

UMTRA PROJECT - FOLS CITY

BOOK I Subcontract Documents

Revised in accordance to approved PID Nos. 1 through 7 as follows:

<u>PID No.</u>	<u>Changes</u>
1	Incorporation of Addenda Nos. 1, 2, 4, 6, 8, 9, 10, 12 and 13 to Request for Proposal.
2	Revision of Safety and Health Training Requirements to Special Condition SC-7 and Relocation of a Barbed Wire Fence (Dwg. Nos. FCT-PS-10-0404, 0415).
3	Reconstruction of the Existing Berms to Pile Nos. 2 and 7 Along Farm Road 1344 and Northwest Side Slope of Pile No. 7 (Dwg. Nos. FCT-PS-10-0408, 0412).
4	Monitoring of Settlement of the Tailings Embankment (Dwg. No. FCT-PS-10-0411).
5	Abandonment of Additional Wells in Specification Section 02090. Wells locations added to Dwg. Nos. FCT-PS-10-0403, 0417.
6	Organic Content and Gradation Requirements in Specification Section 02200, Earthwork.
7	Scarification of Tailings Embankment Subgrade, Specification Section 02200 3.7.D.

BOOK II 1. Response to NRC Open Issues Regarding the Final RAP

Revise RAIP to include additional PI values determination for radon barrier (per Open Issue No. 11) and gradation tests for relocated tailings (per Open Issue No. 25[2]).

2. Calculations

- a. Revised Table of Contents, Page 1 (Vol. I, II, III).

Mark "SUPERSEDED" previously issued copies and replace with enclosed copy.

- b. Embankment Design - Material Properties for Radon Barrier Design, Revision 2 (Calc. No. 20-438-03-02).

Mark "SUPERSEDED" previously issued copies of Calc. No. 20-438-03-01 and replace with enclosed copy in Calculation Vol. I.

- c. Radon Barrier Design - Sensitivity/Statistical Analysis (Calc. No. 20-439-03-00).

New Calculation. Add enclosed copy to Calculation Vol. III.

CALCULATION VOL. IV

NOTICE OF LIMITED DISTRIBUTION

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

FINAL DESIGN FOR CONSTRUCTION

FALLS CITY

CALCULATION INDEX

Calculation No.

Title

VOLUME I - PERMANENT FACILITIES

20-434-01-01	Confined Material Excavation - Excavation Extent and Depth
20-434-02-01	Tailings Excavation - Excavation Quantities
20-435-01-00	Probable Maximum Precipitation Estimate
20-438-01-02	Embankment Design - Geotechnical Properties
20-438-02-02	Embankment Design - Pile Capacity Determination
20-438-03-02	Embankment Design - Material Properties for Radon Barrier Design

VOLUME II - PERMANENT FACILITIES

20-438-04-03	Embankment Design - Liquefaction Analysis
20-438-05-02	Embankment Design - Slope Stability Analysis
20-438-06-03	Embankment Design - Settlement Analysis
20-438-07-00	Embankment Design - Geotechnical Profiles
20-438-08-00	Tailings Pile - Perched Water

VOLUME III - PERMANENT FACILITIES

20-439-01-02	Radon Barrier Design - Radium Content and Embankment Geometry
20-439-02-02	Radon Barrier Design - Radon Barrier Thickness
20-439-03-00	Radon Barrier Design - Sensitivity/Statistical Analysis
20-440-03-00	Disposal Cell - Cover Design, Erosion Protection
20-440-04-00	Erosion Protection - Evaluation of Rock for Riprap at Falls City Disposal Site
20-444-01-03	Summary of Quantities

FINAL DESIGN FOR CONSTRUCTION
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CALCULATION INDEX

Calculation No.

Title

VOLUME IV - TEMPORARY FACILITIES

20-433-01-00	Retention Basin - Sediment Volume
20-433-02-00	Site Hydrology - Temporary Drainage
20-433-03-00	Retention Basin - Berm Stability
20-433-05-00	Temporary Drainage - Drainage Ditch Design
20-433-06-01	Retention Basin - General
20-433-07-00	Retention Basin - Spillway
20-486-02-00	Wastewater Handling and Water Balance II - Treatment/Evaporation/Irrigation Schemes
20-486-03-00	Evaporation Pond - Spillway Sizing
20-436-01-00	Dewatering of Pile 7
20-460-01-00	Road Crossing at FM 1344 - Asphalt Concrete Pavement Design
20-461-01-00	Water Storage Reservoir - Capacity and Dimension Calculation
20-435-02-00	North-East Drainage Area - PMF Level at South Culvert (FM 1344)

Calculation Cover Sheet

Contract No. 5057Discipline CIVILCalc. No. 20433-01-00No. of Sheets 29

Project

UMTRA - FALLS CITY

Feature

RETENTION BASIN

Item

SEDIMENT VOLUME

Sources of Data

Sources of Formulae & References

See sheet - 28Preliminary Calc. ☐Final Calc. ☒

Supersedes Calc. No. _____

0		<u>D. Monette</u>	<u>1/22/88</u>	<u>M. POPPEL</u>	<u>2-6-88</u>	<u>[Signature]</u>	<u>1-21/88</u>
Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



MORRISON-KNUDSEN ENGINEERS, INC.

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Project ULTRA-ECT
Feature RET. BASINS -
Item SED. VOLUME

Contract No. 5057
Designed BRM
Checked msf

Sheet 1
File No.
Date 1/22/88
Date 2-8-88

TABLE OF CONTENTS

- I. PURPOSE
- II. METHOD
- III. ASSUMPTIONS AND BASIS FOR CALCULATION
- IV. CALCULATION

1. General

- A. Rainfall Factor R
- B. Soil Erodibility Factor K
- C. Topographic Factor LS
- D. Erosion Control Factor VM

PARCEL A :

2. Sediment Volume - Retention Basin No. 1
3. Sediment Volume - Retention Basin No. 2
4. Sediment Volume - Retention Basin No. 3
5. Sediment Volume - Retention Basin No. 4

PARCEL B : (NO-USED 7-20-88)

6. Sediment Volume - Retention Basin No. 5
7. SUMMARY





MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTA-FCT
Feature ACT. BASINS
Item SED. VOLUME

Contract No. 5657

Designed KLP

Checked KLD

Sheet 1 A

File No.

Date 6-11-88

Date 7/11/88

The layout of temp. drainage facilities have changed since this calc was done. The total drainage area (Parcel A) (not incl. basin surface area) has been reduced to 181.9 Ac. The sediment flow paths & other parameters are basically unchanged. The length of time (T) that sediment contributes to the basin is reduced to 1.6 yr.

(2.5 yr total time from start up to completion of embankment erosion protection, conservative)

= 11.3 MO (time to construct basin; prior to this no flows will be collected except that which falls directly on pile 4 or pond 6.)

REVISED SEDIMENT VOLUME

$$\text{PARCEL A} = 16.4 \text{ ACFT} \left(\begin{array}{l} \text{OLD VOLUME} \\ \text{BAS 1-4} \end{array} \right) * \frac{181.9 \text{ AC}}{205.3 \text{ AC}} * \frac{1.6 \text{ yr}}{2.0 \text{ yr}} \begin{array}{l} \text{NEW CONST.} \\ \text{TIME} \\ \text{OLD} \\ \text{CONST} \\ \text{TIME} \end{array}$$

(OLD AREA OF BAS 1-4)

$$= 11.6 \text{ ACFT}$$

Note: during excavation Piles 4+3 will drain to a sump within the pile. These sumps will receive flows from their respective piles only. ∴ sediment volumes for piles 4+3 are already included in the quantities for excav. of contaminated material.





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RET. BASINS -

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SED. VOLUME

Contract No.

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MIF

Sheet

2

File No.

Date

1/22/88

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1-1-88

I. PURPOSE

The purpose of this calculation is to estimate volume of sediment expected to collect in the retention basins during the construction period.

II. METHOD

The modified universal soil loss equation was used to estimate an average annual sediment delivery rate. The equation is expressed as

$$A = R * K * LS * VM \quad (REF. 1)$$

In which:

A = computed amount of soil loss per unit area for the time interval represented by factor R, generally expressed as tons per acre per year.

R = Rainfall factor in tons per acre per year

K = Soil erodibility factor in tons per acre per year per unit of R

LS = Topographic factor (dimensionless)

VM = Erosion Control Factor (dimensionless)





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1/22/85

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1-1-85

II. METHOD (CONT'D)

The average annual erosion rate (A) was determined and multiplied by the drainage area and the estimated construction period (T) and divided by an assumed sediment density (γ). For this calculation, the sediment density was assumed to be 50 pcf. The equation for calculating the sediment volume (VOL) is:

$$VOL = A * Area * T * \frac{1}{\gamma} * 2000$$

III. ASSUMPTIONS AND BASIS FOR CALCULATION

1. Sediments draining from the tailings piles will be contained in the retention basins for the full construction period.
2. Construction is expected to begin in 1990. Duration of construction is expected to be 18 to 24 months (ref. 2). No winter shut down is anticipated.
3. The areas included in the 10 yr, 24 hr design storm calculation (calc no. 20-412-00-00) are assumed to be appropriate for this calculation.
4. An assumed average slope configuration and soil type will be used to estimate the soil erosion rate (A).





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Project UMTRA - FCT Contract No. 5057 Sheet 4
Feature RET. BASINS - Designed DRH File No.
Item SED. VOLUME Checked MJP Date 1/22/88
Date 3-8-88

III. ASSUMPTIONS AND BASIS (CONT'D)

5. The retention basins should have enough capacity to hold all sediment inflow for the entire construction period. However, if the estimated sediment volume is excessive, the retention basins will have capacity to hold all sediment inflow for one year only (ref. 2). Contract specifications will contain a provision to remove sediments when the sediment volume becomes excessive.

IV. CALCULATION

1. GENERAL

- A. Rainfall factor R was determined from ref. 1, Figure 5-2 (see slt. 16).

$$R = 230$$

- B. Soil Erodibility Factor K was determined from ref. 1, Figure 2-2 (see slt. 22).

- Estimated values for sand (0.1-2.0 mm) and fine sand and silt (0.002-0.1 mm) were determined from the grain size distribution curves presented on sheets 17-21. It was assumed that these gradations were representative of tailings soils.





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File No.

Designed DBM

Date

1/22/88

Checked MJP

Date

2-8-88

1. (CONTINUED)

- From these curves average values were determined:

SAND - 56%

Fine Sand & Silt - 44%

- No vegetative cover was assumed in calculating K .
- The permeability was assumed to be slow to moderate (No. 4 in Fig. 2-2)
- The soil structure was assumed to be fine granular material (No. 2 in Fig. 2-2)
- From Fig. 2-2, K was estimated to be:

$$K = 0.42 \frac{\text{tons}}{\text{acre-yr} - R}$$





Project

ULTRA-RET

Contract No.

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Sheet

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RET. BASINS -

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DRT

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Date

2.8.88

1. (CONTINUED)

C.

- The topographic factor, LS was determined from the equation:

$$LS = \left(\frac{l}{72.6} \right)^m \left(\frac{65.41 s^2}{s^2 + 10,000} + \frac{4.56 s}{\sqrt{s^2 + 10,000}} + 0.065 \right)$$

in which

. (2-3)

LS = topographic factor

l = slope length in feet

s = slope steepness in percent

m = exponent dependent upon slope steepness
 (0.2 for slopes < 1 percent, 0.3 for slopes 1 percent to 3 percent, 0.4 for slopes 3.5 to 4.5 percent, and 0.5 for slopes > 5 percent)

REF. 1

- An area weighted average was used to determine LS. The average value LS_{avg} was determined from the equation:

$$LS_{avg} = \frac{\sum (LS_i * A_i)}{\text{Total Area}}$$

LS_i = topographic factor determined by assuming an average slope configuration for a representative area.

A_i = representative area in acres





Project UMTRA-ECT
 Feature RET. BASINS -
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1. (CONTINUED)

- D.
- An average erosion control factor $VM_{AVG.}$ was determined from Table 2-2, ref 1 (see s. 23) for the final embankment area (piles 1, 2, 7), and areas to be excavated only (Piles 3, 4, 5).
 - VM_{AVG} for final embankment area :

<u>SOIL CONDITION</u>	<u>VM</u>
Compacted Fill	1.24 - 1.71
Rough, irregular tracked all directions	0.90
Undisturbed except scraped	0.66 - 1.30

$$VM_{AVG.} = 1.10$$

- $VM_{AVG.}$ for areas to be excavated only :

<u>SOIL CONDITION</u>	<u>VM</u>
Rough irregular tracked all directions	0.90
Undisturbed except scraped	0.66 - 1.30

$$VM_{AVG.} = 0.95$$





Project

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Feature

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SED. VOLUME

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File No.

Date 1/22/82

Date 2-8-84

PARCEL A2. SEDIMENT VOLUME - RETENTION BASIN No. 1LS_{AVG}:

- assumed average slope configurations and representative areas are shown on sheets 24-27.

<u>Area (acres)</u>	<u>L (ft)</u>	<u>Avg. % slope</u>	<u>m</u>	<u>LS</u>	<u>LS * Area</u>
6.4	1050	3.0	0.3	0.6	3.8
11.5	850	3.9	0.4	0.9	10.4
5.4	950	2.2	0.3	0.4	2.2
15.4	600	5.4	0.5	1.4	21.6
total = 38.7					

$$\Sigma (LS * Area) = 38.0$$

$$LS_{AVG} = \frac{\Sigma (LS * Area)}{\text{total Area}} = \frac{38.0}{38.7} = 1.0$$

AVERAGE EROSION RATE = A:

$$A = R * K * LS_{AVG} * VM_{AVG}$$

$$R = 230 \quad (\text{sh. 4})$$

$$K = 0.42 \quad (\text{sh. 5})$$

$$LS_{AVG} = 1.0 \quad (\text{sh. 8})$$

$$VM_{AVG} = 1.10 \quad (\text{sh. 7, embankment area})$$

$$A = 230 * 0.42 * 1.0 * 1.10 = 106.3 \frac{\text{tons}}{\text{ac-yr.}}$$





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2. (CONTINUED)

SEDIMENT VOLUME - No. 1

$$Vol = A * Area * T * \frac{1}{Y} * 2000$$

$$A = 106.3 \frac{\text{tons}}{\text{ac-yr}} \left(\text{sht. 8} \right)$$

$$Area = 38.7 \text{ ac} \left(\text{sht. 8} \right)$$

$$T = 2 \text{ yrs.} \left(\text{sht. 3} \right)$$

$$Y = 80 \text{ lb/ft}^3 \left(\text{sht. 3} \right)$$

$$Vol = 106.3 * 38.7 * 2 * \frac{1}{80} * 2000$$

$$= 205,613 \text{ ft}^3 = \underline{4.7 \text{ ac-ft}}$$

3. SEDIMENT VOLUME - RETENTION BASIN NO. 2LS AVG:

<u>Area (acres)</u>	<u>L (ft.)</u>	<u>AVG. % SLOPE</u>	<u>m</u>	<u>LS</u>	<u>LS * Area</u>
7.6	700	4.6	0.4	1.0	7.6
8.6	800	2.5	0.3	0.5	4.3
12.6	1020	1.6	0.3	0.3	3.8
18.9	1370	2.3	0.3	0.5	9.5
1.3	180	5.0	0.5	0.7	0.9
total = 49.0					

$$\Sigma (LS * Area) = 26.1$$

$$LS_{AVG} = \frac{\Sigma (LS * Area)}{\text{Total Area}} = \frac{26.1}{49.0} = 0.5$$





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RET. BASINS -

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3. (CONTINUED)

AVERAGE EROSION RATE = A:

$$A = R * K * LS_{AVG} * VM_{AVG}$$

$$\begin{array}{llll} R & = & 230 & (\text{sh + 4}) \\ K & = & 0.42 & (\text{sh + 5}) \\ LS_{AVG} & = & 0.50 & (\text{sh + 9}) \\ VM_{AVG} & = & 1.10 & (\text{sh + 7, embankment area}) \end{array}$$

$$A = 230 * 0.42 * 0.50 * 1.10 = 53.1 \frac{\text{tons}}{\text{ac-yr}}$$

SEDIMENT VOL. - NO. 2

$$VOL. = A * Area * T * \frac{1}{\gamma} * 2000$$

$$A = 53.1 \frac{\text{tons}}{\text{ac-yr}}$$

$$Area = 49.0 \text{ ac}$$

$$T = 2 \text{ yrs.}$$

$$\gamma = 80 \text{ lb/ft}^3$$

$$\begin{aligned} VOL &= 53.1 * 49.0 * 2 * \frac{1}{80} * 2000 \\ &= 130,169 \text{ ft}^3 = \underline{\underline{3.0 \text{ ac-ft}}} \end{aligned}$$





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Project

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Feature

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SED. VOLUME

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4. SEDIMENT VOLUME - RET. BASIN NO. 3LS_{AVG} :

<u>Area (ac)</u>	<u>L (ft.)</u>	<u>Avg. % Slope</u>	<u>mv</u>	<u>LS</u>	<u>LS * Area</u>
16.6	920	3.5	0.4	0.8	13.3
8.9	1150	2.9	0.3	0.6	5.3
10.4	550	4.5	0.4	0.9	9.4
11.5	700	1.9	0.3	0.3	3.5
5.3	450	4.0	0.4	0.7	3.7
9.6	550	4.2	0.4	0.8	7.7
13.6	440	2.7	0.3	0.4	5.1

total = 75.9

 $\Sigma (LS * Area) = 48.3$

$$LS_{AVG} = \frac{\Sigma (LS * Area)}{total Area} = \frac{48.3}{75.9} = 0.6$$

AVERAGE EROSION RATE = A :

$$A = R * K * LS_{AVG} * VM_{AVG}$$

$$R = 230 \quad (skt +)$$

$$K = 0.42 \quad (skt. 5)$$

$$LS_{AVG} = 0.6 \quad (skt 11)$$

$$VM_{AVG} = 1.10 \quad (skt. 7, embankment area)$$

$$A = 230 * 0.42 * 0.6 * 1.10 = 63.8 \frac{tons}{ac-yr}$$



Project UTRA-EST
Feature RET. BASINS -
Item SED. VOLUME

Contract No. 5057 Sheet 12
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4. (CONTINUED)

SEDIMENT VOLUME - NO. 3

$$VOL. = A * Area * T * \frac{1}{Y} * 2000$$

$$A = 63.8 \text{ tons/ac-yr}$$

$$Area = 75.9 \text{ acre}$$

$$T = 2 \text{ yrs}$$

$$Y = 80 \text{ pcf}$$

$$VOL = 63.8 * 75.9 * 2 * \frac{1}{80} * 2000$$

$$= 241,954 \text{ Ft}^3 = \underline{\underline{5.6 \text{ ac-ft}}}$$

5. SEDIMENT VOLUME - RET. BASIN NO. 4

LS_{AVG.}:

<u>Area (acres)</u>	<u>L(ft)</u>	<u>Avg. % Slope</u>	<u>m</u>	<u>LS</u>	<u>LS*Area</u>
4.4	300	4.2	0.4	0.7	3.1
7.4	720	4.2	0.4	0.9	6.7
6.7	300	6.7	0.5	1.3	8.7
13.5	1,160	1.9	0.3	0.4	5.4
2.1	210	5.7	0.5	0.9	1.9
7.6	700	3.1	0.3	0.5	3.8

total = 41.7

$$\Sigma(LS * Area) = 29.6$$

$$LS_{AVG.} = \frac{\Sigma(LS * Area)}{\text{total Area}} = \frac{29.6}{41.7} = 0.7$$



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 Feature RET. BASINS -
 Item SED. VOLUME

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5. (CONTINUED)

AVERAGE EROSION RATE = A

$$A = R_{\text{max}} K * L S_{\text{avg}} * V M_{\text{avg}}$$

$$R = 230 \quad (\text{slt. 4})$$

$$K = 0.42 \quad (\text{slt. 5})$$

$$L S_{\text{avg}} = 0.7 \quad (\text{slt. 12})$$

$$V M_{\text{avg}} = 0.95 \quad (\text{slt. 7, excavation area})$$

$$A = 230 * 0.42 * 0.7 * 0.95 = 64.2 \frac{\text{tons}}{\text{ac-yr}}$$

SEDIMENT VOL. - NO. 4 :

$$\text{VOL.} = A * \text{Area} * T * \frac{1}{\gamma} * 2000$$

$$A = 64.2 \frac{\text{tons}}{\text{ac-yr}} \quad (\text{slt. 13})$$

$$\text{Area} = 41.7 \text{ ac} \quad (\text{slt. 12})$$

$$T = 2 \text{ yrs.} \quad (\text{slt. 3})$$

$$\gamma = 80 \text{ pcf} \quad (\text{slt. 3})$$

$$\text{VOL.} = 64.2 * 41.7 * 2 * \frac{1}{80} * 2000$$

$$= 133,857 \text{ ft}^3 = \underline{\underline{3.1 \text{ ac-ft}}}$$





MORRISON-KNUDSEN ENGINEERS, INC.

Project U.M. RA - FCTFeature RET. BASINS -Item SED. VOLUMEContract No. 5057Designed DRMChecked WIPSheet 14File No. Date 1/22/88Date 2-1-88PARCEL B6. SEDIMENT VOLUME - RET. BASIN No. 5LS_{AVG.}:

<u>Area (ac.)</u>	<u>L (ft.)</u>	<u>% Slope</u>	<u>m</u>	<u>LS</u>	<u>LS * Area</u>
3.6	260	12.3	0.5	3.0	10.8
21.1	1550	1.8	0.3	0.4	8.4
7.4	870	3.1	0.3	0.6	4.4
total = 32.1					

$$\Sigma (LS * Area) = 23.6$$

$$LS_{AVG.} = \frac{\Sigma (LS * Area)}{\text{total Area}} = \frac{23.6}{32.1} = 0.7$$

AVERAGE EROSION RATE = A:

$$A = R * K * LS_{AVG.} * VM_{AVG.}$$

$$R = 230 \quad (\text{slt. 4})$$

$$K = 0.42 \quad (\text{slt. 5})$$

$$LS_{AVG.} = 0.7 \quad (\text{slt. 14})$$

$$VM_{AVG.} = 0.95 \quad (\text{slt. 7, excavation area})$$

$$A = 230 * 0.42 * 0.7 * 0.95 = 64.2 \frac{\text{tons}}{\text{ac.-yr}}$$





Project

ULTRA-FCT

Feature

RET. BASIN

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SED. VOLUME

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Date 1/22/88

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6. (CONTINUED)

SED. VOLUME - BASIN NO. 5:

$$VOL. = A * Area * T * \frac{1}{Y} * 2000$$

$$A = 64.2 \frac{ton}{ac \cdot yr} (skt. 14)$$

$$Area = 32.1 ac (skt. 14)$$

$$T = 2 yrs. (skt. 3)$$

$$Y = 80 pct (skt. 3)$$

$$VOL. = 64.2 * 32.1 * 2 * \frac{1}{80} * 2000$$

$$= 103,041 ft.^3 = \underline{\underline{2.4 ac \cdot ft.}}$$

7.

SUMMARY

	RET. BASIN				
	1	2	3	4	5
SEDIMENT VOLUME (AC-FT)	4.7	3.0	5.6	3.1	2.4





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Project ULTRA - FCT
 Feature RET. BASINS -
 Item SED VOLUME

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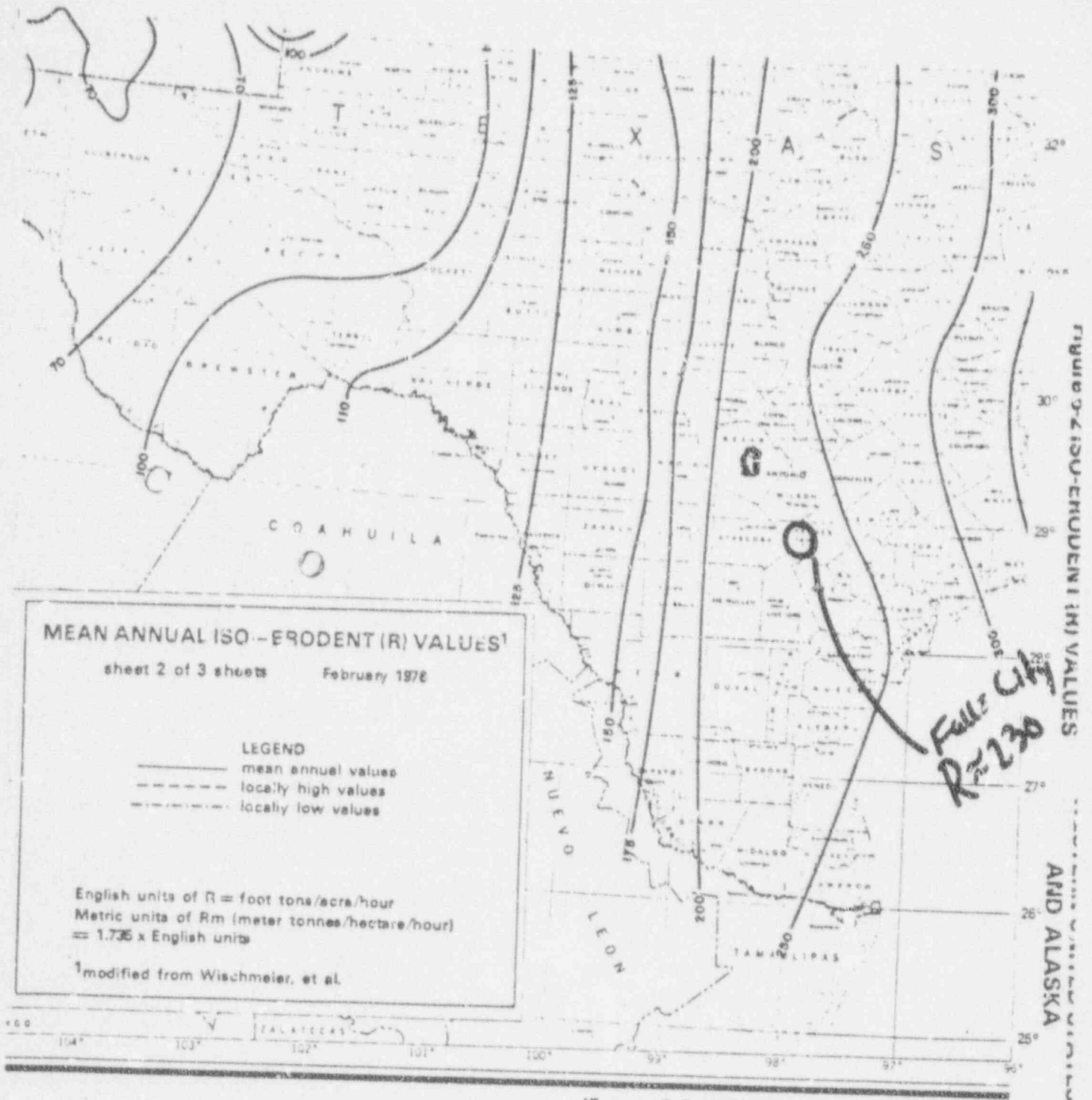


Figure 5-2 ISO-ERODENT (R) VALUES

FROM REF. 1

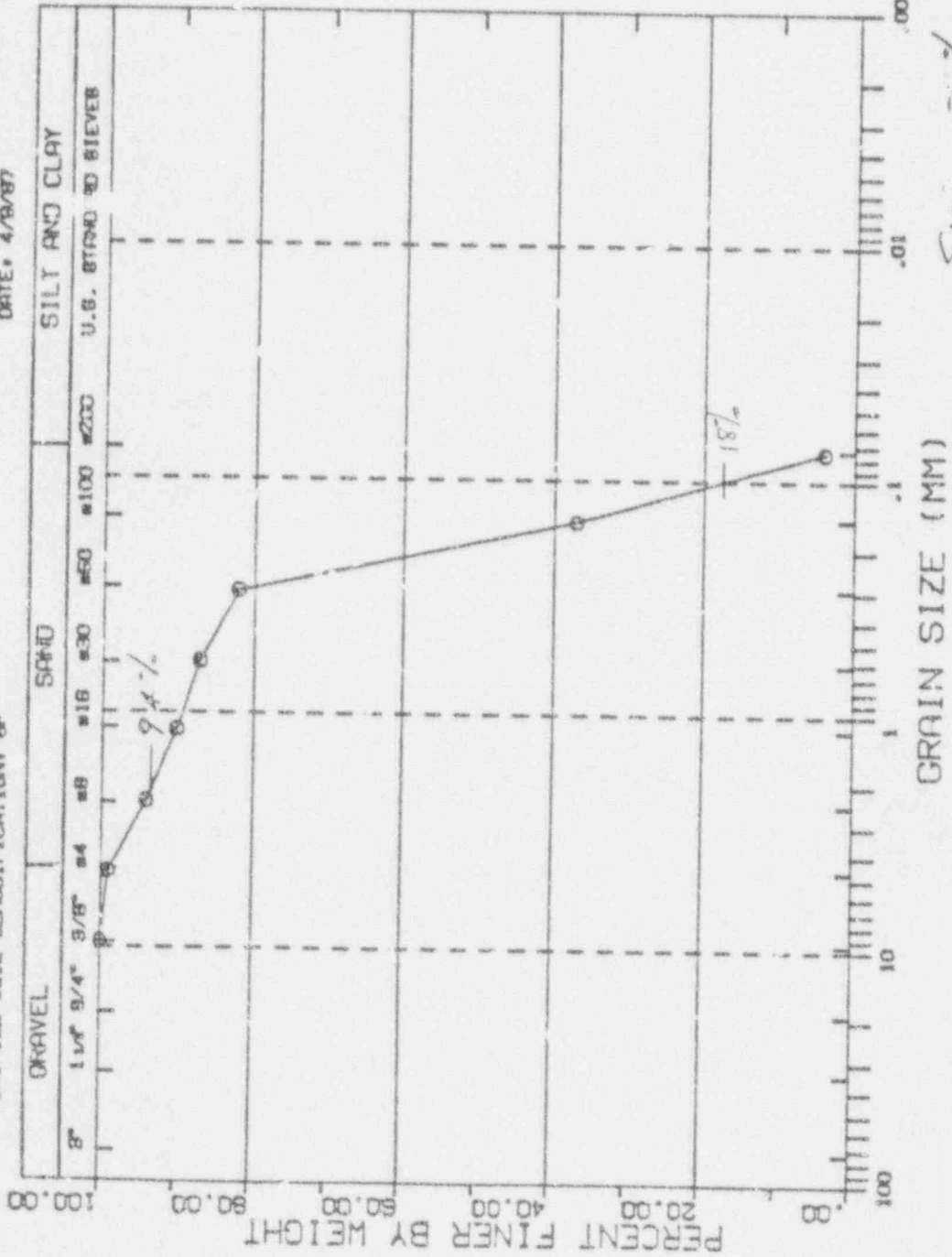


ULTRA-FCT
RET. BASINS -
SED. VOLUME

Sht. 17
DRM 1/22/98

CHK MSP 2-8-88

LOCATION ID: 084
SAMPLE ID: 02
DEPTH INTERVAL (FT): 18.2 - 18.7
UNIFIED SOIL CLASSIFICATION: SP



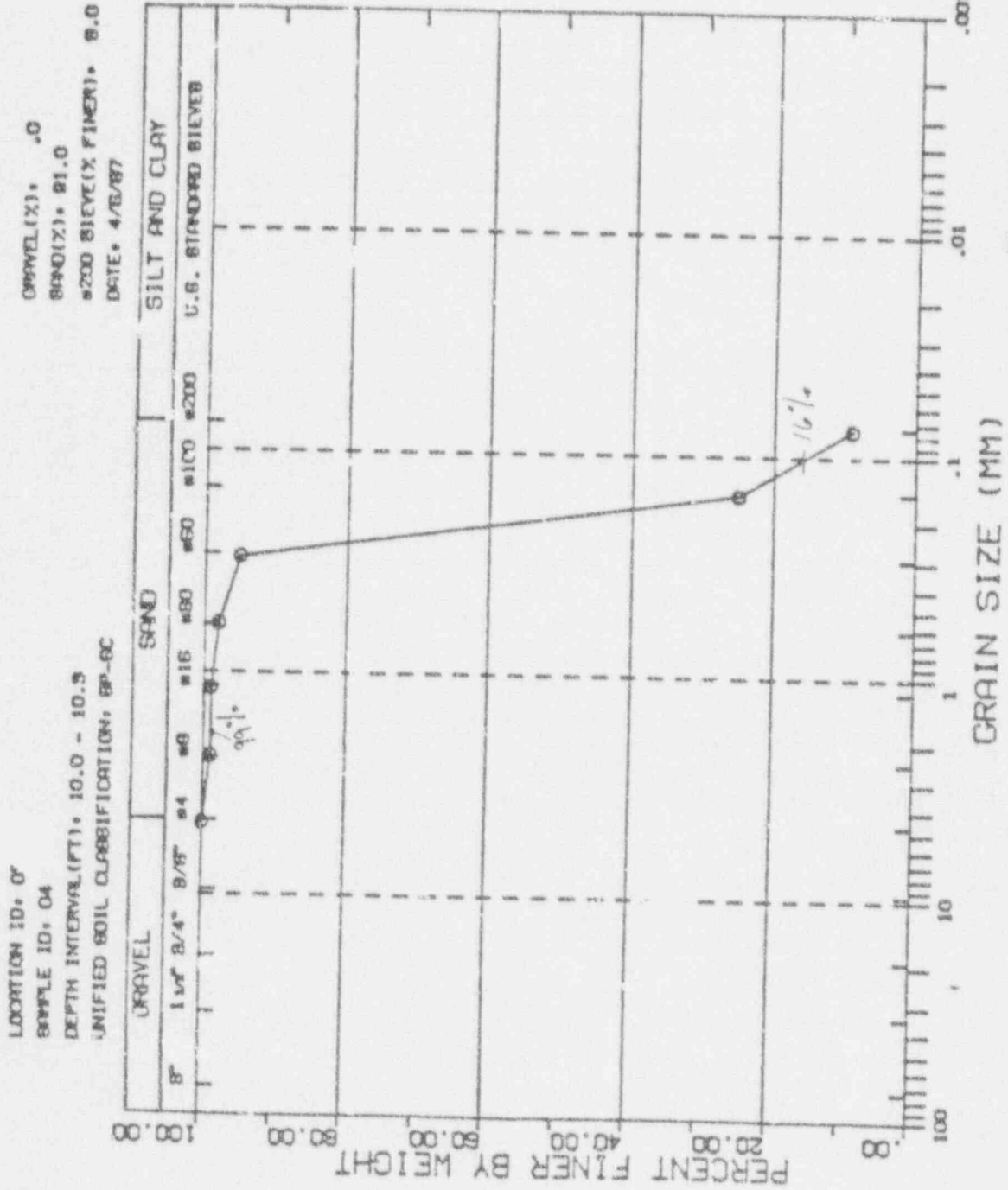
SAND 76.0%
SILT + FINE SAND 18.0%

From Ref. 2

ULTRA-FCT
RET. BASINS -
SED VOL.

SLT 18
DRM 1/22/1

CHK MIP 2-8-88



SAND 83%
SILT + FINE SAND 16%

From Ref. 2

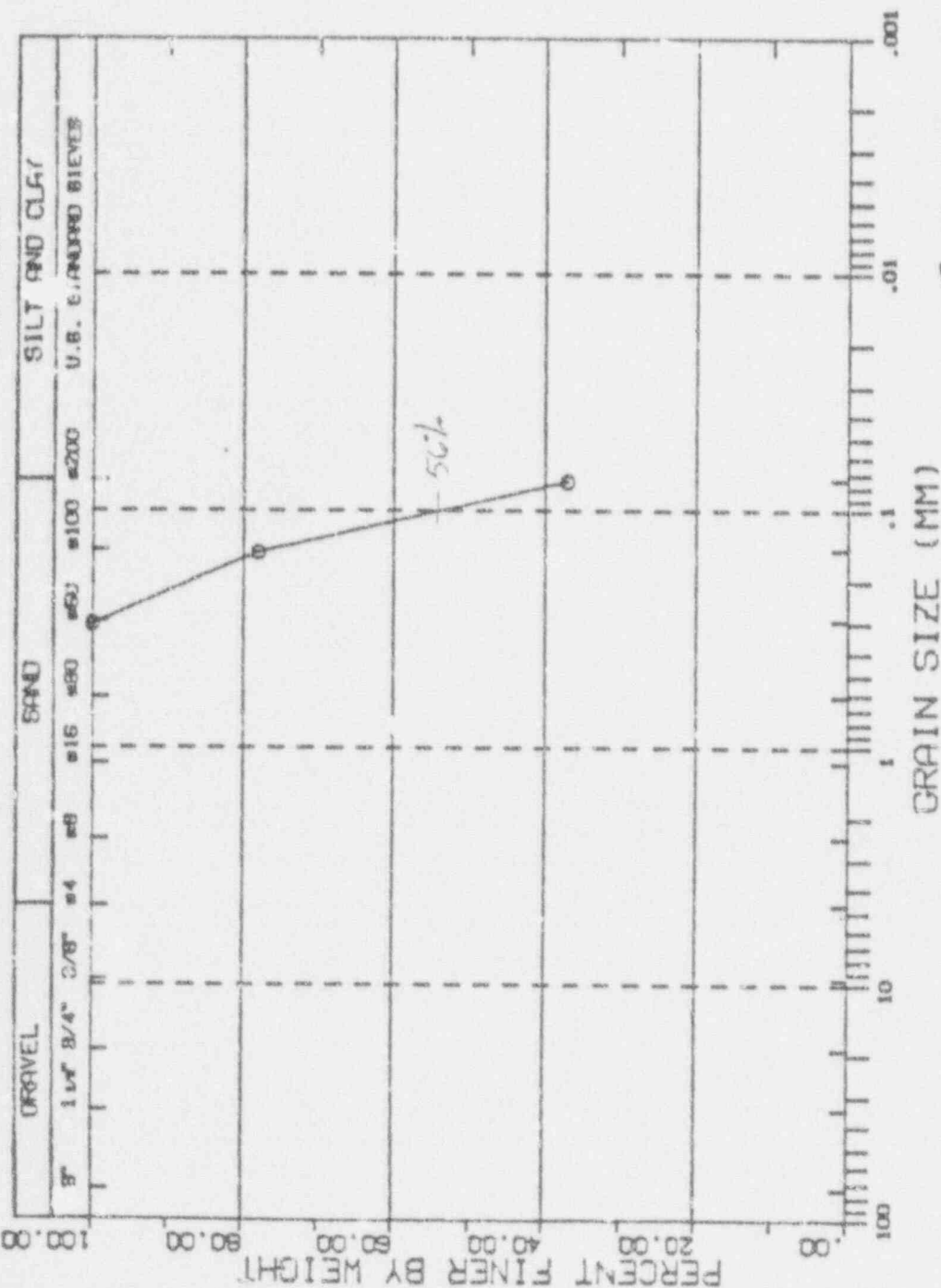
ULTRA-FINE
RET. BASINS-
SED. VOLUME

SLT. 19
JRM 1/22/88

CHK MSP 2-8-88

GRAVEL (%): .0
SAND (%): 63.0
#200 SIEVE (% FINER): 57.0
DATE: 4/8/87

LOCATION ID: 046
SAMPLE ID: 30
DEPTH INTERVAL (FT): 92.0 - 92.8
UNIFIED SOIL CLASSIFICATION: SM



SAND 44%
SILT + FINE SAND 56%

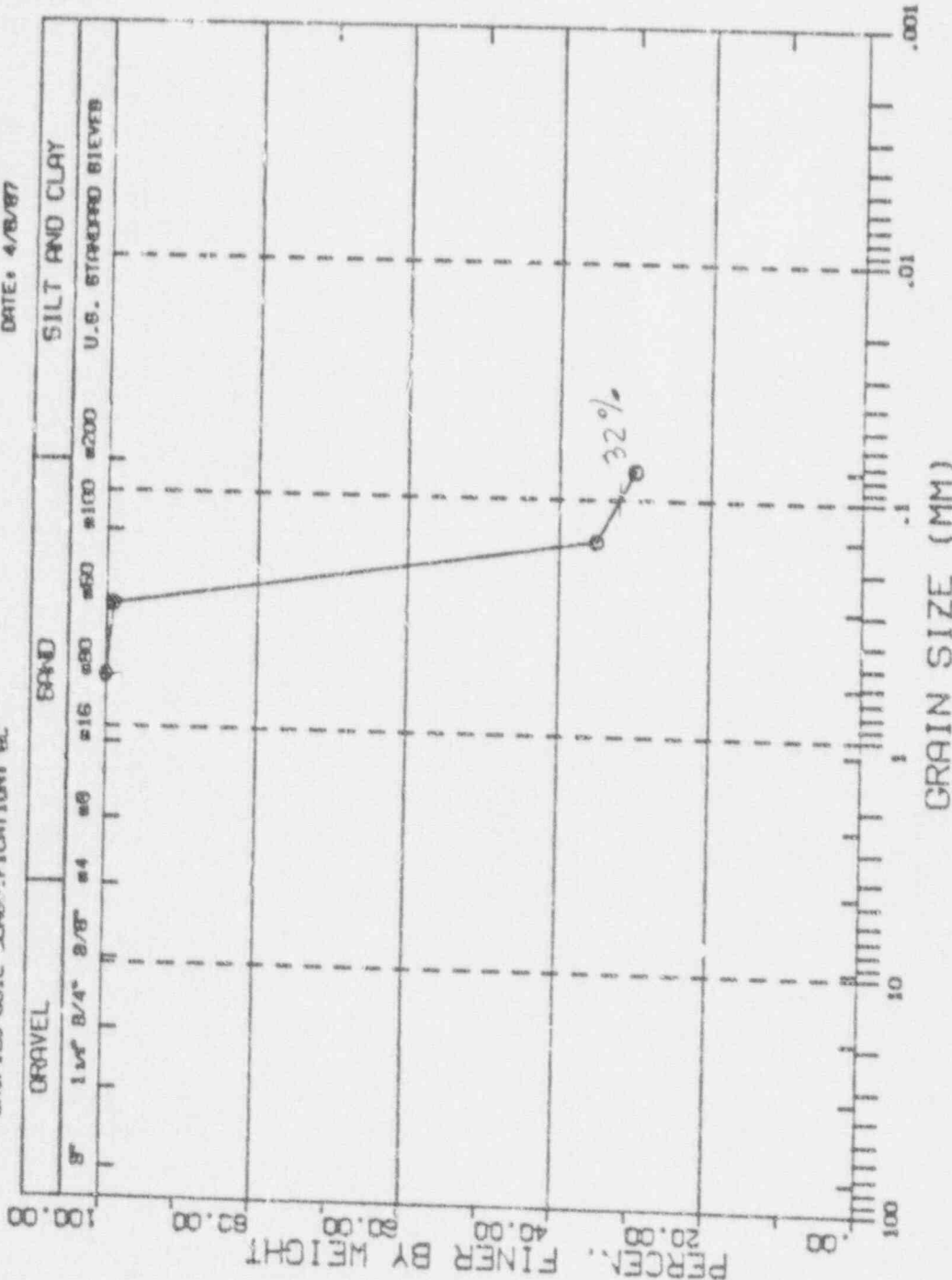
From Ref. 2

ULTRA-FCT
RET. BASINS -
RED. VOLUME

SLT .20

DRM 1/22/88
CHK M/S 2-1-88

LOCATION ID: 082
SAMPLE ID: 28
DEPTH INTERVAL (FT): 8.8 - 7.9
UNIFIED SOIL CLASSIFICATION: SC
GRAVEL (%): 0
SAND (%): 70.0
#200 SIEVE (X FINER): 80.0
DATE: 4/8/87



SAND 68%
SILT + FINE SAND 32%

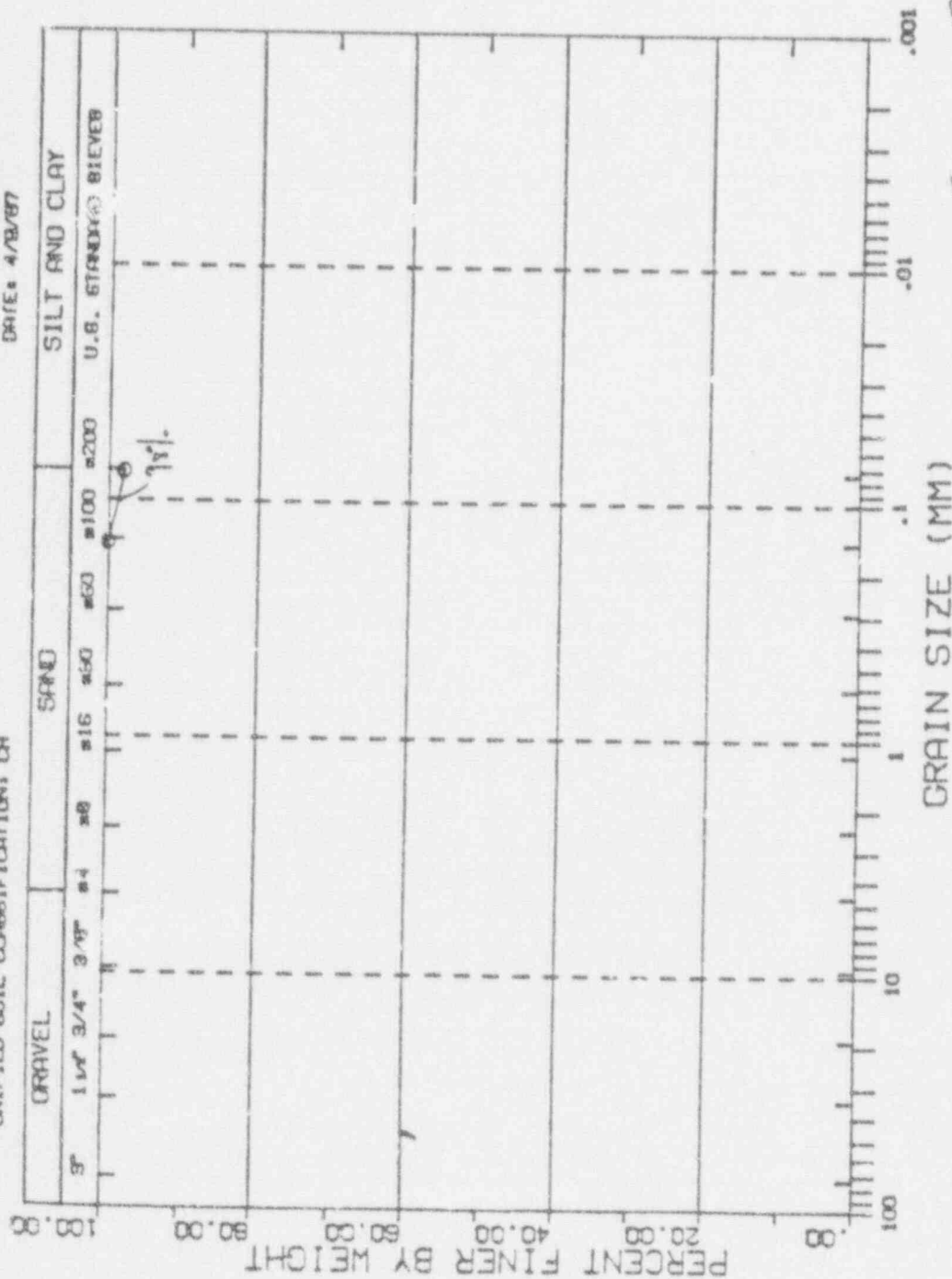
From Ref. 2

ULTRA-FCT
RET. BASINS -
SED. VOLUME

St. 21
DEM 1/22/88
CHK MSP 2-8-88

GRAVEL (%) = .0
SAND (%) = 2.0
%200 SIEVE (% FINER) = 98.0
DATE = 4/28/87

LOCATION ID: 072
SAMPLE ID: 6A
DEPTH INTERVAL (FT): 21.0 - 21.5
UNIFIED SOIL CLASSIFICATION: CH



From Ref. 2



MORRISON-KNUDSEN ENGINEERS, INC.
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Project

Feature

Item

MTA - ET

RET. BASINS -

SIED. VOLUME

Contract No. 5057

Designed DRM

Checked WCP

Sheet 22

File No.

Date 1/22/88

Date 2-8-88

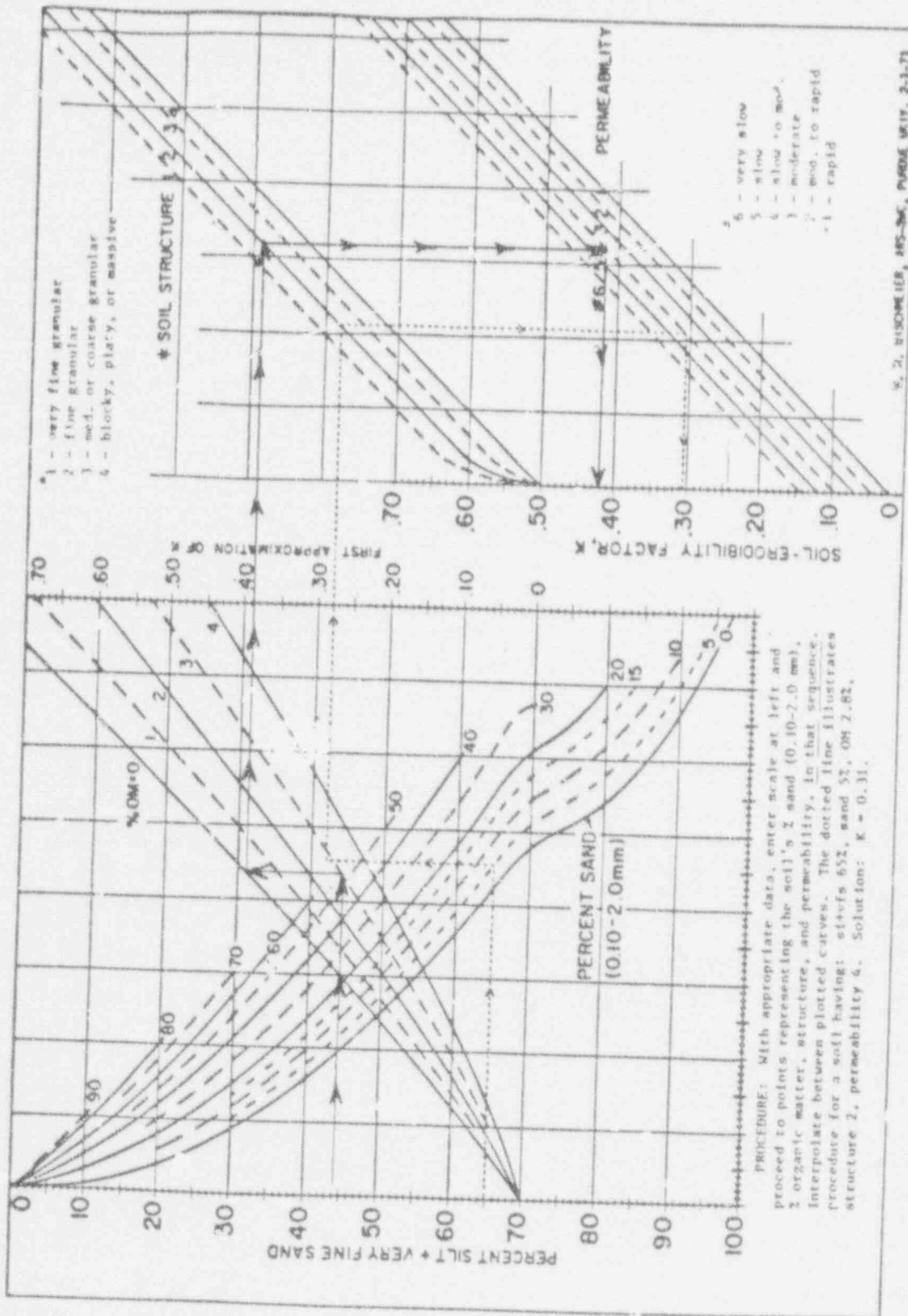


Figure 2-2. Nomograph for determining soil erodibility factor K.

From Ref 1.





MORRISON-KNUDSEN ENGINEERS, INC.

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Project UMTRA - ERT
Feature RET. BASINS -
Item SED. VOLUME

Contract No. 5057

Designed DRM

Checked AKP

Sheet 28

File No. 1/22/81

Date 1/22/81

Date 2-8-81

Table 2-2. Typical VM factor values reported in the literature.*

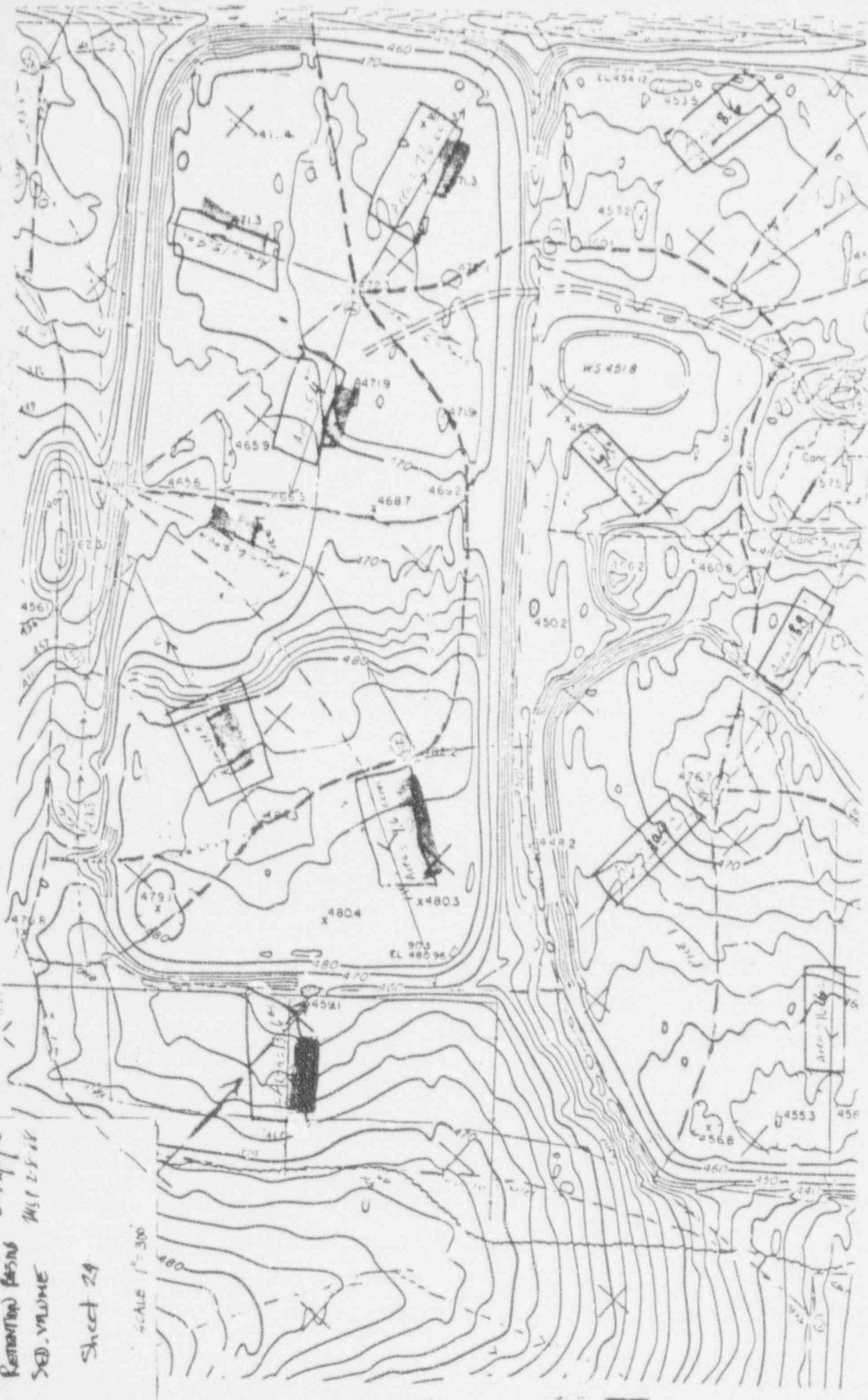
Condition	VM Factor
<u>1. Bare soil conditions</u>	
freshly disked to 6-8 inches	1.00
after one rain	0.89
loose to 12 inches smooth	0.90
loose to 12 inches rough	0.80
compacted bulldozer scraped up and down	1.30
same except root raked	1.20
compacted bulldozer scraped across slope	1.20
same except root raked across	0.90
rough irregular tracked all directions	0.90
seed and fertilize, fresh	0.64
same after six months	0.54
seed, fertilizer, and 12 months chemical	0.38
not tilled algae crusted	0.01
tilled algae crusted	0.02
compacted fill	1.24-1.71
undisturbed except scraped	0.66-1.30
scarified only	0.76-1.31
sawdust 2 inches deep, disked in	0.61
<u>2. Asphalt emulsion on bare soil</u>	
1250 gallons/acre	0.02
1210 gallons/acre	0.01-0.019
605 gallons/acre	0.14-0.57
302 gallons/acre	0.28-0.60
151 gallons/acre	0.65-0.70
<u>3. Dust binder</u>	
605 gallons/acre	1.05
1210 gallons/acre	0.29-0.78
<u>4. Other chemicals</u>	
1000 lb. fiber Glass Roving with 60-150 gallons asphalt emulsion/acre	0.01-0.05
Aquatrain	0.68
Aerospray 70, 10 percent cover	0.94
Curasol AE	0.30-0.48
Petroset SB	0.40-0.46
PVA	0.71-0.90
Terra-Tack	0.66
Wood fiber slurry, 1000 lb/acre fresh	0.05 -0.73
Wood fiber slurry, 1400 lb/acre fresh	0.01 -0.36
Wood fiber slurry, 3500 lb/acre fresh	0.009-0.10
Portland cement + Latex	
1000 lbs/ac + 8 gals/ac	0.13
1500 lbs/ac + 12 ga v/ac	0.006
<u>5. Seedings</u>	
temporary, 0 to 50 days	0.40
temporary, after 60 days	0.75
permanent, 0 to 60 days	0.40
permanent, 2 to 12 months	0.05
permanent, after 12 months	0.01
<u>6. Brush</u>	0.35
<u>7. Excelsior blanket with plastic net</u>	0.04-0.10
<u>8. Mulch</u> (see Figures 2-4, 2-5, 2-6, 2-7)	

From Ref. 1



USRA-FCI
RESTORATION FARM
SED. VOLUME

Sheet 29

$$\frac{1}{4} \text{CALE } 1^{\text{st}} = 300'$$


PARCEL A



UMTRA-FCI
RETENTION BASINS
SED. VOLUME

DRH 2/5/88
2-2-88

sheet 25

SCALE 1"=300'

PARCEL A

ULTRA-FET
RETENTION BASINS
SED. VOLUME

DEM 2/5/88

MSP 2/5/88

Sheet 26

Scale 1" = 300'

ULTRA-FET
RET. BASINS
SEDIMENT VOL.

DEM 2/5/88
MSP 2/5/88

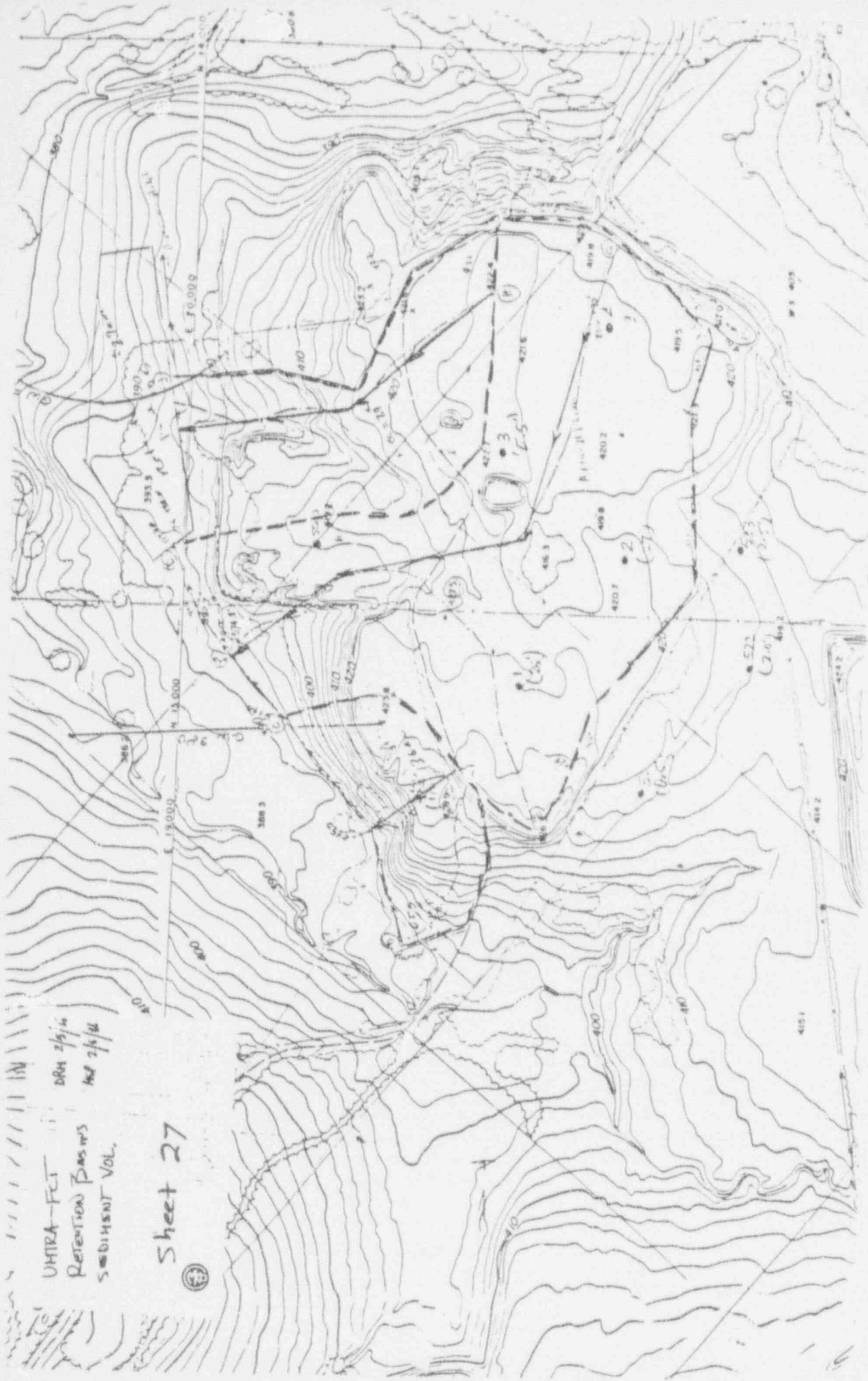
ULTRA-FET
RET. BASINS
SEDIMENT VOL.

PARCEL A



UHTA-FET
RETENTION BASINS
SEDIMENT VOL.

Sheet 27



Parcel B-Pile 3



MORRISON-KNUDSEN ENGINEERS, INC.

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Project UMTRA-FCT
Feature RET. BASINS-
Item SER. VOLUME

Contract No. 5057

Designed DRM

Checked MIP

Sheet 28

File No. _____

Date 1/22/88

Date 2-8-88

REFERENCES

1. Israelsen, C.E, et.al., Erosion Control During Highway Construction, National Cooperative Highway Research Program Report No. 221, Transportation Research Board, Washington D.C., April 1980.
2. Department of Energy, Remedial Action Plan and Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Near Falls City, Texas, Draft Oct. 1987.
3. MIKE, UMTRA Design Procedures Rev. 4 1987.



Calculation Cover Sheet

Contract No. 5057

Discipline

CIVILCalc. No. 20-423-C2-00No. of Sheets 9

Project

UMTRA-FALLS CITY

Feature

SITE HYDROLOGY - TEMP DRAINAGE

Item

INTENSITY VS. DURATION CURVES
FOR 10 AND 25 YR. RETURN PERIODS

Sources of Data

Sources of Formulae & References

See Sheet 10Preliminary Calc. ☒Final Calc. ☒

Supersedes Calc. No. _____

0	<u>original</u>	<u>D. Nease</u>	<u>12/23/87</u>	<u>M. Lloyd</u>	<u>2-5-88</u>	<u>E. C. T/M</u>	<u>2/20/88</u>
Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



Project UMTRA - FCT
Feature SITE Hydrology - TEMP. DRAINAGE
Item _____

Contract No. 5057
Designed DRM
Checked THP

Sheet 1
File No. _____
Date 12/23/57
Date 2.5.68

I. Purpose

The purpose of this calculation is to determine precipitation values for storm events of interest in the design of temporary drainage facilities.

II. DESIGN CRITERIA

The storm events of interest are the following:

- 1) The peak 24 hr. 10 yr. storm event is required to determine retention basin capacity (ref. 1)
- 2) The peak 1 hr. 25 yr. storm event is required to design the emergency outlet of the retention basin (ref. 1)
- 3) Drainage ditches will be sized for 10 yr precipitation for durations equivalent to anticipated time of concentrations (ref. 3).





Project

ULTRA - FCT

Feature

SITE HYDROLOGY - TEMPORARY DRAINAGE

Item

Contract No. 5057

Designed DRH

Checked TJP

Sheet

2

File No.

Date 12/27/82

Date 2/5/88

III. CALCULATION

- The method outlined in reference 2 was used to determine rainfall values for the storm events of interest.
- Rainfall values for both 2- and 100-year return periods were obtained from the isopleth maps in ref. 2. Values for other return periods were determined from the return period diagram (figure 7) see sheet 8.

The 2- and 100-yr. rainfall values are shown below.

RETURN PERIOD (YEARS)	PRECIPITATION (IN.)						
	1/2 hr	1 hr	2 hr	3 hr	6 hr	12 hr	24 hr
2	1.6	2.0	2.4	2.7	3.1	3.6	4.1
100	3.5	4.4	5.5	6.1	7.4	9.0	10.5

- These values were plotted on the return period diagram (fig. 7) and a straight line drawn between the 2-yr and 100-yr rainfall values.





Project

UMIRA-FCT

Contract No. 5057

Sheet

3

Feature

SITE HYDROLOGY - TEMPORARY DRAINAGE

Designed

JRM

File No.

Item

Checked

HJP

Date

12/22/87

Date

2-5-88

III. CALCULATION (CONT'D)

Rainfall values for 5, 10, 25 & 50 year return periods were determined from figure 7 and checked by using the isopluvial maps in ref. 2.

Listed below are rainfall values determined from figure 7 and from the isopluvial maps for the return periods of interest.

10-yr. Return Period:

Duration (hours)	Interpolated Rainfall value from fig. 7 (in.)	Rainfall Value from Isopluvial map (in.)
1/2	2.4	2.4
1	3.0	3.0
2	3.7	3.7
3	4.1	4.1
6	4.8	5.0
12	5.8	5.9
24	6.7	6.9



Project

ULTRA-EET

Feature

SITE HYDROLOGY - TEMP. DRAINAGE

Item

Contract No. 5057

Designed DPM

Checked TWP

Sheet

4

File No.

Date

12/8/77

Date

2-6-88

III. CALCULATION (CONT'D)25-YR. RETURN PERIOD:

Duration (hours)	Interpolated Rainfall Value from fig. 7 (in.)	Rainfall Value from Iso. map (in.)
1/2	2.8	2.8
1	3.5	3.5
2	4.3	4.4
3	4.8	4.8
6	5.6	5.9
12	6.9	7.0
24	8.0	8.1

- For the 10 and 25 year return periods, the interpolated rainfall values from (fig. 7) shows good agreement with the rainfall values obtained from the Isopluvial maps.
- For durations shorter than 30 minutes, the average relationship between 30 min. rainfall and 5, 10, 15 min. rainfall values can be obtained from table 3 (ref. 2).





MORRISON-KNUDSEN ENGINEERS, INC.

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Project

UNTRA-FIT

Contract No.

507

Sheet

5

Feature

SITE HYDROLOGY - TEMP DRAINAGE

Designed

DRM

File No.

Item

Checked

THP

Date

12/3/07

Date

2-5-08

III. CALCULATION (CONT'D)

- The estimated rainfall values for durations shorter than 1/2 hour are shown below.

RETURN PERIOD (YEARS)	PRECIPITATION (INCHES)			
	30 MIN	15 MIN	10 MIN	5 MIN
2	1.6	1.2	0.9	0.6
5	2.1	1.5	1.2	0.8
10	2.4	1.7	1.4	0.9
25	2.8	2.0	1.6	1.0
50	3.2	2.3	1.8	1.2
100	3.5	2.5	2.0	1.3

- rainfall values are converted to rainfall intensity by dividing by the duration. The rainfall intensities are presented on the following sheet.





MORRISON-KNUDSEN ENGINEERS, INC.

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Project

UMTRA - ECT

Contract No. 5057

Sheet 6

Feature

SITE HYDROLOGY - TEMP. DRAINAGE

Designed DRT

File No.

Item

Checked MSP

Date 12/23/87

Date 2-5-88

III. CALCULATION (CONT'D)

RETURN PERIOD (YEARS)	RAINFALL INTENSITY (IN/HR)				
	60 MIN	30 MIN	15 MIN	10 MIN	5 MIN
2	2.0	3.2	4.8	5.4	7.2
5	2.7	4.2	6.0	7.6	9.6
10	3.0	4.8	6.8	8.4	10.8
25	3.5	5.6	8.0	9.6	12.0
50	3.9	6.4	9.2	10.8	14.4
100	4.4	7.0	10.0	12.0	15.6

For durations shorter than 1 hour, the rainfall intensity vs. duration curves for the 2, 5, 10, 25, 50 and 100-yr return periods are shown on the following sheet.



UMTRA-FET

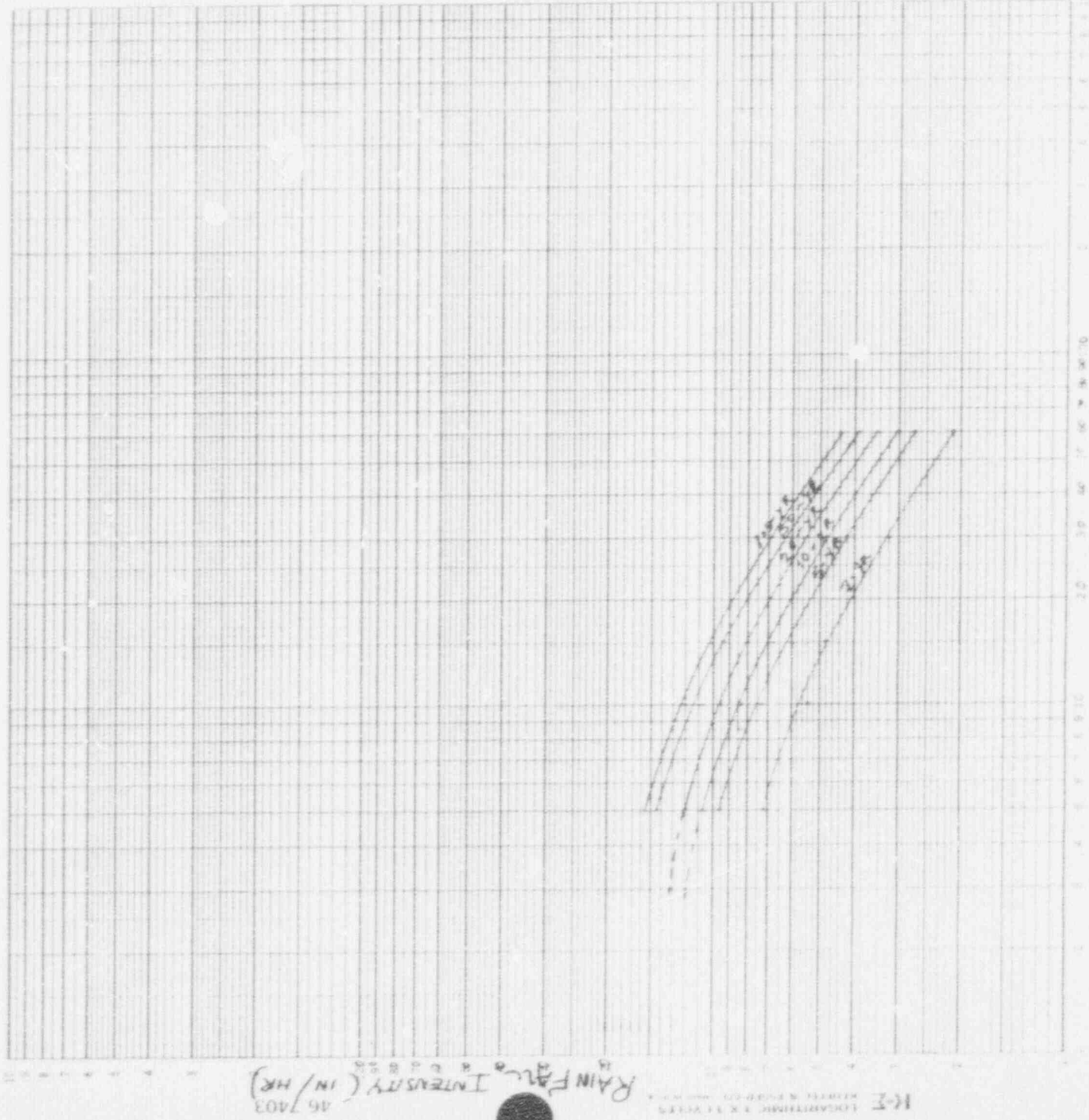
SITE HYDROLOGY - TEMPORARY DRAINAGE

DRM

12/22/87

SH. 7

CAD FILE 2-5-88





MORRISON-KNUDSEN ENGINEERS, INC.

Project

ULTRA-ECT

Feature

SITE HYDROLOGY - TEMP. DRAINAGE

Item

Contract No.

5057

Sheet

8

File No.

Designed

DRM

Date

12/22/87

Checked

HL

Date

2-5-88

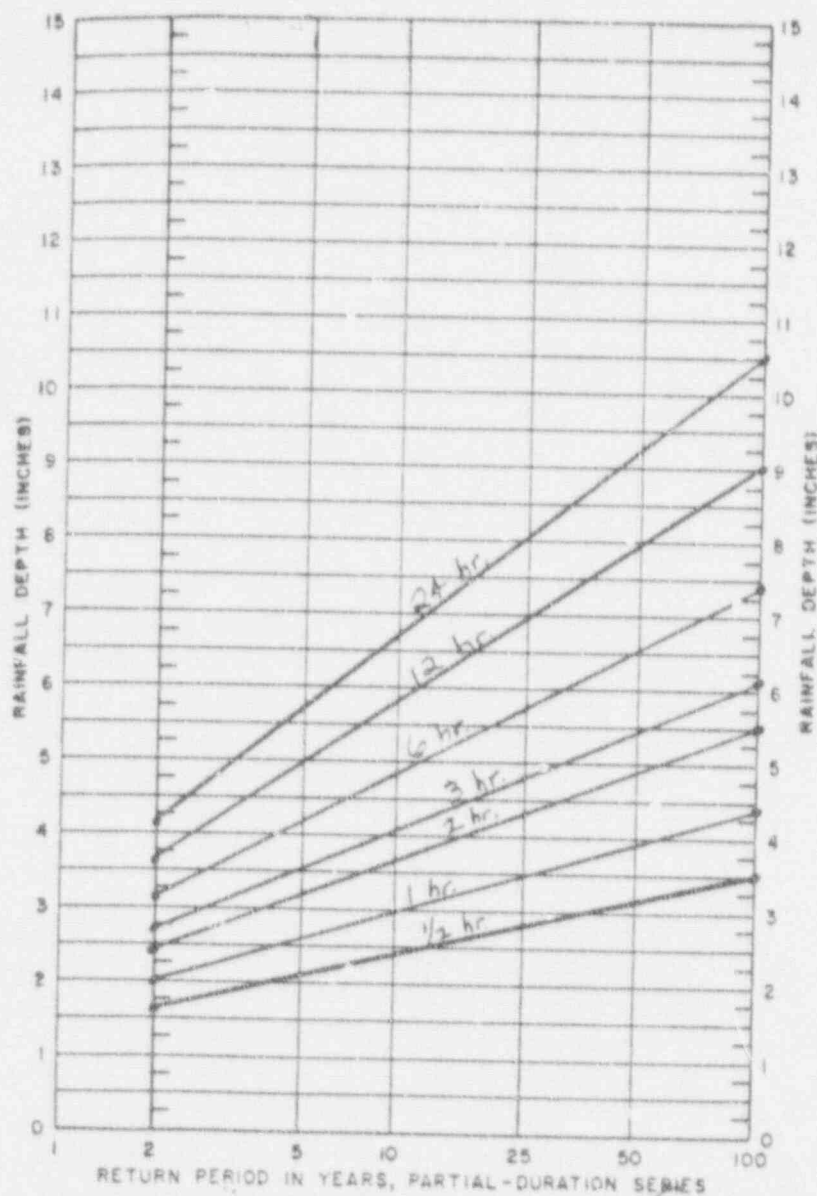


FIGURE 7.—Rainfall depth versus return period. (Ref. 2)

TABLE 3.—Average relationship between 30-minute rainfall and shorter duration rainfall for the same return period

Duration (min.)	5	10	15
Ratio	0.37	0.57	0.72
Average error (percent)	8	7	6

(Ref. 2)





MORRISON KNUDSEN ENGINEERS, INC.

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Project UMTRA-FCT Contract No. 5057 Sheet 9
Feature HYDROLOGY CALCULATION Designed MSP File No. _____
Item _____ Checked DRM Date 3-2-88
Date 4/12/88

PURPOSE: Check if this project's ^{basic} hydrologic criteria + procedures are consistent with State of Texas standards

REFERENCE: State of Texas, Dept of Highways + Public Transportation, Bridge Div.
Hydraulic Man. 3rd ED REV. 6-6-86

SUMMARY: Intensity + total volume of rainfall for various storm events: This project's values are virtually identical to those shown in the Texas standards. (They are based on the same reference.)

Runoff coefficient (C) + Time of concentration (t_c) values: This project's values are consistent with those in the Texas stds + are generally more conservative.





MORRISON-KNUDSEN ENGINEERS, INC.

Project

UMTRA - PCT

Contract No.

5057

Sheet

10

Feature

SITE HYDROLOGY - TEMP DRAINAGE

Designed

DRM

File No.

Date 12/23/87

Item

Checked

JP

Date 6-5-88

REFERENCES

1. D.O.E., Remedial Action Plan and Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site Near Falls City, Texas. Draft RAP Oct. 1987.
2. U.S. Weather Bureau, Rainfall Frequency Atlas of the United States Technical Paper 40, May 1961
3. MKE, UMTRA Design Procedure Manual July 1983, Rev. 4.



Calculation Cover Sheet

Contract No. 5057-04Discipline ECOLCalc. No. 5057-01-00No. of Sheets 2

Project

UNTRA - FALL CITY

Feature

RETENTION BASIN

Item

SEED STABILITY

Sources of Data

ALL PG. 7

Sources of Formulae & References

ALL PG. 7Preliminary Calc. ☒Final Calc. ☒

Supersedes Calc. No. _____

0		P. LI	5/12/88	ELTAL	1/15/90	E. C. TAL	7/25/90
Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



MORRISON-KNUDSEN ENGINEERS, INC.

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Project	<u>ULTRAJECT</u>	Contract No.	<u>SN7-04</u>	Sheet	<u>1</u>
Feature	<u>Retention Basins</u>	Designed	<u>P.L.T.</u>	File No.	
Item	<u>Slope Stability</u>	Checked	<u>EST</u>	Date	<u>3/16/88</u>
				Date	<u>6/8/88</u>

SLOPE STABILITY OF RETENTION BASIN BERMSI) PURPOSE

The purpose of this calculation is to determine the minimum slope that will attain a stability safety factor of 1.3, which is the minimum required factor of safety for "during construction stability" (REF 1)

II) APPROACH & METHOD

Stability charts from REF 2 were used. A minimum possible slope ratio was first assumed, and factor of safety was calculated using charts. If the factor of safety was below 1.3, a flatter slope was used and factor of safety calculated until a factor of safety of at least 1.3 was attained.

The analysis was performed in the most critical case, in which the height of the berm is maximum and no water is outside ^{the} slope (i.e. no water in retention basin).

III) ASSUMPTIONS

1. Uniform Soil conditions

Berms will be built up of foundation soils compacted at a density of at least 90% standard Proctor density.





MORRISON-KNUDSEN ENGINEERS, INC.

Project VMTRP/RET
 Feature Retention Basin
 Item Basin Stability

Sheet 2
 Contract No. 5057-04 File No.
 Designed P.I. Date 3/16/88
 Checked EST Date 2/18/88

Ducksville sandstone member is found at this location (REF 3 p. D222).
 And CRAP (REF 3 p. 44) describes the material as being "stiff and
 high strength" and the Ducksville sandstone as a "clayey
 sand".

From previous data, average ϕ for in-situ sand foundation soil $\approx 35^\circ$
 and average ϕ for in-situ sandy silt / silty sand $\approx 32^\circ$
 (REF 4)

No cohesion data are available for clayey sand material.

Since only in-situ strength (angle) data are available, it is
 assumed that the strength of compacted clayey sand foundation
 (at least 90% S.T.B.) is similar to that of in-situ soil.
 And to be conservative, the following strength parameters are
 assumed in the analysis:

$$\left\{ \begin{array}{l} \phi = 32^\circ \\ c = 0 \end{array} \right\}$$

- (3) No unit weight data are available for compacted clayey sand
 foundation. Based on REF 5 table 6 - (Average properties of
 soils), for clayey sand (SC), maximum dry density is
 Proctor Compaction is 115 p.c. with optimum water content





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Project UMTRA/FCT
 Feature Retention Basins
 Item Some Stability

Contract No. 5037-25

Designed PLT

Checked PLT

Sheet 3

File No.

Date 3/4/85

Date 2/15/88

of 14.7 %

Thus, 90% of maximum dry density $= 0.9 \times 115 = 103.5 \text{ pcf}$

Converting to total unit weight, $\gamma_t = 103.5 \times 1.147 = 118.7 \text{ pcf}$

And in this analysis, a unit weight of 115 pcf is assumed.

- (4) Assume the conditions were uniform above and beneath the toe of the slope, i.e. no weak layers above or beneath the toe. Thus the circles as cut-out circles are assumed herein.
- (5) Based on RET 6, a distributed surface load surcharge of 300 pcf is assumed to account for storage of construction materials and equipment.
- (6) Assume no seepage into the berm.
- (7) Assume no tension cracks in the berm.





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Project UMTRA / ECT

Feature Retention Curve

Item Curve Stability

Contract No. 5047-04

Designed P.I.E.

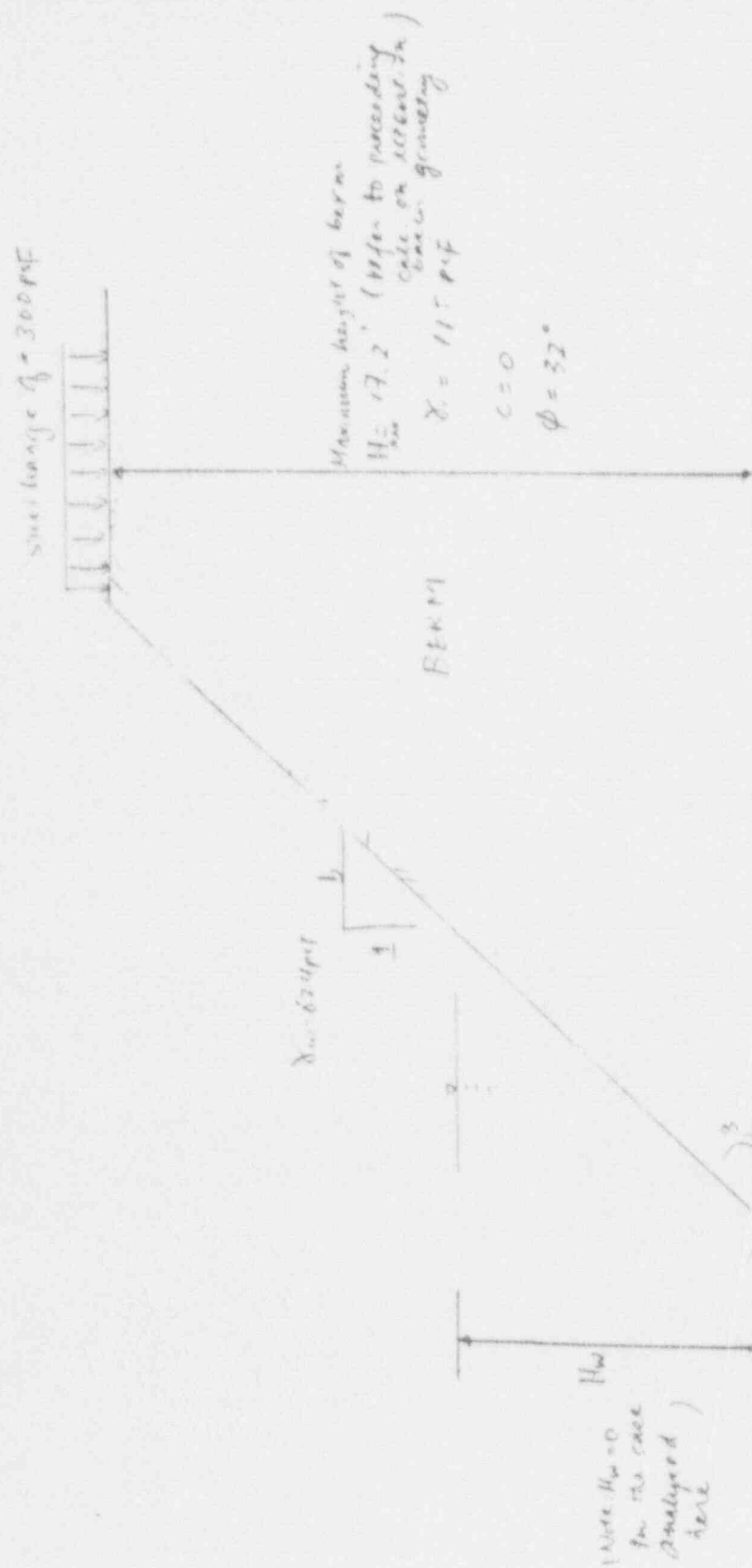
Checked ECT

Sheet 4

File No. _____

Date 3/16/88

Date 2/18/88



Project UM7KA/TCTContract No. 5219-06Sheet 5Feature Retention BasinDesigned PLJFile No. Item Flow StabilityChecked ECTDate 3/16/85Date 3/8/85IV) ANALYSIS*charts on sh. 3-8Refer to figure on sh. 4 for definition of symbols.

$$P_d = \frac{\gamma H + q - \gamma_w H_w}{U_g U_w U_s}$$

 U_g = surcharge correction factor (from chart) U_w = submergence correction factor (from chart) = 1 U_s = tension crack correction factor (from chart) = 1

$$P_c = \frac{\gamma H + q - \gamma_w H_w'}{U_g U_w'}$$

 H_w' = height of water within slope = 0 U_w' = leakage correction factor = 1 (from chart)For $C = 0$

$$\text{Factor of safety } F = \frac{P_c}{P_d} \tan \phi$$

4) Assume $b = 2$ (slope 2:1)

$$\text{For } q = 300 \text{ psf}$$

$$\frac{q}{\gamma H} = \frac{300}{115 \times 17.2} = 0.15$$

from chart, $U_g = 0.97$

$$P_d = \frac{115 \times 17.2 + 300 - 0}{0.97 \times 1 \times 1}$$

$$= 2348 \text{ psf}$$

$$P_c = \frac{115 \times 17.2 + 300}{0.97}$$

$$= 2348 \text{ psf}$$

$$F = \frac{2348}{2348} \times 2 \times \tan \phi = 1.25 < (1.3)$$





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Project UMTKA/FCT
 Feature Retention Basins
 Item Channel Stability

Contract No. 5057-4Designed P.L.E.Checked E.T.Sheet 6File No. Date 2/16/88Date 2/8/88

B) Try $b = 2.5$ (slope = 2.5:1)

$$F = \frac{2348}{2348} \times 2.5 \times \tan 32^\circ = \underline{1.56} \quad (> 1.3) \quad \checkmark$$

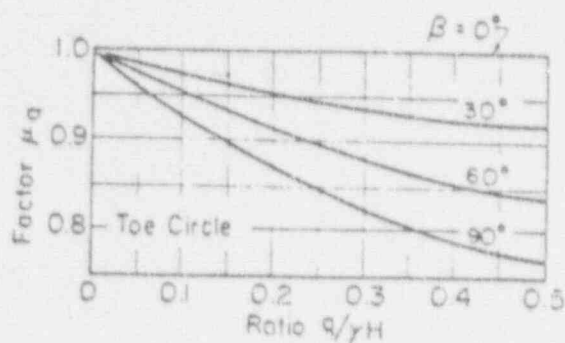
C) $b = 3$

$$F = 1 \times 3 \times \tan 32^\circ = \underline{1.87} \quad (> 1.3) \quad \checkmark$$

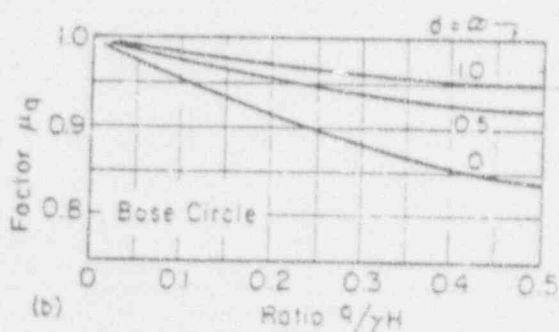
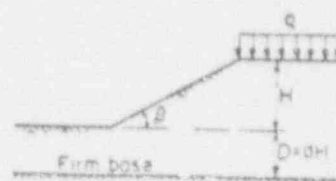
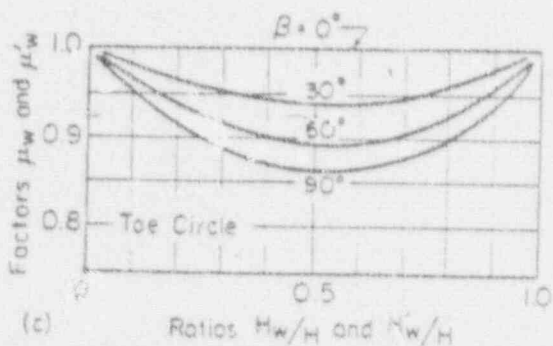
V) RESULTS & CONCLUSIONS

A slope of 2.5:1 or flatter will give a factor of safety greater than 1.3.

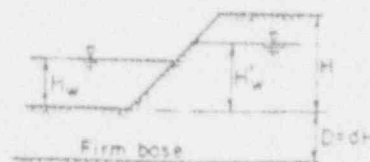
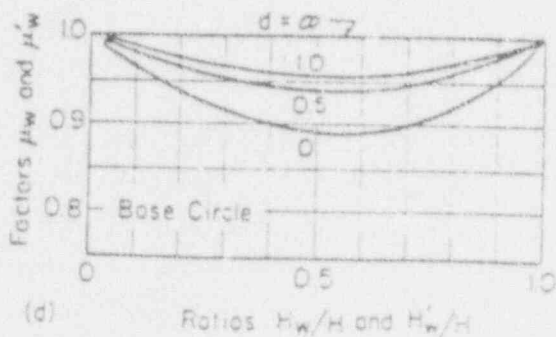
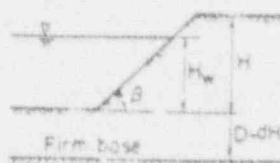




Key Sketch

REDUCTION FACTORS FOR SUBMERGENCE (μ_w) AND SEEPAGE (μ'_w)

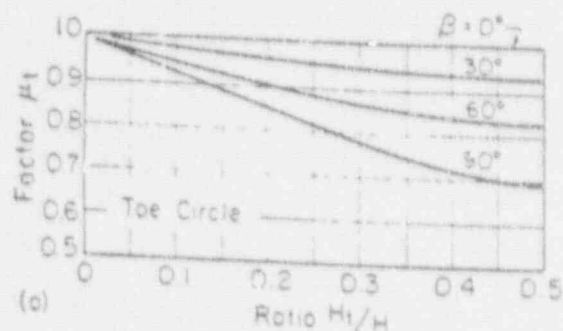
Key Sketches

Fig 7 REDUCTION FACTORS FOR SLOPE STABILITY CHARTS FOR $\phi = 0$ AND $\phi > 0$ SOILS. (after Janbu, 1968)

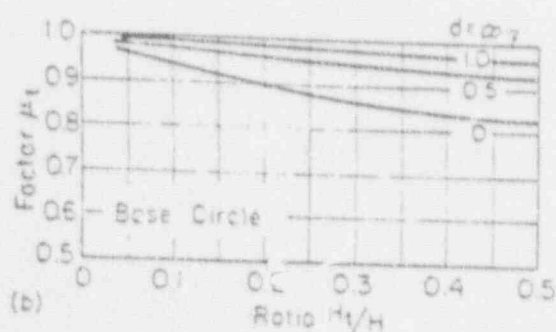
REDUCTION FACTOR FOR TENSION CRACK

No Hydrostatic Pressure in Crack

(from Ref. 2)

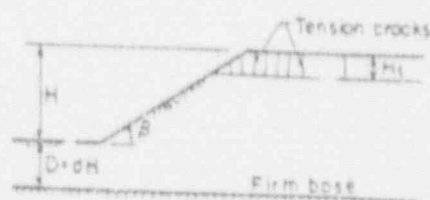


(c)



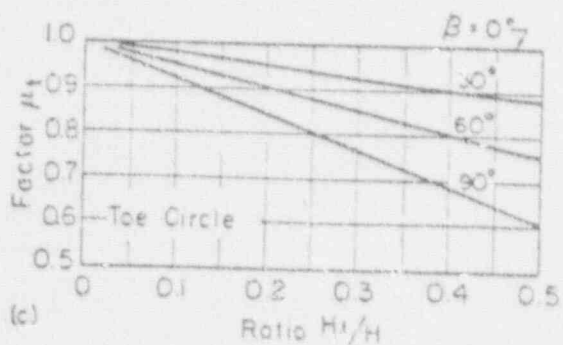
(d)

Key Sketch

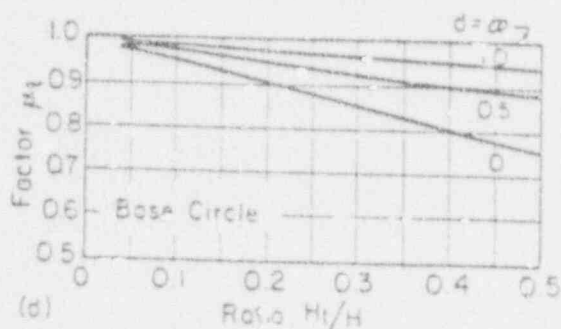


REDUCTION FACTOR FOR TENSION CRACK

Full Hydrostatic Pressure in Crack



(c)



(d)

Key Sketch

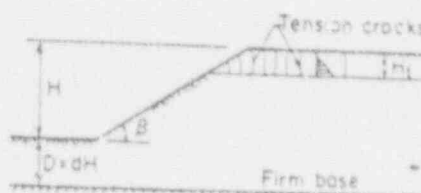


Fig B REDUCTION FACTORS FOR SLOPE STABILITY CHARTS FOR $\phi = 0$ AND $\phi > 0$ 50'LS. (after Janbu, 1968)



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Project	VMTRA/ELT	Contract No.	5057-04	Sheet	9
Feature	Retention Basin	Designed	CLZ	File No.	
Item	Break Stability	Checked	ES7	Date	3/16/88
				Date	6/8/88

REFERENCES:

1. U.S. Dept. of Energy, "VMTRAP Technical Approach Document", May, 1986
2. Duncan, J. M., and Bushignani, A. L., "An Engineering Manual For Slope Stability Studies", University of California, Berkeley, Department of Civil Engineering, March 1975
3. U.S. Dept. of Energy, "Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site Near Falls City, Texas", Draft Part and App A, B, C, D., November 1987
4. Morrison-Knudsen Engineers Inc. "Embankment Design, Geotechnical Properties", Calc No. 20-438-01-10, January 1988
5. U.S. Dept. of the Interior Bureau of Reclamation, "Design of Small Dams", 1965
6. Dept. of the Navy, "Design Manual 7.2", NAVFAC DM-7.2 May 1982





MORRISON-KNUDSEN ENGINEERS, INC.

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Project UNITA - EST
Feature TEMP DRAINAGE
Item DITCH DES.

Contract No. 5057
Designed DM
Checked MIP

Sheet _____
File No. _____
Date 3/28/58
Date 2-28-88

REFERENCES (CONT'D)

6. Chow, V.T., Open Channel Hydraulics,
McGraw-Hill Book Co, 1959.
7. L.A. County Flood Control District, Design Manual,
Hydraulics, March 1982
8. John's Manville Publication TA-641A; 9-1978
Design Flow Chart.





MORRISON-KNUDSEN ENGINEERS, INC.

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Project UMTRA - ECT
Feature TEMP. DRAINAGE
Item DITCH DES.

Contract No. 5057

Designed DRM

Checked MSP

Sheet 1

File No.

Date 2/7/88

Date 3-28-88

TABLE OF CONTENTS

	<u>Sheet</u>
1. SCOPE & PURPOSE	2
2. DESIGN METHODOLOGY	2-4
3. DITCH DESIGN + TIME OF CONCENTRATION	5-10
4. DRAINAGE MAPS	11-14
5. BACKUP DATA + DESIGN CHARTS	15-20





MORRISON-KNUDSEN ENGINEERS, INC.

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Project ULTRA-ECTFeature TEMP. DRAINAGEItem DITCH DES.Contract No. 5052Designed DRMChecked MSPSheet 2File No. Date 2/7/88Date 2-28-881. SCOPE AND PURPOSE

As part of the remedial action plan at Falls City, waste water collection ditches will be required to drain on-pile runoff to retention basins. Off-pile runoff will be diverted away from the site via diversion ditches.

Included in this calc. is the design of diversion and wastewater collection ditches for both parcels A & B.

2. DESIGN METHODOLOGY

Peak runoff discharge was estimated using the Rational formula $Q = C i A$.

Q = peak runoff discharge (cfs)

C = coefficient of runoff was estimated to be 0.6 (conservative) from table B ref. 2 for a loam soil without vegetation (see sheet 15).

i = average rainfall intensity (in/hr) was determined from the 10 year rainfall intensity vs. duration curve for a duration equal to time of conc. (ref. 1, see sht. 16)

A = drainage area, acres (see shts. 11-14)





Project UTTRA-ECT
 Feature TEMP. DRAINAGE
 Item PITCH DES.

Contract No. 5057
 Designed MJP
 Checked OM

Sheet 3
 File No. _____
 Date 2/7/88
 Date 3-28-88

Time of concentration for the watershed is the sum of overland and ditch flow path time.

Overland flow time (T_o) was estimated using the Kirpich equation (ref. 4):

$$T_o = \left(\frac{11.9 * L^2}{H_o} \right)^{0.385} \text{ in HRS.}$$

L = length of flow path in miles

H_o = difference in elevation between higher and lowest points of flow path in ft.

Ditch flow time (T_d) was determined by dividing the length of reach (L) by the average flow velocity (V_{avg}) for the reach:

$$T_d = \frac{L}{V_{avg}}$$

Ditch properties - flow depth + velocity were determined from uniform flow design charts (ref. 5, stds. 17-20).

The roughness coefficient " n " was conservatively estimated to be 0.03 for unlined ditches. (Ref. 6)

When flow velocities exceeded 7 fps, ditches were lined with synthetic liner.

(unlined ditches shall be seeded) Note that all reaches with high velocities are in cut (i.e. no berms will be needed); all eroded sediments will end up in the basin; short service life + short duration of peak flows.

— 17 for plastic liner; use n for PVC RSPC = .01

REF 8





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Project

UMTA - FCT

Contract No.

5057

Sheet

4

Feature

TEMP. SITE DRAINAGE

Designed

MSP

File No.

Item

DITCH DES.

Checked

FLW

Date

6-3-88

Date

7/8/88

Ditch side slopes = 2:1

Use 1 ft freeboard on all temp. drainage ditches.

Determination of Drainage Boundary of Ditches 1+2
near final tailings embankment:

Based on the const. sequence, Ditch 1+2 won't
be built until piles 1+2 are graded to drain
in approx. same pattern as final tailings
embankment. The upstream portions of ditch 1+2
won't be built until much of Pile 7 is graded to
drain in approx. same pattern as final embankment.
Notice that exact Pile 7 drains in almost the
same pattern as final tailings embank.

∴ Use final tailings embank. grading plan to
delineate watershed for the portion of ditches
1+2 adjacent to tailings embank



Date 7/2/88



MORRISON-KNUDSEN ENGINEERS, INC.

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Project UNITED-FCY
 Feature TEMP. DRAINAGE
 Item DITCH DES.

Contract No. 5057Designed WSPChecked FLDSheet 6File No. Date 6-6-88Date 7/8/88

DITCH 1 STA 0+00 - 35+11 $t_c = 20$
 STA 35+00 - 71+14 $t_c = 22$

CHECK DITCH 1 SUPER-ELEV. 104 @ JCT w/ DITCH 2:

 $\Delta = 40^\circ$

ALL OTHER SUPERELEVATION IS NEGLIGIBLE)

 $R = 200$

$$\text{MAX SUPER-ELEV} = S_{\text{max}} = \frac{1.15 V^2 (8 + 2(1.6))}{2g (R \cos 40^\circ)}$$

REF 7

A C-11

$$= \frac{1.15 (15)^2 (8 + 2(1.6))}{2 (32.2) (200)} = 0.3 \text{ ft}$$

→ this super-elevation will be contained
 in the 1 ft freeboard. no need to
 increase freeboard.





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Project VMTR & FLT
Feature TEMP DRAINAGE
Item DITCH DES.

Contract No. 5057
Designed MSP
Checked ELC

Sheet 7
File No. _____
Date 6-1-81
Date 7/8/82

DITCH 2

OVERLAND FLOW

$$T_{OV} = \left(\frac{11.9 (L_0)^3}{N_0} \right)^{.385}$$

$$L_0 = 600$$

$$H_0 = 447.8 - 463.7 = 34.1$$

$$T_{OV} = .0604 \quad H_0 = 3.6 \text{ MEN}$$

SEE NOTE BELOW

STM 22400 - 44483 USE VALUED TRAP CHANNEL, 2:1 SIDES $b = 4$

STM 0400 TO 22400 USE VALUED TRAP CHANNEL, 5:1 SIDES, $b = 4'$

(0400 TO 5400 SIDE VARY FROM 5:1 TO 12:1, USE 5:1)



ASSUMED t_c	VARIABLES	REACH			
		0400-5400	5400-22460	22460-28400	28400-40483 (JCT W/ DITCH 1)
19 MEN $I = 6.2$	Q VIS	7	31	158	191
	Q D/S	31	158	191	223
	S_0	.0144	.0118	.0028	.0028
	V VIS	2.8	3.8	3.7	4.3
	V D/S	4.3	6.4	3.8	4.5
	V AVE	3.6	5.1	3.8	4.4
	DEPTH (MAX)	0.9	2.0	3.1	4.1
	t_{ditch}	2.5	5.6	2.4	4.9
	AREA VIS	2.0	8.3	42.4	51.3
	AREA D/S	8.3	42.4	51.3	60.0

REF 3
TAB 7-11

$$t_c = 19 \text{ MEN}$$

NOTES: CALC VELOCITIES + t_c + DEPTHS USING 5:1 SIDES (YIELDS SAME RESULT AS 5:1 SIDES) ² THIS IS DONE TO EXPEDITE CALCS, USING DESIGN CHART.
SEE PG 7A FOR EXAMPLE





MORRISON-KNUDSEN ENGINEERS, INC.
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Project UPPER FCT
Feature TEMP. DRAINAGE
Item DITCH DES.

Contract No. 5057
Designed WSP
Checked YLD

Sheet 7A
File No.
Date 6-6-88
Date 7/8/88

EXAMPLE SHOWING THAT DEPTH CALC'D USING 4:1 SIDES
IS SAME AS THAT FOR 5:1 SIDES:

STA 28400 Q = 191

TRY D = 3.1 A = 50.84 SF ∴ V = 7.8

$$R = \frac{(b + 2D)D}{b + 2D\sqrt{1+2^2}}$$

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

REF 6

$$R = \frac{(4 + 2(3.1))3.1}{4 + 2(3.1)\sqrt{1+5^2}} = 1.697$$

$$= 1.697$$

$$V = \frac{1.486 (1.697)^{2/3} (.0028)^{1/2}}{.03}$$

$$= 3.7$$

$$\therefore D = 3.1'$$





MORRISON-KNUDSEN ENGINEERS, INC.
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Project VIETNAM-ECY
Feature TEMP DRAINAGE
Item DITCH BAS

Contract No. 5057 Sheet 8
Designed 10/80 File No.
Checked 10 Date 6-6-88
Date 7/8/88

AREA PERFECTLY TRIBUTARY TO BASIN

AREA = 5.5 AC

CLOW PATH IS ALL OVERLAND FLOW

$$T_{OV} = \left(\frac{11.9 (L_o)^3}{H_o} \right)^{.385} \quad L_o = 750$$

$$H_o = 53.5 - 31 = 22.5$$

↑
TOP OF BASIN

$$T_{OV} = .0821 \quad RR = 5 \quad MIN = t_c$$

DITCH 4

CLEAN WITH
(DOVENS 20W DITCH)

OVERLAND FLOW

$$T_{OV} = \left(\frac{11.9 (L_o)^3}{H_o} \right)^{.385}$$

$$L_o = 665, \quad H_o = 88.2 - 72 = 16.2$$

$$T_{OV} = .0811 \quad RR = 9.9 \quad MIN$$

DITCH FLOW

V DITCH 2:1 SIDES UNGRADED

ASSUMED TL	VARIABLES	REACH
		0100 TO #435
7 MIN I = 9.8	Q _{UIS}	2
	Q _{DIS}	24
	S _o	.01
	V _{UIS}	2.2
	V _{OIS}	4.1
	V _{AVE}	3.2
	DEPTH (MAX)	1.7
	t _{DITCH}	2.3
	AREA _{UIS}	0.3
	AREA _{DIS}	4.0

$$Y = \left(\frac{Q_n}{1.74 \cdot 5^{1/2}} \right)^{3/8}$$

REF 3
TAB 7-10

$$\therefore t_c = 7 \text{ MIN}$$





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A MORRISON-KNUDSEN COMPANY

Project UNPLA - FLT
Feature TEMPORARY SITE DRAINAGE
Item DITCH DES.

Contract No. 5057
Designed 1/1/88
Checked 2/10

Sheet 9
File No. 6-16-88
Date 7/4/89

CALCS

DITCH 3

t_c

OVERLAND FLOW: $L < 1000'$ $H = 30'$

$$t_{OV} = \left(\frac{11.9 L^3}{H} \right)^{.385} = .1025 \text{ HR} = 6.2 \text{ MIN}$$

REF. 4

(L IN FEET)

UNLEINED

DITCH FLOW:

TRAP CHANNEL $Z = 2:1$ $b = 4$

ASSUMED					
t_c	VARIABLES	REACH		AT 50' TO WW	
		XY = WW	WW = YY	A A A YY = 19.8 AL	
				A A A XX = 6.5 AL	
14 MIN					
$I = 7.3$	Q ULS	28	43		
	Q D/S	43	87		
	S_o	.002	.002		
	V ULS	2.4	2.7		
	V D/S	2.7	3.2		
	V AVG	2.6	3.0		
	L	230	1110		
	DEPTH (MAX)	2.0	2.9		
	n	.03	.03		
	t_{DITCH}	1.5	6.2		

USE

$$\Rightarrow t_c = 14 \text{ MIN}$$

AT 50' UPSTREAM OF XY BEGIN TRANSITION FROM TRAP CHANNEL
WITH $b = 4$, TO A $b = 25$ (MINIMUM) @ XY



PROJECT: STAX - ECT
 NAME: TEMPORARY SILL DRAINAGE
 DATE: DITCH DES.

