City of Scottsdale
Desert Greenbelt Project

VOLUME III:

REATA PASS/BEARDSLEY WASH EROSION SEDIMENTATION CONTROL AND CHANNEL IMPROVEMENT DESIGN

The Desert Greenbelt
SCOTTSDALE, ARIZONA

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EXECUTIVE SUMMARY

The Desert Greenbelt Project, located in the City of Scottsdale, Arizona, was proposed by the City and the Flood Control District of Maricopa County (FCDMC) to control the alluvial fan flows emanating from the McDowell Mountains along the Reata Pass/ Beardsley Wash Channel. Flows are primarily contributed from the Reata Pass Wash East Branch, North Reata Pass Wash, Foothills Tributary, North Beardsley Wash, South Beardsley Wash, and Thompson Peak Channel. Improvement to the existing alluvial fan drainage system will provide flood protection and erosion control to a large area currently zoned as a Special Flood Hazard Area (AO Zone) by the Federal Emergency Management Agency (FEMA). The project will also provide recreational opportunities for trails and paths; preservation of the desert environment is to be integrated with the channel improvement. Figure 1.1 illustrates the overall project.

The main project reach extends over 5.2 miles from Pinnacle Road Bridge to the Bureau of Reclamation detention basin in WestWorld. A one-mile reach upstream of Pinnacle Peak Road was included for analysis of the hydraulic, erosion, and sedimentation features, and major tributaries were studied to provide sediment inflows to the main channel.

A previous report entitled *Reata Pass/Beardsley Wash Channel Response Analysis with Ultimate Levee Encroachment*, dated February 1997, was prepared by Simons, Li & Associates, Inc., (SLA) to assess the overall channel stability based on a previous design concept, which was to confine the 100-year flood flows using levees and flood walls with minimal excavation. That report (Volume I) and its technical addendum (Volume II), which established the baseline data for sediment inflows, soils, hydrology, and natural channel responses under confinement conditions, were submitted to FEMA in February 1997 as part of an application for a Conditional Letter of Map Revision (CLOMR). The report identified the channel stability concerns, including high velocities and significant erosion/sedimentation, that need to be addressed in the channel system design.

This report (Volume III) and its technical addendum (Volume IV) present the design analysis for the Reata Pass/Beardsley Wash Channel and the resultant proposed improvements. The design addresses the channel stability concerns discussed in the February 1997 report. The design includes approximately 5.2 miles of channel improvements and earthen levee construction. Excavation of the channel invert will be required throughout much of the project. The existing high velocities are to be mitigated primarily through reduction of channel slope and hydraulic gradient using grade control/drop structures. Erosion protection is to be applied to channel invert and banks where erosion potential will occur under channel design conditions. Soil cement and articulated concrete blocks, such as Armorflex, are primary lining materials proposed for the project. Reinforced concrete lining is proposed where velocities are higher than 30 feet per second, which is the upper limit of articulated concrete block application. An erosion/sedimentation analysis was performed to determine the sediment flushing capability for the lined reaches and the aggradation and degradation potential along the movable channel reaches. The results of hydraulic and erosion/sedimentation analyses were used to determine top of levee and toe depth elevations.

The following is a brief description of the channel reaches and the proposed improvement along each reach:

Upper Reata (Pinnacle Peak Road Bridge to Deer Valley Road Alignment - Station 271+95 to 215+74)

Improvements along this reach will include a 330-foot-long concrete lined channel below Pinnacle Peak Road. The concrete channel will transition into a soil cement channel which will extend along the remainder of this reach. Within the soil cement channel, 200 feet of articulated concrete block lining is proposed where velocities exceed the erosion resistance level for soil cement and where revegetation will be needed to address aesthetic concerns. The bottom width of the channel will be maintained at 80 feet wide throughout the reach, and the side slopes will be 1 (horizontal) to 1 (vertical) up to 4 feet high. The side slopes and top widths will vary for banks higher than 4 feet.

A series of 32 concrete grade control/drop structures are proposed to reduce the existing steep slope of 3 - 4% to 1.8%, allowing velocity reduction and application of aesthetic treatment along the channel. Integration of aesthetic treatment with the flood control protection is essential for acceptance by public and neighborhood residents.

DC Ranch (Deer Valley Road Alignment to Union Hills Drive - Station 215+74 to Station 100+00)

The soil cement channel discussed above will extend from the Deer Valley Road alignment (Station 215+74) to the beginning of a transition at Station 197+00. Similar to the upstream Upper Reata reach, channel lining may be articulated concrete block where velocity is higher and revegetation is needed. The existing channel gradient is relatively steep and a series of 33 grade control/drop structures are proposed to reduce the gradient from more than 4.0% to 1.8%.

The soil cement channel will transition into a natural channel from Station 197+00 to Station 192+00. Downstream from the transition, the channel bottom will remain natural to Station 125+40. The 100-year flow will be naturally contained from Station 192+00 to about 189+00 without channel improvements. Soil cement bank protection along the natural channel is proposed from Station 189+00 on the west bank and from Station 181+20 on the east bank to Stations 161+80 and 163+00, respectively. The wide overbank areas along this reach will be filled by the DC Ranch developer to confine the 100-year flow within the defined channel. Two grade control/drop structures are to be included in the reach, with one downstream of the future Thompson Peak Parkway bridge crossing and another at about Station 179+10.

From downstream of the future Thompson Peak Parkway through the middle portion of the North Beardsley Wash confluence, the 100-year flow will be naturally contained. Earthen levees with soil cement bank protection are proposed from about Station 147+00 on the west bank and Station 133+60 on the east bank to Station 125+40. Combined flows from Reata Pass and North Beardsley

Wash will be confined by a proposed graded earth bottom channel with soil cement bank protection and grade control from Station 125+40 to upstream of future Union Hills Road crossing. From Station 125+40, the channel bottom will reduce to 180 feet downstream of Station 119+80. Soil cement bank protection and drop structures are proposed to provide erosion control. The natural channel slope of 2 to 2.5% will be reduced to 1.2% by the drop structures.

Upstream of the Future Union Hills Bridge to Upstream of the Bell Road Bridge (Station 100+00 to 48+00) and Sediment Basin

The earthen channel, with soil cement bank protection and 17 grade control/drop structures, will extend from Station 100+00 to the end of this reach. Earthen berms are to be placed where additional freeboard is required. A sediment basin with earthen bottom and soil cement bank protection is proposed upstream of the Bell Road Bridge to prevent significant aggradation due to loading from Reata Pass Wash, South Beardsley Wash and Thompson Peak Channel. In addition, an 880-foot-long pilot channel is proposed to increase the flow capacity under the bridge and to prevent flow overtopping at the bridge. A sediment basin will be constructed just upstream from the Bell Road bridge.

Bell Road Bridge to the Outlet (Station 43+60 to Station 0+00)

Earthen levees with soil cement bank protection are to be constructed along both banks of the natural channel from downstream of Bell Road to a drop structure at about Station 14+70. The channel bottom will remain natural upstream of the drop structure except for local erosion control.

Downstream of the drop structure at about Station 14+70, the channel is to be lined with soil cement for protection of a sewer line crossing and to provide a crossing for the Thompson Peak Parkway exit road. Further downstream, a sediment basin is to be constructed for reducing sediments entering the Bureau of Reclamation detention basin.

The proposed channel was designed to contain the 100-year flood flow with sufficient freeboard as required by Federal Emergency Management Agency (FEMA) and Maricopa County Flood Control District (District), except for the outlet sediment basin where the 100-year flow may overtop the west bank into an area called WestWorld. WestWorld is included in the inundation area of the Bureau of Reclamation detention basin, which is the pre-project point of disposal for flows from Reata Pass and Beardsley Washes. Flows remain supercritical throughout the project reach except for local variation and the two sediment basins.

The proposed channel will be below ground and fully lined in all critical erosion areas from Pinnacle Peak Bridge to DC Ranch golf course (Station 271+75 to 196+50) including historical alluvial fan apexes. The proposed design will ensure significantly increased safety of conveyance and reduced risk of failure and damages compared to the natural alluvial fan and the levee/wall confinement alternative proposed previously by others. Throughout the remaining reach, channel downcutting is controlled by using drop structures and grade control structures and lateral movement is controlled by using bank protection and low flow realignment. Flows are mostly contained in an excavated channel, naturally confined areas or natural channel with graded banks. Bank protection was designed with toe depths considering short-term and long-term sediment supplies as well as local scour caused by low flow impingement, contraction, channel bends, and sand wave movement.

The proposed channel improvements will require periodic routine inspection and maintenance. Three specific reaches that will need particular attention are as follows:

1. Station 192+00 to 183+00. This reach is subject to both long-term and short-term degradation, which will be controlled by grade control structures. The reach should be monitored to ensure that the structures are performing adequately.

2. Station 140+00 to 125+40. This reach receives sediments loading from North Beardsley Wash and is subject to both long-term and short-term aggradation. Levees are to be constructed in the lower reach which were designed to accomodate the anticipated sedimentation. The channel should be monitored and sediments may need to be removed to ensure that the channel capacity within the levees are sufficient. Sediment management areas should be preserved and incorporated in the future development plan.

3. Station 125+40 to 48+00. This reach will have a series of grade control structures, and the channel bottom will tend to fluctuate about the structures. Initially, the channel will degrade, but aggradation is expected over the long term. Although the channel bank and toedown were designed to accomodate both short term erosion and long term sedimentation, the reach should be monitored to ensure that the structures perform adequately and the channel capacity remains sufficient to convey the 100-year design flood.

I. INTRODUCTION

1.1 GENERAL

Simons, Li & Associates, Inc. (SLA) was retained by the City of Scottsdale to provide design and analysis of a flood control system for the City of Scottsdale Desert Greenbelt Project in Maricopa County, Arizona. The project confines flows from Reata Pass and Beardsley Washes, which are located in the northeastern portions of the City of Scottsdale. The main project reach extends approximately 5.2 miles from Pinnacle Peak Road Bridge to the Bureau of Reclamation detention basin in WestWorld (see Figure 1.1). A one-mile reach upstream of Pinnacle Peak Road was included for analysis of the hydraulic, erosion, and sedimentation features, and major tributaries were studied to provide sediment inflows to the main channel.

The Reata Pass and Beardsley Washes originate from the McDowell Mountains located in northeast Scottsdale. The sediment-laden flow within these washes is transported downstream through steep washes to the desert plain. Sediments are primarily supplied from Reata Pass Wash, North Reata Pass Wash, a tributary south of Foothills Drive Bridge (referred to as Foothills Tributary), North Beardsley Wash, South Beardsley Wash, and Thompson Peak Channel. The Reata/Beardsley alluvial fans were formed along the desert plains, creating a wide floodplain within the study area. In addition to flood hazards, the alluvial fan channels are subject to dynamic changes as a result of erosion and sedimentation.

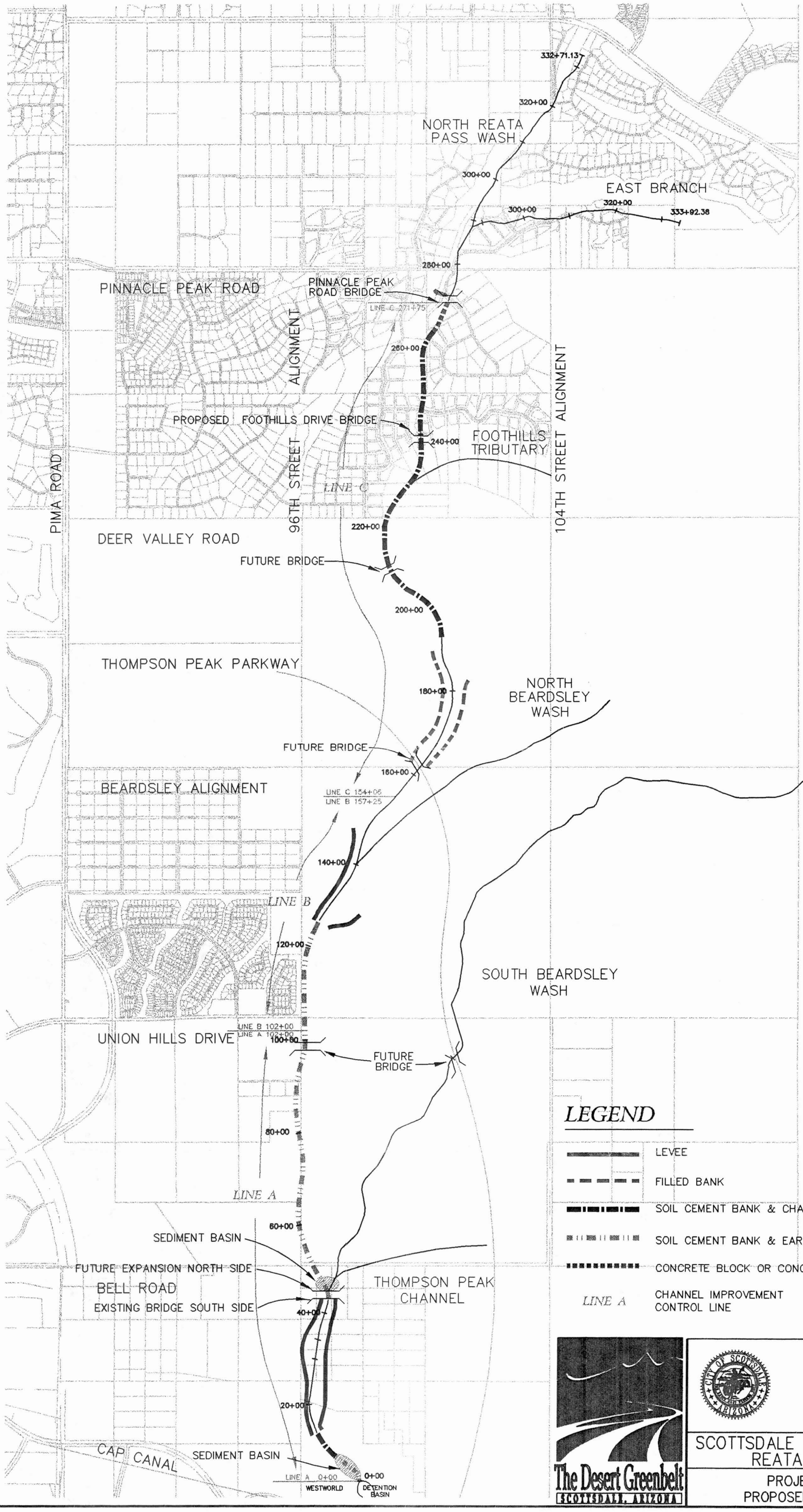

FIGURE 1.1

The Desert Greenbelt
SCOTTSDALE, ARIZONA

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3939 CIVIC CENTER BLVD.
SCOTTSDALE, ARIZONA 85251

SCOTTSDALE DESERT GREENBELT
REATA PASS WASH

PROJECT REACH &
PROPOSED IMPROVEMENTS

The Desert Greenbelt Project was proposed by the City of Scottsdale and Maricopa County to control the alluvial fan flows along the main channel of Reata Pass/ Beardsley Wash channel. As a result, existing and future developments within the current floodplain will be protected, and the existing floodplain can be reduced. In concert with the City's planning goal, the channel improvement design will incorporate paths, trails, environmental preservation, and aesthetic treatment.

1.2 PREVIOUS REPORT

A report entitled *Reata Pass / Beardsley Wash Channel Response Analysis with Ultimate Levee Encroachment*, prepared by SLA, dated February 1997, assessed the overall channel stability under floodplain encroachment conditions previously proposed by the URS/Greiner Inc. As part of that investigation, SLA performed a detailed hydraulic and erosion/sedimentation analysis of the previously proposed project. To determine the sediment inflow contributions to the main channel, the channels upstream of Pinnacle Peak Road Bridge (North Reata Pass and the main channel) and all lateral tributaries (Foothills Tributary, North Beardsley Wash, and South Beardsley Wash and Thompson Peak Channel) were studied. Analyses were performed for various flood frequencies considering short- and long-term sediment supply conditions. That report summarized the channel stability concerns that need to be addressed. The concerns include high velocities (supercritical flow throughout most of channel reaches) and the extent of erosion and sedimentation (channel downcutting, channel aggradation, and bank failure.)

The report mentioned above and its technical addendum were submitted to the Federal Emergency Management Agency (FEMA) in February 1997 as Volumes I and II respectively for application of a Conditional Letter of Map Revision (CLOMR). Hydrology, soils and sediment inflow data presented in Volumes I and II were used for the design analysis presented in this report. Models for hydraulic and sediment transport analyses described in Volumes I and II were applied to analysis of the proposed channel.

1.3 OBJECTIVES OF CURRENT REPORT

Based on results of the alluvial fan encroachment analysis reported in Volumes I and II, it was found that channel stability and structural safety (including bridges, levees and flood walls) may not be ensured without a comprehensive erosion/sedimentation control system including slope reduction and grade control along the channel. The high levees and walls addressed in the previous study would be subject to highly erosive flows with potential risk to the lives of residents and to structures located within the existing floodplain. Reaches identified in Volume I to be of particular concern included Station 262+00 to Station 232+50, Station 205+00 to Station 201+00, and Station 22+50 to Station 16+50 (Volume I stationing). Total scour depths in these reaches ranged from 10 feet to 21 feet. Therefore, the previously proposed design prepared by URS/Greiner, Inc., (80% Design Plans) was revised from the "levee confinement" alternative to a "channel containment alternative" for reaches along the existing housing areas (Upper Reata from Pinnacle Peak Road to Deer Valley Road alignment) as well as future developments (downstream of Upper Reata to Bell Road). An exception to this is the North Beardsley confluence area where levees with natural channel were found to be the best alternative to manage the dynamic sediment transport condition at the confluence prior to development along the North Beardsley Wash.

The proposed channel includes sufficient capacity to convey the 100-year design flood and necessary channel lining, bank protection, and grade control/drop structures to limit channel migration and downcutting. The design was based on a comprehensive hydraulic, erosion and sedimentation analysis considering both short- and long-term performance.

This report and its technical addendum are Volumes III and IV for the CLOMR submittal for the Desert Greenbelt Project (refer to Section 1.5, Volume I). Volume III presents the proposed design from Pinnacle Peak Road to the outlet at WestWorld and the hydraulic, erosion, and sedimentation analyses for the proposed channel. Volume IV contains detailed back up data and design support documents.

II. PROPOSED CHANNEL IMPROVEMENTS

Figure 1.1 provides an overview of the proposed improvements. This chapter provides descriptions of the proposed improvement. Sheets 1 through 5 show types of improvements, channel/levee alignments and locations of grade control structures and sediment basins. Sheets 6 through 10 show channel invert, top of banks, toedown elevation, adjacent ground, water surface, velocity and width profiles. Sheet 11 shows levee profiles and Sheet 12 show typical sections. It should be noted that the control line for this proposed channel design is not the same as the control line for the conceptual plan shown as part of the February 1997 report Volumes I and II.

In general, the design is based on a system of grade control/drop structures, which will control the vertical movement of the channel, and bank protection, which will control the horizontal alignment and velocities. Levees or constructed channel banks are proposed to confine the flow. The construction materials proposed are based on the flow velocities that are anticipated for the design conditions. In reaches where the velocity exceeds 30 feet per second (fps), concrete must be used for construction. Articulated concrete block such as Armorflex and Petraflex, will be used for construction in reaches where the velocities are less than 30 fps and where revegetation is required for environmental and aesthetic reasons. Soil cement will be used for construction along channel reaches where the flow velocity is less than 25 fps.

Each grade control structure will be constructed with a hard bottom apron downstream of the drop such as articulated concrete blocks to resist erosion associated with high velocity downstream of the drop.

The following is a detailed description of the channel improvements that are proposed for each reach and the physical conditions that influence the design selection.

2.1 UPPER REATA (UPSTREAM OF PINNACLE PEAK ROAD TO DEER VALLEY ROAD ALIGNMENT - STATION 271+95 TO 215+74)

The project begins at the Pinnacle Peak Road Bridge. The existing invert of the bridge controls the upstream invert of the proposed channel. The upstream portion of the Reata Pass Wash / Beardsley Wash Channel is characterized by steep slopes which result in velocities up to 33 feet per second (fps). To provide the protection needed for these velocities, the proposed channel from Station 271+95 to Station 266+20 will be concrete lined. Near Station 266+20 the velocities have decreased to the point where articulated concrete block can be used for the channel construction. The articulated concrete block will extend to Station 264+20, at which point the velocities have decreased enough that soil cement can be used for the channel construction. The soil cement construction will continue to the end of this reach. Soil cement will be used for construction along channel reaches where the flow velocity is less than 25 fps. Articulated concrete blocks will be applied to the high velocity area downstream of each drop structure. The channel to the end of the reach will be a trapezoidal section with an 80-foot wide bottom width and varying side slopes. There are 32 grade control/drop structures proposed in this reach.

2.2 DC RANCH (DEER VALLEY ROAD ALIGNMENT TO UPSTREAM OF UNION HILLS DRIVE) (STATION 215+74 TO 100+00)

The soil cement channel, including grade control structures, will extend from the upstream reach to Station 192+00. The bottom width of the trapezoidal channel will transition from 80 feet at Station 211+00 to 130 feet at Station 208+50. Velocities along this reach are less than 25 fps; therefore, soil cement will be used for construction. Articulated concrete blocks will be applied to downstream of grade control structures or where aesthetic treatment is desirable.

The soil cement channel will transition into a natural channel between Station 196+50 and Station 192+00. Flow is fully contained in the transition channel down to Station 195+00. The natural channel bottom will then extend to Station 125+40. Maximum design velocities within the natural channel will vary from 10 fps to 18 fps. Soil cement bank protection along the natural channel is proposed from about Station 195+00 (centerline stationing) on the west bank and Station 181+10 on the east bank (centerline stationing) down to Station 162+00 on the west bank and Station 163+00 on the east bank. No protection along the east bank is provided between Station 195+00 to Station 181+10 because the channel is naturally protected by the existing mountain slope. Grade control structures will be provided near Station 192+00, downstream of 183+00, and Station 164+00.

A levee is proposed from Station 147+00 on the west bank and Station 133+60 on the east bank to Station 125+40. The bank protection and levees limit the extent of the 100-year floodplain. The alignment of the levee along the west bank was chosen in order to direct flow from North Beardsley Wash into the improved channel.

Between Stations 125+40 and 120+00, the channel transitions into an earthen, trapezoidal channel with a 180-foot bottom width, soil cement bank protection, and grade control structures which extends to the end of this reach. The control elevation for the reach from DC Ranch to Union Hills Drive is the existing invert at the Union Hills Bridge.

2.3 UPSTREAM OF UNION HILLS DRIVE TO BELL ROAD BRIDGE (STATION 100+00 TO 46+50) AND BELL ROAD SEDIMENT BASIN

The upstream earthen channel with soil cement bank protection and grade control structures will extend to Station 48+00. Seventeen grade control/drop structures are proposed along this reach. At Station 48+00, flow will be directed into a 4-foot deep sediment basin with soil cement bank protection. This basin will extend to the Bell Road Bridge. The control

elevation along this reach is the existing invert at Bell Road Bridge.

2.4 BELL ROAD BRIDGE TO THE OUTLET (DOWNSTREAM OF STATION 46+50)

Downstream of Bell Road, the proposed channel will be an earthen trapezoid with soil cement protected levees on the west and east bank to Station 15+00. A pilot channel with soil cement bank protection is proposed from Bell Road to Station 35+60 to direct the low flow along the centerline of the channel. At Station 15+00 the channel transitions at a grade control structure into a soil cement lined channel. This channel continues to Station 10+00 where flow will enter a four-foot-deep sediment basin. This basin will have soil cement bank protection on the west bank and will extend to the downstream limit of the project. At that point a soil cement grade control structure will direct flow into the existing WestWorld detention basin. The two grade control structures along this reach will be constructed of soil cement.

III. HYDRAULIC ANALYSIS

Hydraulic analysis was performed for the following two objectives:

(1) Determination of design bank and levee elevations using the 100-year flood water surface profile and other hydraulic parameters. Peak flows for the 100-year flood range from 11,236 cubic feet per second (cfs) at Pinnacle Peak Road to 15,265 cfs at the downstream end of the project.

(2) Preparation of hydraulic parameters of 2-, 5-, 10-, 25-, 50-, and 100-year floods for sediment transport computations, erosion and sedimentation analysis

This chapter describes the hydraulic methodologies and result summary; application of hydraulic parameters for bank/levee flow containment and erosion and sedimentation control is presented in the following chapters. The Technical Addendum, Volume IV, contains the detailed information and back up computations.

Generally speaking, the proposed channel exhibits supercritical flow characteristics except for the backwater reach at to the Bureau of Reclamation detention basin at the downstream end of the project. The design flow velocities will remain high throughout the supercritical flow reach, similar to the levee confinement alternative presented previously in Volumes I and II. The high erosion potential resulting from the high velocities will be mitigated by the proposed lining, bank protection, and grade controls.

3.1 METHODOLOGY AND MODEL DATA

3.1.1 Hydraulic Model

Both HEC-2 and HEC-RAS Models, developed by U.S. Army Corps of Engineers, were used in the hydraulic analysis, and the two models produced consistent results. Since the HEC-2 Model is part of the sediment routing model selected for the Desert Greenbelt Project (refer to Volumes I and II and Chapter IV of this report), HEC-2 model results are presented in this report (Volume III) and its Technical Addendum (Volume IV).

The hydraulic characteristics presented in this chapter are based on the results from both the supercritical and subcritical HEC-2 analysis. The results were further combined to reflect the expected flow regimes and water surface elevations along the entire project reach. To be conservative, the results of the subcritical model (which produces critical water surface for supercritical flows) were used to determine the levee heights.

3.1.2 Channel Data and Reach Definition

A total of 389 cross sections (including 20 sections for upstream sediment inflow areas) was included in the hydraulic and erosion/sedimentation analysis. Natural ground cross sectional data were obtained from topographic data provided by the City of Scottsdale, and the improved section was prepared according to the proposed design. The cross sectional locations follow the channel improvement control line which can be found on the plans (see Figures 1.1 and 3.1).

For erosion/sedimentation analysis, the 389 sections were divided into 71reaches based on channel design features as well as hydraulic characteristics (described later in this chapter). Figure 3.1 shows the extent of each study reach.

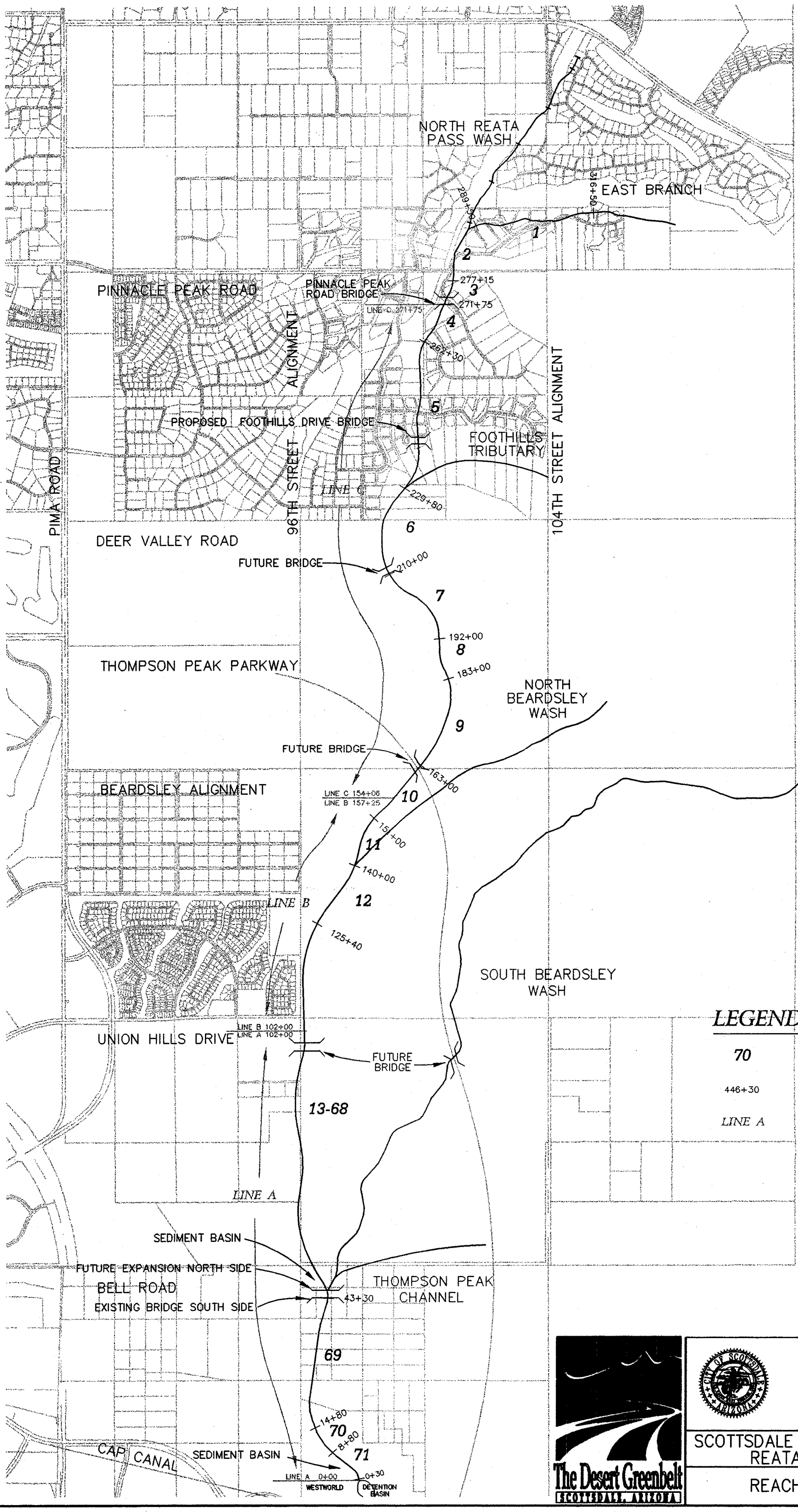

FIGURE 3.1

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SCOTTSDALE DESERT GREENBELT
REATA PASS WASH

REACH DEFINITIONS

3.1.3 Design Discharges

The design discharges along the proposed channel were determined using results from the HEC-1 Model summarized in Chapter II of Volume I. The 2-, 10-, 25-, 50-, and 100-year discharges are shown in Table 3.1.

