Modeling Sediment Transport in the Agua Fria River

Prepared for:

Flood Control District of Maricopa County

2801 West Durango Street
Phoenix, AZ 85009-6399

FCD Contract No. 1999C048 - Assignment # 6

Prepared by:

WEST CONSULTANTS, INC.

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Tempe, AZ 85282

March 2002

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1. INTRODUCTION

The two most important controls determining whether or not a channel is stable over a period of years or decades are sediment supply and flow regime. If either of these undergoes progressive or sudden change, the channel may experience some degree of adjustment.

The supply of sediment to a channel can vary in response to changes in the source areas: hillslopes, small tributary channels, or the margins of the channel itself. Except for the impact of major floods, most changes in sediment supply relate to changes in land use within the watershed of which the most important are urbanization and mineral extraction. Urbanization, and specifically the construction phase, when local sediment yields can increase by two or three orders of magnitude, is a major land-use change with significant implications for sediment supply to the channel (Thorne, Hey & Newson, 1997). In theory, the impact of urbanization is two-fold. Initially, there is a reduction in channel capacity due to local aggradation caused by increased sediment supply to the channel during the construction phase. This is followed by erosion and an increase in channel capacity as the local sediment supply is reduced (in response to the newly concreted and asphalted surfaces) and the frequency of higher flows is increased (in response to overland flow directed into the river via storm-water sewers). Commercial mining of sand and gravel from rivers often causes considerable localized channel instability and bank erosion, and can also damage (indirectly) riparian vegetation and water resources (Thorne, Hey & Newson, 1997). Gravel extraction destroys the bed armor and significantly increases the hydrodynamic roughness of the channel, enhancing bed scouring and transport rates of bed material. Where the rate of bed material removed from a reach exceeds the bed material load supplied from upstream, channel down-cutting invariably develops. Channel incision is self-enhancing and perpetuated by progressive confinement of flood flows and associated increases of in-channel flow velocity and shear stress. This generally continues until gravel mining ceases, water and sediment discharges change or the river degrades down to a resistant substrate. Very frequently, the rooting zone of riparian vegetation (an important control of scouring and bank stability) becomes elevated above the water table, making banks more susceptible to erosion.

Changes in flow regime can also arise from land-use changes. Urbanization can locally cause significant increases in high flows with potential impacts on channel stability. On the other hand, in-channel reservoirs, like the one behind New Waddell Dam, can reduce the magnitude of floods associated with a given return period. However, at the same time, the dam may increase the bed erosion potential by releasing clear water to the channel.

This work presents a sediment transport study of the Agua Fria River from Cactus Road to Jomax Road, a distance of approximately ten miles. The purpose of the sediment transport study was to construct a numerical model that could be used for predictive analysis and as a management tool. The sediment transport model will serve to evaluate potential effects on channel stability of bank protection measures, floodplain encroachments and sand and gravel mining operations along the river.

2. SEDIMENT TRANSPORT MODELING

Sediment transport models have been created using the computer program HEC-6T, Version 5.13.15, dated May 24, 2001. HEC-6T is a one-dimensional, movable boundary, open channel flow numerical code, designed to simulate and predict changes in river profiles resulting from scour and/or deposition of sediments over long time periods. HEC-6T is an enhanced version of HEC-6 (USACE, 1993) written by William A. Thomas, who developed the original HEC-6 code. The inputs to the HEC-6T model include geometric data, sediment data and hydrologic data.

The sediment transport modeling effort proceeded in three steps. First, an initial baseline model based on topography from 1964-65 was created (Initial Model). Simulations were performed using the historical flow records between 1965 and 1982 as inputs. Simulated profiles were then compared to the profiles recorded in topographic surveys from 1982-83. This comparison was the base for calibration of the Initial Model.

Next, a second model was developed from the 1982-83 topography (Intermediate Model). Using this model and the historical series of flow events from 1983 to 2000 as inputs, simulations were performed again using HEC-6T. Simulated profiles were compared to the current profile obtained from a topographic mapping completed in October 2000. In this case, the analysis was performed to verify the suitability of the selected parameters and sediment transport equations.

Finally, a third model was developed from the 2000 topography (Current Model). This model incorporates the modeling methods (equations and parameters) tested in the Initial and Intermediate models. Since this model is based on the most up-to-date geometry, it is expected to be used as the management and prediction tool.

2.1. Initial Model

2.1.1. Geometric Data

The geometry of the Initial Model was obtained from a HEC-2 input file developed in 1974 by the U.S. Army Corps of Engineers (Corps). This HEC-2 file is a hydraulic model of the Agua Fria River from its confluence with the Gila River to a cross section identified as the river mile 24.32. The file included no information about cross section locations. After examination of cross section 24.32, the upstream limit of the Corps model was determined to be located a distance of about 1.8 miles downstream of Jomax Road.

The HEC-2 file was imported into the computer program HEC-RAS and the cross section geometry was inspected. The only cross sections that could be precisely located were those corresponding to the bridges (Grand Avenue Bridge, the AT & SF Railroad Bridge, and Bell Road Bridge in the study reach). Section 16.4 was identified as being approximately on the Cactus Road alignment. Therefore, cross sections 15.44 through

15.44
↓
24.32

24.32 were selected for use in the sediment transport model. An extra mile (from 15.44 to 16.4) was added to prevent boundary effects in the lower end of the study reach.

The geometry of the Initial Model was first examined in HEC-RAS. Cross sections were divided into three strips: left overbank (from the left most conveyance area to the left bank station), channel, and right overbank (from right bank station to the right most conveyance area). Cross sections are orientated left to right looking downstream. Bank stations were identified from aerial photographs, field visits and cross section geometry. The reach lengths however were kept the same since no information was available about the cross section location.

River erosion occurs mainly within the channel, while floodplains are mainly depositional areas. Thus the importance of appropriately locating bank stations in the model. In braided systems like the Agua Fria River, it is recommended to identify the predominant channel, since the hydraulic variables calculated within the defined channel will be used to compute the sediment transport capacity that is then applied over the entire cross section. This criterion was followed for the selection of the bank stations.

Roughness coefficients were selected based on the values reported in the study titled *Agua Fria Sediment Transport Study*, by engineers from Arizona State University (Carriaga, Mays & Ruff, 1994). Manning *n* coefficients shown in this report came from a previous HEC-2 file dating from 1979. The energy loss coefficients for channel contraction and expansion were set to 0.1 and 0.3 respectively, except in the proximity of bridges where they were correspondingly increased to 0.3 and 0.5.

The hydraulics of the model were first examined under fixed bed conditions. Three steady flow runs corresponding to a small flow (1000 cfs), a near-bank-full flow (5000 cfs) and high flow (20000 cfs) were performed and their width, depth and velocity profiles were checked to ensure that the model produced acceptable hydraulic results. Conveyance limits (XL records) used to ensure that the expansion rate was at least 3:1 (3 units in the flow direction to 1 lateral unit) and the contraction ratio at least 1:1. X3 records were also used to set ineffective flow areas were appropriate.

It was also observed that, when running steady state flows under fixed bed conditions assuming a subcritical regime, the program assigned critical depth as the solution for some sections. Examination of the model revealed that at these locations the distance between cross sections was excessive and the model was not able to balance the energy equation in the solution routine. Using the capabilities of HEC-RAS, interpolated cross sections were added where needed until the program was able to generate completely subcritical profiles. A total of four interpolated cross sections (16.80, 18.02, 18.48 and 23.15) were needed to achieve fully subcritical profiles.

In HEC-6T a bridge is coded using a single cross section. There are no special records to code the pier or road/deck geometry. Instead the section geometry (GR records) is modified in such a way that it incorporates the shape of piers and deck. For this model it was not expected that the flow would reach the deck at any of the three

bridges in the reach. Thus, the pier shape was the only bridge feature that was added to the cross section geometry.

The final model geometry extended from section 15.44 (about one mile downstream of Cactus road) to section 24.32 (about 1.8 miles downstream of Jomax Road), and included 51 cross sections. Table 2.1 lists the cross sections and indicates the river mile and the approximate location of some of them. The cross section plots are included in Appendix A.

Table 2.1 – Cross sections for the Initial Model.

No.	River Mile	Sediment Sample	Approximate Location
1	15.44	1	
2	15.64	2	
3	15.9	2	
4	16.1	3	
5	16.2	3	
6	16.4	3	Cactus Road alignment
7	16.56	3	
8	16.71	3	
9	16.80	3	
10	16.9	4	
11	17	5	
12	17.07	5	Grand Avenue Bridge
13	17.08	5	
14	17.1	5	AT & SF Railroad Bridge
15	17.15	5	
16	17.2	5	
17	17.3	6	
18	17.4	6	
19	17.6	6	
20	17.9	6	
21	18.02	6	
22	18.14	6	
23	18.2	6	
24	18.36	7	
25	18.48	7	Greenway Road alignment
26	18.61	7	
27	18.82	8	
28	19	8	
29	19.23	8	
30	19.48	9	
31	19.59	9	Bell Road Bridge
32	19.7	9	
33	19.86	10	
34	20.08	10	
35	20.3	10	
36	20.48	11	
37	20.65	11	
38	20.86	11	
39	21.09	12	
40	21.26	12	
41	21.57	13	
42	21.87	13	
43	22.07	13	
44	22.32	14	Downstream of Rose Garden Lane
45	22.72	15	Upstream of Rose Garden Lane
46	22.97	16	
47	23.15	16	
48	23.33	17	
49	23.62	17	
50	24.04	18	
51	24.32	19	Downstream of Hatfield Road

2.1.2. Sediment Data

The Agua Fria River is a sand bed stream. Information about the particle size distribution of the bed sediment was obtained from the Arizona State University report (Carriaga, Mays and Ruff, 1994, referred to herein as the ASU study). Nineteen sediment samples from that report were used to describe the bed composition for the Initial Model. Table 2.1 relates each cross section to its corresponding sediment sample from the ASU study, and their respective gradation curves are presented in Appendix E. These curves were coded as N records and added to the HEC-6T input file.

Figure 2.1 shows the variation in D_{15}, D_{50} and D_{85} along the Agua Fria River study reach. The samples presented in the ASU report were collected in or prior to 1992, and are representative of the sediment bed to a depth of 3 feet except for sample No 9 which was taken between 5 and 21 inches of depth and samples 14 and 15 which were taken between 0 and 15 inches of depth. See Table 2.1 to relate sample numbers to model cross sections.

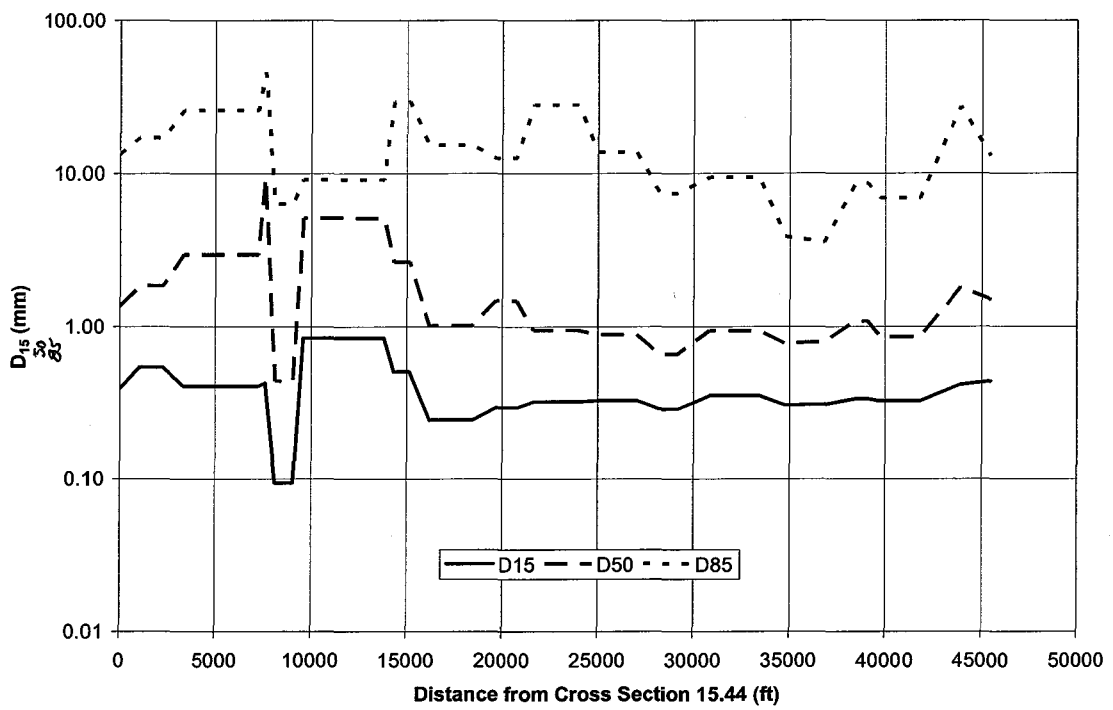

Figure 2.1 – Sediment D_{15}, D_{50} and D_{85} in the Agua Fria River study reach for the Initial Model (from ASU, 1994).

Using HI records, the bed sediment reservoir depth for the Initial Model was set at 15 ft for all cross sections, and the movable bed limits were set at the boundaries of the floodplain, thus allowing deposition to occur on the overbank areas. HE records were used to limit erosion within the channel.

The ASU study tested a variety of sediment transport equations for the conditions of the Agua Fria River. The report conclusions indicated that the transport relation provided by the combination of Toffaleti and Schoklitsch formulas described very closely the transport dynamics of sediment movements along a study reach from Bell Road to Jomax Road, and it was considered to be the best option for the sedimentation modeling of the Agua Fria River. The same report also identifies the Meyer-Peter and Muller formula as a good alternative to the Toffaleti and Schoklitsch combination. The Meyer-Peter and Muller relationship had been used twice in past sedimentation studies of the Agua Fria River conducted by Simons, Li and Associates, Inc. (1983) and Water Resources Associates, Inc. (1986). Therefore, the Toffaleti and Schoklitsch combination and the Meyer-Peter and Muller equation were selected for model testing.

Using the SAM program from the US Army Corps of Engineers, and considering the river geometry, the sediment characteristics and the expected discharges, three other sediment transport relations were selected for investigation. These relations were Yang's sediment transport equation, the combination of Toffaleti and Meyer-Peter and Muller equations, and the Laursen and Copeland relation.

Inflowing sediment load data at the most upstream section of the river reach are non-existent. The assumption of clear inflowing data can be considered valid immediately downstream of New Wadell Dam. However, the upstream boundary of the model is several miles downstream of New Wadell Dam and therefore the hypothesis of clear inflow to the study reach is not physically realistic. As explained in the following paragraph, equilibrium bed material load curves were estimated using the upstream 2-mile segment of the study reach for the selected five sediment transport relations. This 2-mile portion of the river is relatively undisturbed.

The equilibrium bed material load calculations were performed for the reach segment between cross sections 22.32 and 24.32. The process involved using HEC-6T in an iterative mode to synthesize the inflowing bed material load and gradation from the grain size distribution curves measured in the field. In order to do this, the recirculation option ($RE record) of HEC-6T was activated. The recirculation option takes sediment passing cross section 22.32 and recirculates it to become the inflowing sediment discharge for the next time step. This process was repeated until the calculated sediment discharges converged to the equilibrium discharge for each grain size considered.

Sediment inflow estimations were carried out for a range of discharges: 100 cfs, 500 cfs, 1000 cfs, 5000 cfs, 10000 cfs, 20000 cfs, 40000 cfs and 60000 cfs. Results of the simulations included the total load of bed material discharge and the gradation of the load. This information was then used in the model as the upstream boundary condition in simulating the sediment transport processes in the river. Figures 2.2 through 2.6 show the estimated bed material inflow for each transport relationship considered. The lines corresponding to sediment concentrations of 500 and 5000 mg/l are also shown for comparison. Based on these results alone it is not possible to say that any relation is better than another.

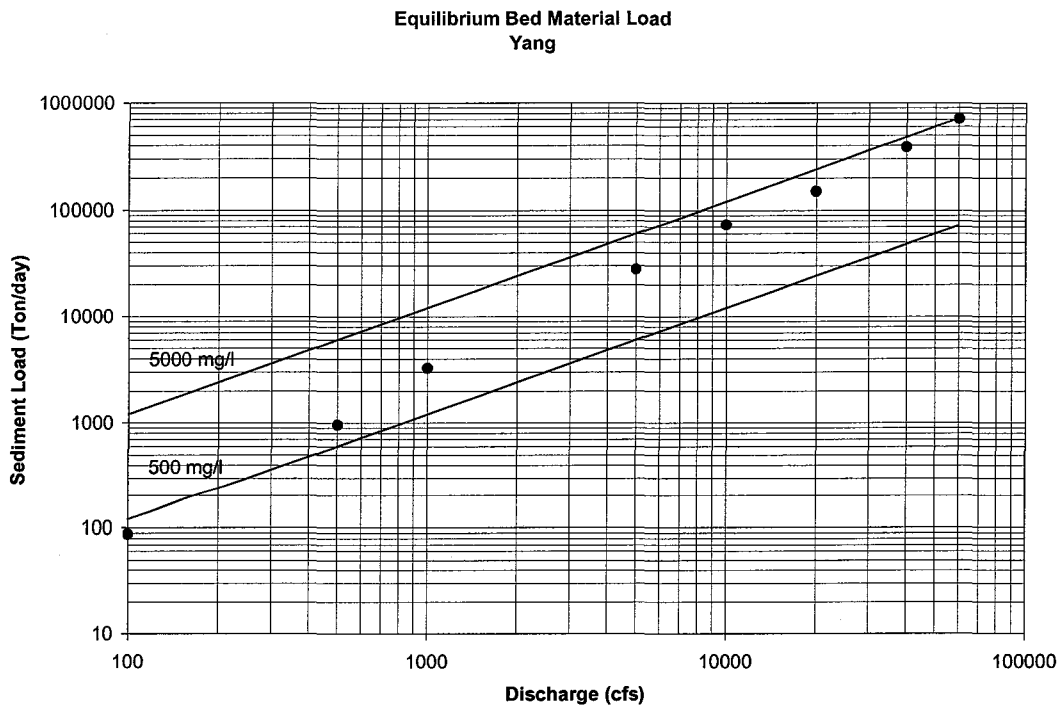

Figure 2.2 – Equilibrium bed material load using Yang relation for Initial Model.

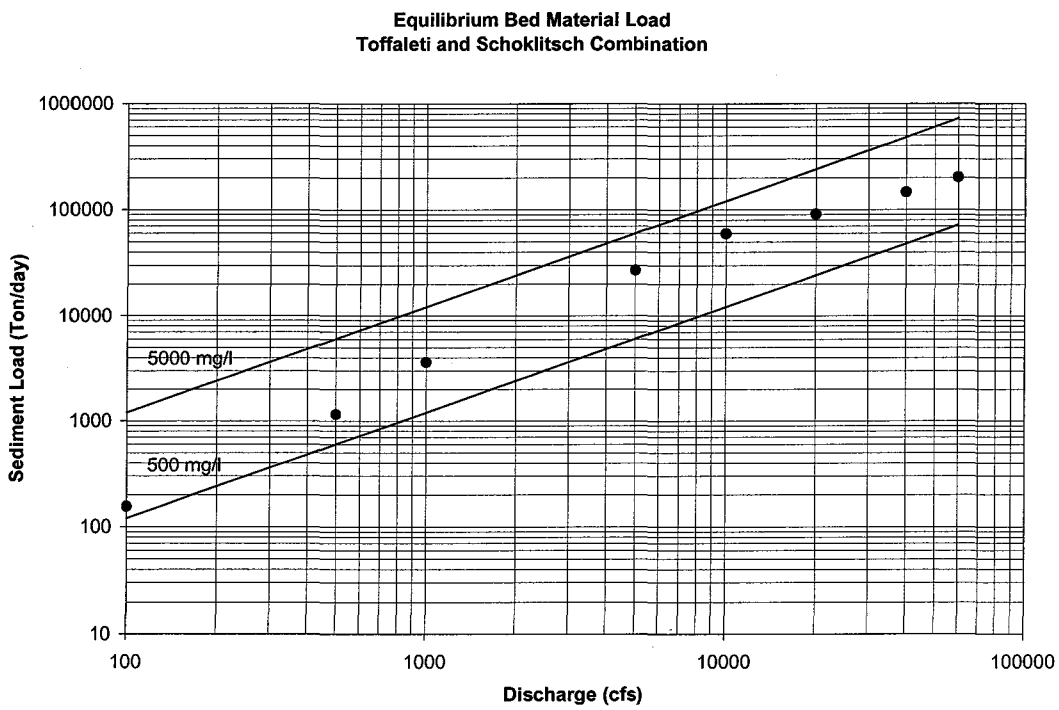

Figure 2.3 – Equilibrium bed material load using Toffaleti and Schoklitsch combination for Initial Model.

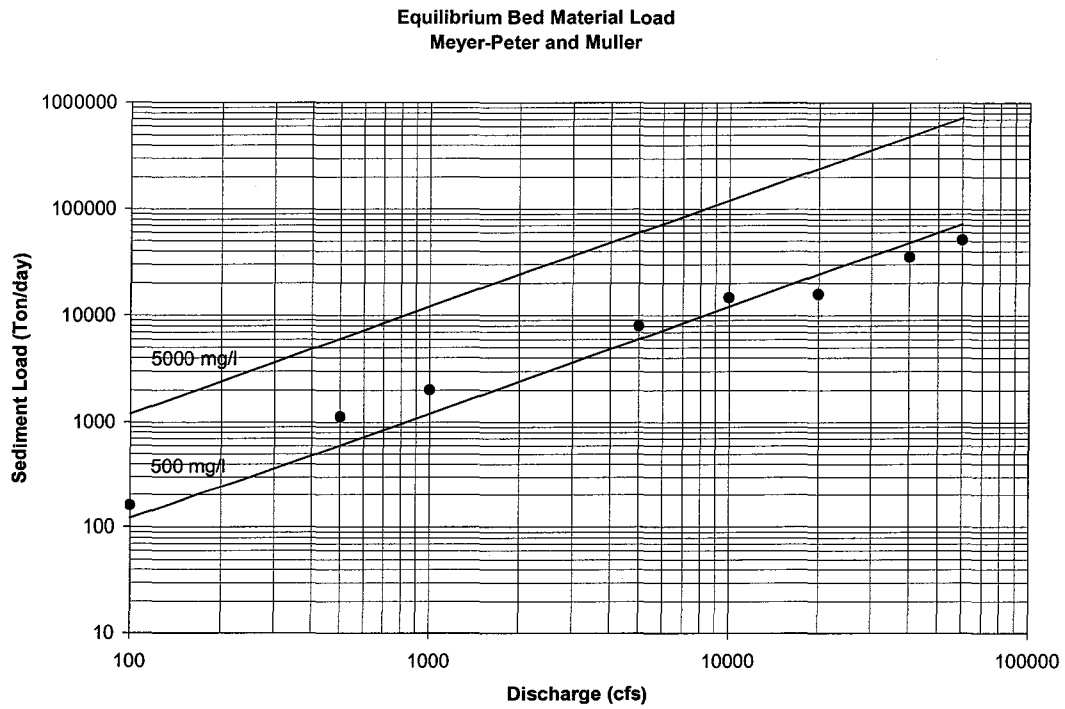

Figure 2.4 – Equilibrium bed material load using Meyer-Peter and Muller relation for Initial Model.

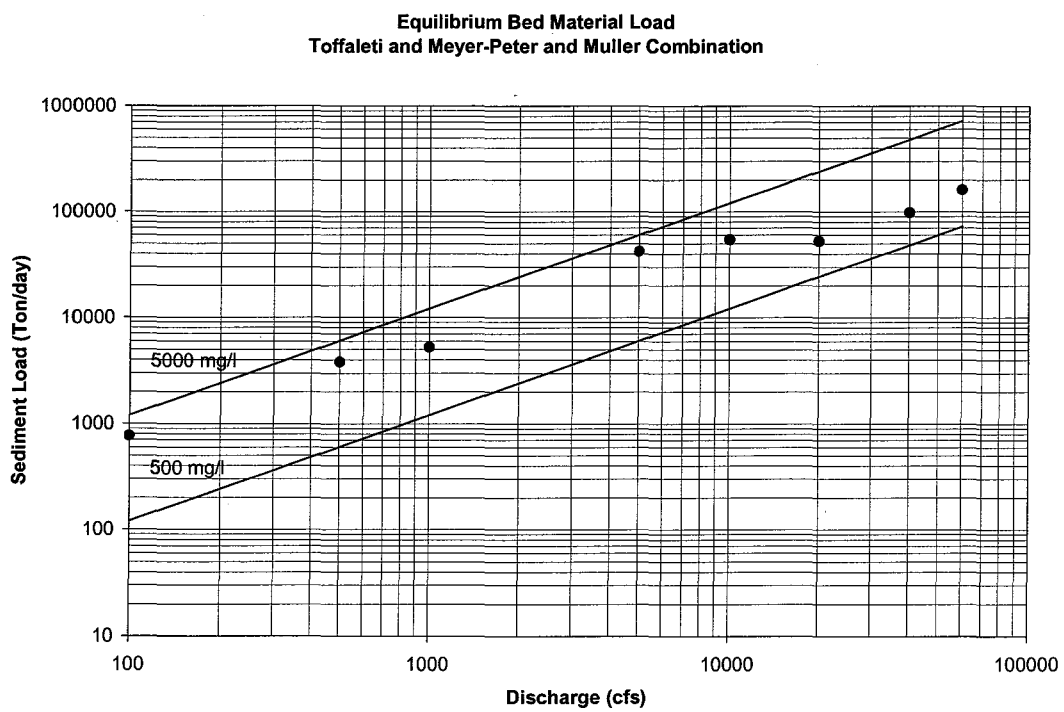

Figure 2.5 – Equilibrium bed material load using Toffaleti and Meyer-Peter and Muller combination for Initial Model.

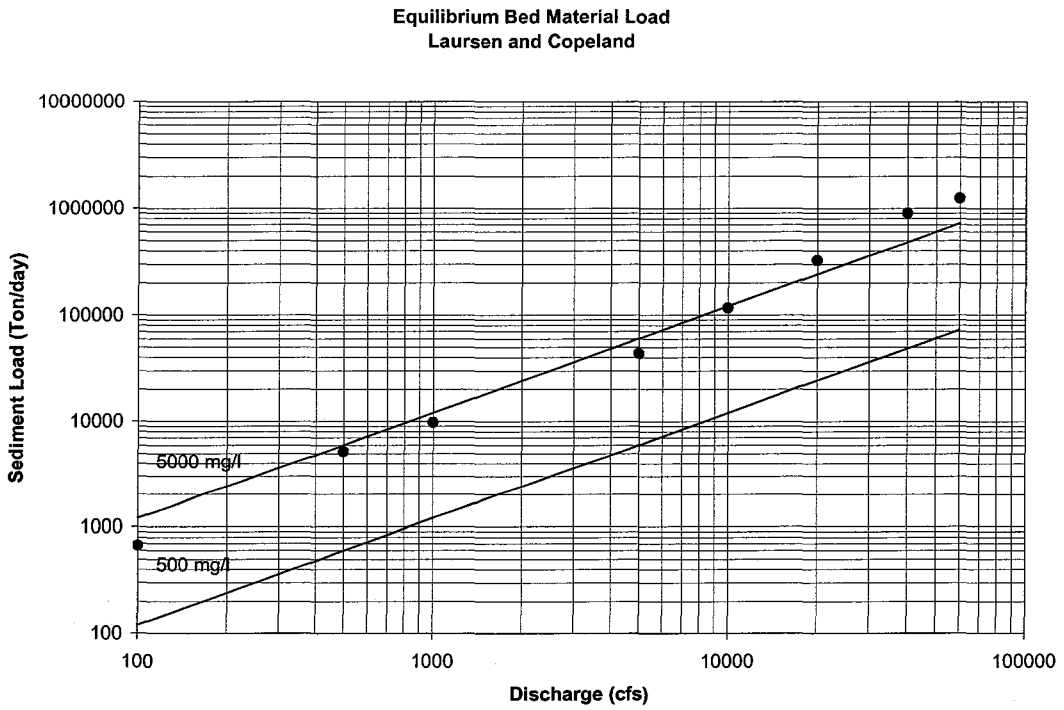

Figure 2.6 – Equilibrium bed material load using Laursen and Copeland relation for Initial Model.

Underestimation of the sediment inflow can lead to excessive scour prediction in the study reach. On the other hand, if the sediment inflow to the system is overestimated, the model will respond predicting aggradation. In order to evaluate the sensitivity of the model to the sediment inflow, simulations were performed considering three scenarios: 50% of equilibrium sediment inflow, 100% of equilibrium sediment inflow, and 150% of equilibrium sediment inflow.

2.1.3. Hydrologic Data

The Initial Model was created for calibration purposes, and its objective was to reproduce the 1983 geometry using the 1965 geometry as the starting point. With that in mind, historical flow data were collected from the available sources. Existing data included mean daily flows and peak flows from the USGS database, and detailed discharge records from the FCDMC database. However, data were available only for limited periods of time as shown in Tables 2.2, 2.3 and 2.4.

Table 2.2 – Mean daily flows available from the USGS database.

Sensor Location	Beginning of Record	End of Record
Agua Fria River @ Avondale	10/01/67	09/30/82
Agua Fria River @ El Mirage	11/10/93	09/30/98
New River @ Glendale	02/09/64	09/30/70
New River @ Glendale	04/01/90	09/30/98
New River @ Bell Road	10/01/67	09/30/84
New River @ Bell Road	06/01/90	09/30/93

Table 2.3 – Peak annual flows available from the USGS database.

Sensor Location	Beginning of Record	End of Record
Agua Fria River @ Avondale	1959	1982
Agua Fria River @ El Mirage	1963	1998
New River @ Glendale	1943	1998
New River @ Peoria	1943	1971
New River @ Bell Road	1963	1993

Table 2.4 – Detailed discharge records available from the FCDMC database.

Sensor Location	Beginning of Record	End of Record
Agua Fria River @ Grand Avenue	04/27/94	present
Agua Fria River @ Buckeye	04/21/89	present
New River @ Glendale	03/21/90	present

The daily records available do not cover the entire period of study for the Initial Model, years 1965-82, or for the Intermediate Model, years 1983-2000. Daily flows recorded at El Mirage or Grand Avenue are considered the most appropriate to generate the hydrologic input for the sediment transport modeling. However, there are no records at any of these locations prior to 1993.

The Agua Fria River and New River confluence is located about 5 miles downstream of the model boundary, and the gauging station in Avondale is located approximately 6 miles downstream of the confluence. Flow estimates for the Initial Model were generated by subtracting the recorded flow at a New River gauging station (Glendale or Bell Road) from the measured flows at the Agua Fria station in Avondale. This estimation method implicitly assumes that the lower part of the watershed is not contributing significantly to the river flow, and that the channels are merely storing and conveying the flow. The hydrologic study carried out by the Corps of Engineers (USACE, 1995) shows that the flow peaks tend to attenuate in the downstream direction confirming the validity of the assumption.

The flows resulting from subtracting the discharges at the New River stations from those at the Agua Fria River stations were then compared to the peak flows reported at El Mirage, and scaled to match the measured peaks. This procedure permitted the generation of a daily flow series from October 1967 to September 1982. From the peak values reported at El Mirage, it was observed that the period from 1965 to 1967 was not very active in terms of flow and was disregarded for the analysis. Also, very small readings (less than 10 cfs) were not considered relevant for sediment transport purposes and were ignored. This analysis generated a set of 50 mean daily flow values (pulses) that are representative of the observed flows between 1965 and 1982.

The hydrologic input for the Initial Model consisted then of a series of 50 pulses, each one 24 hours long (Figure 2.7). Computations were performed at 0.05 hours intervals to ensure model stability. The flow pulses were provided in a continuous sequence, without dry periods between flow events, because during dry periods HEC-6T does not compute sediment transport.

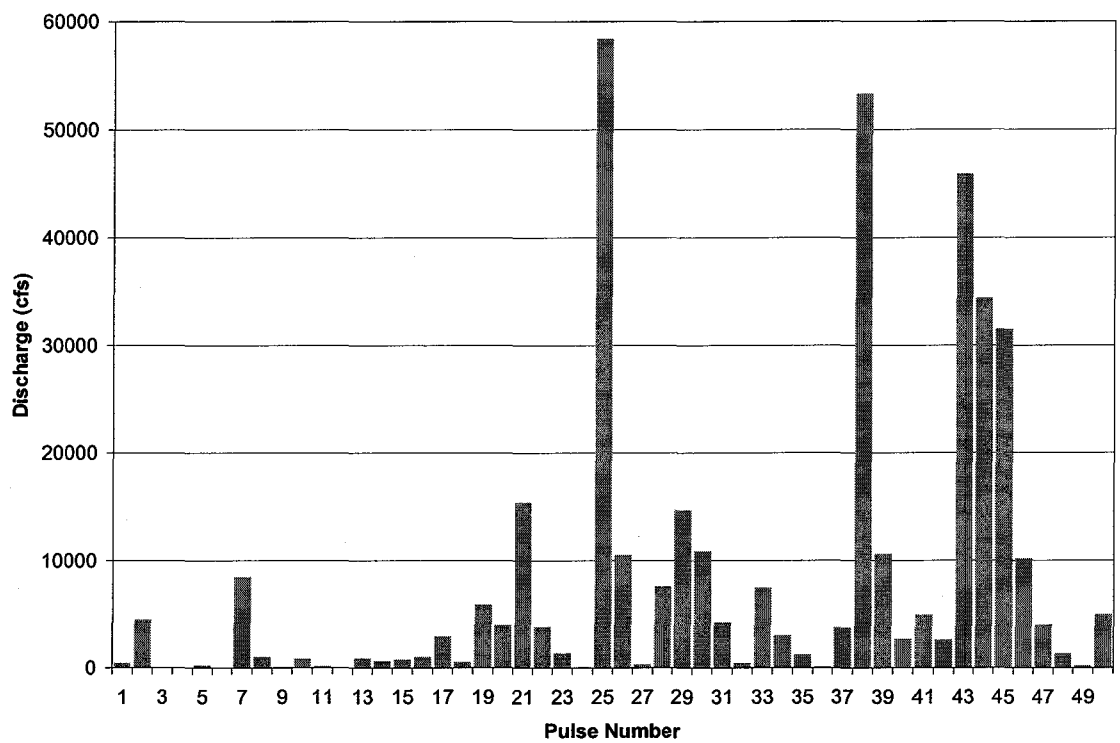

Figure 2.7 – Hydrologic input for Initial Model.

The hydrology part of the HEC-6T input file also requires a hydraulic boundary condition at the downstream end of the reach. This boundary condition can be either a known water surface elevation at the boundary for each discharge prescribed, or a rating curve. When a rating curve is used, the program will interpolate the water surface elevation for each of the discharges prescribed from the curve. Then, the known water elevation will be used as the start point to compute a subcritical water profile.

A rating curve was generated at cross section 15.44 (downstream boundary) using HEC-RAS. Cross sections within two miles of the downstream boundary of the Initial Model (RM 15.44) were copied from the original HEC-2 file and added to the Initial Model (from RM 13.5 to RM 15.28). The addition of this extra segment ensured that the effect of considering an incorrect boundary condition in HEC-RAS would be minimized at section 15.44. HEC-RAS was executed for discharges ranging from 2000 cfs to 60000 cfs, in 2000 cfs increments, considering normal flow conditions at cross section 13.5. The stage-discharge relationship at section 15.44 was obtained from the results and is shown in Figure 2.8.

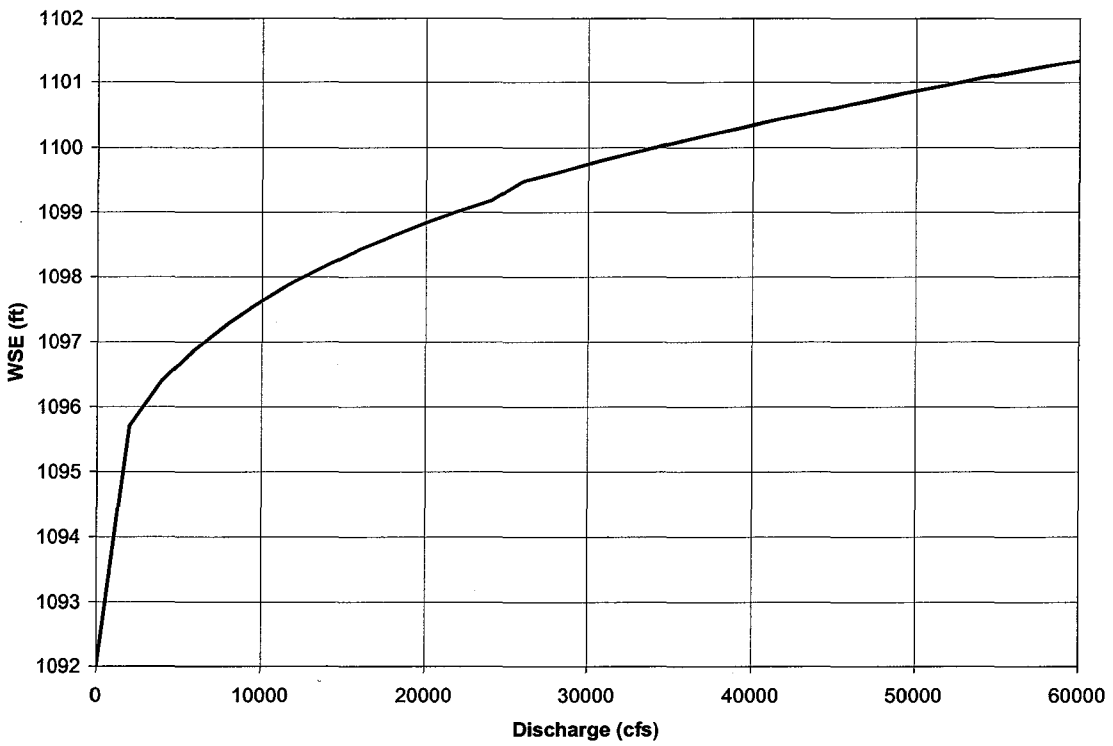

Figure 2.8 – Stage-discharge relationship at cross section 15.44 for the Initial Model.

2.2. Intermediate Model

2.2.1. Geometric Data

The geometry for this model was derived from a second HEC-2 hydraulic model of the Agua Fria River created by the Corps of Engineers in 1983. The HEC-2 file contained cross sections of the Agua Fria River from the confluence with the Gila River to Jomax Road. The beginning of the file included comment lines with information about the location of some cross sections and the dates they were surveyed. The reach between Cactus Road and Jomax Road was surveyed during 1982 and 1983.

The 1983 HEC-2 file was imported into HEC-RAS and the cross section geometry was inspected. Section 15.647 was identified as being approximately on the Cactus Road alignment. The study reach extended from section 15.647 to section 25.592, which was located just upstream of Jomax Road. Approximately one additional mile (from section 14.311 to 15.454) was retained in the model below to the study reach to prevent downstream boundary condition impacts in the study reach.

The Intermediate Model geometric data were assembled similarly to the Initial Model: cross sections were divided into three strips, with orientation based upon left to right looking downstream. Cross sections 16.191 to 18.707 were flipped since they had been defined looking upstream in the original HEC-2 file. Bank stations, reach distances and roughness coefficients were inspected and kept as they were set in the original hydraulic model. Energy loss coefficients for channel contraction and expansion were set to 0.1 and 0.3 respectively, except in the bridge sections and vicinity where they were increased to 0.3 and 0.5 respectively.

The Intermediate Model geometry was examined under fixed bed conditions. Due to differences in the representation of bridges it was necessary to modify a single cross section to represent the pier geometry for each of the three bridges. Three hydraulic profiles corresponding to a small flow (1000 cfs), near-bank-full flow (5000 cfs) and high flow (20000 cfs) were created. Flow width, depth and velocity along the study reach were inspected to ensure a reliable hydraulic model. Conveyance limits (XL records) were placed at those locations in which cross section width was greater than the expected effective width of the flow.

The hydraulic model was set to simulate subcritical flow profiles. In some cross sections characterized by long reach distances and relatively steep bed slopes, the computer program solution defaulted to critical depth. Nine additional cross sections were interpolated to prevent the hydraulic model to default to critical depth. The interpolated cross sections are: 18.97, 21.1, 23.46, 23.52, 23.87, 24.03, 24.09, 24.59 and 24.66.

The Intermediate Model geometry included 84 cross sections. Table 2.5 lists the cross sections and indicates the location of some of them. Cross section plots are shown in Appendix B.

2.2.2. Sediment Data

Bed sediment characteristics for the Intermediate Model were obtained from the ASU report. Twenty three of the samples included in that report were used to describe the bed sediment gradation in the study reach (Appendix E). Table 2.5 identifies the sediment sample from the ASU study that is associated with each cross section in the Intermediate Model.

Table 2.5 – Cross sections for the Intermediate Model.

No.	River Mile	Sediment Sample	Location
1	14.311	1	
2	14.501	2	Peoria Avenue alignment
3	14.69	2	
4	14.879	2	
5	15.069	3	Varney Road alignment
6	15.258	3	
7	15.454	3	
8	15.647	4	Cactus Road alignment
9	15.823	4	
10	16.013	4	
11	16.153	4	Meyer Lane alignment
12	16.35	5	Grand Avenue Bridge
13	16.355	5	
14	16.376	5	AT & SF Railroad Bridge
15	16.431	6	
16	16.481	6	
17	16.58	6	
18	16.681	6	
19	16.78	6	
20	16.879	6	
21	16.979	6	
22	17.078	6	
23	17.174	6	
24	17.273	6	
25	17.398	6	
26	17.509	6	
27	17.607	6	
28	17.71	7	Greenway Road
29	17.81	7	
30	17.909	7	
31	18.009	7	
32	18.109	7	
33	18.207	7	
34	18.306	7	
35	18.406	8	
36	18.507	8	
37	18.606	8	
38	18.707	8	
39	18.808	8	
40	18.893	9	Bell Road Bridge
41	18.906	9	
42	18.97	10	
43	19.029	10	
44	19.245	11	
45	19.491	11	
46	19.7	11	
47	19.929	11	
48	20.122	11	
49	20.382	12	
50	20.575	12	
51	20.738	12	
52	20.993	13	

No.	River Mile	Sediment Sample	Location
53	21.1	13	
54	21.241	13	
55	21.469	14	
56	21.681	14	Rose Garden Lane
57	21.88	15	
58	22.069	15	
59	22.258	16	
60	22.448	16	
61	22.637	17	
62	22.827	17	
63	23.016	18	
64	23.205	18	
65	23.395	18	
66	23.46	18	
67	23.52	19	
68	23.584	19	
69	23.774	19	
70	23.87	19	
71	23.963	19	
72	24.03	19	
73	24.09	20	
74	24.152	20	Happy Valley Road
75	24.342	20	
76	24.531	20	
77	24.59	20	
78	24.66	21	
79	24.721	21	
80	24.91	21	
81	25.099	21	
82	25.289	22	
83	25.459	22	Jomax Road
84	25.592	23	Upstream of Jomax Road

Figure 2.9 shows the variation of D_{15}, D_{50} and D_{85} along the study reach as described by the selected sediment samples. Samples were collected in or prior to 1992, to a depth of 3 feet, with the exceptions previously mentioned (samples 9, 14 and 15). Figure 2.9 is based on the same gradations used to develop Figure 2.1, but they are applied to different cross sections. In addition, Figure 2.9 shows four extra samples at the upstream end.

Using HI records, the bed sediment reservoir depth was initially set at 15 feet for all cross sections, although it was later increased to 40 feet in some cross sections in which dredging was used to simulate long term sediment removal from the river bed. The movable bed limits were set at the floodplain boundaries to allow deposition to occur on the overbank areas, while erosion was restricted to the main channel by using HE records.

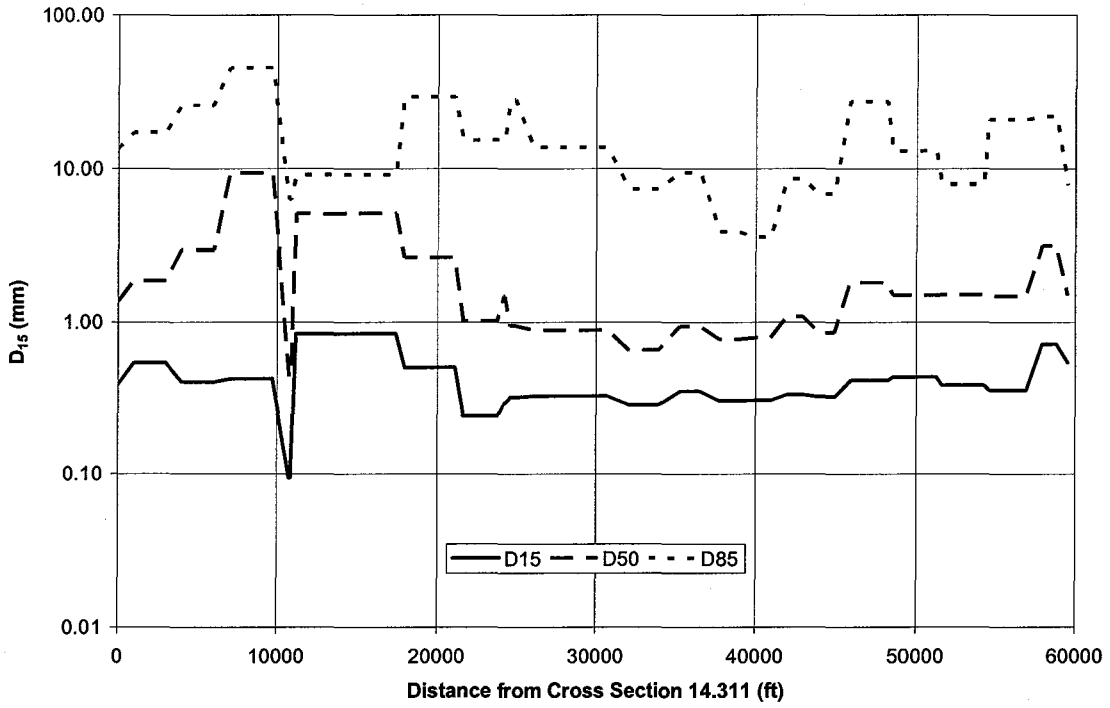

Figure 2.9 – Sediment D_{15}, D_{50} and D_{85} in the Agua Fria River study reach for the Intermediate Model (from ASU, 1994).

Initially all five sediment transport relations selected for the Initial Model were tested in the Intermediate Model too. Equilibrium bed material sediment loads were computed for the reach segment between sections 23.584 and 25.592. As for the Initial Model, HEC-6T was used with the recirculation option to synthesize the inflowing sediment load and gradation from the grain size distribution of the bed samples.

Sediment inflow calculations were carried out for discharges between 100 cfs and 60000 cfs. Computation results included total sediment load and gradation, and were used to specify the model upstream boundary condition. Figures 2.10 through 2.14 show the estimated bed material inflow for each transport relationship investigated.

In order to assess the sensitivity of the model to the upstream boundary condition, simulations were performed once more considering three scenarios: 50% equilibrium sediment load inflow, 100% equilibrium sediment load inflow, and 150% equilibrium sediment load inflow.

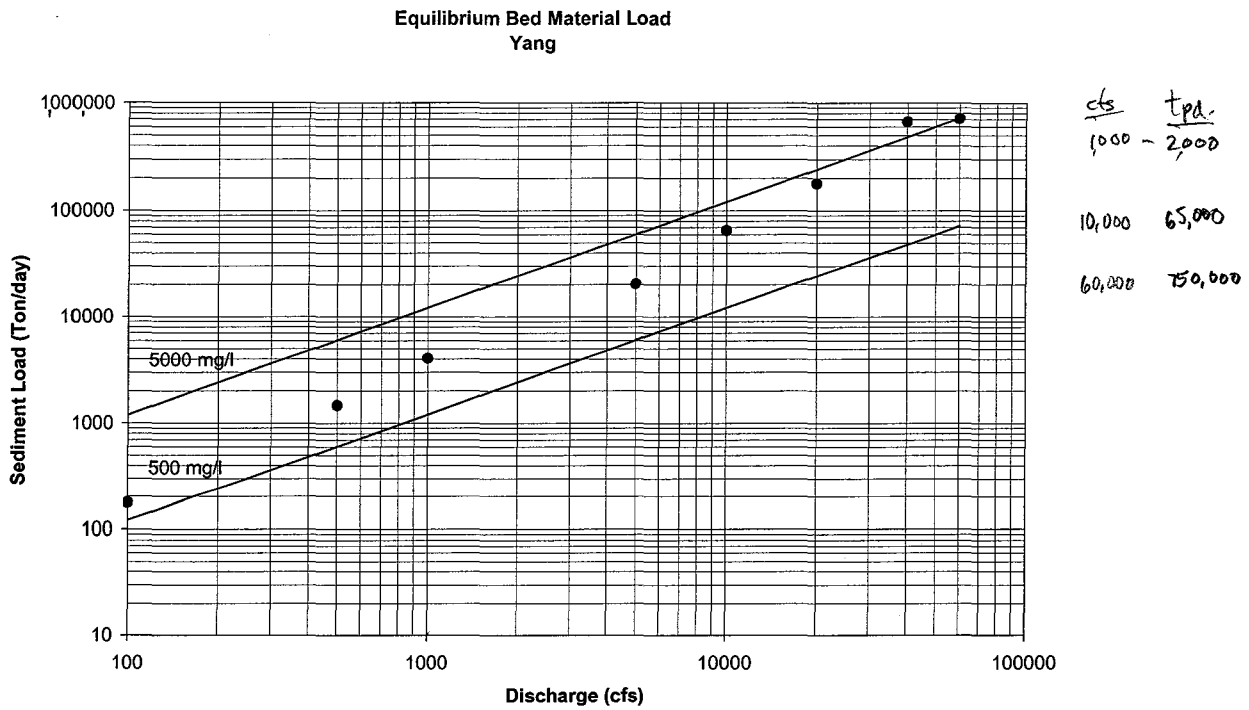

Figure 2.10 – Equilibrium bed material load using Yang relation for Intermediate Model.

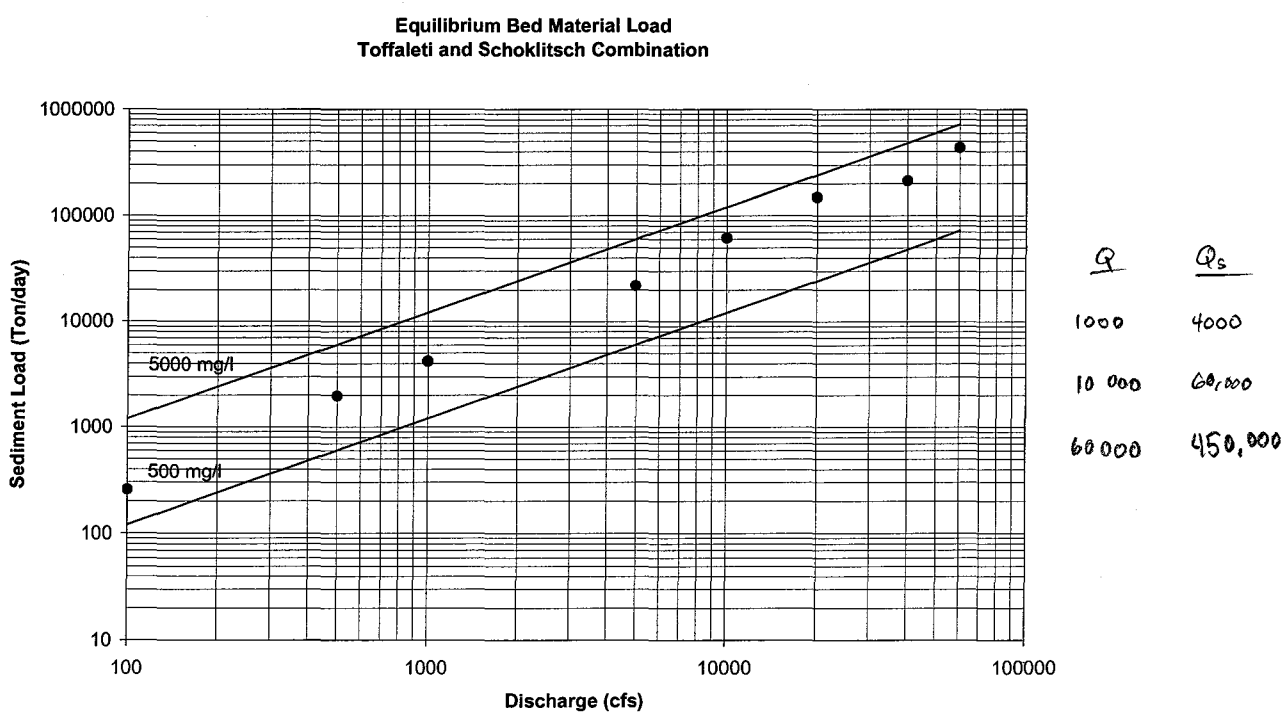

Figure 2.11 – Equilibrium bed material load using Toffaleti and Schoklitsch combination for Intermediate Model.

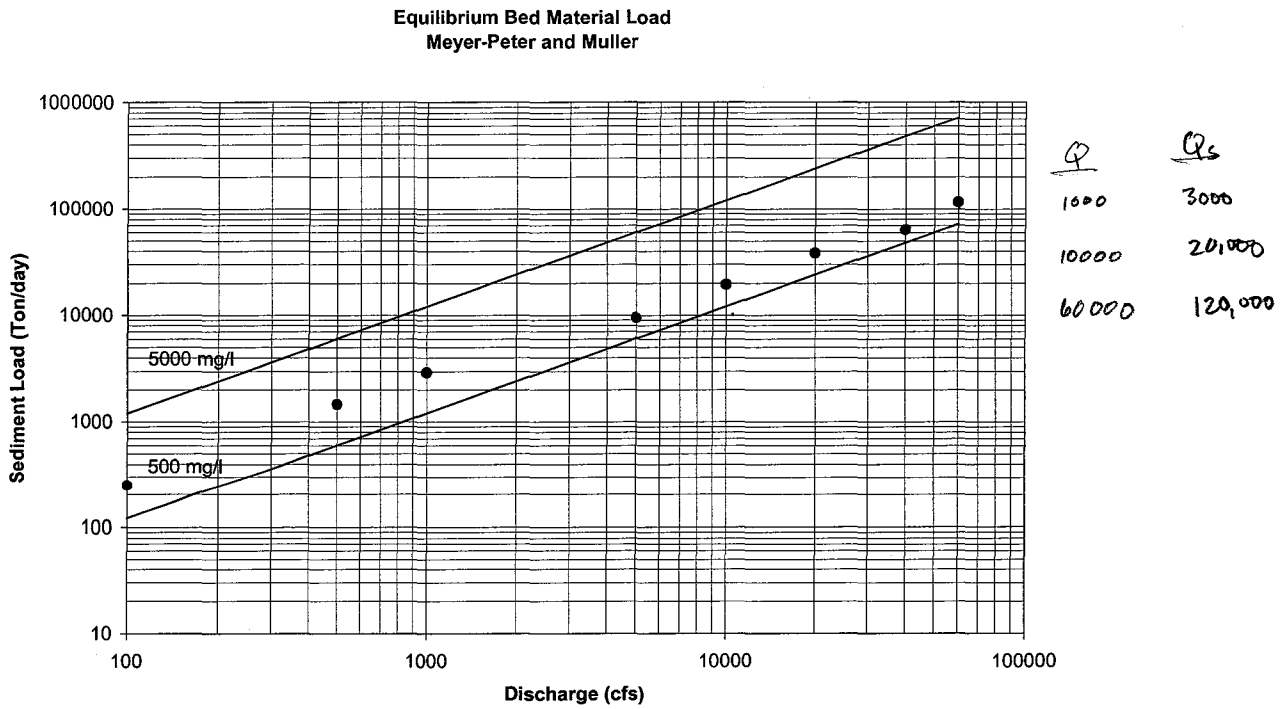

Figure 2.12 – Equilibrium bed material load using Meyer-Peter and Muller relation for Intermediate Model.

