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

WM DOCKET CONTROL CENTER

'86 FEB -7 P1:01

FEB 4 1986

Mr. Leo Higginbotham
Chief
Low Level Waste & Uranium
Recovery, Recovery Projects
Branch, U.S. NRC
Mail Stop 623-SS
Washington, D.C. 20555

Dear Mr. Higginbotham:

Enclosed for your information is Morrison-Knudsen's (M-K) response to the Nuclear Regulatory Commission's comments on the Shiprock Phase II Design Revisions. Please be advised that M-K has been directed to complete the Remedial Action Plan Modification incorporating these changes.

If you should have any questions regarding this matter, please contact Frank Bosiljevac of my staff at (505) 846-1208.

Sincerely,

John G. Themelis

John G. Themelis, Project Manager
Uranium Mill Tailings Project Office

Enclosure

cc w/enclosure:
T. Johnson, NRC, Wash, D.C.

WM Record File

WM Project 58
Docket No.
PDR ✓
LPDR

Distribution:
LBH DEM DGillen
GGnugnoli

(Return to WM, 623-SS)

Response to NRC Comments of 16 January 1986 on Shiprock Phase II Design Revisions:

At a meeting on 16 January 1986, NRC made the following further comments* regarding proposed Phase II Design Revisions.

1. Could the PMP flow parallel to the embankment erode the natural material beyond the apron along the SE side of the embankment?

2. Could the PMP overflow from Ditch D-2 erode the natural material beyond the D-2 apron.

The responses to these comments are:

1. The grading adjacent to the SE edge of the embankment has been revised and the thickness and width of the apron have been increased to safely transfer the flow beyond the apron away from the embankment at velocities which will not erode the natural materials.

2. The maximum allowable slope beyond the D-2 apron has been set at 10H:1V, which is acceptable for this location.

The supporting Drawings and Calculations are attached as follows:

SHP-PS-10-0012, Rev. 4: Site Plan
SHP-PS-10-0016, Rev. 4: Permanent Drainage Ditches
SHP-PS-10-0018, Rev. 4: Tailings Embankment Grading Plan & Sections
SHP-PS-10-0019, Rev. 4: Site Grading Plan
SHP-PS-10-0020, Rev. 3: Sections & Details
SHP-PS-10-0022, Rev. 3: Borrow Area Grading Plan
Calculation No. 04-390-17-04, Sheets B1 through B14

*See Report dated 24 January 1986 (MKE Document No. 4005-SHP-R-01-02155-00) for previous comments and response.

Calculation Cover Sheet

Calc. No. 04-390-17-04

Contract No. 4005 Discipline Task No. 390 No. of Sheets 59, A1-A6, B1-B14

Project

UMTRA / SHIPROCK

Feature

Embankments & Ditches

Item

Erosion Protection / Revised Design

Sources of Data

1. NOAA - HMR No. 49 (1977)
2. W. H. Walters - "Rock Riprap Design Methods etc" 1982 NUREG/CR-2684, PNL-4052
3. W. H. Walters - "Overland Erosion etc." 1983 NUREG/CR-3027
4. MKE - UMTRA Design Procedures 1985
5. MKE Calc. No. 04-390-01-00 & 04-390-16-00

Sources of Formulae & References

6. NRC memorandum report "Meeting with National Weather Service to discuss PMP" dated Aug 1, 1985 (R. Codell & T. L. Johnson to M. R. Knapp)
7. MKE calc. no. 04-390-18-01
8. Safety factor program MKE Ese + 4005-Gen # -01-0104's
9. Stephenson - "Rockfill in Hydraulic Engineering", Elsevier, 1979.

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. 04-390-17-03

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
4	SE Apron Revisions	A R Hlau	1/23/86	WYLIN	1/24/86	A.R. Thies	1/24/86
3	Ditch D-3 revision	RA Jones	1/14/86	WYLIN	1/15/86	A.R. Thies	1/15/86
2	[illegible]	RA Jones	1/3/86	AR Hlau	1/3/86	A.R. Thies	1/3/86
1	—	WY Lin	11/20/85	[illegible]	11/22/85	A.R. Thies	11/27/85
0	—	WY Lin	10/30/85	[illegible]	[illegible]	A.R. Thies	10/31/85

IECO Form 42-110

SUMMARY

(1) Riprap size (rock size) to resist erosion due to PMP runoff from tailings embankment top and side were calculated for the revised apron design.
The basin sub-area calculations are shown on pages B-6 & B-7. The input data used for the calculation of run off are shown on page B-2. Longitudional slope of 0.5% was used for the upper 895 feet and 1.0% slope was used for the remaining 600 feet. Apron width of 60 feet at end of the first reach and 190 feet at the end of of the second reach were used in the analysis.
The results using the safety factor method analysis (Ref 8) showed that Type B Select Rock (median size 4-inch) can be used to protect the sloping sides (5:1) (and flat-area widths) adjacent to the apron. The rock sizes required to resist erosion of the relatively flat apron ~~apron~~ bottom (0.5 percent to 1.0 percent slope) were then calculated using Stephenson's (Hydraulic Rockfill) Method (Ref. 9) The results indicate that 3/4-inch median size rock will be required. [The gravel formation over which the apron is to be placed has minimum median size of 3/4-inch.]

ABH/1-23-86 B-2
CK'd WYL /1-24-86

DITCHES

TITLE

** MORRISON / KNUDSEN ENGINEERS, INC. 22 JAN 86 ** ** DATA **
****
** APRON (D-3) - PROPOSED REVISION #5 FILE-NAME APRSI:2 **
** OUTPUT IS IN FILE NAMED APRSO:2 **

END TITLE

PARAMETER TE = 0.000
PARAMETER G = 2.079
PARAMETER M = 0.555
PARAMETER POROSITY = 0.250
PARAMETER PHI = 40.00
PARAMETER FINETUNING = ON
PARAMETER START K = 0.10
PARAMETER INCREMENT K = 0.01
PARAMETER SPECIFIC GRAVITY = 2.700
PARAMETER WATER UNIT WEIGHT = 62.40

PARAMETER INITIAL T PRIME = 2.5
PARAMETER INCREMENT Y = .01
PARAMETER START Y = .10
PARAMETER SHORT OUTPUT = TRUE

START DATA

DITCH	SFC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF
3	1	11.31	60.0	895.0	9.17	895.0	0.50	1.55

END DATA

ABH/ 1-23-86
ckd WYL / 1-24-86 B-3

```
** MORRISON / KNUDSEN ENGINEERS, INC.   22 JAN 86 ** 14:23:47 ** DATA **
*************************************************************************
** APRON (D-3) - PROPOSED REVISION #5  FILE+NAME APRSI:2               **
** OUTPUT IS IN FILE NAMED APRSO:2                                      **

TIME CONCENTRATION FROM EMBANKMENT :        0.000

ROCK SPECIFIC GRAVITY              :        2.700

ROCK POROSITY                      :        0.250

ROCK FRICTION ANGLE                :       40.000

WATER UNIT WEIGHT                  :       62.400

G                                  :        2.079

H                                  :        0.555
```

DITCH	SEC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF
3	1	11.31	60.0	895.0	9.17	895.0	0.50	1.55

1

```
** MORRISON / KNUDSEN ENGINEERS, INC.   22 JAN 86 ** 14:23:47 ** PAGE  1
*************************************************************************
** APRON (D-3) - PROPOSED REVISION #5  FILE+NAME APRSI:2               **
** OUTPUT IS IN FILE NAMED APRSO:2                                      **

*************************************************************************
**                                                                      **
** DITCH NO:  3 (SECTION 1)                                             **
** ------------                                                         **
** WATERSHED AREA       (ACRES):     9.170                              **
** DITCH LENGTH         (FEET ):   895.000                              **
** HYDRAULIC LENGTH     (FEET ):   895.000                              **
** SIDE SLOPE           (DEG. ):    11.310                              **
** BOTTOM WIDTH         (FEET ):    60.000                              **
** LONGITUDINAL SLOPE (%      ):     0.500                              **
**                                                                      **
**  K=D50    Y      N      QV     QD       V        T     IPMP   SAFETY **
**  (IN)   (FT)          (CFS)  (CFS)  (FT/SEC)  (MIN)  (IN/HR) FACTOR **
** ------ ----- ------ ------ ------- -------- ------ ------- ------ **
**   1.86  1.67  0.024   1.34  660.14     5.78   2.58   72.13   1.00 **
**                                                                      **
*************************************************************************
*************************************************************************
**                                                                      **
```

ABH/1-23-86
CK'd WYL/1-24-86

B-4

DITCHES

TITLE

** MORRISON-KNUDSEN ENGINEERS, INC.   24 JAN 86 **   ** DATA **

****

** APRON (D-3) - PROPOSED REVISION #5 FILE+NAME APR51:4   **

** OUTPUT IS IN FILE NAMED APR50:4   **

END TITLE

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PARAMETER G = 2.079
PARAMETER H = 0.555
PARAMETER POROSITY = 0.250
PARAMETER PHI = 40.00
PARAMETER [illegible] NETUNING = ON
PARAMETER START K = 0.10
PARAMETER INCREM[illegible]T K = 0.01
PARAMETER SPECIFIC GRAVITY = 2.700
PARAMETER WATER UNIT WEIGHT = 62.40

PARAMETER INITIAL T PRIME = 4.0
PARAMETER INCREMENT Y = .01
PARAMETER START Y = .10
PARAMETER SHORT OUTPUT = TRUE

START DATA

DITCH	SEC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF
3	2	11.31	120.0	1495.0	18.31	0.0	1.00	1.55

END DATA

ACH/1-23-86
CKd WYL/1-24-86
B-5

** APRON (D-3) - PROPOSED REVISION #5 FILE-NAME APRSI:4 **
** OUTPUT IS IN FILE NAMED APRSO:4 **

TIME CONCENTRATION FROM EMBANKMENT : 4.000

ROCK SPECIFIC GRAVITY : 2.700

ROCK POROSITY : 0.250

ROCK FRICTION ANGLE : 40.000

WATER UNIT WEIGHT : 62.400

G : 2.079

H : 0.555

DITCH	SEC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF
3	2	11.31	120.0	1495.0	18.31	0.0	1.00	1.55

1

** APRON (D-3) - PROPOSED REVISION #5 FILE-NAME APRSI:4 **
** OUTPUT IS IN FILE NAMED APRSO:4 **

** DITCH NO: 3 (SECTION 2)

- WATERSHED AREA (ACRES): 18.310
- DITCH LENGTH (FEET): 1495.000
- HYDRAULIC LENGTH (FEET): 0.000
- SIDE SLOPE (DEG.): 11.310
- BOTTOM WIDTH (FEET): 120.000
- LONGITUDINAL SLOPE (%): 1.000

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
3.04	1.27	0.027	3.83	1013.69	6.32	4.00	55.57	1.00

1
COST OF RUN: $ 0.62 = 4.11 CPU SECONDS * $.15 / CPU SECOND

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - Shiprock	Contract No. 4005	Sheet B-6	
Feature:	Designed: ABH	File No.	Date 1/22/86
Item:	Checked: WYL		Date 1/24/86

Ref: (1) Rockfill in Hydraulic Engineering (1979) by Stephenson

(2) APR50:2

From Ref (1), p. 51

$$k = \left[\frac{q (\tan\theta)^{7/6} n^{1/6}}{C g^{1/2} \left[(1-n)(S-1)\cos\theta (\tan\phi - \tan\theta) \right]^{5/3}} \right]^{2/3}$$

where
$C = 0.22$ for gravels
$g = 9.81\ m/s^2$
p = porosity = 0.25
θ = slope angle
q = surface flow rate m^3/s per meter
$S = 2.70$
ϕ = rock friction angle = 40 degrees.
k = rock size in meters

1 ft = 0.3048 meters] Ref (1) p. X
& 1 m = 3.281 feet]

From Ref (2), for section 3-1,

$$q = 661.5\ ft^3/s\ /\ 60\ ft\ \text{width}$$
$$= \left(\frac{661.5}{3.281^3}\right)\frac{m^3}{s} \Big/ \left(\frac{60}{3.281}\right)m = 1.024\ \frac{m^3}{s}/\text{meter}$$

$$\theta = \arctan(0.5\%) = 0.2865 \text{ degrees.}$$

Then
$$K = \left[\frac{1 (0.005)^{7/6} (0.25)^{1/6}}{0.22 (9.81)^{1/2} \left[0.75(1.70)(1)(0.839 - 0.005)\right]^{5/3}} \right]^{2/3}$$
$$= 0.016\ m\ (16\ mm) = 0.66\ \text{inches}$$

From Ref (2), for section 3-2,

$$q = 1137 \frac{ft^3}{s} / 120 \text{ ft width} \longleftarrow$$

$$= \left(\frac{1137}{3.281^3}\right)\frac{m^3}{s} / \left(\frac{120}{3.281}\right)m = 0.88 \ \frac{m^3}{s} / \text{meter width.}$$

$$\theta = \arctan(1\%) = 0.573 \text{ degrees}$$

then $$K = \left[\frac{.88(0.01)^{7/6}(0.25)^{1/6}}{0.22(9.81)^{1/2}\left[(0.75)(1.70)(0.839-0.01)\right]^{5/3}}\right]^{2/3}$$

$$= 0.026 \, m \ (26 \, mm) = 1.02 \text{ inches.}$$

$$> 0.75 \text{ inches.}$$

Widen the apron as follows:

$$q = c' k^{3/2}$$

and $$q = \frac{Q}{W}$$

therefore $$W = \frac{1}{c' k^{3/2}}$$

$$W_2 = W_1 \left(\frac{K_2}{K_1}\right)^{3/2}$$

$$= 120 \left(\frac{1.02}{0.75}\right)^{3/2} = 190 \text{ feet.} \longleftarrow$$

then use $K_2 = 0.75$ inches.

Check Section (DD)

From APR50:4

$Q' = 1017$ cfs.

