UMGRJ080A01 V02D001
PRELIMINARY FINAL VOL 1 OF 5
BOX:RU 16 DOC:08/01/1990
SURF000516

Uranium Mill Tailings Remedial Action Project (UMTRAP) Grand Junction, Colorado

GRJ-PH-II
Calculations
Preliminary Final

Volume I

August 1990

MORRISON-KNUDSEN ENGINEERS, INC.

WM-54

Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque New Mexico 87115

OCT 2 2 1991

Mr. Ramon Hall
Director, Uranium Recovery Field Office
Region IV
U.S. Nuclear Regulatory Commission
P.O. Box 25325
Denver, CO 80225

DOCKETED
OCT 28 1991
USNRC
MAIL SECTION
DOCKET CLERK

URFO
RECEIVED
'91 OCT 28 P12:15

Dear Mr. Hall:

The final Remedial Action Plan (RAP) for the Grand Junction, Colorado, site is enclosed for your information. An additional copy of the RAP was not available to provide to you at the time the RAP was transmitted to the Nuclear Regulatory Commission in Washington, D.C. The enclosure contains complete sets of the Remedial Action Selection Report, Attachment 2 - Geology Report, Attachment 3 - Groundwater Hydrology Report, and Attachment 4 - Water Resources Protection Strategy with all revisions. In addition, the revised specifications and calculations sets from Attachment 1 are enclosed along with new calculation sets and calculation revisions from Appendix A to Attachment 3. Instructions are provided with the enclosure outlining the steps to be taken to update your volumes. The enclosure has been three-hole punched for insertion into the binders that were provided with the preliminary final document. For ease in review, substantive inserts have been underlined and substantive text deletions have been designated with brackets ([]).

If you have any questions or concerns please contact Don Leske at FTS 326-6008 or Chris Watson of the Technical Assistance Contractor at FTS 845-4030.

Sincerely,

ARChernoff

Albert R. Chernoff
Project Manager
Uranium Mill Tailings Remedial Action
Project Office

2 Enclosures

cc w/o enclosures:
D. Gillen, NRC-LLWM
L. Callan, NRC-Region IV
D. Leske, UMTRA/GJPO
M. Abrams, UMTRA
C. Watson, TAC
J. Oldham, MK-F

9710230273 911022
PDR WASTE
WM-54 PDR

G2-11.50

UM/GRJ-8.A.1
VOL 1

UMTRA PROJECT

NOTICE OF LIMITED DISTRIBUTION

THIS DRAFT DOCUMENT IS PART OF THE DELIBERATIVE PROCESS OF THE U.S. DEPARTMENT OF ENERGY (DOE) IN ITS DECISION-MAKING FUNCTION UNDER THE URANIUM MILL TAILINGS RADIATION CONTROL ACT OF 1978, THE NATIONAL ENVIRONMENTAL POLICY ACT, AND OTHER APPLICABLE LAW. IT IS PROVIDED TO THE RECIPIENT PARTICIPATING FEDERAL OR STATE AGENCY OR INDIAN TRIBE WITH THE EXPRESS UNDERSTANDING THAT IT IS ONLY TO BE USED FOR THE PURPOSE OF PROVIDING THE DOE WITH INPUT TO SUCH DECISION-MAKING PROCESS. THE RECIPIENT PARTICIPATING FEDERAL OR STATE AGENCY EXPRESSLY AGREES TO LIMIT DISTRIBUTION OF THIS DOCUMENT TO THOSE EMPLOYEES WHO WILL PROVIDE INPUT TO THE DOE.

SHELF COPY

Following are instructions for updating the final Remedial Action Plan for the Grand Junction site. Please retain all plates provided earlier.

- Remedial Action Selection Report (RAS) - Please replace the complete RAS in your binder with the enclosed RAS.

- Attachment 1 - Please replace the appropriate specifications and calculation sets with the enclosed revised specifications and calculation sets.

- Attachment 2 - Please replace the complete Attachment 2 in your binder with the enclosed Attachment 2.

- Attachment 3 - Please replace the complete Attachment 3 in your binder with the enclosed Attachment 3.

- Attachment 4 - Please replace the complete Attachment 4 in your binder with the enclosed Attachment 4.

- Attachment 3, Appendix A, Volume IV - Please replace page iii of the Table of Contents with the enclosed page iii; also, calculations GRJ-03-07-90-13-06(01)-00 and GRJ-03-07-90-14-14-01-00 are provided to ensure completeness. Please insert new calculation GRJ-01-91-15-02-00 and revised calculation GRJ-08-90-14-11 at the end of the volume.

- Attachment 5, Volume I - Please replace the Table of Contents page with the enclosed Table of Contents page.

- Attachment 5, Volume II - Please replace the Table of Contents page with the enclosed Table of Contents page; also, remove and discard the pages titled "Terms and Abbreviations Used on Logs" and "Cheney Disposal Area Test Pit Logs."

- Attachment 3, Appendix A, Volumes II through IV - Please replace page iii of the Table of Contents with the enclosed page iii.

- MK Document GRJ-PH-II, Calculations, Volume II - Please replace calculation 05-505-02-00 with new calculation 05-505-02-02.

- MK Calculations, Volume III - Please replace calculation 05-505-03-00 with new calculation 05-505-03-01.

Deckler

ENGINEERS
AND
CONSTRUCTORS

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

HEADQUARTERS OFFICE
ONE ERIEVIEW PLAZA
CLEVELAND, OHIO U.S.A. 44114
PHONE: (216) 523-5600/TELEX: 985542

RECEIVED
MAY 13 1991
HAZARDOUS MATERIALS
AND WASTE MANAGEMENT

REPLY TO: MK-FERGUSON COMPANY
REMEDIAL ACTIONS
CONTRACTOR-UMTRA PROJECT
P.O. BOX 9136
ALBUQUERQUE, NEW MEXICO U.S.A. 87119
91-3050-388

May 9, 1991

Mr. Mark L. Matthews
Project Manager
U.S. Department of Energy
Uranium Mill Tailings Remedial Action Project Office
First National Bank Building
5301 Central Avenue N.E.
Suite 1700
Albuquerque, New Mexico 87108

SUBJECT: Grand Junction Calculations

REFERENCE: Contract No. DE-AC04-83AL18796.

Dear Mr. Matthews:

Enclosed, per TSC's request, are twenty (20) copies of the following Grand Junction calculations.

CALCULATION NO.	VOLUME	TITLE
✓05-626-01-03	I	Tailings Excavation - Tailings Pile Limits and Quantities
✓05-626-02-04	I	Tailings Excavation Off-Pile Excavation Limits and Quantities
✓05-504-01-02	II	Erosion Protection - Top and Sideslopes of Tailings Embankment
✓05-670-01-05	III	Radon Barrier Design - Thickness
✓05-670-02-03	III	Radon Barrier Design - average Ra-226 Concentrations
✓05-670-06-02	IV	Embankment Design - Settlement and Cover Cracking
✓05-670-07-05	V	Embankment Design - Slope Stability
✓05-670-09-02	V	Embankment Design - Depth of Frost Penetration

Please note only the revised sheets have been copied and provided.

5239K

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

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HAZARDOUS MATERIALS
AND WASTE MANAGEMENT

The following calculations have been deleted from the calculation package.

CALCULATION NO.	VOLUME	TITLE
05-504-06-00	II	Permanent Drainage - Gullying Potential for Vegetated Cover
05-670-10-00	V	Embankment Cover Design - Vegetative Cover

A revised calculation index is enclosed.

If you have any questions, please contact Ralph Waddington or Rob Cooney of my staff at 766-3093.

Sincerely,

MK-Ferguson Company

J. G. Oldham
Project Director

JGO/REC/REW/mno

Enclosures:

cc: w/enclosures:
C. Smythe, DOE/UMTRA
D. Leske, DOE/UMTRA/GRJ
R. Portillo, TSC/UMTRA
~~P. Martinek, CDH~~ Denkler

5239K

Martinek

ENGINEERS
AND
CONSTRUCTORS

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

HEADQUARTERS OFFICE
ONE EREVIEW PLAZA
CLEVELAND, OHIO U.S.A. 44114
PHONE: (216) 523-5600/TELEX: 985542

MAY 02 1991

REPLY TO. MK-FERGUSON COMPANY
REMEDIAL ACTIONS
CONTRACTOR-UMTRA PROJECT
P.O. BOX 9136
ALBUQUERQUE, NEW MEXICO U.S.A. 87119

91-3050-351

April 29, 1991

Mr. Mark L. Matthews
Project Manager
U.S. Department of Energy
Uranium Mill Tailings Remedial Action Project Office
First National Bank Building
5301 Central Avenue N.E.
Suite 1700
Albuquerque, New Mexico 87108

SUBJECT: Grand Junction Phase II
Revised Design Calculations

REFERENCE:
1. Meeting with NRC in GRJ on March 15, 1991
2. DOE letter to MK-Ferguson, dated December 11, 1990
3. Contract No. DE-AC04-83AL18796

Dear Mr. Matthews:

Enclosed, as requested, are copies of the final calculations for NO. 05-504-07-00 Permanent Site Drainage and NO. 05-504-05-02 Embankment Design. These calculations were necessitated by the change in cover design from partial vegetation to rock riprap.

Copies of these calculations are being provided to the Colorado Department of Health and the TSC, as noted.

Should you have any questions, please contact Mr. Ralph Waddington or Mr. Rob Cooney of my staff at 766-3093.

Sincerely,

MK-Ferguson Company

for J. O

J. G. Oldham
Project Director

JGO/REC/REW/mno

Enclosures:
cc: w/enclosures:
D. Leske, DOE/UMTRA/GRJ
R. Portillo, TSC/UMTRA (2 copies)
P. Martinek, CDOH
w/o enclosures:
C. Smythe, DOE/UMTRA

5210K

ENGINEERS
AND
CONSTRUCTORS

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

HEADQUARTERS OFFICE
ONE ERIEVIEW PLAZA
CLEVELAND, OHIO U.S.A. 44114
PHONE: (216) 523-5600/TELEX: 985542

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FEB 20 1991
HAZARDOUS MATERIALS
AND WASTE MANAGEMENT

REPLY TO: MK-FERGUSON COMPANY
REMEDIAL ACTIONS
CONTRACTOR-UMTRA PROJECT
P.O. BOX 9136
ALBUQUERQUE, NEW MEXICO U.S.A. 87119

February 13, 1991

91-3050-114

Mr. Mark L. Matthews
Project Manager
U.S. Department of Energy
Uranium Mill Tailings Remedial Action Project Office
First National Bank Building
5301 Central Avenue N.E.
Suite 1700
Albuquerque, New Mexico 87108

SUBJECT: Grand Junction Phase II
Revised Design Calculation

REFERENCE: 1. Our letter 91-3050-001 dated January 3, 1991.
2. Contract No. DE-AC04-83AL18796

Dear Mr. Matthews:

Enclosed are revised pages to calculation number 05-670-07-05, from MKES for the Embankment Design Slope Stability. The Table enclosed has been corrected (Page 10 of the calculations). Errors occurred when data was transferred from a previous version, the correct data was used in all computer runs and the remainder of the calculations require no changes.

Please insert these revised pages into your copy of the calculations. These items are to be submitted to the NRC.

If you have any questions, please contact Tom Jennings or Rob Cooney of my staff at 766-3093.

Sincerely,

MK-Ferguson Company

J. G. Oldham
Project Director

JGO/REC/TPJ/mno
Enclosures
cc: C. Smythe - DOE/UMTRA (w/o enc.)
D. Leske, DOE/UMTRA (w/enc.)
R. Portillo - TAC/UMTRA (w/2 copies)
P. Martinek - CDOH (w/enc.)

5013K

ENGINEERS
AND
CONSTRUCTORS

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

HEADQUARTERS OFFICE
ONE ERIEVIEW PLAZA
CLEVELAND, OHIO U.S.A. 44114
PHONE: (216) 523-5600/TELEX: 985542

REPLY TO: MK-FERGUSON COMPANY
REMEDIAL ACTIONS
CONTRACTOR-UMTRA PROJECT
P.O. BOX 9136
ALBUQUERQUE, NEW MEXICO U.S.A. 87119

January 17, 1991 91-3050-039

Mr. Mark L. Matthews
Project Manager
U.S. Department of Energy
Uranium Mill Tailings Remedial Action Project Office
First National Bank Building
5301 Central Avenue N.E.
Suite 1700
Albuquerque, New Mexico 87108

SUBJECT: Grand Junction, Phase II
Revised Design Calculations

REFERENCE: 1. Our letter 91-3050-001 (01/03/91)
2. Contract No. DE-AC04-83AL18796

Dear Mr. Matthews:

Our referenced letter transmitted revised calculations for Grand Junction. Enclosed are changes to these calculations as requested by Raoul Portillo of the TAC:

1. Calculation 05-670-07-04, "Slope Stability": Cover Sheet and Sheet ii.

2. Calculation 05-670-06-01, "Settlement and Cover Cracking": Front page.

3. Calculation 05-504-01-02, "Top and Side Slopes of Embankment": Sheet 1 and Sheet 10.

4. Calculation 05-504-03-03, "Off-Pile Drainage Swale": Complete calculation, i through F-16.

These items are to be submitted to the NRC.

4936K

JAN 23 1991

If you have any questions, please contact Tom Jennings or Rob Cooney of my staff at 766-3093.

Sincerely,

MK-Ferguson Company

William A. Zebrch
for
J. G. Oldham
Project Director

JGO/REC/TPJ/sls

cc: C. Smythe - DOE/UMTRA (w/o enc.)
D. Leske - DOE/UMTRA/GRJ (w/enc.)
R. Portillo - TAC/UMTRA (w/2 copies)
P. Martinek - CDOH (w/enc.)

ENGINEERS
AND
CONSTRUCTORS

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

HEADQUARTERS OFFICE
ONE ERIEVIEW PLAZA
CLEVELAND, OHIO U.S.A. 44114
PHONE: (216) 523-5600/TELEX: 985542

REPLY TO: MK-FERGUSON COMPANY
REMEDIAL ACTIONS
CONTRACTOR-UMTRA PROJECT
P.O. BOX 9136
ALBUQUERQUE, NEW MEXICO U.S.A. 87119

January 14, 1991 91-3050-030

Mr. Mark L. Matthews
Project Manager
U.S. Department of Energy
Uranium Mill Tailings Remedial Action Project Office
First National Bank Building
5301 Central Avenue N.E.
Suite 1700
Albuquerque, New Mexico 87108

SUBJECT: Grand Junction, Phase II
Revised Calculations and Responses to Comments

REFERENCE:
1. Our letter 90-3050-909 (12/27/90).
2. Our letter 91-3050-001 (01/03/91)
3. Contract No. DE-AC04-83AL18796

Dear Mr. Matthews:

Enclosed are the following revised calculations for the Grand Junction cover design:

1. 05-670-07-04 - Slope Stability
2. 05-670-06-02 - Settlement and Cover Cracking

Also enclosed are responses to TAC comments transmitted on January 2, 1991. These calculations and responses are in addition to the material transmitted by our letters, References 1 and 2, and should complete this phase of the redesign. We expect to have the revised drawings and specifications by the end of January.

Please note that our letter, Reference 2, transmitted responses by MK-Ferguson to comments made by CDH in their letter to M.L. Matthews of December 17, 1990. It appears that the comments which MK-Ferguson did not respond to should be handled by the TAC. Therefore, we do not plan to respond further.

4922K

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

JAN 22 1991
HAZARDOUS
AND WASTE

If you have any questions, please contact Tom Jennings or Rob Cooney of my staff at 766-3093.

Sincerely,

MK-Ferguson Company

J. G. Oldham
Project Director

JGO/REC/TPJ/sls

Enclosures

cc: C. Smythe - DOE/UMTRA (w/o enc.)
D. Leske - DOE/UMTRA/GRJ (w/enc.)
R. Portillo - TAC/UMTRA (w/7 copies)
P. Martinek - CDOH (w/2 copies)

4922K

ENGINEERS
AND
CONSTRUCTORS

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

HEADQUARTERS OFFICE
ONE ERIEVIEW PLAZA
CLEVELAND, OHIO U.S.A. 44114
PHONE: (216) 523-5600/TELEX: 985542

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JAN 07 1991
HAZARDOUS AND WASTE MANAGEMENT

REPLY TO: MK-FERGUSON COMPANY
REMEDIAL ACTIONS
CONTRACTOR-UMTRA PROJECT
P.O. BOX 9136
ALBUQUERQUE, NEW MEXICO U.S.A. 87119

91-3050-001

January 3, 1991

Mr. Mark L. Matthews
Project Manager
U.S. Department of Energy
Uranium Mill Tailings Remedial Action Project Office
First National Bank Building
5301 Central Avenue N.E.
Suite 1700
Albuquerque, New Mexico 87108

SUBJECT: Grand Junction - Design Calculations

REFERENCE:
1. Meeting with NRC in Washington, D.C., 10/11/90.
2. TAC memo, "Grand Junction Revised Design Calculations", dated 12/06/90.
3. Contract No. DE-AC04-83AL18796

Dear Mr. Matthews:

Enclosed are two attachments pertaining to the Grand Junction redesign. Attachment 1 consists of calculations (see list) which have been revised in response to NRC comments made during the 10/11/90 meeting, and TAC comments made subsequently. These revised calculations should be forwarded to the NRC; copies are furnished to the TAC for this purpose. Attachment 2 consists of formal responses to TAC comments transmitted by Reference 2.

If you have any questions, please contact Tom Jennings or Rob Cooney of my staff at 766-3093.

Sincerely,

MK-Ferguson Company

for J. G. Oldham
Project Director

JGO/REC/TPJ/sls
Enclosures
cc: C. Smythe - DOE/UMTRA (w/o enc.)
D. Leske - GRJ (w/enc.)
R. Portillo - TAC/UMTRA (w/7 enc.)
P. Martinek - CDOH (w/enc.)

4889K

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

FERGUSON CO.
ALBUQUERQUE
JAN 11 1991
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DOCUMENT TRANSMITTAL

TO :	J.G. Oldham Attn: R.E. Cooney	DATE :	10 January 1991
LOCATION :	MK-F, Boise	SITE :	Grand Junction
NO. :	3885-GRJ-N-01-04781-00	COPY NO.(S) :	

We are sending our response to TAC comments dated 2 January 1991 along with the newly revised calculations as follows:

05-670-07-04 - Slope Stability
05-670-06-02 - Settlement and cover Cracking

COMMENTS :

D. R. Sanders

D.R. Sanders

REP	INFO	DIST	REP	INFO	DIST
		JCO			RDC
		WAL			JAWH
	✓	REC w/att			RAP
		WTD			MRP
		WWJ			DRS/MKE
		JBH			GBG/PD
		DPB			JWS
		CRS			LJB
	✓	TPJ w/att			SJS
		WAB			DEW
		JRB			
WORK FILE					

INFORMATION FOR REVIEWERS

PRELIMINARY FINAL REMEDIAL ACTION PLAN (RAP)

UMTRA PROJECT - GRAND JUNCTION

The following documents are submitted herein by MK-F (RAC) for Preliminary Final RAP of UMTRA - Grand Junction:

(i) Subcontract Documents, consisting of:

a. Bid Schedule
b. Special Conditions
c. Specifications
d. Subcontract Drawings

(ii) Five volumes of Calculations supporting the design.
A Table of Contents is presented in the front of each of the five volumes showing the contents of all the volumes.

Reviewers are alerted to the following additional items:

(i) Construction is presently ongoing concurrently with the design activities. Thus, several items in the Subcontract Documents reflect drawings and specifications for items under construction or those already completed.

(ii) The initial design of the cell was based on accommodating approximately 4.6 million cubic yards of tailings. Subsequently, in the letter from J. Pepin to R. Cooney dated 12 July 1990, the estimate was revised to 5.7 million cubic yards which prompted an additional 6 feet of excavation into the Mancos Shale. The effects of the additional excavation are reflected in the revised quantities in calculations No. 05-626-01-01 and 05-626-02-02 in Volume I.

The Subcontract Documents reflect the most current excavation plan, i.e. the additional 6 feet of excavation. However, the supporting calculations are for the shallower excavation, i.e. they have not been revised for the additional 6 feet of excavation. We believe that the revisions to the calculations are unnecessary since a 6-foot deeper excavation will either render the design more conservative as the infiltration calculation (Calculation No.05-670-13-00) or will not affect the design at all, e.g. size of riprap, radon barrier thickness.

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

MKE DOCUMENT NO. 5025-GRJ-C-01-00989-00

Calc. No. 05-622-01-00

Contract No. 5025 · Discipline ESCUP · No. of Sheets 11

Project UMTRA - GRAND JUNCTION

Feature DEWATERING

Item

Sources of Data

SEE P. 1

Sources of Formulae & References

SEE p. 1

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

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0		S.E. BOTSFORD	9/12/86	M.D. Lowenstein	9/22/86	[illegible]	11/4/86

Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet ____

Project: UMTRA GRJ | Contract No. 5025 | File No. ____
Feature: DEWATERING | Designed: SGB | Date: 9-12-86
Item ____ | Checked: MDL | Date: 9/22/86

INTRODUCTION:

A FIELD INVESTIGATION WAS PERFORMED BY LINCOLN DEVORE, AUGUST 18-25 1986, TO DETERMINE THE PERMEABILITY AT THE GRAND JUNCTION PROCESSING SITE. THE TESTING CONSISTED OF EXCAVATING 5 TEST PITS ALONG THE PILE PERIMETER. THE TEST PITS WERE DUG 5 FEET INTO THE WATER BEARING LAYER. (IN MOST CASES SHALE WAS ENCOUNTERED.) A WELL WAS INSTALLED IN EACH PIT WITH A MEASURING STICK TO MEASURE DRAWDOWN. A PUMP WAS PLACED IN EACH PIT AND THE PUMPING RATE WAS ADJUSTED UNTIL A CONSTANT HEAD WAS MAINTAINED. THE RATE OF WATER PUMPED AND DRAWDOWN WERE MEASURED AT REGULAR INTERVALS. SEE REFERENCE 1 FOR DATA.

REFERENCES:

1. LINCOLN DEVORE, "FIELD PERMEABILITY TESTS AT GRAND JUNCTION COLORADO", AUGUST 1986

2. LEONARDS, G.A., "FOUNDATION ENGINEERING", McGRAW HILL, NEW YORK, 1962.

3. USBR, "DRAINAGE MANUAL" 1st ED. 1978

4. DEPT. OF THE ARMY, NAVY, AND AIR FORCE, "DEWATERING AND GROUNDWATER CONTROL FOR DEEP EXCAVATIONS," TM 5-818-5, NAVFAC P-418, AFM 88-5, CHAP 6, APRIL 1971

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMRA - GRJ
Feature: DEWATERING
Item:
Contract No. 5025
Designed: SKB
Checked: MDL
Sheet 2
File No.
Date 9/12/86
Date 9/22/86

PURPOSE:

THE PURPOSE OF THIS CALCULATION IS TO 1) VERIFY THE RESULTS OF THE INVESTIGATION OF PERMEABILITY PERFORMED BY LINCOLN DEVORE AND TO 2) ESTIMATE THE AMOUNT OF WATER WHICH WILL INFILTRATE INTO THE EXCAVATIONS DURING CONSTRUCTION. IT IS IMPORTANT TO KNOW THE AMOUNT OF WATER FROM THE DEWATERIN PROCESS SO THAT WE MAY SIZE A WATER TREATME PLANT. THE WATER TREATMENT PLANT FROM CANONSBURG WHICH HAS A MAXIMUM CAPACITY OF 250 GPM WILL BE REUSED IF AT ALL POSSIBLE

PROCEDURE:

METHOD 1:-

THE THIEM EQUATION WILL BE USED TO CALCULAT K. THE COLORADO RIVER WILL BE CONSIDERED A LINE SOURCE. THE PARAMETERS LISTED IN TABLE 1 ARE FROM FIELD NOTES TAKEN DURING THE LINCOLN DEVORE INVESTIGATION SUPPLEMENTED BY LINCOLN DEVOR DATA.

METHOD 2 -

METHOD 2 USES THE USBR DRAINAGE MANUAL, 1978 p95 TO CALCULATE K (AS RECOMMENDED BY J. KAM)

LINCOLN DEVORE CALCULATED K FOR THE TEST PITS USING THE SICHARDT EQUATION TO CALCULATE R. AS WELL AS THE THIEM EQUATION. (NOTE THAT THE SICHARDT IS EMPIRICAL AND DOES NOT ACCOUNT FOR A LINE SOURCE.

THE RESULTS ARE TABULATED IN THE TABLE BELOW.

LINCOLN DEVORE CALCULATED K USING THE THIEM EQUATION AS WELL AS THE SICHARDT EQUATION (NOTE THAT SICHARDT'S EQUATION APPLIES TO SITUATIONS WHERE THE RADIUS OF INFLUENCE IS LARGE COMPARED WITH THE RADIUS OF THE WELL).

MDL 9/22/86
SKB 9/23/86

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 2

Project UMTRA - GJ
Feature
Item

Contract No. 5025
Designed SKB
Checked MDL

File No.
Date 8-29-86
Date 9/2/86

R&C' TR (H-h)

TEST PIT NO.	K VALUES THIEM EQUATION (cm/s)	DRAINAGE MANUAL (cm/s)	LINCOLN & DEVORE (cm/s)
MKE-1	.00711 ~~.00697~~ MDL 9/2/86	.0051	.00598
MKE-2A	.0126	.0018	.0119
MKE-3	.0194	.014	.0353
MKE-4	.0095	.0056	.0142
MKE-5	.0073 ~~.0052~~ MDL 9/2/86	.0018 ~~.012~~ MDL 9/2/86	.0100

Change acknowledged
by SKB 9/23/86

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - GRJ | Contract No. 5025 | Sheet 4
Feature: | Designed SGB | File No.
Item: | Checked MDL | Date 8-29-86 | Date 9/3/86

TABLE 1
VARIABLES FOR THIEM EQUATION

Q gpm	H FT	h_w FT	P FT	r $\frac{qth}{\pi}$ FT	
3.2	8	(8-5.2) 2.8	1010	10 x 12 = 7	MKE - 1
8.3	10.9	(10.9-4.3) 6.6	900	20 x 9 = 9.2	MKE - 2A
20	9.2	(9.2-5.5) 3.7	120	18 x 13 = 9.9	MKE - 3
5.8	7.4	(7.4-4.3) 3.1	160	19.5 x 13 = 10.3	MKE - 4
7.6	11	(11-4.8) 6.2	200	21 x 10.5 = 10	MKE - 5
9.3		4.5	MKE - 1		

METHOD 1

$$Q = \frac{K \pi \, 7.48 \, (H^2 - h^2)}{\ln \frac{2P}{r}}$$

$$3.2 = \frac{K_1 \pi \, 7.48 \, (8^2 - 2.8^2)}{\ln \frac{2(1010)}{7}}$$

5.66

SGB 9/23
MDL 9/3/86

K_{MKE-1} = .0140 / .0137 ft/min = .00711 / .00697 cm/s

METHOD 2

Wendy 303 331 455[illegible]

$$K = \frac{1{,}440 \, Q}{C \, d \, D}$$

$$K = \frac{1{,}440 \left(3.2 \text{ gpm} \frac{FT^3}{7.48 \text{ gal}}\right)}{1.5(2.8)(10)}$$

$$= 14.6 \frac{ft}{d} \cdot \frac{d}{24h} \frac{h}{3600s} \frac{12 in}{ft} \frac{2}{h}$$

$D/d = \frac{2.8}{10}$

$= .28$

$5.49 (.28)$

$\therefore C \approx 1.5$

K_{MKE-1} = .0051 cm/s

MKE-2A

METHOD 1

$$8.3 = \frac{K \pi \, 7.48 \, (10.9^2 - 6.6^2)}{\ln \frac{2(900)}{9.2}}$$

75.35

5.270

$K_{MKE-2A} = .0247$ ft/min $= .0126$ cm/s

METHOD 2

$$K = \frac{1440 \, (8.3) \, \frac{FT^3}{7.48 \, gal}}{5.39 \, (6.6)(9)}$$

$D/2 = \frac{6.6}{9}$

.73 (7.35)

C ~ 5.39

$= 4.99$ ft/d $(.0003528 \frac{cm/s}{ft/d})$

$K_{MKE-2A} = .0018$ cm/s ?

MKE-3

METHOD 1

$$20 = \frac{K \pi \, 7.48 \, (9.2^2 - 3.7^2)}{\ln \frac{2(120)}{9.9}}$$

70.95

3.185

$K_{MKE-3} = .0382$ ft/min $= .0194$ cm/s

.0194 ok

MDL 9/3/86

METHOD 2

$$K = \frac{1440 \, (20) \, \frac{FT^3}{7.48 \, gal}}{2 \, (3.7)(13)}$$

$D/2 = \frac{3.7}{13}$

.28 (7.35)

C ~ 2.0

$K = 40$ ft/d $(.0003528$ cm/s/ft/d$)$

$K_{MKE-3} = .014$ cm/s

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - GRJ
Feature:
Item:

Contract No. 5025
Designed: SKB
Checked: MDL

Sheet 6
File No.:
Date 8-29-8
Date 9/3/86

MKE -4

METHOD 1

$$5.8 = \frac{K \pi \, 7.48 \, (7.4^2 - 3.1^2)}{\ln \frac{2(100)}{10.5}}$$

45.15 ; 120 stet ; 3.436

K_{MKE-4} = .0188 ft/min = .0095 cm/s

.0171 stet ; .0087 stet ; .0095 cL

MDL 9/3/86

METHOD 2

$$K = \frac{1440 \, (5.8) \, \frac{FT^3}{7.48 \, gal}}{1.75 \, (3.1)(13)}$$

$D/a = \frac{3.1}{13}$

.24 (7.35)

C ~ 1.75

K_{MKE-4} = 15.83 FT/d (.0003528 cm/s / ft/d)

= .0056 cm/s

MKE - 5

METHOD 1

$$7.6 = \frac{K \pi \, 7.48 \, (11^2 - 6.2^2)}{\ln \frac{2(200)}{10}}$$

6.2 ; 3.689

K_{MKE-5} = .010 ft/min = .0052

.016 ; .0073 ; .0052 cm/sec

MDL 9/3/86

SKB 9/23/

METHOD 2

$$K = \frac{1440 \, (7.6) \, \left(\frac{FT^3}{7.48 \, gal}\right)}{1.68 \, (2.4)(10.5)}$$

1.68 ; 4.34 ; 6.2

$D/a = \frac{2.4}{10.5}$

.228 (7.35)

1.68 ; 4.34

K_{MKE-5} = 34.56 FT/d (.0003528 cm/s / ft/d)

6.18

= .012 cm/s

.0018

MDL 9/3/86

SKB 9/23/86

A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ | Contract No. 5025 | File No.
Feature DENATERING | Designed SKB | Date 9-8-86
Item | Checked MDL | Date 9/22/86

THE FOLLOWING CALCULATIONS ARE PERFORMED TO ESTIMATE THE FLOW INTO EXCAVATIONS OF THE SIZES SPECIFIED BELOW:

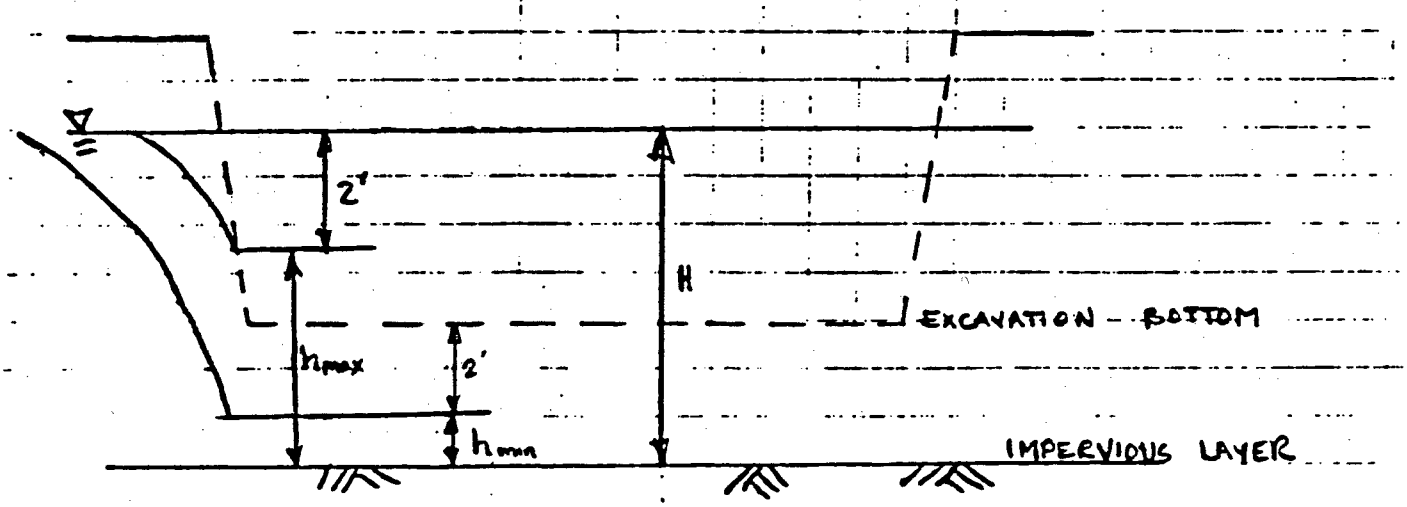
EXCAVATE 1000' BAND 100' WIDE PARALLEL TO RIVER

DRAWDOWN 2 FEET BELOW EXCAVATION

$K_{MKE-3} = .0194$ cm/s

h_{min} = EXC. ELEV. (4564) DEPTH -2' - BEDROCK ELEV. (4551) = 11'

H_{max} = GROUNDWATER ELEV. (4566) - BEDROCK ELEV. (4551) = 15'



$$Q_{max} = \frac{KX}{2L}\left(H_{max}^2 - h_{min}^2\right) \quad \text{(REF 4)}$$

$$Q_{SLOT} = \frac{.0194\,(1000)\,(15^2 - 11^2)\,(14.72)}{2\,(100)}$$

$Q = 148$ gpm

$$Q_{SIDE} = \frac{.0194\,(200)\,(15^2 - 11^2)\,(14.72)}{(2)150}$$

$Q = 20$ gpm

$Q_{max\,TOTAL} = 168$ gpm

EXCAVATION 1000 x 100'

NOTE: THIS CALC. IS BASE ON STATIC CONDITIONS AND DOES NOT TAKE INTO ACCOUNT THE WATER PRES IN THE EXCAVATION AT t=0 BEFORE THE WATER IS DRAWN DOWN.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - GRJ
Feature DEWATERING
Item

Contract No. 5025
Designed SLB
Checked MDL

Sheet 8
File No.
Date 9-10-86
Date 9/22/86

MOVE EXCAVATION 50' FROM RIVER. ESTIMATE WORST CASE CONDITIONS

$$Q_{slot} = \frac{.0194\,(1000)\,(10^2)\,(14.72)}{2\,(50)}$$

$Q = 286$ gpm (TOO HIGH)

$$h_{min} = \underset{\text{ELEV}}{\overset{4551}{\text{EXC.}}}\ \text{DEPTH} - 2' - \underset{\text{ELEV}}{\overset{4549}{\text{BEDROCK}}} = 0$$

$$H_{max} = 4563 - 4553 = 10'$$

REDUCE SLOT SIZE

$$Q_{slot} = \frac{.0194\,(500)\,(10^2)\,(14.72)}{2\,(50)}$$

$Q_{slot} = 143$ gpm

$$Q_{side} = \frac{.0194\,(800)\,(10^2)\,(14.72)}{2\,(75)}$$

$Q_{side} = 38$ gpm

$Q_{TOTAL} = 181$ gpm OK

EXCAVATION 500' x 100'

MOVE EXCAVATION 10' FROM RIVER - ESTIMATE WORST CASE CONDITIONS

$$Q_{slot} = \frac{.0194(100)(10^2)(14.72)}{2(10)}$$

$$Q_{slot} = 143 \text{ gpm}$$

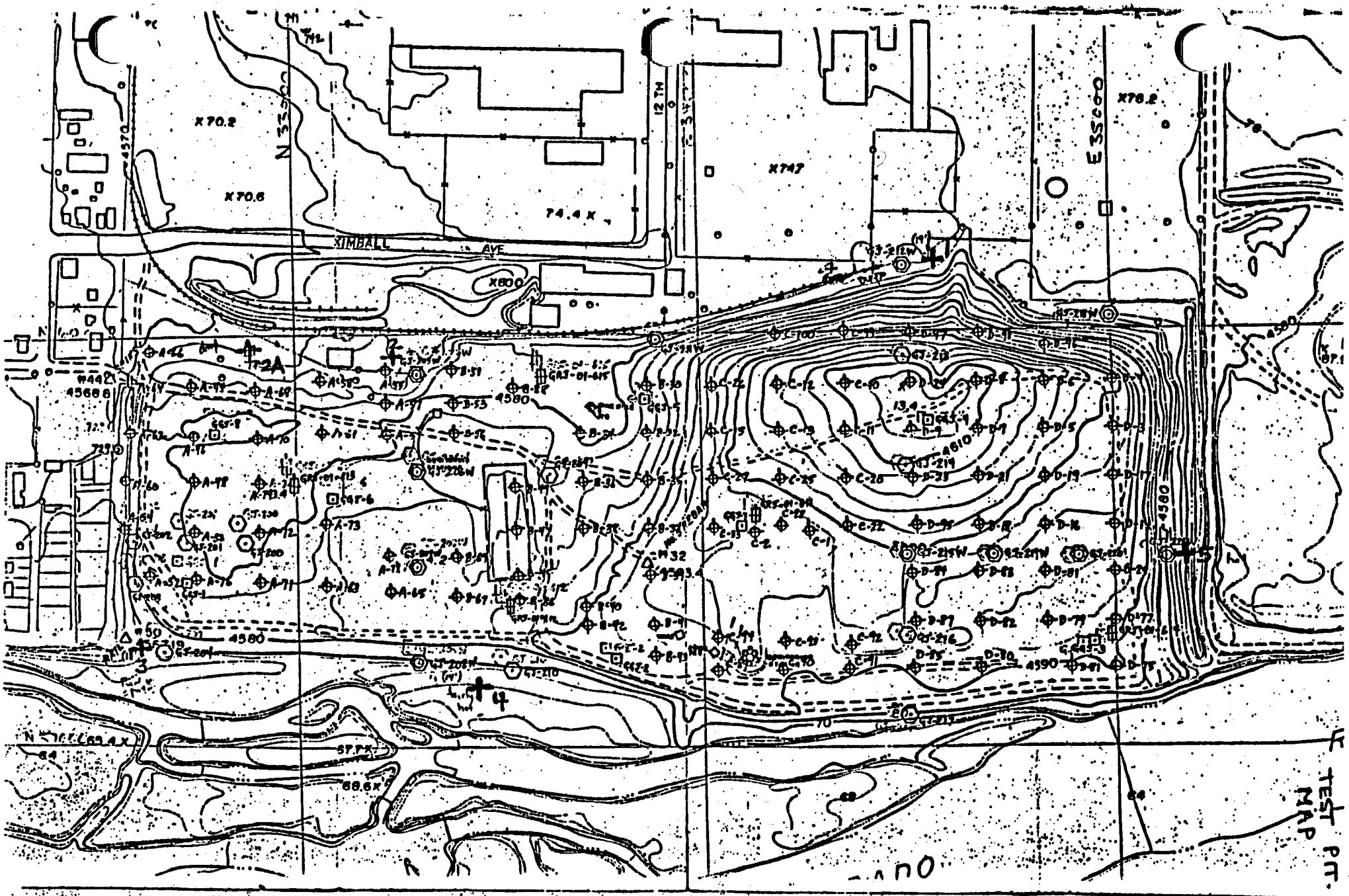
$$Q_{side} = \frac{.0194(50)(10^2)(14.72)}{2(15)}$$

$$Q_{side} = 48 \text{ gpm}$$

$$Q_{TOTAL} = 143 + 48 = 191 \text{ gpm} \quad \text{OK}$$

EXCAVATION 100' X 25'

SAME ASSUMPTIONS FOR H - SAME AS THAT FOR 50' FROM RIVER.


KIMBALL AVE
N 33000
E 35000
12TH
X70.2
X70.6
74.4 X
X747
X76.2
X800
4580
4610
4590
4570
TP-2A
TP-4
TP-5
TEST PIT LOCATION MAP

Calculation Cover Sheet

MKE DOCUMENT NO. 5025-GRJ-C-01-01002-03

Calc. No. 5-626-01-00 of 03

Contract No. 5025 Discipline ESCI No. of Sheets 36 ~~53~~ 63

Project

UMTRA / GRAND JUNCTION (GRJ)

Feature

Tailings Excavation

RECEIVED MAY 16 1991 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

Item

Tailings Pile Limits and Quantities

Sources of Data

Sources of Formulae & References

1. US 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, Draft RAP Vol 1)
2. Sandia National Laboratory, "Radium-226 Measurements Below Uranium Mill Tailings Piles" SAND82-0288A, June 1982, DOE Contract No. DE-AC04-76DP00789
3. MKE Calculation No ~~5-639-01-00~~ 5-670-05-01, 9/__/86 "Embankment Design - Material properties" MKE Doc. No. 5025-GRJ-C-01-01013-01

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

Rev No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
3		S.E. Botsford	12-17-90	H. Lubls	12/20/90	P. Sirca	12/20/90
2	TO INCLUDE THE LATEST DATA	H. LUBLS	8/14/90	S.E. Botsford	8.14.90	S.E. Botsford	8/14.90
1	EXCAVATION LIMIT REVISED	S.E. Botsford	8/31/87	W Y Lin	1/18/88	[illegible]	1/18/88
0	—	Weinfeld / MDOX	9/15/86	S.E. Botsford	9/15/86	[illegible]	9/30/86

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 Nos. 05-626-01-01 and 05-626-02-02

These two calculations on tailings pile excavation limits and off-pile excavation limits and quantities could be revised to incorporate new data and revised volume estimates presented in the letter report from J.G. Oldham to Mark I. Matthews, dated October 4, 1990, on test pit results at the processing site. Is the current excavation plan to go to the cobble interface at all areas beneath the tailings pile? If so, what is the average depth between the tailings interface and the cobble interface? How does this affect the tailings/subpile volume estimates? Will new excavation contour maps be generated? What percentage of these volume estimates is contingency? The TAC needs more information on current excavation plans in order to adequately run the DECNEM model.

SECTION 2

Response: _____ By: S.E. Botsford

Date: December 20, 1990

The current excavation plan remains the same as explained in the IOC from D.R. Sanders to J.G. Oldham dated 15 November 1990, which is attached herein.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: _____ Date: _____

Approved by: _____ _____

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

UMTRA PROJECT

INTER-OFFICE CORRESPONDENCE

TO: J.G. Oldham
Attn: R.F. Cooney
LOCATION: MK-F, Boise

SUBJECT: UMTRA - Grand Junction Limits of Contaminated Material at the Processing Site

DATE: 15 November 1990
DOC. NO.: 3885-GRJ-I-01-04712-00
FROM: D.R. Sanders
LOCATION: San Francisco

A concern was raised by the site in August 1990 that the uncertainty of the quantity of contaminated material in the subpile may contribute to a need for additional cell capacity. A total quantity of up to 5.6 million cubic yards was estimated. MK-F was directed by DOE, August 8, 1990, to conduct a test pit investigation. In a letter from J.G. Oldham to Mark Matthews, dated October 4, 1990, results of the investigation were presented.

The data gathered in the investigation generally agrees with the Subcontract Excavation Plan drawings. Information is tabulated as follows:

Test Pit	Elevation of Interface Estimated by Investigation	Elevation of Interface Design	Remarks
1	4560	4563	—
2	4567	4556	Appear deep because of grading
3	4570	4560	
A	4553	4568	Edge of Pile (High level of uncertainty)
B	4566	4570	
C	4561	4570	

The original estimate of contaminated material agrees favorably with the latest investigation. The total volume of contaminated material appears to be conservative in that some areas are well below contamination because of grading. In addition, the "Contaminated Material Excavation Plan" takes all previous investigations into consideration, therefore a change in the excavation plan is not recommended. We agree that a total 5.26 million cubic yards of contaminated material at the processing site is a reasonable estimate at this time.

D.R. Sanders
DRS/SEB/dla

cc: J. Pepin

MATERIOC.GRJ

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 Nos. 05-626-01-01 and 05-667-04-02

Calculation No. 05-626-01-01 states a volume of contaminated material of 5,664,500 cubic yards on sheet 3A. Calculation No. 05-667-04-02, "Quantity Estimate Summary," states a tailings embankment capacity of 5,642,242 cubic yards, which appears to include the radon barrier and other cover material layers. The embankment capacity calculation must therefore include a compaction reduction factor for the contaminated material volume (which I have not been able to find), or else does not correlate to the contaminated material volume in calculation No. 05-626-01-01. A revised volume estimate of contaminated material of 5,260,100 cubic yards was presented In a letter from J.G. Oldham to Mark I. Matthews dated October 4, 1990; on test pit results at the processing site. What is the current summary of contaminated material volume estimates to be presented in the revised RAS? Will calculation Nos. 05-626-01-01 and 05-667-04-02 (if necessary) be revised?

SECTION 2

Response: By: H. Lubis

Date: December 20, 1990

The October 4, 1990 estimates by MK-Ferguson will be incorporated into the calculations. The total quantity of contaminated material will be reduced to 5,260,100 c.y. Calculations 05-626-01-01, 05-626-02-01, 05-667-04-02 and 05-670-02-01 will be revised. The tailings embankment capacity will remain at 5,642,243 c.y with the intent of placing mancos shale over the radon barrier as frost protection. The volumes do not incorporate any compaction shrinkage factors and therefore are conservative from a capacity standpoint.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: Date:

Approved by:

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

Project UMTRA - GRJ
Feature TAILINGS EXCAVATION
Item MAIN PILE TAILINGS EXCAVATION

Contract No. 3885-34
Designed Sho
Checked HL

Sheet 1
File No.
Date 12-17-90
Date 12/20/90

REVISION 3

FURTHER SITE INVESTIGATION WAS PERFORMED BY MKF TO DETERMINE THE LOCATION OF THE TAILINGS / CLEAN MATERIAL INTERFACE. THE CONCLUSIONS OF THIS INVESTIGATION ARE INCLUDED IN A LETTER FROM J.G. OLDHAM TO M. MATTHEWS DATED OCTOBER 4, 1990 (SEE APPENDIX A). THE TOTAL QUANTITY OF MAIN-PILE TAILINGS ESTIMATED BY MKF = 2696000 CY. THIS COMPARES TO THE ORIGINAL MKE ESTIMATE = 2441860 CY. THE MKF ESTIMATE IS WITHIN 10%, THEREFORE WE SHALL USE THE MKF ESTIMATE FOR SUBSEQUENT CALCULATIONS. NOTE THAT THE MKF ESTIMATE ADDS 5% TO ACCOUNT FOR 1 FOOT OF CONTAMINATION BELOW THE TAILINGS. THIS MATERIAL IS ADDED TO THE MAIN PILE FIGURE FOR A TOTAL OF 2830800 CY IN THE MAIN PILE.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-GJ
Feature TAILINGS EXCAVATION
Item MAIN-PILE TAILINGS EXCV.

Contract No. 5025
Designed H.L.
Checked SKB

Sheet 1A
File No.
Date 8/14/90
Date 8-14-90

REVISION 2

The purpose of Revision 2 is to include the latest data and an additional contingency provided by MKF Field Office at Grand Junction (See sheet 3A).

SUMMARY OF MAIN-PILE TAILINGS QUANTITY

Total QUANTITY = 3,235,200 c.y.

To Mark Matthews, "MKE Doc. 3885 - H.L. 8/14/9.
GRJ-L-02-0449-00 SMS 8.14.90
ATTACHMENT A

MK-FERGUSON CO.
ALBUQUERQUE

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

JUL 17 1990

RECEIVED

INTER-OFFICE CORRESPONDENCE

DATE: July 12, 1990

TO: Rob Cooney

FROM: John Pepin

LOCATION: Albuquerque, NM

LOCATION: Grand Junction, CO

SUBJECT: ESTIMATE OF CONTAMINATED MATERIAL
GRAND JUNCTION SITE

The site office has re-evaluated the estimated quantity of contaminated material to be remediated. The following is a breakdown of quantities as currently estimated:

1.	Main Tailings Pile	2,696,000 cy
2.	Vicinity Property Pile	1,981,500 cy
3.	Pond 1	31,000 cy
4.	Pond 2	28,000 cy
5.	Pond 3	100,000 cy
6.	Areas Adjacent to Main Pile	51,000 cy
	TOTAL	4,887,500 cy

A brief explanation of each item listed above follows:

ITEMS 1 AND 6

ICC plotted the original ground elevations and bottom of excavation from the contract documents. Cross sections were calculated on 100' centers across the processing site main pile. The excavation depth noted on the contract documents is marginal because the tailings are expected to extend into the gravels below the main pile.

ITEM 2

This quantity is provided by UNC (see attachment). Per UNC, approximately 250,000 cy (13%) contingency is included. MK-F considers the contingency to be marginal because the total quantity of properties included is not final, furthermore, UNC is only 53% complete at this time.

ITEM 3

This quantity includes the tailings remaining at northwest corner of Pond 1. Remainder of contaminated material was excavated and placed with VP material at Pond 2.

ITEM 4

This quantity includes the estimate of contaminated material below original ground level only (no VP material). Test pits and auger holes have been utilized in Pond 2 to characterize for Thorium. A (2) foot depth of contamination was verified.

S1A001

Sn - SA
H.L 8/14/
SLS 8.14.9

ITEM 5

This quantity is based on four foot depth of contamination below the base line that UNC used for their estimate. This depth was utilized based on discussions with B. Franz and the experience gained from the excavation at Pond 1.

The site office has evaluated the depth of contamination of the main pile as illustrated in the subcontract drawings (see memo to R. Cooney dated 7/12/90). The result is a contamination depth of 12% (average over entire pile) greater than specified. This percentage should be increased to 20% and added to Item 1 as contingency.

In addition, from past experience, the 13% contingency that UNC used to derive their given volume is insufficient. In the past two years, UNC's quantity estimate has increased by an average of 25%. An additional 12% should be incorporated into the contingency for a more realistic quantity and safety factor.

Therefore, it is our recommendation that the cell capacity be increased, as a minimum, to incorporate the following volumes.

1.	Main Tailings Pile	3,235,200 cy
2.	Vicinity Property Pile	2,219,300 cy
3.	Pond 1	31,000 cy
4.	Pond 2	28,000 cy
5.	Pond 3	100,000 cy
6.	Areas Adjacent to Main Pile	51,000 cy
	TOTAL	5,664,500 CY

Main Pile Tailings
H.L. 8/14/90

Should you have any questions, feel free to contact myself or Thom Myer.

cc: w/att.
D. Sanders
B. Zebick
T. Myer
file

GRJ90319

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UMTRA - GRJ	Contract No. 5025	Sheet 1
Feature	TAILINGS EXCAVATION	Designed SLE	File No.
Item		Checked WYL	Date 1-12-??
			Date 1/18/88

REVISION 1

THE EXCAVATION LIMITS OF THE TAILINGS PILE AREA WAS REVISED TO INCLUDE DATA COLLECTED DURING THE SITE CHARACTERIZATION PERFORMED BY CHEM-NUCLEAR SYSTEMS INC (CNSI) IN JUNE 1987. THE DATA SHOWS AN INCREASED AMOUNT OF CONTAMINATION IN THE DIKE AREA

I. PURPOSE

The purpose of this calculation is to determine the limits and quantities. The results will be used to prepare construction plans and specifications for tailings pile excavation and tailings pile quantities.

II. ANALYSES AND CRITERIA

A. The Bendix report (Ref. 1, Addendum D1 & D2) will be used to define locations of existing contamination. This report is the most recent and reflects existing conditions the best due to cleanup activities that occurred in the 1970's and 1980's.

B. Based on studying 12 uranium tailings piles, the Sandia report (Ref. 2) indicated that four conditions were found beneath the piles –

(1) rock, with essentially no contamination

(2) Very dry soil with contamination of 1000 pci/g above the interface to 15 pci/g at 7.5 feet below the interface.

(3) near-saturated to saturated soils with contamination similar to condition (2)

(4) Saturated soils underlaid by cobbles and water where the water contained very fine particles of Ra-226 in suspension.

C. Based on our observation, the relation of radium concentration vs depth below tailings pile interface is like a tangent curve instead of a straight line; ie. the radium concentration will drop quite fast within a short distance in soil below the interface then taper off gradually to the background level, therefore the excavation limits can be determined using the Sandia's finding above by calculating the decreasing rate 1000 ÷ 7.5 = 133 pci/g per foot in depth, if there were no sufficient data available.

D. The previous investigation mentioned that part of the site for the existing tailings pile was in the Colorado River, the shore line might be located where the storm drain ends. The existing tailings pile was confined in the river front by a dike constructed by dredged alluvium from the inside wet area. The original height of the dike might be at EL456ft. The fill slope and cut slope of the impoundment might be 5:1 and 3:1 (horizontal to vertical), respectively.

E. The EPA standards for cleanup of land contaminated with residual radioactive materials from inactive uranium processing site indicates that

(1). 5 pci/g, average over the first 15 cm of soil below the surface, and

(2) 15 pci/g, average over 15 cm thick layers of soil more than 15 cm below the surface

The site will be restored at completion of remedial action, the excavation criteria shall be set to the lowest 15 pci/g above background in soil.

F. Limits of excavation will be determined based on the following guidelines

(1) Areas of contamination exceeding standards will be excavated

(2) Excavation quantities will be minimized as much as practicable to help minimize the disposal embankment size

(3) Final excavation depths will be based on plans and excavation control during construction to verify that radium has been adequately removed to meet standards.

III. Summary

The tailings pile is bounded by the railroad tracks on the north and by the contour line of elev. 4570 on the east, the south and the west

The tailings pile contains ~~2,248,800~~ 2,442,220 cy of contaminated materials and covers a area of 54.4 acres.