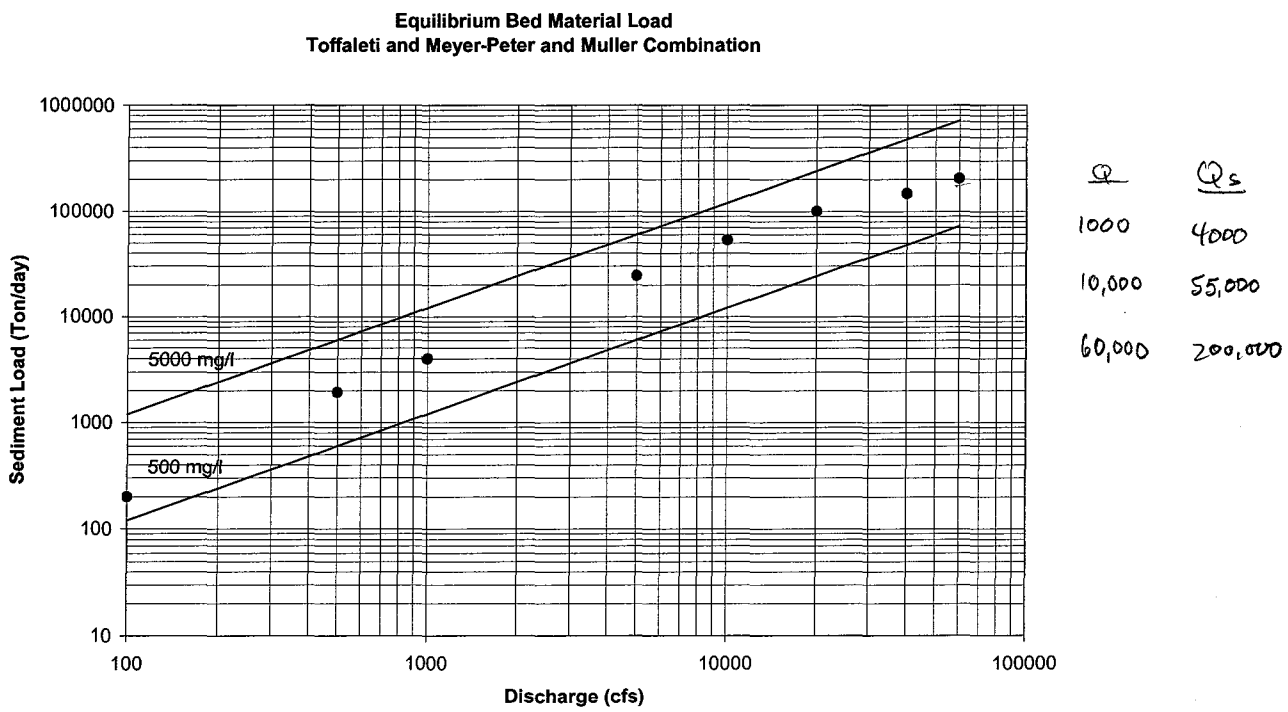

Figure 2.13 – Equilibrium bed material load using Toffaleti and Meyer-Peter and Muller combination for Intermediate Model.

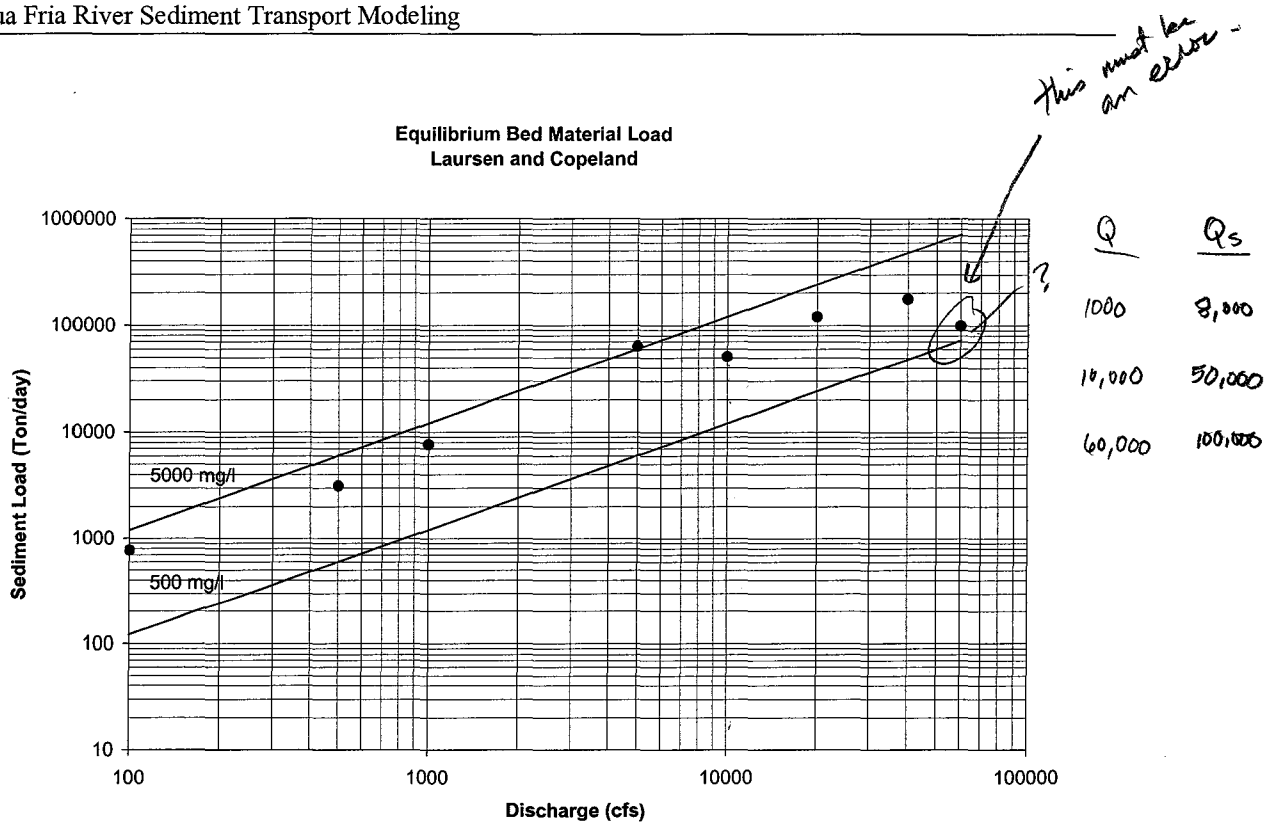

Figure 2.14 – Equilibrium bed material load using Laursen and Copeland relation for Intermediate Model.

2.2.3. Hydrologic Data

The Intermediate Model was intended to validate the selections made in the Initial Model. The objective was to reproduce the 2000 geometry using the 1983 geometry as the starting point. With this goal in mind, historical flow records were collected from the available sources (see Tables 2.2, 2.3 and 2.4).

The FCDMC sensor at Grand Avenue provided a continuous record from May 1994. Between May 1989 and May 1994 the flow series was obtained as the difference of the FCDMC sensors at Buckeye Road (Agua Fria River) and Glendale (New River). The resulting flows were compared to the peaks recorded at El Mirage (USGS records) to ensure they had the proper magnitude. Readings less than 10 cfs were ignored. Due to the non existence of continuous records from 1983 to 1988, the flow series was completed with the peak discharges recorded for these years.

Figure 2.15 shows the hydrologic input for the Intermediate Model representing the period 1983-2000, consisting of a series of 111 pulses, each one 24 hours long, with no dry periods in between. Computations were performed at 0.05 hours intervals. The magnitude of the flows for this period contrasts markedly with the magnitude of the flows for the Initial Model, in part due to the effect of the New Waddell Dam, which was completed in 1992 and the lack of large flow events on the river.

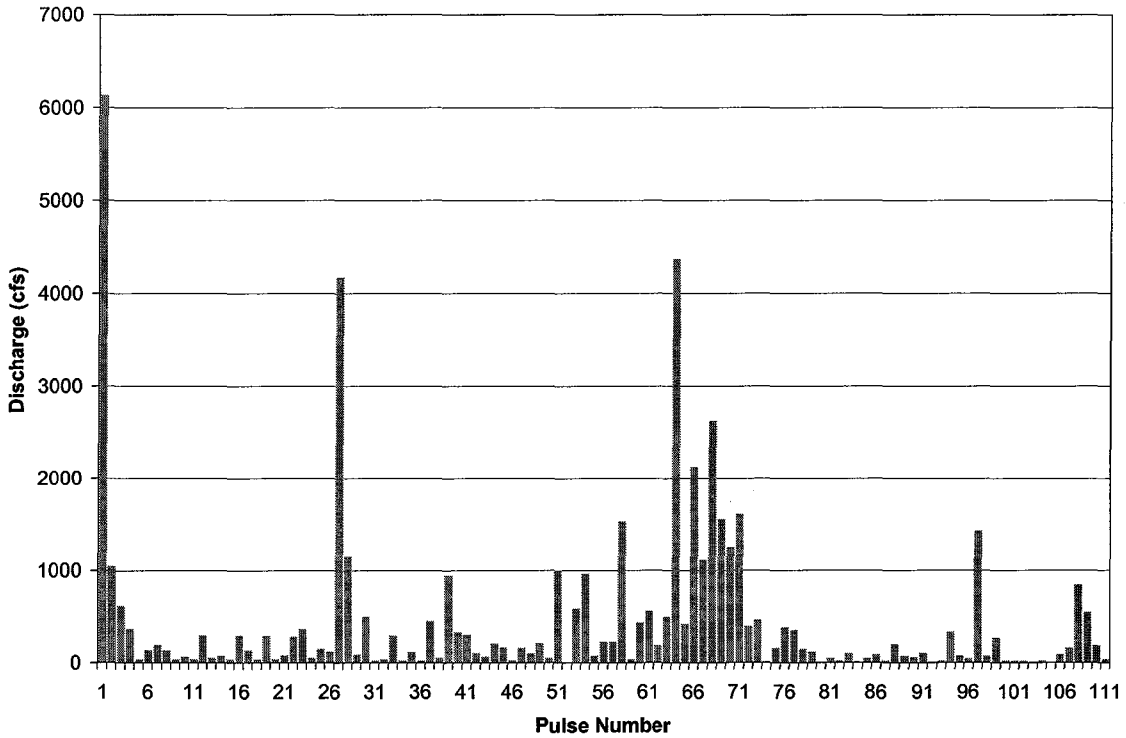

Figure 2.15 – Hydrologic input for Intermediate Model.

The downstream boundary condition consisted of a rating curve at cross section 14.311. To generate this rating curve, two extra river miles from the 1983 HEC-2 file (from RM 12.357 to RM 14.122) were retained from the existing Corps HEC-2 model at the downstream end to guarantee that the effect of a wrong boundary condition at section 12.357 would be minimized at section 14.311. HEC-RAS was executed for discharges ranging from 2000 cfs to 60000 cfs, in 2000 cfs increments, considering normal flow conditions at section 12.357. The rating curve at section 14.311 obtained from this analysis is shown in Figure 2.16.

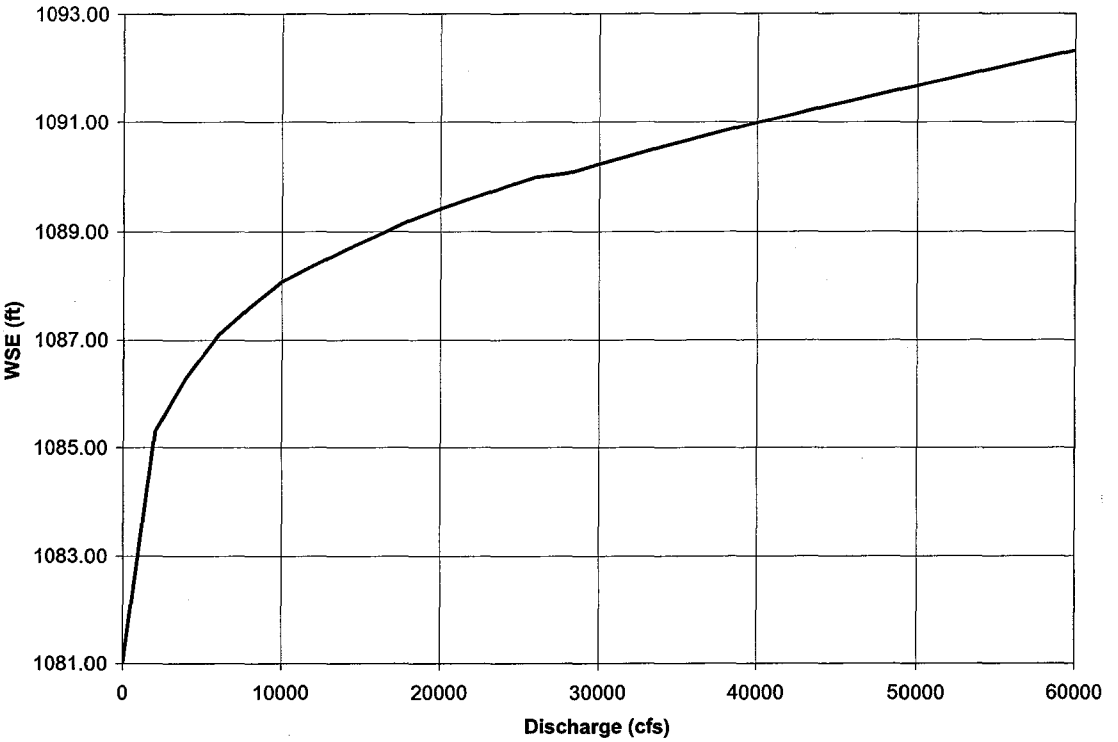

Figure 2.16 – Stage-discharge relationship at cross section 14.311 for the Intermediate Model.

2.3. Current Model

2.3.1. Geometric Data

The geometry for this model was obtained from the 2000 mapping of the Agua Fria River from Cactus Road to Happy Valley Road. The cross section geometry was generated using HEC-GeoRAS and then imported into HEC-RAS for inspection. Bank stations were set according to field observations, aerial photographs and slope changes in the cross section. Roughness coefficients were obtained from a current floodplain delineation study in conjunction with field visits, and contraction/expansion energy loss coefficients were set to 0.1 and 0.3 respectively, except at bridges and sections in their proximity where they were set to 0.3 and 0.5. Conveyance limits were used to limit the effective width of the flow to the main channel near mining sites and other ineffective flow areas were identified.

The Current Model geometry contains 101 cross sections. Table 2.6 shows a list of the cross sections and identifies the location of some of them. Cross section plots are provided in Appendix C. Appendix D displays a plan view of the study reach and the layout of the cross sections. And Figure 2.17 shows the three measured profiles against each other (the location of the 1965 and 2000 cross sections has been modified so that the bridges and other known landmarks match those in the 1983 profile).

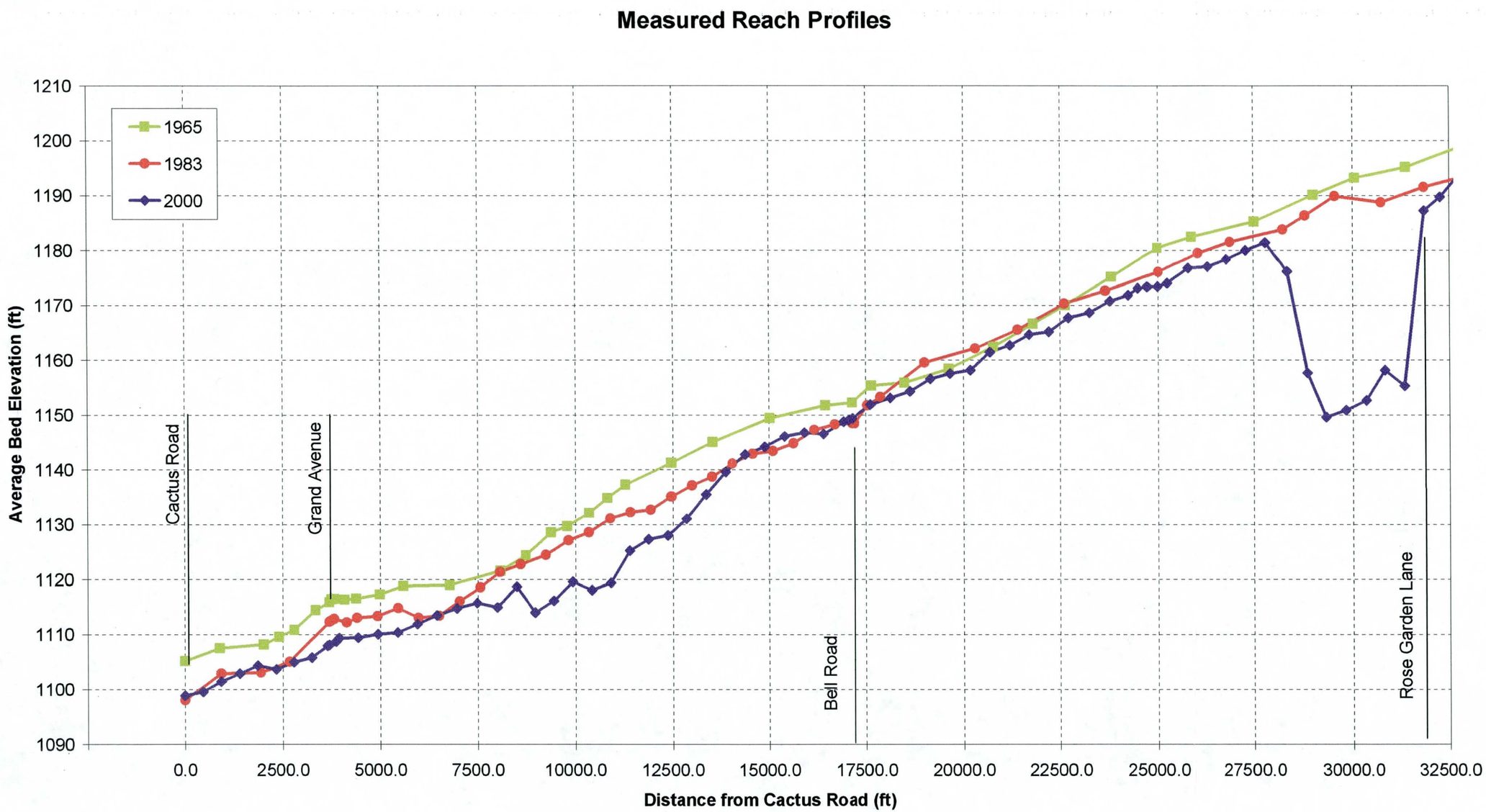

Figure 2.17 – Measured average bed elevation profiles.

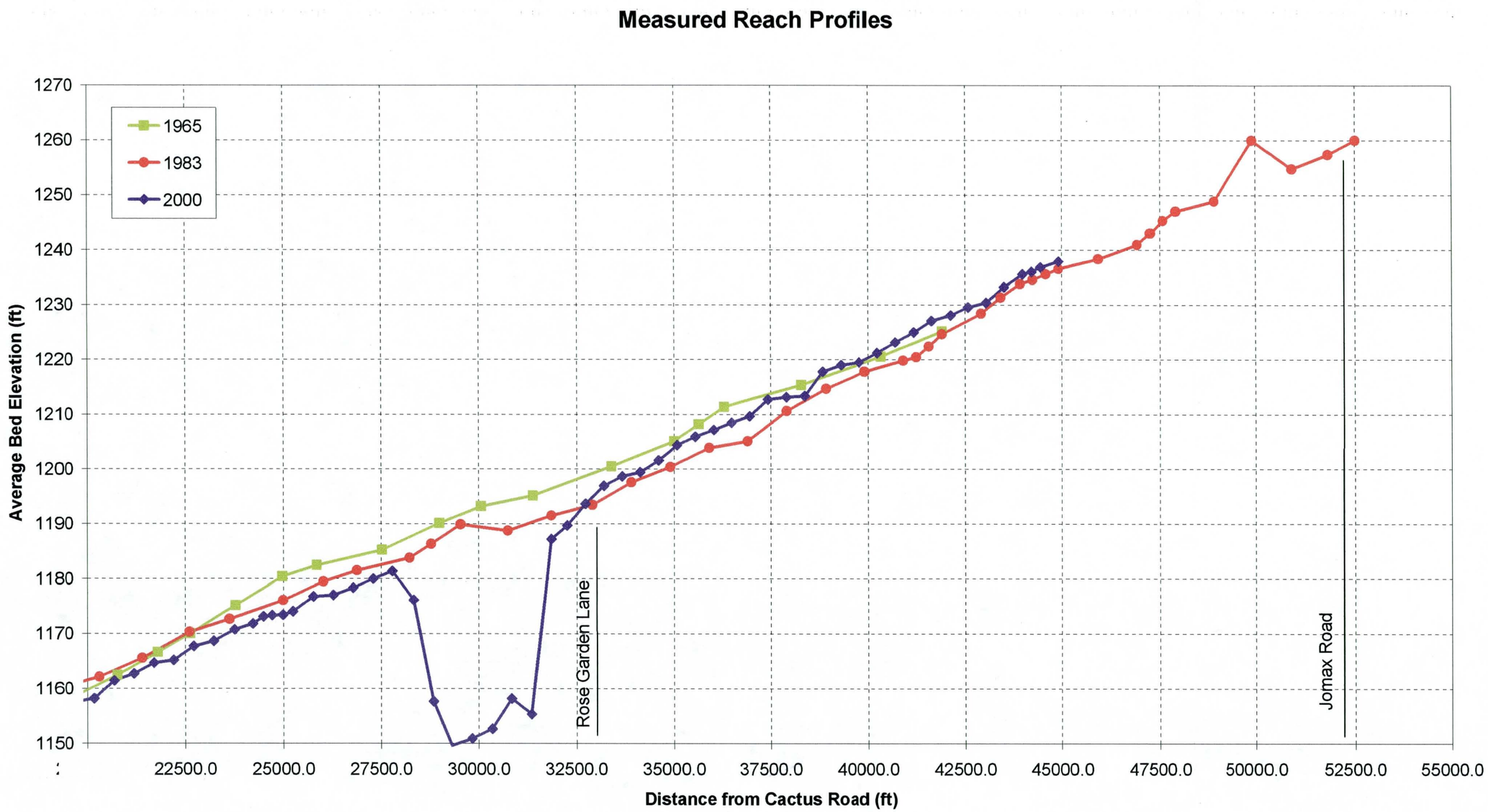

Figure 2.17 – Continued.

Table 2.6 – Cross sections for the Current Model

No.	River Mile	Sediment Sample	Location
1	15.50	KHA1	Cactus Road alignment
2	15.60		
3	15.69		
4	15.78		
5	15.88		
6	15.98		
7	16.07		
8	16.17		
9	16.25	KHA2	
10	16.26	KHA3	Grand Avenue Bridge
11	16.28		
12	16.29		AT & SF Railroad Bridge
13	16.30		
14	16.39		
15	16.49		
16	16.58		
17	16.68		
18	16.77		
19	16.87		
20	16.96		
21	17.06		
22	17.15	KHA4	
23	17.24		
24	17.33		
25	17.42		
26	17.51		
27	17.60		
28	17.69		
29	17.78	KHA5	Greenway Boulevard
30	17.87		
31	17.96		
32	18.06		
33	18.15		
34	18.25		
35	18.34		
36	18.44		
37	18.53	KHA6	Paradise Lane
38	18.62		
39	18.72		
40	18.74		
41	18.76	KHA7	Bell Road Bridge
42	18.85		
43	18.94		
44	19.04		
45	19.13		
46	19.23		
47	19.32		
48	19.42		
49	19.51		
50	19.61		
51	19.70		
52	19.80	KHA8	

No.	River Mile	Sediment Sample	Location
53	19.89		
54	19.99		
55	20.08		
56	20.13		
57	20.17		
58	20.22		
59	20.27		
60	20.36		
61	20.46		
62	20.55		
63	20.65		
64	20.74	KHA9	Beardsley Road
65	20.84		Mine
66	20.94		Mine
67	21.03		Mine
68	21.12		Mine
69	21.22		Mine
70	21.31		Mine
71	21.40		Mine
72	21.50		Rose Garden Lane
73	21.58	KHA10	
74	21.68		
75	21.77		
76	21.87		
77	21.96		
78	22.06		
79	22.15	KHA11	Deer Valley Road
80	22.25		
81	22.34		
82	22.44		
83	22.53		
84	22.63		
85	22.72		
86	22.82		
87	22.91		
88	23.01		
89	23.10		
90	23.20	KHA12	Pinnacle Peak Road
91	23.29		
92	23.39		
93	23.48		
94	23.58		
95	23.67		
96	23.76		
97	23.86		
98	23.95		
99	24.00		
100	24.05		
101	24.14	KHA13	Happy Valley Road

Most of the sand and gravel mines are located on the floodplain of the Agua Fria River. Several, however are located in the channel and have a protective berm surrounding them to prevent flow from entering into the mining pits. In these cases it was

possible to identify a channel going around the mines and conveyance limits were placed near the pit border to prevent the use of the pit area in the flow and sediment transport calculations.

One of the mining operations completely eliminated the channel, and the pit cross section was used in the flow and sediment transport analysis. The cross sections affected by this mining site are 20.84, 20.94, 21.03, 21.12, 21.22, 21.31 and 21.40. HEC-6T is a steady state analysis program and can not be used to analyze the local processes occurring in the channel upstream and downstream of a mining site due to unsteady flow conditions. These effects include head cutting and possibly tail cutting. Regardless of this limitation, simulations have been performed with HEC-6T using the current geometry including the pit to show the impacts of the various events on the river. It is, however; necessary to acknowledge this limitation of the program when analyzing the results from this analysis.

In order to assess the damage to the channel that can be induced by the large sand and gravel mine located in the main channel, a separate analysis was performed. This analysis used methods specifically designed to evaluate the effects of mining pits and is discussed later in this report.

2.3.2. Sediment Data

Bed sediment information for the Current Model was obtained from thirteen sediment samples collected by Kimley-Horn and Associates, Inc. for the Agua Fria River Watercourse Master Plan in October and November 2000. Sediment gradation curves corresponding to these samples are included in Appendix E, and Figure 2.18 shows the variation of D_{15}, D_{50} and D_{85} along the study reach. Most of the sediment samples were taken within the top 3 feet of depth, and some were 4 to 5 feet deep.

Comparing Figures 2.9 and 2.18 it appears that during the last 8 years the sediment bed has become coarser. This may be a result of sampling strategy but it appears that while D_{15} remains about the same it was in 1992, D_{50} has increased from around 1 mm in most of the samples collected in 1992 to around 3 mm in 2000. A similar trend can be observed in D_{85}. It is unlikely that the small flows registered during the intermediate period (Figure 2.15) are completely responsible for this change, and it is suspected that it is due in part to human activities in the channel.

The bed sediment reservoir depth was set at 15 feet for all cross sections, deposition limits were established at the floodplain boundaries (HI records) and erosion was restricted to the main channel (HE records).

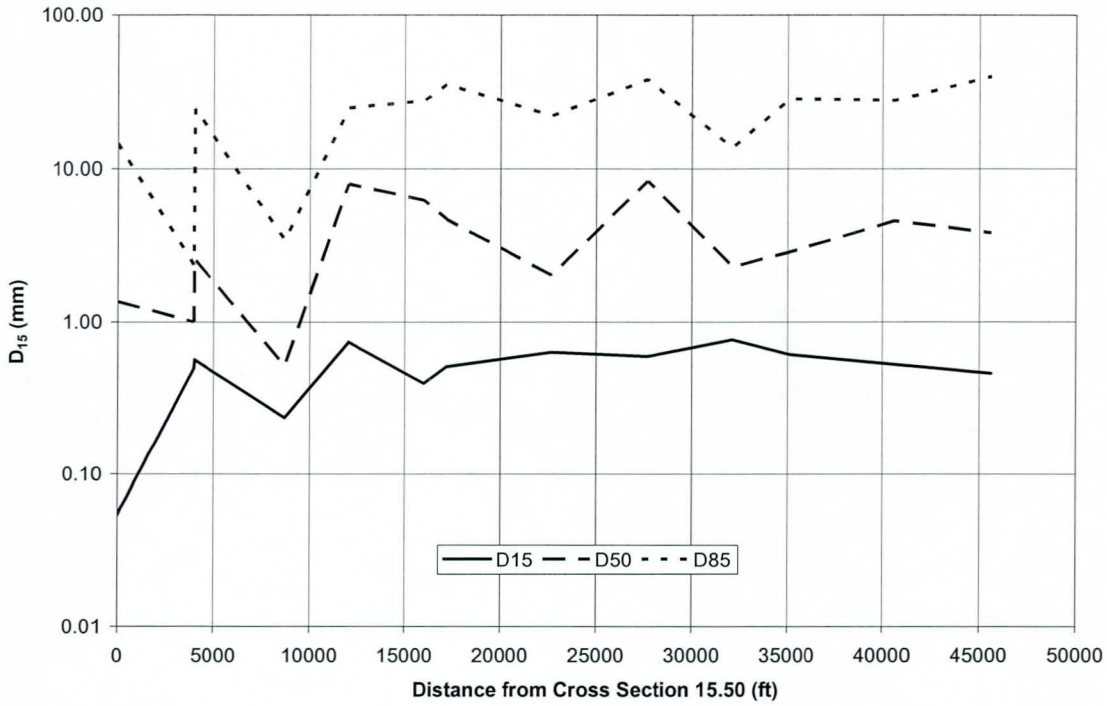

Figure 2.18 – Sediment D_{15}, D_{50} and D_{85} in the Agua Fria study reach for the Current Model (Kimley-Horn and Associates, 2000)

Equilibrium bed material loads were computed once again for the upstream two-mile segment of the study reach, in this case from section 22.15 to 24.14. HEC-6T was used with the recirculation option on to generate inflowing sediment rates for a range of discharges between 100 cfs and 60000 cfs. Results from the analysis were used to specify the upstream boundary condition of the sediment transport model. Figures 2.19 through 2.23 show sediment load versus discharge for all five sediment transport equations.

Although the five sediment transport relations used in the Initial and Intermediate Models were used to determine the upstream boundary condition for the Current Model, at the end only one equation will be selected for the Current Model. The selection will be based on the results of the analysis of the Initial and Intermediate Models.

Equilibrium sediment loads for the Current Model show a decreasing tendency when compared to the equilibrium loads for the Initial and Intermediate Models, reflecting the coarsening of the river bed.

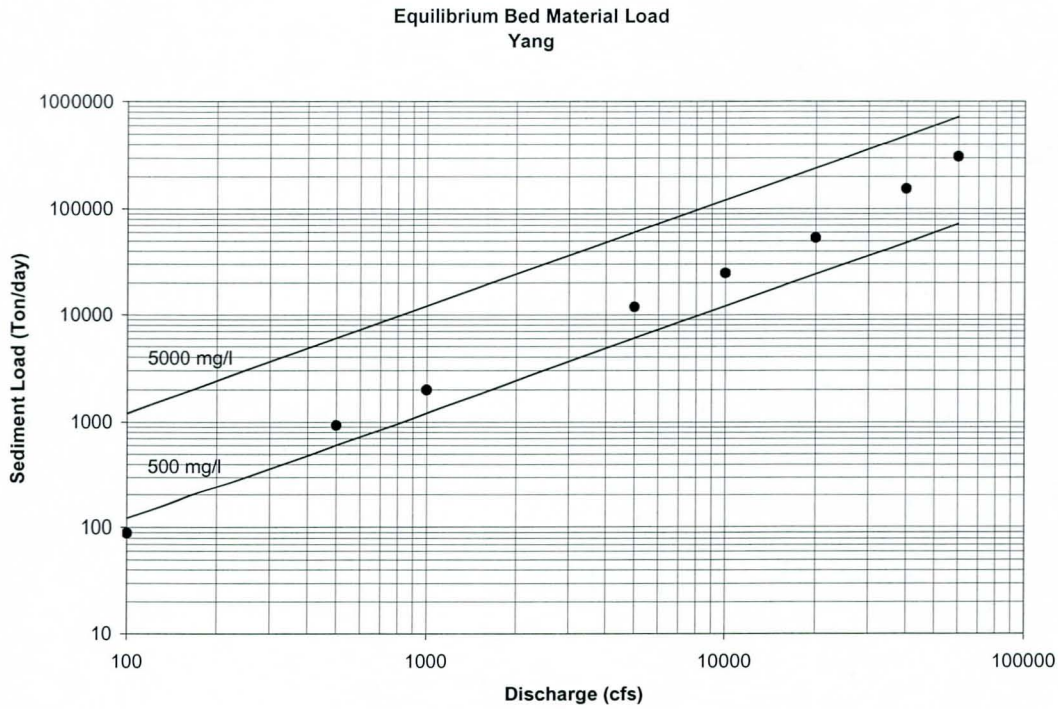

Figure 2.19 – Equilibrium bed material load using Yang relation for Current Model.

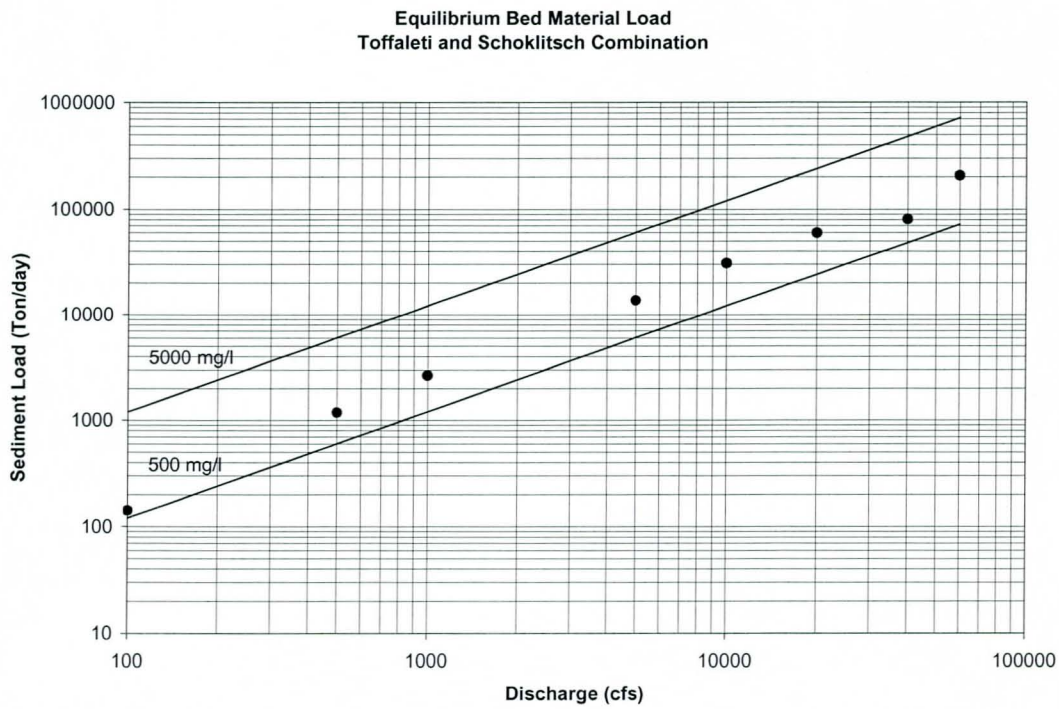

Figure 2.20 – Equilibrium bed material load using Toffaleti and Schoklitsch relation for Current Model.

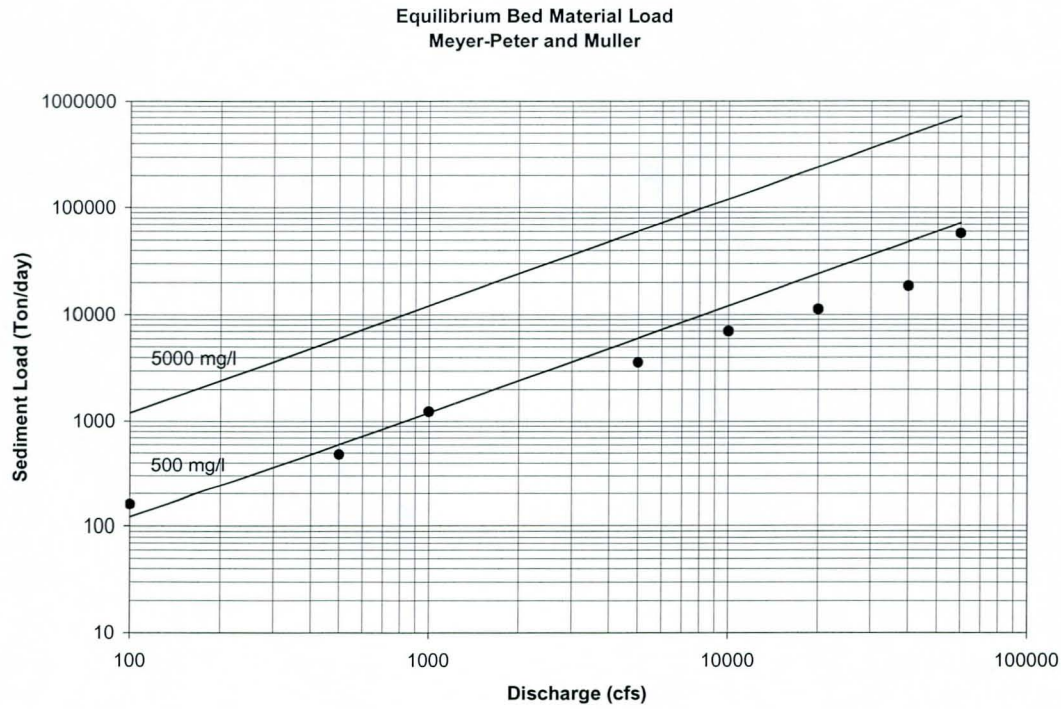

Figure 2.21 – Equilibrium bed material load using Meyer-Peter and Muller relation for Current Model.

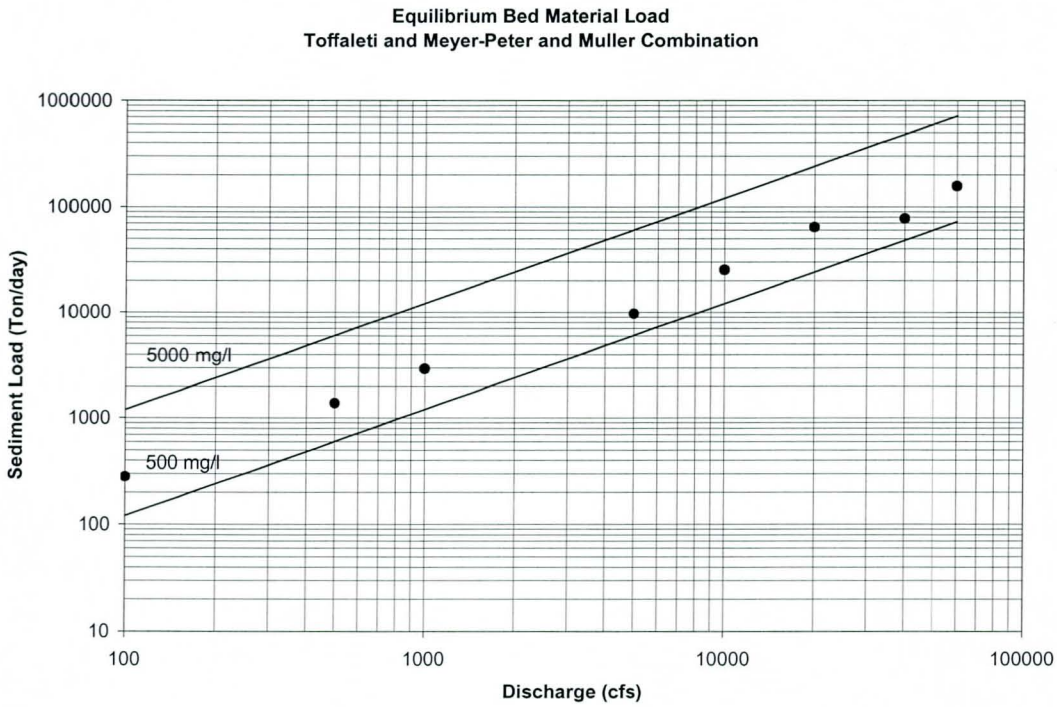

Figure 2.22 – Equilibrium bed material load using Toffaleti and Meyer-Peter and Muller relation for Current Model.

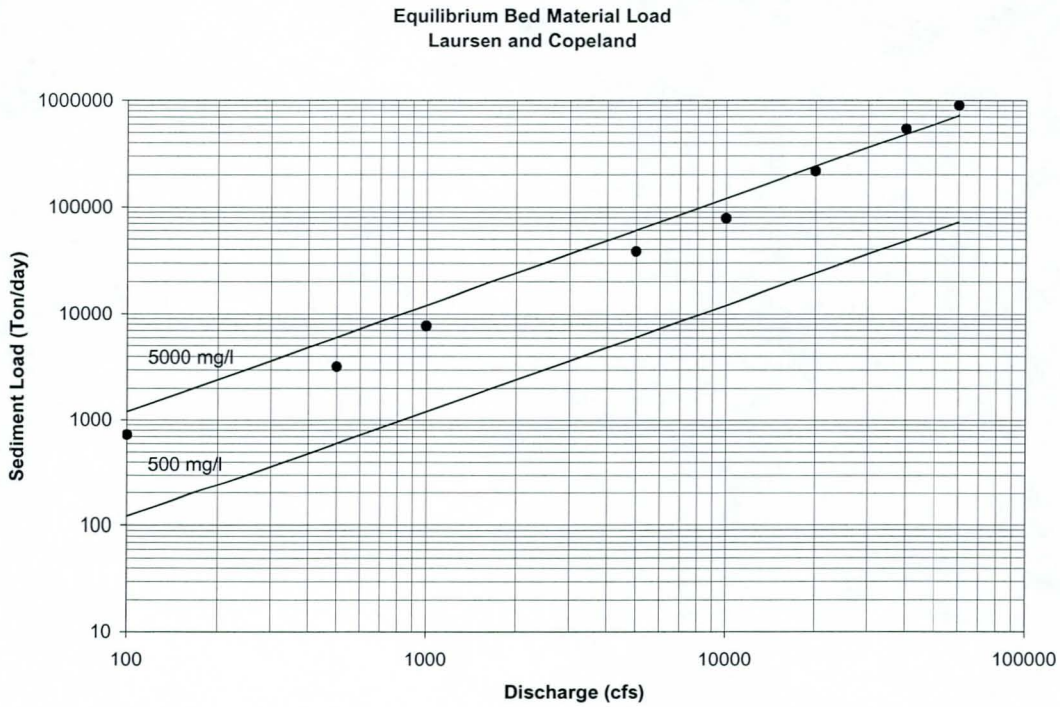

Figure 2.23 – Equilibrium bed material load using Laursen and Copeland relation for Current Model.

2.3.3. Hydrologic Data

The objective of the Current Model is to serve as a predictive tool to estimate future trends of the Agua Fria River as a result of different management alternatives. For that reason, the driving flows applied to the current geometry must be able to represent the long-term behavior of the system.

Due to the lack of events of large or moderate magnitude in the period 1983-2000, it is hypothesized that a single event with a probability of occurrence of 0.1 or less (return period of 10-years or more), or a combination of two such events, can be representative of the long-term (years to decades) sediment transport under the current flow regime.

In addition to the single- and double-event hydrologic inputs, the model was also tested with the historical 1965-2000 input. Since the recorded flows before 1992 are not representative of the current flow regime, the flow series is considered to be a test more strict than the frequency flows, and probably represents a longer-term system behavior (decades to centuries).

The Corps of Engineers hydrologic evaluation of the Agua Fria River (USACE, 1995) provides the 100-year hydrograph at Bell Road under the current flow regime (with

New Waddell Dam). This hydrograph has been discretized in 1-hour intervals and was used to test the current sediment transport model (Figure 2.23).

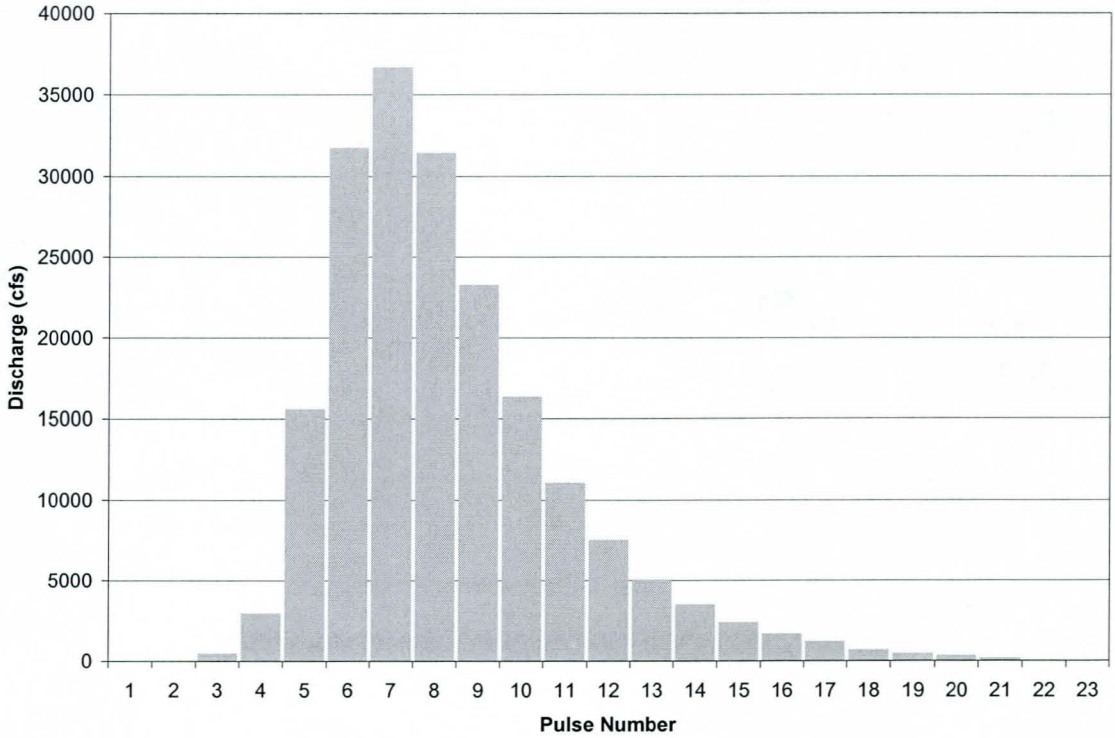

Figure 2.24 – 100-year flood at Bell Road discretized in 1-hour intervals.

The report also presents the peak discharge for return periods from 2 to 500 years (Table 2.7). Assuming the watershed behaves as a linear system, the 100 year hydrograph has been scaled up and down using the ratio of peak discharges to generate hydrographs for 10, 25, 50, 200 and 500 year return periods.

Table 2.7 – Frequency–discharge relationship on the Agua Fria River at Bell Road.

Return Period (years)	Peak Discharge (cfs)
10	11000
25	20500
50	29000
100	37500
200	46500
500	59000

The interval containing the peak discharge has been subdivided into two narrower sub-intervals, one 0.75 hours long and the other 0.25 hour long, in order to get a better definition of the hydrograph peak. The time step for computations has been set at 0.001

hours. In addition, a "warm-up" flow of 1000 cfs (not shown in Figure 2.23) will be run for 24 hours before running the hydrograph through the study reach.

The 2000 mapping does not cover the river downstream of Cactus Road. Therefore, the downstream boundary condition for the Current Model was computed using HEC-RAS and considering normal flow conditions at the downstream end. Normal depth was computed for a range of discharges, from 2000 cfs to 40000 cfs, in 2000 cfs increments. The following rating curve was derived using this procedure (Figure 2.25).

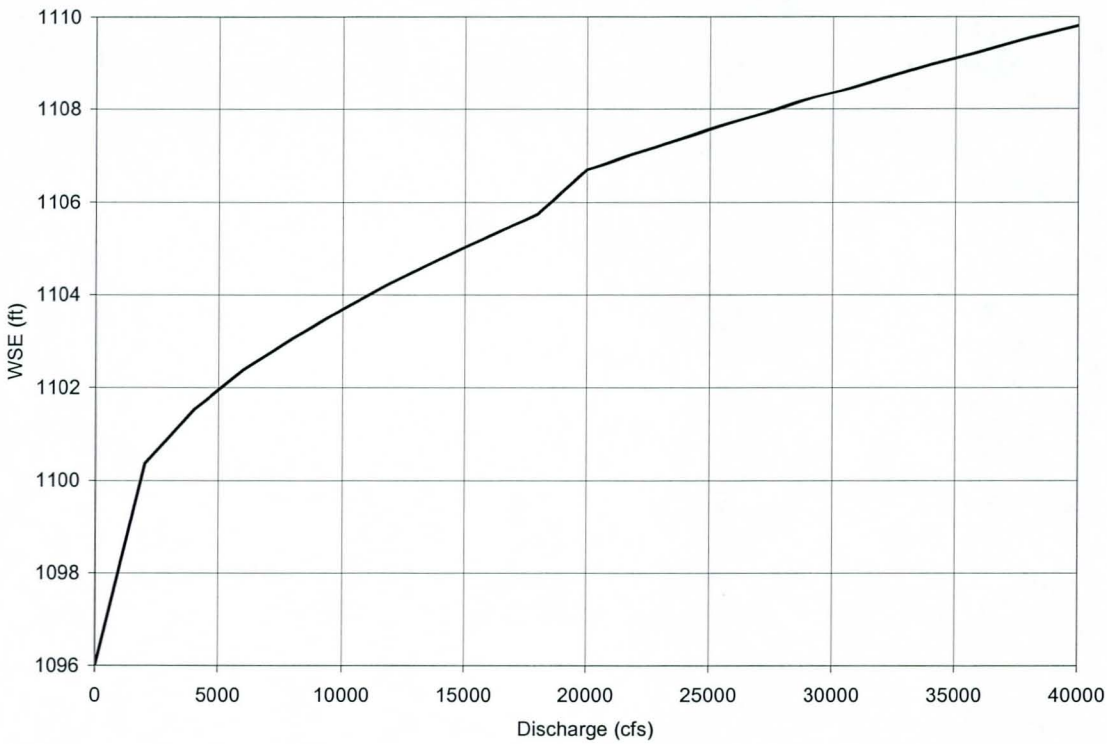

Figure 2.25 – Stage-discharge relationship at cross section 15.50 for the Current Model.

2.4. Mining Operations in the Study Reach

The Agua Fria River has a long history of sand and gravel mining both in the floodplains and in the main channel, as can be seen in the historical series of aerial photographs obtained from J. E. Fuller and Associates and presented in Appendix F. This series of photographs has been a valuable tool in identifying the location of mines in relation to the river channel, the duration of operation at each site, and the approximate size of the pits. Figure 2.26 identifies the location of the mining sites and Table 2.8 indicates the cross sections affected in both the Initial Model and the Intermediate Model.

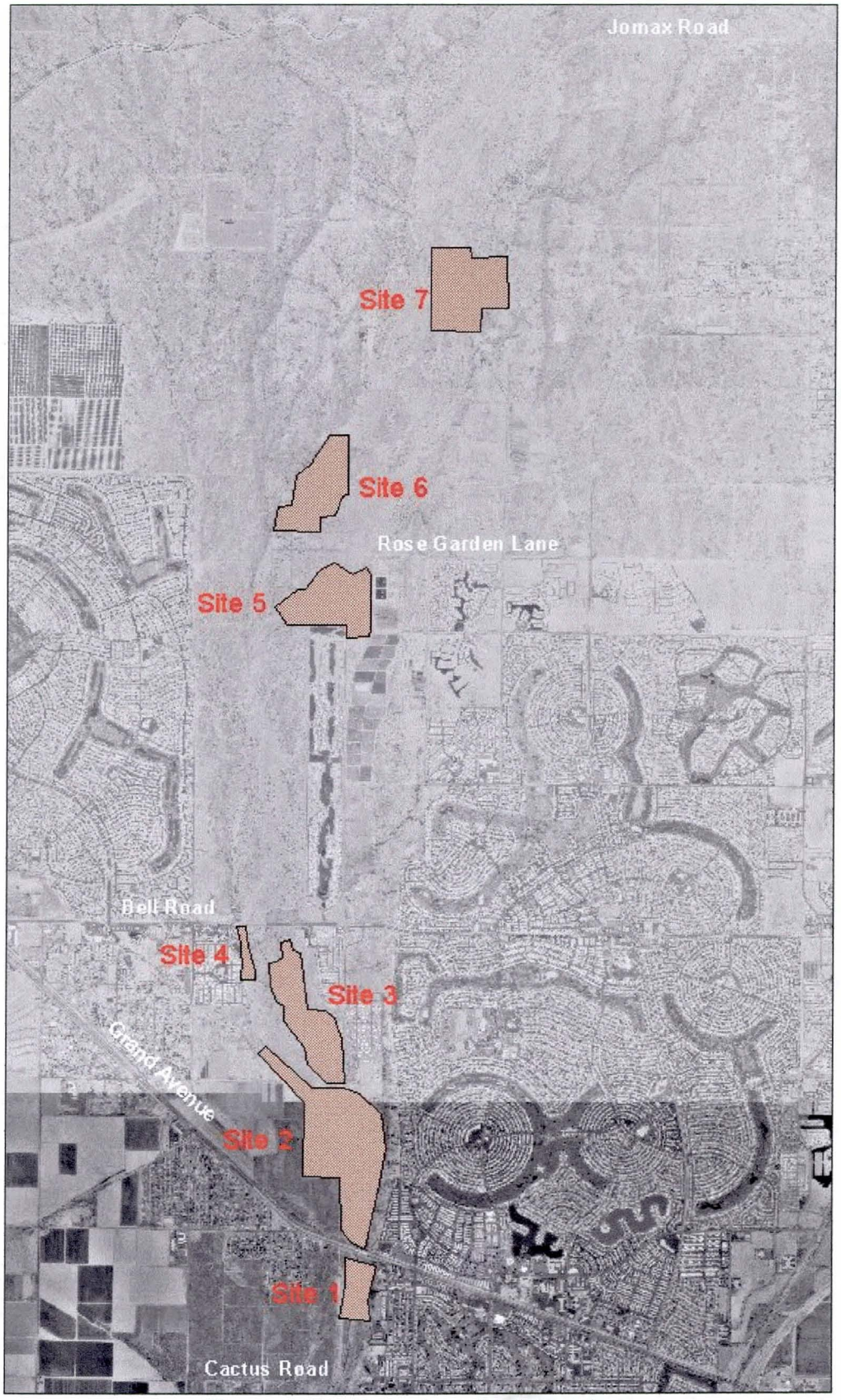

Figure 2.26 – Location of mining sites.

Table 2.8 – Historical sand and gravel mining sites in the study reach.

