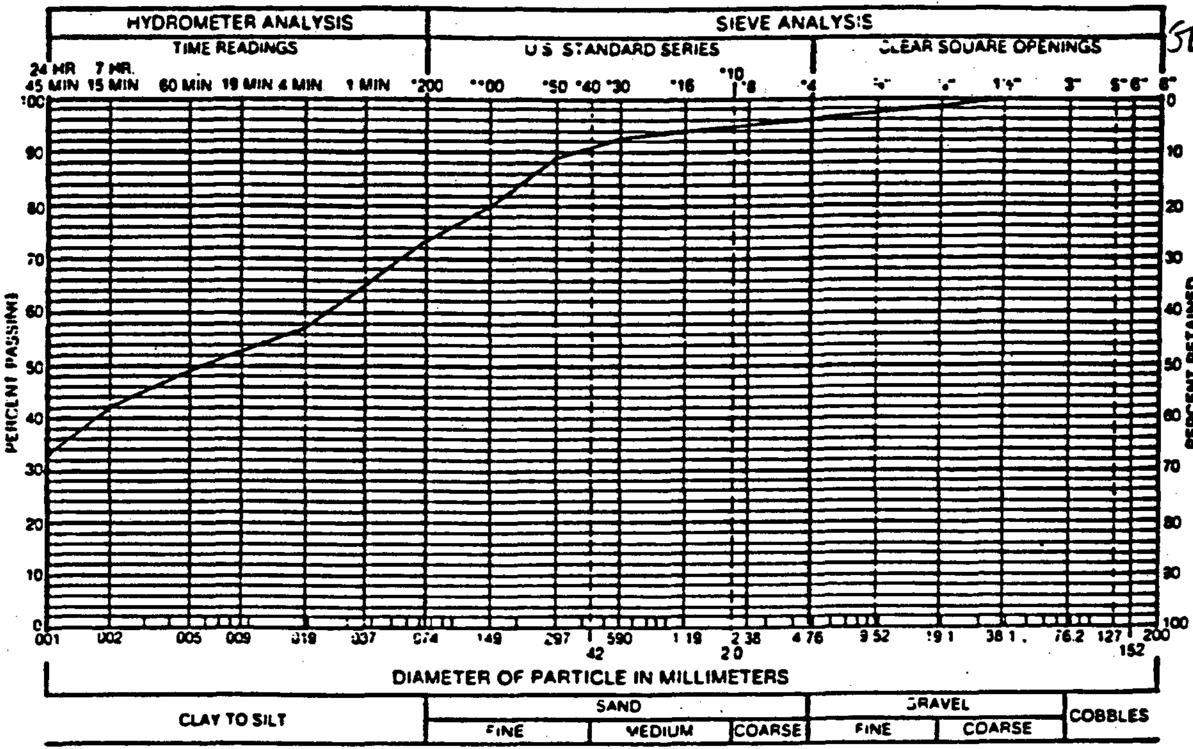
LIQUID LIMIT 33 % PLASTICITY INDEX 17 %

SAMPLE OF Sandy lean clay FROM TP 130 at depth 10.5-14.5, Sample No. 17

1 126 90	Chen & Northern, Inc.	GRADATION TEST RESULTS	Fig. 5

D-D

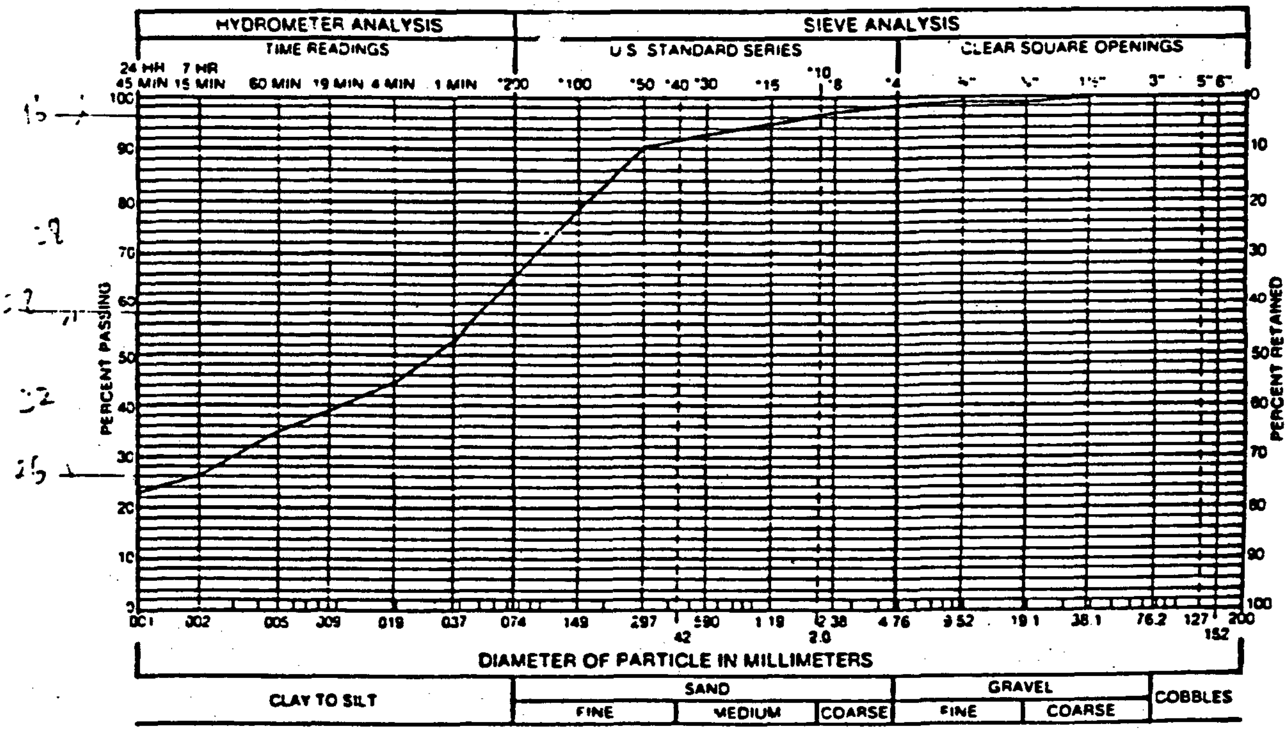
REV. 3
H.L. 4/5/90
SDSS-22-9.



GRAVEL 4 % SAND 23 % SILT AND CLAY 73 %

LIQUID LIMIT 41 % PLASTICITY INDEX 24 %

SAMPLE OF Lean clay with sand FROM TP 131 at depth 0-1.5, Sample No. 18



GRAVEL 2 % SAND 32 % SILT AND CLAY 66 %

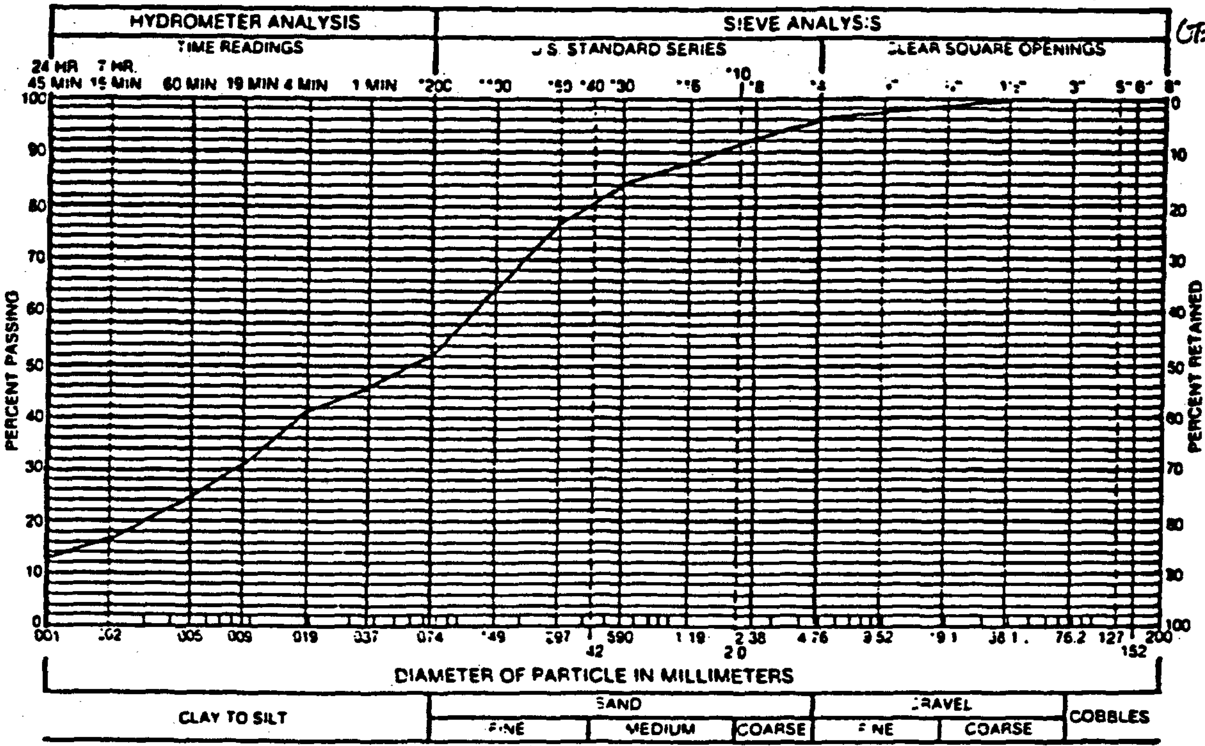
LIQUID LIMIT 29 % PLASTICITY INDEX 15 %

SAMPLE OF Sandy lean clay FROM TP 131 at depth 17.0-25.0, Sample No. 19

1 126 90	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 6

B-9.

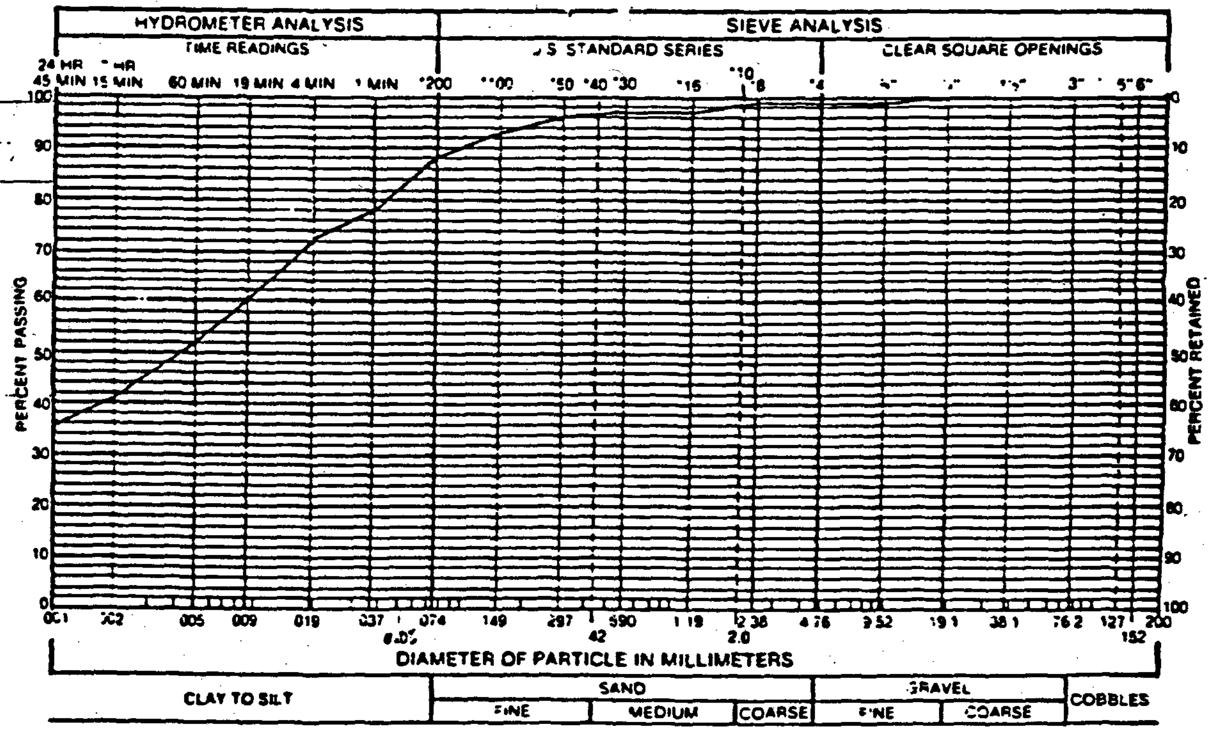
REV. 3
H.L. 2/5/90



GRAVEL 4 % SAND 44 % SILT AND CLAY 52 %

LIQUID LIMIT 28 % PLASTICITY INDEX 13 %

SAMPLE OF Sandy lean clay FROM TP 133 at depth 11.0-15.0, Sample No. 20



GRAVEL 1 % SAND 11 % SILT AND CLAY 88 %

LIQUID LIMIT 38 % PLASTICITY INDEX 24 %

SAMPLE OF Lean clay FROM TP 136 at depth 10.0-17.0, Sample No. 21

1 126 90	Chen-Northern, Inc.	GRADATION TEST RESULTS	Fig. 7

Project	Contract No.	Sheet
Feature	Designed	File No.
Item	Checked	Date
		Date

Appendix C

CAPILLARY MOISTURE TEST RESULTS

MKE DOC. No. 5025-GRJ-I-02-03843-00 SCB
C-1.

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

INTER-OFFICE CORRESPONDENCE

Revision 3
H.L. 2/5/90
GBS 5-22-90

DATE: December 12, 1989

TO: F. J. Feliz

FROM: R. E. Cooney REC

LOCATION: San Francisco, CA - MKES

LOCATION: Albuquerque, NM - 3050

SUBJECT: Grand Junction, Phase II
Soil Testing - P.O. #3050-511-10034

Enclosed for your review and use are Chen-Northern's test results for the Subject P.O. (Cheney Site). Your Scope of Work for this testing was #5025-GRJ-R-01-03532-00. Please note that the triaxial permeability tests have not yet been completed.

Please advise Tom Jennings of this office whether this testing and the results are acceptable.

REC:JCB:kja

RECEIVED-MKE
[illegible]
UMTRA-S.F.

Enclosure

cc w/o enc.: R. E. Cooney
T. P. Jennings
J. G. Pepin
File

Attachment(s): 5025-GRJ-L-09-03844-00
5025-GRJ-R-09-03845-00

3761K

STA001

MKE DOC. No. 5025-GRJ-L-09-03844-00 C – 2

Chen-Northern, Inc.

Consulting Engineers and Scientists

96 South Zuni Street
Denver, Colorado 80223

303 744-7105
303 744-0210 Facsimile

REVISION 3
H.L. 2/5/90
[illegible] 5-22-90

November 29, 1989

RECEIVED-MKE
[illegible]
UMTRA-S.F.

MK - Ferguson Company
P.O. Box 9136
Alburquerque, New Mexico 87119

Attention: Mr. Jerry Hymes

Subject: Laboratory Testing, P.O. No. 3050-511-10034

Job No.: 1 126 90

Dear Mr. Hymes:

As requested, we have performed the required laboratory tests on soil samples from the UMTRAP Cheney site which we received October 24, 1989, at our Denver laboratory. The results are presented on Tables I and II and Figures 1 through 18. Also enclosed are copies of all worksheets.

The triaxial permeability tests are still in progress. We anticipate completing these tests by December 20th, 1989.

If you have any questions regarding this submittal, please call.

Sincerely,

Sally K. Miller

Sally K. Miller, A.E.T.
Soils Laboratory Supervisor

Rev. By: NFL
SKM/dmm
Enclosures

A member of the HIH group of companies

CHEN-NORTHERN, INC.

November 29, 1989

Job No. 1 126 90
P.O. No. 3050-511-10034

TABLE I

Summary of Laboratory Test Results

Test Pit No.	Depth, Feet	Sample No.	Liquid Limit	Plastic Index	Shrinkage Limit	Shrinkage Ratio	Specific Gravity	Organic Content	Carbonate Content*	Cation Exchange Ratio**
114	0 - 1	5	23	10						
122	7 - 12	9	23	7						
* 123	14 - 23	10	33	18	11.0	2.0	2.788	0.28%	15.3	25.5
124	18.5 - 23	11	40	24						
* 125	18 - 21	12	40	25			2.768			
126	1 - 4	13	41	19						
126	14 - 21	14	43	25						
* 127	15 - 25.5	15	37	22	10.2	2.0	2.772	0.38%	18.1	26.3
128	16 - 25	16	44	27						
* 130	10.5 - 14.5	17	33	17			2.767			
131	0 - 1.5	18	41	24						
* 131	17 - 25	19	29	15			2.762			
133	11 - 15	20	28	13	14.1	1.9		0.10%	8.3	12.9
*136	10 - 17	21	38	24			2.788			

$\Sigma = 0.76$

$Av. = \frac{0.76}{3}$

$= 0.25$

* % CaCO3 equivalents
** meq/100g

NOTE

$SG = \frac{2.788 + 2.768 + 2.772 + 2.767 + 2.762 + 2.788}{6}$

$= 2,774$

MKE DOC. No. 5025-GRJ-R-09-03845-00

REVISION 3

H.L. 2/5/90

5-22-90

C-3

CHEN-NORTHERN, INC.

November 29, 1989

TABLE II

Job No. 1 126 90
P.O. No. 3050-511-10034

Summary of Capillary-Moisture Relationship Test Results

Test Pit No. Depth, feet	123 @ 14 - 23	125 @ 18 - 21	127 @ 15 - 25.5	130 @ 10.5 - 14.5	131 @ 17 - 25	136 @ 10 - 17	
Average Initial Moisture Content, %	15.3	16.9	14.5	16.0	15.9	15.6	
Average Initial Dry Density, pcf	108.1	104.4	111.2	105.1	109.5	109.4	AVER. = 107.95
Average Initial Compaction, %	94.6	95.2	94.6	95.0	95.3	95.2	Aver = 95%

Tension, bars	Moisture Content, %						
0.1	18.4	21.8	18.3	19.8	18.9	19.9	
0.3	19.3	22.2	18.6	20.4	19.6	20.1	
0.5	15.8	18.6	15.7	16.5	14.9	17.2	
1.0	16.9	19.9	16.6	17.5	16.1	18.2	
2.0	15.9	18.1	15.4	16.3	14.7	16.8	
4.0	15.6	17.5	15.1	16.0	14.2	16.5	
7.0	17.1	17.2	16.9	18.8	13.3	15.8	
15.0	14.5	16.6	14.1	14.6	13.1	15.5	AVER. = 14.73

Q-4
REV. 3
H.L. 2/5/90
5-22-90

Project ______ Contract No. ______ Sheet ______
Feature ______ Designed ______ File No. ______
Item ______ Checked ______ Date ______
Date ______

Appendix D

RADON DIFFUSION COEFFICIENT TEST RESULTS

Table B.6.3 Radon diffusion coefficients for off-pile soils

Sample	Max. dry density (g/cc)	Specific gravity	Optimum moisture (% dry wt.)	As tested dry density (g/cc)	Test moisture (% dry wt.)	Diffusion coefficient (cm^2/s)	Porosity (fraction)	Saturation (fraction)
GRJ-01-616 0-1' Area A	1.742	2.66	19.0	1.58	6.3	2.70E-02	0.41	0.24
				1.57	6.9	1.90E-02	0.41	0.27
				1.57	13.2	1.90E-02	0.41	0.51
				1.57	13.2	9.20E-03	0.41	0.50
				1.58	17.6	7.00E-03	0.41	0.67
				1.58	17.4	2.40E-03	0.41	0.68
GRJ-01-618 0-5' Pond 3	1.865	2.68	13.3	1.68	5.5	2.60E-02	0.37	0.25
				1.68	5.9	2.50E-02	0.38	0.26
				1.68	11.1	1.80E-02	0.37	0.50
				1.68	11.5	1.50E-02	0.37	0.52
				1.69	14.8	1.00E-03	0.37	0.68
				1.69	14.7	1.30E-03	0.37	0.67
GRJ-01-617 0-5' Ponds 1 and 2	1.726	2.76	19.8	1.58	7.0	2.40E-02	0.43	0.26
				1.53	9.0	4.30E-02	0.45	0.31
				1.56	14.6	1.70E-02	0.44	0.52
				1.55	14.5	1.20E-02	0.44	0.51
				1.57	18.3	2.90E-03	0.43	0.67
				1.56	19.3	4.80E-03	0.43	0.70

UMTRA [illegible]
VYL 2/11/87 D-1
chk PS 2/23/87

Table B.6.2 Radon diffusion coefficients for uranium tailings

Sample	Max. dry density (g/cc)	Specific gravity	Optimum moisture (% dry wt.)	As tested dry density (g/cc)	Test moisture (% dry wt.)	Diffusion coefficient (cm^2/s)	Porosity (fraction)	Saturation (fraction)
GRJ-01-613 1-4' Sand	1.622	2.71	5.3	1.46	5.1	2.80E-02	0.46	0.16
				1.46	5.4	2.30E-02	0.46	0.17
				1.46	9.7	2.80E-02	0.46	0.31
				1.45	10.2	2.20E-02	0.46	0.32
				1.47	12.0	2.10E-02	0.46	0.39
				1.47	12.2	1.50E-02	0.46	0.39
GRJ-01-611 0.5-3' Sandy silt	1.317	2.79	33.0	1.16	14.2	2.50E-02	0.58	0.28
				1.16	14.2	2.30E-02	0.58	0.28
				1.19	26.0	1.30E-02	0.58	0.54
				1.17	25.5	8.50E-03	0.58	0.52
				1.20	32.7	4.00E-03	0.57	0.69
				1.17	35.6	4.00E-03	0.58	0.72
GRJ-01-611 3.5-7' Sand	1.635	2.69	11.6	1.47	4.8	5.50E-02	0.45	0.15
				1.45	6.4	3.10E-02	0.46	0.20
				1.48	9.0	2.40E-02	0.45	0.29
				1.47	9.5	2.90E-02	0.45	0.31
				1.47	12.1	1.60E-02	0.45	0.40
				1.48	12.1	1.70E-02	0.45	0.40

UMTRA/SFS D-2
WYL 2/11/87
chk PS 2/25/87

MKE DOCUMENT NO. 5025-GRJ-L-04-01262-00

WYL
PS
JL

JE
JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS
5301 CENTRAL AVENUE N.E. — SUITE 1700, ALBUQUERQUE, NEW MEXICO 87108
TELEPHONE (505) 846-4030

September 30, 1987

Mr. Robert Heneks
Morrison-Knudsen Engineering, Inc.
Headquarters Office
180 Howard Street
San Francisco, California 94105

Dear Mr. Heneks:

Enclosed are the results of radon diffusion coefficient testing for Grand Junction, Colorado uranium tailings.

Should you have any questions, please contact me.

Sincerely,
JACOBS ENGINEERING GROUP INC.

DGonzales

Douglas E. Gonzales
Senior Health Physicist

DEG:jw
Enclosure

cc: TWathen, MKE (w/o encl.)

Attachment: 5025-GRJ-C-04-01263-00

RECEIVED-MKE
OCT 05 1987
UMTRA-S.E.

PS 3/28/88
WYL 4/5/88

ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-S-87-0032

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS

TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE Sept. 8, 1987
CONTRACT C8717 - 103
BY RYB

SAMPLE IDENTIFICATION Tailings - Grand Junction, CO
SUBMITTED BY Rogers & Associates Engineering Corporation DATE RECEIVED July 30, 1987

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] (Mp/P)	COMMENTS POROSITY
MKBH33-F-B(2-20')	10.0	1.68	1.3E-02	0.44	0.38
MKBH33-F-B(2-20')	13.5	1.72	1.8E-03	0.63	0.37
MKBH33-F-B(2-20')	17.0	1.67	1.4E-04	0.74	0.38

[a] BASED ON A SPECIFIC GRAVITY OF 2.71 g/cm^3.

