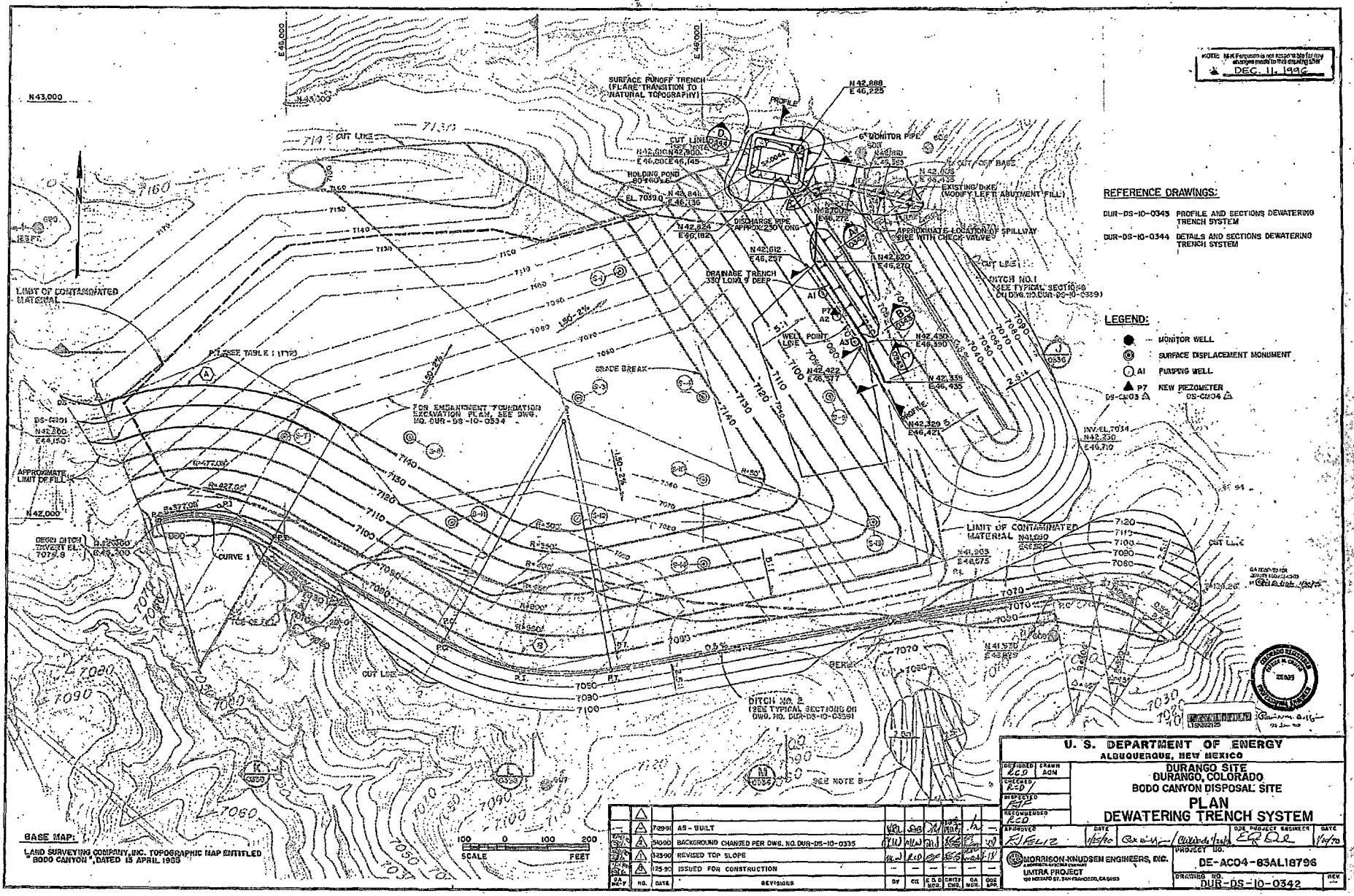
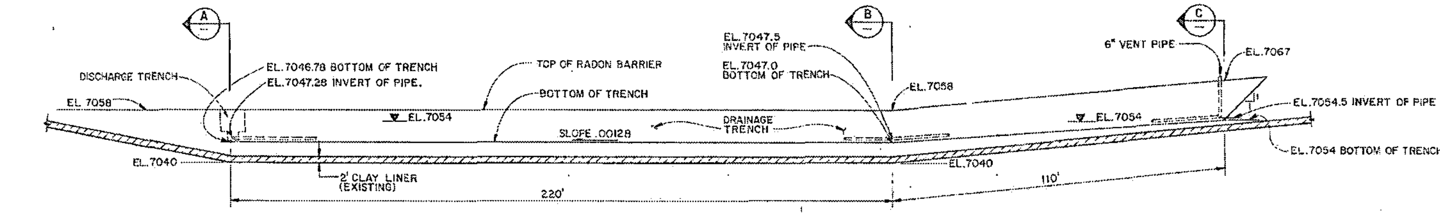
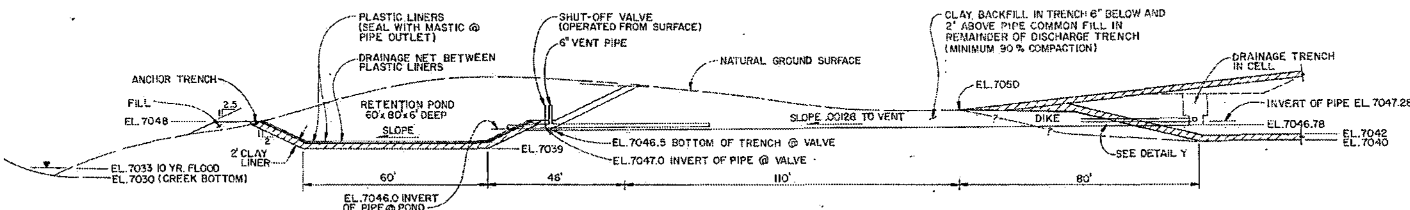

NOTE: M-K Ferguson is not responsible for any changes made to this drawing after DEC. 11, 1996
REFERENCE DRAWINGS:
DUR-DS-10-0343 PROFILE AND SECTIONS DEWATERING TRENCH SYSTEM
DUR-DS-10-0344 DETAILS AND SECTIONS DEWATERING TRENCH SYSTEM
LEGEND:
MONITOR WELL
SURFACE DISPLACEMENT MONUMENT
AI PUMPING WELL
P7 NEW PIEZOMETER
SURFACE RUNOFF TRENCH (FLARE TRANSITION TO NATURAL TOPOGRAPHY)
HOLDING POND
DISCHARGE PIPE APPROX 250' LONG
APPROXIMATE LOCATION OF SPILLWAY (SEE WITH CHECK VALVE)
DRAINAGE TRENCH 330' LONG, 9' DEEP
DITCH NO. 1 (SEE TYPICAL SECTIONS ON DWG. NO. DUR-DS-10-0339)
DITCH NO. 2 (SEE TYPICAL SECTIONS ON DWG. NO. DUR-DS-10-0339)
LIMIT OF CONTAMINATED MATERIAL
APPROXIMATE LIMIT OF FILL
GRADE BREAK
CUT LINE
EXISTING DIKE (MODIFY LEFT ABUTMENT FILL)
BASE MAP:
LAND SURVEYING COMPANY, INC. TOPOGRAPHIC MAP ENTITLED "BODO CANYON", DATED 15 APRIL 1995
SCALE FEET
U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO
DURANGO SITE
DURANGO, COLORADO
BODO CANYON DISPOSAL SITE
PLAN
DEWATERING TRENCH SYSTEM
MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT
DE-AC04-83AL18796
DUR-DS-10-0342
REVISIONS
AS-BUILT
BACKGROUND CHANGED PER DWG. NO. DUR-DS-10-0335
REVISED TOP SLOPE
ISSUED FOR CONSTRUCTION



PROFILE OF DRAINAGE TRENCH

SCALE 20 0 20 40 FEET



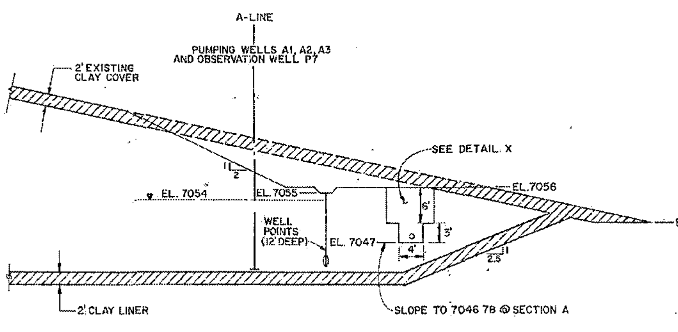
PROFILE OF DISCHARGE TRENCH

SCALE 20 0 20 40 FEET

REFERENCE DRAWINGS:

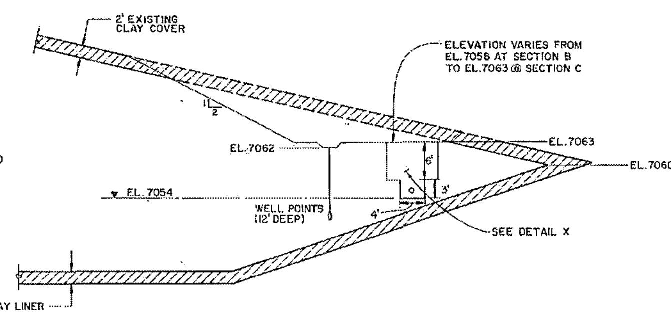
DUR-DS-10-0342 PLAN-DEWATERING TRENCH SYSTEM

DUR-DS-10-0344 DETAILS AND SECTIONS-DEWATERING TRENCH SYSTEM



SECTION A 0342 AND B 0342

SCALE 10 0 10 20 FEET



SECTION C 0342
SOUTH END OF TRENCH

SCALE 10 0 10 20 FEET

NOTE: M-K Ferguson is not responsible for any changes made to this drawing after DEC. 11, 1996

25985

LTSM002126

NO.	DATE	REVISIONS	BY	CK	
	7-29-91	AS-BUILT			
	1-25-90	ISSUED FOR CONSTRUCTION			

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

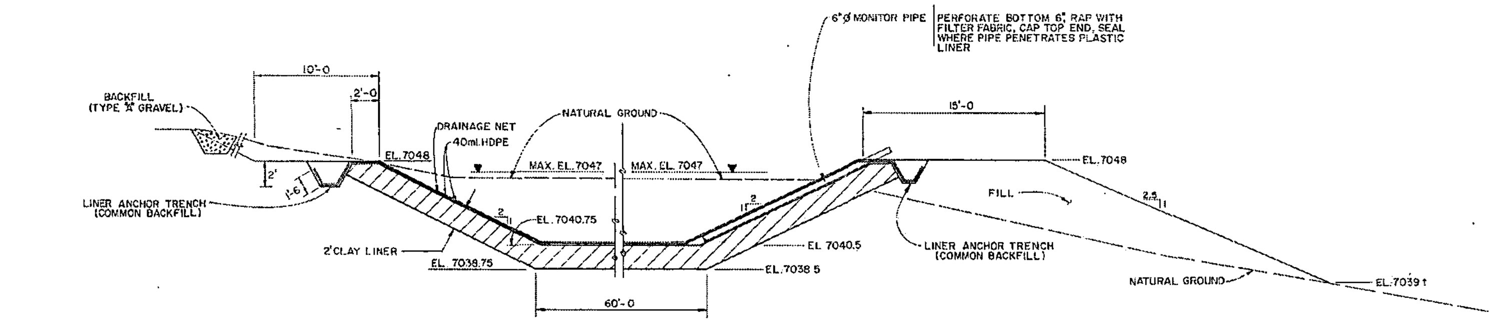
DURANGO SITE
DURANGO, COLORADO
BODO CANYON DISPOSAL SITE

PROFILE AND SECTIONS
DEWATERING TRENCH SYSTEM

MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. DUR-DS-10-0343



SECTION D (0341)

RETENTION POND

NOT TO SCALE

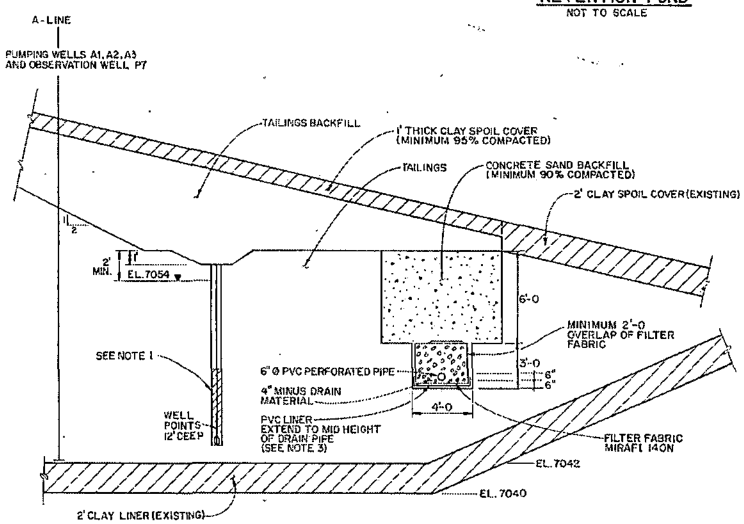
NOTES:

1. AFTER COMPLETION OF TRENCH, BOTTOM 5 FEET OF WELL POINT HOLES WERE GROUTED USING BENTONITE GEL.
2. PVC LINER JOINTS WERE OVERLAPPED MINIMUM 2 FEET AND GLUED.

REFERENCE DRAWINGS:

DUR-DS-10-0342 PLAN - DEWATERING TRENCH SYSTEM

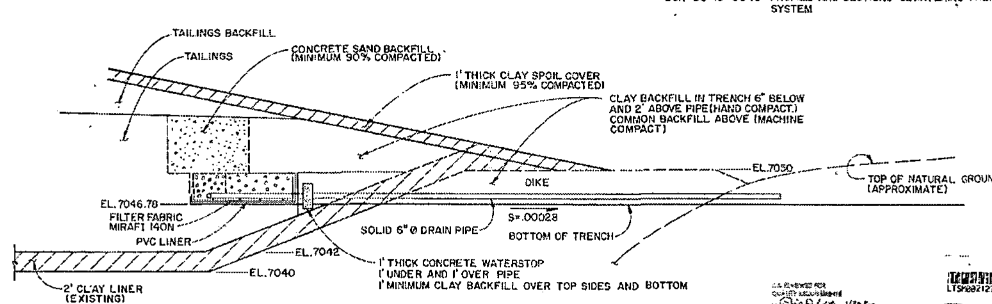
DUR-DS-10-0343 PROFILE AND SECTIONS-DEWATERING TRENCH SYSTEM



DETAIL X (0343)

TYPICAL SECTION OF DRAINAGE TRENCH

SCALE 4 0 4 8 FEET



DETAIL Y (0343)

PROFILE OF DISCHARGE TRENCH

SCALE 6 0 6 12 FEET

NOTE: M-K Ferguson is not responsible for any changes made to this drawing after DEC. 11, 1996

LTSM002127

—		7-29-91	AS-BUILT							—
		1-25-90	ISSUED FOR CONSTRUCTION		—	—	—	—	—	—
Q A MK-F	NO.	DATE	REVISIONS	BY	CK	C&D MGR.	CHIEF ENG.	QA MGR	DOE APP.	

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DURANGO SITE
DURANGO, COLORADO
BODO CANYON DISPOSAL SITE

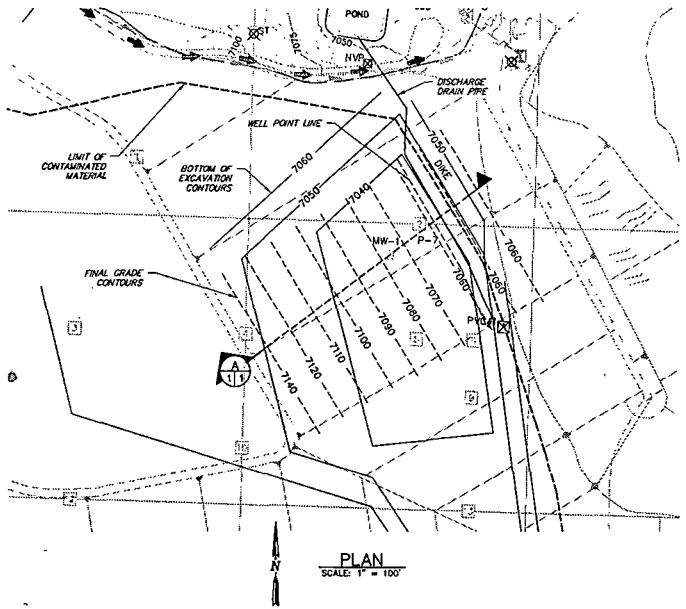
DETAILS AND SECTIONS DEWATERING TRENCH SYSTEM

DESIGNED RCD | DRAWN AMC | CHECKED RCD | INSPECTED FJF | RECOMMENDED RCD | APPROVED F.J. FELIZ

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

PROJECT NO. DE-AC04-83AL18796

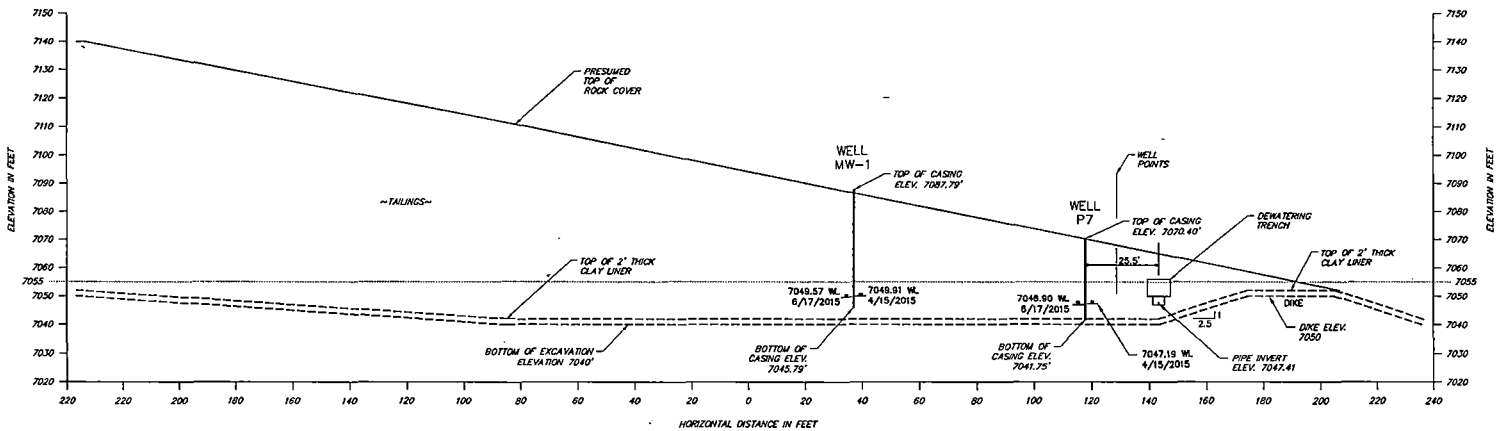
DRAWING NO. DUR-DS-10-0344 | REV. —



PLAN
SCALE: 1" = 100'

GENERAL NOTES:

1. CROSS SECTION CREATED USING AS-BUILT INFORMATION PROVIDED BY MK FERGUSON AS-BUILT DATA DATED 1991.
2. WELLS MW-1 AND P-7 WERE TRANSFERRED FROM MK FERGUSON'S PLATE 1, LONG TERM SURVEILLANCE PLAN, DISPOSAL SITE MAP, DRAWING #DUR-DS-10-0301D, DATED 3/24/94 IN ADOBE FILE FORMAT (PDF) BY OVERLAYING ONTO THE SITE AUTOCAD BASE DRAWING AND TRACES FOR HORIZONTAL LOCATIONS.
3. WATER LEVEL DATA PROVIDED BY NAVARRO SAMPLING GROUP.
4. BOTTOM OF EXCAVATION CONTOURS AND LIMITS OF CONTAMINATED MATERIAL WERE TRANSFERRED FROM THE MK FERGUSON AS-BUILT SET BY OVERLAYING THE EMBANKMENT FOUNDATION EXCAVATION PLAN, DRAWING #DUR-DS-10-0334, AS-BUILT REVISION DATED 07-29-91 IN ADOBE FILE FORMAT (PDF) ONTO THE SITE AUTOCAD BASE DRAWING AND THEN TRACED.
5. FINAL GRADE CONTOURS WERE TRANSFERRED FROM THE MK AS-BUILT DRAWING SET BY OVERLAYING THE EMBANKMENT FINAL GRADING PLAN, DRAWING #DUR-DS-10-0334, AS-BUILT REVISION DATED 07-29-91 IN ADOBE FILE FORMAT (PDF) ONTO THE SITE AUTOCAD BASE DRAWING AND TRACED.



A 1/1 SECTION
SCALE: HORZ. 1" = 20'
VERT. 1" = 20'

ELEVATIONS AT NVP

7051.12 TOP OF PVC CASING
7048.19 WL 4/15/2015 (LAST KNOWN MEASUREMENT)
7047.00 (+\-) BOTTOM OF PIPE
TO POND

NOTE:
ELEVATIONS ARE BASED FROM MEASURED TOTAL DEPTH OF THE VENT PIPE FROM THE TOP OF PVC CASING TO THE INVERT OF HORIZONTAL PIPE. SEE MK ENGINEERING DRAWING #DUR-DS-10-0343.

FINAL

U.S. DEPARTMENT OF ENERGY | Legacy Management
GRAND JUNCTION, COLORADO

Work Performed Under DOE Contract No. DE-AM0000421
Navarro Research and Engineering, Inc.
Contractor to the U.S. Department of Energy Office of Legacy Management

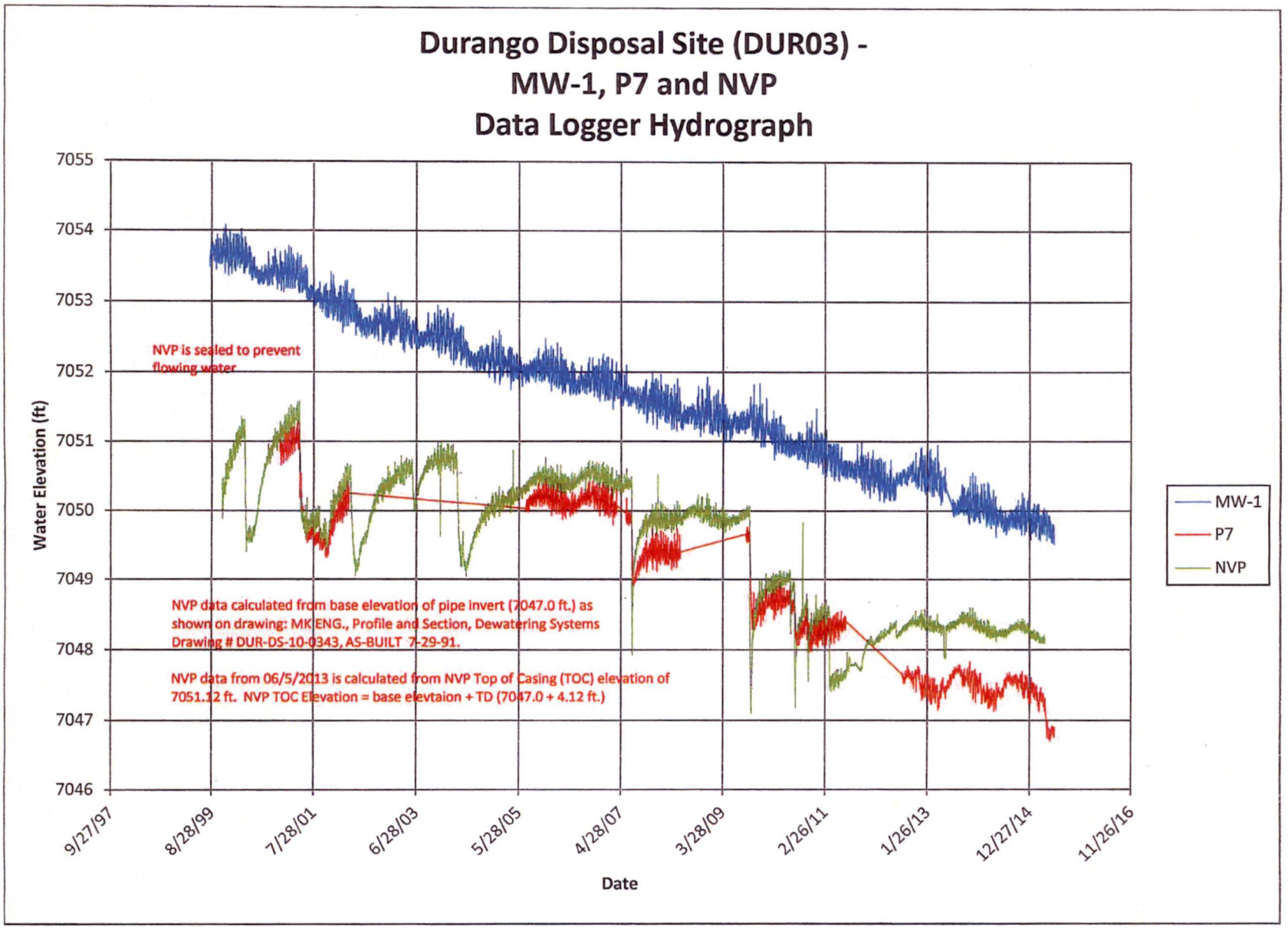
APPROVALS		
DESIGN BY	D. NORDEEN	01/05/16
DRAWN BY	D. NORDEEN	01/05/16
PROJECT ENGINEER	A. TURCHETTI	01/05/16
PROJECT MANAGER	D. BRENNECKE	01/05/16
READY TO ISSUE	D. MILLER	01/05/16
ENVIRONMENTAL COMPLIANCE	D. MILLER	01/05/16

PROJECT LOCATION: DURANGO, CO
REFERENCE NAMES HERE

DURANGO DISPOSAL SITE
EVAPORATION POND DECOMMISSION
WELLS MW-1 AND P7
WATER LEVELS
CROSS SECTION

PROJECT NO. LTS-111-0005-17-000
DRAWING NO. E13756-R00-C01-D+
SHT 1 OF 1

Durango Disposal Site (DUR03) - MW-1, P7 and NVP Data Logger Hydrograph



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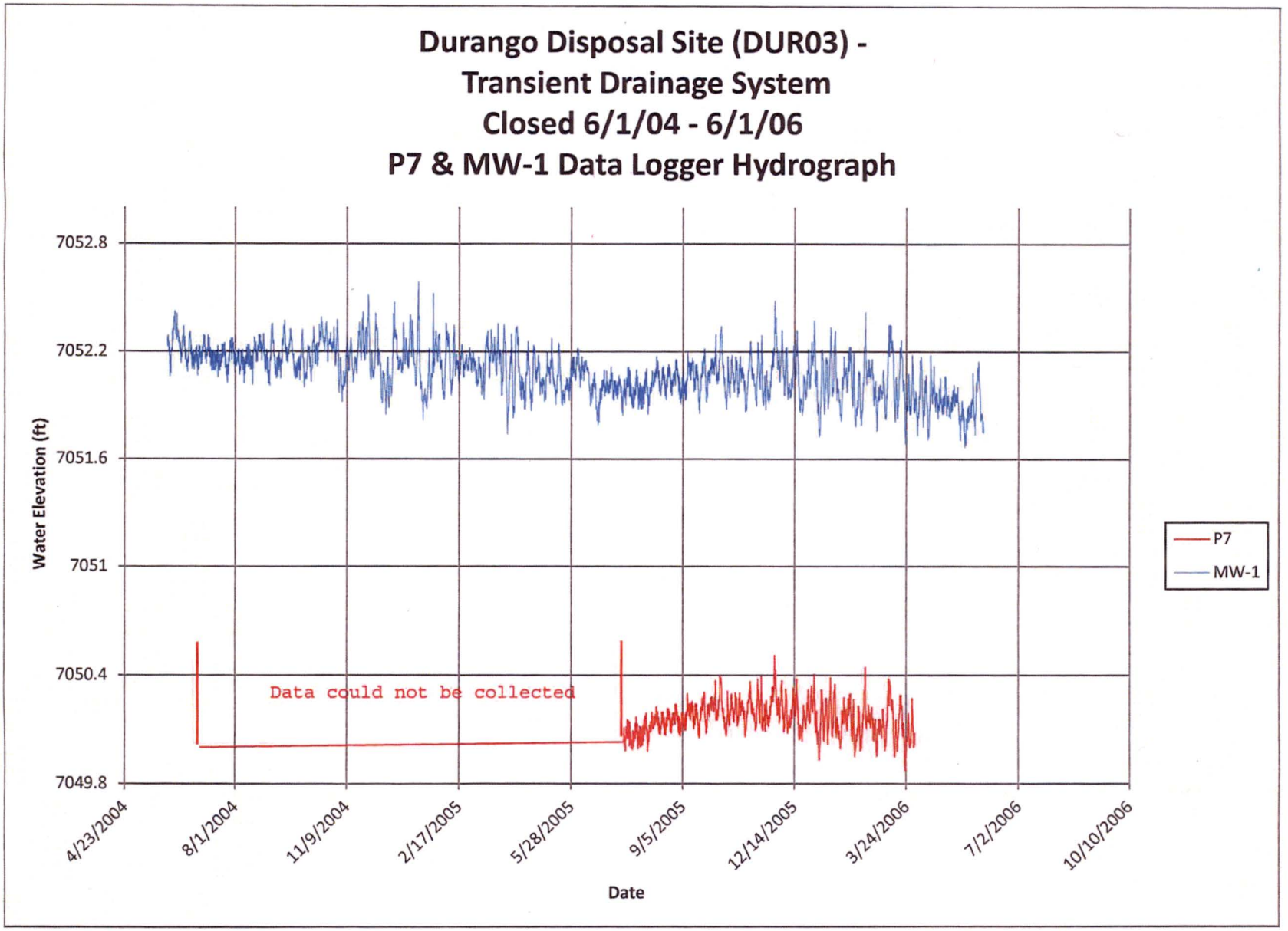

