

FINAL "n" VALUE REPORT
CAVE CREEK
FLOOD INSURANCE STUDY

Property of
Flood Control District of MC Lib.
Please Return to
2801 W. Durango
Phoenix, AZ 85009

Submitted to:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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Submitted by:

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EARPT709.WPD

I. Introduction

This report is being prepared by Willdan Associates as part of the Flood Insurance study of Cave Creek for the Flood Control District of Maricopa County. The limits of the study are the Cave Buttes Dam to 600 feet upstream of Carefree Highway a distance of approximately five miles. The Photo Location/Cross Section map in Appendix 1 shows the study limits.

The data contained in this report is preliminary and subject to review.

II. Methodology

Values for Manning's roughness coefficient, "n", are assigned for conditions that exist at the time of the preparation of the study. The Manning's "n" values developed in this study for the Cave Creek Flood Insurance study were developed for the 100-year peak flood discharges.

Several sources of data were utilized to develop the "n" values presented in this preliminary report. The information available included: 1) aerial photo contact prints (flown on January 12, 1996); 2) ground level photographs; 3) site reconnaissance. The ground level photographs and field reconnaissance were conducted April 4, 1996.

The "n" values assigned to a stream reach should represent the roughness factors that create energy loss due to friction. The reach Manning's roughness coefficients were calculated by assigning a base "n" (n_b) value that represents the surface roughness for a straight, uniform channel or overbank region composed of a given bed material. Vegetation, channel shape and irregularity, stage, discharge, and other factors that increase roughness were accounted for by adding increments of roughness to n_b .

Two procedures are available to integrate the "n" values into the detailed hydraulic model (HEC-2). The first procedure ("NC" cards) assigns "n" values to channel and overbank areas of a typical cross section representing a stream reach of uniform roughness characteristics. The second procedure ("NH" cards) assigns "n" values to a specific cross section. The cross sections are horizontally subdivided into segments of uniform roughness. The hydraulic model (HEC-2) then computes the average "n" value for the specific section. This procedure was utilized for this study for Cave Creek, defining the cross section "n" values only by channel, left overbank and right overbank regions was insufficient to adequately describe the lateral roughness variation created by the multiple channels, vegetation areas and overbank conditions.

Cave Creek shows evidence of sediment movement on the right bank channel invert and fines deposition on the right overbank. The left bank is generally stable with nearly vertical slopes. The channel bed form is a function of flow velocity, grain size and other variables.

The "n" values developed for sand bed channels can also be a function of bed form roughness. The field reconnaissance revealed very few signs of bed form creation and or sediment transport due to bed form movement. For this reason bed form roughness was judged as negligible and was not included in the calculations.

III. Base "n" Value Determination Reach Calculations

The base "n" values used in this study generally apply to average conditions rather than the smoothest reach attainable for a given bed material. The bed material is characterized as medium to coarse grain sand. Close examination of the bed material photographs indicates a representative base "n" value for Cave Creek would be 0.025 for a sandy bottom and 0.035 for the cobble bottom. Photographs 4 and 5 illustrate these two bottom materials. Photographs 7 and 10 illustrates typical overbank vegetation. Additional overbank photographs have been included were the vegetation varies significantly from these norms.

The base "n" values for the overbanks were assigned considering stable channel conditions. Review of photographs of the overbanks provides little evidence of bed material movement except in locations where small channels have formed in the overbank. The bed material is considered "firm soil". Therefore, a base "n" value of 0.020 was assigned to the overbanks for Cave Creek. Photographs 6 and 13 illustrate typical small channel bed material and vegetation characteristics.

IV. Adjustments to the Base Value

The base "n" value (n_b) must be adjusted accordingly for factors such as depth of flow, channel irregularities (n_1), obstructions (n_2), vegetation (n_3), changes in channel shape, and degree of meandering. The method used for this study to arrive at the overall "n" was to add increments of roughness (n_1 , n_2 , and n_3) to n_b for each condition that increases the roughness.

Channel irregularity can have a great impact on the overall "n" when the width-to-depth ratio is small. Cave Creek alternates from a relatively uniform main channel to flow paths disrupted by the current gravel operations. In these areas channel irregularity is so great that it will be characterized by changes in the cross section geometry rather than roughness coefficients.

Obstructions are physical objects that disturb the flow pattern and increase the “n” value. The amount of increase depends upon the channel slope, shape of the obstruction, the size in relation to the cross section, and the number, arrangement, and spacing of obstructions. Engineering judgment and experience was applied when assigning adjustments to the base “n” value for obstructions so as not to duplicate conditions considered for other adjustment factors. The adjustment for obstructions (n_2) is relatively small throughout the Cave Creek study reach.

Several factors impact the extent to which vegetation affects the base “n” values. The percentage of wetted perimeter covered by vegetation, the density of vegetation below the high water line, the degree to which high water flattens the vegetation, and the alignment of vegetation relative to the flow, all impact the value assigned to the vegetation adjustment factor (n_3).

Photographs are used to illustrate typical features and characteristics for representative reaches of the channel. The channel and overbank features in the photographs are representative of that particular reach. See Appendix 1 for these photographs. See Appendix 2 the reach “n” value calculations.

V. Reach “n” Values vs. Cross Section “n” Values

The topography shows the extent that the water course varies within a given reach. The vegetation also varies from section to section. Because of this variation, it was judged that the calculated reach “n” values are too generalized to accurately represent the roughness of individual cross sections. A second field reconnaissance was performed on August 8 and 9, 1996 to determine the individual cross section roughness. This more detailed analysis is described below.

VI. Detailed Analyses

Vegetation is the primary factor that affects “n” for the Cave Creek. Therefore, vegetation is the basis for assigning “n” values rather than the material in which it is growing for most parts of the channel or flood plains. The density of the vegetation was used to assign “n” values for each cross section. Varying degrees of density of trees, brush and weeds exist throughout the study reach. The levels of density are described as dense, medium and light.

The cross sections also contain areas of no vegetation. The “n” values for these areas were assigned based on the material that composed the bed of the water course in these areas. Where there is a significant range of bed material sizes the final “n” value is a combination

of the “n” values for the different material sizes. The following is a listing of bed and vegetation type and the corresponding “n” value.

<u>Bed Material / Vegetation</u>	<u>Mannings Roughness Factor “n”</u>
Light Vegetation	0.06
Medium Vegetation	0.08
Dense Vegetation / Trees	0.12
Sand	0.025
Cobbles	0.035
Boulders	0.045

“n” values were assigned to individual subareas on each cross section. The values will be entered into the NH card for each section. HEC 2 will calculate the composite “n” value. The cross sections with “n” values are shown in Appendix 3.

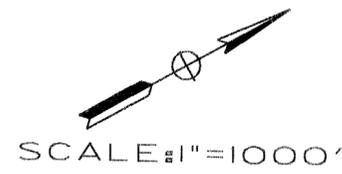
VII. References

1. Established Manning’s Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona
B.W. Thomsen and H.W. Hjalmarson, U.S. Geological Survey and the Flood Control District of Maricopa County April, 1991
2. Open Channel Hydraulics
Ven Te Chow
McGraw Hill, 1959
3. Roughness Characteristics of Natural Channels
U.S. Geological Survey Water Supply Paper 1849
Harry H. Barnes 1967

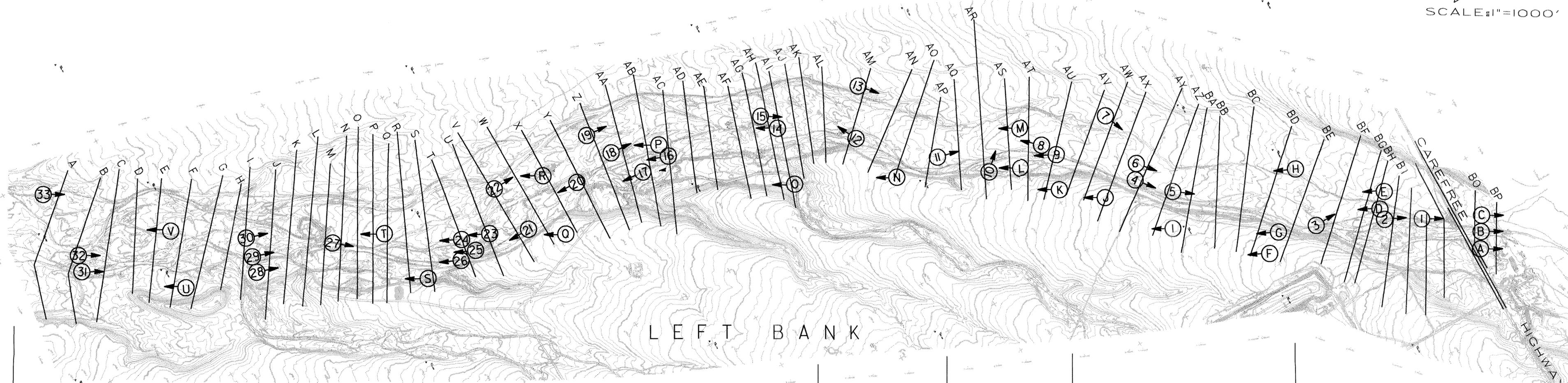
APPENDIX 1

- ***Photo / Cross Section Location Map***
- ***List of Photographs***
- ***Photographs***

R I G H T B A N K



SCALE: 1"=1000'



L E F T B A N K

REACH 1

REACH 2

REACH 3

REACH 4

REACH 5

REACH 6

REACH 7

REACH 8

PHOTO LOCATION MAP

List of Photographs

PHOTOGRAPH NO.

1. Reach 8 - Looking Upstream at Carefree Highway
2. Reach 8 - Main Channel Bed
3. Reach 8 - Looking Upstream at Right Overbank
4. Reach 7 - at Powerline Crossing Looking Upstream at Main Channel With Sandy Bottom
5. Reach 7 - at Powerline Crossing Looking Upstream at Main Channel With Cobble Bottom
6. Reach 7 - at Powerline Crossing Looking Upstream at Right Overflow Channel
7. Reach 7 - below Powerline Crossing Looking Upstream at Right Overbank
8. Reach 6 - Looking Downstream at Main Channel
9. Reach 6 - Looking Downstream at Left Overbank
10. Reach 6 - Looking at Main Channel and Right Overbank
11. Reach 6 - Looking Upstream at Main Channel
12. Reach 5 - Looking Downstream at Main Channel
13. Reach 5 - Looking Upstream at Right Overflow Channel
14. Reach 4 - Looking Downstream at Main Channel
15. Reach 4 - Looking Upstream at Right Overflow Area
16. Reach 4 - Looking Downstream at Main Channel
17. Reach 3 - Looking Downstream at Main Channel Obstruction
18. Reach 3 - Looking Upstream at Right Overflow Channel
19. Reach 3 - Looking Upstream at Right Bank
20. Reach 3 - Looking Downstream at Main Channel
21. Reach 3 - Looking Downstream at Main Channel

22. Reach 3 - Looking Upstream at Right Bank
23. Reach 2 - Looking Downstream at Right Overbank
24. Reach 2 - Looking Downstream at Right Overflow Channel
25. Reach 2 - Looking Downstream at Right Overbank
26. Reach 2 - Looking Downstream at Main Channel
27. Reach 2 - Looking Upstream at Main Channel
28. Reach 1 - Upstream End - Looking Upstream at Left Bank
29. Reach 1 - Upstream End - Looking Upstream at Main Channel
30. Reach 1 - Upstream End - Looking Upstream at Right Bank
31. Reach 1 - Downstream End - Looking Upstream at Largest Channel
32. Reach 1 - Downstream End - Looking Upstream at Small Channel
34. Reach 1 - Downstream End - Looking Upstream at Overbank Area

SUPPLEMENTAL PHOTOGRAPHS

- A. Reach 8 - Looking Upstream From Bridge at Left Bank Rip Rap
- B. Reach 8 - Looking upstream From Bridge at Main Channel
- C. Reach 8 - Looking Upstream From Bridge at Left Bank
- D. Reach 8 - Looking Downstream at Right Bank
- E. Reach 8 - Looking Downstream at Right Over Bank
- F. Reach 7 - Looking Downstream at Left Over Bank
- G. Reach 7 - Looking Downstream at Main Channel
- H. Reach 7 - Looking Downstream at Right Over Bank
- I. Reach 7 - Looking Downstream at Left Over Bank
- J. Reach 7 - Looking Downstream at Left Over Bank
- K. Reach 7 - Looking Downstream at Left Over Bank

- L. Reach 6 - Looking Downstream at Main Channel
- M. Reach 6 - Looking Downstream at Right Over Bank
- N. Reach 5 - Looking Downstream at Left Over Bank
- O. Reach 5 - Looking at Stockpiled Cobbles and Boulders
- P. Reach 4 - Looking Downstream at Right Over Bank
- Q. Reach 3 - Looking Downstream at Left Over Bank
- R. Reach 3 - Looking Downstream at Right Bank
- S. Reach 2 - Looking Downstream at Left Bank
- T. Reach 2 - Looking Downstream at Right Over Bank
- U. Reach 1 - Looking Downstream at Left Over Bank
- V. Reach 1 - Looking Downstream at Right Over Bank

PHOTOGRAPHS
For
CAVE CREEK FLOOD INSURANCE STUDY
Taken
April 10, 1996



1. Reach 8 Looking Upstream at Carefree Highway



2. Reach 8 - Main Channel Bed



3. Reach 8 - Looking Upstream at Right Overbank



4. Reach 7 - At Powerline Looking Upstream at Main Channel With Sandy Bottom



5. Reach 7 - At Powerline Looking Upstream at Main Channel With Cobble Bottom



6. Reach 7 - At Powerline Looking Upstream at Right Overflow Channel



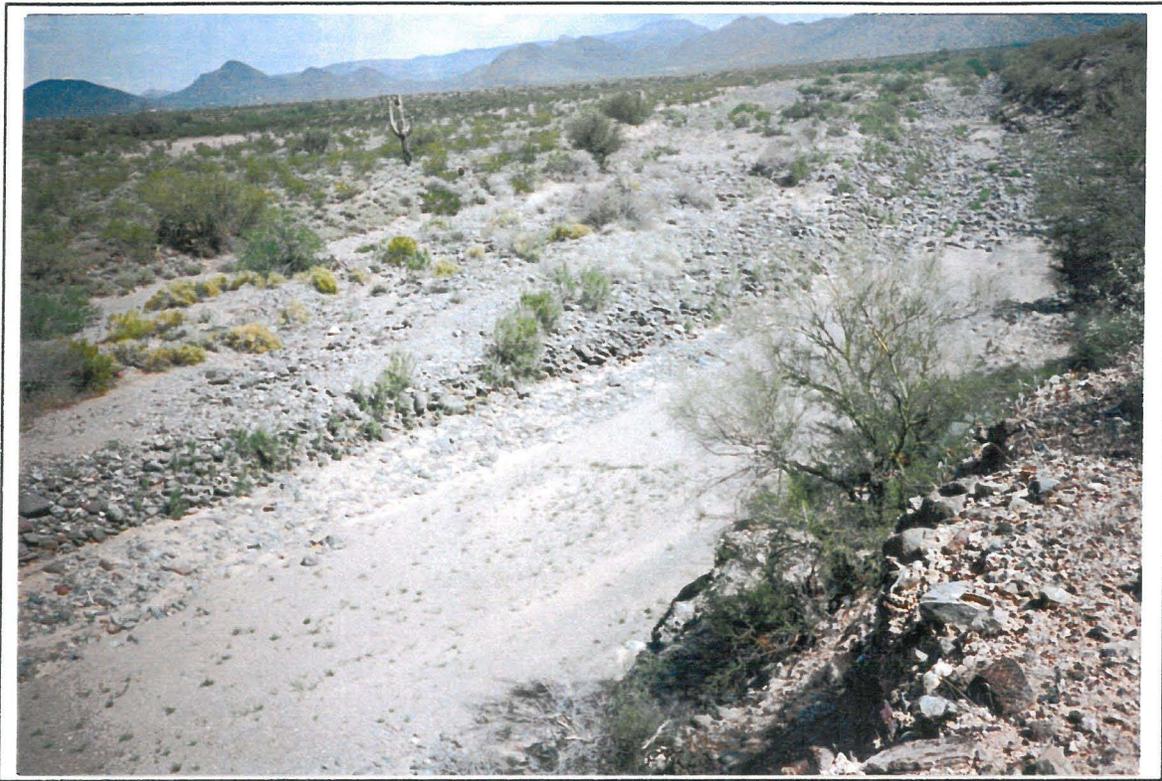
7. Reach 7 - Below Powerline Crossing Looking Upstream at Right Overbank



8. Reach 6 - Looking Downstream at Main Channel



9. Reach 6 - Looking Down Stream at Left Overbank



10. Reach 6 - Looking at Main Channel and Right Overbank



11. Reach 6 - Looking Upstream at Main Channel



12. Reach 5 - Looking Downstream at Main Channel



13. Reach 5 Looking upstream at Right Overflow Channel



14. Reach 4 - Looking Downstream at Main Channel



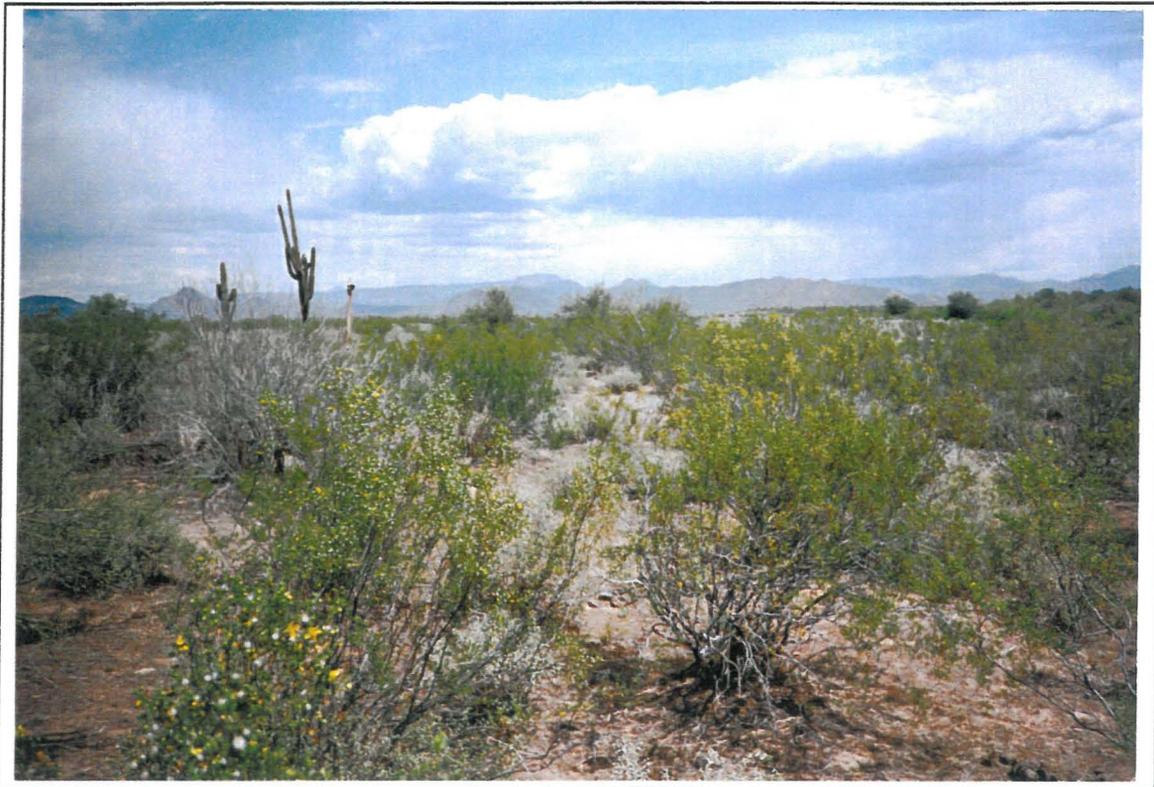
15. Reach 4 - Looking Upstream at Right Overflow Area



16. Reach 4 - Looking Downstream at Main Channel



17. Reach 3 - Looking Downstream at Main Channel Obstruction



18. Reach 3 - Looking Upstream at Right Overflow Area



19. Reach 3 - Looking Downstream at Right Bank Channel



20. Reach 1 - Looking Downstream at Main



21. Reach 3 - Looking Downstream at Main Channel



22. Reach 3 - Looking Upstream at Right Bank



23. Reach 2 - Looking Downstream at Right Bank



24. Reach 2 - Looking Downstream at Right Overflow Channel



25. Reach 2 - Looking Downstream at Right Over Bank



26. Reach 2 - Looking Downstream at Main Channel



27. Reach 2 - Looking Upstream at Main Channel



28. Reach 1 - Upstream End Looking Upstream at Left Bank



29. Reach 1 - Upstream End Looking at Main Channel



30. Reach 1 -Upstream End Looking Upstream at Right Bank



31. Reach 1 - Downstream End Looking Upstream at Largest Channel

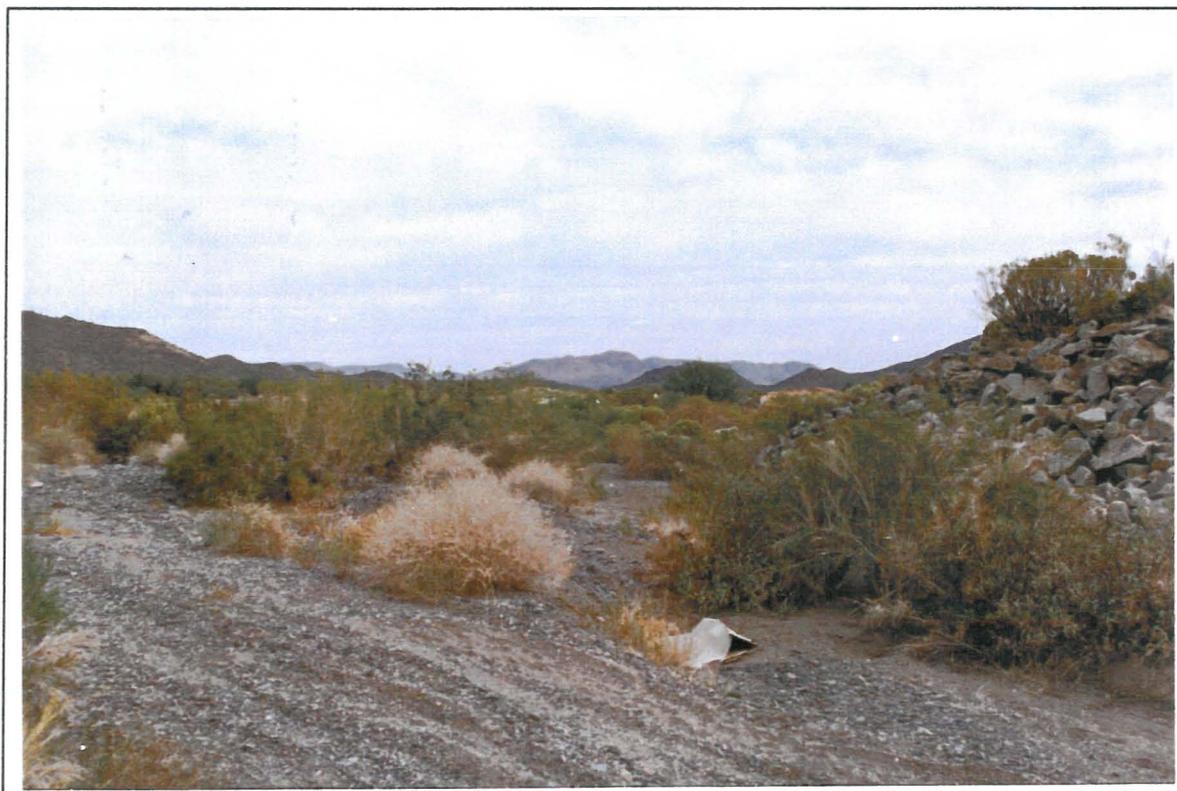


32. Reach 1 - Downstream End Looking Upstream at Small Channel

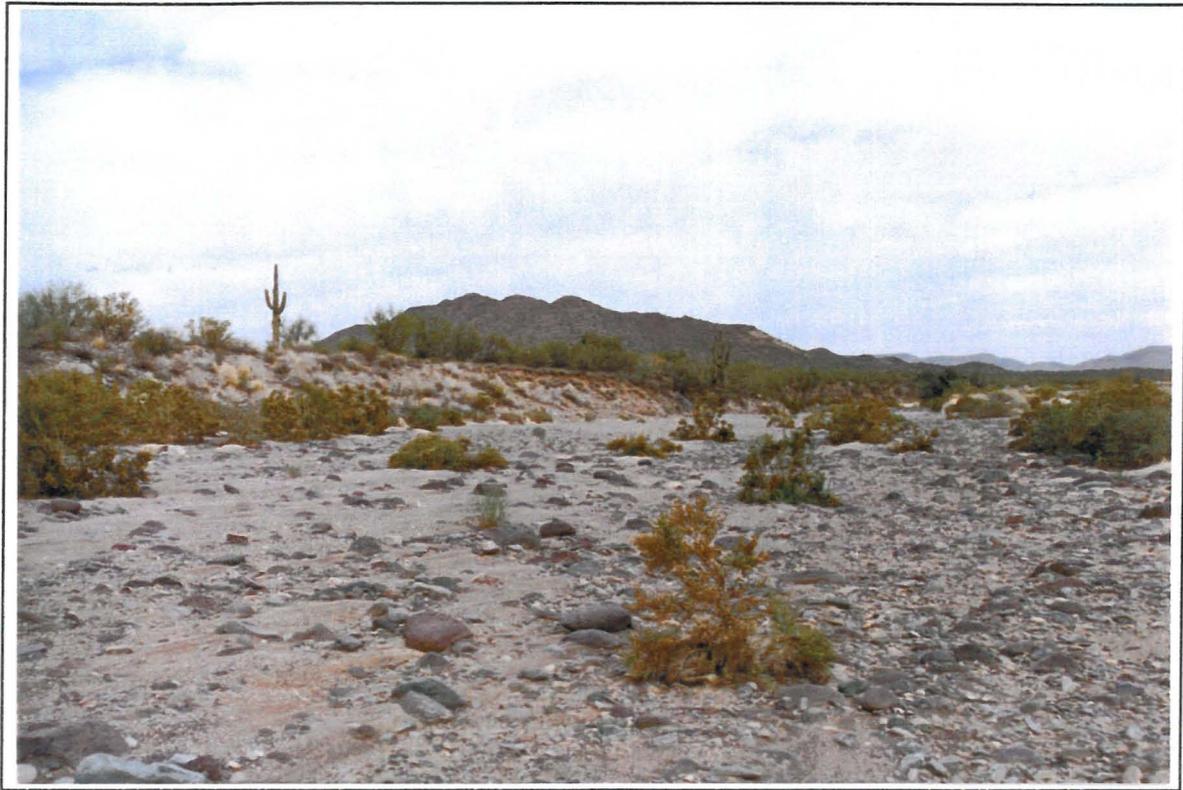


33. Reach 1 - Downstream End Looking Upstream at Overbank Area

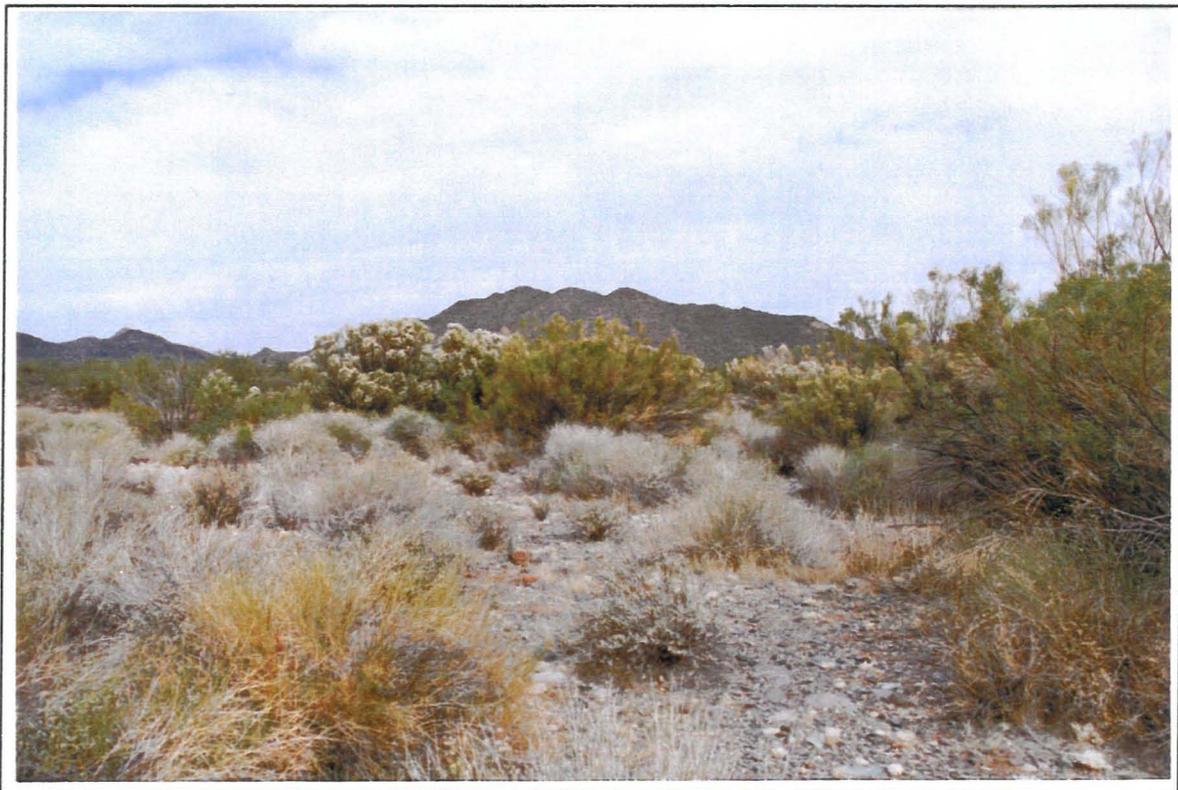
SUPPLEMENTAL PHOTOGRAPHS
For
CAVE CREEK FLOOD INSURANCE STUDY
Taken
December 9, 1996



A. Reach 8 - Looking Upstream From Bridge at Left Bank Rip Rap



B. Reach 8 - Looking Upstream From Bridge at Main Channel



C. Reach 8 - Looking Upstream From Bridge at Left Bank



D. Reach 8 - Looking Downstream at Right Bank



E. Reach 8 - Looking Downstream at Right Over Bank



F. Reach 7 Looking Down Stream at Left Over Bank



G. Reach 7 - Looking Downstream at Main Channel



H. Reach 7 - Looking Downstream at Right Over Bank



I. Reach 7 - Looking Downstream at Left Over Bank



J. Reach 7 - Looking Downstream at Left Over Bank



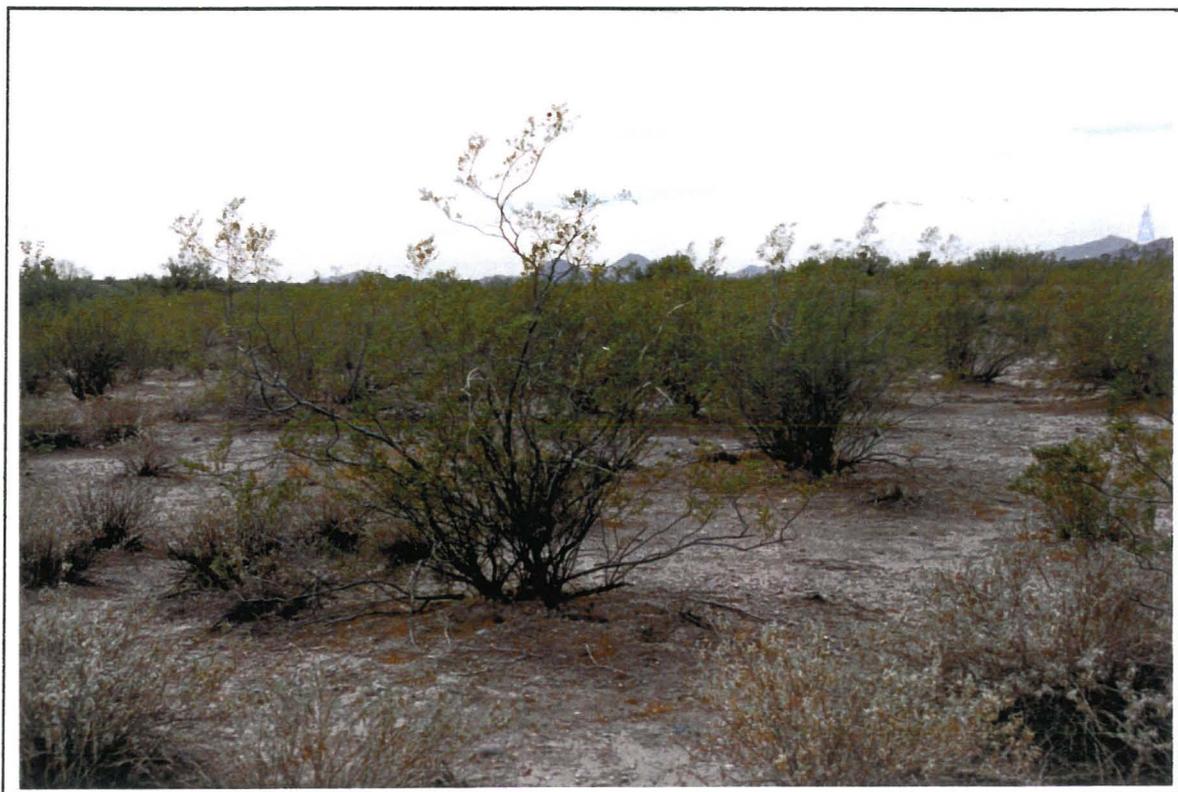
K. Reach 6 - Looking Downstream at Left Over Bank



L. Reach 6 - Looking Downstream at Main Channel



M. Reach 6 - Looking Downstream at Right Over Bank



N. Reach 5 - Looking Downstream at Left Over Bank



O. Reach 4 - Looking at Stockpiled Cobbles and Boulders



P. Reach 4 - Looking Downstream at Right Over Bank



Q. Reach 3 - Looking Downstream at Left Over Bank



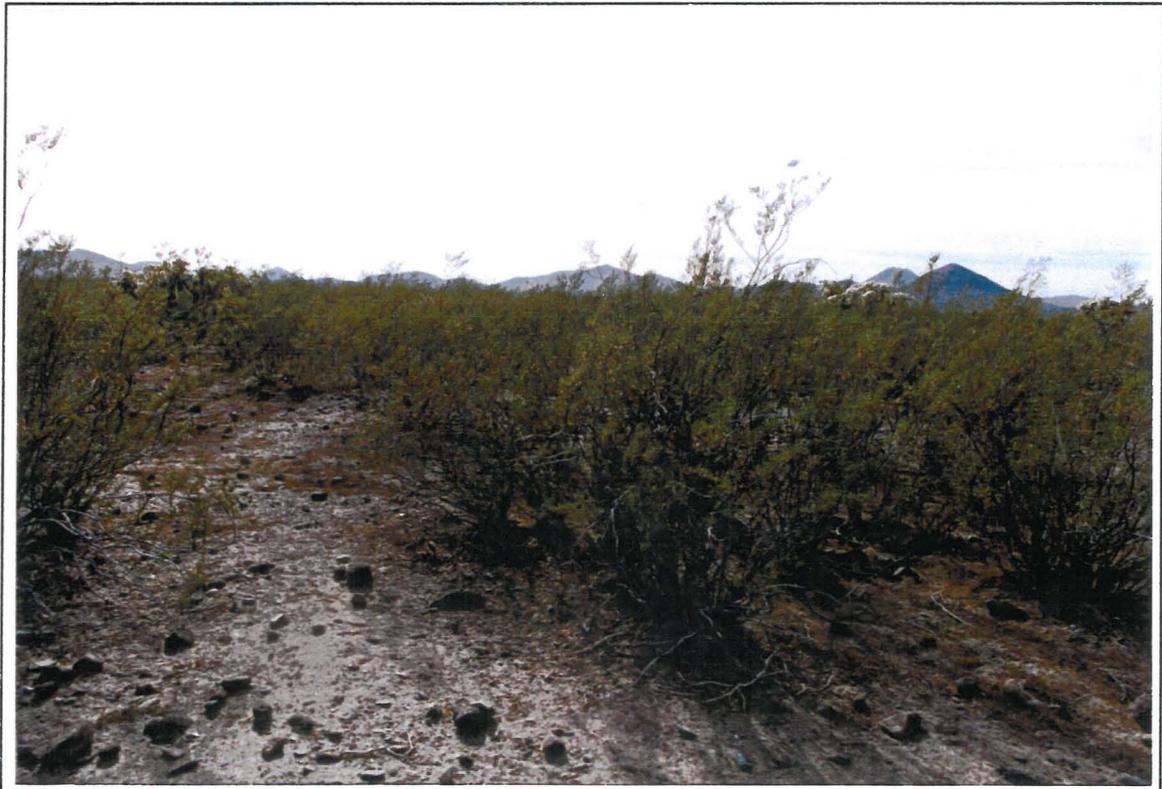
R. Reach 3 - Looking Downstream at Right Bank



S. Reach 2 - Looking Downstream at Left Bank



T. Reach 2 - Looking Downstream at Right Over Bank



U. Reach 1 - Looking Downstream at Left Over Bank



V. Reach 1 - Looking Downstream at Right Over Bank

APPENDIX 2

- ***Mannings Roughness Factor Calculations for Reachs***

1. REACH DESIGNATION:

LOCATION 4000 ft. upstream of end of topo to the end of topo

SECTIONS J - A

CROSS SECTION DESCRIPTION Flow area is braided with no obvious single main channel
Numerous small sandy washes with widths aprox. 15-20 ft.
Medium to heavy brush with trees.

