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

DOCUMENT TRANSMITTAL

TO: R. E. Hopkins Attention: J. G. Oldham	DATE: 24 January 1986
LOCATION: M-K Boise	SITE: Shiprock
NO.: 4005-SHP-N-01-02170-00	COPY NO.(S):

Transmitted herewith are:

1. Report "Response to NCR Comments of 16 January 1986 on Shiprock Phase II Design Revisions" (MKE Document No. 4005-SHP-R-01-02174-00).

2. Calculation No. 04-390-17-04, Sheets B1 through B14.

3. Original and 1 blueline print of each of the following drawings:

Drawing Number	Title
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

T. R. Wathen

COMMENTS:

WM DOCKET CONTROL CENTER
'86 JAN 27 P12:00

WM Record File

WM Project 58
Docket No.
PDR ✓
LPDR

Distribution:
Ted Johnson | Eillen
(Return to WM, 623-SS)

cc: Ted Johnson - NRC w/enclosures including blueline print of each drawing.

8603170052 860124
PDR WASTE
WM-58 PDR

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.

4005-SHP-R-02174-00
1700U/39U

Calculation Cover Sheet

IECO

Contract No. 4005 Discipline Task No. 390 Calc. No. 04-390-17-04
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-4252
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 Doc # 4005-Gen #-C1-01048
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	AB Hray	1/23/86	WYLIN	1/24/86	G.R. Thiers	1/24/86
3	Ditch D-3 revision	AA Jones	1/15/86	WY LIN	1/15/86	G. R. Thiers	1/15/86
2	Increased Shear at Heads	AA Jones	1/3/86	AB Hray	1/3/86	G.R. Thiers	1/3/86
1	—	WY Lin	11/20/85	[illegible]	11/20/85	G.R. Thiers	11/27/85
0	—	WY Lin	10/30/85	[illegible]	10/30/85	G.R. Thiers	10/31/85

IECO Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA – Shiprock.	Contract No. 4005	Sheet B-1	
Feature Proposed Apron Rev. # 5.	Designed ABH	File No. 390	Date 1/23/86.
Item	Checked WYL		Date 1/24/86

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. Longitudinal 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) adjacent to the apron. The rock sizes and flat-area widths 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  H             =   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
                      BOTTOM  DITCH     SHED     HYDR
               THETA  WIDTH   LENGTH    AREA     LENGTH   SLOPE SHEAR
DITCH SEC (DEG)  (FT)    (FT)      (ACRES)  (FT)     (%)   COEFF
----- --- ------ ------- -------- ------- -------- ----- -----
  3    1   11.31   60.0    895.0    9.17    895.0    0.50  1.55


END DATA
```

ABH/ 1-23-86
ck'd 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 APR50:2                                      **

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

                   BOTTOM  DITCH     SHED     HYDR
             THETA WIDTH   LENGTH    AREA     LENGTH   SLOPE SHEAR
DITCH SEC   (DEG)  (FT)    (FT)     (ACRES)   (FT)     (%)   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 APR50:2                                      **

*************************************************************************
**                                                                      **
** 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

DITCHES

TITLE
** MORRISON-KNUDSEN ENGINEERS, INC.   24 JAN 86 **   ** DATA **
****
** APRON (D-3) - PROPOSED REVISION #5 FILE-NAME APRSI:4   **
** OUTPUT IS IN FILE NAMED APR50:4   **

END TITLE

```
PARAMETER  TE             =    4.000
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    = 4.0
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	2	11.31	120.0	1495.0	18.31	0.0	1.00	1.55

