Low Flow Channel Design Analysis for Rio Salado (Salt River), Arizona

TECHNICAL APPENDICES I (1 – 3)

Prepared for

U.S. Army Corps of Engineers, Los Angeles District

WEST

CONSULTANTS, INC.

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WEST Consultants, Inc.
4500 South Lakeshore Drive, Suite 210
Tempe, AZ 85282

Contract No. DACW09-97-D-0022
Delivery Order No. 0007

January 11, 2000

Appendix 1. Field Notes and Photograph

Appendix 2. Low Flow Channel Design Computations

Appendix 3. Hydraulic Technical Notes

APPENDIX 1

Field Notes, Observations, and Action Items

FIELD NOTES

Rio Salado (Salt River), Phoenix, Arizona
Field Reconnaissance

Marc A. Schulte

WEST Consultants, Inc.

Project No. 250A01

March 2, 1999

Field Trip Information

Date	March 1, 1999
Time	9:00 a.m. MST
Location	Rio Salado, Phoenix, Arizona from downstream of Interstate 10 to 19th Street

Name	**Organization**
Don Rerick	Maricopa Co. Flood Control
Laurence Spanulescu	Maricopa Co. Flood Control
John Fincel	City of Phoenix
Glenn Mashburn	U.S. Army Corps of Engineers, Los Angeles District
Van Crisostomo	U.S. Army Corps of Engineers, Los Angeles District
David Williams	WEST Consultants, Inc. (San Diego)
Brian Doeing	WEST Consultants, Inc. (San Diego)
Marc Schulte	WEST Consultants, Inc. (San Diego)
Dennis Richards	WEST Consultants, Inc. (Phoenix)

Stop 1 Just Downstream of Interstate 10

This is the upstream limit of our study area. Grade control structure here consists of two parallel concrete walls. Downstream wall is buried or at grade entire width of channel. Upstream wall has scour downstream on right side of channel (looking downstream), but is at grade or buried on left side. Grouted riprap protects the upstream side of sill. These grade control structures are apparently to protect the integrity of the Interstate 10 crossing. Challenge here is to concentrate flow into the low-flow channel without compromising upstream stream stability. One possibility is to use spur dikes in this area.

There was discussion about the design of the low-flow channel. Corps' initial estimate is a 200-foot wide channel approximately 20 feet deep. The design criterion was to contain a flow of 12,500 cfs to a velocity of less than 6 fps. These numbers are not set in stone. We may want to ask if the magnitude of the design event (approximately a 5-10 year return period) can be reduced. Also, we must clarify what is meant by "non-damaging" flow. If we consider 12,500 cfs to be "non-damaging" and not the in-channel design criteria, we may be able to design a channel that will overtop, but have very low velocities in the overbank areas. In this case, the design criteria might be the duration of the inundation, not just magnitude of flow. We would need to contact a "vegetation expert" to define this criterion.

Stop 2 24th Street

Discussion here revolved around taking the lead on defining acceptable average bed elevations. This way, designers could work backwards from this acceptable elevation without worrying too much about causing an unacceptable increase in the ultimate flood elevation. Channel template using a Manning's roughness coefficient of n=0.04 perhaps. We would have to assume that a 100-year event would wipe out some or even most vegetation in the channel.

Stop 3 Near Utility Crossing

Channel narrows here. Brian says that utility crossing is not modeled in HEC-RAS hydraulic model.

Stop 4 16th Street

Stop 5 Downstream of 16th Street

Bed gradation here is very different. It appears that cobbles might have been scraped from channel and used as bank protection.

Stop 6 Central Avenue

Stop 7 7th Avenue

There is a large amount of construction debris just upstream of the 7th Avenue Crossing. Underneath the 7th Avenue crossing there appears to be remains from an old grade control structure. This feature may not be shown on topography developed from aerial photographs.

Downstream of 7th Avenue has a more typical bed gradation seen upstream near utility crossing, with low brush present in channel. Around 19th Avenue, the channel is much cleaner and the banks are constructed of soil cement. The channel and bank conditions worsen downstream of 19th Street. Special note that only four piers of the 19th Street crossing remain exposed to the flow, starting with Pier No. 2 (counting from left bank of channel looking downstream). Brian says this change, along with the soil-cement channel improvement, is not reflected in the HEC-RAS model.

Notes from Technical Debriefing

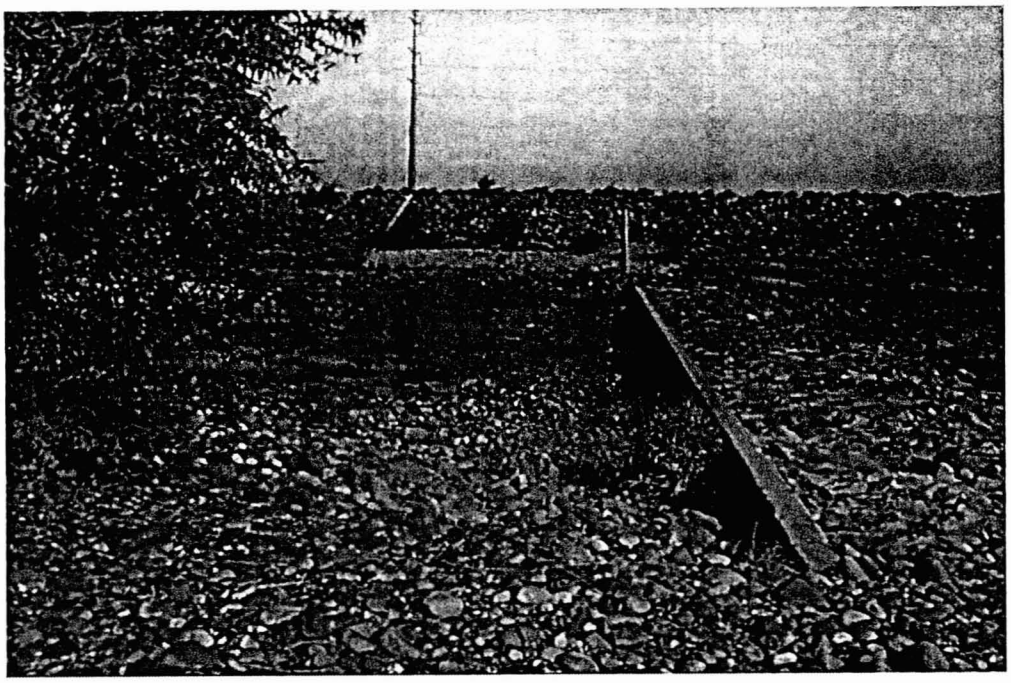
After examining the study reach, representatives from WEST met with Glenn Mashburn and Van Crisostomo from the U.S. Army Corps of Engineers, Los Angeles District for a "technical debriefing." Where many of the points outlined above were reiterated and emphasized. Some of the topics included:

- We need to be more certain of Salt River Project (SRP) reservoir release procedures. Why 12,500 cfs? Why 30 days? We need to know whether our design will be driven from a frequency or duration-based perspective.

- The "footprint" of the preliminary channel as envisioned by the Corps (200 ft) is really quite large: at a 20 ft depth and a sideslope cotangent of 3 or 4 (a "natural" looking channel), equates to a channel topwidth of 320+ feet. This would be a problem getting through most crossings.

- We should ensure that maximum terrace height does not exceed elevation we define that will change floodwater surfaces (see notes at Stop 2 above).

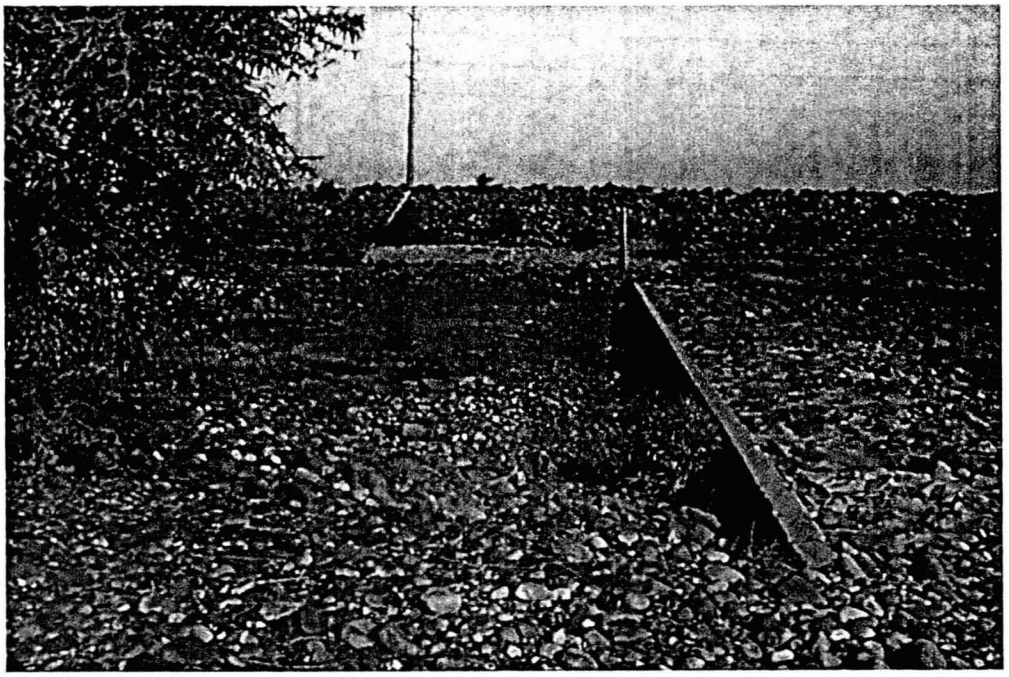
Photographs



• Figure 1 Current grade control structure downstream of Interstate 10. Looking from mid-channel toward right bank. Note that downstream sill is apparently buried.

• Figure 2 Current grade control structure downstream of Interstate 10. Looking from mid-channel toward left bank. Sill is buried or is near grade under water.

Photographs



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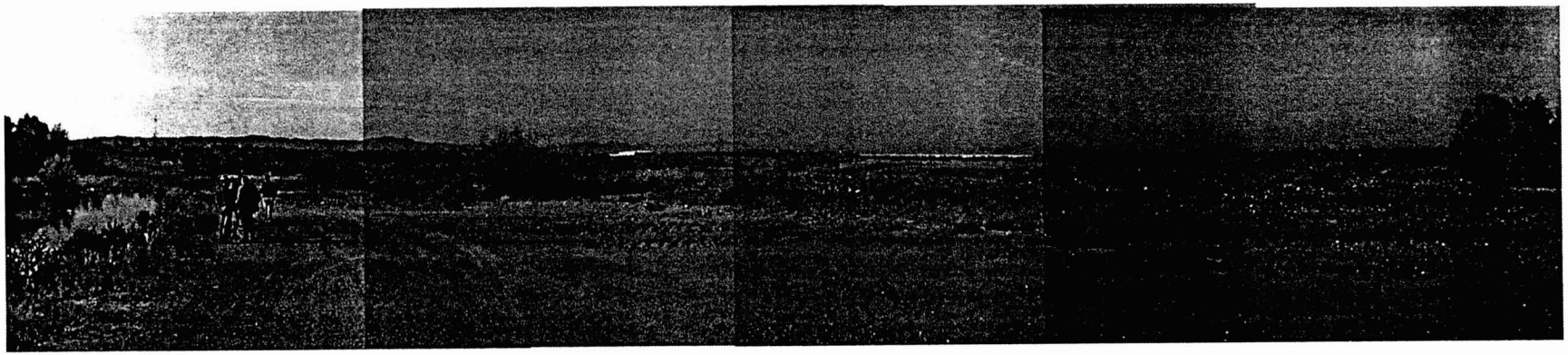
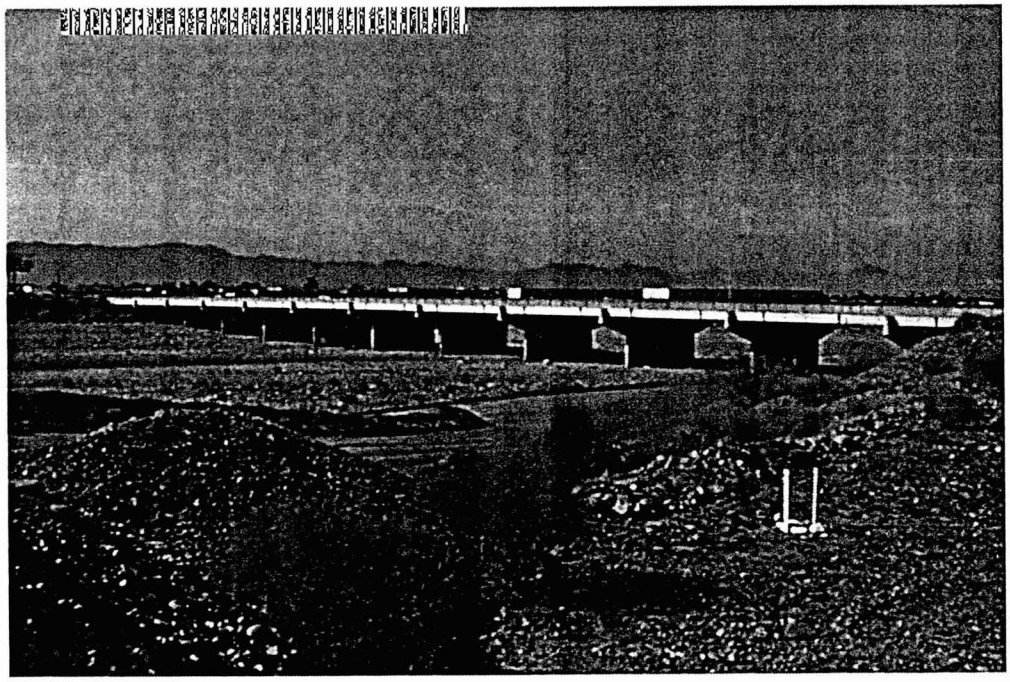
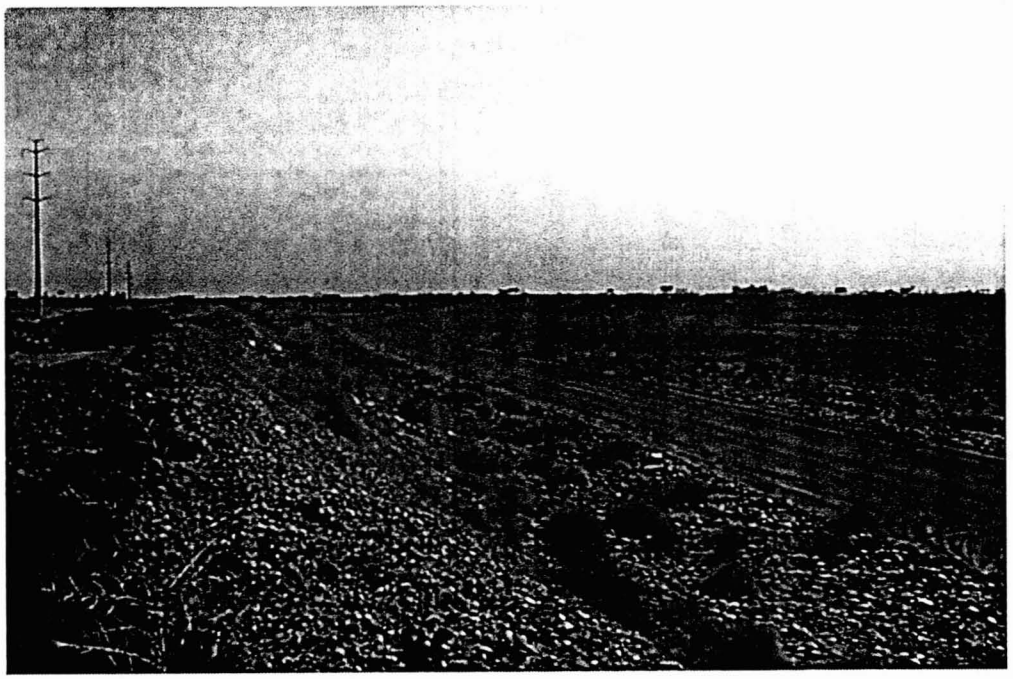


• Figure 3 Panorama looking downstream from grade control structure near Interstate 10.

- Figure 4 Current "low-flow channel" has migrated towards left side of channel. This photo was taken looking upstream toward the left bank from the approximate location of the downstream sill of the grade control structure at Interstate 10.

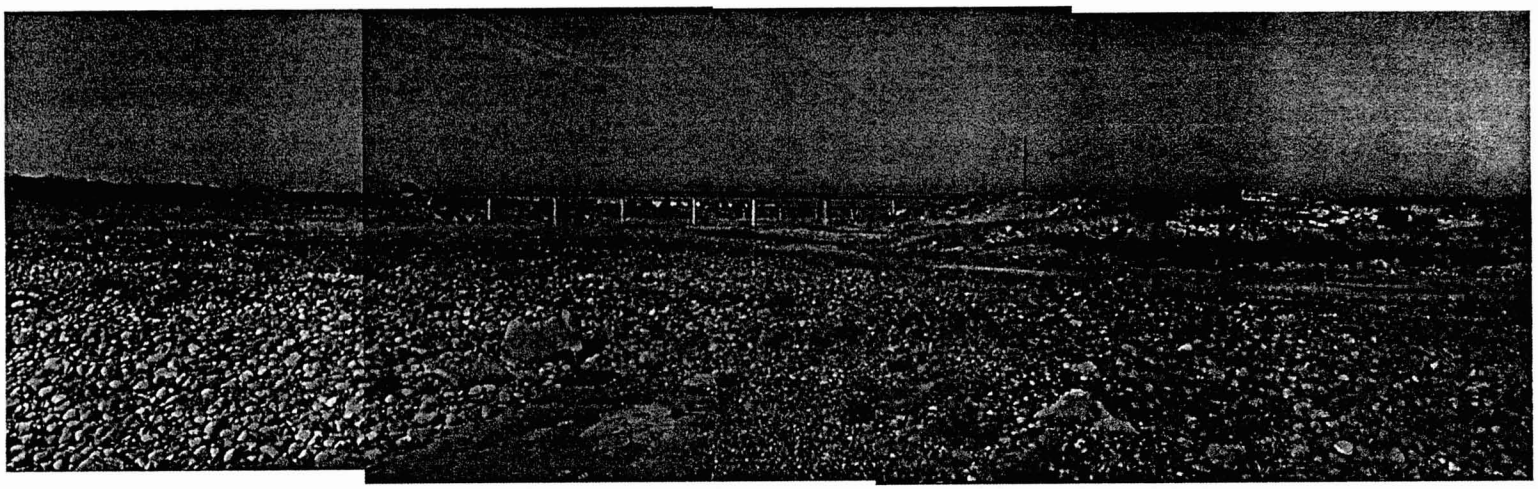


- Figure 5 Upstream face of 24th Street bridge as seen from right bank. Gabions provide protection on abutments.

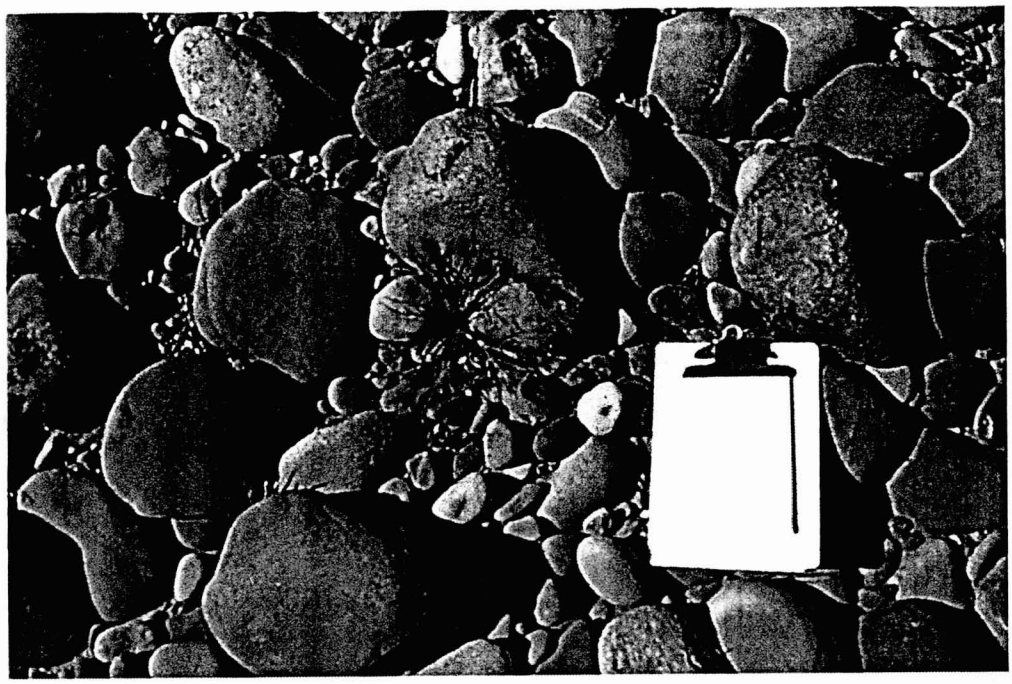


• Figure 6 Looking upstream from the right bank just upstream of 24th Street crossing. Interstate 10 is in background.

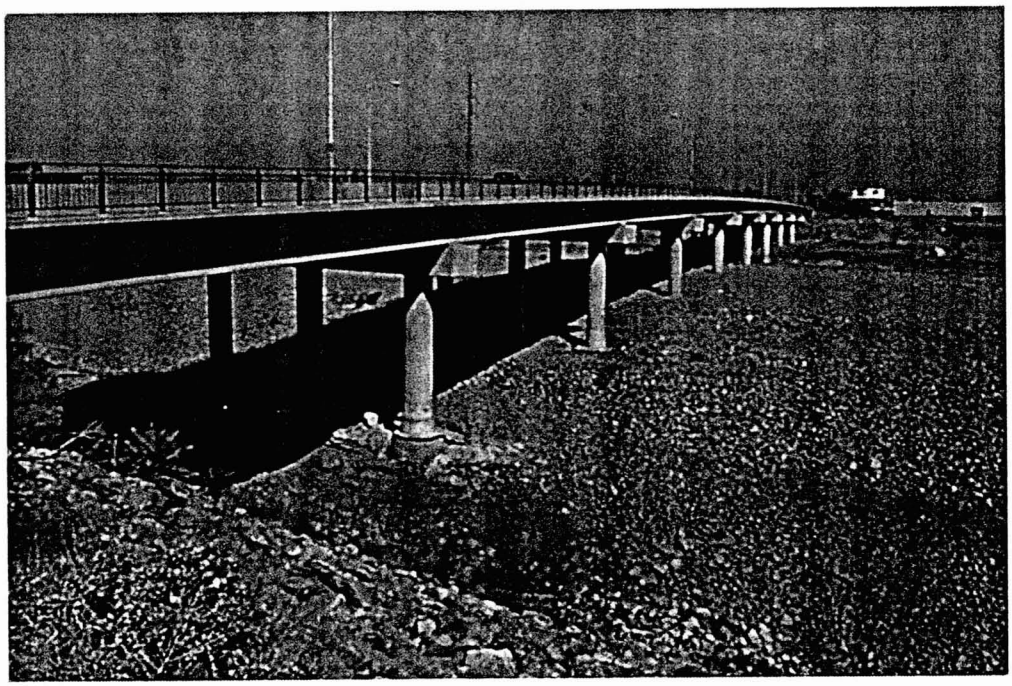
• Figure 7 Looking upstream from mid-channel near utility crossing toward 24th Street crossing.



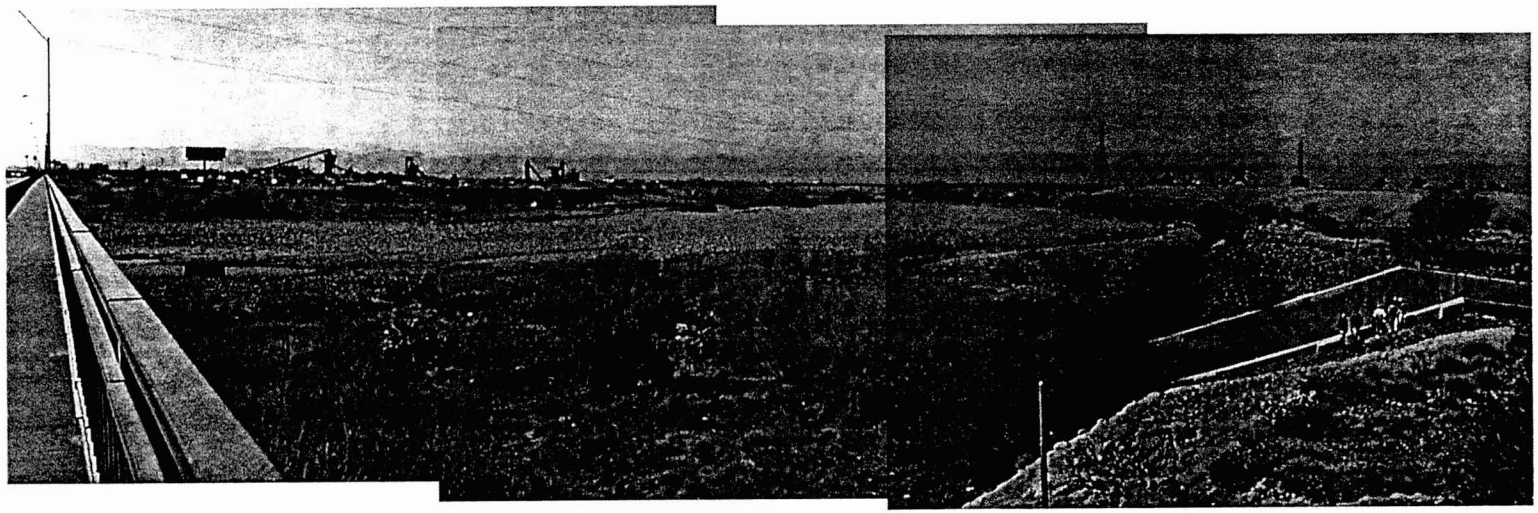
• Figure 8 Looking downstream toward utility crossing from same location as previous photographs.



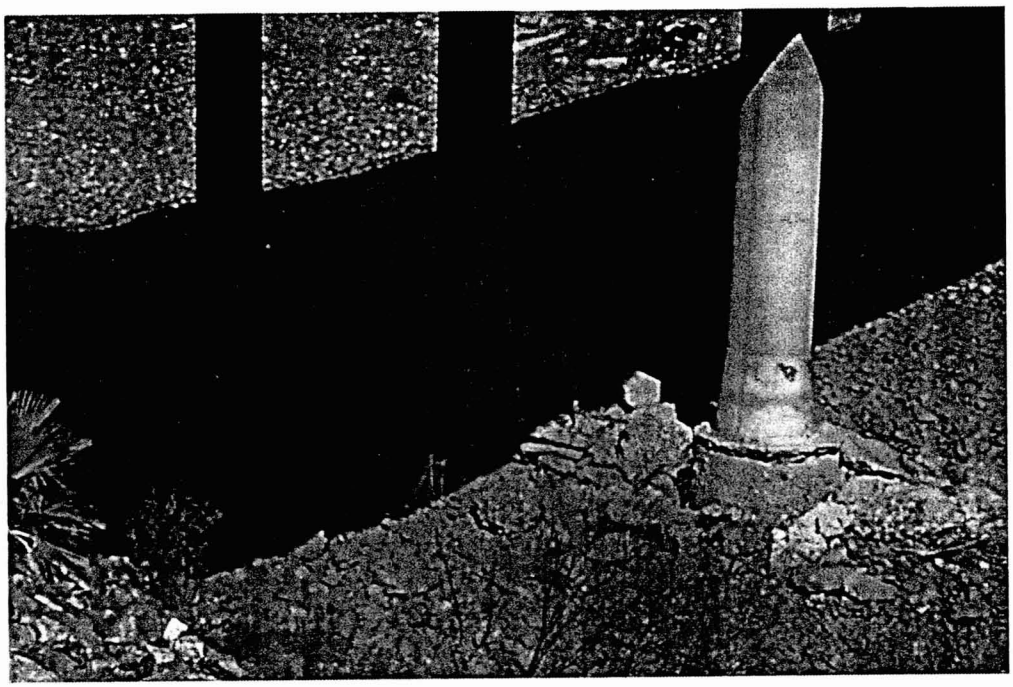
• Figure 9 Typical bed gradation upstream of utility bridge. Clipboard measures 9" x 12.5".



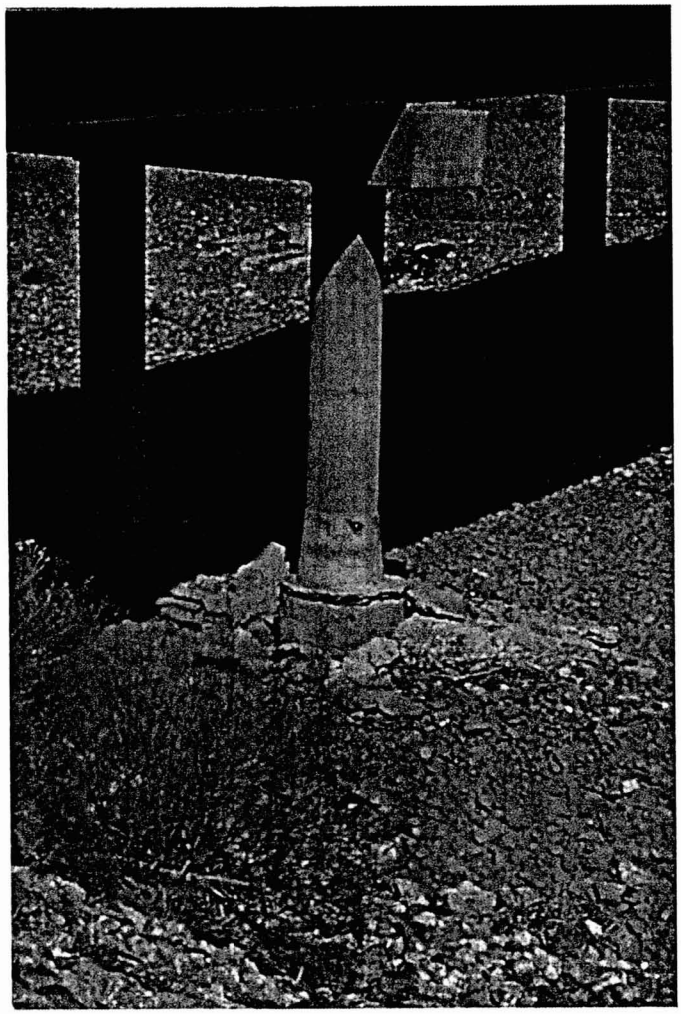
• Figure 10 Upstream face of the 16th Street bridge as seen from the left bank. Riprap protects abutments. Note pier scour on piers in foreground and on other side of channel.



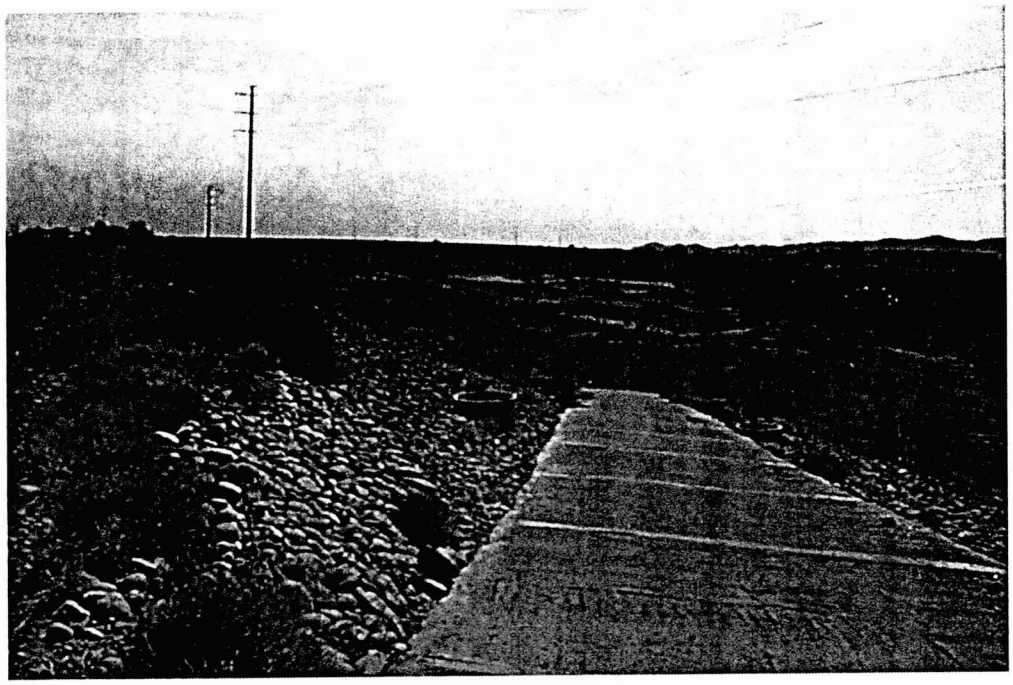
• Figure 11 Looking upstream from 16th Street crossing, left bank. Utility crossing is in background.



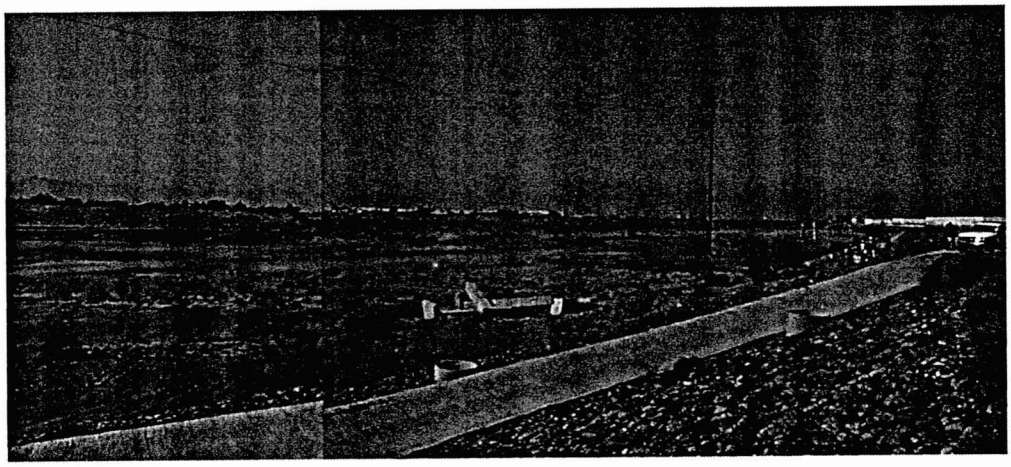
- Figure 12 Tight shot of scour on left piers of 16th Street crossing. Note how scour has occurred even with large channel bed gradation. This scour might indicate that flow is concentrating on the left side of channel at this location.



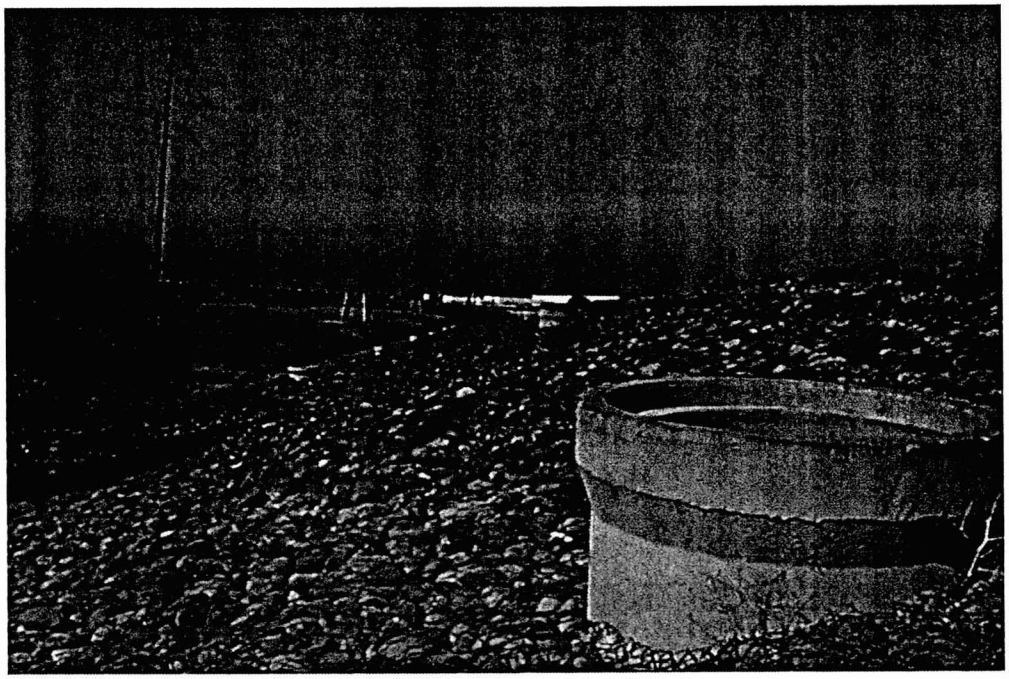
• Figure 13 Another view of pier scour at 16th Street crossing.



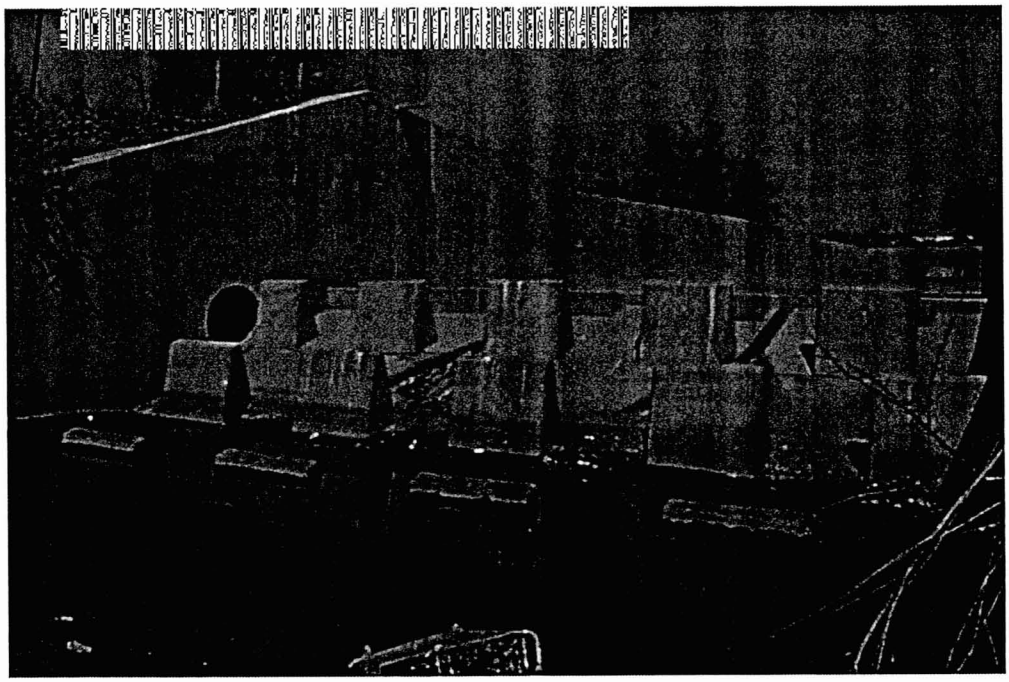
• Figure 14 Downstream face of 16th Street crossing as seen from right bank. Note gabion protection on right bank.



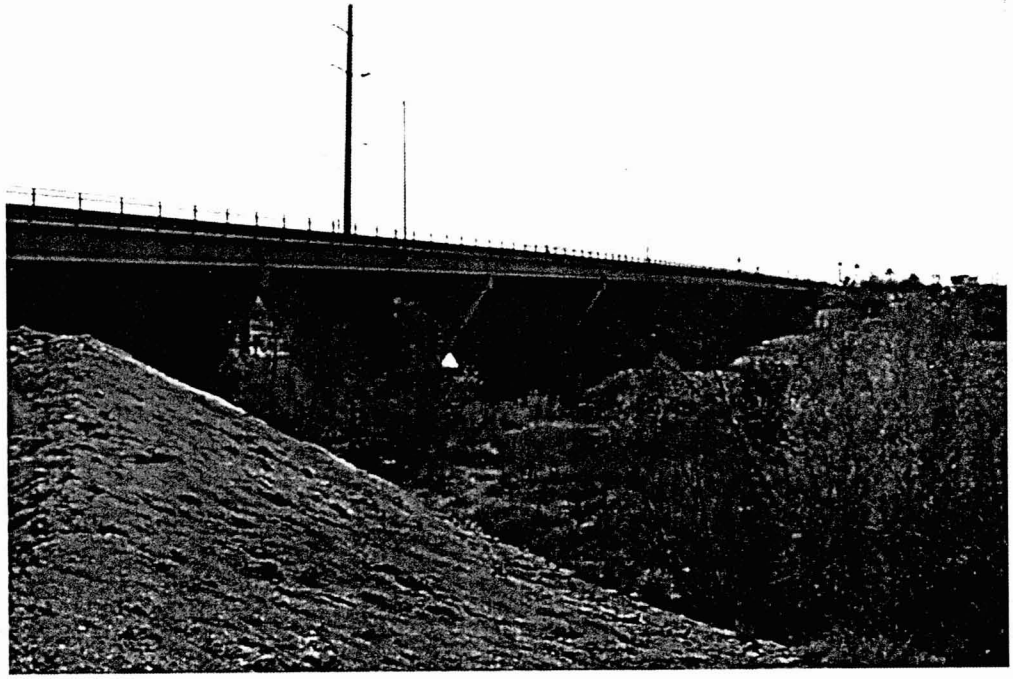
• Figure 15 Looking downstream from same location on right bank. 7th Street crossing is in background.



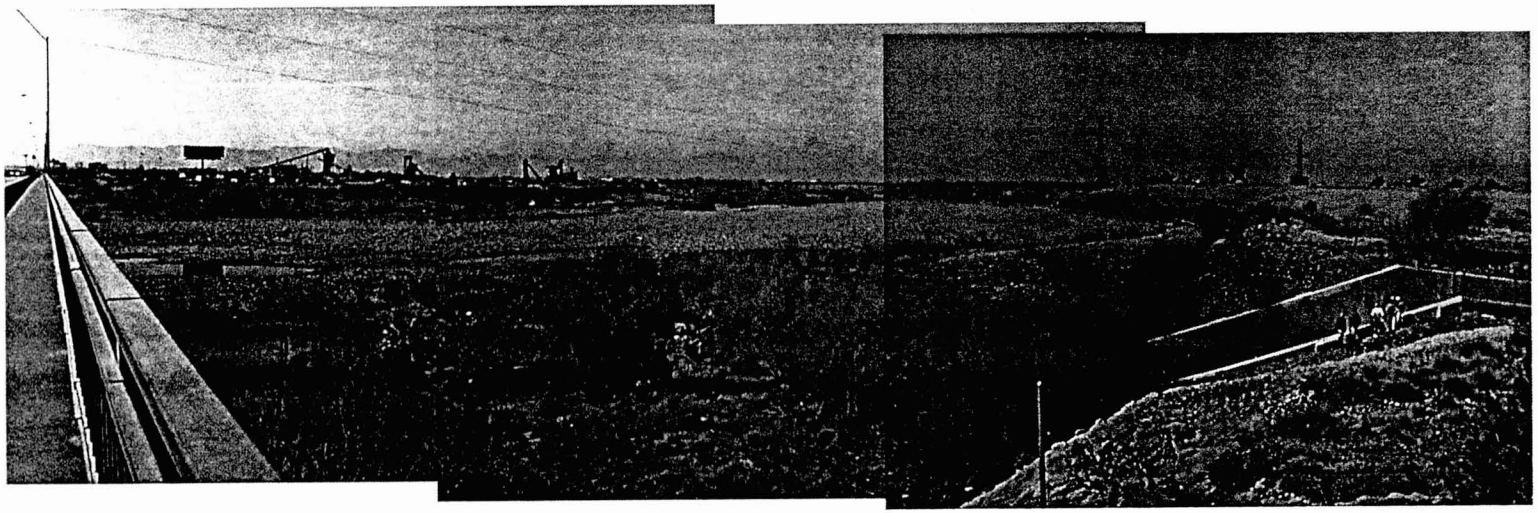
• Figure 16 Tight shot of gabion protection on right bank.



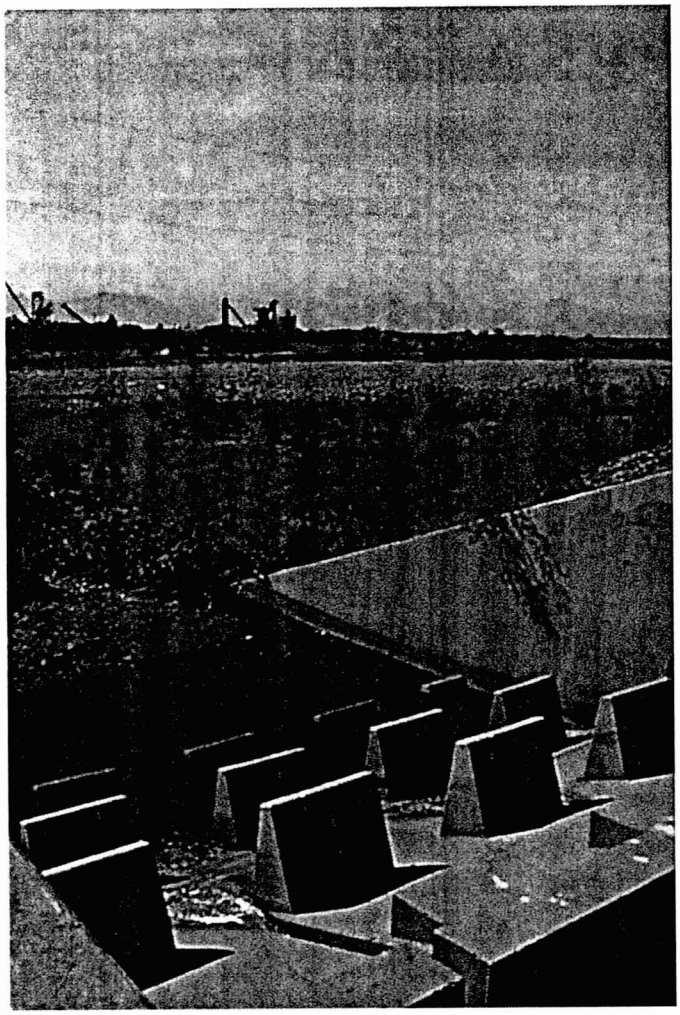
• Figure 17 Outlet works of Central Avenue storm sewer outfall with baffles.



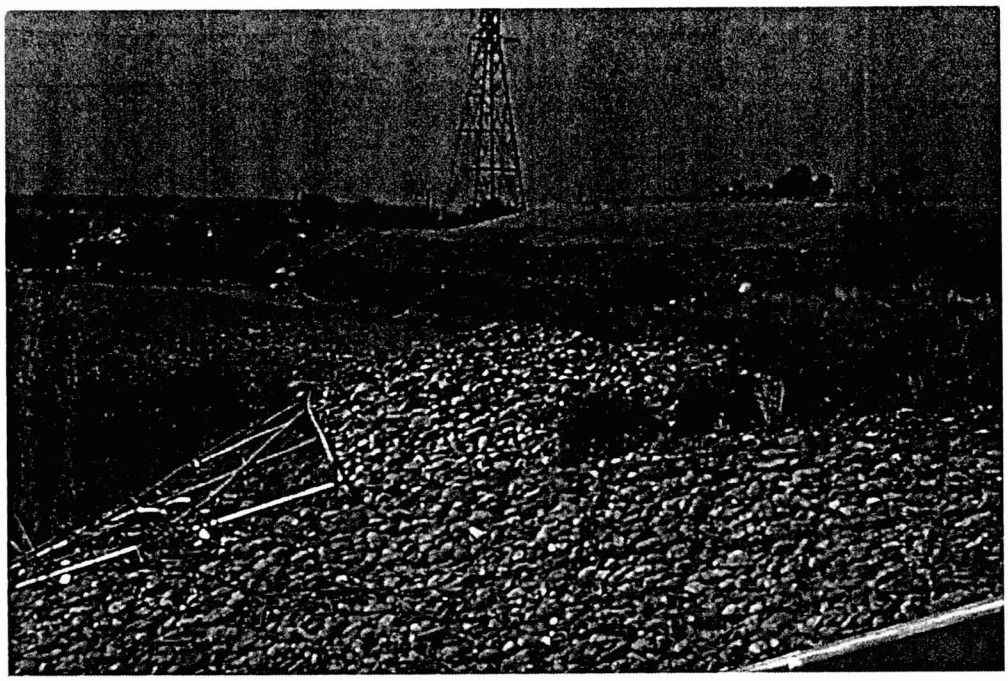
• Figure 18 Downstream face of Central Avenue bridge. Abutment bank protection is grouted riprap and gabions.



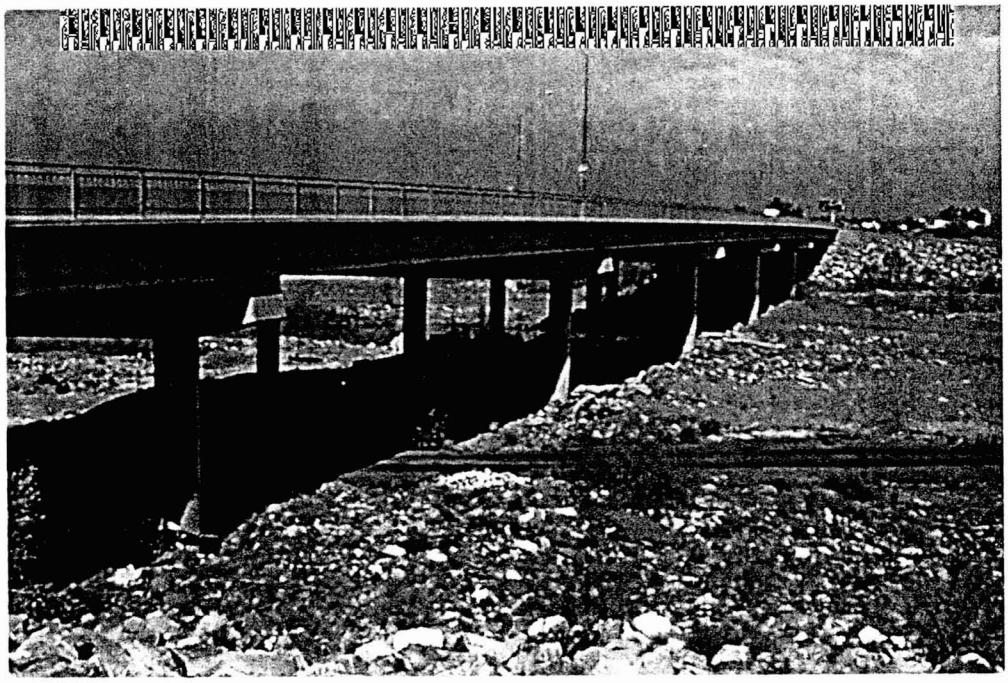
• Figure 19 Looking downstream from right bank at Central Avenue.



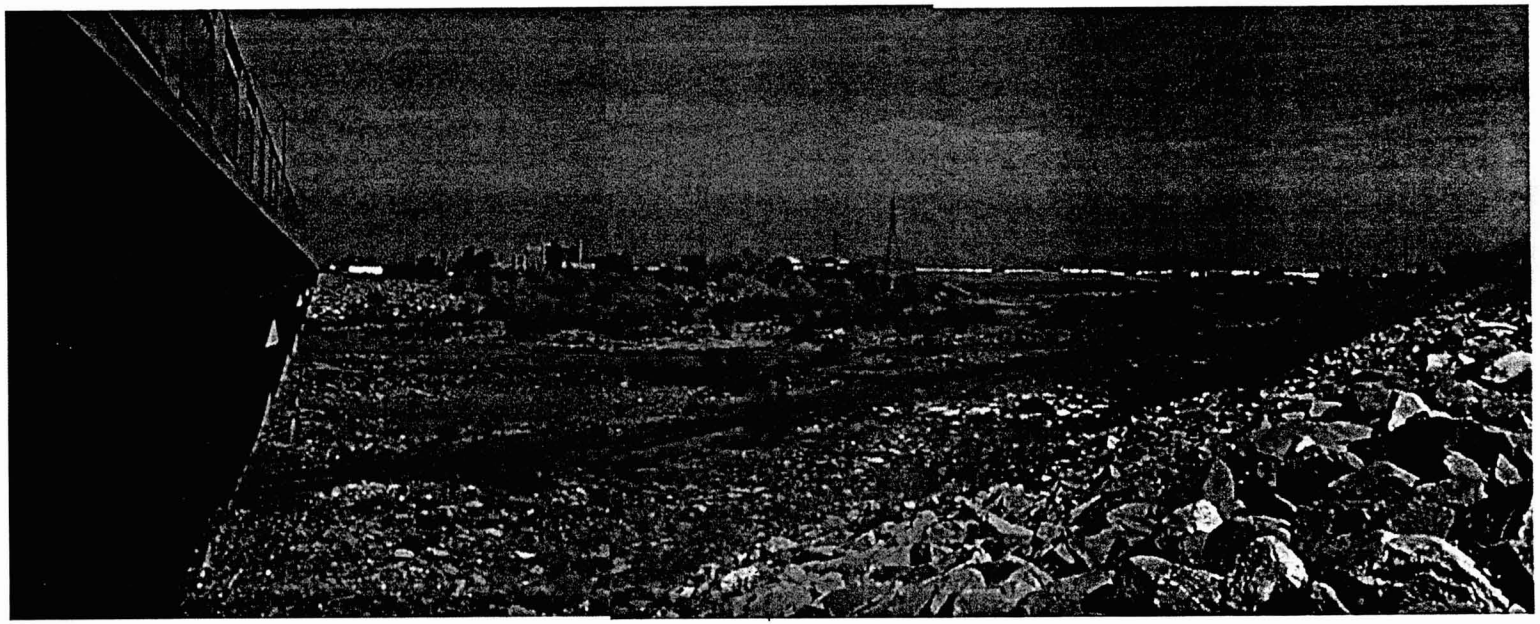
• Figure 20 Central Avenue storm sewer outfall. We should keep low-flow channel alignment well away from the high flow velocities here.



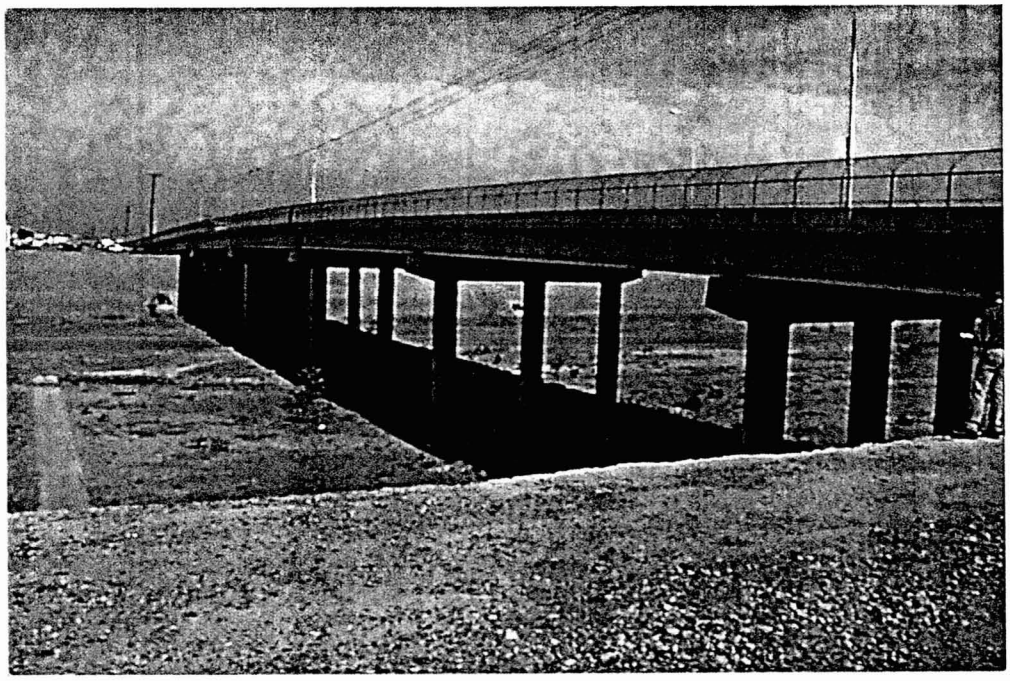
• Figure 21 Tighter shot of gabion protection on right bank downstream of Central Avenue.



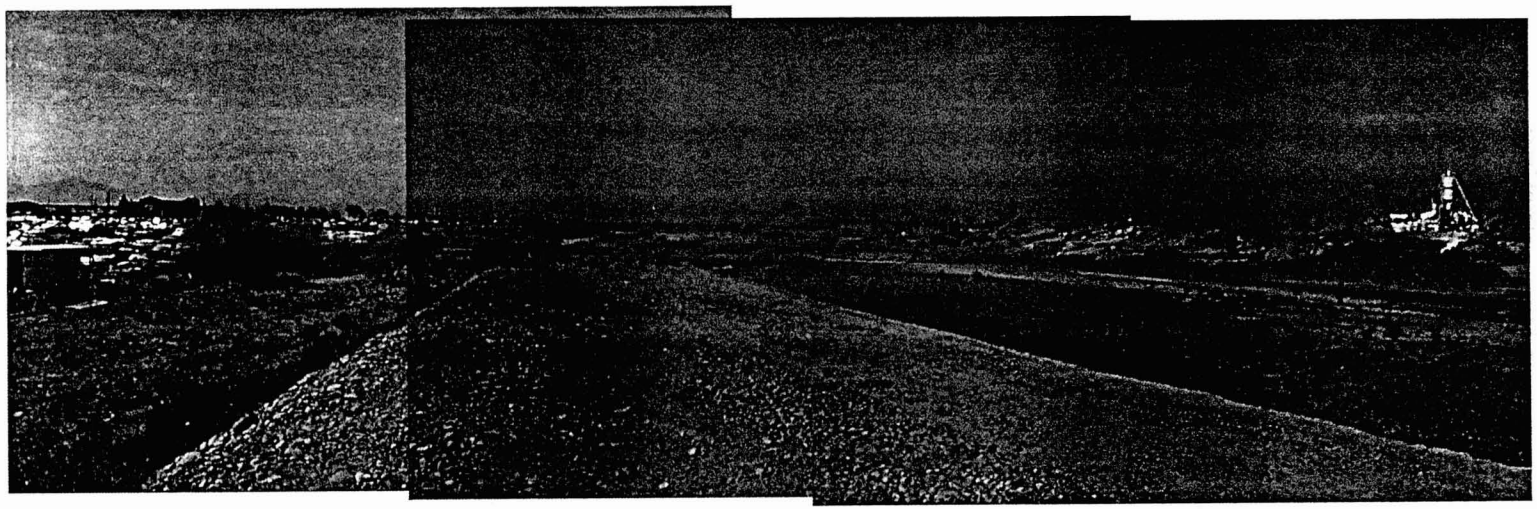
• Figure 22 Upstream face of 7th Avenue bridge as seen from left bank. Riprap protection at abutments.



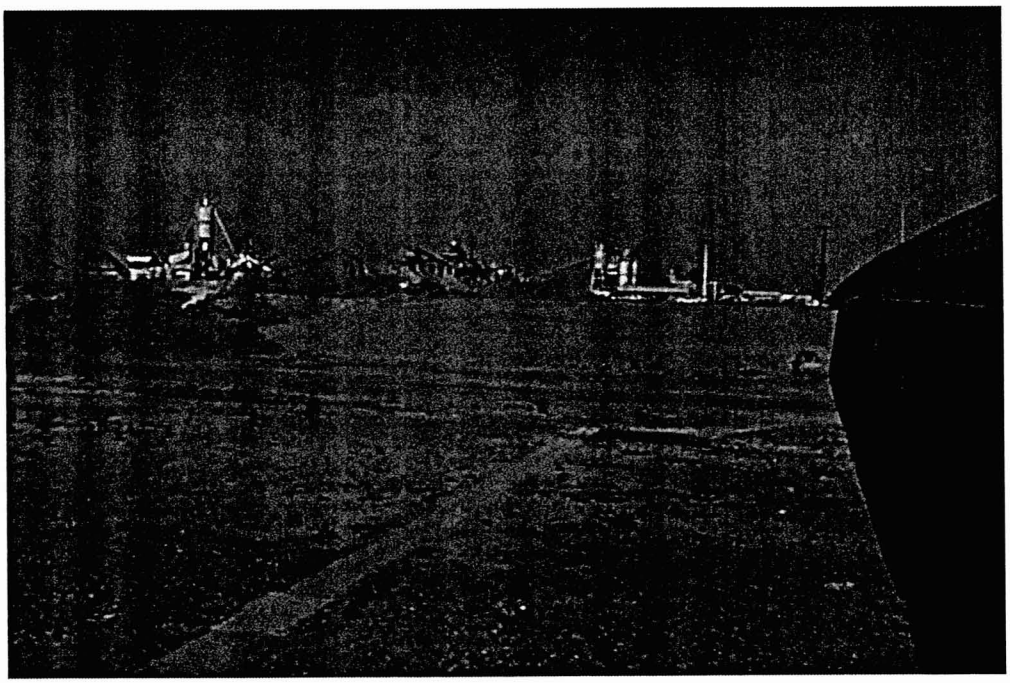
• Figure 23 Looking upstream from left bank at 7th Avenue crossing. Channel has more vegetation in this vicinity. Central Avenue bridge is in background.



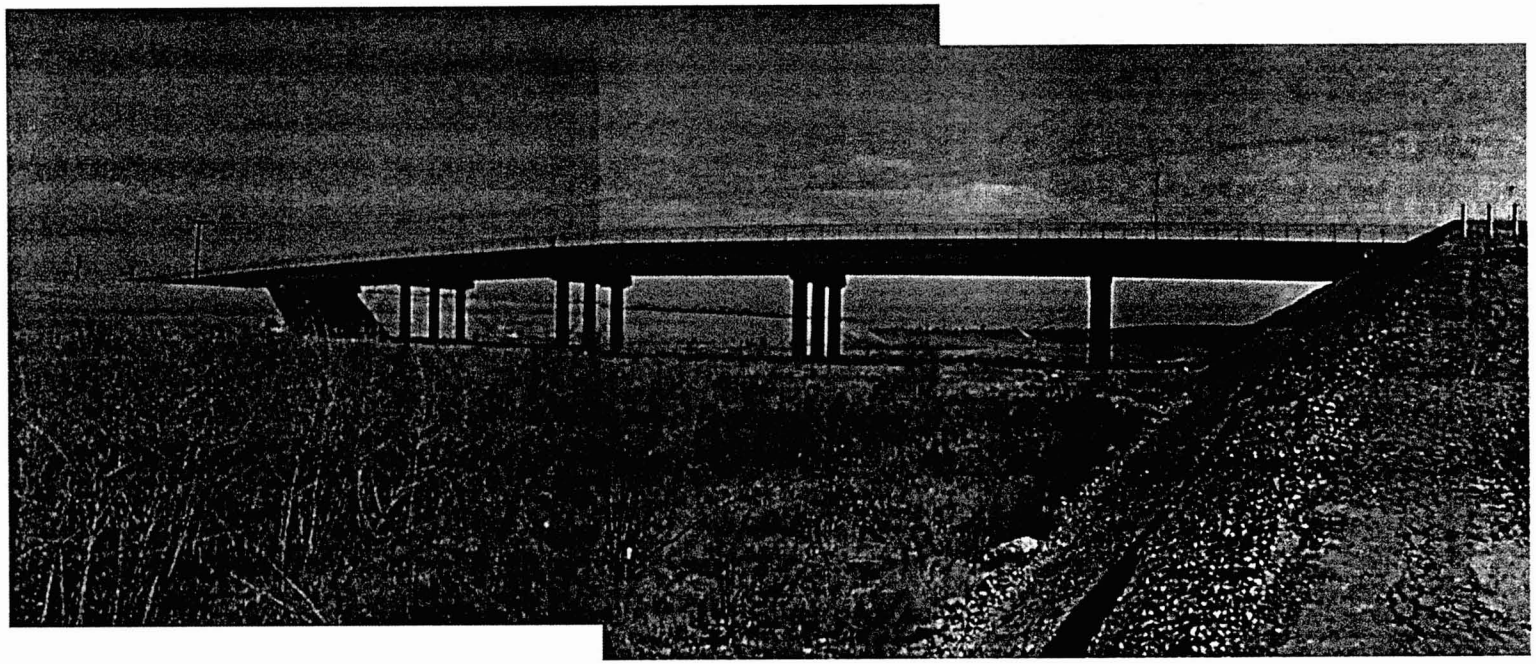
• Figure 24 Downstream face of 19th Avenue bridge from left bank. Note grade control sill at left of picture.



• Figure 25 Looking downstream from left bank at 19th Avenue crossing.



- Figure 26 Channel improvements end just downstream of 19th Avenue bridge. Again note sill approximately 75 feet downstream of crossing.



• Figure 27 19th Avenue crossing and channel improvements at lower end of the study reach as seen from left bank of channel.

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PHOENIX RIO SALADO PROJECT

FIELD TRIP OF FEBRUARY 19, 1999
AND
FIELD TRIP OF MARCH 1, 1999
NOTES, OBSERVATIONS AND ACTION ITEMS

On Friday, February 19, 1999 the FCDMC, Don Rerick, Amir Motamedi, Laurence Spanulescu, Warren Rosebraugh, the City of Phoenix (City), Jon Fincel, and the Corps of Engineers consultant, West Consultants, Inc. (West), David Williams and Dennis Richards made a field trip of the project limits beginning at 19th Avenue and ending at the I-10 crossing of the Salt River.

On Monday, March 1, 1999 another field trip occurred and included the FCDMC, Don Rerick, Laurence Spanulescu, the City of Phoenix (City), Jon Fincel, and the Corps of Engineers consultant, West Consultants, Inc. (West), David Williams and Dennis Richards, and the Corps of Engineer (Corps), Glenn Mashburn and Van Crisostomo. This trip began at I-10 and ended at 19th Avenue.

The following is a summary of field notes taken, observations made, and items requiring attention and action (**). *Field notes, observations, and items requiring attention and action from the March 1 field trip are denoted by italics.* It is apparent that there still remains a number of significant items requiring attention and resolution in order to meet present project schedules.

19th Avenue –

1. There is an existing grade control structure (GCS) immediately D/S of the bridge.
2. The GCS will need to be modified, notched, to accommodate the D/S end of the low flow channel (LFC). Some grading to daylight of the LFC will be required D/S of the GCS.
3. (**) As-Built plans of the GCS must be obtained in order to determine how to modify it.
4. According to West Engineering (West), groundwater (GW) was encountered during the construction of this GCS and the cement stabilized alluvium (CSA) bank protection in this area.
5. (**) It is clear that GW investigation must be done for the project and this information must be provided in the construction documents, including an appropriate bid item.
6. (**) Impacts to the bridge piers must be evaluated for the LFC, and required modifications to the piers must be determined. This will be typical for all the seven bridges within the project limits.
7. **(**) The width, capacity and alignment of the LFC must be reevaluated in the context of impacts to the bridges. Clearly a 200' wide LFC, as has been discussed, could have serious impacts on this and the other bridges.**
8. **(**) Who is responsible to evaluate the impacts to the bridges, and to design any required modifications to and reinforcement of the bridges?**
9. **(**) The decision on the type of LFC and what will be acceptable bridge modifications are very much interrelated and must be made as soon as possible to not delay the final design process.**
10. (**) It has been an understanding between the City and the FCDMC, that the FCDMC will not cost share in any modifications to any of the bridges required for this project.
11. There are a number of storm drain outlets into the river near this bridge. And, such outlets occur at many other locations along the project alignment, consisting of some very large pipes and box culverts.
12. (**) What is the expected method for handling these side flows. Intentionally direct the flows to the LFC or allow the flows to randomly flow across the terraces and enter the LFC?
13. *The Corps understanding is that the LFC will end at about the 15th Avenue alignment and then be "daylighted" to existing grade before the existing GCS D/S of 19th Avenue. This means no modifications to the GCS or concerns for the bridge. This negates item 2 above.*

Other Issues –

14. Surface water is evident in the area U/S of the 19th Avenue bridge. Such water has many sources, including nuisance runoff, discharge from S&G operations, and local storm drain outlets.

15. (**) Surface as well as GW management must be identified in the P&S, possibly including a bid item(s) for these activities.
16. Construction access appears to be very limited along the river. In fact, except for S&G operations, there does not appear to be any convenient construction access into the river from surface streets and other areas. United Metro, for example, may be willing to provide construction access along the south side of the river between 19th Avenue and 7th Avenue.
17. **(**) As part of the City's responsibility to obtain all project right-of-way, the <u>CITY MUST</u> obtain and provide construction access rights and/or temporary construction easements (TCE) at frequent locations along the river. These access locations must be coordinated with District construction staff, and must be provided as part of the City right-of-way certification package before the FCDMC can begin advertising for construction. Recent aerials and discussions with S&G operators should be used to identify possible access points.**

7th Avenue –

18. Similar concerns were noted at this bridge location; especially relating to LFC design, bridge impacts and possible modifications, side inflow to manage, etc. The foundations for the central bridge piers are already exposed.
19. There is major surface water to be managed at this location.
20. U/S of this location is significant amounts of large pieces of broken concrete and asphalt, and other debris.
21. **(**) A decision must be made regarding how to handle and dispose of this material. Can it be used as backfill for CSA toedowns? Must it be hauled off and disposed of off-site? What is the makeup and quantity of this material and how will this be determined? How should it be bid? A bid item must be provided in the P&S. Can the material remain in the river and placed along the high banks as bank protection in order to minimize handling and disposal costs? Can it be buried in the terrace areas, and/or used to create mounds?**
22. Both U/S and D/S of this location is a lot of surface water; and probably some inflow of GW.
23. (**) Some kind or reasonable management plan should be evaluated for both surface and GW water to ensure that it is possible, and to be able to adequately account for this cost in the Corps' development of the Engineers Cost Estimate for construction. And, again, it may be appropriate to have a separate bid item for water management.
24. (**) Immediately U/S of the bridge is a partially buried large concrete "structure". How will this be dealt with in the P&S? Should a separate bid item under Section 350 be provided for removal and disposal of such items? How should the bid item be quantified? A field reconnaissance must be done to identify such items. Some kind of contingency or allowance should be made in the bid schedule for similar items that will likely be uncovered during construction.
25. There is significant flowing water from an existing storm drain at the northwest corner of the bridge.