100-YEAR N-VALUE CALCULATIONS

Subsection of Channel	Components	"n" Total
A (sandy bottom)	nb= 0.025 n1= 0.000 n2= 0.000 n3= 0.075	0.100
A (boulder/cobble bottom)	nb= 0.035 n1= 0.001 n2= 0.000 n3= 0.035	0.071
B	nb= 0.020 n1= 0.005 n2= 0.000 n3= 0.035	0.060
C	nb= 0.025 n1= 0.000 n2= 0.000 n3= 0.075	0.100

2. REACH DESIGNATION:

LOCATION Lower reach of gravel operation adjacent to stock piles. Area is currently being worked by gravel company

SECTION V - K

CROSS SECTION DESCRIPTION Main channel against right bank with an overflow area against bluffs on left side. Area between has medium to heavy brush with trees. Right bank location is poorly defined. Right over bank has medium brush with scattered trees and occasional bare patches caused by gravel operations

100-YEAR N-VALUE CALCULATIONS

Subsection of Channel	Components	"n" Total
A	nb=	0.020
	n1=	0.002
	n2=	0.003
	n3=	0.040
		0.065
B	nb=	0.030
	n1=	0.005
	n2=	0.000
	n3=	0.010
		0.045
C	nb=	0.030
	n1=	0.005
	n2=	0.005
	n3=	0.030
		0.070

3. REACH DESIGNATION:

LOCATION Central section of the gravel operation
SECTIONS AA - W

CROSS SECTION DESCRIPTION Flow paths twisted and disrupted by gravel operation.
Bottom is sandy with frequent patches of cobbles/boulders
Light brush in the main channel with medium brush on both
overbanks

100-YEAR N-VALUE CALCULATIONS

Subsection of Channel	Components	"n" Total
A	nb=	0.025
	n1=	0.000
	n2=	0.005
	n3=	0.025
		0.055
B	nb=	0.028
	n1=	0.002
	n2=	0.003
	n3=	0.010
		0.043
C	nb=	0.020
	n1=	0.000
	n2=	0.000
	n3=	0.045
		0.065

4. REACH DESIGNATION:

LOCATION : Upstream most section of gravel operation
SECTIONS AK - AB

CROSS SECTION DESCRIPTION : Stream flow paths have been disrupted by gravel operations
There are stockpiles of cobbles and boulders in the left overbank area. The main channel becomes broken with no consistent thalweg. Light medium sized brush in the main channel and medium brush with some small trees in the overbanks.

100-YEAR N-VALUE CALCULATIONS

	Subsection of Channel	Components	"n" Total
Left Bank	A	nb=	0.030
		n1=	0.001
		n2=	0.000
		n3=	0.030
Channel	B	nb=	0.030
		n1=	0.005
		n2=	0.005
		n3=	0.010
Right bank	C	nb=	0.025
		n1=	0.007
		n2=	0.001
		n3=	0.035

5. REACH DESIGNATION:

LOCATION 3000 ft. upstream of gravel operation to 300 ft. upstream of gravel operation.
 SECTIONS AP - AL

CROSS SECTION DESCRIPTION : Fairly uniform crosssections with overflow area on the right bank . Left bank is stable at nearly vertical slope. Main channel bottom alternates from sandy bottom in flatter reaches to cobbles and boulders in steeper reaches. Right Bank is stabilized by small trees. Right over bank has medium height brush and small trees with medium density.

100-YEAR N-VALUE CALCULATIONS

Subsection of Channel		Components	"n" Total
Left Bank	A	nb=	0.020
		n1=	0.000
		n2=	0.000
		n3=	0.040
			0.060
Channel	B (sandy bottom)	nb=	0.025
		n1=	0.005
		n2=	0.002
		n3=	0.020
			0.052
Channel	B (boulder/cobble bottom)	nb=	0.035
		n1=	0.005
		n2=	0.002
		n3=	0.020
			0.062
Right bank	C	nb=	0.025
		n1=	0.005
		n2=	0.003
		n3=	0.050
			0.083

6. REACH DESIGNATION:

LOCATION : 900 ft downstream of powerlines to 3500 downstream of powerlines

SECTIONS AQ - AU

CROSS SECTION DESCRIPTION : Flow spreads along vertical left bank with main channel against right bank. Right bank overflow area has medium height brush with light density. Channel alternates sandy and cobble/boulder bottom with patches of light to medium vegetation in the main channel

100-YEAR N-VALUE CALCULATIONS

	Subsection of Channel		Components	"n" Total
Left Bank	A		nb= 0.020 n1= 0.000 n2= 0.000 n3= 0.022	0.042
Channel	B	(sandy bottom)	nb= 0.025 n1= 0.005 n2= 0.005 n3= 0.003	0.038
Channel	B	(boulder/cobble bottom)	nb= 0.035 n1= 0.008 n2= 0.005 n3= 0.005	0.053
Right bank	C		nb= 0.025 n1= 0.002 n2= 0.003 n3= 0.060	0.090

7. REACH DESIGNATION :

LOCATION : 3400 upstream of powerline crossing to 900 downstream of powerlines.
 SECTIONS BE - AV

CROSS SECTION DESCRIPTION : Uniform crosssections with overflow area on the right bank
 Left bank is stable at nearly vertical slope. Main channel bottom alternates from sandy bottom in flatter reaches to cobbles and boulders in steeper reaches. Right bank is stabilized by small trees. Right over bank has medium height brush with medium density.

100-YEAR N-VALUE CALCULATIONS

Subsection of Channel		Components	"n" Total
Left Bank	A	nb=	0.020
		n1=	0.000
		n2=	0.000
		n3=	0.040
			0.060
Channel	B (sandy bottom)	nb=	0.025
		n1=	0.005
		n2=	0.005
		n3=	0.023
			0.058
Channel	B (boulder/cobble bottom)	nb=	0.035
		n1=	0.000
		n2=	0.000
		n3=	0.028
			0.063
Right bank	C	nb=	0.020
		n1=	0.000
		n2=	0.000
		n3=	0.035
			0.055

8. REACH DESIGNATION :

LOCATION : Carefree Highway to 3000 ft. downstream.

SECTIONS BP - BF

CROSS SECTION DESCRIPTION : Cross sections are characterized by low flow braiding with settling of material caused by reduction of velocities upon exiting bridge constriction. Main channel has areas of low height, light density vegetation. Over banks have medium density brush with some small trees.

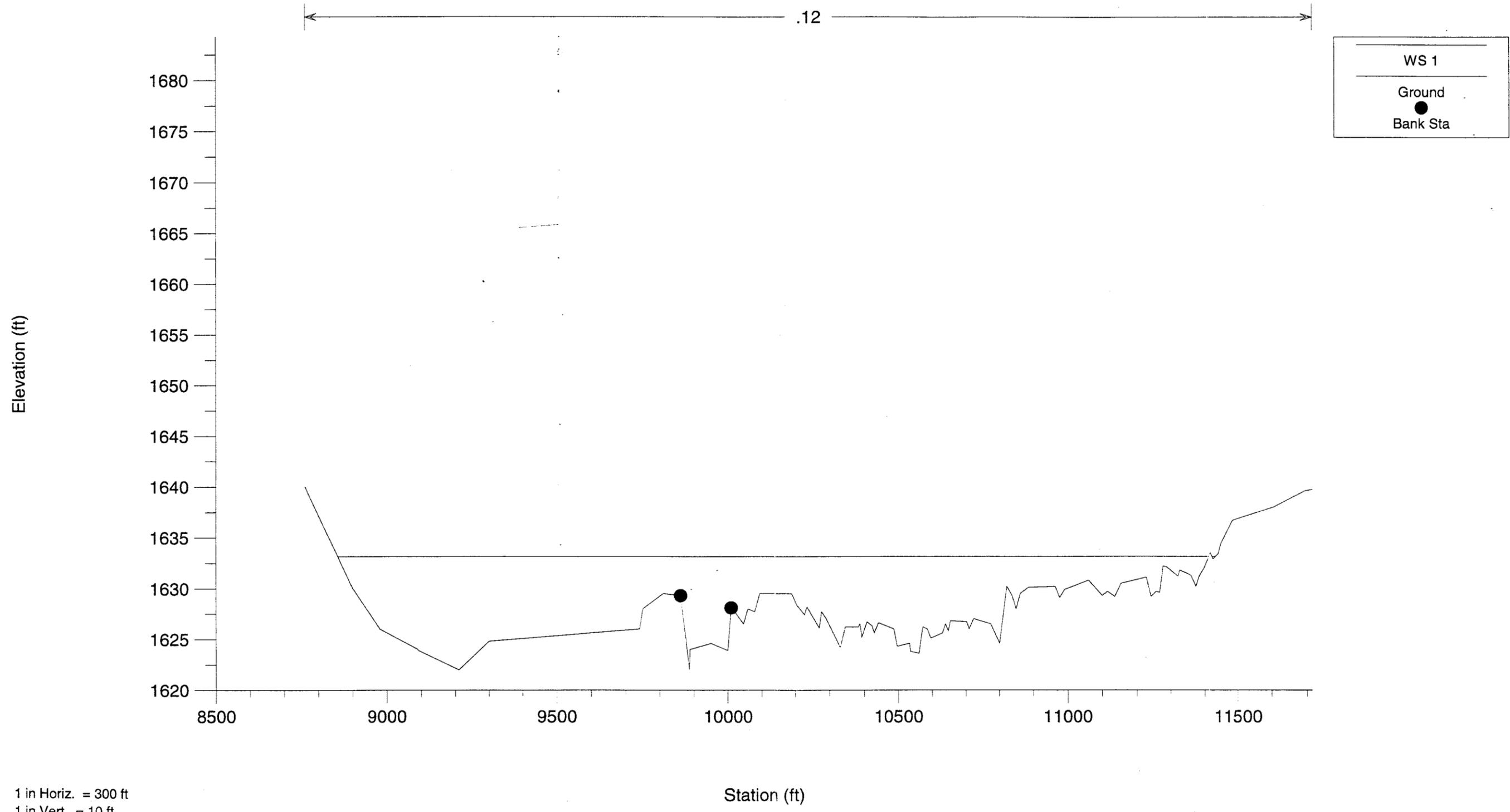
100-YEAR N-VALUE CALCULATIONS

	Subsection of Channel	Components	"n" Total
Left Bank	A	nb= 0.025 n1= 0.005 n2= 0.000 n3= 0.030	0.060
Channel	B	nb= 0.030 n1= 0.005 n2= 0.002 n3= 0.005	0.042
Right bank	C	nb= 0.025 n1= 0.005 n2= 0.000 n3= 0.035	0.065

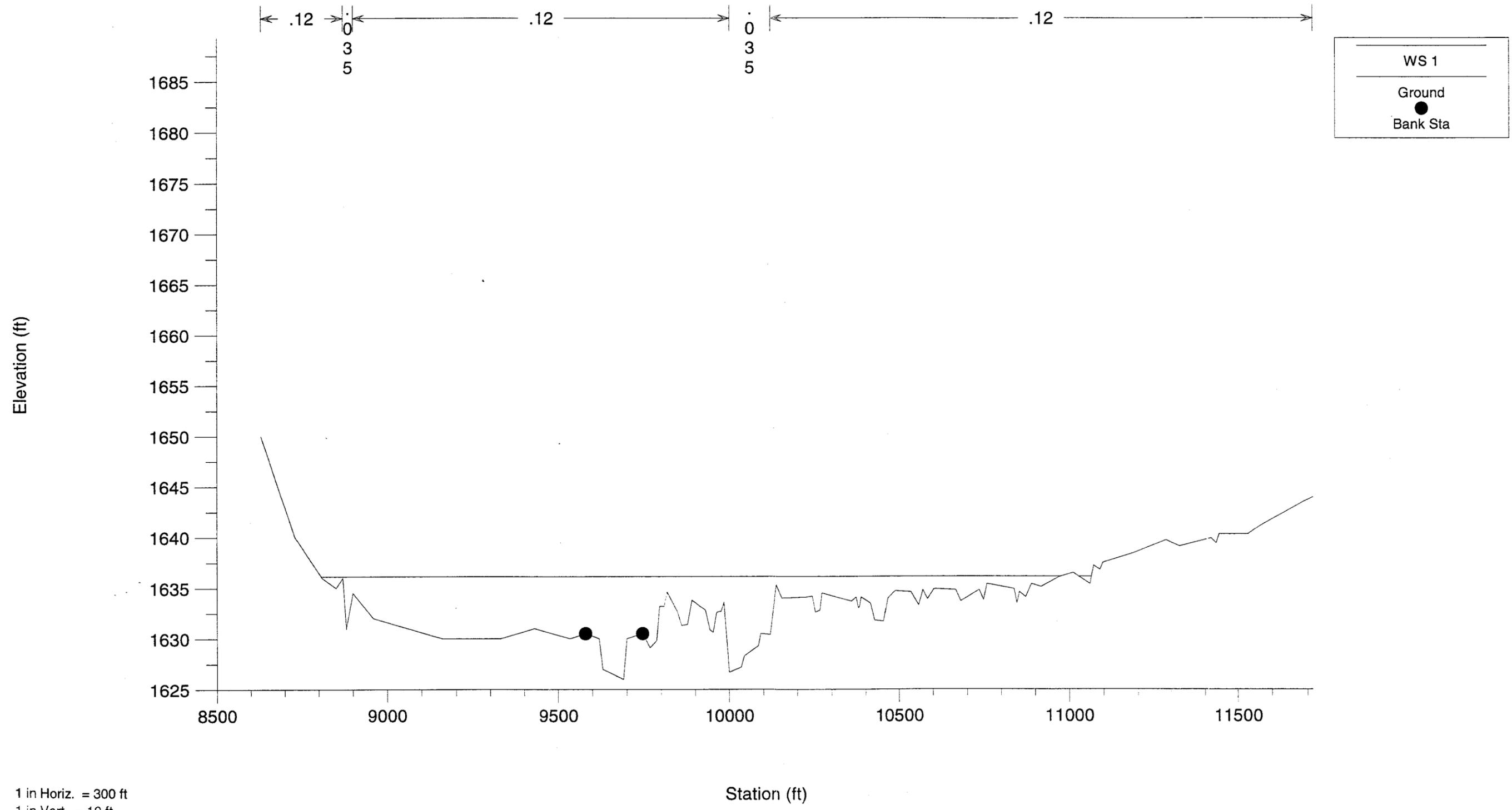
APPENDIX 3

- ***Cross Sections with “n” Values***

Cave Creek Wash South FIS 100-Year "n" Values
24.525 Cross Section A

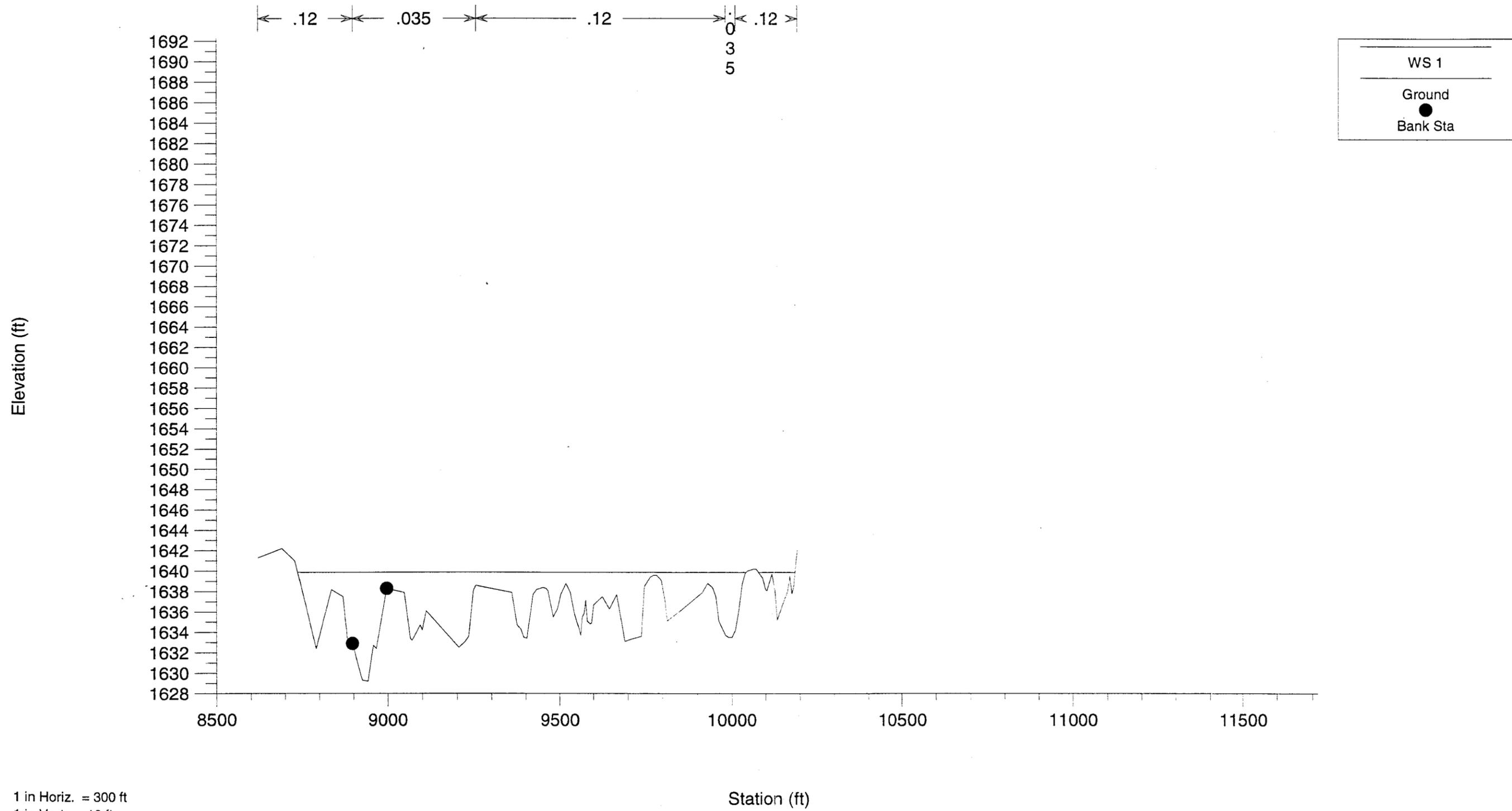


Cave Creek Wash South FIS 100-Year "n" Values
24.646 Cross Section B

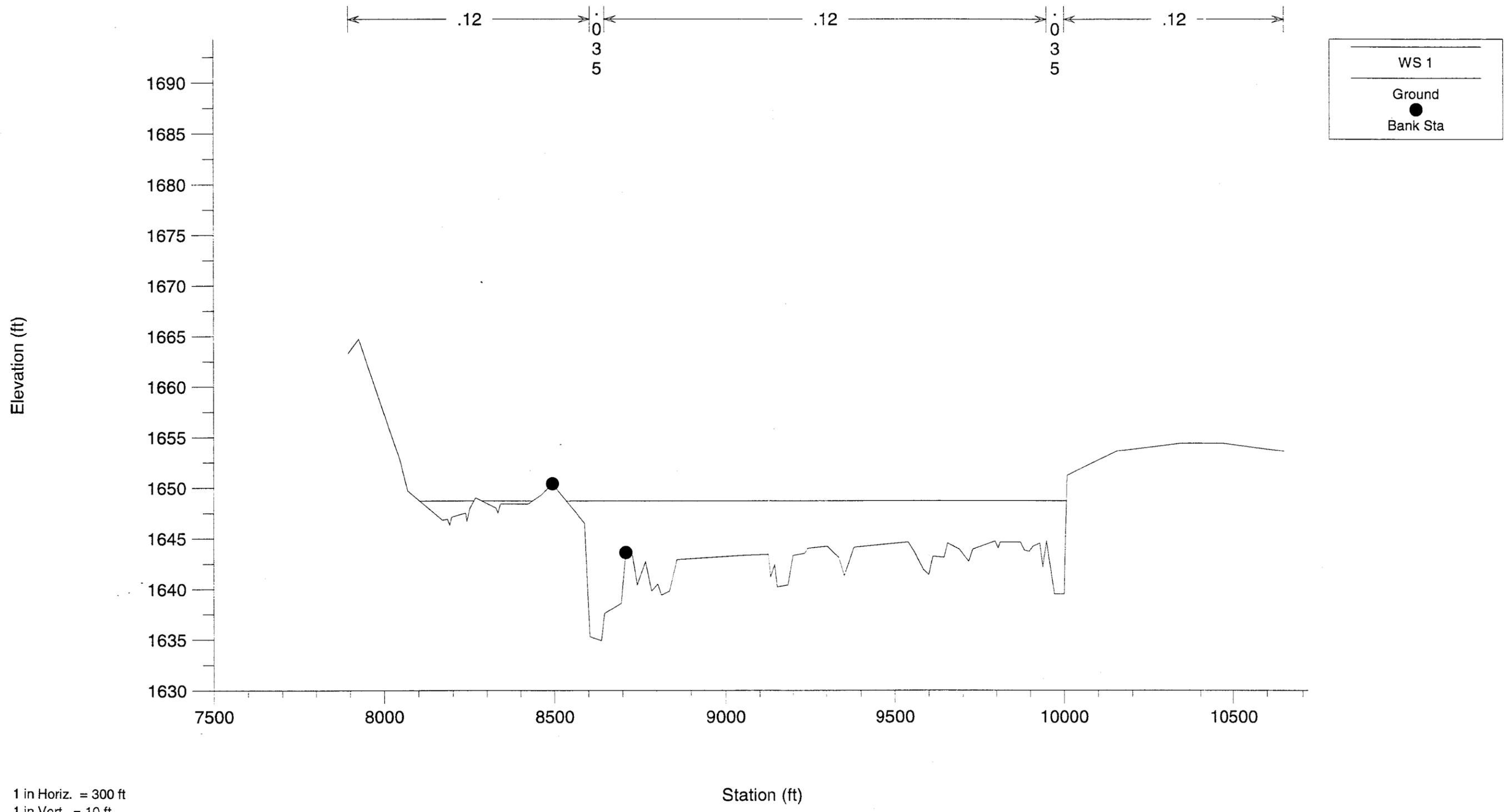


1 in Horiz. = 300 ft
1 in Vert. = 10 ft

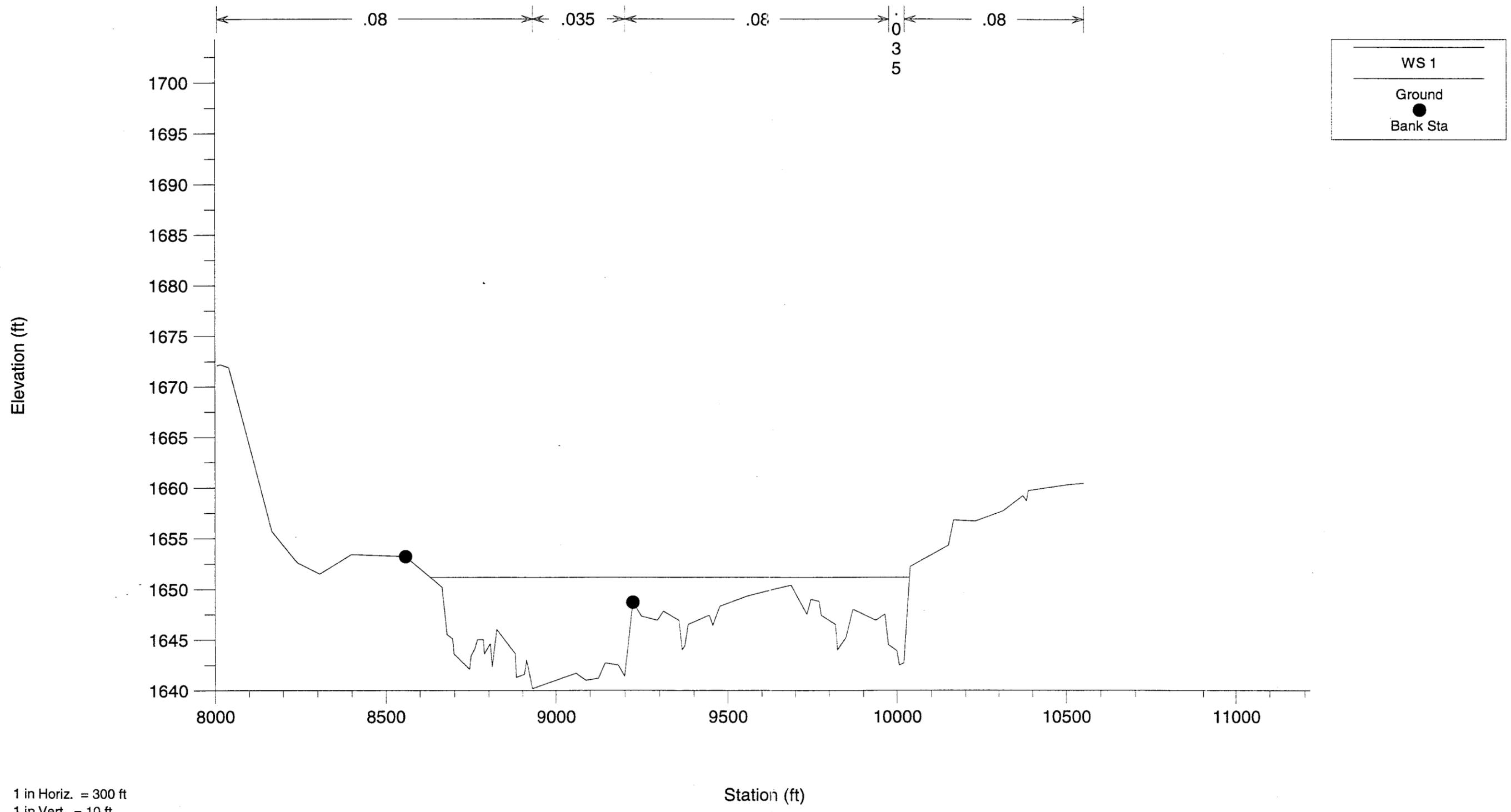
Cave Creek Wash South FIS 100-Year "n" Values
24.752 Cross Section C



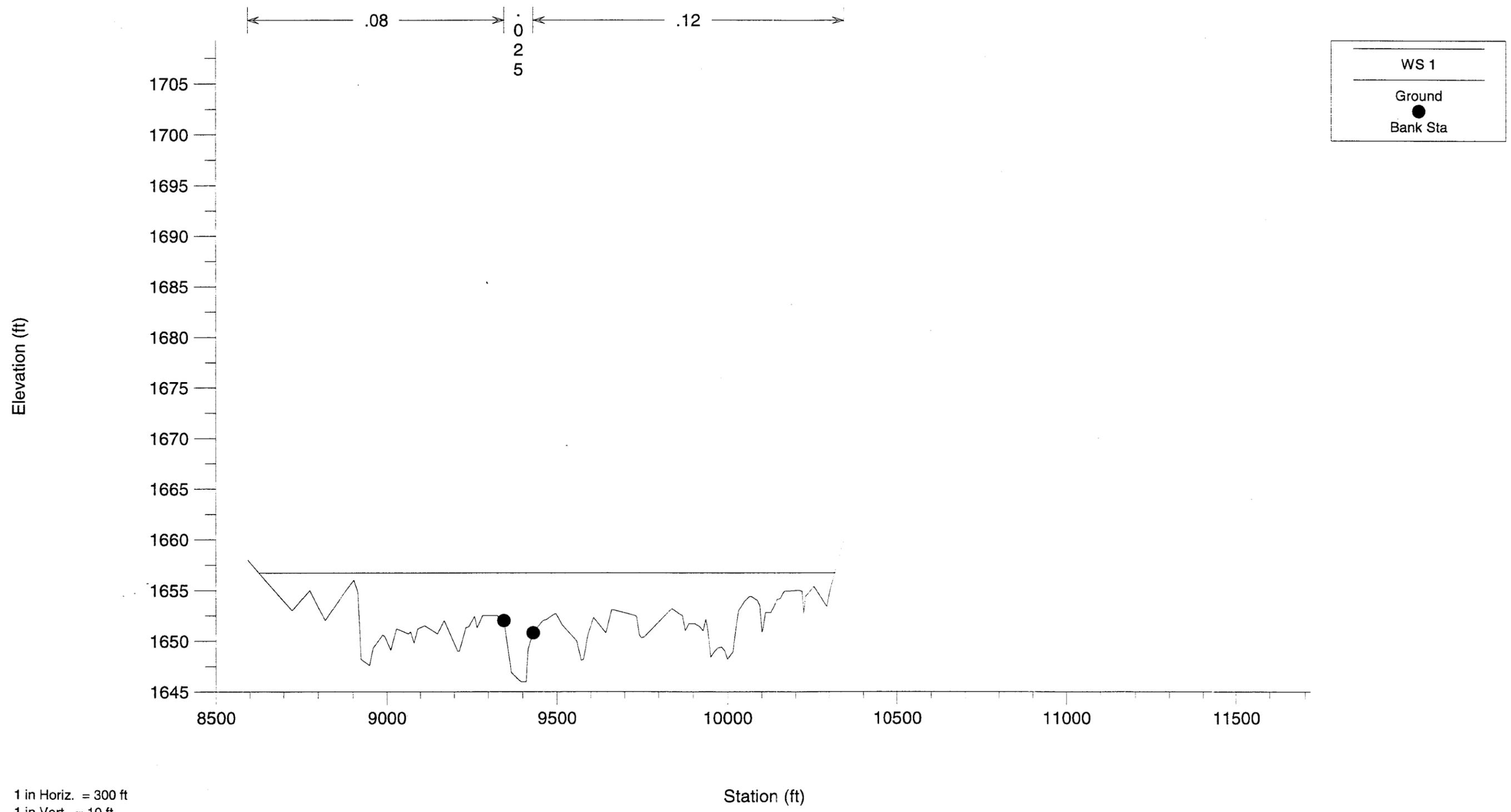
Cave Creek Wash South FIS 100-Year "n" Values
24.919 Cross Section E



Cave Creek Wash South FIS 100-Year "n" Values
25.010 Cross Section F



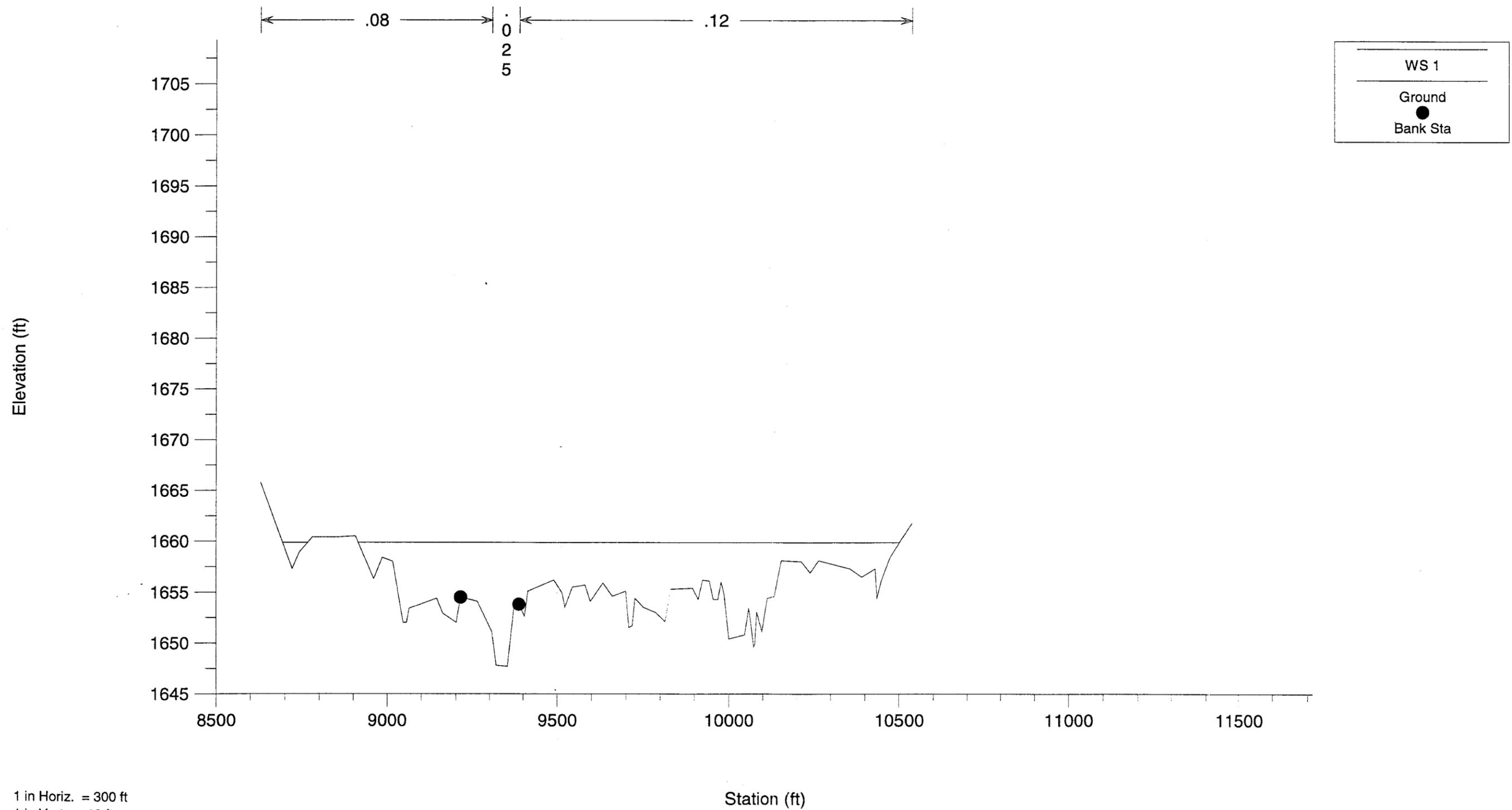
Cave Creek Wash South FIS 100-Year "n" Values
25.099 Cross Section G



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

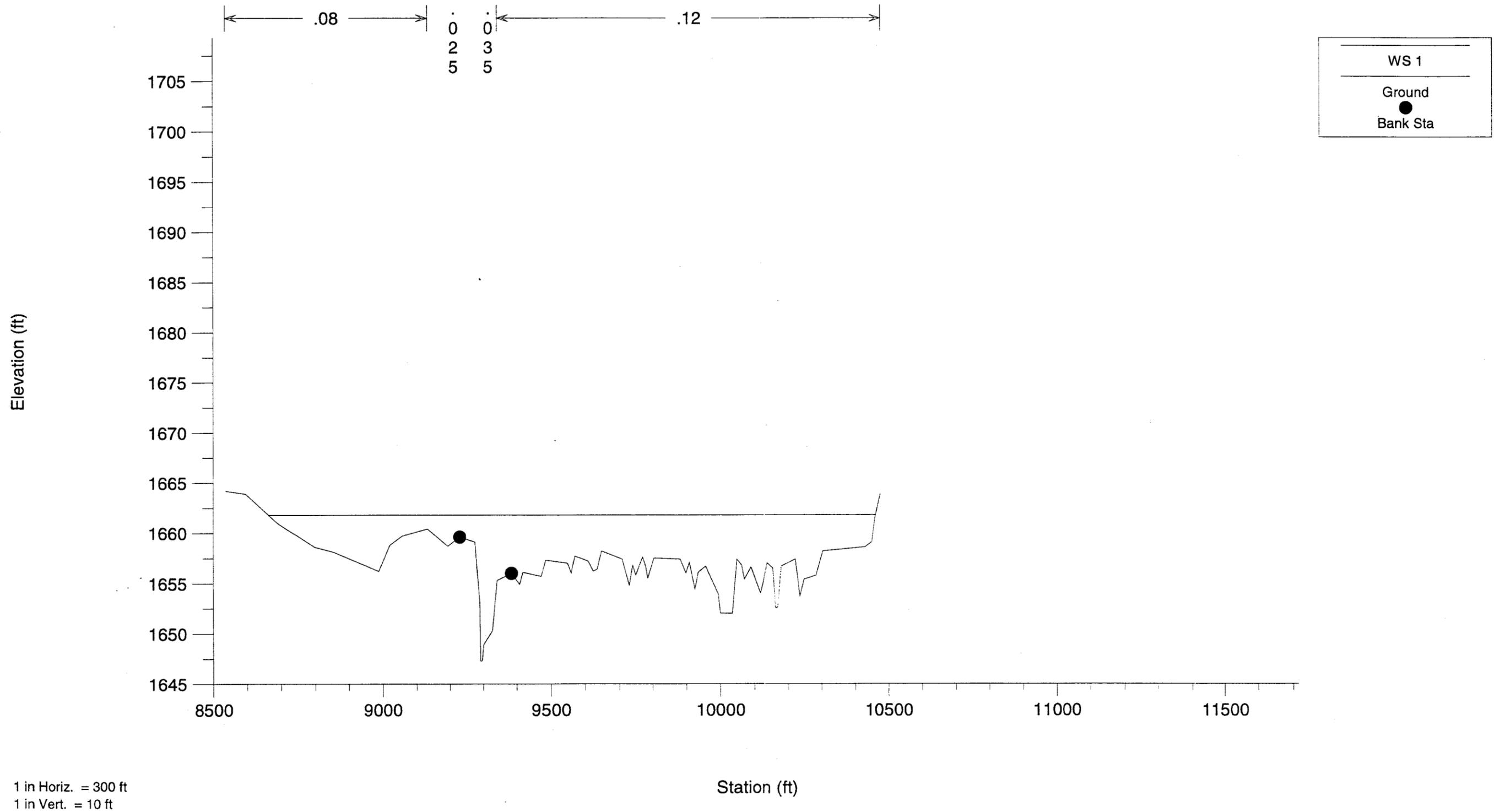
Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
25.180 Cross Section H