END DATA

ADH / 1-23-86 B-5
ckd WYL / 1-24-86

```
** MORRISON-KNUDSEN ENGINEERS, INC.      24 JAN 86 ** 14:35:16 ** DATA **
************************************************************************
** APRON (D-3) - PROPOSED REVISION #5  FILE+NAME APR5I:4              **
** OUTPUT IS IN FILE NAMED APR5O: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

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


1
** MORRISON-KNUDSEN ENGINEERS, INC.      24 JAN 86 ** 14:35:16 ** PAGE  1
************************************************************************
** APRON (D-3) - PROPOSED REVISION #5  FILE+NAME APR5I:4              **
** OUTPUT IS IN FILE NAMED APR5O: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    Y      N      QV      QD       V        T     IPMP   SAFETY **
**  (IN)   (FT)          (CFS)   (CFS)  (FT/SEC)  (MIN) (IN/HR) 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.
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Project: UMTRA - Shiprock	Contract No. 4005	Sheet B-6	File No.
Feature	Designed ABH	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

$g = 9.81\ m/s^2$

n = 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]
1 m = 3.281 feet] Ref(1) p. X

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

$$q = 661.5\ \frac{ft^3}{s} / 60\ ft\ \text{width}$$

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

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

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) $= 0.66$ inches

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

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