Contract No. _____
 Designed AMP
 Checked KIC

Sheet 10
 File No. _____
 Date 6-16-83
 Date 7/8/84

DITCH 3:

CHECK SUPERELEVATION @ CURVE UPSTREAM OF YY

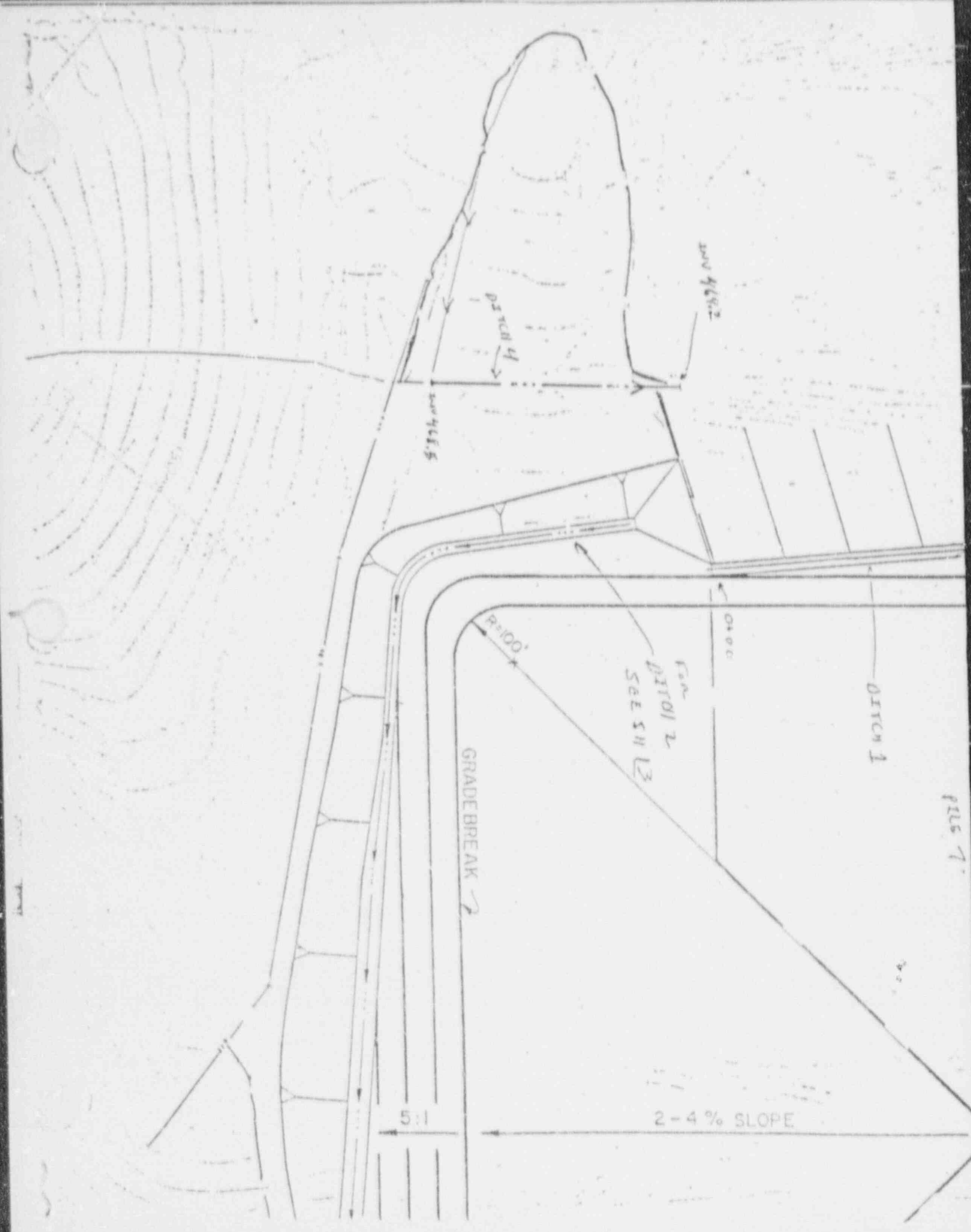
$$\Delta E = 32.0 \quad \text{USE RADIUS} = R = 75'$$

$$S_{\text{max}} = \text{MAX SUPERELEV.} = \frac{1.15 V^2 (6 + 2.2 D)}{2 g R}$$

REF 7
 P.C. 11

$$S_{\text{max}} = \frac{1.15 (3.2)^2 (4 + 2(2)(2.9))}{2 (32.2)^{.75}} = .04'$$

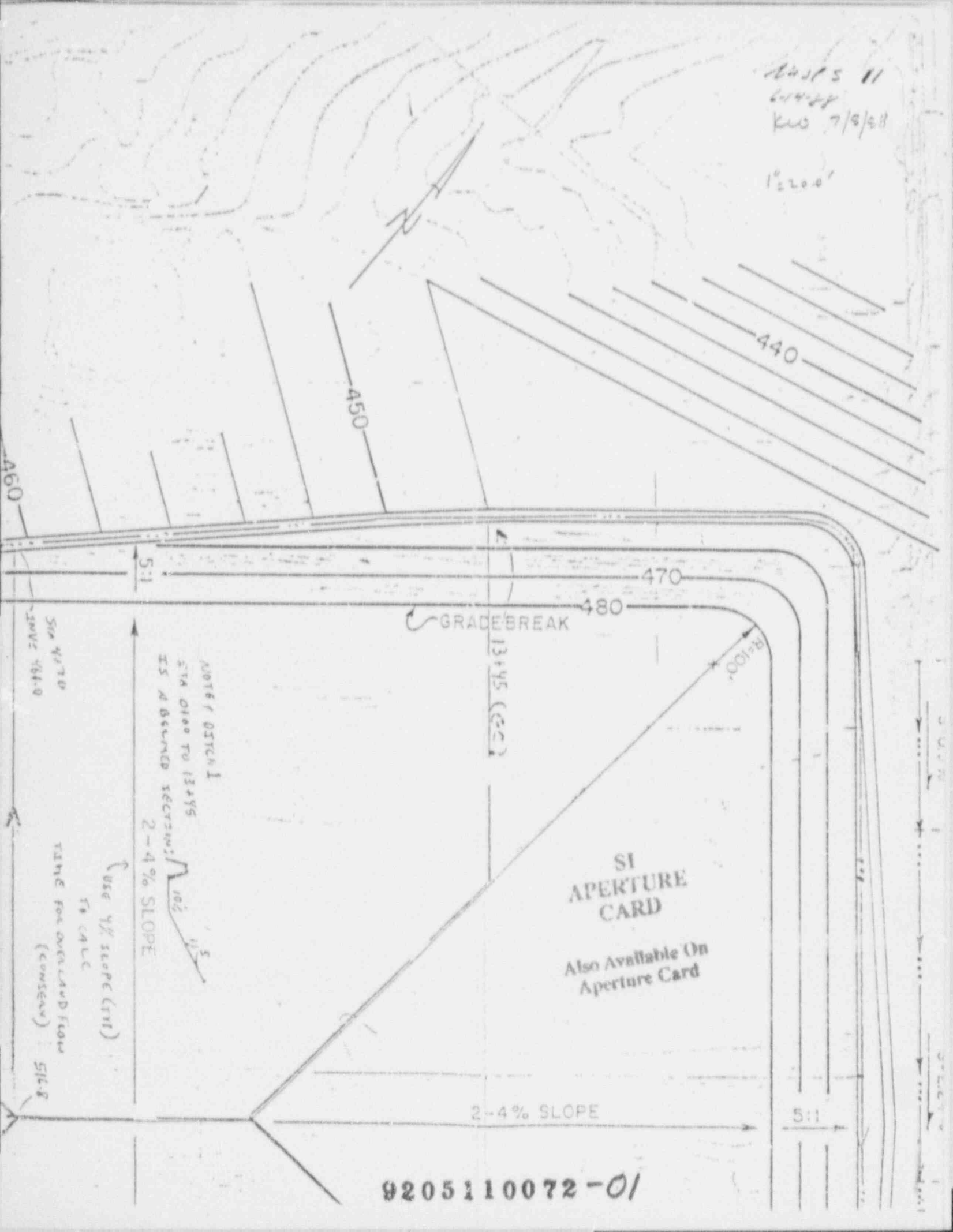
NEGLIGIBLE, USING
 SUPER ELEV.



FILE 7

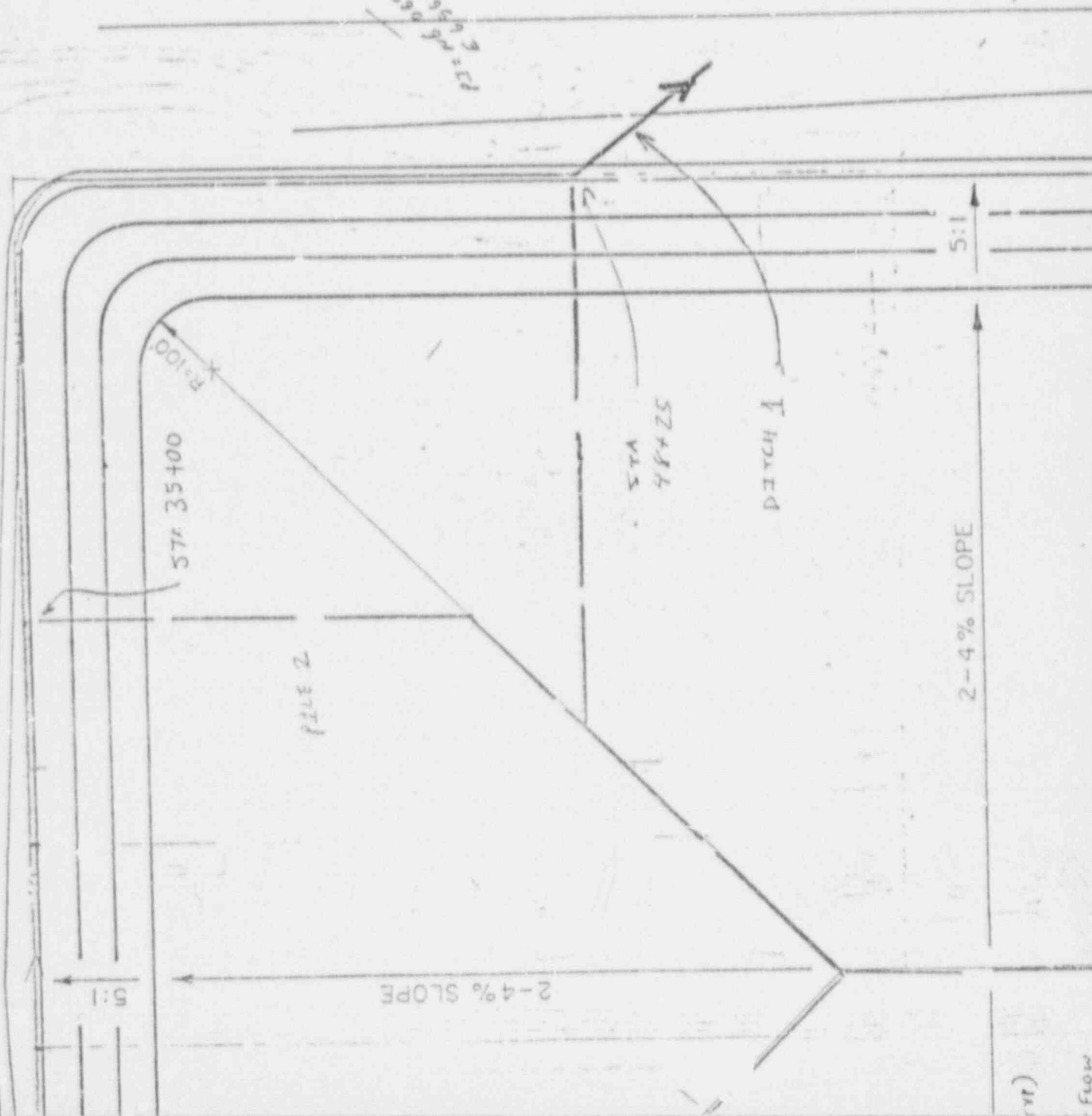
24515 11
6/4/58
K10 7/8/58

1"=200'



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CARD
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9205110072-01



STN 35+00

FILE 2

3.95×0.695
 2.74525
 2.75

CONT ON
 SH 14

(vr)
 FLOW

5112

ANSP 6-14-88

ENC 7/8/98

--- DRAINAGE
--- BOUNDARY

→ IGNORE THESE
CONTOURS, THEY
GIVEN WILL NOT
BE DONE UNTIL
ALL OTHER WORK
IS COMPLETE &
TEMP DRAINAGE
FACILITIES
ARE REMOVED.

FOR ITEM 2
SEE 511/3

SI
APERTURE
CARD

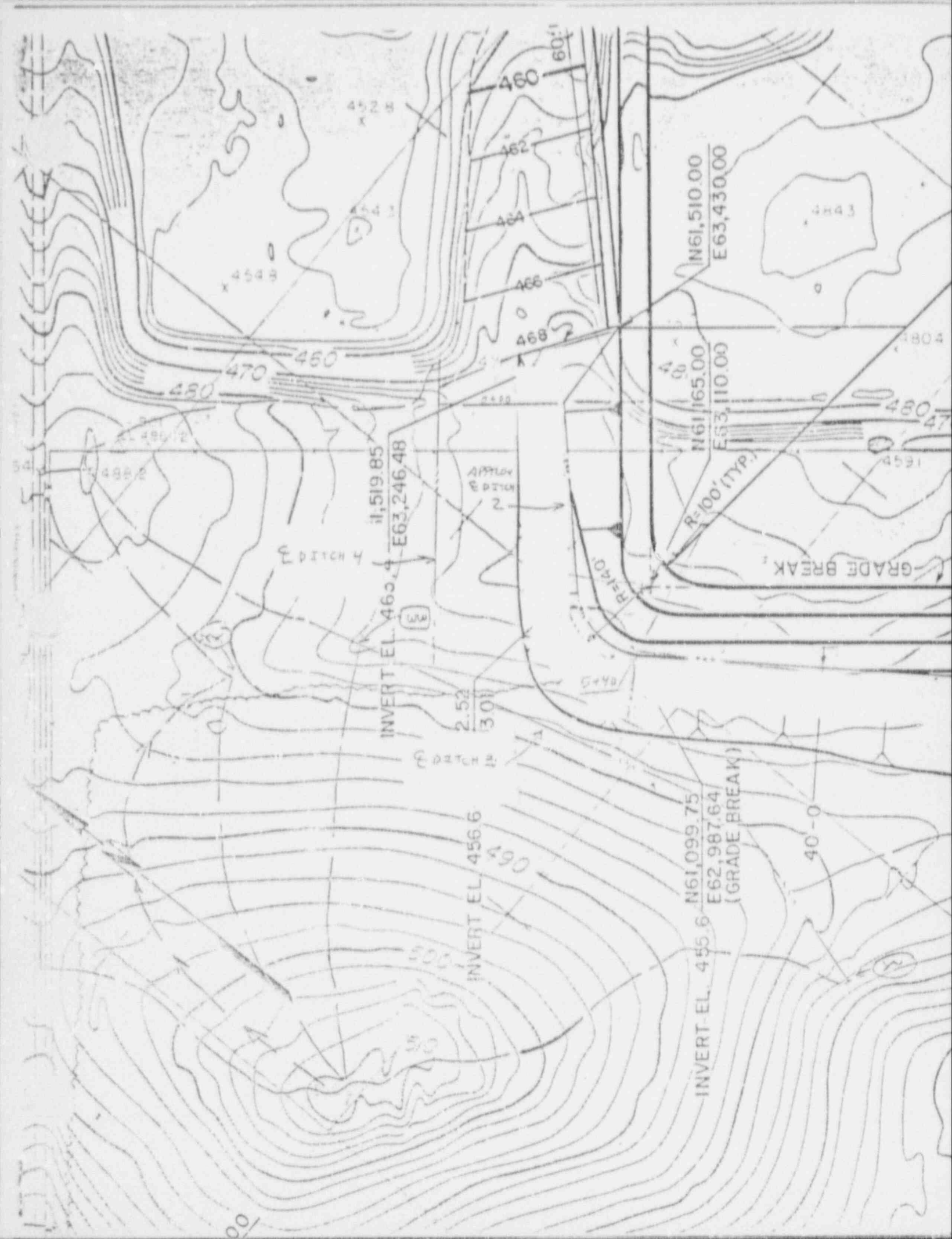
Also Available On
Aperture Card

FIG 1

2-4% SLOPE

5:1

9205110072-02



USDA Forest Service

11/11/11

00

INVERT EL. 460.4
E63,246.48
11,519.85

2.52
301

INVERT EL. 456.6

INVERT EL. 455.6
N61,099.75
E62,987.64
(GRADE BREAK)

N61,165.00
E63,110.00

N61,510.00
E63,430.00

R=100'(TYP.)

GRADE BREAK

APPROX
SECTION
2

DITCH 4

DITCH 2

490

40-0

5+40

R=140'

4591

4804

4804

4843

468

466

464

462

460

60'

480

470

460

4543

4523

4543

4532

4512

4512

4512

4512

4512

4512

4512

4512

4512

TAILING

2-4% SLOPE

5:1

B
0412

N60,429.28
E63,476.89

N60,103.24
E63,708.62

N59,768.00
E63,953.24

N59,335.40
E64,165.80
(GRADE BREAK)

N59,755.00
E64,280.00

N59,560.00
E65,440.00

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CARD

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9205110072-03

CONT ON SH 14

MATCH

5113
4011/6-14-18
K20 7/8/85



DRAINAGE — RUNOFF — 2

Q = Aci RATIONAL FORMULA (Logical approach).

Q = RUNOFF = Peak discharge of watershed in cubic feet per second (c.f.s.) due to maximum storm assumed. See Figs. A to F, Pg. 18-01 (Usually 10-25 years).

A = Area of watershed in acres.

C = Coefficient of runoff, Table B (Measure of losses due to infiltration, etc.).

i = Intensity of rainfall in inches per hour based on concentration time. See Pg. 18-01. Concentration time = time required for rain falling at most remote point to reach discharge point. Concentration time may include overland flow time, Fig. H, Pg. 18-01, and Channel flow time, Pg. 18-05, 18-06, 18-69 and 18-71.

TABLE A-COMPUTATION FORM FOR RATIONAL FORMULA.

LOCATION			A		TIME OF FLOW - MIN.			DESIGN							PROFILE					
STREET	FROM	TO	INCR	TOTAL	C	TO INLET	IN CHAN	TIME OF CONC	L	Q	CHAN- NEL OR PIPE SIZE	SLOPE ft. per ft.	n	CAPA- CITY FULL C.F.B.	V ft. per SEC.	LENGTH ft.	FALL ft.	OTHER LOSSES ft. +	INV. ELEV. UPPER END	INV. ELEV. LOWER END
FIRST ST.	A	B	1.8	1.8	.44	165	0.3	165	3.8	30	15"	.008	.015	4.6	3.9	60	0.48	0	82.00	81.52
MAIN RD.	B	C	1.9	3.7	.50		2.5	168	3.7	68	D-2	.011	.030	12.0	2.8	120	4.62	0	81.52	76.90
" "	C	D	2.0	5.7	.50		1.8	193	3.5	100	21"	.007	.015	11.1	4.5	480	3.36	2.20	74.70	70.34

* Note that the sequence of design as in example, Fig. J, Pg. 18-01 involves trial assumptions in determining i.

+ Fall in manhole.

TABLE B-VALUES OF C = $\frac{\text{RUNOFF}}{\text{RAINFALL}}$

SURFACES			RAIN FALL		PROPOSED AUTHORITY	
			MIN.	MAX.	MIN.	MAX.
ROOFS, sloped to metal.			0.90	1.00	0.70	0.95
PAVEMENTS	Concrete or Asphalt.		0.90	1.00	0.95	1.00
	Bituminous Macadam, open and closed type.		0.70	0.90	0.70	0.90
	Gravel, from clean and loose to clayey and compact.		0.25	0.70	0.15	0.30
R. R. YARDS			0.10	0.30	0.10	0.30
EARTH SURFACES	SAND, from uniform grain size, no fines, to well graded, some clay or silt.	Bare	0.15	0.30	0.01	0.55
		Light Vegetation	0.10	0.40	0.01	0.55
		Dense Vegetation	0.05	0.30	0.01	0.55
	LOAM, from sandy or gravelly to clayey.	Bare	0.20	0.60		
		Light Vegetation	0.10	0.45		
		Dense Vegetation	0.05	0.35		
	GRAVEL, from clean gravel and gravel sand mixtures, no silt or clay to high clay or silt content.	Bare	0.25	0.65		
		Light Vegetation	0.15	0.50		
		Dense Vegetation	0.10	0.40		
	CLAY, from coarse sandy or silty to pure colloidal clays.	Bare	0.30	0.75	0.10	0.70
		Light Vegetation	0.10	0.60	0.10	0.70
		Dense Vegetation	0.15	0.60	0.10	0.70
COMPOSITE AREAS	City, business areas.		0.60	0.75	0.60	0.95
	City, dense residential areas, vary as to soil and vegetation.		0.50	0.65	0.30	0.60
	Suburban residential areas.		0.35	0.55	0.25	0.40
	Rural Districts.		0.10	0.25	0.10	0.25
	Parks, Golf Courses, etc.		0.10	0.35	0.05	0.25

NOTE: Values of "C" for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice.

① Bryant & Kuichling, Report, Back Bay Sewerage District, Boston, 1909.

② Metcalf and Eddy, American Sewerage Practice, 1928. M^s Graw-Hill.

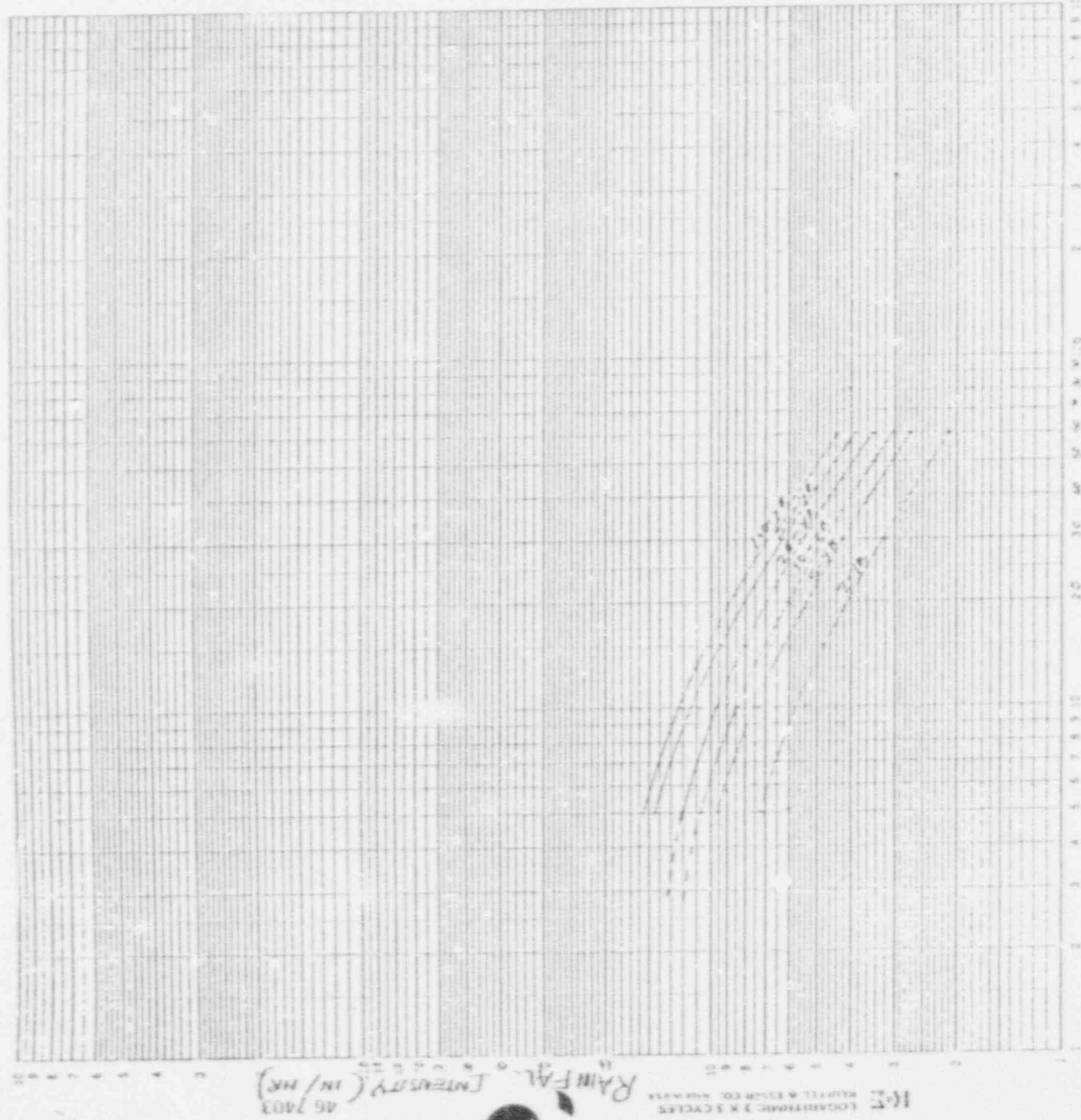
③ Used by City of Boston, reported by Metcalf & Eddy.

④ Used by City of Detroit, reported by Metcalf & Eddy.

⑤ L. C. Urquhart, Civil Engineering Handbook, 1940. M^s Graw-Hill.

ULTRA-FET
SITE HYDROLOGY-TEMPERARY DRAINAGE

Loc. 2101/10
THIRPALLU
Sht. 16



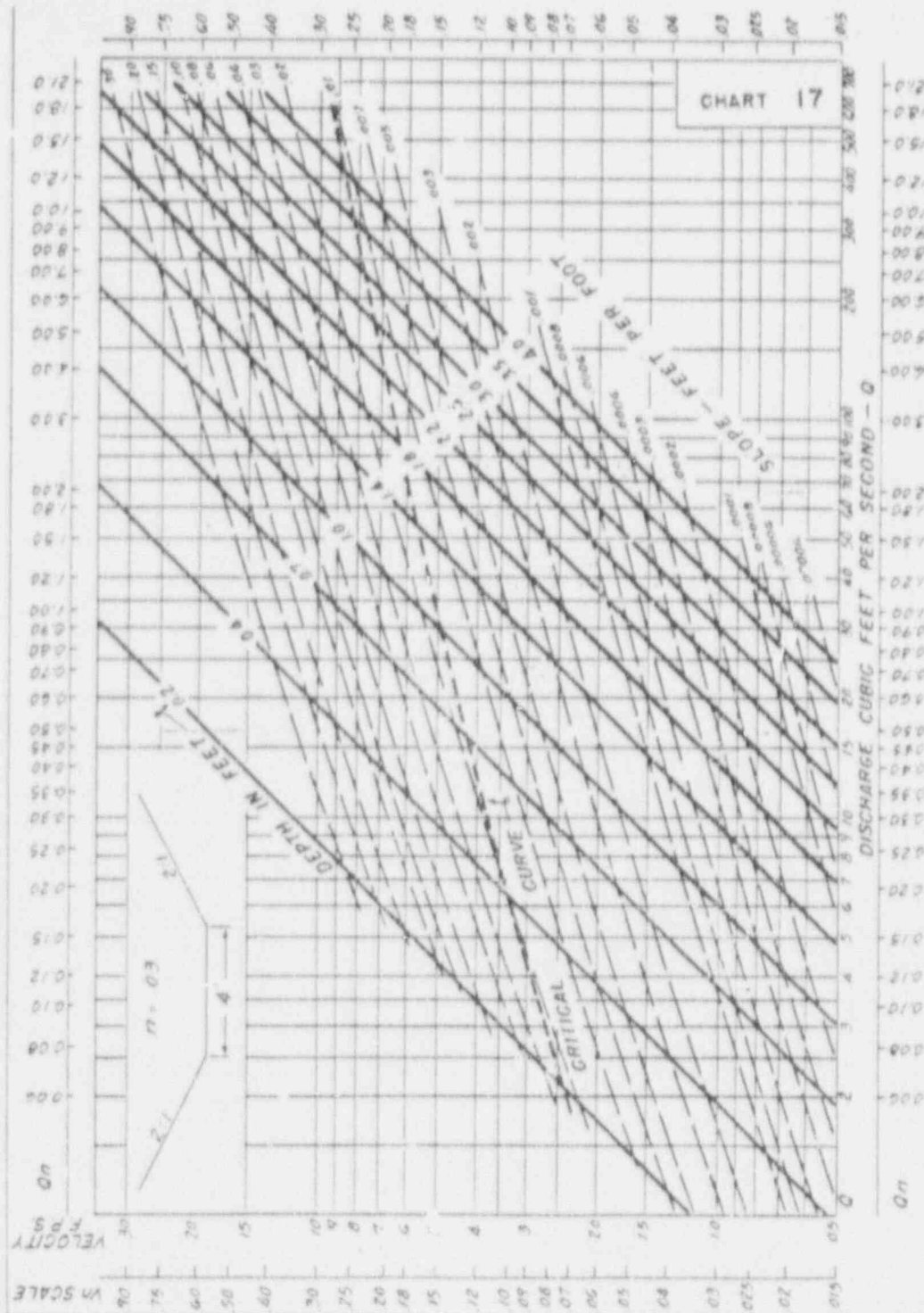
DURATION (in.)

REF. 1

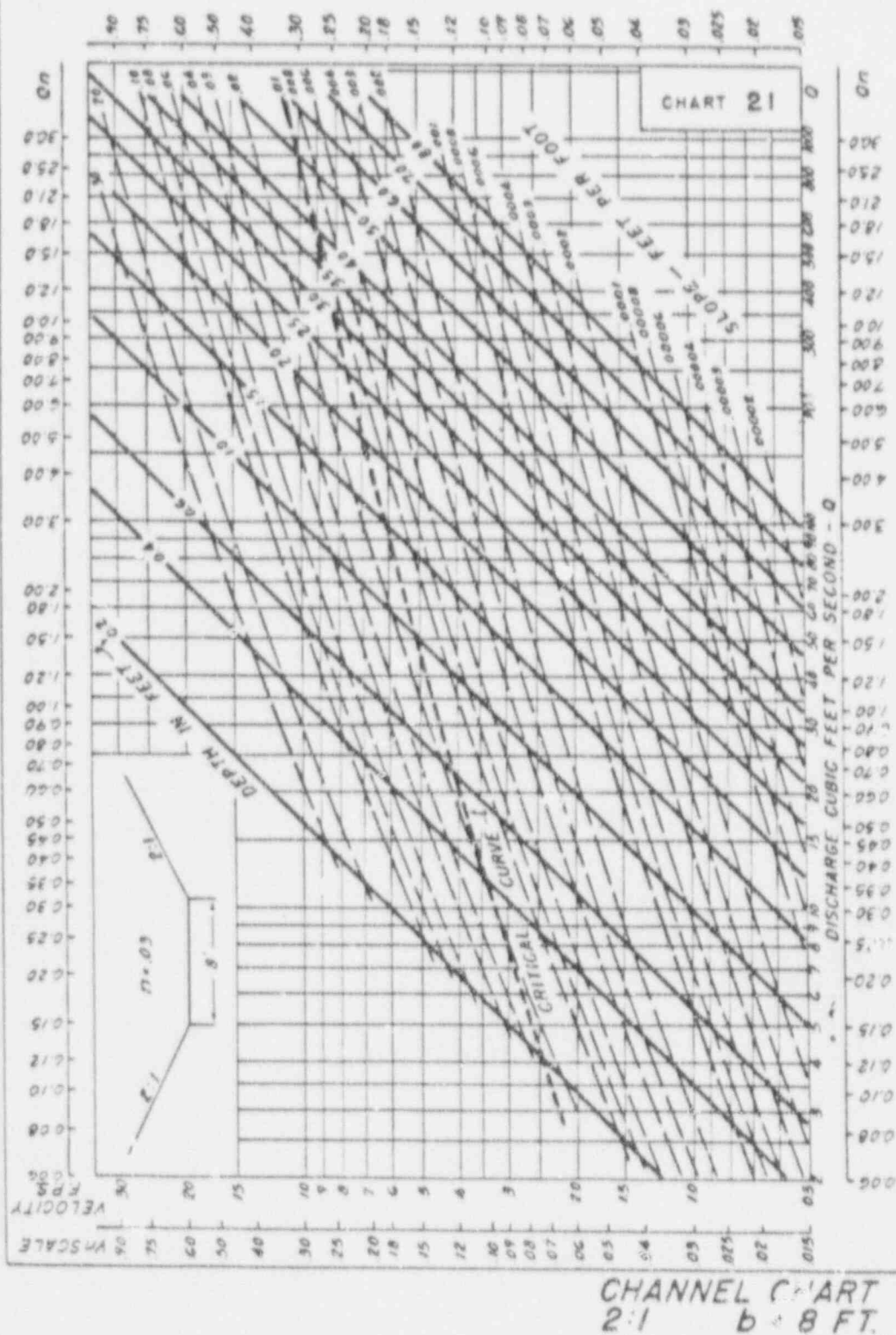
UMTRA-ECT
TEMP SITE DRAINAGE

DRM 3/24/88
MIP 3-28-88

SH 17



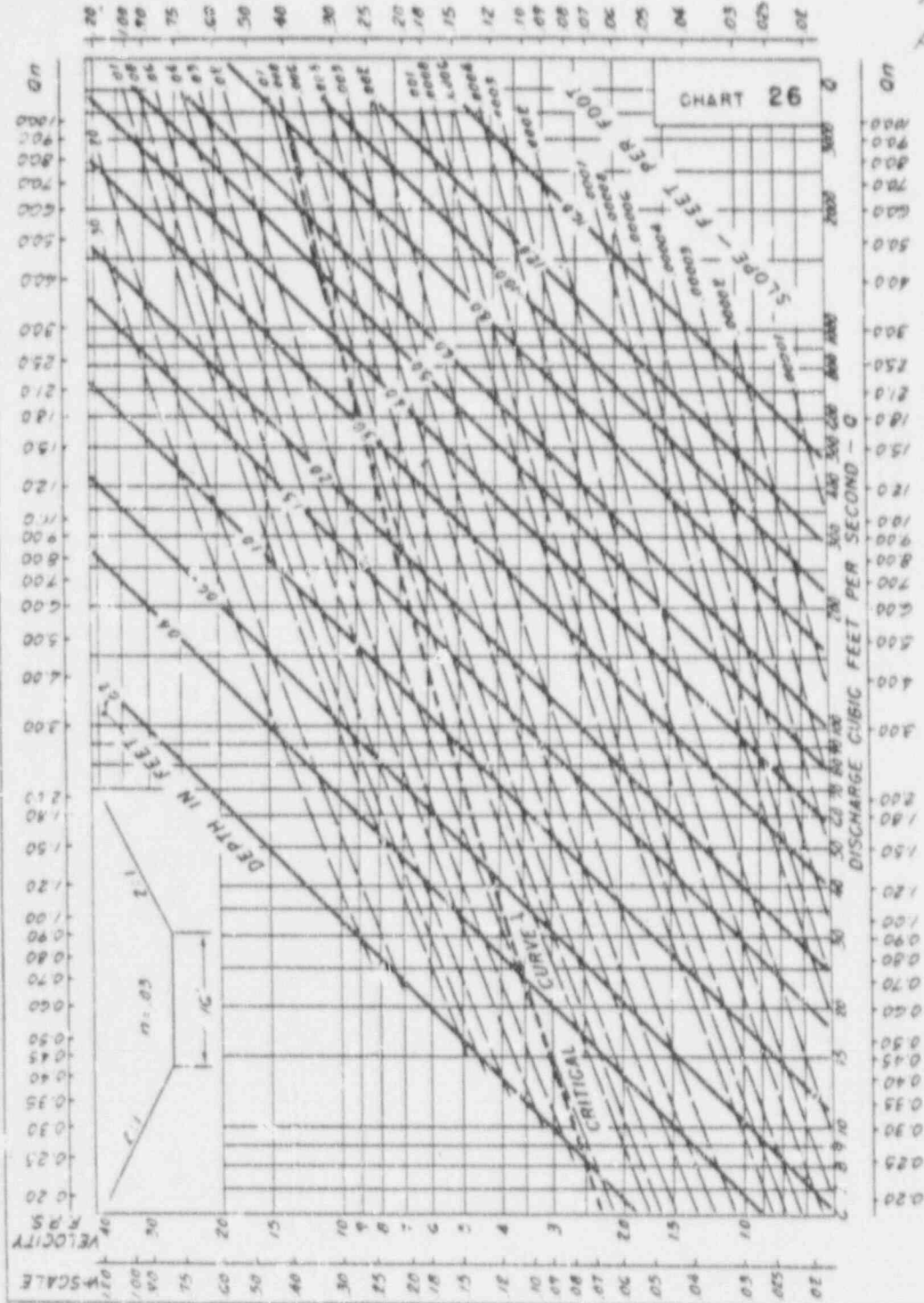
MSJ 608
Kno 7/8/88



5419

WJ 6-6-68

KLO 7/8/98



CHANNEL CHART
2:1 b = 16 FT.

Calculation Cover Sheet

Contract No. 5057-04Discipline ESC1Calc. No. 20-433-06-01No. of Sheets 49

Project

VMTRA - FCT

Feature

RETENTION BASIN

Item

GENERAL

Sources of Data

Sources of Formulae & References

1. MKE Calc # 20-433-02-00 Site Hydrology & Temporary Drainage.
2. McCuen, R.H. & Smith, L. Hydrologic Analysis Using SCS Methods. 1982, Prentice Hall.
3. US Dept of Energy. Remedial Action Plan & Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site Near Jolla City, TX. Draft 10-1987 MKE Doc# 5057-FCT-R03-00088-00
4. Rawls, W.L., Brakensiek, D.L., et al., "Green-Ampt Infiltration Parameters for Soil Data" Journal of Hydrologic Division, Vol 109, No 1 ASCE, New York Jan 1983.

Preliminary Calc. ☒Final Calc. ☒

Supersedes Calc. No. _____

C1	THIS ADDENDUM ON DEWATERING VOLUME	REVIEW	12/2/87	FLS	7/19/89	2/10/89	
0		1. INQUIRY	7/7/88	FLS	4/18/88	7/16/88	
		REVIEW	4/12/88	K.L. OHSIDE	7/18/88	7/16/88	
REV NO	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



MORRISON-KNUDSEN ENGINEERS, INC.

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UTAH FCT

Project

Feature

Item

RETENTION BASIN

GENERAL

Contract No. 5057

Designed MIP

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Sheet a

File No.

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Date

5. MKE Calc NO 20-433-05-00 Temporary Drainage, Drainage
Outlet Design.
6. U.S. Dept of Interior, Office of Surface Mining Sept 1982
Surface Mining Water Diversion Manual 054/02-8212
7. MKE Calc # 20-433-08-00 Retention Basin, Dewatering Volumes.
8. Ling & Brater Handbook of Hydraulics 6TH ED 1976 McGraw-Hill
9. MKE Doc # 4005-GEN-Q-21-00684-00 Santa Barbara Urban
Hydrograph - A rainfall-runoff model.
10. MKE Calc # 20-433-04-00 Temporary Drainage - Water Balance Study
11. MKE Calc # 20-433-01-00 Retention Basin - Sediment Volume.





MORRISON-KNUDSEN ENGINEERS, INC.
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Project: UMYGA-ECT
Feature: RETENTION BASIN
Item: _____

Contract No. 5057
Designed: HSP
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Sheet 1
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CONTENTS

I. SUMMARY & DISCUSSION	PG. 1a
II. 10yr 24 hr STORM	PG. 1b
III. BASIN SIZING	PG. 25
IV. 25yr 6hr STORM	PG. 29
I SPILLWAY COMPUTER RUN	PG. 35





MORRISON-KNUDSEN ENGINEERS, INC.

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Project UMTA - ECT
 Feature RETENTION BASIN
 Item SUMMARY & DISCUSSION

Contract No. 5057Designed MLPChecked LioSheet 1a

File No. _____

Date 4-18-88Date 7/5/89METHODOLOGY

Non-Accumulating Design is used for basins.

REF 10

Basin Designed to hold 10yr 24hr runoff volume,
 max runoff from 1 event contributing*, sediment
 volume for entire construction period; Spillway elev^a

Spillways are designed to convey 25yr 6hr runoff
 (after reservoir routing) with 1ft freeboard.

Runoff volumes, flowrates & reservoir routing were generated
 using Santa Barbara Urban Hydrograph (modified
 to perform reservoir routing) REF 9 & given impd
 infiltration parameters.

Additional discussion is found in each calc. section

* to max monthly runoff.

^a shall be elev. corresponding to this volume, plus 6".





MORRISON-KNUDSEN ENGINEERS, INC.

Project UNITRA-ECT
Feature RETENTION BASIN
Item 10-yr - 24 hr storm

Contract No. 5057Designed DRMChecked AKPSheet 16File No. Date 2/11/88Date 4/12/88

CALCULATION - RUNOFF ESTIMATE FOR 10-YR. 24-HR DESIGN STORM

1. GENERAL

A. Rainfall Distribution:

1. The 10-yr, 24-hr precipitation was determined in reference 1 (calc. no. 20-433-02-00) and was determined to be 6.7 inches.
2. The 10-yr, 24-hr precipitation was then temporally distributed by using the SCS Type II distribution (ref. 2). A copy of the SCS type II distribution is included on sheet 4.
3. The rainfall distribution is shown on sheets 2-3.
4. Incremental rainfall (inches) was then entered into the SBUHYD computer program.
5. TIME OF CONCENTRATION FROM REF 5





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Project WATER - ECTFeature RETENTION BASINItem 10yr - 24hr STORMContract No. 5037Designed DRMChecked MLPSheet 2File No. Date 2/18/88Date 8-12-88

A. (Continued)

DISTRIBUTION OF RAINFALL

Time (Hr)	Precipitation Ratio	Precipitation (inches)	
		Cumulative	Incremental
0.0	0.0000	0.0000	0.0000
0.5	0.0053	0.0355	0.0355
1.0	0.0109	0.0724	0.0369
1.5	0.0164	0.1099	0.0375
2.0	0.0223	0.1494	0.0395
2.5	0.0284	0.1903	0.0409
3.0	0.0347	0.2325	0.0422
3.5	0.0414	0.2774	0.0449
4.0	0.0483	0.3236	0.0462
4.5	0.0555	0.3719	0.0483
5.0	0.0632	0.4234	0.0515
5.5	0.0712	0.4770	0.0536
6.0	0.0797	0.5340	0.0570
6.5	0.0887	0.5943	0.0603
7.0	0.0984	0.6593	0.0650
7.5	0.1089	0.7296	0.0703
8.0	0.1203	0.8060	0.0764
8.5	0.1328	0.8898	0.0838
9.0	0.1467	0.9929	0.0931
9.5	0.1625	1.0888	0.1059
10.0	0.1808	1.2114	0.1226
10.5	0.2042	1.3681	0.1567
11.0	0.2351	1.5752	0.2071
11.5	0.2833	1.8981	0.3229
12.0	0.6632	4.4434	2.5453
12.5	0.7351	4.9252	0.4818





MORRISON-KNUDSEN ENGINEERS, INC.

Project LMRA - PCT
 Feature RETENTION BASIN
 Item 10yr - 24 hr storm

Contract No. 5037Designed DRMChecked MLPSheet 2File No. Date 2/18/88Date 4/1/88

A. (Continued)

DISTRIBUTION OF RAIN FALL

Time (Hr.)	Precipitation Ratio	Precipitation (inches)	
		Cumulative	Incremental
13.0	0.7724	5.1751	0.2499
13.5	0.7989	5.3526	0.1775
14.0	0.8197	5.4920	0.1394
14.5	0.8380	5.6146	0.1226
15.0	0.8538	5.7205	0.1059
15.5	0.8676	5.8129	0.0924
16.0	0.8801	5.8967	0.0838
16.5	0.8914	5.9724	0.0757
17.0	0.9019	6.0427	0.0703
17.5	0.9115	6.1070	0.0644
18.0	0.9206	6.1680	0.0610
18.5	0.9291	6.2250	0.0570
19.0	0.9371	6.2786	0.0536
19.5	0.9446	6.3288	0.0502
20.0	0.9519	6.3777	0.0489
20.5	0.9588	6.4240	0.0463
21.0	0.9653	6.4675	0.0435
21.5	0.9717	6.5104	0.0429
22.0	0.9777	6.5506	0.0402
22.5	0.9836	6.5901	0.0395
23.0	0.9892	6.6276	0.0375
23.5	0.9947	6.6645	0.0369
24.0	1.0000	6.7000	0.0355





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Project CH-12-ELT
 Feature RETENTION BASIN
 Item 10yr - 24hr STORM

Contract No. 5057Sheet 4Designed DRHFile No. Checked RAHDate 2/11/89Date 4/1/88

TABLE 1. Ordinates of the SCS Type I and Type II Precipitation Distributions

Storm Time (hours)	Precipitation Ratio	
	Type I *	Type II *
0.0	0.000	0.0000
0.5	0.008	0.0053
1.0	0.017	0.0108
1.5	0.026	0.0164
2.0	0.035	0.0221
2.5	0.045	0.0284
3.0	0.055	0.0347
3.5	0.065	0.0411
4.0	0.076	0.0481
4.5	0.087	0.0551
5.0	0.099	0.0632
5.5	0.122	0.0717
6.0	0.125	0.0757
6.5	0.140	0.0807
7.0	0.151	0.0984
7.5	0.174	0.1089
8.0	0.194	0.1203
8.5	0.215	0.1328
9.0	0.254	0.1467
9.5	0.300	0.1625
10.0	0.515	0.1808
10.5	0.581	0.2042
11.0	0.624	0.2351
11.5	0.654	0.2833
12.0	0.682	0.6632
12.5	0.705	0.7351
13.0	0.727	0.7724
13.5	0.748	0.7989
14.0	0.767	0.8197
14.5	0.784	0.8380
15.0	0.800	0.8538
15.5	0.816	0.8676
16.0	0.830	0.8801
16.5	0.844	0.8914
17.0	0.857	0.9019
17.5	0.870	0.9115
18.0	0.882	0.9206
18.5	0.893	0.9291
19.0	0.905	0.9371
19.5	0.916	0.9446
20.0	0.926	0.9519
20.5	0.936	0.9588
21.0	0.946	0.9653
21.5	0.955	0.9717
22.0	0.965	0.9777
22.5	0.974	0.9836
23.0	0.983	0.9892
23.5	0.992	0.9947
24.0	1.000	1.0000

* Type I - applicable to Hawaii, Alaska, coastal side of the Sierra Nevada & Cascade mountains in Calif., Oregon and Washington.
 Type II - standards of the U.S., Puerto Rico and the Virgin Islands.





Project ULTRA - ECT
 Feature RETENTION BASIN
 Item 10yr - 24 hr storm

Contract No. 5057
 Designed DEM
 Checked ML

Sheet 5
 File No. _____
 Date 2/29/77
 Date 4/1/77

8.

SOIL PARAMETERS

1. The SBUHYD computer program requires four soil parameters as input:

initial volumetric moisture content = $IVMC$
 saturated volumetric moisture content = $SVMC$
 soil suction head = ψ_f
 hydraulic conductivity = K

2. Three types of tailings materials will be excavated and relocated to the final embankment area:

Sand tailings
 sand-slime tailings } from Ref. 2
 Slime tailings

3. Soil parameters $IVMC$, $SVMC$, ψ_f , and K were determined for in-situ soil conditions for the final embankment and excavation areas (more conservative estimates of volume of runoff will be obtained).
4. Nine samples for each type of tailings were used to determine average values for water content (w) and dry unit weight (γ_d). These samples were the following:





Project WATER - ECT
 Feature RETENTION BASIN
 Item 10yr - 24hr storm

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 Designed DRM
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4. (CONT'D)

Sand	Tailings	Sand-Slime	Tailings	Slime	Tailings
Location	Sample	Location	Sample	Location	Sample
20	02	18	3B	18	4A
32	2A		4B		5A
	2B	32	2C		5B
	3B	43	2B	19	02
	04	46	3A	29	01
43	2B		3B	24	2A
	03		3C		2C
46	2B	83	7A		2C
54	02		7B	93	5A

5. Average values w and γ_d were determined as follows:

$$w = \frac{\sum \text{Sample Moisture Content}}{\text{No. of Samples}}$$

$$\gamma_d = \frac{\sum \text{Sample Dry Unit Weight}}{\text{No. of Samples}}$$

Refer to
 Tables
 D.4.7-64.9
 for Sample
 moisture
 content &
 dry unit weight
 (Stats. 15-17)

Average values are the following:

$$w = 54.6\%$$

$$\gamma_d = 65.9 \text{ pcf}$$





MORRISON-KNUDSEN ENGINEERS, INC.

Project

UMTRA - EST

Feature

RETENTION BASIN

Item

10 yr - 24 hr storm

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5057

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DRM

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HID

Sheet

7

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Date

2/29/83

Date

4/12/83

6. An average specific gravity (G_s) was determined from the following samples:

Location	Sample	(From Table D.4.5, Ref. 3)
020	02	
032	2B	
036	1C	
046	3B	

The average specific gravity was determined as follows:

$$G_s = \frac{\sum \text{Sample Specific Gravity}}{\text{No. of Samples}}$$

The average specific gravity G_s is:

$$\underline{G_s = 2.65}$$

7. From the average values of w , G_s , and γ_d the initial vol. moisture content $IVMC$ was determined:

definition: $IVMC = \frac{V_w}{V_T} = \frac{\text{Vol. of water in soil voids}}{\text{total volume}}$

Solve for e : $\gamma_d = \frac{G_s \gamma_w}{1+e} \Rightarrow e = \frac{G_s \gamma_w}{\gamma_d} - 1$

$$e = \frac{2.65 * 62.4}{65.9} - 1 = 1.51$$

e = void ratio

γ_w = unit wght. of water = 62.4 pcf





MORRISON-KNUDSEN ENGINEERS, INC.

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UMTRA-FET

Feature

RETENTION BASIN

Item

10yr - 24hr storm

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HCP

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4/1/88

7. (CONT'D)

Solve for V_v : $V_T = V_v + V_s$

(1) $V_v = V_T - V_s = 1 - V_s$

 V_v = vol. voids V_s = vol. solids V_T = total unitvol. = 1 ft³

Substitute $V_s = \frac{V_v}{e}$ into (1) & solve for V_v :

$$V_v = \frac{1}{1 + \frac{1}{e}} = \frac{1}{1 + \frac{1}{1.51}} = 0.60$$

Solve for Degree of Saturation (S): $S e = w G_s \Rightarrow S = \frac{w G_s}{e}$
 $S = \frac{0.546 \times 2.65}{1.51} = 0.958$

Solve for V_w : $S = \frac{V_w}{V_v} \Rightarrow V_w = S V_v = 0.958 \times 0.60 = 0.57$

By Definition: $IVHC = \frac{V_w}{V_T} = \frac{0.57}{1} = 0.57$

8. The saturated volumetric moisture content $SVMC$ is equal to the porosity n , for saturated conditions. $SVMC$ was determined from the void ratio e :

$$SVMC = n = \frac{e}{1 + e} = \frac{1.51}{1 + 1.51} = 0.60$$

9. The soil suction head (ψ_f) was determined from ref. 4, table 2. The soil texture class was assumed to be sandy clay loam.

The value of ψ_f was determined to be 23.90 cm. (see sheet 19 for copy of table 2).





Project CHIRA-FET
 Feature RETENTION BASIN
 Item 10yr - 24hr STORM

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10. The saturated hydraulic conductivity K was determined from table 2 (sheet 19).

$$K = 0.15 \text{ cm/hr} = 0.059 \text{ in/hr}$$

11. Summary of Soil Parameters:

$$SVMC = 0.60$$

$$IVMC = 0.57$$

$$K = 0.059 \text{ in/hr}$$

$$\psi_f = 9.4 \text{ in}$$

C. TIME OF CONCENTRATION

1. Calculations for time of conc. T_c are included in the temporary drainage design calculation (calc no. 20-433-05-00).
2. Refer to temporary drainage design calculation for drainage plan and description of flow paths.



UNCLASSIFIED

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MJA 4-12-91

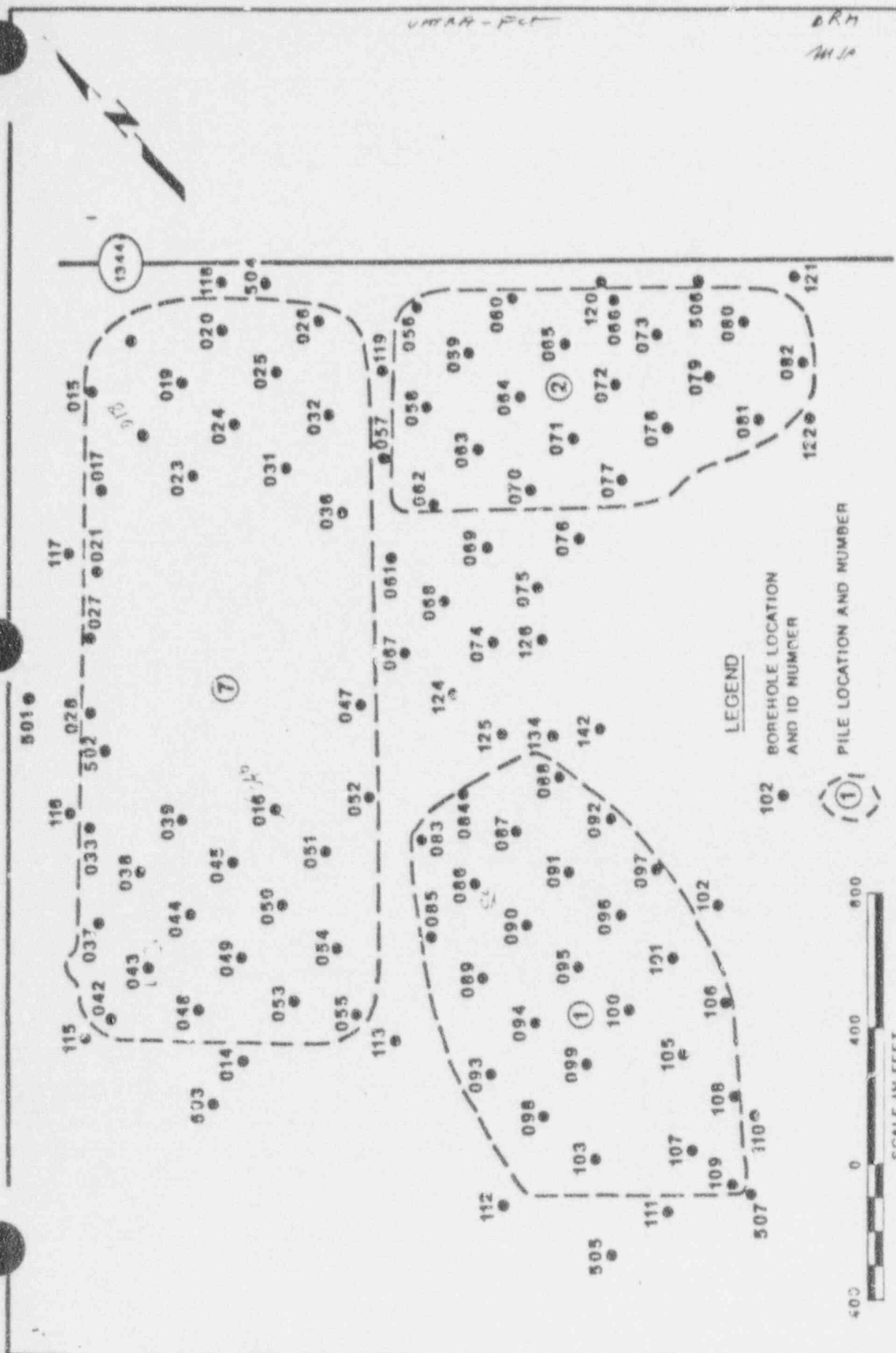


FIGURE 3.11a
BOREHOLE LOCATIONS AT THE FALLS CITY TAILINGS SITE
NEAR FALLS CITY, TEXAS

DRM 2/11/88

HSP 4/12/88

SH 11

Table D.4.6 Summary of in-situ foundation material natural moisture content and unit weight

Location ID	Sample ID	Sample depth (ft)	Moisture content (%)	Dry unit weight (pcf)
24	2B	37.4 - 37.9	40.9	78.4
83	11	22.2 - 22.7	37.0	84.5
54	3A	25.5 - 26.0	31.7	90.3
	3B	26.0 - 26.5	28.3	95.7
	04	34.1 - 34.6	43.8	73.9
72	6B	21.5 - 22.0	42.6	77.1
502	3A	20.0 - 20.5	27.7	95.7
	3B	20.5 - 21.0	35.4	84.3
	3C	21.0 - 21.5	37.0	82.3
Average for use in design:			36.0	84.7

Table D.4.7 Summary of sand tailings, natural moisture content, and unit weight

Location ID	Sample ID	Sample depth (ft)	Moisture content (%)	Dry unit weight (pcf)
20	02	8.0 - 10.0	11.4	83.0
32	2A	6.3 - 6.8	13.2	82.7
	2B	6.8 - 7.3	16.1	80.0
	3B	9.0 - 9.5	19.2	76.7
	04	10.0 - 10.5	30.5	85.3
43	2B	9.0 - 9.5	32.3	83.4
	03	14.0 - 16.0	15.4	77.1
46	2A	12.0 - 12.5	7.6	80.0
	2B	12.5 - 13.0	9.6	80.9
54	02	16.2 - 16.7	13.8	84.3
Average for use in design:			16.9	81.3

Table D.4.8 Summary of sand-slime tailings, natural moisture content, and unit weight

Location ID	Sample ID	Sample depth (ft)	Moisture content (%)	Dry unit weight (pcf)
18	3B	8.5 - 9.0	32.8	82.8
	4B	10.0 - 10.5	61.4	64.4
32	2C	7.3 - 7.8	24.6	80.0
43	2B	9.0 - 9.5	23.9	77.4
46	3A	31.5 - 32.0	67.5	54.9
	3B	32.0 - 32.5	45.5	63.1
	3C	32.5 - 33.0	34.3	73.6
83	7A	13.0 - 13.5	47.9	71.2
	7B	13.5 - 14.0	40.1	78.3
Average for use in design:			42.0	71.7

Table D.4.9 Summary of slime tailings, natural moisture content, and unit weight

Location ID	Sample ID	Sample depth (ft)	Moisture content (%)	Dry unit weight (pcf)
18	4A	9.5 - 10.0	113.9	39.6
	5A	24.0 - 24.5	72.1	55.8
	5B	24.5 - 25.0	100.9	44.1
19	02	34.2 - 34.7	123.2	38.9
24	01	34.5 - 35.0	91.2	48.2
26	2A	6.0 - 6.5	78.9	52.6
	2B	6.5 - 7.0	117.0	39.8
	2C	7.0 - 7.5	118.2	39.7
68	03	7.0 - 7.5	36.4	81.9
81	01	4.1 - 4.6	184.2	26.8
83	7L	14.3 - 14.8	50.5	71.2
93	5A	12.4 - 12.9	119.5	40.7
502	01	11.5 - 12.0	33.5	88.4
Average for use in design:			95.4	51.4

Table D.4.5 Summary of tailings classification and specific gravity tests

Location ID	Sample ID	Sample depth (ft)	Liquid limit (%)	Plasticity index (%)	#200 sieve (% finer)	USCS	Specific gravity
018	3A	8.0 - 8.5	38.0	13.0	36.0	SM	2.63
	3B	8.5 - 9.0	-	-	31.0	-	-
	4A	9.5 - 10.0	-	-	88.0	-	-
	4B	10.0 - 10.3	-	-	33.0	-	-
	5B	24.5 - 25.0	99.9	69.0	92.0	CH	2.63
019	02	34.2 - 34.7	99.9	59.0	96.0	CH	2.74
020	02	8.0 - 10.0	-	-	10.0	SP-SC	2.59
024	01	34.5 - 34.8	99.0	61.0	86.0	CH	2.62
	2A	37.5 - 37.7	71.0	36.0	97.0	MH	2.64
	2B	37.7 - 37.9	67.0	34.0	99.0	MH	2.69
026	2B	6.5 - 7.0	-	-	90.0	-	-
032	2A	6.3 - 6.8	-	-	15.0	SC	-
	2B	6.8 - 7.3	-	-	30.0	SC	2.65
	2C	7.3 - 7.8	-	-	15.0	SC	2.63
	3A	8.0 - 8.5	-	-	82.0	-	-
	3B	9.0 - 9.5	-	-	7.0	SP-SC	-
	04	10.0 - 10.3	-	-	9.0	SP-SC	2.61
036	1C	19.0 - 19.5	71.0	40.0	98.0	CH	2.75
043	2A	8.5 - 9.0	-	-	31.0	-	-
	2B	9.0 - 9.5	-	-	16.0	SC	2.71
	03	14.0 - 16.0	-	1.0	12.0	SC	-
046	2C	13.0 - 13.5	-	-	10.0	SC	2.62
	3B	32.0 - 32.5	41.0	13.0	37.0	SM	2.62

D-275

VMP-100

024 2/12/07
MJP 4/12/10

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Project _____
Feature _____
Item _____

ANDRSEN COMPANY
UPTRA - PCT
STENSON BASIN
m-24hr storm

Contract No. 5057
Designed ORM
Checked KIP

Sheet 15
File No. _____
Date 2/12/82
Date 4/12/88

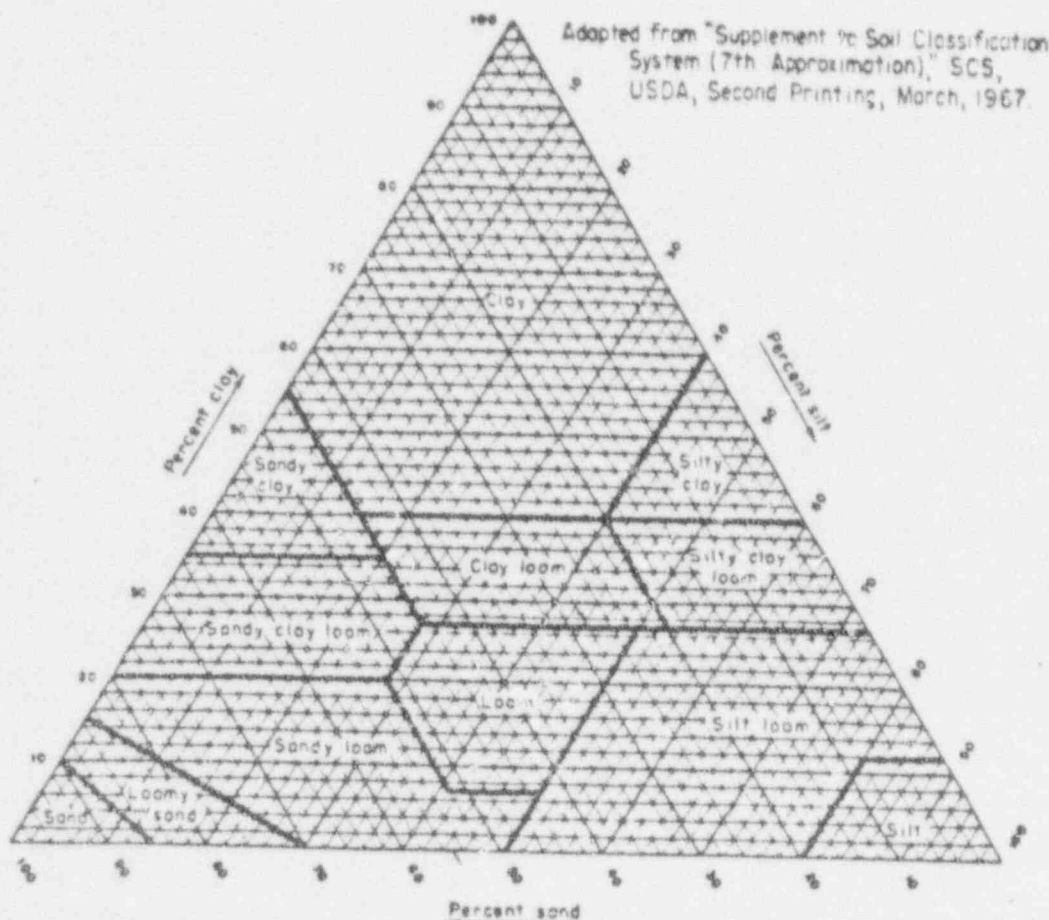
TABLE 2.—Green and Angit Parametors According to Self-Yachurs Classes and Electrons

Soil markers class	Horizon	Sample area	Total porosity, ϕ , in cubic centi- meters per cubic centimetre	Effective porosity, ϕ_e , in cubic centimetres per cubic centimetre	Weighted liquid capil- lary pressure, ϕ_w , in centimetres	Hydraulic conductivity, k , in cm/sec. crevices per foot
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sand	A	762	0.437 (0.374-0.500) ^a	0.417 (0.354-0.480)	4.95 (0.97-25.36)	13.70
		370	0.452 (0.394-0.508)	0.431 (0.375-0.487)	5.54 (1.24-23.96)	
		185	0.440 (0.385-0.495)	0.421 (0.365-0.477)	4.36 (1.31-21.06)	
Loamy sandy silt	A	127	0.424 (0.385-0.463)	0.408 (0.365-0.451)	2.07 (0.32-13.16)	2.99
		336	0.437 (0.365-0.506)	0.401 (0.329-0.473)	6.13 (1.35-27.94)	
		110	0.457 (0.385-0.529)	0.412 (0.347-0.478)	6.01 (1.58-23.87)	
Sandy loam	A	49	0.447 (0.379-0.515)	0.411 (0.334-0.490)	4.21 (1.03-17.74)	
		36	0.424 (0.372-0.476)	0.385 (0.323-0.447)	5.16 (0.78-34.89)	
		666	0.453 (0.351-0.555)	0.412 (0.325-0.541)	11.01 (2.67-27.47)	1.00
Loam	A	119	0.505 (0.399-0.611)	0.460 (0.330-0.679)	15.24 (5.56-41.76)	0.36
		219	0.646 (0.352-0.940)	0.438 (0.271-0.595)	8.99 (2.02-39.06)	
		66	0.618 (0.351-0.886)	0.389 (0.310-0.669)	4.79 (1.16-39.65)	0.60
Silty loam	A	383	0.663 (0.375-0.951)	0.434 (0.334-0.534)	8.89 (1.35-59.38)	
		76	0.512 (0.427-0.907)	0.476 (0.376-0.576)	10.01 (2.14-44.81)	0.15
		47	0.512 (0.406-0.616)	0.498 (0.382-0.614)	8.80 (1.01-40.49)	
Silty clay loam	A	47	0.612 (0.350-0.874)	0.382 (0.305-0.459)	9.27 (0.87-99.29)	
		1,296	0.551 (0.420-0.582)	0.504 (0.394-0.579)	16.68 (2.92-96.79)	0.05
		363	0.527 (0.444-0.610)	0.514 (0.423-0.603)	10.91 (1.89-63.09)	
Silty clay loam	A	287	0.533 (0.480-0.636)	0.515 (0.387-0.643)	7.21 (0.86-40.83)	
		75	0.470 (0.409-0.531)	0.460 (0.396-0.524)	12.63 (1.54-40.45)	0.15
		498	0.398 (0.332-0.464)	0.330 (0.235-0.425)	21.65 (4.42-108.01)	
Silty loam	A	198	0.505 (0.310-0.629)	0.330 (0.223-0.437)	26.10 (4.78-142.80)	
		37	0.407 (0.309-0.455)	0.312 (0.251-0.413)	25.90 (5.51-103.75)	0.90
		566	0.604 (0.405-0.519)	0.509 (0.279-0.670)	20.68 (4.79-61.10)	
Silty clay loam	A	28	0.697 (0.454-0.960)	0.430 (0.338-0.532)	27.00 (6.15-118.9)	
		96	0.551 (0.401-0.901)	0.397 (0.228-0.559)	18.52 (4.36-78.75)	0.05
		55	0.452 (0.412-0.492)	0.400 (0.320-0.480)	15.21 (3.79-63.02)	
Silty clay loam	A	689	0.571 (0.418-0.546)	0.432 (0.347-0.517)	13.87 (4.20-46.53)	
		45	0.506 (0.449-0.569)	0.477 (0.410-0.544)	13.90 (4.20-46.53)	0.05
		191	0.649 (0.423-0.515)	0.441 (0.373-0.509)	18.56 (4.08-64.44)	
Silty clay	A	39	0.575 (0.436-0.514)	0.451 (0.366-0.516)	22.14 (4.56-101.7)	0.05
		65	0.430 (0.370-0.490)	0.331 (0.267-0.429)	23.90 (4.06-140.2)	
		23	0.435 (0.377-0.499)	0.335 (0.226-0.450)	36.74 (6.33-162.1)	0.05
Silty clay	A	127	0.679 (0.425-0.533)	0.423 (0.336-0.512)	29.22 (6.15-139.4)	
		38	0.478 (0.445-0.507)	0.428 (0.365-0.505)	30.66 (7.15-131.5)	
		21	0.664 (0.430-0.496)	0.416 (0.366-0.466)	45.65 (10.27-114.1)	0.05
Silty clay	A	291	0.475 (0.427-0.523)	0.385 (0.309-0.501)	31.63 (6.39-156.5)	
		70	0.670 (0.426-0.514)	0.412 (0.309-0.515)	27.72 (6.21-123.7)	0.05
		73	0.603 (0.441-0.525)	0.410 (0.294-0.544)	34.45 (10.94-274.0)	

*Arcting of the log mean and standard deviation

^bValues for *Blasius*, set at 1.33.

"Values for the fracture close"

^cNumbers in () = one standard deviation.^aSee different attempts to determine parameters.

INPUT DATA

TITLE1: UMTRA/FCT 25 YE
TITLE2: RETENTION BASIN

RAINFALL DATA

TYPE OF DATA: 1
1 = RAINFALL IN INCHES
2 = PERCENT OF TOTAL DEPTH
TIME STEP: 5.0 MINUTES
NUMBER OF RAINFALLS: 72
RAINFALLS IN INCHES:
0.031 0.031 0.031 0.031 0.031 0.031 0.031 0.031
0.031 0.031 0.031 0.031 0.031 0.031 0.031 0.031
0.033 0.033 0.033 0.075 0.075 0.075 0.075 0.075
0.105 0.140 0.210 0.315 0.560 1.015 0.420 0.24
0.105 0.075 0.075 0.075 0.075 0.075 0.075 0.03
0.033 0.033 0.033 0.031 0.031 0.031 0.031 0.03
0.031 0.031 0.031 0.031 0.031 0.031 0.031 0.03
0.031 0.031

SOIL PARAMETERS

INITIAL SOIL MOISTURE CONTENT: 0.5700
SATUR II SOIL MOISTURE CONTENT: 0.6000
SOIL SUCTION HEAD: 9.40 INCHES
HYDRAULIC CONDUCTIVITY: 0.0590000004 IN/HR

DRAINAGES

NUMBER OF DRAINAGE AREAS: 3

NAME OF THE 1st DRAINAGE AREA: DITCH 1
DRAINAGE AREA: 116.4 ACRES
IMPERVIOUS AREA: 0.0 ACRES
TIME OF CONCENTRATION: 32.0 MINUTES

NAME OF THE 2nd DRAINAGE AREA: DITCH 2
DRAINAGE AREA: 60.0 ACRES
IMPERVIOUS AREA: 0.0 ACRES
TIME OF CONCENTRATION: 19.0 MINUTES

NAME OF THE 3rd DRAINAGE AREA: DIRECTLY TRIB.
DRAINAGE AREA: 16.7 ACRES
IMPERVIOUS AREA: 11.2 ACRES
TIME OF CONCENTRATION: 5.0 MINUTES

CNT. DAT; 18

MSF 6-11-68
KLB 7/8/88

5835

on 2.2, March 29, 1988

R 6 HOUR RAINFALL

0.031 0.031
0.033 0.033
0.075 0.075
0.175 0.140
0.033 0.033
0.031 0.031
0.031 0.031

SI
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TO BASIN

0205110072-05

MORRISON-KNUDSEN ENGINEERS, INC.
SANTA BARBARA URBAN HYDROGRAPH MODEL: SBUHYD, Versi

RAINFALL-RUNOFF COMPUTATION

TITLE1: UMTRA/FCT 25 YEA
TITLE2: RETENTION BASIN

NAME OF DRAINAGE AREA: DITCH 1
DRAINAGE AREA: 116.4 ACRES
IMPERVIOUS AREA: 0.0 ACRES
IMPERVIOUS PORTION: 0.0000
TIME OF CONCENTRATION: 32.0 MINUTES

SOIL PARAMETERS:
INITIAL SOIL MOISTURE CONTENT: 0.5700
SATURATED SOIL MOISTURE CONTENT: 0.6000
SOIL SUCTION HEAD: 9.40 INCHES
HYDRAULIC CONDUCTIVITY: 0.0590000004 IN/HR

TOTAL RAINFALL: 5.917 INCHES
TIME STEP: 5.0 MINUTES
NUMBER OF RAINFALLS: 72

RUNOFF VOLUME:
IMPERVIOUS: 0.00 INCHES OR 0.00 AC-FT
PERVIOUS: 5.09 INCHES OR 49.41 AC-FT
TOTAL: 5.09 INCHES OR 49.41 AC-FT

PEAK FLOW: 437.1 CFS AT 3.17 HRS

NUMB	TIME (HRS)	RAINFALL DEPTH (IN)	INFILTRATION (IN)	IMPERVIOUS RUNOFF (IN)
0	0.000	0.000	0.000	0.000
1	0.083	0.031	0.031	0.000
2	0.167	0.031	0.031	0.000
3	0.250	0.031	0.031	0.000
4	0.333	0.031	0.027	0.000
5	0.417	0.031	0.023	0.000
6	0.500	0.031	0.020	0.000
7	0.583	0.031	0.018	0.000
8	0.667	0.031	0.017	0.000
9	0.750	0.031	0.016	0.000
10	0.833	0.031	0.015	0.000
11	0.917	0.031	0.015	0.000
12	1.000	0.031	0.014	0.000
13	1.083	0.031	0.014	0.000
14	1.167	0.031	0.013	0.000
15	1.250	0.031	0.013	0.000
16	1.333	0.031	0.013	0.000
17	1.417	0.031	0.012	0.000
18	1.500	0.033	0.012	0.000
19	1.583	0.033	0.012	0.000
20	1.667	0.033	0.011	0.000
21	1.750	0.033	0.011	0.000

MJP 6-11-88
Kub 7/8/88

SN36

on 2.2, March 29, 1988

AR 6 HOUR RAINFALL

PERVIOUS RUNOFF (IN)	TOTAL RUNOFF (IN)	INSTANT HYDROGRAPH (CFS)	FINAL HYDROGRAPH (CFS)
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.004	0.004	6.1	0.4
0.008	0.008	11.9	1.7
0.011	0.011	15.4	3.4
0.013	0.013	17.8	5.3
0.014	0.014	19.5	7.3
0.015	0.015	20.9	9.1
0.016	0.016	22.1	10.9
0.016	0.016	23.0	12.6
0.017	0.017	23.8	14.2
0.017	0.017	24.5	15.6
0.018	0.018	25.0	16.9
0.018	0.018	25.6	18.1
0.018	0.018	26.0	19.3
0.019	0.019	26.5	20.3
0.021	0.021	29.6	21.4
0.021	0.021	30.0	22.6
0.022	0.022	30.3	23.7
0.022	0.022	30.6	24.7

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9205110072-06

22	1.833	0.033	0.011	0.000
23	1.917	0.033	0.011	0.000
24	2.000	0.075	0.011	0.000
25	2.083	0.075	0.011	0.000
26	2.167	0.075	0.010	0.000
27	2.250	0.075	0.010	0.000
28	2.333	0.075	0.010	0.000
29	2.417	0.075	0.010	0.000
30	2.500	0.075	0.010	0.000
31	2.583	0.105	0.010	0.000
32	2.667	0.140	0.010	0.000
33	2.750	0.210	0.010	0.000
34	2.833	0.315	0.010	0.000
35	2.917	0.560	0.009	0.000
36	3.000	1.015	0.009	0.000
37	3.083	0.420	0.009	0.000
38	3.167	0.245	0.009	0.000
39	3.250	0.175	0.009	0.000
40	3.333	0.140	0.009	0.000
41	3.417	0.105	0.009	0.000
42	3.500	0.075	0.009	0.000
43	3.583	0.075	0.009	0.000
44	3.667	0.075	0.009	0.000
45	3.750	0.075	0.009	0.000
46	3.833	0.075	0.009	0.000
47	3.917	0.075	0.009	0.000
48	4.000	0.033	0.009	0.000
49	4.083	0.033	0.009	0.000
50	4.167	0.033	0.009	0.000
51	4.250	0.033	0.008	0.000
52	4.333	0.033	0.008	0.000
53	4.417	0.033	0.008	0.000
54	4.500	0.031	0.008	0.000
55	4.583	0.031	0.008	0.000
56	4.667	0.031	0.008	0.000
57	4.750	0.031	0.008	0.000
58	4.833	0.031	0.008	0.000
59	4.917	0.031	0.008	0.000
60	5.000	0.031	0.008	0.000
61	5.083	0.031	0.008	0.000
62	5.167	0.031	0.008	0.000
63	5.250	0.031	0.008	0.000
64	5.333	0.031	0.008	0.000
65	5.417	0.031	0.008	0.000
66	5.500	0.031	0.008	0.000
67	5.583	0.031	0.008	0.000
68	5.667	0.031	0.008	0.000
69	5.750	0.031	0.008	0.000
70	5.833	0.031	0.008	0.000
71	5.917	0.031	0.008	0.000
72	6.000	0.031	0.008	0.000
TOTALS		5.917	0.823	0.000

ANP 6-11-88
KNO 7/2/88

51137

0.022	0.022	30.9	25.6
0.022	0.022	31.1	26.3
0.064	0.064	90.5	31.3
0.064	0.064	90.7	39.9
0.065	0.065	90.9	47.3
0.065	0.065	91.1	53.6
0.065	0.065	91.3	59.1
0.065	0.065	91.4	63.8
0.065	0.065	91.6	67.8
0.095	0.095	134.0	74.3
0.130	0.130	183.4	86.5
0.200	0.200	282.2	107.7
0.305	0.305	430.2	143.7
0.551	0.551	775.4	210.3
1.006	1.006	1416.3	338.6
0.411	0.411	578.4	434.1
0.236	0.236	332.0	437.1
0.166	0.166	233.6	414.8
0.131	0.131	184.4	384.9
0.096	0.096	135.2	352.3
0.066	0.066	93.0	317.8
0.066	0.066	93.1	285.2
0.066	0.066	93.2	257.4
0.066	0.066	93.3	233.6
0.066	0.066	93.3	213.3
0.066	0.066	93.4	195.9
0.024	0.024	34.3	175.8
0.024	0.024	34.4	156.1
0.024	0.024	34.5	138.5
0.025	0.025	34.5	123.4
0.025	0.025	34.6	110.5
0.025	0.025	34.7	99.5
0.023	0.023	31.9	89.9
0.023	0.023	32.0	81.5
0.023	0.023	32.0	74.4
0.023	0.023	32.1	68.2
0.023	0.023	32.1	63.0
0.023	0.023	32.2	58.5
0.023	0.023	32.2	54.7
0.023	0.023	32.3	51.4
0.023	0.023	32.3	48.7
0.023	0.023	32.4	46.3
0.023	0.023	32.4	44.3
0.023	0.023	32.5	42.6
0.023	0.023	32.5	41.1
0.023	0.023	32.6	39.9
0.023	0.023	32.6	38.8
0.023	0.023	32.6	37.9
0.023	0.023	32.7	37.2
0.023	0.023	32.7	36.5
0.023	0.023	32.8	36.0
5.094	5.094	7174.3	6945.7

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9205110072-07

MORRISON-KNUDSEN ENGINEERS, INC.
SANTA BARBARA URBAN HYDROGRAPH MODEL: SBUHYD, Vers 1

RAINFALL-RUNOFF COMPUTATION

TITLE1: UMTRA/FCT 25 YEA
TITLE2: RETENTION BASIN

NAME OF DRAINAGE AREA: DITCH 2
DRAINAGE AREA: 60.0 ACRES
IMPERVIOUS AREA: 0.0 ACRES
IMPERVIOUS PORTION: 0.0000
TIME OF CONCENTRATION: 19.0 MINUTES

SOIL PARAMETERS:
INITIAL SOIL MOISTURE CONTENT: 0.5700
SATURATED SOIL MOISTURE CONTENT: 0.6000
SOIL SUCTION HEAD: 9.40 INCHES
HYDRAULIC CONDUCTIVITY: 0.0590000004 IN/HR

TOTAL RAINFALL: 5.917 INCHES
TIME STEP: 5.0 MINUTES
NUMBER OF RAINFALLS: 72

RUNOFF VOLUME:
IMPERVIOUS: 0.00 INCHES OR 0.00 AC-FT
PERVIOUS: 5.09 INCHES OR 25.47 AC-FT
TOTAL: 5.09 INCHES OR 25.47 AC-FT

PEAK FLOW: 306.2 CFS AT 3.08 HRS

NUMB	TIME (HRS)	RAINFALL DEPTH (IN)	INFILTRATION (IN)	IMPERVIOUS RUNOFF (IN)
0	0.000	0.000	0.000	0.000
1	0.083	0.031	0.031	0.000
2	0.167	0.031	0.031	0.000
3	0.250	0.031	0.031	0.000
4	0.333	0.031	0.027	0.000
5	0.417	0.031	0.023	0.000
6	0.500	0.031	0.020	0.000
7	0.583	0.031	0.018	0.000
8	0.667	0.031	0.017	0.000
9	0.750	0.031	0.016	0.000
10	0.833	0.031	0.015	0.000
11	0.917	0.031	0.015	0.000
12	1.000	0.031	0.014	0.000
13	1.083	0.031	0.014	0.000
14	1.167	0.031	0.013	0.000
15	1.250	0.031	0.013	0.000
16	1.333	0.031	0.013	0.000
17	1.417	0.031	0.012	0.000
18	1.500	0.033	0.012	0.000
19	1.583	0.033	0.012	0.000
20	1.667	0.033	0.011	0.000
21	1.750	0.033	0.011	0.000

MSP 6-11-88
FID 7/8/88

5438

on 2.2, March 29, 1988

R 6 HOUR RAINFALL

PERVIOUS RUNOFF (IN)	TOTAL RUNOFF (IN)	INSTANT HYDROGRAPH (CFS)	FINAL HYDROGRAPH (CFS)
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.004	0.004	3.2	0.4
0.008	0.008	6.1	1.4
0.011	0.011	7.9	2.7
0.013	0.013	9.2	4.0
0.014	0.014	10.1	5.3
0.015	0.015	10.8	6.5
0.016	0.016	11.4	7.6
0.016	0.016	11.6	8.5
0.017	0.017	12.3	9.3
0.017	0.017	12.6	10.1
0.018	0.018	12.9	10.7
0.018	0.018	13.2	11.2
0.018	0.018	13.4	11.7
0.019	0.019	13.6	12.1
0.021	0.021	15.3	12.7
0.021	0.021	15.5	13.3
0.022	0.022	15.6	13.8
0.022	0.022	15.8	14.3

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9205110072 - 08

22	1.833	0.033	0.011	0.000
23	1.917	0.033	0.011	0.000
24	2.000	0.075	0.011	0.000
25	2.083	0.075	0.011	0.000
26	2.167	0.075	0.010	0.000
27	2.250	0.075	0.010	0.000
28	2.333	0.075	0.010	0.000
29	2.417	0.075	0.010	0.000
30	2.500	0.075	0.010	0.000
31	2.583	0.105	0.010	0.000
32	2.667	0.140	0.010	0.000
33	2.750	0.210	0.010	0.000
34	2.833	0.315	0.010	0.000
35	2.917	0.560	0.009	0.000
36	3.000	1.015	0.009	0.000
37	3.083	0.420	0.009	0.000
38	3.167	0.245	0.009	0.000
39	3.250	0.175	0.009	0.000
40	3.333	0.140	0.009	0.000
41	3.417	0.135	0.009	0.000
42	3.500	0.075	0.009	0.000
43	3.583	0.075	0.009	0.000
44	3.667	0.075	0.009	0.000
45	3.750	0.075	0.009	0.000
46	3.833	0.075	0.009	0.000
47	3.917	0.075	0.009	0.000
48	4.000	0.033	0.009	0.000
49	4.083	0.033	0.009	0.000
50	4.167	0.033	0.009	0.000
51	4.250	0.033	0.008	0.000
52	4.333	0.033	0.008	0.000
53	4.417	0.033	0.008	0.000
54	4.500	0.031	0.008	0.000
55	4.583	0.031	0.008	0.000
56	4.667	0.031	0.008	0.000
57	4.750	0.031	0.008	0.000
58	4.833	0.031	0.008	0.000
59	4.917	0.031	0.008	0.000
60	5.000	0.031	0.008	0.000
61	5.083	0.031	0.008	0.000
62	5.167	0.031	0.008	0.000
63	5.250	0.031	0.008	0.000
64	5.333	0.031	0.008	0.000
65	5.417	0.031	0.008	0.000
66	5.500	0.031	0.008	0.000
67	5.583	0.031	0.008	0.000
68	5.667	0.031	0.008	0.000
69	5.750	0.031	0.008	0.000
70	5.833	0.031	0.008	0.000
71	5.917	0.031	0.008	0.000
72	6.000	0.031	0.008	0.000
TOTALS		5.917	0.823	0.000

MSP 6-11-88
END 7/8/88

SH39

0.022	0.022	15.9	14.6
0.022	0.022	16.0	14.9
0.064	0.064	46.6	18.8
0.064	0.064	46.8	25.3
0.065	0.065	46.9	30.3
0.065	0.065	47.0	34.1
0.065	0.065	47.1	37.1
0.065	0.065	47.1	39.4
0.065	0.065	47.2	41.2
0.095	0.095	69.1	45.2
0.130	0.130	94.6	53.7
0.200	0.200	145.4	69.1
0.305	0.305	221.7	95.7
0.551	0.551	399.7	145.7
1.006	1.006	730.0	243.2
0.411	0.411	298.1	306.2
0.236	0.236	171.2	289.6
0.166	0.166	120.4	256.1
0.131	0.131	95.0	221.6
0.096	0.096	69.7	169.2
0.066	0.066	47.9	158.9
0.066	0.066	48.0	133.1
0.066	0.066	48.0	113.3
0.066	0.066	48.1	98.1
0.066	0.066	48.1	86.5
0.066	0.066	48.2	77.6
0.024	0.024	17.7	67.2
0.024	0.024	17.7	55.7
0.024	0.024	17.8	46.9
0.025	0.025	17.8	40.1
0.025	0.025	17.8	34.9
0.025	0.025	17.9	31.0
0.023	0.023	16.5	27.7
0.023	0.023	16.5	25.1
0.023	0.023	16.5	23.1
0.023	0.023	16.5	21.6
0.023	0.023	16.6	20.4
0.023	0.023	16.6	19.5
0.023	0.023	16.6	18.3
0.023	0.023	16.6	18.3
0.023	0.023	16.7	17.9
0.023	0.023	16.7	17.6
0.023	0.023	16.7	17.4
0.023	0.023	16.7	17.3
0.023	0.023	16.8	17.1
0.023	0.023	16.8	17.1
0.023	0.023	16.8	17.0
0.023	0.023	16.8	17.0
0.023	0.023	16.8	16.9
0.023	0.023	16.9	16.9
0.023	0.023	16.9	16.9
5.094	5.094	3698.1	3633.9

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9205110072-09

RAINFALL-RUNOFF COMPUTATION

TITLE1: UMTRA/FCT 25 YEA
TITLE2: RETENTION BASIN

NAME OF DRAINAGE AREA: DIRECTLY TRIB. T
DRAINAGE AREA: 16.7 ACRES
IMPERVIOUS AREA: 11.2 ACRES
IMPERVIOUS PORTION: 0.6707
TIME OF CONCENTRATION: 5.0 MINUTES

SOIL PARAMETERS:
INITIAL SOIL MOISTURE CONTENT: 0.5700
SATURATED SOIL MOISTURE CONTENT: 0.6000
SOIL SUCTION HEAD: 9.40 INCHES
HYDRAULIC CONDUCTIVITY: 0.0590000004 IN/HR

TOTAL RAINFALL: 5.917 INCHES
TIME STEP: 5.0 MINUTES
NUMBER OF RAINFALL: 72

RUNOFF VOLUME:
IMPERVIOUS: 3.97 INCHES OR 5.52 AC-FT
PERVIOUS: 1.68 INCHES OR 2.33 AC-FT
TOTAL: 5.65 INCHES OR 7.86 AC-FT

PEAK FLOW: 139.6 CFS AT 3.08 HRS

NUMB	TIME (HRS)	RAINFALL DEPTH (IN)	INFILTRATION (IN)	IMPERVIOUS RUNOFF (IN)
0	0.000	0.000	0.000	0.000
1	0.083	0.031	0.031	0.021
2	0.167	0.031	0.031	0.021
3	0.250	0.031	0.031	0.021
4	0.333	0.031	0.027	0.021
5	0.417	0.031	0.023	0.021
6	0.500	0.031	0.020	0.021
7	0.583	0.031	0.018	0.021
8	0.667	0.031	0.017	0.021
9	0.750	0.031	0.016	0.021
10	0.833	0.031	0.015	0.021
11	0.917	0.031	0.015	0.021
12	1.000	0.031	0.014	0.021
13	1.083	0.031	0.014	0.021
14	1.167	0.031	0.013	0.021
15	1.250	0.031	0.013	0.021
16	1.333	0.031	0.013	0.021
17	1.417	0.031	0.012	0.021
18	1.500	0.033	0.012	0.022
19	1.583	0.033	0.012	0.022
20	1.667	0.033	0.011	0.022
21	1.750	0.033	0.011	0.022

MSP 6-11-88
K10 7/8/88

on 2.2, March 29, 1988

P 6 HOUR RAINFALL

D BASIN

PERVIOUS RUNOFF (IN)	TOTAL RUNOFF (IN)	INSTANT HYDROGRAPH (CFS)	FINAL HYDROGRAPH (CFS)
0.000	0.000	0.0	0.0
0.000	0.0021	4.2	1.4
0.000	0.0071	4.2	3.3
0.000	0.0111	4.2	3.9
0.001	0.022	4.5	4.2
0.003	0.024	4.8	4.5
0.004	0.024	4.9	4.7
0.004	0.025	5.0	4.9
0.005	0.025	5.1	5.0
0.005	0.025	5.2	5.1
0.005	0.025	5.2	5.2
0.005	0.025	5.3	5.2
0.006	0.025	5.3	5.3
0.006	0.027	5.4	5.3
0.006	0.027	5.4	5.4
0.006	0.027	5.4	5.4
0.006	0.027	5.4	5.4
0.006	0.027	5.5	5.4
0.007	0.027	5.9	5.6
0.007	0.027	5.9	5.8
0.007	0.029	5.9	5.9
0.007	0.029	5.9	5.9

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22	1.833	0.033	0.011	0.022
23	1.917	0.033	0.011	0.022
24	2.000	0.075	0.011	0.050
25	2.083	0.075	0.011	0.050
26	2.167	0.075	0.010	0.050
27	2.250	0.075	0.010	0.050
28	2.333	0.075	0.010	0.050
29	2.417	0.075	0.010	0.050
30	2.500	0.075	0.010	0.050
31	2.583	0.105	0.010	0.070
32	2.667	0.140	0.010	0.094
33	2.750	0.210	0.010	0.141
34	2.833	0.315	0.010	0.211
35	2.917	0.560	0.009	0.376
36	3.000	1.015	0.009	0.681
37	3.083	0.420	0.009	0.282
38	3.167	0.245	0.009	0.164
39	3.250	0.175	0.009	0.117
40	3.333	0.140	0.009	0.094
41	3.417	0.105	0.009	0.070
42	3.500	0.075	0.009	0.050
43	3.583	0.075	0.009	0.050
44	3.667	0.075	0.009	0.050
45	3.750	0.075	0.009	0.050
46	3.833	0.075	0.009	0.050
47	3.917	0.075	0.009	0.050
48	4.000	0.033	0.009	0.022
49	4.083	0.033	0.009	0.022
50	4.167	0.033	0.009	0.022
51	4.250	0.033	0.008	0.022
52	4.333	0.033	0.008	0.022
53	4.417	0.033	0.008	0.022
54	4.500	0.031	0.008	0.021
55	4.583	0.031	0.008	0.021
56	4.667	0.031	0.008	0.021
57	4.750	0.031	0.008	0.021
58	4.833	0.031	0.008	0.021
59	4.917	0.031	0.008	0.021
60	5.000	0.031	0.008	0.021
61	5.083	0.031	0.008	0.021
62	5.167	0.031	0.008	0.021
63	5.250	0.031	0.008	0.021
64	5.333	0.031	0.008	0.021
65	5.417	0.031	0.008	0.021
66	5.500	0.031	0.008	0.021
67	5.583	0.031	0.008	0.021
68	5.667	0.031	0.008	0.021
69	5.750	0.031	0.008	0.021
70	5.833	0.031	0.008	0.021
71	5.917	0.031	0.008	0.021
72	6.000	0.031	0.008	0.021

TOTALS

5.917

0.823

3.968

MORRISON-KNUDSEN ENGINEERS, INC.
SANTA BARBARA URBAN HYDROGRAPH MODEL: SBUHYD, Versi

RAINFALL-RUNOFF COMPUTATION

TITLE1: UMTRA/FCT 25 YEAR 6 HOUR RAINFALL
TITLE2: RETENTION BASIN

COMBINED OUTFLOWS:

NUMB	TIME (HRS)	OUTFLOW D AREA(1) (CFS)	OUTFLOW D AREA(2) (CFS)	OUTFLOW D AREA(3) (CFS)	CO OU
0	0.00	0.0	0.0	0.0	
1	0.08	0.0	0.0	1.4	
2	0.17	0.0	0.0	3.3	
3	0.25	0.0	0.0	3.9	
4	0.33	0.4	0.4	4.2	
5	0.42	1.7	1.4	4.5	
6	0.50	3.4	2.7	4.7	
7	0.58	5.3	4.0	4.9	
8	0.67	7.3	5.3	5.0	
9	0.75	9.1	6.5	5.1	
10	0.83	10.9	7.6	5.2	
11	0.92	12.6	8.5	5.2	
12	1.00	14.2	9.3	5.3	
13	1.08	15.6	10.1	5.3	
14	1.17	16.9	10.7	5.4	
15	1.25	18.1	11.2	5.4	
16	1.33	19.3	11.7	5.4	
17	1.42	20.3	12.1	5.4	
18	1.50	21.4	12.7	5.6	
19	1.58	22.6	13.3	5.8	
20	1.67	23.7	13.8	5.9	
21	1.75	24.7	14.3	5.9	
22	1.83	25.6	14.6	5.9	
23	1.92	26.3	14.9	5.9	
24	2.00	31.2	18.8	8.3	
25	2.08	39.9	25.3	12.6	
26	2.17	47.3	30.3	13.8	
27	2.25	53.6	34.1	14.2	
28	2.33	59.1	37.1	14.4	
29	2.42	63.8	39.4	14.5	
30	2.50	67.8	41.2	14.5	
31	2.58	74.3	45.2	16.5	
32	2.67	86.5	53.7	21.6	
33	2.75	107.7	69.1	30.3	
34	2.83	143.7	95.7	45.0	
35	2.92	210.3	145.7	73.5	
36	3.00	338.6	243.2	130.2	
37	3.08	434.1	306.2	139.6	
38	3.17	437.1	289.6	90.9	
39	3.25	414.9	256.1	58.2	
40	3.33	384.9	221.6	40.2	
41	3.42	352.3	189.2	29.5	
42	3.50	317.8	158.9	21.6	
43	3.58	285.2	133.1	16.9	

MSP 6-11-88 JH42
Kno 7/8/88

on 2.2, March 29, 1988

MBINED
TFLDW
(CFS)

0.0
1.4
3.3
3.9
5.0
7.5
10.8
14.3
17.6
20.8
23.7
26.4
28.8
31.0
33.0
34.8
36.4
37.8
39.7
41.7
43.4
44.8
46.1
47.2
58.9
77.7
91.4
102.0
110.6
117.7
123.5
136.0
161.8
207.2
284.5
429.5
712.0
879.9
817.6
729.1
646.8
571.0
498.2
435.2

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44	3.67	257.4	113.3	15.3
45	3.75	233.6	98.1	14.8
46	3.83	213.3	86.5	14.7
47	3.92	195.9	77.6	14.6
48	4.00	176.8	67.2	11.8
49	4.08	156.1	55.7	8.0
50	4.17	138.5	46.9	6.7
51	4.25	123.4	40.1	6.3
52	4.33	110.5	34.9	6.2
53	4.42	99.5	31.0	6.1
54	4.50	89.9	27.7	6.0
55	4.58	81.5	25.1	5.8
56	4.67	74.4	23.1	5.7
57	4.75	68.2	21.6	5.7
58	4.83	63.0	20.4	5.7
59	4.92	58.5	19.5	5.7
60	5.00	54.7	18.8	5.7
61	5.08	51.5	18.3	5.7
62	5.17	48.7	17.9	5.7
63	5.25	46.3	17.6	5.7
64	5.33	44.3	17.4	5.7
65	5.42	42.6	17.3	5.7
66	5.50	41.1	17.1	5.7
67	5.5	39.9	17.1	5.7
68	5.6	38.8	17.0	5.7
69	5.75	37.9	17.0	5.7
70	5.83	37.2	16.9	5.7
71	5.92	36.5	16.9	5.7
72	6.00	36.0	16.9	5.7

MIP 6-11-88 SHY
KUB 7/3/89

386.0
346.5
314.4
288.1
255.7
219.8
192.1
169.8
151.6
136.6
123.7
112.5
103.2
95.5
89.1
83.8
79.3
75.5
72.4
69.7
67.5
65.6
64.0
62.7
61.6
60.6
59.8
59.2
58.6

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MORRISON-KNUDSEN ENGINEERS, INC.
SANTA BARBARA URBAN HYDROGRAPH MODEL: SBUHYD, Versi

RESERVOIR ROUTING COMPUTATION

TITLE1: UMTRA/FCT 25 YEAR 6 HOUR R
TITLE1: RETENTION BASIN

OUTLET STRUCTURE: BROAD-CRESTED WEIR
RESERVOIR AREA: 10.1 ACRES - USE AVE. OF T
DISCHARGE COEFFICIENT: 3.0000
LENGTH OF CREST: 55.0 FEET

NUMB	TIME (HRS)	INFLOW (CFS)	SUM OF INFLOWS (CFS)	STORAGE INDICAT(1) (CFS)	ST INT
0	0.00	0.0	1.4	0.0	
1	0.08	1.4	4.7	1.4	
2	0.17	3.3	7.2	6.0	
3	0.25	3.9	8.9	13.1	
4	0.33	5.0	12.5	21.8	
5	0.42	7.5	18.3	33.9	
6	0.50	10.8	25.1	51.5	
7	0.58	14.3	31.9	75.2	
8	0.67	17.6	38.4	104.8	
9	0.75	20.8	44.5	139.6	
10	0.83	23.7	50.0	179.0	
11	0.92	26.4	55.1	222.0	
12	1.00	28.8	57.2	267.8	
13	1.08	31.0	57.0	315.5	
14	1.17	33.0	57.7	364.5	
15	1.25	34.8	71.1	414.2	
16	1.33	36.4	74.2	467.8	
17	1.42	37.8	77.5	511.1	
18	1.50	39.7	81.4	561.7	
19	1.58	41.7	85.1	610.6	
20	1.67	43.4	88.2	659.1	
21	1.75	44.8	90.9	706.1	
22	1.83	46.1	93.3	752.6	
23	1.92	47.2	106.1	796.9	
24	2.00	58.9	136.6	849.2	
25	2.08	77.7	169.1	924.6	
26	2.17	91.4	193.4	1022.3	
27	2.25	102.0	212.6	1132.2	
28	2.33	110.6	228.3	1248.0	
29	2.42	117.7	241.2	1365.1	
30	2.50	123.5	259.5	1480.2	
31	2.58	136.0	297.8	1598.3	
32	2.67	161.8	369.0	1735.6	
33	2.75	207.2	491.7	1917.1	
34	2.83	284.5	714.1	2180.1	
35	2.92	429.5	1141.5	2595.1	
36	3.00	712.0	1591.9	3111.1	
37	3.08	879.7	1697.5	4200.0	
38	3.17	817.6	1546.7	5097.4	
39	3.25	729.1	1375.9	5643.7	

MS P 6-11-88 SN 99
 RLB 7/2/88

on 2.2, March 29, 1988

AINFALL

A BOTTOM OF DRYEN

RAGE ICAT(2)	DEPTH OF RESERVOIR	DEPTH OF CHANNEL	HEADLOSS	OUTFLOW
(FS)	(FT)	(FT)	(FT)	(CF2)
0.0	0.000	0.000	0.000	0.0
1.4	0.000	0.000	0.000	0.0
6.1	0.002	0.002	0.000	0.0
13.2	0.004	0.004	0.000	0.0
22.0	0.007	0.007	0.000	0.1
34.3	0.012	0.012	0.000	0.2
52.2	0.018	0.018	0.000	0.4
76.5	0.026	0.026	0.000	0.7
107.0	0.036	0.036	0.000	1.1
143.1	0.048	0.048	0.000	1.7
184.1	0.062	0.062	0.000	2.5
229.0	0.077	0.077	0.000	3.5
277.1	0.093	0.093	0.000	4.7
327.5	0.110	0.110	0.000	6.0
379.5	0.127	0.127	0.000	7.5
432.2	0.144	0.144	0.000	9.0
485.3	0.162	0.162	0.000	10.7
538.1	0.179	0.179	0.000	12.5
590.6	0.196	0.196	0.000	14.4
643.2	0.214	0.214	0.000	16.3
695.7	0.231	0.231	0.000	18.3
747.2	0.248	0.248	0.000	20.4
797.4	0.264	0.264	0.000	22.4
845.8	0.280	0.280	0.000	24.5
893.1	0.299	0.299	0.000	26.9
935.9	0.326	0.326	0.000	30.7
993.7	0.361	0.361	0.000	35.7
1015.8	0.400	0.400	0.000	41.8
1044.9	0.442	0.442	0.000	48.5
1076.3	0.484	0.484	0.000	55.6
1106.1	0.526	0.526	0.000	63.0
1140.0	0.569	0.569	0.000	70.8
1176.3	0.619	0.619	0.000	80.4
1214.4	0.686	0.686	0.000	93.7
1240.5	0.782	0.782	0.000	114.2
1284.1	0.936	0.936	0.000	149.4
1337.2	1.200	1.200	0.000	217.0
1385.6	1.560	1.560	0.000	321.4
1450.2	1.883	1.883	0.000	426.4
1544.2	2.095	2.095	0.000	500.2

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40	3.33	646.8	1217.8	5937.3	70
41	3.42	571.0	1069.3	6042.5	71
42	3.50	498.2	933.5	6007.4	71
43	3.58	435.2	821.2	5874.7	69
44	3.67	386.0	732.6	5683.9	66
45	3.75	346.5	661.0	5464.9	64
46	3.83	314.4	602.5	5236.5	61
47	3.92	288.1	543.8	5009.9	58
48	4.00	255.7	475.5	4781.4	55
49	4.08	219.8	411.9	4544.4	52
50	4.17	192.1	361.9	4301.6	49
51	4.25	169.8	321.5	4064.3	46
52	4.33	151.6	288.3	3837.8	43
53	4.42	136.6	260.3	3624.8	41
54	4.50	123.7	236.1	3425.3	38
55	4.58	112.5	215.7	3240.9	36
56	4.67	103.2	198.7	3068.9	34
57	4.75	95.5	184.7	2910.8	32
58	4.83	89.1	172.9	2765.4	30
59	4.92	83.8	163.0	2632.8	29
60	5.00	79.3	154.8	2511.8	27
61	5.08	75.5	147.9	2401.7	26
62	5.17	72.4	142.0	2301.3	25
63	5.25	69.7	137.2	2210.0	24
64	5.33	67.5	133.0	2127.1	23
65	5.42	65.6	129.6	2052.1	22
66	5.50	64.0	126.7	1984.3	21
67	5.58	62.7	124.2	1923.1	20
68	5.67	61.6	122.2	1867.1	19
69	5.75	60.6	120.5	1817.1	18
70	5.83	59.8	119.0	1771.7	17
71	5.92	59.2	117.8	1730.9	16
72	6.00	58.6	58.6	1694.1	15
73	6.08	0.0	0.0	1609.7	14
74	6.17	0.0	0.0	1483.5	13
75	6.25	0.0	0.0	1271.5	12
76	6.33	0.0	0.0	1271.6	11
77	6.42	0.0	0.0	1182.3	10
78	6.50	0.0	0.0	1102.0	9
79	6.58	0.0	0.0	1029.7	8
80	6.67	0.0	0.0	964.4	7
81	6.75	0.0	0.0	905.1	6
82	6.83	0.0	0.0	851.2	5
83	6.92	0.0	0.0	802.0	4
84	7.00	0.0	0.0	756.8	3
85	7.08	0.0	0.0	715.4	2
86	7.17	0.0	0.0	677.3	1
87	7.25	0.0	0.0	642.1	
88	7.33	0.0	0.0	609.6	
89	7.42	0.0	0.0	579.5	
90	7.50	0.0	0.0	551.6	
91	7.58	0.0	0.0	525.5	
92	7.67	0.0	0.0	501.3	
93	7.75	0.0	0.0	478.9	
94	7.83	0.0	0.0	457.8	
95	7.92	0.0	0.0	438.1	
96	8.00	0.0	0.0	419.5	
97	8.08	0.0	0.0	402.2	
98	8.17	0.0	0.0	385.9	
99	8.25	0.0	0.0	370.6	

MSP 6-11-28 5445
 ELO 7/9/28

20.8	2.209	2.209	0.000	541.7
56.2	2.250	2.250	0.000	556.9
11.0	2.236	2.236	0.000	551.8
40.2	2.185	2.185	0.000	532.8
95.6	2.110	2.110	0.000	505.8
16.2	2.025	2.025	0.000	475.6
26.2	1.937	1.937	0.000	444.8
40.0	1.850	1.850	0.000	415.1
53.0	1.762	1.762	0.000	385.8
57.2	1.671	1.671	0.000	356.4
55.8	1.578	1.578	0.000	327.1
63.2	1.488	1.488	0.000	299.4
85.6	1.402	1.402	0.000	273.9
26.0	1.321	1.321	0.000	250.6
84.4	1.247	1.246	0.000	229.5
62.1	1.177	1.177	0.000	210.6
56.0	1.112	1.112	0.000	193.6
67.5	1.053	1.053	0.000	178.3
94.9	0.999	0.999	0.000	164.2
38.2	0.950	0.950	0.000	152.7
95.8	0.905	0.905	0.000	142.0
66.7	0.864	0.864	0.000	132.5
49.4	0.827	0.827	0.000	124.1
43.1	0.793	0.793	0.000	116.6
46.9	0.763	0.763	0.000	109.9
60.1	0.735	0.735	0.000	104.0
81.8	0.710	0.710	0.000	98.8
11.3	0.688	0.688	0.000	94.1
47.0	0.667	0.667	0.000	89.9
89.6	0.649	0.649	0.000	86.3
37.6	0.632	0.632	0.000	83.0
91.0	0.617	0.617	0.000	80.1
49.0	0.604	0.604	0.000	77.3
53.0	0.573	0.573	0.000	71.6
09.9	0.527	0.527	0.000	63.2
83.5	0.487	0.487	0.000	56.0
71.4	0.451	0.451	0.000	49.9
71.6	0.418	0.418	0.000	44.6
82.2	0.389	0.389	0.000	40.1
102.0	0.363	0.363	0.000	36.1
029.8	0.340	0.340	0.000	32.7
64.5	0.319	0.319	0.000	29.7
05.3	0.299	0.299	0.000	27.0
51.4	0.282	0.282	0.000	24.7
02.1	0.266	0.266	0.000	22.6
56.9	0.251	0.251	0.000	20.7
15.5	0.237	0.237	0.000	19.1
77.3	0.225	0.225	0.000	17.6
42.1	0.213	0.213	0.000	16.3
09.6	0.203	0.203	0.000	15.1
79.5	0.193	0.193	0.000	14.0
51.5	0.184	0.184	0.000	13.0
25.5	0.175	0.175	0.000	12.1
01.4	0.17	0.167	0.000	11.3
478.8	0.160	0.160	0.000	10.5
457.8	0.153	0.153	0.000	9.8
438.0	0.146	0.146	0.000	9.2
419.5	0.140	0.140	0.000	8.7
402.1	0.134	0.134	0.000	8.1
385.9	0.129	0.129	0.000	7.6

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100	8.23	0.0	0.0	356.2
101	8.42	0.0	0.0	342.7
102	8.50	0.0	0.0	329.8
103	8.58	0.0	0.0	317.7
104	8.67	0.0	0.0	306.3
105	8.75	0.0	0.0	295.5
106	8.83	0.0	0.0	285.2
107	8.92	0.0	0.0	275.5
108	9.00	0.0	0.0	266.2
109	9.08	0.0	0.0	257.4
110	9.17	0.0	0.0	249.0

70.6	0.124	0.124	0.000	7.2
56.2	0.119	0.119	0.000	6.8
42.6	0.115	0.115	0.000	6.4
29.8	0.110	0.110	0.000	6.1
17.8	0.106	0.106	0.000	5.7
06.4	0.103	0.103	0.000	5.4
95.5	0.099	0.099	0.000	5.1
85.2	0.096	0.096	0.000	4.9
75.5	0.092	0.092	0.000	4.6
66.2	0.089	0.089	0.000	4.4
57.4	0.086	0.086	0.000	4.2

MSR 6-11-58
54 46
K10 7/2/59

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MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project UMTA - FLY
 Feature Retention Basin
 Item General

Contract No. 5057 Sheet 2E
 Designed ASP File No.
 Checked Kuo Date 6-11-88
 Date 7/8/89

REV 1 ASP 1-20-89
PYL 2/9/89

Basin Capacity :

REV 1: NO CAPACITY WILL BE PROVIDED IN BASIN FOR
 DEWATERING FLOWS BECAUSE THE TREATMENT RATES ARE FAST ENOUGH
 TO ACCOMMODATE TO THE DEWATERING FLOW RATES.