Site	Location	Operation		Cross Sections Affected	
		Beginning	End	Initial Model	Intermediate Model
1	D/S Grand Avenue	< 1954	1967-77	16.56, 16.71, 16.80, 16.9	
2	U/S Grand Avenue (ROB)	1954-64	I/O†	17.6, 17.9, 18.02, 18.14, 18.20	17.078, 17.174, 17.273, 17.398, 17.509, 17.607
3	U/S Grand Avenue (LOB)	1977-79	I/O	18.36, 18.48, 18.61	17.71, 17.81, 17.909, 18.009, 18.109
4	D/S Bell Road	1967-77	1977-79	19.23, 19.48	
5	D/S Rose Garden Lane	1977-79	I/O	20.86, 21.09	21.1, 21.241, 21.469
6	U/S Rose Garden Lane	1985-92	I/O		Channel not affected
7	D/S Hatfield Road	1985-92	I/O		Channel not affected

† I/O: Mine still in operation.

Site number 1: Located just downstream of the Grand Avenue bridge. Disturbance in the channel is clearly seen in the 1954 photograph, but there is evidence of pits in the channel even in the 1949 photograph. Continuation of sand and gravel mining is apparent until at least 1967. Between 1977 and 1979 excavation terminated and began the construction of a landfill on the right overbank that eventually extended from Grand Avenue to the Cactus Road alignment.

Site number 2: Located just upstream of Grand Avenue. Widespread disturbance in the channel is clearly noticeable in the 1964 photograph, but could have started as soon as 1954. Mining operations expanded in the channel area until 1977, when the degree of channel alteration reached a maximum. At this time even a baseball field appeared on the river channel (see photograph Reach 1: 1977). Between 1977 and 1979 some of the pits and the ball field were 'erased' by floods and mining began on the right overbank area. Again in 1980, floods wiped out more pits from the channel. Since then, mining continued mainly on the right overbank.

Site number 3: Located one mile upstream of Grand Avenue. There is no sign of activity at this site until 1979, when the first pits appear near the channel. In 1980 these pits were also wiped out by the flood waters. Since then, mining proceeded mainly on the left overbank area and extended north following the channel to Bell Road.

Site number 4: Located just downstream of the Bell Road bridge. It is not clear whether this site was a mining operation or whether it was disturbed only during construction of the Bell Road bridge. Signs of disturbance are visible in the 1977 photograph, and disappeared with the floods.

Site number 5: South of Rose Garden Lane and north of Coyote Lakes Golf Course. The first clear signs of mining appeared in 1979. By 1980 the pits looked partially filled with sediment as a consequence of the floods, and mining was temporarily stopped or continued at slow rates. The 1985 photographs show no appreciable mining, but by 1992 the pits occupied the whole channel width and part of the left overbank area. Excavation is still active in these areas.

Site number 6: Located north of Rose Garden Lane. The 1985 photograph shows no activity at this site. However, the 1992 photograph shows that a large area on the right overbank and a small part of the channel had been excavated. Currently, excavation is taking place in the same areas.

Site number 7: Located just south of Hatfield Road. The site operation appears for the first time on the 1992 photograph and affects an area on the left overbank as well as a fraction of the channel. The site is surrounded by a berm which is expected to protect the site from small to moderate floods. Currently, excavation is active in the same areas.

Based on the visit to the study reach and the 2000 topography, it appears that most of the mining activities are currently taking place on the floodplains or are protected against flood waters by a berm. There is only one mining site that will be affected during all flood events: site number 5.

2.4.1. Method of Analysis

Steady state models like HEC-6T can not be used to reproduce successfully the processes occurring in the vicinity of sand and gravel pits as a consequence of a flood event. A steady model would consider that the pit is completely filled with water from the very beginning of the simulation, thus minimizing the effects upstream of the pit. Therefore, for estimating the effects at specific sites of a flood hydrograph, it is necessary to use special calculation methods.

Our objective was to perform a long-term simulation and to consider the consequences of the removal of sediment that historically has been taking place in the study reach. HEC-6T has a dredging command ($DREDG) that allows the user to specify different dredging sites (mining pits), each one with a particular geometry, rate of removal and time of operation. The mining sites were identified in the HI records. This method was used to simulate sediment removal from the stream bed at the sites selected based on the study of the historical series of photographs, both for the Initial Model and the Intermediate Model.

3. HEC-6T RESULTS

3.1. Performance Analysis of the Initial Model

3.1.1. Modeling Approach

Simulations were conducted using HEC-6T and 45 different input files. Table 3.1 shows how the sediment transport relations where combined with the three conditions set at the upstream boundary (50%, 100% and 150% sediment inflow) and the three mining scenarios.

Table 3.1 – Modeling approach for Initial Model (complete set of combinations shown only for Yang's equation).

Sediment Transport Relation	Boundary Condition	Mining Scenario
Yang	50% Sediment Inflow	No Mining
		Low Intensity
		High Intensity
	100% Sediment Inflow	No Mining
		Low Intensity
		High Intensity
	150% Sediment Inflow	No Mining
		Low Intensity
		High Intensity
Toffaleti-Schoklitsch	same 9 combinations	
Meyer-Peter and Muller	same 9 combinations	
Toffaleti-MPM	same 9 combinations	
Laursen-Copeland	same 9 combinations	

The mining scenarios were arbitrarily selected based on the study of aerial photographs, and were intended only to examine the applicability of the dredging option in HEC-6T for simulating long term sediment removal from the stream bed. Dredging templates were applied to the selected cross sections at each site during specified periods of time. At each cross section, a constant dredging depth was prescribed between the channel bank stations using the HI command. The HI command allows the user to identify each cross section as pertaining to a different site.

When dredging is initiated using the $DREDG record, a series of DC records are used to prescribe different dredging rates at each site. In this model, dredging rates were set either to 1.0E+15 or 0.1E-15 (cubic yards per day). The former rate is equivalent to instantaneous dredging, and means that the dredging template is applied to the selected cross sections at the beginning of each flow event, while the later rate is equivalent to zero and is used whenever mining is not active at a site. New $DREDG and DC

command lines are needed when a new flow event is specified. Table 3.2 shows the dredging characteristics at each site. See Figure 2.26, Table 2.8 and the paragraphs that follow for the location and description of each site.

Table 3.2 – Simulation of long term bed sediment removal in Initial Model.

Site	Time of Application	Dredging Depth (ft)	
		Low Mining Intensity	High Mining Intensity
1	1965-72	3	5
2	1965-80	5	10
3	1978-80	5	10
4	1972-78	3	5
5	1972-83	3	5

3.1.2. Analysis of Results

Tables showing the predicted average bed elevation and thalweg elevation for each cross section are included in Appendix G. The tables also show the original (1965 topography) and the final (1983 topography) average bed and thalweg elevation for comparison.

As stated before, the only cross sections that are accurately located in the 1965 model are those representing the bridges: Grand Avenue, AT & SF Railroad and Bell Road. The locations of all other cross sections, including the model end sections, have been approximately identified based on the examination of the model geometry and the distances set in the original HEC-2 file. Consequently, the analysis of the simulated profiles has focused on the segment between the Grand Avenue Bridge and the Bell Road Bridge, since this is the only segment where 1965 cross sections can be compared with some degree of confidence to the 1983 geometry. Significant differences in channel length existed between the two models as originally supplied.

The segment between the bridges, about 3 miles henceforth referred to as the *analysis reach*, contains a total of 20 cross sections (from cross section 17.07 to 19.59). The "observed" profiles were obtained forcing the distance between the bridge cross sections in the 1983 geometry to be equal to the distance in the 1965 model. The observed profile elevations (average bed and thalweg) were interpolated from the 1983 profile at the location of the 1965 cross sections.

It is difficult to analyze the results based on the inspection of the profiles plots. In order to help identify the best combinations of sediment transport equation, sediment inflow and mining level, an index was computed from the simulated and observed profiles in the analysis reach. The index is known as the *Root Mean Square Error* (RMSE) and was calculated as:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(P_i - O_i)^2}{N}}$$

where i is a cross section index, P_i is the predicted elevation at cross section i, O_i is the 1983 observed elevation at cross section i and N is the number of cross sections in the analysis reach. This index gives a measure of the mean estimate error, and is independent of the error sign. The smaller the RMSE the more closely the simulated profile is reproducing the observations.

The index was computed for all predicted profiles (average bed elevation profiles and thalweg profiles) and is shown in the tables in Appendix G. Profiles were then ranked according to the values of the index. Table 3.3 shows the ten best profiles based on the average bed elevation RMSE, and Table 3.4 shows the ten best profiles based on the thalweg elevation RMSE.

Table 3.3 – Initial Model: best profiles based on average bed elevation RMSE.

Rank	RMSE (ft)	Sediment Transport Relation	U/S Boundary Sediment Inflow	Mining Scenario
1	2.28	Yang	150%	Low
2	2.40	Toffaleti and Schoklitsch	150%	No
3	2.47	Yang	100%	Low
4	2.56	Toffaleti and Schoklitsch	100%	No
5	2.63	Toffaleti and Schoklitsch	50%	No
6	2.74	Laursen and Copeland	100%	High
7	2.92	Laursen and Copeland	150%	High
8	2.95	Meyer-Peter and Muller	100%	No
9	3.01	Yang	50%	Low
10	3.11	Meyer-Peter and Muller	50%	No

Table 3.4 – Initial Model: best profiles based on thalweg elevation RMSE.

Rank	RMSE (ft)	Sediment Transport Relation	U/S Boundary Sediment Inflow	Mining Scenario
1	2.98	Toffaleti and Schoklitsch	150%	No
2	3.04	Yang	100%	Low
3	3.20	Yang	50%	Low
4	3.23	Toffaleti and Schoklitsch	50%	No
5	3.28	Toffaleti and Schoklitsch	100%	No
6	3.31	Yang	150%	Low
7	3.32	Yang	100%	High
8	3.39	Yang	150%	High
9	3.48	Yang	150%	No
10	3.59	Toffaleti and MPM	50%	No

These results show the strengths and weaknesses of the different sediment transport relations. RMSE values for the average bed elevation are smaller than RMSE values for thalweg, indicating that the estimation of the average bed elevation is more accurate.

Yang's equation is well ranked in both tables. This equation is able to reproduce both the 1983 average bed and thalweg profiles with a small RMSE, but it requires the activation of the dredging option. The best performances of Yang's equation occur in association with a low intensity mining scenario, which is consistent with the observations from the historical aerial photographs.

The Toffaleti and Schoklitsch combination is well ranked in both tables too. This sediment transport relation is able to reproduce the 1983 average bed elevation and thalweg profiles with small RMSE values, without the need of artificially removing sediment using the dredging option. The ASU report (Carriaga, Mays & Ruff, 1994) recommended the Toffaleti and Schoklitsch combination as the best option for modeling sediment transport in the Agua Fria River.

The Meyer-Peter and Muller equation is ranked among the best ten based on the average bed elevation RMSE, but not for the thalweg RMSE. The best models based on this sediment equation correspond to the no mining scenario. The Meyer-Peter and Muller equation was recommended as an alternative to the Toffaleti and Schoklitsch combination in the ASU report.

The Laursen and Copeland relation reproduces the 1983 average bed elevation with a small overall error (small RMSE) when mining is simulated with the dredging option (high mining scenario). However it is not well ranked for the thalweg profiles. The Toffaleti and MPM combination appears only once in the thalweg RMSE table (10th place) with a model under a no mining scenario.

The model results are not especially sensitive to the level of sediment inflow at the upstream boundary. Figure 3.1 and Figure 3.2 show that profile changes due to variations in sediment inflow are small. The most upstream cross section is the most sensitive to differences in sediment inflow, but its effect quickly dissipates in the downstream direction. Also, the simulation of sediment removal using the $DREDG routine helped reduce the differences associated to sediment inflow. In general larger sediment volumes were removed from the pits with larger sediment inflow rates at the upstream boundary.

The objective of the Initial Model is to help in the selection of a sediment transport relationship for the Current Model. The Current Model will need to be able to model bed changes associated with current or future mining operations in the river channel. Therefore, if there indeed was mining in the channel during the initial model period, then any transport relationship that appears in Tables 3.3 and 3.4 under the "No Mining" scenario should be eliminated from any consideration for use in the Current Model. This argument leaves only two candidates for further investigation: Yang's equation, and Copeland's modification of Laursen's equation.

3.1.3. Summary

The analysis performed suggests that Yang's formula is the best relationship to model sediment transport in the Agua Fria River from 1965 to 1982. This result is in agreement with the findings by Kimley-Horn and Associates in their sediment trend analysis for the Agua Fria River Watercourse Master Plan. Copeland's modification of Laursen's equation is the second best relationship.

The model is relatively insensitive to the inflowing concentration at the upstream boundary. Therefore, an inflowing load equal to the equilibrium sediment load at the upstream boundary should be adequate for modeling purposes. Figures 3.1 and 3.2 show the simulated average bed elevation profiles computed with these two sediment transport relations.

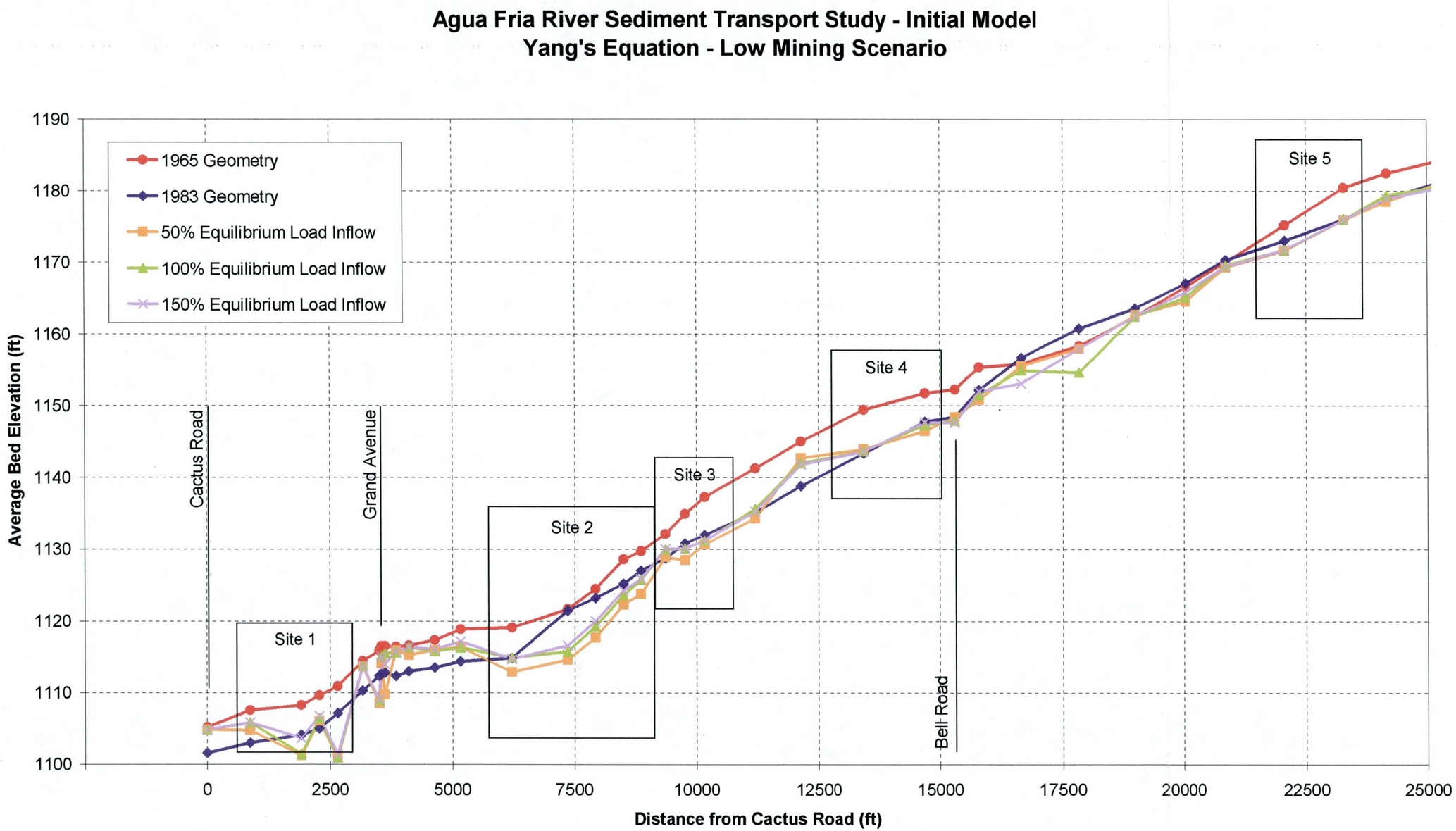

Figure 3.1 – Initial Model: Simulated profiles using Yang's sediment transport equation.

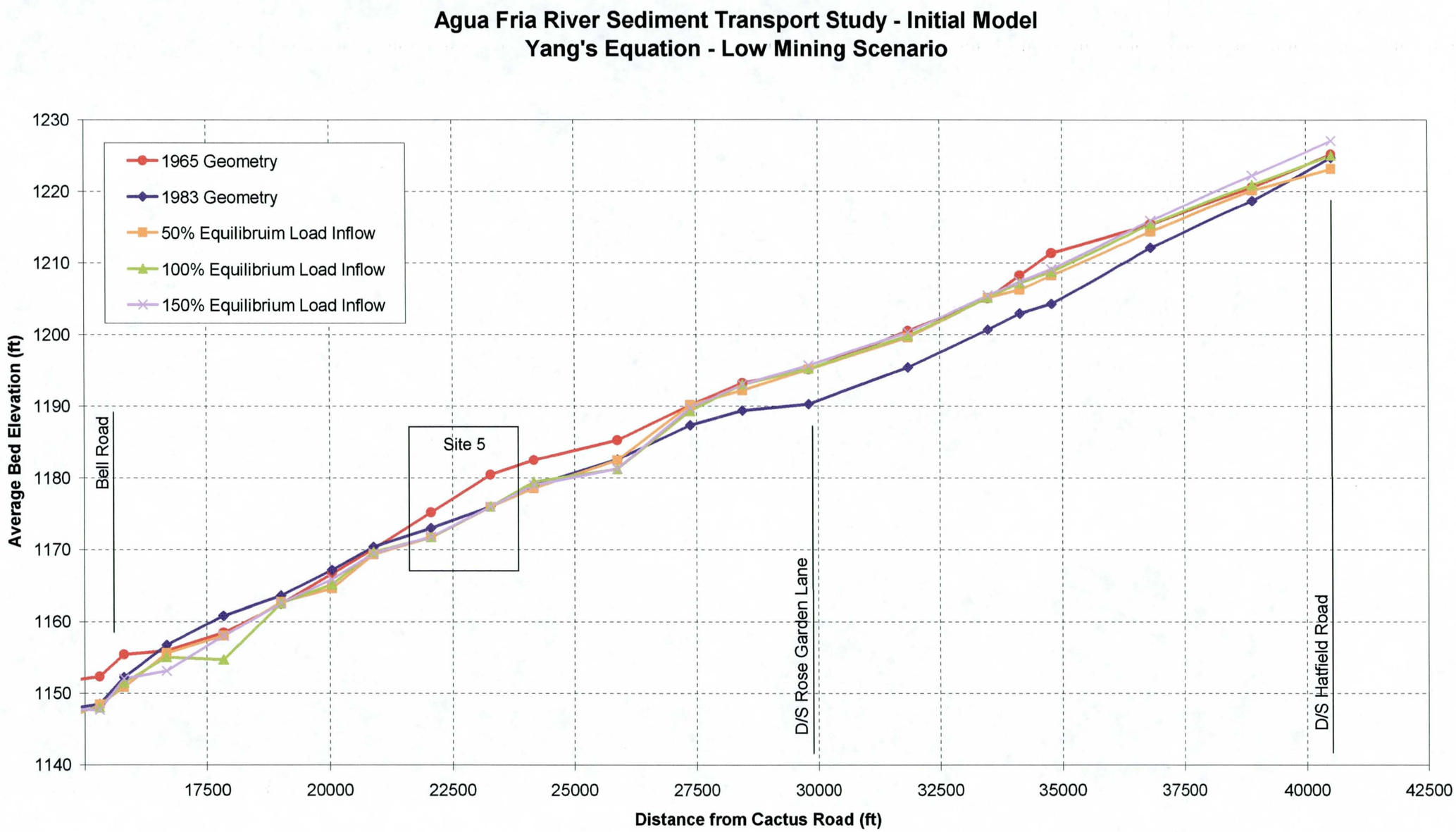

Figure 3.1 – Continued.

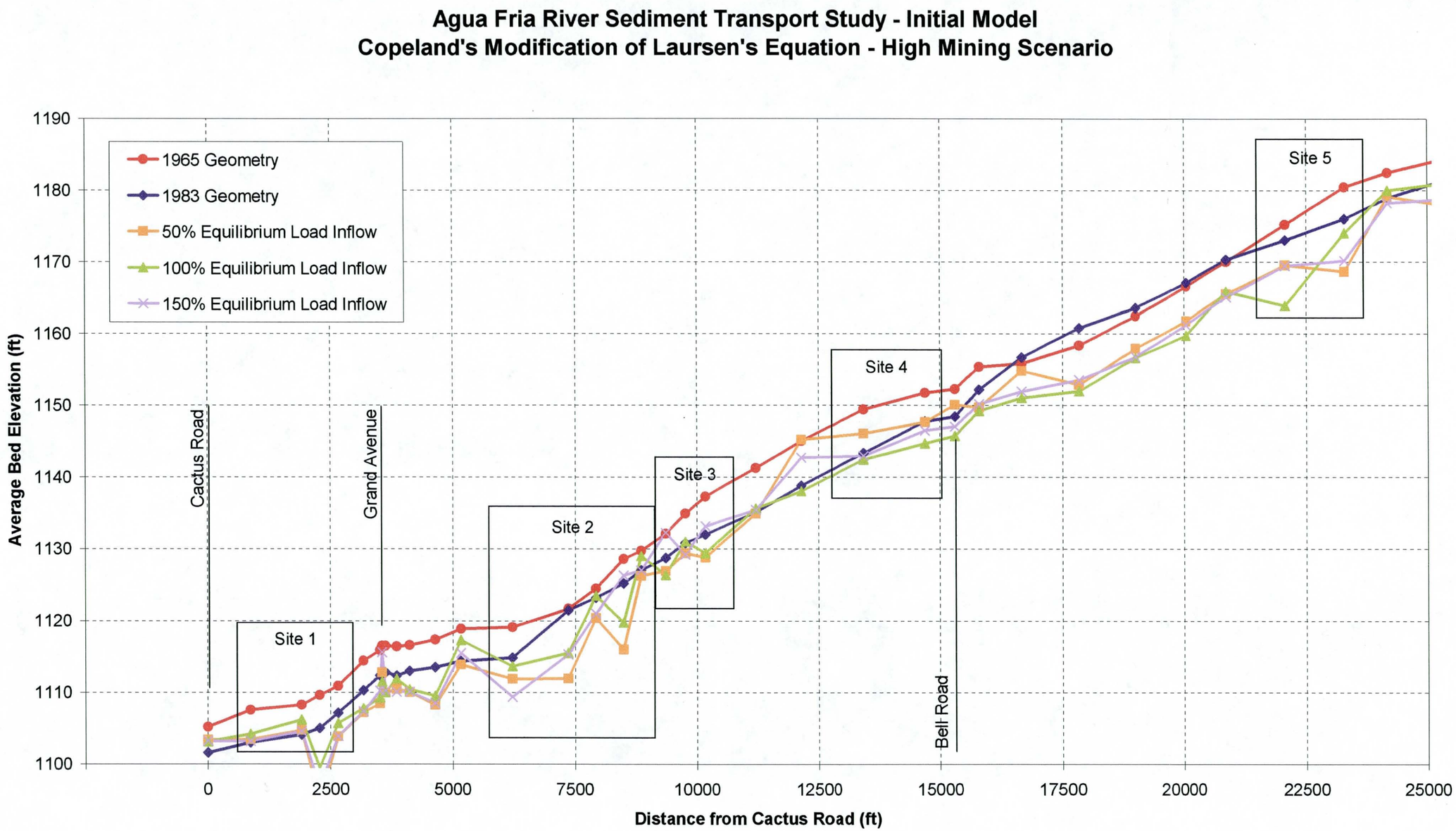

Figure 3.2 – Initial Model: Simulated profiles using Laursen and Copeland relation.

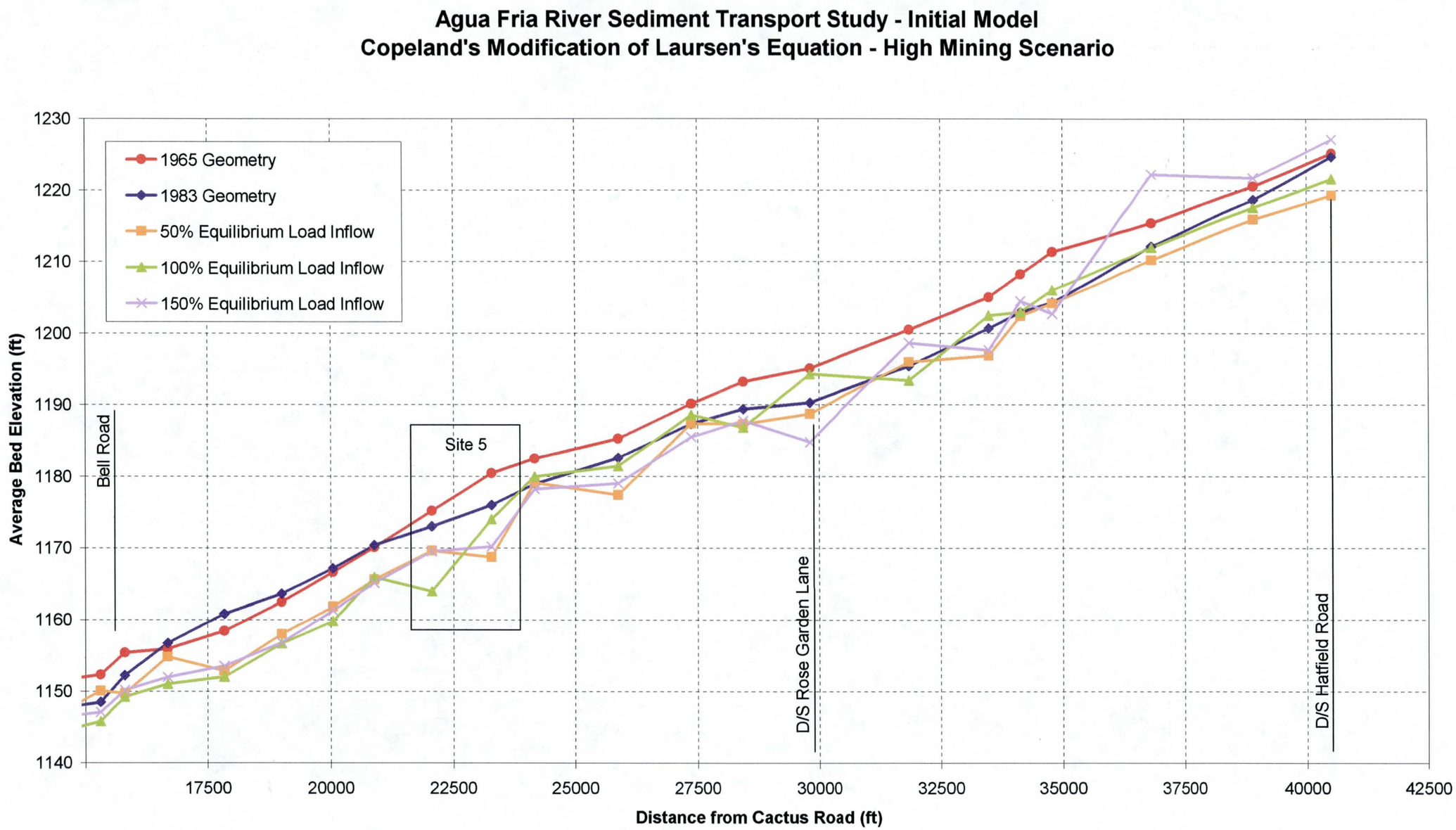

Figure 3.2 – Continued.

3.2. Performance Analysis of the Intermediate Model

3.2.1. Modeling Approach

The simulation results from the Initial Model suggested that two of the sediment transport relations (Yang's formula, and Laursen and Copeland relation) were apparently better for the Agua Fria River than the other three for that particular time period. Nevertheless, due to the change in flow regime in the second time period, all five transport functions were used again to perform the Intermediate Model simulations. The three different sediment inflow rates and three mining scenarios were also tested, yielding a total of 45 input files. Thus, the modeling approach was identical to the Initial Model (Table 3.1).

When simulating long term sediment removal from the stream bed, three mining sites were considered. The three sites were selected based on the historical aerial photographs and field observations (March 2001 tour of the project reach). The sites are identified as Site 2, Site 3 and Site 5 in Table 2.8 and Figure 2.26. Sediment extraction was simulated using the $DREDG and DC command lines in HEC-6T. Table 3.5 shows the characteristics of each simulated mining site.

Table 3.5 – Simulation of long term bed sediment removal in Intermediate Model

Site	Time of Application	Dredging Depth (ft)	
		Low Mining Intensity	High Mining Intensity
2	1983-2000	3	5
3	1983-2000	3	5
5	1983-2000	10	30

3.2.2. Analysis of Results

Appendix H contains tables showing the average bed elevation and thalweg elevation for all 45 simulations. In addition, the tables show the 1983 and the 2000 observed elevations. The 2000 topographic mapping covered the area from Cactus Road to Happy Valley Road. The observed average bed and thalweg elevations were interpolated from the 2000 profiles at the estimated location of the 1983 cross sections.

The performance index RMSE was again computed for the average bed elevation and thalweg profiles and is shown in the appendix tables (Appendix H). The RMSE index provides a measure of the global error. The simulated profiles were then ranked according to the values of the indexes. Table 3.6 shows the ten best profiles based on the average bed elevation RMSE, and Table 3.7 shows the ten best profiles based on the thalweg elevation RMSE.

Table 3.6 – Intermediate Model: best profiles based on average bed elevation RMSE.

Rank	RMSE (ft)	Sediment Transport Relation	U/S Boundary Sediment Inflow	Mining Scenario
1	3.969	Toffaleti and MPM	150%	High
2	3.975	Meyer-Peter and Muller	150%	High
3	3.976	Meyer-Peter and Muller	50%	High
4	3.976	Meyer-Peter and Muller	100%	High
5	3.981	Toffaleti and MPM	50%	High
6	3.985	Toffaleti and MPM	100%	High
7	4.042	Toffaleti and Schoklitsch	150%	High
8	4.061	Yang	150%	High
9	4.066	Yang	100%	High
10	4.071	Yang	50%	High

Table 3.7 – Intermediate Model: best profiles based on thalweg elevation RMSE.

Rank	RMSE (ft)	Sediment Transport Relation	U/S Boundary Sediment Inflow	Mining Scenario
1	4.10	Yang	100%	High
2	4.23	Yang	50%	High
3	4.24	Yang	150%	High
4	5.03	Meyer-Peter and Muller	150%	High
5	5.04	Meyer-Peter and Muller	50%	High
6	5.05	Meyer-Peter and Muller	100%	High
7	5.10	Toffaleti and MPM	50%	High
8	5.27	Toffaleti and Schoklitsch	50%	High
9	5.27	Toffaleti and MPM	100%	High
10	5.29	Toffaleti and Schoklitsch	100%	High

These results show that none of the sediment transport relations is capable of simulating the changes experienced by the river system using the recorded flows as the only driving force shaping the channel bed. Simulation results clearly improve when sediment is artificially removed from the system at selected locations. In fact, all the selected models are run under a "High Mining" scenario. As with the Initial Model, the sediment inflow rate does not appear to have a consistent effect on the simulation performance.

In terms of the average bed elevation, all five sediment transport relations yielded very similar RMSE coefficients provided the high mining scenario was selected. In fact, the top 15 candidates are within 10% of the first ranked one, and consist of all the models with a "High Mining" scenario. The mining templates were applied at the beginning of each new flow event (between two flow events with non-consecutive dates). Thus, the application of a template ensured that, at the beginning of each flow event, the geometry of the mined cross sections was the same independently of the sediment transport

relationship used. As a consequence, the differences associated to the sediment transport relationships can only be found in the reaches between mining sites, and these differences are small because the flows recorded in this time period were small (the largest flows are only 6140, 4169 and 4373 cfs, which are only about 50% of the 10-year flow).

The thalweg based RMSE values show slightly more sensitivity than the average bed elevation based coefficients. With the high mining scenario active, both coefficients rank Yang's equation as the best, followed by Meyer-Peter and Muller, the Toffaleti and MPM combination, and the Toffaleti and Schoklitsch combination (not necessarily in this order). The Laursen and Copeland equation seems to yield the worst thalweg profiles under the high mining scenario.

Under no mining conditions the simulated profiles do not change significantly from the 1983 profile, due in part to the small magnitude of the flow events occurring during this period. Figure 3.3 depicts the average bed elevation profiles simulated using Yang's equation with a 100% equilibrium load inflow.

3.2.3. Summary

The Intermediate Model results reveal that it is not possible to simulate the changes in the river system without explicitly accounting for the mining activities in the channel bed. However, because of the small flows registered in this period, the results of the Intermediate Model should carry little weight in the selection of the transport equation for the Current Model. The results also suggest that under the current flow regime, Yang's sediment transport equation is the best method to model sediment transport in the Agua Fria River.

The rate of sediment inflow at the upstream boundary of the river reach did not have a significant effect on the simulated profiles. The artificial removal of sediment from the system using the dredge commands prevented the upstream boundary condition from having major effects downstream.

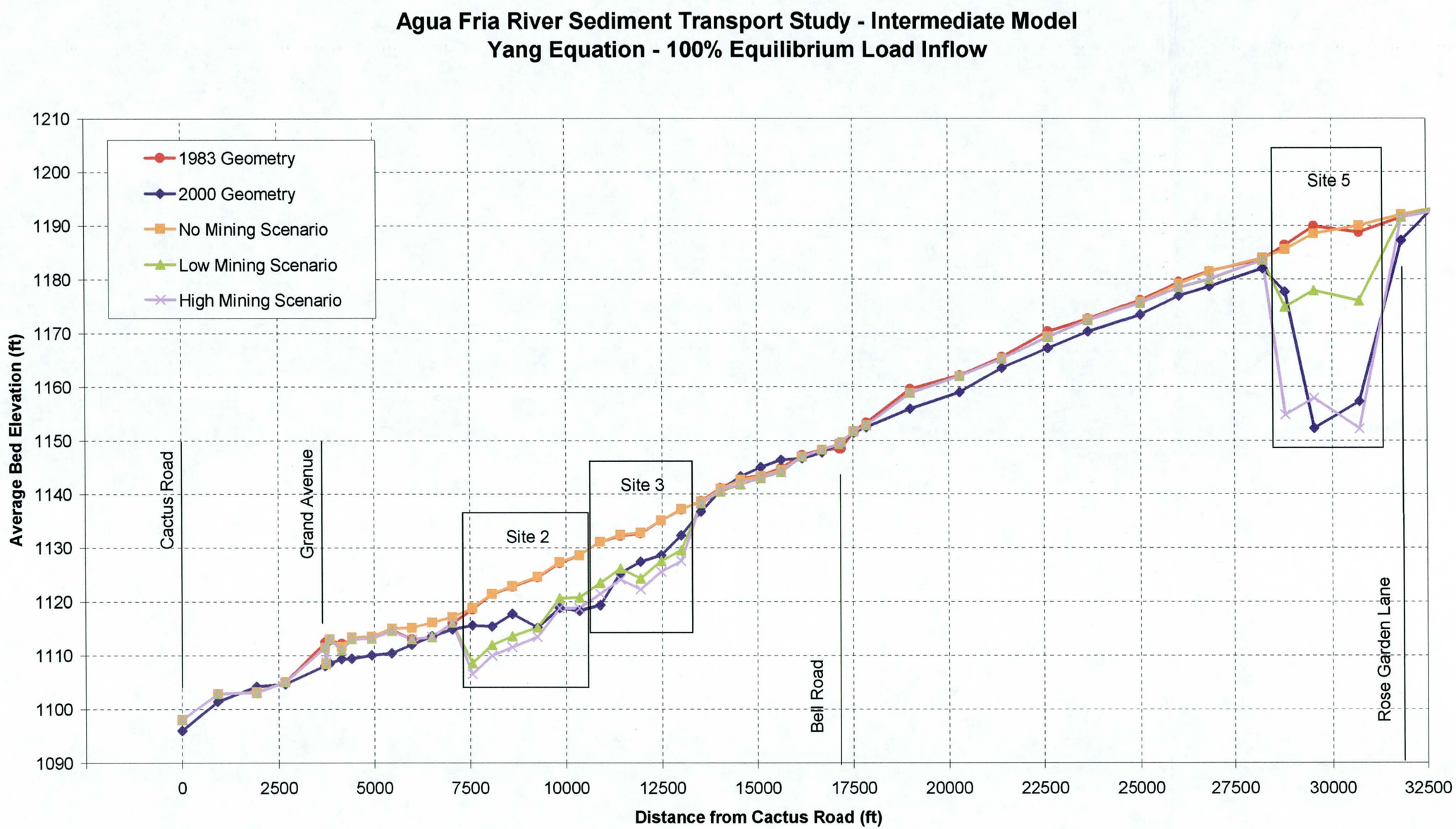

Figure 3.3 – Intermediate Model: Simulated profiles using Yang's equation.

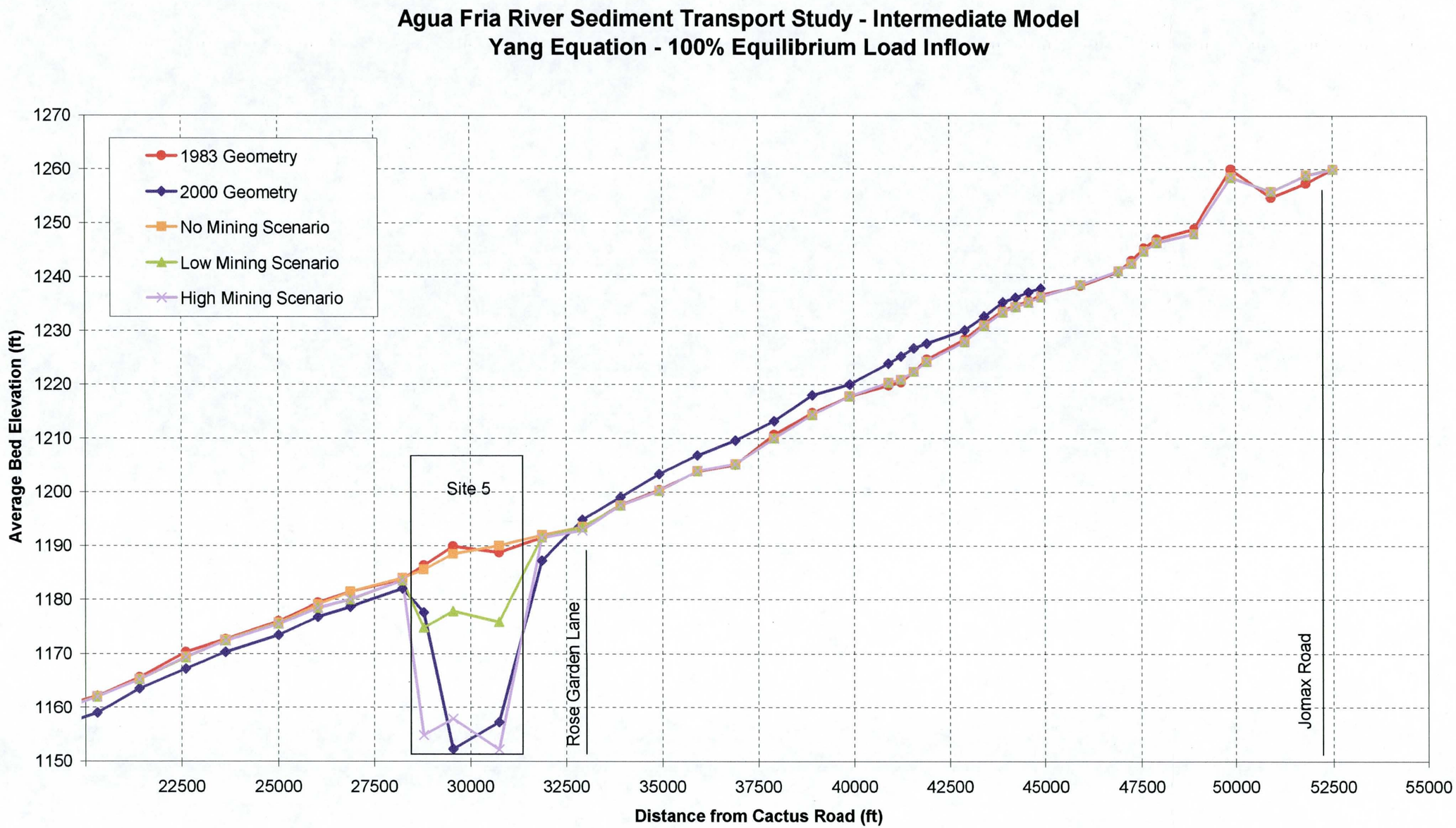

Figure 3.3 – Continued.

3.3. Performance Analysis of the Current Model

3.3.1. Modeling Approach

Based on the results of the Initial and Intermediate Models, Yang's transport equation was selected to simulate sediment transport on the Agua Fria River under the current flow regime. The effect of the upstream sediment inflow regime was analyzed again, even though previous models did not show much sensitivity to this factor.

Simulations were performed for different hydrologic inputs and combination of hydrographs, as shown in Table 3.8. Model results are discussed in detail in the following sections. In addition, using the 100-year hydrograph, three different sediment inflow rates were tested at the upstream model boundary: 50% equilibrium load, 100% equilibrium load and 150% equilibrium load.

Table 3.8 – Modeling approach for Current Model.

Hydrologic Input	Sediment Inflow (% Equilibrium Load)
10-year	100%
25-year	100%
50-year	100%
100-year	50%
100-year	100%
100-year	150%
200-year	100%
500-year	100%
10-year followed by 100-year	100%
25-year followed by 100-year	100%
50-year followed by 100-year	100%
Historical series 1965-2000	100%

3.3.2. Analysis of Results

Figure 3.6 shows the simulated average bed elevation profile using Yang's transport Equation, the 100-year flood hydrograph and a sediment inflow equal to 100% of the equilibrium bed load. The simulated profile appears stable with some scour and deposition that fills and smoothes some bed irregularities. The large mining operation downstream of Rose Garden Lane does not seem to affect the river bed upstream or downstream of the pit, and only minor deposition is observed within the pit, evidencing the limitations of the program. As mentioned before, HEC-6T is a steady state code and can not reproduce the local processes that would occur in a pit like this – especially the head cutting upstream from the pit.

Figure 3.7 shows in detail the magnitude of scour and deposition along the study reach for the three levels of sediment inflow considered. As for the Initial and Intermediate Models, the Current Model is relatively insensitive to the sediment inflow rate. The result of modifying the upstream boundary condition can be observed only on the uppermost cross sections, and its effect fades off quickly in the downstream direction as sediment is removed from the bed to achieve equilibrium in the flow. This indicates that a sufficient supply reach still exists at the upstream end of the reach modeled. This may not continue to be true if upstream sediment supplies are reduced due to future flow events.

Most of the cross sections experience some degree of degradation, suggesting that the reach is not exactly in equilibrium. In general the average bed elevation changes less than 0.5 feet, and reaches almost 1.5 feet in the most scoured areas. There are four segments of the reach that show a higher degree of degradation. The first one is located upstream of Grand Avenue, between cross sections 16.3 and 16.96. This is an area that has been mined in the past and that has experienced significant change with respect to natural conditions. The other three segments are located in the vicinity of mining operations, in areas where the main channel has been constricted by berms that protect the mining pits.

Aggradation occurs at some locations. One of the most significant deposition sites is cross section 21.31, which is located within the mine pit downstream of Rose Garden Lane. Another area with significant deposition corresponds to cross sections 17.24 and 17.33. This area is located between Grand Avenue and Bell Road and has been mined in the past.

The effect of the flood magnitude on the sediment transport results has been examined. Figures 3.8 and 3.9 show the average bed elevation change for the 10-year, 25-year, 50-year, 100-year, 200-year and 500-year floods. The same trends of scour/deposition can be observed for all floods, with the magnitude of the average bed elevation change proportional to the magnitude of the flood. Despite the increased flow rates, many of the cross sections remain stable and high levels of degradation are limited to the same segments described before.

Figure 3.10 displays the simulation results for the 100-year flood following one smaller event. The trends in these simulations continue to be the same, but with the characteristic that in some cross sections the degree of scour/deposition is even higher than that for the 500-year event.

Figure 3.11 shows the simulation results for the historical series of flows (1965-2000). The historical series has a length of 161 flow-days and contains a combination of large, moderate and small mean daily flows. Such a hydrologic input is not considered representative of the Agua Fria River flow regime after the completion of New Waddell Dam, but can be used to simulate the system behavior if it was allowed to evolve from its current condition, without any human intervention, and for a long period of time. Simulation results show that in the long run most of the cross sections would experience some degree of degradation. The area where degradation is expected to be most severe is

the reach downstream of the mining site that is located within the channel. According to the simulation results, the pit would act as a sediment sink and would experience large deposition rates. Consequently, the water leaving the pit would be clear water that could severely scour up to two miles of channel bed in the long term.

3.3.3. Summary

The Current Model has proven to be relatively insensitive to the upstream sediment inflow rate when tested with the 100-year flood. In the longer term however, it is expected that a reduction in sediment inflow loads would increase degradation in the study reach. Following the same reasoning, an increase of sediment inflow in the system would probably increase deposition along the Agua Fria River reach.

Simulation results with the frequency floods suggest that the study reach is not in equilibrium, but no major instabilities could be found. More degradation segments than aggradation segments are seen in the results, and the scour depths are in general larger than the deposition depths. This aspect is also reflected in the trapping efficiency variable that can be found in the output files. For the 100-year flood and 100% equilibrium inflow load the volume of sediment inflow to the system is 10.76 Ac-ft, while the volume leaving is 19.87 Ac-ft. The trapping efficiency of the system is therefore -85% (negative).

Aggradation and degradation are associated to locations of current or old mining operations. In old mining sites the river bed has to be reshaped until a new equilibrium is reached. Active mining operations occupying part of the channel constrict the flow, thus reducing the effective cross section of the channel and causing a velocity increase and the consequent augment in bed scour. Scour and deposition depth increase with flow magnitude. However, a series of small flow event (10 to 50-year) followed by a 100-year event can have a larger effect than the 500-year flood at some locations.

Simulation results with the historical series show generalized degradation in the longer term, more severe downstream of the mining pit located within the channel. The pit would act as a sediment trap, experiencing significant deposition.

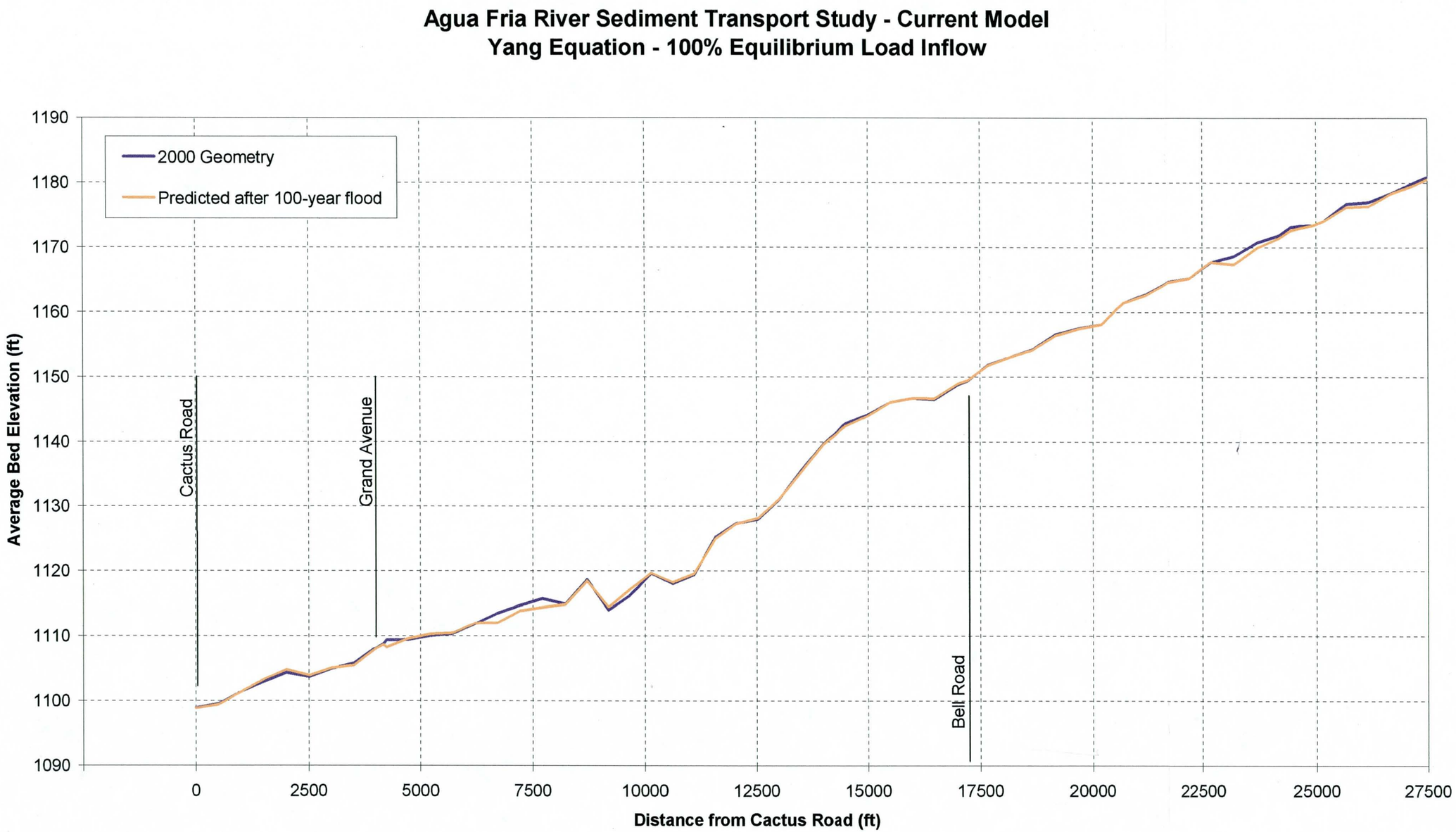

Figure 3.6 – Current Model: Simulated bed profile using Yang, 100-year flood and 100% equilibrium load inflow.

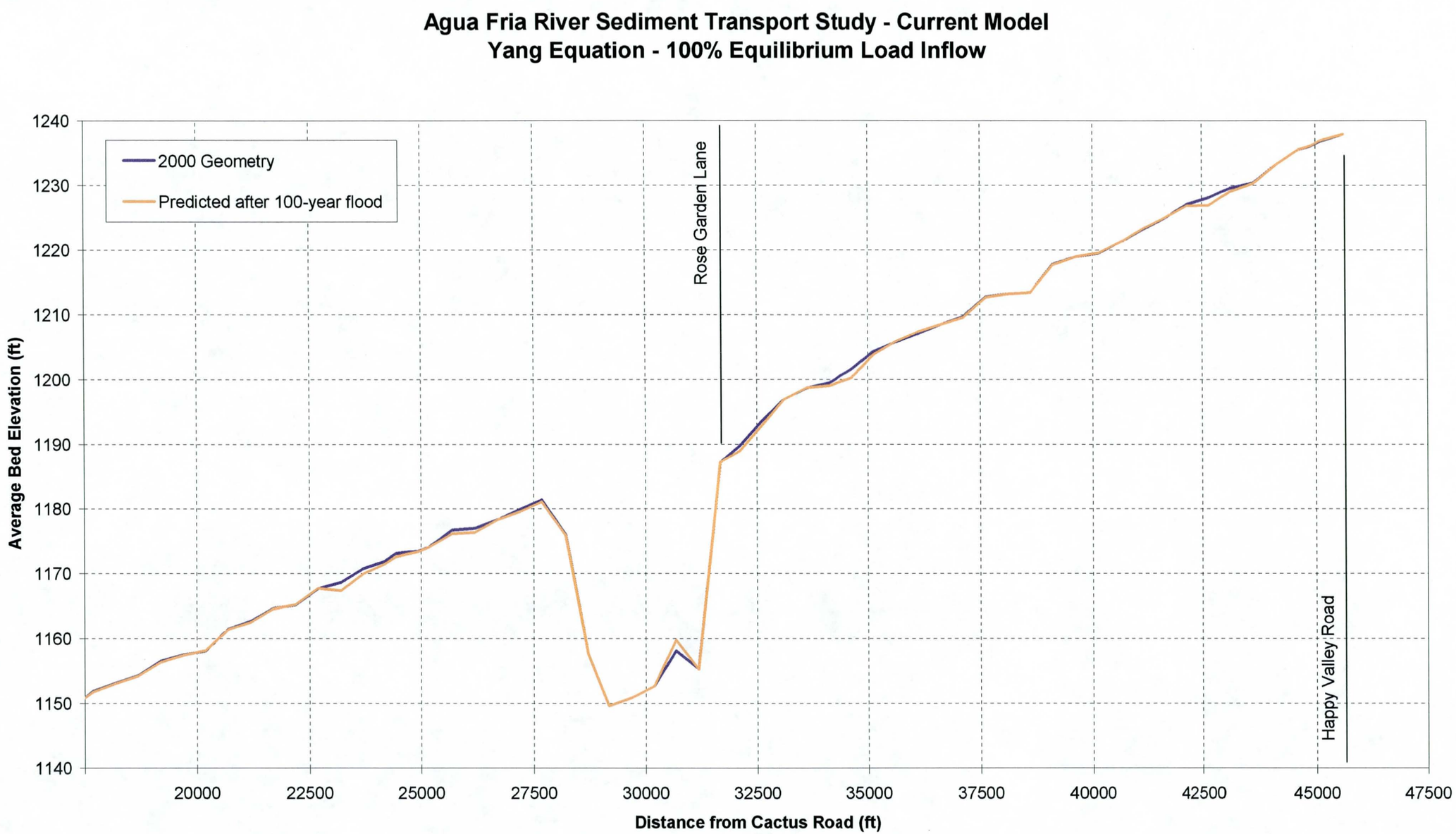

Figure 3.6 – Continued.

