PRELIMINARY DESIGN WILLIAMS-CHANDLER WPP, ARIZONA RWCD FLOODWAY

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE Arizona		PROJECT Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO. RWCD - Reach 1
SUBJECT Index				SHEET 1 OF 1

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2801 W. Durango
Phoenix, AZ 85009

DESIGN REPORT

Job:	RWCD Floodway, Reach 1
Project:	Williams-Chandler WPP
Location:	Maricopa and Pinal Counties, Arizona
Authority:	PL 566
Phase:	Preliminary Design

Summary: The preliminary design is in accordance with the work plan and its supplements with the following exceptions:

1. The outlet structure located at the confluence of the floodway with the Gila River has been changed from a baffled chute to a type "C" drop.

2. The beginning point of the first reach has been moved from Station 1209+00± to Station 1216+00±.

Description of Job

The job consists of 4.65 miles of earth channel, a reinforced concrete drop outlet structure, and 2.5 miles of concrete-lined irrigation lateral.

The channel crosses a major highway (State Route 93) and an irrigation canal (San Tan Canal No. 9). The highway crossing will consist of a bridge that is being designed by the Arizona Department of Transportation and the canal crossing is an inverted siphon 335± feet long.

Alignment

Except for some minor changes in the curve data, the alignment is in accordance with the work plan.

Hydrology

Additional hydrologic design data has been developed relating the flows in the Gila River to the flows in the floodway.

Hydraulic Design

1. The floodway has been designed using uniform flow conditions and the tractive force and tractive power procedure that was used for the formulation of the work plan supplement. A more detailed subsurface investigation will be conducted in the final design to more accurately delineate the limits of the weaker material that will have to be removed and replaced by more erosion-resistant material. The final design will also include a water surface profile for the channel.

2. The design of lateral 9-49 is based on the normal flows (Q_d = 22 cfs) required to supply irrigation water for 806 acres and a freeboard flow of 44 cfs (BIA requirement).

3. The design of the inverted siphon for the San Tan Canal No. 9 is based on a freeboard flow of 102 cfs and velocities between 3.5 fps and 10.0 fps.

4. Hydraulic Design Criteria

   (a) NEH, Section 5
   (b) Technical Release No. 25, Planning and Design of Open Channels
   (c) Design of Small Canal Structures - USDI, Bureau of Reclamation, 1974
   (d) Engineering Design Standards, Far West States
   (e) Handbook of Hydraulics, 5th Edition - King and Brater
   (f) Bureau of Indian Affairs Policy
   (g) Mannings "n"

Channel - "as built"	0.024
Channel - "Aged"	0.027
Concrete Lining	0.015
Concrete Pipe	0.012
Loose Rock Riprap	0.035

Structural Design

1. The outlet structure is a type "C" drop and the design discharge is 8700 cfs.

2. A rock riprap section will be used both upstream and downstream of the outlet structure.

3. Design Criteria

   (a) NEH, Section 6
   (b) NEH, Section 11
   (c) Engineering Monograph No. 25, Hydraulic Design of Stilling Basins and Energy Dissipators - USDI, Bureau of Reclamation
   (d) f_c = 4,000 psi
   (e) f_s = 20,000 psi

Submitted by John L. Sullivan Date 4-20-78

Approved by Paul Mannville Date 4-21-78

Floodway Alignment

STATE Arizona		PROJECT Williams - Chandler WPP		
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Objective

Determine the protection that is required where there is a change in the ℄ alignment.

Basic Information

$Q = 8700$ cfs
$b = 200'$ max
$z = 3$
$d_n = 5.95'$
$V = 6.71$ fps
$S = 0.00155$

References

1. TR No. 25, Planning and Design of Open Channels - SCS
2. Engineering Design Standards, Far West States
3. Monroe 1880, Water Surface Profile

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JLS	3-13-78	AM		RWCD- Phase I
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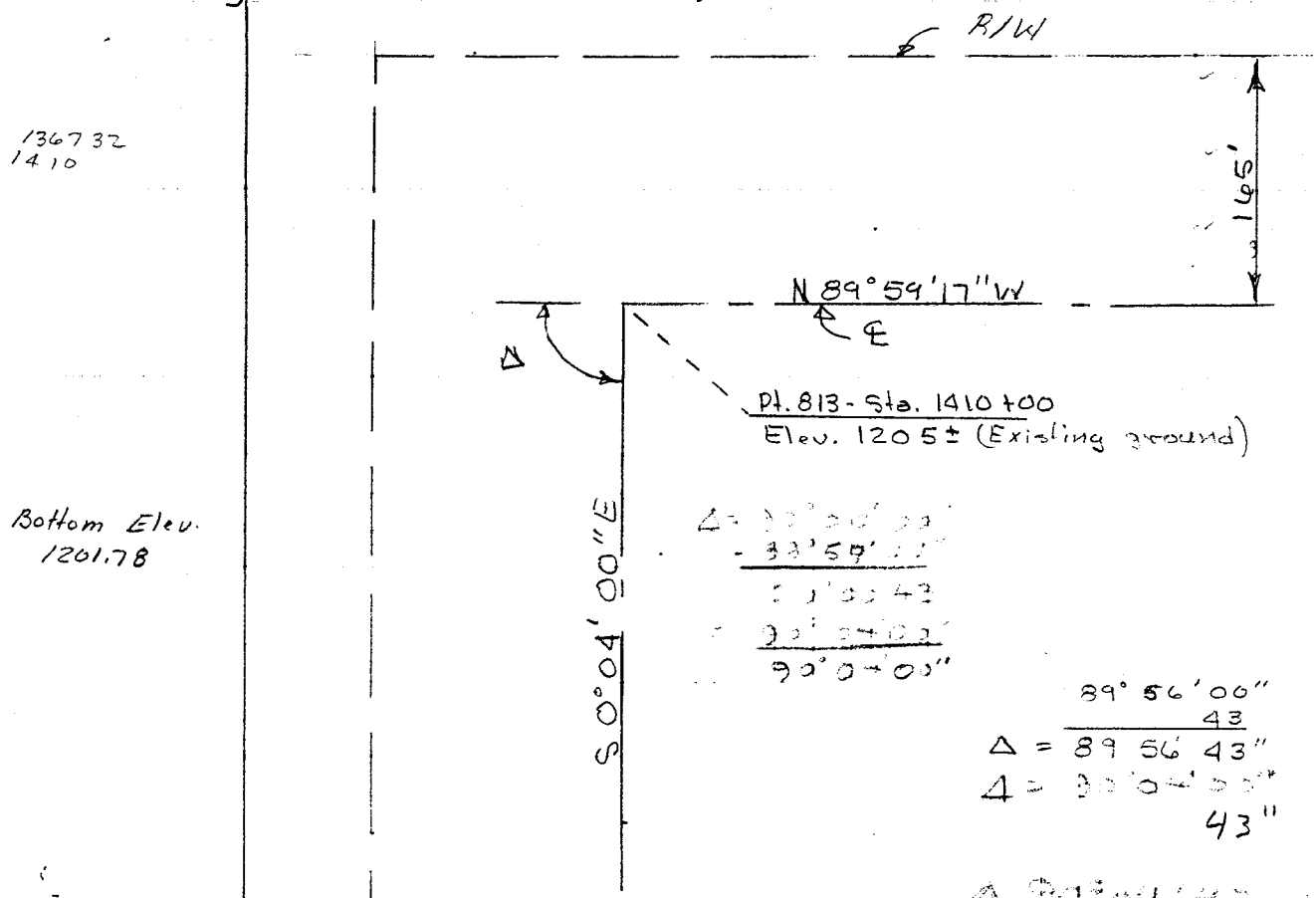

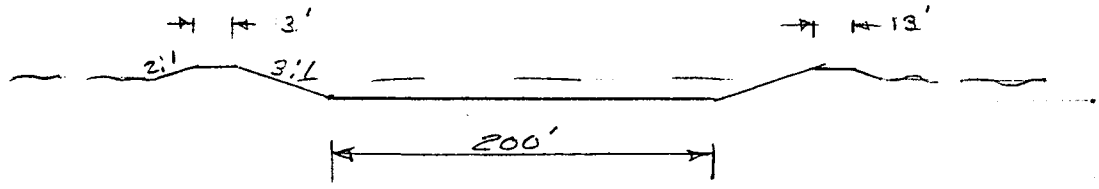

Typical X-Section

STATE		PROJECT		
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Distance Required For X-Section

Bottom Elev. - 1201.8 ±

Existing Ground Line Elev. - 1205 ±

Top of Embankment - 1209.8 ±

$200 + (2)(3)(8) + (2)(13) + (2)(2)(4.8) \approx 293$

Curve Data

"Route Survey & Design" Hickerson 4th Edition P. 57 → 64

$\Delta = 89° 56' 43''$

$D = 7° 00'$ From Work Plan Data.

Monroe 1880 Circular Curve Program - 8200 A

$R = \frac{5729.58}{D} = 818.51'$

$T = R \tan \frac{1}{2}\Delta = 817.73'$

$L = 100\ \Delta/D = 1284.93'$

FWS P. 6-6

Superelevation

F.W.S P. 6-6

$$S = \frac{V^2(b + 2zd)}{2(gR - 2zV^2)}$$

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$$S = \frac{(6.71)^2[200+(2)(3)(5.95)]}{2[(32.2)(818.51)-(2)(3)(6.71)^2]} = 0.203 < 1.0' \text{ ok}$$

FWS - P. 6-13c

Rock Riprap

$$D_{75} = \frac{3.5}{CK} \; wDS \quad (\text{inches})$$

$$\frac{\text{Curve Radius}}{\text{Water Surface width}} = \frac{819}{236} = 3.5$$

Use $C = 0.60$, $K = 0.87$, $W = 64.2$, $D = 5.95$ & $S = 0.00155$

$$D_{75} = \frac{3.5}{(0.60)(0.87)}(62.4)(5.95)(0.00155) \approx 4''$$

∴ would not need protection for the curve, but will check more throughly in final Design

Conclusions

1. Required Superelevation - 0.2'
2. No bank protection required

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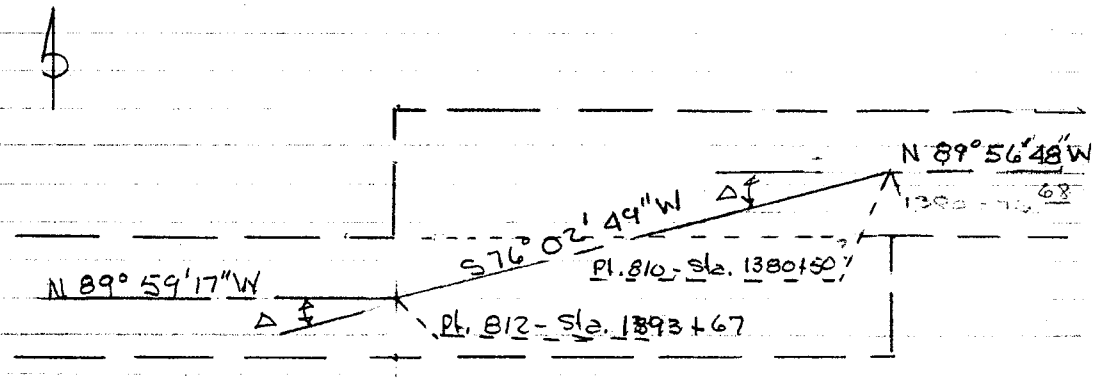

1317

1360.52

The above stationing is not correct, but the distance between Pl. 812 & 810 is 680.16 + 680.16 = 1360.32' (from survey data)

89 59 60
76 02 49
13° 57' 11"
43
13° 57' 54"

Pl. 812

T = 680.16 - max.

Δ = 13° 57' 54"

Distance Req'd For X-Section

Bottom Elev. - 1204.3 ±

Existing Ground Surface - 1209.0 ±

Top of Embankment - 1212.3 ±

200 + (2)(5)(8) + (2)(13) + (2)(2)(3.3) = 287.2

Max. E = 330 - 287 ≈ 43' - Use 35'

$T = \frac{E}{\tan \frac{1}{4}\Delta}$ = 573.68 max. for this restriction of E

Use 573.50

$$R = \frac{T}{\tan \frac{1}{2}\Delta} = 4682.606'$$

$$D = \frac{5729.58}{R} = 1°13'25''$$

$$L = 100\,\frac{\Delta}{D} = 1141.\overset{.293'}{317}'$$

$$\text{Chord} = 2R \sin \tfrac{1}{2}\Delta = 1138.493'$$

1138.515

Superelevation

$$S = \frac{V^2(b + 2.3d)}{2(gR - 2zV^2)} = \frac{(6.71)^2[200 + (2)(3)(5.95)]}{(2)[(32.2)(4682.61) - (2)(3)(6.71^2)]}$$

$$S = 0.035'$$

∴ do not need to increase bank height

Rock Riprap

Will not be needed for this curve

Pt. 810

13 57 11
3 12
14°00'23

$$\Delta = 14°00'\overset{23''}{28''}$$

E - Use 35'

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$$T = \frac{E}{\tan \frac{1}{4}\Delta} = 571.92 \text{ — Use } 572.0'$$

$$E = T \tan \tfrac{1}{4}\Delta = 35.00'$$

$$R = \frac{T}{\tan \frac{1}{2}\Delta} = 4655.954'$$

$$D = \frac{5729.58}{R} = 1°13'50''$$

$$L = 100 \frac{\Delta}{D} = 1138.296'$$

$$\text{Chord} = 2R \sin \tfrac{1}{2}\Delta = 1135.463$$

Superelevation

$$S = \frac{(6.71)^2[200 + (2)(3)(5.95)]}{2\,[(32.2)(4655.95) - (2)(3)(6.71^2)]} = 0.0355'$$

∴ Will not need to increase the embankment height for this small amount

Rock Riprap

Will not need for this curve

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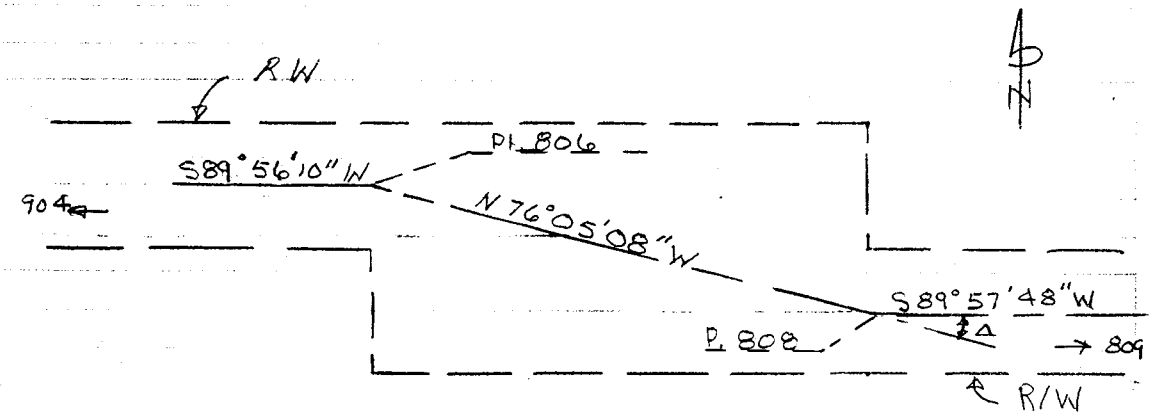
Alignment - Preliminary Design				

Pt. 809

Use an angle point 0°01' change in bearing

Pt. 808

89 59 60
76 05 08
13 54 52
2 12
13 57 04



1367.32
1.84
1365.48

Distance between 806 & 808 - 1360.46'

Bottom Elev. - 1226.7 ±

Top of Embankment - 1234.7 ±

Ground Surface - 1233.0 ±

Distance req'd for X-section

200 + (2)(3)(8) + (2)(13) + (2)(2)(2) = 282

330 - 282 = 48

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Curve Data

E - Use 40'

$\Delta = 13°57'04''$

$T = \frac{E}{\tan \frac{1}{4}\Delta} = 656.292'$

$R = \frac{T}{\tan \frac{1}{2}\Delta} = 5363.985'$

$D = \frac{5729.58}{R} = 1°04'05''$

$L = 100 \frac{\Delta}{D} = 1306.092'$

$\text{Chord} = 2R \sin \frac{1}{2}\Delta = 1302.868'$

Superelevation

$$S = \frac{(6.71)^2[200 + (2)(3)(5.95)]}{(2)[(32.2)(5363.99) - (2)(3)(6.71)^2]} = 0.031'$$

∴ Do not need to increase the height of the embankment

Rock Riprap

Protection will not be required

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Alignment - Preliminary Design				

Point 806

13 54 52
3 50
13° 58 42

Curve Data

$\Delta = 13°58'42''$

E - Use 40'

$T = \frac{E}{\tan \frac{1}{4}\Delta} = 655.01'$

$R = \frac{T}{\tan \frac{1}{2}\Delta} = 5342.984'$

$D = \frac{5729.58}{R} = 1°04'20''$

$L = 100 \frac{\Delta}{D} = 1303.516'$

$\text{Chord} = 2R \sin \frac{1}{2}\Delta = 1300.286$

Superelevation

$$S = \frac{(6.71^2)[200 + (2)(3)(5.95)]}{(2)[(32.2)(5342.94) - (2)(3)(6.71^2)]} = 0.0309'$$

∴ Do not need to increase the height of the embankment

Rock Riprap

Protection will not be required

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Point	Grid Distance	Ground Distance	Grid Stationing	Ground Stationing	Plan-Profile Stationing
904			1209+00	1209+00	1209+00
	2639.27	2639.69			
806			1235+39.27	1235+39.69	1235+42
	680.23	680.34			
807			1242+19.50	1242+20.03	1242+00
	680.23	680.34			
808			1248+99.73	1249+00.37	1248+53
	6595.75	6596.79			
809			1314+95.48	1314+97.16	1314+48
	6592.78	6593.82			
810			1380+88.26	1380+90.98	1380+50
	680.16	680.26			
811			1387+68.42	1387+71.24	1387+16
	680.16	680.26			
812			1394+48.58	1394+51.50	1393+67
	1484.73	1484.96			
813			1409+33.31	1409+36.46	1410+00
	4813.32	4814.08			
814			1457+46.63	1457+50.54	1459+93

Grid Bearings	From	To	Grid Azimuth	Grid Dist.	~~Grid~~ GROUND Dist.
N 11° 24' 40" E	PI2	PI1	11-24-40	None	None
N 69° 49' 21" W	PI2	800	290-10-39	467.36	467.43
S 25° 43' 28" W	800	801	205-43-28	1182.75	1185.94
S 26° 20' 42" W	801	802	206-20-42	1867.84	1868.14
S 19° 19' 39" W	802	803	199-19-39	785.74	785.87
S 64° 57' 29" W	803	804	244-57-29	4326.95	4327.63
S 65° 37' 02" W	804	805	245-37-02	2931.06	2931.52
	End Existing RWCD Floodway				
S 52° 00' 28" W	805	901	232-00-28	5324.23	5325.07
S 73° 42' 12" E	901	900	106-17-48	1383.10	1383.32
S 87° 08' 31" W	901	902	267-08-31	712.54	712.65
N 52° 45' 38" W	901	903	307-14-22	826.13	826.26
	End Pit and Spoil Area				
S 16° 12' 54" W	805	904 (1209+00)	196-12-54	4399.53	4400.23
S 89° 56' 10" W	904	806	269-56-10	2639.27	2639.69
S 19° 03' 23" E	901	806	160-56-37	1005.19	1005.35
N 76° 05' 08" W	806	807	283-54-52	680.23	680.34
N 76° 05' 08" W	807	808	283-54-52	680.23	680.34
S 89° 57' 48" W	808	809	269-57-48	6595.75	6596.79
N 89° 56' 48" W	809	810	270-03-12	6592.78	6593.82
S 76° 02' 49" W	810	811	256-02-49	680.16	680.26
S 76° 02' 49" W	811	812	256-02-49	680.16	680.26
N 89° 59' 17" W	812	813	270-00-43	1484.73	1484.96
S 0° 04' 10" E	813	814	179-56-00	4813.32	4814.08
	End Proposed RWCD Floodway				
S 89° 58' 29" W	815	711	269-58-29	1520.88	1521.12
S 89° 58' 30" W	711	816	269-58-30	2636.75	2637.16
N 0° 03' 04" W	816	809	359-56-56	1484.76	1484.99
N 89° 57' 00" W	816	819	270-03-00	5383.78	5384.63
N 0° 03' 01" W	819	819X	359-56-59	149.98	150.00
S 0° 03' 01" E	819	817	179-56-59	1320.15	1320.36
N 89° 57' 10" W	817	818	270-02-50	2537.73	2538.13
	End Proposed Lateral 9-49				
S 0° 05' 40" E	814	M-1	179-54-20		280.65
S 34° 27' 03" W	M-1	M-2	264-27-03		655.35
S 70° 33' 14" W	M-2	M-3	250-33-14		424.20
S 61° 57' 32" W	M-3	M-4	241-57-32		298.99
S 47° 11' 53" W	M-4	M-5	227-11-53		472.20
S 17° 57' 39" W	M-5	M-6	197-57-39		610.74
S 39° 24' 44" W	M-6	M-7	219-24-44		603.10
S 37° 54' 04" W	M-7	M-8	217-54-04		612.71
S 68° 01' 40" W	M-8	M-9	248-01-40		341.65
S 86° 56' 18" W	M-9	M-10	266-56-18		411.28
N 58° 54' 30" W	M-10	M-11	301-05-30		413.33
N 68° 24' 49" W	M-11	M-12	291-35-11		378.25
N 49° 00' 58" W	M-12	M-13	310-59-02		412.73

AERIAL MAPPING COMPANY, INC.

RWCD FLOODWAY (GILA BUTTE AREA) JOB NO. 77125 X

U.S. CONSERVATION SERVICE

700 - Point listed is a Rebar
800 - Points listed are Brass Caps Set in Concrete
900 - Points listed are Rebars
M - Points listed are 2 x 2 Hubs

CONTROL POINT LISTING
COORDINATES ON STATE PLANE CENTRAL

Point No.	Northing	Easting	Elevation
Gila Butte	784156.87	516948.23	1656 VA
711	787452.93	531296.13	1223.17
800	799363.45	548634.31	1294.47
801	798297.92	548120.94	1292.32
802	796624.07	547292.04	1284.09
803	795882.62	547031.98	1278.27
804	794051.10	543111.78	1253.01
805	792841.07	540442.15	1244.28
806	788613.61	536574.35	1237.12
807	788777.18	535914.07	1234.38
808	788940.76	535253.80	1233.17
809	788936.53	528658.05	1221.70
810	788942.68	522065.27	1211.47
811	788778.67	521405.19	1210.79
812	788614.67	520745.10	1208.87
813	788614.97	519260.37	1205.15
814	783801.66	519265.97	1200.31
815	787453.60	532817.00	1231.25
816	787451.78	528659.38	1216.27
816 Nail	787601.78	528659.25	None
817	786136.33	523276.76	1208.92
818	786138.43	520739.03	1205.94
819	787456.48	523275.60	1212.88
819 X	787606.46	523275.47	1212.60
900	789175.60	537573.68	1240.74
901	789563.71	536246.15	1248.25
902	789528.18	535534.50	1237.25
903	790063.64	535588.46	1232.51
5/a 1209+00 904	788616.54	539213.62	1240.90
PI 2	799202.25	549072.99	1295.33 VA

BM Anderson — Set Brass Cap in Concrete in Granite Bowlder Near S.E. End of Gila Butte Elevation 1202.39

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BY: JLS | DATE: 4-14-78 | CHECKED BY: | DATE: | JOB NO.: RWCD-Reach 1
SUBJECT: Lateral 9-49; Preliminary Design | SHEET 15 OF 23

Point	Bearing	Distance	Station
815			10+00.00
	S 89°58'29" W	1520.88	
711			25+20.88
	S 89° 58' 30" W	2636.75	
816			51+57.63
	N89°57'00" W	5383.78	
819			105+41.41
	N89° 57'00" W	20.00	
819' (20' West of 819)			105+61.41
	S0° 03'01" E	1250.15	
817' (North of 817 70')			118+11.56
	N89° 57' 10" W	2517.73	
818 (20' North of 818)			143+29.29

AERIAL MAPPING COMPANY, INC.

RWCD FLOODWAY (GILA BUTTE AREA) JOB NO. 77125 X

U.S. CONSERVATION SERVICE

700 - Point listed is a Rebar
800 - Points listed are Brass Caps Set in Concrete
900 - Points listed are Rebars
M - Points listed are 2 x 2 Hubs

CONTROL POINT LISTING
COORDINATES ON STATE PLANE CENTRAL

Point No.	Northing	Easting	Elevation
Gila Butte	784156.87	516948.23	1656 VA
711	787452.93	531296.13	1223.17
800	799363.45	548634.31	1294.47
801	798297.92	548120.94	1292.32
802	796624.07	547292.04	1284.09
803	795882.62	547031.98	1278.27
804	794051.10	543111.78	1253.01
805	792841.07	540442.15	1244.28
806	788613.61	536574.35	1237.12
807	788777.18	535914.07	1234.38
808	788940.76	535253.80	1233.17
809	788936.53	528658.05	1221.70
810	788942.68	522065.27	1211.47
811	788778.67	521405.19	1210.79
812	788614.67	520745.10	1208.87
813	788614.97	519260.37	1205.15
814	783801.66	519265.97	1200.31
815	787453.60	532817.00	1231.25
816	787451.78	528659.38	1216.27
816 Nail	787601.78	528659.25	None
817	786136.33	523276.76	1208.92
818	786138.43	520739.03	1205.94
819	787456.48	523275.60	1212.88
819 X	787606.46	523275.47	1212.60
900	789175.60	537573.68	1240.74
901	789563.71	536246.15	1248.25
902	789528.18	535534.50	1237.25
903	790063.64	535588.46	1232.51
Sta 1209+00 904	788616.54	539213.62	1240.90
PI 2	799202.25	549072.99	1295.33 VA

BM Anderson — Set Brass Cap in Concrete in Granite Bowlder Near S.E. End of Gila Butte Elevation 1202.39

Grid Bearings	From	To	Grid Azimuth	Grid Dist.	~~Grid~~ GROUND Dist.	
N 11° 24'40"E	PI2	PI1	11-24-40	None	None	
N6 "21"W	PI2	800	290-10-39	467.36	467.43	
S 2: 28" W	800	801	205-43-28	1182.75	1185.94	
S 26° 20'42"W	801	802	206-20-42	1867.84	1868.14	
S 19° 19'39"W	802	803	199-19-39	785.74	785.87	
S 64° 57'29"W	803	804	244-57-29	4326.95	4327.63	
S 65°37'02"W	804	805	245-37-02	2931.06	2931.52	
	End Existing RWCD Floodway					
S 52°00'28"W	805	901	232-00-28	5324.23	5325.07	
S 73° 42'12"E	901	900	106-17-48	1383.10	1383.32	
S 87° 08'31"W	901	902	267-08-31	712.54	712.65	STUB
N 52° 45'38"W	901	903	307-14-22	826.13	826.26	STUB
	End Pit and Spoil Area					
S 16° 12'54"W	805	904	196-12-54	4399.53	4400.23	
S 89°56'10"W	904 →	806	269-56-10	2639.27	2639.69	
S 19° 03'23"E	901	806	160-56-37	1005.19	1005.35	
N 76°05'08"W	806	807	283-54-52	680.23	680.34	
N 76°05'08"W	807	808	283-54-52	680.23	680.34	
S 89°57'48"W	808	809	269-57-48	6595.75	6596.79	
N 89°56'48"W	809	810	270-03-12	6592.78	6593.82	
S 76°02'49"W	810	811	256-02-49	680.16	680.26	
S 7 "49"W	811	812	256-02-49	680.16	680.26	
N 8 9'17"W	812	813	270-00-43	1484.73	1484.96	
S 0° 04'10"E	813	814	179-56-00	4813.32	4814.08	
	End Proposed RWCD Floodway					
S 89°58'29"W	815	711	269-58-29	1520.88	1521.12	
S 89°59'30"W	711	816	269-58-30	2636.75	2637.16	
N 0° 03'04"W	816	809	359-56-56	1484.76	1484.99	
N 89°57'00"W	816	819	270-03-00	5383.78	5384.63	
N 0° 03'01"W	819	819X	359-56-59	149.98	150.00	
S 0° 03'01"E	819	817	179-56-59	1320.15	1320.36	
N 89°57'10"W	817	818	270-02-50	2537.73	2538.13	
	End Proposed Lateral 9-49					
S 0° 05'40"E	814	M-1	179-54-20		280.65	
S 84° 27'03"W	M-1	M-2	264-27-03		655.35	
S 70° 33'14"W	M-2	M-3	250-33-14		424.20	
S 61°57'32"W	M-3	M-4	241-57-32		298.99	
S 47° 11'53"W	M-4	M-5	227-11-53		472.20	
S 17°57'39"W	M-5	M-6	197-57-39		610.74	
S 39° 24'44"W	M-6	M-7	219-24-44		603.10	
S 37°54'04"W	M-7	M-8	217-54-04		612.71	
S 68° 01'40"W	M-8	M-9	248-01-40		341.65	
S 8 "18"W	M-9	M-10	266-56-18		411.28	
S. 4'30"W	M-10	M-11	301-05-30		413.33	
S 68° 24'49"W	M-11	M-12	291-35-11		378.25	
S 49°00'58"W	M-12	M-13	310-59-02		412.73	

COMPUTATION SHEET
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SOIL CONSERVATION SERVICE

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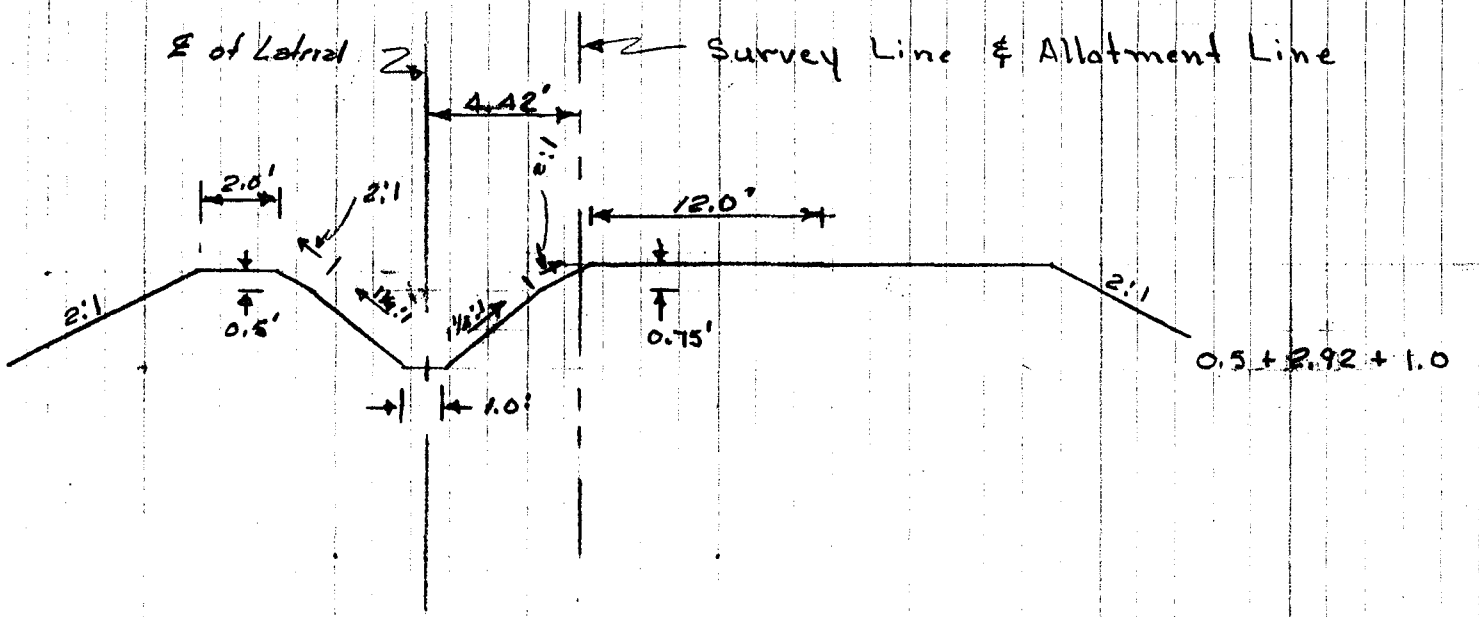
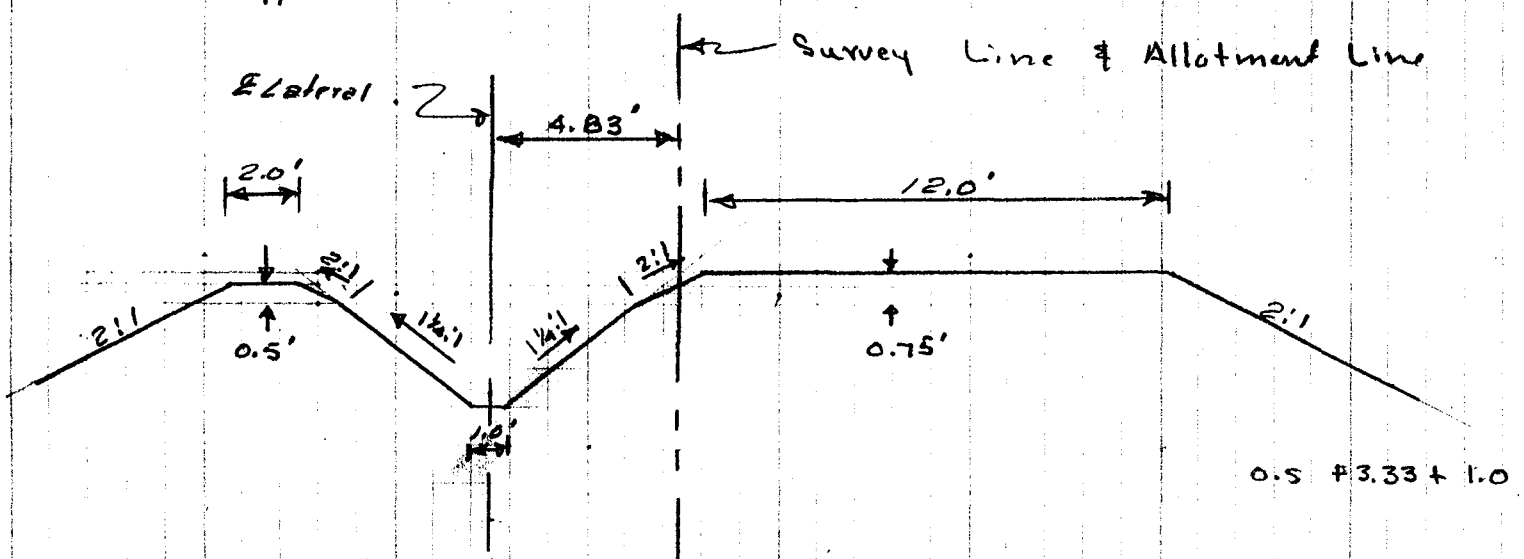
STATE	PROJECT	JOB NO.
Arizona	William-Chandler WPP	RWCD - Reach 1
BY JLS	DATE 4-17-78	CHECKED BY
SUBJECT Lateral 9-49 ; Preliminary Design		DATE
		SHEET 18 OF 23



Typical X-Section Between Sta. 10+00 & 60+00 (28" Depth)



Typical X-Section Between Sta 60+00 & 103+25 (32" depth)

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-23-78			RWCD - Phase I
SUBJECT Hydraulics - Preliminary Design				SHEET 1 OF 13

Objective

Determine the effect that the Gila River would have on the outlet of the RWCD Floodway

Basic Information

$Q_{Floodway}$ = 8700 cfs
$b_{Floodway}$ = 200'
$W_{outlet\ str.}$ = 200'
$S_{Floodway}$ = 0.00155

References

1. "Handbook of Hydraulics," 5th Edition - King & Brater
2. T.R. No. 25 - "Planning And Design Of Open Channels" - SCS
3. "Engineering Design Standards", Far West States - SCS
4. NEH 11, "Drop Spillways - SCS
5. Monroe 1880, Water Surface Profile program
6. Hydrology by R.P. McArthur

STATE Arizona		PROJECT William-Chandler WPP		
BY JLS	DATE 3-23-78	CHECKED BY	DATE	JOB NO. RWCD- Phase I
SUBJECT Hydraulics - Preliminary Design				SHEET 2 OF 13

Assumptions & Criteria

1. Most severe conditons will be:

   a. Gila River carrying the 1% chance and the RWCD Floodway carrying the 10% chance or base flow.

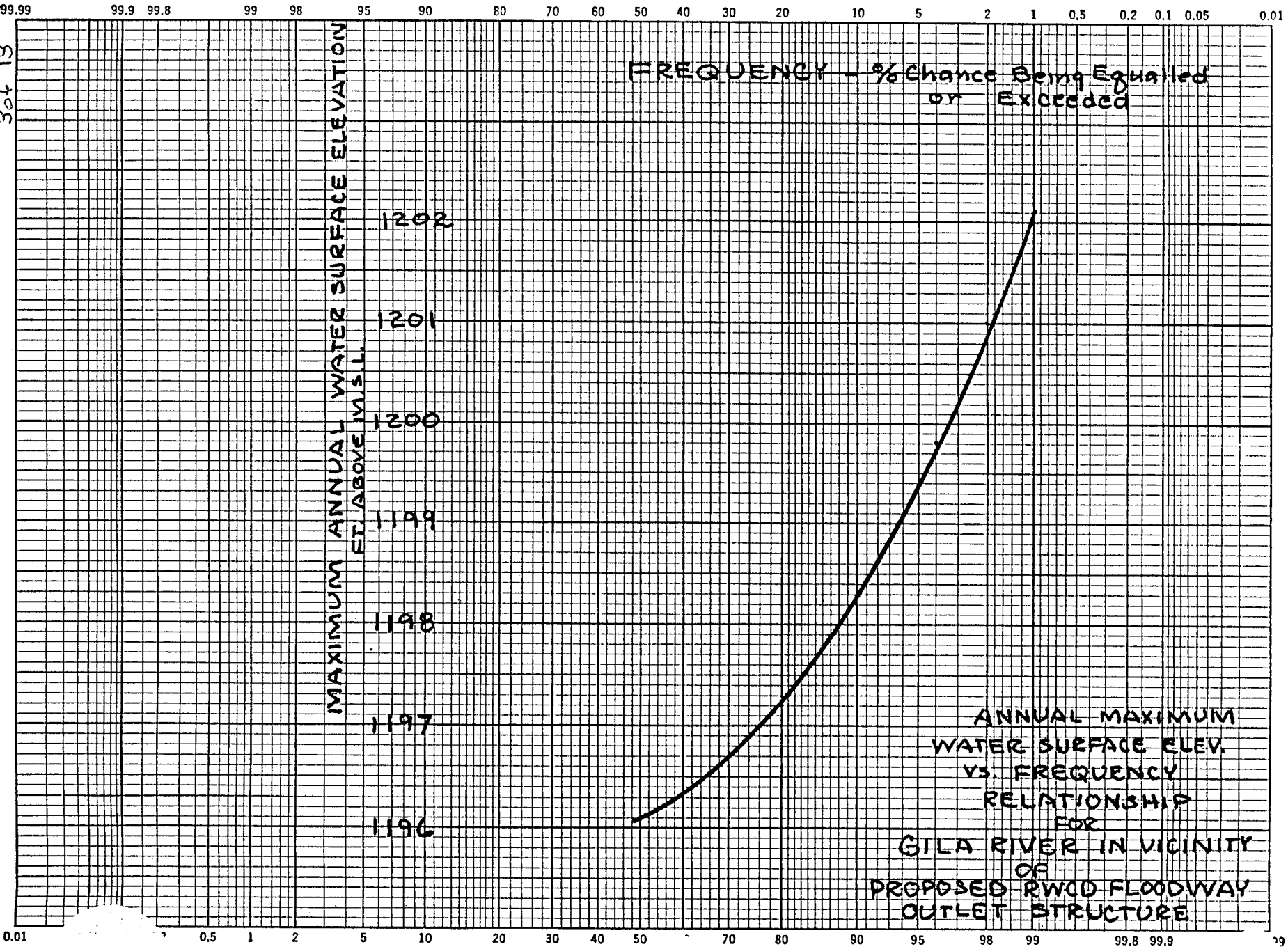
   1% Gila & — 10% RWCD (2200) / Base Flow RWCD — Which ever is greater — Powerline (650) / Queen Cr. (1775) — 2425

   b. Gila River carrying the 10% & the RWCD Floodway carrying design flow 8700 cfs

   c. No Flow Gila River & RWCD flow being Q_d - 8700 cfs

2. Max. width of channel, outside toe of embankment to outside toe of embankment can not exceed 330.0'

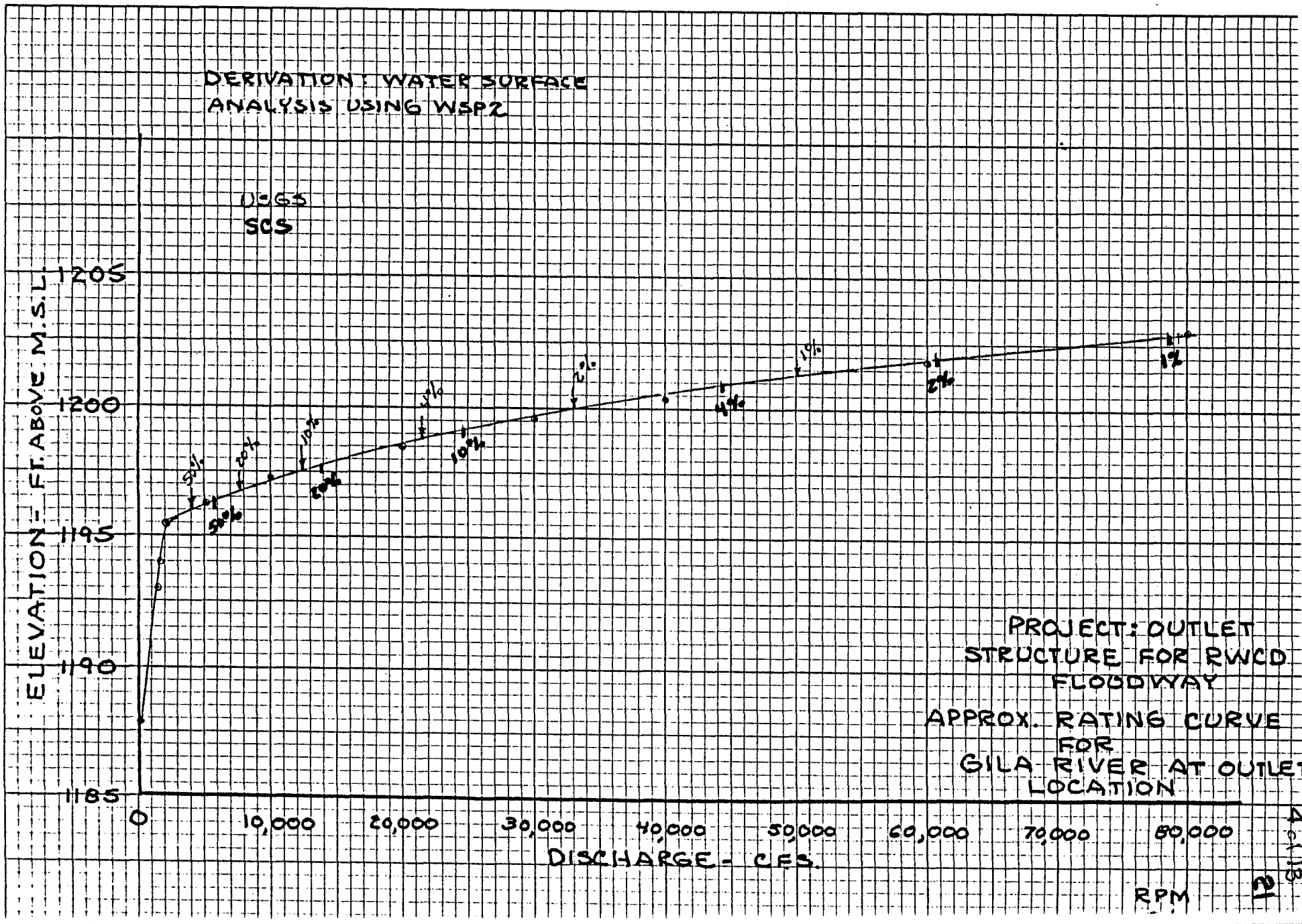
3. Elev. of the crest of outlet str - 1194.15


FREQUENCY - % Chance Being Equalled or Exceeded
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
MAXIMUM ANNUAL WATER SURFACE ELEVATION
FT. ABOVE M.S.L.
1202
1201
1200
1199
1198
1197
1196
ANNUAL MAXIMUM WATER SURFACE ELEV. VS. FREQUENCY RELATIONSHIP FOR GILA RIVER IN VICINITY OF PROPOSED RWCD FLOODWAY OUTLET STRUCTURE

RPI
3/70

K•E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 0780

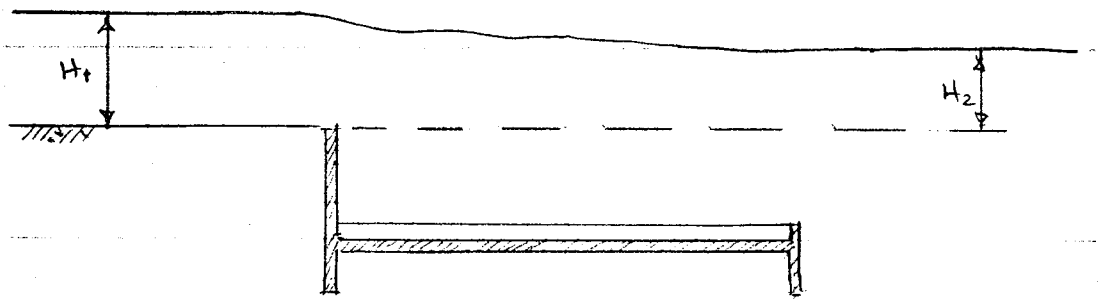


STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 3-27-78	CHECKED BY	DATE	JOB NO. RWCD - Phase I
SUBJECT Hydraulics - Preliminary Design				SHEET 5 OF 13

Condition 1.a.

Gila River flow equal to the 100 yr. storm & the RWCD flow equal to the Base flow 2425 cfs

Max. W.S. of the Gila River - 1202.1 ±



Crest of drop spillway 1194.1 ±

$\therefore H_2 = 8.0'$ use

Max Bank Height

Ground surface use 1201

1201
- 1194.1
6.9

$330 - [200 + (2)(6.9)(3) + (2)(13) + (10)(X)] = 0$

$62 = 10X$

$X = 6.2$ use 5.5

max bank Elev. = 1194.1 + 6.9 + 5.5 = 1206.5

STATE Arizona		PROJECT Williams-Chandler WPP.		
BY JLS	DATE 3-27-78	CHECKED BY	DATE	JOB NO. RWCD - Phase I
SUBJECT Hydraulics - Preliminary Design				SHEET 6 OF 13

Develope a curve H_2/H_1 vs Q_s using $H_2 = 8.0$

Let $H_1 = 8.1$ $H_2/H_1 = 0.988$ & $R = 0.065$

NEH 11 P. 3.16

$Q_f = 3.1\ L H_1^{3/2} = 14,293$

$Q_s = R Q_f = 929$ cfs

Let $H_1 = 8.2$; $H_2/H_1 = 0.976$; $R = 0.17$

$Q_f = 14,558$

$Q_s = 2475$ cfs

Let $H_1 = 8.3$; $H_2/H_1 = 0.964$; $R = 0.24$

$Q_f = 14,825$

$Q_s = 3558$ cfs.

Let $H_1 = 8.4$; $H_2/H_1 = 0.952$; $R = 0.32$

$Q_f = 15,094$

$Q_s = 4830$

Let $H_2 = 8.5$; $H_2/H_1 = 0.941$; $R = 0.38$

$Q_f = 15,365$

$Q_s = 5839$

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 3-27-78	CHECKED BY MLG	DATE 9-5-78	JOB NO. RWCD - Phase I
SUBJECT Hydraulics - Preliminary Design				SHEET 7 OF 13

Let $H_2 = 8.6$; $H_2/H_1 = 0.93$; $R = 0.43$

$Q_f = 15,636$

$Q_s = 6724$

Let $H_2 = 8.7$; $H_2/H_1 = 0.92$; $R = 0.495$

$Q_f = 15,910$

$Q_s = 7875$

Let $H_2 = 8.8$; $H_2/H_1 = 0.91$; $R = 0.55$

$Q_f = 16,185$

$Q_s = 8,902$

Let $H_2 = 8.9$; $H_2/H_1 = 0.899$; $R = 0.595$

$Q_f = 16,462$

$Q_s = 9,795$

Let $H_2 = 9.0$; $H_2/H_1 = 0.889$; $R = 0.64$

$Q_f = 16,740$

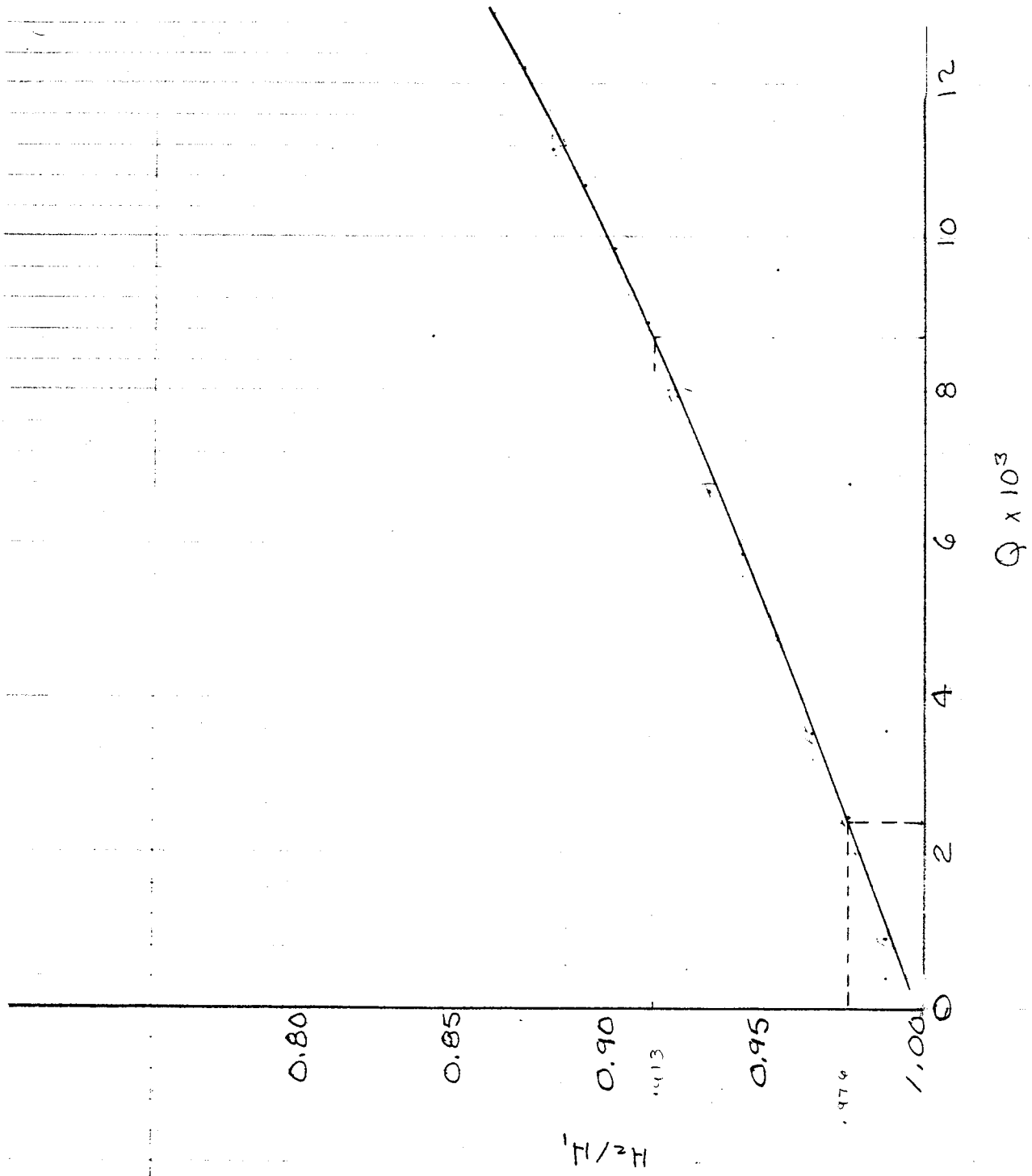
$Q_s = 10,714$

Let $H_2 = 9.1$; $H_2/H_1 = 0.879$; $R = \cancel{0.655}$ 0.665

$Q_f = 17,020$

$Q_s = \cancel{11,148}$ 11,318

STATE Arizona		PROJECT Williams-Chandler WPP		
BY JLS	DATE 3-27-78	CHECKED BY	DATE 9-5-78	JOB NO. RWCD-Phase I
SUBJECT Hydraulics - Preliminary Design				SHEET 8 OF 13



STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-27-78	MLG	9-6-78	RWCD - Phase I
SUBJECT				SHEET 9 OF 13
Hydraulics - Preliminary Design				

For $Q_s = 2425$

$H_2/H_1 = 0.976$

$H_1 = 8.00/0.976 = 8.198$

$H_1 = H + V^2/2g = 8.198$

$V^2 = 64.4(8.198 - H)$

&

$V = Q/A = 2425/[200H + 3H^2]$

then

$[64.4(8.198 - H)]^{1/2}[200H + 3H^2] = 2425$

$H \approx 8.171$

$[64.4(8.198 - 8.171)]^{1/2}[(200)(8.171) + (3)(8.171^2)] = 2425$

$(\cancel{1.217}\ 1.318)(1635 + 200.3) = 2425$

$2419 = 2425$ ok use

$V^2/2g = 0.027$

$V = 1.32$ fps

Total Height of Embankment

FWS P.64 $F.B = .2\,H_e = 0.2 \times 8.198 = 1.64$

$1194.1 + 8.171 + 1.64$ (9.81) $= 1203.91$ Use 1204.0

ok < 1206.5 will be within the 330'

STATE Arizona		PROJECT Williams-Chandler WPP		
BY JLS	DATE 3-27-78	CHECKED BY	DATE	JOB NO. FWSD-Phase I
SUBJECT Hydraulics - Preliminary Design				SHEET 10 OF 18

2,425.00	o
0.0270	n
0.001550	SI
0.00	t
1.15	A
.....	
145,925.00	S1
1,194.15	e
200.00	X
3.00	z
8.171	D1
1.32	Λ
1.72	Da
0.08	F
145,500.00	S2
1,194.80	e
200.00	X
3.00	z
7.526	D2
1.44	Λ
1.72	Da
0.09	F
.....	
.....	
145,000.00	S2
1,195.58	e
200.00	X
3.00	z
6.773	D2
1.62	Λ
1.72	Da
0.11	F
144,500.00	S2
1,196.35	e
200.00	X
3.00	z
6.032	D2
1.84	Λ
1.72	Da
0.13	F
.....	
.....	
144,000.00	S2
1,197.13	e
200.00	X
3.00	z
5.309	D2
2.11	Λ
1.72	Da
0.16	F
.....	
.....	
143,500.00	S2
1,197.90	e
200.00	X
3.00	z
4.619	D2
2.45	Λ
1.72	Da
0.20	F
.....	
.....	
143,000.00	S2
1,198.68	e
200.00	X
3.00	z
3.987	D2
2.86	Λ
1.72	Da
0.26	F

STATE		PROJECT		
Arizona		Williams - Chandler		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-27-78			RWCD - Phase I
SUBJECT				SHEET 11 OF 13
Hydraulics - Preliminary Design				

142,500.00		S2	140,500.00	S2
1,199.45	e		1,202.55	e
200.00		X	200.00	X
3.00		Z	3.00	Z
3.457		D2	2.796	D2
3.33	Λ		4.16	Λ
1.72		Da	1.72	Da
0.32		F	0.44	F
142,000.00		S2	140,000.00	S2
1,200.23	e		1,203.33	e
200.00		X	200.00	X
3.00		Z	3.00	Z
3.086		D2	2.791	D2
3.75	Λ		4.16	Λ
1.72		Da	1.72	Da
0.38		F	0.44	F
141,500.00		S2	139,800.00	S2
1,201.00	e		1,203.64	e
200.00		X	200.00	X
3.00		Z	3.00	Z
2.890		D2	2.790	D2
4.01	Λ		4.16	Λ
1.72		Da	1.72	Da
0.42		F	0.44	F
141,000.00		S2	139,600.00	S2
1,201.78	e		1,203.95	e
200.00		X	200.00	X
3.00		Z	3.00	Z
2.817		D2	2.790	D2
4.12	Λ		4.17	Λ
1.72		Da	1.72	Da
0.44		F	0.44	F

STATE		PROJECT		
Arizona		Williams- Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-27-78			RWCD- Phase I
SUBJECT				SHEET 12 OF 13
Hydraulics - Preliminary Design				

Condition 1.b.

Gila River having the 10% chance flow & the RWCD Floodway flow being the design Q - 8700 cfs.

Water surface in the Gila would be 1198.3± & having a flow of 18,000 cfs, but the RWCD Floodway would be putting 8,700 into the river raising is base flow up to 26,700 cfs.
The W.S. elev. for this base flow would be 1199.4 ±

$\therefore H_2 = 1199.4 - 1194.15 = 5.25'$

$\& \; H_1 = 5.95 + (6.71)^2/64.4 = 6.649'$

$Q_f = (3.1)(200)(6.649)^{3/2} = 10,630'$

$H_2/H_1 = 5.25/6.65 = 0.79'$

Then $R = 0.845'$

$Q_s = (10,630)(0.845) = 8982'$ cfs > 8700
$\therefore$ will not be enough submergence to restrict the flows in the floodway

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 4-3-77	CHECKED BY	DATE	JOB NO. RWCD - Phase I
SUBJECT Hydraulics - Preliminary Design				SHEET 13 OF 13

Condition 1.C.

No flow in the Gila River & the RWCD flow being 8700 cfs

The water surface in the Gila River would be 1197.0 ±

$\therefore H_2 = 1197.0 - 1194.15 = 2.85$

& $H_2/H_1 = 2.85/4.65 = 0.43$ (For H_1 see sht. 10)

$R = 0.985$

$\therefore$ Submergence is not enough to restrict the flows in the floodway.

Conclusions

The only condition that would affect the flows in the floodway would be 1.a. - Gila Rive flow being the 1% & the Floodway having the base flow - 2425 cfs.
It would take approx. 6,000 feet for the water depth in the Floodway to be back to normal depth. This would not affect the operation of the floodway or the bridge for State Route 93.