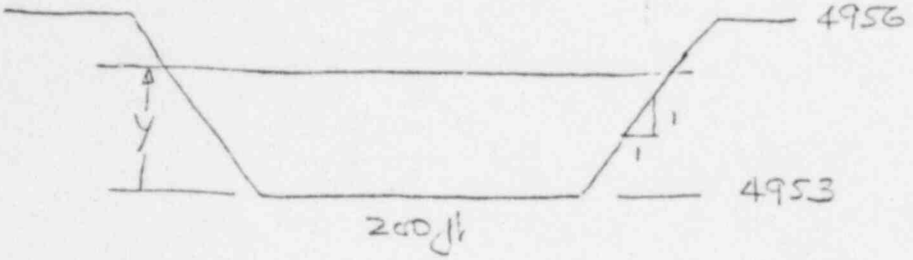
From Calc. No. 04-390-17-03, p 5:

$\Delta Q = 0.770$ cfs/ft $\times (1650 - 895 - 600)$ ft

$= 120$ cfs.

then $Q = Q' + \Delta Q$

$= 1017 + 120 = 1137$ cfs.



Using Manning's formula

$$Q = \frac{1.49}{n} y^{2/3} S^{1/2} B y$$

$$1137 = \frac{1.49}{0.027} (200)(0.005)^{1/2} y^{5/3}$$

or $y = 1.25$ ft.

and $V = \frac{1137}{200 \times 1.25} \cong 4.55$ ft/sec.

Check Section (DD), including runoff from PMP on the area between Section (CC) and Sect (DD)

Using $t_c = 4$ min.

$i = 55.57$ inches/hour.

then $Q = ciA$

where A is the watershed area up to Sect (DD)

$A = (18.31 + 0.30 + 0.78 + 7.09) = 26.48$ ac

$C = 1.0$ — zero infiltration loss

$Q = (55.57 \text{ in/hr})(26.48 \text{ ac})$

$= 1470$ cfs

Then, using Manning's formula:

$$1470 = \frac{1.49}{0.027}(200)(0.005)^{1/2}\, y^{5/3}$$

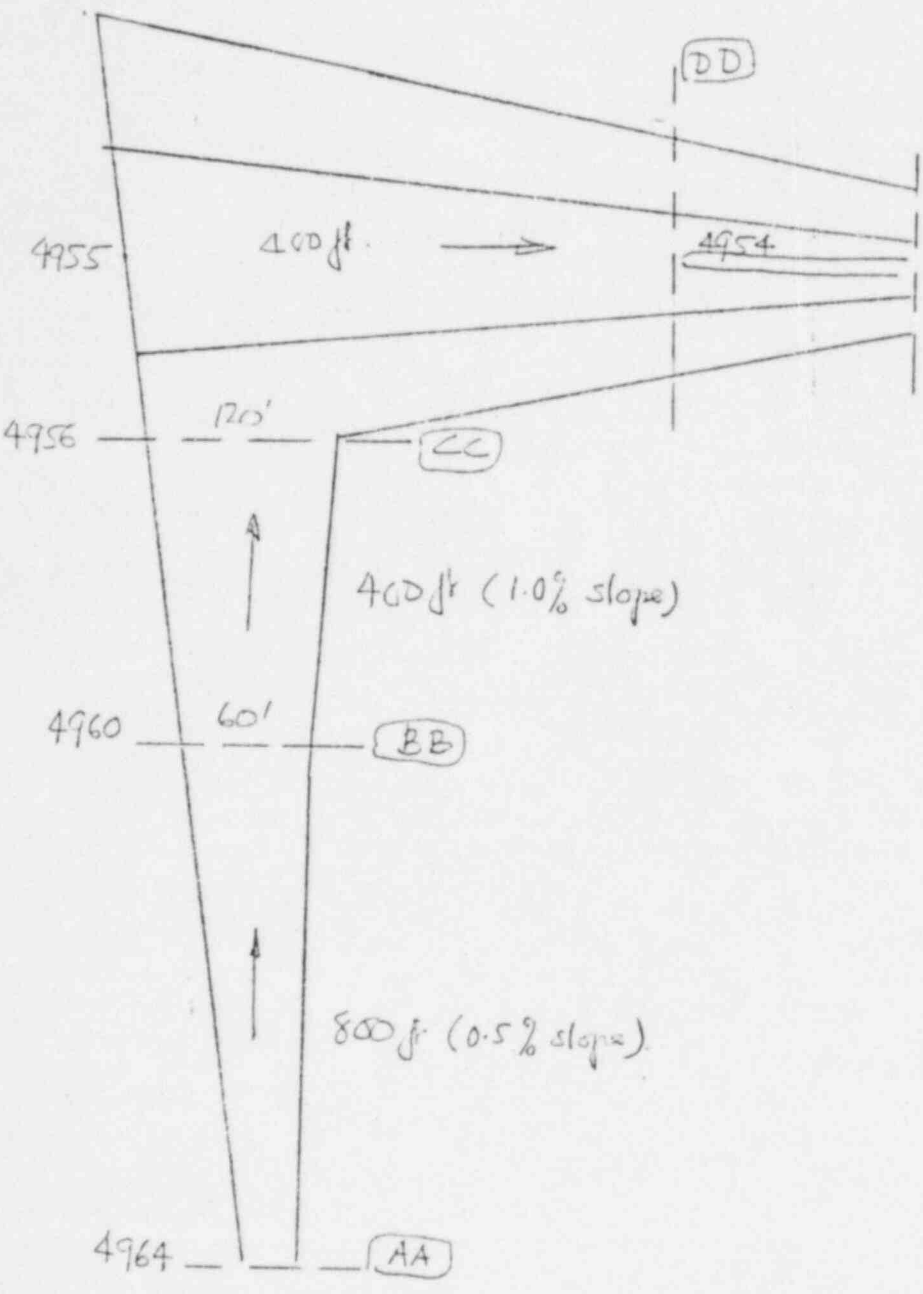
or $y = 1.46$ feet.

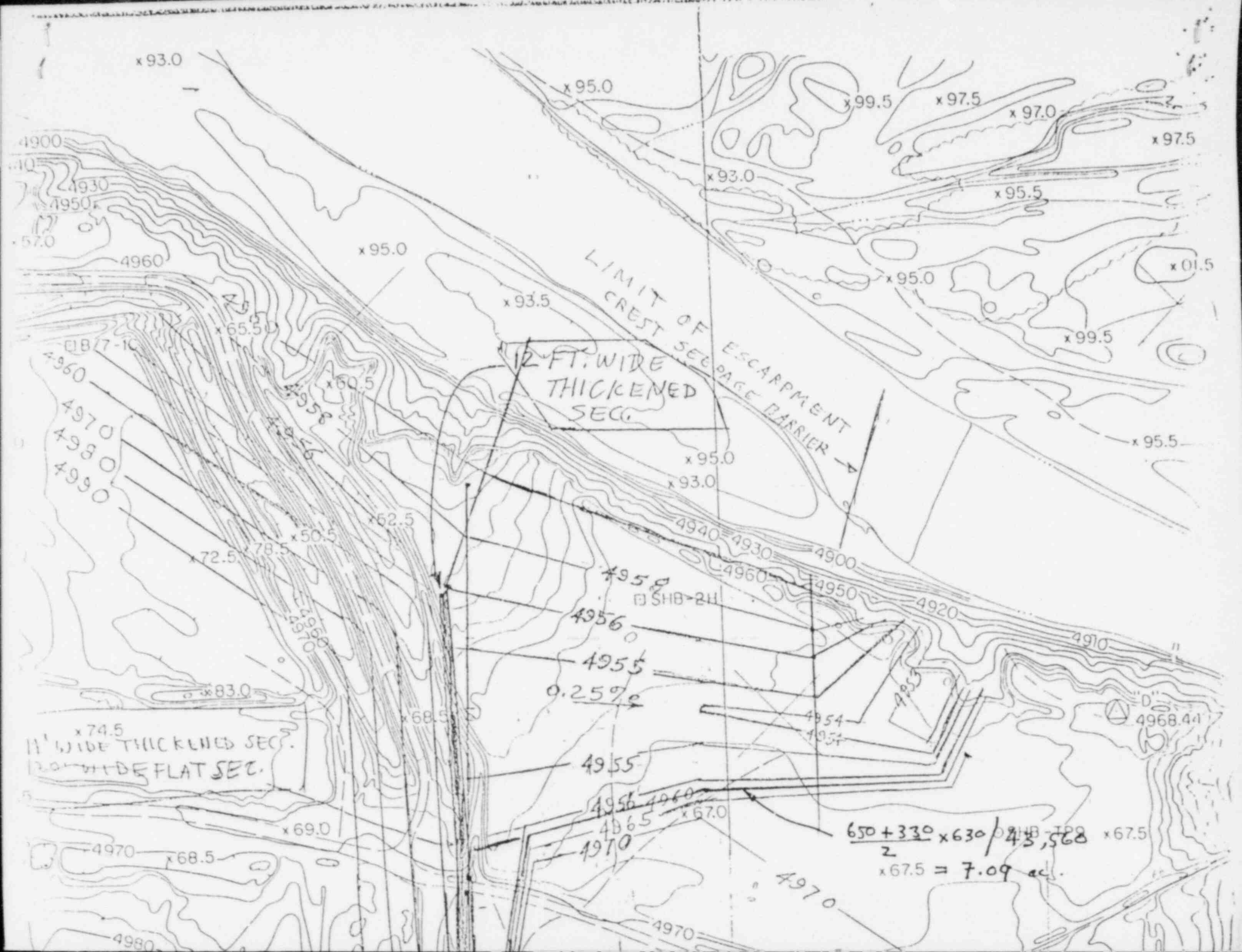
and $V = \frac{Q}{by}$

$$= \frac{1470}{200 \times 1.46} = 5.03 \text{ ft/sec}.$$

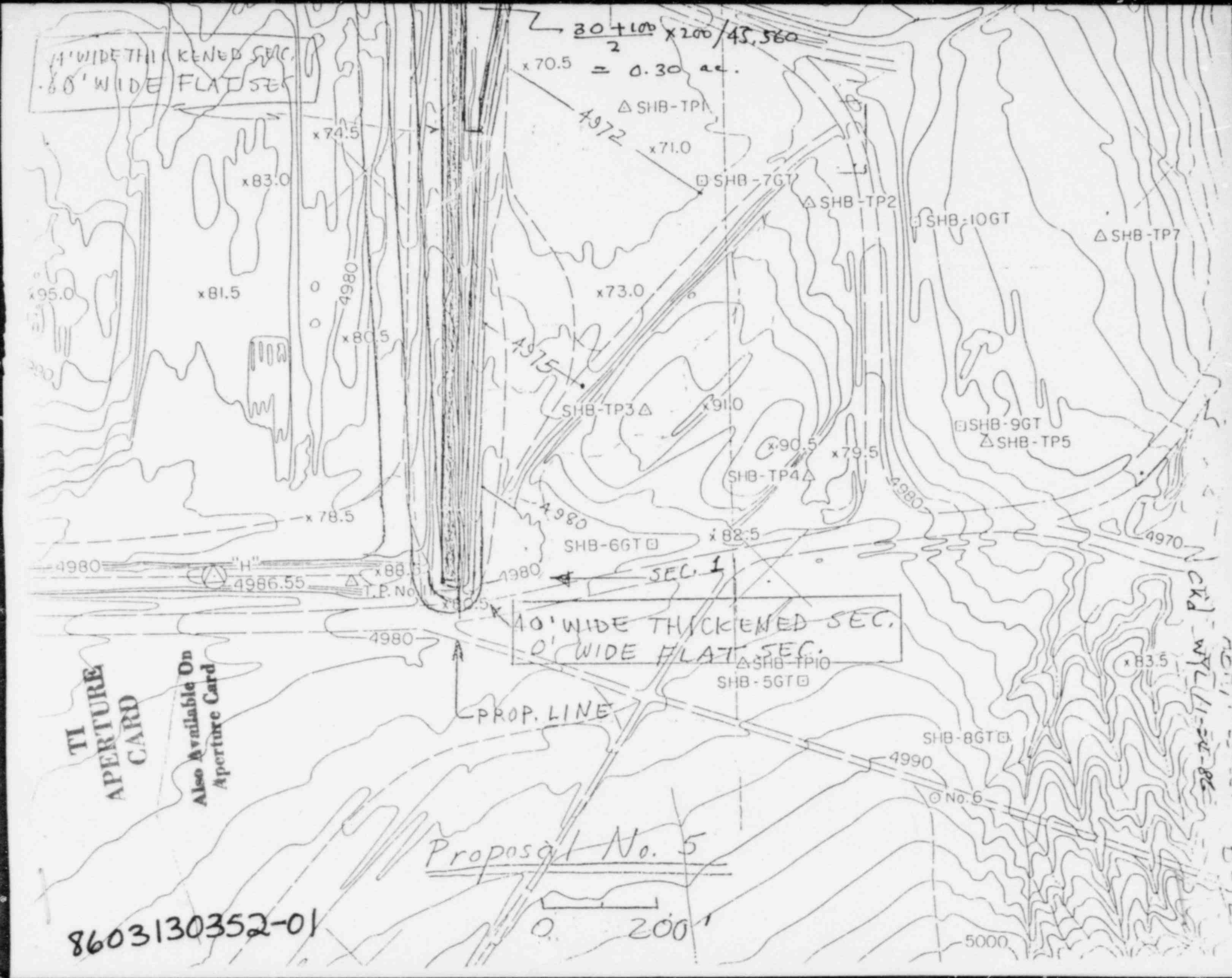
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - Shiprock	Contract No. 4605	Sheet E-10
Feature	Designed ABH	File No. 390
Item	Checked WYL	Date 1/24/86
		Date 1/24/86