Other Issues –

26. **(**) Many S&G operation haul roads exist within and across the river bottom. What is the expected disposition of these roads for construction of the LFC? Do the S&G operations expect these roads to remain intact during construction, and after construction. Must accommodations be made for these roads in the design *of the LFC* and construction of the project? Specific direction must be provided in the P&S on how to deal with these roads. The <u>CITY MUST</u> obtain input from the S&G operators immediately on these issues, and provide direction to the final design on how these roads must be accommodated. *This direction must be incorporated into the final design and P&S.***
27. *(**) The existing S&G haul roads must be delineated and identified on the base sheets for the plans.*
28. (**) The existing surface water must be delineated and identified on the plans with respect to the alignment of the LFC. This will facilitate the contractor in determining approximate impacts of surface water to LFC construction. Obviously some of the surface water limits will change because of the early excavation efforts by the S&G operators. These changed limits should be identified during the as-built field survey to be dome after the S&G excavation has occurred.
29. (**) A decision must be made on the disposition of the LFC excavation material. This material generally consists of large cobbles, not exactly "good dirt" for landscape and vegetation mounds.

Should it be stockpiled in the river, what are floodplain management allowances for such stockpiling, must it be exported?

Central Avenue –

30. Similar concerns were noted at this bridge location; especially relating to LFC design, bridge impacts and possible modifications, side inflow to manage, etc.
31. Bridge piers appear to be more closely spaced here than at 7th Avenue.
32. There does not appear to be as much debris in the river at this location.
33. There is an existing single pole transmission tower that will need to be avoided on the U/S side of the bridge.
34. There is an abandoned four column transmission tower foundation near the new transmission tower. It can probably be left in place.
35. The river at this location appears to be much narrower than at 19th Avenue. The LFC width must be evaluated in the context of existing river bottom width, lest there be no remaining terrace areas for revegetation work.
36. *(**) The LFC should be aligned more to the south side of the existing river alignment.*

7th Street –

37. Similar concerns were noted at this bridge location; especially relating to LFC design, bridge impacts and possible modifications, side inflow to manage, etc.
38. There is a significant amount of large rubble and debris in this area all the way D/S to 7th Avenue, including concrete and boulders.
39. (**) Again, a decision must be made regarding how rubble and debris will be handled during construction. Separate bid item? Should it be exported and disposed of? What is impact to construction costs, etc. and available FCDMC funding for construction.
40. U/S of this location the river bottom appears much "cleaner" and free of debris.
41. The river U/S of this location also appears to be much wider than D/S reaches.

16th Street –

42. Similar concerns were noted at this bridge location; especially relating to LFC design, bridge impacts and possible modifications, side inflow to manage, etc.
43. (**) U/S of the bridge is a large concrete slab exposed in the river bottom. Again, how should this and similar conditions be identified in the P&S and bid schedule?
44. U/S of this location the river appears much "cleaner" and free of debris.
45. (**) Some distance U/S of the bridge is a large mass of "waste concrete" measuring at least 50' by 25'. It actually looks like it could remain as a habitat feature that could be "masked" with new vegetation. A decision is required on what to do with this mass of concrete. Remove and dispose of as a construction cost? It must be described in the P&S.
46. *It is not the intent of the project to make bank stabilization improvements to existing high banks of the river.*
47. *(**) The north bank of the river encroaches significantly into the river just U/S of the 20th Street S&G conveyor. How will this be dealt with in the design analysis and disposition of the bank material during construction? Must it be removed? Direction must be provided in the P&S for this and any other similar encroachment area.*
48. *It is not anticipated that side flows will be "structurally" defined and directed to the LFC. There may be some need for small GCS to discharge the flows into the LFC.*

Other Issues –

48. (**) The geotechnical report to be made available to the contractors must clearly identify the materials and gradation to be removed for LFC excavation.
49. *(**) All large rubble, concrete slabs, waste concrete masses must be delineated on the plans whenever possible so the Contractor knows what he is dealing with as Section 350 in the Special Provisions.*
50. *(**) It would be beneficial for the project, and potentially offer some considerable construction cost savings to the project, to obtain permission from the owner(s) of the abandoned S&G pits along the project alignment to use the pits as disposal sites for excavation material generated by the LFC. The City should obtain this information and the necessary written permissions to allow the pits to be used*

and to be able to present this option in the Special Provisions. It would then be left to the contractors to develop the most cost effective plan for use of these pits as part of the project.

24th Street –

51. Similar concerns were noted at this bridge location; especially relating to LFC design, bridge impacts and possible modifications, side inflow to manage, etc.
52. U/S of this location the river appears much "cleaner" and free of debris. It also appears wider.

I-10 –

53. A GCS exists D/S of the bridge. It will need to be modified to accept U/S flows into the LFC.
54. (**) As-built plans for the GCS must be obtained from ADOT, and modifications to the GCS must be approved by ADOT. The approval coordination and timeline must be closely followed and scheduled so as not to delay design.
55. (**) Some kind of transition into the LFC may be required U/S of the GCS and through the bridge. This will also require review and approval by ADOT.
56. *The U/S end of the LFC would begin D/S of the I-10 GCS. Would anticipate capturing the flows into the LFC about mid-way between I-10 and 25th Street. This then negates item 55 above.*
57. *The alignment of the LFC at this location would probably favor the north side of the river.*
58. *Diversion structures would be used to direct flows into the U/S end of the LFC. These might consist of dumped riprap of a D50 = 36" +/-, or a grouted rock feature. Cost analysis will be needed to assist in deciding what type to use. O&M effort and costs to maintain these features must also be considered in the decision.*
59. *(**) Again the issue about what the LFC section should be and what flow rate to design for was discussed. Need to evaluate lesser flows (< 12,500 cfs) as design basis for the LFC as long as the terrace vegetation can be sustained and not adversely affected. Need input from the environmental group on root inundation impacts, durations. Etc to assist I the decision.*
60. *(**) HEC-RAS analysis will require some understanding of the built out vegetation layout, mounding, terracing, etc. So this plan development needs to occur at the same time as the alternatives analysis. Consider using n-values in the range of 0.040.*
61. *The Post-Roosevelt 100-yr "Q" will be the basis for design. Should not worsen the WSE of this flow from pre to post project conditions.*
62. *(**) These design basis issues must be discussed in more detail at the next meeting on March 10 to ensure that everyone is in agreement. This should help avoid disagreements and delays during the review process.*

Other Issues –

63. **(**) It will be extremely important that the Corps develop construction durations for both phases of the project. These durations will be reviewed by the FCDMC, and then will become the basis for determining construction contract time.**
64. Based on this field trip and the amount of debris, surface and GW to be managed, minimal access points and possible disposal requirements for excavated materials and debris, it appears likely that Phase 1 (19th Avenue to 7th Street) could require at least 12 months to construct, and Phase 2 (7th Street to I-10) could require at least 18 months to construct. This will cause winter river flows to have more of a potential impact on construction of both phases, and will affect the FCDMC funding schedule for the two phases.
65. *(**) The final 1' C.I. mapping being done by the Corps is expected to be submitted to the City and the FCDMC on/about March 10. The files will be in microstation .DGN. West must have the digital files converted for their use because they do not have microstation capabilities.*
66. *(**) The City will utilize the .DGN mapping files to overlay the right-of-way information for the project. These overlays must be provided to the Corps and the FCDMC.*
67. *(**) There seemed to be some concerned expressed that West may not be able to meet the first submittal date IAW the Scope.*
68. *(**) Decisions on any need for and how to modify any of the bridges cannot be done until the sediment and scour analyses have been done. This may affect decision timelines on what to show in the P&S for any bridge work.*

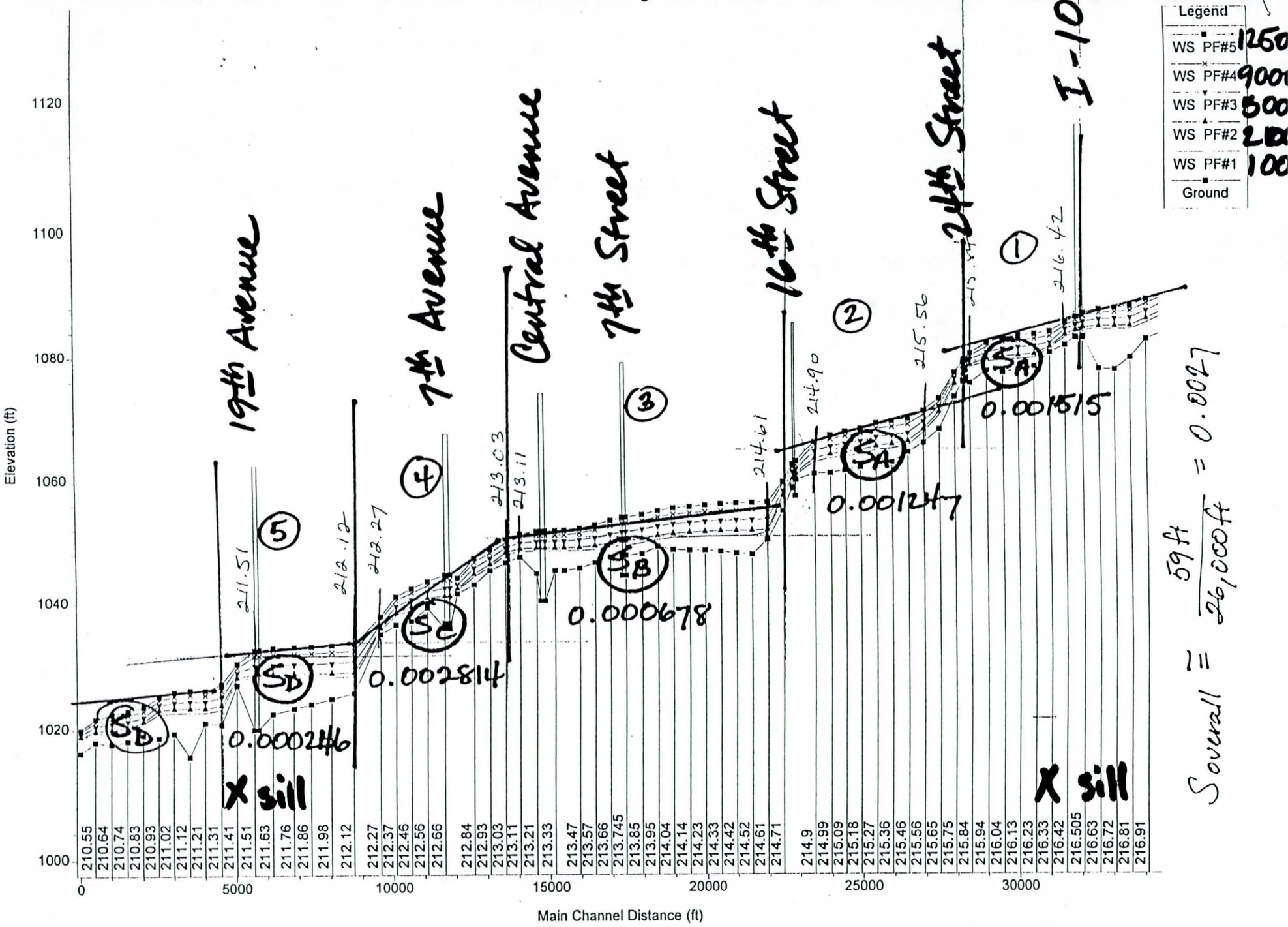
APPENDIX 2

Channel Design Computations

APPENDIX 2

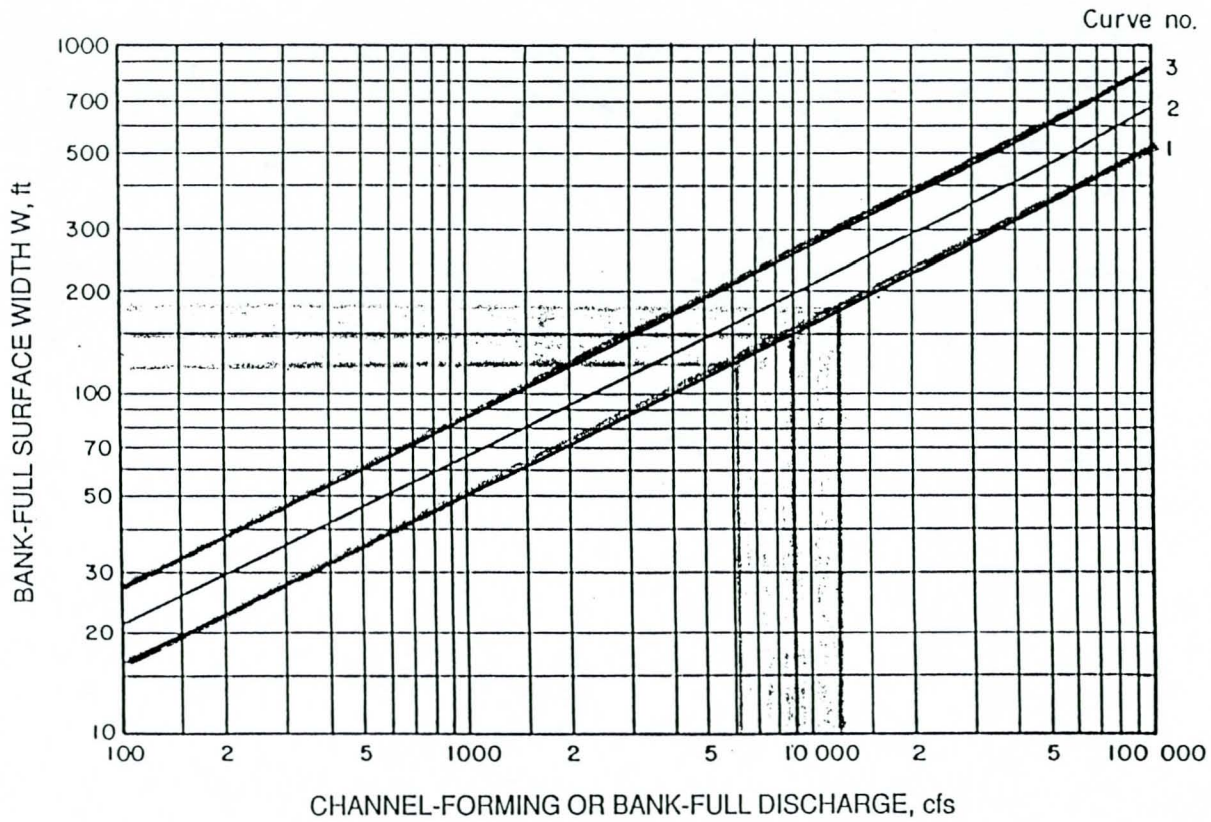
STABLE SLOPE ESTIMATES

CHANNEL SIZE



$S_{overall} = \frac{59\,ft}{26{,}000\,ft} = 0.0027$

1 in Horiz. = 4000 ft 1 in Vert. = 20 ft

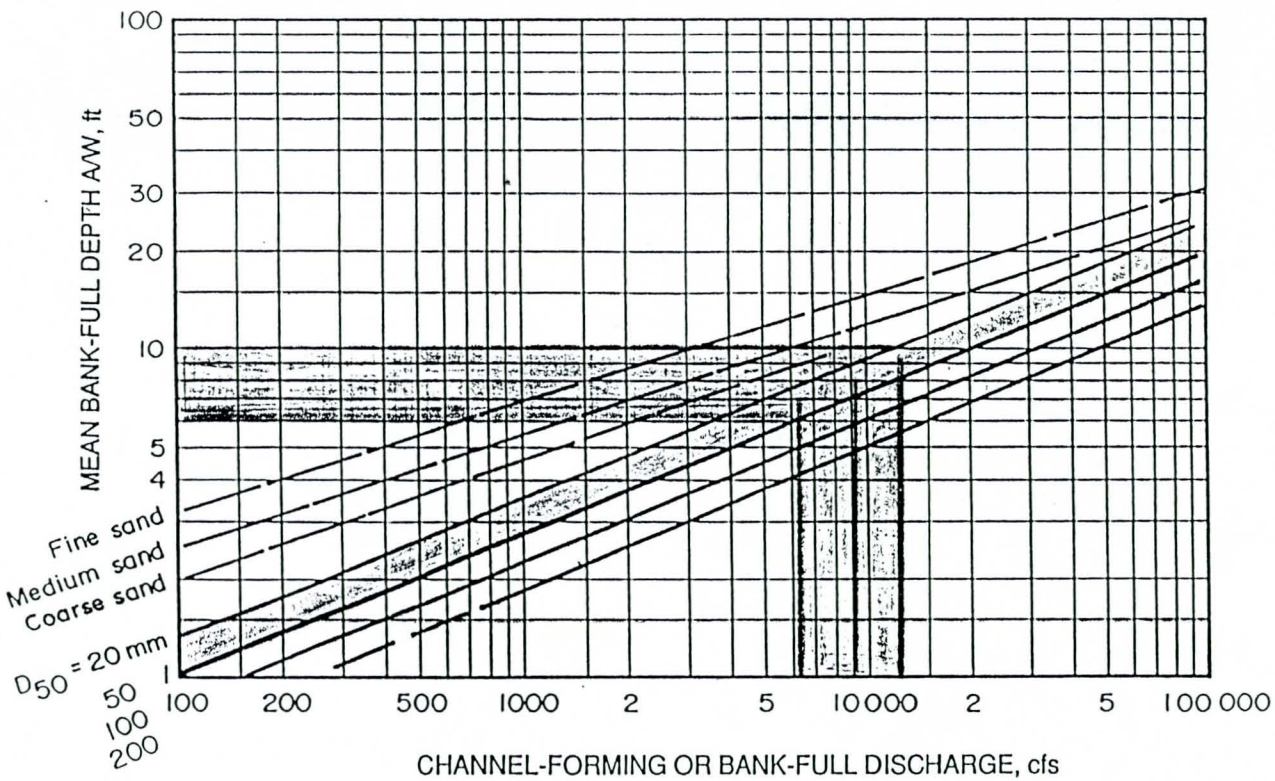


TENTATIVE GUIDANCE: CURVE 1: STIFF COHESIVE OR VERY COARSE GRANULAR BANKS.
CURVE 2: AVERAGE COHESIVE OR COARSE GRANULAR BANKS.
CURVE 3: SANDY ALLUVIAL BANKS.

SEE PARAGRAPH 5-5 FOR LIMITATIONS.

FORMULA: $W = C\,Q^{0.5}$ WITH $C = 1.6, 2.1, 2.7$

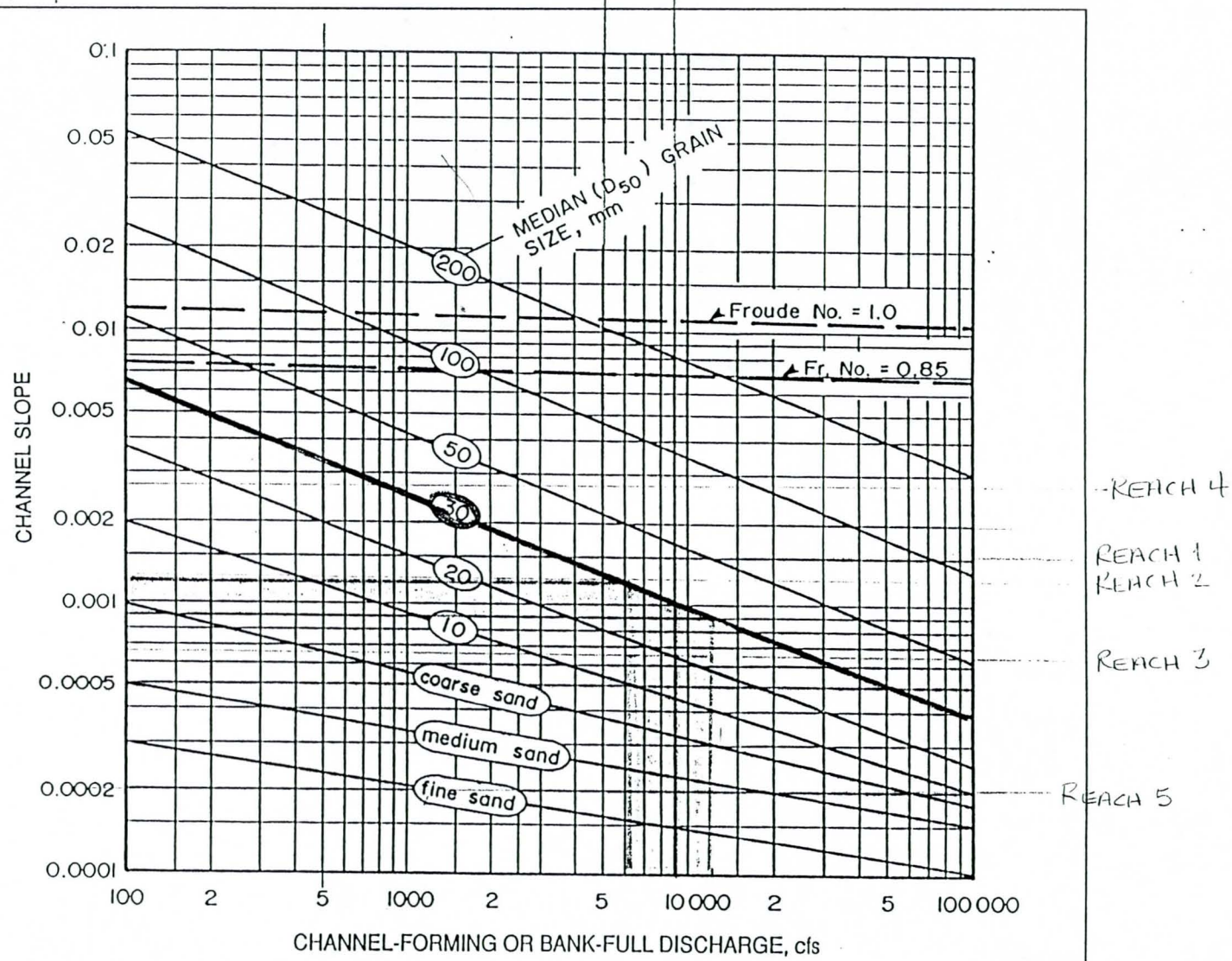
Figure 5-9. Tentative guide to width-discharge relationships for erodible channels. See Appendix B for derivation.



NOTE: FOR VERY APPROXIMATE GUIDANCE ONLY; DEPTHS SHOULD BE CHECKED BY UNIFORM-FLOW CALCULATION USING SELECTED WIDTH AND SLOPE (FIGURES 5-4 AND 5-5) AND ESTIMATED ROUGHNESS (SEE PARAGRAPH 4-7E).

APPLIES BASICALLY TO CHANNELS WITH LOW BED SEDIMENT TRANSPORT.

Figure 5-10. Tentative guide to depth-discharge relationships for erodible channels. See Appendix B for derivation.



NOTE: FOR LIMITATIONS SEE PARAGRAPH 5.5. CURVES ARE BASICALLY FOR SINGLE CHANNELS WITH FULLY ALLUVIAL BED BUT LOW BED SEDIMENT TRANSPORT. SLOPES MAY BE MUCH HIGHER WITH HIGH SEDIMENT TRANSPORT, ESPECIALLY WITH SAND BEDS.

Figure 5-11. Tentative guide to slope-discharge relationships for erodible channels. See Appendix B for derivation.

• Table 4 Channel geometry estimates following AMAFCA method, assuming width-depth ratio of F=20, maximum Froude number of Fr=0.70, and a Manning's roughness coefficient of n=0.030.

Design Discharge, Q (cfs)	Stable Slope, S_s (ft/ft)	Channel Width, W (ft)
6,500	0.00356	117
9,000	0.00340	133
12,200	0.00327	150

• Table 5 AMAFCA estimate of stable slope using 5- and 10-year post-Roosevelt modification discharges. The slopes are slightly steeper than the overall slope currently found on the study reach.

Discharge*, Q (cfs)	Return Period (yrs)	Stable Slope, S_s (ft/ft)	Channel Width, W (ft)
20,200	5	0.00305	183
53,000	10	0.00269	270

Discharges for Salt River at Central Avenue, taken from U.S. Army Corps, Los Angeles District, (1998), Rio Salado Salt River, Arizona Feasibility Report and Environmental Impact Statement, Appendix A: Hydrology.

FROM DRAFT of 50% SUBMITTAL

AMAFCA STABLE SLOPE SAMPLE CALCULATION

$$S_s = 18.28\, n^2\, F^{0.133}\, FR^{2.133}\, Q^{-0.133}$$

$$n = 0.030;\quad F = 20;\quad FR = 0.70$$

$$Q = 12{,}200$$

$$S_s = 18.28\,(0.030)^2\,(20)^{0.133}\,(0.70)^{2.133}\,(12200)^{-0.133}$$

$$S_s = 0.00327$$

$$W = 0.50\, F^{0.60}\, FR^{-0.40}\, Q^{0.40}$$

$$F = 20;\quad FR = 0.70;\quad Q = 12200$$

$$W = 0.50\,(20)^{0.60}\,(0.70)^{-0.40}\,(12200)^{0.40}$$

$$W = 150'$$

CALCULATE STABLE CHANNEL DIMENSIONS.

MEDIAN BED SIZE ON BED, MM	=	29.62103
GRADATION COEFFICIENT	=	25.305
VALLEY SLOPE, FT/FT	=	0.00500000

		LEFT BANK	RIGHT BANK
SIDE SLOPE	=	3.000	3.000
Ks, FT	=	0.4200	0.4200
n-VALUE	=	0.02960	0.02960

TABLE 4-1. STABLE CHANNELS FOR Q= 12500.0 C,mgl= 1000. D50= 29.621

K:	BOTTOM WIDTH FT	DEPTH FT	ENERGY SLOPE FT/FT	CMPOS^T: n-Value	HYD RADIUS: FT	VEL FPS	FROUDE: NUMBER:	SHEAR: STRESS: #/SF:	BED * B-REGIME
1	10.	13.3	0.011541	0.0309	7.03	18.94	0.92	9.54	UP
2	20.	12.9	0.008612	0.0319	7.46	16.49	0.81	6.93	UP
3	30.	12.3	0.007528	0.0328	7.62	15.23	0.77	5.76	UP
4	40.	11.6	0.007003	0.0335	7.65	14.41	0.75	5.07	UP
5	50.	10.9	0.006732	0.0342	7.60	13.80	0.74	4.59	UP
6	60.	10.3	0.006598	0.0347	7.49	13.32	0.73	4.25	UP
7	70.	9.7	0.006547	0.0352	7.35	12.92	0.73	3.98	UP
8	80.	9.2	0.006550	0.0356	7.18	12.58	0.73	3.77	UP
9	90.	8.7	0.006589	0.0359	7.00	12.29	0.73	3.60	UP
10	100.	8.3	0.006653	0.0362	6.81	12.03	0.74	3.45	UP
11	110.	7.9	0.006736	0.0364	6.62	11.80	0.74	3.33	UP
12	120.	7.6	0.006832	0.0366	6.43	11.59	0.74	3.22	UP
13	130.	7.2	0.006937	0.0368	6.24	11.40	0.75	3.13	UP
14	140.	6.9	0.007050	0.0369	6.06	11.22	0.75	3.05	UP
15	150.	6.6	0.007168	0.0371	5.88	11.06	0.76	2.97	UP
16	160.	6.4	0.007290	0.0372	5.72	10.91	0.76	2.91	UP
17	170.	6.2	0.007414	0.0373	5.55	10.77	0.77	2.85	UP
18	180.	5.9	0.007541	0.0373	5.40	10.64	0.77	2.79	UP
19	190.	5.7	0.007668	0.0374	5.25	10.52	0.77	2.74	UP
20	200.	5.5	0.007797	0.0374	5.11	10.40	0.78	2.70	UP
RESULTS AT MINIMUM STREAM POWER									
21	74.	9.5	0.006543	0.0354	7.28	12.77	0.73	3.88	UP

>>>> MINIMUM SLOPE IS GREATER THAN VALLEY SLOPE - THIS IS A SEDIMENT TRAP <<<<

* REGIMES: LO=LOWER, TL=TRANSITIONAL-LOWER, TU=TRANSITIONAL-UPPER, UP=UPPER.

...END OF JOB... Printout is in FILE [CURVEA.hoT]

LOW-FLOW CHANNEL DIMENSIONS

$Q = 12,200$ cfs. $S = 0.25\%$

use $n = 0.030$ (will be conservative for velocity but not for depth)

set $\bar{u} = 6.50$ fps (conservative)

Uniform flow equation:

$$\bar{u} = \frac{\phi}{n} R^{2/3} \sqrt{S} \quad \text{solve for } R = \left[\frac{n}{\phi} \bar{u} / \sqrt{S}\right]^{3/2}$$

$\bar{u} = 6.50$
$n = 0.030$
$S = 0.00250$
$z = 3$

$R = 4.235$

if $Q = 12,200$ cfs, $A = 1877$

$$AR^{2/3} = \frac{[(b+zy)y]^{3/2}}{\sqrt{b+2zy}}$$

BASE WIDTH*	YN	
205	8.0	
230	7.5	
255	7.0	
168	9.0	← use 160
140	10.0	

$Q = 12,200$ cfs $S = 0.125\%$

$\bar{u} = 6.50$
$n = 0.030$
$S = 0.00125$
$z = 3$

$R = 7.12$

if $Q = 12,200$ cfs, $A = 1877$

BASE WIDTH*	YN	
205	10.0	← use 205
245	9.0	
295	8.0	

* rounded up slightly to ensure capacity

$Q = 9000$ cfs $\quad S = 0.00250$

$\bar{u} = 6.50$ $\quad R = 4.24$
$n = 0.030$
$S = 0.00250$
$z = 3$

if $Q = 9000$ cfs, $A = 1385$

BASE WIDTH	YN
150	8
120	9
100	10

$Q = 6500$ cfs $\quad S = 0.00250$

$\bar{u} = 6.50$ $\quad R = 4.24$
$n = 0.030$
$S = 0.00250$
$z = 3$

if $Q = 6500$ cfs, $A = 1000$.

BASE WIDTH	YN
65+	10.0
75	9.5
85	9.0
105	8.0

$Q = 9000$ cfs $\quad S = 0.00125$

$\bar{u} = 6.50$ $\quad R = 7.122$
$n = 0.030$
$S = 0.00125$
$z = 3$

if $Q = 9000$, $A = 1385$

BASE WIDTH	YN
145+	10
175+	9
215	8

RIO SALADO | MAS 3/30/99

$Q = 6500$ cfs $S = 0.00125$

$\bar{u} = 6.5$ $R = 7.122$

$n = 0.030$

$S = 0.00125$

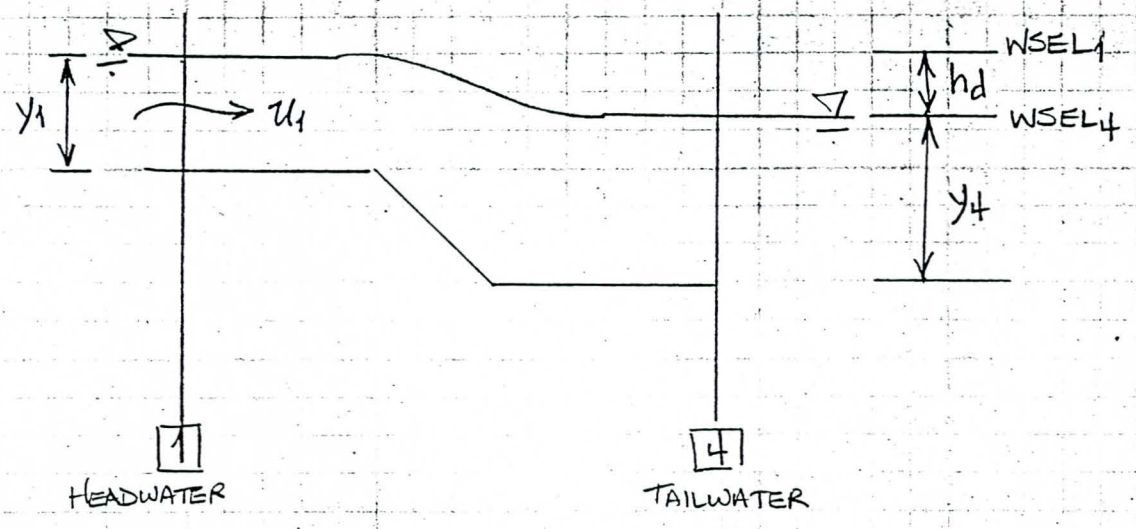
$z = 3$ if $Q = 6500$, $A = 1000$

BASE WIDTH	YN
150+	8
122+	9
100	10

AMPAD 22-141 100 SHEETS 22-142 200 SHEETS 22-144

APPENDIX 2

DROP STRUCTURE SAFETY EVALUATION



$H_e = y_1 + \frac{u_1^2}{2g}$ "specific head" ≡ specific energy at $\boxed{1}$

$h_d = WSEL_1 - WSEL_4$ "hydraulic drop" difference in WSEL over drop

<u>total head</u> $\frac{\overset{h_d}{(WSEL_1 - WSEL_4)} + y_4}{y_1 + \frac{u_1^2}{2g}}$

<u>hydraulic drop</u> specific head $\frac{\overset{h_d}{(WSEL_1 - WSEL_4)}}{y_1 + \frac{u_1^2}{2g}}$

at LFC Capacity ($Q = 12200$ cfs) & 215.65

$u_1 = 7.65$ $y_1 = 8.57$ $H_e = \frac{(7.65)^2}{2(32.17)} + 8.57$

$H_e = 9.48$

$WSEL_1 = 1068.95$ $WSEL_4 = 1064.72$

$h_d = (WSEL_1 - WSEL_4) = 1068.95 - 1064.72$

$h_d = 4.23'$

$y_4 = 8.95$

$$\frac{h_d + y_4}{H_e} = \frac{4.23 + 8.95}{9.48} = 1.39$$

$$\frac{h_d}{H_e} = \frac{4.23}{9.48} = 0.45$$

$\mathcal{E}$214.65 Q_{LFC}

$h_d = 1051.34 - 1047.2 = 4.14$

$y_4 = 7.9$

$$H_e = \frac{(7.97)^2}{2(32.17)} + 7.84 = 8.82$$

$$\frac{h_d + y_4}{H_e} = \frac{4.14 + 7.9}{8.82} = 1.36$$

$$\frac{h_d}{H_e} = \frac{4.14}{9.82} = 0.47$$

$\mathcal{E}$ 215.65 Q_5

$$H_e = \frac{u_1}{2g} + y_1 = \frac{(8.65)^2}{2(32.17)} + 11.21 = 12.37$$

$$y_4 = 8.75$$

$$h_d = 1071.59 - 1067.48 = 4.11$$

$$\frac{h_d + y_4}{H_e} = \frac{4.11 + 8.75}{12.37} = \frac{12.86}{12.37} = 1.04$$

$$\frac{h_d}{H_e} = \frac{4.11}{12.37} = 0.33$$

$\mathcal{E}$ 215.65 Q_{10}

$$H_e = \frac{u_1}{2g} + y_1 = \frac{(11.88)^2}{2(32.17)} + 16.88 = 19.07$$

$$y_4 = 11.97$$

$$h_d = 1077.26 - 1074.06 = 3.20$$

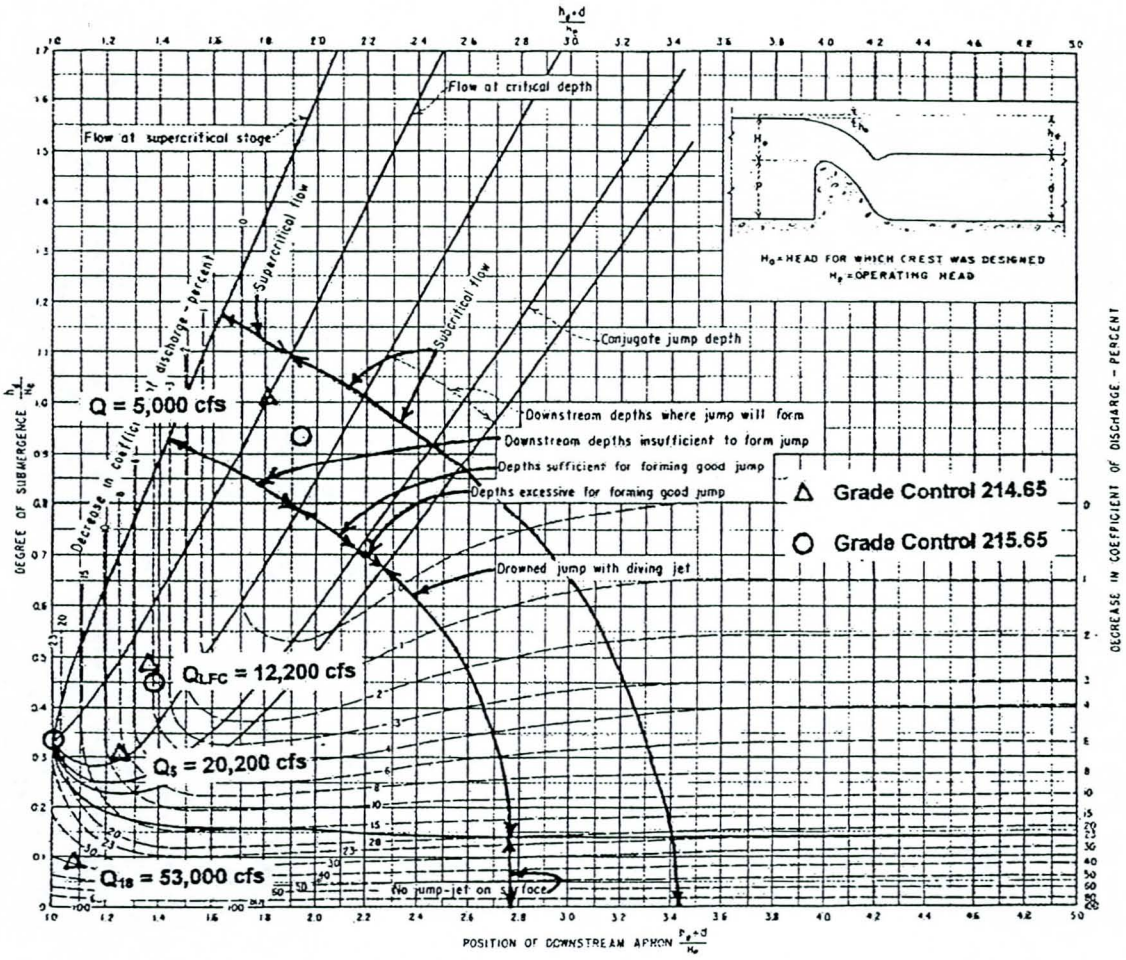
$$\frac{h_d + y_4}{H_e} = \frac{3.20 + 11.97}{19.07} < 1.0$$ no jump.

$\mathcal{E}$ 214.65 Q_5

$$H_e = \frac{(9.43)^2}{2(32.17)} + 10.07 = 11.45$$

$$h_d = 1053.57 - 1050.01 = 3.56$$

$$y_4 = 10.71$$


Flow at critical depth
Flow at supercritical stage
Supercritical flow
Subcritical flow
Conjugate jump depth
Downstream depths where jump will form
Downstream depths insufficient to form jump
Depths sufficient for forming good jump
Depths excessive for forming good jump
Drowned jump with diving jet
No jump-jet on surface
Decrease in coefficient of discharge - percent
Q = 5,000 cfs
Q_{LFC} = 12,200 cfs
Q_S = 20,200 cfs
Q_{18} = 53,000 cfs
Grade Control 214.65
Grade Control 215.65
H_0 = HEAD FOR WHICH CREST WAS DESIGNED
H_e = OPERATING HEAD
DEGREE OF SUBMERGENCE
DECREASE IN COEFFICIENT OF DISCHARGE - PERCENT
POSITION OF DOWNSTREAM APRON

APPENDIX 2

TOE-DOWN DEPTH

Local Scour Estimates (SLA)

Rio Salado (Salt River), Phoneix, Arizona

$$D_s = 0.80 q^{0.667} (\Delta H / y_2)^{0.158} (1 - (\Delta H / y_2))^{-0.13}$$

DROP NO. 1

Location	Channel Discharge, Q (cms)	Channel Width, b (m)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
216.23	2650.4	65.7	40.3		334.00		8.83							
216.33	2406.6	85.6	28.1	334.43			6.77							
	2528.5	75.6	33.4			0.91		0.10	5.9	35.37	70.73	19.3	116.0	232.1

DROP NO. 2

Location	Channel Discharge, Q (cms)	Channel Width, b (m)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
215.53	2703.2	63.4	42.7		331.35		9.81							
215.56	2570.5	59.8	43.0	331.36			8.90							
	2636.9	61.6	42.8			0.91		0.09	6.8	40.98	81.95	22.4	134.4	268.9

DROP NO. 3

Location	Channel Discharge, Q (cms)	Channel Width, b (m)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
214.62	3414.9	81.8	41.7		327.32		10.35							
214.65	3138.9	62.2	50.5	327.05			9.13							
	3276.9	72.0	45.5			0.91		0.09	7.0	42.28	84.56	23.1	138.7	277.4

23.1 x 130% = 30.03' use 30'

Local Scour Estimates (SLA)

Rio Salado (Salt River), Phoneix, Arizona

$$D_s = 0.80 q^{0.667} (\Delta H / y_2)^{0.158} (1 - (\Delta H / y_2))^{-0.13}$$

Grade Control 216.13

Location	Overbank Discharge, Q (cfs)	Overbank Width, b (ft)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
216.23	1936.7	204.9	9.5		332.54		4.56							
216.33	2534.4	190.7	13.3	333.13			3.34							
	2235.6	197.8	11.3			0.91		0.20	3.2	19.34	38.68	10.6	63.4	126.9

Drop 215.56

Location	Overbank Discharge, Q (cfs)	Overbank Width, b (ft)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
215.53	1553.5	122.3	12.7		330.10		6.10							
215.56	1408.9	108.5	13.0	330.11			5.56							
	1481.2	115.4	12.8			0.91		0.15	3.3	19.95	39.89	10.9	65.4	130.9

Drop 214.65

Location	Overbank Discharge, Q (cfs)	Overbank Width, b (ft)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
214.62	137.5	21.1	6.5		325.91		5.12							
214.65	534.8	27.2	19.6	325.54			6.71							
	336.2	24.1	13.9			0.91		0.18	3.6	21.74	43.48	11.9	71.3	142.6

11.9 x 1.30 = 15.5' use 16'

Local Scour Estimates (SLA)

Rio Salado (Salt River), Phoneix, Arizona

$$D_s = 0.80 q^{0.667} (\Delta H / y_2)^{0.158} (1 - (\Delta H / y_2))^{-0.13}$$

Grade Control 216.13

Location	Overbank Discharge, Q (cfs)	Overbank Width, b (ft)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
216.23	435.3	42.7	10.2		332.54		4.46							
216.33	372.3	31.2	11.9	333.13			4.50							
	403.8	36.9	10.9			0.91		0.21	3.2	19.00	38.00	10.4	62.3	124.7

Drop 215.56

Location	Overbank Discharge, Q (cfs)	Overbank Width, b (ft)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
215.53	908.8	85.9	10.6		330.10		6.09							
215.56	1223.1	102.2	12.0	330.11			6.02							
	1065.9	94.1	11.3			0.91		0.15	3.1	18.36	36.71	10.0	60.2	120.4

Drop 214.65

Location	Overbank Discharge, Q (cfs)	Overbank Width, b (ft)	Unit Discharge, q (cms/m)	Upstream WSEL (m)	Downstream WSEL (m)	Drop Height, delH (m)	Flow Depth (m)	delH/y2	Estimated Scour (m)	Length Deepest Scour (m)	Max Length Scour (m)	Estimated Scour (ft)	Length Deepest Scour, X (ft)	Max Length Scour, L (ft)
214.62	1538.3	118.7	13.0		325.91		6.24							
214.65	1377.9	126.4	10.9	325.84			3.97							
	1458.1	122.5	11.9			0.91		0.15	3.1	18.89	37.77	10.3	62.0	123.9

10.4 x 1.30 = 13.5 use 16'

APPENDIX 2

RIPRAP LAYOUT & SIZING

NOTE: Three alternatives for downstream scour protection at the grade control structures were initially considered. These alternatives were: 1) riprap protection; 2) soil cement aprons; and 3) cable-stayed block. The project design team agreed that cable-stayed block was not an acceptable alternative and that riprap protection was not economical. Therefore, the designs presented in this report are for downstream protection using soil cement aprons. The results of the riprap evaluation included in this appendix originally appeared in the Pre-Final (90 Percent) Low Flow Channel Design Technical Analysis Report (June 21, 1999).

1.1.1. RIPRAP

Riprap was evaluated as one of the protection alternatives downstream of the grade control structures. Riprap protection will help prevent scour near the grade control structure and protect the integrity of the channel design. Scour below the grade control structure could promote the development of a hydraulic jump and dangerous hydraulic rollers, decreasing the safety of the grade control stabilizers as designed.

1.1.1.1. Riprap Size

Riprap dimensions and gradation were determined using the RIPRAP Design System (WEST, 1996). The results of three alternative riprap sizing methods (U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and Isbash high turbulence) were compared. The Bureau of Reclamation and Isbash methods yielded very similar results, but the U.S.B.R. method was slightly more conservative and was therefore the basis for design.

Riprap gradations for the 25-year and 100-year event were calculated in conjunction with the draft (75%) low flow channel design analysis. However, the size of rock riprap required for such large events was not economical. Therefore, riprap gradations for the 10-year event have been computed during this phase of the analysis. For the 10-year event, a flow depth of 18.5 feet with a velocity of 12.0 feet/sec was assumed. These values are conservative estimates of the flow regime based on output from an HEC-RAS model of the system conveying 53,000 cfs. The recommended riprap gradation can be found in Table 1.

Table 1. Recommended riprap gradations for a 10-year (53,000 cfs) event.

Computed d_{50}, ft	2.04
Computed d_{30}, ft	1.67
Specific Weight, pcf	165
Layer Thickness, ft	3.5
Selected Minimum d_{30}, ft	1.7
Selected Minimum d_{90}, ft	2.47

	Stone Weight, lbs	
Percent Lighter by Weight	**Minimum**	**Maximum**
W100	1,482	3,704
W50	741	1,096
W15	232	548

1.1.1.2. Riprap Layout

1.1.1.2.1. Upstream

Riprap upstream of the structure will help prevent local scour as flow approaches the structure. Both bed and bank protection should extend upstream of the sill for a length equivalent to the flow depth, or 18.5 feet. The bed-protection riprap should form a trapezoidal seam two layers thick as shown in Figure 1. Bank protection riprap should include a seam of launchable rock on the top edge to help defend against flanking during larger flow events (Figure 2,

Table 2).

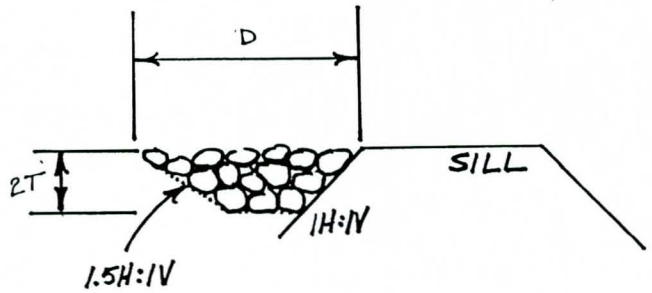


Figure 1. Typical riprap protection upstream of grade control structures.

Table 2. Upstream riprap blanket protection dimensions.

Event Return Period (years)	Riprap Blanket Thickness, 2T (feet)	Length Upstream, Equal to Depth of Flow, D (feet)
10	7.0	18.5

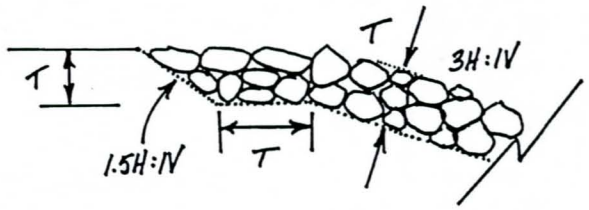


Figure 2. Top of bank protection should be keyed to provide protection against flanking.

1.1.1.2.2. Downstream

Riprap downstream of the structure will help prevent a scour hole from forming at the base of the grade control structure. The recommended design follows the riprap configuration recommendations found in Engineering Manual 1605 (Table 4, Figure 4). Riprap should extend approximately ten times the flow depth downstream of the sill (18.5 feet for the 10-year event), plus 2.5 times the initial depth (x). The initial depth should be twice the riprap layer thickness recommended by the RIPRAP design system, and the riprap blanket should be keyed in with a trapezoidal seam at the downstream end. Bank protection riprap should be designed similarly to the upstream bank protection (Figure 1).

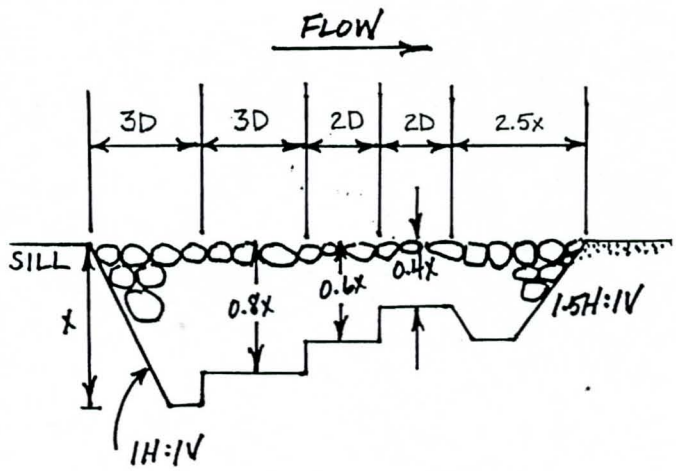


Figure 4. Typical riprap layout downstream of grade control structures, following EM 1110-2-1605 (Corps, 1988). The initial thickness (x) is twice the recommended riprap layer thickness.

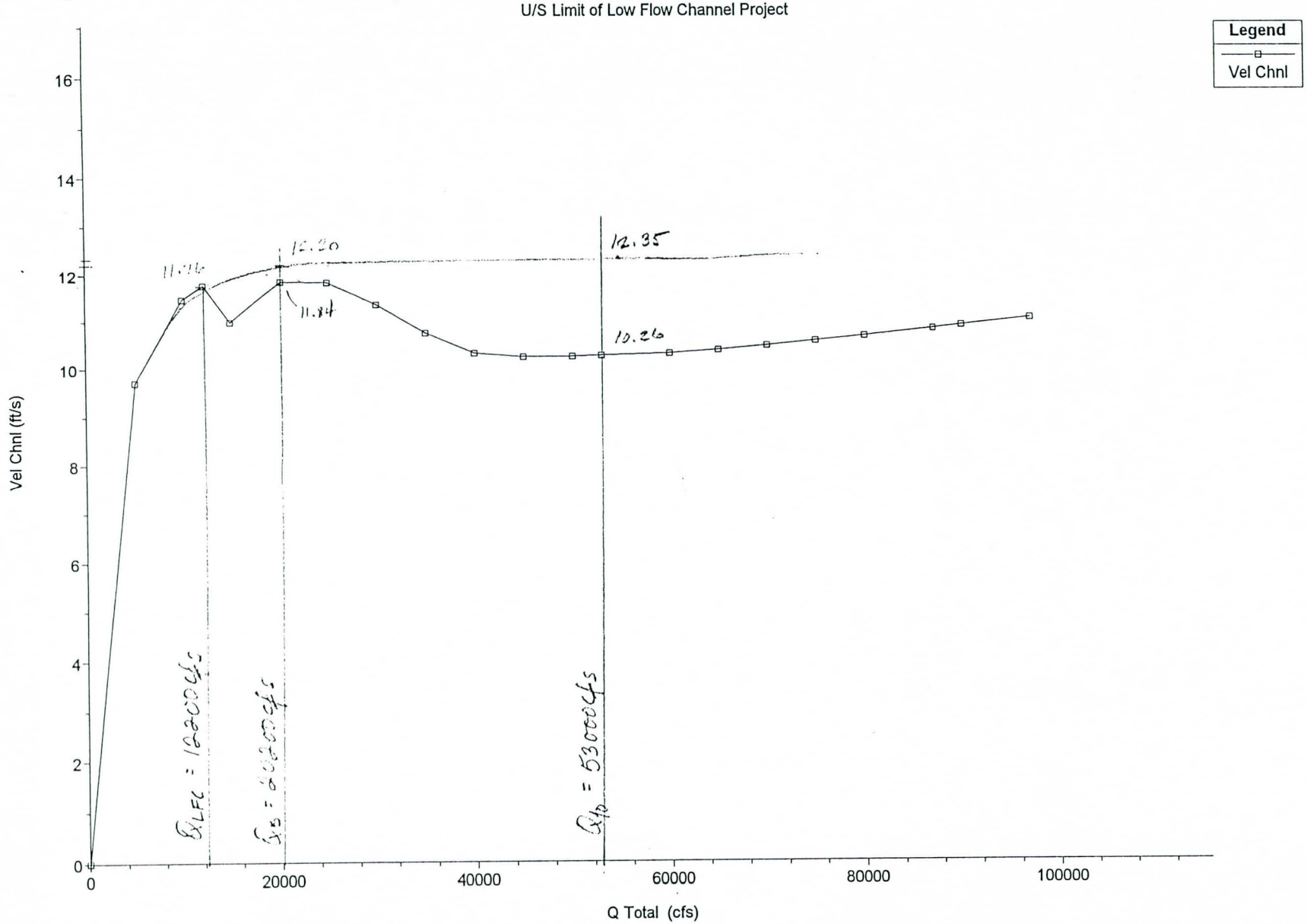
Table 4. Dimensions for downstream riprap blanket.

Event Return Period (years)	Initial Riprap Blanket Thickness, x=2T (feet)	Riprap Layer Thickness, T (feet)	Downstream Length of Riprap, 10D+2.5x (feet)
10	7.0	3.5	202.5

216.33

Salt River Low Flow Channel Design Rating Curve for Rip-Rap 5/27/99

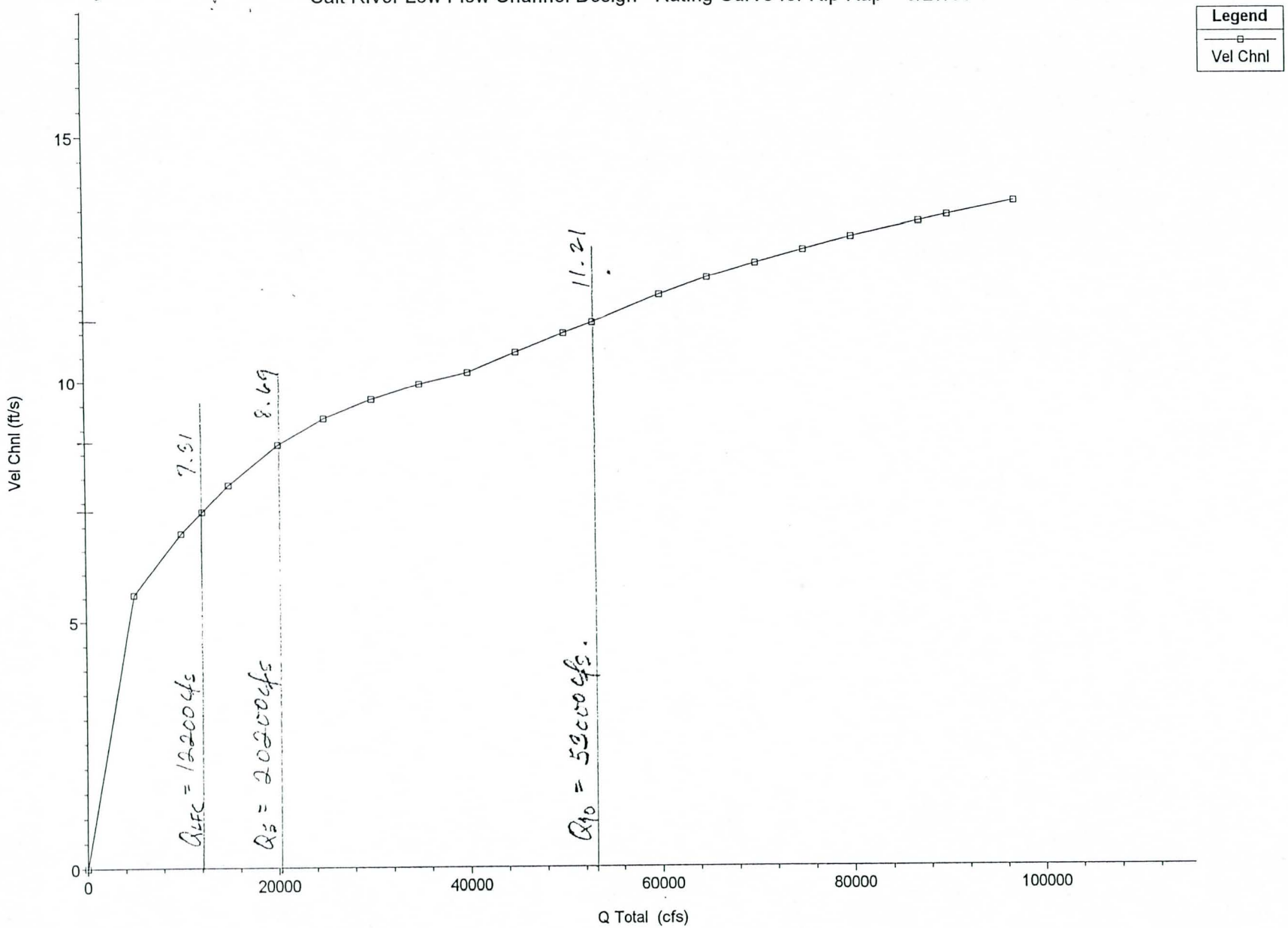
U/S Limit of Low Flow Channel Project



1 in Horiz. = 15000 cfs 1 in Vert. = 3 ft/s

216.23

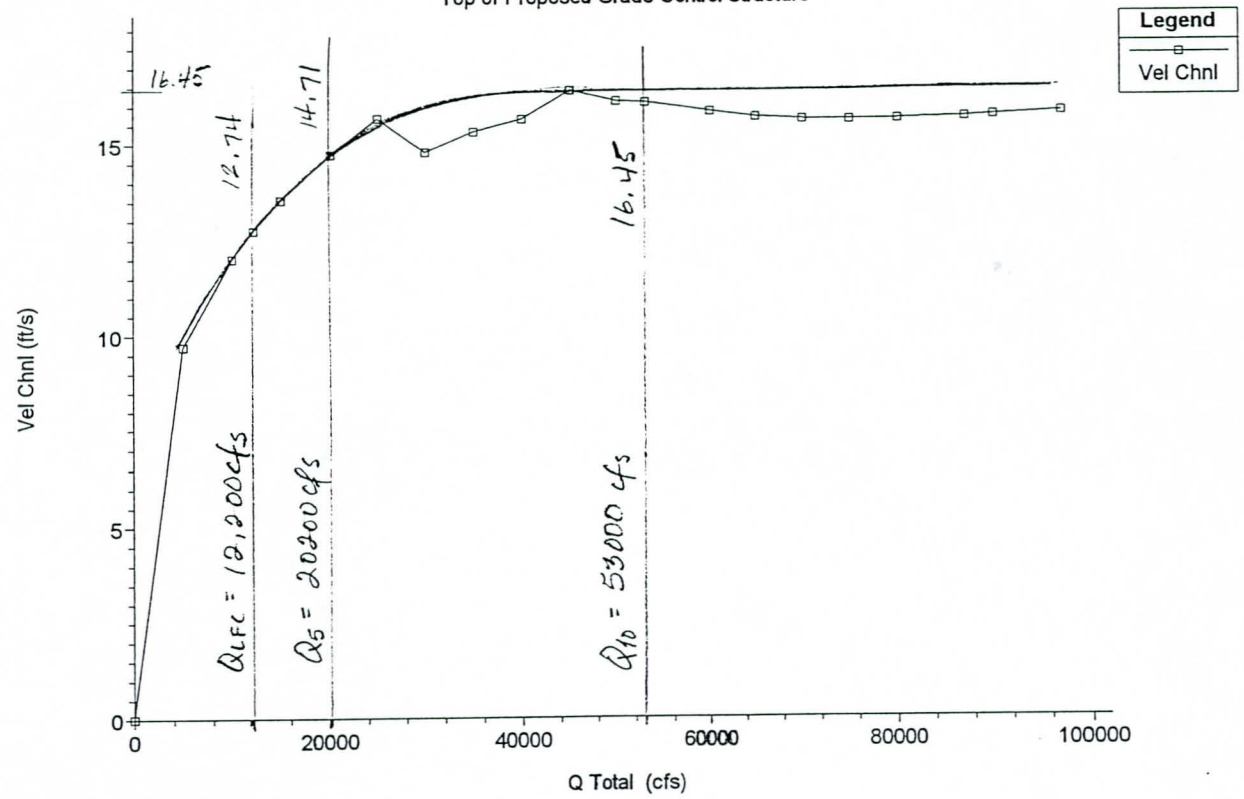
Salt River Low Flow Channel Design Rating Curve for Rip-Rap 5/27/99



1 in Horiz. = 15000 cfs 1 in Vert. = 3 ft/s

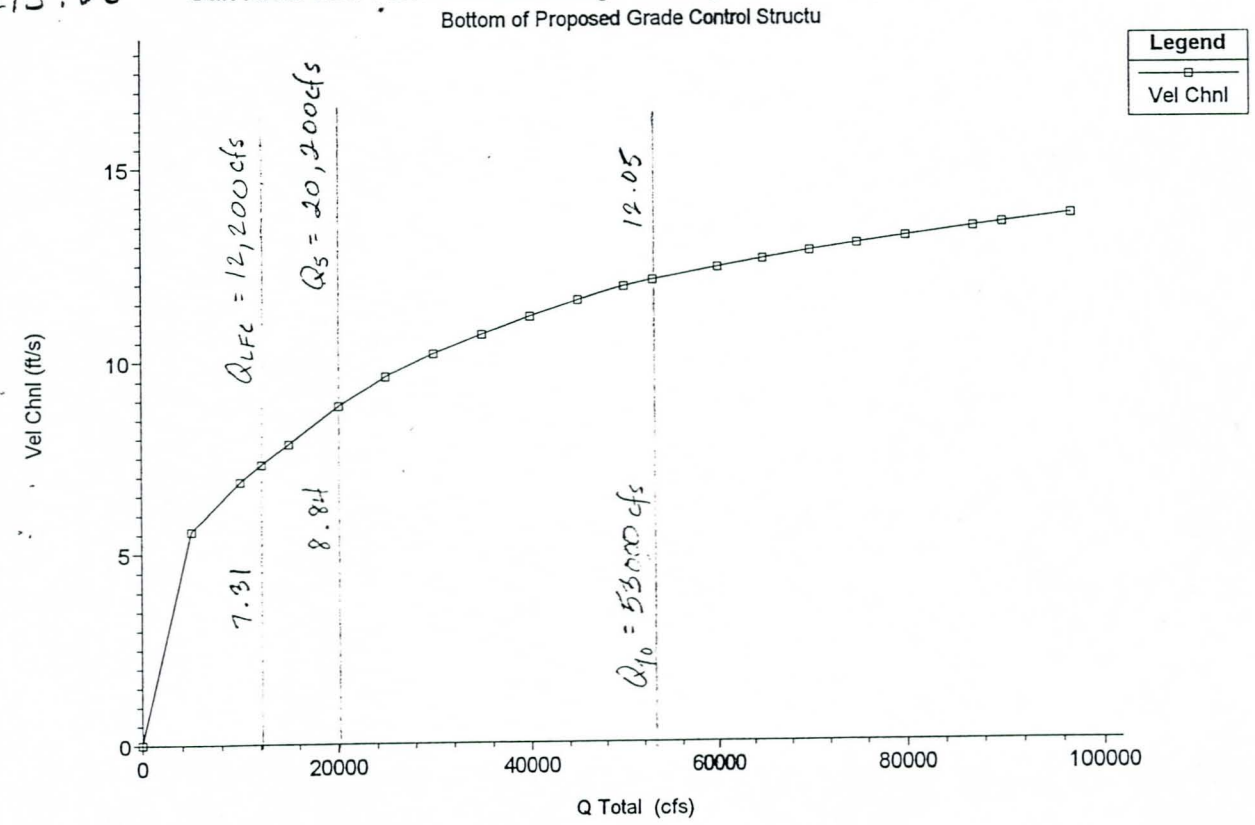
215.651 Salt River Low Flow Channel Design Rating Curve for Rip-Rap 5/27/99

Top of Proposed Grade Control Structure



* 215.65 Salt River Low Flow Channel Design Rating Curve for Rip-Rap 5/27/99

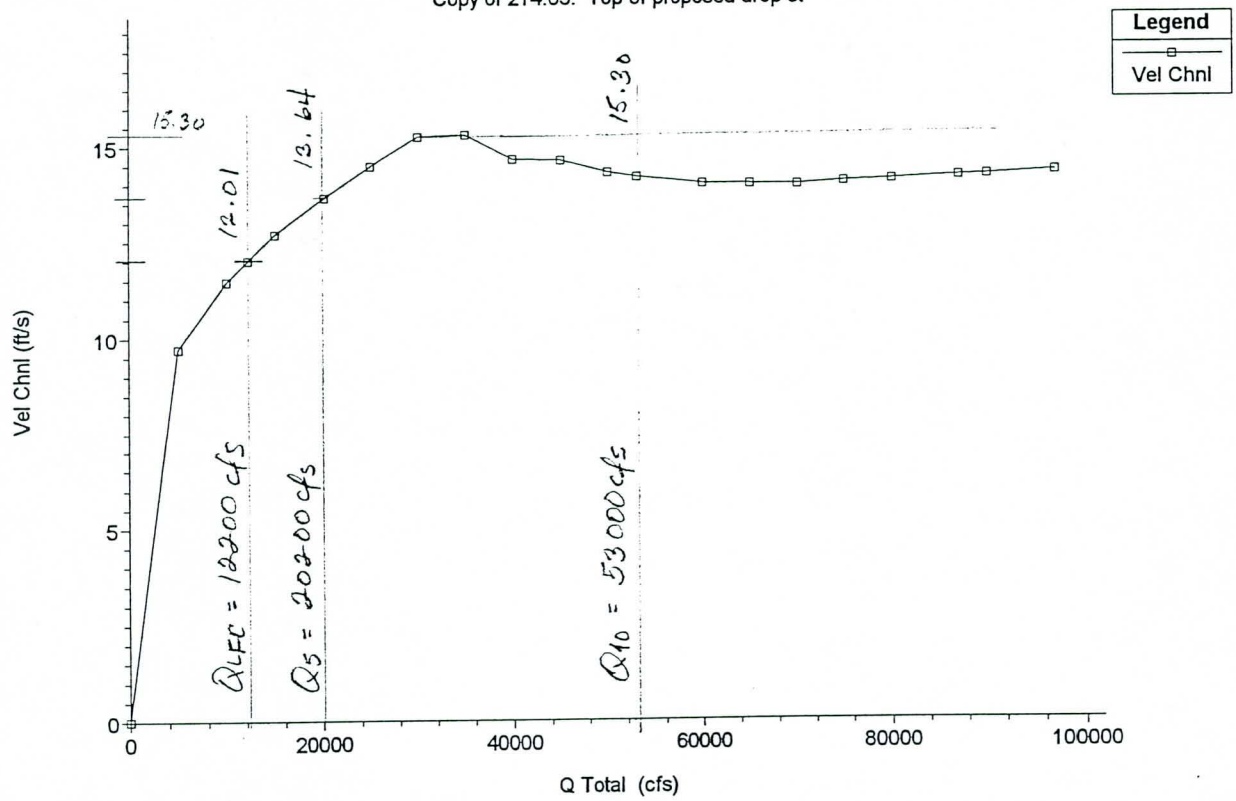
Bottom of Proposed Grade Control Structu



1 in Horiz. = 20000 cfs 1 in Vert. = 5 ft/s

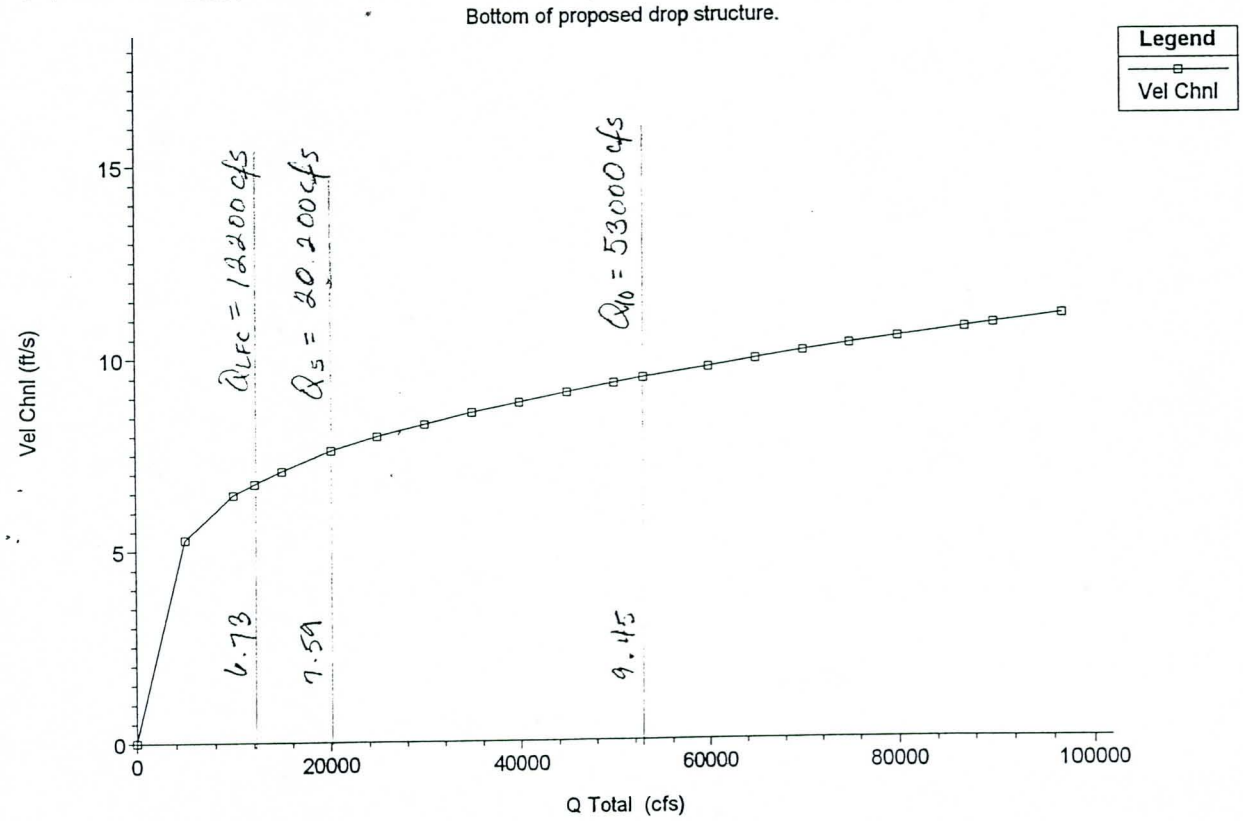
214.651 Salt River Low Flow Channel Design Rating Curve for Rip-Rap 5/27/99

Copy of 214.65. Top of proposed drop st



* 214.65 Salt River Low Flow Channel Design Rating Curve for Rip-Rap 5/27/99

Bottom of proposed drop structure.