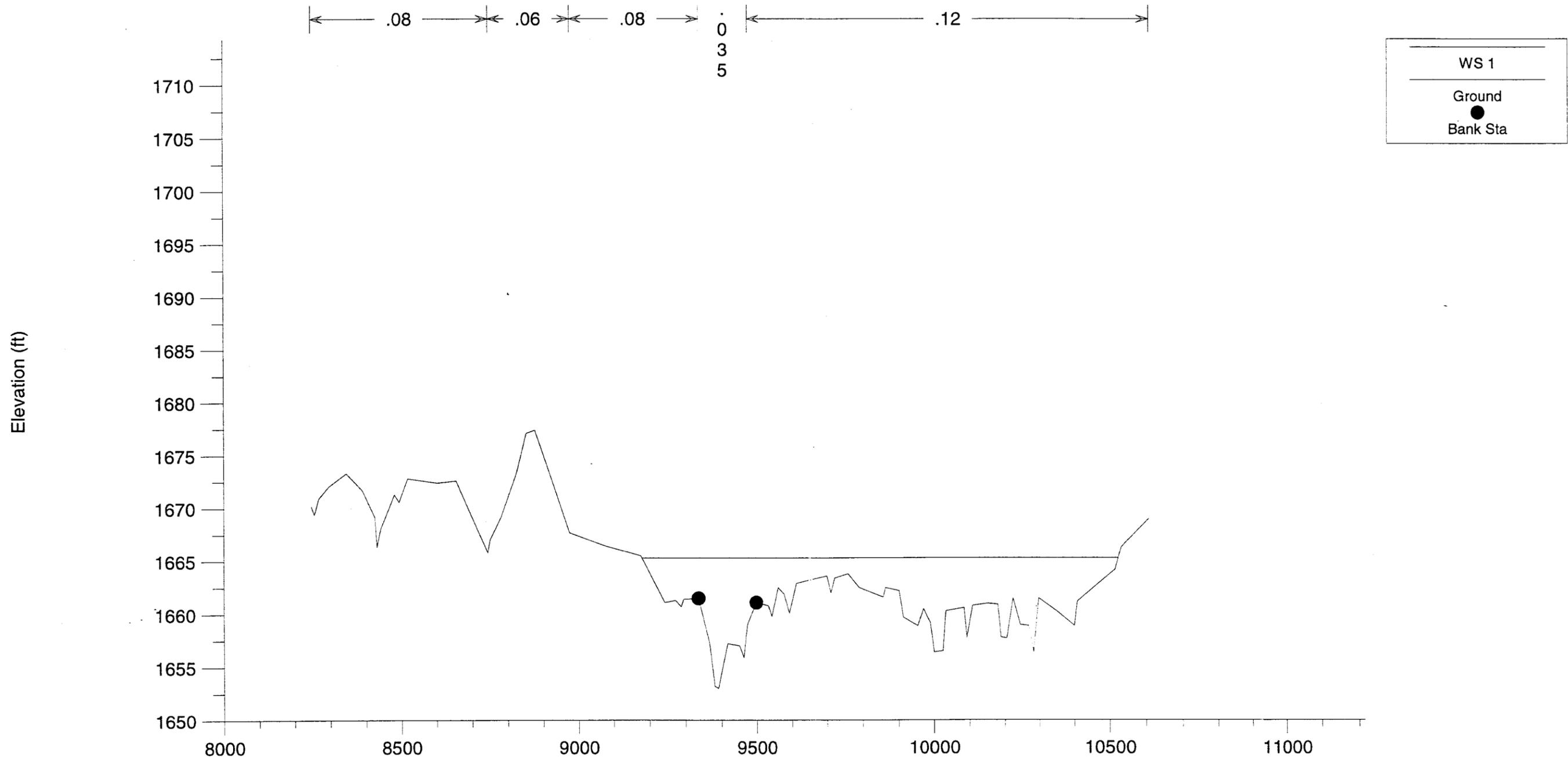
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
25.233 Cross Section I

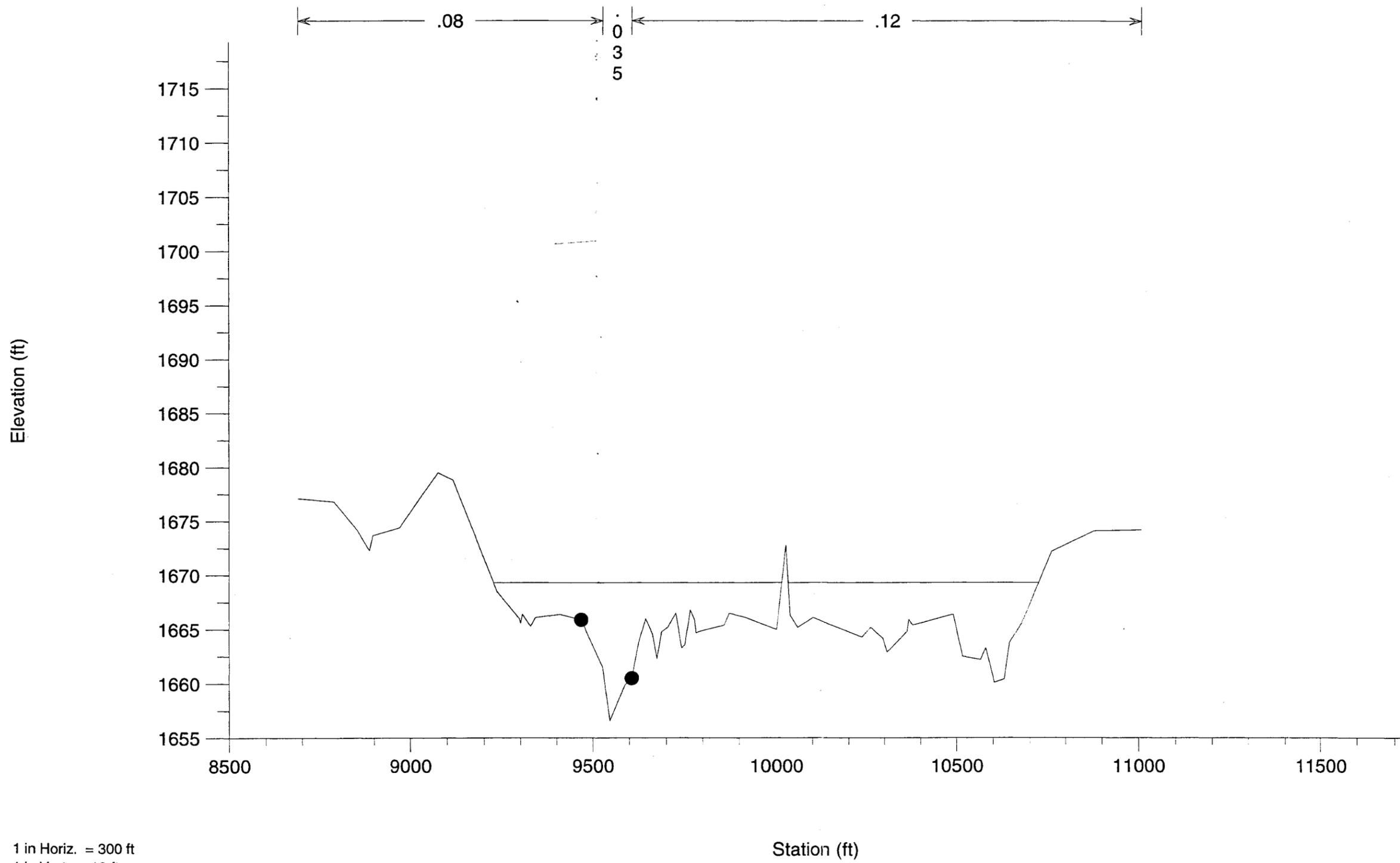


1 in Horiz. = 300 ft
1 in Vert. = 10 ft

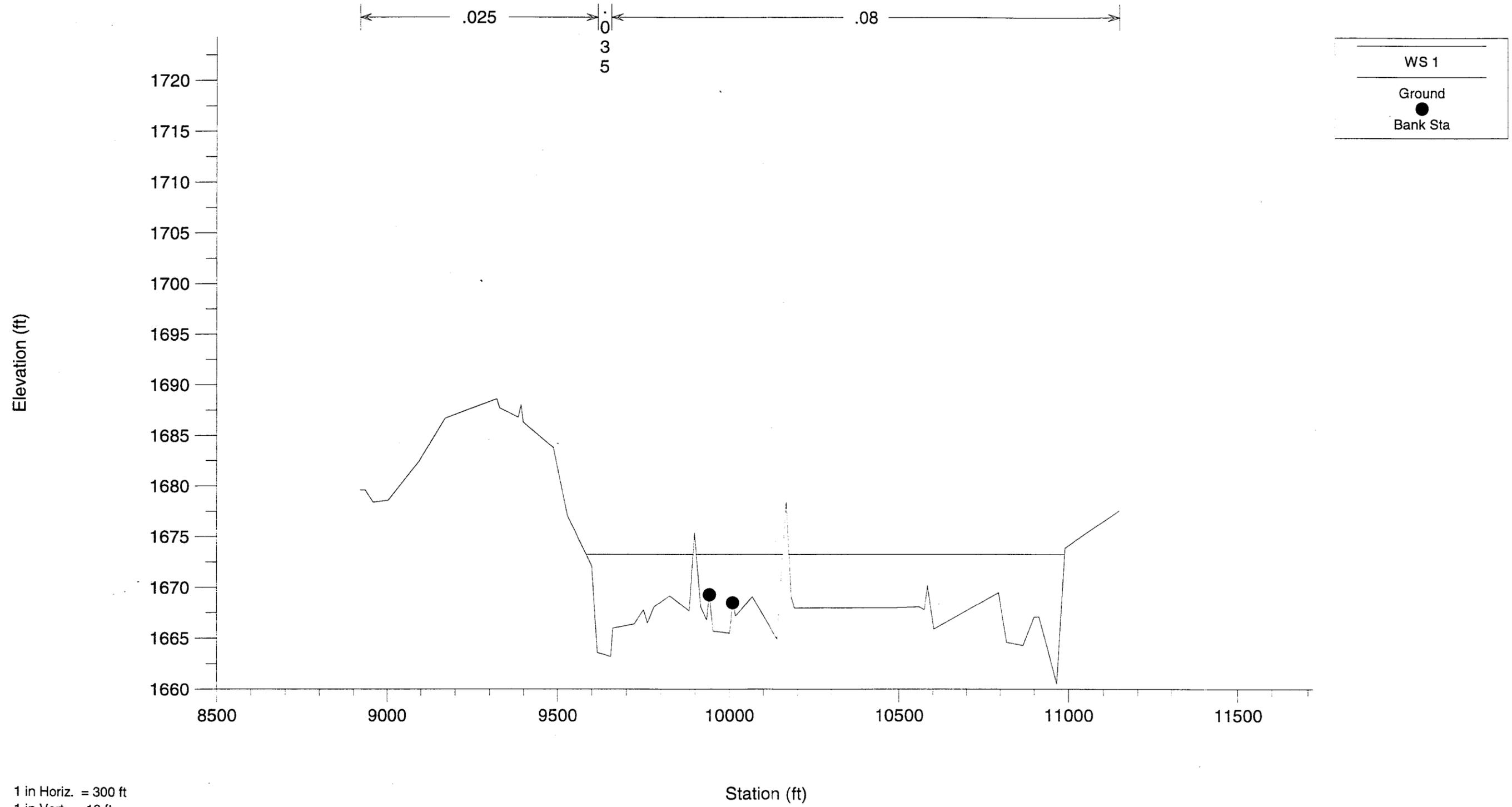
Cave Creek Wash South FIS 100-Year "n" Values
25.326 Cross Section J



Cave Creek Wash South FIS 100-Year "n" Values
25.388 Cross Section K

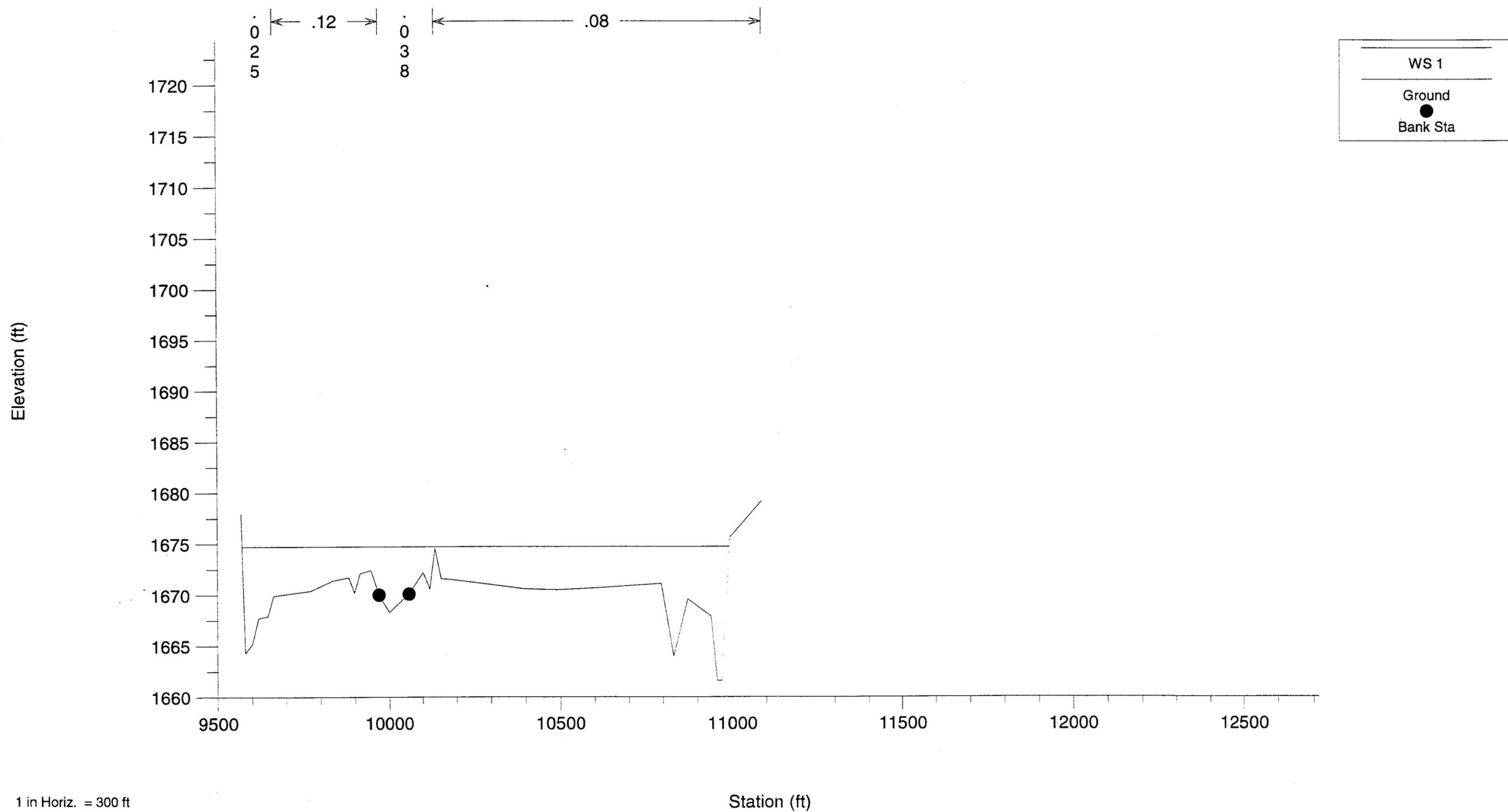


Cave Creek Wash South FIS 100-Year "n" Values
25.458 Cross Section L



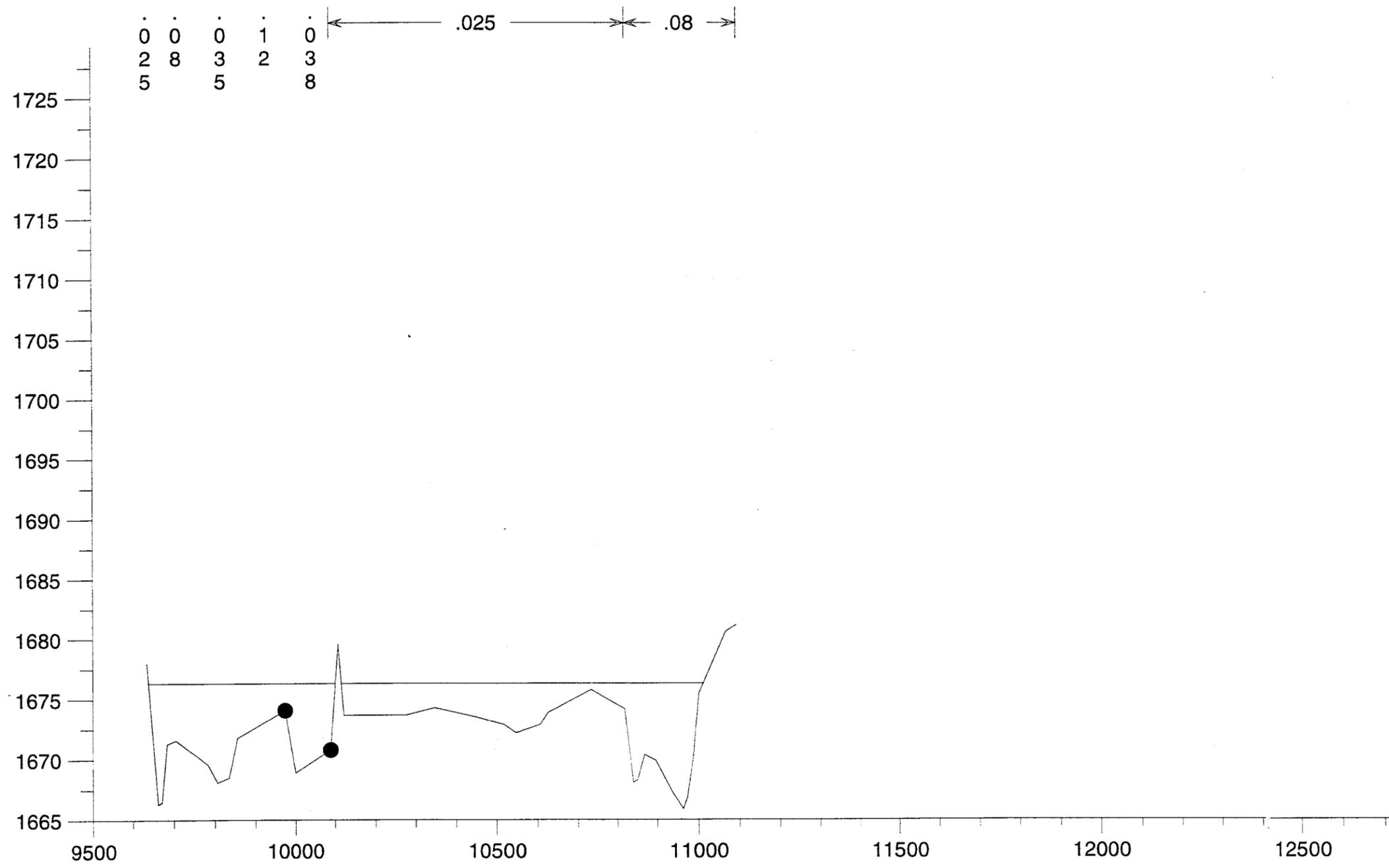
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
25.519 Cross Section M



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
25.580 Cross Section N

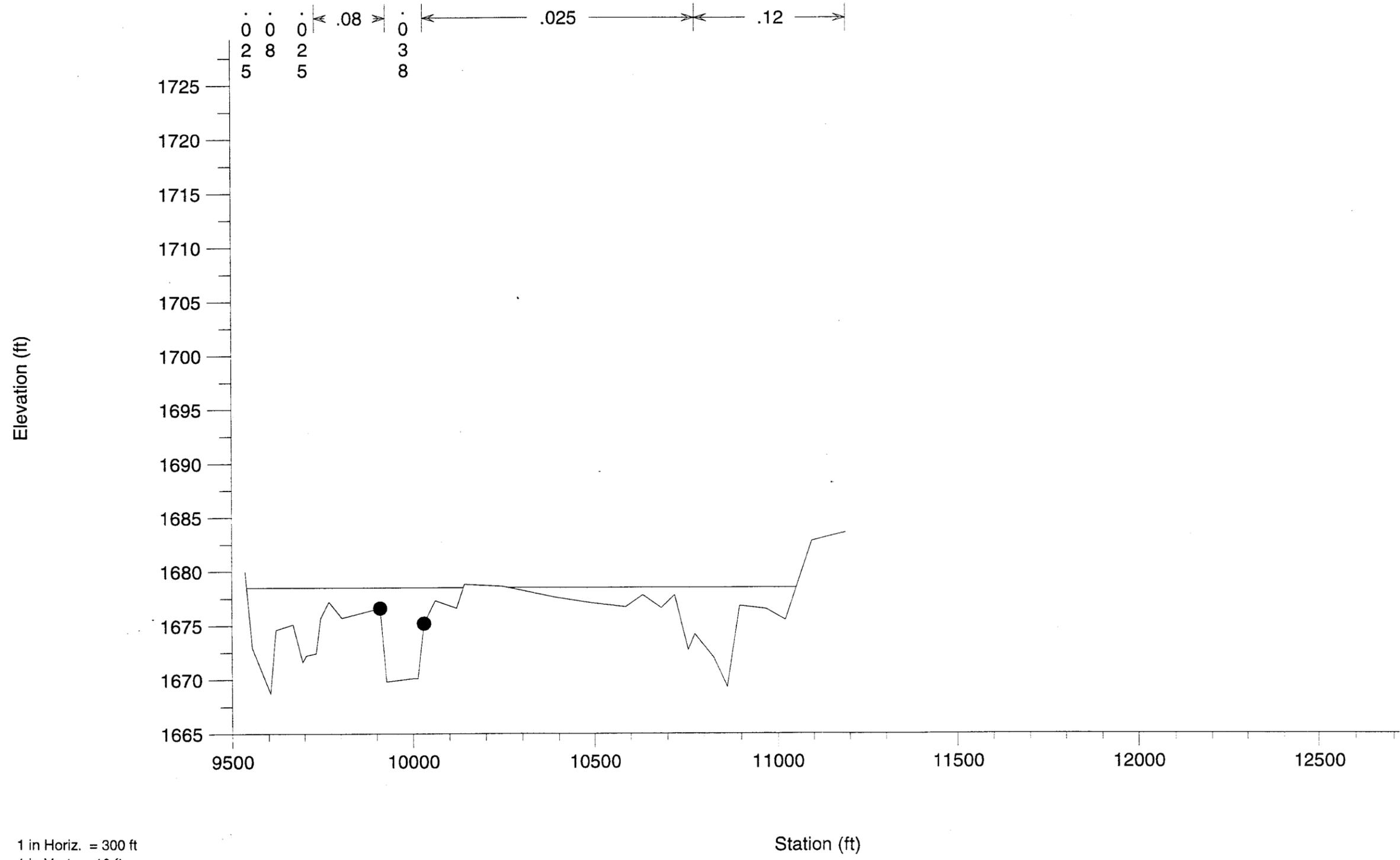


WS 1
Ground
●
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
25.644 Cross Section O

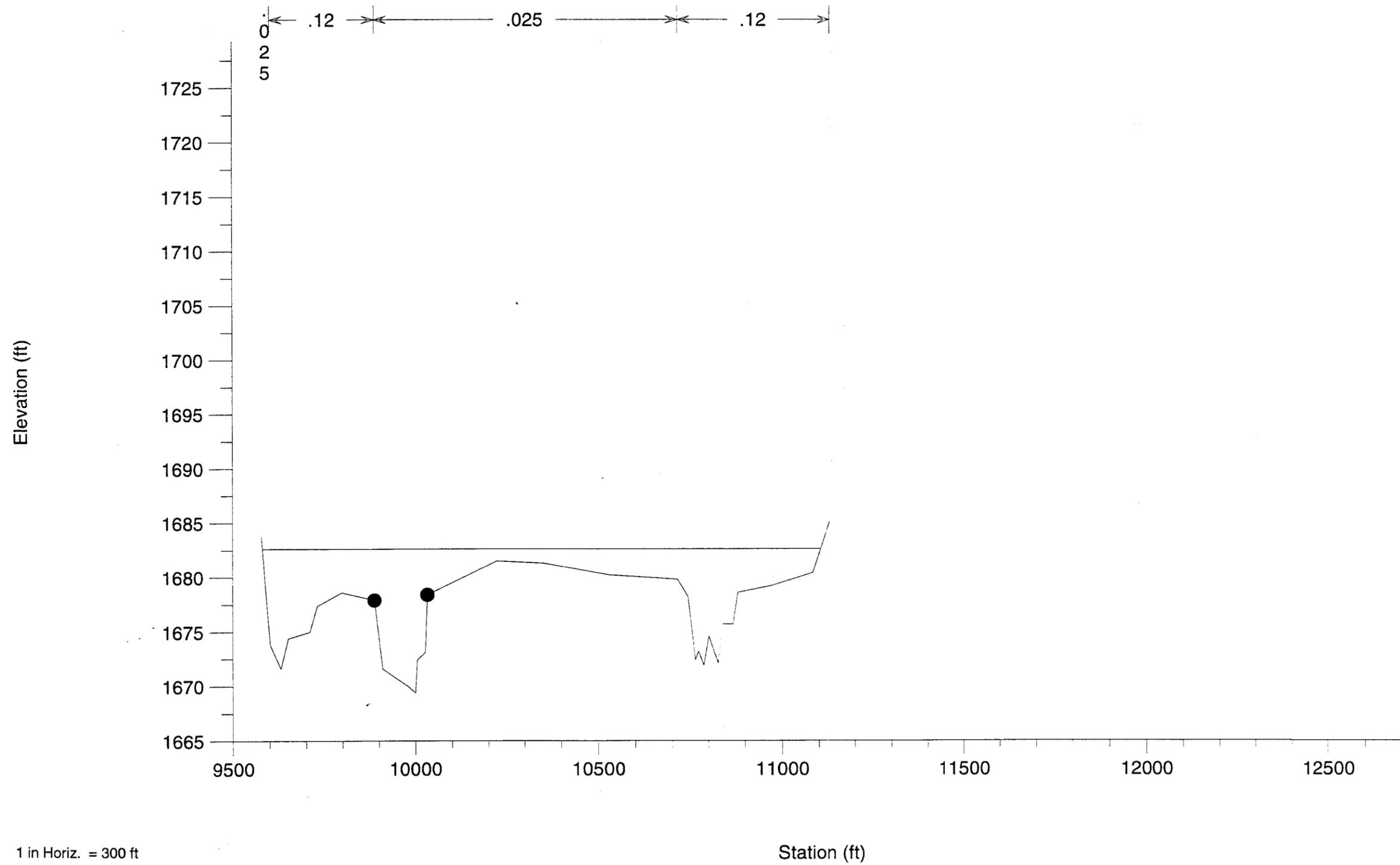


WS 1
Ground
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

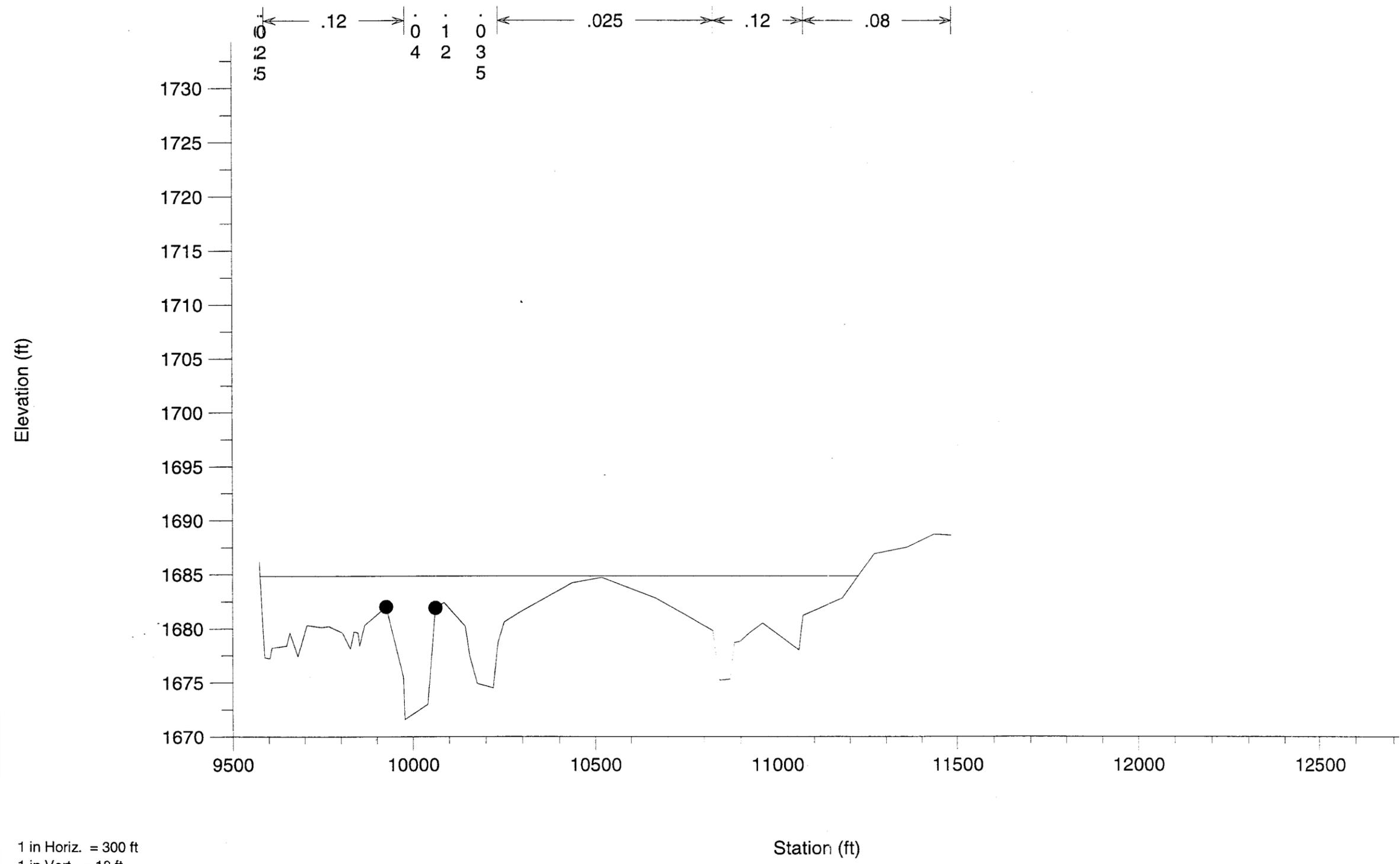
Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
25.699 Cross Section P



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

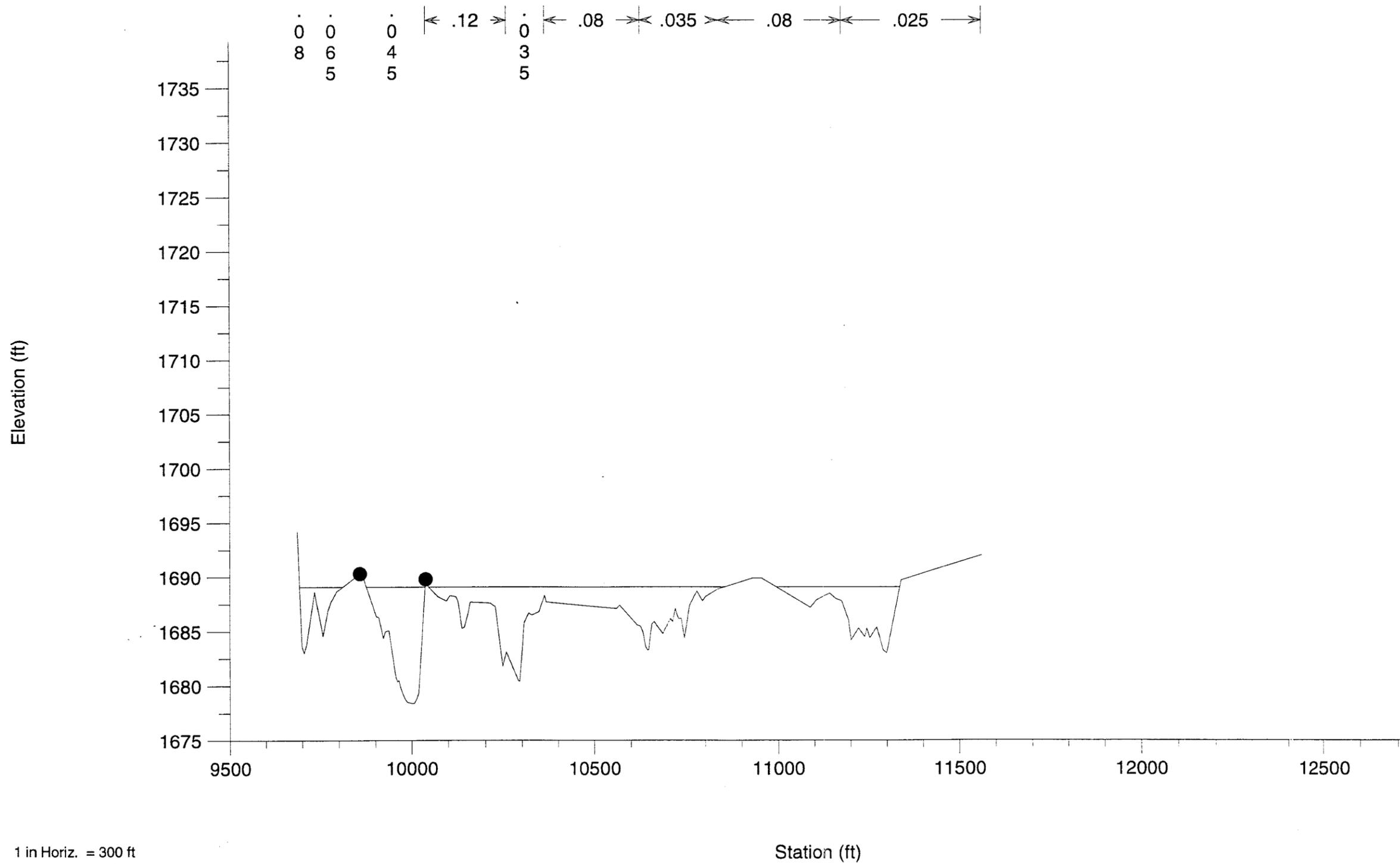
Cave Creek Wash South FIS 100-Year "n" Values
25.750 Cross Section Q