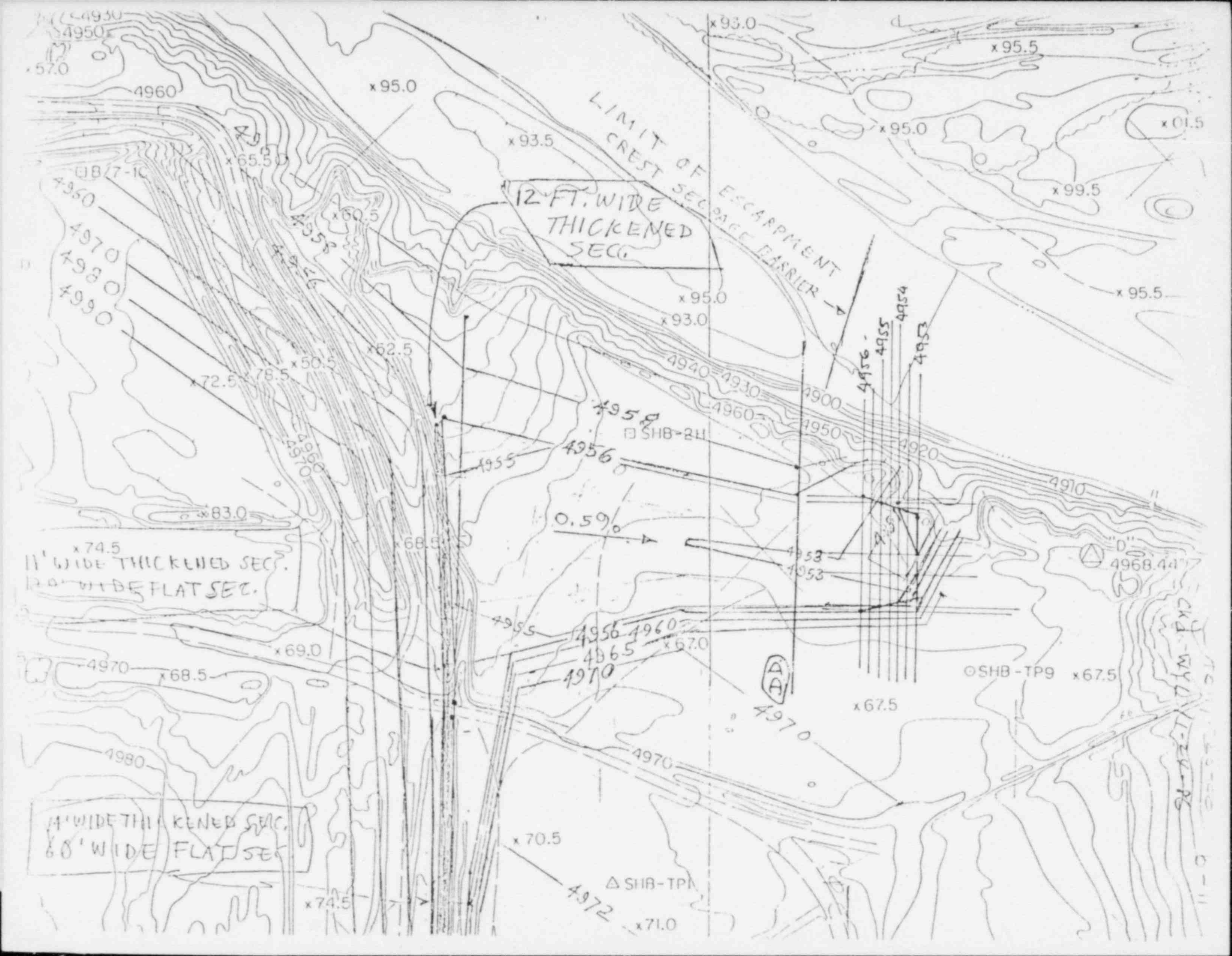


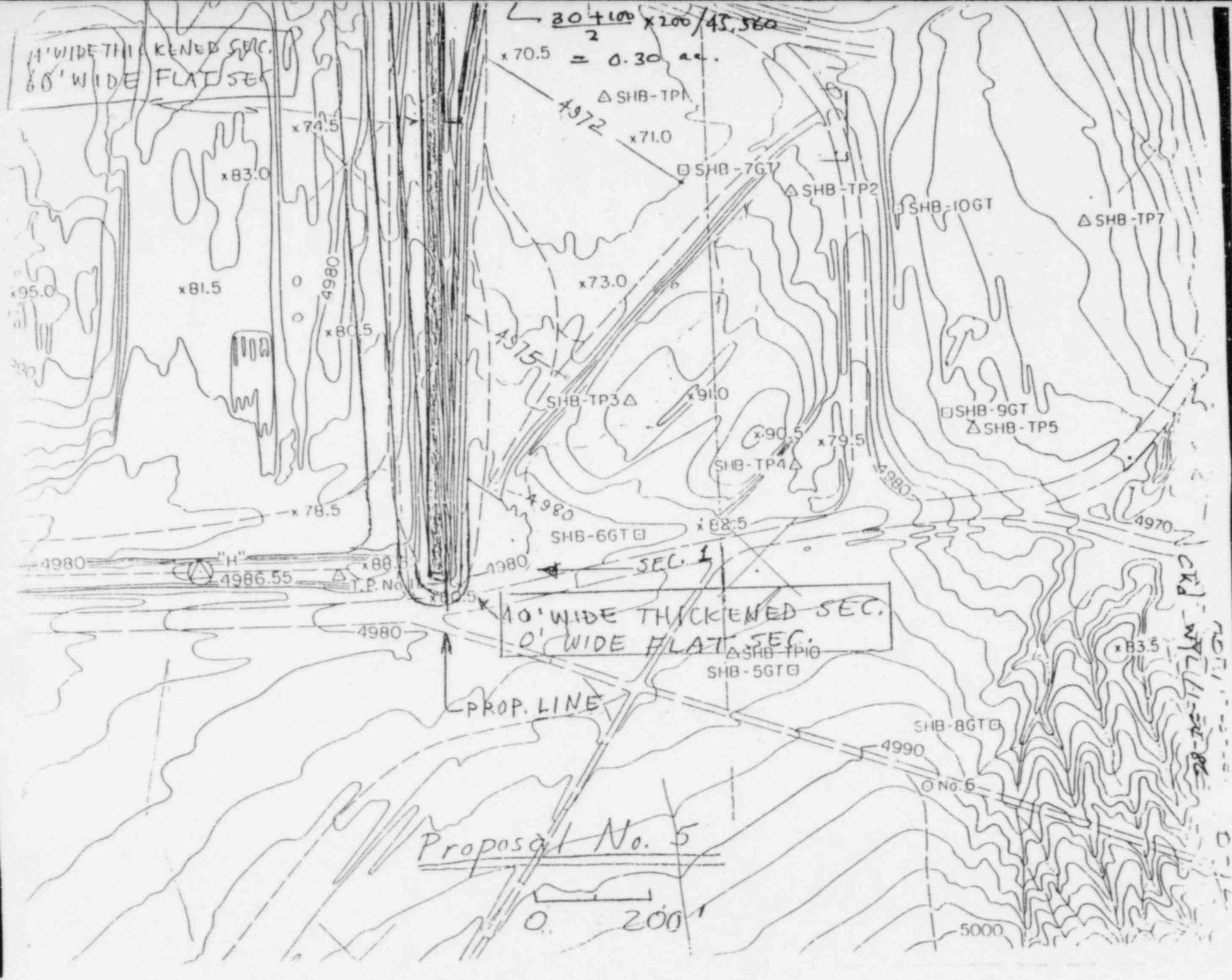


LIMIT OF ESCARPMENT
CREST SEEPAGE BARRIER
12 FT. WIDE THICKENED SEC.
11' WIDE THICKENED SEC.
WIDE FLAT SEC.
4958
4956
4955
0.25%
4954
SHB-2H
4968.44
x 93.0
x 95.0
x 99.5
x 97.5
x 97.0
x 95.5
x 01.5
x 93.5
x 65.5
x 60.5
x 62.5
x 50.5
x 72.5
x 78.5
x 83.0
x 74.5
x 68.5
x 69.0
x 67.0
x 67.5
4900
4910
4920
4930
4940
4950
4960
4970
4980
4990
$\frac{650 + 330}{2}$ x 630 / 43,568
= 7.09 ac.

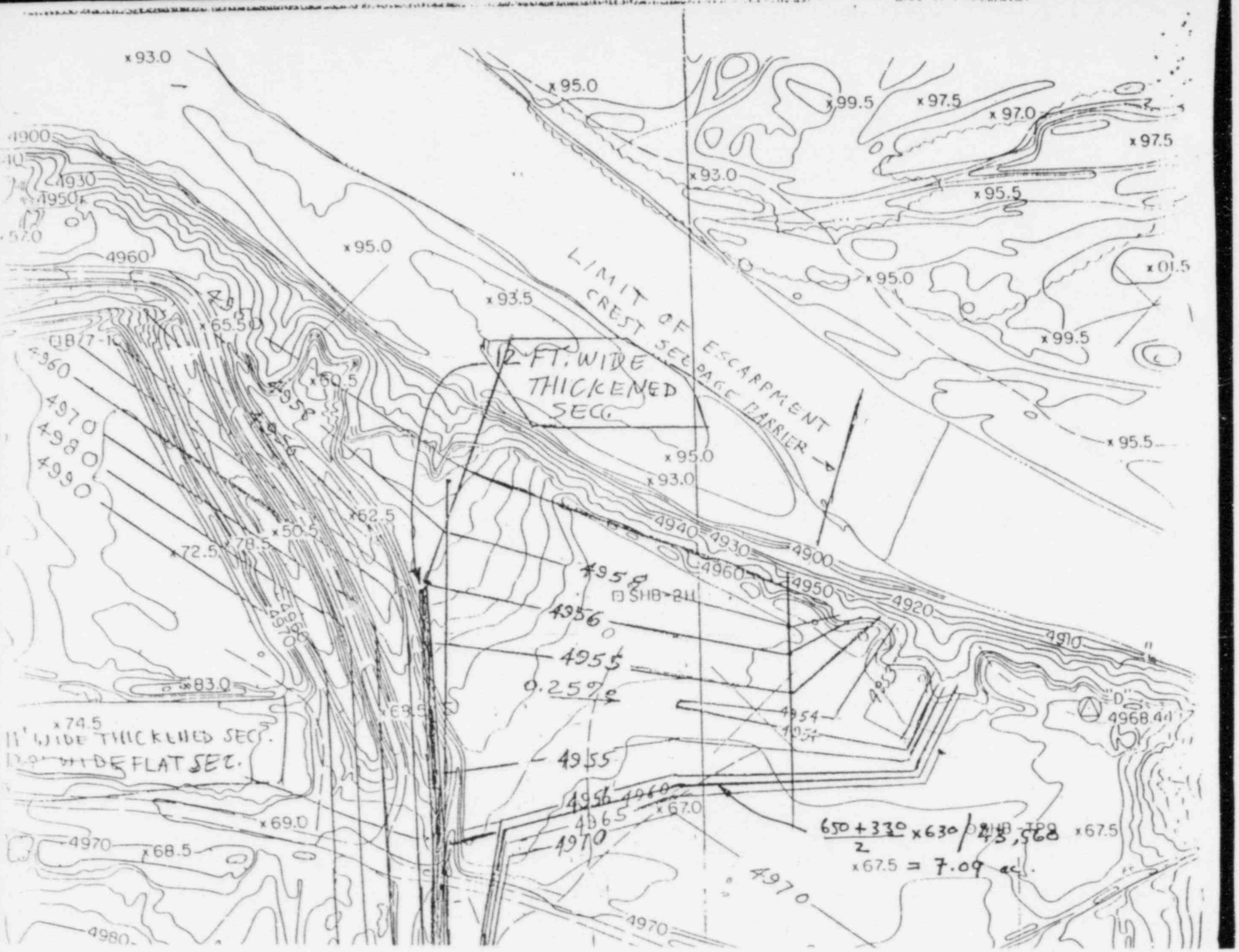


8603130352-01


LIMIT OF ESCARPMENT
CREST SEEPAGE BARRIER
12 FT. WIDE THICKENED SEC.
11' WIDE THICKENED SEC.
WIDE FLAT SEC.
WIDE THICKENED SEC.
68' WIDE FLAT SEC.
0.5%
SHB-2H
SHB-TP9
SHB-TP1
4968.44
CKd WYL 11-24-86
4956
4955
4954
4953
4958
4965
4970
4972
4980
4990
4960
4950
4940
4930
4920
4910
4900
x 95.0
x 93.5
x 93.0
x 95.5
x 99.5
x 67.5
x 67.0
x 69.0
x 68.5
x 70.5
x 71.0
x 74.5
x 83.0