1 in Horiz. = 20000 cfs 1 in Vert. = 5 ft/s

Estimated Channel Velocities and Depths, Required Rip-Rap Stone Size (Isbash)

Rio Salado (Salt River) Phoenix Arizona

Low-Flow Channel Capacity (Q=12,200 cfs)

Location	Velocities, u (ft/s)		Depth, y (ft)		Stone Size (Isbash Method), d_{50} (ft)	
	Crest	Base	Base	Crest	Crest	Base
Grade Control 216.23	11.76	7.31	8.96	5.68	1.76	0.68
Drop Structure 215.65	12.74	7.31	8.96	5.45	2.07	0.68
Drop Structure 214.65	12.01	6.73	7.90	5.54	1.84	0.58

5-yr Event (Q=20,200 cfs)

Location	Velocities, u (ft/s)		Depth, y (ft)		Stone Size (Isbash Method), d_{50} (ft)	
	Crest	Base	Base	Crest	Crest	Base
Grade Control 216.23	11.84	8.69	11.68	7.66	1.79	0.96
Drop Structure 215.65	14.71	8.84	11.74	7.54	2.76	1.00
Drop Structure 214.65	13.64	7.59	10.75	7.44	2.37	0.73

10-yr Event (Q=53,000 cfs)

Location	Velocities, u (ft/s)		Depth, y (ft)		Stone Size (Isbash Method), d_{50} (ft)	
	Crest	Base	Base	Crest	Crest	Base
Grade Control 216.23	12.35	11.21	17.94	13.85	1.94	1.60
Drop Structure 215.65	16.45	12.05	18.28	14.29	3.45	1.85
Drop Structure 214.65	15.30	9.45	18.56	14.59	2.98	1.14

05/27/99

WEST Consultants, Inc.
2111 Palomar Airport Rd.
Suite 180
Carlsbad, CA 92009-1419

Riprap 2.0

PROGRAM OUTPUT

USCOE Method

Input Parameters:

Run Name: SALADO90 Description: RIO SALADO PHOENIX AZ Q5

Velocity	Local
Channel Type	N/A
Straight Channel	N/A
Bend Angle, °	N/A
Local Channel Velocity, ft/sec	9.00
Bottom Width, ft	N/A
Minimum Centerline Bend Radius, ft	N/A
Water Surface Width, ft	N/A
Unit Weight of Stone, lbs/cu ft	165.00
Riprap Layer Thickness	1.00
Local Flow Depth, ft	12.00
Cotangent of Sideslope	3.00
Safety Factor	1.10

Output Results:

Computed Local Depth Average Velocity, ft/sec	N/A
Local Velocity / Avg. Channel Velocity	N/A
Correction for Layer Thickness	1.00
Side Slope Correction Factor	1.01
Correction for Secondary Currents	1.22

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.38
Specific Weight, pcf	165.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	35	86
W50	17	26
W15	5	13

USBR Method

Input Parameters:

Run Name: SALADO90 Description: RIO SALADO PHOENIX AZ Q5

Average Channel Velocity, ft/sec 9.00

Output Results:

Computed D50, ft 1.13

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.92
Specific Weight, pcf	165.00
Layer Thickness, ft	2.00
Selected Minimum D30, ft	0.97
Selected Minimum D90, ft	1.41

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	276	691
W50	138	205
W15	43	102

Isbash Method

Input Parameters:

Run Name: SALADO90 Description: RIO SALADO PHOENIX AZ Q5

Average Channel Velocity, ft/sec	9.00
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft 1.03

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.85
Specific Weight, pcf	165.00
Layer Thickness, ft	1.75
Selected Minimum D30, ft	0.85
Selected Minimum D90, ft	1.23

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	185	463
W50	93	137
W15	29	69

APPENDIX 2

BEND SCOUR

ZL
AA 12/02/99

Bend Scour Calculation

- $Y_s = \left(0.0685\, Y\, V_{avg}^{0.8} \left(2.1\left(\left(\sin^2(A_i/2)/\cos(A_i)\right)^{0.2}\right) - 1\right)\right) / \left(Y_h^{0.4}\, S_o^{0.3}\right)$

(Ref. 1) (equat. 5.25)

A_i = Impingement Angle (degrees)

S_o = energy / bed slope (ft/ft)

Y_h = hydraulic depth (ft)

Y = Maximum flow depth (ft)

V_{avg} = Average Channel velocity (fps)

$\measuredangle_1 = 26^\circ \qquad \measuredangle_2 = 21^\circ$

$A_i = 26^\circ$

$Q_{100yr} = 166000$ cfs

$S_o = 0.00155$

$Y_h = 22.3$ ft.

$Y = 33.62$ ft.

$V = 14.63$ fps.

$$Y_s = \frac{0.0685 \cdot (33.62) \cdot (14.63)^{0.8}}{(22.3)^{0.4}\,(0.00155)^{0.3}} \left[2.1\left(\frac{\sin^2\left(\frac{26}{2}\right)}{\cos(26)}\right)^{0.2} - 1\right] =$$

$Y_s = 39.63 \times 0.181 = 7.18$ ft, use 7.2 ft

- Distance Downstream to which bend scour will be applied.

$x = 2.3\left(\frac{c}{\sqrt{g}}\right) Y$; $c = \frac{1.486}{m} R^{1/6}$

$\Rightarrow x = 1160.4$ ft use $x = 1161$ ft (measured from the end of bend)

Ref. 1: Design Manual For Engineer. Analysis of Fluvial System
Simons, Li & Associat. Inc., March 1985.

ZL
NA

12/02/99

Bed Form Scour.

(1.)

$d_{50} = 25$ mm.; use $d_{50} = 10$ mm for Bed Form purpose.

$\tau_0 V$ is in range from 2 for low flow to 18 for 25-yr, and in range from 28 to 66 for 100-yr flow (see next Table).

According to the chart, the bed forms are antidunes.
(Fig 4.2, Reference 1).

The dept of antidune troughs is:

$$h_a = 0.027 V^2 = 7.29 \text{ ft}.$$

Through Depth $= 1/2 \times h_a = 3.65$ ft.

also, $h_a <$ dept of flow $\Rightarrow$ it's <u>OK</u>

In summary use scour of 3.65 ft.

Reference 1: "Design Manual for Engineer Analysis" SLA; 1985

Summary of Boulder Levee Protection Top-Down Calc

Location: Bend D/S of Central Avenue Bridge.

- NORTH BANK:
  - Bed Form Scour = 3.65 ft
  - Bend Scour = 7.2 ft
  - Long Term Degradation - HEC-6 = Aggrading

Total Scour = 3.65 + 7.2 + 0 = 10.85 ft.

Safety Factor = 1.3 ⇒ Total Scour = 14.11 ft ⇒

⇒ use 15 ft

APPENDIX 3

Hydraulic Appendix

APPENDIX 3

TECHNICAL NOTES

APPENDIX 3. HYDRAULIC ANALYSIS TECHNICAL NOTES

1.1. MODEL BASIS

The existing conditions HEC-RAS project geometry is sr.g01, contained within sr.prj, which is provided on CD-ROM as part of this submittal. See Table 1-1 for file descriptions. The existing conditions geometry was built using salt_ex.prj (which is based on four-foot contour interval topography) as a basis. Changes included updating the section geometry through the project reach with newer one-foot contour interval topography and with details from the 1995 CLOMR by Simons Li and Associates. Reach3.prj was used as the basis for the reach below the project.

Table 1-1. Description of hydraulic models used to perform analyses in this report.

Filename	Description
sr.prj	HEC-RAS project prepared by WEST for comparison of existing and proposed conditions and preparation of HEC-6T model geometry.
sr.g01	HEC-RAS geometry file for existing conditions.
salt_ex.prj	Salt-Gila existing conditions HEC-RAS model with low flow channel 100-year flow, Reach 3: 27th Avenue to 7th Street (Sec 210.17 to 214.78) by Michael Baker Jr., Inc. (Used for low flow channel geometry analysis by the Corps.)
reach3r.prj	HEC-RAS model (Stations 214.14 to 225.30) with the 1998 proposed FIS 100-year water surface elevations (post-Roosevelt Dam modification) obtained from Michael Baker, Jr., Inc. on April 2, 1999.
reach4r.prj	HEC-RAS model (Stations 199.82 to 214.14) with the 1998 proposed FIS 100-year water surface elevations (post-Roosevelt Dam modification) obtained from Michael Baker, Jr., Inc. on April 2, 1999.
scour.prj	HEC-RAS project prepared by WEST for bridge scour analysis.

1.2. SR.PRJ

This HEC-RAS project contains the project geometry and hydrology files used to perform the hydraulic analyses.

Table 1-2. Plan summary for HEC-RAS models in project SR.PRJ.

Plan	Geometry	Hydrology	Description
SR.P01	SR.G01	SR.F01	Existing conditions geometry with Q100, Q25 and Q = 12,200 cfs.
SR.P02	SR.G02	SR.F01	Low flow channel design geometry with Q100, Q25 and Q = 12,200 cfs.
SR.P03	SR.G03	SR.F02	Existing conditions geometry with proposed FIS model bridges and hydrology.
SR.P04	SR.G01	SR.F02	Existing conditions geometry with proposed FIS model and hydrology.
SR.P05	SR.G04	SR.F01	Existing conditions geometry with adjusted banks, Q100, Q25 and Q = 12,200 cfs.
SR.P06	SR.G05	SR.F01	Low flow channel design geometry with adjusted banks, Q100, Q25 and Q = 12,200 cfs.

1.3. EXISTING CONDITIONS MODEL

1.3.1. CHANNEL GEOMETRY

The geometry file sr.g01 within sr.prj is the existing conditions geometry developed by WEST. The geometry upstream of station 216.63 is relatively unchanged from the existing conditions geometry in salt_ex.prj.

Cross Sections 211.51 through 216.53 were modified to reflect the one-foot contour interval topography. This topography was obtained in the form of nineteen AutoCAD files, and a separate cross section location file, all converted from Intergraph Microstation format by the Corps. The cross section layout file was not on the same lateral coordinate grid as the topographic files. To overcome this problem, the section file was manually adjusted 100 feet North and 100 feet East to best match the hard copy cross section locations shown in enclosures one through four of the Rio Salado Feasibility Report. The centerline shown in the cross section drawing was used to locate the channel centerline at 20000 where available (this feature ends upstream of Cross

Section 214.23). Excel check plots and engineering judgement were then used to locate the updated geometry in the most reasonable location. The one-foot contour interval topography update resulted in a channel that is generally lower than the salt_ex.prj geometry by three to four feet, and by as much as ten feet in some locations.

Although the soft bottom geometry is based on the one-foot contour interval topography, the main channel side slopes for Cross Sections 211.44 through 212.27 of sr.prj were revised to reflect the engineered channel in the 1995 CLOMR (Simons, Li & Associates). The CLOMR stations and the salt_ex.prj model stations reference different longitudinal origins and scales. To overcome this, the section immediately downstream of 19th Avenue was used to anchor the model station with the plan stations. Reach lengths were then used to transform the model stationing to plan stationing. Specific notes are included in the model.

To better match the downstream boundary condition of the proposed FIS model, the downstream Cross Sections 207.99 through 211.41 from the proposed FIS model, reach3.prj, were added in place of the salt_ex.prj sections. Although the WEST model, sr.prj, begins with normal depth as the downstream boundary condition, the water surface elevations match exactly at station 208.95. This is ten sections upstream of the downstream model limit and about two and one half miles downstream of the project reach.

1.3.2. ASSUMPTIONS

The model is run in subcritical mode based on the assumption that the earthen bottom reach cannot sustain supercritical flow. It was also assumed that the lower limit of the model is under normal depth control from the average downstream thalweg slope of 0.007 feet/foot.

The 1995 CLOMR (Simons, Li & Associates, 1995) and one-foot contour interval topography is based on NGVD29 (used in sr.prj). It is assumed that the existing model,

salt_ex.prj, and the proposed FIS model, reach3.prj, are based on this same vertical datum; but this assumption could not be explicitly verified. However, the comparison of bank stations and bridge elevations between the topographic files and the models supports the assumption that these models are based on NGVD29.

1.4. PROPOSED CONDITIONS MODEL

1.4.1. CHANNEL GEOMETRY

The HEC-RAS geometry for the proposed conditions model is data file sr.g02. This was generated based upon the existing conditions geometry data file, sr.g01. It was modified by making the design cuts for the low flow channel using the HEC-RAS channel modification routine. The reach modified was from Cross Section 211.76 to 216.33. After cutting the low flow channel, the bank stations were moved to where the low flow channel side slopes reached the ground elevations of the overbanks. Ineffective flow areas were defined at the top of the new bank stations, as needed, to keep flow within the channel until overtopping.

The cuts produce a five-strip Manning *n* model. The strips are 1) left overbank, 2) left side channel slope, 3) main channel bottom, 4) right side channel slope and 5) right overbank. These five strips are also modeled in the sediment transport model. For the proposed conditions model, the low flow channel bottom has a Manning roughness coefficient (*n*) of 0.032 and the sideslope is set to 0.060 to account for vegetation.

Under most flow conditions, overbank areas are expected to be fully vegetated such that a Manning *n* value of 0.085 is appropriate, per the feasibility study. High flows in the overbank area are expected to remove much of this vegetation; 70 to 90 percent removed is reported in the feasibility study. Therefore, Manning *n* of 0.04 is used for the overbank areas when analyzing the water surface elevations associated with the 100-year discharge of 166,000 cfs.

1.4.2. FLOW FILES

The flow files for the proposed conditions model are sr.f01 and sr.f02. File sr.f01 contains the Q_{100} of 166,000 cfs, Q_5 of 20,200 cfs and low flow channel design discharge of 12,200 cfs.

The flow file sr.f02 contains the 100-year discharge for the proposed FIS models, reach3.prj and reach4.prj. The discharge changes at Cross Section 213.21 from 169,000 cfs upstream to 166,000 cfs downstream for sr.f02.

1.4.3. ASSUMPTIONS

Any flow outside of the low flow channel banks is assumed ineffective until overtopping. It was assumed the Manning roughness coefficient of the overbank area of the design channel will decrease from 0.08 to 0.04 under high flow conditions as previously discussed.

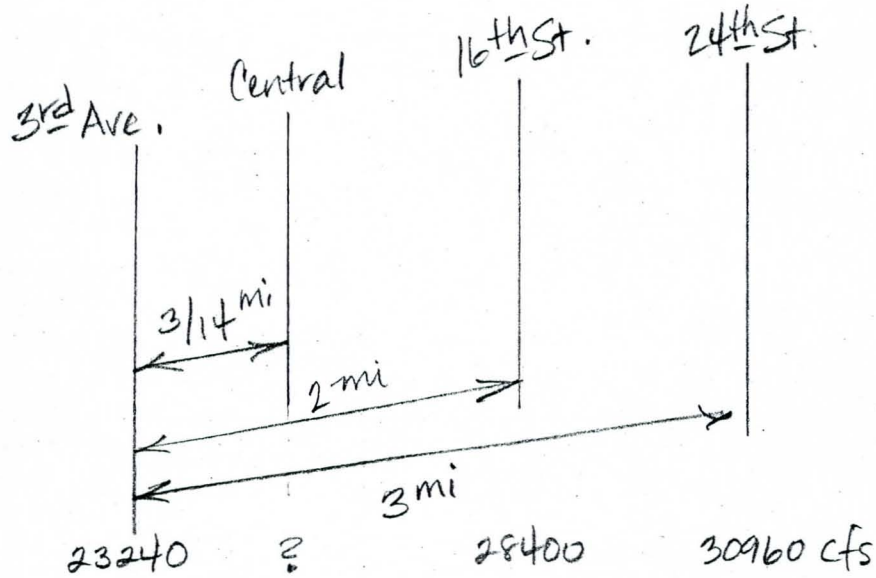
APPENDIX 3

TEMPE TOWN LAKE DAM BREAK ANALYSIS

Inundation Maps

The following maps and table are applicable to a downstream dam failure. The scale on the maps is approximate, and the x-section locations were copied from the inundation maps by CH2M Hill, so they should not be used for any type of engineering measurement. Any flow from an upstream dam failure is entirely contained within the channel, so no inundation map is needed. For flows that involve large-scale releases from the Granite Reef Dam, see the EAP manual for that structure. The table below summarizes the estimated times to peak, peak discharges and maximum depth and velocity for a sudden failure of a single outside dam segment.

X-Section #	Distance Below Dam	General Location	Time from Failure	Peak Discharge (cfs)	Depth (feet)	Velocity (fps)
1	0	Dam	10 seconds	49,400	12.0	19.6
2	2,300'	East of Priest Drive	6 minutes	45,000	5.0	12
3	4,200'	Below Priest Drive	8 minutes	44,500	4.1	11.4
4	2 miles	Hohokam Expressway	18 minutes	39,530	6.8	9
5	3 miles	University Drive	28 minutes	36,280	6.5	8
6	4 miles	Eelwood & Harbor Rd.	36 minutes	34,130	8.1	9
7	5 miles	24th Street	49 minutes	30,960	6.0	7
8	6 miles	16th Street	1.1 hours	28,400	6.2	6
9	7 miles	Broadway Road	1.3 hours	26,240	5.9	6
10	8 miles	3rd Avenue	1.6 hours	23,240	5.5	5
11	9 miles	13th Avenue	1.9 hours	21,080	5.2	5
12	10 miles	23rd Avenue	2.1 hours	19,780	4.4	5
13	11 miles	31st Avenue	2.5 hours	17,860	2.6	4
14	12 miles	39th Avenue	2.9 hours	16,580	5.2	4
15	13 miles	47th Avenue	3.4 hours	14,720	2.9	3
16	14 miles	West of 51st Avenue	4.0 hours	13,380	3.0	3
17	15 miles	Loop 101 alignment	4.4 hours	12,950	2.7	4
18	16 miles	71st Avenue	4.7 hours	12,610	2.8	4
19	17 miles	West of 75th Avenue	5.2 hours	12,150	3.0	3
20	18 miles	West of 83rd Avenue	6.1 hours	10,670	3.4	2
21	19 miles	West of 91st Avenue	7.0 hours	9,850	3.3	2



$$Q_{central\ ave} \approx 23240 + \frac{3/14}{3}(30960 - 23240)$$

$$\approx 23791 \text{ cfs}$$

$$Q_{central\ ave} \approx 23240 + \frac{3/14}{2}(28400 - 23240)$$

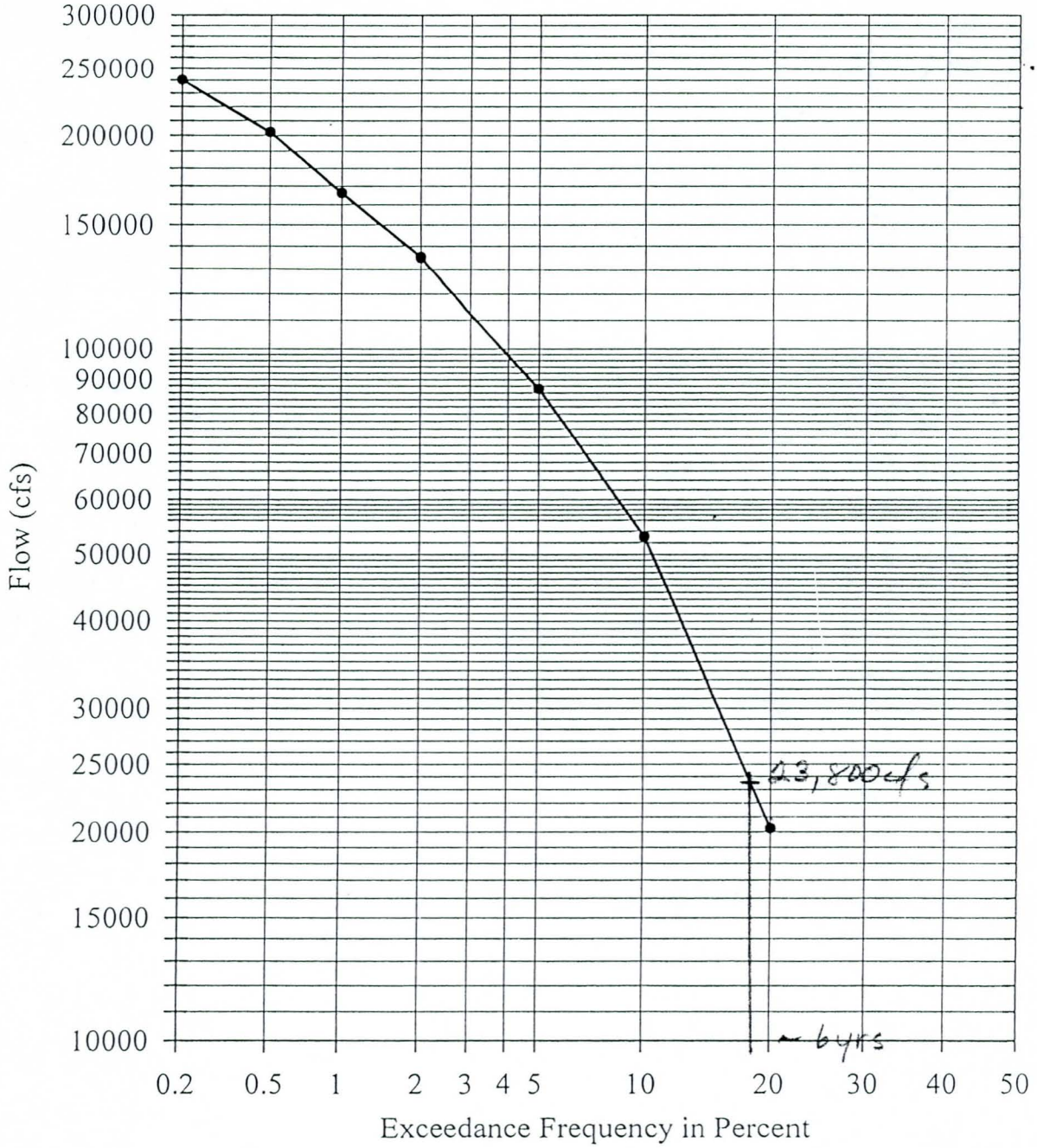
$$\approx 23792 \text{ cfs}$$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Rio Salado

Salt River Discharge-Frequency Curve at Central Avenue

(Feasibility Report Table 4.1)



APPENDIX 3

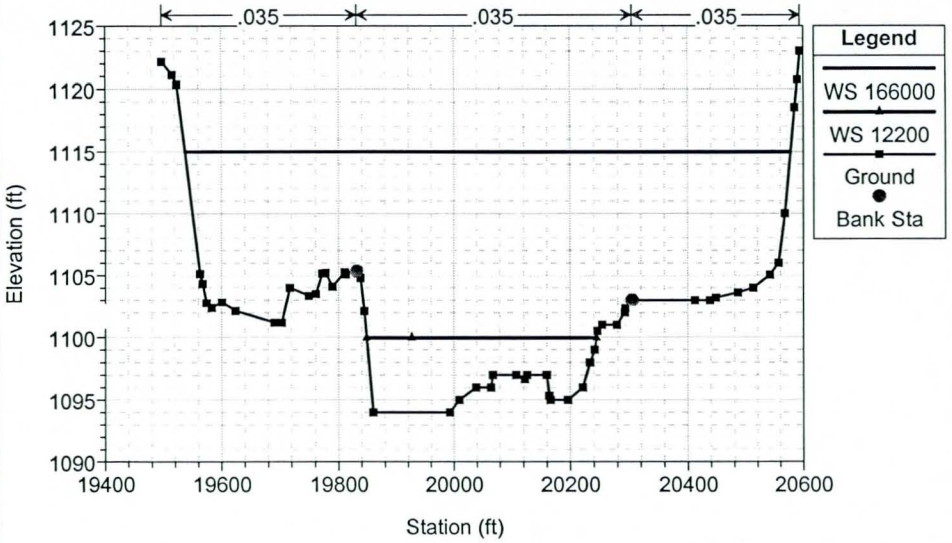
CROSS SECTION PLOTS FOR EXISTING CONDITIONS

(WITH RELOCATED BANK STATIONS)

Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

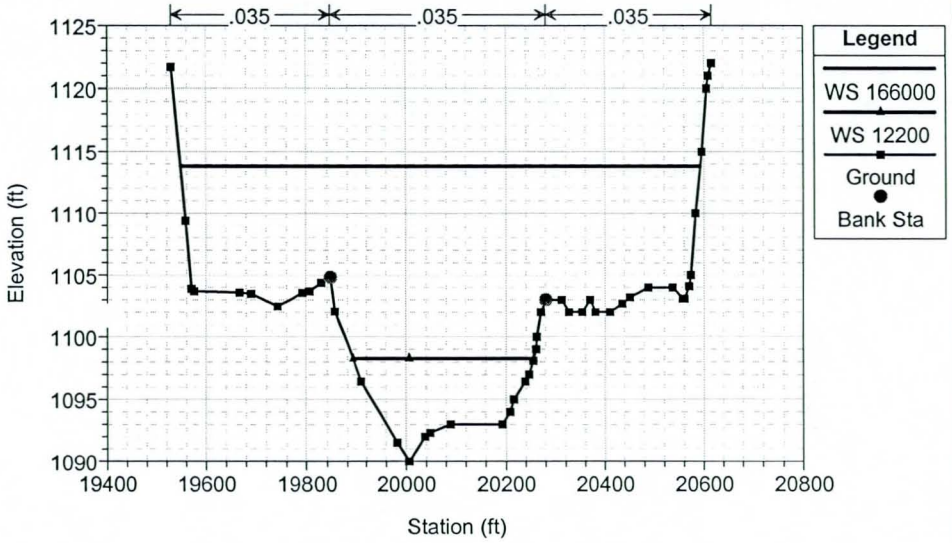
River = Rio Salado Reach = LFCD RS = 217.95



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

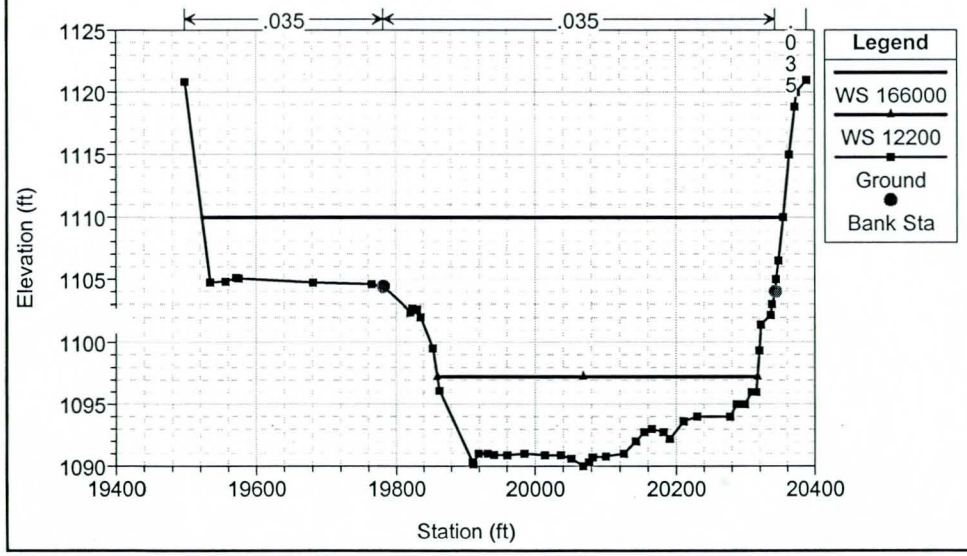
River = Rio Salado Reach = LFCD RS = 217.86



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

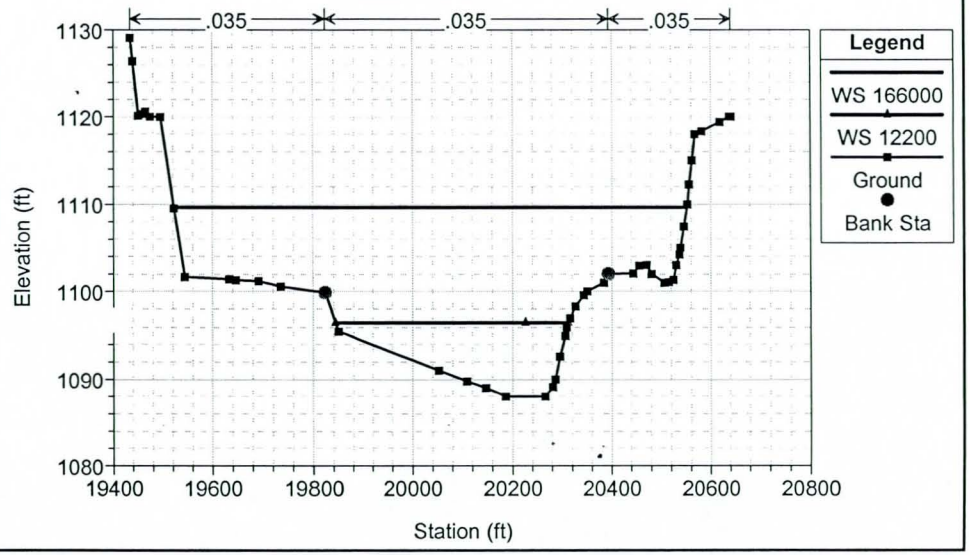
River = Rio Salado Reach = LFCD RS = 217.76



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

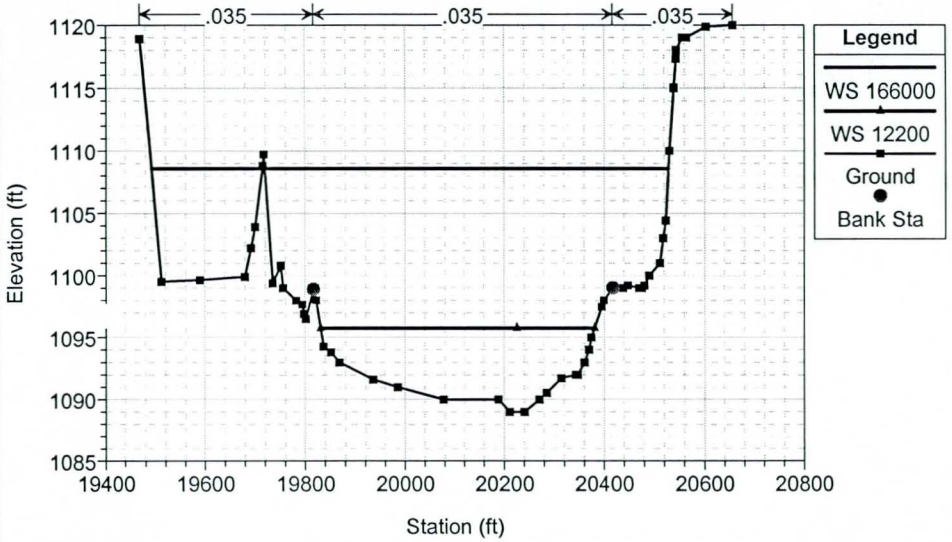
River = Rio Salado Reach = LFCD RS = 217.66



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

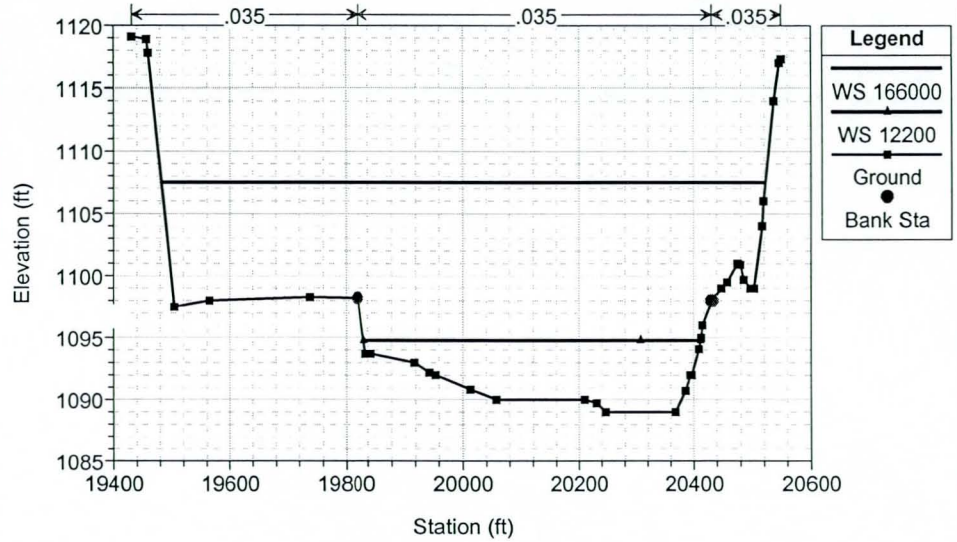
River = Rio Salado Reach = LFCD RS = 217.57



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

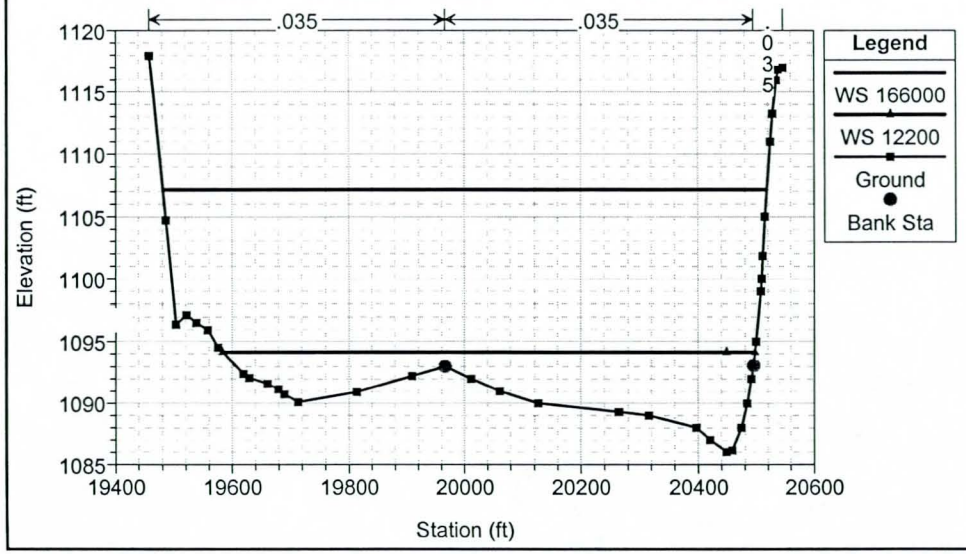
River = Rio Salado Reach = LFCD RS = 217.48



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

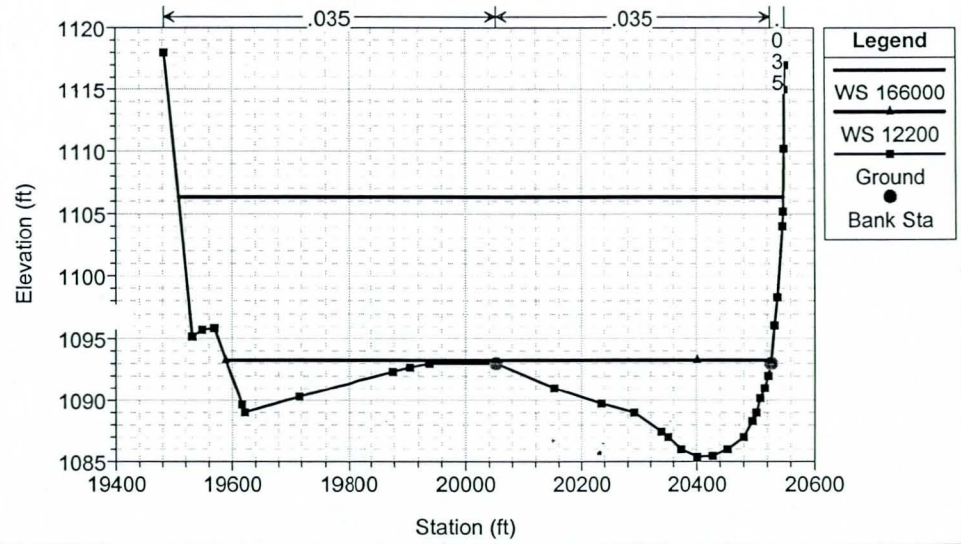
River = Rio Salado Reach = LFCD RS = 217.38



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

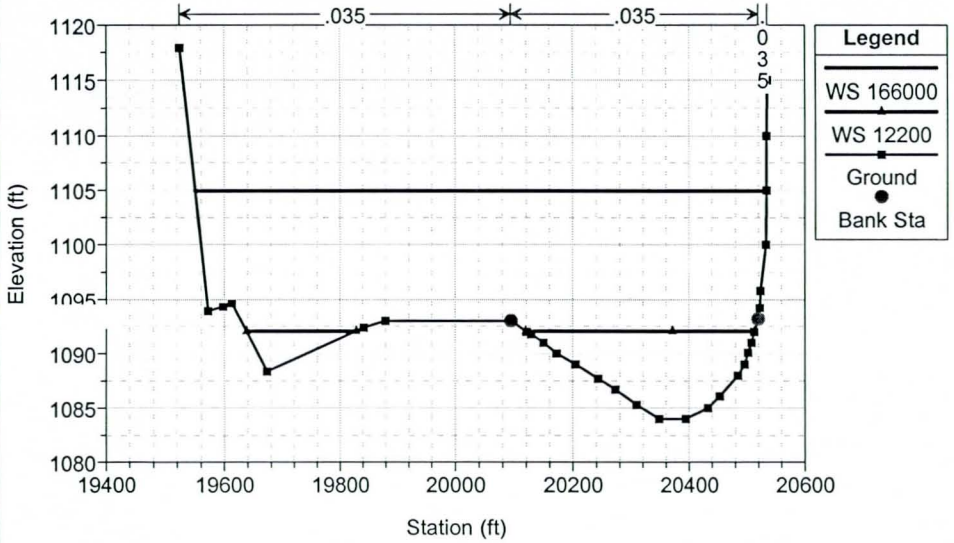
River = Rio Salado Reach = LFCD RS = 217.29



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

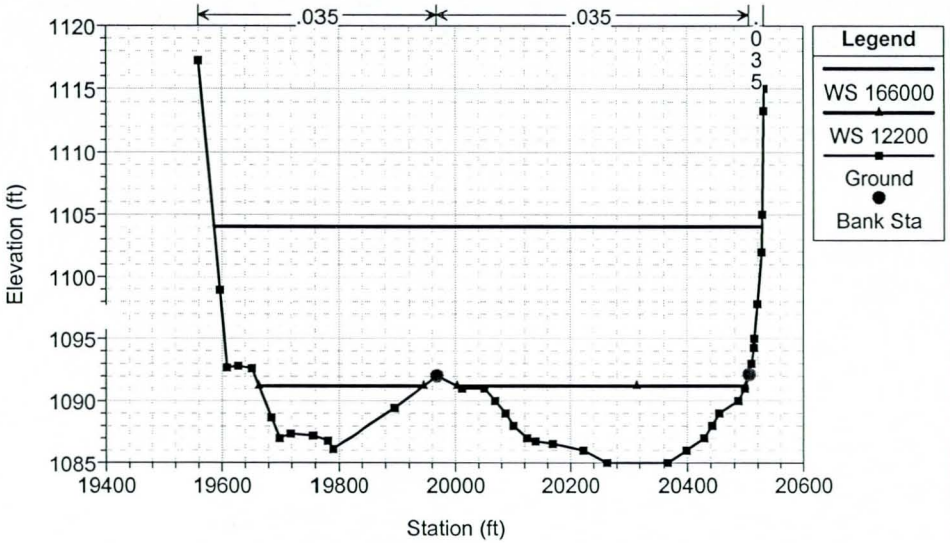
River = Rio Salado Reach = LFCD RS = 217.19



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

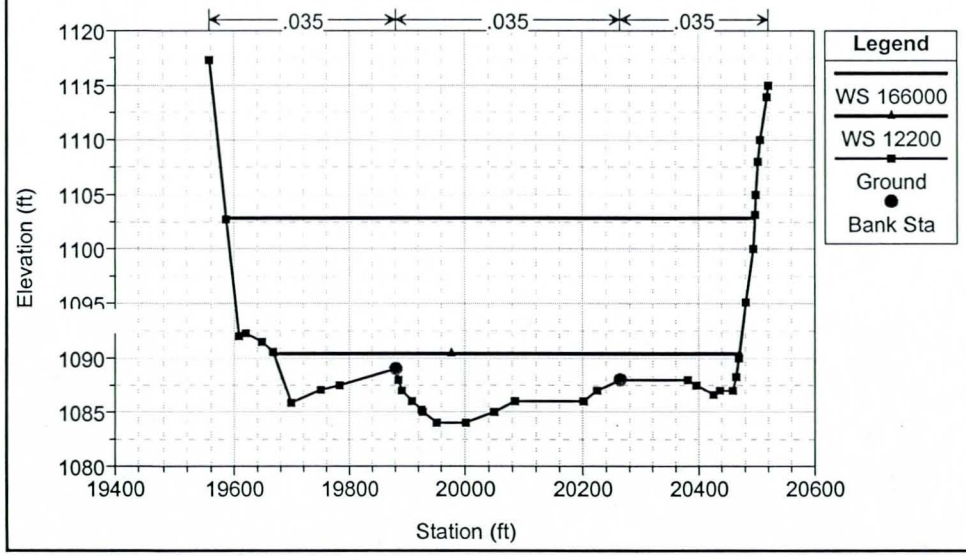
River = Rio Salado Reach = LFCD RS = 217.1



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

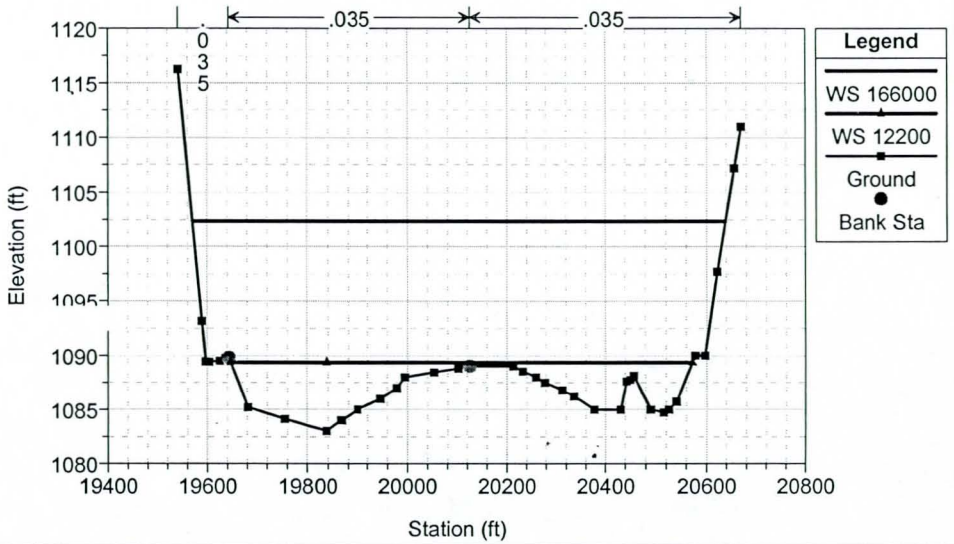
River = Rio Salado Reach = LFCD RS = 217



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

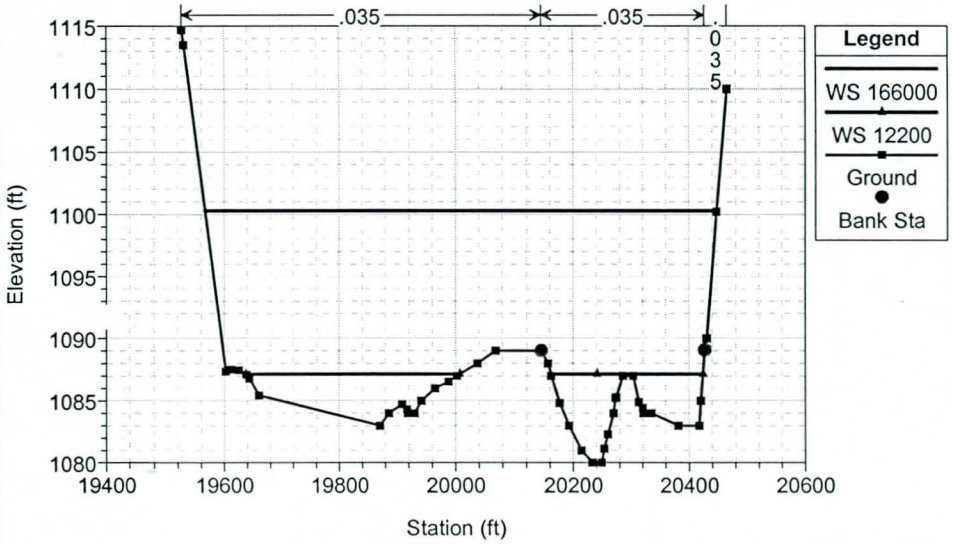
River = Rio Salado Reach = LFCD RS = 216.91



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

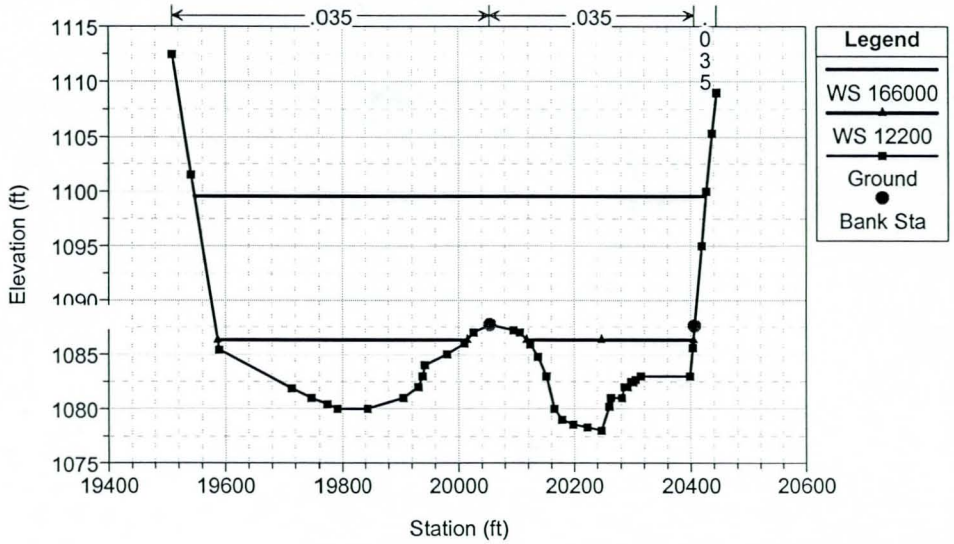
River = Rio Salado Reach = LFCD RS = 216.81



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

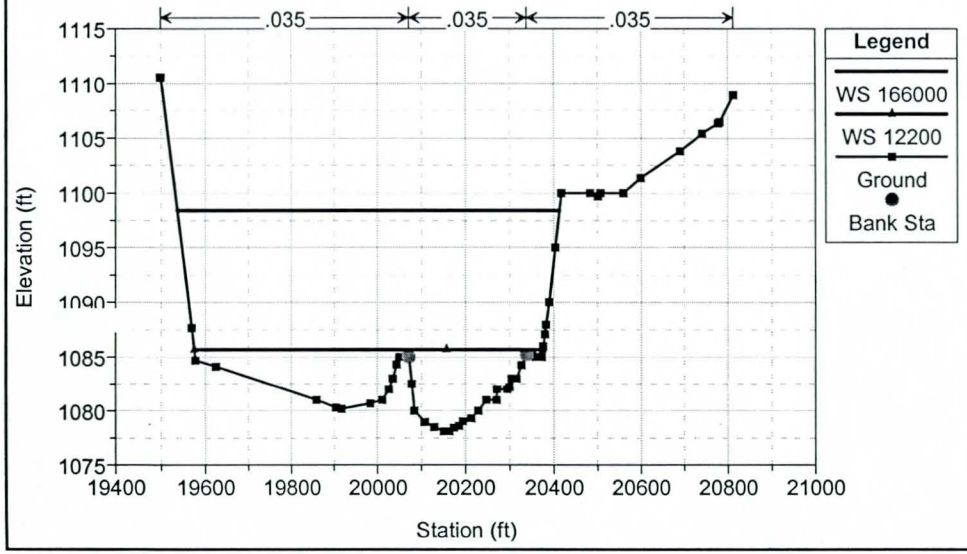
River = Rio Salado Reach = LFCD RS = 216.72



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

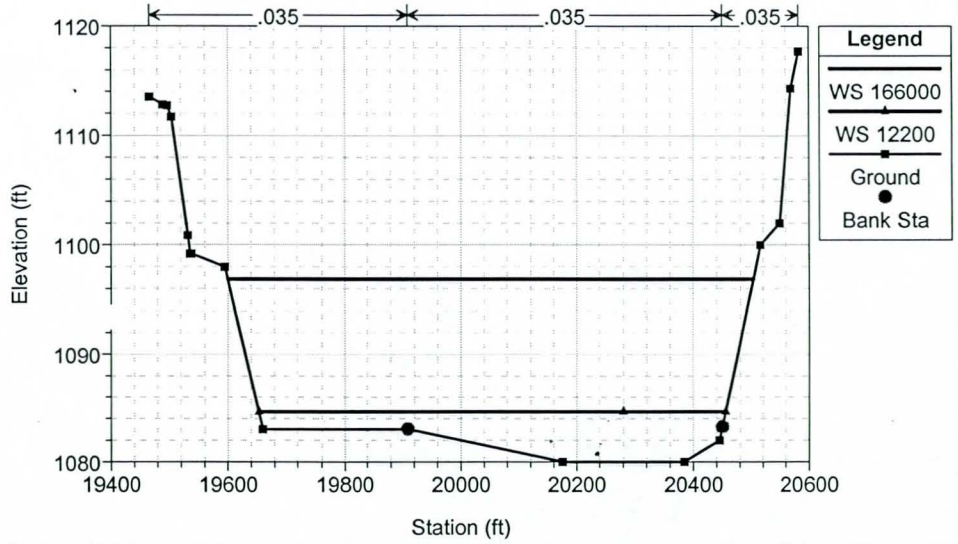
River = Rio Salado Reach = LFCD RS = 216.63



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

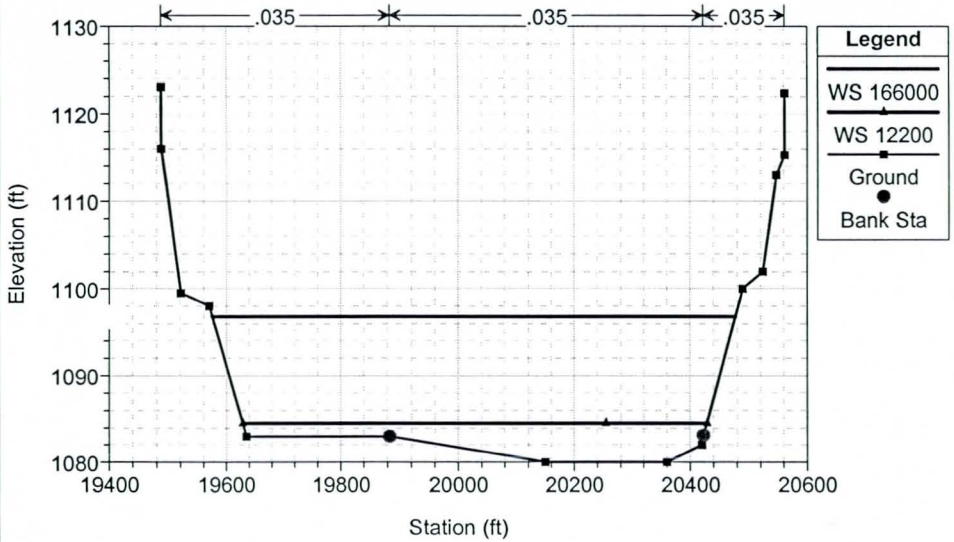
River = Rio Salado Reach = LFCD RS = 216.53



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

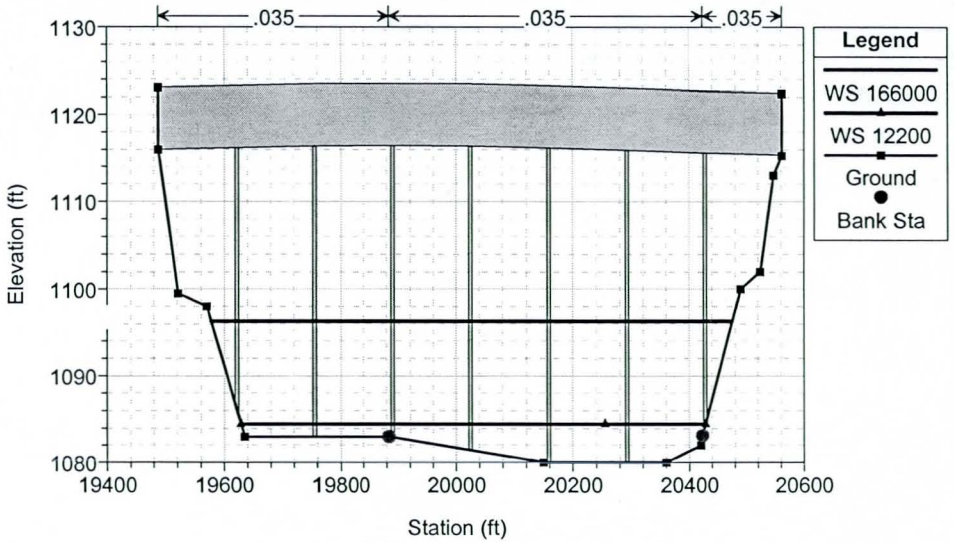
River = Rio Salado Reach = LFCD Upstream face of I-10, Maricopa Freeway RS = 216.52



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

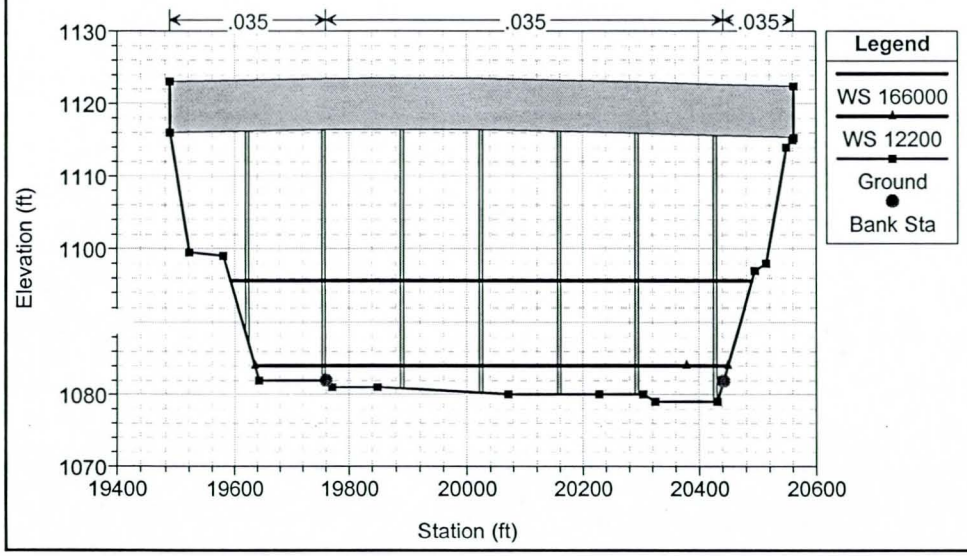
River = Rio Salado Reach = LFCD Bridge #7, Interstate Highway 10 (I-10), RS = 216.505



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

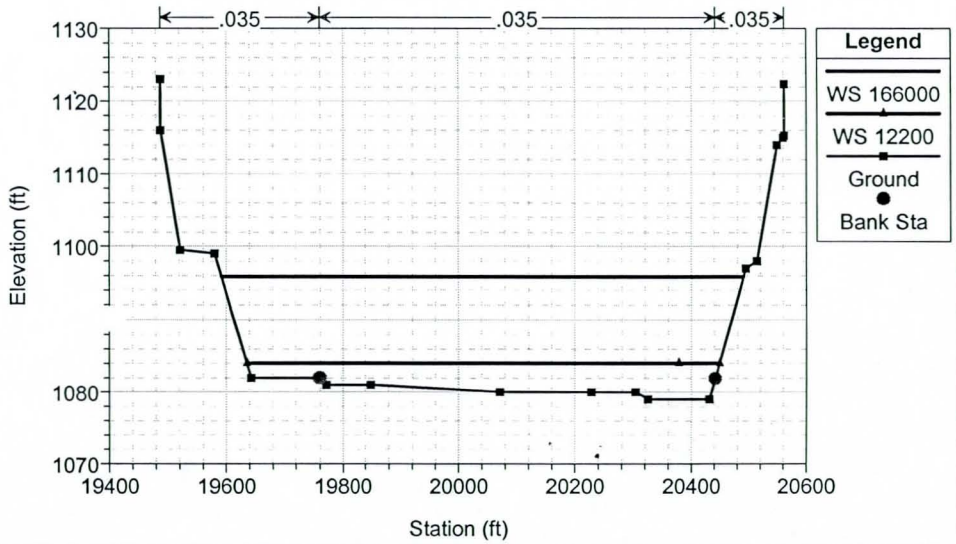
River = Rio Salado Reach = LFCD Bridge #7, Interstate Highway 10 (I-10), RS = 216.505



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

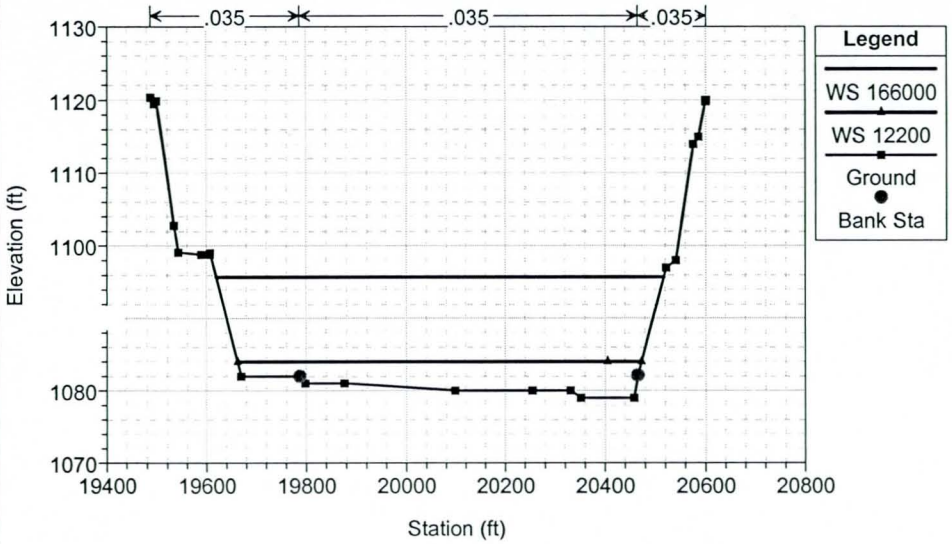
River = Rio Salado Reach = LFCD Downstream face of I-10, Maricopa Freewa RS = 216.49



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

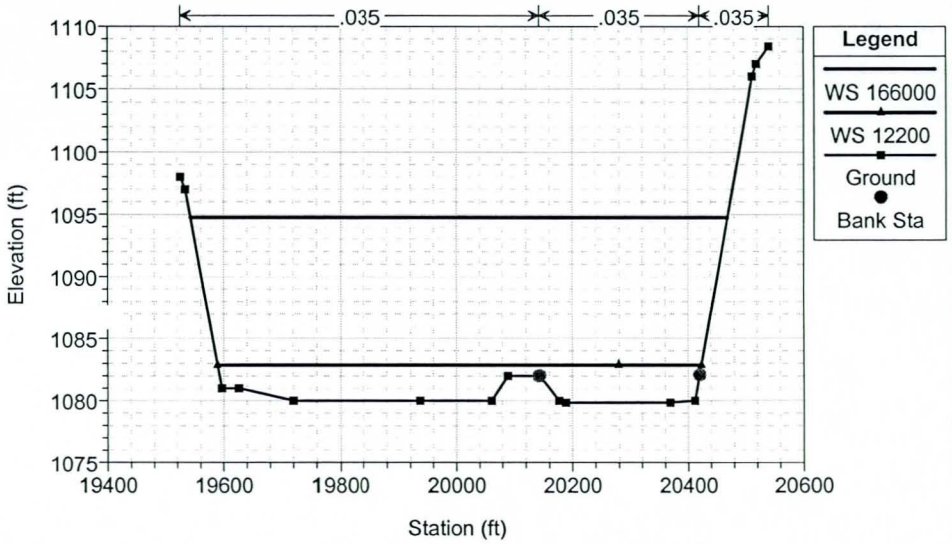
River = Rio Salado Reach = LFCD RS = 216.48



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

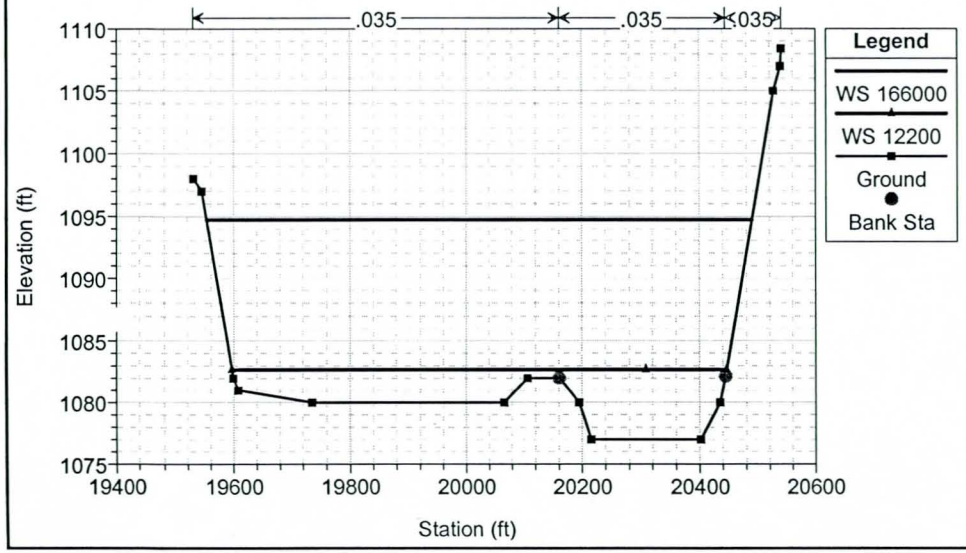
River = Rio Salado Reach = LFCD Changed D/S reach lengths to accomodate RS = 216.42



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

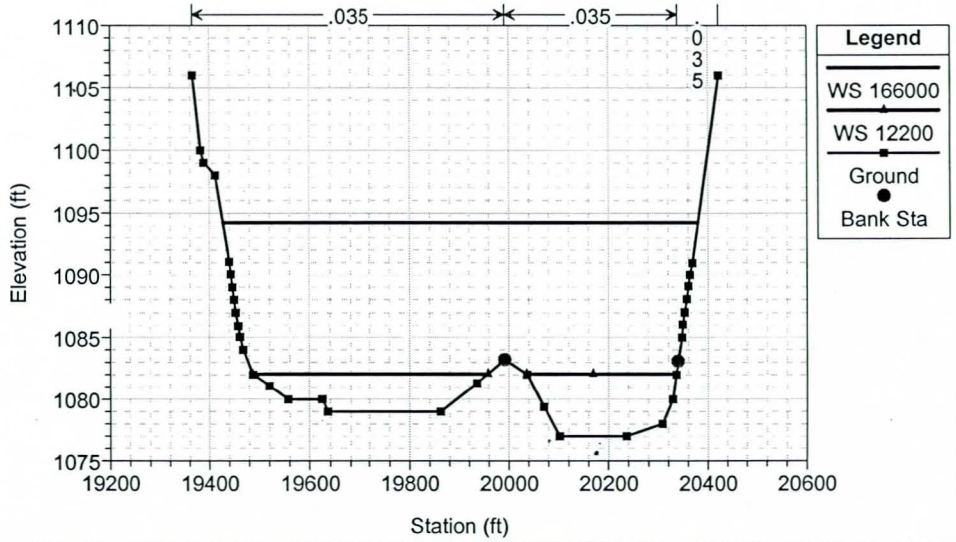
River = Rio Salado Reach = LFCD U/S end of grade control structure. O/B RS = 216.40



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

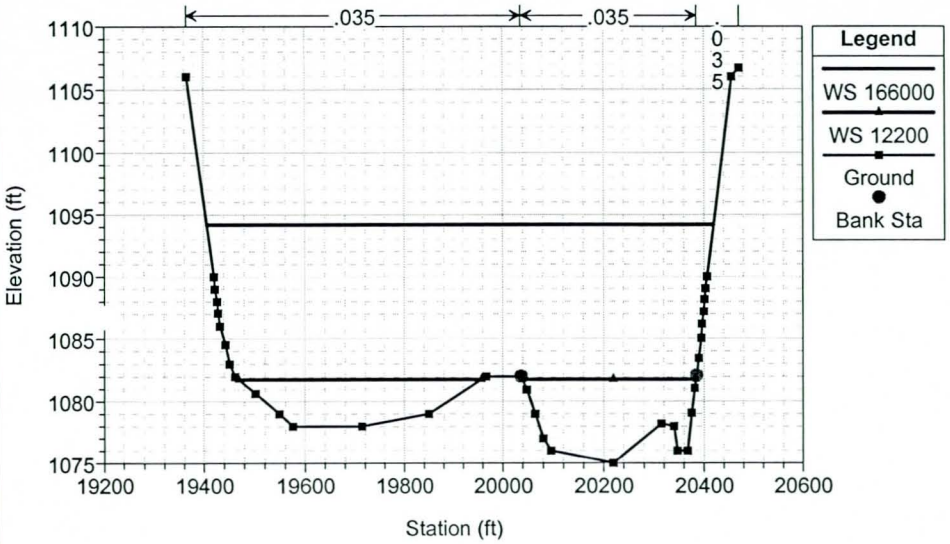
River = Rio Salado Reach = LFCD D/S end of grade control structure. O/B RS = 216.38



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

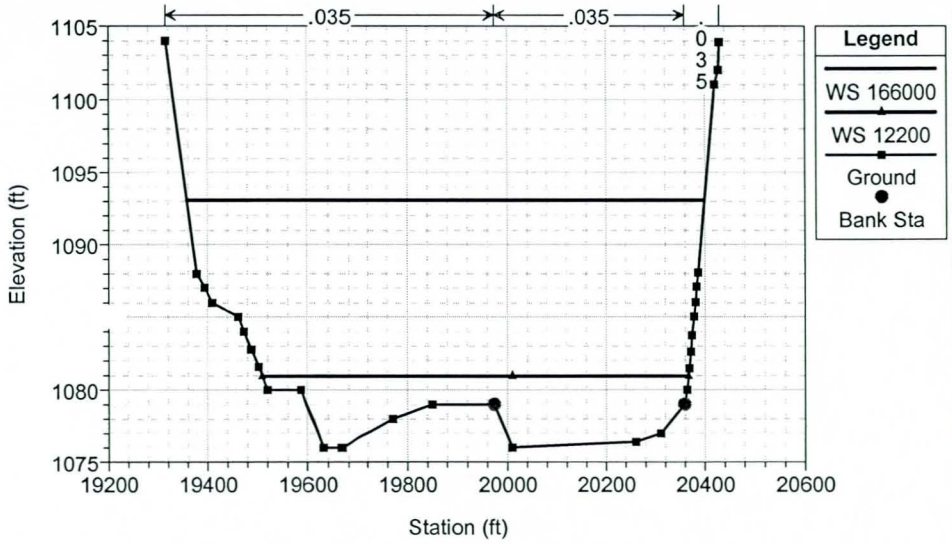
River = Rio Salado Reach = LFCD U/S Limit of Low Flow Channel Project RS = 216.33



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

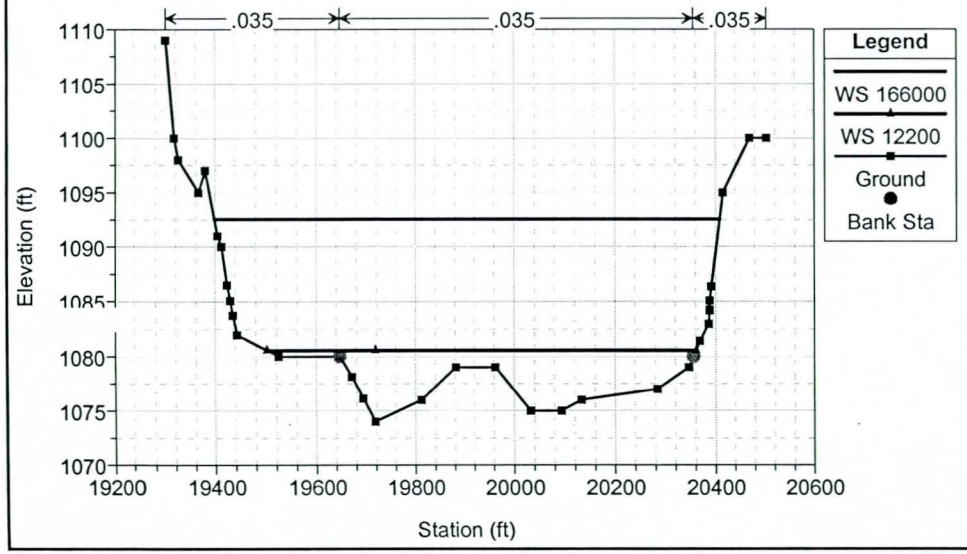
River = Rio Salado Reach = LFCD RS = 216.23