Depth @ normal flow = 1202.15

Top of bank would have to be 1204.0, it would have S = 0.00 for 1194.0' upstream then the slope of the bank would be the same as the bottom S = 0.00155

STATE	PROJECT			
Arizona	Williams-Chandler WPP			
BY JLS	DATE 3-29-78	CHECKED BY	DATE	JOB NO. RWCD- Phase I
SUBJECT Floodway X-ing of San Tan Canal No. 9				SHEET 1 OF 11

Objective

Select a pipe size that can carry the expected flows of San Tan Canal No. 9 under the RWCD Floodway at Sta. 1284+00 ±

Basic Information

The following information was obtained from Hugh Nelmes, Irrigation Specialist, BIA on 3-31-78

Q - design 51 cfs

Q - Freeboard 102 cfs

n = 0.012

References

1. Design Of Small Canal Structures - USDI Bureau Of Reclamation, 1974
2. NEH 5, Hydraulics - SCS

Assumptions & Criteria

1. Velocity be — $3.5 < V < 10.0$
2. Min. cover 2.0'

STATE		PROJECT		
Arizona		Williams- Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-29-78			RWCD- Phase I
SUBJECT				SHEET 2 OF 11
Floodway & San Tan Canal No.9 x-ing				

3. Min Slope = 0.005 ≠ 2:1 Max.

4. Sharp Cornered Entrance

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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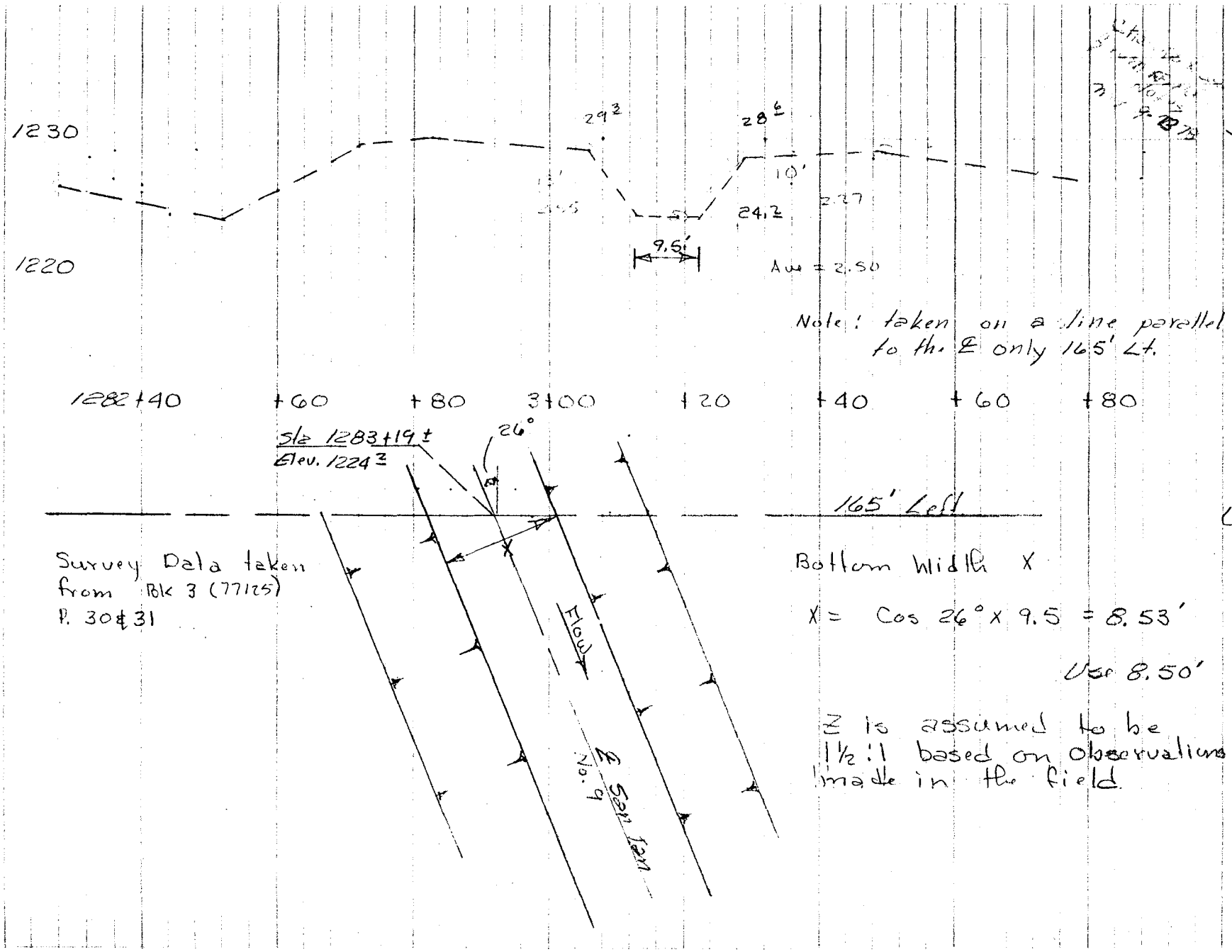
STATE	PROJECT
Arizona	Williams-Chandler WPP
BY JLS / DATE 3-29-78	CHECKED BY / DATE
SUBJECT Floodway ℄ San Tan No. 9 X-ing	JOB NO. RWCD-Phase I
	SHEET 3 OF 11



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SOIL CONSERVATION SERVICE

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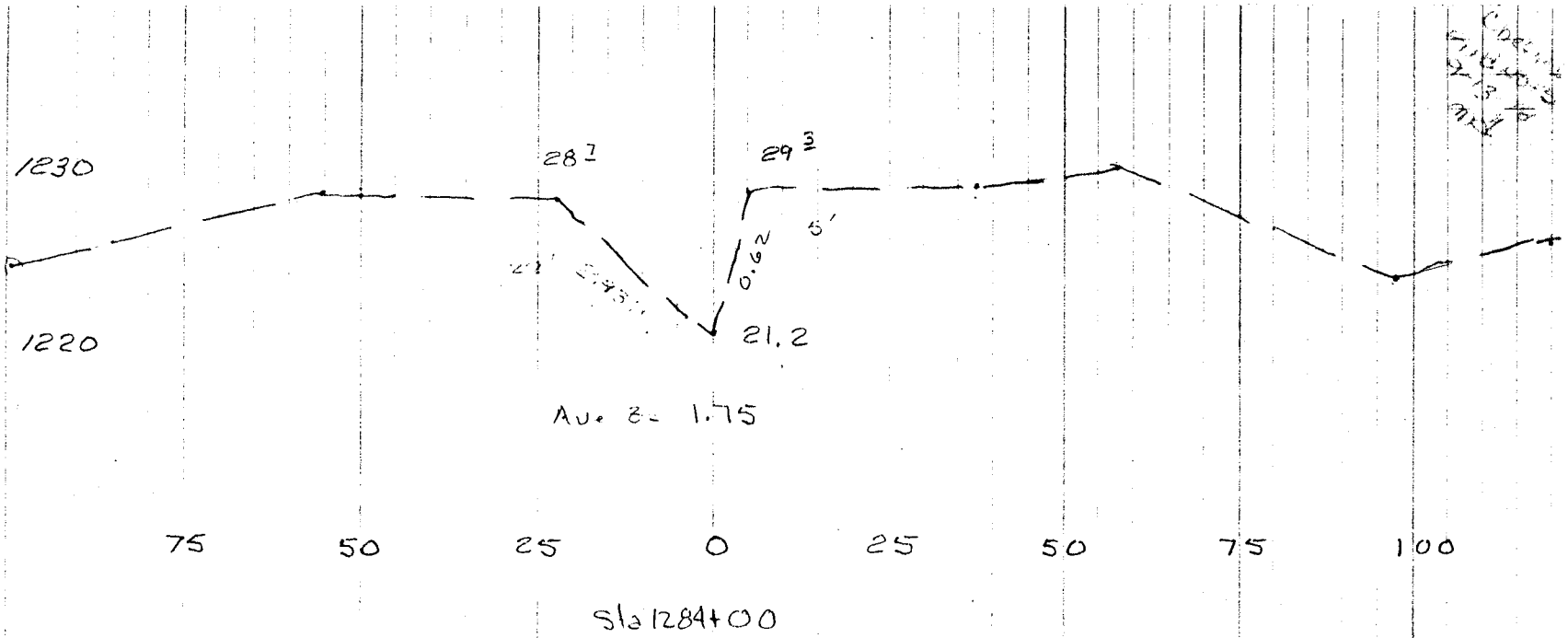
STATE	PROJECT	JOB NO.
Arizona	Williams - Chandler WPP	RWCD - Phase I
BY JLS / DATE 3-30-78	CHECKED BY / DATE	SHEET 4 OF 11
SUBJECT Floodway & San Tan Canal No. 9 x-ing		



Survey Data taken from
Bk # 3 (77125) P. 30

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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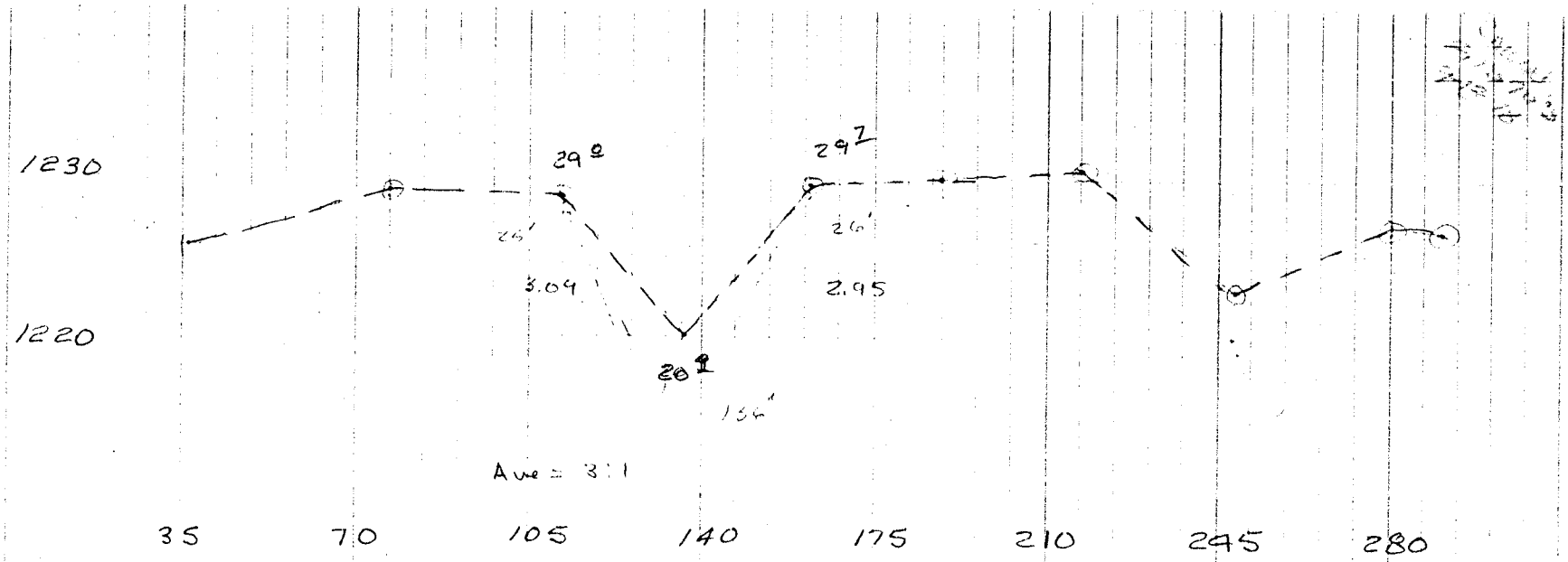
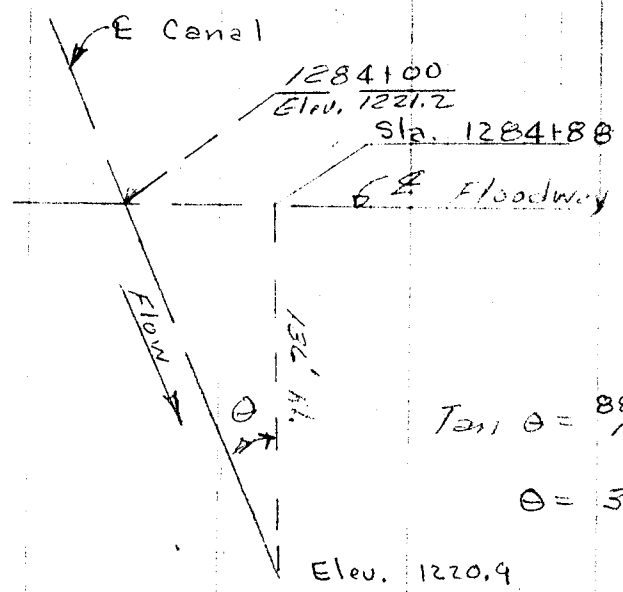
STATE	PROJECT	JOB NO.
Arizona	Williams-Chandler WPP	RWCD- Phase I
BY JLS	DATE 3-30-78	CHECKED BY
SUBJECT Floodway & San Tan Canal No. 9 X-ing	DATE	SHEET 5 OF 11



Note: X-Section taken from ℄ Sta. 1284+88

Survey Data taken from
Bk 3 (17125) P. 30 & 31



$\tan \theta = 88/136$

$\theta = 33°$

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-30-78	MG	9-14-78	RWCD - Phase I
SUBJECT				SHEET 6 OF 11
Floodway & San Tan Canal No 9 X-ing				

Determine Slope In The Existing Canal

Length $= \sqrt{88^2+136^2} + \sqrt{81^2+165^2}$

$= 162 + 184 = 346'$

Difference in elev. between the pts. 1283+19 165' Lt & Sta 1284+88, 136' Rt.

$1224.2 - 1220.9 = 3.3'$

Difference in elev. between the Pts. at 1284+00 ℄ & 1284+88, 136' Rt.

$1221.2 - 1220.9 = 0.3'$

Slope

Between the Pts. @ Sta 1283+19, 165' Lt. & Sta. 1284+88, 136' Rt.

$S = 3.3/346 = 0.00954$

Between the Pts. @ Sta. 1284+00 ℄ & Sta. 1284+88, 136' Rt.

$S = 0.3/162 = 0.00185$

Determine Flow In Canal

Obtained from H. Nelms BIA

$Q_D = 51$ cfs

$Q_{F.B.} = 102$ cfs

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-30-78			RWCD - Phase I
SUBJECT				SHEET 7 OF 11
Floodway & San Tan Canal No. 9 x-ing				

$S = 0.00185$ (will give the greater flow depth)

$Z_{avg} = 2.25$ (The ave of x-section @ 1284+00 & 1284+88, 136' rt.)

$b = 2.0$ (assumed)

Kings P. 7-17 Dredged earth Channels - 0.0275

n = Use same as Floodway 0.027

Kings - P. 7-14 4th Edition

$$Q = \frac{K' b^{8/3} S^{1/2}}{n}$$

$$K'_{51} = \frac{Qn}{b^{8/3} S^{1/2}} = \frac{(51)(0.027)}{(2^{8/3})(0.00185^{1/2})} = 5.042$$

King - P. 7-38 4th Edition

$D/b = 1.213$

$D = 2.43'$

$V = Q/A = 51/[(2)(2.43) + (2.25)(2.43^2)]$

$= 2.81$ fps — appears reasonable

$$K'_{102} = \frac{(102)(0.027)}{(2^{8/3})(0.00185^{1/2})} = 10.08$$

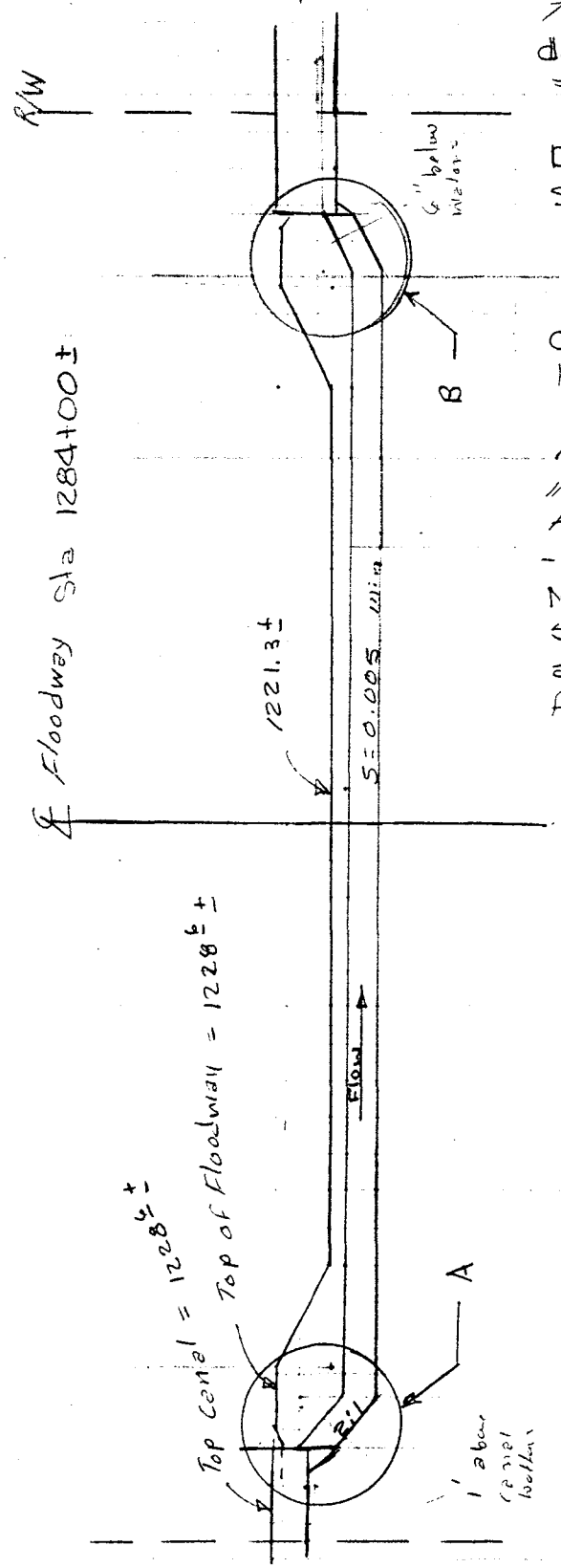
$D/b = 1.63$

$D = 3.26'$

$V = 3.35$ fps

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-30-78			RWCD - Phase I
SUBJECT				SHEET 8 OF 11
Floodway & San Tan Canal No. 9 X-ing				

Inverted Siphon

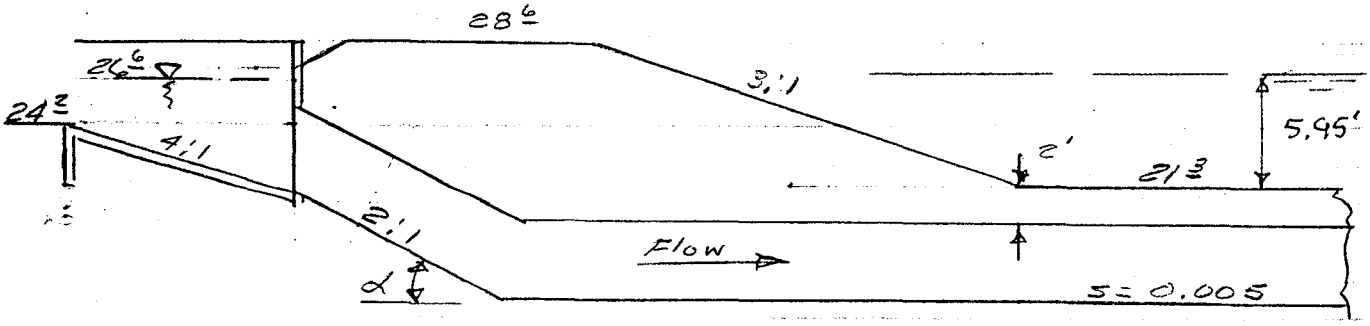


Total depth of Floodway is
$d_n + 0.2 H_e = 5.95 + (0.2)(5.95 + \frac{6.7^2}{64.4})$
$= 7.28'$ use $7.30'$

Design of Small Canal Structures - USDI Bureau of Reclamation - 1974

Obtained from Hugh Welmes, Irrig Specialist BIA.
Need to pass enough water through the siphon to irrigate 1,914 acres - 12 gpm/ac = 51.2 cfs
Min design flow Q_0 = 51 cfs but have to be able to pass freeboard flows of 102 cfs

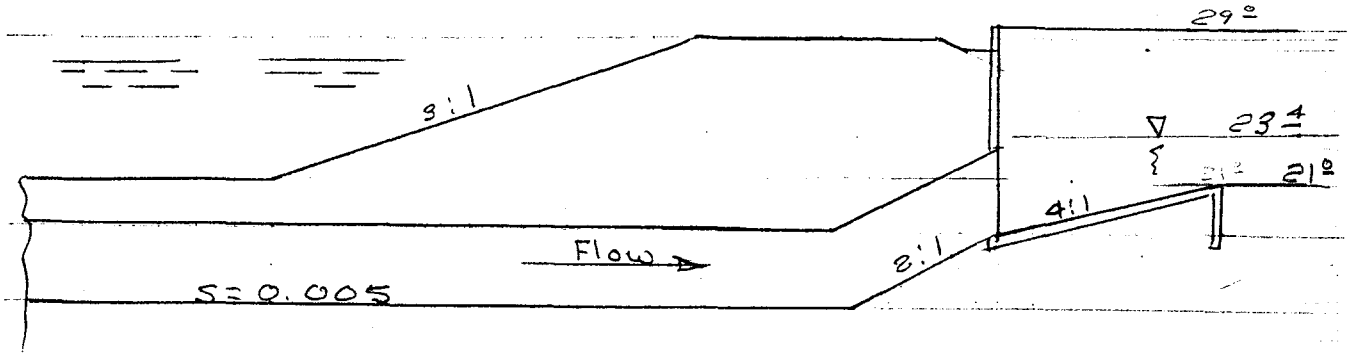
STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-31-78			RWCD - Phase I
SUBJECT				SHEET 9 OF 11
Floodway & San Tan Canal No. 9 x-ing				



$\tan \alpha = 1/2$

$\alpha = 26.57°$

A



B

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY JLS	DATE 3-31-78	CHECKED BY	DATE	JOB NO. RWCD - Phase I
SUBJECT Floodway & San Tan Canal No. 9 X-ing				SHEET 10 OF 11

Try 42" Dia R/C Pipe

$$Q = A\sqrt{\frac{2gH}{1+k_m+K_pL}}$$

$Q_D = 51$ $\qquad V = 5.30$ fps > 3.5 ok

$Q_{F.B} = 102$

$A = 9.62\ ft^2$

NEH 5 ES 42 $\qquad K_p = 0.00502$

NEH 5 P. 5.5-6 → 11 $\qquad K_m = K_e + K_b$ $\qquad$ ($K_e = 0.50$ = sharp corners; $K_b = [1 - (\frac{90-26.6}{90})^2]\ 1.37 = 0.68$)

$= 1.18$

$L \approx 240 + 57 + 31 \approx 328$
use 335'

$$H = \left(\frac{Q}{A}\right)^2 \frac{1+K_m+K_pL}{2g}$$

$$H = \left(\frac{51}{9.62}\right)^2 \frac{1+1.18+(0.00502)(335)}{64.4} = 1.69 \quad +10\%$$

$H = 1.69 \times 1.1 = \underline{1.85'}$ have 3.2'

U.S.B.R. Design of Small Canal Structures P. 28

$$H = \left(\frac{102}{9.62}\right)^2 (0.06) = 6.74$$

$H = 6.74 \times 1.1 = \underline{7.42'}$ N.G only have 4.3' max.

21.0
3.26
24.26
28.66
24.26
4.3

Try 48" Dia. R/C Pipe

$A = 12.57\ ft^2$

$K_p = 0.0042$

STATE	PROJECT		
Arizona	Williams Chandler W.P.P.		
BY: JLS	DATE: 4-3-78	CHECKED BY:	DATE:
SUBJECT: Floodway & San Tan Canal No. 4 X-ing			JOB NO.: RWCD - Phase I
			SHEET 11 OF 11

$K_m = 1.18$

$Q_D = 51$ $\qquad V = 4.06$ fps > 3.5 ok

$Q_{FIB} = 102$

$$H = \left(\frac{51}{12.57}\right)^2 \left(\frac{1 + 1.18 + (0.0042)(335)}{64.4}\right)$$

$= 0.92$

$H_{reqd} = 0.92 \times 1.1 = 1.01'$

$$H = \left(\frac{102}{12.57}\right)^2 (0.056) = 3.67$$

$H_{reqd} = 3.67 \times 1.1 = 4.03'$ ok $< 4.3'$

Use a 48" Dia RCP pipe.

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	4-4-78			RWCD - Phase I
SUBJECT				SHEET 1 OF 23
Lateral 9-49 — Preliminary Design				

1320
660
1980

Objective

Design a concrete lined lateral to replace the existing lateral that has to be relocated approx. 2000 feet South to allow room for the construction of the RWCD Floodway.

Basic Information

Design Q - 22 cfs } Obtained from H. Nelmes BIA
Freeboard Q - 44 cfs }
b - 1.0' → 3.0'
z - 1¼:1
n - 0.015 (NEH 2)

References

1. NEH 2 - Standard 430-A, SCS
2. Linings For Irrigation Canals, 1st Edition 1963 ; USDI - Bureau Of Reclamation
3. Design Of Small Canal Structures, 1974, USDI - Bureau Of Reclamation
4. Handbook Of Hydraulics, 5th Edition, King & Brater

Assumptions & Criteria

1. V_{max} = 8 fps
2. Thickness of lining - 2" (BIA Requirements)

STATE Arizona		PROJECT Williams-Chandler WPP		
BY JLS	DATE 4-5-78	CHECKED BY	DATE	JOB NO. RWCD- Phase I
SUBJECT Lateral 9-49 — Preliminary Design				SHEET 2 OF 23

3. Min. Bottom slope 0.001 (obtained from BIA) this would prevent siltation in the channel.

4. Transverse Contraction Joints - Min ¼" wide & depth-⅓ the thickness of the lining. Spacing of the Joints not to exceed 10 feet

5. Longitudinal Contraction Joints - Not necessary in canals having lined perimeters less than 30 feet.

6. Base width to Water depth ratio should be between 1 & 2. Small canals normally have a ratio of nearly 1, but BIA prefers 2

7. Freeboard - 0.2 He but not less than 3"

8. Use inverted siphon at Hwy 93 x-ing

9. Maintenance road 12' wide will be on the right hand side.

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 4-5-78	CHECKED BY	DATE	JOB NO. RWCD - Phase I
SUBJECT Lateral 9-49 - Preliminary Design				SHEET 3 OF 23

Try 1.0' Bottom Width, S = 0.001

$Q_D = 22$ cfs
$z = 1.25$
$S = 0.001$
$n = 0.015$

Design of Small Canal Structures P. 124 & Kings P. 7-39

$$K' = \frac{Qn}{b^{8/3} S^{1/2}}$$

$$K' = \frac{(22)(0.015)}{(1)^{8/3}(.001)^{1/2}} = 10.436$$

$d/b = 2.036$

$\therefore d = 2.04'$

$A = bd + zd^2$

$A = (1)(2.04) + (1.25)(2.04)^2 = 7.24 \text{ ft}^2$

$V = Q/A$

$V = 22/7.24 = 3.04$ fps

Min F.B. $= 0.2 H_e$

$F.B_{min.} = 0.2(2.04 + 3.04^2/64.4) = 0.44$

Depth = 2.48 use 2.50

Check to determine if lateral will carry the required F.B. flow 44 cfs

$$K' = \frac{(44)(0.015)}{(1)^{8/3}(.001)^{1/2}} = 20.87$$

$d/b = 2.743$

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 4-5-77	CHECKED BY	DATE	JOB NO. RWCD - Phase I
SUBJECT Lateral 9-49 - Preliminary Design				SHEET 4 OF 23

D = 2.743, but it is common practice to use 2" increments ∴ use 2.67'

Try 2.0' Bottom Width, S = 0.001

$$K' = \frac{(22)(0.015)}{(2.0)^{8/3}(0.001)^{1/2}} = 1.64$$

$d/b = 0.8675$

$d = 1.74'$

$A = (2)(1.74) + (1.25)(1.74)^2 = 7.25\ ft^2$

$V = 22/7.25 = 3.04$ fps

$F.B._{min.} = 0.2(1.74 + 3.09^2/64.4) = 0.38$

Min. depth = 2.12 use 2.25

Check to determine if channel min. depth will carry required $Q_{F.B.}$

$$K' = \frac{(44)(0.015)}{(2)^{8/3}(.001)^{1/2}} = 3.29$$

$d/b = 1.283$

$d = 2.57$ ∴ Use 2.50' depth

STATE Arizona		PROJECT Williams-Chandler WPP		
BY JLS	DATE 4-5-78	CHECKED BY	DATE	JOB NO. RWCD - Phase I
SUBJECT Lateral 9-49 - Preliminary Design				SHEET 5 OF 23

Critical Flow Conditions

1.0 Foot Bottom

Kings P. 8-16

$$S_c = 14.56 \frac{n^2 dm}{r^{4/3}} \qquad dm = a/T \quad r = a/p$$

7.53

$$dm = 7.24/6.10 = 1.19$$

$$r = 7.24/7.53 = 0.96$$

$$S_c = 14.56 \frac{(0.015)^2 (1.19)}{(0.96)^{4/3}} = 0.00412$$

Unstable zone is when $0.7 S_c < S_o < 1.3 S_c$

$\therefore$ flow ok

2.04

Find d_c

$$K' = \frac{(22)(0.015)}{(1)^{8/3}(.00412)^{1/2}} = 5.14$$

$$d_c/b = 1.395$$

$$d_c = 1.395'$$

Linings For Irrig. Canals P. 33

Check to see if flows can approach critical depth by using a $n = 0.015 - 0.003 = 0.012$

$$K' = \frac{(22)(0.012)}{(1)^{8/3}(.001)^{1/2}} = 8.348$$

$$d/b = 1.845$$

$d = 1.845 > 1.395 \therefore$ ok

STATE Arizona		PROJECT Williams-Chandler WPP		
BY JLS	DATE 4-5-78	CHECKED BY	DATE	JOB NO. RWCD - Phase I
SUBJECT Lateral 9-49 - Preliminary Design				SHEET 6 OF 23

2.0' Foot Bottom

$d_m = 7.25/6.35 = 1.14$

$r = 7.25/7.57 = 0.96$

$S_c = 14.56 \dfrac{(0.015)^2(1.14)}{(0.96)^{4/3}} = 0.00393$ Close to that shown on preceeding page Check ok

Unstable Flow Zone - $0.7 S_c < S_o < 1.3 S_c$

Find d_c

$K' = \dfrac{(22)(0.015)}{(2)^{8/3}(0.00393)^{1/2}} = 0.829$

$d_c/b = 0.615$

$d_c = 1.23'$

Check to see if flow depth approaches critical depth

$K' = \dfrac{(22)(0.012)}{(2)^{8/3}(.001)^{1/2}} = 1.315$

$d/b = 0.778$

$d = 1.56' > 1.23$ close but should be ok

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	4-12-78			RWCD - Reach 1
SUBJECT				SHEET 7 OF 23
Lateral 9-49 ; Preliminary Design				

Using Hwy 93 as a vertical control select bottom slopes that are between 0.001 & 0.7 S_c ($\approx$ 0.0028)

	Sta	Slope	Elev.
	10+00		1226.375
		0.0022	
	60+00		1215.375
		0.001	
	103+25		1211.050
		Siphon	
105150	105+45		1209.200
		0.001	
	143+75		1205.37

Try 1.0' Bottom, S = 0.0022

47

$$K' = \frac{(22)(0.015)}{(1)^{8/3}(0.0022)^{1/2}} = 7.036$$

$d/b = 1.71$

depth of flow = 1.71'

A = 5.365'

$V = Q/A = 22/5.365 = 4.10$ fps

Min F.B. = $0.2[1.71 + 4.10^2/64.4] = 0.39$

D = 2.10'

Check to determine depth of lining required to carry $Q_{F.B.}$

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	4-12-78			RWCD - Reach 1
SUBJECT				SHEET 7 OF 23
Lateral 9-49 ; Preliminary Design				

Using Hwy 93 as a vertical control select bottom slopes that are between 0.001 & 0.7 S_c ($\approx$ 0.0028)

	Sta	Slope	Elev.
	10+00		1226.375
		0.0022	
	60+00		1215.375
		0.001	
	103+25		1211.050
		Siphon	
105+50	105+45		1209.200
		0.001	
	143+75		1205.37

Try 1.0' Bottom, S = 0.0022

47

$$K' = \frac{(22)(0.015)}{(1)^{8/3}(0.0022)^{1/2}} = 7.036$$

$d/b = 1.71$

depth of flow = 1.71'

A = 5.365'

$V = Q/A = 22/5.365 = 4.10$ fps

Min F.B. = $0.2[1.71 + 4.10^2/4.4] = 0.39$

D = 2.10'

Check to determine depth of lining required to carry $Q_{F.B.}$

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 4-12-78	CHECKED BY	DATE	JOB NO. RWCD - Reach 1
SUBJECT Lateral 9-49; Preliminary Design				SHEET 8 OF 23

$$K' = \frac{(44)(0.015)}{(1)^{8/3}(0.0022)^{1/2}} = 14.071$$

1.5 $d/b = 2.318$

$d = 2.32'$ Use $2.33'$ ← 28"

Try 2.0' Bottom, S = 0.0022

$$K' = \frac{(22)(0.015)}{(2)^{8/3}(0.0022)^{1/2}} = 1.108$$

6 $d/b = 0.713$

depth of flow = 1.426'

$A = 5.394 \text{ ft}^2$

$V = 22/5.394 = 4.08 \text{ fps}$

Min F.B. $= 0.2\left[1.426 + 4.08^2/64A\right] = 0.337'$

$D = 1.76'$

Check to determine depth of lining required to carry $Q_{F.B.}$

$$K' = \frac{(44)(0.015)}{(2)^{8/3}(0.0022)^{1/2}} = 2.216$$

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY JLS	DATE 4-12-78	CHECKED BY	DATE	JOB NO. RWCD - Reach 1
SUBJECT Lateral 9-49 ; Preliminary Design				SHEET 9 OF 23

23

$d/b = 1.001$

Depth of flow = 2.00'

24"

Summary

Bottom Width	Slope	Velocity (fps)	Depth of Lining Ft.	Depth of Flow ÷ B
1.0	0.0010	3.04	2.67	2.04
1.0	0.0022	4.10	2.33	1.71
2.0	0.0010	3.04	2.50	0.87
2.0	0.0022	4.08	2.00	0.88

Compare costs based on bottom widths

5000

~~4325~~

8150

— 0.001 Slope —

Concrete

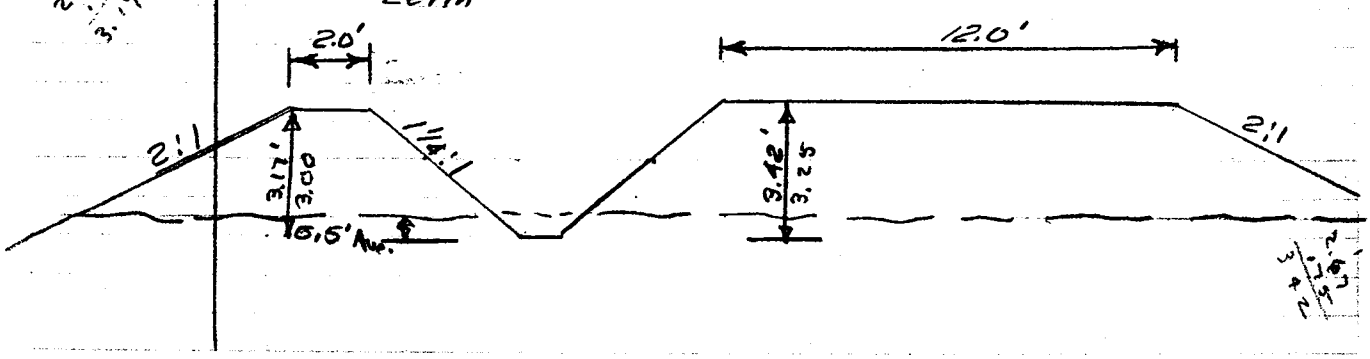
$[(1.0)(2/12)(8150)/27 - (2)(0.27)(2/12)(8150)/27]$

$50 - 27 = 23\ yd^3$ not enough to consider

6000 +

2.67
.56
3.17

Earth



STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 4-12-78	CHECKED BY	DATE	JOB NO. RWCD - Reach 1
SUBJECT Lateral 9-49 ; Preliminary Design				SHEET 10 OF 23

[(2)(2.67)/2][2.67] + [(2)(2.67)] + [(1.25)(2.67)/2][2.67] +
[(1.25)(2.92)/2][2.92] + [(12.0)(2.92)] + [(2)(2.92)/2][2.92]
- [(2)(2.50)/2][2.50] - [(2.0)(2.50)] - [(1.25)(2.50)/2]
[2.50] - [(1.25)(2.75)/2][2.75] - [(12)(2.75)] - [(2)(2.75/2]
[2.75]

= 5.37 ft^3/ft more fill in the 1.0' Bottom than the 2.0' bottom
≈ 2,600 yd^3

—— 0.0022 Slope ——

Concrete

13375
225
13150

[(1.0)(3/12)(5000)/27] - [(2)(0.52)(3/12)(5000)/27]

30.9 - 32.1 1.0' bottom has less but is not enough to make a difference

Earthwork

[(2)(2.33)/2][2.33] + [(2)(2.33)] + [(1.25)(2.33)/2][2.33] +
[(1.25)(2.58)/2][2.58] + [(12.0)(2.58)] + [(2)(2.58)/2][2.58]
- [(2.0)(2.00)/2][2.00] - [(2)(2.00)] - [(1.25)(2.00)/2]
[2.00] - [(1.25)(2.25)/2][2.25] - [(12)(2.25)] -
[(2)(2.25)/2][2.25]

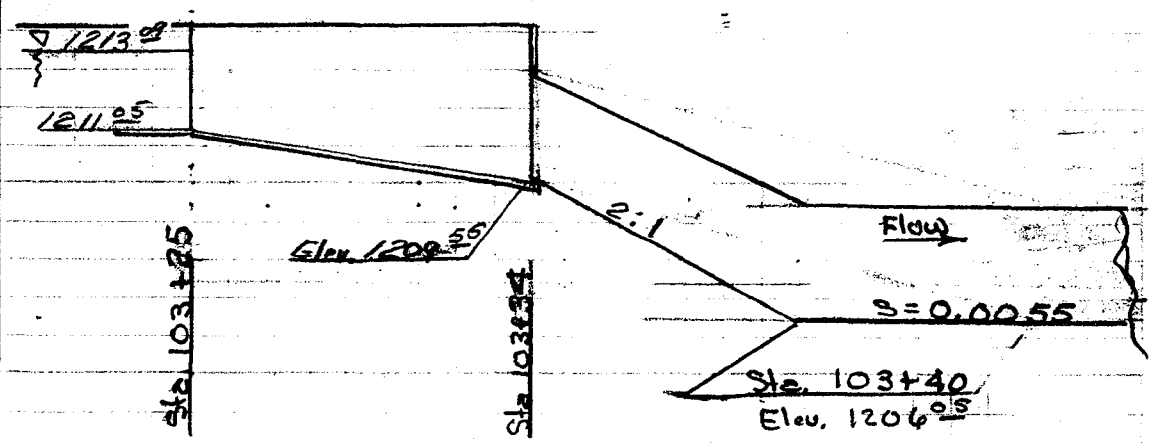
= 9.5 ft^3/ft more in the 1.0' bottom
≈ 4700 yd^3

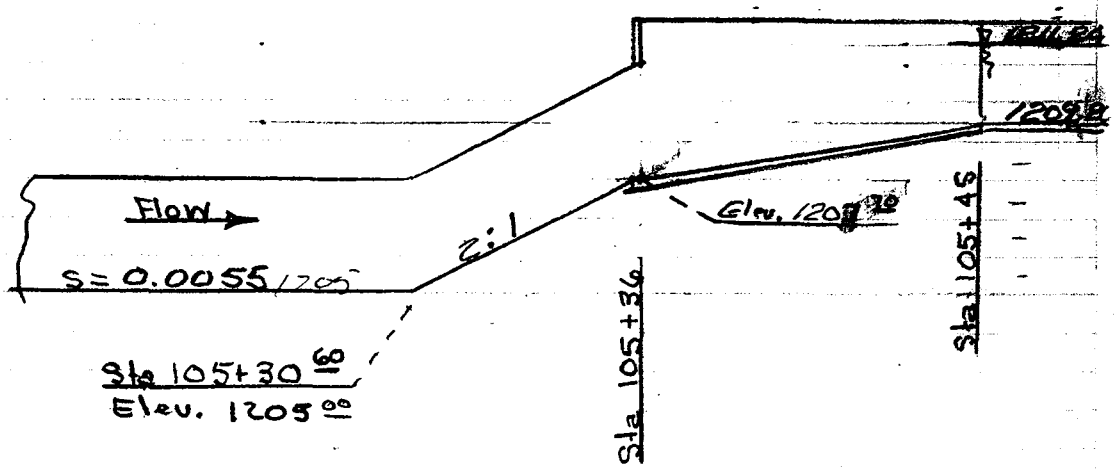
COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	4-12-78			RWCD - Reach 1
SUBJECT				SHEET 11 OF 23
Lateral 9-49 ; Preliminary Design				

State Route 93 x-ing



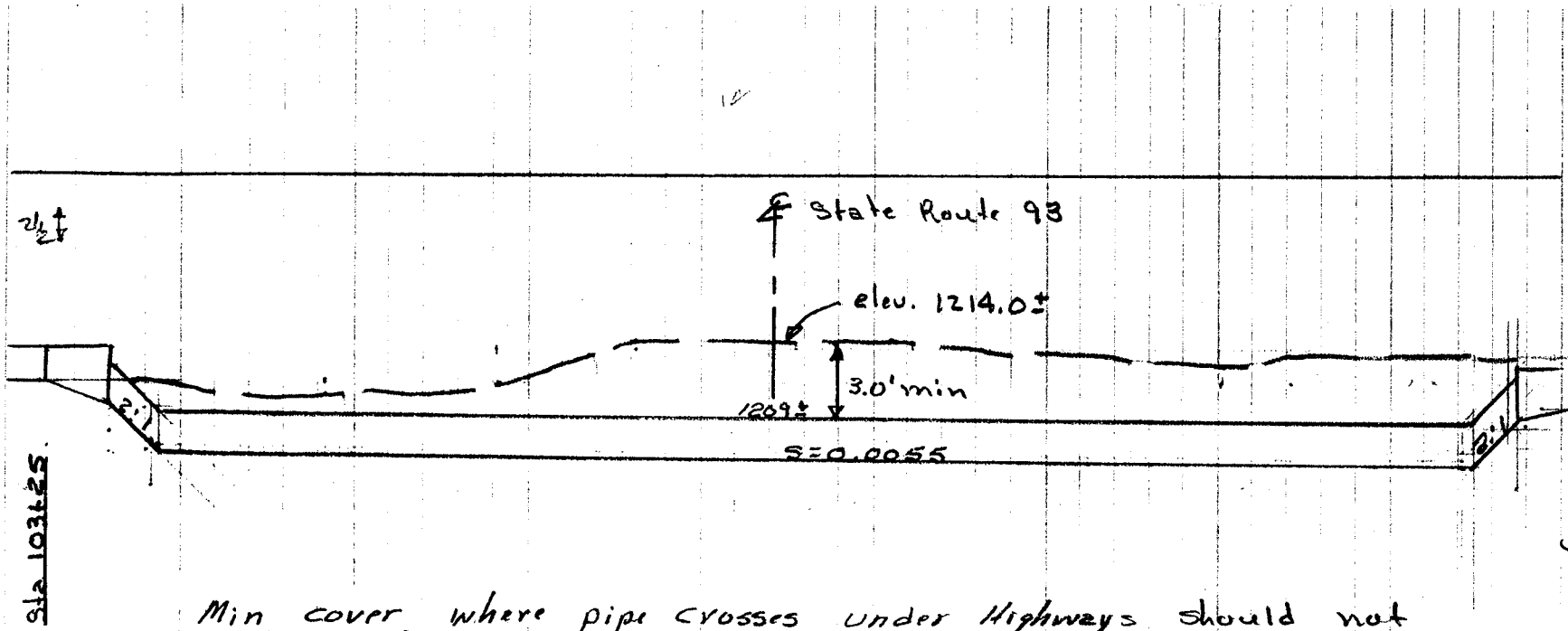


2.1
1.5
F. 17

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE	PROJECT	JOB NO.
Arizona	Williams - Chandler WPP	RWCD - Reach 1
BY JLS / DATE 4-13-78	CHECKED BY / DATE	SHEET 12 OF 23
SUBJECT Lateral 9-49; Preliminary Design		



Min cover where pipe crosses under Highways should not be less than 3.0' (Design of Small Canal Structures p. 27)
Actually have 5.0'±

Pipe slope should not be less than 0.005 or more than 2:1 (Design of Small Canal Structures p. 27)

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	4-13-78			RWCD - Reach 1
SUBJECT				SHEET 13 OF 23
Lateral 9-49 ; Preliminary Design				

Try 30" Dia R/C Pipe

$$Q = A\sqrt{\frac{2gH}{1+K_m+K_pL}}$$

$Q_D = 22$ (Obtained from the BIA)

$Q_{F.B} = 40$ (Obtained from BIA)

$A = 4.91\ ft^2$

NEH 5 Eq. 42 $K_p = 0.00786$

NEH 5 P. 5.5-6 → -11 $K_m = K_e + K_b$ $\left(K_e = 0.50 - \text{Sharp Cornered};\ K_b = \left[1 - \frac{90-26.6}{90}\right]1.37 = 0.68\right)$

$$H = \left(22/4.91\right)^2 \frac{1+1.18+(0.00786)(202)}{64.4} = 1.17 + 10\%$$

$= 1.29'$ ok have $1.85'$

$$H = \left(40/4.91\right)^2 \frac{1+1.18+(0.00786)(202)}{64.4} = 3.88 + 10\%$$

$= 4.27'$ No good.

Try 36" Dia. R/C Pipe

$A = 7.07\ ft^2$

$K_p = 0.00616$

STATE		PROJECT		
Arizona		Williams- Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	4-13-78			RWCD- Reach 1
SUBJECT				SHEET 14 OF 23
Lateral 9-49; Preliminary Design				

$$H = \left(22/7.07\right)^2 \frac{1 + 1.18 + (0.00616)(202)}{64.4} = 0.51' + 10\%$$

$$= 0.57' \text{ ok}$$

$$H = \left(40/7.07\right)^2 \frac{1 + 1.18 + (0.00616)(202)}{64.4} = 1.70' + 10\%$$

$$= 1.87' \text{ ok}$$

have 1.85'

Use 36" Dia. ←

Overflow Siphon X-ing San Tan Road

Sta 129 + 96

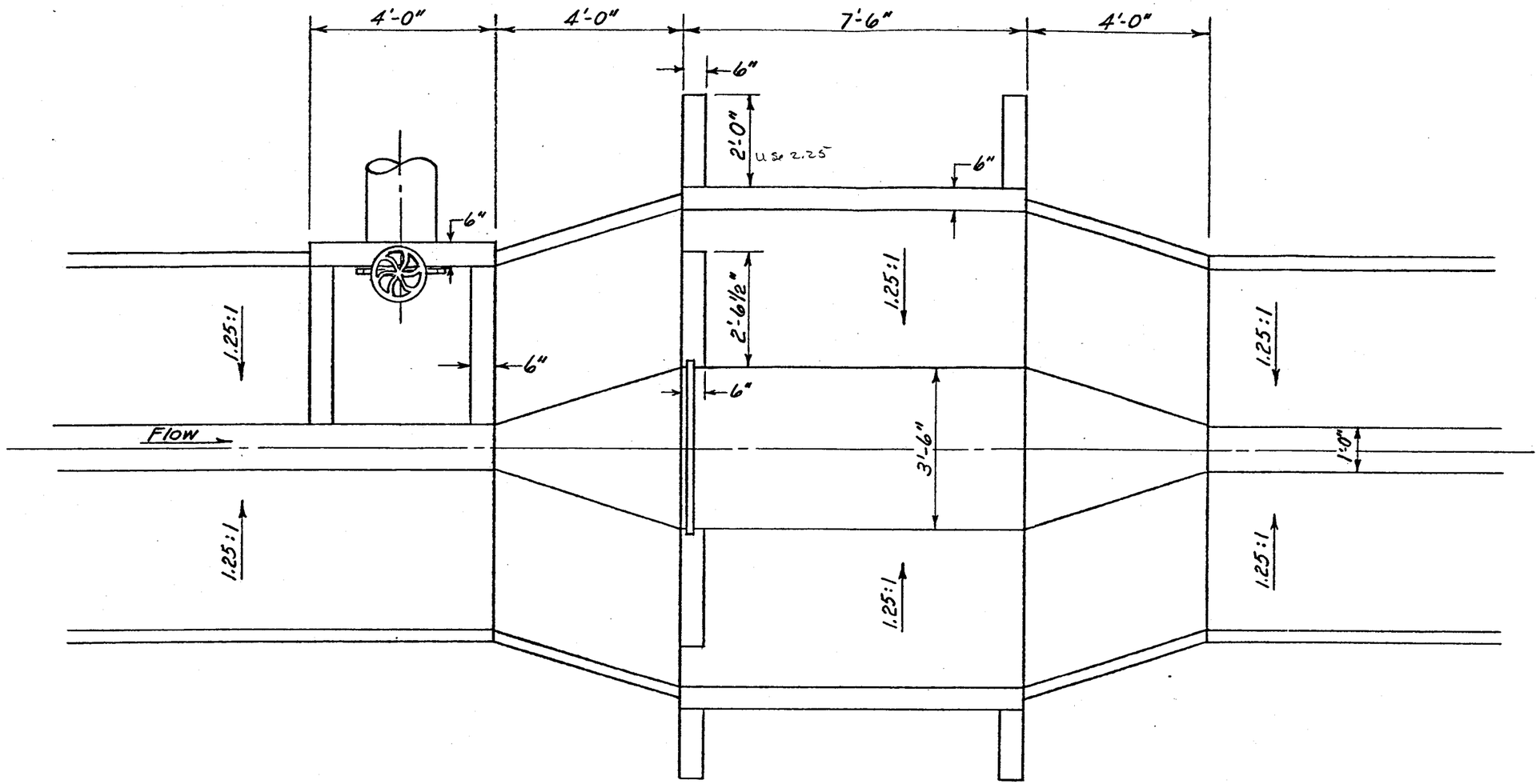
$Q_{F.B} = 40$

$L = 110'$

Use same results as for 93 X-ing

36" Dia. R/C pipe ←

Alignment



TYPICAL TAKE-OUT & CHECK STRUCTURE
FOR LATERAL 9-49
WILLIAMS-CHANDLER W.P.P.
MARICOPA & PINAL COUNTIES, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed J.L.S	Date 4-78	Approved by	
Drawn E.F.S.	4-78	Title	
Traced		Title	
Checked		Sheet No. 20 of 23	Drawing No.

SCS-ENG-313A REV 8-75

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	4-14-78			RWCD - Reach 1
SUBJECT				SHEET 22 OF 23
Lateral 9-49; Preliminary Design				

R/C Pipe

110
202
312

36" Dia = 312'

18" Dia - (10)(30) + 140 + 100 = 540'

1.77 ft²

.0155

$H = \left(\frac{Q}{A}\right)^{1+.146}$

Gates

H = 0.83

0.78
0.68
1.46

13 - 18" cast Iron Similar to Armco
101

2.33

11 - 42" x 24"

24
4
28

24
32

12
9
21

STATE	PROJECT		
Arizona	Williams-Chandler WPP		
BY: JLS	DATE: 4-17-78	CHECKED BY:	DATE:
JOB NO.: RWCD - Reach 1			
SUBJECT: Lateral 9-49; Preliminary Design		SHEET 23 OF 23	

Conclusions

1. Will use a 1.0' bottom and the lining will have a 28" depth between Sta 18+00 & 60+00 (5000'). The slope will be 0.0022 ft./ft.

2. Will use a 1.0' bottom and a lining depth of 32" Between Sta. 60+00 and Sta. 143+29.29. The slope S = 0.001 ft./ft.

3. The State Route 93 x-ing will consist of a 36" dia R/C pipe Inverted siphon

4. All take-outs will have a min. of 30' of R/C pipe

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 3-10-78	CHECKED BY PM	DATE 4-3-78	JOB NO. RWCD - Phase I
SUBJECT Outlet Structure - Preliminary Design				SHEET 1 OF 29

Math Checked JEB. Apr 78

Objective

Select a outlet structure that will perform under submerged conditions & have a 5.75'± drop.

Basic Information

Q = 8700
b = 200' max
z = 3
d_n = 5.95'
S = 0.00155
Transitions - 12½° max. 12½° ℄
Max. Drop 5.65'
F.B. 20% of H_e, or 1.0' whichever the greatest

References

1. TR No. 25 - Planning And Design Of Open Channels - SCS
2. Engineering Design Standards, Far West States - SCS
3. NEH 11, Drop Spillways - SCS
4. Engineering Monograph No. 25, Hydraulic Design of Stilling Basins and Energy Dissipators - USBR
5. Monroe 1880, Water Surface Profile Program

STATE Arizona		PROJECT		
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SUBJECT Outlet Structure - Preliminary Design				SHEET 2 OF 29

Assumptions & Criteria

1. Gila River W.S. when Floodway is flowing at design Q - 1195.0
2. Mannings "n" - 0.035 for rock riprap & 0.027 for earth channel
3. Mannings "n" - 0.014 for Concrete
4. Install rock riprap for all transitions
5. Cost of Concrete - $230.00/yd³ (Approx. ave of Spook Hill, including steel)
6. Cost of rock riprap - $20.00

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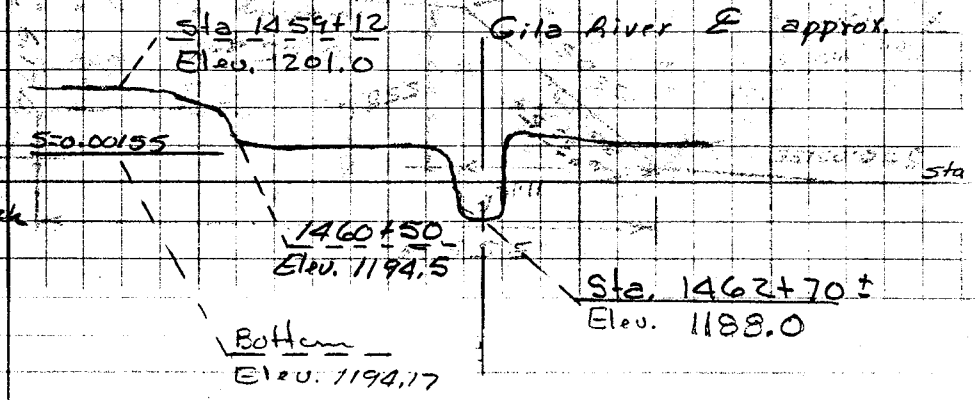
SUBJECT Outlet Structure - Preliminary Design			SHEET 3 OF 29

Math checked JLB Apr. 78

The channel is planned to outlet into the Gila River using a baffled chute. There is a main channel & flood plain channel as shown below.



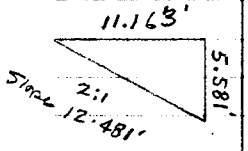
Baffled chute 2:1 Slope

chan. invert elev. − (2:1 slope)(X) = River invert + (slope)(358 ft − X)

$$1194.17 - 0.5X = 1188.0 + (0.00155)(358 - X)$$

$$0.4985X = 5.61$$

$$X = 11.25' \quad (11.163 \text{ check})$$

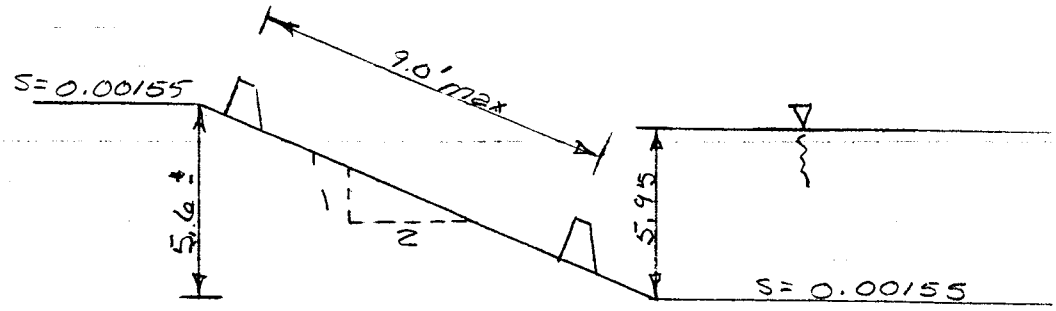


Without water in the river flow depth is 5.95'

see tape attached

Slope distance on a 2:1 (Baffled chute)

$$\left[(5.6)^2 + (11.25)^2\right]^{1/2} \approx 12.6' \quad (12.481' \text{ slope length})$$



Bearing & Bearing in Degrees

| | | |

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SUBJECT Outlet Structure - Preliminary Design SHEET 4 OF 29

Memo No. 25 P. 187 9.

Math check JEB Apr 78

Four rows of baffle piers are required to establish full control of the flow.

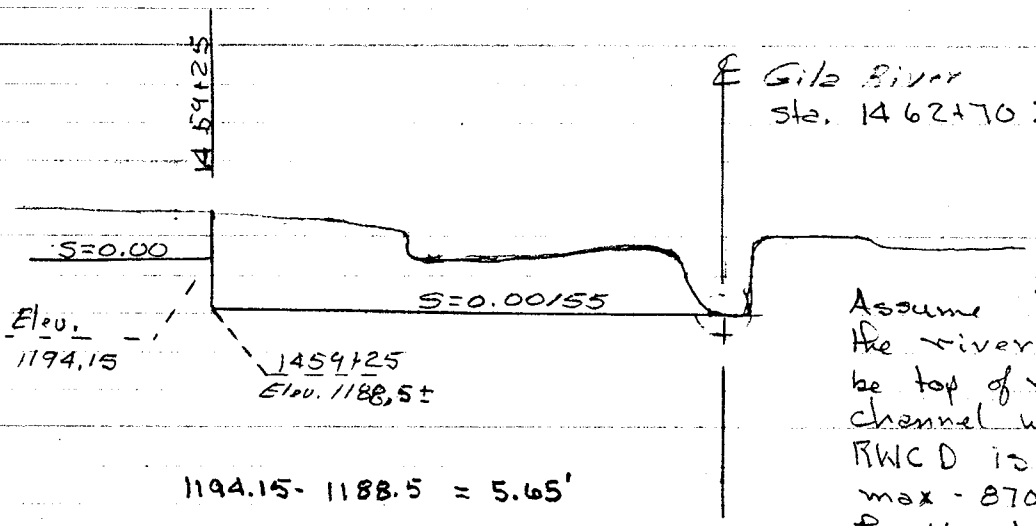
Therefore should consider other types of structures

NEH Sec. 11

Type C Drop Spillway

C = 3.1

Set at Sta. 1459+25



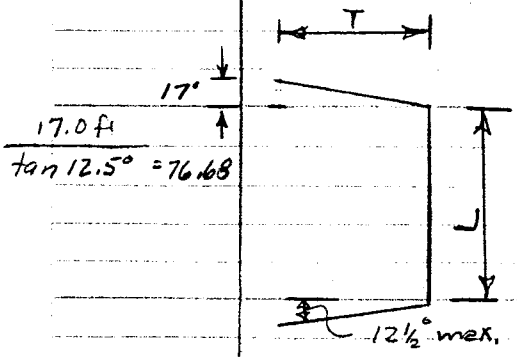
Assume that the river will be top of main channel when RWCD is flowing max - 8700. Then W.S. elev. 1195.0'

1194.15 - 1188.5 = 5.65'

Eq 3.15 P. 3.16

$Q_r = CLH^{3/2}$ where C = 3.1

Q_r = design discharge = 8700 cfs



Try 166' Wier length

$\left(Q/CL\right)^{2/3} = H$

$\left(8700/(3.1)(166)\right)^{2/3} = H = 6.59'$

Where $H = (h + V^2/2g)$

L = 166' T = 77' check 76.682

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Math Check
JEB April 78

~~Try A 200' Weir Width~~

$H = \left(8700/(3.1)(200)\right)^{2/3} = 5.82'$

$F.B = 5.82 \times 0.20 = 1.16$

$h = 7.0'$ 6.98 check

$d_c = 2/3\,h = 4.66'$

$F_{reqd} = 5.65'$ min.

$t \geq 1.75\,d_c = 8.155$

95.0
8.15
86.85

$\therefore$ Transverse sill max elev. = 1186.85

Then $F = 7.3'$ use 7.5 in final design

94.15
86.85
7.30

$Q_{fr} = (1.1 + 0.01F)\,Q_r = 10{,}205$ cfs

$q_s = (7)^{3/2}(3.1) = 57.4$ cfs/ft.