WS 1
Ground
Bank Sta

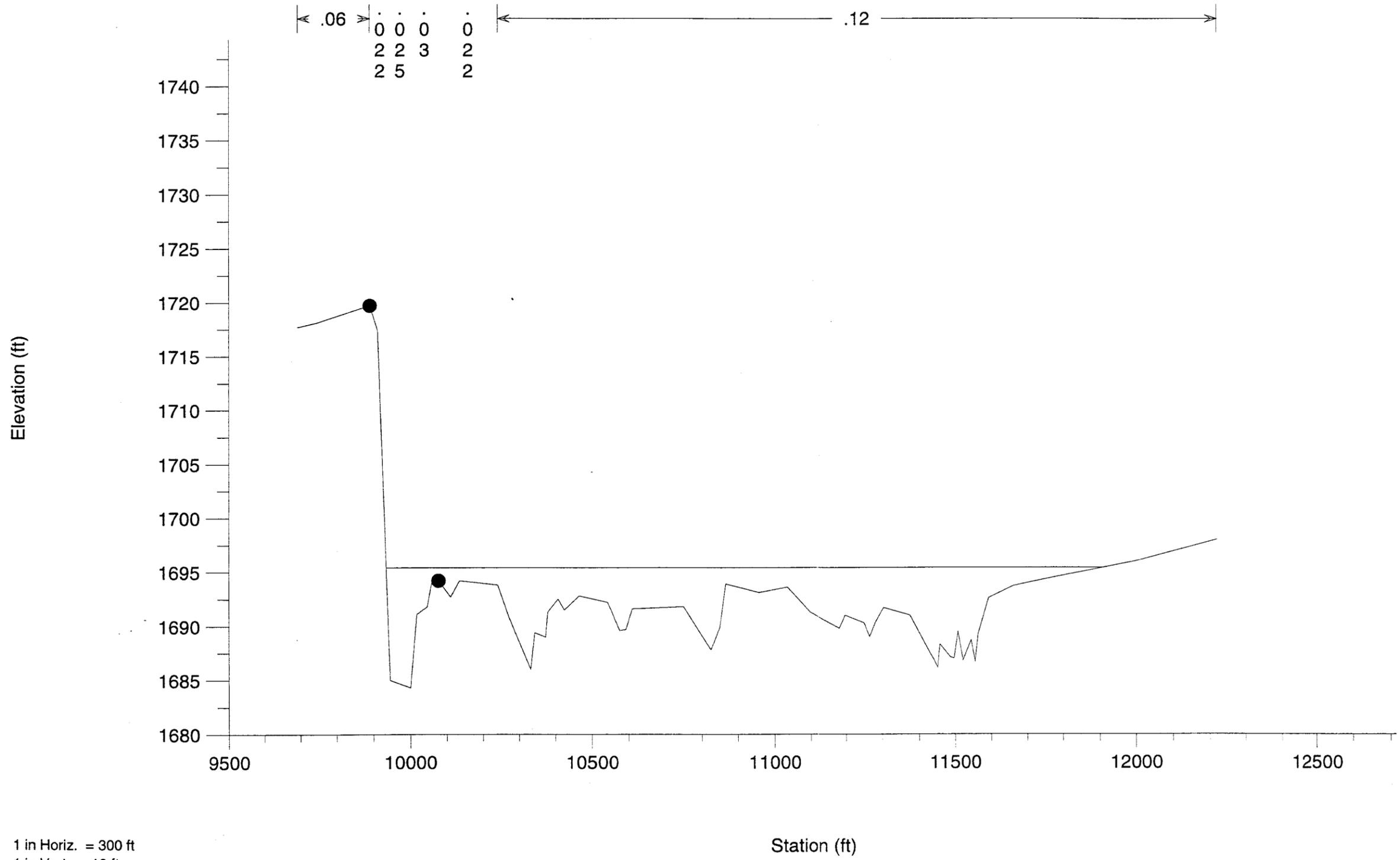
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
25.919 Cross Section S



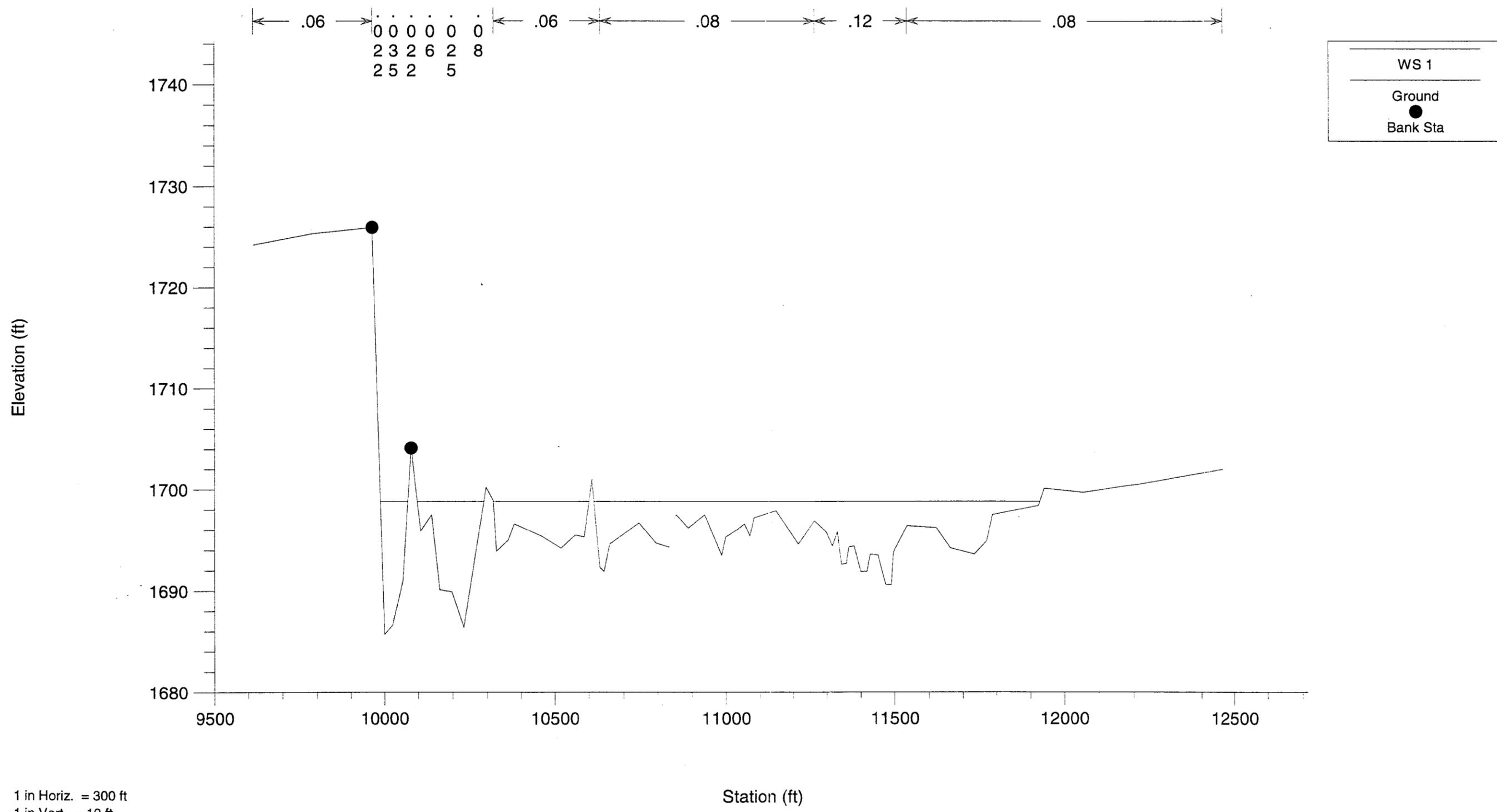
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
26.044 Cross Section T



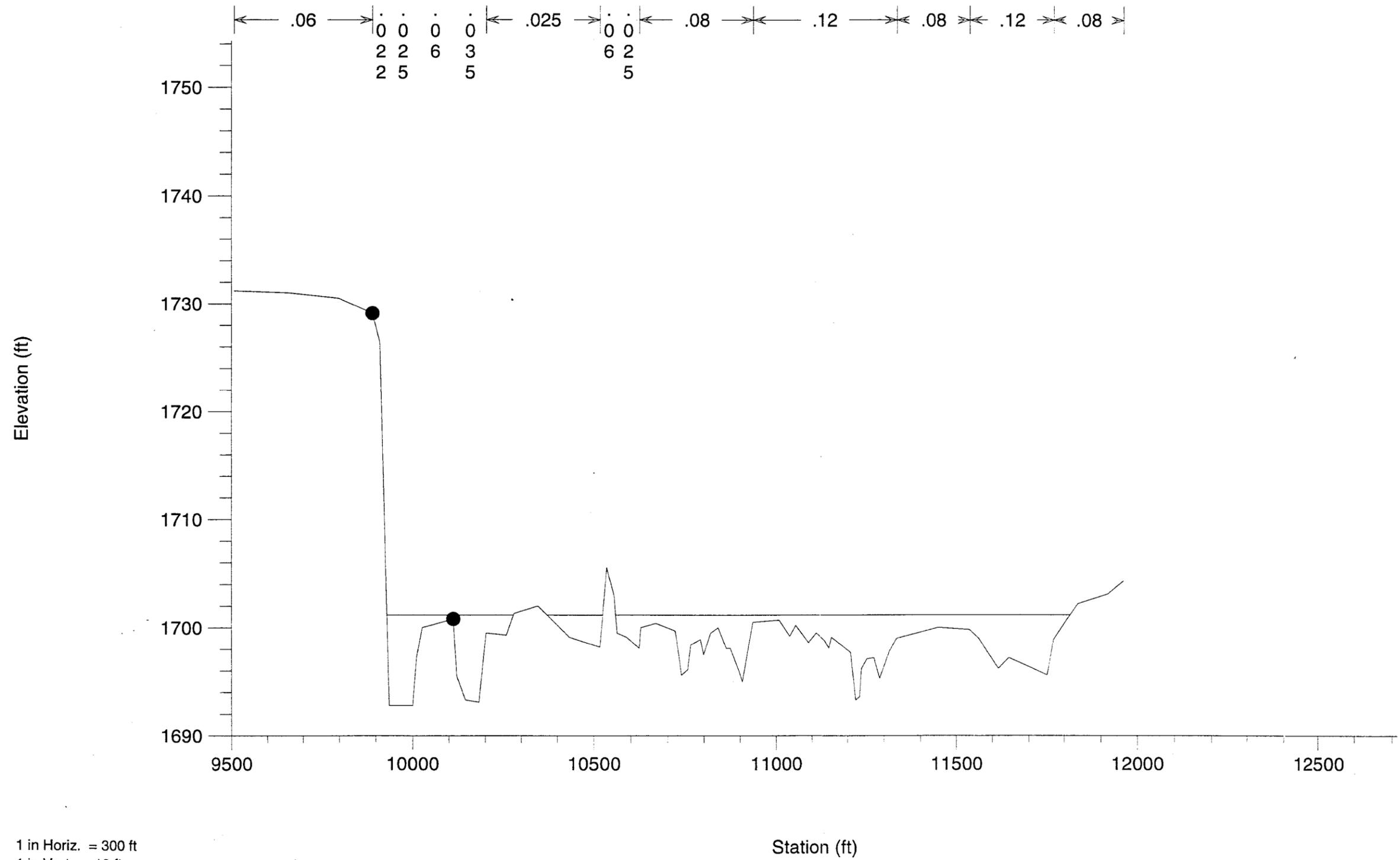
WS 1
Ground
● Bank Sta

Cave Creek Wash South FIS 100-Year "n" Values
26.137 Cross Section U



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

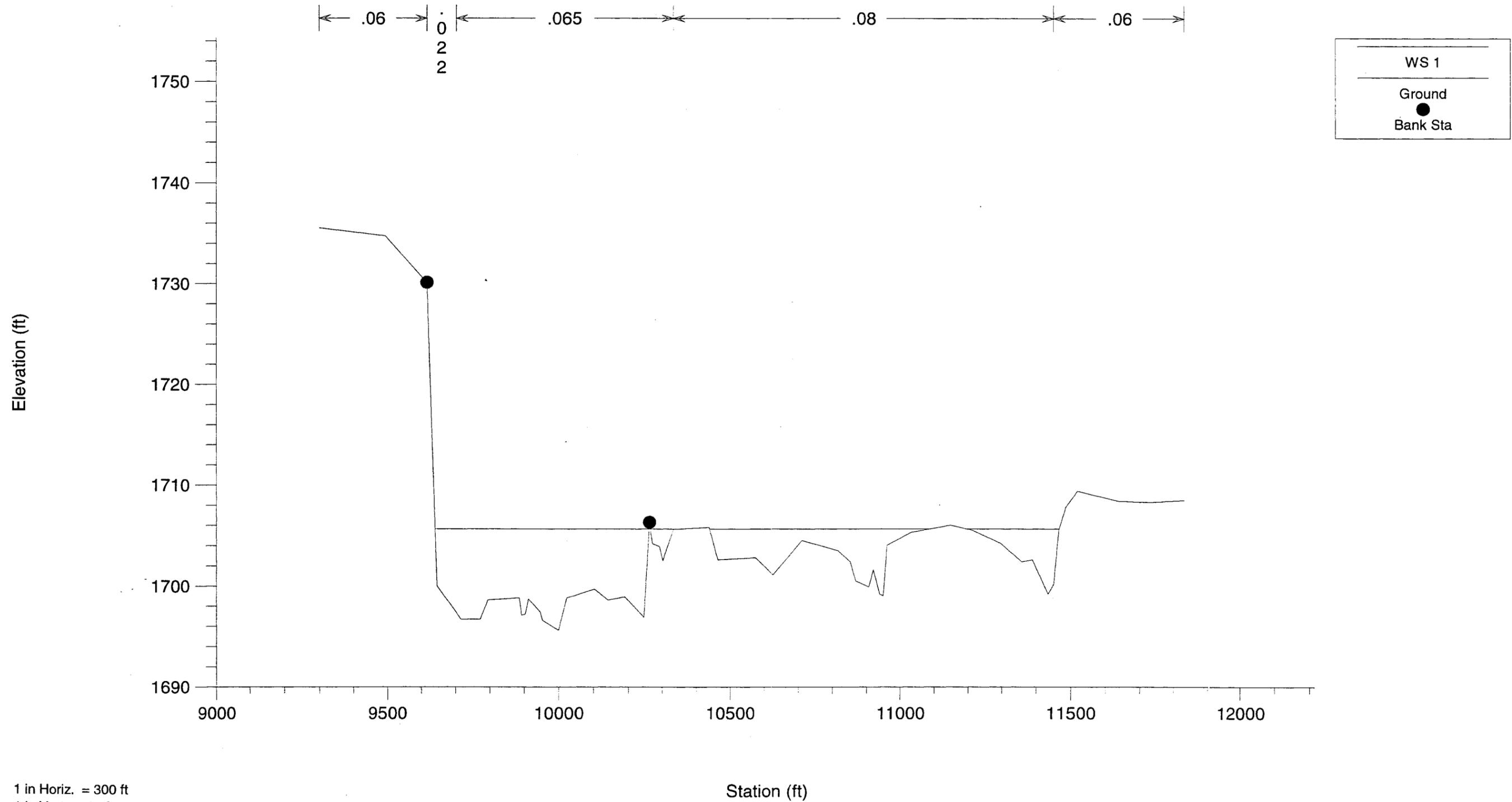
Cave Creek Wash South FIS 100-Year "n" Values
 26.239 Cross Section V



WS 1
Ground
Bank Sta

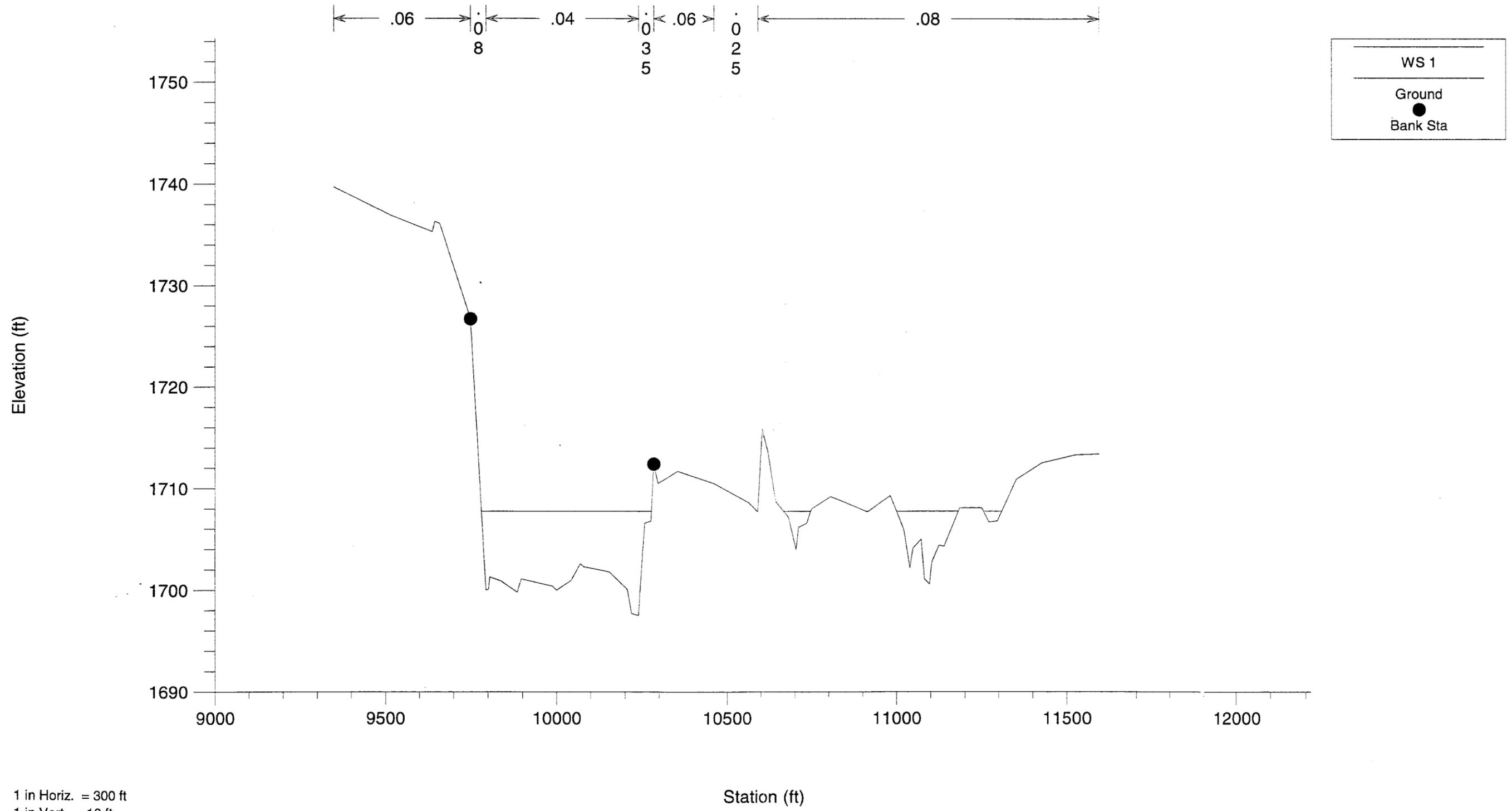
1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
26.335 Cross Section W



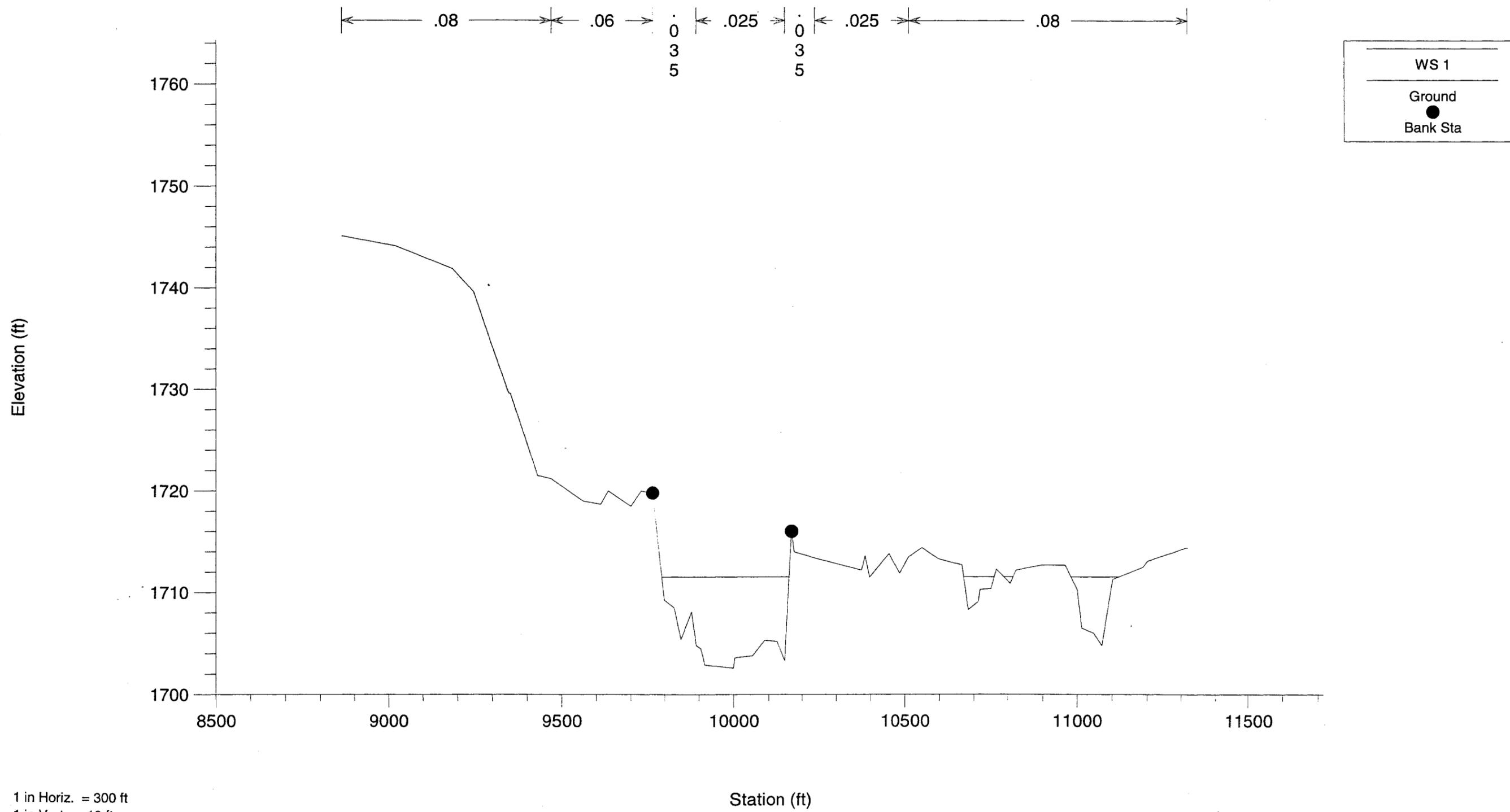
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
26.430 Cross Section X

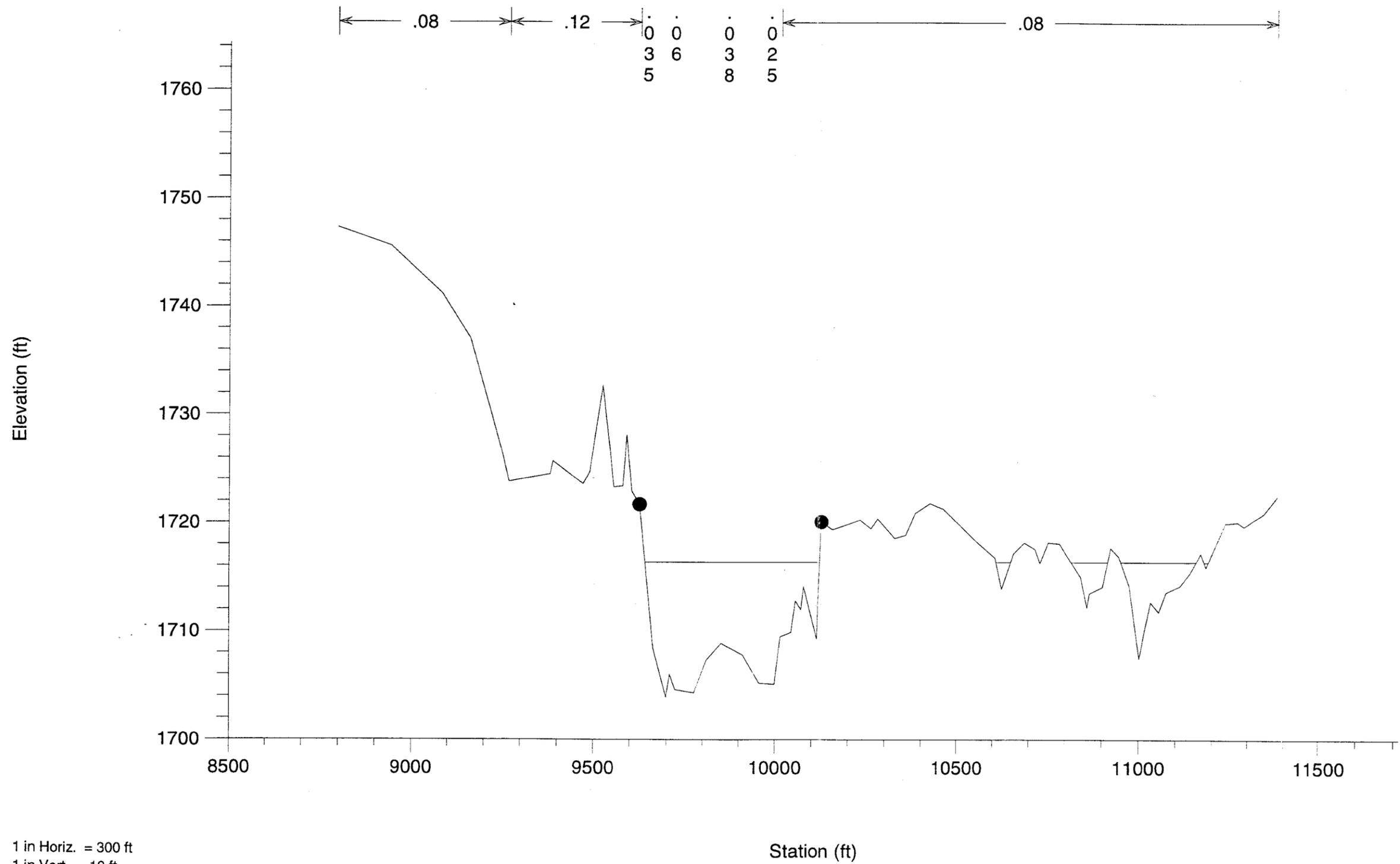


1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
26.529 Cross Section Y



Cave Creek Wash South FIS 100-Year "n" Values
 26.623 Cross Section Z



WS 1
 Ground
 ● Bank Sta

1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

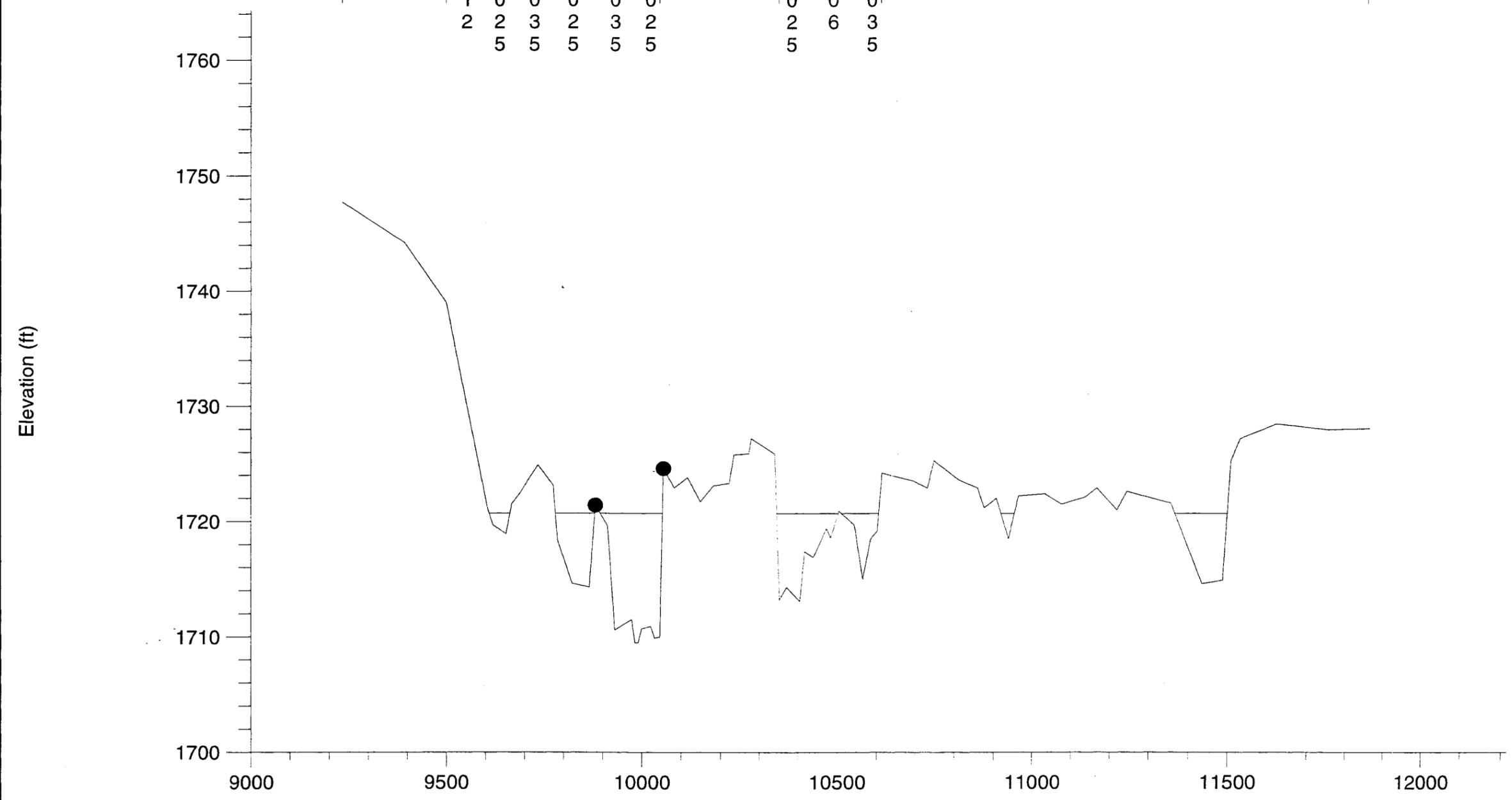
Cave Creek Wash South FIS 100-Year "n" Values
 26.695 Cross Section AA

← .06 →						← .06 →			← .08 →			
1	0	0	0	0	0	0	0	0				
2	2	3	2	3	2	2	6	3				
	5	5	5	5	5	5		5				

WS 1

Ground

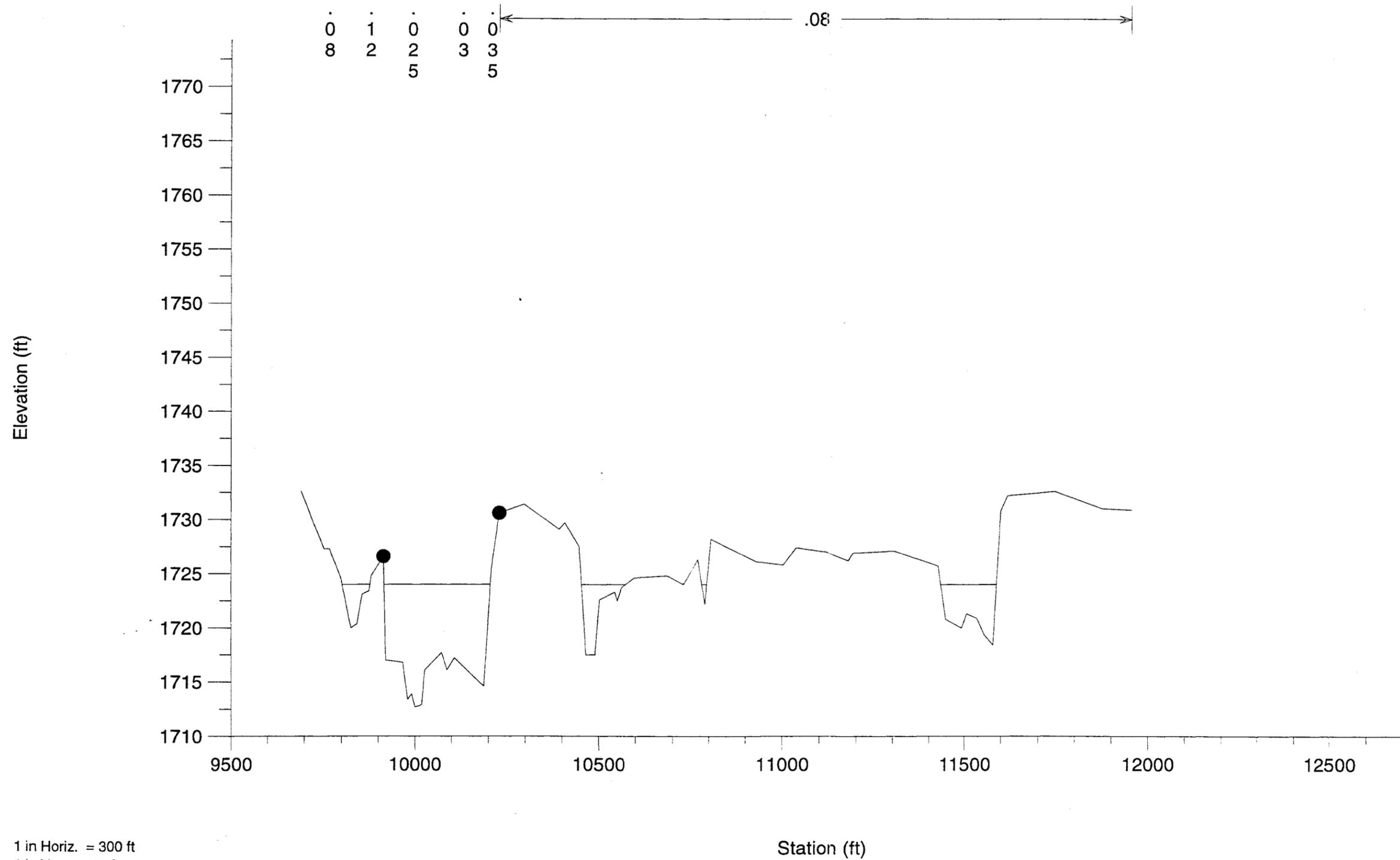
● Bank Sta



1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

Station (ft)

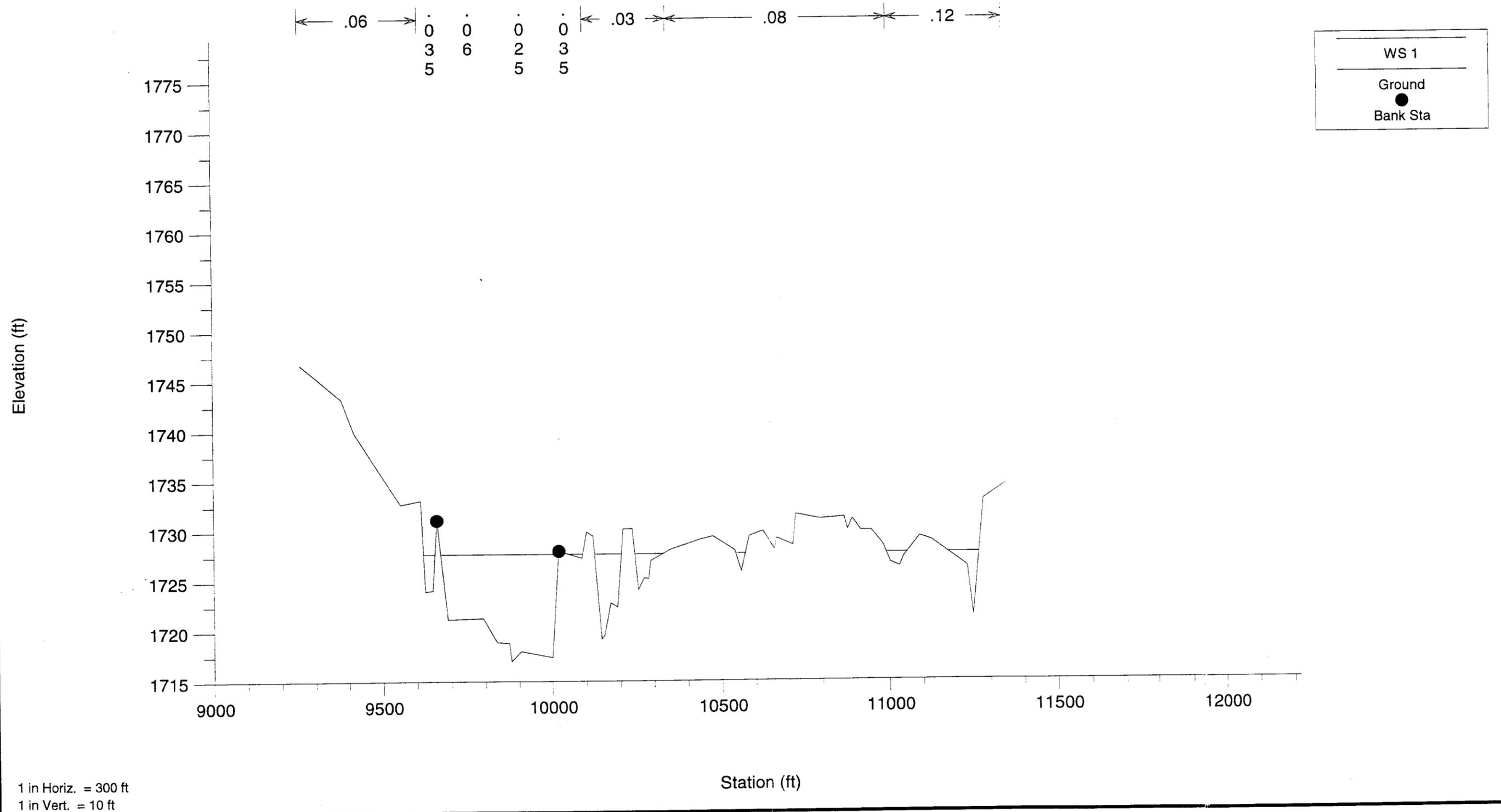
Cave Creek Wash South FIS 100-Year "n" Values
26.775 Cross Section AB