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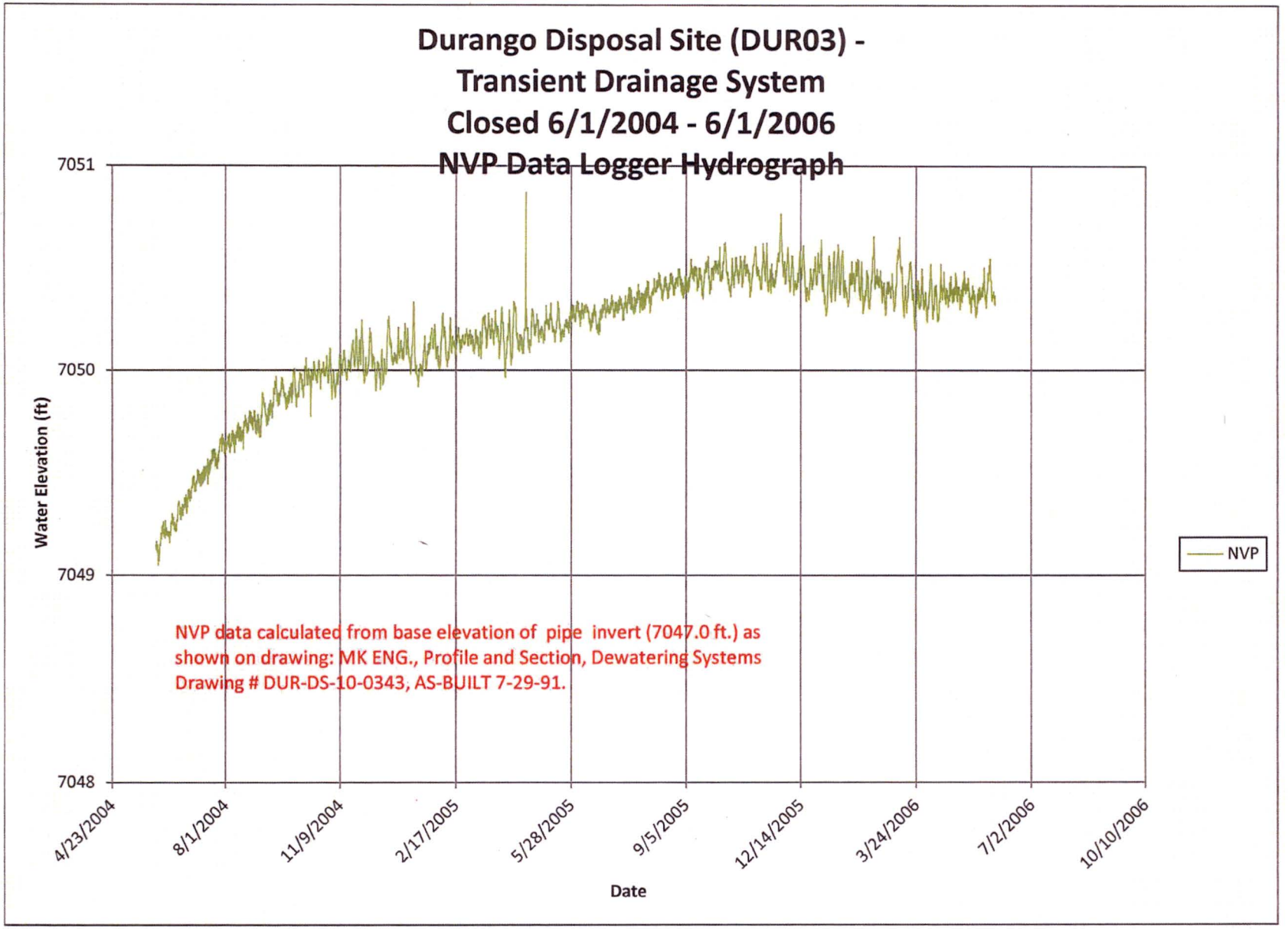
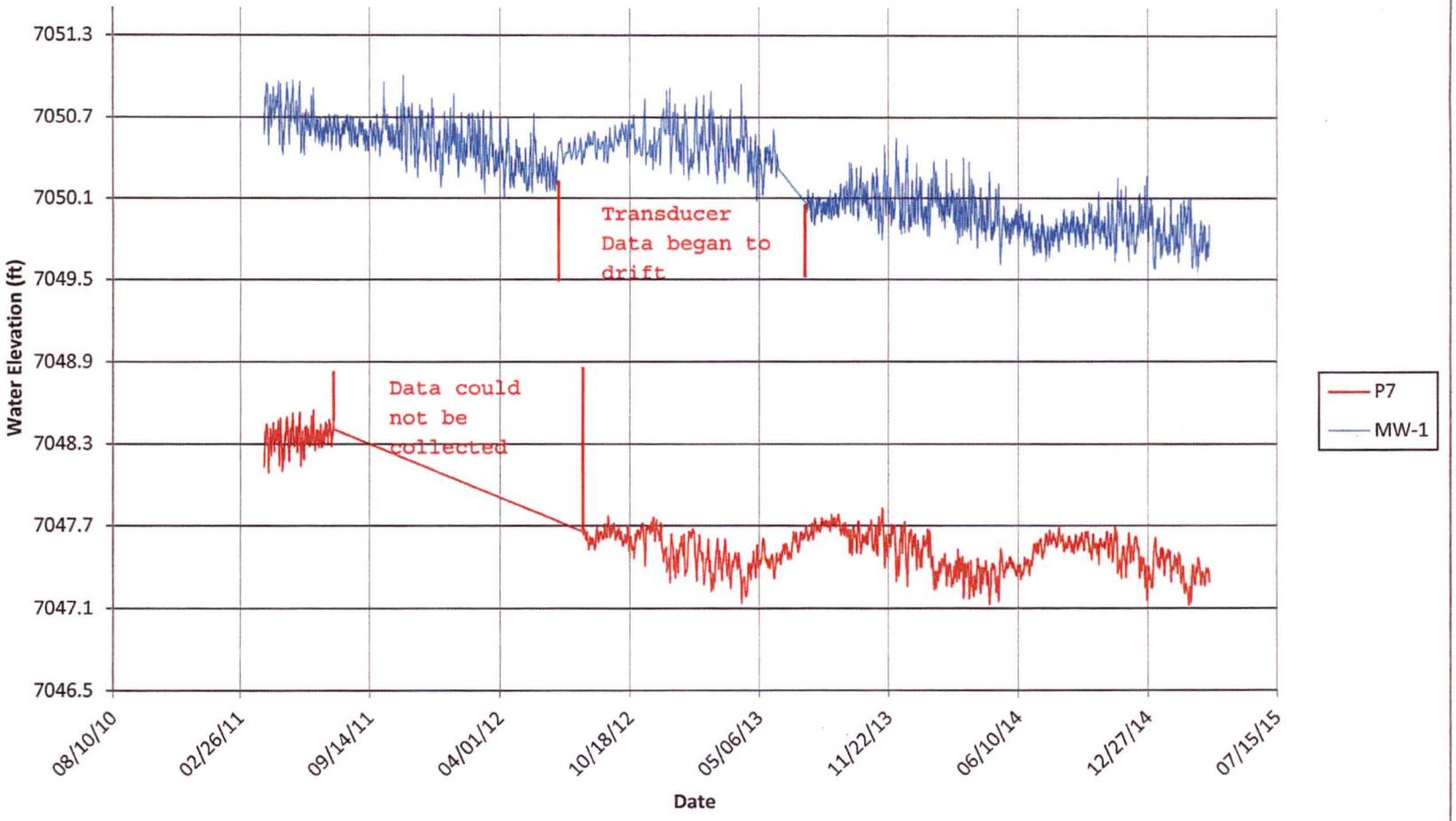


2/10/2016 4:22 PM

Durango Disposal Site (DUR03) - Transient Drainage System Closed 4/1/11 - 4/11/15 Wells P7 and MW-1 Hydrograph



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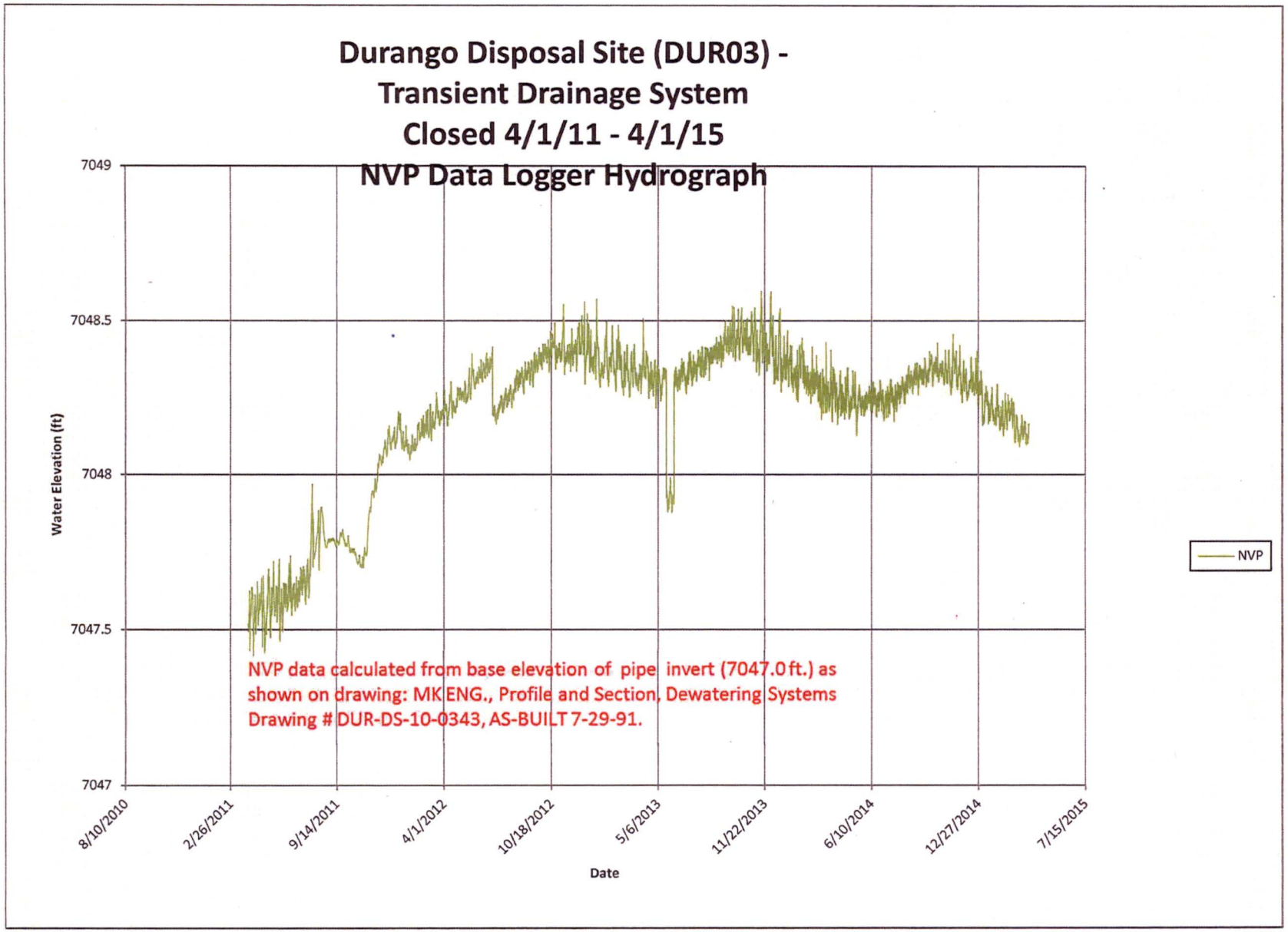


2/10/2016 4:02 PM

UMT 13790

3.19.2.8

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. DUR-09-94-03-01 DISCIPLINE CIVIL/GEOTECH NO. OF SHEETS _____

PROJECT:
UMTRA

SITE:
DURANGO CO. - BODO CANYON DISPOSAL CELL

FEATURE:
SLOPE STABILITY ANALYSIS WITH PHREATIC SURFACE AT 7055.0

SOURCES OF DATA:
SEE ATTACHED

SOURCES OF FORMULAE & REFERENCES:
SEE ATTACHED

PRELIMINARY CALC. ☒ FINAL CALC. ☐ SUPERSEDES CALC. NO. _____

REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
		[signature]	9/94	J. Lomma	9/94	J. Lomma	9/94

JEG-AL-ENG-51 (6/87)

JACOBS ENGINEERING

DATE 9/94 SUBJECT DURANGO TOE DRAIN SLOPE STABILITY ANALYSIS SHEET NO. 1

BY RM CHKD. JOB NO. UMTRA

PURPOSE

A SLOPE STABILITY ANALYSIS IS PERFORMED AT THE TOE DRAIN OF THE DISPOSAL CELL, TO VERIFY THE STABILITY OF THE SLOPE WITH THE PHREATIC SURFACE OF THE SATURATED TAILINGS ABOVE THE VIP CLAY LAYER AT AN ELEVATION OF 7055.0. THIS ELEVATION WAS ESTABLISHED AS THE MAXIMUM PHREATIC SURFACE ELEVATION ALLOWABLE FOR EQUILIBRIUM CONDITIONS WITHOUT CREATING A SEEPAGE FACE ON THE SURFACE OF THE RADON/INFILTRATION BARRIER, (REF. 1).

SINCE THE DISPOSAL CELL HAS BEEN IN PLACE FOR ALMOST 5 YEARS, SOIL PARAMETERS AND REQUIRED FACTORS OF SAFETY WILL BE BASED ON LONG TERM STATIC & LONG-TERM SEISMIC CONDITIONS.

A PREVIOUS CALCULATION (REF. 2) WAS PERFORMED DURING CONSTRUCTION OF THE DISPOSAL CELL TO ASSESS SLOPE STABILITY WITH A PHREATIC SURFACE AT THE ELEVATION OF JAN 95 PRIOR TO DEWATERING, (ELEV. ~ 7063) SOME 8 FEET ABOVE THAT ANALYZED IN THIS CALC. FACTORS OF SAFETY WERE DETERMINED TO BE ACCEPTABLE IN THAT CALC. HOWEVER, "BLOCK FAILURE ANALYSIS" WAS NOT CONSIDERED.

THIS CALCULATION WILL INCLUDE BLOCK FAILURE ANALYSIS AND WILL USE A MORE CONSERVATIVE ANALYSIS IN TERMS OF SOIL PARAMETERS.

METHOD

A CROSS SECTION WAS DEVELOPED BASED ON THE AS-BUILT DRAWINGS OF THE DISPOSAL CELL AT THE TOE DRAIN. ALL LAYERS WERE INCLUDED AND THE VP LAYER CREATING THE PERCHED CONDITION WAS ALSO INCLUDED AS SHOWN IN FIGURES 1 & 2. RIPRAP, BEDDING, AND DRAIN LAYERS WERE CONSIDERED AS ONE MATERIAL. FROST PROTECTION, BIO-INTRUSION, AND ROOTING MEDIUM WERE CONSIDERED AS A SINGLE MATERIAL UNIT. TABLE 1 CONTAINS A SUMMARY OF THE SOIL PROPERTIES USED IN THE ANALYSIS.

PCSTABL5, A SLOPE STABILITY COMPUTER MODEL (REF. 3) WAS USED TO ANALYZE THE VARIOUS CASES OF SLOPE STABILITY. THE MOST CONSERVATIVE METHOD OF ANALYSIS WAS USED, WHICH IS THE SIMPLIFIED JANBU METHOD (REF 3).

THE LOAD CASES ANALYZED WERE LONGTERM STATIC AND LONGTERM SEISMIC, SINCE THE DISPOSAL CELL HAS BEEN IN PLACE FOR 5 YEARS. THE SOIL STATE OF STRESS IS CHARACTERIZED BY DRAINED CONDITIONS AFTER THAT PERIOD OF TIME. THESE SOIL STATE OF STRESS VALUES (CONSOLIDATED-DRAINED CONDITIONS) WERE USED FOR THE JANBU METHOD CIRCULAR FAILURE PLANE AND FOR THE BLOCK ANALYSIS.

A PIEZOMETRIC SURFACE WAS INPUT IN THE PCSTABL5 ANALYSIS AT ELEVATION 7055.0 AND FOLLOWING A PROFILE SIMILAR TO THE SEEPAGE ANALYSIS (REF 1). ALTHOUGH THE CONDITION IN THE FIELD IS ONE OF A PERCHED WATER TABLE, THE ANALYSIS CONSERVATIVELY ASSUMED FULL SATURATION BELOW THE PIEZOMETRIC SURFACE (ONE PIEZOMETRIC SURFACE).

METHOD (CONT.)

SOIL STRENGTH PARAMETERS ARE DERIVED FROM THE MKES CALC. (REF. 2) IN GENERAL. THE PARAMETERS USED FOR LONGTERM STATIC CONDITIONS ARE UNCHANGED. HOWEVER, FOR LONGTERM SEISMIC, ADDITIONAL CONSERVATISM IS USED BY MODIFYING THE UU SOIL PARAMETERS USED FOR LONGTERM SEISMIC ALSO INCLUDES AN INCREASED PORE PRESSURE CONDITION USING THE r_u PARAMETER. AS A SECOND CONSERVATIVE ASSUMPTION, A SEPERATE ANALYSIS IS RUN WITH LONGTERM COHESION VALUES SET TO 0.

THE SEISMIC COEFFICIENT IS 0.16g AS DETERMINED AND USED IN PREVIOUS ANALYSES.

SUMMARY OF RESULTS

LOAD CASE	F.S.	REQ'D F.S.
LONGTERM SEISMIC (BLOCK FAILURE, r_u = 0.2)	3.67	1.0
LONGTERM SEISMIC (BLOCK FAILURE, C = 0)	1.16	1.0
LONGTERM SEISMIC (JANBU CIRCLE, r_u = 0.2)	1.37	1.0
LONGTERM SEISMIC (JANBU CIRCLE, C = 0)	1.19	1.0
LONGTERM STATIC	2.80	1.5

JACOBS ENGINEERING

DATE 9/94 SUBJECT Quinnebaug Toe Drain SHEET NO. 4

BY RM CHKD. Slope Stability Analysis JOB NO. UMRA

REFERENCES

(1) JEG calc. DUR-05-94-12-06-00 "Determination of Maximum Allowable Long-Term Phreatic Surface" May 1994.

(2) MKES calc. No. 03-594-02-00 "Slope Stability Without Dewatering", Mar. 1989 MKE Doc. No. 4005-DUR-C-01-03059-00 *(Included as an Attachment)

(3) Carpenter, J.R. "Information Report STABL5/PCSTABL5 User Manual" May, 1986

* See Sheets 7-16

Material Designations Used In PCSTABL5[1]

1	**Riprap/Bedding/Drainage Layers**
2	**Frost Protection/Biointrusion/Root Medium Layers**
3	**Foundation Material (Mancos Shale)**
4	**Clean Fill Dike Material[2]**
5	**Radon Barrier Material**
6	**Clay Waste Layer[3]**
7	**Tailings Material**
8	**Bottom Liner**
9	**VP Layer[4]**

Footnotes:

1 Material properties are shown on next sheet from Ref. 2

2 Clean fill dike properties are based on tailings properties

3 Clay waste layer is based on radon barrier properties

4 VP layer is based on bottom liner properties

Material	Moist Unit Wt (pcf)	Saturated Unit wt (pcf)	Short-Term Strength Parameters: Cohesion (psf)	Short-Term Strength Parameters: Friction Angle, ϕ (degrees)	Long-Term Strength Parameters: Cohesion (psf)	Long-Term Strength Parameters: Friction Angle, ϕ (degrees)	Case	Soil Number in PCSTABL5 Analysis
Riprap (types A, C, B), bedding, drain	125 (sh. 15 of Ref. 1)	125 (sh. 15 of Ref. 1)	0 (sh. 15 of Ref. 1)	38 (sh. 15 of Ref. 1)	0 (sh. 15 of Ref. 1)	38 (sh. 15 of Ref. 1)	All	1
Frost Protection/ Rooting Media	124.3 (sh. 37)	130.8 (sh. 37)	1045 (sh. 15)	14 (sh. 13) UU	319 (sh. 18) 1045	27 CU 14 (sh. 16)	static 2 seismic 1	2
Tailings	111.3 (sh. 38)	119.5 (sh. 38)	526 (sh. 20)	30 (sh. 20) CU	303 (sh. 20) 526	31 CU 30 (sh. 20)	static 2 seismic 1	4, 7
Foundation Clays	126.8 (sh. 40)	129.3 (sh. 40)	4535 (sh. 22)	0 (sh. 22) UU	455 (sh. 22) 4535	27 (sh. 22) CU 0 UU	static 2 seismic 1	3
Radon Barrier	125.7 (sh. 44)	128.4 (sh. 44)	1270 (sh. 30)	8 (sh. 30) UU	245 (sh. 30) 1270	22 CU (sh. 30) 8 UU	static 2 seismic 1	5, 6
Low Permeability Liner	125.7 (sh. 44)	130.8 (sh. 44)	1270 (sh. 30)	8 (sh. 30) UU	245 (sh. 30) 1270	22 CU (sh. 30) 8 UU	static 2 seismic 1	8, 9

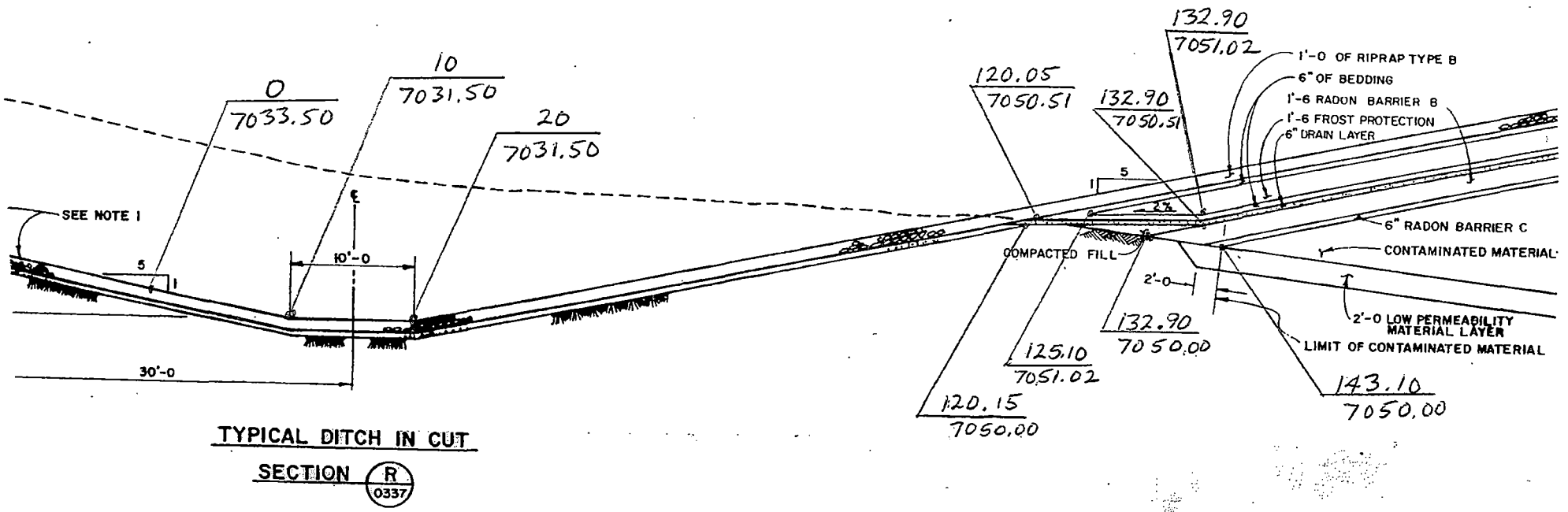
Columns Modified for DUR-09-94-03-01

TABLE 1
(FROM REF. 2)
See Attachment

FOOTNOTES

1 USED FOR LONGTERM SEISMIC W/ r_u (PORE PRESSURE COEFFICIENT)

2 USED FOR LONGTERM STATIC & LONGTERM SEISMIC WITH C=0



TYPICAL DITCH IN CUT

SECTION R 0337

FIGURE 1

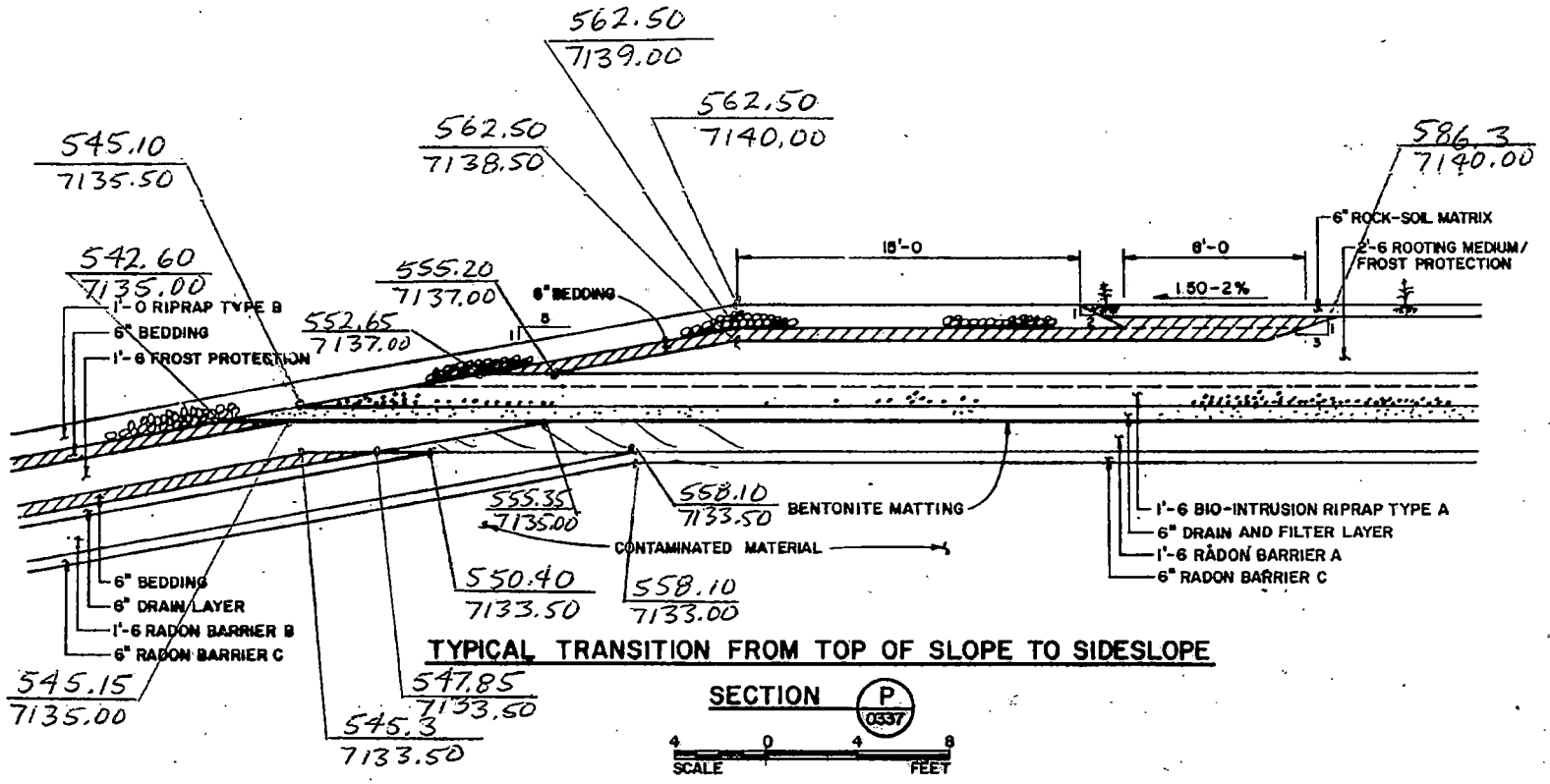

562.50
7139.00
562.50
7140.00
562.50
7138.50
545.10
7135.50
586.3
7140.00
6" ROCK-SOIL MATRIX
2'-6 ROOTING MEDIUM/
FROST PROTECTION
15'-0
8'-0
1.50-2%
542.60
7135.00
555.20
7137.00
6" BEDDING
1'-0 RIPRAP TYPE B
6" BEDDING
1'-6 FROST PROTECTION
552.65
7137.00
555.35
7135.00
558.10
7133.50
BENTONITE MATTING
CONTAMINATED MATERIAL
1'-6 BIO-INTRUSION RIPRAP TYPE A
6" DRAIN AND FILTER LAYER
1'-6 RADON BARRIER A
6" RADON BARRIER C
550.40
7133.50
558.10
7133.00
6" BEDDING
6" DRAIN LAYER
1'-6 RADON BARRIER B
6" RADON BARRIER C
545.15
7135.00
547.85
7133.50
545.3
7133.50
TYPICAL TRANSITION FROM TOP OF SLOPE TO SIDESLOPE
SECTION P 0337
4 0 4 8
SCALE FEET

FIGURE 2

Rg 7

Calculation Cover Sheet

Attachment – Reference #2

Contract No. 4005-15 Discipline ESCI

Calc. No. 03-594-02-00

No. of Sheets 44 text 56 Appendix

Project
UMTRA - DUR

Feature
EMBANKMENT

Item
SLOPE STABILITY WITHOUT DENATERING

Sources of Data & References

(1) UMTRA - DUR Embankment Slope Stability Analyses Calc., MKE Calc. No. 03-565-04-02.

(2) Siegel, R.A., 1975, STABL User Manual, Purdue University and Indiana State Highway Commission, Publication JHRP-75-9.

(3) Carpenter, J.R., 1985, PCSTABL4 User Manual, 77p.

(4) Durango Site Additional Investigations During Construction, Laboratory Test Results Submittals, March 1988, 3 volumes, MKE Doc. No. 4005-DUR-R-01-02361-00.

(5) Western Technologies Inc. Geotechnical Evaluation for: UMTRA Project Triaxial Compression Tests, July 1, 1987, MKE Doc. No. 4005-DUR-C-09-01900-00.

(6) UMTRA, Durango, Colorado Site Geotechnical Parameters, 6/24/86, MKE Calc. No. 03-511-02-01.

(continued on sh. i)

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

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
				JC PORTELA	3-2-89	H.R. Thiers	3/9/89
				S.F. Bolaffi	3-2-89		
00	—	D. Unruh	1MAR89	M.A. Nybakken	3-2-89		
				K.L. OHSIEK	3/2/89		

Form 42-110

References (cont.):

(7) UMTRA Project - Durango, Colorado Subcontract Documents, Final Design for Construction, Section 02200, Issued for Construction - Revision 4, Earthwork, MKE Doc. No. 4005 DVR-5-01-00424-06.

(8) UMTRA - GEN, Potential Infiltration of Construction Water, Basic Data for UNSATZ Input Parameters, AEE Calc. No. 00-165-01-00.

(9) UMTRA - General, Infiltration of Cons
Durango - UNSATZ Input Data/Analyses, Al

Slope stability analysis of the Bodo Canyon embankment was conducted for the new cover design and embankment configuration for short-term static, short-term seismic, long-term static and long-term seismic conditions assuming the pile is not dewatered (i.e. - potentiometric levels as of 4JAN89 (sh. 7) are not altered with time either by man or natural processes).

In all cases, the minimum design factors of safety were met (sh. 6) indicating the modeled potentiometric surface will not adversely affect slope stability.

A cross-section was taken through the pile parallel to grade on the longest slope (see sheets 9 & 10) for modeling purposes. A coordinate system was then imposed on the cross-section. Six types of material were defined and contact boundaries delineated (see sheets 11 & 12). Riprap (types A & B), bedding & drain material were considered to represent one unit.

The rooting media and frost protection layer were likewise considered to be a single unit. The other 4 material types were tailings, foundation clay, radon barrier material and the low permeability liner. Sheet 8 contains a summary table of the soil properties data used in the slope stability analysis.

PCSTABL4, a slope stability computer model (Refs 2&3) was utilized to analyze the four conditions described on sh. 1. The most critical factor of safety, calculated with modified Bishop method of slices for each scenario is presented on sh. 6. The input data files and corresponding output are included as sheets A2-A12, A13-A23, A24-A34 and A35-A45 for short-term static, short-term seismic, long-term static and long-term seismic, respectively. Plots of the most critical failure surfaces for each of these cases are presented on sheets 13-16.

An additional PCSTABL4 run was conducted for a scenario where the tailings impoundment was fully saturated and a long-term seismic load was applied. A most critical factor of safety of 1.07 was computed for this case indicating that the tailings embankment should be stable for most forseeable scenarios (i.e. - even the rare event of seismic loading and full saturation yields a factor of safety > 1.0). Results of this PCSTABL4 analysis are included as sheets A46-A56. A plot of the most critical failure surface is presented on sh. 17.

A review of the strength properties used in previous slope stability analyses conducted for the Durango site indicated that these values were inadequate for use in subsequent modeling due to the availability of new strength test data.

Therefore, strength properties were reevaluated for all materials with data currently available with the exception of the riprap and bedding materials. Specific strength characteristics of the drain material in the new cover design were not known and were assumed equivalent to those of the riprap and bedding material due to their origin from the same borrow source.

The frost protection and rooting media materials are extracted from the spoils pile. Therefore, their strengths were determined from test data collected for the spoils pile material.

Shear strength data for all materials used in the stability analysis are summarized in the table on sh. 8.

In addition, average unit weights were calculated for all materials with the exception of the riprap/bedding/drain material. The value of 125 pcf used in previous slope stability analyses (Ref. 1, sh. 15) was assumed to be representative of the material. All unit weights used in this analysis are also included in the table on sh. 8.