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

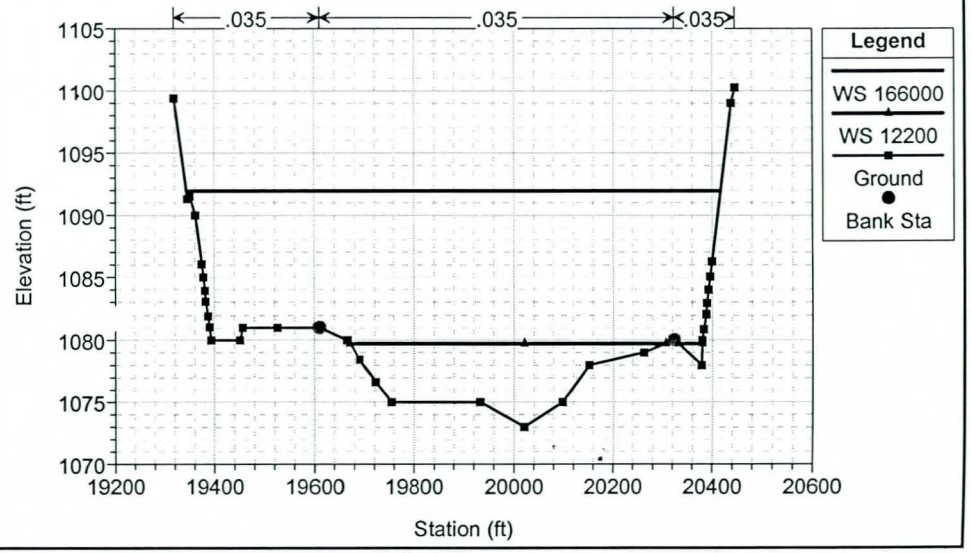
River = Rio Salado Reach = LFCD Added for resolution RS = 216.19



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

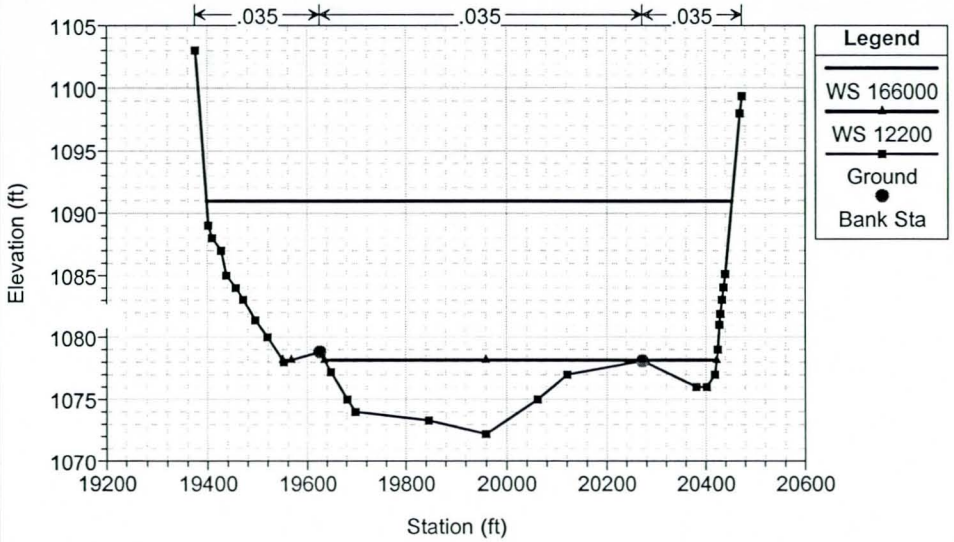
River = Rio Salado Reach = LFCD RS = 216.13



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

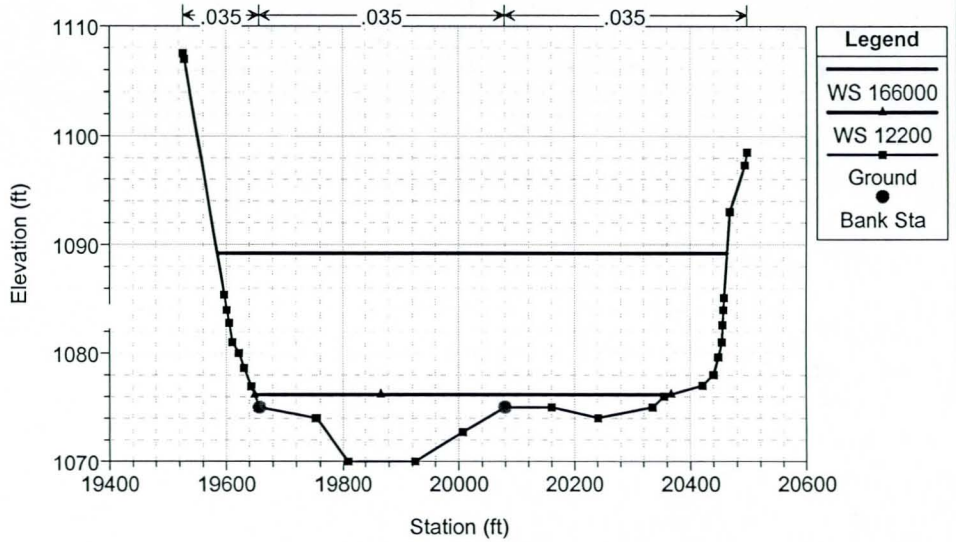
River = Rio Salado Reach = LFCD RS = 216.04



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

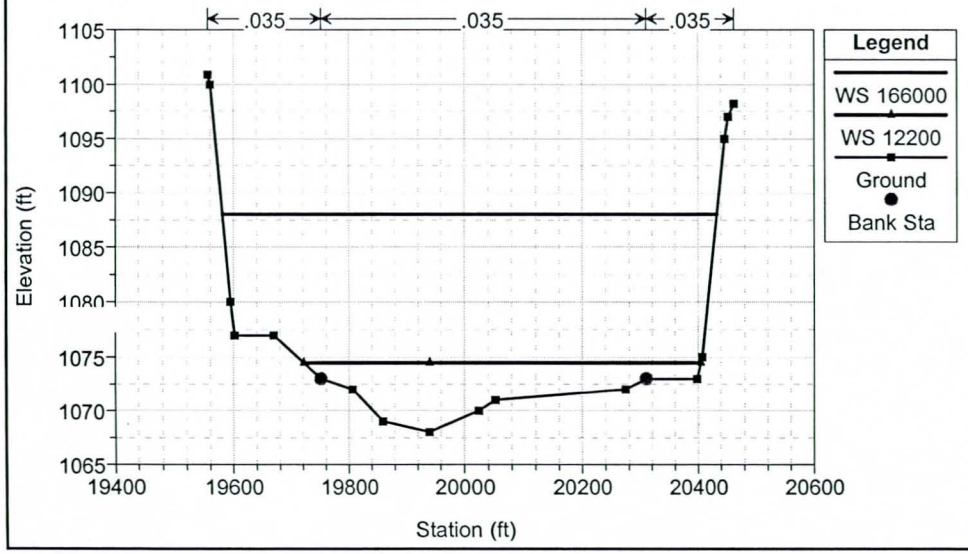
River = Rio Salado Reach = LFCD RS = 215.94



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

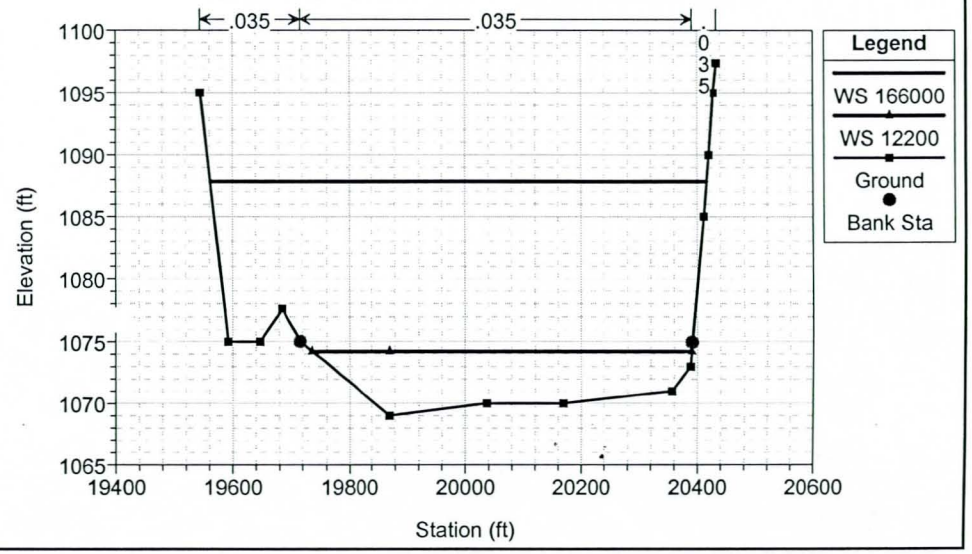
River = Rio Salado Reach = LFCD RS = 215.84



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

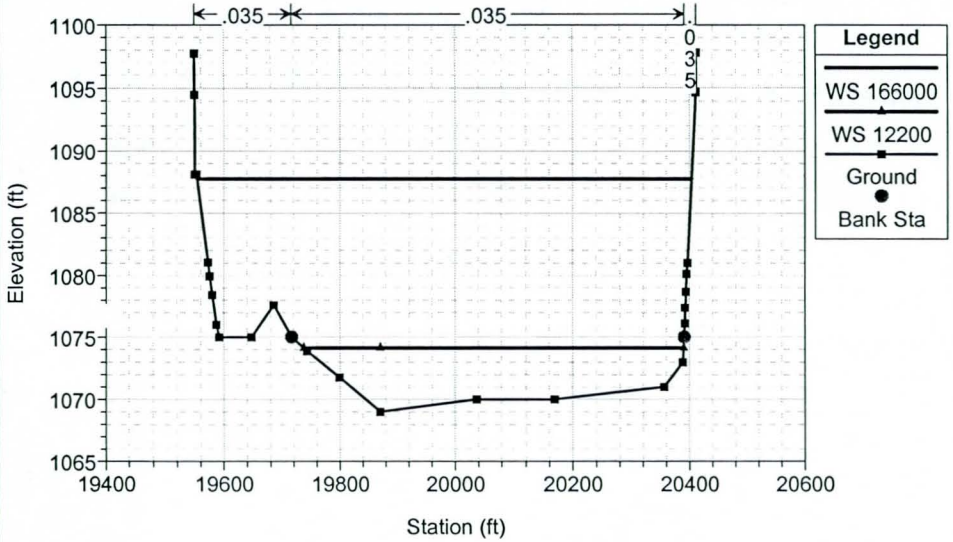
River = Rio Salado Reach = LFCD RS = 215.83



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

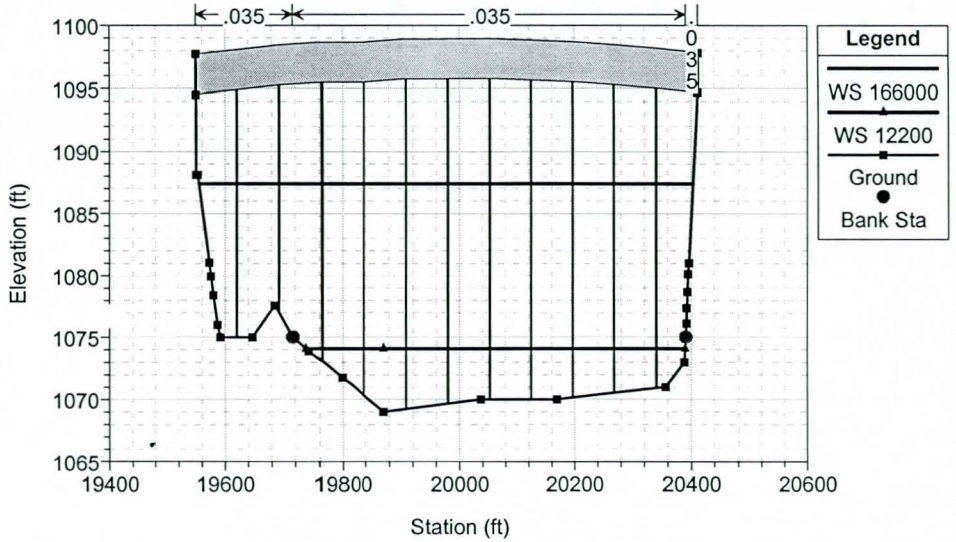
River = Rio Salado Reach = LFCD Upstream face of 24th Street Bridge RS = 215.82



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

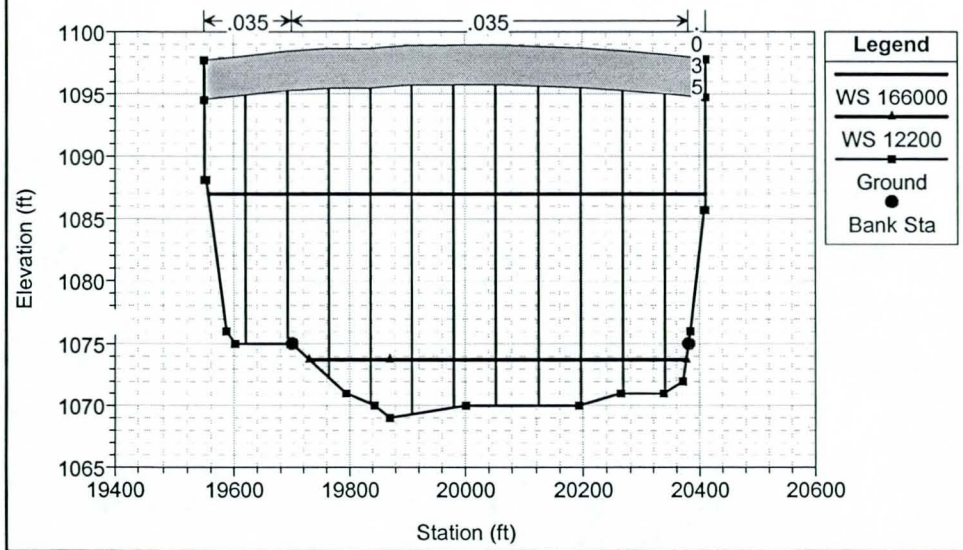
River = Rio Salado Reach = LFCD Bridge #6, 24th Street Bridge RS = 215.815



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

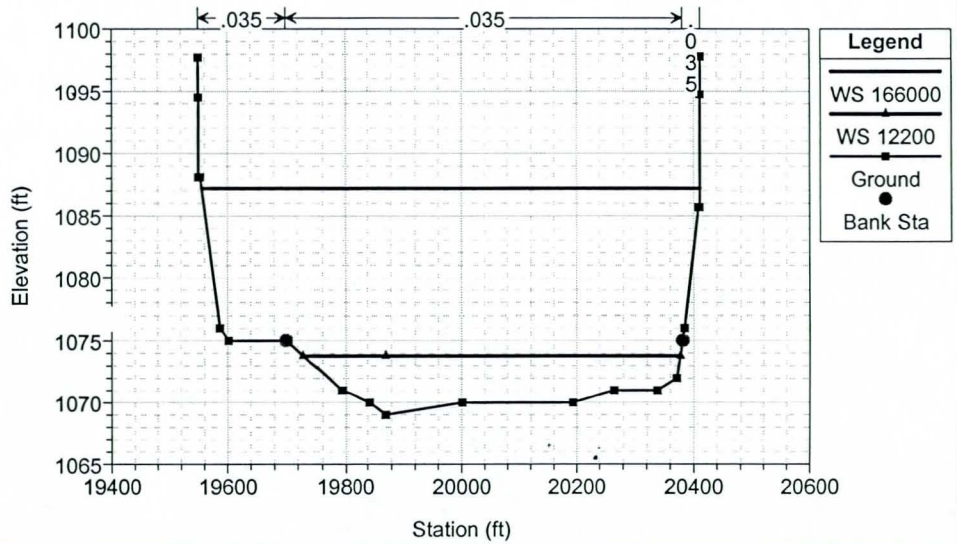
River = Rio Salado Reach = LFCD Bridge #6, 24th Street Bridge RS = 215.815



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

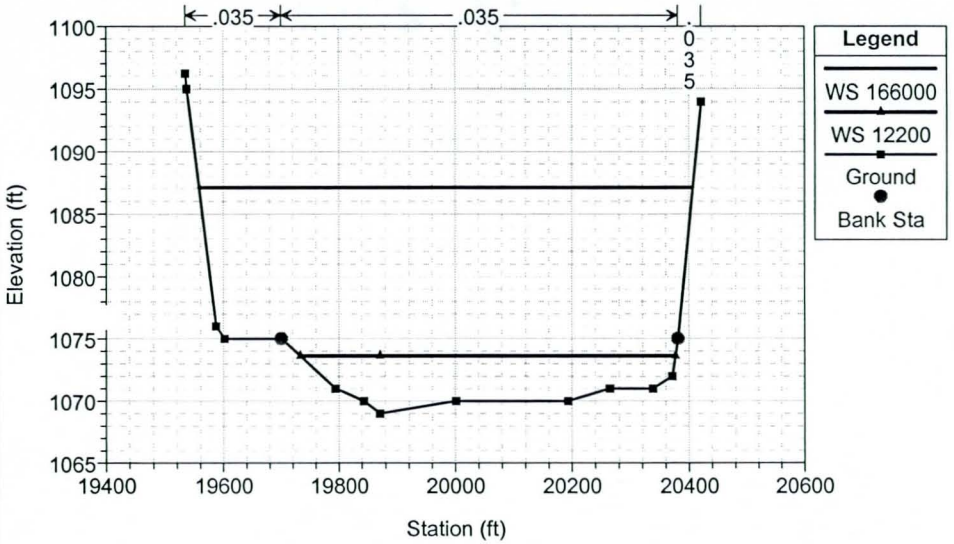
River = Rio Salado Reach = LFCD Upstream face of 24th Street Bridge RS = 215.81



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

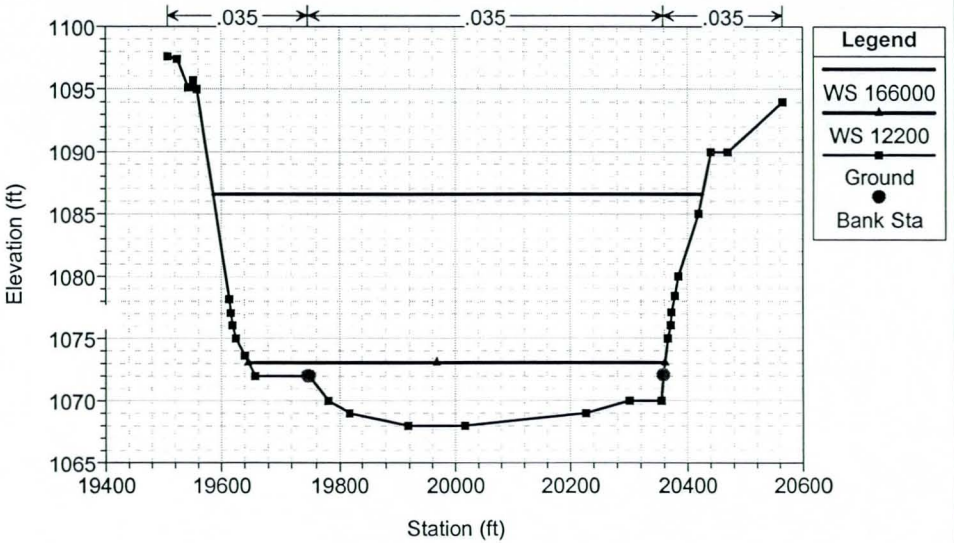
River = Rio Salado Reach = LFCD RS = 215.8



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

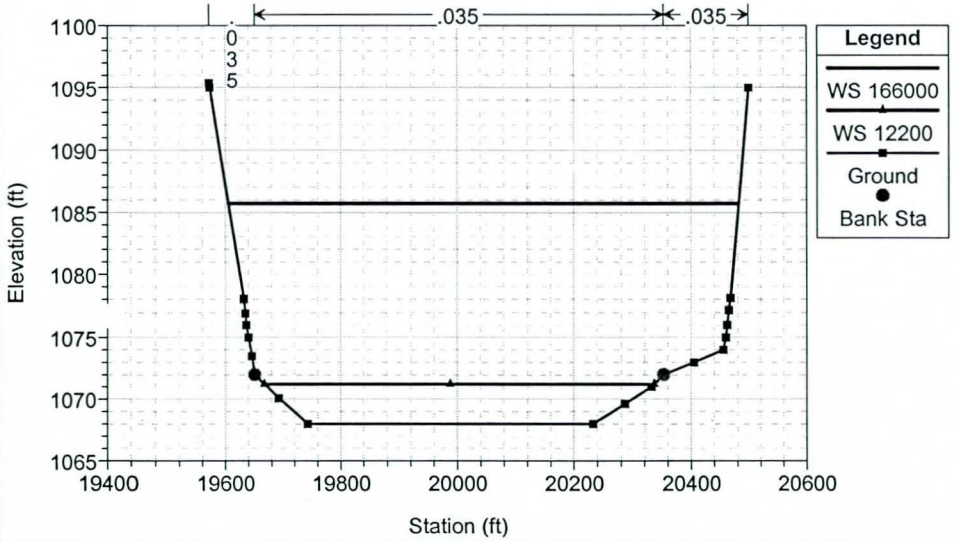
River = Rio Salado Reach = LFCD RS = 215.75



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

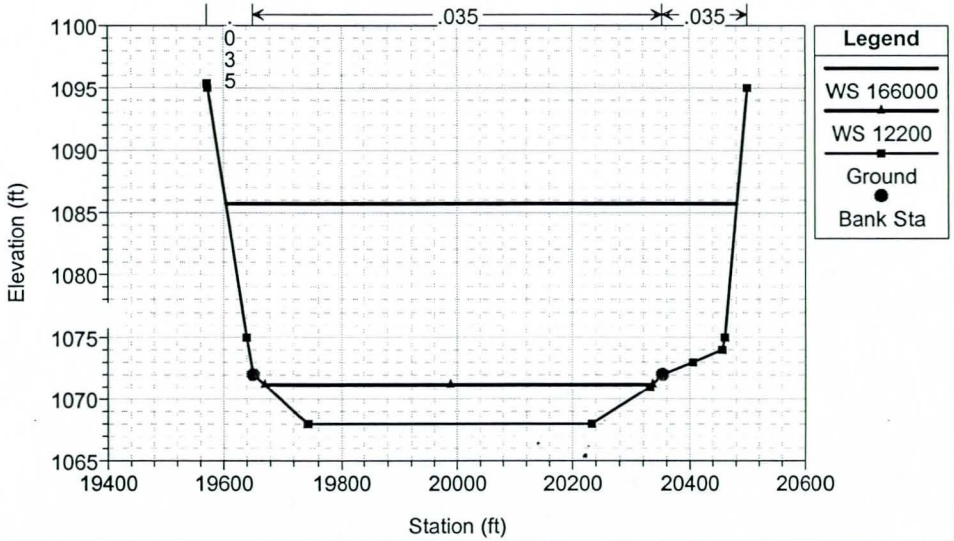
River = Rio Salado Reach = LFCD Top of Proposed Grade Control Structure RS = 215.651



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

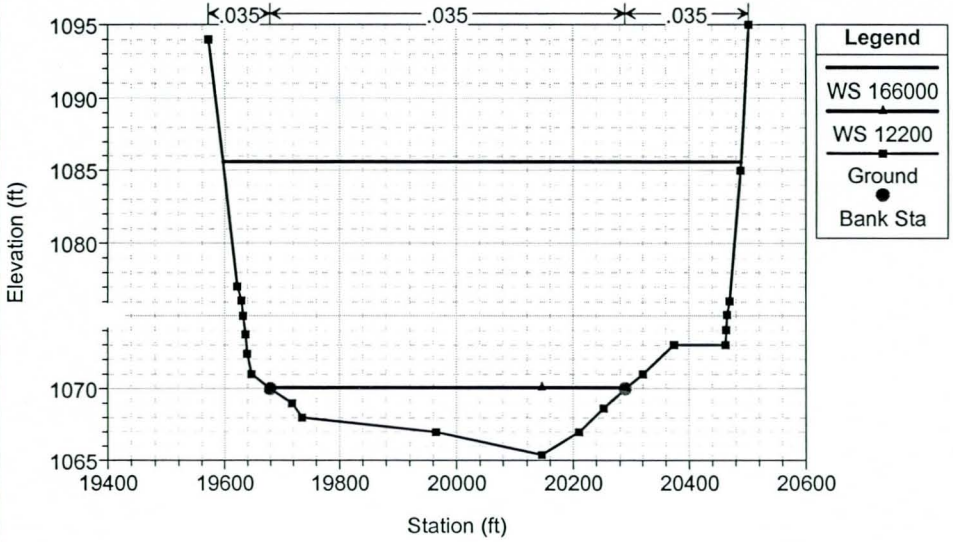
River = Rio Salado Reach = LFCD Bottom of Proposed Grade Control Structu RS = 215.65



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

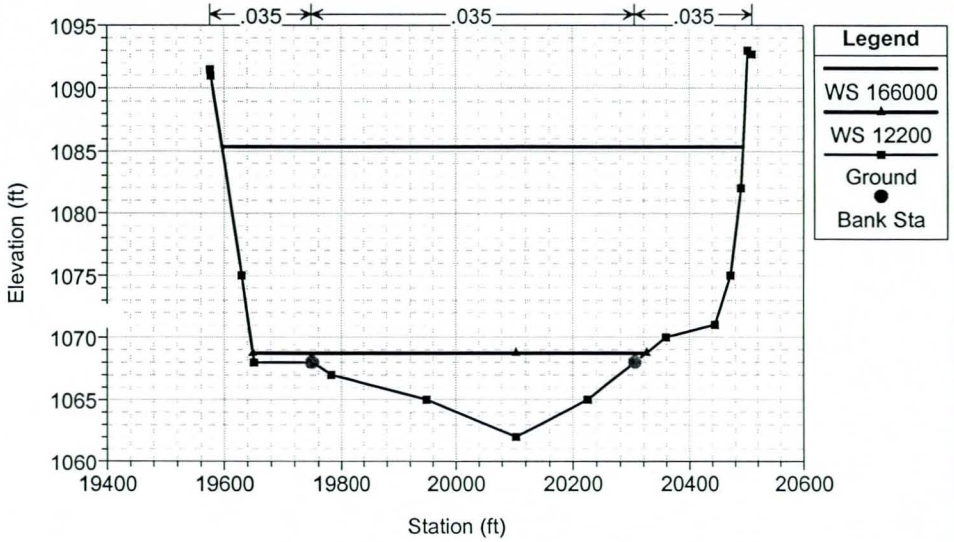
River = Rio Salado Reach = LFCD Bottom of proposed 3' drop RS = 215.62



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

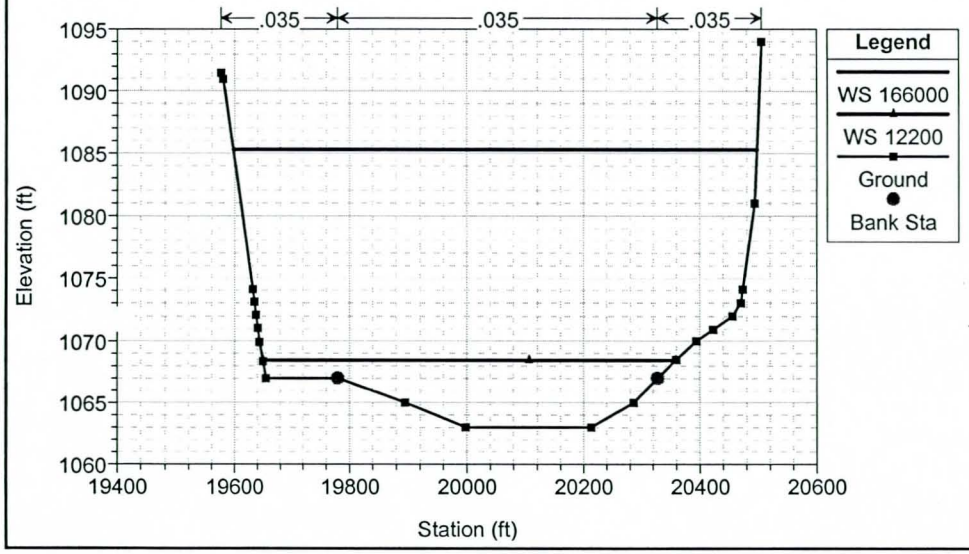
River = Rio Salado Reach = LFCD Bottom of Proposed Drop Structure RS = 215.56



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

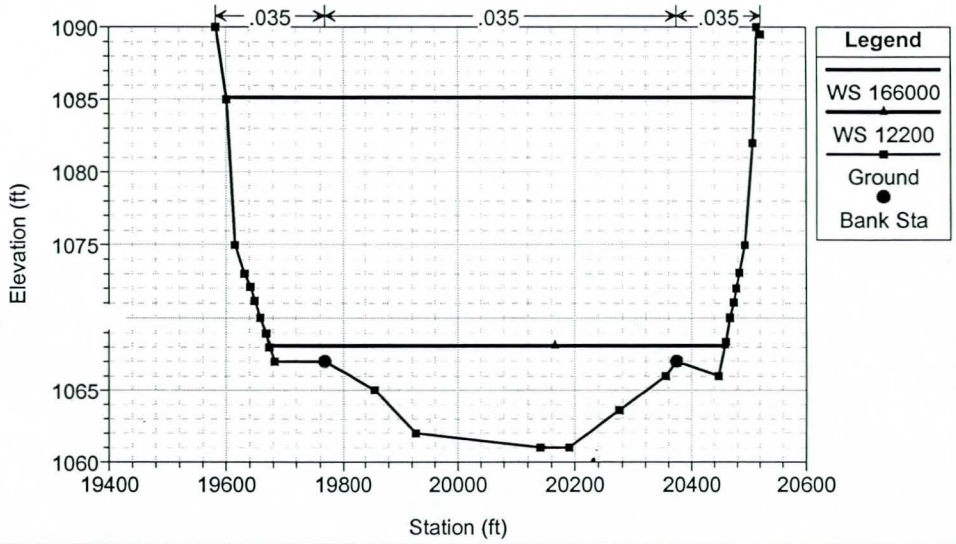
River = Rio Salado Reach = LFCD Added section, O/B copied from 215.56 RS = 215.53



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

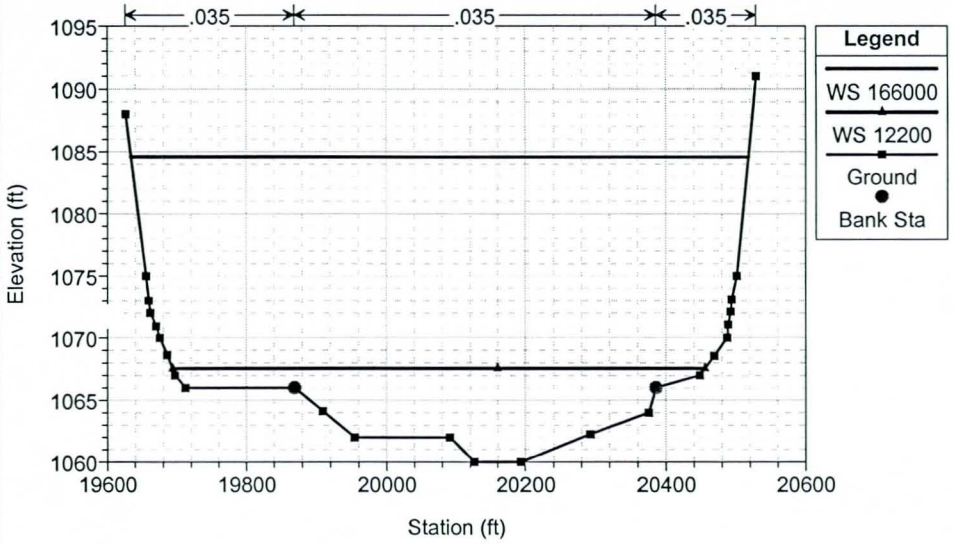
River = Rio Salado Reach = LFCD RS = 215.46



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

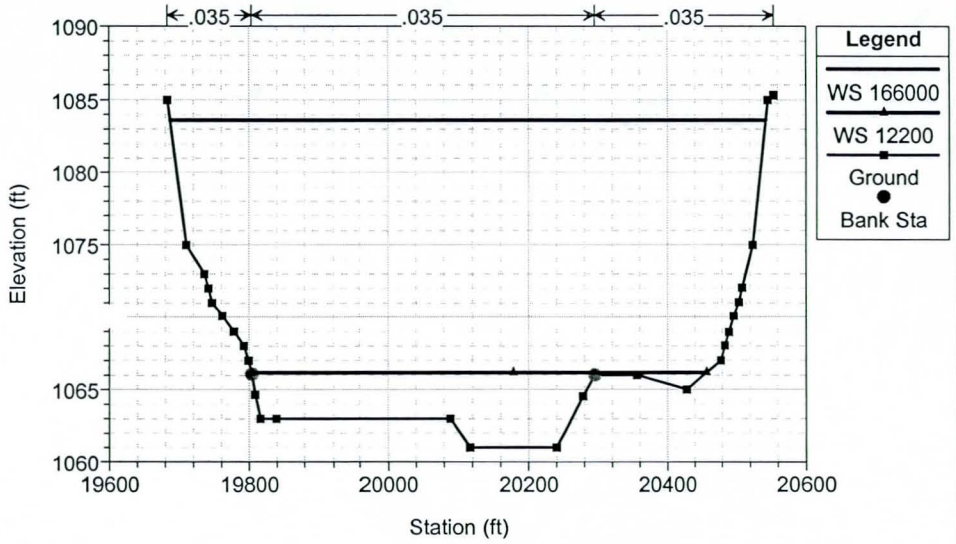
River = Rio Salado Reach = LFCD RS = 215.36



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

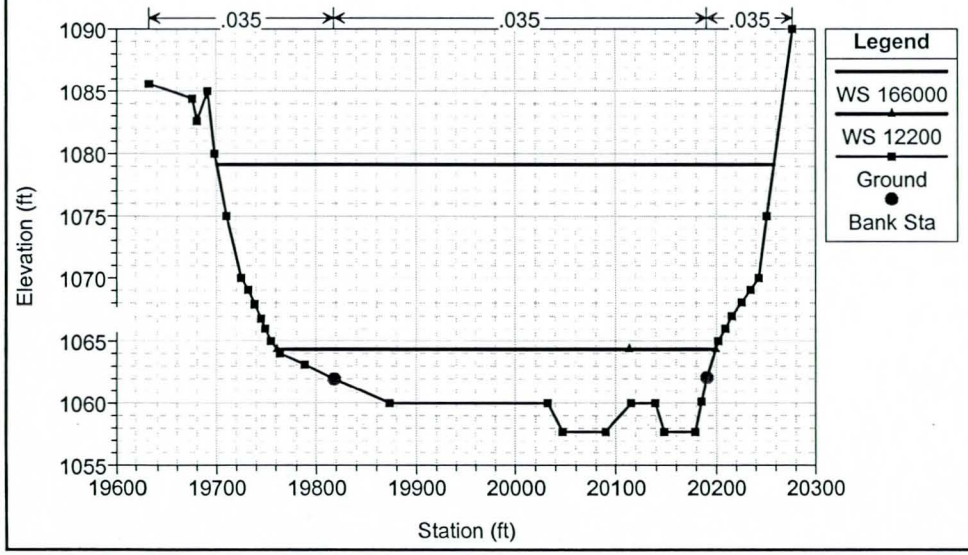
River = Rio Salado Reach = LFCD RS = 215.27



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

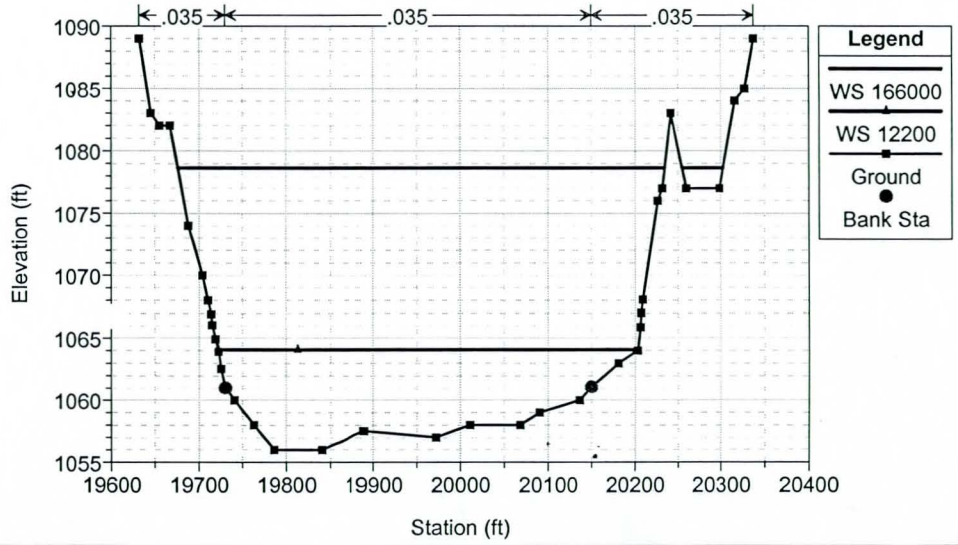
River = Rio Salado Reach = LFCD RS = 215.18



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

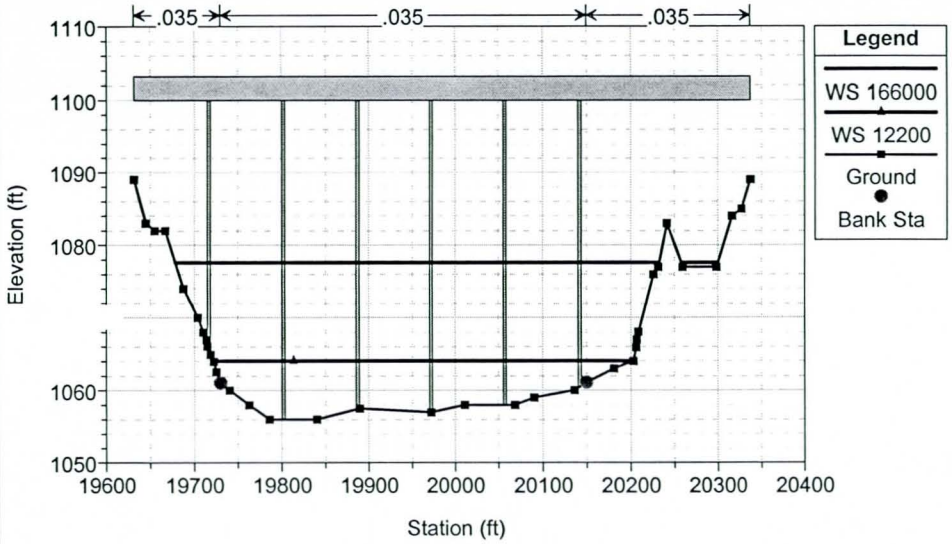
River = Rio Salado Reach = LFCD U/S Face of Conveyor Bridge RS = 215.125



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

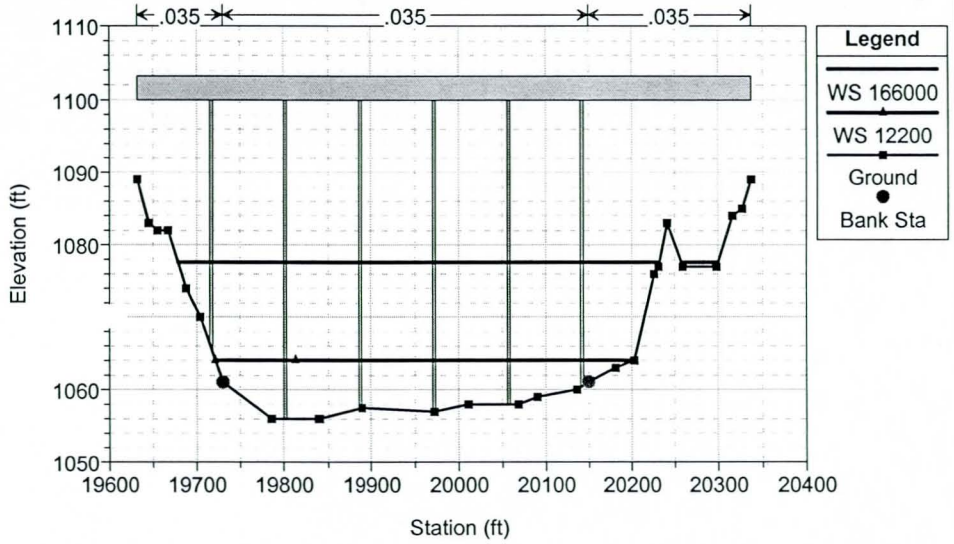
River = Rio Salado Reach = LFCD CalMat Plant, C&F Equipment, Conveyor Br RS = 215.12



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

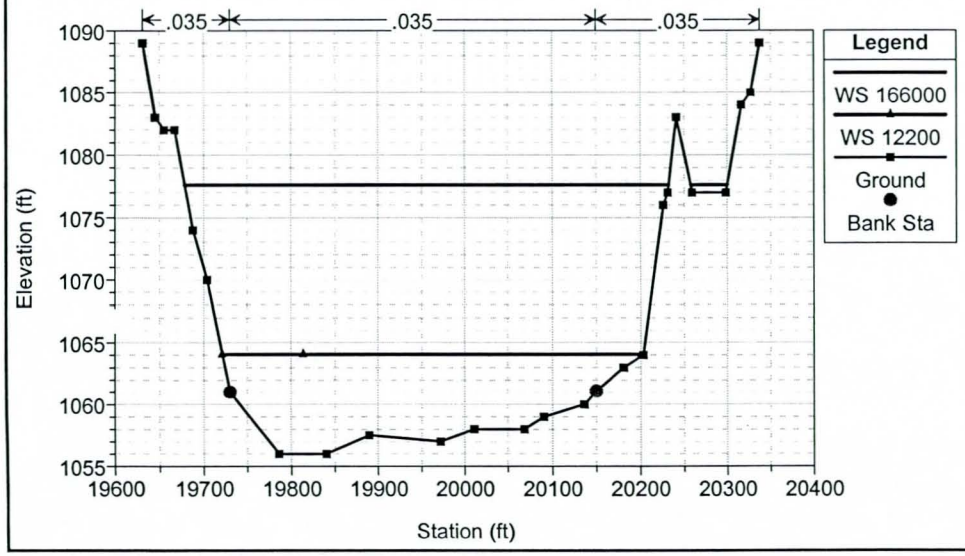
River = Rio Salado Reach = LFCD CalMat Plant, C&F Equipment, Conveyor Br RS = 215.12



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

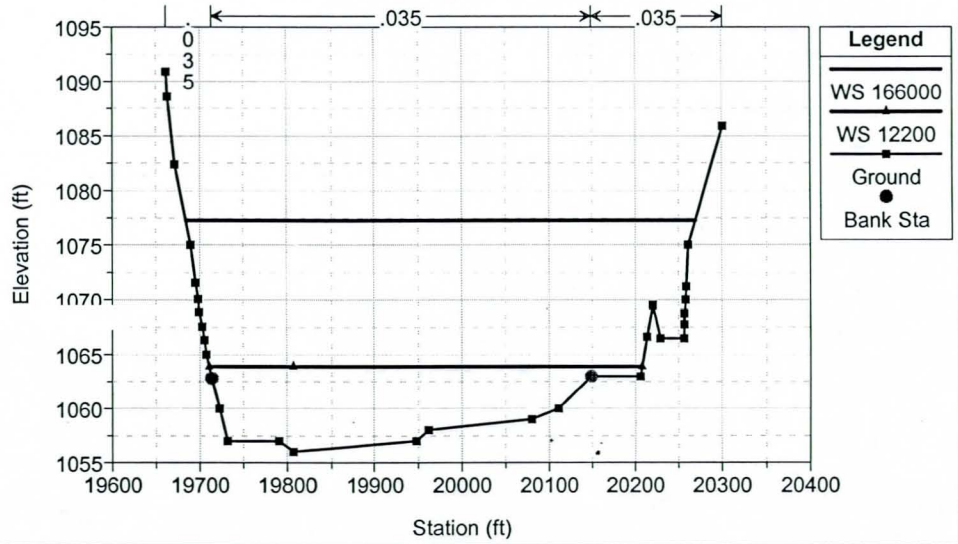
River = Rio Salado Reach = LFCD D/S Face of Conveyor Bridge RS = 215.115



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

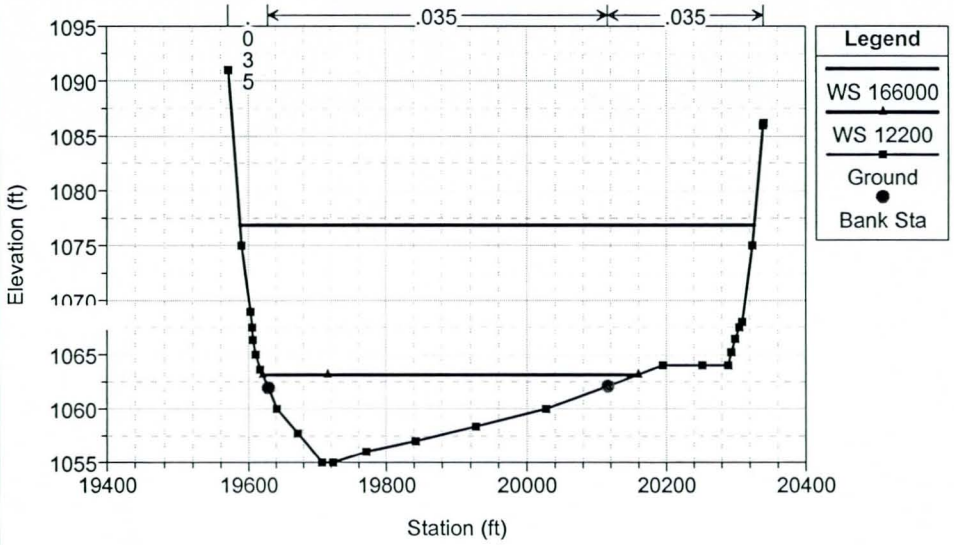
River = Rio Salado Reach = LFCD RS = 215.09



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

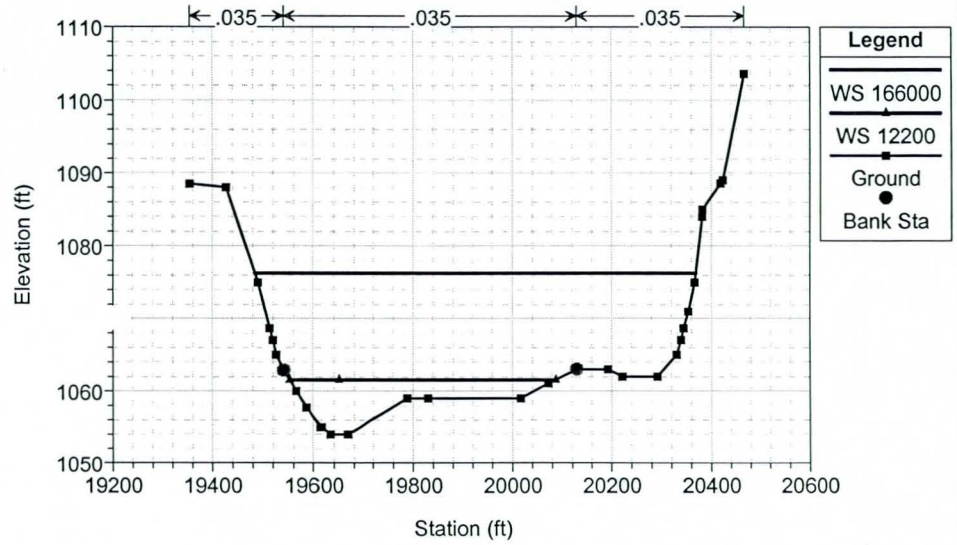
River = Rio Salado Reach = LFCD RS = 214.99



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

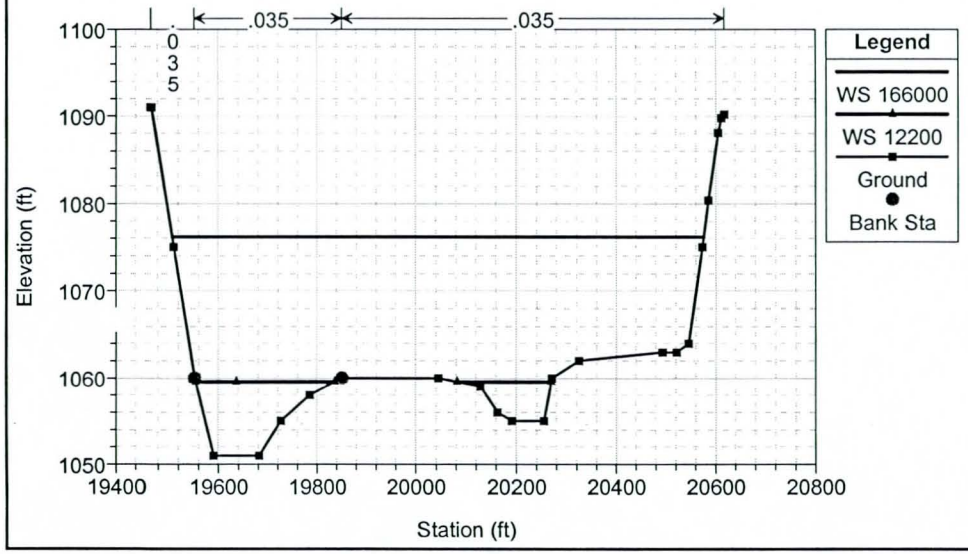
River = Rio Salado Reach = LFCD RS = 214.9



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

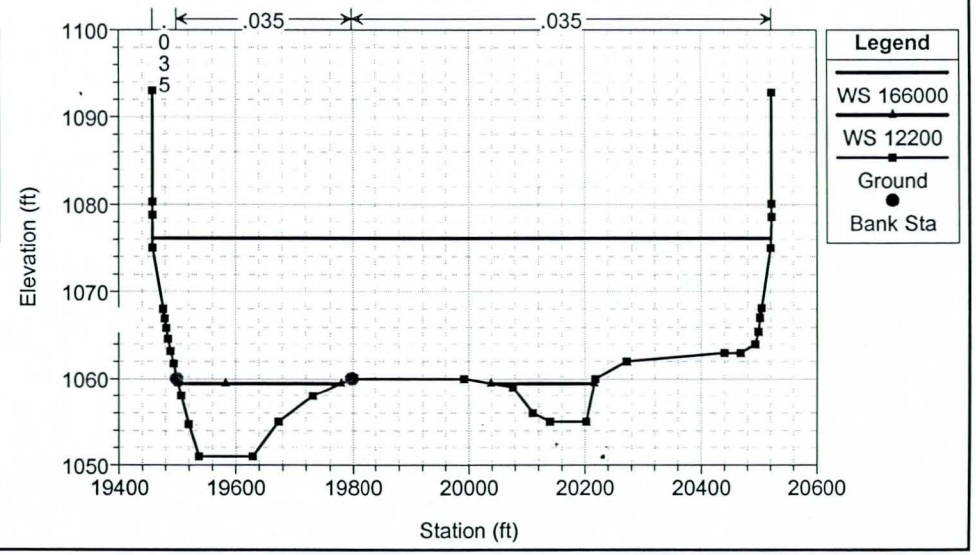
River = Rio Salado Reach = LFCD RS = 214.8



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

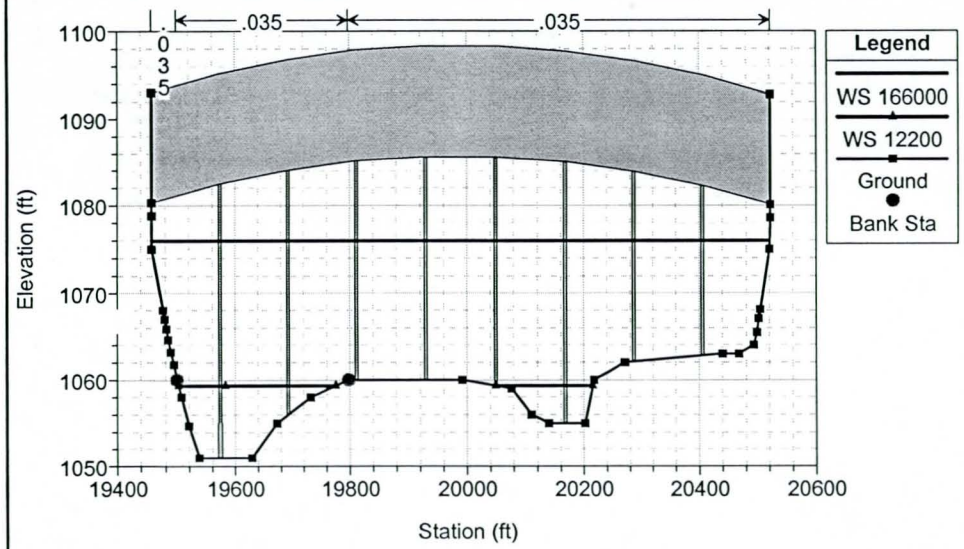
River = Rio Salado Reach = LFCD Upstream face of 16th Street Bridge RS = 214.79



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

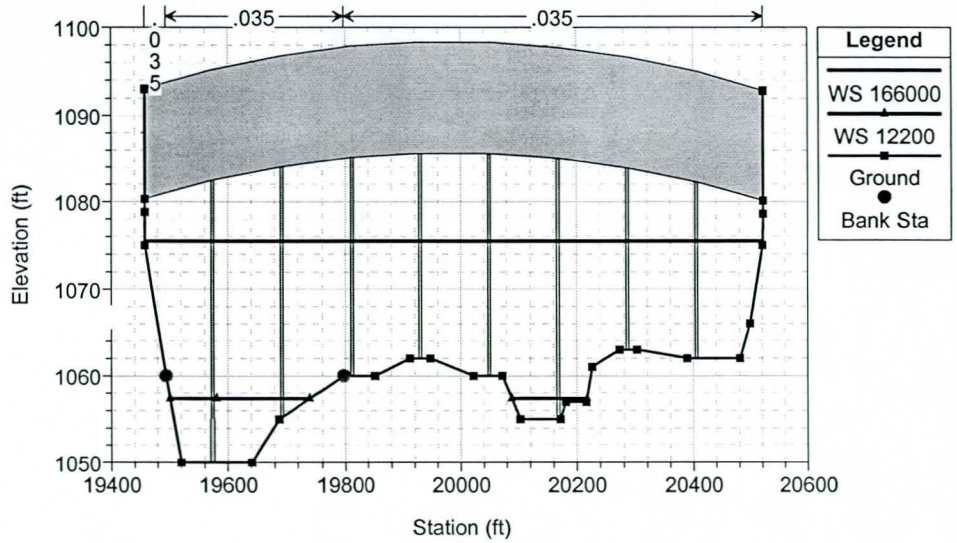
River = Rio Salado Reach = LFCD Bridge #5, 16th Street Bridge RS = 214.785



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

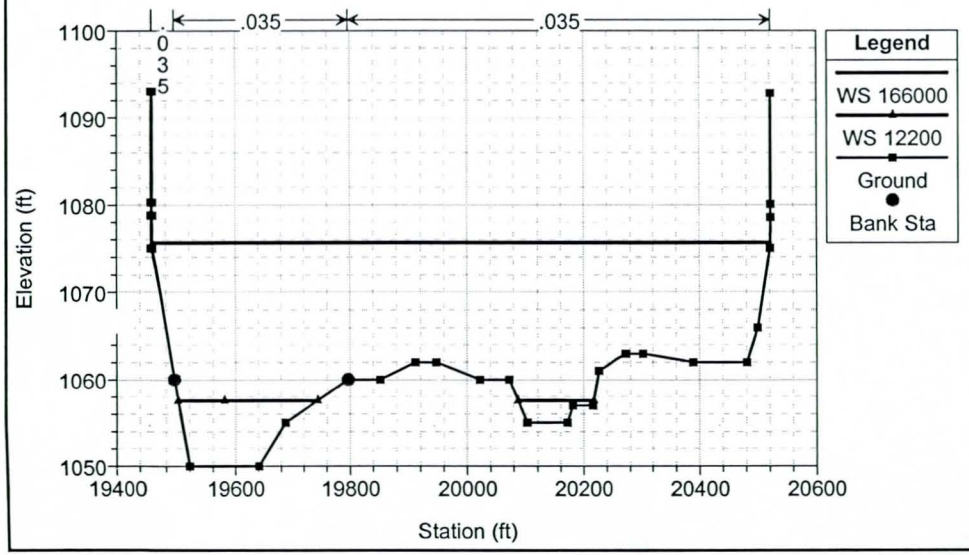
River = Rio Salado Reach = LFCD Bridge #5, 16th Street Bridge RS = 214.785



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

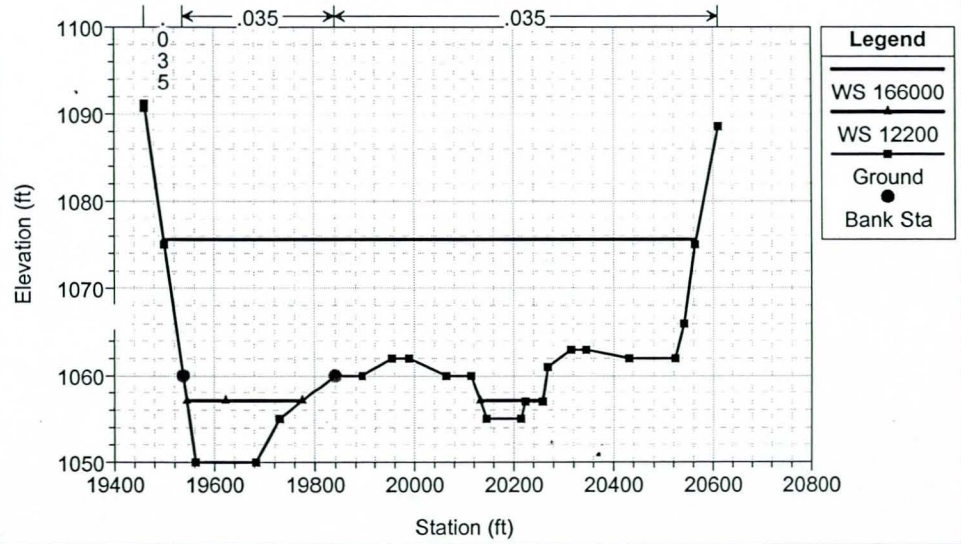
River = Rio Salado Reach = LFCD Downstream face of 16th Street Bridge RS = 214.78



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

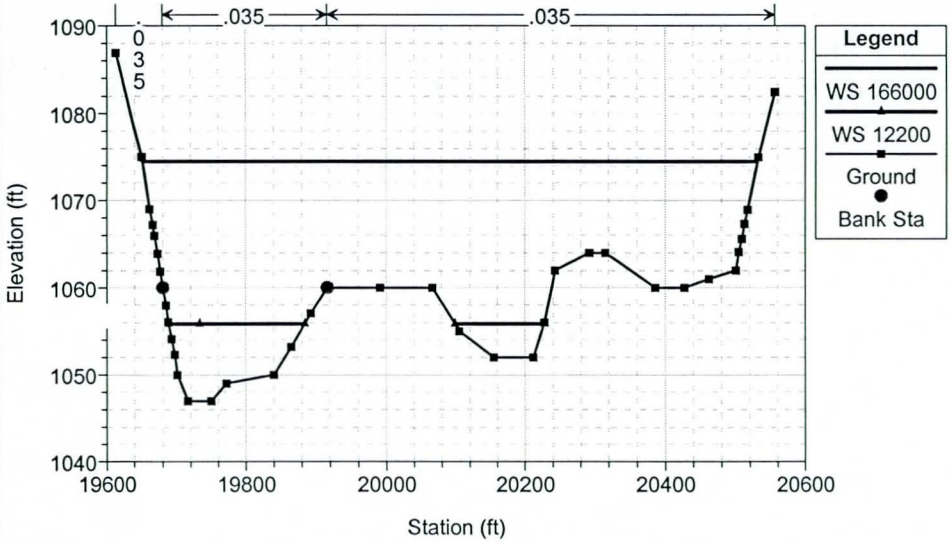
River = Rio Salado Reach = LFCD RS = 214.77



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

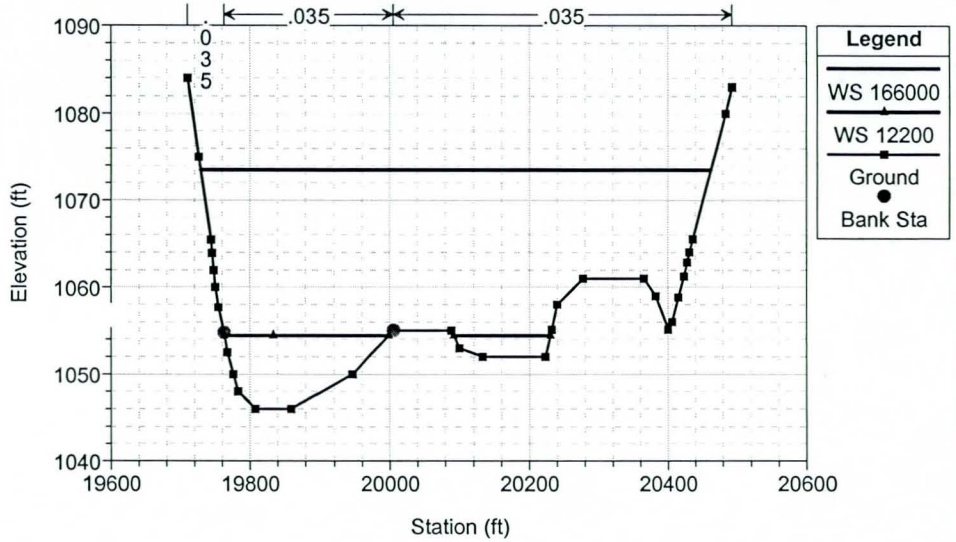
River = Rio Salado Reach = LFCD RS = 214.71



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

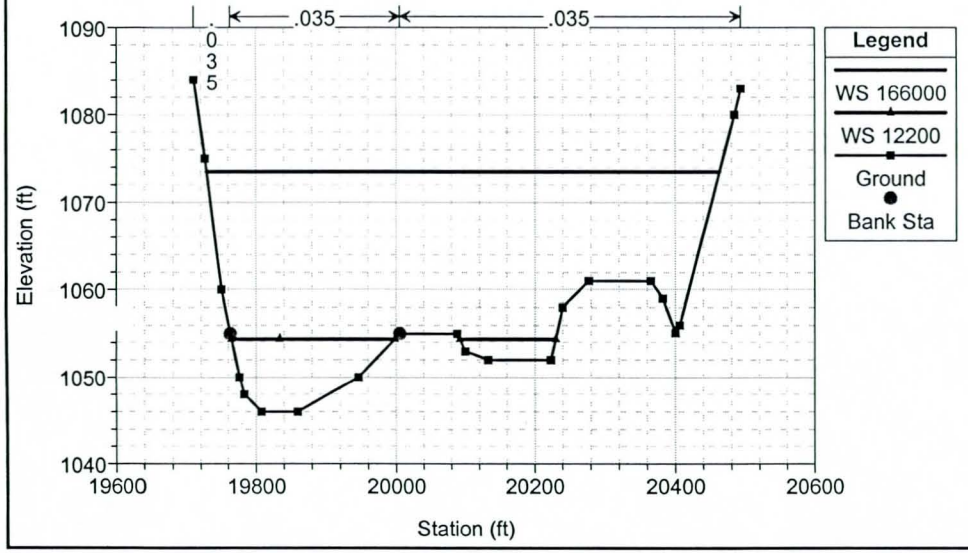
River = Rio Salado Reach = LFCD Copy of 214.65. Top of proposed drop st RS = 214.651



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

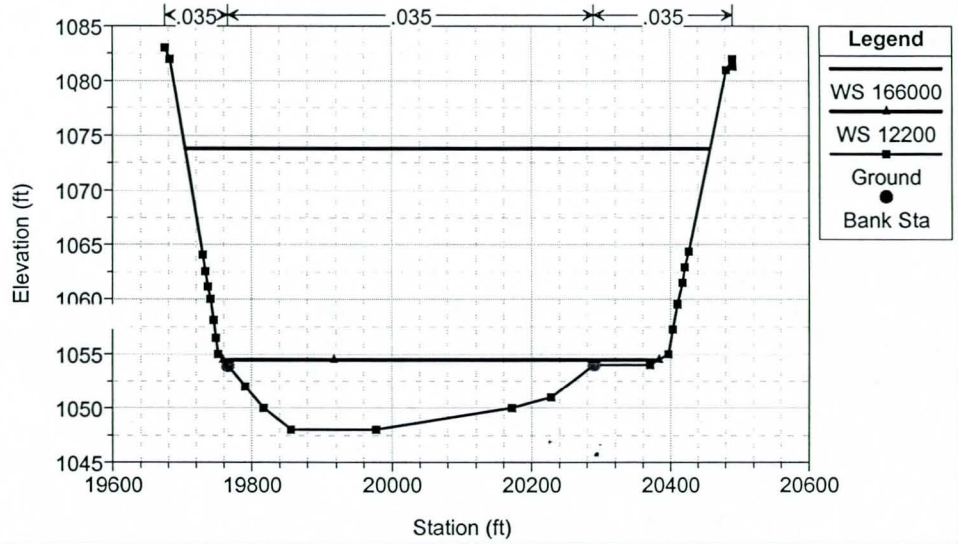
River = Rio Salado Reach = LFCD Bottom of proposed drop structure. RS = 214.65



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

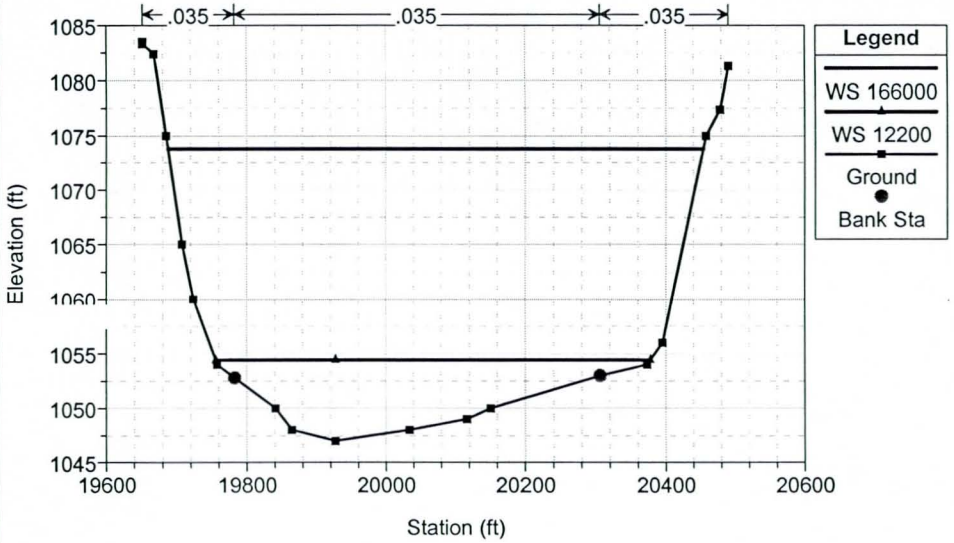
River = Rio Salado Reach = LFCD Added Section. Copy of 214.61 RS = 214.62



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

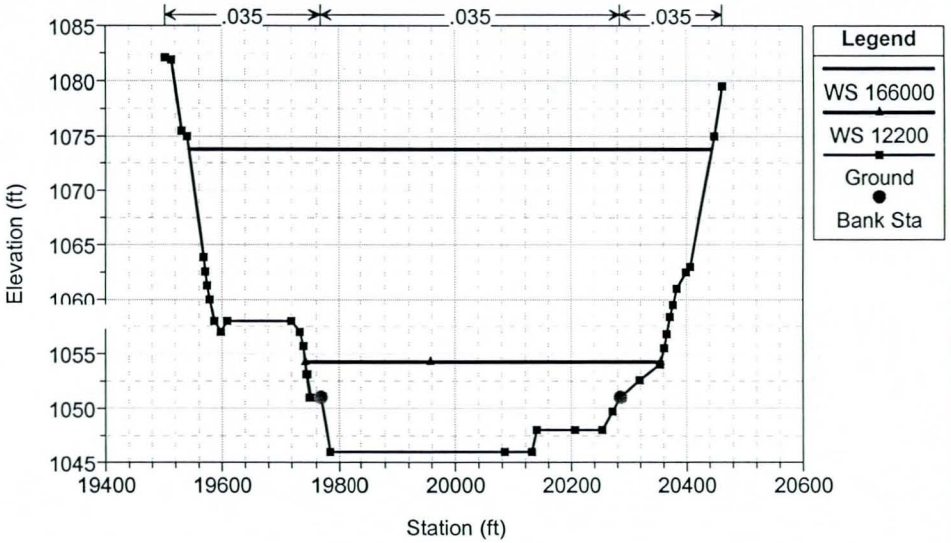
River = Rio Salado Reach = LFCD RS = 214.61



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

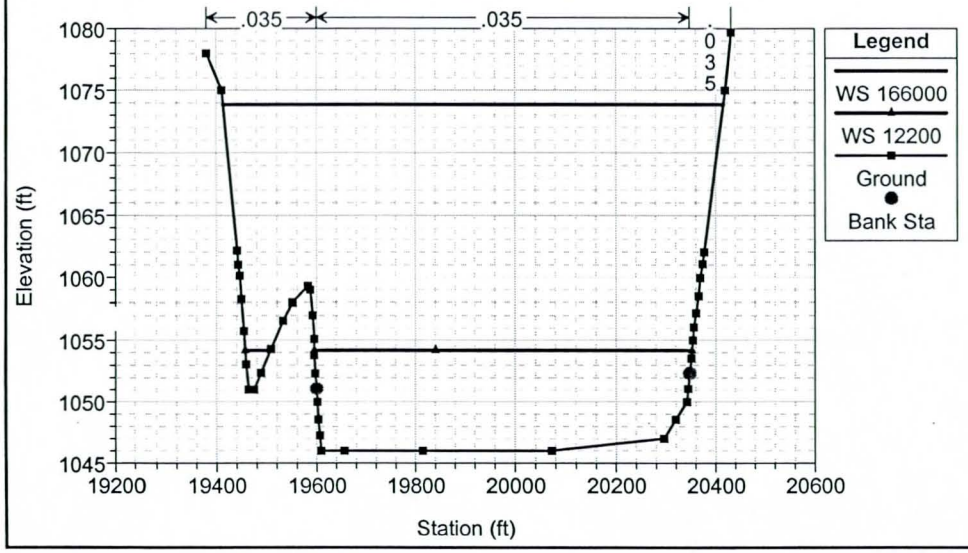
River = Rio Salado Reach = LFCD RS = 214.52