3.1.4 Starting Water Surface Elevation

For the subcritical flow model, the downstream water surface control is at the existing WestWorld detention basin. Elevation 1528.1 ft mean sea level was used as the backwater control for the 100 -year flood peak discharge which was obtained from a report produced by the Bureau of Reclamation (see Volume IV). For sediment routing, the slope-area method was used for computing downstream elevations for various flow discharges in a hydrograph.

3.1.5 Manning's *n* Value

Manning's *n* values, representing the roughness of the natural channel bottom were first determined based upon field evaluation of vegetation conditions revealed in the aerial photographs. The *n* values were estimated at 0.040-0.050 for the natural bottom channel with vegetation (see Section 3.1, Volume I). For natural bottom channel reaches (Station 192+00 to 125+40 and 43+58 to 14+80) a Manning's *n* value of 0.050 was used in the hydraulic model analysis to account for high resistance due to vegetation growth. For earth bottom channel reaches between grade controlling structures, where vegetation will be controlled by channel maintenance (Station 125+40 to 48+00) and at the sediment basins (Station 48+00 to 44+63 and Station 10+00 to 0+00), a Manning's *n* value of 0.03 was used in the hydraulic model. The results were used to confirm that the design bank heights are adequate and/or to establish levee heights to contain the 100-year flood flows with required freeboard. (Chapter V addresses freeboard requirements.)

Table 3.1 Reach Definitions and Design Discharges

REACH DEFINITIONS and DESIGN DISCHARGES For Sediment Transport Computations								
Reach #	Station		Design Discharge Range (cfs)					
	From	To	100-Yr	50-Yr	25-Yr	10-Yr	5-Yr	2-Yr
1	316+50	289+50	5,766	4,823	3,803	2,684	1,896	1,022
2	289+50	277+15	11,236	9,324	7,438	5,069	3,689	2,027
3	277+15	271+75	11,236	9,324	7,438	5,069	3,689	2,027
4	271+75	262+30	11,236	9,324	7,438	5,069	3,689	2,027
5	262+30	229+80	11,236	9,324	7,438	5,069	3,689	2,027
6	229+80	210+00	11,742	9,538	7,644	5,227	3,827	2,162
7	210+00	192+00	11,742	9,538	7,644	5,227	3,827	2,162
8	192+00	183+00	11,742	9,538	7,644	5,227	3,827	2,162
9	183+00	163+00	11,742	9,538	7,644	5,227	3,827	2,162
10	163+00	151+00	11,742	9,538	7,644	5,227	3,827	2,162
11	151+00	140+00	10,579	8,751	6,838	4,745	3,537	2,044
12	140+00	125+40	12,814	10,496	8,208	5,666	4,222	2,456
13	125+40	124+40	12,814	10,496	8,208	5,666	4,222	2,456
14	124+40	121+90	12,814	10,496	8,208	5,666	4,222	2,456
15	121+90	121+40	12,814	10,496	8,208	5,666	4,222	2,456
16	121+40	119+80	12,814	10,496	8,208	5,666	4,222	2,456
17	119+80	119+30	12,814	10,496	8,208	5,666	4,222	2,456
18	119+30	117+00	12,814	10,496	8,208	5,666	4,222	2,456
19	117+00	116+50	12,814	10,496	8,208	5,666	4,222	2,456
20	116+50	114+60	12,814	10,496	8,208	5,666	4,222	2,456
21	114+60	114+10	12,814	10,496	8,208	5,666	4,222	2,456
22	114+10	112+00	12,814	10,496	8,208	5,666	4,222	2,456
23	112+00	111+50	12,814	10,496	8,208	5,666	4,222	2,456
24	111+50	109+60	12,814	10,496	8,208	5,666	4,222	2,456
25	109+60	109+10	12,814	10,496	8,208	5,666	4,222	2,456
26	109+10	107+60	12,814	10,496	8,208	5,666	4,222	2,456
27	107+60	107+10	12,814	10,496	8,208	5,666	4,222	2,456
28	107+10	105+50	12,814	10,496	8,208	5,666	4,222	2,456
29	105+50	105+00	12,814	10,496	8,208	5,666	4,222	2,456
30	105+00	103+00	12,814	10,496	8,208	5,666	4,222	2,456
31	103+00	101+00	12,814	10,496	8,208	5,666	4,222	2,456
32	101+00	99+20	12,814	10,496	8,208	5,666	4,222	2,456
33	99+20	98+10	12,185	9,821	7,721	5,319	3,976	2,338
34	98+10	96+00	12,185	9,821	7,721	5,319	3,976	2,338
35	96+00	95+50	12,185	9,821	7,721	5,319	3,976	2,338
36	95+50	93+50	12,185	9,821	7,721	5,319	3,976	2,338

Table 3.1 Reach Definitions and Design Discharges (Cont.)

REACH DEFINITIONS and DESIGN DISCHARGES (cont.) For Sediment Transport Computations								
Reach #	Station		Design Discharge Range (cfs)					
	From	To	100-Yr	50-Yr	25-Yr	10-Yr	5-Yr	2-Yr
37	93+50	93+00	12,185	9,821	7,721	5,319	3,976	2,338
38	93+00	91+50	12,185	9,821	7,721	5,319	3,976	2,338
39	91+50	91+00	12,185	9,821	7,721	5,319	3,976	2,338
40	91+00	89+50	12,185	9,821	7,721	5,319	3,976	2,338
41	89+50	89+00	12,185	9,821	7,721	5,319	3,976	2,338
42	89+00	87+50	12,185	9,821	7,721	5,319	3,976	2,338
43	87+50	87+00	12,185	9,821	7,721	5,319	3,976	2,338
44	87+00	82+50	12,185	9,821	7,721	5,319	3,976	2,338
45	82+50	82+00	12,185	9,821	7,721	5,319	3,976	2,338
46	82+00	80+50	12,185	9,821	7,721	5,319	3,976	2,338
47	80+50	80+00	12,185	9,821	7,721	5,319	3,976	2,338
48	80+00	74+00	12,185	9,821	7,721	5,319	3,976	2,338
49	74+00	73+50	12,185	9,821	7,721	5,319	3,976	2,338
50	73+50	71+00	12,185	9,821	7,721	5,319	3,976	2,338
51	71+00	70+50	12,185	9,821	7,721	5,319	3,976	2,338
52	70+50	68+50	12,185	9,821	7,721	5,319	3,976	2,338
53	68+50	68+00	12,185	9,821	7,721	5,319	3,976	2,338
54	68+00	66+00	12,185	9,821	7,721	5,319	3,976	2,338
55	66+00	65+50	12,185	9,821	7,721	5,319	3,976	2,338
56	65+50	63+50	12,185	9,821	7,721	5,319	3,976	2,338
57	63+50	63+00	12,185	9,821	7,721	5,319	3,976	2,338
58	63+00	61+00	12,185	9,821	7,721	5,319	3,976	2,338
59	61+00	60+50	12,185	9,821	7,721	5,319	3,976	2,338
60	60+50	58+50	12,185	9,821	7,721	5,319	3,976	2,338
61	58+50	58+00	12,185	9,821	7,721	5,319	3,976	2,338
62	58+00	53+00	12,185	9,821	7,721	5,319	3,976	2,338
63	53+00	52+50	12,185	9,821	7,721	5,319	3,976	2,338
64	52+50	50+00	12,185	9,821	7,721	5,319	3,976	2,338
65	50+00	49+50	12,185	9,821	7,721	5,319	3,976	2,338
66	49+50	48+00	12,185	9,821	7,721	5,319	3,976	2,338
67	48+00	44+58	12,185-15,265	9,821-12,231	7,721-9,546	5,319-6,613	3,976-5,031	2,338-3,065
68	44+58	43+30	15,265	12,231	9,546	6,613	5,031	3,065
69	43+30	14+80	15,265	12,231	9,546	6,613	5,031	3,065
70	14+80	8+80	15,265	12,231	9,546	6,613	5,031	3,065
71	8+80	0+30	15,265	12,231	9,546	6,613	5,031	3,065

In order to allow conservative estimates of the sediment transport and aggradation/degradation analyses and resistance reduction under high-flow conditions, the hydraulic parameters were computed using a lower limit Manning's *n* value of 0.030 for natural invert reaches. This value was also used for graded, unlined channel reaches that will be maintained and for sediment basins. The results of this low Manning's *n* hydraulic analysis were used in the sediment transport analysis (Level II and Level III, Chapter IV).

For lined channel invert reaches, Manning's *n* of 0.025 was applied to soil cement, 0.025 to 0.030 was used for articulated concrete block, and 0.015-0.017 was used for reinforced concrete. The selected *n* values for the lined reaches are based on Maricopa County standards (see Volume IV). It should be noted that vegetation will be placed along the channel banks and downstream of drop structures within part of concrete block aprons, which may increase the actual flow resistance and reduce flow velocities. According to the aesthetic treatment requirements set forth for the Desert Greenbelt Project, soil cement channel lining will remain rough from construction, which will also increase the actual flow resistance and reduce the actual velocities compared to the computations performed in the study.

3.1.6 Bridges

There are two existing bridges, Pinnacle Peak Road Bridge (Station 272+15) and Bell Road Bridge (Station 44+08), and one proposed bridge at Foothills Drive (Station 240+81) included in the hydraulic models. Three future bridges were also included in the hydraulic model, at DC Ranch Golf Course (Station 211+86), Thompson Peak Parkway (Station 164+65), and future expansion of the upstream side of the Bell Road Bridge. The six bridges were modeled using the Special Bridge method. Volume IV contains cross section data that define the geometry of the bridges, including spans and piers.

3.1.7 Sediment Basins

The hydraulic model results presented in this chapter are based upon both of the sediment basins being full to the channel design gradeline. A hydraulic analysis considering the sediment basins empty was performed to confirm that the 100-year flood water surface will be contained in the proposed channel.

3.2 HYDRAULIC SUMMARY

The 100-year flood water surface, velocity and width profiles are presented in the profile sheets (Sheets 6 through 10), Table 3.2, and Figure 3.2. The 10-year flood velocity and width variations are shown in Figure 3.3. The computed hydraulic information shown in Table 3.2, Figure 3.2, and the profile sheets are based on low Manning's *n* of 0.03 for natural bottom reaches, sediment basins full (to channel design grade line), and downstream backwater (1528.1 feet MSL) at the outlet. For the 10-year flood, a normal depth elevation was used at the outlet without backwater control. Detailed hydraulic model data and summaries for the 2-, 5-, 10-, 25-, 50-, and 100-year floods are contained in Volume IV.

The entire study reach was divided into 71subreaches as shown in Figures 3.2 and 3.3 based on velocity and width variation and design features. The station limits for each subreach are shown in Figure 3.1 and Table 3.1. Average hydraulic parameters for each subreach were obtained for sediment transport analysis by applying the distance weighting factor to each section. The results are summarized in Tables 3.3 and 3.4 for the 100- and 10-year floods, respectively. Note that effective width, which is defined as the flow area divided by the representative flow depth (thalweg depth is the representative depth for Reata Pass/Beardsley Wash) , in lieu of top width is shown in these tables. Low Manning's *n* value of 0.03 for natural bottom channel and maintained earthen channel, sediment basins full, and no backwater control were assumed for hydraulic computations for sediment transport analysis.

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs) total	Elevation (ft) thalweg	Elevation (ft) water sfc	Depth (ft)	channel velocity	Topwidth (ft)	Energy Slope	Froude #
316.50	5766	2309.6	2313.2	3.6	7.7	426.0	0.0285	1.0
313.50	5766	2300.1	2302.5	2.4	15.6	370.5	0.0290	2.7
310.50	5766	2291.9	2295.6	3.7	8.5	385.8	0.0283	1.1
307.50	5766	2282.5	2285.9	3.4	14.8	259.4	0.0317	2.1
304.50	5766	2273.5	2276.0	2.5	10.6	368.8	0.0318	1.5
301.50	5766	2262.9	2267.8	4.9	12.4	213.7	0.0253	1.5
298.50	5766	2256.2	2259.8	3.6	13.1	226.1	0.0280	1.7
295.50	5766	2247.4	2251.2	3.8	11.9	293.7	0.0282	1.6
292.50	5766	2237.9	2243.4	5.5	11.9	243.9	0.0273	1.5
289.50	11236	2228.6	2234.4	5.8	12.9	491.6	0.0333	1.7
288.00	11236	2224.2	2227.5	3.3	15.6	392.3	0.0393	2.0
286.50	11236	2217.7	2222.6	4.9	12.9	504.6	0.0352	1.7
284.15	11236	2210.8	2216.1	5.3	11.8	529.7	0.0276	1.5
280.30	11236	2200.8	2205.6	4.8	13.4	369.8	0.0321	1.6
277.15	11236	2194.6	2199.4	4.8	14.7	182.3	0.0344	1.3
276.95	11236	2188.6	2192.2	3.6	24.7	134.9	0.0460	2.4
275.40	11236	2183.9	2188.8	4.9	20.4	130.0	0.0318	1.8
272.45	11236	2174.9	2178.4	3.5	25.8	130.2	0.0308	2.5
272.35	11236	2174.2	2177.9	3.7	26.1	117.9	0.0650	2.4
271.95	11236	2173.5	2178.1	4.6	20.7	117.9	0.0500	1.7
271.75	11236	2173.0	2177.4	4.4	21.5	118.0	0.2550	1.8
271.74	11236	2169.0	2172.5	3.5	27.4	118.0	0.2571	2.6
271.60	11236	2168.5	2171.9	3.4	27.7	118.2	0.0171	2.6
271.40	11236	2167.8	2171.2	3.4	28.1	118.1	0.0187	2.7
270.65	11236	2165.3	2171.3	6.0	26.4	73.2	0.0187	1.9
270.55	11236	2165.0	2170.7	5.7	27.0	76.2	0.0147	2.0
269.80	11236	2163.0	2169.5	6.5	27.6	67.4	0.0113	2.0
269.65	11236	2162.8	2168.7	5.9	28.3	71.0	0.0117	2.1
269.55	11236	2162.7	2167.8	5.1	29.1	80.3	0.0111	2.3
268.00	11236	2160.7	2165.8	5.1	29.3	80.2	0.1186	2.4
267.96	11236	2156.7	2161.9	5.2	32.4	72.3	0.1223	2.6
267.50	11236	2156.7	2161.4	4.7	32.0	79.4	0.0229	2.7
266.20	11236	2154.4	2158.7	4.3	30.7	88.5	0.1464	2.7
266.17	11236	2151.4	2155.8	4.4	32.9	82.6	0.1791	2.9
265.70	11236	2151.4	2156.4	5.0	26.3	89.2	0.1624	2.4
265.67	11236	2148.4	2153.3	4.9	39.0	83.2	0.1539	2.6
265.20	11236	2148.4	2154.0	5.6	23.2	89.8	0.0522	2.2
264.20	11236	2146.6	2152.7	6.1	21.4	90.5	0.0261	2.0
262.30	11236	2143.2	2149.2	6.0	21.8	91.1	0.1361	1.8
262.26	11236	2139.2	2144.7	5.5	26.4	82.5	0.1511	2.2
261.80	11236	2139.2	2144.7	5.5	23.8	90.6	0.0372	2.0
260.50	11236	2136.8	2142.3	5.5	23.6	95.0	0.1445	1.9
260.47	11236	2133.8	2139.1	5.3	26.7	84.5	0.1578	2.1
260.00	11236	2133.8	2139.3	5.5	23.7	95.0	0.0341	1.9

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs) total	Elevation (ft) thalweg	Elevation (ft) water sfc	Depth (ft)	channel velocity	Topwidth (ft)	Energy Slope	Froude #
257.10	11236	2128.6	2134.3	5.7	22.9	95.3	0.1430	1.8
257.07	11236	2125.6	2131.0	5.4	26.1	84.8	0.1535	2.0
256.60	11236	2125.6	2130.6	5.0	24.2	108.4	0.0332	2.1
256.33	11236	2125.1	2129.9	4.8	24.2	117.1	0.0296	2.1
256.00	11236	2124.5	2130.2	5.7	22.2	99.5	0.0292	1.7
255.80	11236	2124.2	2130.0	5.8	21.9	99.6	0.1375	1.7
255.76	11236	2120.2	2125.7	5.5	26.2	83.1	0.1402	2.0
255.30	11236	2120.2	2125.4	5.2	24.8	99.1	0.0292	2.0
254.80	11236	2119.3	2124.6	5.3	24.1	103.8	0.0259	2.0
254.00	11236	2117.8	2123.3	5.5	23.3	104.8	0.1452	1.9
253.97	11236	2114.8	2120.2	5.4	26.3	84.8	0.1567	2.1
253.50	11236	2114.8	2120.2	5.4	23.4	104.6	0.0341	1.9
252.80	11236	2113.6	2119.2	5.6	22.6	102.5	0.1440	1.8
252.77	11236	2110.6	2116.1	5.5	25.8	85.0	0.1546	2.0
252.30	11236	2110.6	2116.1	5.5	23.0	102.0	0.0313	1.9
251.50	11236	2109.1	2114.7	5.6	22.8	102.3	0.1433	1.8
251.47	11236	2106.1	2111.6	5.5	25.9	84.9	0.1557	2.0
251.00	11236	2106.1	2111.6	5.5	23.2	102.0	0.0323	1.9
250.10	11236	2104.5	2110.1	5.6	22.6	105.5	0.1475	1.8
250.06	11236	2100.5	2105.9	5.4	26.7	82.9	0.1603	2.1
249.60	11236	2100.5	2105.8	5.3	24.3	103.6	0.0350	2.0
248.90	11236	2099.2	2104.6	5.4	23.4	104.6	0.1455	1.9
248.87	11236	2096.2	2101.6	5.4	26.4	84.7	0.1567	2.1
248.40	11236	2096.2	2101.6	5.4	23.5	104.5	0.0351	1.9
247.80	11236	2095.2	2100.8	5.6	22.7	105.5	0.1450	1.8
247.77	11236	2092.2	2097.7	5.5	25.8	85.0	0.1546	2.0
247.30	11236	2092.2	2097.7	5.5	23.1	105.0	0.0320	1.9
246.60	11236	2090.9	2096.5	5.6	22.7	105.4	0.1440	1.8
246.57	11236	2087.9	2093.4	5.5	25.8	85.0	0.1557	2.0
246.10	11236	2087.9	2093.7	5.8	22.6	91.7	0.0309	1.7
245.40	11236	2086.6	2092.3	5.7	22.9	91.5	0.1336	1.7
245.36	11236	2082.6	2088.0	5.4	27.1	82.7	0.1489	2.1
244.90	11236	2082.6	2088.0	5.4	24.4	90.8	0.0346	1.9
244.20	11236	2081.4	2086.9	5.5	23.8	91.1	0.1440	1.8
244.17	11236	2078.4	2083.7	5.3	26.9	84.5	0.1589	2.1
243.70	11236	2078.4	2084.0	5.6	23.5	91.2	0.0347	1.8
243.10	11236	2077.3	2082.9	5.6	23.5	91.2	0.1425	1.8
243.07	11236	2074.3	2079.6	5.3	26.6	84.6	0.1578	2.1
242.60	11236	2074.3	2079.9	5.6	23.3	91.3	0.0328	1.8
242.00	11236	2073.2	2078.8	5.6	23.3	91.3	0.1417	1.8
241.97	11236	2070.2	2075.5	5.3	26.5	84.7	0.1578	2.1
241.50	11236	2070.2	2075.9	5.7	23.1	91.3	0.0324	1.8
241.06	11236	2069.9	2075.8	5.9	22.3	91.7	0.0180	1.7
240.56	11236	2069.5	2075.7	6.2	20.9	92.5	0.0135	1.5

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs) total	Elevation (ft) thalweg	Elevation (ft) water sfc	Depth (ft)	channel velocity	Topwidth (ft)	Energy Slope	Froude #
239.70	11236	2068.8	2075.0	6.2	21.0	92.4	0.1535	1.5
239.67	11236	2065.8	2071.5	5.7	24.8	85.4	0.1702	1.9
239.20	11236	2065.8	2071.8	6.0	21.7	92.1	0.1535	1.6
239.17	11236	2062.8	2068.4	5.6	25.2	85.2	0.1474	1.9
238.60	11236	2062.8	2068.5	5.7	22.9	91.4	0.1474	1.7
238.57	11236	2059.8	2065.2	5.4	26.2	84.8	0.1567	2.1
238.10	11236	2059.8	2065.5	5.7	22.9	91.5	0.0324	1.7
237.60	11236	2058.9	2064.6	5.7	23.0	91.4	0.1423	1.8
237.57	11236	2055.9	2061.3	5.4	26.3	84.8	0.1567	2.1
237.10	11236	2055.9	2061.6	5.7	22.9	91.4	0.0326	1.7
236.50	11236	2054.8	2060.5	5.7	23.1	91.4	0.1342	1.8
236.46	11236	2050.8	2056.1	5.3	27.3	82.7	0.1489	2.2
236.00	11236	2050.8	2056.2	5.4	24.4	90.8	0.0359	1.9
235.50	11236	2049.9	2055.2	5.3	24.3	102.5	0.1370	2.0
235.46	11236	2045.9	2051.1	5.2	28.1	82.4	0.1511	2.2
235.00	11236	2045.9	2051.0	5.1	25.3	102.2	0.0411	2.1
234.50	11236	2045.0	2050.2	5.2	24.3	102.5	0.1483	2.0
234.47	11236	2042.0	2047.2	5.2	27.2	84.4	0.1578	2.2
234.00	11236	2042.0	2047.3	5.3	24.1	102.6	0.0365	2.0
233.50	11236	2041.1	2046.5	5.4	23.6	97.6	0.1453	1.9
233.47	11236	2038.1	2043.3	5.2	26.6	87.4	0.1578	2.1
233.00	11236	2038.1	2043.5	5.4	23.5	97.8	0.1495	1.9
232.96	11236	2034.1	2039.3	5.2	27.5	85.0	0.1500	2.2
232.50	11236	2034.1	2039.3	5.2	24.7	96.7	0.0354	2.0
229.80	11742	2029.2	2035.1	5.9	22.7	96.9	0.1354	1.7
229.78	11742	2027.2	2033.0	5.8	24.8	87.6	0.1438	1.9
229.30	11742	2027.2	2032.9	5.7	22.5	109.5	0.0271	1.8
226.80	11742	2022.7	2028.8	6.1	22.4	92.2	0.1584	1.7
226.77	11742	2019.7	2025.4	5.7	25.8	85.4	0.1713	2.0
226.30	11742	2019.7	2025.7	6.0	22.7	92.0	0.0296	1.7
223.30	11742	2014.3	2020.1	5.8	23.5	91.6	0.1417	1.8
223.27	11742	2011.3	2016.8	5.5	26.7	85.1	0.1567	2.1
222.80	11742	2011.3	2017.1	5.8	23.5	91.7	0.0322	1.8
219.00	11742	2004.5	2010.3	5.8	23.7	91.6	0.1421	1.8
218.97	11742	2001.5	2007.0	5.5	26.8	85.0	0.1578	2.1
218.50	11742	2001.5	2007.3	5.8	23.6	91.6	0.0330	1.8
216.50	11742	1998.4	2004.4	6.0	22.7	92.0	0.1585	1.7
216.47	11742	1995.4	2001.0	5.6	26.1	85.3	0.1649	2.0
216.00	11742	1995.4	2001.4	6.0	22.9	91.9	0.0229	1.7
215.00	11742	1993.6	1999.5	5.9	23.2	91.8	0.1455	1.7
214.97	11742	1990.6	1996.3	5.7	26.3	83.5	0.1592	2.0
214.50	11742	1990.6	1996.3	5.7	23.8	91.5	0.0317	1.8
214.00	11742	1989.7	1995.4	5.7	23.8	91.5	0.1433	1.8
213.97	11742	1986.7	1992.2	5.5	27.0	85.0	0.1589	2.1

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs) total	Elevation (ft) thalweg	Elevation (ft) water sfc	Depth (ft)	channel velocity	Topwidth (ft)	Energy Slope	Froude #
213.50	11742	1986.7	1992.5	5.8	23.7	91.6	0.0345	1.8
213.00	11742	1985.8	1991.6	5.8	23.7	91.6	0.1423	1.8
212.97	11742	1982.8	1988.3	5.5	26.8	85.0	0.1578	2.1
212.50	11742	1982.8	1988.6	5.8	23.6	91.6	0.0301	1.8
212.06	11742	1982.0	1987.7	5.7	24.1	91.4	0.0207	1.8
211.66	11742	1981.3	1987.2	5.9	23.1	91.8	0.0203	1.7
211.00	11742	1980.1	1985.8	5.7	23.9	91.5	0.0173	1.8
210.00	11742	1978.3	1982.8	4.5	24.8	109.1	0.0265	2.1
209.00	11742	1976.5	1980.5	4.0	24.0	127.9	0.0315	2.2
208.50	11742	1975.6	1979.4	3.8	23.1	137.6	0.1545	2.1
208.46	11742	1971.6	1975.0	3.4	27.2	128.9	0.1755	2.6
208.00	11742	1971.6	1975.6	4.0	22.1	137.9	0.0520	2.0
207.50	11742	1970.7	1974.8	4.1	21.3	146.4	0.1473	1.9
207.47	11742	1967.7	1971.4	3.7	24.8	131.4	0.1652	2.3
207.00	11742	1967.7	1972.1	4.4	19.5	147.8	0.0404	1.7
206.00	11742	1965.9	1970.3	4.4	19.7	147.7	0.0175	1.7
205.00	11742	1964.1	1968.5	4.4	19.9	138.8	0.1423	1.7
204.97	11742	1961.1	1965.0	3.9	23.9	131.8	0.1610	2.2
204.50	11742	1961.1	1965.8	4.7	18.8	139.3	0.1777	1.6
204.47	11742	1958.1	1962.1	4.0	23.1	132.0	0.1766	2.1
204.00	11742	1958.1	1963.0	4.9	17.9	139.8	0.1933	1.5
203.97	11742	1955.1	1959.2	4.1	22.5	132.2	0.1911	2.0
203.50	11742	1955.1	1960.4	5.3	16.5	140.5	0.0305	1.3
203.00	11742	1954.2	1959.1	4.9	17.8	139.8	0.1560	1.4
202.97	11742	1951.2	1955.3	4.1	22.4	132.2	0.1755	2.0
202.50	11742	1951.2	1956.6	5.4	16.0	140.8	0.1922	1.2
202.47	11742	1948.2	1952.5	4.3	21.4	132.5	0.1879	1.9
202.00	11742	1948.2	1953.5	5.3	16.3	140.6	0.0263	1.3
201.50	11742	1947.3	1952.2	4.9	17.7	139.8	0.1550	1.4
201.47	11742	1944.3	1948.4	4.1	22.3	132.2	0.1766	2.0
201.00	11742	1944.3	1949.7	5.4	16.0	140.8	0.1933	1.2
200.97	11742	1941.3	1945.6	4.3	21.5	132.5	0.1879	1.9
200.50	11742	1941.3	1946.6	5.3	16.4	140.6	0.1713	1.3
200.47	11742	1938.3	1942.5	4.2	21.7	132.5	0.1723	1.9
200.00	11742	1938.3	1943.6	5.3	16.4	140.6	0.1723	1.3
199.97	11742	1935.3	1939.5	4.2	21.6	132.5	0.1723	1.9
199.50	11742	1935.3	1940.6	5.3	16.4	140.6	0.1723	1.3
199.46	11742	1931.3	1935.4	4.1	22.9	130.1	0.1750	2.0
199.00	11742	1931.3	1936.1	4.8	18.2	139.6	0.0325	1.5
198.00	11742	1929.5	1934.0	4.5	19.3	141.9	0.0155	1.6
197.00	11742	1927.7	1932.0	4.3	19.8	147.1	0.1413	1.7
196.97	11742	1924.7	1928.7	4.0	23.5	133.9	0.1610	2.1
196.50	11742	1924.7	1929.6	4.9	18.1	142.9	0.0367	1.5
196.00	11742	1923.8	1928.0	4.2	19.4	163.7	0.0190	1.8