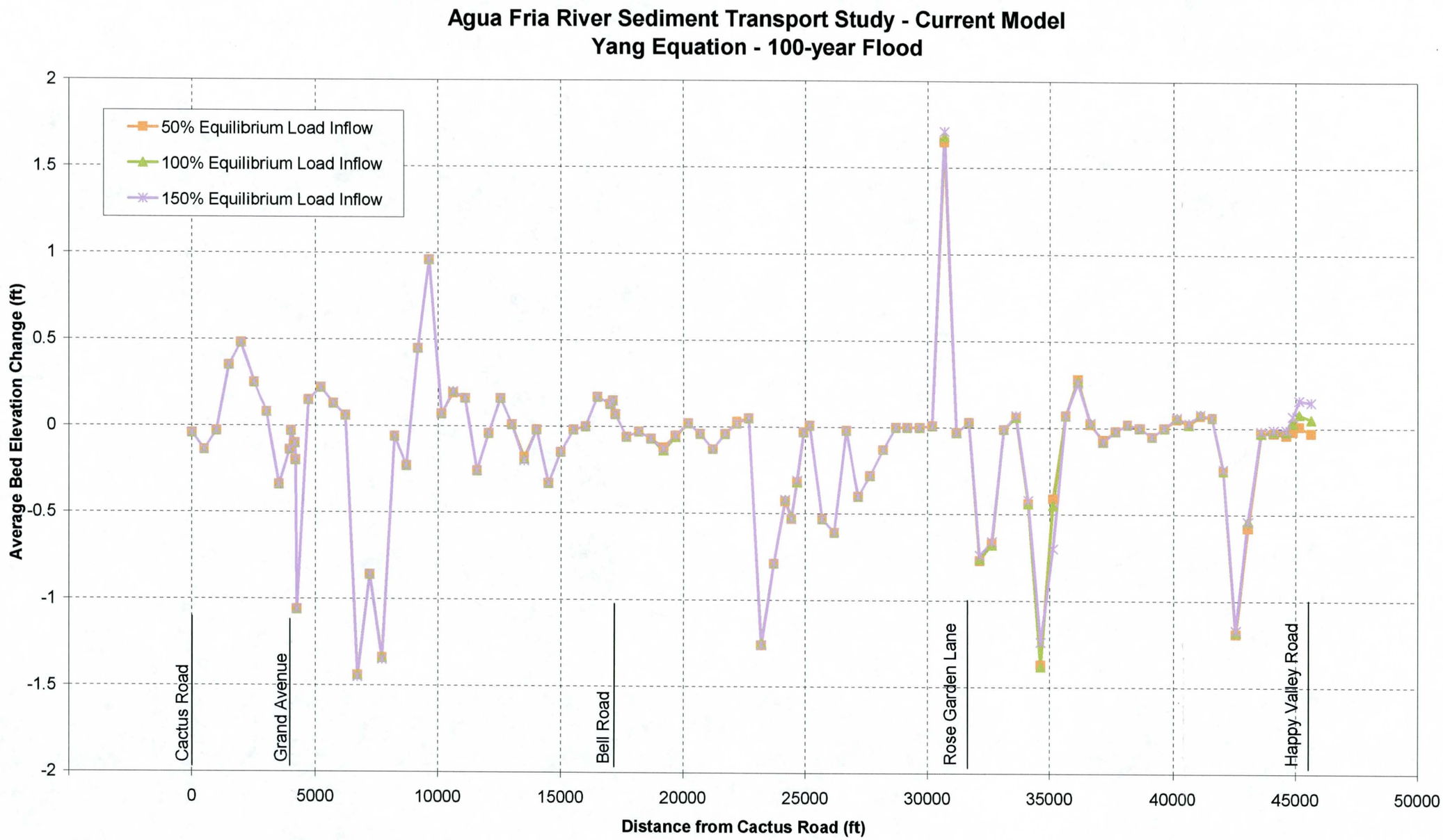

Figure 3.7 – Current Model: Average bed elevation change using Yang, 100-year flood and three sediment inflow rates.

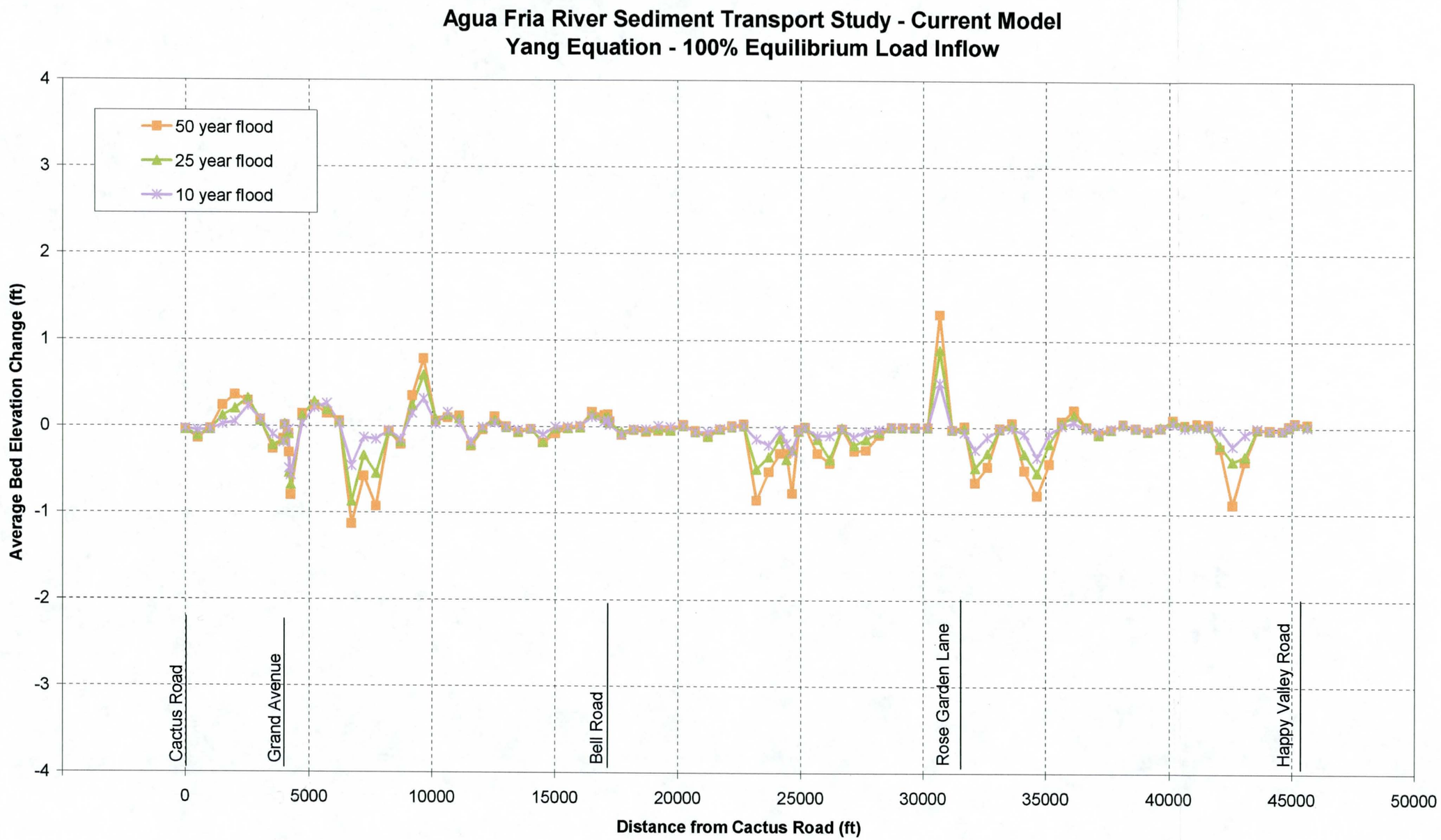

Figure 3.8 - Current Model: Average bed elevation change using Yang, 100% equilibrium inflow load and 10, 25 and 50-year floods.

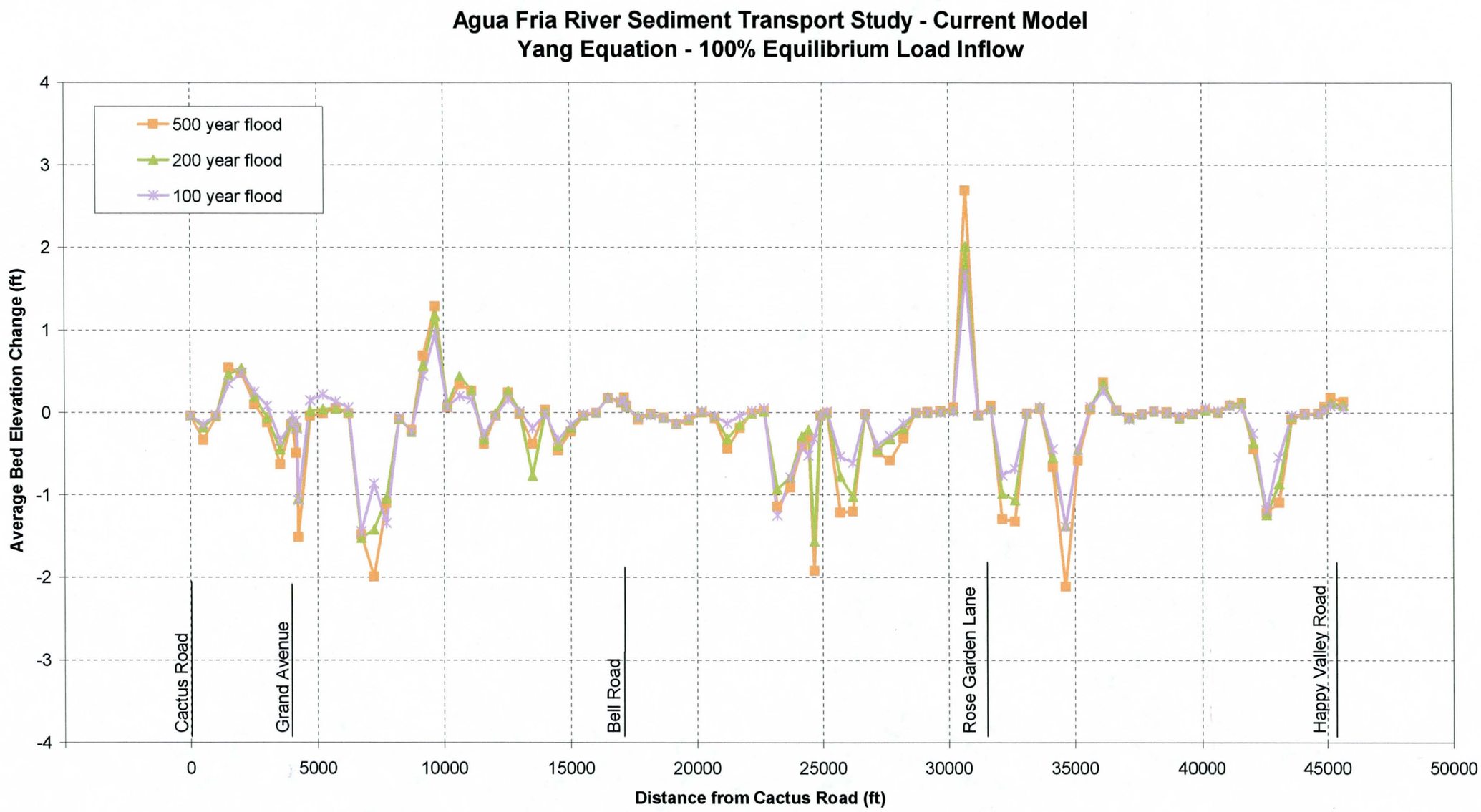

Figure 3.9 - Current Model: Average bed elevation change using Yang, 100% equilibrium inflow load and 100, 200 and 500-year floods.

Figure 3.10 - Current Model: Average bed elevation change using Yang, 100% equilibrium inflow load and 100-year flood following the 10, 25 and 50-year floods.

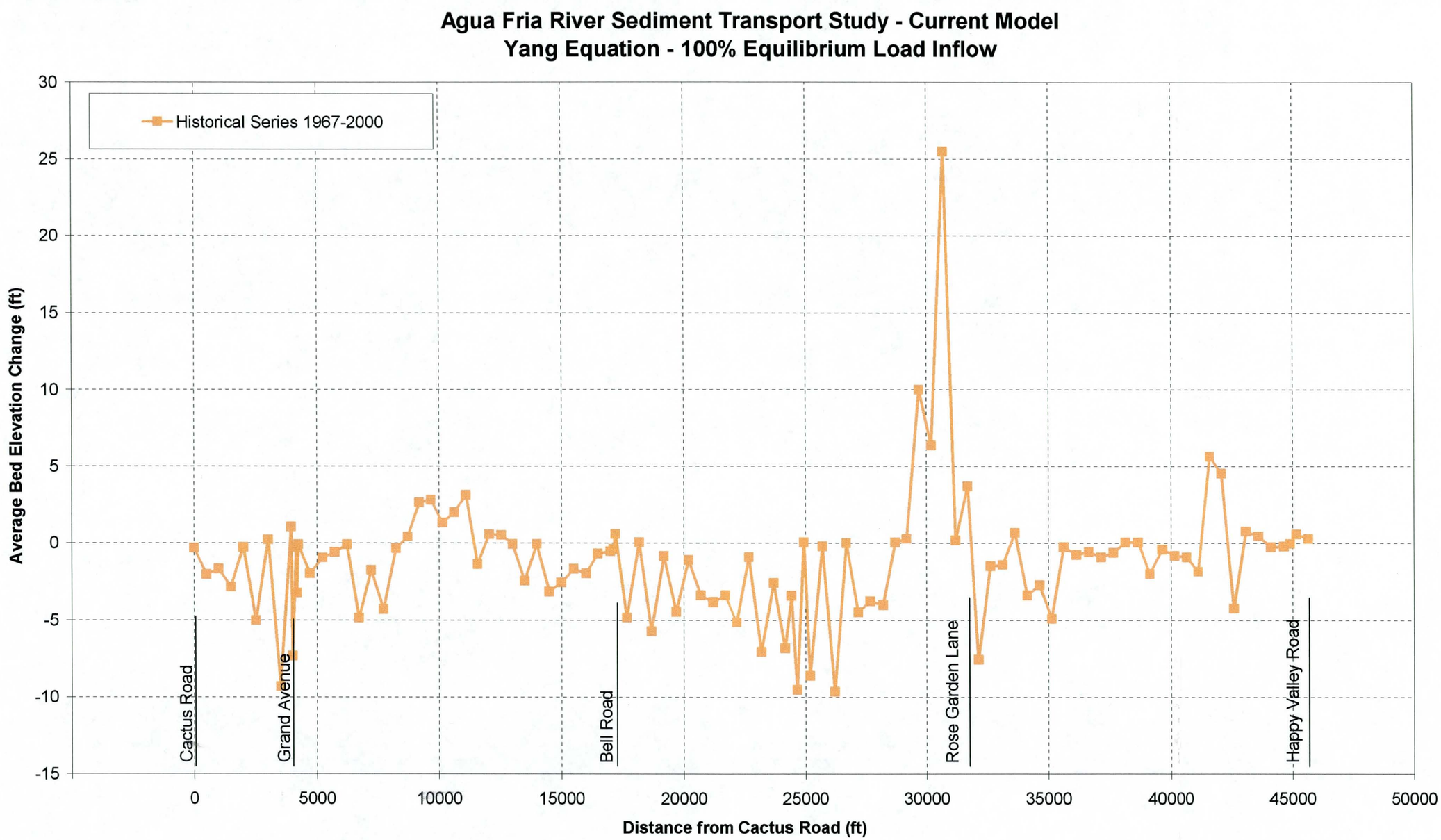

Figure 3.11 – Current Model: Average bed elevation change using Yang, 100% equilibrium inflow load and historical hydrologic input.

4. LOCAL PROCESSES AT SAND AND GRAVEL PITS

4.1.1. Physical Processes

Sand and gravel mining in the stream bed inevitably affects the stream hydraulics. Alluvial channel response to in-stream excavation can put in danger property and structures located near the mining operation. River responses to mining include accelerated degradation above and below the mined reach, aggradation within the mined reach, and associated changes in channel width.

The extent of damage to the system that can result from a head cut induced by sand and gravel mining is a function of volume and depth of the pit, location of the pit, bed material size, flood discharge, and sediment inflow rates and volume. The presence of an in-stream gravel pit can add energy to the system by increasing the energy slope just upstream of the pit. The steeper slope has greater erosive power and can initiate bank erosion and head cutting. These processes can tip the balance of sediment transport and induce degradation just upstream of the pit, and aggradation in the pit.

When storm runoff impinges on the gravel pit the energy slope, flow velocity and sediment transport capacity increase at the upstream boundary of the gravel pit and then attenuate in the pit. In response to the changes of sediment transport capacity at the pit boundary, the channel initiates down cutting of the bed upstream of the pit. This down cutting leads to sloughing of the resulting high banks and widening of the resulting deep and narrow channel. Furthermore, since the velocity of the flow through the pit is negligible compared with both the floodplain and the main channel velocities, the pit will act as a sediment trap. The water in the lower reaches (downstream end) of the pit does not have the capacity to carry sand and gravel-sized material. This clearer water will flow back into the main channel downstream and scour sediment until the balance between sediment load and transport capacity is reached. The tail cutting due to the release of clear water into the main channel from the pit must also be considered (Simons, Li & Associates, Inc., 1982).

The length of time that conditions are favorable for bank erosion and head cutting depends on the volume of the pit and on the inflow hydrograph. For a low-flow event an in-stream pit will not fill or reach equilibrium as soon as it will during a high-flow event.

The degradation and aggradation problems associated with sand and gravel mining are very complicated. The physical processes include water runoff, sediment transport, sediment routing by size fraction, degradation, aggradation, the breaking and forming of armor layers, etc. These processes are unsteady and complex in nature, and simplifying assumptions are needed to obtain practical and economical solutions.

4.1.2. Estimating the Effects of Pits in the Channel

Computer simulations performed to study the effects of in-stream gravel mines in the Salt River (Boyle Engineering Corporation, 1980) demonstrated that, for pits 15 to 50

ft deep, the depth of the headcut at the upstream pit face was about one half of the pit depth when the maximum headcut distance occurred, and that the bed slope was approximately one percent. These results were the basis for the design of sand and gravel mining guidelines (Figure 4.1), which can give an estimate of the extent of the headcut.

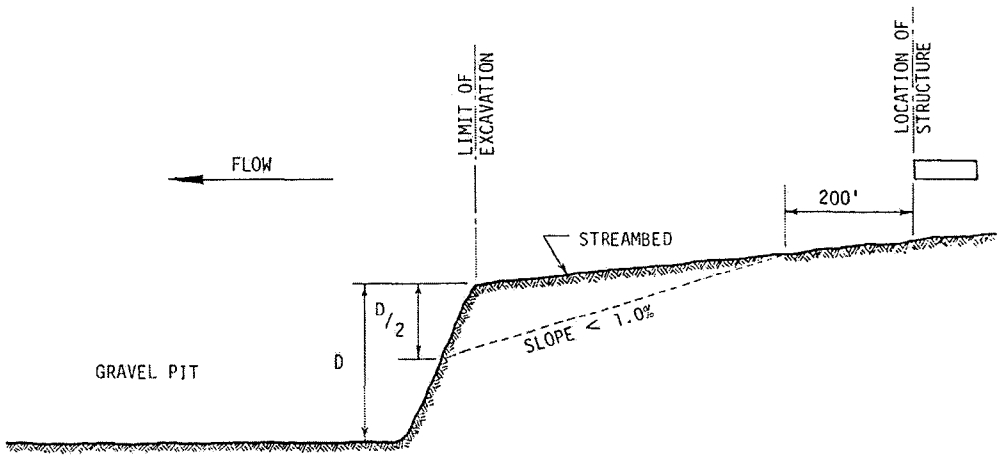

Figure 4.1 – Guidelines for the location of gravel pits with respect to utility crossings or structures (Boyle Engineering Corporation, 1980)

Cotton and Ottozawa-Chatupron (1990) described an analysis procedure developed for the Arizona Department of Transportation for estimating the short-term longitudinal channel response due to in-stream mining. The procedure was developed using a simulation model formulated specifically for the hydraulic conditions typical of mined river reaches in Arizona. The model was calibrated using data from mined river reaches in sand bed and gravel bed channels throughout Arizona. Simulations were then conducted to create synthetic data sets by varying the channel slope, discharge and excavation shape (length, width and depth). General dimensionless equations were then developed from the data sets generated. The result was a series of regression equations to estimate the maximum depth and distance of scour upstream and downstream of an in-stream excavation from a flood hydrograph. The equations are applicable for the case of a sand bed channel with a sediment gradation characterized by a D_{50} = 1 mm.

The regression equations presented by Cotton and Ottozawa-Chatupron, hereafter referred to as "regression equations", were applied to site number 5 (located downstream of Rose Garden Lane) with the 100 year flood hydrograph.

4.1.3. Headcut Analysis

To calculate the headcut and tailcut using the regression equations, we need to know the size of the mining pit and the inflow hydrograph entering the pit. The pit has a complex geometry, but it has been simplified for these calculations. It has been assumed that the pit has a rectangular base shape, 2963 feet long and 1391 feet wide, with a constant depth of 35.7 feet. Therefore, the volume of the mining pit has been estimated to be approximately 1.47×10^8 cubic feet.

The pit occupies the entire Agua Fria River channel as well as the floodplain on the east side of the channel. For simplicity it has been assumed that the discharge entering the pit is equal to the 100-year hydrograph. Taking into account the pit volume, it would take between four and five hours for the 100-year flood to fill the pit volume.

Results from the headcut analysis are shown in Figure 4.2. The headcut depth computed is 17.9 feet, which is equal to half the average depth of the mining pit. This is the maximum depth allowed by the method and coincides with the headcut depth given by the guidelines for the location of mining pits. The headcut scour length given by the regression equations is 565 feet, however, the headcut length associated with the 1.0% slope, as suggested by the guidelines, is 5425 feet.

The regression equations can also be used to compute tail cutting. The scour depth downstream of the pit was estimated in 7.4 feet, while the scour length computed was 2813 feet.

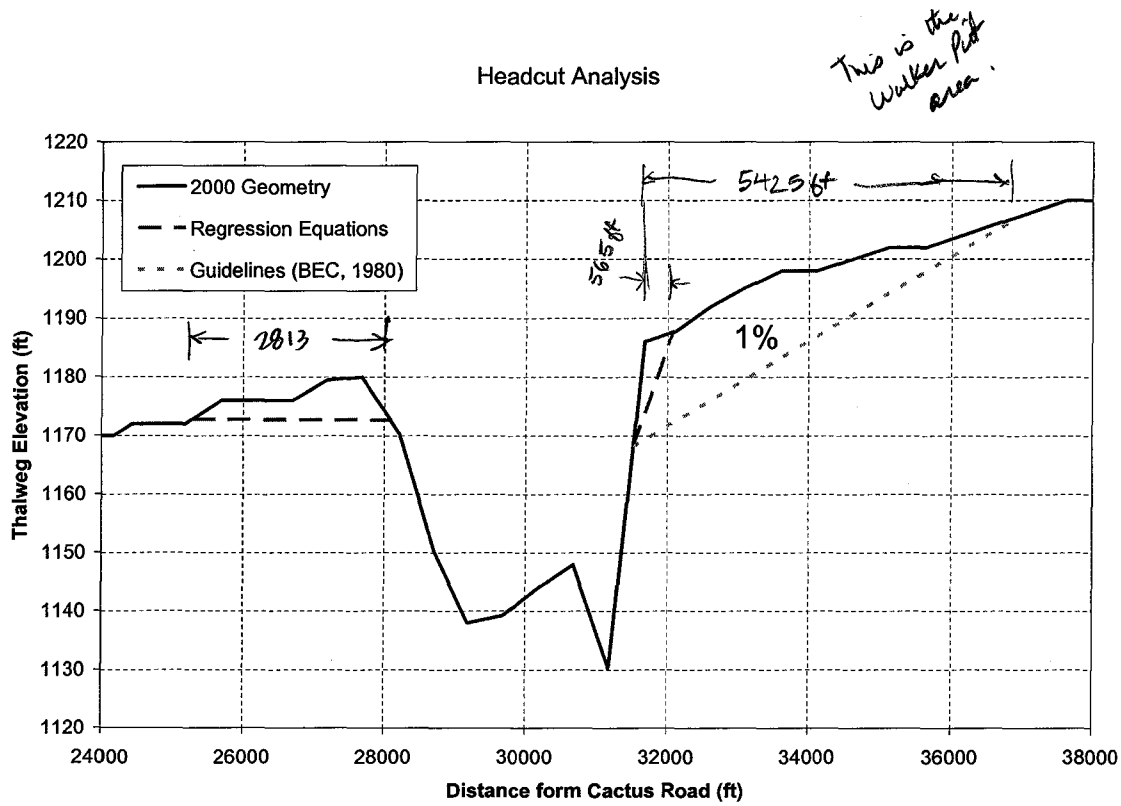

Figure 4.2 – Headcut analysis results.

The amount of deposition in the pit is not given by the regression equations. Considering that the bed sediment eroded upstream of the mining operation is completely deposited within the pit, the sediment depth in the pit would be 1.7 feet for the regression equations and 16.4 feet for the guidelines estimates. It is expected that the values will be closer to the higher estimate rather than the lower given the fine bed material.

5. SUMMARY AND CONCLUSIONS

Results of this study suggest that the single most important factor currently affecting the Agua Fria River channel morphology is human activity in the channel and surrounding areas, especially sand and gravel mining.

The analyses performed with the Initial Model suggested that either Yang's formula or Copeland's modification of Laursen's equation could be used to model sediment transport in the Agua Fria River (with Yang's equation being the ~~best~~ better of the two). The other sediment transport relations failed to reproduce the 1983 profile when mining was simulated using the dredge routines in HEC-6T.

The magnitude of the flow events on the Agua Fria River changed markedly with the construction of New Waddell Dam. Because of the small size of the flows registered, the most important factor affecting channel morphology in this period has been human activity. Simulation runs showed that the performance of all sediment transport relations was similar, provided the model was executed under the "High Mining" scenario. Therefore, results from the Intermediate Model provide little information about the performance of the candidate transport equations.

After analyzing the results of both Initial and Intermediate Models, it is fair to conclude that Yang's sediment transport equation is the best relationship to model sediment transport in the Agua Fria River. This result is in agreement with the findings by Kimley-Horn and Associates in their sediment trend analysis for the Agua Fria River Watercourse Master Plan. Based on the findings of this study Yang's sediment transport equation was selected to model sediment transport in the Current Model.

All three models, Initial, Intermediate and Current, have proven to be relatively insensitive to the upstream sediment inflow rate. In the longer term however, it is expected that a continued reduction in sediment inflow loads would increase degradation in the study reach. This will occur as upstream sediment supplies are depleted in the channel or captured by new sand and gravel mining operations upstream.

Simulation results with the Current Model suggest that the study reach is not absolutely in equilibrium. More degradation than aggradation is seen in the model results and the scour depths are in general larger than the deposition depths. This aspect is also reflected in the negative trapping efficiency values generated by the computer program. Scour and deposition depth increase with flow magnitude. However, a small flow event (10 to 50-year return period) followed by a 100-year event can have an effect larger than the 500-year flood at some locations. The Agua Fria River does not appear to be extremely unstable but some continued erosion is predicted throughout the study reach probably due to the trapping of sediment by sand and gravel mines in the channel.

The Current Model shows that aggradation and degradation are associated with locations of current or old mining operations. In old mining sites the river bed has to be reshaped until a new equilibrium is reached. Active mining operations occupying part of

the channel constrict the flow, thus reducing the effective cross section of the channel and causing a velocity increase and the consequent augment in bed scour.

Processes near the mining pits associated with unsteady flows can not be analyzed using HEC-6T. Instead it is necessary to use computer models that will simulate sediment movement under unsteady flow or empirical methods calibrated for the area of study. Results from two empirical methods applied to a mine pit located just downstream of Rose Garden Lane suggest that headcutting and tailcutting caused by a single 100-year event could affect the channel for a distance of more than one mile upstream and more than one half mile downstream.

If no measures were taken to prevent them from happening, the long term effects of such pit would be even more severe. In the long run the pit would progressively fill up of sediment, releasing basically clear water downstream to the channel. This clear water would scour a reach about two miles long, and maybe even threaten the stability of the Bell Road Bridge.

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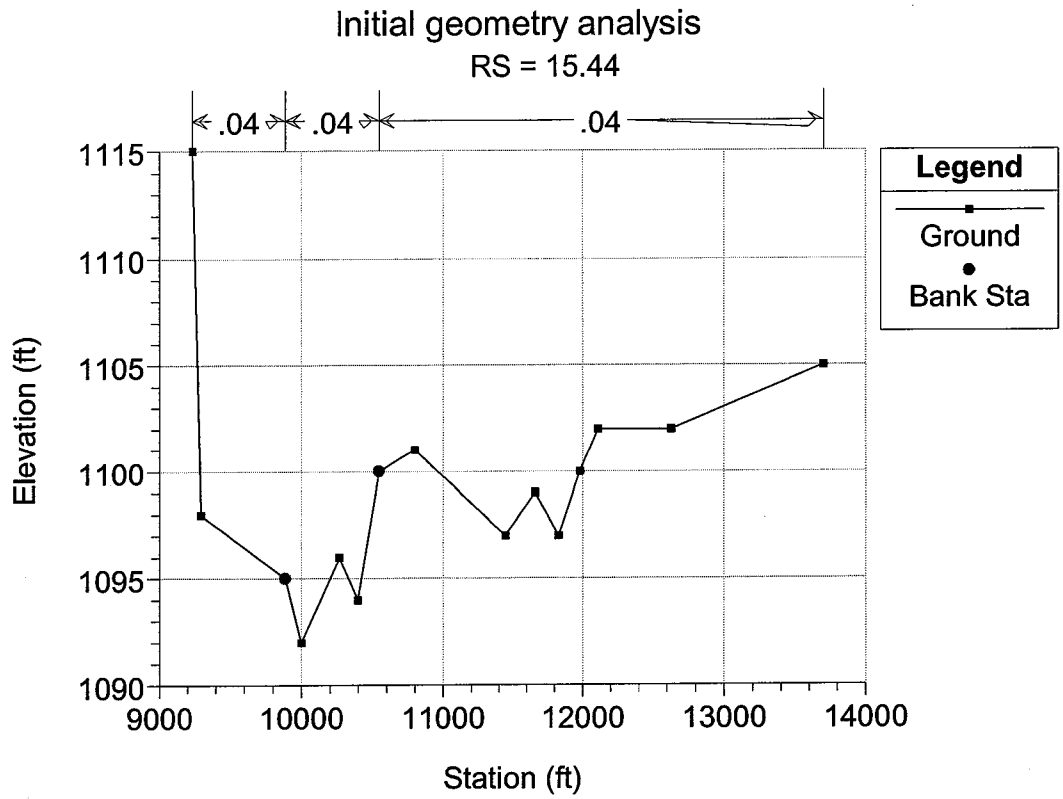
APPENDIX A