The majority of the contaminated tailings pile is tailings sand which consists of Sand 86% and silt-clay 14% (Ref 3)

The sand has the following properties (Ref. 3):

Specific gravity = 2.70

in-situ moisture content = 9.7%

in-situ dry density = 89.5 pcf

Standard Proctor

Optimum moisture content = 15.0%

max. dry density = 104.5 pcf

The other quantities of the tailings pile are summarized in the following:

Location	Ave Ra-226 (pci/g)	Total Excav. Depth (ft)	Depth Between Interface and Excav Bottom (ft)
Pile Area A (821,463 cy)	364.1	22.3	5.82
Pile Area B (569,731 cy)	669.9	26.3	5.53
Pile Area C (466,236 cy)	668.9	34.0	5.45
Pile Area D (391,366 cy)	565.2	37.3	5.77
Average →	574.8	30.8	5.65

The Th-230 concentration in the pile may be estimated assuming the Ra-226 is in secular equilibrium. The regional background Ra-226 concentration in soil in Grand Junction average 1.6 pci/g (Ref. 1, Section 3.2)

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - GRJ
Feature: ON-PILE EXCAVATION QUANTITY
Item:

Contract No. 5025-06
Designed: SLC
Checked: WYL

Sheet 5
File No.
Date 8/28/87
Date 1/18/88

Rev. 1

See DWG NO GRJ-PS-13-0212

SECTION	AREA (FT²)	AVERAGE AREA (FT²)	LENGTH (FT)	VOLUME (FT³)
		13361	190	2538590
AT	26722			
		28589	165	4717185
BT	30456			
		33735	165	5566275
CT	37014			
		38297	160	6127520
DT	39579			
		58245	165	9610425
ET	37332			
		35712	165	5892480
FT	34092			
		32143	165	5303595
GT	30194			
		27210	160	4353600
HT	24227			
		22119	160	3539040
IT	20011			
		18814	160	3010240
JT	17616			
		16849	165	2780085
KT	16081			
		16109	155	2496895
LT	16136			
		16076	165	2651550
MT	16004			
		15896	160	2543360
NT	15787			
		16651	160	2664160
OT	17515			
		12253	160	1960480
PT	6990			
		3495	50	174750

65930230 FT³

= 2,441,860 CY

NOTES:

1. SEE NOTES ON DWG. NO. GRJ-PS-10-0211.

REFERENCE DRAWINGS:

GRJ-PS-10-0211 CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 1 OF 2)

LEGEND:

- 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

Tailings Pile Limit

SLB 8/31/87
WYL 1/18/88

PRELIMINARY REVIEW

E&D MANAGER	CHIEF ENGINEER	QA MANAGER

QA MK-F	NO.	DATE	REVISIONS	BY	CK	ENG VGR	CHIEF ENG	TEC REV	DOE APP
	4	7 16 87	ISSUED FOR PRELIMINARY REVIEW	—	—	—	—		

SCALE 100 0 100 200 FEET

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

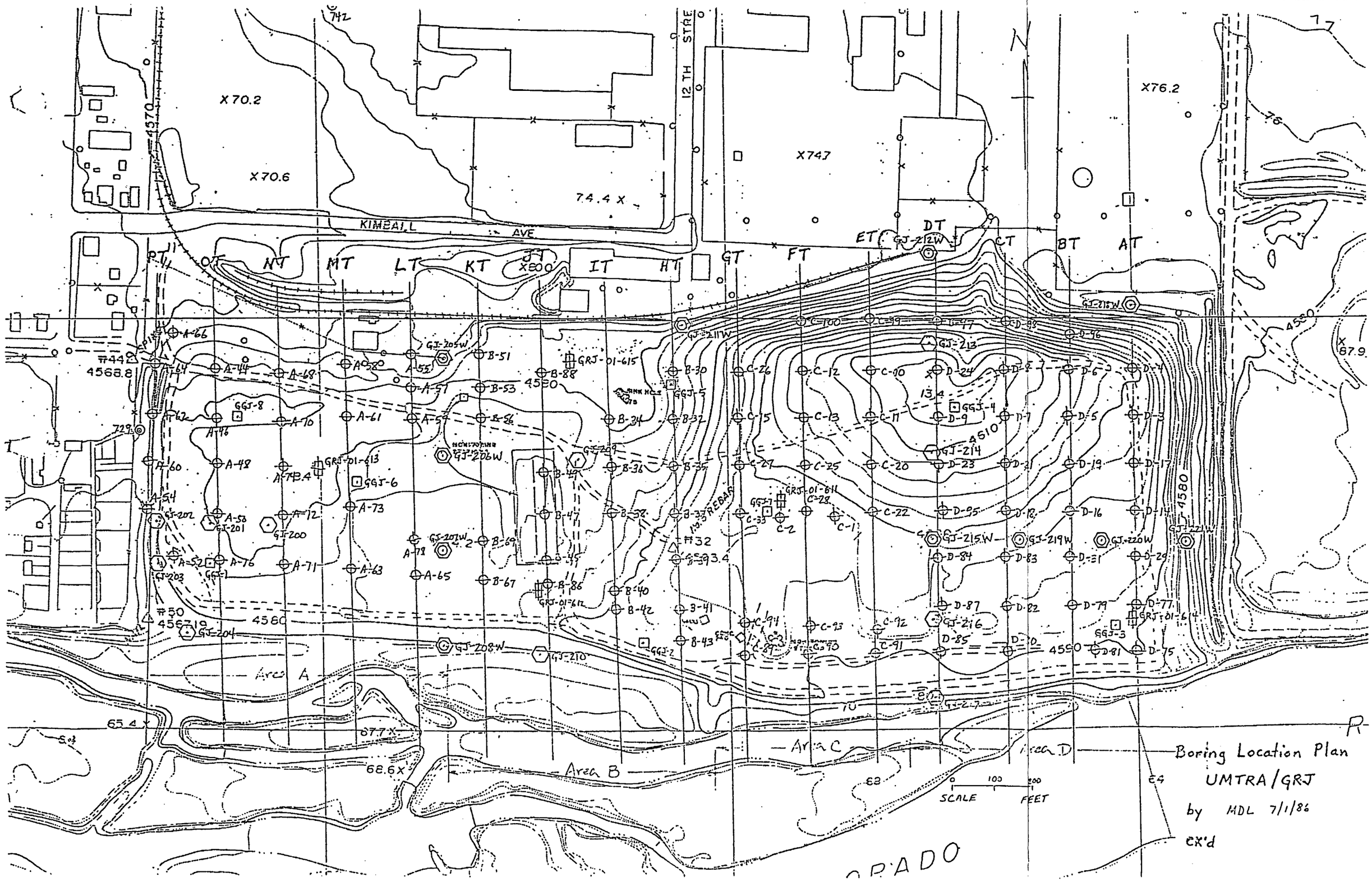
CONTAMINATED MATERIAL EXCAVATION PLAN
SHEET 2 OF 2

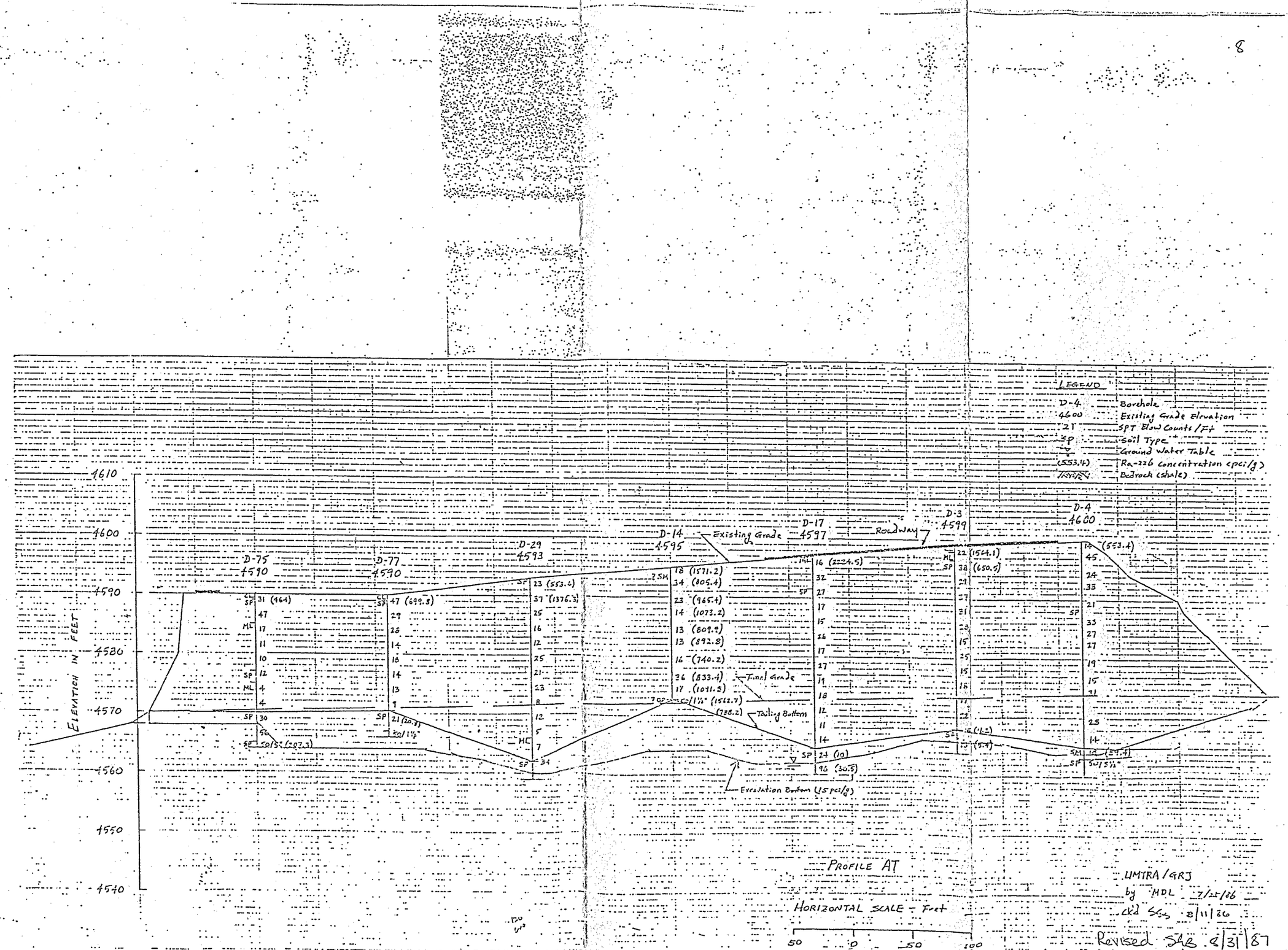
DESIGNED | DRAWN JMM/ECG | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DATE | DOE PROJECT ENGINEER | DATE

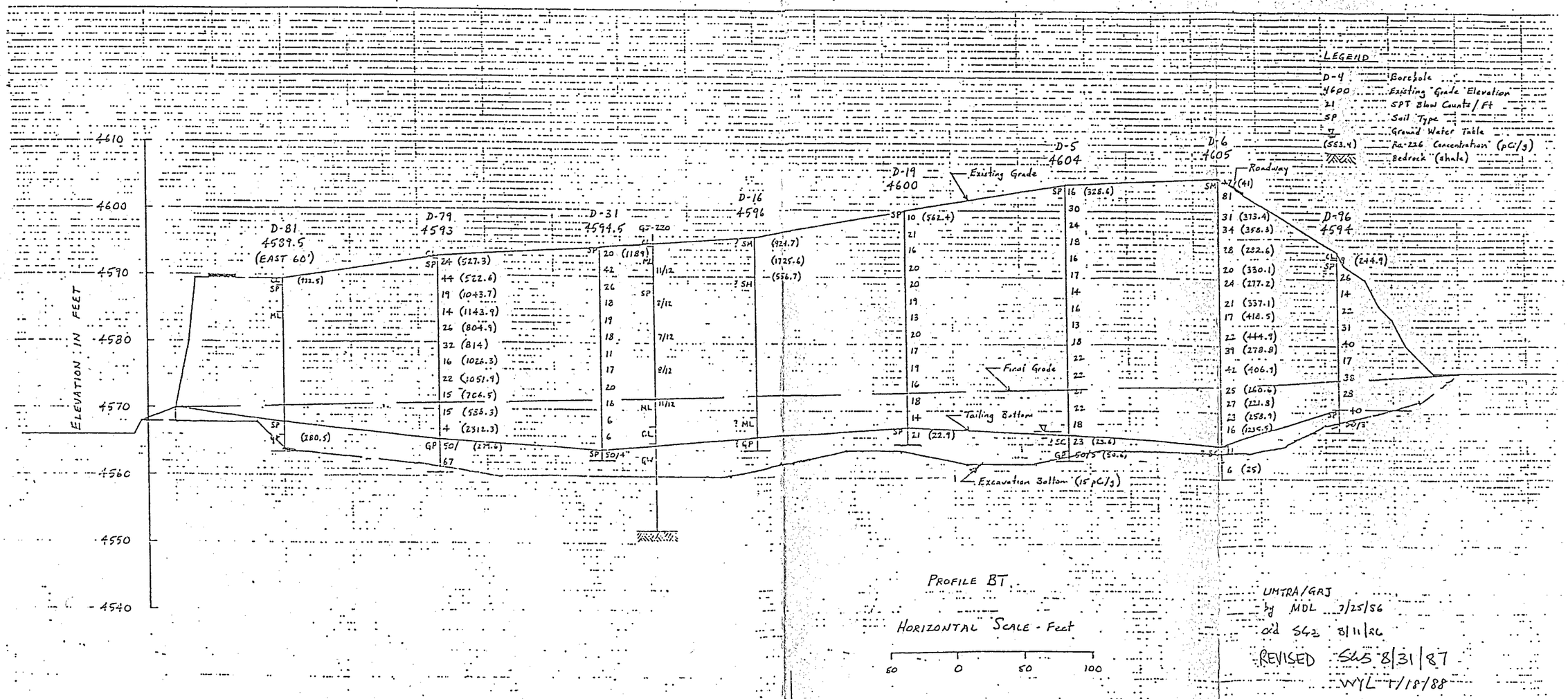
MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT
50 FREMONT ST SAN FRANCISCO CA 94105

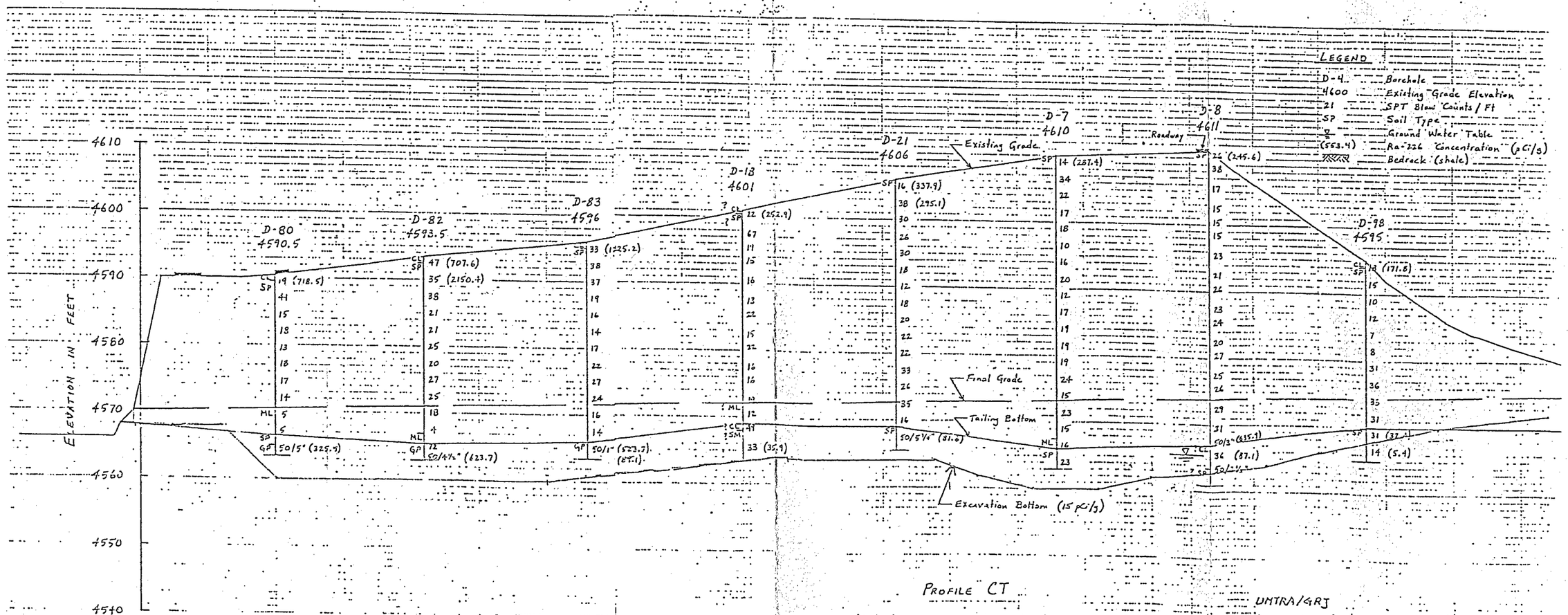
PROJECT NO. DE-AC04-83AL18796

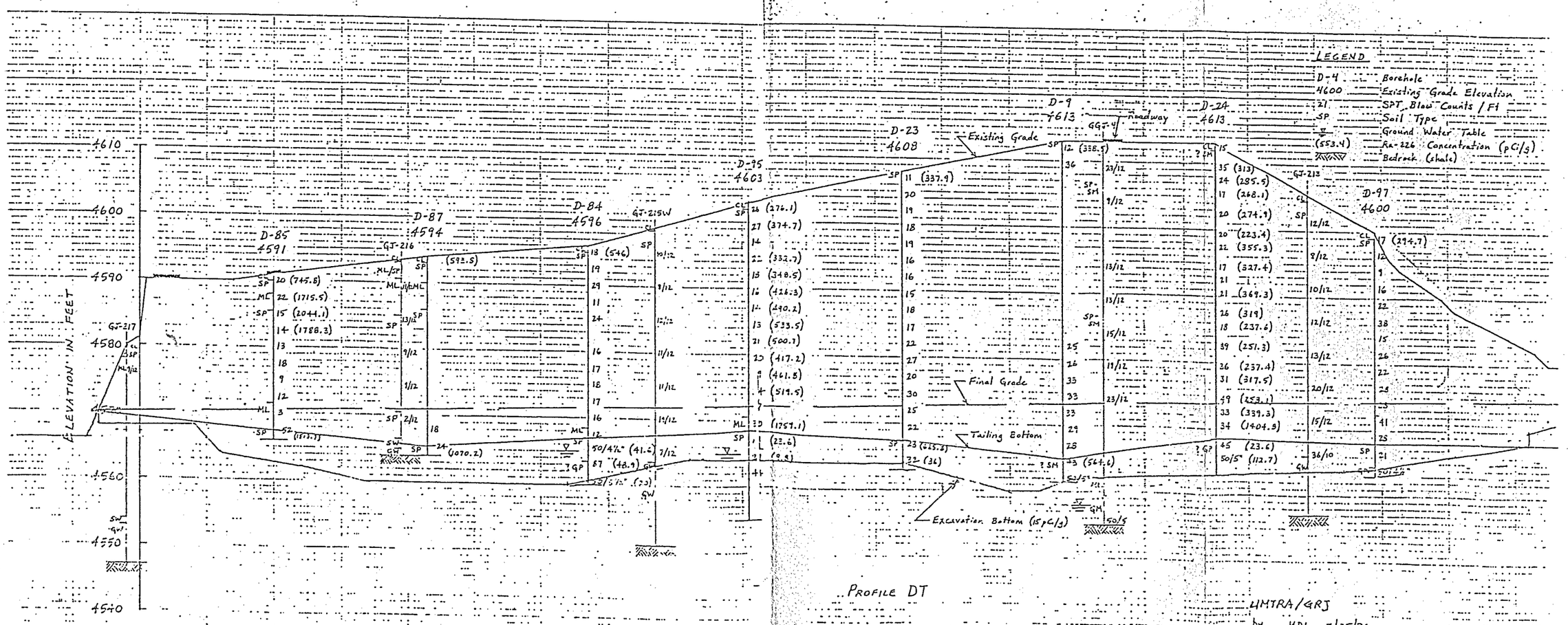
DRAWING NO. GRJ-PS-10-0212 REV A


KIMBALL AVE
12 TH STREET
Area A
Area B
Area C
Area D
SCALE FEET
Boring Location Plan
UMTRA/GRJ
by MDL 7/1/86
ck'd

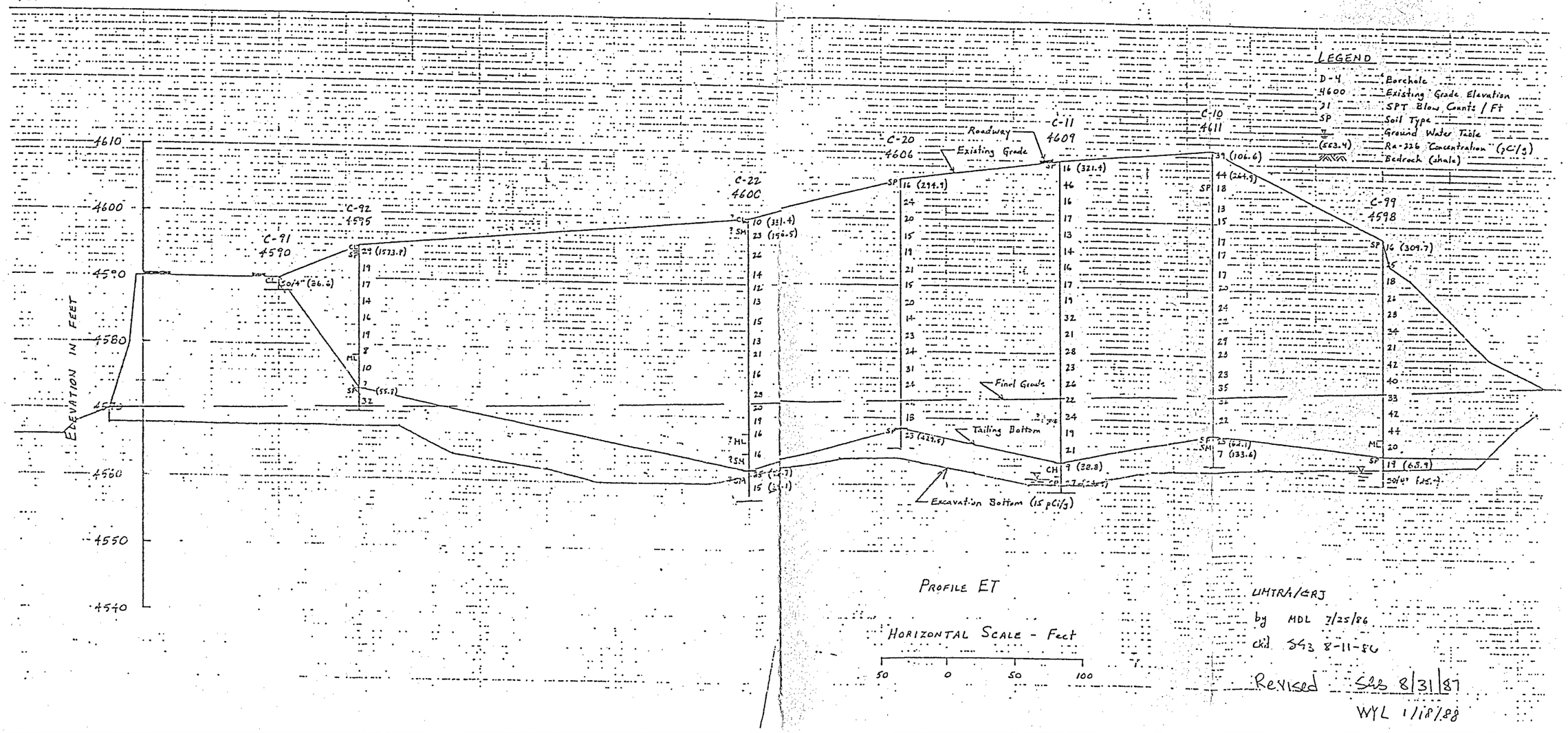

LEGEND
D-4 Borehole
4600 Existing Grade Elevation
21 SPT Blow Counts / Ft
SP Soil Type
Ground Water Table
(553.4) Ra-226 Concentration (pci/g)
Bedrock (shale)
ELEVATION IN FEET
1610
1600
1590
1580
1570
1560
1550
1540
D-75 4590
D-77 4590
D-29 4593
D-14 4595
D-17 4597
D-3 4599
D-4 4600
Existing Grade
Roadway
Tunnel Grade
Tailing Bottom
Excavation Bottom (15 pci/g)
PROFILE AT
HORIZONTAL SCALE - Feet
50 0 50 100
UMTRA / GRJ
by MDL 7/25/86
ck'd SGS 8/11/86
Revised SAB 8/31/87
WL 1/18/88


LEGEND
D-4 Borehole
4600 Existing Grade Elevation
21 SPT Blow Counts/Ft
SP Soil Type
Ground Water Table
(553.4) Ra-226 Concentration (pCi/g)
Bedrock (shale)
ELEVATION IN FEET
4610
4600
4590
4580
4570
4560
4550
4540
D-81
4589.5
(EAST 60')
D-79
4593
D-31
4594.5
D-16
4596
D-19
4600
D-5
4604
D-6
4605
D-96
4594
Existing Grade
Roadway
Final Grade
Tailing Bottom
Excavation Bottom (15 pCi/g)
PROFILE BT
HORIZONTAL SCALE - Feet
60
0
50
100
UMTRA/GRJ
by MDL 7/25/86
ckd SGJ 8/11/86
REVISED SLS 8/31/87
WYL 7/18/88

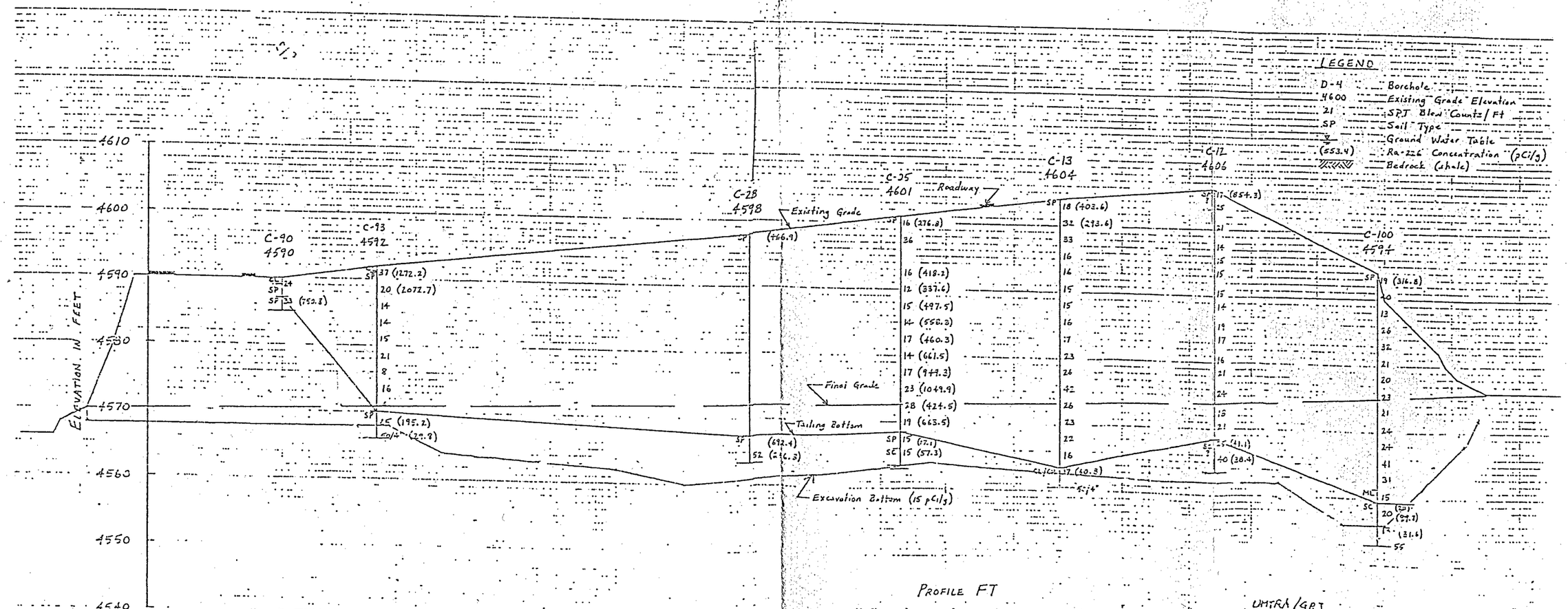

LEGEND
D-4 Borehole
4600 Existing Grade Elevation
21 SPT Blow Counts / Ft
SP Soil Type
Ground Water Table
(563.4) Ra-226 Concentration (pCi/g)
Bedrock (shale)
ELEVATION IN FEET
4610
4600
4590
4580
4570
4560
4550
4540
D-80
4590.5
D-82
4593.5
D-83
4596
D-18
4601
D-21
4606
D-7
4610
D-8
4611
D-78
4595
Existing Grade
Roadway
Final Grade
Tailing Bottom
Excavation Bottom (15 pCi/g)
19 (718.5)
47 (707.6)
35 (2150.4)
33 (1325.2)
12 (252.9)
16 (337.9)
38 (295.1)
14 (287.4)
22 (245.6)
18 (171.8)
50/15" (325.9)
50/4½" (623.7)
50/1" (523.2)
(85.1)
33 (35.9)
50/5¼" (81.6)
36 (87.1)
50/3" (635.9)
31 (37.4)
14 (5.4)
PROFILE CT
HORIZONTAL SCALE - Feet
50 0 50 100
UMTRA/GRJ
by HDL 7/25/86
ckd SLS 8/11/86
Revised SLS 8/31/87
WYL 1/18/88



UMTRA/GRJ
by MDL 7/25/86
ckd 843 S-11-86
Revised 8-31-87
WYL 1/18/88

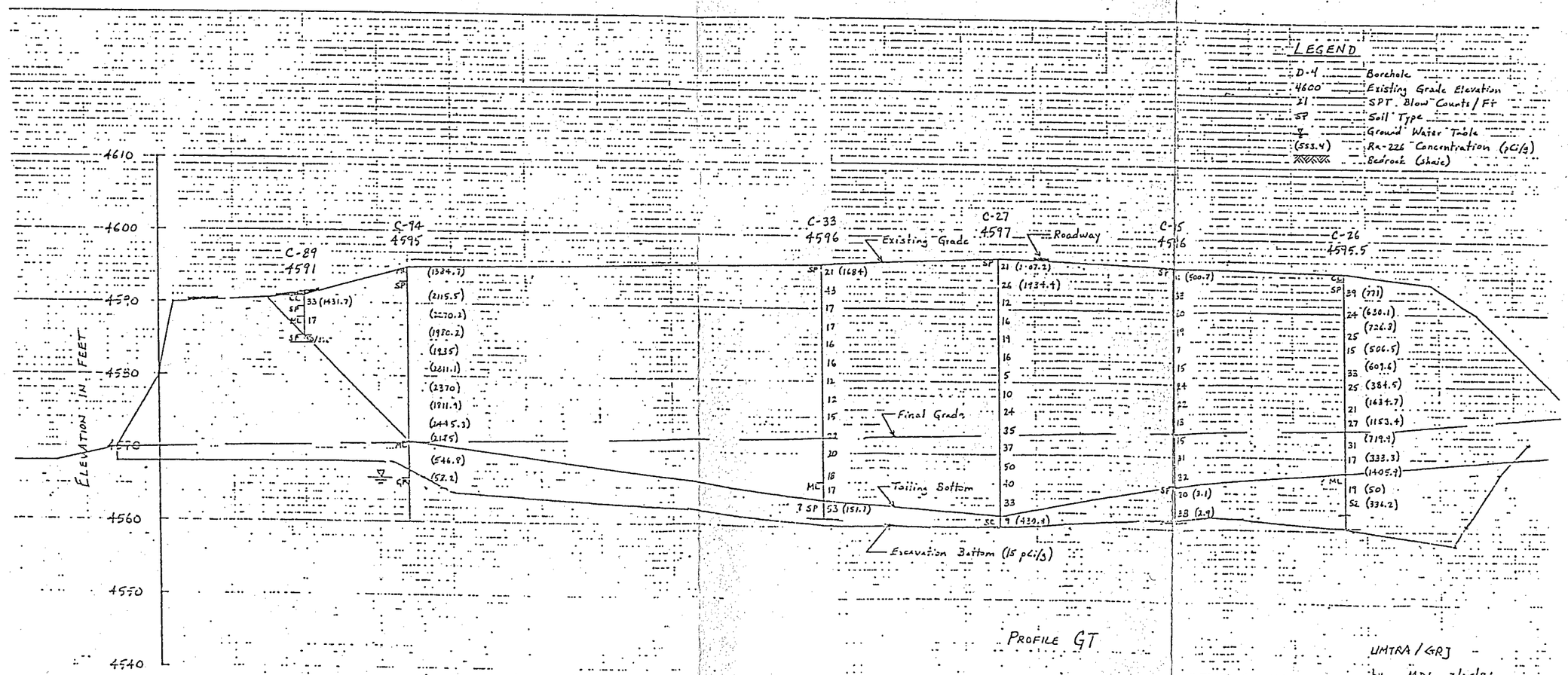


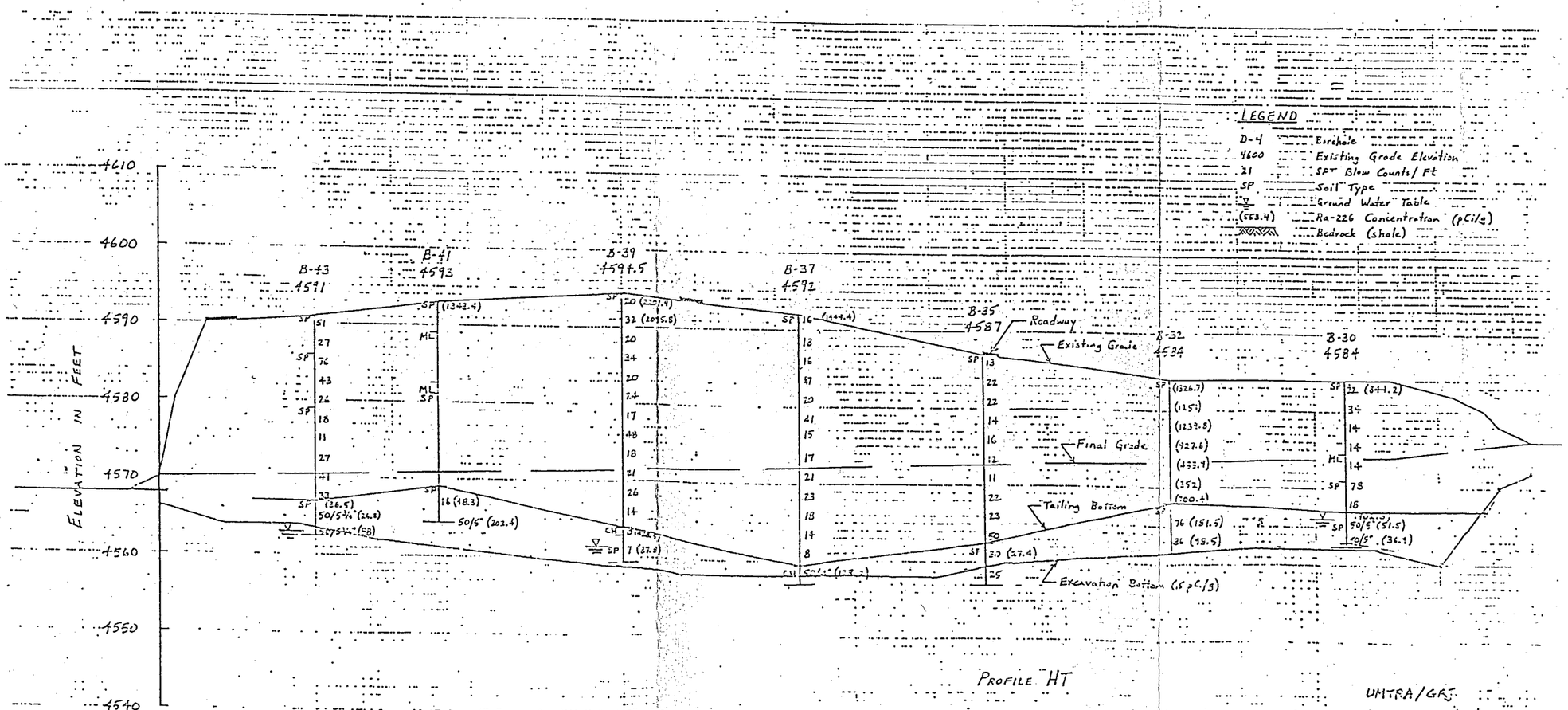
UMTRA/GRJ
by MDL 7/25/86
chk SAS 8-11-86
Revised SAS 8/31/87
WYL 1/18/88



UMTRA/GRJ
by MDL 7/25/86
ckd SFC 8-11-86
Revised SWB 8/31/87
WYL 1/18/88

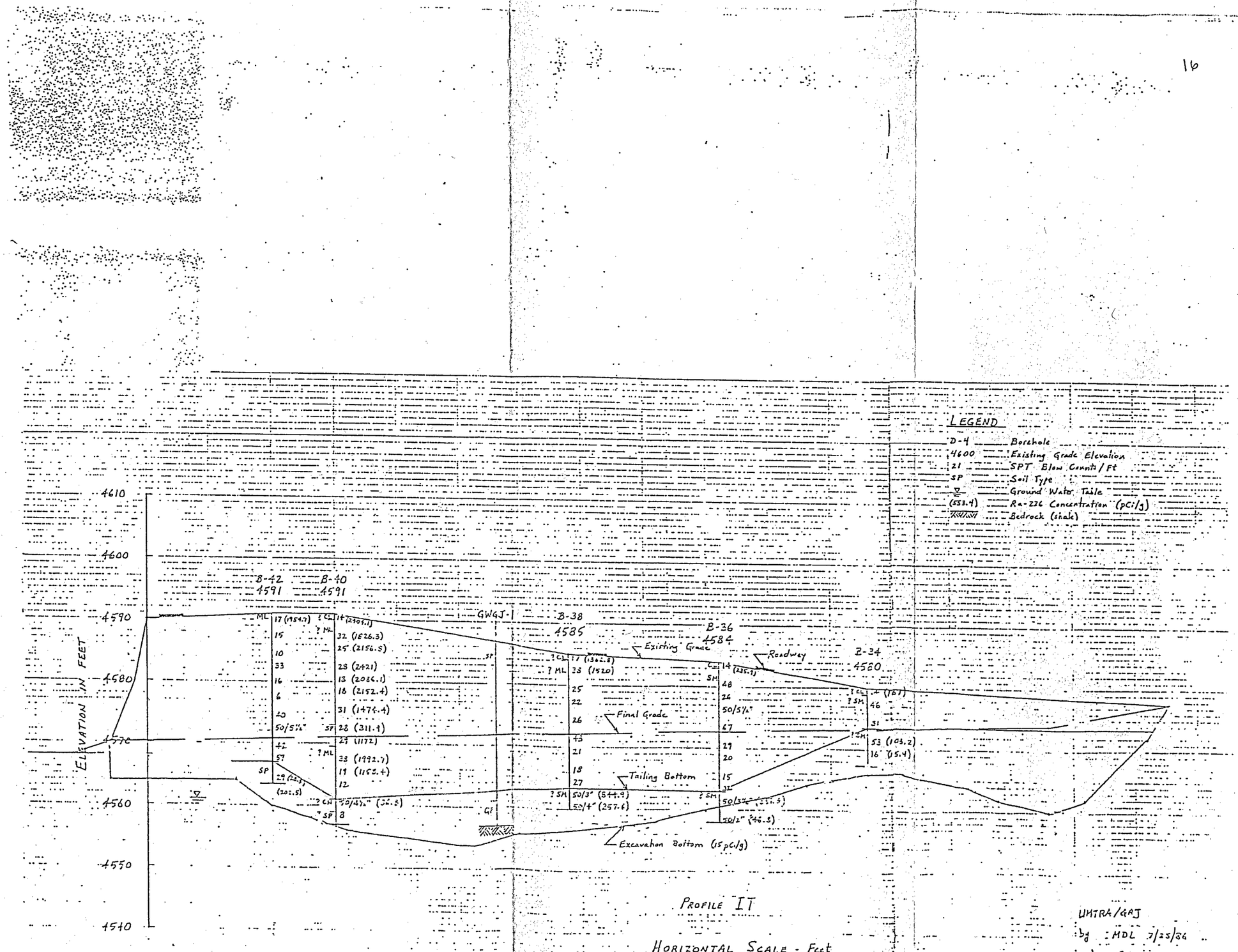
14


LEGEND
D-4 Borehole
4600' Existing Grade Elevation
21 SPT. Blow Counts / Ft
SP Soil Type
Ground Water Table
(555.4) Ra-226 Concentration (pCi/g)
Bedrock (shale)
ELEVATION IN FEET
4610
4600
4590
4580
4570
4560
4550
4540
C-94
4595
C-89
4591
C-33
4596
C-27
4597
C-5
4596
C-26
4595.5
Existing Grade
Roadway
Final Grade
Tailing Bottom
Excavation Bottom (15 pCi/g)
33 (1431.7)
17
(1384.7)
(2115.5)
(2270.2)
(1970.2)
(1935)
(2311.1)
(2370)
(1911.9)
(2445.3)
(2185)
(546.8)
(52.2)
21 (1684)
43
17
17
16
16
12
12
15
20
18
17
53 (151.7)
21 (1067.2)
26 (1934.4)
12
16
19
16
5
10
24
35
37
50
40
33
9 (430.4)
(500.7)
32
20
19
7
15
24
22
15
15
31
22
20 (3.1)
38 (2.9)
39 (771)
24 (650.1)
(726.2)
25
15 (506.5)
(607.6)
33
25 (384.5)
(1634.7)
21
27 (1153.4)
(719.4)
31
17 (333.3)
(1405.7)
19 (50)
52 (334.2)
PROFILE GT
HORIZONTAL SCALE - FEET
50 0 50 100
UMTRA / GRJ
by MDL 7/25/86
ckd 8-11-86
Revised 8/31/87
WYL 1/18/88

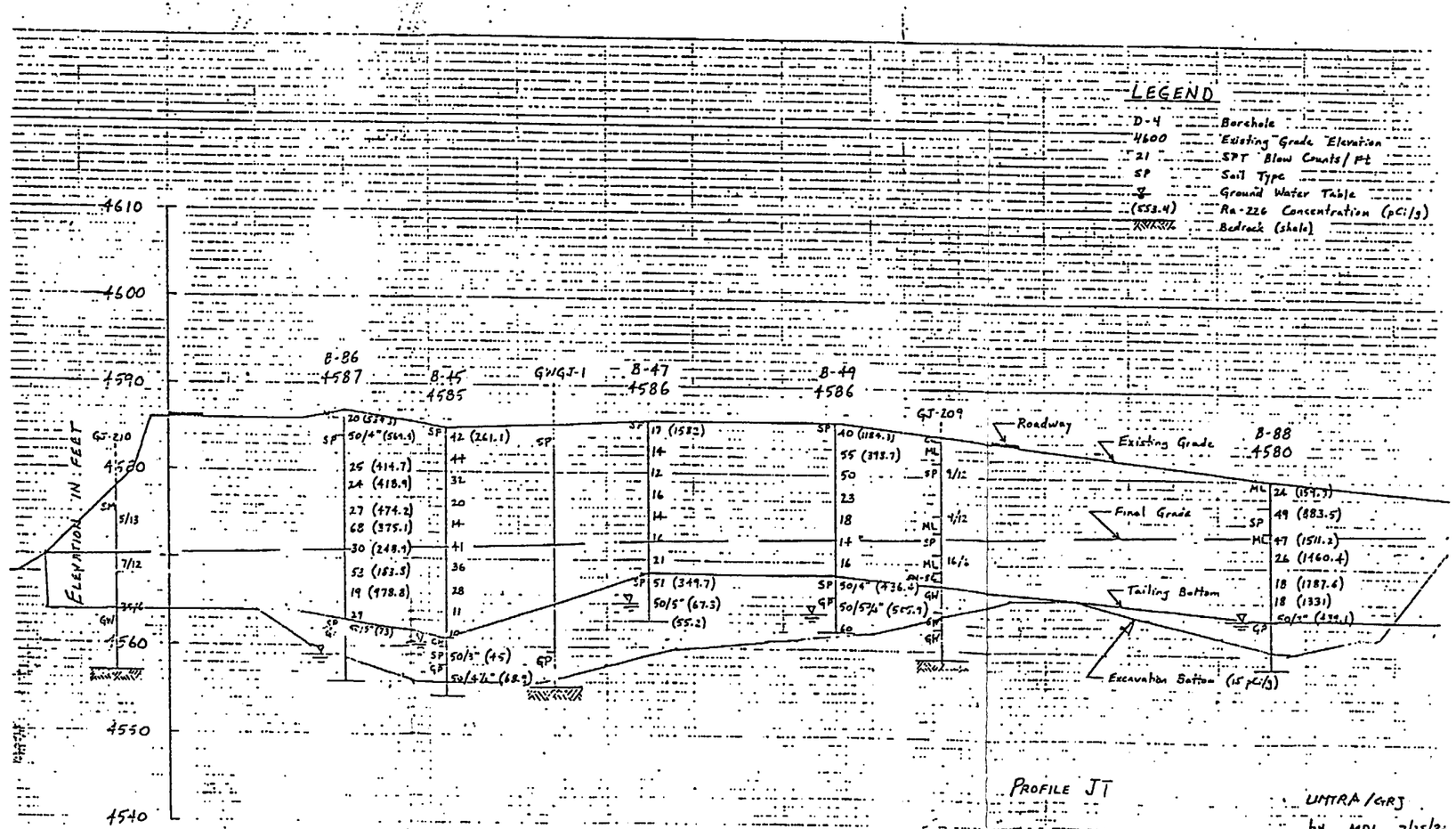


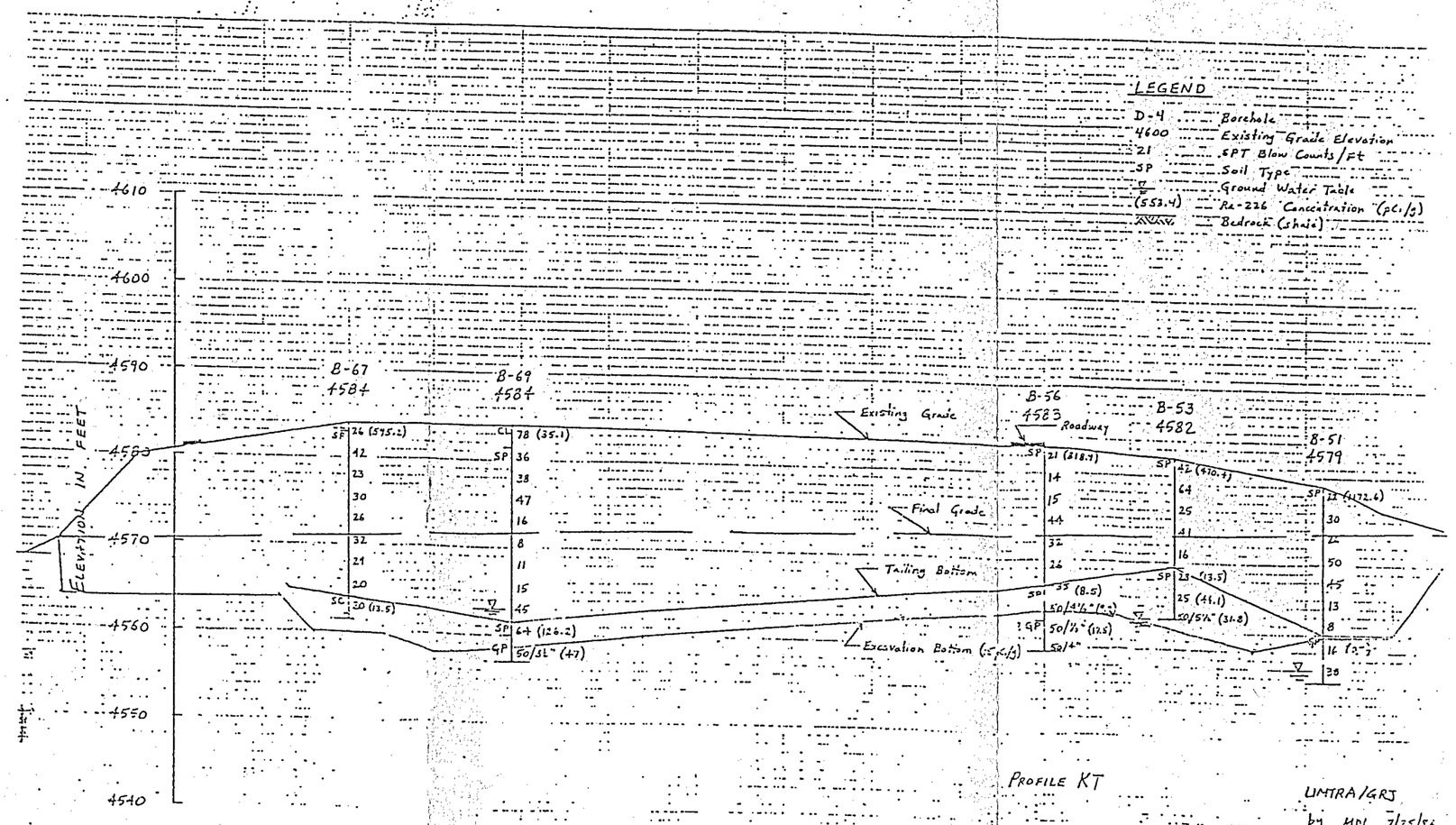
UMTRA/GJ
by MDL 7/25/86
ck'd 8-11-86

Revised SWS 8/31/87
WYL 1/18/88

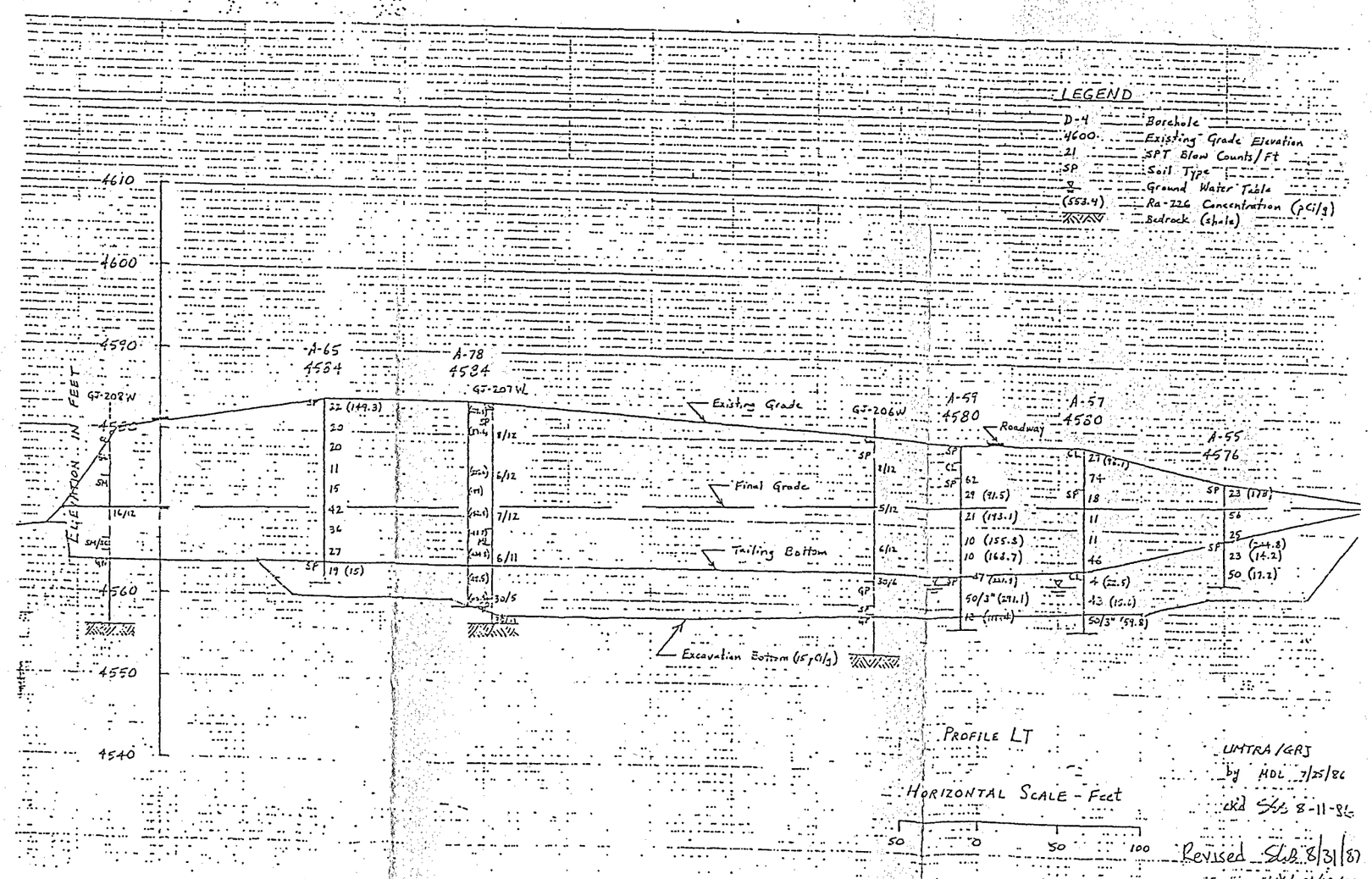


UMTRA/GRJ
by MDL 7/25/86
ck'd SLS 8-11-86
Revised SLS 8/31/87
WYL 1/18/88

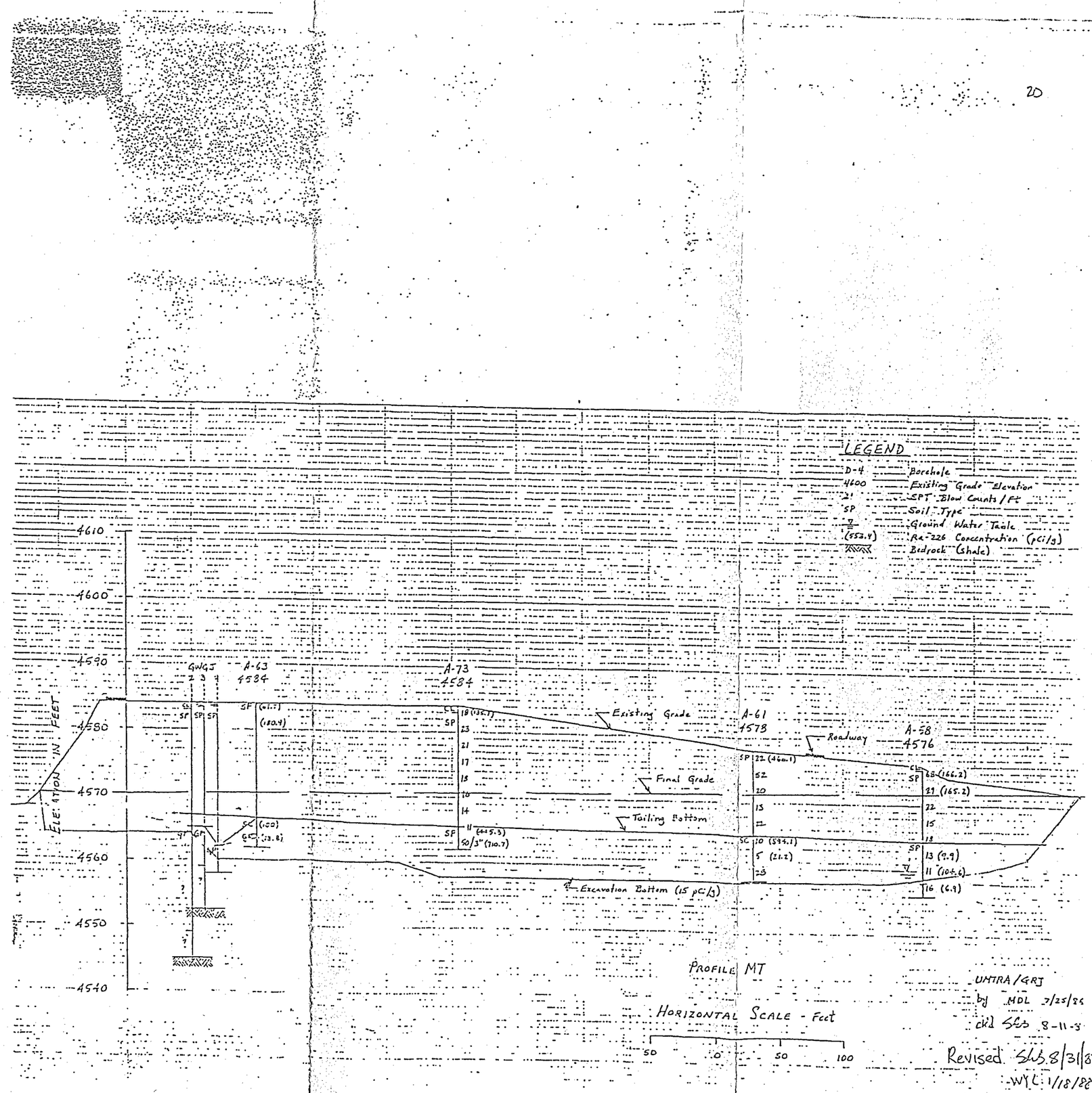

LEGEND
D-4 Borehole
4600 Existing Grade Elevation
21 SPT Blow Counts/ft
SP Soil Type
Ground Water Table
(553.4) Ra-226 Concentration (pCi/g)
Bedrock (shale)
ELEVATION IN FEET
4610
4600
4590
4580
4570
4560
4550
4540
GJ-210
B-86
4587
B-45
4585
GW/GJ-1
B-47
4586
B-49
4586
GJ-209
B-88
4580
Roadway
Existing Grade
Final Grade
Tailing Bottom
Excavation Bottom (15 pCi/g)
20 (584.3)
50/4" (561.5)
25 (414.7)
24 (418.9)
27 (474.2)
68 (375.1)
30 (248.4)
53 (183.5)
19 (478.8)
50/5" (73)
42 (261.1)
44
32
20
14
41
36
28
11
10
50/3" (45)
50/4.7" (68.9)
17 (158.2)
14
12
16
14
16
21
51 (349.7)
50/5" (67.5)
(55.2)
40 (1284.1)
55 (393.7)
50
23
18
14
16
50/4" (436.4)
50/5¼" (555.9)
60
7/12
7/12
14/6
24 (159.7)
49 (883.5)
47 (1511.2)
26 (1460.4)
18 (1187.6)
18 (1331)
50/5" (436.1)
5/13
7/12
26/6
PROFILE JT
HORIZONTAL SCALE - Feet
50 0 50 100
UMTRA/GRJ
by MDL 7/25/86
ckd SLS 8-11-8
Revised SLS 8/31/8
WYL 1/15/88



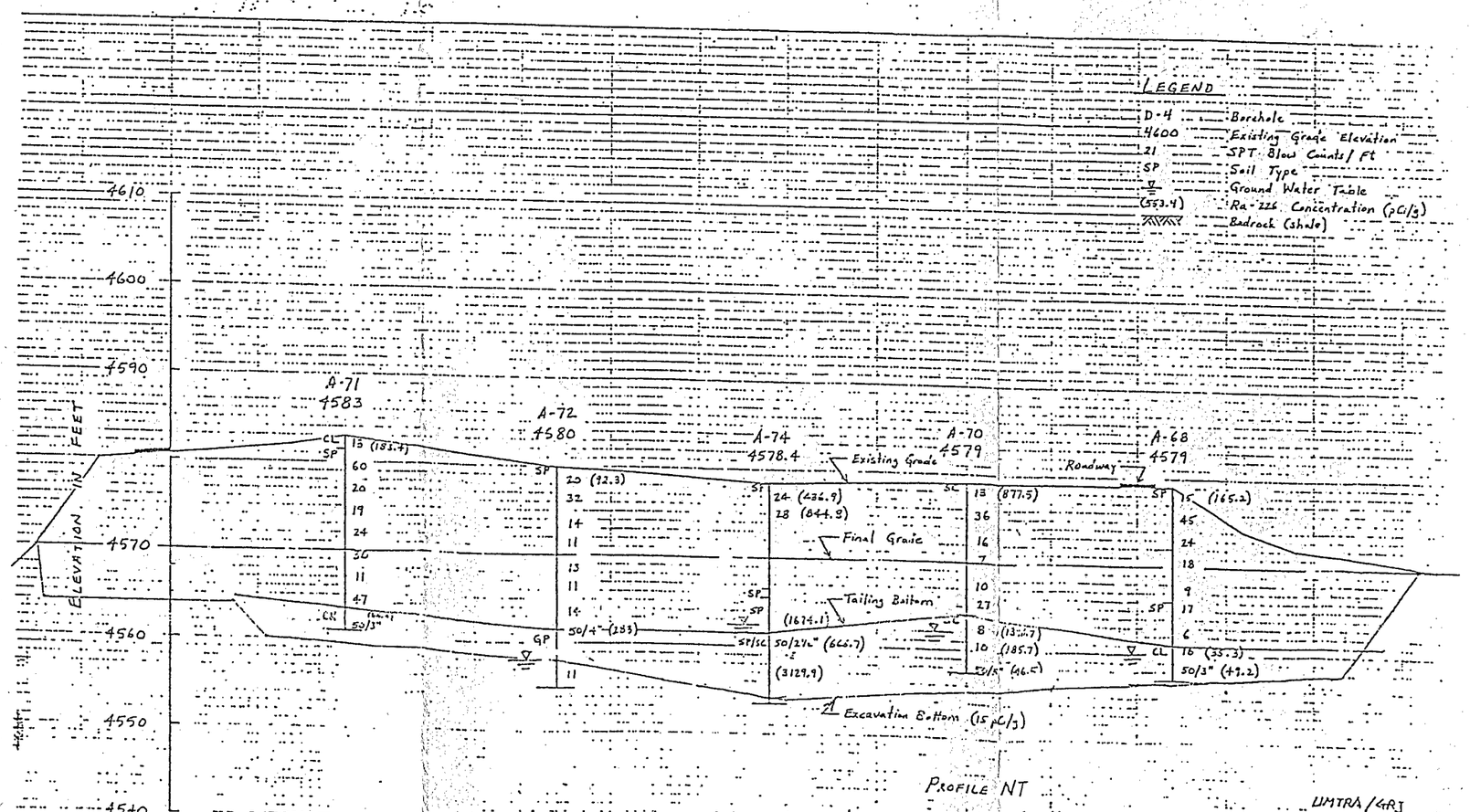
UMTRA/GRJ
by MDL 7/25/86
ckd SGS 8-11-
Revised SGS 8/31/87
WYL 1/18/88