In Summary:

CASE	GROUNDWATER LEVELS	FACTOR OF SAFETY	MINIMUM-DESIGN FACTOR OF SAFETY *
Short-Term Static	see sh. 9	3.08 (sh. A-5)	1.3
Short-Term Seismic (k = 0.05 g, sh. 2 of Ref. 1)	see sh. 9	2.45 (sh. A-17)	1.1
Long-Term Static	see sh. 9	2.71 (sh. A-27)	1.5
Long-Term Seismic (k = 0.16 g, sh. 2 of Ref. 1)	see sh. 9	1.67 (sh. A-39)	1.1
Long-Term Seismic (k = 0.16 g, sh. 2 of Ref. 1) Saturated Case	see sh. 17	1.07 (sh. A-50)	1.1

* From MKE UMTRA Design Procedures Manual p. 10-3.

Sheet 7 of 915

DTM 23FEB89 MAN 3-2-89

COMPANY

OPERATION DURANGO - UMTRA ITEM NO SHEET OF PAGE

EL SEEP MONITOR WELLS WATER LEVEL LOG JOB

QUANTITY UNIT EST. BY D. TAZZAN CK'D BY DATE

FORM PS 13/1974 PRINTED IN U.S.A.

WELL No.	SURFACE EL.	DEPTH	H_2O LEVEL 11-29-88	H_2O LEVEL 12-14-88	H_2O LEVEL 12-21-88	H_2O LEVEL 12-29-88
1	7080.6	35.0	7062.6	7062.2	7067.9	7068.4
2	7103.8	55.5	7064.8	7065.8	7065.7	7065.7
3	7105.0	47.5	7066.0	7069.5	7069.3	7069.3
4	7097.4	50.0	7050.4	7060.4	7060.2	7060.3
5	7051.0	30.0	7033.0	DRY	DRY	DRY
7	7107.6	42.5	7071.6	7075.9	7075.7	7076.0

WELL No.	H_2O LEVEL 1-4-89	H_2O LEVEL 1-11-89	H_2O LEVEL 1-18-89	H_2O LEVEL 1-25-89
1	7063.4			
2	7065.7			
3	7069.1			
4	7060.4			
5	DRY			
7	(FLOWING) 7075.9			

WELL No.	H_2O LEVEL 2-1-89	H_2O LEVEL 2-8-89	H_2O LEVEL 2-15-89	H_2O LEVEL 2-22-89
1				
2				
3				
4				
5				
7				

From MKE Doc. No. 4005-DVR-I-01-02926-00.

WELL No.	H_2O LEVEL 3-1-89	H_2O LEVEL 3-8-89	H_2O LEVEL 3-15-89	H_2O LEVEL 3-22-89
1				
2				
3				
4				
5				
7				

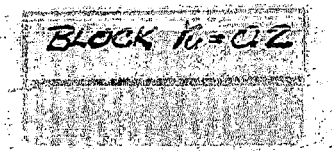
WELL No.	H_2O LEVEL 3-29-89	H_2O LEVEL 4-12-89	H_2O LEVEL 4-26-89
2			
3			
4			
5			

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

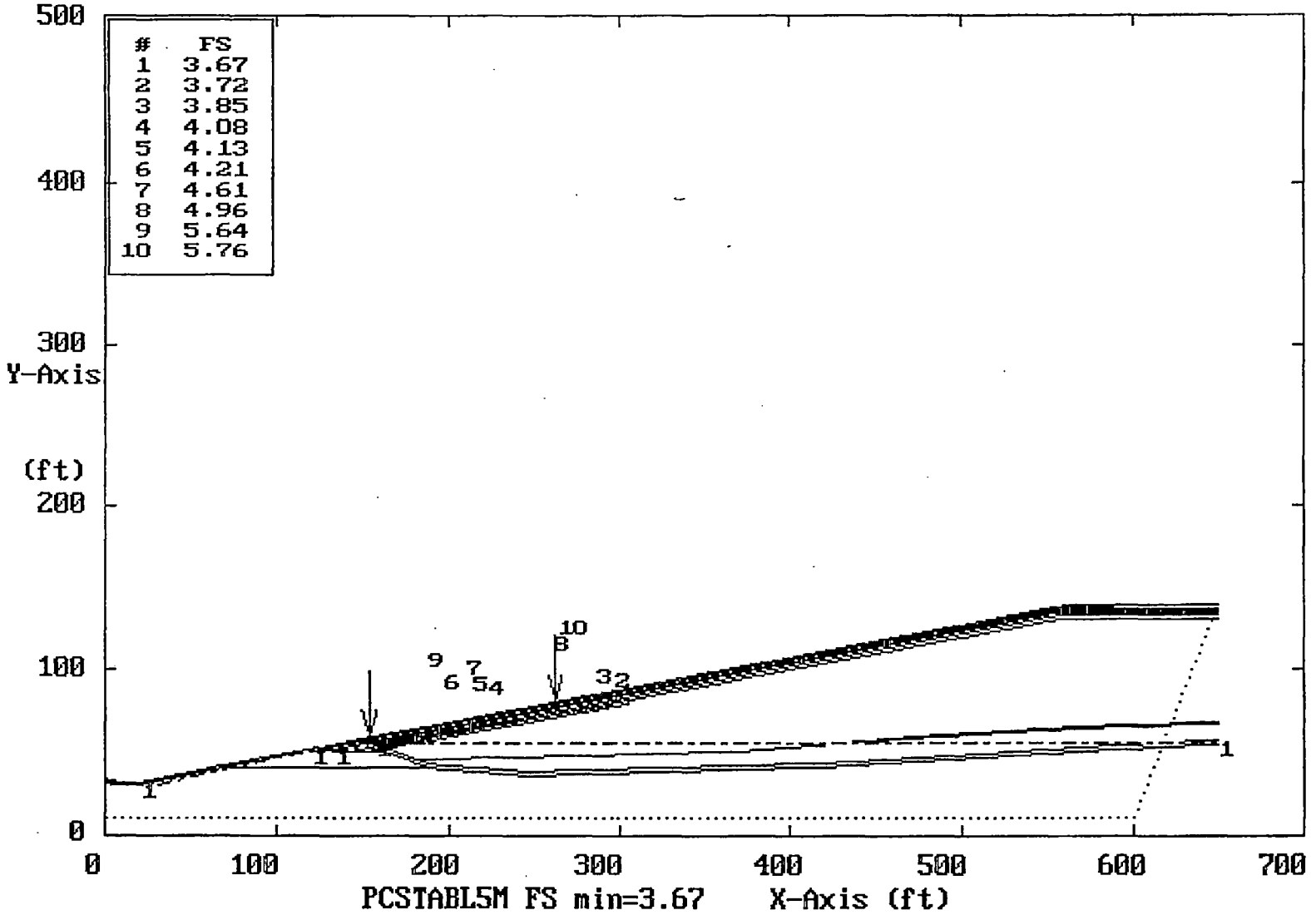
Project: UMTRA-SVR | Contract No. 4605-15 | Sheet 0
Feature: SLOPE STABILITY | Designed DJU | Date 28 FEB 89 | File No.
Item: SOIL PROPERTIES | Checked MAN | Date 3-2-89

Material	Moist Unit Wt (pcf)	Saturated Unit wt (pcf)	Short-Term Strength Parameters: Cohesion (psf)	Short-Term Strength Parameters: Friction Angle, ϕ (degrees)	Long-Term Strength Parameters: Cohesion (psf)	Long-Term Strength Parameters: Friction Angle, ϕ (degrees)	Case	Soil Number in PCSTABL4 Analysis
Riprap (types A & B), bedding, drain	125 (sh. 15 of Ref. 1)	125 (sh. 15 of Ref. 1)	0 (sh. 15 of Ref. 1)	38 (sh. 15 of Ref. 1)	0 (sh. 15 of Ref. 1)	38 (sh. 15 of Ref. 1)	All	1
Frost Protection/ Rooting Media	124.3 (sh. 37)	130.8 (sh. 37)	1045 (sh. 18)	14 (UU) (sh. 18)	319 (sh. 18) 1045	27 (CU) 14 (sh. 18)	Static Seismic	2
Tailings	111.3 (sh. 38)	119.5 (sh. 38)	526 (sh. 20)	30 (CU) (sh. 20)	308 (sh. 20) 526	31 (CU) 30 (sh. 20)	Static Seismic	3
Foundation Clays	126.8 (sh. 40)	129.3 (sh. 40)	4535 (sh. 22)	0 (UU) (sh. 22)	455 (sh. 22) 4535	27 (CU) (sh. 22) 0 (UU)	Static Seismic	4
Radon Barrier	125.7 (sh. 44)	128.4 (sh. 44)	1270 (sh. 30)	8 (UU) (sh. 30)	245 (sh. 30) 1270	22 (CU) 8 (UU) (sh. 30)	Static Seismic	5
Low Permeability Liner	125.7 (sh. 44)	130.8 (sh. 44)	1270 (sh. 30)	8 (UU) (sh. 30)	245 (sh. 30) 1270	22 (CU) 8 (UU) (sh. 30)	Static Seismic	6

9/16/1


BLOCK 11-02

Durango Toe Drain Longterm Seismic w/ Phreatic EQh = 0.16 ru=0.2 Block Failure
Ten Most Critical. C:DURTDHW2.PLT By: RAM 09-20-94 2:03pm



** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 09-20-94
Time of Run: 2:03pm
Run By: RAM
Input Data Filename: C:DURTDHW2.BLK
Output Filename: C:DURTDHW2.OUT
Plotted Output Filename: C:DURTDHW2.PLT

PROBLEM DESCRIPTION Durango Toe Drain Longterm Seismic w/
Phreatic EQh = 0.16 ru=0.2 Block Failure

BOUNDARY COORDINATES

5 Top Boundaries
71 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	33.50	10.00	31.50	1
2	10.00	31.50	20.00	31.50	1
3	20.00	31.50	562.50	140.00	1
4	562.50	140.00	586.30	140.00	1
5	586.30	140.00	650.00	140.00	1
6	.00	32.50	10.00	30.50	1
7	10.00	30.50	20.00	30.50	1
8	20.00	30.50	545.10	135.50	1
9	545.10	135.50	552.65	137.00	2
10	552.65	137.00	562.50	139.00	1
11	562.50	139.00	579.50	139.00	1
12	579.50	139.00	579.60	139.50	1
13	579.60	139.50	587.60	139.50	1
14	587.60	139.50	650.00	139.50	2
15	552.65	137.00	555.20	137.00	2
16	555.20	137.00	562.50	138.50	2

17	562.50	138.50	587.50	138.50	2
18	587.50	138.50	587.60	139.50	2
19	555.20	137.00	650.00	137.00	2
20	545.10	135.50	650.00	135.50	1
21	120.15	50.00	122.70	50.51	1
22	122.70	50.51	125.10	51.02	1
23	125.10	51.02	545.15	135.00	2
24	545.15	135.00	555.35	135.00	2
25	555.35	135.00	650.00	135.00	5
26	125.10	51.02	132.90	51.02	1
27	132.90	51.02	545.30	133.50	1
28	545.30	133.50	547.85	133.50	1
29	547.85	133.50	555.35	135.00	5
30	122.70	50.51	132.90	50.51	1
31	132.90	50.51	547.85	133.50	1
32	547.85	133.50	550.40	133.50	1
33	.00	32.00	10.00	30.00	3
34	10.00	30.00	20.00	30.00	3
35	20.00	30.00	70.20	40.00	3
36	70.20	40.00	120.15	50.00	4
37	120.15	50.00	132.90	50.00	4
38	132.90	50.00	550.40	133.50	5
39	132.90	50.00	143.10	50.00	4
40	143.10	50.00	558.10	133.00	6
41	558.10	133.00	650.00	133.00	6
42	143.10	50.00	153.30	50.00	4
43	153.30	50.00	163.30	52.00	8
44	163.30	52.00	558.10	131.00	7
45	558.10	131.00	650.00	131.00	7
46	163.30	52.00	180.80	45.00	8
47	180.80	45.00	202.30	45.50	9
48	202.30	45.50	372.00	50.00	9
49	372.00	50.00	432.00	55.00	9
50	432.00	55.00	492.00	60.00	9
51	492.00	60.00	572.00	65.00	9
52	572.00	65.00	650.00	67.50	9
53	180.80	45.00	182.05	44.50	8
54	182.05	44.50	202.30	45.00	7
55	202.30	45.00	372.00	49.50	7
56	372.00	49.50	432.00	54.50	7
57	432.00	54.50	492.00	59.50	7
58	492.00	59.50	572.00	64.50	7
59	572.00	64.50	650.00	67.00	7
60	182.05	44.50	188.30	42.00	8
61	188.30	42.00	252.00	37.00	8
62	252.00	37.00	422.00	42.00	8
63	422.00	42.00	572.00	52.00	8
64	572.00	52.00	650.00	56.00	8
65	153.30	50.00	163.30	50.00	4
66	163.30	50.00	188.30	40.00	4
67	70.20	40.00	188.30	40.00	3
68	188.30	40.00	252.00	35.00	3

69	252.30	35.00	422.00	40.00	3
70	422.00	40.00	572.00	50.00	3
71	572.00	50.00	650.00	54.00	3

1

ISOTROPIC SOIL PARAMETERS

9 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	.0	38.0	.00	.0	1
2	124.0	131.0	1045.0	14.0	.00	.0	1
3	126.0	129.0	4500.0	.0	.20	.0	1
4	111.0	120.0	500.0	30.0	.20	.0	1
5	126.0	128.0	1270.0	8.0	.20	.0	1
6	126.0	128.0	1000.0	.0	.20	.0	1
7	111.0	120.0	520.0	30.0	.20	.0	1
8	126.0	130.0	1270.0	8.0	.20	.0	1
9	125.0	128.0	1000.0	.0	.20	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	20.00	30.00
2	120.15	50.00
3	132.90	50.00
4	157.90	55.00
5	650.00	55.00

A Horizontal Earthquake Loading Coefficient
Of .160 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

Searching Routine Will Be Limited To An Area Defined By 4 Boundaries
Of Which The First 4 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	10.00	200.00	10.00
2	200.00	10.00	300.00	10.00
3	300.00	10.00	600.00	10.00
4	600.00	10.00	650.00	140.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Sliding Block Surfaces, Has Been
Specified.

The Active And Passive Portions Of The Sliding Surfaces
Are Generated According To The Rankine Theory.

10 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of
Sliding Block Is 10.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	155.80	51.52	163.30	53.02	4.00
2	168.10	53.97	174.40	55.24	4.00
3	184.40	57.20	304.40	81.20	4.00

WARNING - Limitation Boundaries Have Been Specified,
These Are Ignored In This Program Routine.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.35	58.17
2	154.82	57.46
3	155.54	57.11
4	157.13	55.87
5	157.87	55.50
6	158.61	55.14
7	160.52	53.48
8	162.22	51.78
9	162.23	51.77
10	168.92	53.73
11	256.67	71.74
12	257.88	72.96
13	260.03	75.43
14	260.30	75.99
15	260.58	76.56
16	262.01	78.39
17	262.28	78.95
18	262.83	80.07

*** 3.668 ***

Individual data on the 21 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	1.5	91.8	.0	.0	.0	.0	14.7	.0	.0
2	.7	113.3	.0	.0	.0	.0	18.1	.0	.0
3	1.6	451.4	.0	.0	.0	.0	72.2	.0	.0

4	.7	306.1	.0	.0	.0	.0	49.0	.0	.0
5	.7	353.4	.0	.0	.0	.0	56.5	.0	.0
6	.2	84.8	.0	22.5	.0	.0	13.6	.0	.0
7	1.7	1133.0	.0	409.6	.0	.0	181.3	.0	.0
8	1.7	1527.8	.0	787.2	.0	.0	244.5	.0	.0
9	.0	11.1	.0	5.8	.0	.0	1.8	.0	.0
10	.1	127.3	.0	52.3	.0	.0	20.4	.0	.0
11	5.7	5710.9	.0	2067.6	.0	.0	913.7	.0	.0
12	.8	781.0	.0	236.6	.0	.0	125.0	.0	.0
13	6.2	5825.7	.0	1437.9	.0	.0	932.1	.0	.0
14	81.6	74618.6	.0	15234.8	.0	.0	11939.0	.0	.0
15	1.2	1002.7	.0	283.6	.0	.0	160.4	.0	.0
16	2.1	1367.3	.0	416.8	.0	.0	218.8	.0	.0
17	.3	131.4	.0	.0	.0	.0	21.0	.0	.0
18	.3	113.8	.0	.0	.0	.0	18.2	.0	.0
19	1.4	408.9	.0	.0	.0	.0	65.4	.0	.0
20	.3	42.6	.0	.0	.0	.0	6.8	.0	.0
21	.5	34.4	.0	.0	.0	.0	5.5	.0	.0

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	156.10	58.72
2	157.56	58.01
3	158.29	57.65
4	159.87	56.41
5	160.62	56.05
6	161.36	55.69
7	162.69	54.53
8	170.96	55.92
9	293.17	77.30
10	293.62	78.08
11	296.15	80.61
12	298.30	83.08
13	298.58	83.65
14	298.85	84.21
15	300.29	86.04
16	300.56	86.60
17	301.10	87.72

*** 3.720 ***

1

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	147.91	57.08
2	149.37	56.37
3	150.09	56.02
4	151.68	54.78
5	152.42	54.41
6	153.16	54.05
7	155.07	52.39
8	156.77	50.69
9	157.57	50.00
10	157.59	49.99
11	171.94	55.06
12	284.62	77.76
13	285.30	78.44
14	287.45	80.91
15	287.72	81.47
16	288.00	82.04
17	289.43	83.87
18	289.70	84.43
19	290.25	85.55

*** 3.847 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	149.58	57.42
2	151.04	56.70
3	151.76	56.35
4	153.35	55.11
5	154.09	54.75
6	154.83	54.39
7	156.74	52.73
8	158.02	51.45
9	173.04	53.75
10	222.16	66.57
11	223.50	68.12
12	223.78	68.69
13	224.05	69.25
14	225.49	71.09
15	225.76	71.64
16	226.30	72.76

*** 4.082 ***

1

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	148.73	57.25
2	150.19	56.53
3	150.92	56.18
4	152.51	54.94
5	153.25	54.58
6	153.99	54.22
7	155.90	52.56
8	157.60	50.86
9	157.64	50.82
10	169.30	54.71
11	209.56	61.66
12	211.60	63.70
13	213.75	66.17
14	214.02	66.73
15	214.30	67.30
16	215.74	69.14
17	216.01	69.69
18	216.55	70.81

*** 4.128 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	149.90	57.48
2	151.36	56.77
3	152.08	56.41
4	153.67	55.17
5	154.41	54.81
6	155.15	54.45
7	157.06	52.79

8	158.69	51.16
9	171.12	53.93
10	194.44	58.96
11	196.08	60.60
12	198.23	63.07
13	198.50	63.63
14	198.78	64.20
15	200.22	66.04
16	200.49	66.59
17	201.03	67.71

*** 4.212 ***

1

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	149.12	57.32
2	150.58	56.61
3	151.30	56.26
4	152.89	55.02
5	153.63	54.66
6	154.37	54.29
7	156.28	52.64
8	157.52	51.39
9	170.06	56.07
10	206.69	60.28
11	206.95	60.73
12	209.50	63.28
13	211.64	65.75
14	211.92	66.31
15	212.19	66.88
16	213.63	68.72
17	213.90	69.27
18	214.45	70.39

*** 4.609 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.73	58.25
2	155.19	57.53
3	155.92	57.18
4	157.50	55.94
5	158.24	55.58
6	158.99	55.22
7	160.70	53.73
8	170.14	55.96
9	260.30	72.92
10	260.95	73.57
11	263.10	76.04
12	263.37	76.60
13	263.65	77.17
14	265.09	79.01
15	265.36	79.56
16	265.90	80.68

*** 4.962 ***

1

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	154.49	58.40
2	155.95	57.68
3	156.67	57.33
4	158.26	56.09
5	159.00	55.73
6	159.74	55.37
7	161.65	53.71
8	161.96	53.39
9	174.01	56.31
10	184.95	57.82
11	185.63	58.51
12	187.78	60.98
13	188.06	61.54
14	188.33	62.11
15	189.77	63.95
16	190.04	64.50
17	190.59	65.62

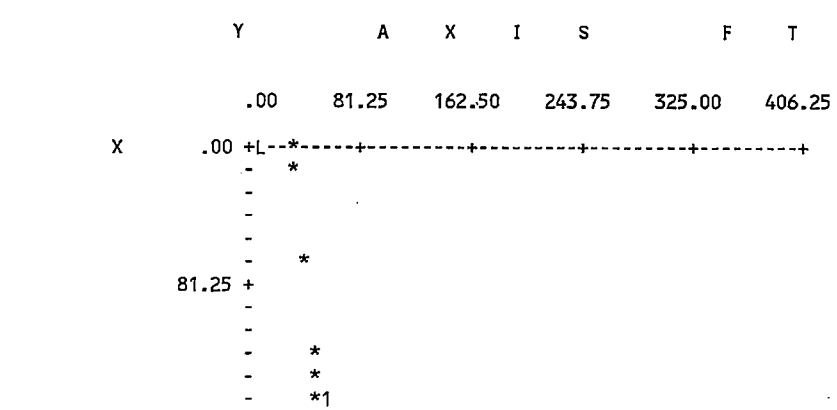
*** 5.635 ***

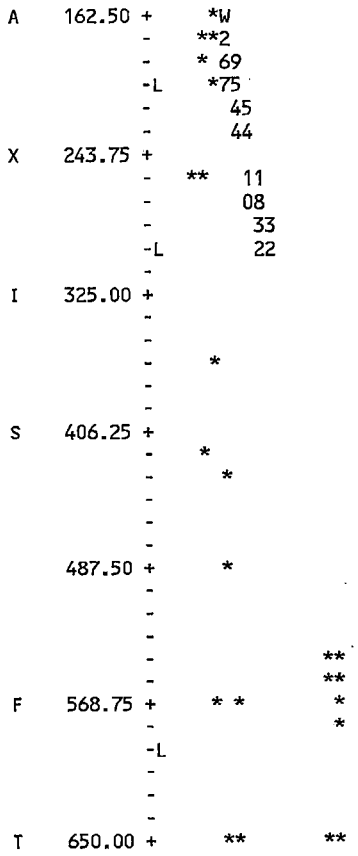
Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.94	57.69
2	152.40	56.98
3	153.12	56.62
4	154.71	55.38
5	155.45	55.02
6	156.19	54.66
7	158.10	53.00
8	159.71	51.39
9	168.70	55.95
10	262.35	73.91
11	264.44	76.31
12	264.72	76.87
13	264.99	77.44
14	266.43	79.28
15	266.70	79.83
16	267.24	80.95

*** 5.759 ***

1

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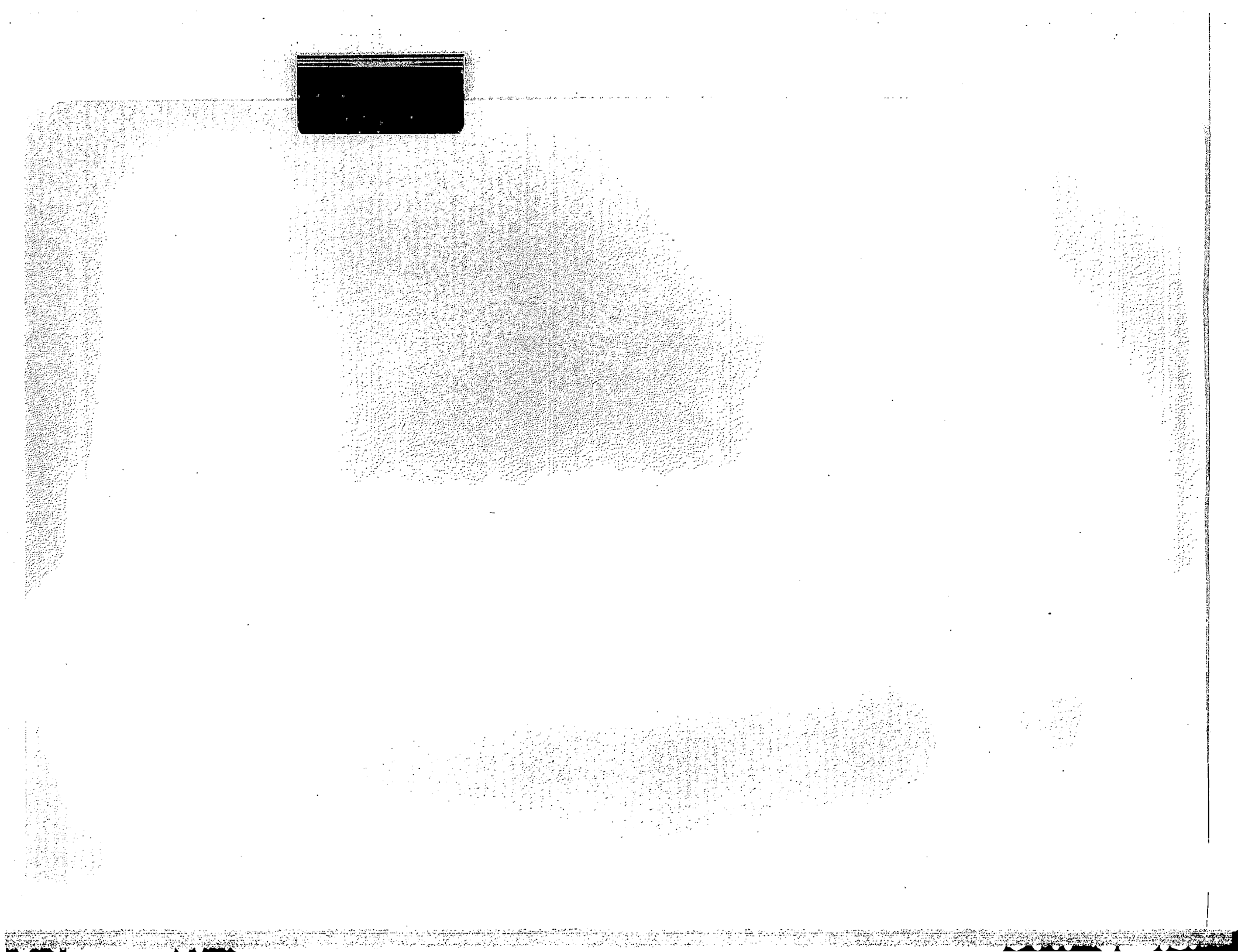
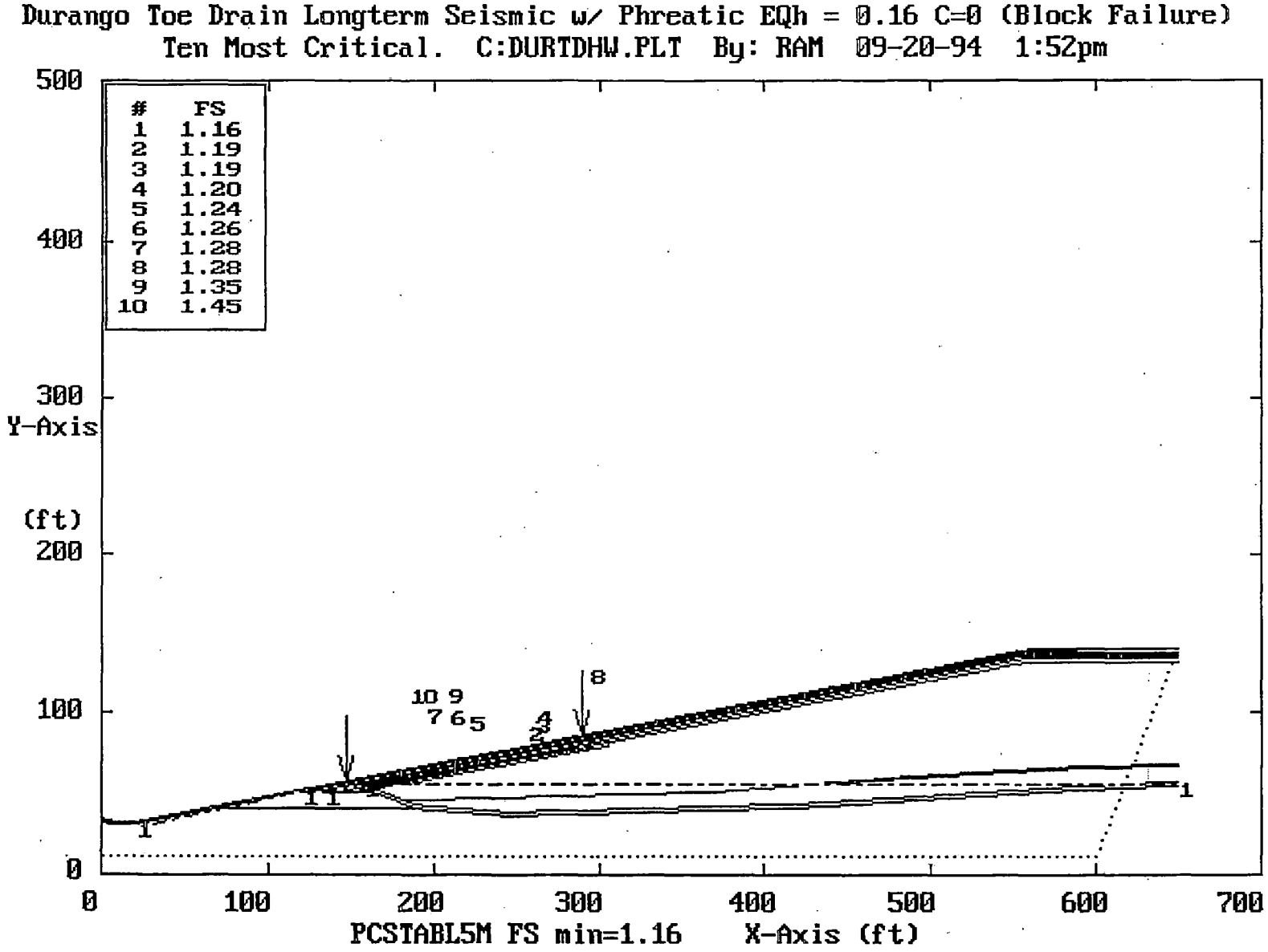
X 243.75
I 325.00
S 406.25
487.50
F 568.75
T 650.00




Durango Toe Drain Longterm Seismic w/ Phreatic EQh = 0.16 C=0 (Block Failure)
Ten Most Critical. C:DURTDHW.PLT By: RAM 09-20-94 1:52pm
FS
1 1.16
2 1.19
3 1.19
4 1.20
5 1.24
6 1.26
7 1.28
8 1.28
9 1.35
10 1.45
500
400
300
Y-Axis
(ft)
200
100
0
0
100
200
300
400
500
600
700
PCSTABL5M FS min=1.16
X-Axis (ft)

** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 09-20-94
Time of Run: 1:52pm
Run By: RAM
Input Data Filename: C:DURTDHW.BLK
Output Filename: C:DURTDHW.OUT
Plotted Output Filename: C:DURTDHW.PLT

PROBLEM DESCRIPTION Durango Toe Drain Longterm Seismic w/
Phreatic EQh = 0.16 C=0 (Block Failure)

BOUNDARY COORDINATES

5 Top Boundaries
71 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	33.50	10.00	31.50	1
2	10.00	31.50	20.00	31.50	1
3	20.00	31.50	562.50	140.00	1
4	562.50	140.00	586.30	140.00	1
5	586.30	140.00	650.00	140.00	1
6	.00	32.50	10.00	30.50	1
7	10.00	30.50	20.00	30.50	1
8	20.00	30.50	545.10	135.50	1
9	545.10	135.50	552.65	137.00	2
10	552.65	137.00	562.50	139.00	1
11	562.50	139.00	579.50	139.00	1
12	579.50	139.00	579.60	139.50	1
13	579.60	139.50	587.60	139.50	1
14	587.60	139.50	650.00	139.50	2
15	552.65	137.00	555.20	137.00	2
16	555.20	137.00	562.50	138.50	2

17	562.50	138.50	587.50	138.50	2
18	587.50	138.50	587.60	139.50	2
19	555.20	137.00	650.00	137.00	2
20	545.10	135.50	650.00	135.50	1
21	120.15	50.00	122.70	50.51	1
22	122.70	50.51	125.10	51.02	1
23	125.10	51.02	545.15	135.00	2
24	545.15	135.00	555.35	135.00	2
25	555.35	135.00	650.00	135.00	5
26	125.10	51.02	132.90	51.02	1
27	132.90	51.02	545.30	133.50	1
28	545.30	133.50	547.85	133.50	1
29	547.85	133.50	555.35	135.00	5
30	122.70	50.51	132.90	50.51	1
31	132.90	50.51	547.85	133.50	1
32	547.85	133.50	550.40	133.50	1
33	.00	32.00	10.00	30.00	3
34	10.00	30.00	20.00	30.00	3
35	20.00	30.00	70.20	40.00	3
36	70.20	40.00	120.15	50.00	4
37	120.15	50.00	132.90	50.00	4
38	132.90	50.00	550.40	133.50	5
39	132.90	50.00	143.10	50.00	4
40	143.10	50.00	558.10	133.00	6
41	558.10	133.00	650.00	133.00	6
42	143.10	50.00	153.30	50.00	4
43	153.30	50.00	163.30	52.00	8
44	163.30	52.00	558.10	131.00	7
45	558.10	131.00	650.00	131.00	7
46	163.30	52.00	180.80	45.00	8
47	180.80	45.00	202.30	45.50	9
48	202.30	45.50	372.00	50.00	9
49	372.00	50.00	432.00	55.00	9
50	432.00	55.00	492.00	60.00	9
51	492.00	60.00	572.00	65.00	9
52	572.00	65.00	650.00	67.50	9
53	180.80	45.00	182.05	44.50	8
54	182.05	44.50	202.30	45.00	7
55	202.30	45.00	372.00	49.50	7
56	372.00	49.50	432.00	54.50	7
57	432.00	54.50	492.00	59.50	7
58	492.00	59.50	572.00	64.50	7
59	572.00	64.50	650.00	67.00	7
60	182.05	44.50	188.30	42.00	8
61	188.30	42.00	252.00	37.00	8
62	252.00	37.00	422.00	42.00	8
63	422.00	42.00	572.00	52.00	8
64	572.00	52.00	650.00	56.00	8
65	153.30	50.00	163.30	50.00	4
66	163.30	50.00	188.30	40.00	4
67	70.20	40.00	188.30	40.00	3
68	188.30	40.00	252.00	35.00	3

69	252.30	35.00	422.00	40.00	3
70	422.00	40.00	572.00	50.00	3
71	572.00	50.00	650.00	54.00	3

1

ISOTROPIC SOIL PARAMETERS

9 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	.0	38.0	.00	.0	1
2	124.0	131.0	.0	27.0	.00	.0	1
3	126.0	129.0	.0	27.0	.00	.0	1
4	111.0	120.0	.0	30.0	.00	.0	1
5	126.0	128.0	.0	22.0	.00	.0	1
6	126.0	128.0	.0	22.0	.00	.0	1
7	111.0	120.0	.0	30.0	.00	.0	1
8	126.0	130.0	.0	22.0	.00	.0	1
9	125.0	128.0	.0	22.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	20.00	30.00
2	120.15	50.00
3	132.90	50.00
4	157.90	55.00
5	650.00	55.00

A Horizontal Earthquake Loading Coefficient
Of .160 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

Searching Routine Will Be Limited To An Area Defined By 4 Boundaries
Of Which The First 4 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	10.00	200.00	10.00
2	200.00	10.00	300.00	10.00
3	300.00	10.00	600.00	10.00
4	600.00	10.00	650.00	140.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Sliding Block Surfaces, Has Been
Specified.