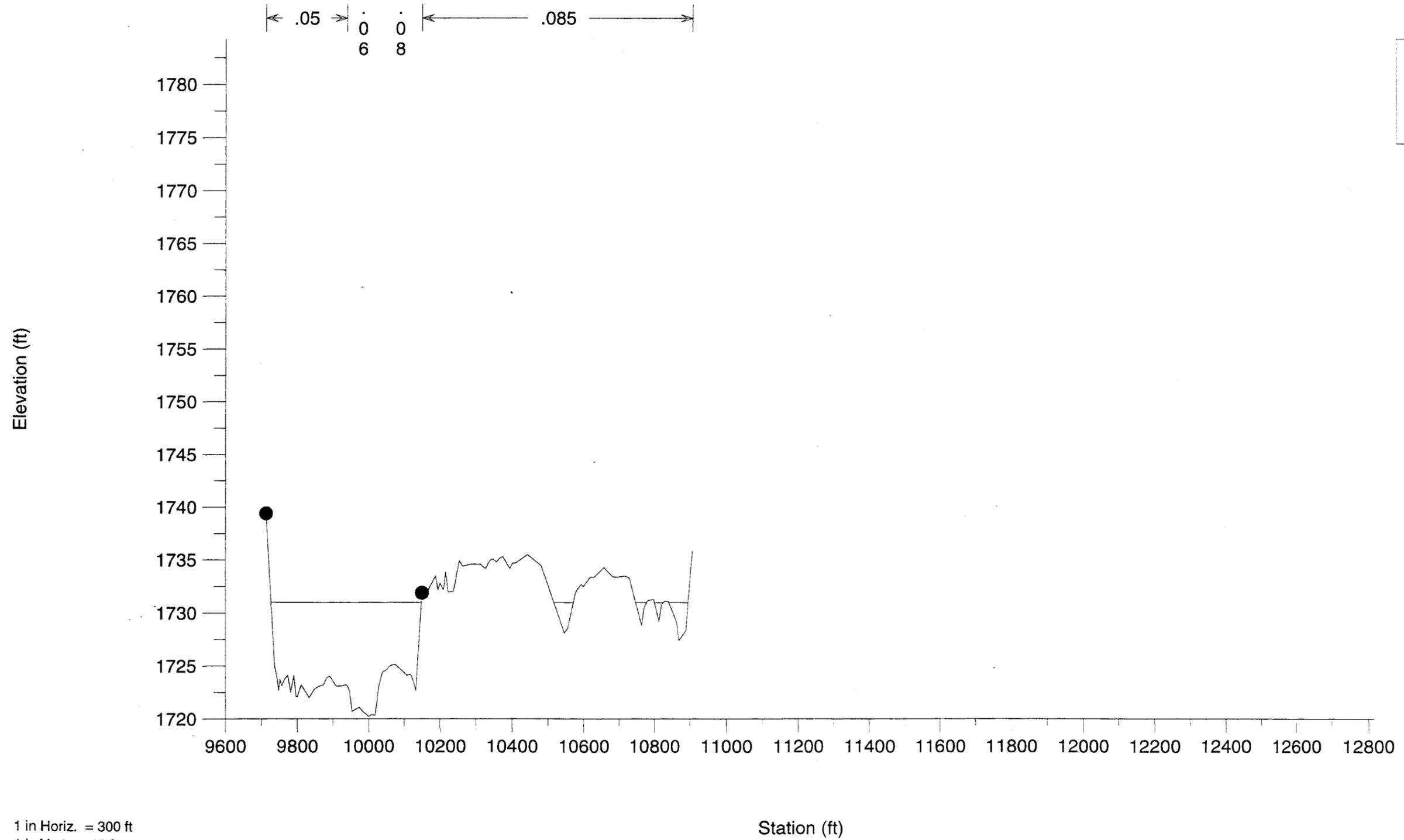
WS 1
Ground
●
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
26.845 Cross Section AC



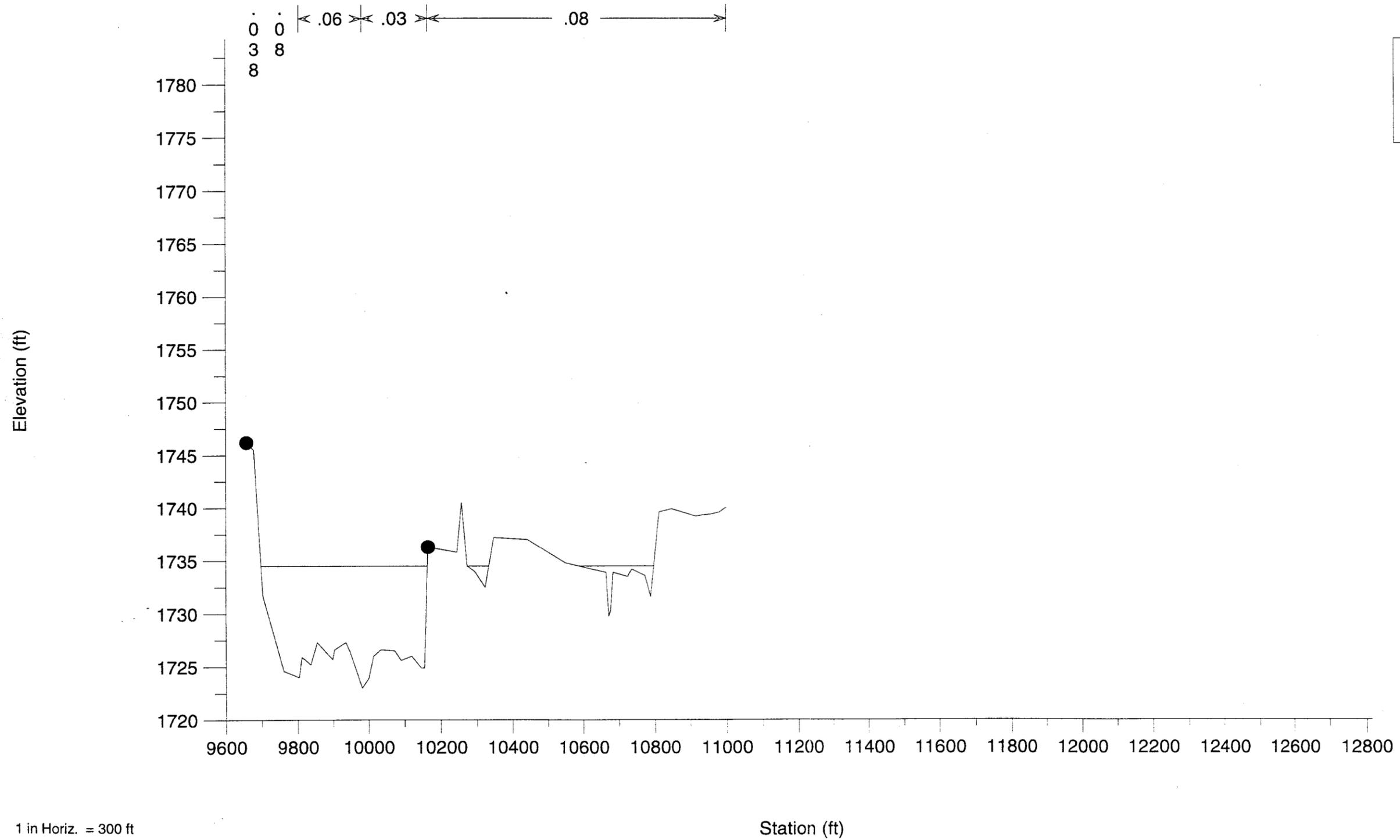
Cave Creek Wash South FIS 100-Year "n" Values
26.921 Cross Section AD



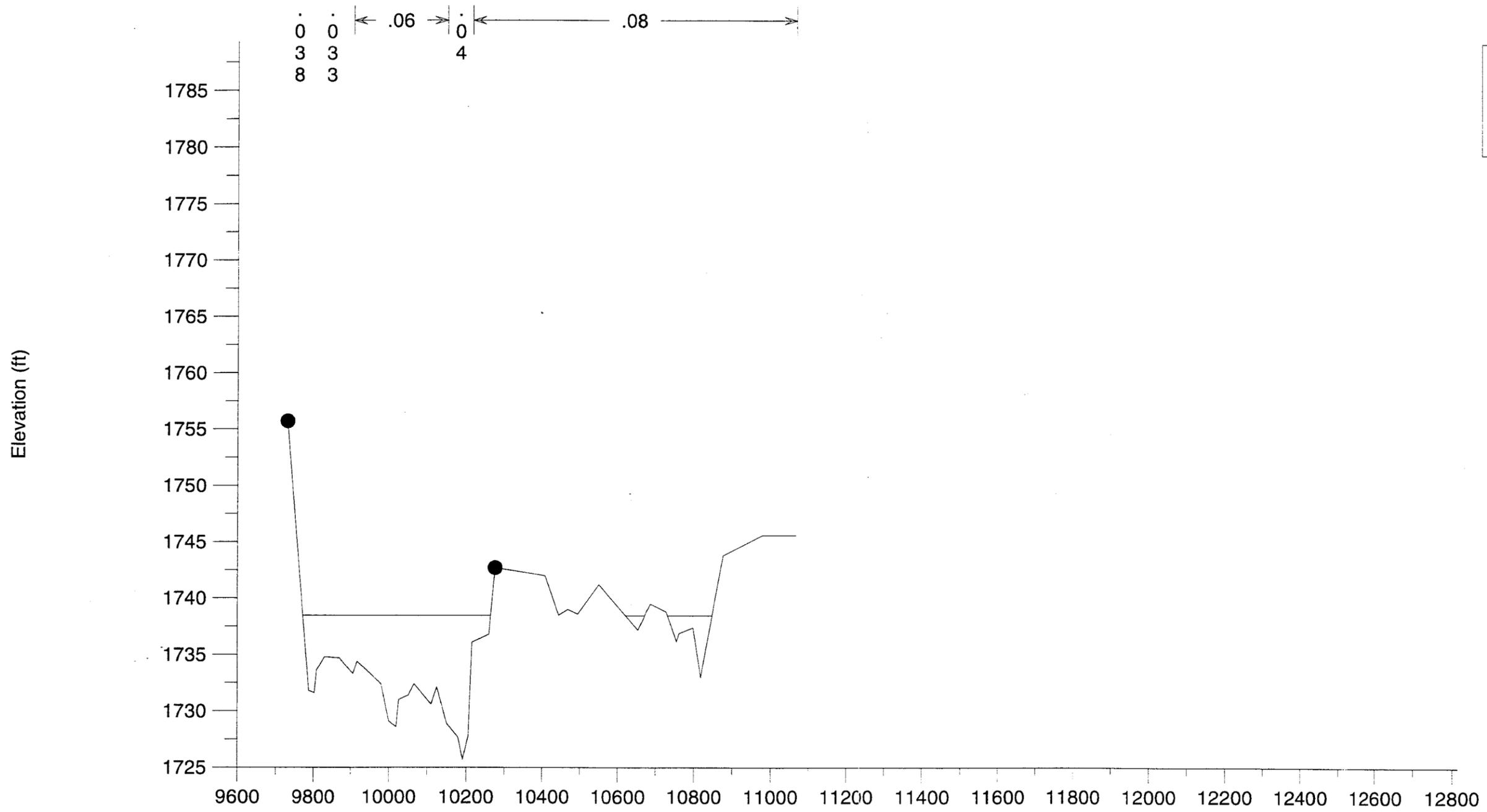
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
27.008 Cross Section AE



Cave Creek Wash South FIS 100-Year "n" Values
27.106 Cross Section AF

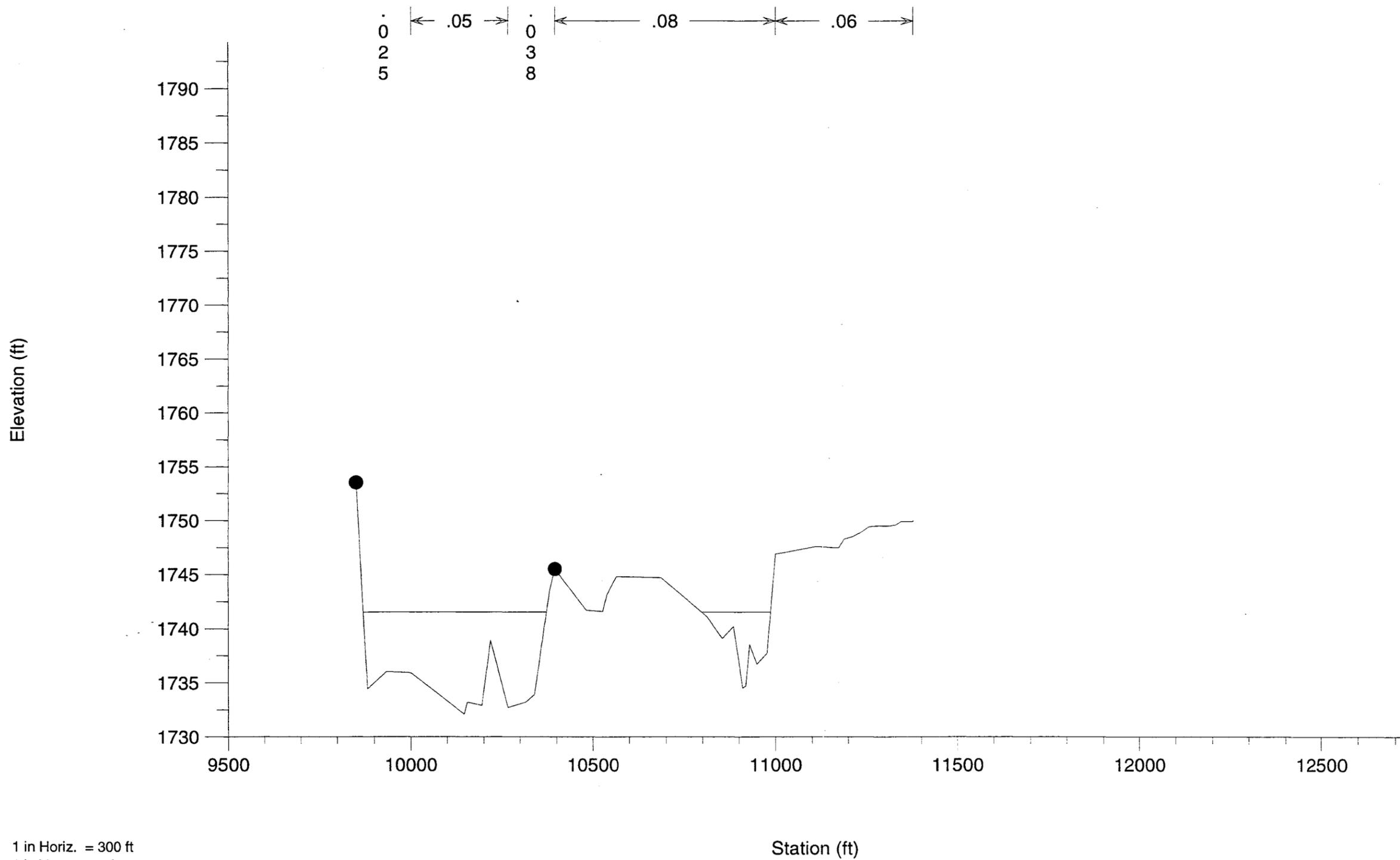


WS 1
Ground
● Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
27.169 Cross Section AG



WS 1
Ground
● Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
27.226 Cross Section AH

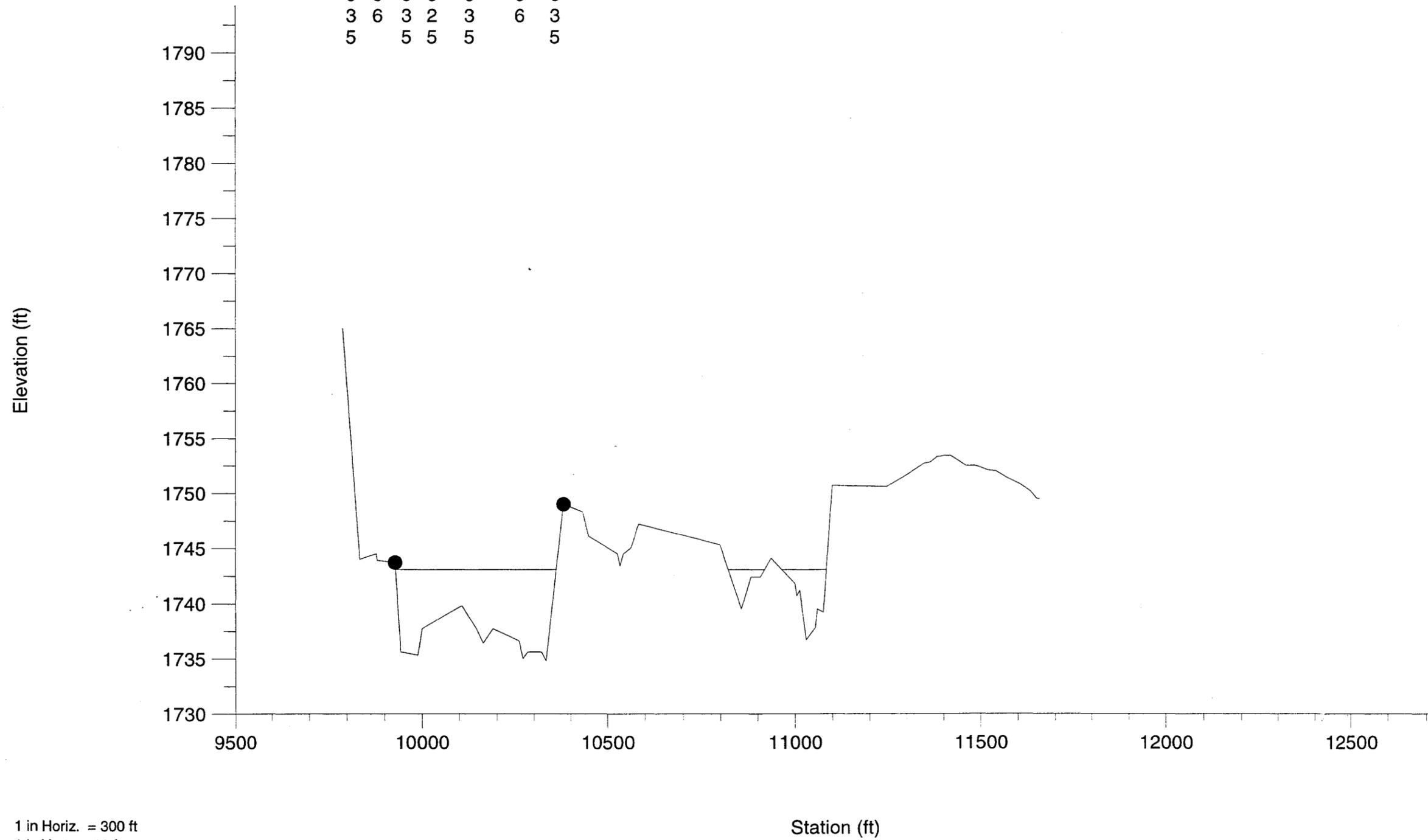
0	0	0	0	0	0	0	← .06	→ .08
3	6	3	2	3	6	3		
5		5	5	5		5		

WS 1

Ground

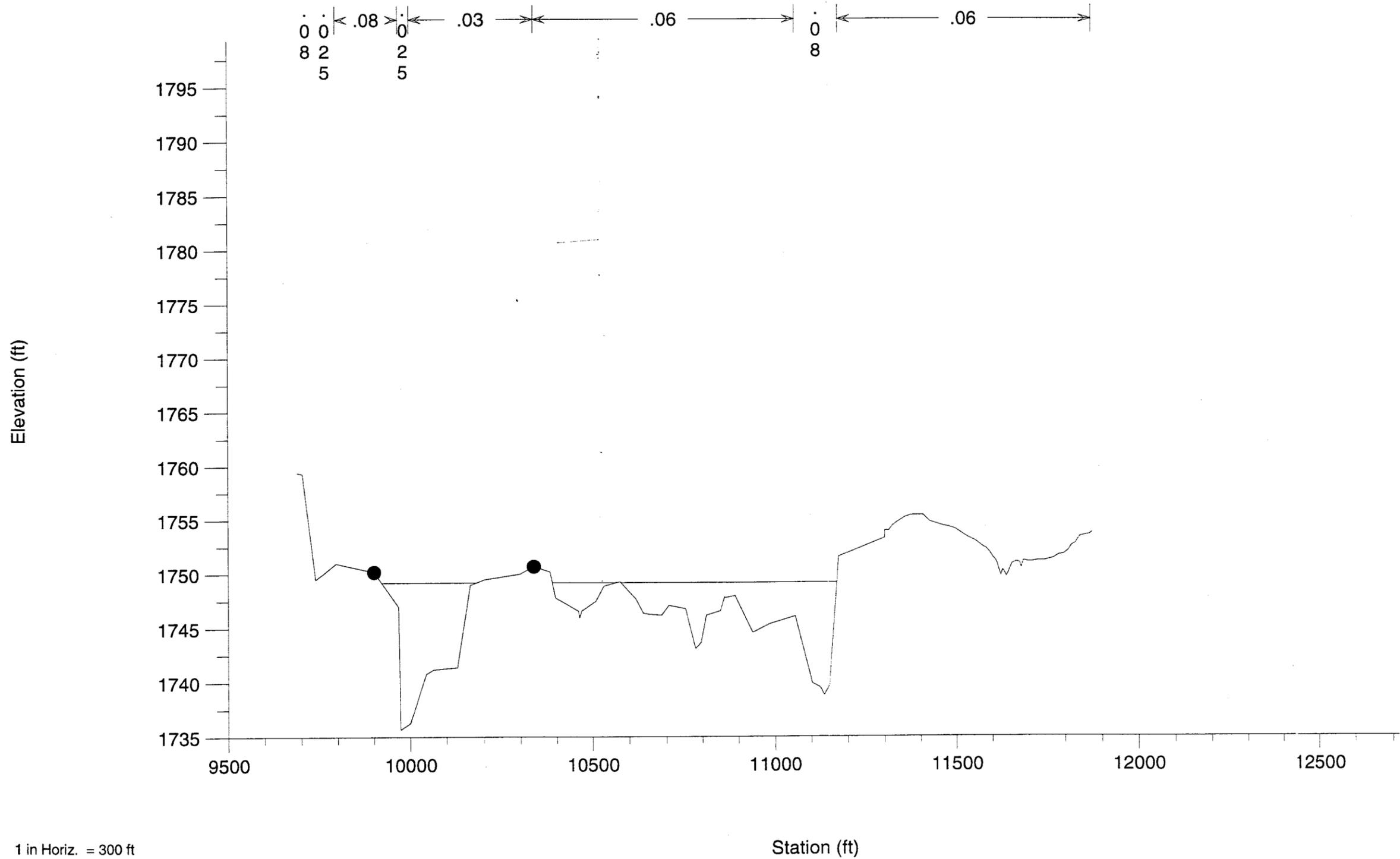
●

Bank Sta



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

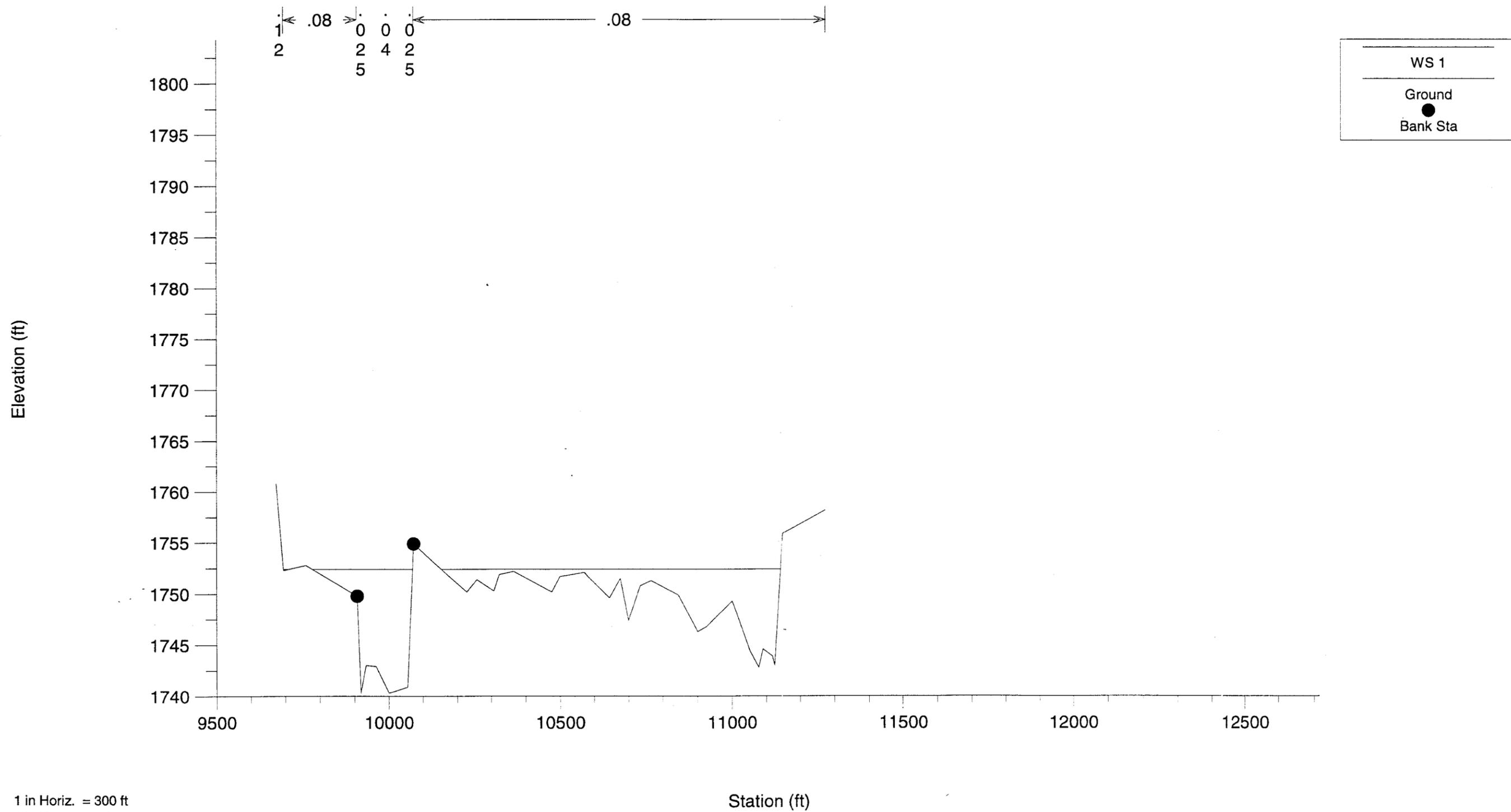
Cave Creek Wash South FIS 100-Year "n" Values
27.265 Cross Section A1



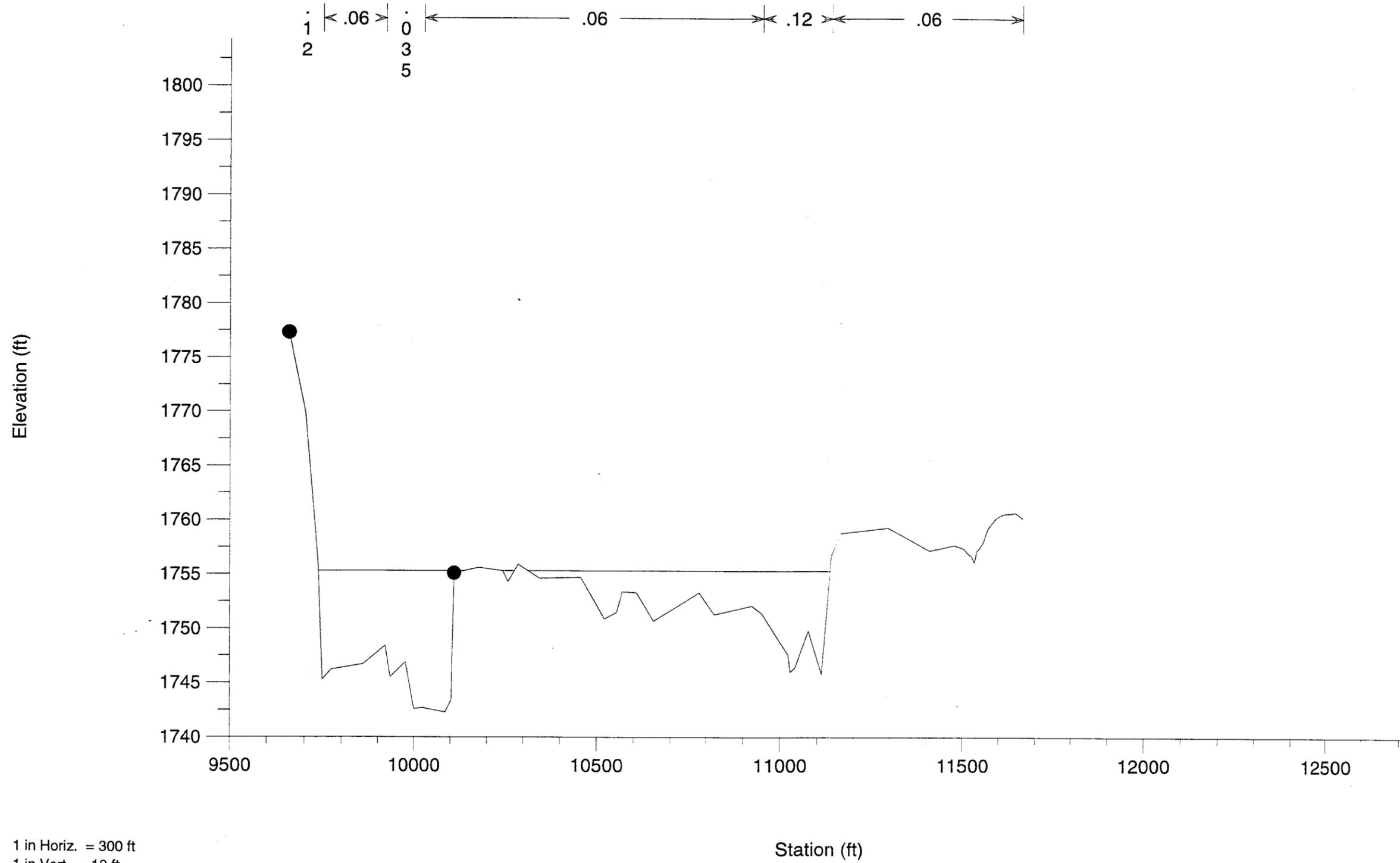
WS 1
Ground
●
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
27.320 Cross Section AJ



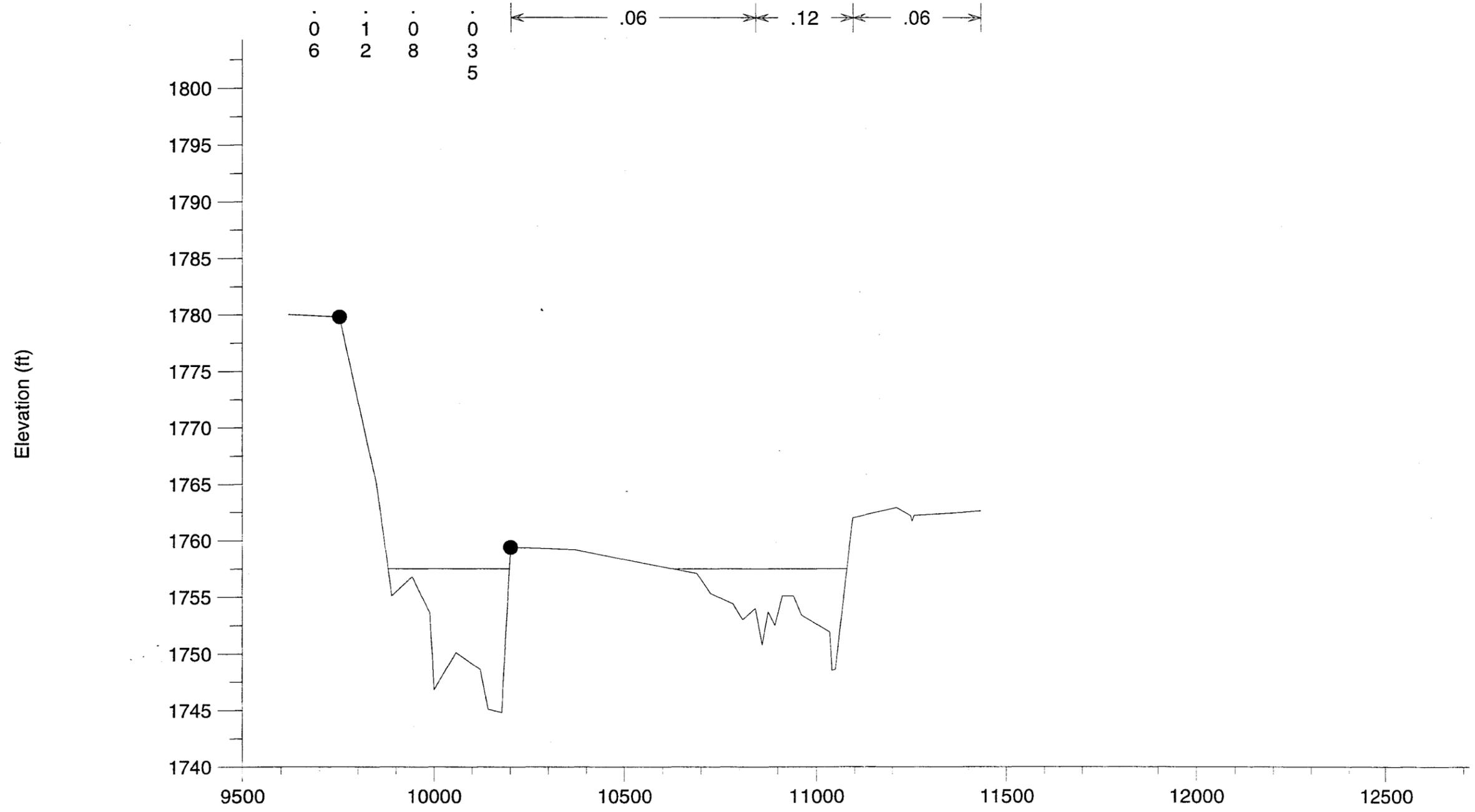
Cave Creek Wash South FIS 100-Year "n" Values
27.366 Cross Section AK



WS 1
Ground
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
 27.417 Cross Section AL