JEG-AL-AS-2 (8/87)

D-5

PS 3/28/88
WYL 4/5/88

ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-S-87-0032

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS
TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE Sept. 8, 1987
CONTRACT C8717 - 103
BY RYB

SAMPLE IDENTIFICATION Tailings - Grand Junction, CO
SUBMITTED BY Rogers & Associates Engineering Corporation DATE RECEIVED July 30, 1987

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION* (M_p/P)	COMMENTS POROSITY
MKBH29(0-20')	5.5	1.68	2.0E-02	0.25	0.37
MKBH29(0-20')	13.5	1.70	2.2E-03	0.63	0.36
MKBH29(0-20')	18.7	1.67	4.2E-04	0.84	0.37

* BASED ON A SPECIFIC GRAVITY OF 2.67 g/cm^3.

JEG-AL-AS-2 (2/87)

D-6

PS 3/28/88
WYL 4/5/88

ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-S-87-0032

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS
TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE Sept. 8, 1987
CONTRACT C8717 - 103
BY RYB

SAMPLE IDENTIFICATION Tailings - Grand Junction, CO
SUBMITTED BY Rogers & Associates Engineering Corporation DATE RECEIVED July 30,1987

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] (Mp/P)	COMMENTS POROSITY
MKBH2~~9~~6(20'-30')	9.3	1.70	1.5E-02	0.43	0.37
MKBH2~~9~~6(20-30')	13.5	1.67	1.2E-03	0.60	0.38
MKBH2~~9~~6(20-30')	17.9	1.70	2.0E-04	0.83	0.37

[a] BASED ON A SPECIFIC GRAVITY OF 2.68 g/cm^3.

MKE DOC. No. 5025-GRJ-L-04-03839-00

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS
5301 CENTRAL AVENUE N.E. — SUITE 1700, ALBUQUERQUE, NEW MEXICO 87108
TELEPHONE (505) 845-4030

Received 1-12-'90
JEGA/MIS/0190-0002
Revision 3
H.L. 2/5/90

January 8, 1990 [illegible] 5-22-90

Mr. Robert Heneks
MK-ES
180 Howard Street
San Francisco, CA 94105

Re: Diffusion Coefficient Measurements

Dear Mr. Heneks:

Enclosed are diffusion coefficient measurements for Grand Junction/Cheney II, Colorado (Task 126) as per your correspondence of November 8, 1989.

If you have any questions concerning these results, do not hesitate to contact me.

Sincerely,
JACOBS ENGINEERING GROUP INC.
DEGonzales

Douglas E. Gonzales, Ph.D
Senior Health Physicist

DG/sh
Enclosures

cc: (w/o enclosures)
FFeliz
MLucero
CNestor
WTaber

RECEIVED-MKE
JAN 1 · 1990
UMTRA-S.E.

Attachment(s) : MKE DOC. No. 5025-GRJ-R-04-03840-00
MKE DOC. No. 5025-GRJ-R-09-03841-00

ATTACHMENT NO. 1 TO EXHIBIT D MKE DOC. No. 5025-GRJ-R-04-03840-00

JE JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

copy #1

DATE: December 20, 1989

Rev. 3
H.L. 2/5/90

DELIVERABLE TRANSMITTAL/REVIEW

SUBCONTRACT NO. 34-6704-S-87-0032 SITE: GRJ PROJ. NO. C8944

SUBCONTRACTOR:
Rogers & Associates Engineering
515 East 4500 South
Salt Lake City, UT 84107

PLEASE CHECK APPROPRIATE BOX(ES):

☐ DRAFT ☒ FINAL
☐ PARTIAL ☐ TOTAL
☐ REVISION

DELIVERABLE Task- 126

TITLE/DESCRIPTION OF DOCUMENTS Report of Radon Diffusion Coefficient Measurements Time-Dependent Diffusion Method for cover soils from Grand Junction, CO (Cheney II site)

NO. ORIG. REQ. ______ NO. RECD. ______ (INIT.) ______

3 NO. COPY REQ. 2 NO. RECD. (INIT.)

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RECD 12-27-89 ROUTED 12-27-89 SUSPENSE 12-27-89

TO:	ACCEPTED	• NOT ACCEPTED	SIGNATURE/DATE
1. (TR) D Gonzales	☒	☐	12/27/89
2. (QA) B Bearden	☒	☐	B Bearden 12/27/89
3. (SM) E Barker	☑	☐	E Barker 1/3/90
4. (TM) L Leyva	☑	☐	Linda Leyva 1/5/90

TO DOC. CONTROL (DATE) ______ BY: ______
(Technical Representative)

FILE NO. 517.8.5

(DC) ______ ☐ ☐ D Gonzales 1/8/90

Rita E. Peterson 1/6/90

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JAN 11 1990
UMTRA-S.E.

CC: (WITHOUT ATTACHMENTS)
(CR) C. Nectar (SM) E Barker
(TR) D. Gonzales

• COMMENTS: ______

JAN 1990
RECEIVED

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D-9

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DATE: December 20, 1989

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DELIVERABLE TRANSMITTAL/REVIEW

SUBCONTRACT NO. 34-6704-S-87-0032

SITE: GRJ

PROJ. NO. C8944

SUBCONTRACTOR:

Rogers & Associates Engineering
515 East 4500 South
Salt Lake City, UT 84107

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DELIVERABLE Task- 126

TITLE/DESCRIPTION OF DOCUMENTS Report of Radon Diffusion Coefficient Measurements Time-Dependent Diffusion Method for cover soils from Grand Junction, CO (Cheney II site)

____ NO. ORIG. REQ. ____ NO. RECD. ____ (INIT.)

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TO:	ACCEPTED	* NOT ACCEPTED	SIGNATURE/DATE
1. (TR)	☐	☐	/
2. (QA)	☐	☐	/
3. (SM)	☐	☐	/
4. (TM)	☐	☐	/

TO DOC. CONTROL (DATE) ____ BY: ____
(Technical Representative)

FILE NO. ____

(DC) ____ ☐ ☐ ____/____

CC: (WITHOUT ATTACHMENTS)

(CR) ____ (SM) ____

(TR) ____

* COMMENTS: ____

D-10

ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-S-87-0032

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ALBUQUERQUE OPERATIONS

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REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS

TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE 12-20-89

CONTRACT C8944 - 126

BY RYB RKW

SAMPLE IDENTIFICATION Cover Soils - Grand Junction, CO (Cheney II Site)

SUBMITTED BY Rogers & Associates Engineering Corporation DATE RECEIVED

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] (Mp/P)	COMMENTS POROSITY
#10 TP-123	9.3	1.74	1.0E-02	0.43	0.37
#10 TP-123	11.4	1.75	1.2E-02	0.54	0.37
#10 TP-123	13.7	1.74	3.9E-03	0.64	0.38
#10 TP-123	15.4	1.75	4.8E-04	0.72	0.37
#10 TP-123	17.2	1.75	2.7E-04	0.81	0.37
AVERAGE	13.4	1.746			0.372
			RADON DIFFUSION COEFF.	m$_r$	
			1.0E-02	0.430	
			1.2E-02	0.540	
			3.9E-03	0.630	
			4.8E-04	0.724	
			2.7E-04	0.808	

$$\text{Avg porosity} = \frac{0.372 + 0.395 + 0.352 + 0.39 + 0.364 + 0.372}{6}$$

$= 0.3742$

use 0.375

---

[a] BASED ON A SPECIFIC GRAVITY OF 2.788 g/cm^3.

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ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-S-87-0032

JE JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

REV. 3
H.L. 45/90
OBS 7-22-9

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS

TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE Dec. 20, 1989

CONTRACT C8944' - 126

BY RYB / KRW

SAMPLE IDENTIFICATION Cover Soils - Grand Junction, CO (Cheney II Site)

SUBMITTED BY Rogers & Associates Engineering Corporation DATE RECEIVED

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] (Mp/P)	COMMENTS POROSITY
#12 TP-125	10.5	1.67	2.1E-02	0.44	0.40
#12 TP-125	12.4	1.68	1.4E-02	0.53	0.39
#12 TP-125	14.3	1.68	8.6E-03	0.61	0.39
#12 TP-125	17.2	1.68	3.7E-04	0.74	0.39
#12 TP-125	17.6	1.67	4.5E-04	0.75	0.40
#12 TP-125	18.9	1.68	1.2E-04	0.80	0.40
AVERAGE	15.15	1.676			0.395
			RADON DIFF COEFF	m	
			2.1E-2	0.442	
			1.4E-2	0.53	
			8.6E-3	0.61	
			3.7E-4	0.735	
			4.5E-4	0.741	
			1.2E-4	0.808	

[a] BASED ON A SPECIFIC GRAVITY OF 2.768 g/cm^3.

ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-S-87-0032

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JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

Rev. 3
H.L. 2/5/92

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS

TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE 12-20-89

CONTRACT C8944 - 126

BY RYB / KKN

SAMPLE IDENTIFICATION Cover Soils - Grand Junction, CO (Cheney II Site)

SUBMITTED BY Rogers & Associates Engineering Corporation

DATE RECEIVED

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION [a] (Mp/P)	COMMENTS POROSITY
#15 TP-127	8.7	1.79	1.7E-02	0.44	0.35
#15 TP-127	10.4	1.80	1.1E-02	0.53	0.35
#15 TP-127	12.7	1.79	4.0E-03	0.64	0.35
#15 TP-127	15.2	1.79	2.0E-04	0.77	0.36
#15 TP-127	16.6	1.79	2.8E-04	0.84	0.35
Average	12.72	1.792			0.352

[a] BASED ON A SPECIFIC GRAVITY OF 2.772 g/cm^3.

ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-S-87-0032

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JE JACOBS ENGINEERING GROUP INC.
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H.L. 2/15/90
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REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS

TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE 12-20-89

CONTRACT C8944 - 126

BY RYB / KKN

SAMPLE IDENTIFICATION Cover Soils - Grand Junction, CO (Cheney II Site)

SUBMITTED BY Rogers & Associates Engineering Corporation DATE RECEIVED

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] (Mp/P)	COMMENTS POROSITY
#17 TP-130	10.2	1.69	1.4E-02	0.44	0.39
#17 TP-130	12.6	1.69	8.1E-03	0.55	0.39
#17 TP-130	15.5	1.68	2.5E-03	0.66	0.39
#17 TP-130	16.9	1.69	4.6E-04	0.73	0.39
#17 TP-130	19.1	1.69	1.7E-04	0.82	0.39
AVERAGE	14.86	1.688			0.39

[a] BASED ON A SPECIFIC GRAVITY OF 2.767 g/cm^3.

ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-5-87-0032

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JE JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

REVISION 3
H.L. 2/5/90
GB55-22-90

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS

TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE 12-20-89

CONTRACT C8944 -126

BY RYB / KKN

SAMPLE IDENTIFICATION Cover Soils - Grand Junction, CO (Cheney II Site)

SUBMITTED BY Rogers & Associates Engineering Corporation DATE RECEIVED

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] (Mp/P)	COMMENTS POROSITY
#19 TP-131	9.0	1.75	1.3E-02	0.43	0.37
#19 TP-131	10.9	1.76	9.9E-03	0.53	0.36
#19 TP-131	12.3	1.76	1.1E-02	0.60	0.36
#19 TP-131	15.4	1.75	4.0E-04	0.74	0.37
#19 TP-131	17.3	1.76	1.5E-04	0.84	0.36
AVERAGE	12.98	1.756			0.364

[a] BASED ON A SPECIFIC GRAVITY OF 2.762 g/cm^3.

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ATTACHMENT 7 TO EXHIBIT C, CONTRACT NO. 34-6704-S-87-0032

JE JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

Revision 3
H.L. 2/5/90
0855-22-70

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS

TIME-DEPENDENT DIFFUSION TEST METHOD

REPORT DATE 12-20-89

CONTRACT C8944 -126

BY RYB / KKN

SAMPLE IDENTIFICATION Cover Soils - Grand Junction, CO (Cheney II Site)

SUBMITTED BY Rogers & Associates Engineering Corporation DATE RECEIVED

SAMPLE ID	MOISTURE (DRY WT.%)	DENSITY (g/cm³)	RADON DIFFUSION COEFF. (cm²/s)	SATURATION [a] (Mp/P)	COMMENTS POROSITY
#21 TP-136	9.3	1.75	1.4E-02	0.44	0.37
#21 TP-136	12.5	1.74	1.2E-02	0.58	0.38
#21 TP-136	13.1	1.76	7.1E-03	0.63	0.37
#21 TP-136	13.3	1.76	3.3E-04	0.73	0.37
#21 TP-136	17.5	1.76	1.5E-04	0.84	0.37
AVERAGE	13.54	1.754			0.372

[a] BASED ON A SPECIFIC GRAVITY OF 2.788 g/cm³.

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MKE DOC. No. 5025-GRJ-R-09-03841-00

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H.L. 2/5/91
0855-22-90

REPORT OF DIFFUSION RUN "SPLIT SAMPLE" MOISTURES

RECEIVED-MKE
JAN 11 1990
UMTRA-S.F.

REPORT DATE 12-20-89

TASK # 126

SAMPLE ID #10 TP-123

MASS WEIGHTED AVERAGE MOISTURE 13.7

Layer #	Moisture %	Dry Mass (g)
1	13.5	364.57
2	14.3	326.73
3	14.3	312.08
4	12.6	299.26

MASS WEIGHTED AVERAGE MOISTURE 15.4

Layer #	Moisture %	Dry Mass (g)
1	15.4	308.65
2	15.5	347.82

MASS WEIGHTED AVERAGE MOISTURE 17.2

Layer #	Moisture %	Dry Mass (g)
1	17.2	360.35
2	17.3	276.59

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REV. 3

H.L. 2/5/90

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REPORT OF DIFFUSION RUN "SPLIT SAMPLE" MOISTURES

REPORT DATE 12-20-89

TASK # 126

SAMPLE ID #12 TP-125

MASS WEIGHTED AVERAGE MOISTURE 14.3

Layer #	Moisture %	Dry Mass (g)
1	14.3	345.89
2	15.3	319.10
3	14.8	290.76
4	12.8	283.56

MASS WEIGHTED AVERAGE MOISTURE 17.2

Layer #	Moisture %	Dry Mass (g)
1	17.2	317.30
2	17.1	312.64

MASS WEIGHTED AVERAGE MOISTURE 17.6

Layer #	Moisture %	Dry Mass (g)
1	17.7	350.81
2	17.6	254.09

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D- 18
REV. 3
H.L. 2/5/90
5-22-90

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REPORT OF DIFFUSION RUN "SPLIT SAMPLE" MOISTURES

REPORT DATE 12-20-89

TASK # 126

SAMPLE ID #12 TP-125

MASS WEIGHTED AVERAGE MOISTURE 18.9

Layer #	Moisture %	Dry Mass (g)
1	19.0	298.26
2	18.7	311.91

MASS WEIGHTED AVERAGE MOISTURE

Layer #	Moisture %	Dry Mass (g)

MASS WEIGHTED AVERAGE MOISTURE

Layer #	Moisture %	Dry Mass (g)

RAE

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REV. 3
H.L. 2/5/9
GBS 5-22-90

REPORT OF DIFFUSION RUN "SPLIT SAMPLE" MOISTURES

REPORT DATE 12-20-89

TASK # 126

SAMPLE ID #15 TP-127

MASS WEIGHTED AVERAGE MOISTURE 12.7

Layer #	Moisture %	Dry Mass (g)
1	12.8	337.15
2	13.2	325.60
3	13.2	337.76
4	11.6	318.02

MASS WEIGHTED AVERAGE MOISTURE 15.2

Layer #	Moisture %	Dry Mass (g)
1	15.1	328.49
2	15.3	329.65

MASS WEIGHTED AVERAGE MOISTURE 16.6

Layer #	Moisture %	Dry Mass (g)
1	16.5	373.00
2	16.7	278.33

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REV. 3
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GB 5-22-90

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REPORT OF DIFFUSION RUN "SPLIT SAMPLE" MOISTURES

REPORT DATE 12-20-89

TASK # 126

SAMPLE ID #17 TP-130

MASS WEIGHTED AVERAGE MOISTURE 15.5

Layer #	Moisture %	Dry Mass (g)
1	15.9	293.65
2	15.5	330.32
3	15.5	315.23
4	15.1	275.99

MASS WEIGHTED AVERAGE MOISTURE 16.9

Layer #	Moisture %	Dry Mass (g)
1	16.9	307.47
2	16.9	303.86

MASS WEIGHTED AVERAGE MOISTURE 19.1

Layer #	Moisture %	Dry Mass (g)
1	19.1	299.03
2	19.0	310.34

R
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REPORT OF DIFFUSION RUN "SPLIT SAMPLE" MOISTURES

REPORT DATE 12-20-89

TASK # 126

SAMPLE ID #19 TP-131

MASS WEIGHTED AVERAGE MOISTURE 12.3

Layer #	Moisture %	Dry Mass (g)
1	11.8	325.51
2	13.0	307.44
3	13.0	276.83
4	11.5	387.29

MASS WEIGHTED AVERAGE MOISTURE 15.4

Layer #	Moisture %	Dry Mass (g)
1	15.4	323.67
2	15.4	306.29

MASS WEIGHTED AVERAGE MOISTURE 17.3

Layer #	Moisture %	Dry Mass (g)
1	17.4	310.63
2	17.3	327.31

D-22

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GBS 5-22-90

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REPORT OF DIFFUSION RUN "SPLIT SAMPLE" MOISTURES

REPORT DATE 12-20-89
TASK # 126
SAMPLE ID #21 TP-136

MASS WEIGHTED AVERAGE MOISTURE 13.1

Layer #	Moisture %	Dry Mass (g)
1	13.2	383.57
2	13.9	263.81
3	13.5	251.63
4	12.1	378.16

MASS WEIGHTED AVERAGE MOISTURE 15.3

Layer #	Moisture %	Dry Mass (g)
1	15.2	321.16
2	15.3	319.36

MASS WEIGHTED AVERAGE MOISTURE 17.5

Layer #	Moisture %	Dry Mass (g)
1	17.8	359.25
2	17.2	280.71

R
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Appendix E

SWRDAT COMPUTER OUTPUTS

Page E-1.

DATA FOR CALCULATED SOIL WATER RETENTION CURVE

METHOD CODE: SCS NSSL BAUMER C985 ID: 406082

Revision 3
H.L. 2/5/90
GBS 5-22-90

ME: umtra-grj, 3, tp123
: a, 14-23
ROCK FRAGMENTS (VOL%): 16.0, CLAY: 26.0, SILT: 39.0, SAND: 35.0, OM: .25, CLAY ACTIVITY: HIGH

WATER CONTENTS

SOIL SUCTION (CM) (1 BAR = 1020 CM)	MODERATELY HIGH COMPACTION			EXPECTED COMPACTION (MEDIUM)			MODERATELY LOW COMPACTION		
	<2MM SOIL FRACTION WEIGHT %	<2MM SOIL FRACTION VOLUME %	WHOLE SOIL VOLUME %	<2MM SOIL FRACTION WEIGHT %	<2MM SOIL FRACTION VOLUME %	WHOLE SOIL VOLUME %	<2MM SOIL FRACTION WEIGHT %	<2MM SOIL FRACTION VOLUME %	WHOLE SOIL VOLUME %
.00	23.22	36.92	31.01	27.01	40.44	33.97	31.31	43.55	36.58
10.00	23.22	36.92	31.01	27.01	40.44	33.97	31.31	43.55	36.58
20.00	23.22	36.92	31.01	27.01	40.44	33.97	31.29	43.52	36.56
30.00	23.22	36.92	31.01	27.01	40.44	33.97	31.23	43.44	36.49
40.00	23.22	36.92	31.01	27.00	40.43	33.96	31.11	43.29	36.36
60.00	23.22	36.92	31.01	26.95	40.36	33.90	30.69	42.73	35.89
80.00	23.20	36.88	30.98	26.78	40.11	33.70	30.04	41.88	35.18
100.00	23.10	36.74	30.86	26.43	39.61	33.27	29.30	40.90	34.36
150.00	22.36	35.61	29.91	25.15	37.77	31.72	27.55	38.58	32.41
200.00	21.52	34.33	28.83	24.01	36.13	30.35	26.19	36.76	30.88
300.00	20.34	32.52	27.32	22.45	33.88	28.46	24.31	34.24	28.76
340.00	19.99	31.98	26.87	21.99	33.21	27.89	23.75	33.49	28.13
400.00	19.55	31.31	26.30	21.41	32.37	27.19	23.05	32.54	27.34
600.00	18.52	29.71	24.96	20.06	30.39	25.53	21.42	30.33	25.48
1000.00	17.33	27.87	23.41	18.53	28.15	23.64	19.58	27.82	23.37
2000.00	15.90	25.64	21.54	16.72	25.47	21.40	17.44	24.87	20.89
5000.00	14.29	23.11	19.42	14.73	22.52	18.92	15.12	21.66	18.19
10000.00	13.25	21.48	18.04	13.48	20.65	17.35	13.70	19.66	16.52
15300.00	12.68	20.58	17.29	12.81	19.64	16.50	12.94	18.60	15.62
102000.00	10.66	17.36	14.59	10.49	16.15	13.57	10.39	15.01	12.61

CLOD BULK DENSITY FOR <2MM SOIL FRACTION:			
OVEN DRY	1.79	1.69	1.60
WET (1/3 BAR)	1.60	1.51	1.41

EQUATION PARAMETERS:			
ALPHA	.008466	.009788	.012107
RM	.026973	.044558	.080645
RN	7.411980	5.171140	3.141490
WCS(WT%)	23.22	27.01	31.31
WCR(WT%)	6.27	6.27	6.27
BD.INTER	1.66	1.57	1.47
BD.SLOPE	-.003151	-.002546	-.002526

MODEL EQUATIONS:

WATER CONTENT (WT%) = WCR + ((WCS - WCR) / (1.0 + (ALPHA * SUCTION) ** RN)) ** RM)
FIELD BULK DENSITY = BD.INTER + WATER(WT%) * BD.SLOPE
WATER CONTENT (VOL%) = WATER(WT%) * (FIELD BULK DENSITY)
WATER CONTENT (WHOLE SOIL - VOL%) = WATER(VOL%) * (1.0 - (ROCK FRAGMENTS(VOL%) / 100.0))

EXPLANATIONS: WCS = WT% OF WATER AT ZERO SUCTION; WCR = RESIDUAL WATER CONTENT (NEAR AIR DRY)

Page E-2

DATA FOR CALCULATED SOIL WATER RETENTION CURVE METHOD CODE: SCS NSSL BAUMER C985 ID: 309102

Revision 3
H.L. 2/5/90
GBS 5-22-90

AME: umtra-grj, 3, tp125
N: a, 18-21
ROCK FRAGMENTS (VOL%): 3.0, CLAY: 44.0, SILT: 45.0, SAND: 11.0, OM: .25, CLAY ACTIVITY: MODERATELY HIGH