The Active And Passive Portions Of The Sliding Surfaces
Are Generated According To The Rankine Theory.

10 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of
Sliding Block Is 10.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	155.80	51.52	163.30	53.02	4.00
2	168.10	53.97	174.40	55.24	4.00
3	184.40	57.20	304.40	81.20	4.00

WARNING - Limitation Boundaries Have Been Specified,
These Are Ignored In This Program Routine.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	146.34	56.77
2	147.80	56.06
3	148.53	55.70
4	150.44	54.53
5	151.19	54.17
6	151.93	53.81
7	154.26	52.23
8	156.59	50.66
9	157.57	50.00
10	157.59	49.99
11	171.94	55.06
12	284.62	77.76
13	285.04	78.39
14	286.63	80.75
15	286.91	81.31
16	287.19	81.88
17	288.27	83.64
18	288.54	84.20
19	289.08	85.32

*** 1.159 ***

Individual data on the 23 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	1.5	91.8	.0	.0	.0	.0	14.7	.0	.0
2	.7	113.2	.0	.0	.0	.0	18.1	.0	.0
3	1.9	545.1	.0	.0	.0	.0	87.2	.0	.0
4	.7	306.1	.0	.0	.0	.0	49.0	.0	.0
5	.7	353.4	.0	.0	.0	.0	56.5	.0	.0
6	2.3	1490.6	.0	175.7	.0	.0	238.5	.0	.0
7	2.3	2099.5	.0	526.9	.0	.0	335.9	.0	.0
8	1.0	1060.3	.0	324.8	.0	.0	169.6	.0	.0
9	.0	22.2	.0	6.8	.0	.0	3.6	.0	.0
10	.0	36.3	.0	10.2	.0	.0	5.8	.0	.0
11	.3	319.0	.0	89.4	.0	.0	51.0	.0	.0
12	5.3	5785.9	.0	1399.0	.0	.0	925.8	.0	.0
13	4.9	4759.3	.0	692.0	.0	.0	761.5	.0	.0
14	3.7	3270.9	.0	156.6	.0	.0	523.4	.0	.0
15	.2	153.9	.0	.0	.0	.0	24.6	.0	.0
16	112.7	95131.8	.0	.0	.0	.0	15221.1	.0	.0
17	.4	340.9	.0	.0	.0	.0	54.5	.0	.0
18	1.6	1013.2	.0	.0	.0	.0	162.1	.0	.0
19	.3	131.4	.0	.0	.0	.0	21.0	.0	.0
20	.3	113.8	.0	.0	.0	.0	18.2	.0	.0
21	1.1	308.1	.0	.0	.0	.0	49.3	.0	.0
22	.3	42.7	.0	.0	.0	.0	6.8	.0	.0
23	.5	34.5	.0	.0	.0	.0	5.5	.0	.0

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	151.97	57.89
2	153.43	57.18
3	154.15	56.83
4	156.07	55.65
5	156.81	55.29
6	157.55	54.93
7	159.88	53.36
8	162.22	51.78
9	162.23	51.77
10	168.92	53.73
11	256.67	71.74
12	257.42	72.86
13	259.02	75.22
14	259.29	75.79
15	259.57	76.35

16	260.65	78.12
17	260.92	78.67
18	261.47	79.79

*** 1.186 ***

1

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.02	58.10
2	154.48	57.39
3	155.21	57.04
4	157.12	55.86
5	157.86	55.50
6	158.61	55.14
7	160.70	53.73
8	170.14	55.96
9	260.30	72.92
10	260.71	73.52
11	262.30	75.88
12	262.57	76.44
13	262.85	77.01
14	263.93	78.78
15	264.20	79.33
16	264.75	80.45

*** 1.190 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	149.59	57.42
2	151.05	56.70
3	151.77	56.35
4	153.69	55.18
5	154.43	54.82
6	155.17	54.45

7	157.50	52.88
8	159.71	51.39
9	168.70	55.95
10	262.35	73.91
11	263.90	76.20
12	264.17	76.76
13	264.45	77.33
14	265.53	79.10
15	265.80	79.65
16	266.35	80.77

*** 1.201 ***

1

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	148.35	57.17
2	149.81	56.46
3	150.53	56.10
4	152.45	54.93
5	153.19	54.57
6	153.93	54.21
7	156.26	52.63
8	158.02	51.45
9	173.04	53.75
10	222.16	66.57
11	223.15	68.05
12	223.43	68.62
13	223.70	69.18
14	224.79	70.95
15	225.06	71.50
16	225.60	72.62

*** 1.235 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	147.34	56.97
2	148.80	56.25
3	149.52	55.90
4	151.44	54.73
5	152.18	54.37
6	152.92	54.00
7	155.25	52.43
8	157.59	50.86
9	157.64	50.82
10	169.30	54.71
11	209.56	61.66
12	210.83	63.55
13	212.42	65.90
14	212.70	66.47
15	212.97	67.03
16	214.06	68.81
17	214.33	69.36
18	214.87	70.47

*** 1.255 ***

1

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	148.54	57.21
2	150.00	56.50
3	150.72	56.14
4	152.64	54.97
5	153.38	54.61
6	154.12	54.24
7	156.46	52.67
8	158.69	51.16
9	171.12	53.93
10	194.44	58.96
11	195.46	60.47
12	197.05	62.83
13	197.33	63.40
14	197.60	63.96
15	198.69	65.73
16	198.96	66.29
17	199.50	67.40

*** 1.281 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	155.47	58.59
2	156.94	57.88
3	157.66	57.53
4	159.58	56.36
5	160.32	55.99
6	161.06	55.63
7	162.69	54.53
8	170.96	55.92
9	293.17	77.30
10	293.62	78.08
11	295.20	80.42
12	296.79	82.78
13	297.07	83.34
14	297.34	83.91
15	298.42	85.67
16	298.69	86.23
17	299.24	87.35

*** 1.283 ***

1

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	147.90	57.08
2	149.36	56.37
3	150.08	56.02
4	152.00	54.84
5	152.74	54.48
6	153.48	54.12
7	155.82	52.54
8	157.52	51.39
9	170.06	56.07
10	206.69	60.28

11	206.95	60.73
12	208.54	63.09
13	210.13	65.45
14	210.41	66.01
15	210.68	66.58
16	211.77	68.35
17	212.04	68.90
18	212.58	70.02

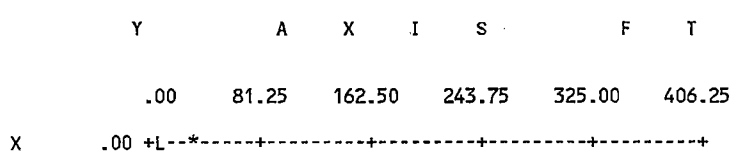
*** 1.350 ***

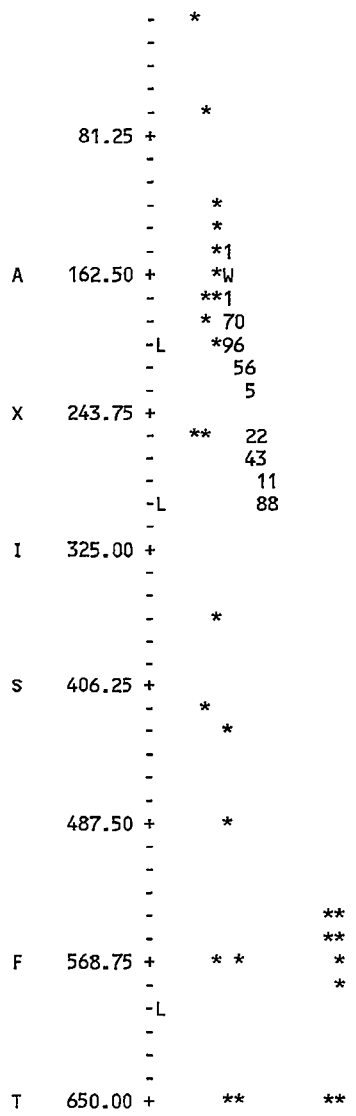
Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.61	58.22
2	155.08	57.51
3	155.80	57.16
4	157.71	55.98
5	158.46	55.62
6	159.20	55.26
7	161.53	53.69
8	161.96	53.39
9	174.01	56.31
10	184.95	57.82
11	185.38	58.46
12	186.97	60.81
13	187.24	61.38
14	187.52	61.94
15	188.61	63.72
16	188.87	64.27
17	189.42	65.38

*** 1.450 ***

1

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S 406.25
487.50
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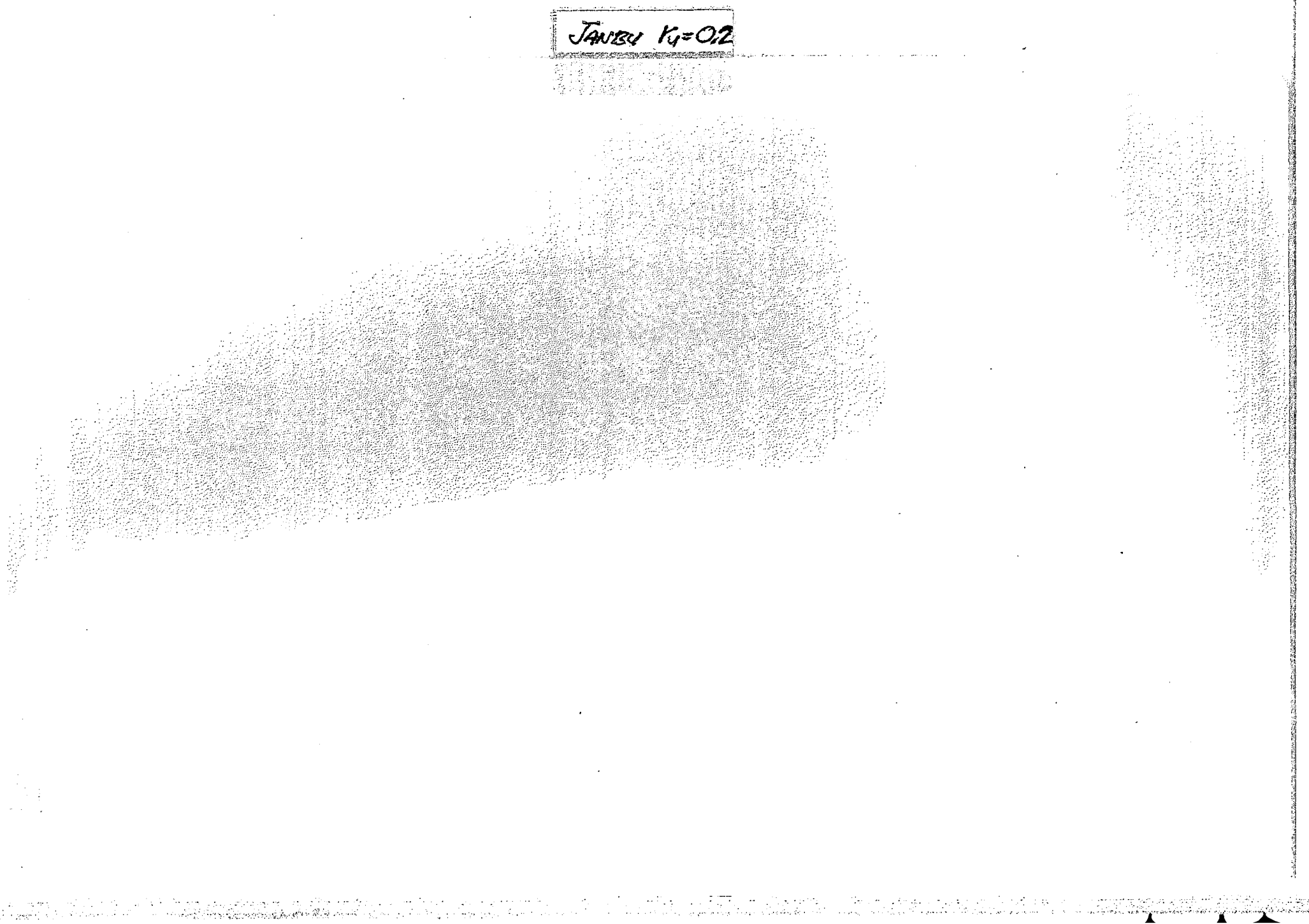
T 650.00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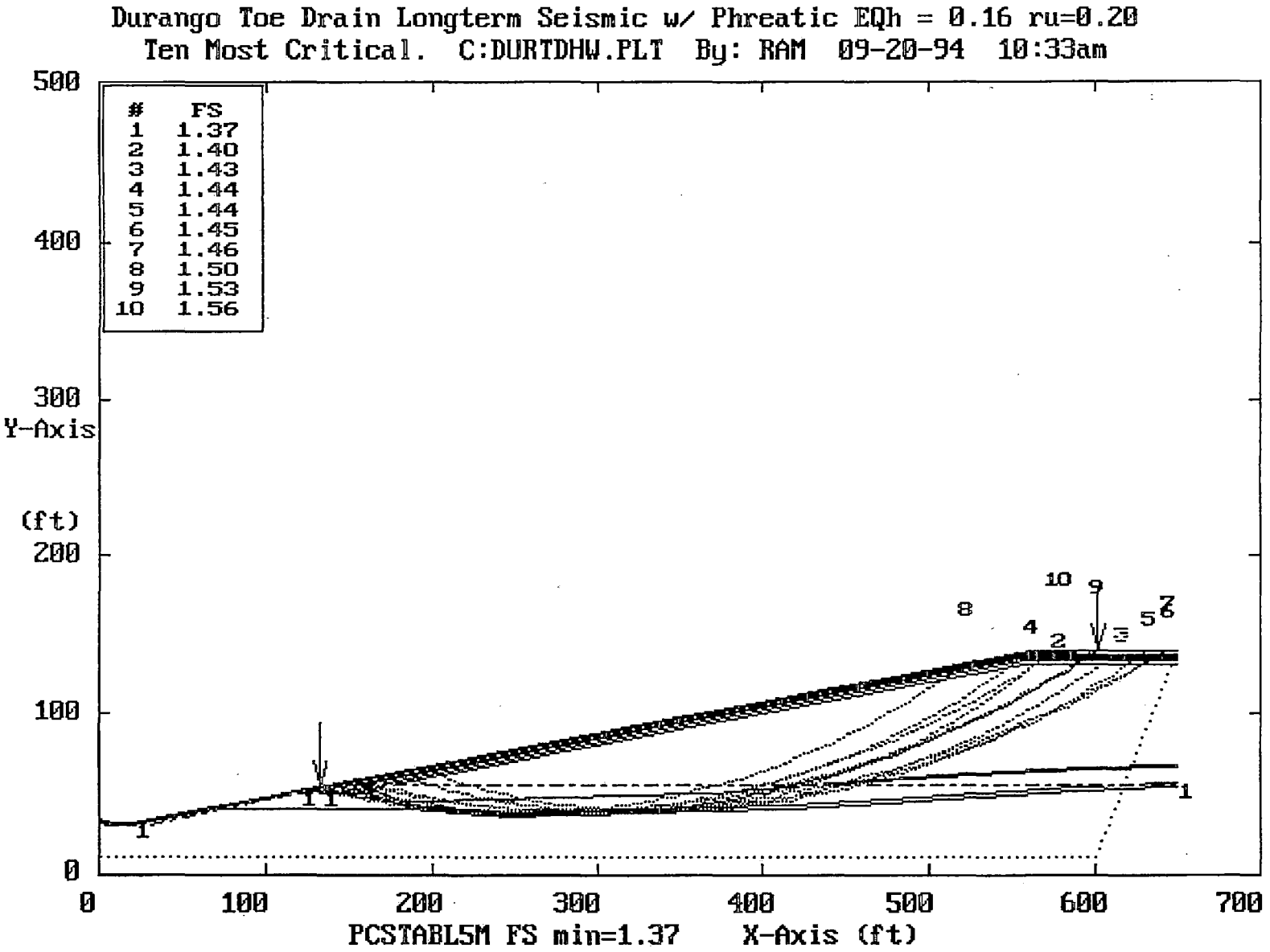

Durango Toe Drain Longterm Seismic w/ Phreatic EQh = 0.16 ru=0.20
Ten Most Critical. C:DURTDHW.PLT By: RAM 09-20-94 10:33am
FS
1 1.37
2 1.40
3 1.43
4 1.44
5 1.44
6 1.45
7 1.46
8 1.50
9 1.53
10 1.56
500
400
300
Y-Axis
(ft)
200
100
0
0
100
200
300
400
500
600
700
PCSTABL5M FS min=1.37
X-Axis (ft)

** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 09-20-94
Time of Run: 10:33am
Run By: RAM
Input Data Filename: C:DURTDHW.JL7
Output Filename: C:DURTDHW.OUT
Plotted Output Filename: C:DURTDHW.PLT

PROBLEM DESCRIPTION Durango Toe Drain Longterm Seismic w/
Phreatic EQh = 0.16 ru=0.20

BOUNDARY COORDINATES

5 Top Boundaries
71 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	33.50	10.00	31.50	1
2	10.00	31.50	20.00	31.50	1
3	20.00	31.50	562.50	140.00	1
4	562.50	140.00	586.30	140.00	1
5	586.30	140.00	650.00	140.00	1
6	.00	32.50	10.00	30.50	1
7	10.00	30.50	20.00	30.50	1
8	20.00	30.50	545.10	135.50	1
9	545.10	135.50	552.65	137.00	2
10	552.65	137.00	562.50	139.00	1
11	562.50	139.00	579.50	139.00	1
12	579.50	139.00	579.60	139.50	1
13	579.60	139.50	587.60	139.50	1
14	587.60	139.50	650.00	139.50	2
15	552.65	137.00	555.20	137.00	2
16	555.20	137.00	562.50	138.50	2

17	562.50	138.50	587.50	138.50	2
18	587.50	138.50	587.60	139.50	2
19	555.20	137.00	650.00	137.00	2
20	545.10	135.50	650.00	135.50	1
21	120.15	50.00	122.70	50.51	1
22	122.70	50.51	125.10	51.02	1
23	125.10	51.02	545.15	135.00	2
24	545.15	135.00	555.35	135.00	2
25	555.35	135.00	650.00	135.00	5
26	125.10	51.02	132.90	51.02	1
27	132.90	51.02	545.30	133.50	1
28	545.30	133.50	547.85	133.50	1
29	547.85	133.50	555.35	135.00	5
30	122.70	50.51	132.90	50.51	1
31	132.90	50.51	547.85	133.50	1
32	547.85	133.50	550.40	133.50	1
33	.00	32.00	10.00	30.00	3
34	10.00	30.00	20.00	30.00	3
35	20.00	30.00	70.20	40.00	3
36	70.20	40.00	120.15	50.00	4
37	120.15	50.00	132.90	50.00	4
38	132.90	50.00	550.40	133.50	5
39	132.90	50.00	143.10	50.00	4
40	143.10	50.00	558.10	133.00	6
41	558.10	133.00	650.00	133.00	6
42	143.10	50.00	153.30	50.00	4
43	153.30	50.00	163.30	52.00	8
44	163.30	52.00	558.10	131.00	7
45	558.10	131.00	650.00	131.00	7
46	163.30	52.00	180.80	45.00	8
47	180.80	45.00	202.30	45.50	9
48	202.30	45.50	372.00	50.00	9
49	372.00	50.00	432.00	55.00	9
50	432.00	55.00	492.00	60.00	9
51	492.00	60.00	572.00	65.00	9
52	572.00	65.00	650.00	67.50	9
53	180.80	45.00	182.05	44.50	8
54	182.05	44.50	202.30	45.00	7
55	202.30	45.00	372.00	49.50	7
56	372.00	49.50	432.00	54.50	7
57	432.00	54.50	492.00	59.50	7
58	492.00	59.50	572.00	64.50	7
59	572.00	64.50	650.00	67.00	7
60	182.05	44.50	188.30	42.00	8
61	188.30	42.00	252.00	37.00	8
62	252.00	37.00	422.00	42.00	8
63	422.00	42.00	572.00	52.00	8
64	572.00	52.00	650.00	56.00	8
65	153.30	50.00	163.30	50.00	4
66	163.30	50.00	188.30	40.00	4
67	70.20	40.00	188.30	40.00	3
68	188.30	40.00	252.00	35.00	3

69	252.30	35.00	422.00	40.00	3
70	422.00	40.00	572.00	50.00	3
71	572.00	50.00	650.00	54.00	3

1

ISOTROPIC SOIL PARAMETERS

9 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	.0	38.0	.00	.0	1
2	124.0	131.0	1045.0	14.0	.00	.0	1
3	126.0	129.0	4500.0	.0	.20	.0	1
4	111.0	120.0	500.0	30.0	.20	.0	1
5	126.0	128.0	1270.0	8.0	.20	.0	1
6	126.0	128.0	1000.0	.0	.20	.0	1
7	111.0	120.0	520.0	30.0	.20	.0	1
8	126.0	130.0	1270.0	8.0	.20	.0	1
9	125.0	128.0	1000.0	.0	.20	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	20.00	30.00
2	120.15	50.00
3	132.90	50.00
4	157.90	55.00
5	650.00	55.00

A Horizontal Earthquake Loading Coefficient
Of .160 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

Searching Routine Will Be Limited To An Area Defined By 4 Boundaries
Of Which The First 4 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	10.00	200.00	10.00
2	200.00	10.00	300.00	10.00
3	300.00	10.00	600.00	10.00
4	600.00	10.00	650.00	140.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

200 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 120.00 ft.
and X = 200.00 ft.

Each Surface Terminates Between X = 500.00 ft.
and X = 650.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

7.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation.
The Angle Has Been Restricted Between The Angles Of -45.0
And 12.0 deg.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 72 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	132.63	54.03
2	139.42	52.31
3	146.23	50.69
4	153.06	49.14
5	159.90	47.68
6	166.77	46.31
7	173.65	45.02
8	180.54	43.82
9	187.45	42.70
10	194.37	41.66
11	201.31	40.72
12	208.26	39.85
13	215.21	39.08
14	222.18	38.39
15	229.15	37.78
16	236.13	37.27
17	243.12	36.84
18	250.11	36.49
19	257.11	36.23
20	264.11	36.06
21	271.11	35.98
22	278.11	35.98
23	285.10	36.07
24	292.10	36.24
25	299.10	36.50
26	306.09	36.85
27	313.08	37.28
28	320.06	37.81
29	327.03	38.41
30	334.00	39.10
31	340.95	39.88
32	347.90	40.75
33	354.83	41.70
34	361.76	42.74
35	368.67	43.86

36	375.56	45.07
37	382.44	46.36
38	389.30	47.74
39	396.15	49.20
40	402.98	50.74
41	409.78	52.38
42	416.57	54.09
43	423.34	55.89
44	430.08	57.77
45	436.80	59.74
46	443.49	61.79
47	450.16	63.92
48	456.80	66.13
49	463.41	68.43
50	469.99	70.80
51	476.55	73.26
52	483.07	75.80
53	489.56	78.42
54	496.02	81.12
55	502.45	83.90
56	508.84	86.76
57	515.19	89.69
58	521.51	92.71
59	527.79	95.80
60	534.03	98.97
61	540.23	102.22
62	546.39	105.55
63	552.51	108.95
64	558.58	112.42
65	564.62	115.97
66	570.61	119.60
67	576.55	123.29
68	582.45	127.07
69	588.30	130.91
70	594.10	134.83
71	599.85	138.81
72	601.52	140.00

***	1.368	***

Individual data on the 116 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	2.2	139.4	.0	.0	.0	.0	22.3	.0	.0
2	1.1	171.9	.0	.0	.0	.0	27.5	.0	.0
3	3.4	980.1	.0	.0	.0	.0	156.8	.0	.0
4	.0	8.0	.0	.0	.0	.0	1.3	.0	.0
5	1.1	471.2	.0	.0	.0	.0	75.4	.0	.0
6	1.2	553.5	.0	.0	.0	.0	88.6	.0	.0
7	4.5	2862.2	.0	869.2	.0	.0	457.9	.0	.0
8	.1	109.5	.0	40.5	.0	.0	17.5	.0	.0
9	2.9	2454.4	.0	985.5	.0	.0	392.7	.0	.0
10	3.8	3894.5	.0	1769.3	.0	.0	623.1	.0	.0
11	.2	277.4	.0	132.4	.0	.0	44.4	.0	.0
12	4.6	5787.7	.0	2893.2	.0	.0	926.0	.0	.0
13	2.0	2858.6	.0	1491.6	.0	.0	457.4	.0	.0
14	3.4	5314.7	.0	2740.0	.0	.0	850.4	.0	.0
15	3.5	5997.1	.0	3063.2	.0	.0	959.5	.0	.0
16	1.3	2461.3	.0	1247.9	.0	.0	393.8	.0	.0
17	5.5	11104.6	.0	5590.2	.0	.0	1776.7	.0	.0
18	3.7	8268.9	.0	4117.6	.0	.0	1323.0	.0	.0
19	.9	2110.6	.0	1046.9	.0	.0	337.7	.0	.0
20	2.2	5354.7	.0	2652.3	.0	.0	856.7	.0	.0
21	.3	629.8	.0	311.0	.0	.0	100.8	.0	.0
22	1.3	3080.1	.0	1519.1	.0	.0	492.8	.0	.0
23	3.9	10012.9	.0	4924.2	.0	.0	1602.1	.0	.0
24	1.5	4014.5	.0	1969.0	.0	.0	642.3	.0	.0
25	6.9	19696.7	.0	9582.7	.0	.0	3151.5	.0	.0
26	2.4	7315.3	.0	3529.3	.0	.0	1170.5	.0	.0
27	4.5	14312.8	.0	6868.8	.0	.0	2290.1	.0	.0
28	1.0	3240.0	.0	1546.0	.0	.0	518.4	.0	.0
29	6.0	20270.6	.0	9619.6	.0	.0	3243.3	.0	.0
30	7.0	25321.0	.0	11880.8	.0	.0	4051.4	.0	.0
31	7.0	27056.0	.0	12542.9	.0	.0	4329.0	.0	.0
32	7.0	28714.2	.0	13152.0	.0	.0	4594.3	.0	.0
33	7.0	30294.4	.0	13708.0	.0	.0	4847.1	.0	.0
34	7.0	31795.3	.0	14210.8	.0	.0	5087.2	.0	.0
35	7.0	33215.9	.0	14660.2	.0	.0	5314.5	.0	.0
36	1.9	9197.4	.0	4026.1	.0	.0	1471.6	.0	.0
37	5.1	25371.9	.0	11033.0	.0	.0	4059.5	.0	.0
38	7.0	35877.1	.0	15412.0	.0	.0	5740.3	.0	.0
39	7.0	37103.7	.0	15711.7	.0	.0	5936.6	.0	.0
40	7.0	38246.5	.0	15957.9	.0	.0	6119.4	.0	.0
41	7.0	39304.7	.0	16150.6	.0	.0	6288.8	.0	.0
42	7.0	40277.7	.0	16289.7	.0	.0	6444.4	.0	.0
43	7.0	41164.7	.0	16375.1	.0	.0	6586.4	.0	.0
44	7.0	41965.7	.0	16407.0	.0	.0	6714.5	.0	.0
45	7.0	42680.0	.0	16385.2	.0	.0	6828.8	.0	.0