10yr 24hr VOL = 77.2 ACFT.

MAX MONTHLY RUNOFF (NON-ACCUMULATED) = 15.2

REF 10

That month has 2 rain events

∴ MAX RUNOFF FROM 1 event = $\frac{15.2}{2} = 7.6$ ACFT.

DESIGN BASIN FOR :

10yr 24hr VOL = 77.2 ACFT

MAX RUNOFF FROM 1

EVENT CONTRIBUTING TO

MAX MONTHLY RUNOFF = 7.6 ACFT

pumping out of basin
 shall be continuous @
 a rate $\geq$ dewatering Q

SEDIMENT = 11.6 ACFT

REF 11

$\Sigma = 96.4$ ACFT

ADD ON 6" FREEBOARD TO SPILLWAY PER DESIGN ETDS.

DESIGN TREAT. PLT TO :

TREAT DEWATERING flows * @ the dewatering flow rate.

TREAT 10yr VOLUME in 180 days.

TREAT MAX RUNOFF FROM 1 EVENT

CONTRIBUTING TO MAX MONTHLY

RUNOFF IN 15 days (SAME AS TREATING MAX MONTHLY IN 20d)

* i.e., surface H₂O pumped from pond 6.





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

Project UMMA-ECT
Feature Retention Basin
Item General

Contract No. 5067

Designed MJP

Checked MD

Sheet 26

File No.

Date 6/11/82

Date 7/8/82

BASIN CAPACITY:

keep bottom of Basin 1.5 ft above ground water.

SURFACE AREA @ SPILLWAY = 11.2 AC

SEE SH 27

" " @ BASIN BOTTOM = 8.9 AC

SPILLWAY @ $427.8 + 6" = 428.3$

$$\begin{aligned} \text{VOL BASIN} &= \left(\frac{11.2 + 8.9}{2} \right) \left(427.8 - \left(\frac{424.9 + 418.7 + 411.5 + 415.6 + 413.0}{5} \right) \right) \\ &= 71.2 \times 427.8 \\ &= 99.1 \text{ AC FT} \quad \therefore \text{OK} \end{aligned}$$

$$* \quad 415.6 = \text{GND WATER EL } (411.5) + 1.5' + 52.0 \text{ CF} \times .005$$

IN ORDER TO
PROVIDE A SLOPE
TOWARDS SUMP.

GROUNDWATER EL FROM REF 3

SEE SH 28









MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project ULTRA-ECT
 Feature REVENTON BASIN
 Item 25yr 6hr STORM

Contract No. 6057Designed MJPChecked KSCSheet 29File No. Date 2-29-88Date 7/9/88

USE 25yr 6hr RAINFALL FOR SPILLWAY DESIGN

25yr 6hr RAINFALL DISTRIBUTION

REF 1

TIME (hr)	RAIN FALL (IN)	INCREMENTAL RAINFALL (IN)
0.5	2.8	2.8
1.0	3.5	0.7
2.0	4.4	0.9
3.0	4.8	0.4
6.0	5.9	1.1

USE THIS DISTRIBUTION FOR TIMES 1 THRU 6 HR ,
 FOR 0-1 hr USE 1hr DISTRIBUTION PER FIG A , SH 30.
 THEN REARRANGE THIS DISTRIBUTION SO
 THAT PEAK IS @ MID POINT OF DURATION (@ 3 hr) SH 31 & 32

VOL 25yr 6hr RAINFALL = 5.9 IN





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

Project UMTA - FLT
Feature RETENTION BASIN
Item 25yr - 6hr STORM

Contract No. 5067

Designed MIP

Checked KLO

Sheet 30

File No. _____

Date 2-24-88

Date 7/6/88

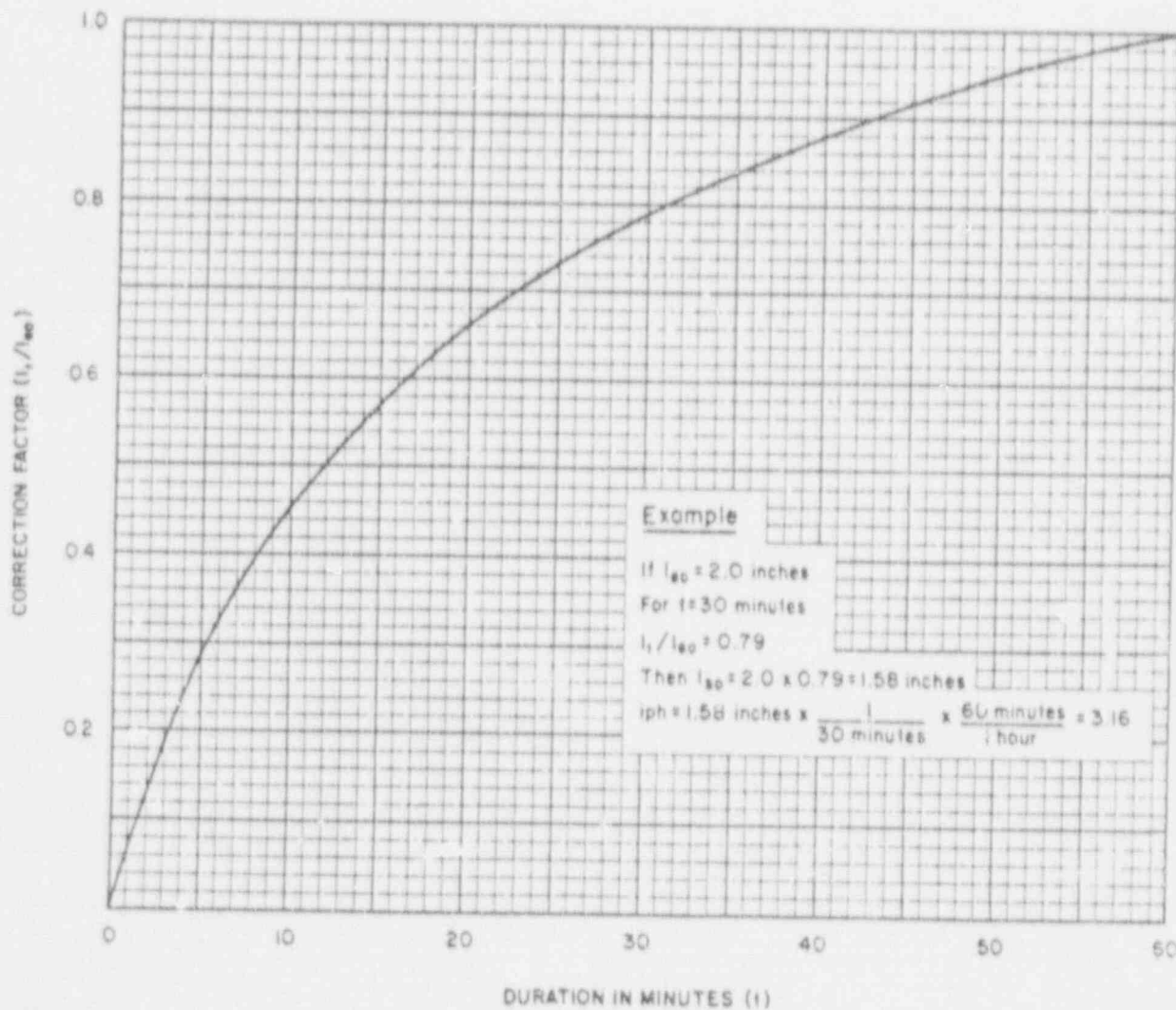


FIG A

REF 6

5113.8





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project ULTRA FLY
 Feature RETENTION BASIN
 Item 25 yr - 61 - STORM

Contract No. 5057Sheet 31Designed MSF

File No. _____

Checked KLODate 2-29-88Date 7/8/88

TIME (MIN)	FRACTION OF 1 HR RAINFALL	INCREMENTAL FRACTION OF 1 HR RAINFALL	INCREMENTAL RAINFALL (IN)	REARRANGED INCREMENTAL RAINFALL (IN)
0	0	0	0	0
5	.29	.29	.015	.031
10	.46	.16	.06	
15	.57	.12	.020	
20	.66	.09	.016	
25	.73	.07	.015	
30	.79	.06	.010	
35	.84	.05	.015	
40	.88	.04	.010	
45	.92	.04	.010	
50	.95	.03	.005	
55	.975	.03	.005	
60	1.00	.02	.075 USE .075	
65			.075	
70			.075	
75		$\frac{44.35}{12}$	.075	
80			.075	
85			.075	.031
90				.033
95				.033
100				.033
105				.033
110				.033
115				.033
120				.033
125				.075
130				.075
135		$\frac{48.44}{12}$		.075
140				.075
145				.075
150				.075
155				.105
160				.140





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project UNITA-ECT
 Feature RETENTION BASIN
 Item 25 yr 6 hr storm

Contract No. 5057

Sheet 32

Designed MS

File No.

Checked LO

Date 2-29-88

Date 7/8/88

TIME (MIN)	INCREMENTAL RAINFALL (IN)	REARRANGED INCREMENTAL RAINFALL (IN)	TIME (MIN)	INCREMENTAL RAINFALL (IN)	REARRANGED INCREMENTAL RAINFALL (IN)
165	.083	.210	270	.031	.031
170		.315	275		
175		.540	280		
180	<u>Y</u>	1.015	285		
185	.031	.420	290		
190		.245	295		
195		.175	300		
200	<u>5.9-4.7</u>	.140	305		
205	<u>36</u>	.105	310		
210		.075	315		
215		.075	320		
220		.075	325		
225		.075	330		
230		.075	335		
235		.075	340		
240		.033	345		
245			350		
250			355		
255			360	<u>Y</u>	<u>Y</u>
260					
265	<u>Y</u>	<u>Y</u>			





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project UTRA-FCY
 Feature RETENTION BASIN
 Item WEIR COEFF.

Contract No. 5087Designed MSPChecked ELOSheet 33File No. Date 6-10-88Date 7/8/89

SPILLWAY DATA

$$Q = 550.9 \text{ CFS}$$

$$\text{PEAK SPILLWAY FLOW DEPTH} = 2.3'$$

$$\text{SPILLWAY WIDTH} = 55'$$

SEE SH 45

CALC WEIR COEFF. C

$$(Q = CLH^{3/2})$$

TRAPEZOIDAL BROAD CRESTED WEIR

3:1 SLOPES

(BOTH FACES)

$$\text{BREADTH} \cong 16 \text{ FT}$$

REF 8 TAB 5-9 & 5-10 MODELS THIS KIND OF
 WEIR WELL EXCEPT THAT BREADTH IS SMALL (1.67 MAX)

USE AN AVERAGE OF VALUES FROM ^{TAB} 5-9 & 5-10 &
 TAB 5-4 (RECTANGULAR, BROAD CRESTED, BREADTH = 6.56)

$$\text{FOR } H=1 \text{ USE } \frac{2.83 + 3.43}{2} = 3.13$$

DUE TO OUR LARGER BREADTH USE $C = 3.0$ TO BE CONSERVATIVE

$$\text{FOR } H=.5 \text{ USE } \frac{3.13 + 2.83}{2} = 2.98 \text{ USE } 2.9$$





MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTA-ECT
Feature RETENTION BASIN
Item WEIR COEFF.

Contract No. 5067 Sheet 34
Designed THP File No.
Checked KLD Date 6/10/88
Date 7/8/88

$$\text{For } H = 1.5 \quad \text{USE} \quad \frac{2.83 + 3.61}{2} = 3.22$$

TO BE CONSERVATIVE USE $C = 3.0$ FOR $H \geq 0.5$



INPUT DATA

TITLE1: UMTRA/FCT
TITLE2: RETENTION BASIN

RAINFALL DATA

TYPE OF DATA: 1
1 = RAINFALL IN INCHES
2 = PERCENT OF TOTAL DEPTH
TIME STEP: 30.0 MINUTES
NUMBER OF RAINFALLS: 48
RAINFALLS IN INCHES:
0.036 0.037 0.038 0.040 0.041 0.042 0.045 0.046
0.054 0.057 0.060 0.065 0.070 0.076 0.084 0.092
0.157 0.207 0.323 2.545 0.482 0.250 0.178 0.139
0.092 0.084 0.076 0.070 0.064 0.061 0.057 0.054
0.046 0.044 0.043 0.040 0.040 0.038 0.037 0.036

SOIL PARAMETERS

INITIAL SOIL MOISTURE CONTENT: 0.5700
SATURATED SOIL MOISTURE CONTENT: 0.6000
SOIL SUCTION HEAD: 9.40 INCHES
HYDRAULIC CONDUCTIVITY: 0.0590000004 IN/HR

DRAINAGES

NUMBER OF DRAINAGE AREAS: 3

NAME OF THE 1st DRAINAGE AREA: DITCH 1
DRAINAGE AREA: 116.4 ACRES
IMPERVIOUS AREA: 0.0 ACRES
TIME OF CONCENTRATION: 32.0 MINUTES

NAME OF THE 2nd DRAINAGE AREA: DITCH 2
DRAINAGE AREA: 60.0 ACRES
IMPERVIOUS AREA: 0.0 ACRES
TIME OF CONCENTRATION: 19.0 MINUTES

NAME OF THE 3rd DRAINAGE AREA: DIRECTLY TRIB.
DRAINAGE AREA: 16.7 ACRES
IMPERVIOUS AREA: 11.2 ACRES
TIME OF CONCENTRATION: 5.0 MINUTES

OUT-DAT 15

1952 6-11-22

5416

on 2.2, March 29, 1988

10 YEAR 24 HOUR RAINFALL

0.048 0.052
0.106 0.123
0.123 0.106
0.050 0.049

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RET 5 ()

TO BASIN

BASED WATER SURF. AREA)

9205110072 -17

 RAINFALL-RUNOFF COMPUTATION

TITLE1: UMTRA/FCT
 TITLE2: RETENTION BASIN

NAME OF DRAINAGE AREA: DITCH 1
 DRAINAGE AREA: 116.4 ACRES
 IMPERVIOUS AREA: 0.0 ACRES
 IMPERVIOUS PORTION: 0.0000
 TIME OF CONCENTRATION: 32.0 MINUTES

SOIL PARAMETERS:
 INITIAL SOIL MOISTURE CONTENT: 0.5700
 SATURATED SOIL MOISTURE CONTENT: 0.6000
 SOIL SUCTION HEAD: 9.40 INCHES
 HYDRAULIC CONDUCTIVITY: 0.0590000004 IN/HR

TOTAL RAINFALL: 6.704 INCHES
 TIME STEP: 30.0 MINUTES
 NUMBER OF RAINFALLS: 48

RUNOFF VOLUME:
 IMPERVIOUS: 0.00 INCHES OR 0.00 AC-FT
 PERVIOUS: 4.68 INCHES OR 45.39 AC-FT
 TOTAL: 4.68 INCHES OR 45.39 AC-FT

PEAK FLOW: 301.5 CFS AT 12.50 HRS

NUMB	TIME (HRS)	RAINFALL DEPTH (IN)	INFILTRATION (IN)	IMPERVIOUS RUNOFF (IN)
0	0.000	0.000	0.000	0.000
1	0.500	0.036	0.036	0.000
2	1.000	0.037	0.037	0.000
3	1.500	0.038	0.038	0.000
4	2.000	0.040	0.040	0.000
5	2.500	0.041	0.041	0.000
6	3.000	0.042	0.042	0.000
7	3.500	0.045	0.045	0.000
8	4.000	0.046	0.046	0.000
9	4.500	0.048	0.048	0.000
10	5.000	0.052	0.052	0.000
11	5.500	0.054	0.054	0.000
12	6.000	0.057	0.057	0.000
13	6.500	0.060	0.054	0.000
14	7.000	0.065	0.052	0.000
15	7.500	0.070	0.050	0.000
16	8.000	0.076	0.049	0.000
17	8.500	0.084	0.048	0.000
18	9.000	0.093	0.047	0.000
19	9.500	0.106	0.046	0.000
20	10.000	0.123	0.045	0.000
21	10.500	0.157	0.044	0.000

WILLEY 3417

KLO 7/4/88

on 2.2, March 29, 1988

10 YEAR 24 HOUR RAINFALL

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PERVIDOUS RUNOFF (IN)	TOTAL RUNOFF (IN)	INSTANT HYDROGRAPH (CFS)	FINAL HYDROGRAPH (CFS)
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.006	0.006	1.4	0.5
0.013	0.013	3.0	1.6
0.020	0.020	4.6	3.0
0.027	0.027	6.4	4.6
0.036	0.036	8.5	6.4
0.046	0.046	10.9	8.5
0.060	0.060	14.2	11.1
0.078	0.078	18.3	14.4
0.113	0.113	26.5	19.5

9205110072-18

22	11.000	0.207	0.043	0.000
23	11.500	0.323	0.043	0.000
24	12.000	2.545	0.042	0.000
25	12.500	0.482	0.042	0.000
26	13.000	0.250	0.041	0.000
27	13.500	0.178	0.041	0.000
28	14.000	0.139	0.041	0.000
29	14.500	0.123	0.040	0.000
30	15.000	0.106	0.040	0.000
31	15.500	0.092	0.040	0.000
32	16.000	0.084	0.039	0.000
33	16.500	0.076	0.039	0.000
34	17.000	0.070	0.039	0.000
35	17.500	0.064	0.039	0.000
36	18.000	0.061	0.038	0.000
37	18.500	0.057	0.038	0.000
38	19.000	0.054	0.038	0.000
39	19.500	0.050	0.038	0.000
40	20.000	0.049	0.038	0.000
41	20.500	0.046	0.037	0.000
42	21.000	0.044	0.037	0.000
43	21.500	0.043	0.037	0.000
44	22.000	0.040	0.037	0.000
45	22.500	0.040	0.037	0.000
46	23.000	0.038	0.037	0.000
47	23.500	0.037	0.037	0.000
48	24.000	0.036	0.036	0.000
TOTALS		6.704	2.024	0.000

MSR 6-11-88 5418
K10 7/8/88

0.164	0.164	38.4	27.8
0.280	0.280	65.7	43.3
2.503	2.503	587.4	224.1
0.440	0.440	103.3	301.5
0.209	0.209	49.0	157.7
0.137	0.137	32.2	82.9
0.098	0.098	23.1	47.6
0.083	0.083	19.4	30.8
0.066	0.066	15.5	22.3
0.052	0.052	12.3	16.9
0.045	0.045	10.5	13.4
0.037	0.037	8.7	10.9
0.031	0.031	7.3	9.1
0.025	0.025	6.0	7.5
0.023	0.023	5.2	6.3
0.019	0.019	4.4	5.4
0.016	0.016	3.8	4.6
0.012	0.012	2.9	3.8
0.011	0.011	2.7	3.1
0.009	0.009	2.0	2.6
0.007	0.007	1.6	2.1
0.006	0.006	1.4	1.7
0.003	0.003	0.7	1.3
0.003	0.003	0.7	0.9
0.001	0.001	0.3	0.7
0.000	0.000	0.1	0.4
0.000	0.000	0.0	0.2
4.680	4.680	1098.5	1098.4

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MORRISON-KNUDSEN ENGINEERS, INC.
SANTA BARBARA URBAN HYDROGRAPH MODEL: SBUHYD, Vers 1

RAINFALL-RUNOFF COMPUTATION

TITLE1: UMTRA/FCT
TITLE2: RETENTION BASIN

NAME OF DRAINAGE AREA: DITCH 2
DRAINAGE AREA: 60.0 ACRES
IMPERVIOUS AREA: 0.0 ACRES
IMPERVIOUS PORTION: 0.0000
TIME OF CONCENTRATION: 19.0 MINUTES

SOIL PARAMETERS:
INITIAL SOIL MOISTURE CONTENT: 0.5700
SATURATED SOIL MOISTURE CONTENT: 0.6000
SOIL SUCTION HEAD: 9.40 INCHES
HYDRAULIC CONDUCTIVITY: 0.0590000004 IN/HR

TOTAL RAINFALL: 6.704 INCHES
TIME STEP: 30.0 MINUTES
NUMBER OF RAINFALLS: 48

RUNOFF VOLUME:
IMPERVIOUS: 0.00 INCHES OR 0.00 AC-FT
PERVIOUS: 4.68 INCHES OR 23.40 AC-FT
TOTAL: 4.68 INCHES OR 23.40 AC-FT

PEAK FLOW: 174.9 CFS AT 12.50 HRS

NUMB	TIME (HRS)	RAINFALL DEPTH (IN)	INFILTRATION (IN)	IMPERVIOUS RUNOFF (IN)
0	0.000	0.000	0.000	0.000
1	0.500	0.036	0.036	0.000
2	1.000	0.037	0.037	0.000
3	1.500	0.038	0.038	0.000
4	2.000	0.040	0.040	0.000
5	2.500	0.041	0.041	0.000
6	3.000	0.042	0.042	0.000
7	3.500	0.045	0.045	0.000
8	4.000	0.046	0.046	0.000
9	4.500	0.048	0.048	0.000
10	5.000	0.052	0.052	0.000
11	5.500	0.054	0.054	0.000
12	6.000	0.057	0.057	0.000
13	6.500	0.060	0.054	0.000
14	7.000	0.065	0.052	0.000
15	7.500	0.070	0.050	0.000
16	8.000	0.076	0.049	0.000
17	8.500	0.084	0.048	0.000
18	9.000	0.093	0.047	0.000
19	9.500	0.106	0.046	0.000
20	10.000	0.123	0.045	0.000
21	10.500	0.157	0.044	0.000

74JP 611-68
K-10 7/2/68

SH 19

on 2.2, March 29, 1988

10 YEAR 24 HOUR RAINFALL

PERVIOUS RUNOFF (IN)	TOTAL RUNOFF (IN)	INSTANT HYDROGRAPH (CFB)	FINAL HYDROGRAPH (CFB)
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.000	0.000	0.0	0.0
0.006	0.006	0.7	0.3
0.013	0.013	1.6	1.0
0.020	0.020	2.4	1.9
0.027	0.027	3.3	2.7
0.036	0.036	4.4	3.7
0.046	0.046	5.6	4.9
0.060	0.060	7.3	6.3
0.078	0.078	9.5	8.1
0.113	0.113	13.7	11.2

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9205110072-20

22	11.000	0.207	0.043	0.000
23	11.500	0.323	0.043	0.000
24	12.000	2.545	0.042	0.000
25	12.500	0.482	0.042	0.000
26	13.000	0.250	0.041	0.000
27	13.500	0.178	0.041	0.000
28	14.000	0.139	0.041	0.000
29	14.500	0.123	0.040	0.000
30	15.000	0.106	0.040	0.000
31	15.500	0.092	0.040	0.000
32	16.000	0.084	0.039	0.000
33	16.500	0.076	0.039	0.000
34	17.000	0.070	0.039	0.000
35	17.500	0.064	0.039	0.000
36	18.000	0.061	0.038	0.000
37	18.500	0.057	0.038	0.000
38	19.000	0.054	0.038	0.000
39	19.500	0.050	0.038	0.000
40	20.000	0.049	0.038	0.000
41	20.500	0.046	0.037	0.000
42	21.000	0.044	0.037	0.000
43	21.500	0.043	0.037	0.000
44	22.000	0.040	0.037	0.000
45	22.500	0.040	0.037	0.000
46	23.000	0.038	0.037	0.000
47	23.500	0.037	0.037	0.000
48	24.000	0.036	0.036	0.000
TOTALS		6.704	2.024	0.000

MSP 6-11-88
KLO 7/3/89

5420

0.164	0.164	19.8	16.1
0.280	0.280	33.9	25.6
2.503	2.503	302.8	151.6
0.440	0.440	53.3	174.9
0.209	0.209	25.2	55.2
0.137	0.137	16.6	24.9
0.098	0.098	11.9	15.5
0.083	0.083	10.0	11.5
0.066	0.066	8.0	9.2
0.052	0.052	6.3	7.4
0.045	0.045	5.4	6.0
0.037	0.037	4.5	5.1
0.031	0.031	3.8	4.2
0.025	0.025	3.1	3.5
0.023	0.023	2.7	3.0
0.019	0.019	2.3	2.6
0.016	0.016	1.9	2.2
0.012	0.012	1.5	1.8
0.011	0.011	1.4	1.5
0.009	0.009	1.0	1.2
0.007	0.007	0.8	1.0
0.006	0.006	0.7	0.8
0.003	0.003	0.4	0.6
0.003	0.003	0.4	0.4
0.001	0.001	0.2	0.3
0.000	0.000	0.1	0.1
0.000	0.000	0.0	0.0
4.680	4.680	566.2	566.2

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9205110072-21

RAINFALL-RUNOFF COMPUTATION

TITLE1: UMTRA/FCT
TITLE2: RETENTION BASIN

NAME OF DRAINAGE AREA: DIRECTLY TRIB.
DRAINAGE AREA: 16.7 ACRES
IMPERVIOUS AREA: 11.2 ACRES
IMPERVIOUS PORTION: 0.6707
TIME OF CONCENTRATION: 5.0 MINUTES

SOIL PARAMETERS:
INITIAL SOIL MOISTURE CONTENT: 0.5700
SATURATED SOIL MOISTURE CONTENT: 0.6000
SOIL SUCTION HEAD: 9.40 INCHES
HYDRAULIC CONDUCTIVITY: 0.0590000004 IN/HR

TOTAL RAINFALL: 6.704 INCHES
TIME STEP: 30.0 MINUTES
NUMBER OF RAINFALLS: 48

RUNOFF VOLUME:
IMPERVIOUS: 4.50 INCHES OR 6.26 AC-FT
PERVIOUS: 1.54 INCHES OR 2.14 AC-FT
TOTAL: 6.04 INCHES OR 8.40 AC-FT

PEAK FLOW: 66.9 CFS 4" 12.00 HRS

NUMB	TIME (HRS)	RAINFALL DEPTH (IN)	INFILTRATION (IN)	IMPERVIOUS RUNOFF (IN)
0	0.000	0.000	0.000	0.000
1	0.500	0.036	0.036	0.024
2	1.000	0.037	0.037	0.025
3	1.500	0.038	0.038	0.025
4	2.000	0.040	0.040	0.027
5	2.500	0.041	0.041	0.027
6	3.000	0.042	0.042	0.028
7	3.500	0.045	0.045	0.030
8	4.000	0.046	0.046	0.031
9	4.500	0.048	0.048	0.032
10	5.000	0.052	0.052	0.035
11	5.500	0.054	0.054	0.036
12	6.000	0.057	0.057	0.038
13	6.500	0.060	0.054	0.040
14	7.000	0.065	0.052	0.044
15	7.500	0.070	0.050	0.047
16	8.000	0.076	0.049	0.051
17	8.500	0.084	0.048	0.056
18	9.000	0.093	0.047	0.062
19	9.500	0.106	0.046	0.071
20	10.000	0.123	0.045	0.082
21	10.500	0.157	0.044	0.105

APR 6-11-48
CLO 7/8/68

5421

on 2.2, March 29, 1968

10 YEAR 24 HOUR RAINFALL
D BASIN

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PERVICUS RUNOFF (IN)	TOTAL RUNOFF (IN)	INSTANT HYDROGRAPH (CFS)	FINAL HYDROGRAPH (CFS)
0.000	0.000	0.0	0.0
0.000	0.024	0.8	0.6
0.000	0.025	0.8	0.9
0.000	0.025	0.9	0.8
0.000	0.027	0.9	0.9
0.000	0.027	0.9	0.9
0.000	0.028	0.9	0.9
0.000	0.030	1.0	1.0
0.000	0.031	1.0	1.0
0.000	0.032	1.1	1.1
0.000	0.035	1.2	1.2
0.000	0.036	1.2	1.2
0.000	0.038	1.3	1.3
0.002	0.042	1.4	1.4
0.004	0.048	1.6	1.6
0.006	0.053	1.8	1.8
0.009	0.060	2.0	2.0
0.012	0.068	2.3	2.2
0.015	0.078	2.6	2.6
0.020	0.091	3.1	3.0
0.026	0.108	3.6	3.5
0.037	0.142	4.8	4.5

9205110072-22

22	11. 000	0. 207	0. 043	0. 139
23	11. 500	0. 323	0. 043	0. 217
24	12. 000	2. 545	0. 042	1. 707
25	12. 500	0. 482	0. 042	0. 323
26	13. 000	0. 250	0. 041	0. 168
27	13. 500	0. 178	0. 041	0. 119
28	14. 000	0. 139	0. 041	0. 093
29	14. 500	0. 123	0. 040	0. 082
30	15. 000	0. 106	0. 040	0. 071
31	15. 500	0. 092	0. 040	0. 062
32	16. 000	0. 084	0. 039	0. 056
33	16. 500	0. 076	0. 039	0. 051
34	17. 000	0. 070	0. 039	0. 047
35	17. 500	0. 064	0. 039	0. 043
36	18. 000	0. 061	0. 038	0. 041
37	18. 500	0. 057	0. 038	0. 038
38	19. 000	0. 054	0. 038	0. 036
39	19. 500	0. 50	0. 038	0. 034
40	20. 000	0. 049	0. 038	0. 033
41	20. 500	0. 046	0. 037	0. 031
42	21. 000	0. 044	0. 037	0. 30
43	21. 500	0. 043	0. 037	0. 029
44	22. 000	0. 040	0. 037	0. 027
45	22. 500	0. 040	0. 037	0. 027
46	23. 000	0. 038	0. 037	0. 025
47	23. 500	0. 037	0. 037	0. 025
48	24. 000	0. 036	0. 036	0. 024

TOTALS

6. 704

2. 024

4. 496

MSP 6-11-88 5422
pro 7/8/88

0.054	0.193	6.5	6.2
0.092	0.309	10.4	9.6
0.824	2.531	85.2	66.9
0.145	0.468	15.8	42.3
0.069	0.236	8.0	0.0
0.045	0.164	5.5	10.1
0.032	0.126	4.2	2.3
0.027	0.110	3.7	4.8
0.022	0.093	3.1	2.7
0.017	0.079	2.7	3.0
0.015	0.071	2.4	2.3
0.012	0.063	2.1	2.2
0.010	0.057	1.9	1.9
0.008	0.051	1.7	1.8
0.007	0.048	1.6	1.6
0.006	0.044	1.5	1.5
0.005	0.041	1.4	1.4
0.004	0.038	1.3	1.3
0.004	0.037	1.2	1.2
0.003	0.034	1.1	1.2
0.002	0.032	1.1	1.1
0.002	0.031	1.0	1.0
0.001	0.028	0.9	1.0
0.001	0.028	0.9	0.9
0.000	0.026	0.9	0.9
0.000	0.025	0.8	0.8
0.000	0.024	0.8	0.8
1.541	7	203.3	205.4

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9205110072-23

MORRISON-KNUDSEN ENGINEERS, INC.
SANTA BARBARA URBAN HYDROGRAPH MODEL: SBUHYD, Versi

RAINFALL-RUNOFF COMPUTATION

TITLE1: UMTRA/FCT

TITLE2: RETENTION BASIN 10 YEAR 24 HOUR RAINFALL

COMBINED OUTFLOWS:

NUMB	TIME (HRS)	OUTFLOW D AREA(1) (CFS)	OUTFLOW D AREA(2) (CFS)	OUTFLOW D AREA(3) (CFS)	CO DU
0	0.00	0.0	0.0	0.0	
1	0.50	0.0	0.0	0.6	
2	1.00	0.0	0.0	0.9	
3	1.50	0.0	0.0	0.8	
4	2.00	0.0	0.0	0.9	
5	2.50	0.0	0.0	0.9	
6	3.00	0.0	0.0	0.9	
7	3.50	0.0	0.0	1.0	
8	4.00	0.0	0.0	1.0	
9	4.50	0.0	0.0	1.1	
10	5.00	0.0	0.0	1.2	
11	5.50	0.0	0.0	1.2	
12	6.00	0.0	0.0	1.3	
13	6.50	0.5	0.3	1.4	
14	7.00	1.6	1.0	1.6	
15	7.50	3.0	1.9	1.8	
16	8.00	4.6	2.7	2.0	
17	8.50	6.4	3.7	2.2	
18	9.00	8.5	4.9	2.6	
19	9.50	11.1	6.3	3.0	
20	10.00	14.4	8.1	3.5	
21	10.50	19.5	11.2	4.6	
22	11.00	27.8	16.1	6.2	
23	11.50	43.3	25.6	9.6	
24	12.00	224.1	151.6	66.9	
25	12.50	301.5	174.9	42.3	
26	13.00	157.7	55.2	0.0	
27	13.50	82.9	24.9	10.1	
28	14.00	47.6	15.5	2.3	
29	14.50	30.8	11.5	4.8	
30	15.00	22.3	9.3	2.7	
31	15.50	16.9	7.4	3.0	
32	16.00	13.4	6.0	2.3	
33	16.50	10.9	5.1	2.2	
34	17.00	9.1	4.2	1.9	
35	17.50	7.5	3.5	1.8	
36	18.00	6.3	3.0	1.6	
37	18.50	5.4	2.6	1.5	
38	19.00	4.6	2.2	1.4	
39	19.50	3.8	1.8	1.3	
40	20.00	3.1	1.5	1.2	
41	20.50	2.6	1.2	1.2	
42	21.00	2.1	1.0	1.1	
43	21.50	1.7	0.8	1.0	

M41P 6-11-88
KLO 7/2/88

SH 23

on 2.2, March 29, 1988

MBINED
TFLOW
(CFS)

0.0
0.4
0.5
0.5
0.9
0.9
0.9
1.0
1.0
1.1
1.2
1.2
1.3
2.2
4.2
6.7
9.3
12.4
15.9
20.3
26.1
35.2
50.0
78.4
442.6
518.7
212.9
118.0
63.4
47.1
34.3
27.3
21.7
18.3
15.2
12.8
10.9
9.5
8.1
6.8
5.8
5.0
4.1
3.5

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9205110072 -24

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44 22.00
45 22.50
46 23.00
47 23.50
48 24.00

1.3
0.9
0.7
0.4
0.2

0.6
0.4
0.3
0.1
0.0

1.0
0.9
0.9
0.8
0.8

2.8
2.3
1.9
1.3
1.0

WSP 6-11-88
KLO 7/2/88

5424

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Also Available On
Aperture Card

9205110072-25

Calculation Cover Sheet

Contract No. 5057Discipline ESCICalc. No. 20-Y73-07-00No. of Sheets 10

Project

UMTRA - FCT

Feature

RETENTION BASIN

Item

SPILLWAY

Sources of Data

Sources of Formulae & References

1. U.S. Bureau of Reclamation, 1974 Design of Small Dams.
2. CROW V.T., 1959 open Channel Hydraulics McGraw Hill.
3. Army Corps of Engineers 3-31-65 (Ames Change 1) Hydraulic Design of Spillways EM 1110-2-1603
4. U.S. Army Engineer Waterways Experiment Station, 1970 Design & Repair Requirements at Culvert & Storm Drain Outlets Research Report H-76-2
5. U.S. Army Engineer Waterways Experiment Station (Inter Army) Hydraulic Design Criteria

Preliminary Calc. ☒Final Calc. ☒

Supersedes Calc. No. _____

0		POPPER	6-15-88	T. Kambhampati K. J. F. USCE	6-21-88 7/11/89	2000.12	7-1-89
Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



Project

UPSTAR - ECT

Contract No.

5057

Sheet

a

Feature

RETENTION BASIN

Designed

MSP

File No.

Item

SPILLWAY

Date

6-15-88

Checked

KLD

Date

7/11/88

6. U.S. Dept of Interior, Office of Surface Mining. Sept 1982
Surface Mining Water Diversion Design Manual OSM/T2-822
7. Stephenson D. 1979, Rockfill in Hydraulic Engineering, Elsevier
Scientific Pub. Co., New York.
8. Ultrac Design Procedures Manual MKE DOC # 4005-GEN-Q-01-00571-02
9. US Army Corps of Engineers, July 1970 (since changes 1-4) Hydraulic
Design of Flood Control Channels EM11-0-2-1601
10. MKE calc # 20-440-02-00 Erosion Protection, Riprap design for apron.
11. MKE calc # 20-433-06-00 Retention Basin, General
12. Ling, H.W. Handbook of Hydraulics GTED, 1982, M. Grant-Hill,
New York
13. US Dept. of Interior, Bureau of Reclamation Design of Small Canal
Structures, 1978





Project UNITED STATES
 Feature RETENTION BASIN
 Item SPILLWAY

Contract No. 5057Sheet 1

File No.

Designed 11/1Date 6-15-88Checked YLCDate 7/11/89

PURPOSE: Determine stable rock size & thickness
 at spillway outlet.

CONSIDER USING A REGRAP LINED STELLING BASIN

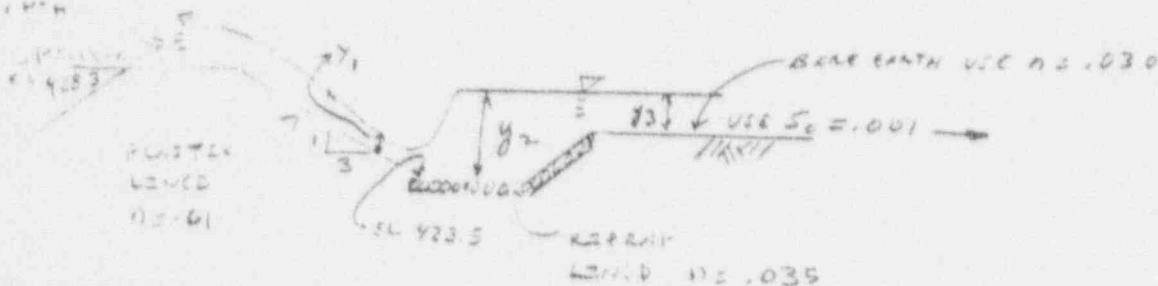
(SEE SHE FOR TYPICAL CONFIGURATION)

ANALYZE REGRAP SIZE BY SEVERAL METHODS

$$Q = 556.9 \text{ (CFS)}, \text{ SPILLWAY LENGTH} = 55 \text{ FT}$$

$$q = \frac{Q}{b} = \frac{\text{FLOW}}{\text{PLAN}} = \frac{556.9}{55} = 10.1 \frac{\text{CFS}}{\text{FT}}$$

SPILLWAY
 DESIGN
 FULL WIDTH
 2.3



y_1 & y_2 ARE UPSTREAM & DOWNSTREAM CONJUGATE DEPTHS OF HYDRAULIC JUMP

$$y_c = y_{\text{CRITICAL}} = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{(10.1)^2}{32.2}} = 1.47 \quad \text{REF 12}$$

USE $y_c = 1.47$ AS DEPTH OF FLOW @ TOP OF SPILLWAY, (@ BEGINNING OF 3:1 SLOPE)

$$V_c = \frac{q}{y_c} = \frac{10.1}{1.47} = 6.87 \text{ FPS}$$

BERNOULLI EQU. WATER SURF ELEV. (TOP SPILLWAY) + $\frac{V_{\text{TOP SPILLWAY}}^2}{2g} = \text{WATER SURF} + \frac{V_1^2}{2g}$

← SHORT REACH
 1. = NONE HEAD
 LOSS DUE TO
 FRICTION

$$(28.3 + 1.47) + \frac{6.87^2}{64.4} = (23.5 + y_1) + \frac{V_1^2}{64.4}$$

1. = REACH $y_1 = 1.9$ & $V_1 = 20.6$

SPILLWAY LENGTH = 14.4
 REF 13 P. 105 SAYS FOR
 SPILLWAYS < 30' LONG
 IGNORE HEADLOSS DUE
 TO FRICTION

(HENCE USE 6.55 FOR 1.50% OF FLOW FOR ALL SECTIONS)





Project UNFAA-ECT
Feature RETENTION BASIN
Item SPILLWAY

Contract No. 5057

Designed ThP

Checked KLN

Sheet 1A

File No.

Date 6-5-71

Date 7-25-98

$$F_1 = \text{Froude \#} = \frac{V_1}{\sqrt{gy_1}} = \frac{20.6}{\sqrt{32.2(4.9)}} = 5.2 < 10 \therefore \text{STENDING BASON}$$

IS APPROPRIATE
TO USE AS REF 13
P. 106
ENERGY DISSIPATION

$$y_2 = \text{SUBCRITICAL CONJUGATE DEPTH OF } y_1 = (-)\frac{y_1}{2} + \sqrt{\frac{2V_1^2 y_1}{g} + \frac{y_1^2}{4}}$$

REF 13 P. 106

NOTE: This eqn. is for rectangular spillway channel = stilling basin (vertical walls) $\Rightarrow$ our case has the flow run unforced when going down the 3:1 spillway (sloped flow). It is therefore conservative to use this equation because it will yield a y_2 SLIGHTLY GREATER THAN ACTUAL.

$$y_2 = (-)\frac{4.9}{2} + \sqrt{\frac{2(20.6)^2(4.9)}{32.2} + \frac{(4.9)^2}{4}} = 3.36$$

$$V_2 = \frac{10.1}{3.36} = 3.0 \text{ FPS}$$

$$\begin{aligned} EGL_2 = \text{energy grade line @ 2} &= 423.5 + y_2 + \frac{V_2^2}{2g} \\ &= 423.5 + 3.36 + \frac{3.0^2}{64.4} = 427.0 \end{aligned}$$

$$y_3 = \text{NORMAL DEPTH DOWNSTREAM OF STILLING BASIN} = \left(\frac{qn}{1.486 C^{1/2}} \right)^{3/5} = \left(\frac{10.1(1.03)}{1.486(1.001)^{1/2}} \right)^{3/5}$$

(MANNING'S
EQ. 14.2
INTENSITELY
WEBC FLOW)

$$= 3.06$$



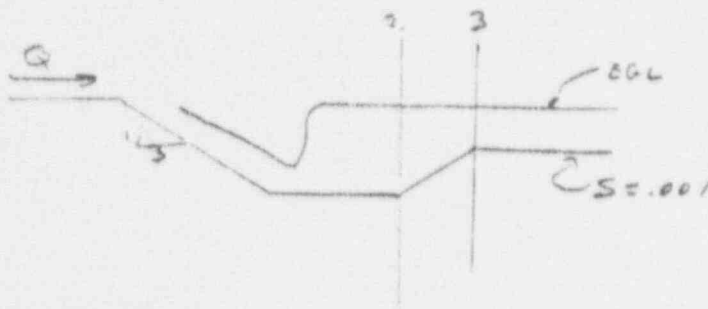


Project UMTRA-ECT Contract No. 5857 Sheet 2
Feature RETENTION BASIN Designed MSP File No. _____
Item SPILLWAY Checked LLO Date 6-15-88
Date 7/5/88

$$V_3 = \frac{10.1}{3.06} = 3.30$$

$$\text{ELEV HEAD + VELOCITY HEAD @ 3} = y_3 + \frac{V_3^2}{2g} = 3.06 + \frac{3.3^2}{64.4}$$

$$= 3.23'$$



EGL₃ MUST EQUAL EGL₂ (APPROX) by continuity.

$$\therefore \text{INVERT EL @ 3} = \text{EGL}_3 - (\text{ELEV HEAD}_3 + \text{VELOCITY HEAD}_3)$$

$$= 427.0 - 3.23 = 423.77$$

$$\text{DEPTH OF STILLING BASIN} = 423.77 - 423.5 = 0.27 \text{ FT}$$

THIS IS
SINCE SUCH A SHALLOW STILLING BASIN DEPTH DO NOT
CONSTRUCT STILLING BASIN, PROVIDE RIPRAP EROSION
PROTECTION @ TVE & EXTEND DOWNSTREAM PAST THE END OF THE
HYDRAULIC JUMP.

$$\text{LENGTH OF JUMP: FOR FLAT SLOPES USE } \frac{\text{LENGTH}}{y_2} = 6.15$$

REF 12
P. 4-27

$$\therefore \text{LENGTH OF JUMP} = 6.15 (3.36) = 20.7$$

USE 21'



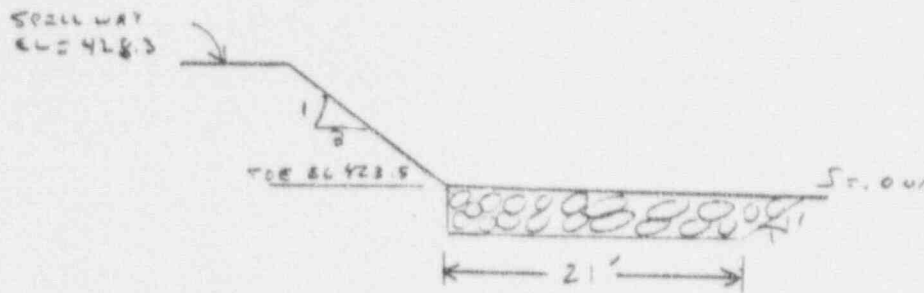


Project ULTRA-FCT
 Feature RETENTION BASIN
 Item SPILLWAY

Contract No. 5057
 Designed MSP
 Checked KIC

Sheet 3
 File No. _____
 Date 6/5/88
 Date 7/11/88

USE THIS CONFIGURATION:



DESIGN WILL BE BASED ON ENERGY DISTRIBUTION (MOST FAVORABLE
 IN TERMS OF CONSTRUCTION & DEMOLITION)

ALL WIRE REINFORCING SHALL BE SEVERAL METERS





Project UMTRA-FCT
Feature RETENTION DAM
item SPILLWAY

Contract No. 5067
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Checked ELD
Sheet 4
File No. _____
Date 6-5-88
Date 7/11/88

1.

$$d_s = \text{stone diam required} = .25 D_o F_o$$

to prevent failure
of apron

USE MIN. TAIL WATER
CASE (MORE CONSERVATIVE)

REF 4
P. 12

$$F_o = \text{friction } F = 5.2$$

$$D_o = \text{use flow depth} = .49 \text{ FT} = y_1$$

$d_s = .64 \text{ FT}$ ← USE this as a guide only. note
our case with $F=5.2$ is beyond
range of data used in this eqn. ($F=4$ PAGE 13)

2. CALC. CURVED STEEL

$$D_{50} = C \frac{D_o^2}{TW} \left(\frac{q}{D_o^{3/2}} \right)^{4/3}$$

REF 5
CHART 722-7

$$C = .02$$

$$D_o = .49 \text{ (USE FLOW DEPTH @ UPSTREAM)}$$

$$TW = y_3 = 3.06$$

$$D_{50} = 0.4 \text{ ft}$$





Project UTAH - FLY
Feature RETENTION BASIN
Item SPILLWAY

Contract No. 5057
Designed MSP
Checked LLO

Sheet 5
File No. _____
Date 6-15-68
Date 7/11/68

These values should be used as a guide only, since chart 72.7 is for culvert outlets & may not model our case of a shallow, 55 foot wide hydraulic section very well.

3. REF 5 CHART 712.1

$$D_{50} = \left(\frac{V}{C \left[2g \left(\frac{\delta_s - \delta_w}{\delta_w} \right) \right]^{1/2}} \right)^2$$

$$\delta_s = 2.6(62.4) = 162.2$$

$$\delta_w = 62.4$$

$$C = .86 \text{ (HIGH TURBULENCE)}$$

$$V = 20.6$$

$$D_{50} = \left(\frac{20.6}{.86 \left[2g \left(\frac{162.2 - 62.4}{62.4} \right) \right]^{1/2}} \right)^2 = 56'$$

This method is overly conservative for our purposes since flow depth & q are relatively small & depth is not considered directly in this method





Project

UMTRA-ECT

Contract No. 5057

Sheet

6

Feature

Retention Basin

Designed MJP

File No.

Item

Spillway

Checked ELC

Date 6-15-88

Date 7/11/88

7. REF 8 For channels with high turbulence due to grade changes from steep to flat use Safety Factor Method with shear stress greater than that for uniform flow. PS-16
45-6

FOR 0.1% SLOPE $\gamma = \gamma_2 = \left(\frac{10.1(0.035)}{1.48(0.001)} \right)^{3/5} = 3.4$ (USE 0.035 FOR RIPRAP (LUGSENUMATS))

$\tau_s = \gamma \delta_w S = 3.4(62.4)(0.001) = 0.2$ PSF

INCREASE τ_s by 1.5 to account for high turbulence (JUDGMENT)

NOTE: REF 9, PLATE 34, FACTOR = 1.5 TO account for high turbulence OVER PLATES; FOR A ROUGH CHANNEL WITH $\frac{E}{RADIUS OF BED} = 3.3$
CHANNEL WIDTH

$\therefore$ USE $\tau_s = 0.2 \times 1.5 = 0.3$ PSF

$n_s = \cos \theta \left(\frac{1}{SF} - \frac{\tan \theta}{\tan \phi} \right) = \cos 0.57 \left(\frac{1}{1} - \frac{\tan 0.57}{\tan 38} \right) = 1.0$

$D_{50} = \frac{\tau_s 2.1}{\gamma_s (5-1) \delta_w} = \frac{0.3(2.1)}{1(2.6-1)(62.4)} = .06$ ft

FOR 3:1 slope $\gamma_s = .54$
 $\gamma = \gamma_1 = .49$

542

$\tau_s = 1.5 \tau_s = 1.5(\gamma \delta_w S) = 1.5 \times .49 \times 62.4 \times .33 = 15.1$

$\therefore D_{50} = \frac{15.1(2.1)}{.54(1.6)62.4} = 5.9$ ft

NOTE: The rock size for the flatter slope (.001) should govern the design since the slope of the riprap erosion protection is .001.





Project

UMTAA-ECT

Contract No.

5067

Sheet

7

Feature

Retention Basin

Designed

AKP

File No.

6-15-88

Item

Spillway

Checked

KLD

Date

7/11/88

DISCUSSION

Rock sizing methods are difficult to apply to the case of a hydraulic jump @ the base of a spillway where velocity is large & depth & unit flow rate are small. i. Considerable judgement must be used in this design.

Spilling flow occurs only for 25 yr or greater frequency storms. Flows ≥ 500 cfs occur for only 25 minutes REF 1
acc'd to 25 yr bkr design storm. Flows ≥ 400 cfs occur
for only 46 min. Flows ≥ 550 cfs occur for only 9 min.
" ≥ 350 " " " " 57 "

Based on the low frequency of occurrence & short duration use $D_{50} = 9.0$ " rock for basin 2 (MAX SIZE USED FOR PERMANENT DISTURBS REF 10)
(USE GRADATION PER REF 10)
(NOTE THE CORRESPONDING $D_{10} = 15$ ")

RIPRAP AT TOE OF SPILLWAY SHALL BE 25' WIDE





Project UNITA FCT
Feature Retention Basin
Item Spillway

Contract No. 5057
Designed MSP
Checked KLD

Sheet 8
File No. _____
Date 6-15-88
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Thickness of Riprap Layer:

$$= 1.5 D_{50 \text{ MAX}} = 1.5 (11") = 16.5 "$$

$$\approx 1.9 D_{50 \text{ MAX}} = 1.9 (9") = 17.1 "$$

USE 18 "

Gradation

USE GRADATION FOR $D_{50} = 9.0"$ ROCK PER REF 10 5444



Calculation Cover Sheet



Contract No. 3885-28 Discipline MKES Calc. No. 20-V86-07-00
 No. of Sheets 142 + Appendix C

Project

UMTRA - FCT

Feature

Wastewater Handling and Water Balance II

Item

Treatment / Evaporation / Irrigation Schemes

Sources of Data

(see sheet 2.111)

Sources of Formulae & References

(see sheet 2.111)

Preliminary Calc. ☐Final Calc. ☒

Supersedes Calc. No.

20-433-04-00
 20-433-09-01
 20-433-05-01

0	—	P. Y. LI	3/19/91	A. C. (initials)	2/26/91	P. C. Chen	3/26/91
Rev No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



MORRISON-KNUDSEN ENGINEERS, INC.

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Project UMTRA - FCT
 Feature Wastewater Evap. Study
 Item Water bal. & Wastewater handling

Contract No. 3885-28

Designed PYL

Checked WYL

Sheet 1

File No.

Date 11/6/90

Date 11/7/90

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Project UMTRA - FCT
 Feature Wastewater Evap. Study
 Item Water bal. & Wastewater handling

Contract No. 3885-28

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Sheet 11

File No.

Date 11/6/90

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Project UNITED - ECT
 Feature Waste Handling II
 Item Treatment / Exposure / Integration scheme

Contract No. 3815-28
 Designed PYL
 Checked AL

Sheet 1
 File No. _____
 Date 3/11/91
 Date 3/22/91

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Project UMTRA - FLT
Feature Wastewater Handling
Item _____

Contract No. 3885-CE Sheet 2
Designed P.L. File No. _____
Checked AG Date 3/12/91
Date 3/22/91

I PURPOSE

Three possible schemes have been proposed to handle the wastewater during construction at Falls City Tailings Site. They are namely i) Treatment and then discharge, ii) Evaporation pond, and iii) Irrigation of a grass crop. The purpose of this calculation was to perform water balance assessment on each of the schemes. In the cases of evaporation and irrigation schemes, the acreages required were determined independently. In the case of the treatment/discharge scheme, the treatment plant size was determined. Cost estimates were provided for comparison purposes.

As a result of a meeting held at MKS San Francisco, in which combination of evaporation and treatment had also been discussed (Ref 20), one additional scheme of this combination was also evaluated herein. And cost estimate was also provided. Cost estimate was also provided for the scheme with primarily ^{full} evaporation pond (QAP) with mobile treatment plant for emergency use.



Project
Feature
Item

UMTIA-FCI

Wastewater Handling II

Contract No. 385-28

Designed P.Y.L.

Checked A.L.

Sheet 3

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Date 3/12/91

Date 3/21/91

II. APPROACH1. Reduction of Runoff Area

The construction sequence was carefully re-examined in order to reduce the contaminated area and water as much as possible during construction period.

The construction sequence proposed herein is -

- i) Construct the wastewater retention basin (in the existing pile #4) and the evaporation pond of the irrigation farmland. Pump the dewatering water, if encountered into pond #6.
- ii) If the migration of the irrigator scheme is chosen, pretreat the water pond #6 and pump into the evaporation pond in the irrigation farmland.
- iii) Construct a temporary dike at the edge of the existing pile #2 next to the FH1344. Retain the tailings pile #5 above the present location of pile #2 and the millyard area as shown on sheet 6. Construct temporary ditches surrounding that disturbed part of the embankment area. The water of area 10 is about 25 ft. high. Direct the water of disturbed site into the retention basin. If migration to irrigation scheme is chosen, pretreat the water and pump into the evaporation pond in the irrigation farmland.



Project
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WATER TREAT

Wastewater Handling

Contract No. 3285 75
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Date 2/22/91

- v) Near the completion of pie #5, cleanup pond #6
- v) Close temporary ditches surrounding pie #5, construct the rest of the ditch surrounding the embankment area. Reshape tailings piles #1, 2 and #7. Direct the water if encountered into the retention basin. If evaporation in the irrigation scheme is chosen, put out the water then pump into the evaporation pond on the farmland.
- The water shed area from embankment and ditches will be 125 Ac. for then on until closure of temporary ditches.
- vi) Relocate pie #3.
- vii) Close the temporary ditches when the radon barrier material is being placed.
- viii) Leaving the retention basin and the evaporation pond on the irrigated farmland; Slope the side and/or dispose of the synthetic membrane liner.

This construction sequence is also presented in bar chart in water balance calculations section on ch 10-17.

2. Consumption of Wastewater in Construction (dust control)

It has been suggested that the wastewater generated during construction could be consumed in compaction of relocated tailings and/or dust control. The relocated tailings are very wet already; it seems not feasible to use some of the waste water in compaction. However the water can be used in





Project WATER-FET
 Feature Wastewater Handling II
 Item _____

Contract No. 5800-38
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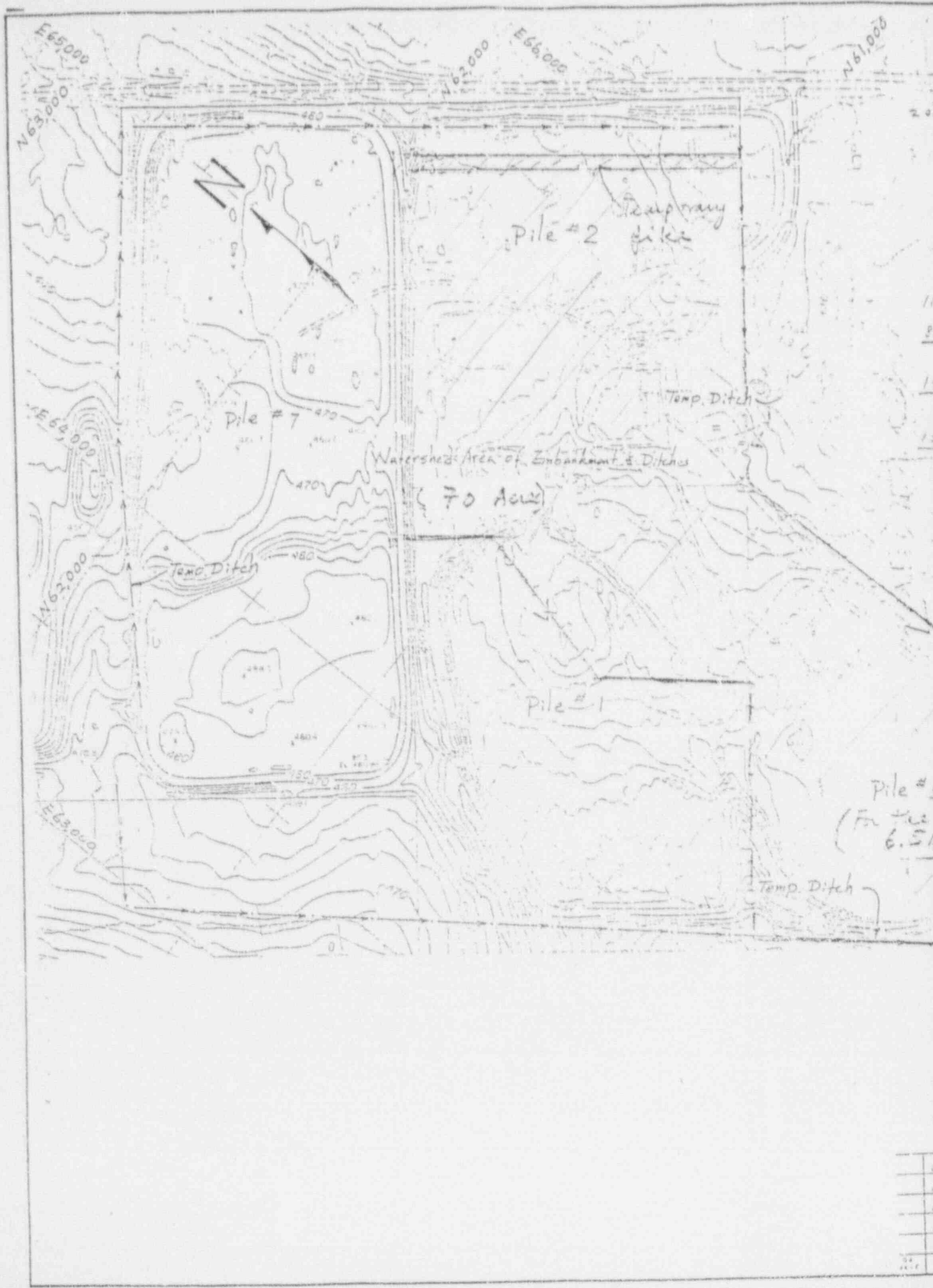
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dust control in contaminated area. It was figured that during construction, about 57 ac-ft of the wastewater generated can be used in dust control based on an estimate of 3000 gal water truck covering an area of 6 miles long and 15 ft wide in one hour. (see calc. on sh. 91)

2. Determination of acreage of evaporation pond and irrigation farmland, and treatment plant capacity

In order to have a fair comparison between the 3 schemes, a criterion has been set up that all wastewater generated should be either treated and discharged, or evaporated out or used up in irrigation about a couple of months before completion of radon barrier construction (i.e. about June-Sept. 1993) (see the charts in water balance calc. section on sh. 100-107)

The acreage of evaporation pond or irrigation farmland required was determined by trial and error until zero accumulated water resulted fall within the months just before completion of radon barrier. As for the treatment/discharge method, a 60 cfd flow was assumed (June 1993). The surplus water in each month (using the 100 cfd accumulating design, see sh. 92-94) was plotted, and the maximum monthly average volume was determined. This will be the capacity of the treatment plant required.



E67.000

UMTRA-TCT

Sh. 6

PTL 3/12/91

ACC 3/22/91

$$2 \times 2650 + 43260 = 12$$

$$50 \times 1350 = 67.5$$

$$\frac{7 + 500}{2} \times 650 = 6.97$$

$$\frac{100 + 1000}{2} \times 700 = 350$$

$$10 \times 600 = 6$$

$$59.54$$

SI APERTURE CARD

Also Available On
Aperture Card

Pile #4

Wastewater Retention Basin
(11 Acres)

Pond #6
(7 Acres)

9205110072 -26

SCALE
0 200 400
FEET

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

FALLS CITY SITE

(Initial Stage) 10-19-91
WASTEWATER EVAPORATION STUDY

DESIGNED BY
ENGINEER
CHECKED BY
RECOMMENDED BY
APPROVED BY

DATE PROJECT ENGINEER DATE

MORRISON-KNUDSEN ENGINEERS, INC.
A FALCON COMPANY
UMTRA PROJECT
300 HUNTER ST. SAN FRANCISCO, CA 94104

PROJECT NO.
DE-AC04-63AL18796

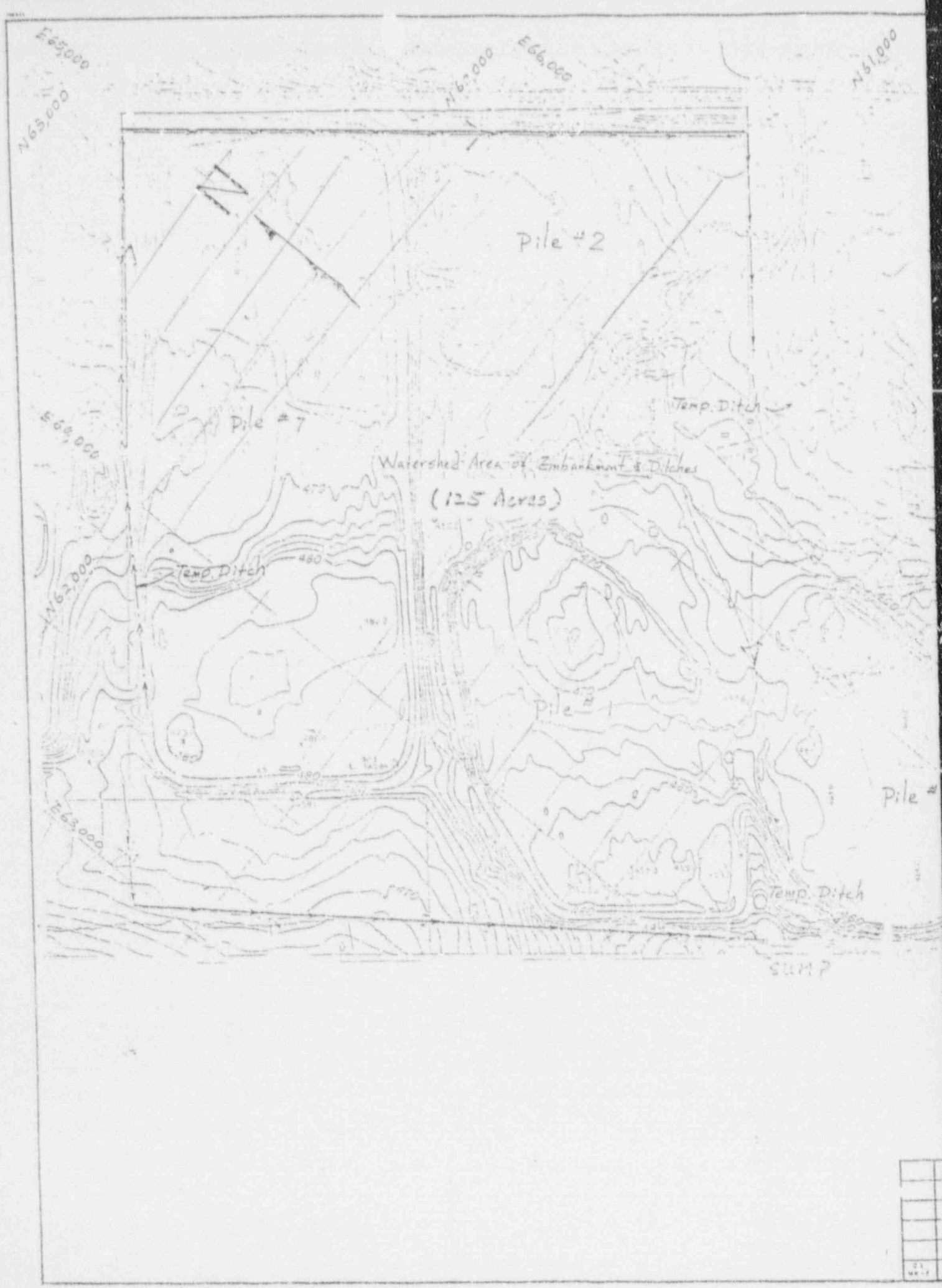
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REVISIONS

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			REV 4

ISSUED FOR PRELIMINARY REVIEW

REFERENCES

Year	Age	Sex	Height	Weight	Body Mass Index
1990	18	M	1.75	75	24.2
1991	19	F	1.65	60	22.0
1992	20	M	1.80	80	24.7
1993	21	F	1.70	65	22.6
1994	22	M	1.85	85	24.8
1995	23	F	1.75	70	22.4
1996	24	M	1.90	90	25.0
1997	25	F	1.80	75	23.1
1998	26	M	1.95	95	25.0
1999	27	F	1.85	80	23.3
2000	28	M	2.00	100	25.0

SUMMARY

		WASTE WATER VOLUME * (Ac-ft)	POND / FARM AREA (Ac-ft)	OPERATING PERIOD (months)		PLANT CAPACITY (gpm)
N O S T O R M	TREATMENT/ DISCHARGE	128	--	19	\$2,270,471	105
	EVAPORATION	201	20	19	\$ 272,554 (bare soil)	--
					\$ 469,051 (bentonite)	--
					\$ 803,331 (liner)	--
	IRRIGATION	117	30	18	\$ 773,625	--
	MOBILE PLANT/ EVAPORATION	159	0	19	\$ 832,751	60
W I T H S T O R M	TREATMENT/ DISCHARGE	207	--	19	\$1,882,793	245
	EVAPORATION	359	40	20	\$ 476,339 (bare soil)	--
					\$ 869,346 (bentonite)	--
					\$1,523,768 (liner)	--
	IRRIGATION	286	60	22	\$1,496,621	--
	MOBILE PLANT/ EVAPORATION	299	15	21	\$1,088,649 (bare soil) \$1,236,027 (bentonite) \$1,489,409 (liner)	60

* Note: Volume handled by that particular scheme

Project Wastewater Handling II
Feature WATER. ECT
Item WATER. ECT

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Contract No. 3885-24 Sheet 8
Designed PTL File No. 319/11
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Date 3/21/91



IV

TABLE ____ COMPARISON OF ALTERNATIVES

	ADVANTAGES	DISADVANTAGES
TREATMENT/ DISCHARGE	-Easier to control -Treatment plants already available	-Costs higher -Local residents objections to discharging into a drinking water source
EVAPORATION	-cheapest -Zero discharge -Required minimum maintenance	-Negative public perception of, and reaction to, a pond adjacent to FM1344 -Foundation soils contaminated
IRRIGATION	-Costs less than treatment method -Zero discharge -Minimize negative public perception of, and reaction to, a pond adjacent to FM1344 -Complex & costly equipment for removing sulfates, chlorides, and ammonia not required	-Needs maintenance -Costs higher than evaporation pond -Foundation soils contaminated -Difficult to cut grass in wet months -May increase organic content in disposal cell



Project

UMTEA - FCT

Feature

Wastewater Evaporation Study

Item

Water balance & Wastewater Handling

Contract No. 385-28

Sheet

9

File No.

Designed

WYL

Date

10/25/90

Checked

WYL

Date

11/7/90

CALCULATIONS:

A. DEWATERING VOLUME

Volume of dewatering from tailings piles 3, 4, 5 and 6 and portion of in-situ piles 1, 2 & 7 calculated here will be entered into the dewatering inflow column in the water balance calculation.

A summary of dewatering volumes is presented on sh. 16

a) Approach, Methodology & Assumptions

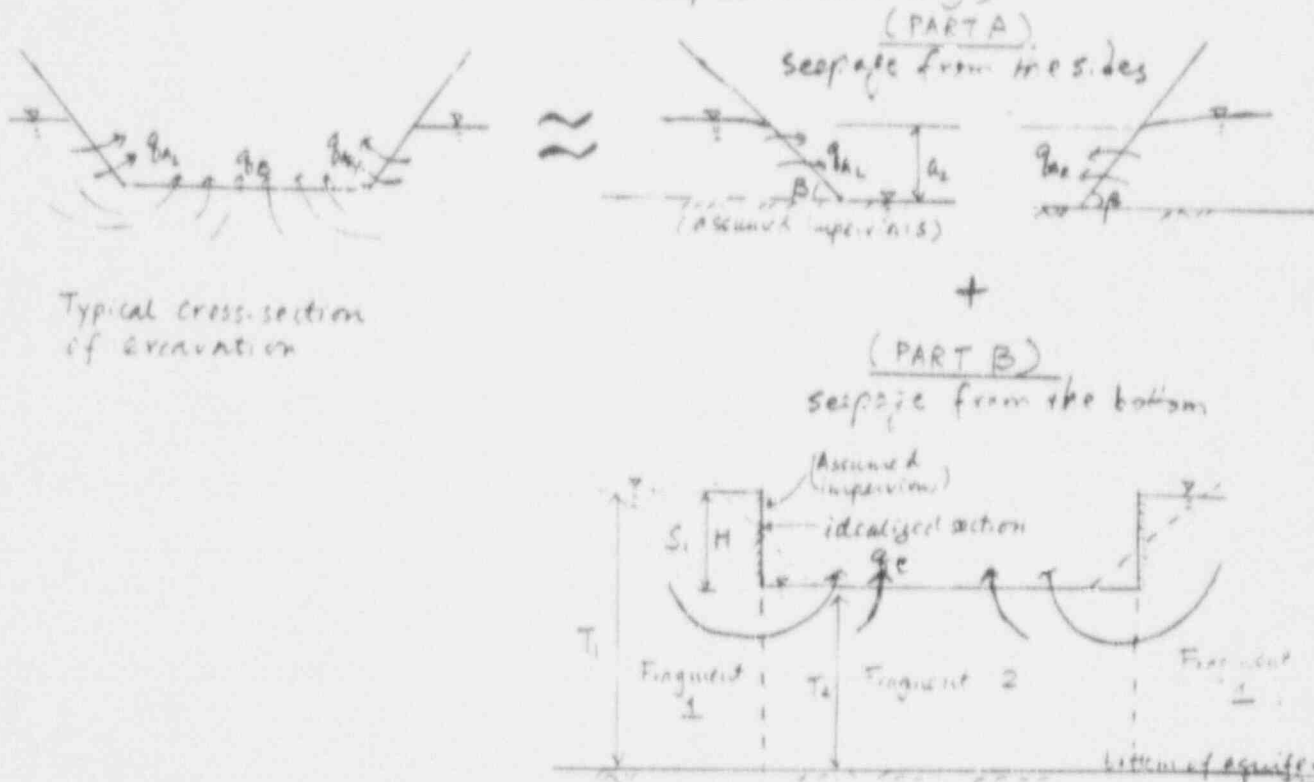
1. Dewatering volume from each tailings pile will be comprised of either one or both of the following:
 - (i) From portion of the excavation below parched water
 - (ii) From portion of the excavation below ground water plus seepage of groundwater into excavation.
2. Parched water elevation and groundwater levels are based on available data, such as from boring logs, from potentiometric contours developed in DRAP (Ref 1)
3. Volumes of dewatering from portion of excavation below parched water and/or below ground water can be determined by multiplying the volume of the excavation below water by the specific yield at water table. Vol. of excavation below water can be determined by using cross section drawings of each pile (Ref 2) and calculating the volume of excavation by the method.





Project WATER - FET Contract No. 7885-28 Sheet 10
 Feature Wastewater Evaporation Study Designed PTL File No.
 Item Water balance and wastewater handling Checked WYL Date 10/25/90
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4. Seepage into Excavation (i.e. to determine vol. needs to be pumped to keep excavation dry)



- i) It is assumed that in a typical cross-section of an excavation as shown above the seepage makes up of 2 parts. part A and part B, each can be treated independently.

ii) Part A

Seepage from the sides of the excavation only is similar to the seepage out of the downstream slope of a dam, which Pavlovsky calls Part II (Ref 3). Pavlovsky's solution for the seepage rate is given by the following equation:

$$q = K \frac{C_u}{m_1} \left(1 + \ln \frac{a_2 + h_0}{a_1} \right)$$





Project UMTRA-ECT
 Feature Wastewater Evaporation Study
 Item Water balance & Wastewater handling

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where K = permeability

$$m = \cot \beta \Rightarrow \bar{m} = \tan \beta \quad (\text{refer to diagram on previous page})$$

h_o = height of tail water

Since in our case, there is no tail water, $h_o = 0$

d_2 = height of phreatic surface from tail water

For detailed theory & assumptions of Pavlovsky's method, refer to Ref 3.

Thus, the equation can be written as:

$$q = K \cdot d_2 \cdot \tan \beta$$

iii) Part B

Seepage for part B (seepage from bottom of excavation) can be estimated using Method of Fragments (Ref 3), originated with Pavlovsky. For theory behind the method, refer to Han (Ref 3). Basically, the flow system is divided into fragments; in our case fragment 1 & 2. Both are Fragment Type II according to Han (Ref 3). The flow is:

$$q_B = \frac{K H}{\sum_{n=1}^N \Phi} \quad (\text{for each side of the excavation})$$

where H = head loss

Φ = Form Factor for the particular Fragment type

For Type II fragment, $\Phi = K/K'$. Both K & K' are functions of m and can be looked up in table or sh 14.





Project UTTRA-TET Contract No. 5855-28 Sheet 12
Feature Wastewater Evaporation Study File No. _____
Item Water balance & wastewater handling Designed PYL Date 10/25/80
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m is defined as
$$m = \frac{\sin \frac{\pi S}{2T}}$$

where S = depth of sheet pile (or impervious wall)

T = thickness of soil layer / aquifer

(Refer to sketch on sh. 12)

In this part B, the sides of the excavation are assumed to be impervious, like sheet piles, since the flow from the sides have already been taken care of in part A. And for simplicity, the sides are idealized as vertical.

Elevations of bottom of aquifer below the tailings pile are estimated from sh 31452.

- (v) To simplify the calculation, excavation with irregular bottom is idealized to be flat. Head of water is assumed to be the same for the left and right sides of the excavation by using the average head.

v) Part A + Part B

Seepage into each cross-section of excavation is simply:

$$q = q_1 + 2q_2$$

Total flow rate Q into the excavation of each pile is determined by the End area method.

- vi) Total volume seeped into the excavation for each pile (i.e. volume to be pumped to wet land etc. dry) is determined by multiplying Q by the number of days to excavate the portion





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Project LAMPRA - FET
 Feature Wastewater Evaporation Study
 Item Water Balance & Wastewater Handling

Contract No. 3885-28
 Designed PTL
 Checked WYL

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 File No. _____
 Date 10/25/90
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of tailings below water.

5. Permeability of foundation (the Deweesville/Languista Aquifer) is based on Ref 4. Use the higher value for conservatism.

$$1. K = 6.4 \times 10^{-6} \text{ cm/s} = 2.1 \times 10^{-7} \text{ ft/s}$$

6. Other assumptions specific to the particular tailings piles in question is discussed in the calculation section on sh 21



UMTRA-FC
 Wetwater Evap Study
 3865-28
 PXL 10/25/90
 WYL 11/7/90

Table B-1. Complete Elliptic Integrals of the First Kind*

m^2	K	K'	$\frac{K}{K'}$	$\frac{K'}{K}$	m^2	m^2	K	K'	$\frac{K}{K'}$	$\frac{K'}{K}$	m^2
0.000	1.571	∞	0.000	∞	1.000	0.21	1.665	2.235	0.745	1.34	0.79
0.001	1.571	4.841	0.325	3.08	0.999	0.22	1.670	2.214	0.754	1.33	0.78
0.002	1.572	4.495	0.349	2.86	0.998	0.23	1.675	2.194	0.763	1.31	0.77
0.003	1.572	4.293	0.366	2.73	0.997	0.24	1.680	2.175	0.773	1.29	0.76
0.004	1.572	4.150	0.379	2.64	0.996	0.25	1.686	2.157	0.782	1.28	0.75
0.005	1.573	4.039	0.389	2.57	0.995	0.26	1.691	2.139	0.791	1.26	0.74
0.006	1.573	3.949	0.398	2.51	0.994	0.27	1.697	2.122	0.800	1.25	0.73
0.007	1.574	3.872	0.406	2.46	0.993	0.28	1.702	2.106	0.808	1.24	0.72
0.008	1.574	3.806	0.413	2.42	0.992	0.29	1.708	2.090	0.817	1.22	0.71
0.009	1.574	3.748	0.420	2.38	0.991	0.30	1.714	2.075	0.826	1.21	0.70
0.01	1.575	3.696	0.426	2.35	0.99	0.31	1.720	2.061	0.834	1.20	0.69
0.02	1.579	3.354	0.471	2.12	0.98	0.32	1.726	2.047	0.843	1.19	0.68
0.03	1.583	3.156	0.502	1.99	0.97	0.33	1.732	2.033	0.852	1.17	0.67
0.04	1.587	3.016	0.526	1.90	0.96	0.34	1.738	2.020	0.860	1.16	0.66
0.05	1.591	2.908	0.547	1.83	0.95	0.35	1.744	2.008	0.869	1.15	0.65
0.06	1.595	2.821	0.565	1.77	0.94	0.36	1.751	1.995	0.877	1.14	0.64
0.07	1.599	2.747	0.582	1.72	0.93	0.37	1.757	1.983	0.886	1.13	0.63
0.08	1.604	2.684	0.598	1.67	0.92	0.38	1.764	1.972	0.895	1.12	0.62
0.09	1.608	2.628	0.612	1.63	0.91	0.39	1.771	1.961	0.903	1.11	0.61
0.10	1.612	2.578	0.625	1.60	0.90	0.40	1.778	1.950	0.911	1.10	0.60
0.11	1.617	2.533	0.638	1.57	0.89	0.41	1.785	1.939	0.920	1.09	0.59
0.12	1.621	2.493	0.650	1.54	0.88	0.42	1.792	1.929	0.929	1.08	0.58
0.13	1.626	2.455	0.662	1.51	0.87	0.43	1.799	1.918	0.938	1.07	0.57
0.14	1.631	2.421	0.674	1.48	0.86	0.44	1.806	1.909	0.946	1.06	0.56
0.15	1.635	2.389	0.684	1.46	0.85	0.45	1.814	1.899	0.955	1.05	0.55
0.16	1.640	2.359	0.695	1.44	0.84	0.46	1.822	1.890	0.964	1.04	0.54
0.17	1.645	2.331	0.706	1.42	0.83	0.47	1.829	1.880	0.973	1.03	0.53
0.18	1.650	2.305	0.716	1.40	0.82	0.48	1.837	1.871	0.982	1.02	0.52
0.19	1.655	2.281	0.726	1.38	0.81	0.49	1.846	1.863	0.991	1.01	0.51
0.20	1.660	2.257	0.735	1.36	0.80	0.50	1.854	1.854	1.000	1.00	0.50
m^2	K'	K	$\frac{K'}{K}$	$\frac{K}{K'}$	m^2	m^2	K'	K	$\frac{K'}{K}$	$\frac{K}{K'}$	m^2

* From V. I. Aravin, and S. Numerov, "Seepage Computations for Hydraulic Structures," Stoitel'stvu i Arkhitekture, Moscow, 1955.

From Ref 3



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b). Summary of Dewatering

SUMMARY

PILE/ POND #	DEWATERING VOLUME (Ac.-ft.)				TOTAL VOL. OF CONT. MAT'L (c.y.) (Ref.)	MANHOUR (hr.) (a)	TOTAL CONSTRUCTION TIME	
	Below perched water (sh.)	Below grnd water (sh.)	Seepage into excavation (sh.)	SUBTOTAL			(mon.)	(b)
3	5.6 (sh. 24)	-	-	5.6	418900	644		3.76
4	-	6.5 (sh. 25)	0.0860 (sh. 27)	6.6	230600	355		2.07
5	7.3 (sh. 31)	0.37 (sh. 30)	0.0014 (sh. 35)	7.7	695700	1070		6.24
6	[15.3]* (sh. 36)	7.2 (sh. 37)	0.1300 (sh. 41)	22.6	736500	1133		6.61
1,2,7	80.0 (sh. 43)	-	-	80.0	94300	145		0.85
			TOTAL	122.5 Ac.-ft.	2176000 c.y.	3348 hr.		19.53 mon.

NOTES:

(a) Based on excavation rate of 650 c.y./hr. (Ref. 5)

(b) Based on 40-hour work week

* Surface water in pond

U1177RA-FC7
SL 16
Lakeland Co. Pump Study
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Feature

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C) Dewatering of Tailings Piles #3, 4, 5 & Pond #61 Specific Yield of Tailings in Piles #3, 4, 5 & Pond #6 (relined piles)

- No pumping tests had been performed in tailings piles at Falls City Site. Therefore specific yield of tailings for dewatering volume calculation has to be estimated by other means.
- Refer to Ref 4, ch 88, distribution of the 3 kinds of tailings in piles 4 & 5 is (by volume).

Sand 42%, Sand/slime 10%, Slime 48%.

The distributions for pile #3 & pond #6 are not known, but it is assumed that they are the same as that for piles #4 & 5.

It is considered reasonable to assume that the weighted average specific yield of these piles would be similar to that of the sand-slime tailings alone.

- Freeze & Cherry in Ref 6 define specific yield as "the volume of water that an unconfined aquifer releases from storage per unit surface area of aquifer per unit decline in the water table". Lindsay and Frazar in Ref 7 define it as "the volume of water (expressed as a percent of the total volume of the aquifer) which will drain freely from the aquifer and the water is that which will flow by gravity". Based on these definitions, it is considered reasonable to assume that the specific yield is the porosity minus the "field capacity", as described in Ref 8.

Verhwey and Hendrickson have defined the "field capacity" as





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 Feature Wastewater Evap. Study
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the amount of water held in the soil after the excess gravitational water has drained away and after the rate of downward movement of water has materially decreased." (Ref. 2) In turn, the 'field capacity' was found to compare to the 'moisture equivalent' introduced by Briggs and McLaure (Ref. 2) Richards and Weaver later showed that the 'moisture equivalent' represents the moisture content when the soil is subjected to a tension of about $\frac{1}{3}$ atmosphere on a porous plate. Based on the above correlations, the 'specific yield' can be estimated as the porosity, minus the moisture content at $\frac{1}{3}$ atm tension.

$$i.e. \quad S_y \approx n - m.c. @ \frac{1}{3} \text{ atm tension}$$

Two capillary moisture tests had been performed on sand-shine tailings (see sh. 16 & 20)

$$\text{Avg. } m.c. @ \frac{1}{3} \text{ atm} \approx 0.34$$

$$\text{Porosity } n \text{ of sand-shine tailings} = 0.52 \text{ (Ref. 4)}$$

$$\therefore \text{ Specific yield } S_y = 0.52 - 0.34 = \boxed{0.18}$$





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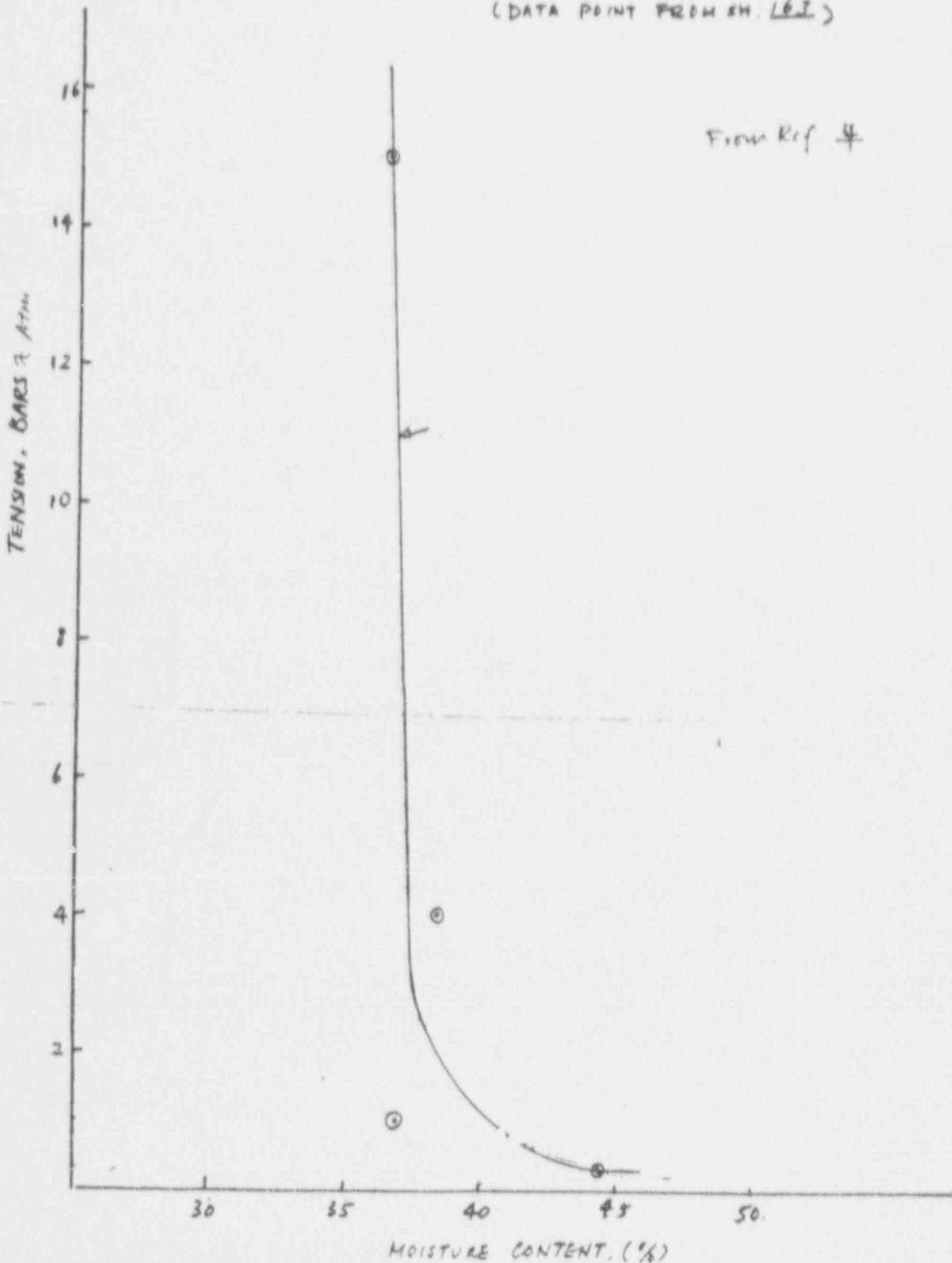
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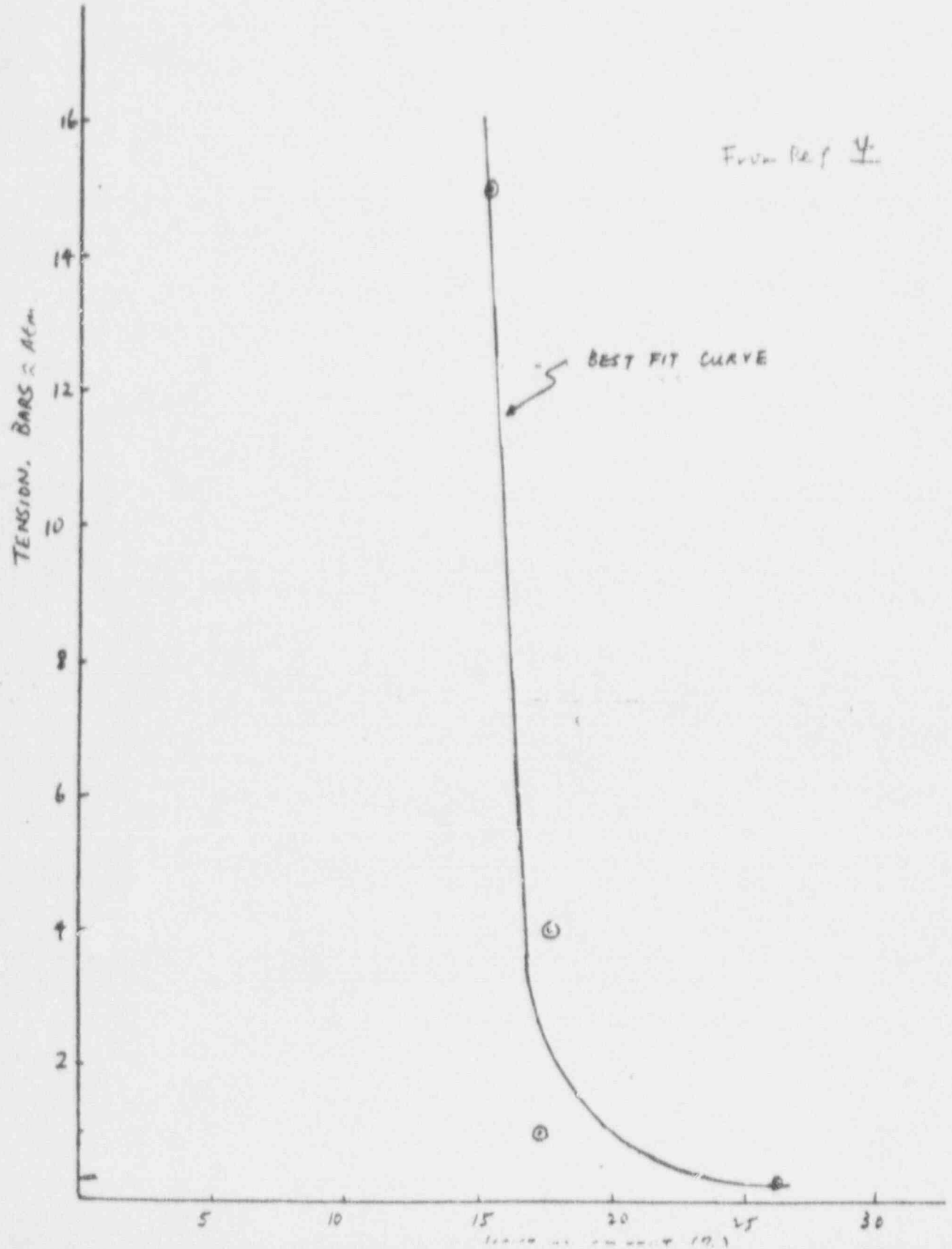
CAPILLARY MOISTURE TEST (IN-SITU SAND-SLIME) (B-8 @ 5'-7')
 (DATA POINT FROM SH. 161)



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CAPILLARY MOISTURE TEST (IN-SITU SAND-SLING) (B-565-7)
(Data points from sh. 42)
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 Feature Wastewater Evap Study
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2 Calculation

• Pile #3

Based on boring logs for B 16 & B 17 (sh 49-50 (Ref 9)), perched water exists in the tailings pile. Since these are the only perched water data available, it is assumed that perched water elevation is uniform throughout the pile at EL 398.3. Groundwater is well below the bottom of excavation. Dewatering vol. calculation is on sh 24.

• Pile #4

No perched water was found in the tailings. Ground water elevations at pile #4 are based on potentiometric contours presented in DRAP (Ref 1). Also see sh 23.

Average elevation of bottom of the Deweesville / Conquista Aquifer is ~ EL 351 (sh 51).

Vol. of dewatering from excavation below ground water is calculated on sh 25.

Seepage into excavation calculation is presented on sh 26-29.

• Pile #5

Perched water was found in the tail on the elevation 17 which is based on Ref 9 (sh 46-48). Well # B10, B11, B12.

A portion of the pile was also found to be below groundwater. Groundwater elevations are based on sh 23.

Avg el. of bottom of the aquifer is ~ EL 388 (sh 52).

Dewatering calculation is on sh 26-29.





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is presented on sh 31.

Dewatering volume from portion of pile below groundwater is presented on sh 30.

Seepage into excavation calculation is presented on sh 32 - 35.

• POND #6

Referred to existing topo, elev. of existing surface water is @ 401.5'.

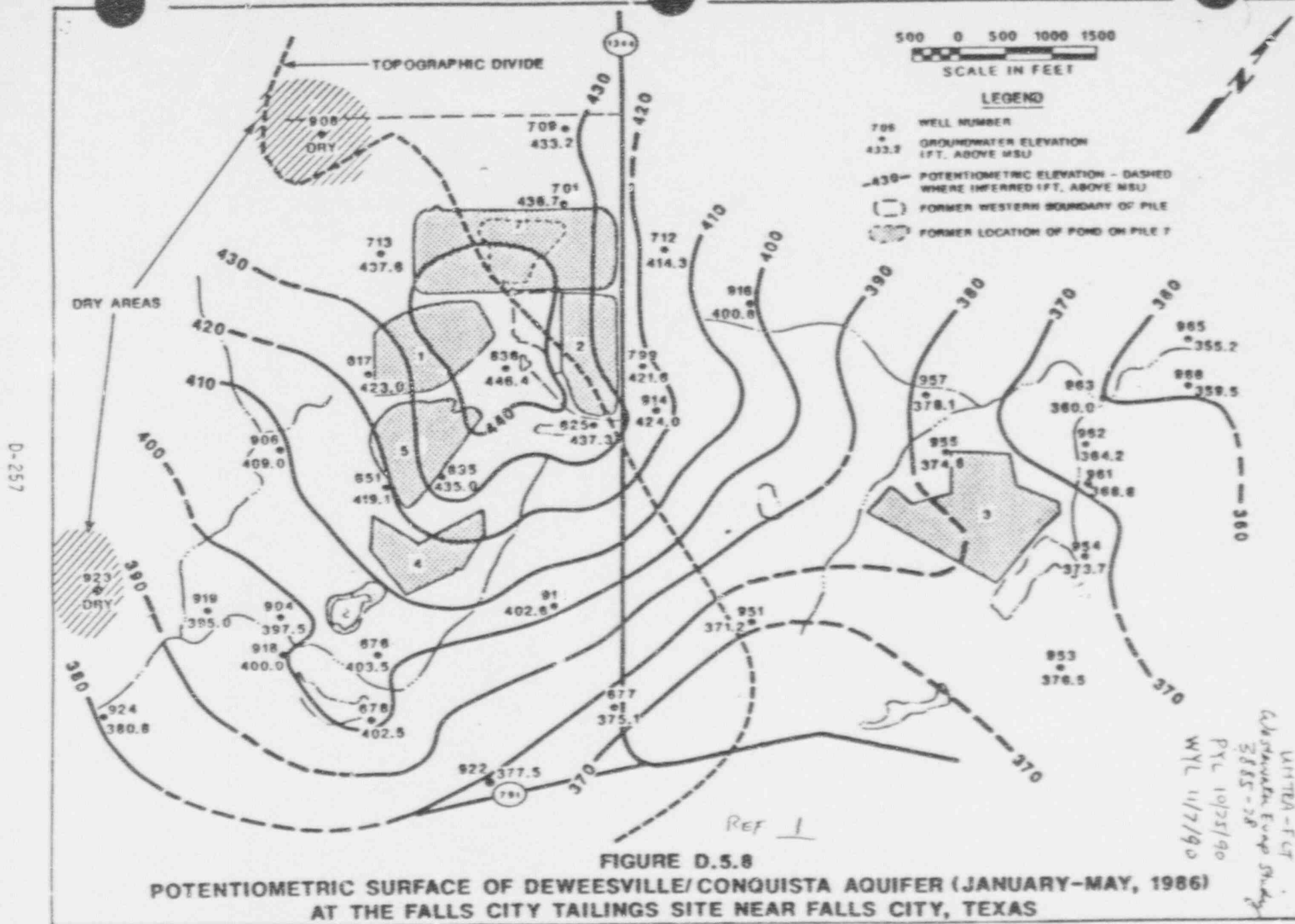
Based on BRAP (Ref L), depth of water is ~ 6.5'. Portion of the pond to be excavated is below groundwater. The average ground water level at pond #6 used in calc. is ~ EL 401.5.

Elev. of bottom of aquifer is extrapolated from section on sh 51, at ~ EL. 348'.

Vol. of surface water is calculated on sh 36.

Dewatering vol. of portion of pond below gw water is presented on sh 37.

Seepage into excavation is calculated on sh. 38 - 41.



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 Westwater Evap Study
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PILE #3 - VOL. OF EXCAVATION BELOW PERCHED WATER TO BE
 DEWATERED

SECTION (sh 54-82)	AREA (SF.)	AVG. AREA (SF.)	LENGTH (FT.)	VOLUME (C.Y.)
A	0	29.0	100	107
B	58	50	100	185
C	42	607.4	100	2250
D	1172.8	2522.4	100	9342
E	3872	3725.9	100	13800
F	3579.8	3096.8	100	11470
G	2613.8	2126.9	100	7877
H	1640	1178.8	100	4366
I	717.5	358.8	60	797
I'	0			
TOTAL				50194 C.Y.

NOTES:

- 1) Section I' is 60 ft. North of section I
 (approx. location where perched water el. = bottom of excav.)

$$\begin{aligned}
 \text{DEWATERING VOLUME} &= 50194 \text{ cy} \times 27 \text{ ft}^3/\text{cy} \times \text{SEPCIFIC YIELD} \\
 &= 50194 \times 27 \times 0.18 \text{ ft}^3 \\
 &= 243943 \text{ ft}^3 = 5.6 \text{ Ac.-ft}
 \end{aligned}$$

UMTRA-FLR Sh 3
 Wetland Evap Study
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PILE #4 - VOL. OF EXCAVATION BELOW GROUND WATER TO BE
 DEWATERED

SECTION	AREA (SF.)	AVG. AREA (SF.)	LENGTH (FT.)	VOLUME (C.Y.)
R	0			
S	172	86	100	319
T	1000	586	100	2170
U	7168	4084	100	15126
V	4940	6054	100	22422
W	1980	3460	100	12815
X	580	1280	100	4741
Y	0	290	100	1074
TOTAL				58667 C.Y.

DEWATERING VOLUME = $58667 \text{ cy} \times 27 \text{ ft}^3/\text{cy} \times \text{specific yield}$
 = $58667 \times 27 \times 0.18 \text{ ft}^3$
 = $285122 \text{ ft}^3 = 6.5 \text{ Ac.-ft}$

PILE #6 - SEEPAGE INTO EXCAVATION -- PART A

K OF AQUIFER = 6.40E-06 cm/s = 2.10E-07 ft/s

SECTION (sh 43-27)	LEFT (L)				RIGHT (R)				TOTAL Q A ($q(L) + q(R)$) (eq. ft./day)
	m2(L) (ft.)	B(L) (deg.)	tan B(L)	Q A (L) (eq. ft./s) (eq. ft./day)	m2(R) (ft.)	B(R) (deg.)	tan B(R)	Q A (R) (eq. ft./s) (eq. ft./day)	
S	4	3.8	0.066	5.6E-08	4	11.3	0.220	1.7E-07	0.0193
T	10	4.4	0.077	1.6E-07	10	8.13	0.143	3.0E-07	0.0399
U	14	4.7	0.082	2.4E-07	14	8.8	0.155	4.6E-07	0.0602
V	#	5.7	0.100	1.7E-07	8	9.1	0.16	2.7E-07	0.0
W	6	8.5	0.149	1.9E-07	6	11.3	0.200	2.3E-07	0.0580
X	4	2.3	0.044	3.7E-08	4	14.9	0.266	2.2E-07	0.0225

NOTES:

$$Q = K \cdot S_p \cdot (\tan B)$$

UMTRA-TCT Sh 26
Wastewater Evap Study
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PILE #4 - SEEPAGE INTO EXCAVATION -- PART B

K OF AQUIFER = $6.40E-06$ cm/s = $2.10E-07$ ft/s = 0.018141 ft/day

SECTION (sh. 61-69)	HEAD H (ft.)	FRAGMENT 1					FRAGMENT 2					ΣI	$2 \cdot q \cdot B$ ($= 2 \cdot K \cdot H / L$) (eq. ft./day)
		S1 (ft.) (a)	T1 (ft.) (b)	m 1 (c)	$(m1)^2/2$ (d)	$(m1/K)$ (e)	S2 (ft.) (a)	T2 (ft.) (b)	m 2 (c)	$(m2)^2/2$ (d)	$(m2/K)$ (e)		
S	-	-	-	-	-	-	-	-	-	-	-	-	0.000
T	-	-	-	-	-	-	-	-	-	-	-	-	0.000
U	14	14	65.5	0.329	0.109	0.638	0	51.5	0	0	0	0.638	0.796
V	8	8	64	0.195	0.038	0.543	0	56	0	0	0	0.543	0.535
W	6	6	62	0.151	0.023	0.480	0	56	0	0	0	0.480	0.454
X	4	4	63	0.100	0.010	0.426	0	59.0	0	0	0	0.426	0.341

NOTES:

- (a) Refer to sections α , sh. 64-69
 (b) Based on an average el. of bottom of aquifer @ EL. 351'
 (c) $m = \sin((S \cdot \pi)/(L \cdot T))$
 (d) From table on sh. 14

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PILE #4 -SEEPAGE INTO EXCAVATION --- PART A + PART B

SECTION	q_A (sq. ft./d) (sh. 76)	$2 \cdot q_B$ (sq. ft./d) (sh. 27)	TOTAL q ($q_A + 2q_B$) (sq. ft./d)	AVG. q (sq. ft./d)	LENGTH, L (FT.)	Q (AVG. $q \cdot L$) (ft ³ /day)
R	0	0	0	0.0097	100	0.965
S	0.0191	0	0.0191	0.0296	100	2.960
T	0.0399	0	0.0399	0.4481	100	44.805
U	0.0602	0.796	0.8562	0.7145	100	71.445
V	0.0377	0.535	0.5727	0.5324	100	53.235
W	0.0380	0.454	0.4920	0.4278	100	42.775
X	0.0225	0.341	0.3635	0.1818	100	18.175
Y	0	0	0			
TOTAL						234.4 ft ³ /day

ULTRA-EC SH 28
 Illustration Equip Study
 3865-28
 PHL 10/22/90
 WFL 11/7/90



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 Feature Wastewater Evap Study
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PILE #4 (cont'd)

No. of days to excavate portion of pile 4 below groundwater

$$= \frac{58.667 \text{ cy}}{(1 \text{ sh } 25)} \times \frac{1 \text{ hr}}{650 \text{ cy}}^{(a)} \times \frac{1 \text{ day}}{8 \text{ hr}}^{(b)} \times \frac{7}{5}^{(c)} = 16 \text{ days}$$

∴ Dewatering vol from outside of excavation

$$= 2344 \text{ ft}^3/\text{day} \times 16 \text{ days} = 3750 \text{ ft}^3 = \underline{\underline{0.086 \text{ A.C.F.}}}$$

Notes:

(A) Based on excavation rate of 650 cy/hr. (Ref 2)

(b) based on 8 hour work day

(c) factor to account for 5-day work week



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PILE #5 - VOL. OF EXCAVATION BELOW GROUND WATER TO BE
DEWATERED

SECTION	AREA (SF.)	AVG. AREA (SF.)	LENGTH (FT.)	VOLUME (C.Y.)
4'	0	* 45.7	30	51
4	137	102.5	100	380
5	68	99	100	367
6	130	65	100	241
7	0	400	100	1481
8	800	* 266.7	80	790
8'	0			
TOTAL				3309 C.Y.