WATER CONTENTS

	MODERATELY HIGH COMPACTION			EXPECTED COMPACTION (MEDIUM)			MODERATELY LOW COMPACTION		
SOIL SUCTION (CM)	<2MM SOIL FRACTION		WHOLE SOIL	<2MM SOIL FRACTION		WHOLE SOIL	<2MM SOIL FRACTION		WHOLE SOIL
(1 BAR = 1020 CM)	WEIGHT %	VOLUME %	VOLUME %	WEIGHT %	VOLUME %	VOLUME %	WEIGHT %	VOLUME %	VOLUME %
.00	24.89	38.58	37.42	29.11	42.19	40.92	33.96	45.77	44.39
10.00	24.89	38.58	37.42	29.11	42.19	40.92	33.96	45.77	44.39
20.00	24.89	38.58	37.42	29.11	42.19	40.92	33.96	45.77	44.39
30.00	24.89	38.58	37.42	29.11	42.19	40.92	33.96	45.77	44.39
40.00	24.89	38.58	37.42	29.11	42.19	40.92	33.96	45.77	44.39
60.00	24.89	38.58	37.42	29.11	42.19	40.92	33.90	45.69	44.32
80.00	24.89	38.58	37.42	29.11	42.19	40.92	33.87	45.65	44.28
100.00	24.89	38.58	37.42	29.11	42.19	40.92	33.83	45.60	44.23
150.00	24.89	38.58	37.42	29.05	42.11	40.85	33.70	45.44	44.08
200.00	24.89	38.58	37.42	29.02	42.06	40.80	33.55	45.25	43.89
300.00	24.89	38.58	37.42	28.93	41.95	40.69	33.20	44.80	43.46
340.00	24.89	38.58	37.42	28.89	41.89	40.63	33.04	44.60	43.27
400.00	24.86	38.54	37.38	28.82	41.80	40.55	32.79	44.29	42.96
600.00	24.83	38.48	37.33	28.57	41.46	40.21	31.93	43.19	41.90
1000.00	24.71	38.31	37.16	27.96	40.62	39.40	30.24	41.04	39.81
2000.00	24.21	37.58	36.45	26.31	38.34	37.19	27.11	37.01	35.90
5000.00	22.11	34.48	33.45	22.72	33.36	32.35	22.72	31.27	30.33
10000.00	19.57	30.71	29.78	19.80	29.25	28.37	19.87	27.49	26.67
15300.00	18.02	28.37	27.52	18.20	26.96	26.16	18.38	25.50	24.73
102000.00	13.09	20.84	20.21	13.23	19.80	19.20	13.72	19.19	18.62

CLOD BULK DENSITY FOR <2MM SOIL FRACTION:

OVEN DRY	1.83	1.73	1.63
WET (1/3 BAR)	1.55	1.45	1.35

EQUATION PARAMETERS:

ALPHA	.000260	.000468	.001111
RM	.183756	.226672	.200002
RN	2.071580	1.651060	1.649940
WCS(WT%)	24.89	29.11	33.96
WCR(WT%)	8.34	8.34	8.34
BD.INTER	1.64	1.54	1.43
BD.SLOPE	-.003538	-.002977	-.002542

MODEL EQUATIONS:

WATER CONTENT (WT%) = WCR + ((WCS - WCR) / (1.0 + (ALPHA * SUCTION) ** RN)) ** RM)
FIELD BULK DENSITY = BD.INTER + WATER(WT%) * BD.SLOPE
WATER CONTENT (VOL%) = WATER(WT%) * (FIELD BULK DENSITY)
WATER CONTENT (WHOLE SOIL - VOL%) = WATER(VOL%) * (1.0 - (ROCK FRAGMENTS(VOL%) / 100.0))

EXPLANATIONS: WCS = WT% OF WATER AT ZERO SUCTION; WCR = RESIDUAL WATER CONTENT (NEAR AIR DRY)

Revision 3
H.L. 2/5/90
GBS 5-22-90

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DATA FOR CALCULATED SOIL WATER RETENTION CURVE                              METHOD CODE: SCS NSSL BAUMER C985    ID: 308072


  NAME: umtra-grj, 3, tp127
     N: a, 15-25.5
ROCK FRAGMENTS (VOL%): 10.0, CLAY: 38.0, SILT: 34.0, SAND: 28.0, OM:  .25, CLAY ACTIVITY: MODERATELY HIGH

                                                     ***W A T E R   C O N T E N T S***

                          MODERATELY HIGH COMPACTION          EXPECTED COMPACTION (MEDIUM)          MODERATELY LOW COMPACTION
 SOIL SUCTION (CM)      <2MM SOIL FRACTION  WHOLE SOIL  <2MM SOIL FRACTION  WHOLE SOIL  <2MM SOIL FRACTION  WHOLE SOIL
 (1 BAR = 1020 CM)      WEIGHT %  VOLUME %  VOLUME   %  WEIGHT %  VOLUME %  VOLUME   %  WEIGHT %  VOLUME %  VOLUME   %
          .00            22.94     36.86     33.18            26.66     40.08     36.08            30.89     43.53     39.18
        10.00            22.94     36.86     33.18            26.66     40.08     36.08            30.89     43.53     39.18
        20.00            22.94     36.86     33.18            26.66     40.08     36.08            30.87     43.51     39.16
        30.00            22.94     36.86     33.18            26.66     40.08     36.08            30.85     43.47     39.13
        40.00            22.93     36.85     33.16            26.66     40.08     36.08            30.81     43.42     39.07
        60.00            22.92     36.83     33.14            26.64     40.05     36.05            30.67     43.23     38.91
        80.00            22.89     36.79     33.11            26.60     40.00     36.00            30.46     42.96     38.67
       100.00            22.86     36.74     33.07            26.54     39.92     35.93            30.20     42.61     38.35
       150.00            22.74     36.56     32.90            26.27     39.53     35.57            29.42     41.57     37.41
       200.00            22.58     36.31     32.68            25.85     38.94     35.04            28.61     40.49     36.44
       300.00            22.19     35.71     32.14            24.93     37.62     33.86            27.24     38.65     34.78
       340.00            22.02     35.46     31.91            24.60     37.15     33.43            26.79     38.04     34.24
       400.00            21.79     35.10     31.59            24.15     36.50     32.85            26.20     37.25     33.52
       600.00            21.12     34.06     30.66            23.02     34.87     31.38            24.75     35.28     31.75
      1000.00            20.20     32.64     29.37            21.66     32.91     29.62            23.03     32.93     29.64
      2000.00            18.97     30.74     27.67            19.99     30.47     27.42            20.94     30.07     27.06
      5000.00            17.51     28.46     25.61            18.07     27.65     24.89            18.60     26.82     24.13
     10000.00            16.53     26.91     24.22            16.81     25.80     23.22            17.10     24.72     22.25
     15300.00            15.97     26.04     23.43            16.12     24.77     22.29            16.28     23.57     21.21
    102000.00            13.87     22.72     20.44            13.59     20.99     18.89            13.39     19.49     17.54

  CLOD BULK DENSITY FOR <2MM SOIL FRACTION:
    OVEN DRY                       1.84                          1.75                                1.65
    WET (1/3 BAR)                  1.61                          1.51                                1.42

  EQUATION PARAMETERS:
    ALPHA                      .003657                      .005297                      .007107
    RM                         .061345                      .053927                      .083402
    RN                        2.408250                     3.340820                     2.485730
    WCS(WT%)                 22.94                        26.66                        30.89
    WCR(WT%)                 7.39                         7.39                         7.39
    BD.INTER                 1.68                         1.59                         1.49
    BD.SLOPE                 -.003360                     -.003130                     -.002650

  MODEL EQUATIONS:
    WATER CONTENT (WT%) = WCR + ((WCS - WCR) / (1.0 + (ALPHA * SUCTION) ** RN)) ** RM)
    FIELD BULK DENSITY = BD.INTER + WATER(WT%) * BD.SLOPE
    WATER CONTENT (VOL%) = WATER(WT%) * (FIELD BULK DENSITY)
    WATER CONTENT (WHOLE SOIL - VOL%) = WATER(VOL%) * (1.0 - (ROCK FRAGMENTS(VOL%) / 100.0))

  EXPLANATIONS:  WCS = WT% OF WATER AT ZERO SUCTION; WCR = RESIDUAL WATER CONTENT (NEAR AIR DRY)
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DATA FOR CALCULATED SOIL WATER RETENTION CURVE

METHOD CODE: SCS NSSL BAUMER C985 ID: 406072

Revision 3
H.L. 2/5/90
GBS 5-22-90

NAME: umtra-grj, 3, tp130
: a, 10.5-14.5
ROCK FRAGMENTS (VOL%): 1.0, CLAY: 25.0, SILT: 32.0, SAND: 43.0, OM: .25, CLAY ACTIVITY: HIGH

WATER CONTENTS

	MODERATELY HIGH COMPACTION			EXPECTED COMPACTION (MEDIUM)			MODERATELY LOW COMPACTION		
SOIL SUCTION (CM)	<2MM SOIL FRACTION		WHOLE SOIL	<2MM SOIL FRACTION		WHOLE SOIL	<2MM SOIL FRACTION		WHOLE SOIL
(1 BAR = 1020 CM)	WEIGHT %	VOLUME %	VOLUME %	WEIGHT %	VOLUME %	VOLUME %	WEIGHT %	VOLUME %	VOLUME %
.00	22.88	36.58	36.21	26.59	40.03	39.63	30.79	43.08	42.64
10.00	22.88	36.58	36.21	26.59	40.03	39.63	30.77	43.04	42.61
20.00	22.88	36.58	36.21	26.59	40.03	39.63	30.67	42.91	42.49
30.00	22.88	36.58	36.21	26.59	40.03	39.63	30.48	42.67	42.24
40.00	22.88	36.58	36.21	26.58	40.02	39.62	30.22	42.32	41.90
60.00	22.88	36.58	36.21	26.51	39.92	39.52	29.52	41.40	40.99
80.00	22.84	36.52	36.16	26.22	39.51	39.11	28.74	40.37	39.97
100.00	22.63	36.20	35.84	25.68	38.73	38.34	27.98	39.36	38.97
150.00	21.59	34.60	34.25	24.22	36.63	36.26	26.38	37.22	36.85
200.00	20.78	33.36	33.03	23.15	35.07	34.72	25.17	35.60	35.24
300.00	19.71	31.72	31.40	21.72	32.99	32.66	23.50	33.34	33.00
340.00	19.40	31.23	30.92	21.30	32.38	32.05	23.00	32.66	32.33
400.00	19.00	30.62	30.32	20.78	31.61	31.29	22.37	31.80	31.49
600.00	18.07	29.17	28.88	19.55	29.80	29.50	20.90	29.79	29.49
1000.00	16.99	27.48	27.21	18.14	27.73	27.46	19.20	27.47	27.19
2000.00	15.67	25.42	25.17	16.47	25.26	25.00	17.22	24.71	24.47
5000.00	14.18	23.08	22.84	14.62	22.49	22.27	15.05	21.69	21.47
10000.00	13.21	21.54	21.33	13.45	20.73	20.52	13.70	19.80	19.60
15300.00	_12.68_	20.69	20.48	12.81	19.77	19.57	12.98	18.78	18.59
102000.00	10.75	17.62	17.44	10.59	16.41	16.24	10.52	15.29	15.14

CLOD BULK DENSITY FOR <2MM SOIL FRACTION:			
OVEN DRY	1.80	1.70	1.61
WET (1/3 BAR)	1.61	1.52	1.42

EQUATION PARAMETERS:			
ALPHA	.010243	.011683	.014251
RM	.018286	.035885	.101194
RN	10.302160	6.091830	2.379260
WCS(WT%)	22.88	26.59	30.79
WCR(WT%)	6.27	6.27	6.27
BD.INTER	1.67	1.58	1.48
BD.SLOPE	-.003247	-.002723	-.002696

MODEL EQUATIONS:
WATER CONTENT (WT%) = WCR + ((WCS - WCR) / (1.0 + (ALPHA * SUCTION) ** RN)) ** RM)
FIELD BULK DENSITY = BD.INTER + WATER(WT%) * BD.SLOPE
WATER CONTENT (VOL%) = WATER(WT%) * (FIELD BULK DENSITY)
WATER CONTENT (WHOLE SOIL - VOL%) = WATER(VOL%) * (1.0 - (ROCK FRAGMENTS(VOL%) / 100.0))

EXPLANATIONS: WCS = WT% OF WATER AT ZERO SUCTION; WCR = RESIDUAL WATER CONTENT (NEAR AIR DRY)

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Revision 3
H.L. 2/5/90
OBS 5-22-90

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DATA FOR CALCULATED SOIL WATER RETENTION CURVE                          METHOD CODE: SCS NSSL BAUMER C985     ID: 406072


    NAME: umtra-grj, 3, tp131
      N: a, 17-25
ROCK FRAGMENTS (VOL%):  3.0, CLAY: 27.0, SILT: 33.0, SAND: 40.0, OM:  .25, CLAY ACTIVITY: HIGH

                                                ***WATER CONTENTS***

                        MODERATELY HIGH COMPACTION          EXPECTED COMPACTION (MEDIUM)         MODERATELY LOW COMPACTION
  SOIL SUCTION (CM)   <2MM SOIL FRACTION  WHOLE SOIL  <2MM SOIL FRACTION  WHOLE SOIL  <2MM SOIL FRACTION  WHOLE SOIL
  (1 BAR = 1020 CM)   WEIGHT %  VOLUME %  VOLUME   %  WEIGHT %  VOLUME %  VOLUME   %  WEIGHT %  VOLUME %  VOLUME   %
           .00         22.88     36.58     35.48       26.59     40.03     38.83       30.79     43.08     41.78
         10.00         22.88     36.58     35.48       26.59     40.03     38.83       30.77     43.04     41.75
         20.00         22.88     36.58     35.48       26.59     40.03     38.83       30.67     42.91     41.63
         30.00         22.88     36.58     35.48       26.59     40.03     38.83       30.48     42.67     41.39
         40.00         22.88     36.58     35.48       26.58     40.02     38.82       30.22     42.32     41.05
         60.00         22.88     36.58     35.48       26.51     39.92     38.72       29.52     41.40     40.16
         80.00         22.84     36.52     35.43       26.22     39.51     38.32       28.74     40.37     39.16
        100.00         22.63     36.20     35.11       25.68     38.73     37.57       27.98     39.36     38.18
        150.00         21.59     34.60     33.56       24.22     36.63     35.53       26.38     37.22     36.10
        200.00         20.78     33.36     32.36       23.15     35.07     34.02       25.17     35.60     34.53
        300.00         19.71     31.72     30.77       21.72     32.99     32.00       23.50     33.34     32.34
        340.00         19.40     31.23     30.30       21.30     32.38     31.41       23.00     32.66     31.68
        400.00         19.00     30.62     29.70       20.78     31.61     30.66       22.37     31.80     30.85
        600.00         18.07     29.17     28.29       19.55     29.80     28.91       20.90     29.79     28.90
       1000.00         16.99     27.48     26.66       18.14     27.73     26.90       19.20     27.47     26.64
       2000.00         15.67     25.42     24.66       16.47     25.26     24.50       17.22     24.71     23.97
       5000.00         14.18     23.08     22.38       14.62     22.49     21.82       15.05     21.69     21.04
      10000.00         13.21     21.54     20.89       13.45     20.73     20.11       13.70     19.80     19.20
      15300.00         12.68     20.69     20.07       12.81     19.77     19.17       12.98     18.78     18.21
     102000.00         10.75     17.62     17.09       10.59     16.41     15.91       10.52     15.29     14.83

  CLOD BULK DENSITY FOR <2MM SOIL FRACTION:
    OVEN DRY                     1.80                           1.70                           1.61
    WET (1/3 BAR)                1.61                           1.52                           1.42

  EQUATION PARAMETERS:
    ALPHA                 .010243                        .011683                        .014251
    RM                    .018286                        .035885                        .101194
    RN                  10.302160                       6.091830                       2.379260
    WCS(WT%)            22.88                          26.59                          30.79
    WCR(WT%)             6.27                           6.27                           6.27
    BD.INTER             1.67                           1.58                           1.48
    BD.SLOPE            -.003247                       -.002723                       -.002696

  MODEL EQUATIONS:
    WATER CONTENT (WT%) = WCR + ((WCS - WCR) / (1.0 + (ALPHA * SUCTION) ** RN)) ** RM)
    FIELD BULK DENSITY = BD.INTER + WATER(WT%) * BD.SLOPE
    WATER CONTENT (VOL%) = WATER(WT%) * (FIELD BULK DENSITY)
    WATER CONTENT (WHOLE SOIL - VOL%) = WATER(VOL%) * (1.0 - (ROCK FRAGMENTS(VOL%) / 100.0))

  EXPLANATIONS:  WCS = WT% OF WATER AT ZERO SUCTION; WCR = RESIDUAL WATER CONTENT (NEAR AIR DRY)
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H.L. 2/5/90
0855-22-90

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DATA FOR CALCULATED SOIL WATER RETENTION CURVE                              METHOD CODE: SCS NSSL BAUMER C985     ID: 109092

    NAME: umtra-grj, 3, tp136
       N: a, 10-17
ROCK FRAGMENTS (VOL%):  1.0, CLAY: 42.0, SILT: 43.0, SAND: 15.0, OM:  .25, CLAY ACTIVITY: LOW

                                                  ***W A T E R   C O N T E N T S***

                        MODERATELY HIGH COMPACTION        EXPECTED COMPACTION (MEDIUM)        MODERATELY LOW COMPACTION
 SOIL SUCTION (CM)    <2MM SOIL FRACTION  WHOLE SOIL  <2MM SOIL FRACTION  WHOLE SOIL  <2MM SOIL FRACTION  WHOLE SOIL
 (1 BAR = 1020 CM)    WEIGHT %  VOLUME %  VOLUME   %  WEIGHT %  VOLUME %  VOLUME   %  WEIGHT %  VOLUME %  VOLUME   %
           .00         25.85     39.74     39.34         30.26     43.45     43.02         35.34     47.16     46.68
         10.00         25.85     39.74     39.34         30.26     43.45     43.02         35.34     47.16     46.68
         20.00         25.85     39.74     39.34         30.26     43.45     43.02         35.34     47.16     46.68
         30.00         25.85     39.74     39.34         30.26     43.45     43.02         35.34     47.16     46.68
         40.00         25.85     39.74     39.34         30.26     43.45     43.02         35.34     47.16     46.68
         60.00         25.84     39.73     39.33         30.26     43.45     43.02         35.34     47.16     46.68
         80.00         25.82     39.70     39.30         30.26     43.45     43.02         35.30     47.11     46.64
        100.00         25.77     39.63     39.23         30.25     43.43     43.00         34.89     46.57     46.10
        150.00         25.48     39.18     38.79         29.54     42.44     42.02         32.89     43.96     43.52
        200.00         25.01     38.47     38.09         28.47     40.94     40.53         31.47     42.09     41.67
        300.00         24.11     37.12     36.75         27.01     38.89     38.50         29.58     39.62     39.22
        340.00         23.82     36.68     36.32         26.58     38.28     37.89         29.02     38.89     38.50
        400.00         23.44     36.11     35.75         26.03     37.50     37.12         28.32     37.96     37.58
        600.00         22.52     34.72     34.38         24.72     35.65     35.29         26.65     35.77     35.41
       1000.00         21.42     33.06     32.73         23.18     33.47     33.14         24.72     33.22     32.88
       2000.00         20.04     30.96     30.65         21.29     30.77     30.47         22.36     30.10     29.80
       5000.00         18.38     28.44     28.15         19.07     27.62     27.35         19.67     26.53     26.26
      10000.00         17.25     26.71     26.44         17.60     25.51     25.26         17.91     24.18     23.94
      15300.00        _16.60_    25.72     25.46         16.77     24.33     24.09         16.94     22.88     22.65
     102000.00         14.10     21.88     21.67         13.68     19.89     19.69         13.40     18.14     17.96

CLOD BULK DENSITY FOR <2MM SOIL FRACTION:
  OVEN DRY                       1.63                            1.53                            1.43
  WET (1/3 BAR)                  1.54                            1.44                            1.34

EQUATION PARAMETERS:
  ALPHA                      .006565                         .007946                         .010571
  RM                         .027067                         .011932                         .012818
  RN                        4.624250                       13.137170                       14.112850
  WCS(WT%)                 25.85                           30.26                           35.34
  WCR(WT%)                  4.75                            4.75                            4.75
  BD.INTER                  1.57                            1.47                            1.37
  BD.SLOPE                 -.001301                        -.001091                        -.000896

MODEL EQUATIONS:
  WATER CONTENT (WT%) = WCR + ((WCS - WCR) / (1.0 + (ALPHA * SUCTION) ** RN)) ** RM)
  FIELD BULK DENSITY = BD.INTER + WATER(WT%) * BD.SLOPE
  WATER CONTENT (VOL%) = WATER(WT%) * (FIELD BULK DENSITY)
  WATER CONTENT (WHOLE SOIL - VOL%) = WATER(VOL%) * (1.0 - (ROCK FRAGMENTS(VOL%) / 100.0))

EXPLANATIONS:  WCS = WT% OF WATER AT ZERO SUCTION; WCR = RESIDUAL WATER CONTENT (NEAR AIR DRY)
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Appendix F
RAECOM COMPUTER OUTPUTS

REV. 4 HL 11/15/90

SLS 11.16.90

Run A

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RAECOMET.FOR - SUMMARY OF INPUT

     INPUT FILENAME:                 grja.dat

     HEADING:             UMTRA-GRAND JUNCTION (RUN A)
     LAYERS:              3
     INITIAL FLUX:         .000
     AMBIENT RN:           .800
     OPTIMIZED LAYER:     3
     SURFACE FLUX LIMIT:  20.000
     PRECISION:           .0010

     LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
     NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
     -----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
         3       30.5     .00292      .375      .0        .00          1.73     .0000000   14.7300     2.768
         2      304.8     .01000      .340    66.5        .35          1.78     .0002556   10.0300     2.697
         1     1220.0     .01200      .492   570.0        .36          1.39     .0012162   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0    +/-    .100E-02 pCi/m2/sec

     BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6      pCi/m2/sec


       *****  RESULTS OF RADON DIFFUSION MODELING         CALCULATION    -    RAECOMET/FOR   *****

     LAYER    THICKNESS        EXIT FLUX          EXIT CONC.          MIC          AIR CONC.          H2O CONC.
                (cm)         (pCi/m2/sec)       (pCi/liter)                        (pCi/l)            (pCi/l)

       3         30.          1.9991E+01         3.9771E-01          .4971        .8000E+00          .2080E+00
       2        305.          2.6717E+01         7.4276E+04          .6114        .1215E+06          .3158E+05
       1       1220.          1.3622E+02         4.0520E+05          .6237        .6497E+06          .1689E+06
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1

RUN B

Rev. 4
HL 11/15/90

SLB 11·16·90

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RAECOMET.FOR - SUMMARY OF INPUT

 INPUT FILENAME:                GRJB.DAT

 HEADING:              UMTRA-GRAND JUNCTION (RUN B)
 LAYERS:               3
 INITIAL FLUX:          .000
 AMBIENT RN:            .800
 OPTIMIZED LAYER:      3
 SURFACE FLUX LIMIT:   20.000
 PRECISION:            .0010

 LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
 NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
 -----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
    3        30.5     .00395      .375      .0        .00          1.73     .0000000   14.3400     2.768
    2       304.8     .01000      .340    81.0        .38          1.78     .0003381    9.7400     2.697
    1      1220.0     .01200      .492   600.0        .37          1.39     .0013158   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0    +/-   .100E-02 pCi/m2/sec

 BARE SOURCE FLUX (Jo) FROM LAYER 1 :  489.6      pCi/m2/sec


   *****  RESULTS OF RADON DIFFUSION MODELING        CALCULATION   -   RAECOMET/FOR  *****

 LAYER   THICKNESS      EXIT FLUX          EXIT CONC.         MIC        AIR CONC.        H2O CONC.
           (cm)       (pCi/m2/sec)       (pCi/liter)                     (pCi/l)          (pCi/l)

   3        49.        2.0009E+01        4.0836E-01        .5105       .8000E+00        .2080E+00
   2       305.        3.4121E+01        9.8762E+04        .6227       .1586E+06        .4124E+05
   1      1220.        1.4098E+02        4.4656E+05        .6237       .7160E+06        .1862E+06
```

Sh. F-3
REV. 4
HL 11/15/90
SWS 11/16/90

RUN C