UMTRA/GRJ
by HDL 7/25/86
ckd SLB 8-11-86
Revised SLB 8/3/87
WYL 1/18/88


20
LEGEND
D-4 Borehole
4600 Existing Grade Elevation
21 SPT Blow Counts / Ft
SP Soil Type
Ground Water Table
(552.4) Ra-226 Concentration (pCi/g)
Bedrock (Shale)
ELEVATION IN FEET
4610
4600
4590
4580
4570
4560
4550
4540
GWQJ
A-63
4584
A-73
4584
A-61
4578
A-58
4576
Existing Grade
Roadway
Final Grade
Tailing Bottom
Excavation Bottom (15 pCi/g)
PROFILE MT
HORIZONTAL SCALE - Feet
50 0 50 100
UMTRA/GRJ
by MDL 7/25/86
ckd SLS 8-11-3
Revised SLS 8/31/87
WYC 1/18/88

21

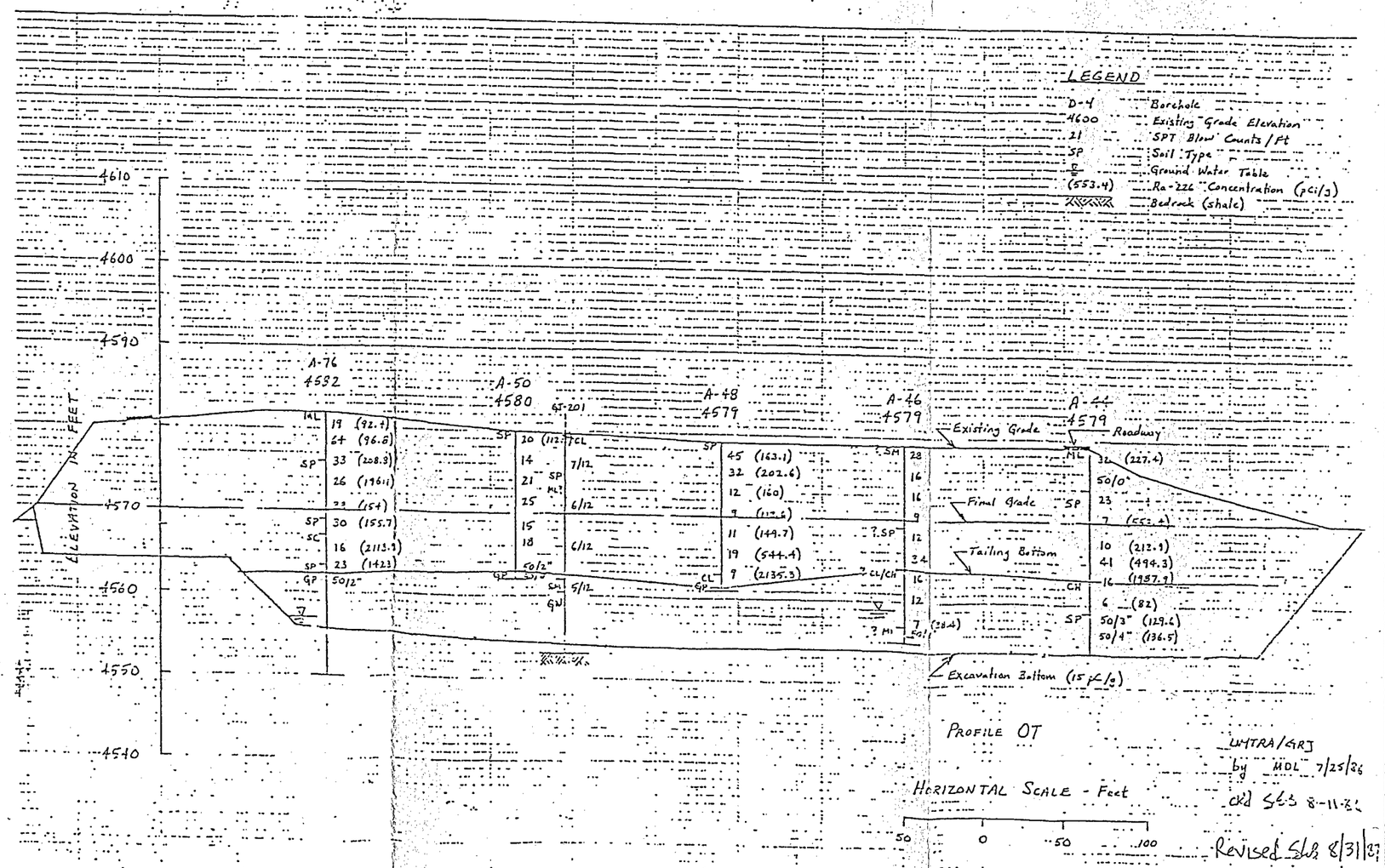


PROFILE NT

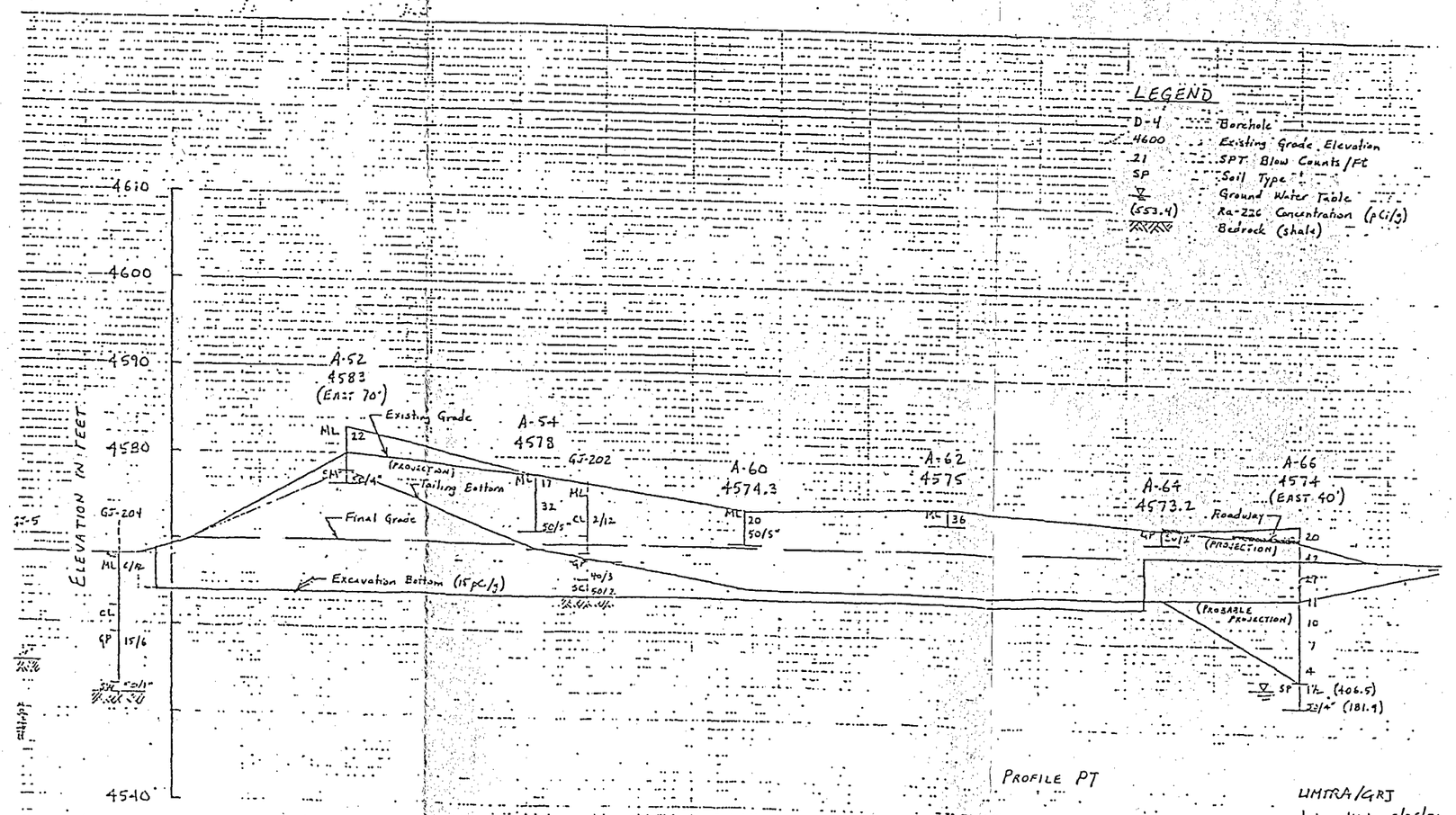
HORIZONTAL SCALE - Feet

50 0 50 100

UMTRA/GRJ
by MDL 7/25/8-
ck'd SSS 8-11-
Revised SKB 8/31/87
WYL 7/18/88



WTRA/GRJ
by MDL 7/25/88
ckd SLS 8-11-88
Revised SLS 8/3/89
WLS 1/18/88


LEGEND
D-4 Borehole
4600 Existing Grade Elevation
21 SPT Blow Counts/Ft
SP Soil Type
Ground Water Table
(553.4) Ra-226 Concentration (pCi/g)
Bedrock (shale)
ELEVATION IN FEET
4610
4600
4590
4580
4570
4560
4540
A-52
4583
(East 70')
Existing Grade
A-54
4578
GJ-202
A-60
4574.3
A-62
4575
A-64
4573.2
A-66
4574
(East 40')
Roadway
(Projection)
Tailing Bottom
Final Grade
Excavation Bottom (15 pCi/g)
GJ-204
GJ-5
(Probable Projection)
(406.5)
(181.9)
Profile PT
Horizontal Scale - Feet
50
0
50
100
UMTRA/GRJ
by MDL 7/25/86
ckd SJS 8-11-8
Revised SJS 8/31/87
WYL 1/18/88

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/GRJ 24
by WYL 7/18/86
ck'd

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)/elev.
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 10,260.1

UHTRA/GRJ 26
by WYL 7/18/86
ckd

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)/elev.
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			

UMTRA/GRJ 27
by WYL 7/18/86
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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)/elev.
			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	27.5/4554.5
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		1106.4			
			41 Subtotal		31,571.9			

UMTRA/GRJ 28
by WYL 7/18/86
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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)/elev.
			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	32.7/4558
			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			

UMTRA/GRJ 29
by VIYL 7/12/86
ck'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)/elev.
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		

= Subtotal 12660.8

41 Subtotal 26,790.0

UMTRA/GRJ 30
by WYL 7/18/86
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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)/elev.
			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		12,620.8			

UMTRA/GRJ 31
by WYL 7/13/86
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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)/elev.
			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	34.9 /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 /4561
			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 /4579.6
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 32
by WYL 7/18/86
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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) /elev.
			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	36.3/4562
			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			
			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	9 subtotal 1476.9		

LIMTRA/GRJ 33
by WYL 7/18/86
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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)/elev.
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			

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)/elev.
			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	814			
			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	31.0/4559.5
			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	35.6/4561
			S1	30-32.5	532.7			
			S2	32.5-35	89.1			

39 Subtotal 26,409.1

UMTRA/GRJ 3L
by WYL 7/12/86
CK'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 (elev.)
D-84	36	29	1	0-2.5	546		36	36.0/4560
			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	32.5/4552.5
			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	40.0/4544
			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	37.5/4566
			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	26.0/4568
D-97	36	32	1	0-2.5	294.7		MSG	40.0/4560
			13	30-32.5		1248.9		
D-98	30	25	1	0-2.5	171.8		27.5	27.5/4567.5
			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

UMTRA/GRJ 36
by WYL 7/18/86
ckd

Table D2.1 Borehole information (Concluded)

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)/elev.
S-4	MSG	8					MSG	
S-5	MSG	4					MSG	
S-6	MSG	2					MSG	
S-7	MSG	8.8					MSG	
S-8	MSG	13.75					MSG	
S-9	MSG	1.5					MSG	
S-10	MSG	0					MSG	
S-11	MSG	16					MSG	
S=12	MSG	12					MSG	
S-13	MSG	16					MSG	
S-14	MSG	12					MSG	

Location	Ave. Ra-226 (pci/g)	Total Excavated Depth (ft)	Depth From Interface To Bottom (ft)
Pile Area A (821,463 ft³)	30946.3/85 = 364.1	446.8/20 = 22.3	116.4/20 = 5.82
Pile Area B (569,701 ft³)	62974.0/94 = 669.9	577.7/22 = 26.3	121.7/22 = 5.53
Pile Area C (466,236 ft³)	72904.9/109 = 668.9	747.0/22 = 34.0	119.9/22 = 5.45
Pile Area D (391,366 ft³)	76307.9/135 = 565.2	1156.6/31 = 37.3	178.9/31 = 5.77
2,248,800 ft³ total	243133.1/423 = 574.8 ave	2927.1/95 = 30.8 ave	536.9/95 = 5.65 ave

CNSI DATA
REV 1

WJL 8/12/87
SWS 1-15-88

SHT 20 37

Grand Junction Site Characterization Borehole Log Data

Boreholes drilled by Rig

Borehole #	Location (CORRECTED)	Contamination Depth in Feet	EL.	EL.	*Max Activity Ra-226 pCi/g	Depth (in feet)
2C	N 59200, E 32500	4545.8	0-7.5	4558.3	224	1.5-3.0
2D	N 59300, E 32600	4569.3	0-10.5	4558.8	4418	4.5-6.0
2DE-2	N 59350, E 32620	4582.9	0-19.5	4563.4	552	1.5-3.0
2F-2	N 59500, E 32625	4580.0	0-19.5	4560.5	518	1.5-3.0
2GH	N 59650, E 32650	4580.8	0-19.5	4561.3	1180	13.5-15.0
2.5CD	N 59265, E 32650	4570.0	0-10.5	4559.5	3536	1.5-3.0
3D	N 59312, E 32700	4583.1	0-19.5	4563.6	322	4.5-6.0
4D-2	N 59300, E 32816	4584.8	0-19.5	4565.3	2750	16.5-18.0
5CD	N 59250, E 32900	[illegible]	0-19.5	[illegible]	1570	7.5-9.0
5E	N 59400, E 32900	?	0-4.5		904	1.5-3.0
6D	N 59300, E 33000	4584.2	0-19.5	4564.7	324	16.5-18.0
8CD	N 59250, E 33295	4577.5	0-13.5	4564.0	3160	10.5-12.0
9C	N 59200, E 33300	4565.1	0-7.5	4557.6	198	1.5-3.0
9H	N 59700, E 33300	4588.2	0-19.5	4568.7	2154	1.5-3.0
10CD	N 59250, E 33400	4577.7	0-13.5	4564.2	344	4.5-6.0
12CD	N 59268, E 33600	4590.6	0-22.5	4565.1	2508	22.5-24.0
13C	N 59280, E 33688	4590.4	0-31.5	4558.9	4244	1.5-3.0
1-C	N 59300, E 33800	4590.8	0-25.5	4565.3	3154	16.5-18.0
15A	N 59215, E 33943	4573.9	None	4573.9	8	1.5-3.0
15EC	N 59170, E 33900	4591.2	0-25.5	4565.7	3028	10.5-12.0
15F	N 59500, E 33878	4590.9	0-37.0	4559.4	2138	1.5-3.0
(17B	N 59100, E 3-100		0-21.0		1864	13.5-15.0
17B-2	N 59107, E 3-108	4590.0	0-22.5	4567.5	3208	16.5-18.0
18B-2	N 59100, E 34214	4589.7	0-22.0	4569.2	3724	17.5-19.0
(19B	N 59100, E 34300		0-22.5		3554	13.5-15.0
19B-2	N 59110, E 34305	4589.0	0-33.5	4555.2	2730	19.5-21.0
21B	N 59108, E 34500	4589.9	0-23.5	4566.4	3032	14.5-16.0
21J	N 59800, E 34500	4593.5	0-49.5	45[illegible]	3194	44.5-46.0
22.5B	N 59100, E 34650		0-22.5	[illegible]	3-30	16.5-18.0
(22.5B-2	N 59132, E 34650	4588.0	0-37.0	4551.0	3206	14.5-16.0
2-3C	N 59143, E 34800	4589.5	0-20.5	4569.0	2358	14.5-16.0
2.5BC	N 59146, E 35002	4588.9	0-19.5	4569.4	52	16.5-18.0
2.5EC	N 59174, E 35200	4577.0	0-4.5	4572.5	27	1.5-3.0
2FG	N 59800, E 35308	4589.9	0-22.5	4567.4	64	1.5-3.0
2FG	N 60400, E 35300	[illegible]	None		10	1.5-3.0
32M	N 60100, E 35600	4587.6	0-19.5	4568.1	200	13.5-15.0
33F-B	N 60297, E 35676		0-21.0		216	19.5-21.0
34P	N 60300, E 35800	[illegible]	None		6	1.5-3.0
34T	N 60700, E 35800	[illegible]	None		5	16.5-18.0
34L	N 60000, E 36000	[illegible]	Surface		11.8	0-0.5
40K	N 59700, E 36400	[illegible]	Surface		7.2	0-0.5
40M	N 60000, E 36400	[illegible]	None		5	16.5-17.0

* Estimated final activity after ingrowth
Correction factor used to obtain final activity from initial pCi/g count is 2 x initial result.

Grand Junction Site Characterization Borehole Log Data

Boreholes drilled by Little Beaver Auger

Borehole #	Location	Contamination Depth (in inches)	Max CPM and Depth	
1	N 59550, E 32550	0 - 18	1818340	6
2 (2D)	N 59300, E 32600	0 - 15 +	1553120	15
3	N 59300, E 32535	0 - 24	174200	Surface
4	N 59235, E 32535	0 - 36 +	235020	6
5	N 59250, E 32535	0 - 26	183430	6
6	N 59250, E 32600	0 - 66 +	1819150	24
7	N 59200, E 32650	0 - 36 +	2075600	18
8 (2C)	N 59200, E 32600	0 - 42 +	1231240	12
9	N 59200, E 32700	0 - 30 +	232100	18
10	N 59200, E 32500	0 - 66	107600	43
11	N 59250, E 32520	0 - 36 +	1050230	36
12	N 59211, E 32300	0 - 42 +	41020	12
13	N 59250, E 32900	0 - 42 +	500350	30
14	N 59219, E 33000	0 - 36 +	693130	12
15	N 59219, E 32995	0 - 42 +	695699	12
16	N 59210, E 33100	0 - 48 +	878040	48
17	N 59210, E 33200	0 - 54	286930	36
18	N 59150, E 33400	HED at 24	41110	Surface
19	N 59195, E 33400	0 - 78 +	217370	78
20	N 59125, E 33500	0	42170	Surface
21	N 59196, E 33586	0 - 42 +	845070	48
22	N 59150, E 33710	0 - 6	636400	Surface
23	N 59122, E 33790	0 - 6	72330	Surface
24	N 59100, E 33800	0 - 6	66810	Surface
25	N 59090, E 33885	0 - 6	56920	Surface
26	N 59061, E 34000	0 - 6	64090	Surface
27	N 59056, E 34000	0 - 6	55540	Surface
28	N 59124, E 34100	0 - 6	56900	Surface
29	N 59030, E 34200	0 - 6	48760	Surface
30	N 59049, E 34300	0 - 68	81260	68
31	N 59059, E 34300	0 - 72	78250	66
32	N 59025, E 34400	0 - 6	42590	Surface
33	N 59054, E 34500	0 - 0	46660	Surface
34	N 59092, E 34500	0 - 0	47230	Surface
35	N 59095, E 34700	0 - 6	50330	Surface
36	N 59100, E 35000	0 - 24 +	599150	24
37	N 59095, E 35000	0 - 24 +	319290	24
38	N 59000, E 34900	0 - 30 +	509520	30
39	N 59090, E 34725	0 - 6	54140	Surface
40	N 59100, E 35005	0 - 36 +	250100	36
41	N 59075, E 35100	0 - 6 +	84740	Surface
42	N 59100, E 35075	0 - 43 +	129272	10
43	N 59095, E 34750	0 - 48 +	115190	24
44	N 59075, E 34755	0 - 54	52640	24
45	N 59087, E 34750	0 - 6	54560	Surface
46	N 59080, E 34775	0 - 6	52340	Surface

Grand Junction Site Characterization Borehole Log Data

Boreholes drilled by Little Beaver Auger

Borehole #	Location	Contamination Depth (in inches)	Max CPM and Depth	
47	N 59600, E 32500	0 - 60 +	1766200	30
48	N 59112, E 33600	0 - 60 +	115720	60
49	N 59112, E 32597	0 - 72 +	165940	72
50	N 59100, E 32300	0 - 60 +	360250	48
51	N 59083, E 32800	0 - 54 +	735250	54
52	N 59125, E 33000	0 - 60 +	145340	48
53	N 59140, E 33200	None	28070	0
54	N 59155, E 33200	None	32750	0
55	N 59175, E 33200	0 - 90 +	198260	72
56	N 59100, E 33400	0 - 90 +	251780	72
57	N 59040, E 33400	None	29480	0
58	N 59070, E 33400	0 - 84 +	616100	54
59	N 59100, E 33600	Surface	44100	Surface
60	N 59060, E 33600	None	32650	Surface
61	N 59000, E 33800	Surface	42770	Surface
62	N 59085, E 34020	Surface	61730	Surface
63	N 59085, E 34025	0 - 78 +	65190	78
64	N 59005, E 34000	Surface	41680	Surface
65	N 59102, E 33988	None	35100	Surface
66	N 59040, E 34100	Surface	34870	Surface
67	N 59050, E 34100	0 - 78 +	201500	30
68	N 59040, E 34200	0 - 54	43400	48
69	N 59053, E 34300	Surface	42970	Surface
70	N 59800, E 32500	0 - 48	666510	18
71	N 59100, E 33300	0 - 90 +	53520	84
72	N 59075, E 33300	0 - 96 +	58110	96
73	N 59100, E 33500	0 - 66	47780	36
74	N 59075, E 33500	None	30440	Surface
75	N 59085, E 33500	None	36850	Surface
76	N 59000, E 33650	None	36800	Surface
77	N 59040, E 33650	Surface	40090	Surface
78	N 59060, E 33650	None	39110	Surface
79	N 59080, E 33650	Surface	44510	Surface
80	N 59000, E 33700	None	37180	Surface
81	N 59010, E 33705	Surface	41300	Surface
82	N 59150, E 33700	Surface	51260	Surface
83	N 59150, E 33690	Surface	58230	Surface
84	N 59165, E 33690	Surface	60170	Surface
85	N 59130, E 33650	Surface	53790	Surface
86	N 59140, E 33600	Surface	55700	Surface
87	N 59150, E 33300	0 - 88 +	589510	Surface
88	N 59175, E 33300	0 - 102 +	50730	102
89	N 59180, E 33300	0 - 90 +	250520	6
90	N 59050, E 33600	None	37310	Surface
91	N 59052, E 33600	None	33430	Surface

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-438	RAF. POND COMP.	< 0.5	18.7	37.4**	
GJ-SS-257	West Machine Shop	< 0.5	65.2	130.4**	
GJ-SS-258	West Machine Shop	< 0.5	9.4	18.8**	
GJ-SS-259	West Machine Shop	< 0.5	18.3	37	
GJ-SS-366	N 59,000; E 33,500	< 0.5	1.1	2.2**	
GJ-SS-346	N 59,000; E 33,600	< 0.5	1.2	2.4**	62
GJ-SS- 45	N 59,000; E 33,700	< 0.5	1.2	1.7	
GJ-SS-371	N 59,000; E 33,700	< 0.5	1.1	2.2**	20
GJ-SS-325	N 59,000; E 33,800	< 0.5	1.2	2.4**	61
GJ-SS- 41	N 59,000; E 33,900	< 0.5	1.0	0.4	
GJ-SS-419	N 59,000; E 33,900	1.5-3.0	4.3	8.6**	
GJ-SS-420	N 59,000; E 33,900	4.5-6.0	4.2	7.4	
GJ-SS-421	N 59,000; E 33,900	13.5-15.0	3.9	0.9	15A
GJ-SS-422	N 59,000; E 33,900	16.5-18.0	1.2	1.1	
GJ-SS-423	N 59,000; E 33,900	19.5-21.0	2.0	4.0**	
GJ-SS-424	N 59,000; E 33,900	22.5-23.0	3.0	6.0**	
GJ-SS-389	N 59,000; E 34,000	IN H2O	1.4	2.8**	
GJ-SS-373	N 59,010; E 33,905	< 0.5	1.3	2.6**	51
GJ-SS-113	N 59,010; E 34,000	< 0.5	1.1	1.3	
GJ-SS-134	N 59,020; E 33,820	< 0.5	1.0	1.1	
GJ-SS- 50	N 59,020; E 34,100	< 0.5	1.4	1.6	
GJ-SS-329	N 59,024; E 34,100	< 0.5	0.9	1.8**	
GJ-SS-314	N 59,024; E 34,500	< 0.5 H2O ?	1.4	2.8**	
GJ-SS-310	N 59,030; E 34,200	< 0.5	1.6	3.2**	
GJ-SS-328	N 59,030; E 34,200	< 0.5	0.6	1.2**	
GJ-SS-343	N 59,030; E 34,200	1.5	1.1	2.2**	29
GJ-SS-336	N 59,040; E 33,400	< 0.5	1.3	2.6**	57
GJ-SS-372	N 59,040; E 33,650	< 0.5	1.1	2.2**	77
GJ-SS-316	N 59,040; E 34,200	< 0.5	1.3	2.6**	[illegible]
GJ-SS-313	N 59,040; E 34,500	< 0.5	1.0	2.0**	
GJ-SS-331	N 59,049; E 34,300	< 0.5	1.8	3.6**	
GJ-SS-356	N 59,049; E 34,300	1.0-1.5	1.2	2.4**	30
GJ-SS-368	N 59,049; E 34,300	< 0.5	1.2	2.4**	
GJ-SS-328	N 59,050; E 32,550	< 0.5	1.3	2.6**	
GJ-SS-378	N 59,050; E 33,500	< 0.5	1.5	3.0**	
GJ-SS- 96	N 59,050; E 34,300	< 0.5	1.7	1.8	
GJ-SS-318	N 59,050; E 34,500	2.0-2.5	124.5	249.0**	
GJ-SS-317	N 59,053; E 34,300	< 0.5	1.3	2.6**	[illegible]
GJ-SS-354	N 59,056; E 34,000	1.0-1.5	2.1	4.2**	
GJ-SS-358	N 59,056; E 34,000	0.5-1.0	2.1	4.2**	27
GJ-SS-365	N 59,056; E 34,000	< 0.5	1.0	2.0**	
GJ-SS-348	N 59,059; E 34,300	< 0.5	1.5	3.0**	
GJ-SS-360	N 59,059; E 34,300	1.0-1.5	1.8	3.6**	31
GJ-SS-320	N 59,061; E 34,000	< 0.5	0.7	1.4**	24
GJ-SS-367	N 59,065; E 34,000	1.5-2.0	1.3	2.6**	
GJ-SS-387	N 59,065; E 34,400	< 0.5	1.4	2.8**	
GJ-SS-364	N 59,065; E 34,400	< 0.5	1.1	2.2**	[illegible]
GJ-SS-370	N 59,065; E 34,400	1.5	2.9	5.8**	
GJ-SS-374	N 59,070; E 33,650	< 0.5	1.2	2.4**	
GJ-SS-377	N 59,070; E 33,300	< 0.5	1.8	3.6**	72
GJ-SS-131	N 59,070; E 34,500	< 0.5	1.0	0.7	
GJ-SS-333	N 59,070; E 34,500	< 0.5	0.9	1.8**	
GJ-SS-131	N 59,080; E 33,400	< 0.5	0.8	1.2	

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-345	N 59,084; E 34,876	< 0.5	2.6	5.2**	46
GJ-SS-322	N 59,085; E 34,020	< 0.5	1.7	3.4**	62
GJ-SS-306	N 59,085; E 34,025	< 0.5	1.4	2.8**	63
GJ-SS-359	N 59,087; E 34,900	< 0.5	2.7	5.4**	
GJ-SS-337	N 59,094; E 34,800	1.5	2.0	3.1	33
GJ-SS-357	N 59,094; E 34,800	< 0.5	2.6	5.2**	
GJ-SS-361	N 59,100; E 32,612	< 0.5	1.6	3.2**	
GJ-SS- 47	N 59,100; E 32,700	< 0.5	1.2	0.7	
GJ-SS-355	N 59,100; E 32,800	< 0.5	1.3	2.6**	50
GJ-SS- 94	N 59,100; E 32,900	< 0.5	1.3	1.8	
GJ-SS-335	N 59,100; E 33,000	< 0.5 H_2O	0.8	1.6**	
GJ-SS- 43	N 59,100; E 33,300	< 0.5	1.2	1	71
GJ-SS-312	N 59,100; E 33,400	< 0.5	0.9	1.8**	56
GJ-SS-369	N 59,100; E 33,400	< 0.5	1.3	2.6**	
GJ-SS- 93	N 59,100; E 33,500	< 0.5	1.6	1.1	73
GJ-SS-375	N 59,100; E 33,500	< 0.5	0.9	1.8**	
GJ-SS-307	N 59,100; E 33,600	< 0.5	1.0	2.0**	59
GJ-SS-311	N 59,100; E 33,600	1.5-2.0	1.4	2.8**	
GJ-SS- 42	N 59,100; E 33,700	< 0.5	0.7	1.2	
GJ-SS-338	N 59,100; E 33,800	1.5-2.0	1.6	3.2**	
GJ-SS-340	N 59,100; E 33,800	0.5-1.0	1.2	2.4**	24
GJ-SS-482	N 59,100; E 33,800	< 0.5	0.9	1.4	
GJ-SS-483	N 59,100; E 33,800	1.0-1.5	0.6	1.9	
GJ-SS- 95	N 59,100; E 33,900	< 0.5	1.3	1.7	
GJ-SS-173	N 59,100; E 34,100	1.5-3.0	3.3	1.9	
GJ-SS-174	N 59,100; E 34,100	4.5-6.0	2.6	5.2**	
GJ-SS-175	N 59,100; E 34,100	7.5-9.0	3.3	2.7	
GJ-SS-176	N 59,100; E 34,100	10.5-12.0	56.0	112.0**	17B
GJ-SS-177	N 59,100; E 34,100	13.5-15.0	931.6	1863.2**	
GJ-SS-178	N 59,100; E 34,100	16.5-18.0	903.2	1806.4**	
GJ-SS-179	N 59,100; E 34,100	19.5-21.0	856.5	1713.0**	
GJ-SS-248	N 59,100; E 34,100	28.5-30.0	10.9	12.8	
GJ-SS-402	N 59,100; E 34,200	14.5-16.0	1704.9	3409.8**	
GJ-SS-403	N 59,100; E 34,200	17.5-19.0	1654.4	3308.8**	18B
GJ-SS-404	N 59,100; E 34,200	20.5-22.0	6.1	7.5*	
GJ-SS-405	N 59,100; E 34,200	23.5-25.0	4.0	8.0**	
GJ-SS-396	N 59,100; E 34,214	14.5-16.0	1740.5	3481.0**	
GJ-SS-397	N 59,100; E 34,214	17.5-19.0	1862.3	3724.6**	
GJ-SS-398	N 59,100; E 34,214	20.5-22.0	7.34	14.7**	19B
GJ-SS-399	N 59,100; E 34,214	26.5-28.0	1.8	3.6**	
GJ-SS-400	N 59,100; E 34,214	33.5-34.0	1.1	2.2**	
GJ-SS-401	N 59,100; E 34,214	35.5-37.0	5.6	3.4	
GJ-SS-180	N 59,100; E 34,300	1.5-3.0	72.8	145.6**	
GJ-SS-181	N 59,100; E 34,300	4.5-6.0	6.7	5.8	
GJ-SS-182	N 59,100; E 34,300	7.5-9.0	1674.6	3349.2**	
GJ-SS-183	N 59,100; E 34,300	10.5-12.0	1693.4	3386.8**	
GJ-SS-184	N 59,100; E 34,300	13.5-15.0	1776.5	3553.0**	19B
GJ-SS-185	N 59,100; E 34,300	16.5-18.0	1655.2	3310.4**	
GJ-SS-186	N 59,100; E 34,300	17.5-21.0	1491.8	2983.6**	
GJ-SS-187	N 59,100; E 34,300	22.5-24	4.7	9.4**	
GJ-SS-203	N 59,100; E 34,500	14.5-16.0	1516.4	3032.8**	
GJ-SS-204	N 59,100; E 34,500	17.5-17.0	1060.6	2121.2**	21B
GJ-SS-205	N 59,100; E 34,500	20.5-22.0	1071.8	2143.6**	

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-206	N 59,100; E 34,500	23.5-25.0	3.7	7.0	
GJ-SS-207	N 59,100; E 34,500	26.5-28.0	2.3	4.6**	
GJ-SS-208	N 59,100; E 34,500	29.5-31.0	1.0	2.0**	218
GJ-SS-209	N 59,100; E 34,500	32.5-34.0	1.1	2.2**	
GJ-SS-210	N 59,100; E 34,500	35.5-37.0	3.6	7.2**	
GJ-SS-211	N 59,100; E 34,650	1.5-3.0	1.8	3.6**	
GJ-SS-212	N 59,100; E 34,650	7.5-9.0	202.7	405.4**	
GJ-SS-213	N 59,100; E 34,650	10.5-12.0	1543.3	3086.6**	
GJ-SS-214	N 59,100; E 34,650	13.5-15.0	1703.3	3406.6**	
GJ-SS-215	N 59,100; E 34,650	16.5-18.0	1714.5	3429.0**	22.5B
GJ-SS-216	N 59,100; E 34,650	19.5-21.0	1443.3	2886.6**	
GJ-SS-217	N 59,100; E 34,650	22.5-24.0	14.8	24.8	
GJ-SS-123	N 59,100; E 34,800	< 0.5	1.9	3.8**	
GJ-SS-135	N 59,100; E 34,900	< 0.5	0.8	1.6	
GJ-SS-114	N 59,100; E 35,000	< 0.5	1.3	1.5	
GJ-SS-341	N 59,100; E 35,000	< 0.5	1.1	2.2	36
GJ-SS-363	N 59,100; E 35,000	1.5-2.0	121.8	243.6**	
GJ-SS-117	N 59,100; E 35,100	< 0.5	8.8	23.6	
GJ-SS- 44	N 59,100; E 35,200	< 0.5	1.3	12.5	
GJ-SS-332	N 59,100; E 35,300	< 0.5	1.0	2.0**	
GJ-SS-326	N 59,100; E 35,400	< 0.5	1.8	3.6**	
GJ-SS-136	N 59,105; E 32,700	< 0.5	0.8	1.6**	
GJ-SS-222	N 59,107; E 34,108	16.5-18.0	1604.3	3208.6**	
GJ-SS-223	N 59,107; E 34,108	19.5-21.0	1007.2	2014.4**	
GJ-SS-224	N 59,107; E 34,108	22.5-24.00	2.0	3.6	17.5-B
GJ-SS-225	N 59,107; E 34,108	31.5-33.0	1.5	3.0**	
GJ-SS-188	N 59,110; E 34,108	1.5-3.0	17.4	117.2	
GJ-SS-189	N 59,110; E 34,108	4.5-6.0	5.8	6.6	
GJ-SS-190	N 59,110; E 34,108	19.5-21.0	1365.3	2730.6**	
GJ-SS-191	N 59,110; E 34,108	22.5-24.0	1.0	1.5	
GJ-SS-192	N 59,110; E 34,108	25.5-27.0	3.2	6.4**	[illegible]-3
GJ-SS-193	N 59,110; E 34,108	28.5-30.0	7.0	14.0**	
GJ-SS-194	N 59,110; E 34,108	33.5	33.7	35.5	
GJ-SS-308	N 59,112; E 32,600	< 0.5	0.9	1.8**	47
GJ-SS-315	N 59,122; E 34,250	< 0.5	0.5	1.0**	[illegible]
GJ-SS-323	N 59,125; E 33,000	2.0-2.5	2.7	5.4**	52
GJ-SS-324	N 59,125; E 33,000	< 0.5	1.4	2.8**	
GJ-SS-330	N 59,130; E 33,650	< 0.5	1.4	2.8**	25
GJ-SS-249	N 59,132; E 34,650	14.5-16.0	1903.1	3806.2**	
GJ-SS-250	N 59,132; E 34,650	17.5-19.0	1791.5	3583.0**	
GJ-SS-251	N 59,132; E 34,650	20.5-22.0	1598.8	3197.6**	
GJ-SS-252	N 59,132; E 34,650	23.5-25.0	1437.2	2874.4**	
GJ-SS-253	N 59,132; E 34,650	26.5-28.0	35.8	71.6**	22.5 B-3
GJ-SS-254	N 59,132; E 34,650	29.5-31.0	12.9	25.8	
GJ-SS-255	N 59,132; E 34,650	32.5-34.0	10.6	20.3	
GJ-SS-256	N 59,132; E 34,650	35.5-37.0	11.4	25.0	
GJ-SS-116	N 59,140; E 35,300	< 0.5	1.4	1.8	
GJ-SS-377	N 59,140; E 35,600	< 0.5	1.3	2.6**	26
GJ-SS-124	N 59,142; E 32,300	< 0.5	0.9	0.5	
GJ-SS-380	N 59,150; E 31,300	< 0.5	2.4	4.8**	57
GJ-SS-384	N 59,150; E 33,400	< 0.5	1.0	2.0**	
GJ-SS-387	N 59,150; E 33,710	< 0.5	1.3	2.3	
GJ-SS-479	N 59,150; E 33,710	1.0-1.5	0.6	1.2**	

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-480	N 59,150; E 33,710	1.5-2.0	0.9	1.2	
GJ-SS-481	N 59,150; E 33,710	< 0.5	14.4	32.4	
GJ-SS-484	N 59,150; E 33,710	0.5-1.0	0.8	2.3	
GJ-SS-164	N 59,150; E 33,900	1.5-3.0	711.6	1423.2**	
GJ-SS-165	N 59,150; E 33,900	4.5-6.0	1136.0	2272.0**	
GJ-SS-166	N 59,150; E 33,900	10.5-12.0	1513.1	3026.2**	
GJ-SS-167	N 59,150; E 33,900	13.5-15.0	1491.4	2982.8**	
GJ-SS-168	N 59,150; E 33,900	16.5-18.0	1501.2	3002.4**	
GJ-SS-169	N 59,150; E 33,900	19.5-21.0	603.8	1207.6**	
GJ-SS-170	N 59,150; E 33,900	22.5-24.0	21.3	42.6**	
GJ-SS-171	N 59,150; E 33,900	25.5-27.0	2.4	2.8	
GJ-SS-172	N 59,150; E 33,900	31.5-33.0	2.6	5.2**	
GJ-SS-454	N 59,150; E 34,596	1.0-1.5	2.4	4.8**	
GJ-SS-195	N 59,150; E 34,800	14.5-16.0	1429.3	2858.6**	
GJ-SS-196	N 59,150; E 34,800	17.5-19.0	1236.8	2473.6**	
GJ-SS-197	N 59,150; E 34,800	20.5-22.0	2.9	5.8**	
GJ-SS-198	N 59,150; E 34,800	23.5-25.0	1.0	2.0**	
GJ-SS-199	N 59,150; E 34,800	26.5-28.0	3.2	6.4**	
GJ-SS-200	N 59,150; E 34,800	29.5-31.0	3.8	7.6**	
GJ-SS-201	N 59,150; E 34,800	32.5-34.0	1.6	3.5	
GJ-SS-202	N 59,150; E 34,800	37.0-37.5	6.6	10.0	
GJ-SS-218	N 59,150; E 35,000	16.5-18.0	26.0	52.0**	
GJ-SS-219	N 59,150; E 35,000	19.5-21.0	0.9	1.8**	
GJ-SS-220	N 59,150; E 35,000	22.5-24.0	0.9	1.0	
GJ-SS-221	N 59,150; E 35,000	31.5-33.0	0.6	1.2**	
GJ-SS-226	N 59,150; E 35,200	1.5-3.0	21.5	26.5*	
GJ-SS-227	N 59,150; E 35,200	4.5-6.0	4.5	5.6*	
GJ-SS-228	N 59,150; E 35,200	7.5-9.0	1.6	3.2**	
GJ-SS-229	N 59,150; E 35,200	10.5-12.0	2.4	4.8**	
GJ-SS-230	N 59,150; E 35,200	13.5-15.0	0.8	1.6**	
GJ-SS-231	N 59,150; E 35,200	16.5-18.0	1.3	2.6**	
GJ-SS-232	N 59,150; E 35,200	19.5-21.0	0.6	1.2	
GJ-SS-233	N 59,150; E 35,200	21.0-22.0	0.9	1.2	
GJ-SS-122	N 59,155; E 33,600	< 0.5	0.9	2.2	
GJ-SS-123	N 59,155; E 33,400	< 0.5	1.1	1.3	
GJ-SS- 97	N 59,165; E 33,100	< 0.5	1.5	1.4	
GJ-SS-381	N 59,165; E 33,650	< 0.5	0.8	1.6**	
GJ-SS-125	N 59,175; E 33,000	< 0.5	0.8	1.2	
GJ-SS-129	N 59,175; E 33,100	< 0.5	1.0	0.6	
GJ-SS-309	N 59,175; E 33,200	< 0.5	5.2	6.3*	
GJ-SS-383	N 59,175; E 33,300	< 0.5	1.7	3.4**	
GJ-SS-319	N 59,180; E 33,400	< 0.5	1.3	2.6**	
GJ-SS-126	N 59,185; E 33,300	< 0.5	1.0	2.0**	
GJ-SS-330	N 59,185; E 33,475	< 0.5	1.1	2.2**	
GJ-SS-127	N 59,185; E 33,485	< 0.5	1.2	3.5	
GJ-SS-331	N 59,189; E 33,885	< 0.5	0.7	1.4**	
GJ-SS-403	N 59,195; E 33,400	< 0.5	1.0	0.8	
GJ-SS-406	N 59,195; E 33,400	0.5-1.0	1.3	2.5	
GJ-SS-407	N 59,195; E 33,400	1.5-2.0	0.8	1.8	
GJ-SS-347	N 59,196; E 33,596	1.5-2.0	86.2	172.4**	
GJ-SS-500	N 59,196; E 34,596	0.5-1.0	1.6	3.6	
GJ-SS- 96	N 59,200; E 33,500	< 0.5	9.7	15.6	
GJ-SS-111	N 59,200; E 33,575	< 0.5	2.1	1.6	

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-425	N 59,200; E 32,600	1.5-3.0	112.2	224.4**	
GJ-SS-426	N 59,200; E 32,600	4.5-6.0	16.5	33.0**	
GJ-SS-427	N 59,200; E 32,600	7.5-9.0	1.1	2.2**	2C
GJ-SS-428	N 59,200; E 32,600	10.5-12.0	0.2	0.4**	
GJ-SS-429	N 59,200; E 32,600	14.5-16.0	1.8	3.6**	
GJ-SS-430	N 59,200; E 32,600	16.0-16.5	1.6	3.2**	
GJ-SS-110	N 59,200; E 32,700	< 0.5	10.5	16.2	9
GJ-SS- 79	N 59,200; E 32,900	1.5-3.0	10.7	13.1*	
GJ-SS- 80	N 59,200; E 32,900	4.5-6.0	630.0	1260.0**	
GJ-SS- 81	N 59,200; E 32,900	7.5-9.0	794.7	1589.4**	
GJ-SS- 82	N 59,200; E 32,900	10.5-12.0	1.6	2.1	
GJ-SS- 83	N 59,200; E 32,900	13.5-15.0	4.2	8.4**	5C
GJ-SS- 84	N 59,200; E 32,900	16.5-18.0	7.3	15.6	
GJ-SS- 85	N 59,200; E 32,900	19.5-21.0	1.0	2.0**	
GJ-SS- 99	N 59,200; E 32,900	> 0.5	1.2	2.0	
GJ-SS- 48	N 59,200; E 33,100	< 0.5	40.4	8[illegible].3	
GJ-SS-120	N 59,200; E 33,110	1.5	85.1	170.2**	
GJ-SS-112	N 59,200; E 33,300	< 0.5	9.0	12.6	
GJ-SS-243	N 59,200; E 33,300	1.5-3.0	98.5	197.0**	
GJ-SS-244	N 59,200; E 33,300	4.5-6.0	22.5	45.0**	
GJ-SS-245	N 59,200; E 33,300	7.5-9.0	1.4	2.0	9C
GJ-SS-246	N 59,200; E 33,300	10.5-12.0	0.9	0.6	
GJ-SS-247	N 59,200; E 33,300	16.5-18.0	2.8	2.6	
GJ-SS- 49	N 59,200; E 33,500	< 0.5	1.6	1.3	
GJ-SS-260	N 59,200; E 33,700	1.5-3.0	2121.6	4243.2**	
GJ-SS-261	N 59,200; E 33,700	4.5-6.0	814.7	1629.4**	
GJ-SS-262	N 59,200; E 33,700	7.5-9.0	1316.5	2633.0**	
GJ-SS-263	N 59,200; E 33,700	13.5-15.0	1233.3	2466.6**	
GJ-SS-264	N 59,200; E 33,700	16.5-18.0	1262.7	2525.4**	13C
GJ-SS-265	N 59,200; E 33,700	19.5-21.0	226.4	452.8**	
GJ-SS-266	N 59,200; E 33,700	22.5-24.0	1223.4	2446.8**	
GJ-SS-267	N 59,200; E 33,700	31.5-33.0	1.3	1.5	
GJ-SS-268	N 59,200; E 33,700	34.5-35.5	0.8	0.8	
GJ-SS-269	N 59,200; E 33,700	35.5-36.0	10.2	11.6	
GJ-SS-270	N 59,200; E 33,800	1.5-3.0	5.7	11.4**	
GJ-SS-271	N 59,200; E 33,800	4.5-6.0	1259.1	2518.2**	
GJ-SS-272	N 59,200; E 33,800	7.5-9.0	59.0	118.0**	
GJ-SS-273	N 59,200; E 33,800	10.5-12.0	672.6	1335.2**	
GJ-SS-274	N 59,200; E 33,800	13.5-15.0	1413.0	2826.0**	
GJ-SS-275	N 59,200; E 33,800	16.5-18.0	1576.9	3153.8**	14C
GJ-SS-276	N 59,200; E 33,800	19.5-21.0	689.7	1379.4**	
GJ-SS-277	N 59,200; E 33,800	22.5-24.0	162.7	325.4**	
GJ-SS-278	N 59,200; E 33,800	25.5-27.0	1.13	2.3**	
GJ-SS-279	N 59,200; E 33,800	28.5-30.0	0.5	1.0**	
GJ-SS-280	N 59,200; E 33,800	37.0-37.1	4.7	9.4**	
GJ-SS-396	N 59,200; E 35,200	IN HOLE	33.7		
GJ-SS-115	N 59,210; E 33,200	< 0.5	3.7	6.3	
GJ-SS-119	N 59,210; E 33,200	2.0-2.3	3.2	6.7	
GJ-SS-122	N 59,210; E 33,200	1.5-2.0	2.1	5.3	17
GJ-SS-12[illegible]	N 59,210; E 33,200	< 0.5	14.0	40.1	
GJ-SS-1[illegible]	N 59,210; E 33,200	0.5-1.0	1.4	1.8	
GJ-SS-118	N 59,21[illegible]; E 33,[illegible]	1.5	9.9	29.5	
GJ-SS-2[illegible]	N 59,21[illegible]; E 33,[illegible]	1.5-3.0	1[illegible].8	3[illegible]**	

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-288	N 59,250; E 32,650	4.5-6.0	1757.1	3514.2**	
GJ-SS-289	N 59,250; E 32,650	7.5-9.0	378.8	757.6**	2,5CD
GJ-SS-290	N 59,250; E 32,650	10.5-12.0	2.7	3.3*	
GJ-SS-291	N 59,250; E 32,650	13.5-15.0	1.0	2.0**	
GJ-SS-292	N 59,250; E 32,650	16.5-18.0	5.4	10.8**	
GJ-SS-293	N 59,250; E 32,650	19.5-21.0	2.7	2.3	
GJ-SS- 86	N 59,250; E 33,200	1.5-3.0	4.6	2.7	
GJ-SS- 87	N 59,250; E 33,200	4.5-6.0	111.9	223.5**	
GJ-SS- 88	N 59,250; E 33,200	7.5-9.0	112.3	224.6**	
GJ-SS- 89	N 59,250; E 33,200	10.5-12.0	1579.4	3158.8**	8CD
GJ-SS- 90	N 59,250; E 33,200	13.5-15.0	4.1	8.2**	
GJ-SS- 91	N 59,250; E 33,200	16.5-18.0	0.7	1.4**	
GJ-SS- 92	N 59,250; E 33,200	22.5-22.7	2.0	0.6	
GJ-SS-155	N 59,250; E 33,400	1.5-3.0	7.3	5.1	
GJ-SS-156	N 59,250; E 33,400	4.5-6.0	172.3	344.6**	
GJ-SS-157	N 59,250; E 33,400	7.5-9.0	207.9	415.8**	
GJ-SS-158	N 59,250; E 33,400	10.5-12.0	153.0	306.0**	
GJ-SS-159	N 59,250; E 33,400	13.5-15.0	2.5	5.0**	10CD
GJ-SS-160	N 59,250; E 33,400	16.5-18.0	3.1	6.2**	
GJ-SS-161	N 59,250; E 33,400	19.5-21.0	0.4	0.8**	
GJ-SS-162	N 59,250; E 33,400	22.5-25.0	0.9	1.8**	
GJ-SS-163	N 59,250; E 33,400	25.0-26.5	0.9	1.6	
GJ-SS-234	N 59,250; E 33,600	1.5-3.0	459.1	918.2**	
GJ-SS-235	N 59,250; E 33,600	4.5-6.0	720.9	1441.8**	
GJ-SS-236	N 59,250; E 33,600	7.5-9.0	250.0	500.0**	
GJ-SS-237	N 59,250; E 33,600	13.5-15.0	414.0	828.0**	
GJ-SS-238	N 59,250; E 33,600	16.5-18.0	844.5	1689.0**	12CD
GJ-SS-239	N 59,250; E 33,600	19.5-21.0	198.0	396.0**	
GJ-SS-240	N 59,250; E 33,600	22.5-24.0	1253.7	2507.4**	
GJ-SS-241	N 59,250; E 33,600	25.5-27.0	5.1	11.4	
GJ-SS-242	N 59,250; E 33,600	28.5-30.0	2.7	6.2	
GJ-SS- 71	N 59,300; E 32,600	1.5-3.0	711.6	1423.2**	
GJ-SS- 72	N 59,300; E 32,600	4.5-6.0	2209.1	4418.2**	
GJ-SS- 73	N 59,300; E 32,600	7.5-9.0	47.7	58.2*	
GJ-SS- 74	N 59,300; E 32,600	10.5-12.0	0.5	0.5	2D
GJ-SS- 75	N 59,300; E 32,600	13.5-15.0	1.6	2.2	
GJ-SS- 76	N 59,300; E 32,600	16.5-18.0	0.9	1.4	
GJ-SS- 77	N 59,300; E 32,600	19.5-21.0	1.2	1.3	
GJ-SS- 78	N 59,300; E 32,600	21.0	Sample Weight to low for Anal.		
GJ-SS-159	N 59,300; E 33,400	< 0.5	67.5	63.0	
GJ-SS- 31	N 59,300; E 32,700	1.5-3.0	151.6	303.6**	
GJ-SS- 32	N 59,300; E 32,700	4.5-6.0	161.1	322.2**	
GJ-SS- 33	N 59,300; E 32,700	7.5-9.0	127.3	254.6**	
GJ-SS- 34	N 59,300; E 32,700	10.5-12.0	148.6	297.2**	
GJ-SS- 35	N 59,300; E 32,700	13.5-15.0	94.9	189.8**	3D
GJ-SS- 36	N 59,300; E 32,700	16.5-18.0	71.9	118.6	
GJ-SS- 37	N 59,300; E 32,700	19.5-21.0	1.5	3.7	
GJ-SS- 38	N 59,300; E 32,700	22.5-24.0	0.6	0.7	
GJ-SS- 39	N 59,300; E 32,700	25.5-27.0	1.8	2.7	
GJ-SS- 40	N 59,300; E 32,700	28.5-30.0	1.2	1.7	
GJ-SS-303	N 59,300; E 32,800	< 0.5	1.4	1.5	
GJ-SS-[illegible]	N 59,300; E 32,800	1.5-3.0	30.7	61.4**	
GJ-SS-[illegible]	N 59,300; E 32,800	4.5-6.0	107.0	214.0**	4D

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-490	N 59,300; E 32,800	7.5-9.0	218.8	437.6**	
GJ-SS-491	N 59,300; E 32,800	10.5-12.0	159.9	319.8**	4D
GJ-SS-492	N 59,300; E 32,800	13.5-15.0	272.1	544.2**	
GJ-SS-493	N 59,300; E 32,800	16.0-18.0	1761.4	3522.8**	
GJ-SS- 51	N 59,300; E 32,816	1.5-3.0	144.7	289.4**	
GJ-SS- 52	N 59,300; E 32,816	4.5-6.0	157.8	315.6**	
GJ-SS- 53	N 59,300; E 32,816	7.5-9.0	164.7	329.4**	
GJ-SS- 54	N 59,300; E 32,816	10.5-12.0	133.2	266.4**	
GJ-SS- 55	N 59,300; E 32,816	13.5-15.0	189.2	378.4**	
GJ-SS- 56	N 59,300; E 32,816	16.5-18.0	1475.4	2950.8**	4D-S
GJ-SS- 57	N 59,300; E 32,816	19.5-21.0	1.5	1.2	
GJ-SS- 58	N 59,300; E 32,816	22.5-24.0	2.02	4.0**	
GJ-SS- 59	N 59,300; E 32,816	25.5-27.0	1.1	2.2**	
GJ-SS- 60	N 59,300; E 32,816	28.5-30.0	1.3	2.6**	
GJ-SS- 61	N 59,300; E 32,816	31.5-33.0	0.9	3.0	
GJ-SS- 62	N 59,300; E 33,000	1.5-3.0	76.9	118.9	
GJ-SS- 63	N 59,300; E 33,000	4.5-6.0	129.0	258.0**	
GJ-SS- 64	N 59,300; E 33,000	7.5-9.0	152.7	305.4**	
GJ-SS- 65	N 59,300; E 33,000	10.5-12.0	181.3	362.6**	
GJ-SS- 66	N 59,300; E 33,000	13.5-15.0	122.6	245.2**	6D
GJ-SS- 67	N 59,300; E 33,000	16.5-18.0	191.7	383.4**	
GJ-SS- 68	N 59,300; E 33,000	19.5-20.0	2.3	4.9	
GJ-SS- 69	N 59,300; E 33,000	22.5-24.0	1.6	1.2	
GJ-SS- 70	N 59,300; E 33,000	29.5-30.0	1.8	1.8	
GJ-SS-499	N 59,350; E 32,650	1.5-3.0	127.5	255.0**	
GJ-SS-500	N 59,350; E 32,650	4.5-6.0	420.9	841.8**	
GJ-SS-501	N 59,350; E 32,650	7.5-9.0	158.5	317.0**	2DE
GJ-SS-502	N 59,350; E 32,650	10.5-12.0	16.4	20.0*	
GJ-SS- 21	N 59,350; E 32,660	1.5-3.0	279.5	559.0**	
GJ-SS- 22	N 59,350; E 32,660	4.5-6.0	175.1	350.2**	
GJ-SS- 23	N 59,350; E 32,660	7.5-9.0	153.4	306.8**	
GJ-SS- 24	N 59,350; E 32,660	10.5-12.0	150.3	300.6**	
GJ-SS- 25	N 59,350; E 32,660	13.5-15.0	120.5	241.0**	2DE-B
GJ-SS- 26	N 59,350; E 32,660	16.5-18.0	66.2	109.6	
GJ-SS- 27	N 59,350; E 32,660	19.5-21.0	3.3	6.6	
GJ-SS- 28	N 59,350; E 32,660	22.5-24.0	1.4	3.6	
GJ-SS- 29	N 59,350; E 32,660	25.5-27.0	0.5	1.3	
GJ-SS- 30	N 59,350; E 32,660	29.5-30.0	2.2	1.9	
GJ-SS-342	N 59,400; E 32,550	< 0.5	16.2	32.4**	
GJ-SS-281	N 59,400; E 32,900	1.5-3.0	451.5	903.0**	
GJ-SS-282	N 59,400; E 32,900	4.5-6.0	1.9	3.8**	
GJ-SS-283	N 59,400; E 32,900	7.5-9.0	1.0	2.0**	
GJ-SS-284	N 59,400; E 32,900	13.5-15.0	1.5	3.0**	5E
GJ-SS-285	N 59,400; E 32,900	16.5-18.0	1.1	2.2**	
GJ-SS-286	N 59,400; E 32,900	18.5-19.0	1.3	1.0	
GJ-SS- 46	N 59,497; E 32,900	1.0-1.5	1.9	1.8	
GJ-SS-503	N 59,500; E 32,600	1.5-3.0	15.5	18.9*	
GJ-SS-504	N 59,500; E 32,600	4.5-6.0	5.5	6.7*	2F
GJ-SS- 11	N 59,500; E 32,625	1.5-3.0	259.0	519.0**	
GJ-SS- 12	N 59,500; E 32,625	4.5-6.0	238.3	476.6**	
GJ-SS- 13	N 59,500; E 32,625	7.5-9.0	142.2	284.4**	2F-G
GJ-SS- 14	N 59,500; E 32,625	10.5-12.0	223.0	446.0**	
GJ-SS- 15	N 59,500; E 32,625	13.5-15.0	108.5	217.0**	