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

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

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

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

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

Widen the apron as follows:

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

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

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

$$w_2 = w_1 \left(\frac{k_2}{k_1}\right)^{3/2}$$

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

then use $k_2 = 0.75$ inches.

Check Section DD

From APR50:4

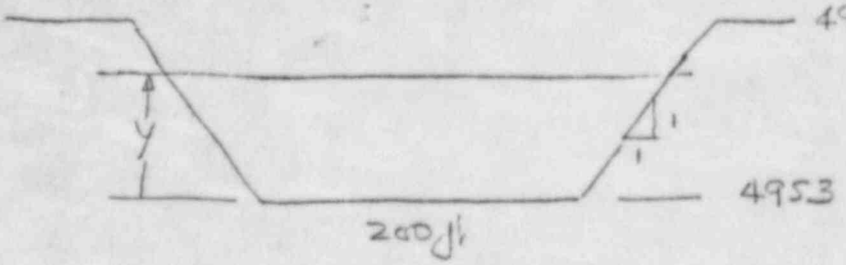
$$Q' = 1017 \text{ cfs.}$$

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

$$\Delta Q = 0.770 \text{ cfs/ft} \times (1650-895-600) \text{ ft}$$
$$= 120 \text{ cfs.}$$

then $Q = Q' + \Delta Q$

$$= 1017 + 120 = 1137 \text{ cfs.}$$



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 $V = \dfrac{1137}{200 \times 1.25} \cong 4.55$ 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 $V = \dfrac{Q}{by}$

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

MORRISON-KNUDSEN ENGINEERS, INC.
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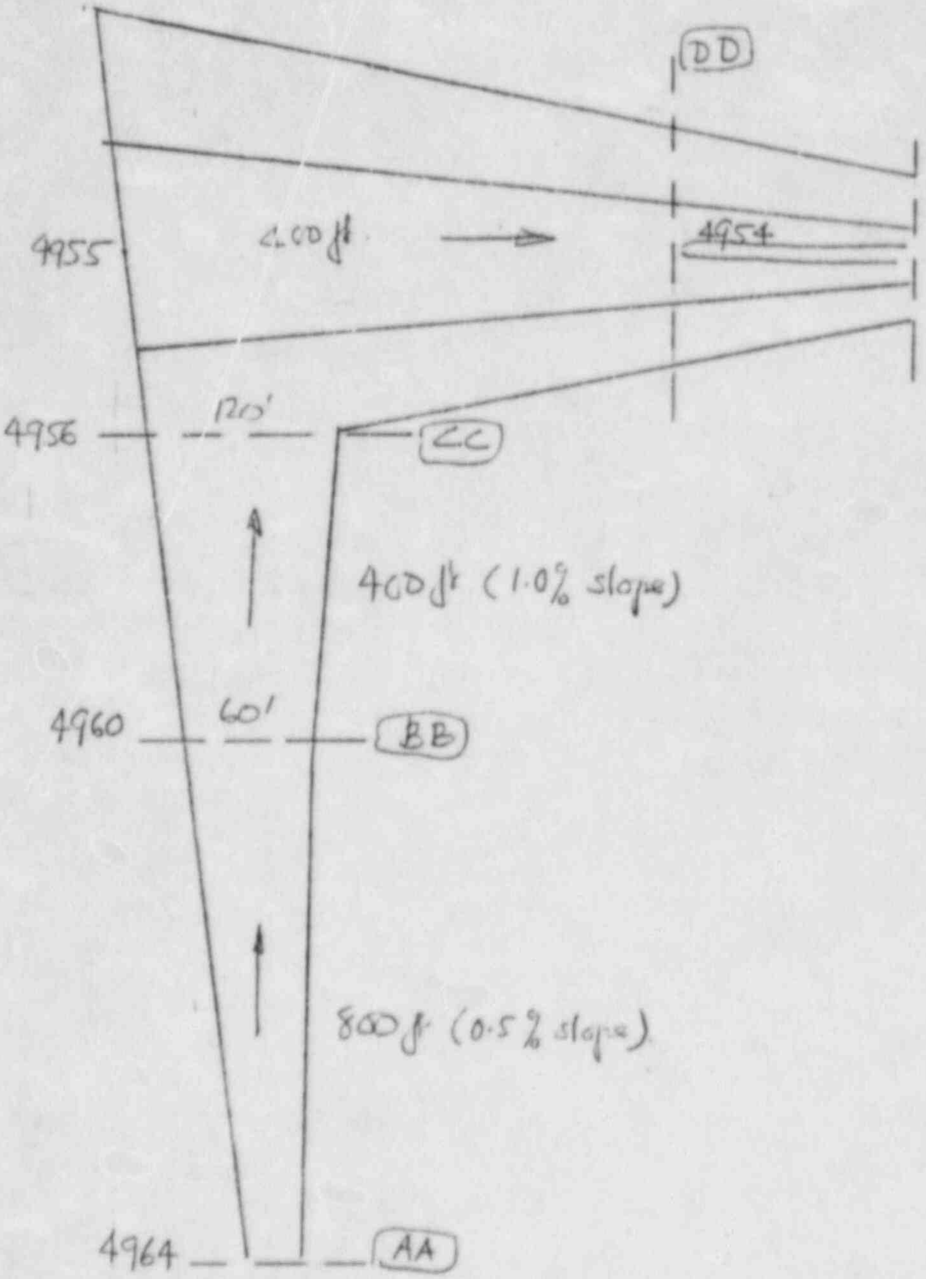
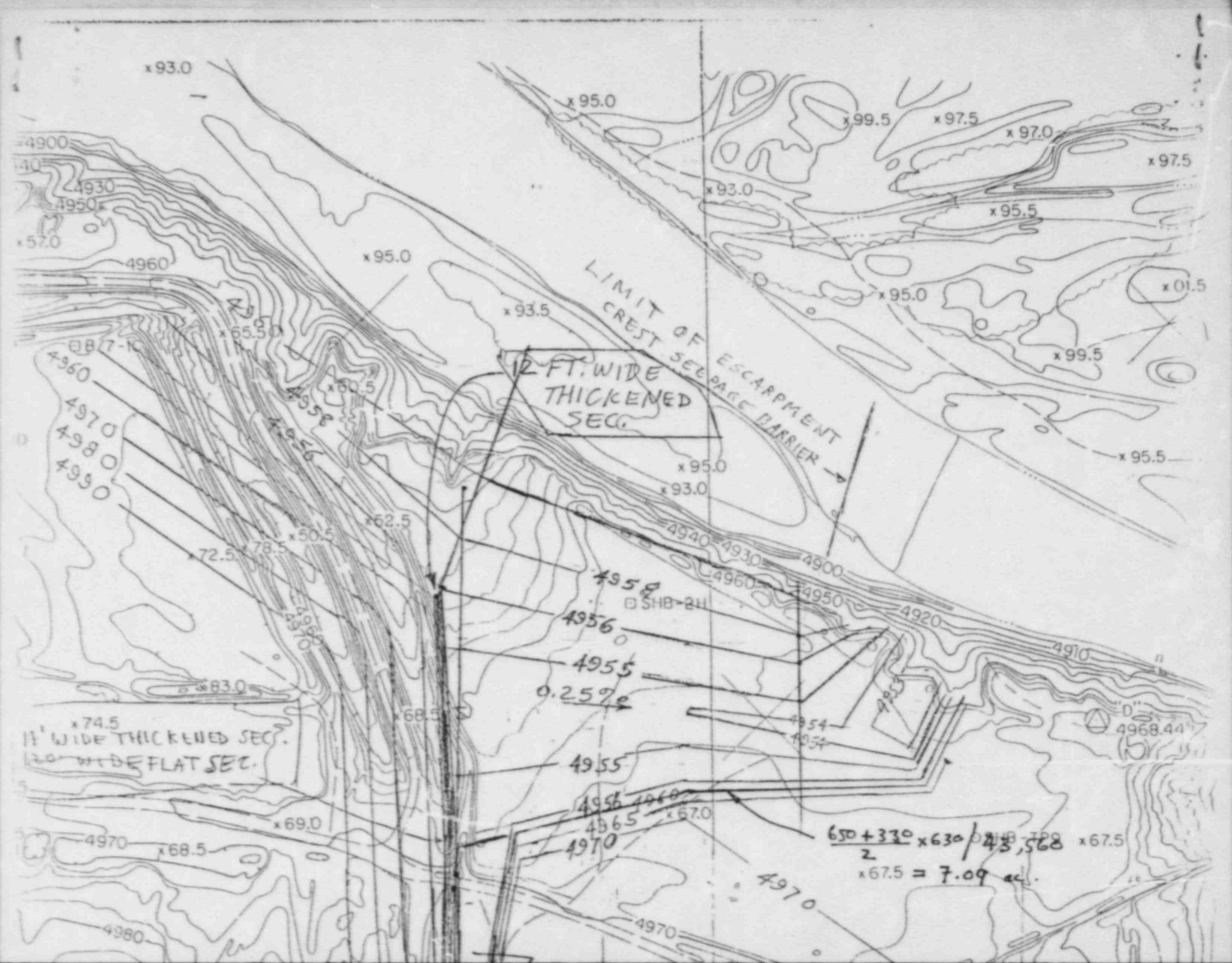
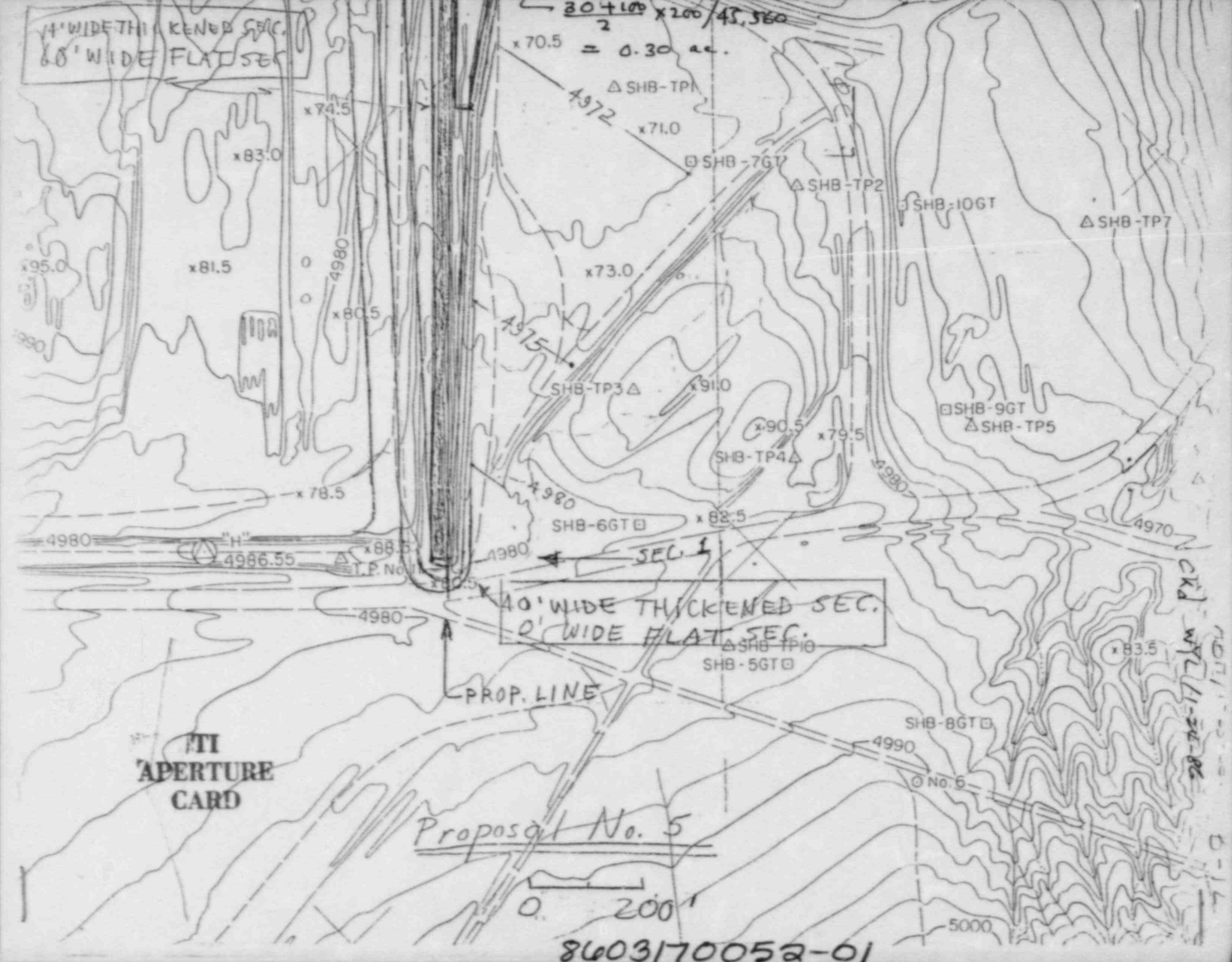
Project UMTRA - Shiprock		Sheet	B-10
Feature	Contract No. 4605	File No.	390
Item	Designed ABH	Date	1/24/86
	Checked WYL	Date	1/26/86

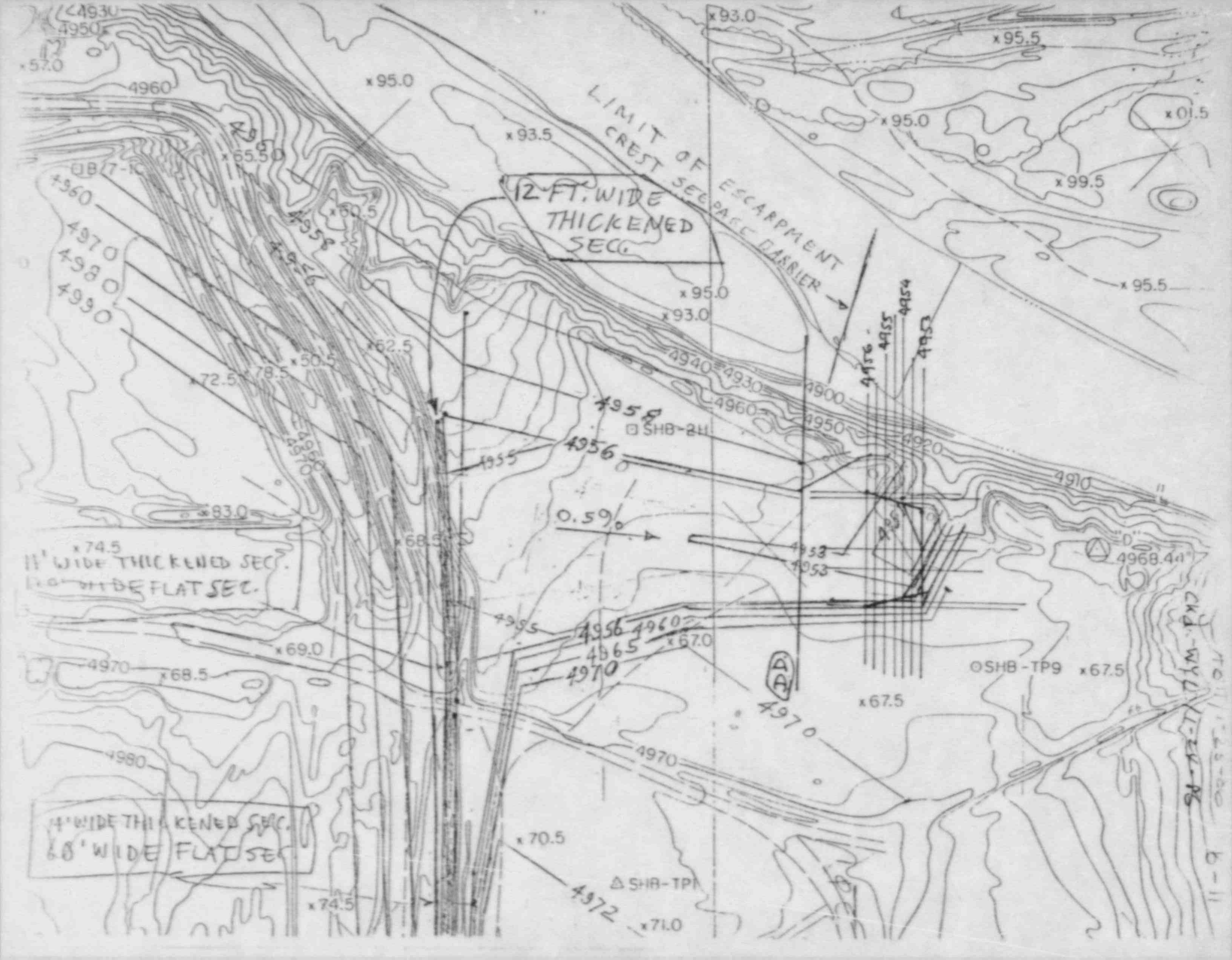



LIMIT OF ESCARPMENT
CREST SEEPAGE BARRIER
12 FT. WIDE THICKENED SEC.