```
RAECOMET.FOR - SUMMARY OF INPUT

 INPUT FILENAME:                    GRJC.DAT

 HEADING:               UMTRA-GRAND JUNCTION (RUN C)
 LAYERS:                3
 INITIAL FLUX:           .000
 AMBIENT RN:             .800
 OPTIMIZED LAYER:       3
 SURFACE FLUX LIMIT:    20.000
 PRECISION:             .0010

 LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
 NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
 -----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
    3       30.5     .00371      .375      .0        .00          1.73     .0000000    14.7900     2.768
    2      304.8     .01000      .340    66.5        .35          1.78     .0002556    10.0300     2.697
    1     1220.0     .01200      .492   570.0        .36          1.39     .0012162    18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0    +/-    .100E-02 pCi/m2/sec

 BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


     *****  RESULTS OF RADON DIFFUSION MODELING          CALCULATION   -   RAECOMET/FOR  *****

 LAYER    THICKNESS        EXIT FLUX          EXIT CONC.          MIC         AIR CONC.        H2O CONC.
             (cm)        (pCi/m2/sec)        (pCi/liter)                       (pCi/l)          (pCi/l)

   3          36.         2.0019E+01         3.9607E-01          .4951        .8000E+00        .2080E+00
   2         305.         2.7810E+01         7.2058E+04          .6114        .1179E+06        .3064E+05
   1        1220.         1.3624E+02         4.0518E+05          .6237        .6496E+06        .1689E+06
```

RUN D

REV. 4

Sh. F-4

H. L. 11/15/9

SHB 11.16.90

```
RAECOMET.FOR - SUMMARY OF INPUT

INPUT FILENAME:               grjd.dat

HEADING:            UMTRA-GRAND JUNCTION (RUN D)
LAYERS:             3
INITIAL FLUX:        .000
AMBIENT RN:          .800
OPTIMIZED LAYER:    3
SURFACE FLUX LIMIT: 20.000
PRECISION:          .0010

LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
-----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
    3       30.5     .00533      .375      .0        .00          1.73     .0000000   13.7900     2.768
    2      304.8     .01000      .340    81.0        .38          1.78     .0003381    9.7400     2.697
    1     1220.0     .01200      .492   600.0        .37          1.39     .0013158   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0    +/-    .100E-02 pCi/m2/sec

      BARE SOURCE FLUX (Jo) FROM LAYER 1 :  489.6     pCi/m2/sec


      *****  RESULTS OF RADON DIFFUSION MODELING        CALCULATION   -   RAECOMET/FOR  *****

LAYER   THICKNESS      EXIT FLUX         EXIT CONC.        MIC        AIR CONC.       H2O CONC.
          (cm)       (pCi/m2/sec)      (pCi/liter)                    (pCi/l)         (pCi/l)

  3        62.        2.0008E+01        4.2338E-01        .5292      .8000E+00       .2080E+00
  2       305.        3.7103E+01        9.2708E+04        .6227      .1489E+06       .3871E+05
  1      1220.        1.4103E+02        4.4650E+05        .6237      .7159E+06       .1861E+06
```

Sh. F-5

REV. 4 HL 11/15/90

SWB 11.16.90

RUN E

```
RAECOMET.FOR - SUMMARY OF INPUT

     INPUT FILENAME:                    GRJE.DAT

     HEADING:              UMTRA-GRAND JUNCTION (RUN E)
     LAYERS:               3
     INITIAL FLUX:          .000
     AMBIENT RN:            .800
     OPTIMIZED LAYER:      3
     SURFACE FLUX LIMIT:   20.000
     PRECISION:            .0010

     LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
     NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
     -----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
         3       30.5     .00292      .375      .0        .00          1.73     .0000000   14.7300     2.768
         2      152.4     .01000      .340    66.5        .35          1.78     .0002556   10.0300     2.697
         1     1220.0     .01200      .492   570.0        .36          1.39     .0012162   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :      20.0    +/-   .100E-02 pCi/m2/sec

     BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


       *****  RESULTS OF RADON DIFFUSION MODELING         CALCULATION   -   RAECOMET/FOR  *****

LAYER     THICKNESS       EXIT FLUX          EXIT CONC.          MIC          AIR CONC.         H2O CONC.
             (cm)        (pCi/m2/sec)        (pCi/liter)                       (pCi/l)           (pCi/l)

  3           42.         2.0013E+01         3.9771E-01         .4971         .8000E+00         .2080E+00
  2          152.         3.3797E+01         1.1412E+05         .6114         .1866E+06         .4853E+05
  1         1220.         1.3840E+02         4.0240E+05         .6237         .6452E+06         .1678E+06
```

Sh. T-6
HL 11/19/90
PS 11/19/90

RUN F

REV. 4

```
RAECOMET.FOR - SUMMARY OF INPUT

     INPUT FILENAME:                  GRJF.DAT

     HEADING:               UMTRA-GRAND JUNCTION (RUN F, LAYER 2=150 PCI/GR)
     LAYERS:                3
     INITIAL FLUX:           .000
     AMBIENT RN:             .800
     OPTIMIZED LAYER:       3
     SURFACE FLUX LIMIT:    20.000
     PRECISION:             .0010

     LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
     NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
     -----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
         3       30.5     .00292      .375      .0        .00          1.73     .0000000   14.7300     2.768
         2      304.8     .01000      .340   150.0        .35          1.78     .0005766   10.0300     2.697
         1     1220.0     .01200      .492   570.0        .36          1.39     .0012162   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :        20.0    +/-    .100E-02 pCi/m2/sec

     BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


       *****  RESULTS OF RADON DIFFUSION MODELING          CALCULATION   -   RAECOMET/FOR  *****


     LAYER    THICKNESS        EXIT FLUX            EXIT CONC.          MIC         AIR CONC.          H2O CONC.
                (cm)          (pCi/m2/sec)         (pCi/liter)                       (pCi/l)            (pCi/l)

       3         57.          2.0012E+01           3.9771E-01          .4971       .8000E+00          .2080E+00
       2        305.          4.7843E+01           1.8210E+05          .6114       .2978E+06          .7743E+05
       1       1220.          8.9994E+01           4.6443E+05          .6237       .7447E+06          .1936E+06
```

1

RUN G

REV. 4

Sh. F-7
HL 11/15/90
SB 11.1690

```
RAECOMET.FOR - SUMMARY OF INPUT

INPUT FILENAME:                 GRJG.DAT

HEADING:              UMTRA-GRAND JUNCTION (RUN G)
LAYERS:               3
INITIAL FLUX:          .000
AMBIENT RN:            .800
OPTIMIZED LAYER:      3
SURFACE FLUX LIMIT:   20.000
PRECISION:             .0010

LAYER THICKNESS DIFFUSION POROSITY RA-226 EMANATING BULK DENSITY SOURCE TERM MOISTURE SPECIFIC
NO.   CM        CM2-SEC   FRACTION PCI/G  FRACTION  G/CM3        PCI/CM3-SEC % DRY WT GRAVITY
----- --------- --------- -------- ------ --------- ------------ ----------- -------- --------
    3      30.5    .00292     .375     .0       .00         1.73    .0000000  14.7300    2.768
    2     457.2    .01000     .340   66.5       .35         1.78    .0002556  10.0300    2.697
    1    1220.0    .01200     .492  570.0       .36         1.39    .0012162  18.0000    2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0    +/-   .100E-02 pCi/m2/sec

     BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


     *****  RESULTS OF RADON DIFFUSION MODELING        CALCULATION   -   RAECOMET/FOR  *****

LAYER   THICKNESS      EXIT FLUX        EXIT CONC.        MIC        AIR CONC.        H2O CONC.
          (cm)       (pCi/m2/sec)      (pCi/liter)                    (pCi/l)          (pCi/l)

  3        28.         1.9994E+01        3.9771E-01       .4971      .8000E+00        .2080E+00
  2       457.         2.6017E+01        6.9756E+04       .6114      .1141E+06        .2966E+05
  1      1220.         1.3589E+02        4.0562E+05       .6237      .6504E+06        .1691E+06
```

RUN H

REV. 4

Sh. F-1A
HL 11/15/90
11.16.90

```
RAECOMET.FOR - SUMMARY OF INPUT

     INPUT FILENAME:                 GRJH.DAT

     HEADING:            UMTRA-GRAND JUNCTION (RUN H)
     LAYERS:             3
     INITIAL FLUX:        .000
     AMBIENT RN:          .800
     OPTIMIZED LAYER:    3
     SURFACE FLUX LIMIT: 20.000
     PRECISION:          .0010

     LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
     NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
     -----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
       3        30.5     .00395      .375      .0        .00          1.73     .0000000   14.3400     2.768
       2       304.8     .01000      .340    81.0        .38          1.78     .0003381    9.7400     2.697
       1      1220.0     .01200      .492   800.0        .37          1.39     .0017544   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0    +/-    .100E-02 pCi/m2/sec

     BARE SOURCE FLUX (Jo) FROM LAYER 1 :  652.8      pCi/m2/sec


       *****  RESULTS OF RADON DIFFUSION MODELING         CALCULATION   -   RAECOMET/FOR  *****


    LAYER   THICKNESS      EXIT FLUX          EXIT CONC.        MIC        AIR CONC.        H20 CONC.
              (cm)       (pCi/m2/sec)       (pCi/liter)                    (pCi/l)          (pCi/l)

      3        50.        2.0009E+01        4.0836E-01        .5105       .8000E+00        .2080E+00
      2       305.        3.4603E+01        1.0088E+05        .6227       .1620E+06        .4212E+05
      1      1220.        2.0404E+02        5.7483E+05        .6237       .9217E+06        .2396E+06
```

RUN I

REV. 4

Sh. F_7
HL 11/15/9
Gh3 11.16.90

```
RAECOMET.FOR - SUMMARY OF INPUT

      INPUT FILENAME:                 GRJI.DAT

      HEADING:             UMTRA-GRAND JUNCTION (RUN I)
      LAYERS:              3
      INITIAL FLUX:         .000
      AMBIENT RN:           .800
      OPTIMIZED LAYER:     3
      SURFACE FLUX LIMIT:  20.000
      PRECISION:           .0010

      LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
      NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
      -----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
          3       30.5     .00395      .375      .0        .00          1.73     .0000000   14.3400     2.768
          2      304.8     .01000      .340    81.0        .38          1.78     .0003381    9.7400     2.697
          1     1220.0     .02000      .492   800.0        .37          1.39     .0017544    8.0000     2.736

  LAYER 3 ADJUSTED TO MEET Jcrit :       20.0     +/-    .100E-02 pCi/m2/sec

      BARE SOURCE FLUX (Jo) FROM LAYER 1 :  842.8      pCi/m2/sec


        *****  RESULTS OF RADON DIFFUSION MODELING         CALCULATION    -    RAECOMET/FOR  *****

      LAYER   THICKNESS        EXIT FLUX           EXIT CONC.          MIC        AIR CONC.         H2O CONC.
                 (cm)        (pCi/m2/sec)         (pCi/liter)                      (pCi/l)           (pCi/l)

        3         49.         2.0009E+01          4.0836E-01          .5105       .8000E+00         .2080E+00
        2        305.         3.4327E+01          9.9670E+04          .6227       .1601E+06         .4162E+05
        1       1220.         1.6797E+02          6.6956E+05          .8327       .8040E+06         .2090E+06
```

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REVISION 3
H.L. 2/5/90
GBS 5-22-90

Run (A)

```
RAECOMET.FOR - SUMMARY OF INPUT

FILENAME:          GRJRB1.DAT

HEADING:           UMTRA - GRJ - A (MEAN)
LAYERS:            3
INITIAL FLUX:       .000
AMBIENT RN:         .800
OPTIMIZED LAYER:   3
SURFACE FLUX LIMIT: 20.000
PRECISION:          .0010

LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
-----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
   3       30.5     .00292      .375      .0        .00           1.73    .0000000   14.7287     2.768
   2      304.8     .01000      .304    66.5        .35           1.87    .0003004   10.0300     2.687
   1     1220.0     .01200      .492   570.0        .36           1.39    .0012162   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0   +/-   .100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


      *****  RESULTS OF RADON DIFFUSION MODELING         CALCULATION   -   RAECOMET/FOR  *****

       LAYER    THICKNESS      EXIT FLUX        EXIT CONC.        MIC        AIR CONC.       H2O CONC.
                  (cm)       (pCi/m2/sec)      (pCi/liter)                    (pCi/l)         (pCi/l)

         3         35.        2.0011E+01       3.9775E-01       .4972       .8000E+00       .2080E+00
         2        305.        2.9682E+01       8.1640E+04       .5434       .1502E+06       .3906E+05
         1       1220.        1.0731E+02       4.4223E+05       .6237       .7091E+06       .1844E+06
```

superseded by REV. 4 Sh. F-1

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REVISION 3

Run ⑧ H.L. 2/5/90

GBS 5-22-90

```
RAECOMET.FOR - SUMMARY OF INPUT

INPUT FILENAME:      GRJRB1.DAT

HEADING:             UMTRA - GRJ - B (MEAN + SEM)
LAYERS:              3
INITIAL FLUX:         .000
AMBIENT RN:           .800
OPTIMIZED LAYER:     3
SURFACE FLUX LIMIT:  20.000
PRECISION:           .0010

LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
-----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
  3        30.5     .00395      .375      .0        .00          1.73    .0000000   14.3365     2.768
  2       304.8     .01000      .304    81.0        .38          1.87    .0003972    9.7400     2.687
  1      1220.0     .01200      .492   600.0        .37          1.39    .0013158   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0     +/-    .100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 :  489.6     pCi/m2/sec


      *****  RESULTS OF RADON DIFFUSION MODELING          CALCULATION   -   RAECOMET/FOR  *****


       AYER   THICKNESS      EXIT FLUX         EXIT CONC.          MIC        AIR CONC.       H2O CONC.
                (cm)       (pCi/m2/sec)      (pCi/liter)                      (pCi/l)         (pCi/l)

        3        56.        2.0012E+01        4.0846E-01          .5106       .8000E+00       .2080E+00
        2       305.        3.8971E+01        1.0680E+05          .5566       .1919E+06       .4989E+05
        1      1220.        1.0909E+02        4.8742E+05          .6237       .7815E+06       .2032E+06
```

Superseded by REV. 4 Sh. F-2

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Revision 3
H.L. 2/5/90
CBS 5-22-90

Run Ⓒ

```
RAECOMET.FOR - SUMMARY OF INPUT

 ILENAME:        GRJRB1.DAT

HEADING:         UMTRA - GRJ - C (MEAN)
LAYERS:          3
INITIAL FLUX:     .000
AMBIENT RN:       .800
OPTIMIZED LAYER:  3
SURFACE FLUX LIMIT: 20.000
PRECISION:       .0010

LAYER THICKNESS DIFFUSION POROSITY RA-226 EMANATING BULK DENSITY SOURCE TERM MOISTURE SPECIFIC
NO.   CM        CM2-SEC   FRACTION PCI/G  FRACTION  G/CM3        PCI/CM3-SEC % DRY WT GRAVITY
----- --------- --------- -------- ------ --------- ------------ ----------- -------- --------
  3      30.5    .00371     .375     .0      .00         1.73     .0000000   14.7941   2.768
  2     304.8    .01000     .304   66.5      .35         1.87     .0003004   10.0300   2.687
  1    1220.0    .01200     .492  570.0      .36         1.39     .0012162   18.0000   2.736

LAYER 3 ADJUSTED TO MEET Jcrit :      20.0    +/-   .100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


     *****  RESULTS OF RADON DIFFUSION MODELING        CALCULATION  -  RAECOMET/FOR  *****

 AYER  THICKNESS      EXIT FLUX        EXIT CONC.        HIC       AIR CONC.      H2O CONC.
          (cm)      (pCi/m2/sec)      (pCi/liter)                   (pCi/l)        (pCi/l)

   3       42.       2.0019E+01        3.9596E-01       .4949     .8000E+00      .2080E+00
   2      305.       3.1014E+01        7.8614E+04       .5434     .1447E+06      .3761E+05
   1     1220.       1.0734E+02        4.4221E+05       .6237     .7090E+06      .1843E+06
```

Superseded by Rev. 4, Sh-F-3

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Run (D)

Revision 3
H.L. 2/5/90
CBS 5-22-90

```
RAECOMET.FOR - SUMMARY OF INPUT

     FILENAME:        grjrb1.dat

HEADING:              UNTRA - GRJ - D (MEAN + SEM FROM SWRDAT)
LAYERS:               3
INITIAL FLUX:          .000
AMBIENT RN:            .800
OPTIMIZED LAYER:      3
SURFACE FLUX LIMIT:  20.000
PRECISION:            .0010

LAYER THICKNESS DIFFUSION POROSITY RA-226 EMANATING BULK DENSITY SOURCE TERM MOISTURE SPECIFIC
NO.   CM        CM2-SEC   FRACTION PCI/G  FRACTION  G/CM3        PCI/CM3-SEC % DRY WT GRAVITY
----- --------- --------- -------- ------ --------- ------------ ----------- -------- --------
   3      30.5    .00533     .375     .0       .00         1.73    .0000000   13.7918    2.768
   2     304.8    .01000     .304   81.0       .38         1.87    .0003972    9.7400    2.687
   1    1220.0    .01200     .492  600.0       .37         1.39    .0013158   18.0000    2.736

LAYER 3 ADJUSTED TO MEET Jcrit :        20.0    +/-    .100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 :  489.6     pCi/m2/sec


       *****  RESULTS OF RADON DIFFUSION MODELING          CALCULATION   -   RAECOMET/FOR  *****


   LAYER   THICKNESS      EXIT FLUX          EXIT CONC.        MIC        AIR CONC.       H2O CONC.
             (cm)       (pCi/m2/sec)       (pCi/liter)                    (pCi/l)         (pCi/l)

     3        70.        2.0009E+01         4.2333E-01       .5292       .8000E+00       .2080E+00
     2       305.        4.2372E+01         9.9078E+04       .5566       .1780E+06       .4628E+05
     1      1220.        1.0915E+02         4.8735E+05       .6237       .7814E+06       .2032E+06
```

Superseded by Rev. 4, Sh F-4

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Rev (E)

REVISION 3
H.L. 2/5/90
OBS 5-22-90

```
RAECOMET.FOR - SUMMARY OF INPUT

 ILENAME:           GRJRB1.DAT

HEADING:            UMTRA - GRJ - A (MEAN, 152.4 CM OFF-PILE TAILING)
LAYERS:             3
INITIAL FLUX:        .000
AMBIENT RN:          .800
OPTIMIZED LAYER:    3
SURFACE FLUX LIMIT: 20.000
PRECISION:          .0010

LAYER THICKNESS DIFFUSION POROSITY RA-226 EMANATING BULK DENSITY SOURCE TERM MOISTURE SPECIFIC
NO.   CM        CM2-SEC   FRACTION PCI/G  FRACTION  G/CM3        PCI/CM3-SEC % DRY WT GRAVITY
----- --------- --------- -------- ------ --------- ------------ ----------- -------- --------
  3       30.5    .00292    .375     .0       .00         1.73    .0000000   14.7287    2.768
  2      152.4    .01000    .304   66.5       .35         1.87    .0003004   10.0300    2.687
  1     1220.0    .01200    .492  570.0       .36         1.39    .0012162   18.0000    2.736

LAYER 3 ADJUSTED TO MEET Jcrit :      20.0    +/-    .100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


      *****  RESULTS OF RADON DIFFUSION MODELING        CALCULATION  -  RAECOMET/FOR  *****


   AYER    THICKNESS      EXIT FLUX        EXIT CONC.       MIC        AIR CONC.       H2O CONC.
             (cm)       (pCi/m2/sec)      (pCi/liter)                   (pCi/l)         (pCi/l)

   3          45        2.0011E+01        3.9775E-01       .4972       .8000E+00       .2080E+00
   2         152.       3.6566E+01        1.1397E+05       .5434       .2097E+06       .5453E+05
   1        1220.       1.1050E+02        4.3815E+05       .6237       .7025E+06       .1827E+06
```

Superseded by Rev. 4, Sh. F-5

~~Page F-7~~

Revision 3
H.L. 2/5/90
OB3 5-22-90

Run ⑥

```
RAECOMET.FOR - SUMMARY OF INPUT

   ILENAME:         GRJRB1.DAT

HEADING:            UMTRA - GRJ - A (MEAN, 457.2 CM OFF-PILE TAILING)
LAYERS:             3
INITIAL FLUX:        .000
AMBIENT RN:          .800
OPTIMIZED LAYER:    3
SURFACE FLUX LIMIT: 20.000
PRECISION:          .0010

LAYER THICKNESS DIFFUSION POROSITY RA-226 EMANATING BULK DENSITY SOURCE TERM MOISTURE SPECIFIC
NO.   CM        CM2-SEC   FRACTION PCI/G  FRACTION  G/CM3        PCI/CM3-SEC % DRY WT GRAVITY
----- --------- --------- -------- ------ --------- ------------ ----------- -------- --------
  3       30.5    .00292    .375     .0       .00          1.73    .0000000  14.7287    2.768
  2      457.2    .01000    .304   66.5       .35          1.87    .0003004  10.0300    2.687
  1     1220.0    .01200    .492  570.0       .36          1.39    .0012162  18.0000    2.736

LAYER 3 ADJUSTED TO MEET Jcrit :       20.0    +/-    .100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


      *****  RESULTS OF RADON DIFFUSION MODELING        CALCULATION   -   RAECOMET/FOR  *****


      AYER  THICKNESS      EXIT FLUX        EXIT CONC.      MIC       AIR CONC.       H2O CONC.
              (cm)       (pCi/m2/sec)      (pCi/liter)                (pCi/l)         (pCi/l)

        3      34.        2.0020E+01       3.9775E-01      .4972     .8000E+00       .2080E+00
        2     457.        2.8976E+01       7.8011E+04      .5434     .1436E+06       .3732E+05
        1    1220.        1.0691E+02       4.4276E+05      .6237     .7099E+06       .1846E+06
```

Superseded by Rev. 4, Sh. F-7

Run (F)

Revision 3
H.L. 2/5/90
OBS 5-22-90

```
RAECOMET.FOR - SUMMARY OF INPUT

INPUT FILENAME:     GRJRB1.DAT

[illegible]:        UNTRA - GRJ - A (MEAN, 100 pCi/gr OFF-PILE TAILING)
LAYERS:             3
INITIAL FLUX:        .000
AMBIENT RN:          .800
OPTIMIZED LAYER:    3
SURFACE FLUX LIMIT: 20.000
PRECISION:          .0010

LAYER  THICKNESS  DIFFUSION  POROSITY  RA-226  EMANATING  BULK DENSITY  SOURCE TERM  MOISTURE  SPECIFIC
NO.    CM         CM2-SEC    FRACTION  PCI/G   FRACTION   G/CM3         PCI/CM3-SEC  % DRY WT  GRAVITY
-----  ---------  ---------  --------  ------  ---------  ------------  -----------  --------  --------
   3       30.5    .00292      .375       .0        .00           1.73    .0000000   14.7287     2.768
   2      304.8    .01000      .304    100.0        .35           1.87    .0004517   10.0300     2.687
   1     1220.0    .01200      .492    570.0        .36           1.39    .0012162   18.0000     2.736

LAYER 3 ADJUSTED TO MEET Jcrit :      20.0    +/-    .100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 :  452.6     pCi/m2/sec


       *****  RESULTS OF RADON DIFFUSION MODELING         CALCULATION   -   RAECOMET/FOR  *****


      LAYER   THICKNESS       EXIT FLUX          EXIT CONC.        MIC        AIR CONC.        H2O CONC.
                (cm)        (pCi/m2/sec)       (pCi/liter)                    (pCi/l)          (pCi/l)