NOTES:

- i) Section 4' is 30 ft. north of section 4
- ii) Section 8' is 80 ft. south of section 8
- * Pyramid shape: vol. = (area * L)/3

$$\begin{aligned}
 \text{DEWATERING VOLUME} &= 3309 \text{ cy} \times 27^3 \text{ ft}^3/\text{cy} \times \text{specific yield} \\
 &= 3309 \times 27 \times 0.18 \text{ ft}^3 \\
 &= 16082 \text{ ft}^3 = 0.37 \text{ Ac.-ft}
 \end{aligned}$$

UMTRA-FCF sh 3
 Wastewater Equip. Study
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PILE #5 - VOL. OF EXCAVATION BELOW PERCHED WATER (BUT ABOVE
 GROUND WATER TABLE) TO BE DEWATERED

SECTION	AREA (SF.)	AVG. A. EA (SF.)	LENGTH (FT.)	VOLUME (C.Y.)
4	144.5			
5	251.6	198.1	100	734
6	695.9	473.75	100	1755
7	5320	3007.95	100	11141
8	10200	7760	100	28741
9	561	5380.5	100	19928
10	745	653.0	100	2419
10'	0	372.5	60	828
TOTAL				65544 C.Y.

NOTES:

- 1) Section 10' is 60 ft. South of section 10
 (approx. location where perched water el. = bottom of excav.)

$$\begin{aligned}
 \text{DEWATERING VOLUME} &= 65544 \text{ cy} \times 27 \text{ ft}^3/\text{cy} \times \text{specific yield} \\
 &= 65544 \times 27 \times 0.18 \text{ ft}^3 \\
 &= 318544 \text{ ft}^3 = 7.3 \text{ Ac.-ft}
 \end{aligned}$$

PILE #5 - SEEPAGE INTO EXCAVATION -- PART A

K OF AQUIFER = $6.40E-06$ cm/s = $2.10E-07$ ft/s

SECTION (sh. 70-76)	LEFT (L)					RIGHT (R)					TOTAL q A (qA(L)+qA(R)) (eq. ft./day)
	a2(L) (ft.)	B(L) (deg.)	tan B(L)	q A (L) (eq. ft./s) (eq. ft./day)		a2(R) (ft.)	B(R) (deg.)	tan B(R)	q A (R) (eq. ft./s) (eq. ft./day)		
4	3.5	5	0.087	$6.4E-08$	0.0056	3.5	6.7	0.117	$8.6E-08$	0.0075	0.0131
5	1.5	8.5	0.149	$4.7E-08$	0.0041	1.5	5.7	0.100	$3.1E-08$	0.0027	0.0068
6	1	5.7	0.100	$2.1E-08$	0.0018	1	5.7	0.100	$2.1E-08$	0.0018	0.0036
7	-	-	-	-	-	-	-	-	-	-	0.0000
8	6	9.7	0.171	$2.2E-07$	0.0186	6	9.7	0.171	$2.2E-07$	0.0186	0.0372

NOTES:

$$q = K \cdot a_2 \cdot (\tan B)$$

UNTRAINED-ECT SH. 22
 Excavation Equip. Study
 3885-28
 PXL 10/22/90
 W/L 11/7/90

PILE #5 - SEEPAGE INTO EXCAVATION -- PART B

K OF AQUIFER = $6.40E-06$ cm/s = $2.10E-07$ ft/s = 0.018141 ft/day

SECTION (sh. 7/-7V)	HEAD H (ft.)	FRAGMENT 1					FRAGMENT 2					ΣH	$2 * q B$ (= $2 * KH / (2 * H)$) (eq. ft./day)
		S1 (ft.) (a)	T1 (ft.) (b)	m 1 (c)	$(m1)^2$ (d)	$H (-K/K')$	S2 (ft.) (a)	T2 (ft.) (b)	m 2 (c)	$(m2)^2$ (d)	$H (-K/K')$		
4	-	-	-	-	-	-	-	-	-	-	-	-	0.000
5	1.5	1.5	43.5	0.054	0.0029	0.366	0	42	0	0	0	0.366	0.149
6	1	1	43	0.037	0.0013	0.333	0	42	0	0	0	0.333	1.109
7	-	-	-	-	-	-	-	-	-	-	-	-	0.000
8	6	6	38	0.245	0.0603	0.565	0	32	0	0	0	0.565	0.385

NOTES:

- (a) Refer to sections on sh. 7/-7V
- (b) Based on an average el. of bottom of aquifer @ El. 388'
- (c) $m = r_{in} ((S^2 T) / (2 * T))$
- (d) From table on sh. 1/4

U1072A-101 sh. 22
Kustavson Corp. Study
3885-28
PCL 10/22/90
WYL 11/7/90

PILE #5 -SEEPAGE INTO EXCAVATION --- PART A + PART B

SECTION	q A (sq.ft./d) (sh. 32)	2*qB (sq.ft./d) (sh. 33)	TOTAL q (qA + 2qB) (sq.ft./d)	AVG. q (sq.ft./d)	LENGTH, L (FT.)	Q (AVG. q * L) (ft ³ /day)
4'	0	0.000	0.0000	* 0.0043	30	0.130
4	0.0130	0.000	0.0130	0.0844	100	8.440
5	0.0068	0.149	0.1558	0.1342	100	13.420
6	0.0036	0.109	0.1126	0.0563	100	5.630
7	0.0000	0.000	0.0000	0.2111	100	21.110
8	0.0372	0.385	0.4222	* 0.1407	80	11.259
8'	0.0000	0.000	0.0000			
					TOTAL	60.0 ft ³ /day

NOTES:

- i) Section 4' is 30 ft. north of section 4
 - ii) Section 8' is 80 ft. south of section 8
- * Pyramid shape : vol. = (area * L)/3

WATER-FLY
WATER-FLY
385-28
P.L. 10/22/90
W/L 11/7/90



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project ULTRA-FCI
 Feature Wastewater Evap Study
 Item Water bal. & Wastewater handling

Contract No. 3865-28
 Designed PYL
 Checked WYL

Sheet 35
 File No. _____
 Date 10/19/90
 Date 11/7/90

PILE #5 (cont'd)

No of days to excavate portion of pile #5 below ground water.

$$= \frac{3310 \text{ c.y.}}{(sh \ 34)} \times \frac{1 \text{ hr.}}{150 \text{ c.y.}} \times \frac{1 \text{ day}}{8 \text{ hr.}} \times \frac{7}{5} = 0.9 \text{ day}$$

say 1 day

$\therefore$ Dewatering vol. from outside of excavation.

$$= 60 \text{ ft}^3/\text{day} \times 1 \text{ day} = 60 \text{ ft}^3 = \underline{\underline{0.0014 \text{ Ac-ft}}}$$



UMTRA-FCT Sh 36
Wastewater Evap Study
3885-28
PYL 10/22/90
WYL 11/7/90

POND #6 - VOL. OF SURFACE WATER TO BE DEWATERED

SECTION	AREA (SF.)	AVG. AREA (SF.)	LENGTH (FT.)	VOLUME (C.Y.)
A	0			
B	0	0.0	100	0
C	1300	650	100	2407
D	1755	1527.5	100	5657
E	2795	2275	100	8426
F	910	1852.5	100	6861
G	0	* 303.3	115	1292
TOTAL				24644 C.Y. = 15.3 AC.-FT

NOTES:

* Pyramid shape: vol. = (area * L)/3

UMTRA-FLT Sh 37
 - Wastewater Evap. Study
 3885-28
 PTL 10/22/90
 WYL 11/7/90

POND #6 - VOL. OF EXCAVATION BELOW GROUND WATER TO BE DEWATERED

SECTION	AREA (SF.)	AVG. AREA (SF.)	LENGTH (FT.)	VOLUME (C.Y.)
A	0	* 400.0	100	1481
B	1200	1930	100	7148
C	2660	3959	100	14663
D	5258	5645.5	100	20909
E	6033	4446.5	100	16469
F	2860	* 953.3	115	4060
G	0			

TOTAL 64731 C.Y.

NOTES:

* Pyramid shape: vol. = (area * L)/3

DEWATERING VOLUME = $64731 \text{ cy} \times 27 \text{ ft}^3/\text{cy} \times \text{specific yield}$
 = $64731 \times 27 \times 0.18 \text{ ft}^3$
 = $314593 \text{ ft}^3 = 7.2 \text{ Ac.-ft}$

✓ POND #6 - SEEPAGE INTO EXCAVATION -- PART A

K OF AQUIFER = $6.40E-06$ cm/s * $2.10E-07$ ft/s

SECTION (sh. 25-77)	LEFT (L)					RIGHT (R)					TOTAL q A (qA(L)+qA(R)) (eq.ft./day)
	e2(L) (ft.)	B(L) (deg.)	tan B(L)	q A (L) (eq.ft./s) (eq.ft./day)		e2(R) (ft.)	B(R) (deg.)	tan B(R)	q A (R) (eq.ft./s) (eq.ft./d)		
B	12	9.7	0.171	$4.3E-07$	0.0372	15	7.1	0.125	$3.9E-07$	0.0339	0.0711
C	16.5	7.4	0.166	$5.7E-07$	0.0496	16.5	7	0.123	$4.3E-07$	0.0368	0.0863
D	16.5	9.9	0.175	$6.0E-07$	0.0522	16.5	7.2	0.126	$4.4E-07$	0.0378	0.0901
E	16.5	11.7	0.207	$7.2E-07$	0.0620	16.5	6.3	0.110	$3.8E-07$	0.0330	0.0950
F	6.5	6.2	0.109	$1.5E-07$	0.0128	6.5	12.2	0.216	$3.0E-07$	0.0255	0.0383

NOTES:

$$q = K * e_2 * (\tan B)$$

WATER - LT SH 38
Washington Univ. Study
3865-28
PYL 10/22/90
WYL 11/7/90

POND #6 - SEEPAGE INTO EXCAVATION -- PART B

K OF AQUIFER = $6.40E-06$ cm/s = $2.10E-07$ ft/s = 0.018141 ft/day

SECTION (sh. 76-79)	HEAD H (ft.)	FRAGMENT 1					FRAGMENT 2					ΣI 9	$2 * q B$ ($=2 * KH / \Sigma I$) (sq. ft./day)
		S1 (ft.) (a)	T1 (ft.) (b)	m 1 (c)	$(m1)^2$ (d)	$(=K/K')$	S2 (ft.) (a)	T2 (ft.) (b)	m 2 (c)	$(m2)^2$ (d)	$(=K/K')$		
B	-	-	-	-	-	-	-	-	-	-	-	-	0.000
C	16.5	16.5	53.5	0.466	0.2169	0.751	0	37	0	0	0	0.751	0.797
D	16.5	16.5	53.5	0.466	0.2169	0.751	0	37	0	0	0	0.751	0.797
E	16.5	16.5	53.5	0.466	0.2169	0.751	0	37	0	0	0	0.751	0.797
F	6.5	6.5	53.5	0.190	0.0361	0.540	0	47	0	0	0	0.540	0.437

NOTES:

- (a) Refer to sections on sh. 76 - 79
- (b) Based on an average el. of bottom of aquifer @ El. 348'
- (c) $m = \sin \{ (5 * \pi) / (2 * T) \}$
- (d) From table on sh. 74

WITHIN-FCI S. 39
 (Washburne Engr. Study)
 3885-28
 P/L 10/22/90
 W/L 11/7/90

POND #6 -SEEPAGE INTO EXCAVATION --- PART A + PART B

SECTION	q A (sq.ft./d) (sh. 38)	2*qB (sq.ft./d) (sh. 37)	TOTAL q (qA + 2qB) (sq.ft./d)	AVG. q (sq.ft./d)	LENGTH, L (FT.)	(AVG. q * L) (ft ³ /day)
A	0	0	0.0000	*		
B	0.0711	0	0.0711	0.0237	100	2.370
C	0.0863	0.797	0.8833	0.4772	100	47.720
D	0.0901	0.797	0.8871	0.8852	100	88.520
E	0.0950	0.797	0.8920	0.8896	100	88.955
F	0.0383	0.437	0.4753	0.6837	100	68.365
G	0	0	0.0000	* 0.1584	115	18.220
					TOTAL	314.1 ft ³ /day

NOTES:

* Pyramid shape : vol. = (area * L)/3

UNITA-FCF
3885-28
PYL 10/22/90
WHL 11/7/90
S/L 40



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project WATER-FACT
 Feature Wastewater Trap Study
 Item Water bed & wastewater handling

Contract No. 3855-28Designed PTLChecked WYLSheet 41File No. Date 10/19/90Date 11/7/90POND #6 (cont'd)

No. of days to excavate portion of Pond #6 below groundwater

$$= 64,731 \text{ c.y.} \times \frac{1 \text{ hr.}}{650 \text{ c.y.}} \times \frac{1 \text{ day}}{8 \text{ hr.}} \times \frac{7}{5} = 17.4 \text{ days}$$

say 18 days

5. Dewatering vol. from outside of excavation

$$= 314.1 \text{ ft}^3/\text{day} \times 18 \text{ days} = 5653.8 \text{ ft}^3$$

$$= 0.13 \text{ Ac.-ft}$$





Project

WTRA - FCT

Contract No. 3855-28

Sheet 112

Feature

Wastewater Evap. Study

Designed PTL

File No.

Item

Water test & Wastewater handling

Checked WYL

Date 10/13/90

Date 11/7/90

d) DEWATERING OF IN-SITU PILES # 1, 2 & 7

Perched water exists in piles # 1, 2, & 7. There are pockets of perched water throughout these piles that do not appear to be interconnected. Dewatering is only needed in the north-eastern portion of pile # 7, where reshaping will be done (see ch 80). It is considered not possible to dewater piles # 1 & 2 either, due to the presence of mainly slime tailings in the perched water zones. (See next page). Therefore, only the volume to be dewatered from pile # 7 is calculated here.

Refer to section on ch 81, tailing below perched water in the north-eastern portion of the pile is mostly sand tailings. Therefore, in this calculation, it is conservatively assumed that the area is all sand tailings, and specific yield of sand tailings will be used in the calculation.

1) Specific Yield S_y of Sand tailings in in-situ piles

No pumping tests or capillary moisture tests had been performed for sand tailings. Typical values for sand used in Ref 1 is 0.25 for permeability of 1×10^{-5} cm/sec ($= 4.7 \times 10^{-4}$ cm/sec). Based on Ref 4, permeability of in-situ sand tailings is 8.4×10^{-6} cm/sec. Thus the specific yield is expected to be less than 0.25. However, for conservatism, $S_y = 0.25$ is used herein.





Project WATER - FCT
 Feature Wastewater Equip. Study
 Item Water and Wastewater Handling

Contract No. 8855-28 Sheet 43
 Designed PYL File No.
 Checked WYL Date 10/23/90
 Date 11/7/90

(i) Dewatering Volume, Pile #7

Referred to section on sh 81, cross-sectional area to be dewatered = 15,840 ft² (by planimeter)

Assume uniform section across the pile,

Length = 880 ft (scaled off from sh 81)

∴ dewatering volume from pile #7

$$= 15,840 \text{ ft}^2 \times 880 \text{ ft} \times \text{specific yield}$$

$$= (15,840 \times 880 \times 0.25) \text{ ft}^3$$

$$= 3484800 \text{ ft}^3 = \underline{\underline{80 \text{ A.C. ft}}}$$

* (note for previous page)

This conclusion is supported by the fact that when wells B, C & D were pumped out they remained dry throughout the sampling period (see sh 44 (Ref 10)). This indicates that the tailings in those locations have since been pumped out.





NATIONAL
ENVIRONMENTAL
TESTING, INC.

NET Gulf Coast, Inc.
Austin Division
2621-130 Ridgepoint Drive
Austin, TX 78754
Tel: (512) 928-8905
Fax: (512) 928-3208

→ FIELD SUMMARY ←

Formerly: Aqualab, Inc.
UMTKA-FCT

Fall City (0 tailings site) .7 mi down F.M. 1344 off F.M. 791
PTL 10/25/90
WYL 11/7/90

<u>Well</u>	<u>Well Depth</u>	<u>Date</u>	<u>Depth From Top of Casing</u>
B 1	27.8'	Dry	32.8'
B 2	26.6'	12-13-88	35.0'
MW 607	Could not obtain	12-13-88	44.0'
B 3	29.0'	12-13-88	37.1'
B 4	20.5'	12-13-88	39.5'
B 8	15.6'	12-14-88	30.5'
B 7	13.9'	Dry	18.7'
B 9	10.3'	Dry	16.4'
B 10	23.7'	12-14-88	33.5'
B 6	15.7'	Dry	26.5'
B 5	15.0'	Dry	19.4'
B 13	Could not locate		
Sampling Time:		10 hrs. 12-13-88	
		8 hrs. 12-14-88	

From Ref 10

RECEIVED-MKE

JAN 17 1989

UMTRA-S.F.

MKE DOC. 5057-FCT-R-09-00716-00

WINTER TCT

3845-28

PTL 10/25/90

WYL 11/7/90

FALLS CITY PROJECT

DRILL HOLES

DRILL HOLES	PLAN LOCATION		SET LOCATION		HUB ELEVATION**
	NORTH	EAST	NORTH	EAST	
B1	61,300.00	63,760.00	61,300.00	63,760.00	484.16
B2	61,380.00	64,115.00	61,380.00	64,115.00	482.11
B3	62,300.00	64,950.00	62,300.00	64,950.00	472.40
B4	62,050.00	64,920.00	62,050.00	64,920.00	473.20
B5	60,710.00	64,375.00	60,710.00	64,375.00	467.63
B6	60,520.00	64,300.00	60,520.00	64,300.00	465.90
B7	61,730.00	65,550.00	61,730.00	65,550.00	456.87
B8	61,880.00	64,350.00	61,880.00	64,350.00	464.55
B9	61,500.00	65,850.00	61,500.00	65,850.00	453.20
B10	59,400.00	64,800.00	59,400.00	64,800.00	466.27
B11	59,120.00	64,780.00	59,120.00	64,780.00	465.71
B12	59,420.00	65,090.00	59,420.00	65,090.00	466.13
B13	58,730.00	65,770.00	58,730.00	65,770.00	440.43
B14	58,800.00	65,940.00	58,800.00	65,940.00	440.28
B15	58,300.00	65,690.00	58,300.00	65,690.00	436.42
B16	62,410.00	70,080.00	62,410.00	70,080.00	420.85
B17	62,600.00	70,340.00	62,600.00	70,340.00	420.58

**These hub elevations were obtained from the following aerial or control points furnished to CEC: #901, 905, 924, 925, 926, SM A and SM B.

From log 9

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-10

3885-28

PYL 10/25/90

WYL 11/7/90

Project Name: UMTRA SiteDate of Boring: July 11, 1988Site: Falls City, TexasProject No.: 312-85070

DESCRIPTION	DEPTH	SAMPLE	H	G _u	G _p	M _u	REMARKS
SURFACE							
Very stiff light brown CLAY - with calcareous materials, and gravel		SS 1	16				
	5	SS 2	5				
Loose gray silty SAND - gray and brown clayey sand at 9'							
	10	SS 3	6				
	15	SS 4	5				
Firm gray sandy CLAY - with silt	20	SS 5	6				
Firm gray and dark brown silty CLAY	25	SS 6	7				
Hard tan silty CLAY	30	SS 7	34				
Boring terminated at 32'							

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-11

UMTRA-FG

3855-28

PYL 10/25/90

WYL 11/7/90

Project Name: UMTRA Site Date of Boring: July 7, 1988
 Site: Falls City, Texas Project No.: 312-85070

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	N_6	REMARKS
SURFACE							
Firm to stiff brown CLAY		SS 1	14				
- with calcareous material							
	5	SS 2	6				
	10	SS 3	5				
	15	SS 4	7				
Medium dense light tan SAND							
- with some clay							
	20	SS 5	7				
Medium dense greenish gray sandy SILT							
	25	SS 6	12				
	30	SS 7	15				
Boring terminated at 30'							

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-12

2885-22

PTL 10/25/90

WYL 11/7/90

Project Name: UMTRA Site Date of Boring: July 7, 1988Site: Falls City, Texas Project No.: 312-85070

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	N_L	REMARKS
SURFACE							
Firm to stiff tan silty CLAY with some calcareous material		SS 1	9				
	5	SS 2	5				
Loose white and gray SAND - with calcareous materials							
	10	SS 3	7				
Loose dark gray silty SAND							
	15	SS 4	9				
Soft light brown silty CLAY		SS 5	4				
	20						
		SS 6	3				
	25						
		SS 7	38				
Hard gray silty CLAY							
	30						
Hard light brown silty CLAY		SS 8	69				
	35						
Boring terminated at 35'							

From Ref 9

UMTRA-F-1

38-5-28

PYL 10/25/90

WYL 11/7/90

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-16

Project Name UMTRA Site Date of Boring August 18, 1988
 Site Falls City, Texas Project No. 312-85070

DESCRIPTION	DEPTH	SAMPLE	N	Q _u	Q _s	N ₆₀	REMARKS
SURFACE							
Hard tan silty CLAY		SS 1	24				
- with gravel		ST 2					
	5	SS 3	18				
		ST 4					
		SS 5	5				
Loose gray silty SAND	10	ST 6					
- moist at 10' and 14'		SS 7	6				
		ST 8					
	15	SS 9	2				
		ST 10					
Soft gray silty CLAY		SS 11	3				
	20	ST 12					
Very soft gray silty CLAY and gray silty SAND		SS 13	1				
- moist at 22.5'		ST 14					
	25	SS 15					
		ST 16					
		SS 17	50/5"				
Hard yellowish tan SILTSTONE	30						
Boring terminated at 29'							

From Ref 9.

UMTRA-TU

3885-28

DYL 10/25/90

WYL 11/7/90

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-17

Project Name: UMTRA Site

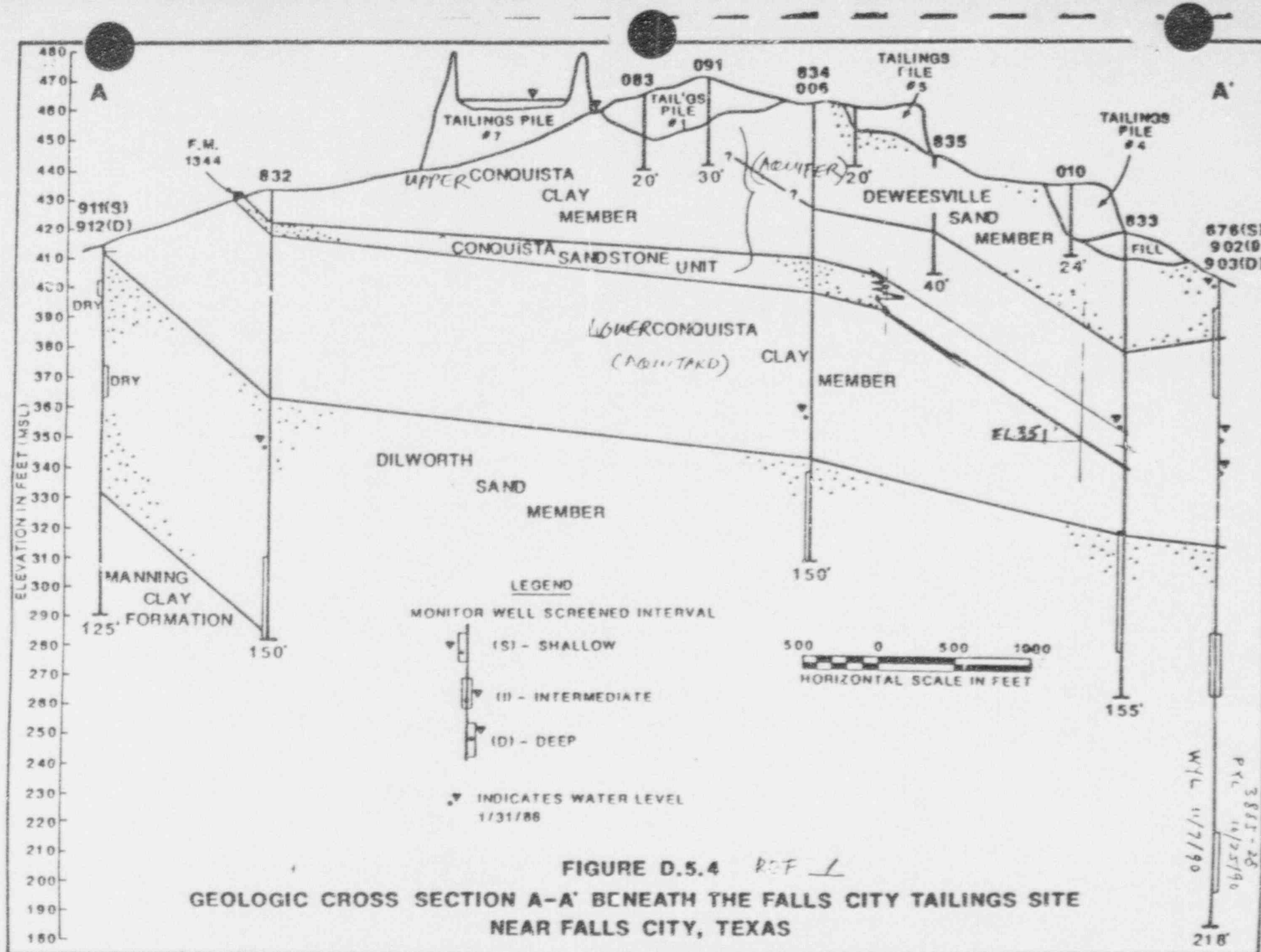
Date of Boring: August 17, 1988

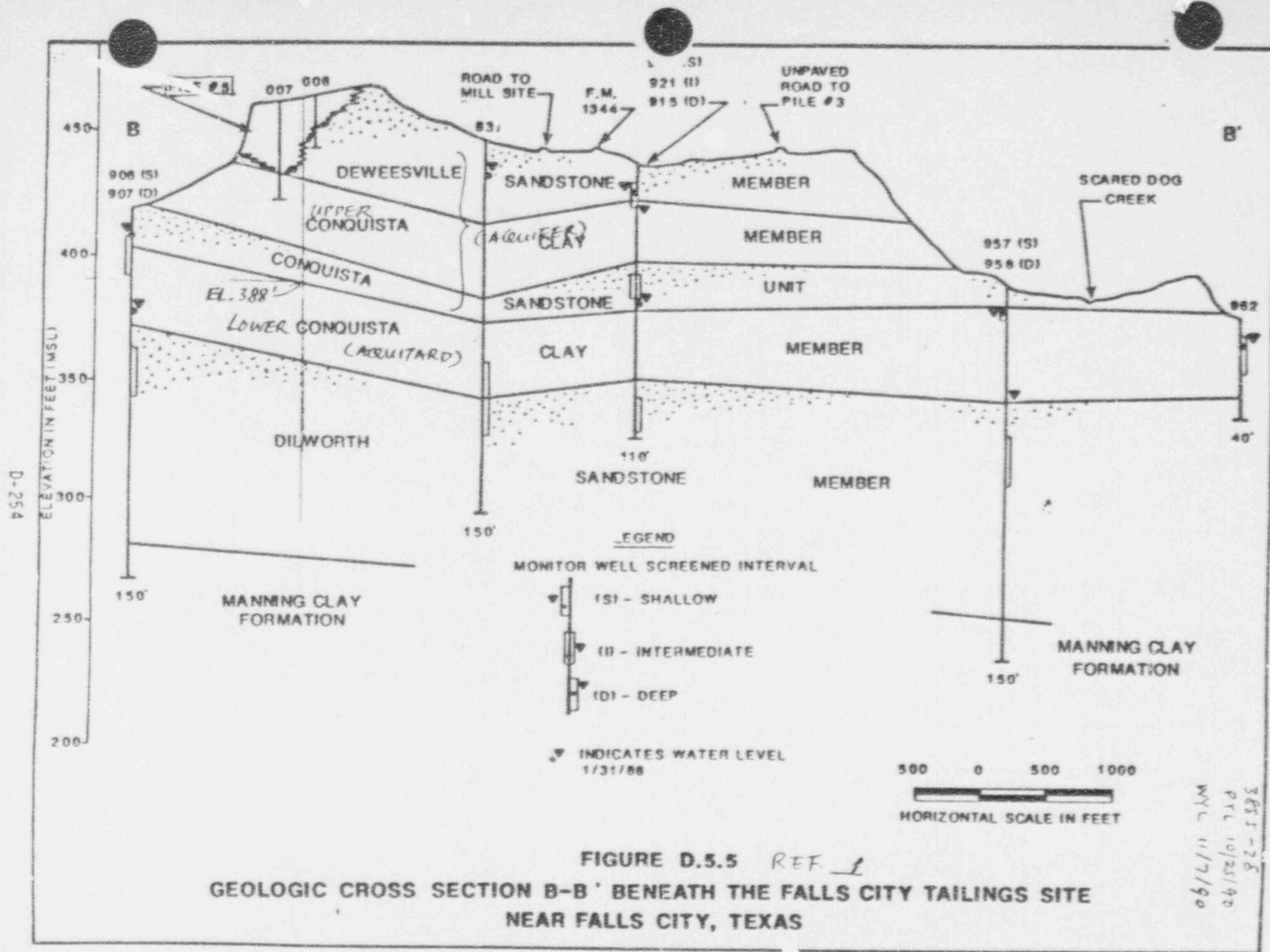
Site: Falls City, Texas

Project No.: 312-85070

DESCRIPTION	DEPTH	SAMPLE	N	C_u	C_p	M_c	REMARKS
SURFACE							
Very stiff tan silty CLAY		SS 1	16				
- with gravel		ST 2					
	5	SS 3	8				
		ST 4					
		SS 5	12				
	10	ST 6					
Loose gray clayey SAND		SS 7	2				
- gray silty clay layer at 11.5'		ST 8					
Loose gray clayey SAND		SS 9	6				
- with silt	15	ST 10					
		SS 11	1				
Tan silty CLAY		ST 12					
	20	SS 13					
Loose gray clayey SAND		ST 14					
- with silt		SS 15	1				
Loose gray silty CLAY		ST 16					
- moist	25	SS 17	50/4"				
Hard SANDSTONE							
- with some silty clay	30						
Boring terminated at 29'							

D-253





3851-28
PTL 10/25/90
WYL 11/7/90

10/17/90 - TCT

SLT2

PYL 10/26/90

WYL 11/7/90

APPENDIX A
(Dec 1988)

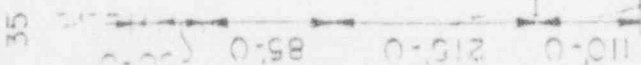
WELL NUMBER

DEPTH TO WATER FROM GROUND SURFACE

B1	24.8 ft.	
B2	23.6 ft.	
B3	16.0 ft	
B4	17.0 ft	
B5	12.5 ft	See next sheet for ground elev.
B6	12.7 ft.	
B7	10.3 ft.	
B8	12.6 ft.	
B9	7.3 ft	
B10	20.7 ft.	
601	11.3 ft.	
602	13.0 ft.	
607	22.0 ft.	
617	11.6 ft.	
625	16.6 ft.	
651	plugged with dirt at 5 ft.	
713	16.2 ft.	
831	27.2 ft.	
834	No water read at depth of 100'	
835	15.8 ft.	
836	19.1 ft.	

From Ref 12

PTL 10/15/90
WYL 11/7/90



JMTEA-FCT

47 55

~~KL 10/24/90~~

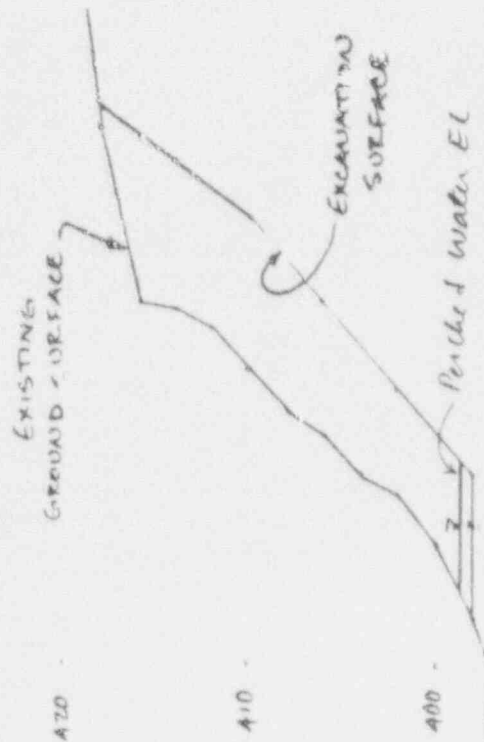
~~RHS 8-9-88~~

PYL 10/25/90

WYL 11/7/90

SECTION B

EXCAVATION = 2,750 FT²



HORIZ. SCALE: 1" = 200'

UMTRA FCT

4/8/55

~~1-18-67/04/90~~

~~RMB-6-9-88~~

PYL 10/25/90

WYL 11/7/90

SECTION C

EXCAVATION = 11,700 FT²

EXISTING GROUND
SURFACE

EXCAVATION
SURFACE

Ponded Water EL.

HORIZ. SCALE: 1" = 200'

1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500 2600 2700 2800 2900 3000 3100 3200 3300 3400 3500 3600 3700 3800 3900 4000 4100 4200 4300 4400 4500 4600 4700 4800 4900 5000 5100 5200 5300 5400 5500 5600 5700 5800 5900 6000 6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100 7200 7300 7400 7500 7600 7700 7800 7900 8000 8100 8200 8300 8400 8500 8600 8700 8800 8900 9000 9100 9200 9300 9400 9500 9600 9700 9800 9900 10000

EL. FT

UMTRA - FCT

49 57

~~XXXXXXXXXX~~

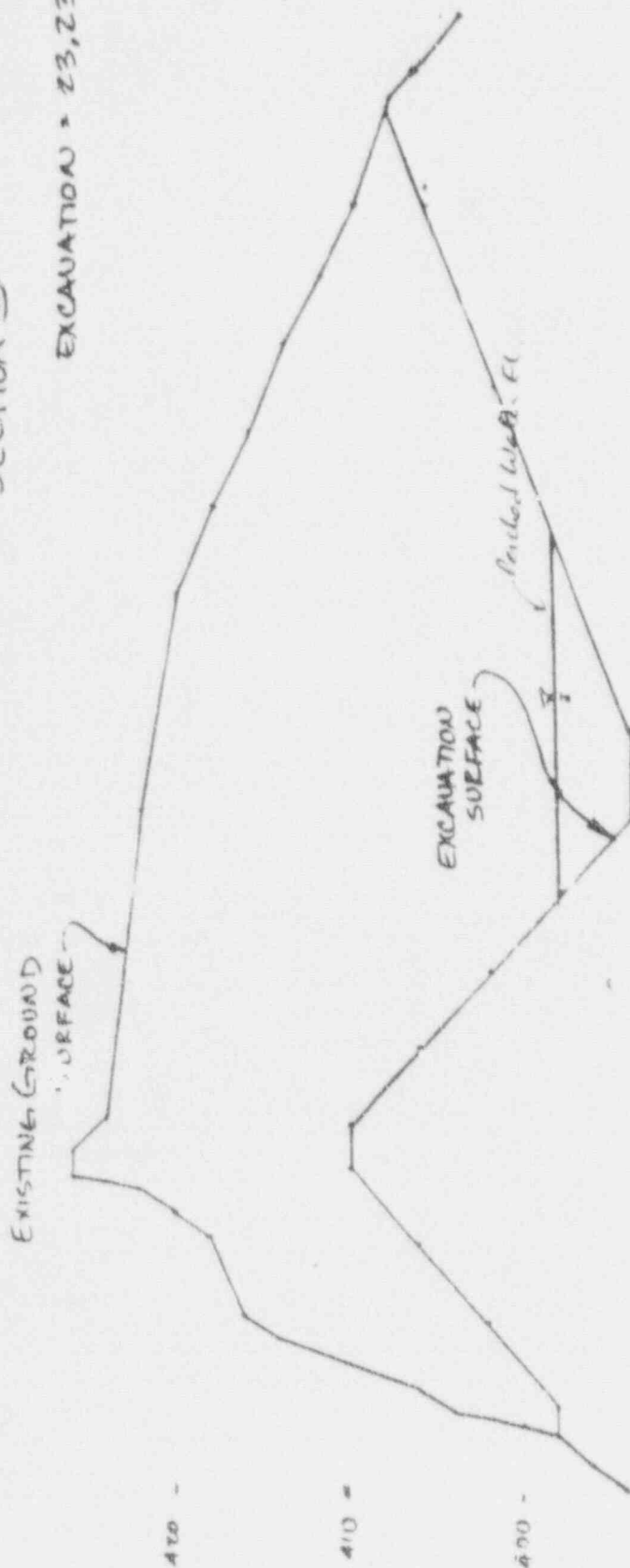
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PYL 10/25/90

WYL 11/7/90

SECTION D

EXCAVATION = 23,230 ft²



HORIZ SCALE: 1" = 200'

UMTRA-FCT

210 58

~~PL 10/25/90~~

PL 10/25/90 - 1
WYL 11/7/90

SECTION E

EXCAVATION = 29,950 FT²

EXISTING GROUND SURFACE

Paved Under E.C.

EXCAVATION SURFACE

420 -
410 -
400 -
390 -

0 200 400 600 800 1000 1200 1400 1600

HORIZ. SCALE: 1" = 200'

1 2

~~WMB 5/24/90~~

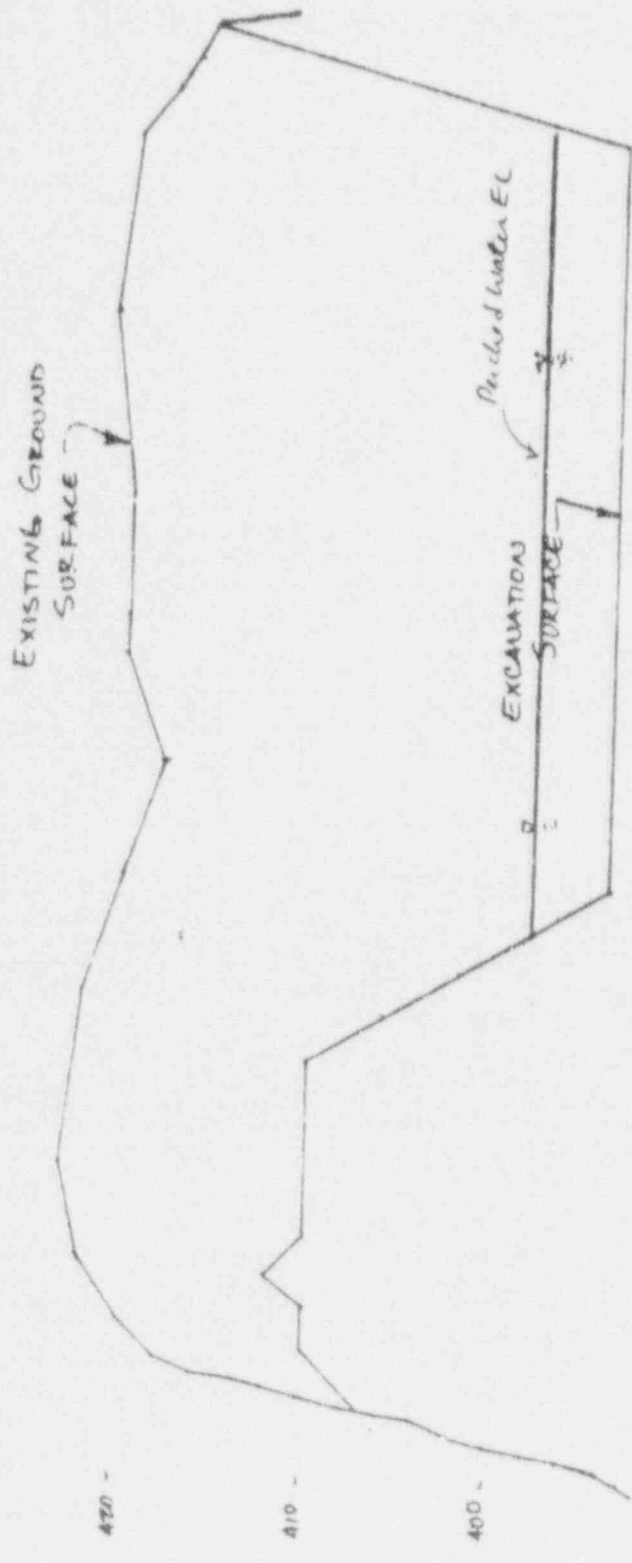
~~RMB 6/9/90~~

PYL 10/25/90

WYL 11/7/90

SECTION F

EXCAVATION = 29,350 FT³



HORIZ. SCALE: 1" = 200'

UMTRA-FCT

52 60

~~10/25/91~~

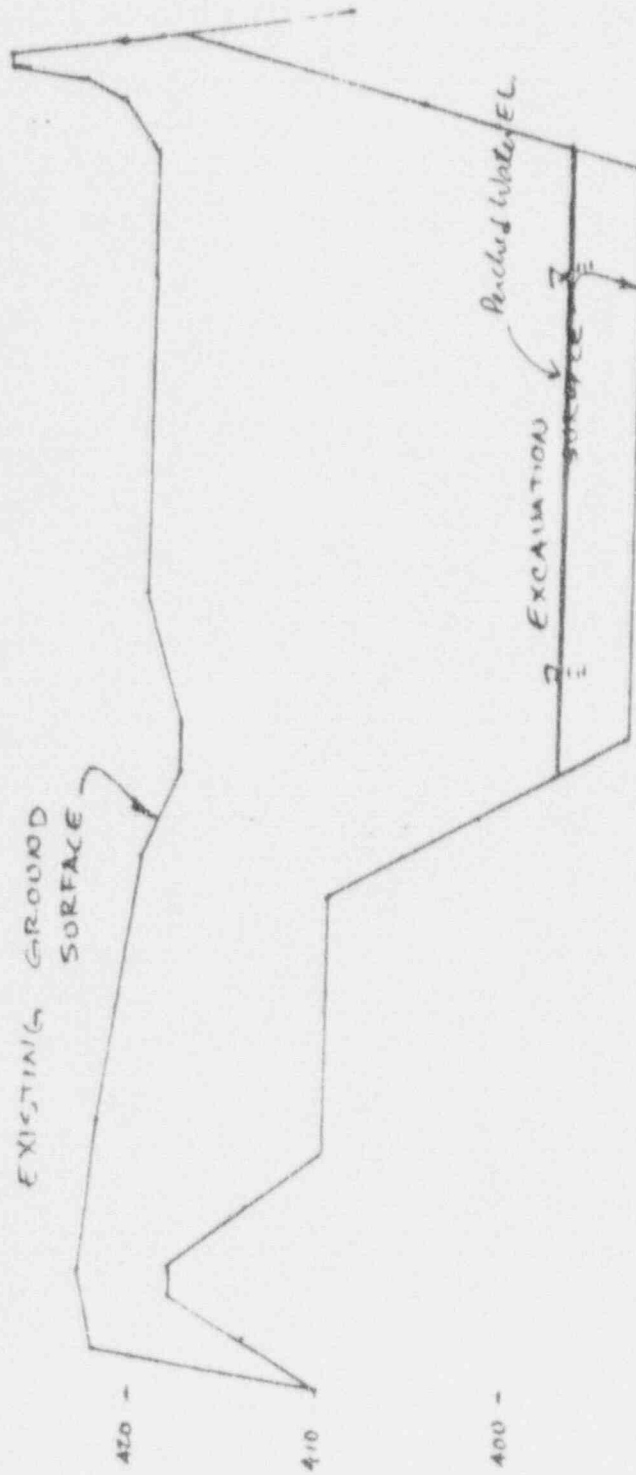
~~11/7/90~~

PYL 10/25/91

WYL 11/7/90

SECTION G

EXCAVATION = 25,000 FT²



HORIZ. SCALE: 1"=200'

(IMTRA-FCT

58 61

~~REVISED~~
~~RMS-6-9-98~~

PYL 10/25/90

WYL 11/7/90

SECTION H

EXCAVATION = 20,700 FT²

EXISTING GROUND
SURFACE

PROPOSED WALK. EL.

EXCAVATION
SURFACE

HORIZ. SCALE: 1"=200'

430 -

420 -

410 -

400 -

390 -

0

200

400

600

800

1000

1200

1400

1600

UTRA-FCJ

54 62

~~LA 4/24/90~~

~~RMB 6-10-88~~

PTL 10/25/90

WYL 11/7/90

SECTION I

EXCAVATION = 14,820 FT²

EXISTING GROUND SURFACE

EXCAVATION SURFACE

Paved Water
EL

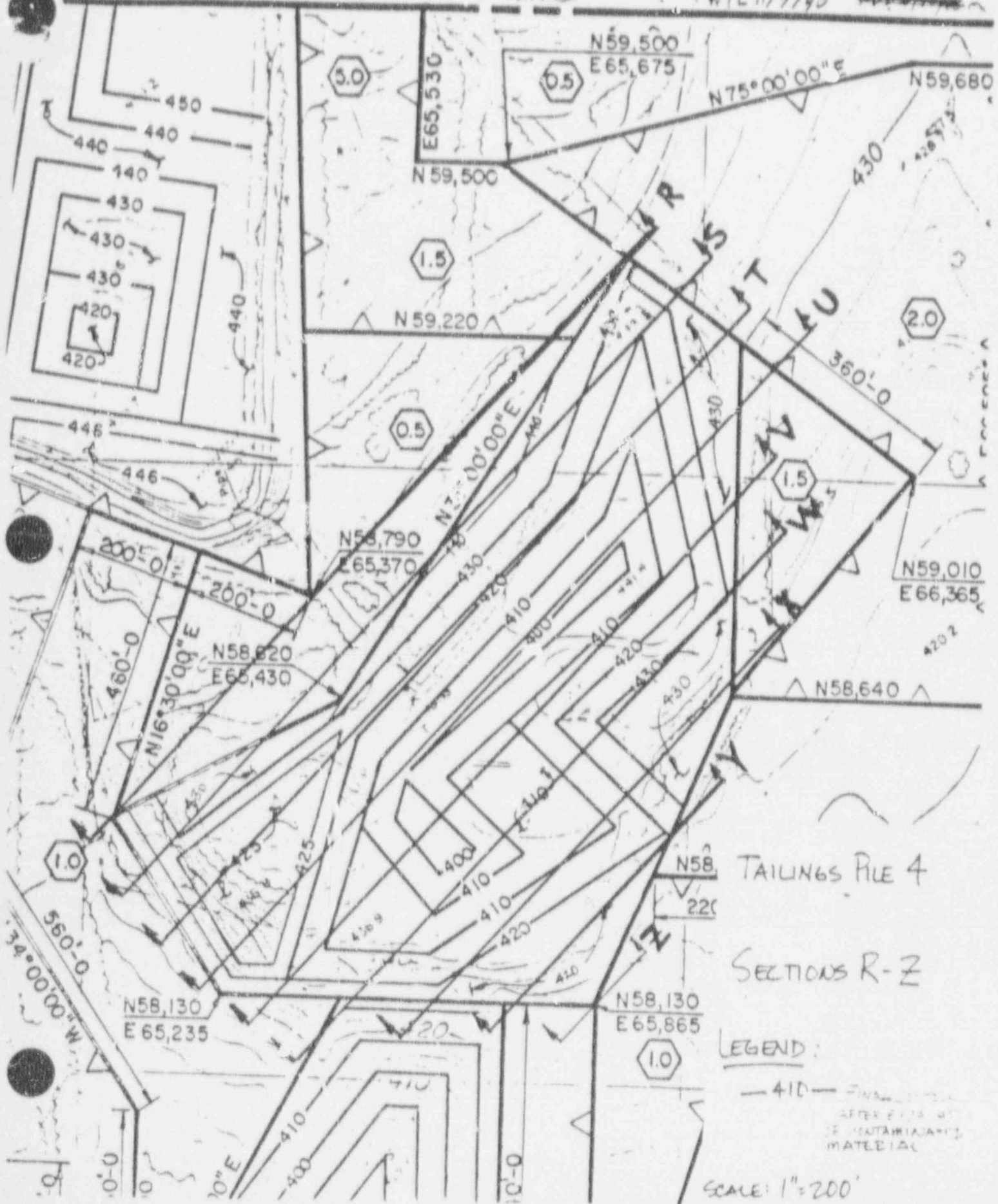
HORIZ. SCALE: 1" = 300'



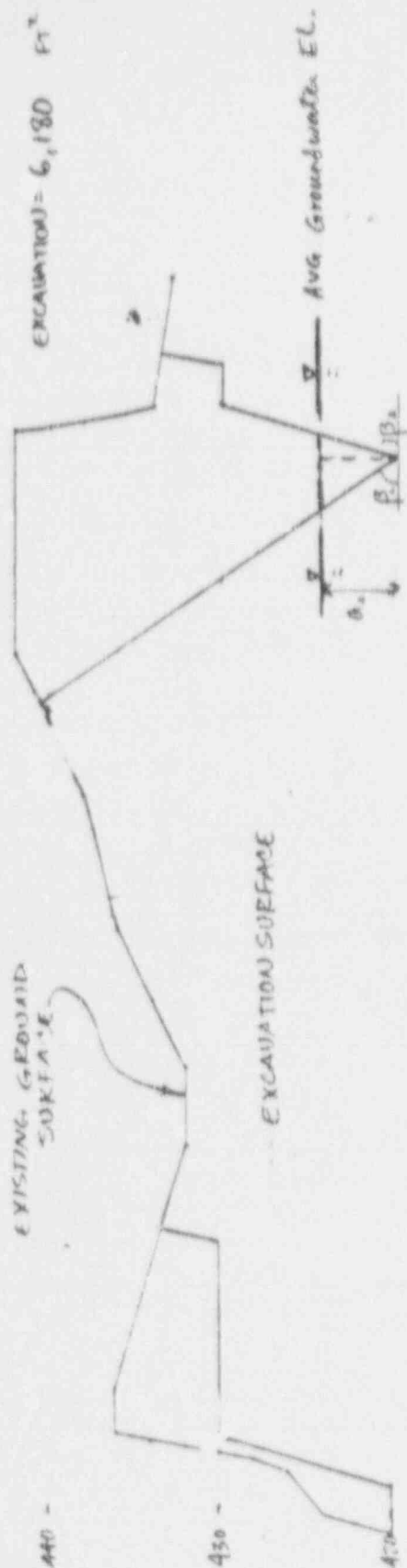
59,750 (SEE DWG.)

PYL 10/25/90

WYL 11/7/90



SECTION S



M-24-E27

PYL 10/23/90

WYL 11/7/90

~~PHOTOGRAPH~~

5 64

440 -

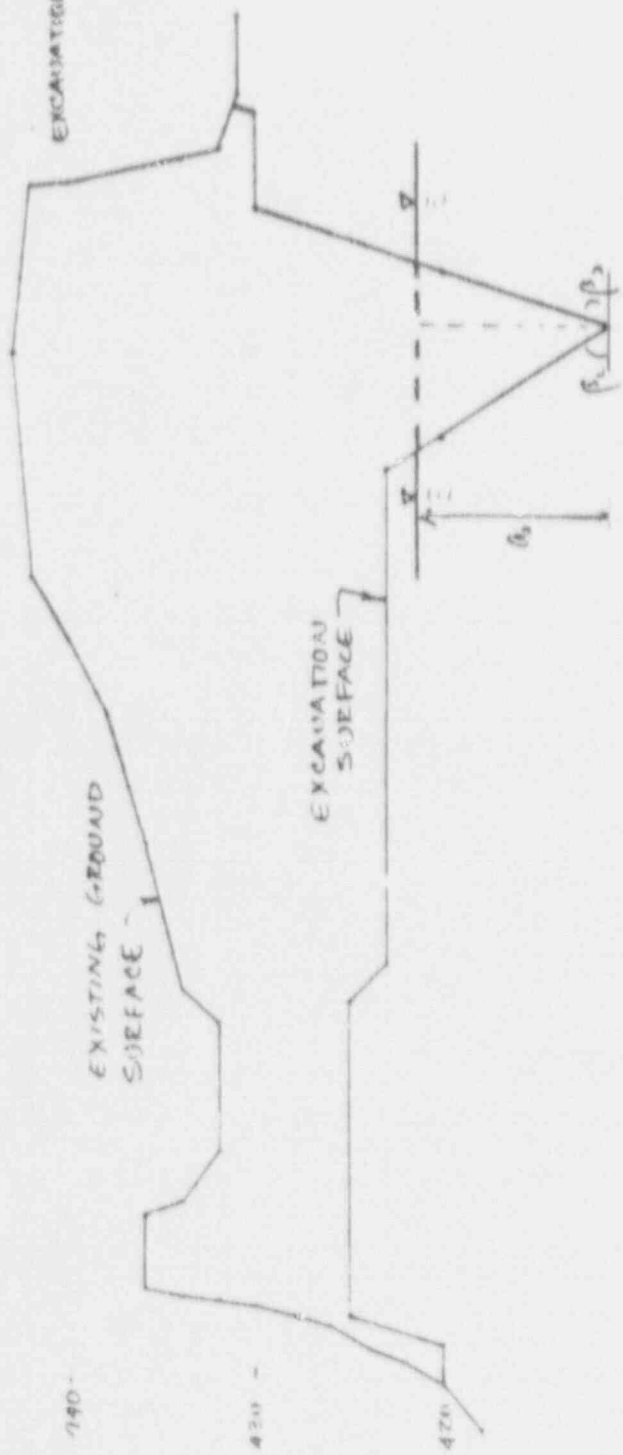
430 -

420 -

HOLES SPACED 1" TO 20"

SECTION T

EXCAVATION = 18,700 FT²



140 -

420 -

470 -

480 -

480 -

580 -

7 6 5 4 3

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

SCALE: 1"=100'

WY 10/25/90

WYL 11/7/90

10/25/90 11/7/90

65

SECTION U

EXISTING GROUND SURFACE

EXCAVATION = 31,800 ft^2



UMTRA - FCT

~~10/25/90~~

~~11/7/90~~

PYL 10/25/90

WYL 11/7/90

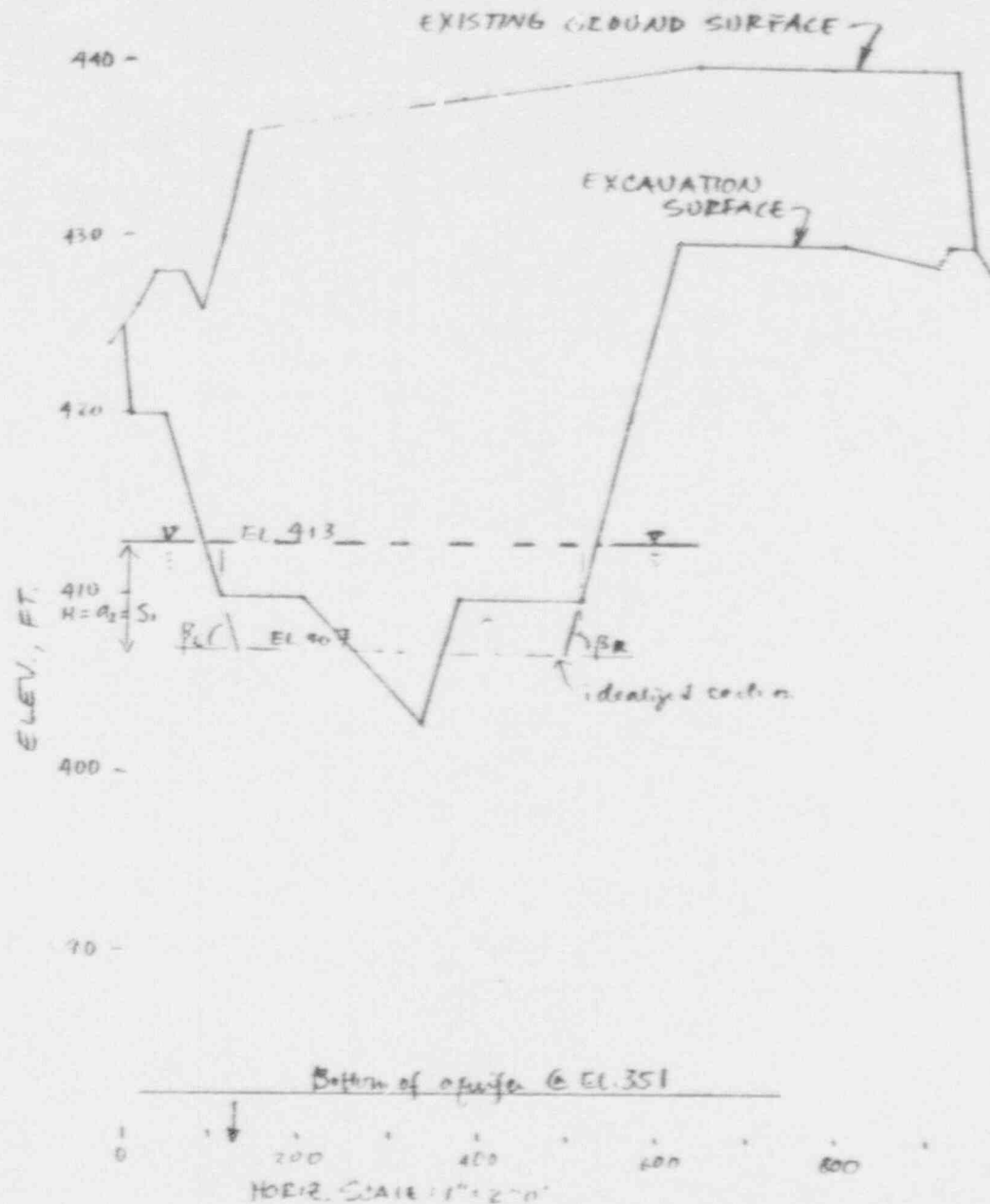
Bottom of aquifer @ EL 351



Horizontal Scale 1" = 100'

SECTION W

EXCAVATION = 17,850 FT³



1M 772A - 1500 rpm

63

~~FEDERAL BUREAU OF INVESTIGATION~~

SECTION X

EXCAVATION = 9,450 FT³

EXISTING GROUND SURFACE

EXCAVATION SURFACE

PL 414
H = 0.5, S₁

ELEV., FT

440 -

450 -

410 -

410 -

400 -

390 -

UMTRA - ECT

PTL 10/25/90
WYL 11/7/90

Station of grade @ EL 351

HORIZ CURVE 1700'

1400

1200

1000

800

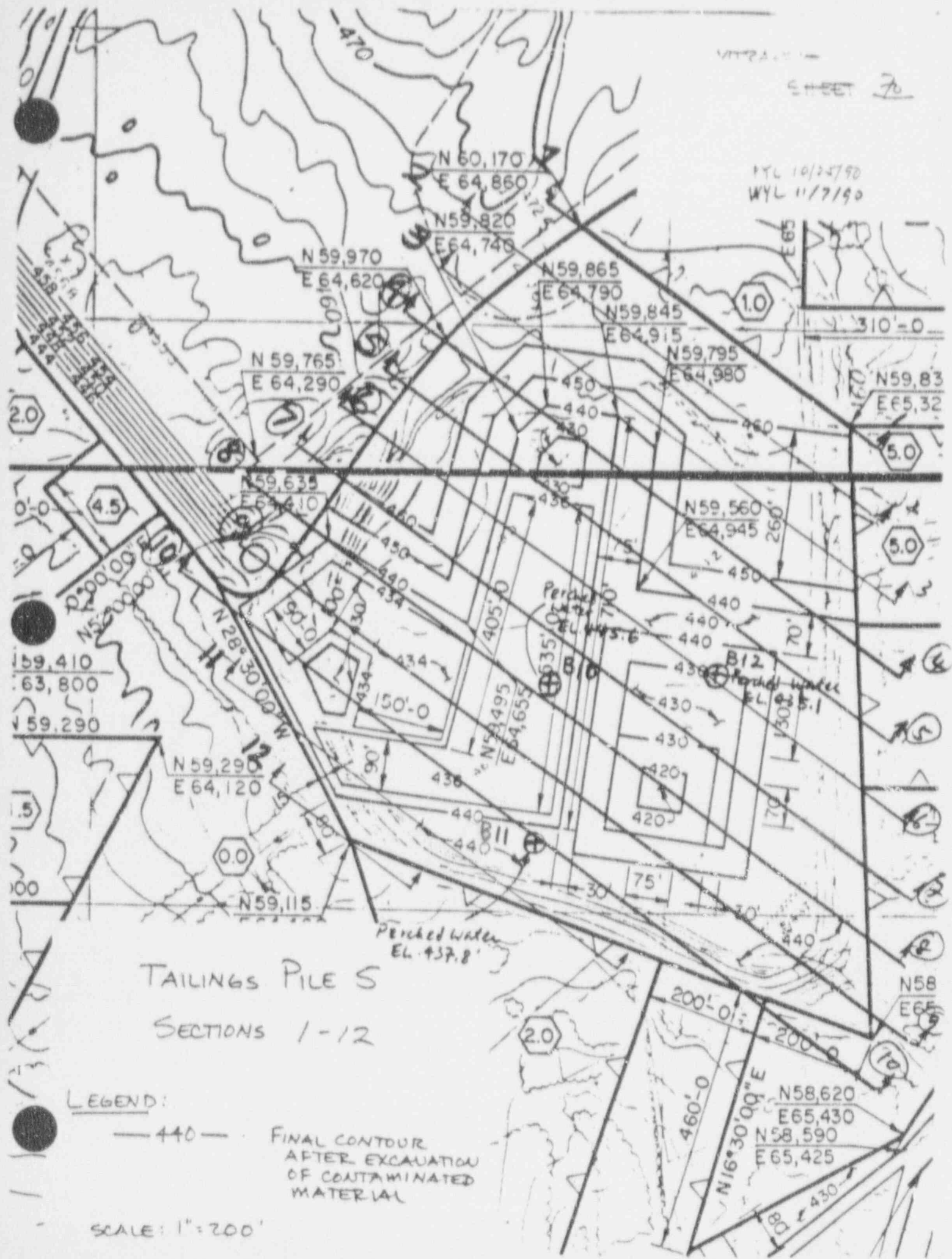
600

400

200

0

TYL 10/25/90
WYL 11/7/90



TAILINGS PILE S
SECTIONS 1-12

LEGEND:

— 440 — FINAL CONTOUR
AFTER EXCAVATION
OF CONTAMINATED
MATERIAL

SCALE: 1" = 200'

UMTRA-FCT

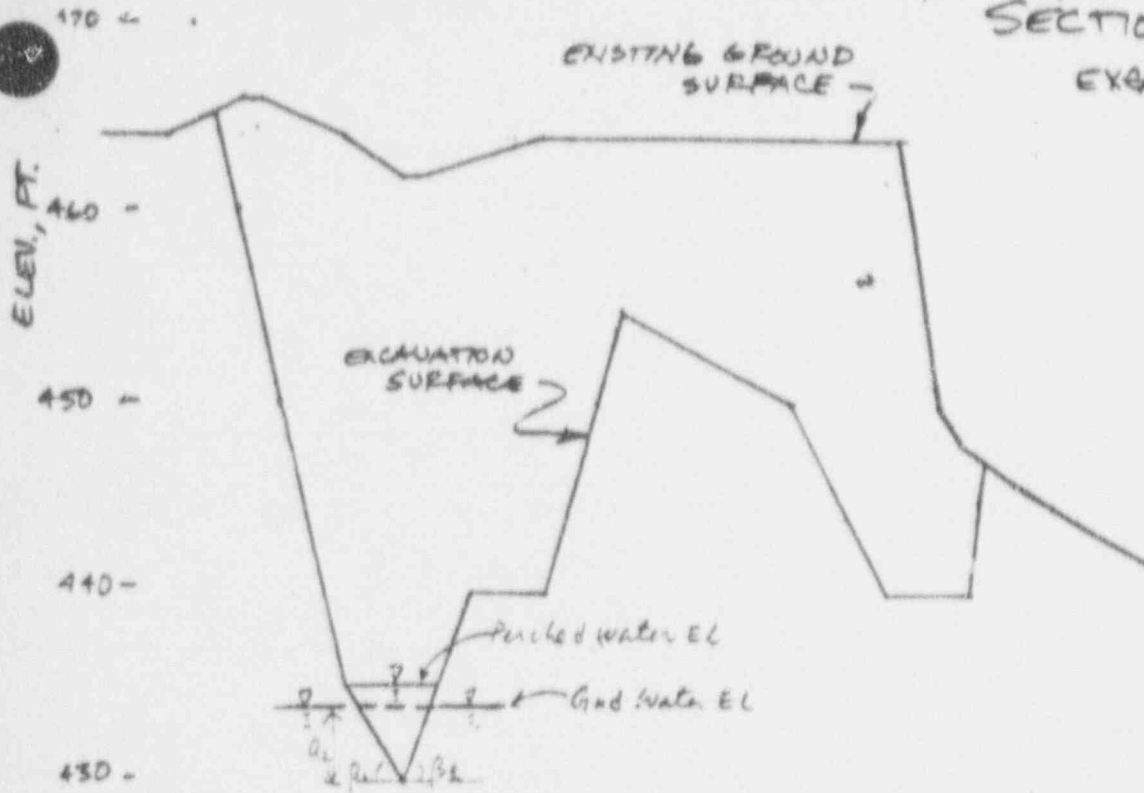
PYL 10/25/90

WYL 11/7/90

JK. 21

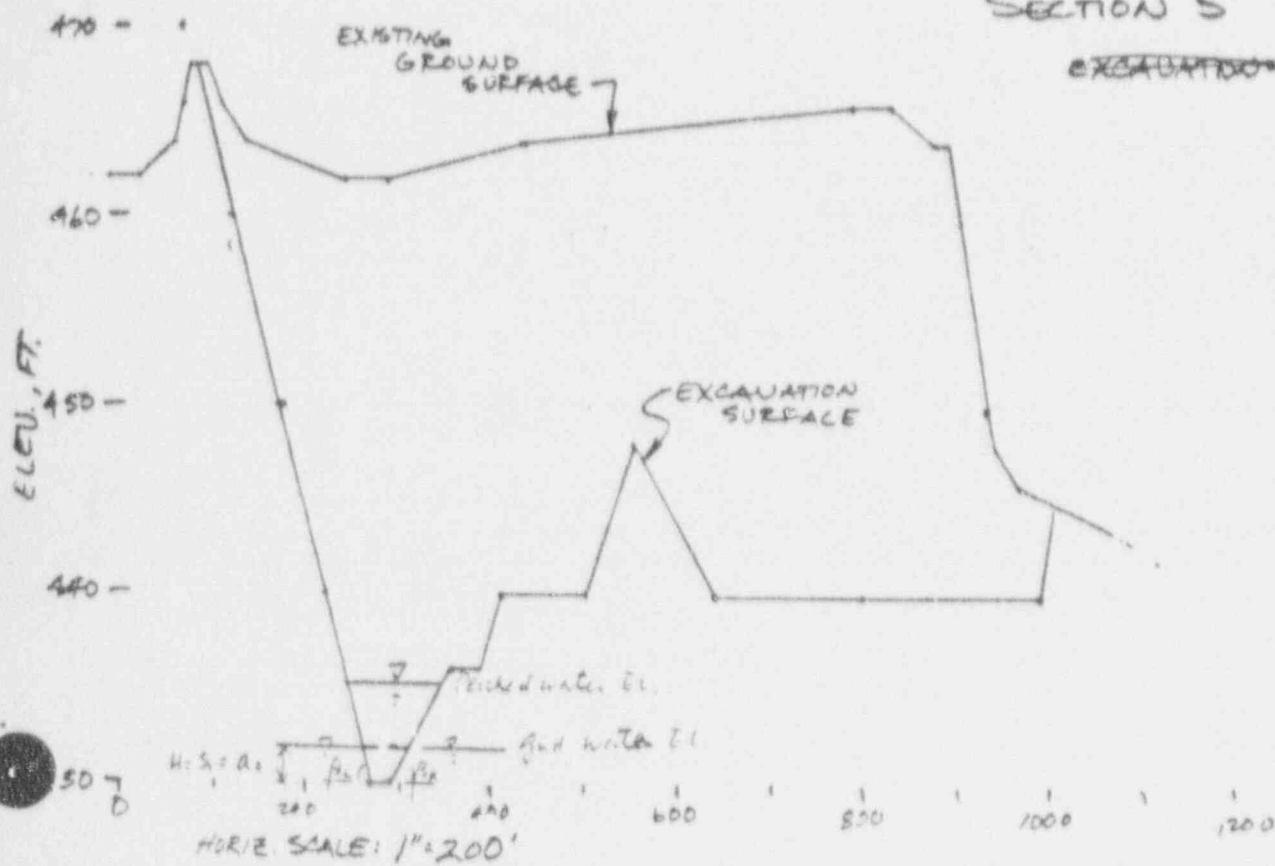
SECTION 4

EXCAVATION = 14,430 ft^2



SECTION 5

EXCAVATION = 11,780 ft^2



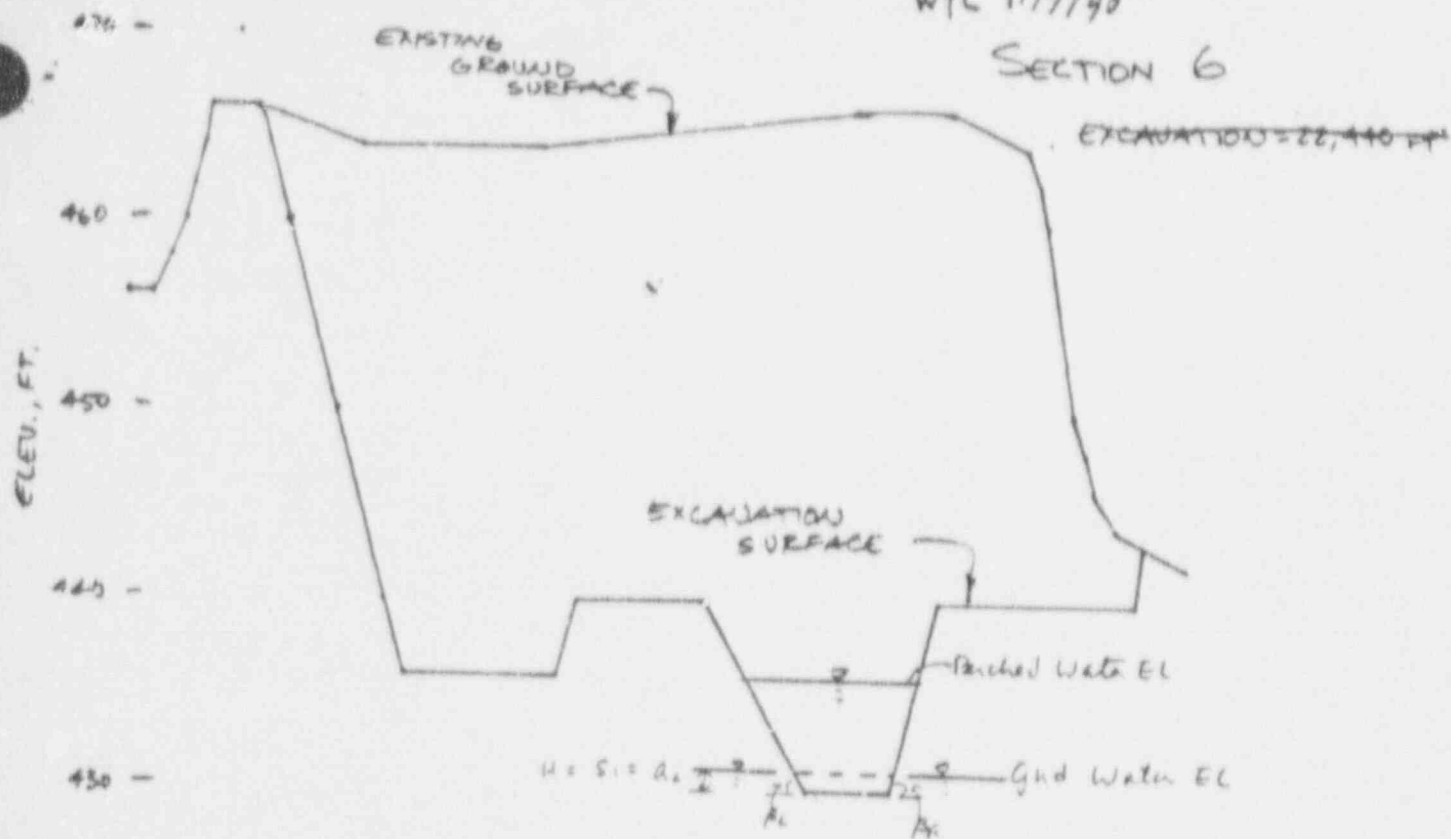
UNITRA-FCI

PTL 10/25/90

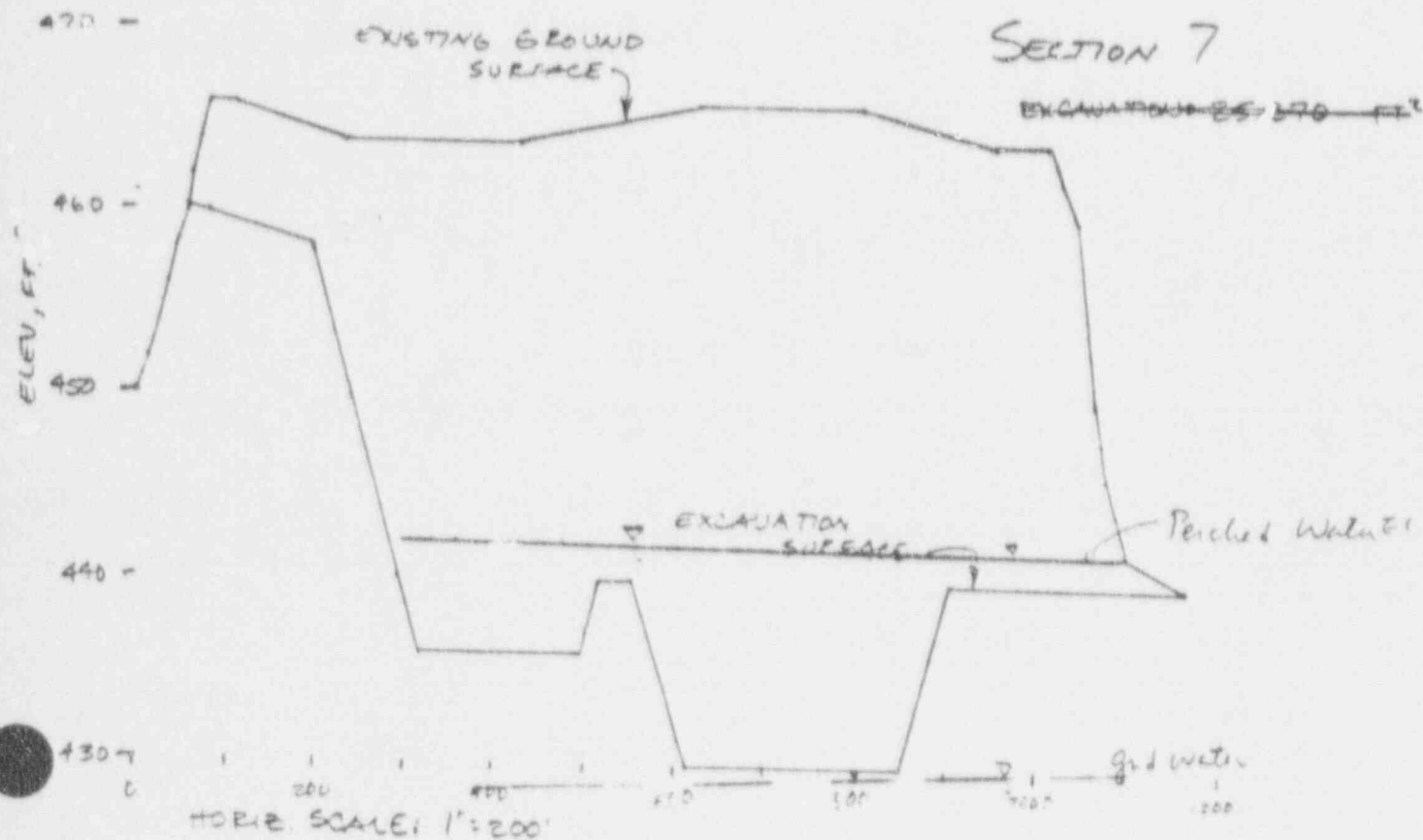
WYL 11/7/90

11 72

SECTION 6



SECTION 7

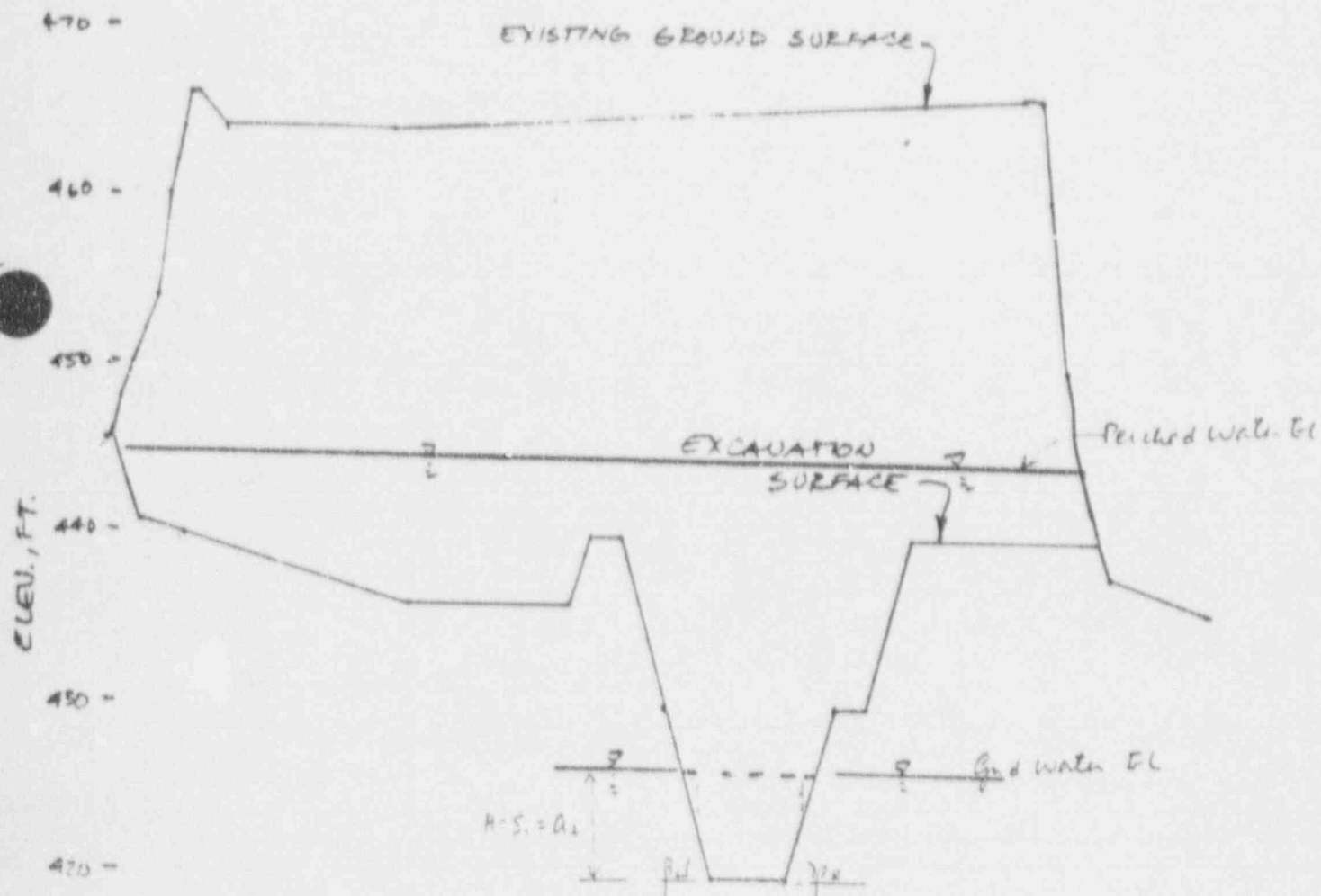


PYL 10/25/90

WYL 11/7/90

SECTION 8

EXCAVATION = 52,410 m^3

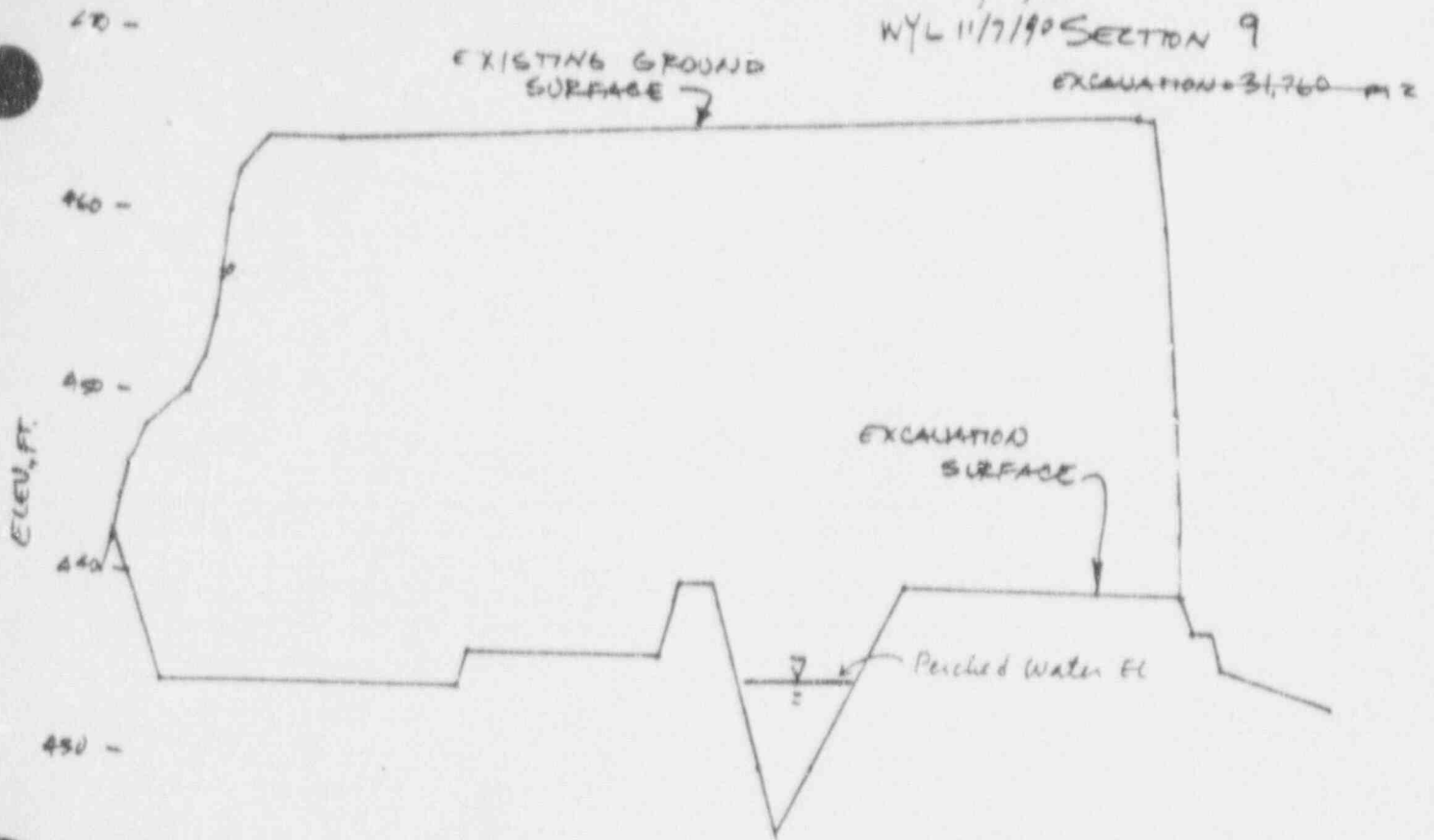


UMTRA-FCT

sh 24

PYL 10/24/90

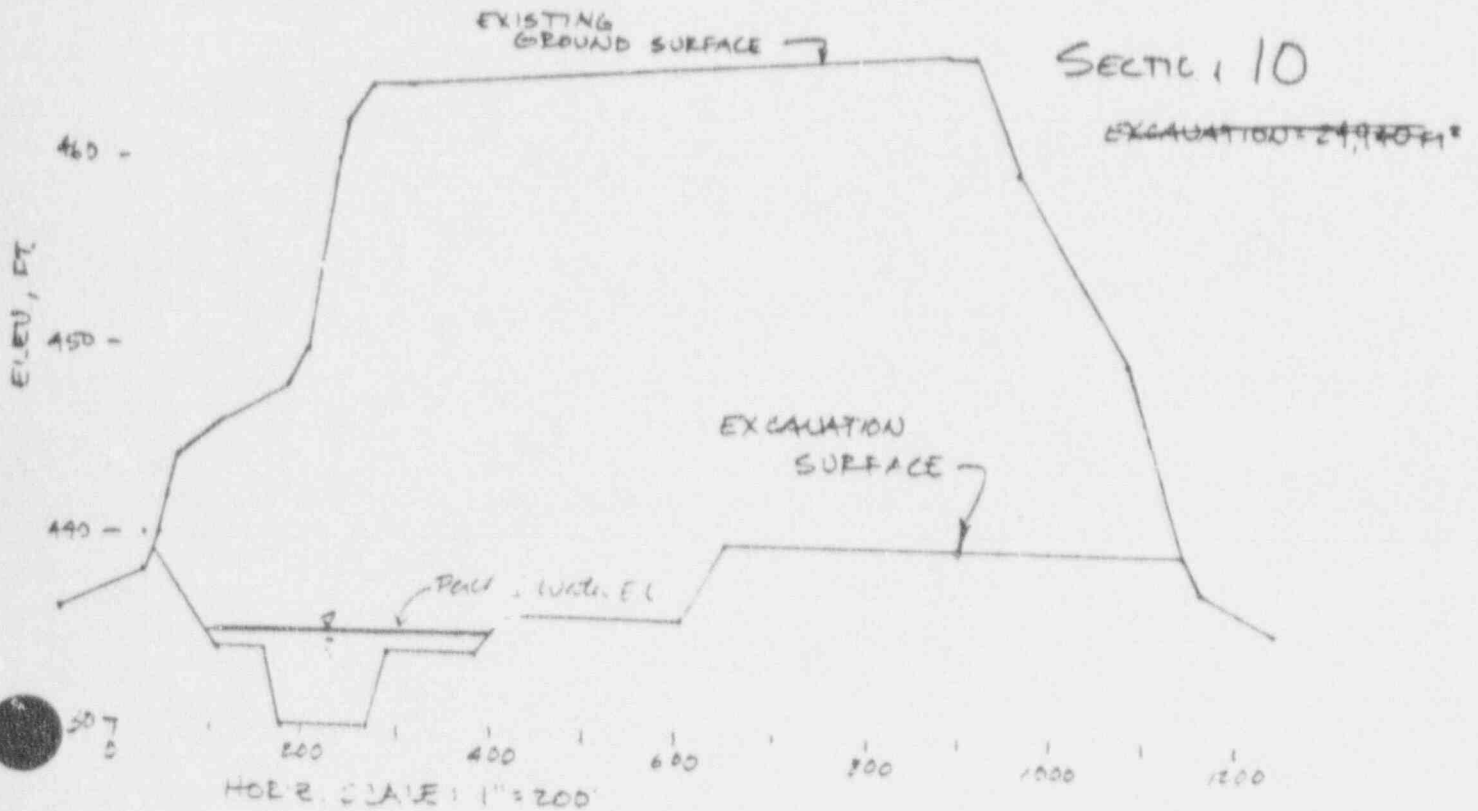
WYL 11/7/90 SECTION 9



EXISTING GROUND SURFACE

SECTION 10

EXCAVATION = 24,940 cu ft



WYL 11/5/90

220-0

N58,130
E 65,235

N 58,130
E 65,865

N57,490
E 65,100

TAILINGS POND 6

SECTIONS A-G

LEGEND:

— 390 —

CONTINUE

SCALE: 1" = 200'

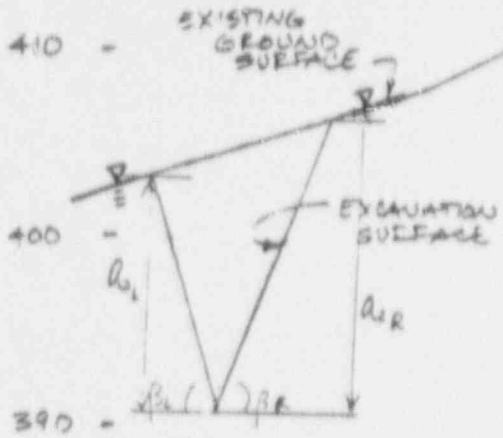
56,600

PYL 10/26/90

WYL 11/7/90

SECTION E

EXCAVATION = 1,240 ft^2

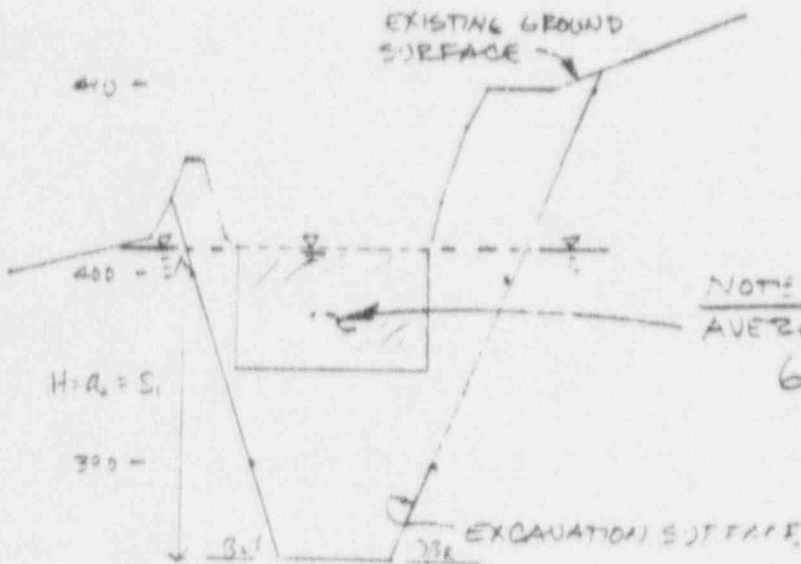


ELEV. FT.

420 -

SECTION C

EXCAVATION = 3,800 ft^2



NOTE:

AVERAGE DEPTH OF POND
6 IS 6.5 FT (S.D. = 11, REF.)

380 -

370 -

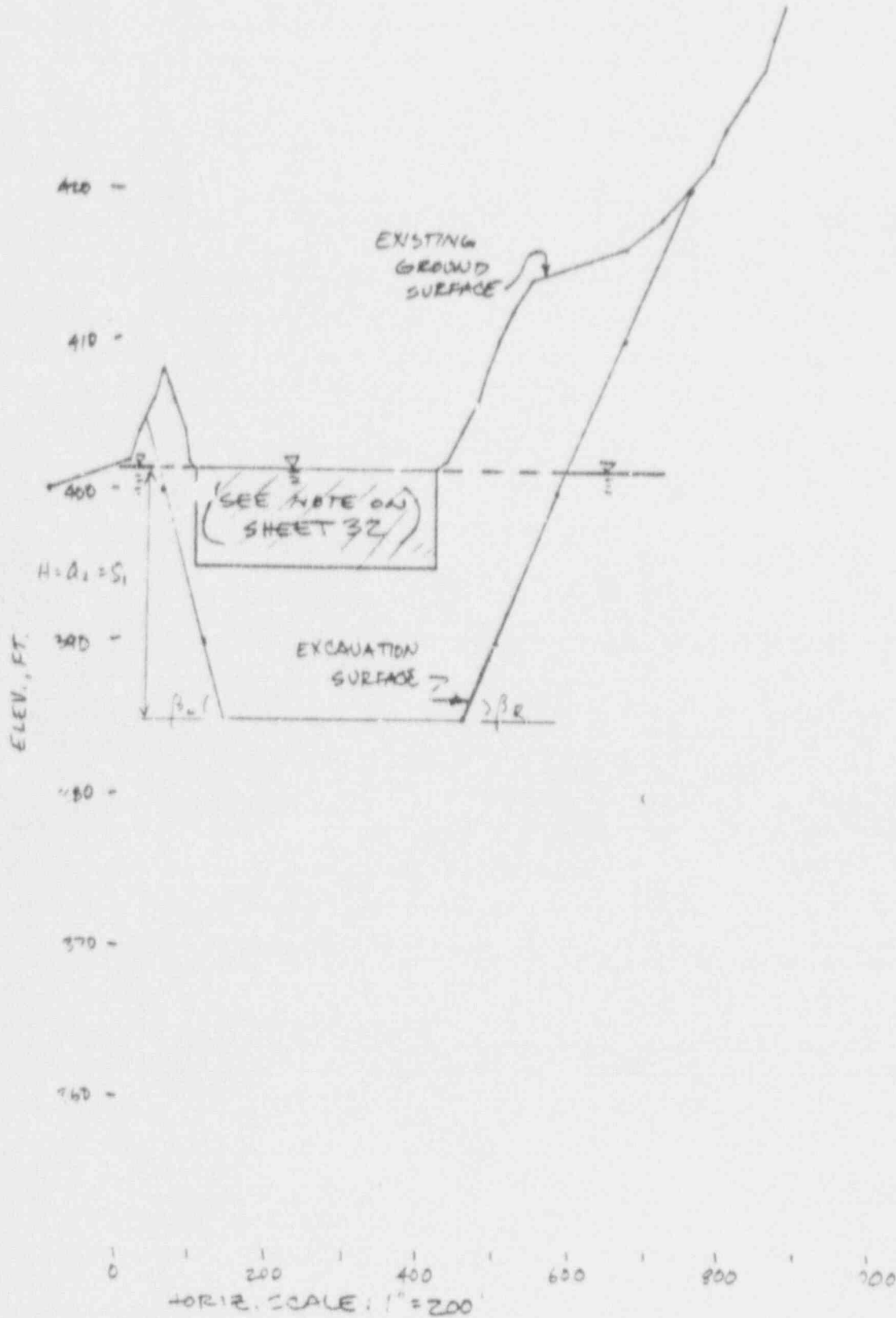
HORIZ. SCALE: 1" = 200'

PYL 10/24/90

WYL 11/7/90

SECTION D

EXCAVATION 7,690 FT

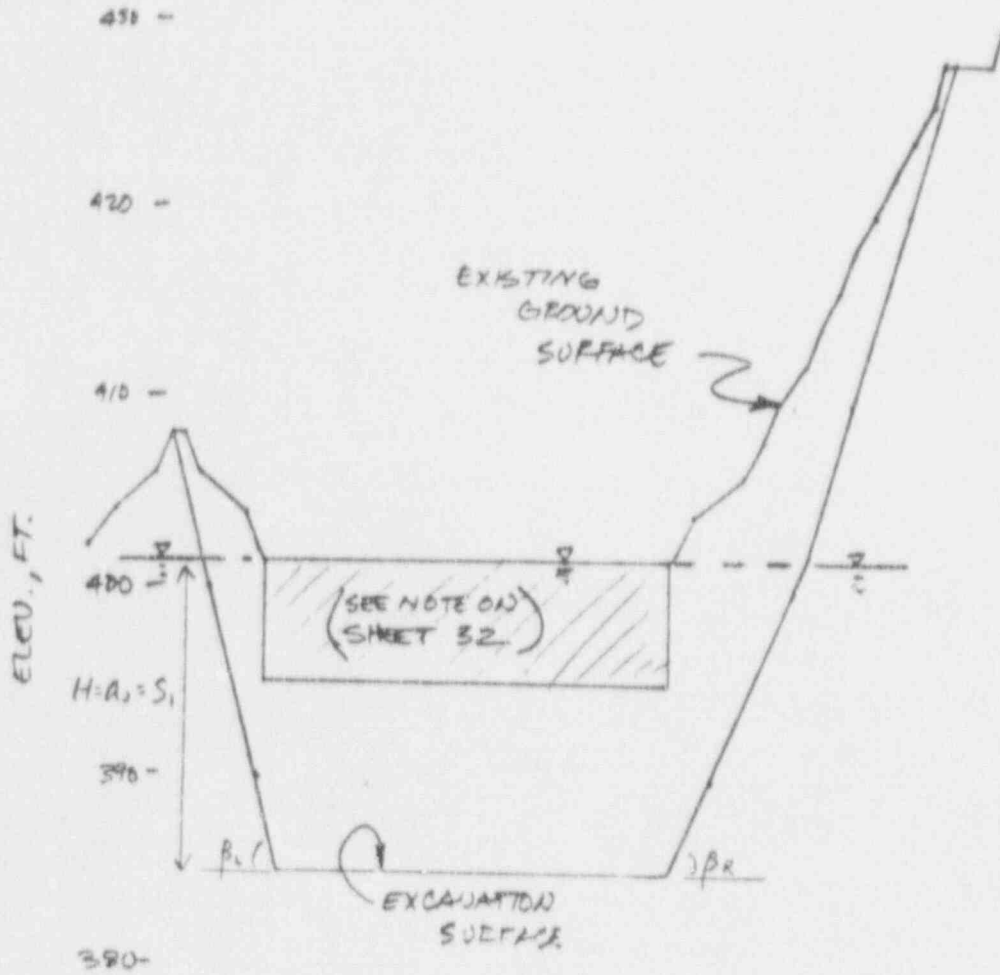


PYL 10/26/90

WYL 11/7/90

SECTION E

EXCAVATION = 8,000 FT²



UMTRA-FCT

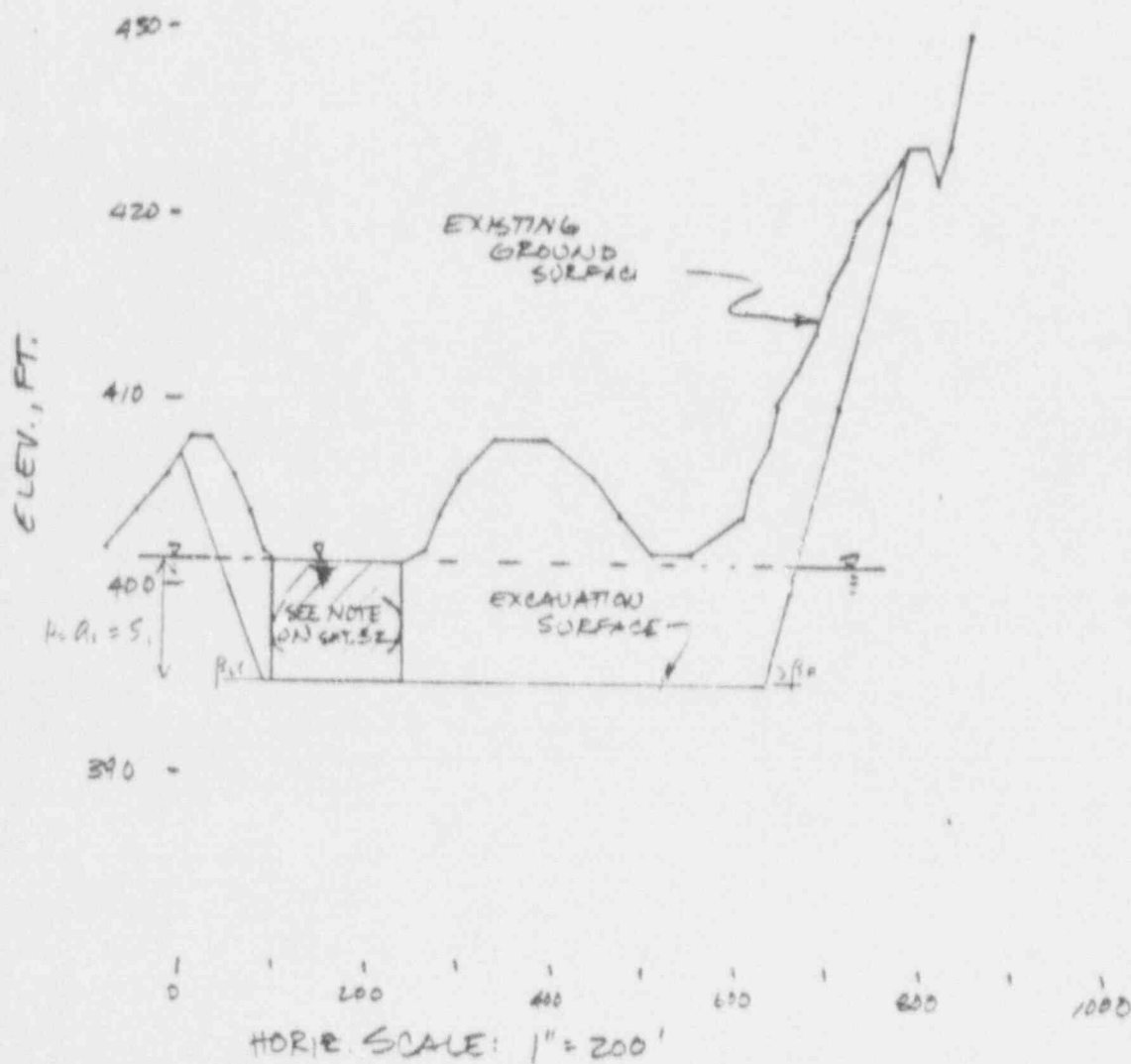
sh 27

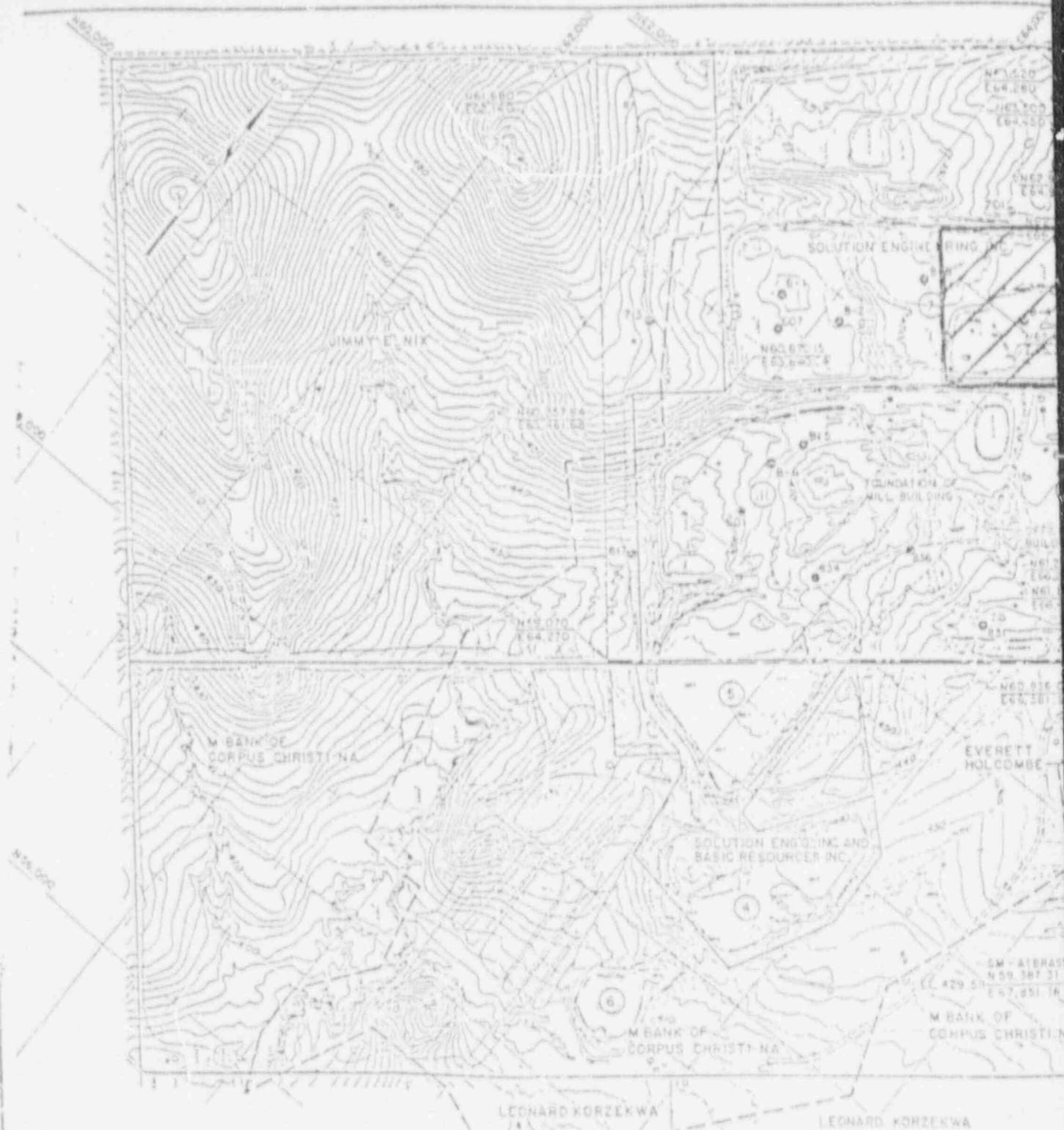
PYL 10/26/90

WVL 11/7/90

SECTION F

EXCAVATION = 5,600 FT²





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CARD

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Aperture Card

FINAL REVIEW

END MANAGER	CHIEF ENGINEER	QA MANAGER

400 0 400 800
SCALE



- 385-28 UMTA-FLT JH 80
 PYL 10/26/90 WYL 11/7/90
- NOTES:**
1. CONTROL SURVEY MONUMENTS HAVE BEEN ESTABLISHED BY JACOBS ENGINEERING GROUP, INC. IN THE FIELD. ALL REV LOCATIONS AND ELEVATIONS SHALL BE REFERENCED TO THE MONUMENTS SHOWN HEREON.
 2. TOPOGRAPHY FEATURES AND GRID SYSTEM ARE TAKEN FROM THE RECORDS OF SURVEY FURNISHED BY JACOBS ENGINEERING GROUP, INC. AND MR-FERGUSON COMPANY IN NOVEMBER, 1984 AND JUNE, 1986, RESPECTIVELY.
 3. CONSTRUCTION GRID COORDINATE SYSTEM IS BASED ON THE S.A.V. WAYS SURVEY IN KARNES COUNTY, TEXAS.
 4. FOR MONITOR WELLS TO BE SEALED, SEE TABLE 02090-I, SECTION 02090 OF THE SUBCONTRACT SPECIFICATION.
- REFERENCE DRAWINGS:**
- FCT-PS-10-0404 CONSTRUCTION FACILITIES AND SITE DRAINAGE
 FCT-PS-10-0413 FINAL GRADING PLAN AND RESTORATION

- LEGEND:**
- △ SM-A EXISTING SURVEY MONUMENT (BRASS CAP)
 - 34' EXISTING FARM ROAD
 - EXISTING TAILINGS PILE NO.
 - - - - - APPROXIMATE PROPERTY LINE AND OWNERSHIP
 - SITE BOUNDARY
 - EXISTING FACILITY TO BE DEMOLISHED AND REM.
 - MONITOR WELL TO BE SEALED