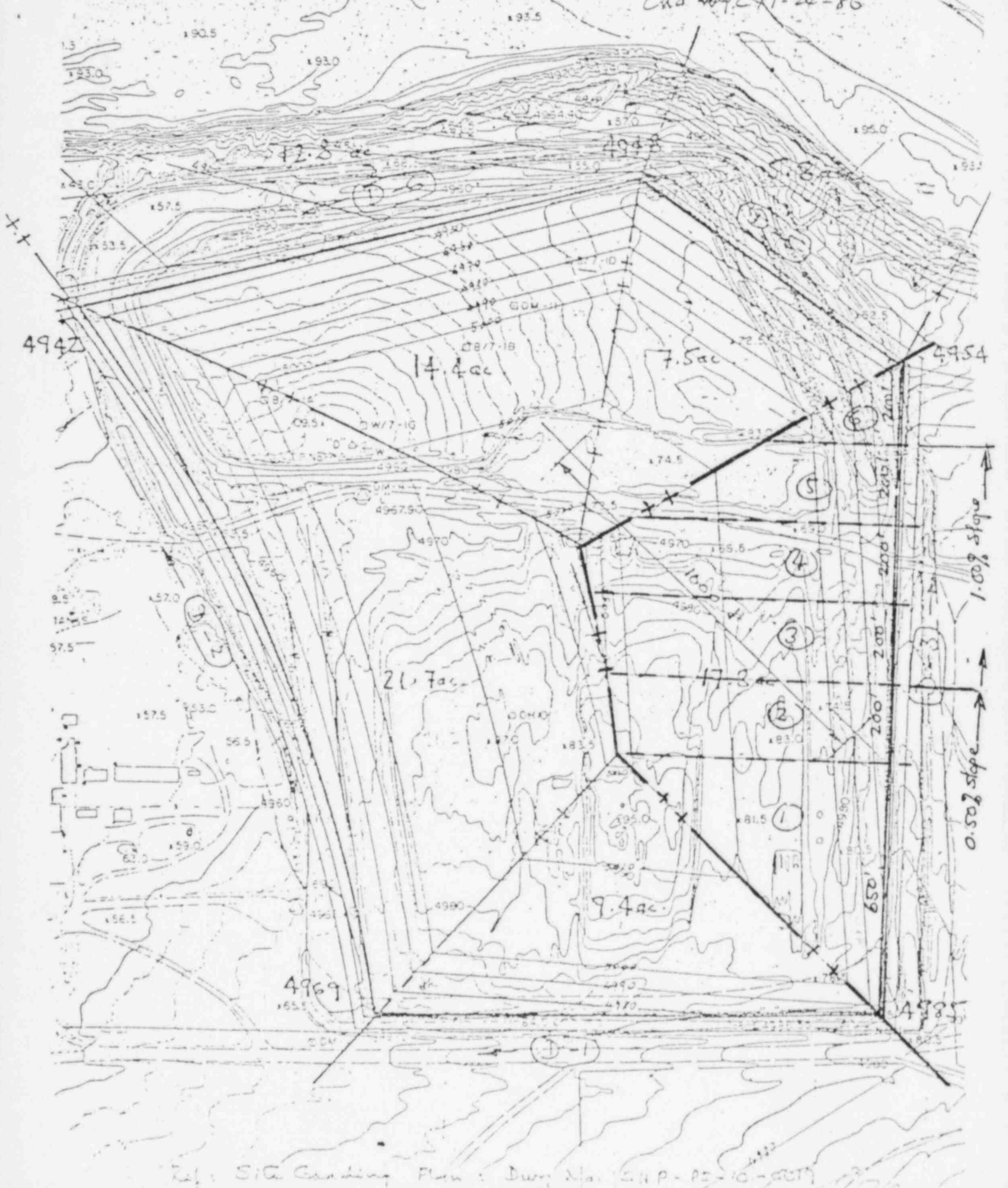


30+100/2 x200/43,560 = 0.30 ac.
WIDE THICKENED SEC.
60' WIDE FLAT SEC.
x70.5
△SHB-TP1
4972
x71.0
x74.5
⊡SHB-7GT
△SHB-TP2
⊡SHB-10GT
△SHB-TP7
x83.0
x81.5
4980
x95.0
x80.5
x73.0
4975
SHB-TP3△
x91.0
⊡SHB-9GT
△SHB-TP5
x90.5
x79.5
SHB-TP4△
4980
x78.5
4980
SHB-6GT⊡
x88.5
4970
"H"
4986.55
x88.5
T.P. No.
SEC. 1
10' WIDE THICKENED SEC.
0' WIDE FLAT SEC.
△SHB-TP10
SHB-5GT⊡
x83.5
PROP. LINE
SHB-8GT⊡
4990
○No. 6
Proposal No. 5
0 200'
5000
Ck'd WYL 11-21-86


LIMIT OF ESCARPMENT
CREST SEEPAGE BARRIER
12 FT. WIDE THICKENED SEC.
11' WIDE THICKENED SEC.
WIDE FLAT SEC.
4958
4956
4955
0.25%
4955
4970
4980
4990
SHB-2H
4968.44
650+330/2 x 630 / 43,560 = 7.09 ac.

Task 322 - Site Drainage
Ditch Erosion Protection

ABH/1-23-86 B-13
Ckd CX 1-24-86



Ref: Site Grading Plan: Dwg No. [illegible]

Sub-basin Areas.

		Ac.	ΣAc.	Corrected ΣAc
(6)	$\frac{200 \times 340}{2} / 43{,}560$	0.78	18.14	17.80
(5)	$200 \times \frac{340 + 650}{2} / 43{,}560$	2.27	17.36	17.03
(4)	$200 \times \frac{650 + 4 \times 790 + 760}{6} / 43{,}560$	3.50	15.09	14.81
(3)	$200 \times \frac{760 + 710}{2} / 43{,}560$	3.37	11.59	11.37
(2)	$200 \times \frac{710 + 675}{2} / 43{,}560$	3.18	8.22	8.07
(1)	$\frac{675 \times 650}{2} / 43{,}560$	5.04	5.04	4.95

Response to NRC Comments on Shiprock Phase II Design Revisions

The Nuclear Regulatory Commission (NRC) comments on the Shiprock Phase II Design Revisions are presented in the attached telecopy from Ted Johnson to Jerry Thiers dated 1/6/86. The comments and responses are:

Comment No. 1.:

"Based on a review of the calculations provided, it is not clear if the channel riprap design includes an allowance for increased shear stresses in the areas of channel bends. While it appears that the alignment, configuration, and sizing of the ditches have been adequately addressed (in accordance with appropriate Corps of Engineers references), additional calculations should be provided to document that the erosion protection at channel bends has been properly designed. Corps of Engineers EM 1110-2-1601 provides acceptable guidance for determining shear stress increases and for designing erosion protection at channel bends."

Response:

The radius of curvature R_o, for each channel bend is equal to 2 x the corresponding width of flow, B_s

As indicated on the attached calculation sheets (MKE Calculation No. 04-390-18-01, Sheets A-1 through A-3, and Calculation No. 04-390-17-02, Sheets 58 and 59:

a. For triangular cross-sections (Ditches D-1 and D-2), the ratio $R_o/B_s = 2$ results in the maximum shear stress in the channel bend being the same as the maximum shear stress in the straight section. Thus no increase in rock size for Bends D-1/D-2 and D-2/D-7 is necessary.

b. For trapezoidal cross-sections (Ditches D-5 and D-6), the ratio $R_o/B_s = 2$ results in the maximum shear stress in the channel bend being approximately 25% higher than the maximum shear stress in the straight section. The mean rock size required to resist the resulting stress in Bend D-5/D-6 is slightly larger than that provided by Type B riprap. Therefore, Type B-1 riprap (see attached PID No. 04-S-23) is being specified for Bend D-5/D-6.

Comment No. 2:

"We note that statistical extrapolation of data was used to determine the "1,000-year" storm. However, there is no basis to support such extrapolations, especially for small ungaged watersheds with limited flooding and precipitation data bases."

"We further note that several of the drainage ditches will be designed to accommodate only this "1,000-year storm", which is also 18% of the PMP. The benefits to be gained by labeling the storm a 1,000-year storm are questionable. We suggest that any reference to a 1000-year storm by deleted. It should be simply called 18% of the PMP."

Response:

All reference to a "1,000-year storm" will be deleted and replaced by "18% of the PMP".

Comment No. 3:

"The elimination of ditches D-3 and D-4 has resulted in a design where runoff is directed over an apron directly over unprotected slopes into the excavated borrow area east of the embankment. While this design concept may be acceptable, it is not immediately evident how erosion of the borrow area slopes will be prevented. Slopes of 5% in silty soils and 10% in gravelly soils (Reference Drawing SHP-PS-10-0022) may not be sufficiently flat to prevent erosion and gullying of the slopes over long time periods. This is particularly true if concentrated rather than sheet flow occurs on the slopes. Based on the design presented, it appears that concentrated flow could occur, gullies could form, and the gullies could eventually enlarge and headcut toward the protected embankments. In order to resolve this potential erosion problem, the NRC staff suggests that one or more of the following be performed:

a. Provide calculations which document that the unprotected 5-10% slopes will not be gullied and eroded.

b. Provide ditches which prevent discharges from flowing over the borrow area side slopes. (Depending on the configuration, there will likely always be some discharges down the slopes due to direct rainfall and runoff.)

c. Provide erosion protection for the borrow area side slopes so that gullying and erosion will not occur.

d. Flatten the slopes (possibly by filling) in the borrow area."

"Regardless of the design selected, the final grading plan and design for the borrow area slopes should be provided for NRC review and approval."

Response:

The embankment side slope along the southeast edge of the embankment (along the NECA borrow area) has been extended downslope to reach the underlying gravel. An armored 10-foot wide apron has been provided at the toe of the slope, to prevent scour of the underlying gravel. The silt beyond the toe of the apron can be left in place or removed, at NECA's discretion. If the silt is left in place, it may eventually

erode to the gravel surface; but the erosion will not undercut the apron. Available data indicate that the gravel surface may slope upward from the beginning of the apron, near the southerly corner of the embankment, to a point approximately 540 feet along the SE edge. This means water could pond to this point. This is considered acceptable. Eventually, the pond could fill with silt, also an acceptable situation. The depth to the top of gravel near the southerly corner of the embankment is approximately 11 to 13 feet. The depth decreases along the SE edge of the embankment, so that by a distance of 975 feet along the edge, no excavation is required to reach the gravel. From this point on the flow is no longer confined, but spreads out on the existing gravel as sheet flow.

Runoff from the embankment is no longer directed over unprotected slopes in silt. Gully development in any silt left in the NECA borrow area will not threaten the embankment. The ground surface beyond the apron, or beyond the cut required to reach the top of gravel, will be sloped to drain away from the SE edge of the embankment at a slope which does not exceed 5%. Calculation 04-390-17-03, Sheet A-5, indicates that the PMP flow on a 5% slope in this area can be tolerated by the existing gravel.

Comment No. 4:

"The redesign of ditches D-1 and D-2 has resulted in a design where only 18% of the PMP will be carried in the ditches and the remainder of the flood peak will overflow the ditches. While this design concept is acceptable, it is not clear if the site grading is such that ditch overflow and off-site floods could possibly enter the ditches further downstream. Examination of the topography in the immediate area of the ditches indicates that ditch overflow will not be directed away from the ditches and that off-site floods could actually overflow into the ditches."

"Accordingly, documentation and drawings should be provided to demonstrate that"

a. overflow from the ditches will either not reenter the ditches further downstream or that the ditches are designed to safely convey this volume of flow;

b. off-site floods either will not enter the ditches or will be safely conveyed by the proposed ditch design. (Note that floods entering ditches D-1 and D-2 may also affect other ditches further downstream); or

c. the apron and erosion protection to be provided on the outside portions of the ditches are capable of resisting (1) PMF velocities produced by overflow out of the ditches and (2) velocities produced by an off-site PMF flowing along the outside toe of the ditch where it meets existing ground."

"Additionally, if credit is taken for the diversion ditch to be placed around the perimeter of the M-K borrow area, the ditch should be designed for a PMF and resulting velocities. Calculations and documentation should be provided to demonstrate that the ditch has been adequately designed."

Response

The comment concerns four related issues. The response is subdivided accordingly:

a. Overflow from Ditches D-1 and D-2: Overflow from Ditch D-1 will flow away from the embankment, for a distance of at least 75 feet, down the slope formed by the final grading contours shown in Drawing SHP-PS-10-0019. Some of this flow will enter the M-K borrow area and eventually be evaporated, as discussed under "d" below. Flow which does not enter the M-K borrow area will run along the south side of the existing access road, eventually reaching the existing arroyo approximately 1500 feet west of the embankment. Such flows will be relatively infrequent, so that any resulting erosion along the access road will not be a significant threat to pile integrity. Overflow from the southern 800 feet of Ditch D-2 will follow the existing topography to the arroyo west of the site. (See drawing SHP-PS-10-0019.) Overflow from the remainder of this ditch will re-enter the drainage system in Ditch D-7. The dimensions and erosion protection for Ditch D-7 are adequate to accommodate these additional flows. The computations supporting this conclusion are summarized on Sheet 6 of Calculation No. 04-390-17-01. The additional flow into Ditch D-7 was accounted for by using the drainage areas shown on Sheet 57 of the same Calculation. (A copy of this Sheet is attached, as it was inadvertantly ommitted from some copies of the Phase II Design Revisions.)

b. Off-site Floods: Final site grading will result in contours which direct off-site flooding away from the ditches, except as follows:

1). Precipitation falling on the area between the escarpment and Ditches D-5, D-6, and D-7 will flow into these ditches.

2). Precipitation falling on the area just south of Ditch D-7 will flow into this ditch.

In both cases, the additional flows have been accounted for in the design.

c. Aprons and Erosion Protection on Outside Portions of Ditches: The design flows for the aprons along Ditches D-1 and D-2 and along the southeast side of the embankment (formerly Ditch D-3) are essentially the same as the design flows for the corresponding Embankment Sides E-1, E-2, and E-3. Resistance to the governing flow is evaluated by the Stephenson's Method

on Sheet 4 of Calculation No. 04-390-17-01. The specified rock size is shown to be adequate. Off-site flooding will either be diverted away from the ditches, as discussed under "b" above, or will flow directly into Ditches D-5, D-6, and D-7 (also discussed under "b" above), and will not cause flow alongside any ditch. The ditches are adequately designed for direct inflow, as shown by Sheet 4 of Calculation No. 04-390-17-01.

d. <u>Diversion Ditch Around M-K Borrow Area</u>: The diversion ditch around the M-K borrow area will only be required during construction and will be eliminated as part of final grading of the borrow area. (See Drawing SHP-PS-10-0022.) As a result, it will be possible for runoff from the south to flow into the abandoned borrow area. Attached Calculation No. 04-390-15-00 indicates that the maximum depth of accummulation in the pit, caused by the PMP runoff, will not exceed 5 feet and will be evaporated within approximately 205 days. These are considered acceptable phenomena.