        3        49.         2.0017E+01        3.9775E-01        .4972       .8000E+00        .2080E+00
        2       305.         4.0029E+01        1.2910E+05        .5434       .2376E+06        .6176E+05
        1      1220.         8.6196E+01        4.6929E+05        .6237       .7525E+06        .1956E+06
```

Superseded by Rev. 4, Sh. F-6

MKE DOCUMENT NO.5025-GRJ-C-01-01828-03

Calculation Cover Sheet

Contract No. 5025 **Discipline** ESCUP **Calc. No.** 05-670-02-~~00~~ ~~01~~ 03
No. of Sheets ~~34~~ 44

Project UMTRA — Grand Junction

Feature Radon Barrier

Item Average Ra-226 Concentrations

Sources of Data and References

1. MKE Calc. No. 05-626-01-01 - "Tailings Excavation - Tailings Pile Limits and Quantities
2. MKE Calc. No. 05-626-02-01 - "Tailings Excavation - Off-Pile Excavation Limits and Quantities

~~Sources of Formulae & References~~

3. "Radiologic Characterization of the Grand Junction, Colorado, Uranium Mine Tailings Remedial Action Site" by Susan M. Rush & Paula Jean Bonner of Bendix Field Engineering Corporation, Grand Junction, Colorado (Bendix Report): MKE Doc. No.
4. Grand Junction Soil Ra 226/Thorium Sample Data; Letter from Garth Stowe (CNSI) to Jim Williams (MKE), MKE Doc. No. 5025-GRJ-C-06-01200-00
5. Grand Junction Site Characterization Data," IOC to J. Williams (MKE) from CNSI; MKE Doc. No. 5025-GRJ-[illegible]

REFERENCES CONTINUED ON PAGE 3

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. ______

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
3		S.E. Botsford	12-18-90	H LUBIS	12/20/90	P. Sircar	12-21-90
2	Ra-226 DISTRIBUTION NEW VP DATA (Sh. 2-A)	P. Sircar	11-16-90	H. LUBIS	11/16/90	P. Sircar	11-16-90
1		S.E. Botsford	2/12/89	P. Sircar	2/14/88	P. Sircar	2/14/88
0		P. Sircar	4-4-88	W. Lin	4/4/88		4/6/88

Form 42-110

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Grand Junction, Colorado Date: December 3, 1990

Document: Preliminary Final Design - August 1990

Commentor: TAC - P. Zelle

Comment: Calculation No. 05-670-02-01

Volume estimates used on sheet 4 are outdated; calculations for on-pile and off-pile average radium-226 concentrations would change slightly if current volume estimates were used. It is recognized that these Ra-226 concentration estimates are reasonable, and any revisions would have no affect on cover thickness calculations as shown by sensitivity analyses in calculation No. 05-670-01-04. Revisions are not considered necessary.

SECTION 2

Response: ________ By: S.E. Botsford

Date: December 20, 1990

We will revise calculation 05-670-02-01 to reflect the current estimate. We have added computations to justify the Ra-226 concentration values used in the calculations.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ________ Date: ________

Approved by: ________ ________

F:\UMTRA\DECDOCRV.GRJ
122690/8

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Grand Junction, Colorado
Date: December 3, 1990
Document: Preliminary Final Design - August 1990
Commentor: TAC - P. Zelle
Comment: Calculation No. 05-670-02-04

Page 8 indicates that the schedule assumes tailings excavation will be completed by mid-1992, and all vicinity property materials will have been deposited in the pond area by the first quarter of 1992 for subsequent relocation to Cheney starting in mid-1992. Is this still the current schedule? If the schedule has been revised, where is the schedule revision located?

SECTION 2

Response:
By: S.E. Botsford
Date: December 20, 1990

The IOC is included to justify the quantities used in the calculation. The calculation 05-670-02-02 needs revision since estimated quantities have been revised per letter from J.G. Oldham to M.L. Matthews dated 4 October 1990. When the calculation is revised (see p.2A calc 05-626-01-01) the "schedule" reference will be omitted. Note that the calculation number in the comment should have been 05-670-02-02.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:
Checked by: Date:
Approved by:

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 1
Project UMTRA-GRJ
Contract No. 5025
File No.
Feature Radon Barrier
Designed PS
Date 3/24/88
Item Average Ra-226 Concentrations
Checked WYL
Date 4/5/88

PURPOSE AND BACKGROUND

The purpose of these computations is to evaluate the maximum average Ra-226 concentrations for each of the distinct layers in the tailings embankment at the Cheney Reservoir Disposal Site. The calculated Ra-226 concentrations are used in the computation of the required radon barrier thickness, from the point of view of emanation of radon gas (see Calc. No. 05-626-01-01 (Ref. 1))

As indicated in the calculations, the present plans are to place the tailings and other contaminated materials from the main pile area (including from the Mill Yard), at the bottom of the embankment, this layer being overlain by contaminated materials from the area of the three former evaporation ponds (Ponds Area Material). Presently contaminated materials from the vicinity are being dumped in the ponds area, a process that will continue till 1991. The ponds area material will be covered by radon barrier, which, in turn, will be overlain by erosion protection materials.

APPROACH

Average Ra-226 concentrations are computed for

- Tailings Material
- Ponds Area Material

A cursory examination is made of the Th-230 content and the Th/Ra ratio for each of the 2 layers, to determine if the Ra-226 concentration will increase any during the 1000-yr design period, from its present value.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ
Feature Radon Barrier
Item Average Ra-226 Concentrations
Contract No. 5025
Designed WYL
Checked Shs
Sheet 2
File No.
Date 3/21/88
Date 12/27/88

SUMMARY OF RESULTS

The data are taken from

- MKE Calc. No. 05-626-01-01 Tailings Excavation - Tailings pile Limits and Quantities (Ref 1)
- MKE Calc. No. 05-626-02-01 Tailings Excavation - Off-pile Excavation Limits and Quantities (Ref. 2)
- Addition Investigation by CNSI in 1987 (Ref 5)
- Radium Concentration in DOE Compound (Ref. 7 & 8)

The Bendix report (Ref. 3) indicated that there was no significant disequilibrium problem between Th-230 and Ra-226. The concentration of Th-230 of the tailings material is very low and can be neglected to determine the thickness of radon barrier cover. A typical set of results is shown on Sheet 31.

A location map of the processing site is presented in Sheet 32.

	Location	Ave Ra-226 Concentration (pc:/g)	Estimated Quantity (cy)
	On-pile		
Tailings Material	Main pile	574.8	2,441,900
	Mill Yard (Area B)	531.7	30,800
	West & South Area (Area C)	240.0	33,800
			2,506,500
	Off-pile		
Ponds Area Material	Pond 1	7.3	9,600
	Pond 2	25.4	11,800
	Pond 3 Existing	47.4	522,300
	Future (Vicinity Property Material, incl. DOE property)	Unknown	1,010,000
			1,553,700

SEE REV 1 p.4
Shs 12-13-88
ps 2/10/89

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

Sheet 2-A
Project UMTRA-GRJ
Contract No. 3885-34
File No.
Feature RADON BARRIER DESIGN
Designed SHB
Date 12.17.90
Item AVERAGE RA-226 CONC.
Checked HL
Date 12/20/90

REVISION 3

QUANTITIES ESTIMATED FOR THE CONTAMINATED MATERIALS HAVE BEEN REVISED PER LETTER FROM J.G. OLDHAM TO M. MATTHEWS DATED OCTOBER 4, 1990 THE FOLLOWING PAGE IS A CHECK TO SEE IF THE CHANGE IN QUANTITIES HAS HAD A APPRECIABLE EFFECT ON THE OVERALL Ra-226 CONCENTRATIONS FOR ON-PILE AND OFF-PILE MATERIALS. THE CONCLUSION IS THAT THE ORIGINAL VALUES ARE ACCEPTABLE FOR USE IN CALCULATING RADON BARRIER THICKNESS.

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

Sheet 2 B

Project UMTRA -GRJ Contract No. 3885-34 File No.
Feature AVE RA-226 CONCENTRATIONS Designed SHB Date 12.17.90
Item Checked HL Date 12 20 90

LOCATION	AVE Ra 226 CONC. (pCi/g)	STANDARD DEVIATION	SEM	ESTIMATED QTY (cy)
ON-PILE				
MAIN PILE	574.8	631.7	30.7	2830800
MILL YARD (AREA B)	461.0	1008.8	87.5	25000
WEST AND SOUTH (AREA C)	297.0	548.0	83.6	26000
OFF-PILE				
POND 1	8.0	11.3	2.5	31000
POND 2	34.2	40.3	8.9	28000
POND 3	60.4	72.2	15.8	2,219,300
GPJO	161.5	-	17.9	100,000

ON-PILE $R_{AVG} = \frac{574.8(2830800) + 461(25,000) + 297(26000)}{2830800 + 25000 + 26000}$

$= \frac{1646390800}{2881800} = 571.3$ pCi/g (569.6 pCi/g USED)

OFF-PILE $R_{AVG} = \frac{8(31000) + 34.2(28000) + 60.4(2,219,300) + 161.5(100,000)}{31000 + 28000 + 2,219,300 + 100,000}$

$= \frac{151401320}{2378300} = 63.7$ pCi/g (66.4 pCi/g USED)

THE AVERAGE VALUES ARE VERY CLOSE TO THOSE ORIGINALLY CALCULATED AND THEREFORE THE RADON BARRIER THICKNESS CALCULATION NEED NOT BE REVISED

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-GRJ
Feature Radon Barrier Design
Item Average Ra-226 Conc.
Contract No. 3885-34
Designed PS
Checked H.L
Sheet 2KC
File No.
Date 11-14-90
Date 11/14/90

REVISION 2

Per comments from NRC and TAC, distributions of Ra-226 concentration were developed for

A. Main Pile Area (including Area B) — Sheet 6C
(other areas, being less contaminated are excluded)

B. Ponds Area (Vicinity Property) Materials — Sheet 6D
(Additional data from 30 samples is included, see Sheet)

The distributions indicate

1. A decreasing frequency with increasing Ra-226 concentration for both distributions

2. For Main Pile tailings, approximately
3/4 of the material below 800 pCi/g
2/3 of the material below 550 pCi/g

3. For Ponds Area/Vicinity Properties materials, approximately
3/4 of the material below 80 pCi/g
2/3 of the material below 40 pCi/g.

4. The average and SEM for the 30 new samples on Sheet 6B are very similar to those on Sheet 5. Thus, nos. on Sheet 5 are used.

Project UMTRA - GRJ	Contract No. 502516	Sheet 3	File No.
Feature AVE Ra 226 CONCENTRATIONS	Designed SWB	Date 12-13-88	
Item	Checked PS	Date 12-14-88	

REVISION 1

THE PURPOSE OF REVISION 1 IS TO RECALCULATE THE AVE. Ra-226 CONCENTRATION FOR THE PILE AND PONDS AREA USING THE METHODS RECOMMENDED IN "RADON BARRIER DESIGN: STATISTICAL AND SENSITIVITY ANALYSIS" (REF.6) AVERAGE Ra_{226} WAS DETERMINED BY VOLUME WEIGHTING AREA RESULTS. SAMPLE SIZE WEIGHTING WAS ALSO DONE. THE MEAN STANDARD DEVIATION AND STANDARD ERROR OF THE MEAN WERE CALCULATED. THE DATA FOR THE DOE COMPOUND WAS INCLUDED IN THE POND AREA AVERAGE CONCENTRATION. (REF. 7)

$$\bar{x} = \Sigma \, x_i / n$$: MEAN

$$s = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{n-1}}$$: STANDARD DEVIATION

$$SEM = \frac{s}{\sqrt{n}}$$: STANDARD ERROR OF THE MEAN

ADD REFERENCES

6. "RADON BARRIER DESIGN: STATISTICAL AND SENSITIVITY ANALYSIS", DRAFT, REV. 1, JULY 26, 1988, MKE DOC NO. 4005-GEN-R-04-05736-00

7. "RADIUM CONCENTRATION OF MATERIALS FROM THE GJPO COMPOUND", US D.O.E. MEMORANDUM, MAY 13, 1988 MKE DOC. NO. 5025-GRJ-R-03-01956-00

8. "Ra-226 CONCENTRATIONS in DOE COMPOUND" MKE Calc. No. 05-670-11-00

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 4
Project UMTRA - GRJ
Contract No. 5025
File No.
Feature Average Ra-226 Concentrations
Designed PS
Date 12-22-88
Item
Checked SWB
Date 2-13-89

LOCATION	Ave. Ra-226 Conc. (pCi/g)	Standard Deviation	SEM	Estimated Qty (cy)
ON-PILE.				
Main Pile	574.8	631.7	30.7	2,441,900
Mill Yard (Area B)	461.0	1008.8	87.5	30,800
West and South Area (Area C)	297.0	548.0	83.6	33,800
OFF-PILE				
Pond 1	8.0	11.3	2.5	9,600
Pond 2	34.2	40.3	8.8	11,800
Pond 3	60.4	72.2	15.8	522,300+910,000(1)
GP JO	161.5(2)	---	17.9(2)	100,000

(1) Estimated additional VP material to be deposited at Pond 3. Assumed similar to Pond 3 material

(2) From Ref 8

$$R_{avg} = \sum R_i V_i / V_{total}$$

On-Pile
$$R_{avg.} = \frac{574.8(2,441,900) + 461.0(30,800) + 297.0(33,800)}{2,441,900 + 30,800 + 33,800}$$
$$= 1,427,841,520 / 2,506,500 = \underline{569.6 \text{ pCi/g}}$$

Off-Pile
$$R_{avg.} = \frac{8.0(9,600) + 34.2(11,800) + 60.4(522,300 + 910,000) + 161.5(100,000)}{9,600 + 11,800 + 522,300 + 910,000 + 100,000}$$
$$= 103,141,280 / 1,553,700 = \underline{66.4 \text{ pCi/g}}$$

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature Average Ra-226 Concentrations
Item
Contract No. 5025
Designed PS
Checked Shz
Sheet 5
File No.
Date 12-22-88
Date 2-13-89

$$SEM_{avg.} = \sqrt{\sum\left(\frac{SEM_i\ V_i}{V_{total}}\right)^2}$$

On-Pile $SEM_{avg.} = \sqrt{\left(\frac{30.7 \times 2{,}441{,}900}{2{,}506{,}500}\right)^2 + \left(\frac{87.5 \times 30{,}800}{2{,}506{,}500}\right)^2 + \left(\frac{83.6 \times 33{,}800}{2{,}506{,}500}\right)^2}$

$= \underline{29.95 \text{ pci/g}}$

Off-Pile $SEM_{avg.} = \sqrt{\left(\frac{2.5 \times 9{,}600}{1{,}553{,}700}\right)^2 + \left(\frac{8.8 \times 11{,}800}{1{,}553{,}700}\right)^2 + \left\{\frac{15.8 \times (522{,}300 + 910{,}000)}{1{,}553{,}700}\right\}^2 + \left(\frac{17.9 \times 100{,}000}{1{,}553{,}700}\right)^2}$

$= \underline{14.61 \text{ pCi/g}}$

		Avg.	Avg. + SEM
Use:	Main Pile	570 pCi/g	600 pCi/g
	Off-Pile	66.5 pCi/g	81.0 pCi/g

Sheet 6
Project UMTRA-GRJ
Contract No. 5025
File No.
Feature Radon Barrier
Designed PS
Date 2/10/89
Item Average Ra-226 Concentrations
Checked SH3
Date 2/13/89

CONCLUSIONS

The 'average' and 'average +SEM' values of Ra-226 concentrati to be used for the design of the radon barrier thickness are :

	Average	Average +SEM
Main Pile	570 pCi/g	600 pCi/g
Ponds Area Material (Off-Pile Material)	66.5 pCi/g	81.0 pCi/g

For the proposed embankment, the value for the Ponds Area Material is of primary significance, since this layer is at least 14 to 15 feet thick.

The Ponds Area material will consist predominantly (see sheets 4 and 7) of vicinity property materials, which are constantly deposited in the Pond 3 area. The process will continue till 1993. Therefore, the computed value above is based on very limited data (only 21 values for over 1.4 million cu yds out of 1.55 cu million). The adequacy of the design will depend on the similarity of the materials already deposited and those that will be deposited in the future. During construction, prior to placement of the radon barrier, in-place Ra-226 concentration measurements will be made, and the radon barrier thickness will be modified, if required.

REV. 2

M DOC.3885-GRJ-R-06-04488-00
Sheet 6A

UMTRA - GRJ
3885-34
AVERAGE Ra-226
P.S. 11-14-90
HL 11/14/90

DATE: 6/27/90

TO: Partha Sircar

FROM: Roger Geary RDG

LOCATION: San Francisco, CA

LOCATION: Grand Junction, CO

SUBJECT: UNC REPOSITORY SOIL SAMPLING PROGRAM

To date, there have been 30 soil samples taken from the repository. The time frame from which the samples were taken was 2/27/89 to 4/20/90. We will continue to send you updated lists.

cc: file
J. Turner

CHEM-NUCLEAR SYSTEMS, INC.

Sheet 6B
UMTRA-GRJ
3885-34
P.S. 11-14-90
HL 11/14/90

GRAND JUNCTION
VICINITY PROPERTY REPOSITORY SAMPLES