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

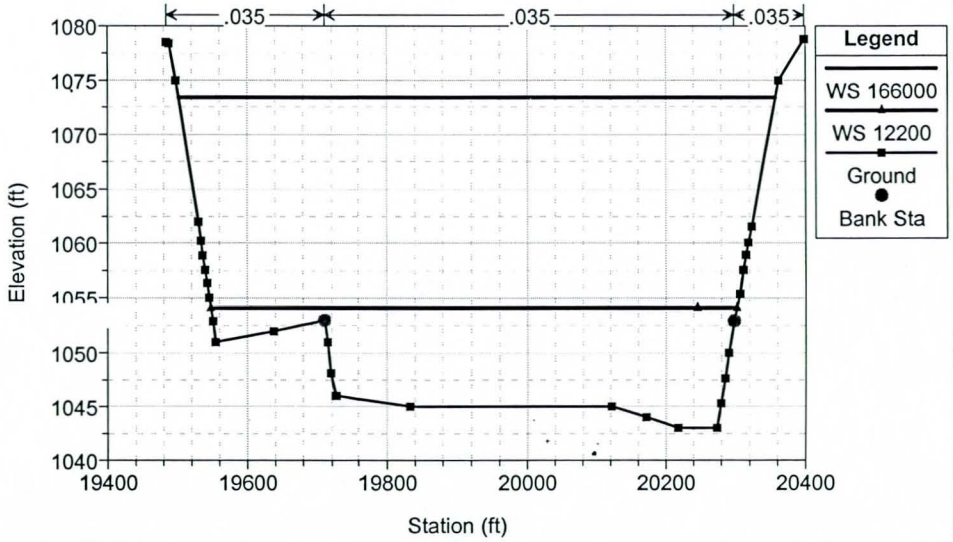
River = Rio Salado Reach = LFCD RS = 214.42



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

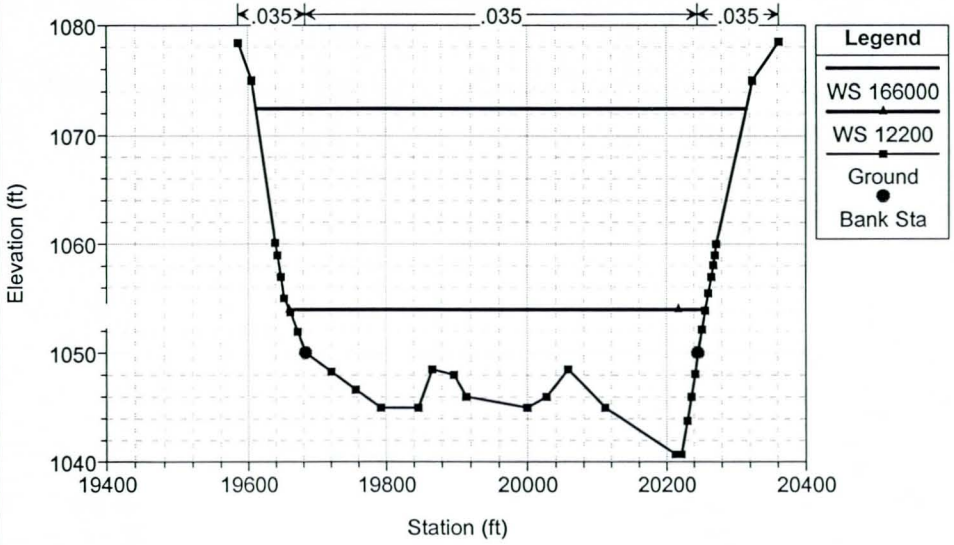
River = Rio Salado Reach = LFCD RS = 214.33



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

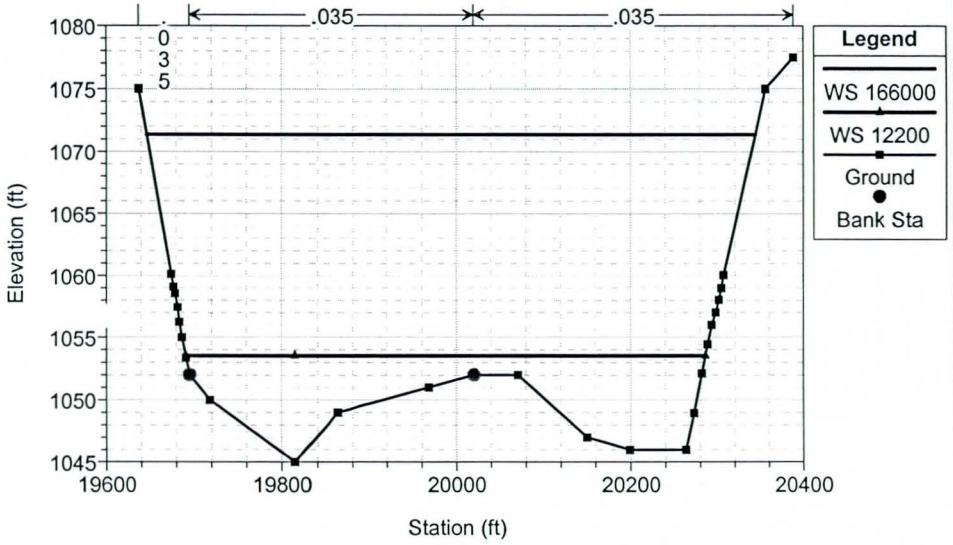
River = Rio Salado Reach = LFCD RS = 214.23



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

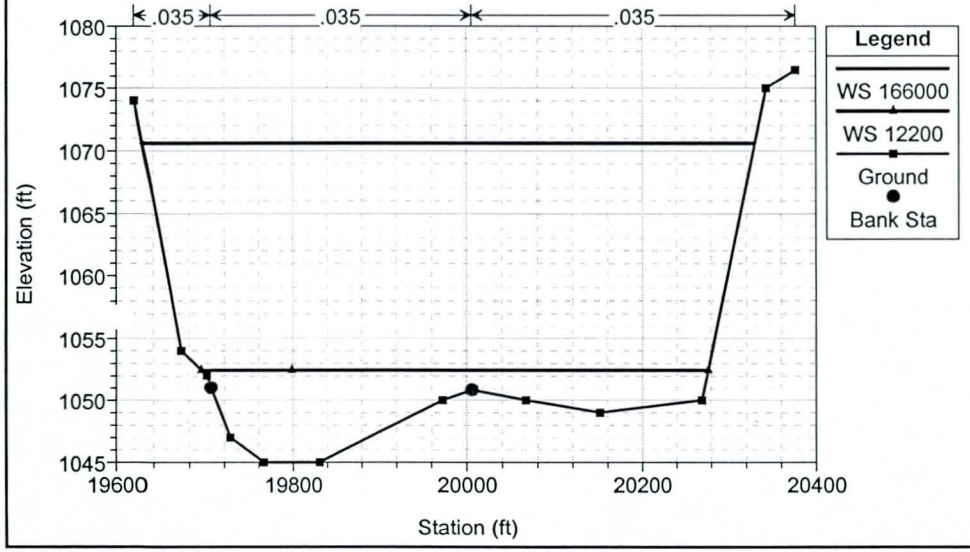
River = Rio Salado Reach = LFCD RS = 214.14



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

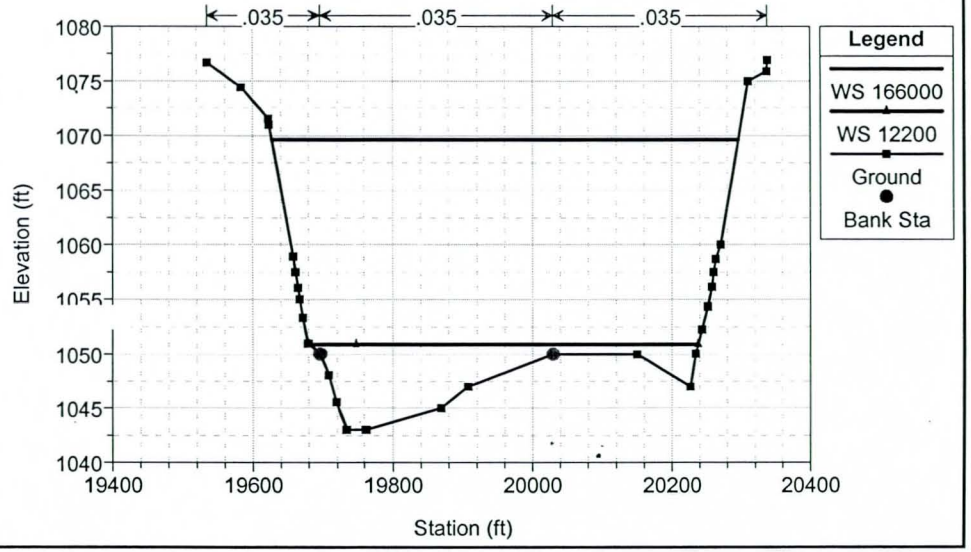
River = Rio Salado Reach = LFCD RS = 214.04



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

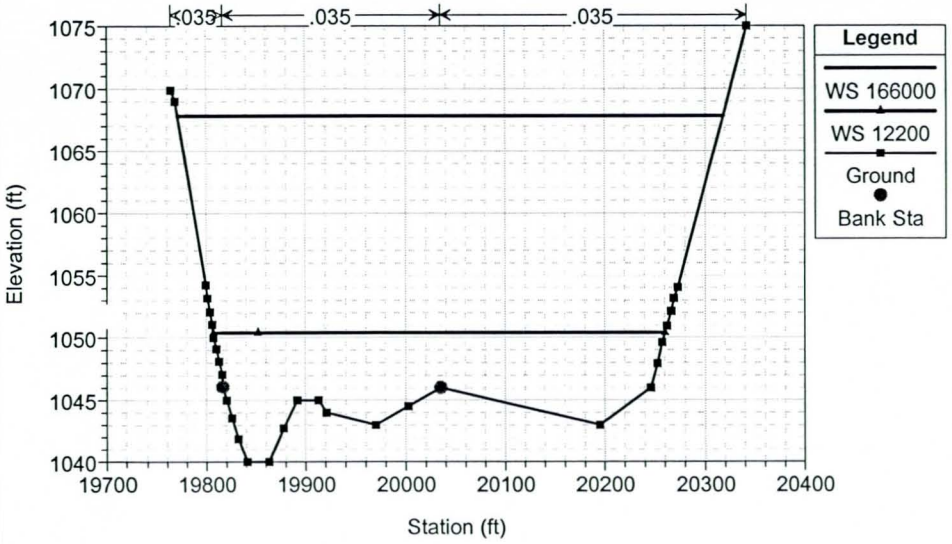
River = Rio Salado Reach = LFCD RS = 213.95



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

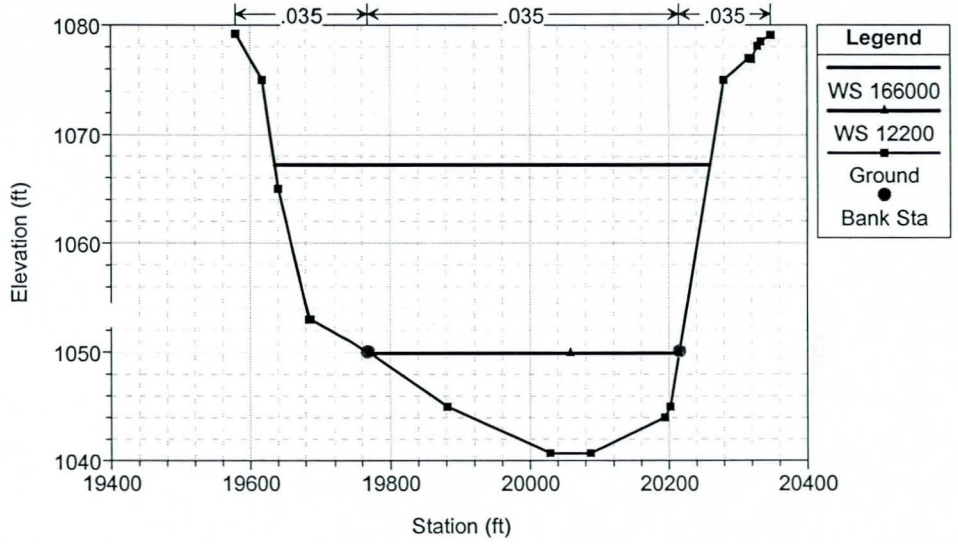
River = Rio Salado Reach = LFCD RS = 213.85



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

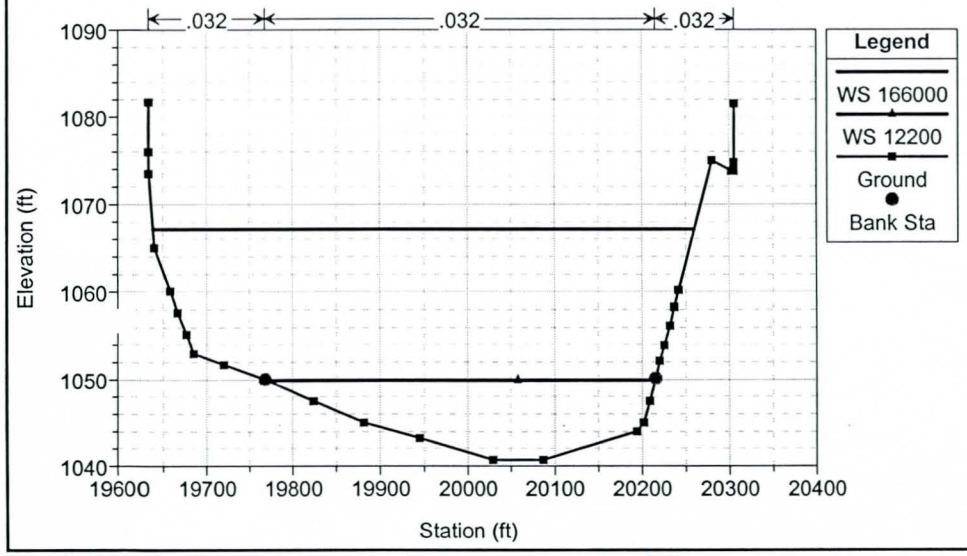
River = Rio Salado Reach = LFCD RS = 213.76



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

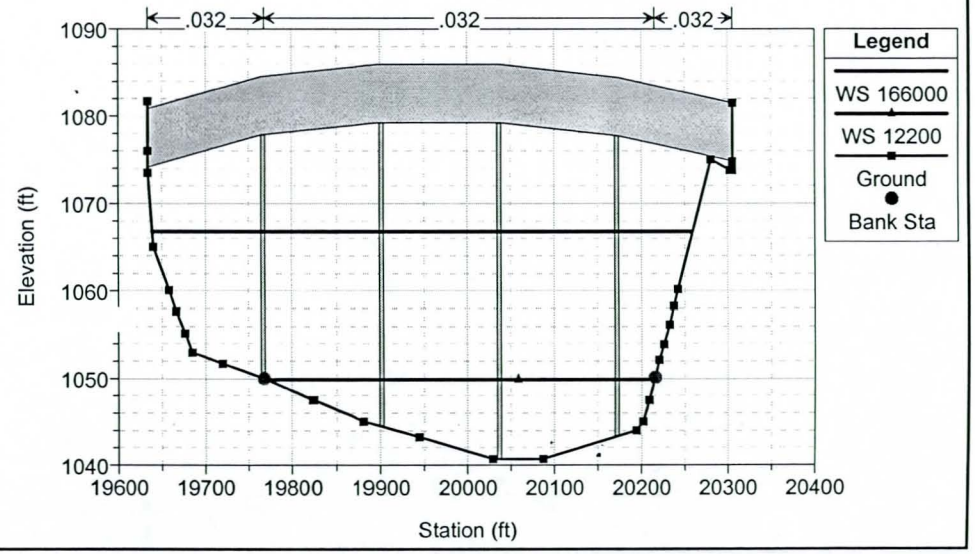
River = Rio Salado Reach = LFCD Upstream face of 7th Street Bridge RS = 213.75



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

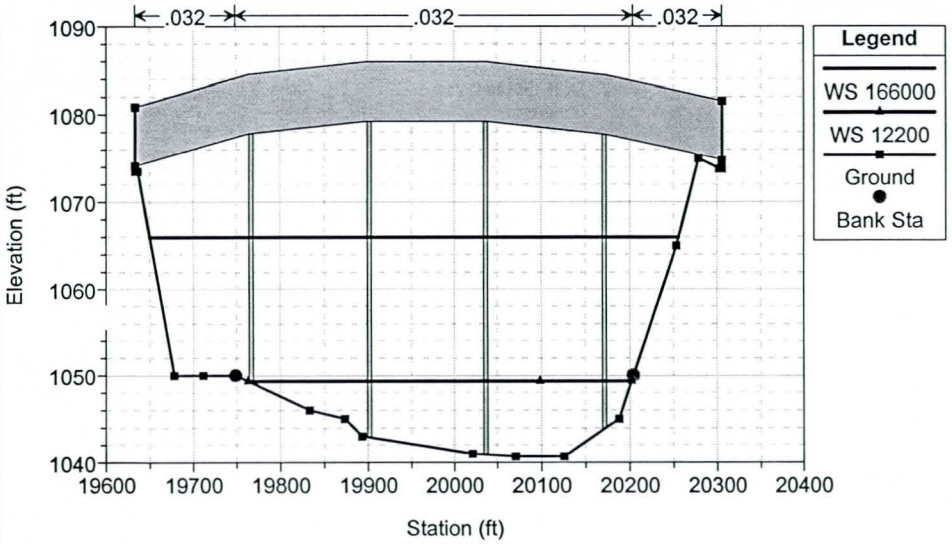
River = Rio Salado Reach = LFCD Bridge #4, 7th Street Bridge RS = 213.745



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

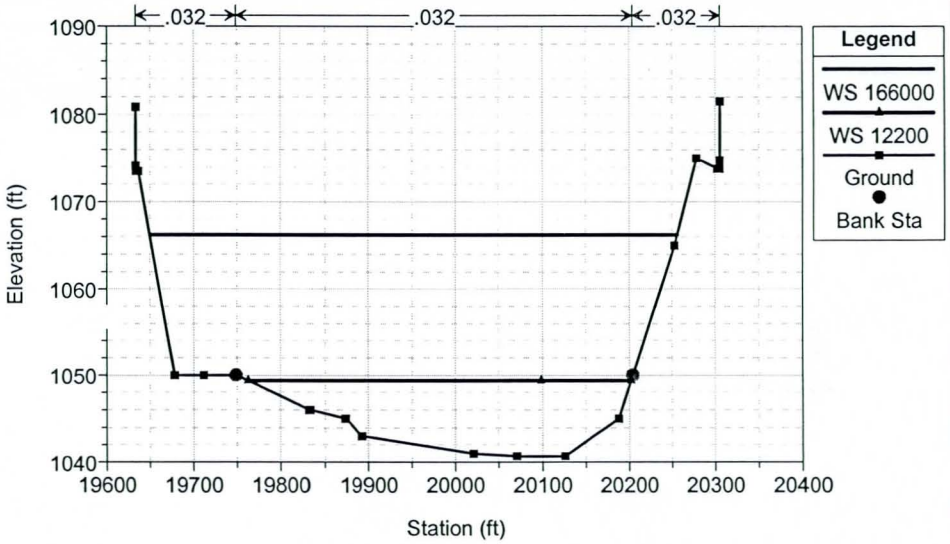
River = Rio Salado Reach = LFCD Bridge #4, 7th Street Bridge RS = 213.745



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

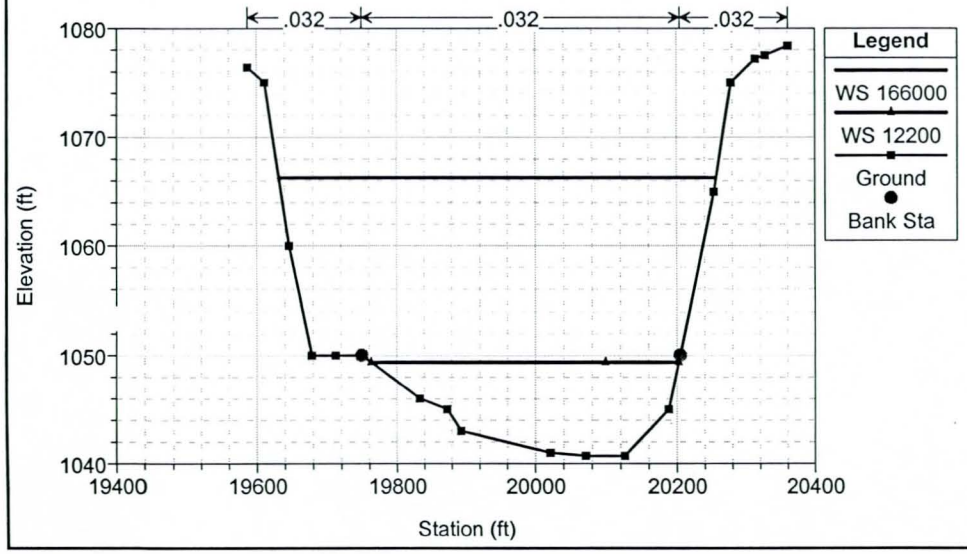
River = Rio Salado Reach = LFCD Downstream face of 7th Street Bridge RS = 213.74



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

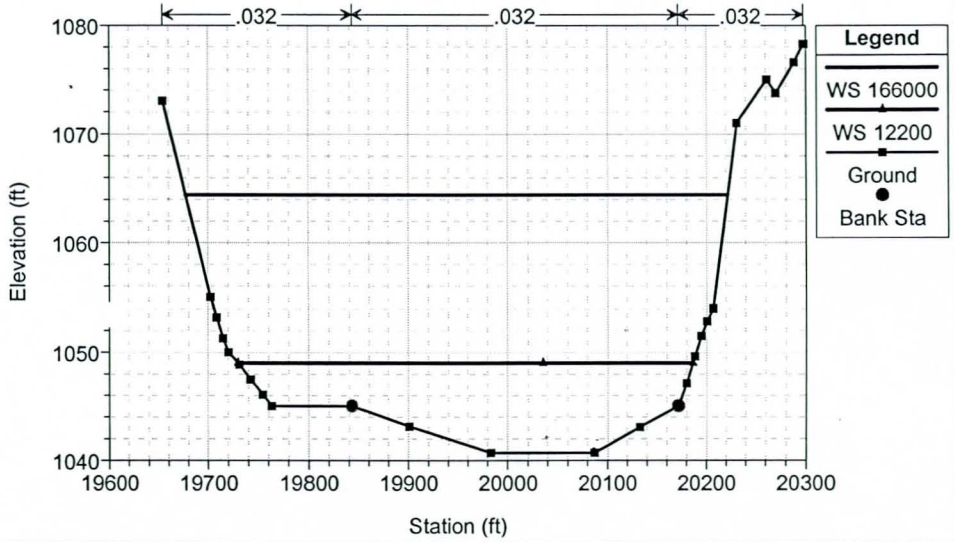
River = Rio Salado Reach = LFCD RS = 213.73



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

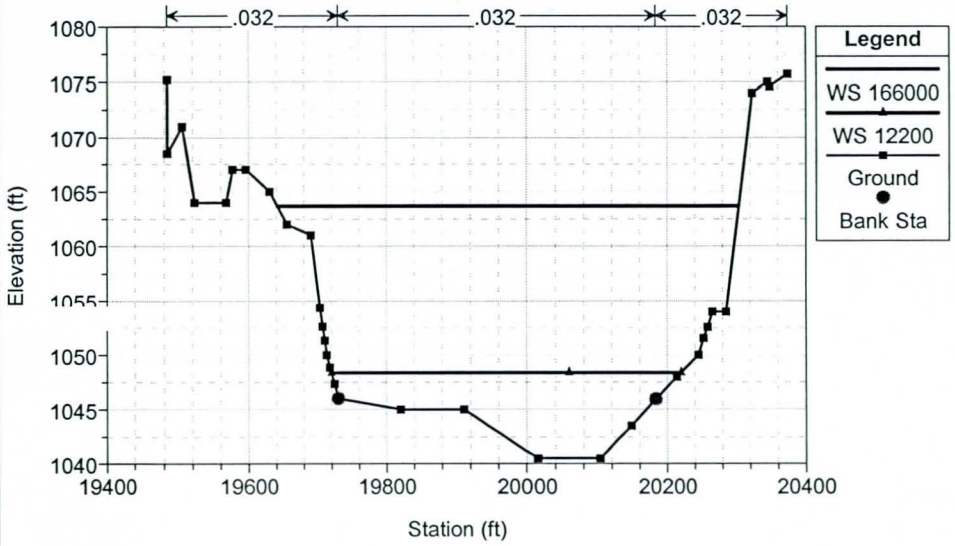
River = Rio Salado Reach = LFCD RS = 213.66



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

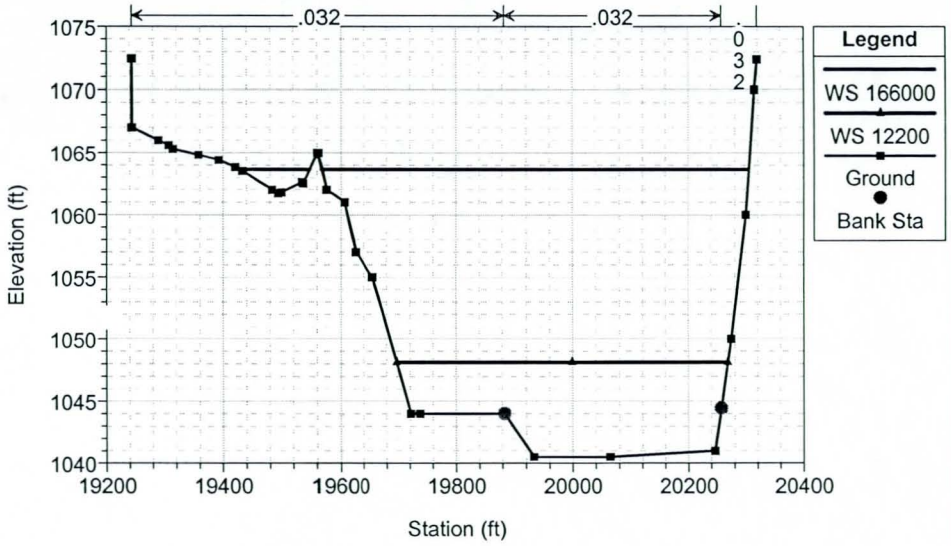
River = Rio Salado Reach = LFCD RS = 213.57



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

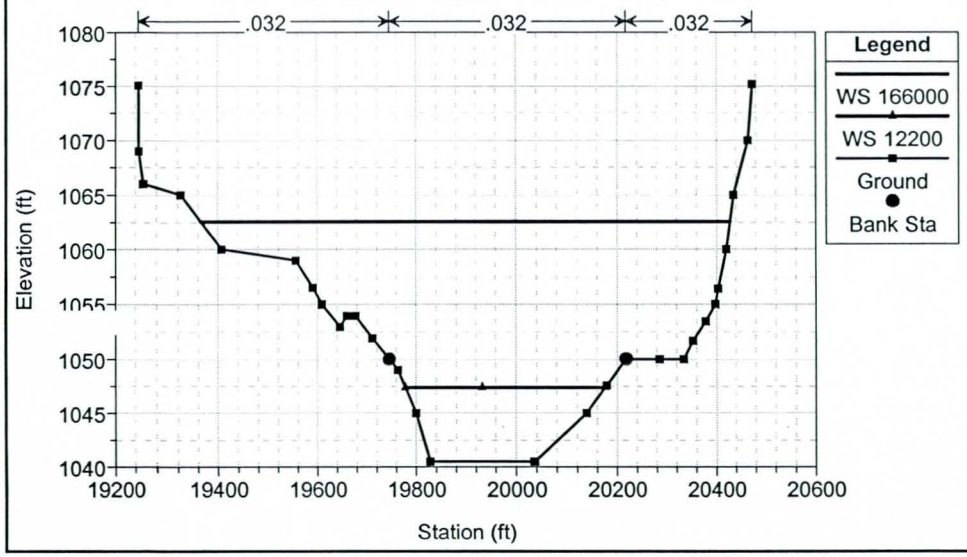
River = Rio Salado Reach = LFCD RS = 213.47



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

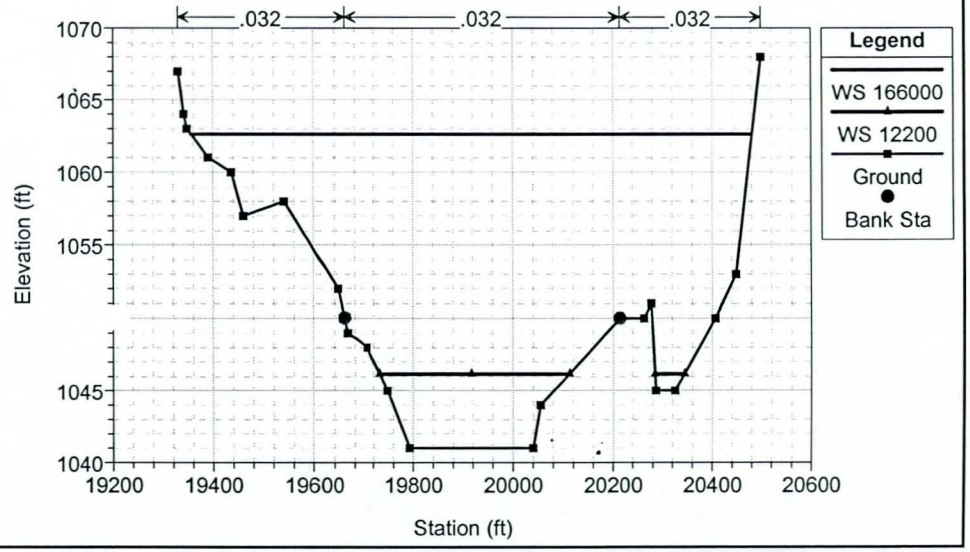
River = Rio Salado Reach = LFCD RS = 213.38



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

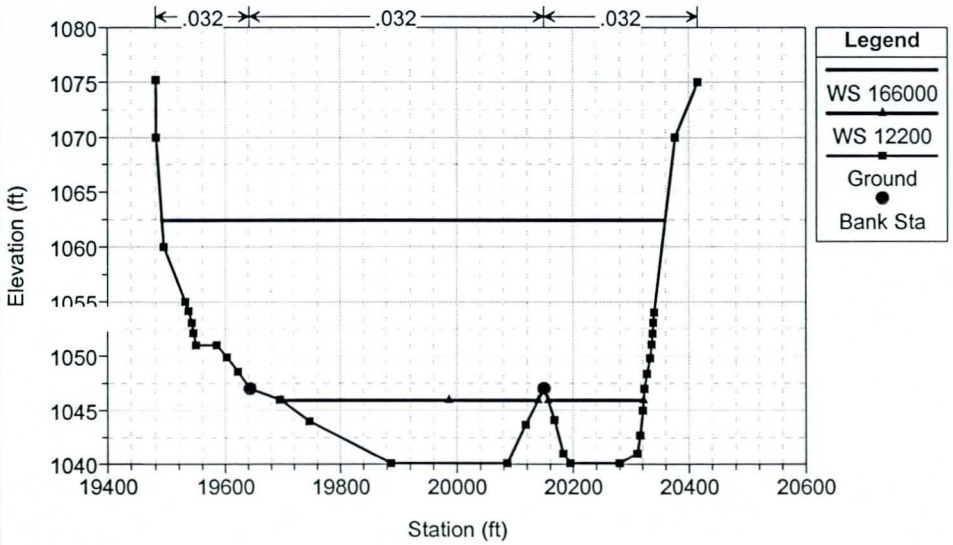
River = Rio Salado Reach = LFCD RS = 213.33



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

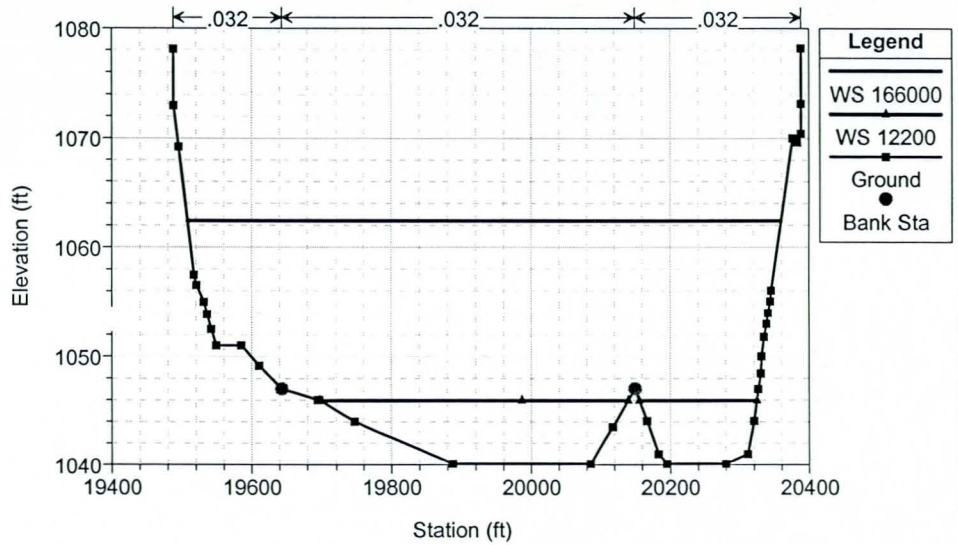
River = Rio Salado Reach = LFCD RS = 213.27



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

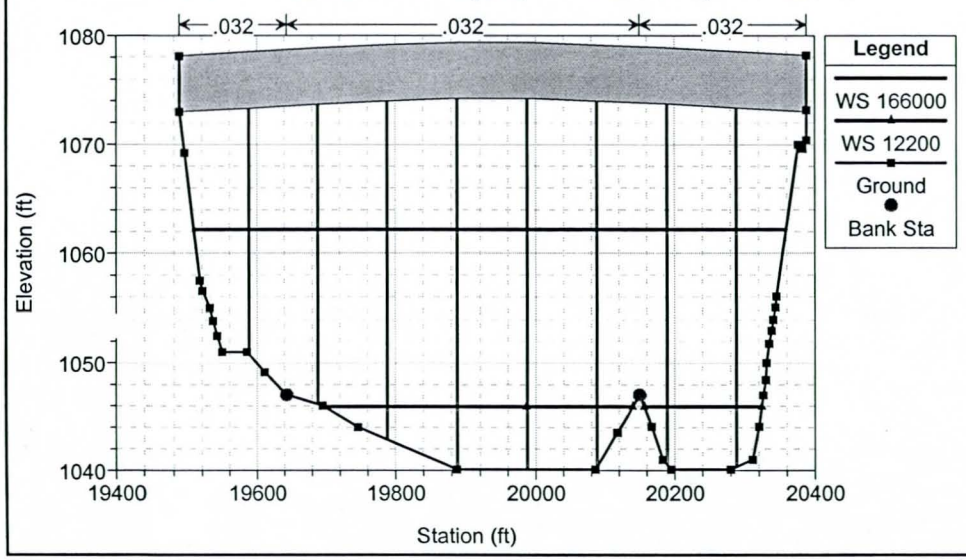
River = Rio Salado Reach = LFCD Upstream face of Central Avenue Bridge RS = 213.26



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

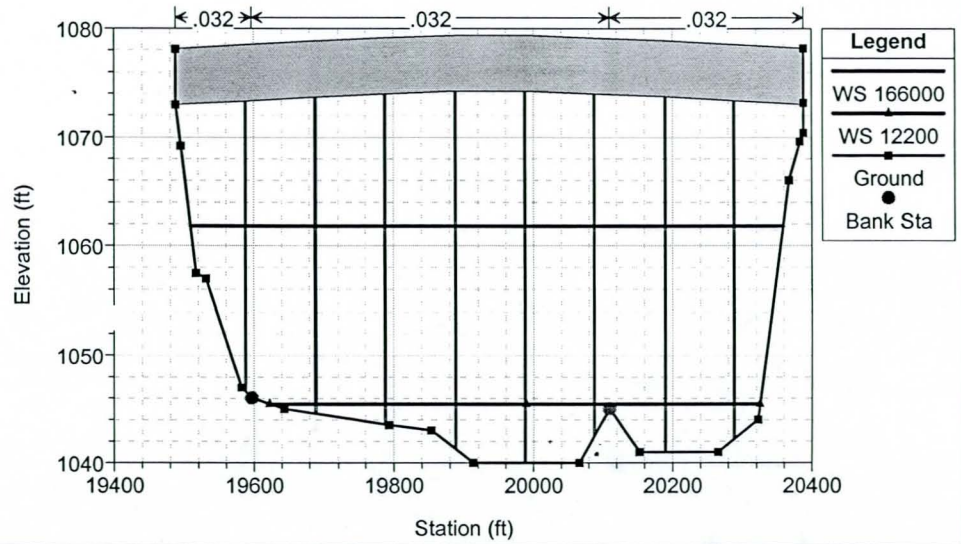
River = Rio Salado Reach = LFCD Bridge #3, Central Avenue Bridge RS = 213.255



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

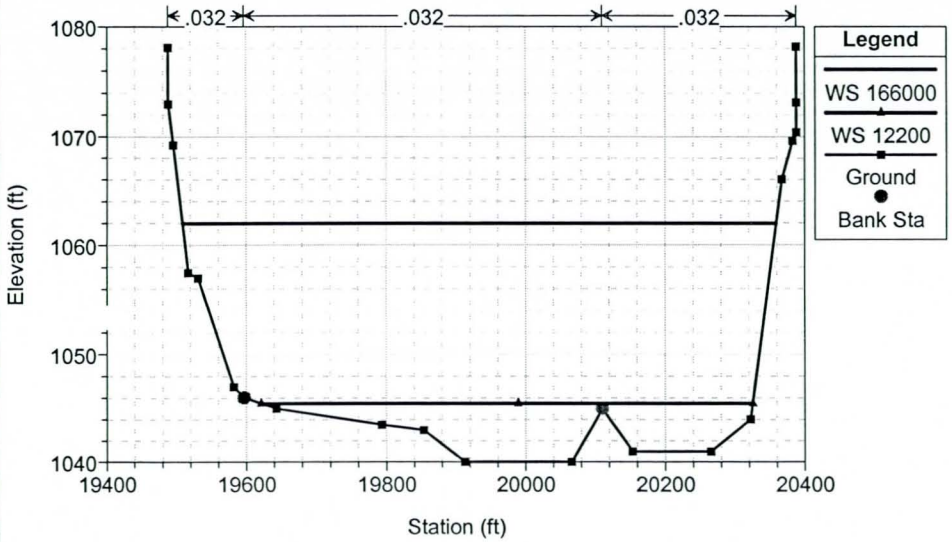
River = Rio Salado Reach = LFCD Bridge #3, Central Avenue Bridge RS = 213.255



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

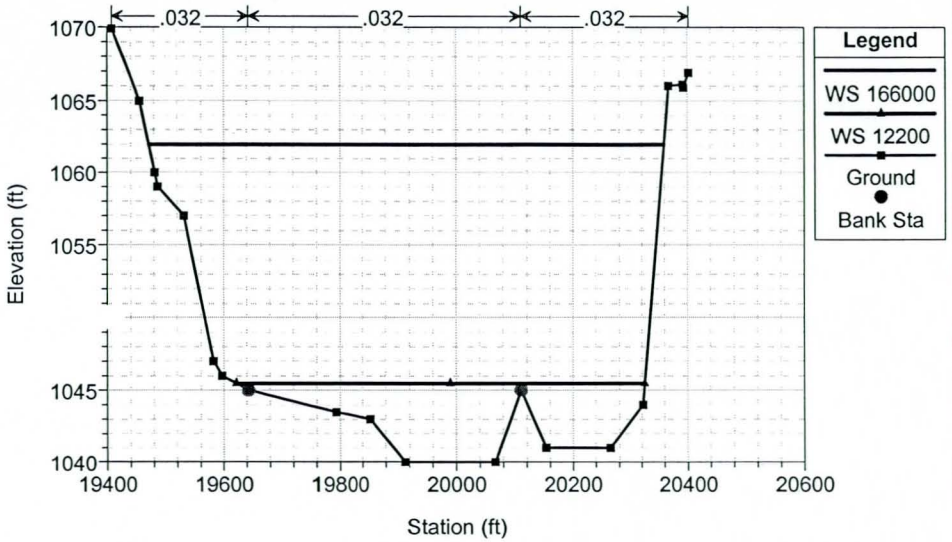
River = Rio Salado Reach = LFCD Downstream face of Central Avenue Bridge RS = 213.25



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

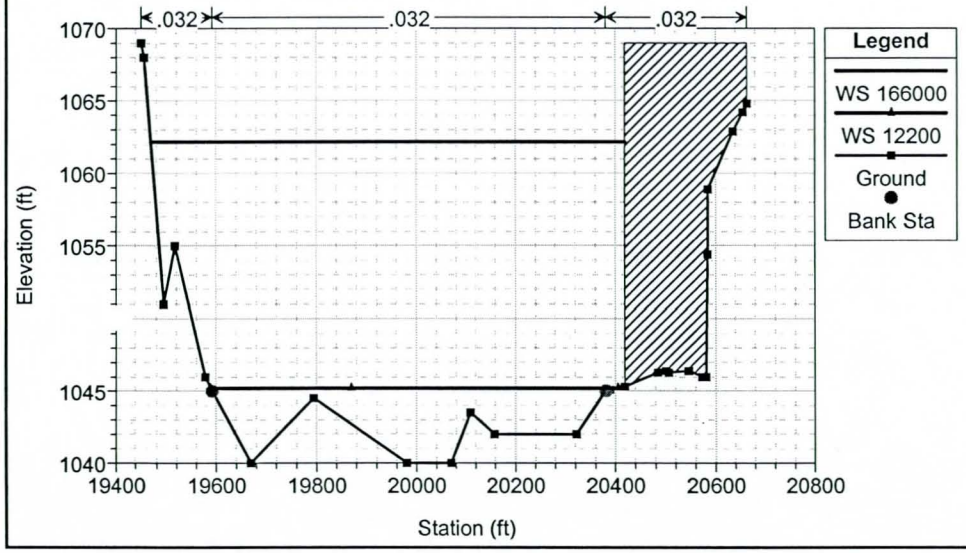
River = Rio Salado Reach = LFCD RS = 213.24



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

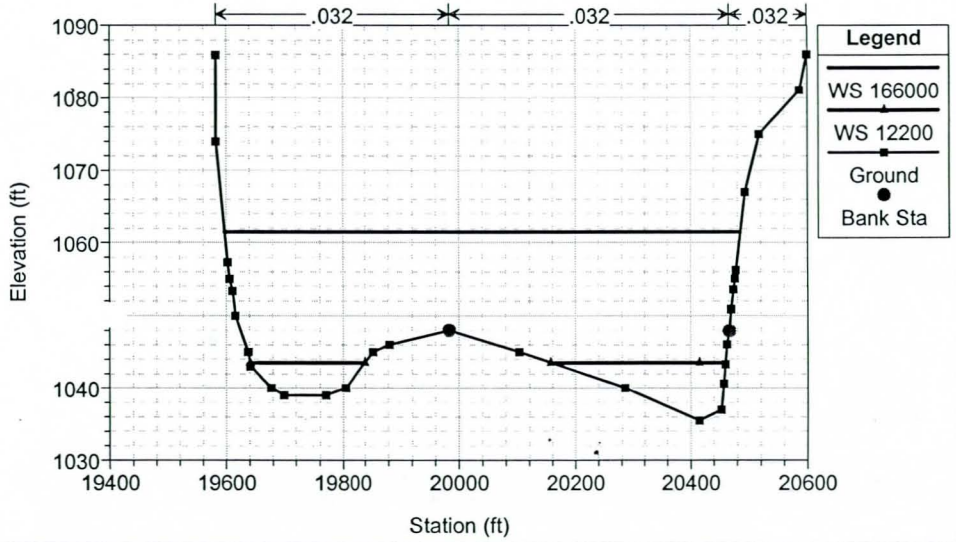
River = Rio Salado Reach = LFCD RS = 213.21



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

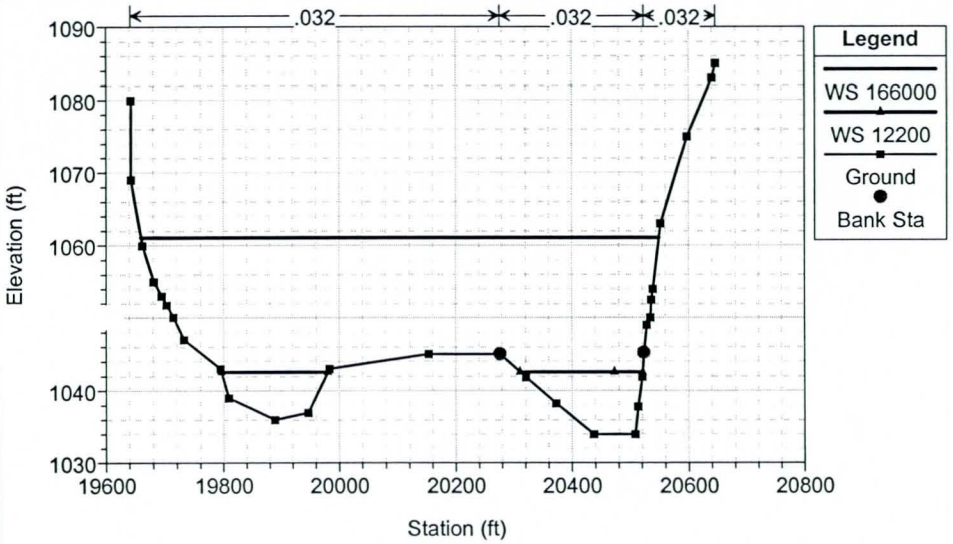
River = Rio Salado Reach = LFCD RS = 213.11



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

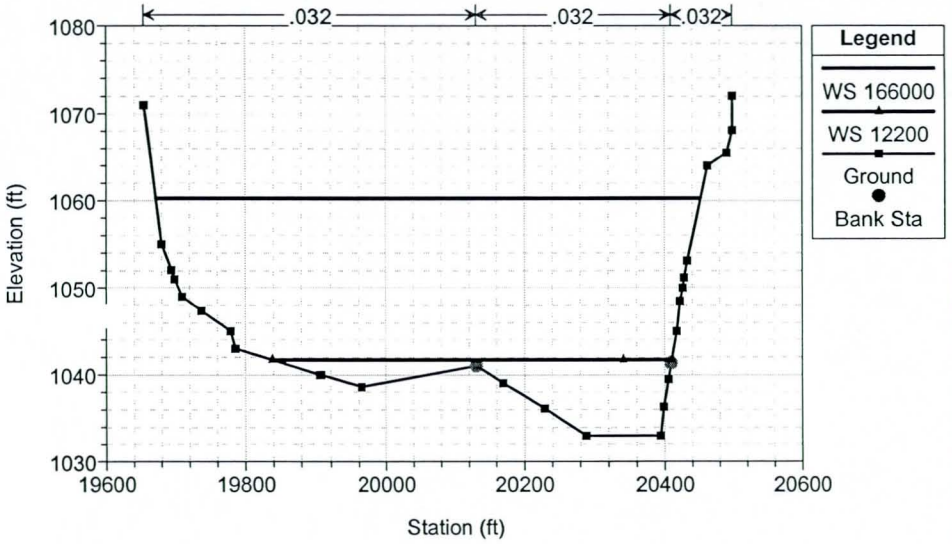
River = Rio Salado Reach = LFCD RS = 213.03



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

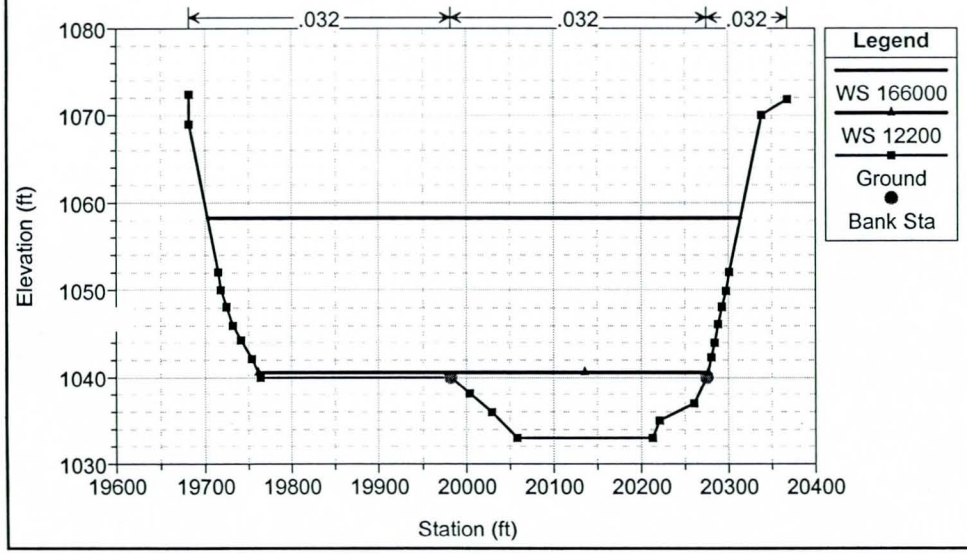
River = Rio Salado Reach = LFCD RS = 212.93



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

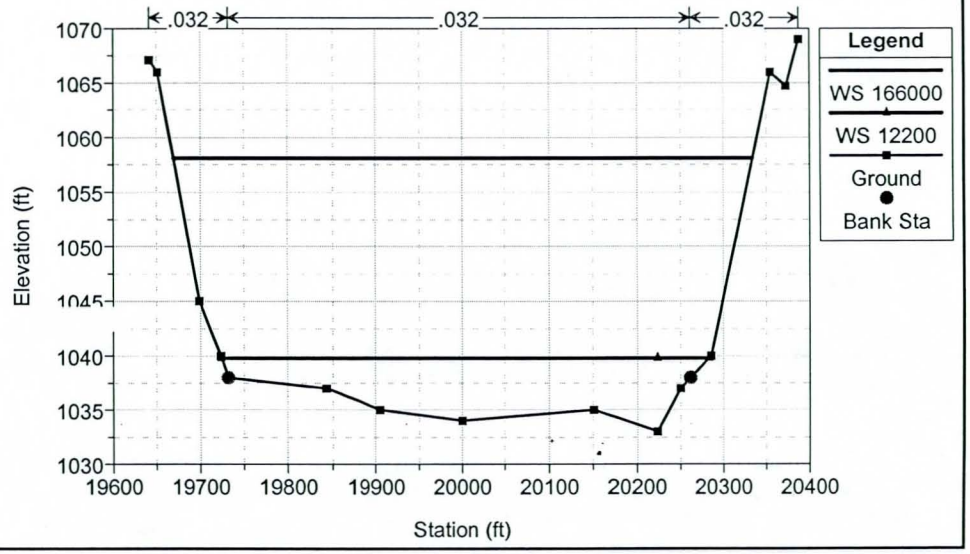
River = Rio Salado Reach = LFCD Eliminate vertical ineffective area in I RS = 212.84



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

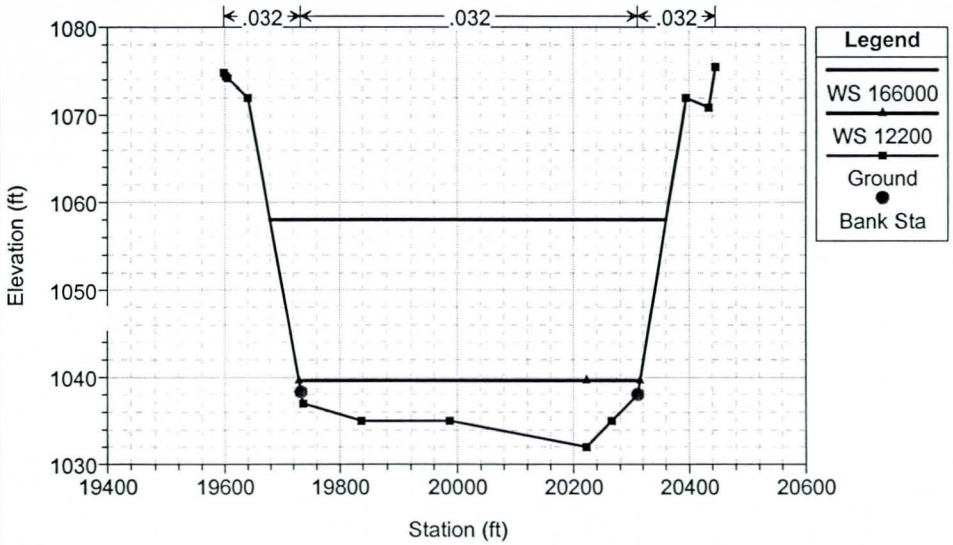
River = Rio Salado Reach = LFCD Eliminate vertical ineffective area in I RS = 212.74



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

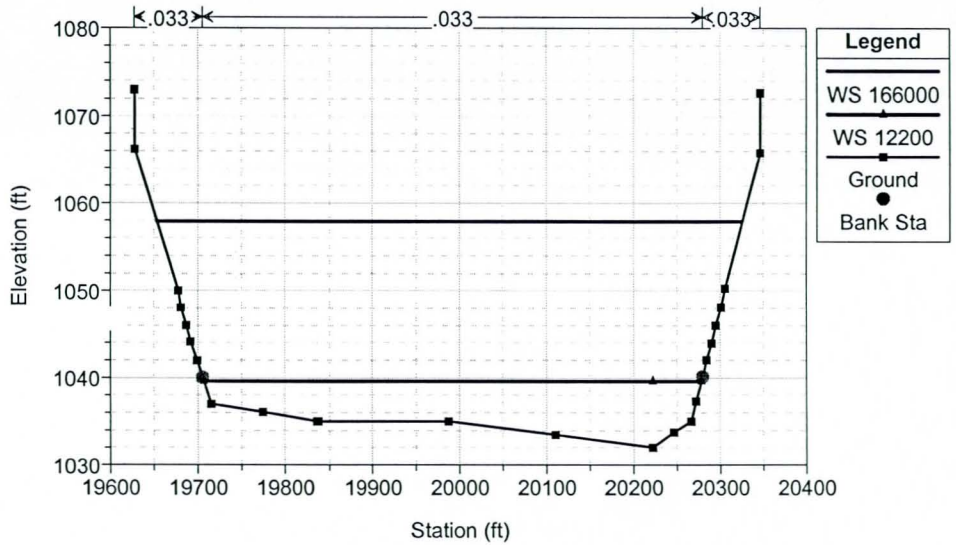
River = Rio Salado Reach = LFCD RS = 212.69



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

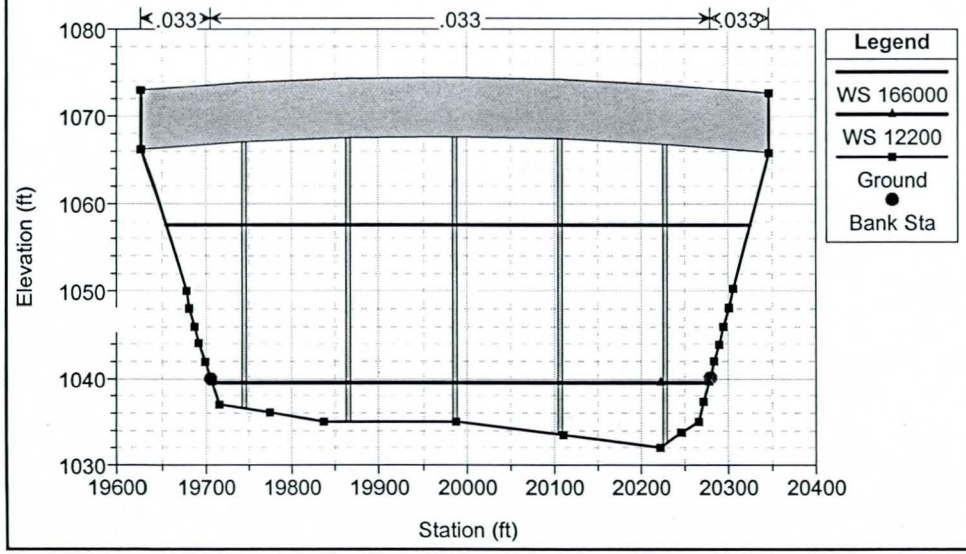
River = Rio Salado Reach = LFCD Upstream face of 7th Avenue Bridge RS = 212.68



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

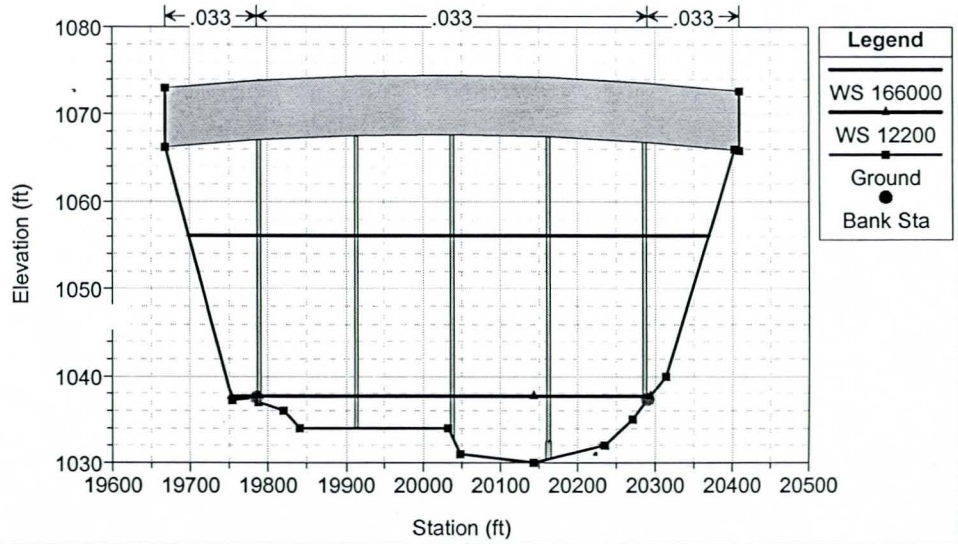
River = Rio Salado Reach = LFCD Bridge #2, 7th Avenue Bridge RS = 212.675



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

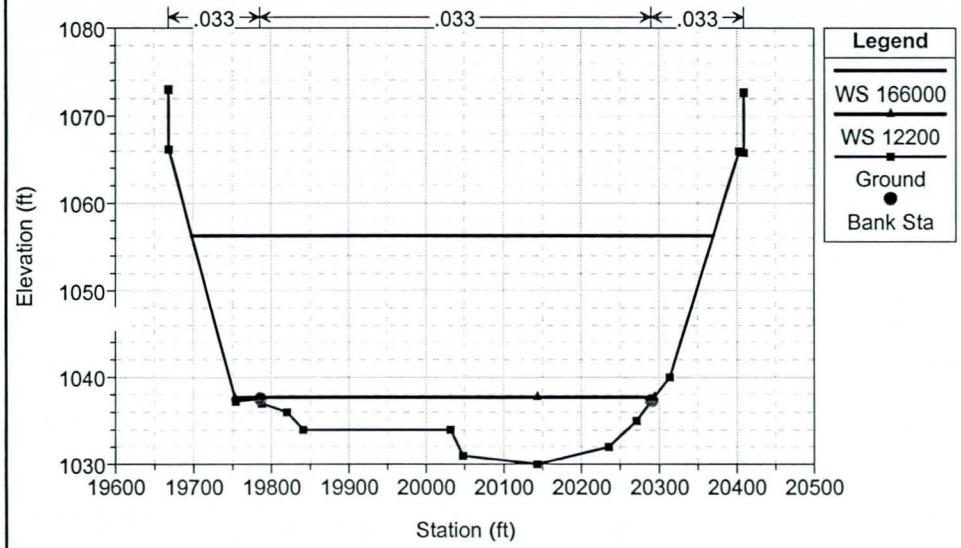
River = Rio Salado Reach = LFCD Bridge #2, 7th Avenue Bridge RS = 212.675



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

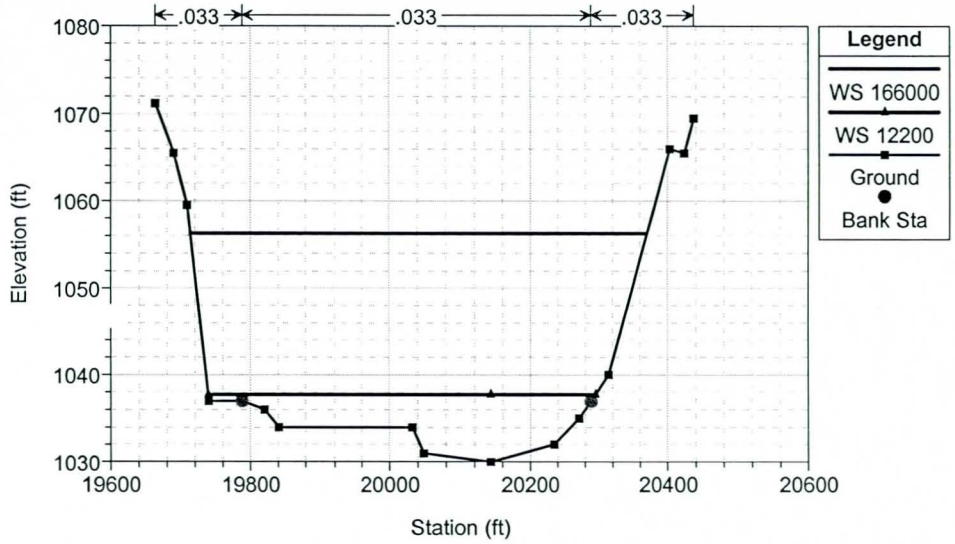
River = Rio Salado Reach = LFCD Downstream face of 7th Avenue Bridge RS = 212.67



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

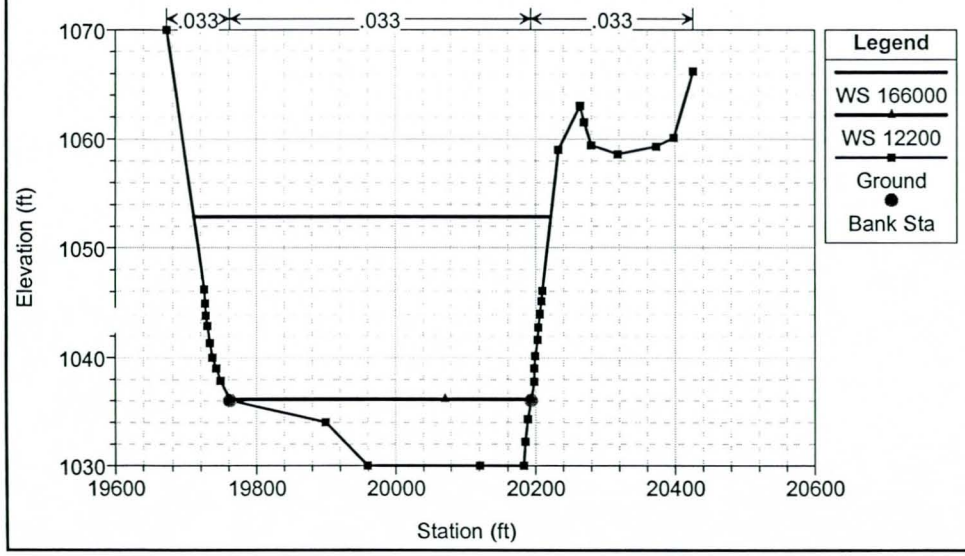
River = Rio Salado Reach = LFCD RS = 212.66



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

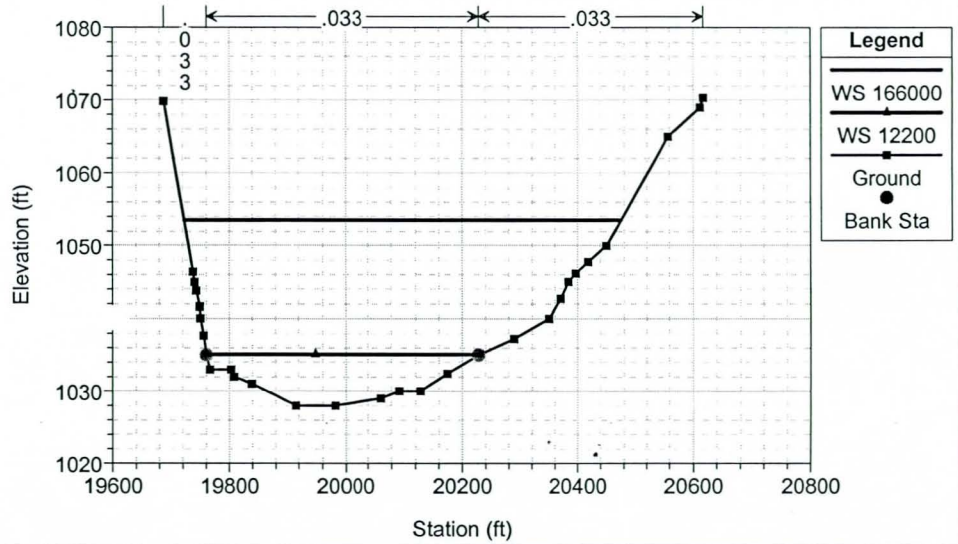
River = Rio Salado Reach = LFCD RS = 212.56



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

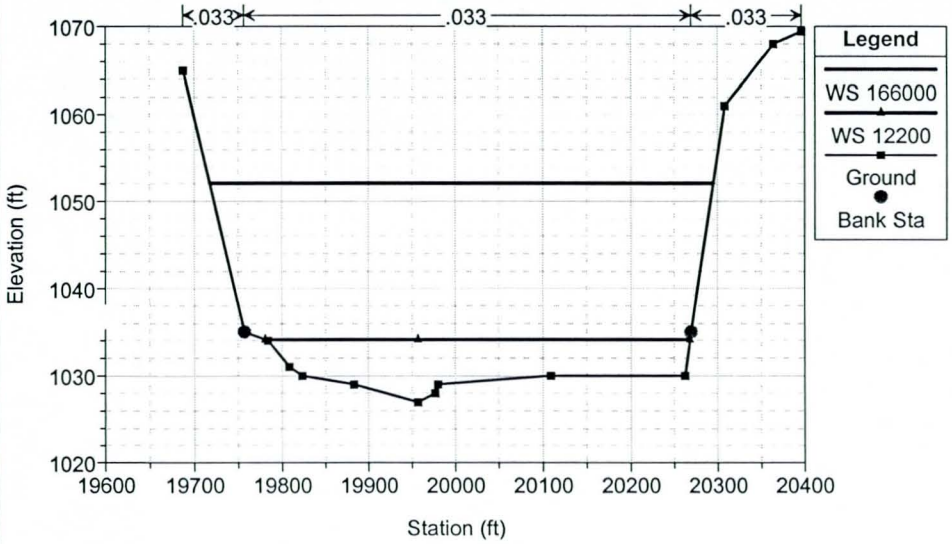
River = Rio Salado Reach = LFCD RS = 212.46



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

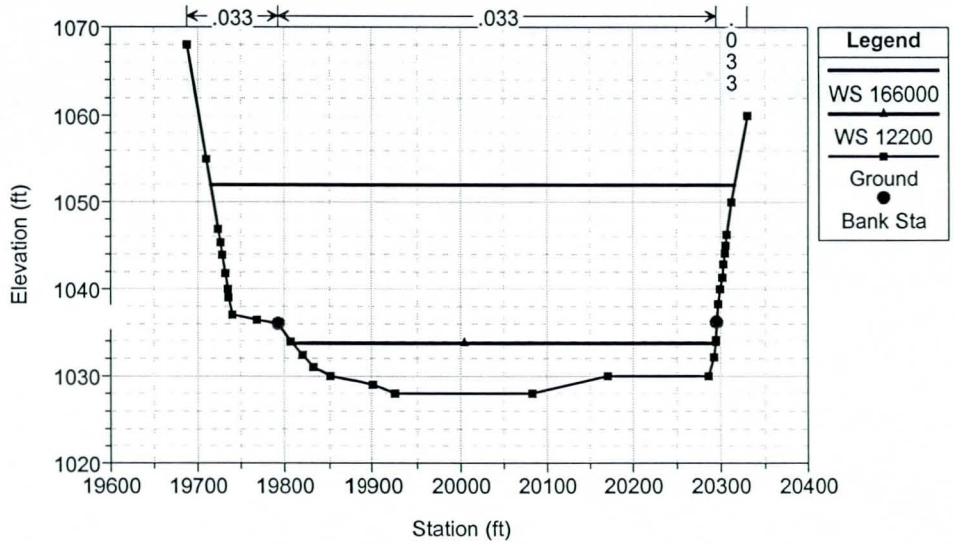
River = Rio Salado Reach = LFCD RS = 212.37



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

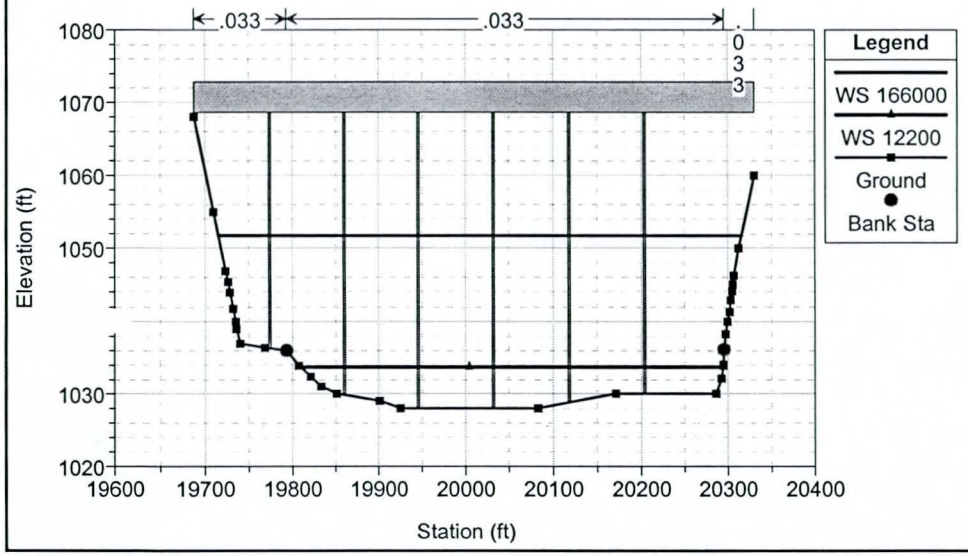
River = Rio Salado Reach = LFCD U/S Face of Conveyor Bridge RS = 212.345