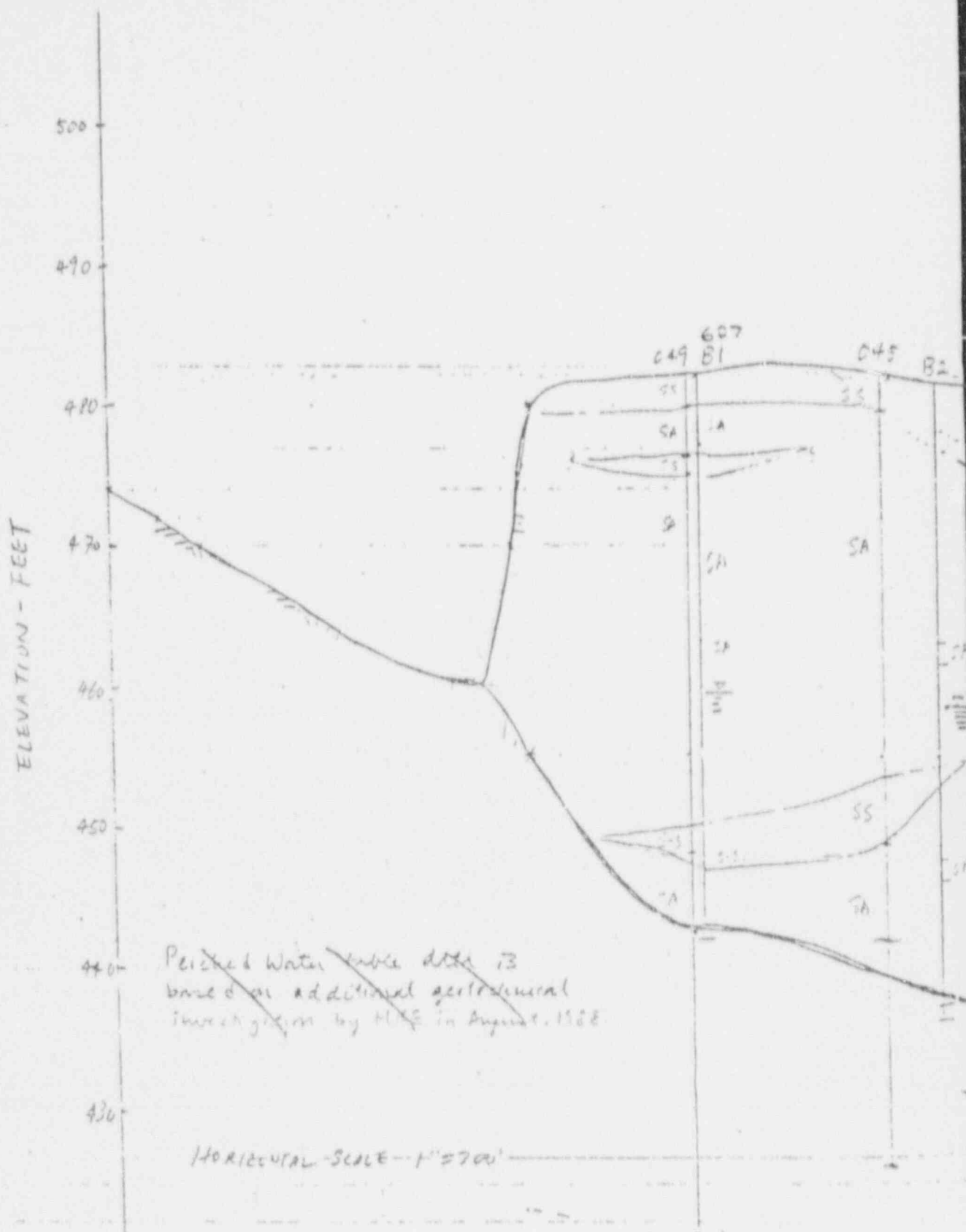
9205110072-28

U. S. DEPARTMENT OF ENERGY ALBUQUERQUE, NEW MEXICO	
FALLS CITY SITE FALLS CITY, TEXAS	
SITE PLAN AND DEMOLITION	
DESIGNED BY: [Signature] CHECKED BY: [Signature] IN CHARGE: [Signature] DATE: [Blank]	PROJECT NO. DE-AC04-83AL18796 DRAWING NO. FCT-PS-10-0403

NO.	DATE	DESCRIPTION	BY	CHK	APP	DATE
1		ISSUED FOR FINAL REVIEW				
2	7/28/84	ISSUED FOR PRELIMINARY REVIEW				
3	10/26/90	REVISED				

Project WATER TREAT
Feature Retention Basin
Item Drainage Vld. Box Δ

Contract No. 5557-09 File No. _____
Designed PVL Date 10/1/58
Checked J Date _____



UMTRA - FCT

3885-28

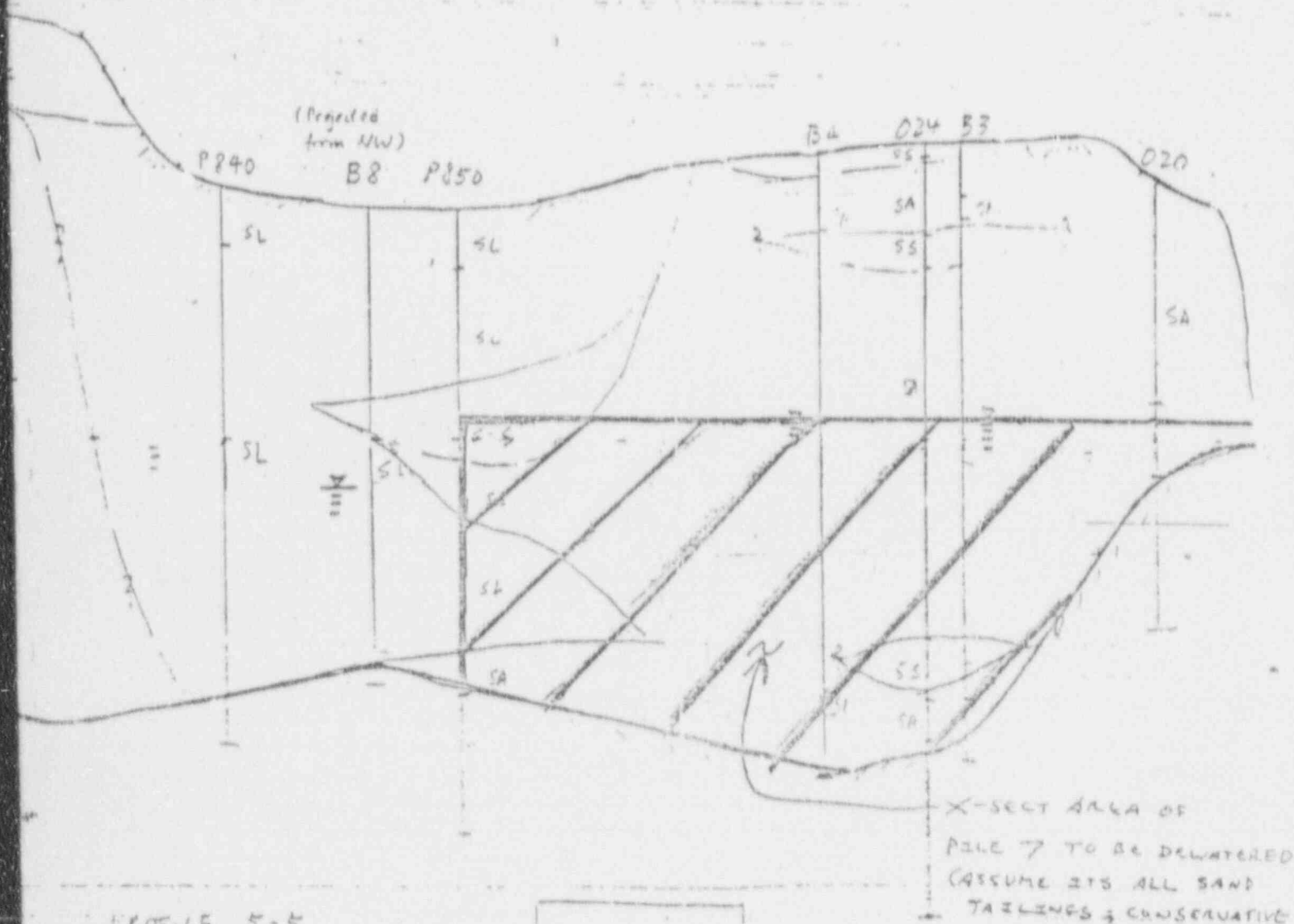
Waste Water Emp Study

PYL 10/25/90

WYL 11/7/90

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Aperture Card



PROFILE 5-5

PILE 7

Refer to SH 15

ALL PENCHED
WATER ELVS
PER SH

TOPO GRAPH & TAILINGS
TYPES PER SH 12d

9205110072-29



Project LIMTRA - ECT
 Feature Wastewater Handling II
 Item _____

Contract No. 385-28
 Designed PTL
 Checked ACC

Sheet 82
 File No. _____
 Date 3/12/91
 Date 5/12/91

I.B. AREAS OF RUNOFF AND EVALUATION

Calculations are presented on sh 83-83a for parcel A) and
 sh 84 for parcel B)

SUMMARY

	<u>Runoff Area</u> (Ac-ft)	<u>Evaporation Area</u> (Ac-ft)
Embankment & Ditches		
- Initial Stage	70	-
- Later Stage	125	-
Pile # 3	34	-
Pond # 6	7	4.5
Retention Basin	11	8.5
Evap Area or Irrigation Area	(TO BE DETERMINED)	



Drainage Area of
Embankment & Ditches

Initial Stage
(Dec. 1992 - mid June 1992)

(pile

Initial Stage

Drainage Area of Embankment & Ditches

= 70 . Ac. (planimetry)

UTTRA - PCT
 3885 - 28
 Wastewater Handling II

PYL 3/12/91
 AC: 1/24/91

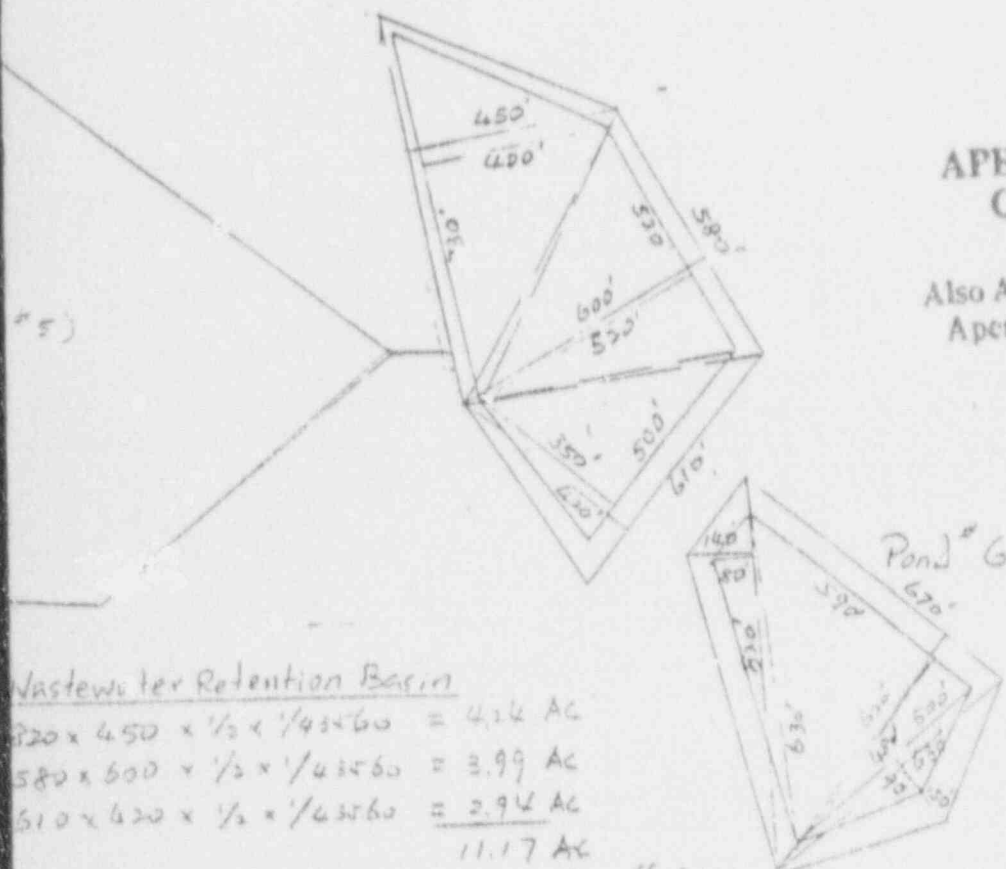
Sh 83

Evaporation Pond on
 Irrigation Farmland Area

Wastewater
 Retention
 Basin

SI
 APERTURE
 CARD

Also Available On
 Aperture Card



Wastewater Retention Basin

$$820 \times 450 \times \frac{1}{2} \times \frac{1}{43560} = 4.14 \text{ AC}$$

$$580 \times 600 \times \frac{1}{2} \times \frac{1}{43560} = 3.99 \text{ AC}$$

$$510 \times 420 \times \frac{1}{2} \times \frac{1}{43560} = 2.94 \text{ AC}$$

$$11.17 \text{ AC}$$

Say 1 Acres Runoff Area

$$730 \times 400 \times \frac{1}{2} \times \frac{1}{43560} = 3.35 \text{ AC}$$

$$520 \times 520 \times \frac{1}{2} \times \frac{1}{43560} = 3.10 \text{ AC}$$

$$500 \times 350 \times \frac{1}{2} \times \frac{1}{43560} = 2.01 \text{ AC}$$

$$8.46 \text{ AC}$$

Say 8.5 Acres Pond Evap Area

Pond # 6

$$0 \times 160 \times \frac{1}{2} \times \frac{1}{43560} = 1.12 \text{ AC}$$

$$670 \times 620 \times \frac{1}{2} \times \frac{1}{43560} = 4.77 \text{ AC}$$

$$630 \times 150 \times \frac{1}{2} \times \frac{1}{43560} = 1.09 \text{ AC}$$

$$7.17 \text{ AC}$$

Say 7 Acres Runoff Area

$$630 \times 40 \times \frac{1}{2} \times \frac{1}{43560} = 0.58 \text{ AC}$$

$$590 \times 480 \times \frac{1}{2} \times \frac{1}{43560} = 3.25 \text{ AC}$$

$$500 \times 40 \times \frac{1}{2} \times \frac{1}{43560} = 0.57 \text{ AC}$$

$$4.35 \text{ AC}$$

Say 4.5 Acres Pond Evap. Area

9205110072 - 30

Drainage Area of Embankment
and Ditches

Later Stage
(From mid June 1992)

Later Stage
Drainage Area of Embankment & Ditches
= 125 Ac (planimeter)

UMTRA-FCF
3885-28
Wastewater Handling II

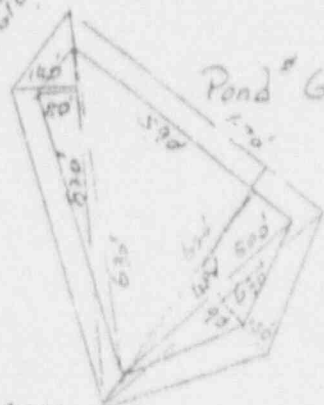
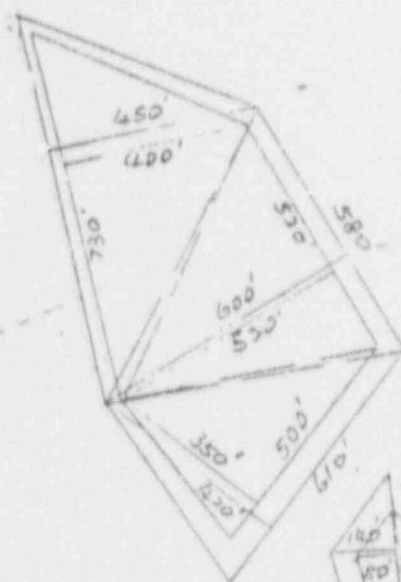
Sh 88a
PTL 3/12/91
Acc 3/22/91

Evaporation Pond or
Irrigation Farmland Area

Wastewater
Retention
Basin

SI
APERTURE
CARD

Also Availab : On
Aperture Card



Wastewater Retention Basin

$$820 \times 450 \times \frac{1}{2} \times \frac{1}{43560} = 4.24 \text{ AC}$$

$$580 \times 600 \times \frac{1}{2} \times \frac{1}{43560} = 3.99 \text{ AC}$$

$$610 \times 420 \times \frac{1}{2} \times \frac{1}{43560} = 2.94 \text{ AC}$$

11.17 AC

Say 11 ACRES Runoff Area

$$730 \times 400 \times \frac{1}{2} \times \frac{1}{43560} = 3.35 \text{ AC}$$

$$520 \times 520 \times \frac{1}{2} \times \frac{1}{43560} = 3.10 \text{ AC}$$

$$500 \times 350 \times \frac{1}{2} \times \frac{1}{43560} = 2.01 \text{ AC}$$

8.46 AC

Say 8.5 Acres Pond Evap Area

Pond # 6

$$820 \times 140 \times \frac{1}{2} \times \frac{1}{43560} = 1.42 \text{ AC}$$

$$670 \times 620 \times \frac{1}{2} \times \frac{1}{43560} = 4.77 \text{ AC}$$

$$630 \times 150 \times \frac{1}{2} \times \frac{1}{43560} = 1.08 \text{ AC}$$

7.17 AC

Say 7 Acres Runoff Area

$$630 \times 80 \times \frac{1}{2} \times \frac{1}{43560} = 0.28 \text{ AC}$$

$$590 \times 480 \times \frac{1}{2} \times \frac{1}{43560} = 3.25 \text{ AC}$$

$$500 \times 90 \times \frac{1}{2} \times \frac{1}{43560} = 0.52 \text{ AC}$$

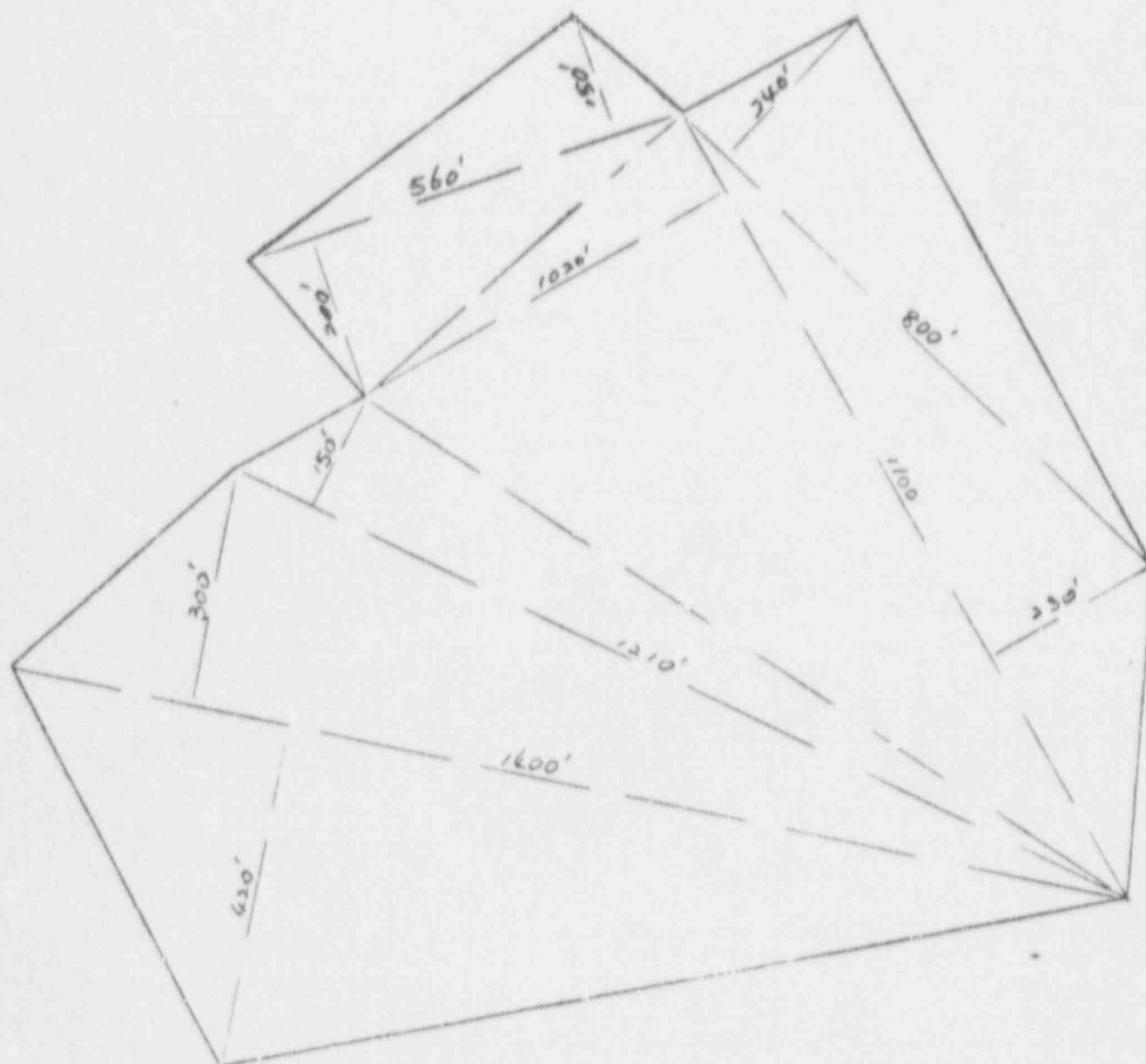
4.35 AC

Say 4.5 Acres Pond Evap Area

9205110072-31

WYL 11/1/90

PTL 11/7/90

Pile # 3


$$560 \times (200 + 150) \times \frac{1}{2} \times \frac{1}{43560} = 2.25 \text{ Acres}$$

$$1600 \times (420 + 300) \times \frac{1}{2} \times \frac{1}{43560} = 11.57 \text{ Acres}$$

$$1210 \times 150 \times \frac{1}{2} \times \frac{1}{43560} = 2.08 \text{ Acres}$$

$$1100 \times (1020 + 230) \times \frac{1}{2} \times \frac{1}{43560} = 15.78 \text{ Acres}$$

$$800 \times 240 \times \frac{1}{2} \times \frac{1}{43560} = 2.20 \text{ Acres}$$

 33.88 Acres Say 34 Acres Runoff Area



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON KNUDSEN COMPANY

Project ULTRA-FIT
 Feature Wastewater Evap. Study
 Item Water Bal. & Wastewater handling

Contract No. 3281-24

Designed PYL

Checked WYL

Sheet 85

File No.

Date 10/26/90

Date 11/7/90

C. DESIGN PARAMETERS

1. Soil SCS Curve No.

Refer to Ref 14.

use pasture in range, poor condition, average of hydrologic soil groups B & C for watershed i.e. = 82.1 in watershed.

use SCS = 100 for basin & ponds.

Then determine area weighted average SCS value in water balance.

2. Hydrologic Data

- Mean No. Days Precipitation > 0.1 inches
- Mean Temp
- Mean Precipitation
- Mean Snow

Refer to sh 88 (Ref 14)

3. Avg. Annual Lake Evaporation

Refer to sh 89 (Ref 15)

use 54 in

4. Monthly Evaporation Distribution Factor

Refer to Ref 6 (sh 90)

use values for San Antonio.

Distribution factor = monthly evap. values ÷ Annual evap.

(Annual evaporation = 76.50)

(could on next page)





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON KNUDSEN COMPANY

Project

UNITED - FET

Feature

Wastewater Evap. Pond

Item

Water body & wastewater handling

Contract No.

2895-28

Designed

PYL

Checked

PYL

Sheet

82

File No.

Date

10/25/90

Date

11/7/90

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Monthly
value

2.96 3.55 5.55 6.29 7.80 9.72 10.94 10.16 7.38 5.44 3.74 2.98

Distri.
Factor

0.039 0.046 0.073 0.082 0.102 0.127 0.143 0.133 0.096 0.071 0.049 0.039

6. Sediment Inflow Volume

Ref [9] p 1A. Sediment inflow volume = 11.6 Ac-ft.

7. 10-Year 24-hour Storm Runoff Volumes

(i) Drainage Area of Embankment & Drainage Ditches

Use 55.5 Ac-ft

(ii) Evaporation Pond

the 10-yr. 24-hr. precipitation was determined to be 6.7" (Ref [9])

i.e. a) For the evaporation pond, area of A Ac., 10-yr. 24-hr storm runoff volume = A Ac. $\times$ 6.7 in. $\times$ $\frac{1 \text{ ft}}{12 \text{ in.}}$
= 0.558 A Ac-ft

(iii) Pile #3

Runoff area = 34 Ac. (sh 84)

Storm runoff vol = $34 \times \frac{6.7}{12} =$ 18.98 Ac-ft





MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTWA - ECT
Feature Wastewater Evap. Study
Item Water bal. & wastewater handling

Contract No. 3255-2P
Designed DTL
Checked VVL

Sheet 27
File No.
Date 10/20/92
Date 11/7/92

iv) Pond #6

Runoff Area = 7 Ac. (sh 83)

$$\text{Storm runoff vol.} = 7 \times \frac{6.7}{12} = \underline{\underline{3.9 \text{ Ac-ft}}}$$



U. S. DEPARTMENT OF COMMERCE
Environmental Science Services Administration

IN COOPERATION WITH
Cotton Economic Research and
Bureau of Business Research of
The University of Texas at Austin

CLIMATOGRAPHY OF THE UNITED STATES NO. 20-41

CLIMATOLOGICAL SUMMARY

STATION KENEDY, TEXAS

LATITUDE 28° 49' N
LONGITUDE 97° 51' W
ELEV. (BAROMETRIC) 283 FT.

CLIMATE AND EXTREMES FOR PERIOD 1949-1966

Month	Temperature (°F)								Mean degree days	Precipitation Totals (Inches)								Mean number of days						Month
	Means				Extremes					Mean	Greatest daily	Year	Snow, Sleet				Precip. 10 inch or more	Temperatures						
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean					Maximum monthly	Year	Greatest	Year		Max	Min					
(a)	17	17	17	17		17		11	17	17		17	17		11		11	11	11	11				
Jan	66.8	41.6	54.2	88	1954*	10	1962	397	1.54	3.00	1965	0.1	2.2	1949	0	11	0	8	0	0	Jan			
Feb	70.2	45.2	57.7	92	1954*	7	1951	252	2.39	2.57	1965	*	0.6	1960	0	10	0	3	0	0	Feb			
Mar	76.5	50.2	63.4	100	1950	23	1965	149	0.99	1.80	1966	0	*	0	0	0	0	0	0	0	Mar			
Apr	83.2	59.7	71.5	106	1963	35	1962*	23	2.70	3.00	1957	*	*	1951*	0	0	0	2	0	0	Apr			
May	88.8	66.6	77.7	104	1955	42	1954	2	3.50	4.26	1952	0	*	0	0	0	0	0	0	0	May			
Jun	94.6	71.2	82.9	105	1953	58	1964	0	2.98	3.09	1951	0	*	0	0	0	0	0	0	0	Jun			
Jul	98.0	75.0	85.5	112	1954	65	1959	0	1.48	4.88	1949	0	*	0	0	0	0	0	0	0	Jul			
Aug	96.7	72.5	85.6	110	1962	60	1956*	0	2.28	3.55	1964	0	*	0	0	0	0	0	0	0	Aug			
Sep	93.3	68.7	81.0	105	1954*	51	1959	0	3.64	5.02	1951	0	*	0	0	0	0	0	0	0	Sep			
Oct	86.2	58.7	72.5	99	1955	33	1964	20	3.03	6.10	1960	0	*	0	0	0	0	0	0	0	Oct			
Nov	75.8	50.1	63.0	94	1949	18	1959	132	2.19	2.66	1963	*	*	1957	0	0	0	2	0	0	Nov			
Dec	68.2	43.4	55.8	88	1964	18	1950	310	1.83	1.98	1962	*	*	1964	0	0	0	5	0	0	Dec			
Year	83.4	58.4	70.9	112	1954	7	1951	1285	28.55	6.10	1960	0.1	2.2	1949	0	16	140	20	0	0	Year			

(a) Average length of record, years.

* Trace, an amount too small to measure.

** Base 65°F

+ Also on earlier dates, months, or years.

* Less than one half.

THE CLIMATE OF KENEDY, TEXAS

Kenedy is a farm-ranch-petroleum center in south central Karnes County. Products include guar, flax fiber, fiberglass, and petroleum derivatives. It is also a center for commercial seed production. The surrounding area is level to rolling with sandy loam, alluvial, and dark clay soils. Karnes County is Texas' leading flax growing county. The production of beef cattle is the county's largest agricultural enterprise.

Kenedy has a subtropical climate with mild dry winters and hot humid summers. Minimum temperatures are 32° or below only about one night in four, on an average, in January—the coldest month. Since Kenedy is only about 80 miles inland from the Gulf of Mexico, its climate is largely controlled by this warm body of water. Polar air masses push southward through Texas in winter, but these undergo considerable modification before reaching the Kenedy area. These colder, drier air masses furnish greater variation in temperature and more abrupt changes in the weather during this season than is normally experienced during spring, summer, or fall. Cold fronts may become stationary in the South Texas area during winter and late spring, resulting in a greater frequency of cloudy, rainy days than in other seasons, but producing only small amounts of precipitation. Polar air masses pushing southward in March become very dry when warmed by the South Texas sun; consequently, average March rainfall is less than that of any other month.

Summers are hot. The average daily maximum temperatures are 96.0° and 98.7° in July and August respectively. While the prevailing southeasterly winds bring humid air from the Gulf of Mexico, little of this moisture is released, and mid-summer is a relatively dry period. Average total July precipitation is 1.48 inches.

The interaction of the warm moisture-laden air from the Gulf with

polar air masses in both spring and fall result in greater precipitation during these seasons. Rain falls mostly as showers and thunderstorms and is not evenly distributed. Occasional tropical disturbances, moving inland from the Gulf during early fall, contribute to the average rainfall during this season. Peak rainfall occurs during September with a secondary peak in May.

Northerly winds prevail during most of the winter, while southeasterly winds from the Gulf of Mexico prevail during all other seasons and may be experienced for long periods during the winter. The area receives about 50 percent of the total possible sunshine during the winter months and about 75 percent of the total possible during the summer. Mean annual relative humidity is 65 percent at 6:00 a.m. and 55 percent at 6:00 p.m. Central Standard Time. Mean annual lake evaporation is 54-56 inches.

The Kenedy area has a long growing season (frost-free period) of 281 days. The average date of the last freeze in the spring is February 24; the average date of the first fall freeze is December 2. Measurable snow has fallen only twice in the 17-year period 1949-1966.

Severe wind storms may accompany the thunderstorms of late spring and early fall. Seven tornadoes are known to have touched ground in Karnes County within the seven-year period 1959-1966. Hailstorms are quite rare.

In summary, Kenedy enjoys mild dry winters and delightful spring and fall seasons. Daytime temperatures are hot in summer and refrigerated air conditioning is recommended June through September.

RECEIVED-MKE

DEC 11 1967

UNITED STATES

35° LAT;

Western
latitudes
intervals

30° LAT;

NOAA TECHNICAL REPORT NWS 33
MAP 3 OF 4 : ANNUAL FWS EVAPORATION
(REF. 2)

SAN ANTONIO, TEXAS, WSO
LAT: 29°31'
LONG: 98°28'
FALLS CITY - APPX. 90 NM SE OF
SAN ANTONIO (REF. 1)

5° LAT 25°

05° LONG:

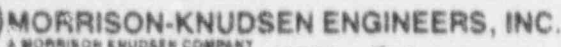
100° LONG:

54.89

WYL 11/17/90

Also Available On
Aperture Card

9205110072-32



Date 3/12/91

26 Apr 1961 (per Hugh G. Humpill) (Ref —)





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON KNUDSEN COMPANY

Project WATER - FCT
Feature Water - FCT
Item

Contract No. 388-2
Designed PC
Checked PC

Sheet
File No.
Date 8/2/91
Date 8/2/91

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for editing





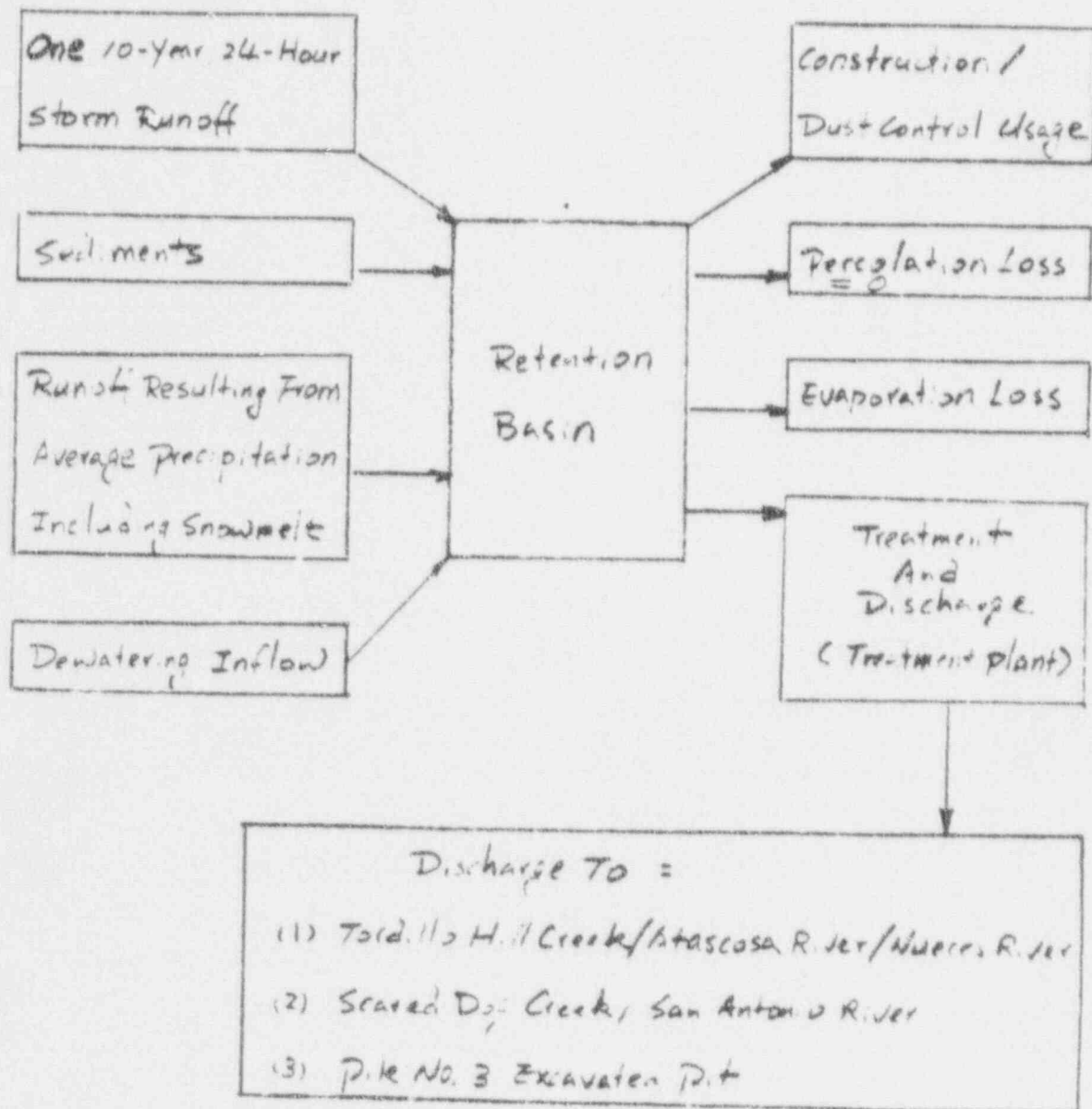
MORRISON-KNUDSEN CORPORATION

Project UMTRA - FCT
Feature Wastewater Handling II
Item _____

Contract No. 385-25
Designed WYL
Checked ACC

Sheet 92
File No. _____
Date 3/6/91
Date 3/22/91

A Treatment And Discharge





Project UMTRA-FCT
 Feature Wastewater Handling II
 Item _____

Contract No. 385-25
 Designed PYL
 Checked KC

Sheet 93
 File No. _____
 Date 3/11/91
 Date 4/24/91

D. WATER BALANCE CALCULATIONS

A water balance 'program' had been developed in MK using Lotus 1-2-3 Software. A copy of the documentation on input data & calculations is attached as sh 118-121. The 'program' has been modified to account for variable runoff area and evaporation areas to suit our cases. In addition, to assess the irrigation scheme, the program was modified to account for water usage in irrigation of grass crop. For the combination of Treatment/Evaporation scheme, a column in the spreadsheet was added to account for water treated by the mobile unit and discharged.

A schematic was developed for each scheme and presented on sh 98, 103, 108, & 113.

Descriptions of the cases analyzed were presented on sh 98-117. Water balance calculations were on sh. 99-117.

There are basically 2 design conditions in the water balance calculation - i) Accumulating and ii) Non-Accumulating.

- i) Accumulating Design - under which all surplus contaminated water generated at each month during construction will be accumulated in the retention basin and/or ponds until all water is evaporated or used in a irrigation or later on treated and discharged at the end of construction.





Project WATER-ECT
 Feature Wastewater Handling II
 Item _____

Contract No. 3885-28
 Designed PYL
 Checked ALL

Sheet 94
 File No. _____
 Date 7/17/91
 Date 5/22/91

- (iii) 'Non-accumulating' Design - under which treatment unit will be provided. Treatment and disposal of wastewater will be provided as inflows into the retention basin and/or ponds occur. Note that in the design, the evaporation rate was assumed to be only $\frac{1}{2}$ of the evaporation rate in the 'accumulating' design. This factor of safety of 2 was included to account for likelihood that there may be insufficient time for maximum evaporation (see 'program' documentation on sh 118-124)

CASES ANALYZED

- Calculation A (1) - Non-accumulating / Discharge, No 10-yr 24-Hr Storm Runoff

Refer to sh 99.100 the maximum monthly average flow is ~6.8 ac-ft/month (from 1/92 to 7/93). Based on this volume, the operating rate of treatment plant required is 105 gpm (see calc. on sh 122). Treatment plant will be required for 19 months, treating a total surplus volume of 128 Ac-ft.

- Calculation A (2) - Non-Accumulating / Discharge, 10-yr 24-Hr Storm Runoff

Refer to sh 101.102, the maximum monthly average flow is ~15.8 ac-ft/month (from 3/93 to 7/93). Based on this volume, the operating rate of treatment plant required is 245 gpm (see calc. on sh 122). Treatment plant will be required for 19 months, treating a total surplus volume of 267 Ac-ft.



Project

ULTRA-FET

Feature

Wastewater Handling II

Item

Contract No. 3885 28

Designed P.T.L.

Checked A.C.S.

Sheet 9C

File No.

Date 3/12/91

Date 3/22/91

• Calculation B (1) - Accumulating / Evaporation Pond, NO 10-yr. 24-Hr Storm Runoff

Refer to sh 104.105 for a pond of 20 Ac, accumulated water volume will become zero in June 1993 (i.e. in 19 months). The evaporation pond can be removed at that time, which is 4 months before completion of radon barrier construct. Total volume of precipitation runoff plus dewatering inflow less water used in dust control, to be evaporated will be ~201 Ac-ft (sh 104)

• Calculation B (2) - Accumulating / Evaporation Pond, 10-yr, 24-Hr Storm Runoff Included

Refer to sh 106.107 for a pond of 40 Ac, accumulated water volume will become zero in July 1993 (i.e. in 20 months). Total waste water volume to be handled by the evaporation scheme will be ~359 Ac-ft (sh 106)

• Calculation C (1) - Accumulating / Irrigation, NO 10-yr. 24-Hr Storm Runoff Included

Refer to sh 109.110 for an irrigation farmland of 30 Ac, accumulated water volume will become zero in May 1993 (i.e. in 18 months). Total waste water volume to be used in irrigation of the grass crop will be 117 Ac-ft (sh 109), based on an irrigation rate of 2.6 Ac-ft/Ac/yr.



Project UMTRA-FET Contract No. 38572E Sheet 96
 Feature Wastewater Handling I Designed PTL File No.
 Item Checked V.C. Date 3/12/91
 Date 3/22/91

• Calculation C (2) - Accumulating/Irrigation 10-yr. 24-Hr Storm Runoff Included

Refer to sh. 111-112 for an irrigative farmland of 60 Ac, accumulated water volume will become zero in Sept. 1993 (i.e. in 22 months). Total waste water volume to be used in irrigation of the grass crop will be 286 Ac-ft (sh. 111), based on an irrigation rate of 2.6 Ac-ft/Ac/yr.

• Calculation D (1) - Accumulating/Mobile Treatment/Evap., No 10-yr. 24-Hr. Storm Runoff Included

Refer to sh. 114-115, using a mobile treatment unit of capacity of 60 gpm, operating 22 days/month, 20 hrs/day, the acc. ^{in the retention basin} water volume will become zero in June 1993 (i.e. in 19 months). No evaporation pond is required. Total waste water volume to be treated by the mobile unit and discharged will be 92 Ac-ft (sh. 114).
Note that, comparing this case with case A (1), this accumulating case requires smaller capacity of treatment unit. It is because a factor of safety of 2 has been incorporated in the estimated evaporation in A (1), while max evaporation is assumed in this case. As a result less volume will be treated in this case. However, if conservation is desired, a larger capacity is recommended.



MORRISON-KNUDSEN CORPORATION

Project UMTRA-FIT
 Feature Wastewater Handling II
 Item _____

Contract No. 3883-28
 Designed PYL
 Checked ALL

Sheet 99
 File No. _____
 Date 3/12/91
 Date 3/22/91

- . Calculation D (2) - Accumulating / Mobile Treatment / Evap. 10-yr
24-hr. Storm Runoff Included

Refer to sh 116, 117. Using a mobile treatment unit of capacity of 60 gpm, operating 22 days/month, 20 hr/day, together with an evaporation pond of 15 ac., the accum. water volume will become zero in Aug. 1993 (i.e. in 21 months). Total wastewater volume to be treated by the mobile unit will be 102 ac-ft., and volume to be evaporated will be 197 ac-ft. (see sh 116)



ANon Accumulating/Discharge 10 NO 10-Yr 24-Hr Storm Runoff

NON-ACCUMULATING, NO STORM RUNOFF INCLUDED
 UHTRA/FALL CITY SITE
 FILE: A-NONACCNO.WK1

INPUT

RETENTION BASIN CAPACITY(AC-FT)=to be determined
 NO EVAPORATION POND
 AVG ANN. LAKE EVAPORAT'N (IN.)= 54

*****INPUT*****																	
MONTH	SOIL MEAN NO. SCS	MEAN NO. PRECIP. >0.1" (EACH)	MEAN TEMP. (IN.)	MEAN SNOW (IN.)	SNOW (IN.)	RAIN-FALL (IN.)	SUBLIM-ATION (IN.)	ACCUM. SNOWPACK (INCHES OF MTR.)	SNOW-MELT (IN.)	TOTAL RAINFALL & SNOWMILT. (IN.)	NUMBER OF PER EVENT EVENTS	WATER PER EVENT (IN. MTR.)	"SCS"-RUNOFF VOLUME (AC-FT)	*INPUT* ASSUMED CONSTR. WATER REQ'D (AC-FT)	*INPUT* ASSUMED DE-WATERING INFLOW (AC-FT)	EST. EVAP'TN.	
1991 JUL	84.7	4	56.0	1.83	0.0	0	1.83	0	0.00	0.00	2	0.92	1.806	1.905	2.60	1.18	1.141
1992 JAN	84.7	3	54.0	1.54	0.1	0	1.54	0	0.00	0.00	2	0.77	1.806	1.106	2.60	10.31	1.105
FEB	84.7	5	58.0	2.39	0.0	0	2.39	0	0.00	0.00	3	0.80	1.806	1.860	2.60	21.26	1.346
MAR	84.7	2	63.0	0.99	0.0	0	0.99	0	0.00	0.00	1	0.99	1.806	1.190	2.60	1.18	1.190
APR	84.7	4	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2	1.35	1.806	5.130	2.60	1.18	2.399
MAY	84.7	4	78.0	3.50	0.0	0	3.50	0	0.00	0.00	2	1.75	1.806	8.853	2.60	1.10	2.984
JUN	84.3	4	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2	1.49	1.862	7.823	4.64	20.59	3.086
JUL	83.9	2	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1	1.48	1.919	4.517	4.64	40.00	2.735
AUG	83.8	3	86.0	2.28	0.0	0	2.28	0	0.00	0.00	2	1.14	1.933	5.387	4.64	20.43	2.544
SEP	83.6	5	81.0	3.64	0.0	0	3.64	0	0.00	0.00	3	1.21	1.962	10.294	4.64	0.86	1.836
OCT	83.6	4	72.0	3.03	0.0	0	3.03	0	0.00	0.00	2	1.52	1.962	11.578	4.64	0.86	1.358
NOV	83.6	4	63.0	2.19	0.0	0	2.19	0	0.00	0.00	2	1.10	1.962	5.250	4.64	0.86	0.937
DEC	83.6	4	56.0	1.83	0.0	0	1.83	0	0.00	0.00	2	0.92	1.962	3.115	4.64	0.86	0.746
1993 JAN	83.5	3	54.0	1.54	0.1	0	1.54	0	0.00	0.00	2	0.77	1.962	1.727	4.64	0.86	0.746
FEB	83.5	5	58.0	2.39	0.0	0	2.39	0	0.00	0.00	3	0.80	1.962	2.936	4.64	0.86	0.880
MAR	83.9	2	63.0	0.99	0.0	0	0.99	0	0.00	0.00	1	0.99	1.919	1.649	0	0.00	1.396
APR	83.9	4	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2	1.35	1.919	7.334	0	0.00	1.568
MAY	100.0	4	78.0	3.50	0.0	0	3.50	0	0.00	0.00	2	1.75	0.000	3.208	0	0.00	1.951
JUN	100.0	4	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2	1.49	0.000	2.732	0	0.00	2.429
JUL	100.0	2	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1	1.48	0.000	1.357	0	0.00	1.357
AUG	100.0	3	86.0	2.28	0.0	0	2.28	0	0.00	0.00	2	1.14	0.000	4.090	0	0.00	2.090
SEP	100.0	5	81.0	3.64	0.0	0	3.64	0	0.00	0.00	3	1.21	0.000	3.337	0	0.00	1.836
OCT	100.0	4	72.0	3.03	0.0	0	3.03	0	0.00	0.00	2	1.52	0.000	2.778	0	0.00	1.358
NOV	100.0	4	63.0	2.19	0.0	0	2.19	0	0.00	0.00	2	1.10	0.000	2.008	0	0.00	0.937
DEC	100.0	4	56.0	1.83	0.0	0	1.83	0	0.00	0.00	2	0.92	0.000	1.678	0	0.00	0.746
1994 JAN	100.0	3	54.0	1.54	0.1	0	1.54	0	0.00	0.00	2	0.77	0.000	1.412	0	0.00	0.746
FEB	100.0	5	58.0	2.39	0.0	0	2.39	0	0.00	0.00	3	0.80	0.000	2.191	0	0.00	0.880
MAR	100.0	2	63.0	0.99	0.0	0	0.99	0	0.00	0.00	1	0.99	0.000	0.908	0	0.00	0.908
APR	100.0	4	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2	1.35	0.000	2.475	0	0.00	1.568
MAY	100.0	4	78.0	3.50	0.0	0	3.50	0	0.00	0.00	2	1.75	0.000	3.206	0	0.00	1.951
JUN	100.0	4	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2	1.49	0.000	2.732	0	0.00	2.429
JUL	100.0	2	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1	1.48	0.000	1.357	0	0.00	1.357
AUG	100.0	3	86.0	2.28	0.0	0	2.28	0	0.00	0.00	2	1.14	0.000	2.090	0	0.00	2.090
SEP	100.0	5	81.0	3.64	0.0	0	3.64	0	0.00	0.00	3	1.21	0.000	3.337	0	0.00	1.836
87.594 57.36 122.47 31.378																	

* NOTE: NO STORM RUNOFF

(95)

DATE: 03/06/91

PTL 3/06/91

Acc 3/22/91

WATER BALANCE ACCUMULATING					ACCUMULATING			
ACTUAL CONSTR. WATER USAGE (AC-FT)	SURPLUS WATER (AC-FT)	EST. EVAPTN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR.	*INPUT* RUNOFF AREA (ACRES)	*INPUT* POND EVAP. AREA (ACRES)	WTR. HT. IN POND & BASIN (FT.)
1.945	0.000	2.202	0.804	0.000	0.039	88	13	0.000
2.600	7.710	2.202	2.600	6.535	0.039	88	13	0.503
2.600	19.175	2.691	2.600	24.364	0.046	88	13	1.874
1.180	0.000	4.274	2.600	19.864	0.073	88	13	1.528
2.600	1.311	4.797	2.600	18.777	0.082	88	13	2.444
2.600	4.449	5.967	2.600	20.242	0.102	88	13	1.567
4.640	20.687	6.172	4.640	37.843	0.127	112	10.8	3.504
4.640	37.142	5.470	4.640	72.250	0.143	136	8.5	4.500
4.640	18.634	5.087	4.640	88.340	0.133	153	8.5	10.393
4.640	4.678	3.672	4.640	91.182	0.096	170	8.5	10.727
4.640	6.440	2.716	4.640	96.264	0.071	170	8.5	11.325
4.640	0.533	1.874	4.640	95.860	0.049	170	8.5	11.278
3.230	0.000	1.492	4.640	93.704	0.039	170	8.5	11.024
1.842	0.000	1.492	4.640	90.160	0.039	170	8.5	10.807
2.917	0.000	1.760	4.640	87.557	0.046	170	8.5	10.301
0.000	0.253	2.792	4.600	86.414	0.073	136	8.5	10.166
0.000	5.766	3.137	0.000	90.612	0.082	136	8.5	10.560
0.000	1.258	3.902	0.000	89.918	0.102	11	8.5	10.579
0.000	0.303	4.858	0.000	87.792	0.127	11	8.5	10.829
0.000	0.000	5.470	0.000	83.679	0.143	11	8.5	9.845
0.000	0.000	5.087	0.000	80.682	0.133	11	8.5	9.892
0.000	1.501	3.672	0.000	80.347	0.096	11	8.5	9.853
0.000	1.420	2.716	0.000	80.408	0.071	11	8.5	9.860
0.000	1.070	1.874	0.000	80.542	0.049	11	8.5	9.875
0.000	0.932	1.492	0.000	80.727	0.039	11	8.5	9.897
0.000	0.666	1.492	0.000	80.647	0.039	11	8.5	9.888
0.000	1.311	1.760	0.000	80.079	0.046	11	8.5	9.539
0.000	0.000	2.792	0.000	75.194	0.073	11	8.5	9.317
0.000	0.907	3.137	0.000	78.532	0.082	11	8.5	9.239
0.000	1.258	3.902	0.000	77.839	0.102	11	8.5	9.158
0.000	0.303	4.858	0.000	75.113	0.127	11	8.5	8.907
0.000	0.000	5.470	0.000	71.600	0.143	11	8.5	8.421
0.000	0.000	5.087	0.000	68.603	0.133	11	8.5	8.071
0.000	1.501	3.672	0.000	68.267	0.096	11	8.5	8.031

128.339

Wastewater H₂ ng study
(UMTRA / Fallsc. site)

(UMTRA / Falls C. & Site)

Note: Balance start

Water Balance End

Project End

Project Start	Water Balance Start	1991	1992	1993	1994	Runoff Area Acres	Estap. Area Acres
Pile #4 (Retention Basin)							
Pile #5							
Pile #1, 2, 7							
Pile #3							
Pile #6							
Waterflow Material							
Runoff Basin/Grassland (Topsoil)							
Trees on Protection (side slope)							
Site Restoration							
Ponding in Piles (Ac. Ft.)							
10-Yr 24-Hr Slope in Retention Basin (Ac-Ft)							
Construction Water for Dust Control (Ac-Ft)							

CHECK STORAGE IN RETENTION BASIN
 SCHEME A (1) TREATMENT / DISCHARGE , NO STORM RUNOFF INCLUDED

MONTH	SURPLUS WATER (from sh.??) (Ac-ft)	TREATMENT PLANT RATE (sh./rr) (Ac-ft)	ACTUAL VOLUME TREATED (Ac-ft)	ACCUM. STORAGE IN RETENTION BASIN (Ac-ft)	
1991 DEC	0.000	6.8	0.0	0.00	o.k.
1992 JAN	7.710	6.8	6.8	0.91	o.k.
FEB	19.175	6.8	6.8	13.28	o.k.
MAR	0.000	6.8	6.8	6.48	o.k.
APR	1.311	6.8	6.8	1.00	o.k.
MAY	4.449	6.8	5.4	0.00	o.k.
JUN	20.687	6.8	6.8	13.89	o.k.
JUL	37.142	6.8	6.8	44.23	o.k.
AUG	15.634	6.8	6.8	56.06	o.k.
SEP	4.678	6.8	6.8	53.94	o.k.
OCT	6.440	6.8	6.8	53.58	o.k.
NOV	0.533	6.8	6.8	47.31	o.k.
DEC	0.000	6.8	6.8	40.51	o.k.
1993 JAN	0.000	6.8	6.8	33.11	o.k.
FEB	0.000	6.8	6.8	26.31	o.k.
MAR	0.253	6.8	6.8	20.37	o.k.
APR	5.766	6.8	6.6	19.33	o.k.
MAY	1.258	6.8	6.8	13.79	o.k.
JUN	0.303	6.8	6.8	7.29	o.k.

 MORRISON-KNUDSEN ENGINEERS, INC.
 PROJECT _____
 FEATURE _____
 ITEM _____
 CONTRACT NO. 2411-34
 DESIGNED BY PRC
 CHECKED BY JRC
 SHEET 1000A
 FILE NO. _____
 DATE 3/19/91
 DATE 3/19/91



Non Accumulating / Discharge (2) 10-Yr 24-Hr Storm Runoff Included

NON-ACCUMULATING, 10-YEAR STORM RUNOFF INCLUDED
 UHTRA/FALL CITY SITE
 FILE: NONACC.WKI

INPUT

RETENTION BASIN CAPACITY (AC-FT) to be determined
 NO EVAPORATION POND
 AVG ANN. LAKE EVAPORAT'N (IN.) = 54

*****INPUT*****

MONTH	SOIL SCS MO.	MEAN DAYS	MEAN TEMP.	MEAN PRECIP.	MEAN SNOW	SNOW FALL	SUBLIM-ATION	ACCUM. SNOWPACK	SNOW-MELT	TOTAL RAINFALL & SNOWMELT	NUMBER OF PER EVENT	WATER (IN. WTR.)	**S** -SCS-	TOTAL RUNOFF VOLUME	*INPUT* ASSUMED CONSTR. WATER REQ'D	*INPUT* ASSUMED DEWATERING INFLOW	EST. EVAPTN.
			DEG. F	(IN. WTR.)	(IN. WTR.)	(IN. WTR.)	(IN. WTR.)	(INCHES OF WTR.)	(IN. WTR.)	(IN. WTR.)			(IN.)	(AC-FT)	(AC-FT)	(AC-FT)	(AC-FT)
1991 DEC	84.7	4	56.0	1.83	0.0	0	0	0.00	0.00	1.83	2	0.92	1.806	1.905	2.60	1.18	1.141
1992 JAN	84.7	3	54.0	1.54	0.1	0	0	0.00	0.00	1.54	2	0.77	1.806	1.106	2.60	10.31	1.106
FEB	84.7	5	58.0	2.39	0.0	0	0	0.00	0.00	2.39	3	0.80	1.806	1.860	2.60	225.16	1.345
MAR	84.7	2	63.0	0.99	0.0	0	0	0.00	0.00	0.99	1	0.99	1.806	1.190	2.60	1.18	1.190
APR	84.7	4	71.0	2.70	0.0	0	0	0.00	0.00	2.70	2	1.35	1.806	5.130	2.60	1.18	2.399
MAY	84.7	4	78.0	3.50	0.0	0	0	0.00	0.00	3.50	2	1.75	1.806	8.853	2.60	1.18	2.984
JUN	84.3	4	83.0	2.98	0.0	0	0	0.00	0.00	2.98	2	1.49	1.862	7.823	4.64	20.59	3.086
JUL	83.9	2	85.0	1.48	0.0	0	0	0.00	0.00	1.48	1	1.48	1.919	4.517	4.64	40.00	2.735
AUG	83.8	3	86.0	2.28	0.0	0	0	0.00	0.00	2.28	2	1.14	1.933	5.387	4.64	20.43	2.544
SEP	83.6	5	81.0	3.64	0.0	0	0	0.00	0.00	3.64	3	1.21	1.962	10.294	4.64	19.84	1.836
OCT	83.6	4	72.0	3.03	0.0	0	0	0.00	0.00	3.03	2	1.52	1.962	11.578	4.64	0.86	1.358
NOV	83.6	4	63.0	2.19	0.0	0	0	0.00	0.00	2.19	2	1.10	1.962	5.250	4.64	0.86	0.937
DEC	83.6	4	56.0	1.83	0.0	0	0	0.00	0.00	1.83	2	0.92	1.962	3.115	4.64	0.86	0.746
1993 JAN	83.6	3	54.0	1.54	0.1	0	0	0.00	0.00	1.54	2	0.77	1.962	1.727	4.64	0.86	0.746
FEB	83.6	5	58.0	2.39	0.0	0	0	0.00	0.00	2.39	3	0.80	1.962	2.936	4.64	0.86	0.880
MAR	83.9	2	63.0	0.99	0.0	0	0	0.00	0.00	0.99	1	0.99	1.919	1.649	0	0	1.396
APR	83.9	4	71.0	2.70	0.0	0	0	0.00	0.00	2.70	2	1.35	1.919	7.334	0	0	1.568
MAY	100.0	4	78.0	3.50	0.0	0	0	0.00	0.00	3.50	2	1.75	0.000	3.208	0	0	1.951
JUN	100.0	4	83.0	2.98	0.0	0	0	0.00	0.00	2.98	2	1.49	0.000	2.732	0	0	2.429
JUL	100.0	2	85.0	1.48	0.0	0	0	0.00	0.00	1.48	1	1.48	0.000	1.357	0	0	2.090
AUG	100.0	3	86.0	2.28	0.0	0	0	0.00	0.00	2.28	2	1.14	0.000	2.090	0	0	2.090
SEP	100.0	5	81.0	3.64	0.0	0	0	0.00	0.00	3.64	3	1.21	0.000	3.337	0	0	1.836
OCT	100.0	4	72.0	3.03	0.0	0	0	0.00	0.00	3.03	2	1.52	0.000	2.778	0	0	1.358
NOV	100.0	4	63.0	2.19	0.0	0	0	0.00	0.00	2.19	2	1.10	0.000	2.008	0	0	0.937
DEC	100.0	4	56.0	1.83	0.0	0	0	0.00	0.00	1.83	2	0.92	0.000	1.678	0	0	0.746
1994 JAN	100.0	3	54.0	1.54	0.1	0	0	0.00	0.00	1.54	2	0.77	0.000	1.412	0	0	0.746
FEB	100.0	5	58.0	2.39	0.0	0	0	0.00	0.00	2.39	3	0.80	0.000	2.191	0	0	0.880
MAR	100.0	2	63.0	0.99	0.0	0	0	0.00	0.00	0.99	1	0.99	0.000	0.908	0	0	0.908
APR	100.0	4	71.0	2.70	0.0	0	0	0.00	0.00	2.70	2	1.35	0.000	2.475	0	0	1.568
MAY	100.0	4	78.0	3.50	0.0	0	0	0.00	0.00	3.50	2	1.75	0.000	3.208	0	0	1.951
JUN	100.0	4	83.0	2.98	0.0	0	0	0.00	0.00	2.98	2	1.49	0.000	2.732	0	0	2.429
JUL	100.0	2	85.0	1.48	0.0	0	0	0.00	0.00	1.48	1	1.48	0.000	1.357	0	0	1.357
AUG	100.0	3	86.0	2.28	0.0	0	0	0.00	0.00	2.28	2	1.14	0.000	2.090	0	0	2.090
SEP	100.0	5	81.0	3.64	0.0	0	0	0.00	0.00	3.64	3	1.21	0.000	3.337	0	0	1.836

* NOTE: 10-YEAR STORM RUNOFF FROM 1) EMBANKMENT (55.5), 2) POND #6 (3.9), & 3) PILE #3 (18.98) ADDED TO DEWATERING INFLOW

87.594 57.36 700.85 32.378

10/10

DATE: 03/06/91

PYL 3/6/91

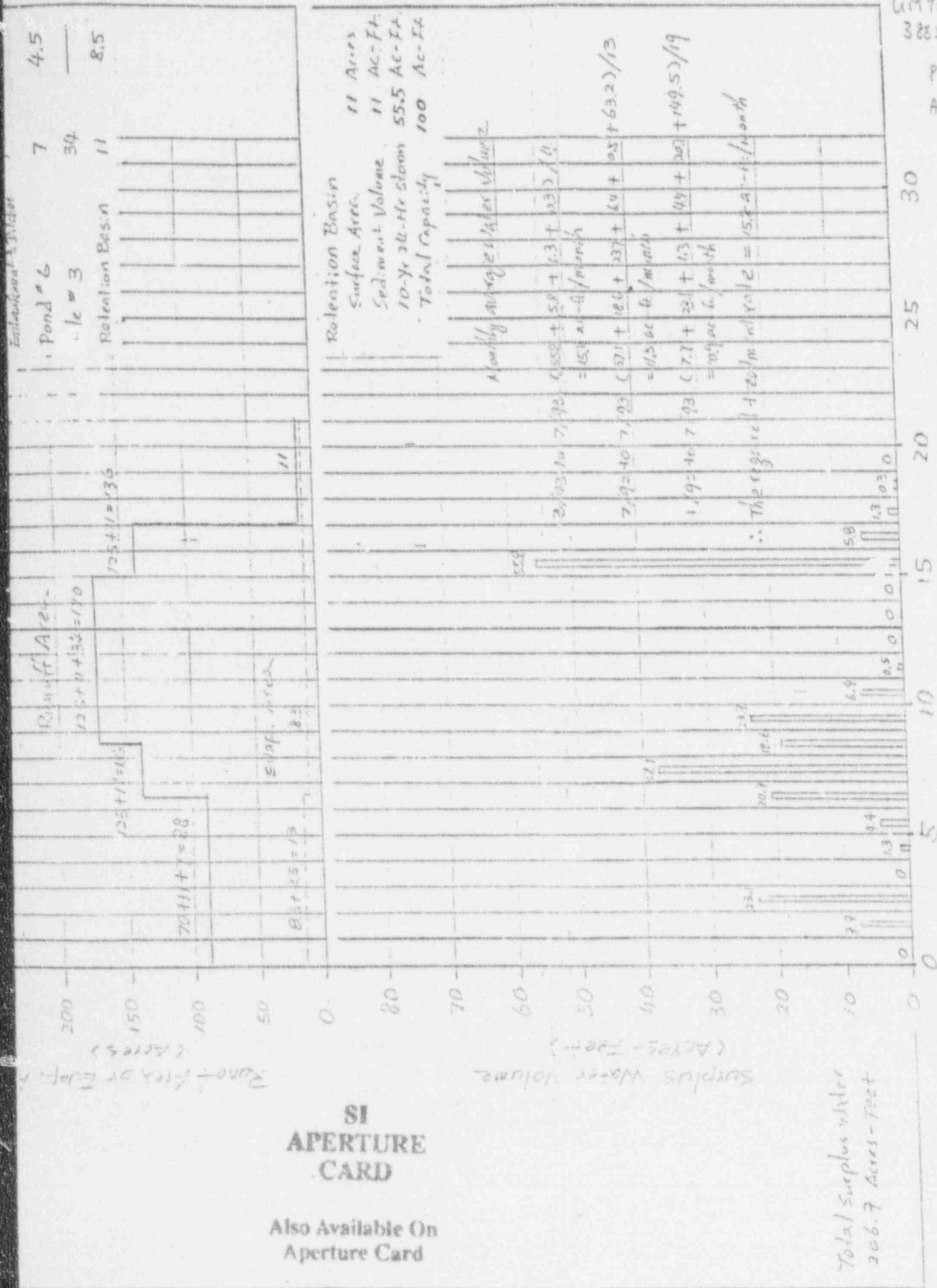
100 3/22/91

-----WATER BALANCE-----								
"ACCUMULATING"----->			-----"ACCUMULATING"-----					
ACTUAL CONSTR. WATER USAGE (AC-FT)	SURPLUS WATER (AC-FT)	EST. EVAPTN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR.	*INPUT* RUNOFF AREA (ACRES)	*INPUT* POND EVAP. AREA (ACRES)	WTR. HT. IN POND & BASIN (FT.)
1.945	0.000	2.202	0.804	0.000	0.039	88	13	0.000
2.600	7.710	2.202	2.600	6.535	0.039	88	13	0.503
2.600	23.075	2.691	2.600	28.264	0.046	88	13	2.174
1.180	0.000	4.270	2.600	23.764	0.073	88	13	1.828
2.600	1.311	4.797	2.600	22.677	0.082	88	13	1.744
1.600	4.449	5.967	2.600	24.142	0.102	88	13	1.857
4.640	20.687	6.172	4.640	41.743	0.127	112	10.8	3.865
4.640	37.142	5.470	4.640	76.150	0.143	136	8.5	8.959
4.640	18.634	5.087	4.640	92.240	0.133	153	8.5	10.852
4.640	23.658	3.672	4.640	114.062	0.096	170	8.5	10.419
4.640	6.440	2.716	4.640	119.144	0.071	170	8.5	14.017
4.640	0.533	1.874	4.640	118.740	0.049	170	8.5	13.969
3.230	0.000	1.492	4.640	116.584	0.039	170	8.5	13.716
1.842	0.000	1.492	4.640	113.040	0.039	170	8.5	13.299
2.917	0.000	1.760	4.640	110.437	0.046	170	8.5	12.993
0.000	55.753	2.792	0.000	164.794	0.073	136	8.5	19.387
0.000	5.766	3.137	0.000	168.992	0.082	136	8.5	19.881
0.000	1.258	3.902	0.000	168.798	0.102	11	8.5	19.200
0.000	0.303	4.858	0.000	166.172	0.127	11	8.5	19.550
0.000	0.000	5.470	0.000	162.059	0.143	11	8.5	19.066
0.000	0.000	5.087	0.000	159.062	0.133	11	8.5	18.713
0.000	1.501	3.672	0.000	158.727	0.096	11	8.5	18.674
0.000	1.420	2.716	0.000	158.788	0.071	11	8.5	18.681
0.000	1.070	1.874	0.000	158.922	0.049	11	8.5	18.637
0.000	0.932	1.492	0.000	159.107	0.039	11	8.5	18.709
0.000	0.666	1.492	0.000	159.027	0.039	11	8.5	18.709
0.000	1.311	1.760	0.000	159.459	0.046	11	8.5	18.760
0.000	0.000	2.792	0.000	157.574	0.073	11	8.5	18.538
0.000	0.907	3.137	0.000	156.912	0.082	11	8.5	18.480
0.000	1.258	3.902	0.000	156.219	0.102	11	8.5	18.379
0.000	0.303	4.858	0.000	154.893	0.127	11	8.5	18.129
0.000	0.000	5.470	0.000	149.980	0.143	11	8.5	17.645
0.000	0.000	5.087	0.000	146.983	0.133	11	8.5	17.293
0.000	1.501	3.672	0.000	146.641	0.096	11	8.5	17.253

206.719

91016

PTL 3/11/91
ACC 3/22/91



SI
APERTURE
CARD

Also Available On
Aperture Card

Total Surplus Value
206.7 Acres - Feet

206.7 Acres-Flat

9205110072-34

CHECK STORAGE IN RETENTION BASIN
 SCHEME A (2) TREATMENT / DISCHARGE , 10-YR, 24-HR STORM RUNOFF INCLUDED

MONTH	SURPLUS WATER (from sh.19) (Ac-ft)	TREATMENT PLANT RATE (sh.19.2) (Ac-ft)	ACTUAL VOLUME TREATED (Ac-ft)	ACCUM. STORAGE IN RETENTION BASIN (Ac-ft)	
1991 DEC	0.000	15.8	0.0	0.00	o.k.
1992 JAN	7.710	15.8	7.7	0.00	o.k.
FEB	23.075	15.8	15.8	7.27	o.k.
MAR	0.000	15.8	7.3	0.00	o.k.
APR	1.311	15.8	1.3	0.00	o.k.
MAY	4.449	15.8	4.4	0.00	o.k.
JUN	20.687	15.8	15.8	4.89	o.k.
JUL	37.142	15.8	15.8	26.23	o.k.
AUG	18.634	15.8	15.8	29.06	o.k.
SEP	23.658	15.8	15.8	36.92	o.k.
OCT	6.440	15.8	15.8	27.56	o.k.
NOV	0.533	15.8	15.8	12.29	o.k.
DEC	0.000	15.8	12.3	0.00	o.k.
1993 JAN	0.000	15.8	0.0	0.00	o.k.
FEB	0.000	15.8	0.0	0.00	o.k.
MAR	55.753	15.8	15.8	39.95	o.k.
APR	5.766	15.8	15.8	29.92	o.k.
MAY	1.258	15.8	15.8	15.38	o.k.
JUN	0.303	15.8	15.7	0.00	o.k.


MORRISON-KNUDSEN ENGINEERS, INC.
 A MORRISON KNUDSEN COMPANY
 Project Waterworks
 Feature Headworks
 Item Headworks
 Contract No. 385-28
 Designed PTL
 Checked ACC
 Sheet 1c 2a
 File No. 3/19/91
 Date 3/22/91





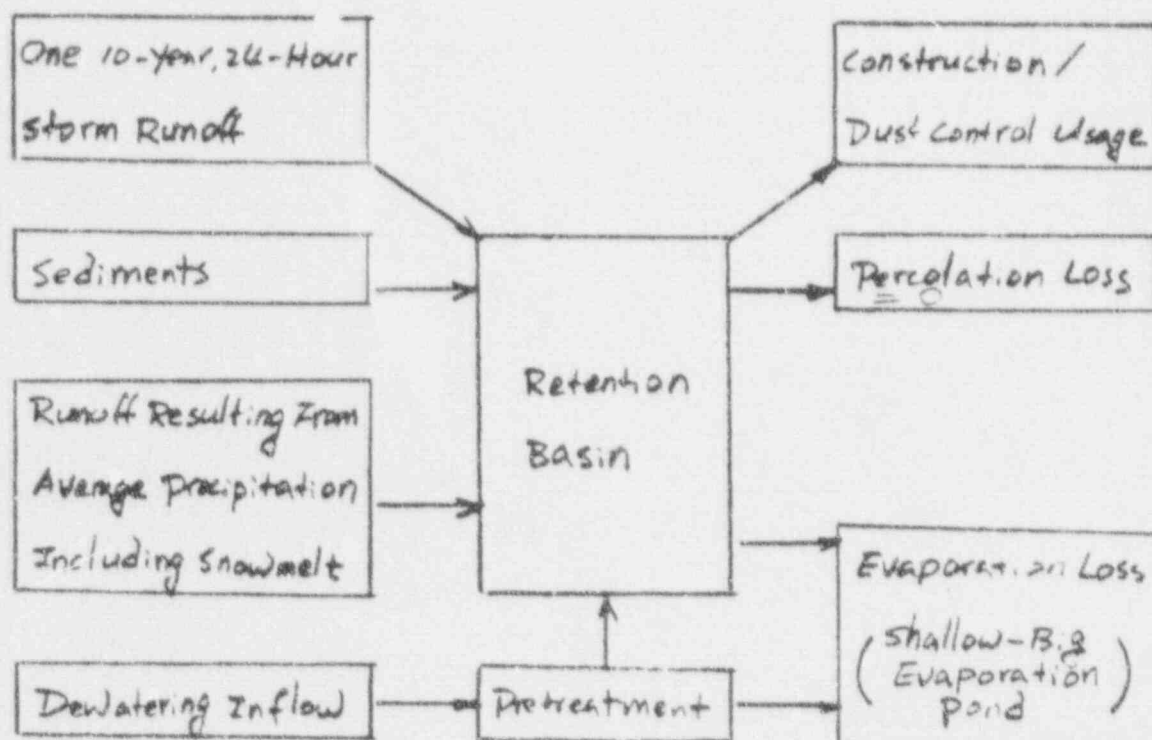
MORRISON-KNUDSEN CORPORATION

Project UMTRA - FCT
Feature Wastewater Handling I
Item _____

Contract No. 3885-22
Designed WYL
Checked PYL

Sheet 103
File No. _____
Date 2/11/91
Date 3/12/91

B Evaporation



D. Accumulating / Evaporation Pond (1) No 10-yr 24-hr Storm Runoff

ACCUMULATING, EVAPORATION SCHEME, NO STORM RUNOFF INCLUDED
 INTRAFALL CITY SITE
 FILE: ACEV20NO.WK1

INPUT

RETENTION BASIN CAPACITY(AC-FT)=to be determined

EVAPORATION POND 20 AC..

AVG ANN. LAKE EVAPORAT'N (IN.)= 54

*****INPUT*****

MONTH SOIL MEAN NO. DAYS MEAN TEMP. MEAN PRECIP. MEAN SNOW (IN.) RAIN- FALL (IN.) SUR- IM- ACCUM. SNOW- MELT (IN.) TOTAL RAINFALL & SNOWMELT (IN.) NUMBER OF PER EVENTS WATER (IN. WTR.) "S" -SCS- (IN.) TOTAL RUNOFF VOLUME (AC-FT) *INPUT* ASSUMED CONSTR. WATER REQ'D (AC-FT) *INPUT* DE- WATERING INFLOM (AC-FT) EST. EVAPIN.

MONTH	SOIL MEAN NO. DAYS	MEAN TEMP.	MEAN PRECIP.	MEAN SNOW	(IN.)	RAIN- FALL (IN.)	SUR- IM- (IN.)	ACCUM. SNOW- (INCHES OF WTR.)	MELT (IN. WTR.)	TOTAL RAINFALL & SNOWMELT (IN. WTR.)	NUMBER OF PER EVENTS	WATER (IN. WTR.)	"S" -SCS- (IN.)	TOTAL RUNOFF VOLUME (AC-FT)	*INPUT* ASSUMED CONSTR. WATER REQ'D (AC-FT)	*INPUT* DE- WATERING INFLOM (AC-FT)	EST. EVAPIN.
1991 DEC	87.5	4	56.0	1.83	0.0	0	1.83	0.00	0.00	1.83	2	0.92	1.429	3.464	2.60	1.18	2.898
1992 JAN	87.5	3	54.0	1.54	0.1	0	1.54	0.00	0.00	1.54	2	0.77	1.429	2.207	2.60	10.31	2.207
FEB	87.5	5	58.0	2.39	0.0	0	2.39	0.00	0.00	2.39	3	0.80	1.429	3.634	2.60	21.26	3.415
MAR	87.5	2	63.0	0.93	0.0	0	0.99	0.00	0.00	0.99	1	0.99	1.429	2.093	2.60	1.18	2.093
APR	87.5	4	71.0	2.70	0.0	0	2.70	0.00	0.00	2.70	2	1.35	1.429	8.179	2.60	1.18	6.089
MAY	87.5	4	78.0	3.50	0.0	0	3.50	0.00	0.00	3.50	2	1.75	1.429	13.341	2.60	1.18	7.573
JUN	86.8	4	83.0	2.98	0.0	0	2.98	0.00	0.00	2.98	2	1.49	1.521	11.430	4.64	20.59	8.801
JUL	86.0	2	85.0	1.48	0.0	0	1.48	0.00	0.00	1.48	1	1.48	1.628	6.227	4.64	40.00	6.227
AUG	85.7	3	86.0	2.28	0.0	0	2.28	0.00	0.00	2.28	2	1.14	1.669	7.574	4.64	20.43	7.574
SEP	85.4	5	81.0	3.64	0.0	0	3.64	0.00	0.00	3.64	3	1.21	1.710	13.975	4.64	0.86	6.156
OCT	85.4	4	72.0	3.03	0.0	0	3.03	0.00	0.00	3.03	2	1.52	1.710	15.117	4.64	0.86	4.553
NOV	85.4	4	63.0	2.19	0.0	0	2.19	0.00	0.00	2.19	2	1.10	1.710	7.292	4.64	0.86	3.142
DEC	85.4	4	56.0	1.83	0.0	0	1.83	0.00	0.00	1.83	2	0.92	1.710	4.556	4.64	0.86	2.501
1993 JAN	85.4	3	54.0	1.54	0.1	0	1.54	0.00	0.00	1.54	2	0.77	1.710	2.715	4.64	0.86	2.501
FEB	85.4	5	58.0	2.39	0.0	0	2.39	0.00	0.00	2.39	3	0.80	1.710	4.538	4.64	0.86	2.950
MAR	86.0	2	63.0	0.99	0.0	0	0.99	0.00	0.00	0.99	1	0.99	1.628	2.504	0	0.00	2.504
APR	86.0	4	71.0	2.70	0.0	0	2.70	0.00	0.00	2.70	2	1.35	1.628	10.287	0	0.00	5.258
MAY	100.0	4	78.0	3.50	0.0	0	3.50	0.00	0.00	3.50	2	1.75	0.000	9.042	0	0.00	6.541
JUN	100.0	4	83.0	2.98	0.0	0	2.98	0.00	0.00	2.98	2	1.49	0.000	7.698	0	0.00	7.698
JUL	100.0	2	85.0	1.48	0.0	0	1.48	0.00	0.00	1.48	1	1.48	0.000	3.823	0	0.00	3.823
AUG	100.0	3	86.0	2.28	0.0	0	2.28	0.00	0.00	2.28	2	1.14	0.000	5.890	0	0.00	5.890
SEP	100.0	5	81.0	3.64	0.0	0	3.64	0.00	0.00	3.64	3	1.21	0.000	9.475	0	0.00	6.156
OCT	100.0	4	72.0	3.03	0.0	0	3.03	0.00	0.00	3.03	2	1.52	0.000	7.878	0	0.00	4.553
NOV	100.0	4	63.0	2.19	0.0	0	2.19	0.00	0.00	2.19	2	1.10	0.000	5.668	0	0.00	3.142
DEC	100.0	4	56.0	1.83	0.0	0	1.83	0.00	0.00	1.83	2	0.92	0.000	4.278	0	0.00	2.501
1994 JAN	100.0	3	54.0	1.54	0.1	0	1.54	0.00	0.00	1.54	2	0.77	0.000	3.978	0	0.00	2.501
FEB	100.0	5	58.0	2.39	0.0	0	2.39	0.00	0.00	2.39	3	0.80	0.000	6.874	0	0.00	2.950
MAR	100.0	2	63.0	0.99	0.0	0	0.99	0.00	0.00	0.99	1	0.99	0.000	2.558	0	0.00	2.558
APR	100.0	4	71.0	2.70	0.0	0	2.70	0.00	0.00	2.70	2	1.35	0.000	6.175	0	0.00	5.258
MAY	100.0	4	78.0	3.50	0.0	0	3.50	0.00	0.00	3.50	2	1.75	0.000	9.042	0	0.00	6.541
JUN	100.0	4	83.0	2.98	0.0	0	2.98	0.00	0.00	2.98	2	1.49	0.000	7.698	0	0.00	7.698
JUL	100.0	2	85.0	1.48	0.0	0	1.48	0.00	0.00	1.48	1	1.48	0.000	3.823	0	0.00	3.823
AUG	100.0	3	86.0	2.28	0.0	0	2.28	0.00	0.00	2.28	2	1.14	0.000	5.890	0	0.00	5.890
SEP	100.0	5	81.0	3.64	0.0	0	3.64	0.00	0.00	3.64	3	1.21	0.000	9.475	0	0.00	6.156

* NOTE: NO STORM RUNOFF

135.823 57.56 122.47

LAUREA - FCT
3855-28
PYL 3/6/91
AC 3/2/91

P.1046

DATE: 03/06/91

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

ACTUAL CONSTR. WATER USAGE (AC-FT)	SURPLUS WATER (AC-FT)	EST. EVAPN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR. (ACRES)	*INPUT* RUNOFF AREA (ACRES)	*INPUT* POND EVAP. AREA (ACRES)	WTR. HI. IN POND BASIN (FT.)	WTR. HT. IN POND (FT.)	EXCESS WTR. STORED IN BASIN (AC-FT)
1.748	0.000	4.644	0.000	0.000	0.039	108	33	0.000	0.000	0
2.000	7.710	5.792	2.600	4.125	0.039	108	33	0.125	0.25	0
2.600	18.879	6.831	2.600	19.589	0.045	108	33	0.594	0.594	0
1.180	0.000	10.840	2.600	9.421	0.073	108	33	0.285	0.285	0
2.600	0.670	12.177	2.600	4.003	0.062	108	33	0.121	0	0
2.600	4.348	15.147	2.600	0.777	0.102	108	33	0.044	0	0
4.840	18.579	17.602	4.640	10.556	0.132	132	30.8	0.343	0.343	0
4.640	35.360	18.340	4.640	33.803	0.133	4	28.5	1.186	1.000	5.30
4.640	15.790	17.057	4.640	40.109	0.096	190	28.5	1.383	1.000	11.60
4.640	4.039	12.312	4.640	37.992	0.071	190	28.5	1.411	1.000	9.44
4.640	6.784	9.106	4.640	40.223	0.049	190	28.5	1.314	1.000	11.21
4.640	0.370	6.284	4.640	37.451	0.039	190	28.5	1.166	1.000	8.95
2.915	0.000	5.002	4.640	33.226	0.039	190	28.5	0.953	0.953	4.73
1.074	0.000	5.000	4.640	27.159	0.046	190	28.5	0.773	0.773	0
2.449	0.000	5.900	4.640	22.018	0.073	156	28.5	0.532	0.532	0
0.000	0.000	9.362	0.000	15.159	0.082	156	28.5	0.524	0.524	0
0.000	5.029	10.517	0.000	14.930	0.102	31	28.5	0.882	0.882	0
0.000	2.501	13.081	0.000	10.890	0.127	31	28.5	0.961	0.961	0
0.000	0.000	16.288	0.000	2.300	0.143	31	28.5	0.900	0	0
0.000	0.000	16.124	0.000	0.000	0.133	31	28.5	0.900	0	0
0.000	0.000	16.690	0.000	0.000	0.096	31	28.5	0.900	0	0
0.000	3.247	16.403	0.000	0.000	0.071	31	28.5	0.900	0	0
0.000	3.275	17.848	0.000	0.000	0.049	31	28.5	0.900	0	0
0.000	2.515	15.658	0.000	0.000	0.039	31	28.5	0.900	0	0
0.000	2.227	14.728	0.000	0.000	0.039	31	28.5	0.900	0	0
0.000	1.477	13.978	0.000	0.000	0.046	31	28.5	0.900	0	0
0.000	3.224	15.000	0.000	0.275	0.073	31	28.5	0.900	0	0
0.000	0.000	2.832	0.000	0.000	0.082	31	28.5	0.900	0	0
0.000	1.717	6.175	0.000	0.000	0.102	31	28.5	0.900	0	0
0.000	2.501	9.000	0.000	0.000	0.127	31	28.5	0.900	0	0
0.000	0.000	8.688	0.000	0.000	0.143	31	28.5	0.900	0	0
0.000	0.000	8.833	0.000	0.000	0.133	31	28.5	0.900	0	0
0.000	0.000	8.800	0.000	0.000	0.096	31	28.5	0.900	0	0
0.000	3.241	16.400	0.000	0.000	0.096	31	28.5	0.900	0	0

← Dry in 19 months/20-acre pond

* Max depth in pond 1.000 in 1'

201.284

B. Accumulation / Evaporation Pond Wastewater Handling Study (UMTRA / Tals C / S. te)

Piped 2nd

Water Balance Start

Project Start

1991	1992	1993	1994
Aug.			
Sept.			
Oct.			
Nov.			
Dec.			
Jan.			
Feb.			
Mar.			
Apr.			
May			
June			
July			
Aug.			
Sept.			
Oct.			
Nov.			
Dec.			

Pile #4
(Retention Basin)

Pile #5

Pile #1, 2, 7

Pile #3

Pond #6

Windblown Material

Rubber Barrier / Guardrail
(Top Slope)

Erosion Protection
(5.3% slope)

Site Restoration

Reinforcing in Piles
(Ac. Ft.)

10-Yr 24-Hr Storm in
Retention Basin (Ac. Ft.)

Construction Wharf for
Dust Control (Ac. Ft.)

3.7 Ac. ft. over 6 1/2 mon

AVG = 2.78 Ac. ft./mon

20 Ac. ft. over 2 mon

AVG = 40 Ac. ft./mon

5.6 Ac. ft. over 6 1/2 mon

AVG = 0.86 Ac. ft./mon

437.6 Ac. ft. over 0.8 mon

AVG = 36.5 Ac. ft./mon

Σ = 1124.7

Σ = 0

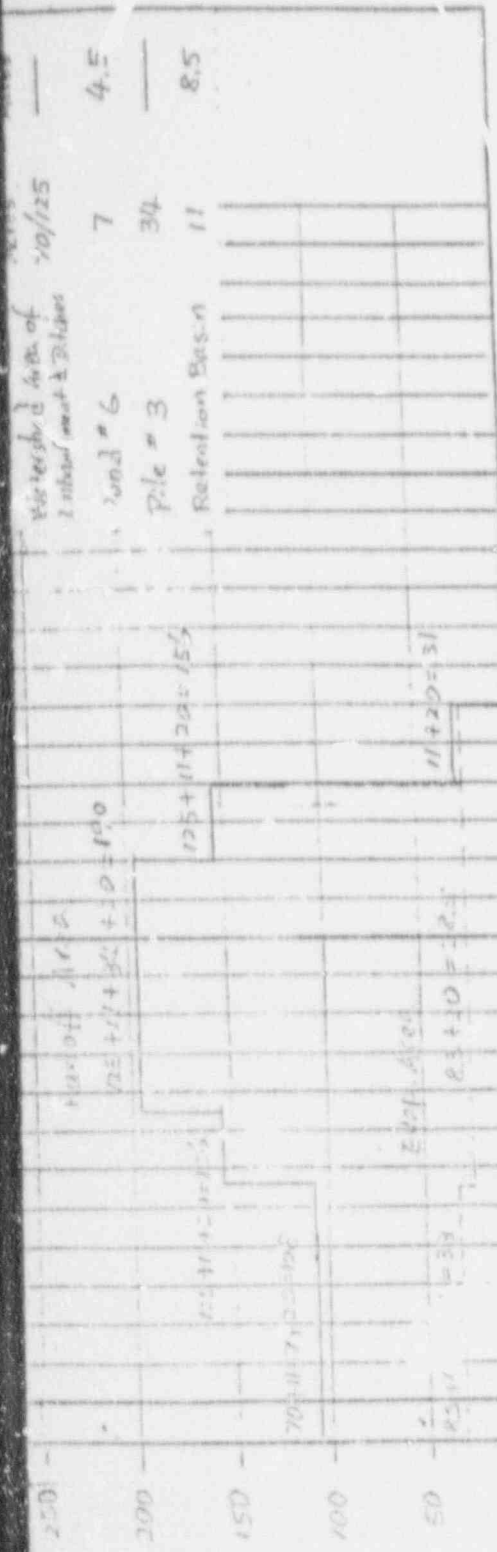
Σ = 5736

Ranoff Area, Esop. Area

UNITED-FCT
3485-28

PTL 3/11/91

ARC 3/22/91

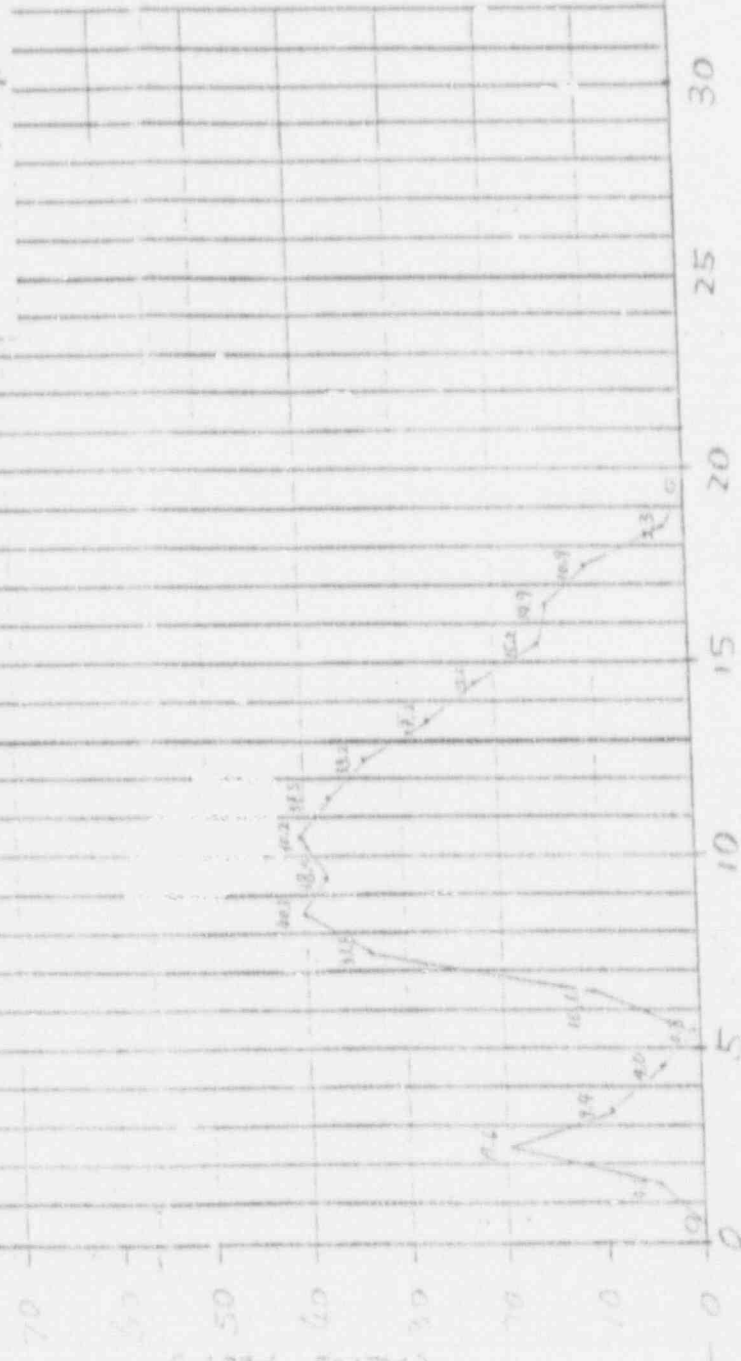


20 Acres
Evaporation Pond

Retention Basin
Surface Area
Sediment Volume
10-yr 24 Hr Storm
Total Capacity

11 Acres
11 Ac-Ft
55.5 1.-Ft
100 Ac-Ft

Accumulated Water Volume (Acres - Feet)



SI APERTURE CARD

Also Available On
Aperture Card

Accumulating / Evaporation Pond

(2) 10-yr 24-hr Storm Runoff Included

ACCUMULATING, EVAPORATION SCHEME, 10-YEAR STORM RUNOFF INCLUDED
 WINTER/FALL CITY STP
 FILE: ACCVAA0.WL3

INPUT

RETENTION BASIN CAPACITY(AC-FT)=to be determined
 EVAPORATION POND 40 AC.
 AVG ANN. LAKE EVAPORAT'N (IN.)= 54

*****INPUT*****

MONTH	SOIL MEAS. NO.	MEAN TEMP.	MEAN PRECIP.	MEAN 'NEW	SNOW FALL	SURF. ATION	ACCUM. SNOWPACK	SNOW-MELT	TOTAL RAINFALL & SNOW-MELT	NUMBER OF PER EVENT	WATER (IN. WTR.)	"S" -SCS-	TOTAL RUNOFF VOLUME	*INPUT* ASSUMED CONSTR. WATER REQ'D (AC-FT)	*INPUT* ASSUMED DEWATERING INFLOW (AC-FT)	EST. EVAP'N
NO.	SCS NO.	DEG. F	(IN. WTR.)	(IN. WTR.)	(IN. WTR.)	(IN. WTR.)	(INCHES OF WTR.)	(IN. WTR.)	(IN. WTR.)	EVENTS	(IN. WTR.)	(IN.)	(AC-FT)	(AC-FT)	(AC-FT)	(AC-FT)
1991 DEC	89.5	4	56.0	1.83	0.0	0	0.00	0.00	1.83	2	0.92	1.173	5.328	2.6	1.18	4.658
1992 JAN	89.5	3	54.0	1.54	0.1	0	0.00	0.00	1.54	2	0.77	1.173	3.579	2.6	10.31	3.579
FEB	89.5	5	58.0	2.39	0.0	0	0.00	0.00	2.39	3	0.80	1.173	5.825	2.6	25.16	5.486
MAR	89.5	2	63.0	0.99	0.0	0	0.00	0.00	0.99	1	0.99	1.173	3.156	2.6	1.18	3.156
APR	89.5	4	71.0	2.70	0.0	0	0.00	0.00	2.70	2	1.35	1.173	11.597	2.6	1.18	9.779
MAY	89.5	4	78.0	3.50	0.0	0	0.00	0.00	3.50	2	1.75	1.173	18.221	2.6	1.18	12.163
JUN	88.6	4	83.0	2.98	0.0	0	0.00	0.00	2.98	2	1.49	1.287	15.279	4.64	20.59	14.516
JUL	87.6	2	85.0	1.48	0.0	0	0.00	0.00	1.48	1	1.48	1.416	8.643	4.64	40.00	8.043
AUG	87.2	3	86.0	2.28	0.0	0	0.00	0.00	2.28	2	1.14	1.468	9.952	4.64	20.43	9.958
SEP	86.8	5	81.0	3.64	0.0	0	0.00	0.00	3.64	3	1.21	1.521	17.860	4.64	40.00	10.476
OCT	86.8	4	72.0	3.03	0.0	0	0.00	0.00	3.03	2	1.52	1.521	18.786	4.64	23.16	7.748
NOV	86.8	4	63.0	2.19	0.0	0	0.00	0.00	2.19	2	1.10	1.521	9.470	4.64	0.86	5.347
DEC	86.8	4	56.0	1.83	0.0	0	0.00	0.00	1.83	2	0.92	1.521	6.127	4.64	0.86	4.256
1993 JAN	86.8	3	54.0	1.54	0.1	0	0.00	0.00	1.54	2	0.77	1.521	3.823	4.64	0.86	3.823
FEB	86.8	5	58.0	2.39	0.0	0	0.00	0.00	2.39	3	0.80	1.521	6.326	4.64	0.86	5.020
MAR	87.6	2	63.0	0.99	0.0	0	0.00	0.00	0.99	1	0.99	1.416	3.453	0	55.50	3.453
APR	87.6	4	71.0	2.70	0.0	0	0.00	0.00	2.70	2	1.35	1.416	13.450	0	0.00	8.948
MAY	100.0	4	78.0	3.50	0.0	0	0.00	0.00	3.50	2	1.75	0.000	14.875	0	0.00	11.131
JUN	100.0	4	83.0	2.98	0.0	0	0.00	0.00	2.98	2	1.49	0.000	12.665	0	0.00	12.665
JUL	100.0	2	85.0	1.48	0.0	0	0.00	0.00	1.48	1	1.48	0.002	6.290	0	0.00	6.251
AUG	100.0	3	85.0	2.28	0.0	0	0.00	0.00	2.28	2	1.14	0.000	9.699	0	0.00	9.699
SEP	100.0	5	81.0	3.64	0.0	0	0.00	0.00	3.64	3	1.21	0.000	15.470	0	0.00	10.476
OCT	100.0	4	72.0	3.03	0.0	0	0.00	0.00	3.03	2	1.52	0.000	12.876	0	0.00	7.748
NOV	100.0	4	63.0	2.19	0.0	0	0.00	0.00	2.19	2	1.10	0.000	9.308	0	0.00	5.347
DEC	100.0	4	56.0	1.83	0.0	0	0.00	0.00	1.83	2	0.92	0.000	7.778	0	0.00	4.256
1994 JAN	100.0	3	54.0	1.54	0.1	0	0.00	0.00	1.54	2	0.77	0.000	4.545	0	0.00	4.256
FEB	100.0	5	58.0	2.39	0.0	0	0.00	0.00	2.39	3	0.80	0.000	10.758	0	0.00	5.020
MAR	100.0	2	63.0	0.99	0.0	0	0.00	0.00	0.99	1	0.99	0.000	4.708	0	0.00	4.708
APR	100.0	4	71.0	2.70	0.0	0	0.00	0.00	2.70	2	1.35	0.000	11.875	0	0.00	8.948
MAY	100.0	4	78.0	3.50	0.0	0	0.00	0.00	3.50	2	1.75	0.000	14.875	0	0.00	11.131
JUN	100.0	4	83.0	2.98	0.0	0	0.00	0.00	2.98	2	1.49	0.000	12.665	0	0.00	12.665
JUL	100.0	2	85.0	1.48	0.0	0	0.00	0.00	1.48	1	1.48	0.000	6.290	0	0.00	6.290
AUG	100.0	3	86.0	2.28	0.0	0	0.00	0.00	2.28	2	1.14	0.000	9.699	0	0.00	9.699
SEP	100.0	5	81.0	3.64	0.0	0	0.00	0.00	3.64	3	1.21	0.000	15.470	0	0.00	10.476

* NOTE: 10-YEAR STORM RUNOFF FROM 1) EMBANKMENT (55.5), 2) POND#6 (3.9), 3) EVAP. POND (22.3), & 4) FILE #3 (18.98) ADDED TO DEWATERING INFLOW

194.111 57.56 223.15

(p.106)

DATE: 03/06/91

PXL 3/6/91

At 3/2/91

-----WATER BALANCE-----										
-----"ACCUMULATING"-----					-----"ACCUMULATING"-----					
ACTUAL CONSTR. WATER USAGE (AC-FT)	SURPLUS WATER (AC-FT)	EST. EVAPTN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR.	*INPUT* RUNOFF AREA (ACRES)	*INPUT* POND EVAP. AREA (ACRES)	WTR. HT. IN POND (FT.)	WTR. HT. IN POND (FT.)	EXCESS WATER STORED IN BASIN (AC-FT)
1.857	0.000	6.508	0.000	0.000	0.039	128	53	0.000	0	0
2.600	7.710	9.302	2.600	1.987	0.039	128	53	0.04	0.04	0
2.600	22.900	10.971	2.600	19.401	0.046	128	53	0.126	0.12	0
1.180	0.000	17.417	2.600	3.727	0.073	128	53	0.040	0.02	0
2.600	0.398	16.503	0.000	0.000	0.082	128	53	0.040	0	0
2.600	4.538	19.401	0.000	0.000	0.102	128	53	0.040	0	0
4.640	16.713	29.032	4.640	2.197	0.127	152	50.8	0.043	0.04	0
4.640	35.360	31.210	4.640	14.390	0.143	176	48.5	0.297	0.30	0
4.640	15.790	29.027	4.640	11.110	0.133	193	48.5	0.229	0.23	0
4.640	22.584	20.952	4.640	23.218	0.096	210	48.5	0.479	0.48	0
4.640	29.558	15.496	4.640	45.028	0.071	210	48.5	0.928	0.93	0
4.640	0.343	10.694	4.640	40.024	0.049	210	48.5	0.825	0.83	0
2.731	0.000	8.512	4.640	33.859	0.039	210	48.5	0.998	0.70	0
0.860	0.000	8.512	4.640	25.391	0.039	210	48.5	0.924	0.52	0
2.166	0.200	10.040	4.640	17.897	0.046	210	48.5	0.169	0.37	0
0.000	55.500	15.932	0.000	60.918	0.073	176	48.5	1.256	1.00	12.42
0.000	4.502	17.897	0.000	56.471	0.082	176	48.5	1.164	1.00	7.93
0.000	3.744	22.261	0.000	49.085	0.102	51	48.5	1.012	1.00	0.58
0.000	0.000	27.718	0.000	34.022	0.127	51	48.5	0.702	0.70	0
0.000	0.000	31.210	0.000	9.112	0.143	51	48.5	0.188	0.19	0
0.000	0.000	18.802	0.000	0.000	0.133	51	48.5	0.000	0	0
0.000	4.994	15.478	0.000	0.000	0.096	51	48.5	0.000	0	0
0.000	5.130	2.878	0.000	0.000	0.071	51	48.5	0.000	0	0
0.000	3.960	9.308	0.000	0.000	0.049	51	48.5	0.000	0	0
0.000	3.522	7.778	0.000	3.000	0.039	51	48.5	0.000	0	0
0.000	2.289	6.545	0.000	0.000	0.039	51	48.5	0.000	0	0
0.000	5.138	10.840	0.000	0.118	0.046	51	48.5	0.082	0.08	0
0.000	0.000	4.026	0.000	0.000	0.073	51	48.5	0.000	0	0
0.000	2.527	11.575	0.000	0.000	0.082	51	48.5	0.000	0	0
0.000	3.744	14.575	0.000	0.000	0.102	51	48.5	0.000	0	0
0.000	0.000	12.605	0.000	0.000	0.127	51	48.5	0.000	0	0
0.000	0.000	6.240	0.000	0.000	0.143	51	48.5	0.000	0	0
0.000	0.000	9.690	0.000	0.000	0.133	51	48.5	0.000	0	0
0.000	4.994	15.478	0.000	0.000	0.096	51	48.5	0.000	0	0

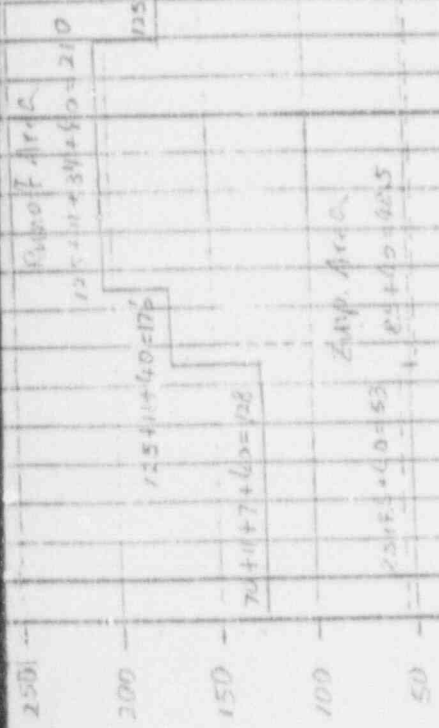
Day in 20 months/40-acre pond

* Max depth of suspension pond
is 1'

358.589

9901

Watershed Area of
Embarkment & Bridges
70/125
Pond # 6
4.5
Pile # 3
34
Retention Basin
11
8.5



Evap. Area
74 + 11 + 40 = 125
125 + 5 = 130
130 + 5 = 135
135 + 5 = 140
140 + 5 = 145
145 + 5 = 150
150 + 5 = 155
155 + 5 = 160
160 + 5 = 165
165 + 5 = 170
170 + 5 = 175
175 + 5 = 180
180 + 5 = 185
185 + 5 = 190
190 + 5 = 195
195 + 5 = 200
200 + 5 = 205
205 + 5 = 210

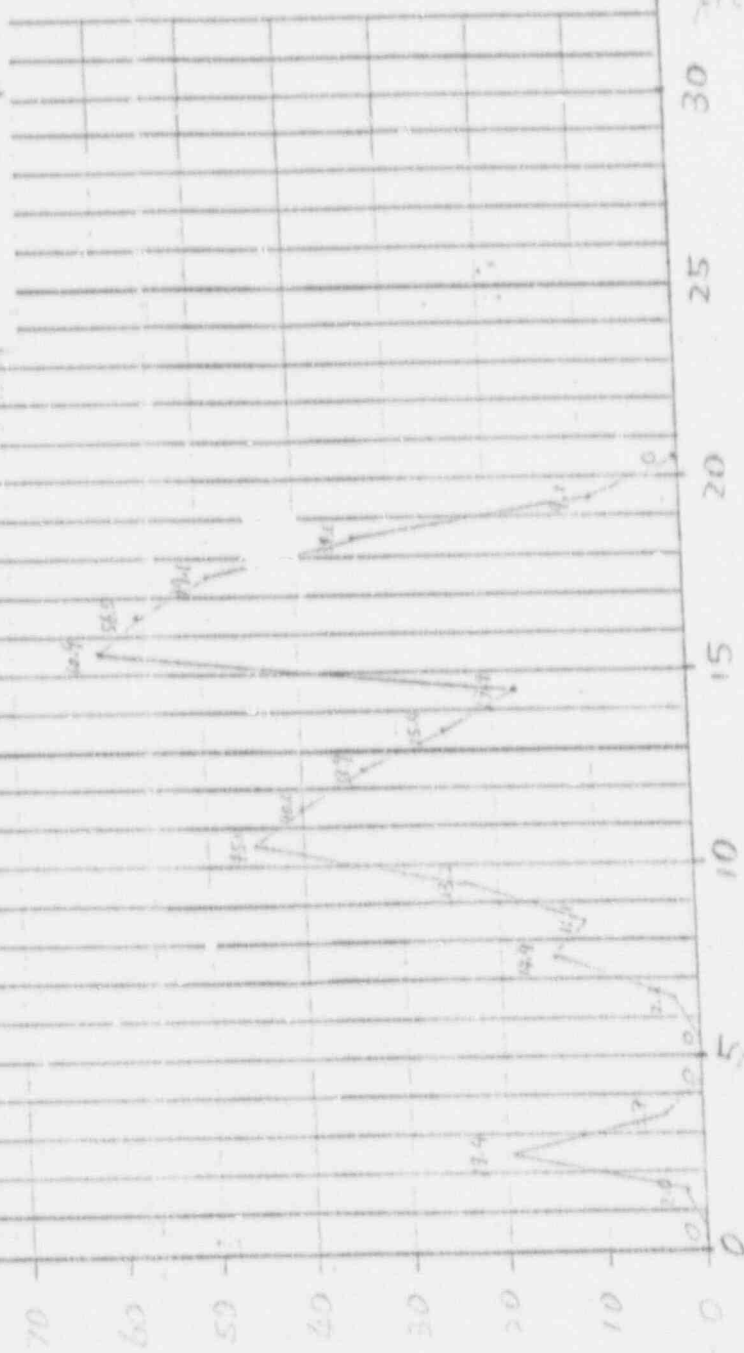
40 Acres
Evaporation Pond

Retention Basin
Surface Area
Sediment Volume
10-yr 20-yr storm
Total Capacity
11 Acres
11 AC-FT
53.5 AC-FT
100 AC-FT

Accumulative Water Volume (Acres - Feet)

SI APERTURE CARD

Also Available On
Aperture Card



UHTRA-FCF
3815-28
PYL 3/11/91
RCC 3/20/91

Time (Months)



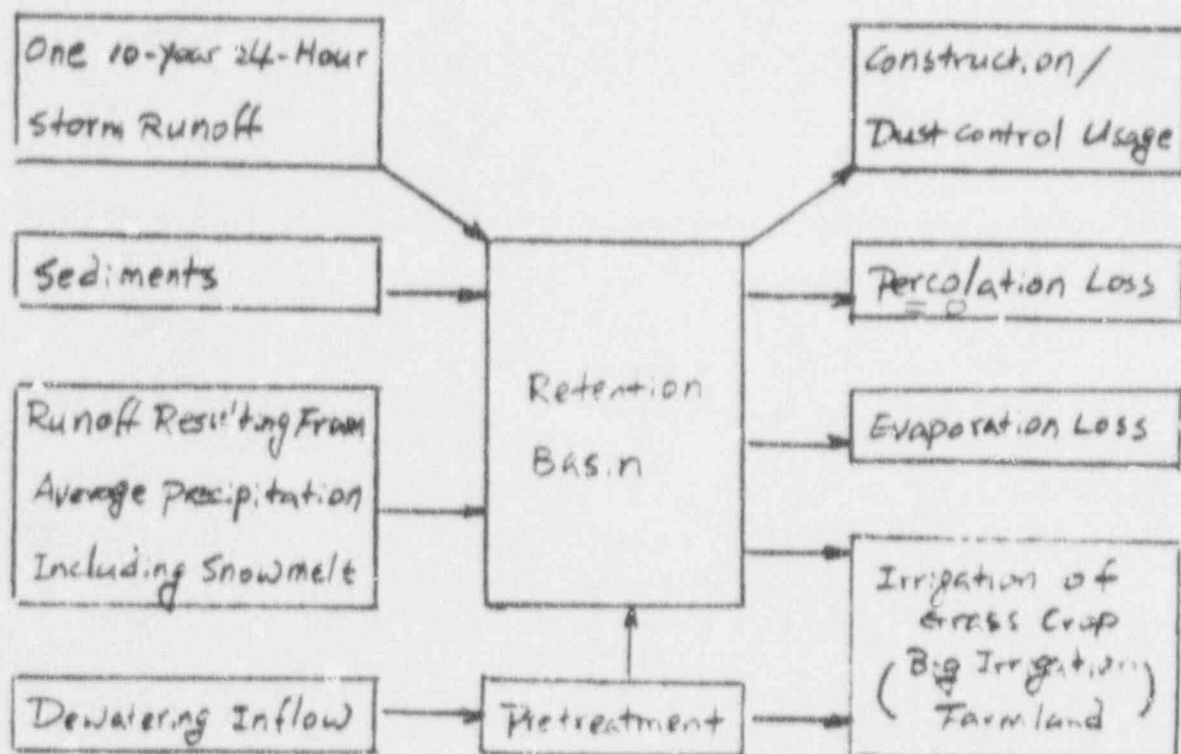
MORRISON-KNUDSEN CORPORATION

Project UMTRCA - ECT
Feature Wastewater Handling
Item _____

Contract No. 3255-28
Designed WYL
Checked A.C.