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs) total	Elevation (ft) thalweg	Elevation (ft) water sfc	Depth (ft)	channel velocity	Topwidth (ft)	Energy Slope	Froude #
195.00	11742	1922.0	1926.4	4.4	18.7	182.4	0.0210	1.8
194.00	11742	1920.2	1924.4	4.2	18.2	178.5	0.0195	1.7
193.00	11742	1918.4	1926.1	7.7	10.9	295.0	0.0175	1.0
192.00	11742	1916.6	1921.4	4.8	17.4	263.2	0.0260	1.9
191.00	11742	1913.1	1918.1	5.0	17.2	251.5	0.0340	1.8
190.00	11742	1910.3	1914.2	3.9	18.1	235.1	0.0360	1.9
189.00	11742	1906.0	1910.3	4.3	18.3	267.8	0.0395	2.1
188.00	11742	1903.0	1906.8	3.8	17.3	269.1	0.0375	1.9
187.00	11742	1900.0	1903.7	3.7	16.6	275.9	0.0330	1.8
186.00	11742	1897.6	1901.0	3.4	15.9	289.1	0.0305	1.8
185.00	11742	1894.3	1897.7	3.4	16.5	270.1	0.0305	1.8
184.00	11742	1891.2	1894.4	3.2	16.7	289.0	0.0315	1.9
183.00	11742	1888.0	1891.7	3.7	15.7	272.7	0.0290	1.7
182.00	11742	1884.0	1889.0	5.0	15.9	264.6	0.0315	1.7
181.00	11742	1882.0	1884.7	2.7	17.2	342.8	0.0370	2.2
180.00	11742	1879.0	1882.6	3.6	13.5	380.7	0.0300	1.6
179.00	11742	1876.3	1880.6	4.3	13.2	333.9	0.0220	1.4
178.00	11742	1873.5	1878.4	4.9	13.2	390.3	0.0220	1.5
177.00	11742	1872.0	1876.6	4.6	12.3	402.4	0.0195	1.4
176.00	11742	1870.0	1874.8	4.8	12.3	368.6	0.0180	1.3
175.00	11742	1867.7	1873.2	5.5	11.9	447.3	0.0205	1.4
174.00	11742	1866.0	1870.5	4.5	13.2	417.0	0.0185	1.6
173.00	11742	1864.0	1870.0	6.0	10.2	378.1	0.0160	1.0
172.00	11742	1860.0	1865.5	5.5	16.9	230.7	0.0225	1.7
171.00	11742	1857.4	1864.5	7.1	12.9	362.6	0.0235	1.4
170.00	11742	1854.1	1862.9	8.8	12.3	344.9	0.0190	1.3
169.00	11742	1852.0	1860.6	8.6	13.3	354.2	0.0245	1.5
168.00	11742	1851.0	1856.2	5.2	16.6	317.1	0.0305	2.0
167.00	11742	1847.0	1853.2	6.2	16.3	249.5	0.0300	1.7
166.00	11742	1846.0	1851.4	5.4	14.2	385.8	0.0275	1.7
165.00	11742	1844.0	1846.8	2.8	16.8	321.4	0.0280	2.0
164.90	11742	1843.6	1846.4	2.8	16.8	321.7	0.0380	2.0
164.10	11742	1841.8	1848.5	6.7	5.3	412.2	0.0268	0.4
164.00	11742	1840.7	1847.0	6.3	10.9	303.0	0.0107	1.0
163.00	11742	1838.0	1844.2	6.2	14.1	298.9	0.0205	1.5
162.00	11742	1835.6	1840.9	5.3	15.6	315.3	0.0280	1.8
161.00	11742	1833.1	1838.0	4.9	15.8	270.0	0.0270	1.7
160.00	11742	1829.0	1835.8	6.8	15.0	271.9	0.0245	1.6
159.00	11742	1827.6	1833.6	6.0	14.5	319.8	0.0260	1.6
158.00	11742	1826.1	1830.4	4.3	15.5	305.7	0.0275	1.7
157.00	11742	1823.1	1828.5	5.4	13.6	338.9	0.0245	1.5
156.00	11742	1821.4	1827.1	5.7	11.8	401.2	0.0230	1.3
*155.00	11742	1819.0	1823.8	4.8	14.0	448.5	0.0256	1.8
157.00	11742	1816.2	1820.9	4.7	12.3	459.7	0.0301	1.5

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs) total	Elevation (ft) thalweg	Elevation (ft) water sfc	Depth (ft)	channel velocity	Topwidth (ft)	Energy Slope	Froude #
156.00	11742	1813.0	1817.7	4.7	13.3	500.4	0.0322	1.8
155.00	11742	1810.7	1815.2	4.5	11.5	571.4	0.0352	1.5
154.00	11742	1806.9	1811.1	4.2	14.1	445.1	0.0396	1.8
153.00	11742	1803.0	1808.3	5.3	12.4	554.8	0.0310	1.7
152.00	11742	1800.0	1806.4	6.4	10.2	652.2	0.0245	1.3
151.00	10579	1799.0	1803.6	4.6	11.3	611.2	0.0225	1.6
150.00	10579	1797.0	1801.4	4.4	10.5	566.7	0.0230	1.4
149.00	10579	1793.3	1798.9	5.6	10.9	583.4	0.0235	1.5
148.00	10579	1793.0	1796.6	3.6	10.6	602.4	0.0240	1.4
147.00	10579	1791.0	1794.0	3.0	11.3	513.1	0.0235	1.5
146.00	10579	1787.4	1791.4	4.0	11.8	459.9	0.0235	1.5
145.00	10579	1785.0	1788.5	3.5	13.0	385.1	0.0230	1.6
144.00	10579	1782.0	1786.0	4.0	13.3	306.7	0.0235	1.5
143.00	10579	1778.5	1782.9	4.4	14.8	308.7	0.0280	1.7
142.00	10579	1776.0	1780.4	4.4	13.5	390.7	0.0290	1.7
141.00	10579	1773.7	1778.5	4.8	11.7	410.7	0.0260	1.4
140.00	12814	1771.1	1775.8	4.7	13.0	434.9	0.0270	1.5
139.00	12814	1769.0	1773.1	4.1	13.4	448.1	0.0260	1.6
138.00	12814	1764.7	1770.9	6.2	12.7	418.7	0.0225	1.4
137.00	12814	1762.3	1768.8	6.5	12.7	436.6	0.0230	1.5
136.00	12814	1761.0	1766.3	5.3	12.8	516.8	0.0255	1.6
135.00	12814	1760.0	1764.1	4.1	11.7	562.2	0.0255	1.5
134.00	12814	1758.0	1761.7	3.7	11.6	617.0	0.0255	1.5
133.00	12814	1755.0	1759.4	4.4	10.4	755.0	0.0255	1.5
132.00	12814	1753.0	1757.1	4.1	10.4	750.0	0.0240	1.4
131.00	12814	1749.0	1754.5	5.5	10.9	728.0	0.0240	1.5
130.00	12814	1747.6	1752.0	4.4	11.1	633.8	0.0235	1.5
129.00	12814	1744.0	1749.4	5.4	11.9	541.5	0.0240	1.5
128.00	12814	1742.0	1746.6	4.6	12.7	480.6	0.0215	1.6
127.00	12814	1740.0	1745.8	5.8	9.8	497.2	0.0170	1.1
126.00	12814	1738.0	1742.9	4.9	13.6	390.0	0.0255	1.5
125.40	12814	1737.0	1739.5	2.5	17.1	307.4	0.1675	1.9
125.36	12814	1733.0	1735.1	2.1	22.5	280.6	0.1837	2.8
124.90	12814	1733.0	1736.1	3.1	14.8	294.8	0.1837	1.5
124.86	12814	1729.0	1731.4	2.4	21.1	258.1	0.1783	2.4
124.40	12814	1729.0	1733.0	4.0	12.7	268.7	0.0325	1.2
121.90	12814	1726.0	1730.2	4.2	14.1	232.4	0.1542	1.3
121.87	12814	1723.0	1726.4	3.4	19.7	201.8	0.1713	1.9
121.40	12814	1722.9	1726.9	4.0	15.1	230.4	0.0266	1.4
119.80	12814	1721.1	1725.8	4.7	13.7	216.4	0.1720	1.2
119.77	12814	1718.1	1721.9	3.8	19.6	185.0	0.1879	1.8
119.30	12814	1718.1	1722.7	4.6	14.1	215.8	0.0269	1.2
117.00	12814	1715.3	1719.6	4.3	15.2	213.9	0.1557	1.3
116.97	12814	1712.3	1716.0	3.7	20.2	184.3	0.1713	1.9

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs) total	Elevation (ft) thalweg	Elevation (ft) water sfc	Depth (ft)	channel velocity	Topwidth (ft)	Energy Slope	Froude #
116.50	12814	1712.3	1716.5	4.2	15.5	213.4	0.0279	1.4
114.60	12814	1710.0	1714.5	4.5	14.6	214.8	0.1566	1.3
114.57	12814	1707.0	1710.7	3.7	19.9	184.6	0.1713	1.9
114.10	12814	1707.0	1711.3	4.3	15.1	214.0	0.0275	1.3
112.00	12814	1704.5	1708.9	4.4	14.7	214.6	0.1562	1.3
111.97	12814	1701.5	1705.2	3.7	20.0	184.6	0.1713	1.9
111.50	12814	1701.5	1705.8	4.3	15.2	213.9	0.0276	1.3
109.60	12814	1699.2	1703.6	4.4	14.8	214.5	0.1563	1.3
109.57	12814	1696.2	1699.9	3.7	20.0	184.5	0.1713	1.9
109.10	12814	1696.2	1700.5	4.3	15.4	213.7	0.0276	1.4
107.60	12814	1694.4	1698.8	4.4	14.7	214.7	0.1563	1.3
107.57	12814	1691.4	1695.1	3.7	20.0	184.6	0.1713	1.9
107.10	12814	1691.4	1695.7	4.3	15.2	213.9	0.0275	1.3
105.50	12814	1689.5	1693.9	4.4	14.7	214.7	0.1563	1.3
105.46	12814	1685.5	1689.1	3.6	21.3	178.6	0.1717	2.0
105.00	12814	1685.5	1689.3	3.8	17.6	210.7	0.0300	1.7
103.00	12814	1683.1	1687.8	4.7	13.8	216.2	0.1749	1.2
102.97	12814	1680.1	1683.7	3.6	19.9	188.3	0.1879	1.9
102.50	12814	1680.1	1684.7	4.6	14.1	215.7	0.1879	1.2
102.47	12814	1677.1	1680.6	3.5	20.0	188.2	0.1890	1.9
102.00	12814	1677.1	1681.9	4.8	13.5	216.8	0.1890	1.1
101.97	12814	1674.1	1677.7	3.6	19.8	188.3	0.1869	1.9
101.50	12814	1674.1	1678.9	4.8	13.7	216.5	0.1869	1.2
101.47	12814	1671.1	1674.7	3.6	19.8	188.3	0.1879	1.9
101.00	12814	1671.1	1675.8	4.7	13.9	216.1	0.0274	1.2
99.20	12185	1668.9	1672.9	4.0	15.8	211.9	0.0061	1.5
98.70	12185	1668.3	1671.8	3.5	18.4	208.7	0.0300	1.8
98.60	12185	1668.2	1672.4	4.2	15.1	212.9	0.1800	1.4
98.58	12185	1666.2	1669.7	3.5	18.9	191.5	0.1667	1.8
98.10	12185	1666.2	1670.7	4.5	13.8	215.0	0.0229	1.2
96.00	12185	1663.7	1667.9	4.2	14.8	213.3	0.1562	1.3
95.98	12185	1661.7	1665.2	3.5	18.7	191.6	0.1656	1.8
95.50	12185	1661.7	1666.4	4.7	13.0	216.4	0.0211	1.1
93.50	12185	1659.3	1663.5	4.2	15.1	212.9	0.1555	1.4
93.48	12185	1657.3	1660.8	3.5	18.9	191.5	0.1656	1.8
93.00	12185	1657.3	1661.8	4.5	13.8	215.0	0.0213	1.2
91.50	12185	1655.5	1659.7	4.2	14.7	213.5	0.1723	1.3
91.47	12185	1652.5	1655.8	3.3	20.2	187.4	0.1890	2.0
91.00	12185	1652.5	1656.9	4.4	14.0	214.6	0.0280	1.2
89.50	12185	1650.7	1655.0	4.3	14.7	213.5	0.1723	1.3
89.47	12185	1647.7	1651.0	3.3	20.1	187.4	0.1890	2.0
89.00	12185	1647.7	1652.3	4.6	13.5	215.5	0.0280	1.2
87.50	12185	1645.9	1650.1	4.2	14.7	213.5	0.1807	1.3
87.48	12185	1643.9	1647.5	3.6	18.7	191.6	0.1906	1.8

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs)	Elevation (ft)		Depth	channel	Topwidth	Energy	Froude
	total	thalweg	water sfc	(ft)	velocity	(ft)	Slope	#
87.00	12185	1643.9	1648.5	4.6	13.6	215.3	0.0213	1.2
82.50	12185	1638.5	1642.6	4.1	15.3	212.5	0.1557	1.4
82.47	12185	1635.5	1638.8	3.3	20.5	187.2	0.1755	2.0
82.00	12185	1635.5	1640.1	4.6	13.6	215.4	0.0309	1.2
80.50	12185	1633.7	1637.9	4.2	14.7	213.5	0.1553	1.3
80.46	12185	1629.7	1632.9	3.2	21.5	183.8	0.1826	2.2
80.00	12185	1629.7	1633.6	3.9	15.9	211.7	0.0383	1.5
74.00	12185	1622.5	1627.1	4.6	13.6	215.4	0.1807	1.2
73.98	12185	1620.5	1624.2	3.7	18.1	192.1	0.1927	1.7
73.50	12185	1620.5	1625.0	4.5	13.7	215.1	0.0231	1.2
71.00	12185	1617.5	1621.7	4.2	15.0	213.1	0.1721	1.3
70.97	12185	1614.5	1617.8	3.3	20.3	187.3	0.1911	2.0
70.50	12185	1614.5	1618.9	4.4	14.2	214.2	0.0300	1.3
68.50	12185	1612.1	1616.3	4.2	14.7	213.5	0.1555	1.3
68.47	12185	1609.1	1612.4	3.3	20.2	187.4	0.1745	2.0
68.00	12185	1609.1	1613.5	4.4	14.1	214.5	0.0300	1.2
66.00	12185	1606.7	1610.9	4.2	14.8	213.4	0.1555	1.3
65.97	12185	1603.7	1607.0	3.3	20.2	187.4	0.1745	2.0
65.50	12185	1603.7	1608.3	4.6	13.5	215.5	0.0300	1.2
63.50	12185	1601.3	1605.5	4.2	14.9	213.2	0.1555	1.3
63.47	12185	1598.3	1601.6	3.3	20.3	187.3	0.1734	2.0
63.00	12185	1598.3	1602.7	4.4	14.0	214.6	0.0292	1.2
61.00	12185	1595.9	1600.1	4.2	14.8	213.4	0.1558	1.3
60.97	12185	1592.9	1596.2	3.3	20.2	187.4	0.1745	2.0
60.50	12185	1592.9	1597.5	4.6	13.6	215.4	0.0300	1.2
58.50	12185	1590.5	1594.7	4.2	14.9	213.2	0.1680	1.3
58.46	12185	1586.0	1589.1	3.1	22.2	182.2	0.1962	2.3
58.00	12185	1586.0	1589.8	3.8	16.8	210.5	0.0399	1.6
53.00	12185	1580.0	1584.7	4.7	13.1	216.3	0.1562	1.1
52.97	12185	1577.0	1580.5	3.5	19.5	187.8	0.1734	1.9
52.50	12185	1577.0	1581.3	4.3	14.3	214.1	0.0290	1.3
50.00	12185	1574.0	1578.2	4.2	14.7	213.4	0.1556	1.3
49.97	12185	1571.0	1574.3	3.3	20.2	187.4	0.1745	2.0
49.50	12185	1571.0	1575.5	4.5	13.8	215.6	0.0298	1.2
48.00	12185	1569.2	1573.4	4.2	14.7	214.1	0.0153	1.3
47.90	12185	1569.0	1573.2	4.2	14.9	213.8	0.0150	1.3
46.50	12185	1567.4	1572.6	5.2	12.9	185.2	0.0108	1.0
44.70	13633	1565.2	1571.8	6.6	8.8	246.4	0.0058	0.6
44.60	15265	1565.2	1571.1	5.9	11.0	244.6	0.0060	0.8
44.60	15265	1565.1	1571.1	6.0	10.8	245.0	0.0080	0.8
43.60	15265	1564.3	1569.9	5.6	11.5	243.9	0.0095	0.9
43.30	15265	1564.0	1569.9	5.9	11.0	244.6	0.0080	0.8
41.80	15265	1562.6	1568.3	5.7	12.6	255.1	0.0073	1.0
40.30	15265	1561.2	1567.2	6.0	12.1	312.1	0.0090	1.1

Table 3.2 100-Year Flood Hydraulic Summary

100-Yr Hydraulics								
Section ID	Q (cfs) total	Elevation (ft) thalweg	Elevation (ft) water sfc	Depth (ft)	channel velocity	Topwidth (ft)	Energy Slope	Froude #
38.80	15265	1559.8	1566.0	6.2	11.6	323.4	0.0113	1.0
37.30	15265	1558.3	1563.0	4.7	14.4	333.9	0.0143	1.5
35.80	15265	1554.7	1561.1	6.4	13.1	324.3	0.0160	1.2
34.30	15265	1552.7	1558.1	5.4	14.5	379.3	0.0203	1.6
32.80	15265	1549.6	1554.9	5.3	13.5	490.0	0.0217	1.6
31.30	15265	1547.3	1552.8	5.5	11.0	500.0	0.0167	1.2
29.80	15265	1544.6	1550.7	6.1	11.7	470.0	0.0143	1.2
28.30	15265	1542.6	1548.2	5.6	12.3	450.0	0.0133	1.3
26.80	15265	1539.0	1547.0	8.0	10.4	410.0	0.0120	1.0
25.30	15265	1536.2	1544.4	8.2	12.8	390.0	0.0120	1.3
23.80	15265	1534.7	1543.2	8.5	11.5	380.0	0.0117	1.0
22.30	15265	1533.0	1540.9	7.9	12.8	390.0	0.0113	1.3
20.80	15265	1531.2	1539.9	8.7	11.1	394.0	0.0120	1.0
19.30	15265	1530.0	1536.9	6.9	13.8	366.5	0.0143	1.4
17.80	15265	1527.8	1536.2	8.4	8.7	338.0	0.0110	0.7
16.30	15265	1525.6	1534.0	8.4	12.8	244.0	0.0065	1.0
15.30	15265	1524.1	1532.9	8.8	13.8	188.6	0.0095	1.0
14.80	15265	1523.2	1531.2	8.0	16.0	183.8	0.0498	1.2
14.72	15265	1523.2	1528.0	4.8	20.2	168.1	0.0737	1.7
14.62	15265	1518.2	1522.6	4.4	25.8	144.1	0.0374	2.2
14.01	15265	1518.2	1522.1	3.9	22.7	182.8	0.0158	2.1
13.30	15265	1517.2	1528.2	11.0	7.2	214.0	0.0175	0.4
11.80	15265	1515.1	1528.4	13.3	4.9	251.0	0.0105	0.2
10.80	15265	1513.7	1528.3	14.6	5.3	206.0	0.0022	0.3
10.10	15265	1512.7	1528.4	15.7	5.0	206.0	0.0007	0.2
10.00	15265	1510.0	1528.4	18.4	4.4	201.0	0.0000	0.2
8.80	15265	1509.7	1528.4	18.7	4.1	208.0	0.0003	0.2
7.30	15265	1509.2	1528.4	19.2	4.1	204.0	0.0003	0.2
5.80	15265	1508.7	1528.4	19.7	4.0	204.0	0.0000	0.2
4.30	15265	1508.3	1528.3	20.0	3.9	204.0	0.0000	0.2
2.80	15265	1507.8	1528.3	20.5	3.8	204.0	0.0000	0.2
2.30	15265	1507.7	1528.3	20.6	3.9	201.0	0.0000	0.2
1.80	15265	1507.5	1528.3	20.8	4.0	193.0	0.0010	0.2
1.30	15265	1507.3	1528.3	21.0	4.2	181.0	0.0010	0.2
0.80	15265	1507.2	1528.2	21.0	4.5	172.0	0.0000	0.2
0.30	15265	1507.0	1528.1	21.1	5.1	150.0	0.0000	0.2
0.00	15265	1507.0	1528.1	21.1	5.1	150.0	0.0000	0.2

* Beginning of upstream control line stationing

Table 3.3 Average Hydraulic Parameters - 100-Year Flood

100-YEAR HYDRAULIC SUMMARY (PER REACH) For Sediment Transport Computations						
				Main Channel		
Reach #	From Station	To Station	Slope (ft/ft)	Velocity (fps)	Depth (ft)	Eff. Width (ft)
1	316+50	289+50	0.0286	11.8	3.7	145
2	289+50	277+15	0.0277	13.0	4.9	180
3	277+15	271+75	0.0336	22.1	4.3	120
4	271+75	262+30	0.0288	28.6	4.9	83
5	262+30	229+80	0.0352	24.7	5.4	84
6	229+80	210+00	0.0256	23.8	5.8	85
7	210+00	192+00	0.0368	20.3	4.5	133
8	192+00	183+00	0.0339	17.1	3.9	179
9	183+00	163+00	0.0241	13.9	5.3	175
10	163+00	151+00	0.0275	13.6	5.3	169
11	151+00	140+00	0.0248	12.1	4.2	217
12	140+00	125+40	0.0235	11.9	4.9	228
13	125+40	124+40	0.0853	21.3	2.3	264
14	124+40	121+90	0.0088	12.7	4	250
15	121+90	121+40	0.0580	19.4	3.5	193
16	121+40	119+80	0.0104	15.1	4	213
17	119+80	119+30	0.0592	19.2	3.8	175
18	119+30	117+00	0.0113	14.1	4.6	197
19	117+00	116+50	0.0584	19.9	3.7	174
20	116+50	114+60	0.0131	15.5	4.2	195
21	114+60	114+10	0.0582	19.6	3.7	175
22	114+10	112+00	0.0122	15.1	4.3	195
23	112+00	111+50	0.0582	19.7	3.7	175
24	111+50	109+60	0.0125	15.2	4.3	196
25	109+60	109+10	0.0580	19.7	3.7	174
26	109+10	107+60	0.0129	15.4	4.3	195
27	107+60	107+10	0.0582	19.7	3.7	175
28	107+10	105+50	0.0124	15.2	4.3	196
29	105+50	105+00	0.0648	20.8	3.7	170
30	105+00	103+00	0.0165	17.6	3.8	193
31	103+00	101+00	0.0600	19.5	3.6	182
32	101+00	99+20	0.0113	13.9	4.7	197
33	99+20	98+10	0.0280	17.4	3.7	189
34	98+10	96+00	0.0111	13.8	4.5	196
35	96+00	95+50	0.0448	18.5	3.6	184
36	95+50	93+50	0.0105	13.1	4.7	197

Table 3.3 Average Hydraulic Parameters - 100-Year Flood (Cont.)

100-YEAR HYDRAULIC SUMMARY (PER REACH) (cont.) For Sediment Transport Computations						
				Main Channel		
Reach #	From Station	To Station	Slope (ft/ft)	Velocity (fps)	Depth (ft)	Eff. Width (ft)
37	93+50	93+00	0.0444	18.7	3.5	184
38	93+00	91+50	0.0111	13.8	4.5	196
39	91+50	91+00	0.0622	19.8	3.4	181
40	91+00	89+50	0.0113	14.0	4.4	196
41	89+50	89+00	0.0636	19.8	3.4	181
42	89+00	87+50	0.0107	13.5	4.6	196
43	87+50	87+00	0.0434	18.5	3.6	184
44	87+00	82+50	0.0114	13.6	4.5	197
45	82+50	82+00	0.0660	20.2	3.3	181
46	82+00	80+50	0.0108	13.6	4.6	196
47	80+50	80+00	0.0746	21.0	3.3	179
48	80+00	74+00	0.0128	15.9	4	194
49	74+00	73+50	0.0396	17.9	3.7	184
50	73+50	71+00	0.0112	13.7	4.5	196
51	71+00	70+50	0.0626	20.0	3.4	181
52	70+50	68+50	0.0116	14.2	4.4	196
53	68+50	68+00	0.0622	19.9	3.4	182
54	68+00	66+00	0.0115	14.1	4.4	196
55	66+00	65+50	0.0636	19.9	3.4	182
56	65+50	63+50	0.0110	13.5	4.6	196
57	63+50	63+00	0.0630	19.9	3.4	181
58	63+00	61+00	0.0114	14.0	4.4	196
59	61+00	60+50	0.0638	19.9	3.4	181
60	60+50	58+50	0.0110	13.6	4.6	197
61	58+50	58+00	0.0798	21.6	3.2	178
62	58+00	53+00	0.0135	16.8	3.8	193
63	53+00	52+50	0.0568	19.1	3.5	182
64	52+50	50+00	0.0117	14.3	4.3	196
65	50+00	49+50	0.0632	19.9	3.4	182
66	49+50	48+00	0.0111	13.8	4.5	197
67	48+00	44+58	0.0114	13.7	4.8	190
68	44+58	43+30	0.0090	10.9	5.9	236
69	43+30	14+80	0.0128	12.2	6.7	187
70	14+80	8+80	0.0273	20.7	4.4	174
71	8+80	0+30	0.0032	10.0	9.6	177

Table 3.4 Average Hydraulic Parameters - 10-Year Flood

10-YEAR HYDRAULIC SUMMARY (PER REACH) For Sediment Transport Computations						
Reach #	From Station	To Station	Slope (ft/ft)	Velocity (fps)	Main Channel Depth (ft)	Eff. Width (ft)
1	316+50	289+50	0.0288	9.7	2.9	108
2	289+50	277+15	0.0289	10.5	4.0	125
3	277+15	271+75	0.0370	17.9	2.6	116
4	271+75	262+30	0.0299	22.5	2.9	81
5	262+30	229+80	0.0351	17.7	3.6	82
6	229+80	210+00	0.0261	16.5	3.9	83
7	210+00	192+00	0.0348	15.4	2.8	128
8	192+00	183+00	0.0338	12.9	2.8	150
9	183+00	163+00	0.0239	11.0	4.1	135
10	163+00	151+00	0.0267	10.7	4.2	119
11	151+00	140+00	0.0253	9.7	3.2	159
12	140+00	125+40	0.0240	9.1	4.0	163
13	125+40	124+40	0.0858	18.6	1.2	262
14	124+40	121+90	0.0095	9.0	2.6	244
15	121+90	121+40	0.0656	17.3	1.8	187
16	121+40	119+80	0.0092	10.1	2.7	208
17	119+80	119+30	0.0614	17.2	2.0	169
18	119+30	117+00	0.0112	10.1	3.0	189
19	117+00	116+50	0.0644	17.6	1.9	169
20	116+50	114+60	0.0111	10.1	3.0	189
21	114+60	114+10	0.0638	17.5	1.9	169
22	114+10	112+00	0.0110	10.1	3.0	189
23	112+00	111+50	0.0636	17.5	1.9	169
24	111+50	109+60	0.0111	10.1	3.0	189
25	109+60	109+10	0.0638	17.5	1.9	169
26	109+10	107+60	0.0109	10.1	3.0	189
27	107+60	107+10	0.0632	17.4	1.9	169
28	107+10	105+50	0.0109	10.1	3.0	189
29	105+50	105+00	0.0786	18.6	1.9	164
30	105+00	103+00	0.0131	12.2	2.5	188
31	103+00	101+00	0.0601	17.0	1.9	178
32	101+00	99+20	0.0114	10.0	3.0	189
33	99+20	98+10	0.0275	14.5	2.0	184
34	98+10	96+00	0.0108	9.5	3.0	189
35	96+00	95+50	0.0446	7.6	3.8	184
36	95+50	93+50	0.0109	9.5	3.0	189

Table 3.4 Average Hydraulic Parameters - 10-Year Flood

10-YEAR HYDRAULIC SUMMARY (PER REACH) For Sediment Transport Computations (cont.)						
				Main Channel		
Reach #	From Station	To Station	Slope (ft/ft)	Velocity (fps)	Depth (ft)	Eff. Width (ft)
37	93+50	93+00	0.0446	7.6	3.8	184
38	93+00	91+50	0.0107	9.5	3.0	189
39	91+50	91+00	0.0640	17.5	1.7	178
40	91+00	89+50	0.0107	9.5	3.0	189
41	89+50	89+00	0.0640	17.5	1.7	178
42	89+00	87+50	0.0107	9.5	3.0	189
43	87+50	87+00	0.0440	7.6	3.8	184
44	87+00	82+50	0.0112	9.5	3.0	189
45	82+50	82+00	0.0670	17.9	1.7	177
46	82+00	80+50	0.0107	9.5	3.0	189
47	80+50	80+00	0.0822	18.7	1.6	176
48	80+00	74+00	0.0121	11.1	2.6	188
49	74+00	73+50	0.0412	15.6	1.9	180
50	73+50	71+00	0.0109	9.5	3.0	189
51	71+00	70+50	0.0654	17.7	1.7	178
52	70+50	68+50	0.0108	9.5	3.0	189
53	68+50	68+00	0.0648	17.6	1.7	178
54	68+00	66+00	0.0108	9.5	3.0	189
55	66+00	65+50	0.0648	17.6	1.7	178
56	65+50	63+50	0.0108	9.5	3.0	189
57	63+50	63+00	0.0648	17.6	1.7	178
58	63+00	61+00	0.0108	9.5	3.0	189
59	61+00	60+50	0.0648	17.6	1.7	178
60	60+50	58+50	0.0108	9.5	3.0	189
61	58+50	58+00	0.0904	19.3	1.6	175
62	58+00	53+00	0.0124	12.0	2.4	188
63	53+00	52+50	0.0600	16.9	1.8	178
64	52+50	50+00	0.0109	9.5	3.0	189
65	50+00	49+50	0.0656	17.7	1.7	178
66	49+50	48+00	0.0107	9.5	3.0	190
67	48+00	44+58	0.0124	10.6	2.7	186
68	44+58	43+30	0.0082	10.0	2.9	231
69	43+30	14+80	0.0130	9.2	5.1	145
70	14+80	8+80	0.0260	15.7	2.6	168
71	8+80	0+30	0.0023	6.9	5.6	172