SAMPLE ID#	INITIAL RA-226 pCi/g	20 DAY RA-226 pCi/g *
1	70.8	N/A 123.9
2	203.0	N/A 355.3
3	193.0	N/A 337.8
4	91.0	N/A 159.3
5	164.0	N/A 287.0
6	76.3	N/A 133.5
7	2.96	6.5
8	1.53	4.2
9	3.61	6.5
10	7.57	15.2
11	26.1	49.3
12	93.6	156.8
13	1.6	2.2
14	1.3	3.2
15	3.6	5.5
16	5.2	9.2
17	9.5	12.5
18	4.8	7.2
19	9.7	17.5
20	15.7	23.4
21	3.1	5.1
22	3.0	17.5
23	3.8	4.7
24	89.7	135.5
25	6.1	9.3
26	2.9	3.1
27	2.8	4.7
28	3.5	3.8
29	1.4	2.2
30	1.7	3.0

Ra-226 AVG. = 63.5

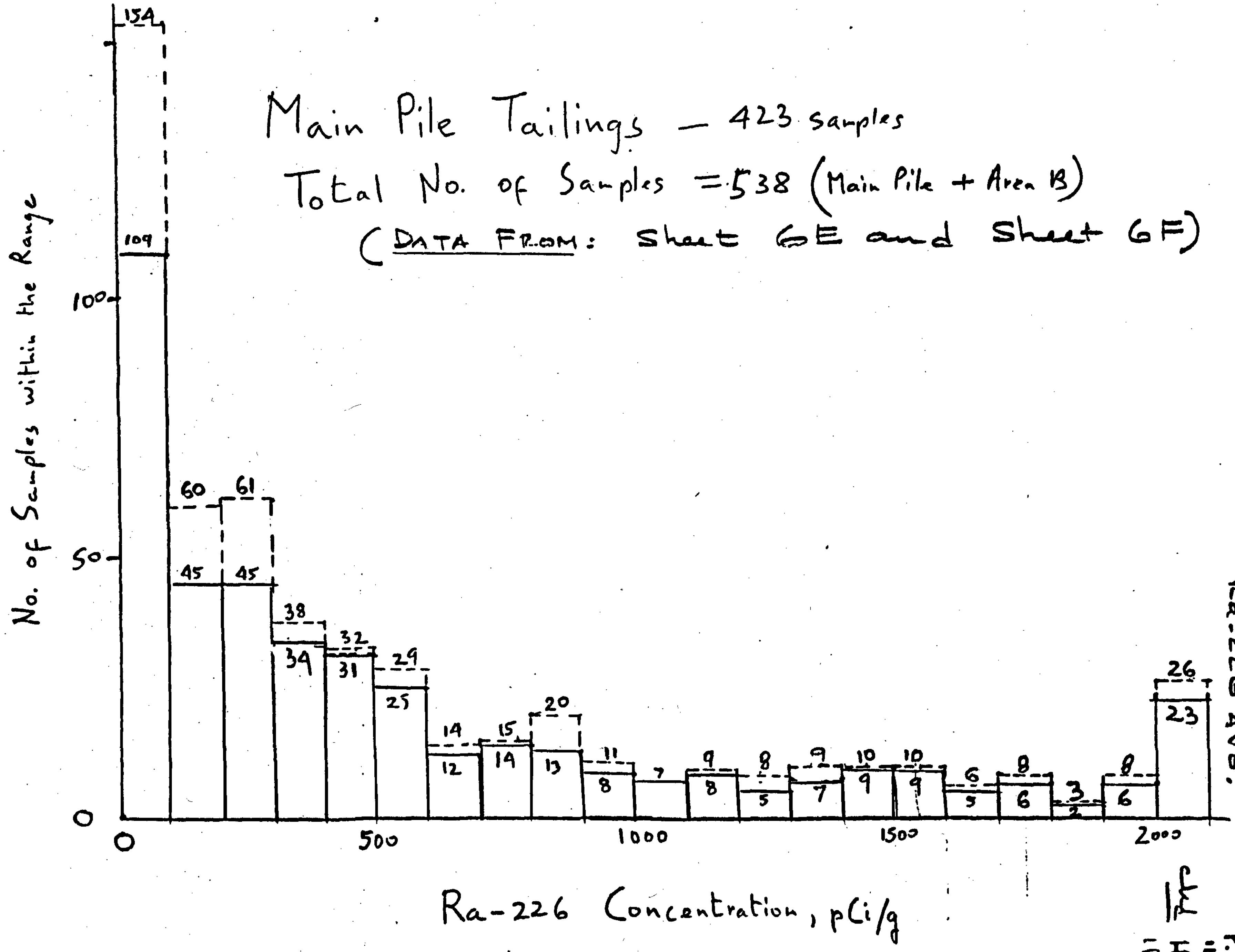
STD = 103.0

$$\text{SEM} = \frac{\text{STD}}{\sqrt{30}} = \frac{103.0}{\sqrt{30}} = 18.8$$

Ra-226 AVG. + SEM = 63.5 + 18.8

= 82.3 pCi/g

Note: A factor of 1.75 was used to calculate the value of 20-day Ra-226 content where it was not available. The value was recommended by Mr. Garth Stowe of CNSS on 11-13-90



Main Pile Tailings — 423 samples

Total No. of Samples = 538 (Main Pile + Area B)

(DATA FROM: Sheet 6E and Sheet 6F)

UMTRA-GRJ
3885-34
Ra-226 AVG.

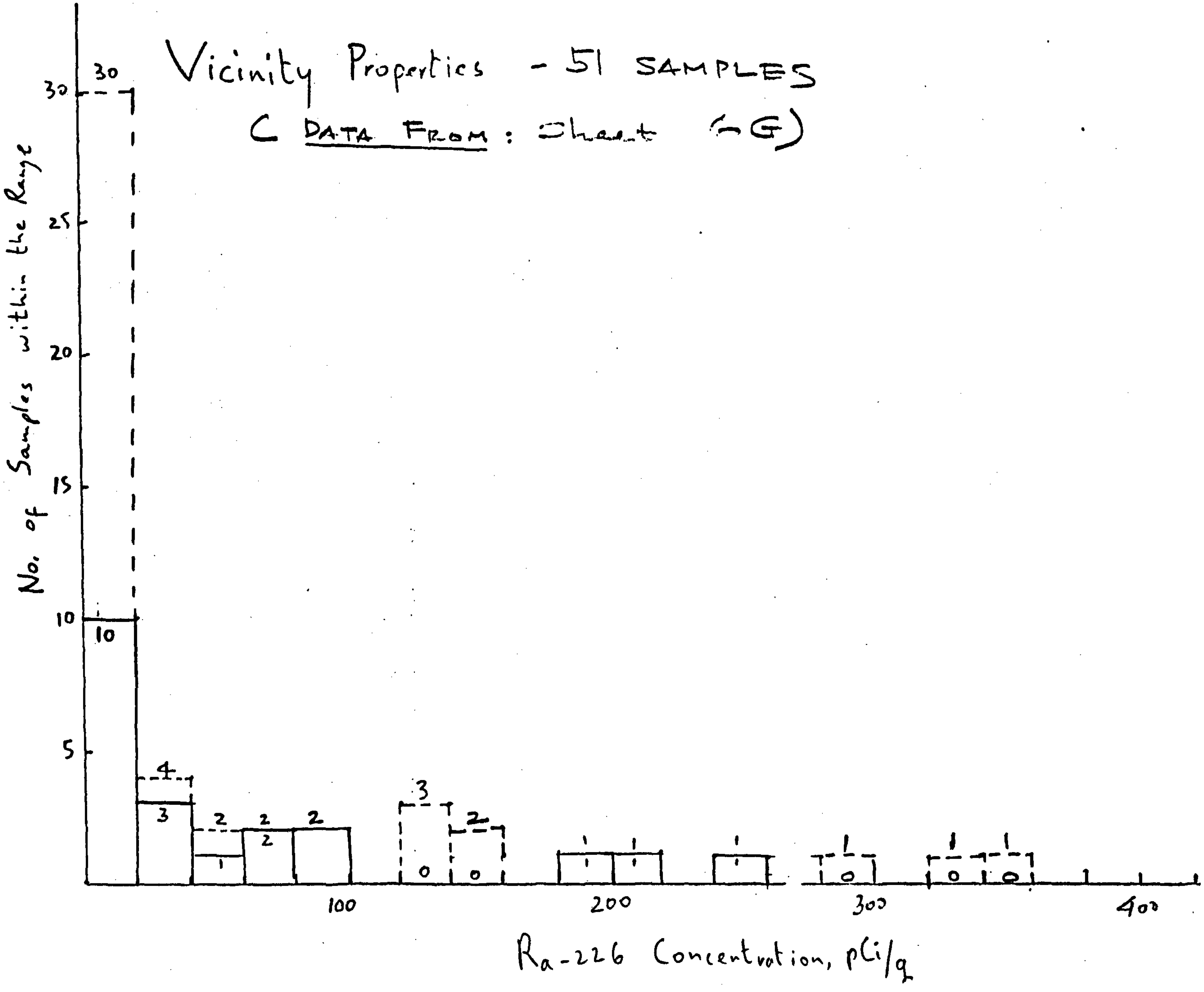
Sheet 6C

P.S.
11-16-90

chkd
HL
11/16/90

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-GJT
Feature Radon Barrier
Item Average Ra-226
Contract No. 3885-34
Sheet 60
File No.
Designed P.S.
Date 11/10/90
Checked HL
Date 11/16/90



MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-GRJ	Contract No. 3885-34	Sheet 6E	
Feature Radon Barrier	Designed P.S.	File No.	
Item Average Ra-226	Checked H.L.	Date 11-10-90	Date 11-16-90

Main Pile Tailings

Total : 423

Ra-conc., pCi/g	No. of Samples	Total
0 - 100	12+12+8+17+10+14+6+14+6+3+7	109
100-200	15+10+8+0+4+4+2+0+0+1+1	45
200-300	6+ 4+2+3+1+4+1+8+6+7+3	45
300-400	0+0+2+3+2+3+3+7+7+4+3	34
400-500	2+3+3+2+5+6+2+3+0+1+4	31
500-600	3+0+0+1+3+2+1+2+3+5+5	25
600-700	0+1+0+0+1+2+3+2+1+2+0	12
700-800	0+1+1+0+2+0+4+0+2+3+1	14
800-900	0+2+2+1+1+1+0+0+4+2+0	13
900-1000	0+0+2+0+2+1+0+0+2+1+0	8
1000-1100	0+0+0+0+0+1+0+0+2+3+1	7
1100-1200	0+0+0+4+1+0+1+0+0+2+0	8
1200-1300	0+0+2+0+0+0+1+1+0+1+0	5
1300-1400	0+1+2+1+1+0+1+0+0+1+0	7
1400-1500	0+2+1+1+2+0+2+0+0+1+0	9
1500-1600	0+0+1+1+1+0+2+1+2+0+1	9
1600-1700	0+1+0+0+1+1+2+0+0+0+0	5
1700-1800	0+0+0+0+2+0+0+0+1+0+3	6
1800-1900	0+0+0+0+0+0+0+1+0+0+0	2
1900-2000	1+0+0+2+0+0+3+0+0+0	6
2000+	1+2+6+1+2+0+7+0+1+2+1	23

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-GRJ
Feature RADON BARRIER
Item AVERAGE Ra-226
Contract No. 3885-34
Designed PS
Checked H.L.
Sheet 6F
File No.
Date 11-12-90
Date 11-16-90

Area B (Millyard, between Kimball Ave. and railroad track)

Ra-conc., pCi/g	No. of Samples	Total
0-100	15+15+15+0	45
100-200	2+5+6+2	15
200-300	7+2+5+2	16
300-400	0+0+2+2	4
400-500	1+0+0+0	1
500-600	1+2+1+0	4
600-700	0+0+1+1	2
700-800	0+0+1+0	1
800-900	2+1+3+1	7
900-1000	1+0+1+1	3
1000-1100	0+0+0+0	0
1100-1200	0+1+0+0	1
1200-1300	1+0+1+1	3
1300-1400	1+0+0+1	2
1400-1500	0+0+1+0	1
1500-1600	0+0+0+1	1
1600-1700	0+1+0+0	1
1700-1800	0+2+0+0	2
1800-1900	0+1+0+0	1
1900-2000	1+0+1+0	2
2000+	1+2+0+0	3
		115

* 7500+

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature RADON BARRIER
Item AVERAGE Ra-226
Contract No. 3885-34
Designed P.S.
Checked HL
Sheet 6G
File No.
Date 11-10-90
Date 11/16/90

VICINITY PROPERTY

Total No. of Samples = 51

0-20	10+20
20-40	3+1
40-60	1+1
60-80	2+0
80-100	2+0
100-120	0+0
120-140	0+3
140-160	0+2
160-180	0+0
180-200	1+0
200-220	1+0
220-240	0+0
240-260	1+0
260-280	0+0
280-300	0+1
300-320	0+0
320-340	0+1
340-360	0+1
360-380	0+0
350-400	0+0
400+	0+0

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY

WYL 3/21/88 WYL
PS 3/23/88

UMTRA PROJECT

INTER-OFFICE CORRESPONDENCE

TO: J. G. Oldham
Attention: J. E. Williams
LOCATION: MKF - Boise
SUBJECT: UMTRA Project - GRJ Quantity of Contaminated Materials

DATE: 15 January 1988
DOC. NO.: 5025-GRJ-I-01-01565-00
FROM: T. R. Wathen
LOCATION: San Francisco, CA

We have reviewed the five correspondences attached to Mr. J. R. Anderson's letter dated November 2, 1987. Although some of the information is inconsistent, we will utilize the information contained in the latest correspondence. We realize that the total VP quantity is the UNC's "predicted" quantity; however, we will use it as our design basis.

Pond 3 Quantity as of August 7, 1987

Using the topo map (dated February 1985) furnished by Jacobs, the Bendix Report and the additional rediological data we obtained, the total quantity of contaminated material is 313,300 c.y.

Calculations based on UNC field survey dated August 7, 1987 indicates that 209,000 c.y. was deposited from February 1985 to August 7, 1987. The total quantity in Pond 3 (August 7, 1987) = 522,300 c.y.

Summary - Contaminated Materials Volume

Main Pile	2,441,900 c.y.
Mill Yard	30,800 c.y.
Along River Bank	33,800 c.y.
Pond 1	9,600 c.y.
Pond 2	11,800 c.y.
Pond 3 (MKE Calc. from 1985 topo map)	313,300 c.y.
Pond 3 (UNC Calc. from 1985 to Aug. 1987)	209,000 c.y.
UNC prediction of remaining VP (complete 1st quarter, 1992)	910,000 c.y.
VP from DOE compound (1989-1990 schedule)	100,000 c.y.
	4,060,200 c.y.

~30-50 cy

Mike Curtis

Tests on the vicinity property materials indicate that the contaminated level is very low and the permeability is in the order of 1 x 10^{-6}cm/sec. In order to take full advantage of these properties, these materials will be placed at the top of the tailings embankment.

8

WYL 3/21/88
PS 3/23/88

At present, the construction schedule indicates that excavation of the main tailings pile will be completed by mid-1992 and excavation of the ponds (including VP materials) will follow. At that time UNC would have deposited all the VP materials (including 100,000 c.y. from DOE compound) in the ponds area (VP complete by first quarter of 1992). Our Phase II contract document will reflect the above conditions.

T. R. Wathen

TRW/JL/bd

Sheet 2 of 9
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature Tailings Excavation
Designed WYL
Date 7/18/86
Item Tailings Pile Limits and Quantities
Checked SWB
Date 9/15/86

Notes to Borehole Information

1. Both BFEC activity and SNL activity were radium contents in dry soils determined with gamma-ray-spectroscopic analyses, BFEC value was for the whole 2.5' long split-barrel sample but SNL value was only for the lower 10" long split-barrel sample that the SNL values are spare (for information only) and are not as accurate as the BFEC values. However, the SNL values do provide valuable information where the BFEC values are unavailable.

2. The last column of 15 pci/g indicates the estimated depth/elevation of the contaminated material to be excavated to at the specified borehole location, if there is no sufficient data available, the decreasing rate of 133 pci/g per foot in depth will be used for extrapolation.

UMTRA/GRJ1
by WYL 7/18/
ckd [illegible]

Main Pile

Table D2.1 Borehole information

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample description	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pCi/g interface depth(ft)/ele
A-44	23	16	1	0-2.5	227.4		MSG	25.9/4553
			4	7.5-10	553.4			
			5	10-12.5	213.9			
			6	12.5-15	494.3			
			7	15-17.5	1987.9			
			S1	17.5-20	82	39.9		
			S2	20-22.5	129.6			
			S3	22.5-25	136.5			
A-46	22.5	20	S1	20-22.5	38.4		MSG	22.7/4556 ✓
A-48	18	18	1	0-2.5	163.1		MSG	23.7/4555
			2	2.5-5	202.6		~~MSG~~	
			3	5-7.5	160			
			4	7.5-10	113.6			
			5	10-12.5	149.7			
			6	12.5-15	544.4			
			7	15-17.5	2135.3			
			S1	17.5-20		499		
A-50	17.5	17	1	0-2.5	112.1		12.5	12.5/4567.5 ✓
A-55	12.5	7	1	2.5-5	178			12.5/4563.5
			S1	5-7.5	244.8			
			S2	7.5-10	14.2	48.6		
			S3	10-12.5	17.2	12.4		
A-57	20.25	15	1	0-2.5	96.1		MSG	22.8/4557 ✓
			S1	15-17.5	22.5			
			S2	17.5-20	15.6	5.2		
			S3	20-22.5	59.8			✓
A-58	19	11.5	1	0-2.5	166.2		19	19.0/4557
			2	2.5-5	165.2			
			S1	12.5-15	9.9			
			S2	15-17.5	104.6			
			S3	17.5-20	6.9	11.1		
A-59	22.5	16	3	5-7.5	91.5		MSG	23.2/4557 ✓
			4	7.5-10	193.1			
			5	10-12.5	155.8			
			6	12.5-15	168.7			
			7	15-17.5	221.9			
			8	17.5-20	291.1			
			S1	20-22.5	111.4			
A-61	20	13	1	0-2.5	466.1		17.5	17.5/4560.5
			S1	12.5-15	594.1			
			S2	15-17.5	21.2	3.3		
			S3	17.5-20		8.3		

40 subtotal | 10,860.1

UMTRA/GRJ
by WYL 7/18/8
ck'd MDL 8/[illegible]

Main Pile (Contd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample descrip- tion	Interval. depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pci/g interface depth(ft)/ele
A-63	20.5	17.5	1	0-2.5	67.7		20.5	20.5/4563.5
			2	2.5-5	180.9			
			S1	17.5-20	100			
			S2	20-22.5	13.8			
A-65	22.25	20	1	0-2.5	149.3		22.25	22.5/4562 ✓
			S2	20-22.5	15			
A-66	20.75	17.5	1	0-2.5	1454.2		22.5	22.5/4551.5
			6	12.5-15		246		
			7	15-17.5		403.1		
			S1	17.5-20	406.5			
			S2	20-22.5	181.9	9.3		
A-68	20.25	18	1	0-2.5	165.2		22.5	22.5/4556.5
			S1	17.5-20	35.3	33.7		
			S2	20-22.5	49.2	10.1		
A-70	21.5	15	1	0-2.5	877.5		MSG	22.7/4556.5 ✓
			6	12.5-15		1280.9		
			S1	15-17.5	1398.7			
			S2	17.5-20	185.7	39.9		
			S3	20-22.5	46.5	31		
A-71	20.75	19.5	1	0-2.5	183.4		MSG	22.7/4560
			S1	17.5-20	66.4	46.3		
			S2	20-22.5		46.3		
A-72	25	18.5	1	0-2.5	92.3		MSG	22.3/4558
			S1	17.5-20	283	319.4		
A-73	20.25	18.5	1	0-2.5	135.7		MSG	27.8/4556.0 ✓
			S1	17.5-20	445.3			
			S2	20-22.5	710.7	388		
A-74	17.75	17	1	0-2.5	436.9		MSG	30.0/4548.5 ✓
			2	2.5-5	844.8			
			S1	15-17.5	1674.1			
			S2	17.5-20	666.7	82		
			S3	20-22.5	3129.9	1733.2		
A-76	20	20	1	0-2.5	92.4		MSG	27.5/4555
			2	2.5-5	96.8			
			3	5-7.5	208.8			
			4	7.5-10	196.1			
			5	10-12.5	154			
			6	12.5-15	155.7			
			7	15-17.5	2113.9			
			8	17.5-20	1423			
A-78	25	20	1	0-2.5	229.3		MSG	26.0/4558
			2	2.5-5	83.6			
			4	7.5-10	229.6			
				39 Subtotal	18,979.8			

[illegible]/GRJ 1:
by WYL 7/18/
Ckd MDL 8/21/

Main Pile (Contd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample description	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pCi/g interface depth(ft)/ele
			5	10-12.5	199			
			6	12.5-15	152.5			
			7	15-17.5	168.7			
			8	17.5-20	424.8	518.2		
			S1	20-22.5	48.5	45.2		
			S2	22.5-25	112.9	146.8		
B-30	21.5	17	1	0-2.5	844.2		21.5	21.5/4563
			6	12.5-15		829.1		
			S1	15-17.5	902.8	1015		
			S2	17.5-20	51.5	22.6		
			S3	20-22.5	36.9	12		
B-32	21.5	16	1	0-2.5	1326.7		22.5	22.5/4561.5
			2	2.5-5	1251			
			3	5-7.5	1239.8			
			4	7.5-10	927.6			
			5	10-12.5	433.9			
			6	12.5-15	352			
			7	15-17.5	700.4			
			S1	17.5-20	181.5	25.4		
			S2	20-22.5	98.5	11.5		
B-34	12.5	6.5	1	0-2.5	167		12.5	12.5/4567.5
			S1	7.5-10	103.2	37.6		
			S2	10-12.5	15.4	16.6		
B-35	30	24.5	S1	25-27.5	27.4	20.4	27.5	27.5/4559.5
B-36	25.75	21	1	0-2.5	235.9		27.5	27.5/4556.5
			S1	20-22.5	351.8	49.1		
			S3	25-27.5	46.8	13.2		
B-37	35	32.5	1	0-2.5	1449.4		MSG	35.9/4556.5
			S1	32.5-35	128.2	19.9		
B-38	25.3	21.5	1	0-2.5	1362.8		27.5	27.5/4558
			2	2.5-5	1520			
			S1	20-22.5	844.9	621.9		
			S2	22.5-25	257.6	461.3		
			S3	25-27.5		19.5		
B-39	35	30	1	0-2.5	2201.9		35	35.5/4559
			2	0-2.5	2095.8			
			S1	30-32.5	428.5	41.8		
			S2	32.5-35	37.8	23.1		
B-40	34	30	1	0-2.5	2404.1		MSG	35.2/4556
			2	2.5-5	1826.3			
			3	5-7.5	2156.8			
			4	7.5-10	2421			
			5	10-12.5	2036.1			

6 subtotal 1106.6

4: subtotal 31,571.9

UMTRA/GRJ 1
by WYL 7/18/
ck'd MDL 8/2

Main Pile (contd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample descrip- tion	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pCi/g interface depth(ft)/el.
			6	12.5-15	2152.4			
			7	15-17.5	1474.4			
			8	17.5-20	311.9			
			9	20-22.5	1172			
			10	22.5-25	1992.7			
			11	25-27.5	1158.4			
			S1	30-32.5	86.8			
			S2	32.5-35		39		
B-41	29.5	24	1	0-2.5	1343.4		MSG	31.4/4562
			S1	25-27.5	48.3	13.7		
			S2	27.5-30	202.4	144.6		
B-42	27.75	24	1	0-2.5	1954.7		MSG	31.8/4559
			10	22.5-25		1748.8		
			S1	25-27.5	28.5	49.4		
			S2	27.5-30	202.5	248.5		
B-43	28.5	22	S1	22.5-25	36.5		MSG	32.7/4552
			S2	25-27.5	26.8	72.9		
			S3	27.5-30	88	174.7		
			S4	30-32.5		37.5		
B-45	30.5	24	1	0-2.5	261.1		MSG	32.7/4552.5
			S1	25-27.5	45			
			S2	27.5-30	68.9	29.3		
			S3	30-32.5		46		
B-47	23	17.5	1	0-2.5	1582		25	25.1/4561
			S1	17.5-20	349.7			
			S2	20-22.5	67.3	88.5		
			S3	22.5-25	55.2	22.3		
B-49	24	17.5	1	0-2.5	1184.3		25	25.1/4561
			2	2.5-5	398.7			
			S1	17.5-20	436.4			
			S2	20-22.5	505.9	8		
			S3	22.5-25		27.8		
B-51	22.5	17	1	0-2.5	1172.6		20	20.0/4559
			S1	17.5-20	27			
			S2	20-22.5		7.9		
B-53	18	12.5	1	0-2.5	470.4		20	20.0/4562
			S1	12.5-15	13.5			
			S2	15-17.5	44.1	46.2		
			S3	17.5-20	31.8	12.4		
B-56	23.3	16	1	0-2.5	818.9		17.5	17.5/4565.5
			S1	15-17.5	8.5			
			S2	17.5-20	9.2	7.2		
			S3	20-22.5	17.5	9		
				37 Subtotal	19,847.7			

Main Pile (contd.)

UMTRA/GRJ 14
by WYL 7/12/8
ck'd MDL 8/[illegible]

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample description	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pci/g interface depth(ft)/elc
B-67	22	20	1	0-2.5	595.2		22	22.0/4562
			S1	20-22.5	13.5			
B-69	25.27	22.5	1	0-2.5	35.1		MSG	27.7/4556
			S1	22.5-25	126.2	9.7		
			S2	25-27.5	47			
B-86	25	24	1	0-2.5	539.3		MSG	25.4/4562
			2	2.5-5	564.4			
			3	5-7.5	414.7			
			4	7.5-10	418.9			
			5	10-12.5	474.2			
			6	12.5-15	375.1			
			7	15-17.5	248.9			
			8	17.5-20	183.8			
			9	20-22.5	978.8			
			S1	22.5-25	73	24.5		
B-88	16.25	16	1	0-2.5	159.9		MSG	✓ 20.7/4559.5
			2	2.5-5	883.5			
			3	5-7.5	1511.2			
			4	7.5-10	1460.4			
			5	10-12.5	1787.6			
			6	12.5-15	1331			
			7	15-17.5	439.1	281.3		
C-1	55	28	1	0-2.5	1714.5		37.5	37.5/4560.5
			2	2.5-5	1669.1			
			3	5-7.5	2012.6			
			4	7.5-10	604			
			5	10-12.5	914.1			
			6	12.5-15	1125.9			
			7	15-17.5	1478.7			
			8	17.5-20	369			
			9	20-22.5	758.5			
			10	22.5-25	746.8			
			11	25-27.5	2035.7			
			12	27.5-30	456.5			
			S1	30-32.5	16.9	32.4		
			S2	32.5-35	48			
			S3	35-37.5	108	10.5		
			S4	37.5-40	8.2	9.4		
			S5	40-42.5	14.7	34		
			S6	42.5-45	24.3	10.5		
			S7	45-47.7	23.7	15.1		
			S8	47.5-50		8.4		
			S9	50-52.2		9.5		

22 subtotal 12630.8

41 Subtotal 26,790.0

UMTRA/GRJ 15
by WYL 7/18/
ckd [illegible]

Main Pile (contd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample descrip- tion	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pci/g interface depth(ft)/el.
			S10	52.5-55		9.9		
			S11	55-57.5		16.9		
C-2	38	26.5	1	0-2.5	1621.3		40	40.0/4557
			11	25-27.5		314.4		
			S1	27.5-30	30.5	25		
			S2	30-32.5	58	16.2		
			S3	32.5-35	10.2	9.1		
			S4	35-37.5	14.9	16.5		
			S5	37.5-40	157.6	12.1		
C-10	47.5	43	1	0-2.5	106.6		MSG	48.4/4563.5
			2	2.5-5	264.9			
			S1	42.5-45	62.1			
			S2	45-47.5	133.6	54.8		
C-11	50	45.25	1	0-2.5	321.4		49	49.0/4560
			S1	45-47.5	38.8	27.2		
			S2	47.5-50	24.9	6.4		
C-12	42.5	37.5	1	0-2.5	854.3		MSG	42.7/4563.5
			S1	37.5-40	41.1	27.2		
			S2	40-42.5	38.4	42.3		