CROSS SECTION PLOTS FOR INITIAL MODEL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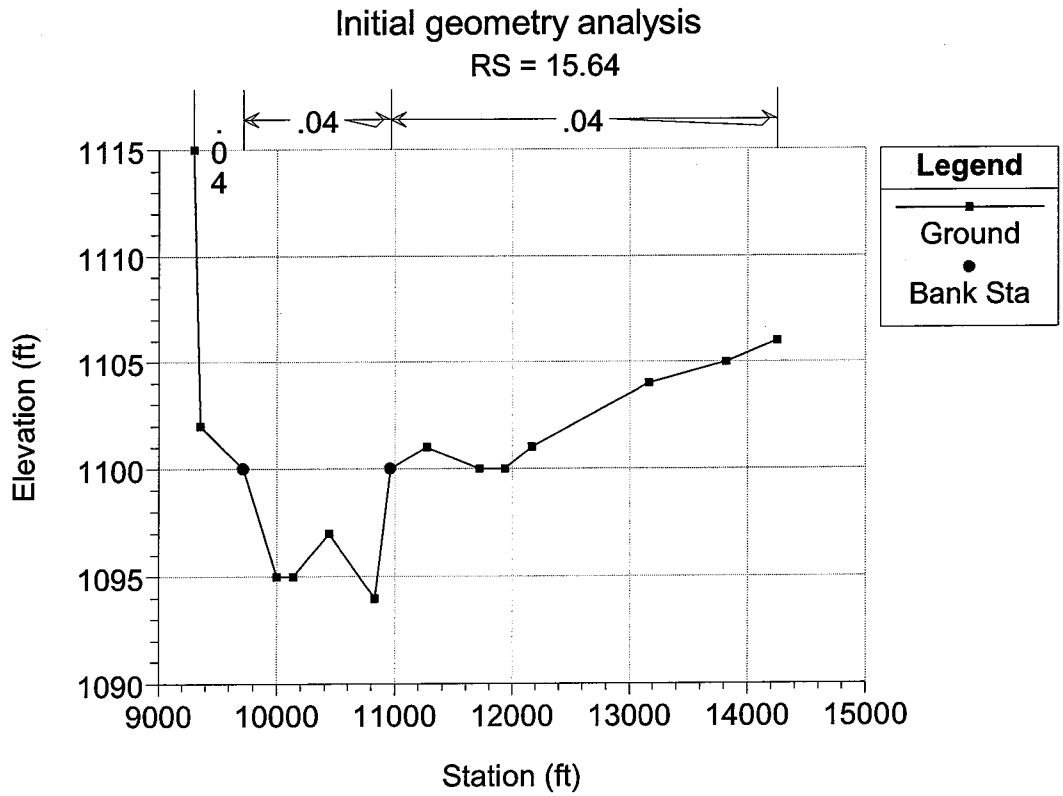
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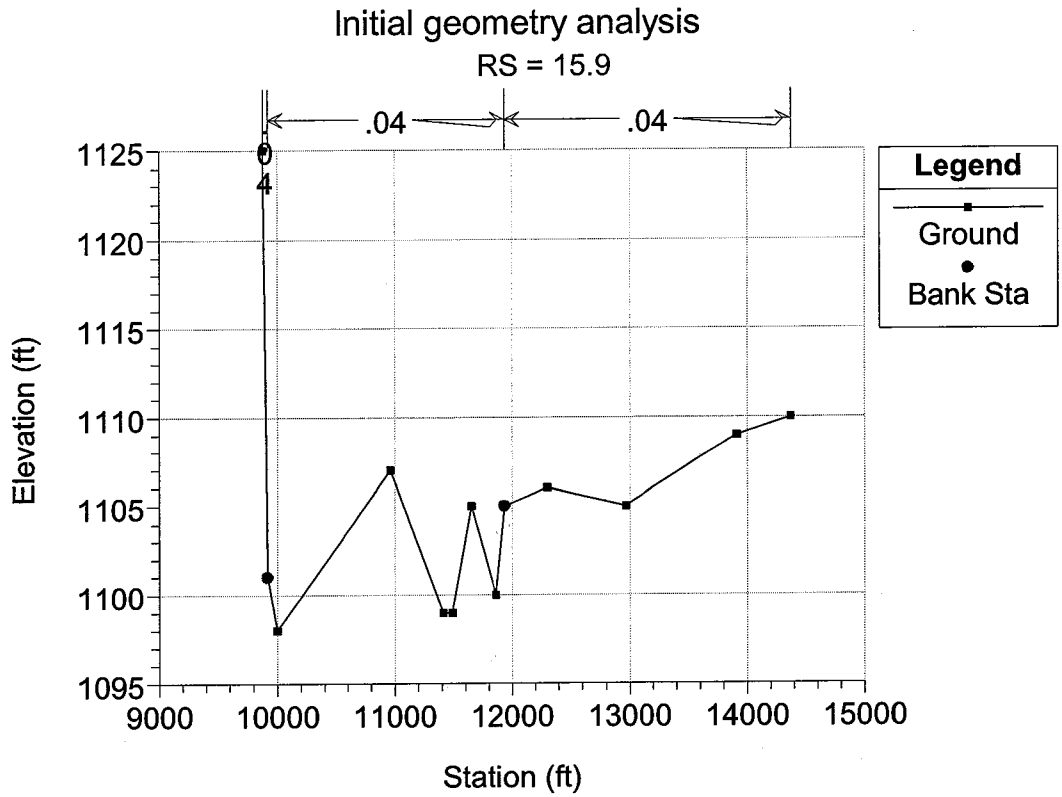
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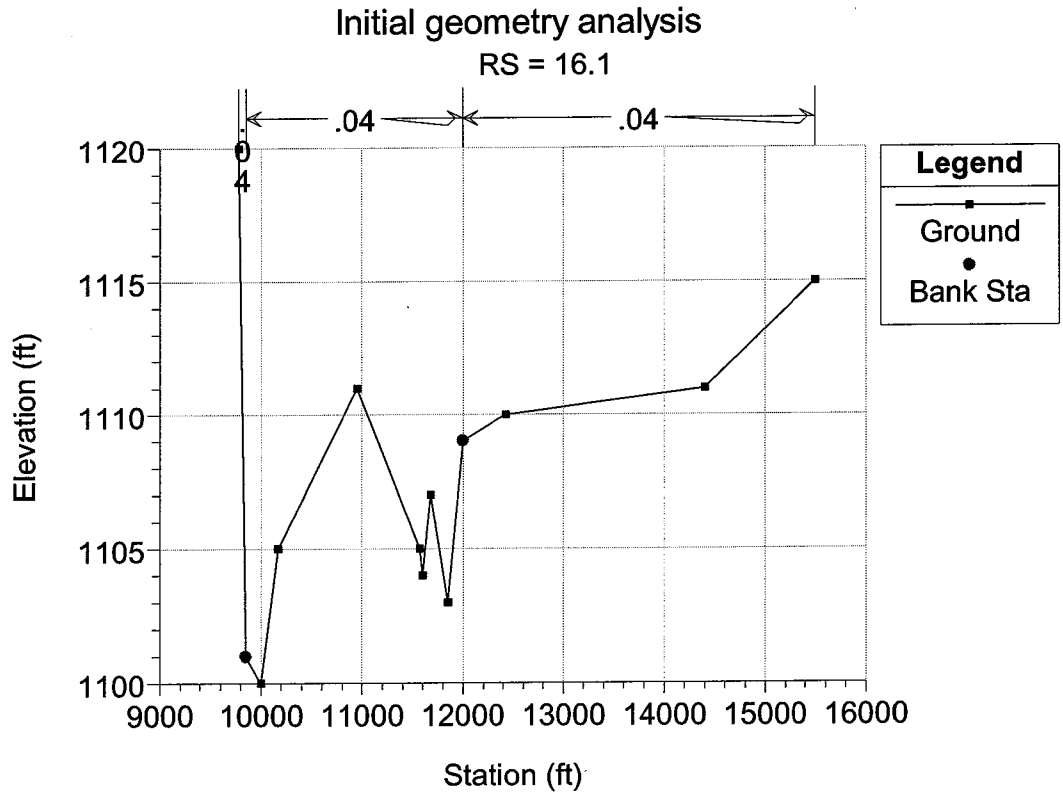
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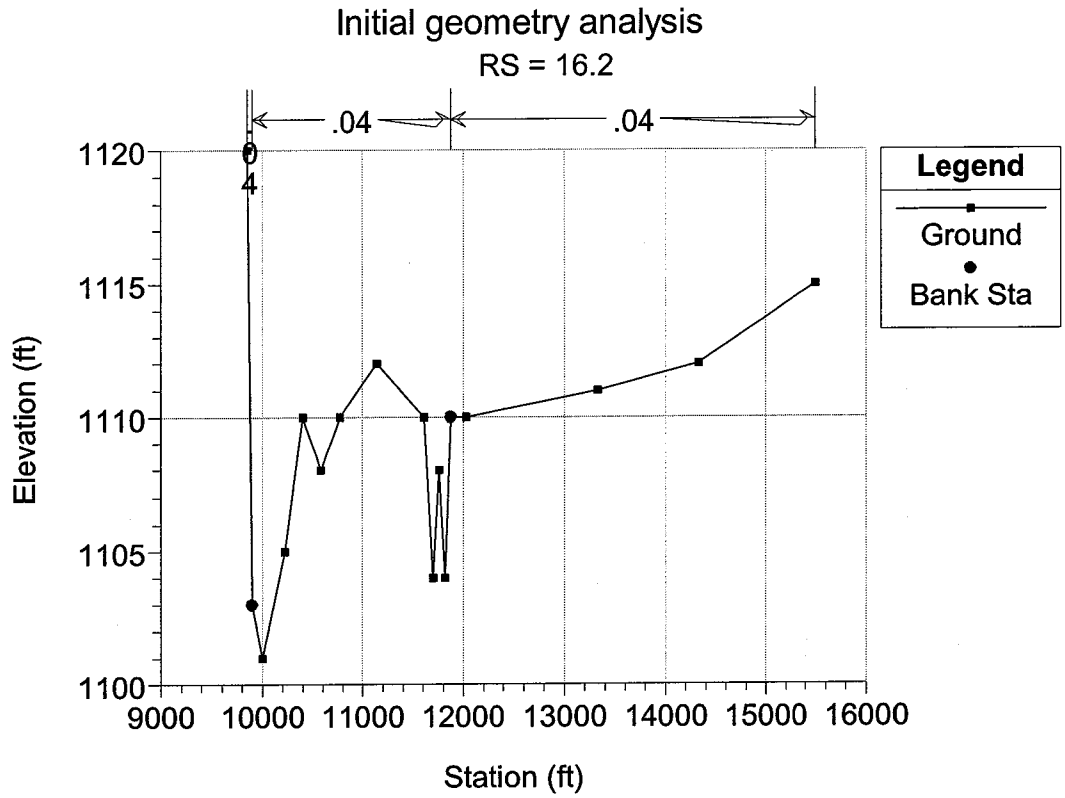
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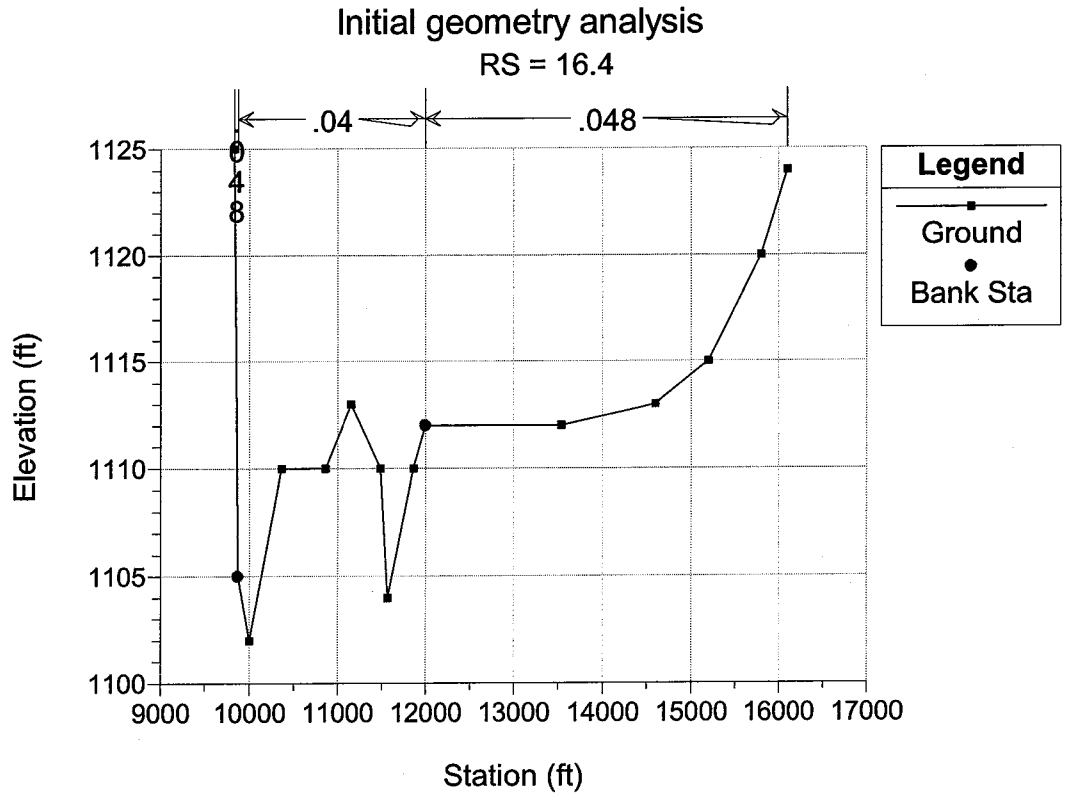
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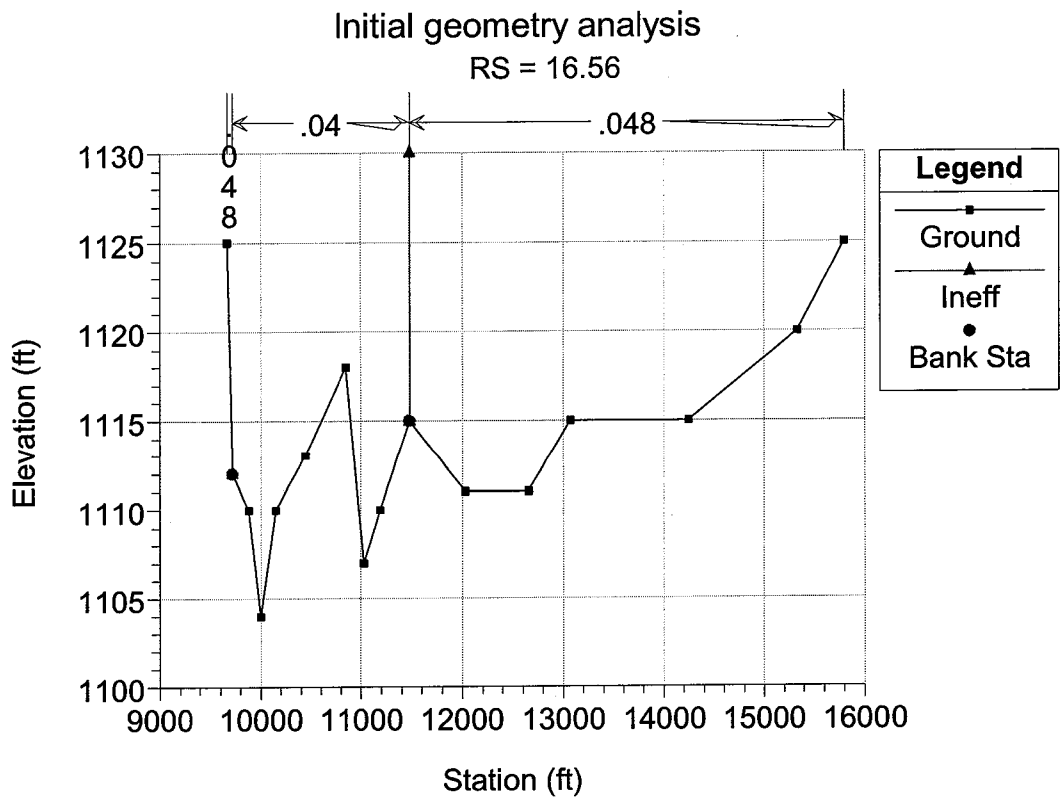
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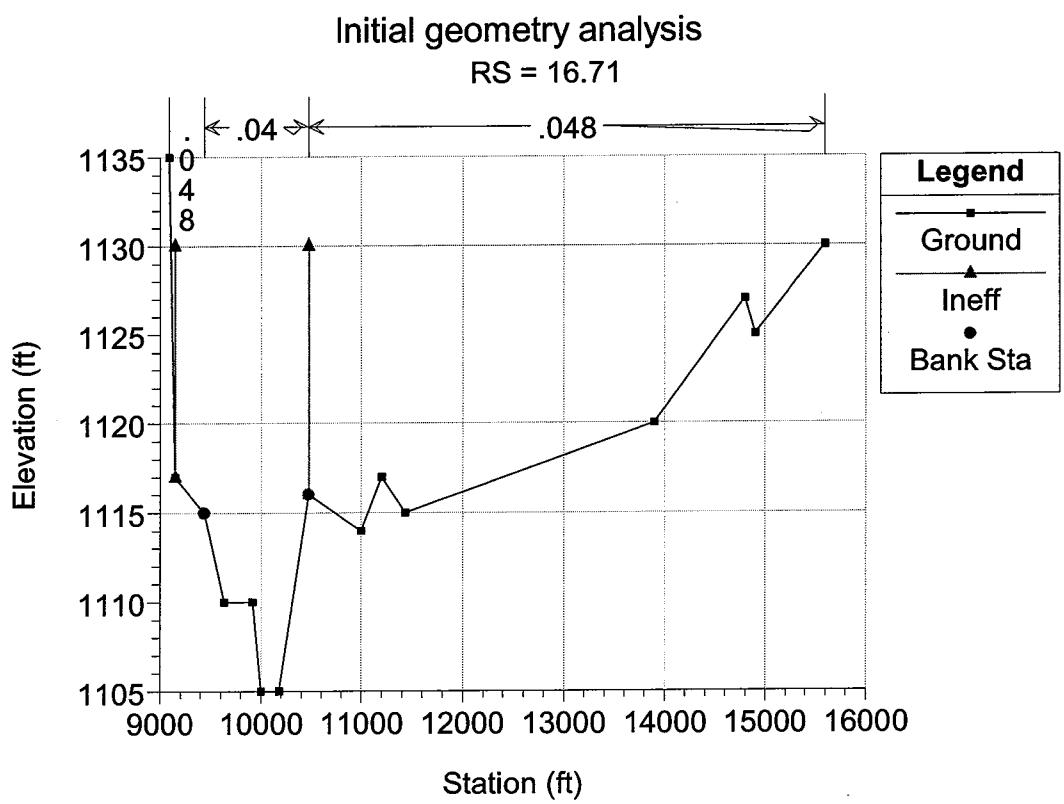
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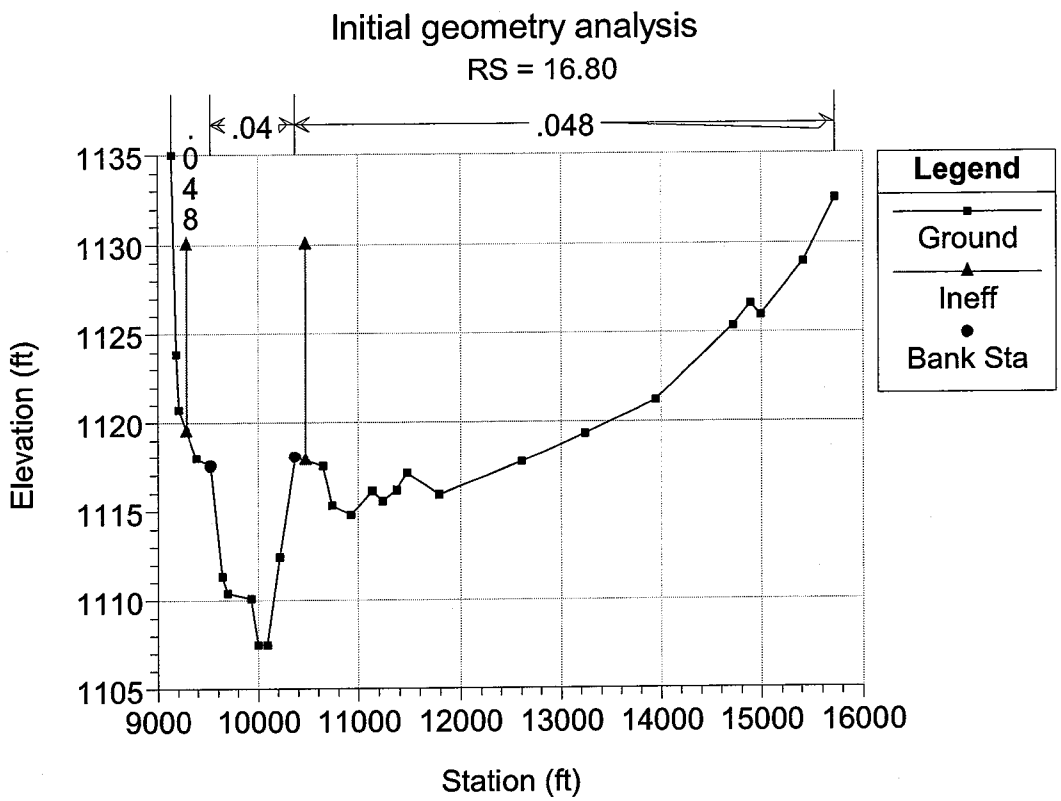
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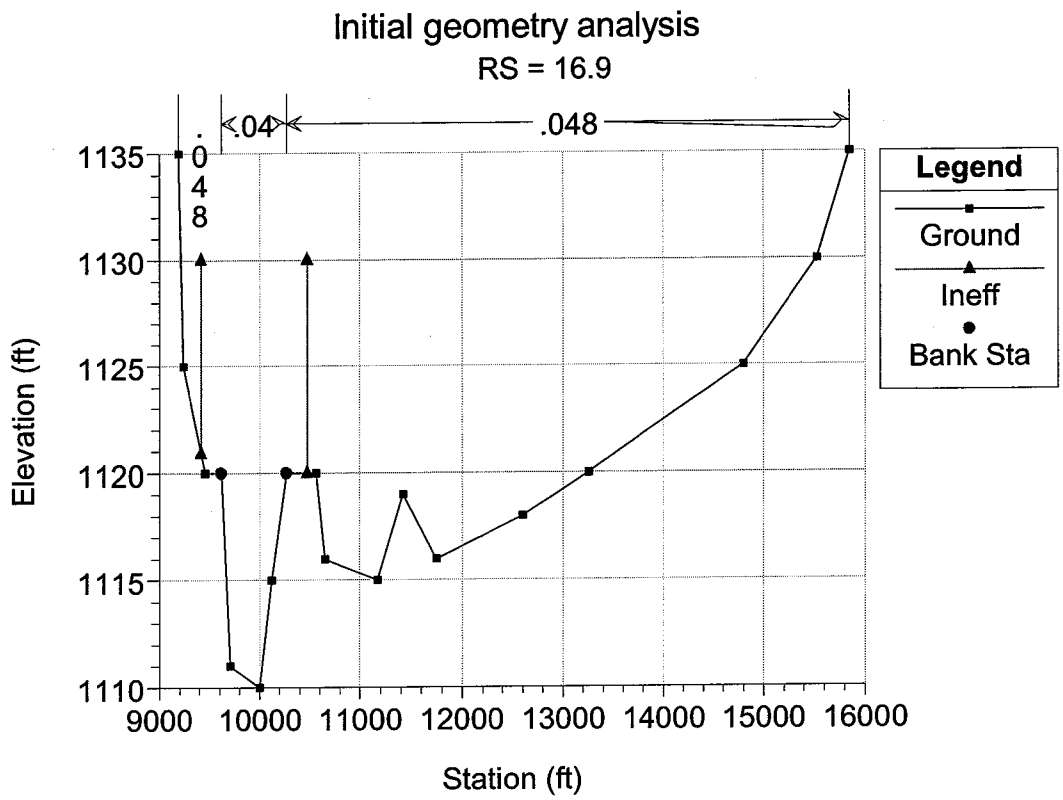
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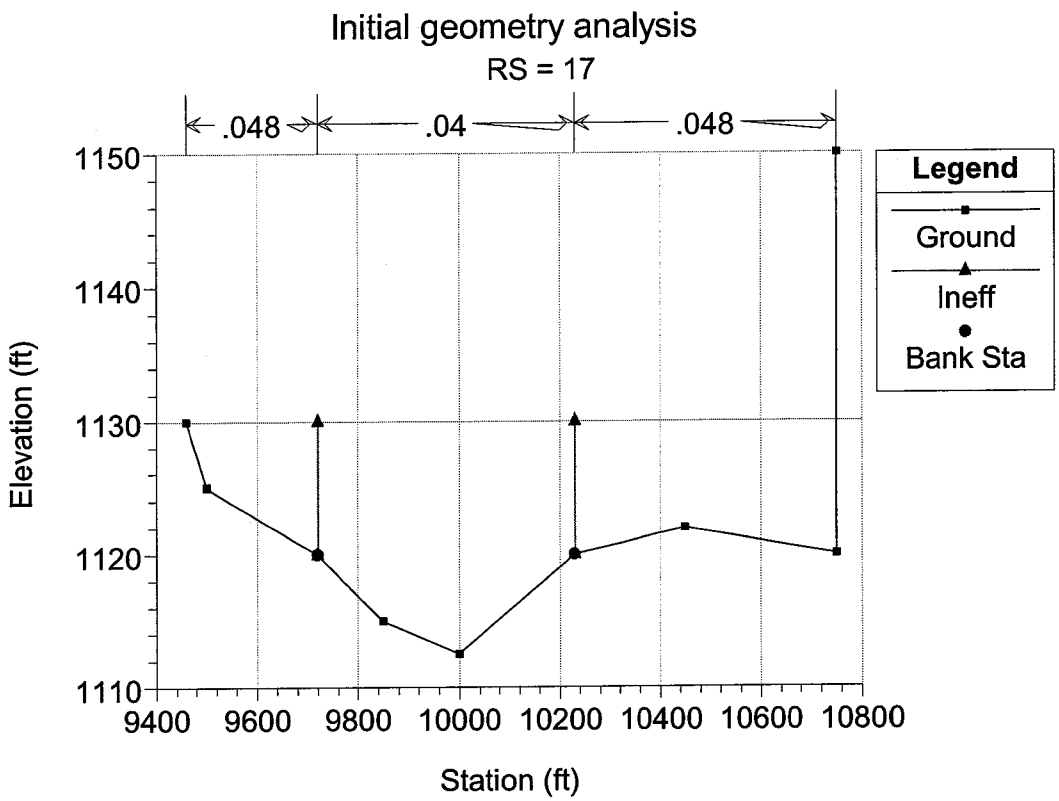
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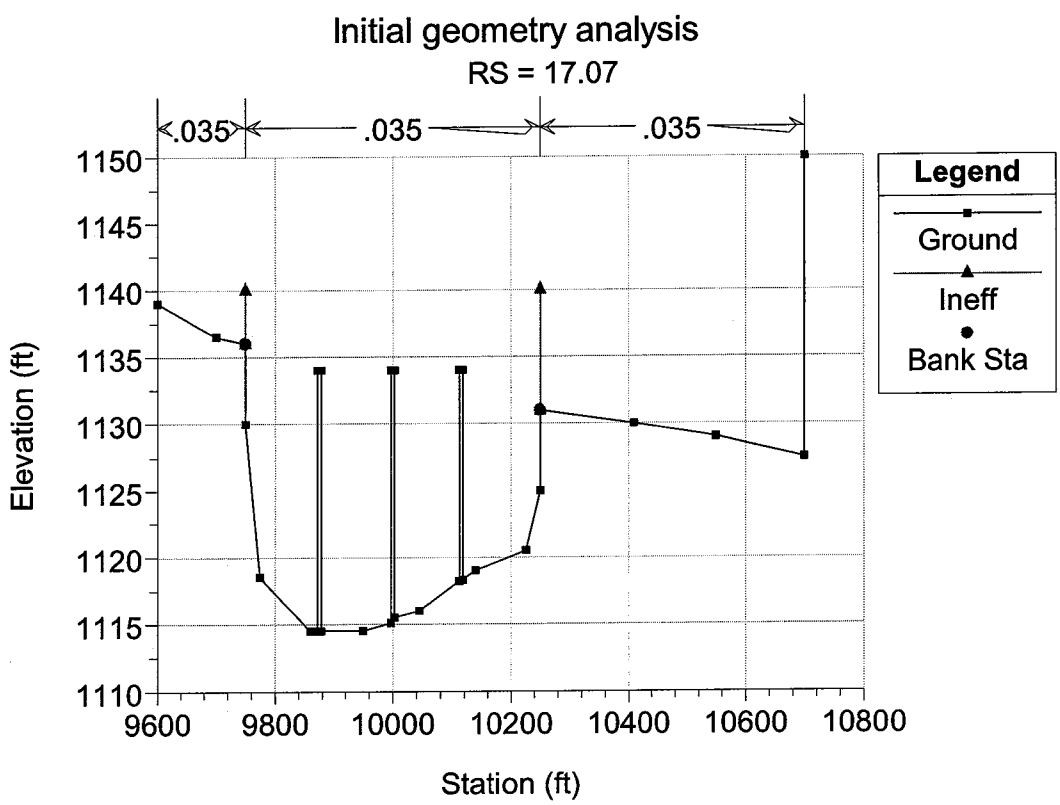
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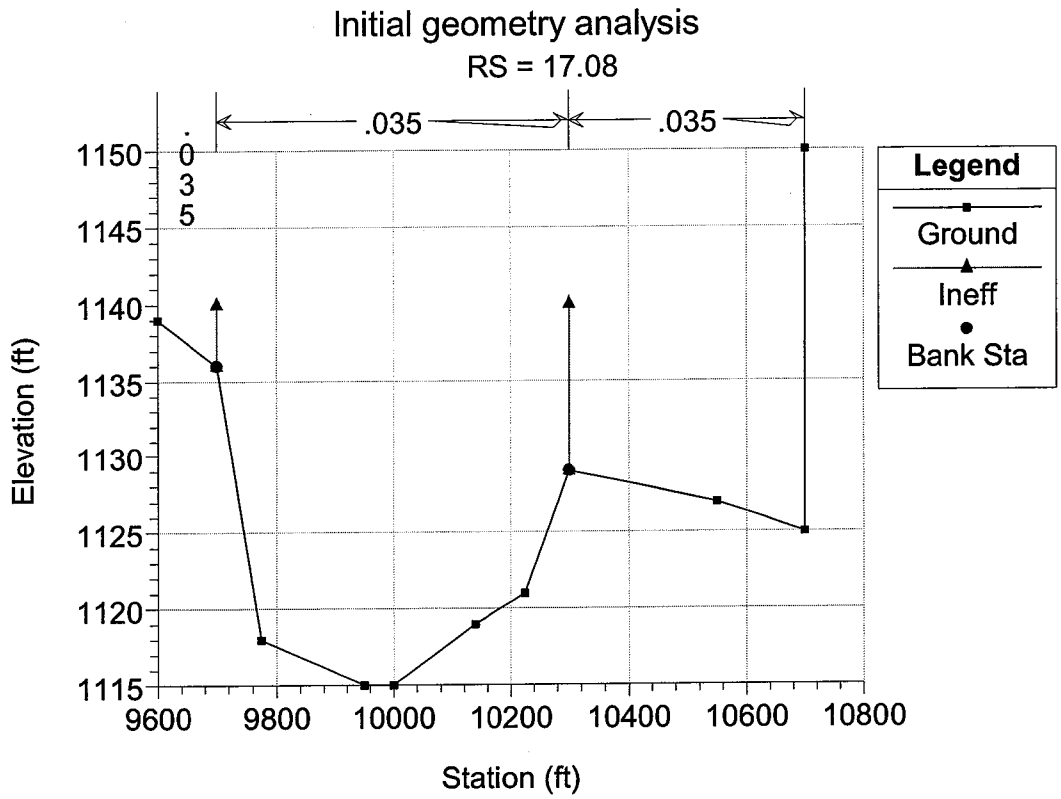
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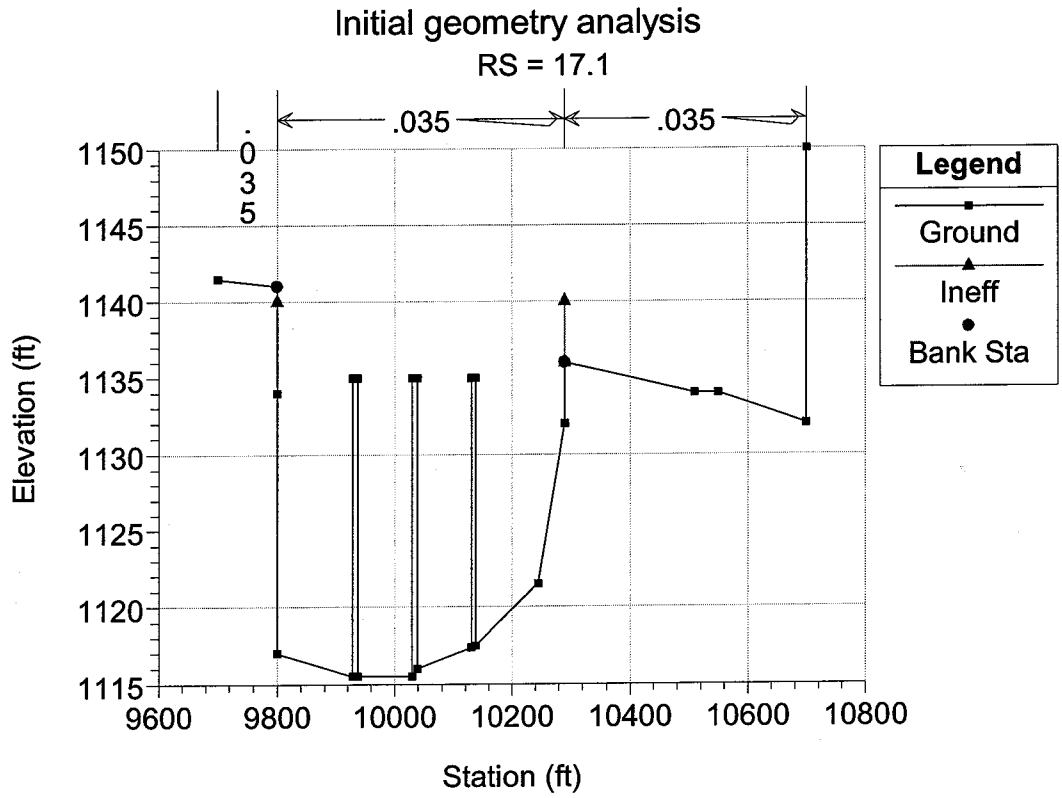
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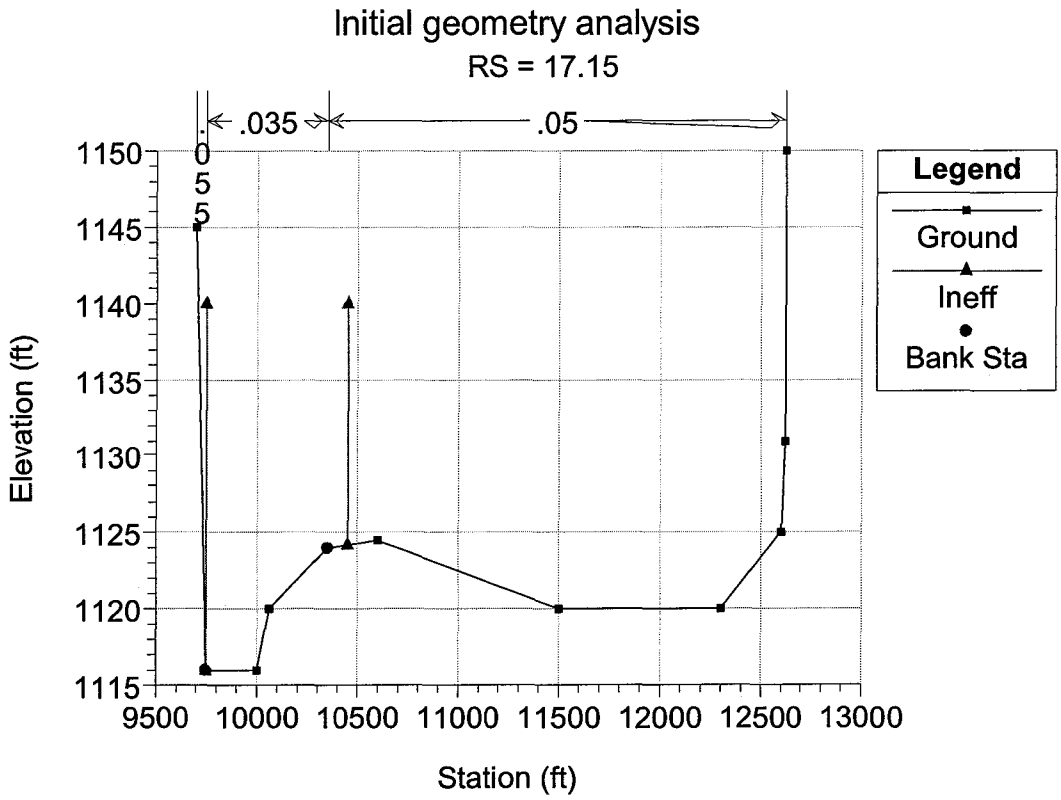
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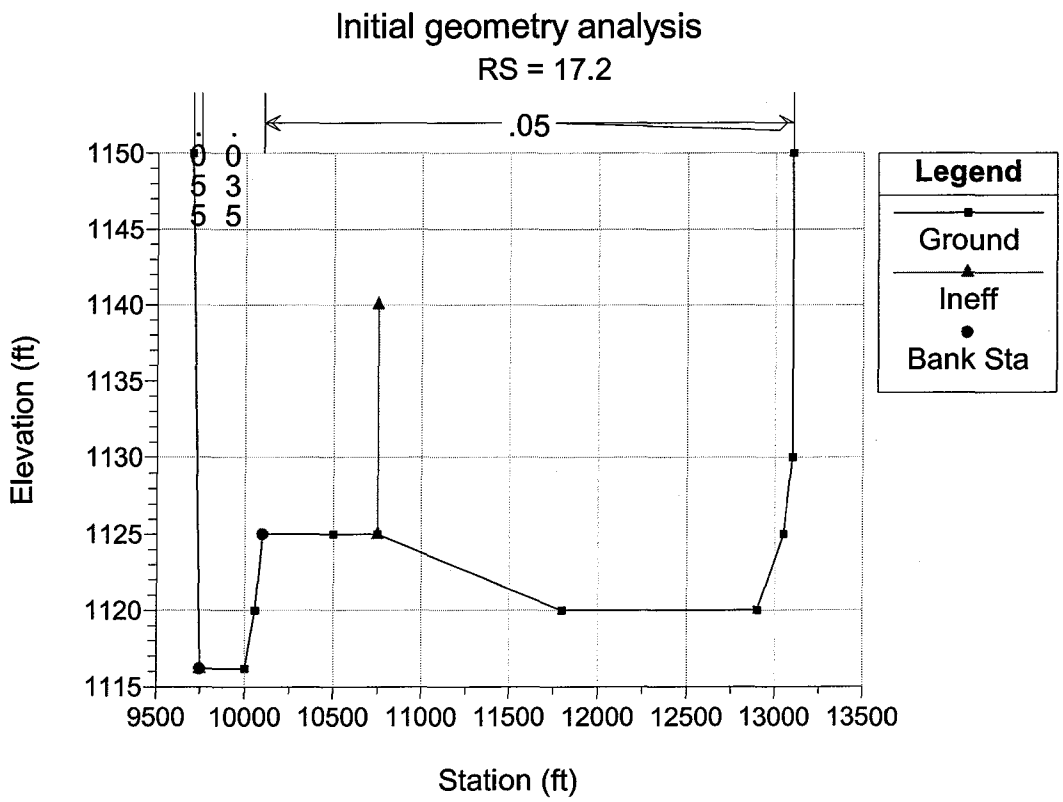
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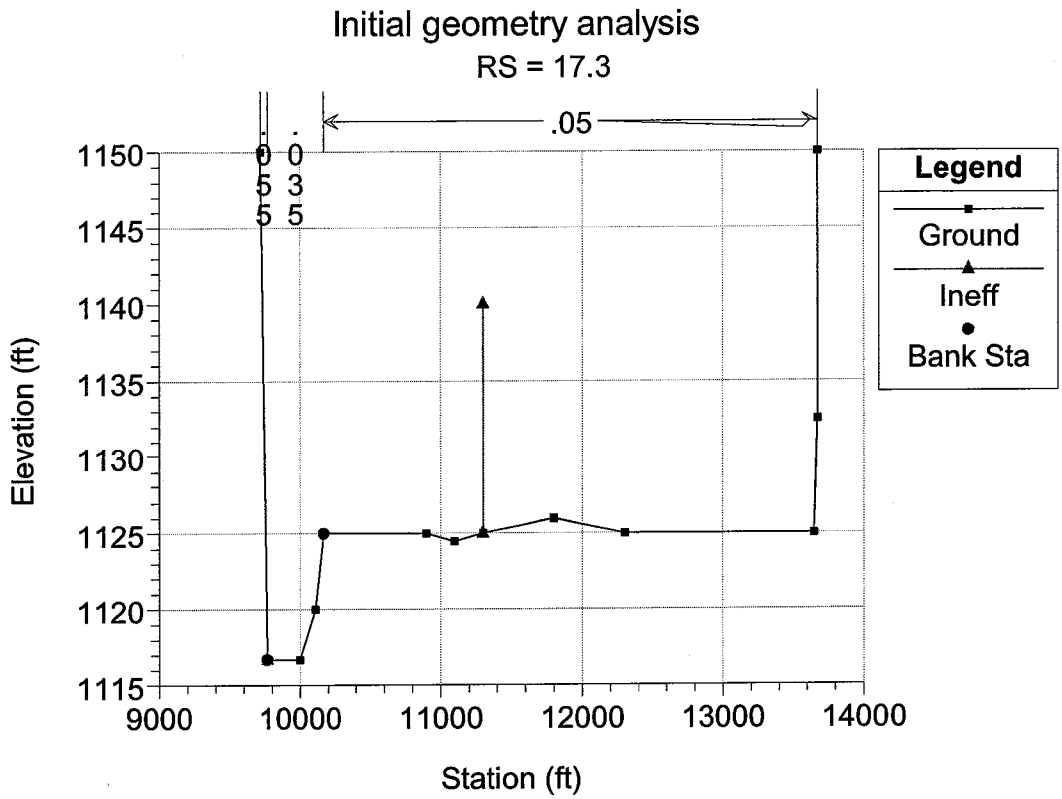
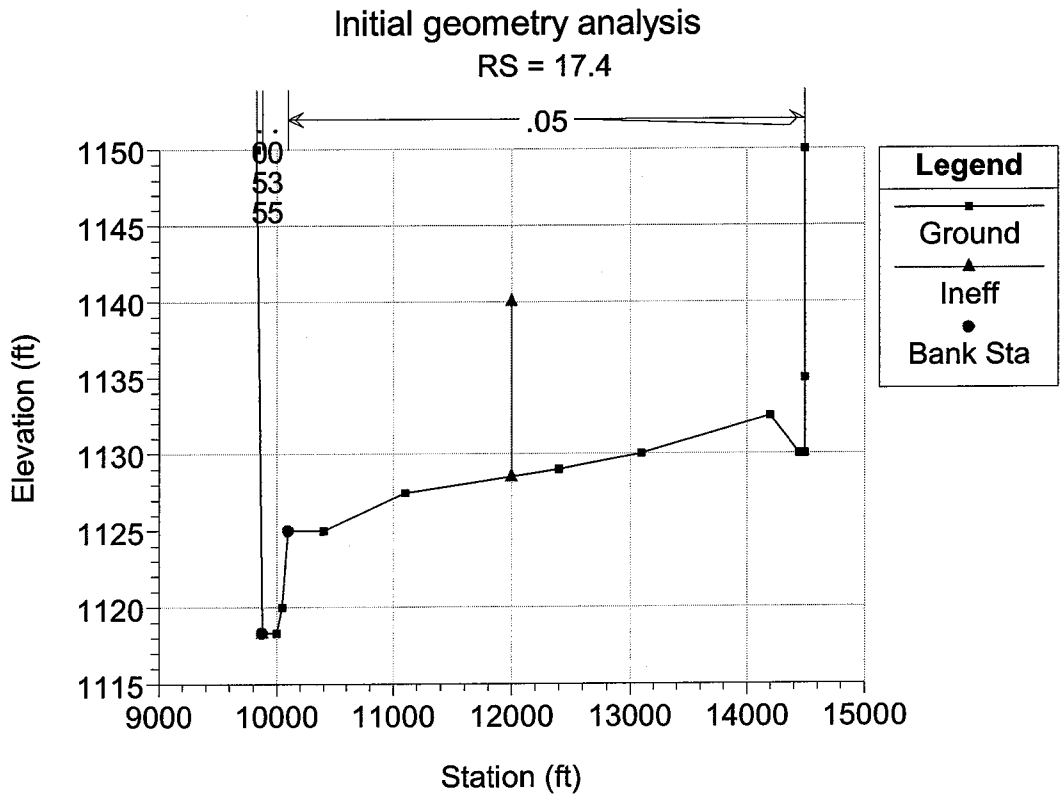
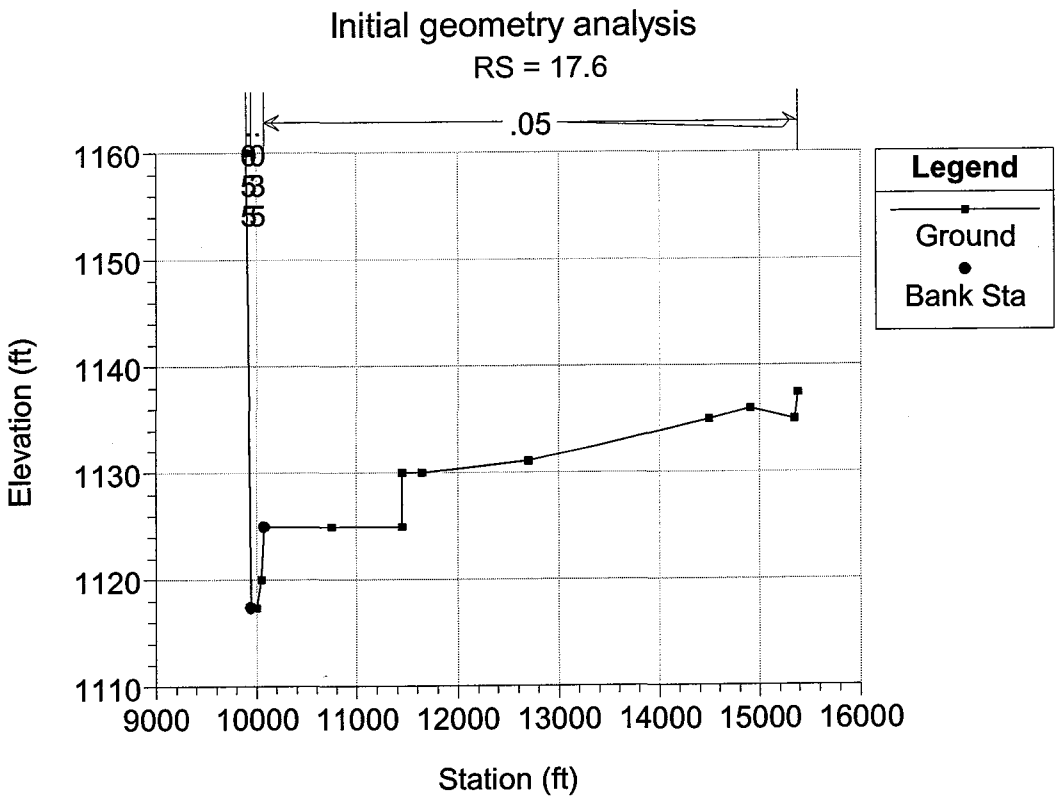
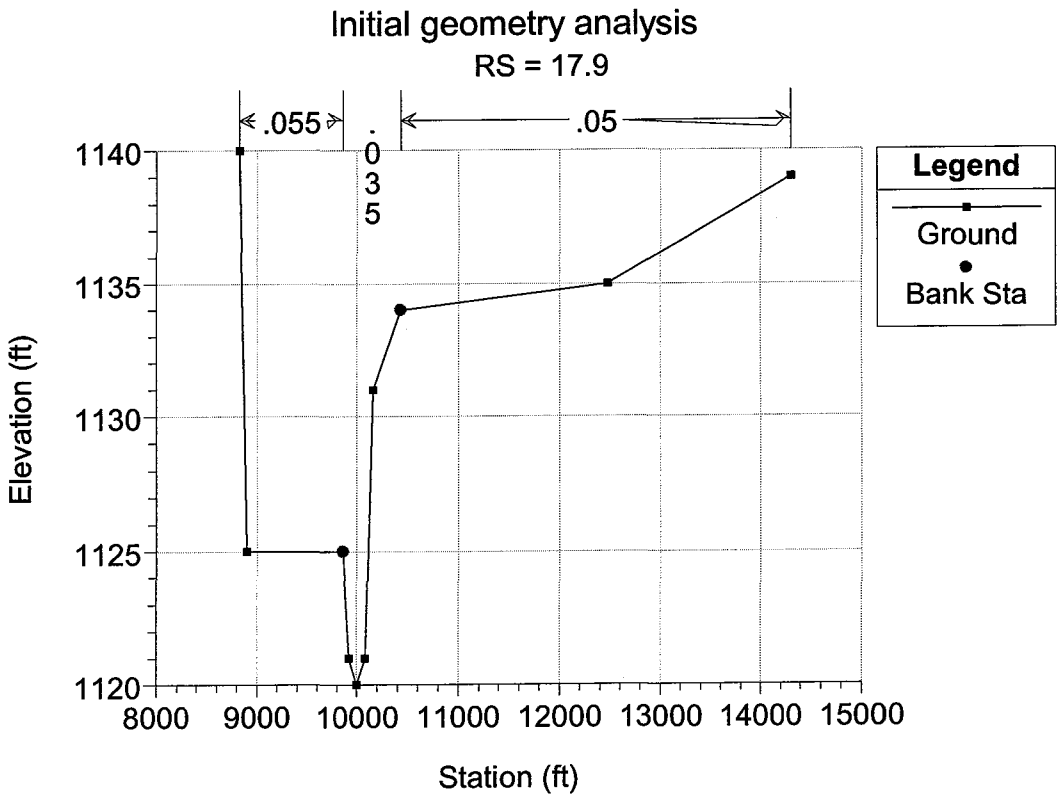
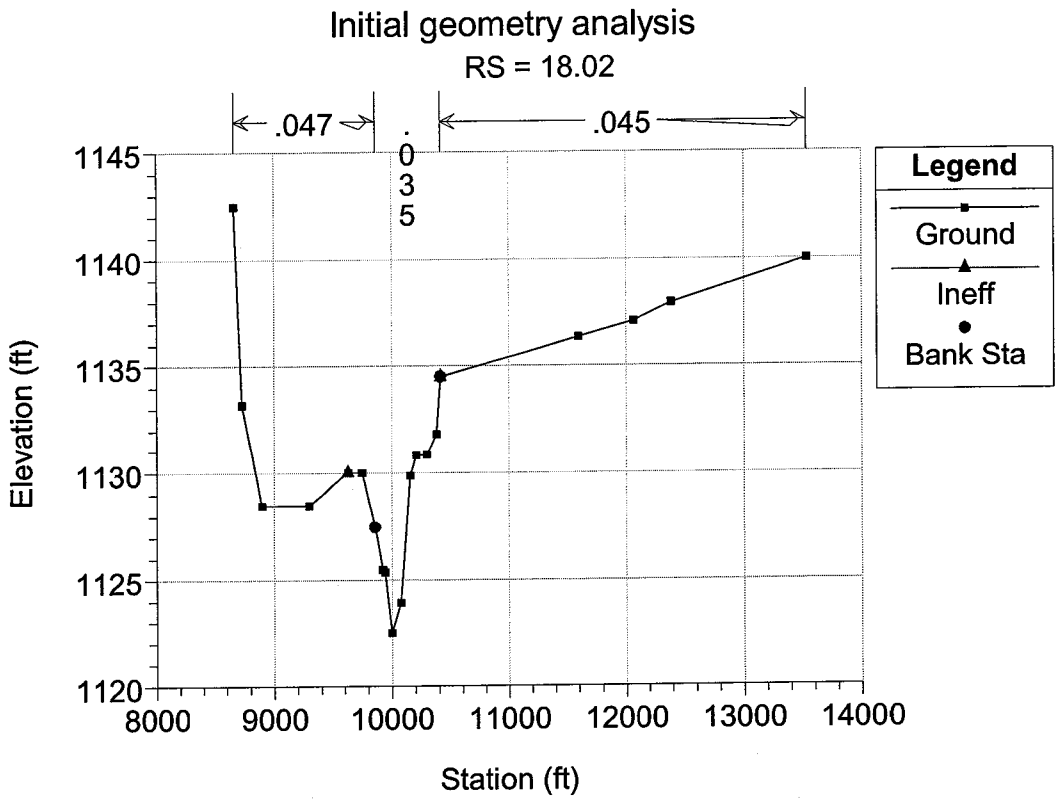
13500
Station (ft)

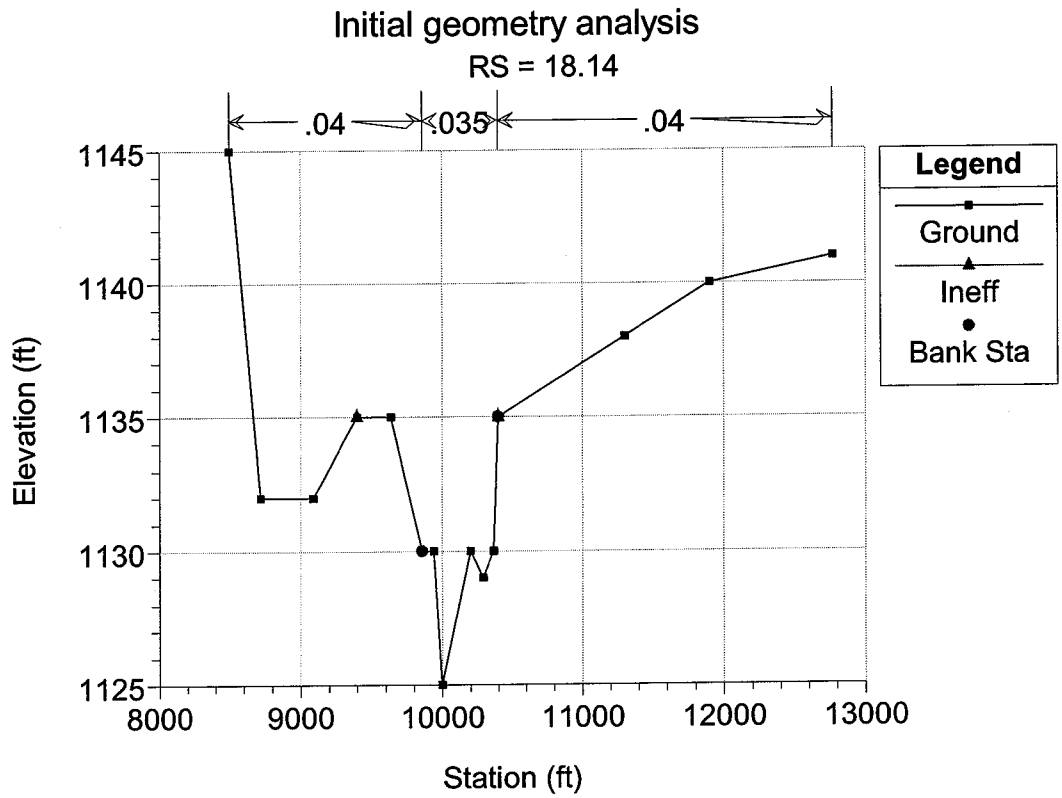

Initial geometry analysis
RS = 17.3
.05
.00
.03
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1145
1140
1135
1130
1125
1120
1115
9000
10000
11000
12000
13000
14000
Station (ft)

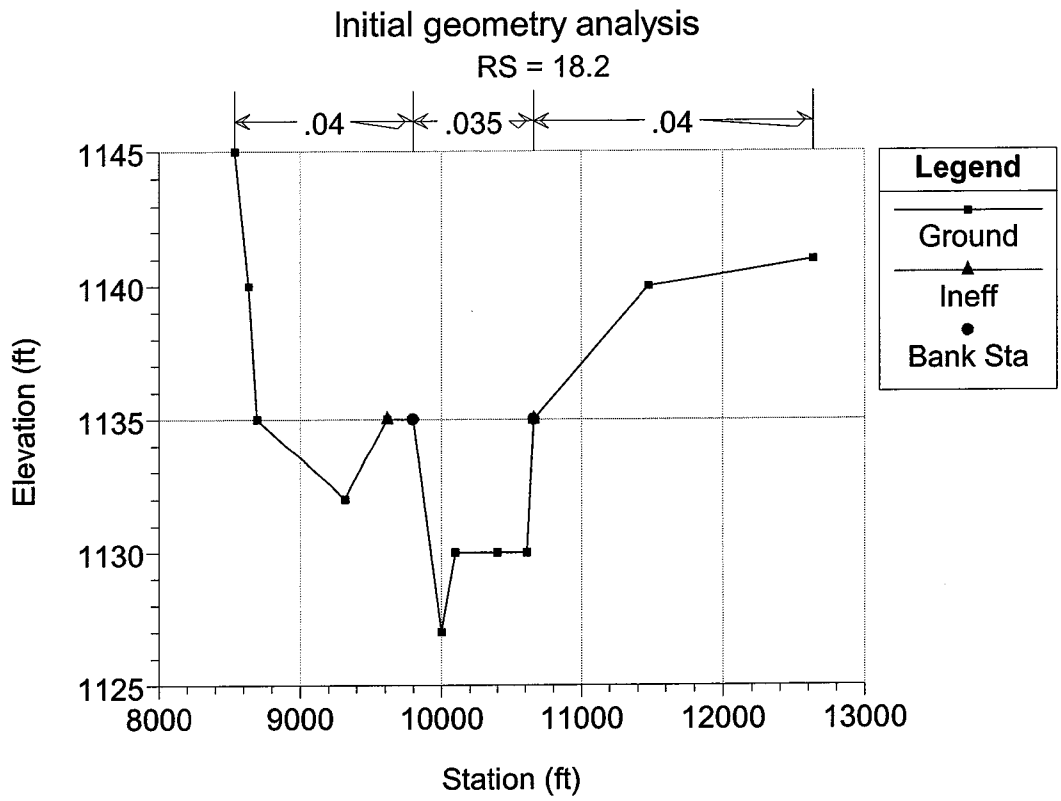

Initial geometry analysis
RS = 17.4
.05
.00
.03
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1145
1140
1135
1130
1125
1120
1115
9000
10000
11000
12000
13000
14000
15000
Station (ft)

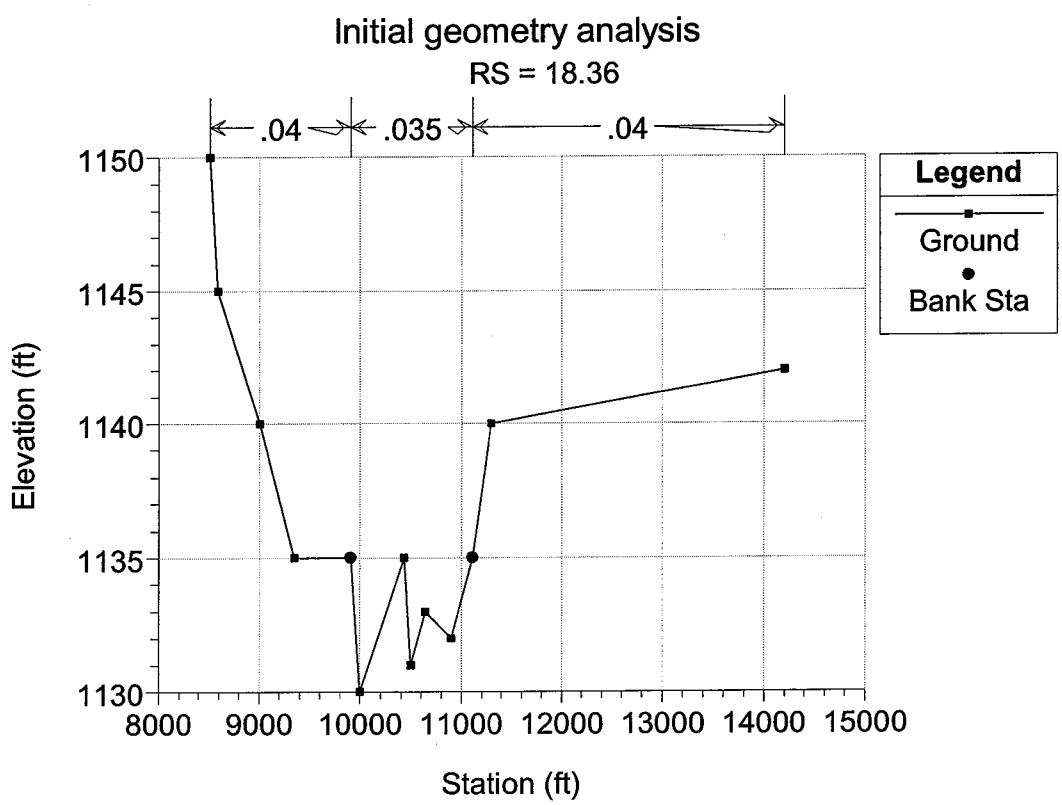

Initial geometry analysis
RS = 17.6
.05
Legend
Ground
Bank Sta
Elevation (ft)
1160
1150
1140
1130
1120
1110
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)

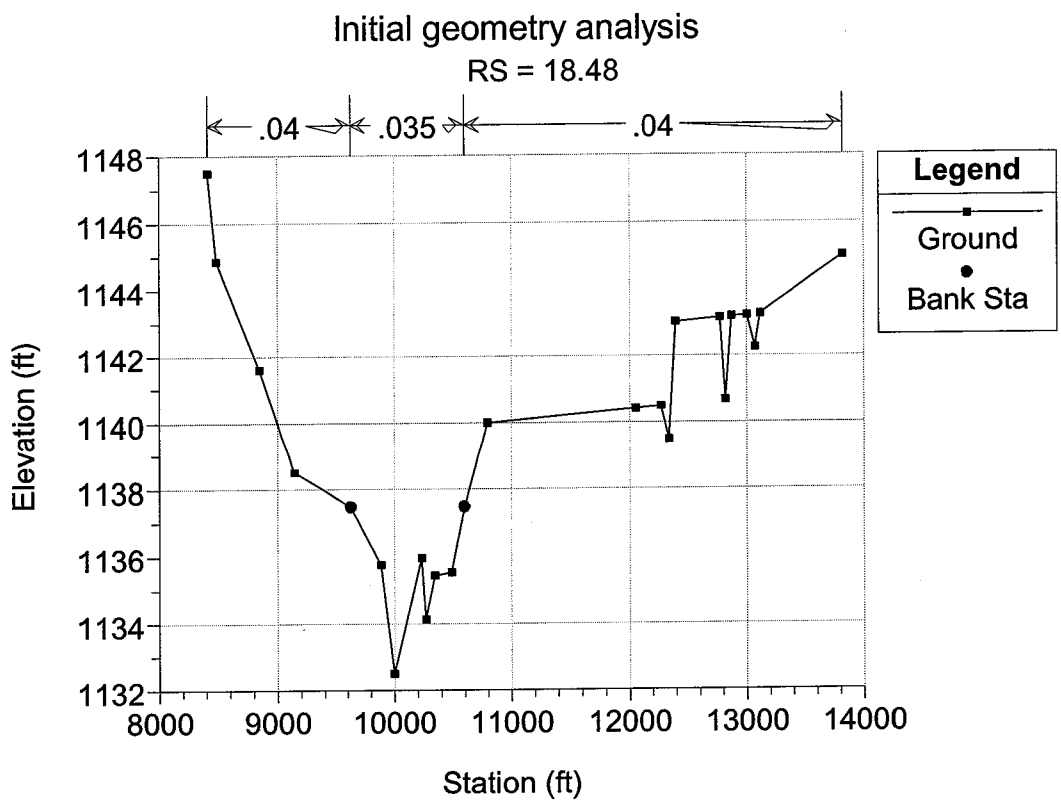

Initial geometry analysis
RS = 17.9
.055
.05
Legend
Ground
Bank Sta
Elevation (ft)
1140
1135
1130
1125
1120
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)

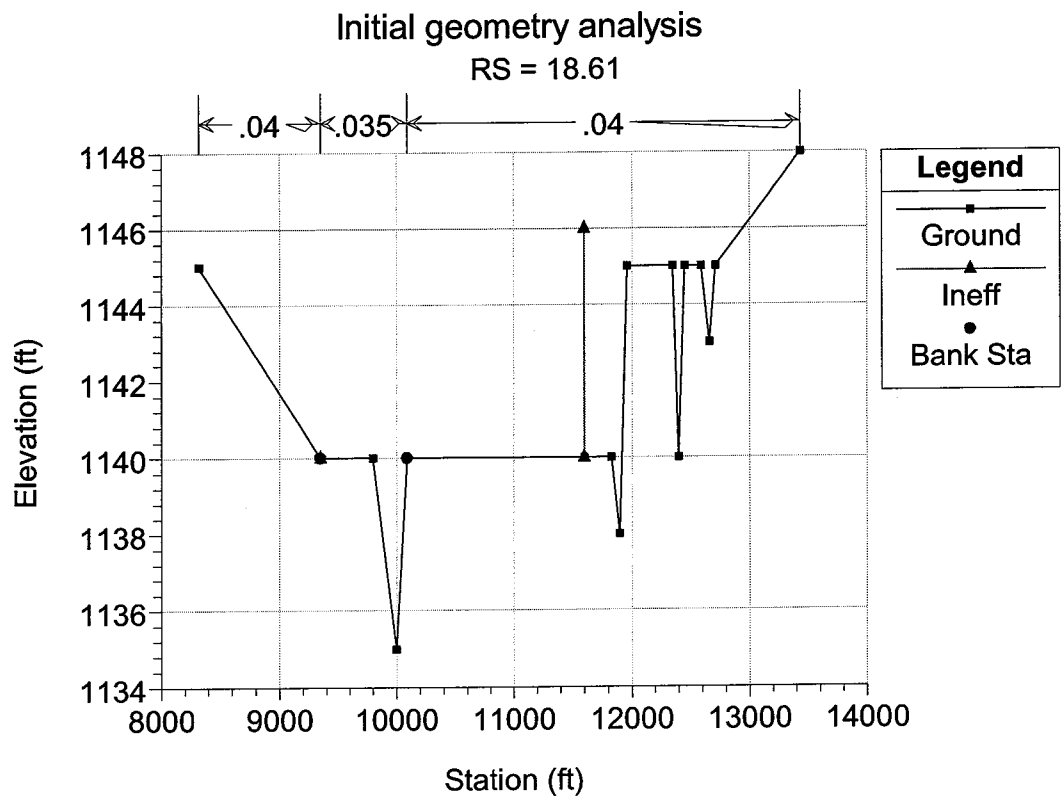

Initial geometry analysis
RS = 18.02
.047
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1145
1140
1135
1130
1125
1120
8000
9000
10000
11000
12000
13000
14000
Station (ft)

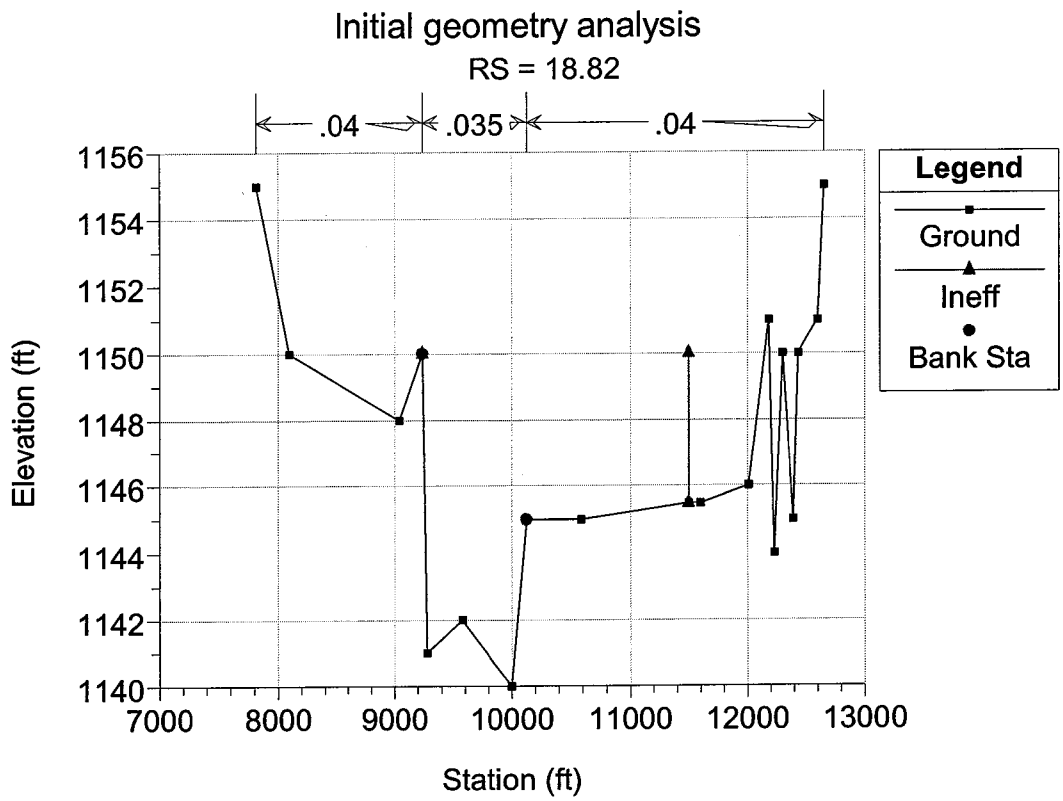

Initial geometry analysis
RS = 18.14
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1145
1140
1135
1130
1125
8000
9000
10000
11000
12000
13000
Station (ft)

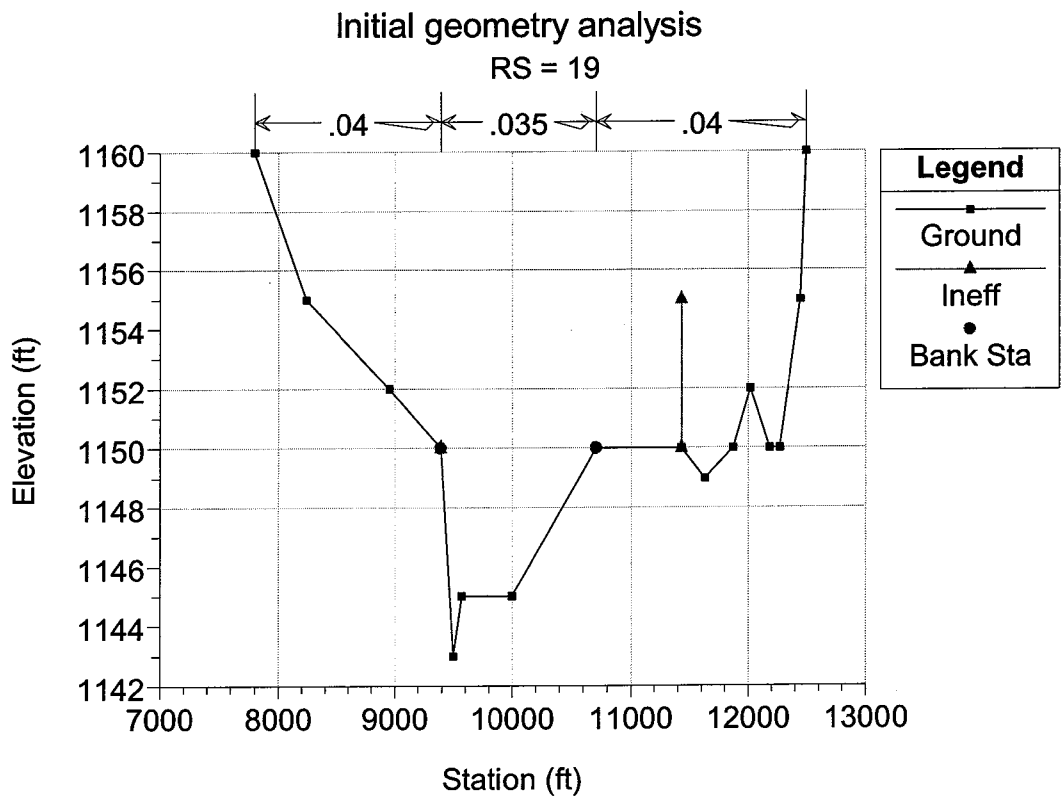

Initial geometry analysis
RS = 18.2
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1145
1140
1135
1130
1125
8000
9000
10000
11000
12000
13000
Station (ft)

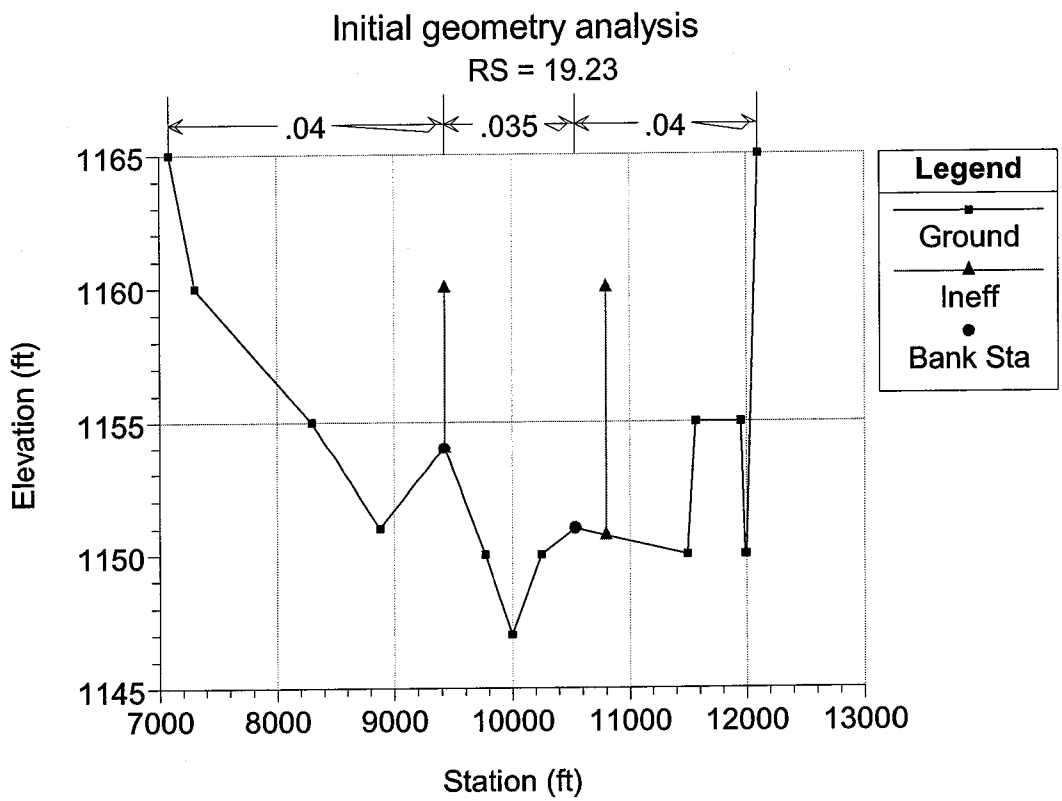

Initial geometry analysis
RS = 18.36
.04
.035
.04
Legend
Ground
Bank Sta
Elevation (ft)
1150
1145
1140
1135
1130
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)

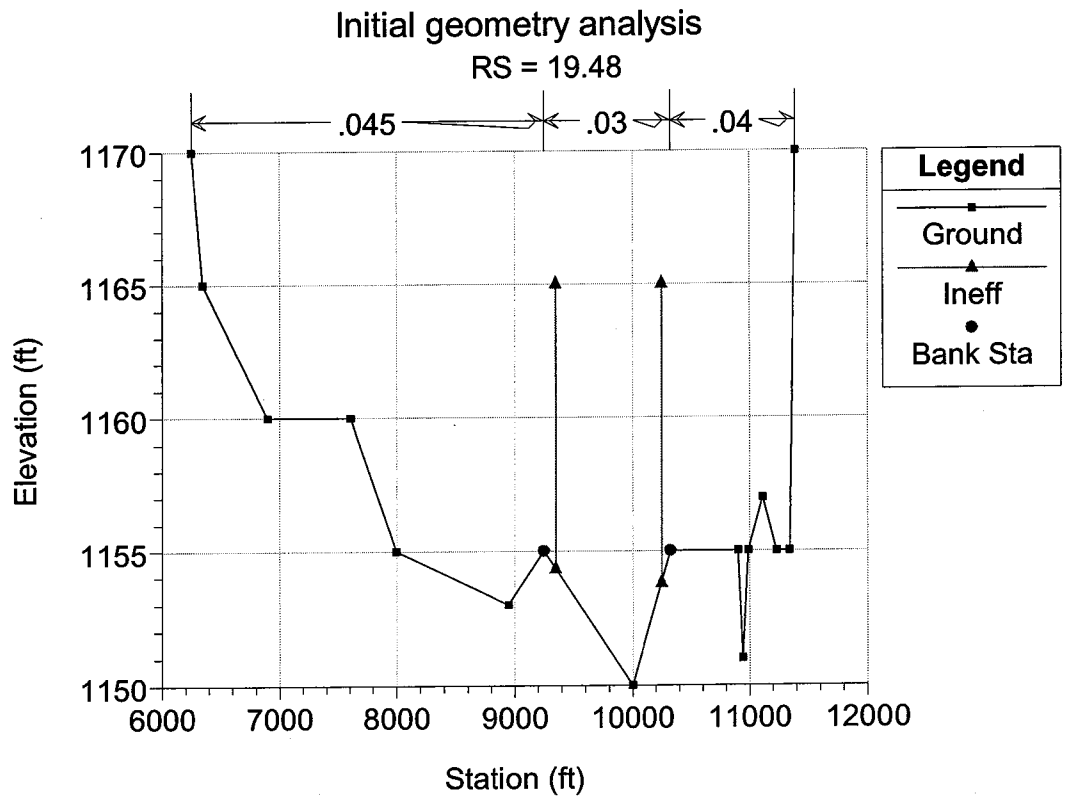

Initial geometry analysis
RS = 18.48
.04
.035
.04
Legend
Ground
Bank Sta
Elevation (ft)
1148
1146
1144
1142
1140
1138
1136
1134
1132
8000
9000
10000
11000
12000
13000
14000
Station (ft)