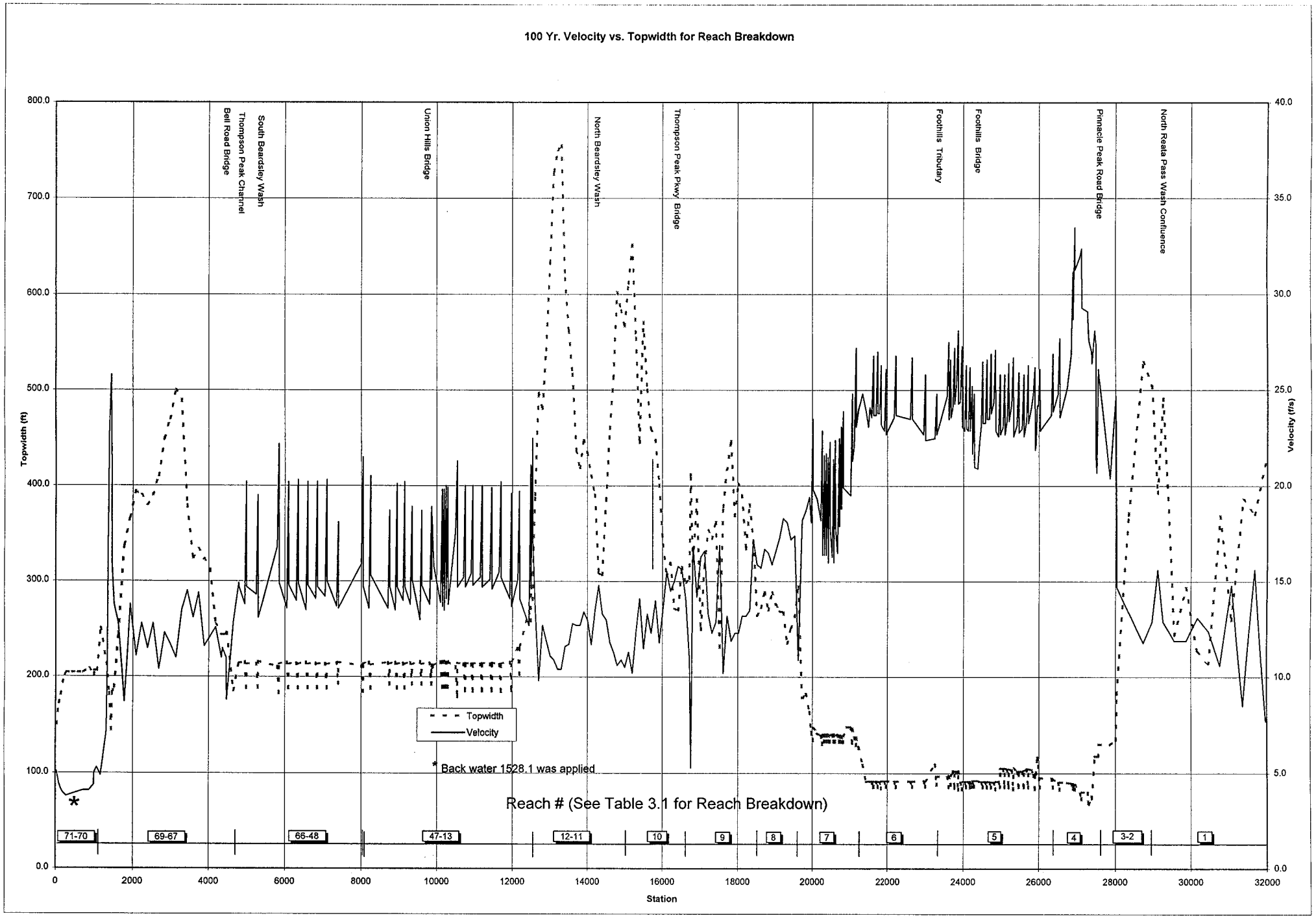

Figure 3.2 Velocity and Top-Width Profiles for the 100-Year Flood

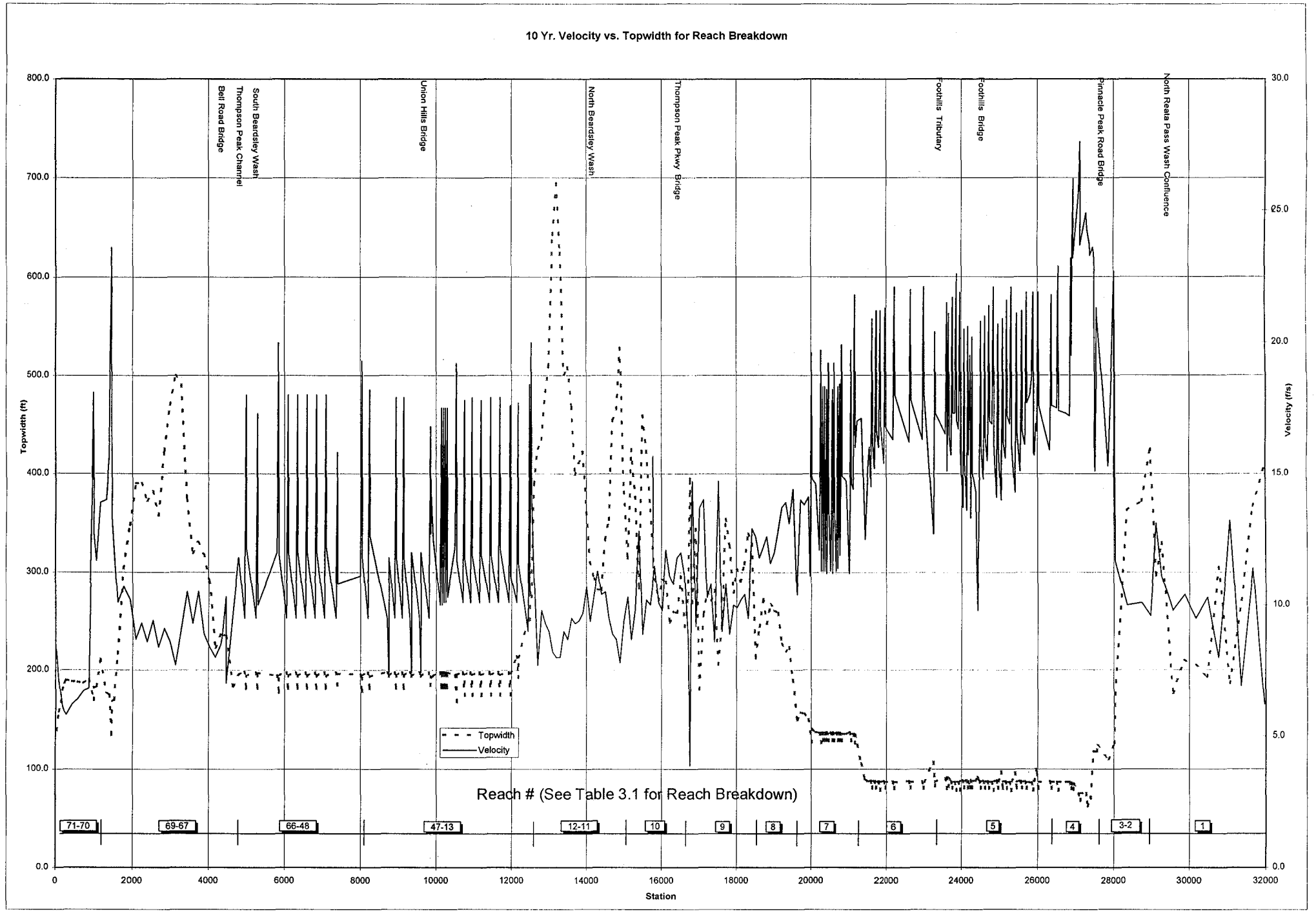

Figure 3.3 Velocity and Top-Width Profile for 10-Year Flood

The following summary velocity data resulting from the hydraulic design computations was taken from Figures 3.2 and 3.3.

(1) Velocities range from 17 fps (10-year flood) to 22 fps (100-year flood) for soil cement channel in Reaches 7 through 5. The velocity range for the same reach is from 22 fps (10-year flood) to 27 fps (100-year flood) downstream of each drop structure where articulated concrete blocks will be applied.

(2) Velocities vary from 11 fps (10-year flood) to 15 fps (100-year flood) for earthen bottom channel with soil cement banks in Reaches 14 through 48 (Stations 48+00 to 125+40). Velocities are 17 fps (10-year flood) to 19 fps (100-year flood) for the soil cement drop structures.

(3) Velocities for natural bottom reaches vary from 10 to 17 fps for a 100-year flood; the highest velocities present immediately downstream of the lined channel (below Station 192+00). The velocity range is from 7 to 13 fps for a 10-year flood.

(4) With backwater present at the Bureau of Reclamation detention basin, the 100-year flood velocity reduces to below 5 fps at the outlet reaches (Reaches 70 to 71).

(5) The flooding widths will be regulated by the proposed channel and bank protection, however, floodplain in the natural reaches such as the North Beardsley Wash confluence (Reach 12) will remain wide.

IV. EROSION AND SEDIMENTATION ANALYSIS

Erosion and sedimentation analysis was performed to determine the required toe depth for bank protection and grade control for natural and unlined (graded earth bottom) reaches. The erosion and sedimentation characteristics were obtained for the 2-, 10-, 25-, 50-, and 100-year floods. Sediment routing was performed for the 10-year and 100-year floods. In addition, long term erosion/sedimentation depths were estimated. This chapter describes the methodologies and summarizes results of the analysis. The results of the erosion/sedimentation analysis were applied to levee/bank toe down design and to estimates of potential maintenance requirements. The Technical Addendum, Volume IV, contains the detailed information and supporting computations.

Generally speaking, high erosion potential areas found through the previous study (Station 16+50 to 22+50, 201+00 to 205+00, and 232+50 to 262+00 - Vol II stationing) will be lined with soil cement, articulated reinforced concrete blocks and concrete; therefore, erosion problems will be minimized by the design. The natural bottom reach from Station 192+00 to Station 183+00 is the only reach to show both consistent short term and long term degradation under design conditions. Reach 12 at the North Beardsley Wash confluence is the only reach, other than the sediment basins, to show consistent aggradation (see Table 4.1). Reaches 13 to 66 have grade controls to prevent significant invert down cutting. However, the earthen channel bottoms within these reaches will be subject to slight degradation during the short term and significant aggradation over the long term.

Table 4.1 Potential Aggradation/Degradation Trends

Reach #	from station	to station	short term trend	long term trend
1	316+50	289+50	Supply Reach	Supply Reach
2	289+50	277+15	Aggradation	Aggradation
3	277+15	271+75	Grade Control - Minimal Change	Grade Control - Minimal Change
4	271+75	262+30	Lined Channel - Minimal Change	Lined Channel - Minimal Change
5	262+30	229+80	Lined Channel - Minimal Change	Lined Channel - Minimal Change
6	229+80	210+00	Lined Channel - Minimal Change	Lined Channel - Minimal Change
7	210+00	192+00	Lined Channel - Minimal Change	Lined Channel - Minimal Change
8	192+00	183+00	Significant Degradation	Degradation
9	183+00	163+00	Aggradation	Aggradation
10	163+00	151+00	Aggradation	Aggradation
11	151+00	140+00	Aggradation	Aggradation
12	140+00	125+40	Aggradation	Aggradation
13-66	125+40	48+00	Slight Degradation	Significant Aggradation
67	48+00	44+58	Significant Aggradation	Significant Aggradation
68	44+58	43+30	Lined Channel - Minimal Change	Lined Channel - Minimal Change
69	43+30	14+80	Aggradation	Aggradation
70	14+80	8+80	Lined Channel - Minimal Change	Lined Channel - Minimal Change
71	8+80	0+30	Significant Aggradation	Significant Aggradation

4.1 METHODOLOGY AND MODEL DATA

The MPM-Einstein sediment transport equation, introduced in Section 5.3 of Vol I, was used to compute sediment transport capacities. The average hydraulic parameters for each subreach shown in Tables 3.3 and 3.4. were used to compute the sediment transport capacities. Soils data for natural bottom and graded earthen channel sections were obtained from Volume I (Sect 4.2) and Volume II. Sediment inflows from tributaries listed in Table 4.2 were obtained from Volume I. Because the concentration of fine material in the project watershed is small compared to other watersheds (such as the Santa Cruz River) the total concentration of sediment in the flow is relatively low.

The Simons, Li & Associates' HEC-2-SR model was applied to simulate the channel response during the 10-year and 100-year floods. (See Section 5.5 of Volume I and the model description in Volume II.) In addition to the short term channel response, long term degradation and aggradation were assessed using the sediment budget and an equilibrium slope analysis. The equilibrium slope analysis was applied to reaches 13 through 66 where the graded earthen channel reaches will tend to fluctuate about the grade controls. For the remaining natural (ungraded) channel bottom reaches, long term aggradation/degradation was estimated by taking the difference between the sediment inflow and outflow in the respective reaches. The ultimate sediment sources from the tributaries were considered to be the long term sediment inflow for the long term sediment analysis. Three sediment inflow scenarios were analyzed. The three conditions are described below.

1. The first scenario includes no adjustments to the sediment supply.

2. The second scenario recognizes the potential for armoring caused by coarser materials present in North Beardsley, South Beardsley and Thompson Peak Washes, which could significantly reduce the sediment inflow into the main channel. (See Section 6.1 of Volume 1 for a discussion of the armoring potential.)

Table 4.2 Sediment Inflow

Source	Reach	100-Year		10-Year	
		cfs	CY	cfs	CY
East Reata Pass	1	20.8	2,922	7.6	1,263
Upper Reata Pass	2	40.9	6,656	16.3	2,662
Foothills Tributary	6	1.5	1,270	0.3	364
North Beardsley Wash	12	18.1	4,084	5.7	1,327
South Beardsley & Thompson Peak Wash	67	23.6	9,506	7.2	2,952

3. The third scenario recognizes the potential for urbanization, which could reduce the sediment supply to the main channel.

The selected design is based on the third scenario which considered the most likely future condition.

4.2. SHORT TERM CHANNEL RESPONSE

Table 4.3 shows the sediment transport rate and aggradation/degradation rate at the flood peaks for the 2-, 5- 10-, 25-, 50- and 100-year events. Table 4.4 shows estimated thalweg elevation changes after the 100-year flood for each section. The thalweg elevation changes shown in Table 4.4 are based on the average aggradation/degradation of a given reach; therefore, some deviation from the results shown in Table 4.4 could occur. The potential deviations have been accounted for in the toe depth design. Table 4.5 and Table 4.6 show the sediment inflow/outflow and average aggradation/degradation depths for the 100-year flood and the 10-year flood, respectively.

4.3 LONG TERM CHANNEL RESPONSE

Tables 4.7 through 4.9 show the long term responses for the 100-year flood for the three scenarios described in paragraph 4.1. The equilibrium slope analysis was applied to reaches 13 through 66 where the earthen channel bottoms will tend to fluctuate about the grade controls.

Table 4.3 Sediment Transport Capacities and Aggradation/Degradation Rates

	Sediment Transport Rate at Peak Discharge (cfs)						Aggradation/Degradation Rate at Peak Discharge (cfs)					
Reach	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1	3.3	5.2	7.6	11.6	16.3	20.8	0.0	0.0	0.0	0.0	0.0	0.0
2	3.3	7.6	11.6	19.7	27.6	37.5	6.2	9.5	12.3	17.9	21.6	24.2
3	3.3	7.6	11.6	19.7	27.6	37.5	0.0	0.0	0.0	0.0	0.0	0.0
4	3.3	7.6	11.6	19.7	27.6	37.5	0.0	0.0	0.0	0.0	0.0	0.0
5	3.3	7.6	11.6	19.7	27.6	37.5	0.0	0.0	0.0	0.0	0.0	0.0
6	3.6	7.8	11.9	20.1	28.0	39.0	0.0	0.0	0.0	0.0	0.0	0.0
7	3.6	7.8	11.9	20.1	28.0	39.0	0.0	0.0	0.0	0.0	0.0	0.0
8	9.2	19.6	30.1	51.7	70.6	92.5	-5.6	-11.8	-18.2	-31.6	-42.6	-53.5
9	6.3	10.5	14.9	25.1	34.7	47.5	2.9	9.1	15.2	26.6	35.9	45.0
10	3.5	7.6	11.9	21.4	29.7	40.5	2.8	2.9	3.0	3.7	5.0	7.0
11	4.0	7.9	11.3	18.3	26.0	34.3	-0.5	-0.2	0.6	3.1	3.7	6.2
12	1.6	3.8	6.2	11.3	17.2	24.3	4.4	7.9	10.8	16.5	21.9	28.1
13	1.6	3.8	6.2	11.3	17.2	24.3	0.0	0.0	0.0	0.0	0.0	0.0
14	4.1	7.3	10.0	15.0	21.7	33.9	-2.4	-3.5	-3.8	-3.7	-4.5	-9.6
15	4.1	7.3	10.0	15.0	21.7	33.9	0.0	0.0	0.0	0.0	0.0	0.0
16	4.2	7.5	12.9	21.2	34.5	49.0	-0.1	-0.3	-3.0	-6.2	-12.8	-15.1
17	4.2	7.5	12.9	21.2	34.5	49.0	0.0	0.0	0.0	0.0	0.0	0.0
18	4.2	7.5	11.9	19.5	31.2	43.4	0.0	0.0	1.0	1.7	3.3	5.6
19	4.2	7.5	11.9	19.5	31.2	43.4	0.0	0.0	0.0	0.0	0.0	0.0
20	4.2	7.5	11.8	20.5	34.7	54.2	0.0	0.0	0.1	-1.0	-3.5	-10.8
21	4.2	7.5	11.8	20.5	34.7	54.2	0.0	0.0	0.0	0.0	0.0	0.0
22	4.2	7.5	11.8	19.7	30.0	54.4	0.0	0.0	0.0	0.8	4.7	-0.2
23	4.2	7.5	11.8	19.7	30.0	54.4	0.0	0.0	0.0	0.0	0.0	0.0
24	4.2	7.5	11.8	19.1	33.8	55.8	0.0	0.0	0.0	0.6	-3.8	-1.4
25	4.2	7.5	11.8	19.1	33.8	55.8	0.0	0.0	0.0	0.0	0.0	0.0
26	4.2	7.5	11.8	19.1	32.9	57.5	0.0	0.0	0.0	0.0	0.9	-1.7
27	4.2	7.5	11.8	19.1	32.9	57.5	0.0	0.0	0.0	0.0	0.0	0.0
28	4.2	7.5	11.8	19.0	31.0	56.7	0.0	0.0	0.0	0.1	1.9	0.8
29	4.2	7.5	11.8	19.0	31.0	56.7	0.0	0.0	0.0	0.0	0.0	0.0
30	5.8	13.9	22.3	36.5	53.7	77.8	-1.6	-6.4	-10.5	-17.5	-22.7	-21.1
31	5.8	13.9	22.3	36.5	53.7	77.8	0.0	0.0	0.0	0.0	0.0	0.0
32	4.2	8.1	12.9	21.6	33.6	51.4	1.5	5.8	9.4	14.9	20.1	26.4
33	4.2	8.1	12.9	21.6	33.6	51.4	0.0	0.0	0.0	0.0	0.0	0.0
34	6.6	11.7	15.5	27.1	41.6	58.9	-2.4	-3.6	-2.6	-5.5	-8.0	-7.5
35	6.6	11.7	15.5	27.1	41.6	58.9	0.0	0.0	0.0	0.0	0.0	0.0
36	6.8	12.2	16.2	30.5	45.4	55.9	-0.2	-0.5	-0.7	-3.4	-3.8	3.0
37	6.8	12.2	16.2	30.5	45.4	55.9	0.0	0.0	0.0	0.0	0.0	0.0
38	6.8	12.3	16.3	31.2	46.9	62.3	0.0	-0.1	-0.1	-0.7	-1.5	-6.4
39	6.8	12.3	16.3	31.2	46.9	62.3	0.0	0.0	0.0	0.0	0.0	0.0
40	6.8	12.3	16.5	30.2	44.1	67.7	0.0	0.0	-0.2	1.0	2.8	-5.4
41	6.8	12.3	16.5	30.2	44.1	67.7	0.0	0.0	0.0	0.0	0.0	0.0
42	6.8	12.3	16.6	30.1	43.4	65.2	0.0	0.0	-0.1	0.1	0.7	2.5
43	6.8	12.3	16.6	30.1	43.4	65.2	0.0	0.0	0.0	0.0	0.0	0.0
44	6.8	12.3	16.3	31.3	47.2	65.6	0.0	0.0	0.3	-1.2	-3.8	-0.4
45	6.8	12.3	16.3	31.3	47.2	65.6	0.0	0.0	0.0	0.0	0.0	0.0
46	6.8	12.2	16.5	30.0	47.6	65.2	0.0	0.1	-0.2	1.3	-0.4	0.4
47	6.8	12.2	16.5	30.0	47.6	65.2	0.0	0.0	0.0	0.0	0.0	0.0
48	6.8	17.8	28.3	46.1	70.5	102.0	0.0	-5.6	-11.8	-16.1	-22.9	-36.8
49	6.8	17.8	28.3	46.1	70.5	102.0	0.0	0.0	0.0	0.0	0.0	0.0
50	6.9	12.8	17.8	34.8	52.7	78.8	0.0	5.0	10.5	11.3	17.8	23.2
51	6.9	12.8	17.8	34.8	52.7	78.8	0.0	0.0	0.0	0.0	0.0	0.0
52	6.8	12.3	16.8	30.2	46.8	78.6	0.1	0.5	1.0	4.6	5.9	0.2
53	6.8	12.3	16.8	30.2	46.8	78.6	0.0	0.0	0.0	0.0	0.0	0.0
54	6.8	12.2	16.5	30.1	44.7	76.3	0.0	0.1	0.3	0.1	2.1	2.3
55	6.8	12.2	16.5	30.1	44.7	76.3	0.0	0.0	0.0	0.0	0.0	0.0
56	6.8	12.2	16.5	28.1	44.0	69.2	0.0	0.0	0.0	2.0	0.7	7.1
57	6.8	12.2	16.5	28.1	44.0	69.2	0.0	0.0	0.0	0.0	0.0	0.0
58	6.8	12.3	16.5	28.6	43.7	72.0	0.0	-0.1	0.0	-0.5	0.3	-2.8
59	6.8	12.3	16.5	28.6	43.7	72.0	0.0	0.0	0.0	0.0	0.0	0.0
60	6.8	12.3	16.5	29.6	43.6	68.0	0.0	0.0	0.0	-1.0	0.1	4.0
61	6.8	12.3	16.5	29.6	43.6	68.0	0.0	0.0	0.0	0.0	0.0	0.0
62	9.9	22.6	36.4	60.3	83.8	116.0	-3.2	-10.3	-19.9	-30.7	-40.2	-48.0
63	9.9	22.6	36.4	60.3	83.8	116.0	0.0	0.0	0.0	0.0	0.0	0.0
64	6.9	13.2	18.8	36.6	51.8	92.3	3.0	9.4	17.6	23.7	32.0	23.7
65	6.9	13.2	18.8	36.6	51.8	92.3	0.0	0.0	0.0	0.0	0.0	0.0
66	6.8	12.4	17.1	33.1	48.3	80.4	0.1	0.8	1.7	3.5	3.5	11.9
67	8.9	17.3	24.6	37.5	51.7	73.5	1.1	0.6	-0.3	7.1	13.5	30.5
68	8.9	17.3	24.6	37.5	51.7	73.5	0.0	0.0	0.0	0.0	0.0	0.0
69	1.7	3.4	4.9	8.7	13.5	20.0	7.2	13.9	19.7	28.8	38.2	53.5
70	1.7	3.4	4.9	8.7	13.5	20.0	0.0	0.0	0.0	0.0	0.0	0.0
71	1.2	2.1	2.8	4.3	5.8	7.7	0.5	1.3	2.1	4.4	7.7	12.4

Table 4.4 Thalweg Change Due to 100-Year Storm Event

Reach Number	Section Number	Beginning Thalweg Elevation	Ending Thalweg Elevation	Elevation Change
8	192	1916.6	1915.2	-1.4
8	191	1913.1	1911.2	-1.9
8	190	1910.3	1909.5	-0.8
8	189	1906	1904.4	-1.6
8	188	1903	1902.2	-0.8
8	187	1900	1899.2	-0.8
8	186	1897.6	1896.9	-0.7
8	185	1894.3	1893.6	-0.7
8	184	1891.2	1890.5	-0.7
9	183	1888	1888	0
9	182	1884	1884.4	0.4
9	181	1882	1882	0
9	180	1879	1879	0
9	179	1876.3	1876.3	0
9	178	1873.5	1873.6	0.1
9	177	1872	1872	0
9	176	1870	1870.1	0.1
9	175	1867.7	1867.7	0
9	174	1866	1866	0
9	173	1864	1864	0
9	172	1860	1860.4	0.4
9	171	1857.4	1857.8	0.4
9	170	1854.1	1854.5	0.4
9	169	1852	1852.7	0.7
9	168	1851	1851.4	0.4
9	167	1847	1847.5	0.5
9	166	1846	1846.4	0.4
9	165	1844	1844	0
9	164.9	1843.6	1843.6	0
9	164.1	1841.8	1841.8	0
9	164	1840.7	1840.9	0.2
10	163	1838	1838.1	0.1
10	162	1835.6	1835.6	0
10	161	1833.1	1833.1	0
10	160	1829	1829	0
10	159	1827.6	1827.6	0
10	158	1826.1	1826.1	0
10	157	1823.1	1823.1	0
10	156	1821.4	1821.4	0
10	155	1819	1819	0
10	154.9	1816.2	1816.2	0
10	154.8	1813	1813	0
10	154.7	1810.7	1810.7	0
10	154	1806.9	1806.9	0
10	153	1803	1803	0
10	152	1800	1800	0

Notes: Reaches 1 - 3 are above improvements
Reaches 13 - 66 are grade controlled
Reaches 4 - 7, and 69 are lined channels

Reach Number	Section Number	Beginning Thalweg Elevation	Ending Thalweg Elevation	Elevation Change
11	151	1799	1799	0
11	150	1797	1797	0
11	149	1793.3	1793.3	0
11	148	1793	1793	0
11	147	1791	1791	0
11	146	1787.4	1787.4	0
11	145	1785	1785	0
11	144	1782	1782	0
11	143	1778.5	1778.5	0
11	142	1776	1776	0
11	141	1773.7	1774	0.3
12	140	1771.1	1771.1	0
12	139	1769	1769	0
12	138	1764.7	1764.8	0.1
12	137	1762.3	1762.7	0.4
12	136	1761	1761	0
12	135	1760	1760	0
12	134	1758	1758	0
12	133	1755	1755	0
12	132	1753	1753	0
12	131	1749	1749	0
12	130	1747.6	1747.6	0
12	129	1744	1744.1	0.1
12	128	1742	1742.2	0.2
12	127	1740	1740	0
12	126	1738	1738.2	0.2
67	48	1569.2	1571	1.8
67	47.9	1569	1570.8	1.8
67	46.5	1567.4	1569.1	1.7
67	44.7	1565.2	1566.5	1.3
67	44.63	1565.2	1566.4	1.2
68	44.6	1565.1	1565.1	0
68	43.58	1564.3	1564.3	0
70	14.8	1523.2	1523.2	0
70	14.72	1523.2	1523.2	0
70	14.62	1518.2	1518.2	0
70	14.01	1518.2	1518.2	0
70	13.3	1517.2	1517.2	0
70	11.8	1515.1	1515.1	0
70	10.8	1513.7	1513.7	0
70	10.05	1512.7	1512.7	0
70	10	1510	1510	0
71	8.8	1509.7	1509.7	0
71	7.3	1509.2	1509.2	0
71	5.8	1508.7	1508.7	0
71	4.3	1508.3	1508.3	0
71	2.8	1507.8	1507.8	0
71	2.3	1507.7	1507.7	0
71	1.8	1507.5	1507.5	0
71	1.3	1507.3	1507.3	0
71	0.8	1507.2	1507.2	0

Table 4.5 Short-Term Response for 100-Year Flood Event

Volume Change and Potential Average Aggradation / Degradation

Reach	Volume in (CY)	Volume out (CY)	Volume Change (CY)	Reach Length (ft)	Average Width (ft)	Average Agg/Deg Depth (ft)
1	2,922	2,922	0	2700	145	0.00
2	9,578	4,858	4,720	1235	180	0.57
3	4,858	4,858	0	540	120	0.00
4	4,858	4,858	0	945	83	0.00
5	4,858	4,858	0	3250	84	0.00
6	6,128	6,128	0	1980	85	0.00
7	6,128	6,128	0	1800	133	0.00
8	6,128	12,068	-5,940	900	181	-0.99
9	12,068	6,788	5,280	2000	183	0.39
10	6,788	5,448	1,340	1519	169	0.14
11	5,448	5,334	114	1100	217	0.01
12	9,418	3,738	5,680	1460	232	0.45
67	13,784	9,574	4,210	342	190	1.75
68	9,574	9,574	0	128	236	0.00
69	9,574	4,814	4,760	2850	207	0.22
70	4,814	4,814	0	470	174	0.00
71	4,814	3,644 / 0*	1,170 / 4,814*	1010	177	0.18 / 0.73*

Notes: Reaches 13 - 66 have a series of grade control structures. Degradation for earthen channel between structures was estimated as 1 foot (see Volume IV). Reaches 3 - 7, 68, and 70 are lined channels. The inflow is passed through the reach. No changes occur.