$Q_s = 57.4 \times 200 = 11{,}480$ cfs $> Q_{fr}$ ok

Transverse Sill Height

$0.4\,d_c = 1.86'$ use $2.0'$

Stilling Basin Length

$h/F = 7/7.3 = 0.96$

$h/t = 7/8.15 = 0.859$ use 0.857 on chart

$L_B = 3.9 \times 7.3 = 28.5$

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Math Check
Apr. 78 JEB

Floor Block Location

$L_f/F = 2.80$

then $L_f = (2.8)(7.3) = 20.5$

$L_B - L_f = 8.0'$

$1.75\, d_c = 8.16'$ ok (will adjust final)

Floor Blocks

Width & Length

$0.4\, d_c = 1.86$ use 1.75'

use 60 blocks $105/200 = 0.53$ ok

50 - 87.5
52 - 91.
54 94.5
56 . 98.0
58 - 101.5
60 - 105
blocks

$\frac{200}{3.5} = 57.14$

Height

$0.8\, d_c = 3.73$ use 3.75'

Sidewalls

$t + 0.85\, d_c = 12.11$ use 12.0'

$8.155 + (0.85)(4.66) = 12.116$

Wingwalls

Use 9.75'

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Math Check
Apr. 78 JEB

Transverse sill Height

Use 1.75'

200
48
2.50
250.50

Quantities

Concrete

Headwall

[(250.5 x 19.95 x 1.0) - (7 x 200 x 1.0)] ÷ 27 = 134 yd³
133.24

Height Headwall
Notch 7.0
Drop 7.2
sill 1.75
floor 1.00
Cutoff 3.00
19.95

Sidewalls (15")

(31.70 x 28.5 x 1.25) ÷ 27 = 42 yd³
41.8

Side wall
7.0
7.2
1.75
1.00
16.95
up str. 12.00
1.75
1.00
30.70

Floor

(200 x 27.5 x 1.0) ÷ 27 = 204 yd³
203.70

Wingwalls

(25.75 x 9.75 x 1.0) ÷ 27 = 10 yd³
9.3

12
1.75
1.00
3.00
17.75
2.25
1.75
1.00
3.00
25.75

Transverse Sill

(200 x 6.0 x 1.0) ÷ 27 = 45 yd³
44.44

STATE Arizona		PROJECT Williams- Chandler WPP		
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Math Check
JEB Apr 78

Blocks

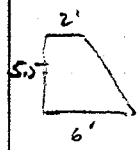
$(60 \times 1.75 \times 1.75 \times 3.75) \div 27 = 26\ yd^3$
25.52

Longitudinal sill

$(15 \times 27.5 \times 1.0 \times 2.0) \div 27 = 31\ yd^3$
30.56

1.5
1.75
3.25

Buttress 15



12 yd^3

Concrete 504 cu.yd.

Rock

Use $D_{50} = 6''$

Upstream - 20'

$[(7^2 + 21^2)^{1/2} \times 1.5 \times 20](2) \div 27 = 50\ yd^3$
49.19

$(200 \times 20 \times 1.5) \div 27 = 225\ yd^3$

275 yd^3

Downstream

Use the same 275

550 yd^3

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Math Check
Apr 78 JEB

Cost

Disregard channel Exc.

Concrete

504 x 230 = $115,920.00

Rock

550 x 20 = 11,000.00

$126,920.00

Comments

1. Transverse sill is 1.15' below river bottom.

2. Cost is only ≈ $500.00 more ∴ use because will not require a transition to the structure (Less Rip Rap Required)

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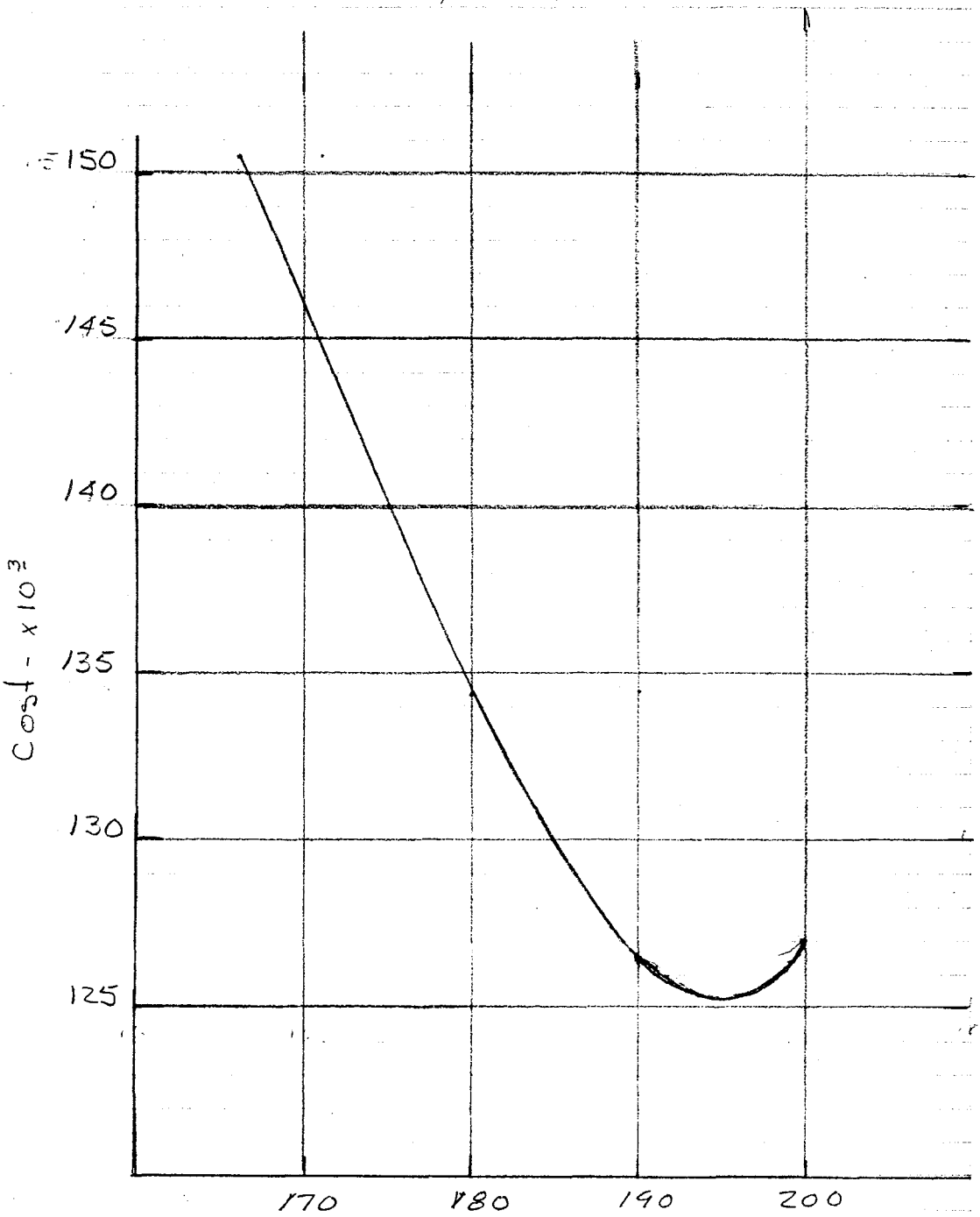
150,500
138,500
126,500
121,500



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5.95
1188.4
1194.35

Conclusions

1. The most economical structure would be the 190' wide drop str., but would not need a transition section if 200' is used.
2. To have the proper submergence the Transverse sill would have to be 1.14' below the bottom of the river when it is flowing full (W.S. Elev. 1195.0). If the river is not flowing then would need to lower the Transvers sill another 0.65'
3. Assumed W.S. elev. 1195 is 0.85' above the Flood Channel invert ∴ would need to raise banks at least this amount to allow for silt build up.
4. A baffled chute needs to have at least 4 rows of blocks to operate properly also the chute would be totally submerged, which is not good. Therefore did not use for these reasons.

Note: Will need to change tailwater to agree with R.P. McArthur study during final design

COMPUTATION SHEET
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SOIL CONSERVATION SERVICE

STATE Arizona		PROJECT Williams-Chandler WPP		
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SUBJECT Cost Estimate				SHEET 11 OF 11

Item No.	Work or Material	Spec. No.	Quantity	Unit	Unit Price	Amount
1	Clearing & Grubbing	2	197	Ac.	$200.00	39,400.00
2.	Mobilization	8	1	Job	-	29,966 ~~30,230.00~~
3.	Channel Excavation	21	1,352,000	C.Y.	0.83	1,121,330.00
4	Structure Excavation	21	3,700	C.Y.	4.00	14,800.00
5	Earth Fill *From Canal Excavation	23	57,256 ~~83,600~~	C.Y.	0.50	mid 28,628.00 9-11-78 ~~41,800.00~~
6.	Structure Backfill	23	1,500	C.Y.	9.00	13,500.00
7.	Pipe Backfill	23	1,160	C.Y.	5.50	5,380.00
8.	Concrete 4000	31	564	C.Y.	230.00	129,720.00
9.	Concrete 2500	31	750	C.Y.	65.00	48,750.00
10.	18" R/C Pipe, Class III	42	300	L.F.	6.75	2,025.00
11.	18" R/C Pipe, Class IV	42	240	L.F	7.50	1,800.00
12.	36" R/C Pipe, Class IV	42	312	L.F	25.00	7,800.00
13	48" R/C Pipe, Class IV	42	335	L.F	38.00	12,730.00
14	Loose Rock Riprap	61	550	C.Y.	20.00	11,000.00
15	18" Dia. Slide Gate	71	13	Ea	250.00	3,250.00
16	42"x24" Slide Gate	71	11	Ea.	700.00	7,700.00
17	Seeding		168	Ac.	230.00	38,640.00
18	Landscaping		1	Job	-	7,500.00
19	Grouted Rock Riprap	200	125	C.Y.	35.00	4,375.00
						~~1,541,730.00~~
						1,528,294.00

STATE Arizona		PROJECT Williams - Chandler WPP		
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Item No. 1 - Clearing & Grubbing (2)

No. of Acres

1209400
1204400 Floodway

24,000 x 330 ÷ 43560 = 182 Ac.

Lateral 9-49

15 Ac

Total 197 Ac

Based on Spook Hill

200.00 / Ac. $39,400

Item No. 2 - Mobilization

Use 2% of Construction Cost.

0.02 x ~~1,511,500.00~~ 1,493,325. $~~30,230~~ 29,900

STATE Arizona		PROJECT Williams - Chandler WPP		
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Item No. 3 - Channel Excavation

Floodway

1,351,000 yd^3

Lateral 9-49

53,800
29,800

1,000 yd^3

Ave haul for Floodway use - 1 mile

Based on a 633C Cap. 32 yd^3

Time reqd to go 1 mile - loaded = 4.5 min

unloaded = 3.0 min

Time to load 1.0 min

136

Time to maneuver & spread 0.8 min

9.3 min

Loads /hr. = 45/9.3 = 4.84

Use 5.00

Capacity of Scraper - 32 yd^3

Blue Book

Cost of Equipment - 136

136/160 = $0.85 / yd^3

53,800 needed for fill for floodway & 29,800 for Lateral 9-49

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Use $0.45 for this portion

83,600 x 0.45 $37,620

1,267,400 x 0.85 1,077,290

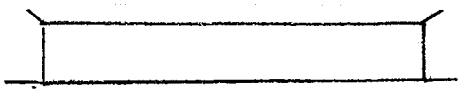
$1,114,910

∴ 1,114,910/1,351,000 = $0.825 use 0.83

then 1,351,000 x 0.83 = $1,121,330

Item No. 4, Structure Excavation

200 x 33



Use 210 x 3.5 x 13 ÷ 27 = 3,540

Use 3700 for both
Floodway & Lateral

From Spook Hill F.R.S. use 4.00

3700 x 4.00 $14,800

Item No. 5, Earth Fill

Floodway

53,800

Lateral

29,800

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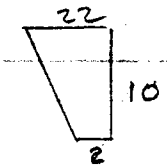
Use $0.50, this would give a total of 0.95
See Sht 3

83,600 x 0.50 $41,800

Item No. 6, Structure Backfill



12 x 10 x 31 x 2 ÷ 27 = 275 yd³

200 x 10 x 11 ÷ 27 = 814 yd³

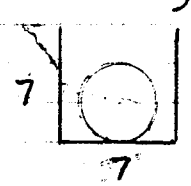
1090

Use 1500

Cost From Spook Hill use
$9.00/yd³ $13,500

Item No. 7, Pipe Back Fill

Floodway



$(7 \times 5) + (9 \times 2) - \left(\frac{\pi 5^2}{4}\right) \approx 33$ ft³/ft

≈ 1.25 yd³/ft

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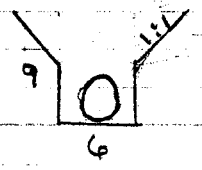
1.25 x 335 = 425 use 500 — 500

Lateral 9-49

140

50

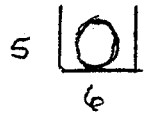


$(10 \times 4) + (5 \times 6) - \left(\frac{\pi 4^2}{4}\right) \approx 57\ ft^3/ft.$

$\approx 2.1\ yd^3/ft$

2.1 x 140 = 294

Use 300 — 300



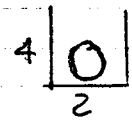
$(5 \times 6) - \left(\frac{\pi 4^2}{4}\right) = 17.4\ ft^3/ft.$

≈ 0.65

50 x 0.65 ≈ 35 yd^3 — 35

110

Take out siphon → 110 x 2.1 = — 250



Take out

$4 \times 2 - \frac{\pi 2^2}{4} = 4.86\ ft^3/ft.$

300 x 4.86 ÷ 27 = 53 use — 75

1160

From Foote Wash 5.00 + 10%

Use $5.50

550

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5.50 x 1160 $5,380

Item No. 8 - Concrete 4000

Floodway

504 yd³ - drop str.

10 yd³ - Siphon

514 x 230

Lateral 9-49

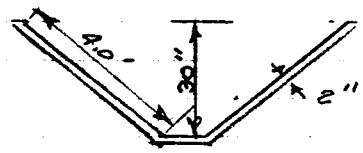
50 yd³ Take-Outs & Siphons

Total 564 of Reinforced

564 x $230.00 $129,720

555

Item No. 9 - Concrete 2500



From CO-01 work a 30" 1.0' bottom will cost approx. $3.05 per ft. for lining only

8 + 1 = 9

9 x 2/12 = 1.50 ft³/ft. = 0.0556 yd³/ft.

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Cost / yd³ = 3.05/0.0556 ≈ $55.00

Use $65.00

5000' of 28" Ditch

[(3.74 x 2) + 1.0][2/12] = 1.41 ft³/ft.

103+25
60+00
43 25

1.41/27 x 5000 = 262 yd³

~~143+29~~
105+45
37 84

8109' of 32" Ditch

[(4.27 x 2) + 1.0][2/12] = 1.59

1.59/27 x 8109 = 478 yd³

740 use 750 yd³

750 x 65 $48,750

Item No. 10 - 48" Dia R/C Pipe Class III

240

300'

From Hydro-Conduit $6.75/ft

300 x 6.75 $2,025

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Item No. 11 - 18" R/C Pipe Class IV

240'

From Hydro-Conduit $7.50 /ft.

240 x 7.50 $1,800

Item No. 12 - 36" R/C Pipe Class IV

312'

From Hydro-Conduit $25.00

312 x 25.00 $7,800

Item No. 13 - 48" R/C Pipe Class IV

335'

From Hydro-Conduit $38.00

335 x 38.00 $12,730

Item No. 14 - Loose Rock Riprap

550 yd³ - Outlet Str.

550 x $20.00 $11,000

STATE		PROJECT		
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Item No. 15 - 18" Slide Gate 5' Frame

13

11 From Armco 101C Flat back
$250.00

13 x 250.00 $3,250

Item No. 16 - 42x 24" Slide Gate 5' Frame

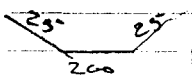
11

From Armco 5-00 Fabricated
$700.00

11 x 700 $7,700

Item No. 17 - Seeding

250
56
306



306 x 24,000 ÷ 43,560 = 168 Ac.

From Spook Hill FRS use
$230.00

248
26
274

330
274
56

230.00 x 168 $38,640

COMPUTATION SHEET
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JLS	4-18-78			RWCD- Reach 1
SUBJECT Cost Estimate - Preliminary				SHEET 10 OF 11

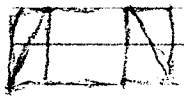
Item No. 18- Landscaping

Est. 10 Ac. - 1 Job.

Use $750.00 / Ac. $7,500

Item No. 19- Grouted Rock Riprap

125 yds.^{3} @ the Beginning of Reach 1 near Hwy 87



From Spook Hill FRS
30, 33 & 26 Use $35.00

8'
250 x 8
x 1.5

125 x 35 $4,375

$1,541,730

STATE		PROJECT		
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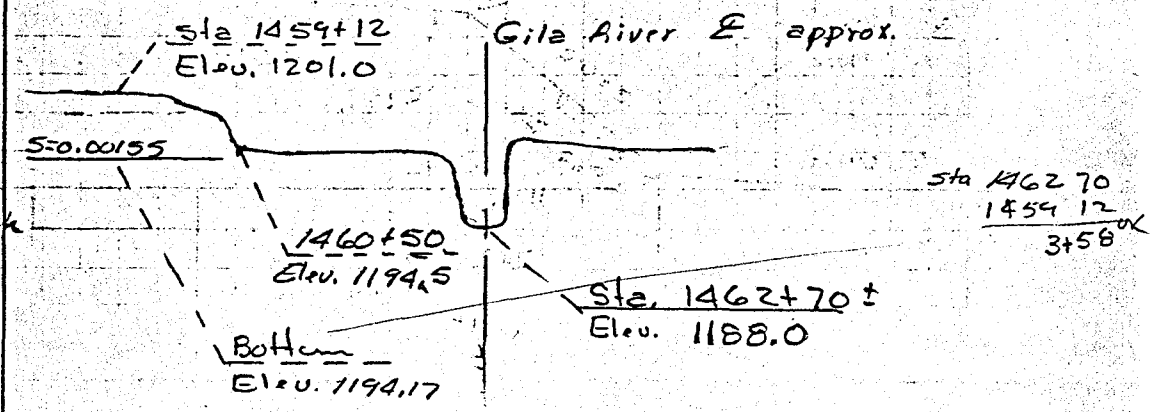
SUBJECT Outlet Structure - Preliminary Design				SHEET 3 OF 29

Math checked JLS Apr. 78

The channel is planned to outlet into the Gila River using a baffled chute. There is a main channel & flood plain channel as shown below.

1194.17
5.95
1200.12

1194.17
88.00
6.17



Length of reach 358 ft.

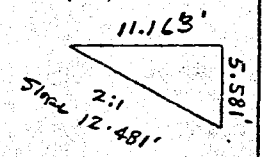
Baffled chute 2:1 Slope

chan. invert elev. − (2:1 slope)(X) = River invert + (slope)(358 ft − X)

$$1194.17 - 0.5X = 1188.0 + (0.00155)(358 - X)$$

$$0.4985X = 5.61$$

$$X = 11.25' \quad (11.163 \text{ check})$$



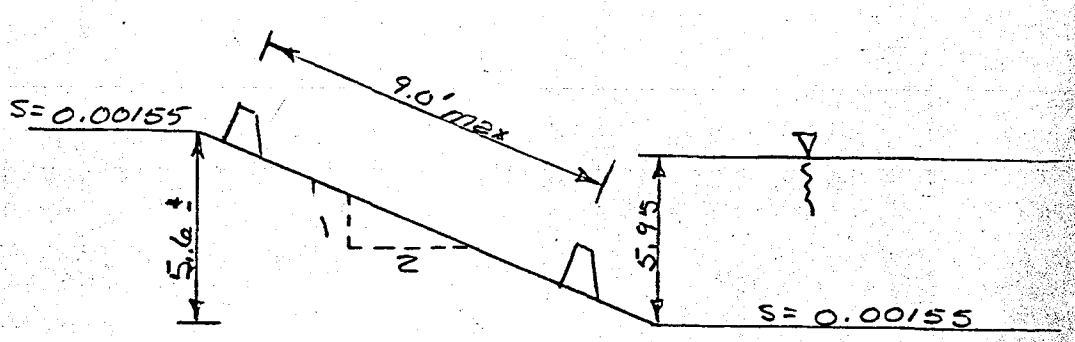
see tape attached

Without water in the river flow depth is 5.95'

Slope distance on a 2:1 (Baffled chute)

$$\left[(5.6)^2 + (11.25)^2\right]^{1/2} \approx 12.6' \quad (12.481' \text{ slope length})$$

31.36 126.56 158.57



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COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

STATE Ariz.
BY JLS
SUBJECT

Bearing - Bearing Interscept

| | | |

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
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JLS	3-7-78			RWCD - Phase 1

SUBJECT Outlet Structure - Preliminary Design SHEET 4 OF 29

Memo No. 25
P. 187 9.

Four rows of baffle piers are required to establish full control of the flow.

Math check
JLB Apr 78

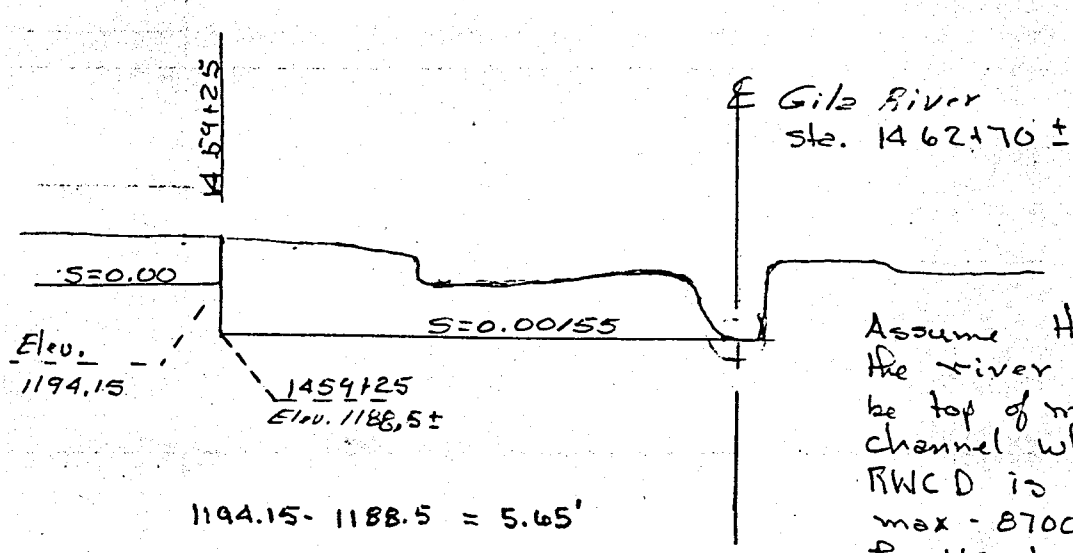
Therefore should consider other types of structures

NEH Sec. 11

Type C Drop Spillway

C = 3.1

Set at sta. 1459 + 25



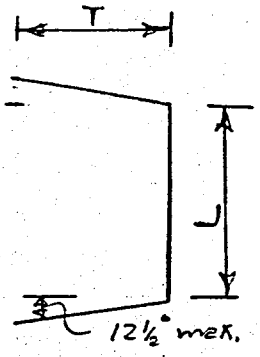
Assume that the river will be top of main channel when RWCD is flowing max - 8700. Then W.S. elev. 1195.0'

1194.15 - 1188.5 = 5.65'

Eq 3.15
P. 3.16

$Q_r = CLH^{3/2}$ where $C = 3.1$

Q_r = design discharge = 8700 cfs



17'

17.0 ft / tan 12.5° = 76.68

Try 166' wier length

$\left(Q/CL\right)^{2/3} = H$

$\left(8700/(3.1)(166)\right)^{2/3} = H = 6.59'$

Where $H = (h + V^2/2g)$

L = 166' T = 77' check 76.682

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Math Check
JEB April 78

~~Try A 200' Wier Width~~

$H = \left(8700/(3.1)(200)\right)^{2/3} = 5.82'$

$F.B = 5.82 \times 0.20 = 1.16$

$h = 7.0'$ 6.98 check

$d_c = 2/3\,h = 4.66'$ (3.90) 8700/200 = 43.5 d_c from chart 3.4

$F_{reqed} = 5.65'$ min.

$t \geq 1.75\, d_c = 8.155$ 6.8

95.0
8.15
86.85

$\therefore$ Transverse sill max elev. = 1186.85

Then $F = 7.3'$ use 7.5 in final design

94.15
86.85
7.30

$Q_{fr} = (1.1 + 0.01F)\,Q_r = 10{,}205$ cfs

$q_o = (7)^{3/2}(3.1) = 57.4$ cfs/ft.

$Q_s = 57.4 \times 200 = 11{,}480$ cfs $> Q_{fr}$ ok

Transverse Sill Height

$0.4\, d_c = 1.86'$ use $2.0'$

Stilling Basin Length

$h/F = 7/7.3 = 0.96$

$h/t = 7/8.15 = 0.859$ use 0.857 on chart

$L_B = 3.9 \times 7.3 = 28.5$

STATE Arizona		PROJECT Williams-Chandler WPP		
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Math Check
Apr 78 GEB

Floor Block Location

$L_f/F = 2.80$

Then $L_f = (2.8)(7.3) = 20.5$

$L_B - L_f = 8.0'$

$1.75\, d_c = 8.16'$ ok (will adjust final)

Floor Blocks

Width & Length

$0.4\, d_c = 1.86$ use 1.75'

use 60 blocks $105/200 = 0.53$ ok

50 - 87.5
52 - 91.
54 94.5
56 . 98.0
58 - 101.5
60 - 105

Blocks
$\frac{200}{3.5} = 57.14$

Height

$0.8\, d_c = 3.73$ use 3.75'

Sidewalls

$\epsilon + 0.85\, d_c = 12.11$ use 12.0'

$8.155 + (0.85)(4.66) = 12.116$

Wingwalls

Use 9.75'

STATE		PROJECT		
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Outlet Structure - Preliminary Design				

Math Check
Apr. 78 QEB

Transverse Sill Height

Use 1.75'

200
48
2.50
250.50

Quantities

Concrete

- Headwall

[(250.5 x 19.95 x 1.0) - (7 x 200 x 1.0)] ÷ 27 = 134 yd³
133.24

Height Headwall
Notch 7.0
Drop 7.2
Sill 1.75
Floor 1.00
Cutoff 3.00
19.95

Sidewalls (15")

(31.70 x 28.5 x 1.25) ÷ 27 = 42 yd³
41.87

Sidewall
7.0
7.2
1.75
1.00
upstr. 16.95
12.00
1.75
1.00
30.70

Floor

(200 x 27.5 x 1.0) ÷ 27 = 204 yd³
203.70

Wingwalls

(25.75 x 9.75 x 1.0) ÷ 27 = 10 yd³
9.3

12
1.75
1.00
3.00
17.75
2.25
1.75
1.00
3.00
25.75

Transverse Sill

(200 x 6.0 x 1.0) ÷ 27 = 45 yd³
44.44

STATE Arizona		PROJECT Williams- Chandler WPP		
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Math Check
QEB Apr 78

Blocks

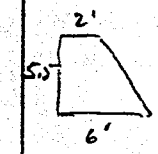
$(60 \times 1.75 \times 1.75 \times 3.75) \div 27 = 26\ yd^3$
25.52

Longitudinal sill

$(15 \times 27.5 \times 1.0 \times 2.0) \div 27 = 31\ yd^3$
30.56

1.5
1.75
3.25

Buttress 15



12 yd^3

Concrete 504 cu.yd

Rock

Use $D_{50} = 6''$

Upstream - 20'

$[(7^2 + 21^2)^{1/2} \times 1.5 \times 20](2) \div 27 = 50\ yd^3$
49.19

$(200 \times 20 \times 1.5) \div 27 = 225\ yd^3$

275 yd^3

Downstream

Use the same 275

550 yd^3

STATE Arizona		PROJECT Williams- Chandler WPP		
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SUBJECT Outlet Structure- Preliminary Design				SHEET 27 OF 29

Math Check
Apr 78 JCB

Cost

Disregard channel Exc.

Concrete

504 x 230 = $115,920.00

Rock

550 x 20 = 11,000.00

$126,920.00

Comments

1. Transverse sill is 1.15' below river bottom.

2. Cost is only ≈ $500.00 more ∴ use because will not require a transition to the structure (Less Rip Rap Required)

STATE Arizona		PROJECT Williams-Chandler WPP		
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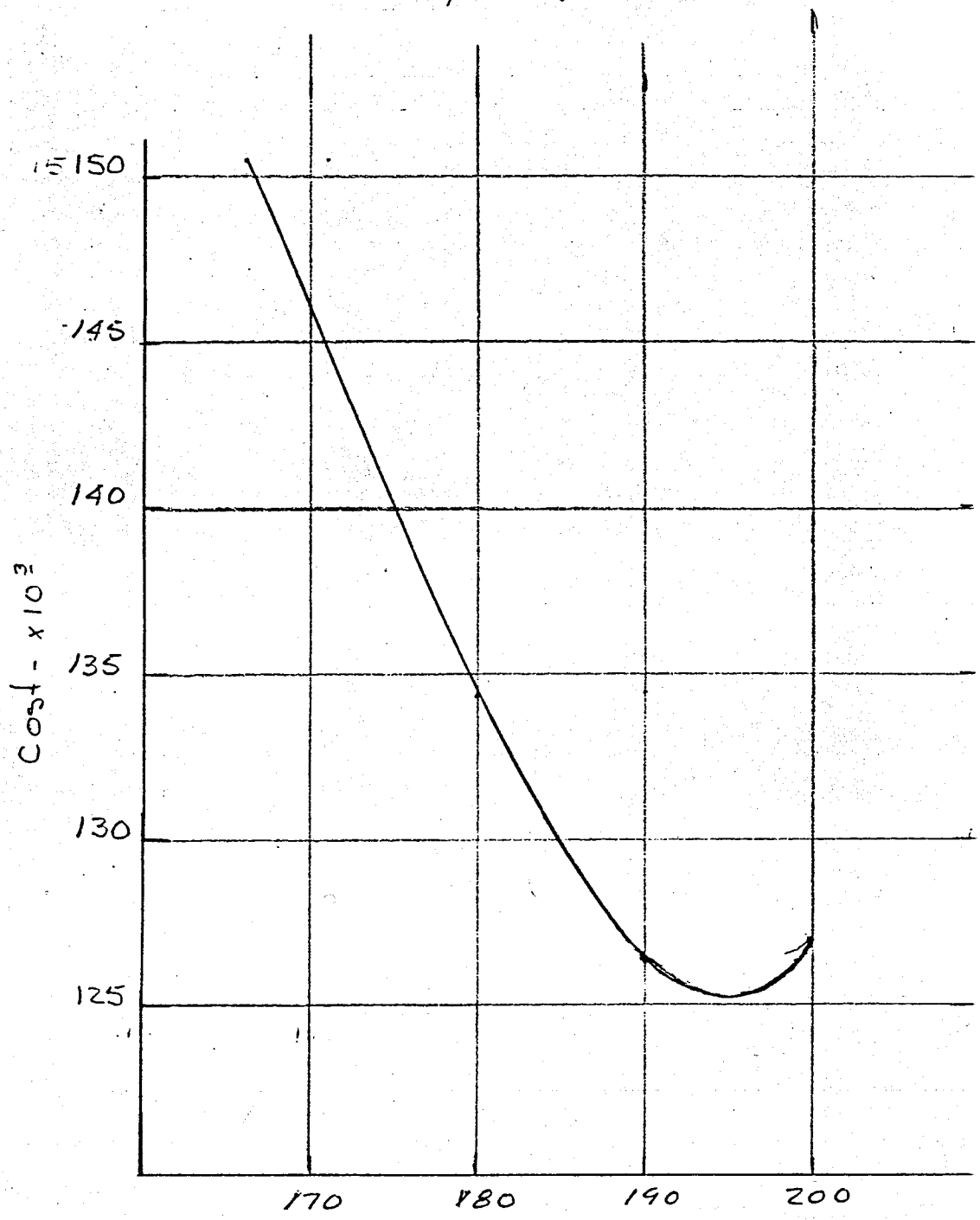
150,500
134,500
126,500
121,500



STATE Arizona		PROJECT Williams- Chandler WPP		
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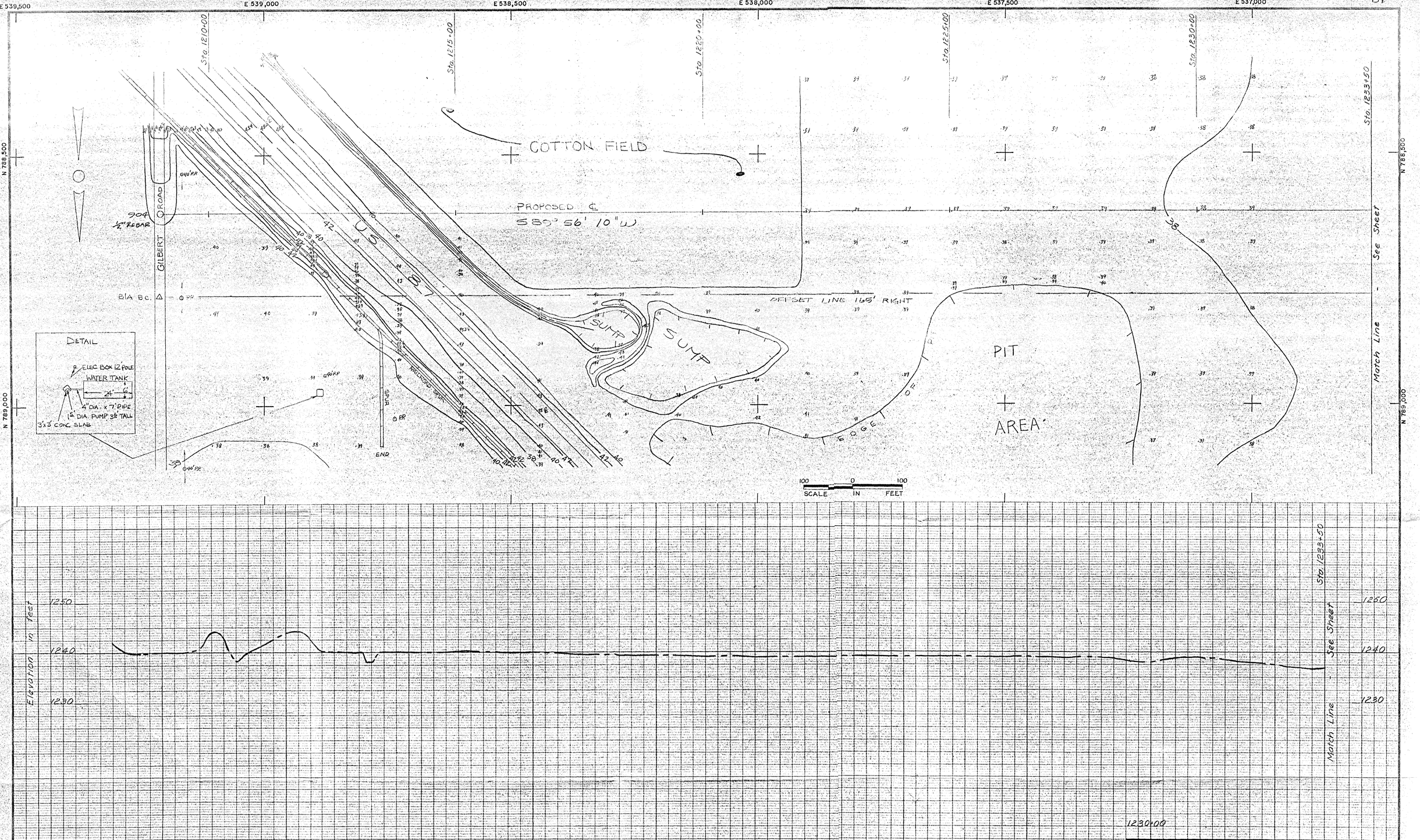
SUBJECT Outlet Structure- Preliminary Design				SHEET 29 OF 29

6.95
1188.4
1194.35

Conclusions

1. The most economical structure would be the 190' wide drop str., but would not need a transition section if 200' is used.
2. To have the proper submergence the Transverse sill would have to be 1.14' below the bottom of the river when it is flowing full (W.S. Elev. 1195.0). If the river is not flowing then would need to lower the Transvers sill another 0.65'
3. Assumed W.S. elev. 1195 is 0.85' above the Flood Channel invert ∴ would need to raise banks at least this amount to allow for silt build up.
4. A baffled chute needs to have at least 4 rows of blocks to operate properly also the chute would be totally submerged, which is not good. Therefore did not use for these reason

Note: Will need to change tailwater to agree with R.P. McArthur study during final design



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RWCD FLOODWAY

WILLIAMS-CHANDLER W.P.P.

PINAL COUNTY, ARIZONA

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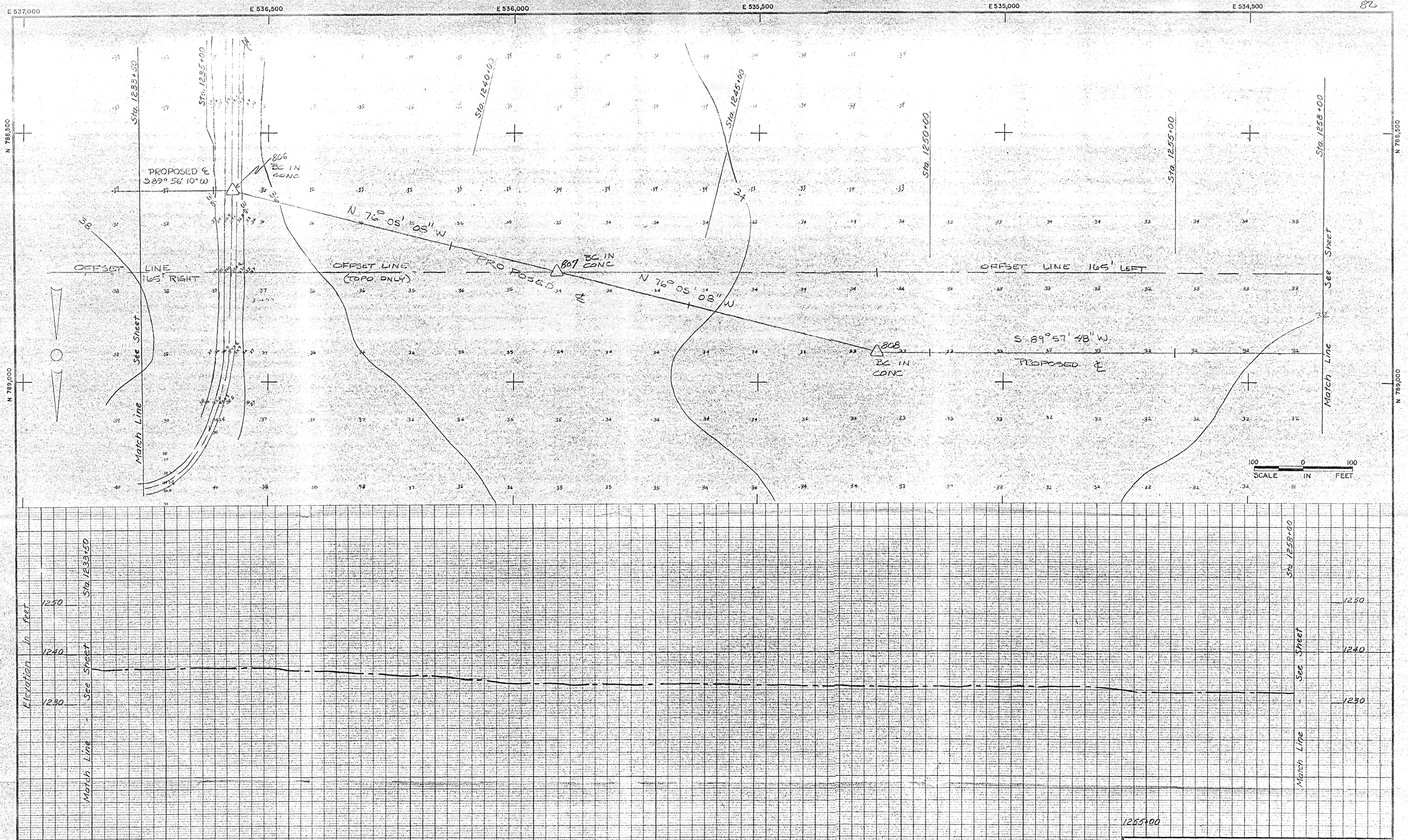

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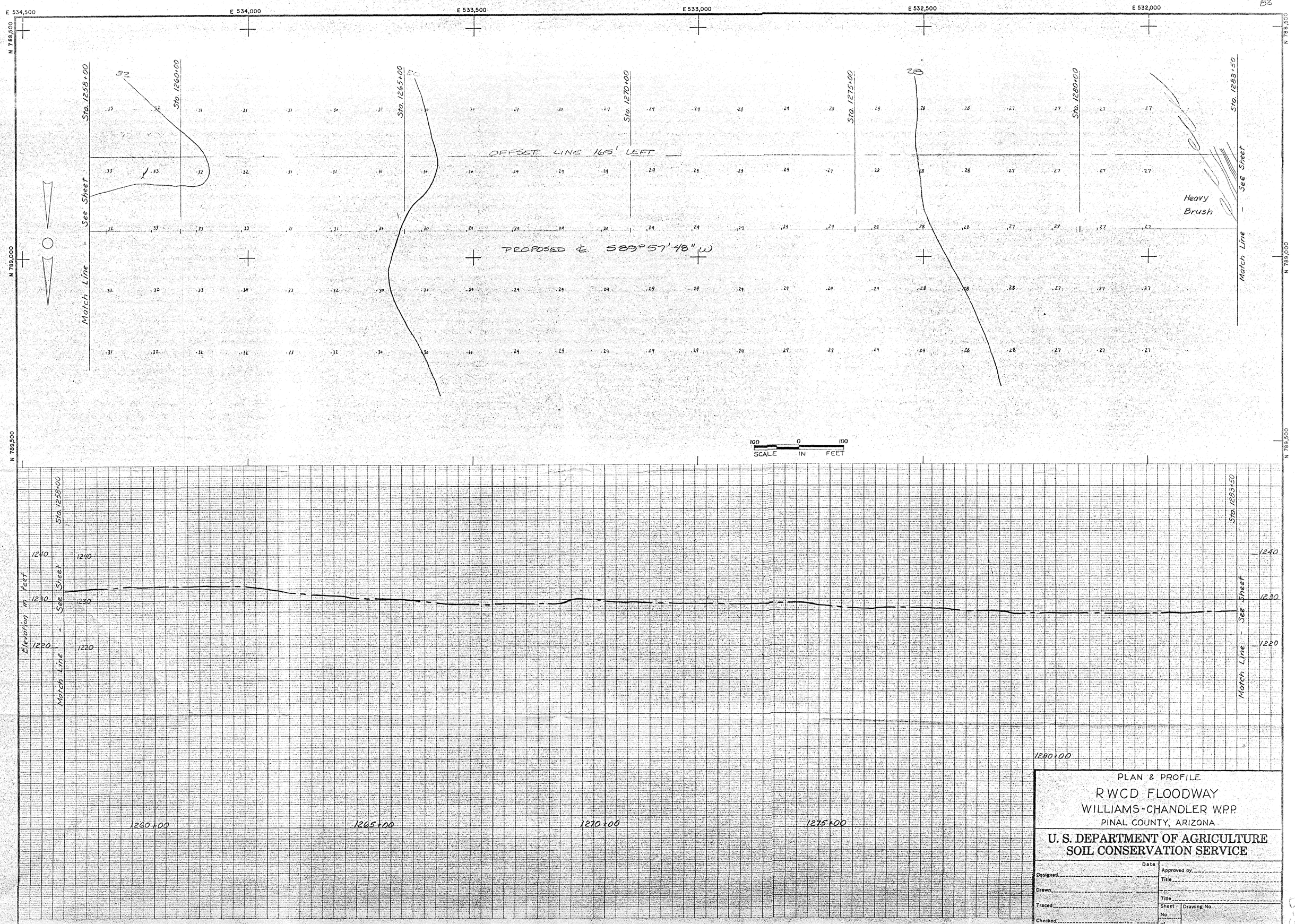
E 534,500
E 534,000
E 533,500
E 533,000
E 532,500
E 532,000
N 789,500
N 789,000
N 789,500
Sta. 1258+00
Sta. 1260+00
Sta. 1265+00
Sta. 1270+00
Sta. 1275+00
Sta. 1280+00
Sta. 1283+50
Match Line - See Sheet
OFFSET LINE 165' LEFT
PROPOSED ℄ S89°57'48"W
Heavy Brush
100 0 100
SCALE IN FEET
Elevation in Feet
1240
1230
1220
1260+00
1265+00
1270+00
1275+00
1280+00
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RWCD FLOODWAY
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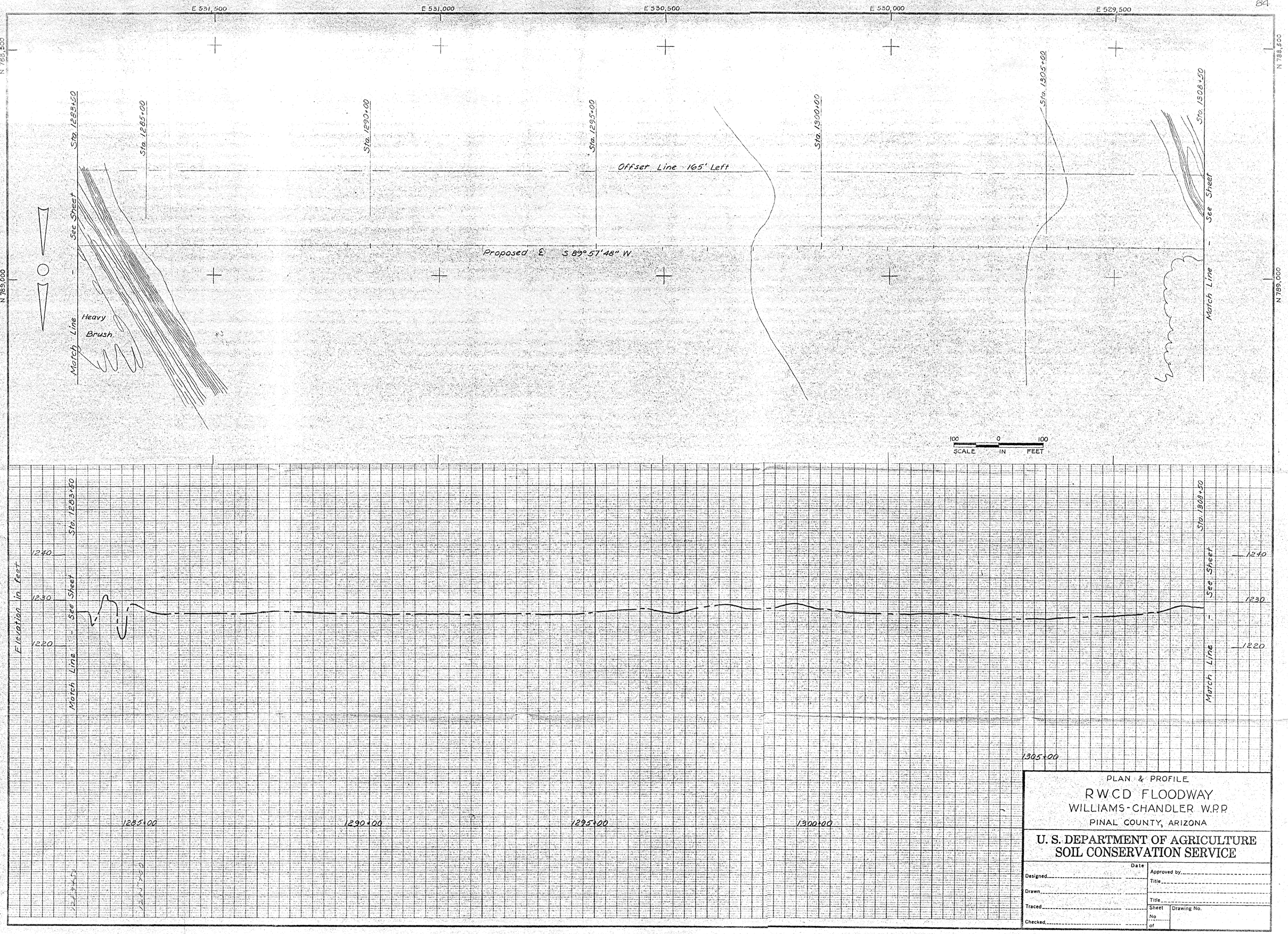
Drawing No.
FORM SCS-312 (NOV. 1966)


E 531,500
E 531,000
E 530,500
E 530,000
E 529,500
N 788,500
N 789,000
Sta. 1283+50
Sta. 1285+00
Sta. 1290+00
Sta. 1295+00
Sta. 1300+00
Sta. 1305+00
Sta. 1308+50
Offset Line 165' Left
Proposed ℄ S 89° 57' 48" W.
See Sheet
Match Line
Heavy Brush
100 0 100
SCALE IN FEET
Elevation in feet
1240
1230
1220
1285+00
1290+00
1295+00
1300+00
1305+00
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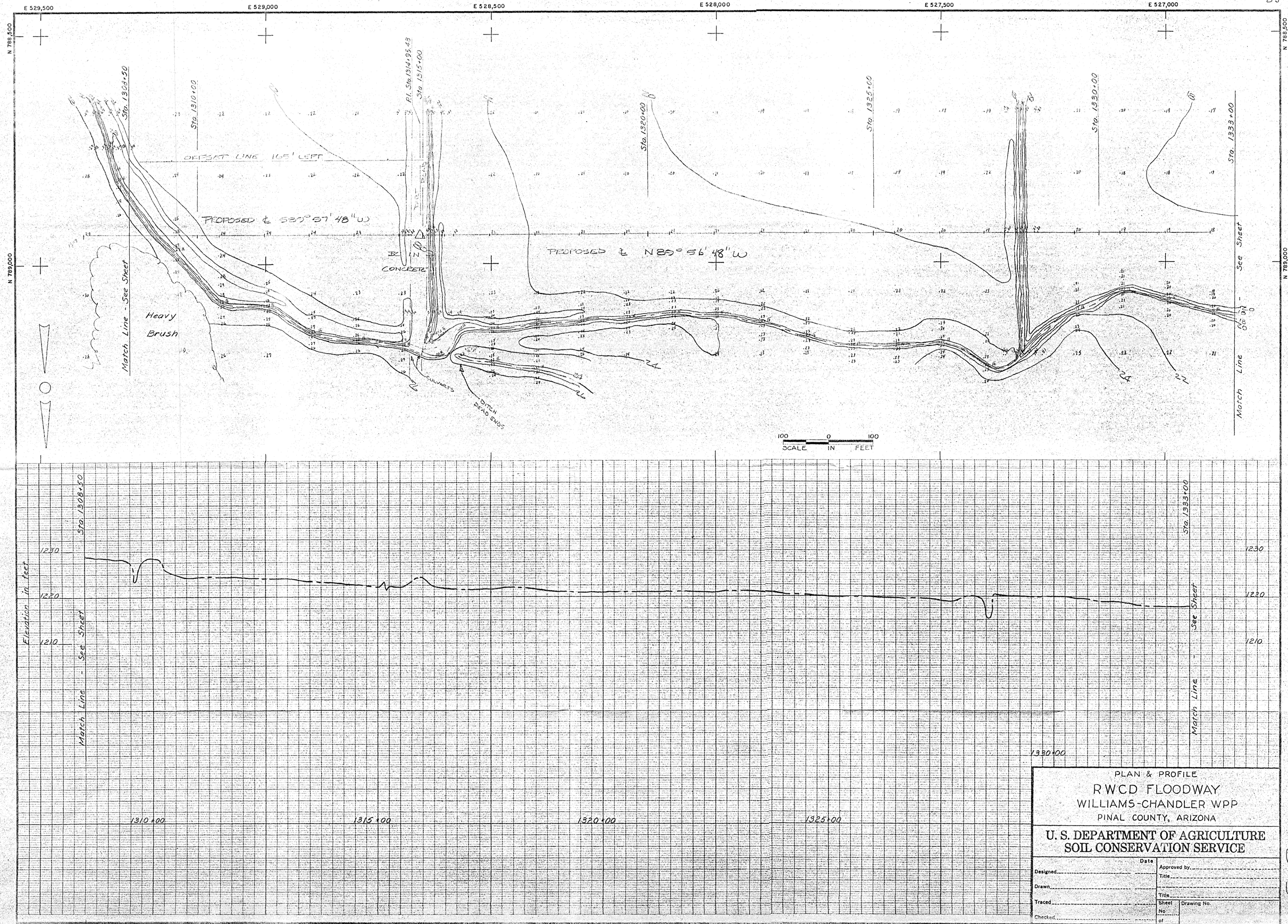

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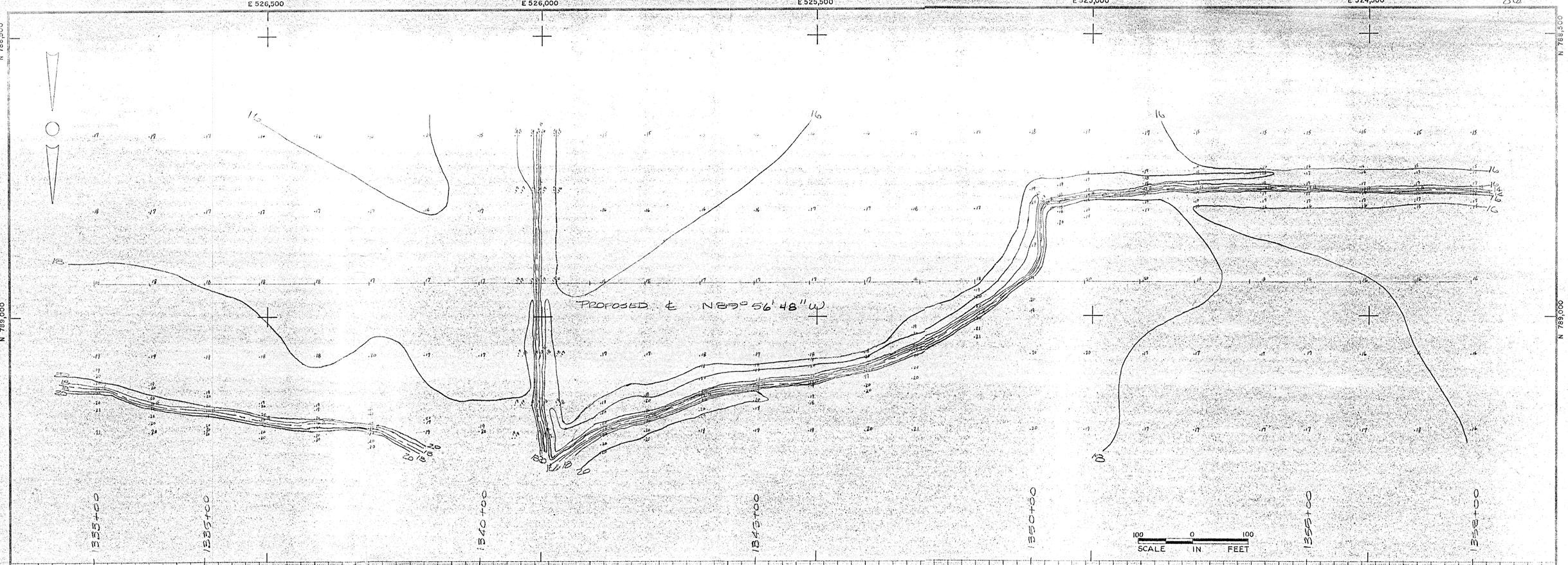

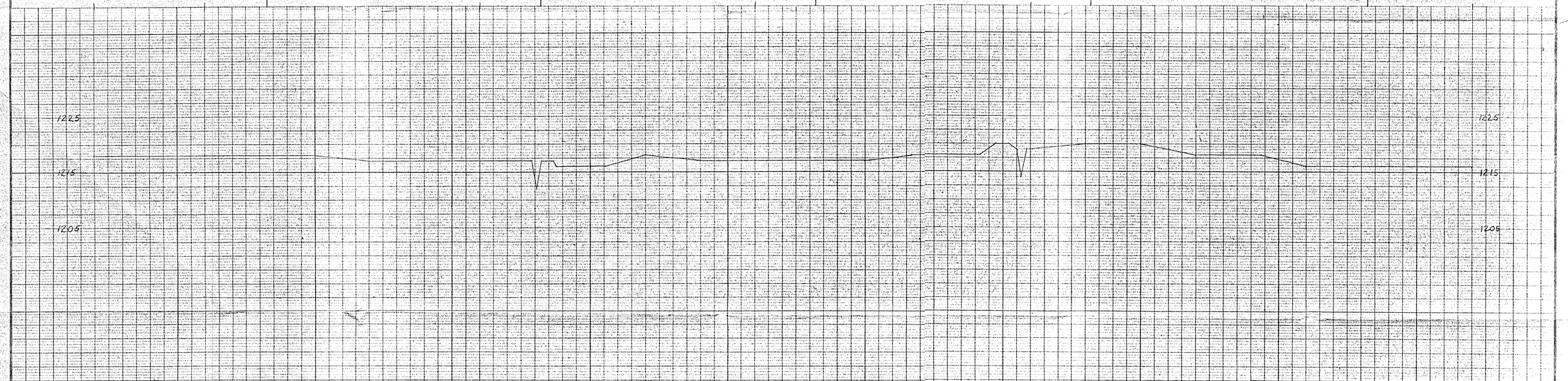

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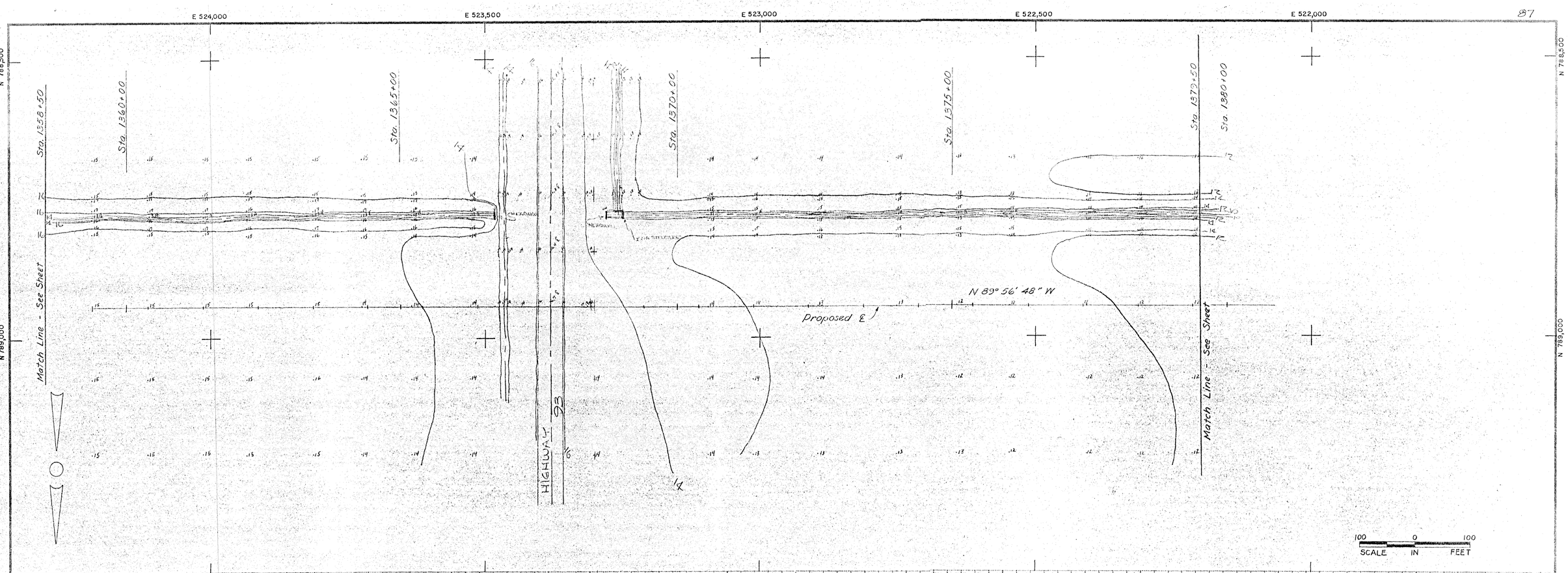