46	7.0	43307.3	.0	16309.8	.0	.0	6929.2	.0	.0
47	7.0	43847.6	.0	16180.8	.0	.0	7015.6	.0	.0
48	7.0	44300.7	.0	15998.2	.0	.0	7088.1	.0	.0
49	3.7	23804.7	.0	8449.8	.0	.0	3808.7	.0	.0
50	3.2	20866.0	.0	7313.0	.0	.0	3338.6	.0	.0
51	6.9	44986.5	.0	15480.6	.0	.0	7197.8	.0	.0
52	6.9	45226.8	.0	15147.2	.0	.0	7236.3	.0	.0
53	6.9	45386.2	.0	14761.7	.0	.0	7261.8	.0	.0
54	6.9	45464.8	.0	14323.9	.0	.0	7274.4	.0	.0
55	3.3	21977.3	.0	6754.1	.0	.0	3516.4	.0	.0
56	3.6	23485.5	.0	7079.9	.0	.0	3757.7	.0	.0
57	6.9	45380.8	.0	13292.2	.0	.0	7260.9	.0	.0
58	6.9	45219.3	.0	12698.3	.0	.0	7235.1	.0	.0
59	6.8	44979.0	.0	12052.7	.0	.0	7196.6	.0	.0
60	6.8	44660.2	.0	11355.2	.0	.0	7145.6	.0	.0
61	6.8	44264.1	.0	10606.2	.0	.0	7082.2	.0	.0
62	1.6	10456.3	.0	2408.7	.0	.0	1673.0	.0	.0
63	3.0	19049.0	.0	4279.9	.0	.0	3047.8	.0	.0
64	2.2	14271.0	.0	3114.0	.0	.0	2283.4	.0	.0
65	3.4	21914.6	.0	4635.7	.0	.0	3506.3	.0	.0
66	3.3	21313.7	.0	4410.9	.0	.0	3410.2	.0	.0
67	6.7	42702.2	.0	8867.1	.0	.0	6832.4	.0	.0
68	6.7	42120.6	.0	8777.3	.0	.0	6739.3	.0	.0
69	6.7	41470.1	.0	8673.7	.0	.0	6635.2	.0	.0
70	6.7	40752.2	.0	8556.6	.0	.0	6520.4	.0	.0
71	6.6	39967.6	.0	8425.8	.0	.0	6394.8	.0	.0
72	6.6	39118.0	.0	8281.5	.0	.0	6258.9	.0	.0
73	6.6	38204.1	.0	8123.5	.0	.0	6112.7	.0	.0
74	6.6	37227.7	.0	7952.0	.0	.0	5956.4	.0	.0
75	6.5	36189.8	.0	7766.9	.0	.0	5790.4	.0	.0
76	6.5	35092.1	.0	7568.3	.0	.0	5614.7	.0	.0
77	6.5	33936.1	.0	7356.3	.0	.0	5429.8	.0	.0
78	6.4	32723.3	.0	7130.8	.0	.0	5235.7	.0	.0
79	6.4	31455.3	.0	6891.8	.0	.0	5032.8	.0	.0
80	6.4	30133.9	.0	6639.6	.0	.0	4821.4	.0	.0
81	6.3	28760.6	.0	6373.9	.0	.0	4601.7	.0	.0
82	6.3	27337.5	.0	6094.9	.0	.0	4374.0	.0	.0
83	6.2	25866.5	.0	5802.8	.0	.0	4138.6	.0	.0
84	6.2	24349.4	.0	5497.4	.0	.0	3895.9	.0	.0
85	4.9	18137.8	.0	4122.0	.0	.0	2902.0	.0	.0
86	.0	181.5	.0	41.2	.0	.0	29.0	.0	.0
87	.2	544.1	.0	123.7	.0	.0	87.1	.0	.0
88	1.1	3924.6	.0	891.9	.0	.0	627.9	.0	.0
89	1.5	5191.7	.0	1187.9	.0	.0	830.7	.0	.0
90	2.6	8860.8	.0	2027.4	.0	.0	1417.7	.0	.0
91	2.1	7131.0	.0	1631.6	.0	.0	1141.0	.0	.0
92	.1	474.4	.0	109.3	.0	.0	75.9	.0	.0
93	2.6	8372.3	.0	1929.0	.0	.0	1339.6	.0	.0
94	.1	484.0	.0	111.5	.0	.0	77.4	.0	.0
95	2.8	8710.0	.0	2006.8	.0	.0	1393.6	.0	.0
96	.5	1501.1	.0	345.9	.0	.0	240.2	.0	.0
97	3.9	11794.1	.0	2737.0	.0	.0	1887.1	.0	.0

98	2.1	6061.5	.0	1406.7	.0	.0	969.8	.0	.0
99	6.0	15528.3	.0	3630.3	.0	.0	2484.5	.0	.0
100	5.9	12995.3	.0	3061.2	.0	.0	2079.2	.0	.0
101	3.0	5538.5	.0	1314.9	.0	.0	886.2	.0	.0
102	.1	176.8	.0	42.0	.0	.0	28.3	.0	.0
103	2.8	4734.2	.0	1123.9	.0	.0	757.5	.0	.0
104	3.9	5481.4	.0	1311.8	.0	.0	877.0	.0	.0
105	1.2	1485.3	.0	355.5	.0	.0	237.6	.0	.0
106	.1	119.0	.0	28.5	.0	.0	19.0	.0	.0
107	.7	807.0	.0	193.1	.0	.0	129.1	.0	.0
108	.1	150.1	.0	36.2	.0	.0	24.0	.0	.0
109	3.0	2959.9	.0	714.2	.0	.0	473.6	.0	.0
110	2.7	2051.1	.0	494.9	.0	.0	328.2	.0	.0
111	.3	158.0	.0	38.5	.0	.0	25.3	.0	.0
112	.7	425.4	.0	.0	.0	.0	68.1	.0	.0
113	2.2	1007.4	.0	.0	.0	.0	161.2	.0	.0
114	2.6	680.6	.0	.0	.0	.0	108.9	.0	.0
115	1.0	101.1	.0	.0	.0	.0	16.2	.0	.0
116	.7	22.0	.0	.0	.0	.0	3.5	.0	.0

Failure Surface Specified By 69 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	128.42	53.18
2	135.21	51.49
3	142.03	49.89
4	148.86	48.38
5	155.72	46.96
6	162.59	45.63
7	169.48	44.39
8	176.39	43.24
9	183.30	42.18
10	190.24	41.22
11	197.18	40.34
12	204.14	39.56
13	211.10	38.86
14	218.08	38.26
15	225.06	37.75
16	232.05	37.33
17	239.04	37.00
18	246.04	36.77
19	253.03	36.63
20	260.03	36.58
21	267.03	36.62
22	274.03	36.75
23	281.03	36.98
24	288.02	37.29
25	295.01	37.70
26	301.99	38.20

27	308.97	38.80
28	315.93	39.48
29	322.89	40.25
30	329.84	41.12
31	336.77	42.08
32	343.69	43.13
33	350.60	44.27
34	357.49	45.50
35	364.36	46.82
36	371.22	48.23
37	378.06	49.73
38	384.87	51.32
39	391.67	53.00
40	398.44	54.77
41	405.19	56.63
42	411.91	58.58
43	418.61	60.61
44	425.28	62.74
45	431.92	64.95
46	438.54	67.24
47	445.12	69.63
48	451.67	72.10
49	458.18	74.66
50	464.67	77.30
51	471.11	80.02
52	477.52	82.84
53	483.90	85.73
54	490.23	88.71
55	496.53	91.77
56	502.78	94.91
57	508.99	98.14
58	515.16	101.45
59	521.29	104.84
60	527.37	108.30
61	533.40	111.85
62	539.39	115.48
63	545.33	119.18
64	551.22	122.97
65	557.06	126.83
66	562.85	130.76
67	568.58	134.78
68	574.26	138.86
69	575.80	140.00

*** 1.402 ***

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	174.74	62.45
2	181.39	60.25
3	188.07	58.16
4	194.78	56.17
5	201.52	54.28
6	208.28	52.49
7	215.08	50.80
8	221.90	49.22
9	228.74	47.74
10	235.60	46.36
11	242.48	45.08
12	249.38	43.91
13	256.30	42.84
14	263.24	41.88
15	270.18	41.02
16	277.14	40.27
17	284.11	39.62
18	291.09	39.07
19	298.08	38.63
20	305.07	38.30
21	312.06	38.07
22	319.06	37.95
23	326.06	37.93
24	333.06	38.01
25	340.06	38.21
26	347.05	38.50
27	354.04	38.90
28	361.02	39.41
29	368.00	40.02
30	374.96	40.74
31	381.91	41.56
32	388.85	42.49
33	395.77	43.52
34	402.68	44.65
35	409.57	45.89
36	416.44	47.23
37	423.29	48.68
38	430.12	50.23
39	436.92	51.88
40	443.70	53.63
41	450.45	55.48
42	457.17	57.44
43	463.86	59.50
44	470.52	61.65

45	477.14	63.91
46	483.74	66.27
47	490.29	68.72
48	496.81	71.27
49	503.29	73.93
50	509.73	76.67
51	516.12	79.52
52	522.47	82.46
53	528.78	85.50
54	535.04	88.63
55	541.26	91.85
56	547.42	95.17
57	553.53	98.58
58	559.59	102.08
59	565.60	105.67
60	571.55	109.35
61	577.45	113.13
62	583.29	116.99
63	589.07	120.93
64	594.79	124.97
65	600.45	129.09
66	606.05	133.29
67	611.58	137.58
68	614.62	140.00

*** 1.430 ***

Failure Surface Specified By 64 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	145.26	56.55
2	151.97	54.55
3	158.71	52.66
4	165.48	50.87
5	172.27	49.19
6	179.10	47.62
7	185.94	46.15
8	192.81	44.80
9	199.69	43.55
10	206.60	42.40
11	213.52	41.37
12	220.46	40.45
13	227.42	39.63
14	234.38	38.93
15	241.35	38.33

16	248.34	37.84
17	255.33	37.47
18	262.32	37.20
19	269.32	37.04
20	276.32	36.99
21	283.32	37.06
22	290.32	37.23
23	297.31	37.51
24	304.30	37.90
25	311.28	38.41
26	318.26	39.02
27	325.22	39.74
28	332.17	40.57
29	339.11	41.51
30	346.03	42.56
31	352.93	43.72
32	359.82	44.98
33	366.68	46.36
34	373.52	47.84
35	380.34	49.42
36	387.13	51.12
37	393.89	52.92
38	400.63	54.83
39	407.33	56.84
40	414.01	58.96
41	420.64	61.19
42	427.24	63.51
43	433.81	65.94
44	440.33	68.48
45	446.82	71.11
46	453.26	73.85
47	459.66	76.69
48	466.01	79.62
49	472.32	82.66
50	478.58	85.80
51	484.79	89.03
52	490.94	92.36
53	497.05	95.79
54	503.10	99.32
55	509.09	102.93
56	515.02	106.64
57	520.90	110.45
58	526.71	114.35
59	532.47	118.33
60	538.16	122.41
61	543.78	126.57
62	549.34	130.83
63	554.84	135.17
64	560.19	139.54

*** 1.438 ***

1

Failure Surface Specified By 70 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	174.74	62.45
2	181.41	60.33
3	188.11	58.31
4	194.84	56.39
5	201.60	54.55
6	208.38	52.82
7	215.18	51.17
8	222.01	49.63
9	228.86	48.17
10	235.73	46.82
11	242.61	45.56
12	249.51	44.40
13	256.43	43.33
14	263.37	42.36
15	270.31	41.49
16	277.27	40.72
17	284.24	40.04
18	291.21	39.46
19	298.19	38.98
20	305.18	38.60
21	312.18	38.31
22	319.18	38.12
23	326.18	38.03
24	333.18	38.04
25	340.17	38.15
26	347.17	38.35
27	354.16	38.66
28	361.15	39.06
29	368.14	39.55
30	375.11	40.15
31	382.08	40.84
32	389.03	41.63
33	395.97	42.52
34	402.90	43.51
35	409.82	44.59
36	416.72	45.77
37	423.60	47.05
38	430.47	48.42
39	437.31	49.89
40	444.14	51.45
41	450.94	53.11

42	457.71	54.86
43	464.46	56.71
44	471.19	58.65
45	477.89	60.69
46	484.55	62.82
47	491.19	65.04
48	497.80	67.36
49	504.37	69.77
50	510.91	72.27
51	517.41	74.86
52	523.88	77.55
53	530.30	80.32
54	536.69	83.18
55	543.04	86.13
56	549.34	89.17
57	555.60	92.30
58	561.82	95.52
59	567.99	98.82
60	574.12	102.21
61	580.20	105.68
62	586.22	109.24
63	592.20	112.88
64	598.13	116.61
65	604.00	120.42
66	609.82	124.31
67	615.58	128.28
68	621.29	132.33
69	626.94	136.47
70	631.64	140.00

*** 1.439 ***

Failure Surface Specified By 77 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	136.84	54.87
2	143.67	53.31
3	150.51	51.82
4	157.36	50.40
5	164.23	49.05
6	171.11	47.78
7	178.01	46.58
8	184.92	45.45
9	191.84	44.40
10	198.77	43.41

11	205.71	42.51
12	212.66	41.67
13	219.62	40.91
14	226.58	40.22
15	233.56	39.60
16	240.54	39.06
17	247.52	38.59
18	254.51	38.20
19	261.50	37.88
20	268.50	37.63
21	275.50	37.46
22	282.49	37.36
23	289.49	37.33
24	296.49	37.38
25	303.49	37.50
26	310.49	37.70
27	317.49	37.97
28	324.48	38.31
29	331.46	38.73
30	338.45	39.22
31	345.42	39.78
32	352.40	40.42
33	359.36	41.13
34	366.32	41.91
35	373.26	42.77
36	380.20	43.70
37	387.13	44.71
38	394.04	45.78
39	400.95	46.93
40	407.84	48.16
41	414.72	49.45
42	421.59	50.82
43	428.44	52.26
44	435.27	53.77
45	442.09	55.35
46	448.89	57.01
47	455.67	58.74
48	462.44	60.53
49	469.19	62.40
50	475.91	64.35
51	482.62	66.36
52	489.30	68.44
53	495.96	70.59
54	502.60	72.81
55	509.21	75.11
56	515.80	77.47
57	522.37	79.90
58	528.90	82.40
59	535.41	84.97
60	541.90	87.61
61	548.35	90.31
62	554.78	93.09

63	561.18	95.93
64	567.55	98.84
65	573.88	101.81
66	580.19	104.86
67	586.46	107.96
68	592.70	111.14
69	598.90	114.38
70	605.07	117.68
71	611.21	121.05
72	617.31	124.49
73	623.37	127.99
74	629.40	131.55
75	635.38	135.18
76	641.33	138.87
77	643.12	140.00

*** 1.452 ***

1

Failure Surface Specified By 75 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.68	58.24
2	160.46	56.48
3	167.25	54.79
4	174.07	53.19
5	180.90	51.67
6	187.75	50.22
7	194.62	48.86
8	201.50	47.57
9	208.39	46.37
10	215.30	45.25
11	222.22	44.21
12	229.16	43.25
13	236.10	42.36
14	243.06	41.57
15	250.02	40.85
16	256.99	40.21
17	263.97	39.66
18	270.95	39.18
19	277.94	38.79
20	284.93	38.48
21	291.93	38.25
22	298.93	38.10
23	305.93	38.03

24	312.93	38.05
25	319.93	38.15
26	326.93	38.32
27	333.92	38.58
28	340.91	38.93
29	347.90	39.35
30	354.88	39.85
31	361.86	40.44
32	368.82	41.11
33	375.78	41.86
34	382.74	42.69
35	389.68	43.60
36	396.61	44.59
37	403.52	45.66
38	410.43	46.82
39	417.32	48.05
40	424.19	49.36
41	431.05	50.76
42	437.90	52.23
43	444.72	53.78
44	451.53	55.42
45	458.32	57.13
46	465.08	58.92
47	471.83	60.79
48	478.55	62.74
49	485.25	64.77
50	491.93	66.87
51	498.58	69.05
52	505.20	71.31
53	511.80	73.65
54	518.37	76.07
55	524.91	78.56
56	531.43	81.12
57	537.91	83.77
58	544.36	86.48
59	550.78	89.28
60	557.16	92.14
61	563.52	95.09
62	569.83	98.10
63	576.11	101.19
64	582.36	104.35
65	588.57	107.59
66	594.74	110.90
67	600.87	114.27
68	606.96	117.72
69	613.01	121.25
70	619.02	124.84
71	624.98	128.50
72	630.91	132.23
73	636.79	136.03
74	642.62	139.89
75	642.77	140.00

*** 1.463 ***

Failure Surface Specified By 60 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	132.63	54.03
2	139.38	52.17
3	146.16	50.42
4	152.96	48.78
5	159.79	47.25
6	166.65	45.83
7	173.52	44.52
8	180.42	43.32
9	187.34	42.23
10	194.27	41.26
11	201.22	40.40
12	208.18	39.65
13	215.15	39.01
14	222.13	38.49
15	229.11	38.07
16	236.11	37.77
17	243.11	37.59
18	250.11	37.52
19	257.10	37.56
20	264.10	37.71
21	271.10	37.98
22	278.09	38.36
23	285.07	38.85
24	292.04	39.46
25	299.01	40.17
26	305.96	41.00
27	312.89	41.95
28	319.81	43.00
29	326.72	44.17
30	333.60	45.45
31	340.46	46.83
32	347.30	48.33
33	354.11	49.94
34	360.90	51.66
35	367.65	53.49
36	374.38	55.43
37	381.07	57.48
38	387.73	59.63
39	394.36	61.89

40	400.94	64.26
41	407.49	66.74
42	414.00	69.32
43	420.46	72.00
44	426.88	74.79
45	433.26	77.68
46	439.59	80.68
47	445.86	83.77
48	452.09	86.97
49	458.27	90.27
50	464.39	93.67
51	470.45	97.16
52	476.46	100.76
53	482.41	104.45
54	488.29	108.23
55	494.12	112.11
56	499.88	116.09
57	505.58	120.15
58	511.21	124.31
59	516.78	128.56
60	520.67	131.63

*** 1.502 ***

1

Failure Surface Specified By 69 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	149.47	57.39
2	156.25	55.65
3	163.05	53.99
4	169.87	52.41
5	176.72	50.93
6	183.58	49.54
7	190.45	48.24
8	197.35	47.03
9	204.26	45.90
10	211.18	44.87
11	218.12	43.93
12	225.07	43.08
13	232.02	42.32
14	238.99	41.66
15	245.97	41.08
16	252.95	40.59
17	259.94	40.20

18	266.93	39.90
19	273.93	39.69
20	280.93	39.57
21	287.93	39.54
22	294.93	39.60
23	301.93	39.76
24	308.92	40.01
25	315.92	40.35
26	322.90	40.78
27	329.88	41.30
28	336.86	41.91
29	343.82	42.61
30	350.77	43.41
31	357.72	44.29
32	364.65	45.27
33	371.57	46.34
34	378.47	47.49
35	385.36	48.74
36	392.23	50.08
37	399.08	51.51
38	405.92	53.02
39	412.73	54.63
40	419.52	56.32
41	426.29	58.11
42	433.04	59.98
43	439.76	61.94
44	446.45	63.99
45	453.12	66.12
46	459.75	68.35
47	466.36	70.66
48	472.94	73.05
49	479.49	75.53
50	486.00	78.10
51	492.48	80.75
52	498.92	83.49
53	505.33	86.31
54	511.70	89.21
55	518.03	92.20
56	524.32	95.27
57	530.57	98.42
58	536.78	101.65
59	542.94	104.97
60	549.06	108.36
61	555.14	111.83
62	561.17	115.39
63	567.16	119.02
64	573.09	122.73
65	578.98	126.52
66	584.82	130.38
67	590.60	134.32
68	596.34	138.33
69	598.65	140.00

*** 1.528 ***

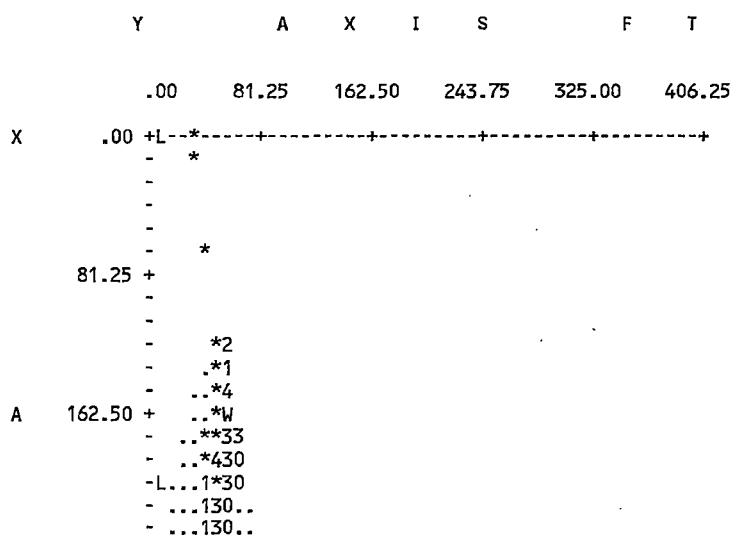
Failure Surface Specified By 60 Coordinate Points

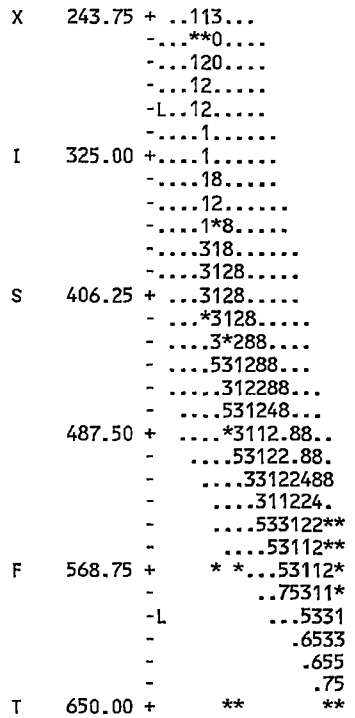
Point No.	X-Surf (ft)	Y-Surf (ft)
1	191.58	65.82
2	198.10	63.28
3	204.68	60.88
4	211.30	58.60
5	217.96	56.45
6	224.66	54.44
7	231.41	52.55
8	238.18	50.80
9	244.99	49.18
10	251.83	47.70
11	258.70	46.34
12	265.59	45.13
13	272.51	44.04
14	279.45	43.10
15	286.40	42.28
16	293.37	41.61
17	300.35	41.07
18	307.33	40.67
19	314.33	40.40
20	321.33	40.27
21	328.33	40.28
22	335.33	40.42
23	342.32	40.70
24	349.31	41.12
25	356.29	41.68
26	363.25	42.37
27	370.20	43.19
28	377.14	44.15
29	384.05	45.25
30	390.94	46.48
31	397.81	47.85
32	404.64	49.35
33	411.45	50.99
34	418.22	52.75
35	424.96	54.65
36	431.66	56.68
37	438.32	58.84
38	444.93	61.13
39	451.50	63.55

40	458.02	66.10
41	464.49	68.78
42	470.91	71.58
43	477.26	74.50
44	483.57	77.55
45	489.81	80.72
46	495.98	84.01
47	502.10	87.43
48	508.14	90.96
49	514.11	94.61
50	520.01	98.37
51	525.84	102.25
52	531.59	106.25
53	537.26	110.35
54	542.85	114.57
55	548.35	118.89
56	553.77	123.32
57	559.11	127.85
58	564.35	132.49
59	569.50	137.23
60	572.39	140.00

*** 1.562 ***

1

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- ....531248...
487.50 + ...*3112.88..
- ....53122.88.
- 33122488
- ....311224.
- 533122**
- 53112**
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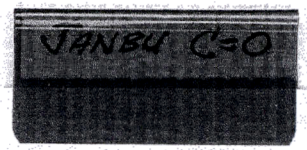
- ..75311*
-L ...5331
- .6533
- .655
- .75
T 650.00 + ** **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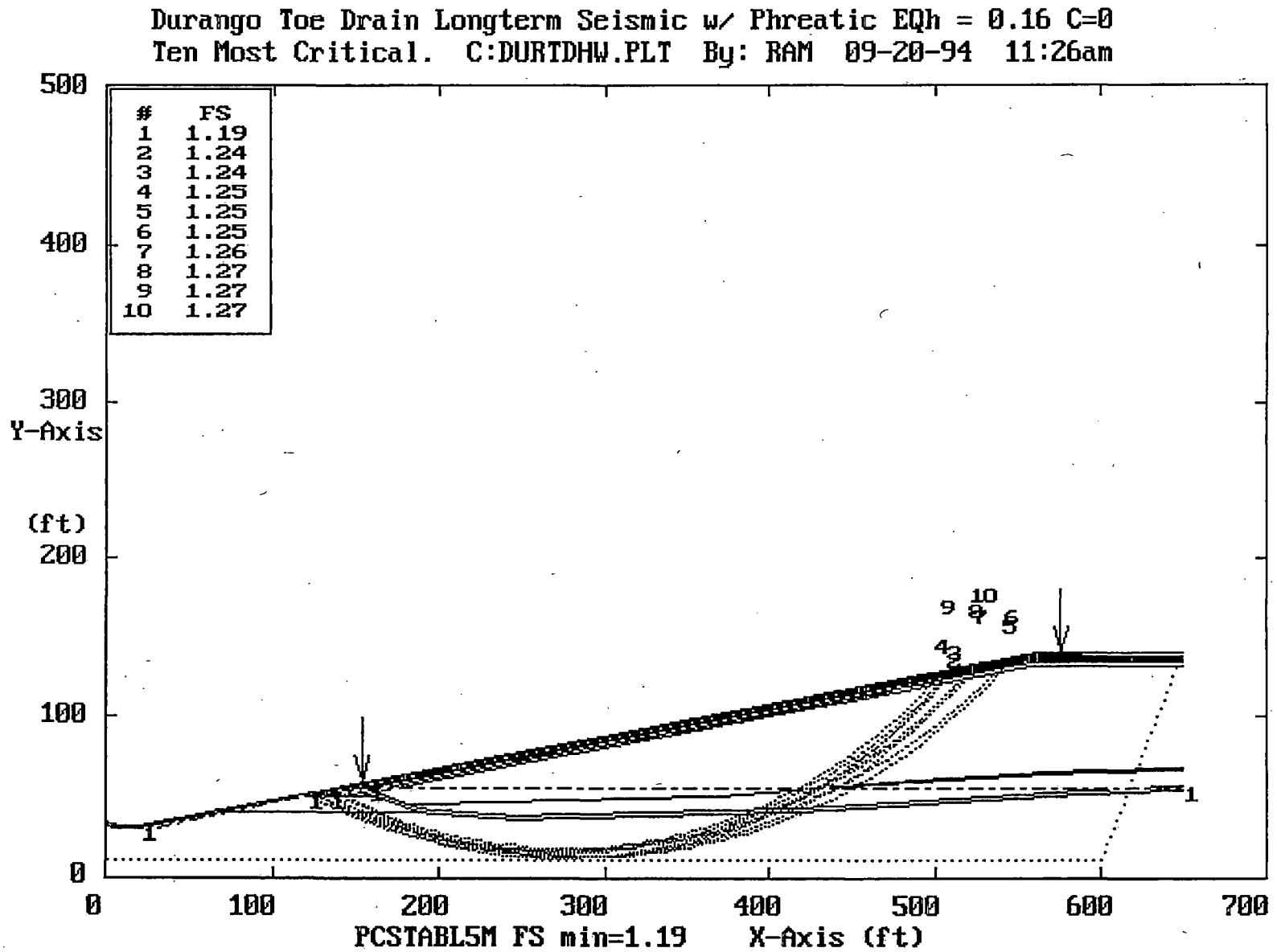

Durango Toe Drain Longterm Seismic w/ Phreatic EQh = 0.16 C=0
Ten Most Critical. C:DURTDHW.PLT By: RAM 09-20-94 11:26am
FS
1 1.19
2 1.24
3 1.24
4 1.25
5 1.25
6 1.25
7 1.26
8 1.27
9 1.27
10 1.27
500
400
300
Y-Axis
(ft)
200
100
0
0
100
200
300
400
500
600
700
PCSTABL5M FS min=1.19
X-Axis (ft)

** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 09-20-94
Time of Run: 11:26am
Run By: RAM
Input Data Filename: C:DURTDHW.JL8
Output Filename: C:DURTDHW.OUT
Plotted Output Filename: C:DURTDHW.PLT

PROBLEM DESCRIPTION Durango Toe Drain Longterm Seismic w/
Phreatic EQh = 0.16 C=0

BOUNDARY COORDINATES

5 Top Boundaries
71 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	33.50	10.00	31.50	1
2	10.00	31.50	20.00	31.50	1
3	20.00	31.50	562.50	140.00	1
4	562.50	140.00	586.30	140.00	1
5	586.30	140.00	650.00	140.00	1
6	.00	32.50	10.00	30.50	1
7	10.00	30.50	20.00	30.50	1
8	20.00	30.50	545.10	135.50	1
9	545.10	135.50	552.65	137.00	2
10	552.65	137.00	562.50	139.00	1
11	562.50	139.00	579.50	139.00	1
12	579.50	139.00	579.60	139.50	1
13	579.60	139.50	587.60	139.50	1
14	587.60	139.50	650.00	139.50	2
15	552.65	137.00	555.20	137.00	2
16	555.20	137.00	562.50	138.50	2

17	562.50	138.50	587.50	138.50	2
18	587.50	138.50	587.60	139.50	2
19	555.20	137.00	650.00	137.00	2
20	545.10	135.50	650.00	135.50	1
21	120.15	50.00	122.70	50.51	1
22	122.70	50.51	125.10	51.02	1
23	125.10	51.02	545.15	135.00	2
24	545.15	135.00	555.35	135.00	2
25	555.35	135.00	650.00	135.00	5
26	125.10	51.02	132.90	51.02	1
27	132.90	51.02	545.30	133.50	1
28	545.30	133.50	547.85	133.50	1
29	547.85	133.50	555.35	135.00	5
30	122.70	50.51	132.90	50.51	1
31	132.90	50.51	547.85	133.50	1
32	547.85	133.50	550.40	133.50	1
33	.00	32.00	10.00	30.00	3
34	10.00	30.00	20.00	30.00	3
35	20.00	30.00	70.20	40.00	3
36	70.20	40.00	120.15	50.00	4
37	120.15	50.00	132.90	50.00	4
38	132.90	50.00	550.40	133.50	5
39	132.90	50.00	143.10	50.00	4
40	143.10	50.00	558.10	133.00	6
41	558.10	133.00	650.00	133.00	6
42	143.10	50.00	153.30	50.00	4
43	153.30	50.00	163.30	52.00	8
44	163.30	52.00	558.10	131.00	7
45	558.10	131.00	650.00	131.00	7
46	163.30	52.00	180.80	45.00	8
47	180.80	45.00	202.30	45.50	9
48	202.30	45.50	372.00	50.00	9
49	372.00	50.00	432.00	55.00	9
50	432.00	55.00	492.00	60.00	9
51	492.00	60.00	572.00	65.00	9
52	572.00	65.00	650.00	67.50	9
53	180.80	45.00	182.05	44.50	8
54	182.05	44.50	202.30	45.00	7
55	202.30	45.00	372.00	49.50	7
56	372.00	49.50	432.00	54.50	7
57	432.00	54.50	492.00	59.50	7
58	492.00	59.50	572.00	64.50	7
59	572.00	64.50	650.00	67.00	7
60	182.05	44.50	188.30	42.00	8
61	188.30	42.00	252.00	37.00	8
62	252.00	37.00	422.00	42.00	8
63	422.00	42.00	572.00	52.00	8
64	572.00	52.00	650.00	56.00	8
65	153.30	50.00	163.30	50.00	4
66	163.30	50.00	188.30	40.00	4
67	70.20	40.00	188.30	40.00	3
68	188.30	40.00	252.00	35.00	3

69	252.30	35.00	422.00	40.00	3
70	422.00	40.00	572.00	50.00	3
71	572.00	50.00	650.00	54.00	3

1

ISOTROPIC SOIL PARAMETERS

9 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	.0	38.0	.00	.0	1
2	124.0	131.0	.0	27.0	.00	.0	1
3	126.0	129.0	.0	27.0	.00	.0	1
4	111.0	120.0	.0	30.0	.00	.0	1
5	126.0	128.0	.0	22.0	.00	.0	1
6	126.0	128.0	.0	22.0	.00	.0	1
7	111.0	120.0	.0	30.0	.00	.0	1
8	126.0	130.0	.0	22.0	.00	.0	1
9	125.0	128.0	.0	22.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	20.00	30.00
2	120.15	50.00
3	132.90	50.00
4	157.90	55.00
5	650.00	55.00

A Horizontal Earthquake Loading Coefficient
Of .160 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

Searching Routine Will Be Limited To An Area Defined By 4 Boundaries
Of Which The First 4 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	10.00	200.00	10.00
2	200.00	10.00	300.00	10.00
3	300.00	10.00	600.00	10.00
4	600.00	10.00	650.00	140.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

200 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 120.00 ft.
and X = 200.00 ft.