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS- 16	N 59,500; E 32,625	16.5-18.0	134.7	269.4**	
GJ-SS- 17	N 59,500; E 32,625	19.5-20.0	0.7	1.4**	
GJ-SS- 18	N 59,500; E 32,625	25.5-27.0	0.7	1.2	27-B
GJ-SS- 19	N 59,500; E 32,625	22.5-24.0	0.4	0.7	
GJ-SS- 20	N 59,500; E 32,625	27.7-27.7	1.3	2.3	
GJ-SS-406	N 59,500; E 33,900	1.5-3.0	1069.2	2138.4**	
GJ-SS-407	N 59,500; E 33,900	4.5-6.0	991.8	1983.6**	
GJ-SS-408	N 59,500; E 33,900	7.5-9.0	359.3	718.6**	
GJ-SS-409	N 59,500; E 33,900	10.5-12.0	338.7	677.4**	
GJ-SS-410	N 59,500; E 33,900	13.5-15.0	442.9	885.8**	
GJ-SS-411	N 59,500; E 33,900	16.5-18.0	586.5	1173.0**	
GJ-SS-412	N 59,500; E 33,900	19.5-21.0	709.0	1418.0**	1'F
GJ-SS-413	N 59,500; E 33,900	22.5-24.0	796.0	1592.0**	
GJ-SS-414	N 59,500; E 33,900	25.5-27.0	22.3	44.6**	
GJ-SS-415	N 59,500; E 33,900	28.5-30.0	18.6	37.2**	
GJ-SS-416	N 59,500; E 33,900	31.5-33.0	2.7	5.4**	
GJ-SS-417	N 59,500; E 33,900	34.5-37.0	8.1	16.2**	
GJ-SS-418	N 59,500; E 33,900	37.0-37.25	4.2	8.9	
GJ-SS-494	N 59,500; E 35,700	1.5-3.0	27.4	54.8**	
GJ-SS-495	N 59,500; E 35,700	4.5-6.0	13.2	16.1*	
GJ-SS-496	N 59,500; E 35,700	7.5-9.0	19.9	39.8**	2'F
GJ-SS-497	N 59,502; E 35,673	14.5-16.0	24.8	49.6**	
GJ-SS-498	N 59,502; E 35,673	17.5-19.0	6.4	7.8*	
GJ-SS-431	N 59,505; E 35,673	1.5-3.0	11.0	11.7	
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	17.8*	33F-B
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**	
GJ-SS-137	N 59,600; E 32,550	< 0.5	12.5	24.0	
GJ-SS-334	N 59,600; E 32,550	< 0.5	7.6	9.2*	1FG
GJ-SS-344	N 59,600; E 32,550	< 0.5	15.3	18.6*	
GJ-SS-294	N 59,600; E 35,300	1.5-3.0	41.6	83.2**	
GJ-SS-295	N 59,600; E 35,300	4.5-6.0	13.0	15.8*	
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**	37G
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	3.5	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- 1	N 57,650; E 32,650	1.5-3.0	143.7	287.4**	
GJ-SS- 2	N 57,650; E 32,650	4.5-6.0	189.5	379.0**	
GJ-SS- 3	N 57,650; E 32,650	7.5-9.0	171.3	342.6**	
GJ-SS- 4	N 57,650; E 32,650	10.5-12.0	176.6	353.2**	
GJ-SS- 5	N 57,650; E 32,650	13.5-15.0	588.6	1177.2**	26-H
GJ-SS- 6	N 57,650; E 32,650	16.5-18.0	417.8	835.6**	
GJ-SS- 7	N 57,650; E 32,650	19.5-20.0	1.4	2.9	
GJ-SS- 8	N 57,650; E 32,650	21.5-23.0	5.0	10.3	
GJ-SS- 9	N 57,650; E 32,650	23.5-24.0	1.5	2.1	
GJ-SS- 10	N 57,650; E 32,650	25.0	10.00	10.0	

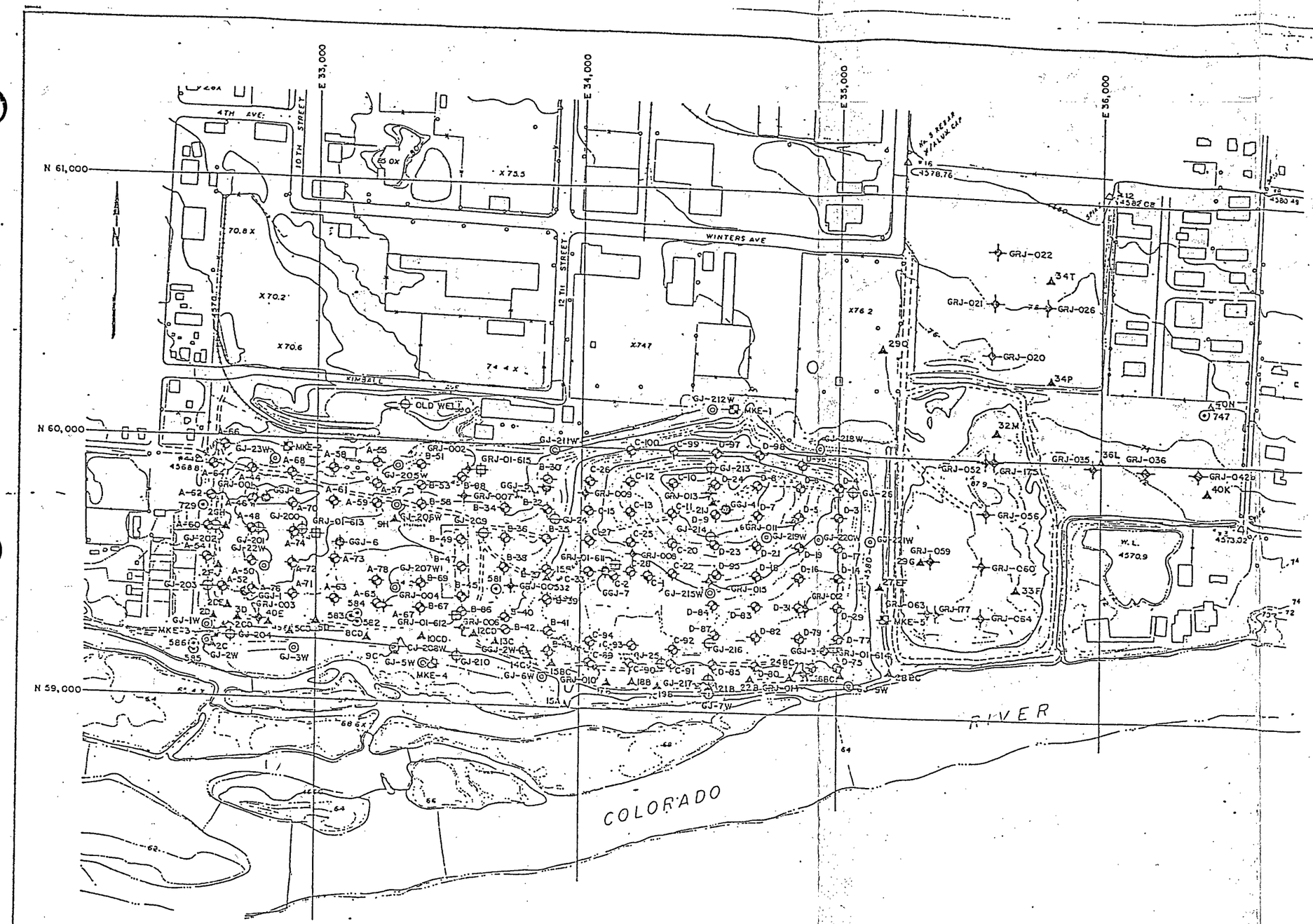
Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION		DEPTH IN FEET	Ra-226 pCi/g INITIAL	FINAL	
GJ-SS-367	N 59,700;	E 32,550	IN H2O	0.6	1.2**	
GJ-SS-100	N 59,700;	E 33,300	1.5-3.0	1077.3	2154.6**	
GJ-SS-101	N 59,700;	E 33,300	4.5-6.0	121.8	243.6**	
GJ-SS-102	N 59,700;	E 33,300	7.5-9.0	95.8	123.0	
GJ-SS-103	N 59,700;	E 33,300	10.5-12.0	141.6	283.2**	9H
GJ-SS-104	N 59,700;	E 33,300	13.5-15.0	539.0	1078.0**	
GJ-SS-105	N 59,700;	E 33,300	16.5-18.0	8.0	21.4	
GJ-SS-106	N 59,700;	E 33,300	19.5-21.0	2.9	3.2	
GJ-SS-107	N 59,700;	E 33,300	21.0-22.5	4.8	5.0	
GJ-SS-108	N 59,700;	E 33,300	22.5-22.7	1.0	2.0**	
GJ-SS-362	N 59,800;	E 32,550	< 0.5	28.1	56.2**	
GJ-SS-374	N 59,800;	E 32,550	< 0.5	15.7	19.2*	
GJ-SS-138	N 59,800;	E 34,500	1.5-3.0	246.7	493.4**	
GJ-SS-139	N 59,800;	E 34,500	4.5-6.0	279.6	559.2**	
GJ-SS-140	N 59,800;	E 34,500	7.5-9.0	232.4	464.8**	
GJ-SS-141	N 59,800;	E 34,500	10.5-12.0	251.7	503.4**	
GJ-SS-142	N 59,800;	E 34,500	13.5-15.0	214.7	429.4**	
GJ-SS-143	N 59,800;	E 34,500	16.5-18.0	192.8	385.6**	
GJ-SS-144	N 59,800;	E 34,500	19.5-21.0	289.5	579.0**	
GJ-SS-145	N 59,800;	E 34,500	22.5-24.0	248.3	496.6**	
GJ-SS-146	N 59,800;	E 34,500	25.5-27.0	237.3	474.6**	21J
GJ-SS-147	N 59,800;	E 34,500	28.5-30.0	272.5	545.0**	
GJ-SS-148	N 59,800;	E 34,500	31.5-33.0	207.0	414.0**	
GJ-SS-149	N 59,800;	E 34,500	34.5-36.0	268.9	537.8**	
GJ-SS-150	N 59,800;	E 34,500	37.5-39.0	199.7	399.4**	
GJ-SS-151	N 59,800;	E 34,500	44.5-46.0	1596.9	3193.8**	
GJ-SS-152	N 59,800;	E 34,500	49.5-51.0	2.0	4.0**	
GJ-SS-153	N 59,800;	E 34,500	54.5-56.0	1.3	2.6	
GJ-SS-154	N 59,800;	E 34,500	57.5-57.8	3.4	5.1	
GJ-SS-439	N 59,800;	E 34,500	COMP.	234.6	469.2**	
GJ-SS-451	N 59,900;	E 36,400	< 0.5	3.6	7.2**	
GJ-SS-471	N 59,900;	E 36,400	1.5-3.0	6.1	12.2**	
GJ-SS-472	N 59,900;	E 36,400	4.5-6.0	2.1	0.8	4.0K
GJ-SS-473	N 59,900;	E 36,400	7.5-9.0	1.3	1.0	
GJ-SS-474	N 59,900;	E 36,400	12.5-15.0	1.8	3.6**	
GJ-SS-453	N 60,000;	E 36,000	< 0.5	5.9	11.8**	
GJ-SS-475	N 60,000;	E 36,000	1.5-3.0	2.2	4.4**	
GJ-SS-476	N 60,000;	E 36,000	4.5-6.0	0.9	1.8**	5.2L
GJ-SS-477	N 60,000;	E 36,000	7.5-9.0	1.2	2.4**	
GJ-SS-478	N 60,000;	E 36,000	10.5-12.0	2.3	4.6**	
GJ-SS-455	N 60,100;	E 35,600	< 0.5	5.5	11.0**	
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	99.7	199.4**	32M
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-452	N 60,200;	E 36,400	< 0.5	1.1	2.2**	
GJ-SS-465	N 60,200;	E 36,400	1.5-3.0	0.8	1.6**	6.1
GJ-SS-466	N 60,200;	E 36,400	4.5-6.0	0.5	1.0	

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-467	N 60,200; E 36,400	7.5-9.0	1.3	0.7	
GJ-SS-468	N 60,200; E 36,400	10.5-12.0	0.6	1.2**	40N
GJ-SS-469	N 60,200; E 36,400	13.5-15.0	0.3	0.6**	
GJ-SS-470	N 60,200; E 36,400	16.5-17.0	2.5	5.0**	
GJ-SS-446	N 60,300; E 35,800	1.5-3.0	3.1	6.2**	
GJ-SS-447	N 60,300; E 35,800	4.5-6.0	1.3	2.6**	34P
GJ-SS-448	N 60,300; E 35,800	8.5-10.0	0.9	1.8**	
GJ-SS-449	N 60,300; E 35,800	10.5-12.0	Sample Weight to Low for Anal		
GJ-SS-450	N 60,300; E 35,800	13.5-15.0	0.9	1.8**	
GJ-SS-349	N 60,400; E 35,300	1.5-3.0	4.5	9.0**	
GJ-SS-350	N 60,400; E 35,300	4.5-6.0	2.1	4.2**	
GJ-SS-351	N 60,400; E 35,300	7.5-9.0	2.8	4.5	39Q
GJ-SS-352	N 60,400; E 35,300	10.5-12.0	1.1	2.2**	
GJ-SS-353	N 60,400; E 35,300	13.5-15.0	Sample Weight to Low for Anal		
GJ-SS-440	N 60,700; E 35,800	1.5-3.0	2.3	4.6**	
GJ-SS-441	N 60,700; E 35,800	4.5-6.0	1.5	3.0**	
GJ-SS-442	N 60,700; E 35,800	7.5-9.0	0.8	1.6**	
GJ-SS-443	N 60,700; E 35,800	10.5-12.0	0.4	0.8**	34T
GJ-SS-444	N 60,700; E 35,800	13.5-15.0	1.4	2.8**	
GJ-SS-445	N 60,700; E 35,800	16.5-18.0	2.4	4.8**	
GJ-SS-385	N unknown; E 33,100	IN H2O	0.9	1.8**	
GJ-SS-384	N unknown; E 33,200	IN H2O	0.7	1.4**	
GJ-SS-391	N unknown; E 33,400	IN H2O	0.6	1.2**	
GJ-SS-393	N unknown; E 33,600	IN H2O	1.4	2.8**	
GJ-SS-394	N unknown; E 34,200	IN H2O	0.7	1.4**	
GJ-SS-395	N unknown; E 34,400	IN H2O	1.3	2.6**	
GJ-SS-392	N unknown; E 35,000	IN H2O	0.7	1.4**	
GJ-SS-390	N unknown; E 35,300	IN H2O	1.3	2.6**	

SHT 33
50



NOTES:

1. GROUNDWATER DATA AND SUBSURFACE EXPLORATION LOGS ARE AVAILABLE FROM THE CONTRACTOR.
2. JACOBS MONITOR WELLS NUMBERED 581 THROUGH 586 CORRESPON 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:

4580	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)

200 0 200 400
SCALE FEET

FINAL REVIEW

E & D MANAGER	CHIEF ENGINEER	QA MANAGER

NO	DATE	REVISIONS	BY	CK	END MGR	CHIEF ENG	PRC REV	DOE APP
		ISSUED FOR FINAL REVIEW						

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED / DRAWN RBC
CHECKED
REVIEWED
RECOMMENDED
APPROVED DATE DOE PROJECT ENGINEER DATE

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

BORINGS AND TEST PITS LOCATION PLAN

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

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. GRJ-PS-10-0217 REV.

REV 1

3A

CONTAMINATION PLOTTED FROM CNSI DATA.

NOTES:

1. SEE NOTES ON DWG NO. GRJ-PS-10-0211.

REFERENCE DRAWINGS:

GRJ-PS-10-0211 CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 1 OF 2)

LEGEND:

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

LIMIT OF EXCAVATION @ EXIST EL. 4570

EL. 4568

SCALE 100 0 100 200 FEET

SLB 8/21/87

WYL 1/14/88

PRELIMINARY REVIEW

E & D MANAGER	CHIEF ENGINEER	QA MANAGER

NO.	DATE	REVISIONS	BY	CK	ENG MGR	CHIEF ENG	FAC REP	QAE REP
3	7/15/87	ISSUED FOR PRELIMINARY REVIEW	—	—	—	—		
2								
1								
0								

U.S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED / DRAWN JMM/ECG

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

CONTAMINATED MATERIAL EXCAVATION PLAN SHEET 2 OF 2

APPROVED / DATE / DOE PROJECT ENGINEER / DATE

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

SUBJECT NO DE-AC04-83AL18796

DRAWING NO GRJ-PS-10-0212 REV 0

I. PURPOSE

The purpose of this calculation is to determine the limits and quantities of off-pile contaminated materials (off-pile tailings). The results will be used to prepare construction plans and specifications for off-pile excavation and for off-pile tailings quantity estimates.

Off-pile refers to all areas within the designated boundary excepting the main tailings pile and vicinity properties

II. ANALYSES AND CRITERIA

A. The Bendix report (Ref 1, Addendum D1) will be used to define locations of existing contamination. This report is the most recent and reflects existing conditions the best due to cleanup activities that occurred in the 1970's and 1980's

B. The Bendix report indicated that there was no significant disequilibrium problem between Th-230 and Ra-226. Ra-226 will be excavated according to the following criteria

(1) Areas restored without backfill or with clean backfill less than 6 inches in thickness, excavated to where 5 pCi/g and 15 pCi/g Ra-226 concentration limits for 6-inch-thick surface and subsurface layers, respectively.

(2) Areas restored with clean backfill more than 6 inches in thickness, excavated to where 15 pCi/g Ra-226 concentration limit for subsurface layers.

C. Areas of contamination exceeding criteria will be excavated and excavation quantities will be minimized as much as practicable to help minimize the disposal embankment size

D. Final excavation depths will be based on plans and excavation control during construction to verify that Ra-226 have been adequately removed to meet standards.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRT
Feature Tailings Excavation
Item Off-pile Excavation Limits and Quantities

Contract No. 5028
Designed WYL
Checked SWB

Sheet 2
File No.
Date
Date 9/10/86

III QUANTITY SUMMARY

Location	Excav Area (ft²)	Excav. Volume cy	Ave Excav. Depth (ft)	Ave Ra-226 (pCi/g)	Ave. Exist Moist (%)
Ore Storage Area	318.600	20,286 NIC	1.7	207.5 ± 9.8	13.43
Mill yard (Between Kimball Ave and Railroad Tracks)	354,125	30,768	2.4	531.7 ± 23.3	11.65
West and South Area	134,000	12,315	2.5	240.0 ± 12.4	15.60
Pond # 1	517,625	9,582	0.5	7.2 ± 1.1	11.62
Pond # 2	181,900	11,215	1.8	25.4 ± 2.0	17.39
Pond # 3	616,350	313,300	20.0	8.2 ± 1.1	—

SUPERSEDED
WKB 1-15-88
WYL 1/15/88

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 MDL
Checked SLS

Sheet 3
File No.
Date 8/4/86
Date -

Quantities Calculation

SLS 4-19-88
WYL 4-19-88
REV 2

LOCATION	AREA (ft²)	DEPTH (ft)	VOLUME (ft³)	
Ore Storage Area				
A	~~11,500~~ 13,000	0.5	~~5750~~ 6500	
B	18,000	1.5	27,000	
Y	18,000	0.0	0	
C	35,000	1.5	~~52,500~~	
D	13,750	7.5	103,125	
E	19,700	4.0	78,800	
F	31,250	2.0	62,500	
Z	86,750	0.0	0	
G	31,250	3.0	93,750	SLS 3/23/86
H	90,450	1.0	90,450	MDL 9/23/86 207
I	66,200	0.5	33,100	~~20,258~~ yd³
				(NIC) SLS 8/31/87
Mill Yard (between Kimball Ave and railroad track)				
J	45,900	2.0	91,800	
K	12,500	9.0	112,500	
L	30,000	4.0	120,000	
M	12,600	7.0	88,200	
N	37,500	2.0	75,000	SLS 9/23/86
O	~~173,600~~ 17	1.5	~~260,400~~	MDL 9/23/86
S	39,625	2.0	79,250	~~30,635~~ yd³
West + South Area				
P	21,000	2.5	52,500	
Q	54,000	3.0	162,000	
R	46,000	2.0	92,000	
X	13,000	2.0	26,000	12,315 yd³
				(REVISED) SLS 8/31/87

INCLUDED IN REVISION 1
REVISED BY CNSI DATA
SLS 4-19-88
WYL 4-19-88

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRS
Feature Tailings Excavation
Item Off-Pile Excavation Limits and Quantities

Contract No. 5025
Designed MDL
Checked

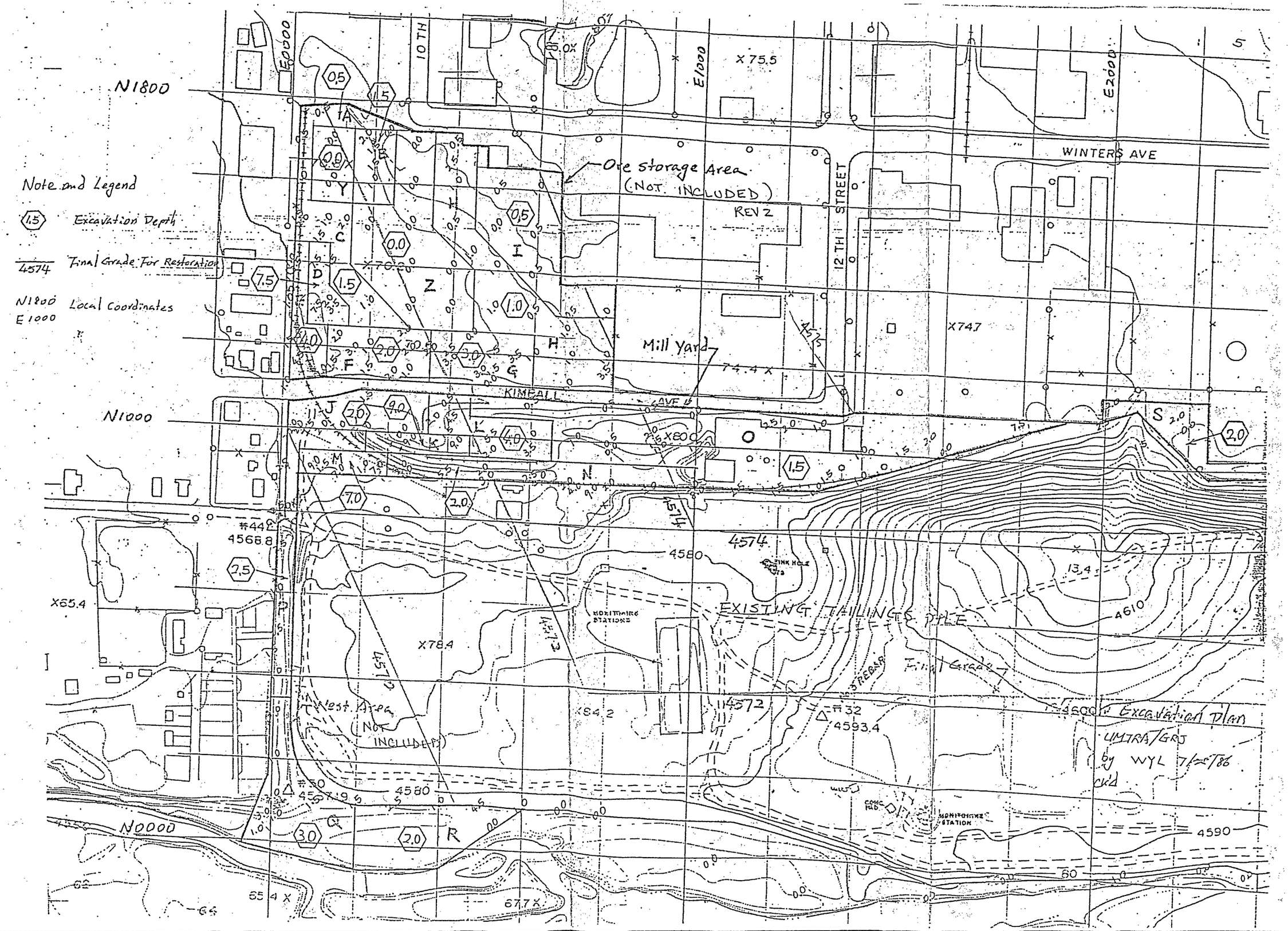
Sheet 4
File No.
Date 8/4/86
Date

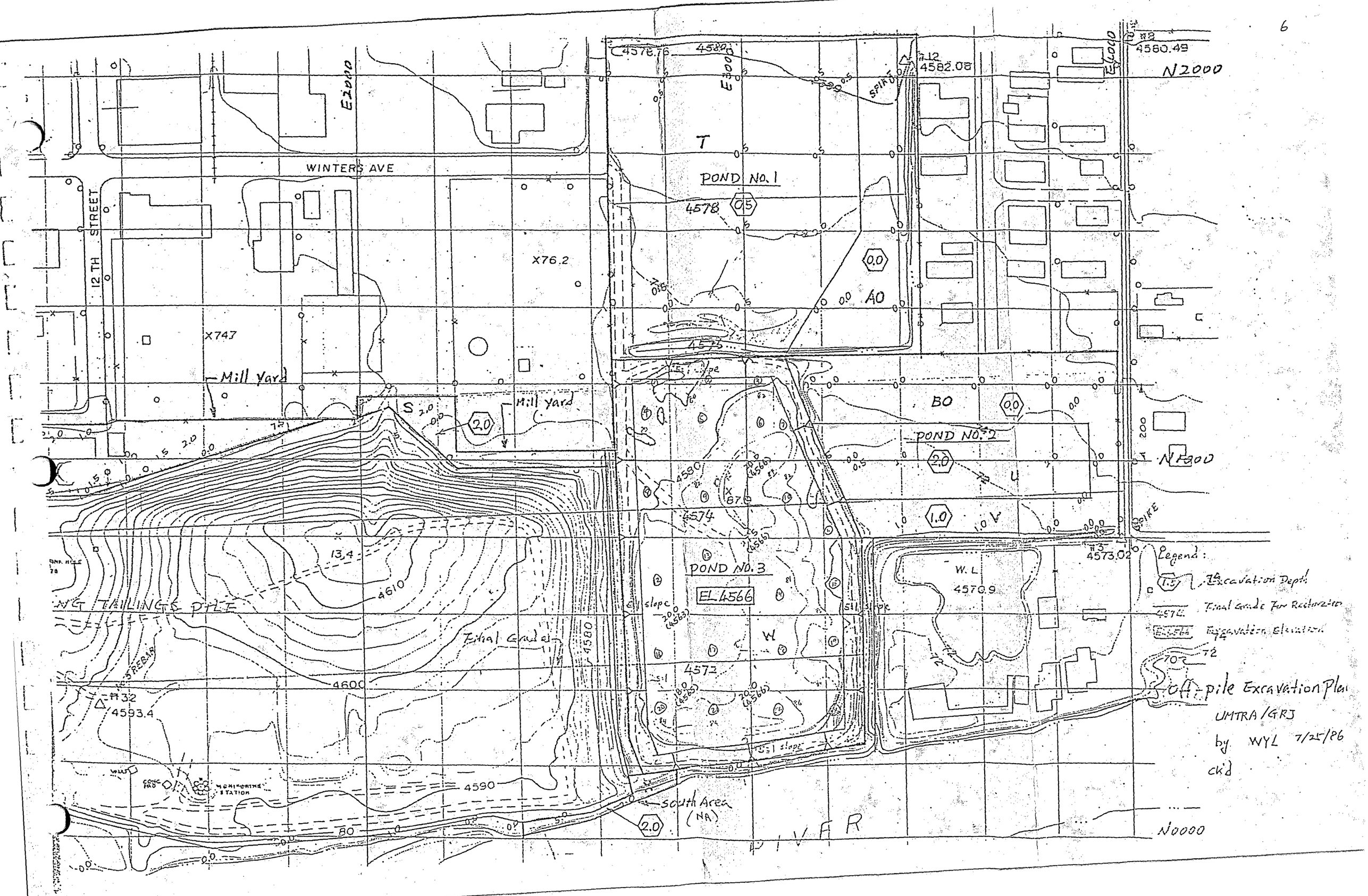
LOCATION	AREA (ft^2)	DEPTH (ft)	VOLUME (ft^3)	
Pond #1				
T	517,425	0.6	258,713	9582 yd^3
AO	157,750	0.0	0	
Pond #2				
BO	193,700	0.0	0	
U	138,000	2.0	276,000	
V	43,000	1.0	43,000	11,815 yd^3
Pond #3				
W	614,350	Varies	8,459,125	313,300 yd^3

~~397,906~~ yd^3

SKB 9/23/86

MDL 9/23/86


Note and Legend
1.5 Excavation Depth
4574 Final Grade For Restoration
N1800 E1000 Local Coordinates
N1800
N1000
N0000
E0000
E1000
E2000
10TH
12TH STREET
WINTERS AVE
KIMBALL AVE
Ore storage Area
(NOT INCLUDED)
REV 2
Mill Yard
EXISTING TAILINGS PILE
Final Grade
West Area
(NOT INCLUDED)
MONITORING STATIONS
SINK HOLE
STREAM
Excavation Plan
ULTRA/GRD
by WYL 7/22/86
ckd


WINTERS AVE
12 TH STREET
E2000
E3000
E4000
N2000
N1000
N0000
T
POND No. 1
4578
0.5
0.0
A0
X76.2
X747
Mill Yard
S
2.0
BO
POND NO. 2
U
1.0
V
4590
4574
POND NO. 3
EL 4566
W
4572
W. L
4570.9
4573.02
4582.08
4580.49
4578.76
13.4
4610
4600
4580
4590
4593.4
Final Grade
NG TAILINGS PILE
SPILLWAY
SPIKE
South Area
(NA)
RIVER
Legend:
Excavation Depth
Final Grade for Restoration
Excavation Elevation
Soil pile Excavation Plan
UMTRA/GRJ
by WYL 7/25/86
ck'd

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRI
Feature Tailings Excavation
Item off-pile Excavation Limits and Quantities

Contract No. 5025
Designed WYL
Checked [illegible]

Sheet 7
File No.
Date 7/24/86
Date

SLW 4-19-88
WYL 4-19-88

Area A (Ore storage Area) (NOT INCLUDED - SEE REV 2)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCG or MDJ No.	Ra-226[1] (pCi/g)	Concentration eRa-226[2] (pCi/g)	Concentration Th-230[1] (pCi/g)	Moisture (%)	Proposed Excav. Depth (ft)
1770	76	0- 6		4	15 ± 1				0.5
1731	233	0- 6		5	4 ± 1				0
1709	184	0- 6		411	338 ± 16	58.9 ± 23.8			2.0
		6- 12		412	43 ± 3	11.9 ± 5.9		14.99	
		12- 18		413	31 ± 2	6.6 ± 3.9			
1700	30	0- 6	70	677	39 ± 2			10.62	0.5
		0- 6		32	3 ± 1				
1700	100	0- 6	71	31	5 ± 1			17.34	0
1700	300	0- 6	73	34	4 ± 1				0
1700	400	0- 6	74	35	20 ± 1			12.24	0.5
1680	200	0- 6	72	33	179 ± 8				1.5
		0- 6		• 1	186 ± 8				
1652	297	0- 6		446	205 ± 13	97.4 ± 39			2.5
		6- 12		447	154 ± 7	22.1 ± 10.9		10.73	
		12- 18		448	111 ± 5	12.5 ± 7			
1637	205	0- 6		• 15	623 ± 29				1.5
		0- 6		414	666 ± 31	18.6 ± 8.6			
		6- 12		415	58 ± 3	6.2 ± 4.3		14.78	
1600	30	0- 6	75	81	55 ± 3				1.0
1600	100	0- 6	76	82	10 ± 1				0
1600	200	0- 6	77	40	22 ± 1				1.0
1600	300	0- 6	78	39	9 ± 1				0
1600	400	0- 6	79	38	21 ± 1				1.0
1600	500	0- 6	80	37	15 ± 1				0.5
1600	600	0- 6	81	36	20 ± 1				1.0
1507	279	0- 6		6	3 ± 1				0
1503	140	0- 6		416	374 ± 20	148.3 ± 58.9			2.0
		6- 12		417	349 ± 17	33.5 ± 18.2			
		12- 18		418	79 ± 4	2.1 ± 3.6			
1500	30	0- 6	82	80	155 ± 7				1.5
1500	100	0- 6		• 5	65 ± 3				1.0
		0- 6	83	83	60 ± 3				
1500	200	0- 6	84	88	12 ± 1				0
1500	300	0- 6	85	41	2 ± 1				0
1500	400	0- 6	86	42	16 ± 1			20.52	0.5
1500	500	0- 6	87	43	2 ± 1				0
1500	599	0- 6	88	44	15 ± 1				0.5
		0- 6		• 2	15 ± 1				
			38	Subtotal	3982 ± 203		7 Subtotal	101.22	

Notes: (1) Indicates gamma-ray-spectroscopic analytical data for soil samples collected

(2) Indicates results of the in-situ delta-gamma radium measurements

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature Tailings Excavation
Item off-pile Excavation Limits and Quantities

Contract No. 5024
Designed WYL
Checked

Sheet 8
File No.
Date 7/24/86
Date

Area A (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. Depth (ft)
1494	34	0- 6		• 10	442 ± 22				2.0
		0- 6		118	460 ± 19	25.3 ± 11			
		6- 12		119	70 ± 3	15.4 ± 7.2			
		12- 18		120	43 ± 2	7.7 ± 4.2			
1467	77	0- 6		3	158 ± 8				1.5
1455	464	0- 6		10	17 ± 1				1.0
1400	25	0- 60	89	678	5 ± 1			16.70	1.0
		0- 6	89	79	23 ± 1				
1400	100	0- 6	90	84	141 ± 6			17.79	1.5
1400	200	0- 6	91	87	8 ± 1				0
1400	300	0- 6	92	89	5 ± 1				0
1400	400	0- 6	93	90	3 ± 1				0
1400	500	0- 6	94	91	37 ± 2				1.0
1400	600	0- 6	95	92	7 ± 1			12.24	0.5
1397	120	0- 6		419	766 ± 33	18.8 ± 8.6			7.5
		6- 12		420	166 ± 7	7.6 ± 4.3		18.94	
		12- 18		421	1315 ± 59	10.5 ± 5.1			
1387	42	0- 6		121	209 ± 10	364.1 ± 142.7			3.5
		6- 12		122	268 ± 12	363.3 ± 162.4			
		12- 18		123	262 ± 14	211.5 ± 83.0			
1300	20	0- 6	96	78	35 ± 2				1.0
1300	60	0- 6		• 27	132 ± 7				1.5
		0- 6	105	676	122 ± 8			5.93	
1300	71	0- 6		136	958 ± 53	1679.8 ± 661.6			7.5
		6- 12		137	1758 ± 72	1746.8 ± 688.0		18.76	
		12- 18		138	1774 ± 63	2006.1 ± 790.3			
1300	100	0- 6	97	85	204 ± 15				2.0
1300	200	0- 6	98	86	74 ± 4				1.0
1300	300	0- 6	99	67	3 ± 1				0
1300	400	0- 6	100	66	6 ± 1				0
1300	500	0- 6	101	65	20 ± 1			15.99	1.0
1300	600	0- 6	102	64	8 ± 1				0.5
		0- 60		679	11.4 ± 1			8.33	
1300	700	0- 6	103	63	12 ± 1				0.5
1300	780	0- 6		• 3	43 ± 3				1.0
		0- 6	104	62	39 ± 3				
			32	subtotal	9604.4 ± 440		& subtotal	114.68	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature Tailings Excavation
Item Off-pile Excavation Limits and Quantities

Contract No. 5024
Designed WYL
Checked

Sheet 9
File No.
Date 7/25/86
Date

Area A (cont'd)

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)
1291	107	0- 6		408	375 ± 23	537.8 ± 212.1			3.5
		6- 12		410	448 ± 22	420.8 ± 166.2			
		12- 18		440	253 ± 11	371.3 ± 146.8			
1266	658	0- 6		11	17 ± 1				1.0
1246	290	0- 6		133	208 ± 8	112.0 ± 44.8			2.0
		6- 12		134	219 ± 9	43.4 ± 18.4		11.4	
		12- 18		135	56 ± 3	28.1 ± 12.6			
1240	441	0- 6		9	5 ± 1				0
1224	133	0- 6		405	326 ± 14	402.6 ± 158.9			2.0
		0- 6		• 7	334 ± 14				
		6- 12		406	455 ± 19	108.3 ± 43.7			
		12- 18		407	84 ± 4	11.3 ± 7.9			
1200	20	0- 6		• 6	108 ± 5				1.5
		0- 6	106	77	102 ± 5				
1200	105	0- 6	107	54	96 ± 6				1.0
1200	200	0- 6	108	55	80 ± 4				1.0
1200	300	0- 6	109	56	196 ± 9				2.0
1200	352	0- 6		127	80 ± 4	482.9 ± 191.5			2.0
		6- 12		128	490 ± 22	625.0 ± 26.9		10.10	
		12- 18		129	30 ± 2		WYL 9/2/86		
		12- 18		• 11	32 ± 2	10.4 ± 9.2			
1200	400	0- 6	110	57	270 ± 11			15.79	2.5
1200	500	0- 6	111	58	134 ± 6				1.5
1200	600	0- 6	112	59	20 ± 1			11.17	1.0
1200	700	0- 6	113	60	38 ± 2				1.0
1200	780	0- 6	114	61	56 ± 3			10.14	1.0
		0- 60		680	34.1 ± 1.8			9.98	
1198	176	0- 6		437	185 ± 10	584.2 ± 230.4			3.0
		6- 12		438	768 ± 45	132.0 ± 53.4			
		12- 18		439	205 ± 9	21.7 ± 12.3			
1197	560	0- 6		• 20	107 ± 4				3.5
		0- 6		441	97 ± 7	641.1 ± 174.0			
		6- 12		442	268 ± 12	425.9 ± 168.1			
		12- 18		443	277 ± 15	438.7 ± 173.2			
1180	400	0- 6		449	320 ± 12	187.8 ± 74.5			3.0
		6- 12		450	113 ± 4	173.4 ± 68.9			
		12- 18		126	175 ± 8	82.3 ± 33.4			
1166	44	0- 6		139	280 ± 13	379.0 ± 149.6			4.5
		6- 12		140	271 ± 15	494.9 ± 145.3			
		12- 18		141	369 ± 20	393.4 ± 155.4			
		12- 18		141	369 ± 20				
1161	785	0- 6		304	1651 ± 68	830.2 ± 328.2			3.5
		6- 12		305	1098 ± 42	114.0 ± 45.2		12.65	
		12- 18		306	226 ± 12	72.6 ± 29.0			
				44 Subtotal	11,325.1 ± 528.8		7 Subtotal	82.23	

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

Sheet 10
File No.
Date 7/25/86
Date

Area A (cont'd)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration Ra-226 (pCi/g)	Concentration eR_a-226 (pCi/g)	Concentration Th-230 (pCi/g)	Moisture (%)	Proposed Excav. Depth (ft)
1155	500	0- 6		444	223 ± 11	37.1 ± 12.2			1.5
		6- 12		445	47 ± 2	6.0 ± 4.9		12.26	
1153	115	0- 6		1	149 ± 9				1.5
1149	273	0- 6		8	316 ± 13				3.0
1145	2020	0- 6		287	241 ± 15	272.7 ± 107			2.0
		6- 12		288	262 ± 13	36.4 ± 14.8			
		12- 18		289	64 ± 3	36.4 ± 14.9			
1143	203	0- 6		100	113 ± 5	129.7 ± 51.5			1.5
		6- 12		435	221 ± 10	11.9 ± 7.1			
		12- 18		436	13 ± 1	9.4 ± 5.9			
1140	300	0- 6	117	53	63 ± 3				1.0
1135	100	0- 6	116	76	70 ± 3			11.93	1.0
1133	500	0- 6	118	52	5 ± 1				0
1132	265	0- 6		130	535 ± 23	178.6 ± 71.3			2.0
		6- 12		131	223 ± 9	20.4 ± 12.5			
		12- 18		132	29 ± 2	11.9 ± 8.5			
1130	700	0- 6	119	51	64 ± 4				1.0
1118	2173	0- 6		290	201 ± 8	28.3 ± 11.7			2.0
		6- 12		291	33 ± 2	7.9 ± 4.4			
		12- 18		292	19 ± 1	12.1 ± 5.5			
			20	Subtotal	2891 ± 138		2	Subtotal 24.19	

Ave Ra-226 Concentration for Area A = 207.5 ± 9.8

Ave Existing Moisture Content for Area A = 13.63 %

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRT
Feature Tailings Excavation
Item Off-pile Excavation Limits and Quantities

Contract No. 1024
Designed WYL
Checked

Sheet 11
File No.
Date 7/24/86
Date

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.	Ra-226 (pCi/g)	eRa_{-226} (pCi/g)	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	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	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	294.3 ± 116.4			
		12- 18		180	417 ± 17	72.6 ± 29.2			
1025	900	0- 6		145	270 ± 11				2.0
		0- 6		145	270 ± 11	98.6 ± 39.3			
		6- 12		146	84 ± 4	188.4 ± 73.5	WYL 9/12/86	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	649.7 ± 248.4		19.79	2.0
		6- 12		165	830 ± 34	63.1 ± 25.5			
		12- 18		166	56 ± 3	24.3 ± 10.6			
				39 Subtotal	13,226 ± 630		4 Subtotal	53.47	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ — Contract No. 5025 — Sheet 12
Feature Tailings Excavation — Designed WYL — File No.
Item Off-pile Excavation Limits and Quantities — Checked — Date 7/24/86

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. Depth (ft)
1000	10	0- 6	131	45	24 ± 2				1.0
1000	76	0- 6		142	84 ± 4				7.5
		0- 6		142	84 ± 4	2033.0 ± 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			11.85	2.0
1000	149	0- 6		161	832 ± 34	72.9 ± 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	2 ± 1				0
1000	400	0- 6	134	71	94 ± 4				
	500	0- 6	135	72	19 ± 1			7.39	5.5
		0- 60		681	66.6 ± 2.1			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	3582.8 ± 1044.2			9.0
		6- 12		188	7589 ± 315	435.9 ± 369.3			
		12- 18		189	1634 ± 67	88.3 ± 36.8			
		12- 18		17	1648 ± 61				
990	800	0- 6	138	683	5 ± 1			5.69	0
985	35	0- 6		207	1787 ± 85	433.7 ± 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		13.88	
		12- 18		183	1104 ± 45	773.9 ± 302.1			
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	33.0 ± 15.0			
				37 Subtotal	30,712.6 ± 1264.1		13 Subtotal	134.92	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ — Contract No. 5025 — Sheet 13
Feature Tailings Excavation — Designed WYL — File No.
Item Off-pile Excavation Limits and Quantities — Checked — Date 7/25/86

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. Depth (ft)
960	500	0- 6		184	231 ± 10	38.7 ± 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 ± 689.0			7.5
		6- 12		202	994 ± 42	849.8 ± 254.3		17.55	
		12- 18		203	783 ± 33	155.0 ± 63.6			
940	1327	0- 6		307	330 ± 19	15.64 ± 7.1			1.5
		6- 12		308	18 ± 1	7.4 ± 5.2		12.62	
935	1400	0- 6	155	243	60 ± 2				1.0
913	485	0- 6		158	223 ± 12	102.8 ± 66.5			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	1305.5 ± 614.3			7.0
		6- 12		170	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			14.69	
904	600	0- 6	147	402	248 ± 12				2.5
904	625	0- 6		154	872 ± 32	30.7 ± 13.0		10.07	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	721.9 ± 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	1338.3 ± 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- 8		322	1217 ± 50	73.6 ± 30.2			
900	1200	0- 6	153	428	122 ± 6			9.46	1.5
900	1300	0- 6	154	427	39 ± 2				1.0
				41	Subtotal 16,332.5 ± 767.2		9	Subtotal 114.42	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

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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. Depth (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	1226.0 ± 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	8253 ± 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 %

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature Tailings Excavation
Item Off-Pile Excavation Limits and Quantities

Contract No. 5024
Designed WYL
Checked [illegible]

Sheet 15
File No.
Date 7/25/86
Date

SUE 4-19-8[illegible]

Area C (South and West Area) (REVISED BY CNSI DATA) REV 2

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)
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	282.4 ± 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	282.7 ± 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	1255.3 ± 499.7			
		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	2698.6 ± 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	2 ± 1	20.7 ± 8.6			0
		6- 12		278	2 ± 1	77.2 ± 30.5			
		12- 18		279	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 ± 15.3			
94	600	0- 6	166	109	20 ± 1			4.42	1.0
94	800	0- 6		297	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		25.64	
		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 I.

Sheet 16
File No.
Date 7/25/86
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Area C (cont'd)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCG or MDJ No.	Concentration Ra-226 (pCi/g)	Concentration eR_a-226 (pCi/g)	Concentration Th-230 (pCi/g)	Moisture (%)	Proposed Excav. Depth (ft)
55	534	0- 6		27	2 ± 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	833.8 ± 318.8			
		28- 41		330	64 ± 6				
		41- 45		331	139 ± 12				
36	2388	0- 6		293	2 ± 1	1.7 ± 2.4			0
		0- 6		• 23	2 ± 1				
34	2275	0- 6		294	4 ± 1	1.3 ± 2.4			0
13	-31	0- 6	173	688	22 ± 2			6.31	1.0
-90	1281	0- 6		246	2 ± 1	2.8 ± 2.6			0
-80	1600	0- 6		• 19	2 ± 1				0
		0- 6		245	2 ± 1	2.2 ± 2.5			
-24	1800	0- 6		• 24	3 ± 1				0
		0- 6		298	3 ± 1	3.0 ± 2.7			
-14	1064	0- 6		247	2 ± 1	1.6 ± 2.8			0
-5	2000	0- 6		248	? 2 ± 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%

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

Sheet 17
File No.
Date 7/24/86
Date

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	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		2		
1800	3200	0- 6	25	238	5 ± 1				0.5
1800	3400	0- 6	30	221	2 ± 1			14.12	0
1600	3000	0- 6	21	225	7 ± 1				0.5
		0- 24	21	358	2.4 ± 1		2		
		24- 48	21	359	1.9 ± 1		2		
		48- 72	21	360	1.4 ± 1		1		
1600	3200	0- 6	26	237	8 ± 1				2.0
		0- 24	26	351	17.2 ± 1		5		
1600	3400	0- 6	29	220	3 ± 1				0
1445	2785	0- 6		12	6 ± 1		5		0.5
1415	3252	0- 6		19	[illegible] ± 1				0
1400	2640	0- 6		242	24 ± 2				1.0
1400	2639	0- 6		207				8.25	—
1400	2800	0- 6	19	277	4 ± 1				0
1400	3000	0- 6	20	276	5 ± 1				0.5
		0- 24	20	254	4.8 ± 1		3		
1400	3200	0- 6	27	236	4 ± 1				0
1400	3400	0- 6	28	219	3 ± 1				0
				Ave.	7.3 ± 1.1		Ave	11.62	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature Tailings Excavation
Item Off-pile Excavation Limits and Quantities

Contract No. 4024
Designed WYL
Checked N.

Sheet 18
File No.
Date 7/21/86
Date

Pond No. 2

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCS or MDJ No.	Ra-226 (pCi/g)	eRa-226 (pCi/g)	Th-230 (pCi/g)	Moisture (%)	Proposed Excav. Depth (ft)
					concentration				
1200	3230	0- 6	32	213	11 ± 1				0
1200	3400	0- 6	33	212	2 ± 1			17.76	0
1200	3600	0- 6	45	200	4 ± 1				0
1200	3800	0- 6	44	199	3 ± 1				0
1200	3925	0- 6	43	198	3 ± 1				0
1133	3852	0- 6		16	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		8		
		12- 24	35	467	18.9 ± 2		4		
1000	3600	0- 6	36	217	53 ± 2				1.5
		0- 12	36	470	132.2 ± 11.8		28		
		12- 24	36	471	5.3 ± 1		2		
1000	3800	0- 6	42	218	17 ± 1			17.42	2.0
		0- 24	42	400	21.4 ± 1.4		5		
		30- 54	42	451	9.7 ± 1		2		
		54- 78	42	452	1.5 ± 1		2		
1000	3925	0- 6	41	235	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	4 ± 1				0
825	3904	0- 6	40	689	3 ± 1			14.35	0
825	3925	0- 6		234	6 ± 1				0
					Ave. 25.4 ± 2		Ave. 17.39		

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA/GRJ
Feature: Tailings Excavation
Item: off-pile Excavation Limits and Quantities

Contract No. 5024
Designed: WYL
Checked: N.

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File No.
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Pond NO 3

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MCB 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		7		20.0
		180-204	175	454	6.4 ± 1		5		
		204-228	175	455	37.5 ± 1.8		52		
800	3010	180-204	56	456	28.3 ± 1.6		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		20.0
		264-282	64	462	3.3 ± 1		2		
		288-294	64	463	5.2 ± 1		2		
400	2820	216-240	177	464	5.6 ± 1		2		18.0
		240-264	177	465	2.9 ± 1		1		
183	2957	0 - 6		30	1 ± 1				0

Ave. 8.2 ± 1.1

CNSI DATA
REV 1

SWS 1-15-88

SHT 20

Grand Junction Site Characterization Borehole Log Data

Boreholes drilled by Rig

Borehole #	Location (CORRECTED)		Contamination Depth in Feet	EL.	EL.	*Max Activity Ra-226 pCi/g	Depth (in feet)
2C	N 59200,	E 32500	4545.8	0-7.5	4558.3	224	1.5-3.0
2D	N 59300,	E 32600	4569.3	0-10.5	4558.8	4418	4.5-6.0
2DE-B	N 59350,	E 32660	4582.9	0-19.5	4563.4	552	1.5-3.0
2F-B	N 59500,	E 32625	4580.0	0-19.5	4560.5	518	1.5-3.0
2GH	N 59650,	E 32650	4580.8	0-19.5	4561.3	1180	13.5-15.0
2.5CD	N 59250,	E 32650	4570.0	0-10.5	4559.5	3536	1.5-3.0
3D	N 59300,	E 32700	4583.1	0-19.5	4563.6	322	4.5-6.0
4D-B	N 59300,	E 32816	4584.8	0-19.5	4565.3	2750	16.5-18.0
5CD	N 59250,	E 32900	45[illegible]	0-19.5	45[illegible]	1570	7.5-9.0
5E	N 59400,	E 32900	?	0-4.5		904	1.5-3.0
6D	N 59300,	E 33000	4584.2	0-19.5	4564.7	324	16.5-18.0
8CD	N 59250,	E 33200	4577.5	0-13.5	4564.0	3160	10.5-12.0
9C	N 59200,	E 33300	4565.1	0-7.5	4557.6	198	1.5-3.0
9H	N 59700,	E 33300	4588.2	0-19.5	4568.7	2154	1.5-3.0
10CD	N 59250,	E 33400	4577.7	0-13.5	4564.2	344	4.5-6.0
12CD	N 59250,	E 33600	4590.6	0-22.5	4565.1	2508	22.5-24.0
13C	N 59200,	E 33700	4590.4	0-31.5	4558.9	4244	1.5-3.0
14C	N 59200,	E 33800	4590.8	0-25.5	4565.3	3154	16.5-18.0
15A	N 59[illegible],	E 33900	4573.9	None	4573.9	8	1.5-3.0
15BC	N 59150,	E 33900	4591.2	0-25.5	4565.7	3026	10.5-12.0
15F	N 59500,	E 33870	4590.9	0-37.0	~~4559.4~~ 4553.4	2132	1.5-3.0
17B	N 59100,	E 34100		0-21.0		1864	13.5-15.0
17B-B	N 59107,	E 34108	4590.0	0-23.5	4567.5	3202	16.5-18.0
18B-B	N 59100,	E 34214	4589.7	0-22.0	~~4569.2~~ 4567	3724	17.5-19.0
19B	N 59100,	E 34300		0-22.5		3554	13.5-15.0
19B-B	N 59110,	E 34305	4589.0	0-33.8	4555.2	2730	19.5-21.0
21B	N 59100,	E 34500	4589.9	0-23.5	4566.4	3038	14.5-16.0
21J	N 59200,	E 34500	4593.5	0-49.5	45[illegible]	3194	44.5-46.0
22.5B	N 59100,	E 34650	[illegible]	0-22.5	4566.5	3430	16.5-18.0
22.5B-B	N 59132,	E 34650	4588.0	0-37.0	4551.0	3206	14.5-16.0
24BC	N 59158,	E 34800	4589.5	0-20.5	4569.0	2358	14.5-16.0
26BC	N 59150,	E 35000	4588.9	0-19.5	4569.4	52	16.5-18.0
28BC	N 59154,	E 35200	4577.0	0-4.5	4572.5	27	1.5-3.0
29B	N 59200,	E 35300	4589.9	0-22.5	4567.4	84	1.5-3.0
29C	N 60400,	E 35300	[illegible]	None		10	1.5-3.0
32M	N 60100,	E 35600	4587.6	0-19.5	4568.1	200	13.5-15.0
33F-B	N 58565,	E 35678		0-21.0		216	19.5-21.0
34P	N 60300,	E 35800	[illegible]	None		6	1.5-3.0
34T	N 60700,	E 35800	[illegible]	None		5	16.5-18.0
36L	N 60000,	E 36000	[illegible]	Surface		11.8	0-0.5
40K	N 59700,	E 36400	[illegible]	Surface		7.2	0-0.5
40N	N 60200,	E 36400	[illegible]	None		5	16.5-17.0

* Estimated final activity after ingrowth
Correction factor used to obtain final activity
from initial pCi/g count is 2 x initial result.