Sheet 162
File No. _____
Date 2/1/91
Date 2/22/91

C. Irrigation



Accumulating/Irrigation

(1) No 10-yr 24 Hr Storm Runoff

ACCUMULATING, IRRIGATION SCHEME, NO STORM RUNOFF INCLUDED

UNTRA/FALL CITY SITE

FILE: ACTROND.W2

IRRIGATION AREA = 30 AC

RETENTION BASIN CAPACITY(AC-FT)=to be determined

Avg Ann. Lake Evaporat'n (in.) = 54

INPUT

*****INPUT*****

*****INPUT*****

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* NOTE: NO 10-YEAR STORM RUNOFF

P109a

DATE: 03/06/91

PXL 3/6/91

Acc 2/22/91

-----WATER BALANCE-----
 ACCUMULATING"-----"ACCUMULATING"-----

ACTUAL CONSTR. WATER USAGE (AC-FT)	SURPLUS WATER (AC-FT)	EST. EVAPTR. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	*INPUT* IRRI- GATION WATER (AC-FT)	ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR.	*INPUT* RUNOFF AREA (ACRES)	*INPUT* POND EVAP. AREA (ACRES)	WTR. HT. IN POND & BASIN (FT.)	EXCESS WATER STOKED IN BASIN (AC-FT.)
2.374	0.000	2.282	1.234	6.5	0.000	0.039	118	13	0.000	0
2.600	7.892	2.282	2.600	6.5	0.252	0.039	110	13	0.019	0.25
2.600	19.552	2.691	2.600	6.5	11.959	0.046	118	13	0.920	11.96
1.182	0.000	4.270	2.600	6.5	1.239	0.073	118	13	0.055	1.24
2.600	2.671	4.797	2.600	6.5	0.000	0.082	118	13	0.000	0
2.600	6.942	5.967	2.600	6.5	0.000	0.102	118	13	0.000	0
4.640	22.437	6.172	4.640	6.5	12.851	0.127	142	10.8	1.190	12.85
4.640	38.040	5.470	4.640	6.5	41.657	0.143	166	8.5	4.901	41.66
4.640	19.539	5.087	4.640	6.5	52.152	0.133	183	8.5	6.135	52.16
4.640	6.361	3.672	4.640	6.5	50.177	0.096	200	8.5	5.903	50.18
4.640	8.363	2.716	4.640	6.5	50.683	0.071	200	8.5	5.963	50.69
4.640	1.383	1.874	4.640	6.5	44.629	0.049	200	8.5	5.250	44.63
3.723	0.000	1.492	4.640	6.5	36.465	0.039	200	8.5	4.290	36.47
2.106	0.000	1.492	4.640	6.5	26.685	0.039	200	8.5	3.139	26.68
3.370	0.000	1.760	4.640	6.5	18.035	0.046	200	8.5	2.122	18.04
0.000	0.562	2.792	0.000	6.5	10.701	0.173	166	8.5	1.759	10.70
0.000	7.209	3.137	0.000	6.5	9.842	0.082	166	8.5	1.158	9.84
0.000	3.006	3.902	0.000	6.5	4.397	0.102	41	8.5	0.517	4.39
0.000	1.242	4.850	0.000	6.5	0.000	0.127	41	8.5	0.000	0
0.000	0.000	1.817	0.000	6.5	0.000	0.143	41	8.5	0.000	
0.000	0.000	1.115	0.000	6.5	0.000	0.133	41	8.5	0.000	
0.000	1.796	3.632	0.000	6.5	0.000	0.096	41	8.5	0.000	
0.000	2.433	2.776	0.000	6.5	0.000	0.071	41	8.5	0.000	
0.000	0.997	1.874	0.000	6.5	0.000	0.049	41	8.5	0.000	
0.000	0.517	1.253	0.000	6.5	0.000	0.039	41	8.5	0.000	
0.000	0.052	0.798	0.000	6.5	0.000	0.039	41	8.5	0.000	
0.000	0.436	1.116	0.000	6.5	0.000	0.046	41	8.5	0.000	
0.000	0.000	0.666	0.000	6.5	0.000	0.073	41	8.5	0.000	
0.000	1.453	3.021	0.000	6.5	0.000	0.082	41	8.5	0.000	
0.000	3.006	3.942	0.000	6.5	0.000	0.102	41	8.5	0.000	
0.000	1.242	3.641	0.000	6.5	0.000	0.127	41	8.5	0.000	
0.000	0.000	1.817	0.000	6.5	0.000	0.143	41	8.5	0.000	
0.000	0.000	2.115	0.000	6.5	0.000	0.133	41	8.5	0.000	
0.000	1.796	3.632	0.000	6.5	0.000	0.096	41	8.5	0.000	

61.855

117.0

← Dry in 18 months/30-acre farmland

7/2/91

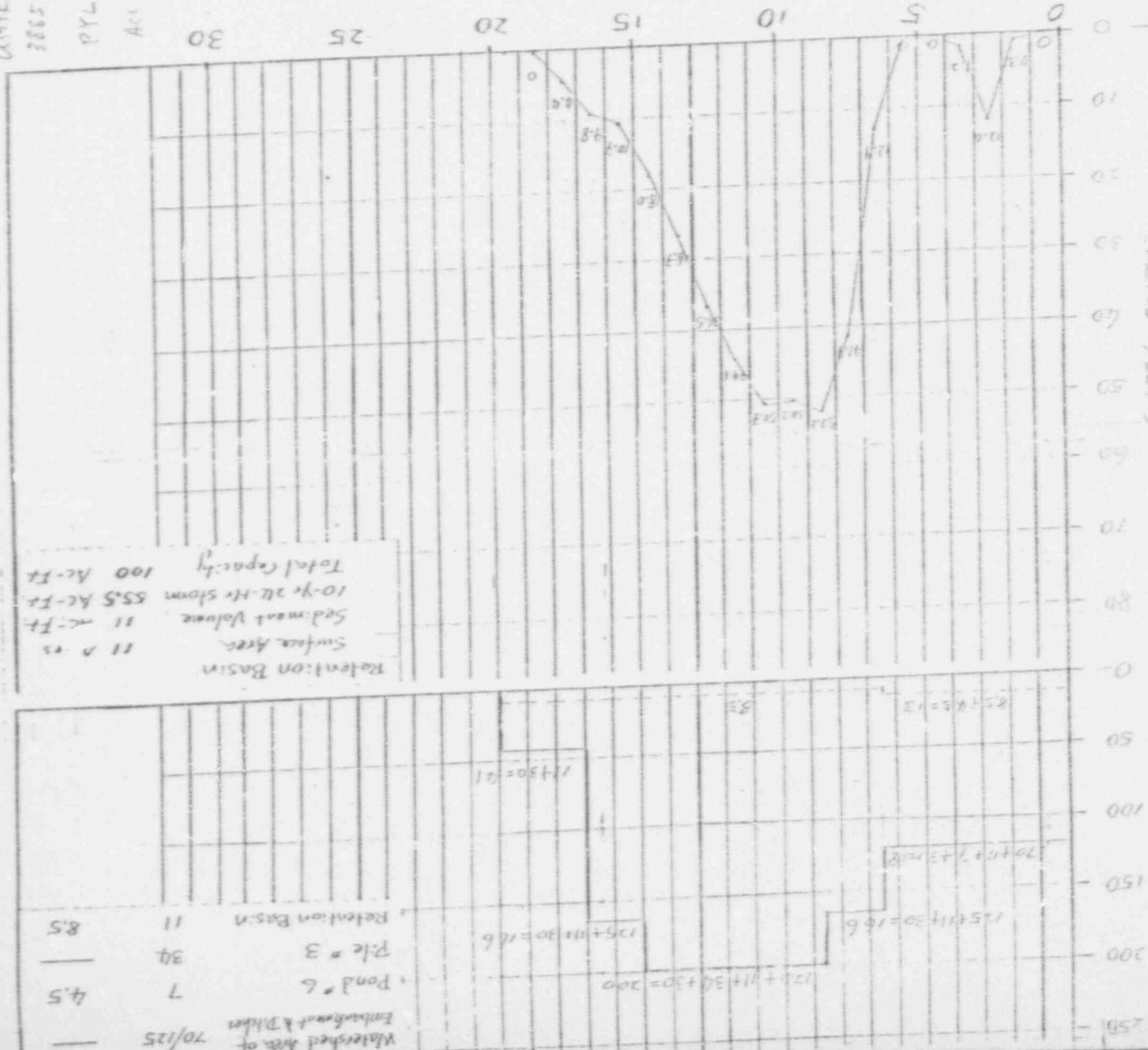
Also Available On
Aperture Card

SI APERTURE CARD

Accumulative Water Volume
(Acres-Feet)

30 Acres Farm land
For Irrigation

Runoff Area or Equip. Area
(Acres)



Retention Basin
Surface Area 11 A. vs
Sediment Volume 11 mc-ft
10-yr 24-Hr storm 55.5 Ac-ft
Total Capacity 100 Ac-ft

Watershed Area of
Embarkment & Ditches 70/125
Pond # 6 7
Pond # 3 34
Retention Basin 11
8.5

Time (Months)

UNITED-TEC

3865-28

16/11/91

19/22/91

C. Accumulating / Irrigation

(2) 10-yr. 24 hr Storm Runoff To Chicago L.

ACCUMULATING. IRRIGATION SCHEME, 10-YEAR STORM RUNOFF INCLUDED

SPRING/FALL CITY SIZE

FILE: ACCIRRS0 WK2

IRRIGATION AREA = 60 AC.

RETENTION BASIN CAPACITY (AC-FY) = to be determined

[illegible]AVG ANN. LAKE EVAPORAT^N (IN)^c 54

MONTH	SOIL NO.	MEAN NO. DAYS	MEAN TEMP.	***** INPUT *****		SNOW MEAN	SNOW FALL	SUBLIM.	ACCU.	SNOW-MELT	TOTAL RAINFALL & SNOW	NUMBER OF EVENTS	WATER PER EVENT	5" -SCS-	TOTAL RUNOFF VOLUME	*INPUT*	
				DEG. F	PRECIP.											REQ'D	ASSUMED
				(IN. MTR.)	(IN. MTR.)	(IN. MTR.)	(IN. MTR.)	(IN. MTR.)	(INCHES OF SNOW)	(IN. MTR.)	(IN. MTR.)	(AC-FT)	(AC-FT)	(IN. MTR.)	(AC-FT)	(AC-FT)	(AC-FT)
1991 DEC	83.8	4	56.0	1.83	0.0	0	1.83	0	0.00	0.00	1.83	2	0.92	1.933	2.798	2.60	1.18
1992 JAN	83.8	3	54.0	1.54	0.1	0	1.54	0	0.00	0.00	1.54	2	0.77	1.933	1.565	2.60	10.31
FEB	83.8	5	58.0	2.39	0.0	0	2.39	0	0.00	0.00	2.39	3	0.80	1.933	2.655	2.60	25.16
MAR	83.8	2	63.0	0.99	0.0	0	0.99	0	0.00	0.00	0.99	1	0.99	1.933	1.770	2.60	1.18
APR	83.8	4	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2.70	2	1.35	1.933	7.503	2.60	1.18
MAY	83.8	4	78.0	3.50	0.0	0	3.50	0	0.00	0.00	3.50	2	1.75	1.933	13.908	2.60	1.18
JUN	83.7	4	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2.98	2	1.49	1.947	11.391	4.64	20.59
JUL	83.5	2	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1.48	1	1.48	1.976	6.280	4.64	40.00
AUG	83.4	3	86.0	4.28	0.0	0	2.28	0	0.00	0.00	2.28	2	1.14	1.990	7.152	4.64	20.43
SEP	83.3	5	81.0	3.64	0.0	0	3.64	0	0.00	0.00	3.64	3	1.21	2.005	13.470	4.64	19.84
OCT	83.3	4	72.0	3.03	0.0	0	3.03	0	0.00	0.00	3.03	2	1.52	2.005	15.254	4.64	0.86
NOV	83.3	4	63.0	2.19	0.0	0	2.19	0	0.00	0.00	2.19	2	1.10	2.005	6.842	4.64	0.86
DEC	83.3	4	56.0	1.83	0.0	0	1.83	0	0.00	0.00	1.83	2	0.92	2.005	4.021	4.64	0.86
1993 JAN	83.3	3	54.0	1.54	0.1	0	1.54	0	0.00	0.00	1.54	2	0.77	2.005	2.199	4.64	0.86
FEB	83.3	5	58.0	2.39	0.0	0	2.39	0	0.00	0.00	2.39	3	0.80	2.005	3.751	4.64	0.86
MAR	83.5	2	63.0	0.99	0.0	0	0.99	0	0.00	0.00	0.99	1	0.99	1.976	2.248	0.00	89.00
APR	83.5	4	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2.70	2	1.35	1.976	10.161	0.00	0.00
MAY	85.2	4	78.0	3.50	0.0	0	3.50	0	0.00	0.00	3.50	2	1.75	1.737	7.414	0.00	0.00
JUN	85.2	4	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2.98	2	1.49	1.737	5.365	0.00	0.00
JUL	85.2	2	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1.48	1	1.48	1.737	2.645	0.00	0.00
AUG	85.2	3	86.0	2.28	0.0	0	2.28	0	0.00	0.00	2.28	2	1.14	1.737	2.939	0.00	0.00

* NOTE: 10-YEAR STORM RUNOFF FROM LIFEGUARDMENT & IRRIGATION AREA (55.5+33.5). 2)POND#6 (1.9). & 3)PILE #3 (18.98) ADDED TO DEWATERING INFLOW

136.844 57.36 230.35

p. 111 a

PYL 3/6/91

Acc 7/26/91

p. 11 b

DATE: 03/06/91

WATER BALANCE									
ACCUMULATING									
ACTUAL CONSTR. USAGE (AC-FT)	SURPLUS WATER (AC-FT)	EST. EVAPTR. (AC-FT)	ACTUAL CONSTR. USAGE (AC-FT)	*INPUT* IRRIG- GATION WATER (AC-FT)	*INPUT* ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR. (AC-FT)	*INPUT* RUNOFF AREA (ACRES)	*INPUT* POND EVAP. AREA (ACRES)	WTR HT IN POND & BASIN (FT)
2.600	0.237	2.282	1.696	13.0	0.000	0.039	148	13	0.060
2.600	0.134	2.282	2.600	13.0	0.000	0.039	148	13	0.060
2.600	23.669	2.691	2.600	13.0	9.524	0.046	146	13	0.713
1.150	0.000	4.270	2.600	13.0	0.000	0.073	148	13	0.060
2.600	4.085	4.797	2.600	13.0	0.000	0.082	148	13	0.060
2.600	9.505	5.967	2.600	13.0	0.000	0.102	148	13	0.060
4.640	24.255	6.172	4.640	13.0	6.169	0.127	172	10.8	0.756
4.640	38.905	5.470	4.640	13.0	31.339	0.143	196	8.5	0.607
4.640	20.398	5.087	4.640	13.0	36.193	0.133	213	8.5	0.58
4.640	26.803	3.672	4.640	13.0	48.191	0.096	230	8.5	0.670
4.640	10.116	2.716	4.640	13.0	43.949	0.071	230	8.5	0.770
4.640	2.125	1.874	4.640	13.0	32.137	0.049	230	8.5	0.781
4.135	0.000	1.492	4.640	13.0	17.886	0.039	230	8.5	0.604
2.313	0.000	1.492	4.640	13.0	1.814	0.039	230	8.5	0.623
0.000	0.000	1.760	4.640	13.0	0.000	0.046	230	8.5	0.600
0.000	89.852	2.792	0.000	13.0	75.455	0.073	196	8.5	0.877
0.000	8.593	3.137	0.000	13.0	69.480	0.082	196	8.5	0.874
0.000	5.464	3.902	0.000	13.0	59.993	0.102	71	8.5	0.858
0.000	2.936	4.858	0.000	13.0	47.500	0.127	71	8.5	0.868
0.000	0.000	5.470	0.000	13.0	31.675	0.143	71	8.5	0.876
0.000	0.395	5.087	0.000	13.0	16.526	0.133	71	8.5	0.844
0.000	3.277	3.672	0.000	13.0	4.967	0.096	71	8.5	0.804
0.000	1.196	2.716	0.000	13.0	0.000	0.071	71	8.5	0.800
0.000	1.725	0.871	0.000	13.0	0.000	0.049	71	8.5	0.800
0.000	0.908	0.492	0.000	13.0	0.000	0.039	71	8.5	0.800
0.000	0.233	0.908	0.000	13.0	0.000	0.046	71	8.5	0.800
0.000	0.759	1.659	0.000	13.0	0.000	0.073	71	8.5	0.800
0.000	0.000	1.627	0.000	13.0	0.000	0.082	71	8.5	0.800
0.000	3.773	3.337	0.000	13.0	0.000	0.102	71	8.5	0.800
0.000	5.464	3.302	0.000	13.0	0.000	0.127	71	8.5	0.800
0.000	2.936	4.858	0.000	13.0	0.000	0.143	71	8.5	0.800
0.000	0.000	2.655	0.000	13.0	0.000	0.16	71	8.5	0.800
0.000	0.385	2.936	0.000	13.0	0.000	0.133	71	8.5	0.800
0.000	3.277	3.672	0.000	13.0	0.000	0.096	71	8.5	0.800

← Dry in 22 months/60-acre farmland

216.0

80.991

Wastewater Handling Study (UMTRA / Falls City Site)

C. Accumulating / Irrigation

(2) 10-Yr 24-Hr Storm Runoff Included

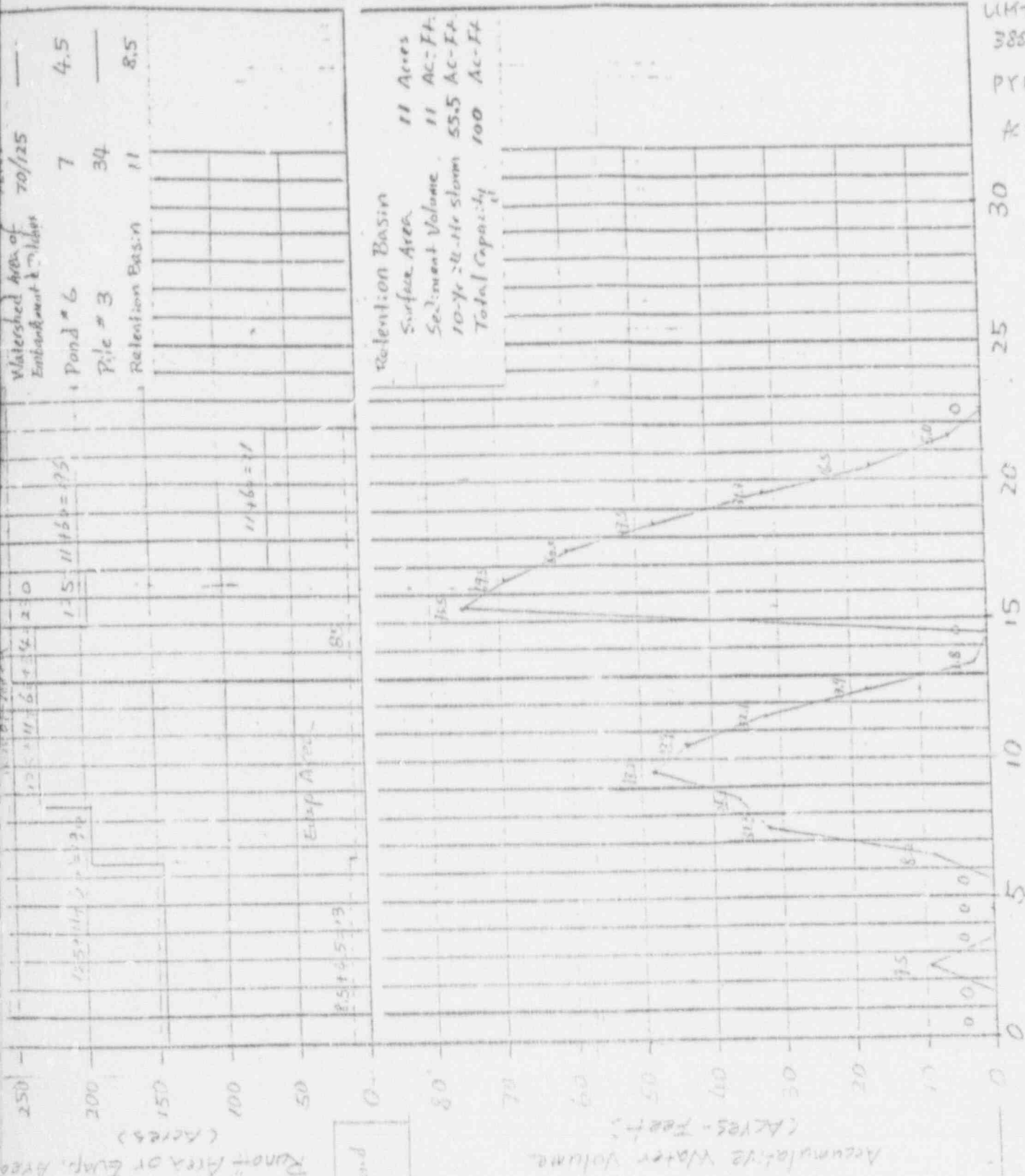
Project Start

Water Balance Start

Project End

	1991	1992	1993	1994	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Pile #4 (Retention Basin)																	
Pile #5																	
Pile #1, 2, 7																	
Pile #3																	
Pond #6																	
Windblown Material																	
Reclaim Batteries / Lead Acid (Topsoil)																	
Erosion Protection (Side Slope)																	
Site Restoration																	
10-Yr 24-Hr Storm																	
Furrow Land (Ac-Ft)																	
Planting in Piles (Ac-Ft)																	
10-Yr 24-Hr 5 ¹ / ₂ min Retention Basin (Ac-Ft)																	
Construction Water for Dust Control (Ac-Ft)																	
	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81
	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59
	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16
	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5
	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50	Σ = 33.50
	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47	Σ = 122.47
	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40	Σ = 78.40
	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36	Σ = 57.36

Runoff Area Eloop Area



SI APERTURE CARD

Also Available On
Aperture Card



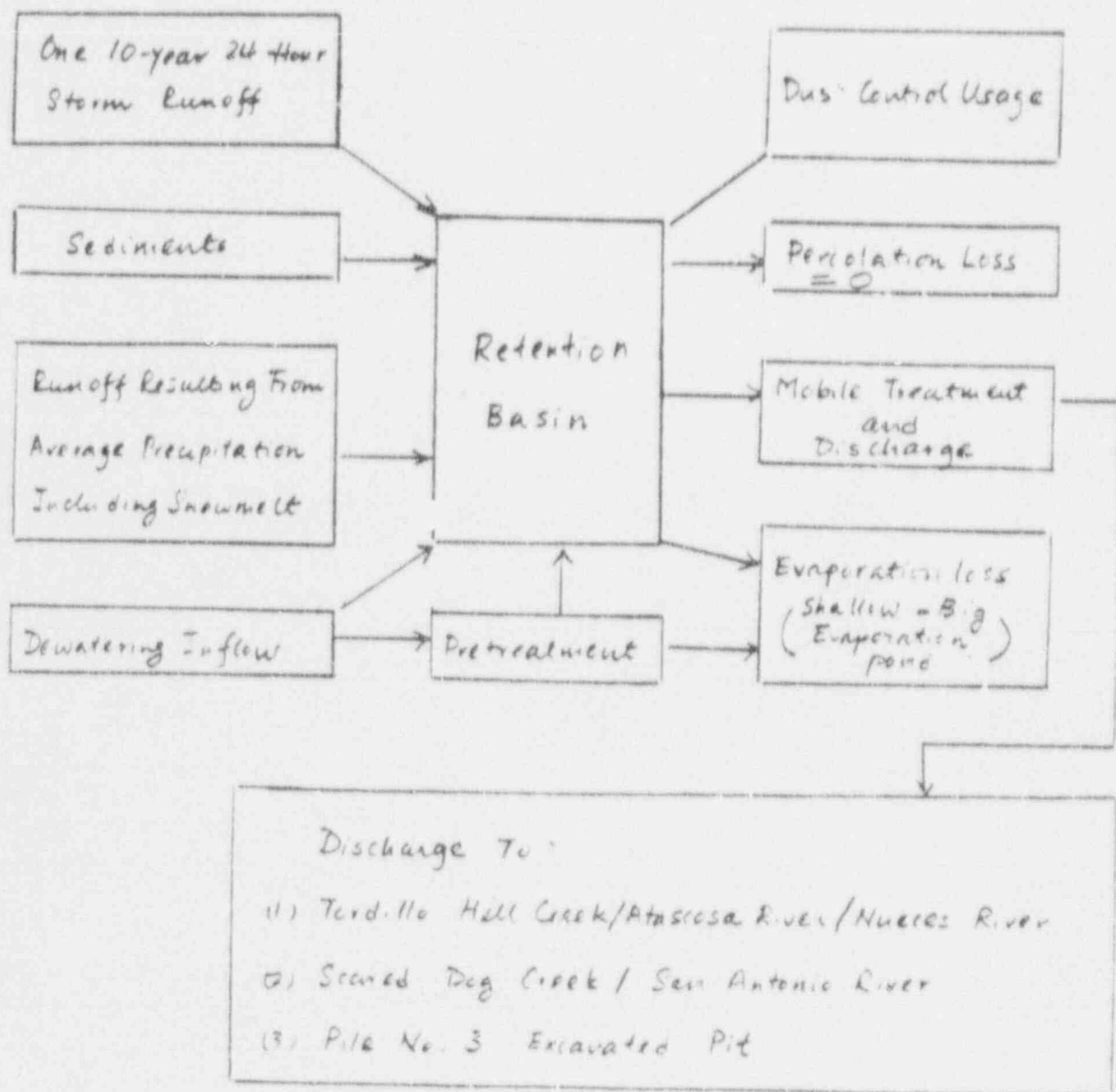
MORRISON-KNUDSEN CORPORATION

Project LMTRA - FCT
Feature Wastewater Handling II
Item _____

Contract No. 3855-28
Designed PYL
Checked ACC

Sheet 113
File No. _____
Date 3/11/91
Date 3/22/91

D. Mobile Treatment / Evaporation Pond



Calculating Mobile Treatment/Evaporation P

(1) No 10-yr 24-Hr Storm Runoff

UTRA/FALL CITY SITE
FALL-MAYFORD, MO

INPUT

RETENTION BASIN CAPACITY(AC-FT) to be determined

AVG ANNUAL LARE EVAPORAT'N (IN.) = 54

MONTH	SOIL MEAN NO.	MEAN TEMP.	MEAN PRECIP.	MEAN SNOW	SNOW FALL	RAIN FALL	SURF. ATTEN	ACCUM. SNOWPACK	SNOWPACK MELS	TOTAL RAINFALL	NUMBER OF PER EVENTS	WATER PER EVENT	SCS-10	TOTAL RUNOFF VOLUME	*INPUT* ASSUMED CONSTR. WATER REQ'D (AC-FT)	*INPUT* ASSUMED DE-ICEING WATER REQ'D (AC-FT)	EST. EMPTN.
		DEG. F	(IN.)	(IN.)	(IN.)	(IN.)	(IN.)	(IN.)	(IN.)	(IN.)		(MTR.)	(IN.)	(AC-FT)	(AC-FT)	(AC-FT)	(AC-FT)
1991 DEC	84.7	56.0	1.83	0.0	0	1.83	0	0.00	0.00	1.83	2	0.92	1.806	1.995	2.60	1.18	1.14
1992 JAN	84.7	54.0	1.54	0.1	0	1.54	0	0.00	0.00	1.54	2	0.77	1.806	1.106	2.60	10.31	1.106
FEB	84.7	58.0	2.39	0.0	0	2.39	0	0.00	0.00	2.39	3	0.80	1.806	1.860	2.60	21.26	1.346
MAR	84.7	63.0	0.99	0.0	0	0.99	0	0.00	0.00	0.99	1	0.99	1.806	1.190	2.60	1.18	1.190
APR	84.7	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2.70	2	1.35	1.806	5.130	2.60	1.18	2.399
MAY	84.7	78.0	3.50	0.0	0	3.50	0	0.00	0.00	3.50	2	1.75	1.806	8.853	2.60	1.18	2.994
JUN	84.3	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2.98	2	1.49	1.862	7.823	4.64	20.59	3.066
JUL	83.9	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1.48	1	1.48	1.919	4.517	4.64	40.00	2.755
AUG	84.5	86.0	2.28	0.0	0	2.28	0	0.00	0.00	2.28	2	1.14	1.834	5.846	4.64	20.43	2.544
SEP	83.6	81.0	3.64	0.0	0	3.64	0	0.00	0.00	3.64	3	1.21	1.962	10.294	4.64	0.86	1.856
OCT	83.6	72.0	3.03	0.0	0	3.03	0	0.00	0.00	3.03	2	1.52	1.962	11.578	4.64	0.86	1.358
NOV	83.6	63.0	2.19	0.0	0	2.19	0	0.00	0.00	2.19	2	1.10	1.962	5.250	4.64	0.86	0.937
DEC	83.6	56.0	1.83	0.0	0	1.83	0	0.00	0.00	1.83	2	0.92	1.962	3.115	4.64	0.86	0.746
1993 JAN	83.6	54.0	1.54	0.1	0	1.54	0	0.00	0.00	1.54	2	0.77	1.962	1.727	4.64	0.86	0.746
FEB	83.6	58.0	2.39	0.0	0	2.39	0	0.00	0.00	2.39	3	0.80	1.962	2.956	4.64	0.86	0.880
MAR	83.9	63.0	0.99	0.0	0	0.99	0	0.00	0.00	0.99	1	0.99	1.919	1.669	0	0.00	1.396
APR	83.9	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2.70	2	1.35	1.919	7.334	0	0.00	1.568
MAY	100.0	78.0	3.50	0.0	0	3.50	0	0.00	0.00	3.50	2	1.75	0.000	3.208	0	0.00	1.951
JUN	100.0	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2.98	2	1.49	0.000	2.732	0	0.00	2.429
JUL	100.0	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1.48	1	1.48	0.000	1.357	0	0.00	1.357
AUG	100.0	86.0	2.28	0.0	0	2.28	0	0.00	0.00	2.28	2	1.14	0.000	2.090	0	0.00	2.090
SEP	100.0	81.0	3.64	0.0	0	3.64	0	0.00	0.00	3.64	3	1.21	0.000	3.337	0	0.00	1.836
OCT	100.0	72.0	3.03	0.0	0	3.03	0	0.00	0.00	3.03	2	1.52	0.000	2.778	0	0.00	1.358
NOV	100.0	63.0	2.19	0.0	0	2.19	0	0.00	0.00	2.19	2	1.10	0.000	2.008	0	0.00	0.937
DEC	100.0	56.0	1.83	0.0	0	1.83	0	0.00	0.00	1.83	2	0.92	0.000	1.678	0	0.00	0.746
1994 JAN	100.0	54.0	1.54	0.1	0	1.54	0	0.00	0.00	1.54	2	0.77	0.000	1.412	0	0.00	0.746
FEB	100.0	58.0	2.39	0.0	0	2.39	0	0.00	0.00	2.39	3	0.80	0.000	2.901	0	0.00	0.880
MAR	100.0	63.0	0.97	0.0	0	0.99	0	0.00	0.00	0.99	1	0.99	0.000	0.908	0	0.00	0.908
APR	100.0	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2.70	2	1.35	0.000	2.675	0	0.00	1.568
MAY	100.0	78.0	3.50	0.0	0	3.50	0	0.00	0.00	3.50	2	1.75	0.000	3.208	0	0.00	1.951
JUN	100.0	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2.98	2	1.49	0.000	2.732	0	0.00	2.429
JUL	100.0	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1.48	1	1.48	0.000	1.357	0	0.00	1.357
AUG	100.0	86.0	2.28	0.0	0	2.28	0	0.00	0.00	2.28	2	1.14	0.000	2.090	0	0.00	2.090
SEP	100.0	81.0	3.64	0.0	0	3.64	0	0.00	0.00	3.64	3	1.21	0.000	3.337	0	0.00	1.836
OCT	100.0	72.0	3.03	0.0	0	3.03	0	0.00	0.00	3.03	2	1.52	0.000	2.778	0	0.00	1.358
NOV	100.0	63.0	2.19	0.0	0	2.19	0	0.00	0.00	2.19	2	1.10	0.000	2.008	0	0.00	0.937
DEC	100.0	56.0	1.83	0.0	0	1.83	0	0.00	0.00	1.83	2	0.92	0.000	1.678	0	0.00	0.746
1994 JAN	100.0	54.0	1.54	0.1	0	1.54	0	0.00	0.00	1.54	2	0.77	0.000	1.412	0	0.00	0.746
FEB	100.0	58.0	2.39	0.0	0	2.39	0	0.00	0.00	2.39	3	0.80	0.000	2.901	0	0.00	0.880
MAR	100.0	63.0	0.97	0.0	0	0.99	0	0.00	0.00	0.99	1	0.99	0.000	0.908	0	0.00	0.908
APR	100.0	71.0	2.70	0.0	0	2.70	0	0.00	0.00	2.70	2	1.35	0.000	2.675	0	0.00	1.568
MAY	100.0	78.0	3.50	0.0	0	3.50	0	0.00	0.00	3.50	2	1.75	0.000	3.208	0	0.00	1.951
JUN	100.0	83.0	2.98	0.0	0	2.98	0	0.00	0.00	2.98	2	1.49	0.000	2.732	0	0.00	2.429
JUL	100.0	85.0	1.48	0.0	0	1.48	0	0.00	0.00	1.48	1	1.48	0.000	1.357	0	0.00	1.357
AUG	100.0	86.0	2.28	0.0	0	2.28	0	0.00	0.00	2.28	2	1.14	0.000	2.090	0	0.00	2.090
SEP	100.0	81.0	3.64	0.0	0	3.64	0	0.00	0.00	3.64	3	1.21	0.000	3.337	0	0.00	1.836

* NOTE: NO STORM RUNOFF

87.594 57.36 122.07

p 114 a

DATE: 03/08/91

242 3/8/91

Acc 3/22/91

-----WATER BALANCE-----

ACCUMULATING

ACTUAL CONSTR. WATER USAGE (AC-FT)	SURPLUS WATER (AC-FT)	*INPUT* WATER TREATED & DISCHARGED (AC-FT)	EST. EVAPTN. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	ACCUM. WTR. VOLUME (AC-FT)	*INPUT* EVAP. DISTR. FTR. (ACRES)	*INPUT* RUNOFF AREA (ACRES)	*INPUT* POND EVAP. AREA (ACRES)	WTR.HT. IN POND & BASIN (FT.)
1.945	0.000	4.86	2.282	0.000	0.000	0.039	88	13	0.000
2.600	7.710	4.86	2.282	2.600	1.675	0.039	88	13	0.129
2.600	19.175	4.86	2.691	2.600	14.644	0.046	88	13	1.126
1.180	0.000	4.86	4.270	2.600	5.284	0.073	88	13	0.406
2.600	1.311	4.86	4.797	1.937	0.000	0.082	88	13	0.000
2.600	4.449	4.86	5.967	0.000	0.000	0.102	88	13	0.000
4.640	20.687	4.86	6.172	4.640	12.741	0.127	112	10.8	1.180
4.640	37.142	4.86	5.470	4.640	42.288	0.143	136	8.5	4.975
4.640	19.092	4.86	5.087	4.640	53.976	0.133	153	8.5	6.350
4.640	4.678	4.86	3.672	4.640	51.959	0.096	170	8.5	6.113
4.640	6.440	4.86	2.716	4.640	52.181	0.071	170	8.5	6.139
4.640	0.533	4.86	1.874	4.640	46.917	0.049	170	8.5	5.520
3.230	0.000	4.86	1.492	4.640	39.900	0.039	170	8.5	4.694
1.842	0.000	4.86	1.492	4.640	31.496	0.039	170	8.5	3.705
2.917	0.000	4.86	1.760	4.640	24.033	0.046	170	8.5	2.827
0.000	0.253	4.86	2.792	0.000	18.030	0.073	136	8.5	2.121
0.000	5.766	4.86	3.137	0.000	17.368	0.082	136	8.5	2.043
0.000	1.258	4.86	3.902	0.000	11.815	0.102	11	8.5	1.390
0.000	0.303	4.86	4.858	0.000	4.829	0.127	11	8.5	0.568
0.000	0.000	4.86	5.470	0.000	0.000	0.143	11	8.5	0.000
0.000	0.000	4.86	2.090	0.000	0.000	0.133	11	8.5	0.000
0.000	1.501	4.86	3.337	0.000	0.000	0.096	11	8.5	0.000
0.000	1.420	4.86	2.716	0.000	0.000	0.071	11	8.5	0.000
0.000	1.070	4.86	1.874	0.000	0.000	0.049	11	8.5	0.000
0.000	0.932	4.86	1.492	0.000	0.000	0.039	11	8.5	0.000
0.000	0.666	4.86	1.612	0.000	0.000	0.039	11	8.5	0.000
0.000	1.311	4.86	1.760	0.000	0.000	0.046	11	8.5	0.000
0.000	0.000	4.86	0.508	0.000	0.000	0.073	11	8.5	0.000
0.000	0.907	4.86	2.475	0.000	0.000	0.082	11	8.5	0.000
0.000	1.258	4.86	3.208	0.000	0.000	0.102	11	8.5	0.000
0.000	0.303	4.86	2.732	0.000	0.000	0.127	11	8.5	0.000
0.000	0.000	4.86	1.351	0.000	0.000	0.143	11	8.5	0.000
0.000	0.000	4.86	2.090	0.000	0.000	0.133	11	8.5	0.000
0.000	1.501	4.86	3.337	0.000	0.000	0.096	11	8.5	0.000

← Day in 19 months / No pond Required

92.34 66.713

P1146

D. Accur. Eng./Mobile Treatment/Expansion Bond
Westerwater Hanging Study
(UMTRA / Falls C. by site)
14-16 Storm Runoff
(1) NO 10-yr

(UMTRA / Falls City site)

Dropt Ends

Project Starts	Water Balance Starts	Water Balance Ends	1991	1992	1993	1994
Pile #4 (Retention Basin)						
Pile #5						
Pile #1, 2, 7						
Pile #3						
Pile #6						
Additional Material						
Retention Basin (Slope)						
Erosion Protection (Slope)						
Site Restoration						
Mobile Treatment (Ac-ft)						
Dewatering in Piles (Ac-ft)						
10-Yr 24-Hr Storm in Retention Basin (Ac-ft)						
Construction Water for Dust Control (Ac-ft)						



D. Accumulating / Mobile Treatment / Evaporative Sub 10-yr. 24-hr Storm Runoff Included

MURKIN TREATMENT FACILITY, 30 YR 24 HR STORM RUNOFF, 1991-1994
 UNIT 24-HR CITY SITE
 FILE: MURKIN.MKT

RETENTION BASIN CAPACITY (AC-FT) to be determined
 CALCULATION: $100 \times 100 \times 10 = 1,000,000$
 AVG ANN. LAKE EVAPORATION (IN.) = 54

***** INPUT *****

MONTH	SOIL MO.	SCS MO.	DEG. F	PRECIP. (IN.)	MEAN PRECIP. (IN.)	MEAN SNOW (IN.)	RAINFALL (IN.)	SUBST. ATION (IN.)	ACCUM. SNOW (IN.)	SNOW-MELT (IN.)	TOTAL RAINFALL & SNOW-MELT (IN.)	NUMBER OF PEAK EVENTS	WATER EVENT (IN.)	SCS-RUNOFF (IN.)	TOTAL RUNOFF VOLUME (AC-FT)	ASSUMED CONSTR. RES'D (AC-FT)	DE-ASSUMED INFLUX (AC-FT)	EST. EVAPOR. (AC-FT)
1991 DEC	66.9	66.9	56.0	1.83	0.0	0.0	1.83	0	0.00	0.00	1.83	2	0.92	1.507	3.046	2.60	1.18	2.457
1992 JAN	66.9	66.9	54.0	1.54	0.1	0.0	1.54	0	0.00	0.00	1.54	2	0.77	1.507	1.907	2.60	10.31	1.907
FEB	66.9	66.9	58.0	2.39	0.0	0.0	2.39	0	0.00	0.00	2.39	2	0.80	1.507	3.153	2.60	25.16	2.808
MAR	66.9	66.9	63.0	0.99	0.0	0.0	0.99	0	0.00	0.00	0.99	1	0.99	1.507	1.853	2.60	1.18	1.853
APR	66.9	66.9	71.0	2.70	0.0	0.0	2.70	0	0.00	0.00	2.70	2	1.35	1.507	7.384	2.60	1.18	5.166
MAY	66.9	66.9	78.0	3.50	0.0	0.0	3.50	0	0.00	0.00	3.50	2	1.75	1.507	12.185	2.60	1.18	6.426
JUN	66.2	66.2	83.0	2.98	0.0	0.0	2.98	0	0.00	0.00	2.98	2	1.49	1.601	10.454	4.64	20.59	7.372
JUL	85.5	85.5	85.0	1.48	0.0	0.0	1.48	0	0.00	0.00	1.48	1	1.48	1.696	5.773	4.64	40.90	5.773
AUG	85.3	85.3	86.0	2.28	0.0	0.0	2.28	0	0.00	0.00	2.28	2	1.14	1.723	7.032	4.64	20.43	7.032
SEP	85.0	85.0	81.0	3.64	0.0	0.0	3.64	0	0.00	0.00	3.64	3	1.21	1.765	13.042	4.64	19.84	5.076
OCT	85.0	85.0	72.0	3.03	0.0	0.0	3.03	0	0.00	0.00	3.03	2	1.52	1.765	14.226	4.64	19.84	3.754
NOV	85.0	85.0	63.0	2.19	0.0	0.0	2.19	0	0.00	0.00	2.19	2	1.10	1.765	6.773	4.64	19.84	2.591
DEC	85.0	85.0	56.0	1.83	0.0	0.0	1.83	0	0.00	0.00	1.83	2	0.92	1.765	4.186	4.64	19.84	2.062
1993 JAN	85.0	85.0	54.0	1.54	0.1	0.0	1.54	0	0.00	0.00	1.54	2	0.77	1.765	2.458	4.64	19.84	2.062
FEB	85.0	85.0	58.0	2.39	0.0	0.0	2.39	0	0.00	0.00	2.39	2	0.80	1.765	4.123	4.64	19.84	2.432
MAR	85.5	85.5	63.0	0.99	0.0	0.0	0.99	0	0.00	0.00	0.99	1	0.99	1.696	2.271	0	19.84	2.271
APR	85.5	85.5	71.0	2.70	0.0	0.0	2.70	0	0.00	0.00	2.70	2	1.35	1.765	9.500	0	19.84	4.356
MAY	100.0	100.0	78.0	3.50	0.0	0.0	3.50	0	0.00	0.00	3.50	2	1.75	0.000	7.383	0	0.00	5.393
JUN	100.0	100.0	83.0	2.98	0.0	0.0	2.98	0	0.00	0.00	2.98	2	1.49	0.000	6.457	0	0.00	6.457
JUL	100.0	100.0	85.0	1.48	0.0	0.0	1.48	0	0.00	0.00	1.48	1	1.48	0.000	3.207	0	0.00	3.207
AUG	100.0	100.0	86.0	2.28	0.0	0.0	2.28	0	0.00	0.00	2.28	2	1.14	0.000	4.940	0	0.00	4.940
SEP	100.0	100.0	81.0	3.64	0.0	0.0	3.64	0	0.00	0.00	3.64	3	1.21	0.000	7.887	0	0.00	5.076
OCT	100.0	100.0	72.0	3.03	0.0	0.0	3.03	0	0.00	0.00	3.03	2	1.52	0.000	4.548	0	0.00	3.754
NOV	100.0	100.0	63.0	2.19	0.0	0.0	2.19	0	0.00	0.00	2.19	2	1.10	0.000	4.745	0	0.00	2.591
DEC	100.0	100.0	56.0	1.83	0.0	0.0	1.83	0	0.00	0.00	1.83	2	0.92	0.000	3.945	0	0.00	2.062
1994 JAN	100.0	100.0	54.0	1.54	0.1	0.0	1.54	0	0.00	0.00	1.54	2	0.77	0.000	3.207	0	0.00	2.062
FEB	100.0	100.0	58.0	2.39	0.0	0.0	2.39	0	0.00	0.00	2.39	2	0.80	0.000	5.178	0	0.00	2.432
MAR	100.0	100.0	63.0	0.99	0.0	0.0	0.99	0	0.00	0.00	0.99	1	0.99	0.000	2.455	0	0.00	2.143
APR	100.0	100.0	71.0	2.70	0.0	0.0	2.70	0	0.00	0.00	2.70	2	1.35	0.000	7.383	0	0.00	4.356
MAY	100.0	100.0	78.0	3.50	0.0	0.0	3.50	0	0.00	0.00	3.50	2	1.75	0.000	12.185	0	0.00	5.393
JUN	100.0	100.0	83.0	2.98	0.0	0.0	2.98	0	0.00	0.00	2.98	2	1.49	0.000	10.454	0	0.00	6.457
JUL	100.0	100.0	85.0	1.48	0.0	0.0	1.48	0	0.00	0.00	1.48	1	1.48	0.000	3.207	0	0.00	3.207
AUG	100.0	100.0	86.0	2.28	0.0	0.0	2.28	0	0.00	0.00	2.28	2	1.14	0.000	4.940	0	0.00	4.940
SEP	100.0	100.0	81.0	3.64	0.0	0.0	3.64	0	0.00	0.00	3.64	3	1.21	0.000	7.887	0	0.00	6.076

* NOTE: 10-YR 24-HR STORM RUNOFF FROM 1) COMBINATION (55.5), 2) POND (5.9), 3) PILE (18.98), & 4) EVAPORATION POND (0.4) ADDED TO DEWATERING VOL.

PYL 3/8/91
Acc 3/22/91

MAX 15.000

DATE: 03/08/91

-----WATER BALANCE-----
ACCUMULATING-----

ACTUAL CONSTR. WATER USAGE (AC-FT)	ACTUAL CORPUS WATER (AC-FT)	WATER TREATED (AC-FT)	EST. EVAPTR. (AC-FT)	ACTUAL CONSTR. WATER USAGE (AC-FT)	ACCU. WTR. VOLUME (AC-FT)	"INPUT" EVAP. DISTR. FTR.	"INPUT" RUMOFF AREA (ACRES)	"INPUT" POND EVAP. AREA (ACRES)	WTR. INT. IN POND & BASIN (FT.)	WTR. INT. IN POND & BASIN (FT.)	EXCESS WTR. STORED IN BASIN
1.769	0.000	4.86	4.226	0.000	0.000	0.039	103	28	0.000	0.000	0
2.600	7.710	4.86	4.914	2.443	0.000	0.039	103	28	0.000	0.000	0
2.600	22.815	4.86	5.796	2.600	15.057	0.046	103	28	0.538	0.88	0.88
1.180	0.000	4.86	9.198	2.600	1.432	0.073	103	28	0.071	0.071	0.071
2.600	0.798	4.86	9.995	0.000	0.000	0.082	103	28	0.000	0.000	0
2.600	4.339	4.86	12.852	0.000	0.000	0.102	103	28	0.000	0.000	0
4.640	19.032	4.86	14.745	4.640	8.799	0.127	127	25.8	0.264	0.264	0.264
4.640	35.360	4.86	15.122	4.640	27.950	0.143	151	23.5	1.189	1.0	1.0
4.640	15.790	4.86	14.065	4.640	31.848	0.133	168	23.5	3.355	1.0	1.0
4.640	23.166	4.86	10.152	4.640	45.078	0.096	185	23.5	9.818	1.0	1.0
4.640	15.092	4.86	7.508	4.640	51.556	0.071	185	23.5	2.904	1.0	1.0
4.640	0.402	4.86	5.102	4.640	44.507	0.549	185	23.5	1.894	1.0	1.0
2.984	0.000	4.86	4.124	4.640	35.930	0.039	185	23.5	1.529	1.0	1.0
1.256	0.000	4.86	4.124	4.640	25.627	0.039	185	23.5	1.900	1.0	1.0
2.551	0.000	4.86	4.865	4.640	16.242	0.046	185	23.5	0.491	0.491	0.491
0.000	55.500	4.86	7.720	0.000	61.434	0.073	151	23.5	2.414	1.0	1.0
0.000	5.164	4.86	8.672	0.000	57.402	0.082	151	23.5	2.143	1.0	1.0
0.000	2.190	4.86	10.786	0.000	49.339	0.102	26	23.5	2.800	1.0	1.0
0.000	0.000	4.86	13.430	0.000	37.506	0.127	26	23.5	1.594	1.0	1.0
0.000	0.000	4.86	15.122	0.000	20.730	0.143	26	23.5	0.882	0.882	0.882
0.000	0.000	4.86	14.065	0.000	4.745	0.133	26	23.5	0.287	0.287	0.287
0.000	2.811	4.86	10.152	0.000	0.000	0.096	26	23.5	0.000	0.000	0
0.000	2.811	4.86	8.567	0.000	0.000	0.071	26	23.5	0.000	0.000	0
0.000	2.154	4.86	7.746	0.000	0.000	0.049	26	23.5	0.000	0.000	0
0.000	1.903	4.86	5.905	0.000	0.000	0.039	26	23.5	0.000	0.000	0
0.000	1.275	4.86	3.327	0.000	0.000	0.039	26	23.5	0.000	0.000	0
0.000	2.744	4.86	4.865	0.000	0.000	0.046	26	23.5	0.000	0.000	0
0.000	0.000	4.86	2.745	0.000	0.000	0.073	26	23.5	0.000	0.000	0
0.000	1.514	4.86	5.860	0.000	0.000	0.082	26	23.5	0.000	0.000	0
0.000	2.190	4.86	7.243	0.000	0.000	0.102	26	23.5	0.000	0.000	0
0.000	0.000	4.86	6.457	0.000	0.000	0.127	26	23.5	0.000	0.000	0
0.000	0.000	4.86	3.203	0.000	0.000	0.143	26	23.5	0.000	0.000	0
0.000	0.000	4.86	4.940	0.000	0.000	0.133	26	23.5	0.000	0.000	0
0.000	2.811	4.86	1.887	0.000	0.000	0.096	26	23.5	0.000	0.000	0

0

4.44
8.34
21.37
28.06
21.01
12.93
2.12
8.93
25.9
25.85
10.01

0 - Dry in 21 months / 15. Area pond

102.06 196.665

(3) 10. 24-Hr. Storm Runoff Estimated
Wastewater Landfill Study
(UMTRA / Falls C. / Site)

Pepper Zeds

Winter Balance Ends

Water Balance starts

Project starts

SL 117

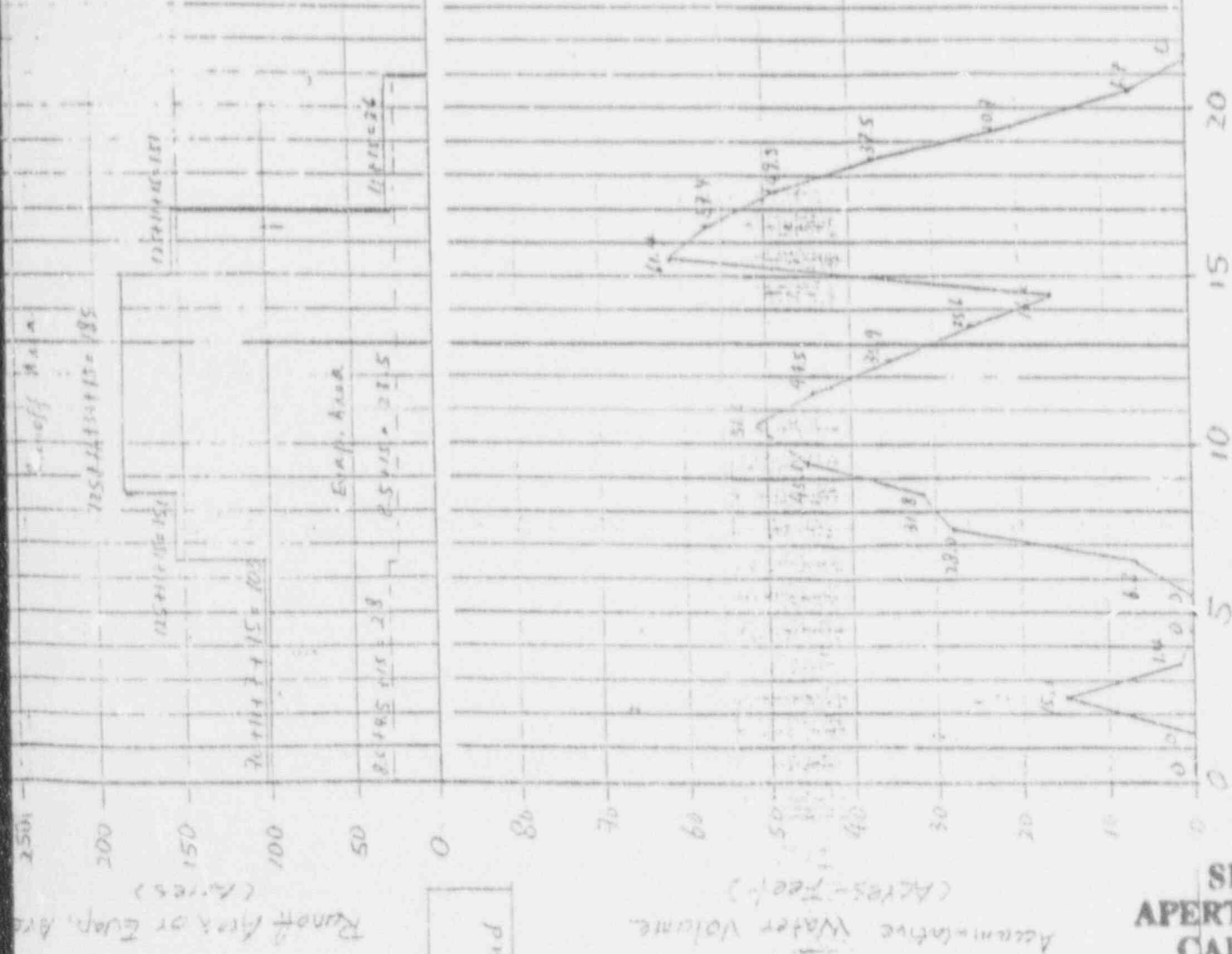
UMTRA-FET
3865-28

PYL 3/11/91

AC 3/22/91

Watershed Area of Embarkment & Dike	7.7/25
Pond # 6	7
Pile # 3	34
Retention Basin	11
	4.5
	8.5

Retention Basin	11 Acres
Surface Area	11 Ac. - 14
Seepage Volume	5.5 Ac. - 27
10-yr. Storage	100 Ac. - 22
Total Capacity	100 Ac. - 22



15 Acres
Evaporation Pond

SI
APERTURE
CARD

Also Available On
Aperture Card

9205110072-40

PROJECT UMIRA CONTR. NO. SHEET UMTRA-ECT SL 100
 FEATURE DESIGNED FILE NO. SECT-28 SH118
 ITEM CHECKED DATE PXL 10/20/90
 WYL 11/7/90

RATIONAL APPROACH FOR ESTIMATING RETENTION BASIN DESIGN WATER
VOLUME USING MEAN CLIMATIC DATA
 (REVISION B DATE 11-16-87)

A. INTRODUCTION

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

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

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

B. INPUT DATA

THE REQUIRED DATA INPUT TO THE SPREADSHEET INCLUDES:

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

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

PROJECT UMTRA CONTR. NO. SHEET
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UMTRA-7CT 5402
 SPES-28 119
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 WYL 11/7/90

ADDITIONAL INPUT FOR OVERALL WATER BALANCE ARE:

These are already given listed in previous page
AVERAGE MONTHLY CONSTRUCTION WATER DEMAND: USED IN PLACING CONTAMINATED EMBANKMENT MATERIAL. APPLIES ONLY TO DISPOSAL SITE WHICH IS BEING EVALUATED, OR WHEN PROCESS SITE WATER CAN BE TRANSPORTED TO DISPOSAL SITE. TRANSPORTING OF CONTAMINATED WATER OVER PUBLIC ROADS IS NOT CONSIDERED PRACTICAL BECAUSE ADDITIONAL PERMITS MAY BE REQUIRED. DURING MONTHS OF NO CONSTRUCTION THIS EQUALS ZERO.

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

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

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

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

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

WHERE: A_F = MAXIMUM WATER SURFACE AREA ASSOCIATED WITH V_F = VOLUME OF WATER WHEN FULL (EXCLUDING SEDIMENT)

V_P = TOTAL RUNOFF VOLUME FOR THAT MONTH

$K=0.5$ CONVERTS THE AREA TO AVERAGE END AREA AS THE EVAPORATION AREA GOES FROM A_F TO ZERO (CONSERVATIVE).

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

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11197KA-107 21.62
 3885-28 120
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 WYL 11/7/90

C. CALCULATIONS

CALCULATION OF TERMS ARE AS FOLLOWS:

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

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

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

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

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

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

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

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

'S': CALCULATED FROM SCS EQUATION WHERE $S = (1000/CN) - 10$

TOTAL RUNOFF VOLUME: CALCULATED FROM SCS EQUATION

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

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

WATER BALANCE (NON ACCUMULATING) - WATER IS DISPOSED OF ON A REGULAR BASIS.

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

PROJECT UMTRA CONTR. NO. SHEET
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UMTRA-FCF 26.10/7
 3885-28 121
 PYL 10/23/90
 WYL 11/7/90

NOTES:

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

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

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

WATER BALANCE (ACCUMULATING) -

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

NOTES:

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

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

REFERENCES:

1. URBAN STORM DRAINAGE MANAGEMENT, J.R. SHEAFFER, K.R. WRIGHT, W.C. TAGGART, & R.M. WRIGHT, 1982, BY MARCEL DEKKER INC., N.Y., NEW YORK.
2. HYDROLOGY, O.E. MEINZER, MCGRAW-HILL, 1942, DOVER PUBLICATIONS, NEW YORK.
3. HANDBOOK OF APPLIED HYDROLOGY, V.T. CHOW, MCGRAW-HILL, 1964.

1

MORRISON-KNUDSEN CORPORATION

Project UMTRA - FCT
Feature Wastewater Handling II
Item _____

Contract No. 381-21 Sheet 122
Designed PL File No. _____
Checked AC Date 3/15/91
Date 3/22/91

E Quantities And Cost Estimates

MORRISON-KNUDSEN CORPORATION

Project UMTRB-FLT
 Feature Wastewater Handling II
 Item _____

Contract No. 3845 24
 Designed PYL
 Checked KCC

Sheet 123
 File No. _____
 Date 3/15/91
 Date 3/22/91

Treatment / Discharge Scheme

Cost Summary

	No STORM (Q = 105 gpm)	WITH STORM (Q = 245 gpm)
Capital Cost	\$ 2,001,254	\$ 3,621,479
Operating Cost	\$ 269,217	\$ 261,314
Plant Mobilization/ Demobilization	—	—
Trailer Transport	—	—
	\$ 2,270,471	\$ 3,882,793



Project WITRA-ECT
 Feature Wastewater Handling I
 Item _____

Contract No. 3885-28Designed PYLChecked ACCSheet 124

File No. _____

Date 3/15/91Date 3/22/91(A) Treatment and Discharge• Capital Costs

For A-(1) Non-Accumulating / Discharge, No storm

The required treatment rate = 6.8 ac-ft/month

$$Q = \frac{6.8 \text{ ac-ft/month} \times 325,829 \text{ gal/ac-ft} \div 0.8}{22 \text{ days/month} \times 24 \text{ hr/day} \times 60 \text{ min/hr}} = 105 \text{ gpm}$$

$$\text{Capital costs} = \$ 2,001.254 \quad (\text{see App. B})$$

For A-(2) Non-Accumulating / Discharge, Storm

The required treatment rate = 15.8 ac-ft/month

$$Q = \frac{15.8 \text{ ac-ft/month} \times 325,829 \text{ gal/ac-ft} \div 0.8}{22 \text{ days/month} \times 24 \text{ hr/day} \times 60 \text{ min/hr}} = 245 \text{ gpm}$$

$$\text{Capital costs} = \$ 3,621.479 \quad (\text{see App. B})$$

• Operating Cost(1) For $Q = 105 \text{ gpm}$, Vol. of wastewater to be treated = 128.3 ac-ft

$$\text{Cost} = \$ 973 / \text{day} \quad (\text{see App. B})$$

$$\text{Unit cost} = \frac{\$ 973 / \text{day} \times 1000 \text{ gallon}}{105 \text{ gpm} \times 1440 \text{ min/day}} = \$ 6.44 / 1000 \text{ gal}$$

$$\begin{aligned} \text{Operating cost} &= 128.3 \text{ ac-ft} \times 325,829 \text{ gal/ac-ft} \times \$ 6.44 / 1000 \text{ gal} \\ &= \$ 219,217 \end{aligned}$$

(2) For $Q = 245 \text{ gpm}$, Vol. of wastewater to be treated = 266.7 ac-ft

$$\text{Cost} = \$ 1,370 / \text{day}$$

$$\text{Unit cost} = \frac{\$ 1370 / \text{day} \times 1000 \text{ gal}}{245 \text{ gpm} \times 1440 \text{ min/day}} = \$ 3.88 / 1000 \text{ gal}$$

$$\begin{aligned} \text{Operating cost} &= 266.7 \text{ ac-ft} \times 325,829 \text{ gal/ac-ft} \times \$ 3.88 / 1000 \text{ gal} \\ &= \$ 261,314 \end{aligned}$$



Project UMTRA-FCT
 Feature Wastewater Handling II
 Item _____

Contract No. 385-28
 Designed PYL
 Checked KWH

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 File No. _____
 Date 3/19/91
 Date 3/25/91

EVAPORATION SCHEME

COST SUMMARY

bottom condition	<u>NO STORM</u>			<u>WITH STORM</u>		
	<u>base soil</u>	<u>bentonite</u>	<u>liner</u>	<u>base soil</u>	<u>bentonite</u>	<u>liner</u>
Construction	\$ 63,456	\$ 221,583	\$ 63,456	\$ 123,660	\$ 639,927	\$ 123,660
Operation	\$ 85,839	\$ 85,839	\$ 85,839	\$ 106,161	\$ 106,161	\$ 106,161
Membrane Liner	-	-	\$ 653,936			\$ 1,293,947
Cleanup	\$ 56,467	\$ 28,233	-	\$ 112,934	\$ 56,466	-
Restoration	\$ 66,792	\$ 33,396	-	\$ 133,584	\$ 66,792	-
Total Costs	\$ 272,554	\$ 469,051	\$ 803,331	\$ 476,339	\$ 869,346	\$ 1,523,768

Project UMTRA-FCT
 Feature Wastewater Handling II
 Item _____

Contract No. 3865-28
 Designed WYL
 Checked Ruth

Sheet 176
 File No. _____
 Date 3/6/91
 Date 3/25/91

B Evaporation

The evaporation of the wastewater will be conducted in ponds divided by inner dikes and bounded by a perimeter dike ^(2' high) which will be constructed on terraces. Each pond will be about 12" deep and 100 to 250 long. Volumes of cut and fill will be in balance for the construction. (There will be sufficient freeboard to contain a 10-yr 24 hr storm)

(1) For the 20-acre evaporation ponds (No storm)

Pond Construction

- Removal of Contaminated topsoil by others = _____
- Cut for pond bottom

$$\frac{20 \text{ acres}}{2} \times 43560 \text{ ft}^2/\text{acre} \times 1.5 \text{ ft} = 27 \text{ ft}^3/\text{cy} \times \$1.06/\text{cy} = \$25,652$$
- Fill for pond bottom and inner dikes

$$\frac{20 \text{ acres}}{2} \times 43560 \text{ ft}^2/\text{acre} \times 1.0 \text{ ft} = 27 \text{ ft}^3/\text{cy} \times \$2.00/\text{cy} = \$32,267$$
- Bentonite - seal pond bottom

$$20 \text{ acres} \times 43560 \text{ ft}^2/\text{acre} \times 0.5 \text{ ft} = 27 \text{ ft}^3/\text{cy} \times \$16.00/\text{cy} = \$258,133$$
- Fill for perimeter dike

$$(20 \text{ acres} \times 43560 \text{ ft}^2/\text{acre})^{1/2} \times 4 \times (2 \text{ ft} \times 10 \text{ ft}) = 27 \text{ ft}^3/\text{cy} \times \$2.00/\text{cy} = \$5,531$$

Operation

- Pretreat dewatering fluid

$$(1225) 123 \text{ gal-ft} \times 32589 \text{ gal}/\text{gal-ft} \times \$1.50/1000 \text{ gal} = \$59,826$$
- Pumping (320 gpm for 4 dia pump to 20' head)

$$(136 + 123 - 57) 21 \text{ ft} \times 32589 \text{ gal}/\text{gal-ft} = 360 \text{ gpm} = 60 \text{ m}^3/\text{hr}$$

$$= 2887 \text{ hrs}$$

$$2887 \text{ hrs} \div 19 \text{ months} \div 30 \text{ days/month} = 5.06 \text{ hrs/day operating}$$

$$2887 \text{ hrs} \times \$9.00/\text{hr} = \$25,983$$

Project UNITA-ECT Contract No. 385-28 Sheet 127
 Feature Wastewater Handling I Designed WVL F.I. No.
 Item Checked ICCS Date 3/6/91
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clean up contaminated soil from ponds & dispose into the embankment

For bare soil pond bottom ($K \approx 5 \times 10^{-7}$ cm/sec water head = 12")

Assume the top 12" will be contaminated (see App. A)

$$20 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 1 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$1.75/\text{cy} = \$66,467$$

For bentonite-soil pond bottom ($K \approx 5 \times 10^{-6}$ cm/sec water head = 12")

Assume the top 6" will be contaminated (see App. A)

$$20 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 0.5 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$1.75/\text{cy} = \$28,233$$

Restoration

For bare soil pond bottom

$$20 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 1 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$2.07/\text{cy} = \$66,792$$

For bentonite-soil pond bottom

$$20 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 0.5 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$2.07/\text{cy} = \$33,396$$

(2) For the 40-acre evaporation ponds (with storm)

Pond Construction

• Removal of contaminated topsoil by others = ———

• Cut for pond bottom

$$\frac{40 \text{ acres}}{2} \times 43560 \text{ ft}^2/\text{ac} \times 1.5 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$1.06/\text{cy} = \$51,304$$

• Fill for pond bottom and inner dikes

$$\frac{40 \text{ acres}}{2} \times 43560 \text{ ft}^2/\text{ac} \times 1.0 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$2.00/\text{cy} = \$64,534$$

• Bentonite-soil pond bottom

$$40 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 0.5 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$16.00/\text{cy} = \$516,267$$

• Fill for perimeter dike

$$(40 \text{ acres} \times 43560 \text{ ft}^2/\text{ac})^{1/2} \times 4 \times (2 \text{ ft} \times 10 \text{ ft}) \div 27 \text{ ft}^3/\text{cy} \times \$2.00/\text{cy} = \$7,822$$



MORRISON-KNUDSEN CORPORATION

Project UMTRP - TLT
 Feature Wastewater Handling II
 Item _____

Contract No. 3825-28 sheet 12E
 Designed WYL File No. _____
 Checked FWH Date 3/6/91
 Date 3-25-91

Operation

- Pretreat dewatering fluid

(122.5')

$$123 \text{ ac-ft} \times 324829 \text{ gal/ac-ft} \times \$1.50/1000 \text{ gall} = \$59,456$$

- Pumping (380 gpm for 4' dia. pump to 20' head)

$$(194 + 223 - 57) \text{ ac-ft} \times 324829 \text{ gal/ac-ft} \div 380 \text{ gpm} \div 60 \text{ min/hr} = 5145 \text{ hrs}$$

$$5145 \text{ hr} \div 20 \text{ months} \div 30 \text{ days/month} = 8.57 \text{ hrs/day operating}$$

$$5145 \text{ hrs} \times \$9.00/\text{hr} = \$46,305$$

clean up contaminated soil from ponds and dispose into the land bank.

For bare soil pond bottom

Assume the top 12" will be contaminated

$$40 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 1 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$1.75/\text{cy} = \$112,934$$

For bentonite-soil pond bottom

Assume the top 6" will be contaminated

$$40 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 0.5 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$1.75/\text{cy} = \$56,466$$

Restoration

For bare soil pond bottom

$$40 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 1 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$2.07/\text{cy} = \$133,584$$

For bentonite-soil pond bottom

$$40 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 0.5 \text{ ft} \div 27 \text{ ft}^3/\text{cy} \times \$2.07/\text{cy} = \$66,792$$





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON KNUDSEN COMPANY

Project UMTRA - PCT
Feature Wastewater Handling II
Item _____

Contract No. 345-28
Designed PYL
Checked KW/S

Sheet 128
File No. _____
Date 3/19/91
Date 3-25-91

Evaporation Pond Cost Estimate (cont'd)

(iii) Synthetic Liner

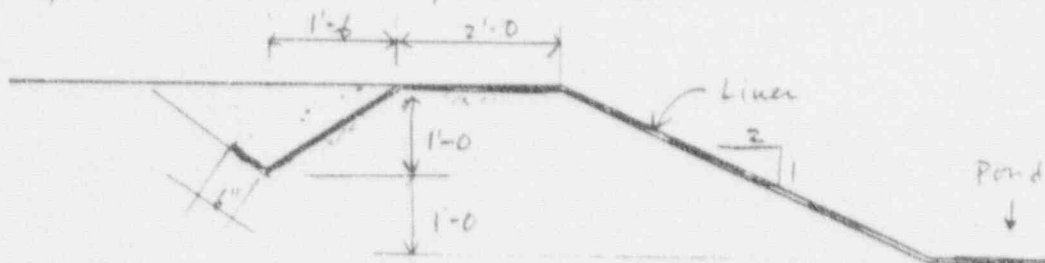
a) No storm Condition - Pond Area = 20 Ac.

$$\begin{aligned}\text{Liner for Pond Bottom} &= 20 \text{ Ac.} \times 43560 \text{ ft}^2/\text{Ac.} \times \frac{1 \text{ sy}}{9 \text{ ft}^2} \\ &= \underline{96,800 \text{ sy}}\end{aligned}$$

Liner for perimeter dike:

$$\begin{aligned}\text{Assume a square pond. } \therefore \text{Length of perimeter} &= \sqrt{20 \times 43560} \times 4 \\ &= \underline{3734 \text{ ft}}\end{aligned}$$

Typ Anchor Trench on perimeter dike:



pond liner per ft of perimeter dike

$$= 0.5' + \sqrt{1^2 + 1.5^2} + 2' + \sqrt{2^2 + 4^2} = \underline{8.8 \text{ ft}}$$

$$\begin{aligned}\therefore \text{Total quantity of liner for perimeter dike} &= (8.8 \times 3734) \text{ ft}^2 \\ &= \underline{3651 \text{ sy}}\end{aligned}$$

$$\therefore \text{Total quantity} = 96,800 + 3,651 = \underline{100,451 \text{ sy}}$$

$$\text{Cost} = 100,451 \text{ sy} \times \$6.51/\text{sy} = \underline{\underline{\$653,936}}$$





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON KNUDSEN COMPANY

Project UMTRA - ECT
 Feature Wastewater Handling II
 Item _____

Contract No. 885-28Designed PTLChecked RWHSheet 128 b

File No. _____

Date 2/19/91Date 3-25-91b) With Storm - Pond Area = 40 Ac

$$\text{Liner for Pond Bottom} = 40 \text{ Ac} \times 43560 \text{ ft}^2/\text{Ac} \times \frac{1 \text{ s.y.}}{9 \text{ ft}^2} = \underline{193,600 \text{ s.y.}}$$

Liner for Perimeter dike.

$$\text{Length of Perimeter} = \sqrt{40 \times 43560} \times 4 = 5280 \text{ ft}$$

$$\text{Pond liner per ft. of perimeter dike} = 8.8 \text{ ft. (see previous sheet)}$$

$$\text{Quantity of liner for perimeter dike} = (5280 \times 8.8) \text{ ft}^2 = \underline{5163 \text{ s.y.}}$$

$$\therefore \text{Total quantity} = 193,600 + 5,163 = 198,763 \text{ s.y.}$$

$$\text{Cost} = 198,763 \text{ s.y.} \times \$ 6.51/\text{s.y.} = \underline{\underline{\$ 1,293,947}}$$





MORRISON-KNUDSEN CORPORATION

Project UNTER-FCF
 Feature Westerns Handing II
 Item _____

Contract No. 5851-26 Sheet 129
 Designed PTL File No. _____
 Checked RWH Date 5/8/91
 Date 3-25-91

C. Irrigation SchemeCosts Summary

	NO STORM	WITH STORM
Construction	\$ 1,694	\$ 2,395
Seeding & Fertilizing	\$ 26,912	\$ 53,824
Capital & Labor	\$ 250,000	\$ 500,000
Operation	\$ 74,904	\$ 96,639
Cleanup	\$ 169,400	\$ 338,800
Restoration	\$ 200,376	\$ 400,752
Mowing	\$ 13,500	\$ 33,000
Maintenance	\$ 36,839	\$ 71,271
Total Costs	\$ 773,625	\$ 1,496,681

MORRISON-KNUDSEN CORPORATION

Project ULTRA-FCI
 Feature Wastewater Handling II
 Item _____

Contract No. 3885 28
 Designed PYL
 Checked 12/1/91

Sheet 130
 File No. _____
 Date 3/12/91
 Date 3-25-91

C. Irrigation

The farmland for irrigation will be constructed in the same area proposed for evaporation pond. The area will be bounded by a perimeter dike of 1' in height. The area will then be seeded.

(1) For the 30-acre Farmland (No Storm)

Farmland Construction

- Removal of contaminated topsoils by others
- Fill for perimeter dike (1' high)

$$(30 \text{ acres} \times 43560 \text{ ft}^2/\text{acre})^{1/2} \times 4 \times (1' \times 5') \rightarrow 279' \times \$2.00/\text{cy} = \$1694'$$

Seeding & Fertilizing

$$30 \text{ acres} \times \$897.07/\text{acre} = \$26,912'$$

Operation

- Pretreat dewatering fluid

$$12247 \text{ ac-ft} \times 325829 \text{ gal/ac-ft} \times \$1.50/1000 \text{ gal} = \$59,856'$$

- Pumping (380 gpm for 4" dia pump + 20' head)

$$117 \text{ Ac-ft} \times 325829 \text{ gal/Ac-ft} \div 300 \text{ gpm} \div 60 \text{ min/hr} = 1672 \text{ hrs}$$

$$1672 \text{ hrs} \div 18 \text{ months} \div 30 \text{ day/month} = 3.1 \text{ hrs/day operating}$$

$$1672 \text{ hrs} \times \$9.00/\text{hr} = \$15,048'$$

Capital Cost & Labor

- Irrigation Equipment & Labor (perforated pipelines)

$$= \$250,000$$

(= half of that for 60 Ac area per Bruce Stevens)

MORRISON-KNUDSEN CORPORATION

Project LIMRA - ECT Contract No. 3885-73 Sheet 131
 Feature Wastewater Handling II Designed PYL File No. _____
 Item _____ Checked GWJH Date 3/12/91
 Date 3-25-91

Cleanup Contaminated Soil from farmland and dispose of into embankment
 (including mixing & compaction)

• Assume topsoil is 6" and depth of contamination 18"

$$\therefore 30 \text{ acres} \times 43560 \text{ ft}^2/\text{acre} \times 2' \div 27 \text{ ft}^3/\text{cy} \times \$ 1.75/\text{cy} = \$ 169,400'$$

Restoration

$$30 \text{ acres} \times 43560 \text{ ft}^2/\text{acre} \times 2' \div 27 \text{ ft}^3/\text{cy} \times \$ 2.07/\text{cy} = \$ 200,376'$$

Lawn Cutting & Mowing (assume required 3 times/year)

$$30 \text{ acres} \times \$ 100/\text{acre} \times \frac{18 \text{ months}}{4} = \$ 13,500'$$

Maintenance

Assume 5% of sum of above

$$0.05 \times 736,786 = \$ 36,839'$$

(2) For the 66-acre Irrigation Farmland (with Storm)

Farmland Construction

• Removal of contaminated topsoil by others = _____

• Fill for perimeter dike (1 high) = _____

$$(66 \text{ acres} \times 43560 \text{ ft}^2/\text{ac})^{1/2} \times 4 \times (1 \times 5') \div 27 \text{ ft}^3/\text{cy} \times \$ 2.10/\text{cy} = \$ 2,395'$$

Seeding & Fertilizing

$$60 \text{ acres} \times \$ 897.07/\text{acre} = \$ 53,824'$$



MORRISON-KNUDSEN CORPORATION

Project

UMTRA-ELT

Contract No. 3885-28

Sheet 152

Feature

Wastewater Handling II

Designed

PYL

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RWN

Date 3-25-91

Operation

- Pretreat dewatering fluid = \$ 59,856
- Pumping (380 gpm for 4' dia pump to 20' head)
 $286 \text{ ac-ft} \times 325879 \text{ gal/ac-ft} \div 380 \text{ gpm} \div 60 \text{ min/hr} = 4087 \text{ hrs}$
 $4087 \text{ hrs} \times \$9.00/\text{hr} = \$36,783$
- Capital Cost & Labor
- Irrigation Equipment & Labor, (pulsated pipelines) = \$ 500,000 (See App. C)

Cleanup Contaminated Soil from farmland and dispose of into earthen pit
 (including mixing & compaction)

Assume 6" topsoil and 18" deep contamination

$$60 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 2' \div 27 \text{ ft}^3/\text{cy} \times \$1.75/\text{cy} = \$538,800$$

Restoration

$$60 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 2' \div 27 \text{ ft}^3/\text{cy} \times \$2.07/\text{cy} = \$400,752$$

Lawn Cutting & Mowing (Assume required 3 times/yr)

$$60 \text{ acres} \times \$100/\text{acre/month} \times \frac{22 \text{ months}}{4} = \$33,000$$

Maintenance

Assume 5% of sum of above

$$0.05 \times \$1425,410 = \$71,271$$



MORRISON-KNUDSEN CORPORATION
 Project 11178A - FCT
 Feature Wastewater Handling II
 Item _____

Contract No. 285-28 Sheet 133
 Designed PYL File No. _____
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 Date 3-25-91

D. Mobile Treatment Unit / Evaporation Pond

Costs Summary

	NO STORM	WITH STORM		
<u>Mobile Treatment Unit</u>				
Capital Costs	\$ 516,499		\$ 516,499	
Operating Costs	\$ 294,552		\$ 325,558	
Plant Mobilization/ Demobilization	\$ 11,500		\$ 11,500	
Trailer Transportation	\$ 10,200		\$ 10,200	
<u>Evaporation Pond</u>				
		base soil	bentonite-soil	Liner
Construction	0	\$ 48,229	\$ 241,829	\$ 48,229
Operation	0	\$ 84,219	\$ 84,219	\$ 84,219
Synthetic Liner	0	-	-	\$ 493,204
Cleanup	0	\$ 42,350	\$ 21,175	-
Restoration	0	\$ 50,094	\$ 25,047	-
Total Costs	\$ 832,751	\$ 1,088,649	\$ 1,236,027	\$ 1,489,409



MORRISON-KNUDSEN CORPORATION

Project UMTRA-FT
 Feature Wastewater Handling
 Item Tr

Contract No. 3885 28Designed PYLChecked RWJSheet 124File No. Date 3/11/91Date 3-25-91D. Mobile Treatment / Evaporation Pond

- (1)
- Mobile Treatment Unit only, No pond required (NO STORM)

Mobile Treatment Unit

capacity = 60 gpm

Assume it will operate 20 hrs/day, 22 days/month

• Capital Costs

including treatment of ammonia

= \$ 516,499

(see App B)

• Operating Costs / Treatment

Vol. of Wastewater to be treated = 92.34 ac-ft

(see App. B)

Energy

$$(\$45/\text{day} \times \frac{60 \text{ gpm}}{80 \text{ gpm}}) + (\$290 \times \frac{60}{100}) = \$143/\text{day}$$

Chemicals

$$\$37/\text{day} \times \frac{60 \text{ gpm}}{80 \text{ gpm}} = \$28/\text{day}$$

Operating Labor

$$425/\text{hr} \times 24 \text{ hr/day} = \$600/\text{day}$$

Monitoring Labor

$$\$25/\text{hr} \times 3 \text{ hr/day} = \$75/\text{day}$$

Waste disposal by others

= -

\$846/day

$$\text{Unit Costs} = \frac{\$846/\text{day} \times 1000 \text{ gal}}{60 \text{ gpm} \times 1440 \text{ min/day}}$$

$$= \$9.79/1000 \text{ gal}$$

$$\therefore \text{Operating Cost} = 92.34 \text{ ac-ft} \times 325,879 \text{ gal/ac-ft} \times \$9.79/1000 \text{ gal}$$

$$= \$294,552$$

MORRISON-KNUDSEN CORPORATION

Project ULTRA-PC1
 Feature Wastewater Handling II
 Item _____

Contract No. 3815-28
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Sheet 135
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 Date .. 25-91

• Plant Mobilization / Demobilization

= \$ 11,500 (App B)

• Trailer Transport

= \$ 10,200 (see App. B)



MORRISON-KNUDSEN CORPORATION

Project
Feature
Item

LIMTRA-7ET

Wastewater Handling II

Contract No. 3885-28

Designed P.Y.L.

Checked R.W.N.

Sheet 136

File No.

Date 3/12/91

Date 3-25-91

(2) Mobile Treatment Unit & Evaporation Pond (with Storm)a) Mobile Treatment Unit

Capacity = 60 gpm

Assume it will operate 20 hrs/day, 22 days/month

• Capital Costs

Including treatment of ammonia

= \$ 51,000

(\$2,500/mo)

• Operating Costs / Treatment

Vol. of Waste water to be treated = 102.06 ac-ft

Energy (Same as (1) on sheet —)

= \$ 148/day

Chemicals

= \$ 28/day

Operating Labor

= \$ 600/day

Monitoring Labor

= \$ 75/day

Waste disposal

= -

\$ 846/day

$$\text{Unit costs} = \frac{\$ 846/\text{day} \times 102.06 \text{ ac-ft}}{\text{to gpm} \times 1440 \text{ min/day}}$$

= \$ 9.79/1000 gal

$$\therefore \text{Operating Cost} = 102.06 \text{ ac-ft} \times 825 \text{ gal/100 ft} \times \$ 9.79/1000 \text{ gal}$$

$$= \$ 325,558$$

Project UMTEA-FCT
 Feature Wastewater Handling II
 Item _____

Contract No. 3885-28 Sheet 137
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• Mobilization/Demobilization Cost = \$ 11,500'

• Trailer Transportation = \$ 10,200'

b) Evaporation Pond 15 Acre

Pond Construction

• Removal of Contaminated topsoil by others = -

• Cut for pond bottom

$$\frac{15 \text{ acres}}{2} \times 43560 \text{ ft}^2/\text{acre} \times 1.5' \div 27 \text{ ft}^3/\text{cy} \times \$ 1.66/\text{cy} = \$ 19,239'$$

• Fill for pond bottom and inner dikes

$$\frac{15 \text{ acres}}{2} \times 43560 \text{ ft}^2/\text{acre} \times 1.0' \div 27 \text{ ft}^3/\text{cy} \times \$ 2.00/\text{cy} = \$ 20,200'$$

• Bentonite - Seal pond bottom

$$15 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 0.5' \div 27 \text{ ft}^3/\text{cy} \times \$ 16.00/\text{cy} = \$ 193,600'$$

• Fill for perimeter dike

$$(15 \text{ ac} \times 43560 \text{ ft}^2/\text{ac})^{1/2} \times 4 \times (2' \times 10') \div 27 \text{ ft}^3/\text{cy} \times \$ 2.00/\text{cy} = \$ 4,790'$$

Operation

• Pretreat denaturing fluid

$$16247 \text{ ac-ft} \times 325,829 \text{ gal/ac-ft} \times \$ 1.50/\text{1000 gal} = \$ 59,856'$$

• Pumping 1380 gpm to 4' dia. pump to 26 head.

$$(131.6 + 209.3 - 69.4 - 162.66) \text{ ac-ft} \times 325,829 \text{ gal/ac-ft} \div 380 \text{ gpm} \div 60 \text{ min/hr} = 2707 \text{ hrs}$$

$$2707 \text{ hrs} \div 21 \text{ months} \div 30 \text{ days/month} = 4.3 \text{ hrs/day operating}$$

$$2707 \text{ hrs} \times \$ 9.00/\text{hr}$$

$$= \$ 24,263$$



Project WATER-EST
 Feature Wastewater Handling II
 Item _____

Contract No. 388-28
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 Checked RWJ

Sheet 138
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Clean up contaminated Soil from ponds and dispose of into the embankment

For bare soil pond bottom

Assume the top 12" will be contaminated

$$15 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 1' \div 27 \text{ ft}^3/\text{cy} \times \$1.75/\text{cy} = \$42,350$$

For bentonite - soil pond bottom

Assume the top 6" will be contaminated

$$15 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 0.5' \div 27 \text{ ft}^3/\text{cy} \times \$1.75/\text{cy} = \$21,175$$

Restoration

For bare soil pond bottom

$$15 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 1' \div 27 \text{ ft}^3/\text{cy} \times \$2.07/\text{cy} = \$50,094$$

For bentonite - soil pond bottom

$$15 \text{ acres} \times 43560 \text{ ft}^2/\text{ac} \times 0.5' \div 27 \text{ ft}^3/\text{cy} \times \$2.07/\text{cy} = \$25,047$$

Project UMTRA-FLT
 Feature Waste Handling II
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Contract No. 3815-28 Sheet 139
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Mobile Treatment / Evaporation Cost Estimate (cont'd).

Synthetic Liner

With Storm Condition - Pond Area = 15 Ac

$$\begin{aligned} \text{Liner for Pond Bottom} &= 15 \text{ Ac} \times 43560 \text{ ft}^2/\text{Ac} \times \frac{1 \text{ sy}}{9 \text{ ft}^2} \\ &= \underline{72,600 \text{ sy}} \end{aligned}$$

Liner for perimeter dike

$$\begin{aligned} \text{Assume a square pond, } \therefore \text{ length of perimeter} &= \sqrt{15 \times 43560} \times 4 \\ &= 3233 \text{ ft} \end{aligned}$$

$$\text{pond liner per ft of perimeter dike} = 8.8 \text{ ft} \quad (\text{see sk 12A})$$

$$\begin{aligned} \therefore \text{Quantity of Liner for perimeter dike} &= (8.8 \times 3233) \text{ ft}^2 \\ &= \underline{3,161 \text{ s.y.}} \end{aligned}$$

$$\therefore \text{Total Quantity} = 72,600 + 161 = \underline{75,761 \text{ s.y.}}$$

$$\text{Cost} = 75,761 \text{ s.y.} \times \$6.51/\text{s.y.} = \underline{\underline{\$493,204}}$$

Project UHTA - FCT
 Feature Wastewater Handling II
 Item _____

Contract No. 3885-28
 Designed PTL
 Checked RWH

Sheet 140
 File No. _____
 Date 3/19/91
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E. Evaporation Pond (primary) + Mobile Treatment Unit
 (for 'With Storm' condition only)

Costs Summary

	With Storm		
<u>Evaporation Pond</u>			
	<u>base soil</u>	<u>bentonite-soil</u>	<u>Liner</u>
Construction	\$ 123,660	\$ 639,927	\$ 123,660
Operation	\$ 106,161	\$ 106,161	\$ 106,161
Synthetic liner	—	—	\$ 1,293,947
Clean up	\$ 112,934	\$ 56,466	—
Restoration	\$ 133,584	\$ 66,792	—
<u>Mobile Treatment Unit</u>			
Capital Costs	← \$ 516,299 →		
Operating Costs	<u>100% operation</u>	<u>50% operation</u>	
	\$ 310,055	\$ 155,027	
Plant Mobilization / Demobilization	← \$ 11,500 →		
Trailer Transportation	← \$ 10,200 →		

Total Costs

Pond:	<u>base soil</u>	<u>bentonite-soil</u>	<u>Liner</u>		
Plant:	<u>100%</u>	<u>50%</u>	<u>100%</u>	<u>50%</u>	
	\$ 1,324,593	\$ 1,169,565	\$ 1,717,600	\$ 1,562,572	\$ 2,372,022
					\$ 2,216,994

Project
Feature
Item

UMTRA - FET

Wastewater Handling II

Contract No. 3865-28

Designed PTL

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Sheet 141

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Date 3/19/91

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E. Evaporation Pond (primary) + Mobile Treatment Planta) Evaporation Pond 40 Ac (w.m. storm)Pond Construction

(Same as sh. 127)

• Removal of contaminated topsoil by others	=	—
• Cut for pond bottom	=	\$ 51,304
• Fill for pond bottom & inner dikes	=	\$ 64,534
• Bentonite-soil pond bottom	=	\$ 516,267
• Fill for perimeter dike	=	\$ 7,822
Synthetic liner (same as sh 1186)	=	\$ 1,293,947

Operation (same as sh 128)

• Preheat dewatering fluid	=	\$ 59,856
• Pumping	=	\$ 46,305

Clean up soil, soil from ponds & dispose of into the Evaporation

For bare soil bottom (same as sh 128)	=	\$ 112,934
For bentonite-soil pond bottom ()	=	\$ 56,466

Restoration

For bare soil bottom (same as sh 128)	=	\$ 133,584
For bentonite-soil pond bottom ()	=	\$ 66,792

Project UMTRA - ECT
 Feature Wastewater Handling I
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Contract No. 3885-28
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Sheet 142
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(b) Mobile Treatment Unit (for emergency use)

Capacity = 60 gpm

• Capital Costs

(same as sk. 134)

= \$ 576,499'

• Operating Costs / Treatment

Unit cost = \$ 9.79 / 1000 gal (sk. 134)

Operating period = 20 months.

i) 100% operation (i.e. 20 hrs/day, 22 days/month) i.e. 486 Ac-ft/month

∴ Vol treated = $20 \times 486 \text{ Ac-ft} = 97.2 \text{ Ac-ft}$

∴ Operating cost = $97.2 \text{ Ac-ft} \times 325.829 \text{ gal/Ac-ft} \times \$9.79/1000 \text{ gal}$
 = \$ 310,055'

ii) 50% operation

Vol treated = $20 \times 486 \text{ Ac-ft} \times \frac{1}{2} = 48.6 \text{ Ac-ft}$

∴ operating cost = $48.6 \text{ Ac-ft} \times 325.829 \text{ gal/Ac-ft} \times \$9.79/1000 \text{ gal}$
 = \$ 155,027'

• Plant Mobilization / Demobilization

= \$ 11,520
(see sk. 135)

• Trailer Transport

= \$ 10,700
(see sk. 135)



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project _____
Feature _____
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Contract No. _____
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Sheet R-1
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APPENDIX A

Infiltration Depth





MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project
Feature
Item

UHIRA - FCT

Contract No. 3885-28

Designed

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Sheet R-2

File No.

Date

Date

Depth of Contamination in the evaporation pond due to infiltration

Pond Area : 41.5 Acres

Water Depth : 3 ft

Term : 3 years

Site Soil Type [CM]

[Ref -] Gradation : 0% gravel, 38% sand, 62% fines (% < #200)

Tension Vs Moist. or Saturation

Permeability at Saturation 1.1×10^{-8} to 1.4×10^{-6} cm/s

Porosity : 0.52

Existing Vol moisture : 35% (27% by Dry Weight)

Existing dry density : 80 pcf

Project UPTRA - Falls City
 Feature Evaporation Pond
 Item Infiltration depth

Contract No. 3885-ZB Sheet P3
 Designed JK File No. _____
 Checked PYL Date 10/30/90
 Date 11/2/90

Based on the gradation and permeability of the foundation soil underlying the evaporation pond, the soil is classified as clay with a wetted front capillary pressure ψ_f of 27.72 cm (see Table 2 Sh. 10)
 (Note: clay as in 45BA and 45CS)

$$\text{check } \psi_f = \frac{2\lambda + 3}{2\lambda + 2} \left(\frac{\psi_b}{2} \right) = \frac{2(0.165) + 3}{2(0.165) + 2} \left(\frac{85.6}{2} \right) \left[\text{Table, Sh. 12} \right]$$

$$= 61.2 \text{ cm (Arithmetic)}$$

$$\psi_f = \frac{2(0.131) + 3}{2(0.131) + 2} \left(\frac{37.3}{2} \right)$$

$$= 26.9 \text{ cm. (Geometric) [Table, Sh. 12]}$$

$$\text{Use } \psi_f = 27.7 \text{ cm} = 0.91 \text{ ft}$$

$$n = \text{porosity} = 0.52$$

θ_r = residual porosity

θ_e = effective porosity

$$\therefore \theta_r = 0.52 - 0.41 = 0.11$$

$$\text{Since } \theta_i = \text{initial } \theta = 0.35 \Rightarrow \theta_e = n - \theta_i = 0.17$$

Project UNITED - Falls City
Feature Evaporation Pond
Item Infiltration depth

Contract No. 3885-28
Designed JTK
Checked CTL

Sheet 24
File No. _____
Date 10/30/90
Date 11/2/90

(A) Infiltration with zero ponding head
 $F - n\psi_f \ln\left(1 + \frac{F}{n\psi_f}\right) = i \cdot t$ (eqn 2 on Sh. 9)

Where F = infiltration amount (cm)

$$\therefore k = \frac{k_{sd}}{2} (\text{cm/hr}) = \frac{6.4 \times 10^{-6}}{2} \times 3600 = 1.15 \times 10^{-2} \text{ cm/hr.}$$

$$\psi_f = \text{wetting front capillary pressure (cm)} = 27.7 \text{ cm}$$

$$n = \text{available porosity calculated as } \theta_e = h - \theta_i = 0.17$$

$$i = \text{infiltration rate (cm/hr)}$$

$$t = \text{time (hr.)} = 3 \times 365 \times 24 = 26,280 \text{ hr (for 3 yr)}$$

$$\therefore F - 0.17(27.7) \ln\left(1 + \frac{F}{(0.17)(27.7)}\right) = 1.15 \times 10^{-2} \times 26,280$$

$$= 302.2$$

$$\Rightarrow F - 4.71 \ln\left(1 + \frac{F}{4.71}\right) = 302.2$$

$$\Rightarrow F = 322.2 \text{ cm}$$

$$\therefore \text{Infiltration depth} = \frac{F}{\theta_e} = \frac{322.2}{0.17} \times \frac{1}{30.48} \text{ ft}$$

$$= 62.2 \text{ ft}$$



MORRISON-KNUDSEN ENGINEERS, INC.

Project WMTRA - Falls City
 Feature Evaporation Pond
 Item Infiltration depth

Contract No. 3885-28Designed JKChecked PTLSheet P5File No. Date Date 11/2/90

(B) Check infiltration based on $k = \frac{K_{sat}}{2} = \frac{6.4 \times 10^{-6}}{2}$ cm/sec
 (Green-Ampt)

And $i = \text{hydraulic gradient} = 1.0$

Darcy's velocity = $6.4 \times 10^{-6} \times 1.0$ cm/sec

Infiltration depth = $\frac{6.4 \times 10^{-6} \times 60 \times 1440 \times 365 \times 3}{30.48 \times 0.17 \times 2.0}$ ft.
 in 3 years
 based on zero ponding

= 59.4 ft

Since i is always greater than 1.0 at the inception of infiltration, this calculated infiltration depth is the minimum theoretical depth possible

< 62.2 ft for Case (A)





McRRISSON-KNUDSEN ENGINEERS, INC.

Project UNTR A - Falls City
 Feature Evaporation Pond
 Item Infiltration depth

Contract No. 5985-28 File No.
 Designed JTC Date
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Sheet A6

(C) for Ponded depth of 3 ft and $K_{sat} = 6.4 \times 10^{-6}$ cm/sec

$$L_f - (H_0 - y_f) \ln \left(1 + \frac{y_f}{H_0 - y_f} \right) = \frac{Kt}{n} \quad (\text{Eqn. 6.25, Sh. 15})$$

Where L_f = infiltration depth.

H_0 = pressure head at the entry surface
 ie ponded depth = 3 ft = 91.4 cm.

Other parameters are defined as in Case (A)

$$L_f - (91.4 + 27.7) \ln \left(1 + \frac{L_f}{(91.4 + 27.7)} \right) = \frac{1.15 \times 10^{-2} \times 26,280}{0.17}$$

$$L_f - 119.1 \ln \left(1 + \frac{L_f}{119.1} \right) = 1777.8$$

$$\Rightarrow L_f = 2127 \text{ cm.}$$

$$= 69.8 \text{ ft}$$





MORRISON-KNUDSEN ENGINEERS INC.
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Project WATER - Falls City
Feature Evaporation Pond
Item Infiltration depth

Contract No. 2885-28
Designed JTH
Checked PTL

Sheet P. 7
File No. _____
Date _____
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(D) 1 mi ponded depth of 3 ft and $K_{set} = 1.0 \times 10^{-7}$ cm/sec

$$\text{Green-Ampt } K = \frac{k_{set}}{2} = \frac{1 \times 10^{-7} \times 3600}{2} = 1.8 \times 10^{-4} \text{ cm/hr}$$

Following the formulation of the problem as in case (c)

$$L_f - 119.1 \ln \left(1 + \frac{L_f}{119.1} \right) = \frac{1.8 \times 10^{-4} \times 26,280}{0.17}$$

$$= 27.8$$

$$\Rightarrow L_f = 100.7 \text{ cm} \\ = 3.3 \text{ ft}$$

Perform check as in case (B)

$$\begin{aligned} \text{Infiltration depth in 3 yr based on green ponding} \\ = \frac{1.0 \times 10^{-7} \times 60 \times 1440 \times 365 \times 3}{30.48 \times 0.17 \times 2.0} \\ = 0.91 \text{ ft} \end{aligned}$$





MORRISON-KNUDSEN ENGINEERS, INC.

Project UNITRA - Falls City
 Feature Evaporation Pond
 Item infiltration depth

Contract No. 3885-18
 Designed JK
 Checked PYL

Sheet A 8
 File No. _____
 Date 11/1/90
 Date 11/2/90

(E) for ponded depth of 6 inches (0.5 ft)

$$H_0 = 6 \text{ inches} = 15.2 \text{ cm}$$

Following the formulation for case (C) on Sh. 4

$$L_f - (15.2 + 27.7) \ln \left(1 + \frac{L_f}{(15.2 + 27.7)} \right) = \frac{kt}{n}$$

$$\text{for } K_{sat} = 1 \times 10^{-7} \text{ cm/sec}$$

$$K = \frac{K_{sat}}{2} = \frac{1.0 \times 10^{-7} \times 3600}{2} = 1.8 \times 10^{-4} \text{ cm/hr}$$

$$L_f - 42.9 \ln \left(1 + \frac{L_f}{42.9} \right) = \frac{1.8 \times 10^{-4} \times 26,280}{0.17}$$

$$= 27.8$$

$$\Rightarrow L_f = 69.0 \text{ cm}$$

$$= 2.5 \text{ ft}$$





MORRISON-KNUDSEN ENGINEERS, INC.

Project WATER - Falls City
 Feature Evaporation Pond
 Item Infiltration depth

Contract No. 3885-88

Sheet 29

Designed VTK

File No.

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Date 11/1/90

Date 11/2/90

for $H_0 = 3$ ft

K_{sat} (cm/sec)	$K = \frac{K_{sat} \times 3600}{2}$ (cm/hr)	$\frac{Kt}{n} = \frac{K \times 26,280}{0.17}$	L_f (ft) from $L_f - 119.1 \ln(1 + \frac{L_f}{119.1}) = \frac{Kt}{n}$
1×10^{-5}	1.8×10^{-2}	2783	104
6.4×10^{-6}			70 (from sh 4)
1.0×10^{-6}	1.8×10^{-3}	279	15
1×10^{-7}			3.3 (from sh 5)
1×10^{-8}	1.8×10^{-5}	2.78	0.9

for $H_0 = 0.5$ ft

K_{sat} (cm/sec)	K (cm/hr)	$\frac{Kt}{n}$	L_f (ft) from $L_f - 42.9 \ln(1 + \frac{L_f}{42.9}) = \frac{Kt}{n}$
1×10^{-5}	1.8×10^{-2}	2783	97
6.4×10^{-6}	1.15×10^{-2}	1778	64
1.0×10^{-6}	1.8×10^{-3}	279	12
1.0×10^{-7}	1.8×10^{-4}	27.8	2.3
1.0×10^{-8}	1.8×10^{-5}	2.78	0.58



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K_{yt} (permeability) cm/sec

46 6212

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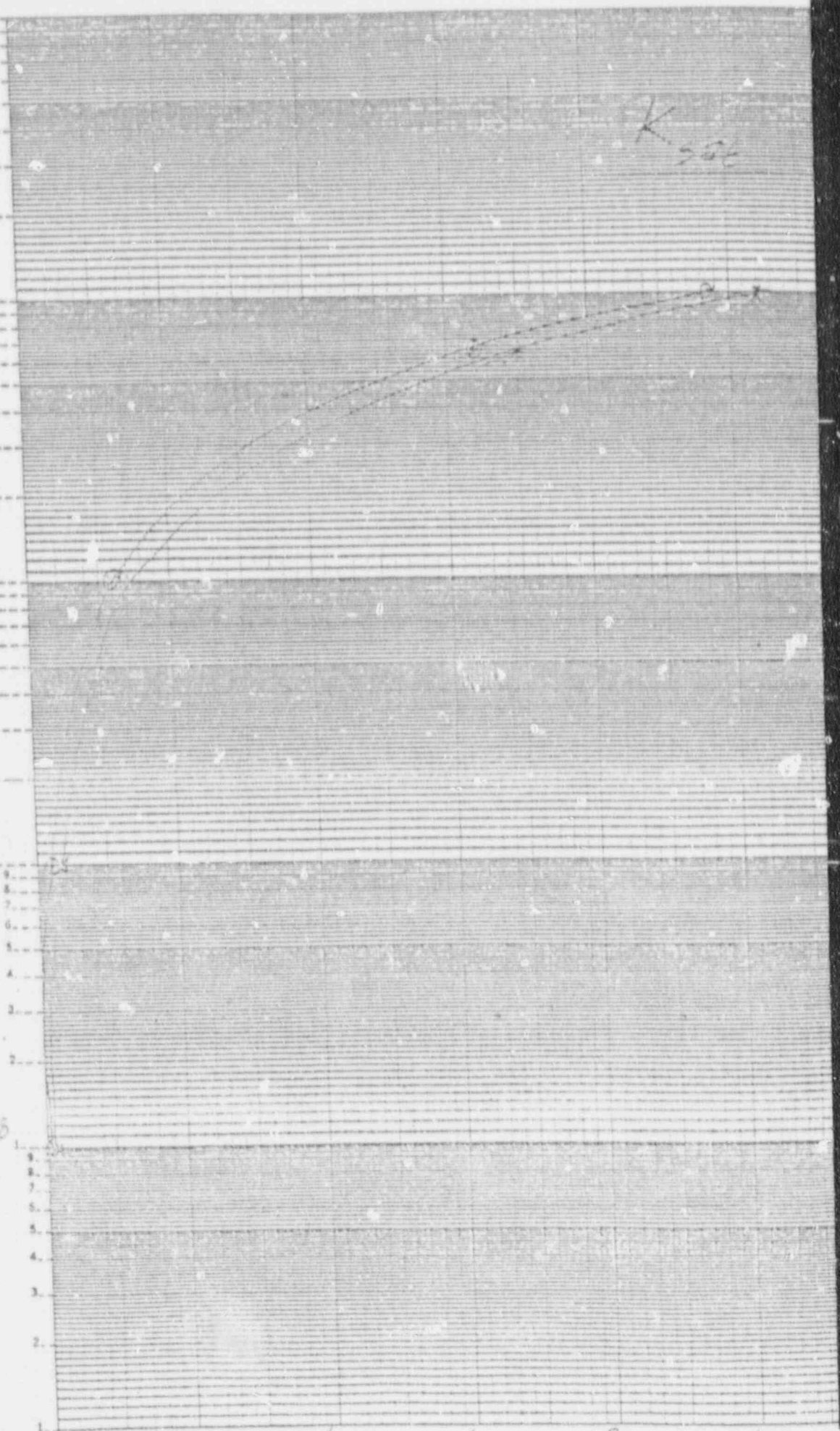
K₂E

10^{-5}

10^{-6}

10^{-7}

10^{-8}



Infiltration etc

Sh. 2-10

Infiltration depth

Groundwater

120 (ft)

140

160

180

200

9205110072-41 Hc 11/1/90

GREEN-AMPT INFILTRATION PARAMETERS FROM SOILS DATA

By Walter J. Rawls,¹ M. ASCE, Donald L. Brakensiek,²
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Abstract: The analysis of approx 5,000 soil horizons indicated that Green and Ampt parameters (effective porosity, wetting front capillary pressure, and hydraulic conductivity) could not be developed based on phases of soil order or suborder. However, sets of average parameters are developed based on soil horizon or soil texture class, or both. A procedure for determining the Green and Ampt parameters based on soil properties utilizing the full spectrum of soil survey information is outlined.