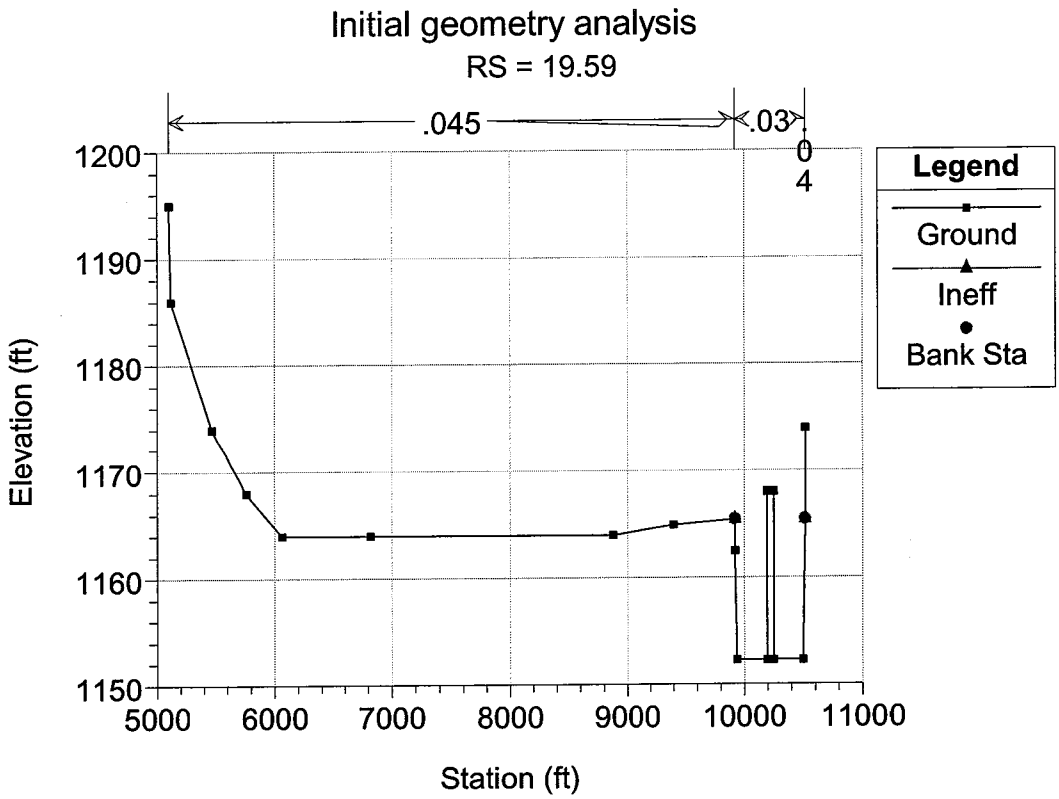

Initial geometry analysis
RS = 18.61
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1148
1146
1144
1142
1140
1138
1136
1134
8000
9000
10000
11000
12000
13000
14000
Station (ft)

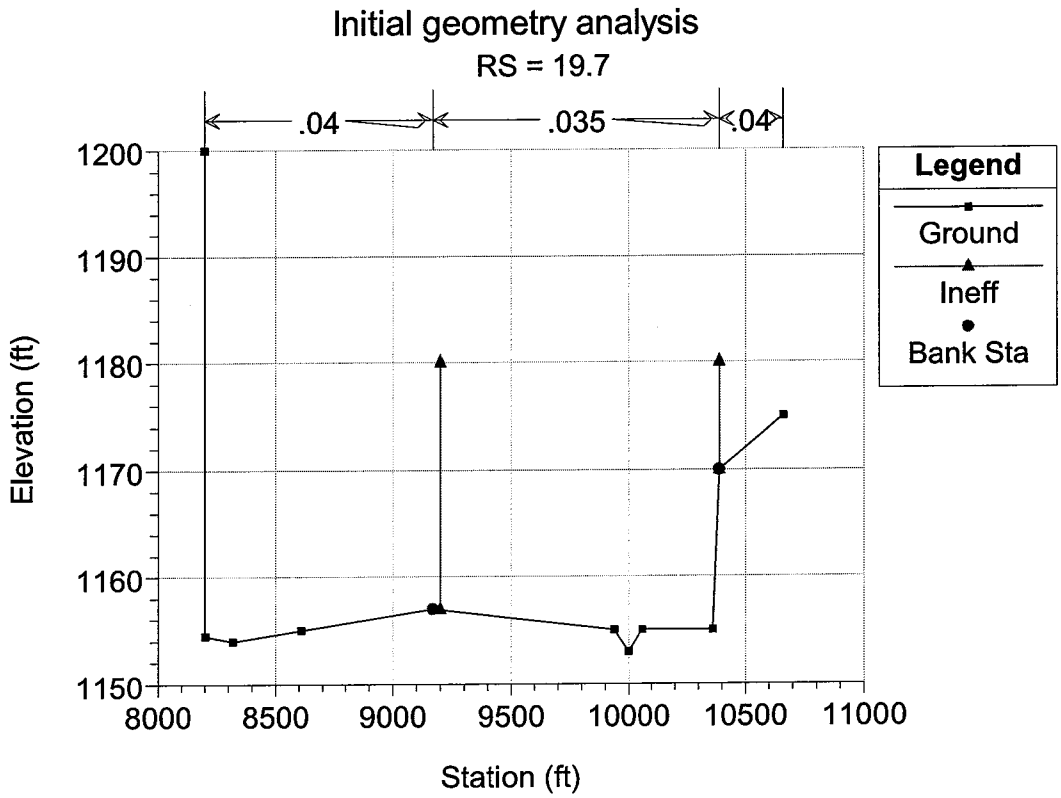

Initial geometry analysis
RS = 18.82
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1156
1154
1152
1150
1148
1146
1144
1142
1140
7000
8000
9000
10000
11000
12000
13000
Station (ft)

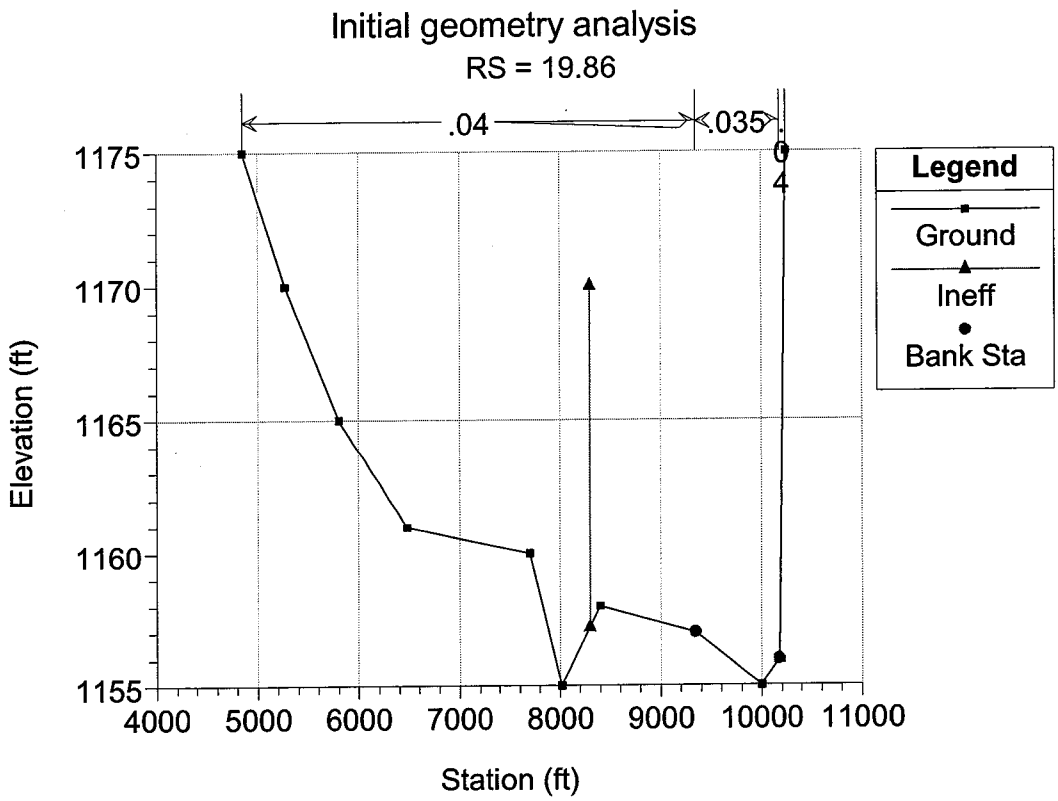

Initial geometry analysis
RS = 19
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1158
1156
1154
1152
1150
1148
1146
1144
1142
7000
8000
9000
10000
11000
12000
13000
Station (ft)

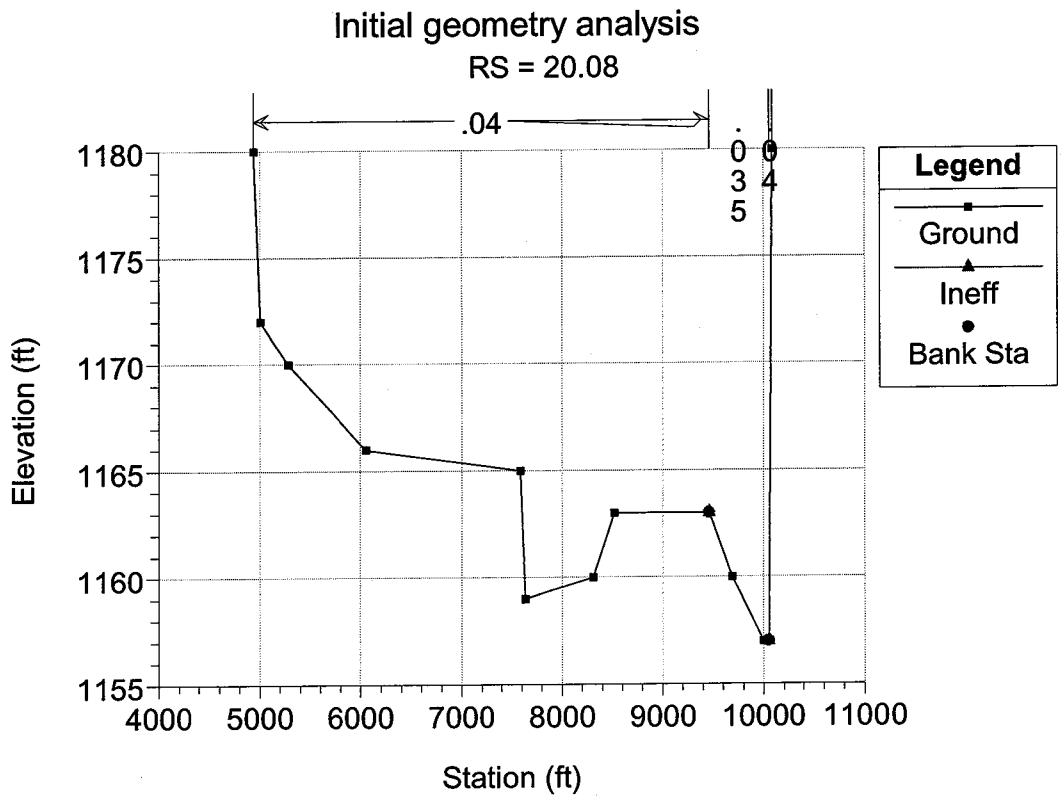

Initial geometry analysis
RS = 19.23
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1165
1160
1155
1150
1145
7000
8000
9000
10000
11000
12000
13000
Station (ft)

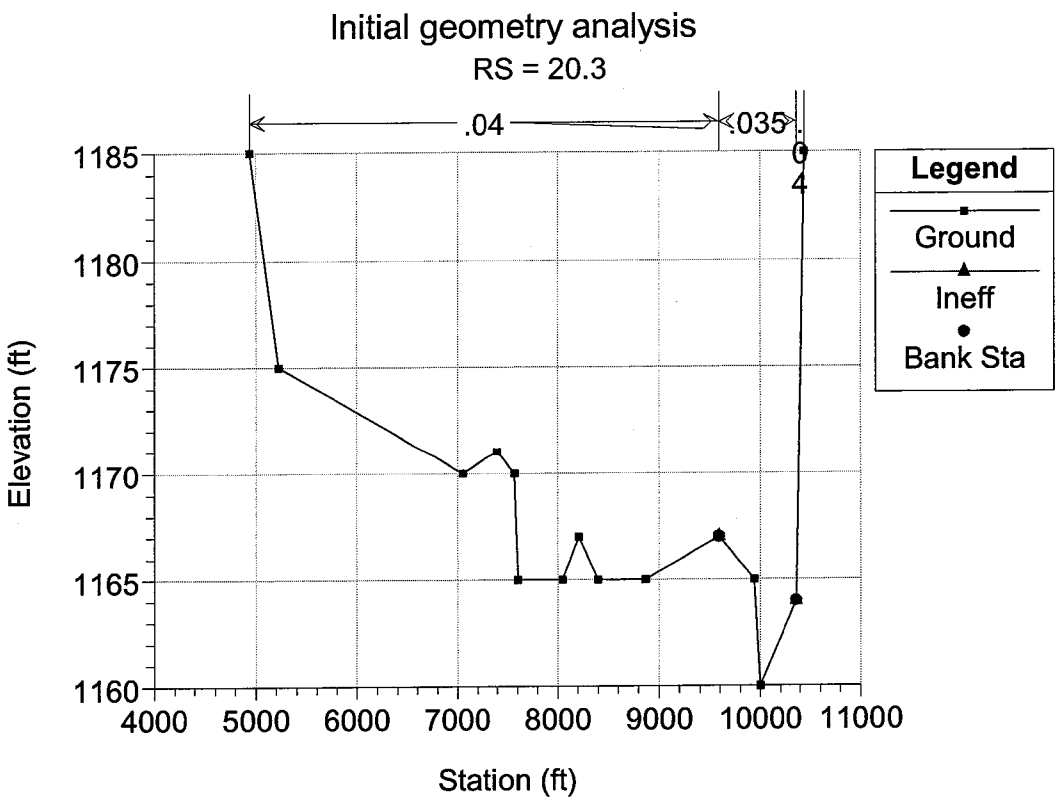

Initial geometry analysis
RS = 19.48
.045
.03
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1165
1160
1155
1150
6000
7000
8000
9000
10000
11000
12000
Station (ft)

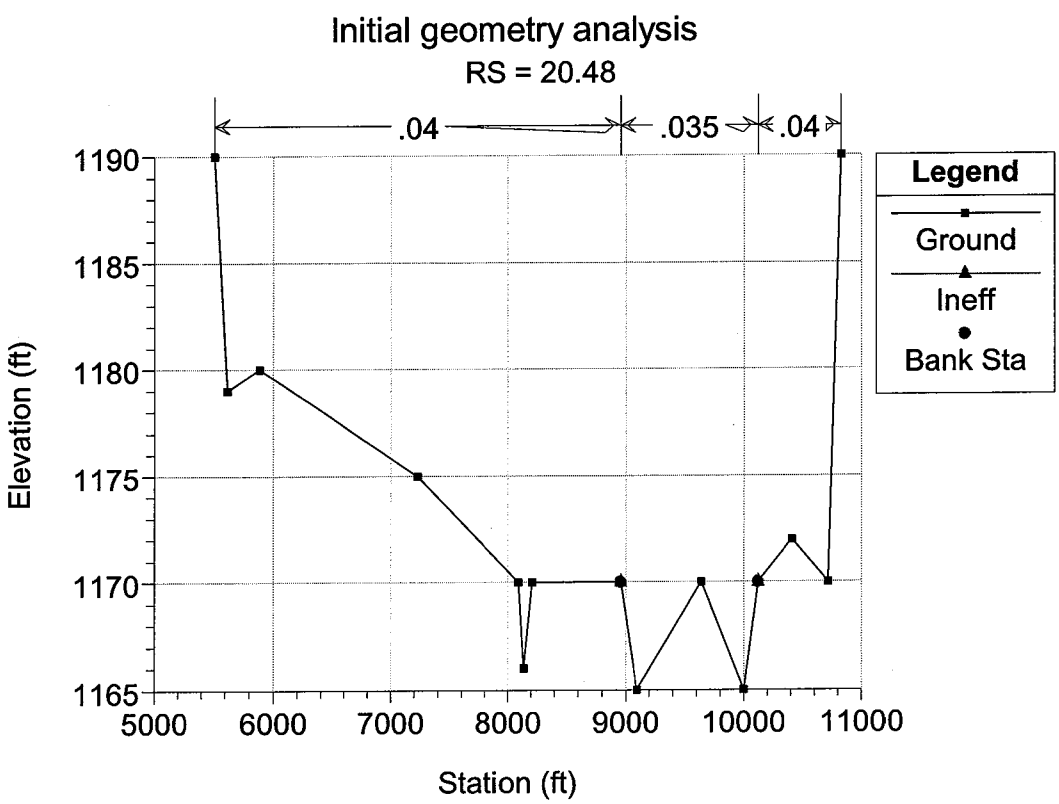

Initial geometry analysis
RS = 19.59
.045
.03
0
4
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1200
1190
1180
1170
1160
1150
5000
6000
7000
8000
9000
10000
11000
Station (ft)

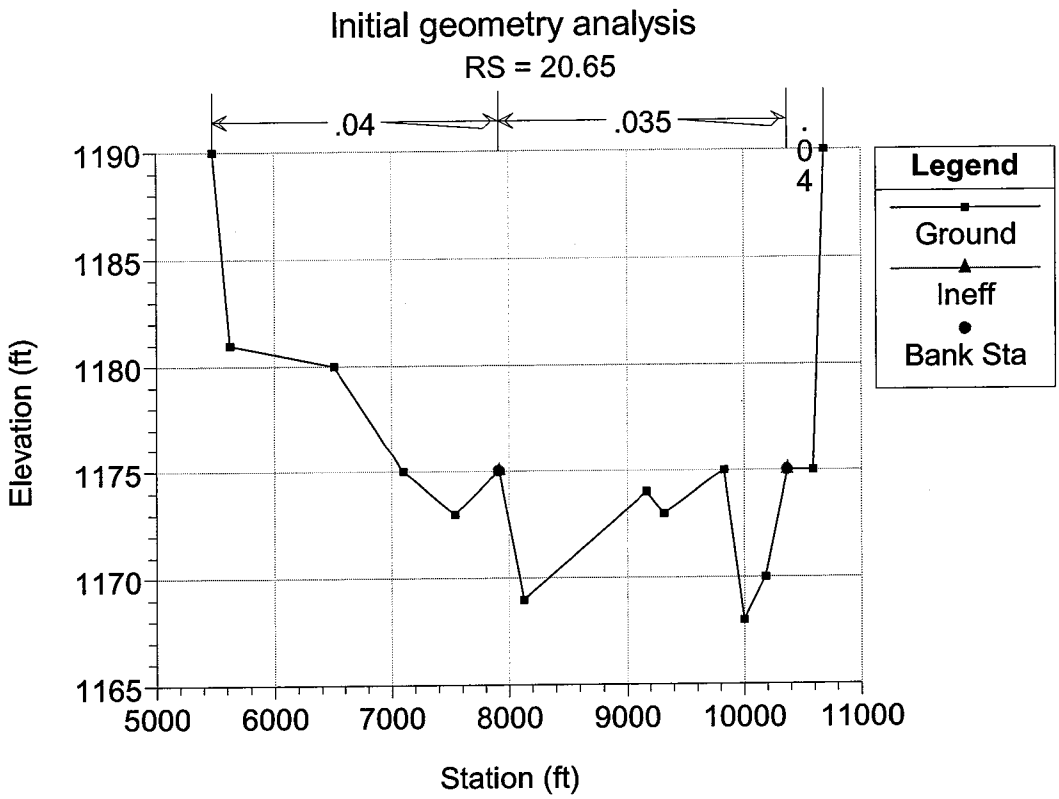

Initial geometry analysis
RS = 19.7
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1200
1190
1180
1170
1160
1150
8000
8500
9000
9500
10000
10500
11000
Station (ft)

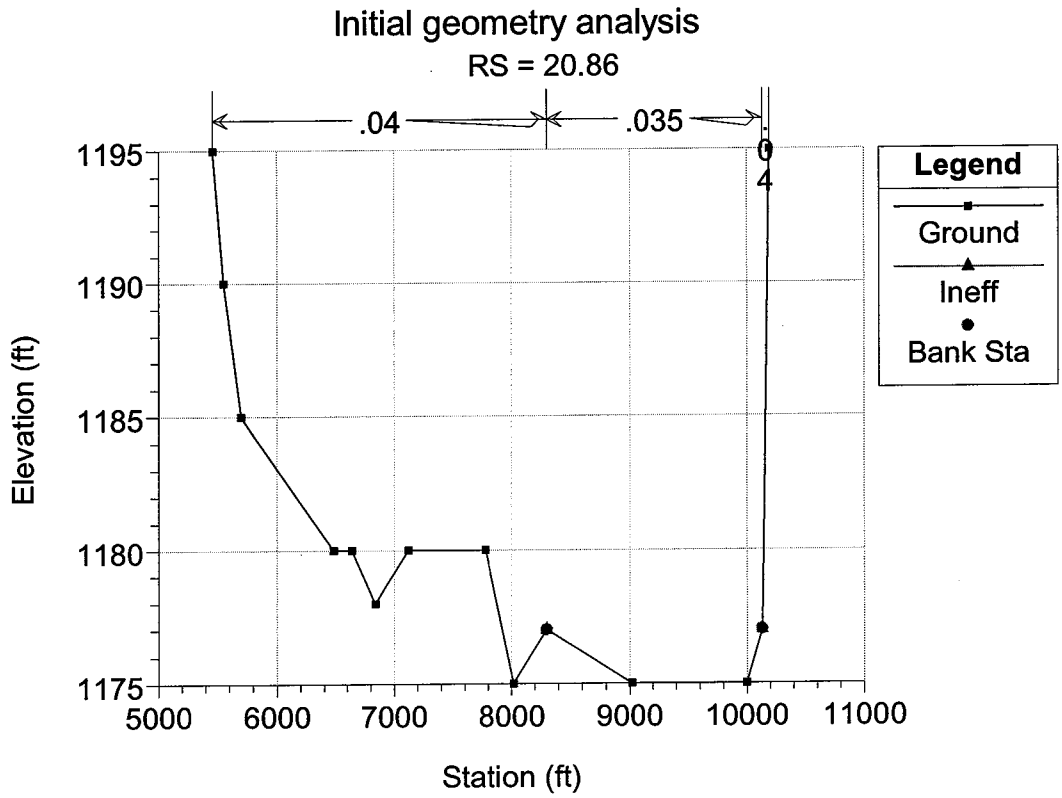

Initial geometry analysis
RS = 19.86
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1175
1170
1165
1160
1155
4000
5000
6000
7000
8000
9000
10000
11000
Station (ft)

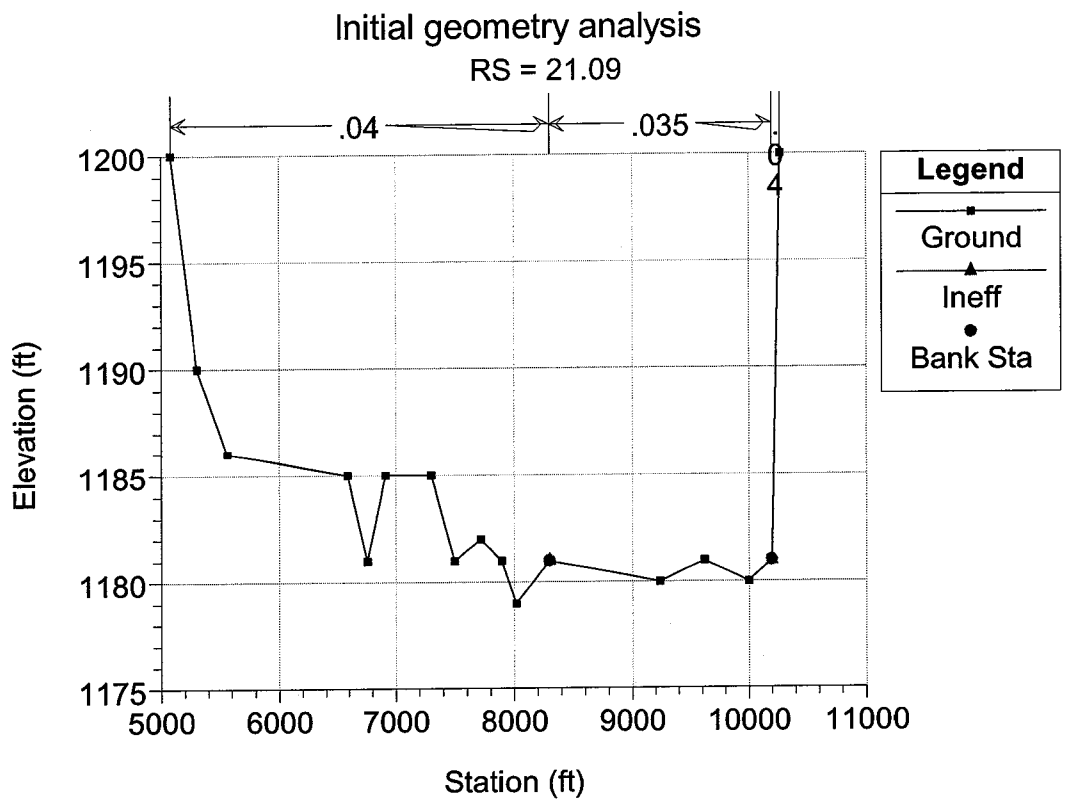

Initial geometry analysis
RS = 20.08
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
4000
5000
6000
7000
8000
9000
10000
11000
Station (ft)

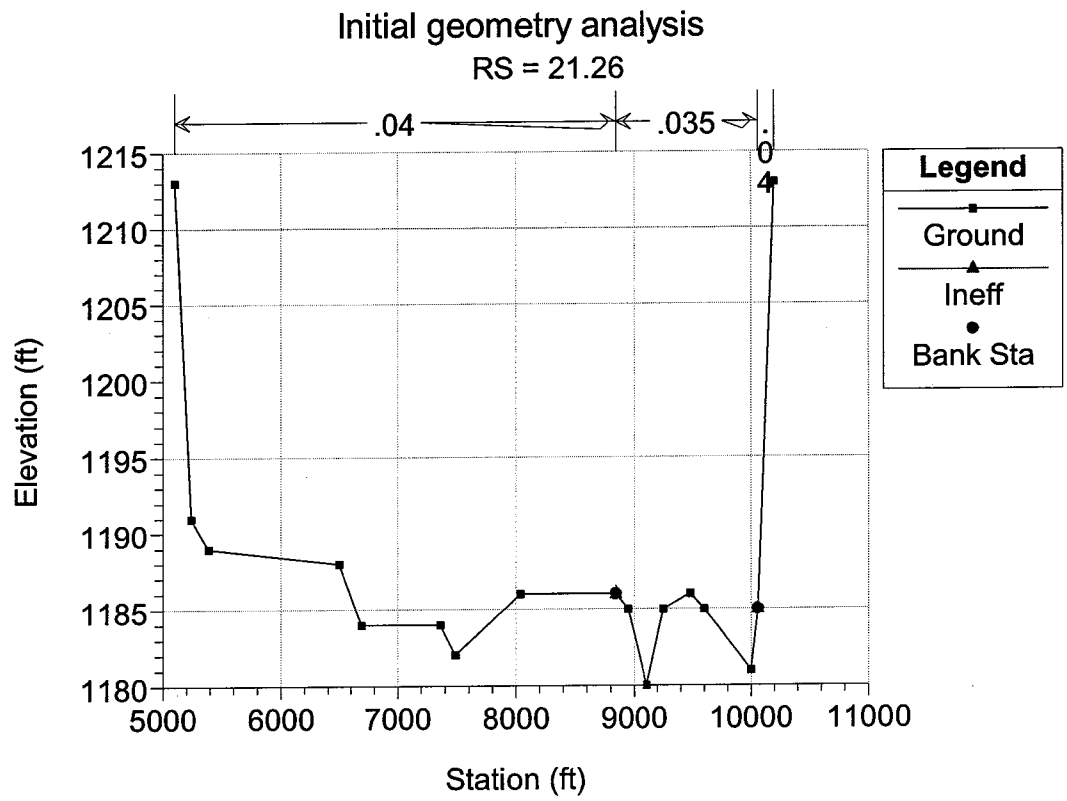

Initial geometry analysis
RS = 20.3
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1185
1180
1175
1170
1165
1160
4000
5000
6000
7000
8000
9000
10000
11000
Station (ft)

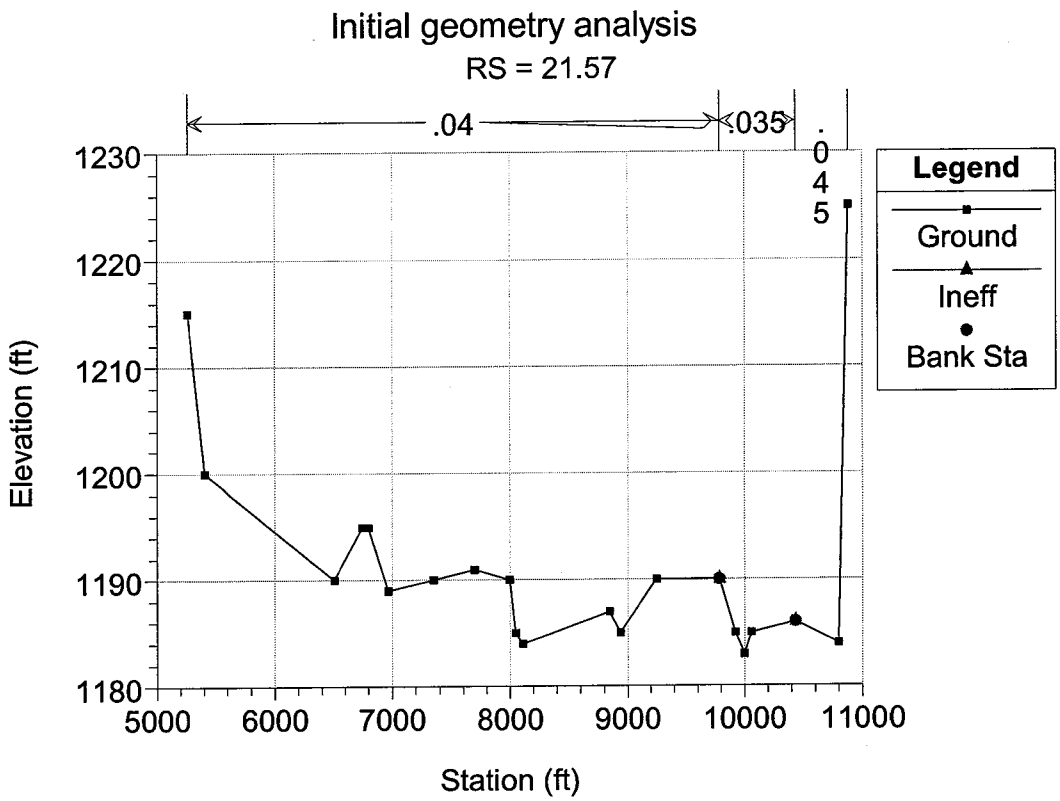

Initial geometry analysis
RS = 20.48
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1190
1185
1180
1175
1170
1165
5000
6000
7000
8000
9000
10000
11000
Station (ft)

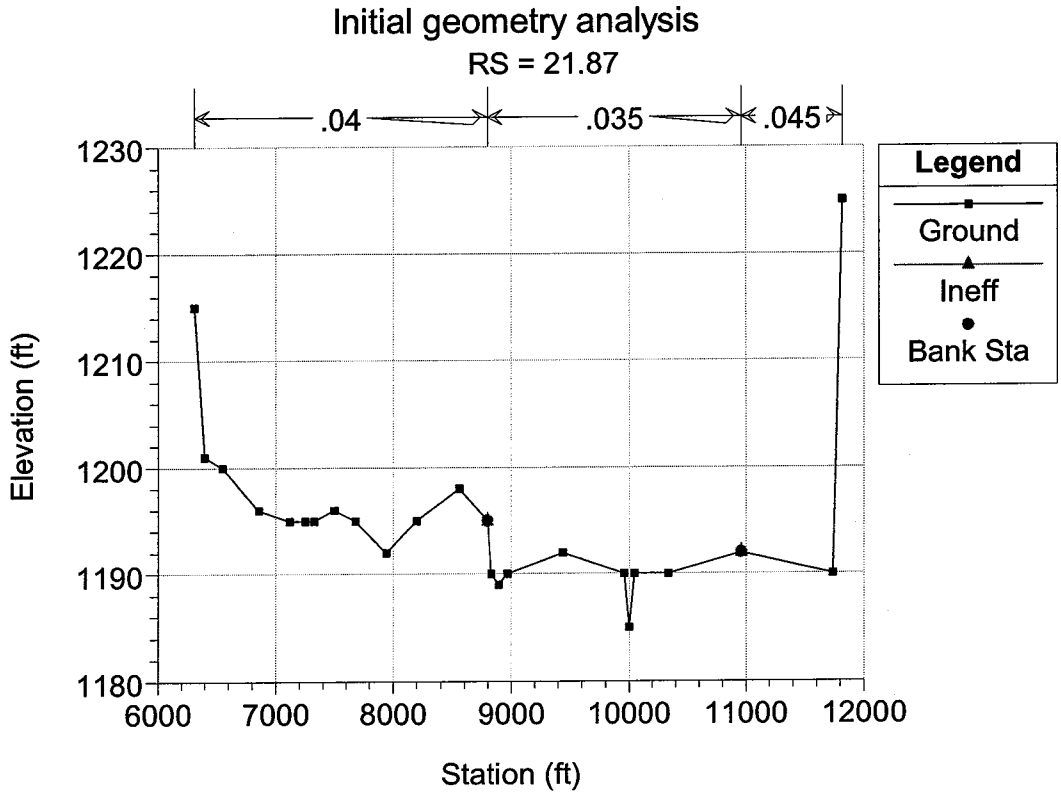

Initial geometry analysis
RS = 20.65
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1190
1185
1180
1175
1170
1165
5000
6000
7000
8000
9000
10000
11000
Station (ft)

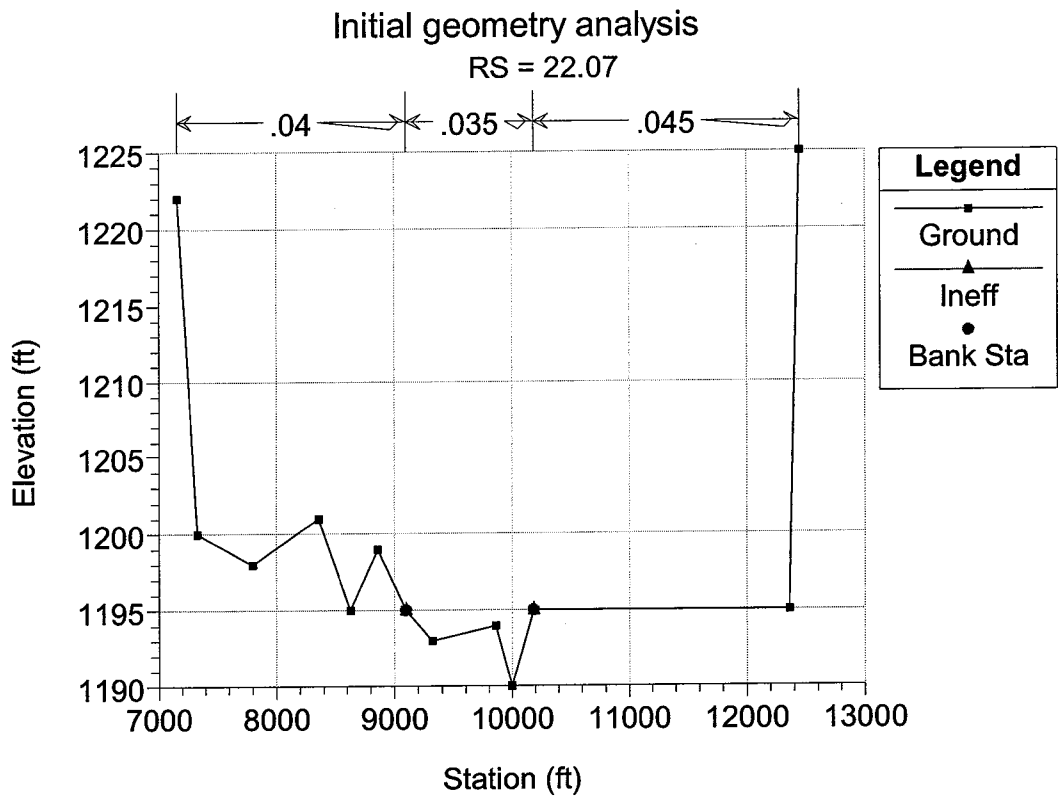

Initial geometry analysis
RS = 20.86
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1195
1190
1185
1180
1175
5000
6000
7000
8000
9000
10000
11000
Station (ft)

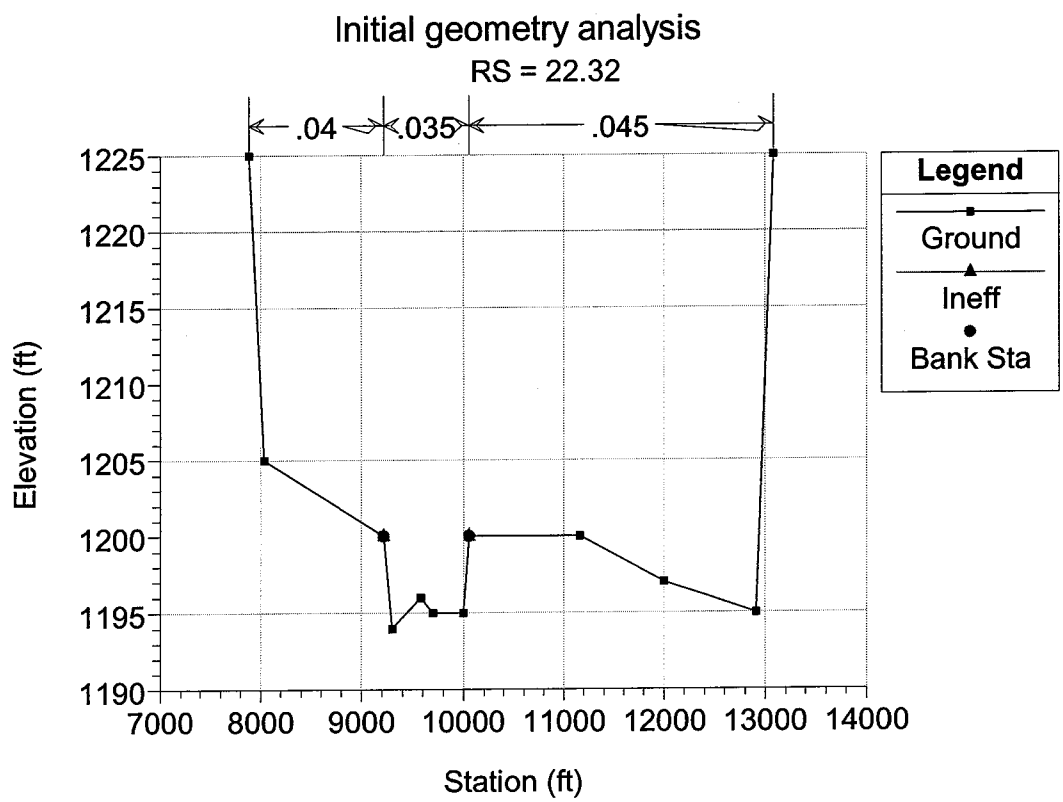

Initial geometry analysis
RS = 21.09
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1200
1195
1190
1185
1180
1175
5000
6000
7000
8000
9000
10000
11000
Station (ft)

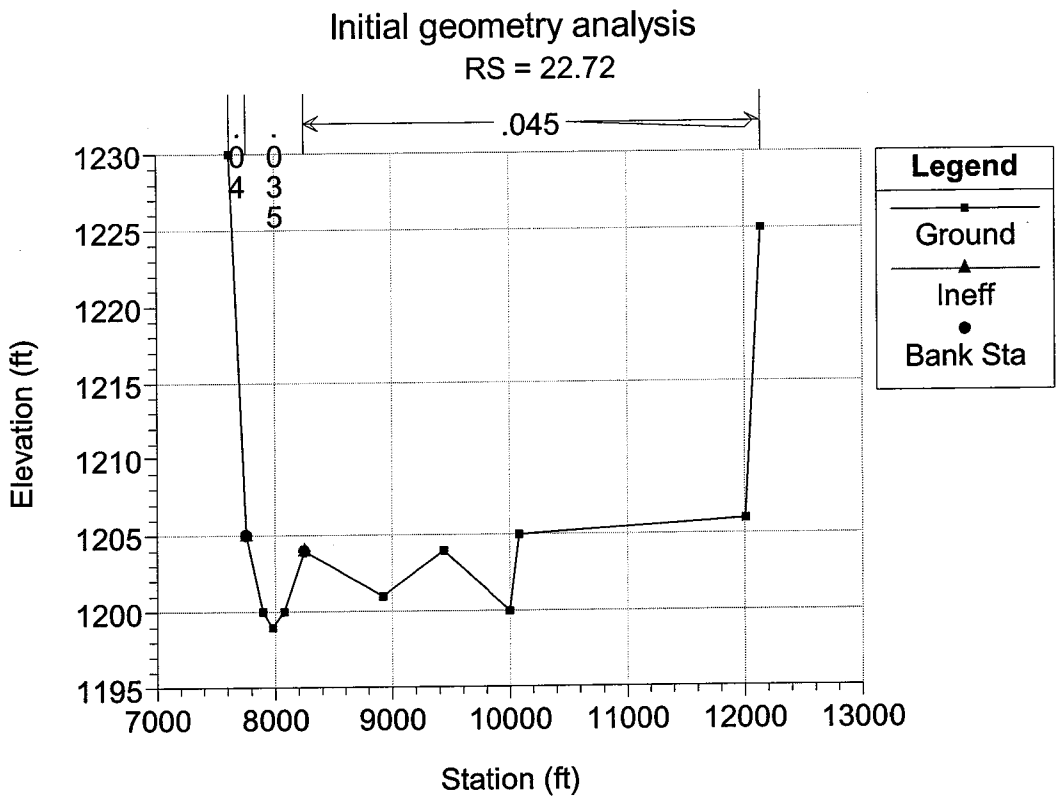

Initial geometry analysis
RS = 21.26
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1215
1210
1205
1200
1195
1190
1185
1180
5000
6000
7000
8000
9000
10000
11000
Station (ft)

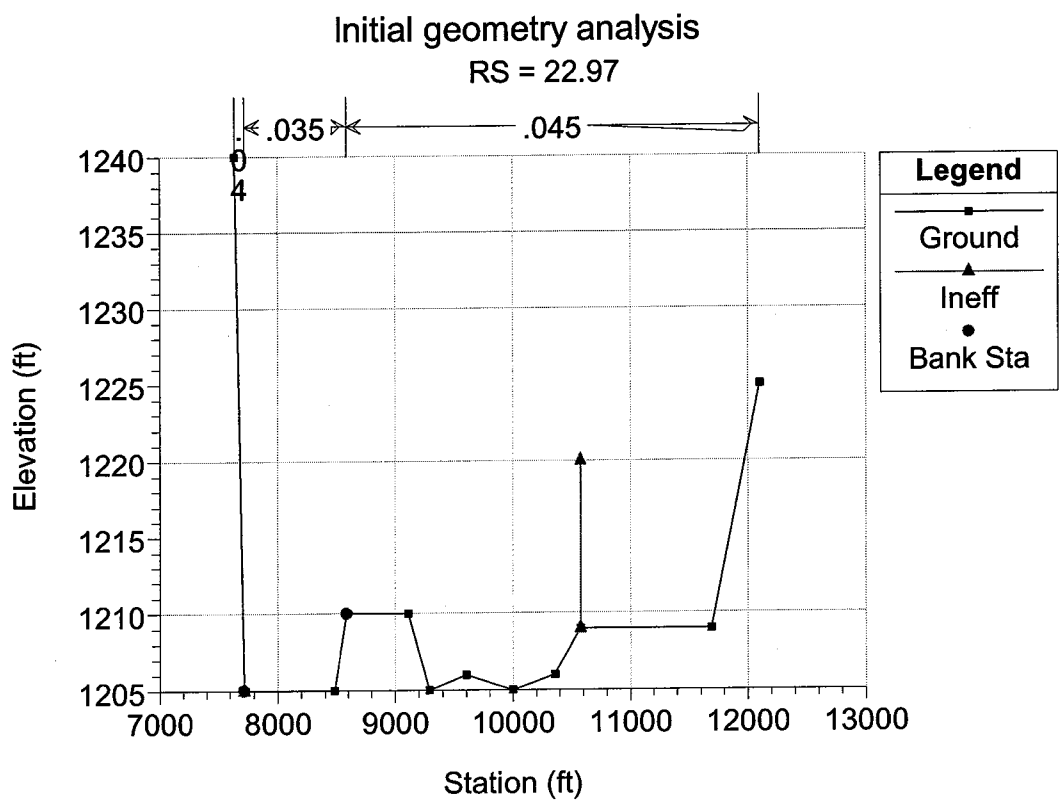

Initial geometry analysis
RS = 21.57
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1230
1220
1210
1200
1190
1180
5000
6000
7000
8000
9000
10000
11000
Station (ft)

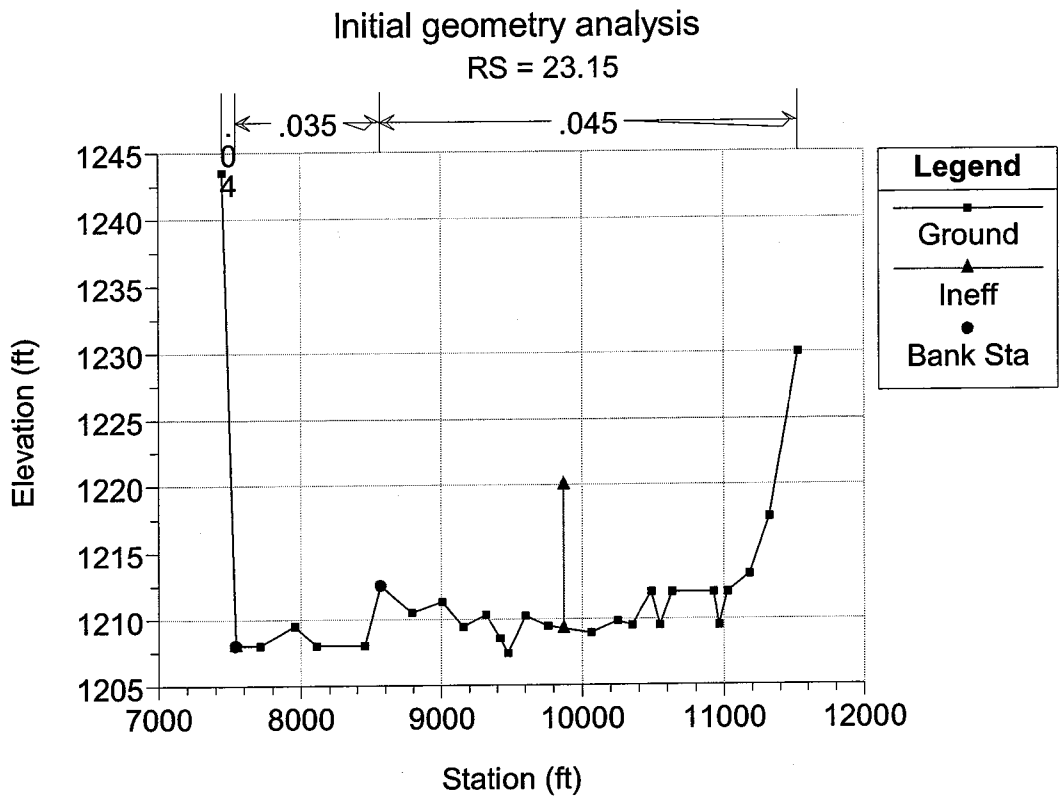

Initial geometry analysis
RS = 21.87
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1230
1220
1210
1200
1190
1180
6000
7000
8000
9000
10000
11000
12000
Station (ft)

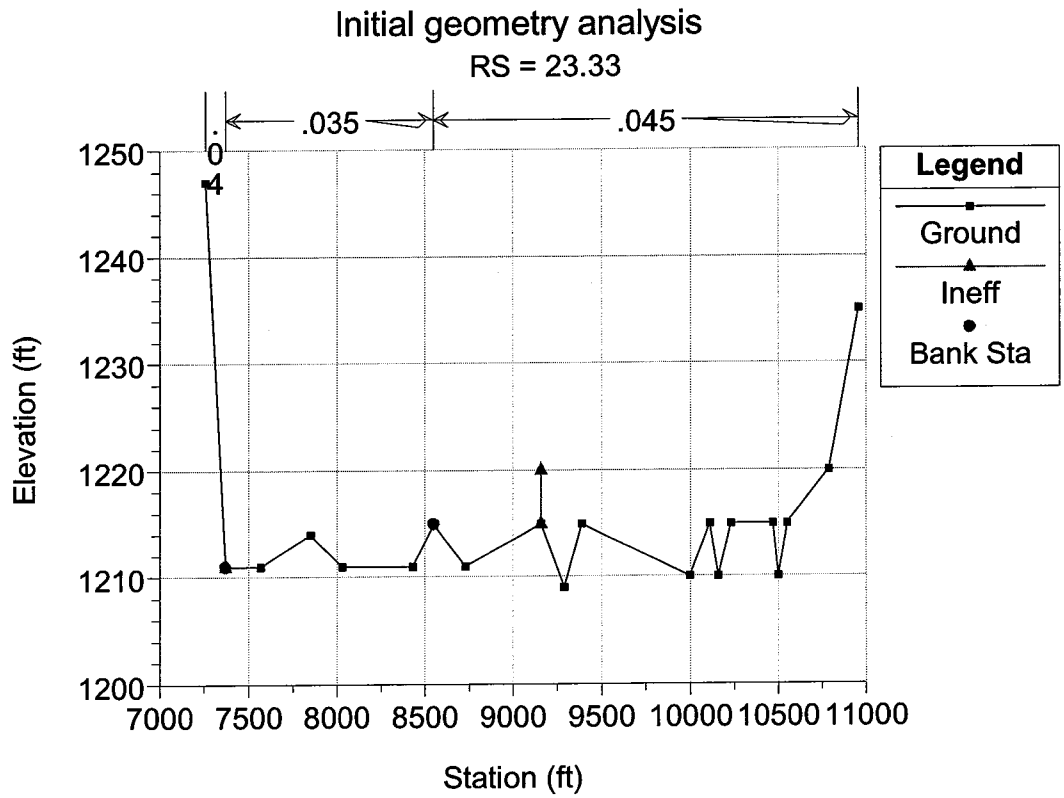

Initial geometry analysis
RS = 22.07
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1225
1220
1215
1210
1205
1200
1195
1190
7000
8000
9000
10000
11000
12000
13000
Station (ft)

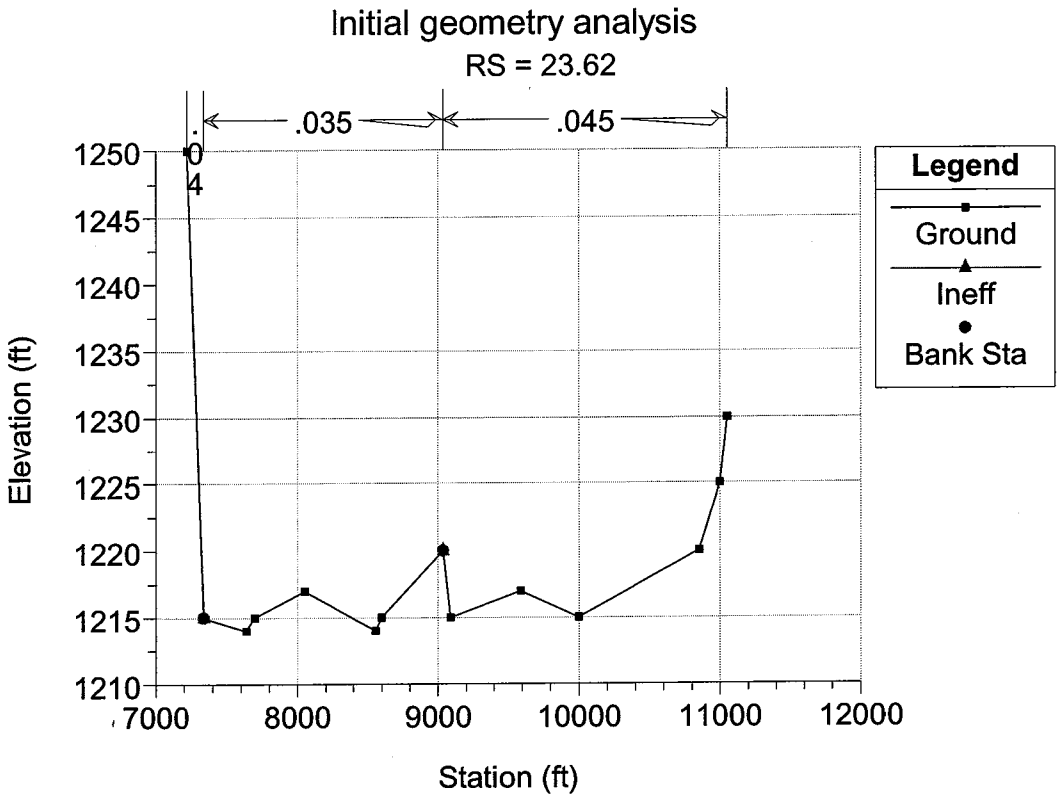

Initial geometry analysis
RS = 22.32
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1225
1220
1215
1210
1205
1200
1195
1190
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)

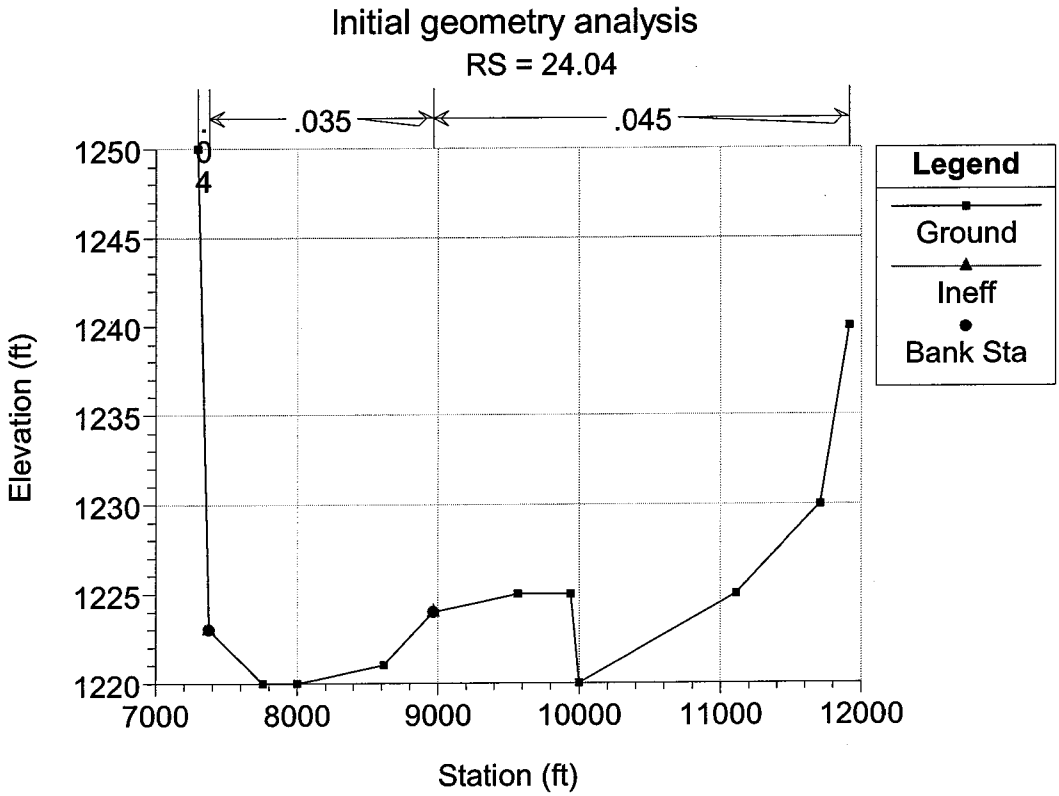

Initial geometry analysis
RS = 22.72
.045
.04
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1230
1225
1220
1215
1210
1205
1200
1195
7000
8000
9000
10000
11000
12000
13000
Station (ft)