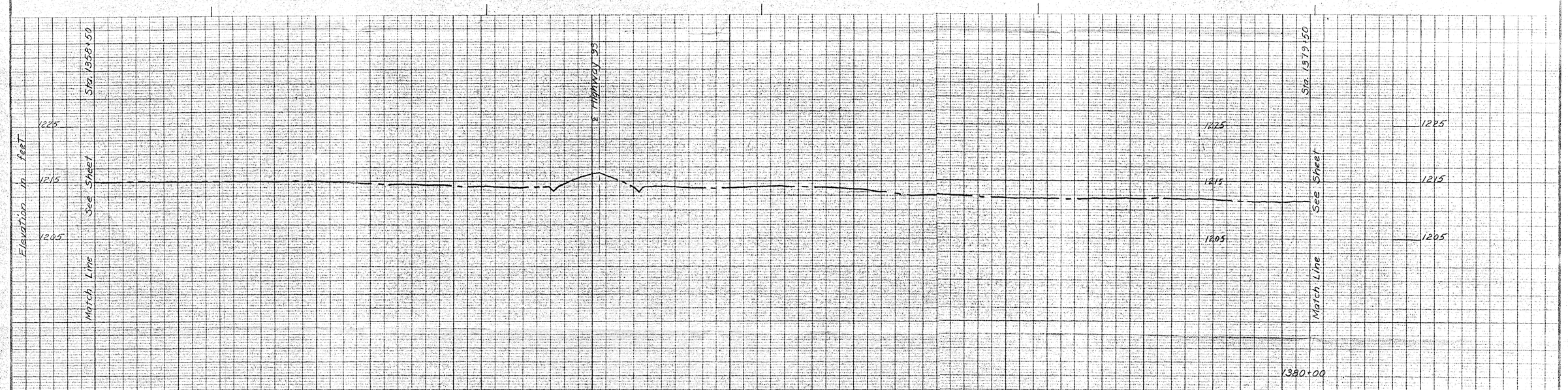

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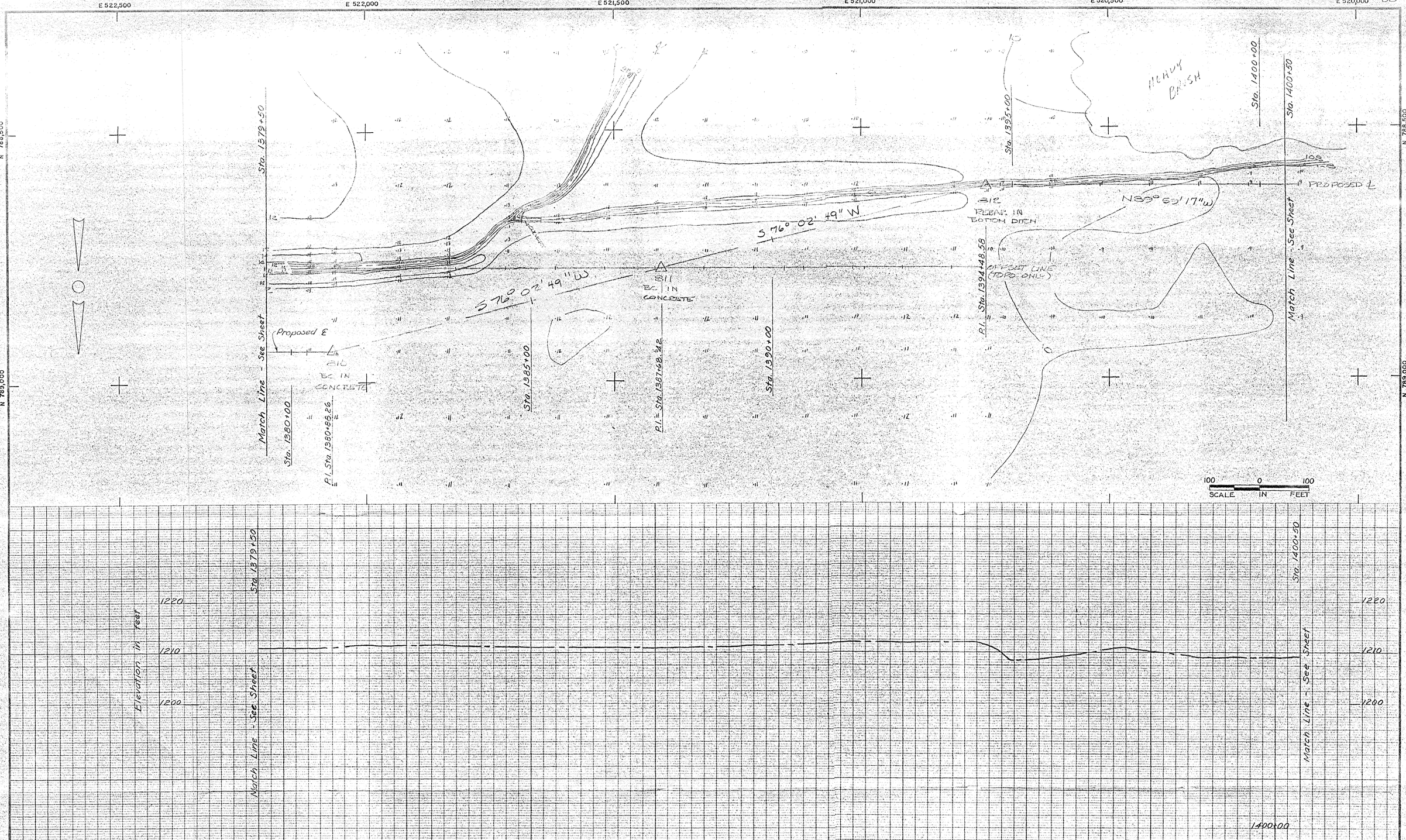

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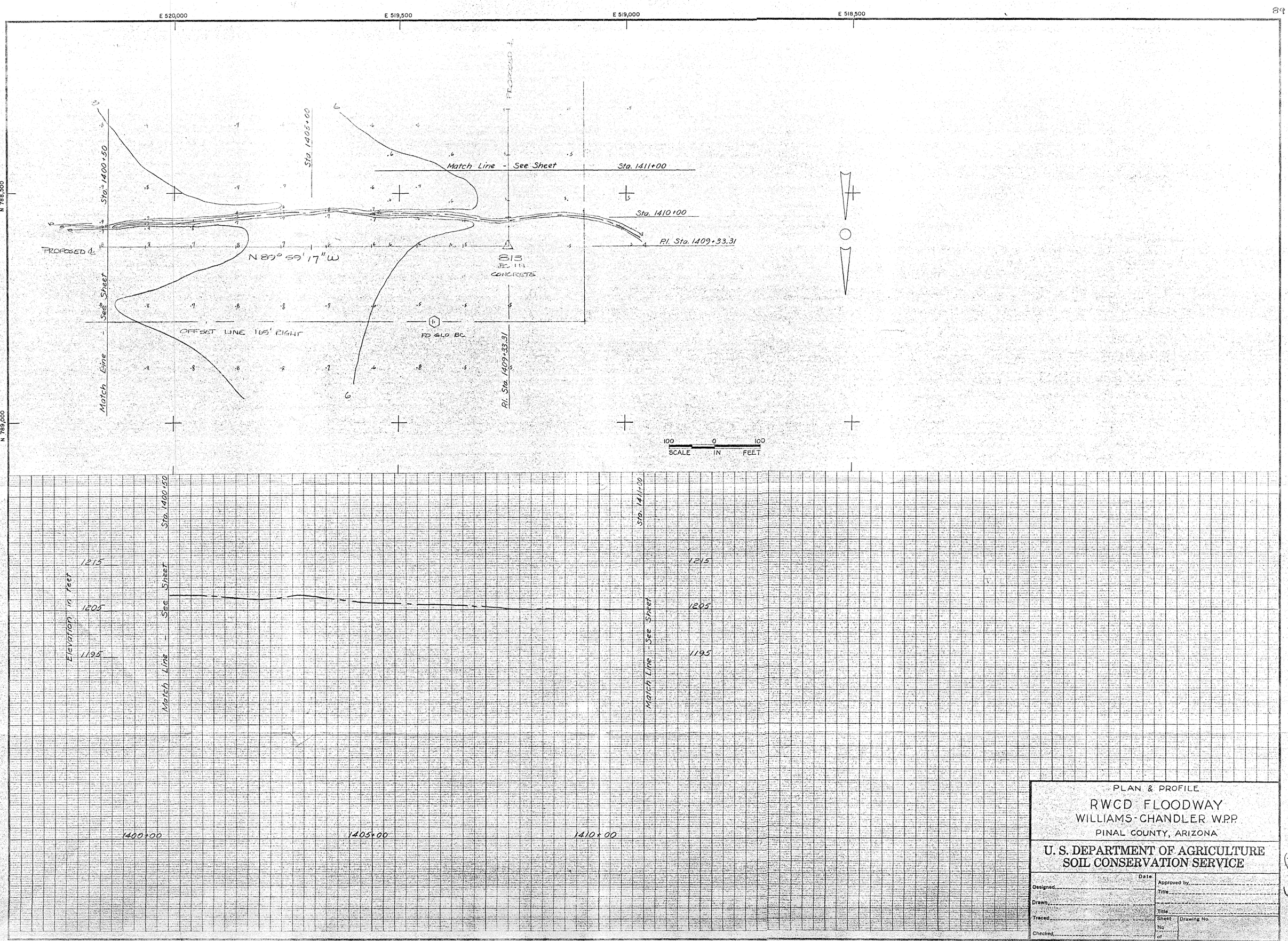

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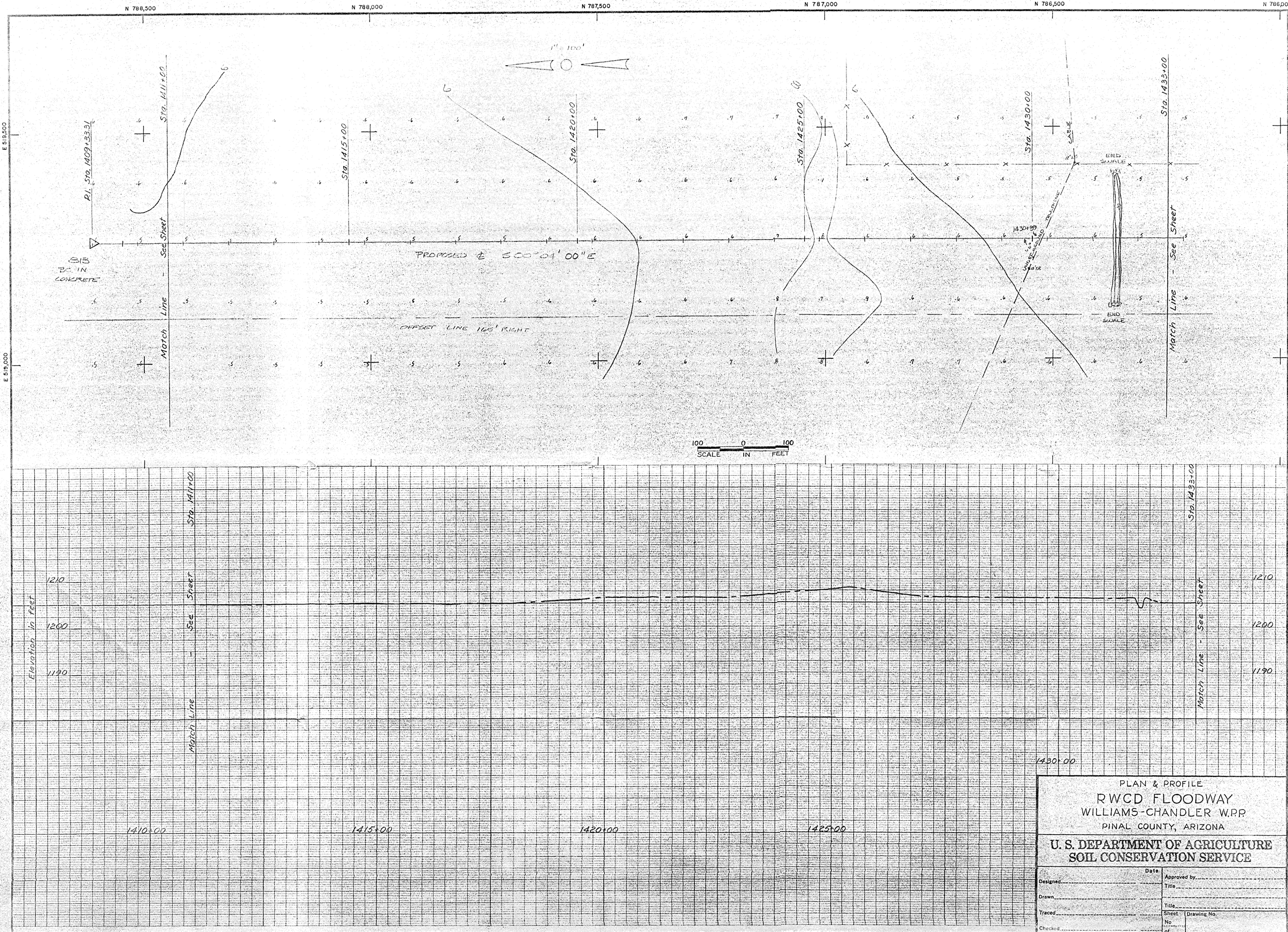
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N 788,000
N 787,500
N 787,000
N 786,500
N 786,000
E 519,500
E 519,000
1" = 100'
P.I. Sta. 1409+33.31
Sta. 1411+00
Sta. 1415+00
Sta. 1420+00
Sta. 1425+00
Sta. 1430+00
Sta. 1433+00
BIB
P.C. IN CONCRETE
PROPOSED ℄ S 00°04' 00" E
OFFSET LINE 16.5' RIGHT
1430+39
END SWALE
END SWALE
Match Line - See Sheet
SCALE IN FEET
100 0 100
Elevation in feet
1210
1200
1190
1410+00
1415+00
1420+00
1425+00
1430+00
PLAN & PROFILE
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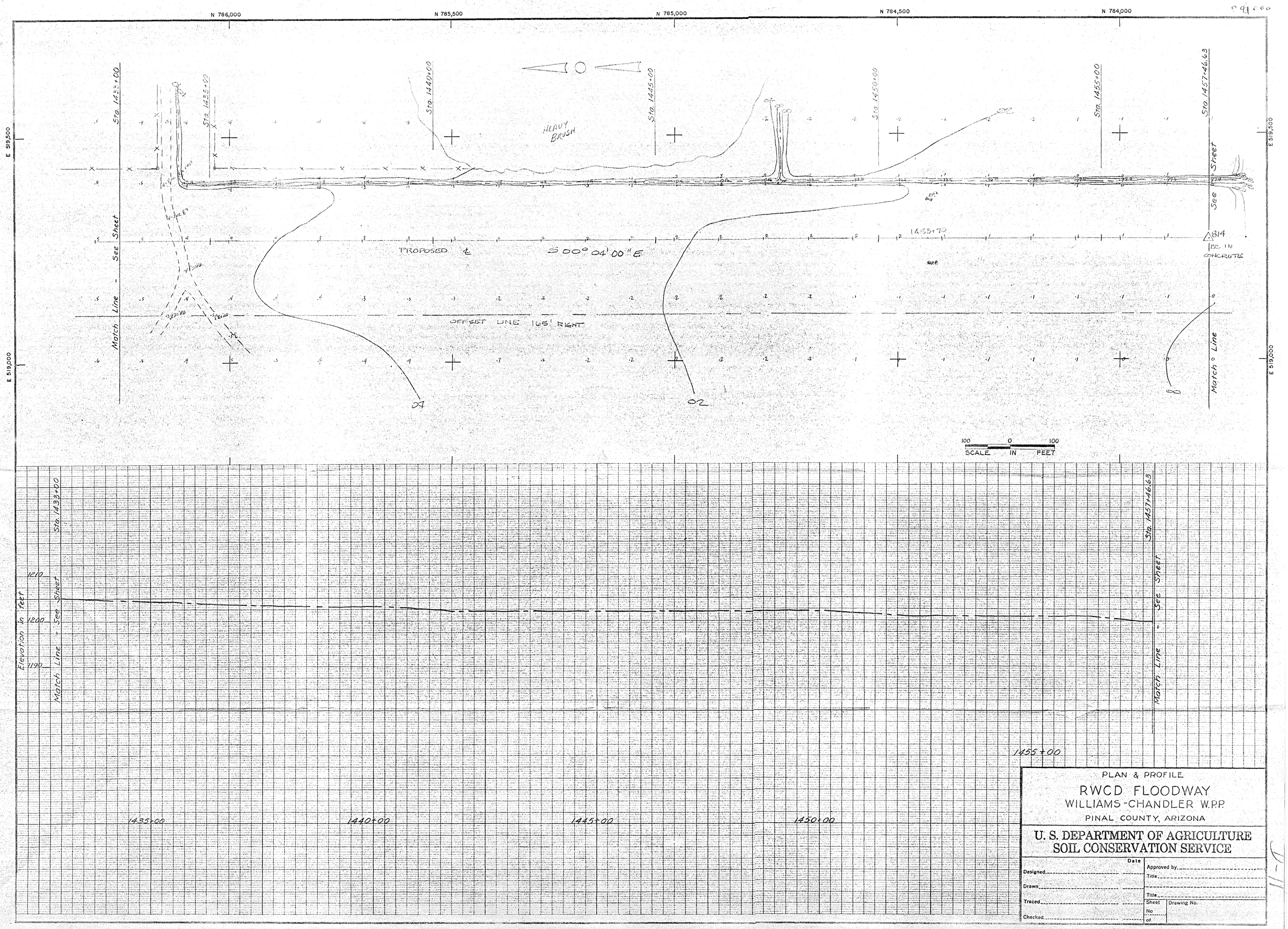

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RWCD FLOODWAY

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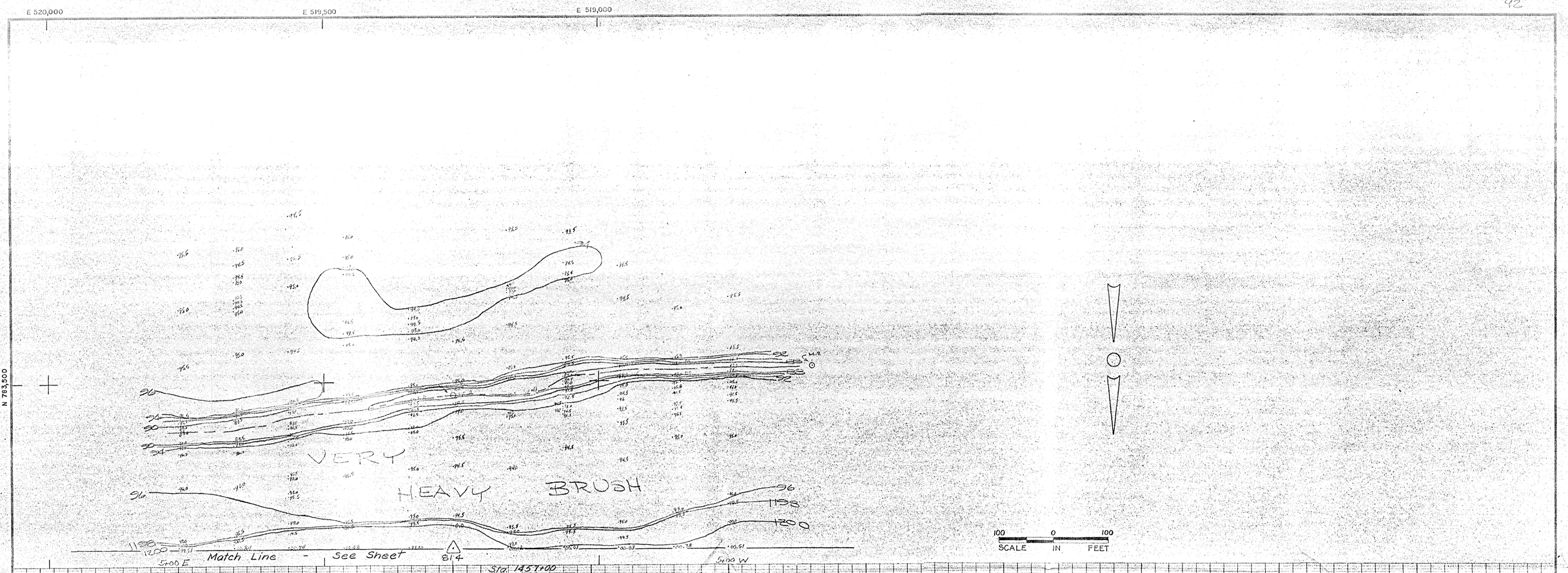

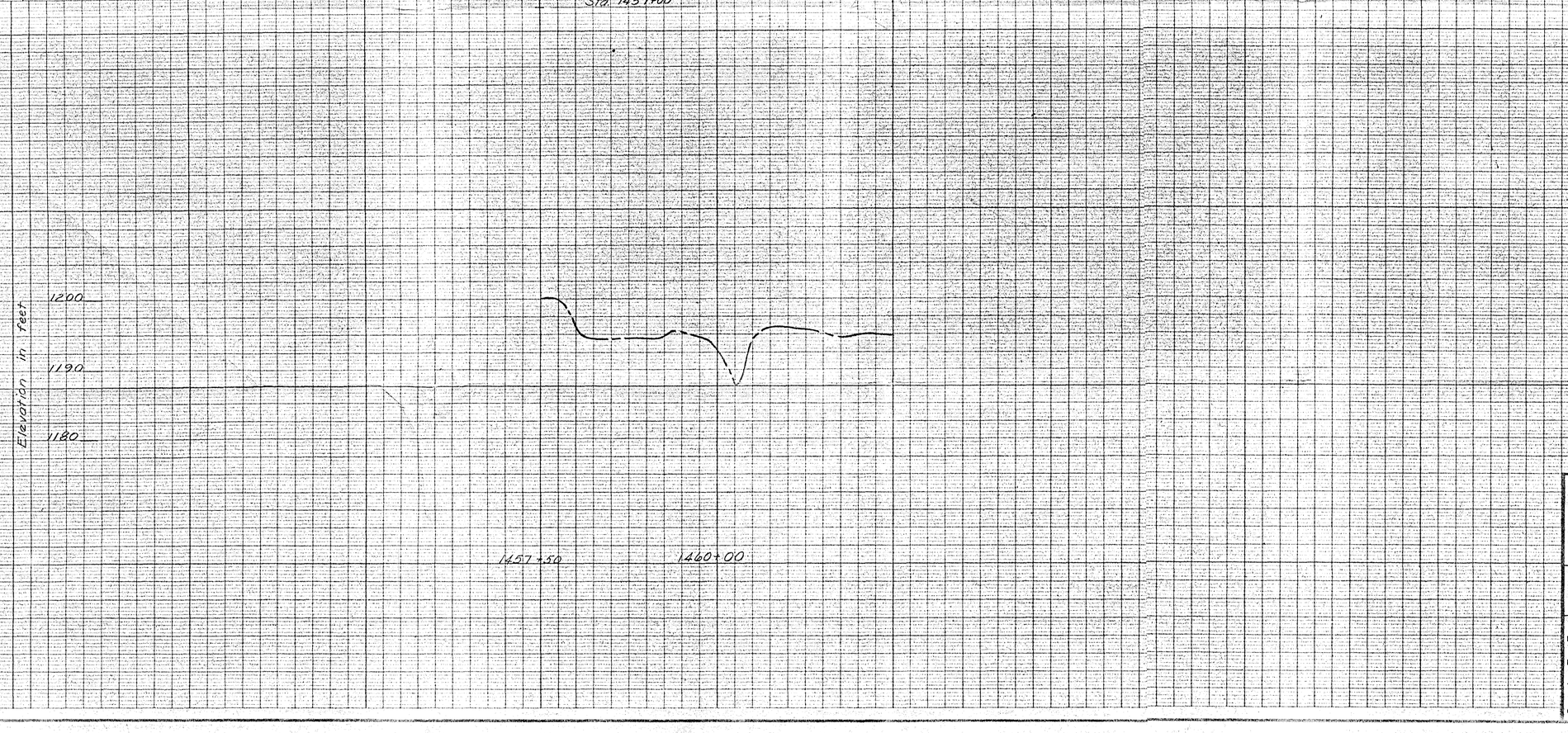

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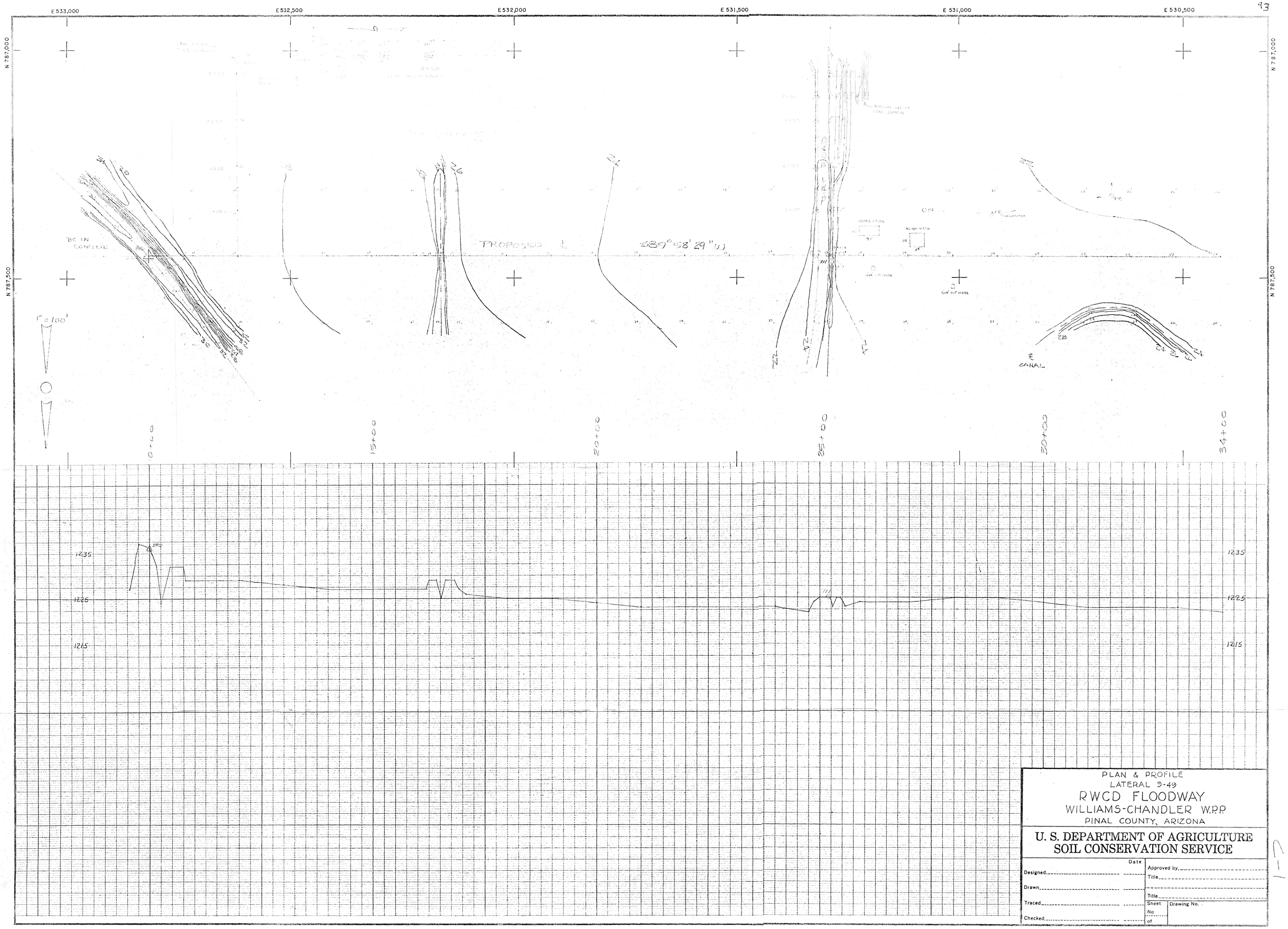

PLAN & PROFILE
LATERAL 3-49
RWCD FLOODWAY
WILLIAMS-CHANDLER W.P.P.
PINAL COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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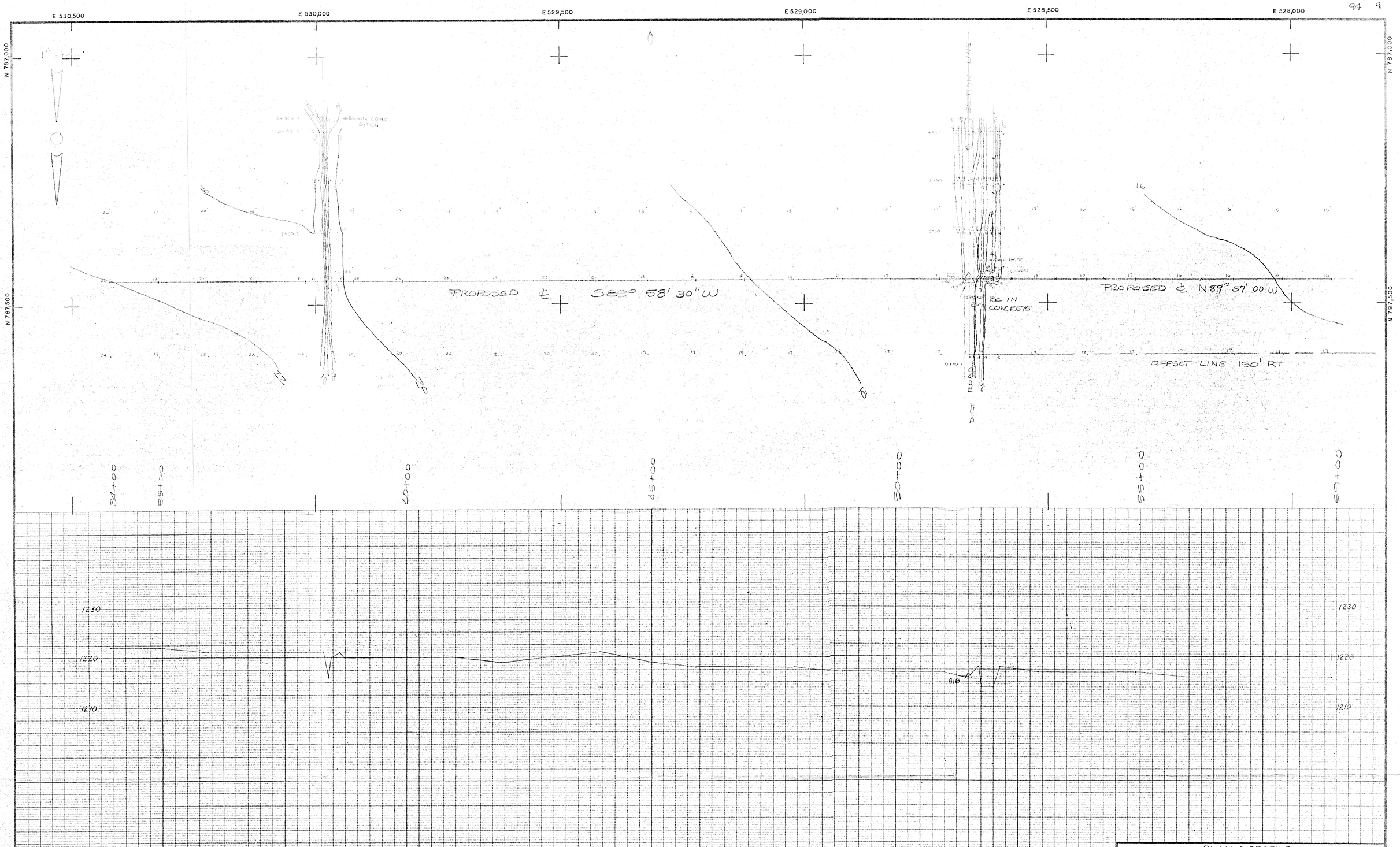

PLAN & PROFILE
LATERAL 9-49
RWCD FLOODWAY
WILLIAMS-CHANDLER W.P.P.
PINAL COUNTY, ARIZONA

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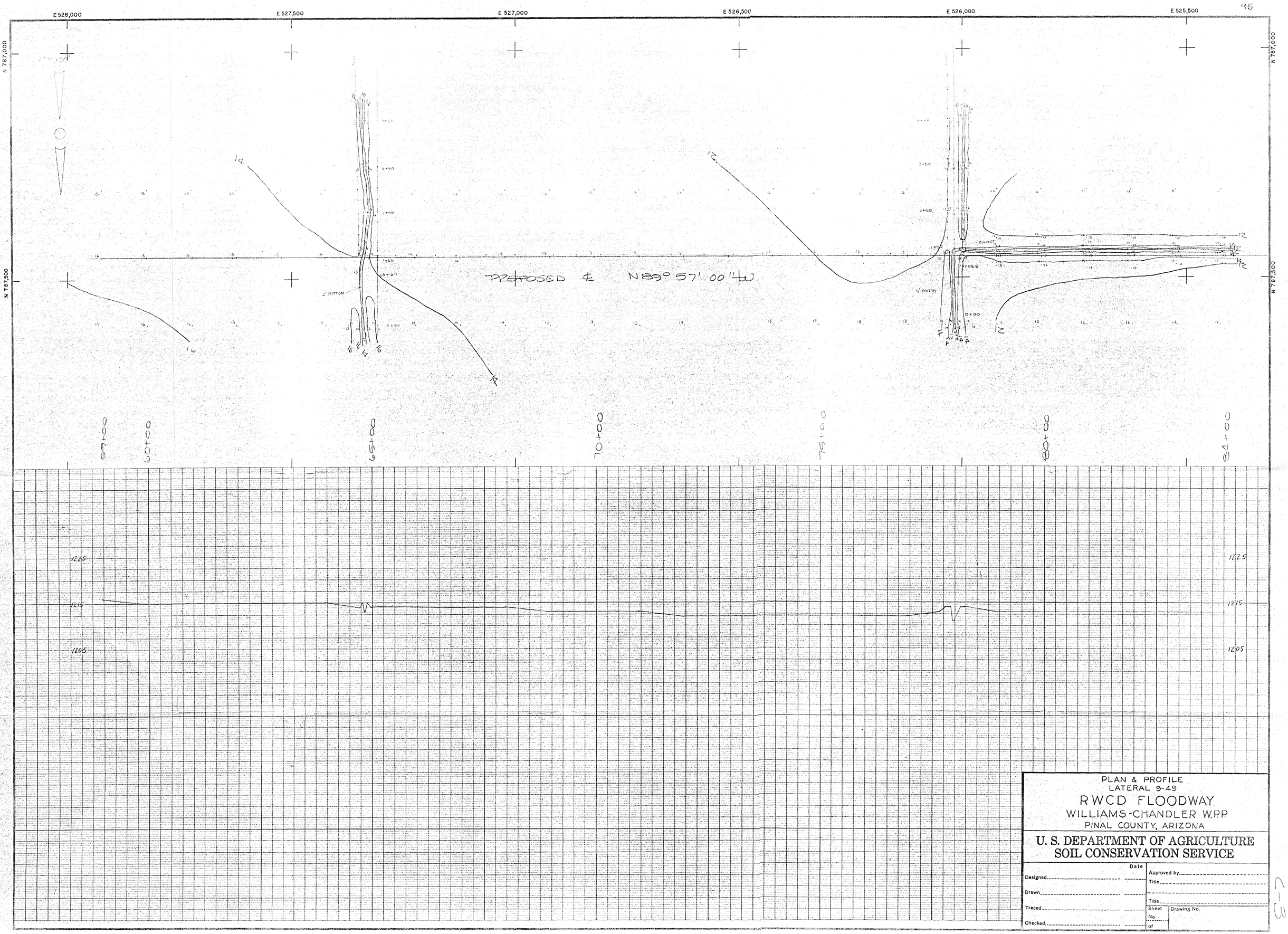

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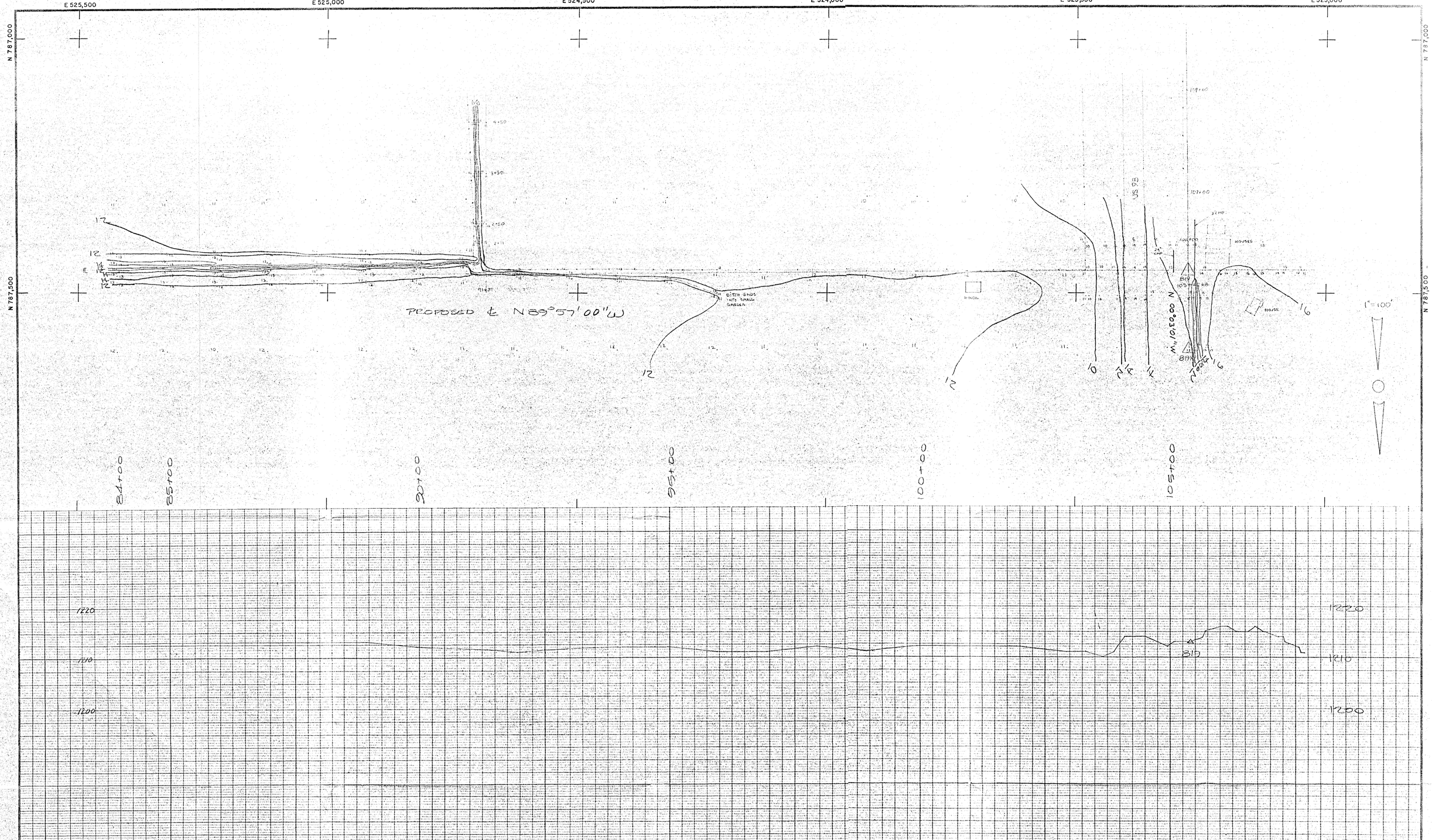

PLAN & PROFILE
LATERAL 9-49
RWCD FLOODWAY
WILLIAMS-CHANDLER W.P.P.
PINAL COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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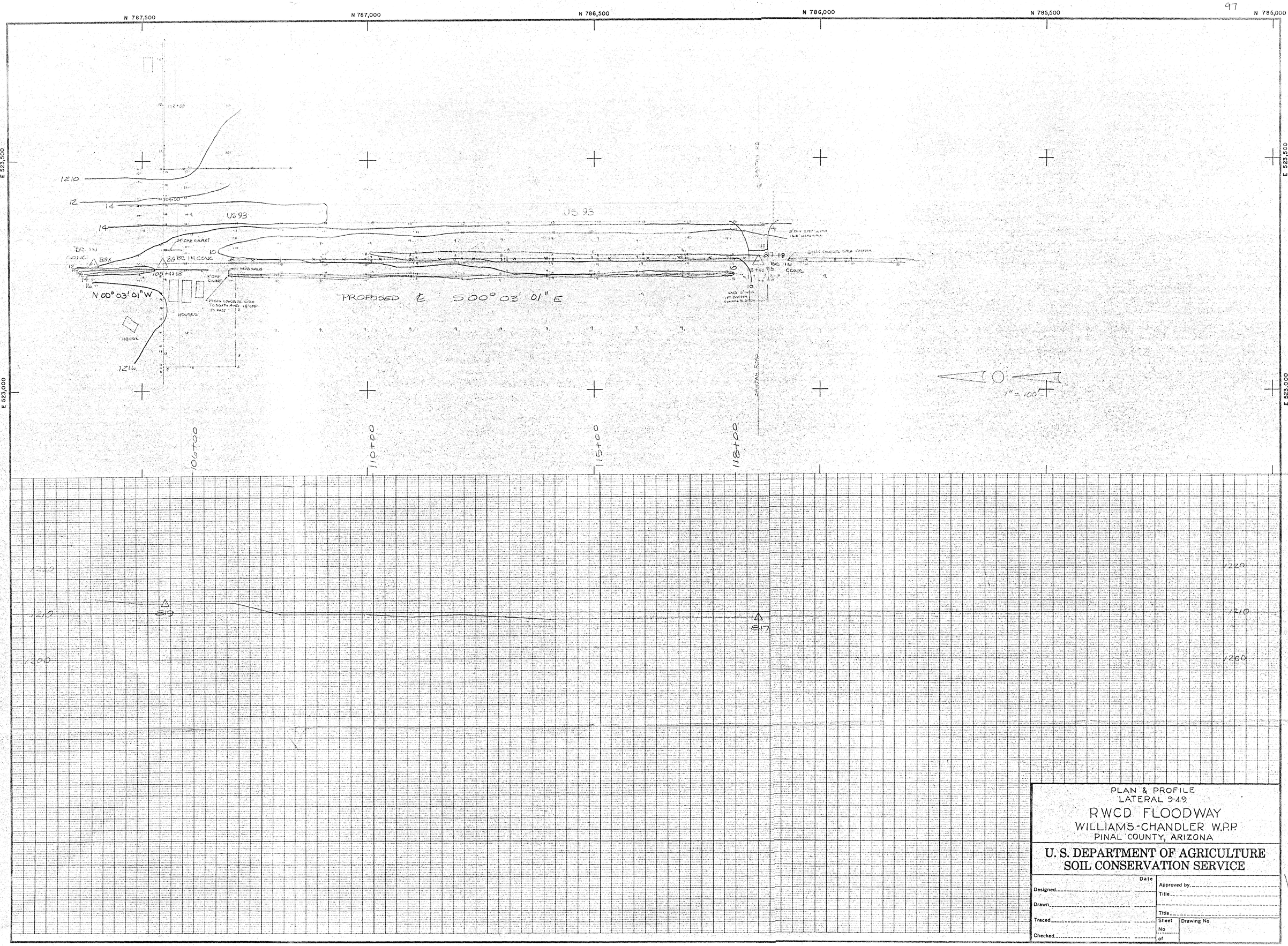

PLAN & PROFILE
LATERAL 9-49
RWCD FLOODWAY
WILLIAMS-CHANDLER W.P.P.
PINAL COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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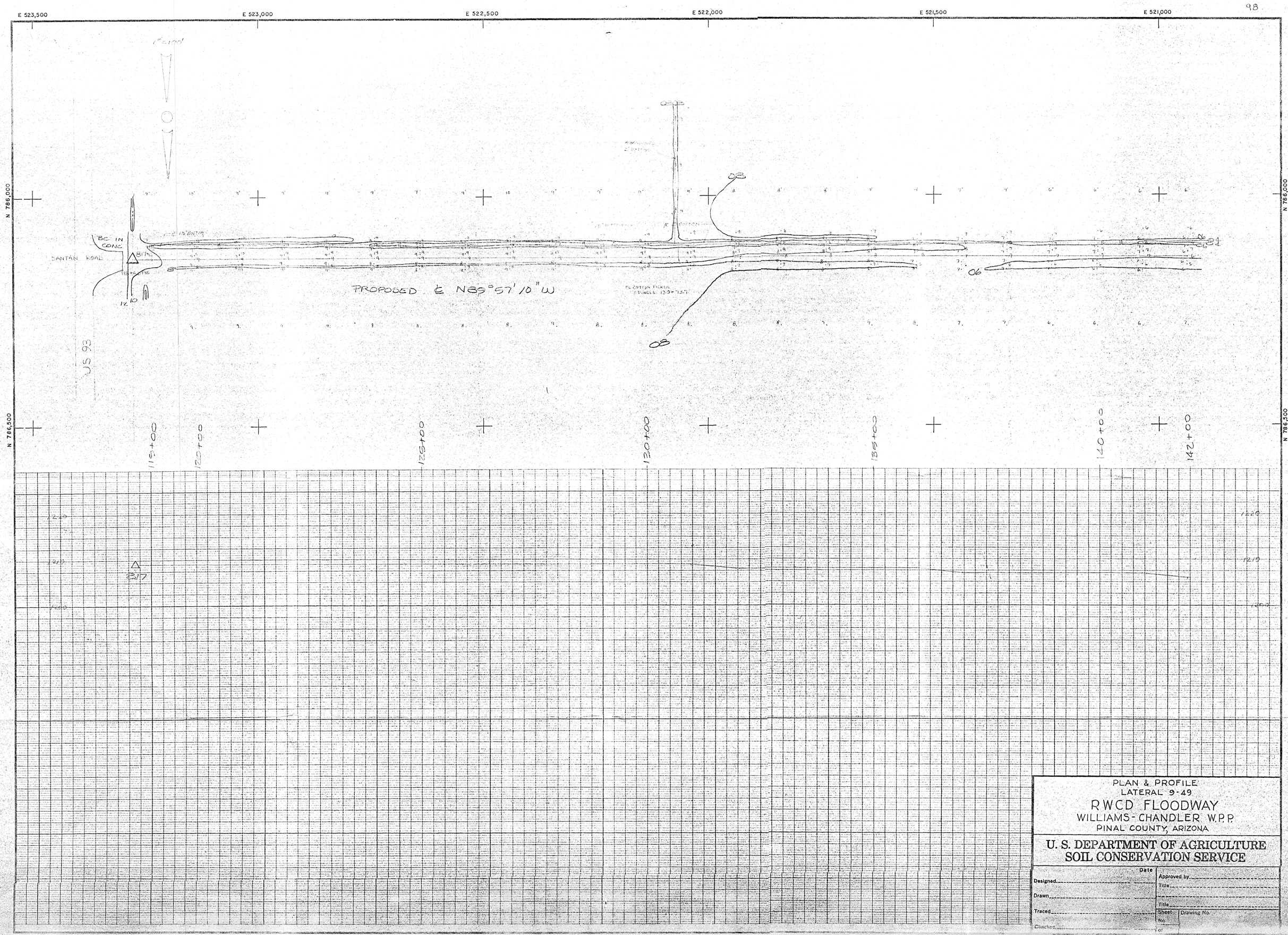

PLAN & PROFILE
LATERAL 9-49
RWCD FLOODWAY
WILLIAMS-CHANDLER W.P.P.
PINAL COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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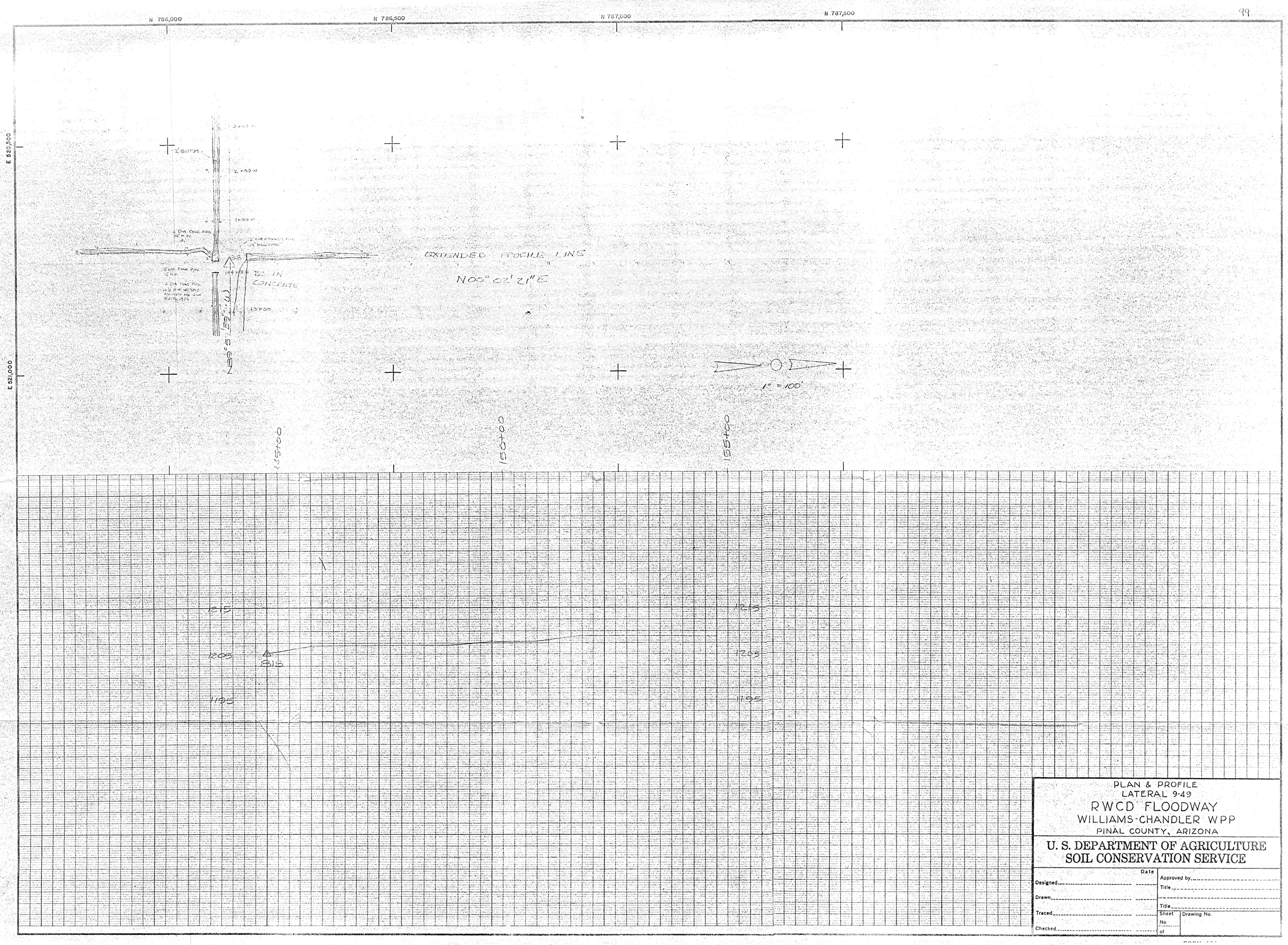

PLAN & PROFILE
LATERAL 9-49
RWCD FLOODWAY
WILLIAMS-CHANDLER WPP
PINAL COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
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PURPOSE OF THIS STUDY

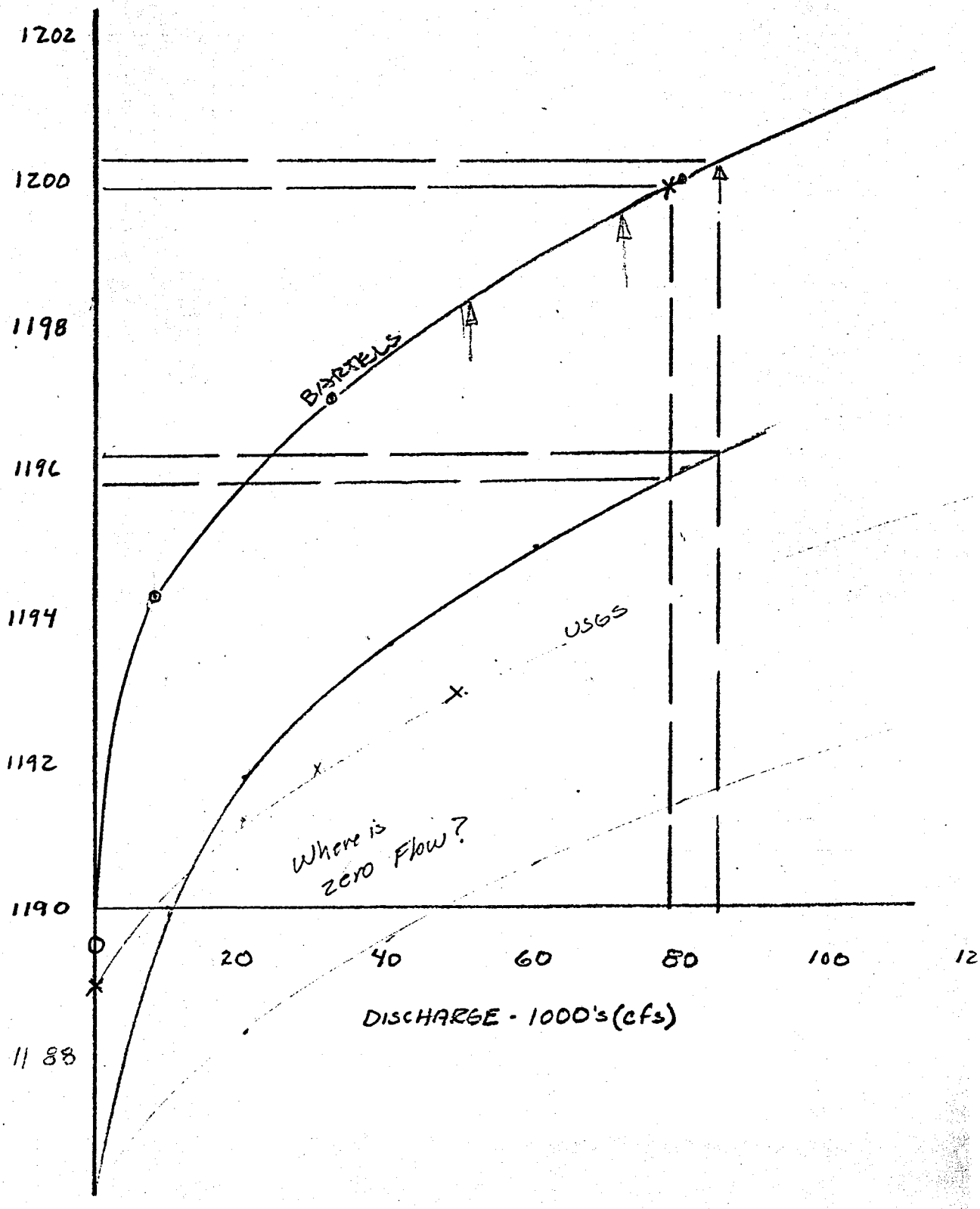
WATER SURFACE CONDITIONS IN GILA RIVER FOR OUTLETTING RWCD FLOODWAY

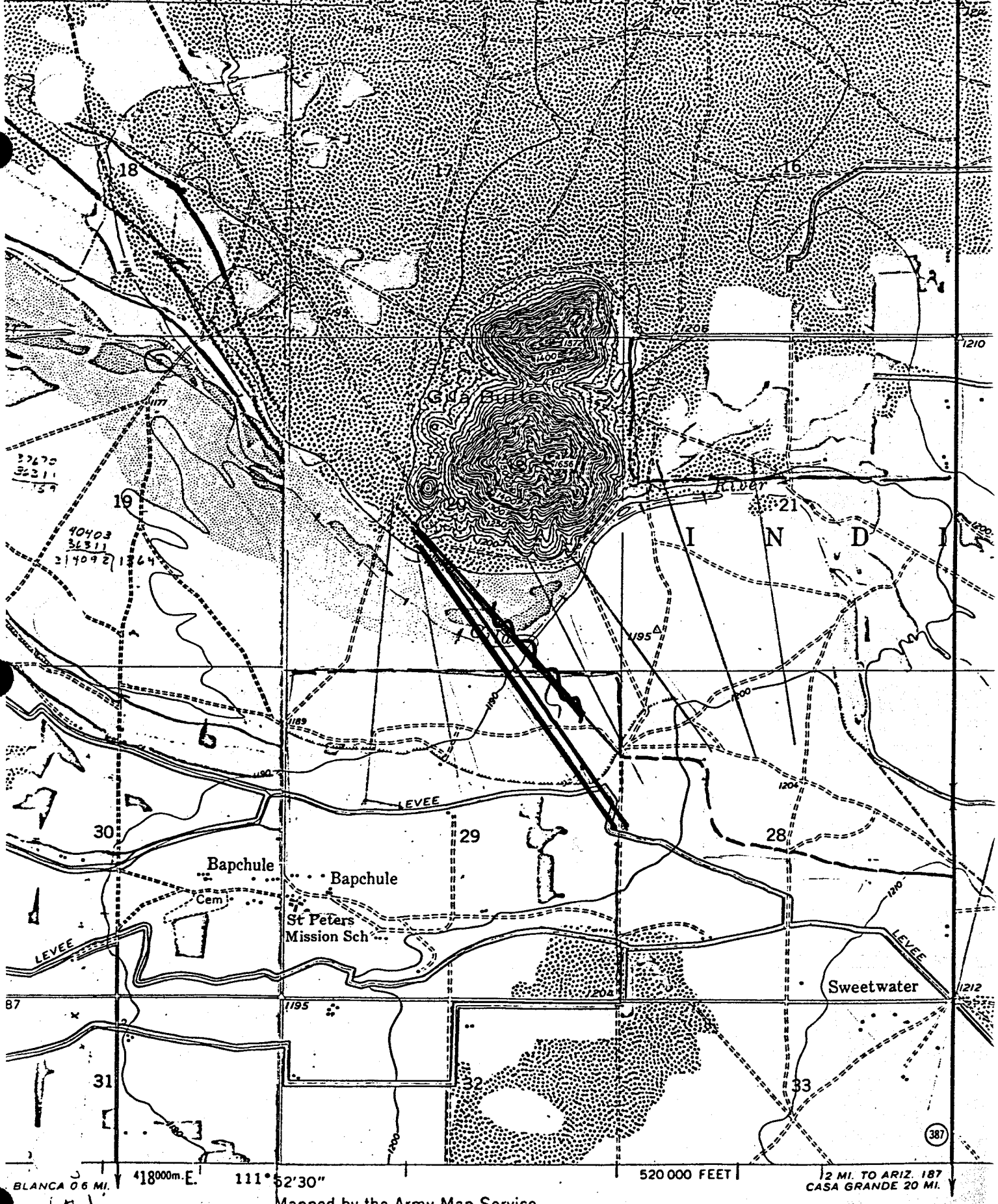
RPMcArthur 3/78

THE PURPOSE OF THIS WORK

There has been sufficient questions related to topographic conditions in the Gila River, the effect of the I-10 Bridge, peak flood flows in the Gila River, etc. to warrant further study to determine what the water surface conditions might be when the RWCD Floodway is discharging into the River.

This study was made to determine the most critical conditions effecting tailwater for the RWCD Floodway outlet structure.


1202
1200
1198
1196
1194
1192
1190
1188
0
20
40
60
80
100
12
DISCHARGE - 1000's (cfs)
B/BRTELS
USGS
Where is zero Flow?



ROAD CLASSIFICATION

Unimproved dirt

Mapped by the Army Map Service
Published for civil use by the Geological Survey
Control by USGS, USC&GS and USCE

USGS STUDY FOR I-10 BRIDGE

United States Department of the Interior

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION
P.O. BOX 4070
TUCSON, ARIZONA 85717

March 19, 1973

Mr. Robert Bartels
Soil Conservation Service
Suite 326, Ariz. Title Bldg.
111 W. Monroe St.
Phoenix, Ariz. 85003

Dear Mr. Bartels:

Enclosed is one copy of our bridge site study for Gila River that you requested. Please note that this is an administrative release for the Arizona Highway Department and is not for release to the general public.

Sincerely yours,

B. N. Aldridge
Hydrologist

Enclosure

3/30

Form 9-014

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

GILA RIVER AT GILA BUTTE, NEAR CHANDLER, ARIZONA

Floodflow Characteristics at Proposed Bridge Site on Interstate Highway 10

February 6, 1962

FOR ADMINISTRATIVE USE ONLY

U. S. GOVERNMENT PRINTING OFFICE 16—68868-2

GILA RIVER AT GILA BUTTE, NEAR CHANDLER, ARIZONA

Floodflow Characteristics at Proposed Bridge Site on Interstate Highway 10

By
Water Resources Division
U. S. Geological Survey.

February 6, 1962

FOR ADMINISTRATIVE USE ONLY

Prepared 2/6/62 by A. Wilson Hydraulic Engineer

Approved 3/9/62 by Douglas D. Lewis District Engineer
Douglas D. Lewis

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GILA RIVER AT GILA BUTTE, NEAR CHANDLER, ARIZONA

Floodflow Characteristics at Proposed
Bridge Site on Interstate Highway 10.