Each Surface Terminates Between X = 500.00 ft.
and X = 650.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

7.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation.
The Angle Has Been Restricted Between The Angles Of -45.0
And 12.0 deg.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.68	58.24
2	160.61	59.24
3	167.54	60.25
4	174.46	61.27
5	181.39	62.30
6	188.31	63.34
7	195.23	64.40
8	202.15	65.46
9	209.07	66.54
10	215.98	67.63
11	222.89	68.73
12	229.80	69.84
13	236.71	70.96
14	243.62	72.09
15	250.53	73.23
16	257.43	74.39
17	264.34	75.55
18	271.24	76.73
19	278.13	77.91
20	285.03	79.11
21	291.93	80.32
22	298.82	81.54
23	305.71	82.77
24	312.60	84.01
25	319.49	85.27
26	326.37	86.53
27	333.25	87.80
28	340.13	89.09
29	347.01	90.39
30	353.89	91.69
31	360.76	93.01
32	367.64	94.34
33	374.51	95.68

34	381.38	97.03
35	388.24	98.40
36	395.11	99.77
37	401.97	101.15
38	408.83	102.55
39	415.68	103.96
40	422.54	105.37
41	429.39	106.80
42	436.24	108.24
43	443.09	109.69
44	449.94	111.15
45	456.78	112.62
46	463.62	114.11
47	470.46	115.60
48	477.30	117.10
49	484.13	118.62
50	490.96	120.15
51	497.79	121.68
52	504.62	123.23
53	511.44	124.79
54	518.26	126.36
55	525.08	127.94
56	531.90	129.53
57	538.71	131.14
58	545.53	132.75
59	552.33	134.37
60	559.14	136.01
61	565.94	137.66
62	572.75	139.31
63	575.55	140.00

*** 1.189 ***

Individual data on the 84 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	6.9	167.3	.0	.0	.0	.0	26.8	.0	.0
2	6.9	496.9	.0	.0	.0	.0	79.5	.0	.0
3	4.7	514.2	.0	.0	.0	.0	82.3	.0	.0
4	2.3	302.2	.0	.0	.0	.0	48.4	.0	.0
5	6.9	1126.0	.0	.0	.0	.0	180.2	.0	.0
6	.5	101.7	.0	.0	.0	.0	16.3	.0	.0
7	6.4	1322.9	.0	.0	.0	.0	211.7	.0	.0
8	6.9	1711.8	.0	.0	.0	.0	273.9	.0	.0

9	6.9	1989.2	.0	.0	.0	.0	318.3	.0	.0
10	6.9	2256.7	.0	.0	.0	.0	361.1	.0	.0
11	6.7	2445.3	.0	.0	.0	.0	391.2	.0	.0
12	.2	69.0	.0	.0	.0	.0	11.0	.0	.0
13	6.9	2762.9	.0	.0	.0	.0	442.1	.0	.0
14	5.5	2385.9	.0	.0	.0	.0	381.7	.0	.0
15	1.4	616.7	.0	.0	.0	.0	98.7	.0	.0
16	6.9	3232.4	.0	.0	.0	.0	517.2	.0	.0
17	5.4	2669.1	.0	.0	.0	.0	427.1	.0	.0
18	1.5	783.1	.0	.0	.0	.0	125.3	.0	.0
19	6.9	3663.3	.0	.0	.0	.0	586.1	.0	.0
20	6.9	3864.8	.0	.0	.0	.0	618.4	.0	.0
21	6.9	4056.3	.0	.0	.0	.0	649.0	.0	.0
22	6.9	4237.8	.0	.0	.0	.0	678.0	.0	.0
23	6.9	4409.2	.0	.0	.0	.0	705.5	.0	.0
24	6.9	4570.7	.0	.0	.0	.0	731.3	.0	.0
25	6.9	4722.2	.0	.0	.0	.0	755.6	.0	.0
26	6.9	4863.7	.0	.0	.0	.0	778.2	.0	.0
27	6.9	4995.2	.0	.0	.0	.0	799.2	.0	.0
28	6.9	5116.8	.0	.0	.0	.0	818.7	.0	.0
29	6.2	4716.2	.0	.0	.0	.0	754.6	.0	.0
30	.7	512.1	.0	.0	.0	.0	81.9	.0	.0
31	6.9	5330.0	.0	.0	.0	.0	852.8	.0	.0
32	6.9	5421.7	.0	.0	.0	.0	867.5	.0	.0
33	6.9	5503.4	.0	.0	.0	.0	880.5	.0	.0
34	6.9	5575.2	.0	.0	.0	.0	892.0	.0	.0
35	6.9	5637.1	.0	.0	.0	.0	901.9	.0	.0
36	6.9	5689.1	.0	.0	.0	.0	910.2	.0	.0
37	6.9	5731.1	.0	.0	.0	.0	917.0	.0	.0
38	6.9	5763.3	.0	.0	.0	.0	922.1	.0	.0
39	6.9	5785.5	.0	.0	.0	.0	925.7	.0	.0
40	6.9	5797.9	.0	.0	.0	.0	927.7	.0	.0
41	6.9	5800.4	.0	.0	.0	.0	928.1	.0	.0
42	6.9	5793.0	.0	.0	.0	.0	926.9	.0	.0
43	6.9	5775.8	.0	.0	.0	.0	924.1	.0	.0
44	6.9	5748.7	.0	.0	.0	.0	919.8	.0	.0
45	6.9	5711.9	.0	.0	.0	.0	913.9	.0	.0
46	6.9	5665.1	.0	.0	.0	.0	906.4	.0	.0
47	6.9	5608.6	.0	.0	.0	.0	897.4	.0	.0
48	6.8	5542.3	.0	.0	.0	.0	886.8	.0	.0
49	6.8	5466.1	.0	.0	.0	.0	874.6	.0	.0
50	6.8	5380.2	.0	.0	.0	.0	860.8	.0	.0
51	6.7	5190.8	.0	.0	.0	.0	830.5	.0	.0
52	.1	93.7	.0	.0	.0	.0	15.0	.0	.0
53	6.8	5179.1	.0	.0	.0	.0	828.7	.0	.0
54	6.8	5063.9	.0	.0	.0	.0	810.2	.0	.0
55	6.8	4939.0	.0	.0	.0	.0	790.2	.0	.0
56	6.8	4804.3	.0	.0	.0	.0	768.7	.0	.0
57	6.8	4659.9	.0	.0	.0	.0	745.6	.0	.0
58	6.8	4505.8	.0	.0	.0	.0	720.9	.0	.0
59	6.8	4342.0	.0	.0	.0	.0	694.7	.0	.0
60	6.8	4168.6	.0	.0	.0	.0	667.0	.0	.0

61	6.8	3985.5	.0	.0	.0	.0	637.7	.0	.0
62	6.8	3792.7	.0	.0	.0	.0	606.8	.0	.0
63	6.8	3590.3	.0	.0	.0	.0	574.5	.0	.0
64	.7	364.6	.0	.0	.0	.0	58.3	.0	.0
65	5.7	2809.6	.0	.0	.0	.0	449.5	.0	.0
66	.0	24.1	.0	.0	.0	.0	3.9	.0	.0
67	.2	72.3	.0	.0	.0	.0	11.6	.0	.0
68	.2	108.4	.0	.0	.0	.0	17.3	.0	.0
69	2.3	1102.9	.0	.0	.0	.0	176.5	.0	.0
70	.8	382.6	.0	.0	.0	.0	61.2	.0	.0
71	3.7	1670.9	.0	.0	.0	.0	267.4	.0	.0
72	.3	140.8	.0	.0	.0	.0	22.5	.0	.0
73	.2	109.7	.0	.0	.0	.0	17.5	.0	.0
74	2.0	897.4	.0	.0	.0	.0	143.6	.0	.0
75	.3	113.2	.0	.0	.0	.0	18.1	.0	.0
76	1.8	779.7	.0	.0	.0	.0	124.8	.0	.0
77	2.1	887.1	.0	.0	.0	.0	141.9	.0	.0
78	3.4	1358.1	.0	.0	.0	.0	217.3	.0	.0
79	.7	282.6	.0	.0	.0	.0	45.2	.0	.0
80	2.7	901.9	.0	.0	.0	.0	144.3	.0	.0
81	3.5	831.4	.0	.0	.0	.0	133.0	.0	.0
82	2.1	320.7	.0	.0	.0	.0	51.3	.0	.0
83	1.3	135.3	.0	.0	.0	.0	21.6	.0	.0
84	2.8	120.4	.0	.0	.0	.0	19.3	.0	.0

Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	120.00	51.50
2	126.19	48.23
3	132.45	45.10
4	138.78	42.11
5	145.17	39.26
6	151.63	36.56
7	158.15	34.01
8	164.72	31.60
9	171.35	29.34
10	178.02	27.24
11	184.75	25.28
12	191.51	23.48
13	198.31	21.82
14	205.15	20.33
15	212.02	18.99
16	218.92	17.80
17	225.84	16.77
18	232.79	15.90
19	239.75	15.18
20	246.73	14.62
21	253.72	14.22

22	260.71	13.97
23	267.71	13.89
24	274.71	13.96
25	281.71	14.19
26	288.70	14.58
27	295.68	15.13
28	302.64	15.83
29	309.59	16.69
30	316.51	17.71
31	323.41	18.88
32	330.29	20.21
33	337.13	21.69
34	343.93	23.33
35	350.70	25.12
36	357.43	27.06
37	364.10	29.16
38	370.74	31.40
39	377.31	33.80
40	383.84	36.34
41	390.30	39.03
42	396.70	41.86
43	403.03	44.84
44	409.30	47.96
45	415.50	51.22
46	421.61	54.62
47	427.66	58.15
48	433.62	61.82
49	439.49	65.63
50	445.28	69.57
51	450.98	73.63
52	456.58	77.83
53	462.09	82.15
54	467.50	86.59
55	472.80	91.16
56	478.01	95.84
57	483.10	100.64
58	488.09	105.55
59	492.96	110.58
60	497.72	115.71
61	502.36	120.95
62	506.89	126.29
63	509.38	129.38

*** 1.235 ***

1

Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	124.21	52.34
2	130.28	48.86
3	136.44	45.52
4	142.67	42.33
5	148.97	39.29
6	155.35	36.40
7	161.79	33.66
8	168.30	31.08
9	174.86	28.65
10	181.48	26.37
11	188.15	24.26
12	194.87	22.30
13	201.64	20.50
14	208.44	18.86
15	215.29	17.39
16	222.16	16.08
17	229.07	14.93
18	236.00	13.94
19	242.95	13.12
20	249.92	12.46
21	256.90	11.97
22	263.89	11.65
23	270.89	11.49
24	277.89	11.50
25	284.89	11.67
26	291.88	12.01
27	298.86	12.51
28	305.83	13.18
29	312.78	14.02
30	319.71	15.02
31	326.61	16.18
32	333.49	17.51
33	340.33	19.00
34	347.13	20.65
35	353.89	22.46
36	360.61	24.43
37	367.27	26.56
38	373.89	28.85
39	380.45	31.29
40	386.95	33.89
41	393.39	36.64
42	399.75	39.55
43	406.05	42.60
44	412.28	45.81
45	418.42	49.15
46	424.49	52.65
47	430.47	56.28
48	436.37	60.06

49	442.17	63.98
50	447.87	68.03
51	453.48	72.22
52	458.99	76.54
53	464.40	80.98
54	469.70	85.56
55	474.89	90.26
56	479.96	95.08
57	484.92	100.02
58	489.76	105.07
59	494.48	110.24
60	499.08	115.52
61	503.55	120.91
62	507.89	126.40
63	510.26	129.55

*** 1.242 ***

Failure Surface Specified By 61 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	124.21	52.34
2	130.40	49.07
3	136.66	45.93
4	142.99	42.95
5	149.39	40.11
6	155.85	37.42
7	162.38	34.89
8	168.96	32.50
9	175.59	30.27
10	182.28	28.19
11	189.01	26.27
12	195.78	24.51
13	202.60	22.90
14	209.44	21.46
15	216.33	20.17
16	223.23	19.04
17	230.17	18.08
18	237.12	17.27
19	244.09	16.63
20	251.07	16.15
21	258.07	15.83
22	265.07	15.68
23	272.07	15.68
24	279.06	15.85

25	286.06	16.19
26	293.04	16.68
27	300.01	17.34
28	306.96	18.16
29	313.89	19.14
30	320.80	20.28
31	327.67	21.58
32	334.52	23.04
33	341.33	24.66
34	348.10	26.43
35	354.83	28.37
36	361.51	30.46
37	368.14	32.70
38	374.72	35.10
39	381.24	37.65
40	387.69	40.35
41	394.09	43.20
42	400.41	46.20
43	406.67	49.35
44	412.85	52.63
45	418.95	56.07
46	424.97	59.64
47	430.90	63.35
48	436.75	67.20
49	442.50	71.18
50	448.17	75.30
51	453.73	79.54
52	459.20	83.92
53	464.56	88.42
54	469.81	93.04
55	474.96	97.79
56	479.99	102.65
57	484.92	107.63
58	489.72	112.72
59	494.40	117.92
60	498.96	123.23
61	502.95	128.09

*** 1.246 ***

1

Failure Surface Specified By 67 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	124.21	52.34

2	130.51	49.28
3	136.86	46.35
4	143.28	43.54
5	149.74	40.87
6	156.27	38.32
7	162.84	35.91
8	169.46	33.63
9	176.12	31.49
10	182.82	29.47
11	189.57	27.60
12	196.35	25.86
13	203.16	24.25
14	210.01	22.79
15	216.88	21.46
16	223.78	20.27
17	230.70	19.22
18	237.64	18.31
19	244.59	17.54
20	251.57	16.90
21	258.55	16.41
22	265.54	16.06
23	272.54	15.85
24	279.54	15.78
25	286.54	15.86
26	293.53	16.07
27	300.52	16.42
28	307.51	16.92
29	314.48	17.55
30	321.43	18.33
31	328.37	19.24
32	335.30	20.30
33	342.19	21.49
34	349.06	22.82
35	355.91	24.29
36	362.72	25.90
37	369.50	27.64
38	376.24	29.52
39	382.95	31.53
40	389.61	33.68
41	396.23	35.97
42	402.80	38.38
43	409.32	40.93
44	415.78	43.61
45	422.20	46.42
46	428.55	49.35
47	434.85	52.42
48	441.08	55.61
49	447.24	58.92
50	453.34	62.36
51	459.37	65.92
52	465.32	69.60
53	471.20	73.40

54	477.00	77.31
55	482.72	81.35
56	488.36	85.49
57	493.92	89.75
58	499.39	94.12
59	504.77	98.60
60	510.05	103.19
61	515.25	107.88
62	520.35	112.68
63	525.35	117.57
64	530.25	122.57
65	535.05	127.67
66	539.75	132.86
67	542.48	136.00

*** 1.254 ***

Failure Surface Specified By 67 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	128.42	53.18
2	134.57	49.84
3	140.80	46.64
4	147.08	43.56
5	153.44	40.63
6	159.85	37.82
7	166.33	35.16
8	172.85	32.63
9	179.44	30.25
10	186.07	28.01
11	192.74	25.91
12	199.46	23.95
13	206.23	22.13
14	213.02	20.46
15	219.86	18.94
16	226.72	17.57
17	233.61	16.34
18	240.53	15.25
19	247.46	14.32
20	254.42	13.54
21	261.39	12.90
22	268.37	12.41
23	275.37	12.07
24	282.36	11.89
25	289.36	11.85

26	296.36	11.96
27	303.36	12.22
28	310.35	12.63
29	317.32	13.19
30	324.29	13.90
31	331.23	14.76
32	338.16	15.77
33	345.07	16.92
34	351.94	18.22
35	358.79	19.67
36	365.61	21.26
37	372.39	23.00
38	379.13	24.89
39	385.83	26.92
40	392.48	29.09
41	399.09	31.40
42	405.65	33.85
43	412.15	36.45
44	418.59	39.18
45	424.98	42.05
46	431.30	45.05
47	437.56	48.19
48	443.75	51.47
49	449.86	54.87
50	455.90	58.40
51	461.87	62.07
52	467.76	65.86
53	473.56	69.77
54	479.28	73.81
55	484.91	77.97
56	490.45	82.24
57	495.90	86.64
58	501.25	91.15
59	506.50	95.78
60	511.66	100.51
61	516.71	105.36
62	521.66	110.31
63	526.50	115.36
64	531.23	120.52
65	535.85	125.78
66	540.36	131.14
67	544.61	136.42

*** 1.254 ***

1

Failure Surface Specified By 64 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	128.42	53.18
2	134.63	49.96
3	140.92	46.87
4	147.27	43.92
5	153.68	41.11
6	160.15	38.45
7	166.68	35.92
8	173.26	33.54
9	179.89	31.30
10	186.57	29.21
11	193.30	27.27
12	200.06	25.48
13	206.87	23.83
14	213.71	22.33
15	220.58	20.99
16	227.47	19.79
17	234.40	18.75
18	241.34	17.86
19	248.30	17.12
20	255.27	16.53
21	262.26	16.10
22	269.26	15.82
23	276.25	15.70
24	283.25	15.73
25	290.25	15.91
26	297.24	16.24
27	304.23	16.73
28	311.20	17.37
29	318.15	18.17
30	325.09	19.12
31	332.00	20.22
32	338.89	21.47
33	345.75	22.87
34	352.57	24.42
35	359.36	26.12
36	366.11	27.97
37	372.82	29.97
38	379.49	32.11
39	386.10	34.40
40	392.66	36.84
41	399.17	39.41
42	405.62	42.13
43	412.01	45.00
44	418.34	48.00
45	424.59	51.13
46	430.78	54.41
47	436.89	57.82
48	442.93	61.36

49	448.89	65.04
50	454.76	68.84
51	460.55	72.78
52	466.26	76.83
53	471.87	81.02
54	477.39	85.32
55	482.81	89.75
56	488.14	94.29
57	493.36	98.95
58	498.48	103.72
59	503.50	108.61
60	508.40	113.60
61	513.20	118.70
62	517.88	123.90
63	522.45	129.21
64	525.19	132.54

*** 1.258 ***

Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	132.63	54.03
2	138.85	50.81
3	145.14	47.74
4	151.50	44.81
5	157.92	42.02
6	164.40	39.38
7	170.94	36.88
8	177.53	34.53
9	184.17	32.32
10	190.87	30.26
11	197.60	28.36
12	204.38	26.60
13	211.19	25.00
14	218.04	23.54
15	224.92	22.24
16	231.82	21.10
17	238.75	20.11
18	245.70	19.27
19	252.67	18.59
20	259.65	18.06
21	266.64	17.69
22	273.64	17.48
23	280.64	17.42

24	287.63	17.52
25	294.63	17.78
26	301.62	18.19
27	308.60	18.75
28	315.56	19.47
29	322.50	20.35
30	329.43	21.38
31	336.33	22.57
32	343.20	23.91
33	350.03	25.40
34	356.84	27.05
35	363.60	28.84
36	370.33	30.79
37	377.01	32.88
38	383.64	35.13
39	390.22	37.52
40	396.74	40.06
41	403.21	42.74
42	409.61	45.56
43	415.95	48.53
44	422.22	51.64
45	428.42	54.89
46	434.55	58.28
47	440.60	61.80
48	446.57	65.45
49	452.46	69.24
50	458.26	73.16
51	463.97	77.20
52	469.59	81.38
53	475.11	85.67
54	480.54	90.09
55	485.87	94.63
56	491.10	99.29
57	496.22	104.06
58	501.23	108.95
59	506.14	113.94
60	510.93	119.05
61	515.60	124.26
62	520.16	129.57
63	522.08	131.92

*** 1.268 ***

1

Failure Surface Specified By 61 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	136.84	54.87
2	142.78	51.17
3	148.82	47.62
4	154.94	44.23
5	161.15	41.00
6	167.44	37.93
7	173.81	35.02
8	180.25	32.28
9	186.76	29.70
10	193.33	27.30
11	199.97	25.06
12	206.65	22.99
13	213.39	21.10
14	220.18	19.39
15	227.01	17.84
16	233.87	16.48
17	240.77	15.29
18	247.70	14.28
19	254.65	13.45
20	261.62	12.80
21	268.60	12.33
22	275.60	12.04
23	282.60	11.92
24	289.60	11.99
25	296.59	12.24
26	303.58	12.67
27	310.55	13.28
28	317.51	14.07
29	324.44	15.04
30	331.35	16.19
31	338.22	17.51
32	345.06	19.02
33	351.85	20.69
34	358.60	22.55
35	365.30	24.57
36	371.95	26.77
37	378.54	29.14
38	385.06	31.67
39	391.52	34.38
40	397.90	37.25
41	404.21	40.28
42	410.44	43.47
43	416.58	46.83
44	422.64	50.34
45	428.60	54.01
46	434.47	57.83
47	440.23	61.80
48	445.90	65.91
49	451.45	70.17
50	456.89	74.58

51	462.22	79.12
52	467.43	83.79
53	472.51	88.60
54	477.47	93.54
55	482.30	98.61
56	487.00	103.80
57	491.57	109.11
58	495.99	114.53
59	500.28	120.06
60	504.41	125.71
61	506.57	128.81

*** 1.269 ***

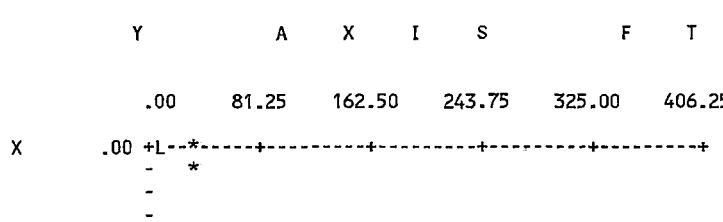
Failure Surface Specified By 63 Coordinate Points

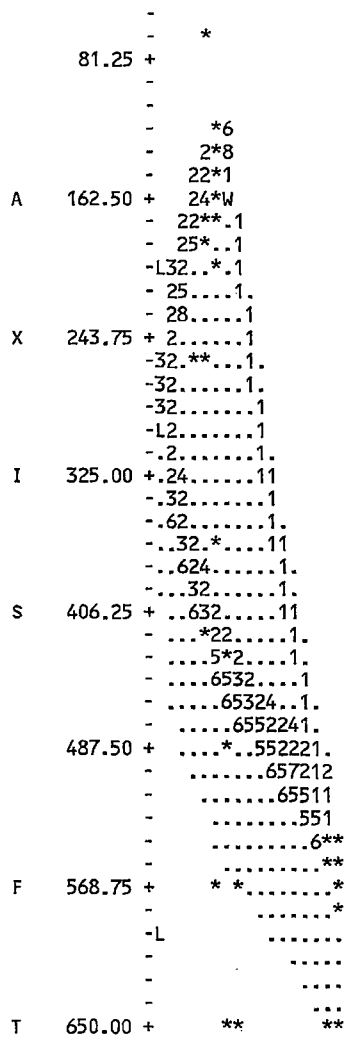
Point No.	X-Surf (ft)	Y-Surf (ft)
1	136.84	54.87
2	142.85	51.27
3	148.94	47.82
4	155.11	44.51
5	161.36	41.36
6	167.68	38.36
7	174.08	35.51
8	180.54	32.82
9	187.06	30.29
10	193.65	27.92
11	200.29	25.70
12	206.98	23.65
13	213.72	21.77
14	220.51	20.04
15	227.33	18.48
16	234.19	17.09
17	241.09	15.87
18	248.01	14.81
19	254.95	13.92
20	261.91	13.20
21	268.89	12.65
22	275.88	12.27
23	282.88	12.06
24	289.88	12.02
25	296.87	12.15
26	303.87	12.45
27	310.85	12.91
28	317.82	13.55

29	324.78	14.36
30	331.71	15.33
31	338.61	16.48
32	345.49	17.79
33	352.33	19.27
34	359.14	20.91
35	365.90	22.72
36	372.62	24.69
37	379.28	26.82
38	385.90	29.12
39	392.45	31.57
40	398.95	34.19
41	405.37	36.96
42	411.73	39.88
43	418.02	42.96
44	424.23	46.19
45	430.36	49.57
46	436.40	53.10
47	442.36	56.78
48	448.23	60.59
49	454.00	64.55
50	459.68	68.65
51	465.25	72.89
52	470.72	77.26
53	476.08	81.76
54	481.33	86.39
55	486.47	91.14
56	491.49	96.02
57	496.39	101.02
58	501.16	106.14
59	505.82	111.37
60	510.34	116.71
61	514.73	122.16
62	518.99	127.72
63	522.04	131.91

*** 1.269 ***

1

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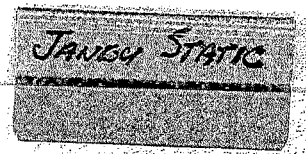
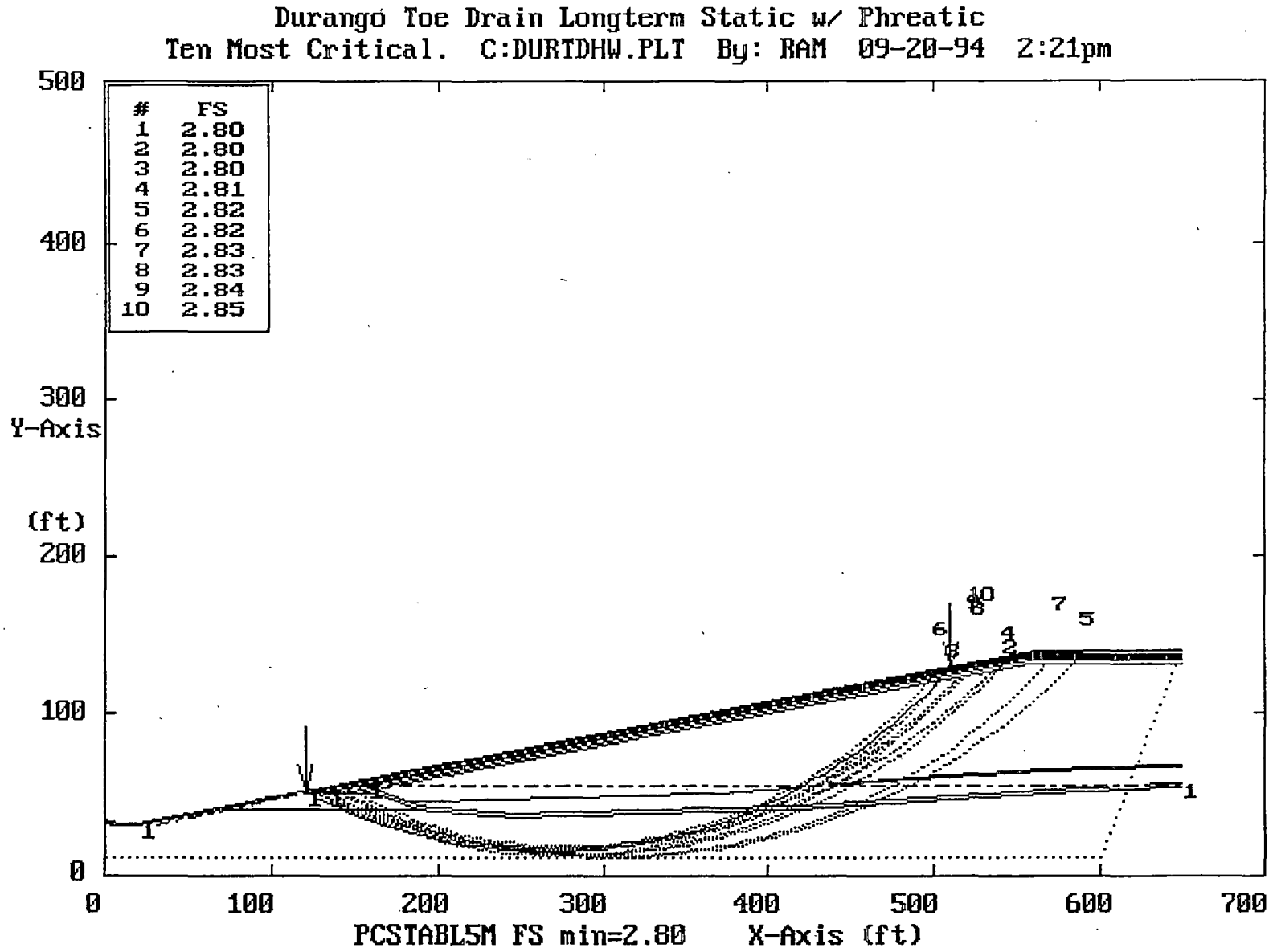

JANGU STATIC


Durango Toe Drain Longterm Static w/ Phreatic
Ten Most Critical. C:DURTDHW.PLT By: RAM 09-20-94 2:21pm
FS
1 2.80
2 2.80
3 2.80
4 2.81
5 2.82
6 2.82
7 2.83
8 2.83
9 2.84
10 2.85
500
400
300
Y-Axis
(ft)
200
100
0
0
100
200
300
400
500
600
700
PCSTABL5M FS min=2.80
X-Axis (ft)

** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	09-20-94
Time of Run:	2:21pm
Run By:	RAM
Input Data Filename:	C:DURTDHW.STC
Output Filename:	C:DURTDHW.OUT
Plotted Output Filename:	C:DURTDHW.PLT

PROBLEM DESCRIPTION Durango Toe Drain Longterm Static
w/ Phreatic

BOUNDARY COORDINATES

5 Top Boundaries
71 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	33.50	10.00	31.50	1
2	10.00	31.50	20.00	31.50	1
3	20.00	31.50	562.50	140.00	1
4	562.50	140.00	586.30	140.00	1
5	586.30	140.00	650.00	140.00	1
6	.00	32.50	10.00	30.50	1
7	10.00	30.50	20.00	30.50	1
8	20.00	30.50	545.10	135.50	1
9	545.10	135.50	552.65	137.00	2
10	552.65	137.00	562.50	139.00	1
11	562.50	139.00	579.50	139.00	1
12	579.50	139.00	579.60	139.50	1
13	579.60	139.50	587.60	139.50	1
14	587.60	139.50	650.00	139.50	2
15	552.65	137.00	555.20	137.00	2
16	555.20	137.00	562.50	138.50	2

17	562.50	138.50	587.50	138.50	2
18	587.50	138.50	587.60	139.50	2
19	555.20	137.00	650.00	137.00	2
20	545.10	135.50	650.00	135.50	1
21	120.15	50.00	122.70	50.51	1
22	122.70	50.51	125.10	51.02	1
23	125.10	51.02	545.15	135.00	2
24	545.15	135.00	555.35	135.00	2
25	555.35	135.00	650.00	135.00	5
26	125.10	51.02	132.90	51.02	1
27	132.90	51.02	545.30	133.50	1
28	545.30	133.50	547.85	133.50	1
29	547.85	133.50	555.35	135.00	5
30	122.70	50.51	132.90	50.51	1
31	132.90	50.51	547.85	133.50	1
32	547.85	133.50	550.40	133.50	1
33	.00	32.00	10.00	30.00	3
34	10.00	30.00	20.00	30.00	3
35	20.00	30.00	70.20	40.00	3
36	70.20	40.00	120.15	50.00	4
37	120.15	50.00	132.90	50.00	4
38	132.90	50.00	550.40	133.50	5
39	132.90	50.00	143.10	50.00	4
40	143.10	50.00	558.10	133.00	6
41	558.10	133.00	650.00	133.00	6
42	143.10	50.00	153.30	50.00	4
43	153.30	50.00	163.30	52.00	8
44	163.30	52.00	558.10	131.00	7
45	558.10	131.00	650.00	131.00	7
46	163.30	52.00	180.80	45.00	8
47	180.80	45.00	202.30	45.50	9
48	202.30	45.50	372.00	50.00	9
49	372.00	50.00	432.00	55.00	9
50	432.00	55.00	492.00	60.00	9
51	492.00	60.00	572.00	65.00	9
52	572.00	65.00	650.00	67.50	9
53	180.80	45.00	182.05	44.50	8
54	182.05	44.50	202.30	45.00	7
55	202.30	45.00	372.00	49.50	7
56	372.00	49.50	432.00	54.50	7
57	432.00	54.50	492.00	59.50	7
58	492.00	59.50	572.00	64.50	7
59	572.00	64.50	650.00	67.00	7
60	182.05	44.50	188.30	42.00	8
61	188.30	42.00	252.00	37.00	8
62	252.00	37.00	422.00	42.00	8
63	422.00	42.00	572.00	52.00	8
64	572.00	52.00	650.00	56.00	8
65	153.30	50.00	163.30	50.00	4
66	163.30	50.00	188.30	40.00	4
67	70.20	40.00	188.30	40.00	3
68	188.30	40.00	252.00	35.00	3

69	252.30	35.00	422.00	40.00	3
70	422.00	40.00	572.00	50.00	3
71	572.00	50.00	650.00	54.00	3

1

ISOTROPIC SOIL PARAMETERS

9 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	.0	38.0	.00	.0	1
2	124.0	131.0	320.0	27.0	.00	.0	1
3	126.0	129.0	455.0	27.0	.00	.0	1
4	111.0	120.0	300.0	30.0	.00	.0	1
5	126.0	128.0	345.0	22.0	.00	.0	1
6	126.0	128.0	245.0	22.0	.00	.0	1
7	111.0	120.0	300.0	30.0	.00	.0	1
8	126.0	130.0	245.0	22.0	.00	.0	1
9	125.0	128.0	245.0	22.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	20.00	30.00
2	120.15	50.00
3	132.90	50.00
4	157.90	55.00
5	650.00	55.00

1

Searching Routine Will Be Limited To An Area Defined By 4 Boundaries
Of Which The First 4 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	10.00	200.00	10.00
2	200.00	10.00	300.00	10.00
3	300.00	10.00	600.00	10.00
4	600.00	10.00	650.00	140.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

200 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 120.00 ft.
and X = 200.00 ft.