* Reach 71: values are based on assuming normal depth / assuming backwater

Table 4.6 Short-Term Response for 10-Year Flood Event

Volume Change and Potential Average Aggradation / Degradation

Reach	Volume in (CY)	Volume out (CY)	Volume Change (CY)	Reach Length (ft)	Average Width (ft)	Average Agg/Deg Depth (ft)
1	1263	1263.00	0	2700	145	0.00
2	3925.00	1715.00	2210	1235	180	0.27
3	1715.00	1715.00	0	540	120	0.00
4	1715.00	1715.00	0	945	83	0.00
5	1715.00	1715.00	0	3250	84	0.00
6	2079.00	2079.00	0	1980	85	0.00
7	2079.00	2079.00	0	1800	133	0.00
8	2079.00	4409.00	-2330	900	181	-0.39
9	4409.00	2769.00	1640	2000	183	0.12
10	2769.00	1868.00	901	1519	169	0.09
11	1868.00	1954.50	-87	1100	217	-0.01
12	3281.50	1001.50	2280	1460	232	0.18
67	3953.50	3915.20	38	342	190	0.02
68	3915.20	3915.20	0	128	236	0.00
69	3915.20	1325.20	2590	2850	207	0.12
70	1325.20	1325.20	0	470	174	0.00
71	1325.20	1359.20	-34	1010	177	-0.01

Notes: Reaches 13 - 66 have a series of grade control structures. Degradation for earthen channel between structures was estimated as < 1 foot (see Volume IV). Reaches 3 - 7, 68, and 70 are lined channels. The inflow is passed through the reach. No changes occur.

Table 4.7 Long-term Conditions 100-Year Flood

No Adjustments

Reach Number	Total Tributary Sed. Inflow (CY)	Sediment Inflow (CY)	Sediment Outflow (CY)	Volume Change (CY)	Reach Length (ft)	Average Top Width (ft)	Aggradation/ Degradation (ft)
1	0	2,922	2922	0	2,700	145	0.00
2	6,656	9,578	5088	4490	1,235	180	0.55
3	0	9,578	9578	0	540	120	0.00
4	0	9,578	9578	0	945	83	0.00
5	0	9,578	9578	0	3,250	84	0.00
6	1,270	10,848	10848	0	1,980	85	0.00
7	0	10,848	10848	0	1,800	133	0.00
8	0	10,848	12848	-2000	900	181	-0.33
9	0	10,848	7188	3660	2,000	183	0.27
10	0	10,848	5798	5050	1,519	169	0.53
11	0	10,848	5596	5252	1,100	217	0.59
12	4,084	14,932	3840	11092	1,460	232	0.88
67	10,046	24,978	9816	15162	342	190	6.30
68	0	24,978	24978	0	128	236	0.00
69	0	24,978	4856	20122	2,850	207	0.92
70	0	24,978	24978	0	470	174	0.00
71	0	24,978	3516	21462	1,010	177	3.24

Notes: Reaches 13 - 66 are grade controlled. See Table 4.10 (equilibrium slope calculation) for the long term response

Reaches 3-7, 68, and 70 are lined reaches. Minimal change will occur along these reaches.

Reach 67 - Sediment Basin will be maintained with no aggradation

Table 4.8 Long-term Conditions 100-Year Flood

Reduced Sediment Supply from N. Beardsley, S. Beardsley and Thompson Peak

Reach Number	Tributary Sed. Inflow (CY)	Sediment Inflow (CY)	Sediment Outflow (CY)	Volume Change (CY)	Reach Length (ft)	Average Top Width (ft)	Aggradation/ Degradation (ft)
1	0	2,922	2922	0	2,700	145	0.00
2	6,656	9,578	4858	4720	1,235	180	0.57
3	0	9,578	9578	0	540	120	0.00
4	0	9,578	9578	0	945	83	0.00
5	0	9,578	9578	0	3,250	84	0.00
6	1,270	10,848	10848	0	1,980	85	0.00
7	0	10,848	10848	0	1,800	133	0.00
8	0	10,848	12068	-1220	900	181	-0.20
9	0	10,848	6788	4060	2,000	183	0.30
10	0	10,848	5448	5400	1,519	169	0.57
11	0	10,848	5334	5514	1,100	217	0.62
12	2,042	12,890	3738	9152	1,460	232	0.73
67	5,023	17,913	9574	8339	342	190	3.46
68	0	17,913	17913	0	128	236	0.00
69	0	17,913	4814	13099	2,850	207	0.60
70	0	17,913	17913	0	470	174	0.00
71	0	17,913	3644	14269	1,010	177	2.16

Notes: Reaches 13 - 66 are grade controlled. See Table 4.10 (equilibrium slope calculation) for the long term response

Reaches 3-7, 68, and 70 are lined reaches. Minimal change will occur along these reaches.

Reach 67 - Sediment Basin will be maintained with no aggradation

Table 4.9 Long-term Conditions 100-Year Flood

Reduced Sediment Supply Upstream and Downstream Tributaries

Reach Number	50% Tributary Sed. Inflow (CY)	Sediment Inflow (CY)	Sediment Outflow (CY)	Volume Change (CY)	Reach Length (ft)	Average Top Width (ft)	Aggradation/ Degradation (ft)
1	0	1,461	2922	-1461	2,700	145	-0.10
2	3,328	4,789	4858	-69	1,235	180	-0.01
3	0	4,789	4789	0	540	120	0.00
4	0	4,789	4789	0	945	83	0.00
5	0	4,789	4789	0	3,250	84	0.00
6	635	5,424	5424	0	1,980	85	0.00
7	0	5,424	5424	0	1,800	133	0.00
8	0	5,424	12068	-6644	900	181	-1.10
9	0	5,424	6788	-1364	2,000	183	-0.10
10	0	5,424	5448	-24	1,519	169	0.00
11	0	5,424	5334	90	1,100	217	0.01
12	2,042	7,466	3738	3728	1,460	232	0.30
67	5,023	12,489	9574	2915	342	190	1.21
68	0	12,489	12489	0	128	236	0.00
69	0	12,489	4814	7675	2,850	207	0.35
70	0	12,489	12489	0	470	174	0.00
71	0	12,489	3644	8845	1,010	177	1.34

Notes: Reaches 13 - 66 are grade controlled. See Table 4.10 (equilibrium slope calculation) for the long term response

Reaches 3-7, 68, and 70 are lined reaches. Minimal change will occur along these reaches.

Reach 67 - Sediment Basin will be maintained with no aggradation

4.4 SUMMARY OF CHANNEL AGGRADATION/DEGRADATION CHARACTERISTICS

A general description of potential response of each channel reach to a short term flood event is given in Table 4.1. This table also summarizes the long term channel response of each reach when the ultimate sediment sources from the Reata Pass Wash East Branch and all tributaries become its sediment supply. More detailed erosion/sedimentation characteristics of the proposed channel are summarized as follows:

1. The lined reaches (Reaches 4 through 7, Station 275+75 to 192+00) were designed to resist high velocity flows and to pass sediments without sedimentation. These reaches have high velocities to flush sediments (the 100-year flood velocity exceeds 30 fps for concrete channel from Station 291+75 to 267+50, and the maximum velocity is 28 fps for the articulated concrete block lining reach from Station 267+50 to 262+30 and downstream drop structures: The velocity exceeds 20 fps for the soil cement lining reach from Station 262+30 to 192+00 and downstream grade control structures. The erosion control ability of concrete block and soil cement under current application is discussed in Chapter V.

2. Reach 8 (Station 192+00 to 183+00) is subject to degradation (both short term and long term, see Table 4.4 through 4.9), but overall channel downcutting will be controlled by grade control structures located near the downstream boundary of the reach. A grade control is also recommended at the upstream boundary to avoid any impact on the integrity of the upstream proposed improvements.

3. Reach 9 (Station 183+00 to 163+00) is subject to short term degradation due to erosion in Reach 8. The reach will continue to aggrade under long term conditions as long as the upstream sediment sources are available. It will become stable to

slightly degradational if the upstream sediment sources are reduced by 50 % or more (see Table 4.9). A grade control structure is recommended near the downstream boundary to prevent bank protection failure due to local scour and long term degradation due to sediment reduction.

4. Reaches 10 and 11 (Station 163+00 to 140+00) are relatively stable based on both short and long term sediment inflow consideration.

5. Reach 12 (station 140+00 to 125+40) is located along the North Beardsley confluence and is subject to aggradation under both short and long term conditions (see Tables 4.4 through 4.9). The aggradation trend remains with 50 % reduction in sediment supply from all sediment inflow sources.

6. Reaches 13 through 66 (Station 125+40 to 48+00) are earthen bottom channels with bank protection and a series of grade control structures. The channel bed between the grade control/drop structures will fluctuate about the tops of the grade control structures. Initially, the channel is subject to degradation and the upper end of the earthen channel reach will tend to degrade more than the lower end. However, sedimentation may occur under the long term sediment supply condition (see Table 4.10).

7. Reach 67 (Station 48+00 to 44+58) includes the sediment basin upstream of Bell Road which has aggradation potential for both short term single flood and long term conditions. Removal of sediments will be required as part of the maintenance program. The sediment basin boundaries will be lined with soil cement to avoid potential headcut erosion which could occur during the initial period of a storm event when the basin is empty.

8. Reach 68 is Bell Road which will be controlled by the proposed soil cement pavement under the bridge and toedown protection downstream of the bridge.

9. Reach 69 (Station 43+30 to 14+80) is the levee reach downstream of Bell Road. This reach has coarse materials and moderate velocities which result in mild aggradation for both short- and long- term conditions (see Tables 4.4 through 4.9).

10. Reach 70 (Station 14+80 to 8+80) is from the drop structure to upper limit of the sediment basin. This reach is to be lined with soil cement, therefore, no erosion will occur. The proposed lining will also protect a sewer line crossing, and it will serve as the road base for a proposed roadway crossing (Thompson Peak Parkway Exit Road). This reach may be subject to sedimentation if the backwater from Bureau of Reclamation remains high at elevation 1528.1 ft for a long duration. This needs to be addressed in the maintenance program.

11. Reach 71 (downstream of Station 8+80) is the sediment basin at the outlet reach. This basin has significant sedimentation potential during high flow, backwater conditions.

4.5 SELECTION OF EROSION CONTROL MATERIALS

4.5.1 Soil Cement

Soil cement lining was selected as the primary erosion control material. As noted in the Hydraulic Summary (Section 3.2), most of the design velocities are under 20 fps. The only exception is during the 100-year peak discharge in the upper reach from Station 196+00 to Station 262+30 where velocities increase up to 25 fps. Historical records for Santa Cruz River, near Tucson, Arizona, show that soil cement lining with a strength less than 750 psi has successfully resisted erosion in 1983 and 1993 floods with average velocities measured as high as 20 fps. USGS personnel have stated that local velocities were measured in the

same events as high as 25 fps (see Volume IV). Similar strength soil cement will be adequate for the Desert Greenbelt project for most reaches. For a more conservative design, higher strength soil cement (1,000 psi) is recommended for channel linings where velocities may exceed 20 fps and for all grade control/drop structures.

4.5.2 Articulated Concrete Block

Federal Highway Administration Publication No. FHWA-RD-89-199 (see Volume IV) references two different tests that have been performed to determine the stability of articulated concrete blocks. The first test, performed in England, shows that Class 30 Armorflex with grass can withstand velocities of 23 to 26 fps and Petraflex can withstand flows exceeding 26 fps. The second test, performed by SLA in Fort Collins, Colorado, show that Armorflex Class 30 without grass can withstand velocities between 12 - 15 fps. The equipment used in that test could not measure velocities greater than 15 fps; the actual failure of the armorflex would have occurred at higher velocities. The concrete blocks will be applied to areas downstream of drop structures in the upper lined channel upstream of Station 216+00 where velocities higher than 25 fps are expected. A higher strength Armorflex product, Class 70, is recommended for application in this case. Class 70 is significantly larger than Class 30 in size (9 inches instead of 6 inches high) and is approximately 100 % heavier than Class 30. The performance of Class 70 under high flow condition should be more reliable than Class 30. A safety factor of 2.4 was estimated for Class 70 on a horizontal bed (see Volume IV). Laboratory tests show blocks typically fail on slopes. Most of the application of blocks on this project will be along horizontal slope, which further supports the reliability of this material. In addition to using Class 70, additional anchors using concrete seals at the joints and special earth anchor system such as Manta Ray (see Volume IV documents) and the use of geofabrics are recommended where applicable to ensure reliable erosion control performance. There have been successful articulated concrete block applications throughout California and Arizona desert washes, as shown in Volume IV.

V. DESIGN OF LEVEE/BANK HEIGHT AND TOE DEPTHS

The bank and levee elevation and toe depth profiles shown in Sheets 6 through 12 were determined using the results of the hydraulic and erosion/sedimentation analyses. This chapter presents factors which have been considered in design of levees, channels, and bank protection. The equations for computing superelevation, bend scour, and contraction scour can be found in Volume II, and detailed computations for levee/bank height and toe depths are presented in Volume IV.

5.1 MINIMUM LEVEE/BANK HEIGHT

5.1.1 Levee Design

Since water surface elevations are higher than the adjacent ground for levee reaches, the criteria for levee height design are more critical than channel banks. The FEMA criteria for levee design, which requires 3 feet base freeboard over the water surface elevation, was applied . For conservative design, the computed 100-year water surface elevation for subcritical flow with Manning's *n* value of 0.05 for natural channel was used. Additional factors that were considered in levee height design are superelevation and sedimentation. No significant superelevation was found in the levee reaches. Table 5.1 shows the minimum design levee heights and various factors considered in establishing them.

5.1.2 Bank Design

The minimum channel bank heights were determined based on the mixed flow water surface elevation (based on a high manning's n-value), base freeboard, and short- and long-term aggradation depth. The base freeboard requirements were determined by the City of Scottsdale and the FCDMC to be 2 feet along the straight reaches and 3 feet along the curved

Table 5.1 Computations for Minimum Levee Elevations

Computations for Minimum Levee Elevations													
Section #	Thalweg Elevation (ft)	Subcritical WSEL (ft)	General Agg. (ft)	Long-term Agg. (ft)	Superelevation (East) (ft)	Superelevation (West) (ft)	Free Board (ft)	Levee Base Elevation (East) (ft)	Levee Base Elevation (West) (ft)	Minimum Top of Levee (East) (ft)	Minimum Top of Levee (West) (ft)	Levee Height from base (East) (ft)	Levee Height from base (West) (ft)
Note: Stations above are channelized													
147.00	1791.0	1794.6	0.0	0.6	0.0	0.0	3.0		1798.1		1798.1		0.0
146.00	1787.4	1792.1	0.0	0.6	0.0	0.0	3.0		1792.2		1795.7		3.5
145.00	1785.0	1789.3	0.0	0.6	0.0	0.0	3.0		1788.5		1792.9		4.4
144.00	1782.0	1786.9	0.0	0.6	0.0	0.0	3.0		1787.0		1790.5		3.5
143.00	1778.5	1783.9	0.0	0.6	0.0	0.0	3.0		1783.5		1787.5		4.0
142.00	1776.0	1781.2	0.0	0.6	0.0	0.0	3.0		1779.5		1784.8		5.3
141.00	1773.7	1779.0	0.3	0.6	0.0	0.0	3.0		1773.5		1782.9		9.3
140.00	1771.1	1776.5	0.0	0.7	0.0	0.0	3.0		1772.0		1780.2		8.2
139.00	1769.0	1773.9	0.0	0.7	0.0	0.0	3.0		1770.2		1777.6		7.3
138.00	1764.7	1771.7	0.1	0.7	0.0	0.0	3.0		1768.5		1775.5		7.0
137.00	1762.3	1769.5	0.4	0.7	0.0	0.0	3.0		1766.8		1773.6		6.8
136.00	1761.0	1767.1	0.0	0.7	0.0	0.0	3.0		1764.2		1770.8		6.6
135.00	1760.0	1764.7	0.0	0.7	0.0	0.0	3.0		1762.0		1768.4		6.4
134.00	1758.0	1762.3	0.0	0.7	0.0	0.0	3.0		1758.0		1766.0		8.0
133.00	1755.0	1759.9	0.0	0.7	0.0	0.0	3.0		1757.1		1763.6		6.5
132.00	1753.0	1757.5	0.0	0.7	0.0	0.0	3.0	1756.8	1754.5	1761.2	1761.2	4.4	6.7
131.00	1749.0	1754.9	0.0	0.7	0.0	0.0	3.0	1753.0	1753.5	1758.6	1758.6	5.6	5.1
130.00	1747.6	1752.5	0.0	0.7	0.0	0.0	3.0	1749.7	1750.5	1756.2	1756.2	6.5	5.7
129.00	1744.0	1750.0	0.1	0.7	0.0	1.5	3.0	1745.9	1748.0	1753.8	1755.3	7.9	7.3
128.00	1742.0	1747.4	0.2	0.7	0.0	1.5	3.0	1745.0	1745.0	1751.3	1752.7	6.3	7.7
127.00	1740.0	1745.9	0.0	0.7	0.0	1.5	3.0	1744.0	1742.7	1749.6	1751.0	5.6	8.3
126.00	1738.0	1743.6	0.2	0.7	0.0	1.5	3.0	1741.0	1741.3	1747.5	1749.0	6.5	7.7
125.40	1737.0	1738.3	0.0	0.0	0.0	1.5	3.0	1740.8	1738.3	1743.7	1744.5	2.9	6.2
Note: Station 125.40 to station 44.60 are channelized													
43.30	1564.0	1569.9	0.0	0.6	1.7	0.0	3.0	1569.2	1567.0	1575.2	1573.5	6.0	6.5
41.80	1562.6	1568.3	0.0	0.6	1.7	0.0	3.0	1572.0	1566.5	1573.6	1571.9	1.6	5.4
40.30	1561.2	1567.3	0.0	0.6	1.7	0.0	3.0	1568.9	1563.0	1572.6	1570.9	3.7	7.9
38.80	1559.8	1566.0	0.0	0.6	1.7	0.0	3.0	1567.8	1562.0	1571.4	1569.6	3.6	7.6
37.30	1558.3	1563.8	0.0	0.6	0.0	0.0	3.0	1566.0	1558.6	1567.4	1567.4	1.4	8.8
35.80	1554.7	1561.6	0.0	0.6	0.0	0.0	3.0	1563.9	1556.8	1565.2	1565.2	1.3	8.4
34.30	1552.7	1558.9	0.0	0.6	0.0	0.0	3.0	1561.0	1556.4	1562.5	1562.5	1.5	6.1
32.80	1549.6	1555.7	0.0	0.6	0.0	0.0	3.0	1552.4	1554.0	1559.3	1559.3	6.9	5.3
31.30	1547.3	1553.2	0.0	0.6	0.0	0.0	3.0	1549.0	1551.1	1556.8	1556.8	7.8	5.7
29.80	1544.6	1551.0	0.0	0.6	0.0	0.0	3.0	1549.0	1548.5	1554.6	1554.6	5.6	6.1
28.30	1542.6	1548.7	0.0	0.6	0.0	0.0	3.0	1547.0	1547.0	1552.3	1552.3	5.3	5.3
26.80	1539.0	1547.0	0.0	0.6	0.0	0.0	3.0	1546.2	1547.0	1550.6	1550.6	4.4	3.6
25.30	1536.2	1544.9	0.0	0.6	0.0	0.0	3.0	1543.7	1541.6	1548.5	1548.5	4.8	6.9
23.80	1534.7	1543.3	0.0	0.6	0.0	0.0	3.0	1541.2	1539.4	1546.9	1546.9	5.7	7.5
22.30	1533.0	1541.6	0.0	0.6	0.0	0.0	3.0	1539.9	1535.2	1545.2	1545.2	5.2	9.9
20.80	1531.2	1539.9	0.0	0.6	0.0	0.0	3.0	1538.1	1535.0	1543.5	1543.5	5.4	8.5
19.30	1530.0	1537.6	0.0	0.6	0.0	0.0	3.0	1537.3	1533.1	1541.2	1541.2	3.9	8.1
17.80	1527.8	1536.2	0.0	0.6	0.0	1.3	3.0	1535.7	1531.9	1539.8	1541.1	4.1	9.2
16.30	1525.6	1534.2	0.0	0.6	0.0	1.3	3.0	1533.4	1529.0	1537.8	1539.1	4.3	10.1
15.30	1524.1	1532.9	0.0	0.6	0.0	1.3	3.0	1532.2	1522.0	1536.5	1537.8	4.3	15.8
14.80	1523.2	1532.0	0.0	0.0	0.0	1.3	3.0	1531.1	1529.0	1535.0	1536.3	3.9	7.3
14.72	1523.2	1529.9	0.0	0.0	0.0	1.3	3.0	1531.0	1529.1	1532.9	1534.3	1.9	5.2
14.62	1518.2	1527.8	0.0	0.0	0.0	1.3	3.0	1530.0	1529.0	1530.8	1532.1	0.8	3.1
14.01	1518.2	1528.1	0.0	0.0	0.0	1.3	3.0	1530.5	1528.0	1531.1	1532.5	0.6	4.4

Note: Remaining downstream stations are part of the detention area in Westworld; containment of a 100-yr flood is not needed.

channels. In the areas where the velocities are high (such as along the upper lined channel between Station 192+00 and Station 269+50) a 3-foot freeboard was used along the straight channel and a 4-foot freeboard along the curved reach for a conservative design.

5.2 MINIMUM LEVEE/BANK PROTECTION TOE DEPTHS

The following factors were considered in the maximum scour depth computation: short-term general scour, low flow channel formation, antidune scour, contraction scour, bend scour, and long term degradation. A factor of 1.3 was applied to total scour (except for long term scour) for additional safety. Table 5.3 summarizes the total scour computation and the required bank and levee protection toe depth. Additional scour that may occur, such as local scour along the hard bank surface, will be addressed as part of the ongoing maintenance. The resulting profiles for bank protection toe depths are presented in Sheets 6 through 11. Sheet 12 displays typical cross sections showing toe depths.

5.3 ROCK BANK STABILIZATION

The geotechnical investigation for the project, performed by AGRA Environmental, will be addressed in a report dated July 1997, and submitted under separate cover. The investigation disclosed the existence of poor quality rock which will form the east bank of the channel from Station 216+00 to 230+00. The east bank rock will be stabilized in this reach by construction of a soil cement lining along the rock face up to the design water surface.

Table 5.2 Computations for Minimum Bank Elevations

Computations for Minimum Bank Elevations																				
Section #	Thalweg Elevation (ft)	Mixed WSEL (ft)	Mixed Velocity (fps)	Mixed Depth (ft)	Superelevation (East) (ft)	Superelevation (West) (ft)	Base Freeboard (East) (ft)	Base Freeboard (West) (ft)	General Agg. (ft)	Long-term Agg. (ft)	Minimum Top of Bank (East) (ft)	Minimum Top of Bank (West) (ft)	Top of Lined Bank (East) (ft)	Top of Lined Bank (West) (ft)	Adjacent High Ground (East) (ft)	Adjacent High Ground (West) (ft)	Available Freeboard East (ft)	Available Freeboard West (ft)	Freeboard Check East (ft)	Freeboard Check West (ft)
271.74	2169.0	2172.5	27.4	3.5	3.0	0.0	4.0	3.0	0.0	0.0	2176.5	2175.5	2180.0	2180.0			7.5	7.5	>4	>4
271.60	2168.5	2171.9	27.7	3.4	3.0	0.0	4.0	3.0	0.0	0.0	2175.9	2174.9	2179.5	2179.5			7.6	7.6	>4	>4
271.40	2167.8	2171.2	28.1	3.4	3.0	0.0	4.0	3.0	0.0	0.0	2175.2	2174.2	2178.5	2178.0			7.3	6.8	>4	>4
270.65	2165.3	2171.3	26.4	6.0	3.0	0.0	4.0	3.0	0.0	0.0	2175.3	2174.3	2178.0	2177.3			6.7	6.0	>4	>4
270.55	2165.0	2170.7	27.0	5.7	3.0	0.0	4.0	3.0	0.0	0.0	2174.7	2173.7	2177.5	2177.0			6.8	6.3	>4	>4
269.80	2163.0	2169.5	27.6	6.5	3.0	2.7	4.0	4.0	0.0	0.0	2173.5	2173.5	2175.5	2174.5			6.0	5.0	>4	>4
269.65	2162.8	2168.7	28.3	5.9	0.0	2.7	3.0	4.0	0.0	0.0	2171.7	2172.7	2175.0	2173.5			6.3	4.8	>4	>4
269.55	2162.7	2167.8	29.1	5.1	0.0	2.7	3.0	4.0	0.0	0.0	2170.8	2171.8	2175.0	2173.0			7.2	5.2	>4	>4
268.00	2160.7	2165.8	29.3	5.1	0.0	2.7	3.0	4.0	0.0	0.0	2168.8	2169.8	2170.7	2170.7			4.9	4.9	>4	>4
267.96	2156.7	2161.9	32.4	5.2	0.0	0.0	3.0	3.0	0.0	0.0	2164.9	2164.9	2170.7	2170.7			8.8	8.8	>4	>4
267.50	2156.7	2161.4	32.0	4.7	2.5	0.0	4.0	3.0	0.0	0.0	2165.4	2164.4	2166.7	2166.7			5.3	5.3	>4	>4
266.20	2154.4	2158.7	31.3	4.3	2.5	0.0	4.0	3.0	0.0	0.0	2162.7	2161.7	2164.4	2164.4			5.7	5.7	>4	>4
266.17	2151.4	2155.7	33.5	4.3	2.5	0.0	4.0	3.0	0.0	0.0	2159.7	2158.7	2164.4	2164.4			8.7	8.7	>4	>4
265.70	2151.4	2156.0	28.7	4.6	2.5	0.0	4.0	3.0	0.0	0.0	2160.0	2159.0	2161.4	2161.4	2162.1		6.1	5.4	>4	>4
265.67	2148.4	2153.0	31.2	4.6	2.5	0.0	4.0	3.0	0.0	0.0	2157.0	2156.0	2161.4	2161.4	2162.2		9.2	8.4	>4	>4
265.20	2148.4	2153.3	26.9	4.9	2.5	0.0	4.0	3.0	0.0	0.0	2157.3	2156.3	2158.4	2158.4	2160.2		6.9	5.1	>4	>4
264.20	2146.6	2151.9	25.1	5.3	2.5	2.1	4.0	4.0	0.0	0.0	2155.9	2155.9	2156.6	2156.6			4.7	4.7	>4	>4
262.30	2143.2	2148.8	23.6	5.6	2.5	2.1	4.0	4.0	0.0	0.0	2152.8	2152.8	2153.2	2153.2			4.4	4.4	>4	>4
262.26	2139.2	2144.5	27.7	5.3	0.0	2.1	3.0	4.0	0.0	0.0	2147.5	2148.5	2153.2	2153.2			8.7	8.7	>4	>4
261.80	2139.2	2144.5	24.8	5.3	0.0	2.1	3.0	4.0	0.0	0.0	2147.5	2148.5	2149.2	2149.2	2153.8	2151.0	9.3	6.5	>4	>4
260.50	2136.8	2142.2	23.9	5.4	0.0	2.1	3.0	4.0	0.0	0.0	2145.2	2146.2	2146.8	2146.8	2149.0		6.8	4.6	>4	>4
260.47	2133.8	2139.1	26.9	5.3	0.0	2.1	3.0	4.0	0.0	0.0	2142.1	2143.1	2146.8	2146.8	2149.0		9.9	7.7	>4	>4
260.00	2133.8	2139.3	23.7	5.5	0.0	2.1	3.0	4.0	0.0	0.0	2142.3	2143.3	2143.8	2143.8	2145.5	2144.5	6.2	5.2	>4	>4
257.10	2128.6	2134.3	22.9	5.7	0.0	0.0	3.0	3.0	0.0	0.0	2137.3	2137.3	2138.6	2138.6	2139.4		5.1	4.3	>4	>4
257.07	2125.6	2131.0	26.1	5.4	0.0	0.0	3.0	3.0	0.0	0.0	2134.0	2134.0	2138.6	2138.6	2139.4		8.4	7.6	>4	>4
256.60	2125.6	2130.6	24.2	5.0	0.0	0.0	3.0	3.0	0.0	0.0	2133.6	2133.6	2135.6	2135.6			5.0	5.0	>4	>4
256.33	2125.1	2129.9	24.2	4.8	0.0	0.0	3.0	3.0	0.0	0.0	2132.9	2132.9	2135.1	2135.1			5.2	5.2	>4	>4
256.00	2124.5	2130.2	22.2	5.7	0.0	0.0	3.0	3.0	0.0	0.0	2133.2	2133.2	2134.5	2134.5			4.3	4.3	>4	>4
255.80	2124.2	2130.0	21.9	5.8	0.0	0.0	3.0	3.0	0.0	0.0	2133.0	2133.0	2134.2	2134.2	2135.2		5.2	4.2	>4	>4
255.76	2120.2	2125.7	26.2	5.5	0.0	0.0	3.0	3.0	0.0	0.0	2128.7	2128.7	2134.2	2134.2	2135.0		9.3	8.5	>4	>4
255.30	2120.2	2125.4	24.8	5.2	0.0	0.0	3.0	3.0	0.0	0.0	2128.4	2128.4	2130.2	2130.2	2134.2	2131.8	8.8	6.4	>4	>4
254.80	2119.3	2124.6	24.1	5.3	0.0	0.0	3.0	3.0	0.0	0.0	2127.6	2127.6	2129.3	2129.3			4.7	4.7	>4	>4
254.00	2117.8	2123.3	23.3	5.5	0.0	0.0	3.0	3.0	0.0	0.0	2126.3	2126.3	2127.8	2127.8	2128.8		5.5	4.5	>4	>4
253.97	2114.8	2120.2	26.3	5.4	0.0	0.0	3.0	3.0	0.0	0.0	2123.2	2123.2	2127.8	2127.8			7.6	7.6	>4	>4
253.50	2114.8	2120.2	23.4	5.4	0.0	0.0	3.0	3.0	0.0	0.0	2123.2	2123.2	2124.8	2124.8			4.6	4.6	>4	>4
252.80	2113.6	2119.2	22.6	5.6	0.0	0.0	3.0	3.0	0.0	0.0	2122.2	2122.2	2123.6	2123.6	2125.6		6.4	4.4	>4	>4
252.77	2110.6	2116.1	25.8	5.5	0.0	0.0	3.0	3.0	0.0	0.0	2119.1	2119.1	2123.6	2123.6			7.5	7.5	>4	>4
252.30	2110.6	2116.1	23.0	5.5	0.8	0.0	3.8	3.0	0.0	0.0	2119.9	2119.1	2120.6	2120.6	2122.6		6.5	4.5	>4	>4
251.50	2109.1	2114.7	22.8	5.6	0.8	0.0	3.8	3.0	0.0	0.0	2118.5	2117.7	2119.1	2119.1	2120.1		5.4	4.4	>4	>4
251.47	2106.1	2111.6	25.9	5.5	0.8	0.0	3.8	3.0	0.0	0.0	2115.4	2114.6	2119.1	2119.1	2120.1		8.5	7.5	>4	>4
251.00	2106.1	2111.6	23.2	5.5	0.8	0.0	3.8	3.0	0.0	0.0	2115.4	2114.6	2116.1	2116.1	2118.1	2117.1	6.5	5.5	>4	>4
250.10	2104.5	2110.1	22.6	5.6	0.8	0.0	3.8	3.0	0.0	0.0	2113.9	2113.1	2114.5	2114.5			4.4	4.4	>4	>4
250.06	2100.5	2105.9	26.7	5.4	0.8	0.0	3.8	3.0	0.0	0.0	2109.7	2108.9	2114.5	2114.5			8.6	8.6	>4	>4
249.60	2100.5	2105.8	24.3	5.3	0.8	0.0	3.8	3.0	0.0	0.0	2109.6	2108.8	2110.5	2110.5	2113.0		7.2	4.7	>4	>4
248.90	2099.2	2104.6	23.4	5.4	0.8	0.0	3.8	3.0	0.0	0.0	2108.4	2107.6	2109.2	2109.2			4.6	4.6	>4	>4
248.87	2096.2	2101.6	26.4	5.4	0.8	0.0	3.8	3.0	0.0	0.0	2105.4	2104.6	2109.2	2109.2			7.6	7.6	>4	>4
248.40	2096.2	2101.6	23.5	5.4	0.8	0.0	3.8	3.0	0.0	0.0	2105.4	2104.6	2106.2	2106.2	2107.0	2108.2	5.4	6.6	>4	>4
247.80	2095.2	2100.8	22.7	5.6	0.8	0.0	3.8	3.0	0.0	0.0	2104.6	2103.8	2105.2	2105.2	2107.2	2105.8	6.4	5.0	>4	>4
247.77	2092.2	2097.7	25.8	5.5	0.8	0.0	3.8	3.0	0.0	0.0	2101.5	2100.7	2105.2	2105.2	2107.2	2105.8	9.5	8.1	>4	>4
247.30	2092.2	2097.7	23.1	5.5	0.8	0.0	3.8	3.0	0.0	0.0	2101.5	2100.7	2102.2	2102.2	2105.2	2104.4	7.5	6.7	>4	>4