INTRODUCTION

The Arizona Highway Department proposes to build a bridge and approach embankment on Interstate Highway 10 across Gila River at Gila Butte, near Chandler, Ariz. The Department has requested an analysis of floodflow characteristics--frequency, magnitude, and flow distribution--at the proposed crossing for a flood having a recurrence interval of 50 years. This report has been prepared by the Water Resources Division of the U. S. Geological Survey in answer to the request.

SITE DESCRIPTION

For several miles upstream the river flows northwestward approximately parallel to the proposed highway and about a mile away. About three-quarters of a mile upstream from the site Gila Butte deflects the channel westward toward the crossing. At the site channel and floodflow direction is west.

PROPOSED CROSSING

The proposed highway crossing bears N33°W making a skewed crossing. Angularity is defined as the acute angle between the plane of the constriction and the line normal to the thread of the stream. The skew angle is thus 33°.

The proposed bridge opening is shown on Highway Department plans to extend from station 1473+15 to station 1496+85. The total span on the skew is 2,370 feet. Plans show 28 spans each supported by piling or piers, not dimensioned.

A shorter total span might be used if feasible on the basis of flow characteristics and other pertinent factors.

DATA AVAILABLE

The Highway Department furnished a location map (fig. 1), a large scale map of the site with 1-foot contours, a cross section of the valley along the centerline of the proposed crossing, and a sketch of the proposed bridge. Highway Department datum is used throughout this report.

Flood data have been systematically collected on the Gila River at Kelvin, Ariz., 51 miles upstream and at Laveen, Ariz., 21.4 miles downstream from the site. Gaging stations on San Pedro River, Aravaipa Creek, and Queen Creek provide other flood data useful in the analysis.

MAGNITUDE AND FREQUENCY OF FLOODS

Methods of analyzing flood data described in "Flood-Frequency Analysis", Water-Supply Paper 1543-A, were used to estimate the magnitude and frequency of floods at the site.

One of the requirements is to derive a mean annual flood for the site. Because of the complex hydrology of the Gila River main stem, the unique relationship of mean annual floods at Kelvin and Laveen was used. The effect of the vast desert expanse between Kelvin and Laveen is to decrease the size of mean annual floods between stations. It was postulated that the flood discharge remains constant from Kelvin to Twin Buttes, where the river debouches into the desert, and then the discharge decreases linearly with distance downstream from Twin Buttes to Laveen. The following table summarizes the computations:

Distance above Laveen (miles)	Location	Mean annual flood (cfs)
-	Kelvin	10,400
64.2	Twin Buttes	10,400
21.4	Gila Butte (bridge site)	4,600
0	Laveen	1,700

Another requirement is to obtain a dimensionless frequency curve in terms of ratio to mean annual flood and recurrence interval, in years, applicable to a region based on all flood records found to be homogeneous with respect to frequency characteristics. The dimensionless curve applicable to the region including Gila River at Gila Butte was derived from records at eight gaging stations.

By combining the magnitude of the mean annual flood with the dimensionless frequency curve, the curve, figure 2, was computed for Gila River at Gila Butte, near Chandler, Ariz. It shows the size of annual floods, in cubic feet per second, related to a range of recurrence intervals, in years. A recurrence interval is the average interval of time within which the given flood will be equaled or exceeded once.

The 50-year flood at Gila Butte is 33,100 cubic feet per second.

RELATION OF STAGE TO DISCHARGE

The elevation, or stage, attained by a flood of selected recurrence interval is important in an evaluation of the hydraulic characteristics of a bridge opening. Because no records of streamflow have been collected

at the crossing site, it was necessary to relate stage to discharge by computational procedures. The synthesis is based on dimensions of the flood channel obtained from the cross section survey, roughness coefficients for the channel selected at the time of a field inspection of the site, and the longitudinal slope of the valley.

The valley cross section along the centerline of the crossing was adjusted for its 33° skew to provide a cross section normal to the thread of the stream. It is assumed that the adjusted cross section represents the unconstricted channel in the reach at the site.

The longitudinal slope of the valley was computed from a 17-mile reach with more or less uniform slope and which extends through the reach at the site. The slope in the reach is 150 feet in 17 miles, or 0.00167 foot per foot. Because the energy gradient of floodflow tends to equal the valley slope, the computed slope can be used in a discharge formula.

Discharges were computed at selected intervals for a range of stage from 1,184 feet to 1,193 feet elevation. Computations were made using the Manning discharge formula:

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

where

Q = discharge, in cubic feet per second
n = coefficient of roughness
r = hydraulic radius, in feet = area/wetted perimeter
s = energy slope, in foot per foot
A = area of cross section, in square feet.

The resulting relation of stage to discharge in the unconstricted channel is the curve, figure 3. This shows the stage of the 50-year flood, 33,100 cubic feet per second, to be at elevation 1,192.0 feet.

DISTRIBUTION OF FLOW IN THE APPROACH SECTION

The cross section representing the channel in the reach at the site, described above, is used to represent the approach section a short distance upstream from the crossing. The distribution of discharge in the unconstricted approach section has been computed and is shown on figure 4. The 5-percent increments of discharge are located between the edges of the full channel. The distance shown is from the right (looking downstream) bank at elevation 1,192.0, the unconstricted channel stage for the 50-year flood.

EFFECT OF A CONSTRICTION

A constriction imposed on the channel would decrease the width of the stream, decrease the cross-sectional area of flow, increase velocity, cause backwater, and shift the flow distribution in part of the channel. The amount of each effect is dependent largely on the degree of constriction by embankments and piers. The diagram of distribution of flow (fig. 4) is a useful means of determining the optimum position of an opening of selected length. The opening is best located where it spans the greatest percent of total discharge within the selected length, although this may not be the most economically designed structure; other lengths should be studied.

The velocity of flow through the opening should be considered. The allowable velocity that will not induce damaging scour may be important as a limiting factor in selection of the area of the opening. The relationship of net area required for selected stages and velocities is shown in figure 5. For example, the 50-year flood with a mean velocity of 6 feet per second through the opening would require an area below 1,192.0 feet of about 5,500 square feet. For 8 feet per second, about 4,100 square feet.

Although mean velocities are shown, the maximum velocity at a point or points in the cross section may be considerably greater than the mean; usually the maximum velocity will be about $1\frac{1}{2}$ times the mean. The geometry of the opening will influence the velocity distribution.

The areas are net; that is, normal to the direction of flow. If the direction of flow is not normal to the centerline of an opening, proper consideration should be given by adjusting opening area by the cosine of the angle of skew with the flow to compute net area.

Backwater is the increase in water-surface elevation resulting from the constriction, above the normal (unconstricted channel) elevation at the approach section upstream. In this case backwater may be estimated by the formula,

$$h = 1.1\ V^2/2g$$

where

h = increase in elevation at approach section, in feet
V = mean velocity through opening, in feet per second
g = acceleration of gravity = 32.16

Low steel of the proposed bridge is at elevation 1,201.0 feet from the sketch. This allows a clearance of 9.0 feet above the 50-year flood elevation or about 7 feet more than usually allowed to clear floating debris.

To illustrate application of the information provided, assume the mean velocity allowable through the opening is 8 feet per second. This requires 4,100 square feet of net opening for the 50-year flood. Referring to figure 4, this area can be obtained between points 680 and 1,600 feet from the right bank. These points intercept a concentration of discharge increments, also.

Converting these locations to the skewed crossing shows the abutments would be at station 1480 + 50 and 1491 + 50. Also, low steel could be as low as elevation 1,194.0 feet with 2 feet clearance for the 50-year flood.

With fill forming a pooled pocket upstream from the right bank fill, the velocity head recovered would raise the water surface by an approximate total of approach section velocity head plus backwater.

The alinement of piers or piling with the direction of floodflow through the opening is important. Poorly alined piers tend to concentrate flow, increase maximum velocities, induce greater turbulence, and increase the possibility of scour.

SUMMARY

The relationship of unconstricted channel stage, discharge, frequency, and required opening area for selected velocities is summarized for a range of conditions in figure 5. The information is summarized below:

1. The 50-year flood at Gila Butte is 33,100 cubic feet per second.

2. The 50-year flood stage in the unconstricted channel is at elevation 1,192.0 feet, Highway Department datum.

3. Distribution of flow of the 50-year flood in the unconstricted channel is found in figure 4.

4. The area of an opening required for a selected unconstricted channel stage and mean velocity can be found in the relationship curves, figure 5.

5. Backwater, the increase in water-surface elevation because of a constriction, above the normal elevation at the approach section, can be estimated by the formula $h = 1.1\ V^2/2g$.

6. The alinement of piers or piling with the direction of flow is an important consideration.

UNITED STATES DEPARTMENT OF THE INTERIOR
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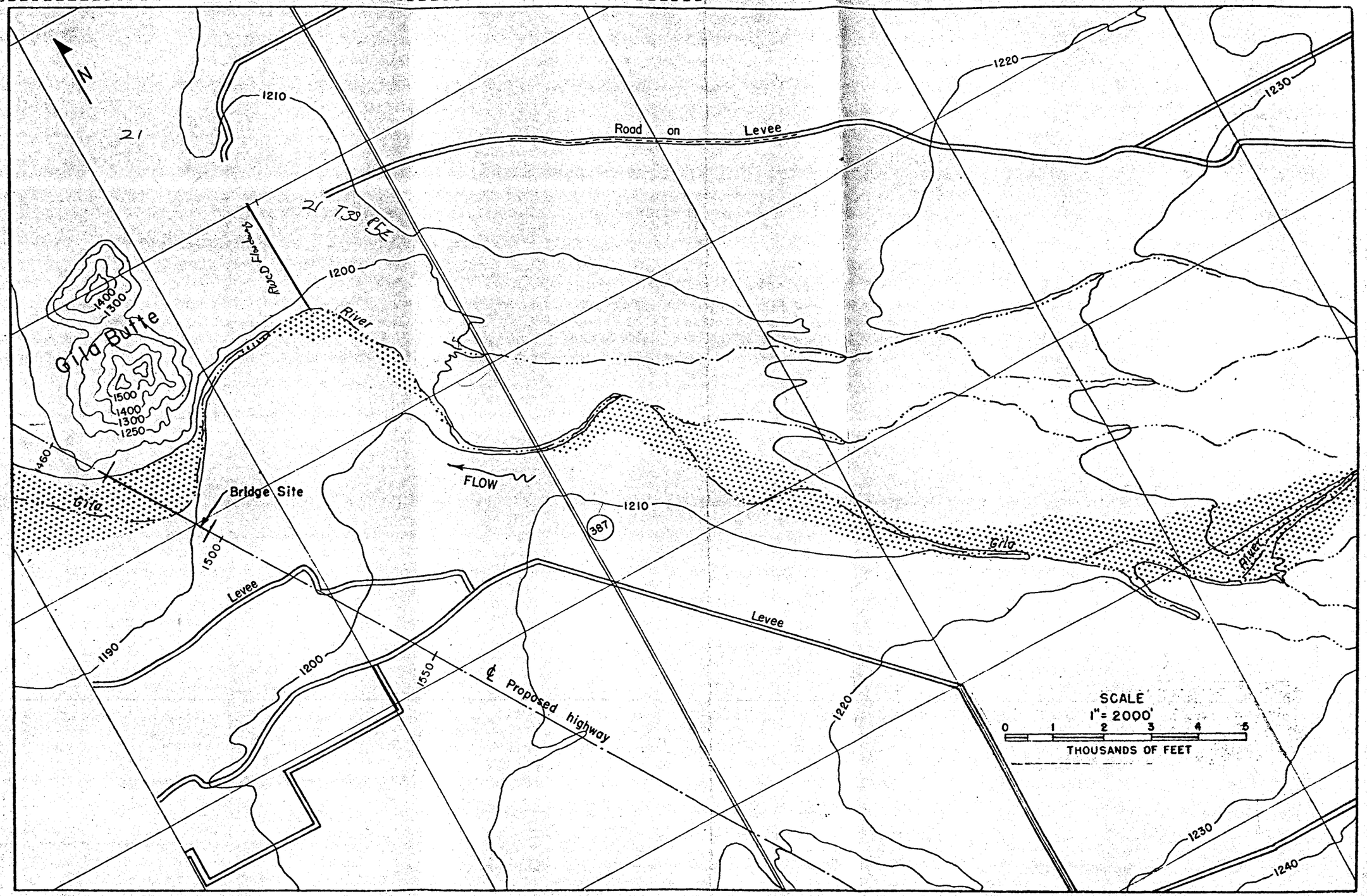
Figure 1.— Location map
Gila River at Gila Butte, near Chandler, Arizona



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GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

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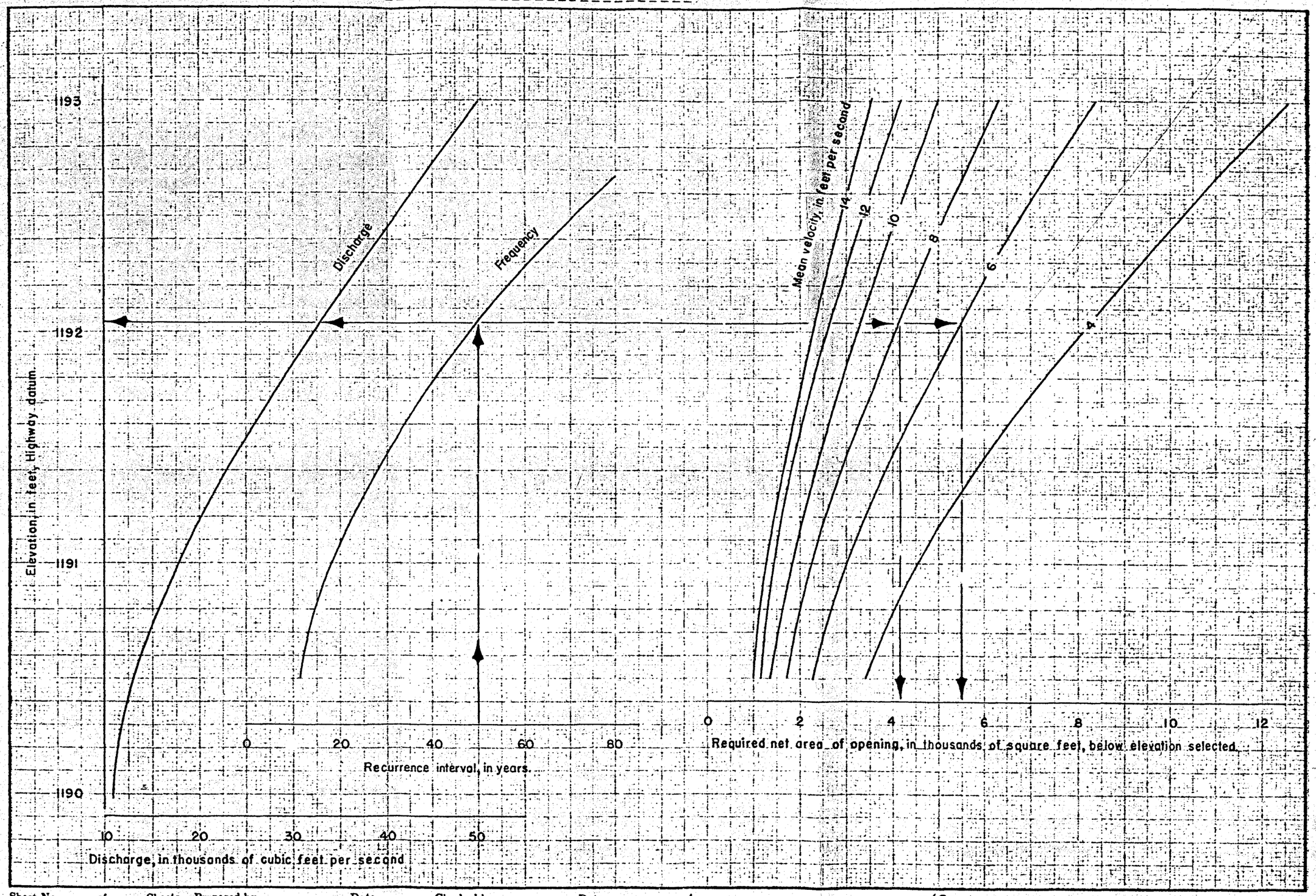
Figure 5--- Relation of unconstricted channel stage, discharge, frequency, and required opening area for selected velocities.



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nitude and frequency of _____ on _____ File _____

Drainage area _____ sq. mi. Period _____

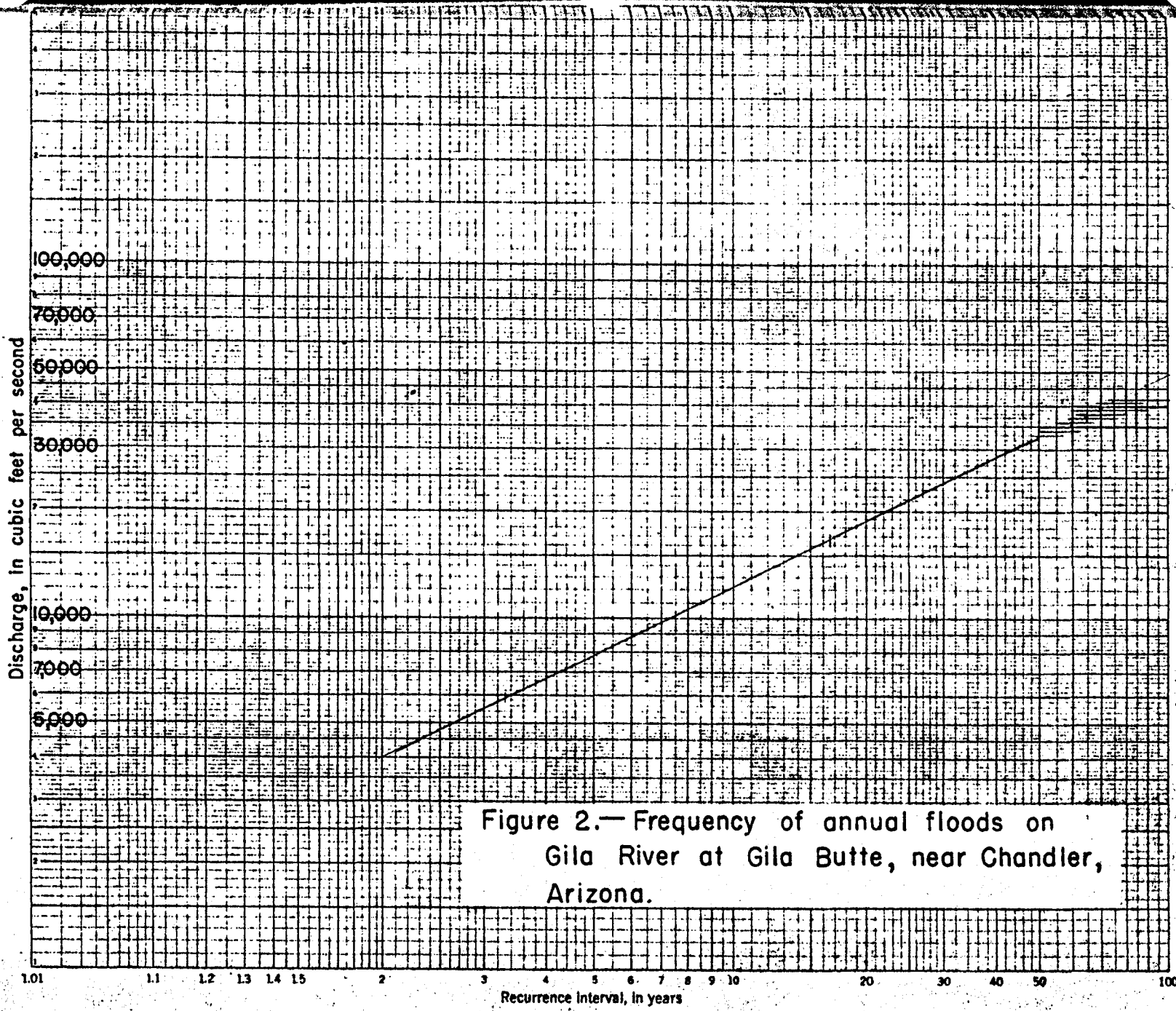

Figure 2.— Frequency of annual floods on Gila River at Gila Butte, near Chandler, Arizona.

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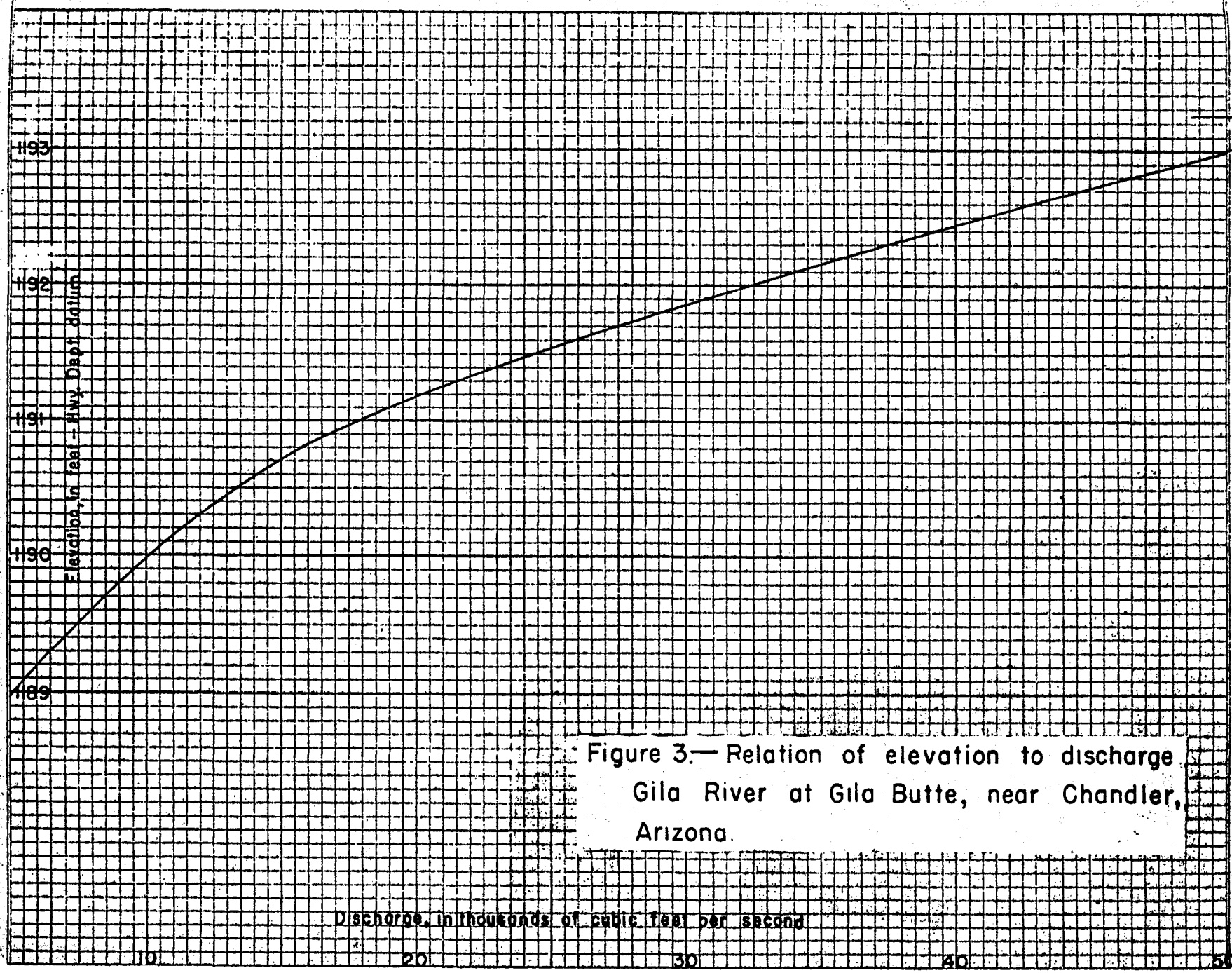

Figure 3.— Relation of elevation to discharge Gila River at Gila Butte, near Chandler, Arizona.

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WATER RESOURCES DIVISION

File Number { Washington ..... District .....

9-213-A (October 1949)

Gila River at Gila Butte, cross section, near Chandler, Arizona

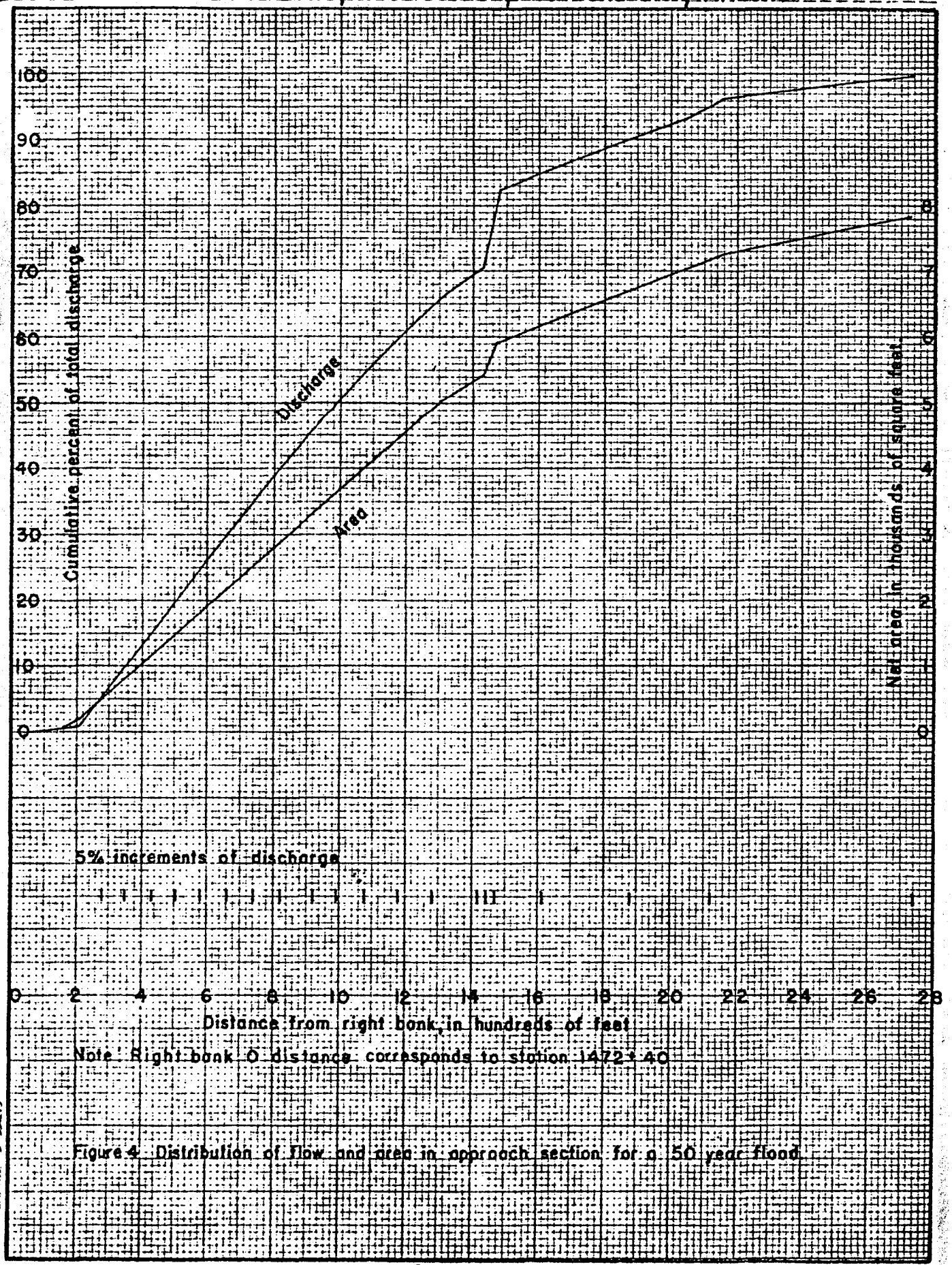


Figure 4. Distribution of flow and area in approach section for a 50 year flood.

PEAK DISCHARGE - FREQUENCY RELATIONSHIP

ANNUAL PEAK DISCHARGE - FREQUENCY
RELATIONSHIP FOR GILA RIVER
AT RWCD FLOODWAY OUTLET

RPMcArthur 3/78

PURPOSE - This work was done to relate the annual maximum peak discharge for the Gila River in the vicinity of the location for outletting the RWCD Floodway to the stage or water-surface elevation for that discharge.

PROCEDURE - There have been many annual peak discharge - frequency studies made for the Gila River in this reach. Probably the oldest was made by the Corps of Engineers for the Bureau of Reclamation in their analysis for Butler Dam.

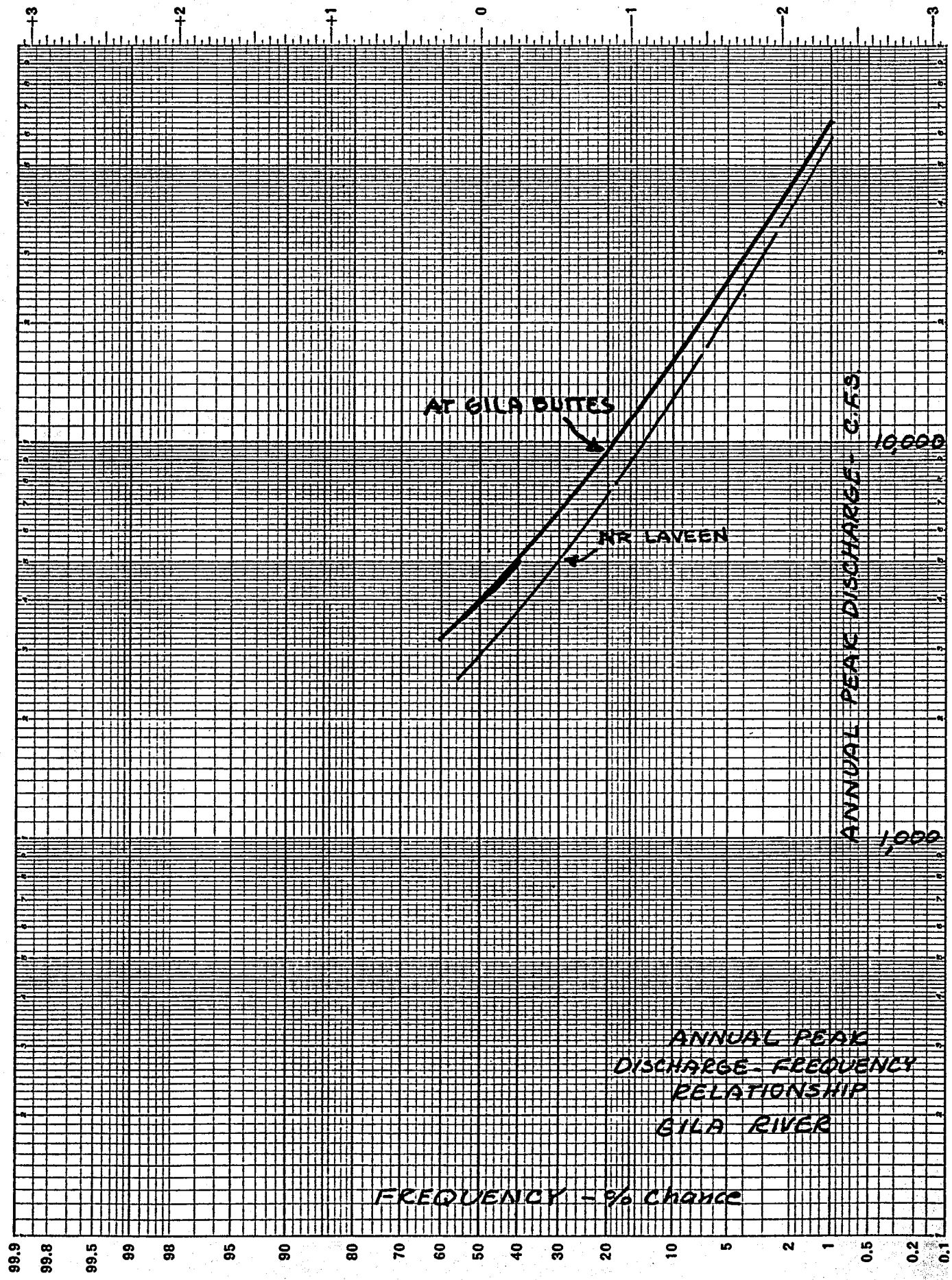
B.N. Aldridge, USGS, made such a study in 1962 for the construction of the Interstate Highway 10 Bridge. Refer to his study report in the previous

section.

Robert Bartels, SCS, made a study in 1973 relating discharge at the gaging stations at Kelvin and near Laveen.

The results of Bartels work was used to adjust the Corps of Engineers work to account for losses from the Buttes Dam site to the location in question. Then the results from USGS WSP 1683 were compared. Figure 24 in WSP 1683 presents a method to estimate losses also.

RESULTS & CONCLUSIONS: Comparing the results of these several studies showed quite a range in flows. Therefor it was decided to use an average of the curves.



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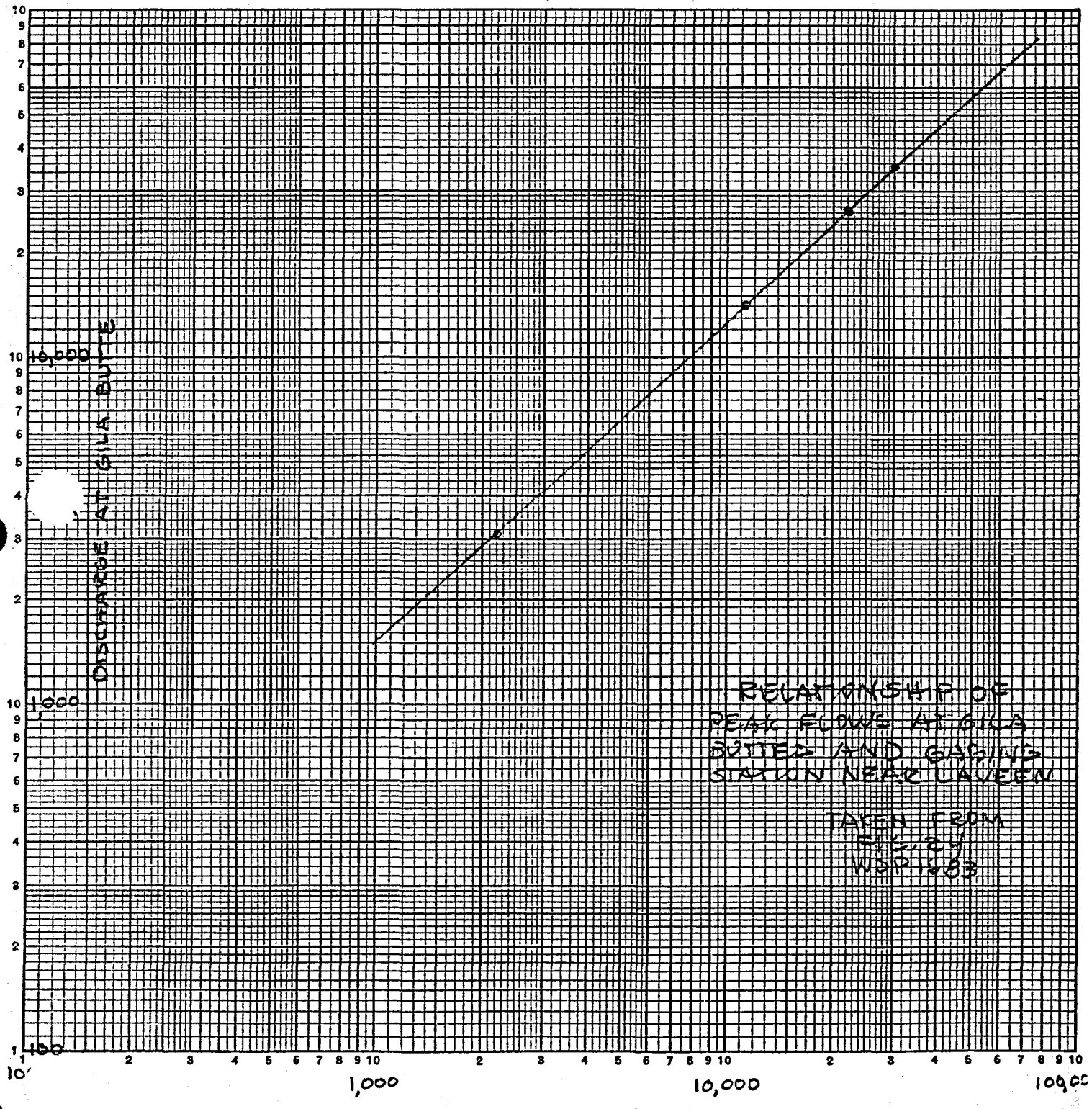

RELATIONSHIP OF PEAK FLOWS AT GILA BUTTE AND GAGING STATION NEAR LAVEEN
TAKEN FROM FILE WSP 1283
DISCHARGE AT GILA BUTTE
DISCHARGE AT LAVEEN
10,000
1,000
100
1,000
10,000

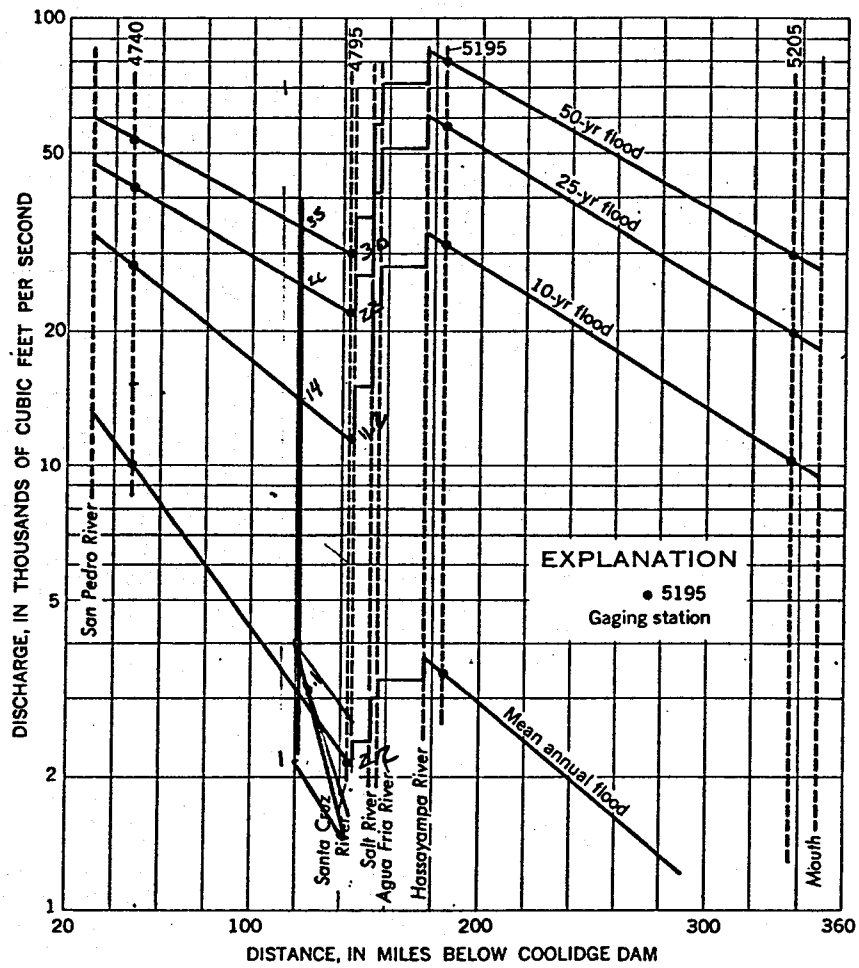
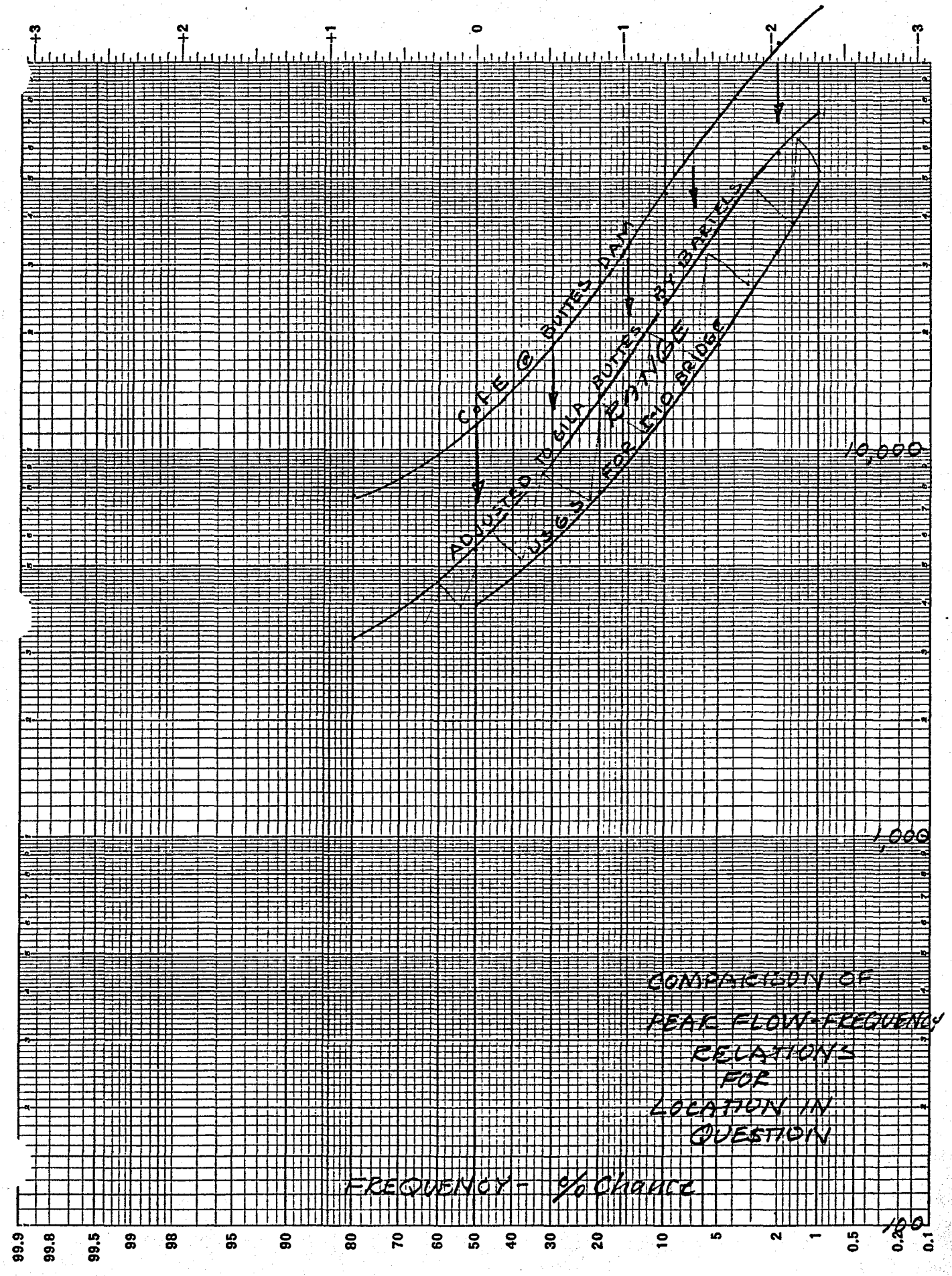


FIGURE 24.—Relation of discharge for selected flood frequencies to miles below Coolidge Dam, Gila River main stem below San Pedro River (regulated conditions, 1929–62).

ILLUSTRATIVE PROBLEM

Assume that it is desired to prepare a flood-frequency curve for a site on Gila River just downstream from San Simon Creek:

1. This site is 75 miles upstream from Coolidge Dam.
2. From figure 23 the magnitudes of floods having recurrence intervals of 2.33, 10, 25, and 50 years at a distance 75 miles upstream from Coolidge Dam are 11,300, 35,000, 64,000, and 96,000 cfs, respectively.
3. Discharges determined in step 2 are plotted against corresponding recurrence intervals on plotting paper similar to that shown in figure 2 or on some other suitable plotting paper, and a smooth curve is then drawn through the plotted points.


+3
+2
+1
0
-1
-2
-3
10,000
1,000
100
CALE @ BUTTE DAM
ADJUSTED TO GILA BUTTES
USGS FOR EHO BRIDGE
R.P. 7/CE
R.P. 13 BETTLS
CONFIDENCE OF
PEAK FLOW-FREQUENCY
RELATIONS
FOR
LOCATION IN
QUESTION
FREQUENCY - % CHANCE
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1

ESTIMATED PEAK DISCHARGE

FOR MARCH 1978 FLOOD

MAXIMUM FLOOD FLOW IN THE GILA RIVER IN THE STUDY AREA FROM THE MARCH 3-6, 1978 FLOOD

R.P. McArthur 3/78

PURPOSE: Since a flood runoff occurred during the period this study was being done it was decided to survey the high water profile along the right (north) floodplain in the River from downstream of the I-10 Bridge to the proposed RWCD Floodway outlet. This was done to (1) estimat the peak discharge for this flood and (2) to compare the water-surfa profile with the computed profile.

PROCEDURE: Levels were carried along the base of Gila Buttes and highwater marks were surveyed. They were located on photos 8 inch to the mile.

The results were plotted on the

same profile developed from the surveys made to compute the water surface profiles

RESULTS & CONCLUSIONS: The resulting profiles indicate a peak discharge of this flood to be about 4000cfs. The resulting profile was irregular but showed the theoretical profiles to be reasonable.

ARIZONA

E. McArthur 3/17/78

SUMMARY (LISTING) OF ROUGH ESTIMATES OF PEAK DISCHARGE ON MAR 3-6. BY CROSS-SECTION AND CONCLUSIONS

CONCLUSION: Peak discharge between 3700 to 4500 cfs

SUMMARY OF ROUGH ESTIMATES

CROSS SECTION	a	r	q low	q high
1	4140	1.94	2500	4800
2	6120	2.17		7000
3	3260	1.27	4300	4600
4	3820	1.44	6300	6600
5	2500	1.02	3400	3600
6	2240	1.74	2300	3900
	3680	1.60	3700	5080

$$S = \frac{95.4 - 90.50}{(40+00) - (10+00)} = \frac{4.9}{3000} = 0.0016$$

$n \approx 0.065$

$$q = \frac{1.486}{0.065}(3680)(1.60)^{2/3}(0.0016)^{1/2}$$

$= 4650$ cfs

CROSS-SECTIONS 3, 4 5, & 6

2955	1.37	4075	4675

$S \approx 0.002$

$$q = \frac{1.486}{0.065}(2955)(1.37)^{2/3}(0.002)^{1/2}$$

$= 3730$ cfs

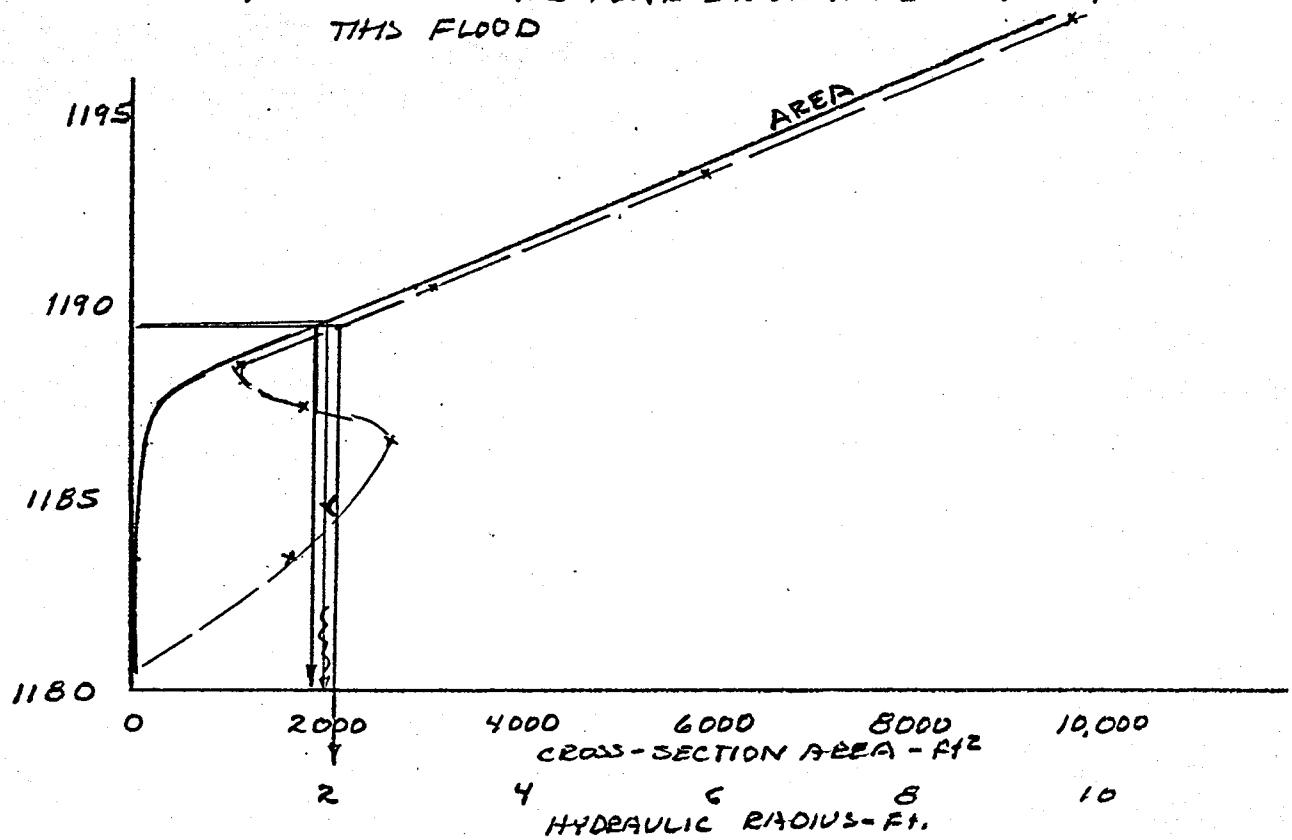
ARIZONA IRWCD FLOODWAY

R. McArthur 3/17/78

HYDRAULIC PARAMETERS OF CROSS-SECTION #7

GIVEN: CROSS-SECTION #7, DOWNSTREAM FROM I-10 BRIDGE
HYDRAULIC PARAMETERS AS FOLLOWS BELOW
APPROXIMATE MAX WATER SURFACE FOR MARCH 3-6 FLOOD IN GILA RIVER TAKEN MAR 8.
=1189.6

FIND: ESTIMATE PEAK DISCHARGE IN GILA FOR THIS FLOOD



@ Elev. 1189.6

$A = 1885 \square'$

$r = 2.1$

$S \approx 0.00068\%$

$n = 0.07$

$$Q = \frac{1.486}{n} a r^{2/3} S^{1/2} = \frac{1.486}{0.07}(1885)(2.1)^{2/3}(0.00068)^{1/2}$$

$= 1711$ cfs say 1700 cfs

CONTACT WITH USGS 3/27/78

PEAK DISCHARGE FOR GAGING STATION

GILA RIVER NR LAVEEN:

q_p = 1590 cfs

DATE - March 6, 1978

GAGE HEIGHT = 8.16

TIME — 1845

WSP2 ANALYSIS

WATER-SURFACE PROFILE COMPUTATIONS

R.P. McArthur 3/78

PURPOSE: This work was done to determine a rating curve for the Gila River in the vicinity of the proposed RWCD Floodway outlet structure.

PROCEDURE: Field surveys were made along the Gila River including a reach from about 1400 feet below the I-10 bridges to 4200 feet above the bridges. Eight cross-sections were surveyed and four others were made up from the surveyed ones. Cross-sections 6A and 6B were made from 6. Cross-section 9 was made from 8 and USGS 7.5 minute quad sheet. Cross-section A was made from topog data for the outlet structure and extended using cross-section 1.

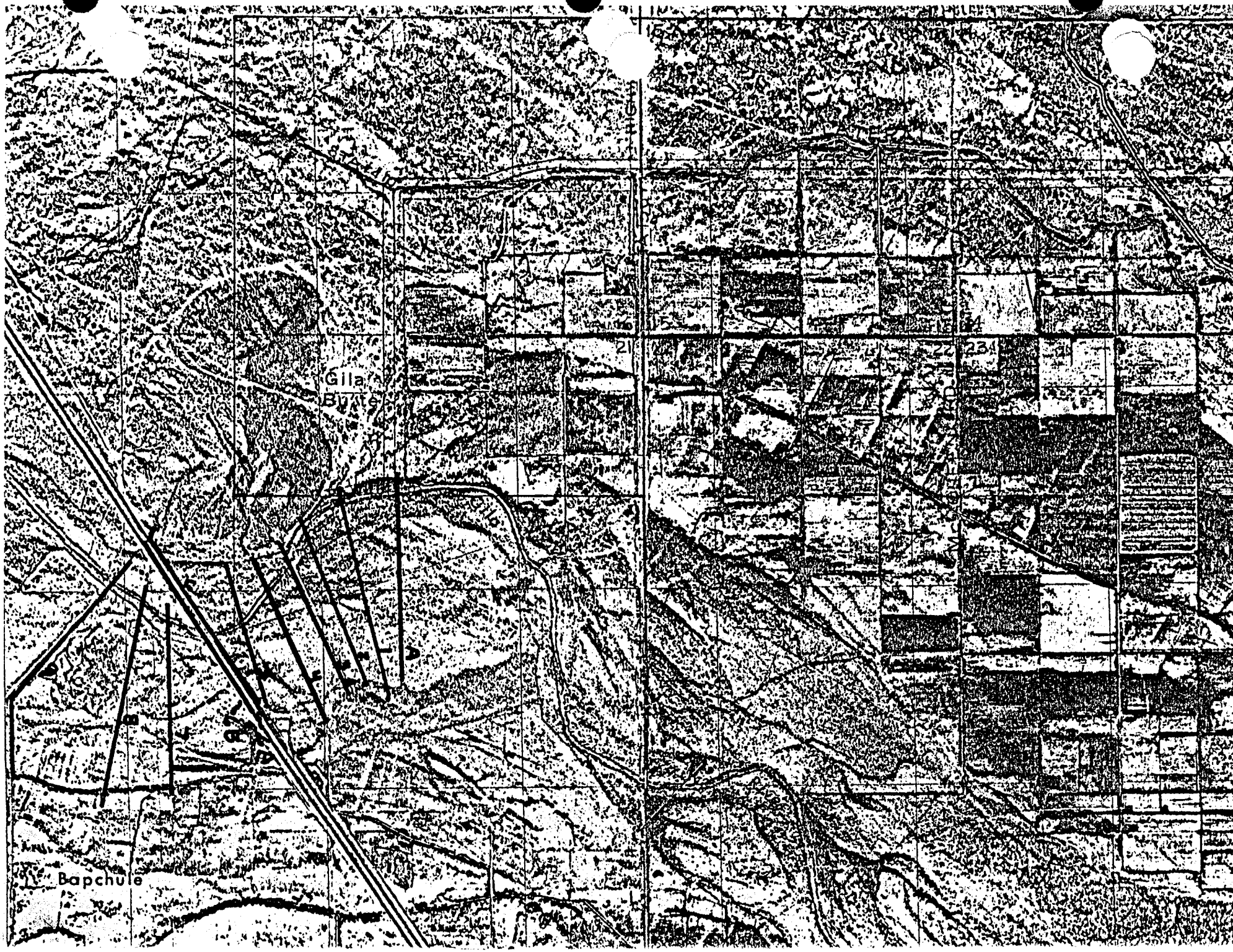
Roughness coefficients were estimated in the field.

WSP 2 computer program was used to

compute the profiles. Processing was done through the Arizona Water Commission computer facilities. Eight profiles were run including 100,000; 80,000; 60,000; 40,000; 20,000; 10,000; 5,000; and 2000 cfs flows. Beginning conditions were derived for Cross-section 9 assuming normal depths up to channel capacity and weir flow over the dike on downstream edge of gravel pit.

RESULTS & CONCLUSIONS: The results are shown in the Results and Conclusion section and the water-surface profiles are plotted on the survey profile found in the appendix section.

The results are also presented in the output found in the packet inside of back cover.


Gila
Butte
Bapchule

ARIZONA RWCD FLOODWAY

R. McArthur 3/16/78

COMPUTATION OF APPROX. RATING OF CROSS-SECTION #9 TO BEGIN WSP-2

1 2

GIVEN: Cross-section 9 which includes the dike around the gravel pit. Avg slope from the plotted profile

FIND: Assuming weir flow over the dike around the gravel pit develop a rough rating curve at this cross-section to begin water surface computations

Assume hydraulic gradient in channel area to be about same as bottom gradient:

1183.7 @ sta. 40+00
1181.7 @ sta 60+00
2.0 2000 = 0.001 ft/ft

From cross-section plot:

① Maximum area at top of dike ≈ 7440 ft²

wp ≈ 900' r = 8.26

n = 0.065

② Max. area in low channel ≈ 285

wp = 33

n = 0.04 r = 8.64

$\frac{75+20}{2}(6.0)$ = 20+18

CHANNEL FLOW

Low Flow @ 1187

$V = \frac{1.486}{n} r^{2/3} s^{1/2} = \frac{1.486}{0.04}(8.64)^{2/3}(0.001)^{1/2}$

V = 4.95 fps $q = aV = 4.95(285\,ft^2) = 1410$ cfs

Channel Flow @ Top of dike elev. 1196

$V = \frac{1.486}{0.065}(8.26)^{2/3}(0.001)^{1/2} = 2.96$ fps

$q = aV = 2.96(7440) = 21{,}990$ cfs

WEIR FLOW

Length of dike downstream edge of gravel pit ≈ 3040'

Assume $H_v = 0.5$

ARIZONA RWCD FLOODWAY

R. McArthur 3/16/78

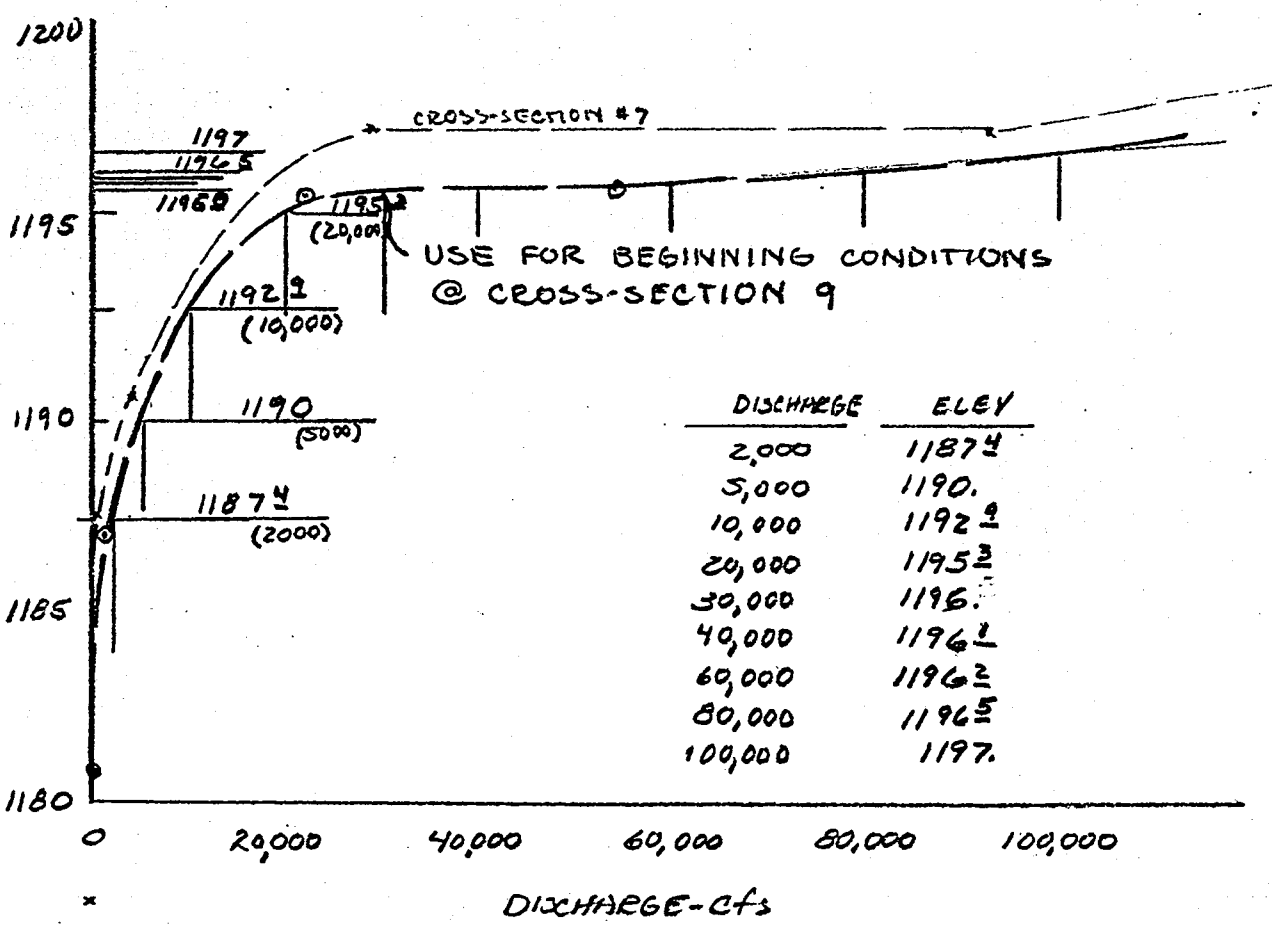
COMPUTATION OF APPROX RATING OF CROSS-SECTION #9 TO BEGIN WSP-2 2 2

With D=2.0 @ elev. 1196

$H_e = D + H_v = 2.0 + 0.5 = 2.5$

$Q = C L H_e^{3/2} = 2.7(3040)(2.5)^{3/2} = 32,400$

$Q_T = 32,400 + 21,990 = 54,390$ cfs



DISCHARGE	ELEV
2,000	1187.4
5,000	1190.
10,000	1192.9
20,000	1195.2
30,000	1196.
40,000	1196.1
60,000	1196.2
80,000	1196.5
100,000	1197.