11' WIDE THICKENED SEC.
120' WIDE FLAT SEC.
4958
4956
4955
0.25%
4955
4954
4965
4970
4960
4980
4990
SHB-211
87-1C
4968.44
"0"
4900
4910
4920
4930
4940
4950
4960
4970
4980
x93.0
x95.0
x99.5
x97.5
x97.0
x95.5
x93.5
x01.5
x65.50
x60.5
x62.5
x50.5
x78.5
x72.5
x83.0
x74.5
x68.5
x69.0
x67.0
x67.5
x57.0
$\frac{650+330}{2}$ x630 / 43,560 = 7.09 ac.



TI APERTURE CARD

8603170052-01

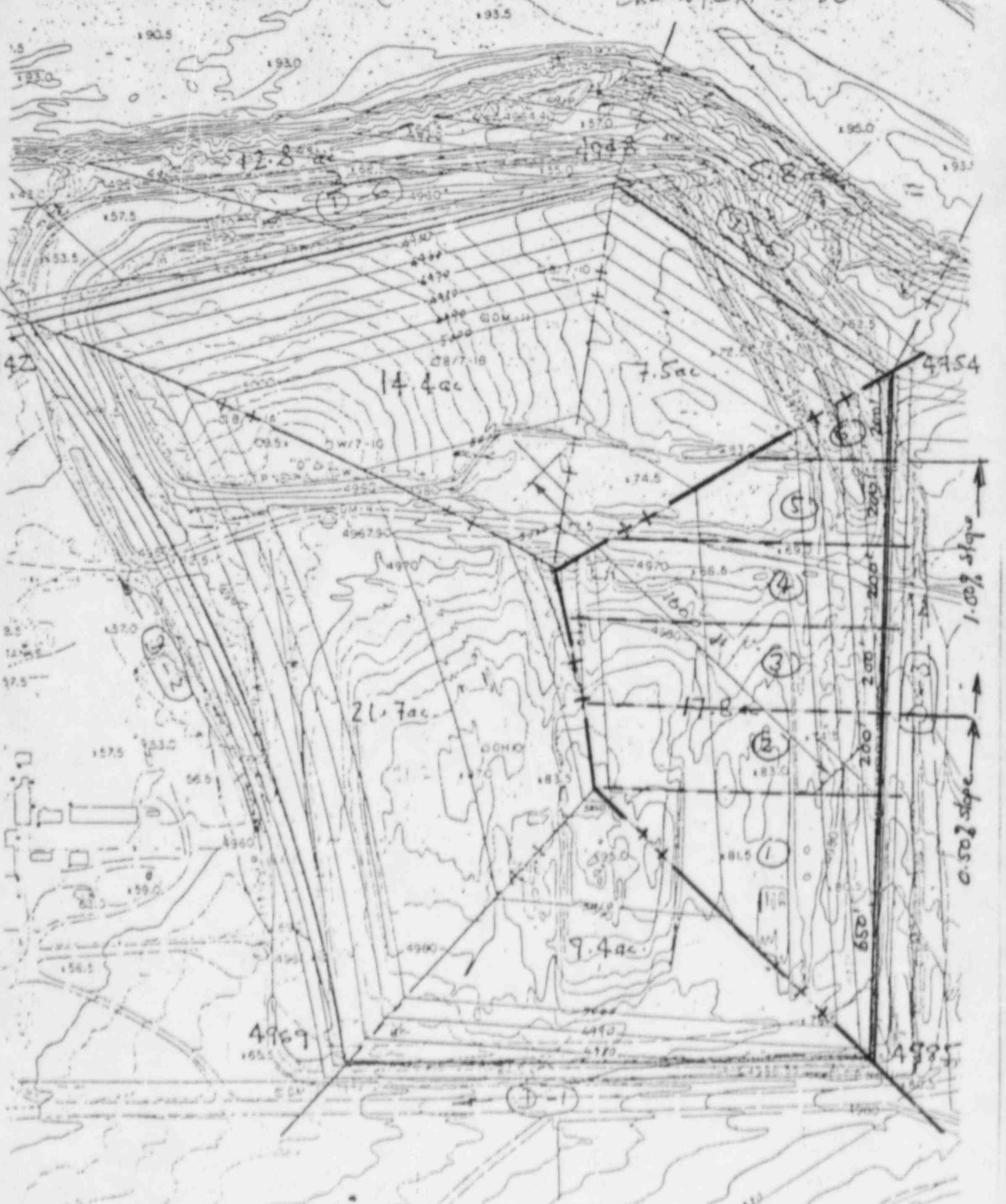


LIMIT OF ESCARPMENT
CREST SEEPAGE BARRIER
12 FT. WIDE THICKENED SEC.
11' WIDE THICKENED SEC.
WIDE FLAT SEC.
14' WIDE THICKENED SEC.
68' WIDE FLAT SEC.
0.5%
SHB-2H
SHB-TP9
SHB-TP
B17-1C
4968.44
4930
4950
4960
4970
4980
4990
4958
4956
4955
4954
4953
4972
4940
4900
4920
4910
x 95.0
x 93.5
x 93.0
x 95.5
x 99.5
x 01.5
x 67.5
x 67.0
x 69.0
x 68.5
x 70.5
x 71.0
x 74.5
x 83.0
x 72.5