Grand Junction Site Characterization Borehole Log Data

Boreholes drilled by Little Beaver Auger

Borehole #	Location	Contamination Depth (in inches)	Max CPM and Depth	
1	N 59550, E 32550	0 - 18	1818340	6
2 (3D)	N 59300, E 32600	0 - 15 +	1553120	15
3	N 59300, E 32535	0 - 24	174200	Surface
4	N 59235, E 32535	0 - 36 +	235020	6
5	N 59250, E 32535	0 - 36	183430	6
6	N 59250, E 32600	0 - 66 +	1819150	24
7	N 59200, E 32650	0 - 36 +	2075600	18
8 (3C)	N 59200, E 32600	0 - 42 +	1231240	12
9	N 59200, E 32700	0 - 30 +	238100	18
10	N 59200, E 32500	0 - 66	107600	48
11	N 59250, E 32520	0 - 36 +	1050830	36
12	N 59211, E 32300	0 - 42 +	41020	12
13	N 59220, E 32900	0 - 42 +	500350	30
14	N 59219, E 33000	0 - 36 +	693130	12
15	N 59219, E 32995	0 - 42 +	695699	12
16	N 59210, E 33100	0 - 45 +	878040	48
17	N 59210, E 33200	0 - 54	256930	36
18	N 59180, E 33400	H20 at 24	41110	Surface
19	N 59195, E 33400	0 - 78 +	217370	78
20	N 59186, E 33500	0	42170	Surface
21	N 59196, E 33586	0 - 42 +	845070	48
22	N 59150, E 33710	0 - 6	636400	Surface
23	N 59122, E 33790	0 - 6	78330	Surface
24	N 59100, E 33800	0 - 6	66810	Surface
25	N 59090, E 33885	0 - 6	56920	Surface
26	N 59061, E 34000	0 - 6	64090	Surface
27	N 59056, E 34000	0 - 6	55540	Surface
28	N 59124, E 34100	0 - 6	56900	Surface
29	N 59030, E 34200	0 - 6	48760	Surface
30	N 59049, E 34300	0 - 68	81260	68
31	N 59059, E 34300	0 - 72	78250	66
32	N 59065, E 34400	0 - 6	42590	Surface
33	N 59094, E 34800	0 - 0	46650	Surface
34	N 59092, E 34800	0 - 0	47230	Surface
35	N 59095, E 34900	0 - 6	50830	Surface
36	N 59100, E 35000	0 - 24 +	599150	24
37	N 59095, E 35000	0 - 24 +	319290	24
38	N 59000, E 34900	0 - 30 +	509520	30
39	N 59090, E 34925	0 - 6	54140	Surface
40	N 59100, E 35005	0 - 36 +	250100	36
41	N 59095, E 35100	0 - 6 +	80740	Surface
42	N 59100, E 35075	0 - 48 +	129272	18
43	N 59095, E 34950	0 - 48 +	115190	24
44	N 59095, E 34755	0 - 54	52640	24
45	N 59087, E 34750	0 - 6	56560	Surface
46	N 59084, E 34876	0 - 6	52340	Surface

Grand Junction Site Characterization Borehole Log Data

Boreholes drilled by Little Beaver Auger

Borehole #	Location	Contamination Depth (in inches)	Max CPM and Depth	
47	N 59600, E 32500	0 - 60 +	1766200	30
48	N 59112, E 32600	0 - 60 +	115720	60
49	N 59112, E 32597	0 - 72 +	165940	72
50	N 59100, E 32800	0 - 60 +	360250	48
51	N 59083, E 32800	0 - 54 +	735250	54
52	N 59125, E 33000	0 - 60 +	145340	48
53	N 59140, E 33200	None	28070	0
54	N 59155, E 33200	None	32750	0
55	N 59175, E 33200	0 - 90 +	198260	72
56	N 59100, E 33400	0 - 90 +	251780	72
57	N 59040, E 33400	None	29480	0
58	N 59070, E 33400	0 - 84 +	616100	54
59	N 59100, E 33600	Surface	44100	Surface
60	N 59000, E 33600	None	32650	Surface
61	N 59000, E 33800	Surface	42770	Surface
62	N 59085, E 34020	Surface	61730	Surface
63	N 59085, E 34025	0 - 78 +	65190	78
64	N 59005, E 34000	Surface	41680	Surface
65	N 59102, E 33988	None	35100	Surface
66	N 59040, E 34100	Surface	34870	Surface
67	N 59050, E 34100	0 - 78 +	201500	30
68	N 59040, E 34200	0 - 54	43400	48
69	N 59053, E 34300	Surface	42970	Surface
70	N 59800, E 32500	0 - 48	666510	12
71	N 59100, E 33300	0 - 90 +	53520	84
72	N 59075, E 33300	0 - 96 +	52110	96
73	N 59100, E 33500	0 - 66	47780	36
74	N 59075, E 33500	None	30440	Surface
75	N 59055, E 33500	None	36850	Surface
76	N 59000, E 33650	None	36200	Surface
77	N 59040, E 33650	Surface	40090	Surface
78	N 59060, E 33650	None	39110	Surface
79	N 59080, E 33650	Surface	44510	Surface
80	N 59000, E 33700	None	37120	Surface
81	N 59010, E 33905	Surface	40200	Surface
82	N 59150, E 33700	Surface	51260	Surface
83	N 59150, E 33690	Surface	58230	Surface
84	N 59165, E 33690	Surface	60170	Surface
85	N 59130, E 33650	Surface	53990	Surface
86	N 59140, E 33600	Surface	55780	Surface
87	N 59150, E 33300	0 - 88 +	589510	Surface
88	N 59175, E 33300	0 - 102 +	50730	102
89	N 59180, E 33300	0 - 90 +	250520	6
90	N 59050, E 33600	None	39810	Surface
91	N 59052, E 33600	None	35430	Surface

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-438	RAF. POND COMP.	< 0.5	18.7	37.4**	
GJ-SS-257	West Machine Shop	< 0.5	65.2	130.4**	
GJ-SS-258	West Machine Shop	< 0.5	9.4	18.8**	
GJ-SS-259	West Machine Shop	< 0.5	18.3	37	
GJ-SS-366	N 59,000; E 33,500	< 0.5	1.1	2.2**	
GJ-SS-346	N 59,000; E 33,600	< 0.5	1.2	2.4**	60
GJ-SS- 45	N 59,000; E 33,700	< 0.5	1.2	1.7	
GJ-SS-371	N 59,000; E 33,700	< 0.5	1.1	2.2**	60
GJ-SS-325	N 59,000; E 33,800	< 0.5	1.2	2.4**	61
GJ-SS- 41	N 59,000; E 33,900	< 0.5	1.0	0.4	
GJ-SS-419	N 59,000; E 33,900	1.5-3.0	4.3	8.6**	
GJ-SS-420	N 59,000; E 33,900	4.5-6.0	4.2	7.4	
GJ-SS-421	N 59,000; E 33,900	13.5-15.0	3.9	0.9	15A
GJ-SS-422	N 59,000; E 33,900	16.5-18.0	1.2	1.1	
GJ-SS-423	N 59,000; E 33,900	19.5-21.0	2.0	4.0**	
GJ-SS-424	N 59,000; E 33,900	22.5-23.0	3.0	6.0**	
GJ-SS-389	N 59,000; E 34,000	IN H2O	1.4	2.8**	
GJ-SS-373	N 59,010; E 33,905	< 0.5	1.3	2.6**	61
GJ-SS-113	N 59,010; E 34,000	< 0.5	1.1	1.3	
GJ-SS-134	N 59,020; E 33,820	< 0.5	1.0	1.1	
GJ-SS- 50	N 59,020; E 34,100	< 0.5	1.4	1.6	
GJ-SS-329	N 59,024; E 34,100	< 0.5	0.9	1.8**	
GJ-SS-314	N 59,024; E 34,500	< 0.5 H_2O ?	1.4	2.8**	
GJ-SS-310	N 59,030; E 34,200	< 0.5	1.6	3.2**	
GJ-SS-328	N 59,030; E 34,200	< 0.5	0.6	1.2**	
GJ-SS-343	N 59,030; E 34,200	1.5	1.1	2.2**	29
GJ-SS-336	N 59,040; E 33,400	< 0.5	1.3	2.6**	57
GJ-SS-372	N 59,040; E 33,650	< 0.5	1.1	2.2**	77
GJ-SS-316	N 59,040; E 34,200	< 0.5	1.3	2.6**	[illegible]
GJ-SS-313	N 59,040; E 34,500	< 0.5	1.0	2.0**	
GJ-SS-331	N 59,049; E 34,300	< 0.5	1.8	3.6**	
GJ-SS-356	N 59,049; E 34,300	1.0-1.5	1.2	2.4**	50
GJ-SS-368	N 59,049; E 34,300	< 0.5	1.2	2.4**	
GJ-SS-328	N 59,050; E 32,550	< 0.5	1.3	2.6**	
GJ-SS-378	N 59,050; E 33,500	< 0.5	1.5	3.0**	
GJ-SS- 96	N 59,050; E 34,300	< 0.5	1.7	1.8	
GJ-SS-318	N 59,050; E 34,500	2.0-2.5	124.5	249.0**	
GJ-SS-317	N 59,053; E 34,300	< 0.5	1.3	2.6**	[illegible]
GJ-SS-354	N 59,056; E 34,000	1.0-1.5	2.1	4.2**	
GJ-SS-358	N 59,056; E 34,000	0.5-1.0	2.1	4.2**	27
GJ-SS-365	N 59,056; E 34,000	< 0.5	1.0	2.0**	
GJ-SS-348	N 59,059; E 34,300	< 0.5	1.5	3.0**	
GJ-SS-360	N 59,059; E 34,300	1.0-1.5	1.8	3.6**	51
GJ-SS-320	N 59,061; E 34,000	< 0.5	0.7	1.4**	26
GJ-SS-367	N 59,065; E 34,000	1.5-2.0	1.3	2.6**	
GJ-SS-327	N 59,065; E 34,400	< 0.5	1.4	2.8**	
GJ-SS-364	N 59,065; E 34,400	< 0.5	1.1	2.2**	
GJ-SS-370	N 59,065; E 34,400	1.5	2.9	5.8**	
GJ-SS-374	N 59,070; E 33,650	< 0.5	1.2	2.4**	
GJ-SS-377	N 59,075; E 33,300	< 0.5	1.8	3.6**	
GJ-SS-121	N 59,075; E 34,500	< 0.5	1.0	0.7	
GJ-SS-333	N 59,075; E 34,500	< 0.5	0.9	1.8**	
GJ-SS-131	N 59,080; E 33,600	< 0.5	0.8	1.2	

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL
GJ-SS-345	N 59,084; E 34,876	< 0.5	2.6	5.2**
GJ-SS-322	N 59,085; E 34,020	< 0.5	1.7	3.4**
GJ-SS-306	N 59,085; E 34,025	< 0.5	1.4	2.8**
GJ-SS-359	N 59,087; E 34,900	< 0.5	2.7	5.4**
GJ-SS-337	N 59,094; E 34,800	1.5	2.0	3.1
GJ-SS-357	N 59,094; E 34,800	< 0.5	2.6	5.2**
GJ-SS-361	N 59,100; E 32,612	< 0.5	1.6	3.2**
GJ-SS- 47	N 59,100; E 32,700	< 0.5	1.2	0.7
GJ-SS-355	N 59,100; E 32,800	< 0.5	1.3	2.6**
GJ-SS- 94	N 59,100; E 32,900	< 0.5	1.3	1.8
GJ-SS-335	N 59,100; E 33,000	< 0.5 H_2O	0.8	1.6**
GJ-SS- 43	N 59,100; E 33,300	< 0.5	1.2	1
GJ-SS-312	N 59,100; E 33,400	< 0.5	0.9	1.8**
GJ-SS-269	N 59,100; E 33,400	< 0.5	1.3	2.6**
GJ-SS- 93	N 59,100; E 33,500	< 0.5	1.6	1.1
GJ-SS-375	N 59,100; E 33,500	< 0.5	0.9	1.8**
GJ-SS-307	N 59,100; E 33,600	< 0.5	1.0	2.0**
GJ-SS-311	N 59,100; E 33,600	1.5-2.0	1.4	2.8**
GJ-SS- 42	N 59,100; E 33,700	< 0.5	0.7	1.2
GJ-SS-338	N 59,100; E 33,800	1.5-2.0	1.6	3.2**
GJ-SS-340	N 59,100; E 33,800	0.5-1.0	1.2	2.4**
GJ-SS-482	N 59,100; E 33,800	< 0.5	0.9	1.4
GJ-SS-483	N 59,100; E 33,800	1.0-1.5	0.6	1.9
GJ-SS- 95	N 59,100; E 33,900	< 0.5	1.3	1.7
GJ-SS-173	N 59,100; E 34,100	1.5-3.0	3.3	1.9
GJ-SS-174	N 59,100; E 34,100	4.5-6.0	2.6	5.2**
GJ-SS-175	N 59,100; E 34,100	7.5-9.0	3.3	2.7
GJ-SS-176	N 59,100; E 34,100	10.5-12.0	56.0	112.0**
GJ-SS-177	N 59,100; E 34,100	13.5-15.0	931.6	1863.2**
GJ-SS-178	N 59,100; E 34,100	16.5-18.0	903.2	1806.4**
GJ-SS-179	N 59,100; E 34,100	19.5-21.0	856.5	1713.0**
GJ-SS-248	N 59,100; E 34,100	28.5-30.0	10.9	12.8
GJ-SS-402	N 59,100; E 34,200	14.5-16.0	1704.9	3409.8**
GJ-SS-403	N 59,100; E 34,200	17.5-19.0	1654.4	3308.8**
GJ-SS-404	N 59,100; E 34,200	20.5-22.0	6.1	7.5*
GJ-SS-405	N 59,100; E 34,200	23.5-25.0	4.0	8.0**
GJ-SS-396	N 59,100; E 34,214	14.5-16.0	1740.5	3481.0**
GJ-SS-397	N 59,100; E 34,214	17.5-19.0	1862.3	3724.6**
GJ-SS-398	N 59,100; E 34,214	20.5-22.0	7.34	14.7**
GJ-SS-399	N 59,100; E 34,214	26.5-28.0	1.8	3.6**
GJ-SS-400	N 59,100; E 34,214	32.5-34.0	1.1	2.2**
GJ-SS-401	N 59,100; E 34,214	35.5-37.0	5.6	3.4
GJ-SS-180	N 59,100; E 34,300	1.5-3.0	72.8	145.6**
GJ-SS-181	N 59,100; E 34,300	4.5-6.0	6.7	5.8
GJ-SS-182	N 59,100; E 34,300	7.5-9.0	1674.6	3349.2**
GJ-SS-183	N 59,100; E 34,300	10.5-12.0	1693.4	3386.8**
GJ-SS-184	N 59,100; E 34,300	13.5-15.0	1776.5	3553.0**
GJ-SS-185	N 59,100; E 34,300	16.5-18.0	1655.2	3310.4**
GJ-SS-186	N 59,100; E 34,300	17.5-21.0	1491.8	2983.6**
GJ-SS-187	N 59,100; E 34,300	22.5-24	4.7	9.4**
GJ-SS-203	N 59,100; E 34,500	14.5-16.0	1516.4	3032.8**
GJ-SS-204	N 59,100; E 34,500	17.5-19.0	1060.6	2121.2**
GJ-SS-205	N 59,100; E 34,500	20.5-22.0	1091.8	2183.6**

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL
GJ-SS-206	N 59,100; E 34,500	23.5-25.0	3.7	7.0
GJ-SS-207	N 59,100; E 34,500	26.5-28.0	2.3	4.6**
GJ-SS-208	N 59,100; E 34,500	29.5-31.0	1.0	2.0**
GJ-SS-209	N 59,100; E 34,500	32.5-34.0	1.1	2.2**
GJ-SS-210	N 59,100; E 34,500	38.5-39.0	3.6	7.2**
GJ-SS-211	N 59,100; E 34,650	1.5-3.0	1.8	3.6**
GJ-SS-212	N 59,100; E 34,650	7.5-9.0	202.7	405.4**
GJ-SS-213	N 59,100; E 34,650	10.5-12.0	1542.3	3026.6**
GJ-SS-214	N 59,100; E 34,650	13.5-15.0	1703.3	3406.6**
GJ-SS-215	N 59,100; E 34,650	16.5-18.0	1714.5	3429.0**
GJ-SS-216	N 59,100; E 34,650	19.5-21.0	1443.3	2886.6**
GJ-SS-217	N 59,100; E 34,650	22.5-24.0	14.8	24.8
GJ-SS-123	N 59,100; E 34,800	< 0.5	1.9	3.8**
GJ-SS-135	N 59,100; E 34,900	< 0.5	0.8	1.6
GJ-SS-114	N 59,100; E 35,000	< 0.5	1.3	1.5
GJ-SS-341	N 59,100; E 35,000	< 0.5	1.1	2.2
GJ-SS-363	N 59,100; E 35,000	1.5-2.0	131.8	263.6**
GJ-SS-117	N 59,100; E 35,100	< 0.5	8.8	23.6
GJ-SS- 44	N 59,100; E 35,200	< 0.5	1.3	12.5
GJ-SS-332	N 59,100; E 35,300	< 0.5	1.0	2.0**
GJ-SS-326	N 59,100; E 35,400	< 0.5	1.8	3.6**
GJ-SS-136	N 59,105; E 32,700	< 0.5	0.8	1.6**
GJ-SS-222	N 59,107; E 34,108	16.5-18.0	1604.3	3208.6**
GJ-SS-223	N 59,107; E 34,108	19.5-21.0	1007.2	2014.4**
GJ-SS-224	N 59,107; E 34,108	22.5-24.00	2.0	3.6
GJ-SS-225	N 59,107; E 34,108	31.5-33.0	1.5	3.0**
GJ-SS-188	N 59,110; E 34,108	1.5-3.0	17.4	117.2
GJ-SS-189	N 59,110; E 34,108	4.5-6.0	5.8	6.6
GJ-SS-190	N 59,110; E 34,108	19.5-21.0	1365.3	2730.6**
GJ-SS-191	N 59,110; E 34,108	22.5-24.0	1.0	1.5
GJ-SS-192	N 59,110; E 34,108	25.5-27.0	3.2	6.4**
GJ-SS-193	N 59,110; E 34,108	28.5-30.0	7.0	14.0**
GJ-SS-194	N 59,110; E 34,108	33.5	33.7	39.5
GJ-SS-308	N 59,112; E 32,600	< 0.5	0.9	1.8**
GJ-SS-315	N 59,122; E 34,250	< 0.5	0.5	1.0**
GJ-SS-323	N 59,125; E 33,000	2.0-2.5	2.7	5.4**
GJ-SS-324	N 59,125; E 33,000	< 0.5	1.4	2.8**
GJ-SS-380	N 59,130; E 33,650	< 0.5	1.4	2.8**
GJ-SS-249	N 59,132; E 34,650	14.5-16.0	1903.1	3806.2**
GJ-SS-250	N 59,132; E 34,650	17.5-19.0	1791.5	3583.0**
GJ-SS-251	N 59,132; E 34,650	20.5-22.0	1598.8	3197.6**
GJ-SS-252	N 59,132; E 34,650	23.5-25.0	1437.2	2874.4**
GJ-SS-253	N 59,132; E 34,650	26.5-28.0	35.8	71.6**
GJ-SS-254	N 59,132; E 34,650	29.5-31.0	12.9	25.2
GJ-SS-255	N 59,132; E 34,650	32.5-34.0	10.6	20.3
GJ-SS-256	N 59,132; E 34,650	35.5-37.0	11.4	26.0
GJ-SS-116	N 59,140; E 33,300	< 0.5	1.4	1.8
GJ-SS-379	N 59,140; E 33,600	< 0.5	1.3	2.6**
GJ-SS-124	N 59,140; E 33,200	< 0.5	0.9	0.5
GJ-SS-302	N 59,150; E 33,300	< 0.5	2.4	4.8**
GJ-SS-304	N 59,150; E 33,400	< 0.5	1.0	2.0**
GJ-SS-337	N 59,150; E 33,710	< 0.5	1.3	2.3
GJ-SS-479	N 59,150; E 33,710	1.0-1.5	0.6	1.2**

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Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL
GJ-SS-480	N 59,150; E 33,710	1.5-2.0	0.9	1.2
GJ-SS-481	N 59,150; E 33,710	< 0.5	14.4	32.4
GJ-SS-484	N 59,150; E 33,710	0.5-1.0	0.8	2.3
GJ-SS-164	N 59,150; E 33,900	1.5-3.0	711.6	1423.2**
GJ-SS-165	N 59,150; E 33,900	4.5-6.0	1136.0	2272.0**
GJ-SS-166	N 59,150; E 33,900	10.5-12.0	1513.1	3026.2**
GJ-SS-167	N 59,150; E 33,900	13.5-15.0	1491.4	2922.8**
GJ-SS-168	N 59,150; E 33,900	16.5-18.0	1501.2	3002.4**
GJ-SS-169	N 59,150; E 33,900	19.5-21.0	603.8	1207.6**
GJ-SS-170	N 59,150; E 33,900	22.5-24.0	21.3	42.6**
GJ-SS-171	N 59,150; E 33,900	25.5-27.0	2.4	3.8
GJ-SS-172	N 59,150; E 33,900	31.5-33.0	2.6	5.2**
GJ-SS-454	N 59,150; E 34,596	1.0-1.5	2.4	4.8**
GJ-SS-195	N 59,150; E 34,800	14.5-16.0	1429.3	2858.6**
GJ-SS-196	N 59,150; E 34,800	17.5-19.0	1236.8	2473.6**
GJ-SS-197	N 59,150; E 34,800	20.5-22.0	2.9	5.8**
GJ-SS-198	N 59,150; E 34,800	23.5-25.0	1.0	2.0**
GJ-SS-199	N 59,150; E 34,800	26.5-28.0	3.2	6.4**
GJ-SS-200	N 59,150; E 34,800	29.5-31.0	3.8	7.6**
GJ-SS-201	N 59,150; E 34,800	32.5-34.0	1.6	3.5
GJ-SS-202	N 59,150; E 34,800	37.0-37.5	6.6	10.0
GJ-SS-218	N 59,150; E 35,000	16.5-18.0	26.0	52.0**
GJ-SS-219	N 59,150; E 35,000	19.5-21.0	0.9	1.8**
GJ-SS-220	N 59,150; E 35,000	22.5-24.0	0.9	1.0
GJ-SS-221	N 59,150; E 35,000	31.5-33.0	0.6	1.2**
GJ-SS-226	N 59,150; E 35,200	1.5-3.0	21.8	26.5*
GJ-SS-227	N 59,150; E 35,200	4.5-6.0	4.5	5.6*
GJ-SS-228	N 59,150; E 35,200	7.5-9.0	1.6	3.2**
GJ-SS-229	N 59,150; E 35,200	10.5-12.0	2.4	4.8**
GJ-SS-230	N 59,150; E 35,200	13.5-15.0	0.8	1.6**
GJ-SS-231	N 59,150; E 35,200	16.5-18.0	1.3	2.6**
GJ-SS-232	N 59,150; E 35,200	19.5-21.0	0.8	1.2
GJ-SS-233	N 59,150; E 35,200	21.0-22.0	0.9	1.2
GJ-SS-128	N 59,155; E 32,600	< 0.5	0.9	2.2
GJ-SS-133	N 59,155; E 33,400	< 0.5	1.1	1.3
GJ-SS- 97	N 59,165; E 33,100	< 0.5	1.5	1.4
GJ-SS-381	N 59,165; E 33,690	< 0.5	0.8	1.6**
GJ-SS-125	N 59,175; E 33,000	< 0.5	0.8	1.2
GJ-SS-129	N 59,175; E 33,100	< 0.5	1.0	0.6
GJ-SS-309	N 59,175; E 33,200	< 0.5	5.2	6.3*
GJ-SS-383	N 59,175; E 33,300	< 0.5	1.7	3.4**
GJ-SS-319	N 59,180; E 33,400	< 0.5	1.3	2.6**
GJ-SS-126	N 59,185; E 35,300	< 0.5	1.0	2.0**
GJ-SS-330	N 59,185; E 35,475	< 0.5	1.1	2.2**
GJ-SS-127	N 59,185; E 35,485	< 0.5	1.2	3.5
GJ-SS-321	N 59,189; E 33,885	< 0.5	0.7	1.4**
GJ-SS-485	N 59,195; E 33,400	< 0.5	1.0	0.8
GJ-SS-486	N 59,195; E 33,400	0.5-1.0	1.3	2.5
GJ-SS-487	N 59,195; E 33,400	1.5-2.0	0.8	1.8
GJ-SS-347	N 59,196; E 33,596	1.5-2.0	86.2	172.4**
GJ-SS-505	N 59,196; E 34,596	0.5-1.0	1.6	3.6
GJ-SS- 90	N 57,200; E 32,500	< 0.5	9.7	15.6
GJ-SS-111	N 59,200; E 32,575	< 0.5	2.1	1.6

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL
GJ-SS-425	N 59,200; E 32,600	1.5-3.0	112.2	224.4**
GJ-SS-426	N 59,200; E 32,600	4.5-6.0	16.5	33.0**
GJ-SS-427	N 59,200; E 32,600	7.5-9.0	1.1	2.2**
GJ-SS-428	N 59,200; E 32,600	10.5-12.0	0.2	0.4**
GJ-SS-429	N 59,200; E 32,600	14.5-16.0	1.8	3.6**
GJ-SS-430	N 59,200; E 32,600	16.0-16.5	1.6	3.2**
GJ-SS-110	N 59,200; E 32,700	< 0.5	10.5	16.2
GJ-SS- 79	N 59,200; E 32,900	1.5-3.0	10.7	13.1*
GJ-SS- 80	N 59,200; E 32,900	4.5-6.0	630.0	1260.0**
GJ-SS- 81	N 59,200; E 32,900	7.5-9.0	794.7	1589.4**
GJ-SS- 82	N 59,200; E 32,900	10.5-12.0	1.6	2.1
GJ-SS- 83	N 59,200; E 32,900	13.5-15.0	4.2	8.4**
GJ-SS- 84	N 59,200; E 32,900	16.5-18.0	7.3	15.6
GJ-SS- 85	N 59,200; E 32,900	19.5-21.0	1.0	2.0**
GJ-SS- 99	N 59,200; E 32,900	> 0.5	1.2	2.0
GJ-SS- 48	N 59,200; E 33,100	< 0.5	40.4	84.3
GJ-SS-120	N 59,200; E 33,110	1.5	85.1	170.2**
GJ-SS-112	N 59,200; E 33,300	< 0.5	9.0	12.6
GJ-SS-243	N 59,200; E 33,300	1.5-3.0	98.5	197.0**
GJ-SS-244	N 59,200; E 33,300	4.5-6.0	22.5	45.0**
GJ-SS-245	N 59,200; E 33,300	7.5-9.0	1.4	2.0
GJ-SS-246	N 59,200; E 33,300	10.5-12.0	0.9	0.6
GJ-SS-247	N 59,200; E 33,300	16.5-18.0	2.8	2.6
GJ-SS- 49	N 59,200; E 33,500	< 0.5	1.6	1.3
GJ-SS-260	N 59,200; E 33,700	1.5-3.0	2121.6	4243.2**
GJ-SS-261	N 59,200; E 33,700	4.5-6.0	814.7	1629.4**
GJ-SS-262	N 59,200; E 33,700	7.5-9.0	1316.5	2633.0**
GJ-SS-263	N 59,200; E 33,700	13.5-15.0	1233.3	2466.6**
GJ-SS-264	N 59,200; E 33,700	16.5-18.0	1262.7	2525.4**
GJ-SS-265	N 59,200; E 33,700	19.5-21.0	226.4	452.8**
GJ-SS-266	N 59,200; E 33,700	22.5-24.0	1223.4	2446.8**
GJ-SS-267	N 59,200; E 33,700	31.5-33.0	1.3	1.5
GJ-SS-268	N 59,200; E 33,700	34.5-35.5	0.8	0.8
GJ-SS-269	N 59,200; E 33,700	35.5-36.0	10.2	11.6
GJ-SS-270	N 59,200; E 33,800	1.5-3.0	5.7	11.4**
GJ-SS-271	N 59,200; E 33,800	4.5-6.0	1259.1	2518.2**
GJ-SS-272	N 59,200; E 33,800	7.5-9.0	59.0	118.0**
GJ-SS-273	N 59,200; E 33,800	10.5-12.0	692.6	1385.2**
GJ-SS-274	N 59,200; E 33,800	13.5-15.0	1413.0	2826.0**
GJ-SS-275	N 59,200; E 33,800	16.5-18.0	1576.9	3153.8**
GJ-SS-276	N 59,200; E 33,800	19.5-21.0	689.7	1379.4**
GJ-SS-277	N 59,200; E 33,800	22.5-24.0	162.7	325.4**
GJ-SS-278	N 59,200; E 33,800	25.5-27.0	1.13	2.3**
GJ-SS-279	N 59,200; E 33,800	28.5-30.0	0.5	1.0**
GJ-SS-280	N 59,200; E 33,800	37.0-37.1	4.7	9.4**
GJ-SS-366	N 59,200; E 35,200	IN H2O	32.7	
GJ-SS-115	N 59,210; E 33,200	< 0.5	3.7	6.3
GJ-SS-119	N 59,210; E 33,200	2.0-2.3	3.2	6.7
GJ-SS-122	N 59,210; E 33,200	1.5-2.0	2.1	5.3
GJ-SS-130	N 59,210; E 33,200	< 0.5	14.0	40.1
GJ-SS-132	N 59,210; E 33,200	0.5-1.0	1.4	1.8
GJ-SS-118	N 59,211; E 32,800	1.5	9.9	25.5
GJ-SS-287	N 59,250; E 32,650	1.5-3.0	1792.8	3585.6**

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	FINAL
GJ-SS-288	N 59,250; E 32,650	4.5-6.0	1757.1	3514.2**
GJ-SS-289	N 59,250; E 32,650	7.5-9.0	378.8	757.6**
GJ-SS-290	N 59,250; E 32,650	10.5-12.0	2.7	3.3*
GJ-SS-291	N 59,250; E 32,650	13.5-15.0	1.0	2.0**
GJ-SS-292	N 59,250; E 32,650	16.5-18.0	5.4	10.8**
GJ-SS-293	N 59,250; E 32,650	19.5-21.0	2.7	2.3
GJ-SS- 86	N 59,250; E 33,200	1.5-3.0	4.6	2.7
GJ-SS- 87	N 59,250; E 33,200	4.5-6.0	111.9	223.8**
GJ-SS- 88	N 59,250; E 33,200	7.5-9.0	112.3	224.6**
GJ-SS- 89	N 59,250; E 33,200	10.5-12.0	1579.4	3158.8**
GJ-SS- 90	N 59,250; E 33,200	13.5-15.0	4.1	8.2**
GJ-SS- 91	N 59,250; E 33,200	16.5-18.0	0.7	1.4**
GJ-SS- 92	N 59,250; E 33,200	22.5-22.7	2.0	0.6
GJ-SS-155	N 59,250; E 33,400	1.5-3.0	7.3	5.1
GJ-SS-156	N 59,250; E 33,400	4.5-6.0	172.3	344.6**
GJ-SS-157	N 59,250; E 33,400	7.5-9.0	207.9	415.8**
GJ-SS-158	N 59,250; E 33,400	10.5-12.0	153.0	306.0**
GJ-SS-159	N 59,250; E 33,400	13.5-15.0	2.5	5.0**
GJ-SS-160	N 59,250; E 33,400	16.5-18.0	3.1	6.2**
GJ-SS-161	N 59,250; E 33,400	19.5-21.0	0.4	0.8**
GJ-SS-162	N 59,250; E 33,400	22.5-25.0	0.9	1.8**
GJ-SS-163	N 59,250; E 33,400	25.0-26.5	0.9	1.6
GJ-SS-234	N 59,250; E 33,600	1.5-3.0	459.1	918.2**
GJ-SS-235	N 59,250; E 33,600	4.5-6.0	720.9	1441.8**
GJ-SS-236	N 59,250; E 33,600	7.5-9.0	250.0	500.0**
GJ-SS-237	N 59,250; E 33,600	13.5-15.0	414.0	828.0**
GJ-SS-238	N 59,250; E 33,600	16.5-18.0	844.5	1689.0**
GJ-SS-239	N 59,250; E 33,600	19.5-21.0	198.0	396.0**
GJ-SS-240	N 59,250; E 33,600	22.5-24.0	1253.7	2507.4**
GJ-SS-241	N 59,250; E 33,600	25.5-27.0	5.1	11.4
GJ-SS-242	N 59,250; E 33,600	28.5-30.0	2.7	6.2
GJ-SS- 71	N 59,300; E 32,600	1.5-3.0	711.6	1423.2**
GJ-SS- 72	N 59,300; E 32,600	4.5-6.0	2209.1	4418.2**
GJ-SS- 73	N 59,300; E 32,600	7.5-9.0	47.7	58.2*
GJ-SS- 74	N 59,300; E 32,600	10.5-12.0	0.5	0.5
GJ-SS- 75	N 59,300; E 32,600	13.5-15.0	1.6	2.2
GJ-SS- 76	N 59,300; E 32,600	16.5-18.0	0.9	1.4
GJ-SS- 77	N 59,300; E 32,600	19.5-21.0	1.2	1.3
GJ-SS- 78	N 59,300; E 32,600	21.0	Sample Weight to low for Analy	
GJ-SS-109	N 59,300; E 32,600	< 0.5	67.8	83.0
GJ-SS- 31	N 59,300; E 32,700	1.5-3.0	151.8	303.6**
GJ-SS- 32	N 59,300; E 32,700	4.5-6.0	161.1	322.2**
GJ-SS- 33	N 59,300; E 32,700	7.5-9.0	127.3	254.6**
GJ-SS- 34	N 59,300; E 32,700	10.5-12.0	148.6	297.2**
GJ-SS- 35	N 59,300; E 32,700	13.5-15.0	94.9	189.8**
GJ-SS- 36	N 59,300; E 32,700	16.5-18.0	71.9	118.6
GJ-SS- 37	N 59,300; E 32,700	19.5-21.0	1.5	3.7
GJ-SS- 38	N 59,300; E 32,700	22.5-24.0	0.6	0.7
GJ-SS- 39	N 59,300; E 32,700	25.5-27.0	1.8	2.7
GJ-SS- 40	N 59,300; E 32,700	28.5-30.0	1.2	1.7
GJ-SS-305	N 59,300; E 32,800	< 0.5	1.4	1.5
GJ-SS-306	N 59,300; E 32,800	1.5-3.0	30.7	61.4**
GJ-SS-307	N 59,300; E 32,800	4.5-6.0	109.8	219.6**

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL
GJ-SS-490	N 59,300; E 32,800	7.5-9.0	218.8	437.6**
GJ-SS-491	N 59,300; E 32,800	10.5-12.0	159.9	319.8**
GJ-SS-492	N 59,300; E 32,800	13.5-15.0	272.1	544.2**
GJ-SS-493	N 59,300; E 32,800	16.0-18.0	1761.4	3522.8**
GJ-SS- 51	N 59,300; E 32,816	1.5-3.0	144.7	289.4**
GJ-SS- 52	N 59,300; E 32,816	4.5-6.0	157.8	315.6**
GJ-SS- 53	N 59,300; E 32,816	7.5-9.0	164.7	329.4**
GJ-SS- 54	N 59,300; E 32,816	10.5-12.0	133.2	266.4**
GJ-SS- 55	N 59,300; E 32,816	13.5-15.0	189.2	378.4**
GJ-SS- 56	N 59,300; E 32,816	16.5-18.0	1475.4	2950.8**
GJ-SS- 57	N 59,300; E 32,816	19.5-21.0	1.5	1.2
GJ-SS- 58	N 59,300; E 32,816	22.5-24.0	2.02	4.0**
GJ-SS- 59	N 59,300; E 32,816	25.5-27.0	1.1	2.2**
GJ-SS- 60	N 59,300; E 32,816	28.5-30.0	1.3	2.6**
GJ-SS- 61	N 59,300; E 32,816	31.5-33.0	0.9	3.0
GJ-SS- 62	N 59,300; E 33,000	1.5-3.0	78.9	118.9
GJ-SS- 63	N 59,300; E 33,000	4.5-6.0	129.0	258.0**
GJ-SS- 64	N 59,300; E 33,000	7.5-9.0	152.7	305.4**
GJ-SS- 65	N 59,300; E 33,000	10.5-12.0	181.3	362.6**
GJ-SS- 66	N 59,300; E 33,000	13.5-15.0	122.6	245.2**
GJ-SS- 67	N 59,300; E 33,000	16.5-18.0	191.7	383.4**
GJ-SS- 68	N 59,300; E 33,000	19.5-20.0	2.3	4.9
GJ-SS- 69	N 59,300; E 33,000	22.5-24.0	1.6	1.2
GJ-SS- 70	N 59,300; E 33,000	29.5-30.0	1.8	1.8
GJ-SS-499	N 59,350; E 32,650	1.5-3.0	127.5	255.0**
GJ-SS-500	N 59,350; E 32,650	4.5-6.0	420.9	841.8**
GJ-SS-501	N 59,350; E 32,650	7.5-9.0	158.5	317.0**
GJ-SS-502	N 59,350; E 32,650	10.5-12.0	16.4	20.0*
GJ-SS- 21	N 59,350; E 32,660	1.5-3.0	279.5	559.0**
GJ-SS- 22	N 59,350; E 32,660	4.5-6.0	175.1	350.2**
GJ-SS- 23	N 59,350; E 32,660	7.5-9.0	153.4	306.8**
GJ-SS- 24	N 59,350; E 32,660	10.5-12.0	150.3	300.6**
GJ-SS- 25	N 59,350; E 32,660	13.5-15.0	120.5	241.0**
GJ-SS- 26	N 59,350; E 32,660	16.5-18.0	66.2	109.6
GJ-SS- 27	N 59,350; E 32,660	19.5-21.0	3.3	6.6
GJ-SS- 28	N 59,350; E 32,660	22.5-24.0	1.4	3.6
GJ-SS- 29	N 59,350; E 32,660	25.5-27.0	0.5	1.3
GJ-SS- 30	N 59,350; E 32,660	29.5-30.0	2.2	1.9
GJ-SS-342	N 59,400; E 32,550	< 0.5	16.2	32.4**
GJ-SS-281	N 59,400; E 32,900	1.5-3.0	451.5	903.0**
GJ-SS-282	N 59,400; E 32,900	4.5-6.0	1.9	3.8**
GJ-SS-283	N 59,400; E 32,900	7.5-9.0	1.0	2.0**
GJ-SS-284	N 59,400; E 32,900	13.5-15.0	1.5	3.0**
GJ-SS-285	N 59,400; E 32,900	16.5-18.0	1.1	2.2**
GJ-SS-286	N 59,400; E 32,900	18.5-19.0	1.3	1.0
GJ-SS- 46	N 59,499; E 32,900	1.0-1.5	1.9	1.8
GJ-SS-503	N 59,500; E 32,600	1.5-3.0	15.5	18.9*
GJ-SS-504	N 59,500; E 32,600	4.5-6.0	5.5	6.7*
GJ-SS- 11	N 59,500; E 32,625	1.5-3.0	259.0	518.0**
GJ-SS- 12	N 59,500; E 32,625	4.5-6.0	228.3	456.6**
GJ-SS- 13	N 59,500; E 32,625	7.5-9.0	142.2	284.4**
GJ-SS- 14	N 59,500; E 32,625	10.5-12.0	223.0	446.0**
GJ-SS- 15	N 59,500; E 32,625	13.5-15.0	108.5	217.0**

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL
GJ-SS- 16	N 59,500; E 32,625	16.5-18.0	134.7	269.4**
GJ-SS- 17	N 59,500; E 32,625	19.5-20.0	0.7	1.4**
GJ-SS- 18	N 59,500; E 32,625	25.5-27.0	0.7	1.2
GJ-SS- 19	N 59,500; E 32,625	22.5-24.0	0.4	0.7
GJ-SS- 20	N 59,500; E 32,625	27.7-27.7	1.3	2.3
GJ-SS-406	N 59,500; E 33,900	1.5-3.0	1069.2	2138.4**
GJ-SS-407	N 59,500; E 33,900	4.5-6.0	991.8	1983.6**
GJ-SS-408	N 59,500; E 33,900	7.5-9.0	359.3	718.6**
GJ-SS-409	N 59,500; E 33,900	10.5-12.0	338.7	677.4**
GJ-SS-410	N 59,500; E 33,900	13.5-15.0	442.9	885.8**
GJ-SS-411	N 59,500; E 33,900	16.5-18.0	586.5	1173.0**
GJ-SS-412	N 59,500; E 33,900	19.5-21.0	709.0	1418.0**
GJ-SS-413	N 59,500; E 33,900	22.5-24.0	796.0	1592.0**
GJ-SS-414	N 59,500; E 33,900	25.5-27.0	22.3	44.6**
GJ-SS-415	N 59,500; E 33,900	28.5-30.0	18.6	37.2**
GJ-SS-416	N 59,500; E 33,900	31.5-33.0	2.7	5.4**
GJ-SS-417	N 59,500; E 33,900	34.5-37.0	8.1	16.2**
GJ-SS-418	N 59,500; E 33,900	37.0-37.25	4.2	8.9
GJ-SS-494	N 59,500; E 35,700	1.5-3.0	27.4	54.8**
GJ-SS-495	N 59,500; E 35,700	4.5-6.0	13.2	16.1*
GJ-SS-496	N 59,500; E 35,700	7.5-9.0	19.9	39.8**
GJ-SS-497	N 59,502; E 35,673	14.5-16.0	24.8	49.6**
GJ-SS-498	N 59,502; E 35,673	17.5-19.0	6.4	7.8*
GJ-SS-431	N 59,505; E 35,673	1.5-3.0	11.0	11.7
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	17.8*
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**
GJ-SS-137	N 59,600; E 32,550	< 0.5	12.5	24.0
GJ-SS-334	N 59,600; E 32,550	< 0.5	7.6	9.2*
GJ-SS-344	N 59,600; E 32,550	< 0.5	15.3	18.6*
GJ-SS-294	N 59,600; E 35,300	1.5-3.0	41.6	83.2**
GJ-SS-295	N 59,600; E 35,300	4.5-6.0	13.0	15.8*
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	3.5	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- 1	N 59,650; E 32,650	1.5-3.0	143.7	287.4**
GJ-SS- 2	N 59,650; E 32,650	4.5-6.0	189.5	379.0**
GJ-SS- 3	N 59,650; E 32,650	7.5-9.0	171.3	342.6**
GJ-SS- 4	N 59,650; E 32,650	10.5-12.0	176.6	353.2**
GJ-SS- 5	N 59,650; E 32,650	13.5-15.0	589.6	1179.2**
GJ-SS- 6	N 59,650; E 32,650	16.5-18.0	417.8	835.6**
GJ-SS- 7	N 59,650; E 32,650	19.5-20.0	1.4	2.9
GJ-SS- 8	N 59,650; E 32,650	21.5-22.0	5.8	12.3
GJ-SS- 9	N 59,650; E 32,650	23.5-24.0	1.5	2.1
GJ-SS- 10	N 59,650; E 32,650	27.0	10.00	14.0

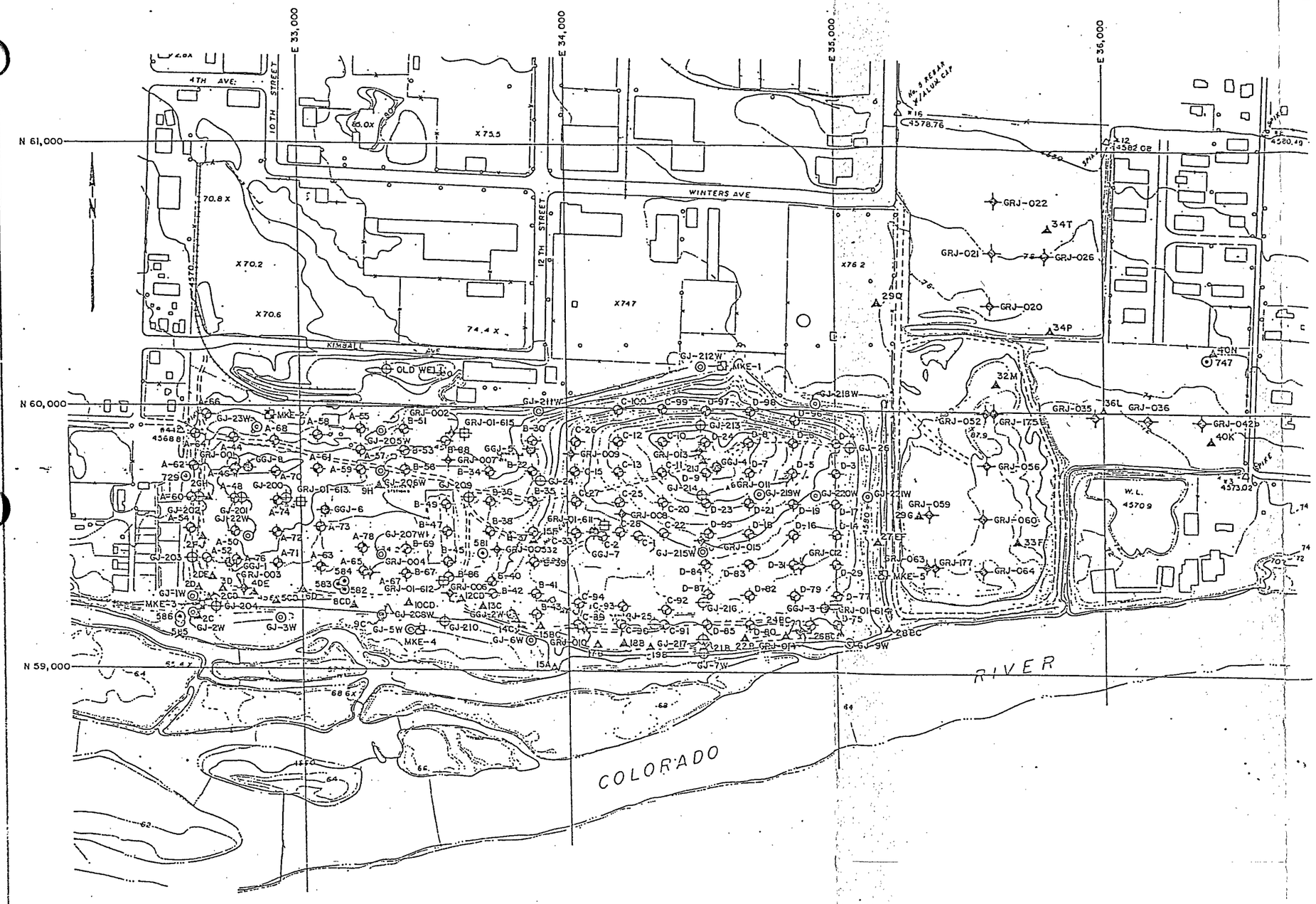
Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL
GJ-SS-387	N 59,700; E 32,550	IN H2O	0.6	1.2**
GJ-SS-100	N 59,700; E 33,300	1.5-3.0	1077.3	2154.6**
GJ-SS-101	N 59,700; E 33,300	4.5-6.0	121.8	243.6**
GJ-SS-102	N 59,700; E 33,300	7.5-9.0	95.8	123.0
GJ-SS-103	N 59,700; E 33,300	10.5-12.0	141.6	283.2**
GJ-SS-104	N 59,700; E 33,300	13.5-15.0	539.0	1078.0**
GJ-SS-105	N 59,700; E 33,300	16.5-18.0	8.0	21.4
GJ-SS-106	N 59,700; E 33,300	19.5-21.0	2.9	3.2
GJ-SS-107	N 59,700; E 33,300	21.0-22.5	4.8	5.0
GJ-SS-108	N 59,700; E 33,300	22.5-22.7	1.0	2.0**
GJ-SS-362	N 59,800; E 32,550	< 0.5	28.1	56.2**
GJ-SS-374	N 59,800; E 32,550	< 0.5	15.7	19.2*
GJ-SS-138	N 59,800; E 34,500	1.5-3.0	246.7	493.4**
GJ-SS-139	N 59,800; E 34,500	4.5-6.0	279.6	559.2**
GJ-SS-140	N 59,800; E 34,500	7.9-9.0	232.4	464.8**
GJ-SS-141	N 59,800; E 34,500	10.5-12.0	251.7	503.4**
GJ-SS-142	N 59,800; E 34,500	13.5-15.0	214.7	429.4**
GJ-SS-143	N 59,800; E 34,500	16.5-18.0	192.8	385.6**
GJ-SS-144	N 59,800; E 34,500	19.5-21.0	289.5	579.0**
GJ-SS-145	N 59,800; E 34,500	22.5-24.0	248.3	496.6**
GJ-SS-146	N 59,800; E 34,500	25.5-27.0	237.3	474.6**
GJ-SS-147	N 59,800; E 34,500	28.5-30.0	272.5	545.0**
GJ-SS-148	N 59,800; E 34,500	31.5-33.0	207.0	414.0**
GJ-SS-149	N 59,800; E 34,500	34.5-36.0	268.9	537.8**
GJ-SS-150	N 59,800; E 34,500	37.5-39.0	199.7	399.4**
GJ-SS-151	N 59,800; E 34,500	44.5-46.0	1596.9	3193.8**
GJ-SS-152	N 59,800; E 34,500	49.5-51.0	2.0	4.0**
GJ-SS-153	N 59,800; E 34,500	54.5-56.0	1.3	2.6
GJ-SS-154	N 59,800; E 34,500	57.5-57.8	3.4	5.1
GJ-SS-439	N 59,800; E 34,500	COMP.	234.6	469.2**
GJ-SS-451	N 59,900; E 36,400	< 0.5	3.6	7.2**
GJ-SS-471	N 59,900; E 36,400	1.5-3.0	6.1	12.2**
GJ-SS-472	N 59,900; E 36,400	4.5-6.0	2.1	0.8
GJ-SS-473	N 59,900; E 36,400	7.5-9.0	1.3	1.0
GJ-SS-474	N 59,900; E 36,400	12.5-15.0	1.8	3.6**
GJ-SS-453	N 60,000; E 36,000	< 0.5	5.9	11.8**
GJ-SS-475	N 60,000; E 36,000	1.5-3.0	2.2	4.4**
GJ-SS-476	N 60,000; E 36,000	4.5-6.0	0.9	1.8**
GJ-SS-477	N 60,000; E 36,000	7.5-9.0	1.2	2.4**
GJ-SS-478	N 60,000; E 36,000	10.5-12.0	2.3	4.6**
GJ-SS-455	N 60,100; E 35,600	< 0.5	5.5	11.0**
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	99.7	199.4**
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-452	N 60,200; E 36,400	< 0.5	1.1	2.2**
GJ-SS-465	N 60,200; E 36,400	1.5-3.0	0.8	1.6**
GJ-SS-466	N 60,200; E 36,400	4.5-6.0	0.5	1.0

Grand Junction Site Characterization Soil Samples

SAMPLE ID	LOCATION	DEPTH IN FEET	Ra-226 pCi/g INITIAL	Ra-226 pCi/g FINAL	
GJ-SS-467	N 60,200; E 36,400	7.5-9.0	1.3	0.7	
GJ-SS-468	N 60,200; E 36,400	10.5-12.0	0.6	1.2**	4.1
GJ-SS-469	N 60,200; E 36,400	13.5-15.0	0.3	0.6**	
GJ-SS-470	N 60,200; E 36,400	16.5-17.0	2.5	5.0**	
GJ-SS-446	N 60,300; E 35,800	1.5-3.0	3.1	6.2**	
GJ-SS-447	N 60,300; E 35,800	4.5-6.0	1.3	2.6**	34P
GJ-SS-448	N 60,300; E 35,800	8.5-10.0	0.9	1.8**	
GJ-SS-449	N 60,300; E 35,800	10.5-12.0	Sample Weight to Low for Analy		
GJ-SS-450	N 60,300; E 35,800	13.5-15.0	0.9	1.8**	
GJ-SS-349	N 60,400; E 35,300	1.5-3.0	4.5	9.0**	
GJ-SS-350	N 60,400; E 35,300	4.5-6.0	2.1	4.2**	
GJ-SS-351	N 60,400; E 35,300	7.5-9.0	2.6	4.5	
GJ-SS-352	N 60,400; E 35,300	10.5-12.0	1.1	2.2**	
GJ-SS-353	N 60,400; E 35,300	13.5-15.0	Sample Weight to Low for Analy		
GJ-SS-440	N 60,700; E 35,800	1.5-3.0	2.3	4.6**	
GJ-SS-441	N 60,700; E 35,800	4.5-6.0	1.5	3.0**	
GJ-SS-442	N 60,700; E 35,800	7.5-9.0	0.8	1.6**	
GJ-SS-443	N 60,700; E 35,800	10.5-12.0	0.4	0.8**	3LT
GJ-SS-444	N 60,700; E 35,800	13.5-15.0	1.4	2.8**	
GJ-SS-445	N 60,700; E 35,800	16.5-18.0	2.4	4.5**	
GJ-SS-385	N unknwn; E 33,100	IN H2O	0.9	1.8**	
GJ-SS-384	N unknwn; E 33,200	IN H2O	0.7	1.4**	
GJ-SS-391	N unknwn; E 33,400	IN H2O	0.6	1.2**	
GJ-SS-393	N unknwn; E 33,600	IN H2O	1.4	2.8**	
GJ-SS-394	N unknwn; E 34,200	IN H2O	0.7	1.4**	
GJ-SS-395	N unknwn; E 34,400	IN H2O	1.3	2.6**	
GJ-SS-392	N unknwn; E 35,000	IN H2O	0.7	1.4**	
GJ-SS-390	N unknwn; E 35,300	IN H2O	1.3	2.6**	

SHT 33



NOTES:

1. GROUNDWATER 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-26, 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

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

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED / DRAWN RBC / CHECKED / INSPECTED / RECOMMENDED / APPROVED / DATE / DOE PROJECT ENGINEER / DATE

GRAND JUNCTION PROCESSING SITE
GRAND JUNCTION, COLORADO
PHASE II CONSTRUCTION

BORINGS AND TEST PITS LOCATION PLAN

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

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. GRJ-PS-10-0217 REV. 5

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

SHT 34 JL,
SHS 4-19-88
WYL 4-19-88

UMTRA PROJECT

INTER-OFFICE CORRESPONDENCE

TO: J. G. Oldham	DATE: 15 January 1988
Attention: J. E. Williams	DOC. NO.: 5025-GRJ-I-01-01565-00
LOCATION: MKF - Boise	FROM: T. R. Wathen
SUBJECT: UMTRA Project - GRJ Quantity of Contaminated Materials	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.

Tests on the vicinity property materials indicate that the contaminated level is very low and the permeability is in the order of 1×10^{-6} cm/sec. In order to take full advantage of these properties, these materials will be placed at the top of the tailings embankment.

4648U/0135U

SHT 35

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.

F.J. Felix for TRW

T. R. Wathen

TRW/JL/bd

MKE DOCUMENT NO. 5025-GRJ-C-01-00483-00

Calculation Cover Sheet

Calc. No. S-628-01-00

Contract No. 5025 Discipline ESCI No. of Sheets 28

Project

UMTRA / GRAND JUNCTION (GRJ)

Feature

Site Drainage

Item

Hydrology Parameters

Sources of Data

Sources of Formulae & References

1. U.S Dept. of Commerce, National Oceanic and Atmospheric Administration, National Weather Service "Precipitation - Frequency Atlas of the Western United States" Vol. III - Colorado NOAA Atlas 2, 1973
2. U.S Dept. of Commerce, Enviromental Science Service Administration, Weather Bureau "Hydrometeorological Report No. 49, Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainage" Sept. 1977
3. 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" March 1986

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

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0	—	Wei-yeh Li	8/19/86	[illegible]	8/8/86	[illegible]	8/18/86

IECO Form 42-110

Sources of Formulae & References (cont'd)

4. U.S. Dept. of Commerce, National Weather Service "Hydrometeorological Report No. 43, Probable Maximum Precipitation, Northwest States" June 1965

5. U.S. Dept. of Commerce, National Weather Service "Hydrometeorological Report (Draft) Probable Maximum Thunderstorm Precipitation Estimates Southwest States (1973 revision)

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ	Contract No. 5025	Sheet 1	
Feature Site Drainage	Designed WYL	File No.	
Item Hydrology Parameter	Checked JTK	Date 6/17/86	Date 8/8/86

I. Purpose

To determine hydrological characteristics of the sites (Grand Junction processing site at 108°30'W, 39°5'N El. 4575 and Cheney Reservoir disposal site at 108°20'W, 38°56'N El. 5260) for the following designs during and after remedial action:

A. During remedial action at the processing site and the disposal site

1. 10-year, 1-hour storm — to size ditches and design erosion protection
2. 10-year, 24-hour storm — to size wastewater retention basins
3. 25-year, 1-hour storm — to size emergency spillway of the basins

B. After remedial action at the disposal site

1. PMP storm intensity Vs duration — to size ditches and design erosion protection for ditches and embankment

II. Rainfall Determination

A. During remedial action, rainfall will be determined from NOAA precipitation-frequency atlas for Colorado (Ref. 1)

1. Rainfall data for duration 6- and 24-hour duration (Ref. 1, pp. 21 ~ 43)

Recurrence Interval	Rainfall inches for duration hours	
Year	6-hour	24-hour
2	0.8	1.0
5	1.0	1.4
10	1.2	1.7
25	1.4	2.0
50	1.6	2.3
100	1.8	2.6

2. To estimate rainfall for a storm less than 6-hour duration

For Gunnison River Basin (See Table 11)

$Y_2 = -0.011 + 0.942\,[(X_1)(X_1/X_2)]$

$Y_{100} = 0.494 + 0.755\,[(X_3)(X_3/X_4)]$

$X_1 = 0.8''$ 2-year, 6-hour storm

$X_2 = 1.0''$ 2-year, 24-hour storm

$X_3 = 1.8''$ 100-year, 6-hour storm

$X_4 = 2.6''$ 100-year, 24-hour storm

a. To obtain 1-hour rainfall

2-year, 1-hour rainfall $Y_2 = -0.011 + 0.942 \times \frac{0.8^2}{1.0} = 0.59''$

100-year, 1-hour rainfall $Y_{100} = 0.494 + 0.755 \times \frac{1.8^2}{2.6} = 1.43''$

From Fig 18

10-year, 1-hour rainfall $Y_{10} = 0.92''$

25-year, 1-hour rainfall $Y_{25} = 1.10''$

b. To obtain rainfall less than 1-hour duration (See Table 12, Fig 18 and pp 5)

Storm Event	Duration (min)	Ratio to 1-hour	Rainfall (inch)	Intensity (inch/hr)
10-year	60	1.0	0.92	0.92
	30	0.79	0.73	1.46
	15	0.57	0.52	2.08
	10	0.45	0.41	2.46
	5	0.29	0.27	3.24
25-year	60	1.0	1.10	1.10
	30	0.79	0.87	1.74
	15	0.57	0.63	2.52
	10	0.45	0.50	3.00
	5	0.29	0.32	3.84

(From Ref. 1)

Table 11. *Equations for estimating 1-hr values in Colorado with statistical parameters for each equation*

Region of applicability*	Equation
South Platte, Republican, Arkansas, and Cimarron River Basins (1)	$Y_2 = 0.218 + 0.709[(X_1)(X_1/X_2)]$ $Y_{100} = 1.897 + 0.439[(X_3)(X_3/X_4)] - 0.008Z$
San Juan, Upper Rio Grande, Upper Colorado, and Gunnison River Basins and Green River Basin below confluence with the Yampa River (2)	$Y_2 = -0.011 + 0.942[(X_1)(X_1/X_2)]$ $Y_{100} = 0.494 + 0.755[(X_3)(X_3/X_4)]$
Yampa and Green River Basins above confluence of Green and Yampa Rivers (3)	$Y_2 = 0.019 + 0.711[(X_1)(X_1/X_2)] + 0.001Z$ $Y_{100} = 0.338 + 0.670[(X_3)(X_3/X_4)] + 0.001Z$
North Platte (4)	$Y_2 = 0.028 + 0.890[(X_1)(X_1/X_2)]$ $Y_{100} = 0.671 + 0.757[(X_3)(X_3/X_4)] - 0.003Z$

⟸ Grand Junction Area and Cheney Reservoir Area

* Numbers in parentheses refer to geographic regions shown in figure 19.

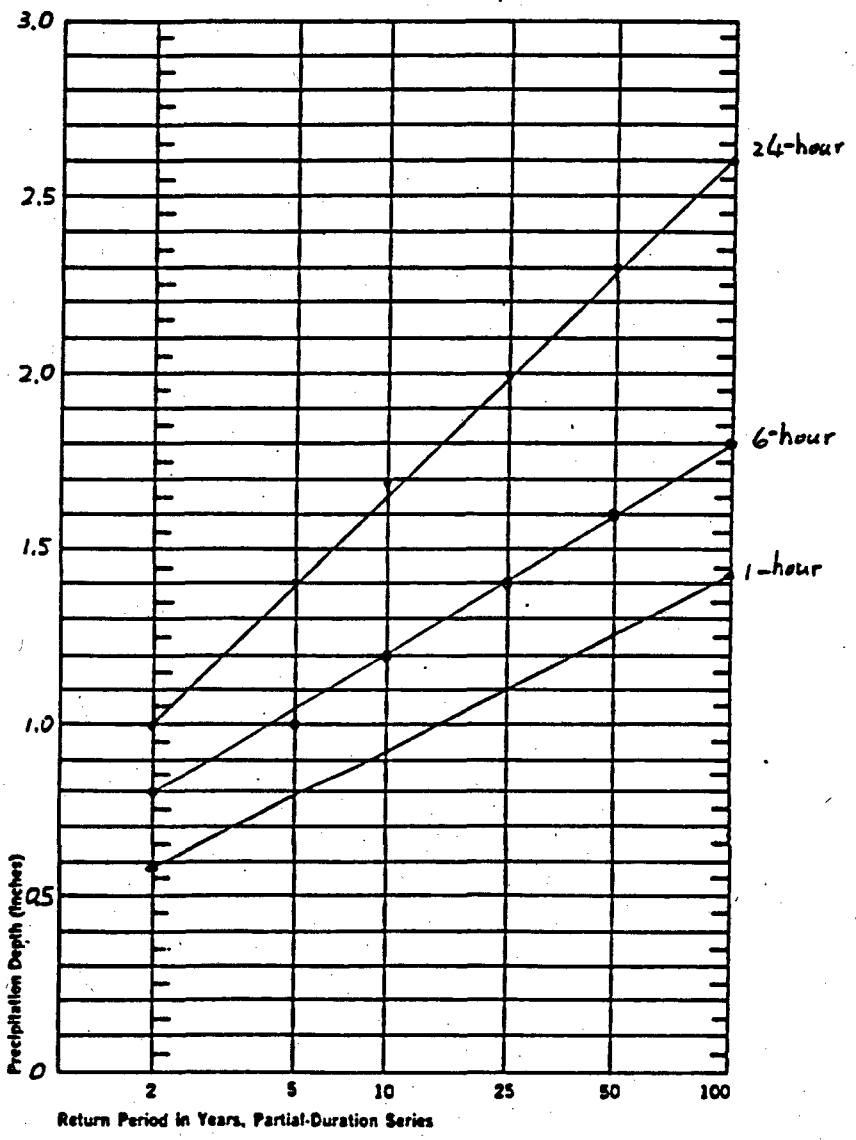
List of variables
Y_2 = 2-yr 1-hr estimated value
Y_{100} = 100-yr 1-hr estimated value
X_1 = 2-yr 6-hr value from precipitation-frequency maps
X_2 = 2-yr 24-hr value from precipitation-frequency maps
X_3 = 100-yr 6-hr value from precipitation-frequency maps
X_4 = 100-yr 24-hr value from precipitation-frequency maps
Z = point elevation in hundreds of feet

Table 12. *Adjustment factors to obtain n-min estimates from 1-hr values*

Duration (min)	5	10	15	30
Ratio to 1-hr	0.29	0.45	0.57	0.79

(Adopted from *U.S. Weather Bureau Technical Paper* No. 40, 1961.)