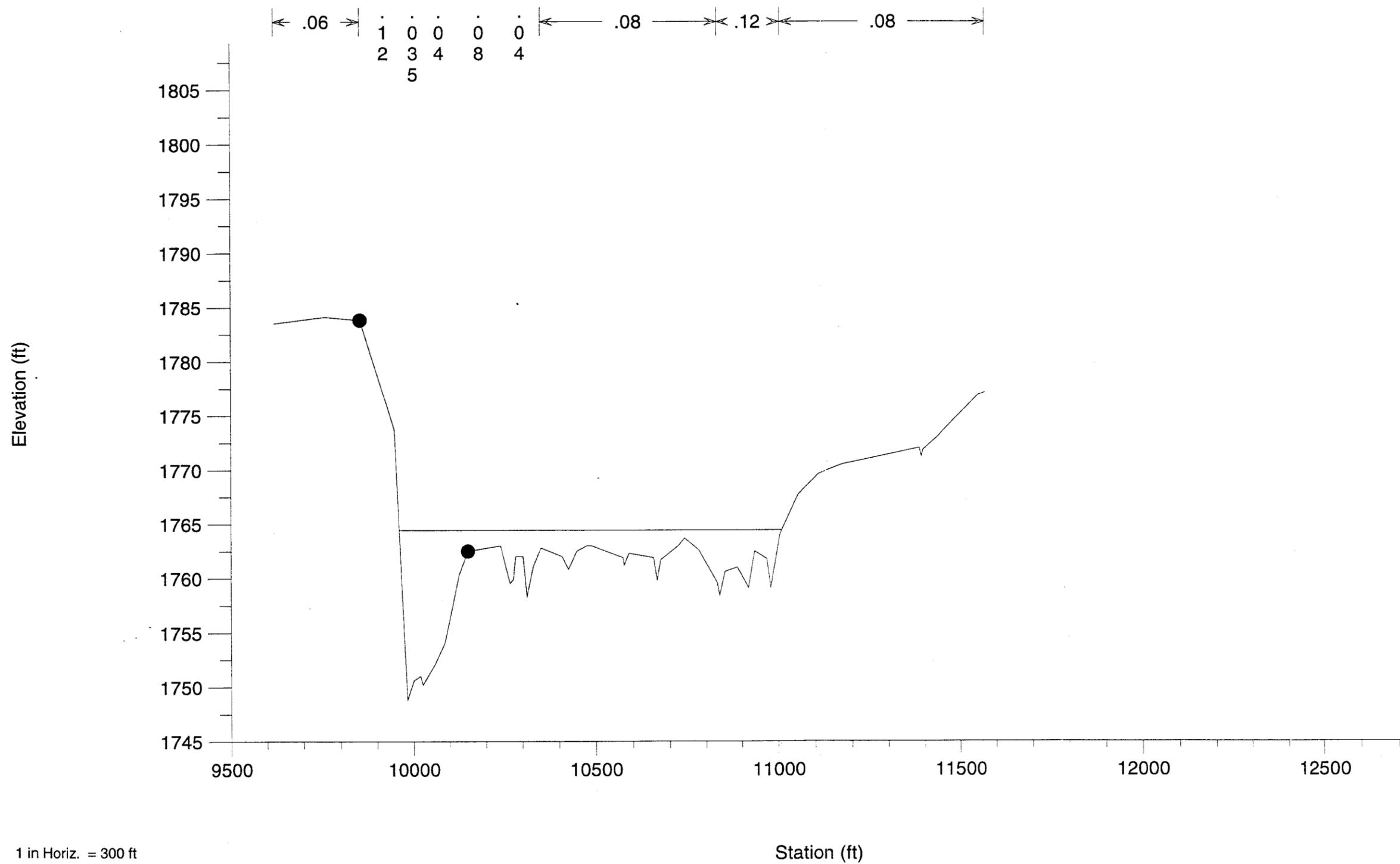


WS 1
Ground
Bank Sta

1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

Station (ft)

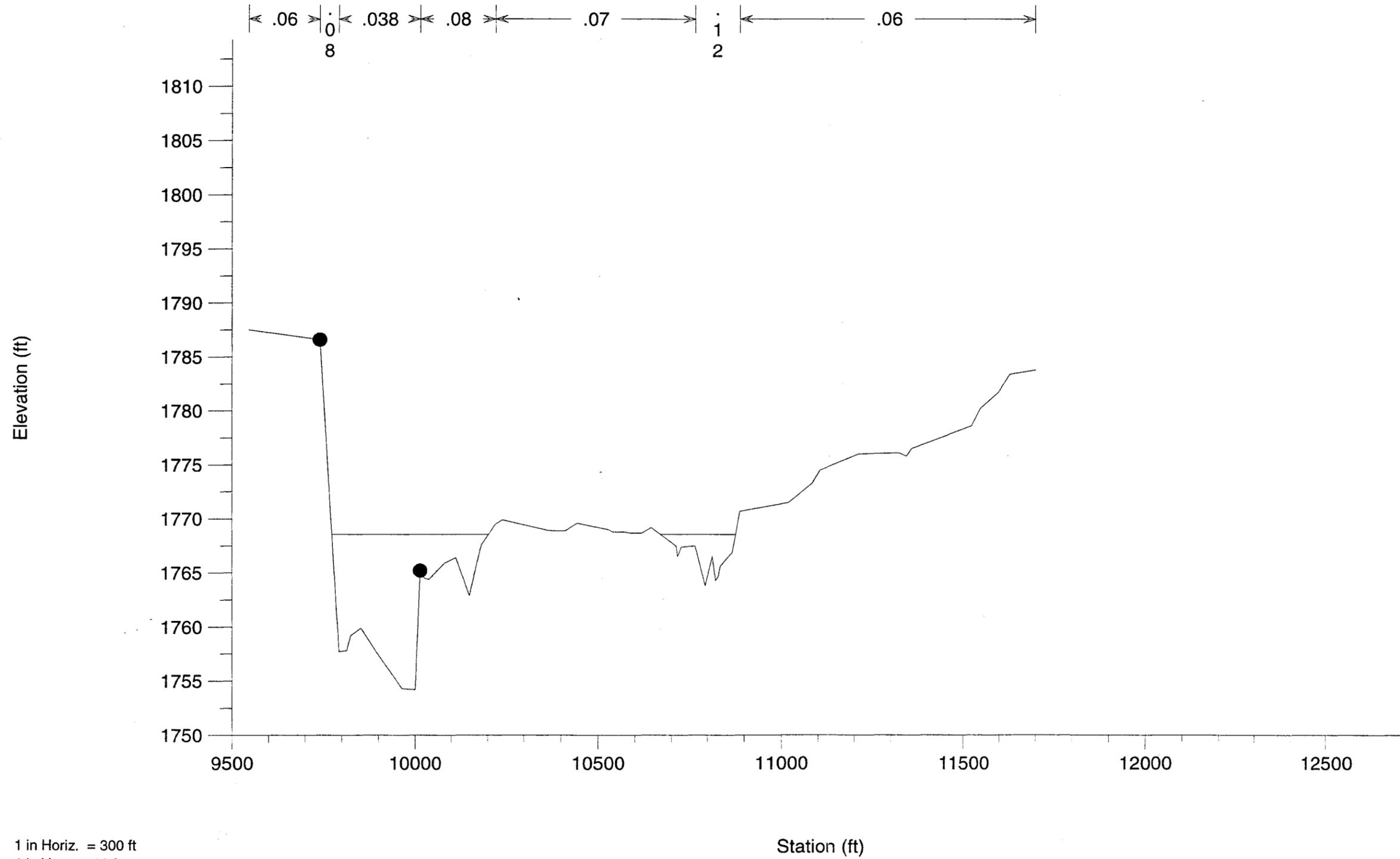
Cave Creek Wash South FIS 100-Year "n" Values
27.502 Cross Section AM



WS 1
Ground
● Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

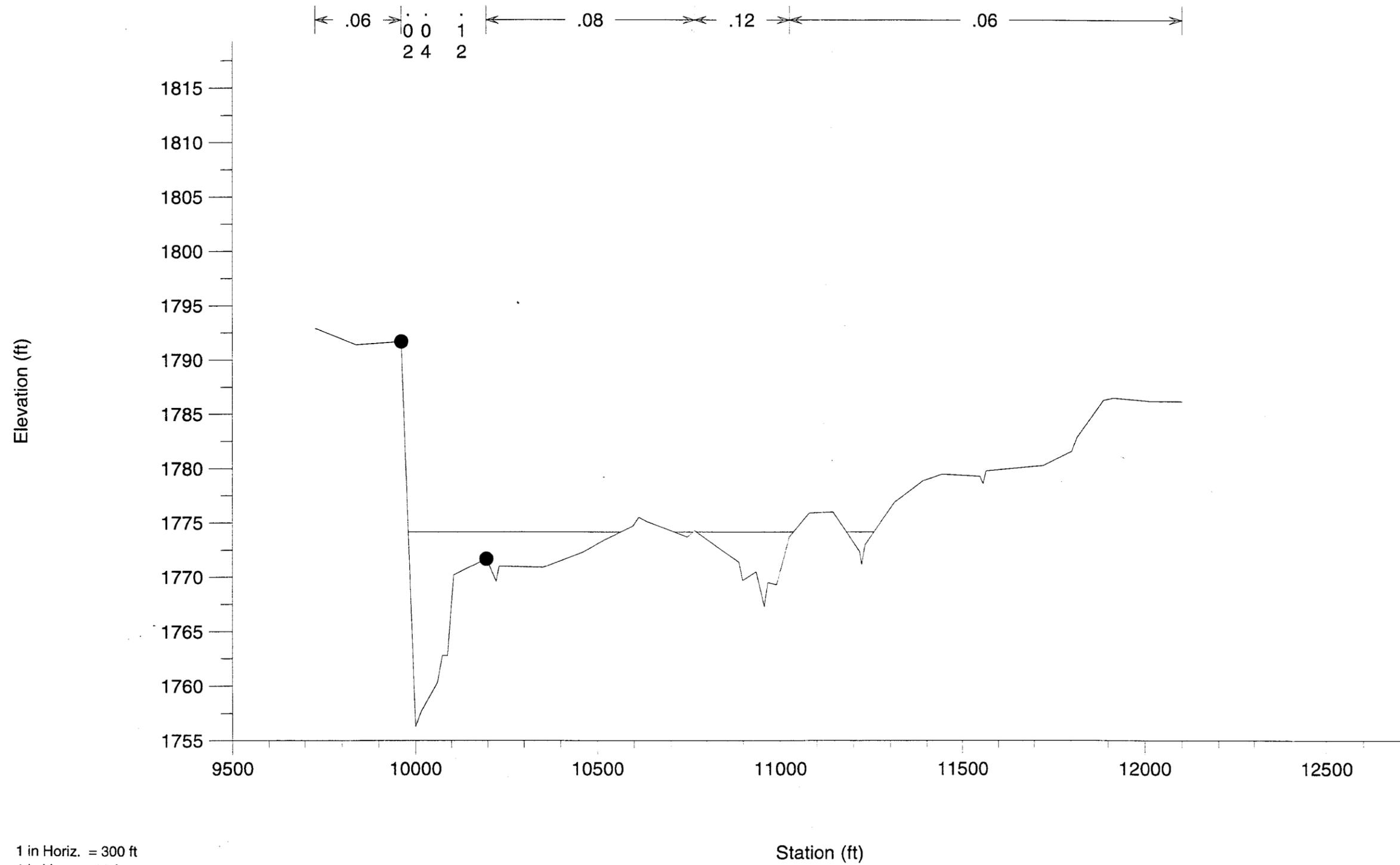
Cave Creek Wash South FIS 100-Year "n" Values
27.604 Cross Section AN



WS 1
Ground
Bank Sta

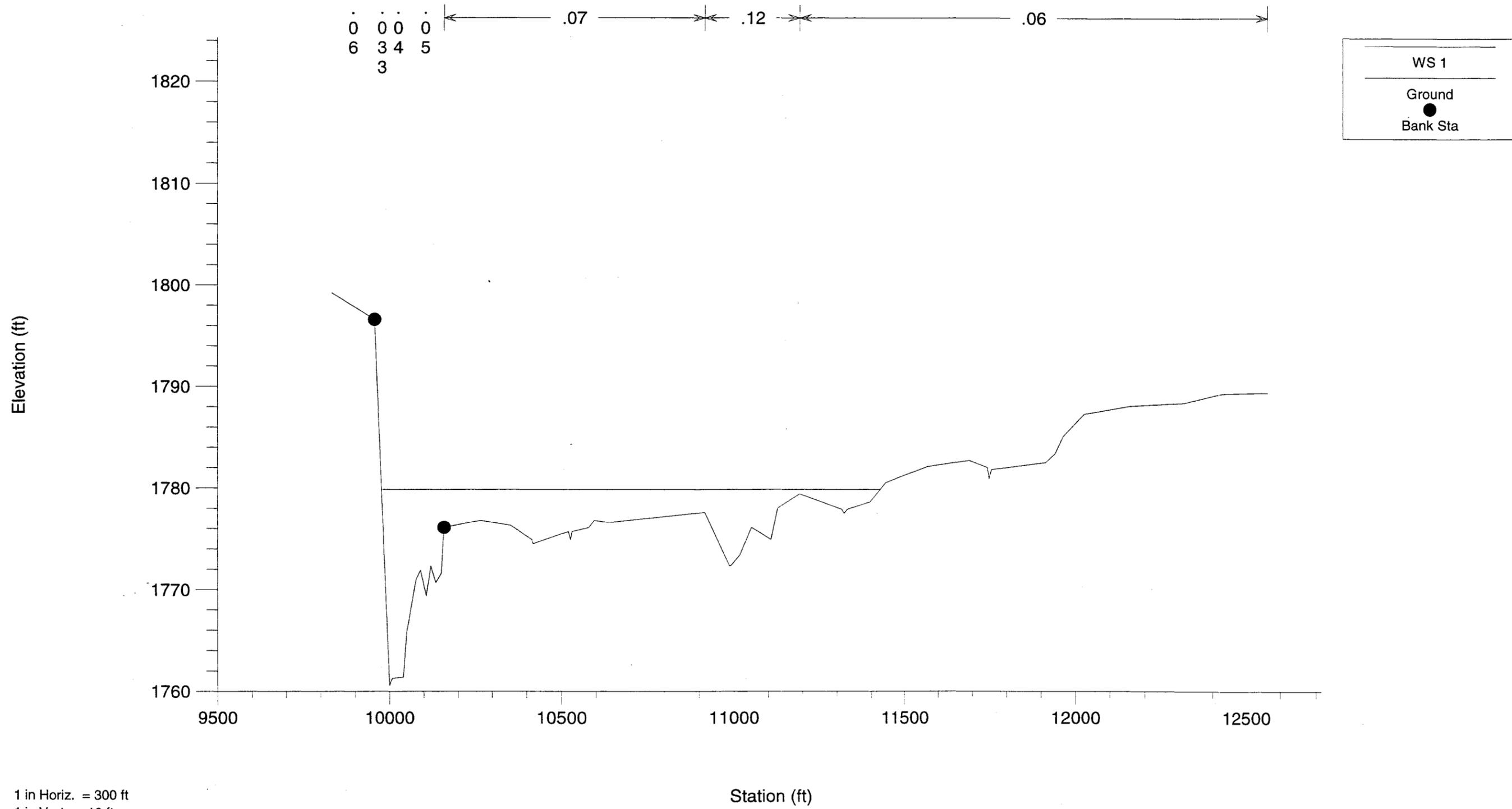
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
27.693 Cross Section AO

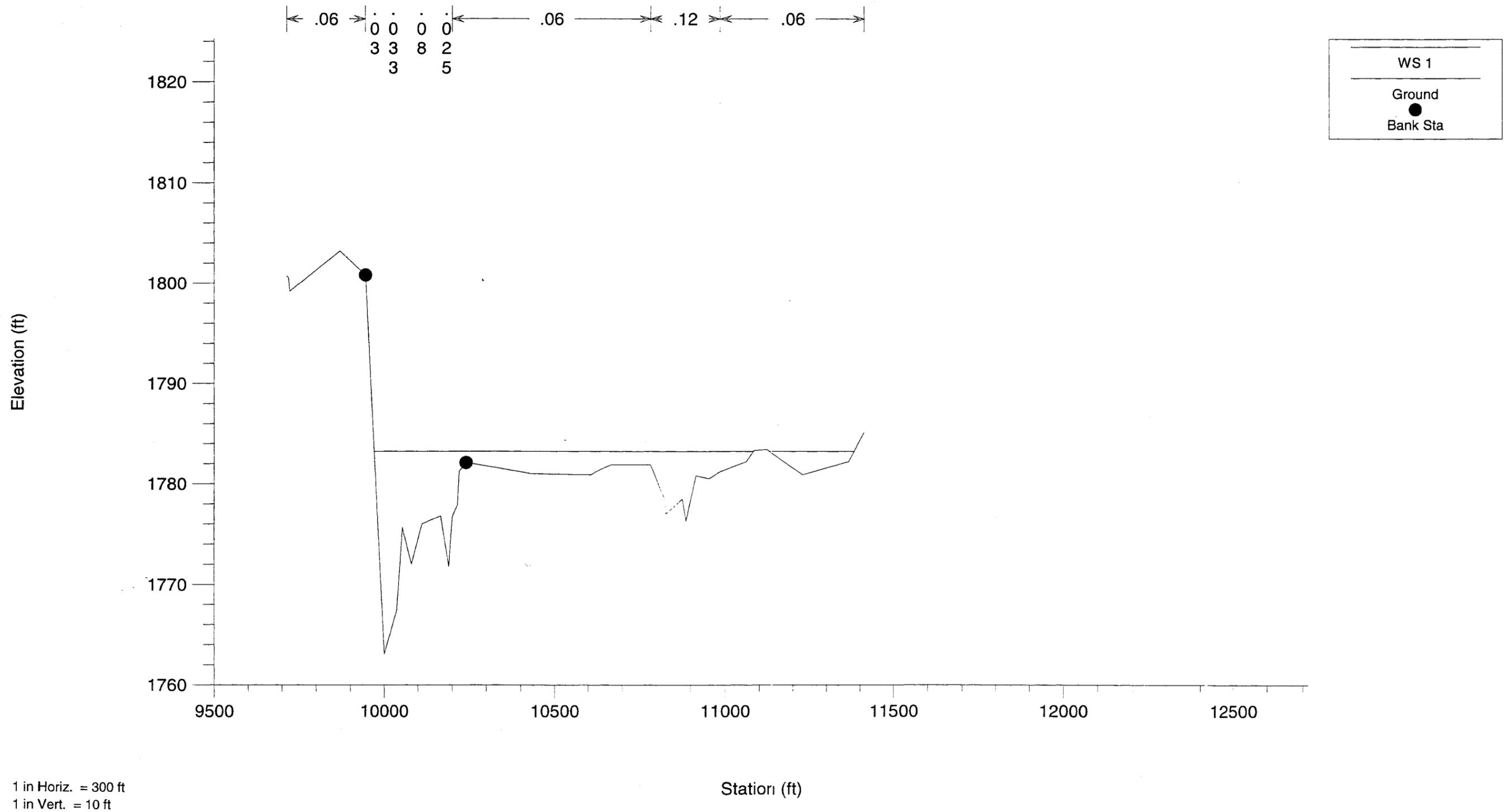


1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
27.797 Cross Section AP



Cave Creek Wash South FIS 100-Year "n" Values
27.913 Cross Section AQ



Cave Creek Wash South FIS 100-Year "n" Values
 28.023 Cross Section AR

0 0 1 0 0
 3 4 2 8 4

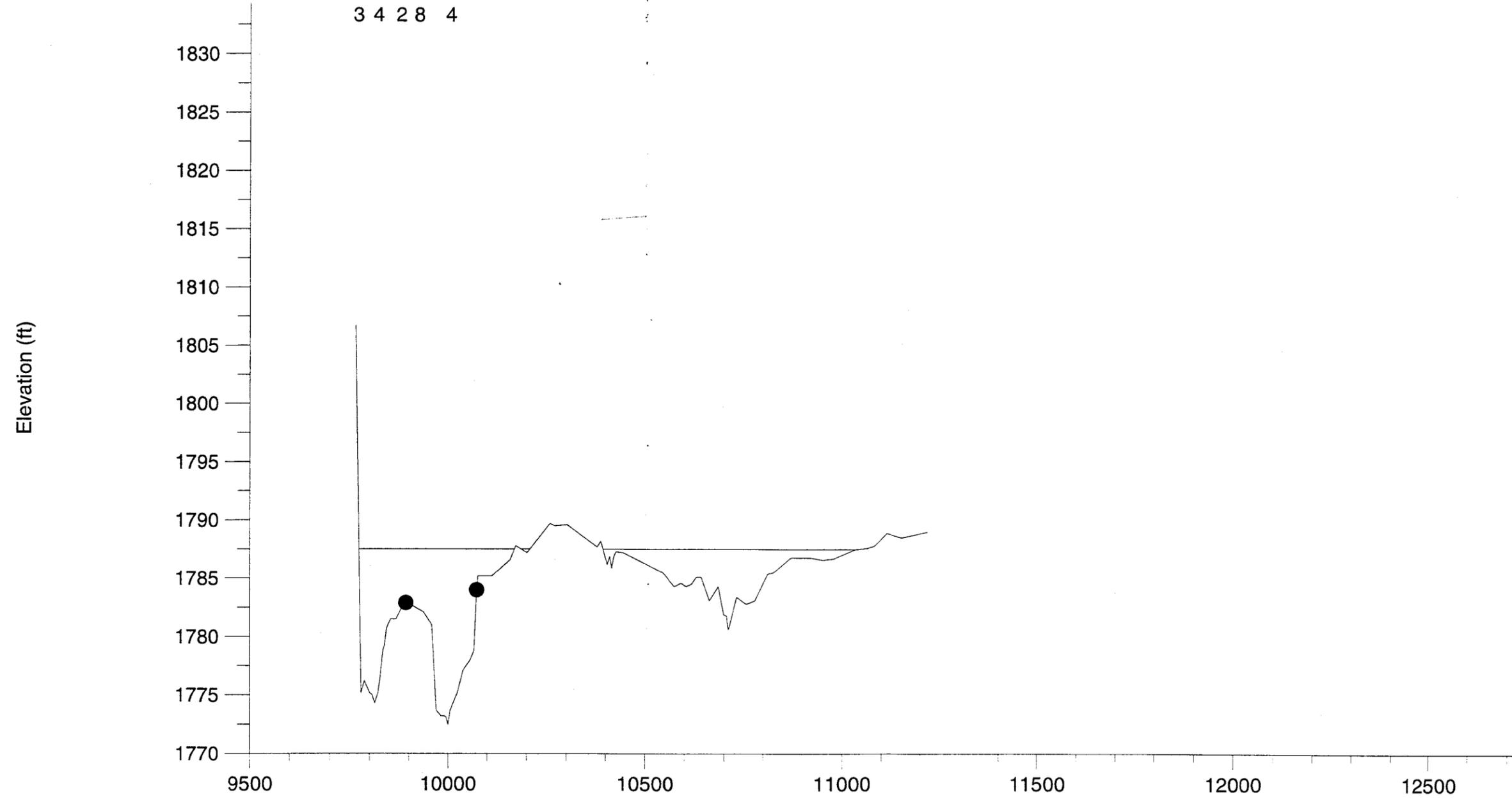
← .06 → .12 → .06 →

WS 1

Ground

●

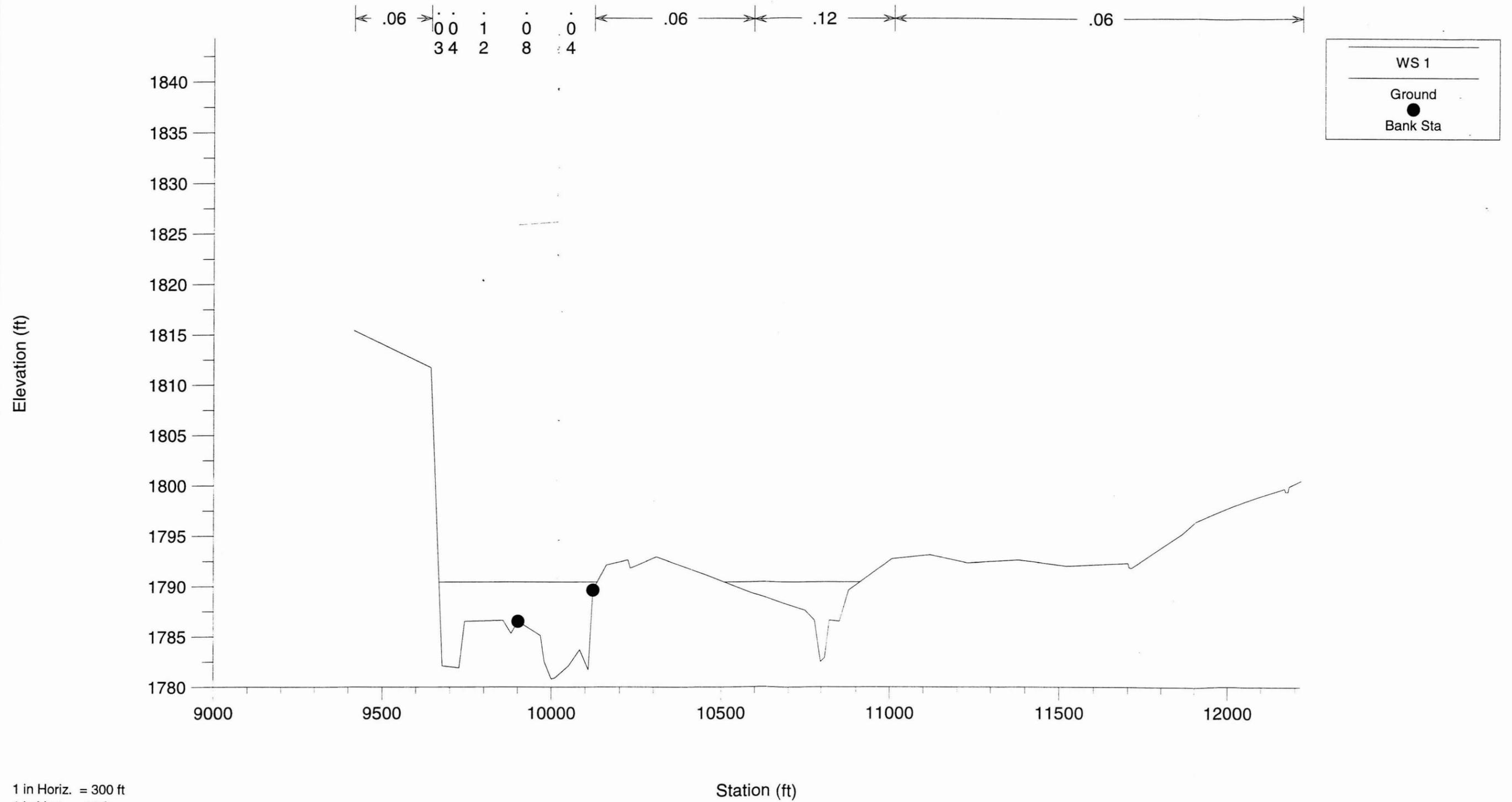
Bank Sta



1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

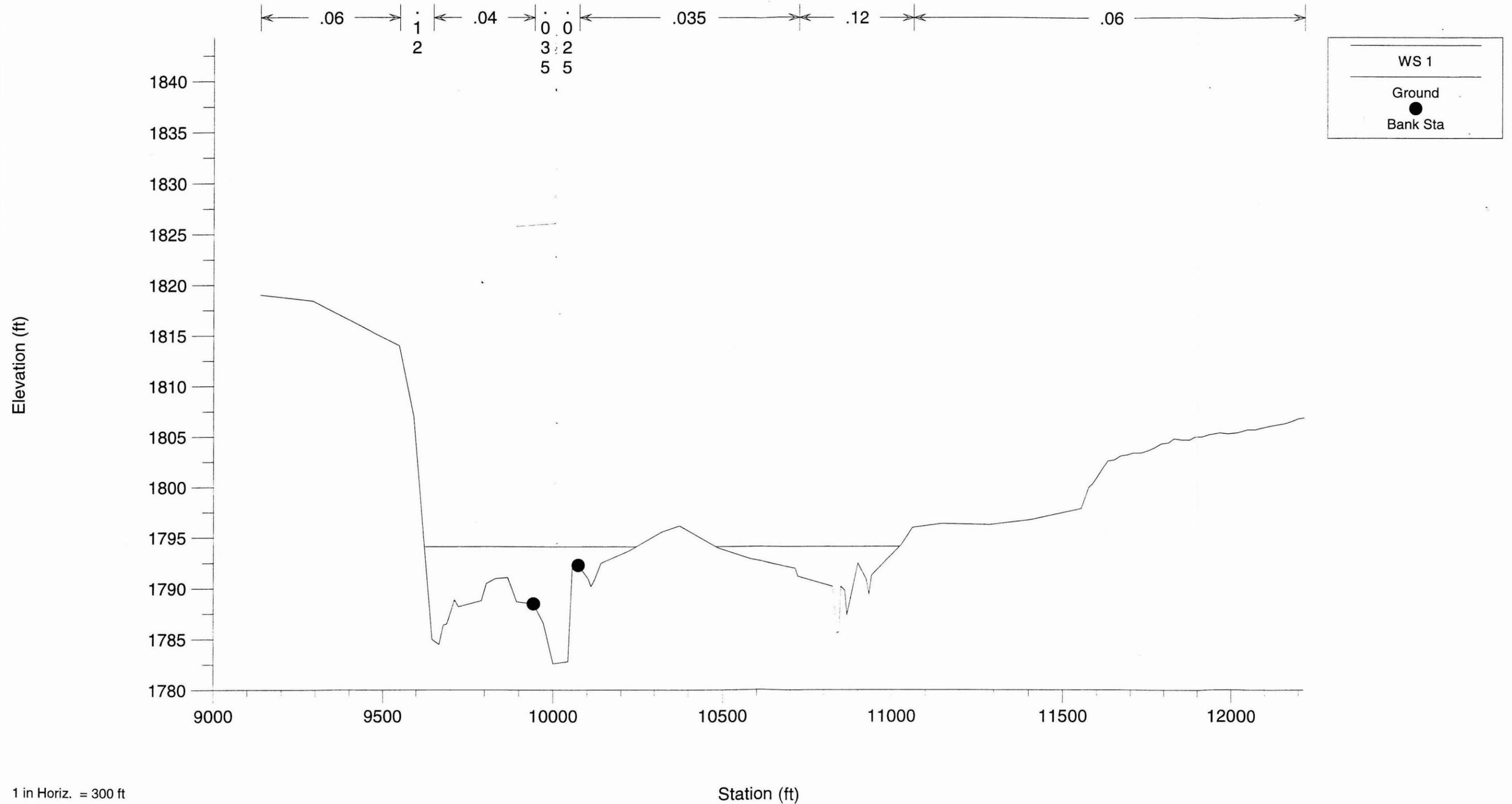
Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
 28.091 Cross Section AS



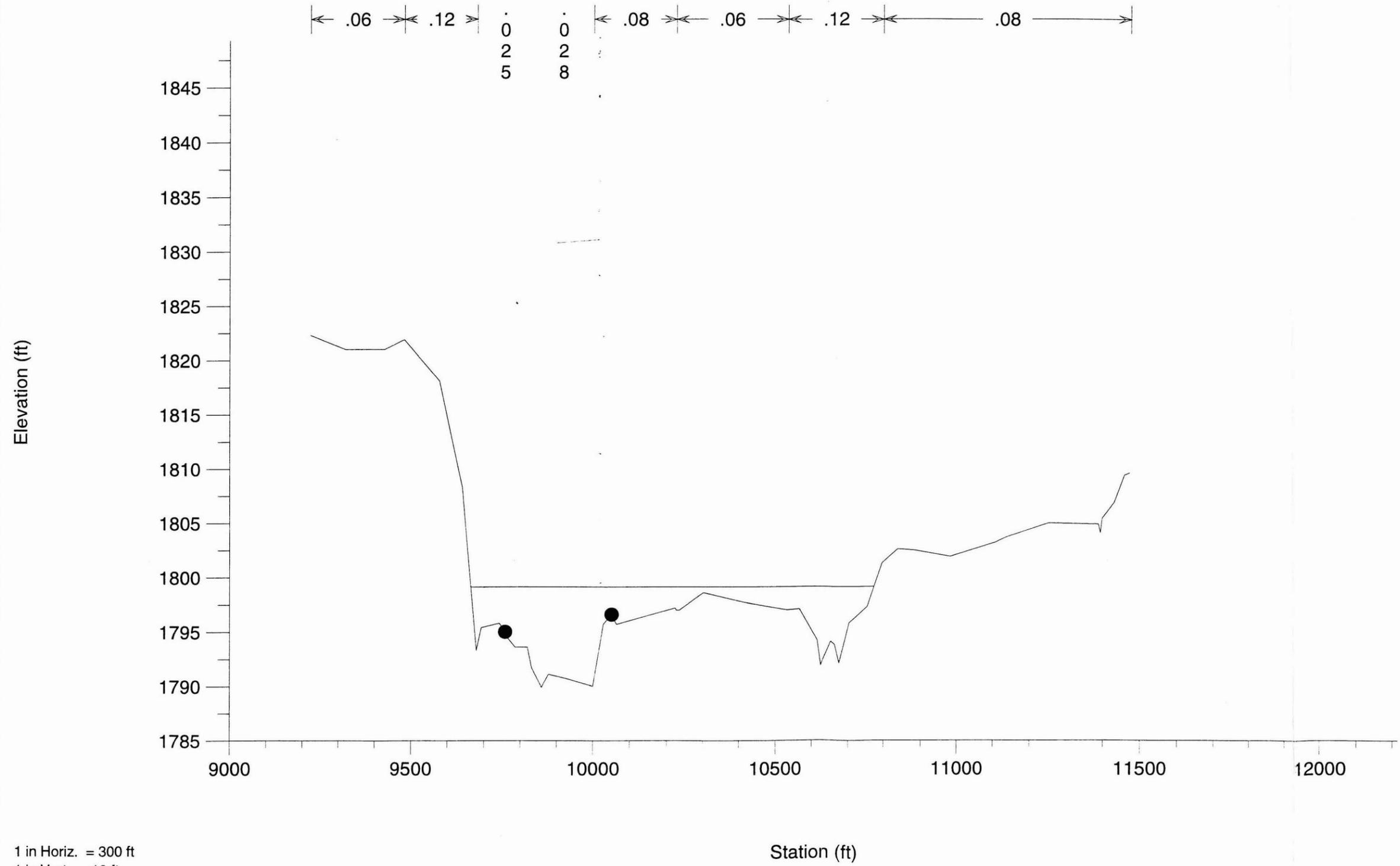
1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
28.157 Cross Section AT



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
28.241 Cross Section AU

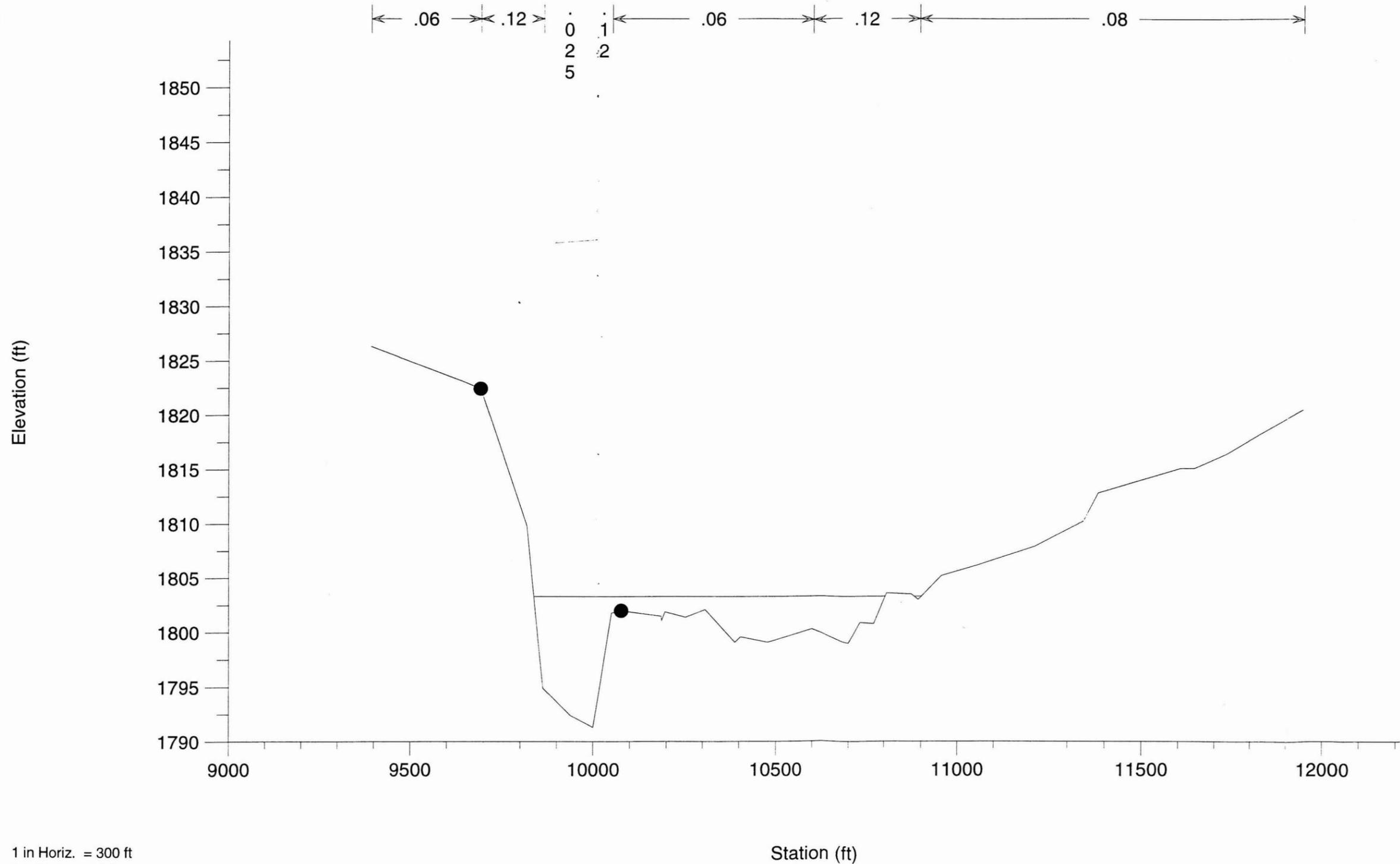


WS 1
Ground
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
28.326 Cross Section AV