COMPARISON WITH ROUGHLY DETERMINE RATING FOR CROSS-SECTION 7

ELEV.	AREA	R	N	V	Q
1177.5	0				0
1187.5	260	1.73	0.04	1.69	440
1190.5	2920	3.11	0.07	1.43	4,180
1197.5	9380	9.67	0.07	3.05	28,600
1197.5	30,200	8.67	0.065	3.05	92,200
1199.5	37,940	10.69	0.065	3.51	133,200

ARIZONA RWCD FLOODWAY

R McArthur 3/16/78

LISTING OF DISCHARGES TO USE TO COMPUTE WSP's 1 1

RANGE OF FLOWS AND WS PROFILES

	DESIRED FLOWS	FACTOR
1	2,000	0.1
2	5,000	0.25
3	10,000	0.50
4	20,000	1.00
5	30,000	1.5
6	40,000	2.0
7	60,000	3.0
8	80,000	4.0
9	100,000	5.0

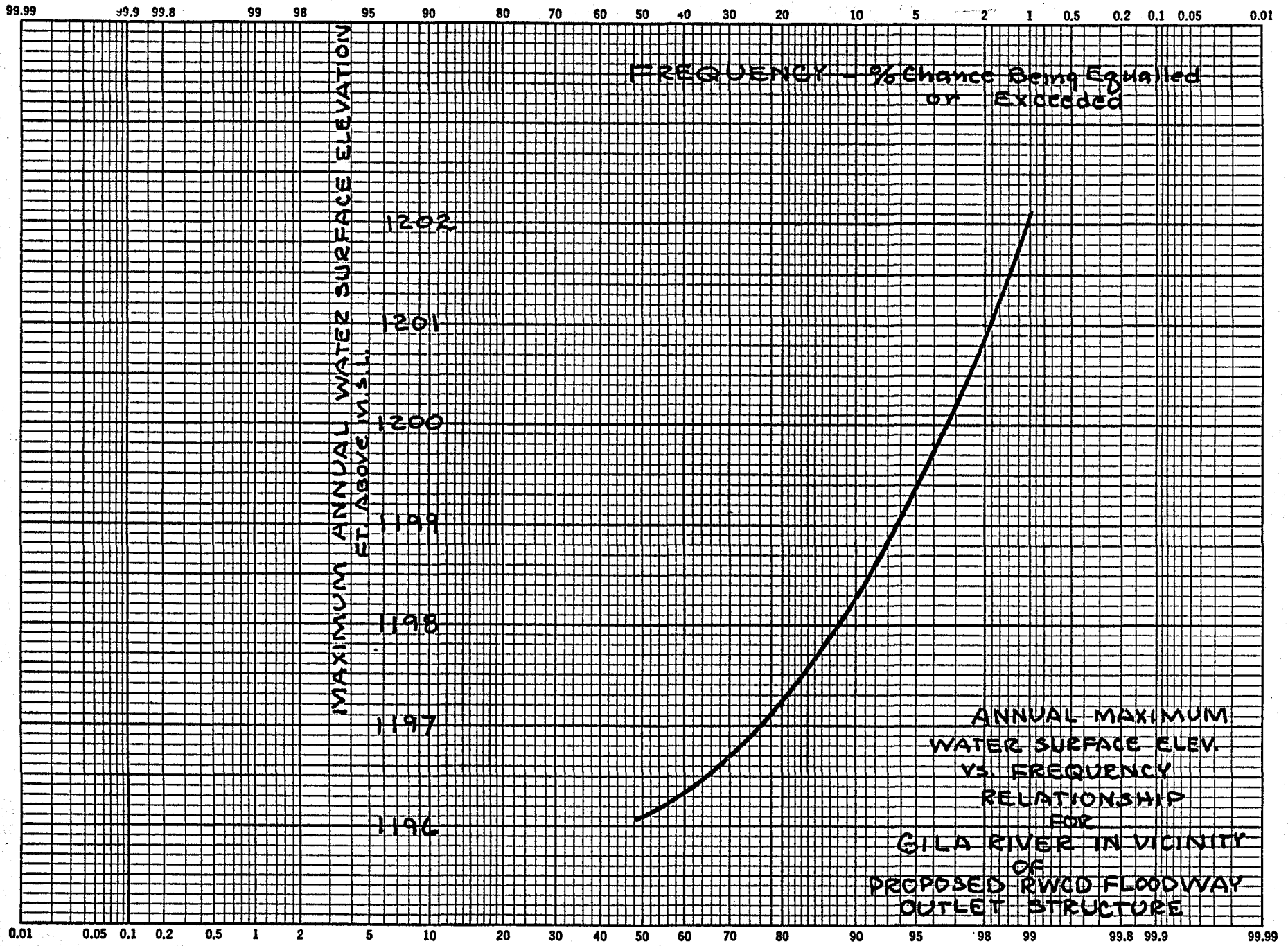
ARIZONA RWCD FLOODWAY

R. McArthur 3/16/78

LISTING OF REACH LENGTHS USED

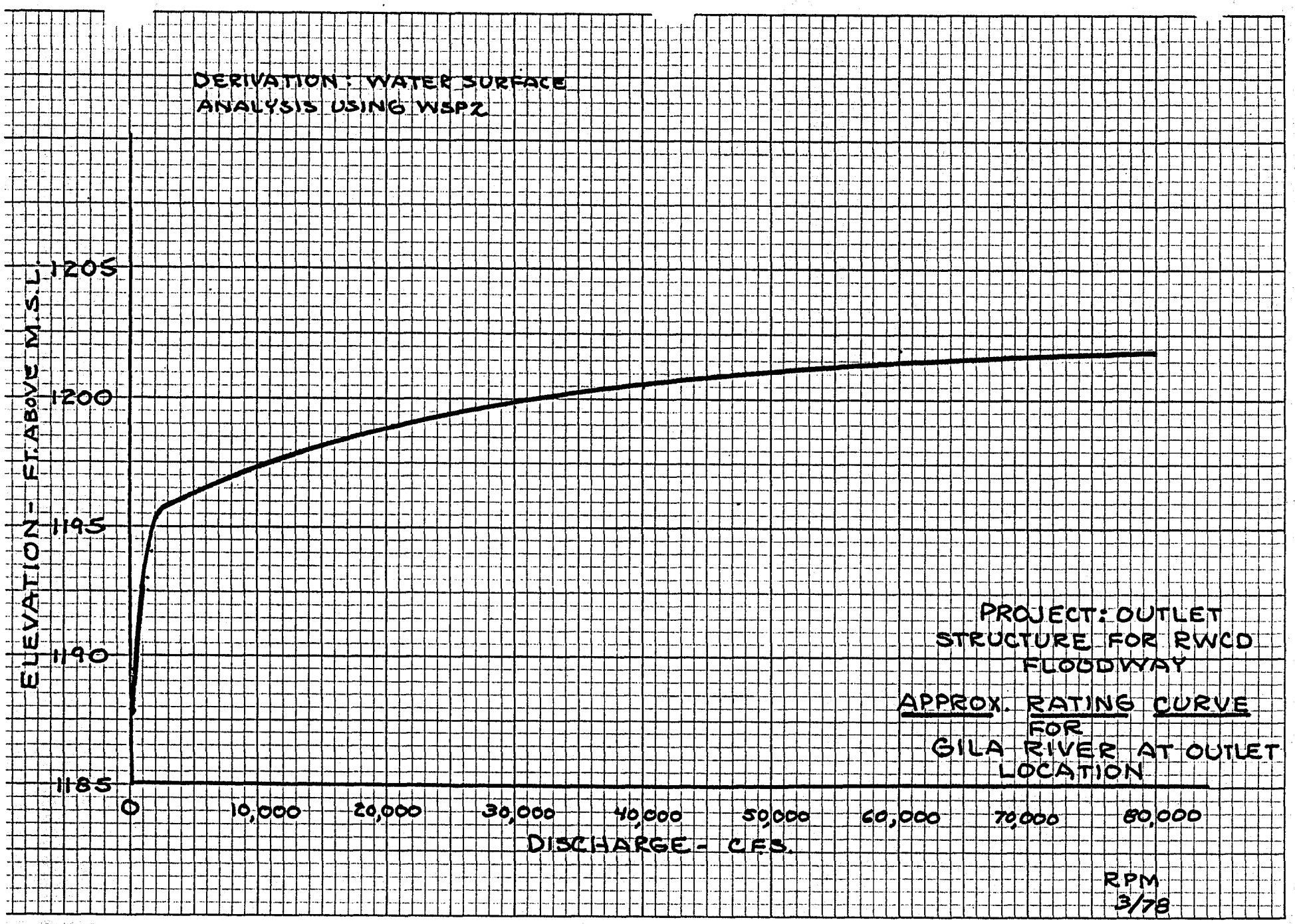
CROSS-SECTION	STATION	CHANNEL LENGTH	FLOOD PLAIN LENGTH	COMMENTS
9	63+00			Location along downstream dike around gravel pit (Fabricated cross-section)
		509	430	
8	57+91			Lower most cross-section surveyed - partially supplemented
		624	320	
7	51+67			
		846	290	
6B	43+21			Lower (South bound bridge) (Fabricated)
		50	50	
6A	42+71			Between Bridges (Fabricated)
		50	50	
6	42+21			Upper (North bound bridge) Actually surveyed
		418	650	
5	38+03			
		738	500	
4	30+65			
		504	500	
3	25+61			
		587	500	
2	19+74			
		689	680	
1	12+85			
		1285	900	
0	0+00			Opposite proposed RWCD FLOODWAY OUTLET

RESULTS AND CONCLUSIONS

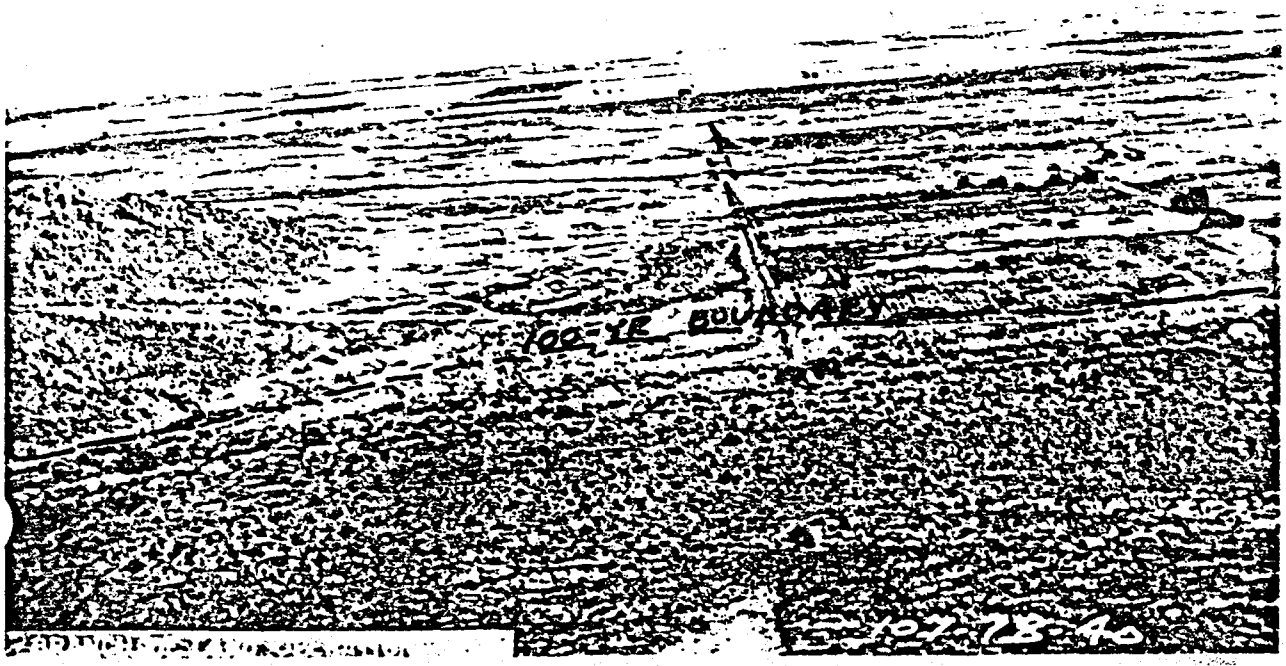


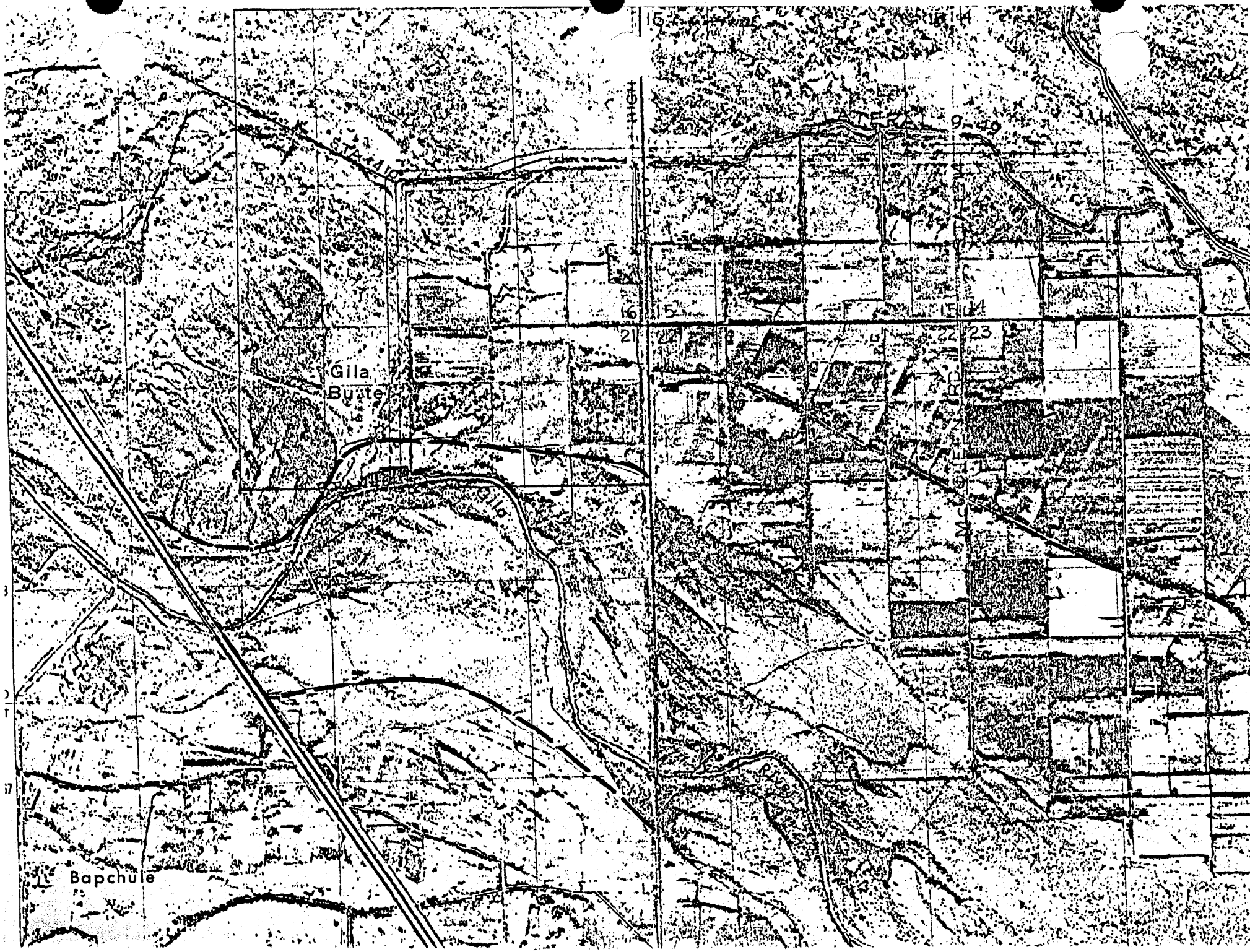
ANNUAL MAXIMUM WATER SURFACE ELEV. VS. FREQUENCY RELATIONSHIP FOR GILA RIVER IN VICINITY OF PROPOSED RWCD FLOODWAY OUTLET STRUCTURE

RPM
3/78


DERIVATION: WATER SURFACE ANALYSIS USING WSP2
ELEVATION - FT. ABOVE M.S.L.
1205
1200
1195
1190
1185
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
DISCHARGE - CFS.
PROJECT: OUTLET STRUCTURE FOR RWCD FLOODWAY
APPROX. RATING CURVE FOR GILA RIVER AT OUTLET LOCATION
RPM
3/78

100-YR BOUNDARY
1977-13-39


100-YR BOUNDARY
1977-13-40


Gila
Butte
Gila
Bapchule
16
15
21
22
23
14

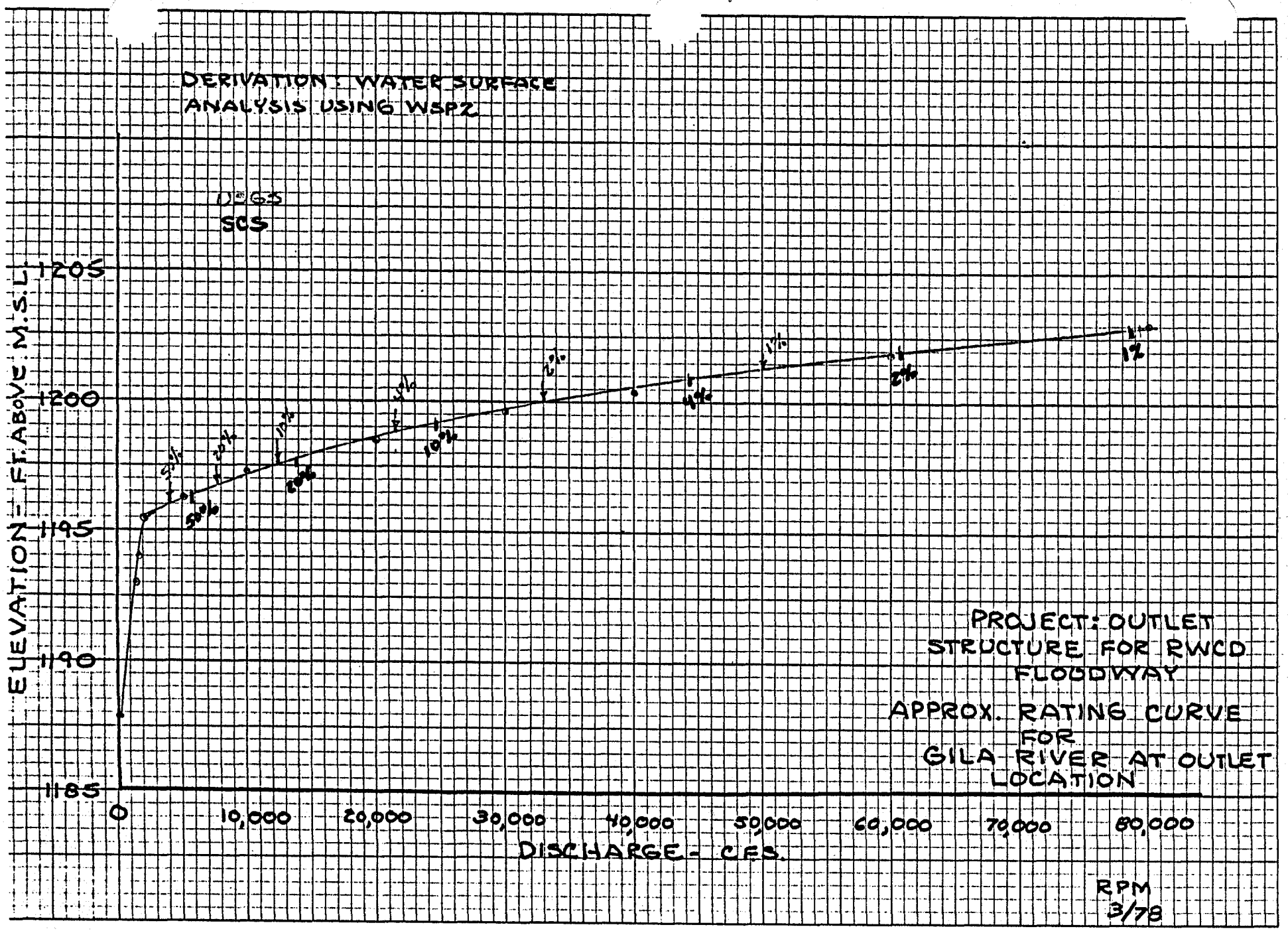
ARIZONA RWCD FLOODWAY

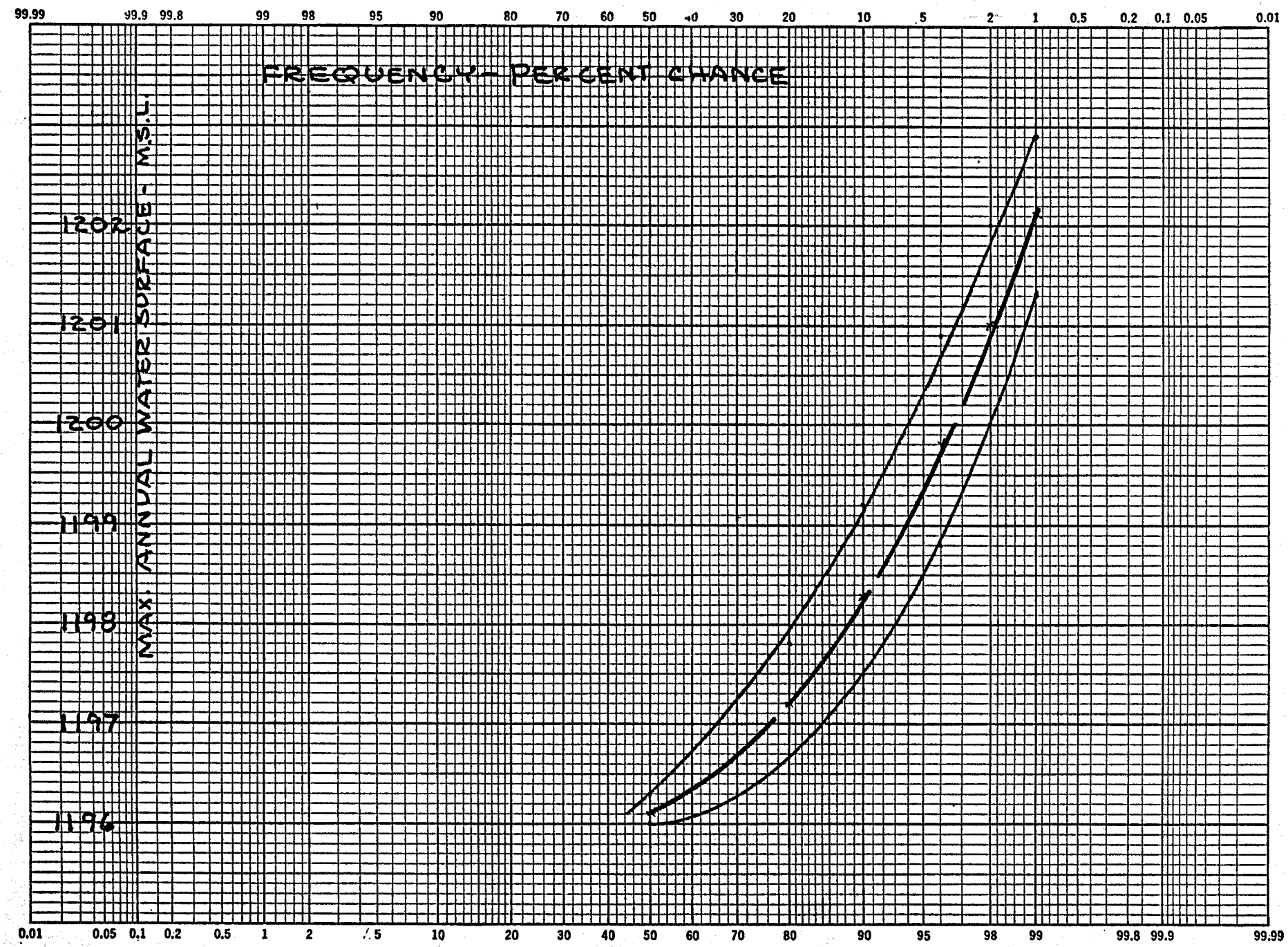
R. McArthur 3/23/78

COMPARISON OF PEAK DISCHARGE - FREQUENCY VARIATIONS AND RESULTING STAGE VARIATIONS

FREQUENCY	COFE ADJUSTED BY SCS		USGS DESIGN OF I-10 BRIDGE		DIFF		ASSUME AVG	
% Chance	DISCHARGE	ELEV.	DISCHARGE	ELEV				
1	78,400	1202.9	50,000	1201.3		1.6	0.8	1202.1
2	60,500	1202.	32,500	1200.		2.0	1.0	1201.0
4	44,100	1200.9	21,500	1198.8		2.1	1.0	1199.8
10	24,500	1199.2	12,200	1197.5		1.7	0.8	1198.3
20	13,900	1197.8	7,800	1196.7		1.1	0.5	1197.2
50	5,600	1196.3	4,000	1196.0		0.3	0.1	1196.1

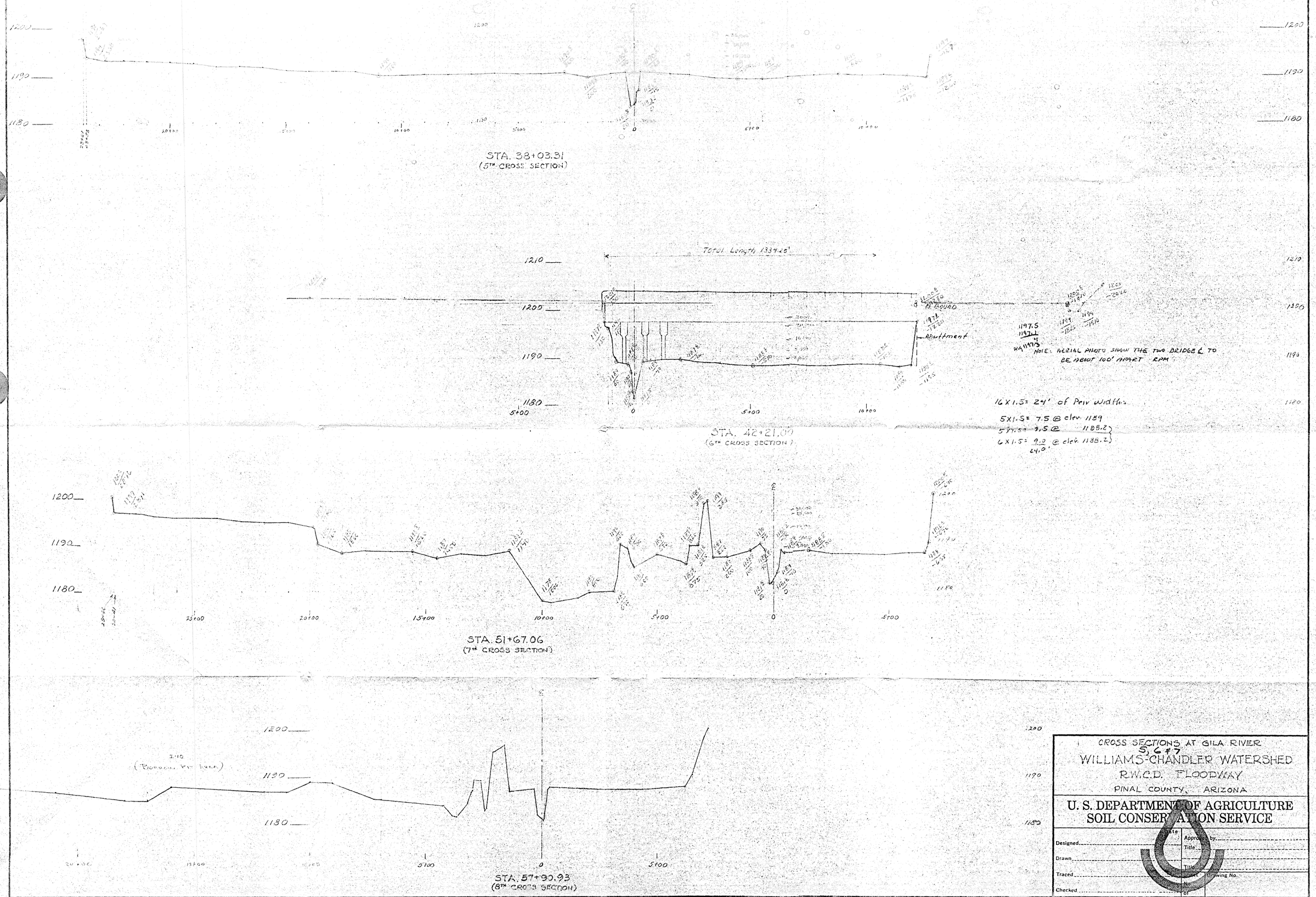
ANNUAL PEAK DISCHARGE-FREQUENCY RELATIONSHIP
GILA RIVER
FREQUENCY - % CHANCE
ANNUAL PEAK DISCHARGE - C.F.S.
1000
10,000
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
+3
+2
+1
0
-1
-2
-3

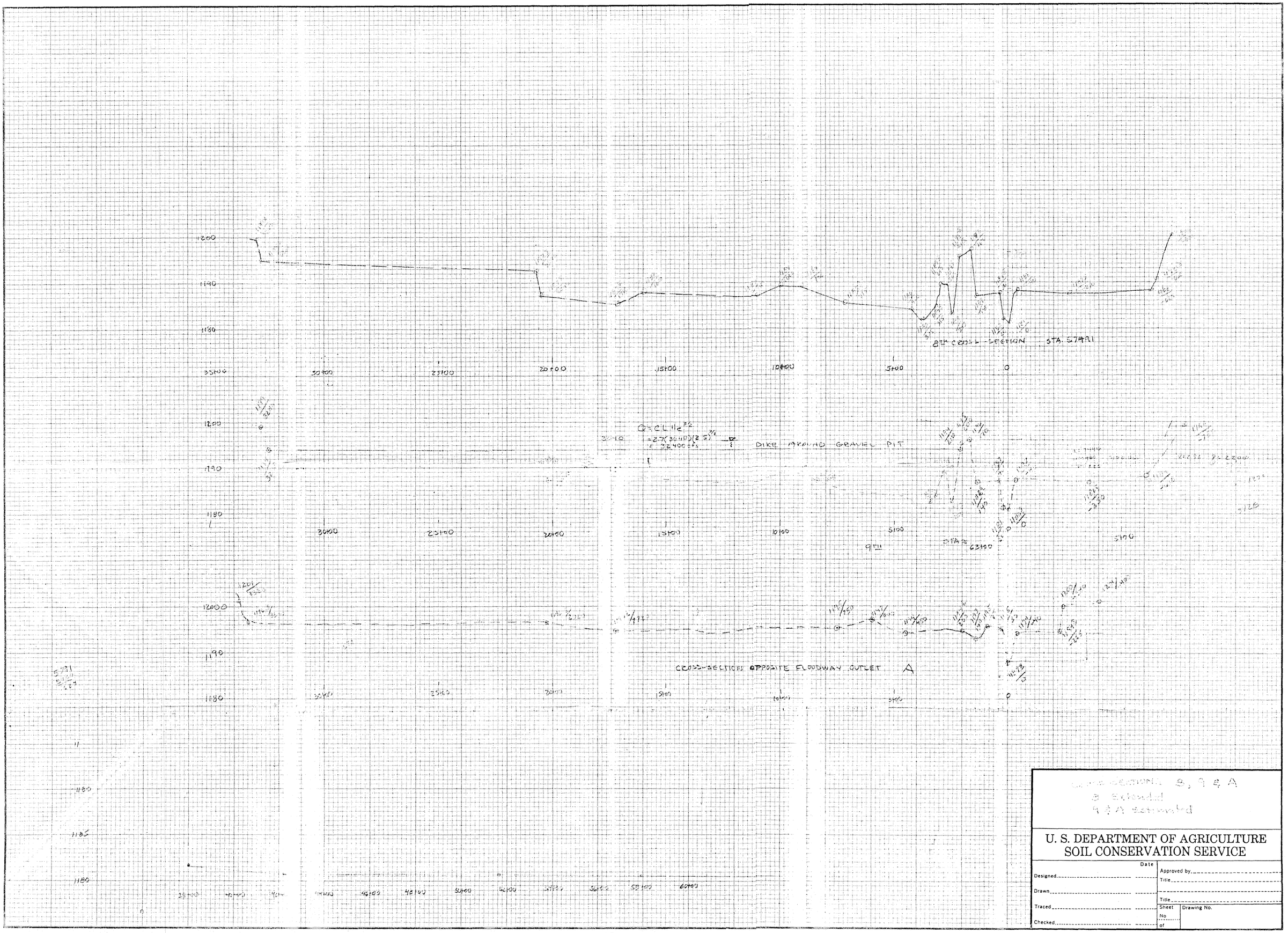

DERIVATION: WATER SURFACE ANALYSIS USING WSPZ
DLGS
SCS
ELEVATION - FT. ABOVE M.S.L.
1205
1200
1195
1190
1185
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
DISCHARGE - CFS.
PROJECT: OUTLET STRUCTURE FOR RWCD FLOODWAY
APPROX. RATING CURVE FOR GILA RIVER AT OUTLET LOCATION
RPM
3/78


FREQUENCY - PER CENT CHANCE
MAX. ANNUAL WATER SURFACE - M.S.L.
1202
1201
1200
1199
1198
1197
1196
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99

APPENDIX

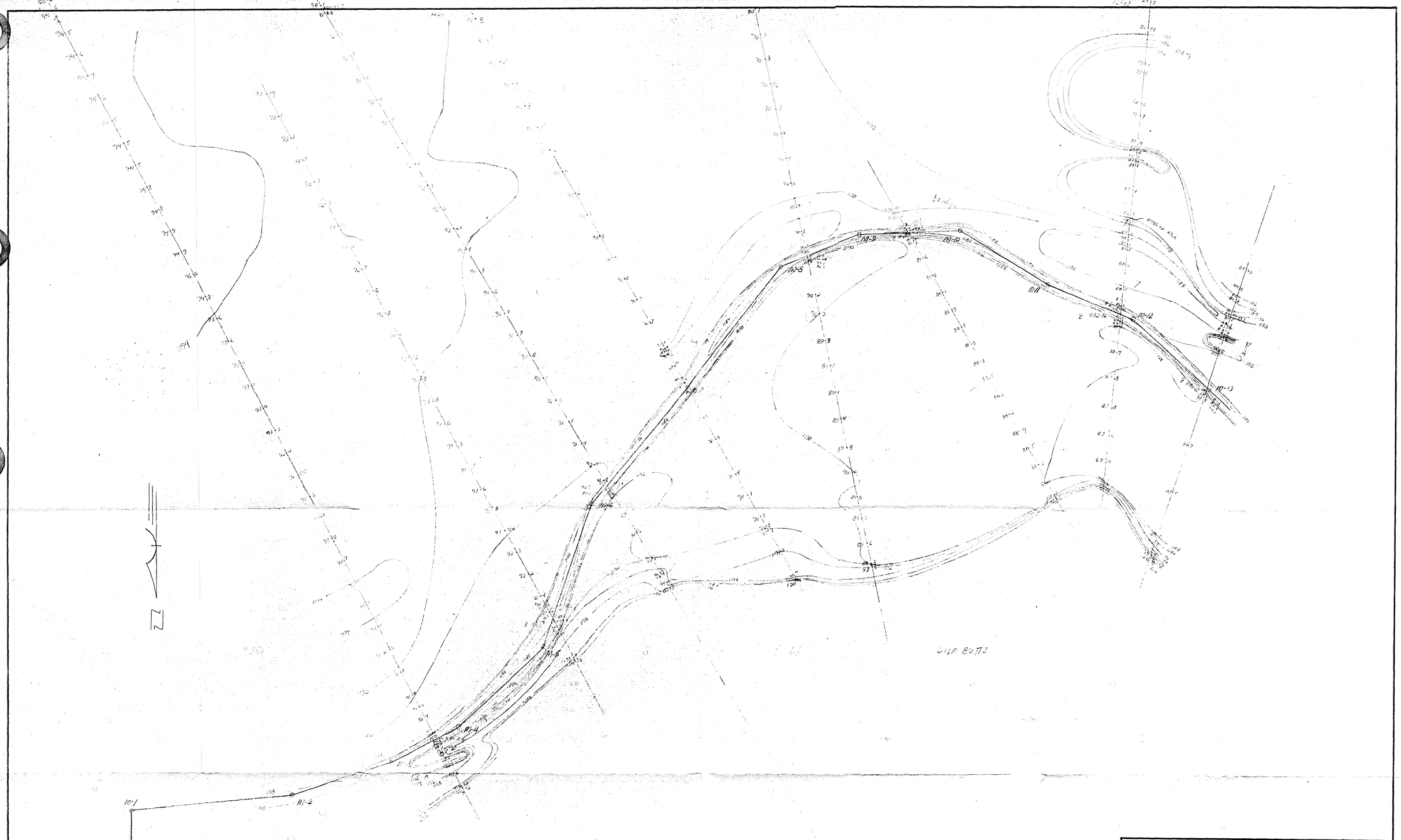
PROFILE, CROSS-SECTIONS, TOPOG AND WSP2 OUTPUT


STA. 38+03.31
(5TH CROSS SECTION)
Total Length 1339.25'
Abutment
NOTE: AERIAL PHOTO SHOW THE TWO BRIDGES TO BE ABOUT 100' APART RPM
16X1.5= 24' of Pair widths
5X1.5= 7.5 @ elev. 1189
5X1.5= 7.5 @ 1188.2
6X1.5= 9.0 @ elev. 1188.2
24.0'
STA. 42+21.09
(6TH CROSS SECTION)
STA. 51+67.06
(7TH CROSS SECTION)
STA. 57+90.93
(8TH CROSS SECTION)
CROSS SECTIONS AT GILA RIVER
5,6+7
WILLIAMS-CHANDLER WATERSHED
R.W.C.D. FLOODWAY
PINAL COUNTY, ARIZONA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed
Drawn
Traced
Checked
Approved by
Title
Drawing No.
SCS-ENG-313-R Rev. 7-60



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by	
		Title	
Drawn		Title	
Traced		Sheet No. of	Drawing No.
Checked			



TOPOGRAPHY

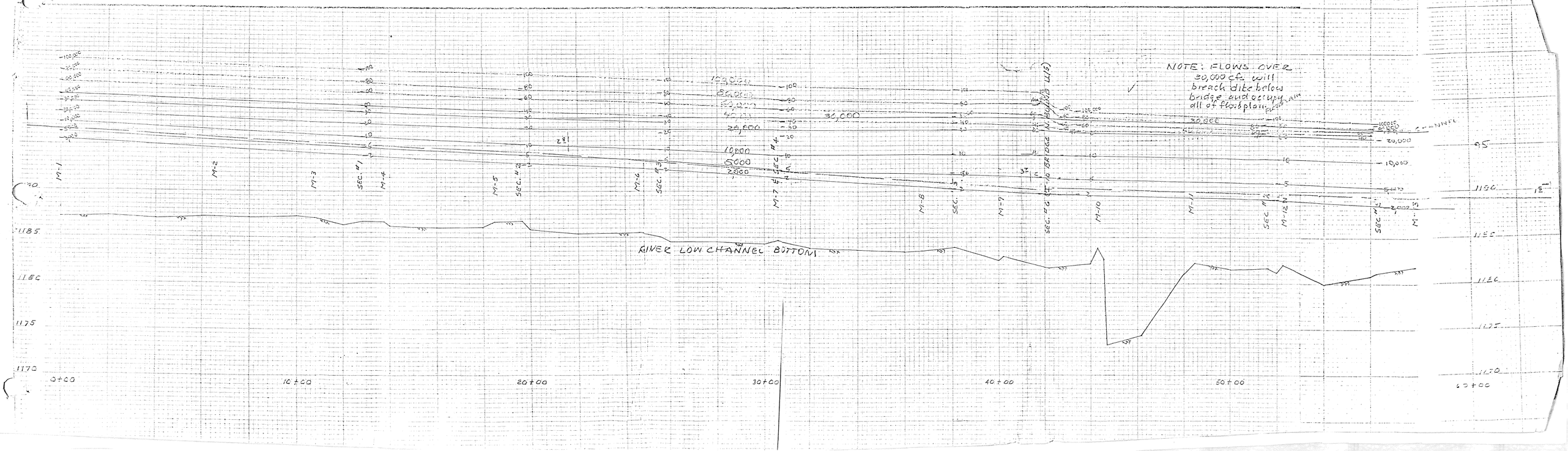
WILLIAMS-CHANDLER WATERSHED

RWCD FLOODWAY

PINAL COUNTY, ARIZONA

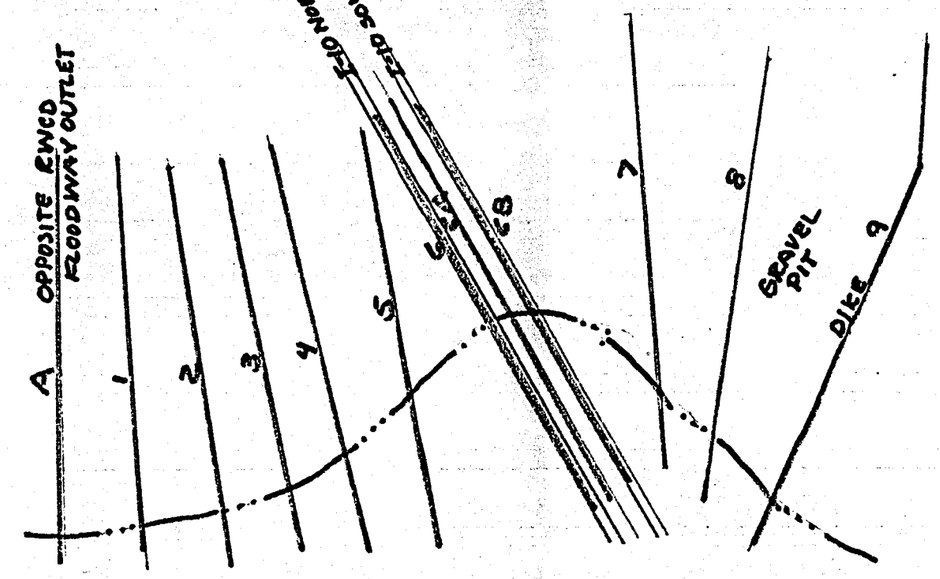
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by	
Drawn		Title	
Traced		Title	
Checked		Sheet No. of	Drawing No.


NOTE: FLOWS OVER 30,000 cfs will breach dike below bridge and occupy all of floodplain
RIVER LOW CHANNEL BOTTOM
M-1
M-2
M-3
M-4
M-5
M-6
M-7
M-8
M-9
M-10
M-11
M-12
SEC. #1
SEC. #2
SEC. #3
SEC. #4
SEC. #5
SEC. #6
SEC. #7
SEC. #8
N. ROUTES 41/15
BRIDGE
100,000
50,000
40,000
36,000
30,000
20,000
10,000
5000
2000
1190
1185
1180
1175
1170
0+00
10+00
20+00
30+00
40+00
50+00
60+00

T8170

WO 001057 AD902AWCS X22 RPM1



SCHEMATIC OF CROSS-SECTIONS USED

NOTE: CROSS-SECTIONS, COORDINATES TO LEFT +, TO RIGHT -, PROGRAM REVERSED THIS CAUSING SOME PROBLEMS W/SEGMENT RPM

DOT*ASG*A*PRINTER1....START JOB 9064.....4.25.48 PM 22 MAR 78....WO 001057....T8170 ....AD902AWCS X22 RPM1 ....PRINTER1*A*DOT*ASG

```
-----------------------------80/80 LIST OF INPUT DATA-----------------------------
WSP2        20.
TITLE       RWCD FLOODWAY: CUTLET STRUCTURE                    MARCH 1978
TITLE       GILA RIVER WSP TO DETERMINE TW CONDITIONS
DISCHARGE   -2          0.1         0.25        0.50        1.0         1.5
STARTE      9           1187.4      1190.       1192.9      1195.3      1196.
OUTPUT      PSK
COMMENT     GILA RIVER BELOW I-10 BRIDGE FOR CHANNEL FLOW ONLY
REACH       9           20000.      0.          0.          0.
REACH       8           20000.      509.        430.        430.
REACH       7           20000.      624.        320.        320.
ROAD        6B          2.7         846.        290.
REACH       6A          20000.      50.         50.         50.
ROAD        6           2.7         50.         50.
REACH       5           20000.      418.        650.        650.
SECTION     9
            170.        1196.       140.        1186.5      40.         1187.
            20.         1181.       0.          1180.8      -40.        1187.
            -350.       1186.5      -610.       1188.       -780.       1199.
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                            DUPLICATE X POINTS NOT CHANGED-----------------------------
SECTION     8
            165.        1197.       140.        1187.       35.         1187.5
            20.         1182.       0.          1181.       -40.        1188.
            -270.       1187.5      -625.       1188.       -650.       1190.5
            -720.       1200.
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                            DUPLICATE X POINTS NOT CHANGED-----------------------------
SECTION     7
            285.        1199.       260.        1187.       200.        1187.
            100.        1188.5      55.         1190.       40.         1188.8
            20.         1181.5      0.          1181.6      -15.        1184.
            -30.        1188.5      -45.        1188.       -150.       1188.5
            -655.       1188.       -670.       1190.2      -690.       1200.8
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                            DUPLICATE X POINTS NOT CHANGED-----------------------------
SECTION     6B
            1400.       1202.5      130.1       1201.2      130.        1197.5
            115.        1196.       80.         1189.       30.         1188.8
            15.         1187.       10.         1182.7      0.          1181.5
            -40.        1189.       -200.       1189.6      -510.       1188.2
            -1060.      1188.2      -1150.      1188.       -1195.      1188.2
            -1220.      1197.1      -1220.1     1200.8      -1870.      1200.6
            -1885.      1199.       -1910.      1199.       -2020.      1203.
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                            DUPLICATE X POINTS NOT CHANGED-----------------------------
SECTION     6A
            1400.       1202.5      130.1       1201.2      130.        1197.5
            115.        1196.       80.         1189.       30.         1188.8
            15.         1187.       10.         1182.7      0.          1181.5
```

```
-----------------------------80/80 LIST OF INPUT DATA-----------------------------
          -40.      1189.     -200.     1189.6    -510.     1188.2
          -1060.    1188.2    -1150.    1188.     -1195.    1188.2
          -1220.    1197.1    -1220.1   1200.8    -1870.    1200.6
          -1885.    1199.     -1910.    1199.     -2020.    1203.
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                             DUPLICATE X POINTS NOT CHANGED-----------------------------
SECTION   6
          1400.     1202.5    130.1     1201.2    130.      1197.5
          115.      1196.     80.       1189.     30.       1188.8
          15.       1187.     10.       1182.7    0.        1181.5
          -40.      1189.     -200.     1189.6    -510.     1188.2
          -1060.    1188.2    -1150.    1188.     -1195.    1188.2
          -1220.    1197.1    -1220.1   1200.8    -1870.    1200.6
          -1885.    1199.     -1910.    1199.     -2020.    1203.
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                             DUPLICATE X POINTS NOT CHANGED-----------------------------
SECTION   5
          2369.     1198.     2358.     1194.     1100.     1190.
          300.      1190.5    200.      1189.5    40.       1190.6
          20.       1183.3    0.        1182.7    -15.      1186.5
          -25.      1190.6    -450.     1189.     -550.     1189.
          -880.     1190.     -1175.    1189.6    -1260.    1189.2
          -1270.    1194.
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                             DUPLICATE X POINTS NOT CHANGED-----------------------------
SEGMENT   9         1         D         -40.      1187.
NVALUE    .07
SEGMENT   9         2         C         40.       1187.
NVALUE    .04
SEGMENT   9         3         D         170.      1196.
NVALUE    .065
SEGMENT   8         1         D         -40.      1188.
NVALUE    .07
SEGMENT   8         2         C         35.       1187.5
NVALUE    .04
SEGMENT   8         3         D         165.      1197.
NVALUE    .065
SEGMENT   7         1         D         -30.      1188.5
NVALUE    .075
SEGMENT   7         2         C         55.       1190.
NVALUE    .04
SEGMENT   7         3         D         285.      1199.
NVALUE    .065
SEGMENT   6A        1         D         -1220.1   1200.8
NVALUE    .035
SEGMENT   6A        2         C         130.1     1201.2
NVALUE    .04
SEGMENT   6A        3         D         1400.     1202.5
```

----------80/80 LIST OF INPUT DATA----------

```
NVALUE    .035
SEGMENT   5        1        D        -25.     1190.6
NVALUE    .06
SEGMENT   5        2        C        40.      1190.6
NVALUE    .04
SEGMENT   5        3        D        2369.    1198.
NVALUE    .065
BPR       6B       A        3.       7.
PIER      1189.    7.5      1188.2   16.5
GIRDER    1199.    1197.3   20.      .8       2.6
          -1220.1  1200.8   -1220.   1197.1   130.     1197.5
          130.1    1201.2
ENDTABLE
BPR       6        A        3.       7.
PIER      1189.    7.5      1188.2   16.5
GIRDER    1199.    1197.3   20.      .8       2.6
          -1220.1  1200.8   -1220.   1197.1   130.     1197.5
          130.1    1201.2
ENDTABLE
COMPUTE   9        5        0
```

----------END OF 80/80 LIST----------

RATING TABLE FOR SECTION 9 DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1180.8	0.0	0.0						
ZERO DAMG	1186.5	296.3	1727.2	0.0	0.0	0.0			
BANK FULL	1187.0	477.1	1878.8	0.0	0.0	0.0			
1	1187.4	686.6	2000.0	0.0	0.0	0.0	0.10	1185.6	0.00281
2	1190.0	2645.3	5000.0	0.0	0.0	0.0	0.25	1187.6	0.00093
3	1192.9	5019.8	10000.0	0.0	0.0	0.0	0.50	1188.3	0.00058
4	1195.3	7103.5	20000.0	0.0	0.0	0.0	1.00	1189.3	0.00083
5	1196.0	7733.4	30000.0	0.0	0.0	0.0	1.50	1190.2	0.00145

SEGMENT TABLE FOR SECTION 9

CSM		TOTAL	SEG NO 1 D	SEG NO 2 C	SEG NO 3 D
1	DISCHARGE CFS	2000.	247.	1686.	67.
0.	VELOCITY FPS	4.73	0.87	4.99	1.01
2	DISCHARGE CFS	5000.	2313.	2179.	507.
0.	VELOCITY FPS	2.85	1.32	3.99	1.47
3	DISCHARGE CFS	10000.	5684.	3134.	1182.
0.	VELOCITY FPS	2.63	1.60	4.03	1.74
4	DISCHARGE CFS	20000.	12114.	5408.	2478.
1.	VELOCITY FPS	3.55	2.35	5.58	2.54
5	DISCHARGE CFS	30000.	18394.	7845.	3761.
1.	VELOCITY FPS	4.85	3.26	7.65	3.52
1	ELEV 1187.4 KD	36788.	3430.	32404.	954.
2	ELEV 1190.0 KD	164119.	75383.	72164.	16572.
3	ELEV 1192.9 KD	415092.	235782.	130287.	49023.
4	ELEV 1195.3 KD	695511.	421149.	189198.	86163.
5	ELEV 1196.0 KD	788767.	483308.	206629.	98830.

RATING TABLE FOR SECTION 8

DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1181.0	0.0	0.0	0.0	0.0	0.0			
ZERO DAMG	1187.0	256.1	1615.6	6.68	0.0	0.0			
BANK FULL	1187.5	343.0	1750.2	7.63	0.0	0.0			
1	1188.4	875.1	2000.0	7.88	0.0	0.0	0.10	1186.2	0.00186
2	1190.5	2526.5	5000.0	8.15	0.0	0.0	0.25	1188.4	0.00099
3	1193.2	4710.8	10000.0	8.39	0.0	0.0	0.50	1189.0	0.00062
4	1195.7	6807.6	20000.0	8.49	0.0	0.0	1.00	1190.0	0.00080
5	1196.7	7635.6	30000.0				1.50	1190.9	0.00126

SEGMENT TABLE FOR SECTION 8

CSM		TOTAL	SEG NO 1 D	SEG NO 2 C	SEG NO 3 D
1	DISCHARGE CFS	2000.	340.	1508.	152.
0.	VELOCITY FPS	3.92	0.85	4.30	1.21
2	DISCHARGE CFS	5000.	2339.	2062.	599.
0.	VELOCITY FPS	2.90	1.41	4.06	1.66
3	DISCHARGE CFS	10000.	5798.	2893.	1309.
0.	VELOCITY FPS	2.67	1.74	4.07	1.94
4	DISCHARGE CFS	20000.	12439.	4866.	2694.
1.	VELOCITY FPS	3.49	2.53	5.42	2.74
5	DISCHARGE CFS	30000.	18963.	6965.	4072.
1.	VELOCITY FPS	4.61	3.41	7.18	3.67
1	ELEV 1188.4 KD	45056.	5891.	35894.	3271.
2	ELEV 1190.5 KD	158691.	73097.	66639.	18955.
3	ELEV 1193.2 KD	401033.	232116.	116427.	52489.
4	ELEV 1195.7 KD	705990.	438761.	172139.	95090.
5	ELEV 1196.7 KD	843884.	533317.	196046.	114521.

RATING TABLE FOR SECTION 7 DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1181.5	0.0	0.0						
ZERO DAMG	1187.0	234.1	1440.7	0.0	0.0	0.0			
BANK FULL	1188.5	708.5	1833.5	6.00	0.0	0.0			
1	1189.1	1209.9	2000.0	6.54	0.0	0.0	0.10	1187.2	0.00094
2	1191.0	2935.0	5000.0	6.90	0.0	0.0	0.25	1188.8	0.00062
3	1193.5	5297.4	10000.0	6.98	0.0	0.0	0.50	1189.3	0.00038
4	1196.1	7754.9	20000.0	7.05	0.0	0.0	1.00	1190.3	0.00045
5	1197.2	8871.0	30000.0	7.09	0.0	0.0	1.50	1191.0	0.00066

SEGMENT TABLE FOR SECTION 7

CSM		TOTAL	SEG NO 1 C	SEG NO 2 C	SEG NO 3 D
1	DISCHARGE CFS	2000.	470.	1172.	358.
0.	VELOCITY FPS	2.65	0.84	3.16	1.28
2	DISCHARGE CFS	5000.	2332.	1569.	1099.
0.	VELOCITY FPS	2.11	1.33	2.99	1.66
3	DISCHARGE CFS	10000.	5452.	2223.	2325.
0.	VELOCITY FPS	2.08	1.62	3.02	1.94
4	DISCHARGE CFS	20000.	11539.	3722.	4738.
1.	VELOCITY FPS	2.75	2.29	3.89	2.68
5	DISCHARGE CFS	30000.	17560.	5297.	7142.
1.	VELOCITY FPS	3.58	3.04	5.02	3.52
1	ELEV 1189.1 KD	62557.	11862.	39416.	11278.
2	ELEV 1191.0 KD	200993.	92562.	64350.	44082.
3	ELEV 1193.5 KD	511361.	278775.	113694.	118892.
4	ELEV 1196.1 KD	940635.	542506.	175298.	222831.
5	ELEV 1197.2 KD	1168538.	683858.	206490.	278190.

ROAD SECTION 6B

NO.	HW	CFS	HL	TW	CSM
0	1181.50	0.00	0.00	0.00	0.00
1	1189.68	2000.00	0.08	1189.61	0.10
2	1191.44	5000.00	0.04	1191.40	0.25
3	1193.81	10000.00	0.02	1193.79	0.50
4	1196.48	20000.00	0.06	1196.42	1.00
5	1197.83	29999.98	0.10	1197.73	1.50

MIN ROAD ELEVATION 1199.00

BRIDGE TYPE 2 GIRDER BOTTOM ELEVATION = 1197.30 OPENING NO.= 1

RATING TABLE FOR SECTION 6A DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1181.5	0.0	0.0						
1	1189.7	1732.2	2000.0	0.0	0.0	0.0	0.10	1188.0	0.00069
2	1191.5	3965.2	5000.0	0.0	0.0	0.0	0.25	1189.0	0.00026
3	1193.8	7050.8	10000.0	0.0	0.0	0.0	0.50	1189.6	0.00016
4	1196.5	10596.2	20000.0	0.0	0.0	0.0	1.00	1190.3	0.00016
5	1197.8	12415.5	30000.0	0.0	0.0	0.0	1.50	1190.9	0.00022

SEGMENT TABLE FOR SECTION 6A

CSM		TOTAL	SEG NO 1 (E)	SEG NO 2 (C)	SEG NO 3 (D)
1	DISCHARGE CFS	2000.	0.	2000.	0.
0.	VELOCITY FPS	1.22	0.0	1.15	0.0
2	DISCHARGE CFS	5000.	0.	5000.	0.
0.	VELOCITY FPS	1.27	0.0	1.26	0.0
3	DISCHARGE CFS	10000.	0.	10000.	0.
0.	VELOCITY FPS	1.43	0.0	1.42	0.0
4	DISCHARGE CFS	20000.	0.	20000.	0.
1.	VELOCITY FPS	1.89	0.0	1.89	0.0
5	DISCHARGE CFS	30000.	0.	30000.	0.
1.	VELOCITY FPS	2.42	0.0	2.42	0.0
1	ELEV 1189.7 KD	75920.	2.	75917.	2.
2	ELEV 1191.5 KD	308983.	2.	308980.	2.
3	ELEV 1193.8 KD	797845.	2.	797842.	2.
4	ELEV 1196.5 KD	1557507.	2.	1557505.	2.
5	ELEV 1197.8 KD	2018571.	2.	2018569.	2.