C-13	43.3	40.3	1	0-2.5	403.6		MSG	42.8/4561 ✓
			2	2.5-5	293.6			
			S1	40-42.5	60.8	27.2		
C-15	35	30	1	0-2.5	500.7		30	35.0/4561
			S1	30-32.5	3.1	9.1		
			S2	32.5-35	2.9	18.9		
C-20	40.5	37.5	1	0-2.5	294.9		MSG	43.2/4563.0 ✓
			S1	37.5-40	429.5			
C-22	42.5	38	1	0-2.5	331.4		42.5	42.5/4557.5
			2	2.5-5	156.5			
			S1	37.5-40	28.7	22.2		
			S2	40-42.5	39.1	10.7		
C-25	37.5	32.5	1	0-2.5	276.8		37.5	37.5/4563 ✓
			4	7.5-10	418.2			
			5	10-12.5	337.6			
			6	12.5-15	497.5			
~~C-25~~	~~37.5~~	~~32.5~~	~~6~~	~~12.5-15~~	~~497.5~~		~~37.5~~	
			7	15-17.5	558.3			
			8	17.5-20	460.3			
			9	20-22.5	661.5			
			10	22.5-25	949.3			
			11	25-27.5	1049.9			
			12	27.5-30	424.5			
			13	30-32.5	663.5			

39 Subtotal 12,620.3

UMTRA/GRJ 16
by WYL 7/13/8
ckd MDL 8/23/8

Main Pile (contd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample description	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pci/g interface depth(ft)/elv
			S1	32.5-35	17.1	12.8		
			S2	35-37.5	57.3	8.4		
C-26	32.5	27.5	1	0-2.5	771		MSG	34.8/4560.5
			2	2.5-5	630.1			
			3	5-7.5	726.8			
			4	7.5-10	506.5			
			5	10-12.5	609.6			
			6	12.5-15	384.5			
			7	15-17.5	1634.7			
			8	17.5-20	1153.4			
			9	20-22.5	719.9			
			10	22.5-25	333.3			
			11	25-27.5	1405.9			
			S1	27.5-30	50	65.8		
			S2	30-32.5	336.2	32.8		
C-27	37	35.25	1	0-2.5	1507.2		MSG	40.7/4556
			2	2.5-5	1934.4			
			S1	35-37.5	430.8	52.5		
C-28	34.5	30.5	1	0-2.5	466.9		MSG	36.8/4551
			S1	30-32.5	692.4			
			S2	32.5-35	246.8	170.1		
C-33	34.5	32.75	1	0-2.5	1684		MSG	36.0/4560
			S1	32.5-35	151.7	31.9		
C-89	6	5.5	1	0-2.5	1431.7			10.0/4581.0
C-90	5	3	S1	2.5-5	750.8		MSG	10.6/4579.5
C-91	1	0	S1	0-2.5	36.6		MSG	2.7/4581
C-92	25	21.5	1	0-2.5	1573.8		22.5	22.5/4572.5
			S1	20-22.5	55.8	9.6		
C-93	26	22	1	0-2.5	1272.2		MSG	27.7/4564
			2	2.5-5	2072.7			
			S1	22.5-25	195.2	10.7		
			S2	25-27.5	29.8	47.8		
C-94	24	24	1	0-2.5	1384.7		30	30.0/4565
			2	2.5-5	2115.5			
			3	5-7.5	2270.2			
			4	7.5-10	1980.2			
			5	10-12.5	1935			
			6	12.5-15	2311.1			
			7	15-17.5	2370			
			8	17.5-20	1811.9			
			9	20-22.5	2445.3			
			10	22.5-25	2185			

42 Subtotal 44,678.0

UMTRA/GRJ
by WYL 7/18/
ck'd MDL 8/[illegible]

Main Pile (contd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample description	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pci/g interface depth(ft)/el
			S1	25-27.5	546.8	19.6		
			S2	27.5-30	58.2	16.9		
C-99	36.25	32.25	1	0-2.5	309.7		36.25	36.3/4552
			S1	32.5-35	68.9	25.6		
			S2	35-37.5	25.1			
C-100	40	34.3	1	0-2.5	316.8		MSG	40.2/4554
			S1	32.5-35	20	9 subtotal 1676.9		
			S2	35-37.5	99.8	90.5		
			S3	37.5-40	31.6	44.6		
D-3	35	31	1	0-2.5	1564.1		32.5	32.5/4566.5
			2	2.5-5	650.5			
			S1	30-32.5	11.2			
			S2	32.5-35	5.4	36.1		
D-4	38	35	1	0-2.5	553.4		37.5	37.5/4563
			14	32.5-35		157.3		
			S1	35-37.3	39.4	19.7		
D-5	41.5	37.5	1	0-2.5	328.6		41.5	41.5/4562.5
			S1	37.5-40	23.6			
			S2	40-42.5	50.6	14.9		
D-6	45	40	1	0-2.5	41		42.5	42.5/4562.5
			3	5-7.5	373.4			
			4	7.5-10	358.3			
			5	10-12.5	282.6			
			6	12.5-15	330.1			
			7	15-17.5	277.2			
			8	17.5-20	337.1			
			9	20-22.5	418.5			
			10	22.5-25	444.9			
			11	25-27.5	278.8			
			12	27.5-30	406.9			
			13	30-32.5	260.6			
			14	32.5-35	221.8			
			15	35-37.5	258.9			
			16	37.5-40	1235.5	1274.1		
			S2	42.5-45	25	8		
D-7	46.75	44	1	0-2.5	287.4		MSG	51.1/4559
			S1	45-47.5		483.9		
D-8	50	44	1	0-2.5	245.6		MSG	50.6/4561
			18	42.5-45	635.9			
			S1	45-47.5	87.1	84.9		
			S2	47.5-50		90.5		

38 subtotal | 11,510.3

UMTRA/GRJ [illegible]
by WYL 7/18/
ckd KDL 8/[illegible]

Main Pile (cont'd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample description	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pci/g interface depth(ft)/e.
D-9	51.5	48	1	0-2.5	338.5		MSG	60.0 / 4553 ✓
			S1	47.5-50	564.6	18		
			S2	50-52.5		1006.4		
D-14	22.5	22	1	0-2.5	1571.2		MSG	33.4 / 4561.5 ✓
			2	2.5-5	805.4			
			3	5-7.5	965.4			
			4	7.5-10	1073.2			
			5	10-12.5	809.9			
			6	12.5-15	892.8			
			7	15-17.5	740.2			
			8	17.5-20	833.4			
			9	20-22.5	1091.8			
			10	22.5-25	1562.7			
			S1	25-27.5	788.2	420.1		
D-16	32	30	1	0-2.5	924.7		MSG	30.0 / 4566
			2	2.5-5	1725.6			
			3	5-7.5	556.7			
D-17	37	32.3	1	0-2.5	2224.5		37	37.0 / 4560
			S1	32.5-35	10	40.2		
			S2	35-37.5	30.5	10		
D-18	37.5	32	1	0-2.5	252.9		37.5	37.5 / 4563.5
			13	30-32.5		1818.3		
			S1	32.5-35		325.6		
			S2	35-37.5	35.9	6.1		
D-19	35	32	1	0-2.5	562.4		35	35.0 / 4565
			13	30-32.5		2215.3		
			S2	32.5-35	22.9	15.3		
D-21	40.5	37	1	0-2.5	337.9		40	40.0 / 4566
			2	2.5-5	295.1			
			15	35-37.5		1533.2		
			S1	37.5-40	81.6	12.3		
D-23	45	40	1	0-2.5	337.9		45	45.0 / 4563
			S1	40-42.5	625.8	24.6		
			S2	42.5-45	36.0	18.3		
D-24	50	44.5	2	2.5-5	313		MSG	50.7 / 4563
			3	5-7.5	285.5			
			4	7.5-10	268.1			
			5	10-12.5	274.9			
			6	12.5-15	223.4			
			7	15-17.5	355.3			
			8	17.5-20	327.4			
			10	22.5-25	369.3			

37 subtotal 22,514.6

UMTRA/GFJ 19
by WYL 7/18/86
CK'd MDL 5/[illegible]

Main Pile (cont'd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample description	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pCi/g interface depth(ft)/el.
			11	25-27.5	319			
			12	27.5-30	237.6			
			13	30-32.5	251.3			
			14	32.5-35	237.4			
			15	35-37.5	317.5			
			16	37.5-40	258.1			
			17	40-42.5	339.3			
			18	42.5-45	1404.8	1363.6		
			S1	45-47.5	23.6	75.9		
			S2	47.5-50	112.7	52.9		
D-29	31.5	31	1	0-2.5	553.6		MSG	36.5/4556.5 ✓
			2	2.5-5	1376.3			
			13	30-32.5		535.9		
D-31	31	30.3	1	0-2.5	1189		MSG	40.0/4554.5 ✓
			13	30-32.5		1030.3		
D-75	26	20	1	0-2.5	464		MSG	29.0/4561 ✓
			9	20-22.5		88.3		
			S3	25-27.5	207.3	92.6		
D-77	22.5	19.5	1	0-2.5	699.8		22.5	22.5/4567.5
			S1	20-22.5	20.8	23.5		
D-79	32.5	27.5	1	0-2.5	527.3		MSG	32.1/4560 ✓
			2	2.5-5	522.6			
			3	5-7.5	1043.7			
			4	7.5-10	1143.9			
			5	10-12.5	804.9			
			6	12.5-15	314			
			7	15-17.5	1026.3			
			8	17.5-20	1051.9			
			9	20-22.5	706.5			
			10	22.5-25	588.3			
			11	25-27.5	2312.3			
			S1	27.5-30	279.6			
			S2	30-32.5		92.4		
D-80	26	24	1	0-2.5	718.5		MSG	31.0/4549.5 ✓
			S1	25-27.5	325.5	478.8		
D-81	25	21.5	1	0-2.5	922.5		MSG	27.0/4562.5 ✓
			S1	22.5-25	280.5	103		
D-82	30.5	28	1	0-2.5	707.6		MSG	37.1/4556.5 ✓
			2	2.5-5	2150.4			
			S1	30-32.5	623.7			
D-83	32.75	30	1	0-2.5	1225.2		MSG	35.5/4561 ✓
			S1	30-32.5	532.7			
			S2	32.5-35	89.1			

39 Subtotal 26,909.1

UMTRA/GRJ 2/2c
by WYL 7/18/c
CK'd MDL 5/23/
LLB 2/13/89
ck PS 2/14/89

Main Pile (cont'd.)

Table D2.1 Borehole information (Continued)

Hole number	Total hole depth (ft)	Physical depth (ft)	Sample descrip-tion	Interval depth	BFEC activity (pCi/g)	SNL activity (pCi/g)	pCi/g interface (ft)	15 pci/g interface depth (ft)/ele
D-84	36	29	1	0-2.5	546		36	36.0/4±60
			S1	30-32.5	41.6	36.7		
			S2	32.5-35	48.9	25.6		
			S3	35-37.5	20			
D-85	24.25	23.5	1	0-2.5	745.8		MSG	32.5/4±58.5 ✓
			2	2.5-5	1715.5			
			3	5-7.5	2044.1			
			4	7.5-10	1788.3			
			S1	22.5-25	1513.7	177.7		
D-87	30.3	28.3	1	0-2.5	593.8		MSG	40.0/4±4 ✓
			12	27.5-30		89.7		
			S1	30-32.5	1070.2			
D-95	42.25	34.5	1	0-2.5	276.1		37.5	37.5/4±56
			2	2.5-5	374.7			
			3					
			4	7.5-10	332.7			
			5	10-12.5	348.5			
			6	12.5-15	426.3			
			7	15-17.5	490.2			
			8	17.5-20	533.5			
			9	20-22.5	500.7			
			10	22.5-25	417.2			
			11	25-27.5	461.8			
			12	27.5-30	519.5			
			14	32.5-35	1759.1	504		
			S1	35-37.5	23.6			
			S2	37.5-40	9.8	3		
D-96	25.25	23.25	1	0-2.5	244.9		MSG	26.0/4±58
D-97	36	32	1	0-2.5	294.7		MSG	40.0/4±60
			13	30-32.5		1248.9		
D-98	30	25	1	0-2.5	171.8		27.5	27.5/4±57.5
			S1	25-27.5	32.4	26.8		
			S2	27.5-30	5.4	29.6		
A-52	MSG	10					MSG	
A-54	MSG	8.5					MSG	
A-60	MSG	9					MSG	
A-62	MSG	10					MSG	
A-64	MSG	8					MSG	
S-1	MSG	8					MSG	
S-2	MSG	9					MSG	
S-3	MSG	8.5					MSG	

30 Subtotal | 17,350.8

REV.1

n=423
m= 574.8
S=631.7
SEM= 30.7

Ave Ra-226 Concentration = 243,133.1 / 423 = 574.8 pci/g

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet # 21
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature Tailings Excavation
Designed WYL
Date 7/24/86
Item Off-pile Excavation Limits and Quantities
Checked MDL
Date 9-2/86

Note: Grid Coordinates refer to a system on plate 1 (sheet 29)

Area B (Mill yard, between Kimball Ave and railroad track)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration Ra-226 (pCi/g)	Concentration eRa-226 (pCi/g)	Concentration Th-230 (pCi/g)	Moisture (%)	Proposed Excav. Depth (ft)
1100	2000	0- 6	169	284	283 ± 12				2.5
1100	2200	0- 6	167	286	ND 4 ± 1				0
1090	10	0- 6	121	684	56 ± 3			9.97	1.0
1080	200	0- 6	122	93	111 ± 5				1.5
1080	400	0- 6	123	94	17 ± 1				0.5
~~1080~~	~~600~~	~~0- 6~~		~~4~~	~~20 ± 1~~				0.5
		0- 6	124	95	20 ± 1				
1080	800	0- 6	125	96	26 ± 1				0.5
1080	900	0- 6	126	97	26 ± 1				0.5
1080	1000	0- 6	127	98	ND 2 ± 1				0
1080	1790	0- 6	157	244	2016 ±117				7.5 ✓
1062	1180	0- 6		23	229 ± 16				2.5
1060	1180	0- 6	128	434	222 ± 14				2.5
1060	1230	0- 6	129	433	202 ± 11				2.0
1060	1300	0- 6	130	432	55 ± 2				1.0
1055	295	0- 6		422	214 ± 10	11.3 ± 5.5			1.5
		6- 12		423	29 ± 2	5.2 ± 3.3		14.22	
1050	2100	0- 6	168	285	147 ± 8				1.5
1035	1580	0- 6		319	1295 ± 55	611.9 ± 241.6			2.0
		~~6- 12~~		~~22~~	~~901 ± 32~~				
		6- 12		320	858 ± 35	70.5 ± 28.6			
		12- 18		321	24 ± 1	37.4 ± 15.7			
1031	368	0- 6		424	507 ± 26	793.8 ± 313.3			2.0
		6- 12		425	13 ± 1	82.0 ± 33			
		~~12- 18~~		~~18~~	~~42 ± 2~~	~~47.5 ± 19.6~~			
		12- 18		177	41 ± 2				
1030	410	0- 6		178	1901 ± 83	159.7 ± 63.6			4.5
		6- 12		179	1321 ± 55	2943 ± 116.8			
		12- 18		180	417 ± 17	72.6 ± 29.2			
1025	900	0- 6		145	270 ± 11		MCG 9/2/86 WYL 9/2/86		2.0
		~~0- 6~~		~~145~~	~~270 ± 11~~	~~98.6 ± 39.3~~			
		6- 12		146	84 ± 4	185.4 ± 73.5		9.49	
		12- 18		147	53 ± 3	152.8 ± 60.6			
1006	200	0- 6		69	32 ± 2				1.0
1006	900	0- 6		426	18 ± 1				1.0
1004	424	0- 6		24	226 ± 9				
1001	42	0- 6		164	988 ± 36	659.7 ± 258.4		19.79	2.0
		6- 12		165	830 ± 34	63.1 ± 25.5			
		12- 18		166	56 ± 3	24.3 ± 10.6			

39 Subtotal 13,826 ± 630

4 Subtotal 53.47

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~12~~ 22
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature Tailings Excavation
Designed WYL
Date 7/24/86
Item Off-pile Excavation Limits and Quantities
Checked [illegible]
Date [illegible]

Area B (cont'd)

Grid Coordinates		Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration			Moisture (%)	Proposed Excav. Dept. (ft)
North	East				Ra-226 (pCi/g)	eRa-226 (pCi/g)	Th-230 (pCi/g)		
1000	10	0- 6	131	45	24 ± 2				1.0
1000	76	0- 6		142	84 ± 4				7.5
		~~0- 6~~		~~142~~	~~84 ± 4~~	2022.0 ± 800.4			
		6- 12		143	1787 ± 73	1659.0 ± 653.7		17.16	
		12- 18		144	1808 ± 66	776.2 ± 306.5			
		~~12- 18~~		~~144~~	~~1808 ± 66~~				
1000	100	0- 6	132	68	182 ± 8			11.8	2.0
1000	149	0- 6		161	832 ± 34	75.9 ± 30.2			2.0
		6- 12		162	87 ± 4	26.4 ± 11.1			
		12- 18		163	16 ± 1	18.4 ± 7.9			
1000	300	0- 6	133	70	no 2 ± 1				0
1000	400	0- 6	134	71	94 ± 4				
	500	0- 6	135	72	19 ± 1			7.39	6.5
		0- 60		681	66.6 ± 21 *10			9.23	
1000	600	0- 6	136	73	16 ± 1				1.0
1000	710	0- 6	137	74	58 ± 3				1.0
1000	800	0- 6	138	75	11 ± 1				0.5
1000	900	0- 6	139	682	99 ± 5			4.57	1.5
	1000	0- 6		99				10.59	
1000	1400	0- 6		226	48 ± 2			11.35	1.0
1000	1500	0- 6		227	130 ± 10			3.94	1.5
1000	1600	0- 6	156	228	12 ± 1			16.34	1.0
999	1000	0- 6	140	99	117 ± 5				1.5
998	310	0- 6		187	168 ± 7	358.8 ± 144.2			9.0
		6- 12		188	7589 ±315	935.9 ± 369.3			
		12- 18		189	1634 ± 67	88.3 ± 36.7			
		~~12- 18~~		~~17~~	~~1648 ± 61~~				
990	800	0- 6	138	683	no 5 ± 1			5.69	0
985	35	0- 6		207	1787 ± 85	423.7 ± 167.4			2.0
		6- 12		208	598 ± 25	49.2 ± 22.5			
		12- 18		209	69 ± 3	34.6 ± 15.9			
980	900	0- 6	171	686	28 ± 2			7.14	1.0
974	423	0- 6		181	7463 ±303	346.4 ± 137.0			9.0
		6- 12		182	506 ± 19	750.1 ± 296.0		13.58	
		12- 18		183	1104 ± 45	772.9 ± 305.1			
969	602	0- 6		148	181 ± 8	318.8 ± 125.9			3.5
		6- 12		149	284 ± 13	222.6 ± 88.2		16.09	
		12- 18		150	264 ± 11	83.0 ± 15.0			

37 Subtotal 30,712.6 ± 1264.1

13 Subtotal 134.92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature Tailings Excavation
Item Off-Pile Excavation Limits and Quantities

Contract No. 5025
Designed WYL
Checked [illegible]

Sheet ~~43~~ 23
File No.
Date 7/25/85
Date 9/1/85

Area B (cont'd)

Grid Coordinates		Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration			Moisture (%)	Proposed Excav. Depth (ft)
North	East				Ra-226 (pCi/g)	eRa-226 (pCi/g)	Th-230 (pCi/g)		
960	500	0- 6		184	231 ± 10	18.7 ± 14.4			2.0
		6- 12		185	77 ± 4	9.5 ± 5.0			
		12- 18		186	16 ± 1	5.3 ± 3.5			
958	209	0- 6		201	834 ± 34	1241.1 ± 489.0			7.5
		6- 12		202	994 ± 42	592.8 ± 234.3		17.55	
		12- 18		203	783 ± 33	155.0 ± 62.6			
940	1327	0- 6		307	330 ± 19	15.6 ± 7.1			1.5
		6- 12		308	18 ± 1	7.4 ± 4.2		12.60	
935	1400	0- 6	155	243	60 ± 2				1.0
913	485	0- 6		158	223 ± 12	102.8 ± 40.5			2.0
		6- 12		159	76 ± 6	14.3 ± 6.6			
		12- 18		160	41 ± 3	7.5 ± 4.2			
905	232	0- 6		169	35 ± 2	1345.5 ± 514.3			7.0
		6- 12		170	685 {754 ± 49	2519.6 ± 992.3			
		6- 12		170	615 ± 40				
		12- 18		171	1499 ± 72	2565.7 ± 1010.5			
904	296	0- 6		204	506 ± 35	60.1 ± 25.3			2.0
		6- 12		205	180 ± 8	28.5 ± 13.3			
		~~6- 12~~		~~16~~	~~182 ± 7~~				
		12- 18		206	29 ± 2	14.1 ± 8.0			
904	400	0- 6	145	50	29 ± 2			14.50	5.5
		0- 60		685	21.5 ± 1.2 * 10			14.69	
904	600	0- 6	147	402	248 ± 12				2.5
904	625	0- 6		154	872 ± 32	30.7 ± 13.0		10.37	2.0
		6- 12		155	120 ± 5	12.9 ± 6.5			
		12- 18		156	11 ± 1	11.0 ± 5.2			
904	1000	0- 6	151	430	168 ± 9				2.0
904	1100	0- 6	152	429	247 ± 13				2.5
900	10	0- 6	141	46	230 ± 10				2.5
900	86	0- 6		210	332 ± 17	751.9 ± 296.4			9.0
		6- 12		211	133 ± 6	1470.6 ± 579.3		15.53	
		~~12- 18~~		~~13~~	~~1818 ± 79~~				
		12- 18		167	1934 ± 79	1238.3 ± 482.0			
900	100	0- 6	142	47	91 ± 7				1.5
900	200	0- 6	143	48	12 ± 1			11.09	1.0
900	300	0- 6	144	49	43 ± 3				1.0
900	800	0- 6	149	404	198 ± 9			8.93	2.0
900	1030	0- 6		309	864 ± 41	492.9 ± 193.2			8.0
		6- 18		322	1217 ± 50	73.6 ± 30.2 * ~~3~~ 2			
900	1200	0- 6	153	428	122 ± 6			9.46	1.5
900	1300	0- 6	154	427	39 ± 2				1.0

41 Subtotal 16,232.5 ± 767.2

9 Subtotal 114.42

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ~~14~~ 24
Project UMTRA/GRJ
Contract No. 5025
File No.
Feature Tailings Excavation
Designed WYL
Date 7/25/88
Item Off-Site Excavation Limits and Quantities
Checked MDL
Date 9/2/88
SWB 2/13/89
chk PS 2/14/89

Area B (cont'd)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration Ra-226 (pCi/g)	Concentration eRa-226 (pCi/g)	Concentration Th-230 (pCi/g)	Moisture (%)	Proposed Excav. Dep (ft)
894	900	0- 6	150	431	160 ± 7				2.0
893	500	0- 6	146	401	335 ± 18				3.0