Figure 18. *Illustration of use of precipitation-frequency diagrams using values from precipitation-frequency maps and relations at 106°00′ W., 39°00′ N.*



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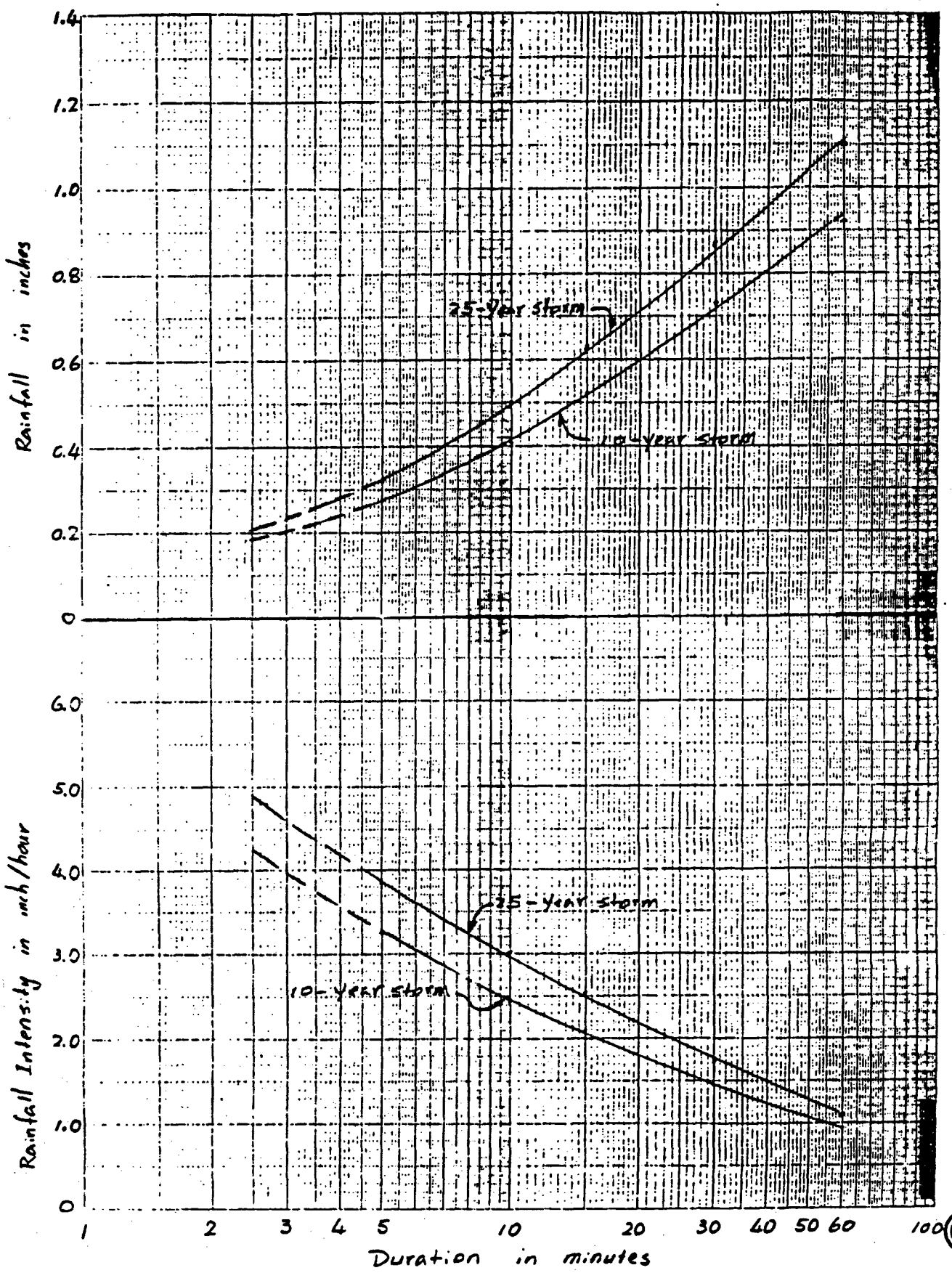
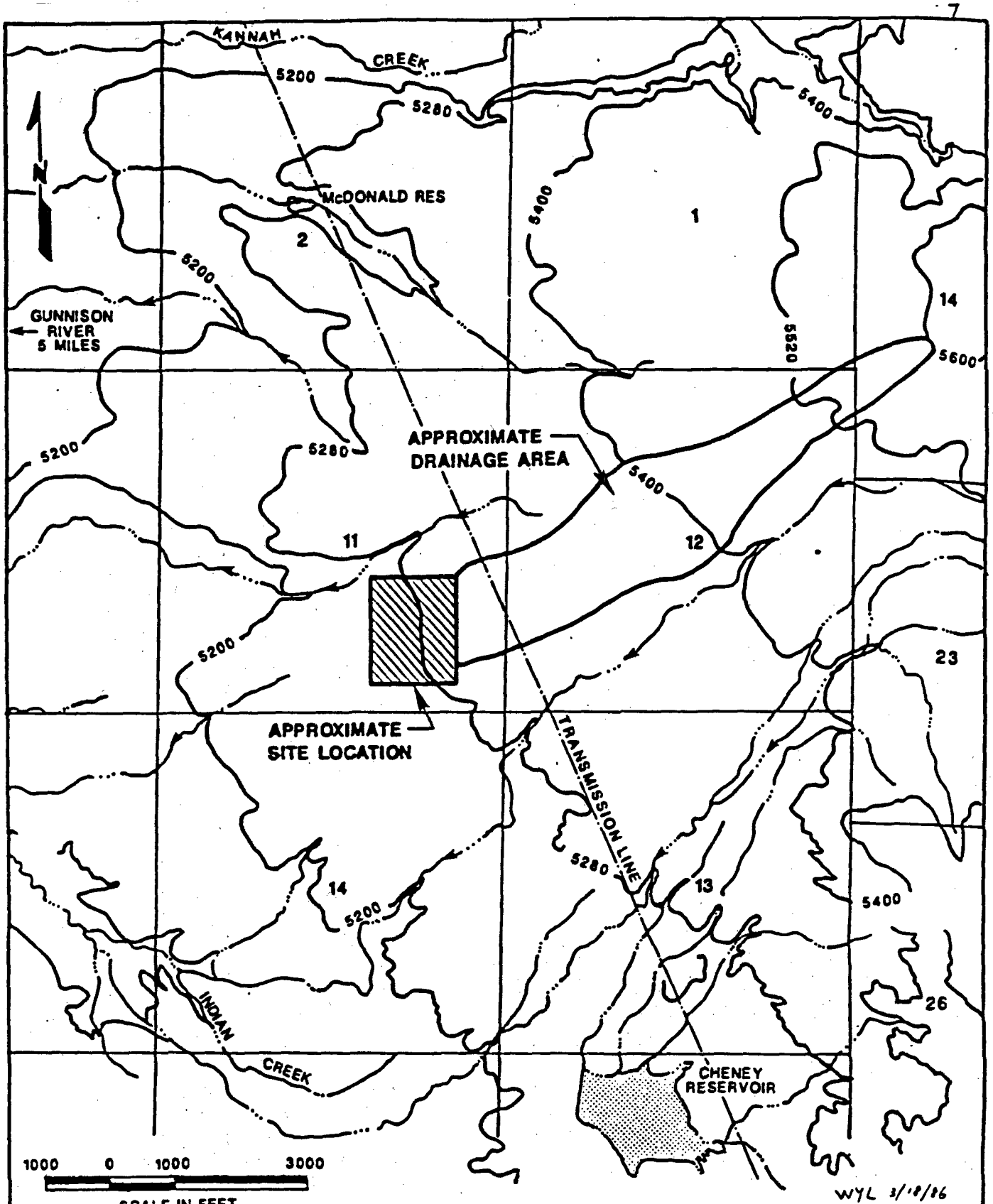


B. After remedial action, rainfall will be determined for the Cheney Reservoir disposal site from the general-storm pmp or the local-storm pmp whichever is more severe according to HMR No 49. The watershed areas of the proposed diversion ditch (if required) and the proposed tailings embankment are 240 acres (0.375 mi²) and 70 acres (0.110 mi²), respectively (Ref 3). No depth-area correction is required for PMP for watershed area less than 10 mi². The site elevation is 4460.

The wet season of the site is from July to October. The general-storm PMP and the local-storm PMP are calculated as shown below (pp. 8-12). It shows that the local-storm PMP is more intense than the general-storm PMP that the local-storm PMP should be used for design.

III. Design Storms

The design storms for the remedial action for Grand Junction site are shown on a plot. Design Storms on pp. 13



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JTK 3/8/86

FIGURE F.1.4

SURFACE DRAINAGE CHARACTERISTICS - CHENEY RESERVOIR SITE

Draft EIS 1986

HMR No. 49

Table 6.1.—General-storm PMP computations for the Colorado River and Great basin

Drainage Chenoy Reservoir Disposal Site El 5260 Area less than 1 mi^2 (km^2)

Latitude 38°54'N, Longitude ___ of basin center 108°20'W

Month July

Step	Duration (hrs) 6	12	18	24	48	72
A. Convergence PMP						
1. Drainage average value from one of figures 2.5 to 2.16 12.5 in. (~~mm~~)						
2. Reduction for barrier-elevation [fig. 2.18] 40 %						
3. Barrier-elevation reduced PMP [step 1 X step 2] 5.0 in. (~~mm~~)						
4. Durational variation [figs. 2.25 to 2.27 and table 2.7].	70	87	94	100	116	120 %
5. Convergence PMP for indicated durations [steps 3 X 4]	3.5	4.4	4.7	5.0	5.7	6.0 in. (~~mm~~)
6. Incremental 10 mi^2 (26 km^2) PMP [successive subtraction in step 5]	3.5	0.9	0.3	0.3	0.7	0.3 in. (~~mm~~)
7. Areal reduction [select from figs. 2.28 and 2.29]	100	100	100	100	100	100 %
8. Areally reduced PMP [step 6 X step 7]	3.5	0.9	0.3	0.3	0.7	0.3 in. (~~mm~~)
9. Drainage average PMP [accumulated values of step 8]	3.5	4.4	4.7	5.0	5.7	6.0 in. (~~mm~~)
B. Orographic PMP						
1. Drainage average orographic index from figure 3.11a to d. 3.0 in. (~~mm~~)						
2. Areal reduction [figure 3.20] 100 %						
3. Adjustment for month [one of figs. 3.12 to 3.17] 101 %						
4. Areally and seasonally adjusted PMP [steps 1 X 2 X 3] 3.0 in. (~~mm~~)						
5. Durational variation [table 3.9]	30	57	80	100	157	185 %
6. Orographic PMP for given durations [steps 4 X 5]	0.9	1.7	2.4	3.0	4.7	5.6 in. (~~mm~~)
C. Total PMP						
1. Add steps A9 and B6	4.4	6.1	7.1	8.0	10.4	11.6 in. (~~mm~~)

2. PMP for other durations from smooth curve fitted to plot of computed data.
3. Comparison with local-storm PMP (see sec. 6.3).

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HMR No. 49

Table 6.1.—General-storm PMP computations for the Colorado River and Great basin

Drainage Cheney Reservoir Disposal Site El 5260 Area less than 1 mi^2 (km^2)

Latitude 38°54'N, Longitude ___ of basin center 108°20'W

Month August

Step	Duration (hrs) 6	12	18	24	48	72	
A. Convergence PMP							
1. Drainage average value from one of figures 2.5 to 2.16	13.4 in. (~~mm~~)						
2. Reduction for barrier-elevation [fig. 2.18]	40 %						
3. Barrier-elevation reduced PMP [step 1 X step 2]	5.4 in. (~~mm~~)						
4. Durational variation [figs. 2.25 to 2.27 and table 2.7].	70	87	94	100	116	120	%
5. Convergence PMP for indicated durations [steps 3 X 4]	3.8	4.7	5.1	5.4	6.2	6.5	in. (~~mm~~)
6. Incremental 10 mi^2 (26 km^2) PMP [successive subtraction in step 5]	3.8	0.9	0.4	0.3	0.8	0.3	in. (~~mm~~)
7. Areal reduction [select from figs. 2.28 and 2.29]	100	100	100	100	100	100	%
8. Areally reduced PMP [step 6 X step 7]	3.8	0.9	0.4	0.3	0.8	0.3	in. (~~mm~~)
9. Drainage average PMP [accumulated values of step 8]	3.8	4.7	5.1	5.4	6.2	6.5	in. (~~mm~~)
B. Orographic PMP							
1. Drainage average orographic index from figure 3.11a to d.	3.0 in. (~~mm~~)						
2. Areal reduction [figure 3.20]	100 %						
3. Adjustment for month [one of figs. 3.12 to 3.17]	100 %						
4. Areally and seasonally adjusted PMP [steps 1 X 2 X 3]	3.0 in. (~~mm~~)						
5. Durational variation [table 3.9]	30	57	80	100	167	185	%
6. Orographic PMP for given durations [steps 4 X 5]	0.9	1.7	2.4	3.0	4.7	5.6	in. (~~mm~~)
C. Total PMP							
1. Add steps A9 and B6	4.7	6.4	7.5	8.4	10.9	12.1	in. (~~mm~~)

2. PMP for other durations from smooth curve fitted to plot of computed data.

3. Comparison with local-storm PMP (see sec. 6.3).

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HMR No. 49

Table 6.1.—General-storm PMP computations for the Colorado River and Great basin

Drainage Cheney Reservoir Disposal Site El 5260 Area less than 1 mi^2 (km^2)

Latitude 38°54'N, Longitude ___ of basin center 108°20'W

Month September

Step	Duration (hrs) 6	12	18	24	48	72
A. Convergence PMP						
1. Drainage average value from one of figures 2.5 to 2.16	13.3 in. (~~mm~~)					
2. Reduction for barrier-elevation [fig. 2.18]	40 %					
3. Barrier-elevation reduced PMP [step 1 X step 2]	5.3 in. (~~mm~~)					
4. Durational variation [figs. 2.25 to 2.27 and table 2.7].	70	87	94	100	114	120 %
5. Convergence PMP for indicated durations [steps 3 X 4]	3.7	4.6	5.0	5.3	6.0	6.4 in. (~~mm~~)
6. Incremental 10 mi^2 (26 km^2) PMP [successive subtraction in step 5]	3.7	0.9	0.4	0.3	0.7	0.4 in. (~~mm~~)
7. Areal reduction [select from figs. 2.28 and 2.29]	100	100	100	100	100	100 %
8. Areally reduced PMP [step 6 X step 7]	3.7	0.9	0.4	0.3	0.7	0.4 in. (~~mm~~)
9. Drainage average PMP [accumulated values of step 8]	3.7	4.6	5.0	5.3	6.0	6.4 in. (~~mm~~)
B. Orographic PMP						
1. Drainage average orographic index from figure 3.11a to d.	3.0 in. (~~mm~~)					
2. Areal reduction [figure 3.20]	100 %					
3. Adjustment for month [one of figs. 3.12 to 3.17]	100 %					
4. Areally and seasonally adjusted PMP [steps 1 X 2 X 3]	3.0 in. (~~mm~~)					
5. Durational variation [table 3.9]	30	57	80	100	157	185 %
6. Orographic PMP for given durations [steps 4 X 5]	0.9	1.7	2.4	3.0	4.7	5.6 in. (~~mm~~)
C. Total PMP						
1. Add steps A9 and B6	4.6	6.3	7.4	8.3	10.7	12.0 in. (~~mm~~)

2. PMP for other durations from smooth curve fitted to plot of computed data.

3. Comparison with local-storm PMP (see sec. 6.3).

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HMR No. 49

Table 6.1.—General-storm PMP computations for the Colorado River and Great basin

Drainage Cheney Reservoir Disposal Site El 5260 Area less than 1 mi^2 (km^2)

Latitude 38°54' N, Longitude ___ of basin center 108°20' W

Month October

Step	Duration (hrs) 6	12	18	24	48	72
A. Convergence PMP						
1. Drainage average value from one of figures 2.5 to 2.16	12.3 in. (~~mm~~)					
2. Reduction for barrier-elevation [fig. 2.18]	40 %					
3. Barrier-elevation reduced PMP [step 1 X step 2]	4.9 in. (~~mm~~)					
4. Durational variation [figs. 2.25 to 2.27 and table 2.7].	67	84	96	100	116	123 %
5. Convergence PMP for indicated durations [steps 3 X 4]	3.3	4.2	4.6	4.9	5.7	6.0 in. (~~mm~~)
6. Incremental 10 mi^2 (26 km^2) PMP [successive subtraction in step 5]	3.3	0.9	0.4	0.3	0.8	0.3 in. (~~mm~~)
7. Areal reduction [select from figs. 2.28 and 2.29]	100	100	100	100	100	100 %
8. Areally reduced PMP [step 6 X step 7]	3.3	0.9	0.4	0.3	0.8	0.3 in. (~~mm~~)
9. Drainage average PMP [accumulated values of step 8]	3.3	4.2	4.6	4.9	5.7	6.0 in. (~~mm~~)
B. Orographic PMP						
1. Drainage average orographic index from figure 3.11a to d.	3.0 in. (~~mm~~)					
2. Areal reduction [figure 3.20]	100 %					
3. Adjustment for month [one of figs. 3.12 to 3.17]	98 %					
4. Areally and seasonally adjusted PMP [steps 1 X 2 X 3]	2.9 in. (~~mm~~)					
5. Durational variation [table 3.9]	30	57	80	100	157	185 %
6. Orographic PMP for given durations [steps 4 X 5]	0.9	1.7	2.3	2.9	4.6	5.4 in. (~~mm~~)
C. Total PMP						
1. Add steps A9 and B6	4.2	5.9	6.9	7.8	10.3	11.4 in. (~~mm~~)

2. PMP for other durations from smooth curve fitted to plot of computed data.

3. Comparison with local-storm PMP (see sec. 6.3).

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HMR No. 49

Table 6.3A.—Local-storm PMP computation, Colorado River, Great Basin and California drainages. For drainage average depth PMP. Go to table 6.3B if areal variation is required.

Drainage Cheney Reservoir Disposal Site Area less than 1 mi^2 (km^2)
Latitude 38°54' N Longitude 108°20' W Minimum Elevation 5260 ft (m)

Steps correspond to those in sec. 6.3A.

1. Average 1-hr 1-mi^2 (2.6-km^2) PMP for drainage [fig. 4.5]. 8.0 in. (mm)

2. a. Reduction for elevation. [No adjustment for elevations up to 5,000 feet (1,524 m): 5% decrease per 1,000 feet (305 m) above 5,000 feet (1,524 m)]. $(100 - 5 \times \frac{5260-5000}{1000}) \times 100\% = 98.7\%$ 98.7 %

   b. Multiply step 1 by step 2a. 7.9 in. (mm)

3. Average 6/1-hr ratio for drainage [fig. 4.7]. 1.20

	Duration (hr)									
	1/4	1/2	3/4	1	2	3	4	5	6	
4. Durational variation for 6/1-hr ratio of step 3 [table 4.4].	74	89	95	100	110	115	118	119	120	%
5. 1-mi^2 (2.6-km^2) PMP for indicated durations [step 2b X step 4].	5.8	7.0	7.5	7.9	8.7	9.1	9.3	9.4	9.5	in. (mm)
6. Areal reduction [fig. 4.9].	100	100	100	100	100	100	100	100	100	%
7. Areal reduced PMP [steps 5 X 6].	5.8	7.0	7.5	7.9	8.7	9.1	9.3	9.4	9.5	in. (mm)
Intensity	23.20	14.00	10.00	7.90	4.35	3.03	2.33	1.88	1.58	in./hr
8. Incremental PMP [successive subtraction in step 7].				7.9	0.8	0.4	0.2	0.1	0.1	in. (mm)
	5.8	1.2	0.5	0.4	} 15-min. increments					

9. Time sequence of incremental PMP according to:

   Hourly increments [table 4.7]. HMR #5 0.1 0.4 7.9 0.8 0.2 0.1 in. (mm)

   Four largest 15-min. increments [table 4.8]. 5.8 1.2 0.5 0.4 in. (mm)

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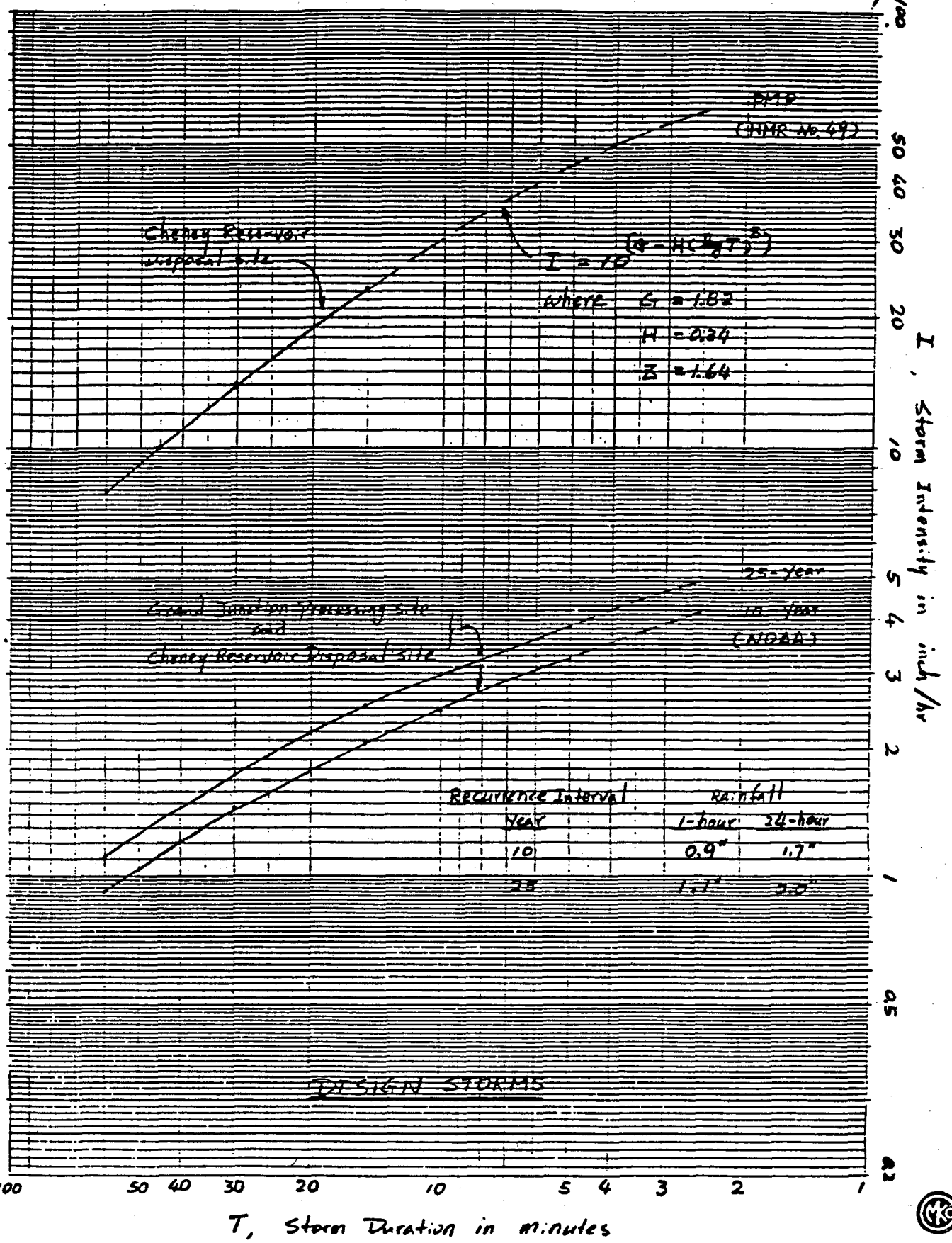

...nces in printing, and (3) precise ...s difficult. This has been done for ...g. 18a) and a line of best fit has ...is nomogram, the line fits the data ...viated noticeably from the line, the ...from the line and the new value ...in preference to the original

...alues for the point were computed ...to Region 1, figure 19 (table 11), ...Continental Divide. The 2-yr 1-hr ...2-yr 6- and 24-hr values from table ...r value is 1.86 in. (100-yr 6- and ...d elevation of 9,500 ft). By plotting ...and connecting them with a straight ...for return periods of 5, 10, 25, and

...an be estimated by using the nomo-...ons (3) and (4). The 1- and 6-hr ...period are obtained as above. Plot ...of figure 16 and connect them with ...ates for 2 or 3 hrs at the intersections ...the 2- and 3-hr vertical lines. An ...8b for the 2-yr return period. The ...3-hr (0.91 in.) values are in italics

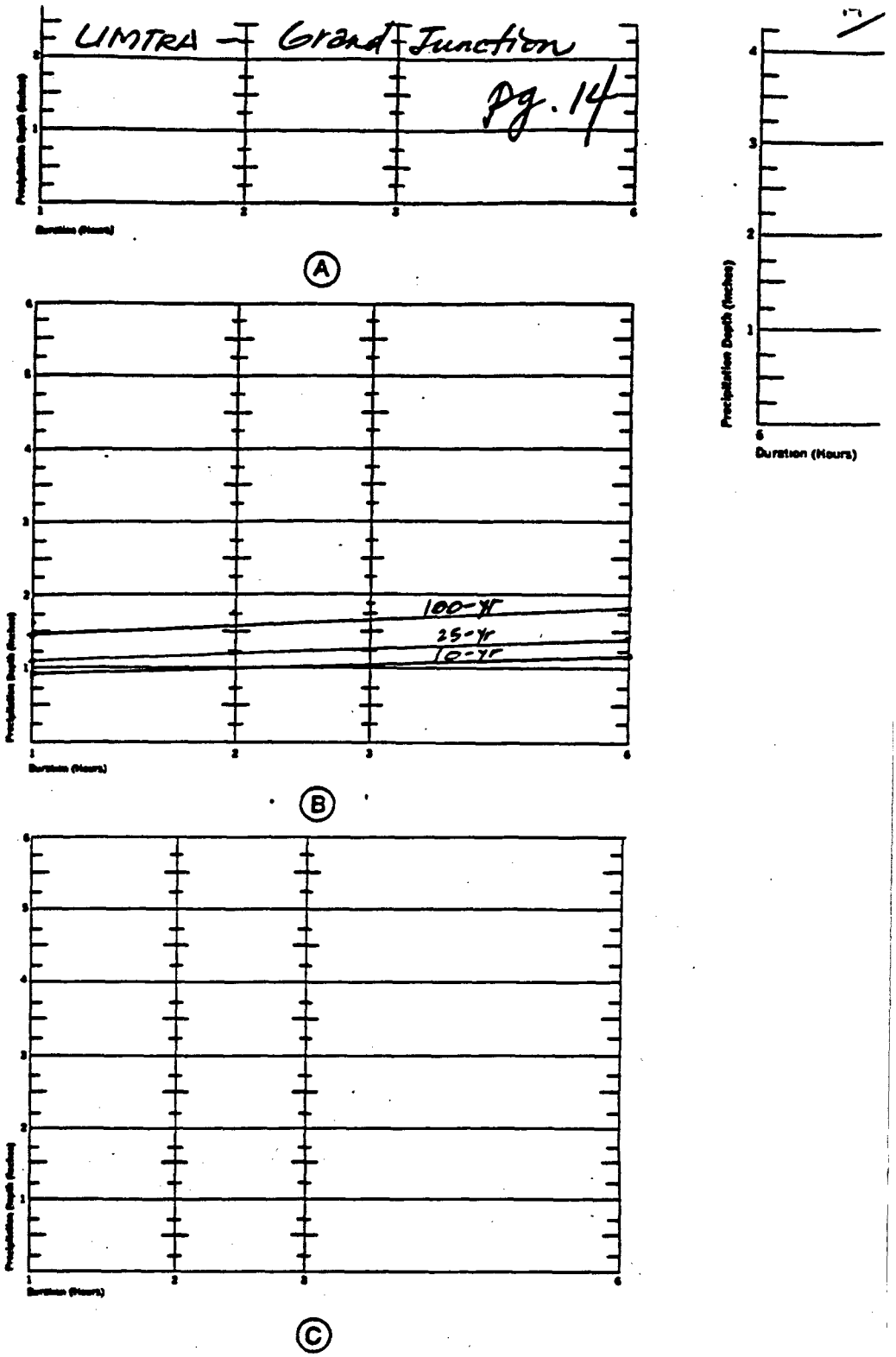

Figure 16. *Precipitation depth-duration diagram (1- to 6-hr).*
a. South Platte, Republican, Arkansas, and Cimarron River Basins (Region 1, fig. 19).
b. San Juan, Upper Rio Grande, Upper Colorado, and Gunnison River Basins and Green River Basin below its confluence with the Yampa River (Region 2, fig. 19).
c. Yampa and Green River Basins above confluence of Green and Yampa Rivers (Region 3, fig. 19) and North Platte Drainage (Region 4, fig. 19).

Figure 2.

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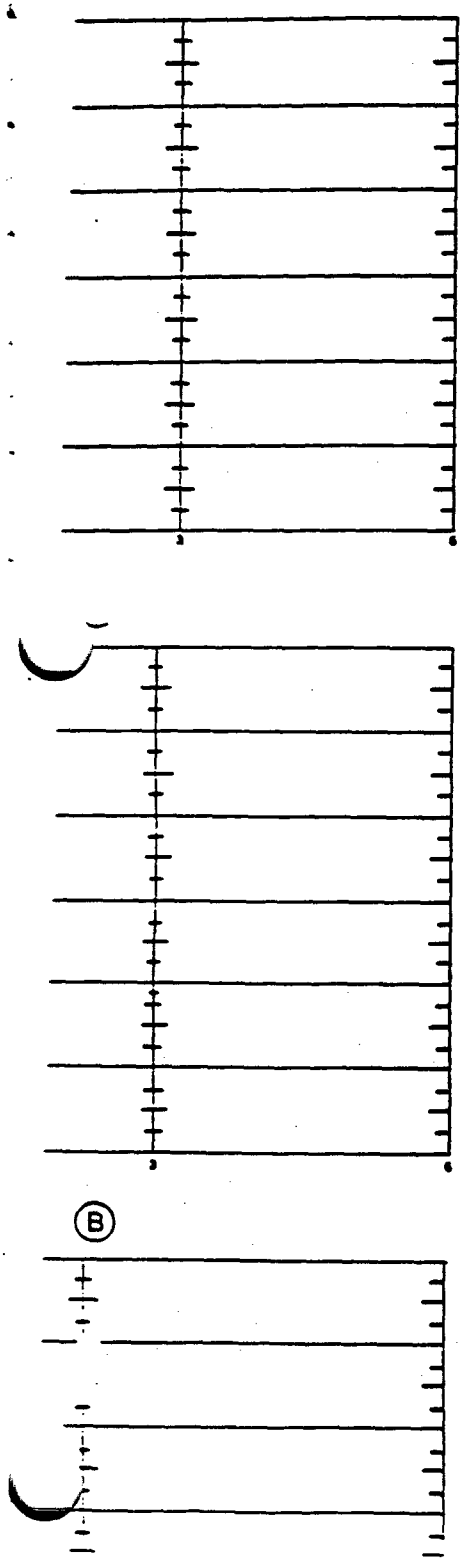
Precipitation-Frequency Atlas of the Western United States

Vol. II Colorado

pg. 15

Figure 17. *Precipitation depth-duration diagram (6- to 24-hr).*



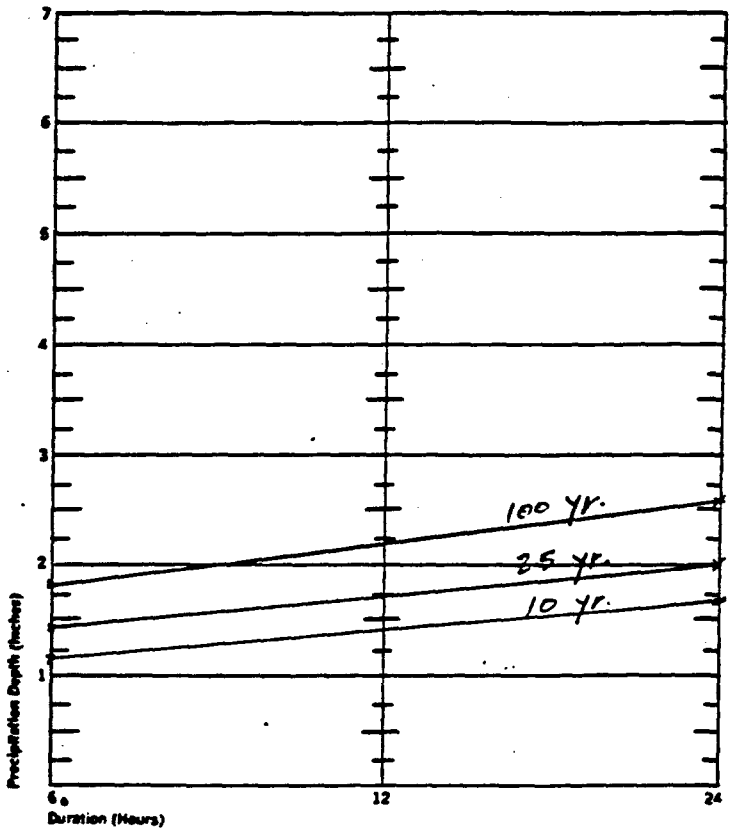


Figure 1 Precipitation depth-duration data

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Fig 16

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Figure 4. Rainfall Frequency-Duration Data

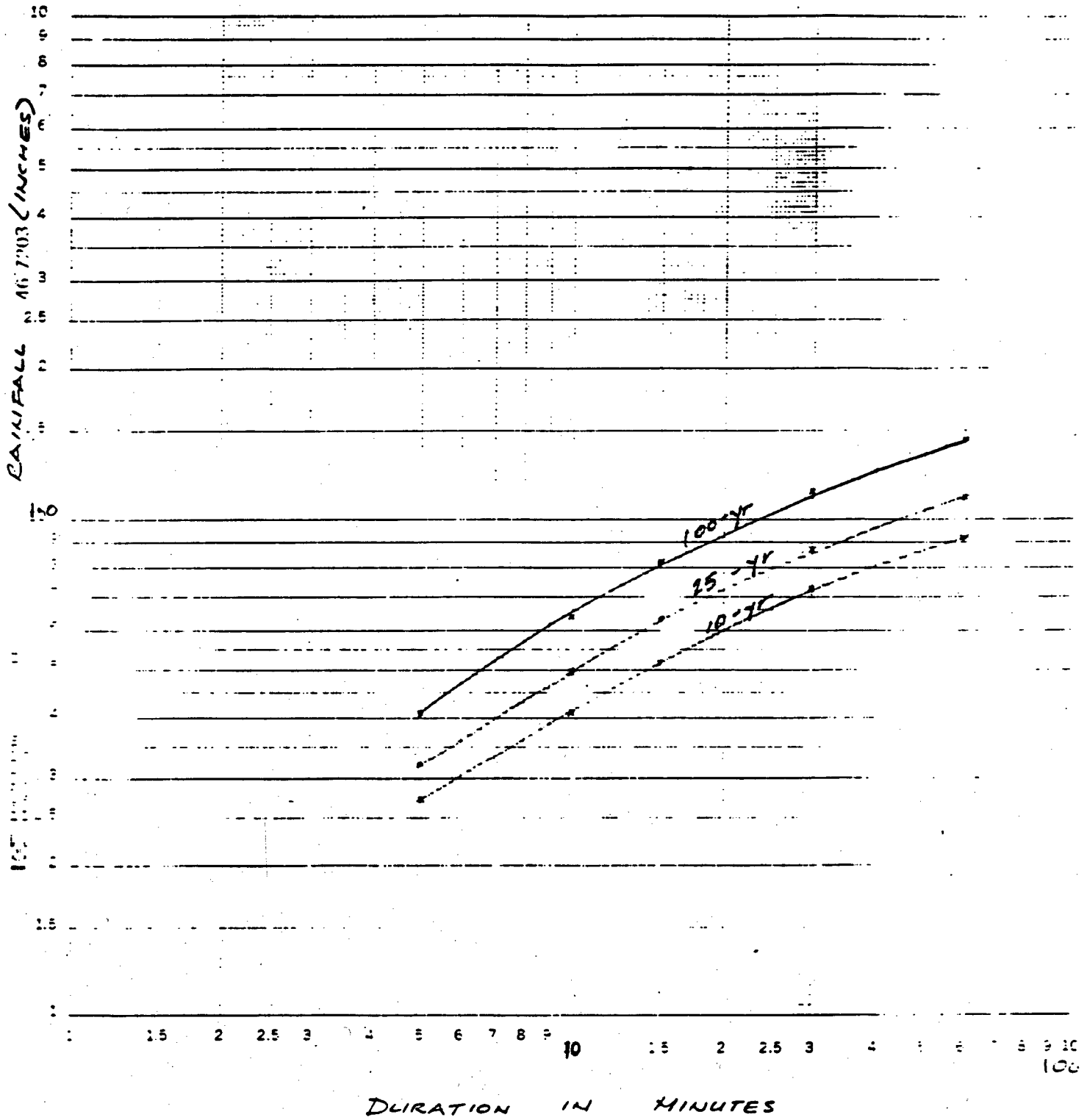

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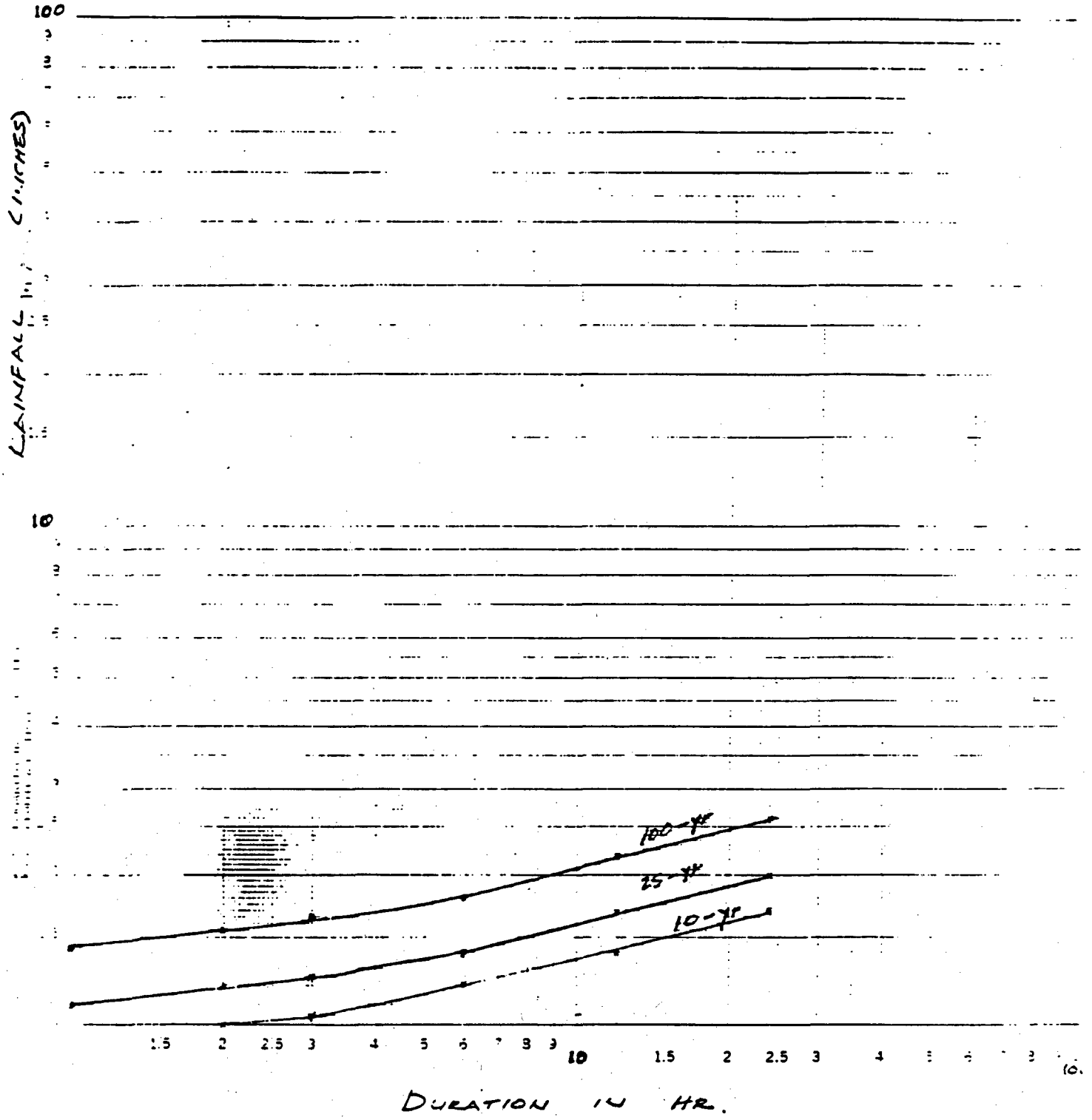
Figure 3. Rainfall Frequency-Duration Data



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Project: UMTRA - Grand Junction
Feature: Hydrology
Item: 10-, 25, 100-yr storms

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From Figure 3, the followings are tabulated.

Recurrence Interval	10-yr.			25-yr.			100-yr.		
Time (hr)	Accum. Rainfall (in)	Increment	Incre. Sequence	Accum. Rainfall (in)	Increment	Incre. Sequence	Accum Rainfall (in)	Increment	Incre. Sequence
6	1.2	1.2	0.1	1.4	1.4	0.1	1.8	1.8	0.2
		0.2	0.2		0.3	0.3		0.4	0.4
12	1.4			1.7			2.2		
		0.2	1.2		0.2	1.4		0.2	1.8
* 18	1.6			1.9			2.4		
		0.1	0.2		0.1	0.2		0.2	0.2
24	1.7			2.0			2.6		

* See Sheet 19 for rainfall distribution between 12th and 18th hrs.

100-yr	Duration (min)	Ratio to 1-hr.	Rainfall (inches)	Intensity (inch/hr)
	60	1.0	1.43	1.43
	30	0.79	1.13	2.26
	15	0.57	0.82	3.28
	10	0.45	0.64	3.84
	5	0.29	0.41	4.92

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Feature: Hydrology
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Date 8/18/86

(Rainfall units are in inches)

Time (hr)	10-yr. Accum. Rainfall	10-yr. Increment	10-yr. Incremental Sequence	25-yr. Accum. Rainfall	25-yr. Increment	25-yr. Incremental Sequence	100-yr. Accum. Rainfall	100-yr. Increment	100-yr. Incremental Sequence
1	0.92	0.92	0.04	1.10	1.10	0.04	1.43	1.43	0.05
2	1.00	0.08	0.05	1.18	0.08	0.06	1.55	0.12	0.07
3	1.04	0.04	0.08	1.25	0.07	0.08	1.63	0.08	0.12
4	1.10	0.06	0.92	1.31	0.06	1.10	1.68	0.05	1.43
5	1.15	0.05	0.06	1.35	0.04	0.07	1.75	0.07	0.08
6	1.20	0.05	0.05	1.40	0.05	0.05	1.80	0.05	0.05

See sheet 20 for rainfall distribution between Hrs. 3 and 4

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Contract No. 5D25
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Date: 8/8/86

Recurrence Interval

Time (Min.)	10-yr. Accum.	10-yr. Increment	10-yr. Incre. sequence	25-yr. Accum	25-yr. Increment	25-yr. Incre. Sequence	100-yr. Accum.	100-yr. Increment	100-yr. Incre. Sequence
5	0.27	0.27	0.03	0.32	0.32	0.03	0.41	0.41	0.05
10	0.41	0.14	0.03	0.50	0.18	0.04	0.64	0.23	0.05
15	0.52	0.11	0.04	0.63	0.13	0.05	0.82	0.18	0.07
20	0.60	0.08	0.07	0.72	0.09	0.08	0.93	0.11	0.10
25	0.66	0.06	0.11	0.80	0.08	0.13	1.03	0.10	0.18
30	0.73	0.07	0.27	0.87	0.07	0.32	1.13	0.10	0.41
35	0.77	0.04	0.14	0.91	0.04	0.18	1.18	0.05	0.23
40	0.81	0.04	0.08	0.96	0.05	0.09	1.25	0.07	0.11
45	0.84	0.03	0.06	1.00	0.04	0.07	1.30	0.05	0.10
50	0.87	0.03	0.04	1.04	0.04	0.04	1.35	0.05	0.05
55	0.90	0.03	0.03	1.07	0.03	0.04	1.40	0.05	0.05
60	0.92	0.02	0.02	1.10	0.03	0.03	1.43	0.03	0.03

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Project: UMTRA – Grand Junction
Feature: Hydrology
Item: Local PMP

Contract No. 5025
Designed: FTK
Checked: WYL

Sheet 21
File No.
Date 7/14/86
Date 8/8/86

Arrange the hourly incremental PMP in sequence according to TABLES 4.7 and 4.8 (HMR #49)

Sequence (Hour)	(Min)	Precipitation (inches) HMR #5		Precipitation (inches) EM 1110-2-1411	
1		0.1		0.1	
2		0.4		0.2	
3	1st 15 min	5.8	7.9	0.8	
	2nd 15 min	1.2			
	3rd 15 min	0.5			
	4th 15 min	0.4			
4	1st 15 min	0.8		5.8	7.9
	2nd 15 min			1.2	
	3rd 15 min			0.5	
	4th 15 min			0.4	
5		0.2		0.4	
6		0.1		0.1	

K+E LOGARITHMIC 46 7323

UMTRA - Grand Junction
Figure 5. Rainfall - Duration Data

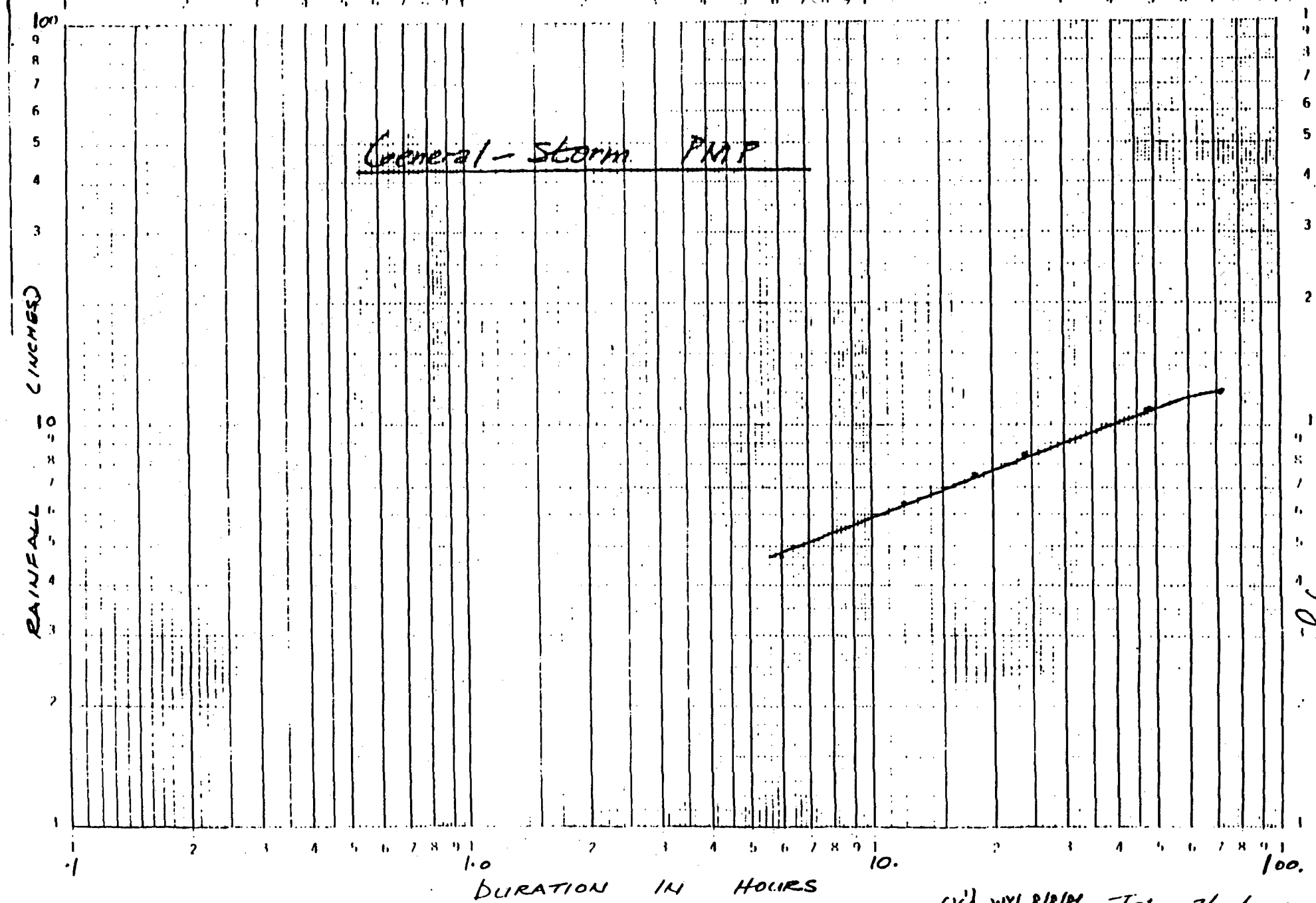


Fig. 22

Ck'd WYL 8/8/86

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA – Grand Junction
Feature: Hydrology
Item: General-Storm PMP
Contract No. 5025
Designed: JTK
Checked: WYL
Sheet 23
File No.
Date 7/15/86
Date 8/18/86

For General-Storm PMP, the month of August (sheet 9) gives the maximum amt. of rainfall, the duration variation of which is plotted on Figure 5.
Time sequence of PMP is based on HRM #43

Time (hr.)	Accum. Rainfall (in)	Incremental Rainfall (in)	Incremental Sequence (in)	Accum. Rainfall in sequence (in)
		4.7	0.2	
6	4.7			0.2
		1.7	0.3	
12	6.4			0.5
		1.1	0.6	
18	7.5			1.1
		0.9	0.6	
24	8.4			1.7
		0.6	0.9	
30	9.0			2.6
		0.6	1.7	
36	9.6			4.3
*		0.7	4.7	
42	10.3			9.0
		0.6	1.1	
48	10.9			10.1
		0.5	0.7	
54	11.4			10.8
		0.3	0.6	
60	11.7			11.4
		0.2	0.5	
66	11.9			11.9
		0.2	0.2	
72	12.1			12.1

* See sheet 24 for rainfall distribution between Hrs 36 and 42

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - Grand Junction
Feature: Hydrology
Item: General - Storm PMP

Contract No. 5025
Designed: FTK
Checked: WYL

Sheet 24
File No.
Date 7/16/86
Date 8/8/86

Based on Distribution, pg. 25

Time (hr.)	Southwestern Division 15 min (inches)	30 min	1 hr	EM 1110-2-1411 1 hr. (inches)
0				
1/4	0.047			
1/2	0.047	0.094		
3/4	0.094			
1	0.094	0.188	0.188	0.47
	0.094			
	0.094	0.188		
	0.094			
2	0.141	0.282	0.376	0.56
	0.188			
	0.235	0.517		
	0.376			
3	0.517	0.799	0.893	0.70
	1.034			
	0.423	1.55		
	0.282			
4	0.188	0.376	2.35	1.79
	0.141			
	0.141	0.235		
	0.094			
5	0.094	0.188	0.517	0.66
	0.094			
	0.094	0.188		
	0.047			
6	0.047	0.094	0.376	0.52

Pg. 25

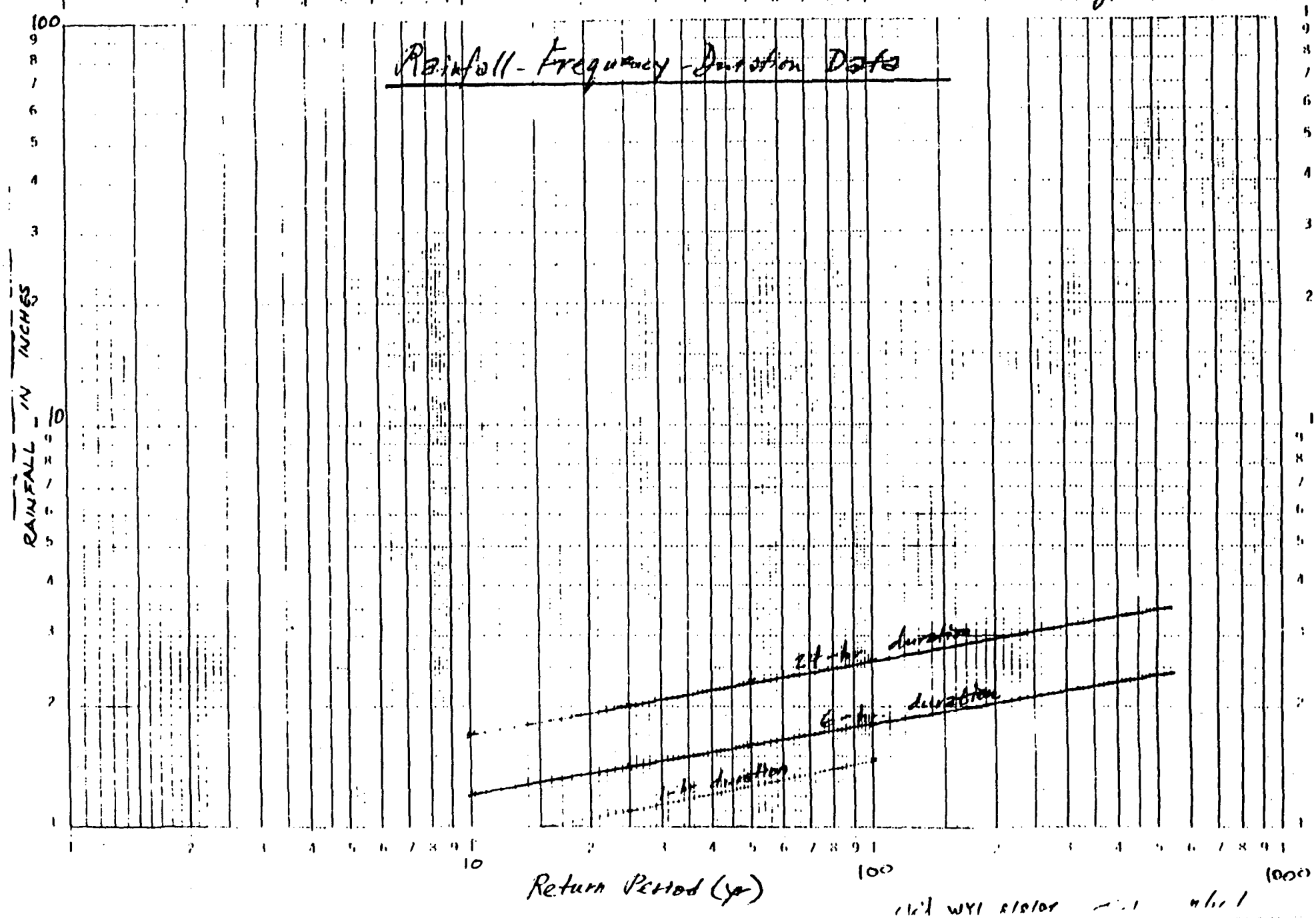
Duration (Hours)	Southwestern Division Critical Distribution of Maximum 6 Hrs. in % of 6-Hour Amount *			52-8 Plate 11 EM 1110-2-1411
	15 min.	30 min.	1 hr.	1 hr.
0	1			
1/4	1	2		
1/2	2			
3/4	2	4	4	10
1	2			
	2	4		
	2			
2	3	6	8	12
	4			
	5	11		
3	8	17	19	15
	11			
	22	33		
	9			
4	6	8	50	38
	4			
	3	5		
5	3	4	11	14
	2			
	2	4		
	2			
6	1	2	8	11

* Approved by OCE

ckd WYL 8/8/86
JTK 7/16/86

UMTRA – Construction

Pg. 2a



MKE DOCUMENT NO. 5025-GRJ-C-01-00486-01

Calculation Cover Sheet

Calc. No. 25-631-01-01

Contract No. 5025 Discipline ESCWP No. of Sheets 9

Project

UMTRA - GRAND JUNCTION

Feature

ACCESS ROAD

Item

CULVERT AT INDIAN CREEK

Sources of Data

SEE PAGE 1

Sources of Formulae & References

SEE PAGE 1

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

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
1	ADD SHT 9 CHANGE TO PROJECTION	S.E. Botsford	4/16/87	M.D. Lucente	4/16/87	[illegible]	4/27/87
0		S.E. Botsford	12/30/86	[illegible]	12/31/86	[illegible]	1/8/87

Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA GRJ
Feature ACCESS ROAD
Item CULVERT DESIGN

Contract No. 5025-06
Designed SLB
Checked RCR

Sheet 1
File No.
Date 12-29-86
Date 12-31-86

PURPOSE : DESIGN CULVERT FOR ACCESS ROAD TO CHENEY RESERVOIR AT INDIAN CREEK

REFERENCES:

1. UMTRA GRJ SITE DRAINAGE, HYDROLOGY PARAMETERS CALCULATION NO 5-628-01-00

2. DESIGN MANUAL, DIVISION OF HIGHWAYS STATE OF COLORADO, OCTOBER 1, 1984

3. MCCUEN, RICHARD H., A GUIDE TO HYDROLOGIC ANALYSIS USING SCS METHOD, PRENTICE HALL INC N.J 1982

4. HEC-1 FLOOD HYDROGRAPH PACKAGE USERS MANUAL, US. ARMY CORPS OF ENGINEERS JANUARY. 1985

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA GRJ
Feature: ACCESS ROAD
Item: CULVERT DESIGN

Contract No. 5025-06 | Sheet 2
Designed SLA | File No.
Checked RCG | Date 12-16-86
Date 12-31-86

(REF 2)

FROM COLORADO HIGHWAY DESIGN MANUAL TABLE 802.4A RECOMMENDS THAT CROSS DRAINAGE FOR RURAL TWO LANE ROAD WITH Q < 4000 CFS BE DESIGNED FOR A 25 YEAR STORM EVENT

$$Q = c\,i\,a$$
$$= (.4)(.6)(6291$$
$$= 1510 \text{ CFS} < 4000$$

USE 25 YEAR - 24 HOUR STORM EVENT

USE HEC-1 TO CALCULATE PEAK FLOW (SCS METHOD) (REF 4)