ROAD SECTION 6

NO.	HW	CFS	HL	TW	CSM
0	1181.50	0.00	0.00	0.00	0.00
1	1189.79	2000.00	0.04	1189.76	0.10
2	1191.51	5000.00	0.04	1191.47	0.25
3	1193.88	10000.00	0.06	1193.82	0.50
4	1196.62	20000.00	0.12	1196.50	1.00
5	1198.05	29999.98	0.20	1197.85	1.50

MIN ROAD ELEVATION 1199.00

BRIDGE TYPE 2 GIRDER BOTTOM ELEVATION = 1197.30 OPENING NO.= 1

RATING TABLE FOR SECTION 5 DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1183.3	0.0	0.0						
ZERO DAMG	1189.0	252.4	1618.7	0.0	0.0	0.0			
1	1190.3	1508.6	2000.0	32.01	0.0	0.0	0.10	1188.4	0.00168
BANK FULL	1190.6	2018.6	2534.2	34.09	0.0	0.0			
2	1191.8	5299.0	5000.0	43.69	0.0	0.0	0.25	1190.1	0.00074
3	1194.0	12475.6	10000.0	53.10	0.0	0.0	0.50	1190.6	0.00026
4	1196.7	22257.4	20000.0	54.25	0.0	0.0	1.00	1191.0	0.00017
5	1198.1	27503.6	30000.0	54.31	0.0	0.0	1.50	1191.4	0.00019

**********PROFILE NO 4 EXCEEDS SURVEY DATA**********
**********PROFILE NO 5 EXCEEDS SURVEY DATA**********

SEGMENT TABLE FOR SECTION 5

CSM		TOTAL	SEG NO 1 D	SEG NO 2 C	SEG NO 3 D
1	DISCHARGE CFS	2000.	669.	1234.	97.
0.	VELOCITY FPS	3.38	0.73	4.09	0.33
2	DISCHARGE CFS	5000.	2392.	1232.	1376.
0.	VELOCITY FPS	1.83	0.89	3.12	0.62
3	DISCHARGE CFS	10000.	4698.	1283.	4019.
0.	VELOCITY FPS	1.13	0.87	2.39	0.62
4	DISCHARGE CFS	20000.	8545.	1677.	9779.
1.	VELOCITY FPS	1.08	0.97	2.35	0.77
5	DISCHARGE CFS	30000.	12452.	2211.	15337.
1.	VELOCITY FPS	1.25	1.18	2.74	0.95
1	ELEV 1190.3 KD	45776.	13728.	30866.	1182.
2	ELEV 1191.8 KD	181788.	87375.	47710.	46703.
3	ELEV 1194.0 KD	613796.	289409.	79848.	244539.
4	ELEV 1196.7 KD	1520237.	650215.	127897.	742125.
5	ELEV 1198.1 KD	2154346.	891508.	157277.	1105562.

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WSP2 XEQ 22  0003
     REV 03/11/74

-----------------------------80/80 LIST OF INPUT DATA-----------------------------
WSP2       20.                                                   MARCH 1978
TITLE      RWCD FLOODWAY; OUTLET STRUCTURE
TITLE      GILA RIVER WSP TO DETERMINE TW CONDITIONS
DISCHARGE -2          .1          .25         .5          1.0         1.5
DISCHARGE -2          2.0         3.0         4.0         5.0
STARTE     9          1187.4      1190.       1192.9      1195.3      1196.
STARTE     9          1196.1      1196.2      1196.5      1197.
OUTPUT     PSK
COMMENT    GILA RIVER RIVER FROM BELOW I-10 BRIDGE UPSTREAM TO
           THE PROPOSED OUTLET STRUCTURE , CONSIDERING ALL THE RIVER CHANNEL
**********************************THE ABOVE CARD IS OUT OF ORDER,DATA IS NOT  RETAINED FOR USE*****************************
REACH      9          20000.      0.          0.          0.
REACH      8          20000.      509.        430.        430.
REACH      7          20000.      624.        320.        320.
ROAD       6B         2.7         846.        290.
REACH      6A         20000.      50.         50.         50.
ROAD       6          2.7         50.         50.
REACH      5          20000.      418.        650.        650.
REACH      4          20000.      738.        500.        500.
REACH      3          20000.      504.        500.        500.
REACH      2          20000.      587.        500.        500.
REACH      1          20000.      689.        680.        680.
REACH      A          20000.      1285.       900.        900.
SECTION    9
           3280.      1199.       3245.       1194.       2050.       1191.
           2020.      1187.       840.        1187.       340.        1182.
           290.       1189.       250.        1182.5      210.        1194.
           200.       1195.       170.        1196.       140.        1186.5
           40.        1187.       20.         1181.       0.          1180.8
           -40.       1187.       -350.       1186.5      -610.       1188.
           -780.      1199.
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                                 DUPLICATE X POINTS NOT CHANGED-----------------
SECTION    8
           3300.      1199.5      3280.       1195.       2070.       1192.5
           2040.      1187.5      1710.       1185.5      1600.       1188.
           1100.      1187.       1000.       1189.       900.        1189.
           715.       1185.5      420.        1184.       375.        1182.
           315.       1184.5      295.        1189.5      265.        1189.5
           245.       1183.       215.        1195.5      165.        1197.
           140.       1187.       35.         1187.5      20.         1182.
           0.         1181.       -40.        1188.       -270.       1187.5
           -625.      1188.       -650.       1190.5      -720.       1200.
ENDTABLE
-----------------------------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
                                 DUPLICATE X POINTS NOT CHANGED-----------------
SECTION    7
           2846.      1200.       2841.       1197.       1980.       1193.8
           1965.      1190.       1860.       1188.       1560.       1188.5
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----------80/80 LIST OF INPUT DATA----------

1450..	1187.	1140.	1188.5	1000.	1178.
800.	1180.	690.	1180.	660.	1190.
630.	1189.	600.	1185.	500.	1187.8
375.	1185.8	360.	1189.6	325.	1189.6
300.	1198.6	285.	1199.	260.	1187.
200.	1187.	100.	1188.5	55.	1190.
40.	1188.8	20.	1181.5	0.	1181.6
-15.	1184.	-30.	1188.5	-45.	1188.
-150.	1188.5	-655.	1188.	-670.	1190.2
-690.	1200.8				

ENDTABLE

----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

SECTION 6B

1400.	1202.5	130.1	1201.2	130.	1197.5
115.	1196.	80.	1189.	30.	1188.8
15.	1187.	10.	1182.7	0.	1181.5
-40.	1189.	-200.	1189.6	-510.	1188.2
-1060.	1188.2	-1150.	1188.	-1195.	1188.2
-1220.	1197.1	-1220.1	1200.8	-1870.	1200.6
-1885.	1199.	-1910.	1199.	-2020.	1203.

ENDTABLE

----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

SECTION 6A

1400.	1202.5	130.1	1201.2	130.	1197.5
115.	1196.	80.	1189.	30.	1188.8
15.	1187.	10.	1182.7	0.	1181.5
-40.	1189.	-200.	1189.6	-510.	1188.2
-1060.	1188.2	-1150.	1188.	-1195.	1188.2
-1220.	1197.1	-1220.1	1200.8	-1870.	1200.6
-1885.	1199.	-1910.	1199.	-2020.	1203.

ENDTABLE

----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

SECTION 6

1400.	1202.5	130.1	1201.2	130.	1197.5
115.	1196.	80.	1189.	30.	1188.8
15.	1187.	10.	1182.7	0.	1181.5
-40.	1189.	-200.	1189.6	-510.	1188.2
-1060.	1188.2	-1150.	1188.	-1195.	1188.2
-1220.	1197.1	-1220.1	1200.8	-1870.	1200.6
-1885.	1199.	-1910.	1199.	-2020.	1203.

ENDTABLE

----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

SECTION 5

2369.	1198..	2358.	1194.	1100.	1190.
300.	1190.5	200.	1189.5	40.	1190.6
20.	1183.3	0.	1183.7	-15.	1186.5
-25.	1190.6	-450.	1189.	-550.	1189.
-880.	1190.	-1175.	1189.6	-1260.	1189.2
-1300.	1194.				

ENDTABLE ----------80/80 LIST OF INPUT DATA----------

SECTION 4 ----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

2340.	1196.5	2300.	1192.8	1900.	1192.2
1800.	1191.8	900.	1191.6	800.	1190.3
600.	1191.	175.	1190.8	165.	1188.2
150.	1190.6	100.	1190.6	45.	1191.3
25.	1185.	0.	1184.8	-15.	1185.2
-25.	1191.	-400.	1191.3	-600.	1190.2
-645.	1190.8	-665.	1193.8	-765.	1194.
-870.	1195.6	-900.	1201.5		

ENDTABLE

SECTION 3 ----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

2240.	1198.	2210.	1193.	1500.	1192.
1300.	1192.8	1000.	1191.2	600.	1191.7
400.	1190.4	100.	1192.	20.	1189.7
18.	1184.8	0.	1184.8	-10.	1185.
-20.	1192.	-40.	1187.6	-45.	1192.
-135.	1192.	-145.	1193.	-235.	1192.
-350.	1192.	-360.	1195.5	-420.	1197.
-425.	1196.	-470.	1195.	-490.	1202.

ENDTABLE

SECTION 2 ----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

2770.	1200.	2750.	1194.2	2700.	1193.
2100.	1193.4	1880.	1192.8	1700.	1193.6
1600.	1192.8	1300.	1193.	800.	1191.2
80.	1192.5	55.	1190.	30.	1189.8
20.	1187.5	0.	1187.3	-10.	1186.
-30.	1186.	-50.	1193.	-65.	1194.
-70.	1196.8	-180.	1200.		

ENDTABLE

SECTION 1 ----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

3380.	1200.8	3350.	1195.6	3300.	1194.8
2000.	1194.8	1900.	1193.6	1700.	1193.
1400.	1193.2	1300.	1192.3	1100.	1194.
800.	1193.5	700.	1194.	600.	1195.5
500.	1193.	300.	1191.6	200.	1192.
140.	1193.	100.	1192.4	20.	1194.5
0.	1186.6	-10.	1186.3	-20.	1189.
-25.	1193.6	-40.	1193.	-55.	1190.2
-65.	1194.	-80.	1194.	-90.	1189.
-105.	1189.	-115.	1190.	-120.	1194.
-150.	1194.	-160.	1198.8	-220.	1200.
-225.	1204.				

ABLE

SECTION A ----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

----------80/80 LIST OF INPUT DATA----------

3380.	1201.	3340.	1196.5	2020.	1196.5
1720.	1194.6	750.	1195.	600.	1197.
450.	1194.	200.	1194.5	140.	1193.
90.	1195.	30.	1195.	0.	1187.8
-40.	1194.	-225.	1194.5	-240.	1200.
-400.	1201.				

ENDTABLE

----------DATA POINTS REORDERED BY PROGRAM ACCORDING TO X VALUES
DUPLICATE X POINTS NOT CHANGED----------

SEGMENT	9	1	D	-40.	1187.
NVALUE	.07				
SEGMENT	9	2	C	40.	1187.
NVALUE	.04				
SEGMENT	9	3	D	3280.	1199.
NVALUE	.065				
SEGMENT	8	1	D	-40.	1188.
NVALUE	.07				
SEGMENT	8	2	C	35.	1187.5
NVALUE	.04				
SEGMENT	8	3	D	3300.	1199.5
NVALUE	.065				
SEGMENT	7	1	D	-30.	1188.5
NVALUE	.075				
SEGMENT	7	2	C	55.	1190.
NVALUE	.04				
SEGMENT	7	3	D	2846.	1200.
NVALUE	.065				
SEGMENT	6A	1	D	-1220.1	1200.8
NVALUE	.035				
SEGMENT	6A	2	C	130.1	1201.2
NVALUE	.04				
SEGMENT	6A	3	D	1400.	1202.5
NVALUE	.035				
SEGMENT	5	1	D	-25.	1190.6
NVALUE	.06				
SEGMENT	5	2	C	40.	1190.6
NVALUE	.04				
SEGMENT	5	3	D	2369.	1198.
NVALUE	.065				
SEGMENT	4	1	D	-25.	1191.
NVALUE	.07				
SEGMENT	4	2	C	45.	1191.3
NVALUE	.045				
SEGMENT	4	3	D	2340.	1196.5
NVALUE	.065				
SEGMENT	3	1	D	-45.	1192.
NVALUE	.08				

```
-----------------------------80/80 LIST OF INPUT DATA-----------------------------
SEGMENT   3        2        C        100.     1192.
NVALUE    .048
SEGMENT   3        3        D        2240.    1198.
NVALUE    .075
SEGMENT   2        1        D        -50.     1193.
NVALUE    .08
SEGMENT   2        2        C        80.      1192.5
NVALUE    .045
SEGMENT   2        3        D        2770.    1200.
NVALUE    .075
SEGMENT   1        1        D        -120.    1194.
NVALUE    .08
SEGMENT   1        2        C        20.      1194.5
NVALUE    .045
SEGMENT   1        3        D        3380.    1200.8
NVALUE    .07
SEGMENT   A        1        D        -40.     1194.
NVALUE    .08
SEGMENT   A        2        C        30.      1195.
NVALUE    .045
SEGMENT   A        3        D        3380.    1201.
NVALUE    .065
BPR       6B       A        3.       7.
PIER      1189.    7.5      1188.2   16.5
GIRDER    1199.    1197.3   20.      .8       2.6
          -1220.1  1200.8   -1220.   1197.1   130.     1197.5
          130.1    1201.2
ENDTABLE
BPR       6        A        3.       7.
PIER      1189.    7.5      1188.2   16.5
GIRDER    1199.    1197.3   20.      .8       2.6
          -1220.1  1200.8   -1220.   1197.1   130.     1197.5
          130.1    1201.2
ENDTABLE
COMPUTE   9        A        9
-----------------------------END OF 80/80 LIST-----------------------------
```

RATING TABLE FOR SECTION S DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1180.8	0.0	0.0						
ZERO DAMG	1182.0	28.3	363.7	0.0	0.0	0.0			
BANK FULL	1187.0	2095.4	1878.8	0.0	0.0	0.0			
1	1187.4	2830.3	2000.0	0.0	0.0	0.0	0.10	1183.9	0.00047
2	1190.0	9462.8	5000.0	0.0	0.0	0.0	0.25	1185.0	0.00009
3	1192.9	17884.3	10000.0	0.0	0.0	0.0	0.50	1186.1	0.00006
4	1195.3	27003.1	20000.0	0.0	0.0	0.0	1.00	1187.5	0.00008
5	1196.0	29789.2	30000.0	0.0	0.0	0.0	1.50	1187.9	0.00013
6	1196.1	30186.6	40000.0	0.0	0.0	0.0	2.00	1188.3	0.00022
7	1196.2	30584.9	60000.0	0.0	0.0	0.0	3.00	1188.9	0.00047
8	1196.5	31781.5	80000.0	0.0	0.0	0.0	4.00	1189.4	0.00074
9	1197.0	33790.0	100000.0	0.0	0.0	0.0	5.00	1189.9	0.00095

RATING TABLE FOR SECTION 8 DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1181.0	0.0	0.0						
ZERO DAMG	1182.0	13.7	301.7	0.0	0.0	0.0			
BANK FULL	1187.5	2300.3	1961.1	15.59	0.0	0.0			
1	1187.6	2548.6	2000.0	15.90	0.0	0.0	0.10	1184.7	0.00040
2	1190.1	8325.6	5000.0	25.87	0.0	0.0	0.25	1185.7	0.00011
3	1192.9	15987.5	10000.0	28.59	0.0	0.0	0.50	1186.6	0.00006
4	1195.3	24352.9	20000.0	38.46	0.0	0.0	1.00	1187.8	0.00009
5	1196.1	27212.1	30000.0	38.93	0.0	0.0	1.50	1188.4	0.00015
6	1196.2	27792.0	40000.0	39.00	0.0	0.0	2.00	1188.7	0.00024
7	1196.5	28700.8	60000.0	39.10	0.0	0.0	3.00	1189.4	0.00049
8	1196.9	30362.1	80000.0	39.23	0.0	0.0	4.00	1189.9	0.00073
9	1197.5	32712.6	100000.0	39.37	0.0	0.0	5.00	1190.4	0.00089

RATING TABLE FOR SECTION 7 DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1178.0	0.0	0.0						
ZERO DAMG	1178.0	0.0	0.0	0.0	0.0	0.0			
1	1187.7	3998.1	2000.0	7.54	0.0	0.0	0.10	1180.3	0.00004
BANK FULL	1188.5	5358.0	3029.0	11.44	0.0	0.0			
2	1190.1	9117.8	5000.0	18.93	0.0	0.0	0.25	1181.2	0.00005
3	1193.0	16531.6	10000.0	19.16	0.0	0.0	0.50	1182.3	0.00003
4	1195.4	23284.1	20000.0	22.42	0.0	0.0	1.00	1184.0	0.00005
5	1196.1	25605.8	30000.0	23.95	0.0	0.0	1.50	1185.3	0.00009
6	1196.3	26224.1	40000.0	24.23	0.0	0.0	2.00	1186.7	0.00015
7	1196.6	27347.9	60000.0	24.62	0.0	0.0	3.00	1189.0	0.00030
8	1197.2	29104.5	80000.0	25.22	0.0	0.0	4.00	1189.6	0.00045
9	1197.8	31389.5	100000.0	25.78	0.0	0.0	5.00	1190.1	0.00056

ROAD SECTION 6B

NO.	HW	CFS	HL	TW	CSM
0	1181.50	0.00	0.00	0.00	0.00
1	1187.97	2000.00	0.18	1187.79	0.10
2	1190.30	5000.00	0.0	1190.30	0.25
3	1193.18	10000.00	0.0	1193.18	0.50
4	1195.53	20000.00	0.0	1195.53	1.00
5	1196.35	29999.98	0.0	1196.35	1.50
6	1196.65	40000.00	0.0	1196.65	2.00
7	1197.21	60000.00	0.0	1197.21	3.00
8	1197.95	80000.00	0.0	1197.95	4.00
9	1198.78	100000.00	0.0	1198.78	5.00

MIN ROAD ELEVATION 1199.00

BRIDGE TYPE 2 GIRDER BOTTOM ELEVATION = 1197.30 OPENING NO.= 1

RATING TABLE FOR SECTION 6A DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1181.5	0.0	0.0						
1	1189.6	1570.1	2000.0	0.0	0.0	0.0	0.10	1188.0	0.00091
2	1190.4	2556.3	5000.0	0.0	0.0	0.0	0.25	1189.0	0.00117
3	1193.2	6234.4	10000.0	0.0	0.0	0.0	0.50	1189.6	0.00024
4	1195.5	9334.3	20000.0	0.0	0.0	0.0	1.00	1190.3	0.00025
5	1196.4	10433.5	30000.0	0.0	0.0	0.0	1.50	1190.9	0.00039
6	1196.7	10843.9	40000.0	0.0	0.0	0.0	2.00	1191.5	0.00061
7	1197.3	11636.1	60000.0	0.0	0.0	0.0	3.00	1192.4	0.00109
8	1198.0	12662.9	80000.0	0.0	0.0	0.0	4.00	1193.3	0.00147
9	1198.9	13805.0	100000.0	0.0	0.0	0.0	5.00	1194.1	0.00173

ROAD SECTION 6

NO.	HW	CFS	HL	TW	CSM
0	1181.50	0.00	0.00	0.00	0.00
1	1189.68	2000.00	0.04	1189.64	0.10
2	1190.54	5000.00	0.12	1190.42	0.25
3	1193.28	10000.00	0.08	1193.21	0.50
4	1195.70	20000.00	0.14	1195.56	1.00
5	1196.67	29999.98	0.28	1196.39	1.50
6	1197.16	40000.00	0.46	1196.71	2.00
7	1198.22	60000.00	0.90	1197.32	3.00
8	1199.28	80000.00	1.18	1198.10	4.00
9	1200.77	100000.00	1.82	1198.95	5.00

MIN ROAD ELEVATION 1199.00

BRIDGE TYPE 2 GIRDER BOTTOM ELEVATION = 1197.30 OPENING NO.= 1

RATING TABLE FOR SECTION 5 DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1183.3	0.0	0.0						
ZERO DAMG	1189.0	252.4	1630.9	0.0	0.0	0.0			
1	1190.3	1427.3	2000.0	30.36	0.0	0.0	0.10	1188.4	0.00183
BANK FULL	1190.6	2018.6	3075.4	34.02	0.0	0.0			
2	1191.2	3484.2	5000.0	40.57	0.0	0.0	0.25	1190.1	0.00207
3	1193.4	10575.8	10000.0	51.32	0.0	0.0	0.50	1190.6	0.00042
4	1195.8	19060.0	20000.0	54.21	0.0	0.0	1.00	1191.0	0.00029
5	1196.8	22698.7	30000.0	54.25	0.0	0.0	1.50	1191.4	0.00037
6	1197.4	24691.9	40000.0	54.27	0.0	0.0	2.00	1191.7	0.00050
7	1198.5	28751.9	60000.0	54.32	0.0	0.0	3.00	1192.4	0.00066
8	1199.5	32678.7	80000.0	54.36	0.0	0.0	4.00	1192.9	0.00074
9	1201.0	37972.8	100000.0	54.42	0.0	0.0	5.00	1193.3	0.00065

**********PROFILE NO 4 EXCEEDS SURVEY DATA**********
**********PROFILE NO 5 EXCEEDS SURVEY DATA**********
**********PROFILE NO 6 EXCEEDS SURVEY DATA**********
**********PROFILE NO 7 EXCEEDS SURVEY DATA**********
**********PROFILE NO 8 EXCEEDS SURVEY DATA**********
**********PROFILE NO 9 EXCEEDS SURVEY DATA**********

RATING TABLE FOR SECTION 4 DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1184.8	0.0	0.0						
ZERO DAMG	1188.2	154.8	1017.7	0.0	0.0	0.0			
BANK FULL	1191.0	714.7	1855.8	18.82	0.0	0.0			
1	1191.5	1376.8	2000.0	20.28	0.0	0.0	0.10	1189.0	0.00144
2	1192.4	3478.6	5000.0	31.47	0.0	0.0	0.25	1191.3	0.00142
3	1193.9	7644.5	10000.0	34.26	0.0	0.0	0.50	1191.7	0.00058
4	1196.0	14532.9	20000.0	36.81	0.0	0.0	1.00	1192.3	0.00032
5	1197.1	17862.2	30000.0	36.93	0.0	0.0	1.50	1192.7	0.00037
6	1197.7	19825.4	40000.0	36.97	0.0	0.0	2.00	1193.0	0.00047
7	1198.9	23688.2	60000.0	37.04	0.0	0.0	3.00	1193.6	0.00059
8	1200.0	27296.3	80000.0	37.10	0.0	0.0	4.00	1194.1	0.00066
9	1201.4	31823.8	100000.0	37.18	0.0	0.0	5.00	1194.6	0.00061

**********PROFILE NO 5 EXCEEDS SURVEY DATA**********
**********PROFILE NO 6 EXCEEDS SURVEY DATA**********
**********PROFILE NO 7 EXCEEDS SURVEY DATA**********
**********PROFILE NO 8 EXCEEDS SURVEY DATA**********
**********PROFILE NO 9 EXCEEDS SURVEY DATA**********

RATING TABLE FOR SECTION 3 CA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1184.8	0.0	0.0						
ZERO DAMG	1190.4	213.9	1487.5	0.0	0.0	0.0			
BANK FULL	1192.0	1103.5	1912.5	18.58	0.0	0.0			
1	1192.3	1728.8	2000.0	19.43	0.0	0.0	0.10	1190.4	0.00178
2	1193.3	3776.6	5000.0	28.42	0.0	0.0	0.25	1191.8	0.00186
3	1194.5	6856.9	10000.0	29.57	0.0	0.0	0.50	1192.3	0.00123
4	1196.4	12072.7	20000.0	30.73	0.0	0.0	1.00	1193.0	0.00083
5	1197.5	14998.4	30000.0	31.12	0.0	0.0	1.50	1193.4	0.00093
6	1198.2	16898.2	40000.0	31.21	0.0	0.0	2.00	1193.7	0.00113
7	1199.5	20449.1	60000.0	31.26	0.0	0.0	3.00	1194.3	0.00136
8	1200.7	23654.7	80000.0	31.29	0.0	0.0	4.00	1194.9	0.00150
9	1202.1	27360.5	100000.0	31.34	0.0	0.0	5.00	1195.4	0.00145

**********PROFILE NO 6 EXCEEDS SURVEY DATA**********
**********PROFILE NO 7 EXCEEDS SURVEY DATA**********
**********PROFILE NO 8 EXCEEDS SURVEY DATA**********
**********PROFILE NO 9 EXCEEDS SURVEY DATA**********

RATING TABLE FOR SECTION 2

NO.	ELEV	AREA	CFS	DA=****** DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1186.0	0.0	0.0	0.0	0.0	0.0			
ZERO DAMG	1191.2	363.5	1514.4	19.35	0.0	0.0	0.10	1190.3	0.00093
BANK FULL	1192.5	1222.3	1892.9	20.44	0.0	0.0	0.25	1192.2	0.00110
1	1192.9	1775.4	2000.0	31.19	0.0	0.0	0.50	1192.9	0.00091
2	1193.9	4089.8	5000.0	32.36	0.0	0.0	1.00	1193.5	0.00066
3	1195.0	7180.1	10000.0	32.54	0.0	0.0	1.50	1193.9	0.00072
4	1196.8	12454.3	20000.0	32.98	0.0	0.0	2.00	1194.2	0.00084
5	1198.0	15653.9	30000.0	33.31	0.0	0.0	3.00	1194.8	0.00095
6	1198.7	17900.9	40000.0	33.92	0.0	0.0	4.00	1195.3	0.00098
7	1200.1	21917.4	60000.0	34.44	0.0	0.0	5.00	1195.8	0.00088
8	1201.3	25427.5	80000.0	35.02	0.0	0.0			
9	1202.7	29274.4	100000.0						

**********PROFILE NO 7 EXCEEDS SURVEY DATA**********
**********PROFILE NO 8 EXCEEDS SURVEY DATA**********
**********PROFILE NO 9 EXCEEDS SURVEY DATA**********

RATING TABLE FOR SECTION 1 DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1186.3	0.0	0.0						
ZERO DAMG	1191.6	214.6	1404.8	0.0	0.0	0.0			
1	1193.8	1826.3	2000.0	24.73	0.0	0.0	0.10	1192.2	0.00122
BANK FULL	1194.0	2091.3	2471.7	27.62	0.0	0.0			
2	1194.8	4045.3	5000.0	43.13	0.0	0.0	0.25	1193.1	0.00152
3	1195.9	7377.8	10000.0	54.47	0.0	0.0	0.50	1193.7	0.00124
4	1197.4	12766.2	20000.0	54.91	0.0	0.0	1.00	1194.4	0.00085
5	1198.6	16777.2	30000.0	55.17	0.0	0.0	1.50	1194.9	0.00080
6	1199.4	19610.2	40000.0	55.61	0.0	0.0	2.00	1195.4	0.00086
7	1200.8	24744.9	60000.0	56.21	0.0	0.0	3.00	1195.8	0.00091
8	1202.0	29199.7	80000.0	56.24	0.0	0.0	4.00	1196.3	0.00094
9	1203.3	33829.3	100000.0	56.26	0.0	0.0	5.00	1196.7	0.00090

**********PROFILE NO 8 EXCEEDS SURVEY DATA**********
**********PROFILE NO 9 EXCEEDS SURVEY DATA**********

RATING TABLE FOR SECTION A DA=******

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1187.8	0.0	0.0						
ZERO DAMG	1193.0	147.0	1354.5	0.0	0.0	0.0			
BANK FULL	1194.0	254.6	1615.0	31.20	0.0	0.0			
1	1195.5	1851.5	2000.0	38.64	0.0	0.0	0.10	1194.4	0.00109
2	1196.3	3805.0	5000.0	58.43	0.0	0.0	0.25	1195.1	0.00134
3	1197.3	6762.0	10000.0	73.70	0.0	0.0	0.50	1195.4	0.00118
4	1198.5	11213.4	20000.0	74.26	0.0	0.0	1.00	1196.1	0.00092
5	1199.6	14894.3	30000.0	74.50	0.0	0.0	1.50	1196.6	0.00081
6	1200.4	17865.6	40000.0	76.28	0.0	0.0	2.00	1197.0	0.00081
7	1201.8	22961.2	60000.0	80.33	0.0	0.0	3.00	1197.4	0.00079
8	1203.0	27464.3	80000.0	83.93	0.0	0.0	4.00	1197.9	0.00072
9	1204.1	31748.1	100000.0	87.35	0.0	0.0	5.00	1199.3	0.00062

**********PROFILE NO 7 EXCEEDS SURVEY DATA**********
**********PROFILE NO 8 EXCEEDS SURVEY DATA**********
**********PROFILE NO 9 EXCEEDS SURVEY DATA**********

1203.0 03
87.8 87
2 16

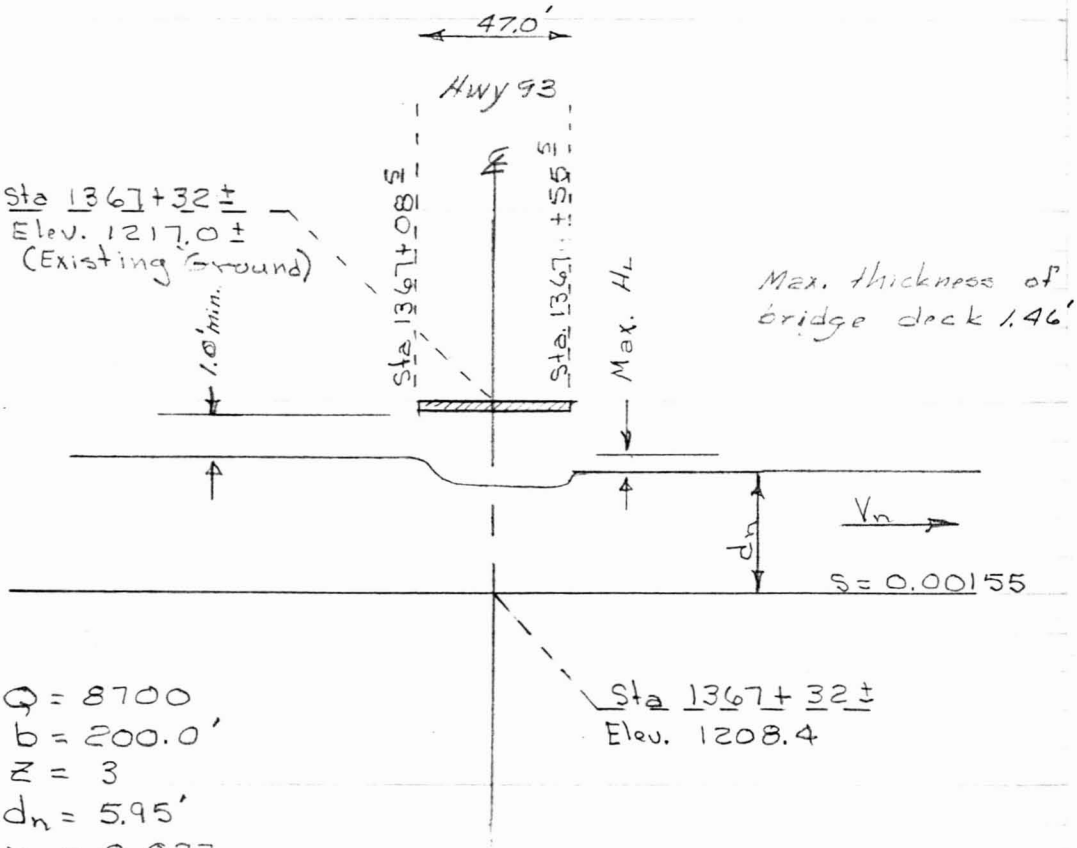
STATE		PROJECT		
Arizona		Williams - Chandler W.P.P.		
BY JLS	DATE 2-16-78	CHECKED BY RJM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy. 93 Bridge Selection				SHEET 1 OF 47

Objective

Determine the best bridge span & channel section based on cost and hydraulic stability.

5.95

Basic Information



Q = 8700
b = 200.0'
Z = 3
d_n = 5.95'
n = 0.027
H_L = 3.5' max for a 200' bottom (To stay inside of the R/W limits)
Pier Width = (14" → 16") → (Use 24" to account for debris)
Bridge Width = 47.0'
Deck Thickness = 1.46' (17½") max.

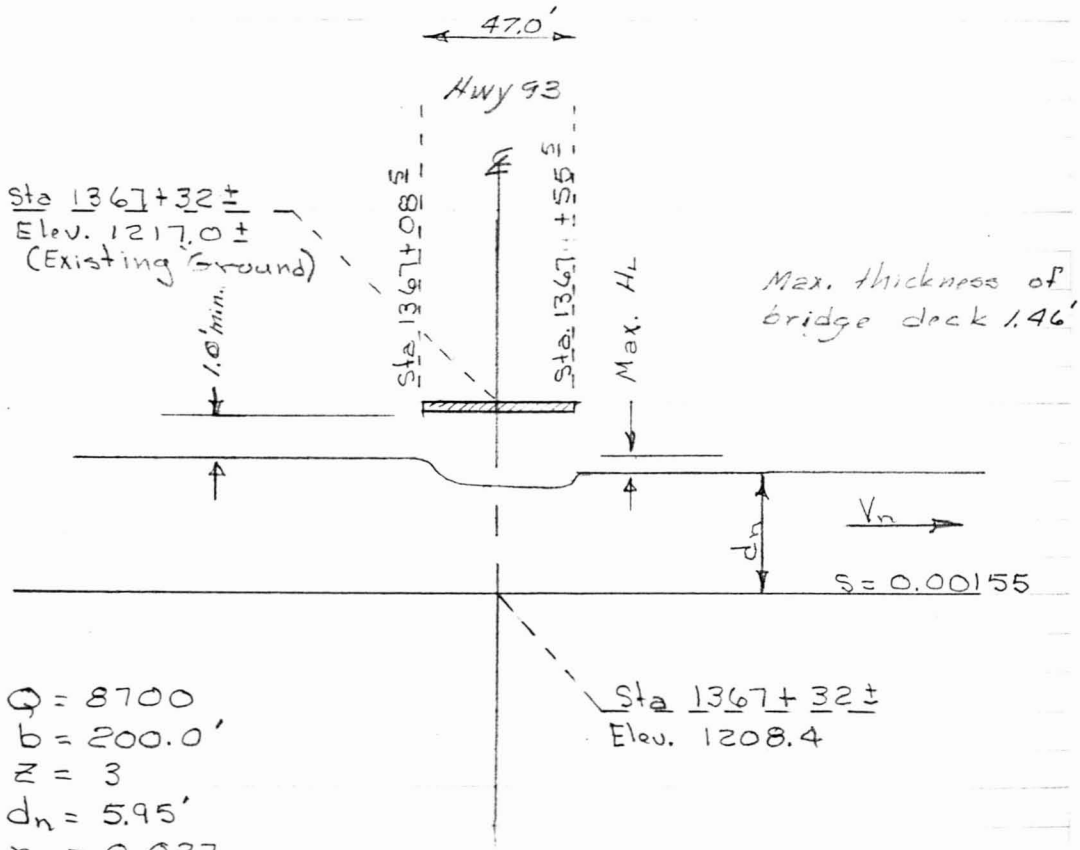
STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-16-78	RJM	3/3/78	RWCD - Reach 1
SUBJECT				SHEET 1 OF 47
Hwy. 93 Bridge Selection				

Objective

Determine the best bridge span & channel section based on cost and hydraulic stability.

5.95

Basic Information



Q = 8700
b = 200.0'
z = 3
d_n = 5.95'
n = 0.027
H_L = 3.5' max for a 200' bottom (To stay inside of the R/W limits)
Pier Width = (14" → 16") → (Use 24" to account for debris)
Bridge Width = 47.0'
Deck Thickness = 1.46' (17½") max.

References

1. Engineering Design Standards - Far West States (SCS)
2. ADOT Standard Drawings Aug. 1976
3. Engr. Monograph No. 25 (USBR)
4. Design of Small Dams (USBR)
5. Hydraulic Engineering Circular No. 11 June 1967 (FHA- BPR)
6. Hydraulic Engineering Circular No. 14 Aug. 1975 (Federal Highway Administration)
7. Letter to Files, 1-31-78, Telephone conversation between P. Monville & D. Grigg
8. Monroe 1880 Program (Water Surface Profile)
9. Concrete Criteria And Economy July 1963 (SCS)
10. Letter to P. Monville, 2-17-78, from ADOT. Estimated costs for Highway grade raises

Assumptions & Criteria

1. ADOT Standard Slab of 30' span
2. Max pile dia. = 16" use 24" to allow for debris
3. Channel side slopes of 2:1 under bridge
4. Bridge is 47.0' wide
6. n = 0.035 for rock riprap
7. n = 0.027 for earth channel

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-24-78	RM	3/3/78	RWCD - Reach 1
SUBJECT				SHEET 3 OF 47
Hwy. 93 Bridge Selection				

8. n = 0.014 for concrete

9. Max. D_{50} - 18",

10. Use rock riprap for V = 7 fps – 15 fps (6. Pg. II-9)

11. Use reinforced concrete for V - above 15 fps (FWS Pg 1-21)

12. Transition convergence & divergence 12½° max

Note: Limiting D_{50} to a max of 18" due to the difficulty in obtaining & placing of the material, also cost would increase with increase in dia.

Procedure

A.

Design channel using a bridge with the following:

1. 8 piers (200' bottom width)
2. 7 piers (180' bottom width)
3. 6 piers (150' " ")
4. 5 piers (120' " ")
5. 4 piers (90 " ")

B.

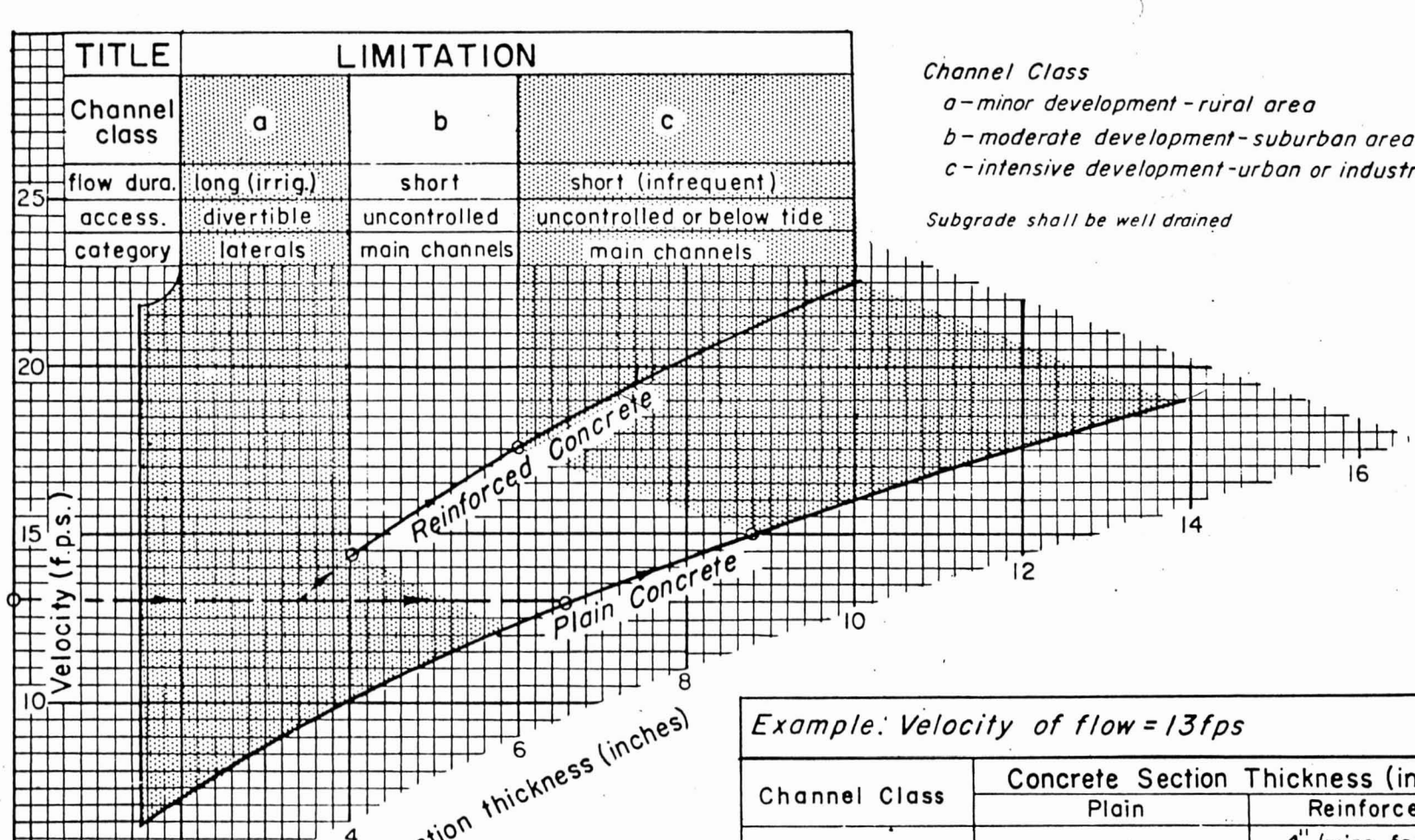
Determine cost of bridge, channel protection & channel excavation

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY JLS	DATE 2-24-78	CHECKED BY RM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 4 OF 47

C.

Develope curve plotting bottom widths vs. costs

D. Determine most economical proposal



TITLE	LIMITATION		
Channel class	a	b	c
flow dura.	long (irrig.)	short	short (infrequent)
access.	divertible	uncontrolled	uncontrolled or below tide
category	laterals	main channels	main channels

Channel Class

a – minor development – rural area

b – moderate development – suburban area

c – intensive development – urban or industrial area

Subgrade shall be well drained

Example: Velocity of flow = 13fps

Channel Class	Concrete Section Thickness (inches)	
	Plain	Reinforced
a	6"	4" (wire fabric) 6" (deformed bars)
b	$6\frac{1}{2}$"	4" (wire fabric) 6" (deformed bars)
c	9"	6" (wire fabric) 6" (deformed bars)

Note:
For plain concrete and
Q < 100 cfs see section I.A.5

FIGURE I.7

MINIMUM SECTION THICKNESS

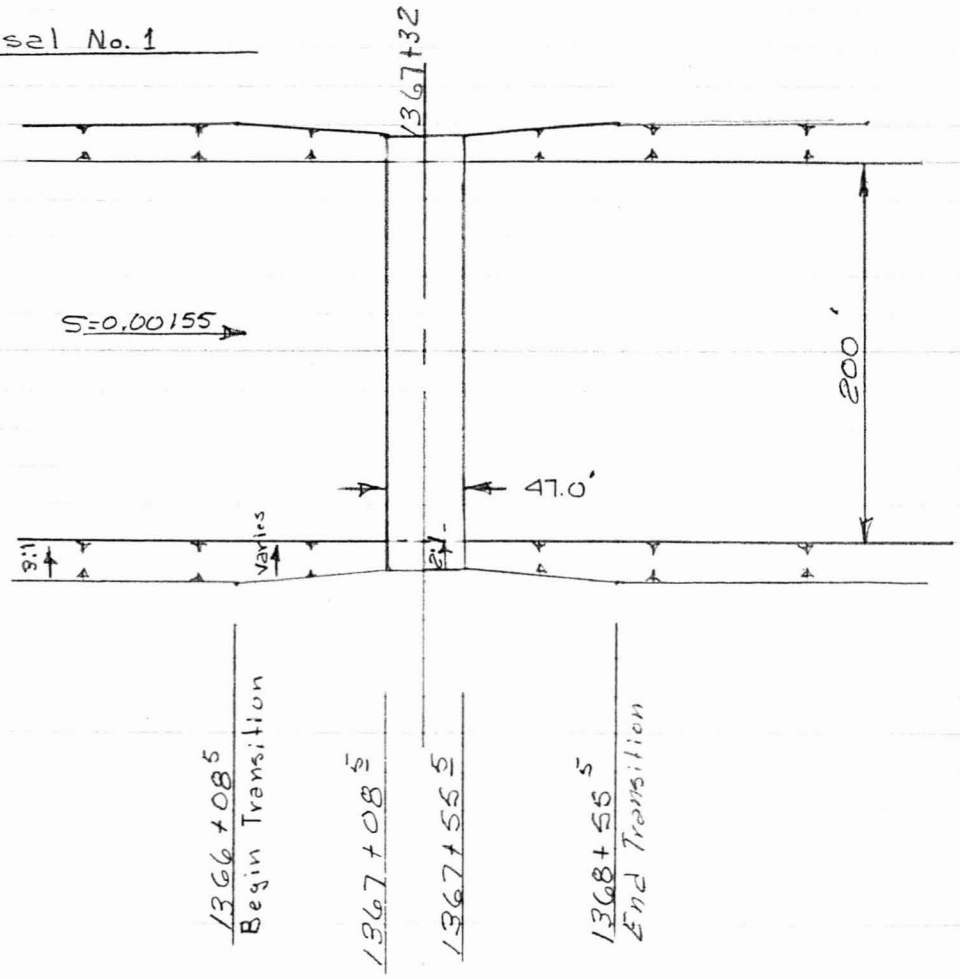
Channel Lining

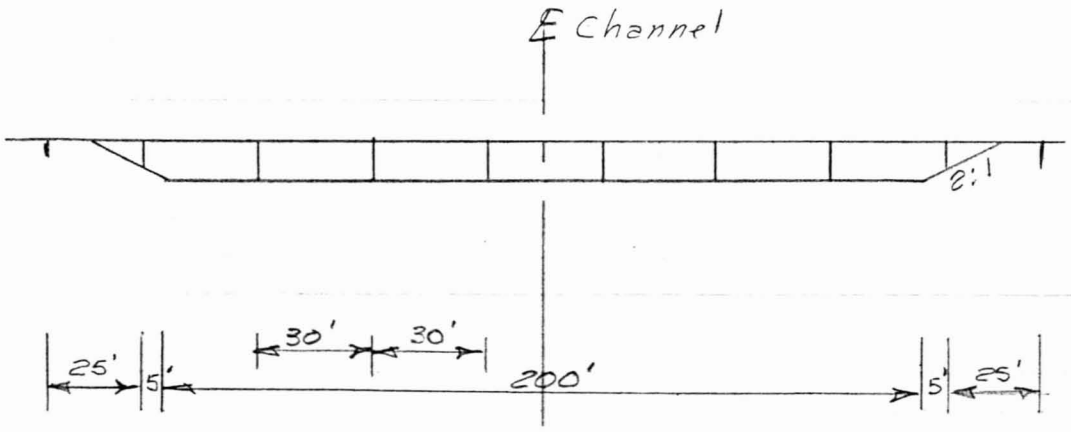
Hwy 43 Bridge

RW 1/13/78

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY JLS	DATE 2-22-78	CHECKED BY KM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge				SHEET 6 OF 47

Proposal No. 1





8 Piers

Bride piers will be 14" to 16" wide — Use 24" to allow for debris

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY JLS	DATE 2-27-78	CHECKED BY LM	DATE 5/3/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 7 OF 47

Begin @ Sta. 1369+05$^{\underline{5}}$ Elev. 1208.17
$S = 0.00155$
$d_n = 5.95$
$Q = 8700$

$b = 200'$
$z = 3$
$n = 0.027$

5.70

1368+55$^{\underline{5}}$ End Transition

$b = 200$
$z = 3$
$n = 0.027$

$n = 0.035$ (Begin Rock)

1368+30$^{\underline{5}}$

$b = 200$
$z = 2.75$
$n = 0.035$

1368+05$^{\underline{5}}$

$b = 200$
$z = 2.50$
$n = 0.035$

1367+80$^{\underline{5}}$

$b = 200$
$z = 2.25$
$n = 0.035$

1367+55$^{\underline{5}}$ Begin Bridge

$b = 200$
$z = 2$
$n = 0.035$

STATE		PROJECT		
Arizona		Williams- Chandler WPP		
BY JLS	DATE 2-27-78	CHECKED BY RM	DATE 3/3/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 8 OF 47

Without Rock Riprap

8,700.00	o	
0.0270	n	
0.001550	SI	
0.00		t
1.15	A	
.....		
136,905.50		S1
1,208.17	e	
200.00	X	
3.00		z
5.950		D1
6.71	Λ	
3.99		Dα
0.50	F	
136,855.50		S2
1,208.24	e	
200.00	X	
3.00		z
5.950		D2
6.71	Λ	
3.99		Dα
0.50	F	
.....		
.....		
8,700.00	o	
0.0270	n	
0.001550	SI	
0.10		t
1.15	A	
.....		
136,830.50		S2
1,208.28	e	
200.00	X	
2.75		z
5.936		D2
6.77	Λ	
3.99		Dα
0.50	F	
.....		
.....		
136,805.50		S2
1,208.32	e	
200.00	X	
2.50		z
5.924		D2
6.83	Λ	
4.00		Dα
0.51	F	
.....		
.....		
136,780.50		S2
1,208.36	e	
200.00	X	
2.25		z
5.911		D2
6.89	Λ	
4.01		Dα
0.51	F	
.....		
.....		
136,755.50		S2
1,208.40	e	
200.00	X	
2.00		z
5.899		D2
6.96	Λ	
4.01		Dα
0.51	F	
.....		

Down stream edge of bridge

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-27-78	RWM	3/3/78	RWCD - Reach 1
SUBJECT				SHEET 9 OF 47
Hwy 93 Bridge Selection				

With Rock

8,700.00	o
0.0270	n
0.001550	SI
0.00	t
1.15	A
. . . . .	
136,905.50	S1
1,208.17	e
200.00	X
3.00	z
5.950	D1
6.71	Λ
3.99	Da
0.50	F
Begin Transition	
Begin Rock 136,855.50	S2
1,208.24	e
200.00	X
3.00	z
5.950	D2
6.71	Λ
3.99	Da
0.50	F
. . . . .	
. . . . .	
8,700.00	o
0.0350	n
0.001550	SI
0.10	t
1.15	A
. . . . .	
136,830.50	S2
1,208.28	e
200.00	X
2.75	z
5.971	D2
6.73	Λ
3.99	Da
0.50	F
. . . . .	
. . . . .	
136,805.50	S2
1,208.32	e
200.00	X
2.50	z
5.992	D2
6.75	Λ
4.00	Da
0.50	F
. . . . .	
. . . . .	
136,780.50	S2
1,208.36	e
200.00	X
2.25	z
6.013	D2
6.77	Λ
4.01	Da
0.50	F
. . . . .	
. . . . .	
136,755.50	S2
1,208.40	e
200.00	X
2.00	z
6.032	D2
6.80	Λ
4.01	Da
0.50	F

Down stream edge of bridge

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-27-78	RM	3/3/78	RWCD - Reach 1
SUBJECT				SHEET 10 OF 47
Hwy 93 Bridge Selection				

Bridge Pier Momentum Losses

200.00 Bottom Width
8.00 No. of Piers
2.00 Side Slope

2.00 Water depth

5,682.79	I	A
6,624.99	II	A
6,134.66	III	A

3.00

4,354.17		A
4,969.90		A
4,649.59		A

3.50

4,149.28		A
4,671.85		A
4,400.06		A

4.00

4,122.60		A
4,575.37		A
4,339.93		A

4.50

4,231.74		A
4,630.28		A
4,423.08		A

5.00

4,451.45		A
4,806.65		A
4,622.02		A

6.00

5,164.50		A
5,454.83		A
5,303.97		A

I - Upstream
II - Under Bridge
III - Downstream

7.00

6,188.52		A
6,432.64		A
6,305.84		A

8.00

7,488.88		A
7,698.47		A
7,589.65		A

9.00

9,048.14		A
9,230.97		A
9,136.07		A

1.00

10,807.68		A
12,730.41		A
11,729.40		A

10.00

10,857.42		A
11,018.93		A
10,935.13		A

1.50

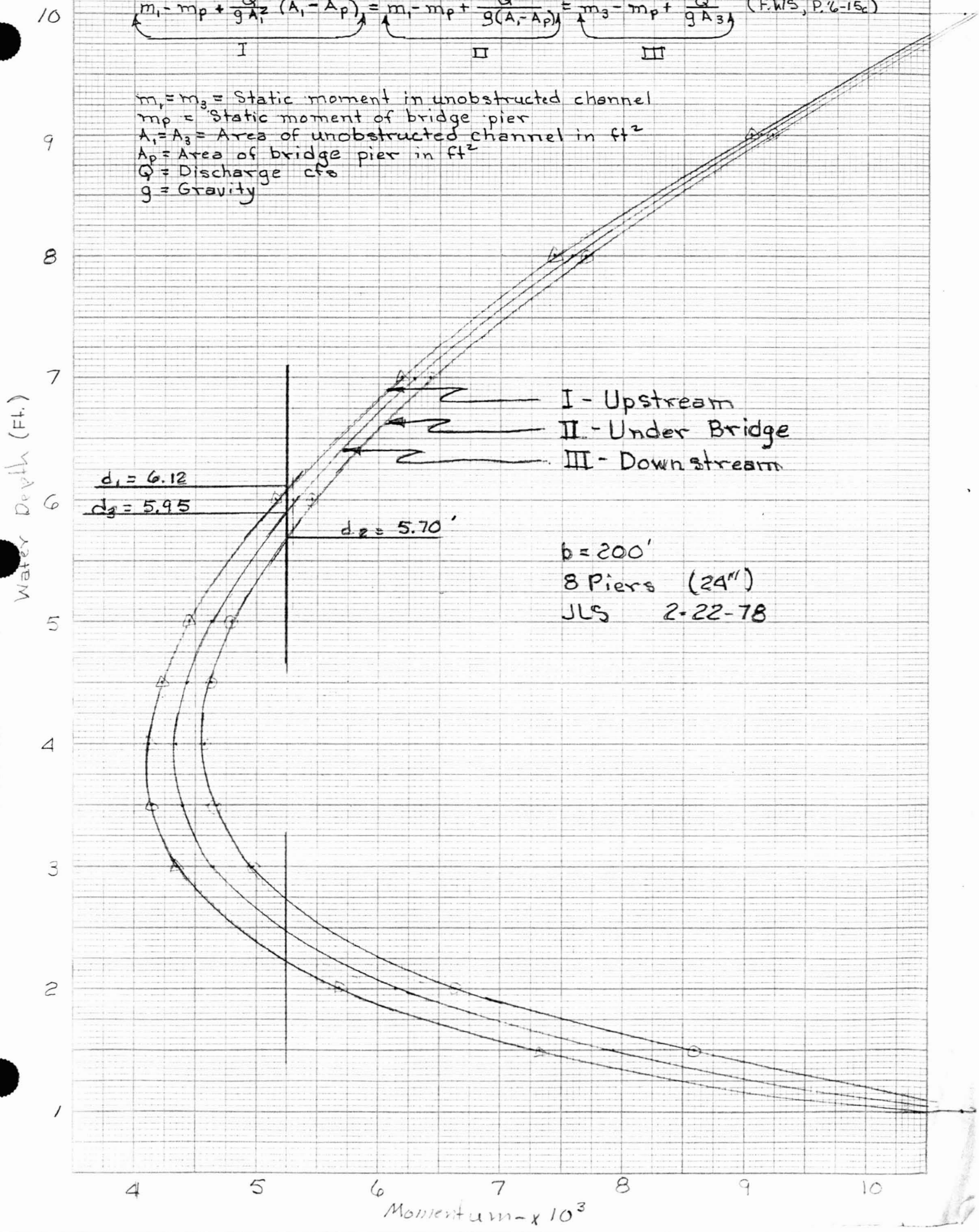
7,320.42		A
8,589.36		A
7,928.86		A

Hwy. 93 Bridge Selection

RJM 3/3/78

$$\underbrace{m_1 - m_p + \frac{Q^2}{gA_1^2}(A_1 - A_p)}_{\mathrm{I}} = \underbrace{m_1 - m_p + \frac{Q^2}{g(A_1 - A_p)}}_{\mathrm{II}} = \underbrace{m_3 - m_p + \frac{Q^2}{gA_3}}_{\mathrm{III}} \quad \text{(F.WS, P.6-15c)}$$

$m_1 = m_3$ = Static moment in unobstructed channel
m_p = Static moment of bridge pier
$A_1 = A_3$ = Area of unobstructed channel in ft^2
A_p = Area of bridge pier in ft^2
Q = Discharge cfs
g = Gravity



Using the design criteria do not need rock riprap except under Bridge V < 7 fps. Therefore will use rock between Sta. 1366+83 ⅝ & Sta. 1367+80 ⅝

(1367 rock ⅝ est)

All Flow is subcritical

```
8,700.00      o
  0.0270      n
0.001550      SI

  0.10          t
  1.15        A
.................
136,805.50        S1
1,208.32      e

  200.00      X
    2.50        Z
    5.924       D1
    6.83      Λ
    4.00        Dα
    0.51      F

136,780.50        S2
1,208.35      e

  200.00      X
    2.25        Z
    5.911       D2
    6.89      Λ
    4.01        Dα
    0.51      F
.................
```

```
.................
8,700.00      o
Changed n → 0.0350      n
for riprap 0.001550     SI

  0.10          t
  1.15        A
.................
136,755.50        S2
1,208.39      e

  200.00      X
    2.00        Z
    5.936       D2
    6.91      Λ
    4.01        Dα
    0.51      F
.................
.................
```

Close to d3 sht 11 ok

Depth of flow under bridge ≈ 5.70' (see sht 11)

Depth of flow above bridge ≈ 6.12

Head loss ≈ 6.12 - 5.94 = 0.08'

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY JLS	DATE 2-27-78	CHECKED BY PJM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy. 93 Bridge Selection				SHEET 13 OF 47

Min elev of bridge = 1208.44 + 6.12 + 1.0 + 1.46

= 1217.02 (This is the elev. of the existing road)

HEC No. 14
Fig II-C-1
P. II-9

D_{50} rock size = V ≈ 7 fps, 0.3' use 0.5'

Max rock size = 12"

Depth of riprap = 1.0' of rock + 0.5' of filter = 1.5'

1100.00/L.F

Cost

Bridge

200
10
50
260

Letter to the Files (9)

Length of bridge 260'

unit cost = $1100.00/L.F

Bridge Cost = 1100.00 x 260 = $286,000.00

Riprap

$$V = (9.7)\left[(200)(1.5) + (1.5)\left(\sqrt{14^2+7^2}\right)(2)\right]/27 = 1247 \text{ yd}^3$$

(3.47)

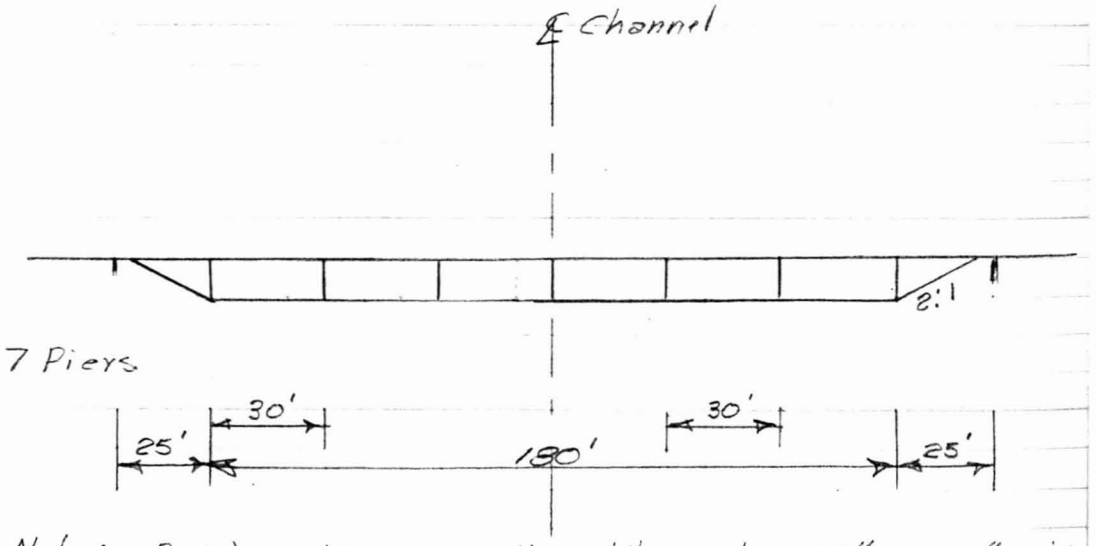
going price of riprap for this area is approx $20.00

Cost of riprap = 1247 yd³ x $20.00/yd³ = $24,940.00

Total Cost of Installation = 286,000 + 24,940 = $310,940.00

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-17-78	RM	3/3/78	RWCD - Reach 1
SUBJECT				SHEET 14 OF 47
Hwy 93 Bridge Selection				

Proposal No. 2



Note: Bridge piers will either be 14" or 16" wide
Use 24" to allow for debris.