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

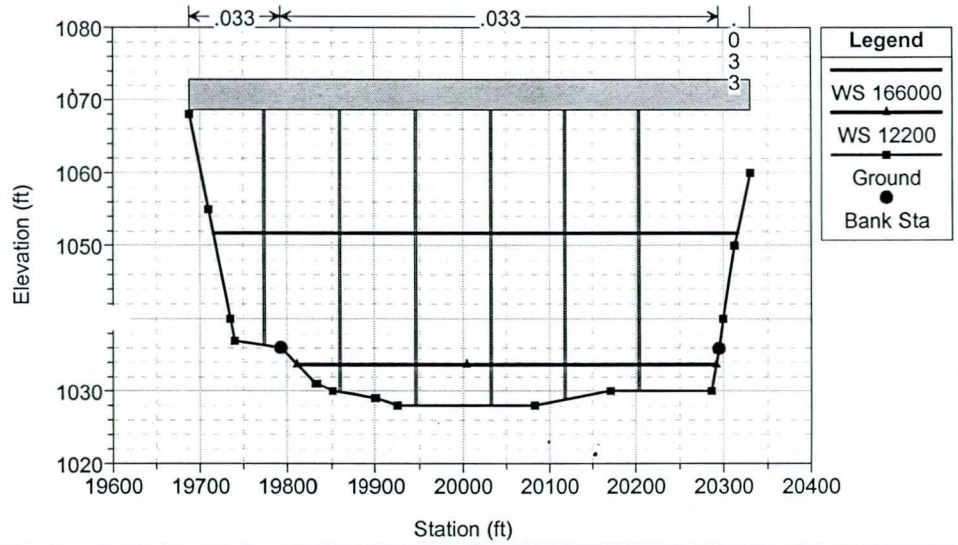
River = Rio Salado Reach = LFCD Union Rock Conveyor Bridge. Details per RS = 212.34



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

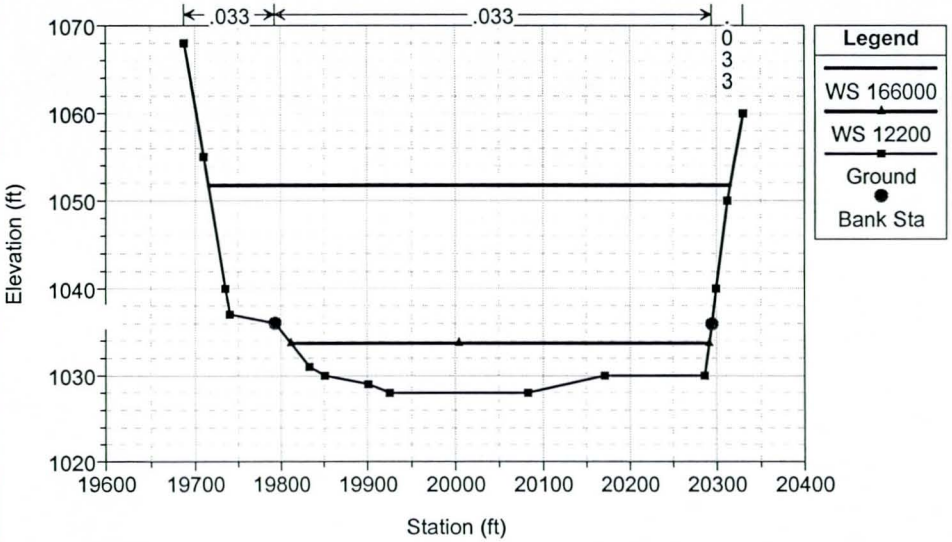
River = Rio Salado Reach = LFCD Union Rock Conveyor Bridge. Details per RS = 212.34



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

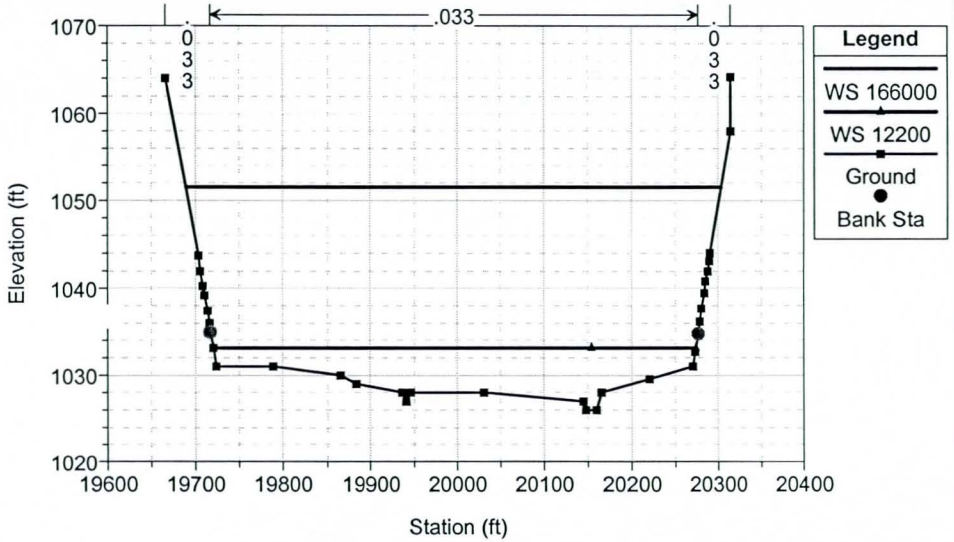
River = Rio Salado Reach = LFCD D/S Face of Conveyor Bridge RS = 212.335



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

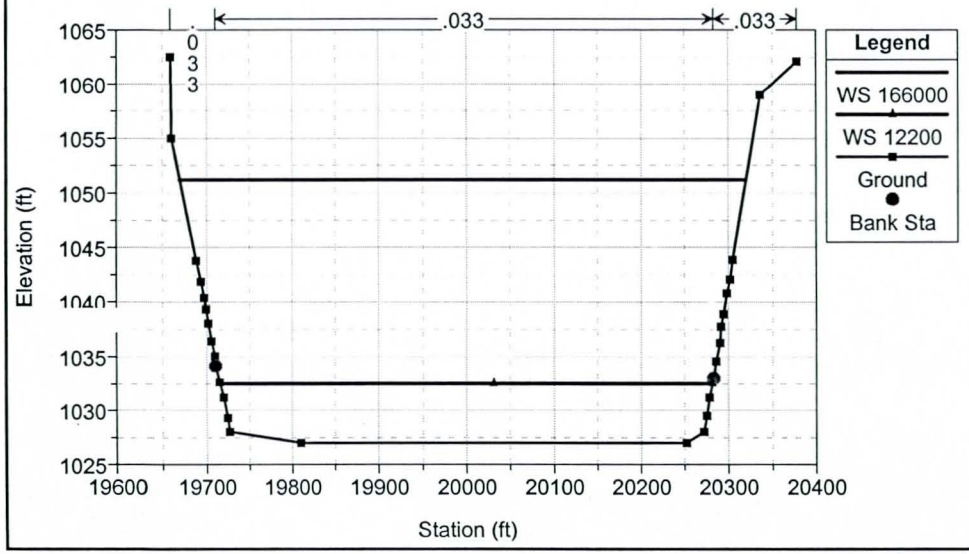
River = Rio Salado Reach = LFCD RS = 212.27



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

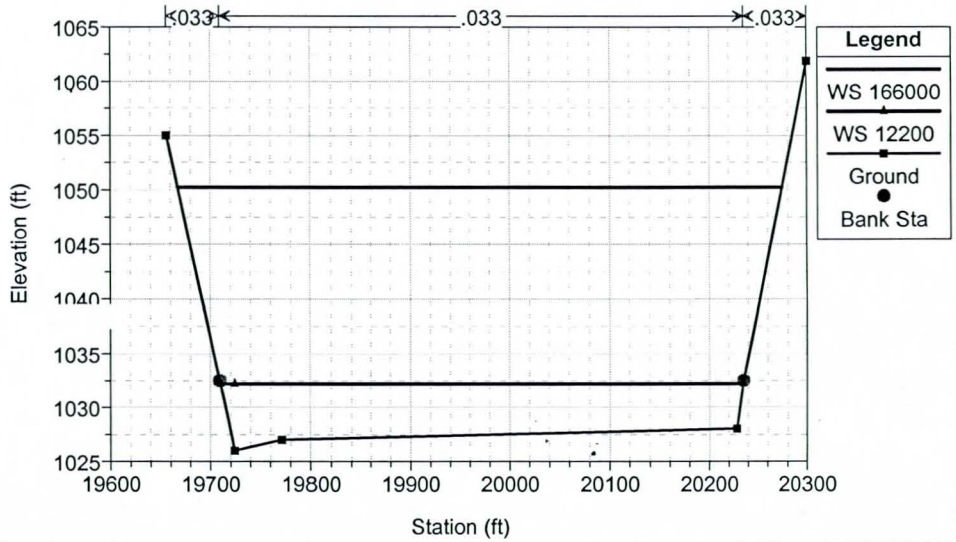
River = Rio Salado Reach = LFCD Edited Copy of 212.12 to reflect LOMR R. RS = 212.16



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

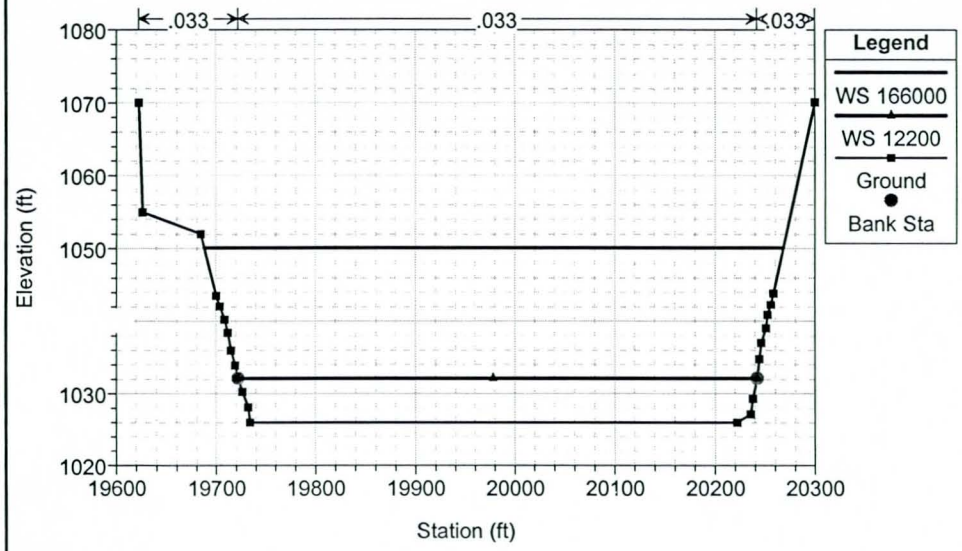
River = Rio Salado Reach = LFCD Edited Copy of 212.12 to reflect LOMR R. RS = 212.15



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

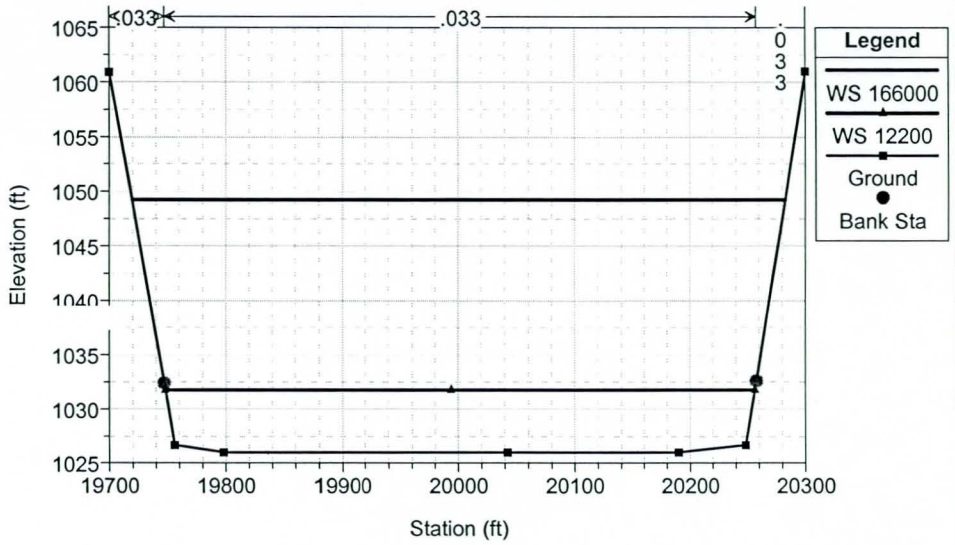
River = Rio Salado Reach = LFCD Edited to reflect LOMR R Bank Protection RS = 212.12



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

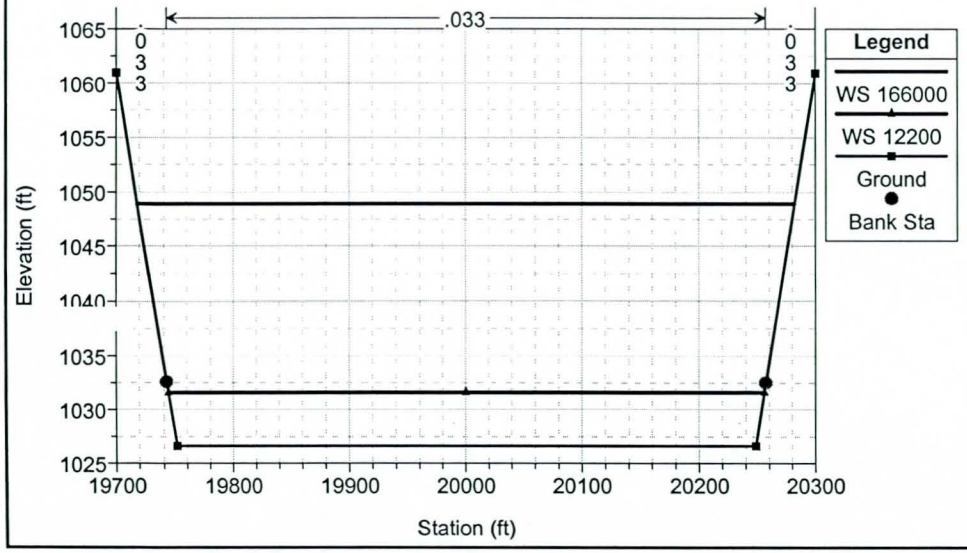
River = Rio Salado Reach = LFCD Edited Copy of 211.98. Location is 70' RS = 212.1



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

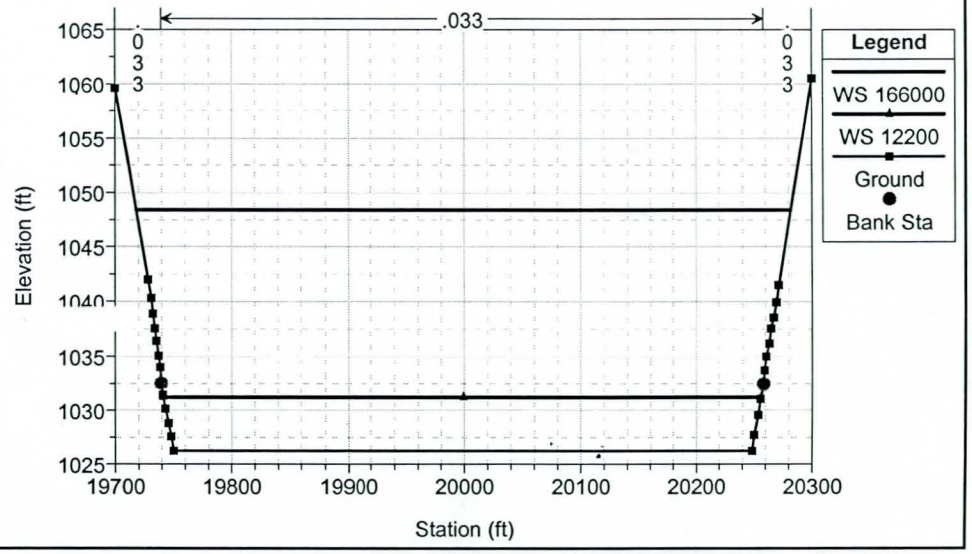
River = Rio Salado Reach = LFCD Edited Copy of 211.98. Location of Left RS = 212



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

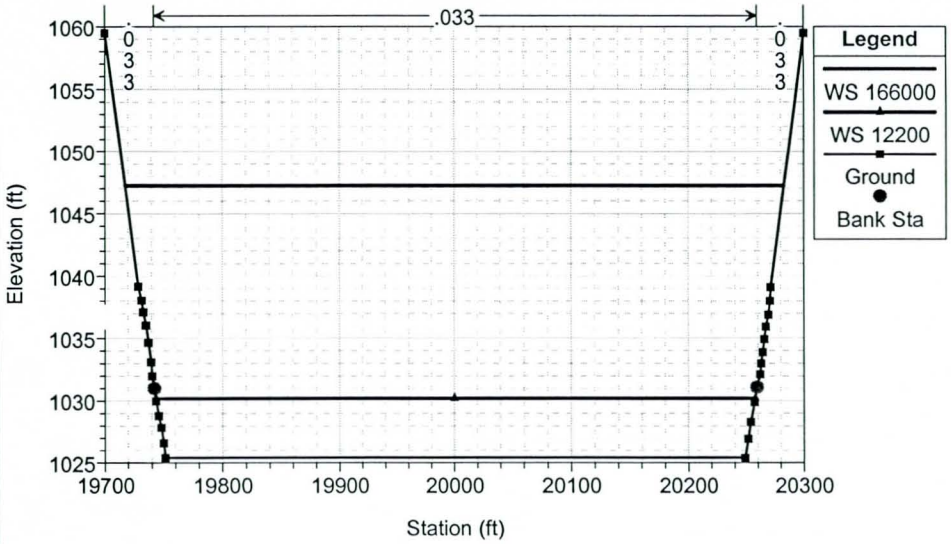
River = Rio Salado Reach = LFCD Edited to reflect LOMR Bank Protection RS = 211.98



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

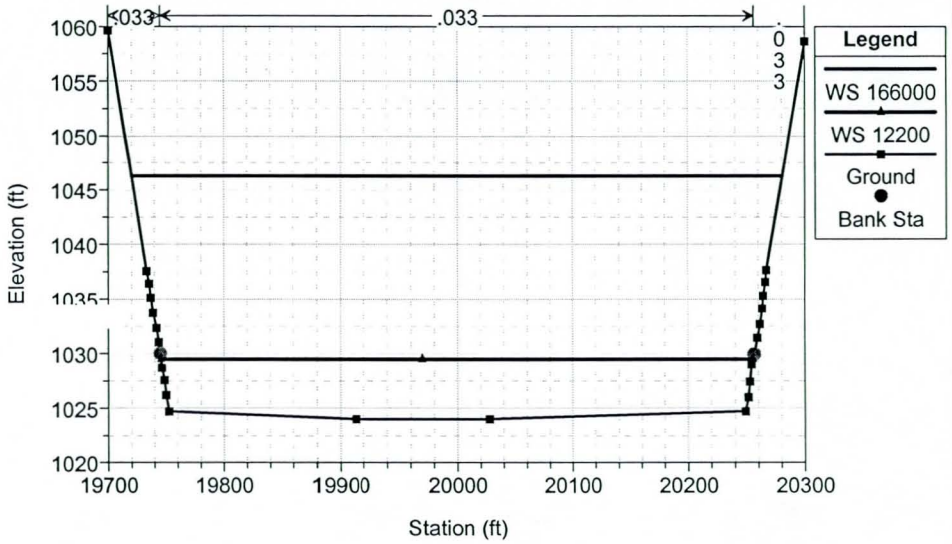
River = Rio Salado Reach = LFCD Edited to reflect LOMR Bank Protection RS = 211.86



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

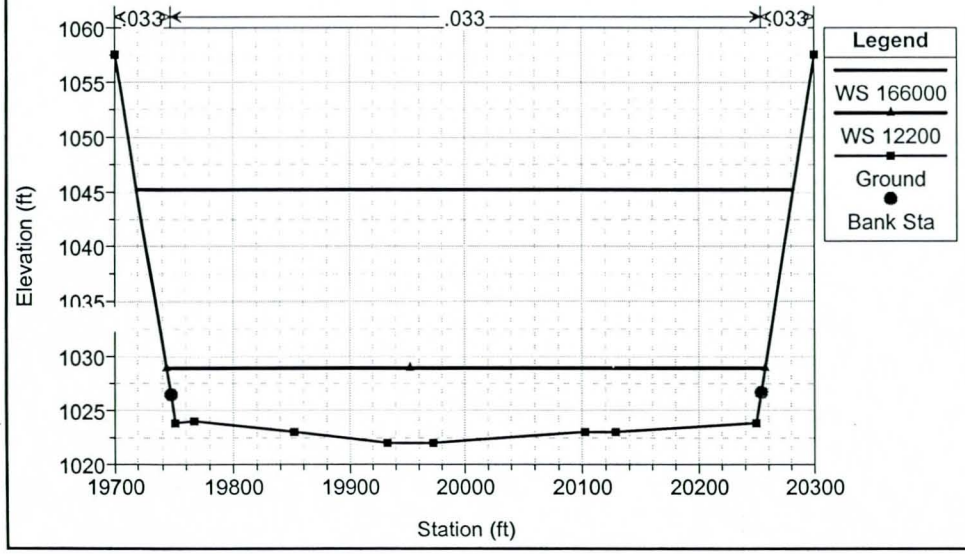
River = Rio Salado Reach = LFCD Edited to reflect LOMR Bank Protection RS = 211.76



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

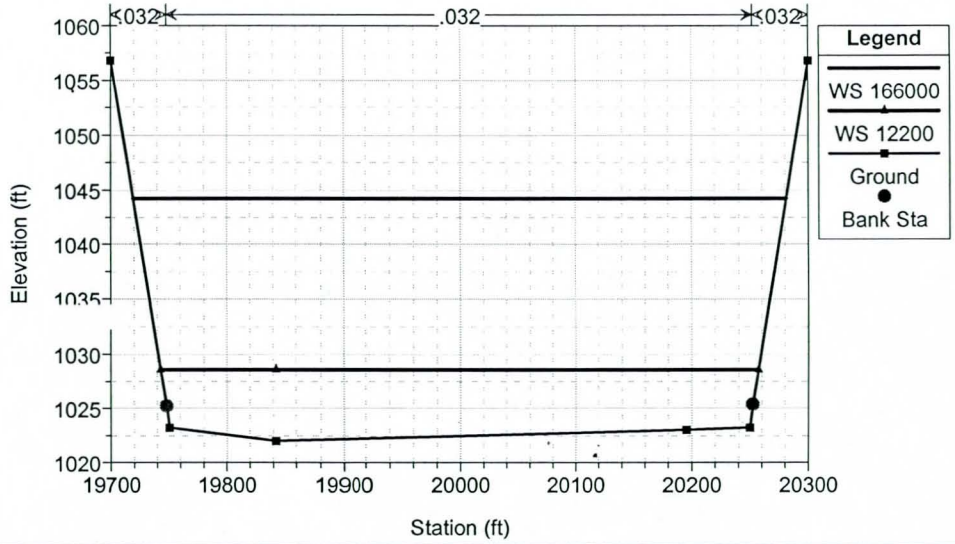
River = Rio Salado Reach = LFCD X-sec Data Taken from SLA's 19th Ave Lan RS = 211.63



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

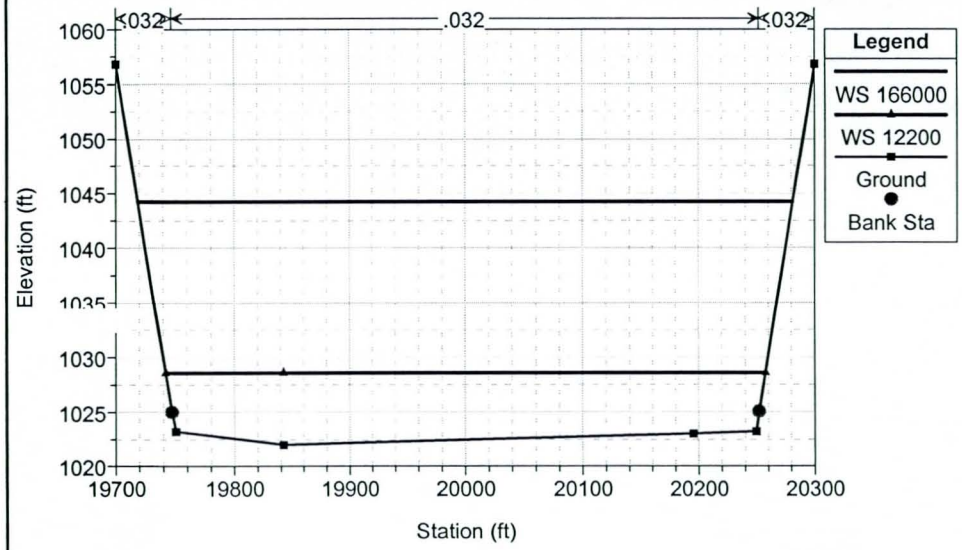
River = Rio Salado Reach = LFCD Edited to reflect LOMR Bank Protection RS = 211.54



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

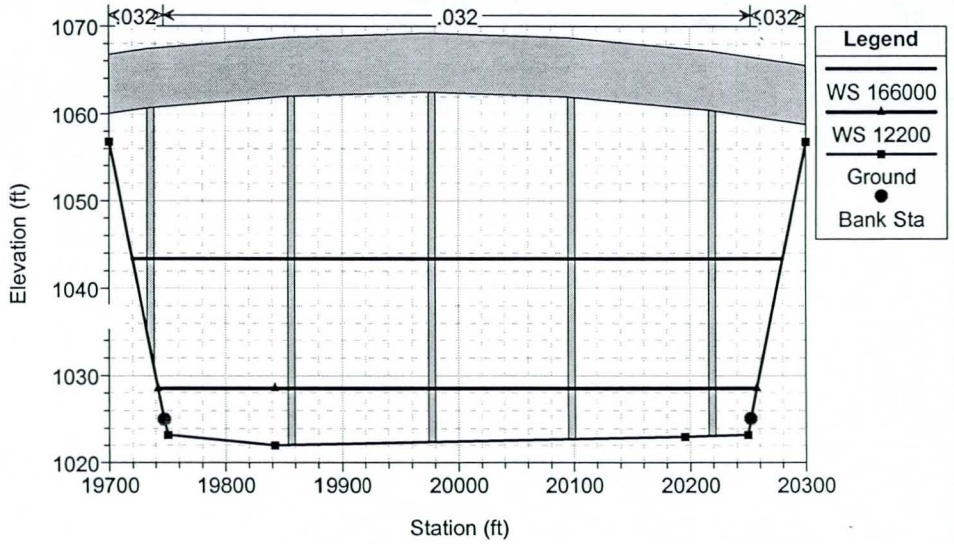
River = Rio Salado Reach = LFCD Upstream face of 19th Avenue Bridge RS = 211.53



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

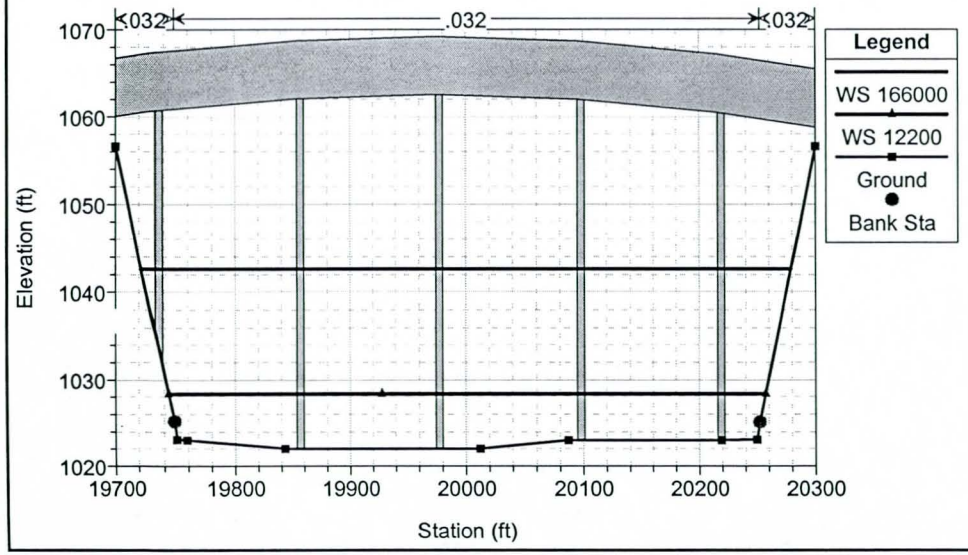
River = Rio Salado Reach = LFCD Bridge #1, 19th Avenue Bridge RS = 211.525



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

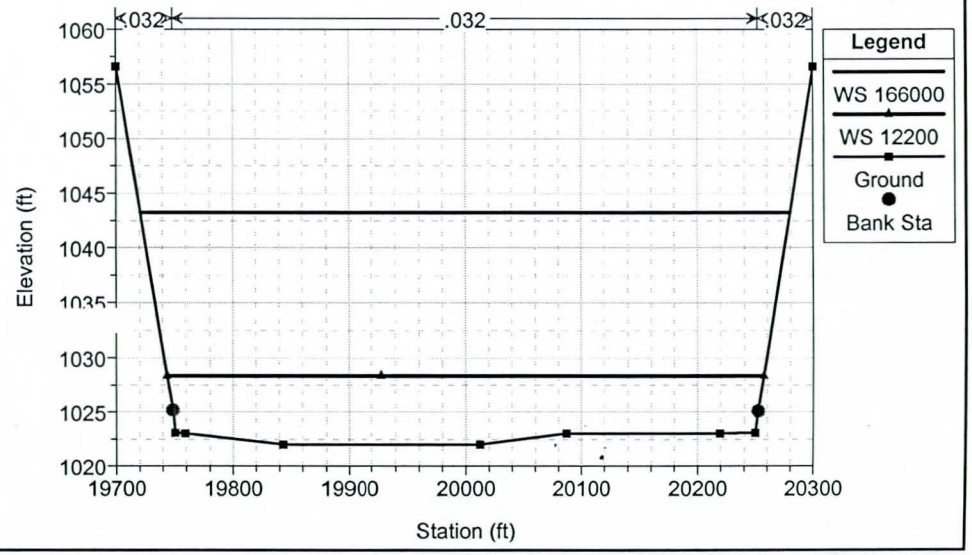
River = Rio Salado Reach = LFCD Bridge #1, 19th Avenue Bridge RS = 211.525



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

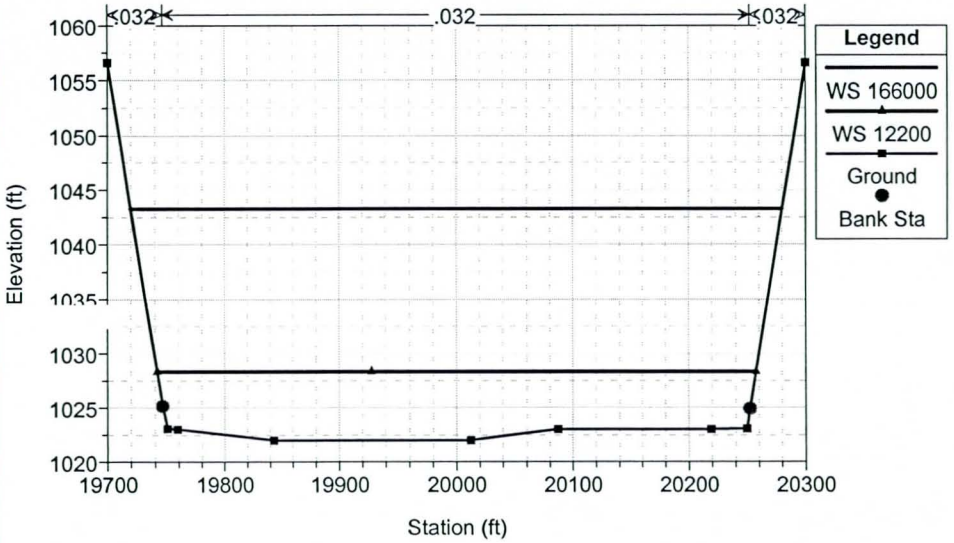
River = Rio Salado Reach = LFCD Downstream face of 19th Avenue Bridge RS = 211.52



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

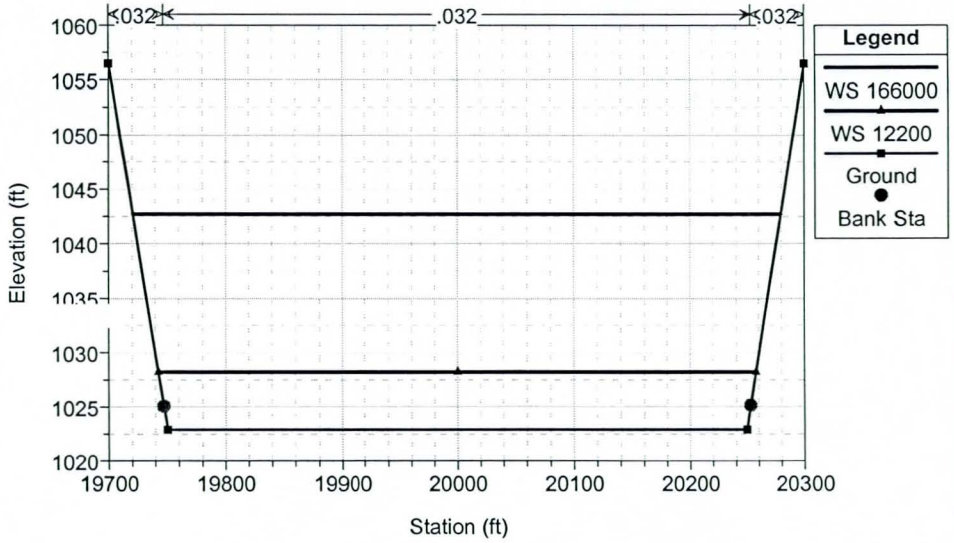
River = Rio Salado Reach = LFCD Edited to reflect LOMR Bank Protection RS = 211.51



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

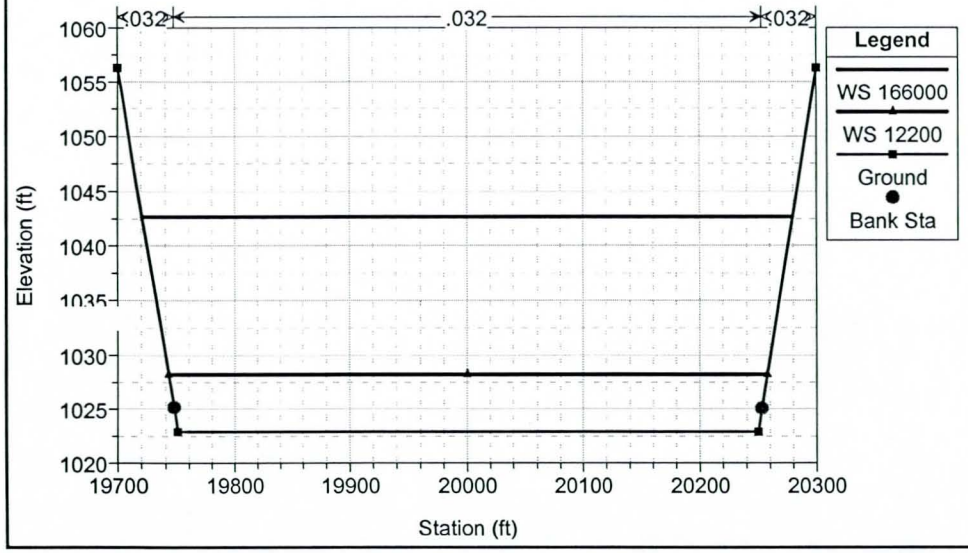
River = Rio Salado Reach = LFCD Edited copy of 211.51 to reflect LOMR Ba RS = 211.50



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

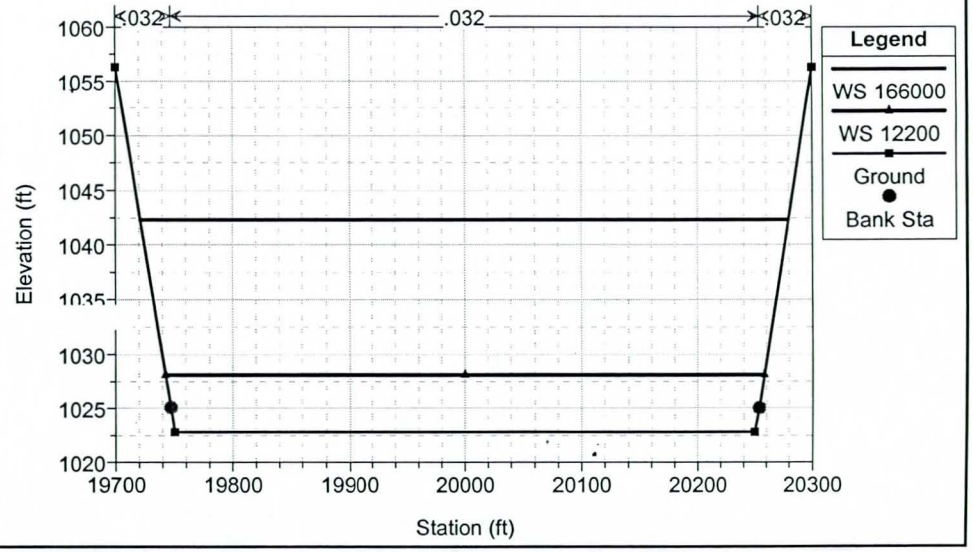
River = Rio Salado Reach = LFCD Edited copy of 211.51 to reflect LOMR Ba RS = 211.49



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

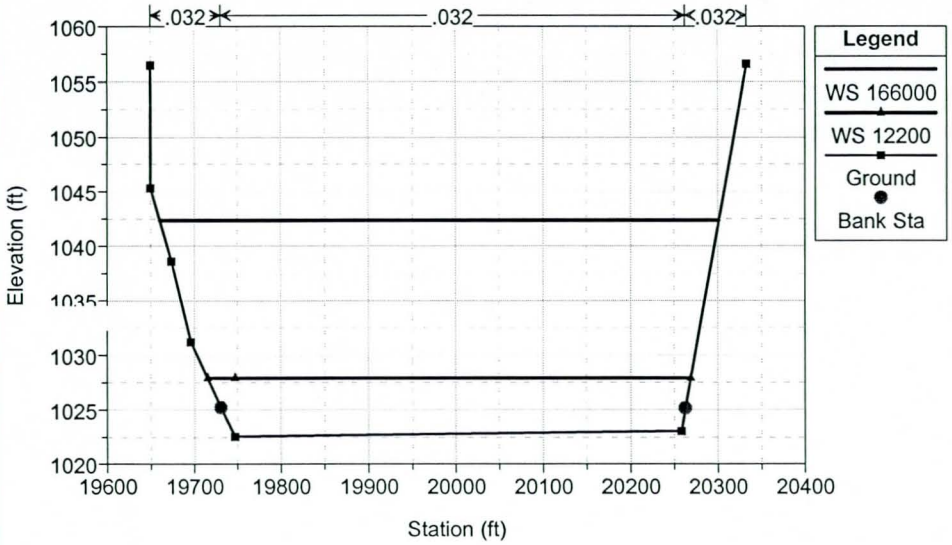
River = Rio Salado Reach = LFCD Edited copy of 211.51 to reflect LOMR Ba RS = 211.47



Salt River Low Flow Channel Design Base w/Adj. Banks 6/17/99 4:51:20 PM

Geom: Base Condition w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

River = Rio Salado Reach = LFCD Edited copy of 211.41 (From Salt_ex.prj) RS = 211.44



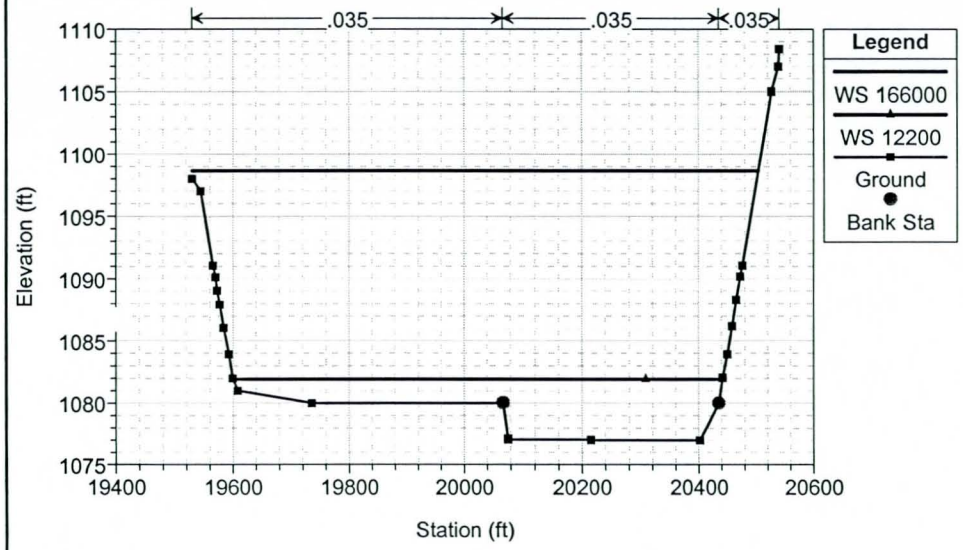
APPENDIX 3

CROSS SECTION PLOTS FOR PROPOSED CONDITIONS

Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

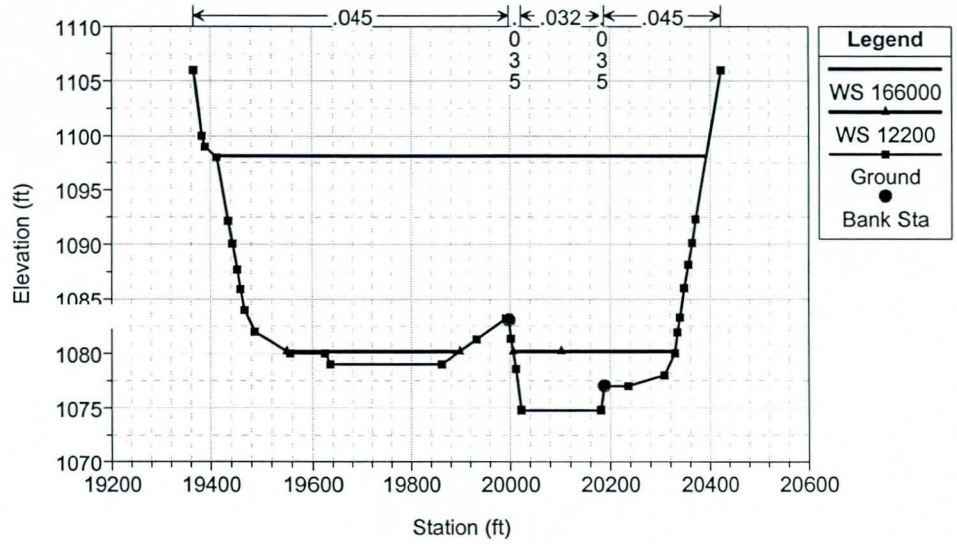
River = Rio Salado Reach = LFCD Downstream sill of grade control structu RS = 216.40



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

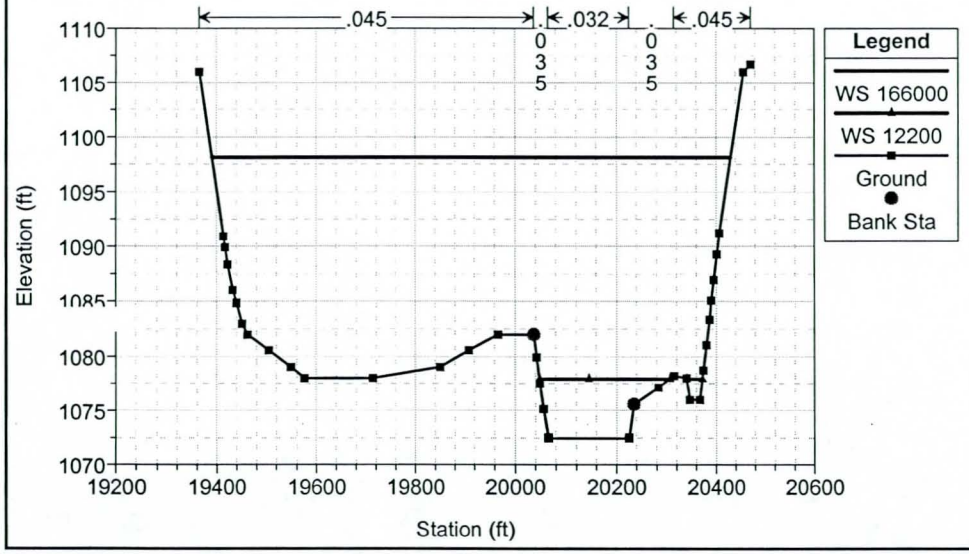
River = Rio Salado Reach = LFCD RS = 216.38



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

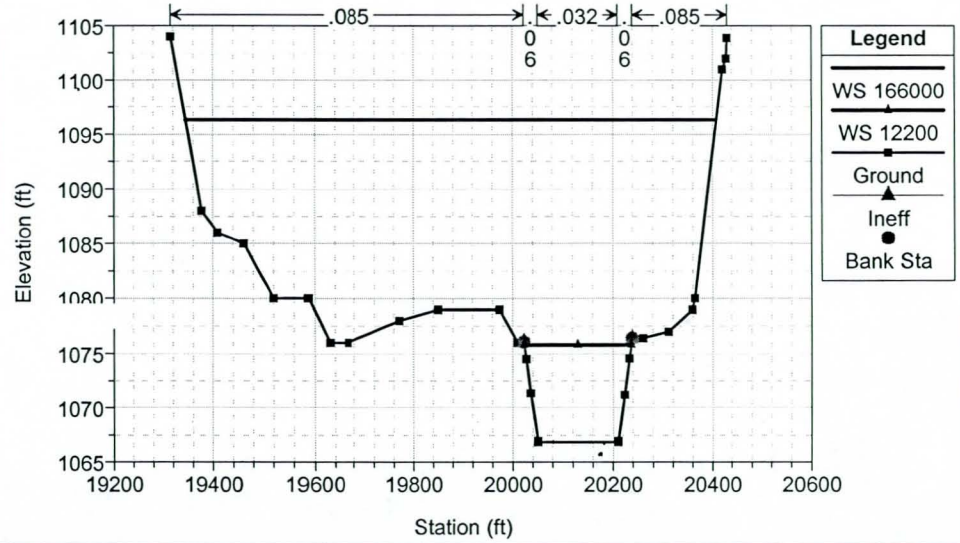
River = Rio Salado Reach = LFCD RS = 216.33



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

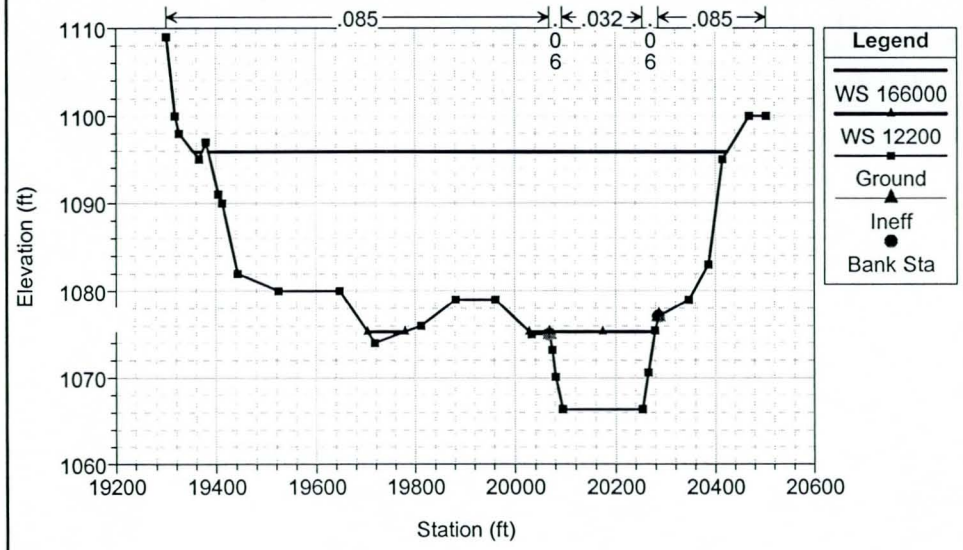
River = Rio Salado Reach = LFCD Beginning of LFC. Proposed Grade Contro RS = 216.23



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

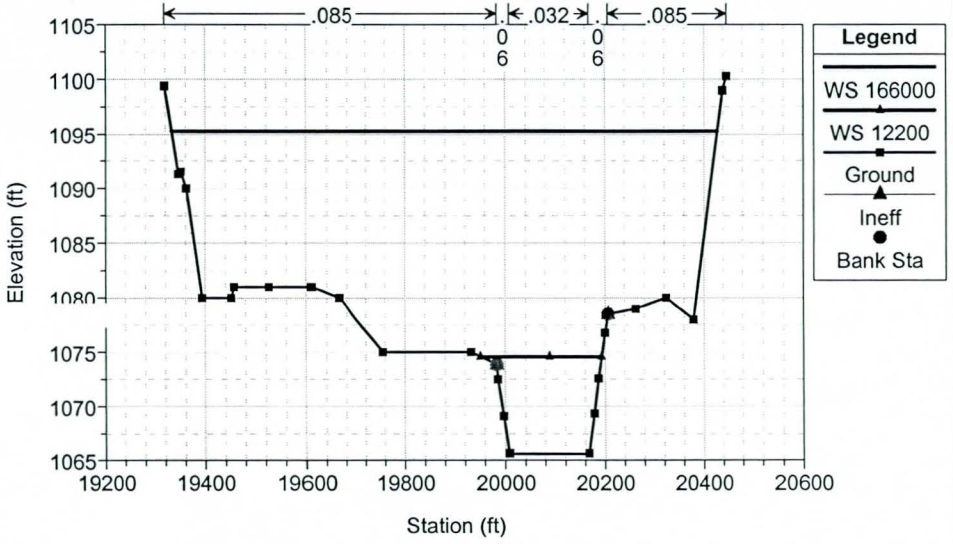
River = Rio Salado Reach = LFCD Down stream of proposed lfc grade contro RS = 216.19



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

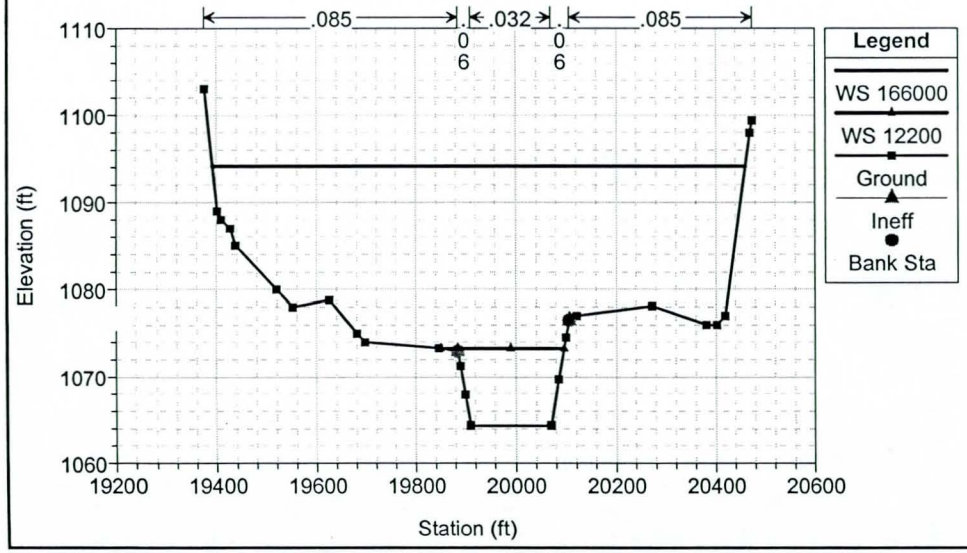
River = Rio Salado Reach = LFCD RS = 216.13



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

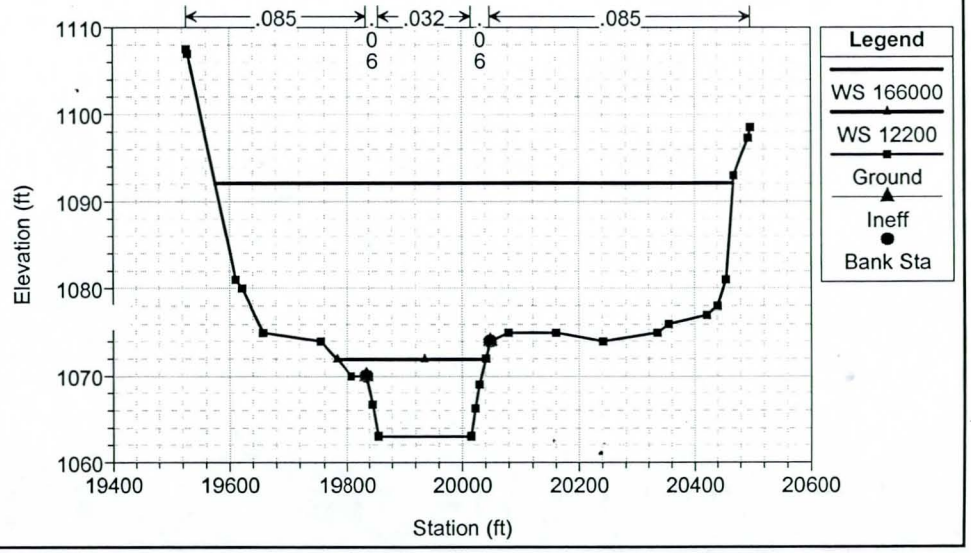
River = Rio Salado Reach = LFCD RS = 216.04



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

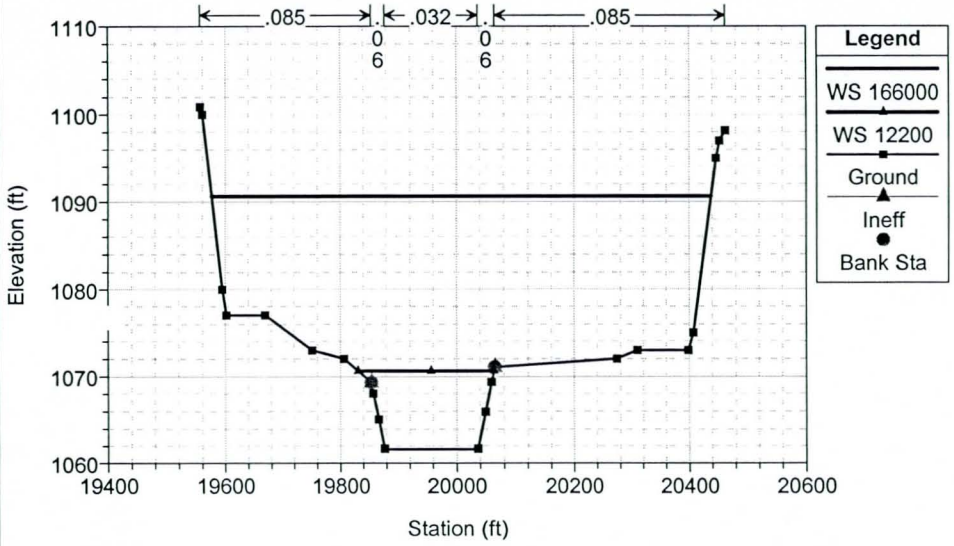
River = Rio Salado Reach = LFCD RS = 215.94



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

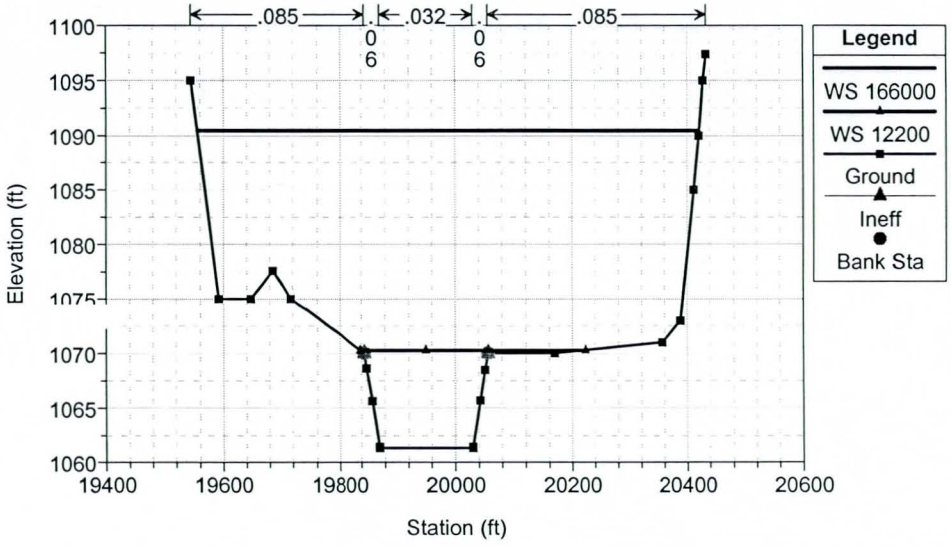
River = Rio Salado Reach = LFCD RS = 215.84



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

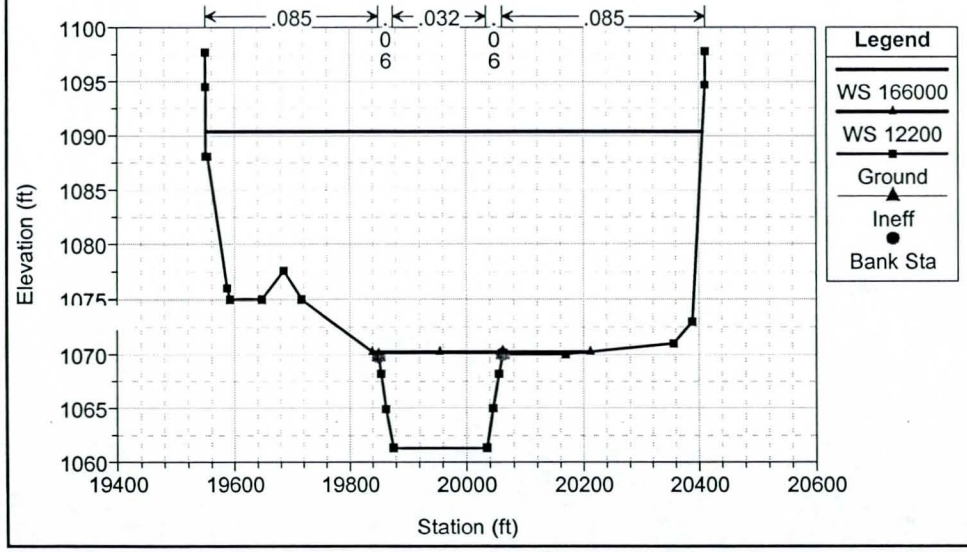
River = Rio Salado Reach = LFCD RS = 215.83



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

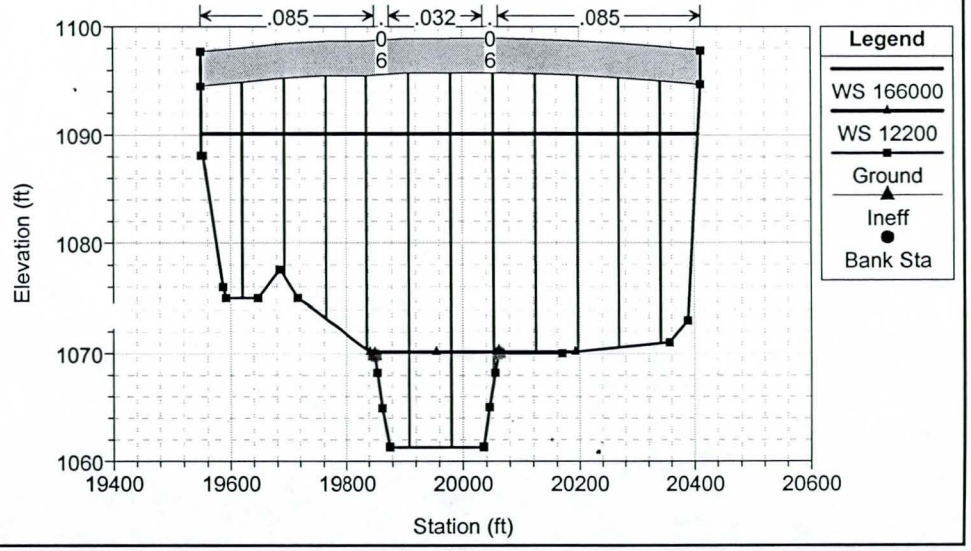
River = Rio Salado Reach = LFCD Upstream face of 24th Street Bridge RS = 215.82



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

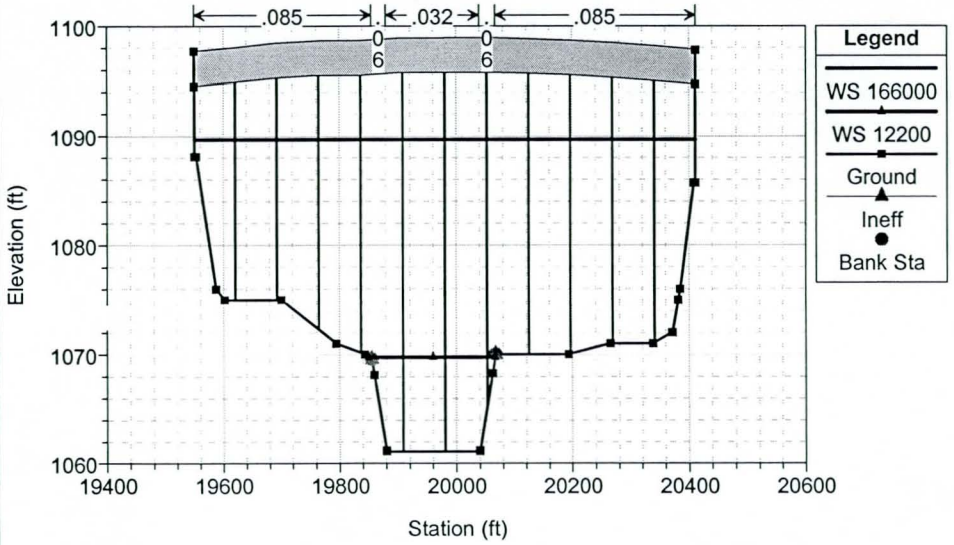
River = Rio Salado Reach = LFCD Bridge #6, 24th Street Bridge RS = 215.815



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

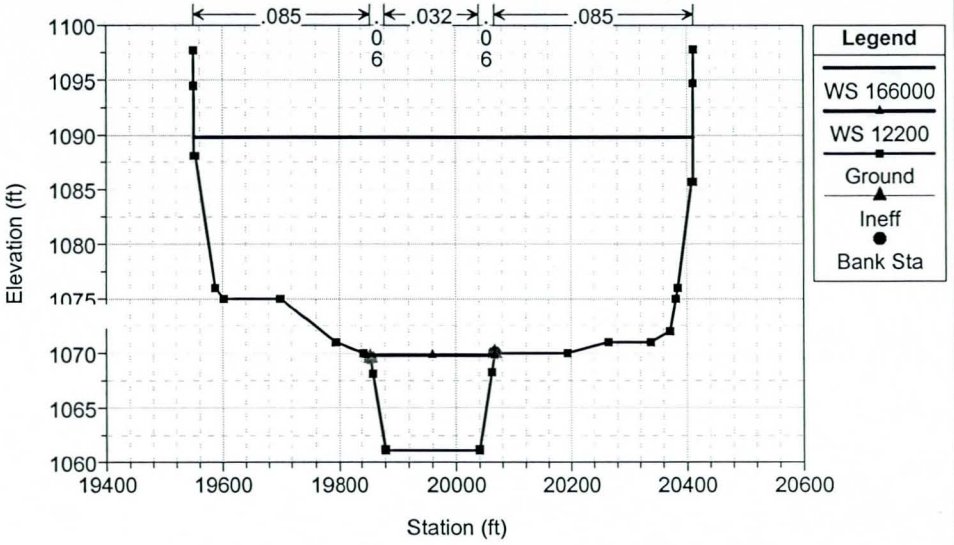
River = Rio Salado Reach = LFCD Bridge #6, 24th Street Bridge RS = 215.815



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

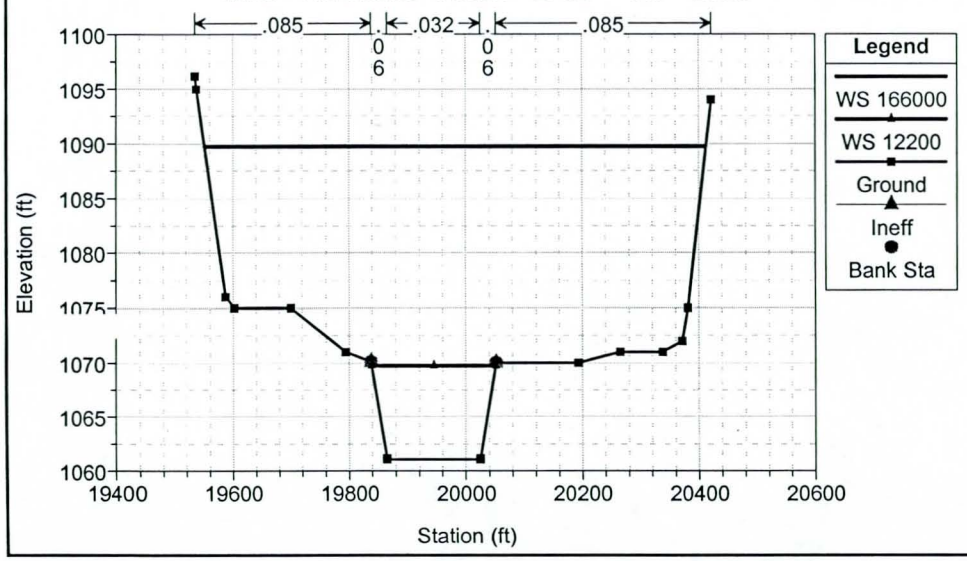
River = Rio Salado Reach = LFCD Downstream face of 24th Street Bridge RS = 215.81



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

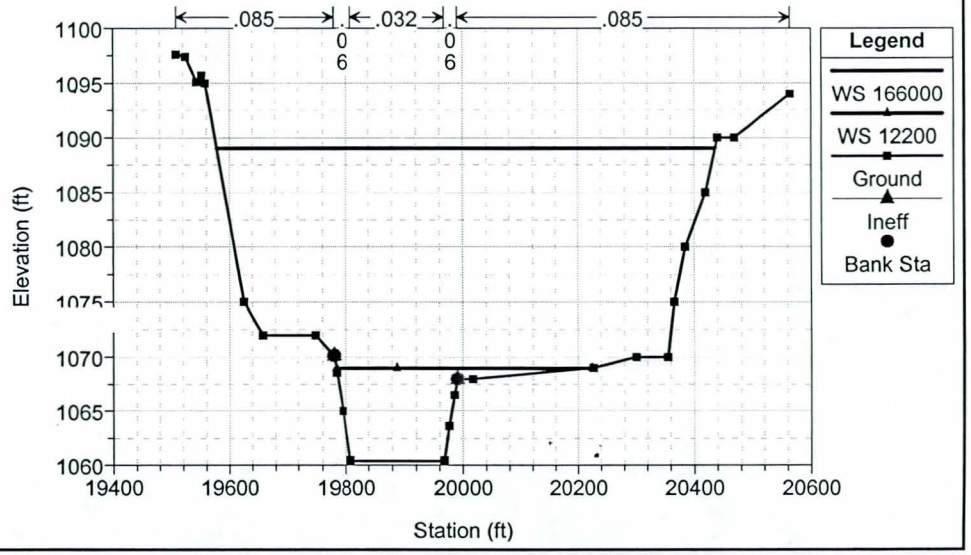
River = Rio Salado Reach = LFCD RS = 215.8



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

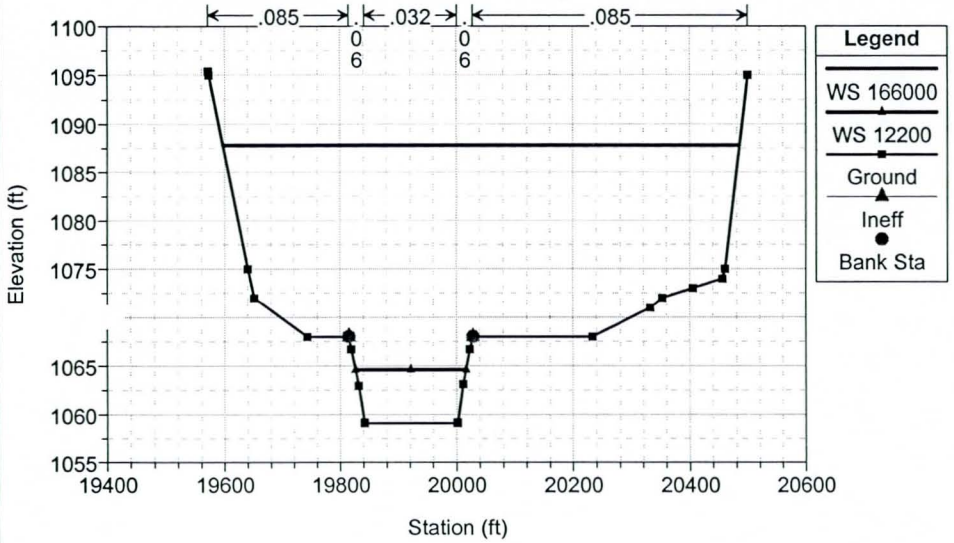
River = Rio Salado Reach = LFCD Upstream of proposed grade control. RS = 215.75