Each Surface Terminates Between X = 500.00 ft.
and X = 650.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

7.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation. The Angle Has Been Restricted Between The Angles Of -45.0 And 12.0 deg.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	120.00	51.50
2	126.19	48.23
3	132.45	45.10
4	138.78	42.11
5	145.17	39.26
6	151.63	36.56
7	158.15	34.01
8	164.72	31.60
9	171.35	29.34
10	178.02	27.24
11	184.75	25.28
12	191.51	23.48
13	198.31	21.82
14	205.15	20.33
15	212.02	18.99
16	218.92	17.80
17	225.84	16.77
18	232.79	15.90
19	239.75	15.18
20	246.73	14.62
21	253.72	14.22
22	260.71	13.97
23	267.71	13.89
24	274.71	13.96
25	281.71	14.19
26	288.70	14.58
27	295.68	15.13
28	302.64	15.83
29	309.59	16.69
30	316.51	17.71
31	323.41	18.88
32	330.29	20.21
33	337.13	21.69
34	343.93	23.33
35	350.70	25.12
36	357.43	27.06
37	364.10	29.16
38	370.74	31.40
39	377.31	33.80
40	383.84	36.34
41	390.30	39.03
42	396.70	41.86
43	403.03	44.84
44	409.30	47.96
45	415.50	51.22
46	421.61	54.62
47	427.66	58.15
48	433.62	61.82

49	439.49	65.63
50	445.28	69.57
51	450.98	73.63
52	456.58	77.83
53	462.09	82.15
54	467.50	86.59
55	472.80	91.16
56	478.01	95.84
57	483.10	100.64
58	488.09	105.55
59	492.96	110.58
60	497.72	115.71
61	502.36	120.95
62	506.89	126.29
63	509.38	129.38

*** 2.796 ***

Individual data on the 94 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	1.4	86.4	.0	.0	.0	.0	.0	.0	.0
2	.7	114.3	.0	.0	.0	.0	.0	.0	.0
3	.6	131.2	.0	.0	.0	.0	.0	.0	.0
4	.1	34.7	.0	.0	.0	.0	.0	.0	.0
5	2.3	811.1	.0	95.5	.0	.0	.0	.0	.0
6	1.1	551.5	.0	114.1	.0	.0	.0	.0	.0
7	6.3	5134.6	.0	1458.0	.0	.0	.0	.0	.0
8	.5	497.9	.0	155.9	.0	.0	.0	.0	.0
9	5.9	8018.4	.0	2822.1	.0	.0	.0	.0	.0
10	4.3	7676.5	.0	3028.6	.0	.0	.0	.0	.0
11	.4	811.6	.0	332.0	.0	.0	.0	.0	.0
12	1.7	3402.0	.0	1408.1	.0	.0	.0	.0	.0
13	6.5	15333.0	.0	6507.4	.0	.0	.0	.0	.0
14	1.7	4494.3	.0	1938.3	.0	.0	.0	.0	.0
15	4.6	13496.6	.0	5906.7	.0	.0	.0	.0	.0
16	.2	778.3	.0	350.1	.0	.0	.0	.0	.0
17	5.2	17086.6	.0	7507.9	.0	.0	.0	.0	.0
18	1.4	5058.5	.0	2187.7	.0	.0	.0	.0	.0
19	3.4	12562.5	.0	5337.7	.0	.0	.0	.0	.0
20	3.2	12811.9	.0	5376.5	.0	.0	.0	.0	.0
21	6.7	28490.1	.0	11667.5	.0	.0	.0	.0	.0
22	.3	1204.9	.0	484.8	.0	.0	.0	.0	.0
23	2.5	11469.7	.0	4596.9	.0	.0	.0	.0	.0

24	1.3	5860.4	.0	2335.9	.0	.0	.0	.0	.0
25	2.7	12959.7	.0	5137.3	.0	.0	.0	.0	.0
26	3.6	17735.7	.0	6931.7	.0	.0	.0	.0	.0
27	3.2	16620.8	.0	6444.3	.0	.0	.0	.0	.0
28	6.8	37065.9	.0	14130.4	.0	.0	.0	.0	.0
29	4.0	22843.8	.0	8563.3	.0	.0	.0	.0	.0
30	2.8	16805.7	.0	6254.5	.0	.0	.0	.0	.0
31	6.9	42105.0	.0	15437.6	.0	.0	.0	.0	.0
32	6.9	44425.6	.0	15989.8	.0	.0	.0	.0	.0
33	6.9	46605.1	.0	16473.9	.0	.0	.0	.0	.0
34	6.9	48637.8	.0	16889.7	.0	.0	.0	.0	.0
35	7.0	50518.6	.0	17237.1	.0	.0	.0	.0	.0
36	7.0	52242.7	.0	17515.8	.0	.0	.0	.0	.0
37	5.3	40456.1	.0	13354.5	.0	.0	.0	.0	.0
38	.3	2332.8	.0	763.0	.0	.0	.0	.0	.0
39	1.4	11024.7	.0	3608.1	.0	.0	.0	.0	.0
40	7.0	55240.0	.0	17866.6	.0	.0	.0	.0	.0
41	7.0	56518.4	.0	17938.5	.0	.0	.0	.0	.0
42	7.0	57626.3	.0	17941.5	.0	.0	.0	.0	.0
43	7.0	58561.3	.0	17875.4	.0	.0	.0	.0	.0
44	7.0	59321.8	.0	17740.3	.0	.0	.0	.0	.0
45	7.0	59906.6	.0	17536.2	.0	.0	.0	.0	.0
46	7.0	60315.0	.0	17263.4	.0	.0	.0	.0	.0
47	6.9	60547.0	.0	16921.9	.0	.0	.0	.0	.0
48	6.9	60602.6	.0	16511.9	.0	.0	.0	.0	.0
49	6.9	60483.2	.0	16033.6	.0	.0	.0	.0	.0
50	6.9	60189.7	.0	15487.1	.0	.0	.0	.0	.0
51	6.8	59724.7	.0	14873.0	.0	.0	.0	.0	.0
52	6.8	59090.1	.0	14191.4	.0	.0	.0	.0	.0
53	6.8	58289.3	.0	13442.6	.0	.0	.0	.0	.0
54	6.7	57325.8	.0	12627.2	.0	.0	.0	.0	.0
55	6.7	56203.3	.0	11745.4	.0	.0	.0	.0	.0
56	6.6	54926.7	.0	10797.7	.0	.0	.0	.0	.0
57	1.3	10368.8	.0	1962.5	.0	.0	.0	.0	.0
58	5.3	43131.9	.0	7822.2	.0	.0	.0	.0	.0
59	6.5	51930.8	.0	8706.8	.0	.0	.0	.0	.0
60	6.5	50223.0	.0	7564.5	.0	.0	.0	.0	.0
61	.1	740.2	.0	105.1	.0	.0	.0	.0	.0
62	4.8	36720.7	.0	4911.2	.0	.0	.0	.0	.0
63	1.5	10918.9	.0	1342.2	.0	.0	.0	.0	.0
64	6.3	46521.0	.0	5089.5	.0	.0	.0	.0	.0
65	6.3	44599.5	.0	3757.9	.0	.0	.0	.0	.0
66	6.2	42572.5	.0	2364.5	.0	.0	.0	.0	.0
67	4.0	26893.0	.0	767.4	.0	.0	.0	.0	.0
68	1.1	6926.1	.0	94.1	.0	.0	.0	.0	.0
69	1.0	6621.7	.0	48.6	.0	.0	.0	.0	.0
70	.7	4231.5	.0	9.1	.0	.0	.0	.0	.0
71	5.4	34051.4	.0	.0	.0	.0	.0	.0	.0
72	6.0	36175.5	.0	.0	.0	.0	.0	.0	.0
73	5.9	33996.6	.0	.0	.0	.0	.0	.0	.0
74	5.8	31752.9	.0	.0	.0	.0	.0	.0	.0
75	5.7	29452.2	.0	.0	.0	.0	.0	.0	.0

76	5.6	27103.5	.0	.0	.0	.0	.0	.0	.0
77	5.5	24715.0	.0	.0	.0	.0	.0	.0	.0
78	5.4	22295.7	.0	.0	.0	.0	.0	.0	.0
79	5.3	19854.6	.0	.0	.0	.0	.0	.0	.0
80	5.2	17400.8	.0	.0	.0	.0	.0	.0	.0
81	5.1	14943.5	.0	.0	.0	.0	.0	.0	.0
82	5.0	12492.2	.0	.0	.0	.0	.0	.0	.0
83	4.9	10056.3	.0	.0	.0	.0	.0	.0	.0
84	4.8	7645.6	.0	.0	.0	.0	.0	.0	.0
85	3.5	4133.5	.0	.0	.0	.0	.0	.0	.0
86	1.2	1126.2	.0	.0	.0	.0	.0	.0	.0
87	.9	757.2	.0	.0	.0	.0	.0	.0	.0
88	2.1	1324.2	.0	.0	.0	.0	.0	.0	.0
89	.5	247.7	.0	.0	.0	.0	.0	.0	.0
90	.5	214.6	.0	.0	.0	.0	.0	.0	.0
91	.5	170.1	.0	.0	.0	.0	.0	.0	.0
92	1.0	261.7	.0	.0	.0	.0	.0	.0	.0
93	.5	78.1	.0	.0	.0	.0	.0	.0	.0
94	1.0	62.5	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 67 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	128.42	53.18
2	134.57	49.84
3	140.80	46.64
4	147.08	43.56
5	153.44	40.63
6	159.85	37.82
7	166.33	35.16
8	172.85	32.63
9	179.44	30.25
10	186.07	28.01
11	192.74	25.91
12	199.46	23.95
13	206.23	22.13
14	213.02	20.46
15	219.86	18.94
16	226.72	17.57
17	233.61	16.34
18	240.53	15.25
19	247.46	14.32
20	254.42	13.54
21	261.39	12.90
22	268.37	12.41
23	275.37	12.07
24	282.36	11.89
25	289.36	11.85
26	296.36	11.96

27	303.36	12.22
28	310.35	12.63
29	317.32	13.19
30	324.29	13.90
31	331.23	14.76
32	338.16	15.77
33	345.07	16.92
34	351.94	18.22
35	358.79	19.67
36	365.61	21.26
37	372.39	23.00
38	379.13	24.89
39	385.83	26.92
40	392.48	29.09
41	399.09	31.40
42	405.65	33.85
43	412.15	36.45
44	418.59	39.18
45	424.98	42.05
46	431.30	45.05
47	437.56	48.19
48	443.75	51.47
49	449.86	54.87
50	455.90	58.40
51	461.87	62.07
52	467.76	65.86
53	473.56	69.77
54	479.28	73.81
55	484.91	77.97
56	490.45	82.24
57	495.90	86.64
58	501.25	91.15
59	506.50	95.78
60	511.66	100.51
61	516.71	105.36
62	521.66	110.31
63	526.50	115.36
64	531.23	120.52
65	535.85	125.78
66	540.36	131.14
67	544.61	136.42

*** 2.800 ***

1

Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	124.21	52.34
2	130.28	48.86
3	136.44	45.52
4	142.67	42.33
5	148.97	39.29
6	155.35	36.40
7	161.79	33.66
8	168.30	31.08
9	174.86	28.65
10	181.48	26.37
11	188.15	24.26
12	194.87	22.30
13	201.64	20.50
14	208.44	18.86
15	215.29	17.39
16	222.16	16.08
17	229.07	14.93
18	236.00	13.94
19	242.95	13.12
20	249.92	12.46
21	256.90	11.97
22	263.89	11.65
23	270.89	11.49
24	277.89	11.50
25	284.89	11.67
26	291.88	12.01
27	298.86	12.51
28	305.83	13.18
29	312.78	14.02
30	319.71	15.02
31	326.61	16.18
32	333.49	17.51
33	340.33	19.00
34	347.13	20.65
35	353.89	22.46
36	360.61	24.43
37	367.27	26.56
38	373.89	28.85
39	380.45	31.29
40	386.95	33.89
41	393.39	36.64
42	399.75	39.55
43	406.05	42.60
44	412.28	45.81
45	418.42	49.15
46	424.49	52.65
47	430.47	56.28
48	436.37	60.06
49	442.17	63.98

50	447.87	68.03
51	453.48	72.22
52	458.99	76.54
53	464.40	80.98
54	469.70	85.56
55	474.89	90.26
56	479.96	95.08
57	484.92	100.02
58	489.76	105.07
59	494.48	110.24
60	499.08	115.52
61	503.55	120.91
62	507.89	126.40
63	510.26	129.55

*** 2.800 ***

Failure Surface Specified By 67 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	124.21	52.34
2	130.51	49.28
3	136.86	46.35
4	143.28	43.54
5	149.74	40.87
6	156.27	38.32
7	162.84	35.91
8	169.46	33.63
9	176.12	31.49
10	182.82	29.47
11	189.57	27.60
12	196.35	25.86
13	203.16	24.25
14	210.01	22.79
15	216.88	21.46
16	223.78	20.27
17	230.70	19.22
18	237.64	18.31
19	244.59	17.54
20	251.57	16.90
21	258.55	16.41
22	265.54	16.06
23	272.54	15.85
24	279.54	15.78
25	286.54	15.86

26	293.53	16.07
27	300.52	16.42
28	307.51	16.92
29	314.48	17.55
30	321.43	18.33
31	328.37	19.24
32	335.30	20.30
33	342.19	21.49
34	349.06	22.82
35	355.91	24.29
36	362.72	25.90
37	369.50	27.64
38	376.24	29.52
39	382.95	31.53
40	389.61	33.68
41	396.23	35.97
42	402.80	38.38
43	409.32	40.93
44	415.78	43.61
45	422.20	46.42
46	428.55	49.35
47	434.85	52.42
48	441.08	55.61
49	447.24	58.92
50	453.34	62.36
51	459.37	65.92
52	465.32	69.60
53	471.20	73.40
54	477.00	77.31
55	482.72	81.35
56	488.36	85.49
57	493.92	89.75
58	499.39	94.12
59	504.77	98.60
60	510.05	103.19
61	515.25	107.88
62	520.35	112.68
63	525.35	117.57
64	530.25	122.57
65	535.05	127.67
66	539.75	132.86
67	542.48	136.00

*** 2.808 ***

1

Failure Surface Specified By 73 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	132.63	54.03
2	138.84	50.80
3	145.12	47.69
4	151.44	44.70
5	157.83	41.83
6	164.26	39.07
7	170.75	36.44
8	177.29	33.93
9	183.87	31.55
10	190.49	29.29
11	197.16	27.15
12	203.86	25.14
13	210.60	23.25
14	217.38	21.49
15	224.18	19.86
16	231.02	18.36
17	237.88	16.98
18	244.77	15.73
19	251.68	14.62
20	258.61	13.63
21	265.56	12.77
22	272.52	12.05
23	279.50	11.45
24	286.48	10.98
25	293.47	10.65
26	300.47	10.45
27	307.47	10.37
28	314.47	10.43
29	321.47	10.62
30	328.46	10.95
31	335.45	11.40
32	342.42	11.98
33	349.38	12.70
34	356.33	13.54
35	363.27	14.52
36	370.18	15.62
37	377.07	16.86
38	383.93	18.22
39	390.77	19.71
40	397.58	21.33
41	404.36	23.08
42	411.11	24.95
43	417.81	26.95
44	424.48	29.08
45	431.11	31.33
46	437.70	33.70
47	444.24	36.20
48	450.73	38.82

49	457.17	41.56
50	463.56	44.42
51	469.89	47.40
52	476.17	50.50
53	482.39	53.71
54	488.54	57.04
55	494.64	60.49
56	500.66	64.05
57	506.62	67.72
58	512.51	71.50
59	518.33	75.40
60	524.07	79.40
61	529.74	83.51
62	535.33	87.72
63	540.84	92.04
64	546.27	96.46
65	551.61	100.98
66	556.87	105.60
67	562.04	110.32
68	567.12	115.14
69	572.11	120.05
70	577.01	125.05
71	581.81	130.14
72	586.51	135.32
73	590.60	140.00

*** 2.820 ***

Failure Surface Specified By 61 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	124.21	52.34
2	130.40	49.07
3	136.66	45.93
4	142.99	42.95
5	149.39	40.11
6	155.85	37.42
7	162.38	34.89
8	168.96	32.50
9	175.59	30.27
10	182.28	28.19
11	189.01	26.27
12	195.78	24.51
13	202.60	22.90
14	209.44	21.46

15	216.33	20.17
16	223.23	19.04
17	230.17	18.08
18	237.12	17.27
19	244.09	16.63
20	251.07	16.15
21	258.07	15.83
22	265.07	15.68
23	272.07	15.68
24	279.06	15.85
25	286.06	16.19
26	293.04	16.68
27	300.01	17.34
28	306.96	18.16
29	313.89	19.14
30	320.80	20.28
31	327.67	21.58
32	334.52	23.04
33	341.33	24.66
34	348.10	26.43
35	354.83	28.37
36	361.51	30.46
37	368.14	32.70
38	374.72	35.10
39	381.24	37.65
40	387.69	40.35
41	394.09	43.20
42	400.41	46.20
43	406.67	49.35
44	412.85	52.63
45	418.95	56.07
46	424.97	59.64
47	430.90	63.35
48	436.75	67.20
49	442.50	71.18
50	448.17	75.30
51	453.73	79.54
52	459.20	83.92
53	464.56	88.42
54	469.81	93.04
55	474.96	97.79
56	479.99	102.65
57	484.92	107.63
58	489.72	112.72
59	494.40	117.92
60	498.96	123.23
61	502.95	128.09

*** 2.821 ***

1

Failure Surface Specified By 70 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	141.05	55.71
2	147.16	52.29
3	153.34	49.01
4	159.59	45.85
5	165.90	42.82
6	172.27	39.92
7	178.70	37.15
8	185.19	34.52
9	191.73	32.02
10	198.32	29.66
11	204.95	27.44
12	211.64	25.35
13	218.36	23.41
14	225.12	21.60
15	231.92	19.93
16	238.75	18.41
17	245.62	17.03
18	252.51	15.79
19	259.42	14.69
20	266.35	13.74
21	273.31	12.93
22	280.28	12.26
23	287.26	11.74
24	294.25	11.36
25	301.24	11.13
26	308.24	11.05
27	315.24	11.11
28	322.24	11.31
29	329.23	11.66
30	336.21	12.16
31	343.18	12.79
32	350.14	13.58
33	357.08	14.51
34	363.99	15.58
35	370.89	16.79
36	377.76	18.15
37	384.59	19.65
38	391.40	21.29
39	398.17	23.07
40	404.90	24.99
41	411.59	27.05
42	418.24	29.25
43	424.83	31.58

44	431.38	34.05
45	437.88	36.66
46	444.32	39.40
47	450.70	42.28
48	457.02	45.28
49	463.28	48.42
50	469.47	51.68
51	475.60	55.08
52	481.65	58.60
53	487.62	62.24
54	493.52	66.01
55	499.35	69.90
56	505.08	73.90
57	510.74	78.03
58	516.31	82.27
59	521.78	86.63
60	527.17	91.10
61	532.46	95.68
62	537.66	100.37
63	542.76	105.17
64	547.76	110.07
65	552.65	115.07
66	557.44	120.18
67	562.13	125.38
68	566.70	130.68
69	571.17	136.07
70	574.29	140.00

*** 2.825 ***

Failure Surface Specified By 64 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	128.42	53.18
2	134.63	49.96
3	140.92	46.87
4	147.27	43.92
5	153.68	41.11
6	160.15	38.45
7	166.68	35.92
8	173.26	33.54
9	179.89	31.30
10	186.57	29.21
11	193.30	27.27
12	200.06	25.48

13	206.87	23.83
14	213.71	22.33
15	220.58	20.99
16	227.47	19.79
17	234.40	18.75
18	241.34	17.86
19	248.30	17.12
20	255.27	16.53
21	262.26	16.10
22	269.26	15.82
23	276.25	15.70
24	283.25	15.73
25	290.25	15.91
26	297.24	16.24
27	304.23	16.73
28	311.20	17.37
29	318.15	18.17
30	325.09	19.12
31	332.00	20.22
32	338.89	21.47
33	345.75	22.87
34	352.57	24.42
35	359.36	26.12
36	366.11	27.97
37	372.82	29.97
38	379.49	32.11
39	386.10	34.40
40	392.66	36.84
41	399.17	39.41
42	405.62	42.13
43	412.01	45.00
44	418.34	48.00
45	424.59	51.13
46	430.78	54.41
47	436.89	57.82
48	442.93	61.36
49	448.89	65.04
50	454.76	68.84
51	460.55	72.78
52	466.26	76.83
53	471.87	81.02
54	477.39	85.32
55	482.81	89.75
56	488.14	94.29
57	493.36	98.95
58	498.48	103.72
59	503.50	108.61
60	508.40	113.60
61	513.20	118.70
62	517.88	123.90
63	522.45	129.21
64	525.19	132.54

*** 2.826 ***

1

Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	136.84	54.87
2	142.85	51.27
3	148.94	47.82
4	155.11	44.51
5	161.36	41.36
6	167.68	38.36
7	174.08	35.51
8	180.54	32.82
9	187.06	30.29
10	193.65	27.92
11	200.29	25.70
12	206.98	23.65
13	213.72	21.77
14	220.51	20.04
15	227.33	18.48
16	234.19	17.09
17	241.09	15.87
18	248.01	14.81
19	254.95	13.92
20	261.91	13.20
21	268.89	12.65
22	275.88	12.27
23	282.88	12.06
24	289.88	12.02
25	296.87	12.15
26	303.87	12.45
27	310.85	12.91
28	317.82	13.55
29	324.78	14.36
30	331.71	15.33
31	338.61	16.48
32	345.49	17.79
33	352.33	19.27
34	359.14	20.91
35	365.90	22.72
36	372.62	24.69
37	379.28	26.82
38	385.90	29.12

39	392.45	31.57
40	398.95	34.19
41	405.37	36.96
42	411.73	39.88
43	418.02	42.96
44	424.23	46.19
45	430.36	49.57
46	436.40	53.10
47	442.36	56.78
48	448.23	60.59
49	454.00	64.55
50	459.68	68.65
51	465.25	72.89
52	470.72	77.26
53	476.08	81.76
54	481.33	86.39
55	486.47	91.14
56	491.49	96.02
57	496.39	101.02
58	501.16	106.14
59	505.82	111.37
60	510.34	116.71
61	514.73	122.16
62	518.99	127.72
63	522.04	131.91

*** 2.840 ***

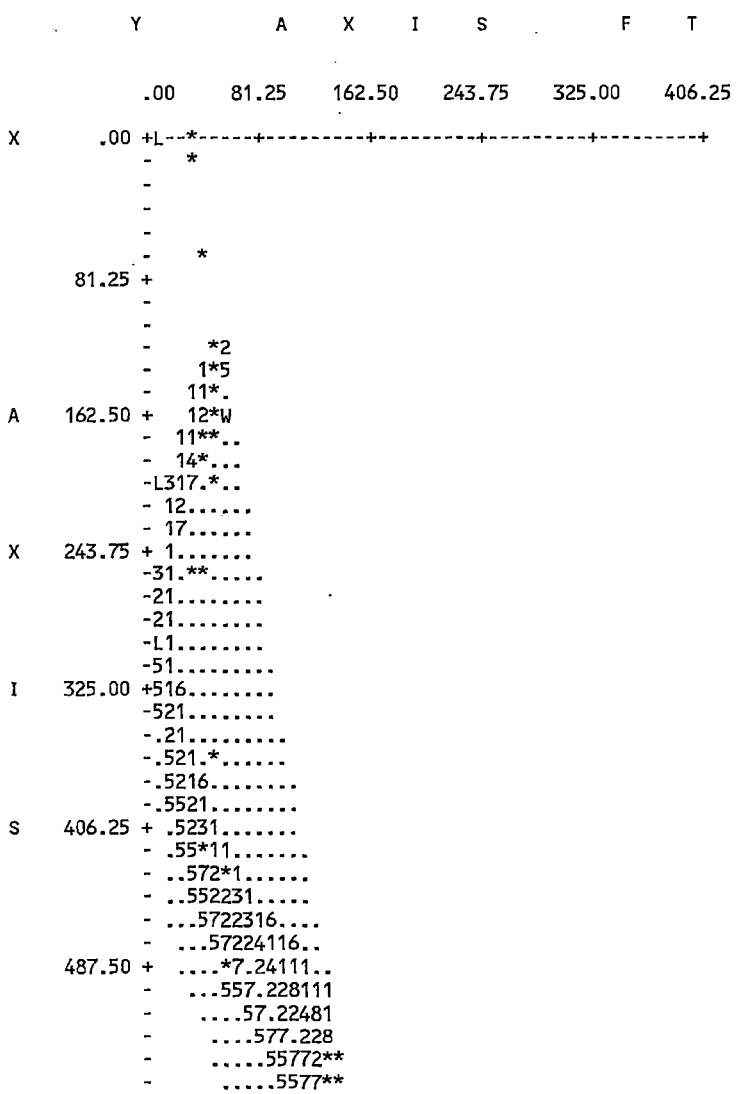
Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	132.63	54.03
2	138.85	50.81
3	145.14	47.74
4	151.50	44.81
5	157.92	42.02
6	164.40	39.38
7	170.94	36.88
8	177.53	34.53
9	184.17	32.32
10	190.87	30.26
11	197.60	28.36
12	204.38	26.60
13	211.19	25.00
14	218.04	23.54

15	224.92	22.24
16	231.82	21.10
17	238.75	20.11
18	245.70	19.27
19	252.67	18.59
20	259.65	18.06
21	266.64	17.69
22	273.64	17.48
23	280.64	17.42
24	287.63	17.52
25	294.63	17.78
26	301.62	18.19
27	308.60	18.75
28	315.56	19.47
29	322.50	20.35
30	329.43	21.38
31	336.33	22.57
32	343.20	23.91
33	350.03	25.40
34	356.84	27.05
35	363.60	28.84
36	370.33	30.79
37	377.01	32.88
38	383.64	35.13
39	390.22	37.52
40	396.74	40.06
41	403.21	42.74
42	409.61	45.56
43	415.95	48.53
44	422.22	51.64
45	428.42	54.89
46	434.55	58.28
47	440.60	61.80
48	446.57	65.45
49	452.46	69.24
50	458.26	73.16
51	463.97	77.20
52	469.59	81.38
53	475.11	85.67
54	480.54	90.09
55	485.87	94.63
56	491.10	99.29
57	496.22	104.06
58	501.23	108.95
59	506.14	113.94
60	510.93	119.05
61	515.60	124.26
62	520.16	129.57
63	522.08	131.92

*** 2.849 ***

1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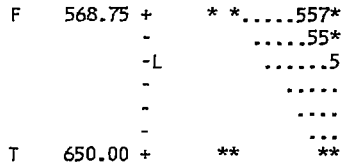
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2591 Legacy Way.
Grand Junction, CO 81503

January 14, 2016

Dan Brennecke, P.E.
DOE Legacy Management
Navarro Research and Engineering, Inc.
2597 Legacy Way
Grand Junction, CO 81503

RE: Review of JEG Calculation Number DUR-09-94-03-01 Slope Stability Analysis with Phreatic Surface at 7055.0, UMTRA Durango Disposal Cell at Bodo Canyon.

Letter is in response to a request to review a slope stability analysis performed by Jacobs Engineering Group (JEG) for the UMTRA Durango Disposal Cell at Bodo Canyon in 1994. The analysis was performed to determine the effect on disposal cell slope stability if a toe drain on the eastern slope is permanently closed. Closing the drain will cause an increase in the phreatic surface within the tailings assuming infiltration is the source of inflow.

The slope stability analysis performed by JEG was done to verify the initial stability analysis made during the initial design of the disposal cell by Morrison Knudsen Environmental Services (MKES)[1]. In the MKES computation, the slope was determined to be stable with a functioning toe drain. JEG ran the analysis assuming the toe drain was closed creating an elevated internal water surface within the embankment. JEG used an updated version of the same slope stability computer code MKES had used (PCSTABL). JEG used more conservative soil strength parameters and included formation of internal pore pressures that would likely develop during shaking in a seismic event. An increase in pore pressure reduces the soil's shear strength. A horizontal acceleration of 0.16g was used in the calculation which is an applied horizontal force of 16% gravity. Additionally, JEG considered a variety of failure modes (both circular and block failure shapes) that had not been previously analyzed.

During construction of the disposal cell an interim winter cover was placed over the relocated tailings, consisting of vicinity property (VP) material. In the JEG analysis of 1994, a phreatic surface was modeled at an elevation of 7055, which is above the VP layer This elevation has also been determined to be the highest phreatic water surface elevation attainable without developing a seepage face (which would limit the phreatic water surface height to that elevation)[2] Additional conservatism is included here because the full thickness below elevation 7055 is modeled as fully saturated, as opposed to only modeling the perched water surface (saturated layer of soil at elevation 7055 to the top of the VP layer).

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[1] MKES Calculation No. 03-594-02-00, "Slope Stability Without Dewatering", March 1989, MKES Document No. 4005-DUR-C-01-03059-00.

[2] JEG Calculation DUR-05-94-12-06-00, "Determination of Maximum Allowable Long-Term Phreatic Surface", May 1994.

Slope stability results (factors of safety (FOS)) for analyses done by JEG are all above the minimum required FOS indicating that the eastern slope will remain stable when the phreatic water surface is at 7055.0 or below. It is my opinion that the work done by JEG is complete and valid and is current with today's engineering practice for slope stability.

Sincerely,

Gregory M. Smith

Gregory M. Smith, P.E.
Manager, Geo-Smith Engineering, LLC

NAVARRO

Navarro Research and Engineering, Inc.

JOB NO.:_____ DATE: 1/25/2016

JOB NAME: DURANGO DISPOSAL CELL - TRANSIENT DRAINAGE SYSTEM CLOSURE

PREPARED: DAN BRENNECKE REVIEWED: _____

SHEET NO.: 1/2

DETERMINATION OF TRANSIENT DRAINAGE SYSTEM CLOSURE PLUG SIZE

DETERMINE SIZE OF PLUG NEEDED AT END OF TOE DRAIN THAT WILL RESIST ANY HEAD PRESSURES CAUSED BY TRANSIENT DRAINAGE WITHIN THE CELL AFTER THE TOE DRAIN IS CLOSED

GIVEN

- 4/15/15 WATER ELEV @ MW-1 = 7049.91
- 4/15/15 WATER ELEV @ P7 = 7047.19
- INVERT ELEV OF TOE DRAIN WHERE DRAIN PENETRATES LINER = 7047.28 PER AS BUILT DWG # DUR-DS-10-0343
- TOE DRAIN IS 6"Ø PIPE

ASSUMPTION

BENTONITE CLAY PLUG UNIT WEIGHT = 115 #/CF

CALCULATE PRESSURE ON PIPE PLUG

W/ P7 WATER ELEV, HEAD ON PIPE PLUG = 7047.19 - 7047.28 = -0.09'

⇒ NO HEAD ON PLUG

W/ MW-1 WATER ELEV, HEAD ON PIPE PLUG = 7049.91 - 7047.28 = 2.63'

$$2.63' \times \frac{62.4\ \#}{ft^3} \times \frac{ft^2}{(12")^2} = 1.14\ psi \text{ ON PIPE PLUG}$$

6"Ø PIPE END AREA = $\pi r^2 = \pi (3")^2 = 28.3\ in^2$

∴ PRESSURE ON PIPE PLUG = $\frac{1.14\ \#}{in^2} \times 28.3\ in^2 = \underline{32.3\ \#}$ ←

NAVARRO

Navarro Research and Engineering, Inc.