WATERSHED AREA = 6291 AC = 9.8 MI^2

LAG_{SCS} : $$L = \frac{l^{.8}\,(ST1)^{.7}}{1900\,Y^{(.5)}}$$ REF 3) p19

MAXIMUM RETENTION $S = \frac{1000}{CN} - 10 = 2.66$

WHERE CN = CURVE NUMBER = 79

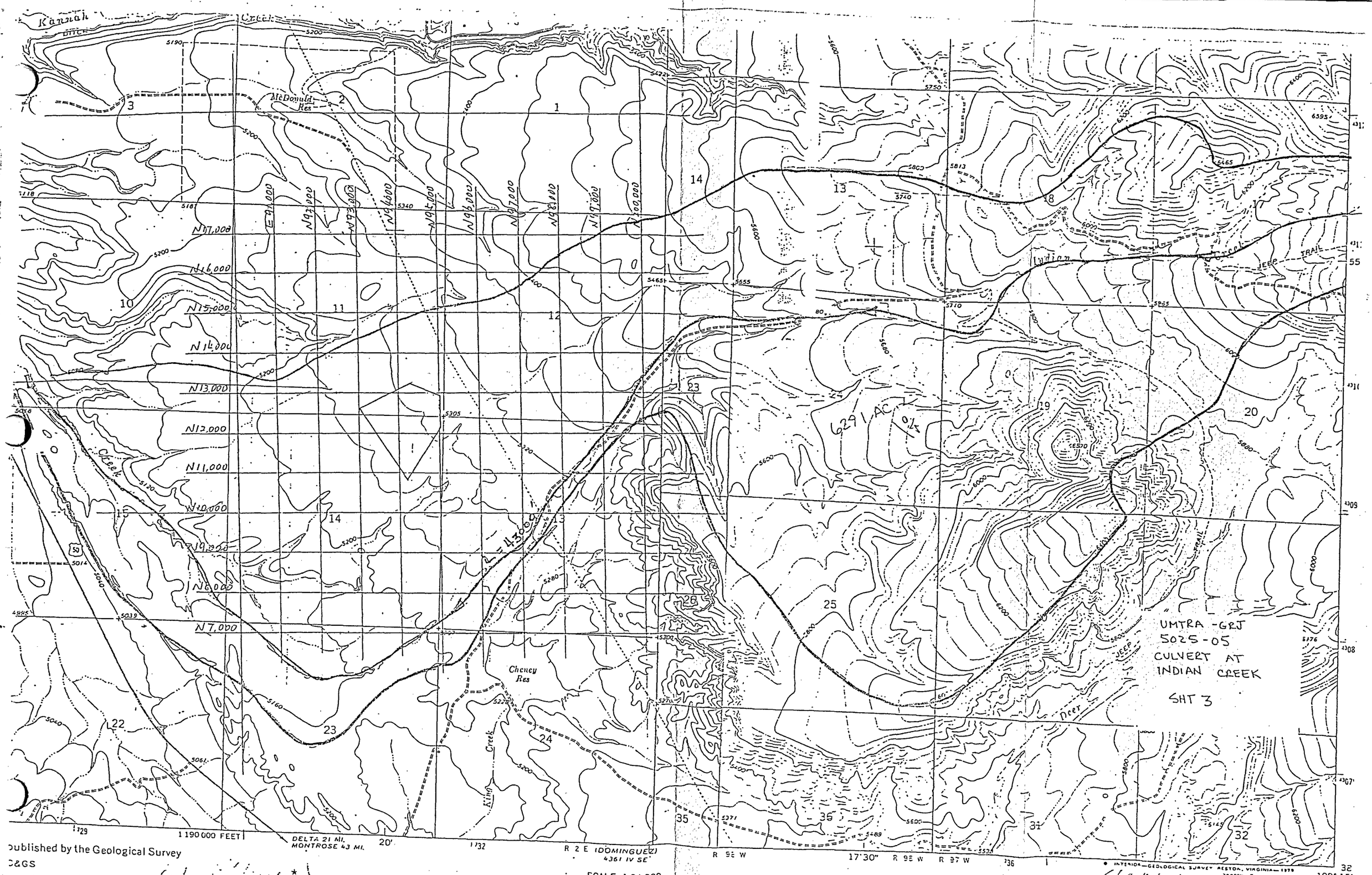
CN - (REF 3) p12 ASSUME GROUP C, CONDITION II FAIR PASTURE → 79

$$\text{SLOPE} = \frac{6500 - 5080}{43000}(100) = 3.3\%$$

$$L = \frac{43000^{.8}\,(2.66+1)^{.7}}{1900\,(3.3)^{.5}}$$

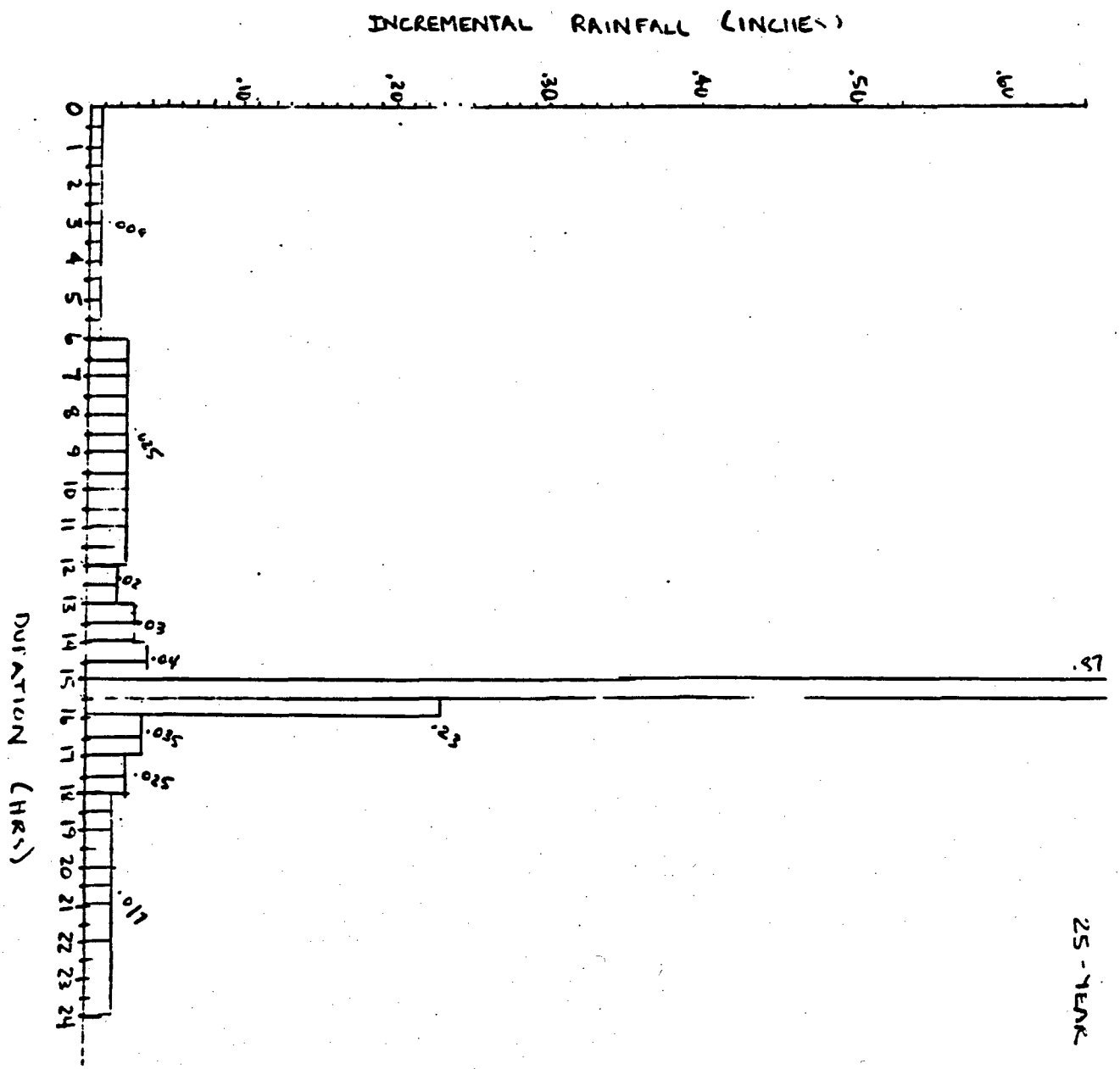
$$L_{ag} = 3.65 \text{ HR}$$

RAINFALL DISTRIBUTION FROM CALC 05-628-01 (REF 1) p18


Kannah Creek
McDonald Res
Indian Creek
JEEP TRAIL
Cheney Res
King Creek
Jeep
629 AC
UMTRA -GRJ
5025-05
CULVERT AT
INDIAN CREEK
SHT 3
N17,000
N16,000
N15,000
N14,000
N13,000
N12,000
N11,000
N10,000
N9,000
N8,000
N7,000
E91,000
N92,000
N93,000
N94,000
N95,000
N96,000
N97,000
N98,000
N99,000
N100,000
1 190 000 FEET
DELTA 21 MI.
MONTROSE 43 MI.
R 2 E (DOMINGUEZ)
4361 IV SE
R 98 W
17'30"
R 98 W
R 97 W
108° 15'
SCALE 1:24 000
1 MILE
ROAD CLASSIFICATION
Primary highway, all weather. Light-duty road, all weather.
Published by the Geological Survey
C&GS

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA GRT	Contract No. 5025-01	Sheet SHT 4	
Feature ACCESS ROAD	Designed SLB	File No.	Date 12-16-86
Item CULVERT DESIGN	Checked RCC		Date 12-30-86



UMTRA - GRJ
5025 - 06
CULVERT AT INDIAN CREEK
SHT 5 SWS 12/30/86
RGR 12/31/86

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1.1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

1 HEC-1 INPUT PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID      UMTRA/GRJ   HAUL ROAD CULVERT DESIGN
  2           ID      25 YR 24 HR STORM EVENT
  3           ID      30 MINUTE INTERVALS
  4           ID      DECEMBER 17,1986
  5           IT     30                   240
  6           IO      5      1