x 50.5
x 62.5
x 57.0

Task 322 - Site Drainage
Ditch Erosion Protection

ABH 1-23-86
CKd CX 1-24-86

B-13



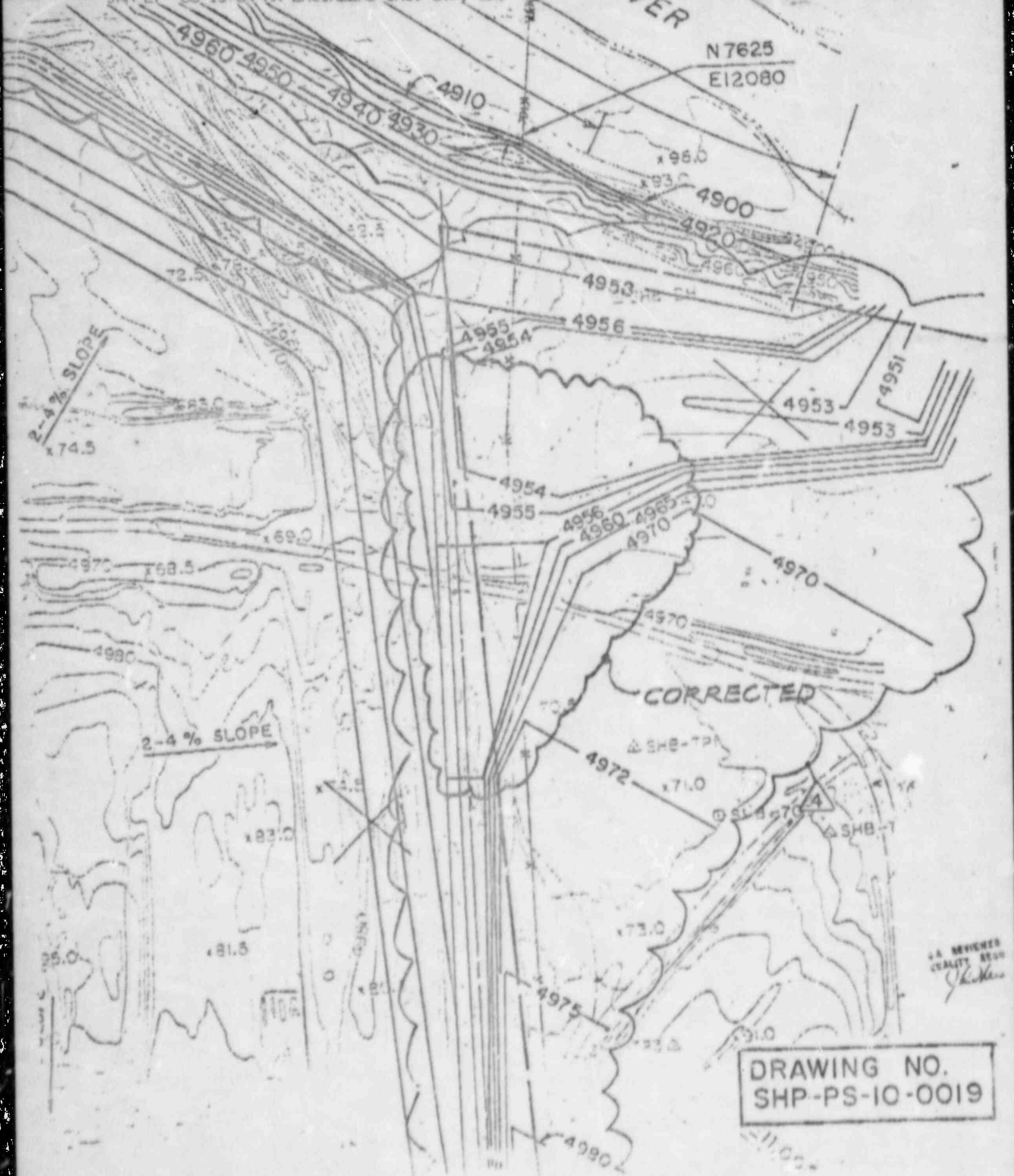
Ref: Site Grading Plan; Dwg No. [illegible]

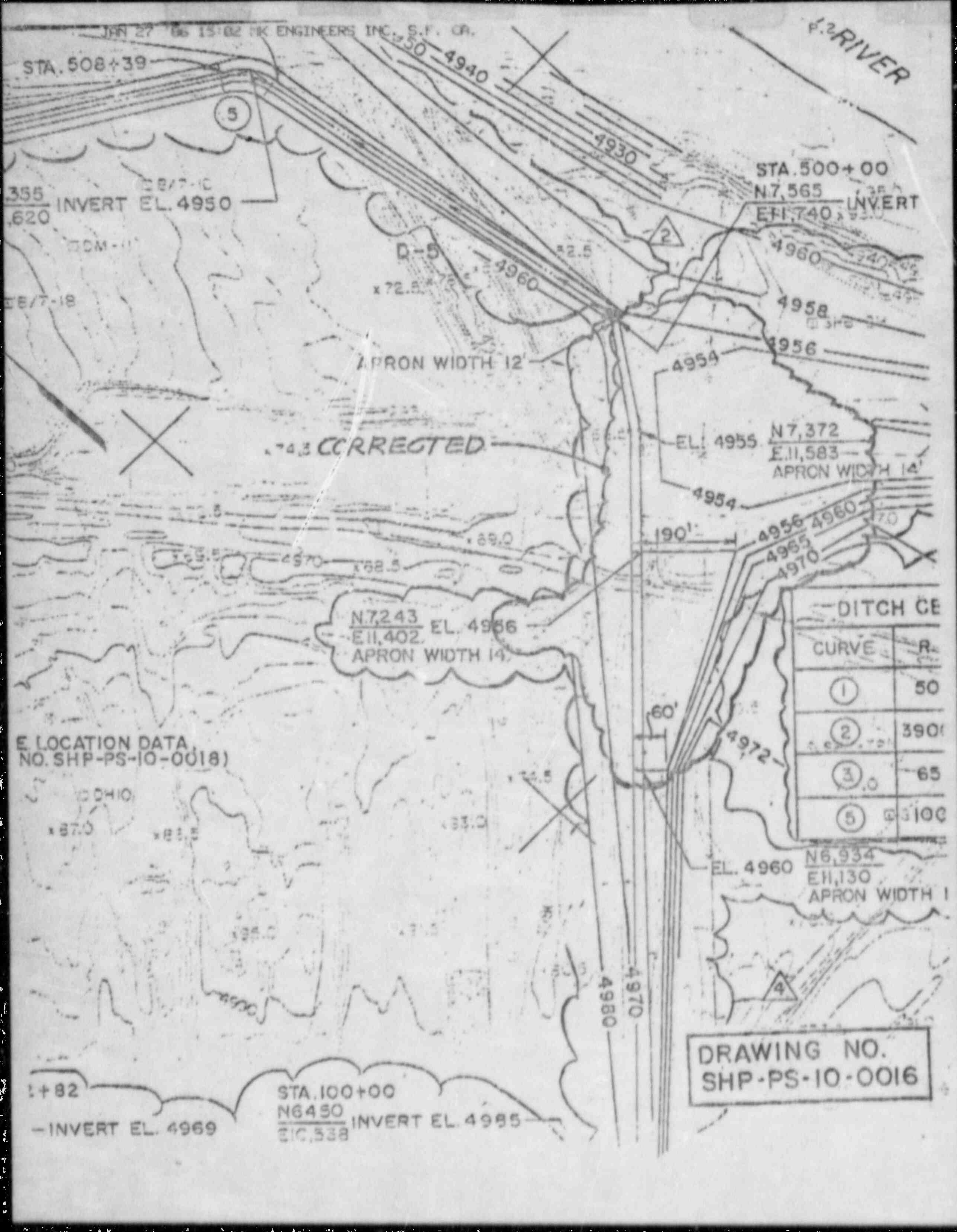
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UMTRA - Shiprock.	Sheet	8-14
Contract No.	4005	File No.	.10
Feature		Designed	ABH
Date	1/22/86	Item	
Checked	WYL	Date	1/24/86

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	$200 \times \frac{650+4\times790+760}{6} / 43,560$	3.50	15.09	14.81
3	$200 \times \frac{760+710}{2} / 43,560$	3.57	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


N 7625
E12080
4960
4950
4940
4930
4910
4900
4920
4953
4956
4955
4954
4951
4953
4953
4954
4955
4956
4960
4965
4970
4970
4970
4980
4972
4975
4980
2-4% SLOPE
2-4 % SLOPE
CORRECTED
SHB-7
DRAWING NO.
SHP-PS-10-0019



JAN 27 '86 15:02 MK ENGINEERS INC. S.F. CA. P.2
RIVER
STA. 508+39
4950
4940
4930
STA. 500+00
N7,565
E11,740
INVERT
.355
.620
INVERT EL. 4950
D-5
4960
4958
4956
4954
APRON WIDTH 12'
CORRECTED
EL. 4955
N7,372
E11,583
APRON WIDTH 14'
4954
190'
4956
4960
4965
4970
N7,243
E11,402
EL. 4966
APRON WIDTH 14'
DITCH CE
CURVE
R
1
50
2
3900
3
65
5
100
E LOCATION DATA
NO. SHP-PS-10-0018)
60'
4972
EL. 4960
N6,934
E11,130
APRON WIDTH
4980
4970
DRAWING NO.
SHP-PS-10-0016
1+82
INVERT EL. 4969
STA. 100+00
N6450
E10,538
INVERT EL. 4985

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF PAGES: 6

ACCESSION NUMBER(S):

8603170054
8603170056
8603170058
8603170060
8603170061
8603170065

APERTURE CARD/HARD COPY AVAILABLE FROM RECORD SERVICES BRANCH, TIDC FTS 492-8989