Attachment 1: NRC Comments

2: Back-Up Calculations

3: P.I.D. No. 04-S-23

ATTACHMENT 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MKE DOCUMENT NO. 4005-SHP-R-09-02142-00

RECEIVED JAN 08 1986 MKE-SFO

FACSIMILE SERVICE REQUEST

DATE 1/6/86

"PLEASE"
USE DARK PEN WHEN FILLING OUT & REMOVE ALL STAPLES

MESSAGE TO: JERRY THIVRS

TELECOPY NUMBER (415) 442-7507

AUTOMATIC: YES NO

VERIFICATION NUMBER (415) 442-7703

NO. OF PAGES 3 EXCLUDING COVER SHEET

RETURN COPIES YES (X) NO ( )

STATE & CITY

MESSAGE FROM: TED JOHNSON

TELECOPY NUMBER 301-427-4298 RAPIFAX AUTOMATIC

301-427-4403 3M VRC AUTOMATIC

VERIFICATION NUMBER 301-427-4287 MAIL ROOM #100

BUILDING WILLSTE OFFICE PHONE ____ MAIL STOP ____

CLASS OF SERVICE ____ OVER NIGHT ____ 4 HOUR ____

____ 1 HOUR ____ IMMEDIATE

Received/Time date	Transmitted/Time date
2 1/6/86 P2	RECEIVED-MKE JAN 06 1986 UMTRA-S.F.

SHIPROCK PHASE II DESIGN REVISIONS
SURFACE WATER HYDROLOGY AND EROSION PROTECTION
QUESTIONS AND COMMENTS

1. Based on a review of the calculations provided, it is not clear if the channel riprap design includes an allowance for increased shear stresses in the areas of channel bends. While it appears that the alignment, configuration, and sizing of the ditches have been adequately addressed (in accordance with appropriate Corps of Engineers references), additional calculations should be provided to document that the erosion protection at channel bends has been properly designed. Corps of Engineers EM 1110-2-1601 provides acceptable guidance for determining shear stress increases and for designing erosion protection at channel bends.

2. We note that statistical extrapolation of data was used to determine the "1,000-year" storm. However, there is no basis to support such extrapolations, especially for small ungaged watersheds with limited flooding and precipitation data bases.

   We further note that several of the drainage ditches will be designed to accomodate only this "1,000-year storm", which is also 18% of the PMP. The benefits to be gained by labeling the storm a 1,000-year storm are questionable. We suggest that any reference to a 1000-year storm be deleted. It should be simply called 18% of the PMP.

3. The elimination of ditches D-3 and D-4 has resulted in a design where runoff is directed over an apron directly over unprotected slopes into the excavated borrow area east of the embankment. While this design concept may be acceptable, it is not immediately evident how erosion of the borrow area slopes will be prevented. Slopes of 5% in silty soils and 10% in gravelly soils (Reference Drawing SHP-PS-10-0022) may not be sufficiently flat to prevent erosion and gullying of the slopes over long time periods. This is particularly true if concentrated, rather than sheet, flow occurs on the slopes. Based on the design presented, it appears that concentrated flow could occur, gullies could form, and the gullies could eventually enlarge and headcut toward the protected embankments. In order to resolve this potential erosion problem, the NRC staff suggests that one or more of the following be performed:

   a. Provide calculations which document that the unprotected 5-10% slopes will not be gullied and eroded.

:EIVED-MKE
AN 06 1986
MTRA-S.F.

WMGT	WMGT					
TJohnson	MFliegel					

b. Provide ditches which prevent discharges from flowing over the borrow area side slopes. (Depending on the configuration, there will likely always be some discharges down the slopes due to direct rainfall and runoff).

c. Provide erosion protection for the borrow area side slopes so that gullying and erosion will not occur.

d. Flatten the slopes (possibly by filling) in the borrow area.

Regardless of the design selected, the final grading plan and design for the borrow area slopes should be provided for NRC review and approval.

4. The redesign of ditches D-1 and D-2 has resulted in a design where only 18% of the PMP will be carried in the ditches and the remainder of the flood peak will overflow the ditches. While this design concept is acceptable, it is not clear if the site grading is such that ditch overflow and off-site floods could possibly enter the ditches further downstream. Examination of the topography in the immediate area of the ditches indicates that ditch overflow will not be directed away from the ditches and that off-site floods could actually overflow <u>into</u> the ditches.

Accordingly, documentation and drawings should be provided to demonstrate that:

a. overflow from the ditches will either not reenter the ditches further downstream or that the ditches are designed to safely convey this volume of flow;

b. off-site floods wither will not enter the ditches or will be safely conveyed by the proposed ditch design (Note that floods entering ditches D-1 and D-2 may also affect either ditches further downstream); or

c. the apron and erosion protection to be provided on the outside portions of the ditches are capable of resisting (1) PMF velocities produced by overflow out of the ditches and (2) velocities produced by an off-site PMF flowing along the outside toe of the ditch where it meets existing ground.

Additionally, if credit is taken for the diversion ditch to be placed around the perimeter of the M-K borrow area, the ditch should be

WMGT	:WMGT	:	:	:	:	:
TJohnson	:MFliegel	:	:	:	:	

designed for a PMF and resulting velocities. Calculations and documentation should be provided to demonstrate that the ditch has been adequately designed.

WMGT	WMGT					
TJohnson	MFliegel					
[illegible]	[illegible]					

JAN 15 '86 11:07 MK ENGINEERS INC. S.F. CA.
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - Shiprock
Feature: Task 390 - Engineering Support
Item:
Contract No. 4005
Sheet A-1
File No.
Designed ABH Date 1/2/86
Checked FAT Date 1/3/86

From NCHRP Report No. 108 (Ref. 6), using Fig 10

$$\tau_{max} = 0.90\, \gamma_w\, y\, S \quad \text{] straight channel}$$

for triangular channel with side slope 5:1.

TRIANGULAR CHANNELS

Curves 1 & 3

From the same reference, using Fig 17,

Calc # 04-390-18-01

$$\tau_{max} = 1.84\, \tau_0$$

$$= 1.84\, \gamma_w R S$$

for flow in bends with $B_s/R_o = 0.5$ ($R_o/B_s = 2.0$)

From Calc No. 04-11-R0-02 (Ref. 7) p. 8/24

$$R = 0.49\, y$$

for triangular channel with side slope 5:1.

hence $\tau_{max} = 1.84\, \gamma_w (0.49 y) S$

$$\tau_{max} = 0.90\, \gamma_w\, y\, S \quad \text{] channel bend}$$

We thus conclude that for bends in triangular channels, Curves 1 & 3, the maximum shear stress in the curved channel is equal to the maximum shear stress in the straight portion.

From NCHRP Report No. 108 (Ref 6), Using Fig. 14,

for trapezoidal channel with (1) side slopes 5:1,

and $B/y = 20/2.85 \simeq 7$ (see this Calc. Rev. 0, page 8/27)

$$\tau_{max}\Big|_{side} = 1.02\ \tau_{max}\Big|_{bottom}$$ ✓

From the same reference, using Fig 12,

$$\tau_{max}\Big|_{bottom} = 1.44\ \gamma_w R S$$ ✓

hence,

$$\tau_{max}\Big|_{side} = (1.02)(1.44)\gamma_w R S$$

$$= 1.47\ \gamma_w R S$$ ✓] straight channel

TRAPEZOIDAL CHANNEL
Curve 5

For the above trapezoidal section

$$A = 5y^2 + 20y$$

$$P = 2y \times \frac{\sqrt{5^2+1}}{1} + 20$$

$$R = A/P = (5 \times 2.85^2 + 20 \times 2.85)/(10.2 \times 2.85 + 20)$$

$$= 1.99 \simeq 2 \text{ feet.}$$

Hence, at design flow depth,

$$R/y = 1.99/2.85 = 0.70$$ ✓

} Not Used.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - Shiprock
Feature: Task 390 - Engineering Support
Item:
Contract No. 4005
Designed: AEU
Checked: GAJ
Sheet: A-3
File No.
Date: 1/2/86
Date: 1/3/86

TRAPEZOIDAL CHANNEL (Cont'd.)
Curve 5

From the preceding reference, using Fig 7,

for flow in bend with $B_s / R_o = 0.5$ $(R_o / B_o = 2.0)$

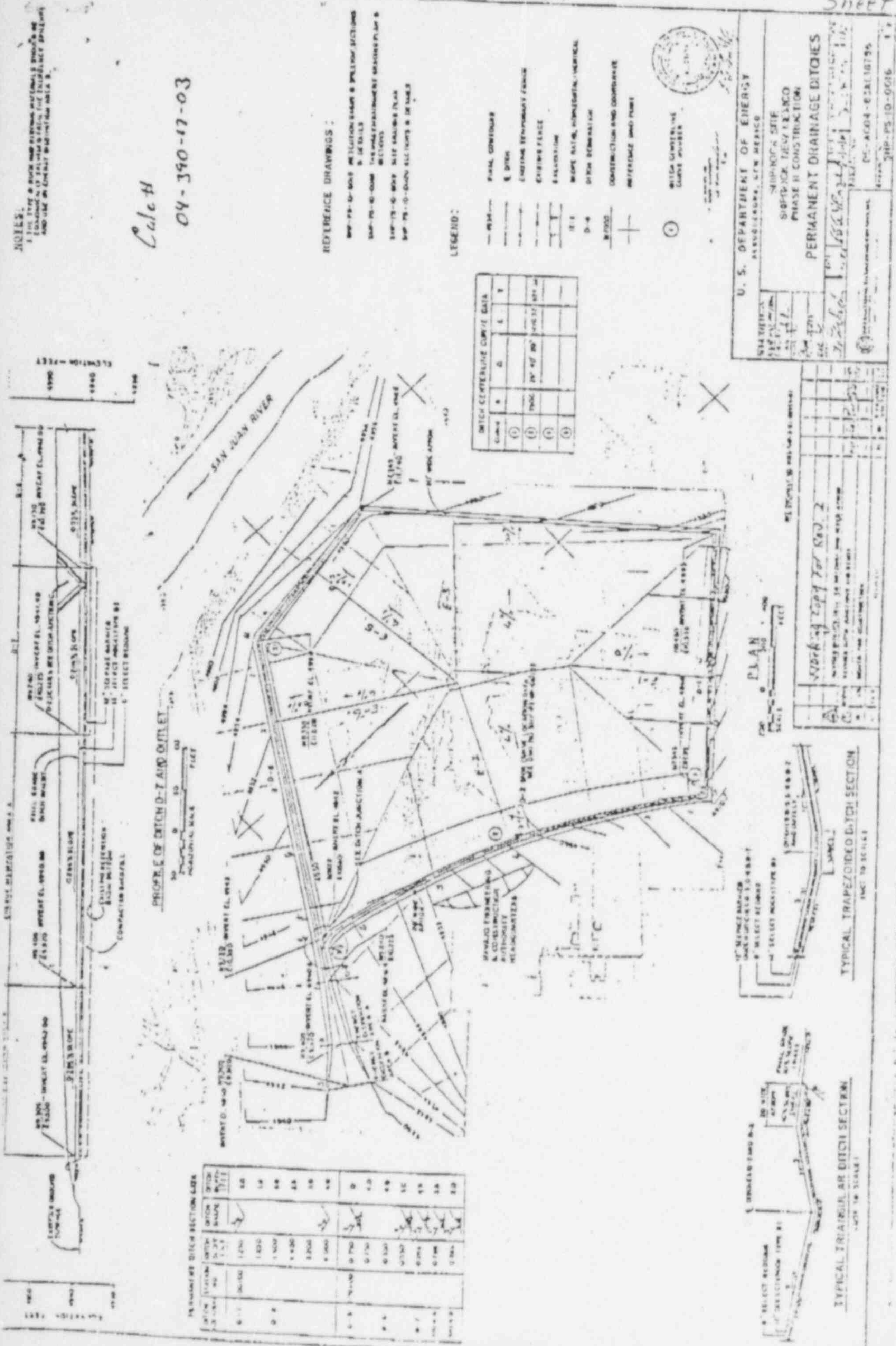
$$\tau_{max}\Big|_{bend} = 1.84 \gamma_w R S$$

Hence

$$\tau_{max}\Big|_{bend} \Big/ \tau_{max}\Big|_{straight}$$

$$= 1.84 \gamma_w R S / (1.47 \gamma_w R S) = 1.25$$

We therefore conclude that for trapezoidal channel bend, Curve 5, maximum shear stress on the side slope in the curved channel is approx. 25 percent greater than the maximum shear stress on the side slope in the straight section.