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-17-78	RJM	3/3/78	RWCD- Reach 1
SUBJECT				SHEET 15 OF 47
Hwy 93 Bridge Selection				

Begin @ Sta 1368+50 – Elev. 1208.22
S = 0.00155
d_n = 5.95'
Q = 8700

b = 200'
z = 3
n = 0.027

Downstream Transition

1368+05 ℄ (End Transition)

b = 200'
z = 3
n = 0.027

n = 0.035 K = 0.1

1367+80 ℄

b = 190
z = 2.5
n = 0.035

Bridge

1367+55 ℄ Bridge

b = 180
z = 2
n = 0.035

K = 0.0

Upstream Transition

1367+08 ℄ Bridge

b = 180
z = 2
n = 0.035

K = 0.2

1366+83 ℄

b = 190
z = 2.5
n = 0.035

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY JLS	DATE 2-17-78	CHECKED BY KM	DATE 3/3/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 16 OF 47

1366 + 58 ⁵ (Begin Transition)

b = 200'
z = 3
n = 0.035

n = 0.027 k = 0.0

1366 + 08 ⁵

b = 200'
z = 3
n = 0.035

5.75

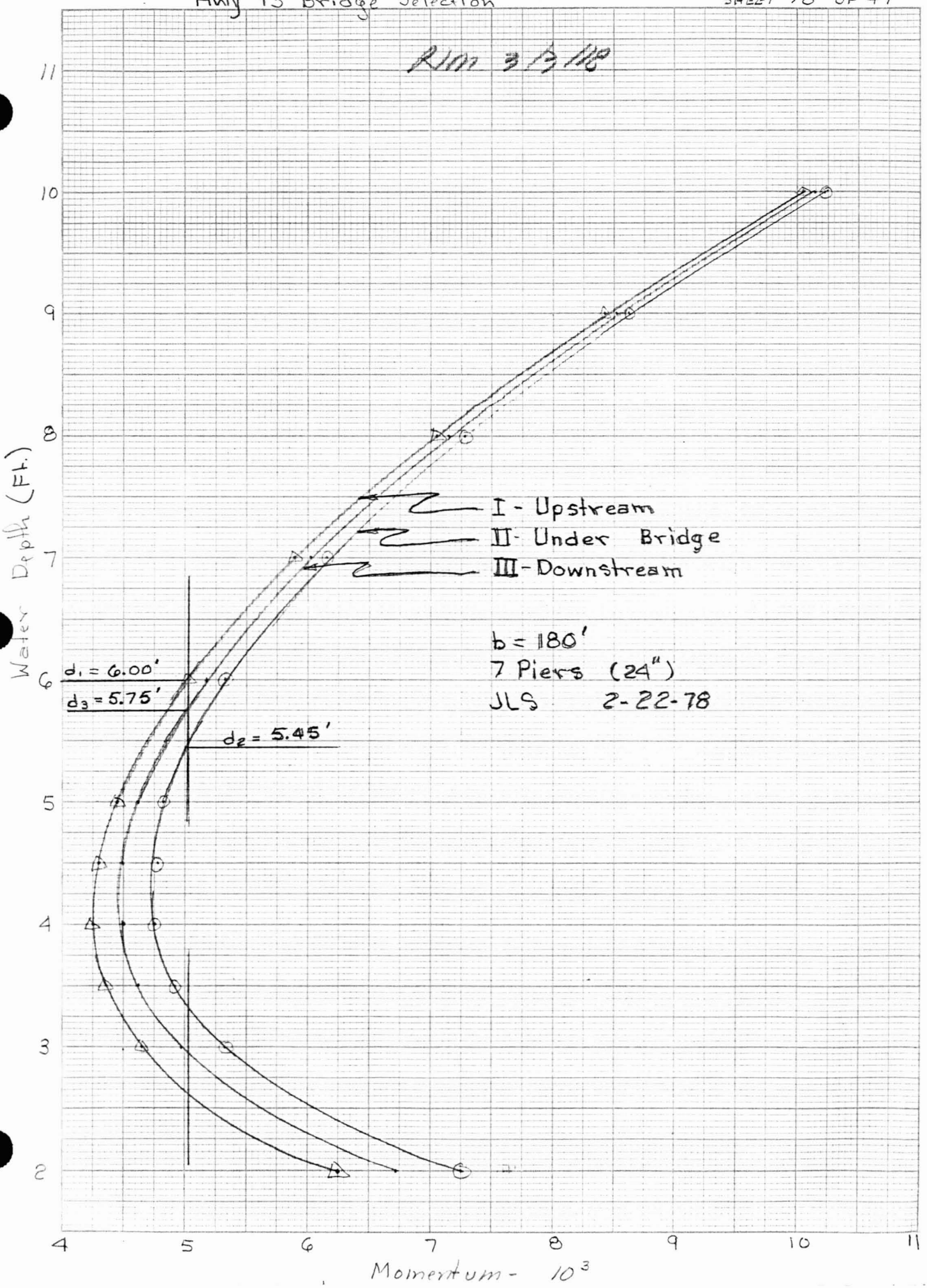
8,700.00	o	8,700.00	o
0.0270	n	0.0350	n
0.001550	SI	0.001550	SI
0.00	t	0.10	t
1.15	A	1.15	A
136,850.00	S1	136,780.50	S2
1,208.22	e	1,208.32	e
200.00	X	190.00	X
3.00	z	2.50	z
5.950	D1	5.860	D2
6.71	Λ	7.25	Λ
3.99	DΔ	4.13	DΔ
0.50	F	0.54	F
136,805.50	S2	136,755.50	S2
1,208.28	e	1,208.36	e
200.00	X	180.00	X
3.00	z	2.00	z
5.950	D2	5.747	D2
6.71	Λ	7.90	Λ
3.99	DΔ	4.30	DΔ
0.50	F	0.59	F

STATE	PROJECT		
Arizona	Williams - Chandler WPP		
BY JLS	DATE 2-27-78	CHECKED BY 3/3/78	DATE	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 17 OF 47

Bridge Pier Momentum Losses

180.00	Bottom Width		6.00	
7.00	No. of Piers		5,023.69	A
2.00	Z		5,332.96	A
			5,172.47	A
2.00	Water depth			
6,238.88	I	A	7.00	
7,250.92	II	A	5,901.70	A
6,724.89	III	A	6,161.24	A
			6,026.61	A
3.00			8.00	
4,660.51		A	7,045.37	A
5,320.47		A	7,267.77	A
4,977.58		A	7,152.45	A
4.00			9.00	
4,263.72		A	8,434.82	A
4,748.00		A	8,628.46	A
4,496.49		A	8,528.09	A
5.00			10.00	
4,450.35		A	10,059.71	A
4,829.49		A	10,230.44	A
4,632.67		A	10,141.98	A
3.50			11.00	
4,367.93		A	11,914.90	A
4,927.45		A	12,067.00	A
4,636.81		A	11,988.22	A
4.50			12.00	
4,300.58		A	13,998.32	A
4,726.42		A	14,134.97	A
4,505.31		A	14,064.22	A

Hwy 93 Bridge Selection



STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY JLS	DATE 2-27-78	CHECKED BY RM	DATE 5/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 19 OF 47

From 50' Upstream of bridge to 50' downstream

Use Rock Riprap between Sta. 1366+58.5 and Sta 1368+05.5 (147')

All flow is subcritical $V \approx 8$ fps $F \approx 0.60$

Depth of flow under the bridge $\approx 5.45'$

Depth of flow above the bridge ≈ 6.0

Min Bridge Deck Elev. = 1208.44 + 6.00 + 1.00 + 1.46

= 1216.90 < 1217.0 ∴ do not need to raise bridge

HEC No. 14 P. II-9

D_{50} rock size - $V \approx 8$ fps = 0.45' use 0.5'

Max. rock dia. - use 1.0'

Thickness of riprap = 1.0' + 0.5' filter = 1.5'

Cost

180
50
230

Length of bridge use 230'

Unit cost = $1100.00 / L.F.

Cost of Bridge = 1100 × 230 = $253,000

Rock riprap

$$V = \left[\left(\frac{200+180}{2}\right) \times 1.5 + \left(1.5 \times \sqrt{(7.5)^2 + (7)^2} \times 2\right)\right](50)/27\ (2)$$

= 1266

STATE		PROJECT		
Arizona		Williams- Chandler WPP		
BY JLS	DATE 2-27-78	CHECKED BY RM	DATE 3/3/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 20 OF 47

$V = (47)[(180)(1.5) + (1.5)(\sqrt{14^2+7^2})(2)]/27$

$= 552$

$V_{Total} = 1266 + 552 = 1818\ yd^3$

Cost of riprap $= 1818 \times 20^{00} = \$36,360^{00}$

Decrease in channel Excavation

200' Wide bottom Use 6.0' of excavation

E.A. @ 1368+05$^{\underline{S}}$ = $[(200)(6) + (3)(6)^2]$ = 1308 ft^2

E.A. @ 1367+80$^{\underline{S}}$ = = 1308 ft^2

E.A. @ 1367+55$^{\underline{S}}$ = $[(200)(6) + (2)(6)^2]$ = 1272 ft^2

E.A. @ 1367+08$^{\underline{S}}$ = = 1272 ft^2
E.A @ 1366+83$^{\underline{S}}$ 1308 ft^2
E.A. @ 1366+58$^{\underline{S}}$ = 1308 ft^2

$V = (1308+1308)(25)/54 + (1308+1272)(25)/54$
$+ (1272+1272)(47)/54 + (1272+1308)(25)/54$
$+ (1308+1308)(25)/54$

$= 7,025\ yd^3$

180' Wide bottom - Use 6.0' of excavation

E.A. @ 1368+05$^{\underline{S}}$ = 1308 ft^2

E.A. @ 1367+55$^{\underline{S}}$ = $[(180)(6) + (2)(6)^2]$ = 1152 ft^2

E.A. @ 1367+08$^{\underline{S}}$ = = 1152 ft^2

E.A. @ 1366+58$^{\underline{S}}$ = = 1308 ft^2

STATE		PROJECT		
Arizona		Williams- Chandler WPP		
BY JLS	DATE 2-27-78	CHECKED BY RM	DATE 3/2/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 21 OF 47

$V = [(1308+1152)(50) + (1152+1152)(47) + (1152+1308)(50)] / 54$

$= 6560 \text{ yd}^3$

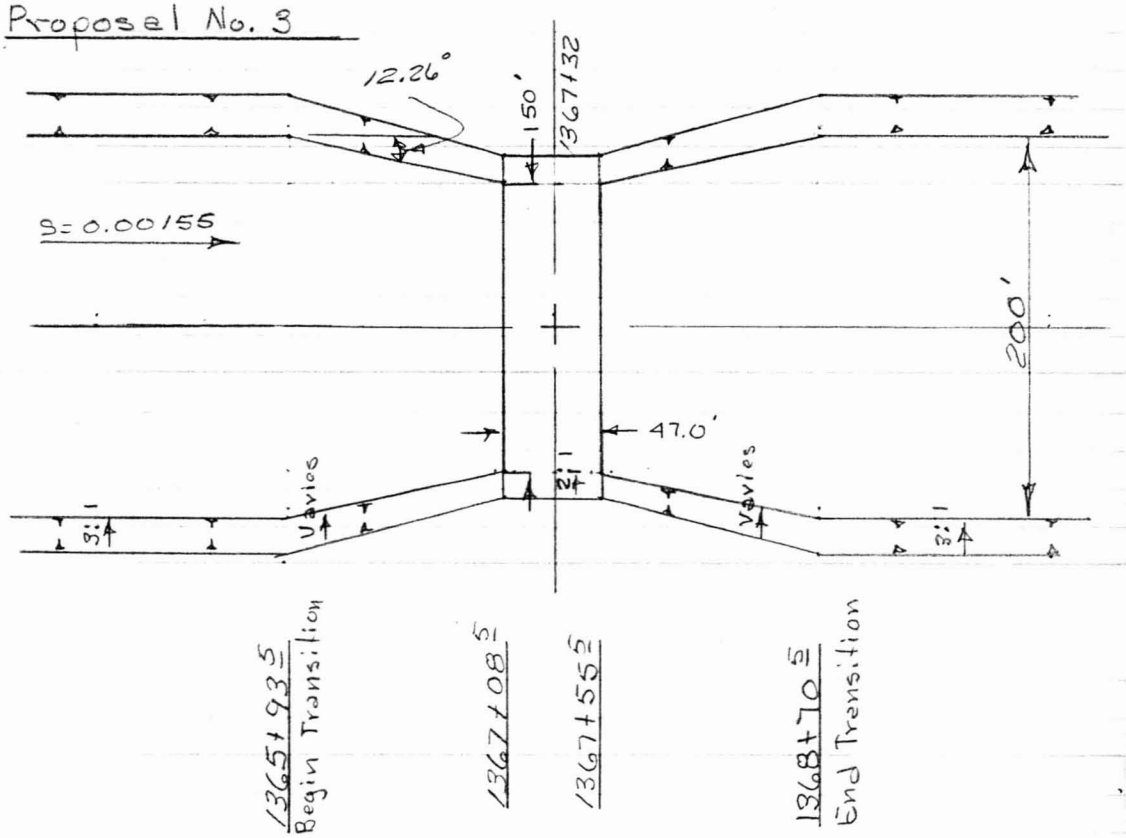
Unit cost use \$0.60

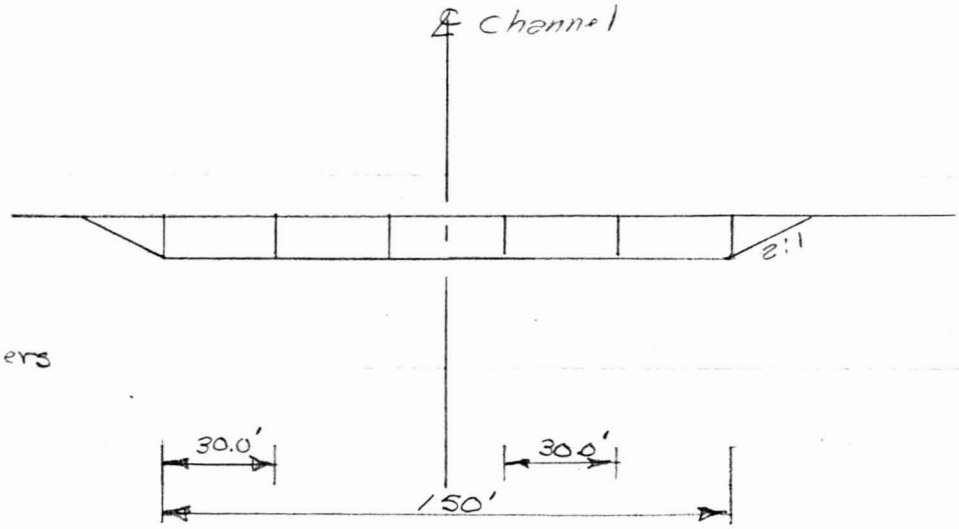
Decrease $= (7025 - 6560)(0.60) = \$279^{00}$ use $\$280^{00}$

Total Cost $= 253{,}000 + 36{,}360 - 280 = \underline{\underline{\$289{,}080^{00}}}$

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-17-78			RWCD - Reach 1
SUBJECT				SHEET 22 OF 47
Hwy 93 Bridge Selection				

Proposal No. 3





6 Piers

Note: The bridge piers will be either 14" or 16" wide. Use 24" to allow for debris

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY JLS	DATE 2-17-78	CHECKED BY KM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 23 OF 47

Begin @ Sta. 1369+20 $^{\underline{S}}$ - Elev. 1208.11
S = 0.00155
d_n = 5.95'
Q = 8700

b = 200'
z = 3
n = 0.027

Downstream Transition

1368+70 $^{\underline{S}}$ (End Transition)

b = 200
z = 3
n = 0.027

Flag n = 0.035 k = 0.1

1368+13

b = 175
z = 2.5
n = 0.035

Bridge

1367+55 $^{\underline{S}}$

b = 150
z = 2
n = 0.035

Flag K = 0.0

Transition

1367+08 $^{\underline{S}}$

b = 150
z = 2
n = 0.035

Flag K = 0.2

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY JLS	DATE 2-23-78	CHECKED BY RJM	DATE 3/3/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 24 OF 47

Upstream

1366 + 51

b = 175
z = 2.5
n = 0.035

1365+93.5 (Begin Transition)

b = 200
z = 3
n = 0.035 (0.027)

Flag n = 0.027 k = 0.0

1365+43.5

b = 200
z = 3
n = 0.027

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-27-78	RM	3/3/78	RWCD - Reach 1
SUBJECT				SHEET 25 OF 47
Hwy 93 Bridge Selection				

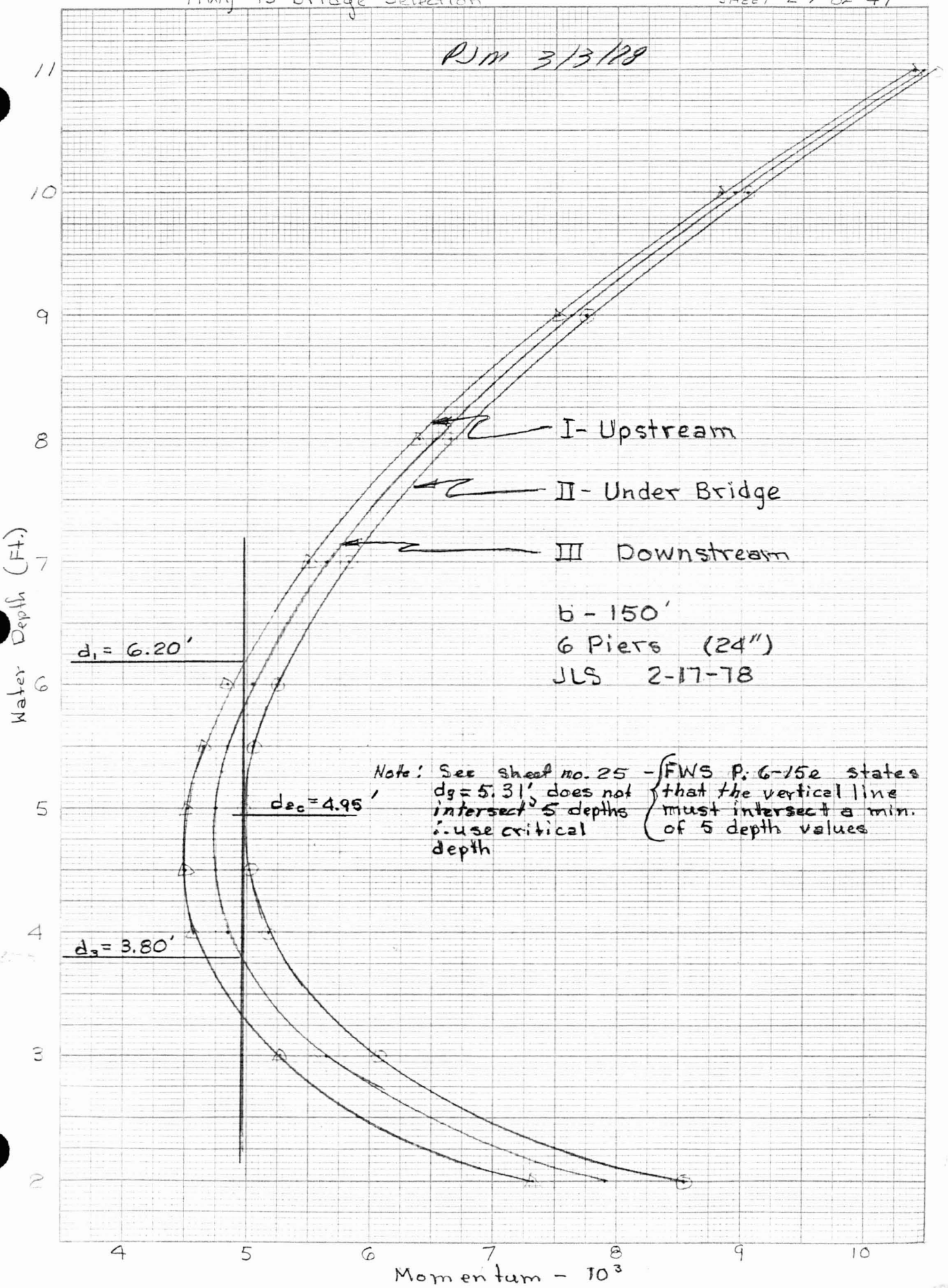
8,700.00	o
0.0270	n
0.001550	SI
0.00	t
1.15	A
.....	
136,920.50	/
1,208.11	e
200.00	X
3.00	z
5.950	D1
6.71	Λ
3.99	Dα
0.50	F
136,870.50	S2
1,208.18	e
200.00	X
3.00	z
5.950	D2
6.71	Λ
3.99	Dα
0.50	F
.....	
.....	
8,700.00	o
0.0350	n
0.001550	SI
0.10	t
1.15	A
.....	
.....	
136,813.00	S2
1,208.27	e
175.00	X
2.50	z
5.738	D2
8.00	Λ
4.36	Dα
0.61	F
.....	
.....	
136,755.50	S2
1,208.36	e
150.00	X
2.00	z
5.305	D2
10.20	Λ
4.82	Dα
0.80	F
.....	
.....	
8,700.00	o
0.0350	n
0.001550	SI
0.00	t
1.15	A
.....	
136,708.50	S2
1,208.43	e
150.00	X
2.00	z
5.870	D2
9.16	Λ
4.82	Dα
0.69	F
.....	

See sht. 27 – Criteria instructs that vert line has to intersect 5 depth. ∴ use critical depth

STATE	PROJECT		
Arizona	Williams - Chandler WPP		
BY JLS	DATE 2-27-78	CHECKED BY RJM	DATE 3/3/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection			SHEET 26 OF 47

Bridge Pier Momentum Losses

150.00	Bottom width	
6.00	No. Piers	
2.00	z	
2.00	Water depth	
7,318.53	I	A
8,558.17	II	A
7,913.22	III	A
3.00		
5,275.33		A
6,080.25		A
5,661.69		A
4.00		
4,583.52		A
5,171.70		A
4,866.00		A
4.50		
4,495.34		A
5,011.47		A
4,743.28		A
5.00		
4,526.24		A
4,984.85		A
4,746.61		A
5.50		
4,654.88		A
5,066.53		A
4,852.74		A
6.00		
4,867.20		A
5,239.80		A
5,046.33		A
7.00		
5,507.42		A
5,818.90		A
5,657.25		A
8.00		
6,399.42		A
6,665.31		A
6,527.38		A
9.00		
7,518.60		A
7,749.23		A
7,629.64		A
10.00		
8,851.78		A
9,054.40		A
8,949.38		A
11.00		
10,392.05		A
10,571.91		A
10,478.73		A
12.00		
12,136.14		A
12,297.17		A
12,213.78		A


PJM 3/13/78
I - Upstream
II - Under Bridge
III Downstream
b - 150'
6 Piers (24")
JLS 2-17-78
d_1 = 6.20'
d_{c_0} = 4.95'
d_3 = 3.80'
Note: See sheet no. 25 - d_3 = 5.31', does not intersect 5 depths ∴ use critical depth
FWS P. 6-15e states that the vertical line must intersect a min. of 5 depth values
Water Depth (Ft.)
Momentum - 10^3
11
10
9
8
7
6
5
4
3
2
4
5
6
7
8
9
10

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-28-78	RJM	3/7/78	RWCD
SUBJECT				SHEET 28 OF 47
Hwy 93 Bridge Selection				

	8,700.00	o
	0.0350	n
	0.001550	SI
	0.20	t
	1.15	A
	.....	
	136,755.50	S1
	1,208.36	e
	150.00	X
	2.00	z
1212.16	3.800	D1
	14.52	Λ
	4.82	Da
	1.34	F
	136,761.25	S2
	1,208.35	e
	152.50	X
	2.05	z
1212.17	3.816	D2
	14.21	Λ
	4.77	Da
	1.31	F
	.....	
	.....	
	136,767.00	S2
	1,208.34	e
	155.00	X
	2.10	z
	3.836	D2
1212.18	13.90	Λ
	4.72	Da
	1.28	F
	.....	
	136,772.75	S2
	1,208.33	e
	157.50	X
1212.19	2.15	z
	3.858	D2
	13.60	Λ
	4.67	Da
	1.25	F
	.....	
	.....	
	136,778.50	S2
	1,208.32	e
	160.00	X
	2.20	z
	3.883	D2
1212.20	13.29	Λ
	4.62	Da
	1.21	F
	.....	
	.....	
	136,784.25	S2
	1,208.31	e
	162.50	X
	2.25	z
	3.912	D2
1212.22	12.97	Λ
	4.57	Da
	1.18	F
	.....	
	.....	
	136,790.00	S2
	1,208.30	e
	165.00	X
	2.30	z
1212.25	3.947	D2
	12.65	Λ
	4.53	Da
	1.15	F

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 2-28-78	CHECKED BY RM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 29 OF 30

	136,795.75		S2		136,801.50		S2
	1,208.29	e			1,208.28	e	
	167.50	X			170.00	X	
	2.35		Z		2.40		Z
1212.28	3.991		D2	1212.34	4.056		D2
	12.32	Λ			11.93	Λ	
	4.48		DU		4.44		DU
	1.11	F			1.07	F	

1367+08 ≦ Elev. of upstream W.S. 1208.44 + 6.2 = 1214.64

Top of bridge deck = 1214.6 + 1.0 + 1.5 ≈ 1217.1*

*This is very close to the existing road elev. ∴ do not need to raise the bridge above the existing road elev.

Flow is supercritical as it leaves the bridge
F = 1.34

Hydraulic Jump

HEC No. 14 P. VI-1 Design of Small Dams, P. 396

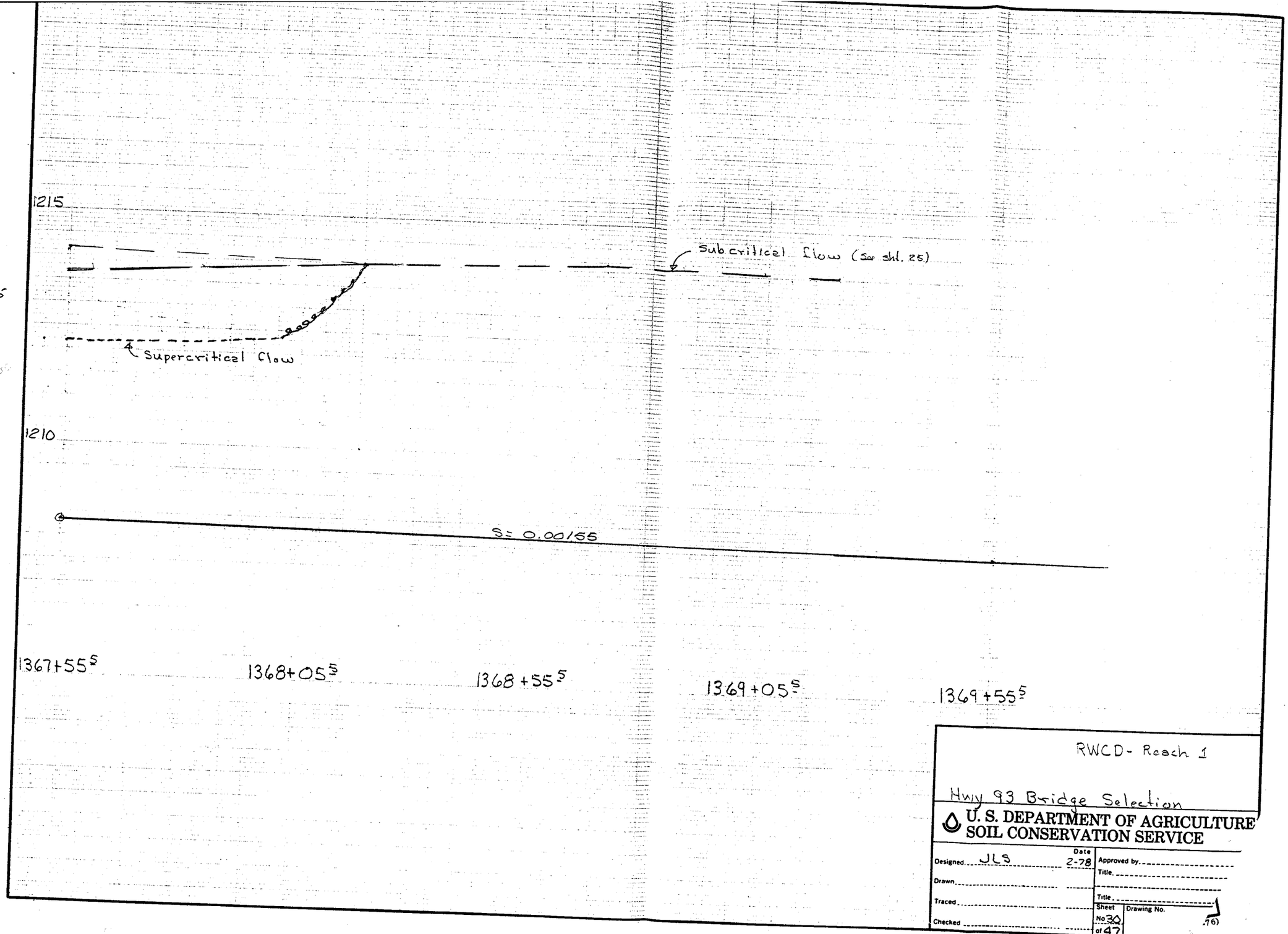
For Froude numbers greater than 1.0, but less than 1.7, the change from supercritical to subcritical flow will result in only a slight disturbance of the water surface.

Distance required to complete the Jump

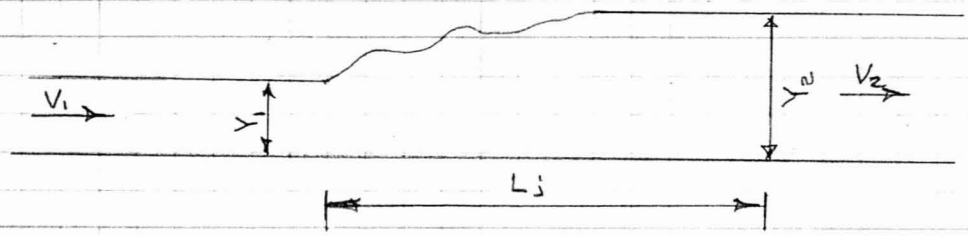
HEC No. 14 P. VI-8

$t = b/2Y_1 \quad 150/(2)(3.8) = 19.74$

$F_{r_1} = 1.34$


1215
V=11.35
Subcritical flow (See shl. 25)
Supercritical flow
1210
S= 0.00155
1367+55S
1368+05S
1368+55S
1369+05S
1369+55S
RWCD- Reach 1
Hwy 93 Bridge Selection
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed JLS
Date 2-78
Drawn
Traced
Checked
Approved by
Title
Title
Sheet No 30 of 47
Drawing No.
SCS-ENG-316

STATE		PROJECT		
Arizona		Williams - Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	2-28-78	RM	3/3/78	RWCD - Reach I
SUBJECT				SHEET 31 OF 47
Hwy 93 Bridge Selection				



HEC No. 14 P. VI-22

$J = Y_2/Y_1 \approx 1.5$ then $Y_2 \approx (1.5)(3.8) \approx 5.70'$

HEC No. 14 P. VI-25

L_j/Y_1 is between 13 & 17

∴ L_j would be between 50' & 65'
Which is between 1368+05± & 1368+20±

This is well within the riprap section ∴ ok

The sequent depth @ 1368+13 (5.73') matches Y_2
∴ would be in this area.

HEC No 14 P. II-9

D_{50} for 14.5 fps = 1.4' < 1.5 ∴ 18" dia. ok

HEC No. 11 P. 11-21

D_{100} = 30" dia

Thickness of riprap use 36"

STATE	PROJECT			
Arizona	Williams - Chandler WPP			
BY JLS	DATE 2-28-78	CHECKED BY RJM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 32 OF 47

7 x 2
150
50
200

Cost

Bridge

Length of bridge - Use 200'

Unit Cost - 1100.00/L.F

Cost of bridge - 1100 x 200 $220,000.00

Riprap

6870.5
6755.5
115

Riprap between Sta 1366+58.5 (50' upstream of the bridge) to Sta. 1368+70.5

$V_1 = 115[(175)(3) + (3)(\sqrt{(7)^2+(17.5)^2})(2)]/27 = 2718 \text{ yd}^3$

$V_2 = 47[(150)(3) + (3)(\sqrt{(7)^2+(19^2)})(2)]/27 = 947$

2.28 = 2 ove

$V_3 = 50[(161)(3) + (3)(\sqrt{(7)^2+(15.5)^2})(2)]/27 = 1084$

4749 yd^3

Unit cost - use $20.00/yd^3

Cost = (20)(4750) $95,000.00

65

Channel Excavation

Compared to the 200' wide channel (6.0')

See sh 20

$V_{200} = 7025 \text{ yd}^3 + [(2616 \times 130)/54] = 13,323 \text{ yd}^3$

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 2-28-78	CHECKED BY RM	DATE 3/13/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 33 OF 47

Volume 150' bottom

E.A@ 1368+70$^{\underline{S}}$ — 1308 ft^2

EA@ 1367+55$^{\underline{S}}$ = $[(150)(6) + (2)(6)^2]$ — 972 ft^2

EA@ 1367+08$^{\underline{S}}$ — 972 ft^2

EA@ 1365+93$^{\underline{S}}$ — 1308 ft^2

$V_{150} = (1308+972)(230) + (972+972)(47)/54 = 11{,}403$ yd^3

Difference in yardage = 13,323 - 11,403

= 1,920 yd^3 less

Unit cost - use \$0.60

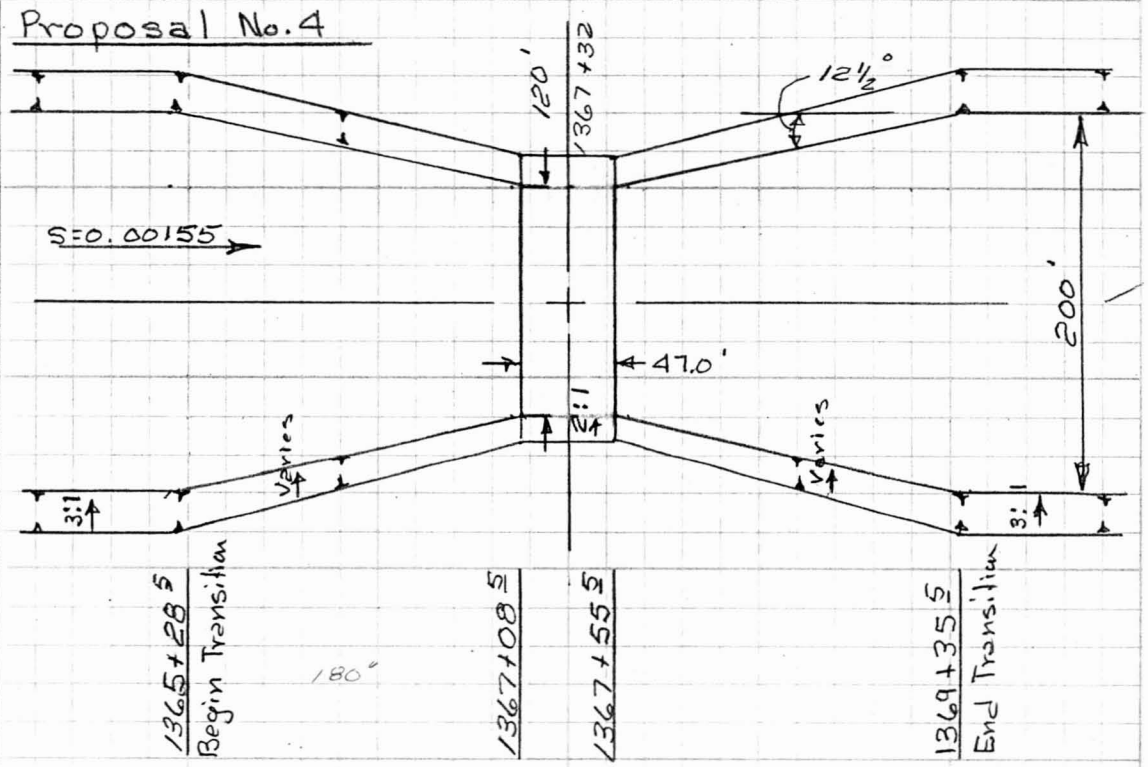
Decrease in cost = 1920 x 0.60 = \$1152.00

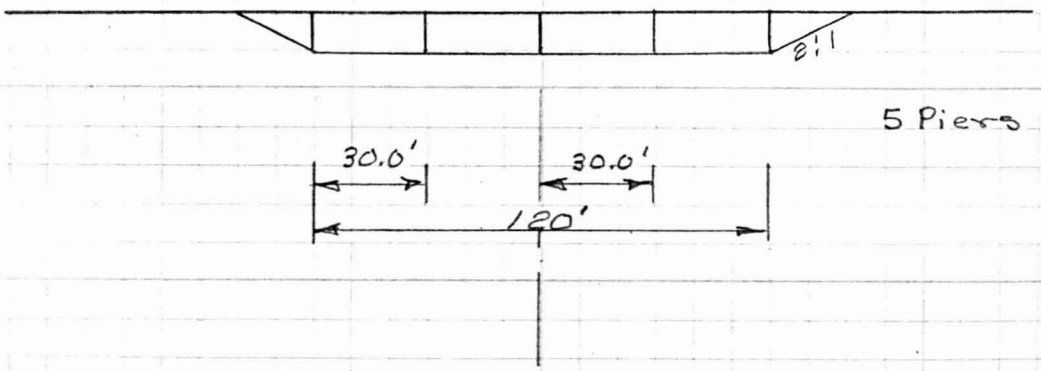
Total installation cost

220,000 + 95,000 + 1152 = \$313,848.00

STATE	PROJECT		
Arizona	Williams - Chandler WPP		
BY JLS / DATE 2-23-78	CHECKED BY RM	DATE 3/3/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection			SHEET 34 OF 47

Proposal No. 4





5 Piers

Note: The bridge piers will ether be 14" or 16" wide, but, will use 24" to allow for debris

STATE		PROJECT		
Arizona		Williams-Chandler WPP		
BY JLS	DATE 2-23-78	CHECKED BY RM	DATE 3/13/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 35 OF 47

Begin @ 1369+85^{S} - Elev. 1208.1
S = 0.00155
d_n = 5.95
Q = 8700

b = 200
z = 3
n = 0.00155

1369 +35^{S} (End Transition)

b = 200
z = 3
n = 0.027 (0.035)
Flag n = 0.035 K = 0.1

1368+75^{S}

b = 173.3
z = 2.67
n = 0.035

Downstream Transition

1368+15^{S}

b = 146.67
z = 2.33
n = 0.035

1367 +55^{S}

b = 120
z = 2
n = 0.035

Bridge

Flag K = 0.0

1367+08^{S}

b = 120
z = 2
n = 0.035

Flag K = 0.2

STATE		PROJECT		
Arizona		William-Chandler WPP		
BY JLS	DATE 3-1-78	CHECKED BY RM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 36 OF 47

	8,700.00	o
	0.0270	n
	0.001550	SI
	0.00	t
	1.15	A
	.....	
	136,985.50	S1
	1,208.01	e
	200.00	X
	3.00	z
1213.45	5.950	D1
	6.71	Λ
	3.99	Dα
	0.50	F
	136,935.50	S2
	1,208.08	e
	200.00	X
1214.05	3.00	z
	5.950	D2
	6.71	Λ
	3.99	Dα
	0.50	F
	.....	
	.....	
	8,700.00	o
	0.0350	n
	0.001550	SI
	0.10	t
	1.15	A
	.....	
	.....	
	136,915.50	S2
	1,208.11	e
	191.10	X
1214.0	2.89	z
	5.888	D2
	7.09	Λ
	4.11	Dα
	0.53	F
	.....	
	.....	
	136,895.50	S2
	1,208.14	e
	182.20	X
1213.95	2.78	z
	5.817	D2
	7.53	Λ
	4.24	Dα
	0.57	F
	.....	
	.....	
	136,875.50	S2
	1,208.18	e
	173.30	X
1213.9	2.67	z
	5.732	D2
	8.04	Λ
	4.38	Dα
	0.61	F
	.....	
	.....	
	136,855.50	S2
	1,208.21	e
	164.40	X
1213.85	2.56	z
	5.625	D2
	8.64	Λ
	4.53	Dα
	0.66	F
	.....	

STATE	PROJECT		
Arizona	Williams - Chandler WPP		
BY JLS	DATE 3-1-78	CHECKED BY RM	DATE 3/2/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 37 OF 47

```
.................
136,835.50          S2
1,208.24      e

155.60          X
2.44              Z
5.482             D2
9.39          ^
4.69              Da
0.73            F
.................
.................
136,815.50          S2
1,208.27      e

146.70          X
2.33              Z
5.254             D2
10.41         ^
4.87              Da
0.83            F
.................
.................
136,810.50          S2
1,208.28      e

144.40          X
2.31              Z
5.159             D2
10.78         ^
4.92              Da
0.86            F
.................
```

1213.7

1213.6

1213.4

```
.................
136,805.50          S2
1,208.28      e

142.20          X
2.28              Z
5.022             D2
11.27         ^
4.97              Da
0.91            F
.................
.................
136,803.00          S2
1,208.29      e

141.10          X
2.26              Z
OVERFLOW
5.00              Da
.................
```

1213.3

Flow becomes critical in this reach

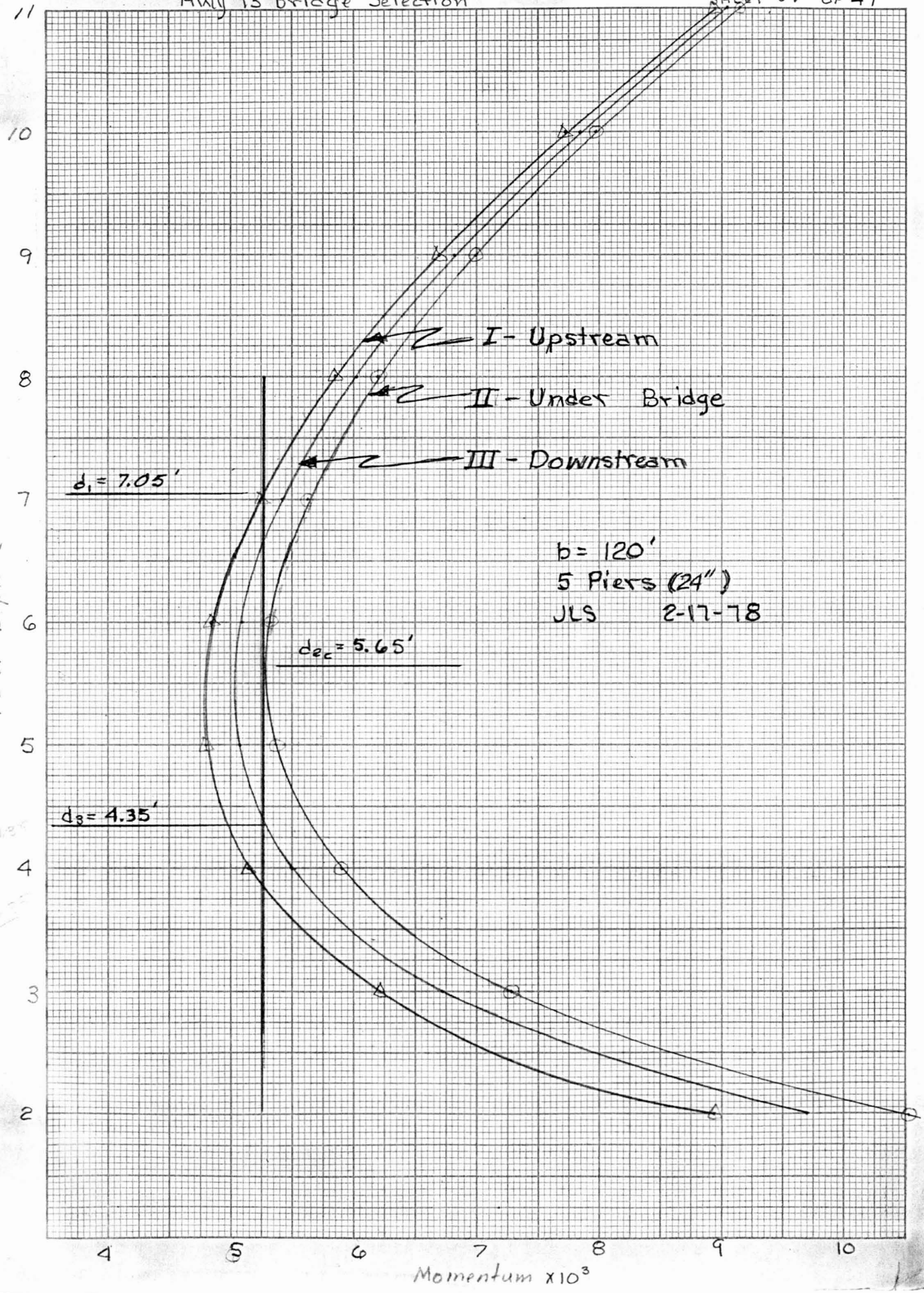
Note: Flow will be super-critical downstream of bridge

STATE		PROJECT		
Arizona		Williams- Chandler WPP		
BY	DATE	CHECKED BY	DATE	JOB NO.
JLS	3-1-78	RM	3/3/78	RWCD- Reach 1
SUBJECT				SHEET 38 OF 47
Hwy 93 Bridge Selection				

Bridge Pier Momentum Losses

120.00	Bottom Width	
5.00	No. of Piers	
2.00	E	
2.00	d	
8,939.26	I	A
10,535.08	II	A
9,703.64	III	A
3.00		
6,238.04		A
7,267.66		A
6,731.57		A
4.00		
5,155.05		A
5,902.80		A
5,513.72		A
5.00		
4,796.49		A
5,376.04		A
5,074.67		A
6.00		
4,867.11		A
5,335.23		A
5,091.96		A
7.00		
5,242.64		A
5,631.76		A
5,429.66		A
8.00		
5,862.97		A
6,193.30		A
6,021.83		A
9.00		
6,696.46		A
6,981.47		A
6,833.61		A
10.00		
7,725.75		A
7,974.84		A
7,845.68		A
11.00		
8,941.24		A
9,161.22		A
9,047.21		A
12.00		
10,337.83		A
10,533.83		A
10,432.31		A

Hwy 93 Bridge Selection



K+E 10 X 10 TO THE ½ INCH 359-11 KEUFFEL & ESSER CO. MADE IN U.S.A.

COMPUTATION SHEET
SCS–ENG–523 Rev. 8–69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE	PROJECT		
Arizona	Williams - Chandler WPP		
BY JLS	DATE 3-1-78	CHECKED BY RDM	DATE 3/2/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection			SHEET 40 OF 47

8,700.00 o
0.0350 n
0.001550 SI

0.20 t
1.15 A

136,755.50 S1
1,208.36 e

120.00 X
12/2.7 2.00 z
4.350 D1
Velocity is more than the 15 fps. but will use riprap to evaluate 15.54 Λ
5.54 Da
1.35 F

136,760.50 S2
1,208.35 e

122.20 X
2.03 z
12/2.7 4.312 D2
15.40 Λ
5.48 Da
1.35 F

136,765.50 S2
1,208.34 e

124.40 X
2.06 z
12/2.6 4.278 D2
15.26 Λ
5.42 Da
1.34 F

136,775.50 S2
1,208.32 e

128.90 X
2.11 z
12/2.66 4.218 D2
14.96 Λ
5.30 Da
1.32 F

136,785.50 S2
1,208.31 e

133.30 X
2.17 z
12/2.5 4.175 D2
14.63 Λ
5.18 Da
1.30 F

136,795.50 S2
1,208.29 e

137.80 X
12/2.4 2.22 z
4.140 D2
14.29 Λ
5.07 Da
1.27 F

136,805.50 S2
1,208.28 e

142.20 X
2.28 z
12/2.4 4.120 D2
13.92 Λ
4.97 Da
1.24 F

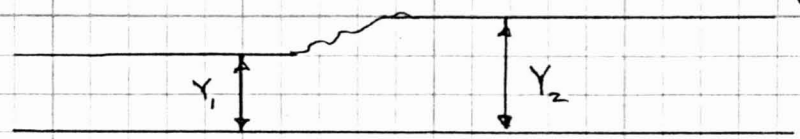
STATE	PROJECT		
Arizona	Williams - Chandler WPP		
BY JLS	DATE 3-1-78	CHECKED BY RM	DATE 3/3/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection			SHEET 41 OF 47

	136,810.50		S2
	1,208.27	e	
	144.40		X
	2.31		Z
1212.4	4.114		D
	13.74	Λ	
	4.92		DU
	1.23		F
	136,815.50		S2
	1,208.26	e	
1212.4	146.70		X
	2.33		Z
Jump	4.105		D2
begins	13.56	Λ	
	4.87		DU
	1.21		F

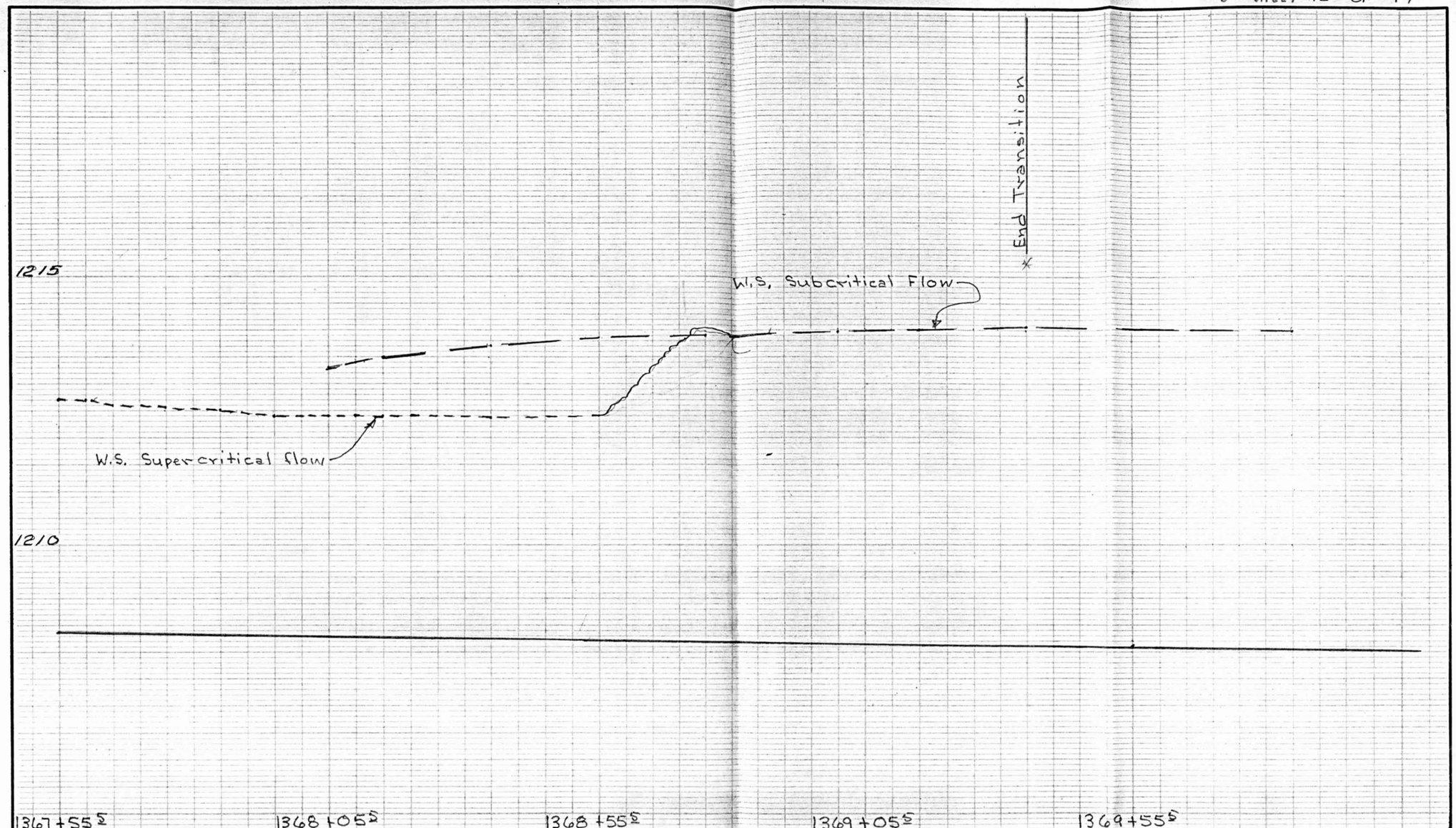
	136,835.50		S2
	1,208.23	e	
	155.60		X
	2.44		Z
1212.35	4.109		D2
	12.78	Λ	
	4.69		DU
	1.14		F
	136,855.50		S2
	1,208.20	e	
	164.40		X
1212.4	2.56		Z
	4.186		D2
	11.86	Λ	
	4.53		DU
	1.05		F

Sta. 1367+08.5 Elev. of upstream W.S. = 1208.44 + 7.05 ≈ 1215.5

Top of bridge Deck = 1215.5 + 2.5 = 1218.0 ± (Would need to raise deck elev. 1.0' min above existing road)



F = 1.21 where transition between super-critical flow & subcritical flow begins.



RWCD - Reach 1
Hwy 93 Bridge Selection

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed JLS	Date 3-78	Approved by	
Drawn		Title	
Traced		Title	
Checked		Sheet No. 42 of 47	Drawing No.

SCS-ENG-316A (Rev. 1-76)

STATE Arizona		PROJECT Williams - Chandler WPP		
BY JLS	DATE 3-1-78	CHECKED BY RM	DATE 3/13/78	JOB NO. RWCD - Reach 1
SUBJECT Hwy 93 Bridge Selection				SHEET 43 OF 47

HEC No. 14 P. VI-22

Hydraulic Jump

Distance required to complete the transition between super & sub-critical flows.

HEC No 14 P. VI-8

$t = b/2Y_1 = 146.7/(2.3)(4.11) \approx 15.6$

HEC No. 14 P. VI-22

$J = Y_2/Y_1 \approx 1.4$ then $Y_2 \approx (4.11)(1.4) \approx 5.75'$

HEC No. 14 P. VI-25

L_j/Y_1 is between 13 & 18

∴ Length of Jump - L_j would between 53' & 74'.
This would be between Sta. 1368+15± & Sta. 1368+90± which is within the riprap section ∴ ok

1369+35

The depth of flow @ 1368+80 ≈ 5.75'
∴ Y_2 would be approx. at this sta.

Riprap

HEC No 14 P. E-9

D_{50} for 15.5 fps ≈ 1.5, this is at the limit set up, but, would be ok

D_{100} use 36"

Riprap thickness - 3.0'

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Cost

Bridge

120
50
170

Length - use 170'

Unit Cost - $1100.00 / L.F

1100 x 170 $187,000.00

(10.) Letter From ADOT

Need to raise the bridge 1.0' min. - Cost 80,000.00

$267,000.00

Riprap

1367+08

Riprap will be installed between sta. 1366 + 58.5 (50' upstream of the bridge) to Sta. 1369 + 35.5

120+200
2

$V_1 = (180)[(160)(3) + (3)(\sqrt{(7)^2+(17.5)^2})(2)] / 27 = 3954$ yd³

$V_2 = (47)[(120)(3) + (3)(\sqrt{7^2+19^2})(2)] / 27 = 790$ yd³

$V_3 = (50)[(131)(3) + (3)(\sqrt{(7)^2+(15)^2})(2)] / 27 = 912$ yd³

5656

Unit Cost - $20.00

Cost = 5656 x 20 = $113,120.00

Channel Excavation

This is compared to the 200' bottom proposal (6.0' depth of Exc.)

See Sht. 20

$V_{200} = 7025 + [(2616)(260)/54] = 19,620 \text{ yd}^3$

120' bottom

E.A. @ 1369+35 ℄ 1308 ft²

E.A. @ 1367+55 ℄ $= [(120)(6) + (2)(6)^2]$ 792 ft²

E.A. @ 1367+08 ℄ 792 ft²

E.A. @ 1365+28 ℄ 1308 ft²

$V_{120} = [(2100)(360) + (1584)(47)] / 54 \approx 15,380 \text{ yd}^3$

Difference in yd^3 = 4,240

Unit cost - \$0.60

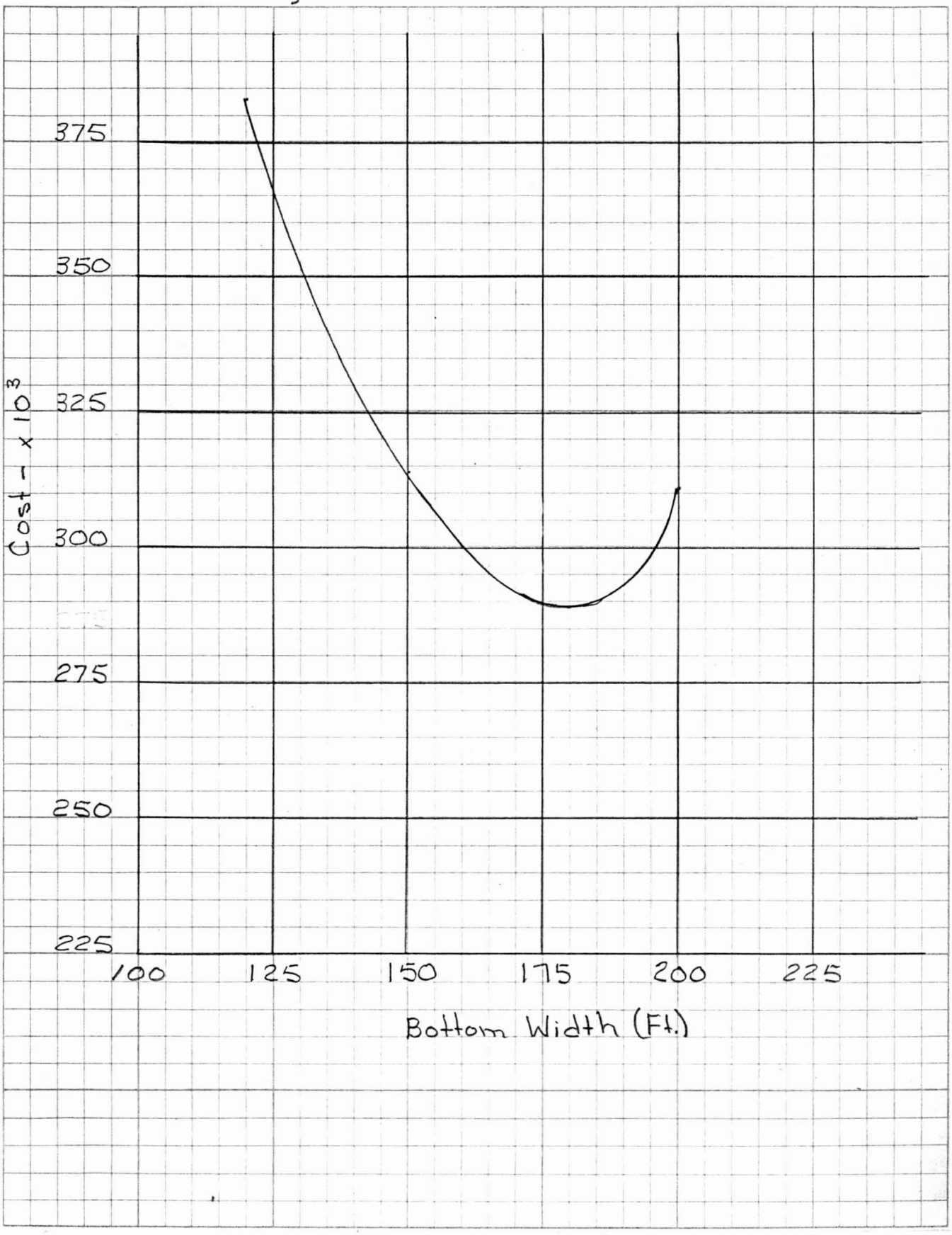
Decrease in cost = 4240 x 0.60 = \$2544.00

Total cost of proposal = \$377,576.00

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE	PROJECT	
Arizona	Williams - Chandler WPP	
BY JLS / DATE 3-1-78	CHECKED BY / DATE NA 3/13/78	JOB NO. RWCD- Reach 1
SUBJECT Hwy 93 Bridge Selection		SHEET 46 OF 47



STATE		PROJECT		
Arizona		Williams-Chandler WPP		
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JLS	3-1-78	RJM	3/2/78	RWCD - Reach 1
SUBJECT				SHEET 47 OF 47
Hwy 93 Bridge Selection				

Conclusions.

1. Cost Summary
   a. 200' Channel Bottom Width $311,000.00
   b. 180' Channel Bottom Width 289,000.00
   c. 150' Channel Bottom Width 314,000.00
   d. 120' Channel Bottom Width 378,000.00

2. Will not need to change existing road grade if the 150', 180' or 200' channel bottom widths are used (℄ bridge @ ℄ channel elev. 1217±)

3. The proposals having a 120', 150' or 180' bottom widths require rock riprap to stabilize the channel

4. The 180' bottom width is the most economical proposal & the velocities are in the sub-critical range. ∴ would recommend that this proposal be used.