Table 5.2 Computations for Minimum Bank Elevations

Computations for Minimum Bank Elevations																				
Section #	Thalweg Elevation (ft)	Mixed WSEL (ft)	Mixed Velocity (fps)	Mixed Depth (ft)	Superelevation (East) (ft)	Superelevation (West) (ft)	Base Freeboard (East) (ft)	Base Freeboard (West) (ft)	General Agg. (ft)	Long-term Agg. (ft)	Minimum Top of Bank (East) (ft)	Minimum Top of Bank (West) (ft)	Top of Lined Bank (East) (ft)	Top of Lined Bank (West) (ft)	Adjacent High Ground (East) (ft)	Adjacent High Ground (West) (ft)	Available Freeboard East (ft)	Available Freeboard West (ft)	Freeboard Check East (ft)	Freeboard Check West (ft)
246.60	2090.9	2096.5	22.7	5.6	0.8	2.2	3.8	4.0	0.0	0.0	2100.3	2100.5	2100.9	2100.9	2101.9		5.4	4.4	>4	>4
246.57	2087.9	2093.4	25.8	5.5	0.0	2.2	3.0	4.0	0.0	0.0	2096.4	2097.4	2100.9	2100.9	2101.9		8.5	7.5	>4	>4
246.10	2087.9	2093.7	22.6	5.8	0.0	2.2	3.0	4.0	0.0	0.0	2096.7	2097.7	2097.9	2097.9	2098.9	2099.2	5.2	5.5	>4	>4
245.40	2086.6	2092.3	22.9	5.7	0.0	2.2	3.0	4.0	0.0	0.0	2095.3	2096.3	2096.6	2096.6			4.3	4.3	>4	>4
245.36	2082.6	2088.0	27.1	5.4	0.0	2.2	3.0	4.0	0.0	0.0	2091.0	2092.0	2096.6	2096.6			8.6	8.6	>4	>4
244.90	2082.6	2088.0	24.4	5.4	0.0	2.2	3.0	4.0	0.0	0.0	2091.0	2092.0	2092.6	2092.6	2093.6		5.6	4.6	>4	>4
244.20	2081.4	2086.9	23.8	5.5	0.0	2.2	3.0	4.0	0.0	0.0	2089.9	2090.9	2091.4	2091.4	2092.4		5.5	4.5	>4	>4
244.17	2078.4	2083.7	26.9	5.3	0.0	0.0	3.0	3.0	0.0	0.0	2086.7	2086.7	2091.4	2091.4	2092.4		8.7	7.7	>4	>4
243.70	2078.4	2084.0	23.5	5.6	0.0	0.0	3.0	3.0	0.0	0.0	2087.0	2087.0	2088.4	2088.4	2090.4	2090.0	6.4	6.0	>4	>4
243.10	2077.3	2082.9	23.5	5.6	0.0	0.0	3.0	3.0	0.0	0.0	2085.9	2085.9	2087.3	2087.3			4.4	4.4	>4	>4
243.07	2074.3	2079.6	26.6	5.3	0.0	0.0	3.0	3.0	0.0	0.0	2082.6	2082.6	2087.3	2087.3			7.7	7.7	>4	>4
242.60	2074.3	2079.9	23.3	5.6	0.0	0.0	3.0	3.0	0.0	0.0	2082.9	2082.9	2084.3	2084.3	2085.3	2086.8	5.4	6.9	>4	>4
242.00	2073.2	2078.8	23.3	5.6	0.0	0.0	3.0	3.0	0.0	0.0	2081.8	2081.8	2083.2	2083.2		2085.2	4.4	6.4	>4	>4
241.97	2070.2	2075.5	26.5	5.3	0.0	0.0	3.0	3.0	0.0	0.0	2078.5	2078.5	2083.2	2083.2			7.7	7.7	>4	>4
241.50	2070.2	2075.9	23.1	5.7	0.0	0.0	3.0	3.0	0.0	0.0	2078.9	2078.9	2080.2	2080.2		2082.7	4.3	6.8	>4	>4
241.06	2069.9	2075.8	22.3	5.9	0.0	0.0	3.0	3.0	0.0	0.0	2078.8	2078.8	2079.9	2079.9	2081.1	2083.0	5.3	7.2	>4	>4
240.56	2069.5	2075.7	20.9	6.2	0.0	0.0	3.0	3.0	0.0	0.0	2078.7	2078.7	2079.5	2079.5	2080.5	2083.0	4.8	7.3	>4	>4
239.70	2068.8	2075.0	21.0	6.2	0.0	0.0	3.0	3.0	0.0	0.0	2078.0	2078.0	2078.8	2078.8			3.8	3.8	>3	>3
239.67	2065.8	2071.5	24.8	5.7	0.0	0.0	3.0	3.0	0.0	0.0	2074.5	2074.5	2078.8	2078.8			7.3	7.3	>4	>4
239.20	2065.8	2071.8	21.7	6.0	0.0	0.0	3.0	3.0	0.0	0.0	2074.8	2074.8	2075.8	2075.8			4.0	4.0	>4	>4
239.17	2062.8	2068.4	25.2	5.6	0.0	0.0	3.0	3.0	0.0	0.0	2071.4	2071.4	2075.8	2075.8			7.4	7.4	>4	>4
238.60	2062.8	2068.5	22.9	5.7	1.7	0.0	4.0	3.0	0.0	0.0	2072.5	2071.5	2072.8	2072.8			4.3	4.3	>4	>4
238.57	2059.8	2065.2	26.2	5.4	1.7	0.0	4.0	3.0	0.0	0.0	2069.2	2068.2	2072.8	2072.8			7.6	7.6	>4	>4
238.10	2059.8	2065.5	22.9	5.7	1.7	0.0	4.0	3.0	0.0	0.0	2069.5	2068.5	2069.8	2069.8	2070.0	2070.8	4.5	5.3	>4	>4
237.60	2058.9	2064.6	23.0	5.7	1.7	0.0	4.0	3.0	0.0	0.0	2068.6	2067.6	2068.9	2068.9			4.3	4.3	>4	>4
237.57	2055.9	2061.3	26.3	5.4	1.7	0.0	4.0	3.0	0.0	0.0	2065.3	2064.3	2068.9	2068.9			7.6	7.6	>4	>4
237.10	2055.9	2061.6	22.9	5.7	1.7	0.0	4.0	3.0	0.0	0.0	2065.6	2064.6	2065.9	2065.9	2067.9	2070.8	6.3	9.2	>4	>4
236.50	2054.8	2060.5	23.1	5.7	1.7	0.0	4.0	3.0	0.0	0.0	2064.5	2063.5	2064.8	2064.8			4.3	4.3	>4	>4
236.46	2050.8	2056.1	27.3	5.3	1.7	0.0	4.0	3.0	0.0	0.0	2060.1	2059.1	2064.8	2064.8			8.7	8.7	>4	>4
236.00	2050.8	2056.2	24.4	5.4	1.7	0.0	4.0	3.0	0.0	0.0	2060.2	2059.2	2060.8	2060.8	2062.5	2061.4	6.3	5.2	>4	>4
235.50	2049.9	2055.2	24.3	5.3	1.7	0.0	4.0	3.0	0.0	0.0	2059.2	2058.2	2059.9	2059.9	2060.8		5.6	4.7	>4	>4
235.46	2045.9	2051.1	28.1	5.2	1.7	0.0	4.0	3.0	0.0	0.0	2055.1	2054.1	2059.9	2059.9			8.8	8.8	>4	>4
235.00	2045.9	2051.0	25.3	5.1	1.7	0.0	4.0	3.0	0.0	0.0	2055.0	2054.0	2055.9	2055.9	2058.8	2057.6	7.8	6.6	>4	>4
234.50	2045.0	2050.2	24.3	5.2	1.7	0.0	4.0	3.0	0.0	0.0	2054.2	2053.2	2055.0	2055.0	2055.4	2055.3	5.2	5.1	>4	>4
234.47	2042.0	2047.2	27.2	5.2	1.7	0.0	4.0	3.0	0.0	0.0	2051.2	2050.2	2055.0	2055.0	2055.4	2055.3	8.2	8.1	>4	>4
234.00	2042.0	2047.3	24.1	5.3	1.7	0.0	4.0	3.0	0.0	0.0	2051.3	2050.3	2052.0	2052.0	2052.5	2052.4	5.2	5.1	>4	>4
233.50	2041.1	2046.5	23.6	5.4	1.7	0.0	4.0	3.0	0.0	0.0	2050.5	2049.5	2051.1	2051.1			4.6	4.6	>4	>4
233.47	2038.1	2043.3	26.6	5.2	1.7	0.0	4.0	3.0	0.0	0.0	2047.3	2046.3	2051.1	2051.1			7.8	7.8	>4	>4
233.00	2038.1	2043.5	23.5	5.4	1.7	0.0	4.0	3.0	0.0	0.0	2047.5	2046.5	2044.1	2048.1	2047.5		4.0	4.6	>4	>4
232.96	2034.1	2039.3	27.5	5.2	1.7	0.0	4.0	3.0	0.0	0.0	2043.3	2042.3	2044.1	2048.1	2043.3		4.8	8.8	>4	>4
232.50	2034.1	2039.3	24.7	5.2	1.7	0.0	4.0	3.0	0.0	0.0	2043.3	2042.3	2038.1	2044.1	2043.3	2045.6	4.0	6.3	>4	>4
229.80	2029.2	2035.1	22.7	5.9	1.7	0.0	4.0	3.0	0.0	0.0	2039.1	2038.1	2035.2	2039.2	2039.1		4.0	4.1	>4	>4
229.78	2027.2	2033.0	24.8	5.8	0.0	0.0	3.0	3.0	0.0	0.0	2036.0	2036.0	2035.2	2039.2	2036.0		3.0	6.2	>3	>4
229.30	2027.2	2032.9	22.5	5.7	0.0	1.0	3.0	4.0	0.0	0.0	2035.9	2036.9	2033.2	2037.2	2035.9	2038.5	3.0	5.6	>3	>4
226.80	2022.7	2028.8	22.4	6.1	0.0	1.0	3.0	4.0	0.0	0.0	2031.8	2032.8	2028.7	2032.8	2031.8		3.0	4.0	>3	>4
226.77	2019.7	2025.4	25.8	5.7	0.0	1.0	3.0	4.0	0.0	0.0	2028.4	2029.4	2028.7	2032.7	2028.4		3.3	7.3	>3	>4
226.30	2019.7	2025.7	22.7	6.0	0.0	1.0	3.0	4.0	0.0	0.0	2028.7	2029.7	2025.7	2029.7	2028.7		3.0	4.0	>3	>4
223.30	2014.3	2020.1	23.5	5.8	0.0	2.0	3.0	4.0	0.0	0.0	2023.1	2024.1	2020.3	2024.3	2023.1	2025.3	3.0	5.2	>3	>4
223.27	2011.3	2016.8	26.7	5.5	0.0	2.0	3.0	4.0	0.0	0.0	2019.8	2020.8	2020.3	2024.3	2019.8	2025.3	3.5	8.5	>3	>4
222.80	2011.3	2017.1	23.5	5.8	0.0	2.0	3.0	4.0	0.0	0.0	2020.1	2021.1	2017.3	2021.3	2020.1	2024.5	3.0	7.4	>3	>4

Table 5.2 Computations for Minimum Bank Elevations

Computations for Minimum Bank Elevations																				
Section #	Thalweg Elevation (ft)	Mixed WSEL (ft)	Mixed Velocity (fps)	Mixed Depth (ft)	Superelevation (East) (ft)	Superelevation (West) (ft)	Base Freeboard (East) (ft)	Base Freeboard (West) (ft)	General Agg. (ft)	Long-term Agg. (ft)	Minimum Top of Bank (East) (ft)	Minimum Top of Bank (West) (ft)	Top of Lined Bank (East) (ft)	Top of Lined Bank (West) (ft)	Adjacent High Ground (East) (ft)	Adjacent High Ground (West) (ft)	Available Freeboard East (ft)	Available Freeboard West (ft)	Freeboard Check East (ft)	Freeboard Check West (ft)
219.00	2004.5	2010.3	23.7	5.8	0.0	2.0	3.0	4.0	0.0	0.0	2013.3	2014.3	2010.5	2014.5	2013.3		3.0	4.2	>3	>4
218.97	2001.5	2007.0	26.8	5.5	0.0	0.0	3.0	3.0	0.0	0.0	2010.0	2010.0	2010.5	2014.5	2010.0		3.5	7.5	>3	>4
218.50	2001.5	2007.3	23.6	5.8	0.0	0.0	3.0	3.0	0.0	0.0	2010.3	2010.3	2007.5	2011.5	2010.3	2012.5	3.0	5.2	>3	>4
216.50	1998.4	2004.4	22.7	6.0	0.0	1.1	3.0	4.0	0.0	0.0	2007.4	2008.4	2004.4	2008.4	2008.4		4.0	4.0	>4	>4
216.47	1995.4	2001.0	26.1	5.6	0.0	1.1	3.0	4.0	0.0	0.0	2004.0	2005.0	2004.4	2008.4	2005.4		4.4	7.4	>4	>4
216.00	1995.4	2001.4	22.9	6.0	0.0	1.1	3.0	4.0	0.0	0.0	2004.4	2005.4	2005.4	2005.4			4.0	4.0	>4	>4
215.00	1993.6	1999.5	23.2	5.9	0.0	1.1	3.0	4.0	0.0	0.0	2002.5	2003.5	2003.6	2003.6			4.1	4.1	>4	>4
214.97	1990.6	1996.3	26.3	5.7	0.0	1.1	3.0	4.0	0.0	0.0	1999.3	2000.3	2003.6	2003.6			7.3	7.3	>4	>4
214.50	1990.6	1996.3	23.8	5.7	0.0	1.1	3.0	4.0	0.0	0.0	1999.3	2000.3	2000.6	2000.6			4.3	4.3	>4	>4
214.00	1989.7	1995.4	23.8	5.7	0.0	1.1	3.0	4.0	0.0	0.0	1998.4	1999.4	1999.7	1999.7		2001.0	4.3	5.6	>4	>4
213.97	1986.7	1992.2	27.0	5.5	0.0	1.1	3.0	4.0	0.0	0.0	1995.2	1996.2	1999.7	1999.7		2001.0	7.5	8.8	>4	>4
213.50	1986.7	1992.5	23.7	5.8	0.0	1.1	3.0	4.0	0.0	0.0	1995.5	1996.5	1996.7	1996.7			4.2	4.2	>4	>4
213.00	1985.8	1991.6	23.7	5.8	0.0	0.0	3.0	3.0	0.0	0.0	1994.6	1994.6	1995.8	1995.8	1996.8		5.2	4.2	>4	>4
212.97	1982.8	1988.3	26.8	5.5	0.0	1.6	3.0	4.0	0.0	0.0	1991.3	1992.3	1995.8	1995.8	1996.8		8.5	7.5	>4	>4
212.50	1982.8	1988.6	23.6	5.8	0.0	1.6	3.0	4.0	0.0	0.0	1991.6	1992.6	1992.8	1992.8	1995.8	1995.8	7.2	7.2	>4	>4
212.06	1982.0	1987.7	24.1	5.7	0.0	1.6	3.0	4.0	0.0	0.0	1990.7	1991.7	1992.0	1992.0			4.3	4.3	>4	>4
211.66	1981.3	1987.2	23.1	5.9	0.0	1.6	3.0	4.0	0.0	0.0	1990.2	1991.2	1991.3	1991.3			4.1	4.1	>4	>4
211.00	1980.1	1985.8	23.9	5.7	0.0	1.6	3.0	4.0	0.0	0.0	1988.8	1989.8	1990.1	1990.1			4.3	4.3	>4	>4
210.00	1978.3	1982.8	24.8	4.5	0.0	1.6	3.0	4.0	0.0	0.0	1985.8	1986.8	1987.3	1987.3			4.5	4.5	>4	>4
209.00	1976.5	1980.5	24.0	4.0	0.0	1.6	3.0	4.0	0.0	0.0	1983.5	1984.5	1984.5	1984.5			4.0	4.0	>4	>4
208.50	1975.6	1979.4	23.1	3.8	0.0	1.6	3.0	4.0	0.0	0.0	1982.4	1983.4	1983.6	1983.6	1986.7		7.3	4.2	>4	>4
208.46	1971.6	1975.0	27.2	3.4	0.0	1.6	3.0	4.0	0.0	0.0	1978.0	1979.0	1983.6	1983.6	1986.5		11.5	8.6	>4	>4
208.00	1971.6	1975.6	22.1	4.0	0.0	1.6	2.9	4.0	0.0	0.0	1978.5	1979.6	1979.6	1979.6	1981.9		6.3	4.0	>4	>4
207.50	1970.7	1974.8	21.3	4.1	0.0	1.6	2.8	4.0	0.0	0.0	1977.6	1978.8	1978.7	1978.8	1982.8	1978.8	8.0	4.0	>4	>4
207.47	1967.7	1971.4	24.8	3.7	0.0	1.6	3.0	4.0	0.0	0.0	1974.4	1975.4	1978.7	1978.7	1982.7		11.3	7.3	>4	>4
207.00	1967.7	1972.1	19.5	4.4	0.0	1.6	2.6	4.0	0.0	0.0	1974.7	1976.1	1975.7	1975.7	1981.7	1976.1	9.6	4.0	>4	>4
206.00	1965.9	1970.3	19.7	4.4	0.0	1.6	2.6	4.0	0.0	0.0	1972.9	1974.3	1973.9	1973.9		1974.3	3.6	4.0	>3	>4
205.00	1964.1	1968.5	19.9	4.4	0.0	1.6	2.6	4.0	0.0	0.0	1971.1	1972.5	1972.1	1972.1		1972.5	3.6	4.0	>3	>4
204.97	1961.1	1965.0	23.9	3.9	0.0	1.6	3.0	4.0	0.0	0.0	1968.0	1969.0	1972.1	1972.1		1969.0	7.1	7.1	>4	>4
204.50	1961.1	1965.8	18.8	4.7	0.0	1.6	2.5	4.0	0.0	0.0	1968.3	1969.8	1969.1	1969.1		1969.8	3.3	4.0	>3	>4
204.47	1958.1	1962.1	23.1	4.0	0.0	1.6	3.0	4.0	0.0	0.0	1965.1	1966.1	1969.1	1969.1		1966.1	7.0	7.0	>4	>4
204.00	1958.1	1963.0	17.9	4.9	0.0	1.6	2.5	4.0	0.0	0.0	1965.5	1967.0	1966.1	1966.1		1967.1	3.1	4.1	>3	>4
203.97	1955.1	1959.2	22.5	4.1	0.0	1.6	3.0	4.0	0.0	0.0	1962.2	1963.2	1966.1	1966.1		1967.1	6.9	7.9	>4	>4
203.50	1955.1	1960.4	16.5	5.3	1.2	1.6	3.6	4.0	0.0	0.0	1964.0	1964.4	1963.1	1963.1	1964.0	1965.2	3.6	4.8	>3	>4
203.00	1954.2	1959.1	17.8	4.9	1.2	0.0	3.6	2.5	0.0	0.0	1962.7	1961.6	1962.2	1962.2	1962.7	1963.7	3.6	4.6	>3	>4
202.97	1951.2	1955.3	22.4	4.1	1.2	0.0	4.0	3.0	0.0	0.0	1959.3	1958.3	1962.2	1962.2	1959.3		6.9	6.9	>4	>4
202.50	1951.2	1956.6	16.0	5.4	1.2	0.0	3.5	2.3	0.0	0.0	1960.1	1958.9	1959.2	1959.2	1960.1	1962.2	3.5	5.6	>3	>4
202.47	1948.2	1952.5	21.4	4.3	1.2	0.0	4.0	2.9	0.0	0.0	1956.5	1955.4	1959.2	1959.2	1956.5	1962.2	6.7	9.7	>4	>4
202.00	1948.2	1953.5	16.3	5.3	1.2	0.0	3.5	2.4	0.0	0.0	1957.0	1955.9	1956.2	1956.2	1957.0	1960.0	3.5	6.5	>3	>4
201.50	1947.3	1952.2	17.7	4.9	1.2	0.0	3.6	2.4	0.0	0.0	1955.8	1954.6	1955.3	1955.3	1955.8	1957.3	3.6	5.1	>3	>4
201.47	1944.3	1948.4	22.3	4.1	1.2	0.0	4.0	3.0	0.0	0.0	1952.4	1951.4	1955.3	1955.3	1952.4	1957.3	6.9	8.9	>4	>4
201.00	1944.3	1949.7	16.0	5.4	1.2	0.0	3.5	2.3	0.0	0.0	1953.2	1952.0	1952.3	1952.3	1953.8	1953.8	4.1	4.1	>4	>4
200.97	1941.3	1945.6	21.5	4.3	1.2	0.0	4.0	2.9	0.0	0.0	1949.6	1948.5	1952.3	1952.3	1953.8	1953.8	8.2	8.2	>4	>4
200.50	1941.3	1946.6	16.4	5.3	1.2	0.0	3.5	2.4	0.0	0.0	1950.1	1949.0	1949.3	1949.3	1950.1		3.5	2.7	>3	2.7
200.47	1938.3	1942.5	21.7	4.2	1.2	0.0	4.0	2.9	0.0	0.0	1946.5	1945.4	1949.3	1949.3	1946.5		6.8	6.8	>4	>4
200.00	1938.3	1943.6	16.4	5.3	1.2	0.0	3.5	2.4	0.0	0.0	1947.1	1946.0	1946.3	1946.3	1947.1		3.5	2.7	>3	2.7
199.97	1935.3	1939.5	21.6	4.2	1.2	0.0	4.0	2.9	0.0	0.0	1943.5	1942.4	1946.3	1946.3	1943.5		6.8	6.8	>4	>4
199.50	1935.3	1940.6	16.4	5.3	1.2	0.0	3.5	2.4	0.0	0.0	1944.1	1943.0	1943.3	1943.3	1944.5		3.9	2.7	>3	2.7
199.46	1931.3	1935.4	22.9	4.1	1.2	0.0	4.0	3.0	0.0	0.0	1939.4	1938.4	1943.3	1943.3	1944.4		9.0	7.9	>4	>4
199.00	1931.3	1936.1	18.2	4.8	1.2	0.0	3.7	2.5	0.0	0.0	1939.8	1938.6	1939.3	1939.3	1943.3	1939.8	7.2	3.7	>4	>3