NOTES:
Calc #
04-390-17-03
REFERENCE DRAWINGS:
LEGEND:
DITCH CENTERLINE CURVE DATA
SAN JUAN RIVER
PROFILE OF DITCH D-7 AND OUTLET
PLAN
TYPICAL TRAPEZOIDAL DITCH SECTION
TYPICAL TRIANGULAR DITCH SECTION
U. S. DEPARTMENT OF ENERGY
SHIPROCK SITE
SHIPROCK, NEW MEXICO
PHASE II CONSTRUCTION
PERMANENT DRAINAGE DITCHES

** MORRISON / KNUDSEN ENGINEERS, INC. 3 JAN 86 ** 10:35:31 ** DATA **
** DITCH D-5 SEC.2-4 **
** 100% PMP **
** Increased Shear in Bend 5 to 6 **

TIME CONCENTRATION FROM EMBANKMENT : 4.130

ROCK SPECIFIC GRAVITY : 2.680

ROCK POROSITY : 0.300

ROCK FRICTION ANGLE : 40.000

WATER UNIT WEIGHT : 62.400

G : 2.079

H : 0.555

DITCH	SEC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF
5	2	11.31	20.0	200.0	5.994	10.0	0.75	1.40
5	3	11.31	20.0	290.0	10.602	290.0	0.75	1.50
5	4	11.31	20.0	110.0	11.521	110.0	0.75	1.88

← 1.5 used in origional design of straight channel, ⇒ increased 25% to check maximum shear in bend

M.K.E Calc. 04-390-18-00 Ref. 7

```
** MORRISON / KNUDSEN ENGINEERS, INC.     3 JAN 86 ** 10:35:31 ** PAGE  1
** DITCH  D-5 SEC.2-4
** 100% PMP                                                                **
**                                                                         **
                                                                           **
****************************************************************************
**
************************************************************************
** DITCH NO:  5 (SECTION 2)                                               **
** ------------                                                           **
** WATERSHED AREA        (ACRES):     5.994                               **
** DITCH LENGTH          (FEET ):   200.000                               **
** HYDRAULIC LENGTH      (FEET ):    10.000                               **
** SIDE SLOPE            (DEG. ):    11.310                               **
** BOTTOM WIDTH          (FEET ):    20.000                               **
** LONGITUDINAL SLOPE (%      ):      0.750                               **
**                                                                        **
**  K=D50    Y      N      QV      QD       V        T      IPMP   SAFETY **
**  (IN)   (FT)          (CFS)   (CFS)  (FT/SEC)   (MIN)  (IN/HR)  FACTOR **
** ------ ----- ------ ------ ------- -------- ------ ------- ------       **
**   2.22  1.68  0.025   1.07  293.22     6.15   4.16   49.10    1.00     **
**                                                                        **
************************************************************************
************************************************************************
**
** DITCH NO:  5 (SECTION 3)                                               **
** ------------                                                           **
** WATERSHED AREA        (ACRES):    10.602                               **
** DITCH LENGTH          (FEET ):   290.000                               **
** HYDRAULIC LENGTH      (FEET ):   290.000                               **
** SIDE SLOPE            (DEG. ):    11.310                               **
** BOTTOM WIDTH          (FEET ):    20.000                               **
** LONGITUDINAL SLOPE (%      ):      0.750                               **
**                                                                        **
**  K=D50    Y      N      QV      QD       V        T      IPMP   SAFETY **
**  (IN)   (FT)          (CFS)   (CFS)  (FT/SEC)   (MIN)  (IN/HR)  FACTOR **
** ------ ----- ------ ------ ------- -------- ------ ------- ------       **
**   3.13  2.35  0.026   1.40  519.14     6.96   4.85   49.10    1.00     **
**                                                                        **
************************************************************************
************************************************************************
**
** DITCH NO:  5 (SECTION 4)                                               **
** ------------                                                           **
** WATERSHED AREA        (ACRES):    11.521                               **
** DITCH LENGTH          (FEET ):   110.000                               **
** HYDRAULIC LENGTH      (FEET ):   110.000                               **
** SIDE SLOPE            (DEG. ):    11.310                               **
** BOTTOM WIDTH          (FEET ):    20.000                               **
** LONGITUDINAL SLOPE (%      ):      0.750                               **
**                                                                        **
**  K=D50    Y      N      QV      QD       V        T      IPMP   SAFETY **
**  (IN)   (FT)          (CFS)   (CFS)  (FT/SEC)   (MIN)  (IN/HR)  FACTOR **
** ------ ----- ------ ------ ------- -------- ------ ------- ------       **
**   4.14  2.51  0.028   1.63  556.62     6.81   5.12   48.46    1.00     **
**                                                                        **
************************************************************************
```

MORRISON-KNUDSEN COMPANY, INC.

UMTRA PROJECT OFFICE
PROJECT INTERFACE DOCUMENT

Site: Shiprock	Date: 12-18-85	PID No.: 04-S-23	Site No.: 04	Vic Pro No.: N/A
Originator and Location: G. R. Thiers - San Francisco	Phone: (415) 442-7556	Organization: MKE	Answer By:	References:
Subject: Gradation Limits for Select Rock Material				Spec. 02270.2.1.C.4.a

Description of Problem and Recommended Solution ☐ Clarification [X] Change

1. Problem: The Phase II Design revisions require that the material used for portions of Ditches D-2, D-5 and for D-7 meet the gradation limits given below for Material Type B-1.

2. Solution: Revise Specification 02270.2.1.C.4.a to read:

(See reverse side)

JAN 1986 RECEIVED Morrison-Knudsen Company, Inc.

Originator G. R. Thiers 12/18/85
Signature Date

Disposition ☐ Approved ☐ Disapproved ☐ Approved as Noted

Criteria Change? ☐ Yes ☐ No

If Yes, DOE approval required

RAC Site Manager ______

RAC Project Control ______

RAC Engineering/Design ______

RAC Construction Engineer ______

Signature Date

Reviewed for Quality Requirements ______

Distribution	Name	Location		Name	Location
RAC Site Mgr.			RAC Constr. Engr. Mgr.		
DOE Proj Engr.			RAC Qual. Mgr.		
TAC Site Mgr.			Other		
RAC Site Qual. Engr.					
RAC HS&E Mgr.					

Cost/Time Est.
☐ Attached
☐ Not Required
☐ DOE Approval Req.

MK-087-MM(10/84)

JAN 16 '86 11:30 MK ENGINEERS INC. S.F. CA.

PID No. 04-S-23

pg. 1 of 2

U.S. Standard Sieve Size (Square Openings)	Percent Passing (By Weight)	Area
Type A		
4-inch	100	Tailings Embankment Top Slope
2-inch	30-1C0	
1&1/2-inch	15-50	
1-inch	0-25	
3/4-inch	0-15	
Type B		
10-inch	100	Tailings Embankment Side Slope and Aprons, Drainage Ditches and Intercept Ditches, except for portions of Ditches D-2, D-5, and D-7, as indicated below.
8-inch	50-100	
6-inch	15-100	
4-inch	0-25	
3-1/2-inch	0-15	
Type B-1		
10-inch	100	Portions of Ditches D-2, D-5, and D-7, defined as follows (See Drawing SHP-PS-10-0016):
8-inch	50-100	
6-inch	15-75	
5-inch	0-35	
4-inch	0-15	

Ditch No.	Beginning Station	Ending Station
D-2	118+79	133+54[524+47(D-7)]
D-5	507+53	508+39
D-7	522+47	524+47

JAN 16 '86 10:51 MK ENGINEERS INC. S.F. CA.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet A-1

Project UMTRA / SHP
Feature Ditch D-3
Item Partial Replacement of Ditch D-3

Contract No. 4005
File No.
Designed FXT
Date 1/10/85
Checked WYL
Date

04-390-17-03

Purpose:

a partial length of ditch D-3 is to be replaced to control runoff over the natural silt, untill runoff can be released onto natural gravel.

Input: The input data is from data source 1 & 2 with the area shown on figure 1. The existing ground and ditch invert are shown on figure 2.

Results: The results from the safety factor program show's that the natural ground has the capability of withstanding the flow from ditch D-3 and the sheet flow from the embankment with a maximum 5% slope.

** MORRISON / KNUDSEN ENGINEERS, INC. 15 JAN 86 ** 11:27:31 ** DATA **
** DITCH 3 **
** 100% PMP **
** **

GHT

TIME CONCENTRATION FROM EMBANKMENT	:	0.000
ROCK SPECIFIC GRAVITY	:	2.700
ROCK POROSITY	:	0.250
ROCK FRICTION ANGLE	:	40.000
WATER UNIT WEIGHT	:	62.400
G	:	2.079
H	:	0.555

DITCH	SEC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF
3	1	11.31	0.0	226.0	.508	226.0	1.16	0.9
3	2	11.31	10.0	147.0	1.57	147.0	1.16	0.9
3	3	11.31	35.0	152.0	3.192	152.0	0.25	1.4
3	4	11.31	50.0	201.0	6.212	201.0	0.25	1.4
3	5	11.31	60.2	169.0	9.165	169.0	0.25	1.4

ck'd WYL 1/15/86

** MORRISON / KNUDSEN ENGINEERS, INC. 15 JAN 86 ** 11:27:31 ** PAGE 1
** DITCH 3
** 100% PMP

** DITCH NO: 3 (SECTION 1)

WATERSHED AREA	(ACRES):	0.568
DITCH LENGTH	(FEET):	226.000
HYDRAULIC LENGTH	(FEET):	226.000
SIDE SLOPE	(DEG.):	11.310
BOTTOM WIDTH	(FEET):	0.000
LONGITUDINAL SLOPE	(%):	1.160

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
1.94	1.14	0.025	0.43	27.46	4.23	0.89	49.10	1.00

** DITCH NO: 3 (SECTION 2)

WATERSHED AREA	(ACRES):	1.570
DITCH LENGTH	(FEET):	147.000
HYDRAULIC LENGTH	(FEET):	147.000
SIDE SLOPE	(DEG.):	11.310
BOTTOM WIDTH	(FEET):	0.000
LONGITUDINAL SLOPE	(%):	1.160

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
2.90	1.71	0.027	0.66	76.43	5.23	1.36	49.10	1.00

** DITCH NO: 3 (SECTION 3)

WATERSHED AREA	(ACRES):	3.192
DITCH LENGTH	(FEET):	152.000
HYDRAULIC LENGTH	(FEET):	152.000
SIDE SLOPE	(DEG.):	11.310
BOTTOM WIDTH	(FEET):	35.000
LONGITUDINAL SLOPE	(%):	0.250

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
0.52	1.04	0.019	0.46	156.27	3.74	2.04	49.10	1.00

ck'd WYL 1/15/86

** MORRISON / KNUDSEN ENGINEERS, INC. 15 JAN 86 ** 11:27:31 ** PAGE 2
** DITCH 3
** 100% PMP

DITCH NO: 3 (SECTION 4)

WATERSHED AREA	(ACRES):	6.212
DITCH LENGTH	(FEET):	201.000
HYDRAULIC LENGTH	(FEET):	201.000
SIDE SLOPE	(DEG.):	11.310
BOTTOM WIDTH	(FEET):	50.000
LONGITUDINAL SLOPE	(%):	0.250

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
0.66	1.29	0.019	0.63	304.37	4.18	2.84	49.10	1.02

DITCH NO: 3 (SECTION 5)

WATERSHED AREA	(ACRES):	9.165
DITCH LENGTH	(FEET):	169.000
HYDRAULIC LENGTH	(FEET):	169.000
SIDE SLOPE	(DEG.):	11.310
BOTTOM WIDTH	(FEET):	60.200
LONGITUDINAL SLOPE	(%):	0.250 0.5%

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
0.74	1.47	0.020	0.75	449.24	4.52	3.46	49.10	1.00

ck'd WYL 1/15/86

0.5% ... 100' wide

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Project	[illegible]	Sheet	A5
Feature	Ditch D-3	Contract No.	4005
		File No.	
Item	Partial Replacement of Ditch D-3	Designed	[illegible]
		Date	1/15/86
		Checked	WYL
		Date	1/15/86

Maximum Slope for drainage from the southeast corner onto natural ground.

$q = .77 \, cfs/ft.$ MKE Calc. 04-390-12-01

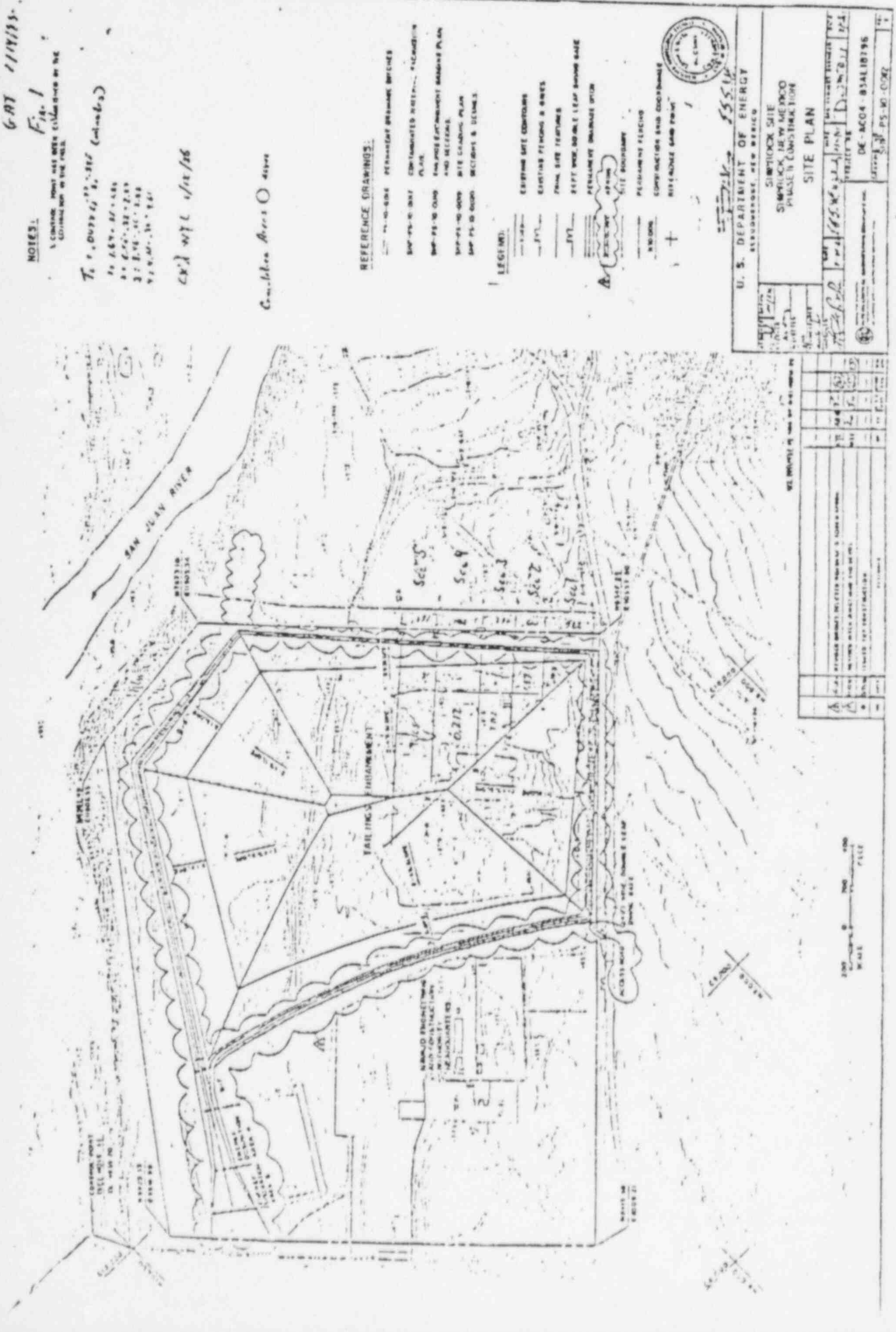
$K = .75''$ or $0.0625'$

Stephenson's Method; Ref. 3

$$0.0625 = \left(\frac{.77 (\tan \theta)^{2/3} \cdot 3^{1/6}}{.22 (32.2^{1/2}) ((1-.3)(2.7-1) \cos \theta (\tan 40 - \tan \theta))^{5/3}} \right)^{2/3}$$