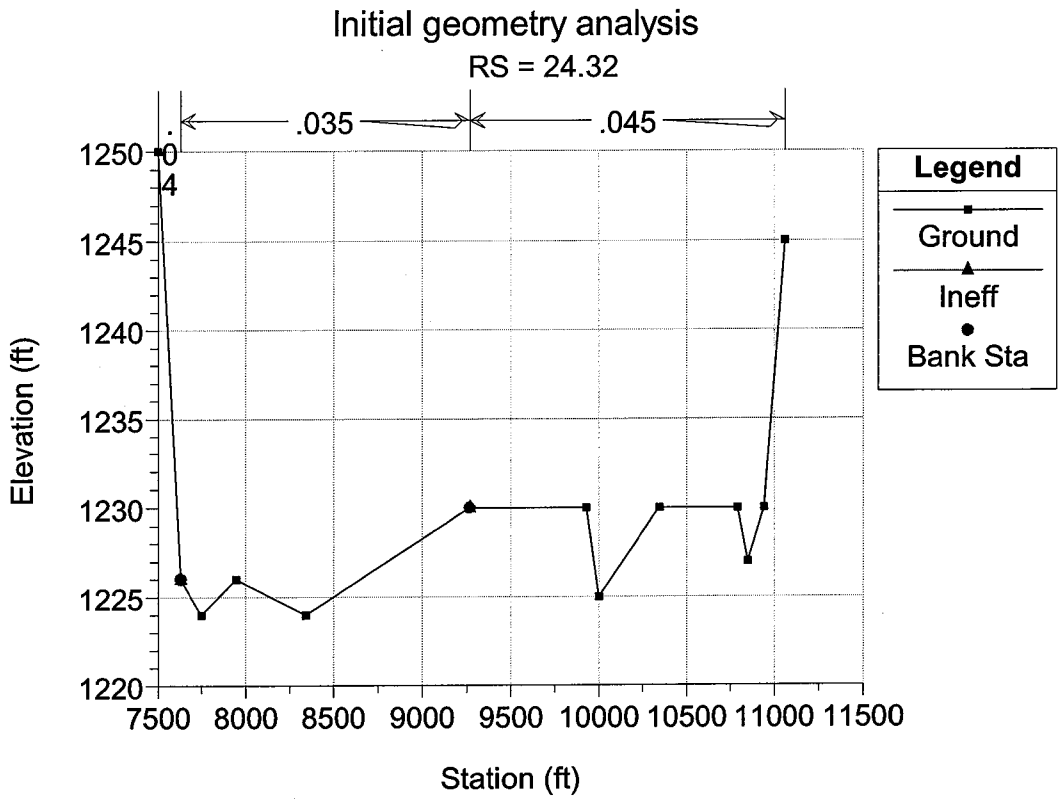

Initial geometry analysis
RS = 22.97
.035
.045
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1235
1230
1225
1220
1215
1210
1205
7000
8000
9000
10000
11000
12000
13000
Station (ft)


Initial geometry analysis
RS = 23.15
.035
.045
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1245
1240
1235
1230
1225
1220
1215
1210
1205
7000
8000
9000
10000
11000
12000
Station (ft)


Initial geometry analysis
RS = 23.33
.035
.045
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1250
1240
1230
1220
1210
1200
7000
7500
8000
8500
9000
9500
10000
10500
11000
Station (ft)

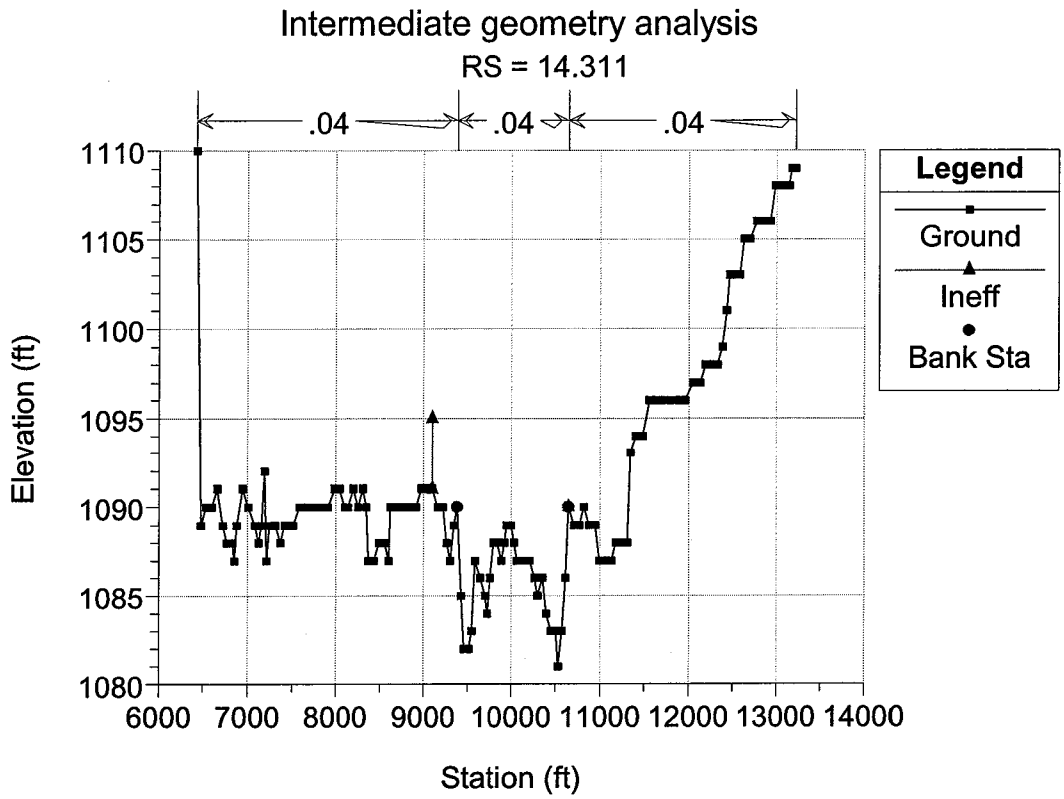

Initial geometry analysis
RS = 23.62
.035
.045
.04
1250
1245
1240
1235
1230
1225
1220
1215
1210
Elevation (ft)
7000
8000
9000
10000
11000
12000
Station (ft)
Legend
Ground
Ineff
Bank Sta

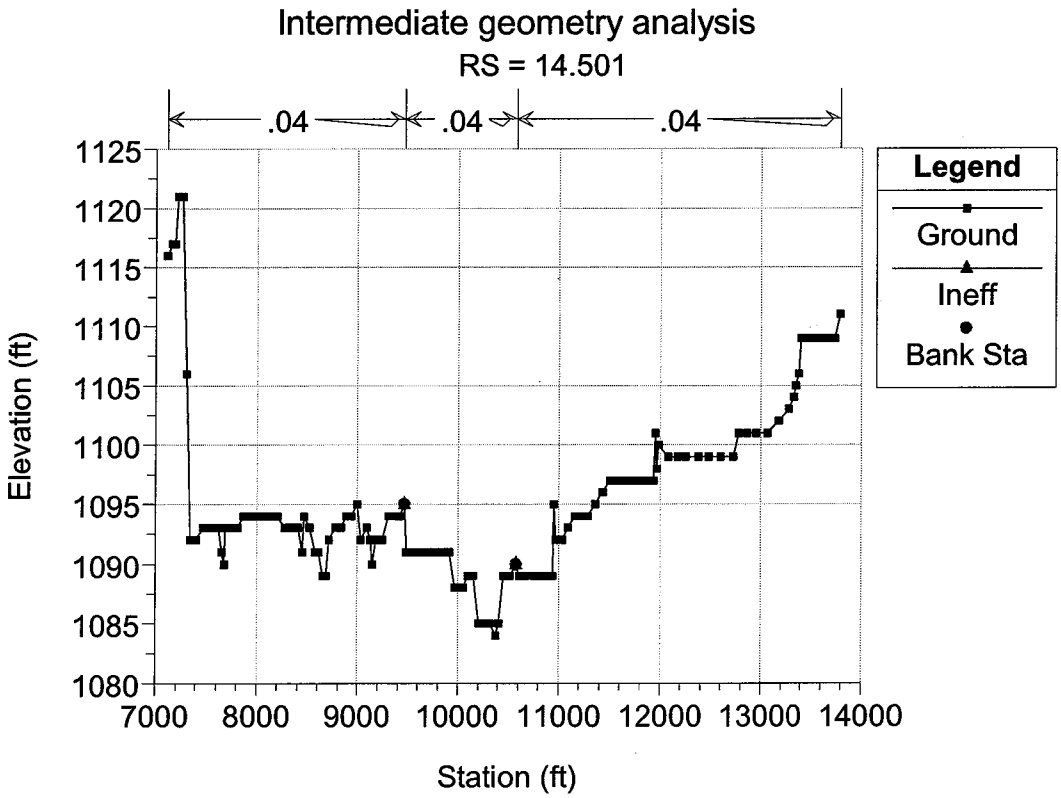

Initial geometry analysis
RS = 24.04
.035
.045
.04
1250
1245
1240
1235
1230
1225
1220
Elevation (ft)
7000
8000
9000
10000
11000
12000
Station (ft)
Legend
Ground
Ineff
Bank Sta

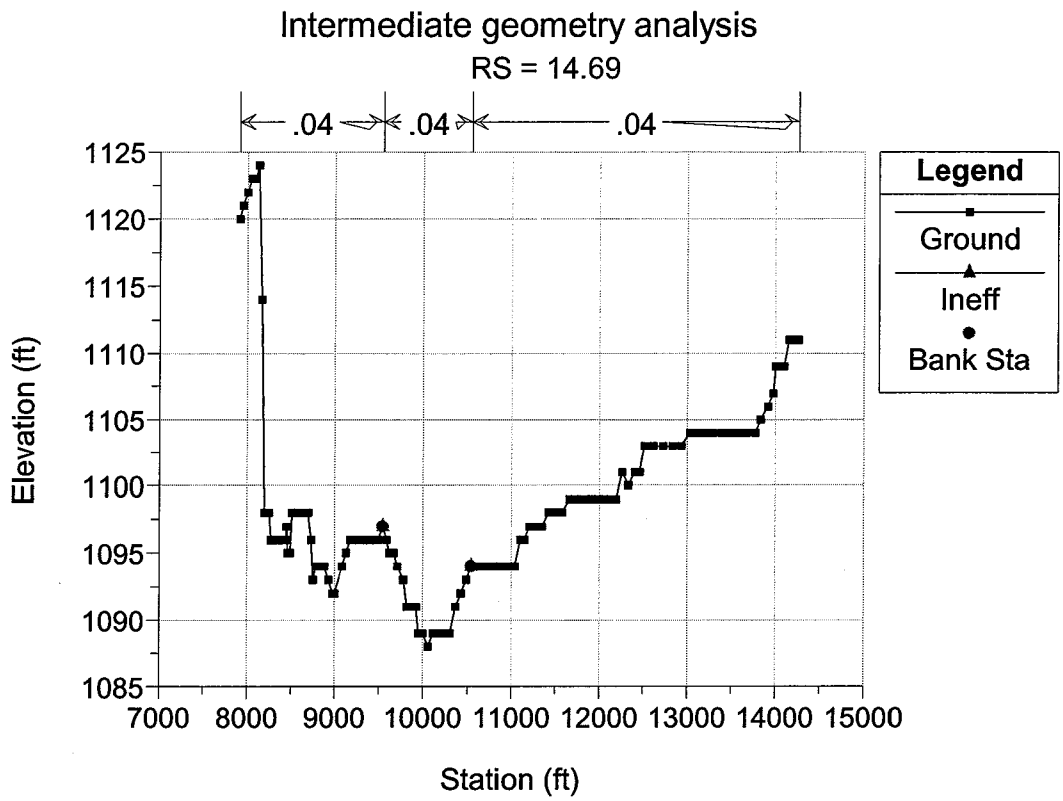

Initial geometry analysis
RS = 24.32
.035
.045
.04
1250
1245
1240
1235
1230
1225
1220
Elevation (ft)
7500
8000
8500
9000
9500
10000
10500
11000
11500
Station (ft)
Legend
Ground
Ineff
Bank Sta

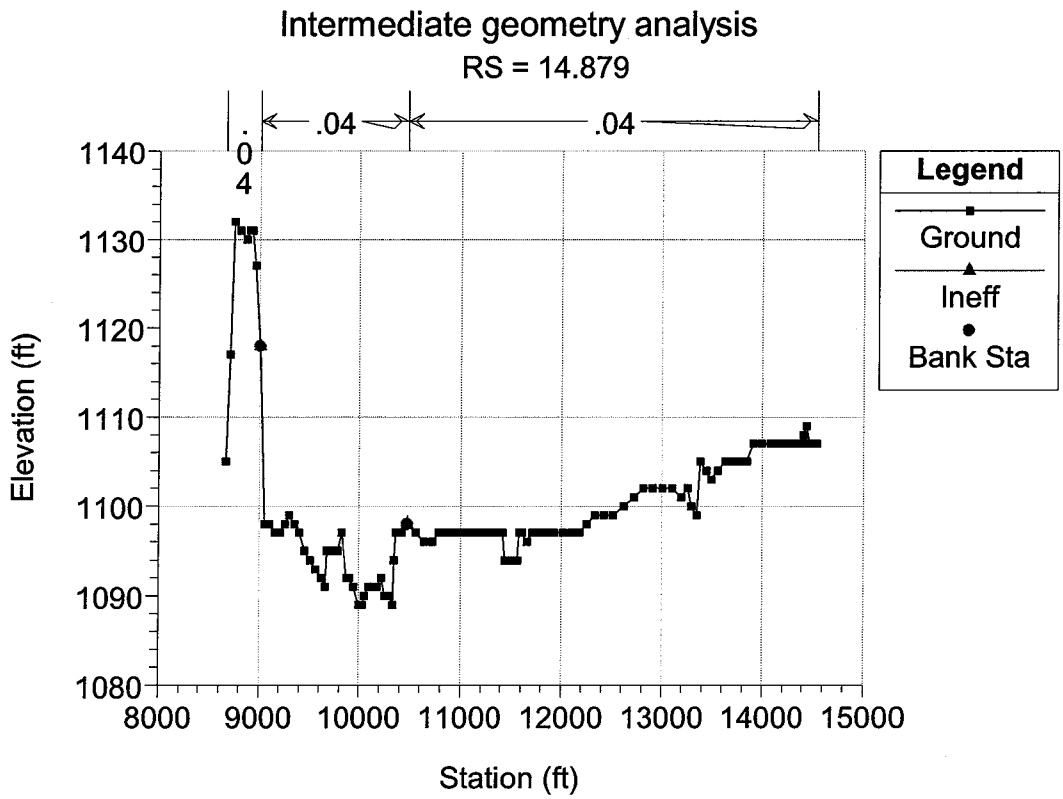
APPENDIX B

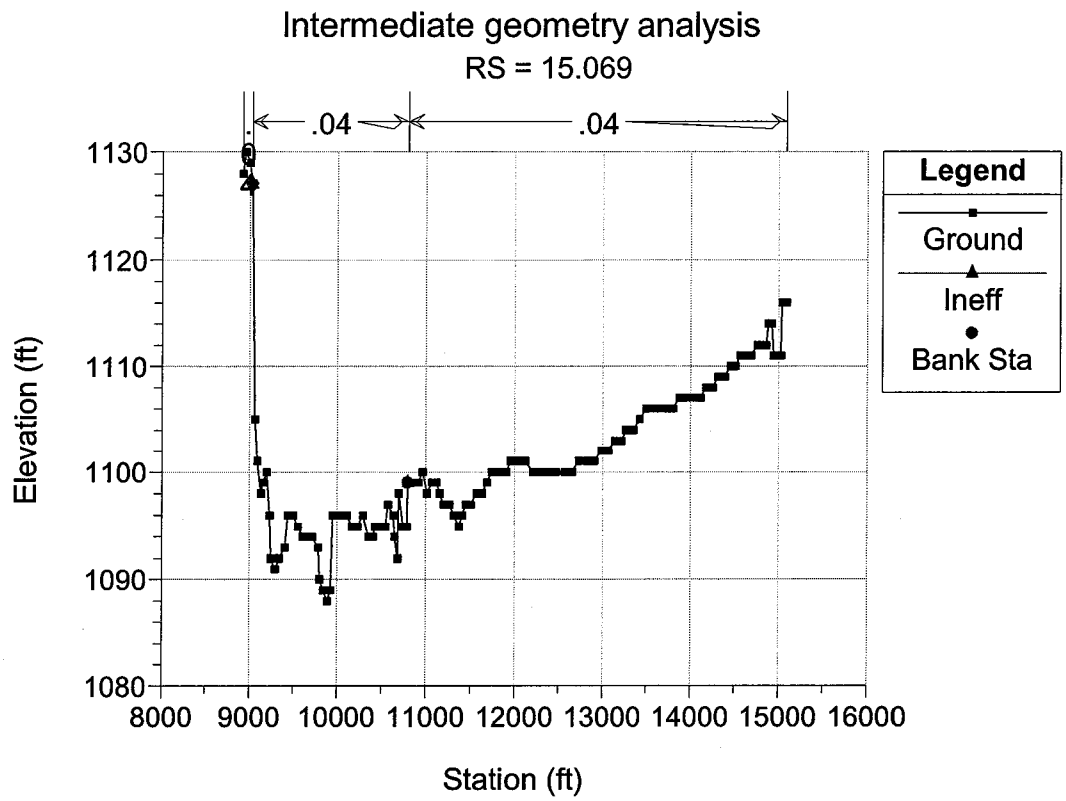
CROSS SECTION PLOTS FOR INTERMEDIATE MODEL

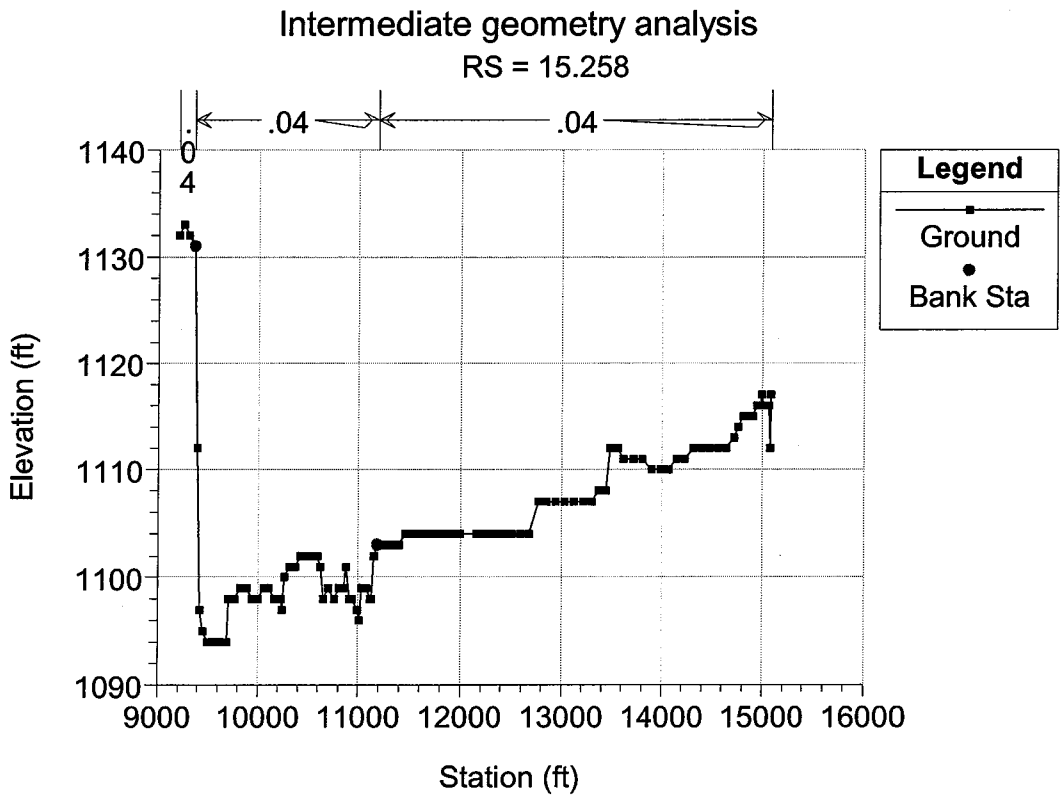

Intermediate geometry analysis
RS = 14.311
.04
.04
.04
Elevation (ft)
1110
1105
1100
1095
1090
1085
1080
6000
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)
Legend
Ground
Ineff
Bank Sta

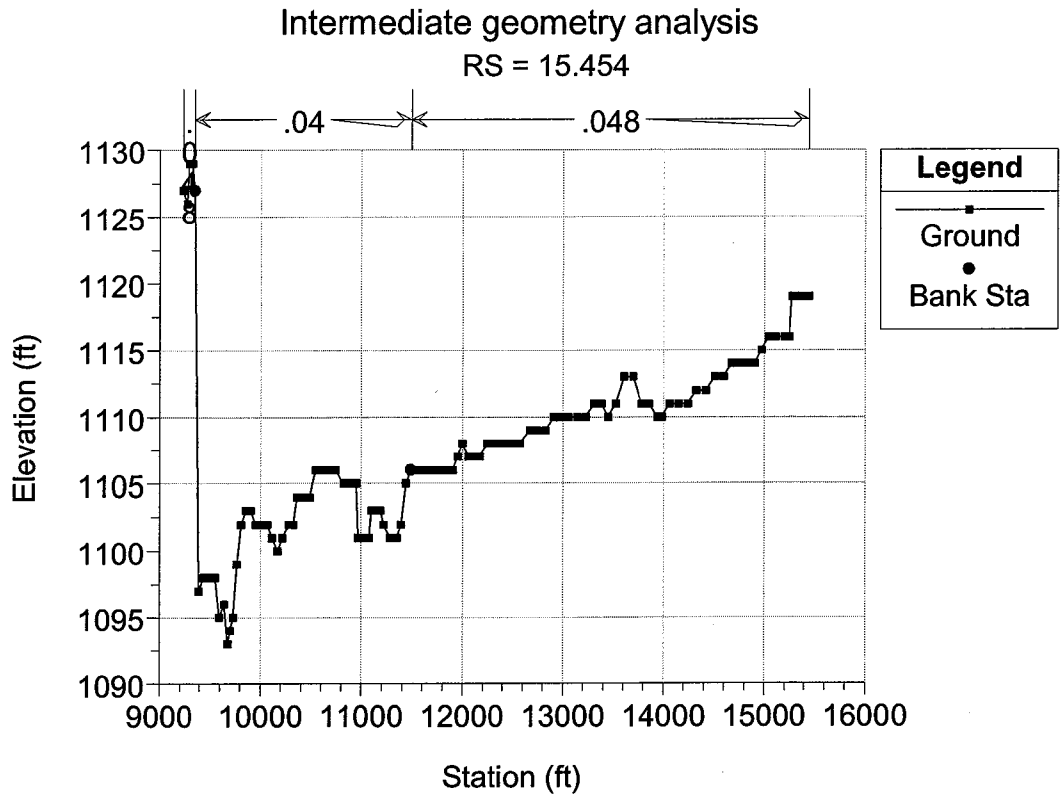

Intermediate geometry analysis
RS = 14.501
.04
.04
.04
Elevation (ft)
1125
1120
1115
1110
1105
1100
1095
1090
1085
1080
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)
Legend
Ground
Ineff
Bank Sta

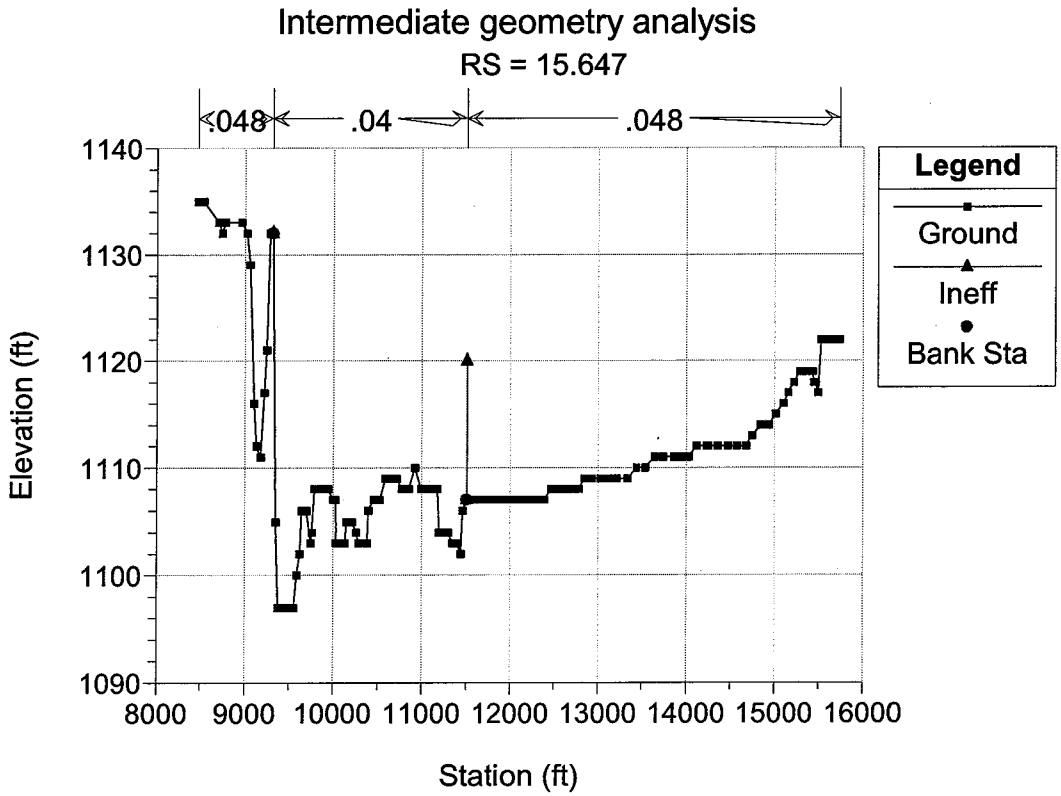

Intermediate geometry analysis
RS = 14.69
.04
.04
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1125
1120
1115
1110
1105
1100
1095
1090
1085
7000
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)


Intermediate geometry analysis
RS = 14.879
.04
.04
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1140
1130
1120
1110
1100
1090
1080
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)


Intermediate geometry analysis
RS = 15.069
.04
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1130
1120
1110
1100
1090
1080
8000
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)


Intermediate geometry analysis
RS = 15.258
.04
.04
Legend
Ground
Bank Sta
Elevation (ft)
1140
1130
1120
1110
1100
1090
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)


Intermediate geometry analysis
RS = 15.454
.04
.048
Legend
Ground
Bank Sta
Elevation (ft)
1130
1125
1120
1115
1110
1105
1100
1095
1090
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)


Intermediate geometry analysis
RS = 15.647
.048
.04
.048
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1140
1130
1120
1110
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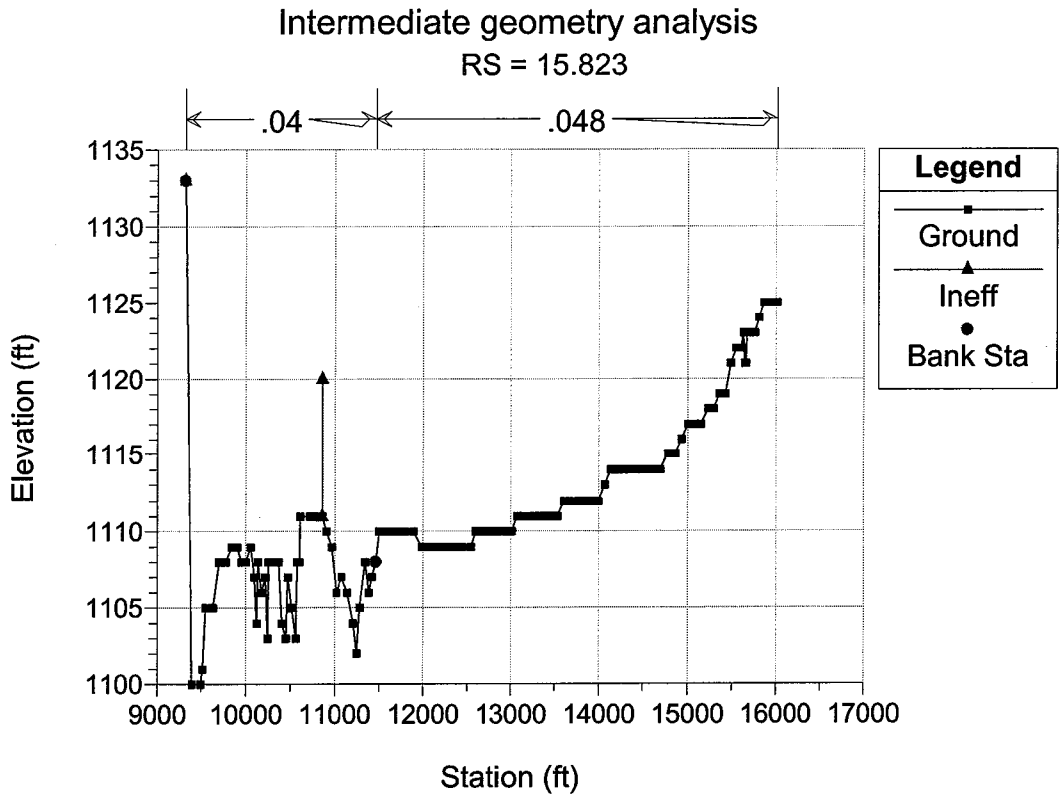
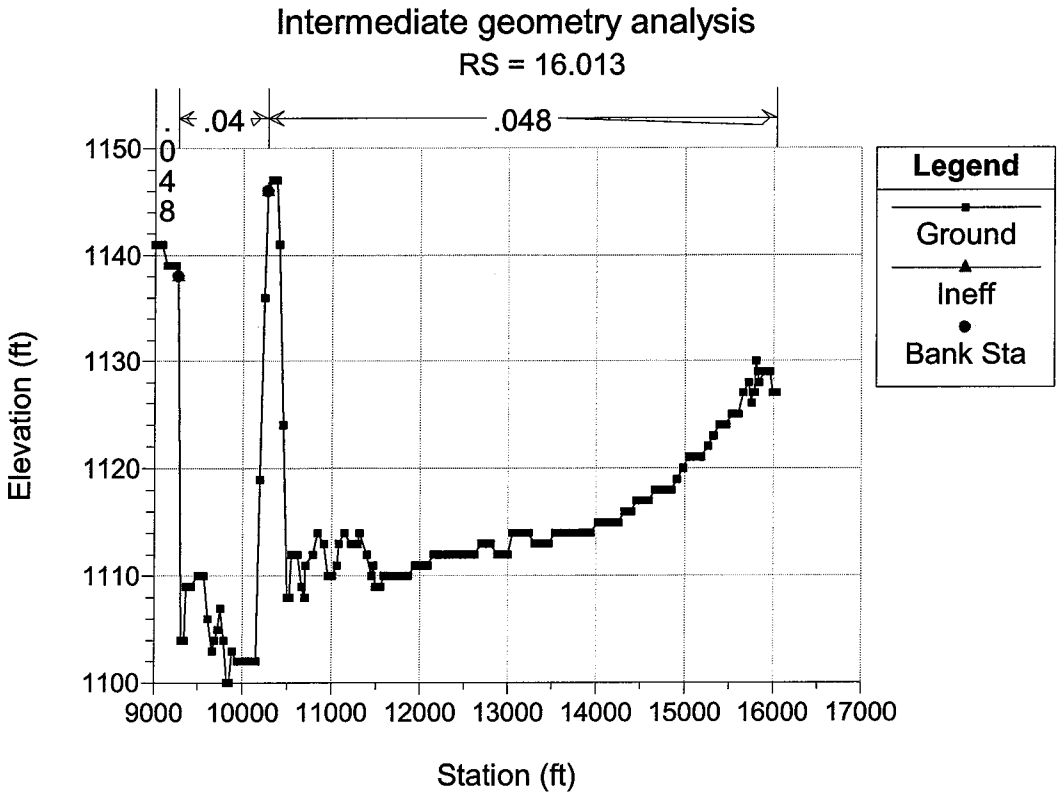
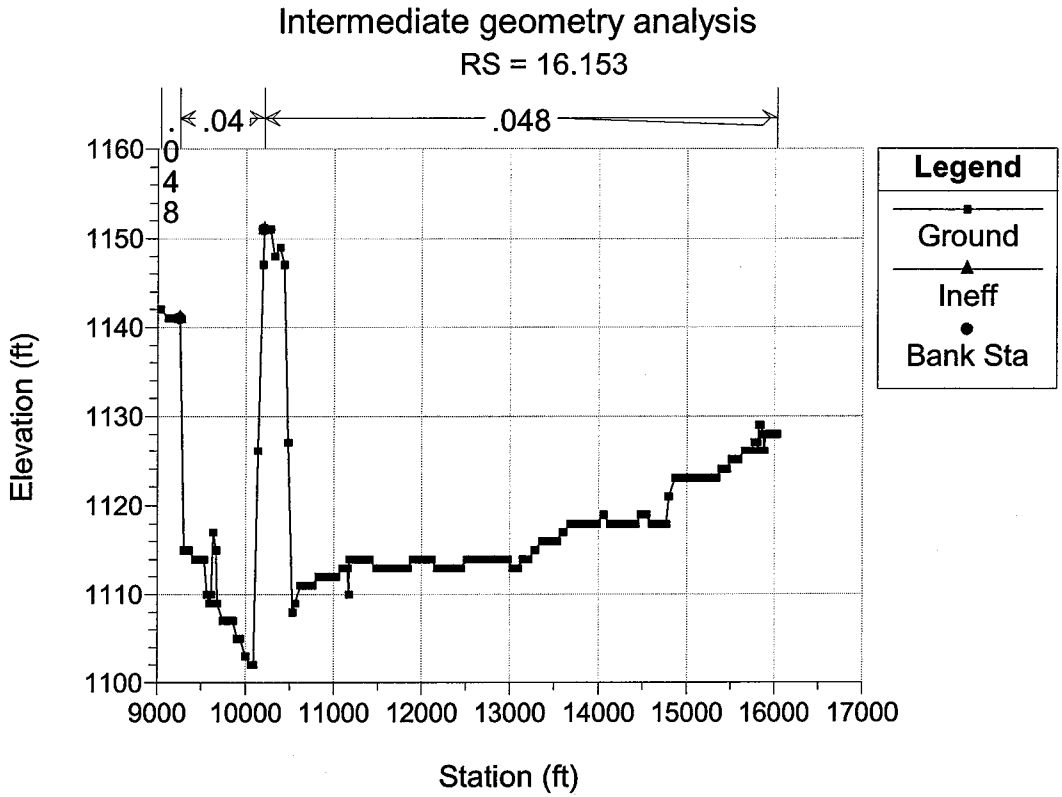
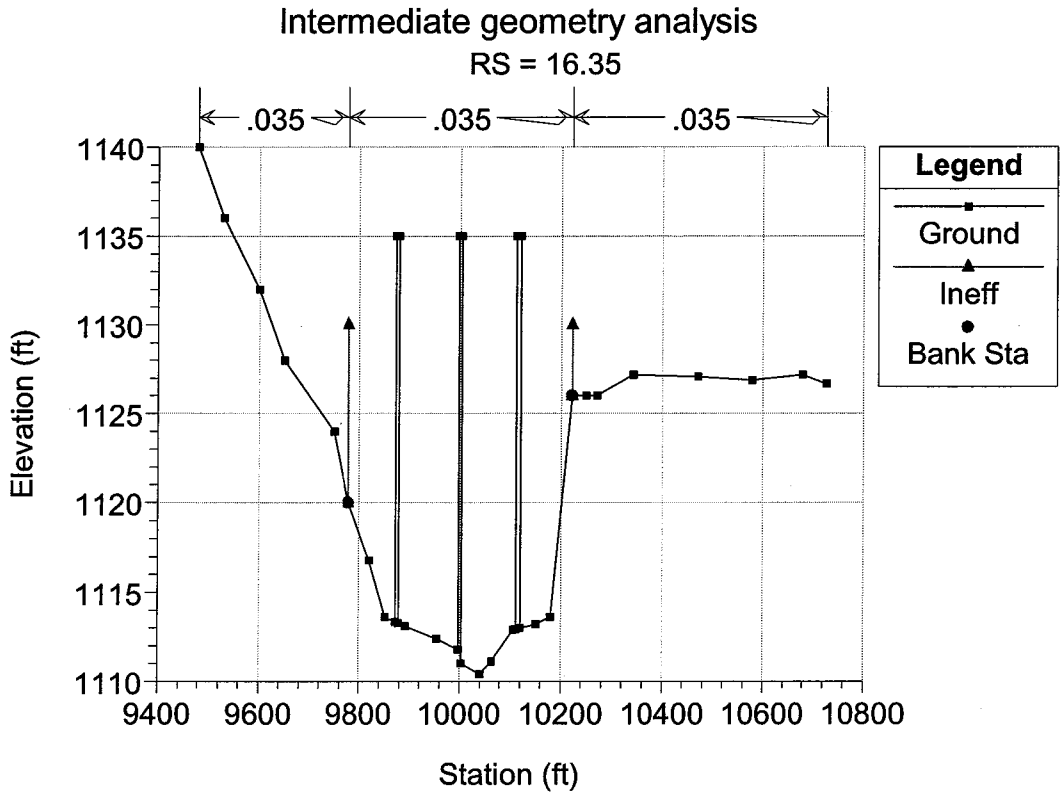
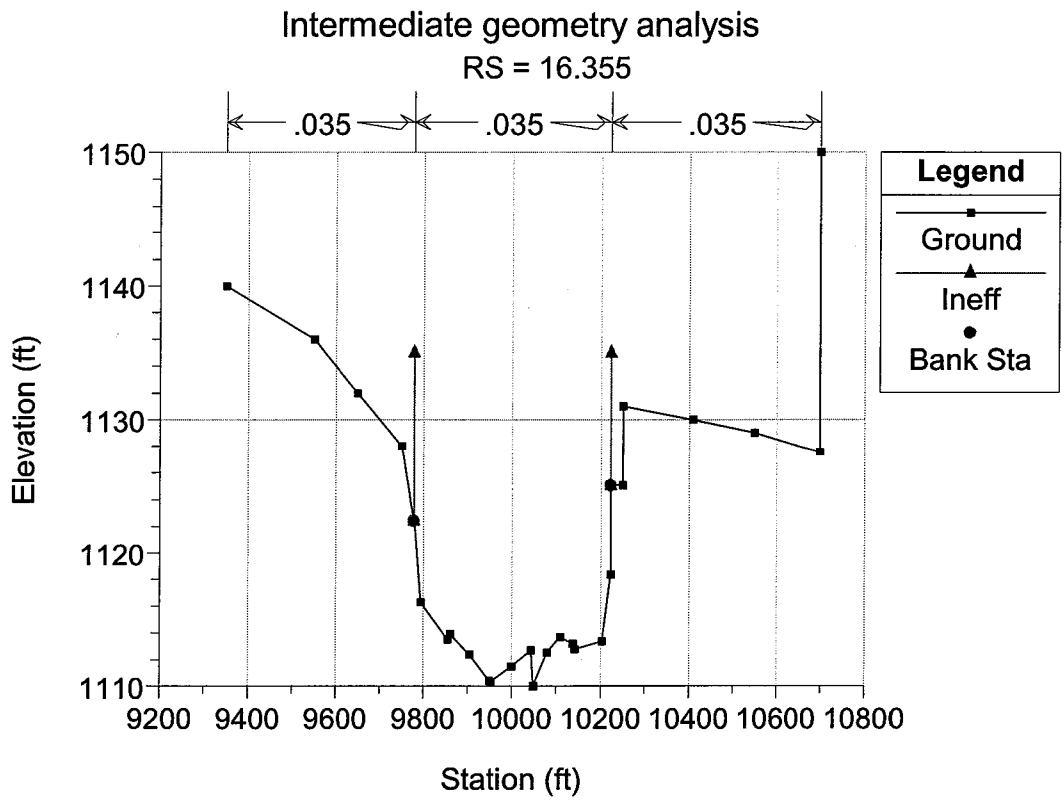
1090
8000
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)

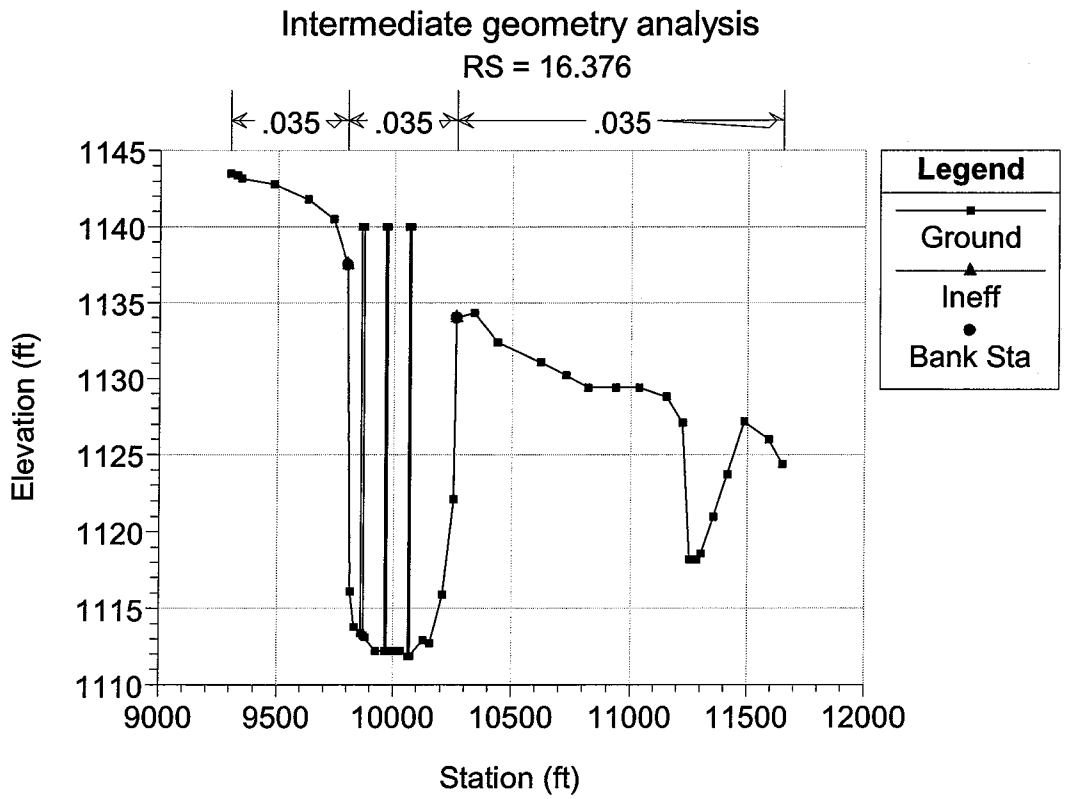

Intermediate geometry analysis
RS = 15.823
.04
.048
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1135
1130
1125
1120
1115
1110
1105
1100
9000
10000
11000
12000
13000
14000
15000
16000
17000
Station (ft)

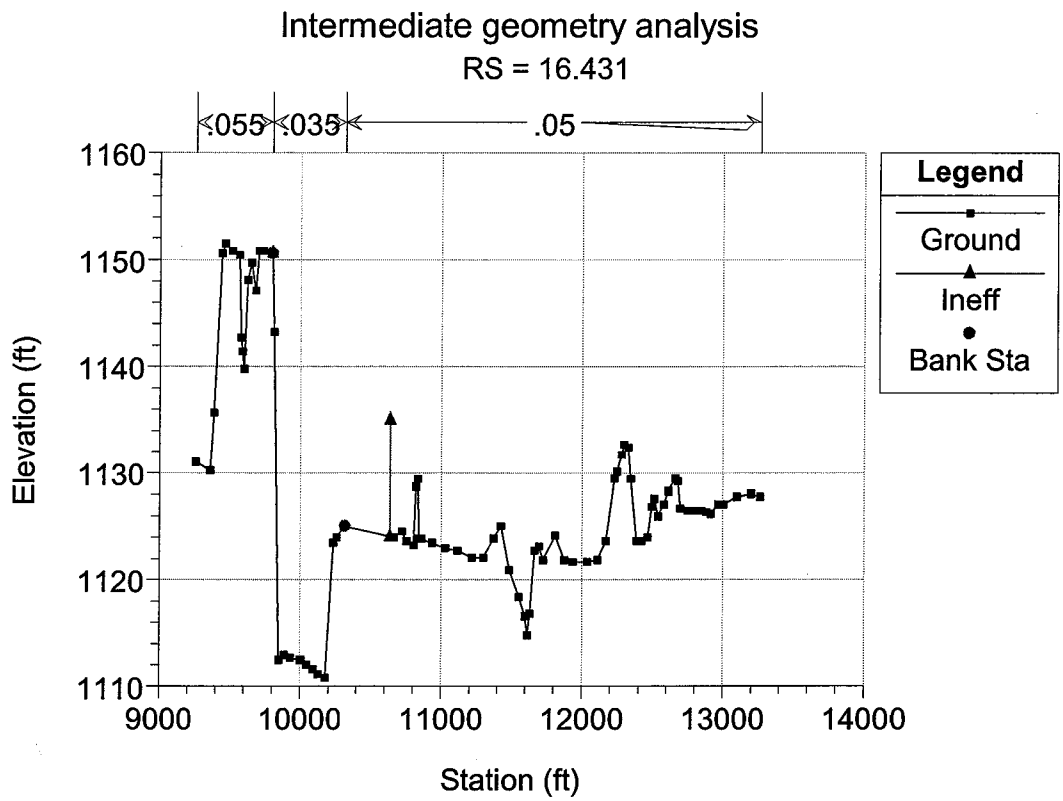

Intermediate geometry analysis
RS = 16.013
.04
.048
.048
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
9000
10000
11000
12000
13000
14000
15000
16000
17000
Station (ft)

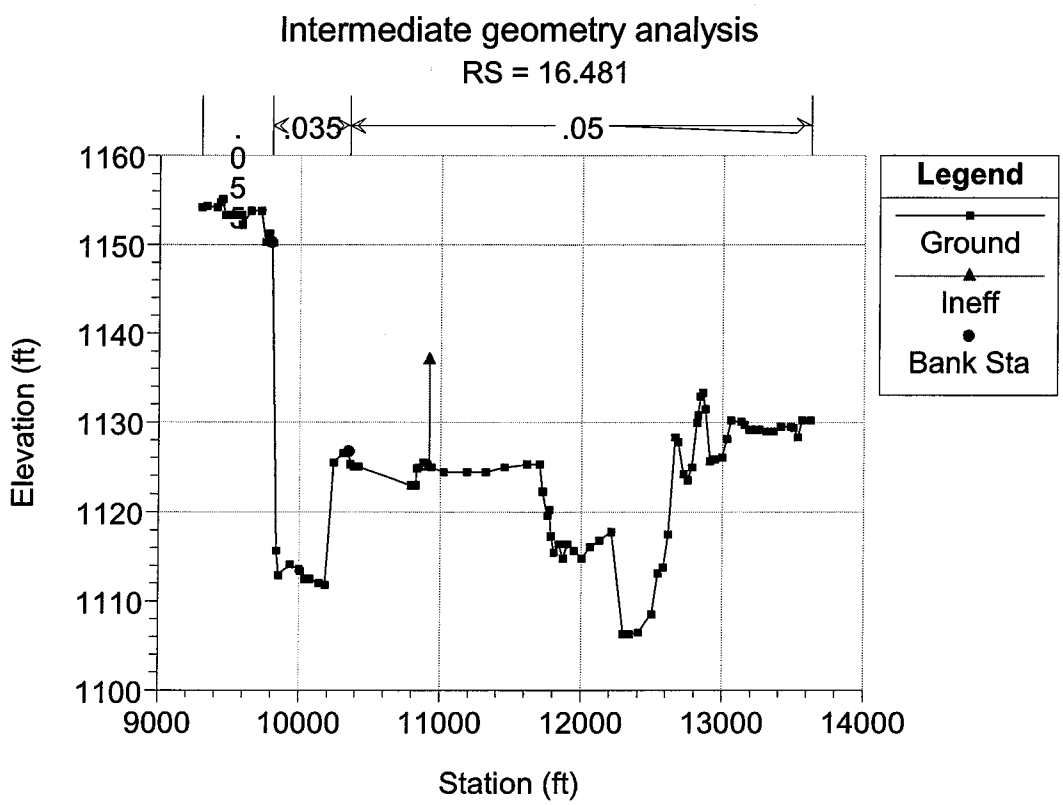

Intermediate geometry analysis
RS = 16.153
.04
.048
.048
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1150
1140
1130
1120
1110
1100
9000
10000
11000
12000
13000
14000
15000
16000
17000
Station (ft)

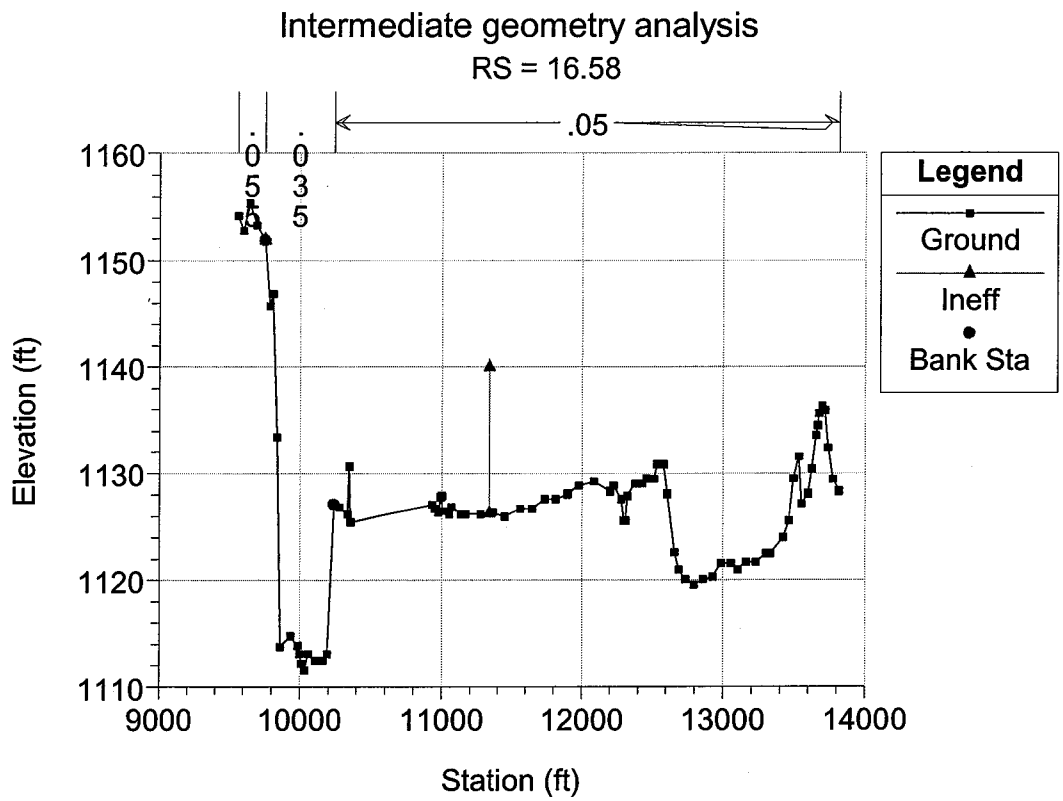

Intermediate geometry analysis
RS = 16.35
.035
.035
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1140
1135
1130
1125
1120
1115
1110
9400
9600
9800
10000
10200
10400
10600
10800
Station (ft)

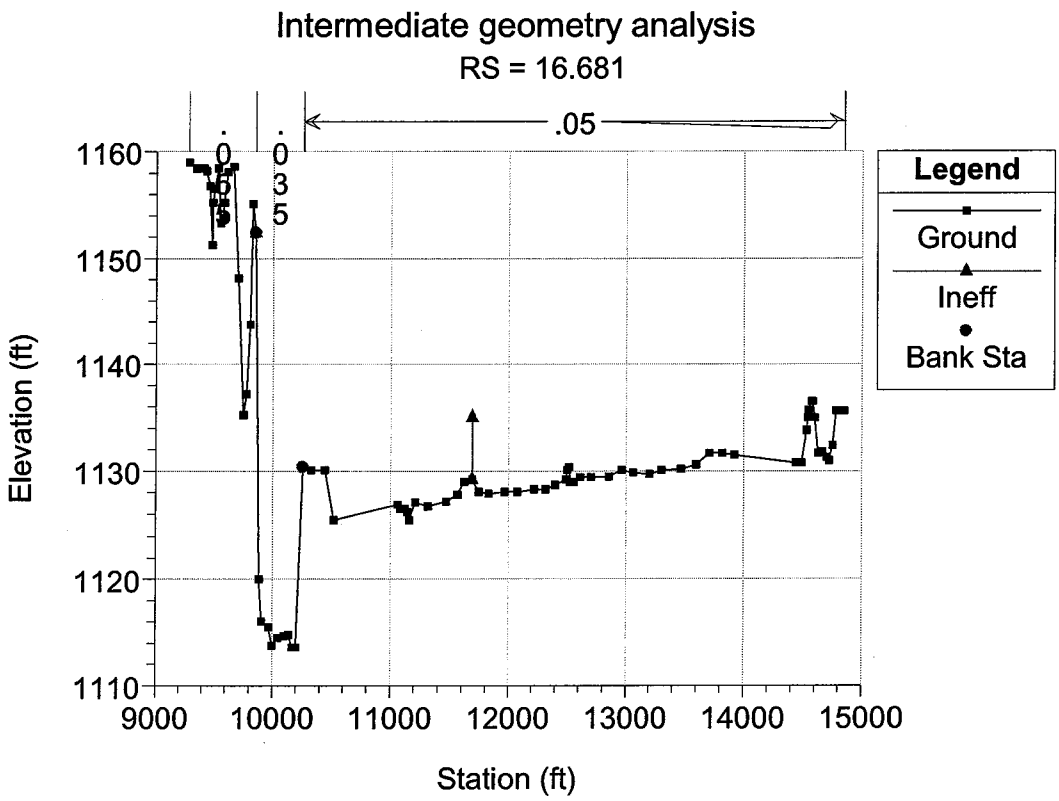

Intermediate geometry analysis
RS = 16.355
.035
.035
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
9200
9400
9600
9800
10000
10200
10400
10600
10800
Station (ft)