INTRODUCTION

If physically based infiltration models are to be used in operational hydrology, procedures for estimating infiltration model parameters based on soil properties must be developed. Not only are improved procedures needed for estimating point soil parameters, but also methods are needed for quantifying the areal and temporal variation of the soil parameters (14).

The Green and Ampt infiltration model has been found⁴ to have wide applicability for modeling the infiltration process (10,15). The Green and Ampt rate equation is written as

$$1 + K \left(1 + \frac{n \phi_f}{F} \right) \quad (1)$$

and its integrated form is

$$F - n \phi_f \ln \left(1 + \frac{F}{n \phi_f} \right) = Kt \quad (2)$$

in which K = hydraulic conductivity, in centimeters per hour; ϕ_f = wetting front capillary pressure head, in centimeters; and n = available porosity which is calculated as the effective porosity, θ , (total porosity, ϕ , minus residual saturation, θ_r), minus initial soil water content. Equation

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variables are f = infiltration rate, in centimeters per hour; F = infiltration amount, in centimeters; and t = time, in hours.

Application of the Green and Ampt infiltration model requires estimates of the hydraulic conductivity, K ; effective porosity, θ ; and wetting front capillary pressure head, ϕ_f . Pioneering work on evaluating the Green and Ampt parameters was first reported by Bouwer (1). Additional work, relating the parameters to soil texture, has been reported by Clapp and Hornberger (7), Brakensiek, et al. (3), and McCuen, et al. (9). Since past work has used only a small portion of the available soil survey information, specifically soil texture, it is the purpose of this study to report on predicting the Green and Ampt parameters (K , θ , ϕ_f) from soil properties utilizing the full spectrum of soil survey information.

The National Cooperative Soil Survey (a joint effort by cooperating Federal agencies, land grant universities, and other state and local agencies), uses a national system of soil classification (11,16). This system is based primarily on soil properties that can be observed in the field (e.g., texture) or inferred from other properties observable in the field (e.g., clay mineralogy). The differentiating soil properties are those that mainly affect plant growth and engineering use of the soil, such as particle size distribution, clay mineralogy, organic matter, soil temperature regime, soil moisture regime, carbonate content, and salt content.

Soil taxonomy is a hierarchy of six categories and each category includes a set of classes that are defined at about the same level. The most general definitions, with the fewest differentiating properties, are in the highest category, which consists of 10 orders. The most specific definitions, with the most differentiating properties, are in the lowest category, which is the soil series. There are more than 12,000 series. Soil series are the classes most commonly used to define and name map units in soil surveys, but classes in other categories are also used. The system is designed to facilitate both the interpretation of the soil data for practical application, and because it is national—the transfer of soil information from one location to another. A soil survey for an individual area is designed to meet certain objectives and satisfy the needs identified by local users and cooperating agencies. The distinguishing characteristics of soil surveys are summarized in Table 1.

A map unit delineated on a soil map is a unique soil area recognized in a particular soil survey area. Map units are named for the dominant soil or soils in the unit. The named soil can be at any of the categorical levels in the soil classification system. The more general the soil resource information needed, the higher the category used for the reference name.

Map unit delineations contain inclusions not identified in the map unit name. These units are named and identified by the taxonomic class they represent. Soils are natural bodies, and their properties have a characteristic natural scatter or variability. Because of this variability, certain properties may fall outside the precise limits defined for the named taxonomic class. Also, the map scale may be too small for precise mapping of a small area of these included soils. Map units are designed so that no more than about 15% of the unit consists of inclusions dissimilar enough that their use and management differ, and these inclusions are described in map unit descriptions. Generally, map units of soil surveys



FIG. 1.—Distribution of Soils

in which θ = soil water content, in cubic centimeters per cubic centimeter; θ_r = residual saturation, in cubic centimeters per cubic centimeter; ϕ = total porosity, in cubic centimeters per cubic centimeter; ϕ_b = bubbling porosity, in cubic centimeters per cubic centimeter; ϕ_p = pore pressure, in centimeters; ϕ_s = soil pressure, in centimeters; and ϕ_t = the pore-size distribution index.

The Green and Ampt parameters can be calculated from the estimated Brooks and Corey constants as follows: The wetting front capillary pressure term, ϕ_p , is calculated by (2)

$$\phi_p = \frac{2\lambda + 3}{2\lambda + 2} \left(\frac{\phi_b}{\phi_s} \right) \quad (2)$$

The effective porosity, ϕ_e , is calculated as

$$\phi_e = \phi - \phi_p \quad (3)$$

in which ϕ = the total porosity, in cubic centimeters per cubic centimeter, and is calculated from bulk density and particle density, and ϕ_r = the residual soil-water content, in cubic centimeters per cubic centimeter. The Green and Ampt hydraulic conductivity, K_e , based on Bouwer's (4) findings that it is one-half the saturated hydraulic conductivity, is calculated as

$$K_e = \frac{K_s}{2} \quad (4)$$

in which the saturated conductivity, K_s , is calculated by an equation (Ref. 5) derived by substituting the Brooks and Corey equation into the Childs, Collis-George permeability integral (6) given by

$$K_s = \frac{\phi_s^3}{\phi_b^3} \left[\frac{\lambda^2}{(\lambda + 1)(\lambda + 2)} \right] \quad (5)$$

in which ϕ_s = a constant representing the effects of various field con-

TABLE 2.—Green and Ampt Parameters According to Soil Texture Classes and Moisture

Soil texture class (1)	Moisture (2)	Grain size (3)	Total porosity, ϕ , in cubic centimeters per cubic centimeter (4)	Effective porosity, ϕ_e , in cubic centimeters per cubic centimeter (5)	Wetting front capillary pressure, ϕ_p , in centimeters (6)	Hydraulic conductivity, K_e , in cubic centimeters per hour (7)
Silt	A	762	0.437 (0.374-0.500)	0.417 (0.304-0.489)	4.05 (0.37-25.30)	11.76
		370	0.432 (0.304-0.500)	0.431 (0.375-0.487)	5.34 (1.34-23.86)	
		185	0.430 (0.304-0.499)	0.421 (0.305-0.477)	6.59 (1.31-21.00)	
Loamy sand	C	127	0.430 (0.304-0.499)	0.409 (0.305-0.493)	3.49 (0.33-13.34)	2.99
		336	0.437 (0.303-0.500)	0.401 (0.370-0.476)	4.13 (1.35-27.94)	
		110	0.437 (0.303-0.500)	0.434 (0.307-0.500)	4.81 (1.35-22.87)	
Sandy loam	B	40	0.437 (0.370-0.500)	0.434 (0.356-0.499)	4.35 (1.05-17.24)	1.89
		36	0.436 (0.373-0.479)	0.389 (0.323-0.457)	5.14 (0.35-24.09)	
		644	0.473 (0.376-0.500)	0.412 (0.305-0.500)	11.84 (2.47-48.47)	
Loam	A	119	0.505 (0.395-0.613)	0.465 (0.358-0.499)	12.36 (0.35-40.70)	0.36
		214	0.466 (0.371-0.569)	0.439 (0.377-0.500)	8.79 (0.33-30.64)	
		303	0.438 (0.382-0.499)	0.389 (0.306-0.459)	6.79 (0.34-20.02)	
Silt loam	C	76	0.512 (0.427-0.597)	0.454 (0.356-0.500)	8.89 (0.35-29.20)	0.36
		47	0.512 (0.400-0.614)	0.499 (0.382-0.614)	10.05 (0.34-40.81)	
		47	0.413 (0.300-0.479)	0.382 (0.276-0.499)	9.27 (0.37-49.29)	0.49
Sandy clay	A	1,206	0.501 (0.430-0.567)	0.461 (0.306-0.500)	14.60 (0.35-40.70)	0.49
		361	0.537 (0.466-0.614)	0.514 (0.428-0.600)	10.91 (0.39-40.82)	
		267	0.537 (0.450-0.636)	0.514 (0.387-0.643)	7.21 (0.36-40.82)	
Clay loam	C	73	0.479 (0.400-0.557)	0.449 (0.395-0.500)	12.65 (0.34-40.45)	0.15
		408	0.506 (0.382-0.600)	0.389 (0.329-0.459)	22.40 (0.42-100.40)	
Clay	A	199	0.501 (0.390-0.600)	0.399 (0.323-0.497)	20.90 (0.37-142.30)	0.15
		31	0.497 (0.380-0.600)	0.393 (0.301-0.478)	22.80 (0.31-140.79)	
		364	0.464 (0.400-0.519)	0.386 (0.276-0.500)	30.80 (0.34-91.10)	
Silty clay loam	B	20	0.491 (0.434-0.549)	0.439 (0.358-0.500)	27.60 (0.33-135.10)	0.15
		19	0.491 (0.400-0.591)	0.397 (0.276-0.500)	30.30 (0.36-70.79)	
		35	0.493 (0.432-0.497)	0.387 (0.306-0.499)	15.21 (0.39-60.61)	
Silty clay	C	409	0.475 (0.410-0.540)	0.403 (0.307-0.500)	27.35 (0.47-131.50)	0.15
		45	0.509 (0.440-0.569)	0.497 (0.412-0.500)	13.97 (0.30-40.50)	
		171	0.499 (0.412-0.576)	0.440 (0.374-0.500)	30.30 (0.40-91.40)	
Sandy clay	B	39	0.475 (0.426-0.514)	0.403 (0.306-0.500)	21.34 (0.36-100.7)	3.61
		45	0.498 (0.430-0.600)	0.391 (0.307-0.499)	25.90 (0.60-140.3)	
		23	0.498 (0.391-0.600)	0.387 (0.320-0.499)	36.74 (0.30-162.1)	
Clay	C	127	0.471 (0.405-0.537)	0.425 (0.304-0.500)	20.20 (0.13-479.4)	0.30
		39	0.475 (0.400-0.567)	0.434 (0.305-0.500)	20.46 (0.13-479.4)	
		31	0.464 (0.426-0.499)	0.404 (0.306-0.499)	40.46 (0.37-114.1)	0.00
Clay	A	291	0.475 (0.427-0.526)	0.389 (0.300-0.391)	7.40 (0.26-29.3)	
		70	0.479 (0.420-0.538)	0.432 (0.300-0.500)	27.37 (0.31-123.7)	
		23	0.485 (0.441-0.529)	0.419 (0.296-0.500)	34.35 (0.30-100.4)	

*Based on the log mean and standard deviation.

*Values for the texture class.

*Values in (1) = one standard deviation.

*Standard sample to determine parameters.

Estimation of Soil Water Properties

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ABSTRACT

RELATIONSHIPS of soil water tension and hydraulic conductivity with soil water content are needed to quantify plant available water and to model the movement of water and solutes in and through soils. Field and laboratory measurement of these hydraulic soil properties is very difficult, laborious, and costly. To provide the best estimates possible from previous analyses, a comprehensive search of the literature and data sources for hydraulic conductivity and related soil-water data was made in 1978. From this search, data for 1,323 soils with about 5,350 horizons from 32 states were assembled. From the data, the Brooks and Corey water retention parameters, soil water retention volumes at 0.33 bar and 15 bar, total porosity, and saturated conductivities for the major USDA soil texture classes were developed. Also, relationships for predicting water retention volumes for particular tensions and saturated hydraulic conductivities based on soil properties are presented.

INTRODUCTION

To incorporate the principles of soil water physics into hydrologic modeling (Mein and Larson, 1973), it is necessary to specify the relationships between matric potential and hydraulic conductivity as a function of soil water content. Measurement of these relationships is very costly and time consuming, making this approach difficult to use in watershed hydrology modeling. To overcome these difficulties, an extensive literature and data search for soil water retention, hydraulic conductivity, and related soils information was performed in 1978. In addition, more than 400 soil scientists were contacted, many of whom contributed unpublished data. The results of this survey are summarized in two parts: (a) the soil water retention data base and analysis, and (b) the hydraulic conductivity data base and analysis.

SOIL WATER RETENTION

The literature and data search for water retention and related soils information produced 26 sources of data (Table 1) each covering at least a matric suction range from 100 cm to 2,000 cm. From this search, data for 1,323 soils with about 5,350 horizons, from 32 states (Fig. 1) were assembled. The data base includes location

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Texture class	Sample size	Total porosity (%)		Effective porosity (%)		Bulk density (g/cm ³)		Particle size distribution (%)		Organic matter (%)		Water retention (%)		Number of horizons
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Less than 2 mm	Less than 0.075 mm	Mean	Standard deviation	At 1/3 bar	At 15 bar	
Sand	762	0.437	0.020	0.173	0.013	1.506	0.26	100	0	0.004	0.002	0.001	0.001	21.00
... (rows omitted for brevity) ...														
Clay	291	0.475	0.015	0.269	0.011	1.511	0.17	0	100	0.109	0.131	0.290	0.272	0.00

* First line is the mean value
 Second line is + one standard deviation about the mean
 † Anything at the top means
 ‡ Obtained from Fig. 2

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water retention at specific matric potentials to (a) percent sand, silt, clay, organic matter content, and bulk density; (b) percent sand, silt, and clay, organic matter, bulk density and 15 bar water retention; and (c) percent particle size content, organic matter, bulk density, and 1/3 and 15 bar water retention. These levels of analysis demonstrate the predictive ability achieved by adding factors which require more costly and/or time consuming laboratory procedures to the standard soil survey data analysis. For example, particle size distribution and organic matter data are the least expensive data to obtain while 1/3 bar water retention and bulk density data are the most expensive. The 15 bar water retention value is an intermediate cost item.

The three levels of regression equations are summarized in Table 3 for the 12 matric potentials reported in the Gupta and Larson (1979) paper. The addition of the 15 bar water retention value and both the 1/3 and 15 bar water retention values to the percent sand, silt and clay, bulk density and organic matter content markedly increased the accuracy (Table 3). In general, the 1/3 bar water retention value was more significant for the matric potentials between 0 and -1/3 bar and the 15 bar water retention was significant for the matric potentials between -1/3 and the -15 bar.

The data base used to develop the equations in Table 3 included 2,541 soils horizons with a wide range of sand (mean 56 percent, range 0.1-99 percent), silt (mean 26 percent, range 0.1-93 percent), clay (mean 18 percent, range 0.1-94 percent), organic matter (mean 0.66 percent, range 0.1-12.5 percent), bulk density (mean 1.42 gm/cm³, range 0.1-2.09 percent). Most agricultural soils, including both expanding (montmorillonite) and nonexpanding (kaolinite, illite, chlorite, and vermiculite) type clay minerals are represented.

HYDRAULIC CONDUCTIVITY

A generalized set of unsaturated hydraulic conductivity

values was defined for the USDA soil texture classes (SCS, 1975) by combining the results of experiments reported in the literature. Table 1 shows principle references from which the hydraulic conductivity data were obtained. Generalized conductivity curves were obtained by digitizing the many reference curves by adequately defining them by straight line segments. Information from the reference or source reports, these data were classed and sorted into the USDA soil texture classes. An average curve was estimated by visual analyses for each texture class. Some minor adjustments of the curves were made to provide a uniform family of curves as shown in Fig. 2.

Generalized curves given in Fig. 2 cannot accurately define the conductivity of any particular soil based only on texture. Each soil will have other characteristics which will cause deviation. However, the degree of definition provided by textural sorting shows that this is a major determinant. Thus, these relationships will provide adequate estimates for applications where more detailed data are not available.

Saturated Hydraulic Conductivity Relationship

The saturated hydraulic conductivities given in Table 2 were taken from Fig. 2. Using the saturated hydraulic conductivity data set compiled by Musalem (1976) a set of mean saturated hydraulic conductivity values were developed according to soil texture and compared with those in Table 2. The Musalem values were similar to those in Table 2, further verifying the representativeness of the saturated hydraulic conductivities in Table 2.

Brutsaert (1967) derived a saturated conductivity relationship by substituting the Brooks and Corey equation into the Childs, Collis-George (1950) permeability in-

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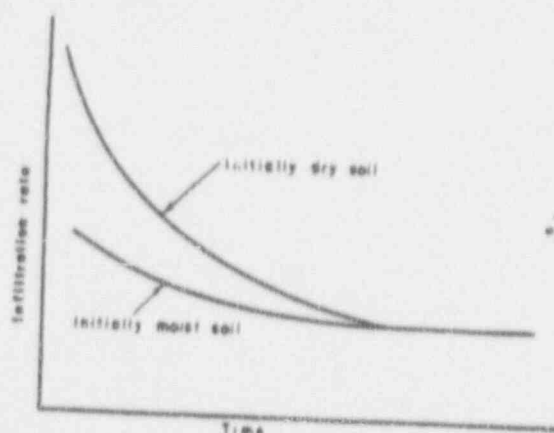


Fig. 6.5. Infiltrability as a function of time in an initially dry and in an initially moist soil.

It should be obvious from the foregoing that the effects of ponding depth and initial wetness (Fig. 6.5) can be significant during early stages of infiltration, but decrease in time and eventually tend to vanish in a very deeply wetted profile. Typical values of the "final" infiltration rate are shown in Table 6.1. These values merely give an order of magnitude, while in actual

Table 6.1

Soil type	Final infiltration rate mm/hr
Sands	>20
Sandy and silty soils	10-20
Loams	5-10
Clayey soils	1-5
Sodic clayey soils	<1

cases the infiltration rate can be considerably higher (particularly during the initial stages of the process and in well-aggregated or cracked soils), or lower (as in the presence of a crust).

F. Green and Ampt's Approach

A much simplified, approximate approach to the infiltration problem was suggested more than half a century ago by Green and Ampt (1911), in their

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F. Green and Ampt's Approach

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classic paper on flow of air and water through soils. Their approach^{*} has been found to apply quite satisfactorily for certain cases of infiltration, into initially dry soils, particularly of the coarse-textured type, which exhibit a sharp wetting front (e.g., Hillel and Gardner, 1970). The solution gives no information about details of the moisture profile during infiltration, but does offer estimates of the infiltration rate and the cumulative infiltration functions of time, i.e., $k(t)$ and $I(t)$.

The principal assumptions of the Green and Ampt approach are that there exists a distinct and precisely definable wetting front, and that the matric suction at this wetting front remains effectively constant, regardless of time and position. Furthermore, this approach assumes that, behind the wetting front, the soil is uniformly wet and of constant conductivity. The wetting front is thus viewed as a plane separating a uniformly wetted infiltrated zone from a totally uninfiltrated zone. In effect, this supposes the K vs. θ relation to be discontinuous, i.e., to change abruptly, at the suction value prevailing at the wetting front.

These assumptions simplify the flow equation, making it amenable to analytical solution. For horizontal infiltration, a Darcy-type equation can be applied directly:

$$i = \frac{dI}{dt} = K \frac{H_0 - H_f}{L_f} \quad (6.16)$$

where i is the flux into the soil and through the transmission zone, I the cumulative infiltration, K the hydraulic conductivity of the transmission zone, H_0 the pressure head at the entry surface, H_f the effective pressure head at the wetting front, and L_f the distance from the surface to the wetting front (the length of the wetted zone). If the ponding depth is negligible and the surface is thus maintained at a pressure head of zero, we obtain simply

$$\frac{dI}{dt} = -K \frac{H_f}{L_f} = K \frac{\Delta H_p}{L_f} \quad (6.17)$$

where ΔH_p is the pressure-head drop from the surface to the wetting front. This indicates that the infiltration rate varies linearly with the reciprocal of the distance to the wetting front.

Since a uniformly wetted zone is assumed to extend all the way to the wetting front, it follows that the cumulative infiltration I should be equal to the product of the wetting front depth L_f and the wetness increment $\Delta\theta = \theta_f - \theta_i$ (where θ_f is the transmission-zone wetness during infiltration and θ_i is the initial profile wetness which prevails beyond the wetting front);

^{*} The Green and Ampt approach has been called the "delta-function solution" (Philip, 1969).

$$I = L_f \Delta \theta \quad (6.18)$$

(In the special case where θ_s is saturation and θ_i is zero, $I = fL_f$, where f is the porosity.) Therefore,

$$\frac{dI}{dt} = \Delta \theta \frac{dL_f}{dt} = K \frac{\Delta H_f}{L_f} = K \frac{\Delta \theta \cdot \Delta H_f}{I} \quad (6.19)$$

where dL_f/dt is the rate of advance of the wetting front. The infiltration rate is thus seen to be inversely related to the cumulative infiltration. Rearranging Eq. (6.19), we obtain:

$$L_f dL_f = K \frac{\Delta H_f}{\Delta \theta} dt = \bar{D} dt \quad (6.20)$$

where the composite term $(K \Delta H_f / \Delta \theta)$ can be regarded as an effective diffusivity $\bar{D}$ for the infiltrating profile. Integration gives

$$\frac{L_f^2}{2} = K \frac{\Delta H_f}{\Delta \theta} t = \bar{D} t \quad (6.21)$$

$$L_f = \sqrt{2Kt \Delta H_f / \Delta \theta} = \sqrt{2\bar{D}t} \quad (6.22)$$

or

$$I = \Delta \theta \sqrt{2\bar{D}t}, \quad i = \Delta \theta \sqrt{\bar{D}/2t} \quad (6.23)$$

which compares with Eqs. (6.4) and (6.5) (the difference being in the $\sqrt{2\pi}$ ratio for the weighting of $\bar{D}$ vs. $\bar{D}$, both being approximate⁷). Thus the depth of the wetting front is proportional to $\sqrt{t}$, and the infiltration rate is proportional to $1/\sqrt{t}$.

With gravity taken into account, the Green and Ampt approach gives

$$\frac{dI}{dt} = \Delta \theta \frac{dL_f}{dt} = K \frac{H_0 - H_f + L_f}{L_f} \quad (6.24)$$

which integrates to

$$\frac{Kt}{\Delta \theta} = L_f - (H_0 - H_f) \ln \left(1 + \frac{L_f}{H_0 - H_f} \right) \quad (6.25)$$

As t increases, the second term on the right-hand side of Eq. (6.25) increases more and more slowly in relation to the increase in L_f , so that, at very large times, we can approximate the relationship by

⁷ $\bar{D}$ can be regarded as an indication of what wetting-front value must be assumed for the Green and Ampt approach to work.

SLP17

or

where δ can eventually

The Green and A value of the effective For infiltration into ir cm H₂O, or ~ -0.1 l However, in actual fi is not uniform, H_f mi front is too diffuse to

G. Infiltration into La

The effect of prof and Bowers (1962),⁸ equation, and by Mill the effect of thin la; conducting soil must values throughout its wetness and conduct interlayer boundaries

One typical situati conductivity, overlying rate is at first contro reaches and penetrat be expected to drop a run, it is the layer of h tion continues for lo table") can develop impeding finer layer.

In the opposite ca over a coarse-textured the upper layer. As w however, the infiltrat normally under sucti into the relatively larg

⁸ This technique was u



MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project LMTRA-FCT Contract No. 3815-20 Sheet _____
Feature Wastewater Handling II Designed _____ File No. _____
Item _____ Checked _____ Date _____

APPENDIX B

WASTEWATER TREATMENT

PLANT SIZING & COST ESTIMATE





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

Project UNITED-ECT
Feature WASTEWATER TREATMENT
Item PLANT COSTS

Contract No. 3885-28

Designed J. P. Jorgensen

Checked 8/8/91

Sheet 1/4

File No.

Date 3/15/91

Date 3/18/91

OBJECT: Per meeting of 3/8/91, estimate capital and operating costs of treatment plant as follows:

Flow rates: 60 gpm, 105 gpm, 245 gpm
Treatment capability: Radium, uranium, and heavy metal removal by conventional chemical precipitation plus ammonia removal.

Basis of costs:

- Capital costs are for site preparation, foundations, equipment, installation, startup, testing, and engineering. For conventional treatment base cost is \$902,000 for 80 gpm plant as calculated for Warden Spring Project ECI/A Report 7/25/88, p. 24, Alt. 2. Cost as of 4/88.
- Capital cost of ammonia removal is based on base cost of \$1 million for 100 gpm system Sid & Brian Junction for site in May 1990.
- 60 gpm conventional treatment will be assumed to be provided by mobile plant. Plant mobilization/demobilization was estimated at \$11,300 in Nov. 90 (see earlier calculation) 10/29/90. Plant transportation cost was estimated to be \$10,000 in Nov. 90 (see earlier calculation) 10/29/90.
- Construction Cost Indices from Engineering News-Record as follows:

Feb 1991	4772
Nov 1990	4700
April 1988	4489
May 1990	4650





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project

VMTA-FCT

Feature

WASTEWATER TREATMENT

Item

PLANT COSTS - CAPITAL

Contract No.

3865-28

Designed

J.E. Gage

Checked

10/9/91

Sheet

2/4

File No.

Date

3/15/91

Date

3/10/91

Calculate new

Adjust capital costs using base cost and adjusting for
flow to the 0.7 power and for change in CCI

$$\text{Cost} = \left[\$962,000 \left(\frac{105}{80} \right)^{0.7} \times \frac{4772}{4489} \right] + \left[\$1,000,000 \left(\frac{105}{160} \right)^{0.7} \left(\frac{4772}{4650} \right) \right]$$

$$= 1,237,073 + 764,181 = \$2,001,254$$

$$\text{Cost} = \left[\$962,000 \left(\frac{245}{80} \right)^{0.7} \left(\frac{4772}{4489} \right) \right] + \left[\$1,000,000 \left(\frac{245}{160} \right)^{0.7} \left(\frac{4772}{4650} \right) \right]$$

$$= 2,238,614 + 1,382,865 = \$3,621,479$$

60 gpm

Ammonia Treatment:

$$1,000,000 \times \left(\frac{60}{160} \right)^{0.7} \times \left(\frac{4772}{4650} \right) = \$516,449$$





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project LIMTA-ECT
 Feature WASTEWATER TREATMENT
 Item PLANT COSTS - OPERATIVE

Contract No. 3885-28 Sheet 3/4
 Designed [Signature] File No.
 Checked [Signature] Date 3/15/91
 Date 3/18/91

Based partly on EEKA Report 112, p. 27

For 80 gpm plant: Energy = \$45/day

Chemicals = \$37/day

Labor = \$675/day

Based on Grand Junction Wd, 180 HP for 160 gpm
 air stripping for ammonia removal

$$180 \text{ HP} \times 0.746 \frac{\text{kW}}{\text{HP}} : \frac{\$0.09}{\text{kWh}} \times 24 \frac{\text{hr}}{\text{day}} = \$240/\text{day}$$

60 gpm

$$\text{Energy} = \left(\$45/\text{day} \times \frac{60}{80} \right) + \left(\$790 \times \frac{60}{160} \right) = \$143/\text{day}$$

$$\text{Chemicals} = \frac{\$37}{\text{day}} \times \frac{60}{80} = \$28/\text{day}$$

$$\text{Labor} = \$675/\text{day}$$

$$\underline{\$846/\text{day}}$$





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

Project UNTRA-FACT
Feature WASTEWATER TREATMENT
Item PLANT COSTS - OPERATING

Contract No. 3885-28

Designed D. B. Jones

Checked H. E. Jones

Sheet 4/4

File No.

Date 3/15/91

Date 3/18/91

105 gpm

$$\text{Energy} = \left(\$45 \times \frac{105}{80} \right) + \left(\$290 \times \frac{105}{160} \right) = \$249/\text{day}$$

$$\text{Chemicals} = \$37 \times \frac{105}{80} = \$49/\text{day}$$

$$\text{Labor} = \$675/\text{day}$$

$$\underline{\$973/\text{day}}$$

245 gpm

$$\text{Energy} = \left(\$45 \times \frac{245}{80} \right) + \left(\$290 \times \frac{245}{160} \right) = \$582/\text{day}$$

$$\text{Chemicals} = \$37 \times \frac{245}{80} = \$113/\text{day}$$

$$\text{Labor} = \$675/\text{day}$$

$$\underline{\$1,370/\text{day}}$$

COST SUMMARY

	<u>60</u>	<u>105</u>	<u>245</u>
Capital Cost, \$	516,499	2,001,254	3,621,479
Operating Cost, \$/day	846	973	1,370
Plant Mobilization/Demobilization, \$	11,500	—	—
Tractor Transport	10,200	—	—





MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project UMTRA - SET
Feature Wastewater Handling II
Item App. C

Contract No. 3883-21
Designed PTL
Checked _____

Sheet _____
File No. _____
Date 5/19/91
Date _____

APPENDIX C

Irrigation - Capital Cost & Labor





MORRISON-KNUDSEN ENGINEERS, INC.

Project ULTRA - FET Contract No. 3805-28 Sheet C-1
 Feature Wastewater Handling II File No. _____
 Item App. C Designed _____ Date _____
 Checked _____ Date _____

Irrigation

60 AC 200 GPM $1616 \times 1616 = 2613600 \text{ SF}$

SCH40 LINE 2' OC

1/2 GPM @ 2'

1/2 GPM / 4 FT²

653400 EMITTERS @ 1/2 GPM

= 326700 GPM FOR FIELD

@ 200 GPM (12000 GPM) FIELD IS IN 27 BLOWS (311 x 311)

NO LINE FRICTION CONSIDERED

Poly 1620/2 x 1620' = 1312200 @ 160/THOUS = \$ 210 000

PVC 12" 1620 x \$5 = \$ 8100

4" 800 x 14 x \$1 = \$ 11200

2" 800 x 14 x .35 = 3920

1" 27 x 311 x .18 = 1511

PVC FITTINGS @ 80% PVC = \$ 7400

MANUAL VALVES 400A x \$40 \$ 1600

LABOR TO INSTALL

CREW 5 MEN @ \$25/HR = \$ 125/HR

TECHNICAL/HOS \$ 60/HR

TRACTOR 35/HR

FLATBED \$ 15/HR

235 \$M 280/HR

MAHS 3 WED x 40 HRS x \$250 = \$ 30 000

Poly 248 MILES @ 2 MPH = 124 HRS @ \$75 = 93 00

CHUCK & FLUSH 160 x 25 = 4000

SUBTOTAL 287 000

OH & SUPERVISION @ 15% 43 000

PROFIT @ 10% 28 700
330 000
33 000





MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project WATER - FIT
Feature Wastewater Handling II
Item App. C

Contract No. 2215-28 Sheet C.2
Designed _____ File No. _____
Checked _____ Date _____
Date _____

ST FROM Previous Pg

CONTINGENCY @ 25%

363 000

91 000

= 454 000

SAY 450 - 500 000

60 AC 200 GPM

1 MONTH = 8 640 000 GAL
PER MONTH

$\frac{8640000 \text{ GAL/MO}}{2613600 \text{ SF}}$

= 3.31 GAL / SF / MO

= 5.3 INCHES / MO OF IRRIGATION



Calculation Cover Sheet

Contract No. 3885-28Discipline HydraulicsCalc. No. 20-486-03-00No. of Sheets 23

Project

UMTRA / FALLS CITY

Feature

Evaporation pond

Item

Spillway sizing

Sources of Data

Sources of Formulae & References

see sheet 1Preliminary Calc. ☐Final Calc. ☒

Supersedes Calc. No. _____

0	—	Fang Hong Wu	4/22/91	P. Y. LI	6/13/91		
Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date

MORRISON-KNUDSEN CORPORATION

Project	UNTRA/ECT	Contract No.	3885-28	Sheet	1
Feature	Evaporation Pond	Designed	FWH	File No.	
Item	Spillway Sifting	Checked	PYL	Date	5/26/91
				Date	6/18/91

References

1. U.S. Army Corps of Engineers, "Standard Project Flood Determination," EM 110-2-1411, 3/26/1952, revised March 1965
2. U.S. Army Corps of Engineers, "HEC-1 Flood Hydrograph packages," Computer program 723-X6-62010, User Manual, Sept. 1981 (revised Jan. 1983)
3. MKE Col. NO. 20-833-02-01, "UNTRA/Falls City, Site Hydrology, Intensity vs Duration Curves for 10 and 25 yr return periods," March, 1988
4. U.S. Dept. of Interior, Office of Surface Mining, "Surface Mining Water Pollution Design Manual," OSM/TA-8212, Sept. 1982
5. Brater, E.F. & King, H.W., "Handbook of Hydraulics," 6th edition, McGraw-Hill, Inc., 1976

 MORRISON-KNUDSEN CORPORATION		Sheet <u>2</u>
Project <u>UNTRA/ECT</u>	Contract No. <u>3885-28</u>	File No. _____
Feature <u>Evaporation pond</u>	Designed <u>FWA</u>	Date <u>5/32/91</u>
Item <u>Spillway sizing</u>	Checked <u>PYL</u>	Date <u>6/13/91</u>

1 Purpose

To size the spillway at end of the evaporation pond to pass a 25-yr 24-hr storm

2 Method and Criteria

- 1) The evaporation pond has no other runoff contributions except the pond itself.
- 2) The pond is divided into 10 separate ponds in tandem cascading downward from pond No. 1 through No. 10 (see sheet 4). The water will be overflowing through the dividing embankment from upstream one to the downstream one if the upstream pond is full.
- 3) A 25-yr 24-hr storm is assumed to dump the water simultaneously on all individual pond, and at the beginning of the storm, each individual pond is assumed full.
- 4) The 6-hr increments of the 24-hr storm is assumed to be distributed in a sequence of 4, 2, 1, 3 with the largest 6-hr on the 3rd one. Within the largest 6-hr increment, the hourly increments is assumed to be distributed in a sequence of 6, 4, 2, 1, 3, 5 with



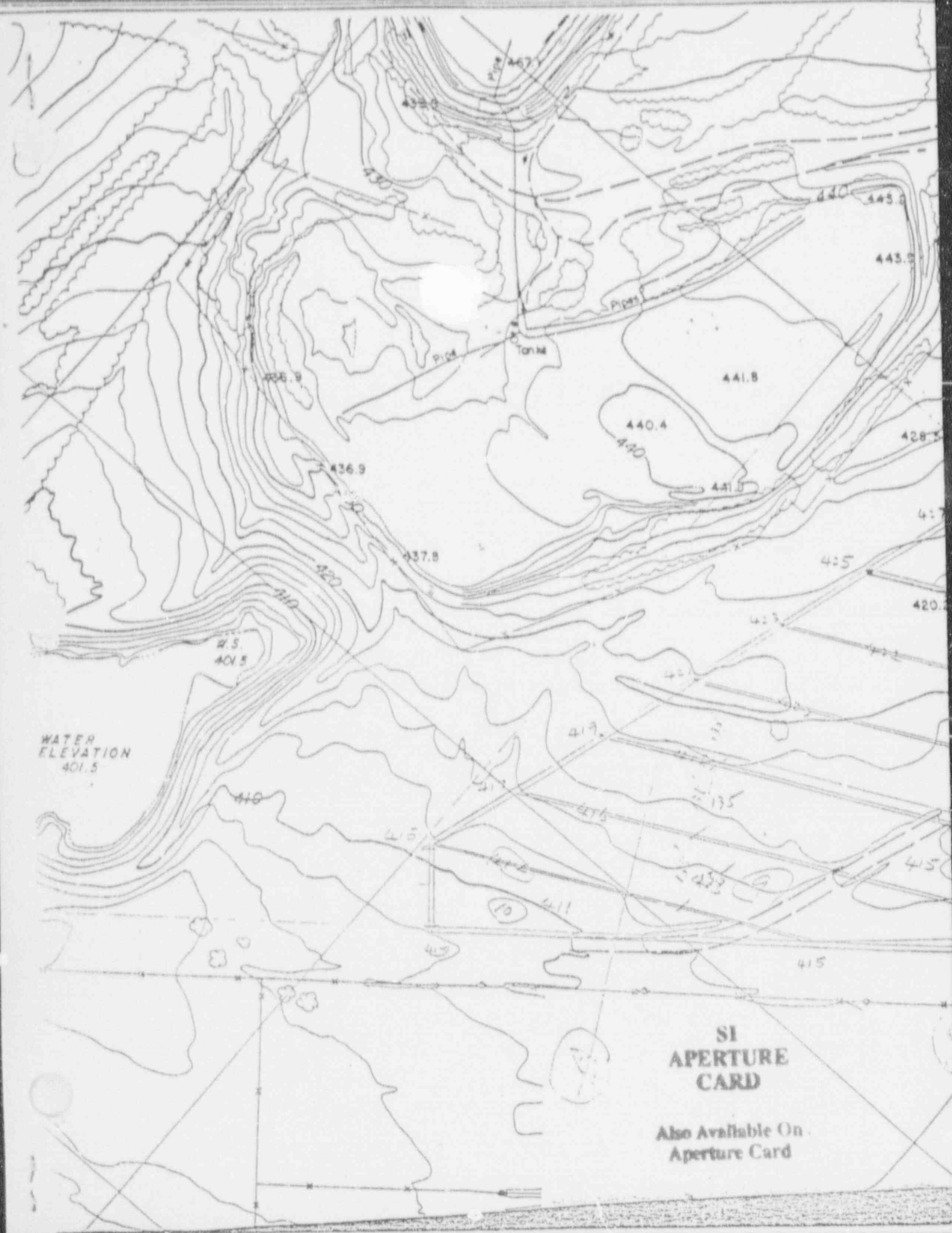
Project	UNITRA/ECT	Contract No.	3885-28	Sheet	3
Feature	Evaporation pond	Designed	FWW	File No.	
Item	Spillway sizing	Checked	PYL	Date	4/22/91
				Date	6/13/91

the largest hourly increment to be placed on the 4th one. This is generally the more critical sequence as adopted by U.S. Army Corps of Engineers (Ref. 1)

5) The rainfall will be divided into 5-min increments. The instantaneous runoff ^{rate} _(cfs) in the ponds, will be the total rainfall volume within each 5 min increment divided by the time increment ($5 \times 60 = 300 \text{ sec}$), and the runoff hydrograph distribution is similar to rainfall distribution.

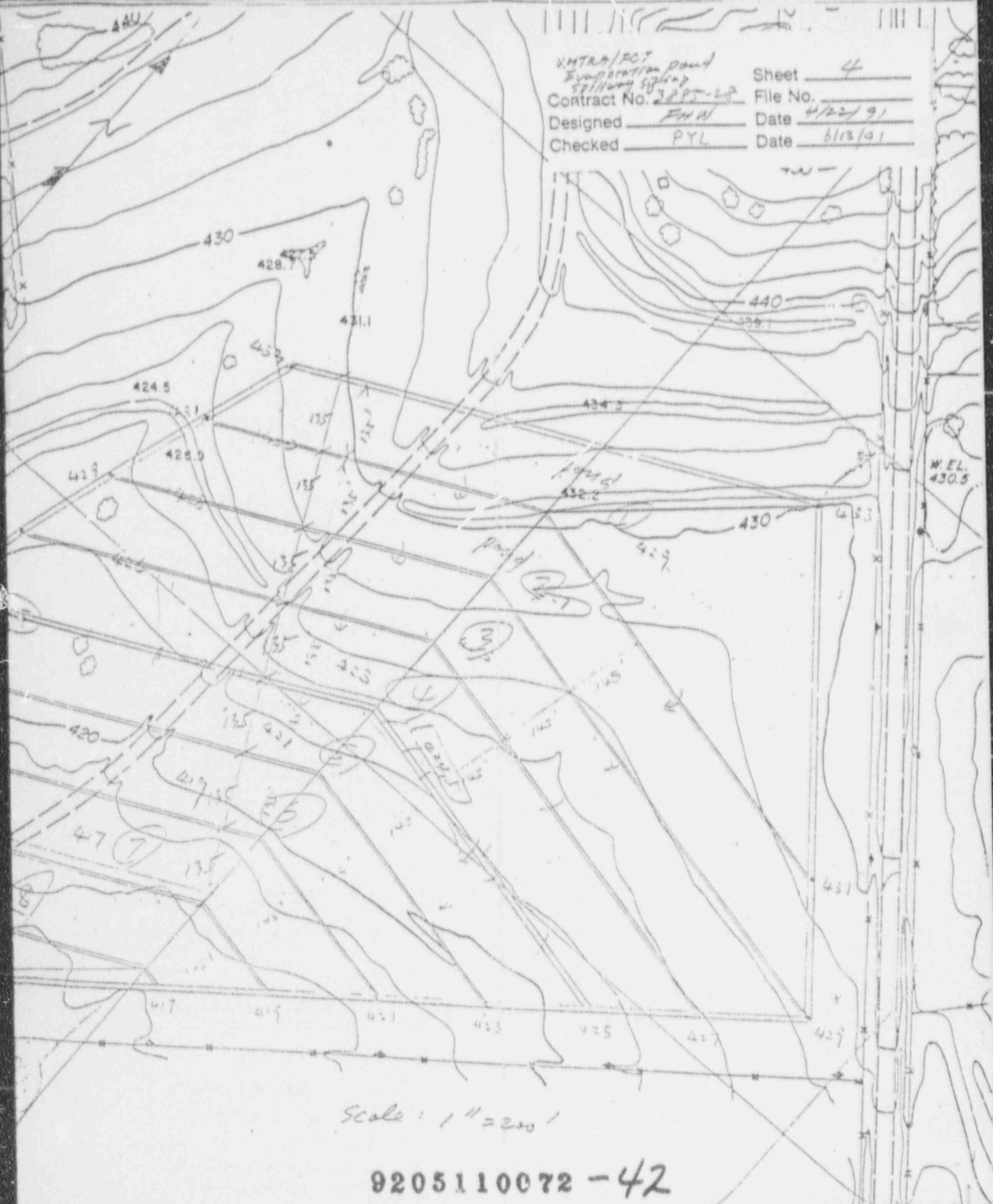
6) Inflow hydrograph from the most upstream pond is then routed through the dividing embankment and combining with the downstream pond, and then routed again through the ^{next} dividing embankment until the most downstream pond.

7) The U.S. Army Corps of Engineers Computer program "HEC-1 Flood Hydrograph Package" ^(Ref 2) was used to compute the inflow hydrograph, and to perform combining and routing through each pond.



KMTR/PCJ
Evaporation Pond
Stillwater Siding
Contract No. 38PT-22
Designed FWW
Checked PYL

Sheet 4
File No. _____
Date 4/22/91
Date 6/13/91



1 MORRISON-KNUDSEN CORPORATION		Sheet <u>5</u>
Project <u>UNTRA/ECT</u>	Contract No. <u>8885-28</u>	File No. _____
Feature <u>Evaporation pond</u>	Designed <u>FWH</u>	Date <u>5/23/91</u>
Item <u>Spillway Sizing</u>	Checked <u>PYL</u>	Date <u>6/13/91</u>

3. Computations

a. 25-yr 24-hr storm

The 25-yr 24-hr storm was obtained from Ref. 3 and are listed and plotted on sheet 6. The 5 min increments are tabulated on sheets 7 and 8. The 5 min increments for the largest 1-hr rainfall are computed as shown on sheet 9 based on Ref. 4. The distributed rainfall increments are also shown on sheets 7 + 8 (see also computer input).

b. Instantaneous Runoff Hydrograph

An one-point equivalent unit hydrograph was computed as follows in cfs.

$$= \frac{1}{12} \times \frac{1}{5 \times 60} \times \text{Area (Ac)}, \text{ in cfs}$$

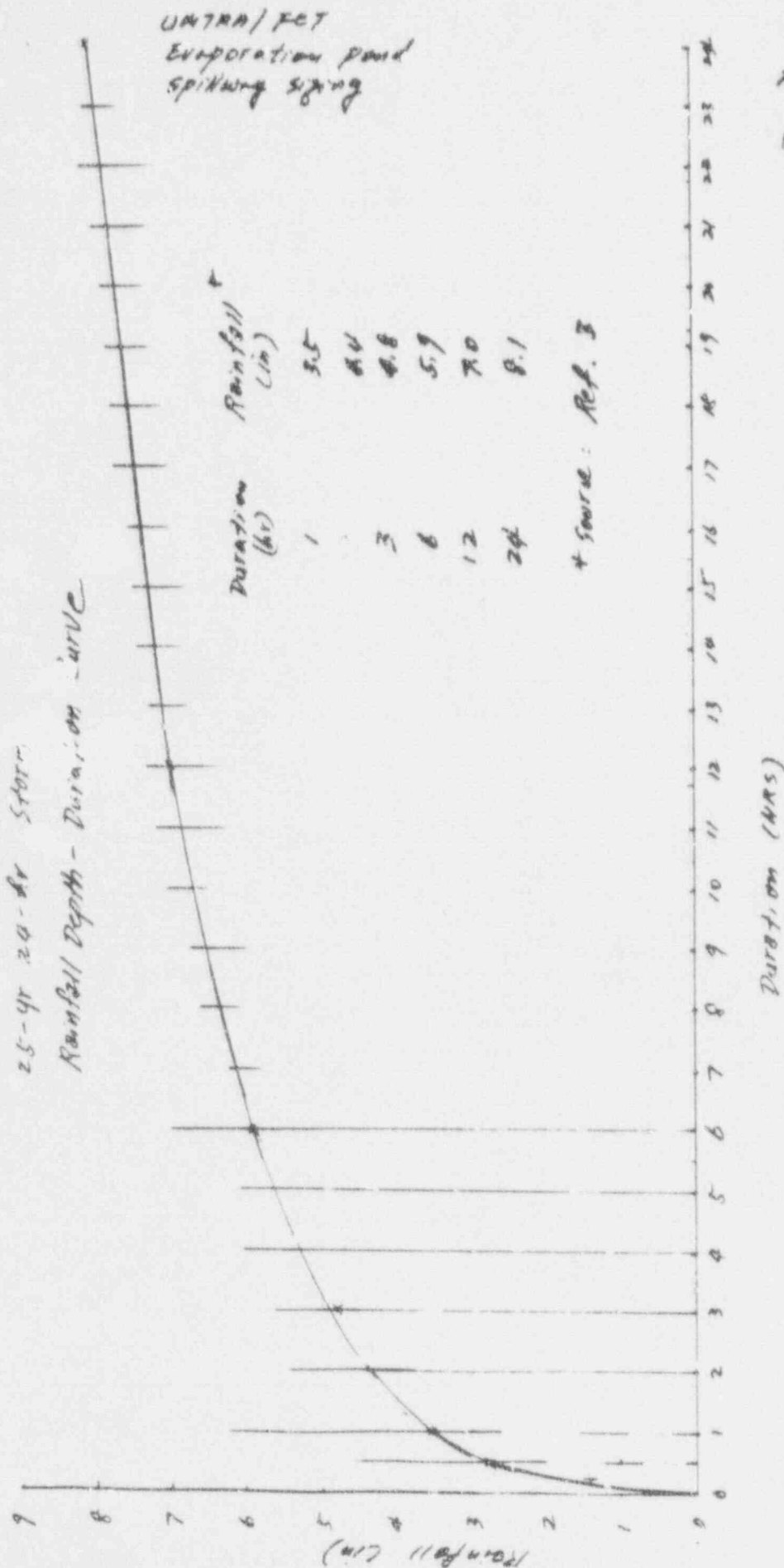
The pond area and equivalent unit hydrograph (one-point) for each pond are summarized on sheet 11.

c. Rating through Each pond

- 1) Area capacity curves for each pond were computed approximately assuming constant surface water
- 2) Discharge Rating Curves for flow over the embankment top of each pond were computed using the weir formula $Q = C L H^{5/2}$ (L = length of overflow embankment, H = head above the top) and assuming broad crest weir with $C = 2.6$ (Ref. 5) (see sheet 12)



2.5-yr 24-hr storm
Rainfall Depth - Duration curve



Sheet 6
FHW
4/4/91
PTL 6/13/91



MORRISON-KNUDSEN CORPORATION

Project UMTRA/FCT
 Feature Evaporation Pond
 Item Spillway Sizing

Contract No. 3885-28 Sheet 7
 File No.
 Designed MMW Date 4/22/91
 Checked PTL Date 6/13/91

25-YR 24-Hr Storm Rainfall Depth - Duration + Distribution

TIME (min)	IRAIN (in)	ARAIN (in)	DISTN AREA (in)	TIME (min)	IRAIN (in)	ARAIN (in)	DISTN AREA (in)	TIME (min)	IRAIN (in)	ARAIN (in)	DISTN AREA (in)
5	1.02	1.02	0.007	5	0.03	0.007	0.007	5	0.02	0.02	0.012
10	1.59	0.57	"	10	"	"	"	10	"	"	"
15	2.0	0.41	"	15	"	"	"	15	"	"	"
20	2.31	0.31	"	20	"	"	"	20	"	"	"
(1) 25	2.57	0.26	"	25	"	"	"	25	"	"	"
30	2.76	0.19	"	(4) 30	"	"	"	(7) 30	"	"	"
35	2.94	0.18	"	35	"	"	"	35	"	"	"
40	3.08	0.14	"	40	"	"	"	40	"	"	"
45	3.21	0.13	"	45	"	"	"	45	0.02	"	"
50	3.33	0.12	"	50	"	"	"	50	0.02	"	"
55	3.42	0.09	"	55	"	"	"	55	0.02	"	"
60	3.57	0.09	"	60	5.3	0.03	"	60	6.15	0.02	"
5	3.60	0.09	0.007	5	0.03	0.007	0.007	5	0.017	0.012	0.012
10	0.09	"	"	10	0.03	"	"	10	0.017	"	"
15	0.08	"	"	15	0.029	"	"	15	0.017	"	"
20	0.08	"	"	20	0.029	"	"	20	0.017	"	"
25	0.08	"	"	25	"	"	"	25	0.017	"	"
(2) 30	4.0	0.08	"	(5) 30	"	"	"	(8) 30	0.017	"	"
35	0.07	"	"	35	"	"	"	35	0.017	0.013	"
40	0.07	"	"	40	"	"	"	40	0.017	"	"
45	4.21	0.07	"	45	"	"	"	45	0.017	"	"
50	0.07	"	"	50	"	"	"	50	0.017	"	"
55	0.06	"	"	55	"	"	"	55	0.017	"	"
60	4.4	0.06	"	60	5.65	"	"	60	6.354	0.017	"
5	0.05	0.007	0.007	5	0.021	0.007	0.007	5	0.017	0.013	0.013
10	0.05	"	"	10	"	"	"	10	0.017	"	"
15	0.05	"	"	15	"	"	"	15	0.017	"	"
20	0.05	"	"	20	"	"	"	20	0.017	"	"
25	0.05	"	"	25	"	"	"	25	0.016	"	"
(3) 30	4.7	0.05	"	(6) 30	"	"	"	(1) 30	0.016	"	"
35	0.04	"	"	35	"	"	"	35	"	"	"
40	0.04	"	"	40	"	"	"	40	"	"	"
45	0.04	"	"	45	"	0.008	"	45	"	"	"
50	0.04	"	"	50	"	"	"	50	"	"	"
55	0.04	"	"	55	"	"	"	55	"	"	"
60	4.94	0.04	"	60	5.96	"	"	60	6.55	"	"





MORRISON-KNUDSEN CORPORATION

Project WATER/FCT
 Feature Evaporation pond
 Item Spilling Sizing

Sheet 8
 Contract No. SCPS-28 File No.
 Designed SWW Date 4/22/91
 Checked PYL Date 4/13/91

25-yr 24-hr Storm Rainfall - Depth, Duration & Distribution

Time (hr) (min)	Depth (in)	Depth (in)	Duration (hr) (min)	Time (hr) (min)	Depth (in)	Depth (in)	Duration (hr) (min)	Time (hr) (min)	Depth (in)	Depth (in)	Duration (hr) (min)
5		0.013	0.016			0.009	0.021			0.008	0.090
10		"	"			0.009	"			"	0.130
15		"	"			"	"			"	0.160
20		"	"			"	"			"	0.190
25		"	"			"	"			"	0.230
(4) 30		"	"	(3)		"	"			"	0.270
35		"	"			"	"	(6)		"	0.310
40		"	"			"	"			"	0.350
45		"	0.017			"	"			"	0.390
50		"	"			"	"			"	0.430
55		"	"			"	"			"	0.470
60	6.70	"	"		7.108	"	"		7.40	"	0.510
5		0.013	0.017			0.009	0.030			0.008	0.050
10		"	"			0.009	"			"	"
15		"	"			0.009	"			"	"
20		"	"			0.009	"			"	"
(11) 25		"	"	(4)		0.008	"	(17)		"	"
30		"	"			"	"			"	"
35		0.012	"			"	"			"	0.040
40		"	"			"	"			"	"
45		"	"			"	"			"	"
50		"	"			"	"			"	"
55		"	"			"	"			"	"
60	6.856	"	"		7.208	"	"		7.496	"	"
5		0.012	0.020			0.008	0.060			0.008	0.030
10		"	"			"	"			"	"
15		"	"			"	0.070			"	0.029
20		"	"			"	"			"	"
25		"	0.021			"	"			"	"
(12) 30		"	"	(45)		"	"	(18)		"	"
35		"	"			"	0.088			"	"
40		"	"			"	"			"	"
45		"	"			"	"			"	"
50		"	"			"	"			"	"
55		"	"			"	"			"	"
60	7.0	"	"		7.304	"	0.090		7.592	"	"
										(19)	470.008
										(20)	1270.007
										(21)	1270.007
										(22)	1270.007
										(23)	1270.007
										(24)	1270.007





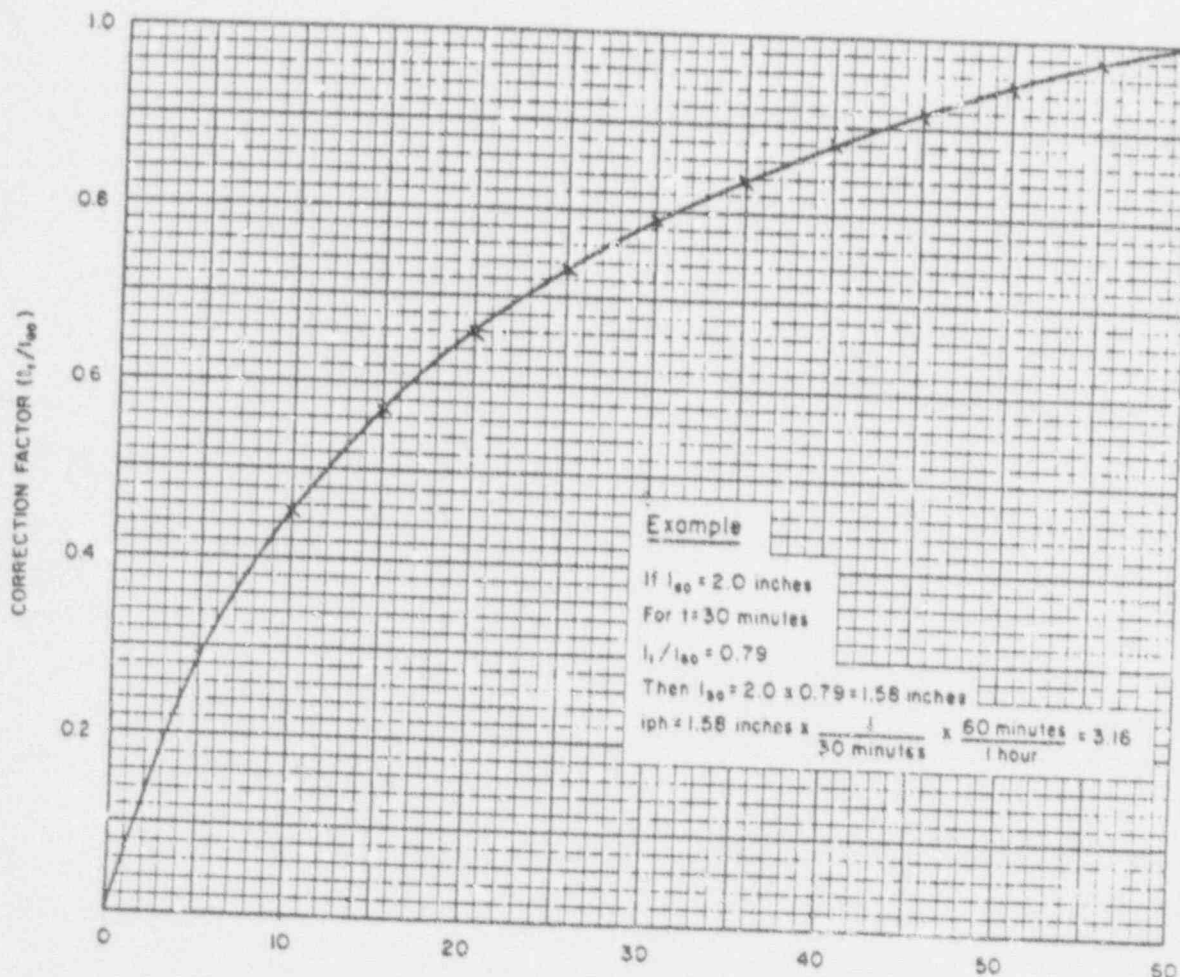
MORRISON-KNUDSEN ENGINEERS, INC.

Project UMTA - FLY
Feature RETENTION BASIN
Item 25% 5hr STORM

Contract No. 5885-28 Sheet 9
Designed 2/18 File No. 23488
Checked KLO Date 2/18/88

Evaporation pond
Spillway sizing

IMW 4/20/91
PYL 6/13/91



DURATION	% of P 1-hr	DURATION IN MINUTES (1)	Ratio
5	29	1.02	1.02
10	45.5	1.59	0.57
15	57	2.00	0.41
20	66	2.31	0.31
25	73.5	2.57	0.26
30	79	2.76	0.19
35	84	2.94	0.18
40	88	3.08	0.14
45	91.75	3.21	0.13
50	95	3.33	0.12
55	97.75	3.42	0.09
60	100	3.50	0.07

Source: Ref. 4





MORRISON-KNUDSEN CORPORATION

Project	UMTRA/FCT	Contract No.	2885-28	Sheet	10
Feature	Evaporation pond	Designed	FWW	File No.	
Item	Spilling sizing	Checked	PYL	Date	4/22/91
				Date	6/13/91

d. Pond Area Computation (see sheet 4)

1) pond 1

$$= \frac{1}{2}(550 + 610) \cdot 135 + \frac{1}{2} \cdot 135 \cdot 380 + \frac{1}{2} \cdot 780 \cdot 390 = 256,050 \text{ ft}^2$$

$$= 5.88 \text{ Ac} = 0.00918 \text{ mi}^2$$

2) pond 2

$$= \frac{1}{2}(610 + 670) \cdot 135 + \frac{1}{2}(780 + 920) \cdot 145 = 209,650 \text{ ft}^2$$

$$= 4.81 \text{ Ac} = 0.00752 \text{ mi}^2$$

3) pond 3

$$= \frac{1}{2}(670 + 730) \cdot 135 + \frac{1}{2}(920 + 780) \cdot 145 = 217,050 \text{ ft}^2$$

$$= 4.98 \text{ Ac} = 0.00779 \text{ mi}^2$$

4) pond 4

$$= \frac{1}{2}(730 + 135) + \frac{1}{2}(780 + 630) \cdot 145 = 205,500 \text{ ft}^2$$

$$= 4.72 \text{ Ac} = 0.00737 \text{ mi}^2$$

5) pond 5

$$= \frac{1}{2}(800 + 850) \cdot 135 + \frac{1}{2}(630 + 480) \cdot 145 = 191,850 \text{ ft}^2$$

$$= 4.4 \text{ Ac} = 0.00688 \text{ mi}^2$$

6) pond 6

$$= \frac{1}{2}(850 + 910) \cdot 135 + \frac{1}{2}(480 + 330) \cdot 145 = 177,525 \text{ ft}^2 = 4.08 \text{ Ac} = 0.00637 \text{ mi}^2$$

7) pond 7

$$= \frac{1}{2}(910 + 980) \cdot 135 + \frac{1}{2}(330 + 180) \cdot 145 = 164,550 \text{ ft}^2 = 3.78 \text{ Ac} = 0.00590 \text{ mi}^2$$

8) pond 8

$$= \frac{1}{2}(980 + 1030) \cdot 135 + \frac{1}{2}(180 + 30) \cdot 145 = 159,900 \text{ ft}^2 = 3.66 \text{ Ac} = 0.00541 \text{ mi}^2$$

9) pond 9

$$= \frac{1}{2}(1030 + 680) \cdot 135 + \frac{1}{2} \cdot 30 \cdot 500 = 122,925 \text{ ft}^2 = 2.82 \text{ Ac} = 0.00441 \text{ mi}^2$$

10) pond 10

$$= \frac{1}{2} \cdot 680 \cdot 150 = 51,000 \text{ ft}^2 = 1.17 \text{ Ac} = 0.00183 \text{ mi}^2$$



MORRISON-KNUDSEN CORPORATION

Project UNTRA/ECT Contract No. 3885-28 Sheet 11
 Feature EVAPORATION POND Designed FAW File No. _____
 Item SPILLWAY SIZING Checked PYL Date 4/23/91
 Date 6/13/91

Summary of Pond Area and equivalent unit hydrograph
and overland flow length (one point only)

Pond No.	Pond Area Acres	sq. mi.	Equivalent unit hydrograph (CU)	Overland length
1	5.88	0.00918	71.125	1860
2	4.81	0.00752	58.236	1560
3	4.98	0.00779	60.292	1490
4	4.72	0.00737	57.083	1400
5	4.40	0.00688	53.092	1310
6	4.08	0.00637	49.312	1220
7	3.78	0.00590	45.708	1130
8	3.46	0.00541	41.917	1050
9	2.82	0.00441	34.146	660
10	1.17	0.00185	14.167	120 (spillway length)
Total	40.1	0.06266		

Project UNTRA/ECT Contract No. 2885-28 Sheet 13
 Feature Evaporation Pond Designed FWH File No.
 Item Spillway Sizing Checked PYL Date 4/22/91
 Date 6/11/91

A-C Curves and Discharge Rating Curve

Pond #	A-C Curve				Discharge Rating Curve			
	E1 (ft)	AR2 (ft)	AV01 (ft)	EV01 (ft)	L (ft)	H (ft)	C	Q=CLH ^{1.48} (cfs)
1	427	5.88	0	0				
	430	5.88	5.88	5.88	350	0		0
	430.5	5.88	2.94	8.82		0.5	2.6	1240
	431	5.88	2.94	11.76		1.0	"	3510
2	427	4.81	0	0				
	428	4.81	4.81	4.81	1560	0		0
	428.5	4.81	2.40	7.21		0.5	2.6	1430
	429	4.81	2.41	9.62		1.0	"	4060
3	425	4.98	0	0				
	426	4.98	4.98	4.98	1490	0		0
	426.5	4.98	2.49	7.47		0.5	2.6	1370
	427	4.98	2.49	9.96		1.0	"	3870
4	423	4.72	0	0				
	424	4.72	4.72	4.72	1400	0		0
	424.5	4.72	2.36	7.08		0.5	2.6	1285
	425	4.72	2.36	9.44		1.0	"	3640
5	421	4.40	0	0				
	422	4.40	4.40	4.40	1310	0		0
	422.5	4.40	2.20	6.60		0.5	2.6	1200
	423	4.4	2.20	8.80		1.0	"	3410
6	419	4.10	0	0				
	420	4.10	4.10	4.10	1220	0		0
	420.5	4.10	2.05	6.15		0.5	2.6	1120
	421	4.10	2.05	8.20		1.0	"	3170
7	417	3.80	0	0				
	418	3.80	3.80	3.80	1170	0		0
	418.5	3.80	1.90	5.70		0.5	2.6	1040
	419	3.80	1.90	7.60		1.0	"	2980
8	415	3.50	0	0				
	416	3.50	3.50	3.50	1050	0		0
	416.5	3.50	1.75	5.25		0.5	2.6	965
	417	3.50	1.75	7.00		1.0	"	2730
9	413	2.82	0	0				
	414	2.82	2.82	2.82	660	0		0
	414.5	2.82	1.41	4.23		0.5	2.6	610
	415	2.82	1.41	5.64		1.0	"	1720
10	411	1.17	0	0				
	412	1.17	1.17	1.17				
	412.5	1.17	0.585	1.755	120	0		0
	413	1.17	0.585	2.34		0.5	2.6	110
	413.5	1.17	0.585	2.93		1.0	"	312
	414	1.17	0.585	3.51		1.5	"	570
	414.5	1.17	0.585	4.10		2.0	"	880
	415	1.17	0.585	4.68		2.5	"	1280

MORRISON-KNUDSEN CORPORATION

Project	UNTRA/ECT	Contract No.	3885-28	Sheet	13
Feature	Evaporation Pond	Designed	EAH	File No.	
Item	Spillway Sizing	Checked	PYL	Date	4/12/91
				Date	6/13/91

4. Results

HECT input and summary output are shown on sheets

Based on the summary output, the evaporation pond should have a spillway length of 130 ft with the crest elevation at El. 413.5 (pond / spillway).

The ^{rated} max water surface elevation would be

El 413.5 assuming that all ponds (1 through 10) are all full at the beginning of the 25-year storm.

The freeboard available under this max. water level (El 413.5) would be 1.5 ft (Top of embankment at El. 415).


```

*****
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
* FEBRUARY 1981 *
* REVISED 01 JUN 88 *
* RUN DATE 04/22/1991 TIME 14:35:43 *
*****

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*****
* U.S. ARMY CORPS OF ENGINEERS *
* THE HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 551-1748 *
*****

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FHW
 4/22/91
 PYL 6113/91

```

X   X   XXXXXX   XXXXX   X
X   X   X       X   X   XX
X   X   X       X       X
XXXXXXX XXXX   X       XXXXX X
X   X   X       X       X
X   X   X       X   X   X
X   X   XXXXXX   XXXXX   XXX

```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION. NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE, SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY, DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL. LOSS RATE:GREEN AND AMPT INFILTRATION. KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM.

HEC-1 INPUT

PAGE 1

```

1  LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
2  1         ID    U M T R A /FALLS CITY
3  2         ID    EVAPORATION POND
4  3         ID    FLOOD ROUTING - 25-YEAR 24-HR STORM
5  4         ID    FILE:FCT251.DAT
6  *** FREE ***
7  5         IT     5              300
8  6         IC     5
9  7         KK     #1POND (5.9 ACRES)
10 8         KM     25 - YEAR 24 - HOUR STORM
11 9         KO     3
1210        BA     .00918
1311        PB     0.00
1412        P1     .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070
1513        P1     .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070
1614        P1     .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070
1715        P1     .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070
1816        P1     .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070
1917        P1     .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070
2018        P1     .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0070 .0080 .0080
2119        P1     .0080 .0080 .0120 .0120 .0120 .0120 .0120 .0120 .0120 .0120
2220        P1     .0120 .0120 .0120 .0120 .0120 .0120 .0120 .0120 .0120 .0120
2321        P1     .0130 .0130 .0130 .0130 .0130 .0130 .0130 .0130 .0130 .0130
2422        P1     .0130 .0130 .0130 .0130 .0130 .0130 .0130 .0130 .0160 .0160
2523        P1     .0160 .0160 .0160 .0160 .0160 .0160 .0170 .0170 .0170 .0170
2624        P1     .0170 .0170 .0170 .0170 .0170 .0170 .0170 .0170 .0170 .0170
2725        P1     .0170 .0170 .0200 .0200 .0200 .0200 .0210 .0210 .0210 .0210

```


ULTRA/ECT EV pond, spillway sizing

Sheet 15

FWW

9/22/91

PYL 6/13/91

26	P1	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210
27	P1	.0210	.0210	.0210	.0210	.0210	.0300	.0300	.0300	.0300
28	P1	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0600	.0600
29	P1	.0700	.0700	.0700	.0700	.0800	.0800	.0800	.0800	.0900
30	P1	.0900	.1200	.1400	.1900	.3100	.5700	1.020	.4100	.2600
31	P1	.1300	.0900	.0500	.0500	.0500	.0500	.0500	.0400	.0400
32	P1	.0400	.0400	.0400	.0400	.0300	.0300	.0290	.0290	.0290
33	P1	.0290	.0290	.0290	.0290	.0290	.0290	.0090	.0090	.0090
34	P1	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
35	P1	.0090	.0090	.0080	.0080	.0080	.0080	.0080	.0080	.0080
36	P1	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
37	P1	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
38	P1	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
39	P1	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
40	P1	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
41	UI	71.125								
42	LS	0	100.							
43	KK	#1POND ROUTING								
44	RS	1	ELEV	430.						
45	SV	5.88	8.82	11.76						
46	SE	430.	430.5	431.						
47	SG	0.	1240.	3510.						

HEC-1 INPUT

PAGE 2

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

48	KK	#2POND (4.8 ACRES)								
49	KM	25 - YEAR	24 - HOUR	STORM						
50	BA	.00752								
51	UI	58.236								
52	KK	COMBINEPOND #1 & 2								
53	HC	2								
54	KK	#2POND ROUTING								
55	RS	1	ELEV	428.						
56	SV	0.	4.81	7.21	9.62					
57	SE	427.	428.	428.5	429.					
58	SG	0.	0.	1430.	4060.					
59	KK	#3POND (5.0 ACRES)								
60	KM	25 - YEAR	24 - HOUR	STORM						
61	BA	.00779								
62	UI	60.292								
63	KK	COMBINEPOND #1 2 & 3								
64	HC	2								
65	KK	#3POND ROUTING								
66	RS	1	ELEV	426.						
67	SV	0.	4.98	7.47	9.96					
68	SE	425.	426.	426.5	427.					
69	SG	0.	0.	1370.	3870.					
70	KK	#4POND (4.7 ACRES)								
71	KM	25 - YEAR	24 - HOUR	STORM						
72	BA	.00737								
73	UI	57.083								
74	KK	COMBINE# 1 TO 4								
75	HC	2								
76	KK	#4POND ROUTING								
77	RS	1	ELEV	424.						

78	SV	0.	4.72	7.08	9.44
79	SE	423.	424.	424.5	425.
80	SD	0.	0.	1285.	3640.

81	KK	#5POND (4.4 ACRES)			
82	KN	25 - YEAR 24 - HOUR STORM			
83	BA	.00688			
84	UI	53.292			

85	KK	COMBINE# 1 TO 5			
86	HC	2			

MEC-1 INPUT

PAGE 3

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

87	KK	#5POND ROUTING			
88	RS	1	ELEV	422.	
89	SV	0.	4.40	6.60	8.80
90	SE	421.	422.	422.5	423.
91	SD	0.	0.	1200.	3410.

92	KK	#6POND (4.1 ACRES)			
93	KN	25 - YEAR 24 - HOUR STORM			
94	BA	.00637			
95	UI	49.312			

96	KK	COMBINE#1 TO 6			
97	HC	2			

98	KK	#6POND ROUTING			
99	RS	1	ELEV	420.	
100	SV	0.	4.1	6.15	8.2
101	SE	419.	420.	420.5	421.
102	SD	0.	0.	1120.	3170.

103	KK	#7POND (3.8 ACRES)			
104	KN	25 - YEAR 24 - HOUR STORM			
105	BA	.00590			
106	UI	45.708			

107	KK	COMBINE# 1 TO 7			
108	HC	2			

109	KK	#7POND ROUTING			
110	RS	1	ELEV	418.	
111	SV	0.	3.8	5.7	7.1
112	SE	417.	418.	418.5	419.
113	SD	0.	0.	1040.	2940.

114	KK	#8POND (3.5 ACRES)			
115	KN	25 - YEAR 24 - HOUR STORM			
116	BA	.00541			
117	UI	41.917			

118	KK	COMBINE# 1 TO 8			
119	HC	2			

120	KK	#8POND ROUTING			
121	RS	1	ELEV	416.	
122	SV	0.	3.5	5.25	7.0
123	SE	415.	416.	416.5	417.
124	SD	0.	0.	965.	2730.

125	KK	#9POND (2.8 ACRES)			
126	KN	25 - YEAR 24 - HOUR STORM			

UNTRM/ECT
EV pond
spillway sizing

Sheet 16
TAN
4/23/91
PYL 6/13/91

127 BA .00441
128 UI 34.146

UMTRA/FCT
EV pond spilling sizing
HEC-1 INPUT

Sheet 17
PAGE 2 FHW
4/22/91
PYL 6/13/91

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

129 KK COMBINE# 1 TO 9
130 HC 2

131 KK #9POND ROUTING
132 RS 1 ELEV 414.
133 SV 0. 2.82 4.23 5.64
134 SE 413. 414. 414.5 415.
135 SQ 0. 0. 610. 1720.

136 KK #10POND(1.2 ACRES)
137 KM 25 - YEAR 24 - HOUR STORM
138 BA .00183
139 UI 14.167

140 KK COMBINE# 1 TO 10
141 HC 2

142 KK #10POND ROUTING
143 KO 1 2
144 RS 1 ELEV 412.5
145 SV 0. 1.17 1.76 2.34 2.93 3.51 4.10 4.68
146 SE 411. 412. 412.5 413. 413.5 414. 414.5 415.
147 SQ 0. 0. 0. 110. 312. 570. 880. 1230.
148 ZZ

FLOOD HYDROGRAPH PACKAGE (HEC-1) *
FEBRUARY 1981 *
REVISED 01 JUN 88 *
* RUN DATE 04/22/1991 TIME 14:35:43 *

* U.S. ARMY CORPS OF ENGINEERS *
* THE HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 551-1748 *

UMTRA/FALLS CITY
EVAPORATION POND
FLOOD ROUTING - 25-YEAR 24-HR STORM
FILE:FCT251.DAT

6 10 OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

.7 HYDROGRAPH TIME DATA
NMIN 5 MINUTES IN COMPUTATION INTERVAL
IDATE 1 0 STARTING DATE
ITIME 0000 STARTING TIME
NQ 300 NUMBER OF HYDROGRAPH ORDINATES
NDATE 2 0 ENDING DATE
NDTIME 0051 ENDING TIME
ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .08 HOURS
TOTAL TIME BASE 24.92 HOURS

Sheet 18
E4W
4/2/91
PYL
6/13/91

ENGLISH UNITS	
DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-Feet
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

[illegible]