$\theta \approx 2.86°$ or 5%

Sheet A-6


NOTES:
REFERENCE DRAWINGS:
LEGEND:
SAN JUAN RIVER
TAILINGS EMBANKMENT
U. S. DEPARTMENT OF ENERGY
SHIPROCK SITE
SHIPROCK, NEW MEXICO
PHASE II CONSTRUCTION
SITE PLAN
DE-AC04-83AL18796

UMTRA / SHP : 4005 .96

Ditch O-3

Partial Replacement of Ditch O-3 GAJ 1/14/86

Figure 2 ch'd WYL 1/15/86

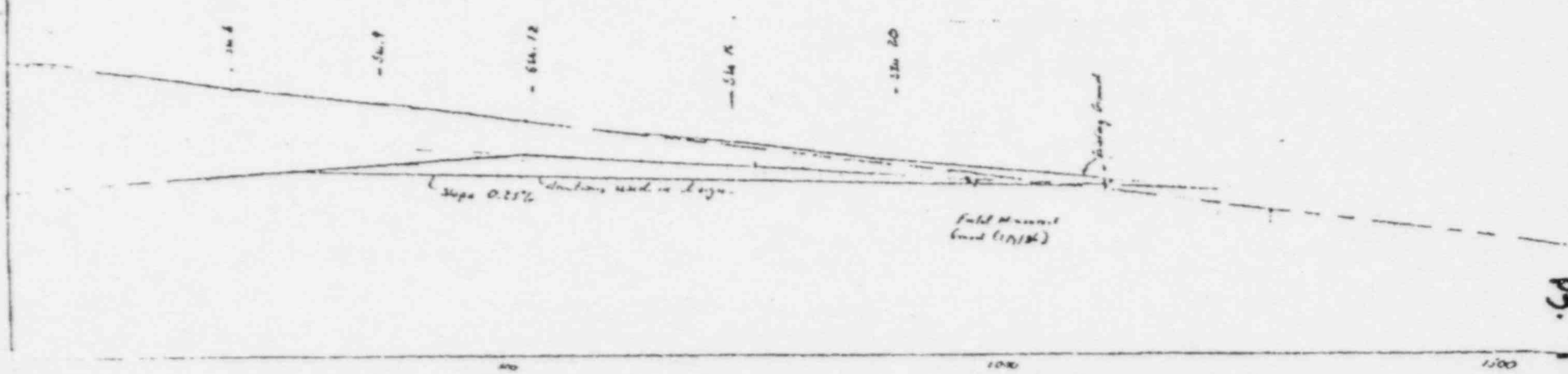
Existing Ground Based on Field Measurements

Doc # 4005-SHP-O-02-08152-00

Gravel Based on Test P.L.

Doc # 4005-SHP-T-01-00474-00

Stations shown on Fig. 1



Calculation Cover Sheet

Contract No. 4005 Discipline ESci

Calc. No. 04-390-15-00

No. of Sheets 9

Project

UMTRA / SHP

Feature

Embankment Riprap

Item

Runoff Volume

Sources of Data

1) MKE Calculation # 04-390-01
2) MKE Calculation # 04-06-RO-01

Sources of Formulae & References

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

Rev No	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
A	[illegible] from south of borrow area	GA Jones	12/20/85	[illegible]	12/20/85	H.R. Thien	12/20/85
	Change 1	GA Jones	12/17/85	ABH	12/17/85	H.R. Thien	12/20/85

Project UMTRA/SHP
Feature Embankment Riprap
Item Runoff Volume
Sheet 1
Contract No. 4905
File No.
Designed RAV Date 10/16/85
Checked ARH Date 10/18/85

Embankment

Purpose & Method

If runoff from area ② (see figure 1) is allowed to flow as overland flow into the excavated area (see figure 2), the accumulated water needs to be evaporated within 1 year to limit ground water infiltration. The 1 hour PMP is used as the rainfall with no infiltration assumed during the storm duration. The following parameters are required in the calculation.

1-hour PMP : 9.1 in/hour (Data Source 1) ✓

Evaporation Rate : ~~65~~ 46 in/year (Data Source 2) — from lakes.

Annual Precipitation : 6.4 in/year (Data Source 2) ✓

Project UMTRA/CHP
Feature Embankment Riprap
Item Runoff Volume

Contract No. 4005
Designed CAT
Checked ABH

Sheet 2
File No.
Date 10/17/85
Date 10/17/85

Calculations

Runoff from embankment:

Area ②: 9.4 acres & ½ will flow into the excavated area: $\frac{9.4}{2}$ acres = 4.7 acres ✓

Volume of runoff from area ②

$$4.7\text{ acres}\left(9.1\ \frac{\text{in}}{\text{hour}}\right)1\text{ hour}\left(\frac{1\text{ ft}}{12\text{ in}}\right) = \underline{3.56\text{ acre-ft}}$$ ✓

Depth of runoff onto excavated area:

Area of excavated area: 39.1 acres ✓

$$(3.56\text{ acre-ft}/39.1\text{ acres})\left(\frac{12\text{ in}}{\text{ft}}\right) = 1.1\text{ inches}$$ ✓

Total depth of runoff due to a 1 hour pmp on to Area ② and the excavated area:

1.1 inches + 9.1 inches = 10.2 inches ✓ assuming uniform distribution over entire excavated area

Project UMTRA / SHP	Contract No. 4005	Sheet 3	
Feature Embankment Riprap		File No.	
Item Runoff Volume	Designed RDT	Date 10/17/85	
	Checked ASH	Date 10/18/85	

Net Evaporation:

mean annual rainfall

~~46.65~~ inch/year − 6.4 inches/year = ~~58.6~~ 39.6 inch/year

(46.65 inch/year = yearly evaporation (from Lakes). 6.4 inches/year = average rainfall)

Time to evaporate the pmp

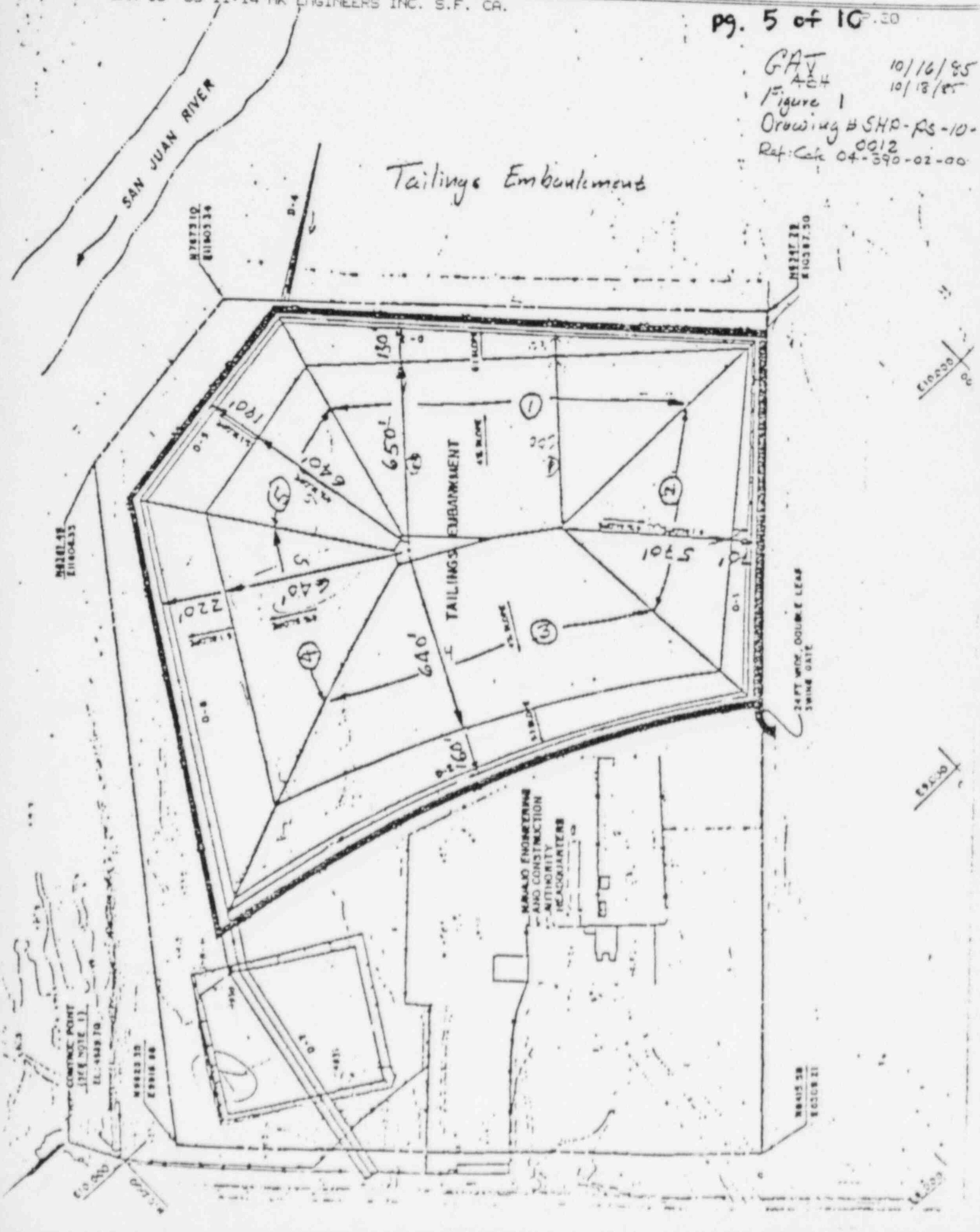
$\frac{10.2 \text{ inches}}{\cancel{58.6}\ 39.6 \text{ inch/year}} (365 \text{ days}) = \cancel{63.5}\ 94. \text{ days}$

Summary

The depth of total rainfall to the excavated area is 10.2 inches and will take ~~63.5~~ 94 days to evaporate

GAT 404 10/16/85 10/18/85
Figure 1
Drawing # SHP-FS-10-0012
Ref: Calc 04-390-02-00

Tailings Embankment



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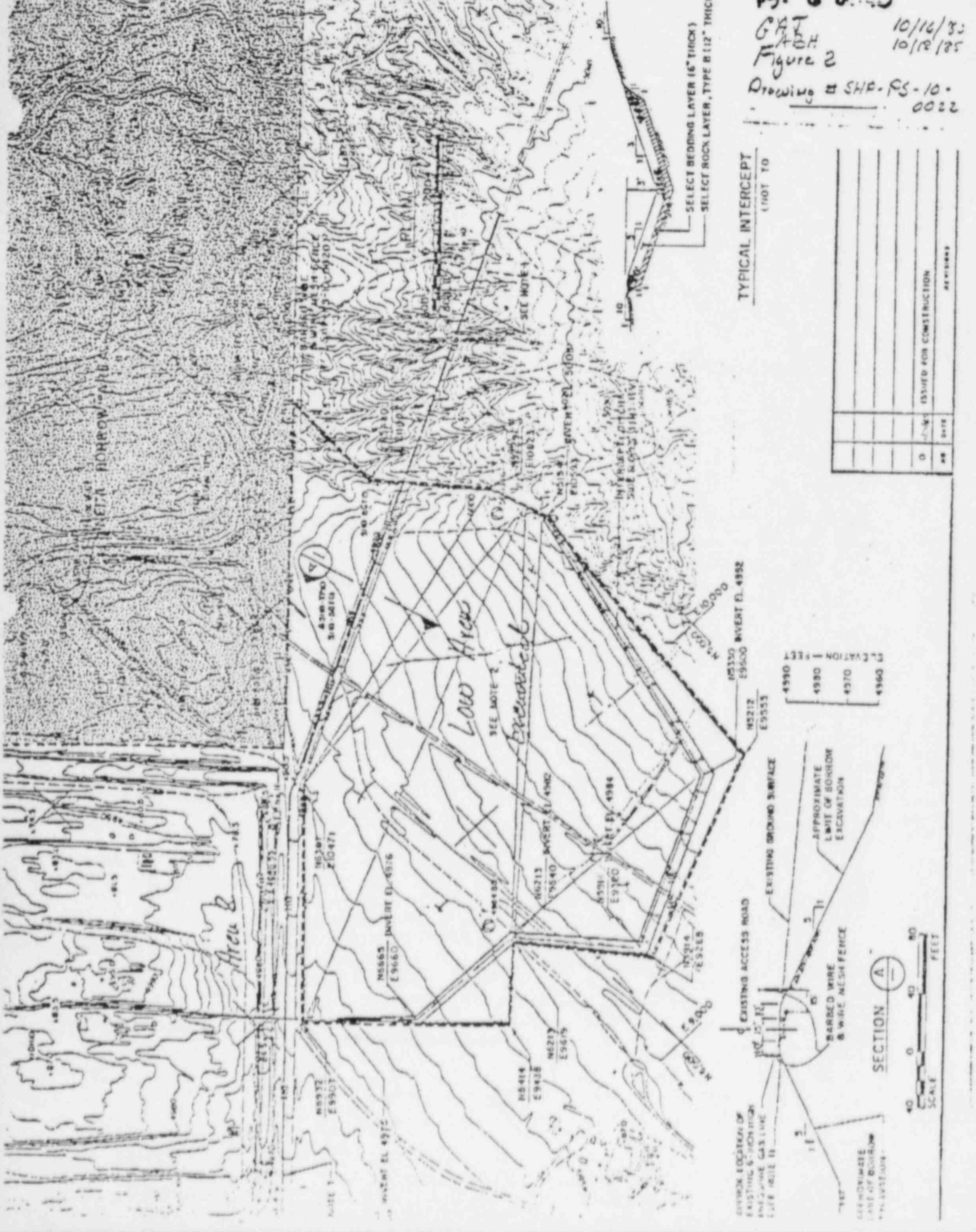
Pg. 6 of 20