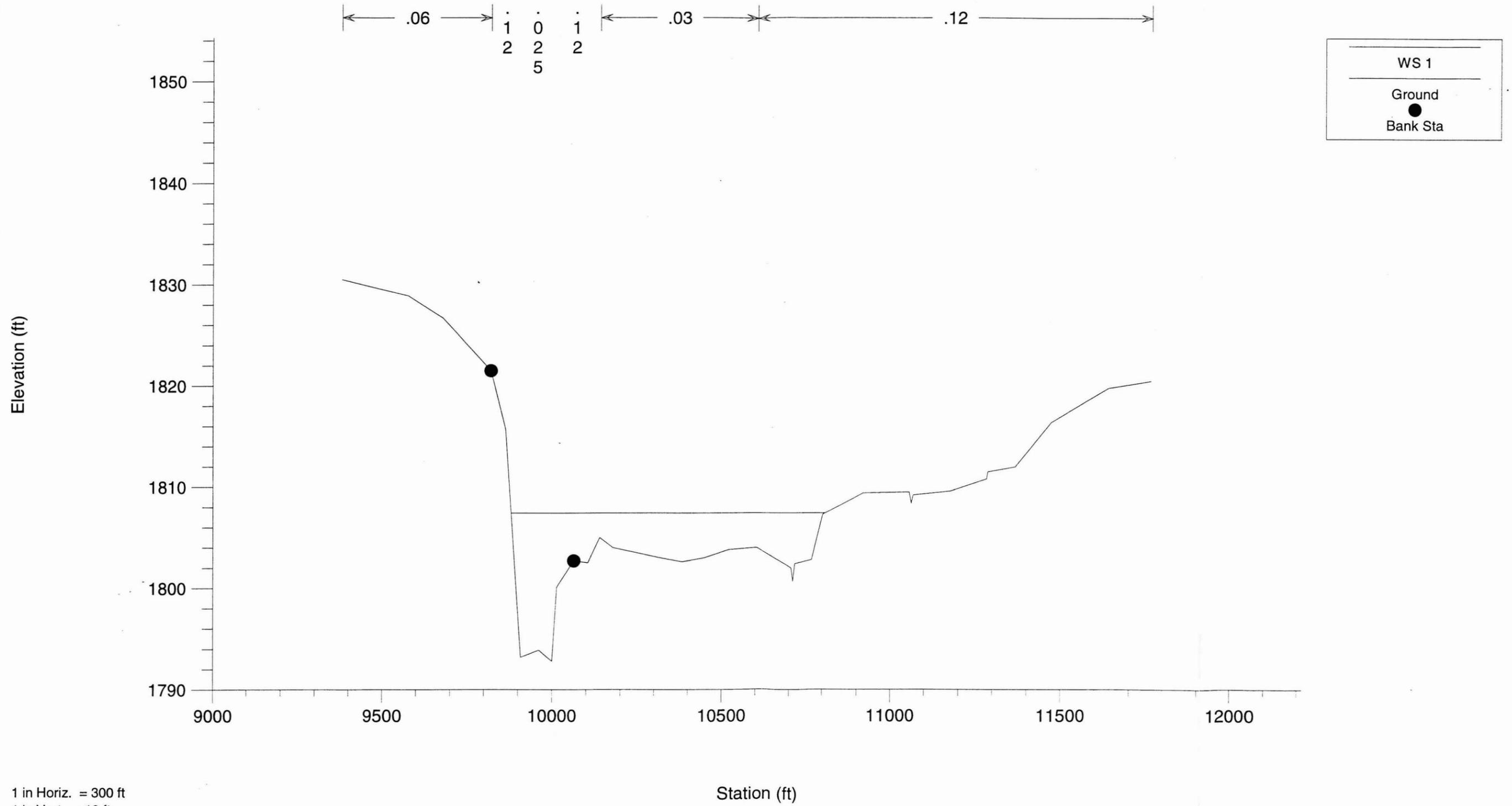


WS 1
Ground
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

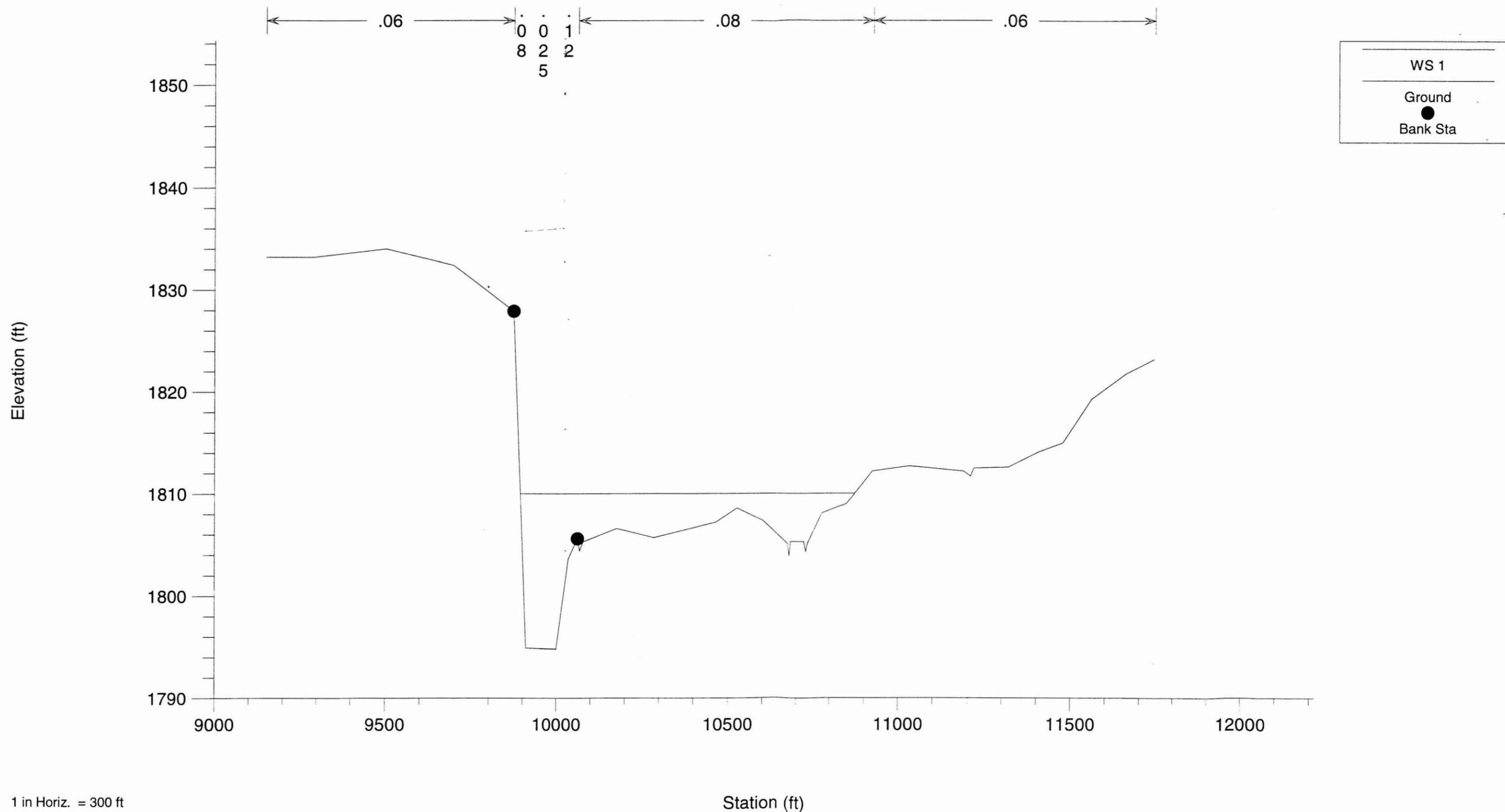
Station (ft)

Cave Creek Wash South FIS 100-Year "n" Values
28.390 Cross Section AW



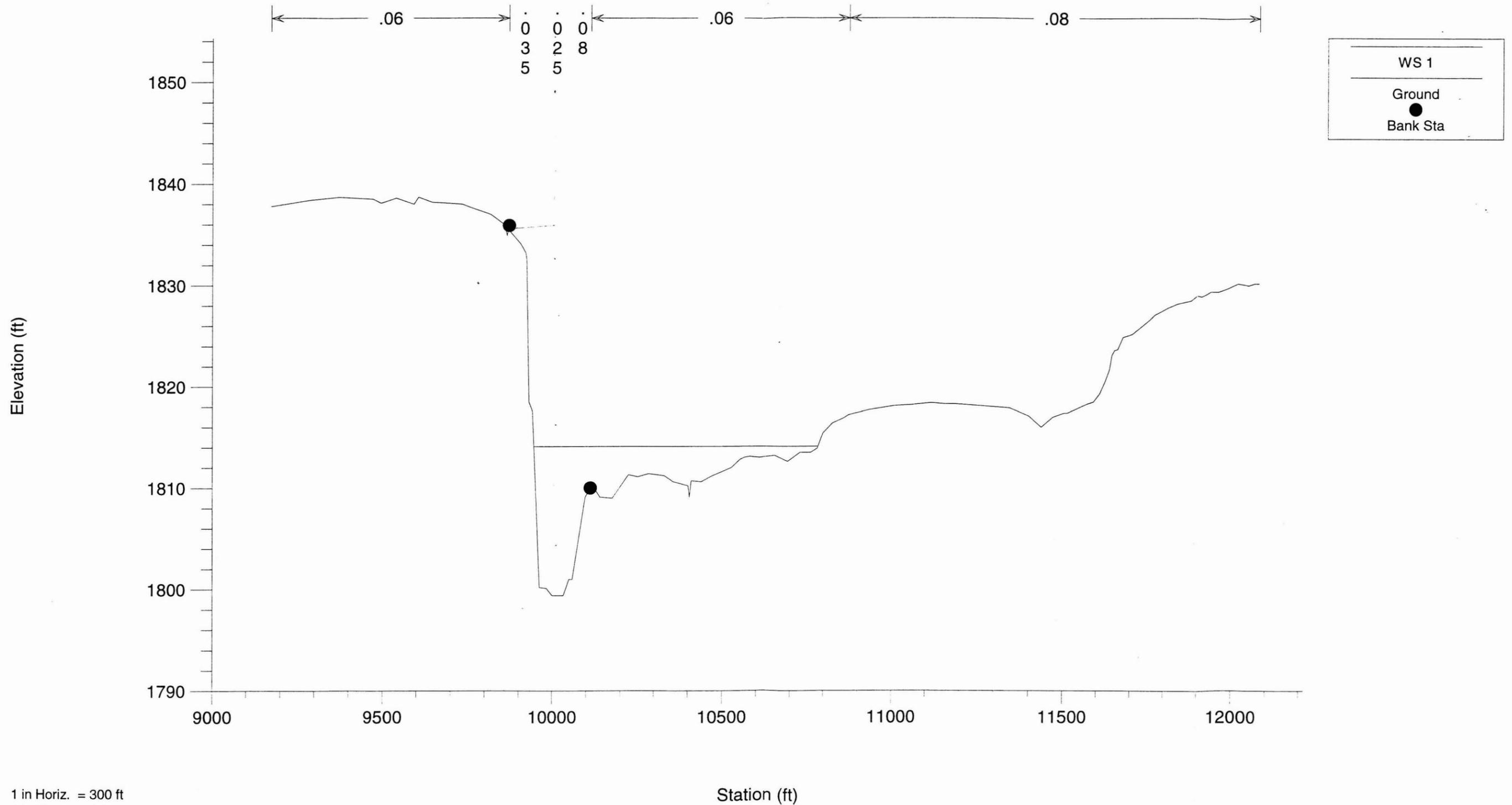
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
28.462 Cross Section AX



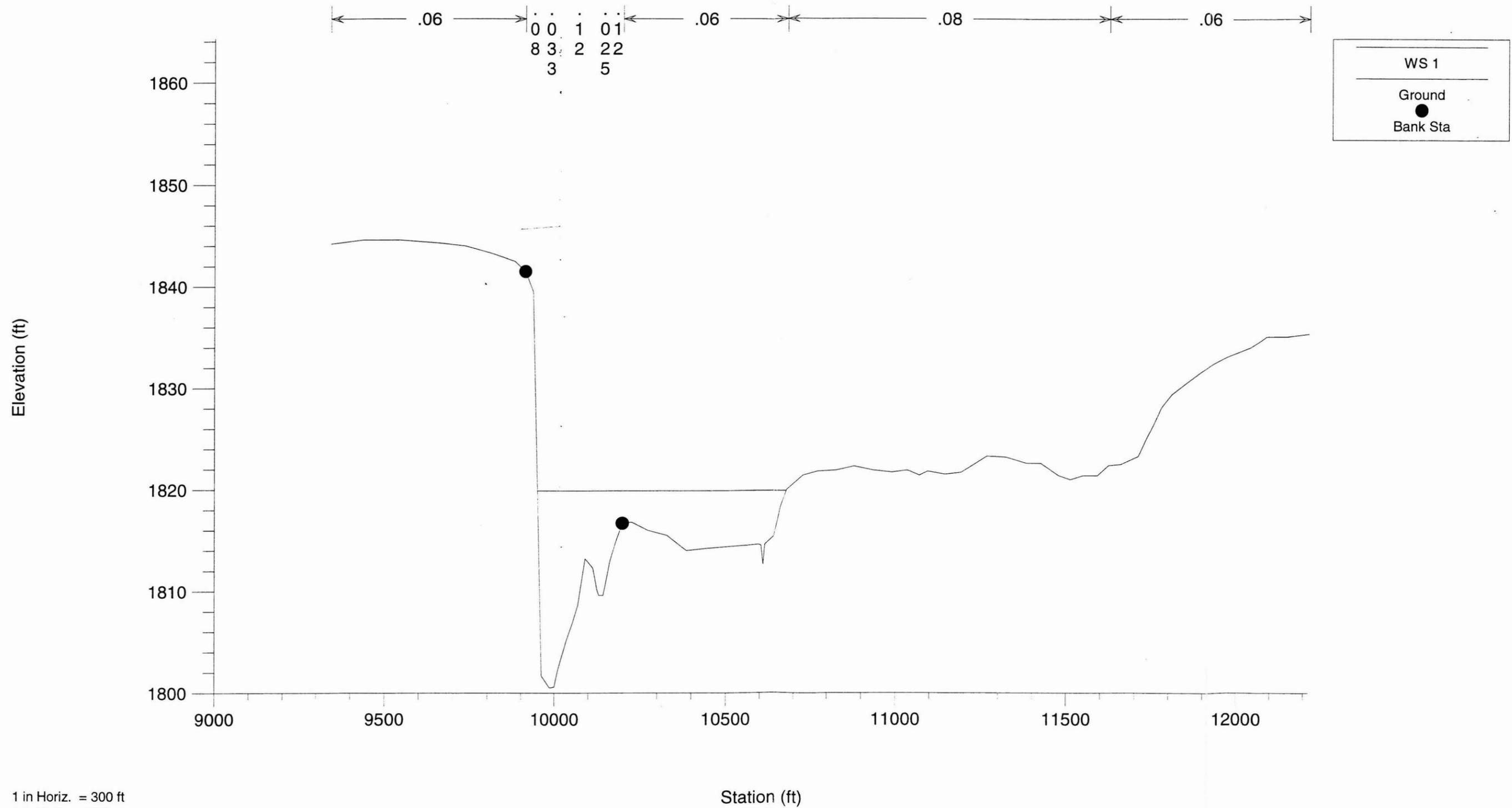
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
28.555 Cross Section AY



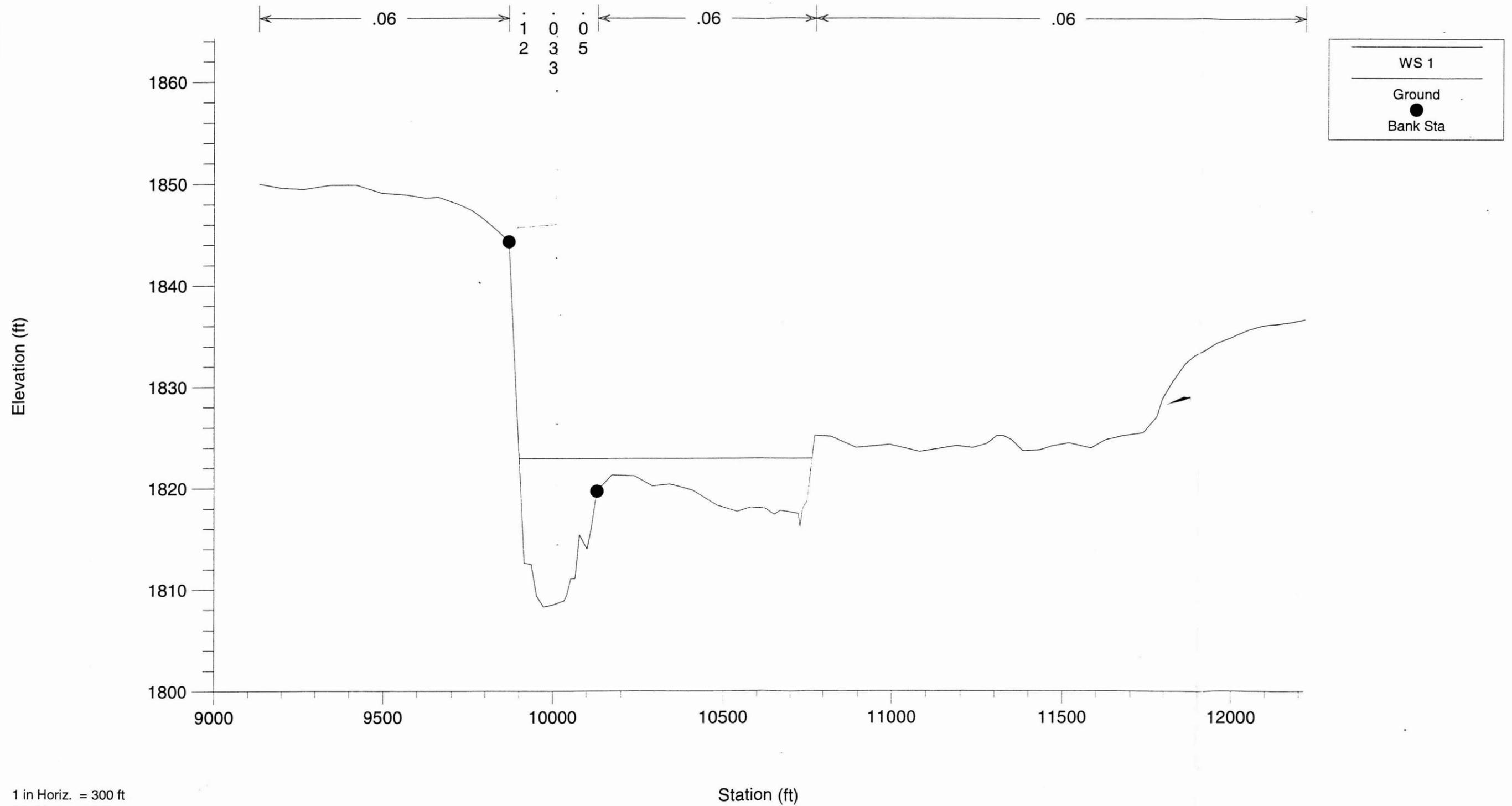
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
28.657 Cross Section AZ



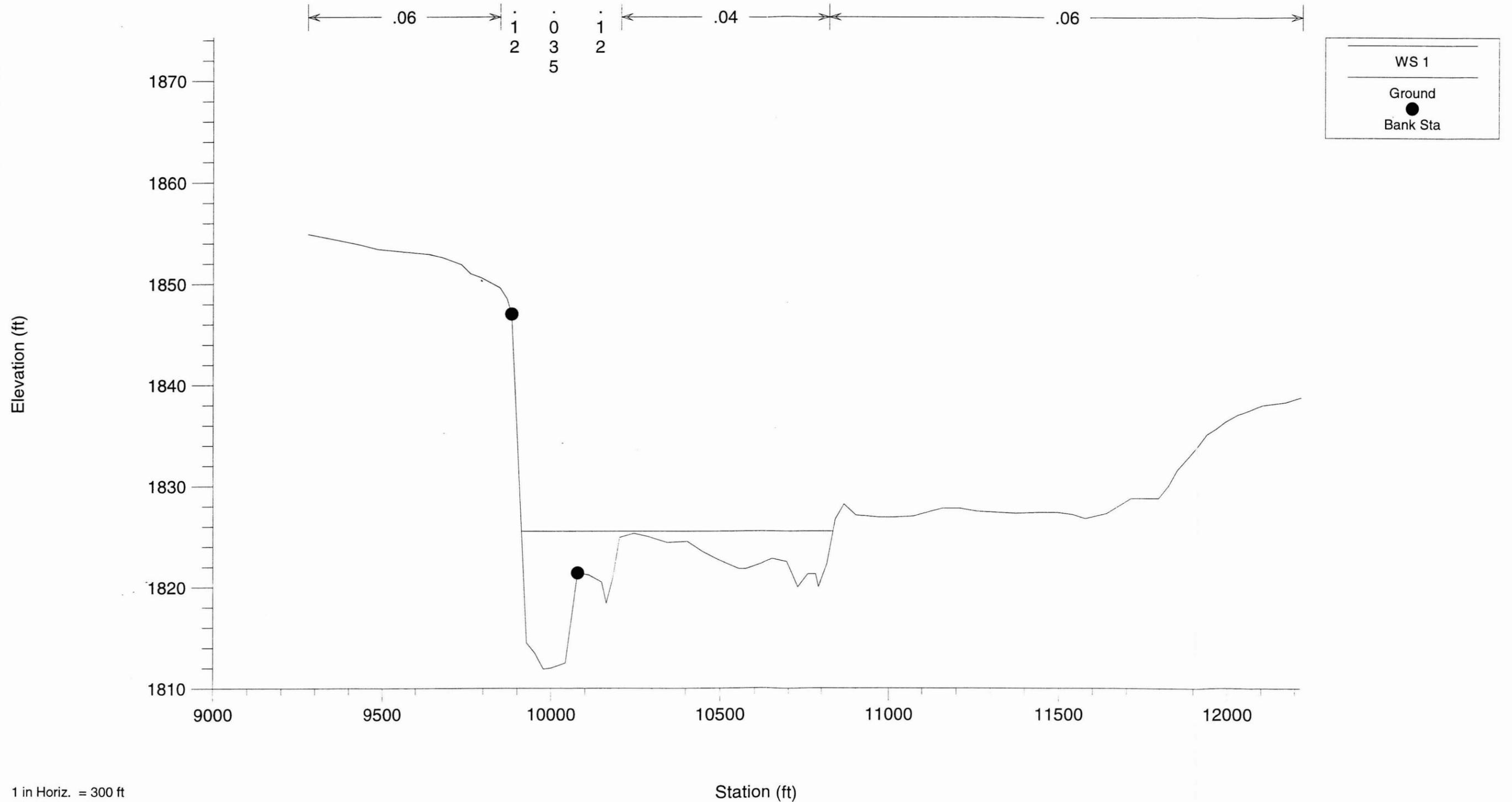
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
28.750 Cross Section BA



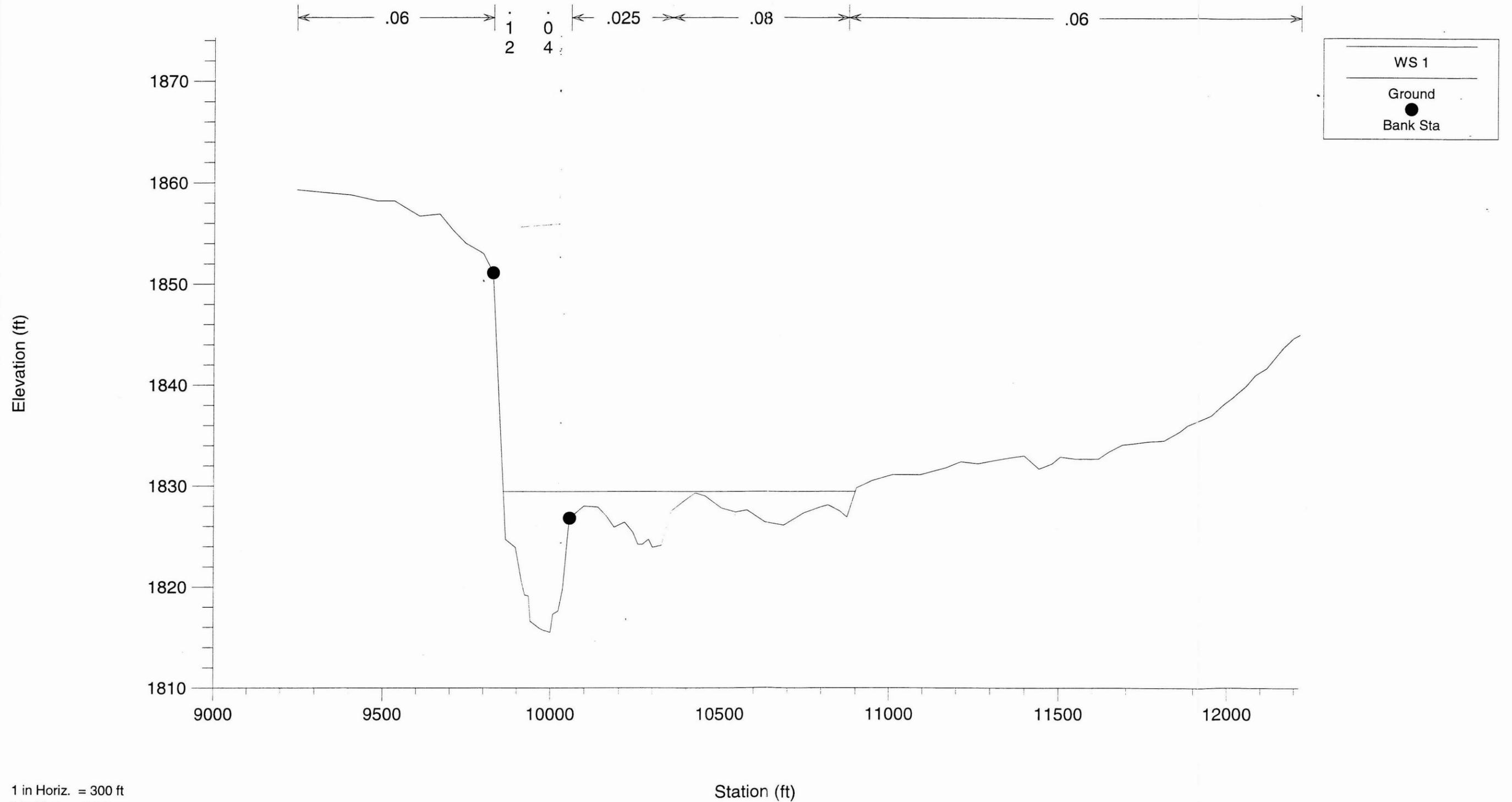
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
28.847 Cross Section BB



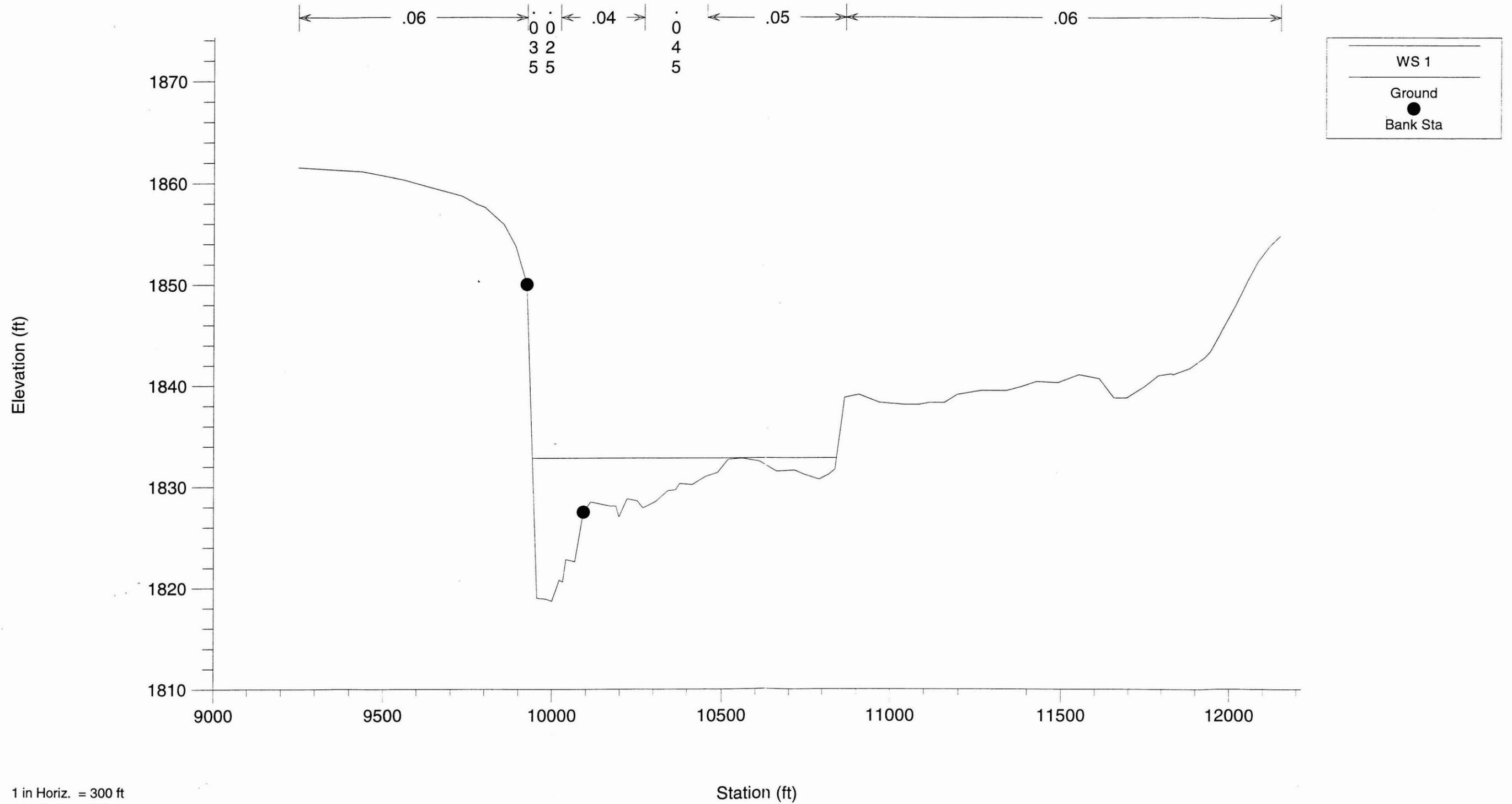
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
 28.934 Cross Section BC



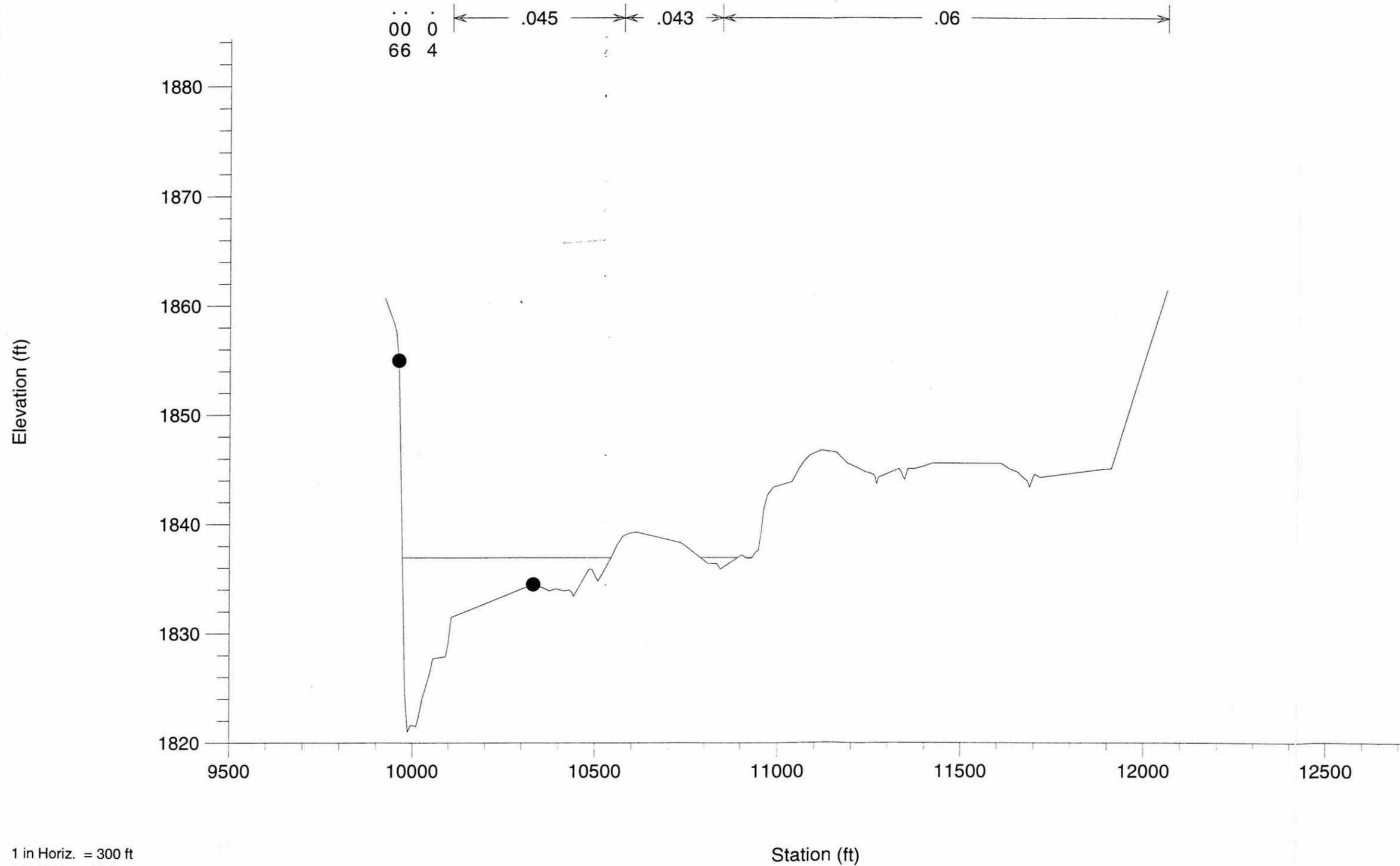
1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
 29.012 Cross Section BD



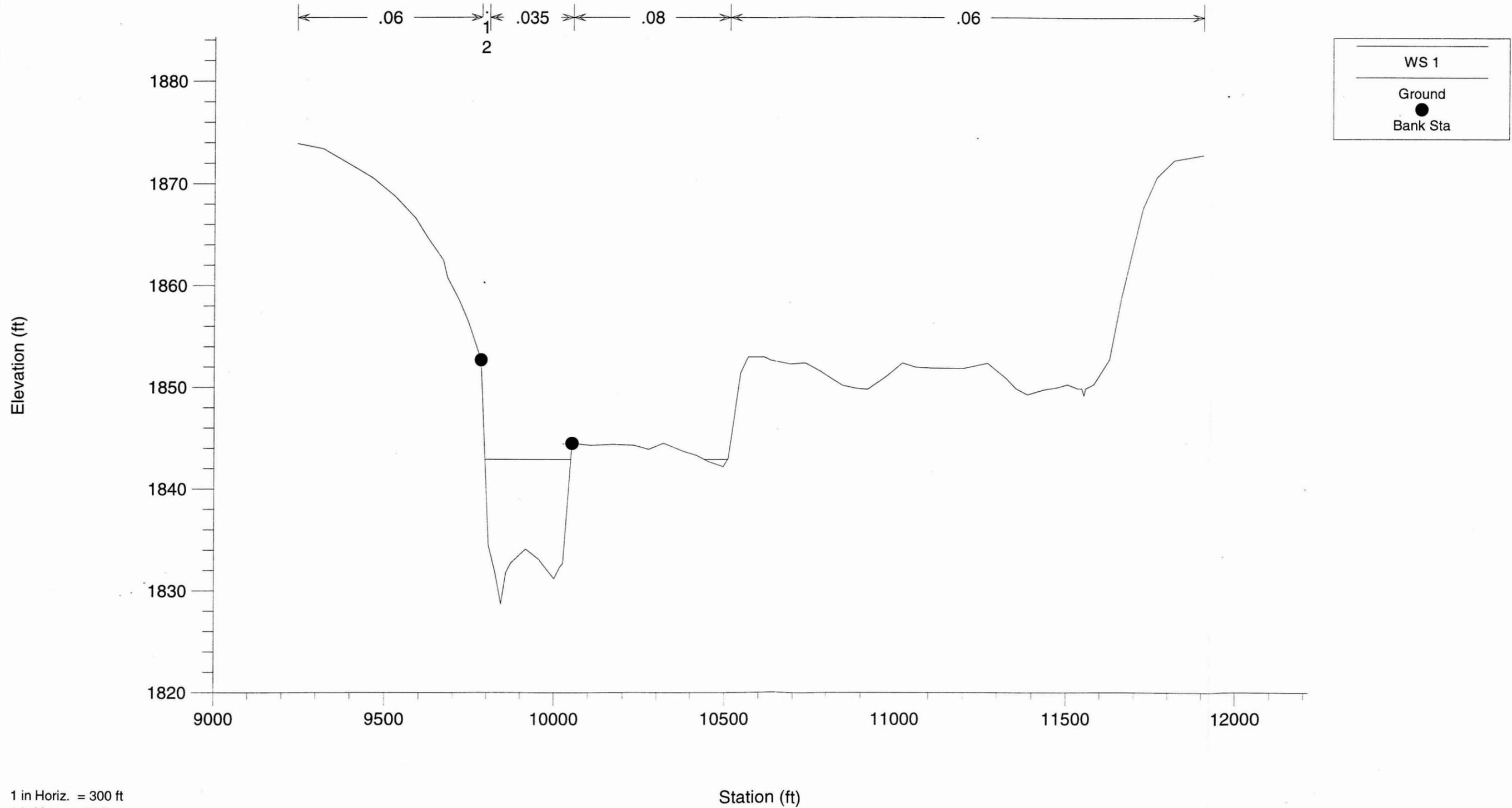
1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
29.130 Cross Section BE