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

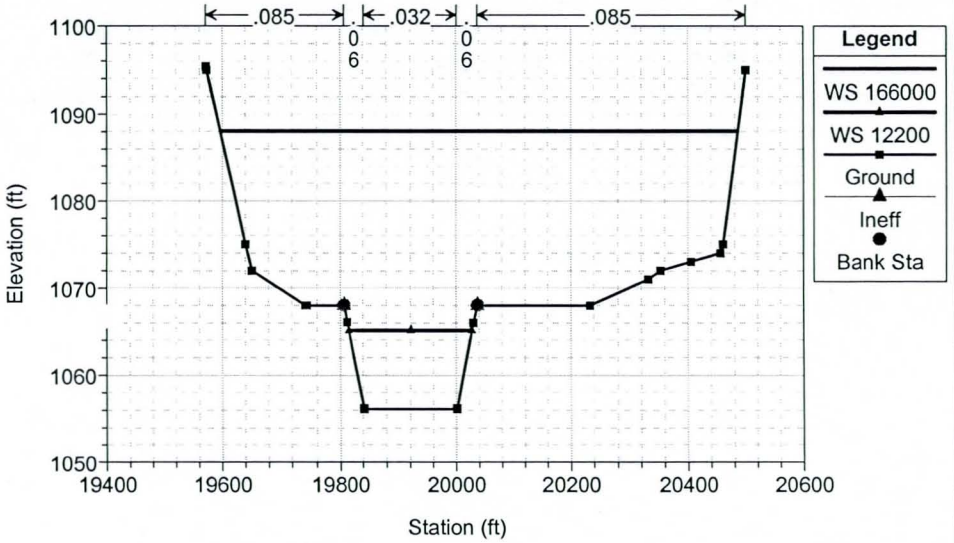
River = Rio Salado Reach = LFCD Top of Proposed Grade Control Structure. RS = 215.651



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

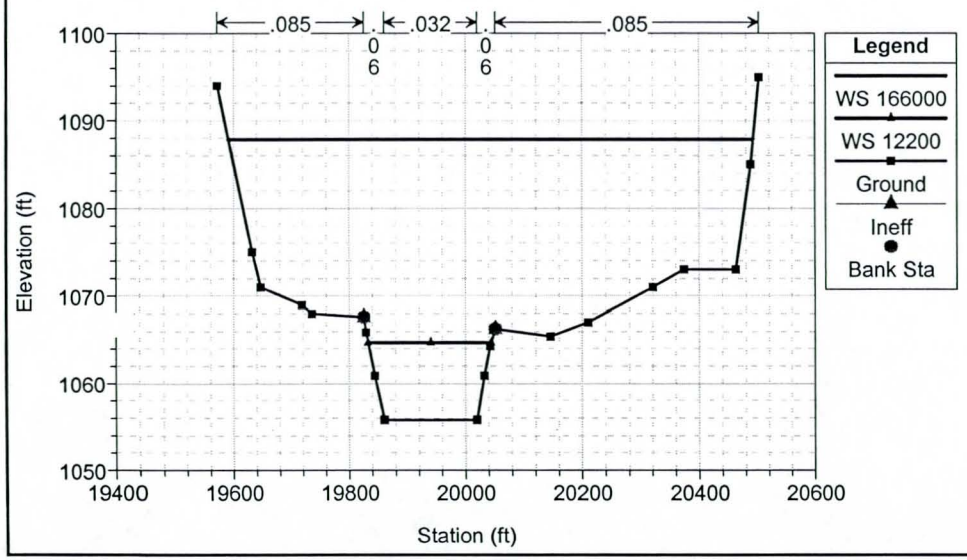
River = Rio Salado Reach = LFCD Bottom of Proposed Grade Control Structu RS = 215.65



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

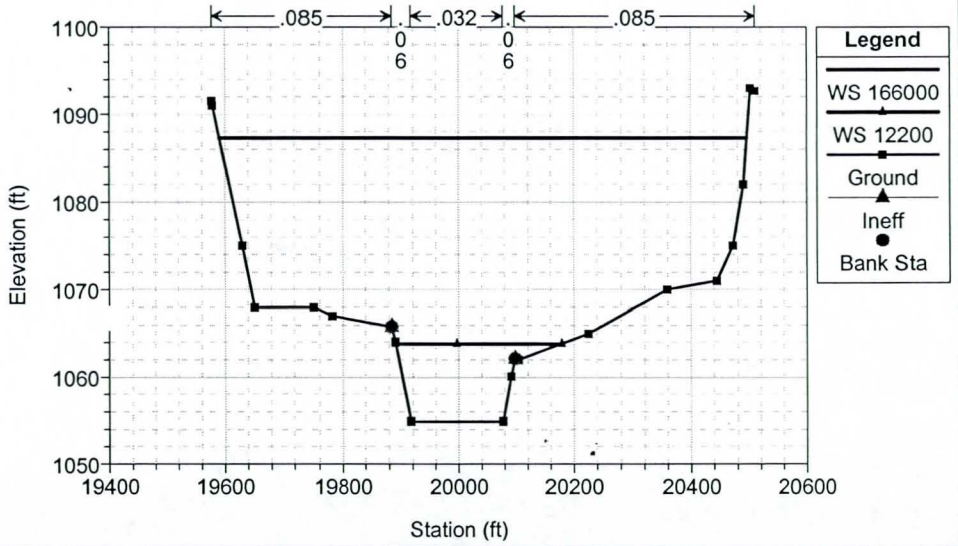
River = Rio Salado Reach = LFCD Downstream of proposed grade control. RS = 215.62



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

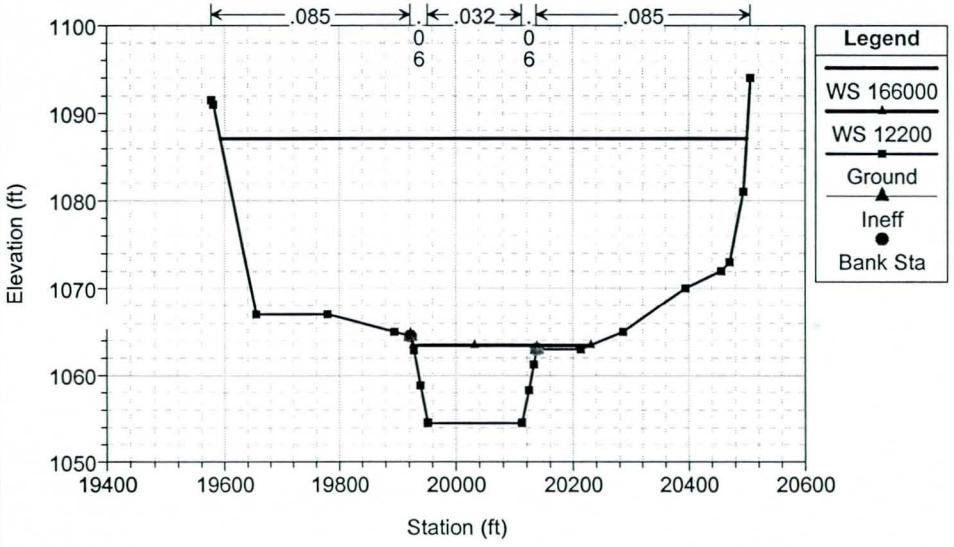
River = Rio Salado Reach = LFCD RS = 215.56



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

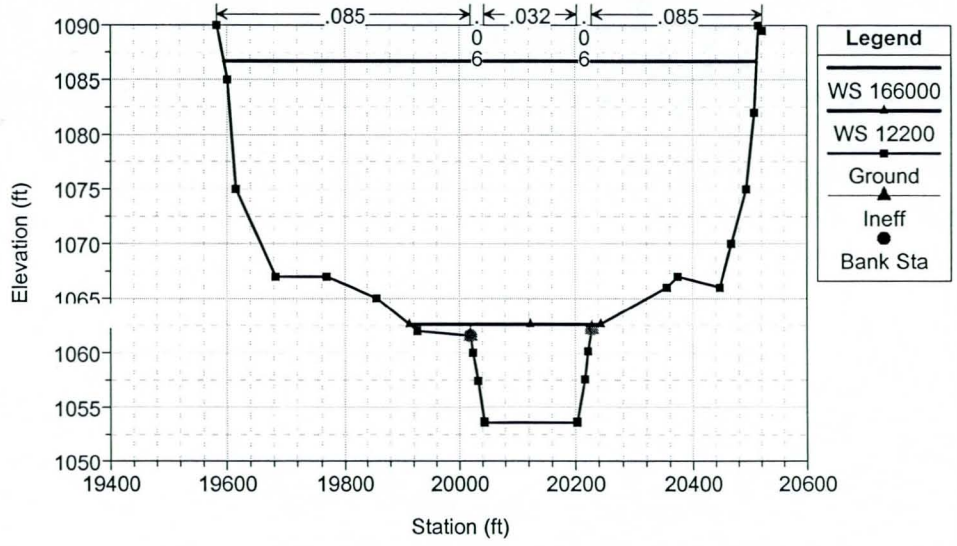
River = Rio Salado Reach = LFCD RS = 215.53



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

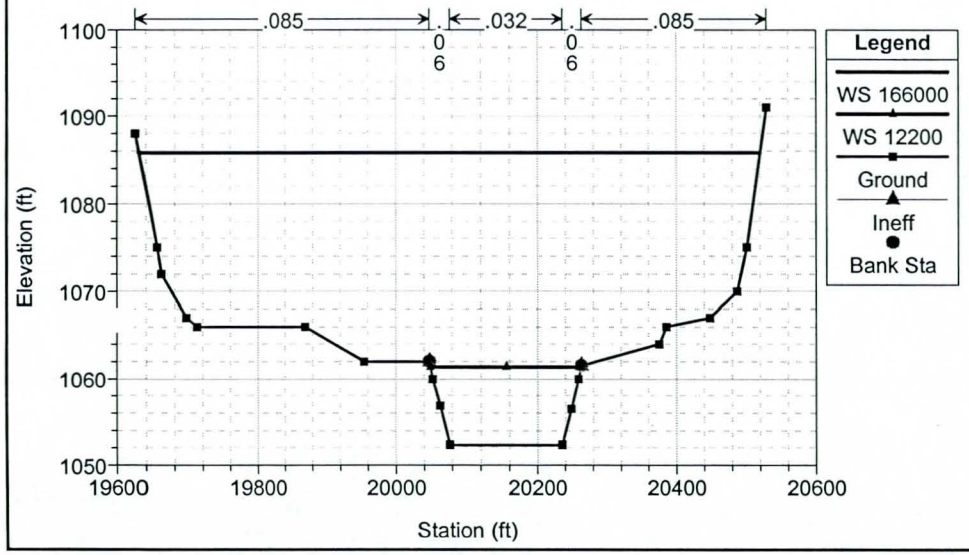
River = Rio Salado Reach = LFCD RS = 215.46



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

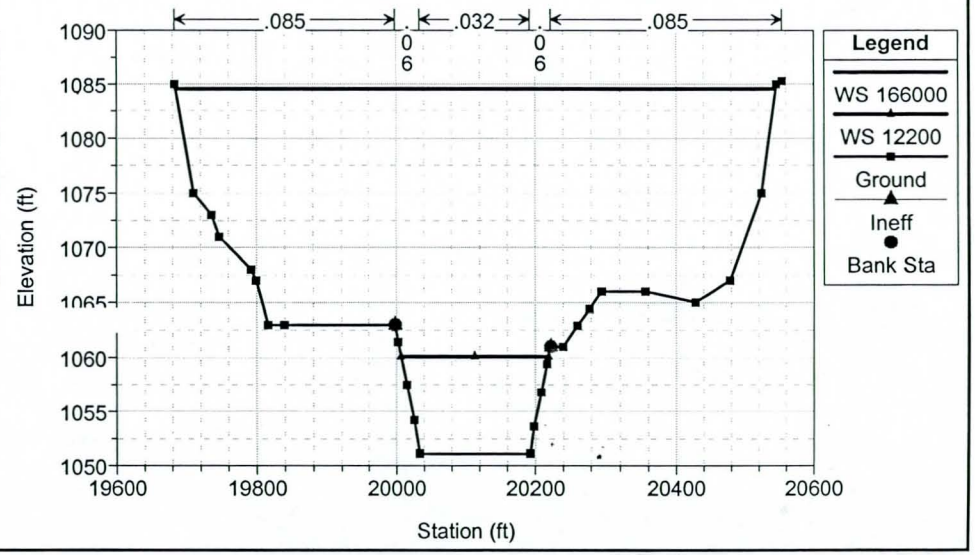
River = Rio Salado Reach = LFCD RS = 215.36



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

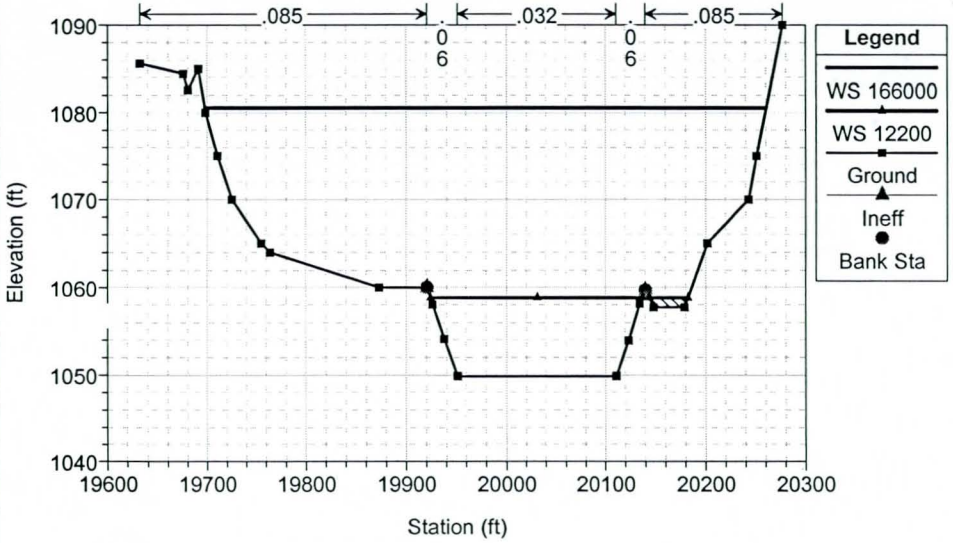
River = Rio Salado Reach = LFCD RS = 215.27



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

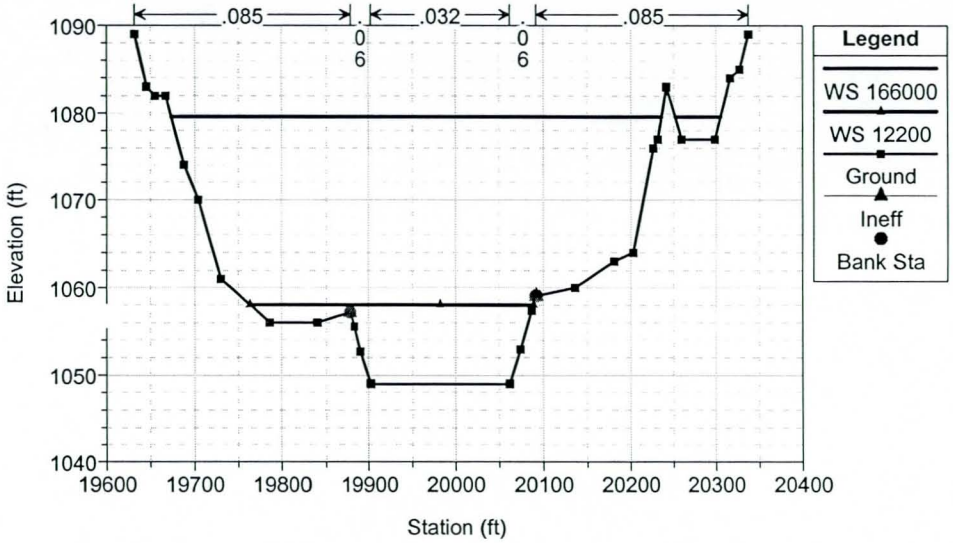
River = Rio Salado Reach = LFCD RS = 215.18



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

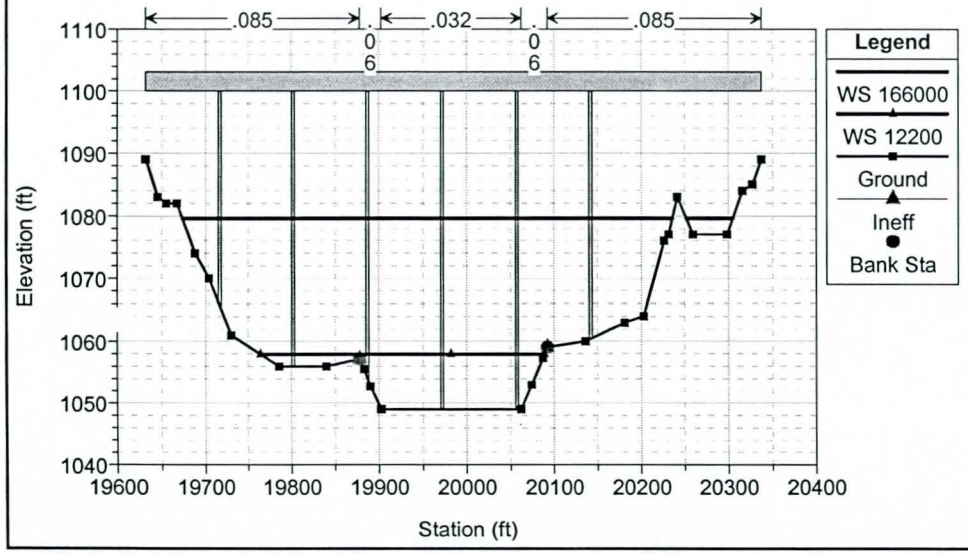
River = Rio Salado Reach = LFCD U/S Face of Conveyor Bridge RS = 215.125



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

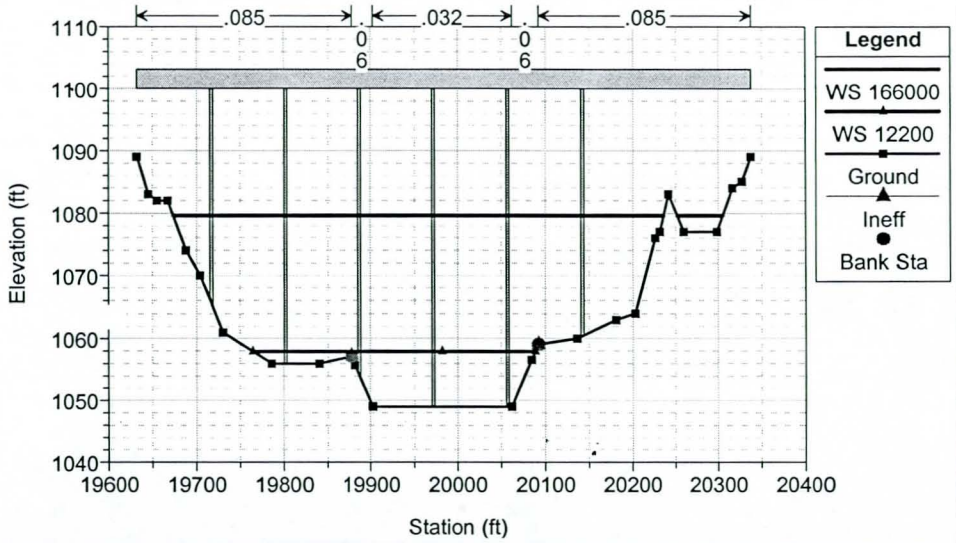
River = Rio Salado Reach = LFCD CalMat Plant, C&F Equipment, Conveyor Br RS = 215.12



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

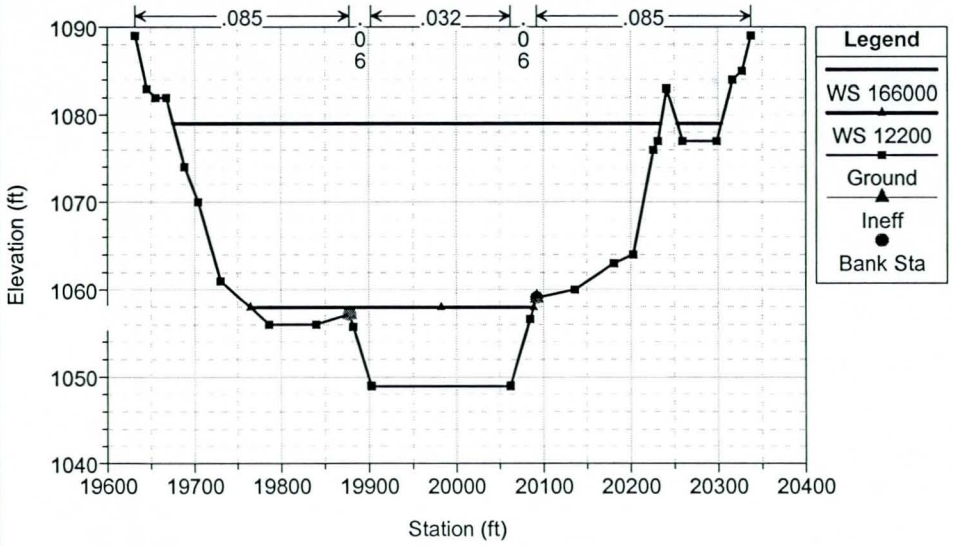
River = Rio Salado Reach = LFCD CalMat Plant, C&F Equipment, Conveyor Br RS = 215.12



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

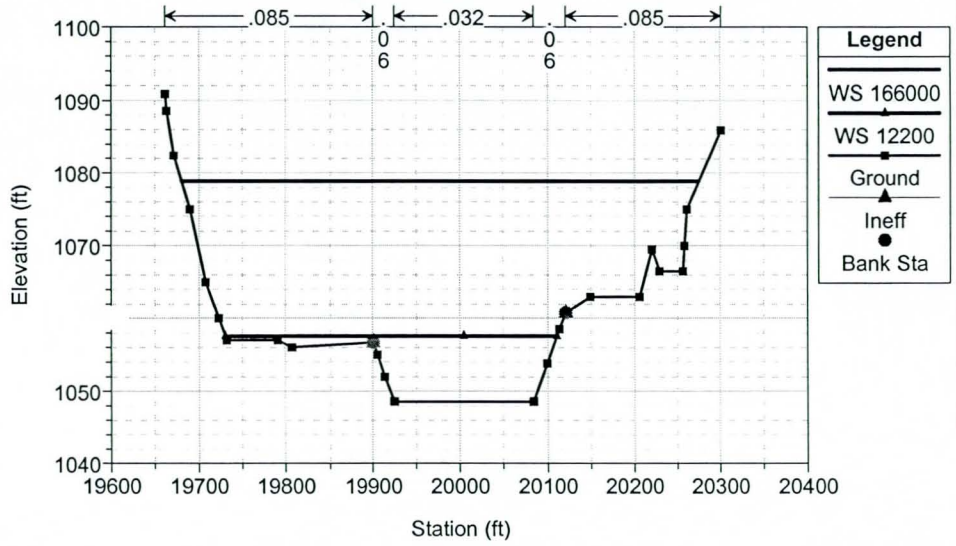
River = Rio Salado Reach = LFCD D/S Face of Conveyor Bridge RS = 215.115



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

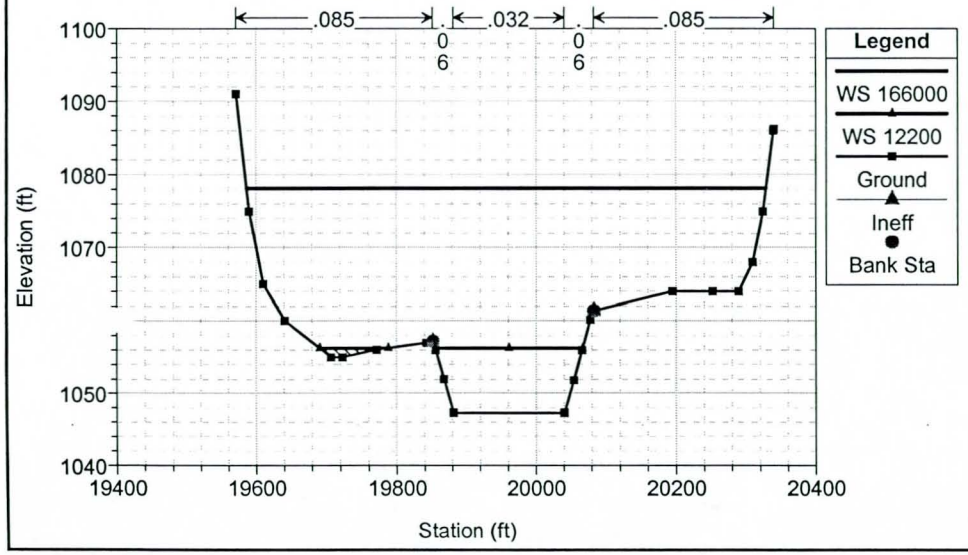
River = Rio Salado Reach = LFCD RS = 215.09



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

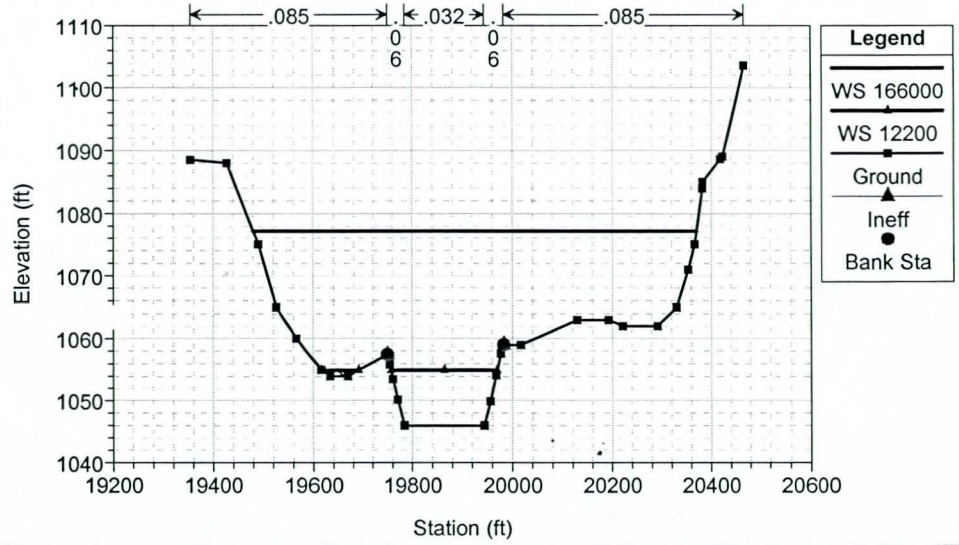
River = Rio Salado Reach = LFCD RS = 214.99



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

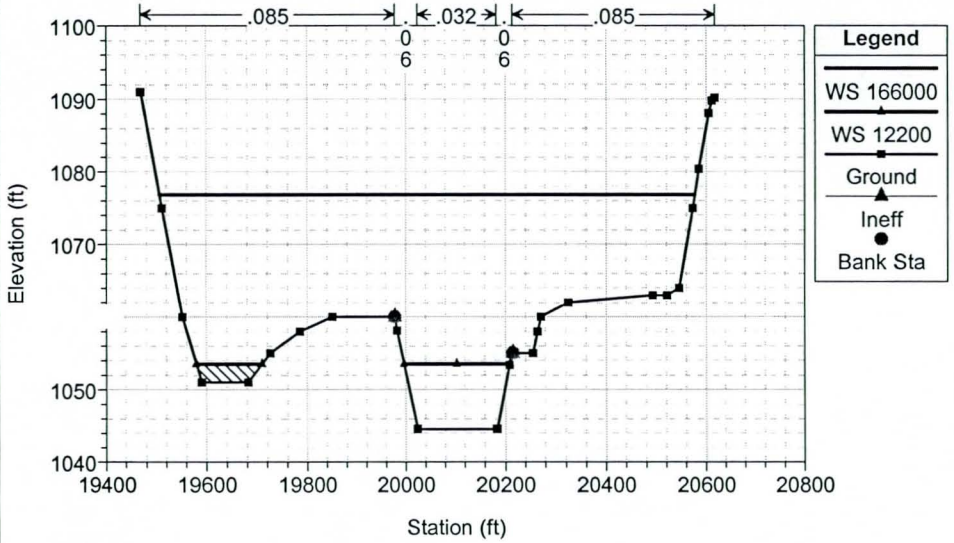
River = Rio Salado Reach = LFCD RS = 214.9



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

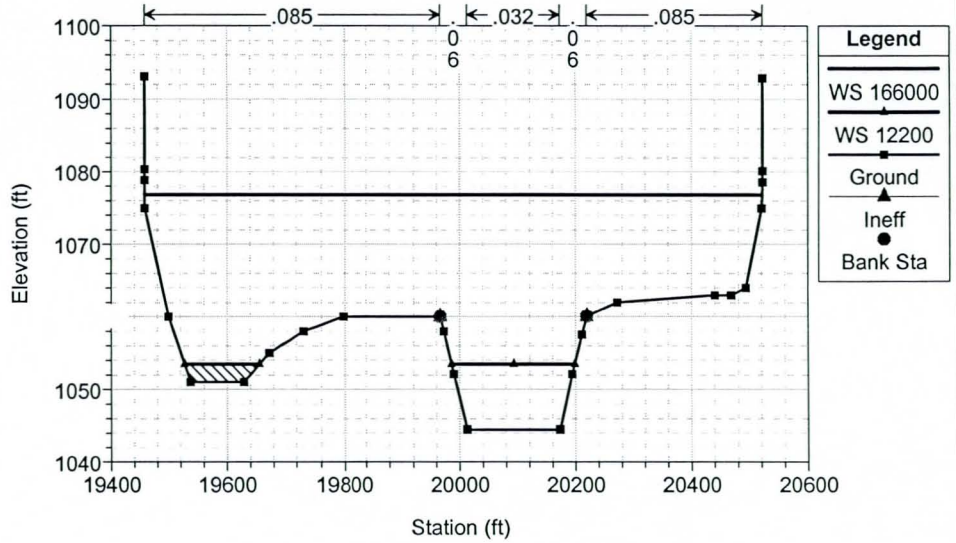
River = Rio Salado Reach = LFCD Waterline crossing. RS = 214.8



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

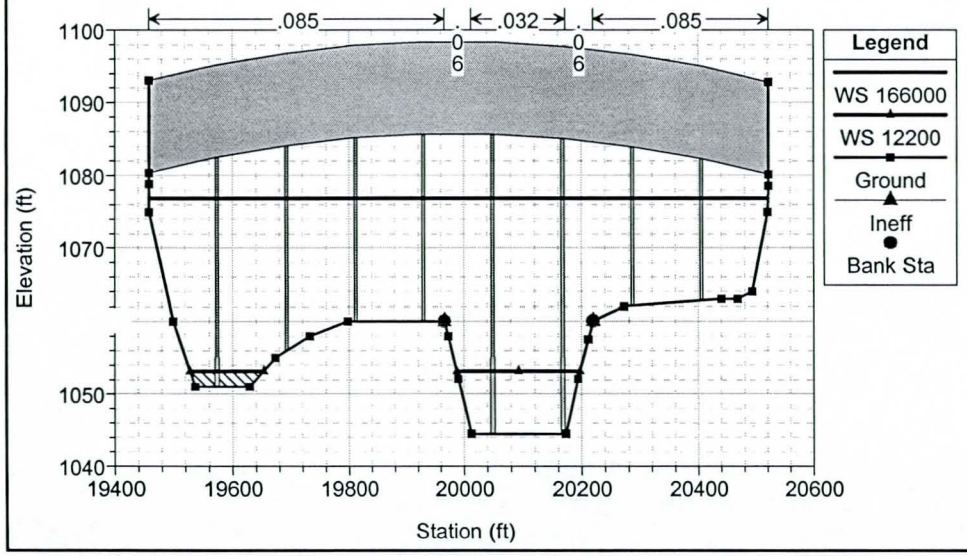
River = Rio Salado Reach = LFCD Upstream face of 16th Street Bridge RS = 214.79



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

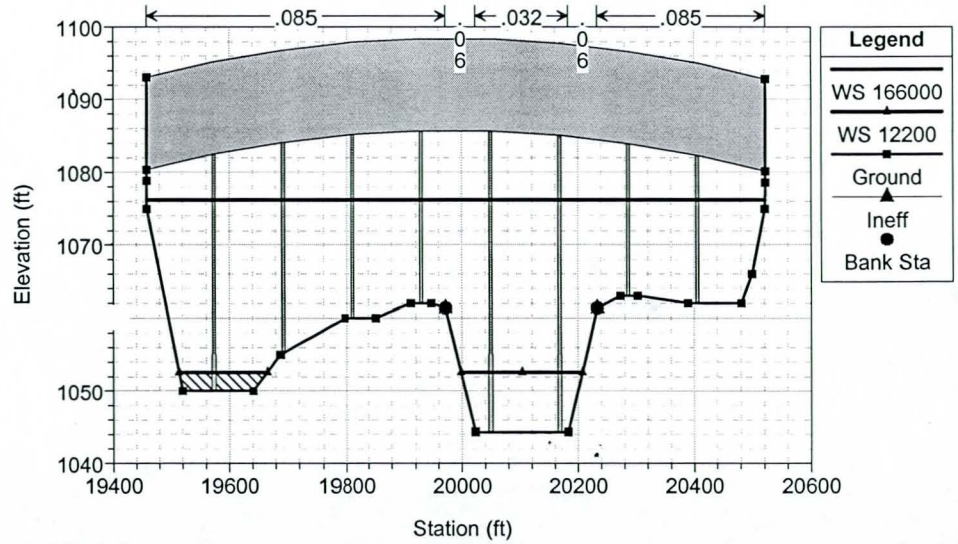
River = Rio Salado Reach = LFCD Bridge #5, 16th Street Bridge RS = 214.785



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

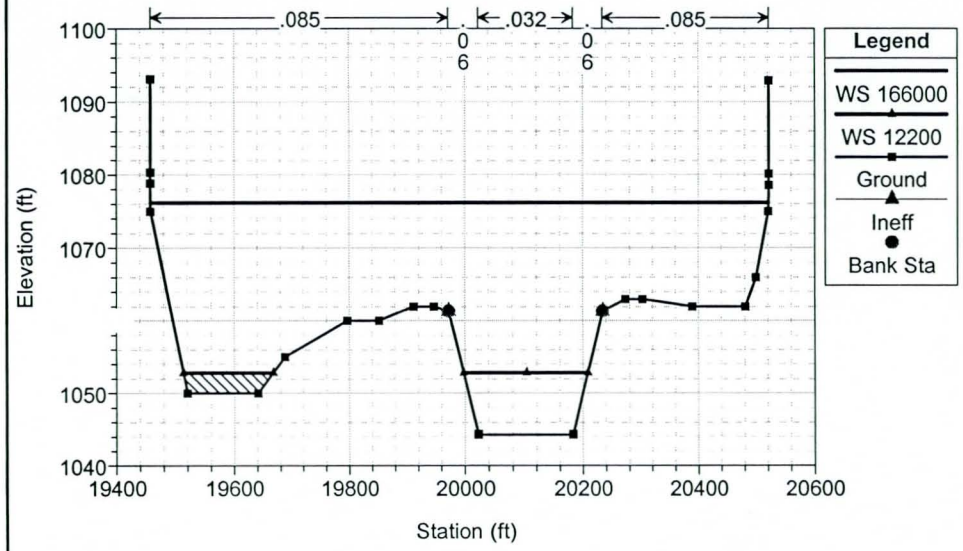
River = Rio Salado Reach = LFCD Bridge #5, 16th Street Bridge RS = 214.785



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

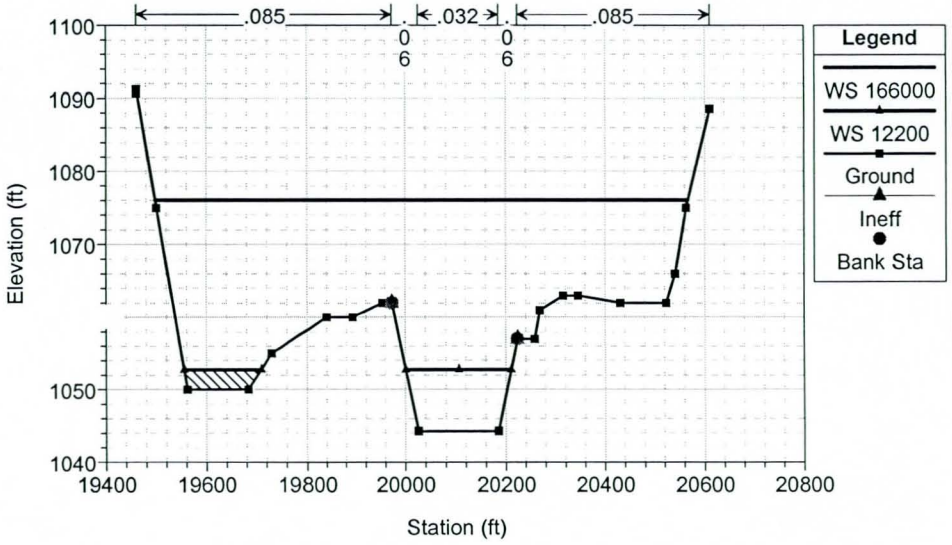
River = Rio Salado Reach = LFCD Downstream face of 16th Street Bridge RS = 214.78



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

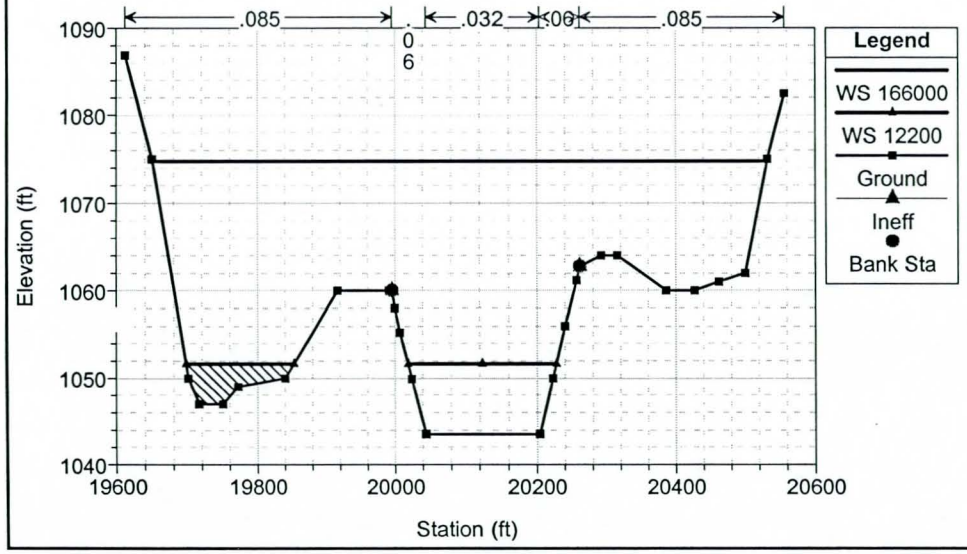
River = Rio Salado Reach = LFCD RS = 214.77



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

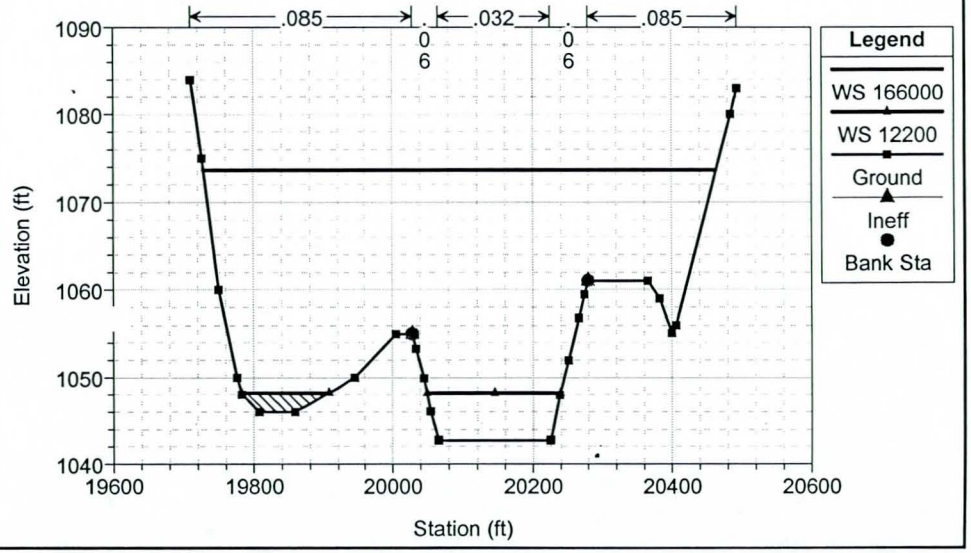
River = Rio Salado Reach = LFCD RS = 214.71



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

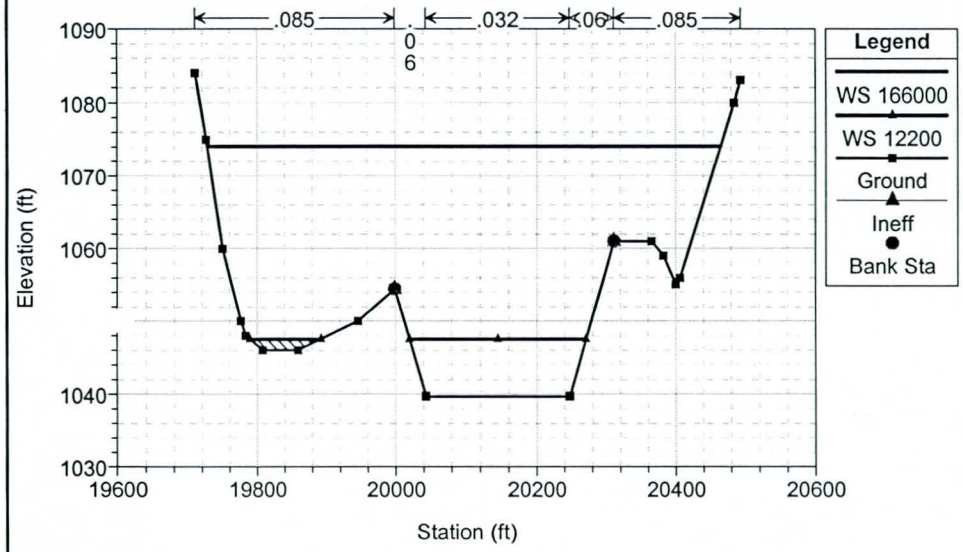
River = Rio Salado Reach = LFCD Copy of 214.65. Top of proposed drop st RS = 214.651



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

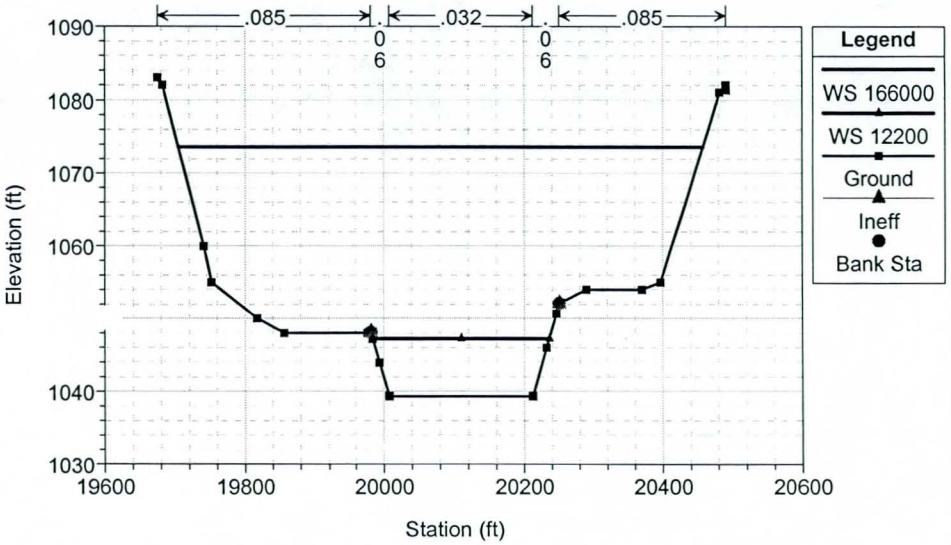
River = Rio Salado Reach = LFCD Bottom of proposed drop structure. RS = 214.65



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

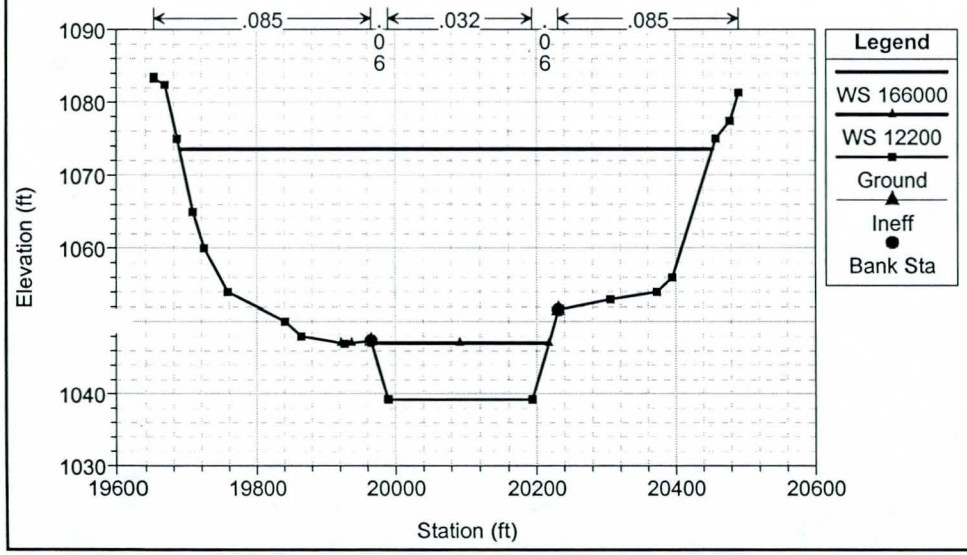
River = Rio Salado Reach = LFCD Added Section. Copy of 214.61 RS = 214.62



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

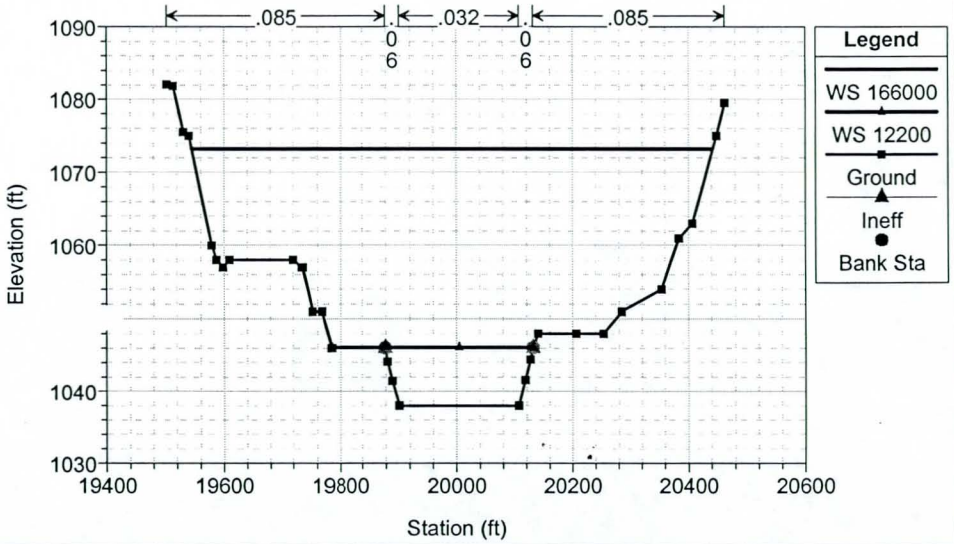
River = Rio Salado Reach = LFCD RS = 214.61



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

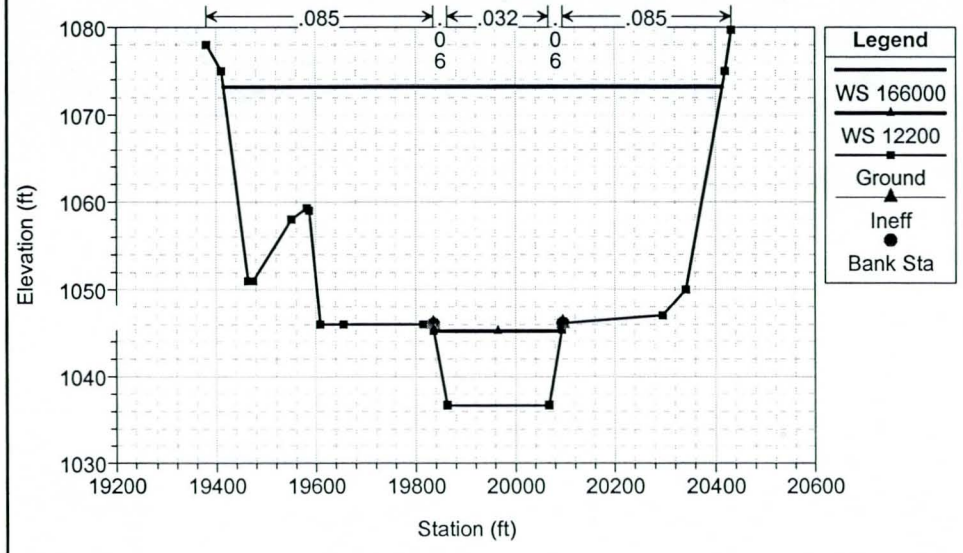
River = Rio Salado Reach = LFCD RS = 214.52



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

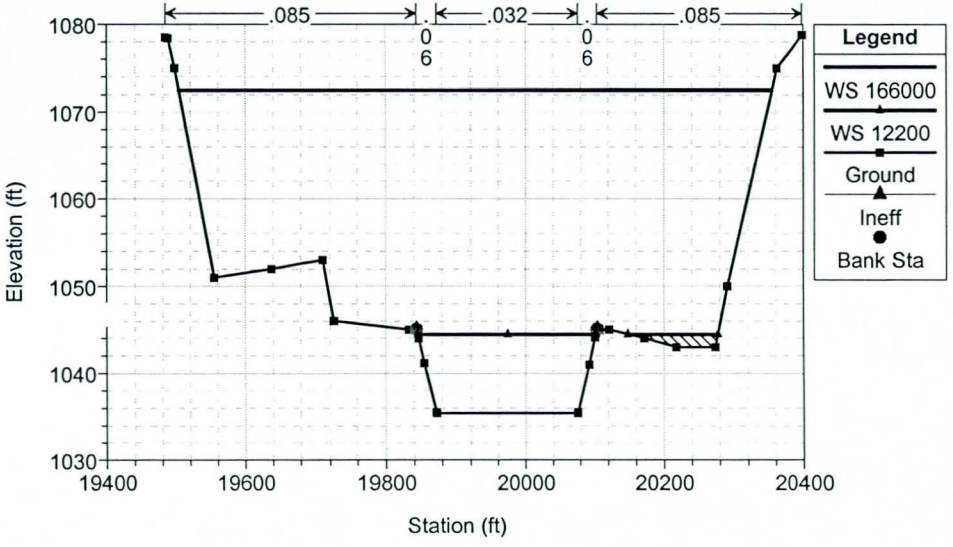
River = Rio Salado Reach = LFCD RS = 214.42



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

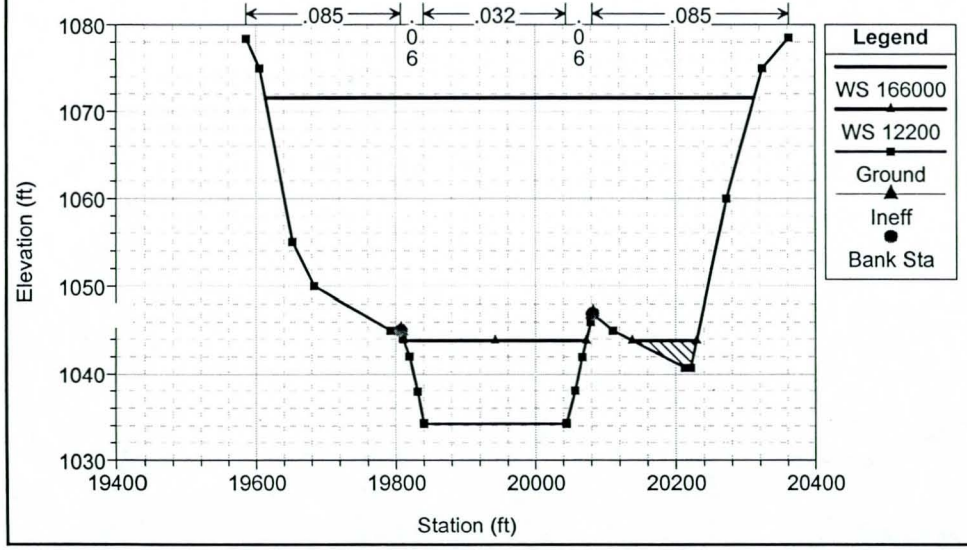
River = Rio Salado Reach = LFCD RS = 214.33



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

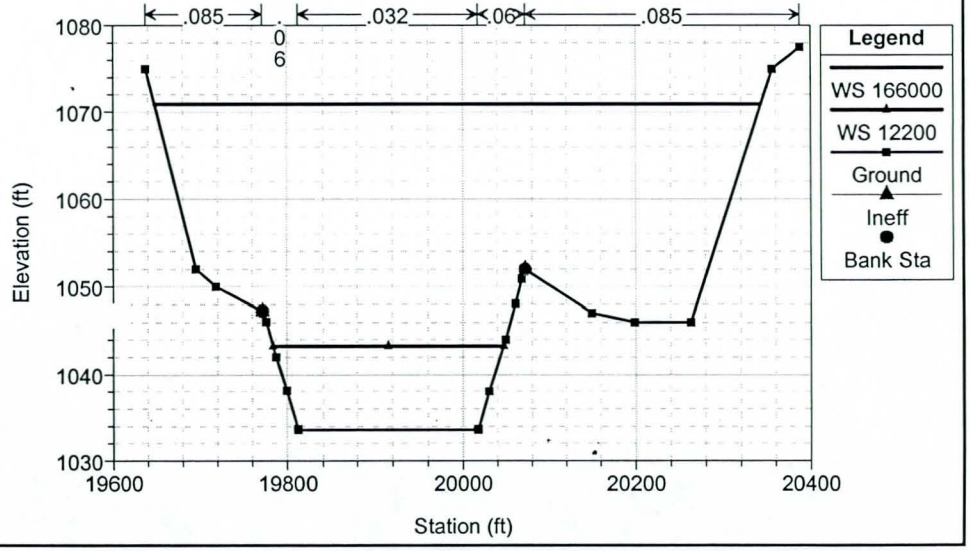
River = Rio Salado Reach = LFCD RS = 214.23



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

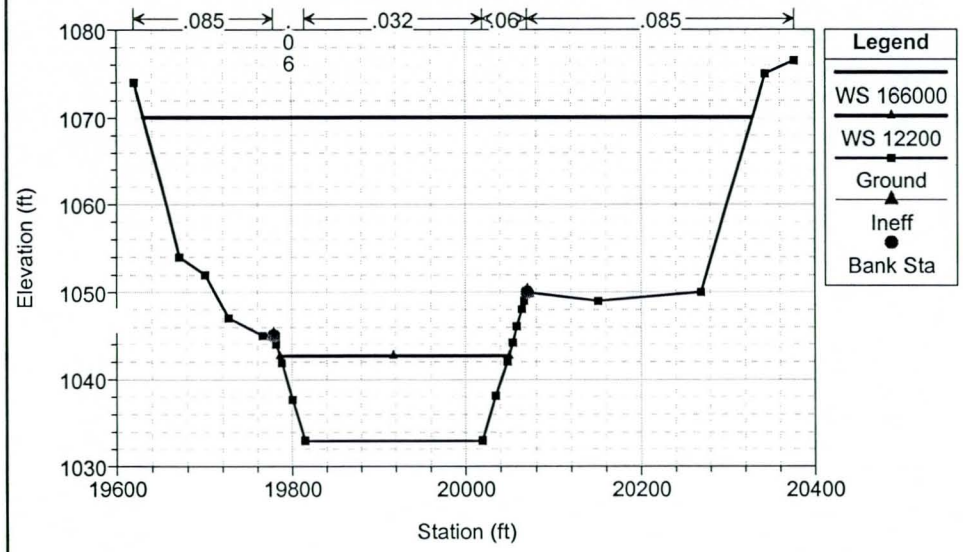
River = Rio Salado Reach = LFCD RS = 214.14



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

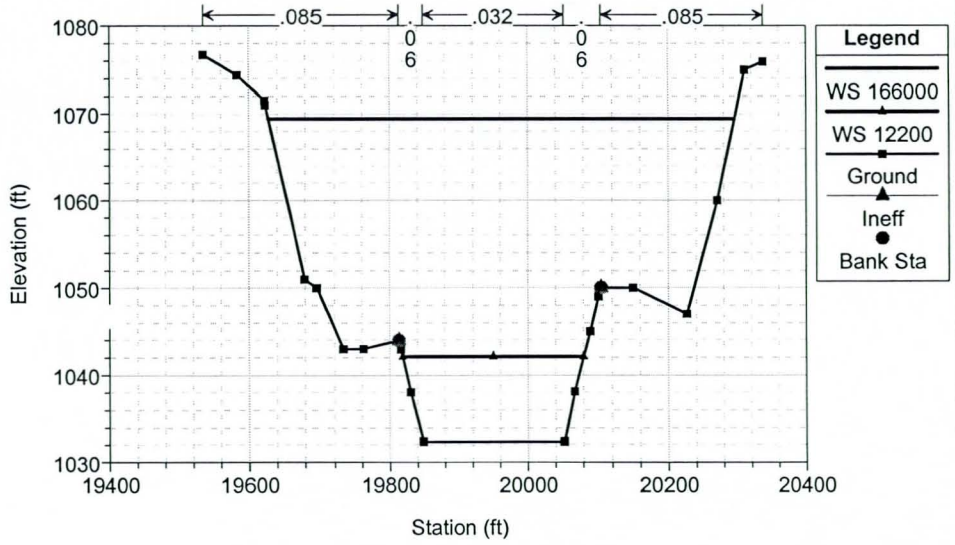
River = Rio Salado Reach = LFCD RS = 214.04



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

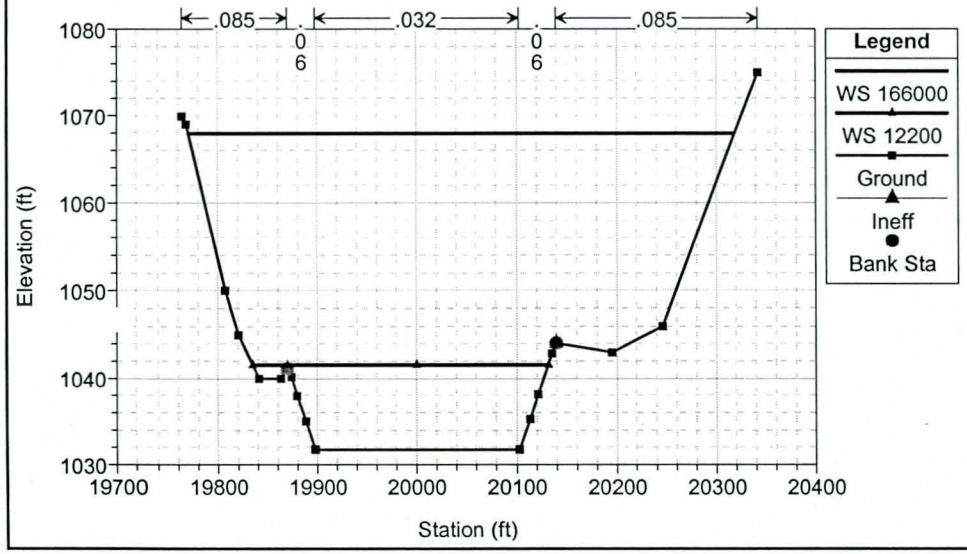
River = Rio Salado Reach = LFCD RS = 213.95



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

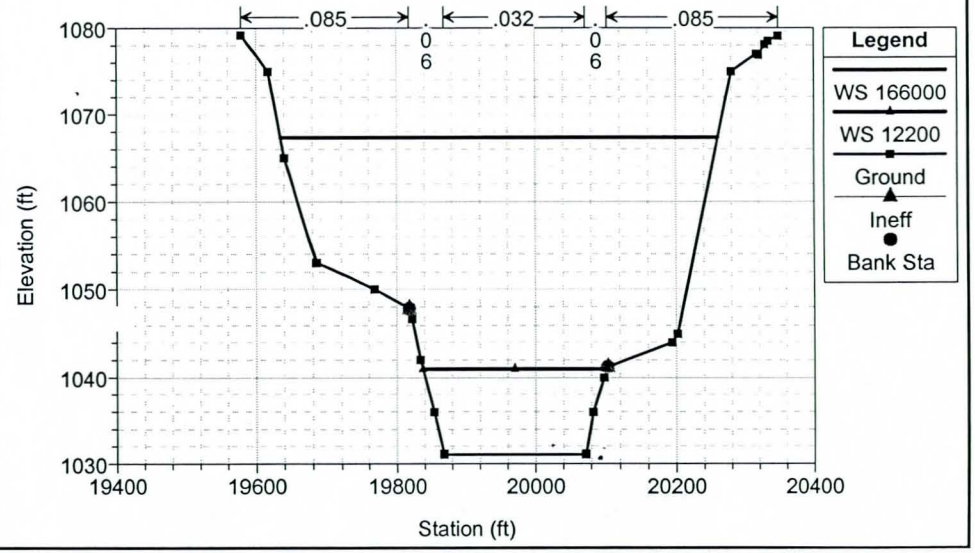
River = Rio Salado Reach = LFCD RS = 213.85



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

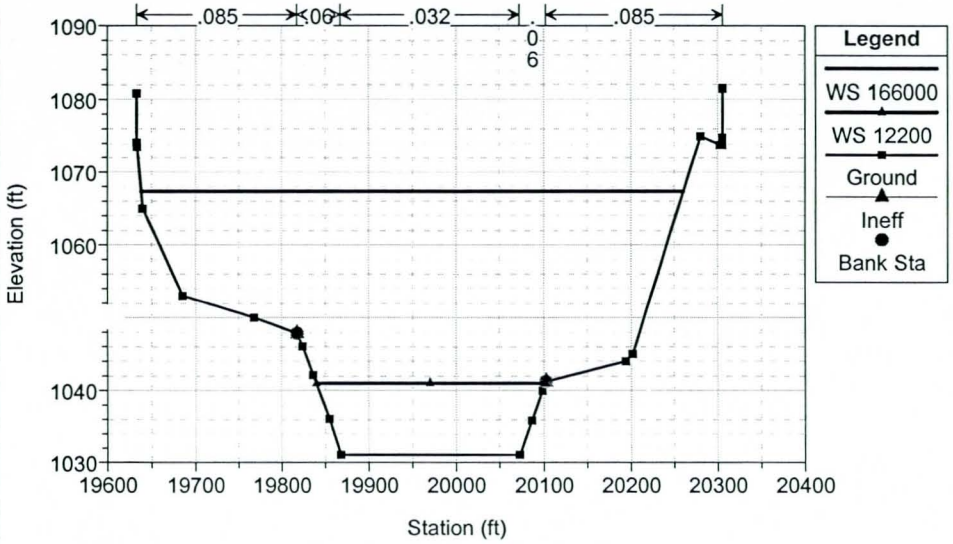
River = Rio Salado Reach = LFCD RS = 213.76



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

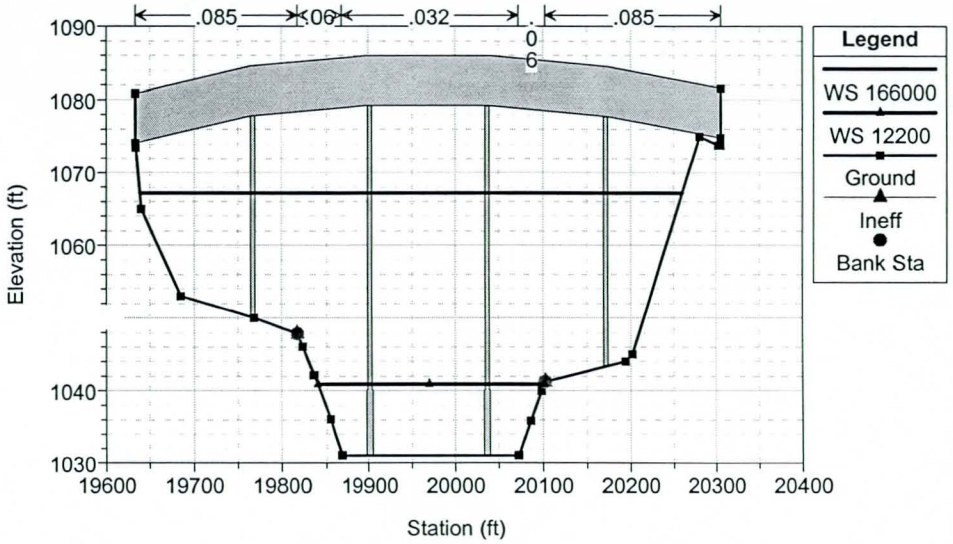
River = Rio Salado Reach = LFCD Upstream face of 7th Street Bridge RS = 213.75



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

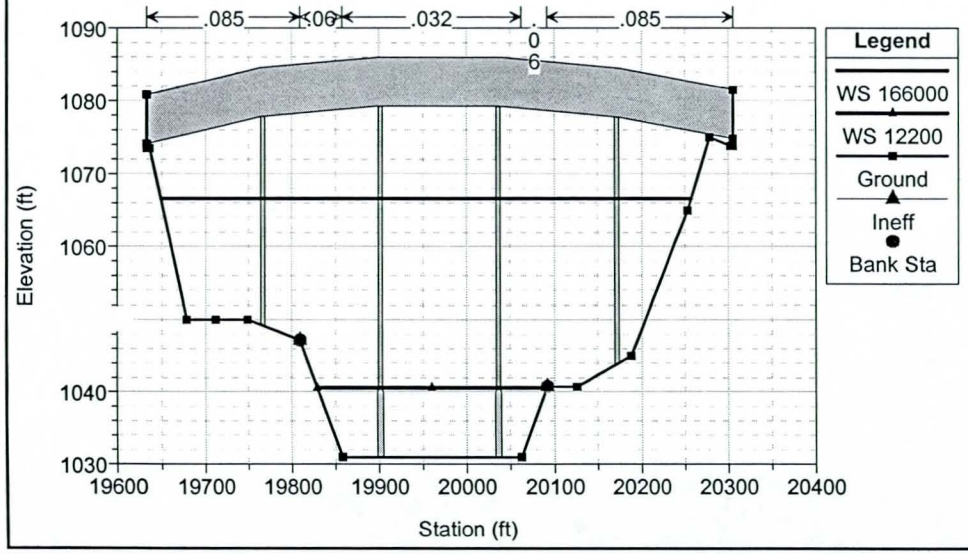
River = Rio Salado Reach = LFCD Bridge #4, 7th Street Bridge RS = 213.745



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

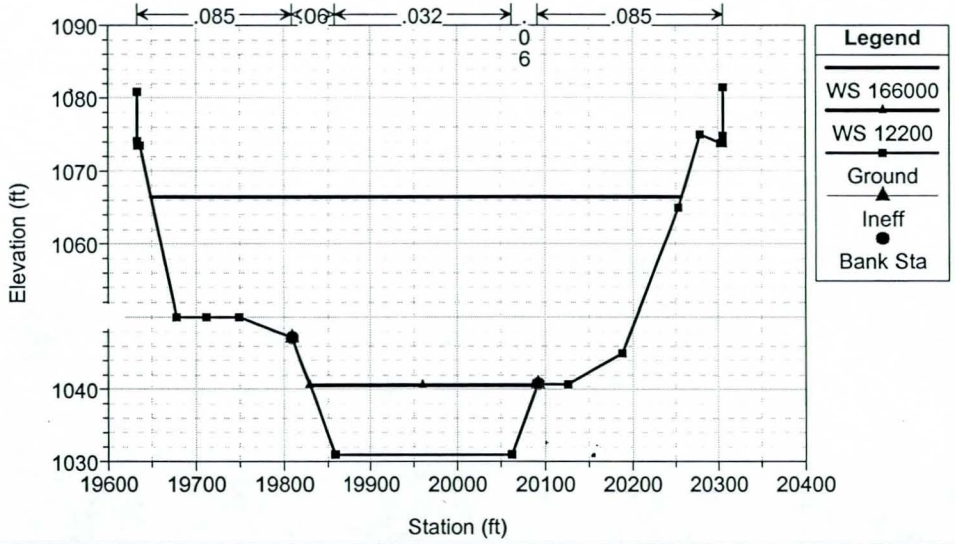
River = Rio Salado Reach = LFCD Bridge #4, 7th Street Bridge RS = 213.745



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

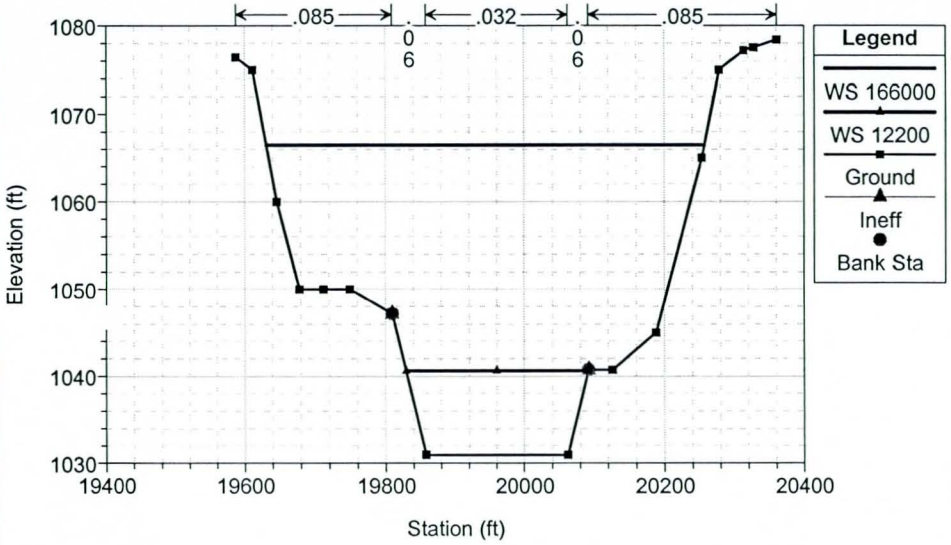
River = Rio Salado Reach = LFCD Downstream face of 7th Street Bridge RS = 213.74