GAT ABH 10/16/85 10/18/85

Figure 2

Drawing # SHP-PS-10-0022



MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA / SHP			Sheet 6
Feature Embankment Riprap	Contract No. 4005		File No.
Item Runoff Volume	Designed GAF		Date 12/20/85
	Checked RDG		Date 12-20-85

Drainage Area South of the borrow area: 51.5 acres
(From Shiprock calc. # 04-05-R0-07 and shown on figure 3)

Volume of runoff from 1 hour PMP due to area south of borrow area

1 hour $\left(9.1 \frac{in}{hour}\right)$ 51.5 acres $\left(\frac{1 ft}{12 in.}\right)$ = 39.0 acre-ft ✓

Depth of runoff onto excavated area:

Area of excavated area: 39.1 acres (p.2)

(39 acre-ft / 39.1 acres) $\frac{12 in}{ft}$ = 12.0 inches ✓

Total depth of runoff due to a 1 hour pmp on to the excavated area:

10.2 inches (p2) + 12 inches = 22.2 inches ✓ based on evenly distributed over 39.1 acres

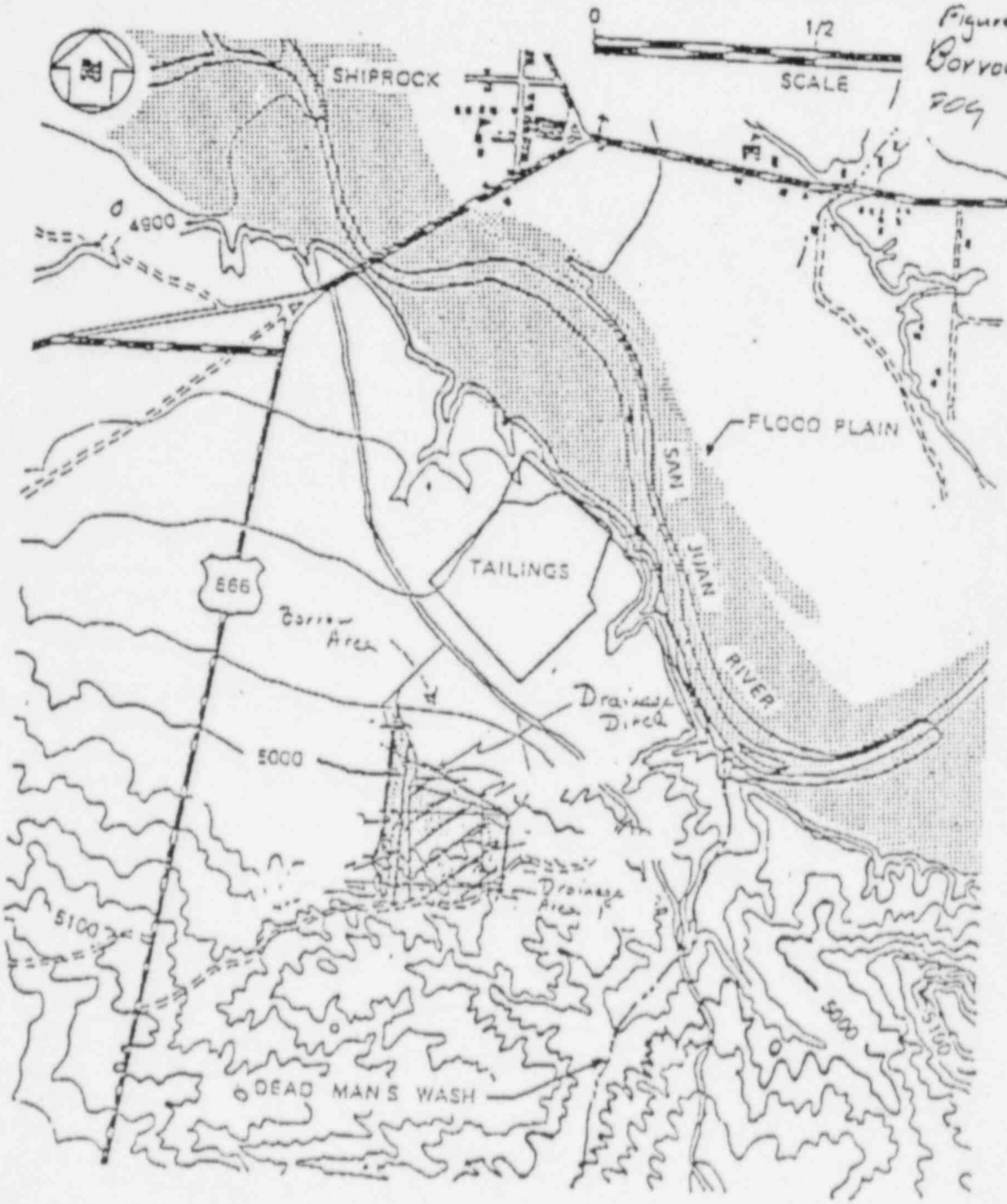
Time to evaporate the pmp

$\frac{22.2}{39.6 \text{ in/year (p3)}}$ (365) = 205 days ✓

% effected by runoff from tailings pile:

$\frac{2.4" \text{ from tailings pile (p2)}}{22.2 \text{ total}}$ = 10.8 % ✓

GAT 12/20/85
Figure 3
Borrow Area Drainage
FOG 12-20-85
50 scale



TOPOGRAPHY IN THE VICINITY OF THE SHIPROCK MILLSITE NOTE THAT THE CONTOURS INDICATE THAT MOST OF THE SURFACE RUNOFF FROM THE WATERSHED AREAS TO THE SOUTH AND WEST WILL NOT DRAIN ONTO THE SITE (ADAPTED FROM U S G S CHIMNEY ROCK, NEW MEXICO - COLORADO 15 MINUTE QUADRANGLE)

FIGURE 2.3
AREA TOPOGRAPHY

Ref: FBDU, 1981

From Processing Site

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRD / SHP			Sheet 8
Feature: Embankment Riprap	Contract No. 4005		File No.
Item: Runoff Volume	Designed GWT		Date 12/20/85
	Checked GHS		Date 12/20/85

Estimate of water surface elevation for borrow area:

Volume required: 22.2 in (1 ft / 12 in) (PMP) 39.1 acres = 72.3 acre-ft

From Figure 4

elevation	diff.	Area (acres)	Ave Area	Volume
4965		12.96		
	5'		14.89	74.45 acre-ft
4970		16.82		

The water surface elevation from the PMP is approximately 4970'

The depth of water is 5'

The water surface elevation would have to reach an elevation of 4980' before flow from the borrow area would begin.

Volume still available

elev	dif (ft)	Area (acres)	Ave. Area	Volume
4970		16.82		
	10'		20.63	206.25 acre-ft.
4980		24.43		

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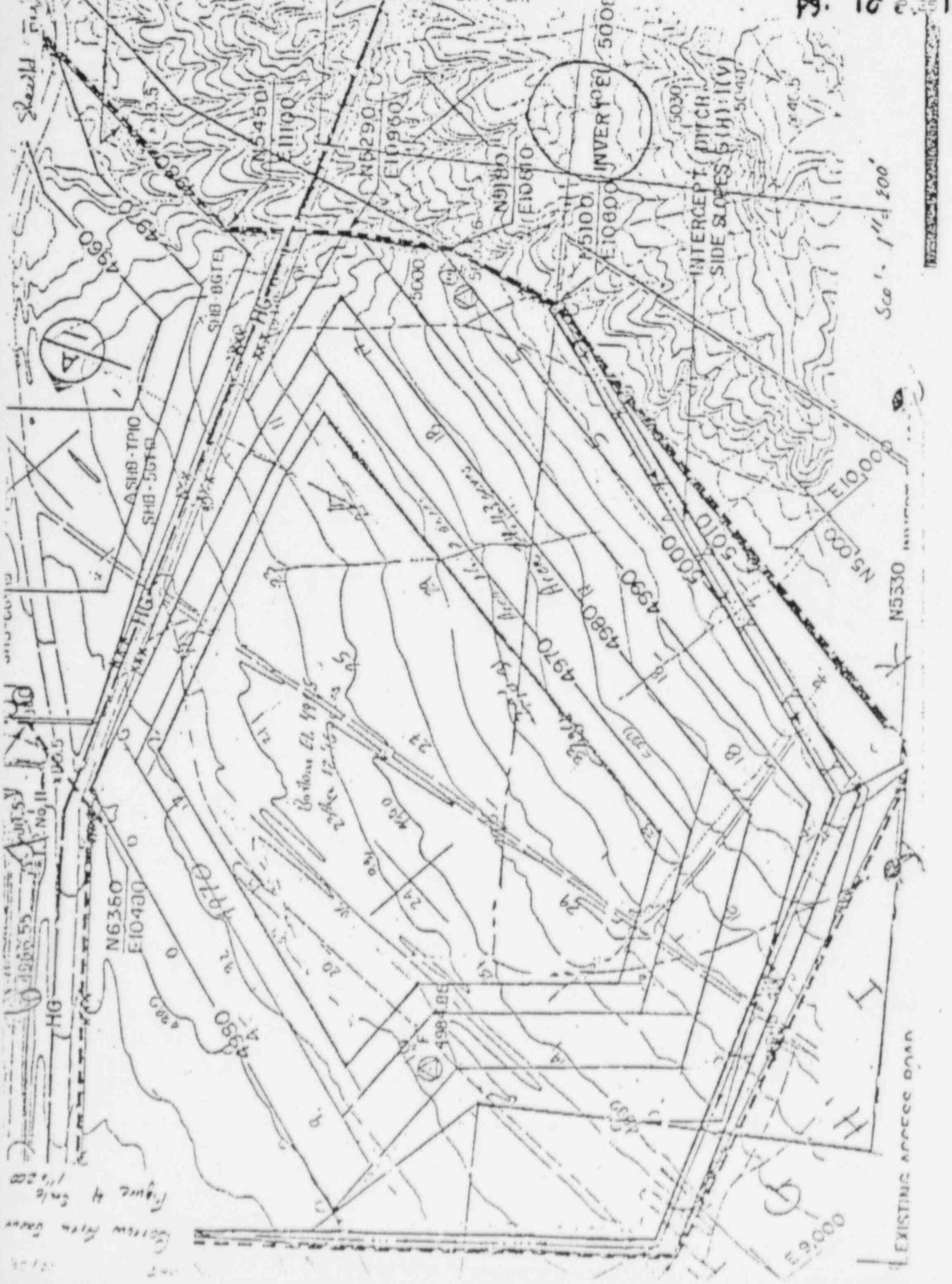
pg. 10 of 10



4005-SHP-A-01-02130-00

MORRISON-KNUDSEN COMPANY, INC.

UMTRA PROJECT OFFICE
PROJECT INTERFACE DOCUMENT

Site: Shiprock	Date: 12-18-85	PID No.: 04-S-23	Site No.: 04	Vic Pro No.: N/A
Originator and Location: G. R. Thiers - San Francisco	Phone: (415) 442-7556	Organization: MKE	Answer By:	References:
Subject: Gradation Limits for Select Rock Material				Spec. 02270.2.1.C.4.a

Description of Problem and Recommended Solution ☐ Clarification ☒ Change

1. Problem: The Phase II Design revisions require that the material used for portions of Ditches D-2, D-5 and for D-7 meet the gradation limits given below for Material Type B-1.

2. Solution: Revise Specification 02270.2.1.C.4.a to read:

(See reverse side)

[signature] 1-13-86 RFS 1-14/86 [initials] 1-14-86

Originator G.R. Thiers 12/15/85
Signature Date

Disposition ☑ Approved ☐ Disapproved ☐ Approved as Noted

Criteria Change? ☐ Yes ☒ No — Incorporate into spec & issue as revision

If Yes, DOE approval required

RAC Site Manager ______
RAC Project Control [signature] 1/3/86
RAC Engineering/Design [signature] 1-3-86
RAC Construction Engineer [signature] 1-13-86
Signature Date

Reviewed for Quality Requirements [signature]

Distribution	Name	Location		Name	Location
RAC Site Mgr.	K. Hagelin		RAC Constr. Engr. Mgr.	J. Waldron	
DOE Proj Engr.	D. Bair		RAC Qual. Mgr.	D. [illegible]	
TAC Site Mgr.	L. Stepp		Other	T. Waldron	
RAC Site Qual. Engr.				P. Hopkins	J. [illegible]
RAC HS&E Mgr.	B. Naylor			J. [illegible]	

Cost/Time Est.
☐ Attached
☐ Not Required
☐ DOE Approval Req.

RECEIVED - MKE
JAN 21 1986

ATTACHMENT 3

MK-067-MM(10/84)

U.S. Standard Sieve Size (Square Openings)	Percent Passing (By Weight)	Area
Type A		
4-inch	100	Tailings Embankment Top Slope
2-inch	30-100	
1&1/2-inch	15-50	
1-inch	0-25	
3/4-inch	0-15	
Type B		
10-inch	100	Tailings Embankment Side Slope and Aprons, Drainage Ditches and Intercept Ditches, except for portions of Ditches D-2, D-5, and D-7, as indicated below.
8-inch	50-100	
6-inch	15-100	
4-inch	0-25	
3-1/2-inch	0-15	
Type B-1		
10-inch	100	Portions of Ditches D-2, D-5, and D-7, defined as follows (See Drawing SHP-PS-10-0016):
8-inch	50-100	
6-inch	15-75	
5-inch	0-35	
4-inch	0-15	

Ditch No.	Beginning Station	Ending Station
D-2	118+79	133+54[524+47(D-7)]
D-5	507+53	508+39
D-7	522+47	524+47