Table 5.2 Computations for Minimum Bank Elevations

Computations for Minimum Bank Elevations																				
Section #	Thalweg Elevation (ft)	Mixed WSEL (ft)	Mixed Velocity (fps)	Mixed Depth (ft)	Superelevation (East) (ft)	Superelevation (West) (ft)	Base Freeboard (East) (ft)	Base Freeboard (West) (ft)	General Agg. (ft)	Long-term Agg. (ft)	Minimum Top of Bank (East) (ft)	Minimum Top of Bank (West) (ft)	Top of Lined Bank (East) (ft)	Top of Lined Bank (West) (ft)	Adjacent High Ground (East) (ft)	Adjacent High Ground (West) (ft)	Available Freeboard East (ft)	Available Freeboard West (ft)	Freeboard Check East (ft)	Freeboard Check West (ft)
198.00	1929.5	1934.0	19.3	4.5	1.8	0.0	4.0	2.6	0.0	0.0	1938.0	1936.6	1937.5	1937.5	1938.0		4.0	3.5	>4	>3
197.00	1927.7	1932.0	19.8	4.3	1.8	0.0	4.0	2.6	0.0	0.0	1936.0	1934.6	1935.7	1935.7	1936.0	1940.5	4.0	8.5	>4	>4
196.97	1924.7	1928.7	23.5	4.0	1.8	0.0	4.0	3.0	0.0	0.0	1932.7	1931.7	1935.7	1935.7	1932.7	1940.5	7.0	11.8	>4	>4
196.50	1924.7	1929.6	18.1	4.9	1.8	0.0	4.0	2.5	0.0	0.0	1933.6	1932.1	1932.7	1932.7	1933.6	1937.1	4.0	7.5	>4	>4
196.00	1923.8	1928.0	19.4	4.2	1.8	0.0	4.0	2.5	0.0	0.0	1932.0	1930.5	1931.8	1931.8	1932.0		4.0	3.8	>4	>3
195.00	1922.0	1926.4	18.7	4.4	1.8	0.0	4.0	2.5	0.0	0.0	1930.4	1928.9	NG	NG	1930.4	1928.9				
194.00	1920.2	1924.4	18.2	4.2	1.8	0.0	4.0	2.3	0.0	0.0	1928.4	1926.7	NG	NG	1928.4	1926.7				
193.00	1918.4	1926.1	10.9	7.7	1.8	0.0	4.0	2.4	0.0	0.0	1930.1	1928.5	NG	NG	1930.1	1928.5				
192.00	1916.6	1921.5	17.4	4.9	1.8	0.0	4.0	2.4	0.0	0.0	1925.5	1923.9	NG	NG	1925.5	1923.9				
191.00	1913.1	1919.4	17.2	6.3	0.0	0.0	2.7	2.7	0.0	0.0	1922.1	1922.1	NG	NG	1922.1	1922.1				
190.00	1910.3	1915.0	18.1	4.7	0.0	0.0	2.4	2.4	0.0	0.0	1917.4	1917.4	NG	NG	1917.4	1917.4				
189.00	1906.0	1911.3	18.3	5.3	0.0	0.0	2.6	2.6	0.0	0.0	1913.9	1913.9	NG	NG	1913.9	1913.9				
188.00	1903.0	1907.8	17.3	4.8	0.0	0.0	2.4	2.4	0.0	0.0	1910.2	1910.2	NG	1910.2	1910.2			2.4		2.4
187.00	1900.0	1904.7	16.6	4.7	0.0	0.0	2.2	2.2	0.0	0.0	1906.9	1906.9	NG	1906.9	1906.9			2.2		2.2
186.00	1897.6	1902.0	15.9	4.4	0.0	0.0	2.1	2.1	0.0	0.0	1904.1	1904.1	NG	1904.1	1904.1			2.1		2.1
185.00	1894.3	1898.6	16.5	4.3	0.0	0.0	2.1	2.1	0.0	0.0	1900.7	1900.7	NG	1900.7	1900.7			2.1		2.1
184.00	1891.2	1895.3	16.7	4.1	0.0	0.0	2.1	2.1	0.0	0.0	1897.4	1897.4	NG	1897.4	1897.4			2.1		2.1
183.00	1888.0	1892.9	15.7	4.9	0.0	0.0	2.2	2.2	0.0	0.3	1895.4	1895.4	NG	1895.4	1895.4			2.5		2.5
182.00	1884.0	1889.9	15.9	5.9	1.0	0.0	3.5	2.5	0.4	0.3	1894.0	1893.0	NG	1893.0	1894.0			3.1		>3
181.00	1882.0	1885.4	17.2	3.4	1.7	0.0	3.7	2.0	0.0	0.3	1889.4	1887.7	1889.4	1887.7			4.0	2.3	>3	2.3
180.00	1879.0	1883.9	13.5	4.9	1.7	0.0	3.7	2.0	0.0	0.3	1887.9	1886.2	1887.9	1886.2			4.0	2.3	>3	2.3
179.00	1876.3	1881.5	13.2	5.2	1.7	0.0	3.7	2.0	0.0	0.3	1885.5	1883.8	1885.5	1883.8			4.0	2.3	>3	2.3
178.00	1873.5	1879.4	13.2	5.9	1.7	0.0	3.8	2.2	0.1	0.3	1883.6	1881.9	1883.6	1881.9			4.2	2.5	>4	2.5
177.00	1872.0	1877.5	12.3	5.5	1.7	0.0	3.7	2.0	0.0	0.3	1881.5	1879.8	1881.5	1879.8			4.0	2.3	>3	2.3
176.00	1870.0	1876.0	12.3	6.0	1.7	0.0	3.8	2.1	0.1	0.3	1880.2	1878.5	1880.2	1878.5			4.2	2.5	>4	2.5
175.00	1867.7	1873.8	11.9	6.1	1.0	0.0	3.1	2.1	0.0	0.3	1877.1	1876.1	1877.1	1876.1			3.3	2.3	>3	2.3
174.00	1866.0	1872.3	13.2	6.3	1.0	0.0	3.3	2.3	0.1	0.3	1875.9	1874.9	1875.9	1874.9			3.6	2.6	>3	2.6
173.00	1864.0	1870.0	10.2	6.0	1.0	0.0	3.0	2.0	0.0	0.3	1873.3	1872.3	1873.3	1872.3			3.3	2.3	>3	2.3
172.00	1860.0	1866.6	16.9	6.6	1.1	0.0	3.9	2.8	0.4	0.3	1871.1	1870.0	1871.1	1870.0			4.5	3.4	>4	>3
171.00	1857.4	1865.7	12.9	8.3	1.1	0.0	3.8	2.7	0.5	0.3	1870.3	1869.2	1870.3	1869.2			4.6	3.5	>4	>3
170.00	1854.1	1863.8	12.3	9.7	1.1	0.0	4.0	3.0	0.5	0.3	1868.6	1867.6	1868.6	1867.6			4.8	3.8	>4	>3
169.00	1852.0	1861.3	13.3	9.3	1.1	0.0	4.0	3.0	0.8	0.3	1866.4	1865.4	1866.4	1865.4			5.1	4.1	>4	>4
168.00	1851.0	1856.8	16.6	5.8	1.1	0.0	3.6	2.5	0.5	0.3	1861.2	1860.1	1861.2	1860.1			4.4	3.3	>4	>3
167.00	1847.0	1854.6	16.3	7.6	0.0	0.0	2.9	2.9	0.5	0.3	1858.3	1858.3	1858.3	1858.3			3.7	3.7	>3	>3
166.00	1846.0	1852.3	14.2	6.3	0.0	0.0	2.4	2.4	0.4	0.3	1855.3	1855.3	1855.3	1855.3			3.0	3.0	>3	>3
165.00	1844.0	1847.3	16.8	3.3	0.0	0.0	2.0	2.0	0.0	0.3	1849.6	1849.6	1849.6	1849.6			2.3	2.3	2.3	2.3
164.90	1843.6	1848.6	16.8	5.0	0.0	0.0	2.3	2.3	0.0	0.3	1851.2	1851.2	1851.2	1851.2			2.6	2.6	2.6	2.6
164.10	1841.8	1848.6	5.3	6.8	0.0	0.0	2.0	2.0	0.0	0.3	1850.9	1850.9	1850.9	1850.9			2.3	2.3	2.3	2.3
164.00	1840.7	1847.5	10.9	6.8	0.0	0.0	2.2	2.2	0.2	0.3	1850.1	1850.1	1850.1	1850.1			2.6	2.6	2.6	2.6
163.00	1838.0	1845.2	14.1	7.2	0.0	0.0	2.6	2.6	0.1	0.5	1848.4	1848.4	1848.4	1848.4			3.2	3.2	>3	>3
162.00	1835.6	1841.7	15.6	6.1	0.0	0.0	2.5	2.5	0.0	0.5	1844.7	1844.7	NG	1844.7	1844.7			3.0		3.0
161.00	1833.1	1839.1	15.8	6.0	0.0	0.0	2.5	2.5	0.0	0.5	1842.1	1842.1	NG	1842.1	1842.1			3.0		3.0
160.00	1829.0	1836.8	15.0	7.8	0.0	0.0	2.8	2.8	0.0	0.5	1840.2	1840.2	NG	NG	1840.2	1840.2				
159.00	1827.6	1834.6	14.5	7.0	0.0	0.0	2.6	2.6	0.0	0.5	1837.7	1837.7	NG	NG	1837.7	1837.7				
158.00	1826.1	1831.2	15.5	5.1	0.0	0.0	2.2	2.2	0.0	0.5	1833.9	1833.9	NG	NG	1833.9	1833.9				
157.00	1823.1	1829.8	13.6	6.7	0.0	0.0	2.4	2.4	0.0	0.5	1832.7	1832.7	NG	NG	1832.7	1832.7				
156.00	1821.4	1827.7	11.8	6.3	0.0	0.0	2.1	2.1	0.0	0.5	1830.3	1830.3	NG	NG	1830.3	1830.3				
*155.00	1819.0	1824.6	14.0	5.6	0.0	0.0	2.2	2.2	0.0	0.5	1827.3	1827.3	NG	NG	1827.3	1827.3				
157.00	1816.2	1821.6	12.3	5.4	0.0	0.0	2.0	2.0	0.0	0.5	1824.1	1824.1	NG	NG	1824.1	1824.1				
156.00	1813.0	1818.4	13.3	5.4	0.0	0.0	2.0	2.0	0.0	0.5	1821.0	1821.0	NG	NG	1821.0	1821.0				

Table 5.2 Computations for Minimum Bank Elevations

Computations for Minimum Bank Elevations																				
Section #	Thalweg Elevation (ft)	Mixed WSEL (ft)	Mixed Velocity (fps)	Mixed Depth (ft)	Superelevation (East) (ft)	Superelevation (West) (ft)	Base Freeboard (East) (ft)	Base Freeboard (West) (ft)	General Agg. (ft)	Long-term Agg. (ft)	Minimum Top of Bank (East) (ft)	Minimum Top of Bank (West) (ft)	Top of Lined Bank (East) (ft)	Top of Lined Bank (West) (ft)	Adjacent High Ground (East) (ft)	Adjacent High Ground (West) (ft)	Available Freeboard East (ft)	Available Freeboard West (ft)	Freeboard Check East (ft)	Freeboard Check West (ft)
155.00	1810.7	1815.8	11.5	5.1	0.0	0.0	2.0	2.0	0.0	0.5	1818.3	1818.3	NG	NG	1818.3	1818.3				
154.00	1806.9	1811.8	14.1	4.9	0.0	0.0	2.0	2.0	0.0	0.5	1814.3	1814.3	NG	NG	1814.3	1814.3				
153.00	1803.0	1809.5	12.4	6.5	0.0	0.0	2.2	2.2	0.0	0.5	1812.3	1812.3	NG	NG	1812.3	1812.3				
152.00	1800.0	1806.9	10.2	6.9	0.0	0.0	2.1	2.1	0.0	0.5	1809.6	1809.6	NG	NG	1809.6	1809.6				
151.00	1799.0	1804.4	11.3	5.4	0.0	0.0	2.0	2.0	0.0	0.6	1807.0	1807.0	NG	NG	1807.0	1807.0				
150.00	1797.0	1801.8	10.5	4.8	0.0	0.0	2.0	2.0	0.0	0.6	1804.4	1804.4	NG	NG	1804.4	1804.4				
149.00	1793.3	1799.7	10.9	6.4	0.0	0.0	2.1	2.1	0.0	0.6	1802.4	1802.4	NG	NG	1802.4	1802.4				
148.00	1793.0	1797.0	10.6	4.0	0.0	0.0	2.0	2.0	0.0	0.6	1799.6	1799.6	NG	NG	1799.6	1799.6				
147.00	1791.0	1794.8	11.3	3.8	0.0	0.0	2.0	Levee	0.0	0.6	1797.4	Levee	NG	Levee	1797.4					
146.00	1787.4	1792.1	11.8	4.7	0.0	0.0	2.0	Levee	0.0	0.6	1794.7	Levee	NG	Levee	1794.7					
145.00	1785.0	1789.6	13.0	4.6	0.0	0.0	2.0	Levee	0.0	0.6	1792.2	Levee	NG	Levee	1792.2					
144.00	1782.0	1786.9	13.3	4.9	0.0	0.0	2.0	Levee	0.0	0.6	1789.5	Levee	NG	Levee	1789.5					
143.00	1778.5	1783.7	14.8	5.2	0.0	0.0	2.2	Levee	0.0	0.6	1786.4	Levee	NG	Levee	1786.4					
142.00	1776.0	1781.3	13.5	5.3	0.0	0.0	2.0	Levee	0.0	0.6	1783.9	Levee	NG	Levee	1783.9					
141.00	1773.7	1779.2	11.7	5.5	0.0	0.0	2.0	Levee	0.3	0.6	1782.1	Levee	NG	Levee	1782.1					
140.00	1771.1	1776.5	13.0	5.4	0.0	0.0	2.0	Levee	0.0	0.9	1779.4	Levee	NG	Levee	1779.4					
139.00	1769.0	1773.9	13.4	4.9	0.0	0.0	2.0	Levee	0.0	0.9	1776.8	Levee	NG	Levee	1776.8					
138.00	1764.7	1771.9	12.7	7.2	0.0	0.0	2.4	Levee	0.1	0.9	1775.3	Levee	NG	Levee	1775.3					
137.00	1762.3	1769.5	12.7	7.2	0.0	0.0	2.4	Levee	0.4	0.9	1773.2	Levee	NG	Levee	1773.2					
136.00	1761.0	1767.2	12.8	6.2	0.0	0.0	2.2	Levee	0.0	0.9	1770.3	Levee	NG	Levee	1770.3					
135.00	1760.0	1764.7	11.7	4.7	0.0	0.0	2.0	Levee	0.0	0.9	1767.6	Levee	NG	Levee	1767.6					
134.00	1758.0	1762.5	11.6	4.5	0.0	0.0	2.0	Levee	0.0	0.9	1765.4	Levee	NG	Levee	1765.4					
133.00	1755.0	1760.0	10.4	5.0	0.0	0.0	2.0	Levee	0.0	0.9	1762.9	Levee	NG	Levee	1762.9					
132.00	1753.0	1757.6	10.4	4.6	0.0	0.0	Levee	Levee	0.0	0.9	Levee	Levee	Levee	Levee						
131.00	1749.0	1754.9	10.9	5.9	0.0	0.0	Levee	Levee	0.0	0.9	Levee	Levee	Levee	Levee						
130.00	1747.6	1752.8	11.1	5.2	0.0	0.0	Levee	Levee	0.0	0.9	Levee	Levee	Levee	Levee						
129.00	1744.0	1750.0	11.9	6.0	0.0	1.5	Levee	Levee	0.1	0.9	Levee	Levee	Levee	Levee						
128.00	1742.0	1748.2	12.7	6.2	0.0	1.5	Levee	Levee	0.3	0.9	Levee	Levee	Levee	Levee						
127.00	1740.0	1745.9	9.8	5.9	0.0	1.5	Levee	Levee	0.0	0.9	Levee	Levee	Levee	Levee						
126.00	1738.0	1743.6	13.6	5.6	0.0	1.5	Levee	Levee	0.2	0.9	Levee	Levee	Levee	Levee						
125.40	1737.0	1739.7	17.1	2.7	0.0	1.5	2.0	3.5	0.0	0.0	1741.7	1743.2	1743.7	1745.7		1743.2	4.0	6.0	>4	>4
125.36	1733.0	1735.2	22.5	2.2	0.0	1.0	2.5	3.5	0.0	0.0	1737.7	1738.7	1742.5	1744.5		1742.7	7.3	9.3	>4	>4
124.90	1733.0	1736.3	14.8	3.3	0.0	1.0	2.0	3.0	0.0	0.0	1738.3	1739.3	1738.5	1740.5		1739.3	2.2	4.2	2.2	>4
124.86	1729.0	1731.5	21.1	2.5	0.0	1.0	2.4	3.4	0.0	0.0	1733.9	1734.9	1738.5	1740.5		1738.9	7.0	9.0	>4	>4
124.40	1729.0	1733.1	12.7	4.1	0.0	1.0	2.0	3.0	0.0	1.8	1736.9	1737.9	1734.5	1736.5	1736.9	1737.9	3.8	4.8	>3	>4
121.90	1726.0	1730.2	14.1	4.2	0.0	1.0	2.0	3.0	0.0	0.0	1732.2	1733.2	1731.5	1733.5	1732.2	1733.2	2.0	3.3	2.0	>3
121.87	1723.0	1726.4	19.7	3.4	0.0	1.0	2.4	3.4	0.0	0.0	1728.8	1729.8	1731.5	1733.5	1728.8	1732.8	5.1	7.1	>4	>4
121.40	1722.9	1726.9	15.1	4.0	0.0	1.0	2.0	3.0	0.0	1.2	1730.1	1731.1	1728.4	1730.4	1730.1	1731.1	3.2	4.2	>3	>4
119.80	1721.1	1725.8	13.7	4.7	0.0	1.0	2.0	3.0	0.0	0.0	1727.8	1728.8	1726.6	1728.8	1727.8	1728.8	2.0	3.0	2.0	>3
119.77	1718.1	1721.9	19.6	3.8	0.0	1.0	2.4	3.4	0.0	0.0	1724.3	1725.3	1726.6	1728.6	1727.3	1728.3	5.4	6.7	>4	>4
119.30	1718.1	1722.7	14.1	4.6	0.0	1.0	2.0	3.0	0.0	1.7	1726.4	1727.4	1723.6	1725.7	1726.4	1727.4	3.7	4.7	>3	>4
117.00	1715.3	1719.6	15.2	4.3	0.0	1.0	2.0	3.0	0.0	0.0	1721.6	1722.6	1720.8	1722.8	1721.6	1722.6	2.0	3.2	2.0	>3
116.97	1712.3	1716.0	20.2	3.7	0.0	1.0	2.5	3.5	0.0	0.0	1718.5	1719.5	1720.8	1722.8	1721.5	1722.5	5.5	6.8	>4	>4
116.50	1712.3	1716.5	15.5	4.2	0.0	1.0	2.0	3.0	0.0	1.4	1719.9	1720.9	1717.8	1719.8	1719.9	1720.9	3.4	4.4	>3	>4
114.60	1710.0	1714.5	14.6	4.5	0.0	1.0	2.0	3.0	0.0	0.0	1716.5	1717.5	1715.5	1717.5	1716.5	1717.5	2.0	3.0	2.0	>3
114.57	1707.0	1710.7	19.9	3.7	0.0	1.0	2.5	3.5	0.0	0.0	1713.2	1714.2	1715.5	1717.5	1716.2	1717.2	5.5	6.8	>4	>4
114.10	1707.0	1711.3	15.1	4.3	0.0	1.0	2.0	3.0	0.0	1.5	1714.8	1715.8	1712.5	1714.5	1714.8	1715.8	3.5	4.5	>3	>4
112.00	1704.5	1708.9	14.7	4.4	0.0	1.0	2.0	3.0	0.0	0.0	1710.9	1711.9	1710.0	1712.0	1710.9	1711.9	2.0	3.1	2.0	>3
111.97	1701.5	1705.2	20.0	3.7	0.0	1.0	2.5	3.5	0.0	0.0	1707.7	1708.7	1710.0	1712.0	1710.7	1711.7	5.5	6.8	>4	>4
111.50	1701.5	1705.8	15.2	4.3	0.0	1.0	2.0	3.0	0.0	1.4	1709.2	1710.2	1707.0	1709.0	1709.2	1710.2	3.4	4.4	>3	>4

Table 5.2 Computations for Minimum Bank Elevations

Computations for Minimum Bank Elevations																				
Section #	Thalweg Elevation (ft)	Mixed WSEL (ft)	Mixed Velocity (fps)	Mixed Depth (ft)	Superelevation (East) (ft)	Superelevation (West) (ft)	Base Freeboard (East) (ft)	Base Freeboard (West) (ft)	General Agg. (ft)	Long-term Agg. (ft)	Minimum Top of Bank (East) (ft)	Minimum Top of Bank (West) (ft)	Top of Lined Bank (East) (ft)	Top of Lined Bank (West) (ft)	Adjacent High Ground (East) (ft)	Adjacent High Ground (West) (ft)	Available Freeboard East (ft)	Available Freeboard West (ft)	Freeboard Check East (ft)	Freeboard Check West (ft)
109.60	1699.2	1703.6	14.8	4.4	0.0	1.0	2.0	3.0	0.0	0.0	1705.6	1706.6	1704.7	1706.7	1705.6	1706.6	2.0	3.1	2.0	>3
109.57	1696.2	1699.9	20.0	3.7	0.0	1.0	2.5	3.5	0.0	0.0	1702.4	1703.4	1704.7	1706.7	1705.4	1706.4	5.5	6.8	>4	>4
109.10	1696.2	1700.5	15.4	4.3	0.0	1.0	2.0	3.0	0.0	1.1	1703.6	1704.6	1701.7	1703.7	1703.6	1704.6	3.1	4.1	>3	>4
107.60	1694.4	1698.8	14.7	4.4	0.0	0.0	2.0	2.0	0.0	0.0	1700.8	1700.8	1699.9	1701.9	1700.8	1700.8	2.0	3.1	2.0	>3
107.57	1691.4	1695.1	20.0	3.7	0.0	0.0	2.5	2.5	0.0	0.0	1697.6	1697.6	1699.9	1701.9	1697.6		4.8	6.8	>4	>4
107.10	1691.4	1695.7	15.2	4.3	0.0	0.0	2.0	2.0	0.0	1.2	1698.9	1698.9	1696.9	1698.9	1698.9		3.2	3.2	>3	>3
105.50	1689.5	1693.9	14.7	4.4	0.0	0.0	2.0	2.0	0.0	0.0	1695.9	1695.9	1695.0	1697.0	1695.9		2.0	3.1	2.0	>3
105.46	1685.5	1689.1	21.3	3.6	0.0	0.0	2.7	2.7	0.0	0.0	1691.8	1691.8	1695.0	1697.0	1691.8		5.9	7.9	>4	>4
105.00	1685.5	1689.3	17.6	3.8	0.0	0.0	2.2	2.2	0.0	1.5	1692.9	1692.9	1691.0	1693.0	1692.9		3.6	3.7	>3	>3
103.00	1683.1	1687.8	13.8	4.7	0.0	0.0	2.0	2.0	0.0	0.0	1689.8	1689.8	1688.6	1690.6	1689.8		2.0	2.8	2.0	2.8
102.97	1680.1	1683.7	19.9	3.6	0.0	0.0	2.4	2.4	0.0	0.0	1686.1	1686.1	1688.6	1690.6	1686.1		4.9	6.9	>4	>4
102.50	1680.1	1684.7	14.1	4.6	0.0	0.0	2.0	2.0	0.0	0.0	1686.7	1686.7	1685.6	1687.6	1686.7		2.0	2.9	2.0	2.9
102.47	1677.1	1680.6	20.0	3.5	0.0	0.0	2.4	2.4	0.0	0.0	1683.0	1683.0	1685.6	1687.6	1683.0		5.0	7.0	>4	>4
102.00	1677.1	1681.9	13.5	4.8	0.0	0.0	2.0	2.0	0.0	0.0	1683.9	1683.9	1682.6	1684.6	1683.9		2.0	2.7	2.0	2.7
101.97	1674.1	1677.7	19.8	3.6	0.0	0.0	2.4	2.4	0.0	0.0	1680.1	1680.1	1682.6	1684.6	1680.1		4.9	6.9	>4	>4
101.50	1674.1	1678.9	13.7	4.8	0.0	0.0	2.0	2.0	0.0	0.0	1680.9	1680.9	1679.6	1681.6	1680.9	1680.9	2.0	2.7	2.0	2.7
101.47	1671.1	1674.7	19.8	3.6	0.0	0.0	2.4	2.4	0.0	0.0	1677.1	1677.1	1679.6	1681.6	1677.1	1680.1	4.9	6.9	>4	>4
101.00	1671.1	1675.8	13.9	4.7	0.0	0.0	2.0	2.0	0.0	1.8	1679.6	1679.6	1676.6	1678.6	1679.6	1679.6	3.8	3.8	>3	>3
99.20	1668.9	1672.9	15.8	4.0	0.0	0.0	2.0	2.0	0.0	0.0	1674.9	1674.9	1674.4	1676.4	1674.9	1674.9	2.0	3.5	2.0	>3
98.70	1668.3	1671.8	18.4	3.5	0.0	0.0	2.2	2.2	0.0	0.0	1674.0	1674.0	1673.8	1675.8	1674.0	1674.0	2.2	4.0	2.2	>4
98.60	1668.2	1672.4	15.1	4.2	0.0	0.0	2.0	2.0	0.0	0.0	1674.4	1674.4	1673.7	1675.7	1674.4	1674.4	2.0	3.3	2.0	>3
98.58	1666.2	1669.7	18.9	3.5	3.0	0.0	4.0	2.3	0.0	0.0	1673.7	1672.0	1673.7	1675.7	1673.7	1672.0	4.0	6.0	>4	>4
98.10	1666.2	1670.7	13.8	4.5	3.0	0.0	4.0	2.0	0.0	1.5	1676.2	1674.2	1671.7	1673.7	1676.2	1674.2	5.5	3.5	>4	>3
96.00	1663.7	1667.9	14.8	4.2	3.0	0.0	4.0	2.0	0.0	0.0	1671.9	1669.9	1669.2	1671.2	1671.9	1669.9	4.0	3.3	>4	>3
95.98	1661.7	1665.2	18.7	3.5	3.0	0.4	4.0	2.7	0.0	0.0	1669.2	1667.9	1669.2	1671.2	1669.2	1667.9	4.0	6.0	>4	>4
95.50	1661.7	1666.3	13.0	4.6	3.0	0.4	4.0	2.4	0.0	1.5	1671.8	1670.2	1667.2	1669.2	1671.8	1670.2	5.5	3.9	>4	>3
93.50	1659.3	1663.5	15.1	4.2	0.0	0.4	2.0	2.4	0.0	0.0	1665.5	1665.9	1664.8	1666.8	1665.5	1665.9	2.0	3.3	2.0	>3
93.48	1657.3	1660.8	18.9	3.5	0.0	0.4	2.3	2.7	0.0	0.0	1663.1	1663.5	1664.8	1666.8	1663.1	1663.5	4.0	6.0	>4	>4
93.00	1657.3	1661.9	13.8	4.6	0.0	0.4	2.0	2.4	0.0	1.1	1665.0	1665.4	1662.8	1664.8	1665.0	1665.4	3.1	3.5	>3	>3
91.50	1655.5	1659.7	14.7	4.2	0.0	0.4	2.0	2.4	0.0	0.0	1661.7	1662.1	1661.0	1663.0	1661.7	1662.1	2.0	3.3	2.0	>3
91.47	1652.5	1655.8	20.2	3.3	0.0	0.4	2.4	2.8	0.0	0.0	1658.2	1658.6	1661.0	1663.0	1658.2	1658.6	5.2	7.2	>4	>4
91.00	1652.5	1656.9	14.0	4.4	0.0	0.4	2.0	2.4	0.0	1.1	1660.0	1660.4	1658.0	1660.0	1660.0	1660.4	3.1	3.5	>3	>3
89.50	1650.7	1655.0	14.7	4.3	0.0	0.4	2.0	2.4	0.0	0.0	1657.0	1657.4	1656.2	1658.2	1657.0	1657.4	2.0	3.2	2.0	>3
89.47	1647.7	1651.0	20.1	3.3	0.0	0.4	2.4	2.8	0.0	0.0	1653.4	1653.8	1656.2	1658.2	1653.4	1653.8	5.2	7.2	>4	>4
89.00	1647.7	1652.3	13.5	4.6	0.0	0.4	2.0	2.4	0.0	1.1	1655.4	1655.8	1653.2	1655.2	1655.4	1655.8	3.1	3.5	>3	>3
87.50	1645.9	1650.1	14.7	4.2	0.0	0.4	2.0	2.4	0.0	0.0	1652.1	1652.5	1651.4	1653.4	1652.1	1652.5	2.0	3.3	2.0	>3
87.48	1643.9	1647.5	18.7	3.6	0.0	0.4	2.3	2.7	0.0	0.0	1649.8	1650.2	1651.4	1653.4	1649.8	1652.2	3.9	5.9	>3	>4
87.00	1643.9	1648.4	13.6	4.5	0.0	0.4	2.0	2.4	0.0	3.3	1653.7	1654.1	1649.4	1651.4	1653.7	1654.1	5.3	5.7	>4	>4
82.50	1638.5	1642.6	15.3	4.1	0.0	0.4	2.0	2.4	0.0	0.0	1644.6	1645.0	1644.0	1646.0	1644.6	1645.0	2.0	3.4	2.0	>3
82.47	1635.5	1638.8	20.5	3.3	0.0	0.4	2.5	2.9	0.0	0.0	1641.3	1641.7	1644.0	1646.0	1641.3	1644.7	5.2	7.2	>4	>4
82.00	1635.5	1640.0	13.6	4.5	0.0	0.4	2.0	2.4	0.0	1.1	1643.1	1643.5	1641.0	1643.0	1643.1	1643.5	3.1	3.5	>3	>3
80.50	1633.7	1637.9	14.7	4.2	0.0	0.4	2.0	2.4	0.0	0.0	1639.9	1640.3	1639.2	1641.2	1639.9	1640.3	2.0	3.3	2.0	>3
80.46	1629.7	1632.9	21.5	3.2	0.0	0.4	2.6	3.0	0.0	0.0	1635.5	1635.9	1639.2	1641.2	1635.5		6.3	8.3	>4	>4
80.00	1629.7	1633.6	15.9	3.9	0.0	0.4	2.0	2.4	0.0	0.0	1635.6	1636.0	1635.2	1637.2	1635.6		2.0	3.6	2.0	>3
74.00	1622.5	1627.1	13.6	4.6	0.0	0.4	2.0	2.4	0.0	0.0	1629.1	1629.5	1628.0	1630.0	1629.1		2.0	2.9	2.0	2.9
73.98	1620.5	1624.2	18.1	3.7	0.7	0.4	2.8	2.6	0.0	0.0	1627.0	1626.8	1628.0	1630.0	1629.0		4.8	5.8	>4	>4
73.50	1620.5	1625.0	13.7	4.5	0.7	0.4	2.7	2.4	0.0	0.0	1627.7	1627.4	1626.0	1628.0	1627.7		2.7	3.0	2.7	>3
71.00	1617.5	1621.7	15.0	4.2	0.7	0.0	2.7	2.0	0.0	0.0	1624.4	1623.7	1623.0	1625.0	1624.4		2.7	3.3	2.7	>3
70.97	1614.5	1617.8	20.3	3.3	0.7	0.0	3.1	2.4	0.0	0.0	1620.9	1620.2	1623.0	1625.0	1623.9		6.1	7.2	>4	>4
70.50	1614.5	1618.9	14.2	4.4	0.7	0.0	2.7	2.0	0.0	0.0	1621.6	1620.9	1620.0	1622.0	1621.6		2.7	3.1	2.7	>3