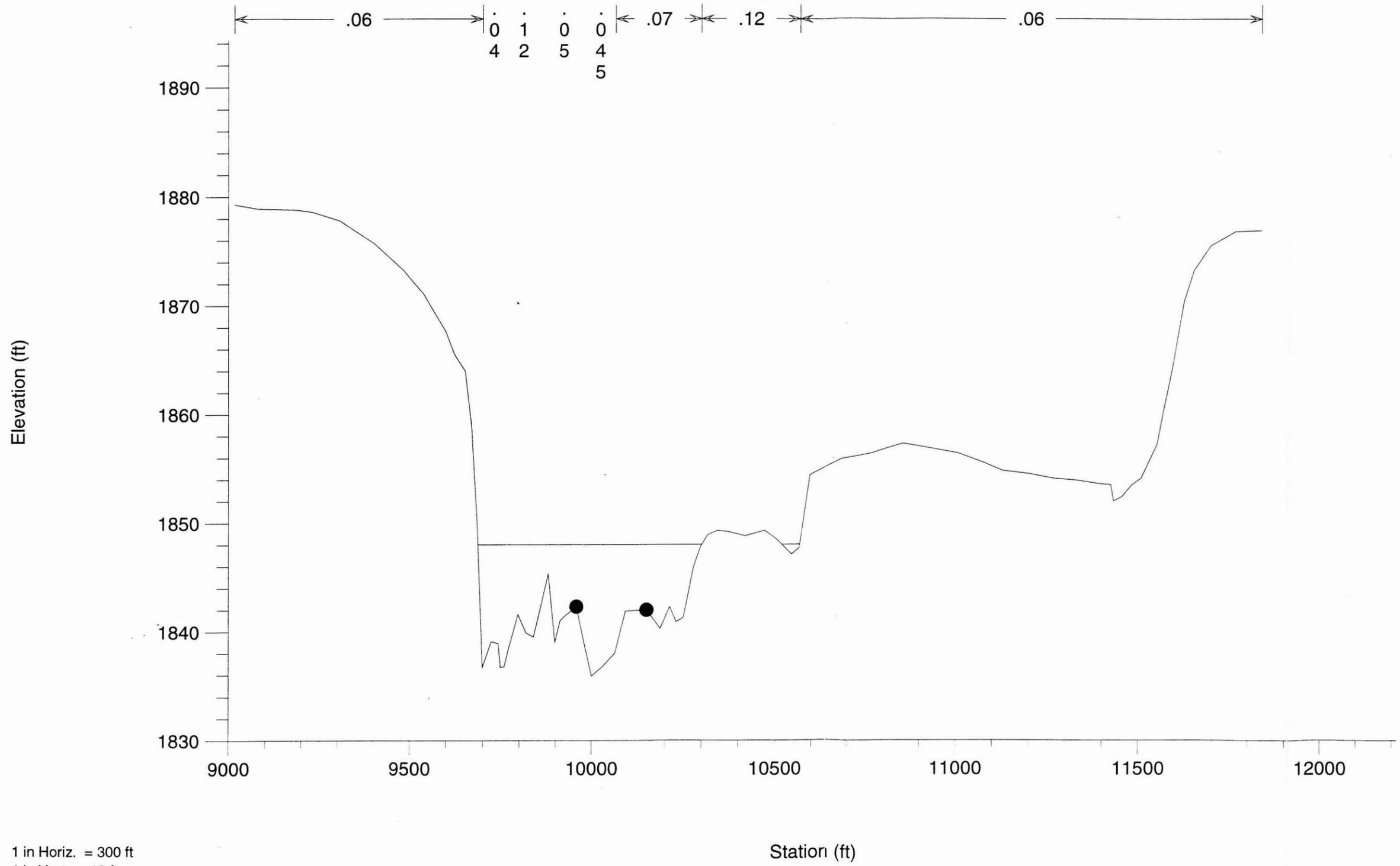
1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
29.258 Cross Section BF



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

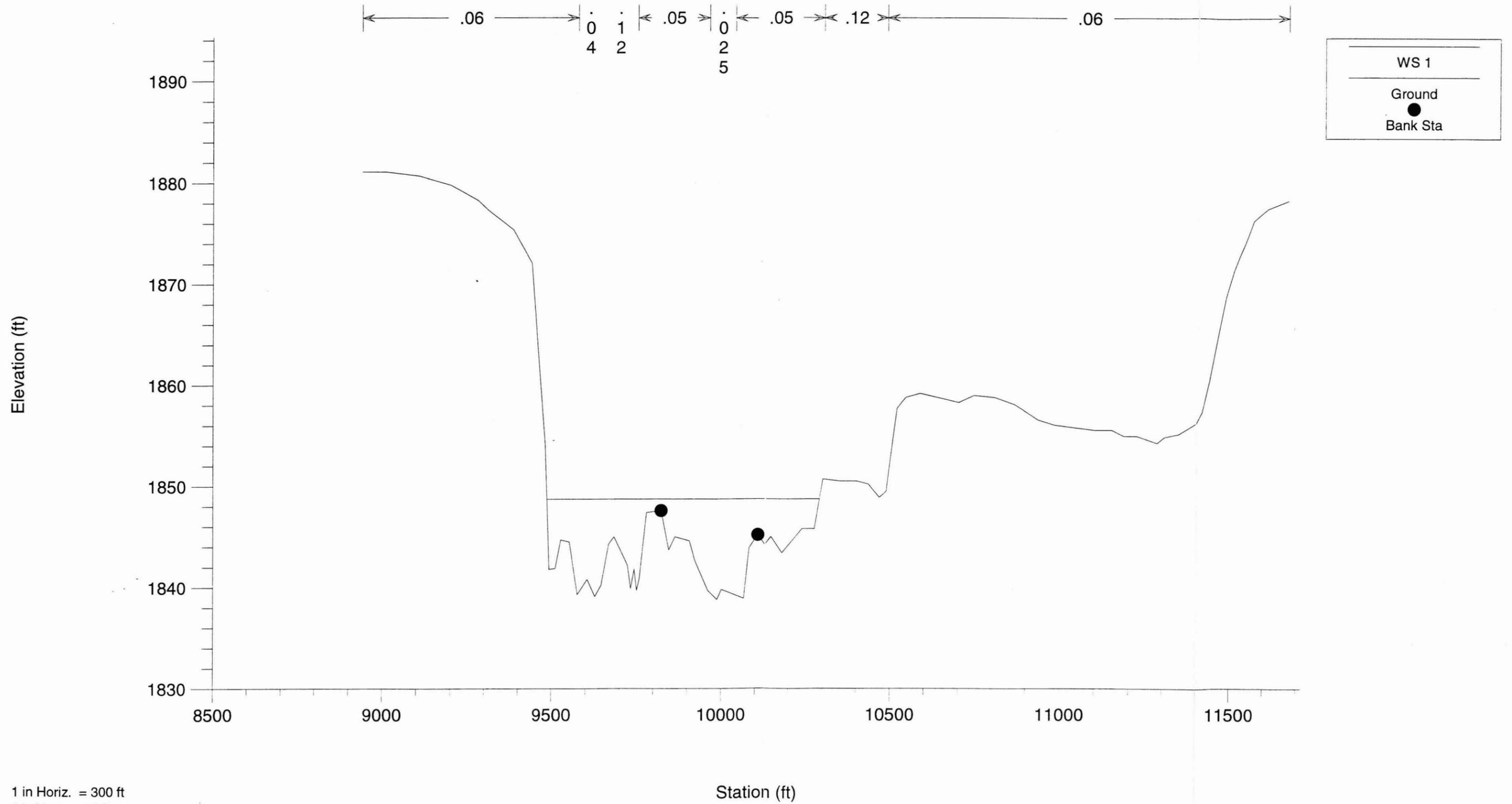
Cave Creek Wash South FIS 100-Year "n" Values
 29.351 Cross Section BG



Legend:

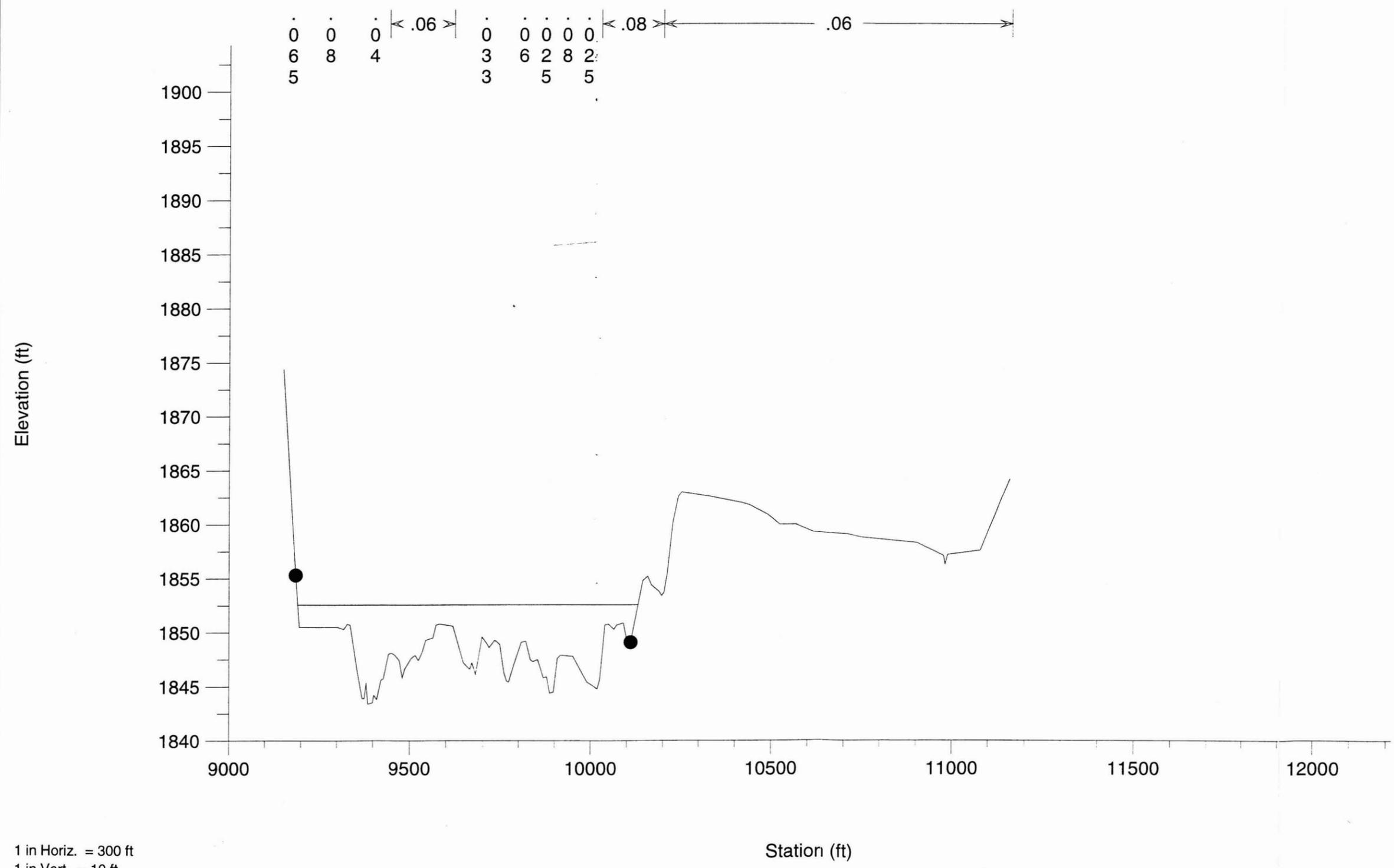
- WS 1
- Ground
- Bank Sta

Cave Creek Wash South FIS 100-Year "n" Values
29.387 Cross Section BH



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

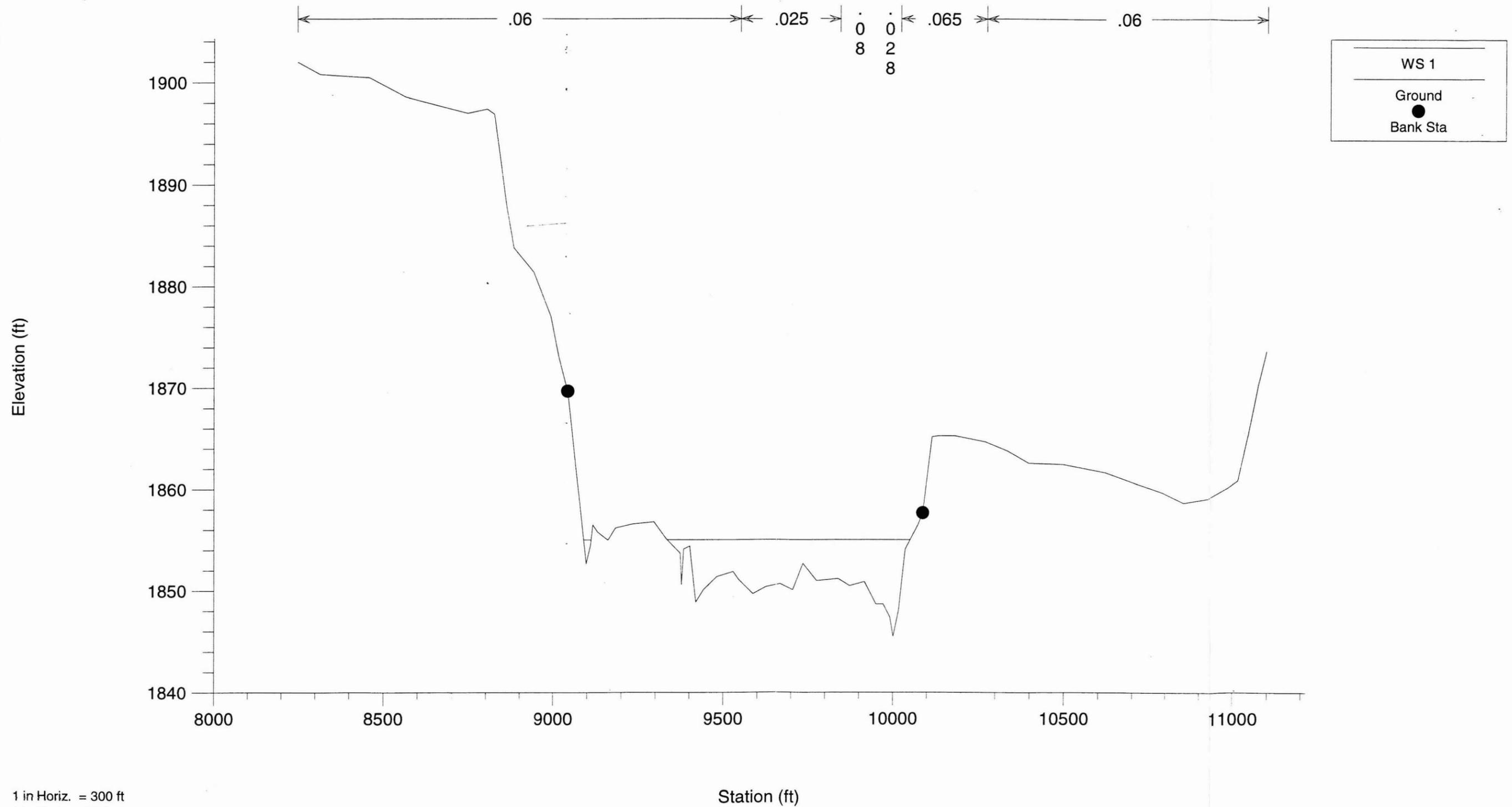
Cave Creek Wash South FIS 100-Year "n" Values
29.493 Cross Section BI



WS 1
Ground
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
29.538 Cross Section BJ



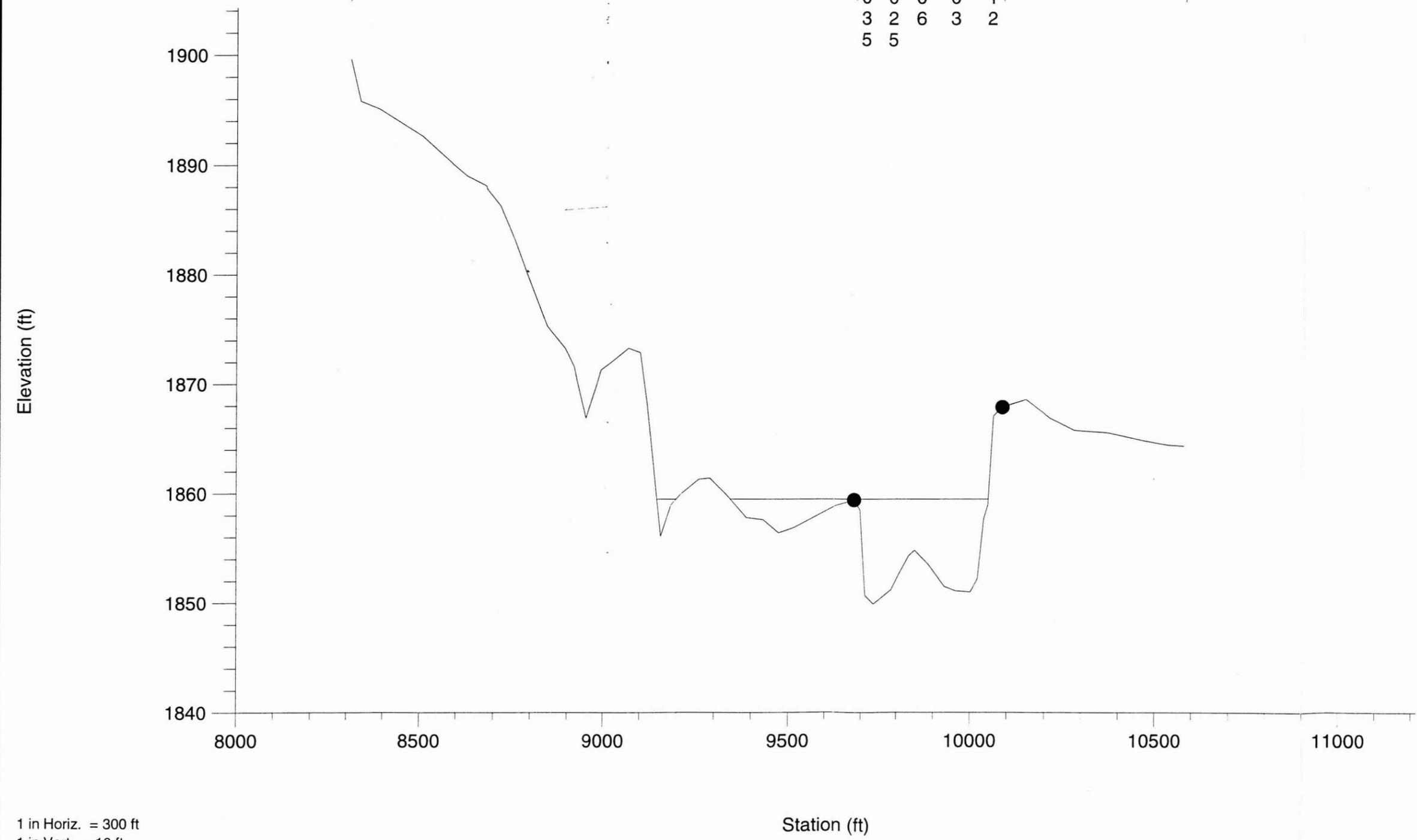
Cave Creek Wash South FIS 100-Year "n" Values
 29.601 Cross Section BK

0	0	0	0	1
3	2	6	3	2
5	5			

WS 1

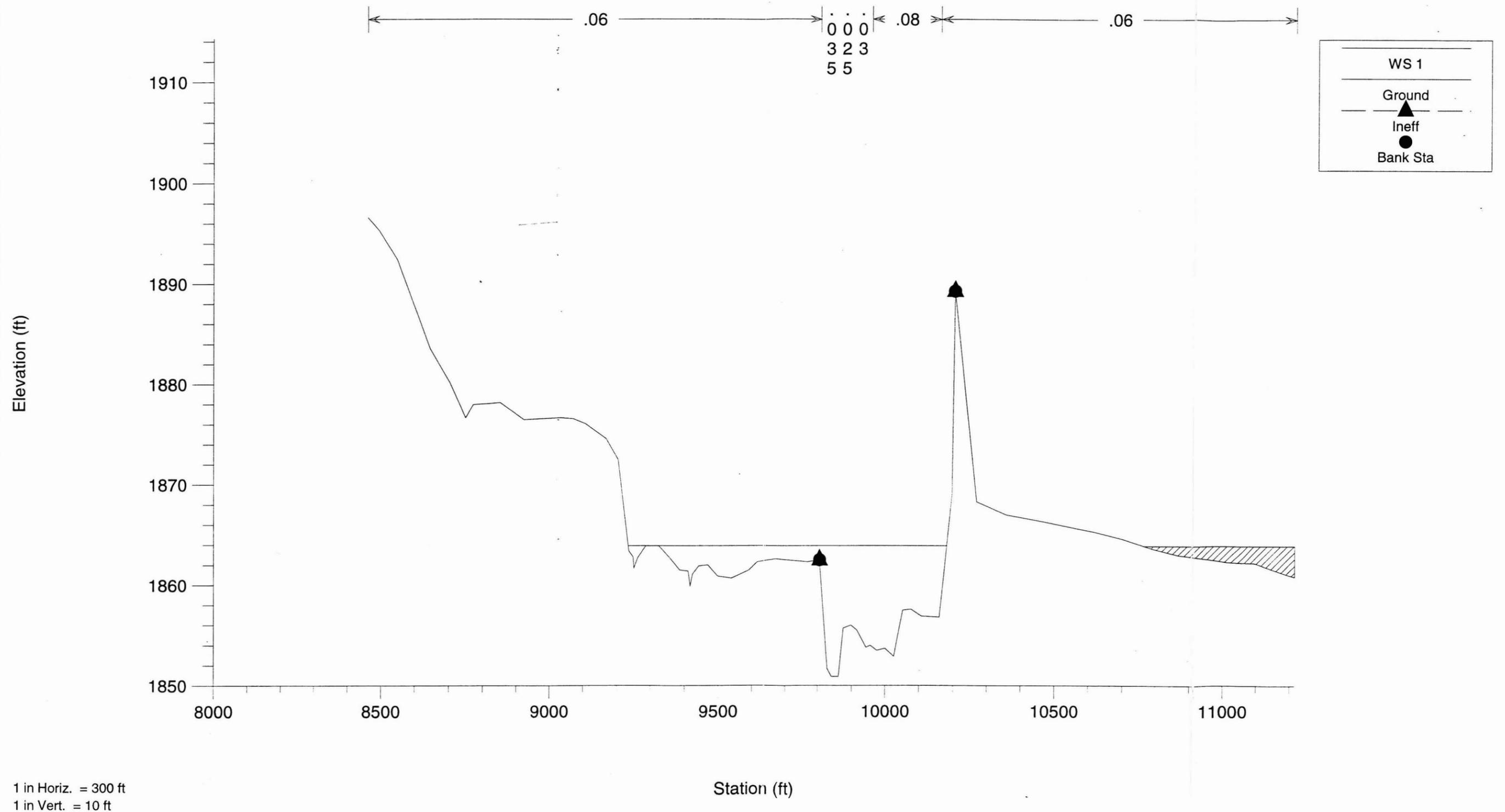
Ground

● Bank Sta

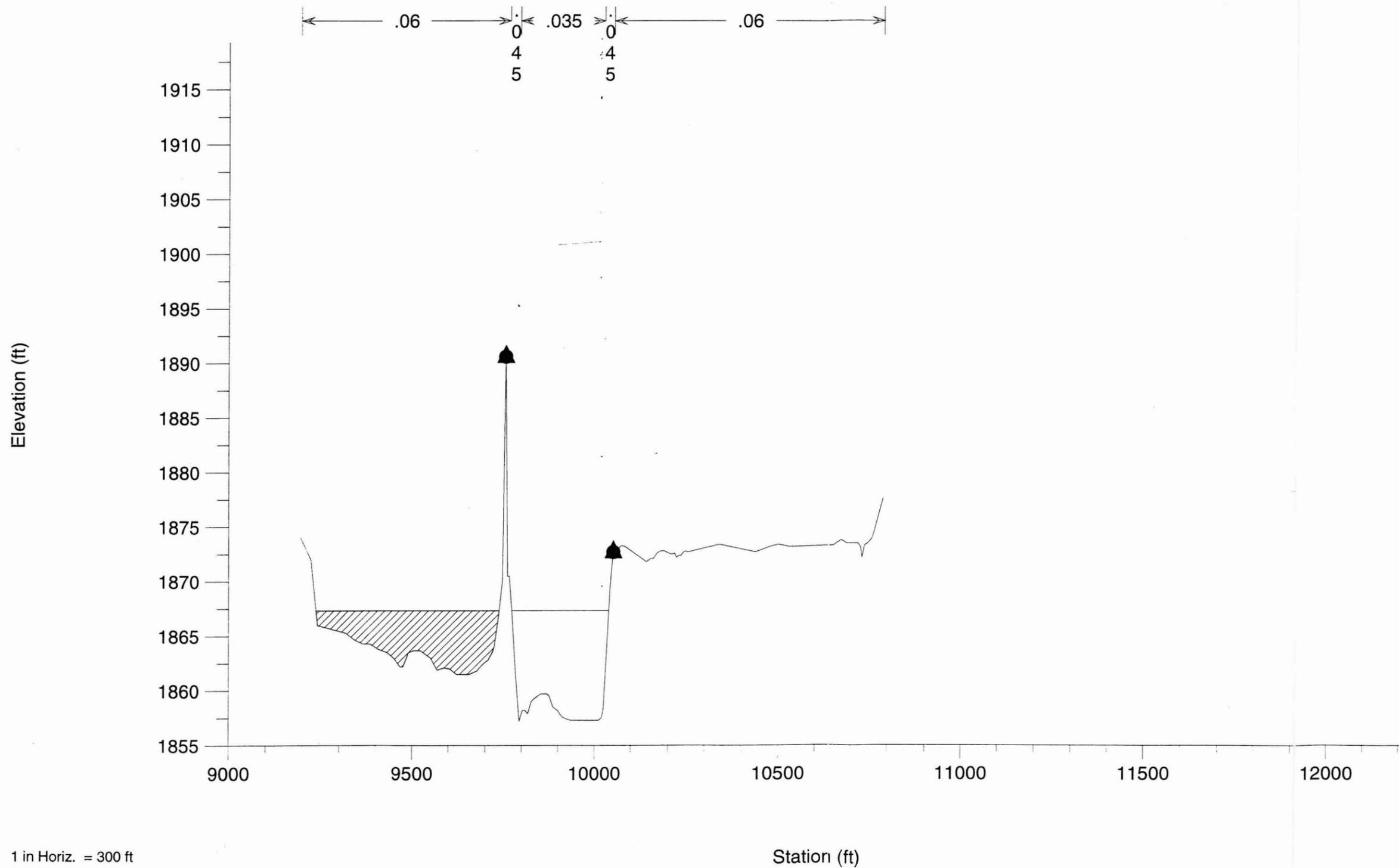


1 in Horiz. = 300 ft
 1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
29.663 Cross Section BL



Cave Creek Wash South FIS 100-Year "n" Values
29.770 Cross Section BO

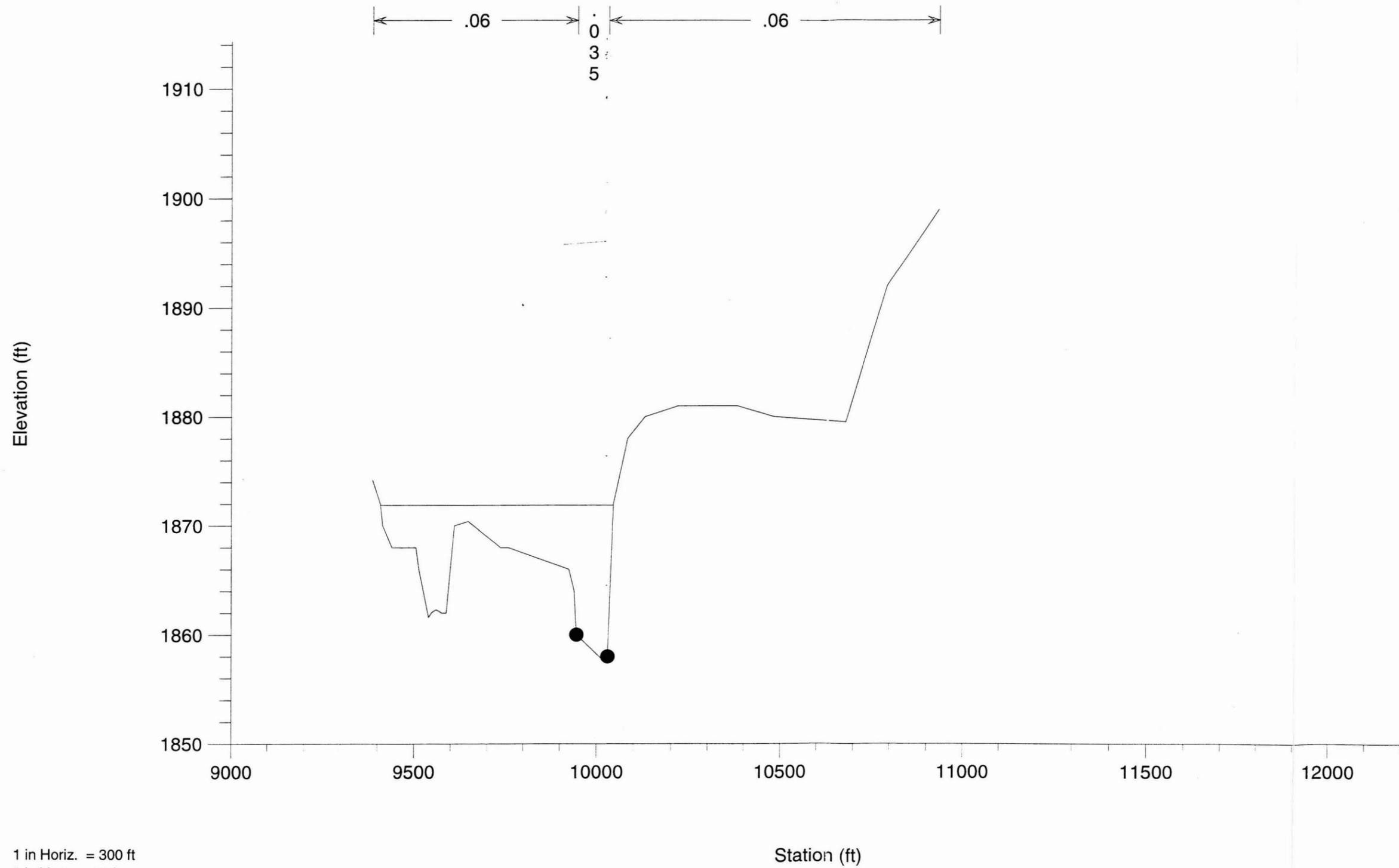


Legend:

- WS 1
- Ground
- Ineff
- Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

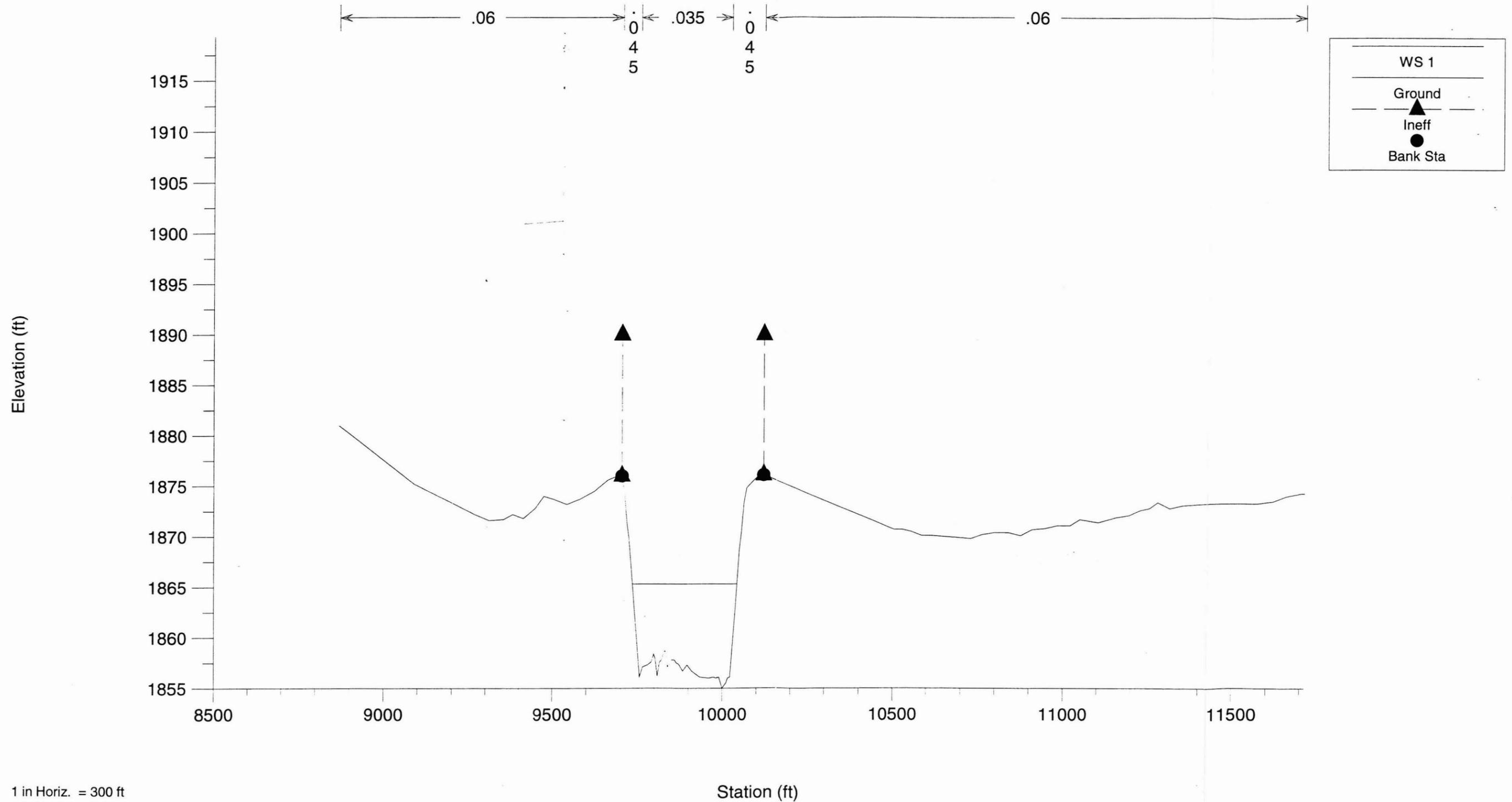
Cave Creek Wash South FIS 100-Year "n" Values
29.850 Cross Section BP



WS 1
Ground
●
Bank Sta

1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
29.710 Cross Section BM



1 in Horiz. = 300 ft
1 in Vert. = 10 ft

Cave Creek Wash South FIS 100-Year "n" Values
29.720 Cross Section BN