  7           KK       1CULVERT DRAINAGE AREA
  8           BA    9.8
  9           PB      0
 10           PI  0.008  0.008  0.008  0.008  0.008  0.008  0.008  0.008  0.008  0.008
 11           PI  0.008  0.008  0.025  0.025  0.025  0.025  0.025  0.025  0.025  0.025
 12           PI  0.025  0.025  0.025  0.025   0.02   0.02   0.03   0.03   0.04   0.04
 13           PI   0.87   0.23  0.035  0.035  0.025  0.025  0.017  0.017  0.017  0.017
 14           PI  0.017  0.017  0.017  0.017  0.017  0.017  0.017  0.017
 15           LS      0     79      0
 16           UD   3.65
 17           ZZ
```

****

FLOOD HYDROGRAPH PACKAGE HEC-1 IBM XT 512K VERSION: -FEB 1.1985

U.S. ARMY CORPS OF ENGINEERS. THE HYDROLOGIC ENGINEERING CENTER. 609 SECOND STREET. DAVIS. CA. 95616

****

UMTRA - GRJ
5025 - 06
CULVERT AT INDIAN CREEK
SHT 6.
EOR 12/31/86

UMTRA/GRJ HAUL ROAD CULVERT DESIGN
25 YR 24 HR STORM EVENT
30 MINUTE INTERVALS
DECEMBER 17.1986

6 ID OUTPUT CONTROL VARIABLES

IPRNT	5	PRINT CONTROL
IPLOT	1	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA

NMIN		30	MINUTES IN COMPUTATION INTERVAL
IDATE	1	0	STARTING DATE
ITIME		0000	STARTING TIME
NQ		240	NUMBER OF HYDROGRAPH ORDINATES
NDDATE	5	0	ENDING DATE
NDTIME		2330	ENDING TIME

COMPUTATION INTERVAL .50 HOURS
TOTAL TIME BASE 119.50 HOURS

ENGLISH UNITS

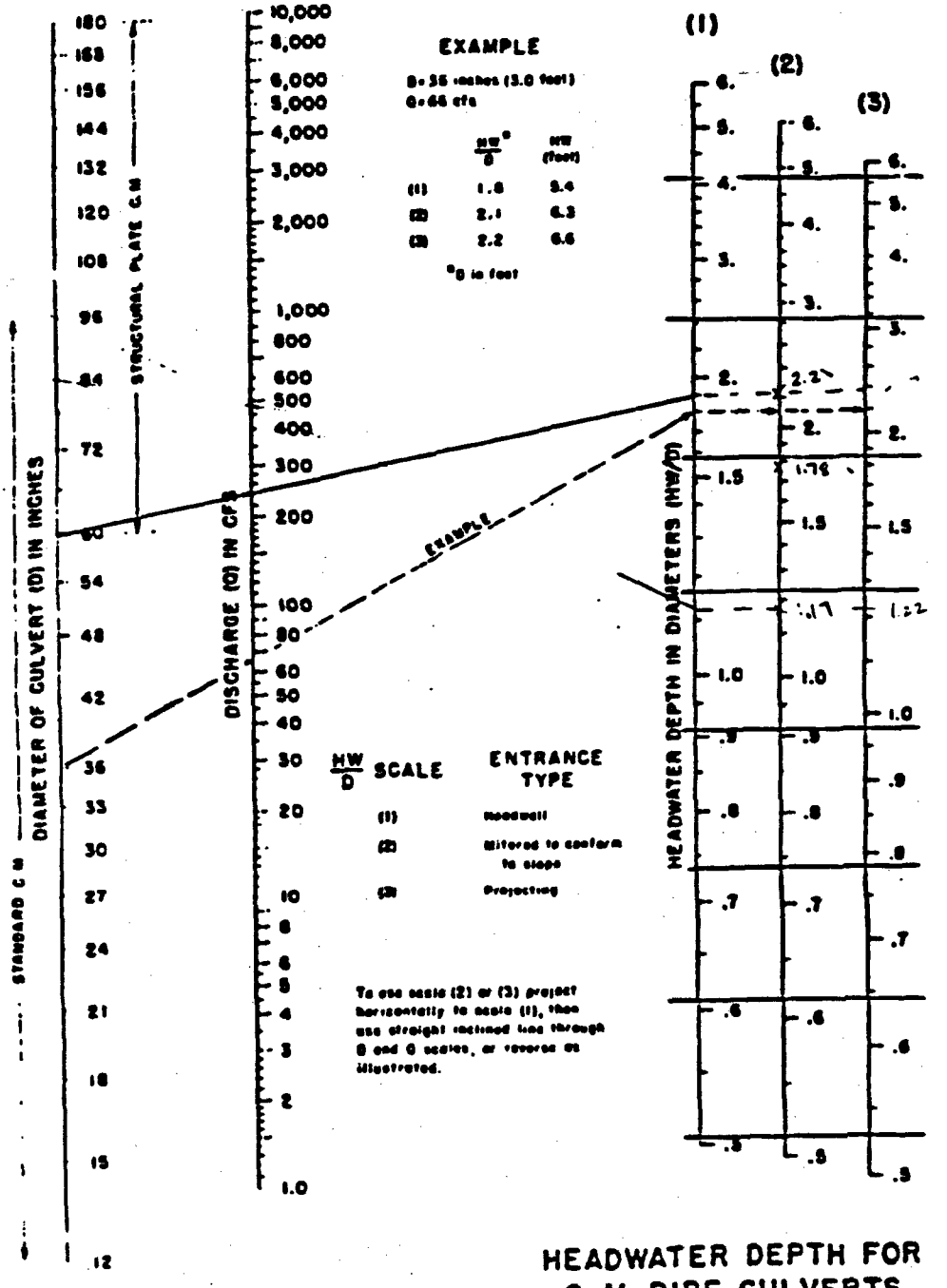
RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS. AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT		473.	19.50	366.	138.	46.	5.80		

*** NORMAL END OF HEC-1 ***

UMTRA GRJ 5025
CULVERT AT INDIAN CREEK SHT 7
FCL 12/31/86
SLG 12/30/86

FIGURE 804-1E



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

(REF 2)

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA GRJ
Feature: ACCESS ROAD
Item: CULVERT DESIGN

Contract No. 5-025-06
Designed: SHR
Checked: RCP

Sheet: SHT 8
File No.:
Date: 12-29-86
Date: 12-31-86

FROM HEC-1 PEAK FLOW = 473 CFS

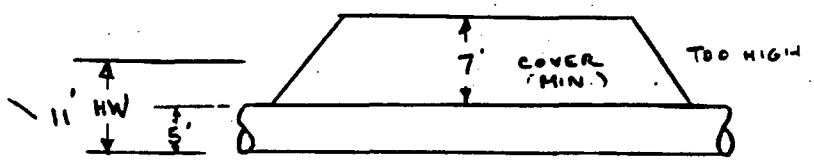
ASSUME THAT WE USE 2 CULVERTS EACH WITH A CAPACITY OF 240 CFS

USING NOMOGRAPH FIGURE 504-1E (REF 2) FOR CALCULATING HEADWATER DEPTH FOR C.M. PIPE CULVERT WITH INLET CONTROL

ASSUME TWO 60" DIAMETER PIPES

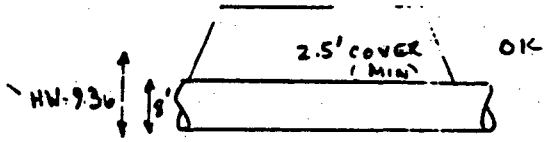
$\frac{HW}{D}$ = 2.2 FOR MITERED SLOPE

$HW = 2.2 \left(\frac{60}{12}\right) = 11.0$ FEET



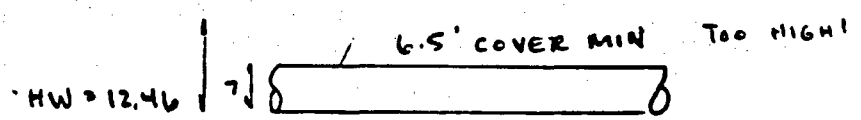
TRY SINGLE 96" ; $\frac{HW}{D} = 1.17$

$HW = 1.17 \left(\frac{96}{12}\right) = 9.36$



TRY SINGLE 84"

$1.78 \left(\frac{84}{12}\right) = 12.46$



USE SINGLE 96" CULVERT

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA GRJ	Contract No. [illegible]	Sheet 9	File No.
Feature ACCESS ROAD	Designed [illegible]	Date 4/[illegible]/87	
Item CULVERT DES (...)	Checked MDL	Date 4/16/87	

REVISION 1

CHANGE 96" PIPE TO ONE WITH PROJECTING ENDS.

$\frac{HW}{D} = 1.22$ $\quad HW = 1.22\left(\frac{96}{12}\right) = 9.76'$

$9.76 - 8' = 1.76 \rightarrow 3'$ COVER MIN

DESIGN WILL USE PROJECTING END.

MKE DOCUMENT NO. 5025-GRJ-C-01-00786-00

Calculation Cover Sheet

Contract No. 5025 Discipline ESCUP Calc. No. 05-631-02-01 No. of Sheets 22

Project

UMTRA / GRAND JUNCTION

Feature

ACCESS AND HAUL ROADS

Item

CULVERT PLACEMENT AND PROTECTION AT INDIAN CREEK

Sources of Data

SEE SHEET 2

Sources of Formulae & References

SEE SHEET 2

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

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
1	OUTLET SUPERSEDED	MD Lowenstein	5/18/87	S.E. Bolzgard	5/19/87	[illegible]	5/18/87
0	–	M.D. Lowenstein	4/22/87	HM	4/22/87	[illegible]	4/27/87

Form 42-110

PURPOSE

An access road will be built from U.S Highway 50 to the Cheney Reservoir disposal site. To prevent flooding of the road, a culvert needs to be designed to provide drainage through, instead of over, the access road. This culvert will be designed to pass a 25-year 24-hour storm.

From MKE Calc. no 05-631-01, the pipe was sized to accommodate a flow of Q = 473 cfs. The pipe chosen has a diameter of 8 ft.

This calculation will provide the bedding and riprap protection at the inlet and outlet of the culvert.

REFERENCES

1. MKE. UMTRA Grand Junction calc. no. 05-631-01. "Access Road - Culvert at Indian Creek."

2. Highway Task Force. Handbook of Steel Drainage and Highway Construction Products. New York: American Iron and Steel Institute, 1967

3. U.S. Department of Transportation. Hydraulic Design of Improved Inlets for Culverts. Washington, D.C., August 1972.

4. Brater, Ernest F., and Horace Williams King. Handbook of Hydraulics, Sixth Ed. New York: McGraw-Hill Co., 1976.

5. U.S. Department of Transportation. Hydraulic Design of Energy Dissipators for Culverts and Channels. Washington, D.C., December 1975.

6. Lindeburg, Michael R. Civil Engineering Review Manual, Third Ed. San Carlos, California: Professional Publications, 1981.

7. State of Illinois. Standard Detail Drawings. Illinois: May 1975.

8. Division of Highways M & S Standards. Colorado Standard Plans. January 1982.

9. Department of the Army Corps of Engineers. Hydraulic Design of Flood Control Channels. Washington, D.C., July 1970.

CULVERT LENGTH AND SKEW

The access road width is 32 ft. shoulder to shoulder, and the fill sideslopes are 2:1. The length of the culvert normal to the road is 82 ft if the pipe outlet were 1 ft lower in elevation than the pipe inlet. The distance is therefore 25' from the shoulder to the edge of the toe on each side of the road. The pipe is skewed to match the upstream line to the downstream line on drawing no. GRJ-DS-10-0123. From this contour map (see sketch on next sheet), the skewed length of the culvert is 116 feet The length of the culvert normal to the road is 82 feet.

$$116 \text{ ft} = \frac{82 \text{ ft}}{\cos\theta}$$

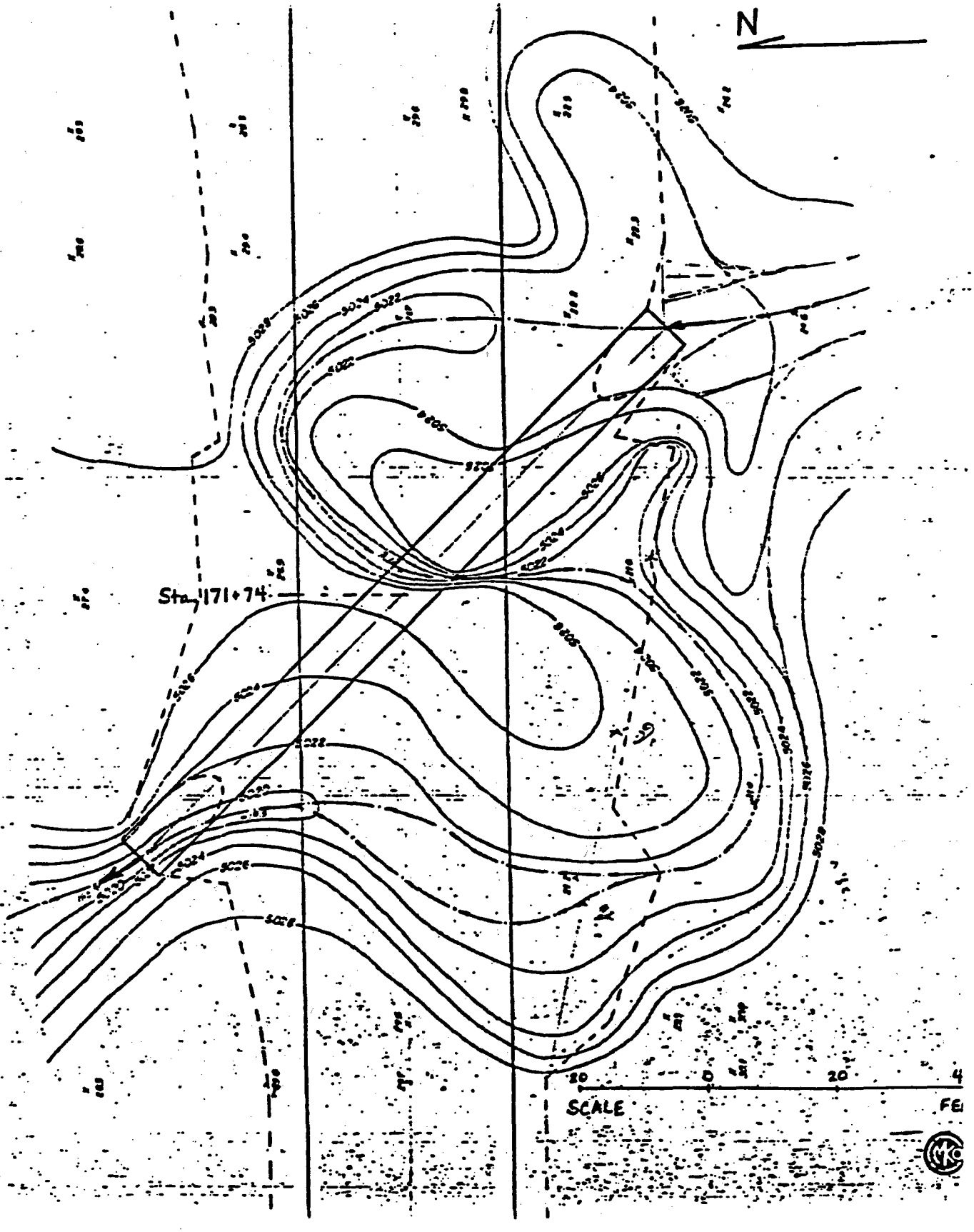
$$\cos\theta = 0.71$$

$$\theta = 45.02°$$

The required length of the pipe is 116 feet, and it will be skewed 45.02° from the normal to the access road.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ	Contract No. 5025	Sheet 4	
Feature ACCESS AND HAUL ROADS	Designed MDL	File No.	
Item CULVERT PLACEMENT AND PROTECTION AT INDIAN CREEK	Checked HM	Date 4/21/87	Date 4/21/87



RIPRAP PROTECTION AT OUTLET

From MKE Calc. No. 05-631-01, a 96"-dia. culvert will be used to accommodate a peak flow Q of 473 cfs during a 25-year 24-hour storm.

"Capacity of a culvert with a free outlet (not submerged) is not increased by placing on a slope steeper than its 'critical slope.' (About 1 per cent for a 96-in. pipe.)" (Ref. 2, p. 190-191).

From the Indian Creek contour map (see previous sheet), the existing inlet elevation is about 5023 ft. The outlet elevation is about 5019.7 ft. Therefore, the existing slope from inlet to outlet is:

$$\frac{5023 - 5019.7}{116'} = 2.84\%$$

To reduce the slope to a subcritical level, the inlet elevation was lowered to el. 5022.0 ft., and the outlet elevation was elevated to el. 5021.0 ft. Now, the slope of the culvert is:

$$\frac{5022.0 - 5021.0}{116'} = 0.86\% \quad \text{(subcritical slope)}$$

For an unpaved 8' ϕ CMP with 3 × 1 in. corrugations the coefficient of roughness $n = 0.027$ (Ref. 2, p. 108).

Headwater calculations were made by assuming both inlet and outlet control. Under inlet control condition, the headwater was found to be higher than the corresponding headwater under outlet control. From this it was concluded that the culvert is inlet controlled — see calculations in Appendix A. The coefficient of roughness n of 0.027 falls within the range of the coefficients checked in Appendix A, therefore the check is valid for our case.

From MKE Calc. no. 05-631-01, for a 96" pipe during a 25-year 24-hour storm:

$$\frac{HW}{D} = 1.22$$

$$HW = 1.22\left(\frac{96''}{12}\right) = 9.76 \text{ ft} > 8 \text{ ft (diameter of pipe)}$$

In determining the potential for scour at the culvert outlet, the tailwater conditions must first be known. The tailwater depth in the natural channel can be calculated using Manning's Equation.

$$Q = \frac{1.486}{n} A R^{2/3} s^{1/2} \quad \text{(Ref 4, p 7-14)}$$

For a winding natural stream channel with some pools, shoals, weeds, and stones, $n = 0.035$ (Ref. 4, p.7-22).

The channel has a rectangular cross section with a width of about 16 feet.

The slope of the natural stream channel is:

$$\frac{\text{el. } 5024.6 - \text{el. } 5019.5}{310'} = 0.0165$$

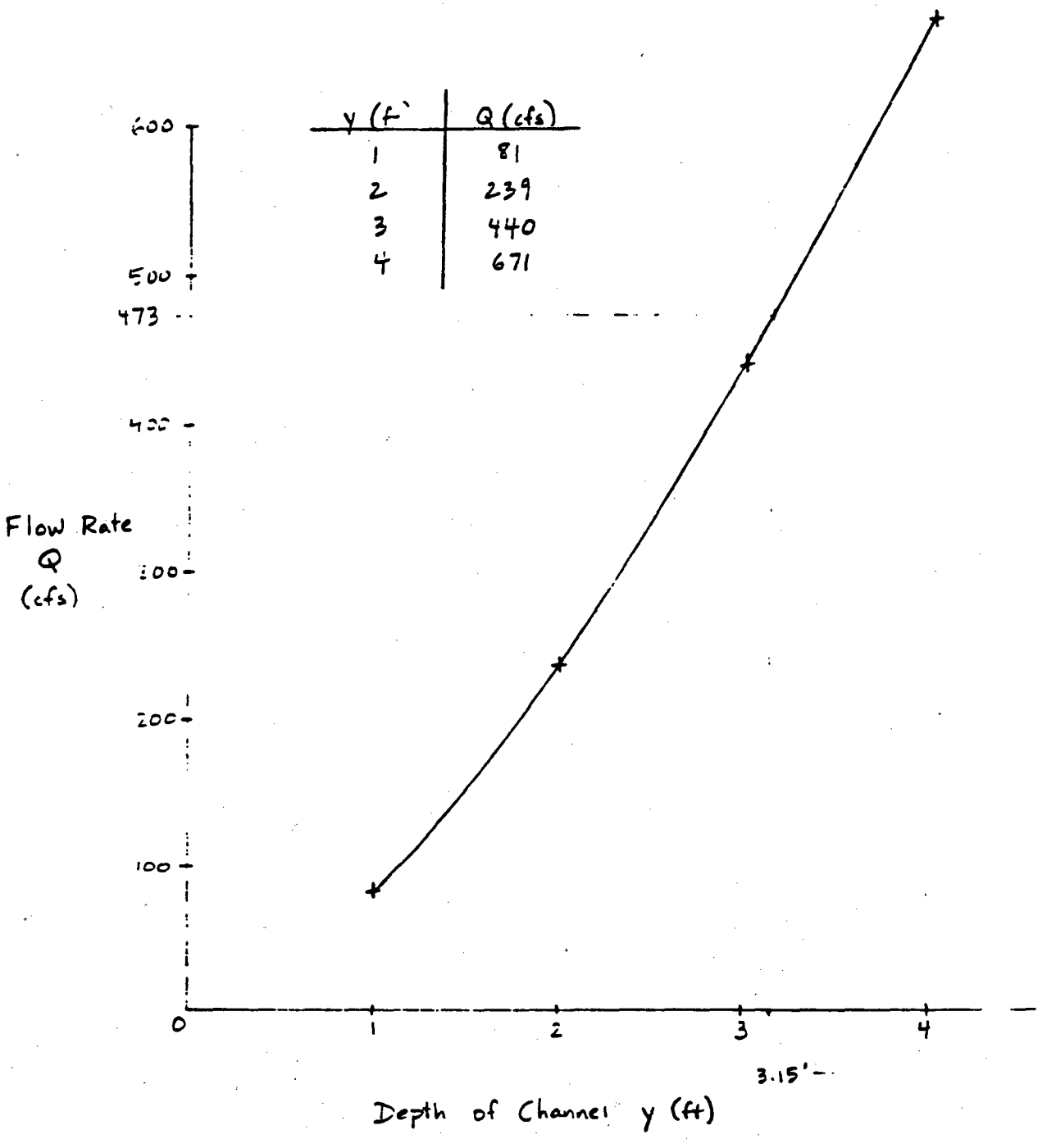
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRT
Feature ACCESS AND HAUL ROADS
Item CULVERT PLACEMENT AND PROTECTION AT INDIAN CR

Contract No. 5025
Designed MDL
Checked HM

Sheet 7
File No.
Date 4/17/87
Date 4/21/87

y (ft)	Q (cfs)
1	81
2	239
3	440
4	671



Manning's Equation $Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

$$Q = \frac{1.486}{0.035}(16 \cdot y)\left(\frac{16 \cdot y}{16+2y}\right)^{2/3}(0.0165)^{1/2}$$

From the previous sheet, the graph shows that for a flow Q of 473 cfs, the normal depth in the outlet channel (tailwater) is 3.15 ft.

Given: $TW = 3.15$ ft
$D = 8$ ft
$Q = 473$ cfs

Using the chart on the following page, we can find the brink depth Y_o.

$$\frac{TW}{D} = \frac{3.15}{8} = 0.39$$

$$\frac{Q}{D^{2.5}} = \frac{473}{8^{2.5}} = 2.61$$

$$\therefore \frac{Y_o}{D} = 0.57 \qquad Y_o = 0.57(8') = 4.56 \text{ ft}$$

The U.S. Department of Transportation offers a design procedure for a riprap basin which will serve to prevent scouring of the creek bed and will act as an energy dissipator. The design procedure begins on p. II-2, Ref 5.

The first step is to establish the brink invert elevation such that $TW/Y_o \leq 0.75$ for design discharge.

$$\frac{TW}{Y_o} = \frac{3.15}{4.56} = 0.69 \leq 0.75 \quad \therefore OK$$

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA/GRJ
Feature ACCESS AND HAUL ROADS
Item CULVERT PLACEMENT AND PROTECTION AT INDIAN CR.

Contract No. 5025
Designed MDL
Checked HM

Sheet 9
File No.
Date 4/17/87
Date 4/21/87

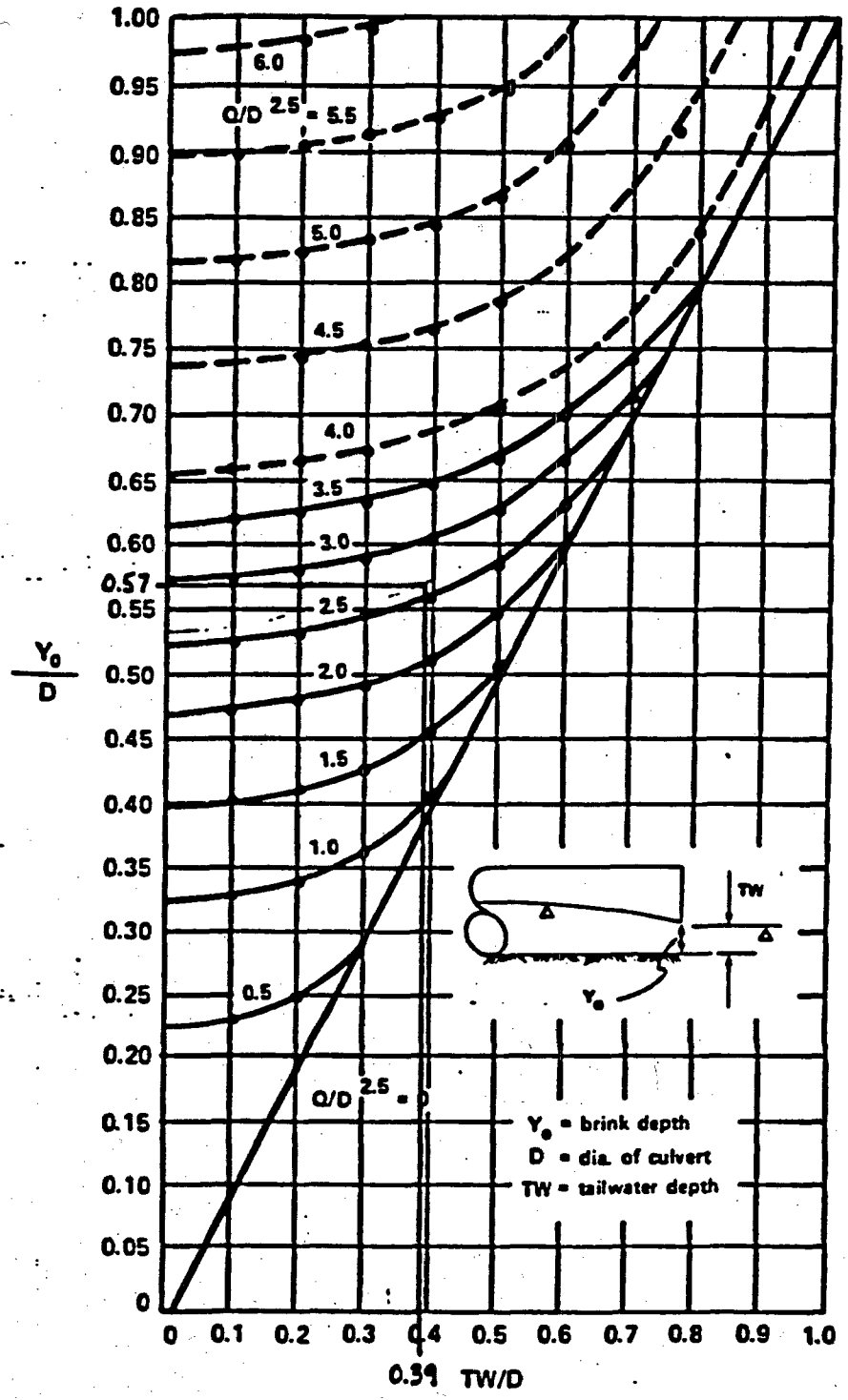


Figure III-10 Dimensionless Rating Curve for the Outlets of Circular Culverts on Horizontal and Mild Slopes from Reference III-2

Ref. 5, p. III-15

Brink depth $Y_o = 4.56$ ft

$$\frac{Y_o}{D} = \frac{4.56}{8} = 0.57 \qquad \therefore \frac{A}{D^2} = 0.4625 \qquad \text{(Ref 6, p.3-61)}$$

$$\frac{A}{8^2} = 0.4625$$

$$A = 29.6 \text{ ft}^2$$

Velocity at outlet $V_o = \frac{Q}{A} = \frac{473 \text{ cfs}}{29.6 \text{ ft}^2} = 15.98$ ft/s

$$V_o = 16.0 \text{ ft/sec}$$

Equivalent brink depth $y_e = \left(\frac{A}{2}\right)^{1/2} = \left(\frac{29.6}{2}\right)^{1/2} = 3.85$ ft

From Fig. XI-2, Ref 5,

Revision 1
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SUPERSEDED BY CALC. NO. 05B1-03

$$\text{Froude number} = \frac{V_{AVE}}{\sqrt{32.2\,(y_e)}}$$

$$= \frac{16.0 \text{ fps}}{\sqrt{(32.2 \text{ ft/s}^2)(3.85')}}$$

$$= 1.44$$

UMTRA/GRJ
ACCESS AND HAUL ROADS
CULVERT PLACEMENT AND PROTECTION AT INDIAN CR.

No. 5025 Sht. 11

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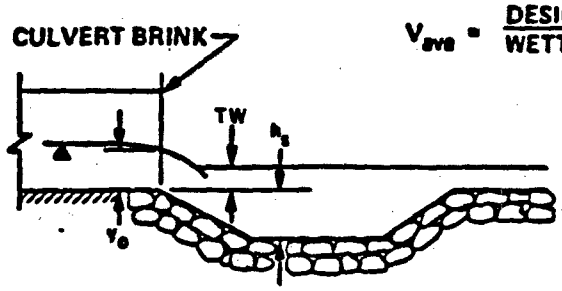
MDL 5/18/87
SKB 5/19/87



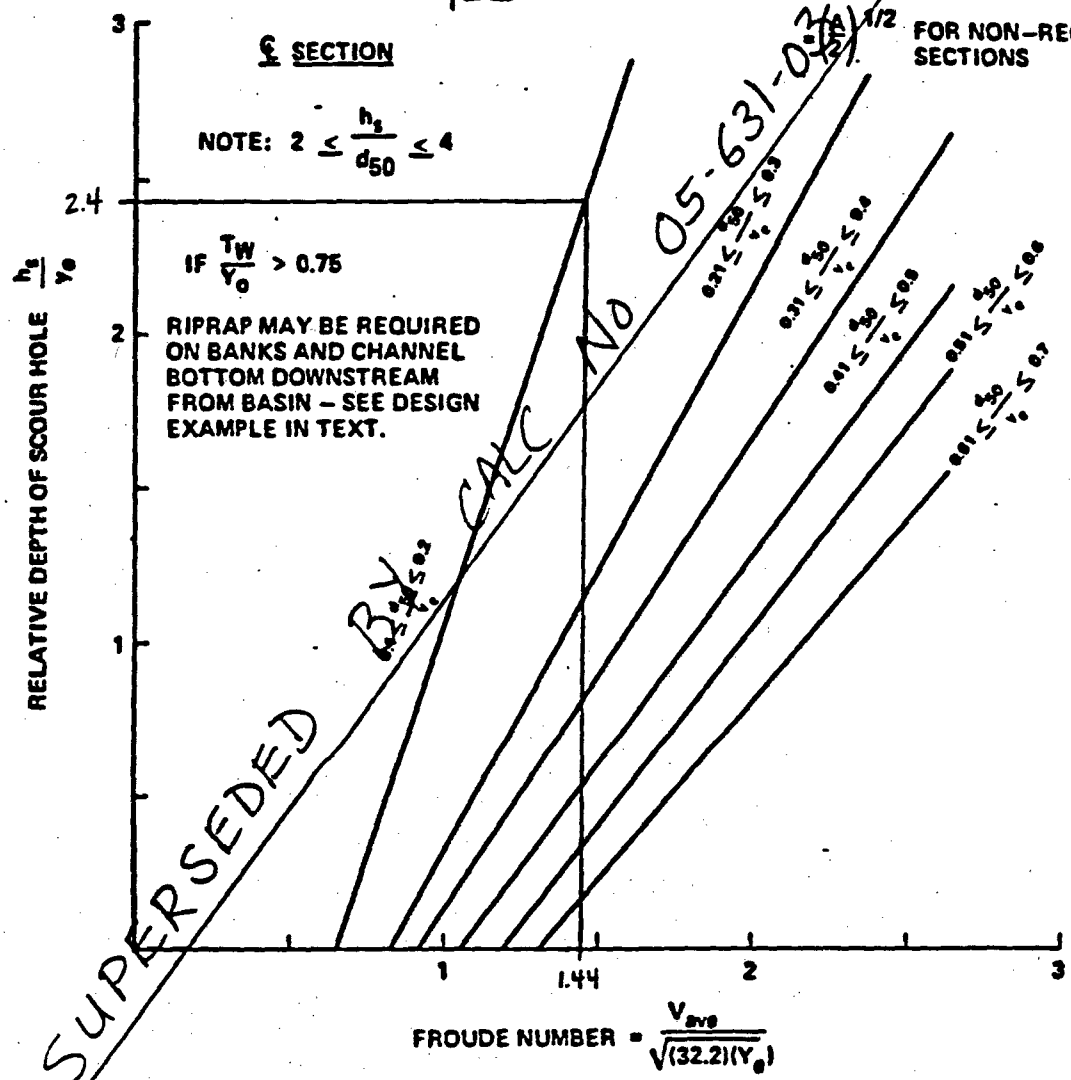
$$V_{ave} = \frac{\text{DESIGN DISCHARGE} - Q}{\text{WETTED AREA AT BRINK OF CULVERT}}$$

d_{50} = THE MEDIAN SIZE OF ROCK BY WEIGHT., ROUNDED ROCK OR ANGULAR ROCK.

Y_e = EQUIVALENT BRINK DEPTH

= BRINK DEPTH FOR BOX CULVERT

$= \left(\frac{A}{B}\right)^{1/2}$ FOR NON-RECTANGULAR SECTIONS



SUPERSEDED BY CALC No 05-631-072

FIGURE X1–2. RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

Ref. 5, p. XI-14

Revision 1
MDL 5/18/87
SHS 5/19/87

Using the limits $0.1 \le \frac{d_{50}}{y_c} \le 0.2$,

$\frac{h_s}{y_c} = 2.4$ when the Froude number is 1.44, .03

$$0.1 \le \frac{d_{50}}{y_c} \le 0.2$$

$$0.1 \le \frac{d_{50}}{3.85} \le 0.2$$

$$0.1(3.85) \le d_{50} \le 0.2(3.85)$$

$$.385' \le d_{50} \le .77'$$

$$4.62'' \le d_{50} \le 9.24'' \rightarrow \text{Use Riprap Type B}$$

$$\frac{h_s}{y_c} = 2.4 \qquad \frac{h_s}{3.85} = 2.4 \qquad h_s = 9.24 \text{ ft}$$

Depth of dissipator pool $h_s = 9.24$ ft $\Rightarrow$ use 10.0 ft.

SUPERSEDED BY CALC. NO. 05-631-03

INTERNATIONAL ENGINEERING COMPANY, INC.

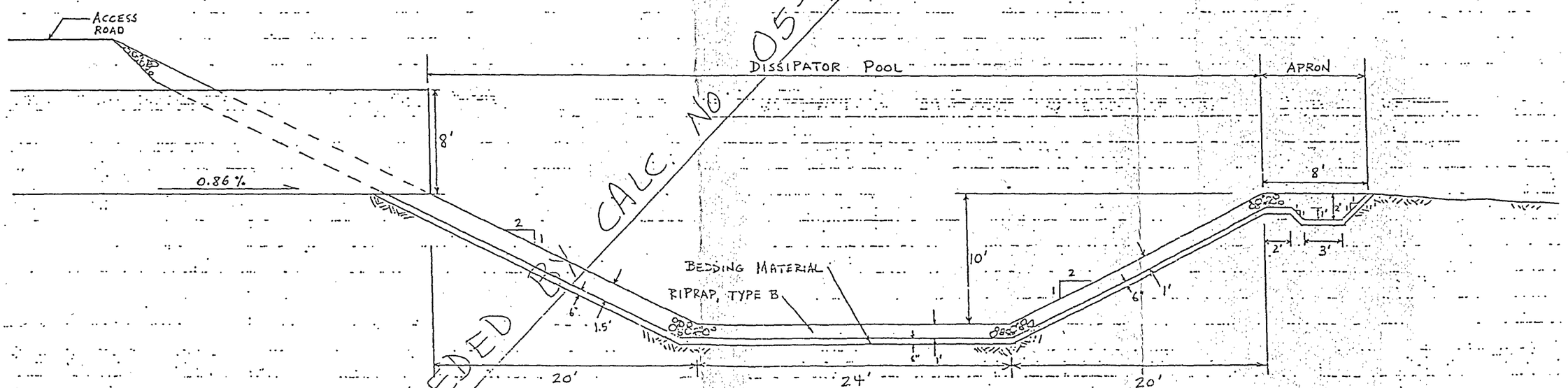
Project UMTRA / GRJ
Feature ACCESS AND HAUL ROADS
Item CULVERT PLACEMENT AND PROTECTION AT INDIAN CR.

Contract No. 5035
Designed MDL
Checked HM

Sheet 13
File No.
Date 4/20/87
Date 4/21/87

Revision 1
MDL 5/18/87
Sha 5/19/87

SUPERSEDED BY CALC. NO 05-631-03



PROFILE OF CULVERT OUTLET

2 0 2 4
SCALE FEET

1" = 8'

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / ERT
Feature Access and Haul Roads
Item Culvert Placement and Protection at Indian Creek

Contract No. 5225
Designed MDL
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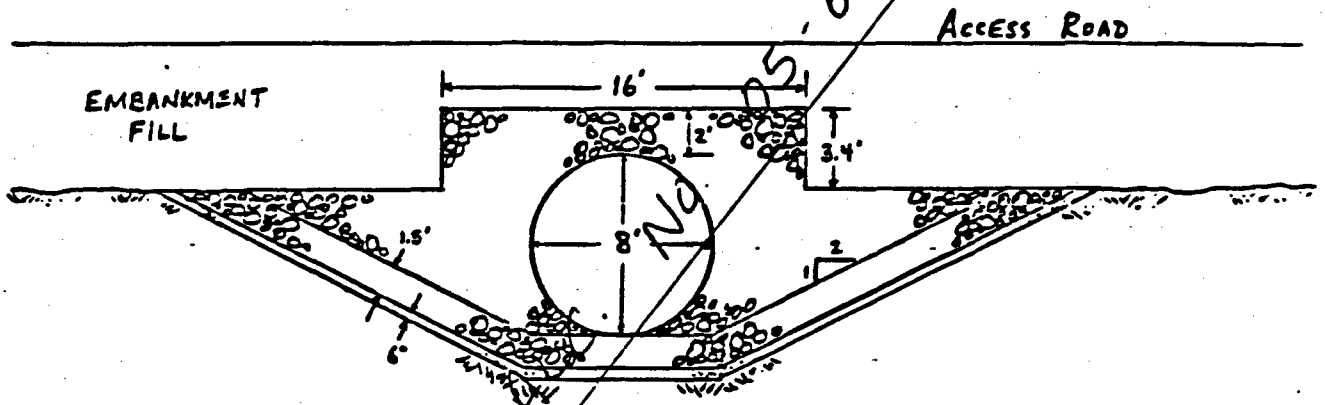
Sheet 14
File No.
Date 4/7/87
Date 4/21/87

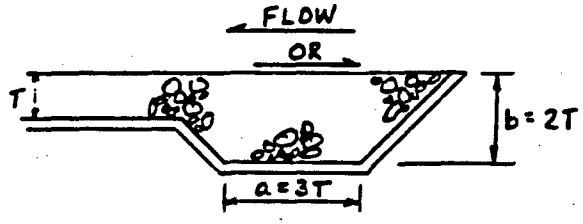
Revision 1
MDL 5/18/87
SWS 5/19/87



Outlet Front View

SUPERSEDED BY CV No. 05-631-03

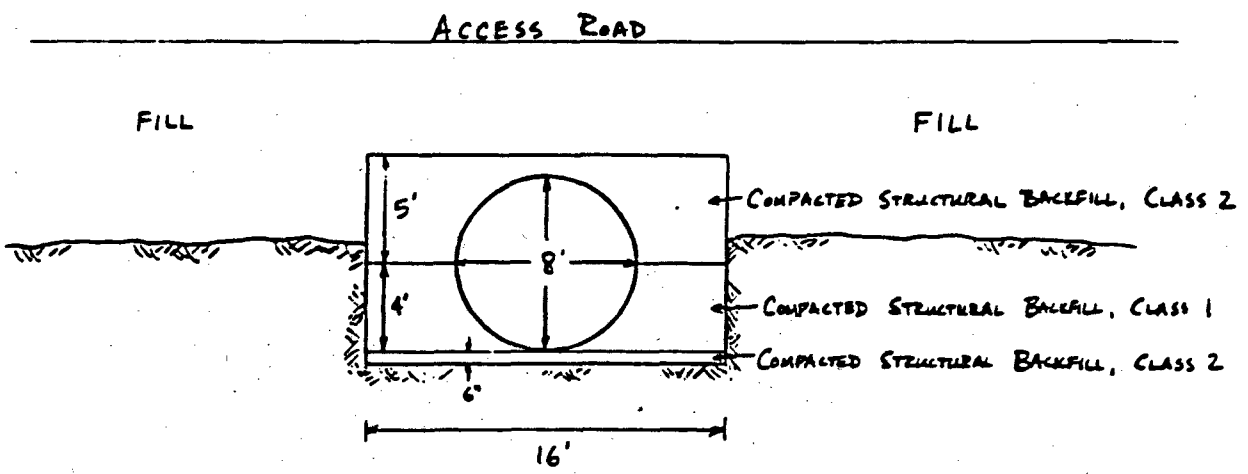
For upstream protection, a key will be placed at the end of the apron to prevent undermining of the riprap blanket. "For all riprap revetments that do not terminate in noneroding natural channel velocities, the ends of the revetment should be enlarged, ... The dimensions a and b should be 3 and 2 times the layer thickness, respectively." Ref. 9, p.45.



Ref. 9, p III-40

BEDDING FOR PIPE

A typical cross section of the bedding and backfill for the pipe is shown below. The thicknesses and types of materials used are from Ref 8, p. 30. From Colorado State Standard M-604-1, the bedding and backfill for a flexible pipe is shown below.



RIPRAP PROTECTION AT INLET

Since steel end sections are not made for 96" diameter pipes, we will use riprap to prevent erosion at the inlet of the culvert.

On approaching the inlet to the culvert, the natural shape of the stream channel is U-shaped. This being the case, the channel near the inlet will be excavated to the shape of a trapizoid with an 8' base and 2H:1V sideslopes. Looking along the longitudinal profile where the trapezoidal channel meets the embankment of the roadway, the embankment will be lined with riprap up to 10 ft from the invert elevation. 10 ft of riprap will be high enough to protect the embankment from maximum headwater conditions. The 2:1 sideslopes will be lined with riprap up to ground level.

To aid in controlling the flow through the pipe, a "fall" will be constructed near the inlet of the culvert. "... the plane of the invert of the barrel be extended upstream from the inlet face a minimum distance of D/2, to provide a smooth flow transition into the inlet; ...." Ref 3, p.13-25
"The fall slope must range from 2:1 to 3:1" Ref. 3, p. 13-29.
"The fall should range from D/4 to 1.5D ...." Ref. 3, p. 13-29.

D/4 will be used for the height of the fall to best match the invert elevation with the natural stream bed elevation.

From Ref. 7, p. J-6.12, a design is outlined for, in part, the length of a concrete apron. The equation they use can be used to determine the necessary distance of riprap protection upstream from the culvert inlet.

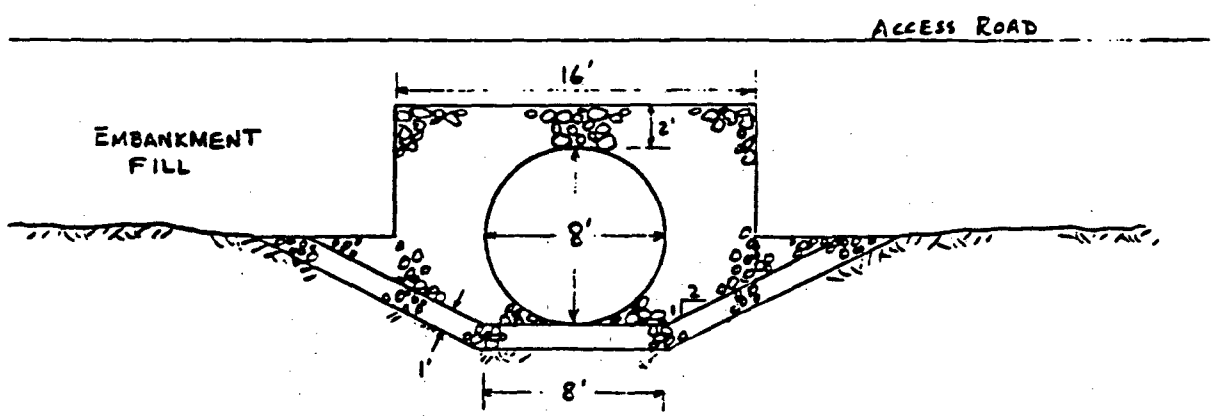
Length of riprap protection $A = S(H - t + 12")$

S = slope of earth embankment
H = Outside diameter of pipe
t = thickness of pipe

$A = 2(8 - 0 + 12")$

$A = 18$ ft. (length of riprap protection upstream)

The size of riprap and the thickness of the riprap apron will be the same as what was used for the outlet.

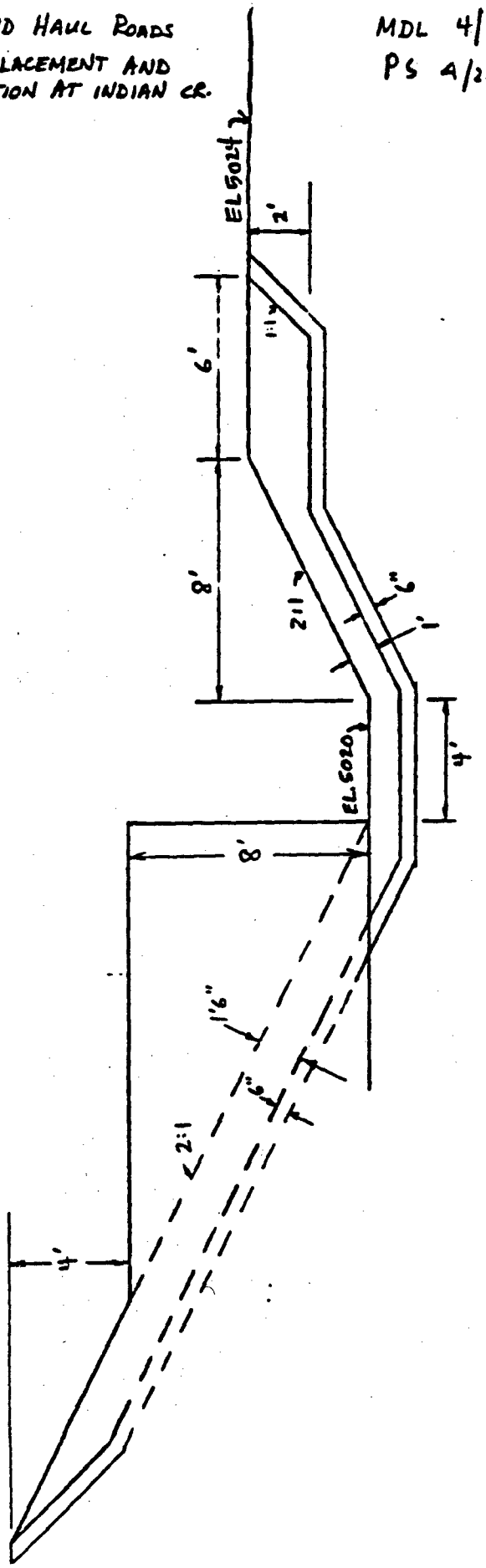


2 0 2 4
SCALE FEET

INLET FRONT VIEW

UMTRA / GRJ
ACCESS AND HAUL ROADS
CULVERT PLACEMENT AND
PROTECTION AT INDIAN CR.

No. 5025
MDL 4/22/87
PS 4/22/87



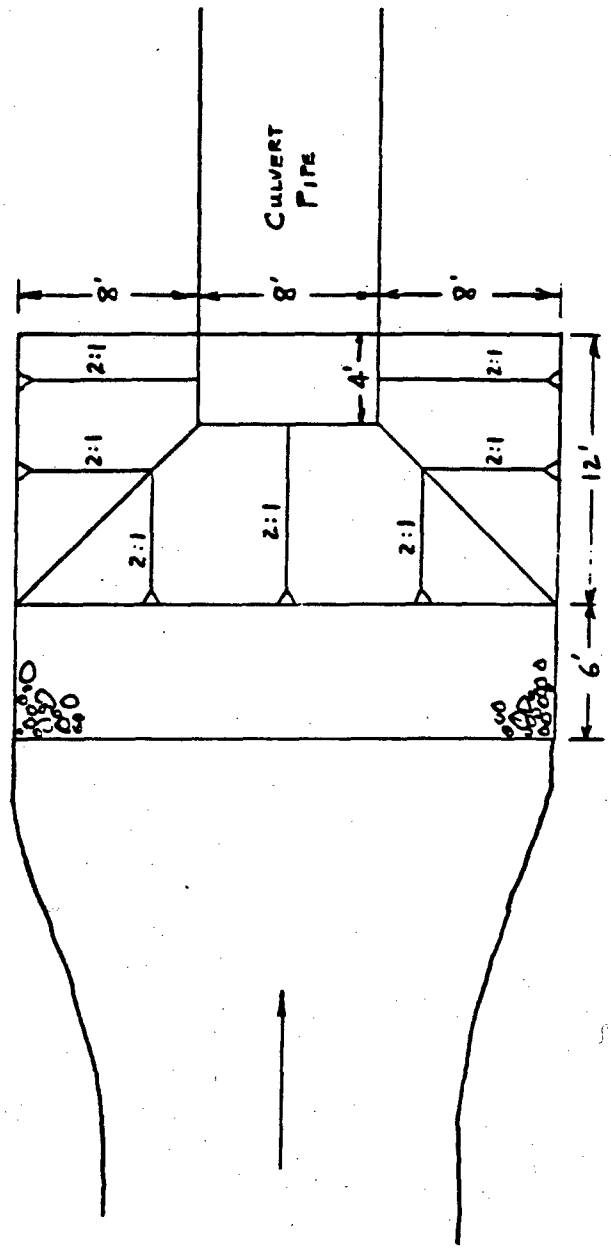
INLET PROFILE

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA / GRJ
Feature: ACCESS AND HAUL ROADS
Item: CULVERT PLACEMENT AND PROTECTION AT INDIAN CR.

Contract No. 5025
Designed MDL
Checked PS

Sheet 20
File No.
Date 4/22/87
Date 4/22/87



INLET PLAN

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: LMTRA/GRS
Feature: Access & Haul Roads
Item: Culvert Pavement & Protection at Indian Creek
Contract No. 5025
Designed: HM
Checked: MDL
Sheet 21 (App. A)
File No.
Date 4/14/87
Date 4/21/87

APPENDIX A

APPENDIX - A

HYDROLOGIC, CHANNEL & TAIL WATER INFORMATION:

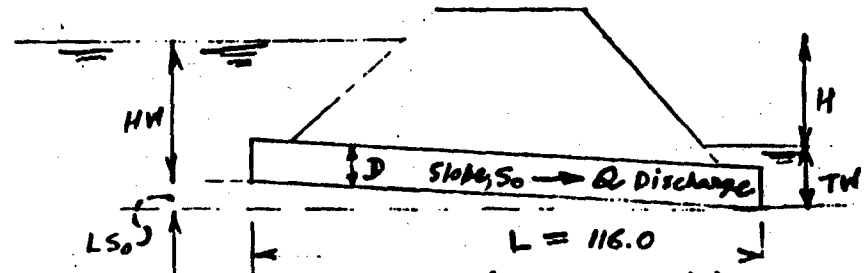
Design Q = 473 cfs (25-year, 24 hour storm)

$V = \frac{Q}{A} = \frac{473}{\frac{\pi}{4}(8)^2} = 9.41$ fps

$\frac{V^2}{2g} = 1.37$ ft

SKETCH

$HW = H + h_o - LS_o$



$S_o = 0.0086$

$LS_o = 1.0'$

Case I: $n = 0.031$

Case II: $n = 0.023$

h_o = Max. of $\left(TW \text{ or } \frac{D+d_c}{2}\right)$

where d_c = critical depth for given Q

H = friction loss + entrance loss + vel. head

$= (1 + K_e + 29\, n^2 L / R^{1.33}) \cdot V^2/2g$

	CULVERT DESCRIPTION (ENTRANCE TYPE)	Q (CFS)	SIZE (DIA) (DX12) (INCH)	HEADWATER COMPUTATION: INLET CONT. HW/D (–)	INLET CONT. HW (FT)	OUTLET CONTROL, HW = H + ho − LSo: Ke (–)	H (FT)	dc (FT)	(dc+D)/2 (FT)	TW (FT)	ho (FT)	LSo (FT)	HW (FT)	CONTROLLING HW (FT)	OUTLET VELOCITY by Manning's (FPS)	COMMENTS
CASE I n = 0.031	C.S. Groove End Projecting	473	96	1.21	9.68	0.5	3.8	5.5	6.75	3.15	6.75	1.0	9.55	9.68	7.1	Inlet Control
CASE II n = 0.023	C.S. Groove End Projecting	473	96	1.21	9.68	0.5	3.0	5.5	6.75	3.15	6.75	1.0	8.75	9.68	9.6	Inlet Control

Calculation Cover Sheet

Calc. No. 05-631-07-01

Contract No. 5025 Discipline ESCUP No. of Sheets 26 29

Project

UMTRA / GRAND JUNCTION

Feature

ACCESS AND HAUL ROADS

Item

CULVERT OUTLET REVISION

Sources of FORMULAE (CONT.)

6. SCS, Engineering Field Manual For Conservation Practices. USDA, Washington, D.C. 1969.
7. Walters, W.H. Rock Riprap Design Methods and their Applicability to Long-Term Protection of Uranium Mill Tailings Impoundments. USNRC, August 1982.

Sources continued on page 2.

Sources of Formulae & References

1. U.S. Department of Transportation. Hydraulic Design of Energy Dissipators for Culverts and Channels. Washington, D.C., December 1975.
2. Simon, Andrew L. Practical Hydraulics. New York: John Wiley and Sons, Inc., 1976.
3. Bowles, Joseph E. Foundation Analysis and Design, Third Edition. New York: McGraw-Hill, Inc., 1982.
4. Bureau of Reclamation. Design of Small Canal Structures. Denver: United States Government Printing Office, 1978.
5. Wang Chu-Kia and Charles G. Salmon. Reinforced Concrete Design, 4th Edition. New York: Harper and Row, 1985.

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

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
1	Added p. 27	MD Lowenstein	6/11/87	HM	6/11/87	[illegible]	6/11/87
0	—	MD Lowenstein	5/15/87	HM/[illegible]	5/15/87	[illegible]	5/15/87

Form 42-110

REFERENCES (CONT. FROM COVER SHEET)

8. MKE. UMTRA Design Procedures. San Francisco, July 1983.

9. Simons, Daryl B., et al. Hydraulic Test to Develop Design Criteria for the Use of Reno Mattresses. Colorado, March 1984.

10. Ferguson, P.M. Reinforced Concrete Fundamentals. New York: Wiley + Sons, 1967

11. American Concrete Institute. Building Code Requirements For Reinforced Concrete. Detroit ACI, August 1978.

PURPOSE:

In MKE Calc. no. 05-631-02, the design configuration of the outlet is a 64 ft long, 48 ft wide, and 10 ft deep riprap dissipator pool. In this calculation, a new outlet structure will be designed to supersede the riprap basin. The new structure is a baffle-wall energy dissipator.

There are several reasons for the change in design to a concrete outlet structure. One reason is that riprap should not be used, regardless of the stone size, when the velocity of the water exceeds 20 fps (see next sheet). Our outlet velocity is about 16 fps which would require an average stone diameter of about 3 feet. This impractical stone size warrants a change in design. Another reason for using a concrete impact basin is its effectiveness to dissipate energy. Compared with the natural hydraulic jump, which would occur in a horizontal basin, the impact basin has a greater capacity for dissipating energy (see the graphic comparison on sheet 3). Another benefit is that much less excavation is required for the impact energy dissipator than for the riprap basin.

This calculation will be done in several parts:

(1) Sizing the outlet structure
(2) Checking the rebar in the critical areas of the concrete structure
(3) Designing the downstream erosion protection
(4) Calculating the quantities of concrete and riprap

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA / GRJ
Feature ACCESS AND HAUL ROADS
Item CULVERT OUTLET REVISION

Contract No. 5025
Designed MDL
Checked JTK

Sheet 2
File No.
Date 5/11/87
Date 5/11/87

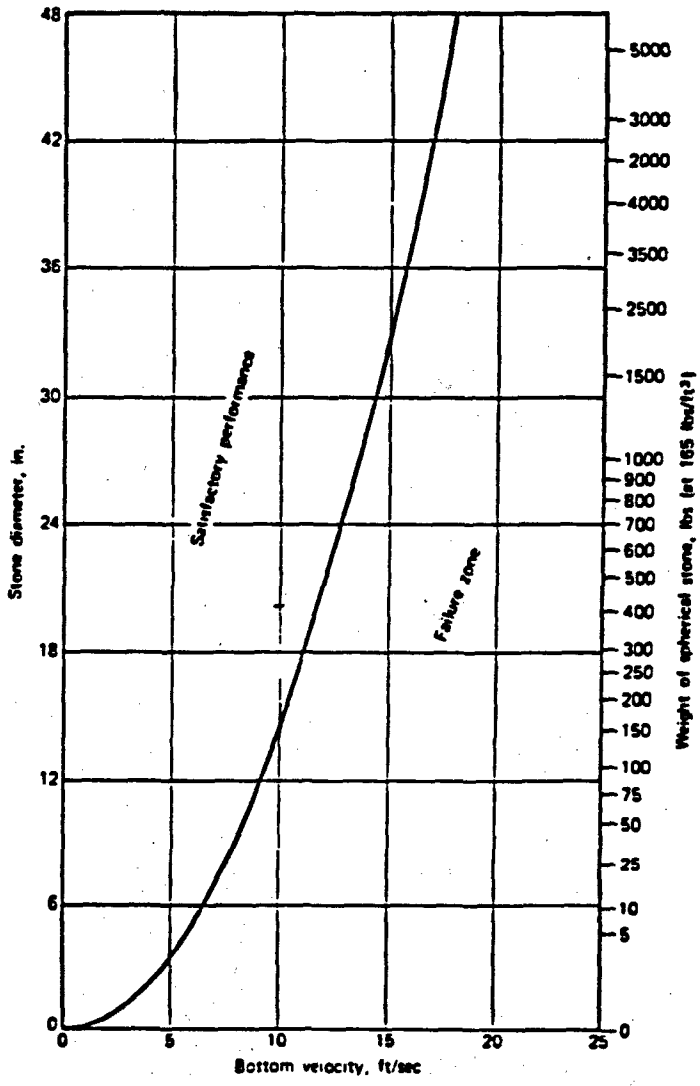


FIGURE 9.20 Recommended size of riprap for erosion control (after Bureau of Reclamation). The riprap should be composed of a well graded mixture, but most of the stones should be of the size indicated by the curve. Riprap should be placed over a filter blanket or bedding of graded gravel in a layer 1.5 times (or more) as thick as the largest stone diameter. Curve shows minimum size stones necessary to resist movement.

Ref. 2

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA / GRJ
Feature ACCESS AND HAUL ROADS
Item CULVERT OUTLET REVISION

Contract No. 5025
Designed MDL
Checked JTK

Sheet 3
File No.
Date 5/1/87
Date 5/11/87

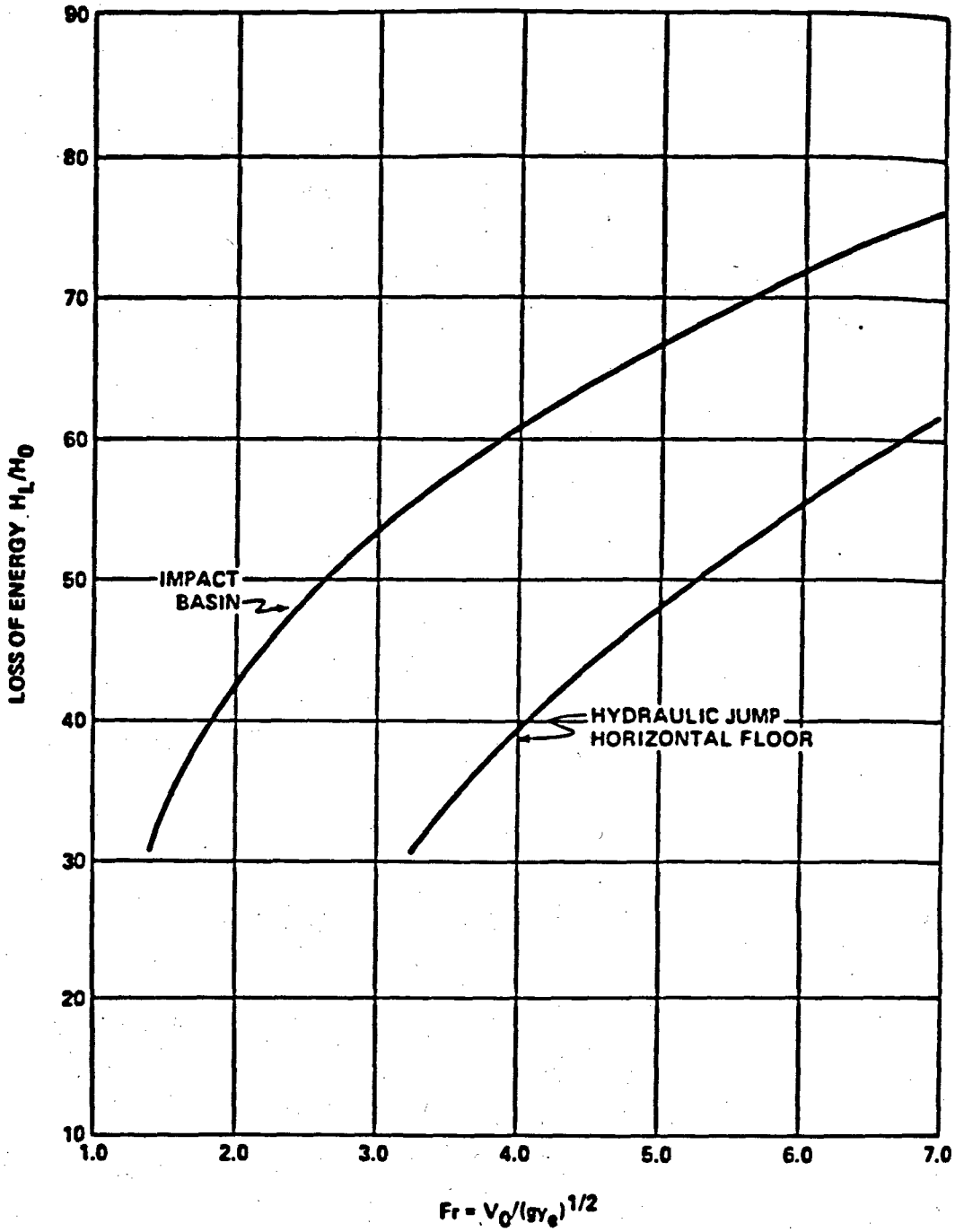


FIGURE VIII–C–3. ENERGY LOSS–IMPACT BASIN–HYDRAULIC JUMP

Ref 1, p. VIII-C-8

DESIGN:

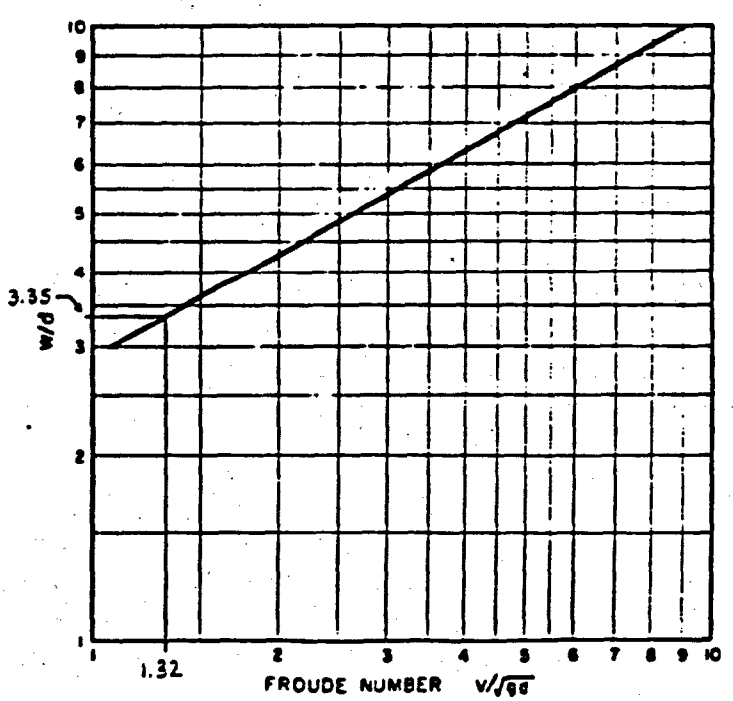
From MKE Calc. no. 05-631-02,

$Q = 473$ cfs
$V = 16$ fps
$D = 8$ ft
$A = 29.6$ ft^2
Depth of flow $d = 4.56$ ft

Compute the Froude number, $F = \frac{V}{\sqrt{gd}}$

$$F = \frac{16.0}{\sqrt{(32.2)(4.56)}} = 1.32$$

Read $\frac{W}{d}$ from the curve below.

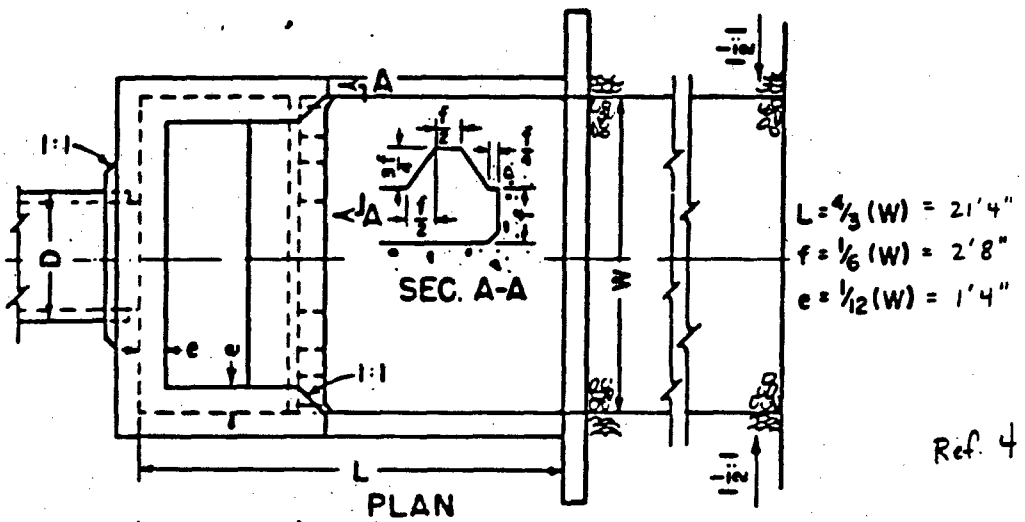


Ref 4

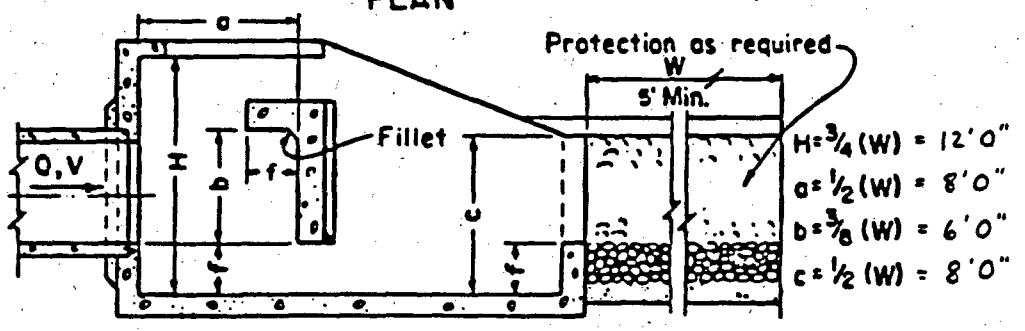
W, ft, is the inside width of the basin
V, fps, is the theoretical velocity of the incoming flow and is $\sqrt{2gh}$
h, ft., is the head to be dissipated
A, ft^2, is the area of flow entering the basin and is Q/V
d, ft., Represents the depth of flow entering the basin and is $\sqrt{A}$

$$\frac{\text{Width of outlet}}{\text{Depth of flow}} = \frac{W}{d} = 3.35$$

$W = 3.35(4.56) = 15.28$ ft **Use $W = 16$ ft**



Ref. 4



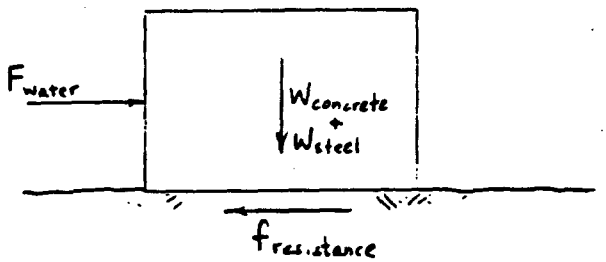
SECTION

Rock diameter for protection = 1/20 (W) = 9.6"

Min. Length of Protection Required = W = 16'

Sliding Resistance

Treat the impact energy dissipator as a concrete block to simplify the sliding stability calculations. Assuming that the outlet is placed on ground surface, the static diagram would look as follows:



To be conservative, let us examine an outlet with a width of 14'3". If the frictional resistance can withstand the force due to the water, then a 16' wide outlet would also be able to resist the force due to the water.

$$F_{water} = \rho Q V = \left(1.94 \frac{slugs}{ft^3}\right)\left(473 \frac{ft^3}{s}\right)\left(16 \frac{ft}{s}\right) \quad [Ref. 3]$$

$$= \underline{14{,}682 \text{ lbs}}$$

$$f_{resistance} = \mu N$$

$$\mu = \tan\phi \text{ to } 0.67 \tan\phi \quad [Ref\ 3]$$

Assume a low angle of internal friction, $\phi = 25°$

Coefficient of friction $\mu = 0.67 \tan 25° = 0.31$

$$N = W_{concrete} + W_{steel}$$

$W_{concrete} = 39 \text{ cy} = 1053 \text{ cf} \cdot 150 \text{ pcf} = 157{,}950 \text{ lbs}$ (Ref. 4)

$W_{steel} = 3460 \text{ lbs}$ (Ref 4)

$N = 157{,}950 \text{ lbs} + 3460 \text{ lbs} = 161{,}410 \text{ lbs.}$

$f_{resistance} = \mu N = 0.31 (161{,}410 \text{ lb}) = \underline{\underline{50{,}037 \text{ lb.}}}$

$f_{resistance} > F_{water}$ $\therefore$ Any baffled outlet with a width greater than 14'3" can withstand the force of water at our pipe outlet.

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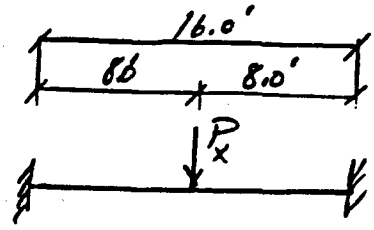
Project WINTER / GRT
Feature ACCESS ROAD -
Item CULVERT OUTLET REVISION

Contract No. 5025
Designed D. Gyrod
Checked MDL

Sheet 8
File No.
Date 5-14-87
Date 5/15/87

REFERENCE:
REINFORCED CONCRETE FUNDAMENTALS,
P.M. Ferguson, WILEY & SONS, N.Y. 1967



PLAN
BAFFLE

CHECK BAFFLE

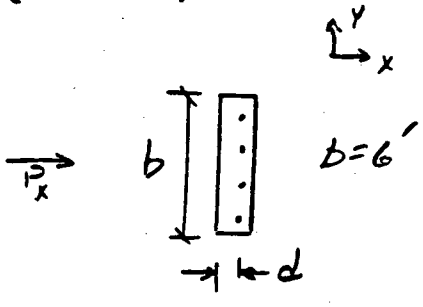
$P_{LL} = 14.682^K$ HORIZONTAL LOAD

$M_{Lx} = \frac{PL}{8}$ (@ Center + Ends)

$= \frac{14.682 \times 16}{8} = 29.36^{'-k}$

$M_{Ux} = \cancel{1.4\,D.L.}^{\,0} + 1.7\,L.L. = 1.7 \times 29.36 = 49.92^{'-k}$

$\bar{M} = \frac{M_u}{\phi} = \frac{49.92}{0.9} = 55.5^{'-k}\ (9.25^{'-k}/ft)$



$f_c' = 4$ ksi
$f_y = 60$ ksi

$\rho_{max} = 0.0214$, $\bar{R}_{MAX} = 1041$, max. $c/d = .378$
$\rho_{min} = 200/f_y = \frac{200}{60000\,psi} = .0033$
min. thickness $= \ell/21 = \frac{16 \times 12}{21} = 9''$ (b or d)

$\bar{M} = \bar{R} b d^2 = 1041\, b d^2 = 55.5^{'-k} \times 1000 \times 12$
Req'd $bd^2 = .640\ in^3$

If $b = 72''$ $\quad d = \sqrt{18.88} = 2.98''$

For a minimum Thickness of $9'' < 12''$ ACTUAL

Assume $1\frac{1}{2}''$ cover plus $\frac{3}{8}''$ to ℄ bar

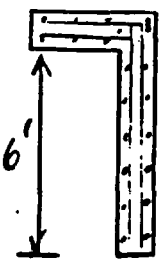
then $d = 12'' - 1.87'' = 10.12''$

and $a/d = .378$

Let $\rho = .0033$ $\quad A_s = .0033 \times 10.12'' \times 12'' = 0.40$ □"/ft

Try $1 - \#6$ @ 12" o.c. $(.44$ sq in$)$ $\rho = \frac{.44}{10.12 \times 12} = .0036$

$$\bar{R}_{ACT} = \frac{\bar{M}}{b\,d^2} = \frac{55.5 \times 1000 \times 12}{6 \times 12 \times 10.12^2} = 90 < 1041 \text{ ok}$$



Check Minimum Steel for ⅓ Increase
Find minimum Req'd Steel

Max. $a = .378 \times 10.12 = 3.82''$

$jd = 10.12 - \frac{a}{2} = 10.12'' - 1.91'' = 8.21''$

Rebar Tension $\bar{T} = \bar{M}/(6' \times jd)$

$$\bar{T} = \frac{55.5'^{1-12} \times 12 \times 1000}{6' \times 8.21''} = 13520 \text{ lbs}$$

Req'd $A_s = \frac{13520 \text{ lbs}}{60000 \text{ psi}} = 0.23$ sq in/ft

Increase by ⅓ per ACI 318 (10.5.2)

Min $A_s = 1.33 \times 0.23 = 0.30$ sq in per ft

<u>Therefore Use 1-#5 @ 12"</u>

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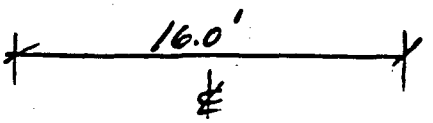
Project: UMTRA — Grand Junction
Feature: Access Road
Item: CULVERT OUTLET REVISION

Contract No. 5025
Designed D. Rappold
Checked MDL

Sheet 10
File No.
Date 5-14-87
Date 5/15/87

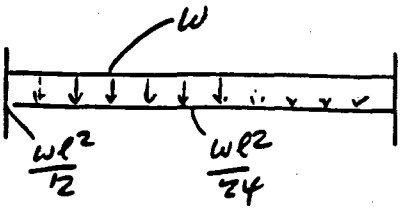


VERTICAL LOADS

$M_u = 1.4\ D.L + 1.7\ \cancel{L.L.}^{\,0}$

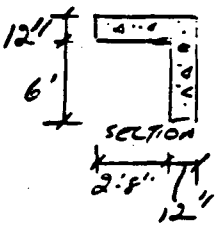
ENDS $M_u = 1.4 \times \dfrac{1.30^{k/'} \times 16^2}{12}$

$= 38.8'$ 1-KS



$w_{DL} = 8.67' \times \frac{12}{12} \times 0.150^{k/cf} = 1.30^{k/'}$

By observation this moment is less than horizontal moment and therefore steel for HORIZONTAL MOMENT WILL MORE THAN ACCOMMODATE this dead load moment.



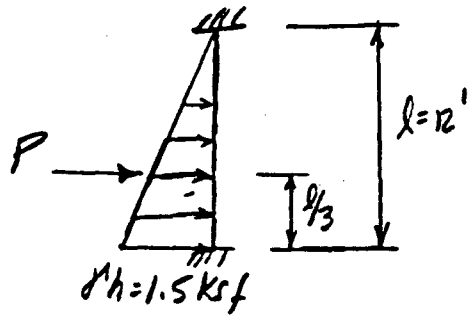
THEREFORE RECOMMENDED REINFORCEMENT IN BAFFLE TO ACCOMMODATE POSITIVE AND NEGATIVE MOMENTS IS TO PROVIDE ONE LAYER OF #5 @ 12" O.C EACH FACE VERTICALLY AND HORIZONTALLY.

HORIZONTAL REINFORCEMENT SHOULD BE TO THE OUTSIDE OF VERTICAL REBAR.

Side Walls

Design BACK walls to accommodate lateral active soil pressure.

Given: $\gamma = 125$ pcf (.125 Kcf)
$\phi = 25°$

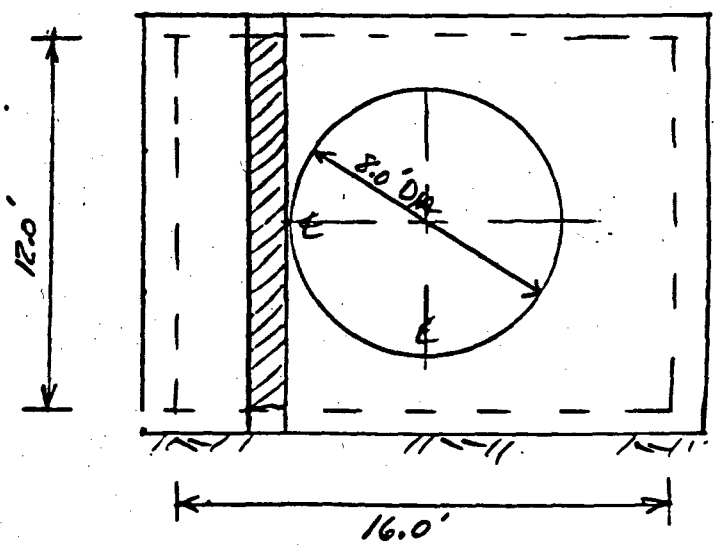


Coefficient of Active Earth Pressure

$$K_a = \tan^2\left(45 - \frac{\phi}{2}\right) = \tan^2(32.5) = 0.40$$

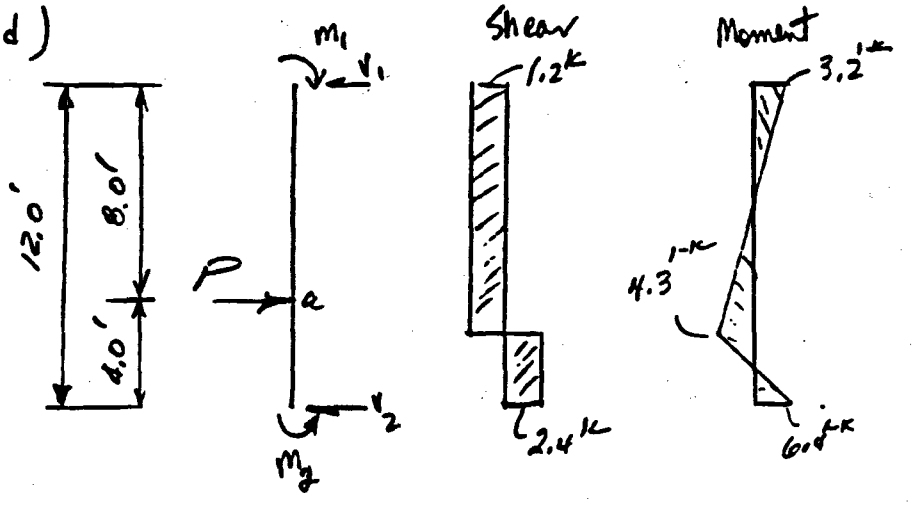
Design a one foot wide section of BACK WALL to accomodate horizontal soil force.

Assume top and bottom are rigid connections.



ELEVATION 1 - END WALL

WALL (Cont'd)



$$P = K_A \frac{\gamma h^2}{2} = 0.4 \times .125 \frac{\times 12^2}{2} = 3.6^k$$

$$V_1 = \frac{4}{12} \times 3.6 = 1.2^k$$

$$V_2 = \frac{8}{12} \times 3.6 = 2.4^k$$

$$m_2 = \frac{Pab^2}{l^2} = \frac{3.6^k \times 4 \times 8^2}{12^2} = 6.4^{1-k}$$

$$m_1 = \frac{Pa^2b}{l^2} = \frac{3.6^k \times 4^2 \times 8}{12^2} = 3.2^{1-k}$$

$$m_a = \frac{2Pa^2b^2}{l^3} = \frac{2 \times 3.6^k \times 4^2 \times 8^2}{12^3} = 4.3^{1-k}$$

$$\bar{m}_2 = 1.4 \times D.L = 1.4 \times 6.4^{1-k} = 9^{1-k}$$

Assume $1\frac{1}{2}$" cover plus $\frac{3}{8}$" to ℄ bar, $d_{tot} = 12" - 1.87"$

Let $\rho = .0033$ $A_s = .0033 \times 10.12" \times 12" = 0.40"/ft$

Try 1-#6 ($A_s = 0.44$ sq in) $\rho = \frac{0.44}{10.12 \times 12} = .0036$

$$\bar{R}_{ACT} = \frac{\bar{M}}{bd^2} = \frac{9^{1-K} \times 1000 \times 12}{12 \times 10.12^2} = 87.9 < 1041 \text{ ok}$$

∴ Tension governs

Max $a/d = .378$

$a = .378 \times 10.12 = 3.82"$

$\bar{C} = .85 f'c \times a \times b$

$\bar{C} = .85 \times 4000 \times 3.82 \times 12 = 155{,}856$ lbs

Req $A_s = \frac{\bar{T}}{f_y} = \frac{\bar{C}}{f_y} = \frac{155{,}856}{60000} = 2.6 \text{ in}^2$

$jd = 10.12 - a/2 = 10.12 - 1.91 = 8.21"$

$\bar{T} = \frac{9^{1-K} \times 1000 \times 12}{8.21"} = 13155$ lbs

Req $A_s = \frac{13155 \text{ lbs}}{60{,}000 \text{ psi}} = 0.219 \text{ in}^2$

Increase by $\frac{1}{3}$ per ACI 318 10.5.2

Min. $A_s = 1.33 \times 0.219 = 0.292 \text{ in}^2$ (Use 1-#5 @ 0.31 in²)

<u>Therefore Use 1-#5 @ 12" o.c.</u>

Check Wall Criteria

WALLS (Per ACI 318 14.3)

Vertical

Minimum Reinforcement for #5 & smaller

= .0012 x gross Area (ACI 318 - para 14.3.2)

= ρ_g x gross Area

$$\rho_g = \frac{2 \times 0.31}{12 \times 12} = .0044 > .0012$$

Use 1 - #5 each face

Horizontal

Min Reinforcement = .0020 x gross Area

$$\rho_g = \frac{2 \times 0.31}{12 \times 12} = .0044 > .0020$$

Use 1 - #5 each face

RECOMMEND ONE LAYER OF #5 @ 12" O.C EACH FACE VERTICALLY AND HORIZONTALLY.

The rebar arrangement will be the same as is shown on p 320, Ref. 4. The only difference is that only #5 bars will be used in the concrete structure

DOWNSTREAM RIPRAP PROTECTION

The design for riprap protection downstream calls for a stone size with $d_{50} = 9.6"$. Since Type B riprap ($d_{50} = 4.5"$) is already being used for the drainage ditches, we would like to use Type B riprap downstream of the concrete impact energy dissipator. Two determinations must first be made: (1) the actual velocity through the channel, and (2) the allowable velocity through the channel.

(1) VELOCITY THROUGH CHANNEL

$$V = \frac{1.486}{n} R^{2/3} S^{1/2} \quad \text{(Ref. 8, p. 5-9)}$$

$$n = 0.0395\, d_{50}^{1/6} \quad \text{(Ref. 6, Table 7.2)}$$

TABLE 7.2

MANNING'S ROUGHNESS COEFFICIENT (n) FOR VARIOUS CHANNEL LININGS

Lining	n
Bare Soil	0.023
Jute Mesh	0.023
Vegetation	
Retardance A	0.160
Retardance B	0.080
Retardance C	0.050
Retardance D	0.040
Retardance E	0.030
Rock Riprap	$0.0395\, D_{50}^{1/6}$*

$$n = 0.0395\left(\frac{4.5}{12}\right)^{1/6} = 0.0335$$

$$R^{2/3} = \left(\frac{bd + zd^2}{b + 2d\sqrt{z^2+1}}\right)^{2/3} = \left(\frac{16\cdot 3.15 + 2\cdot 3.15^2}{16 + 2\cdot 3.15\sqrt{2^2+1}}\right)^{2/3} = 1.76$$

$$S^{1/2} = 0.0165^{1/2} = 0.1285$$

$$V = \frac{1.486}{0.0335}(1.76)(0.1285) = \underline{\underline{10.0 \text{ fps}}}$$

(2) ALLOWABLE VELOCITY THROUGH CHANNEL

The equations used are from Ref. 7, pp. 22-23.

$$SF_m = \frac{\tan\phi}{\tan\theta} = \frac{\tan 38^\circ}{1/2} = 1.563$$

$$\eta = \left(\frac{SF_m^2 - SF^2}{(SF)\,SF_m^2}\right)\cos\theta = \left(\frac{(1.563)^2 - (1)^2}{(1)(1.563)^2}\right)\cos\left(\arctan\tfrac{1}{2}\right)$$

$$\eta = 0.528$$

$$\tau_s = \frac{\eta\, d_{50}\,\gamma_w\,(G_s - 1)}{21} = \frac{(0.528)\left(\frac{4.5}{12}\right)(62.4)(2.65-1)}{21}$$

$$\tau_s = 0.97 \text{ psf}$$

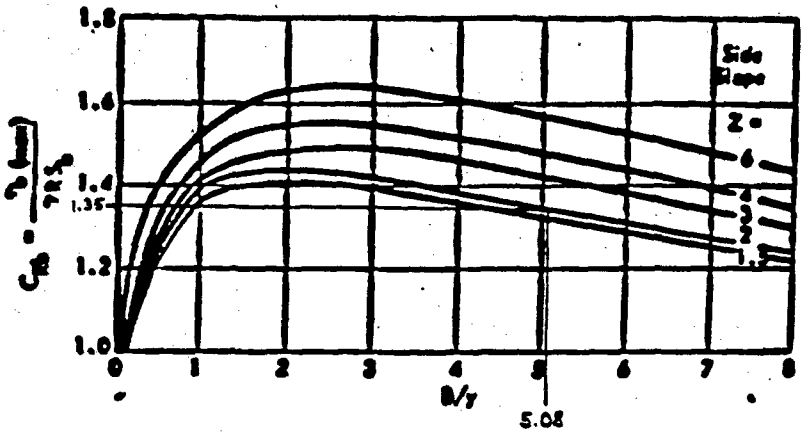


FIGURE 5-3 Maximum boundary shear stress on bottom of trapezoidal channels.

Ref. 8, p. 5-25

By trail and error $y = 0.97$.

$$B/y = \frac{16}{0.97} = 16.5$$

From Fig. 5-3 above, $C_{Rb} = 1.1$ (say).

$$C_{Rb} = \frac{\tau_b(max)}{\gamma R S_b}$$

$$R = \frac{0.97}{(62.4)(1.1)(0.0165)}$$

$R = 0.86 \rightarrow y = 0.97$ (okay).

$$\text{Allowable } V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

$$= \frac{1.486}{0.0335} (0.70)^{2/3} (0.0165)^{1/2}$$

$$= \underline{5.15 \text{ fps}}$$

Is $V <$ Allowable V ?

$10.0 > 5.15$ ∴ Additional protection or larger riprap is required.

Since we would like to use Type B riprap, additional protection such as revet mattresses have to be used. The depth of flow has been recalculated using an iterative process shown on the following sheet → $y = 2.28$ ft $= D$. The following design procedure will determine whether a 9" revet mattress with $d_{90} = 5"$ is adequate for our channel and flow conditions. From Ref 9, App. A:

$$A = (B + ZD)D = (16 + 2 \times 2.28)2.28 = 46.88 \text{ ft}^2$$

$$P = B + 2d\sqrt{1+Z^2} = 16 + 2 \times 2.28\sqrt{1+4} = 26.20 \text{ ft}$$

$$R = \frac{A}{P} = \frac{46.88}{26.20} = 1.79 \text{ ft}$$

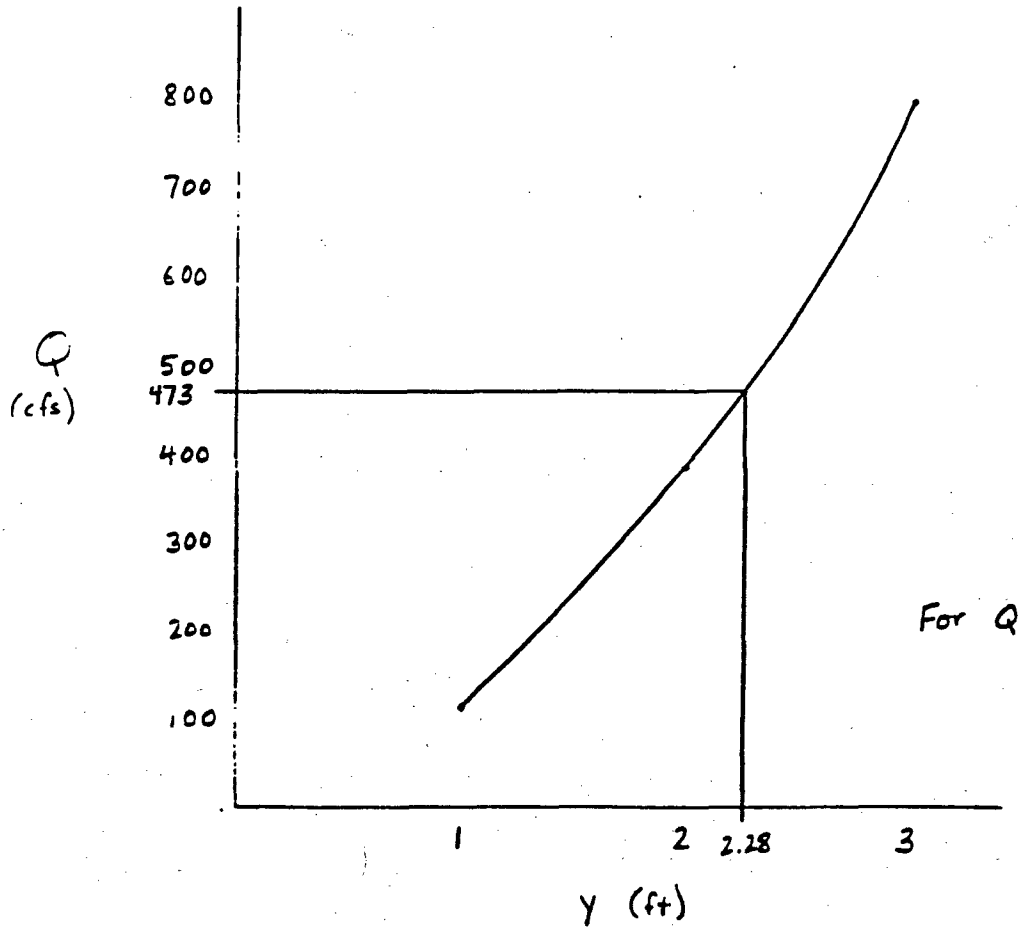
$$T = B + 2Zd = 16 + 2 \times 2 \times 2.28 = 25.12 \text{ ft}$$

$$n = \frac{d_{90}^{1/6}}{26} \text{ (in meters)} \quad \text{(Ref 9, p.5.1)} \quad n = \frac{\left(\frac{5/12}{3.281}\right)^{1/6}}{26} = 0.0273$$

The depth of water through the riprapped channel will not be the same as the tailwater depth that was previously calculated.

$$Q = \frac{1.486}{n} A R^{2/3} s^{1/2}$$

$$Q = \frac{1.486}{.0273}(16+2y)y \cdot \left[\frac{(16+2y)y}{(16+2y\sqrt{5})}\right]^{2/3} \sqrt{0.0165}$$



y	Q
1	116
2	383
3	791

For Q = 473 cfs, y = 2.28 ft

$n = 0.0273$

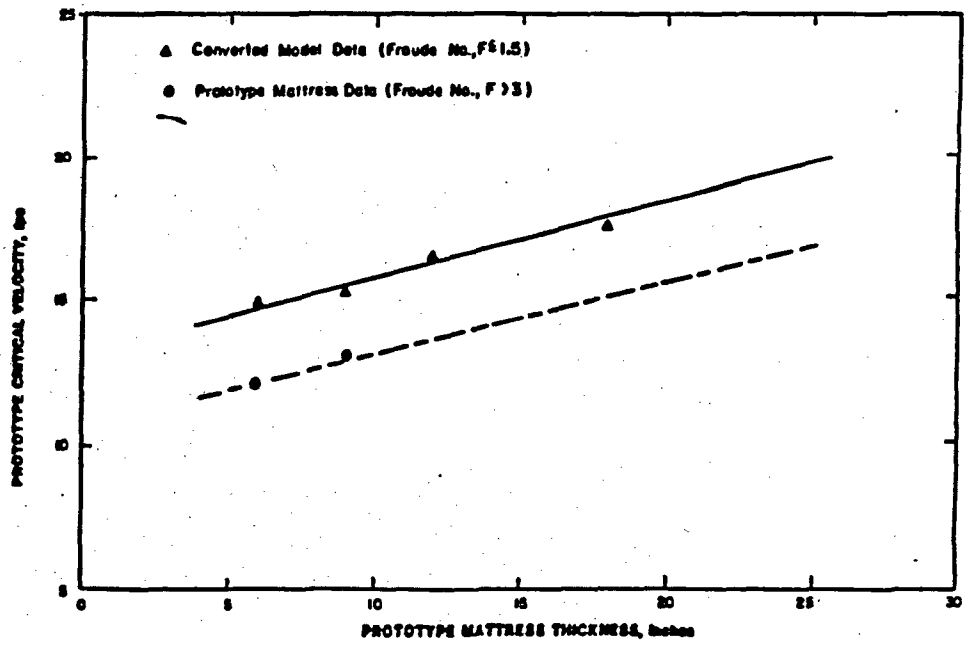
$$V = \frac{1.486}{n} R^{2/3} S^{1/2} = \frac{1.486}{0.0273} (1.79)^{2/3} (0.0165)^{1/2} = 10.3 \text{ fps}$$

$$Q = AV = 46.88 \text{ ft}^2 \times 10.3 \text{ fps} = 483 \text{ cfs} \approx 473 \text{ cfs (design Q)}$$

$$\tau_b = \gamma D S = 62.4 \times 2.28 \times 0.0165 = 2.35 \text{ psf}$$

$$F = \frac{V}{\sqrt{gA/T}} = \frac{10.3}{\sqrt{(32.2)(46.88)/25.12}} = 1.33$$

Based on Fig. 4.10, the design velocity computed above is lower than the critical velocity ($V_c = 15.5$ fps) for the 9" mattress.



Ref. 9, Figure 4.10. Critical velocity that initiates rock movement as a function of mattress thickness.

Therefore, the 9" mattress is adequate to protect the channel bed based on the incipient motion criteria.

For protecting the channel banks, the permissible critical stress or banks protected by mattresses is:

$$\tau_s = \sqrt{1 - \frac{\sin^2\theta}{\sin^2\phi}}\ \tau_c \qquad \text{(Ref. 9, p. 5.2)}$$

$$\theta = 26.6^\circ \qquad \phi = 38^\circ$$

$$\text{(Ref 9, p.5.2)}\ \tau_c = 0.1\,(\gamma_s - \gamma)\,d_{50} = 0.1 \times (165 - 62.4)\ \frac{4.5}{12} = 3.85 \text{ psf}$$

$$\tau_s = 0.686 \times 3.85 = 2.64 \text{ psf}$$

Maximum shear stress τ_m acting on the bank is: (Ref. 9, p.5.2

TW depth
Natural slope of channel

$$\tau_m = 0.75\ \gamma D S = 0.75 \times 62.4 \times 3.15 \times 0.0165 = 2.43 \text{ psf}$$

The permissible critical shear stress τ_s is larger than the flow shear stress τ_m. Therefore, a 9" mattress is suitable for protecting the bank. The dimensions are 12' long, 6' wide, and 9" thick with 4 cells and a capacity of 2 cubic yards.

To satisfy the filter requirements, we will try a filter fabric. The velocity at the mattress / filter interface is:

$$V_b = \frac{1.486}{n_f}\left(\frac{d_m}{2}\right)^{2/3} S^{1/2}$$

$d_m = d_{50}$ (in ft) (Ref. 9, p 5.3)
n_f = roughness coefficient at interface

$$= \frac{1.486}{0.02}\left(\frac{0.375}{2}\right)^{2/3}(0.0165)^{1/2} = 3.127 \text{ fps}$$

The velocity at the filter / soil interface is:

$$V_f \simeq 0.5 V_b = 1.563 \text{ fps}$$

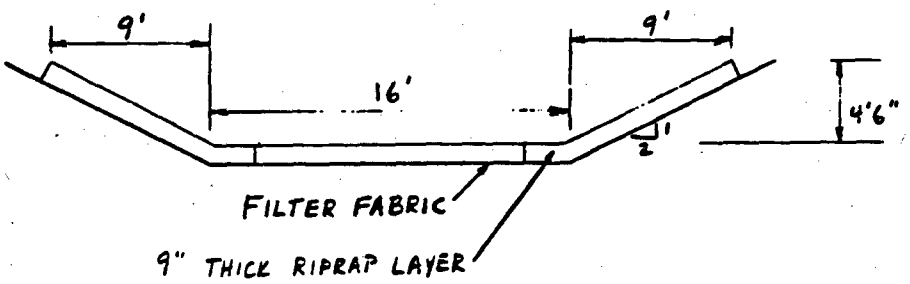
For noncohesive soil, the critical shear stress is (Ref. 9 p. 5.4

$$V_c = 1.67\, d_{50}^{1/2} = 1.67\,(5 \text{ mm})^{1/2} = 3.734 \text{ fps}$$

$$V_c > V_f$$

The critical velocity of soil, V_c, is larger than the flow velocity at the soil / filter interface, V_f. Therefore, a geotextile filter fabric is adequate for the protection.

The cross section of the riprapped channel looks as follows:



3 mattresses to cover cross section (3 × 12' = 36' across)

16' required length of protection downstream

$\frac{16'}{6' \text{ width of mattress}} = 2\frac{2}{3}$ mattresses (round up to 3).

3 mattresses to cover length of protection (3 × 6' = 18' long)

3 mattresses to cover width × 3 mattresses to cover length

= <u>9 revet mattresses needed</u>

CONCRETE

Base: $21.33' \times 16' \times 1' = 341$ cf

Pipe outlet wall. $13.5' \times 18' \times 1' - \left(\frac{\pi 8^2}{4}\right) 1' = 193$ cf

Side walls: $9' \times 13.5' \times 1' \times 2$ walls $= 243$ cf

$13.3' \times \frac{1}{2}(13.5' + 9') \times 1' \times 2$ walls $= 277$ cf

Downstream wall. $16' \times 3.67' \times 0.67' = 39$ cf

Downstream wing walls: $\left[\frac{1}{2}(4' \times 8.00') + (5' \times 8.00') + (9' \times 1')\right] \times \frac{2}{3}' \times 2$ walls $= 87$ cf

Top overhang: $(9' \times 1.33' \times 0.5')2 + (16' \times 1.33' \times 0.5') = 23$ cf

Baffle: $(6.75' \times 1' \times 16') + (0.75' \times 2.67' \times 16')$

$- 2\left[\frac{1}{2}(1.33' + 4') \times 2'\right] 1' = 129$ cf

Concrete ring around pipe: $\left[\frac{\pi(9.33)^2}{4} - \frac{\pi(8)^2}{4}\right] 0.5' = 9$ cf

Total Concrete $= 1{,}341$ cf $= 49.67$ cy $\Rightarrow$ <u>50 cy</u>

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Project: UMTRA/GRJ
Feature: ACCESS AND HAUL ROADS
Item: CULVERT OUTLET REVISION

Contract No. 5025
Designed MDL
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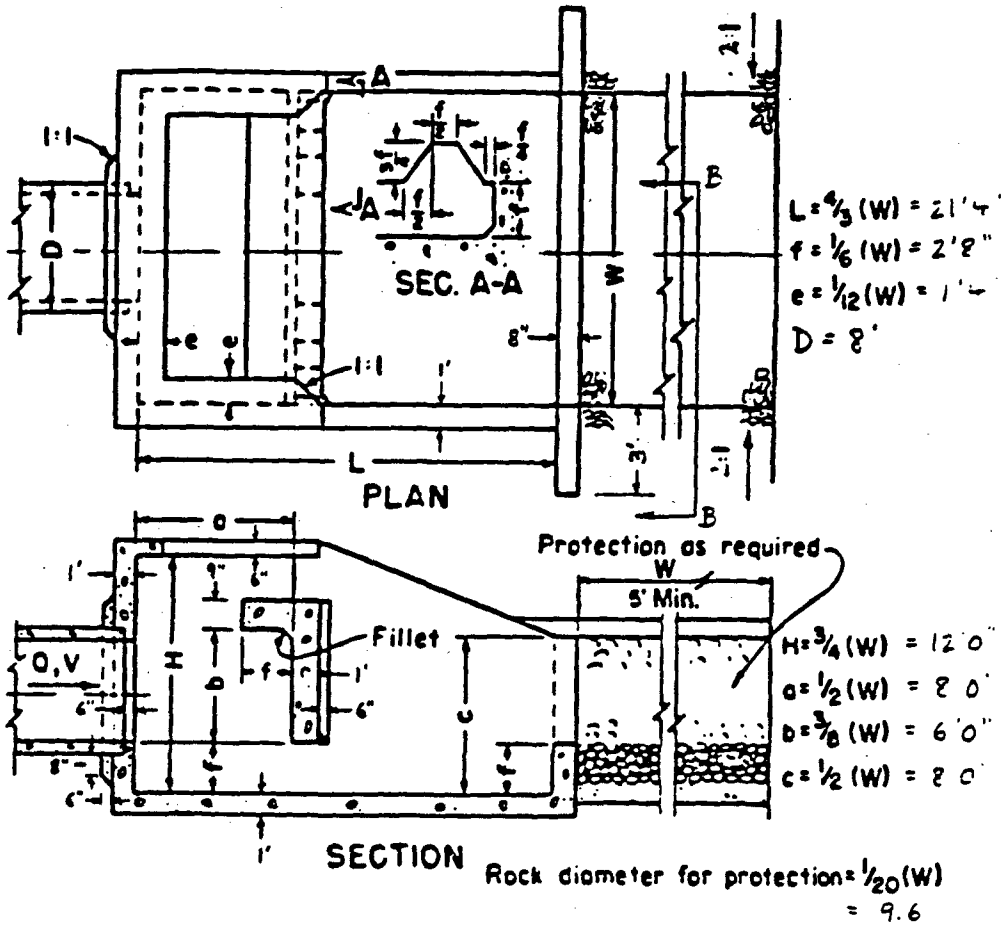
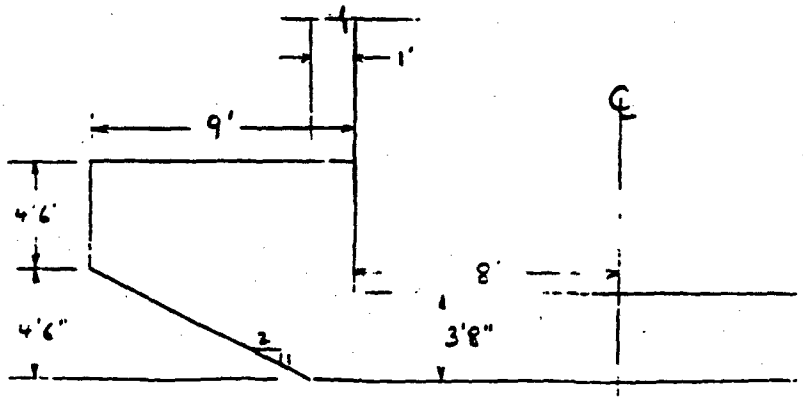
Sheet 25
File No.
Date 5/6/87
Date





SECTION B-B

MORRISON-KNUDSEN ENGINEERS, INC.
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Project: UMTRA / GRJ	Contract No. 5025	Sheet 26	
Feature: ACCESS AND HAUL ROADS	Designed MDL	File No.	Date 5/15/87
Item: CULVERT OUTLET REVISION	Checked PS	Date 5 / 87	

RIPRAP

Riprap Type B encased in 12' x 6' x 9" revet mattresses will serve as protection against erosion downstream of the outlet structure. As shown previously in the calculation 9 revet mattresses are needed to cover the width and necessary length of the channel. Each mattress has a capacity of 2 cubic yards.

9 mattresses x 2 cy = 18 cy of Type B riprap.

ADDITIONAL INLET PROTECTION

At the inlet to the culvert, the critical area for riprap stability is in the 4' x 8' flat area at the mouth of the pipe where the water velocity increases. To ensure that the riprap is not displaced under this condition, revet mattresses should be used to contain the riprap.

Since we are already using 12' x 6' x 9" mattresses downstream of the culvert, we can use the same upstream of the culvert. The dimensions of the area to protect are 24' x 4'. To accomplish this, two revet mattresses can be placed head to head with the 6' width reduced to 4'. The 1' riprap layer will be reduced to 9" in that area to accommodate the 9" thickness of the mattresses. According to the table below, a 9" mattress is equivalent to a 20" layer of riprap; so, in effect, we are increasing the erosion protection.

Shear Stress (lbs/ft^2)	Thickness (inches) Mattress	Riprap	
3.5	6	17	Ref. 9
4.0	9	20	p. 4.21
4.6	12	23	
5.5	18	28	

To prevent the bedding layer from washing away from under the revet mattresses, a geotextile liner will be placed between the mattresses and the bedding layer.