893	700	0- 6	148	403	204 ± 10				2.0
893	719	0- 6		152	826 ± 35	977.1 ± 352.6		10.75	4.0
		6- 12		153	1374 ± 56	216.0 ± 85.0			
		12- 18		157	271 ± 11	80.7 ± 32.2			
		~~12- 18~~		~~12~~	~~287 ± 12~~				
891	138	0- 6		229	307 ± 16				7.0
		6- 12		230	119 ± 5				
		12- 18		168	680 ± 30				
881	775	0- 6		124	984 ± 42	1326.0 ± 519.2			9.0
		6- 12		125	1215 ± 51	1227.3 ± 480.6		12.75	
		12- 18		151	1591 ± 71	289.1 ± 113.6			
			13	Subtotal	8353 ± 364		2 Subtotal	23.50	

Ave. Ra-226 Concentration for Area B = 531.7 ± 23.3

Ave. Existing Moisture Content for Area B = 11.65%

n = 133
m = 461.0
s = 1008.8
SEM = 87.5

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY

Project UMTRA/GRJ
Feature Tailings Excavation
Item Off-pile Excavation Limits and Quantities
Contract No. 5025
Designed WYL
Checked [illegible]
Sheet 45
File No.
Date 7/25/86
Date 9/ /75

Area C (South and West Area)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration Ra-226 (pCi/g)	Concentration eRa-226 (pCi/g)	Concentration Th-230 (pCi/g)	Moisture (%)	Proposed Excav. Depth (ft)
800	0	0- 6		101	240 ± 14			10.02	2.5
800	15	0- 6	158	110	82 ± 4				1.0
700	16	0- 6		111	120 ± 5	238.5 ± 93.5			2.5
		6- 12		176	96 ± 6	213.8 ± 83.9			
		12- 18		190	128 ± 6	285.4 ± 111.9			
600	10	0- 6	159	102	164 ± 8				1.0
500	10	0- 6		112	42 ± 2	715.0 ± 280.0			2.5
		6- 12		174	948 ± 44	250.4 ± 98.3			
		~~6- 12~~		~~14~~	~~953 ± 46~~	~~283.7 ± 110.9~~			
		12- 18		175	127 ± 6				
457	-7	0- 6		25	144 ± 7				1.5
400	10	0- 6	160	103	78 ± 3				1.0
300	10	0- 6		113	58 ± 3	933.0 ± 367.6			9.0 ?
		6- 12		172	196 ± 8	1522.3 ± 599.7			
		12- 18		173	1152 ± 56	135.6 ± 55.9			
200	10	0- 6	161	104	42 ± 2				1.0
100	10	0- 6		114	32 ± 2	2019.2 ± 790.4			9.0 ?
		6- 12		191	977 ± 43	2689.6 ± 1052.4			
		12- 18		192	2119 ± 97	2565.0 ± 1004.0			
100	2670	0- 6		296	2 ± 1	64.2 ± 25.4			2.0
		6- 12		302	66 ± 5	87.2 ± 34.4			
		~~12- 18~~		~~21~~	~~80 ± 6~~	~~53.0 ± 21.1~~			
		12- 18		303	79 ± 6				
99	700	0- 6		117	no 2 ± 1	20.7 ± 8.6			0
		6- 12		278	no 2 ± 1	77.2 ± 30.5			
		12- 18		279	no 2 ± 1	180.4 ± 70.8			
98	400	0- 6	165	108	46 ± 2				1.0
96	500	0- 6		116	2 ± 1	197.6 ± 77.5			4.5
		6- 12		195	139 ± 6	231.9 ± 91.0		18.78	
		12- 18		196	375 ± 20	34.9 ± 14.3			
94	600	0- 6	166	109	20 ± 1			4.42	1.0
94	800	0- 6		297	no 2 ± 1	2.0 ± 2.5			0
93	300	0- 6		115	2 ± 1	306.3 ± 120.1			2.5
		6- 12		193	229 ± 9	221.6 ± 86.9		25.54	
		12- 18		194	133 ± 6	119.3 ± 47.0			
87	200	0- 6	163	107	106 ± 5			17.27	1.5
85	100	0- 6	164	106	128 ± 6				1.5
58	2500	12- 18		301				29.25	
				37 Subtotal	9113 ± 441			6 Subtotal 105.38	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature Tailings Excavation
Item off-pile Excavation Limits and Quantities

Contract No. 5025
Designed WYL
Checked MDL

Sheet r6
File No.
Date 7/25/86
Date 6/2/85

SAB 2/13/89
Chk PS 2/14/89

Area C (cont'd)

Grid Coordinates		Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration			Moisture (%)	Proposed Excav. Depth (ft)
North	East				Ra-226 (pCi/g)	eRa-226 (pCi/g)	Th-230 (pCi/g)		
55	534	0- 6		27	no2 ± 1				0
52	-12	0- 6		26	333 ± 16				3.0
50	10	0- 6	162	105	45 ± 2			13.16	1.0
40	2500	0- 6		299	95 ± 5	1890.1 ± 739.9			5.0
		6- 12		300	1923 ± 96	1877.9 ± 735.1			
		12- 18		301	2107 ±123	853.8 ± 334.8			
		28- 41 13"		330	64 ± 6	* 2/6			
		41- 45 4"		331	139 ± 12	* 4/6			
36	2388	0- 6		293	no2 ± 1	1.7 ± 2.4			0
		~~0- 6~~		• ~~23~~	~~2 ± 1~~				
34	2275	0- 6		294	no4 ± 1	1.3 ± 2.4			0
13	-31	0- 6	173	688	22 ± 2			6.31	1.0
-90	1281	0- 6		246	no2 ± 1	2.8 ± 2.6			0
-80	1600	~~0- 6~~		• ~~19~~	~~2 ± 1~~				0
		0- 6		245	no2 ± 1	2.2 ± 2.5			
-24	1800	~~0- 6~~		• ~~24~~	~~3 ± 1~~				0
		0- 6		298	no3 ± 1	2.0 ± 2.7			
-14	1064	0- 6		247	no2 ± 1	1.6 ± 2.8			0
-5	2000	0- 6		248	? no2 ± 1	1.5 ± 2.4			0
-1	2077	0- 6		29	17 ± 1	41.6 ± 16.6			1.0
		6- 12		295	33 ± 2	4.3 ± 3.0			

21 Subtotal 4804 ± 276

2 subtotal 19.47

Ave Ra-226 Concentration for Area C = 240 ± 12.4

Ave Existing Moisture Content for Area C = 15.60%

n = 43
m = 297.0
s = 548.0
SEM = 83.6

A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ
Feature Tailings Excavation
Item off-pile Excavation Limits and Quantities

Contract No. 5025
File No.
Designed VIYL
Date 7/22/83
Checked MCL
Date 9/2/83
SWB 2/13/89
chk PS 2/19/89

Consider upto 6-in., since that is the planned excavation depth. Consider all samples, since entire area will be excavated.

Pond No. 1

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration Ra-226 (pCi/g)	Concentration eRa-226 (pCi/g)	Concentration Th-230 (pCi/g)	Moisture (%)	Proposed Excav. Depth (ft)
2000	2640	0- 6	17	241	16 ± 1				0.5
2000	2800	0- 6	18	240	4 ± 1				0.5
2000	3000	0- 6	23	223	5 ± 1			13.02	0.5
2000	3200	0- 6	24	239	5 ± 1				0.5
2000	3400	0- 6	31	222	no 2 ± 1			11.30	0
1991	3267	0- 6		21	7 ± 1		5		0.5
1949	2785	0- 6		22	9 ± 1				0.5
1800	3000	0- 6	22	224	7 ± 1				0.5
		0- 24	22	361	3.4 ± 1 *4		2		
1800	3200	0- 6	25	238	5 ± 1				0.5
1800	3400	0- 6	30	221	no 2 ± 1			14.12	0
1600	3000	0- 6	21	225	7 ± 1				0.5
		0- 24	21	358	2.4 ± 1 *4		2		
		24- 48	21	359	1.9 ± 1 *4		2		
		48- 72	21	360	1.4 ± 1 *4		1		
1600	3200	0- 6	26	237	8 ± 1				2.0
		0- 24	26	351	17.2 ± 1 *4		5		
1600	3400	0- 6	29	220	no 3 ± 1				0
1445	2785	0- 6		12	6 ± 1		5		0.5
1415	3252	0- 6		19	no 3 ± 1				0
1400	2640	0- 6		242	54 ± 2				1.0
1400	2619	0- 6		627				8.05	—
1400	2800	0- 6	19	277	no 4 ± 1				0
1400	3000	0- 6	20	276	5 ± 1				0.5
		0- 24	20	354	4.8 ± 1 *4		3		
1400	3200	0- 6	27	236	no 4 ± 1				0
1400	3400	0- 6	28	219	no 3 ± 1				0
				Ave.	7.3 ± 1.1			Ave. 11.62	

** ONLY TOP 6" USED

n = 20
m = 7.95
s = 11.28
SEM = 2.52

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRT
Feature Tailings Excavation
Item Off-pile Excavation Limits and Quantities
Sheet #6
Contract No. 5025
File No.
Designed WYL/KID Date 2-13-89 7/21/83
Checked MDL Date 9/2/75

Consider only those samples with concentration above 5pCi/g. Prorate with thickness of sample. Do not consider samples below 24-in. (the maximum depth of excavation planned)

Pond No: 2

Grid Coordinates		Depth (in.)	Bore-hole No.	MCG or MDJ No.	concentration			Moisture (%)	Proposed Excav. Depth (ft)
North	East				Ra-226 (pCi/g)	eRa-226 (pCi/g)	Th-230 (pCi/g)		
1200	3230	0- 6	32	213	11 ± 1				0
1200	3400	0- 6	33	212	no 2 ± 1			17.76	0
1200	3600	0- 6	45	200	no 4 ± 1				0
1200	3800	0- 6	44	199	no 3 ± 1				0
1200	3925	0- 6	43	198	no 3 ± 1				0
1133	3852	0- 6		16	no 5 ± 1		3		0
1000	3200	0- 6		197	106 ± 4				1.5
		~~0- 6~~		~~9~~	~~109 ± 5~~				
1000	3275	0- 6	34	215	11 ± 1			20.04	0
1000	3400	~~0- 6~~	~~35~~	~~216~~	~~12 ± 1~~				2.0
		0- 12	35	466	20.2 ± 2.2	*2	8		
		12- 24	35	467	18.9 ± 2	*2	4		
1000	3600	~~0- 6~~	~~36~~	~~217~~	~~53 ± 2~~				1.5
		0- 12	36	470	132.2 ± 11.8	*2	28		
		12- 24	36	471	5.3 ± 1	*2	2		
1000	3800	~~0- 6~~	~~42~~	~~218~~	~~17 ± 1~~			17.42	2.0
		0- 24	42	400	21.4 ± 1.4	*4	5		
		30- 54	42	451	9.7 ± 1	*4	2		
		54- 78	42	452	1.5 ± 1	*4	2		
1000	3925	0 - 6	41	235	no 4 ± 1				0
982	3281	0- 6		13	20 ± 1		7		0.5
967	3576	0- 6		14	22 ± 1				0.5
880	3880	0- 6		15	6 ± 1				0
825	3400	0- 6	37	231	27 ± 2				1.0
825	3600	0- 6	38	232	74 ± 5				1.0
825	3800	0- 6	39	233	no 4 ± 1				0
825	3904	0- 6	40	689	no 3 ± 1			14.35	0
825	3925	0- 6		234	6 ± 1				0
					Ave. 25.4 ± 2 ✓			Ave. 17.39	

n = 21
m = 34.2
S = 40.3
SEM = 8.8

Chk PS 2/19/89

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ	Contract No. 5025	Sheet 29
Feature Embankment Design	Designed WYL	Date 3/21/88
Item Average Ra-226 Concentrations	Checked PS	Date 3/30/88

Pond No 3

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCG or MDJ No.	Ra-226 (pCi/g)	eRa-226 (pCi/g)	Th-230 (pCi/g)	Moisture (%)	Proposed Excav. Depth (ft)
1200	3170	0- 6	49	214	8 ± 1				0
1000	3020	156-180	175	453	1.9 ± 1 *4		7		20.0
		180-204	175	454	6.4 ± 1 *4		5		
		204-228	175	455	37.5 ± 1.8 *4		52		
800	3010	180-204	56	456	28.3 ± 1.6 *4		47		17.5
		204-228	56	457	~~1.9 ± 1~~		2		
		228-252	56	458	~~1.5 ± 1~~		2		
600	2800	264-270	59	459	3.4 ± 1		2		20.0
400	3000	240-264	64	461	8.5 ± 1 *4		4		20.0
		264-282	64	462	~~2.2 ± 1~~		2		
		288-294	64	463	~~2.2 ± 1~~		2		
400	2820	216-240	177	464	4.5 ± 1 *4		2		18.0
		240-264	177	465	~~2.1 ± 1~~		1		
183	2957	0 - 6		30	~~1 ± 1~~	99.6 (99.8)			0

Additional Investigation By CNSI in 1987 (Ref 5)
Coordinates of Boring Location refer to a system on DWG No. GRJ-PS-10-0217 (Sheet 28)

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	Boring
GJ-SS-294	N 59,600; E 35,300	1.5-3.0	41.6	83.2** *3	296
GJ-SS-295	N 59,600; E 35,300	4.5-6.0	13.0	15.6*	
GJ-SS-296	N 59,600; E 35,300	7.5-9.0	11.5	14.0*	
GJ-SS-297	N 59,600; E 35,300	10.5-12.0	17.0	20.7*	
GJ-SS-298	N 59,600; E 35,300	13.5-15.0	2.2	4.4**	
GJ-SS-299	N 59,600; E 35,300	16.5-18.0	6.2	12.4**	
GJ-SS-300	N 59,600; E 35,300	19.5-21.0	9.4	18.8**	
GJ-SS-301	N 59,600; E 35,300	22.5-24.0	3.9	7.0*	
GJ-SS-302	N 59,600; E 35,300	~~25.5-27.0~~	~~1.8~~	~~1.6~~	
~~GJ-SS-303~~	~~N 59,600; E 35,300~~	~~28.5-30.0~~	~~1.4~~	~~2.8**~~	
GJ-SS-455	N 60,100; E 35,600	< 0.5	5.5	11.0**	32M
GJ-SS-456	N 60,100; E 35,600	1.5-3.0	4.6	9.2**	
GJ-SS-457	N 60,100; E 35,600	4.5-6.0	30.7	61.4**	
GJ-SS-458	N 60,100; E 35,600	7.5-9.0	122.7	245.4**	
GJ-SS-459	N 60,100; E 35,600	10.5-12.0	15.3	30.6**	
GJ-SS-460	N 60,100; E 35,600	13.5-15.0	97.7	195.4**	
GJ-SS-461	N 60,100; E 35,600	16.0-18.0	37.2	74.4**	
GJ-SS-462	N 60,100; E 35,600	19.5-21.0	2.0	4.0**	
GJ-SS-463	N 60,100; E 35,600	22.5-24.0	~~1.0~~	~~2.0**~~	
GJ-SS-464	N 60,100; E 35,600	25.5-27.0	~~0.4~~	~~0.8**~~	
GJ-SS-431	N 59,505; E 35,673	1.5-3.0	11.0	11.7	357-B
GJ-SS-432	N 59,505; E 35,673	4.5-6.0	23.1	46.2**	
GJ-SS-433	N 59,505; E 35,673	7.5-9.0	32.0	64.0**	
GJ-SS-434	N 59,505; E 35,673	10.5-12.0	14.6	17.5*	
GJ-SS-435	N 59,505; E 35,673	13.5-15.0	46.0	92.0**	
GJ-SS-436	N 59,505; E 35,673	16.5-18.0	10.1	20.2**	
GJ-SS-437	N 59,505; E 35,673	19.5-21.0	108.0	216.0**	

Sheet 30
Project UMTRA-GRJ
Contract No. 5025
File No.
Feature Radon Barrier
Designed PL
Date 2-10-89
Item
Checked SWB
Date 2-13-89

For Pond 3 Material, only the CNSI data is considered, since this is the latest data, and not reflective of the vicinity properties materials being constantly deposited. Data are considered only upto the depth below which Ra-226 concentrations above 15 pCi/g do not exist. The results are :

No. of Samples = 21
Mean = 66.4 pCi/g
Std. Dev. = 72.2 pCi/g
SEM = 15.8 pCi/g.

It may be mentioned that the results are based on the 'Final' Ra-226 values. Most of these final values are estimates, e.g. twice the 'initial' values. Since measured values generally indicate a factor less 2, the computed values are conservative.

31

PS 3/23/88

WYL 3/21/88

(Ref 4)

Date: 9/8/87

To: Jim Williams
From: Garth Stowe
Subject: Grand Junction Soil Ra 226/Thorium Sample Data

Information requested by MKE regarding Thorium concentrations and emanation factors for the Grand Junction tailings pile is presented to you.

Thorium Information:

Twenty samples obtained from various depths were sent to Barringer Laboratories for analysis on Thorium 230 concentrations. The analysis by Barringer confirm a consistent decrease in Thorium 230 levels at the depths where the Radium 226 also decreases. This finding should assist in the excavation criteria for Thorium 230 at the Grand Junction site.

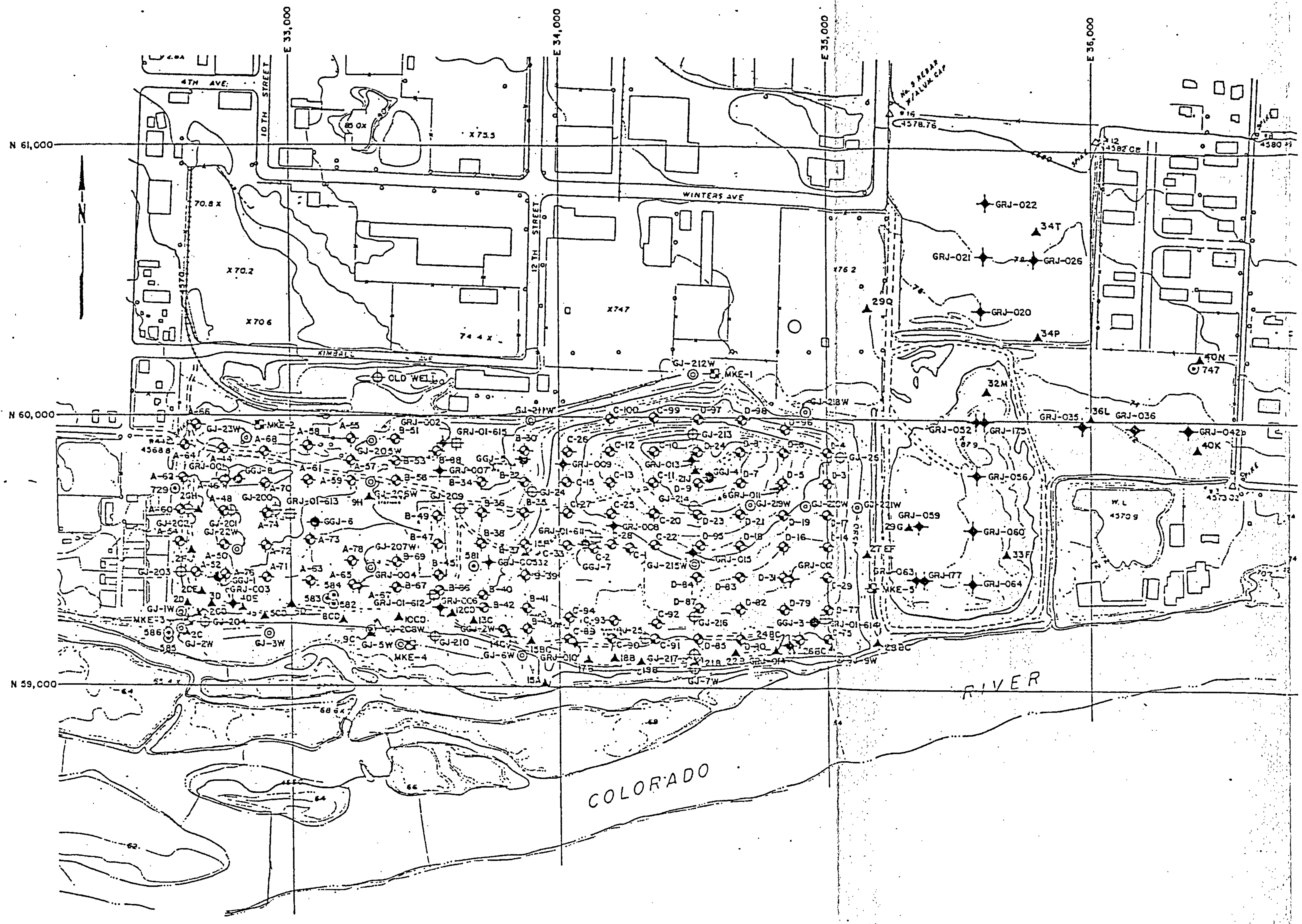
SAMPLE ID	LOCATION	DEPTH IN FEET	Ra 226 INITIAL	pCi/q FINAL	Th 230 pCi/q +/- precisior
GJ-SS-007	N 59,650 E 32,650	19.5	1.4	2.9	1.8 +/- 0.7
GJ-SS-073	N 59,300 E 32,600	7.5	47.7	58.2 *	32 +/- 3
GJ-SS-084	N 59,200 E 32,900	16.5	7.3	15.6	14 +/- 2
GJ-SS-120	N 59,200 E 33,110	1.5	85.1	170.2 **	58 +/- 3
GJ-SS-138	N 59,800 E 34,500	2	246.7	493.4 **	140 +/- 10
GJ-SS-154	N 59,800 E 34,500	57.5	3.4	5.1	3.4 +/- 0.9
GJ-SS-163	N 59,250 E 33,400	25	0.9	1.6	1.2 +/- 0.6
GJ-SS-189	N 59,110 E 34,108	4.5	5.8	6.6	11 +/- 2
GJ-SS-201	N 59,150 E 34,800	32.5	1.6	3.5	3.3 +/- 0.9
GG-SS-217	N 59,100 E 33,650	22.5	14.8	24.8	5.9 +/- 1.1
GJ-SS-302	N 59,600 E 35,300	25.5	1.8	1.6	0.8 +/- 0.5
GJ-SS-349	N 60,400 E 35,300	2.5	4.5	9 **	2 +/- 0.7
GJ-SS-400	N 59,100 E 34,214	32.5	1.1	2.2 **	1.2 +/- 0.6
GJ-SS-444	N 60,700 E 35,800	13.5	1.4	2.8 **	0.6 +/- 0.4
GJ-SS-447	N 60,300 E 35,800	5	1.3	2.6 **	1.4 +/- 0.6
GJ-SS-462	N 60,100 E 35,600	20	2	4 **	1.4 +/- 0.6
GJ-SS-470	N 60,200 E 36,400	17	2.5	5 **	1.6 +/- 0.6
GJ-SS-471	N 59,900 E 36,400	3	6.1	12.2 **	0.8 +/- 0.5
GJ-SS-477	N 60,000 E 36,000	8	1.2	2.4 **	0.6 +/- 0.5
GJ-SS-498	N 59,502 E 35,673	18	6.4	7.8 *	3.4 +/- 0.9

* These samples counted initially wet, final activity determined by correcting for moisture content only.

** These samples counted initially wet, final activity determined by applying a correction factor of 2 to 1.

RECEIVED-MKE
SEP 10 1987

~~SHT 33~~ 32



NOTES:

1. GROUND WATER DATA AND SUBSURFACE EXPLORATION LOGS ARE AVAILABLE FROM THE CONTRACTOR.
2. JACOBS MONITOR WELLS NUMBERED 581 THROUGH 586 CORRESPOND TO FIELD DESIGNATION GWGJ-1 THROUGH GWGJ-6 RESPECTIVELY.
3. EXISTING CONTOURS AND FEATURES SHOWN ARE THOSE WHICH EXISTED PRIOR TO PHASE I-A CONSTRUCTION.

REFERENCE DRAWINGS:

GRJ-PS-10-0208	CONSTRUCTION FACILITIES AND SITE DRAINAGE
GRJ-PS-10-0209	SLURRY TRENCH PLAN
GRJ-PS-10-0211	CONTAMINATED MATERIAL EXCAVATION PLAN SHEET 1 OF 2
GRJ-PS-10-0212	CONTAMINATED MATERIAL EXCAVATION PLAN SHEET 2 OF 2

LEGEND:

4680	EXISTING SITE FEATURES & CONTOURS
N61,000	CONSTRUCTION GRID COORDINATE
⊕ GJ-200	AUGER BORINGS DRILLED BY COLORADO STATE UNIVERSITY (1980)
A-66, B-51 C-25, D-27	AUGER BORINGS DRILLED BY SERGENT, HAUSKINS & BECKWITH (1981)
● GGJ-1	AUGER BORINGS DRILLED IN 1982, MONITORING WELLS 1982.
◎ GJ-205W	MONITOR WELLS INSTALLED BY COLORADO STATE UNIVERSITY (1980)
◉ 724	MONITOR WELL INSTALLED BY JACOBS ENGINEERING GROUP, INC. (1985)
GRJ-01-611	TEST PITS DUG BY JACOBS ENGINEERING GROUP, INC. (1985)
MKE-1	TEST PITS DUG BY MORRISON-KNUDSEN ENGINEERS, INC. (1985)
✦ GRJ-001	AUGER BORINGS DRILLED BY JACOBS ENGINEERING GROUP (1984)
⊕	OLD WELL WEST OF MILL.
▲ 2C	AUGER BORINGS DRILLED BY LINCOLN DEVORE (1987)

FINAL REVIEW

E & D MANAGER	CHIEF ENGINEER	QA MANAGER

JA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR	CHIEF ENG.	TAC REV	DOE APP
	△								
	△								
	△								
	△								
	△B		ISSUED FOR FINAL REVIEW	–	–	–	–		

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

BORINGS AND TEST PITS LOCATION PLAN

DESIGNED	DRAWN RBC
CHECKED	
INSPECTED	
RECOMMENDED	
APPROVED	DATE
DOE PROJECT ENGINEER	DATE

MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT
180 HOWARD ST SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. GRJ-PS-10-0217
REV B

33
WYL 3/21/88
PS 4/4/83