JOB NO.: _____ DATE: 1/25/2016

JOB NAME: DURANCO DISPOSAL CELL - TRANSIENT DRAINAGE SYSTEM CLOSURE
DAN

PREPARED: BRENNECKE REVIEWED: _____

SHEET NO.: 2/2

CALCULATE SIZE OF PLUG NEEDED

VOLUME IN 6" Ø PIPE = $1' \times 28.3 in^2 \times \frac{ft^2}{(12")^2} = 0.20 \frac{ft^3}{LF}$

$115 \frac{\#}{CF} \times \frac{0.20 ft^3}{LF} = 23 \#/LF$ OF RESISTANCE PROVIDED BY CLAY PLUG WEIGHT ONLY IGNORING PIPE/PLUG FRICTION

∴ MIN PLUG LENGTH REQ'D = $32.3 \# \times \frac{LF}{23 \#} = 1.4'$ ←

10' LONG PLUG RESISTANCE = $10' \times \frac{23 \#}{LF} = 230 \#$

FACTOR OF SAFETY W/ 10' LONG PLUG = $\frac{230 \#}{32.3 \#} = 7.1$ ∴ OK

∴ USE A PIPE PLUG W/ A MIN OF 10' LENGTH ←

...vernment

...orandum

Department of Energy
Albuquerque Operations Office

MAR 23 1998

March 16, 1998

ERD:DF

Tramsmittal of the Durango CO, UMTRA Site "White Paper"

Jack Tillman, Manager, DOE Grand Junction Office, Grand Junction, CO.

The attached "White Paper" was produced by the Jacobs Engineering Group, INC., Albuquerque Operations, at the request of former UMTRA emloyee, Sharon Arp.

UMTRA management agrees with the RAC and TAC accords concernings the recommendations contained within the "White Paper". UMTRA management also agrees all activities regarding the Durango UMTRA Site be transfered under GJO jurisdiction.

The UMTRA Office has the following recommendations concerning the Durango UMTRA Site.

Recommendation 1
GJO should decide if Sandia National Laboratories Iron Filings Experiment should continue to be performed under the Groundwater Project. GJO should understand if the experiment is continues, the (1) drain closure will be delayed, and (2) GJO would, in all likelihood, have to apply for a storm water permit.

Recommendation 2
GJO should be responsible for implementing and executing the Drain Closure Procedure for the Durango UMTRA Site.

Recommendation 3
GJO should be responsible for removal and disposition of the Durango UMTRA Site retention basin.

Recommendation 4
GJO should be responsible for formally requesting the RAC terminate the present CDPHE water discharge permit for the Durango UMTRA Site.

If you have any questions, please call Drew Fuller at 505-845-4033.

Frank Bosiljevac
UMTRA Team Leader
Environmental Restoration Division

pencer, RAC
. Pinkel, TAC
D. Metzler, GJO

JACOBS ENGINEERING GROUP INC., ALBUQUERQUE OPERATIONS

LTSM002946

TO: Frank Bosiljevac, UMTRA Team Leader, ERD

FROM: Ed Artiglia, Deputy Project Manager, TAC

DATE: MAR 10 1998

SUBJECT: Transmittal of Durango White Paper
Contract No. DE-AC04-91AL62350

The attached "White Paper" was produced at the request of Sharon Arp. She asked the TAC to provide additional information about the Durango cell toe drain and the details for the application of the closure criteria in the LTSP. She wanted to deliver this information to the Grand Junction Office (GJO) for their use. The RAC and TAC have reached an accord concerning the contents of this paper.

It is my understanding that once this paper was finalized, Sharon intended to transmit it to GJO with the recommendation that the drain closure procedure should be implemented. The GJO would be responsible for closing the drain and removing the retention basin(s). The RAC will terminate the CDPHE water discharge permit.

If GJO wants to continue the Sandia National Laboratory's Iron Filings Experiment, then it should be performed under the Groundwater Project. If this project is continued, GJO will need to apply for a storm water permit if they intend to discharge any water. If the experiment is continued, it will delay closure of the drain until the experiment is completed.

If you have any questions or comments concerning the attached White Paper, or would like additional help in transferring this information to GJO, please contact me.

SWC:LM
Attachment

cc w/attachment:
L. Pinkel, TAC
S. Cox, TAC
L. Maez, TAC
Document Control

LDUR

530.02

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RODUCTION

The purpose of this document is to provide additional information to the Grand Junction Office (GJO) about the Durango cell toe drain and to provide details for application of the closure criteria in the LTSP. This information should help GJO assess the performance of the cell during the toe drain closure period. This information includes a history of the toe drain construction, a general description of the cell modeling, the results of water level and flow monitoring, a description of how this information has been used, and suggested courses of action for the future.

HISTORY

The following history is summarized in other locations, but is presented here for completeness. Details concerning some of the events discussed can be found by searching the references listed in the following section.

The design of the Durango cell was started in the early 1980's, and the remedial action at the processing site was started in June 1985. In September 1987, the EPA Draft Standards for groundwater were issued. In October 1987, remedial action was begun at the Durango disposal site. A meeting was held in February 1988 to discuss the impact of the groundwater standards on cell design and the existence of transient drainage in UMTRA cells was discussed. Transient drainage modeling was performed for the Green River cell in April 1988, resulting in modifications to the design. Remedial action at the Green River disposal site was started in September 1988.

The point of this is that the design of the Durango cell was substantially complete before the groundwater standards were issued and before transient drainage was ever considered. The groundwater protection strategy used for Durango was to meet proposed concentration limits based on groundwater dilution of the seepage from the Durango cell. A low permeability liner was installed to slow seepage. The specifications called for a winter cover of low permeability to be placed prior to the winter shutdown to limit infiltration of surface runoff. A layer of low permeability VP material was used. Because of possible freezing, and to enhance bonding along the interface, the specifications required the upper six inches of this material to be ripped and recompacted during spring construction startup. Thus there is some likelihood that it is not continuous across the cell area. Significant amounts of water (estimated at 80,000 gallons/construction day) were applied for dust control.

In late September 1988, about a year after construction had started and about the time tailings placement was completed, a seep was observed on the east side of the Durango embankment. Monitoring wells were placed in the embankment to determine the areal extent of the saturation and to determine the saturated depth. Dewatering wells were installed in the spring and summer of 1989 and a total of 730,000 gallons of water was removed by November 1989 with this system. Additionally, a number of piezometers were installed to provide information on the effectiveness of the dewatering system. Yields from the dewatering wells decreased and it was determined this method of dewatering would not be sufficient. Anomalous information concerning saturation depths was noted during construction of both the monitoring and dewatering wells and pump tests were inconclusive. Some logs report the winter cover layer, others do not. There are logs and well completion reports for some the wells shown on the

ures in the report; available from MKES. (Well depths are indicated on cross-sections included in the 1989 MK report, however they should not be considered accurate.)

Because of the lack of success with the dewatering wells, a toe drain was designed and installation was begun in September 1989. It was during this construction that the anomalies encountered during well construction were explained. The excavation showed that the low permeability winter cover had remained in place and that the tailings above it were saturated. Below this layer the tailings were not saturated. Excavations did not extend to the clay liner, so saturation conditions at this depth were not determined.

Once the toe drain was installed and the high flow rates showed its effectiveness, the concern turned to how long it would need to remain open. Water balance calculations were performed, but the problem of transient drainage had not been defined. A 1990 modeling effort was performed to verify that transient drainage was the cause of the large amount of water and also had two other purposes. The first was to determine if the transient drainage was likely to create mounding in the alluvium below the cell, causing problems in meeting the proposed concentration limits of the groundwater protection strategy. The second was to get an idea of how long the toe drain would need to operate so that its closure would not cause further seepage. The time of toe drain operation was a concern because it was thought that it would prevent licensing of the site. This modeling effort is discussed in more detail in a later section.

All but five of the monitoring wells and piezometers were abandoned when the dewatering wells were removed in Spring 1990. The four wells left in service were MW1, MW2, MW3 and MW7. Piezometer P7, located very close to the toe drain, was also left in place. Since MW2, MW3 and MW7 were completed near the surface of the tailings and a decision was made not to extend the wells through the cover, pressure transducers were installed in these wells for measuring water levels and the wells were sealed and plugged. Water level measurements from MW2, MW3 and MW7 were obtained until Fall 1990 when the transducers failed.

Water levels readings were continued in MW1 and P7, until the P7 datalogger failed in October 1997. Water levels have also been read in the toe drain's North Vent Pipe (NVP). The readings from P7 and the NVP show water buildup in the toe drain during outlet valve shutdown periods, and an overall decrease in water level in MW1. Readings at these locations were taken manually until September 1993 when dataloggers were installed in these locations. Manual measurements were also taken of flow from the toe drain through this period. Toe drain flow measurements were made using large containers and wristwatches, and are therefore not considered to be precise. In December 1994 a totalizing flow meter was installed at the outlet of the toe drain. This flow meter was circumvented when the Sandia experimental water treatment system was installed in 1995. Flows since that time have only been measured manually and total discharge has not been measured. The dataloggers were last downloaded on January 28, 1998. Plots of datalogger data are included in the appendix of this report.

Information in the 1989 MKES report on the toe drain indicates that MW1 was completed above the level of the winter cover. However, there is conflicting information concerning the elevation of the winter cover in the vicinity of MW1 and it may be completed below the winter cover. Well completion records show that P7 is completed at the top of the clay liner. The screen extends from elevation 7043.3 ft to 7053.3 ft; the bottom of the seal is location at elevation 7056.1 ft. The winter cover was not noted in this boring. This is congruent with the discovery during the toe drain construction that the winter cover is not continuous. Information on the construction of

the toe drain and the NVP is also relatively complete. Based on this, P7 and the NVP are the most reliable indicators of the water level. With the recent failure of the datalogger in P7, the NVP is the most reasonable indicator of water levels within the toe of the cell. We suggest that GJO remove, repair, and reinstall the datalogger in P7 for continuity of data from the Durango toe drain.

REPORTS AND STUDIES

A report on the status of the investigation and action taken to address the problem of the seep was delivered by the RAC in December 1989. It included details of the toe drain construction and water balance calculations.

In 1990, the TAC completed two-dimensional UNSAT2 modeling of the cell. It indicated that the toe drain would need to operate for about 10 years to lower the water level so that a seep would not form after toe drain closure. Details of the modeling are discussed in the next section.

In 1992 the TAC was asked to reassess when the toe drain could be shut off. The TAC conducted an analysis of the drain operation and recommended that field tests be conducted to determine whether water levels had dropped sufficiently to meet closure criteria. Results indicated that water levels were still too high. An analysis of the toe drain discharge records revealed that more water had drained from the tailings than had been estimated to be drainable in the 1989 study.

In 1993 and 1994 the TAC ran a second two-dimensional UNSAT2 model and re-evaluated the maximum allowable height to which the perched water table could rise to without causing seeps from the pile during the design life and without exceeding the pile design slope stability criteria. A level of 7055 feet in the NVP met these conditions. A water balance calculation was performed during the same timeframe that showed 2 to 4 million gallons of water remaining to be drained from the cell as of Fall 1994.

As part of the evaluation of the toe drain, it was suggested that the possibility of recharge from cover infiltration be examined. To determine this, recharge testing was conducted in Fall 1993 through Summer 1994. Recharge curves from toe drain monitoring (NVP) showed no variation as a result of precipitation events nor was there a significant difference between seasons. Therefore cover infiltration was indicated not to have a significant effect on the toe drain discharge.

Settlement of the cover was assessed at the same time. The settlements measured were very small and no cover cracking should have occurred as a result of differential movement, further supporting the determination that infiltration through the cover has not significantly affected the quantity of water in the cell.

CALCULATIONS AND MODELING

The following list provides calculation and study numbers and titles to allow easier reference to documents concerning the Durango toe drain. A summary of the information provided and a discussion of its limitations is also provided for each calculation/study.

MKES 4005-DUR-R-01-03868-00
Results and Impacts of Dewatering Investigations in October 1989
This reports provides a discussion of the dewatering activities at Durango and describes the construction of the toe drain, with accompanying figures and photographs. The purpose of this report was to provide an update on the dewatering activities and to describe test pit investigations and the toe drain excavation.

This report estimates approximately 2 million gallons of drainable water in the cell at the end of construction. This estimate was based on the saturated volume at the time of cell completion. It did not account for transient drainage as unsaturated flow had not previously been considered as being significant.

MKES, November 1990
Dewatering of the Durango Disposal Cell
This paper was presented at the American Institute of Chemical Engineers, National Meeting, Chicago, Illinois.

DUR-09-90-12-01
Modeling of Transient Drainage
Performed a year after installation of the toe drain, this calculation was performed to determine if transient drainage could be responsible for the appearance of the seep, if the transient drainage would affect the groundwater protection strategy, and approximately how long the toe drain would need to operate. The calculation verified that transient drainage could account for the seepage observed, that it would not cause mounding in the alluvium below the cell, and it predicted that the toe drain would need to operate about 10 years.

This modeling did not take into account three-dimensional effects of the cell. It did not use monitor well readings as benchmarks to verify model accuracy. Toe drain flow volumes from the model that were compared with monitored flows for model calibration were approximated using the length of the toe drain, not the total length of the cell. This could result in an under-prediction of the time of transient drainage. Because of these factors, this model should not be relied upon to give precise indications of when the cell may be closed nor should it be used to determine allowable water levels within the cell at the time of closure. It does provide verification that significant water quantities are the result of transient drainage and are not due to water sources beyond the cell or cover failure. The modeling also provides a general estimate of the time required for transient drainage; that it will be about 10 years as opposed to 50 or 100 years.

DUR-05-94-12-06-00
Determination of Maximum Allowable Long-Term Phreatic Surface
This calculation established that the phreatic surface measured in the NVP could reach an elevation of 7055 feet, about 3 feet higher than the clean fill dike, without causing seepage to occur from the toe of the disposal cell. It also examined the effects of anisotropic hydraulic conductivity in the cover layers. It was not intended to model the entire cell, but only to look closely at water levels within the immediate vicinity of the toe of the cell.

In order to have a finite element grid fine (i.e., small) enough to look closely at the phreatic surface at the toe, it was necessary to model only a small part of the cell. By doing this, the

influence of the cell behind the end of the grid can only be approximated by boundary conditions, affecting how pressure heads are developed during time steps.

Furthermore, the phreatic surface behind the location of the toe drain was set as being level, though its elevation was varied through a range to determine the maximum allowable elevation. Recent examination of the much larger 1990 modeling grid has verified that the phreatic surface beyond MW1 is probably not level; its slope closely follows the slope of the winter cover.

This 1994 model did not attempt to predict the time of transient drainage and can not be used for this purpose. The water level established can be used as a maximum allowable level for water in the NVP during the closure period.

DUR-08-94-12-05
Re-evaluation of Drainable Water Volume as of Fall 1994
This calculation was performed to re-evaluate the amount of drainable water within the disposal cell. The original calculation by MKES was based on the data available at that time and did not account for drainable water in the unsaturated volume of the cell. This calculation found that as much as 2 to 4 million gallons of water remained to be drained as of Fall 1994.

This calculation provided verification that significant quantities of water could still be in the cell and that continued operation of the toe drain was required past this date. This type of calculation is cannot be used to predict a time for closure of the toe drain.

DUR-09-94-03-01
Slope Stability Analysis With Phreatic Surface At 7055 Feet
This calculation verifies that the embankment will remain stable, both statically and under seismic loading, with the phreatic surface at the 7055-foot elevation in the North Vent Pipe.

DUR-02-95-12-06
Evaluation of Maximum Phreatic Surface
This calculation extends DUR-05-94-12-06-00, by additional evaluation of anisotropy in other layers of the disposal cell. It also contains a discussion of toe drain closure and uses recorded data and predictions of flow rates from DUR-09-90-12-01 to predict when the toe drain should be ready for closure (June 1997). This prediction is based on a variety of data sources, but relies most heavily on water level monitoring data and the shape of toe drain recharge curves.

PEOPLE

A number of people have had significant involvement in the on-going toe drain effort. The following list may not be comprehensive, but it names the major contributors.

RAC
Marjorie Wesley - Primary author of *Results and Impacts of Dewatering Investigations in October 1989*

PK Chen - Reviewer and Principal Engineer for MKES

Frank Guros - Senior Engineer and reviewer of calculations for MKES

Chris Weston - MKF field technician involved in opening and closing of toe drain outlet valve, treatment of discharge, and monitoring prior to datalogger installation

Derek Bolton (Office), Mark Thompson (Field) - RAC Site Managers

TAC
Ned Larson - Directed the 1990 modeling effort based on new consideration of transient drainage.

Barbara Bridgeman - Performed 1990 *Modeling of Transient Drainage*, 1995 *Evaluation of Maximum Phreatic Surface*, and was primary figure in examining datalogger information and developing closure plan.

Bob Meyers - Performed 1994 *Determination of Maximum Allowable Long-Term Phreatic Surface, Re-evaluation of Drainable Water Volume as of Fall 1994*, and *Slope Stability Analysis With Phreatic Surface At 7055 Feet.*

George Hartmann - Instrumental in getting dataloggers placed in wells and documenting the changes made during the installation of the Sandia experimental water treatment system.

John Lommler - Primary review and principal engineer since 1992.

Russell Edge, Ed Artiglia, Steve Cox - TAC Durango Site Manager

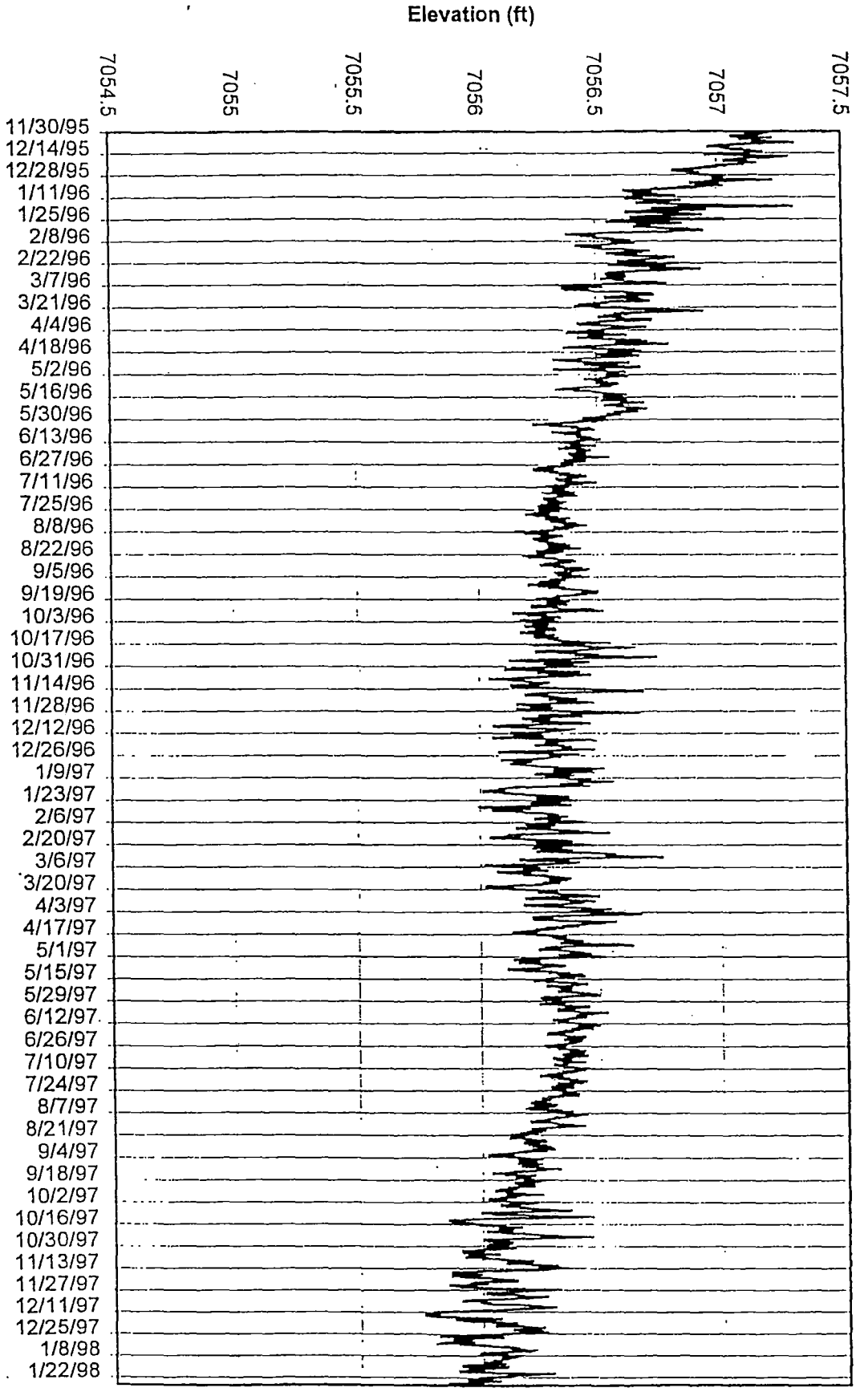
CLOSURE PLAN

The closure plan for the toe drain is presented in the LTSP. Basically, it calls for the toe drain valve to be closed for two years, with datalogger water level downloads to be taken at six-month intervals during that time, prior to abandonment and sealing. The purpose of the monitoring period is to verify, prior to full closure, that equilibrium of the phreatic surface has been reached at an elevation that will not cause surface seepage from the toe of the cell. While a water elevation reading of 7055 feet is given in the LTSP as the maximum measurement prior to finalizing closure procedures, it does not specify which location should have this reading. TAC 1994 modeling intended that the water elevation of 7055 feet be achieved in the toe drain, so we recommend that the NVP data be used to compare to this benchmark elevation.

Figures 1, 2 and 3 show the most recent data from the NVP, P7 and MW1 dataloggers, respectively. This data, as well as past monitoring of the toe drain during winter shutdown and testing performed in 1993 and 1994, indicates that water levels rise fairly quickly in the NVP and P7 when the toe drain valve is closed. A second order polynomial trendline matches the current data closely, showing the curves for both the NVP and P7 leveling off below 7055 ft. In recent time, MW1 does not show a similar quick response. Data since 1996 shows a logarithmic decline in the level of MW1, even during shutdown periods. However a slight rise in MW1 near the end of the most recent shutdown period may indicate a late response. However, its level is well above the 7055 ft. mark and will not become significantly lower than that for a long period according to the trendline prediction. Based on this analysis, it has been recommended by the TAC that the closure period can be initiated now.

While actual monitoring results are unlikely to match the projected trendlines generated from the current data, a trendline analysis should be performed each time data is gathered during the pre-closure monitoring period. Polynomial trendlines have been used in the past as they more closely follow the data. A trendline prediction of water levels greater than 7055 ft in either the NVP or P7 using this method would indicate the need for re-opening the toe drain for a six-month period and new initiation of the pre-closure monitoring period. A two-year monitoring period with continuously rising data, even if values are still below 7055 ft and the trendline shows the water level staying below 7055 ft, would be problematic and would suggest additional monitoring until water levels stop increasing before final closure. Prior to final closure and abandonment of the toe drain, water levels at all three monitoring locations should be at least level, preferably declining.

The Sandia experiment was continued in the summer of 1997. It is not known how much water was released during this period. If the Sandia experiment is to be continued in 1998, the toe drain closure period can not be started until after the experiment is complete. If the Sandia experiment is not to be continued in 1998, the two-year closure period can be begun retroactively at the time the valve was closed for winter shutdown. Alternatively, the closure period can begin now, at some arbitrary date selected for the monitoring period.


Elevation (ft)
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7055
7055.5
7056
7056.5
7057
7057.5
11/30/95
12/14/95
12/28/95
1/11/96
1/25/96
2/8/96
2/22/96
3/7/96
3/21/96
4/4/96
4/18/96
5/2/96
5/16/96
5/30/96
6/13/96
6/27/96
7/11/96
7/25/96
8/8/96
8/22/96
9/5/96
9/19/96
10/3/96
10/17/96
10/31/96
11/14/96
11/28/96
12/12/96
12/26/96
1/9/97
1/23/97
2/6/97
2/20/97
3/6/97
3/20/97
4/3/97
4/17/97
5/1/97
5/15/97
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6/12/97
6/26/97
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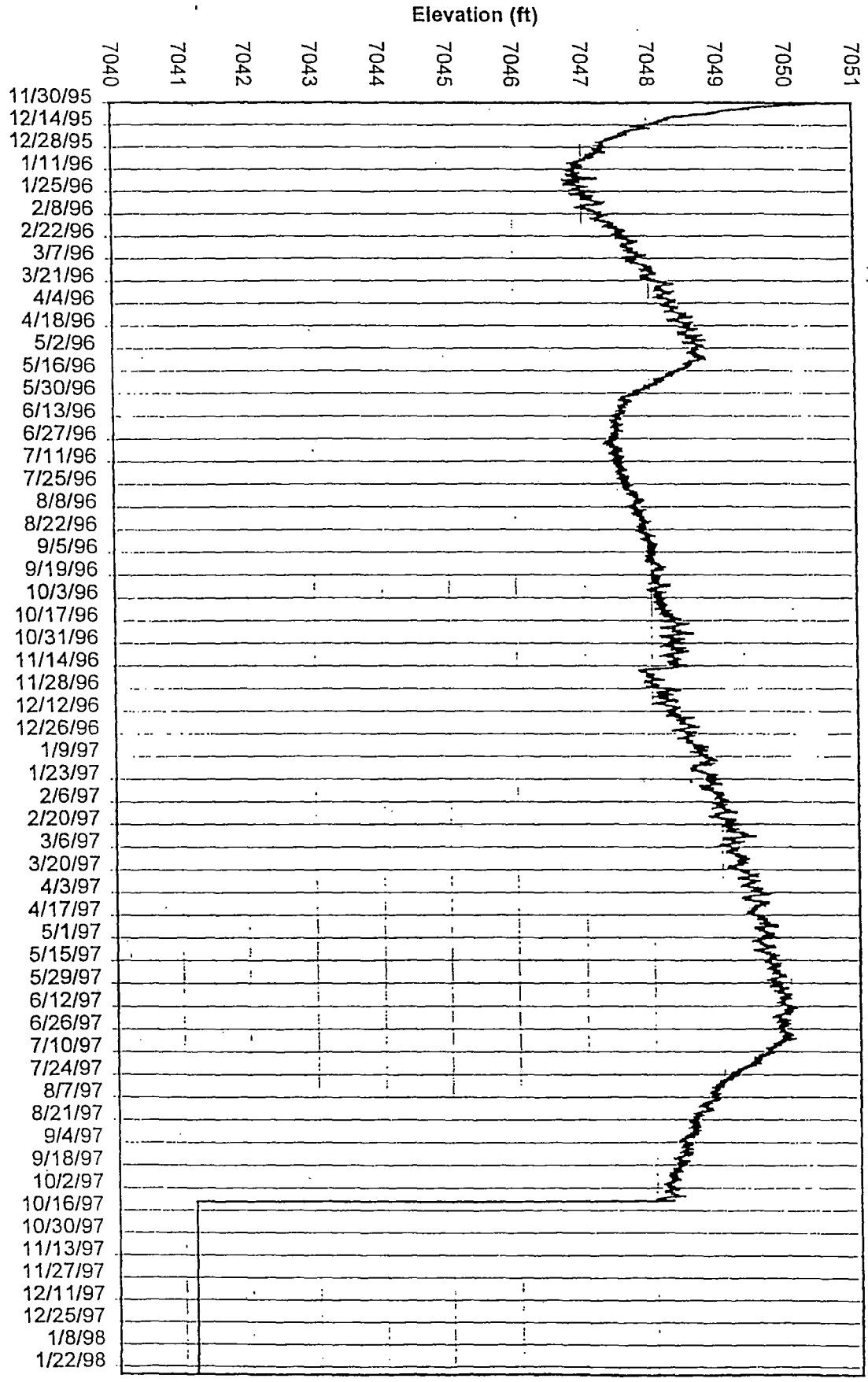
7/24/97
8/7/97
8/21/97
9/4/97
9/18/97
10/2/97
10/16/97
10/30/97
11/13/97
11/27/97
12/11/97
12/25/97
1/8/98
1/22/98

DURANGO- MW1


Elevation (ft)
7040
7041
7042
7043
7044
7045
7046
7047
7048
7049
7050
7051
11/30/95
12/14/95
12/28/95
1/11/96
1/25/96
2/8/96
2/22/96
3/7/96
3/21/96
4/4/96
4/18/96
5/2/96
5/16/96
5/30/96
6/13/96
6/27/96
7/11/96
7/25/96
8/8/96
8/22/96
9/5/96
9/19/96
10/3/96
10/17/96
10/31/96
11/14/96
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12/26/96
1/9/97
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4/17/97
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5/15/97
5/29/97
6/12/97
6/26/97
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7/24/97
8/7/97
8/21/97
9/4/97
9/18/97
10/2/97
10/16/97
10/30/97
11/13/97
11/27/97
12/11/97
12/25/97
1/8/98
1/22/98

DURANGO-P7

Summary of White Paper for Closure of Bodo Canyon Toe Drain and Permit Termination

Jacobs Engineering developed a white paper at the request of Sharon Arp, UMTRA, ERD, DOE-AL.

UMTRA management agrees with the content, recommendations, and transfer of all activities regarding the Durango UMTRA Site to DOE-GJO.

Recommendations:

1. GJO should decide if the SNL experiment should be continued. (we decided it should) GJO should understand if the experiment continues drain closure will be delayed, and GJO would have to apply for a storm water permit. (I do not understand why GJO would need to apply for a storm water permit as opposed to transferring the waste water permit. I could guess that Jacobs thought that by this time the water discharging would meet clean water criteria?? I do not think that is the case, however.)

2. GJO is responsible for implementing this drain closure procedure.

3. GJO is responsible for removal and disposition of the retention basin.

4. GJO is responsible for requesting that the RAC terminate the present CDPHE water discharge permit for the Durango UMTRA Site.

The design of the Bodo Canyon cell was substantially complete before the new groundwater standards were issued and before transient drainage was a consideration.

Studies were conducted following identification of a seep in the disposal cell as a result of transient drainage. Subsequent placement of a toe drain as a mitigation measure followed. This action included monitoring toe drainage water levels in nearby wells, and checking transient drainage versus storm water contributions. This lead to additional studies of water levels in wells which would negatively impact the integrety of the cell, amount of water remaining in the cell, slope stability with phreatic surface maintained below 7055 ft in the North Vent Pipe,and duration of drainage required to ensure well levels remain below 7055 ft, were conducted between 1989 and 1995.

The resulting closure plan presented in the LTSP calls for the toe drain to be closed for two years with datalogger water level info downloaded every 6 months, prior to full closure (i.e., abandonment and sealing). The purpose of the monitoring is to ensure that equilibrium of the phreatic surface is reached at an elevation that will not cause seepage from the toe of the cell (i.e., 7055 ft.). TAC 1994 modeling intended the maximum water elevation to be achieved in the toe drain, so they recommend the NV pipe data be used to track this elevation.

It is believed that toe drain closure and monitoring can begin anytime, based on the most recent data. However, if polynomial trendline prediction of data for NVP or P7 indicate that the water elevation will exceed 7055 ft. in either well, the toe drain will need to be reopened for a 6 month period and the pre-closure monitoring period will need to be restarted.

A two-year monitoring period with continuously rising water elevations, even if the values are still below 7055 ft. and the trendline shows the water staying below this elevation should be considered problematic, and would suggest continued monitoring until water levels stop increasing before final closure.

It appears that no matter what, following closure of the valve, we have a minimum of two more years of trending the data before the drain can be sealed and we can remove the basin. I should think that just in case we need to discharge during that time period, we would keep the permit active.