```

*****
*               *
7 KK  *         #1 *   POND (5.9 ACRES)
*               *
*****

```

```

4 KO      OUTPUT CONTROL VARIABLES
          IPRT      3  PRINT CONTROL
          IPLOT     0  PLOT CONTROL
          QSCAL     0.  HYDROGRAPH PLOT SCALE

```

SUBBASIN RUNOFF DATA

10 BA	SUBBASIN CHARACTERISTICS	
	TAREA	.01 SUBBASIN AREA
1	100	100
2	100	100
3	100	100
4	100	100
5	100	100
6	100	100
7	100	100
8	100	100
9	100	100
10	100	100
11	100	100
12	100	100
13	100	100
14	100	100
15	100	100
16	100	100
17	100	100
18	100	100
19	100	100
20	100	100
21	100	100
22	100	100
23	100	100
24	100	100
25	100	100
26	100	100
27	100	100
28	100	100
29	100	100
30	100	100
31	100	100
32	100	100
33	100	100
34	100	100
35	100	100
36	100	100
37	100	100
38	100	100
39	100	100
40	100	100
41	100	100
42	100	100
43	100	100
44	100	100
45	100	100
46	100	100
47	100	100
48	100	100
49	100	100
50	100	100
51	100	100
52	100	100
53	100	100
54	100	100
55	100	100
56	100	100
57	100	100
58	100	100
59	100	100
60	100	100
61	100	100
62	100	100
63	100	100
64	100	100
65	100	100
66	100	100
67	100	100
68	100	100
69	100	100
70	100	100
71	100	100
72	100	100
73	100	100
74	100	100
75	100	100
76	100	100
77	100	100
78	100	100
79	100	100
80	100	100
81	100	100
82	100	100
83	100	100
84	100	100
85	100	100
86	100	100
87	100	100
88	100	100
89	100	100
90	100	100
91	100	100
92	100	100
93	100	100
94	100	100
95	100	100
96	100	100
97	100	100
98	100	100
99	100	100
100	100	100

PRECIPITATION DATA

PS STORM 8.10 BASIN TOTAL PRECIPITATION

[illegible]

42 LS

SCS LOSS RATE

STRTL .00 INITIAL ABSTRACTION
 CRVMBR 100.00 CURVE NUMBER
 RTIMP .00 PERCENT IMPERVIOUS AREA

UNTRA/ECT
 EV pond
 spillway sizing

Sheet 19
 FHW 4/22/91
 PYL 6/13/91

U1 INPUT UNITGRAPH, 1 ORDINATES, VOLUME = 1.00
 71.1

HYDROGRAPH AT STATION #1

TOTAL RAINFALL = 8.10, TOTAL LOSS = .00, TOTAL EXCESS = 8.10

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
(CFS)	(HR)	6-HR	24-HR	72-HR	24.92-HR
73.	15.58	6.	2.	2.	2.
(INCHES)		5.901	8.100	8.104	8.104
(AC-FT)		3.	4.	4.	4.
CUMULATIVE AREA =		.01 SQ FT			

*** **

142 KK

 * *
 * #10 *
 * *

POND ROUTING

143 KO

OUTPUT CONTROL VARIABLES

IPRMT 1 PRINT CONTROL
 IPLOT 2 PLOT CONTROL
 QSCAL 0. HYDROGRAPH LOT SCALE

HYDROGRAPH ROUTING DATA

144 RS

STORAGE

NS. 1 NUMBER OF SUBREACHES
 ITYP ELEV TYPE OF INITIAL CONDITION
 RS.RIC 412.50 INITIAL CONDITION
 X .00 WORKING R AND D COEFFICIENT

145 SV

STORAGE

.0 1.0 1.8 2.3 2.9 3.5 1 4.7

146 SE

ELEVATION

411.00 412.00 412.50 413.00 413.50 414.00 414.50 415.00

147 SQ

DISCHARGE

0. 0. 0. 110. 312. 570. 880. 1230.

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 110. TO 1230.
 THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
 THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

 HYDROGRAPH AT STATION #10

UNTRA/FC
EV Pond/ Spillway Sizing

Sheet 20
FHW 4/24/91
PYL 6/13/91

DA	MON	HR	MM	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HR	MM	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HR	MM	ORD	OUTFLOW	STORAGE	STAGE
		0000		1	0.	1.8	412.5 *	1	0020		101		0.	1.8	412.5 *	1	1640		201		23.	1.9	412.6
1		0000		2	0.	1.8	412.5 *	1	0825		102		6.	1.8	412.5 *	1	1645		202		21.	1.9	412.6
1		0010		3	1.	1.8	412.5 *	1	0830		103		6.	1.8	412.5 *	1	1650		203		20.	1.9	412.6
1		0015		4	2.	1.8	412.5 *	1	0835		104		6.	1.8	412.5 *	1	1655		204		20.	1.9	412.6
1		0020		5	3.	1.8	412.5 *	1	0840		105		6.	1.8	412.5 *	1	1700		205		19.	1.9	412.6
1		0025		6	3.	1.8	412.5 *	1	0845		106		6.	1.8	412.5 *	1	1705		206		19.	1.9	412.6
1		0030		7	3.	1.8	412.5 *	1	0850		107		6.	1.8	412.5 *	1	1710		207		18.	1.9	412.6
1		0035		8	3.	1.8	412.5 *	1	0855		108		6.	1.8	412.5 *	1	1715		208		17.	1.8	412.6
1		0040		9	3.	1.8	412.5 *	1	0900		109		6.	1.8	412.5 *	1	1720		209		15.	1.8	412.6
1		0045		10	3.	1.8	412.5 *	1	0905		110		6.	1.8	412.5 *	1	1725		210		14.	1.8	412.6
1		0050		11	3.	1.8	412.5 *	1	0910		111		7.	1.8	412.5 *	1	1730		211		14.	1.8	412.6
1		0055		12	3.	1.8	412.5 *	1	0915		112		7.	1.8	412.5 *	1	1735		212		14.	1.8	412.6
1		0100		13	3.	1.8	412.5 *	1	0920		113		8.	1.8	412.5 *	1	1740		213		14.	1.8	412.6
1		0105		14	3.	1.8	412.5 *	1	0925		114		8.	1.8	412.5 *	1	1745		214		14.	1.8	412.6
1		0110		15	3.	1.8	412.5 *	1	0930		115		8.	1.8	412.5 *	1	1750		215		14.	1.8	412.6
1		0115		16	3.	1.8	412.5 *	1	0935		116		8.	1.8	412.5 *	1	1755		216		14.	1.8	412.6
1		0120		17	3.	1.8	412.5 *	1	0940		117		8.	1.8	412.5 *	1	1800		217		14.	1.8	412.6
1		0125		18	3.		412.5 *	1	0945		118		8.	1.8	412.5 *	1	1805		218		13.	1.8	412.6
1		0130		19	3.	1.8	412.5 *	1	0950		119		8.	1.8	412.5 *	1	1810		219		11.	1.8	412.6
1		0135		20	3.	1.8	412.5 *	1	0955		120		8.	1.8	412.5 *	1	1815		220		8.	1.8	412.5
1		0140		21	3.	1.8	412.5 *	1	1000		121		8.	1.8	412.5 *	1	1820		221		6.	1.8	412.5
1		0145		22	3.	1.8	412.5 *	1	1005		122		8.	1.8	412.5 *	1	1825		222		5.	1.8	412.5
1		0150		23	3.	1.8	412.5 *	1	1010		123		8.	1.8	412.5 *	1	1830		223		4.	1.8	412.5
1		0155		24	3.	1.8	412.5 *	1	1015		124		8.	1.8	412.5 *	1	1835		224		4.	1.8	412.5
1		0200		25	3.	1.8	412.5 *	1	1020		125		8.	1.8	412.5 *	1	1840		225		4.	1.8	412.5
1		0205		26	3.	1.8	412.5 *	1	1025		126		8.	1.8	412.5 *	1	1845		226		4.	1.8	412.5
1		0210		27	3.	1.8	412.5 *	1	1030		127		8.	1.8	412.5 *	1	1850		227		4.	1.8	412.5
1		0215		28	3.	1.8	412.5 *	1	1035		128		8.	1.8	412.5 *	1	1855		228		4.	1.8	412.5
		0220		29	3.	1.8	412.5 *	1	1040		129		8.	1.8	412.5 *	1	1900		229		4.	1.8	412.5
1		0225		30	3.	1.8	412.5 *	1	1045		130		8.	1.8	412.5 *	1	1905		230		4.	1.8	412.5
1		0230		31	3.	1.8	412.5 *	1	1050		131		8.	1.8	412.5 *	1	1910		231		4.	1.8	412.5
1		0235		32	3.	1.8	412.5 *	1	1055		132		8.	1.8	412.5 *	1	1915		232		4.	1.8	412.5
1		0240		33	3.	1.8	412.5 *	1	1100		133		8.	1.8	412.5 *	1	1920		233		4.	1.8	412.5
1		0245		34	3.	1.8	412.5 *	1	1105		134		8.	1.8	412.5 *	1	1925		234		4.	1.8	412.5
1		0250		35	3.	1.8	412.5 *	1	1110		135			1.8	412.5 *	1	1930		235		4.	1.8	412.5
1		0255		36	3.	1.8	412.5 *	1	1115		136		9.	1.8	412.5 *	1	1935		236		4.	1.8	412.5
1		0300		37	3.	1.8	412.5 *	1	1120		137		9.	1.8	412.5 *	1	1940		237		4.	1.8	412.5
1		0305		38	3.	1.8	412.5 *	1	1125		138		10.	1.8	412.5 *	1	1945		238		4.	1.8	412.5
1		0310		39	3.	1.8	412.5 *	1	1130		139		10.	1.8	412.5 *	1	1950		239		4.	1.8	412.5
1		0315		40	3.	1.8	412.5 *	1	1135		140		10.	1.8	412.5 *	1	1955		240		4.	1.8	412.5
1		0320		41	3.	1.8	412.5 *	1	1140		141		10.	1.8	412.5 *	1	2000		241		4.	1.8	412.5
1		0325		42	3.	1.8	412.5 *	1	1145		142		10.	1.8	412.5 *	1	2005		242		4.	1.8	412.5
1		0330		43	3.	1.8	412.5 *	1	1150		143		10.	1.8	412.5 *	1	2010		243		4.	1.8	412.5
1		0335		44	3.	1.8	412.5 *	1	1155		144		10.	1.8	412.5 *	1	2015		244		4.	1.8	412.5
1		0340		45	3.	1.8	412.5 *	1	1200		145		10.	1.8	412.5 *	1	2020		245		4.	1.8	412.5
1		0345		46	3.	1.8	412.5 *	1	1205		146		10.	1.8	412.5 *	1	2025		246		4.	1.8	412.5
1		0350		47	3.	1.8	412.5 *	1	1210		147		10.	1.8	412.5 *	1	2030		247		4.	1.8	412.5
1		0355		48	3.	1.8	412.5 *	1	1215		148		10.	1.8	412.5 *	1	2035		248		4.	1.8	412.5
1		0400		49	3.	1.8	412.5 *	1	1220		149		10.	1.8	412.5 *	1	2040		249		4.	1.8	412.5
1		0405		50	3.	1.8	412.5 *	1	1225		150		10.	1.8	412.5 *	1	2045		250		4.	1.8	412.5
1		0410		51	3.	1.8	412.5 *	1	1230		151		10.	1.8	412.5 *	1	2050		251		4.	1.8	412.5
1		0415		52	3.	1.8	412.5 *	1	1235		152		10.	1.8	412.5 *	1	2055		252		4.	1.8	412.5
1		0420		53	3.	1.8	412.5 *	1	1240		153		10.	1.8	412.5 *	1	2100		253		4.	1.8	412.5
1		0425		54	3.	1.8	412.5 *	1	1245		154		10.	1.8	412.5 *	1	2105		254		4.	1.8	412.5
1		0430		55	3.	1.8	412.5 *	1	1250		155		10.	1.8	412.5 *	1	2110		255		4.	1.8	412.5
1		0435		56	3.	1.8	412.5 *	1	1255		156		10.	1.8	412.5 *	1	2115		256		4.	1.8	412.5
		0440		57	3.	1.8	412.5 *	1	1300		157		10.	1.8	412.5 *	1	2120		257		4.	1.8	412.5
1		0445		58	3.	1.8	412.5 *	1	1305		158		10.	1.8	412.5 *	1	2125		258		4.	1.8	412.5
1		0450		59	3.	1.8	412.5 *	1	1310		159		11.	1.8	412.5 *	1	2130		259		4.	1.8	412.5
1		0455		60	3.	1.8	412.5 *	1	1315		160		13.	1.8	412.6 *	1	2135		260		4.	1.8	412.5
1		0500		61	3.	1.8	412.5 *	1	1320		161		14.	1.8	412.6 *	1	2140		261		4.	1.8	412.5

Sheet 21
FW 21/2/91

4. FYL	1.8	412.5
4. 4/3/91	1.8	412.5
4.	1.8	412.5

1	0505	62	3.	1.0	412.5 * 1	1325	162	14.	1.8	412.6 * 1	2145	262	4-FYLC	1.8	412.5
1	0510	63	3.	1.8	412.5 * 1	1330	163	15.	1.8	412.6 * 1	2150	263	4-FYLC	1.8	412.5
1	0515	64	3.	1.8	412.5 * 1	1335	164	15.	1.8	412.6 * 1	2155	264	4-FYLC	1.8	412.5
1	0520	65	3.	1.8	412.5 * 1	1340	165	15.	1.8	412.6 * 1	2200	265	4-FYLC	1.8	412.5
1	0525	66	3.	1.0	412.5 * 1	1345	166	15.	1.8	412.6 * 1	2205	266	4-FYLC	1.8	412.5
1	0530	67	3.	1.8	412.5 * 1	1350	167	15.	1.8	412.6 * 1	2210	267	4-FYLC	1.8	412.5
1	0535	68	3.	1.8	412.5 * 1	1355	168	15.	1.8	412.6 * 1	2215	268	4-FYLC	1.8	412.5
1	0540	69	3.	1.8	412.5 * 1	1400	169	15	1.8	412.6 * 1	2220	269	4-FYLC	1.8	412.5
1	0545	70	3.	1.8	412.5 * 1	1405	170	16.	1.8	412.6 * 1	2225	270	4-FYLC	1.8	412.5
1	0550	71	4.	1.8	412.5 * 1	1410	171	19.	1.9	412.6 * 1	2230	271	4-FYLC	1.8	412.5
1	0555	72	4.	1.8	412.5 * 1	1415	172	23.	1.9	412.6 * 1	2235	272	4-FYLC	1.8	412.5
1	0600	73	4.	1.8	412.5 * 1	1420	173	28.	1.9	412.6 * 1	2240	273	4-FYLC	1.8	412.5
1	0605	74	4.	1.8	412.5 * 1	1425	174	31.	1.9	412.6 * 1	2245	274	4-FYLC	1.8	412.5
1	0610	75	4.	1.8	412.5 * 1	1430	175	33.	1.9	412.7 * 1	2250	275	4-FYLC	1.8	412.5
1	0615	76	4.	1.8	412.5 * 1	1435	176	34.	1.9	412.7 * 1	2255	276	4-FYLC	1.8	412.5
1	0620	77	6.	1.8	412.5 * 1	1440	177	35.	1.9	412.7 * 1	2300	277	4-FYLC	1.8	412.5
1	0625	78	6.	1.8	412.5 * 1	1445	178	37.	2.0	412.7 * 1	2305	278	4-FYLC	1.8	412.5
1	0630	79	6.	1.8	412.5 * 1	1450	179	38.	2.0	412.7 * 1	2310	279	4-FYLC	1.8	412.5
1	0635	80	6.	1.8	412.5 * 1	1455	180	39.	2.0	412.7 * 1	2315	280	4-FYLC	1.8	412.5
1	0640	81	6.	1.8	412.5 * 1	1500	181	39.	2.0	412.7 * 1	2320	281	4-FYLC	1.8	412.5
1	0645	82	6.	1.8	412.5 * 1	1505	182	40.	2.0	412.7 * 1	2325	282	4-FYLC	1.8	412.5
1	0650	83	6.	1.8	412.5 * 1	1510	183	43.	2.0	412.7 * 1	2330	283	4-FYLC	1.8	412.5
1	0655	84	6.	1.8	412.5 * 1	1515	184	48.	2.0	412.7 * 1	2335	284	4-FYLC	1.8	412.5
1	0700	85	6.	1.8	412.5 * 1	1520	185	57.	2.1	412.8 * 1	2340	285	4-FYLC	1.8	412.5
1	0705	86	6.	1.8	412.5 * 1	1525	186	73.	2.1	412.8 * 1	2345	286	4-FYLC	1.8	412.5
1	0710	87	6.	1.8	412.5 * 1	1530	187	106.	2.3	413.0 * 1	2350	287	4-FYLC	1.8	412.5
1	0715	88	6.	1.8	412.5 * 1	1535	188	197.	2.6	413.2 * 1	2355	288	4-FYLC	1.8	412.5
1	0720	89	6.	1.8	412.5 * 1	1540	189	284.	2.8	413.4 * 2	0000	289	4-FYLC	1.8	412.5
1	0725	90	6.	1.8	412.5 * 1	1545	190	303.	2.9	413.5 * 2	0005	290	4-FYLC	1.8	412.5
1	0730	91	6.	1.8	412.5 * 1	1550	191	245.	2.7	413.3 * 2	0010	291	4-FYLC	1.8	412.5
1	0735	92	6.	1.8	412.5 * 1	1555	192	158.	2.5	413.1 * 2	0015	292	4-FYLC	1.8	412.5
1	0740	93	6.	1.8	412.5 * 1	1600	193	98.	2.3	412.9 * 2	0020	293	4-FYLC	1.8	412.5
1	0745	94	6.	1.8	412.5 * 1	1605	194	71.	2.1	412.8 * 2	0025	294	4-FYLC	1.8	412.5
1	0750	95	6.	1.8	412.5 * 1	1610	195	51.	2.0	412.7 * 2	0030	295	4-FYLC	1.8	412.5
1	0755	96	6.	1.8	412.5 * 1	1615	196	36.	2.0	412.7 * 2	0035	296	4-FYLC	1.8	412.5
1	0800	97	6.	1.8	412.5 * 1	1620	197	28.	1.9	412.6 * 2	0040	297	4-FYLC	1.8	412.5
1	0805	98	6.	1.8	412.5 * 1	1625	198	25.	1.9	412.6 * 2	0045	298	4-FYLC	1.8	412.5
1	0810	99	6.	1.8	412.5 * 1	1630	199	24.	1.9	412.6 * 2	0050	299	4-FYLC	1.8	412.5
1	0815	100	6.	1.8	412.5 * 1	1635	200	24.	1.9	412.6 * 2	0055	300	4-FYLC	1.8	412.5

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)				
	(CFS)				
+ 303.	15.75	40.	14.	13.	13.
	(INCHES)	5.892	8.093	8.101	8.101
	(AC-FT)	20.	27.	27.	27.
PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
3.	15.75	2.	2.	2.	2.
PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
413.48	15.75	412.66	412.56	412.56	412.56

CUMULATIVE AREA = .06 SG MI

UNTRAF-OT
EV Pond/Spillway Sizing

Sheet 22

FWW

4/22/91

PYL 6/13/91

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	#1	73.	15.58	6.	2.	2.	.01		
ROUTED TO	#1	61.	15.58	6.	2.	2.	.01	430.02	15.58
HYDROGRAPH AT	#2	59.	15.58	5.	2.	2.	.01	(Pond #1 Crest El 420) overflow	
2 COMBINED AT	COMBINE	120.	15.58	11.	4.	4.	.02		
ROUTED TO	#2	106.	15.58	11.	4.	4.	.02	428.04	15.58
HYDROGRAPH AT	#3	61.	15.58	5.	2.	2.	.01	(Pond #2 overflow Crest El 428)	
2 COMBINED AT	COMBINE	167.	15.58	16.	5.	5.	.02		
ROUTED TO	#3	145.	15.58	16.	5.	5.	.02	426.05	15.58
HYDROGRAPH AT	#4	58.	15.58	5.	2.	2.	.01	(Pond #3 overflow Crest El 426)	
2 COMBINED AT	COMBINE	203.	15.58	20.	7.	7.	.03		
ROUTED TO	#4	187.	15.67	20.	7.	7.	.03	424.07	15.67
HYDROGRAPH AT	#5	54.	15.58	4.	1.	1.	.01	(Pond #4 overflow Crest El 424)	
2 COMBINED AT	COMBINE	231.	15.58	25.	8.	8.	.04		
ROUTED TO	#5	226.	15.67	25.	8.	8.	.04	422.09	15.67
HYDROGRAPH AT	#6	50.	15.58	4.	1.	1.	.01	(Pond #5 overflow Crest El 422)	
2 COMBINED AT	COMBINE	251.	15.58	29.	10.	9.	.05		
ROUTED TO	#6	258.	15.67	29.	10.	9.	.05	420.12	15.67
								(Pond #6 overflow Crest El 420)	

ULTRA/ECT
EV Pond/Spillway Sizing

Sheet 23
FWD 4/24/91

PYL 6/13/91

HYDROGRAPH AT	#7	47.	15.58	4.	1.	1.	.01
2 COMBINED AT	COMBINE	276.	15.67	32.	11.	11.	.05
ROUTED TO	#7	283.	15.67	32.	11.	11.	.05
HYDROGRAPH AT	#8	43.	15.58	3.	1.	1.	.01
2 COMBINED AT	COMBINE	300.	15.67	36.	12.	12.	.06
ROUTED TO	#8	301.	15.67	36.	12.	12.	.06
HYDROGRAPH AT	#9	35.	15.58	3.	1.	1.	.00
2 COMBINED AT	COMBINE	315.	15.67	39.	13.	13.	.06
ROUTED TO	#9	306.	15.67	39.	13.	13.	.06
HYDROGRAPH AT	#10	14.	15.58	1.	0.	0.	.00
2 COMBINED AT	COMBINE	312.	15.67	40.	14.	13.	.06
ROUTED TO	#10	303.	15.75	40.	14.	13.	.06

418.14 15.67
(Pond #7 overflow crest
EI 418)

410.16 15.67
(Pond #8 overflow
crest EI 416)

414.25 15.67
(Pond #9 overflow crest
EI 414)

413.48 15.75
(Pond #10 spillway
crest EI 412.5)

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

Calculation Cover Sheet

Contract No. 5057.04Discipline ESCTCalc. No. 24-436-01-00No. of Sheets 5

Project

UMTRA-FCT

Feature

De-watering of Pile 7

Item

Sources of Data

Sources of Formulae & References

SEE SH 6Preliminary Calc. ☐Final Calc. ☒

Supersedes Calc. No. _____

<u>0</u>	<u> </u>	<u>POTTEL</u>	<u>2-1-89</u>	<u>P.L.I</u>	<u>2/10/89</u>	<u>MAA</u>	<u>2/10/89</u>
Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON KNUDSEN COMPANY

Project UM+AQ-ECT
Feature De-watering of Lake 7
Item _____

Contract No. 5057-01

Designed HP

Checked PTL

Sheet C

File No. _____

Date 2-1-69

Date 2/5/69

REFS:

- 1 Lamb + Whitman "Soil Mechanics" Wiley 1969
- 2 MKE Calc. # 20-433-08-01 "Retention Basin - De-watering
Volumes."
3. Professional Service Industries Inc Gradation Plots
MKE DOC # 5057-ECT-R-09-00707-00
- 4 Leonards "Foundation Engineering" McGraw Hill 1962
- 5 Powers "Construction De-watering" Wiley 1981



Project VMTRA ECT Contract No. 2057-04 Sheet 1
Feature DEWATERING OF PILE 7 Designed HAJ File No.
Item Checked FTL Date 2-1-89
Date 2/10/89

PURPOSE Design layout of dewatering system
for PILE 7. (for estimating purposes)

ASSUM Total dewatering volume (all perched) = 4,460,544 CF REF 2

To be dewatered in 6 mo (approx)

$$6 \text{ mo} + 30.5 \frac{\text{d}}{\text{mo}} = 183 \text{ d}$$

$$\therefore \text{required min flow rate} = 126.6 \text{ GPM (183d)}$$

(CONTINUOUS PUMP)

Calc flow to 1 well using Jacobson eqn:

$$Q_{\text{GPM}} = .035 r_w h_s \sqrt{K}$$

REF 5
P 123

r_w = well radius use 8 IN

h_s = wetted depth of well use 3 FT as a conservative
average over the entire pumping period (OK for estimating
purposes)

K = hydraulic conductivity (GPD/FT²)

$$K = \frac{100 D_{10}^2}{(\text{cm/sec})}, D_{10} \text{ IN CM}$$

REF 1 P 290

D_{10} from borholes B3 & B4 (GM2 VALVES FROM
3.5-5 FT DEPTH)

REF 3

$$\therefore D_{10(\text{AVE})} = \frac{.040 + .012 + .063 + .090}{4} = .051 \text{ mm} = .0051 \text{ CM}$$

$$K = 100 (.0051)^2 = .0026 \frac{\text{CM}}{\text{SEC}} = .0051 \frac{\text{FT}}{\text{MIN}} = 54.93 \frac{\text{GPD}}{\text{FT}^2}$$



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON KNUDSEN COMPANY

Project
Feature
Item

Recovery of Lake 7

WATER FCT

Contract No. 5057.04
Designed HSP
Checked PYL

Sheet 2
File No.
Date 2-1-89
Date 2/10/89

$$Q_{\text{to 3 well}} = .035 (.8) (3) \sqrt{54.93} = 6.2 \text{ GPM}$$

$$\frac{17.6.6 \text{ GPM TOT.}}{6.2 \text{ GPM WELL}} = 20.4 \text{ WELLS}$$

$$20 \text{ wells} \times 6.2 \text{ GPM/well} = 124 \text{ GPM}$$

↑ This Q will increase pump
time by 4 day to 187 d ← OK
NOTE this well actually take
somewhat longer because when water
gets below el 440 some
wells will no longer
be as serviceable this
is acceptable.

∴ use 20 wells @ 6.2 GPM/well

CHECK FLOW FROM EQUIVALENT SLOT SOURCE:

$$Q = \frac{k \times (H^2 - h_0^2)}{2L}$$

REF 4

x = length of slot = 880'

SEE SH 3

L = dist. from western-most well to

impermeable body on west (at pressure 1850) = 175'

SEE SH 4

H = 17' @ impermeable body

use $h_0 = 12, 8, 4, 0$ ft

$$Q_{h_0=0} = \frac{.0091 (880) (17^2 - 0)}{2(175)} = 3.7 \text{ cfm}$$

$$Q_{h_0=4} = 3.5 \text{ cfm} ; Q_{h_0=8} = 2.9 \text{ cfm}$$

$$Q_{h_0=12} = 1.9 \text{ cfm}$$

$$Q_{\text{AVG (APPROX)}} = \frac{3.7 + 3.5 + 2.9 + 1.9}{4} = 3.0 \text{ cfm} = 22.4 \text{ GPM}$$





MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UMTRA - ELY	Contract No.	5057-6Y	Sheet	2a
Feature	Remediation of Pile 7	Designed	MSF	File No.	
Item		Checked	PYL	Date	2-1-89
				Date	2/18/89

$$2 \text{ SLOTS (3 IN EA / SLOPE THE WELL)} = 2 \times 22.4 \text{ GPM} = 44.8 \text{ GPM}$$

over the impervious boundary, there is a row of 5 wells

$$5 \text{ wells} \times 6.2 \text{ GPM/well} = 31 \text{ GPM} < 44.8 \text{ GPM (2 slot source)}$$

$\therefore$ we can achieve the required flow rate



SH 3

MAP 2-1-79

PTL 2/10/79

550'-0"

SECTION 4
FOR SECTION

55'-0"

EXISTING F.

50'-0"

LAYOUT,

20 WELLS,

CA 1/1 A

SUBMERSIBLE

PUMP

DOUBLE LEAF
SWING GATE

40' WIDE DOUBLE-
LEAF SWING GATE

CHAIN LINK FENCE
TO BE INSTALLED
FOR CONSTRUCTION
AT STAGING AREA

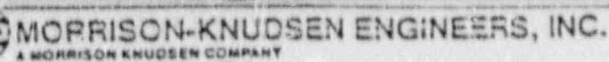
20' WIDE
SWING GATE

N60929 75

E68,574-16

STAGING AREA 300'-0"

PARCEL A



Item

Retention Rec'd.

Disputations Vol. Rev Δ

Contract No. 5057-06Designed 246

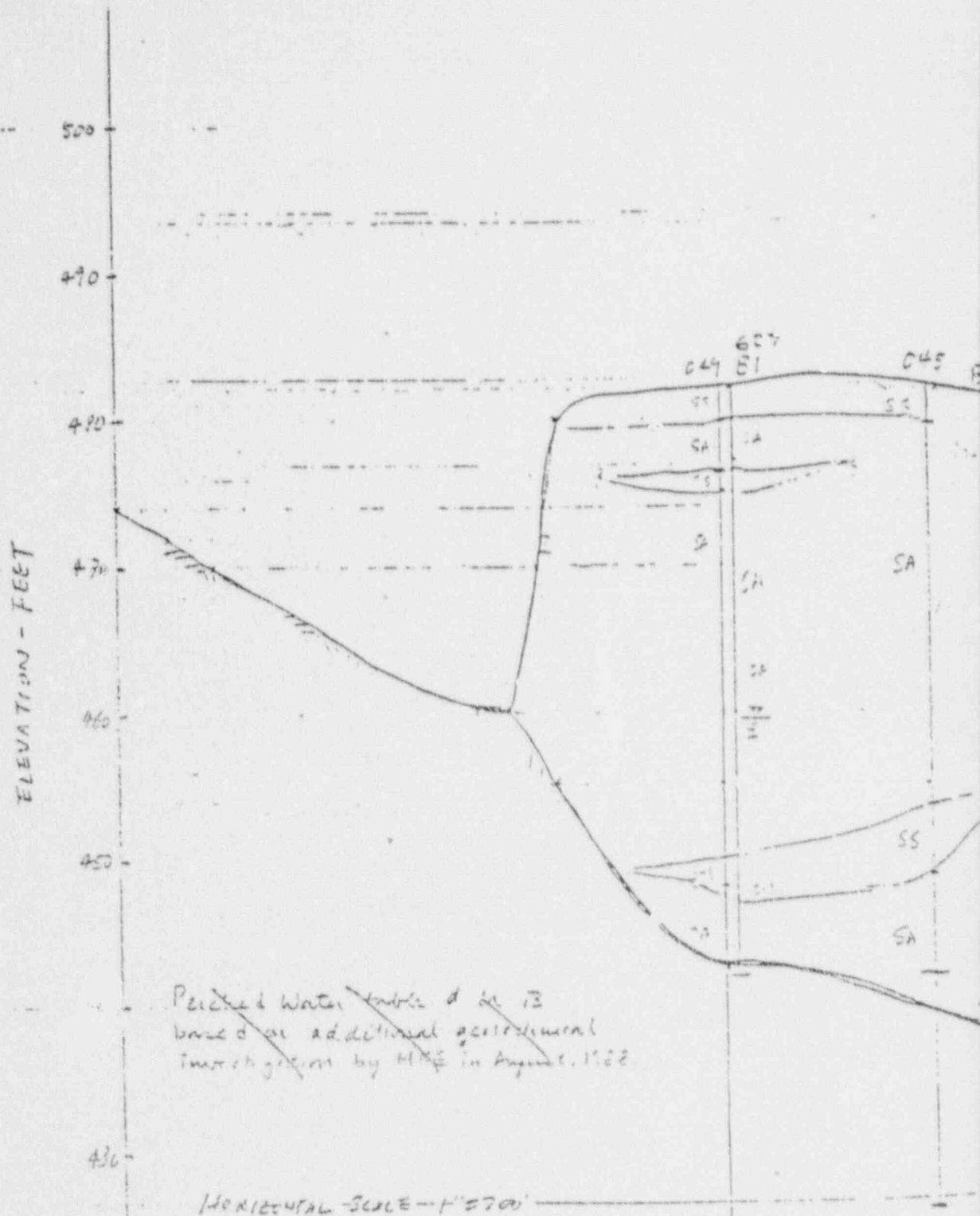
Checked

Sheet _____

File No.

Date 10 _____

Date _____



SH 105 4

7/15/11-89

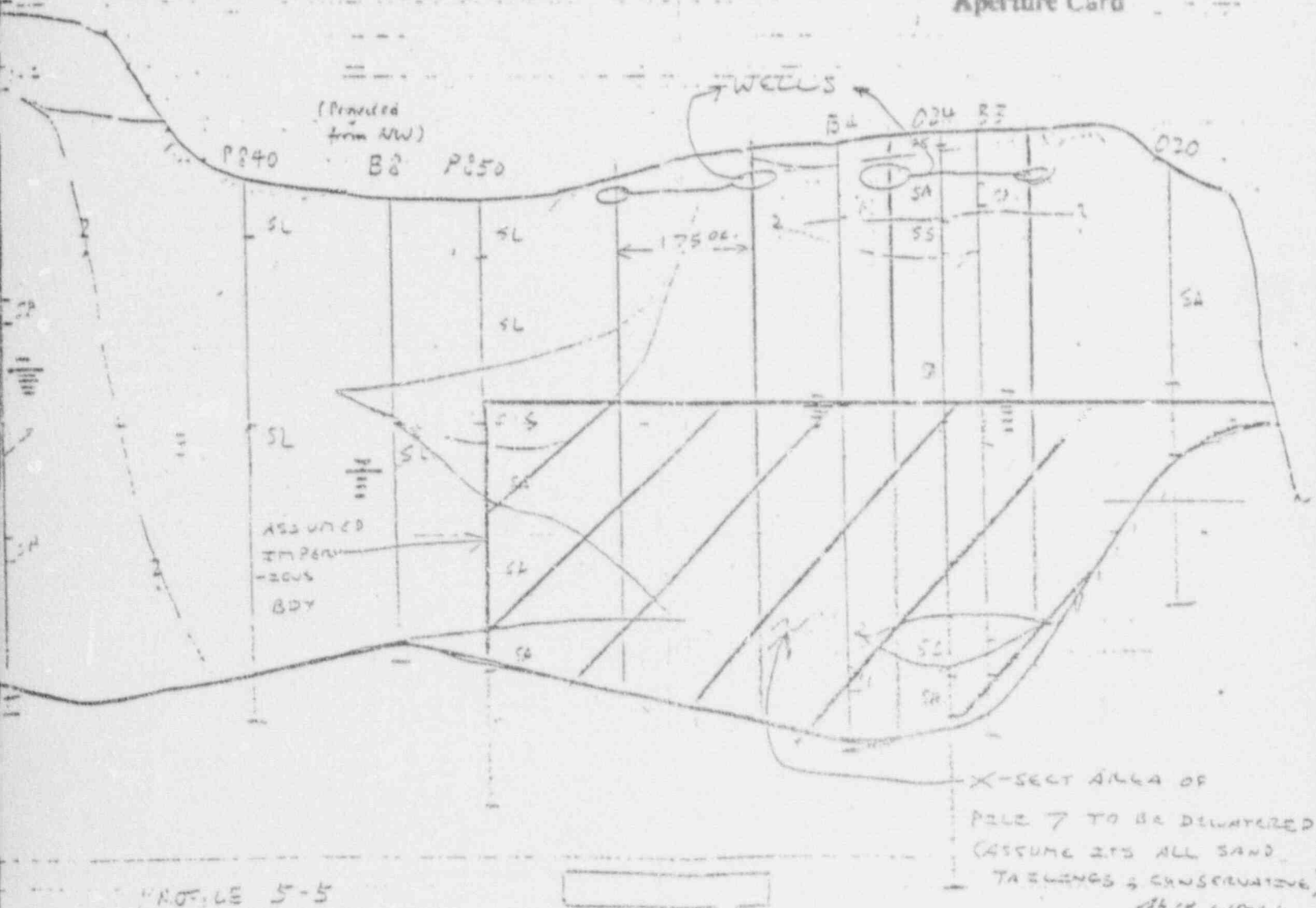
PTL 2/10/89

REV 

REF 2

SI
APERTURE
CARD

Also Available On
Aperture Card



PILE 7

Scale to SH 15

ALL PERCHED
WATER ELIUS
PER SH 10d

TOPO GRAPHIC - 12d
- 10d PILE 7 - 12d

9205110072-43



Calculation Cover 3-1-1Contract No. 5057-04Discipline MKESCalc. No. 20-460-01-00No. of Sheets 1A

Project

UMTRA / FCT

Feature

Road Crossing at FM 1364

Item

Asphaltic Concrete Pavement Design

Sources of Data

1. MKE Calc. No. 20-444-01-01 Summary of Quantities
2. MKE Calc. No. 20-438-01-00 Embankment Design - Geotech. Properties

Sources of Formulae & References

1. Yoder, Principles of Pavement Design
2. Sargious, Pavements And Surfacing For Highways And Airports
3. Seelye, Design, third edition
4. Bowles, Foundation Analysis And Design
5. Winterkorn and Fang, Foundation Engineering Handbook
6. Texas Highway Dept. 1982 standard specifications

Preliminary Calc. ☐Final Calc. ☒

Supersedes Calc. No. _____

0		WYL	1/26/90	JPE	1/31/90	<i>[Signature]</i>	1/31/90
Rev No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project UMTRA / ECT
 Feature ROAD CROSSING AT FM 1344
 Item Asphaltic Concrete Pavement Design

Contract No. 505704
 Designed WYL
 Checked JPB

Sheet 1
 File No. _____
 Date 1/23/90
 Date 1/30/90

Purpose

The purpose of this calculation is to design a asphaltic concrete pavement across County road FM 1344 for transporting material between Parcel A and Parcel B areas at the Falls City site during remedial construction of UMTRA

Methods

AASHTO method and Theoretical Stresses And Deflection Method (Kansas Method) are used to design the asphaltic concrete pavement section which will be for a H-20 truck with 600 trips per day. The pavement consists of at least 6" asphaltic concrete and 10" base course for a 20-year design life

Conclusion

Asphaltic Concrete

6"

Base Course (Texas Type A class 1 or class 2)

18"

Total

24"

REFERENCE DRAWINGS: (CONT'D)

FCT-PS-10-0415	FENCING PLAN
FCT-PS-10-0417	BORINGS, MONITOR WELLS & TEST HITS LOCATION PLAN

LEGEND:

EXISTING SITE FEATURES & MONITORS
(JAN. 1983 & MAY 1986 SURVEY)
EXISTING SURVEY MONUMENT (BRASS CAP)

△ SM-A

344

3

EXISTING FARM ROAD

EXISTING TAILINGS PILE BLUDGE

CONSTRUCTION SITE BOUNDARY

BARBED WIRE FENCE (NEW)

TEMPORARY DRAINAGE DITCH

N60,000

CONSTRUCTION GRID COORDINATE

△
●

RADON MONITOR (RGM)
AIR PARTICULATE (AP)

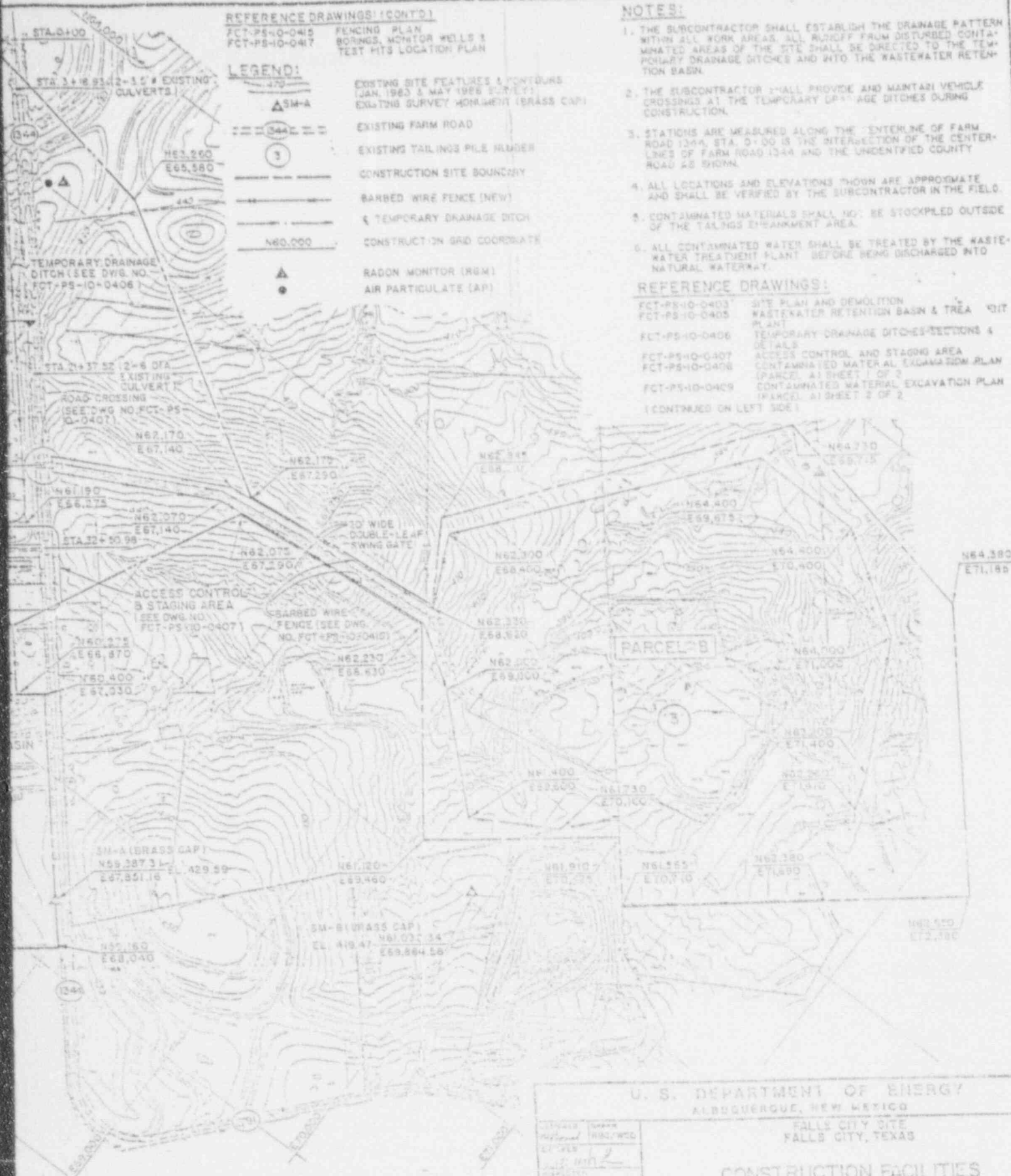
NOTES:

1. THE SUBCONTRACTOR SHALL ESTABLISH THE DRAINAGE PATTERN WITHIN ALL WORK AREAS. ALL RUNOFF FROM DISTURBED CONTAMINATED AREAS OF THE SITE SHALL BE DIRECTED TO THE TEMPORARY DRAINAGE DITCHES AND INTO THE WASTEWATER RETENTION BASIN.
2. THE SUBCONTRACTOR SHALL PROVIDE AND MAINTAIN VEHICLE CROSSINGS AT THE TEMPORARY DRAINAGE DITCHES DURING CONSTRUCTION.
3. STATIONS ARE MEASURED ALONG THE CENTERLINE OF FARM ROAD 1344. STA. 0+00 IS THE INTERSECTION OF THE CENTERLINES OF FARM ROAD 1344 AND THE UNIDENTIFIED COUNTY ROAD 28 SIGNAL.
4. ALL LOCATIONS AND ELEVATIONS SHOWN ARE APPROXIMATE AND SHALL BE VERIFIED BY THE SUBCONTRACTOR IN THE FIELD.
5. CONTAMINATED MATERIALS SHALL NOT BE STOCKPILED OUTSIDE OF THE TAILINGS BULKHEAD AREA.
6. ALL CONTAMINATED WATER SHALL BE TREATED BY THE WASTEWATER TREATMENT PLANT BEFORE BEING DISCHARGED INTO NATURAL WATERWAY.

REFERENCE DRAWINGS:

FCT-PS-10-0403	SITE PLAN AND DEMOLITION	1
FCT-PS-10-0405	WASTEWATER RETENTION BASIN & TREA	1017
	PLANT	
FCT-PS-10-0406	TEMPORARY DRAINAGE DITCHES-SECTIONS 4	
	DETAILS	
FCT-PS-10-0407	ACCESS CONTROL AND STAGING AREA	
FCT-PS-10-0408	CONTAMINATED MATERIAL EXCAVATION PLAN	
	(PANEL A) SHEET 1 OF 2	
FCT-PS-10-0409	CONTAMINATED MATERIAL EXCAVATION PLAN	
	(PANEL A) SHEET 2 OF 2	

(CONTINUED ON LEFT SIDE)



FALLS CITY SITE
FALLS CITY, TEXAS

CONSTRUCTION FACILITIES AND SITE DRAINAGE

DATE	10/10/81	BY	J. J. J.
------	----------	----	----------

13494 ISSUED FOR FINAL REVIEW

72048 153150 904 702 L1M1N 201 80 410 40

2022年 第 2 期 第 1 卷 第 1 期

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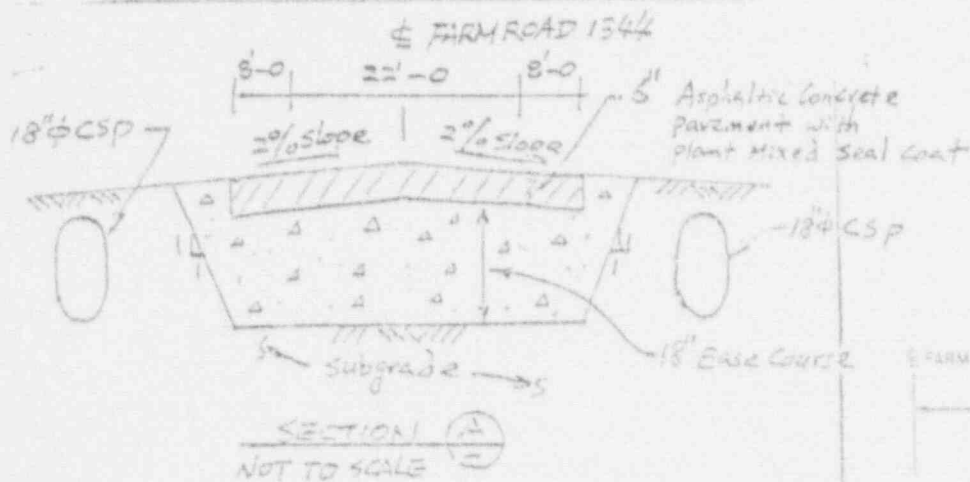
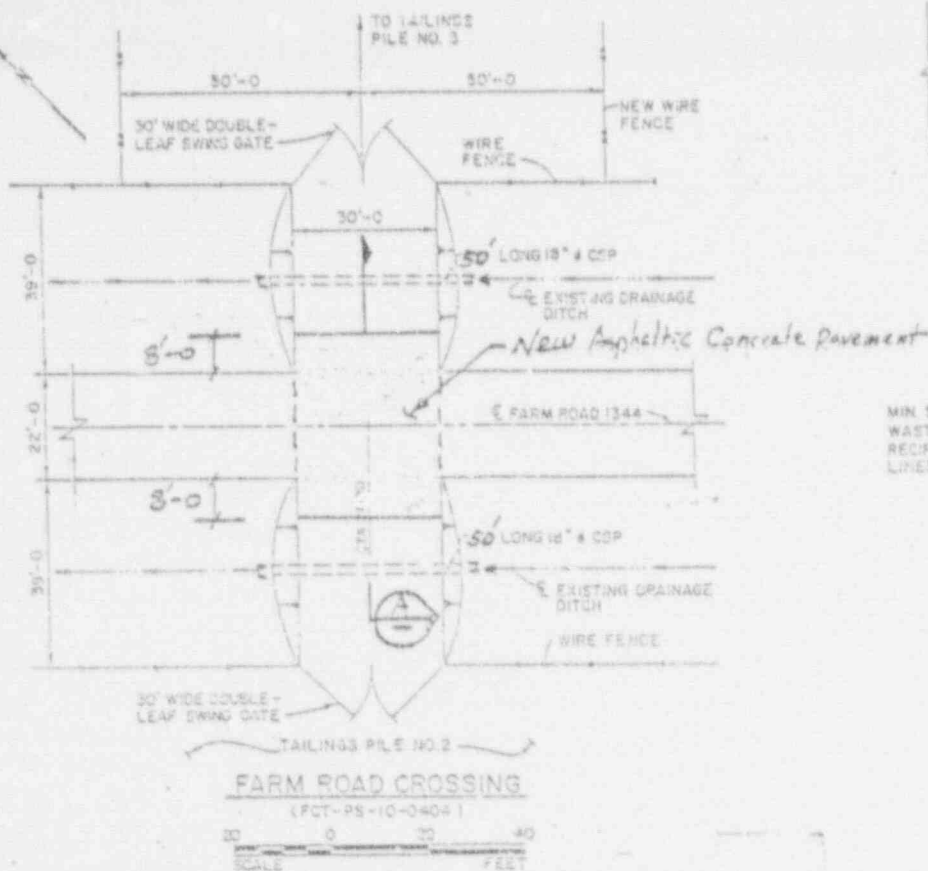
1997

DE-ACO4-83A119796

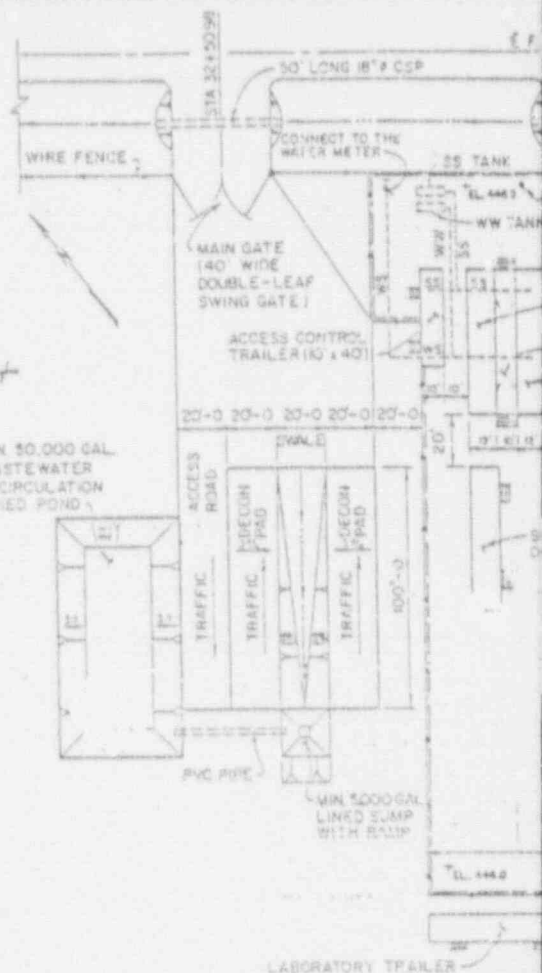
FCT-PS-10-0404

1. e

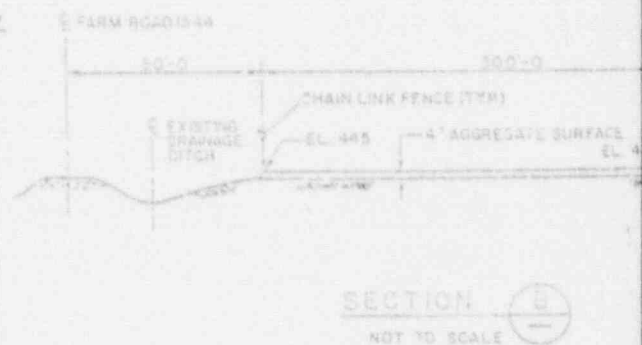
9205110072-44



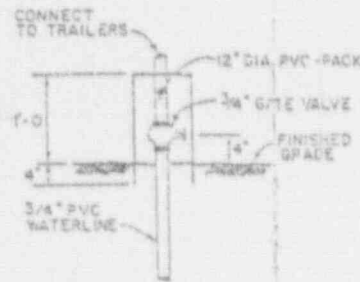
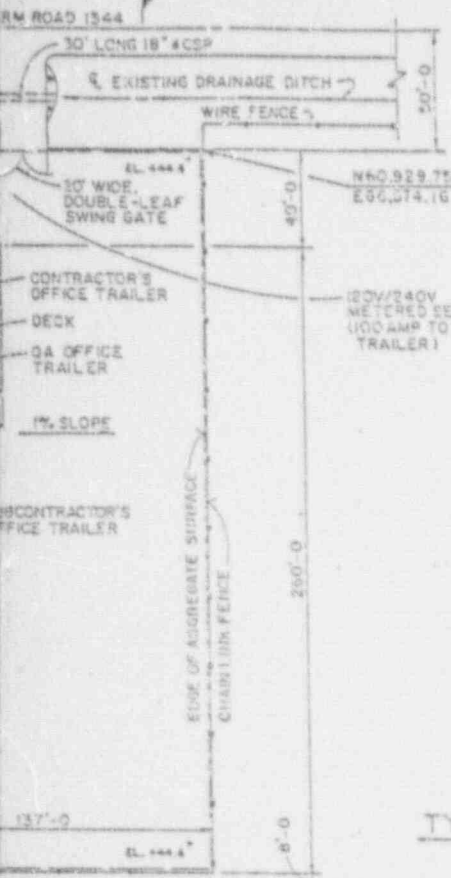
MIN 50,000 GAL
WASTE WATER
RECIRCULATION
LINED POND



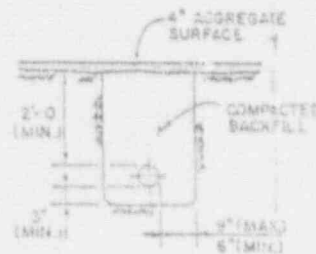
ACCESS CONTROL
10' x 40'
SCALE



1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

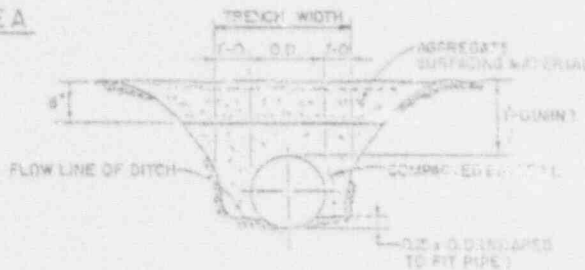


TYPICAL STUB DETAIL
NOT TO SCALE



TYP. EXCAVATION AND BACKFILL
FOR UTILITIES
NOT TO SCALE

AND STAGING AREA
DE-10-0404
FEET



TYP. EXCAVATION AND BACKFILL
FOR PIPE CULVERT
NOT TO SCALE

NOTES:

1. ALL TRAILERS ARE 12' x 60' (TYR), UNLESS NOTED OTHERWISE.
2. THE DETAILS OF WASTEWATER RECIRCULATION LINED POND AND DECOR PAD WITH SWALE AND LINED SUMP ARE SAMPLE DESIGNS. THE SUBCONTRACTOR MAY ADAPT THESE DESIGNS TO SUIT HIS OPERATIONS SUBJECT TO CONTRACTOR'S APPROVAL.

REFERENCE DRAWINGS:

- FCT-PS-10-0404 CONSTRUCTION FACILITIES AND SITE DRAINAGE
FCT-PS-10-0418 FENCE AND GATE DETAILS

LEGEND:

- EMBANKMENT
EXCAVATION
WS WATER SUPPLY LINE
WW WASTEWATER LINE
SS SANITARY SEWER LINE

SI
APERTURE
CARD

Also Available On
Aperture Card

FINAL REVIEW		
DESIGNER	CHIEF ENGINEER	QA INSPECTOR
<i>For Review</i>	<i>[Signature]</i>	<i>[Signature]</i>
	12/15/97	2/12/98

U. S. DEPARTMENT OF ENERGY ALBUQUERQUE, NEW MEXICO			
FALLS CITY SITE FALLS CITY, TEXAS		ACCESS CONTROL AND STAGING AREA	
PROJECT NO.	DE-ACC4-F3AL16796	DRAWING NO.	FCT-PS-10-0407
MORRISON-KIRKMAN ENGINEERS, INC. ULTRA PROJECT 400 NORTH 31 ST. SUITE 100, DALLAS, TEXAS 75201		DATE	2/12/98

DATE	REVISIONS	BY	CHK	ENG	CHK	ENG	CHK	ENG	CHK	ENG
12/15/97	1									
2/12/98	2									

9205110072-45



Project DWTR #1 RT
 Feature Road Crossing at FM 1382
 Item Asphalt Concrete Pavement Design

Contract No. 505706
 Designed WYL
 Checked JPE

Sheet 4
 File No. _____
 Date 1/25/90
 Date 1/30/90

Asphalt Concrete Pavement Design Calculations

(1) AASHTO Method - Design Life 20 years

(Ref. 2)

I. Material To Be Hauled (MKZ Calc. No. 20-444-01-01 Quantities)

a. Contaminated Material Hauled To Tailings Embankment

Pile # 3	736,500 cy	}	932,800 cy
Slurry Pipeline	400 cy		
Windblown Parcel B Area	195,900 cy		

b. Uncontaminated Fill Hauled Back To Parcel B Area

	Fill	Topsoil	}	347,130 cy
Pile # 3	251,870 cy	30,230 cy		
Slurry Pipeline	260 cy	100 cy		
Parcel B Area	—	65,170 cy		

c. Density of Material $\gamma_c = 100 \text{ pcf}$

II. Traffic Considerations

a. Type of Vehicle And Characteristics

The maximum posted load limit of a vehicle on Texas highways is 80,000 lbs. (Ref. 6)

Assume: to haul materials using a 20 cy belly dump truck (H-20) with one single axle and two tandem axles. The total weight of the loaded truck is 80,000 lbs, i.e., 8,000 lbs on the single axle and 32,000 lbs on each tandem axle, and there will be 600 trips/day.

Weight of Soil per truck = $20 \times 27 \times 100 = 54,000 \text{ lbs} = 54 \text{ kips}$

Total trips in Days = $(932,800 + 347,130) \times 27 \times 100 \div (54,000 \times 600) = 160 \text{ days}$



Project

UNTRAT 767

Feature

ROAD CROSSING AT FM 1344

Item

Asphalt Concrete Pavement Design

Contract No. 505706

Sheet 5

Designed WYL

File No.

Checked JPB

Date 1/24/90

Date 1/30/90

Loaded

32 kip tandem axle loads

400 trips/day

axles/truck = $80/32 = 2.5$

Unloaded

 $32 - \frac{84}{2} = 5$ kip tandem axle loads

400 trips/day

axles/truck = 1.0

b. Total Number of Tandem Axes

32 kip (loaded) $2.5 \times 400 \times 160 = 160,000$ axles5 kip (unloaded) $1 \times 400 \times 160 = 64,000$ axles

c. Equivalent Daily 18K Single-Axle Load

Tandem-Axle Load	Expected Repetitions	Equivalent Factor	Equivalent 18K SAL
32 kip	160,000	1.490	238,400
5 kip	64,000	0.006	284
Traffic 160 days $\rightarrow$			238,784

Equivalent Daily 18K SAL Application = $238,784 \div 160 = 1492$

III. Weighted Structural Number

Subgrade $N = 10$ sandy clay CBR = 6Soil Support Value $S = 5$ Serviceability Index $P = 2.0$

Regional Factor = 4.0

Equivalent Daily 18K SAL Application = 1492

 $\therefore SN = 5$



Project

DMTRG/267

Feature

Road Crossing at FM 1362

Item

Asphaltic Concrete Pavement Design

Contract No.

50470K

Designed

WYL

Checked

JPB

Sheet 6

File No.

Date

1/24/90

Date

1/30/90

IV. Thickness of Pavement

$$SV = A_1 D_1 + A_2 D_2 + A_3 D_3$$

Surface Course $D_1 = 6"$

$$A_1 = 0.44$$

plant-mix asphaltic concrete

Base Course $D_2 = x$

$$A_2 = 0.14$$

crushed stone

Sub-base Course $D_3 = 0$

$$S = 0.44 \times 6 + 0.14 \times D_2 + 0$$

$$D_2 = 16.9" \text{ say } 18"$$



6" Asphaltic concrete

18" Crushed stone base course

(Texas Type A Grade 1 or Grade 2)

Subgrade
(Sandy clay)



Project UMTRA / ECT
 Feature Road Crossing at SM 1366
 Item Asphalt Concrete Pavement Design

Contract No. 50570K Sheet 7
 File No. _____
 Designed WYL Date 1/24/90
 Checked JPB Date 1/30/90

(2) Theoretical Stresses And Deflection Method (Kansas Method) (Ref. 1)

$$T = \left[\left(\frac{3PMn}{2\pi EA} \right)^2 - R^2 \right] \left[\frac{3}{n} \sqrt{\frac{E_p}{E_p}} \right]$$

$$T_B = (T - t_p) \sqrt[3]{\frac{E_p}{E_B}}$$

where, T, t_p, T_B - thickness required

E_p, E_B, E - modulus of elasticity

P - base wheel load

m - traffic coeff based on Vol of traffic $m \leq 1$

n - saturation coeff based on rainfall $n \leq 1$

a - radius of area of tire contact corresp. to $P, a = 12"$

Δ - permitted deflection of surface $\Delta \leq 0.1"$

(a) Type of vehicle and characteristics

The maximum posted load limit of a vehicle on Texas highways is 80,000 lbs

Assume: to haul material using a 20 cy belly dump truck (H-20) with one single axle and two tandem axles. The total weight of the loaded truck is 80,000 lbs, i.e., 8,000 lbs on the single axles and 32,000 lbs on each tandem axles, and there will be 600 trips/day.

The base wheel load $P = \frac{32000}{4} = 8000$ lbs



Project

DMTRA 1247

Feature

Road Crossing at FM 1344

Item

Asphaltic Concrete Pavement Design

Contract No.

404704

Designed

WYL

Checked

JPB

Sheet 8

File No.

Date 1/24/90

Date 1/30/90

cb) Modulus of Elasticity

For wheel load

$$\delta = \frac{1}{2} \left(\frac{PL}{AE} \right) = \frac{PL}{2E}$$

$$K = \frac{P}{\delta} = \frac{2E}{L}$$

From CBR test

$$\delta = y = 0.1" \quad L = B = 1.9"$$

$$K = \frac{P}{0.1} = \frac{2E}{1.9} \approx E \quad (E \text{ for plate size } = 1.9")$$

Based on theory of Elasticity to wheel base area

$$K = \frac{P}{y} = \frac{P}{\Delta H} = \frac{P}{B(1-\mu^2)I_w} \quad \text{for } y = \Delta H = 0.1"$$

where $I_w = 0.88$ for circle footing

$\mu = 0.3$ for Sand, gravel and stone

$$B = 6 = \frac{\text{plate size } = 12"}{\text{CBR piston size } = 1.9"}$$

$$K = \frac{E}{6 \times (1 - 0.3^2) \times 0.88} = 0.2E \quad E = 5K \quad (E \text{ for plate size } = 12")$$

From Fig B Textural classification for Road (Ref 3)

Subgrade (Sandy clay N=10) CBR=6 $K=160 \text{ psi}$ $E=800 \text{ psi}$

Base (crushed stone) CBR=60 $K_0=550 \text{ psi}$ $E_B=2750 \text{ psi}$

Asphaltic Concrete

(Assume) $E_p = 15,000 \text{ psi}$



Project UMTRA / R7
 Feature Read Crossing at FM 1366
 Item Asphalt Concrete Pavement Design

Contract No. 505706Sheet 9Designed WYL

File No. _____

Checked JPBDate 1/24/90Date 1/31/90

(c) Thickness of Pavement

Total thickness of Asphaltic Concrete pavement required

$$T = \left[\sqrt{\left(\frac{348000}{2 \times 2.14 \times 800 \times 0.1} \right)^2 - 12^2} \right] \left[\sqrt[3]{\frac{800}{15000}} \right]$$

$$= \left(\sqrt{2282 - 144} \right) \times 0.38$$

$$= 17.6"$$

Design thickness of asphaltic concrete $t_p = 6"$

Then thickness of base

$$T_B = (17.6 - 6) \sqrt[3]{\frac{15000}{2750}}$$

$$= 20.5"$$

Say 18" if saturation and traffic coefficients are taken into consideration



6" Asphaltic Concrete

18" Crushed stone base Course
 (Texas Type A Grade 1 or Grade 2)

Subgrade
 (sandy clay)

course to relieve subsequent saturation of the material immediately under the base course should materially aid the structural capacity of the pavement.

Studies were also made into the mechanics of pavement failure. Measurements were made to determine whether the base or subbase course moved laterally under the action of the heavy loads. It was found that the greatest change in elevation of a section occurred at the surface level and in the outer-wheel path. Also, the materials primarily associated with lateral movement were found to be within the top 6 inches of the pavement. The results of density measurements indicated that a large portion of the rutting that occurred could be explained on the basis of lateral movement of the base course.

The data also showed that no definite relationship exists between structure thickness and depth of rut. Likewise, permanent deformation was no indication of structural weakness.

The primary source of failure on the road was that resulting from lateral movement or displacement of the base-course materials.

DESIGN USING THE TRIAXIAL TEST

Theoretical Stresses and Deflection (Kansos). The first method to be considered under this heading deals with theoretical stresses in ideal masses using the Boussinesq equations (16, 17). The application to design was first proposed by Palmer and Barber (30) and later expanded by Barber (3). Discussions in Chapter 2 dealt with the theoretical deflection due to circular loads, and, for the single-layer condition, it was considered that the pavement was incompressible and that the strains were elastic and took place only in the subgrade. Equation 2.9 gives the deflection in terms of the unit load, radius of the plate, modulus of elasticity, and depth. Under the assumption that the pavement is incompressible the depth z becomes the thickness of the pavement. Solving equation 2.9 for z and substituting values of total load for unit load, equation 15.1 results.

$$z = T = \sqrt{\left(\frac{3P}{2\pi E\Delta}\right)^2 - a^2} \quad (15.1)$$

where T or z = pavement thickness

P = total load on single wheel

E = modulus of elasticity of subgrade

a = radius of contact

Δ = allowable deflection

FLEXIBLE HIGHWAY PAVEMENTS

In equation 15.1 the thickness is given in terms of the total load, the modulus of elasticity of the subgrade soil, the radius of the contact area, and the deflection. To utilize the formula for design purposes, it is necessary to assume a limiting deflection, as was done in the procedure for designing flexible airport pavements by means of the plate-bearing test.

The design deflection of the surface is assumed to be 0.1 inch for flexible pavements. This value was determined from measurements of numerous flexible pavements in various conditions.

Coefficients. The design procedure calls for all samples to be tested in a saturated condition. Saturation is deemed desirable in order to obtain a direct comparison for types of materials and, at the same time, to obtain a measure of the strength when the material is in its weakest condition. To account for the possibility of the soil not being saturated after construction, a coefficient, n , is introduced which gives a decreased thickness of surface or base course required in localities of less rainfall (Table 15.1).

TABLE 15.1*

Saturation Coefficient n	Average ^b Annual Rainfall (in.)
0.5	15.0-19.9
0.6	20.0-24.9
0.7	25.0-29.9
0.8	30.0-34.9
0.9	35.0-39.9
1.0	40.0-50.0

* From Kansas Highway Department.

If the maximum wheel load is 9000 pounds and the percentage of vehicles carrying maximum loads as related to the other lighter vehicles is fairly constant, the variation affecting design occurs mostly in the total volume of traffic. Coefficients have been determined according to the volume of traffic. The coefficients, and their corresponding ranges of traffic are shown in Table 15.2.

Introducing the coefficients into equation 15.1 and using the modification of the formula proposed by Palmer and Barber, equation 15.2 results.

$$T = \left[\sqrt{\left(\frac{M^2 n^2}{2\pi E\Delta}\right)^2 - a^2} \right] \left[\sqrt{\frac{E}{E_p}} \right] \quad (15.2)$$

Ref 1

where T = thickness required

E_p = modulus of elasticity of pavement or surface course

E = modulus of elasticity of subgrade or subbase

P = base wheel load

m = traffic coefficient based on volume of traffic

n = saturation coefficient based on rainfall

a = radius of area of tire contact corresponding to P

Δ = permitted deflection of surface

The stiffness factor $(E/E_p)^{1/3}$ was proposed on the basis of the stiffness factor for slabs and was checked against the elastic displacement due to a point load on a two-layer system.

TABLE 15.2*

Traffic Coefficient m	Total Traffic (veh. per day)
$\frac{1}{2}$	50 - 100
$\frac{2}{3}$	101 - 500
$\frac{3}{4}$	501 - 1,200
1	1,201 - 1,500
$\frac{7}{8}$	1,501 - 2,700
$\frac{9}{10}$	2,701 - 4,000
$\frac{11}{12}$	4,001 - 6,000
$\frac{13}{14}$	6,001 - 9,000
$\frac{15}{16}$	9,001 - 13,500
$\frac{17}{18}$	13,501 - 20,000

* From Kansas Highway Department.

Illustrative Example. Assume the following values for the modulus of elasticity of the subgrade and surfacing, respectively:

$$E = 1,500 \text{ psi} \quad E_p = 15,000 \text{ psi}$$

Likewise, assume $P = 9,000$ pounds; $a = 6$ inches; $\Delta = 0.1$ inch, m and $n = 1$. Then, the thickness of bituminous mat placed directly on the subgrade is

$$T = \sqrt[3]{\left(\frac{9(9,000)}{2 \cdot (15,000)(0.1)}\right)^2} = (6)^2 \sqrt[3]{\frac{1,500}{15,000}} = 12.7 \text{ inches}$$

Stiffness Factor. The stiffness factor appearing in equation 15.2 takes into account the stress-distributing qualities of the paving sur-

face as related to those of the subgrade soil. Disregarding the stiffness factor, equation 15.2 gives the thickness of an incompressible layer which will yield a settlement equal to that of the assumed condition and for the design wheel load. With the stiffness factor, equation 15.2 gives the thickness of a bituminous mat placed directly upon the subgrade soil under the assigned loading conditions. If one wishes to substitute some granular base-course material for a portion of the bituminous mat, the relationship can be determined on the basis of the stiffness factor for the bituminous mat related to the base course. Thus, if a thickness of final wearing surface is assumed, the thickness of base-course material to add to the pavement structure is that given in equation 15.3.

$$t_b = (T - t_p) \sqrt[3]{\frac{E_p}{E_b}} \quad (15.3)$$

where t_b = thickness of base course

T = thickness of bituminous mat

t_p = assumed thickness of wearing surface

E_p = modulus of elasticity of wearing surface

E_b = modulus of elasticity of base course

It is to be noted that the procedure necessitates assuming a thickness of wearing surface to be used in the pavement base structure.

Modulus of Elasticity. The stress-strain curve obtained from the triaxial compression test is used for determining the modulus of elasticity of the material being tested. A lateral pressure of 20 psi is commonly used. Twenty pounds per square inch is considered to be comparable to the lateral support or horizontal resistance which is usually provided by the adjacent similar material under field conditions.

The stress-strain curve for a soil normally is curved for the entire portion, and, therefore, no definite modulus of elasticity can be obtained, as is the case for perfectly elastic materials. For most bituminous paving surfaces and for most granular base-course materials, it is possible to obtain a relative modulus of elasticity by determining the straight portion of the stress-strain curve. Even so, the modulus determined in this manner depends largely upon the judgement of the individual making the interpretation.

Since the stress-strain curves for soils are usually curved, the secant modulus of elasticity depends upon the coordinates on the stress-strain curve at which it is calculated. The modulus for the subgrade can be determined by first calculating the vertical and horizontal stresses

Ref. 1

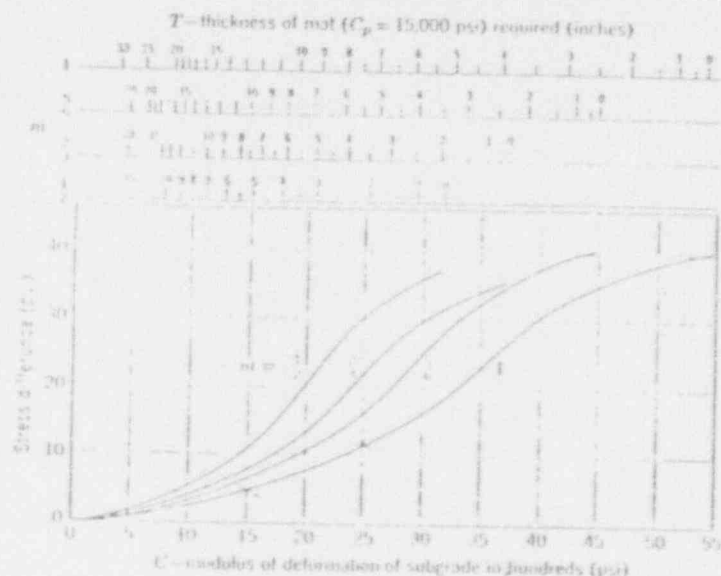


Figure 15.1. Thickness chart, $n = 1.0$, $\Delta = 0.1$ inch, $m = \frac{1}{2}$ to 1.0 . (From Kansas Highway Department.)

existing under the pavement and then finding the modulus by means of a triaxial test for the calculated stress conditions.

The significant stresses that exist under the pavement are the vertical stress, the radial horizontal stress, and the shearing stress existing on a plane around the periphery of the circular loaded area. With the three states of stress known, it is possible to plot a Mohr rupture diagram for the states of stress as they exist under the pavement. On the Mohr rupture envelope, the difference between the major and minor principal stresses is designated the deviator stress. It is also termed "the stress difference." The deviator stress (which is the difference between the total vertical stress during the triaxial test and the horizontal confining stress) is the stress which is used in calculating the modulus of elasticity. The influence curves presented in Figures 2.3-2.6 can be used to facilitate calculation of the stresses under the pavement in question.

It should be pointed out that the maximum stress difference will not always occur under the center line of one wheel, but rather it may be at some intermediate point between the center lines of the wheels.

To facilitate the computations, curves have been prepared which

make the determination of the modulus of elasticity a relatively simple matter. A set of such curves is presented in Figures 15.1 through 15.4 for values of n equal to 1.0 and 0.5, and for a modulus of elasticity of the paving surface equal to 15,000 psi. Triaxial compression-test data, using arbitrarily selected stress-difference values and calculated modulus of elasticity (modulus of deformation), are entered into the chart. If the assumed stress and modulus values are correct, the plot of stress difference against modulus of elasticity will fall on the appropriate m curve. The thickness of bituminous mat in inches is given on the appropriate line at the top of the graph. In practice it is necessary to use various values of stress difference and the corresponding modulus of elasticity from the stress-strain curve.

Illustrative Example. Use the triaxial test data given in Table 15.3, and determine the pavement thickness for a high-type highway carrying 1500 vehicles per day.

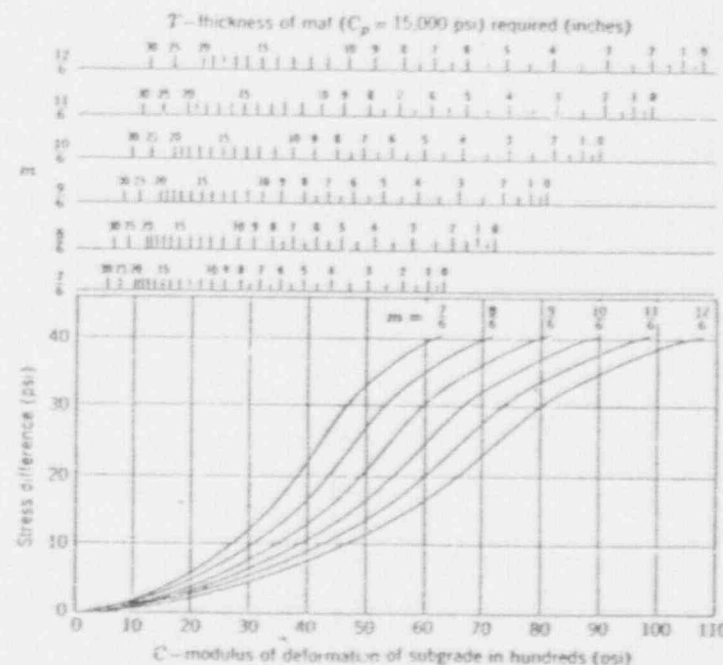


Figure 15.2. Thickness chart, $n = 1.0$, $\Delta = 0.1$ inch, $m = \frac{1}{4}$ to 1.2 . (From Kansas Highway Department.)

Ref. 1

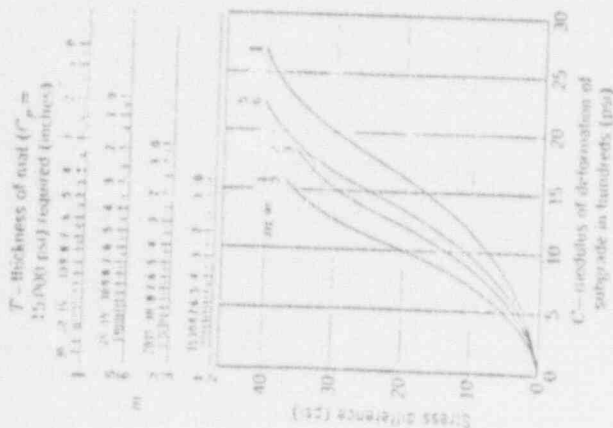


Figure 15.3. Thickness chart
 $n = 0.5$, $\Delta = 0.1$, $m = 1$ to 10.
(From Kansas Highway Department.)

For this case m and n are both taken as unity. Assume that specifications require a minimum 2-inch wearing surface with a modulus of deformation of 15,000 psi. Design pavements for both soils.

TABLE 15.3. MODULI OF DEFORMATION

Soil	Stress Difference	Strain	Modulus (psi)
Sandy clay	6	0.0015	4000
	7	0.00175	4000
	8	0.0020	4000
	9	0.0025	3600
	10	0.003	3300
	11	0.004	2750
	12	0.005	2400
	13	0.0065	2000
	14	0.0075	1710
	15	0.0085	1500
Clay	16	0.010	1330
	17	0.012	1100
	18	0.015	900

Values of modulus of deformation and stress difference are plotted on the thickness chart as shown in Figure 15.1. From this, the modulus of deformation of the sandy clay is 2500 psi, and the modulus for the clay is 1500 psi. The thicknesses of bituminous mat required directly on the subgrade are 7.5 inches and 12.5 inches, respectively.

Assume that a crushed stone with a modulus of deformation equal to 5580 psi and a graded gravel with a modulus of deformation equal to 3740 psi are available for use in the pavement.

For the clay subgrade, using 2 inches of wearing surface, the required thickness of crushed stone base is

$$t_m = (T - t_p) \sqrt[n]{\frac{C_p}{C_b}} = (12.5 - 2) \sqrt[3]{\frac{15,000}{5580}} = 14.3 \text{ inches}$$

Thus, the pavement could be composed of 2 inches of surface on 14½ inches of crushed-stone base. If it would be desirable to use a

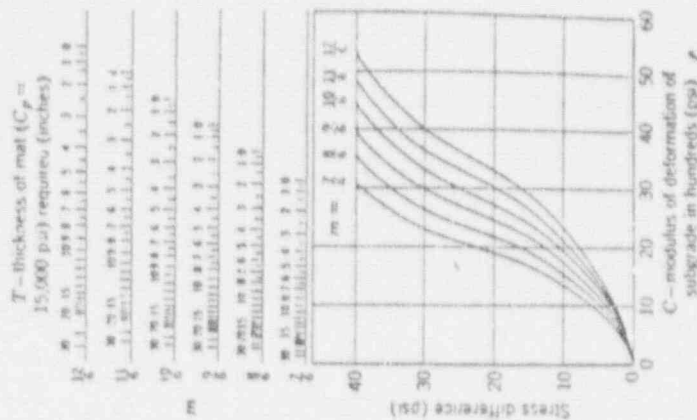


Figure 15.4. Thickness chart,
 $n = 0.5$, $\Delta = 0.1$, $m = 1$ to 10.
(From Kansas Highway Department.)

gravel subbase and assuming 6 inches of base will be used, the thickness of subbase is as follows:

$$I_{sub} = (I_n - 6) \sqrt[3]{\frac{C_{un}}{C_{sub}}} = (11.3 - 6) \sqrt[3]{\frac{5880}{3719}} = 9.7 \text{ inches}$$

The pavement would then consist of 2 inches of surface, 6 inches of base, and 10 inches of subbase.

For the sandy clay and stone base

$$I_n = (7.5 - 2) \sqrt[3]{\frac{15,000}{5880}} = 7.5 \text{ inches}$$

The design for this condition is 2 inches of wearing surface and 7½ inches of base.

The above method of design offers many advantages in that the theory can be used if the appropriate correlation coefficients can be determined. Thus, the method is applicable to most any type of wheel load or loading condition that is encountered; the method can be extended to include a multitude of conditions. This, of course, is predicated upon the assumption that the appropriate correlations would be established. The method, however, offers a distinct disadvantage in that the triaxial test itself is quite complicated and therefore costly. Also, the rate of loading which is used materially affects the test results. Soils tested under transient conditions of loading have a higher modulus of elasticity than soils tested using slower rates.

The procedures outlined above take into account the different qualities of various base-course materials. Therefore, there will be different thicknesses of flexible pavements for different types of base-course materials. This method of design also differentiates between base-course materials of different densities. Base-course materials of low densities require greater depths of pavement than those of the same material but with higher densities.

Texas Method of Design. The Texas method of design (22, 24, 25) is based on a modified triaxial test (see Figure 8.0). In this method, use is made of the Mohr rupture envelope. Significant features of the design procedure are twofold, first the specimens are cured by partially drying them in a forced-draft oven at 140°F for a period of eight hours. After curing the specimens are permitted to absorb water in the cell under 1-psi lateral pressure and with a surcharge ranging between 0.33 and 1.00 psi until equilibrium moisture conditions are obtained. Design is based on whether the life of the road

should be great, that is, ten to thirty years, or less permanent, ten years. The matter of the life of the road introduces a concept of percentage of design (see equation 4.1).

Since the procedures employed in Texas are somewhat different than those adopted by other agencies, some discussion of their testing techniques are in order. First, a 200- to 300-pound sample is air dried, portions of the material retained on a 2-inch screen are discarded. Moisture-density curves are developed for the materials, using a special technique of compacting the soil in a 6-inch diameter by 8-inch high cylinder. The samples are compacted in four equal layers each 2 inches thick. Six specimens are compacted at the optimum moisture content. The samples are stored overnight, and, if the sample does not develop shrinkage cracks, it is partially dried in an oven at 140°F for a period of eight hours. Next, the samples are subjected to capillary water until equilibrium is obtained. A surcharge ranging between 0.33 and 1.00 psi is used during the moisture absorption period.

The samples are then tested in a Texas pressure cell at a rate of strain of 0.15 inch per minute. The data are then plotted in the form

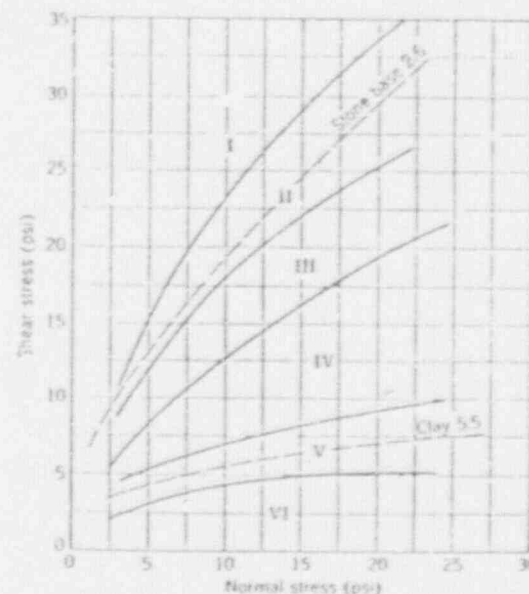


Figure 15.5. Texas classification chart. (From McDowell, Highway Research Board, Research Report 10. B.)

Ref 1

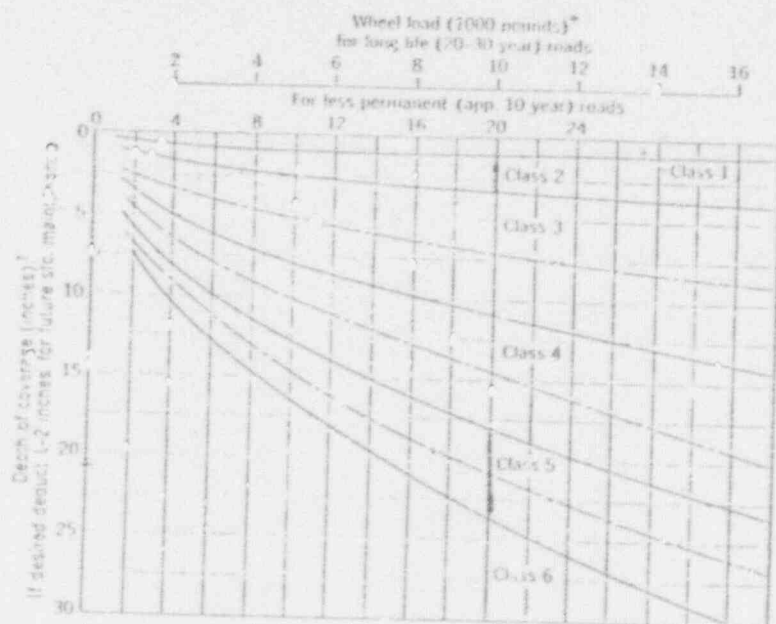


Figure 15.6. Pavement thickness. (From McDowell, Highway Research Board Research Report 16-B.)

* Average of ten heaviest wheel loads per average day.

† Depth of coverage consists of bituminous surfacing, bituminous surfacing plus base, or bituminous surfacing plus base plus subbase existing above material of known strength classification.

of Mohr's circles and rupture envelopes are drawn. Design curves are shown in Figures 15.5 and 15.6. The materials are assigned classification numbers based upon the position and slope of the rupture envelope.

Illustrative Example. Rupture envelopes for a clay subgrade and stone base are shown in Figure 15.5. They are classed as 5.5 and 2.6, respectively. For these values 2 inches of surface and 19 inches of base ($21'' - 2'' = 19''$) (Figure 15.6) are required for 10,000 pounds and long life pavement.

Traffic data are taken into account by the Texas method, using the concept of per cent design. McDowell (22) states that, using these techniques, good long-life pavements may be approximately 1½ inches thinner than required. Thus, it is the practice in Texas to reserve an inch or two of surfacing for future application.

STAGIOMETER

The data in this section presents a summary of a method proposed by Hyem and Carmany (15) of the California Highway Department. A relatively simple design chart has been developed that makes use of certain physical characteristics of the subgrade soil and the pavement, or pavement base, as well as the surface loading.

This design is based upon the principle that the load transferred through a layer of bituminous material or base may or may not be spread over the subgrade in the conventional design fashion. Instead, the particles in any layer may be displaced along a curved path and thus develop an upward force against the underside of the base or surface layer (see Figure 2.11). The analysis sets forth two of the design factors upon which the method of pavement design is based.

The required thickness of pavement depends on several factors. First, from the theoretical analysis presented in Chapter 2, it can be stated that the thickness varies directly as the tire pressure, p , the radius of loading (for a circular imprint as the square root of the area of contact) and the logarithm of the repetition of load (Chapter 4), and, according to Hyem and Carmany, varies inversely as the fifth root of the cohesion of the surface cover. Also field-performance data have indicated that the thickness is a linear function of $1 - (P_h/P_v)$. In order to avoid confusion with conventional bearing values, the resistance value was originally designated as

$$R = \left(1 - \frac{P_h}{P_v}\right) 100 \quad (15.4)$$

This equation was later modified, as given in equation 8.9.

Placing all of the variables in one expression, equation 15.5 results. For this expression T varies as the function $P_h/\bar{c}$, -0.10 .

$$T = K \frac{P \sqrt{A} \log r \left(\frac{P_h}{P_v} - 0.10\right)}{\sqrt[5]{c}} \quad (15.5)$$

where T = thickness of cover

K = correlation constant (0.0175)

P_h = transmitted horizontal pressure

P_v = applied vertical pressure 160 psi

p = effective tire pressure

A = area of contact

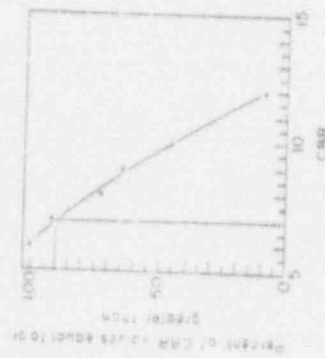
r = number of stress repetitions

$\bar{c}$ = cohesionometer value (approximately equal to modulus of rupture $\times 45.4$)

Ref

CBR	Number equal to or greater than	Percent equal to or greater than
6	11	(11/11) 100 = 100
7	10	(10/11) 100 = 90.9
8	8	(8/11) 100 = 72.7
9	7	(7/11) 100 = 63.6
10	5	(5/11) 100 = 45.4
11	3	(3/11) 100 = 27.3
12	1	(1/11) 100 = 9.1

3. The graphical presentation of the above table is shown below.



4. The design subgrade strength value, $CBR = 7$.

If a sample from a test location has a value so low that it indicates a weak area, additional samples should be obtained and tested to determine the extent of the area. Such locations may require local increases in thickness to provide uniform support for the entire length of the section. Test values representing these locations are omitted from the design strength calculations.

6.7 THE AASHTO METHOD FOR PAVEMENT DESIGN

This method allows for consideration of economical balance of thickness design for the various pavement system layers. In this method [9] the pavement serviceability performance concept has been used to analyze the results of the AASHTO Road Test. Accordingly, the design chart shown in Fig. 6.8 was developed, to relate the structural number SN_{90}

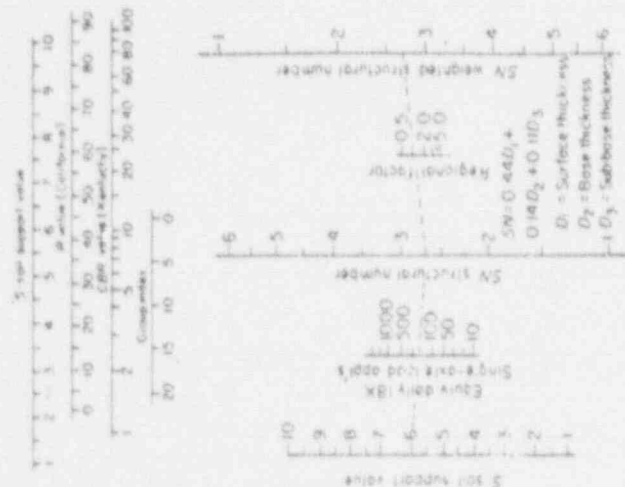


FIG. 6.8 AASHTO iterative procedure for design of flexible pavement (considering 20 year traffic analysis. (From [9].)

soil support value 5 and equivalent daily 18 000 lb single-axle load applications. The equivalent number of daily 18 000 lb single-axle load applications is the same as the Design Traffic Number (DTN) mentioned previously in the Asphalt Institute method of design. It can be calculated using the same traffic analysis procedure given in that method. The chart of Fig. 6.8, which is prepared for a terminal serviceability index $p = 2.0$, is based on a 20 year design period. For other design periods the DTN or the equivalent daily 18 000 lb single-axle load applications should be

adjusted in the same way, as mentioned before in the traffic analysis procedure. In the AASHTO Road Test, an environmental factor was introduced, and is shown in Fig. 6.8 to reflect the greater damage caused to the roads by traffic under adverse conditions. This factor, referred to as the 'regional factor R ' in the chart, is estimated by analysing the duration of certain typical environmental conditions during an annual cycle. A regional factor of 0.5 represents excellent environmental conditions, while a regional factor of 5 indicates very adverse conditions. Suggested regional factors are:

Frozen roadbed	0.20-1.0
Dry soil in the roadbed	0.30-1.5
Saturated roadbed (Spring break-up)	4.0-5.0

Once the structural number SN is determined, from Fig. 6.8, the following equation can be used to determine the thickness of the different layers in the flexible pavement:

$$SN = a_1 D_1 + a_2 D_2 + a_3 D_3 \quad (6.2)$$

where D_1 , D_2 and D_3 = thickness of surface, base and sub-base layers respectively; and

a_1 , a_2 and a_3 = coefficient whose values depend upon material properties.

The most common values for a_1 , a_2 and a_3 are:

$a_1 = 0.44$, and is used if the surface course is a plant-mix asphalt concrete of high stability;

$a_2 = 0.14$, and is used for a base layer consisting of crushed stone;

$a_3 = 0.11$, and is used for a sandy gravel sub-base layer.

However, other values for a_1 , a_2 and a_3 can be used, if the surface, base or sub-base courses consist of materials different from the above. These values are:

$$a_1 = \begin{cases} 0.20, & \text{for low-stability, road-mix asphalt} \\ 0.40, & \text{for sand asphalt} \\ 0.07, & \text{for sand gravel,} \\ 0.23 & \text{for cement treated bases with } \begin{cases} 650 \text{ psi or more} \\ 400-650 \text{ psi} \end{cases} \\ 0.20 & \text{compressive strength after } \begin{cases} 650 \text{ psi or more} \\ 400-650 \text{ psi} \end{cases} \\ 0.15 & \text{7 days as indicated to the right less than 400 psi} \\ 0.30, & \text{for a bituminous treated coarse-graded base} \\ 0.25, & \text{for a bituminous treated sand asphalt} \\ 0.15-0.30, & \text{for a lime treated base} \end{cases}$$

$$a_3 = 0.05-0.10, \text{ for sand or sandy clay sub-bases}$$

The following example illustrates the use of the chart in Fig. 6.8.

Example

Given: CBR = 10.

Equivalent daily 18 000 lb single-axle load applications = 200.

Regional factor $R = 2$.

Determine the weighted structural number SN and the thickness of the different layers for the pavement system.

Solution. The soil support value S corresponding to a CBR of 10 is 6. Using the chart of Fig. 6.8, the structural number $SN = 2.7$. For a regional factor of 2, the weighted structural number = 3.0.

The structural requirement can be met by a variety of different combinations of D_1 , D_2 and D_3 , as indicated by the equation in Fig. 6.8. The tentative coefficients for D_1 , D_2 and D_3 suggest the relative structural value of the layers of the pavement structure. Some possible methods of determining the pavement thickness are:

1. The structural requirement is assumed to be supplied by D_3 , with D_1 and D_2 equal to zero. The thickness requirement would be 3.0 divided by 0.11, or about 27.5 in. Sub-base material is generally gravel or select borrow. The decision to do this would depend on availability (and in-place cost) of a well-graded gravel of excellent quality. Surface treatment (prime and seal) would provide the wearing surface. Then later, as traffic increases and/or as construction funds become available, the layer constructed earlier would provide an excellent base for a paving mat.

2. A 2 in paving mat D_1 is assumed to be combined with a base course D_2 (generally crushed rock or crushed gravel) of minimal thickness, say 3 in, and a sub-base layer D_3 . Then

$$3.0 = (0.44 \times 2) + (0.14 \times 3) + 0.11 D_3$$

from which $D_3 = 15$ in of sub-base material and the resulting total thickness is 20.5 in.

3. D_1 is assumed to consist of a 2 in asphalt wearing course and the rest is an asphalt concrete base course. The layers combined form a full-depth asphalt pavement. Then, $3.0 = 0.44 D_1$; therefore, $D_1 = 6.9$ in. D_1 when rounded gives 7.0 in, from which 2.0 in is wearing course and 5.0 in is asphalt concrete base.

Ref. 2

ROADS & AIRFIELDS-GENERAL SOIL RATING

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

AASHTO	BOULDERS	COARSE GRAVEL	MEDIUM GRAVEL	FINE GRAVEL	COARSE SAND	FINE SAND	SILT	CLAY	COLLOID																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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UNIFIED (IC 61 E)	COBBLES	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES (SILT OR CLAY)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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FIG. B TEXTURAL CLASSIFICATION FOR SOILS

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

EXAMPLE GIVEN: HIGHLY COMPRESSIBLE CLAY SUBGRADE.
CLASSIFICATION IS CH. A-7 OR A-8.

CLASSIFICATION
CBR = 4 TO 7
K = 125 TO 150
R = 45 TO 60

LEGEND OF S

[illegible]

Calculation Cover Sheet

Contract No. 5057-04Discipline ESCICalc. No. 12-461-01-00No. of Sheets 5

Project

UMTRA - FCT

Feature

Water Storage Reservoir

Item

Capacity and Dimension calculation

Sources of Data

Sources of Formulae & References

- ① Calc. No. 20-438-03-00 (Material Properties for Roadway Structure design)
- ② FCT Subcontract documents
- ③ FCT construction cost estimate

Preliminary Calc. ☐Final Calc. ☒

Supersedes Calc. No. _____

0		G. Hibbard	10/18/00	P. Li	10/18/00	W. Jenkins	8-15-90
Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



Project UMTRA - FCT
Feature Water Requirement Calculation
Item Radon Barrier and Dust Control

Contract No. 5122-004Designed CSLChecked P+LSheet 1File No. Date 10/14/88Date 10/18/88

This calculation was performed to determine the quantity of clean water required for use on 1) Dust Control and 2) Radon Barrier Compaction. These are the only 2 uses of clean water for construction requirements.

Since it is very unlikely that a water well, on the FCT site, could produce the volume of water required for instant use, it was proposed that a storage reservoir be constructed to buffer water use against the well pumping rate.

It was determined that the optimum situation would be a weekly balance of water use vs. water production. This plan would require one or more wells to produce water at a minimum rate of 18 gallons per minute. The storage reservoir would need to be approximately 100' (long) x 100' (wide) x 4' (deep). This design allow construction of the radon barrier (the peak water usage period), to take place on a 40 hour per week basis.



Project

UTRA - FET

Feature

Under Requirement Calculation

Item

Radon Barrier and Dust Control

Contract No. 5857-02

Designed

JGL

Checked

PTL

Sheet

2

File No.

Date

10/14/88

Date

10/18/88

Pond size estimates for clean construction water

Assumption: Rate of placement and compaction of the radon barrier is estimated to be: 650 yd^3/hour .

Volume of clean water needed for compaction of the radon barrier is estimated to be: 4,250 gallons/hour
34,000 gallons/day.

Volume of clean water needed for dust control on the clean areas and access roads: 1000 gallons/day

total combined water requirements: 35,000 gallons/day

175,000 gallons/week

Pond should hold 7 days of construction water requirements.

$\Rightarrow$ pump will operate at 168 hours/week.

$\Rightarrow$ water use will be at 40 hours/week.

(?) $\text{gphour} \times 168 \text{ hours} = 4375 \text{ gphour} \times 40 \text{ hours}$.

(?) $\text{gphour} = 1042 \Rightarrow \text{pump rate required: } 17.5 \text{ gpm}$.

say: 18.0 gpm (minimum)

(Assumed) required pond size = $7 \times 35,000 \text{ gallons} = 245,000 \text{ gallons}$

$\Rightarrow$ 32,752 ft^3

Approximate pond dimensions: 100' x 100' x 4'

(provides 0.7' of free board).





Project UMTRA - FCT
Feature Water Requirement Calculation
Item Radon Barrier and Dust Control

Contract No. 5557-64
Designed JKL
Checked PTL

Sheet 3
File No. _____
Date 10/12/88
Date 10/18/88

Water Volume Calculation for Radon Barrier Material Compaction

from calc
20-435-38-00

- Moisture content of In-situ Radon Barrier Material = 35%
- Optimum moisture content for compaction of R.B. Material = 37.6%
- Unit weight of Radon barrier material @ 95% compaction = 77.7 lbs/ft³
(optimum moisture)

Calculation

$$37.6\% - 35.0\% = 2.6\%$$

$$77.7 \text{ pcf} \times 2.6\% = 2.02 \text{ lbs (H}_2\text{O) / ft}^3 \text{ (material)}$$

from
est cost estimate

$$\text{[Estimated quantity of Radon Barrier Material} = 401,545 \text{ ft}^3$$

$$2.02 \text{ lbs/ft}^3 \times 27 \text{ ft}^3/\text{yd}^3 \times 401,545 \text{ yd}^3 = 21,900,264 \text{ lbs (H}_2\text{O)}$$

$$21,900,264 \text{ lbs} \div 8.337 \text{ lbs/gal} = 2,626,576 \text{ gallons}$$

$$\text{say } \Rightarrow 2.7 \text{ million gallons (H}_2\text{O)}$$

Water Volume Calculation for Dust control in clean areas

(Assumed) Estimate 1000 gallons/day for 1 year (260 days)

$$1000 \times 260 = 260,000 \text{ gallons}$$

$$\text{say } \Rightarrow 300,000 \text{ gallons}$$

$$\text{Total clean water needed } \Rightarrow 3.0 \text{ million gallons}$$





Project UMTRA - FCT
Feature Water Requirement Calculations
Item Radon Barrier and Dust Control

Contract No. 5877-27Designed SLChecked PRBSheet 4

File No. _____

Date 12/12/92Date 12/18/93

Total volume of clean water needed for duration of the FCT site clean-up: 3.0 million gallons

Estimated clean water requirements

1) Radon Barrier

$\Rightarrow$ 4252 gallons/hour

2) Dust control on "clean" roads

$\Rightarrow$ 1000 gallons/day

Pumping Requirements

1) For dust control $\Rightarrow$ 10 gallons/minute (Average)

2) For Radon Barrier Compaction $\Rightarrow$ 75 gallons/minute (Average)

80 gallons/minute (Peak)

- Compaction of the Radon Barrier is expected to take 4 months

- Dust control will be in effect for the duration of the project.





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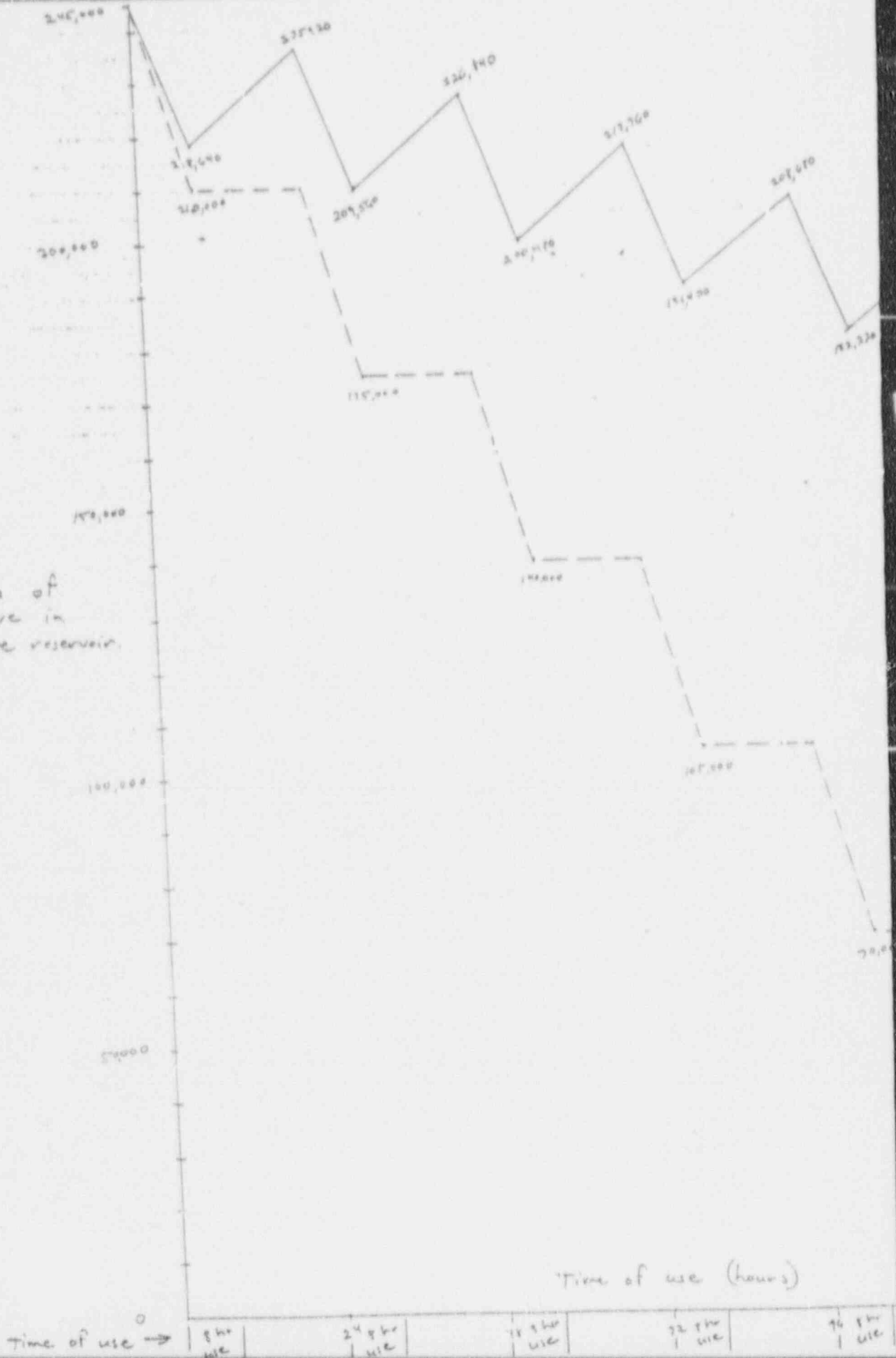
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Project UMTRA - FCT
Feature Water Requirement Calculation
Item Radon Barrier and Dust Control

Contract No. 557-89
Designed ML
Checked PTL

Sheet 5
File No.
Date 10/1/89
Date 10/1/89

Gallons of
reserve in
storage reservoir.



Continuous pump
recharge of reservoir
with a 5 day
construction use.

① Construction use rate : 4,375 gallons / hour
(8 hour day) 35,000 gallons / day

② Pump recharge rate : 1,080 gallons / hour
(24 hour day) 25,920 gallon / day

③ Reservoir drawdown rate : 3,295 gallons / hour
(8 hour construction use) 26,360 gallons / day

Note: It will require approximately 4.0
hours of pumping recharge to
produce enough water for 1.0 hour
of construction use. (Assuming a
pump rate of 15.0 gallons / minute)

7 day construction use
with no pump recharge
of reservoir.

SI APERTURE CARD

Also Available On
Aperture Card

9205110072-46



Calculation Cover Sheet

Contract No. 5057Discipline CIVILCalc. No. 20-435-01-00No. of Sheets 14

Project

UMTRA - FALLS CITY

Feature

NORTH-EAST DRAINAGE AREA

Item

PMF LEVEL AT SOUTH CULVERT (FM 1344)

Sources of Data

Sources of Formulae & References

SEE SHEET 14Preliminary Calc. ☐Final Calc. ☒

Supersedes Calc. No. _____

0		<u>O. Morris</u>	<u>6/7/88</u>	<u>T. F. Rasmussen (checked only)</u>	<u>7-11-88</u>	<u>G. J. Rasmussen</u>	<u>7/21/88</u>
Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project UNITA-ELTFeature NE Drainage AreaItem PMF Level @ South CulvertContract No. 5057Designed LRMChecked RMR / JTKSheet 1File No. Date 6/12/83Date 7-1-88I. PURPOSE

TO DETERMINE THE PROBABLE MAXIMUM FLOOD LEVEL FOR THE NORTH-EAST DRAINAGE AREA AT THE SOUTH CULVERT.

II. DISCUSSION

STORM RUNOFF FROM THE NORTH-EAST DRAINAGE AREA DRAINS TO A CULVERT LOCATED AS SHOWN ON SHEET 11. THE CULVERT HAS BEEN DESIGNED FOR A 10-YR STORM FREQUENCY. THE HEADWATER DUE TO THE PMF WILL EXCEED THE LOW ELEVATION ON THE ROADWAY THUS CAUSING THE PMF TO FLOW OVER THE ROAD AND THROUGH THE CULVERT.

THE PEAK FLOW RATE Q FOR THE DRAINAGE AREA WAS DETERMINED BY THE RATIONAL METHOD. THE DISTRIBUTION OF FLOW THROUGH THE CULVERT AND OVER THE ROAD WAS DETERMINED. THE FLOW RATE THROUGH THE CULVERT Q_c WAS DETERMINED USING STANDARD EQUATIONS FOR FULL PIPE FLOW UNDER PRESSURE. THE FLOW RATE OVER THE ROAD EMBANKMENT Q_o WAS DETERMINED USING WIER EQUATION FOR A BROAD-CRESTED WIER.

THE PROCEDURE FOR DETERMINING FLOW DISTRIBUTION AND THE HEADWATER ELEVATION FOR THE PMF IS FOUND IN THE STATE OF TEXAS, DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION, HYDRAULICS MANUAL (SEE REFERENCE 1.).



Project UMTRA-FLCFeature NE Drainage AreaItem PMF Level @ South CulvertContract No. 5057Designed DRMChecked BMB/STKSheet 2File No. Date 6/13/88Date 7-11-88III. PROCEDURE (THE PROCEDURE IS FOUND IN REF. 1)

THE FOLLOWING PROCEDURE WAS USED IN THIS ANALYSIS.

1. THE HEADWATER HW IS CALCULATED FOR AN ASSUMED Q_c USING EQUATIONS FOR FULL PIPE FLOW.
2. THE REMAINING FLOW OVER THE ROAD Q_o IS CALCULATED USING THE HEADWATER CALCULATED IN STEP 1.
3. THE DISCHARGES Q_c AND Q_o ARE ADJUSTED SO THAT THE TOTAL DISCHARGE Q IS APPROXIMATELY EQUAL TO THE SUM OF Q_c AND Q_o .
4. WHEN THE FLOWS Q_o AND Q_c ARE APPROXIMATELY EQUAL TO THE TOTAL FLOW THE ANALYSIS IS FINISHED (I.E., THE FLOW DISTRIBUTION AND PMF LEVEL IS KNOWN).
5. Q_o IS ESTIMATED BY THE EQUATION FOR A BROAD-CRESTED WIER:

$$Q_o = C L_i h^{3/2}$$

Q_o = DISCHARGE OVER THE ROAD, CFS

C = DISCHARGE COEFFICIENT FOR A BROAD CRESTED WIER = 3.0 (REF. 1)

L_i = HORIZONTAL LENGTH OF OVERFLOW, FT.

h = AVERAGE DEPTH BETWEEN HEADWATER AND ROADWAY ELEVATIONS, FT.





PROJECT NO. 5057

- FCT

Contract No. 5057

Sheet 3

STATION 10+00

Wage Area

Designed GEM

File No.

10+00

Level @ South Culvert

Checked PNB / JTK

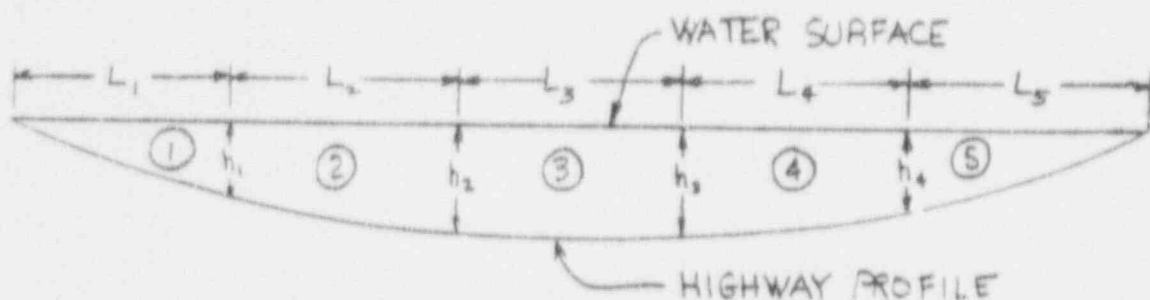
Date 6/13/88

Date 7-11-88

6. THE ROAD PROFILE (SHEET 10) EXHIBITS CURVATURE. IT IS NECESSARY TO DIVIDE THE SECTION OF THE ROAD INTO INCREMENTS AND THEN CALCULATE THE INDIVIDUAL WIER FLOWS FOR EACH INCREMENT. THE TOTAL FLOW Q_0 IS THEN CALCULATED BY ADDING THE INDIVIDUAL WIER FLOWS i.e.,

$$Q_0 = \sum_{i=1}^n Q_{0,i} \quad n = \text{no. of increments}$$

AN ILLUSTRATION AND FIGURE ARE PROVIDED BELOW FOR CLARIFICATION.



INCREMENT UNIT	i-i	AVG. h_i	$Q_{0,i}$
1	L_1	$\frac{0+h_1}{2}$	$CL_1 \left(\frac{0+h_1}{2} \right)^{3/2}$
2	L_2	$\frac{h_1+h_2}{2}$	$CL_2 \left(\frac{h_1+h_2}{2} \right)^{3/2}$
3	L_3	$\frac{h_2+h_3}{2}$	$CL_3 \left(\frac{h_2+h_3}{2} \right)^{3/2}$
4	L_4	$\frac{h_3+h_4}{2}$	$CL_4 \left(\frac{h_3+h_4}{2} \right)^{3/2}$
5	L_5	$\frac{h_4+0}{2}$	$CL_5 \left(\frac{h_4+0}{2} \right)^{3/2}$

$$\text{TOTAL } Q_0 = \sum_{i=1}^5 Q = Q_{0,1} + Q_{0,2} + Q_{0,3} + Q_{0,4} + Q_{0,5}$$

Project MTA-5CContract No. 5057Sheet 4Feature NE Drainage AreaDesigned ARMFile No. Item PMF LEVEL @ South CulvertChecked RMB / JTWDate 6/13/88Date 7/1/88TIME OF CONCENTRATION (T_c):

TIME OF CONCENTRATION WAS DETERMINED IN REF. 3 TO BE 5.5 MIN (19). FOR FLOW OVER THE TAILINGS EMBANKMENT (PATH A-B) (38.11). THIS TIME OF CONC. WAS INCREASED SINCE ADDITIONAL TRAVEL TIME IS REQUIRED TO REACH THE CULVERT INLET BY OVERLAND FLOW. THE OVERLAND TRAVEL TIME WAS CALCULATED USING THE KIRPICH EQUATION AS FOLLOWS:

PATH A-C; OVERLAND PATH LENGTH $L = 210 \text{ FT} = 0.045 \text{ MI}$
 $\Delta \text{ ELEVATION} = 19 \text{ FT.}$

$$(\text{REF. 4}) \quad \text{OVERLAND TRAVEL TIME} = \left(\frac{11.9 L^3}{\Delta \text{ELEV.}} \right)^{0.775} = 0.024 \text{ HR.} = 1.4 \text{ MIN}$$

$$T_c = 5.5 \text{ MIN} + 1.4 \text{ MIN} = 6.9 \text{ MIN} \quad (\text{USE: } 7.0 \text{ MIN})$$

PEAK FLOW RATE Q :

THE PEAK FLOW RATE Q FOR THE PMP IS CALCULATED BY THE RATIONAL METHOD AS FOLLOWS:

$$Q = C i A$$

RUNOFF COEFFICIENT $C = 1.0$ (FOR THE PMP)

DRAINAGE AREA $= A = 34.4 \text{ ACRES}$

$$\text{PMP Rainfall Intensity} = i = 10^{2.250 - 0.5514(\log T_c)^{1.9820}} \quad (\text{IN/HR}) \quad (\text{FROM REF. 2})$$

$$Q = 1.0 (34.4 \text{ AC}) (60.6 \text{ IN/HR}) = \underline{\underline{2,085 \text{ CFS}}}$$





Project

ULTRA - FCT

Contract No.

5557

Sheet

5

Feature

NE DRAINAGE AREA

Designed

DRY

File N

Date 7/6/88

Item

PHF LEVEL AT SOUTH CURVE

Checked

JMB / JTK

Date 7-11-88

TAILWATER DEPTH (TW)

THE TAILWATER DEPTH WAS DETERMINED FOR THE FLOODPLAIN DOWNSTREAM OF ROAD 1344 (SEE SHEET FOR PROFILE). MANNING'S EQUATION WAS USED TO DETERMINE FLOW DEPTH $y = TW$.

MANNING'S EQN

$$Q = 1.486 A R^{2/3} S^{1/2}$$

WHERE:

$$Q = 2085 \text{ CFS (GUT. A)}$$

$$n = 0.040 \text{ ASSUMED}$$

$$S = 0.005 \text{ FT/FT ASSUMED}$$

SOLVING FOR $AR^{2/3}$:

$$AR^{2/3} = \frac{nQ}{1.486 S^{1/2}}$$

$$AR^{2/3} = \frac{0.040 (2085)}{1.486 (0.005)^{1/2}} = 793.$$



PROFILE OF FLOODPLAIN
(SEE SHEETS 11, 12)

$$\text{FLOW AREA } A = 245y + \frac{y^2}{2} (42.5 + 57.5)$$

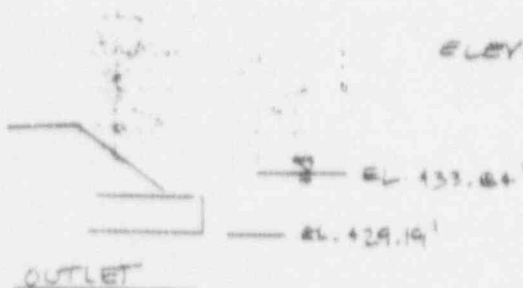
$$\text{WETTED PERIMETER } P = 245 + y[(1 + 42.5^2)^{1/2} + (1 + 57.5^2)^{1/2}]$$

HYD. RADIUS

$$R = \frac{A}{P} = \frac{y(245 + \frac{y}{2}(100))}{245 + y(100)}$$

SOLVE FOR y BY TRIAL: $y = 1.84 \text{ FT}$

$$\text{ELEV. OF TW} = 432.0 + 1.84 = 433.84$$





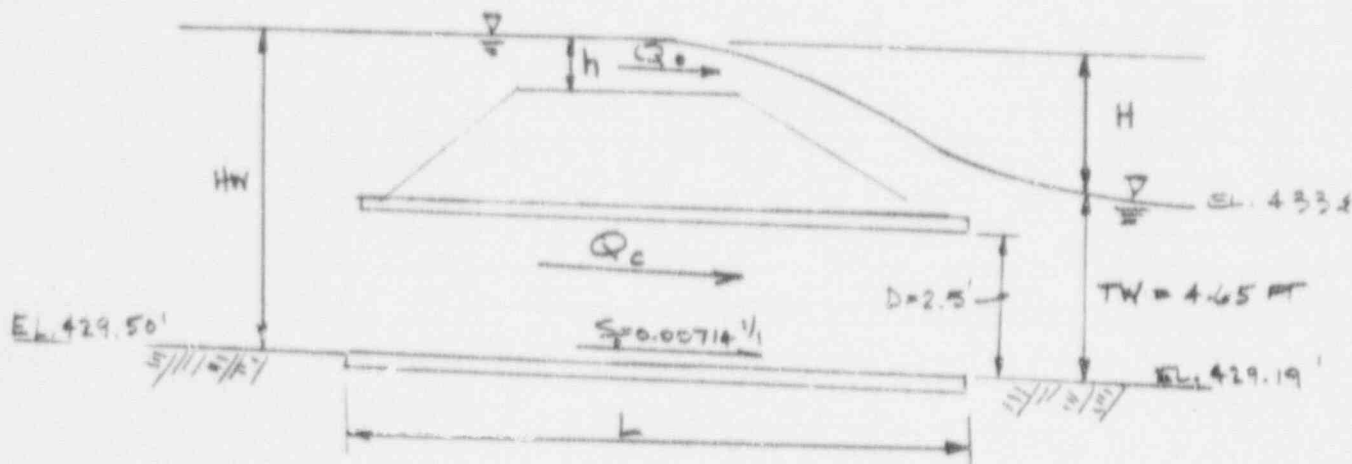
Project WATRA-FIT
Feature NE Drainage Arroyo
Item PMF Level @ South Culvert

Contract No. 5057
Designed DRM
Checked RMB/PRK

Sheet 6
File No. _____
Date 6/13/88
Date 7-11-88

CULVERT FLOW ANALYSIS

THE EXIT IS SUBMERGED ($TW > SL + D$). THE ENTRANCE IS ALSO SUBMERGED ($HW > 1.5D$, SEE SHEET 8). THEREFORE THE HEAD REQUIRED TO DISCHARGE Q_c IS DETERMINED FROM FULL PIPE FLOW EQUATIONS (SEE BELOW).



PMF OVERTOPPING ROAD AT CULVERT

SEE LIST OF DEFINITIONS (SHT. 13)

THE FOLLOWING EQUATIONS ARE REQUIRED TO DETERMINE HEADWATER (HW) FOR FULL PIPE FLOW:

$$\left. \begin{aligned} HW &= H + TW - S_0 L \\ H &= h_v + h_e + h_f \end{aligned} \right\} \text{REF. 1}$$

NOMOGRAPHS ARE AVAILABLE TO CALCULATE H BUT SINCE L IS LESS THAN 50 FT. IT COULD NOT BE USED. H IS SOLVED ANALYTICALLY ON SHEET 7.

THE FOLLOWING VALUES ARE USED IN THIS ANALYSIS:

Reinf. Conc. Pipe	$n = 0.014$	} REF. 1
Entrance Loss Coeff.	$C = 0.50$	
Culvert Length, ft	$L = 43.0$	
Pipe Diameter ft.	$D = 2.5$	
Invert Slope, ft/ft	$S_0 = 0.00714$	





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Project UMTA-ECTFeature NE Drainage AreaItem PMF Level @ South CulvertContract No. 5057Designed DRMChecked RMB / HKSheet 7File No. Date 6/12/86Date 7-11-88

THIS EQUATION FOR H CAN BE WRITTEN IN TERMS OF FLOW RATE THROUGH THE CULVERT (Q_c).

$$H = h_v + h_e + h_f \quad (\text{See Sht. 12 for Definitions})$$

$$H = \frac{v^2}{2g} + C_e \frac{v^2}{2g} + S_f L \quad S_f = \frac{n^2 v^2}{2.208 R^{4/3}}$$

$$H = (1 + C_e) \frac{v^2}{2g} + \frac{n^2 v^2 L}{2.208 R^{4/3}}$$

$$v = \frac{Q_c}{A} = \frac{Q_c}{\pi D^2/4}, \quad R = \frac{A}{P} = \frac{\pi D^2/4}{\pi D} = \frac{D}{4}$$

$$\text{THEN: } H = (1 + C_e) \frac{Q_c^2}{\left(\frac{\pi D^2}{4}\right)^3 2g} + \frac{n^2 L}{2.208} \left(\frac{Q_c^2}{\left(\frac{\pi D^2}{4}\right)^2}\right) \left(\frac{1}{\left(\frac{D}{4}\right)^{4/3}}\right)$$

(Ref. 1)
W.D.H.O.K.

$$H = \left[\frac{2.5204(1 + C_e)}{D^4} + \frac{466.18 n^2 L}{D^{10/3}} \right] \left(\frac{Q_c}{10} \right)^2$$

SUBSTITUTING THE VALUES GIVEN ON SHT. 6 INTO THIS EQN. GIVES:

$$H = 1.264 \times 10^{-3} Q_c^2$$





MORRISON-KNUDSEN ENGINEERS, INC.

Project WATER-FACT
 Feature NE Drainage Area
 Item PMF LEVEL @ South Culvert

Contract No. 5057 Sheet 2
 Designed RRM File No. _____
 Checked RMB/TK Date 6/13/88
 Date 7-11-88

Profile of Road: THE PROFILE IS PROVIDED ON SHEET 10. THIS PROFILE WILL BE USED TO CALCULATE h_i AND L_i .

HEADWATER DEPTH: THE HEADWATER FOR THE PMF IS CALCULATED ACCORDING TO THE PROCEDURE ON SHEET 23.

TRIAL	ASSUMED Q_c , CFS	(1) Q_c/BAL , CFS	H_i , FT.	(2) HW, FT.	(3) ELEV. HW
1	268	67.0	5.67	10.02	439.51
2	246	61.5	4.75	9.12	438.62
3	256	64.0	5.18	9.52	439.00

- (1) FOUR BARRELS ARE USED (i.e., $Q_c/BAL = Q_c/4$)
 (2) $HW = H + TW - SOL$ WHERE $TW = TW \text{ ELEV.} - \text{OUTLET ELEV.}$
 $TW = 433.84 - 429.19 = 4.65$
 (3) $HW \text{ ELEV.} = \text{INLET ELEV.} + HW = 429.5 + HW$

TRIAL	UNIT	L_i	$h_{i, \text{AVG.}}$	Q_n	$\Sigma Q_n = Q_o$	CALCULATED $Q_c = Q - Q_o$
1	1	200	0.95	556	2,868	-732
	2	200	2.01	1,710		
	3	200	0.94	602		
2	1	150	0.51	162	1,040	1,046
	2	200	1.12	711		
	3	160	1.50	167		
3	1	75	0.38	53	1,908	178
	2	100	1.05	323		
	3	100	1.48	540		
	4	100	1.47	535		
	5	100	1.13	360		
	6	100	0.47	97		





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Project UNITA-FLT

Feature NE Drainage Area

Item PMF Level @ South Culvert

Contract No. 5057

Designed DRM

Checked RMB

Sheet 9

File No. _____

Date 4/13/88

Date 7-11-88

FOR TRIAL 3 : THE CALCULATED $Q_c = 178 \text{ CFS}$ WHICH
WHICH IS CLOSE ENOUGH TO ASSUMED $Q_c = 256 \text{ CFS}$
FOR PRACTICAL DESIGN. THE MAXIMUM WATER
SURFACE ELEVATION FOR THE PMF IS 439.00 FT.



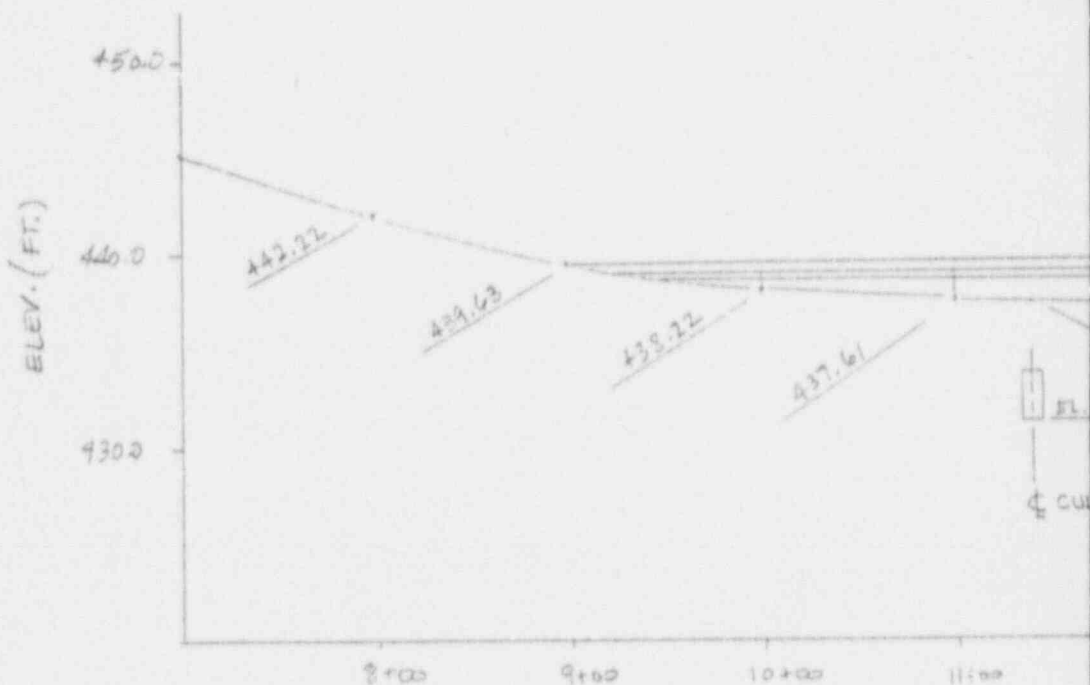


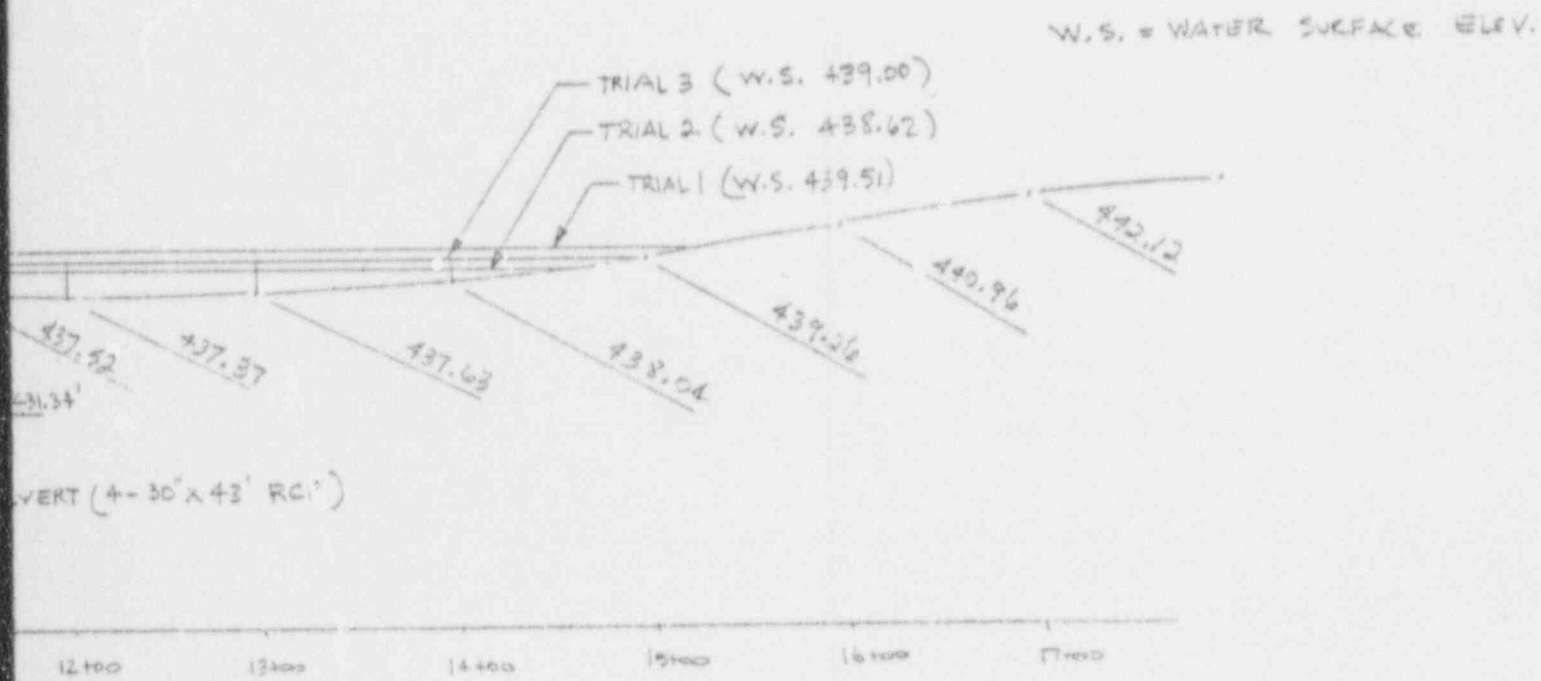
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Project WMTA-ECT
Feature NE Drainage Area
Item PMF Level @ South Culvert

Contract No. 5057 Sheet
Designed DRM File No.
Checked RMB Date 6/7
Date 7-1





PROFILE OF ROAD 1344

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

SI
APERTURE
CARD

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Aperture Card

9205110072-47





MORRISON-KNUDSEN ENGINEERS, INC.

Project

UTRA-RT

Contract No. 5057

Sheet 11

Feature

NE DRAINAGE AREA

Designed DCM

File No.

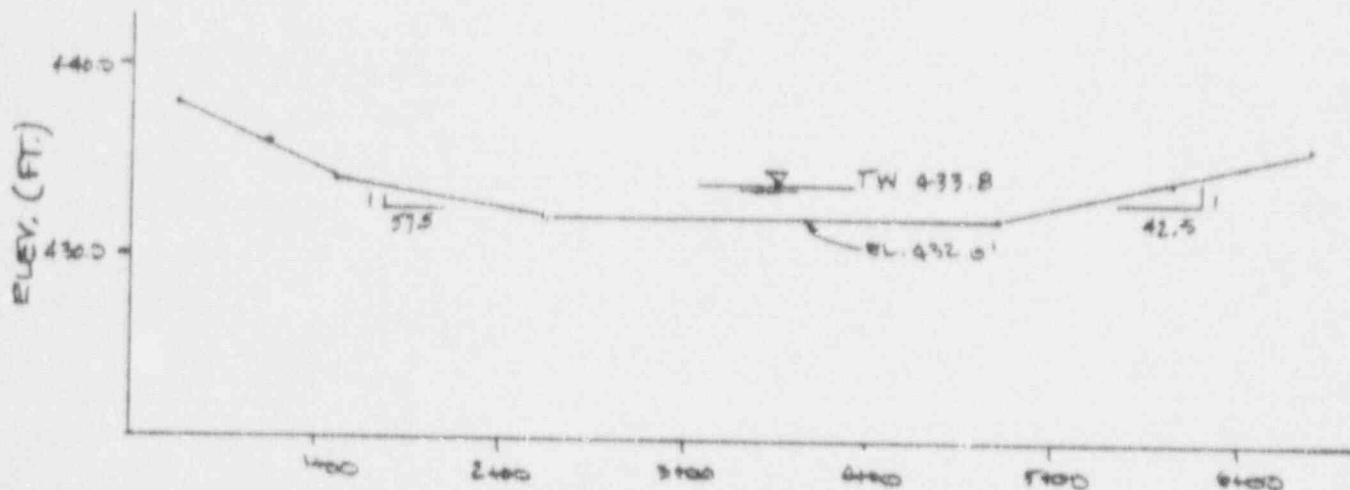
Date 7/7/88

Item

PHI LEVEL @ SOUTH CULVERT

Checked RMB

Date 7-11-88



(A) PROFILE - FLOODPLAIN DOWNSTREAM
OF ROAD 1344

VERT. SCALE 1"=10'

HORT. SCALE 1"=100'





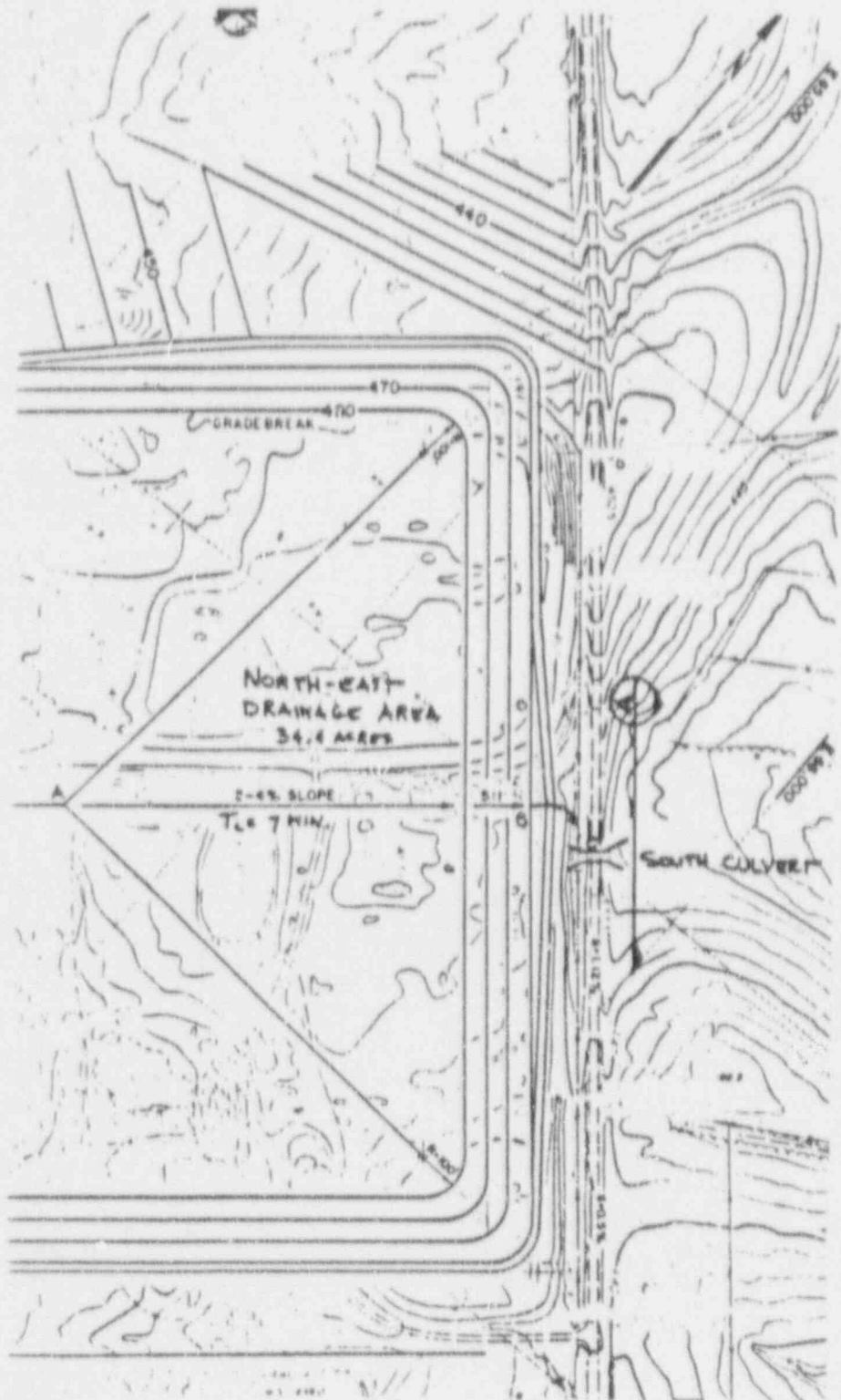
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Project WMT EA - FCT
Feature NE Drainage Area
Item PMF Level @ South Culvert

Contract No. 5057
Designed DRM
Checked LMB

Sheet 12
File No. _____
Date 6/13/88
Date 7-11-88



Scale 1"=40'



Project UMTRA-FLTFeature VE Drainage AreaItem PIF Level @ South CulvertContract No. 5057Designed DEFChecked AMBSheet 1/3

File No.

Date 6/13/88Date 7-11-88DEFINITIONS:

A = Area occupied by water flow in square feet

C_e = Entrance coefficient (Table 1)
(Also termed K_e)D = Diameter of pipe culvert in feet
or height of box culvert in feet

d = Depth of flow in feet

d_c = Critical depth of flow in feetd_u = uniform depth is the depth of water for a given culvert slope, and constant cross-sectional geometry at steady (unchanging discharge) flow.

d/D = Ratio of depth of flow to diameter of pipe

d/w = Ratio of depth of flow to width of culvert

g = Acceleration of gravity = 32.2 feet per second per second

H_L = Head lossesH_E = Headwater depth to low point in highway embankment~~H = Depth of flow over road (immediately upstream)~~~~H_T = Elevation difference between tailwater and low point in highway embankment~~

Hd = Headwater depth in feet

~~H_w = Allowable headwater~~h_e = Entrance head losses in feet =

$$C_e v^2 / (2g)$$

h_f = Friction head losses in feet = S_fLh_v = Velocity head in feet = $v^2 / (2g)$ ~~K_t = Discharge correction factor for over-embankment flow (Figure 11)~~

L = Length of barrel in feet

n = Coefficient of roughness, (Table 2)

~~P = Pressure line height =~~

~~$$\frac{d_c + D}{2}$$

(See Figure 7)~~

Q = Discharge in cubic feet per second

~~q = Discharge per foot of width for rectangular channels in cubic feet per second = Q/w~~

R = Hydraulic radius in feet = A/MP

S_o = Slope of Culvert in feet per footS_c = Critical slope in feet per footS_f = Friction slope = Slope that will produce uniform flow (see Nomographs D and F) at depth under consideration.

$$S_f = \frac{(Q^2 n^2)}{(2.208 (AR)^{(2/3)})^2}$$

T = Water surface width

TW = Tailwater depth in feet

V = Velocity in feet per second

W = Width of rectangular culvert or bottom width of channel in feet

MP = Wetted perimeter in feet

(Ref. 1)



MORRISON-KNUDSEN ENGINEERS, INC.

A MORRISON-KNUDSEN COMPANY

Project UMTKA - EC7
Feature NE Drainage Area
Item PMF level @ South Culvert

Contract No. 5057
Designed DRM
Checked PMB

Sheet 14
File No. _____
Date 6/13/88
Date 7-11-88

REFERENCES

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2. MKE, PROBABLE MAXIMUM PRECIPITATION ESTIMATE, APRIL 1988, CALC. NO.
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