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

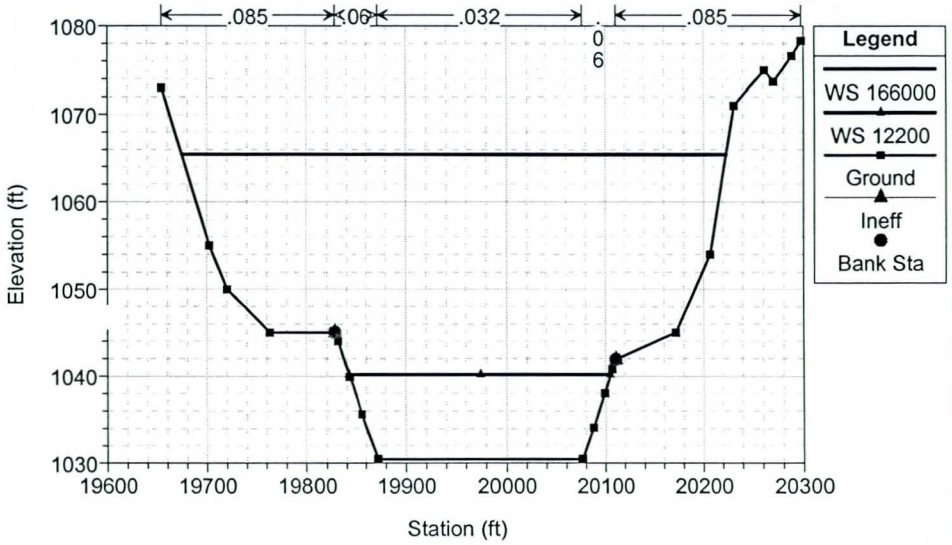
River = Rio Salado Reach = LFCD RS = 213.73



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

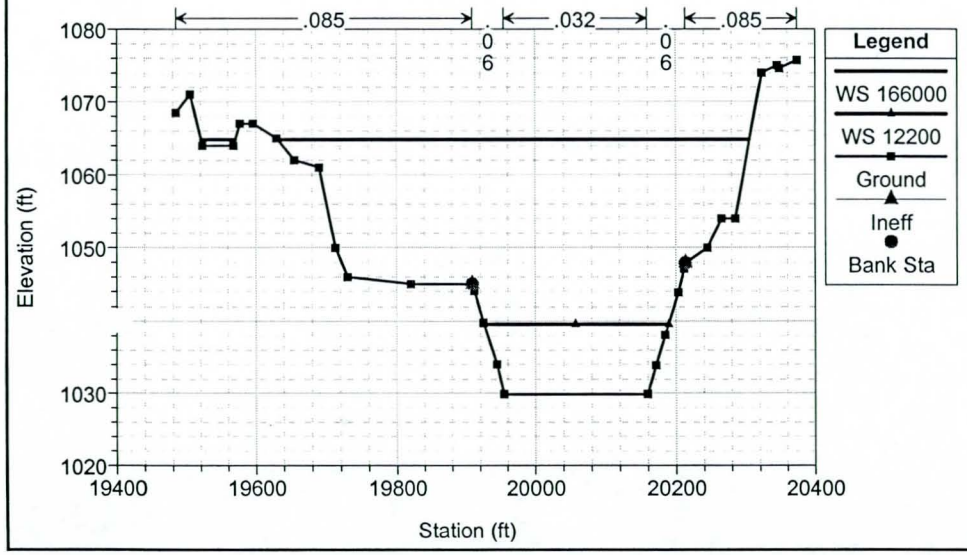
River = Rio Salado Reach = LFCD RS = 213.66



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

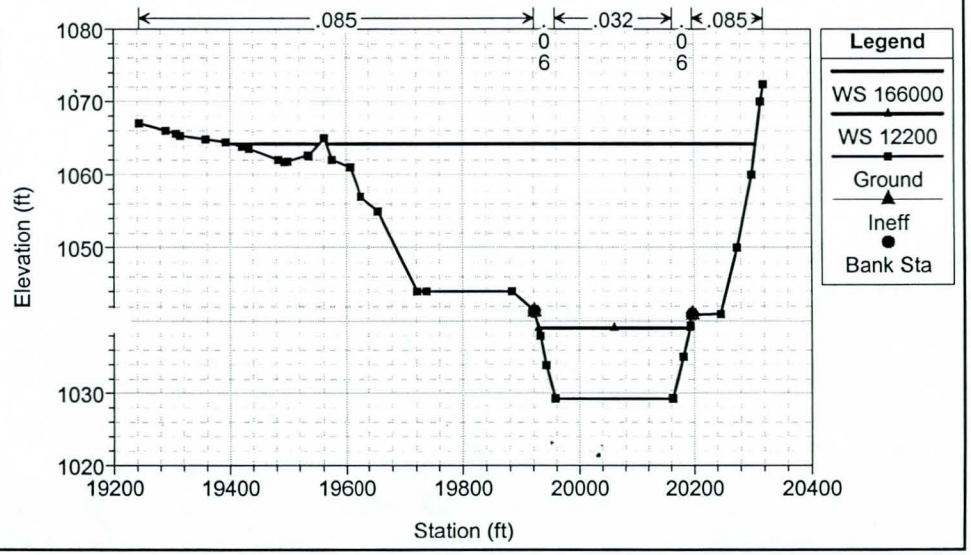
River = Rio Salado Reach = LFCD RS = 213.57



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

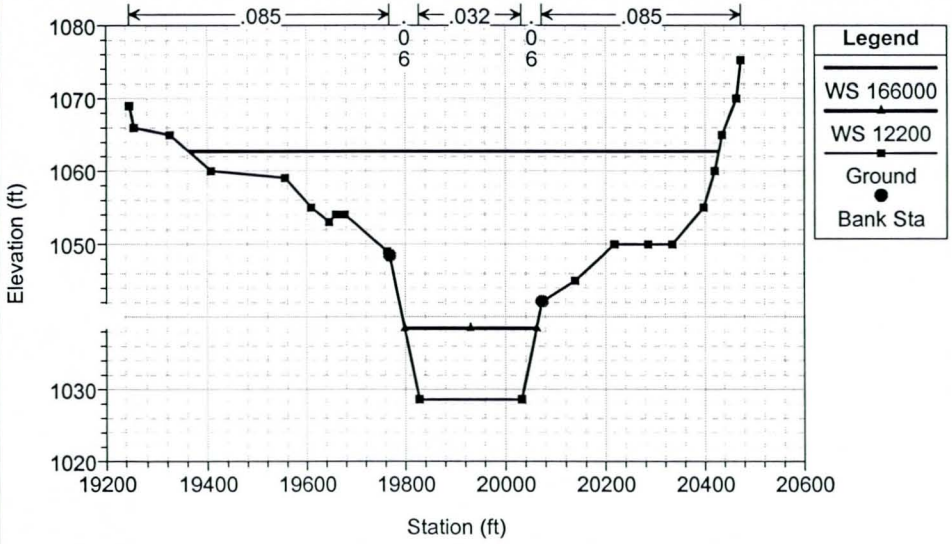
River = Rio Salado Reach = LFCD RS = 213.47



Salt River Low Flow Channel Design Low Flow Channel 6/18/99 9:57:14 AM

Geom: Low Flow Channel Geometry Flow: Q100, Q5, LFCQ (12,200)

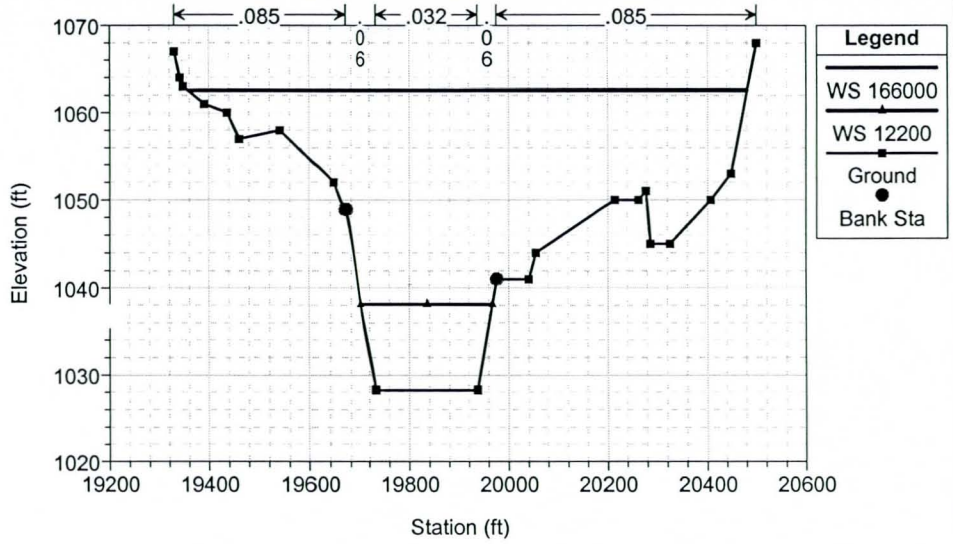
River = Rio Salado Reach = LFCD RS = 213.38



Salt River Low Flow Channel Design Low Flow Channel 6/18/99 9:57:14 AM

Geom: Low Flow Channel Geometry Flow: Q100, Q5, LFCQ (12,200)

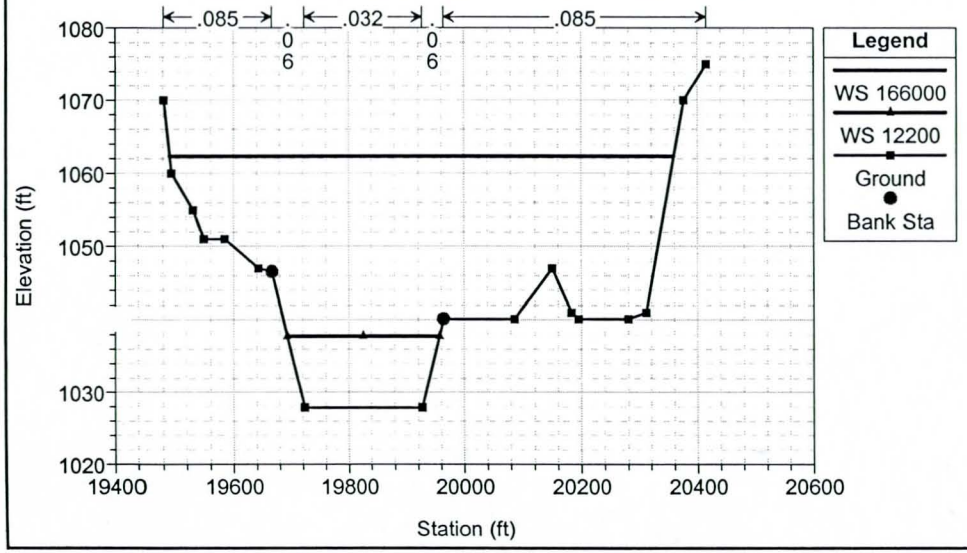
River = Rio Salado Reach = LFCD RS = 213.33



Salt River Low Flow Channel Design Low Flow Channel 6/18/99 9:57:14 AM

Geom: Low Flow Channel Geometry Flow: Q100, Q5, LFCQ (12,200)

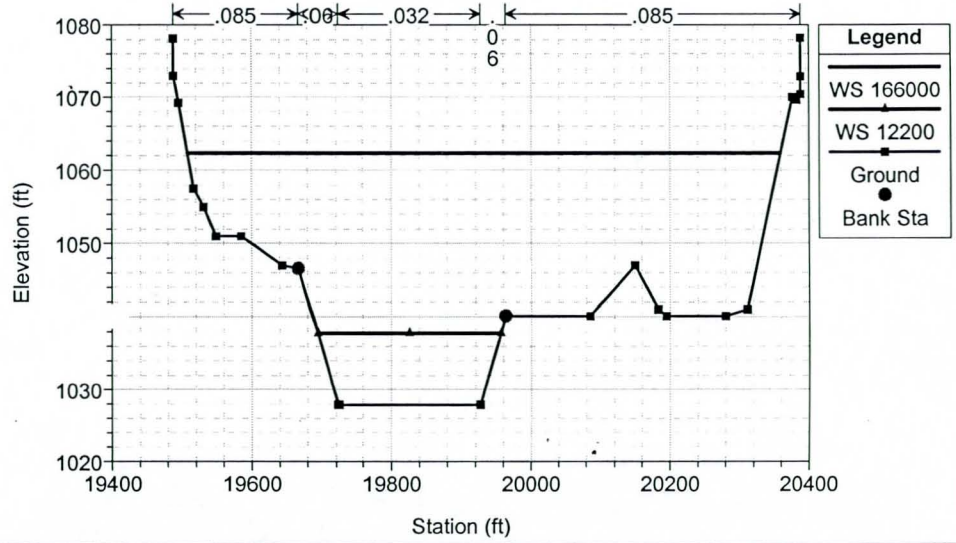
River = Rio Salado Reach = LFCD RS = 213.27



Salt River Low Flow Channel Design Low Flow Channel 6/18/99 9:57:14 AM

Geom: Low Flow Channel Geometry Flow: Q100, Q5, LFCQ (12,200)

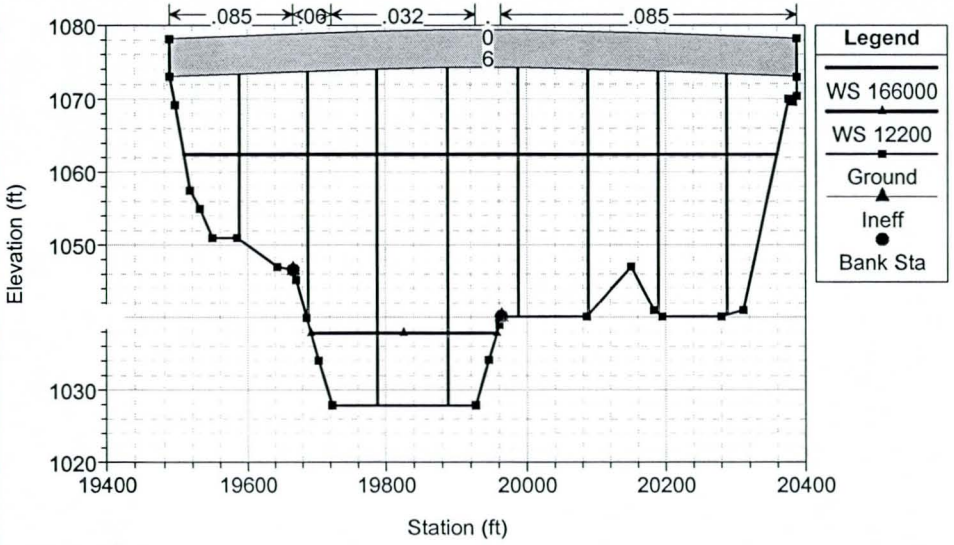
River = Rio Salado Reach = LFCD Upstream face of Central Avenue Bridge RS = 213.26



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

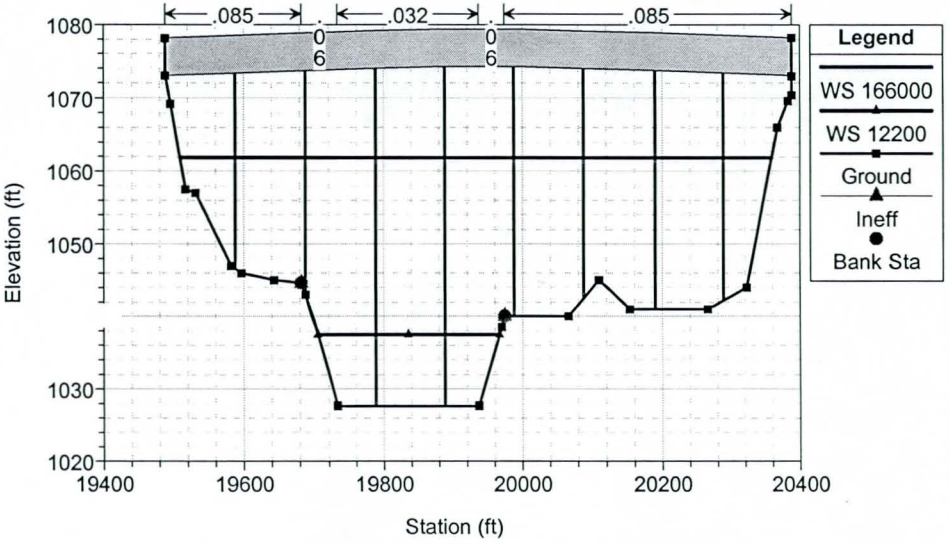
River = Rio Salado Reach = LFCD Bridge #3, Central Avenue Bridge RS = 213.255



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

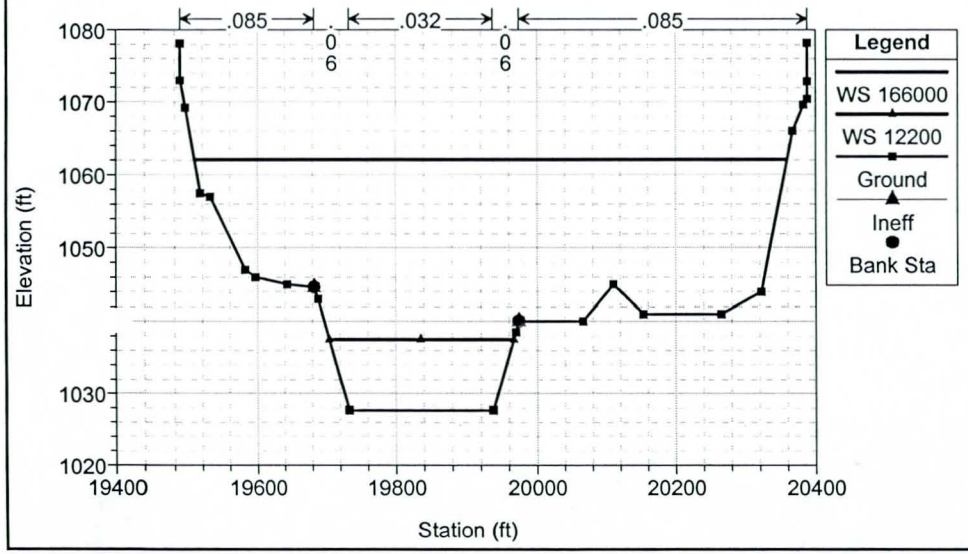
River = Rio Salado Reach = LFCD Bridge #3, Central Avenue Bridge RS = 213.255



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

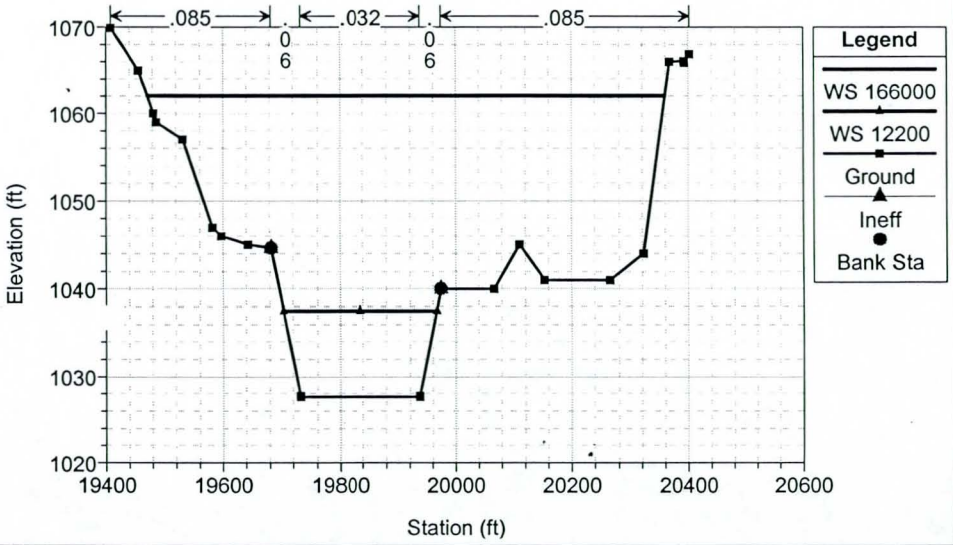
River = Rio Salado Reach = LFCD Downstream face of Central Avenue Bridge RS = 213.25



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

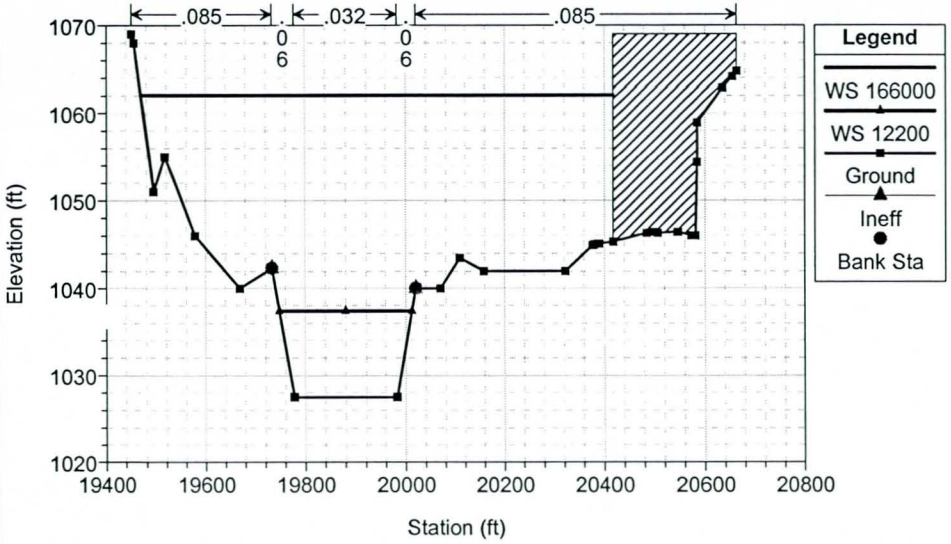
River = Rio Salado Reach = LFCD RS = 213.24



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

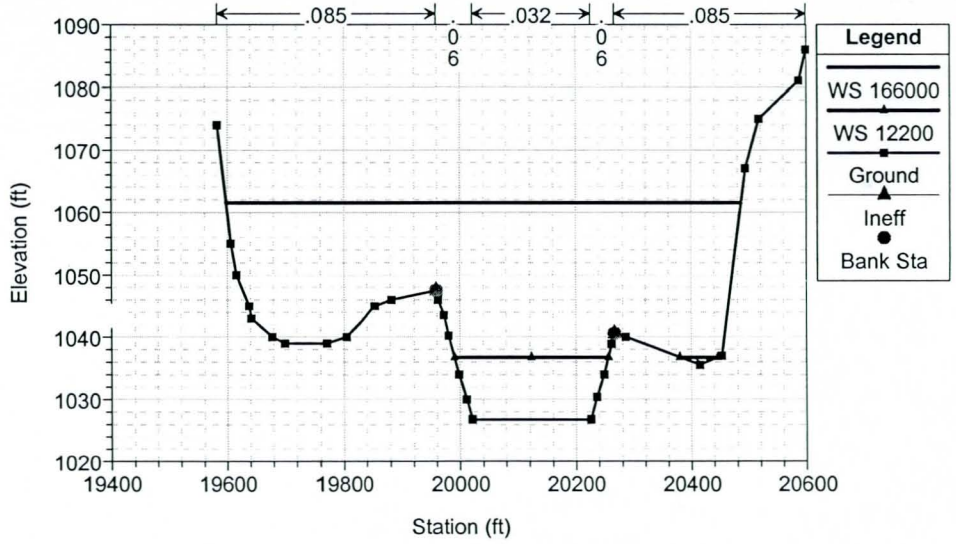
River = Rio Salado Reach = LFCD RS = 213.21



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

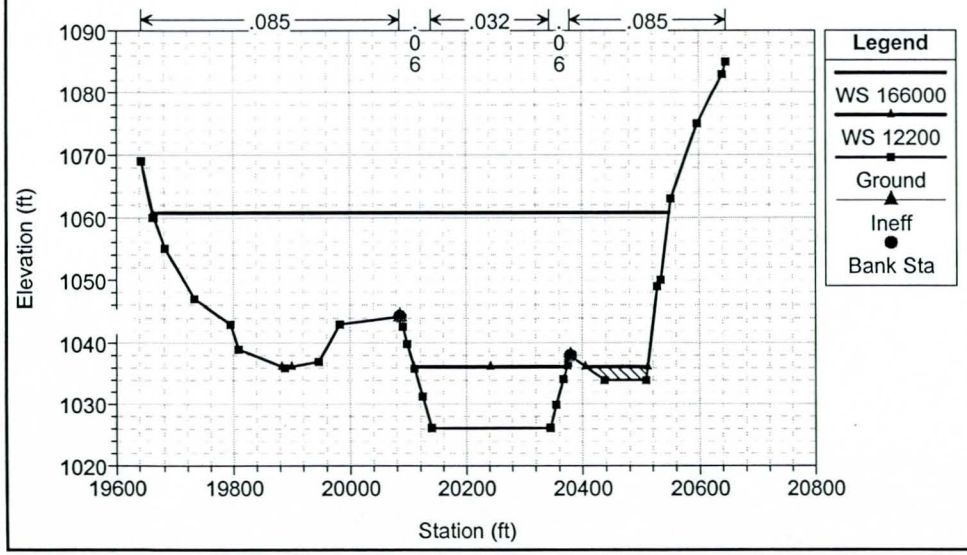
River = Rio Salado Reach = LFCD RS = 213.11



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

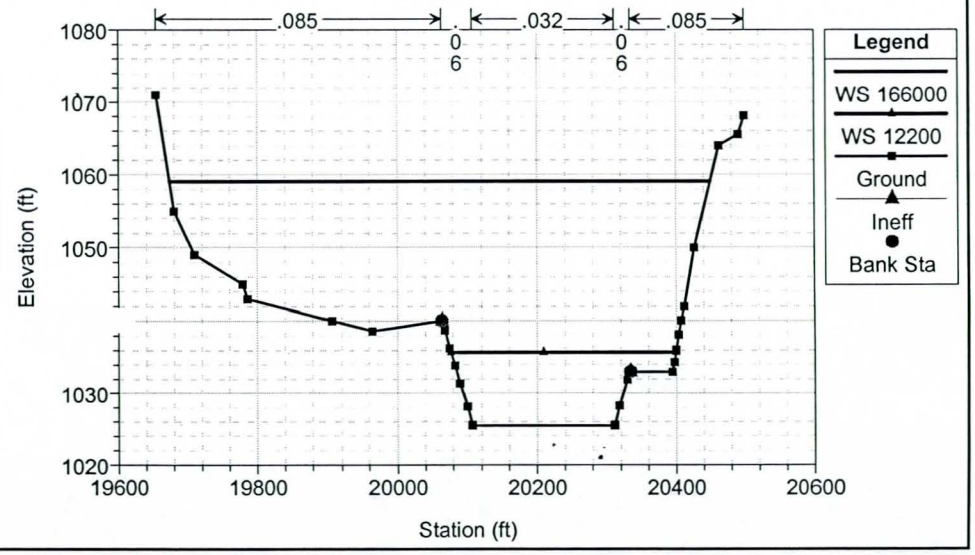
River = Rio Salado Reach = LFCD RS = 213.03



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

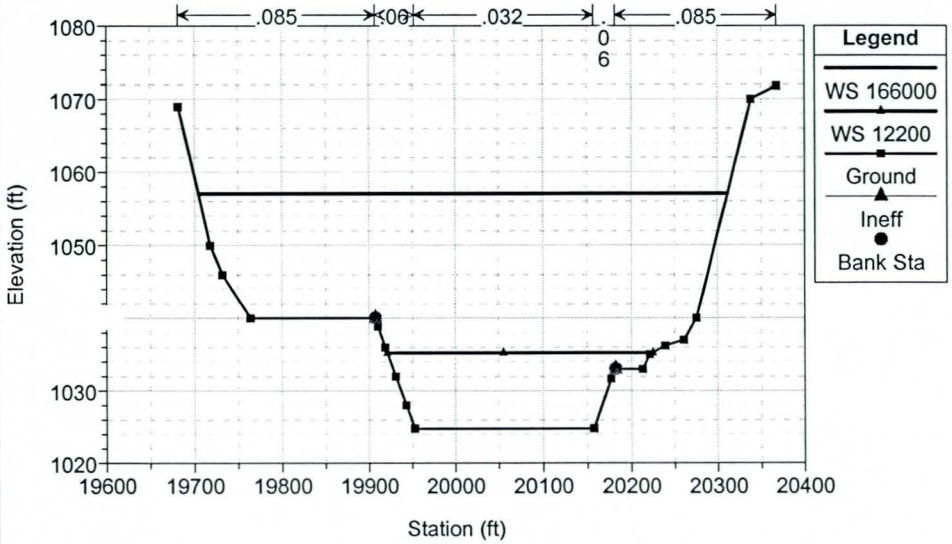
River = Rio Salado Reach = LFCD RS = 212.93



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

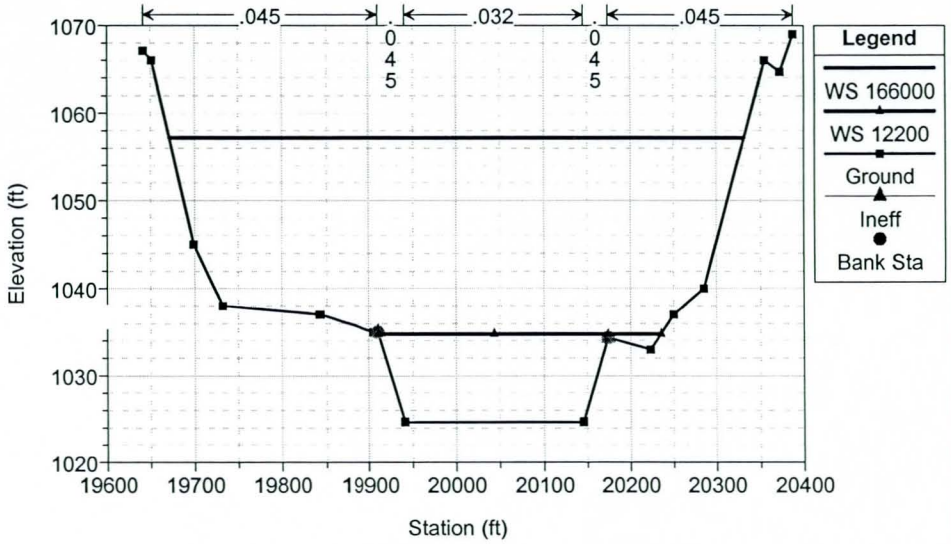
River = Rio Salado Reach = LFCD RS = 212.84



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

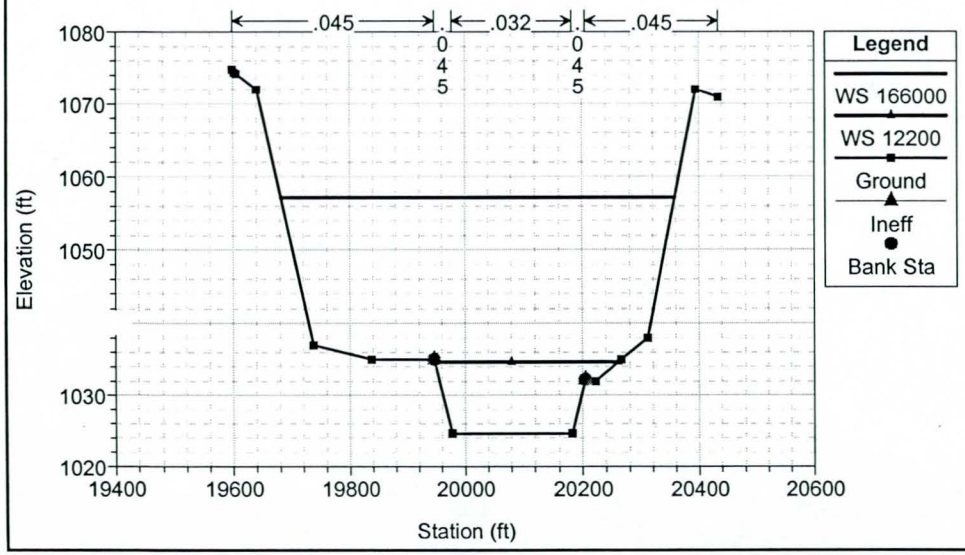
River = Rio Salado Reach = LFCD RS = 212.74



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

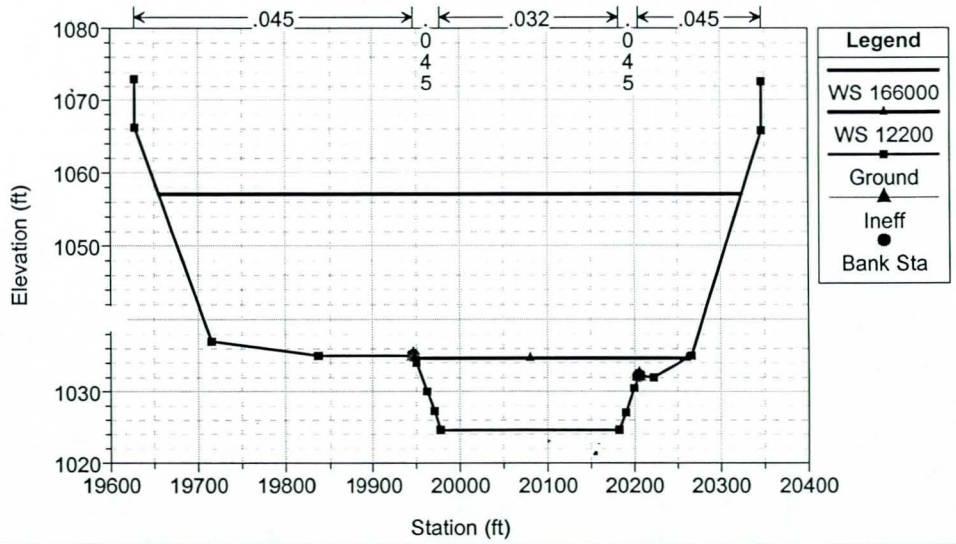
River = Rio Salado Reach = LFCD RS = 212.69



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

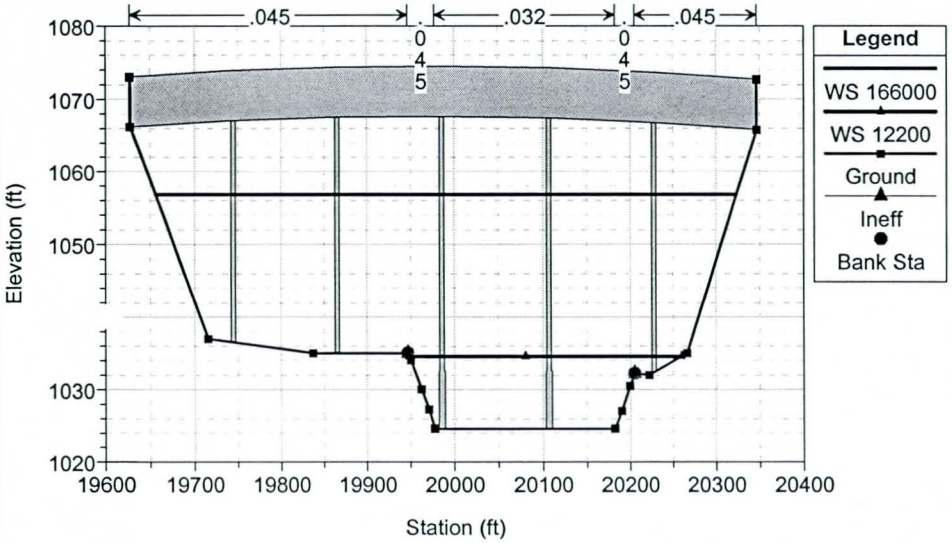
River = Rio Salado Reach = LFCD Upstream face of 7th Avenue Bridge RS = 212.68



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

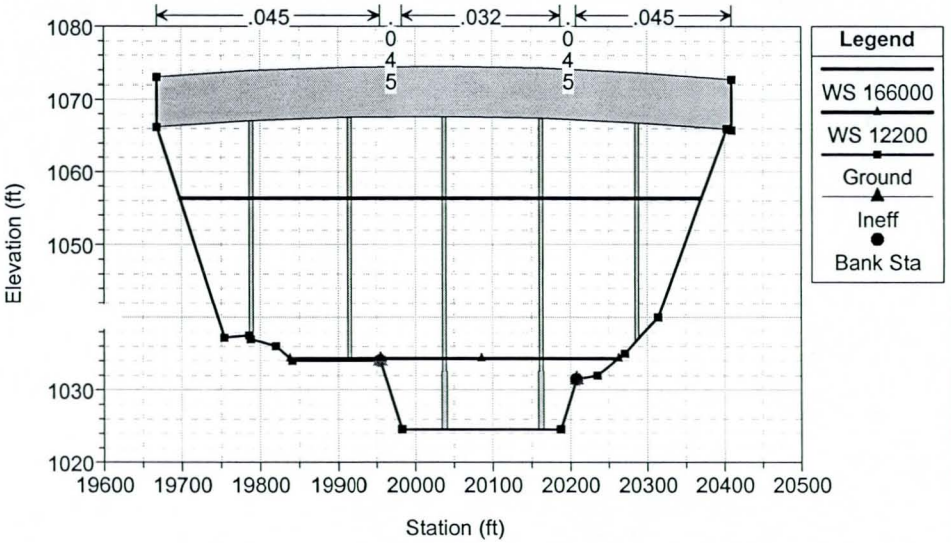
River = Rio Salado Reach = LFCD Bridge #2, 7th Avenue Bridge RS = 212.675



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

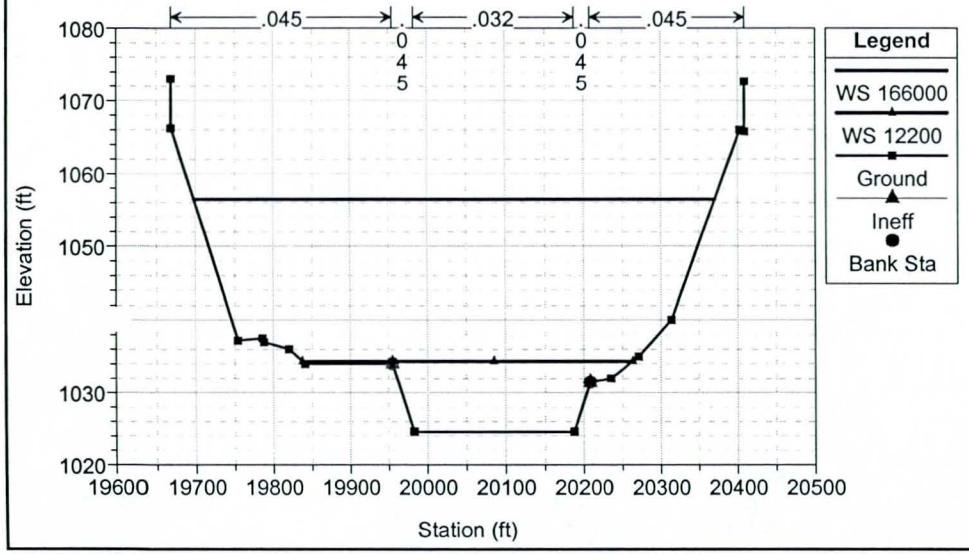
River = Rio Salado Reach = LFCD Bridge #2, 7th Avenue Bridge RS = 212.675



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

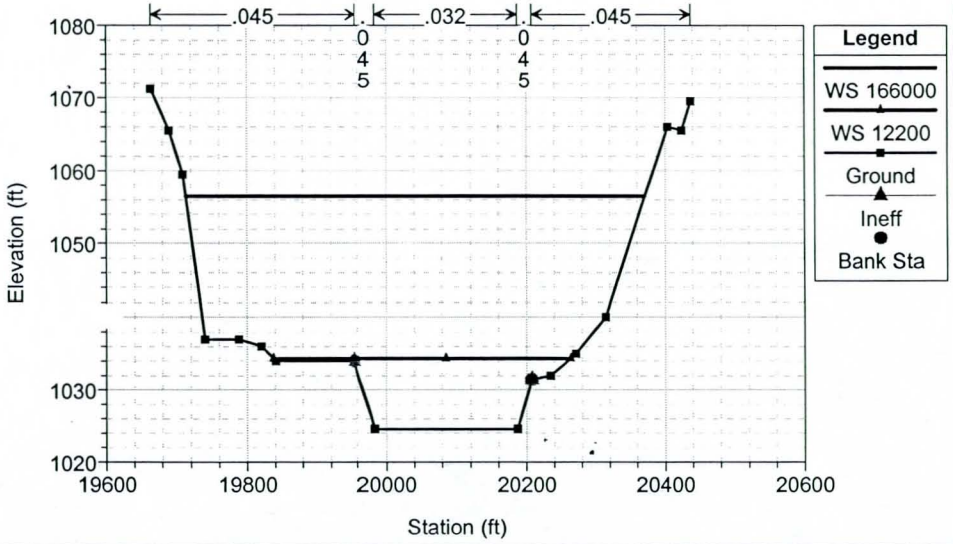
River = Rio Salado Reach = LFCD Downstream face of 7th Avenue Bridge RS = 212.67



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

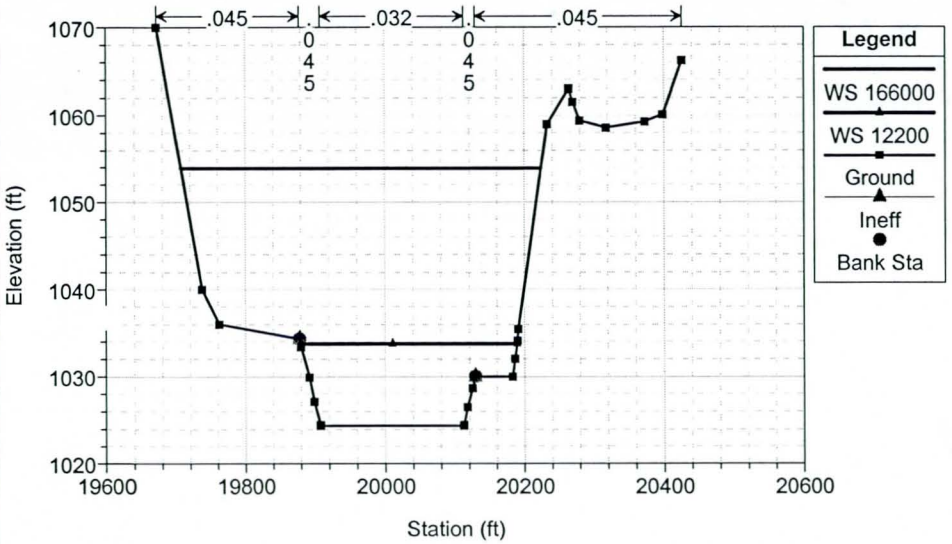
River = Rio Salado Reach = LFCD RS = 212.66



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

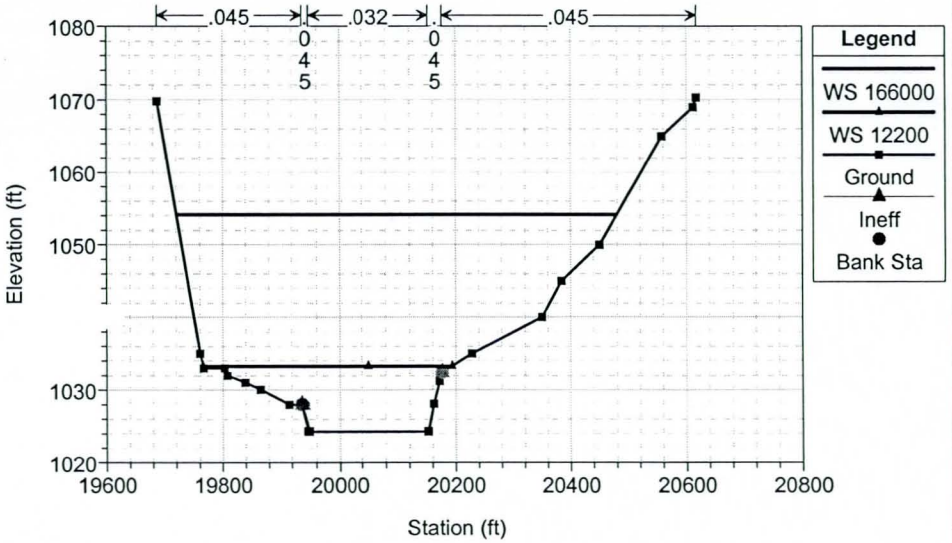
River = Rio Salado Reach = LFCD RS = 212.56



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

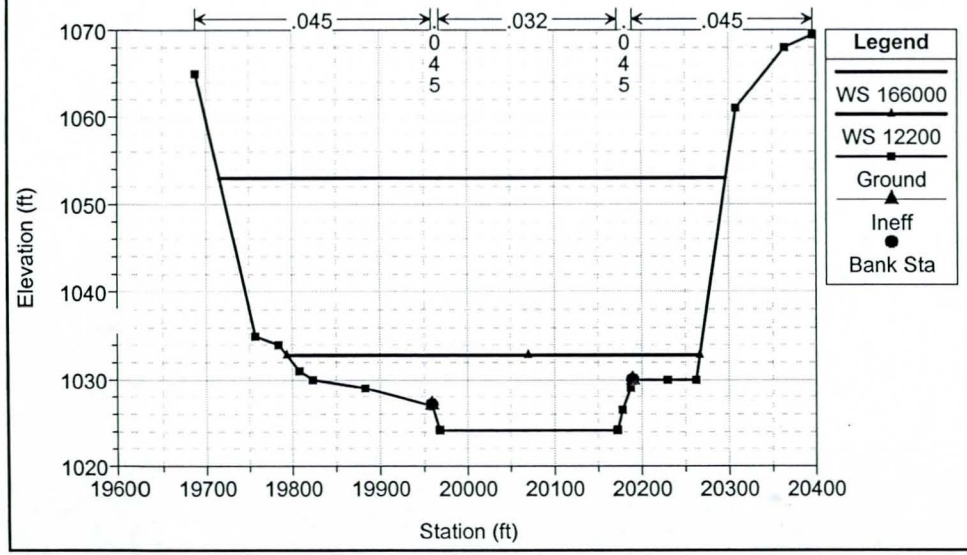
River = Rio Salado Reach = LFCD RS = 212.46



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

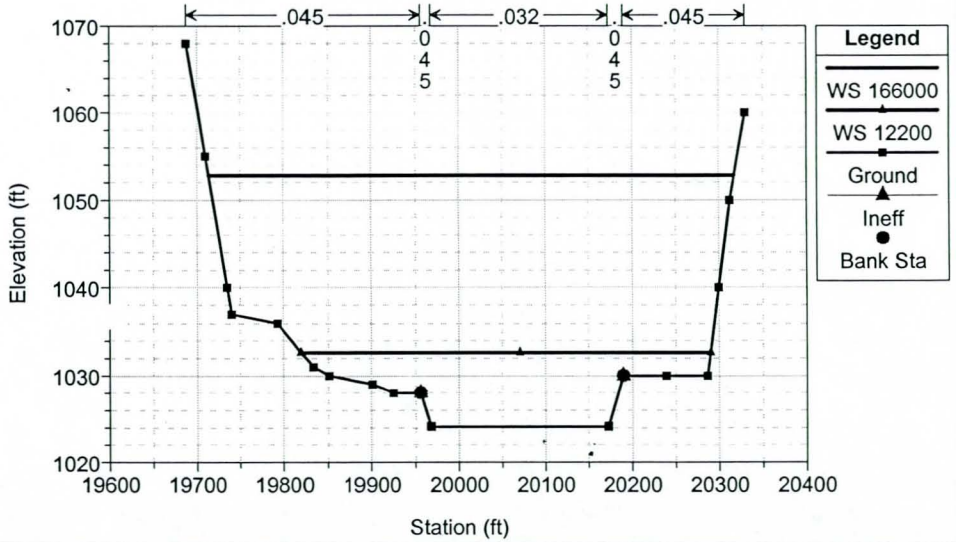
River = Rio Salado Reach = LFCD RS = 212.37



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

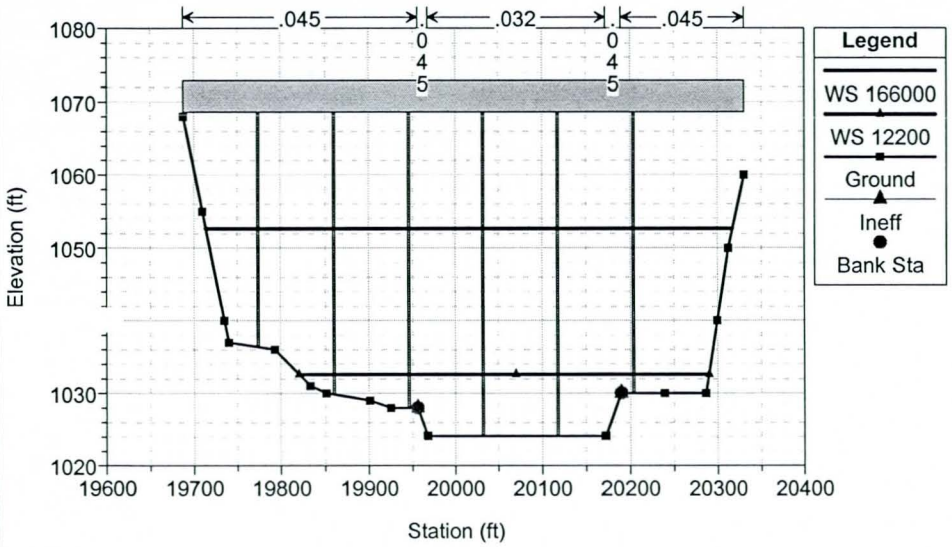
River = Rio Salado Reach = LFCD U/S Face of Conveyor Bridge RS = 212.345



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

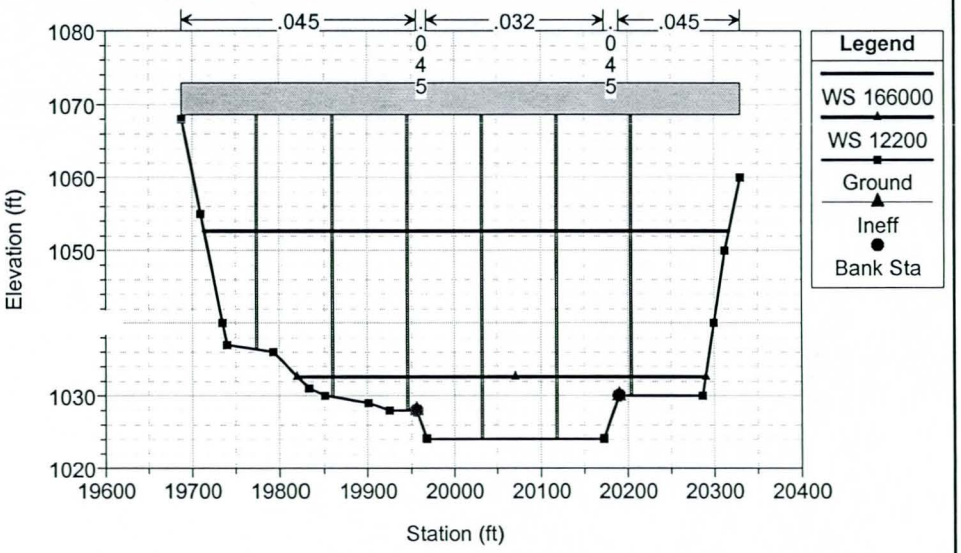
River = Rio Salado Reach = LFCD Union Rock Conveyor Bridge. Details per RS = 212.34



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

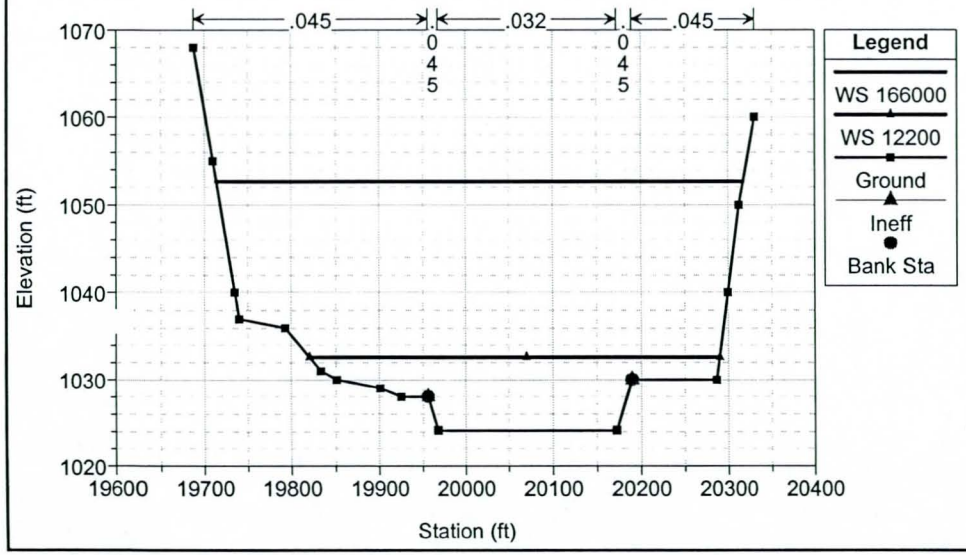
River = Rio Salado Reach = LFCD Union Rock Conveyor Bridge. Details per RS = 212.34



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

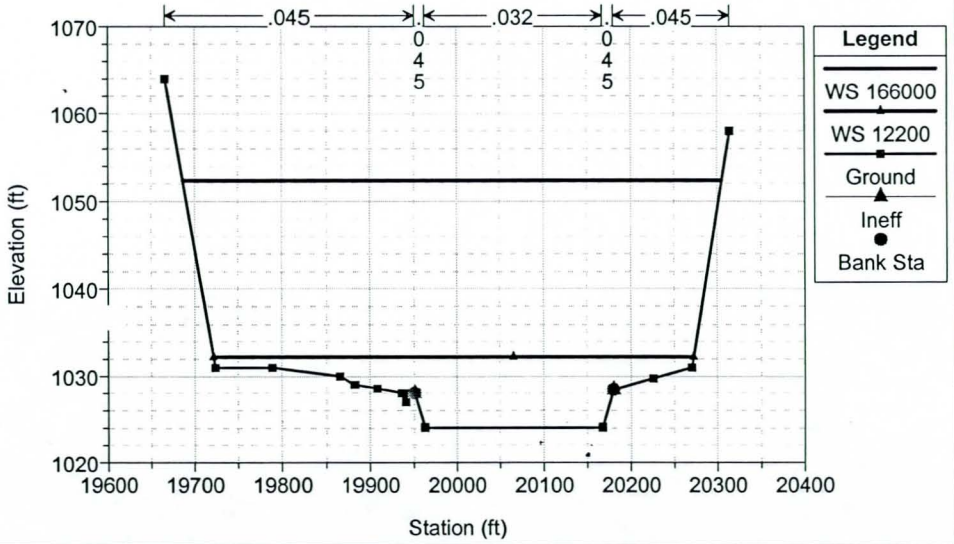
River = Rio Salado Reach = LFCD D/S Face of Conveyor Bridge RS = 212.335



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

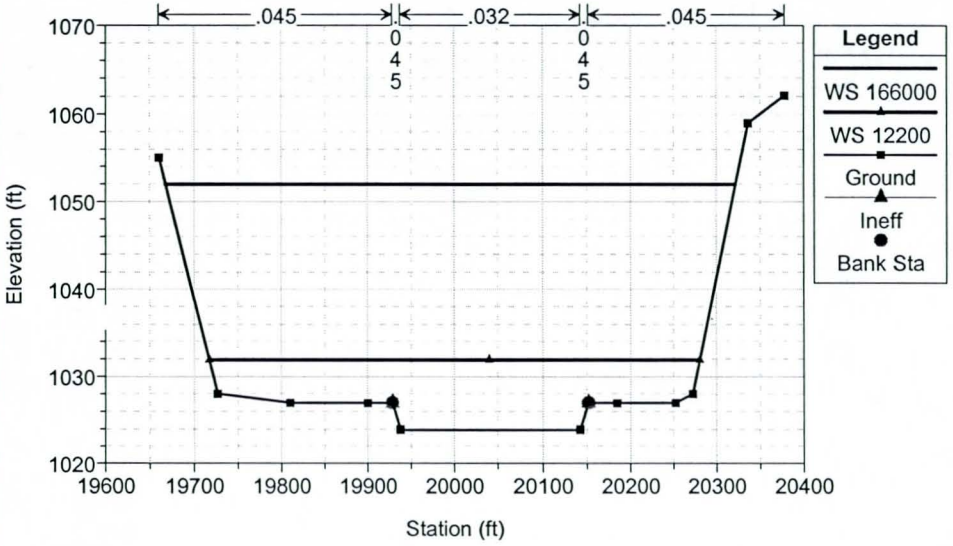
River = Rio Salado Reach = LFCD RS = 212.27



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

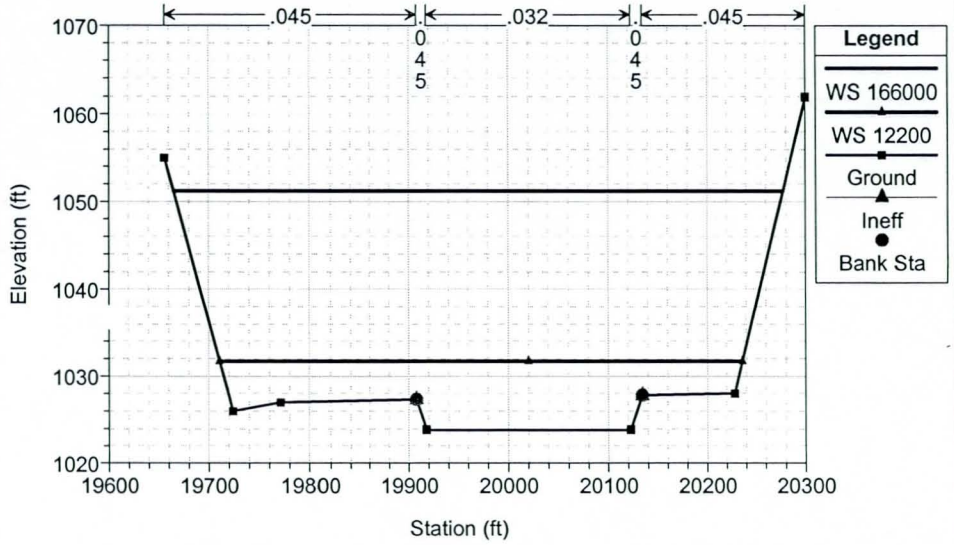
River = Rio Salado Reach = LFCD Edited Copy of 212.12 to reflect LOMR R. RS = 212.16



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

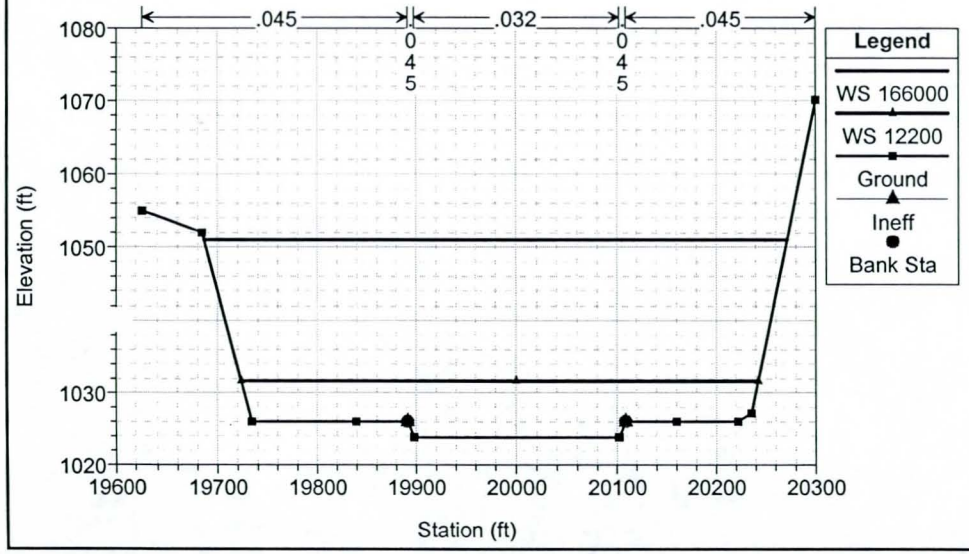
River = Rio Salado Reach = LFCD Edited Copy of 212.12 to reflect LOMR R. RS = 212.15



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

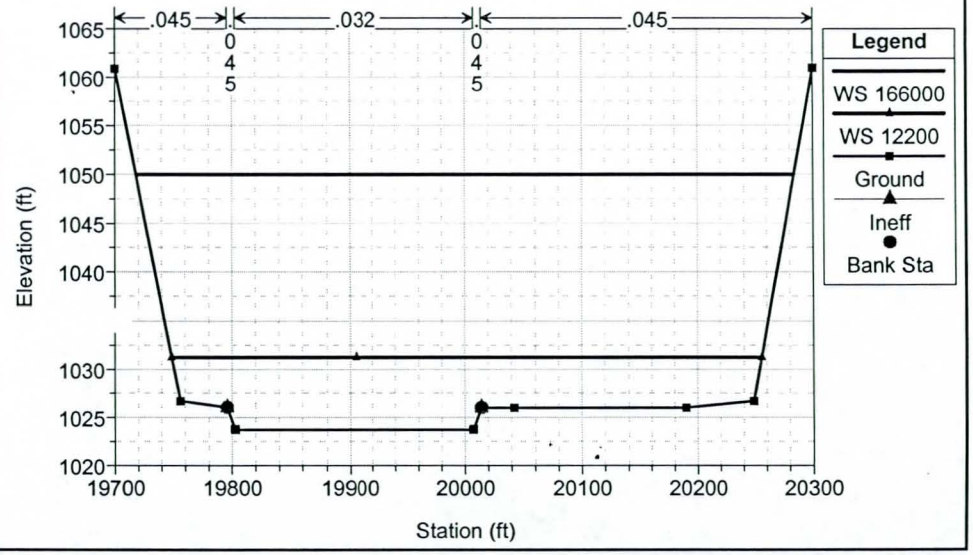
River = Rio Salado Reach = LFCD Edited to reflect LOMR R Bank Protection RS = 212.12



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

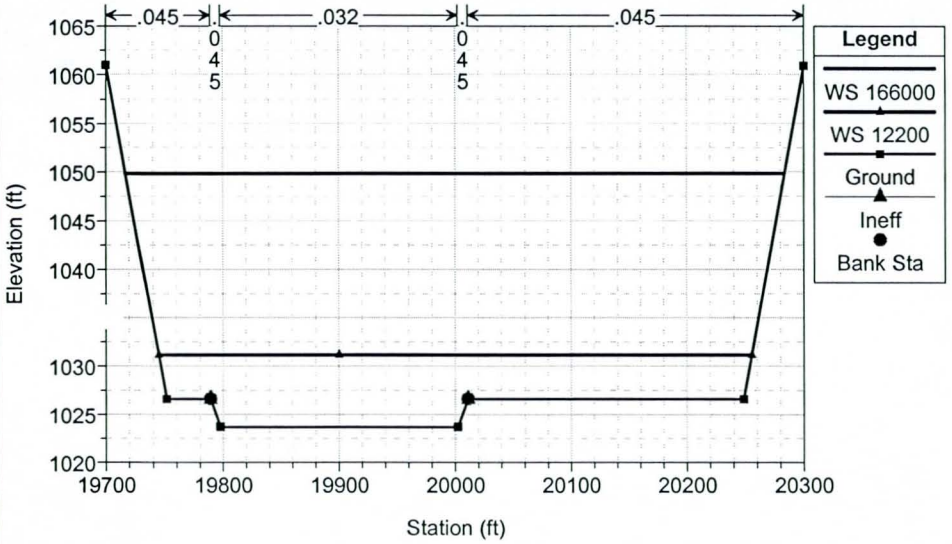
River = Rio Salado Reach = LFCD Edited Copy of 211.98. Location is 70' RS = 212.1



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

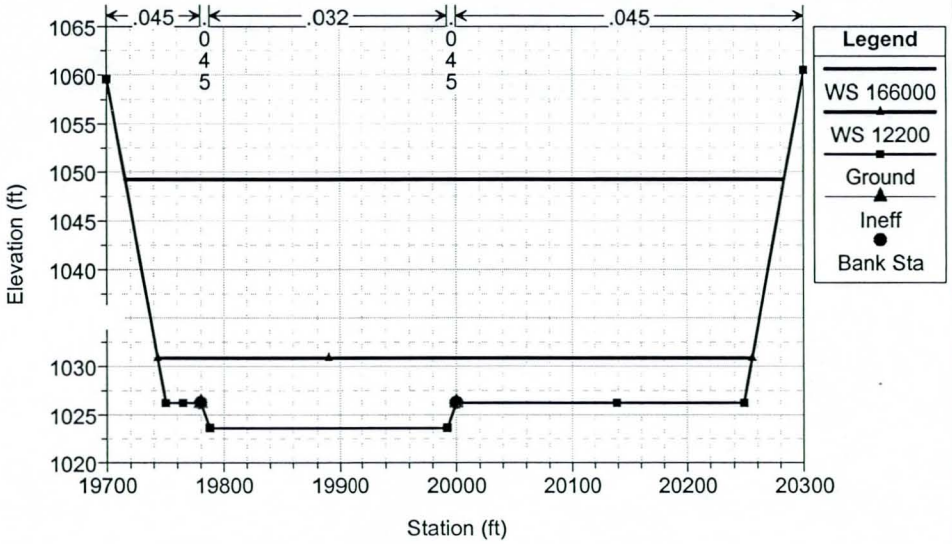
River = Rio Salado Reach = LFCD Edited Copy of 211.98. Location of Left RS = 212



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

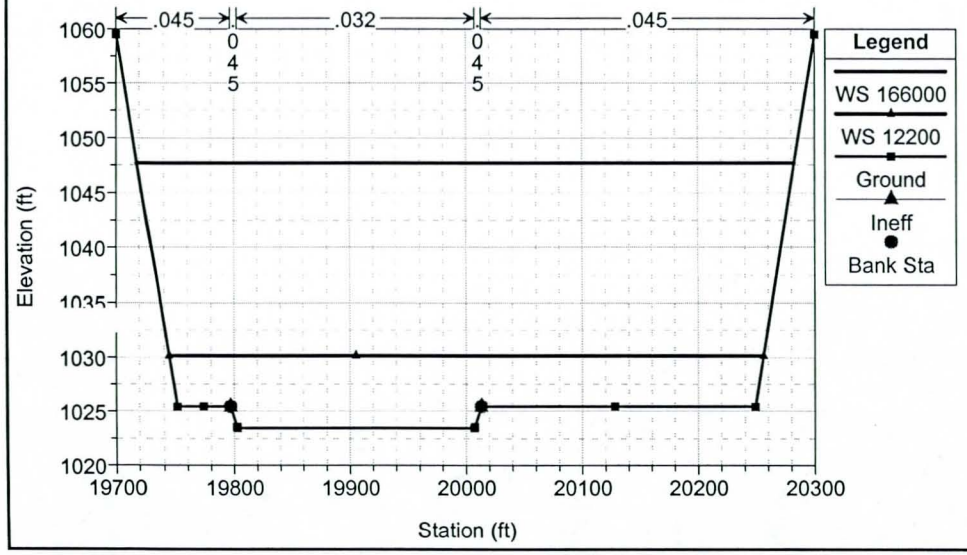
River = Rio Salado Reach = LFCD Edited to reflect LOMR Bank Protection RS = 211.98



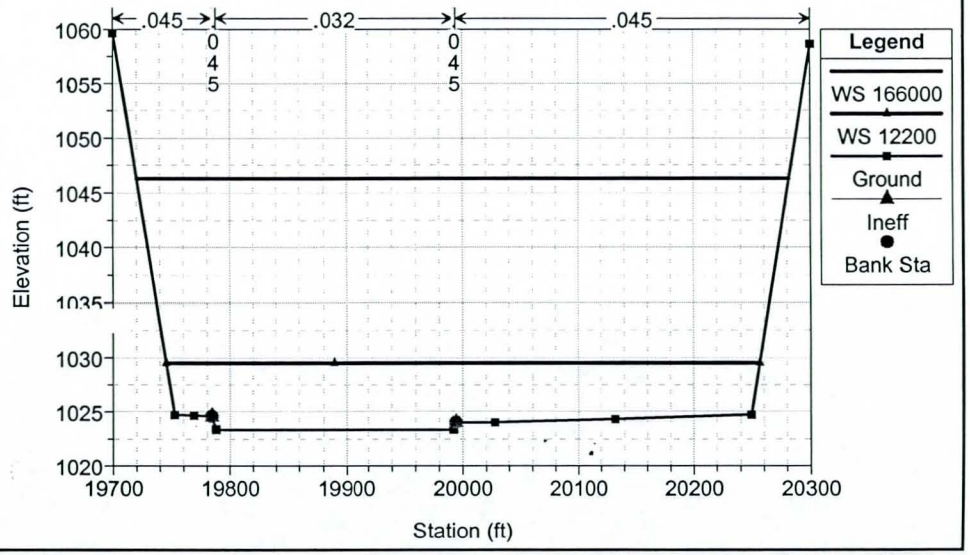
Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

River = Rio Salado Reach = LFCD Edited to reflect LOMR Bank Protection RS = 211.86



Salt River Low Flow Channel Design Low Flow Channel w/Adj. Banks 6/17/99 5:37:42 PM

Geom: Low Flow Channel w/ Adj. Banks Flow: Q100, Q5, LFCQ (12,200)

River = Rio Salado Reach = LFCD Edited to reflect LOMR Bank Protection. RS = 211.76