Table 5.2 Computations for Minimum Bank Elevations

Computations for Minimum Bank Elevations																				
Section #	Thalweg Elevation (ft)	Mixed WSEL (ft)	Mixed Velocity (fps)	Mixed Depth (ft)	Superelevation (East) (ft)	Superelevation (West) (ft)	Base Freeboard (East) (ft)	Base Freeboard (West) (ft)	General Agg. (ft)	Long-term Agg. (ft)	Minimum Top of Bank (East) (ft)	Minimum Top of Bank (West) (ft)	Top of Lined Bank (East) (ft)	Top of Lined Bank (West) (ft)	Adjacent High Ground (East) (ft)	Adjacent High Ground (West) (ft)	Available Freeboard East (ft)	Available Freeboard West (ft)	Freeboard Check East (ft)	Freeboard Check West (ft)
68.50	1612.1	1616.3	14.7	4.2	0.7	0.0	2.7	2.0	0.0	0.0	1619.0	1618.3	1617.6	1619.6	1619.0		2.7	3.3	2.7	>3
68.47	1609.1	1612.4	20.2	3.3	0.7	0.0	3.1	2.4	0.0	0.0	1615.5	1614.8	1617.6	1619.6	1618.5		6.1	7.2	>4	>4
68.00	1609.1	1613.7	14.1	4.6	0.0	0.0	2.0	2.0	0.0	0.0	1615.7	1615.7	1614.6	1616.6	1615.7		2.0	2.9	2.0	2.9
66.00	1606.7	1610.9	14.8	4.2	0.0	0.0	2.0	2.0	0.0	0.0	1612.9	1612.9	1612.2	1614.2	1612.9		2.0	3.3	2.0	>3
65.97	1603.7	1607.0	20.2	3.3	0.0	0.0	2.4	2.4	0.0	0.0	1609.4	1609.4	1612.2	1614.2	1612.4		5.4	7.2	>4	>4
65.50	1603.7	1608.1	13.5	4.4	0.0	0.0	2.0	2.0	0.0	0.0	1610.1	1610.1	1609.2	1611.2	1610.1		2.0	3.1	2.0	>3
63.50	1601.3	1605.5	14.9	4.2	0.0	0.0	2.0	2.0	0.0	0.0	1607.5	1607.5	1606.8	1608.8	1607.5		2.0	3.3	2.0	>3
63.47	1598.3	1601.6	20.3	3.3	0.0	0.8	2.4	3.2	0.0	0.0	1604.0	1604.8	1606.8	1608.8	1604.0		5.2	7.2	>4	>4
63.00	1598.3	1602.7	14.0	4.4	0.0	0.8	2.0	2.8	0.0	0.0	1604.7	1605.5	1603.8	1605.8	1604.7		2.0	3.1	2.0	>3
61.00	1595.9	1600.1	14.8	4.2	0.0	0.8	2.0	2.8	0.0	0.0	1602.1	1602.9	1601.4	1603.4	1602.1		2.0	3.3	2.0	>3
60.97	1592.9	1596.2	20.2	3.3	0.0	0.8	2.4	3.2	0.0	0.0	1598.6	1599.4	1601.4	1603.4	1598.6		5.2	7.2	>4	>4
60.50	1592.9	1597.4	13.6	4.5	0.0	0.8	2.0	2.8	0.0	0.0	1599.4	1600.2	1598.4	1600.4	1599.4		2.0	3.0	2.0	>3
58.50	1590.5	1594.7	14.9	4.2	0.0	0.8	2.0	2.8	0.0	0.0	1596.7	1597.5	1596.0	1598.0	1596.7		2.0	3.3	2.0	>3
58.46	1586.0	1589.1	22.2	3.1	0.0	0.8	2.7	3.5	0.0	0.0	1591.8	1592.6	1595.5	1597.5	1591.8		6.4	8.4	>4	>4
58.00	1586.0	1589.8	16.8	3.8	0.0	0.8	2.0	2.8	0.0	0.0	1591.8	1592.6	1591.5	1593.5	1591.8		2.0	3.7	2.0	>3
53.00	1580.0	1584.7	13.1	4.7	0.0	0.8	2.0	2.8	0.0	0.0	1586.7	1587.5	1585.5	1587.5	1586.7		2.0	2.8	2.0	2.8
52.97	1577.0	1580.4	19.5	3.4	0.0	0.8	2.3	3.1	0.0	0.0	1582.7	1583.5	1585.5	1587.5	1582.7		5.1	7.1	>4	>4
52.50	1577.0	1581.3	14.3	4.3	0.0	0.4	2.0	2.4	0.0	0.0	1583.3	1583.7	1582.5	1584.5	1583.3		2.0	3.2	2.0	>3
50.00	1574.0	1578.2	14.7	4.2	0.0	0.4	2.0	2.4	0.0	0.0	1580.2	1580.6	1579.5	1581.5	1580.2		2.0	3.3	2.0	>3
49.97	1571.0	1574.3	20.2	3.3	0.0	0.4	2.4	2.8	0.0	0.0	1576.7	1577.1	1579.5	1581.5	1576.7		5.2	7.2	>4	>4
49.50	1571.0	1575.5	13.8	4.5	0.0	0.4	2.0	2.4	0.0	0.0	1577.5	1577.9	1576.5	1578.5	1577.5		2.0	3.0	2.0	>3
48.00	1569.2	1573.4	14.7	4.2	0.0	0.4	3.0	3.4	0.0	0.0	1576.4	1576.8	1577.8	1579.0			4.4	5.6	>4	>4
47.90	1569.0	1573.2	14.9	4.2	0.0	0.4	3.0	3.4	0.0	0.0	1576.2	1576.6	1577.5	1579.0			4.3	5.8	>4	>4
46.50	1567.4	1572.6	12.9	5.2	1.7	0.0	4.0	3.0	0.0	0.0	1576.6	1575.6	N/A	1579.0			N/A	6.4	N/A	>4
44.70	1565.2	1571.8	8.8	6.6	1.7	0.0	4.0	3.0	0.0	0.0	1575.8	1574.8	1577.0	1579.0			5.2	7.2	>4	>4
44.60	1565.2	1571.1	11.0	5.9	1.7	0.0	4.0	3.0	0.0	0.0	1575.1	1574.1	1579.0	1579.0			7.9	7.9	>4	>4

1) Remaining downstream stations levees and detention basins
2) * Beginning of upstream control line stationing
3) Shaded area is additional earthen berm
4) N/A Thompson Peak Channel confluence
5) Stations 48.00 to 44.60 maintained with zero aggradation

Table 5.3 Maximum Total Scour Estimates

Maximum Total Scour Estimates														
Section #	Thalweg El (ft)	General Scour (ft)	Low-flow Thalweg (ft)	Antidune Scour (ft)	Contraction Scour (ft)	Bend Scour East (ft)	Bend Scour West (ft)	Factored Total (*1.3) East (ft)	Factored Total (*1.3) West (ft)	Long-term Scour (ft)	Total Scour East (ft)	Total Scour West (ft)	Design Toe Down East (ft)	Design Toe Down West (ft)
Note: Station 271.95 to Station 192.00: Lined channel, no scour.														
192.00	1916.6	1.4	3.0	2.40	0.0	0.0	0.0	8.84	8.84	0.3	9.17	9.17	(20)	(20)
191.00	1913.1	1.9	3.0	2.50	0.0	0.0	0.0	9.62	9.62	0.3	9.95	9.95		
190.00	1910.3	0.8	3.0	1.95	0.0	0.0	0.0	7.48	7.48	0.3	7.81	7.81		
189.00	1906.0	1.6	3.0	2.15	0.0	0.0	0.0	8.77	8.77	0.3	9.10	9.10		10.0
188.00	1903.0	0.8	3.0	1.90	0.0	0.0	0.0	7.41	7.41	0.3	7.74	7.74		10.0
187.00	1900.0	0.8	3.0	1.85	0.0	0.0	0.0	7.35	7.35	0.3	7.68	7.68		10.0
186.00	1897.6	0.7	3.0	1.70	0.0	0.0	0.0	7.02	7.02	0.3	7.35	7.35		10.0
185.00	1894.3	0.7	3.0	1.70	0.0	0.0	0.0	7.02	7.02	0.3	7.35	7.35		10.0
184.00	1891.2	0.7	3.0	1.60	0.0	0.0	0.0	6.89	6.89	0.3	7.22	7.22		10.0
183.00	1888.0	0.0	3.0	1.85	0.0	0.0	0.0	6.31	6.31	0.0	6.31	6.31		10.0
182.00	1884.0	0.0	3.0	2.50	0.0	0.0	0.0	7.15	7.15	0.0	7.15	7.15		10.0
181.00	1882.0	0.0	3.0	1.35	0.0	0.0	0.0	5.66	5.66	0.0	5.66	5.66	10.0	10.0
180.00	1879.0	0.0	3.0	1.80	0.0	0.0	0.0	6.24	6.24	0.0	6.24	6.24	10.0	10.0
179.00	1876.3	0.0	3.0	2.15	0.0	0.0	0.0	6.69	6.69	0.0	6.69	6.69	10(15)	10(15)
178.00	1873.5	0.0	3.0	2.39	0.0	0.0	0.8	7.00	8.02	0.0	7.00	8.02	10.0	10.0
177.00	1872.0	0.0	3.0	2.07	0.0	0.0	0.8	6.59	7.61	0.0	6.59	7.61	10.0	10.0
176.00	1870.0	0.0	3.0	2.07	0.0	0.0	0.8	6.59	7.61	0.0	6.59	7.61	10.0	10.0
175.00	1867.7	0.0	3.0	1.94	0.0	0.0	0.8	6.42	7.44	0.0	6.42	7.44	10.0	10.0
174.00	1866.0	0.0	3.0	2.25	0.0	0.0	0.8	6.83	7.84	0.0	6.83	7.84	10.0	10.0
173.00	1864.0	0.0	3.0	1.43	0.0	0.0	0.0	5.75	5.75	0.0	5.75	5.75	10.0	10.0
172.00	1860.0	0.0	3.0	2.75	0.0	0.0	0.0	7.48	7.48	0.0	7.48	7.48	10.0	10.0
171.00	1857.4	0.0	3.0	2.28	0.0	0.0	0.0	6.86	6.86	0.0	6.86	6.86	10.0	10.0
170.00	1854.1	0.0	3.0	2.07	0.0	0.0	0.0	6.59	6.59	0.0	6.59	6.59	10.0	10.0
169.00	1852.0	0.0	3.0	2.42	0.0	0.0	0.0	7.05	7.05	0.0	7.05	7.05	10.0	10.0
168.00	1851.0	0.0	3.0	2.60	0.0	0.0	0.0	7.28	7.28	0.0	7.28	7.28	10.0	10.0
167.00	1847.0	0.0	3.0	3.10	0.0	0.0	0.0	7.93	7.93	0.0	7.93	7.93	10.0	10.0
166.00	1846.0	0.0	3.0	2.70	0.0	0.0	0.0	7.41	7.41	0.0	7.41	7.41	10.0	10.0
165.00	1844.0	0.0	3.0	1.40	0.0	0.0	0.0	5.72	5.72	0.0	5.72	5.72	10(15)	10(15)
164.90	1843.6	0.0	3.0	1.40	0.0	0.0	0.0	5.72	5.72	0.0	5.72	5.72	10.0	10.0
164.10	1841.8	0.0	3.0	0.38	0.0	0.0	0.0	4.40	4.40	0.0	4.40	4.40	10.0	10.0
164.00	1840.7	0.0	3.0	1.63	0.0	0.0	0.0	6.02	6.02	0.0	6.02	6.02	10.0	10.0
163.00	1838.0	0.0	3.0	2.72	0.0	0.0	0.0	7.44	7.44	0.0	7.44	7.44	10.0	10.0
162.00	1835.6	0.0	3.0	2.65	0.0	0.0	0.0	7.35	7.35	0.0	7.35	7.35		10.0
161.00	1833.1	0.0	3.0	2.45	0.0	0.0	0.0	7.09	7.09	0.0	7.09	7.09		
160.00	1829.0	0.0	3.0	3.08	0.0	0.0	0.0	7.91	7.91	0.0	7.91	7.91		
159.00	1827.6	0.0	3.0	2.88	0.0	0.0	0.0	7.64	7.64	0.0	7.64	7.64		
158.00	1826.1	0.0	3.0	2.15	0.0	0.0	0.0	6.70	6.70	0.0	6.70	6.70		
157.00	1823.1	0.0	3.0	2.53	0.0	0.0	0.0	7.19	7.19	0.0	7.19	7.19		
156.00	1821.4	0.0	3.0	1.91	0.0	0.0	0.0	6.38	6.38	0.0	6.38	6.38		
**155.00	1819.0	0.0	3.0	2.40	0.0	0.0	0.0	7.02	7.02	0.0	7.02	7.02		
157.00	1816.2	0.0	3.0	2.07	0.0	0.0	0.0	6.59	6.59	0.0	6.59	6.59		
156.00	1813.0	0.0	3.0	2.35	0.0	0.0	0.0	6.96	6.96	0.0	6.96	6.96		
155.00	1810.7	0.0	3.0	1.81	0.0	0.0	0.0	6.26	6.26	0.0	6.26	6.26		
154.00	1806.9	0.0	3.0	2.10	0.0	0.0	0.0	6.63	6.63	0.0	6.63	6.63		
153.00	1803.0	0.0	3.0	2.11	0.0	0.0	0.0	6.64	6.64	0.0	6.64	6.64		
152.00	1800.0	0.0	3.0	1.43	0.0	0.0	0.0	5.75	5.75	0.0	5.75	5.75		
151.00	1799.0	0.0	3.0	1.75	0.0	0.0	0.0	6.17	6.17	0.0	6.17	6.17		
150.00	1797.0	0.0	3.0	1.51	0.0	0.0	0.0	5.86	5.86	0.0	5.86	5.86		
149.00	1793.3	0.0	3.0	1.63	3.0	0.0	0.0	9.92	9.92	0.0	9.92	9.92		
148.00	1793.0	0.0	3.0	1.54	3.0	0.0	0.0	9.80	9.80	0.0	9.80	9.80		
147.00	1791.0	0.0	3.0	1.50	3.0	0.0	0.0	9.75	9.75	0.0	9.75	9.75		12.0
146.00	1787.4	0.0	3.0	1.91	3.0	0.0	0.0	10.28	10.28	0.0	10.28	10.28		12.0
145.00	1785.0	0.0	3.0	1.75	3.0	0.0	0.0	10.08	10.08	0.0	10.08	10.08		12.0
144.00	1782.0	0.0	3.0	2.00	3.0	0.0	0.0	10.40	10.40	0.0	10.40	10.40		12.0
143.00	1778.5	0.0	3.0	2.20	0.0	0.0	0.0	6.76	6.76	0.0	6.76	6.76		10.0
142.00	1776.0	0.0	3.0	2.20	0.0	0.0	0.0	6.76	6.76	0.0	6.76	6.76		10.0
141.00	1773.7	0.0	3.0	1.88	0.0	0.0	0.0	6.34	6.34	0.0	6.34	6.34		10.0
140.00	1771.1	0.0	3.0	2.32	0.0	0.0	0.0	6.91	6.91	0.0	6.91	6.91		10.0
139.00	1769.0	0.0	3.0	2.05	0.0	0.0	0.0	6.56	6.56	0.0	6.56	6.56		10.0
138.00	1764.7	0.0	3.0	2.21	0.0	0.0	0.0	6.77	6.77	0.0	6.77	6.77		10.0
137.00	1762.3	0.0	3.0	2.21	0.0	0.0	0.0	6.77	6.77	0.0	6.77	6.77		10.0
136.00	1761.0	0.0	3.0	2.24	0.0	0.0	0.0	6.82	6.82	0.0	6.82	6.82		10.0
135.00	1760.0	0.0	3.0	1.88	0.0	0.0	0.0	6.34	6.34	0.0	6.34	6.34		10.0
134.00	1758.0	0.0	3.0	1.84	0.0	0.0	0.0	6.30	6.30	0.0	6.30	6.30		10.0
133.00	1755.0	0.0	3.0	1.48	3.4	0.0	0.0	10.25	10.25	0.0	10.25	10.25		12.0
132.00	1753.0	0.0	3.0	1.48	3.4	0.0	0.0	10.25	10.25	0.0	10.25	10.25	12.0	12.0
131.00	1749.0	0.0	3.0	1.63	3.4	0.0	0.0	10.44	10.44	0.0	10.44	10.44	12.0	12.0
130.00	1747.6	0.0	3.0	1.69	3.4	0.0	0.0	10.51	10.51	0.0	10.51	10.51	12.0	12.0
129.00	1744.0	0.0	3.0	1.94	3.4	0.0	0.0	10.84	10.84	0.0	10.84	10.84	12.0	12.0
128.00	1742.0	0.0	3.0	2.21	3.4	0.0	0.0	11.19	11.19	0.0	11.19	11.19	12.0	12.0
127.00	1740.0	0.0	3.0	1.32	3.4	0.0	0.0	10.03	10.03	0.0	10.03	10.03	12.0	12.0
126.00	1738.0	0.0	3.0	2.45	3.4	0.0	0.0	11.51	11.51	0.0	11.51	11.51	12.0	12.0
Note: Station 125.40 to station 48.00: No scour at grade control structures														

Table 5.3 Maximum Total Scour Estimates

Maximum Total Scour Estimates														
Section #	Thalweg El (ft)	General Scour (ft)	Low-flow Thalweg (ft)	Antidune Scour (ft)	Contraction Scour (ft)	Bend Scour East (ft)	Bend Scour West (ft)	Factored Total (*1.3) East (ft)	Factored Total (*1.3) West (ft)	Long-term Scour (ft)	Total Scour East (ft)	Total Scour West (ft)	Design Toe Down East (ft)	Design Toe Down West (ft)
*124.40	1729.0	1.0	3.0	2.00	0.0	0.0	0.0	7.80	7.80	0.0	7.80	7.80	**12.0**	**12.0**
*121.40	1722.9	1.0	3.0	2.00	0.0	0.0	0.0	7.80	7.80	0.0	7.80	7.80	**10.0**	**10.0**
*119.30	1718.1	1.0	3.0	2.30	0.0	0.0	0.0	8.19	8.19	0.0	8.19	8.19	**10.0**	**10.0**
*116.50	1712.3	1.0	3.0	2.10	0.0	0.0	0.0	7.93	7.93	0.0	7.93	7.93	**10.0**	**10.0**
*114.10	1707.0	1.0	3.0	2.15	0.0	0.0	0.0	7.99	7.99	0.0	7.99	7.99	**10.0**	**10.0**
*111.50	1701.5	1.0	3.0	2.15	0.0	0.0	0.0	7.99	7.99	0.0	7.99	7.99	**10.0**	**10.0**
*109.10	1696.2	1.0	3.0	2.15	0.0	0.0	0.0	7.99	7.99	0.0	7.99	7.99	**10.0**	**10.0**
*107.10	1691.4	1.0	3.0	2.15	0.0	0.0	0.0	7.99	7.99	0.0	7.99	7.99	**10.0**	**10.0**
*105.00	1685.5	1.0	3.0	1.90	0.0	0.0	0.0	7.67	7.67	0.0	7.67	7.67	**10.0**	**10.0**
*101.00	1671.1	1.0	3.0	2.35	0.0	0.0	0.0	8.26	8.26	0.0	8.26	8.26	**10.0**	**11.0**
*98.10	1666.2	1.0	3.0	2.25	0.0	0.0	0.0	8.13	8.13	0.0	8.13	8.13	**12.0**	**12.0**
*95.50	1661.7	1.0	3.0	2.32	0.0	0.0	0.0	8.21	8.21	0.0	8.21	8.21	**10.0**	**10.0**
*93.00	1657.3	1.0	3.0	2.25	0.0	0.0	0.0	8.13	8.13	0.0	8.13	8.13	**10.0**	**10.0**
*91.00	1652.5	1.0	3.0	2.20	0.0	0.0	0.0	8.06	8.06	0.0	8.06	8.06	**10.0**	**10.0**
*89.00	1647.7	1.0	3.0	2.30	0.0	0.0	0.0	8.19	8.19	0.0	8.19	8.19	**10.0**	**10.0**
*87.00	1643.9	1.0	3.0	2.30	0.0	0.0	0.0	8.19	8.19	0.0	8.19	8.19	**12.0**	**12.0**
*82.00	1635.5	1.0	3.0	2.30	0.0	0.0	0.0	8.19	8.19	0.0	8.19	8.19	**10.0**	**10.0**
*80.00	1629.7	1.0	3.0	1.95	0.0	0.0	0.0	7.73	7.73	0.0	7.73	7.73	**12.0**	**12.0**
*73.50	1620.5	1.0	3.0	2.25	0.0	0.0	0.0	8.13	8.13	0.0	8.13	8.13	**10.0**	**10.0**
*70.50	1614.5	1.0	3.0	2.20	0.0	0.0	0.0	8.06	8.06	0.0	8.06	8.06	**10.0**	**10.0**
*68.00	1609.1	1.0	3.0	2.20	0.0	0.0	0.0	8.06	8.06	0.0	8.06	8.06	**10.0**	**10.0**
*65.50	1603.7	1.0	3.0	2.30	0.0	0.0	0.0	8.19	8.19	0.0	8.19	8.19	**10.0**	**10.0**
*63.00	1598.3	1.0	3.0	2.20	0.0	0.0	0.0	8.06	8.06	0.0	8.06	8.06	**10.0**	**10.0**
*60.50	1592.9	1.0	3.0	2.30	0.0	0.0	0.0	8.19	8.19	0.0	8.19	8.19	**10.0**	**10.0**
*58.00	1586.0	1.0	3.0	1.90	0.0	0.0	0.0	7.67	7.67	0.0	7.67	7.67	**12.0**	**12.0**
*52.50	1577.0	1.0	3.0	2.15	0.0	0.0	0.0	7.99	7.99	0.0	7.99	7.99	**10.0**	**10.0**
*49.50	1571.0	1.0	3.0	2.25	0.0	0.7	0.0	9.01	8.13	0.0	9.01	8.13	**10.0**	**10.0**
*47.90	1569.0	1.0	3.0	2.10	0.0	0.7	0.0	8.81	7.93	0.0	8.81	7.93	**10.0**	**10.0**
46.50	1567.4	1.0	3.0	2.28	0.0	0.7	0.0	9.05	8.16	0.0	9.05	8.16	**10.0**	**10.0**
44.70	1565.2	1.0	3.0	1.06	0.0	0.7	0.0	7.46	6.58	0.0	7.46	6.58	**10.0**	**10.0**
*43.30	1564.0	1.0	3.0	1.66	0.0	0.7	0.0	8.24	7.36	0.0	8.24	7.36	**10.0**	**10.0**
41.80	1562.6	1.0	3.0	2.18	0.0	0.7	0.0	8.91	8.03	0.0	8.91	8.03	**10.0**	**10.0**
40.30	1561.2	1.0	3.0	2.01	0.0	0.7	0.0	8.69	7.81	0.0	8.69	7.81	**10.0**	**10.0**
38.80	1559.8	1.0	3.0	1.84	0.0	0.7	0.0	8.48	7.60	0.0	8.48	7.60	**10.0**	**10.0**
37.30	1558.3	1.0	3.0	2.35	0.0	0.7	0.0	9.14	8.26	0.0	9.14	8.26	**10.0**	**10.0**
35.80	1554.7	1.0	3.0	2.35	0.0	0.7	0.0	9.14	8.26	0.0	9.14	8.26	**10.0**	**10.0**
34.30	1552.7	1.0	3.0	2.70	0.0	0.7	0.0	9.59	8.71	0.0	9.59	8.71	**10.0**	**10.0**
32.80	1549.6	1.0	3.0	2.50	0.0	0.7	0.0	9.33	8.45	0.0	9.33	8.45	**10.0**	**10.0**
31.30	1547.3	1.0	3.0	1.66	0.0	0.7	0.0	8.24	7.36	0.0	8.24	7.36	**10.0**	**10.0**
29.80	1544.6	1.0	3.0	1.88	0.0	0.7	0.0	8.52	7.64	0.0	8.52	7.64	**10.0**	**10.0**
28.30	1542.6	1.0	3.0	2.07	0.0	0.0	0.0	7.89	7.89	0.0	7.89	7.89	**10.0**	**10.0**
26.80	1539.0	1.0	3.0	1.48	0.0	0.0	0.0	7.13	7.13	0.0	7.13	7.13	**10.0**	**10.0**
25.30	1536.2	1.0	3.0	2.24	0.0	0.0	0.0	8.12	8.12	0.0	8.12	8.12	**10.0**	**10.0**
23.80	1534.7	1.0	3.0	1.81	0.0	0.0	0.0	7.56	7.56	0.0	7.56	7.56	**10.0**	**10.0**
22.30	1533.0	1.0	3.0	2.24	0.0	0.0	0.0	8.12	8.12	0.0	8.12	8.12	**10.0**	**10.0**
20.80	1531.2	1.0	3.0	1.69	0.0	0.0	0.0	7.39	7.39	0.0	7.39	7.39	**10.0**	**10.0**
19.30	1530.0	1.0	3.0	2.61	0.0	0.0	0.4	8.59	9.09	0.0	8.59	9.09	**10.0**	**10.0**
17.80	1527.8	1.0	3.0	1.04	3.8	0.0	0.4	11.49	11.98	0.0	11.49	11.98	**15.0**	**15.0**
16.30	1525.6	1.0	3.0	2.24	3.8	0.0	0.4	13.06	13.55	0.0	13.06	13.55	**15.0**	**15.0**
15.30	1524.1	1.0	3.0	2.61	3.8	0.0	0.4	13.53	14.05	0.0	13.53	14.05	**15.0**	**15.0**
Note: Station 14.80 to station 10.00: Grade control, no scour														
10.00	1510.0	0.0	3.0	0.27	0.0	0.0	0.4	4.24	4.74	0.0	4.24	4.74	**10.0**	**10.0**
8.80	1509.7	0.0	3.0	0.24	0.0	0.0	0.4	4.21	4.71	0.0	4.21	4.71		**7.0**
7.30	1509.2	0.0	3.0	0.23	0.0	0.0	0.4	4.20	4.69	0.0	4.20	4.69		**7.0**
5.80	1508.7	0.0	3.0	0.22	0.0	0.0	0.4	4.18	4.68	0.0	4.18	4.68		**7.0**
4.30	1508.3	0.0	3.0	0.21	0.0	0.0	0.4	4.17	4.66	0.0	4.17	4.66		**7.0**
2.80	1507.8	0.0	3.0	0.20	0.0	0.0	0.4	4.16	4.65	0.0	4.16	4.65		**7.0**
2.30	1507.7	0.0	3.0	0.21	0.0	0.0	0.0	4.17	4.17	0.0	4.17	4.17		**7.0**
1.80	1507.5	0.0	3.0	0.22	0.0	0.0	0.0	4.18	4.18	0.0	4.18	4.18		**7.0**
1.30	1507.3	0.0	3.0	0.25	0.0	0.0	0.0	4.23	4.23	0.0	4.23	4.23		**7.0**
0.80	1507.2	0.0	3.0	0.28	0.0	0.0	0.0	4.26	4.26	0.0	4.26	4.26		**7.0**
0.30	1507.0	0.0	3.0	0.36	0.0	0.0	0.0	4.36	4.36	0.0	4.36	4.36		**7.0**
0.00	1507.0	0.0	3.0	0.36	0.0	0.0	0.0	4.36	4.36	0.0	4.36	4.36		**7.0**
Max.		1.9	3.0	3.1	3.8	0.7	0.8	13.5	14.1	0.3	13.5	14.1		
Min.		0.0	3.0	0.2	0.0	0.0	0.0	4.2	4.2	0.0	4.2	4.2		
Avg.		0.4	3.0	1.9	0.4	0.1	0.1	7.6	7.5	0.0	7.6	7.6		

1) * Beginning of earthen bottom channel located just downstream of grade control
2) ** Beginning of upstream control line stationing
3) (#) Depth of lateral toe down structure

why not? Low flow channel only