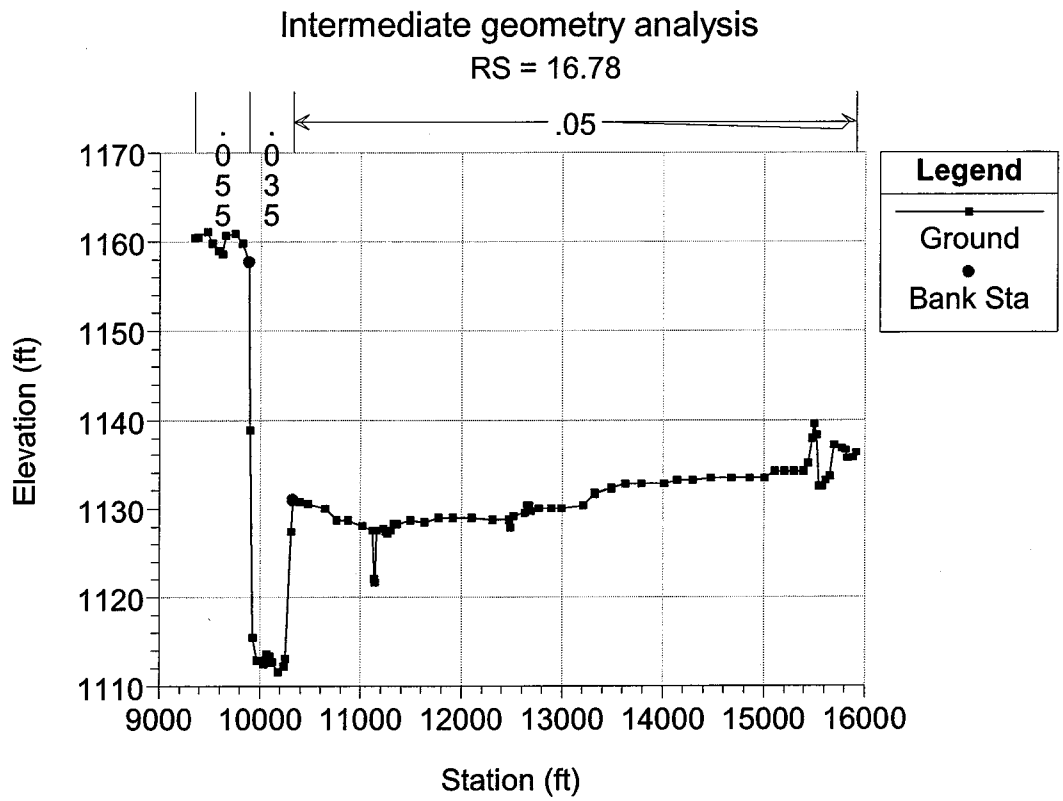

Intermediate geometry analysis
RS = 16.376
.035
.035
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1145
1140
1135
1130
1125
1120
1115
1110
9000
9500
10000
10500
11000
11500
12000
Station (ft)

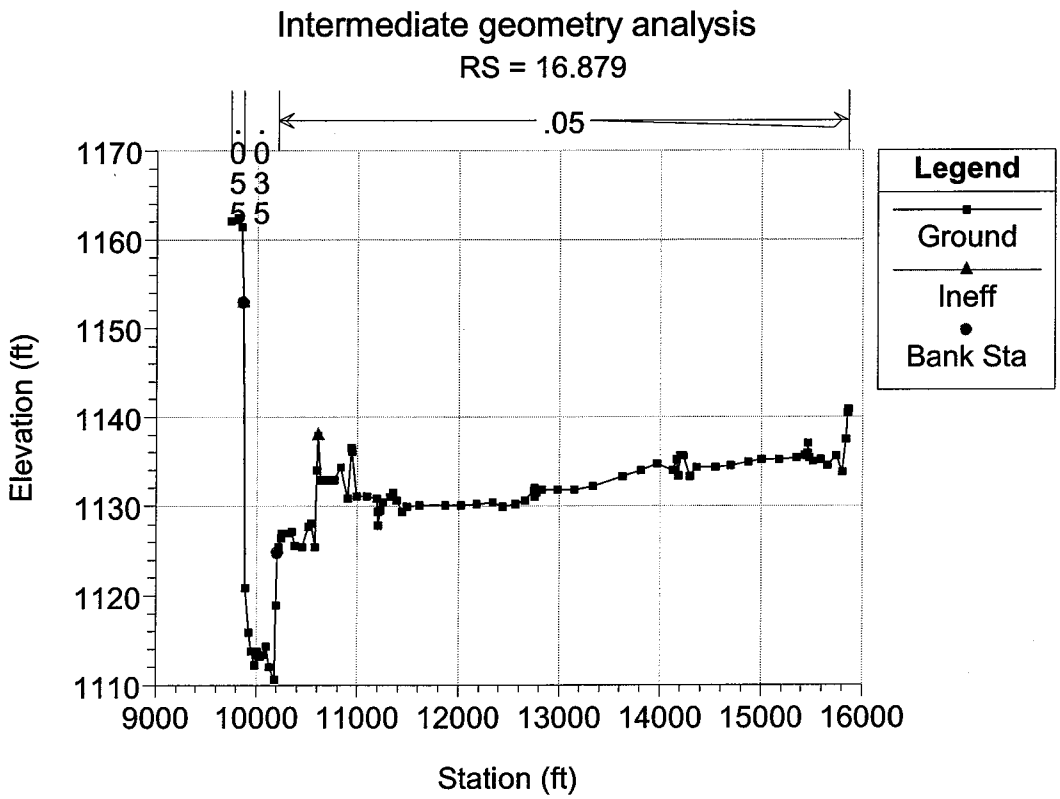

Intermediate geometry analysis
RS = 16.431
.055
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1150
1140
1130
1120
1110
9000
10000
11000
12000
13000
14000
Station (ft)

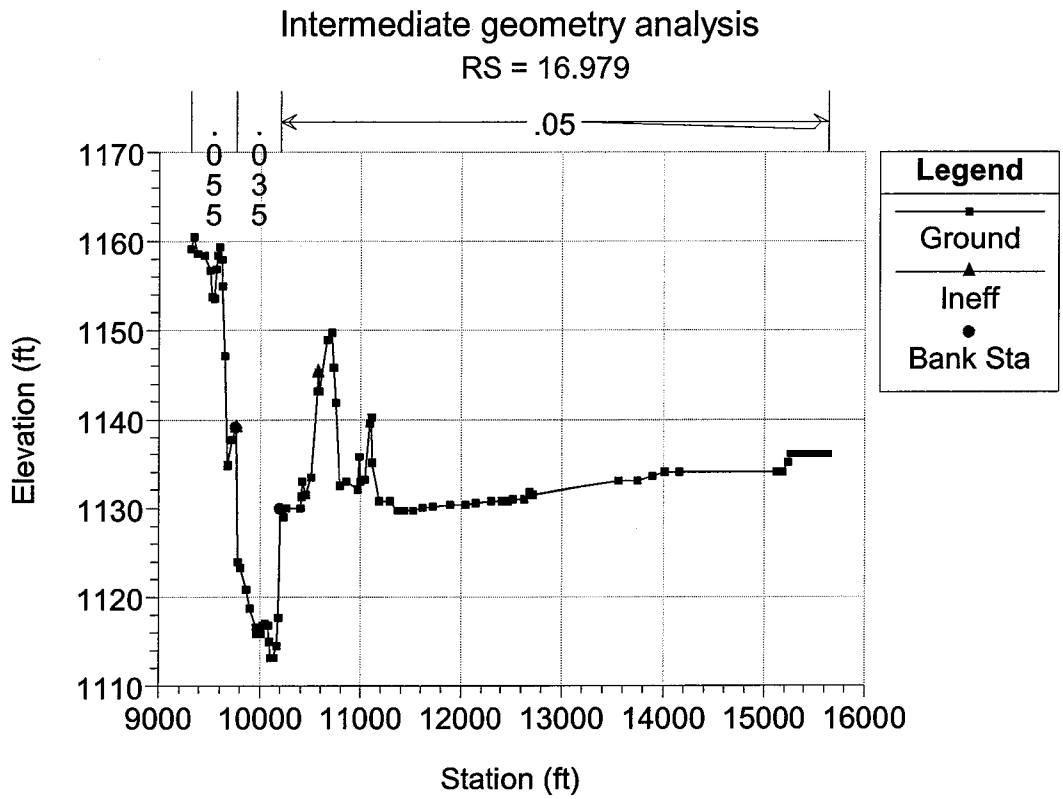

Intermediate geometry analysis
RS = 16.481
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1150
1140
1130
1120
1110
1100
9000
10000
11000
12000
13000
14000
Station (ft)

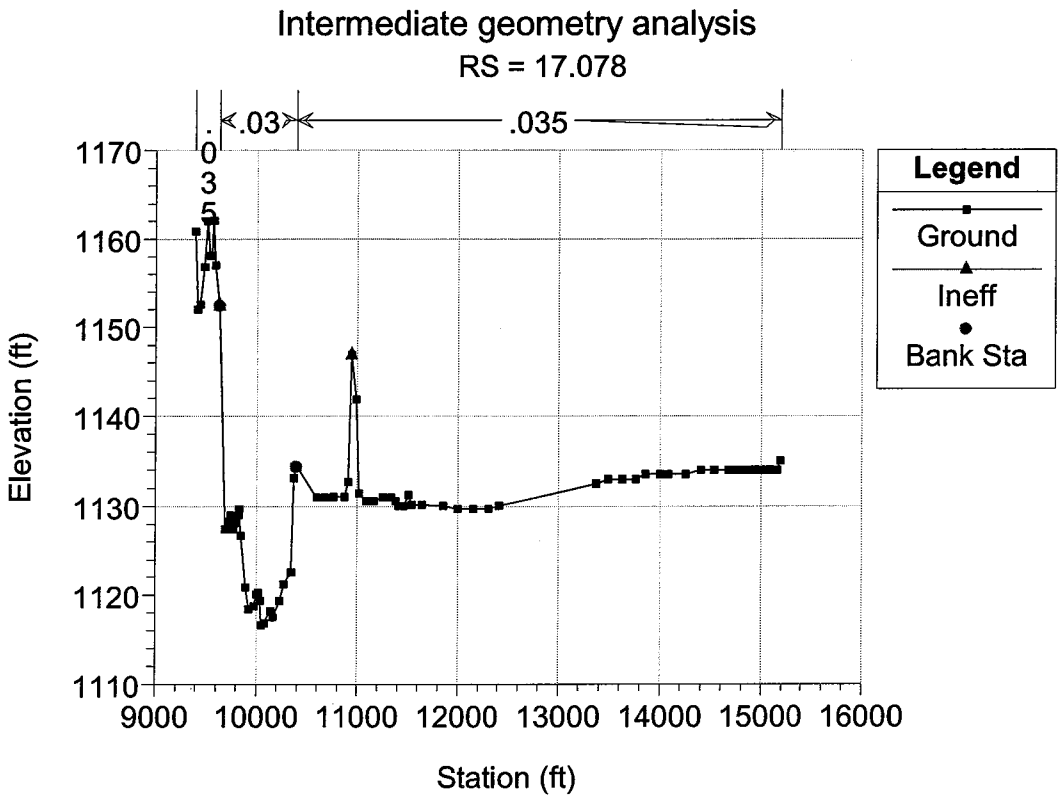

Intermediate geometry analysis
RS = 16.58
.05
.035
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1150
1140
1130
1120
1110
9000
10000
11000
12000
13000
14000
Station (ft)


Intermediate geometry analysis
RS = 16.681
.05
.035
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1150
1140
1130
1120
1110
9000
10000
11000
12000
13000
14000
15000
Station (ft)


Intermediate geometry analysis
RS = 16.78
.05
.055
.035
Legend
Ground
Bank Sta
Elevation (ft)
1170
1160
1150
1140
1130
1120
1110
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)


Intermediate geometry analysis
RS = 16.879
.05
.055
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1160
1150
1140
1130
1120
1110
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)


Intermediate geometry analysis
RS = 16.979
.05
.055
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1160
1150
1140
1130
1120
1110
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)


Intermediate geometry analysis
RS = 17.078
.03
.035
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1160
1150
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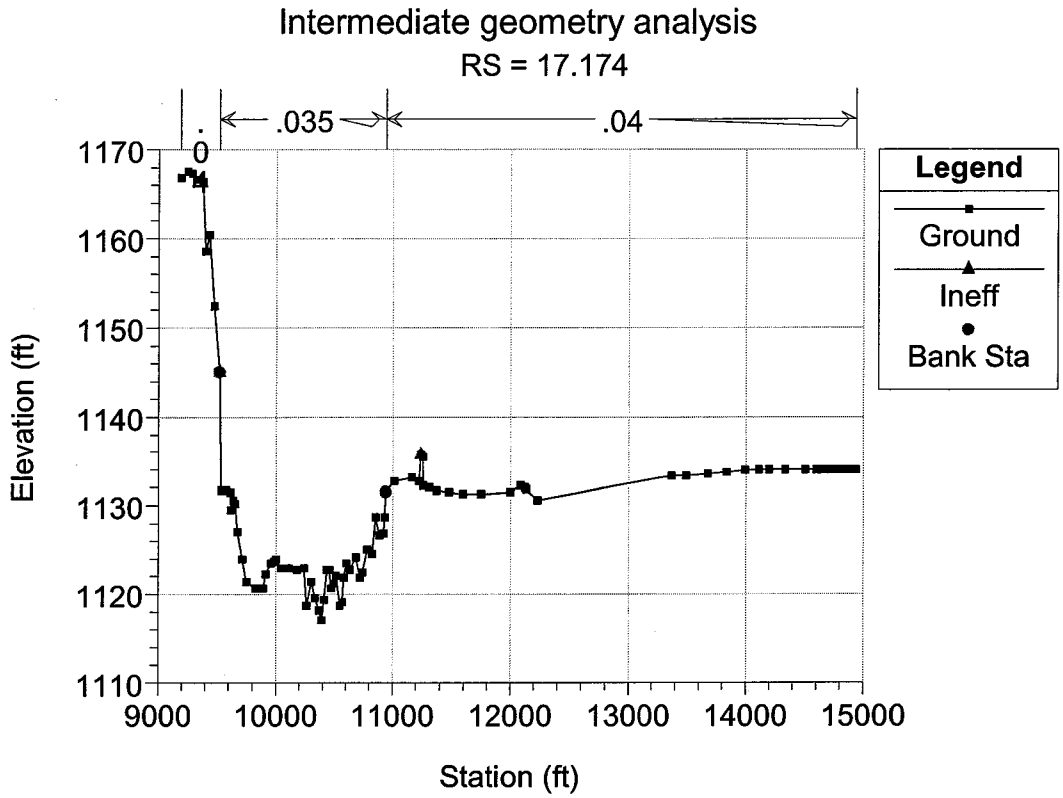
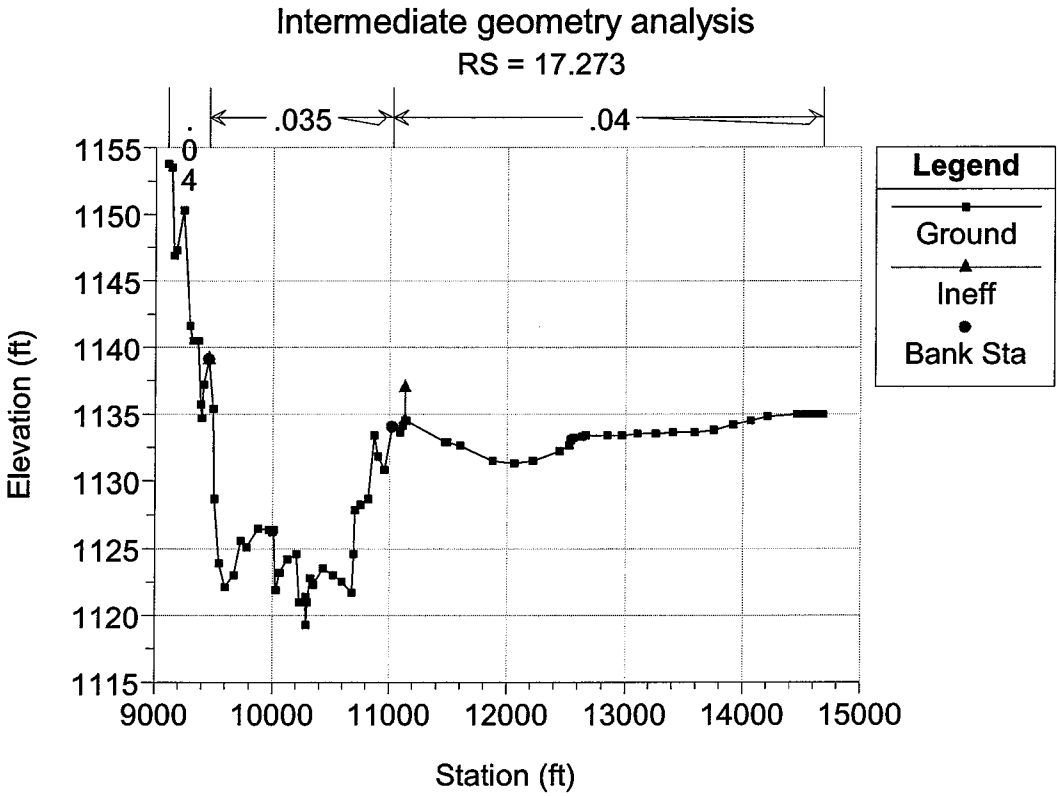
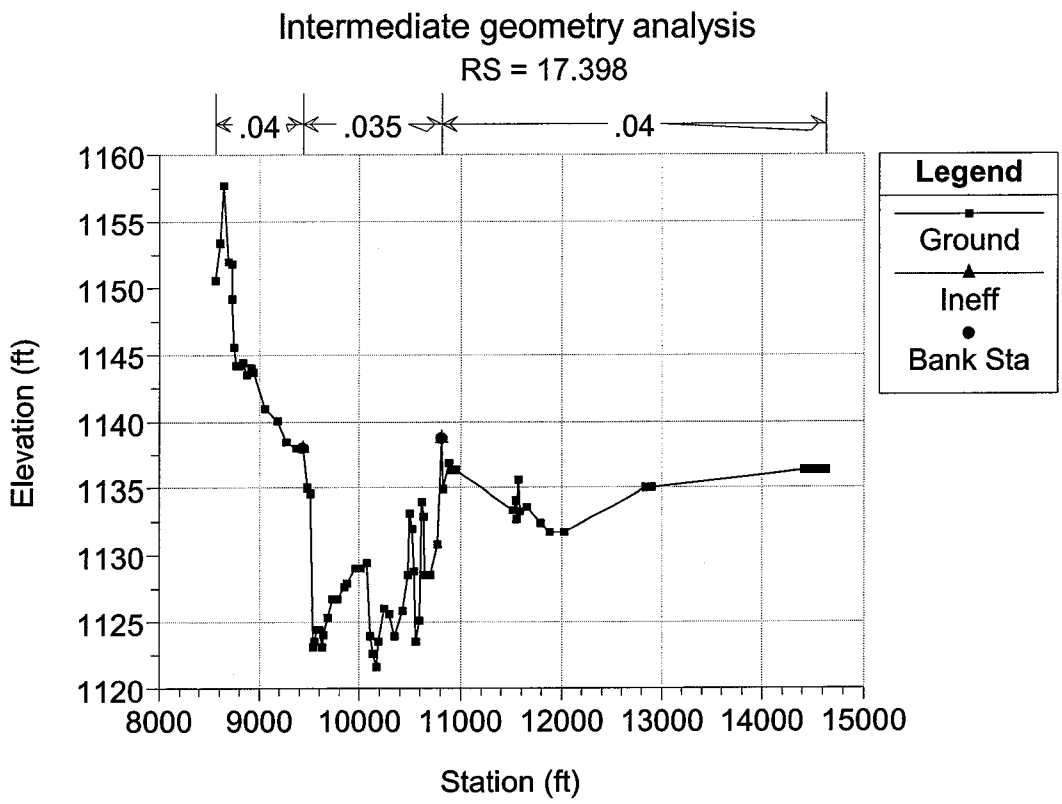
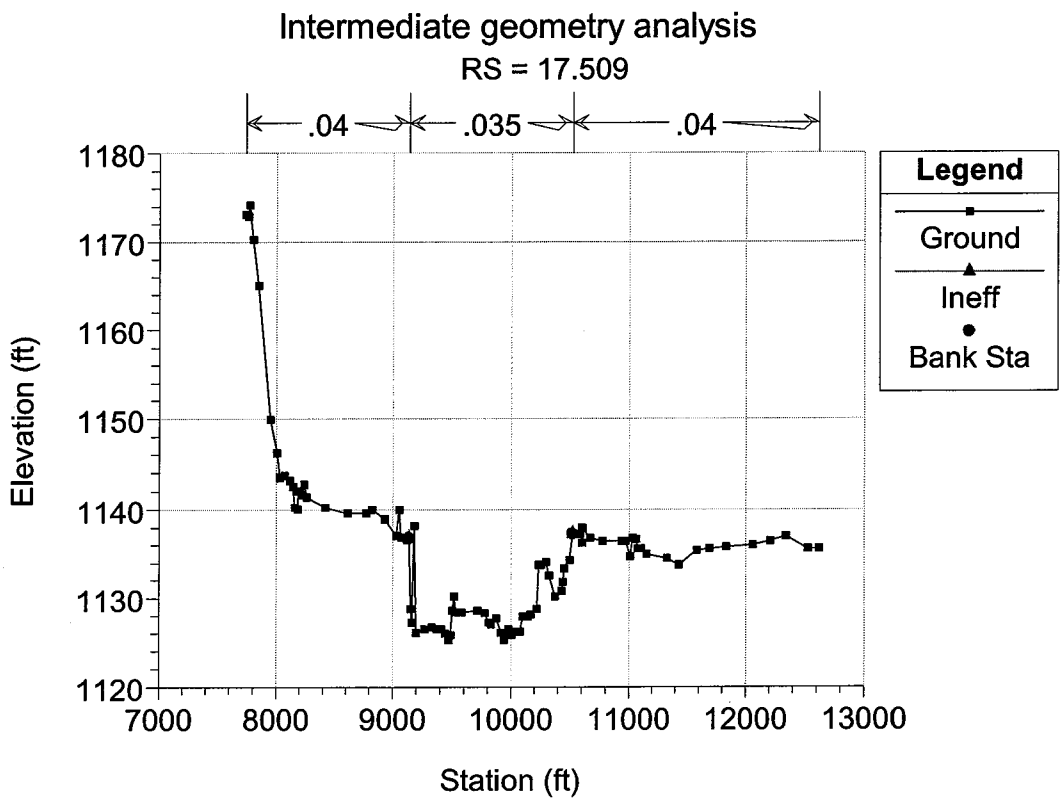
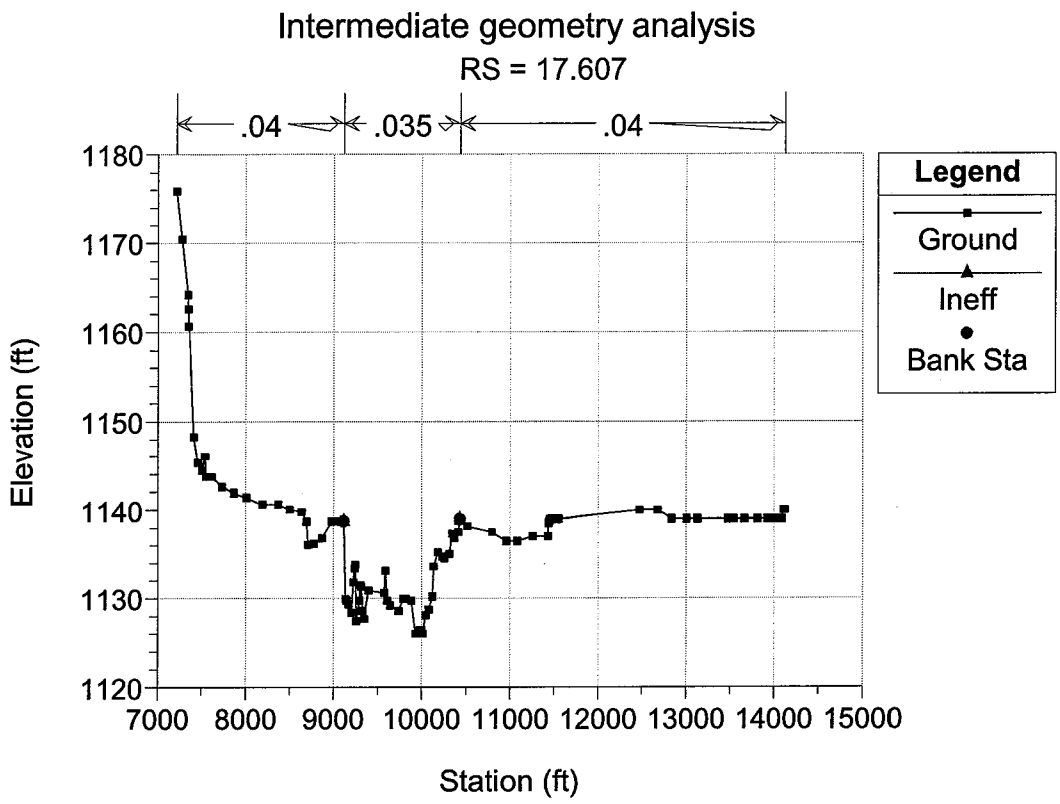
1130
1120
1110
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)

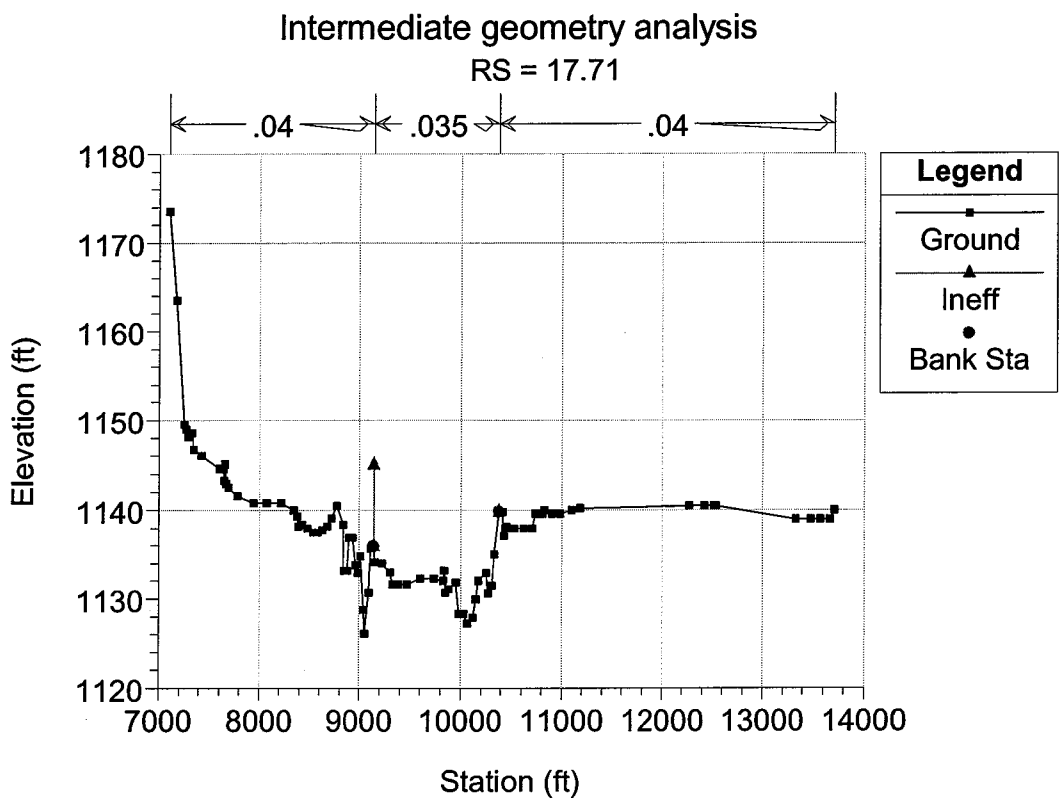

Intermediate geometry analysis
RS = 17.174
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1170
1160
1150
1140
1130
1120
1110
9000
10000
11000
12000
13000
14000
15000

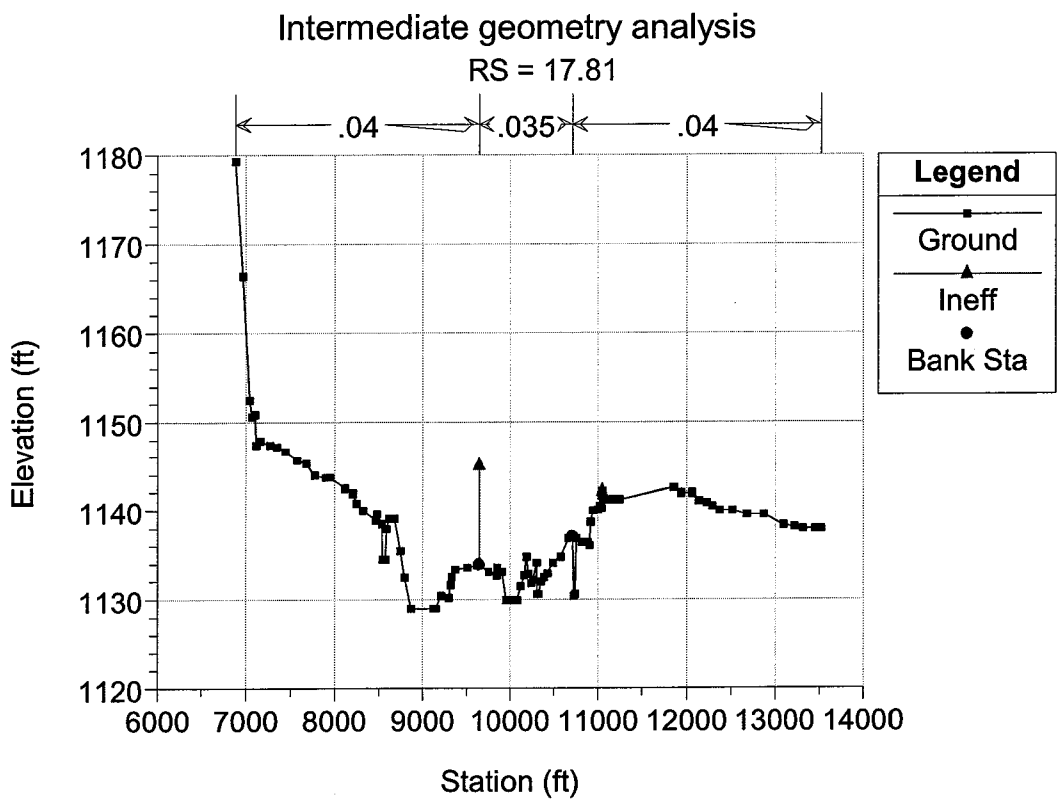

Intermediate geometry analysis
RS = 17.273
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1155
1150
1145
1140
1135
1130
1125
1120
1115
9000
10000
11000
12000
13000
14000
15000

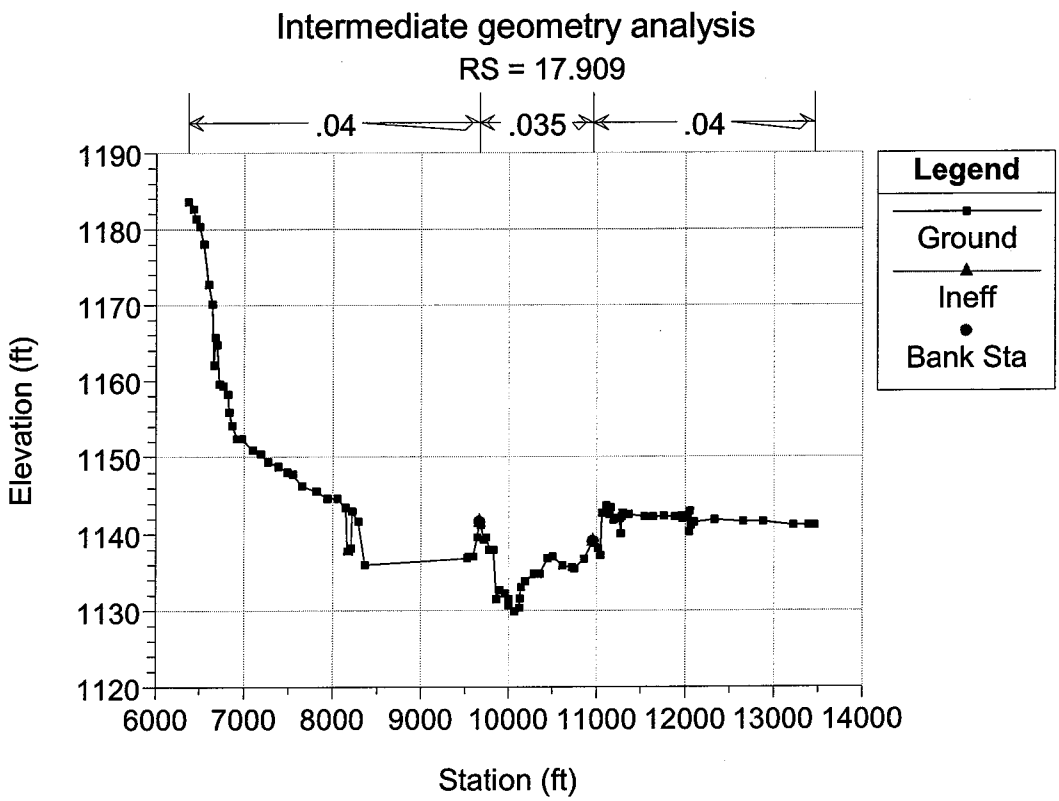

Intermediate geometry analysis
RS = 17.398
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1155
1150
1145
1140
1135
1130
1125
1120
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)

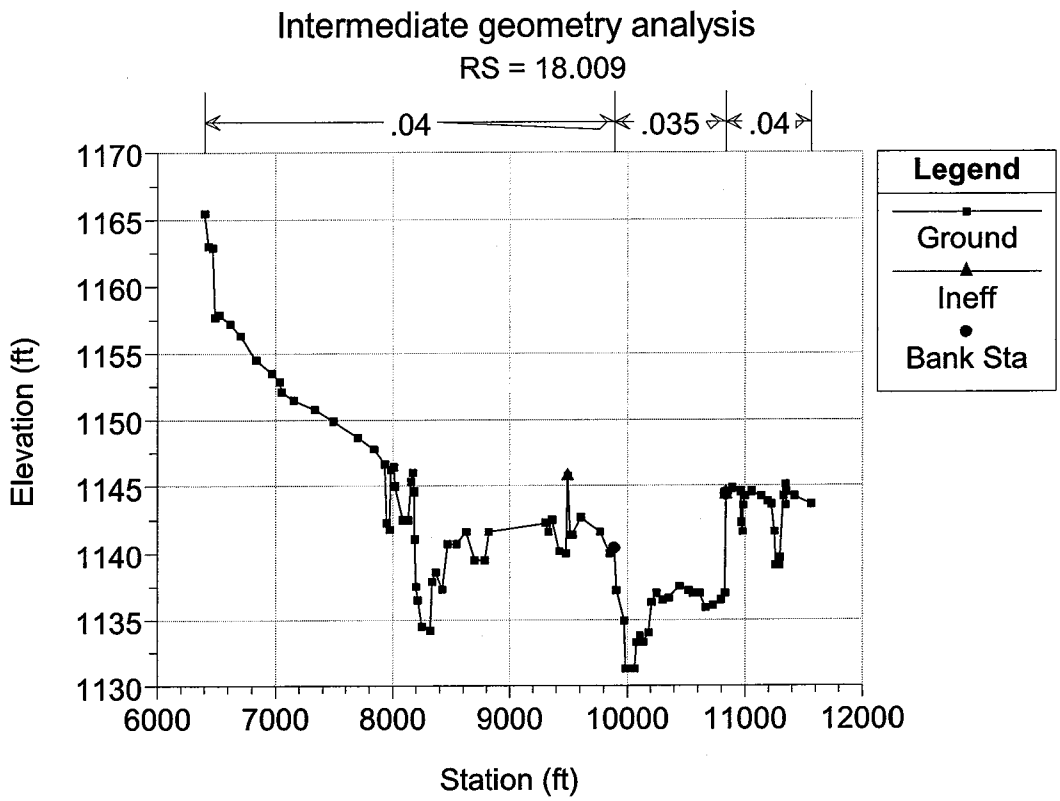

Intermediate geometry analysis
RS = 17.509
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1170
1160
1150
1140
1130
1120
7000
8000
9000
10000
11000
12000
13000
Station (ft)

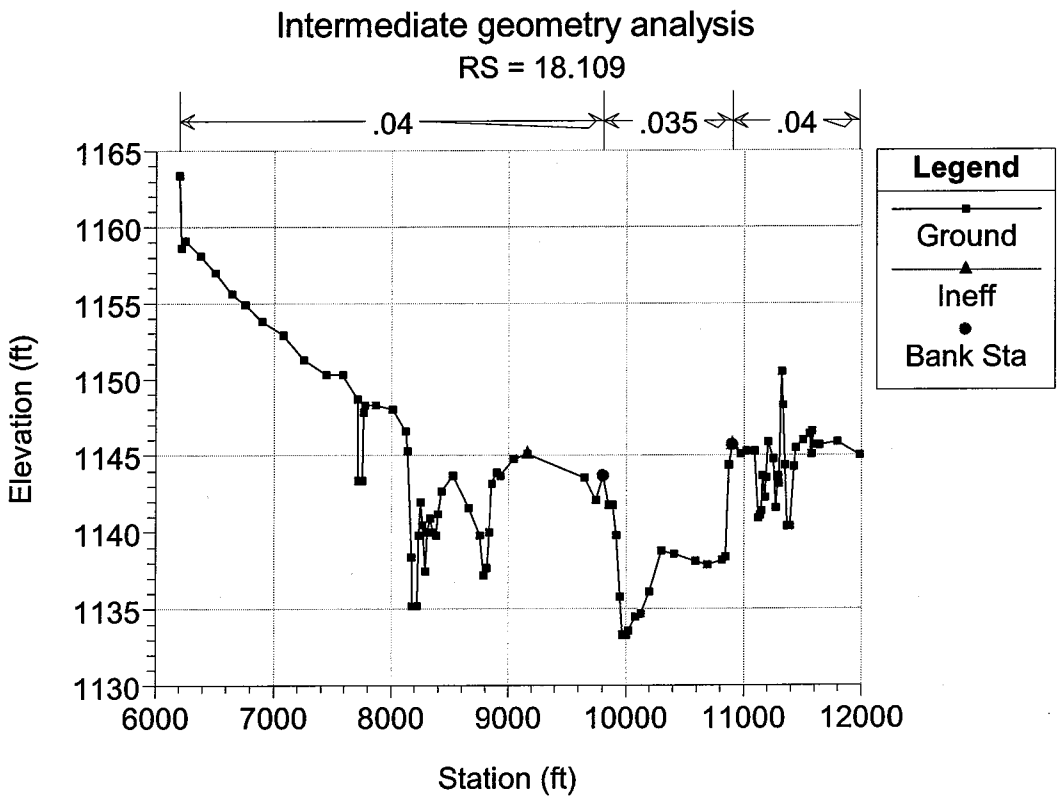

Intermediate geometry analysis
RS = 17.607
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1170
1160
1150
1140
1130
1120
7000
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)

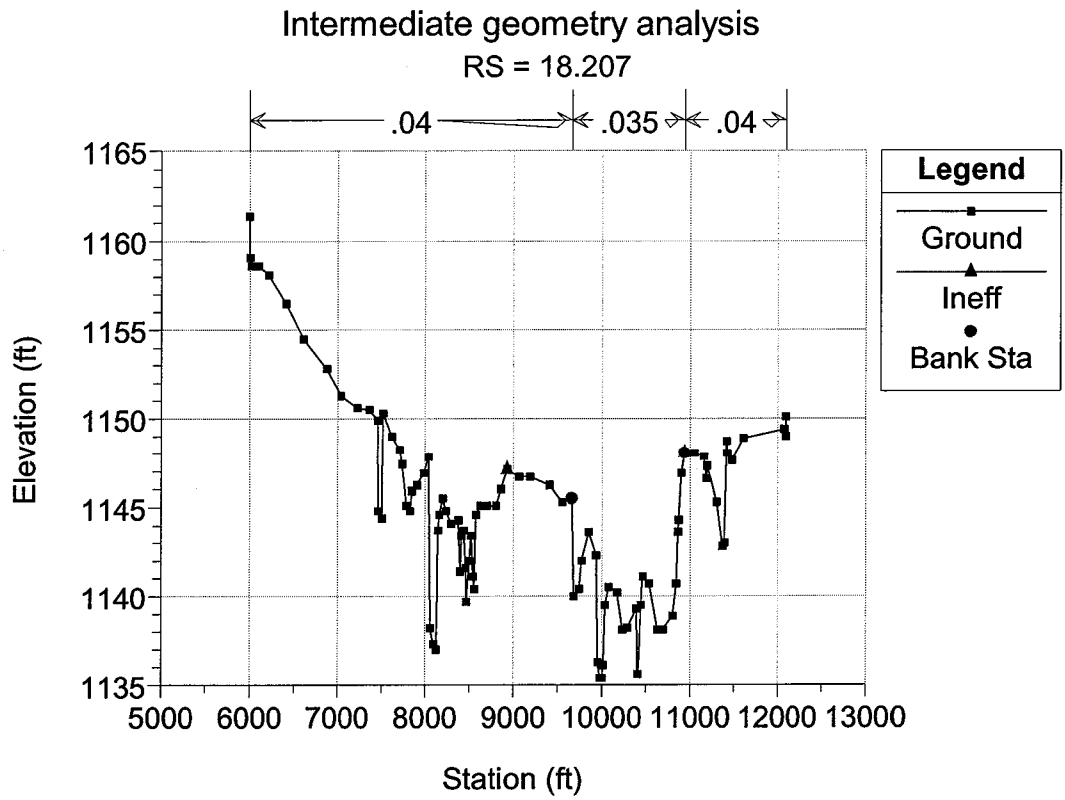

Intermediate geometry analysis
RS = 17.71
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1170
1160
1150
1140
1130
1120
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)

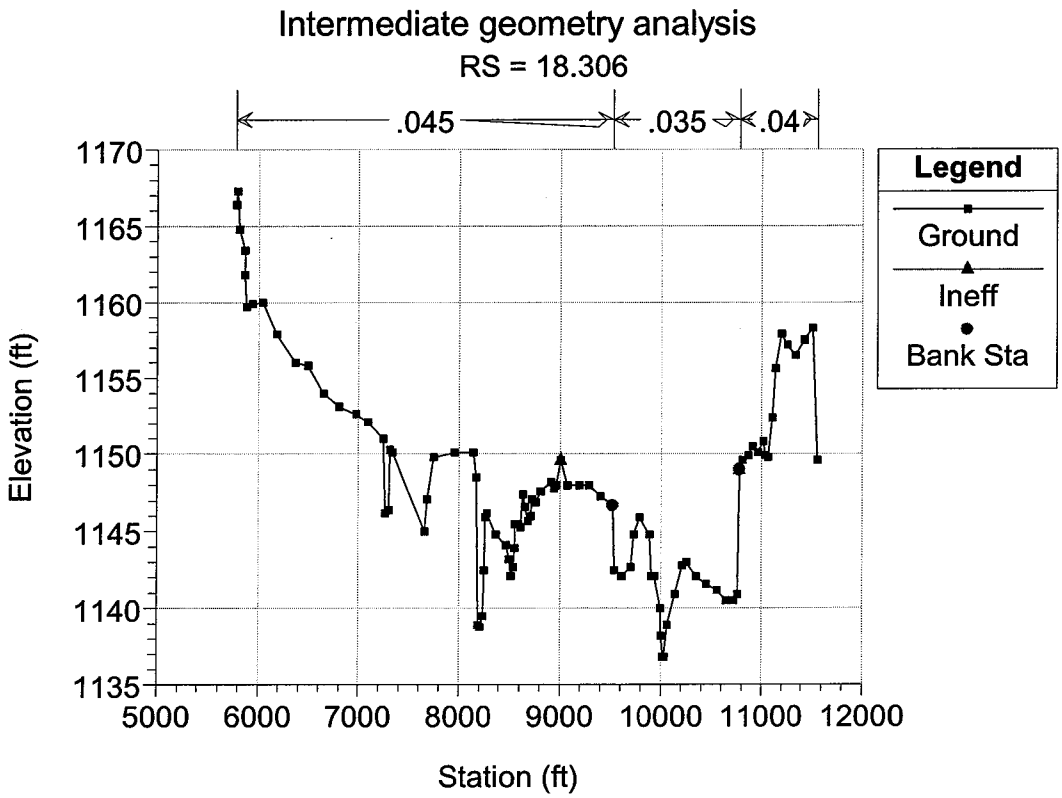

Intermediate geometry analysis
RS = 17.81
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1170
1160
1150
1140
1130
1120
6000 7000 8000 9000 10000 11000 12000 13000 14000
Station (ft)

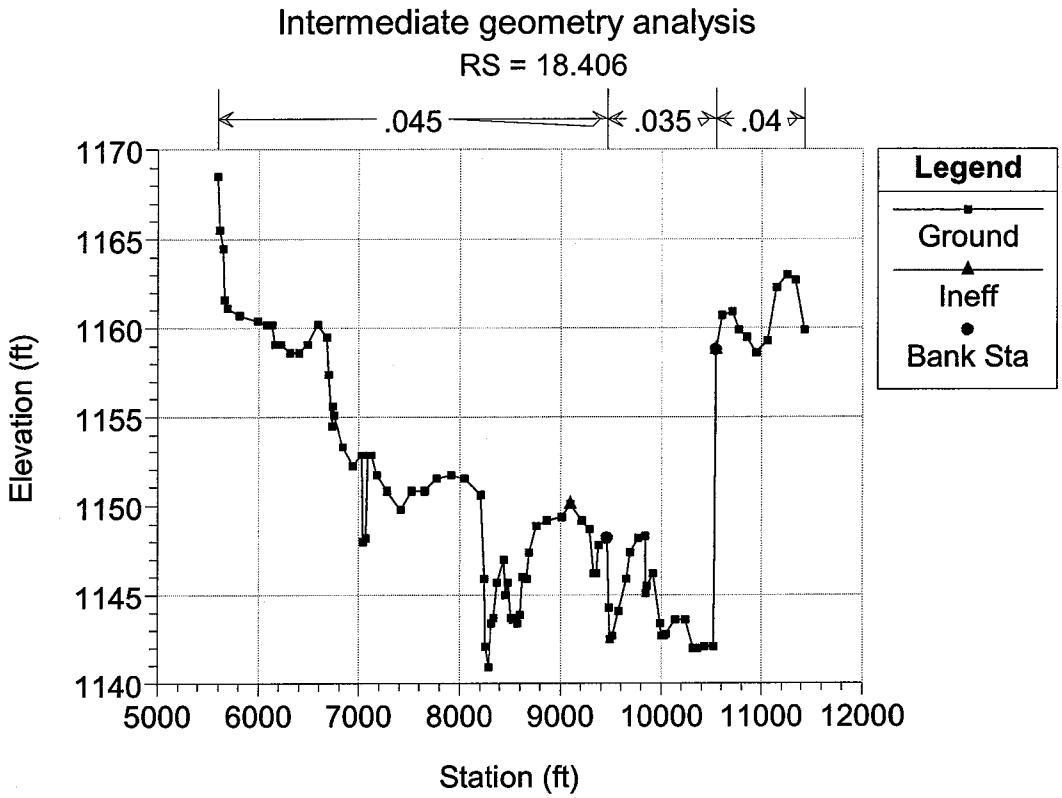

Intermediate geometry analysis
RS = 17.909
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1190
1180
1170
1160
1150
1140
1130
1120
6000 7000 8000 9000 10000 11000 12000 13000 14000
Station (ft)

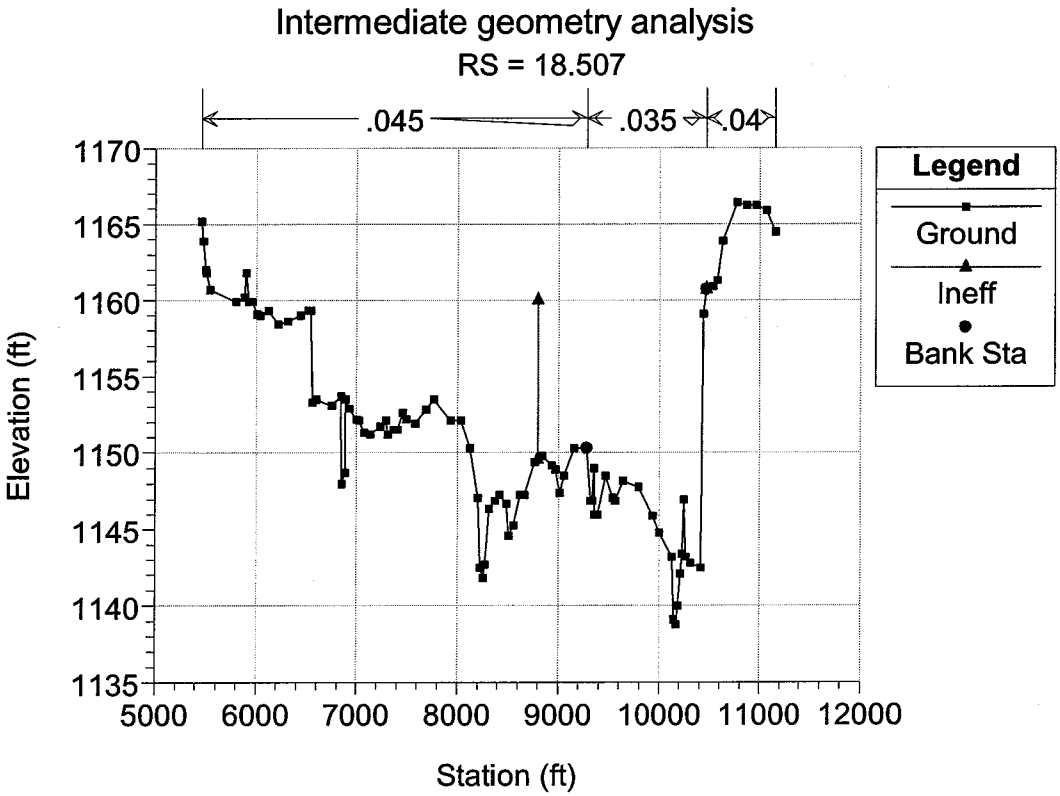

Intermediate geometry analysis
RS = 18.009
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1165
1160
1155
1150
1145
1140
1135
1130
6000
7000
8000
9000
10000
11000
12000
Station (ft)

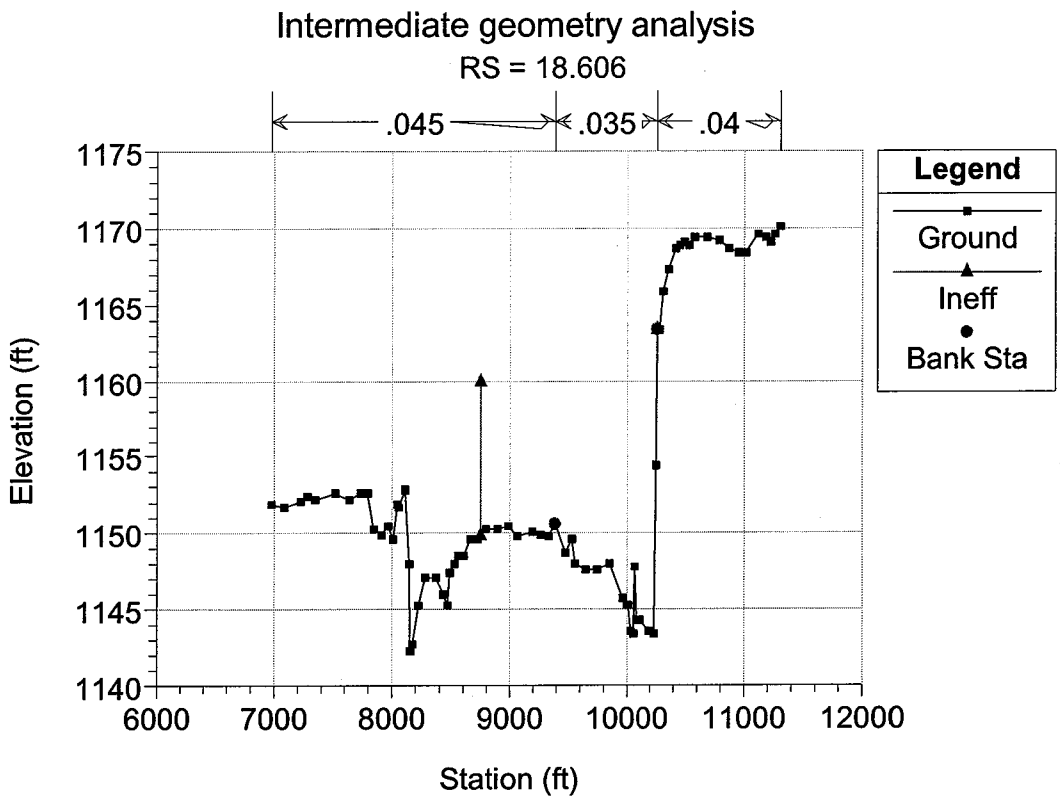

Intermediate geometry analysis
RS = 18.109
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1165
1160
1155
1150
1145
1140
1135
1130
6000
7000
8000
9000
10000
11000
12000
Station (ft)

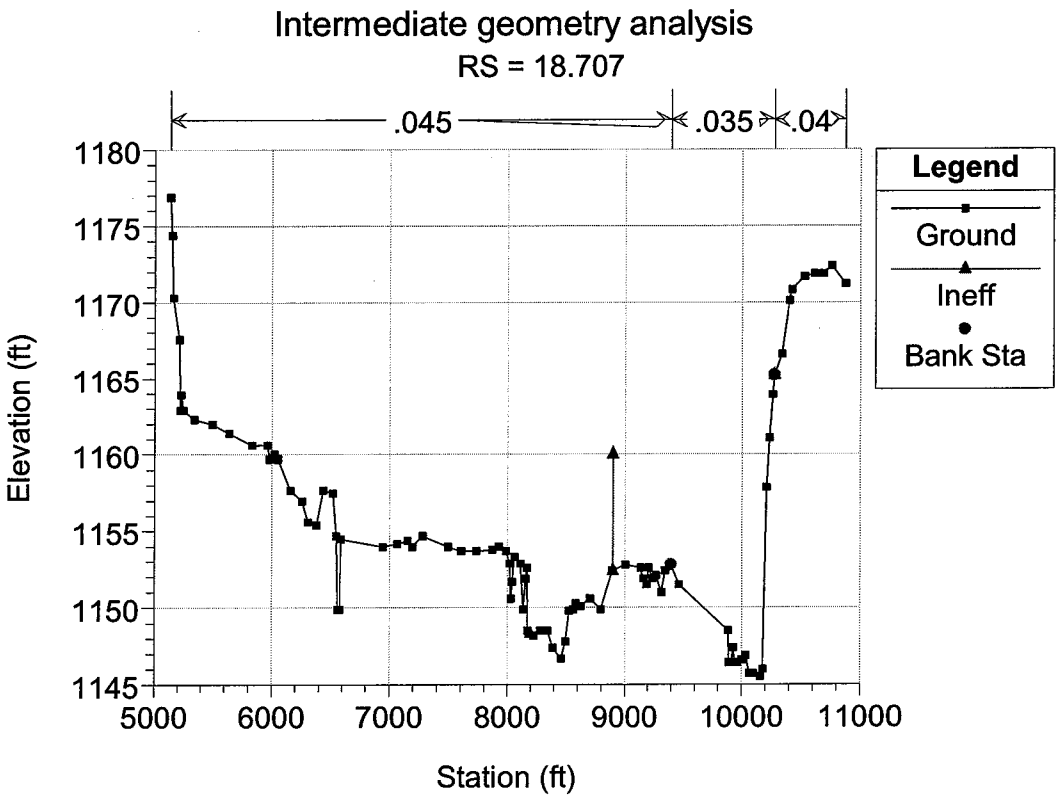

Intermediate geometry analysis
RS = 18.207
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1165
1160
1155
1150
1145
1140
1135
5000
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

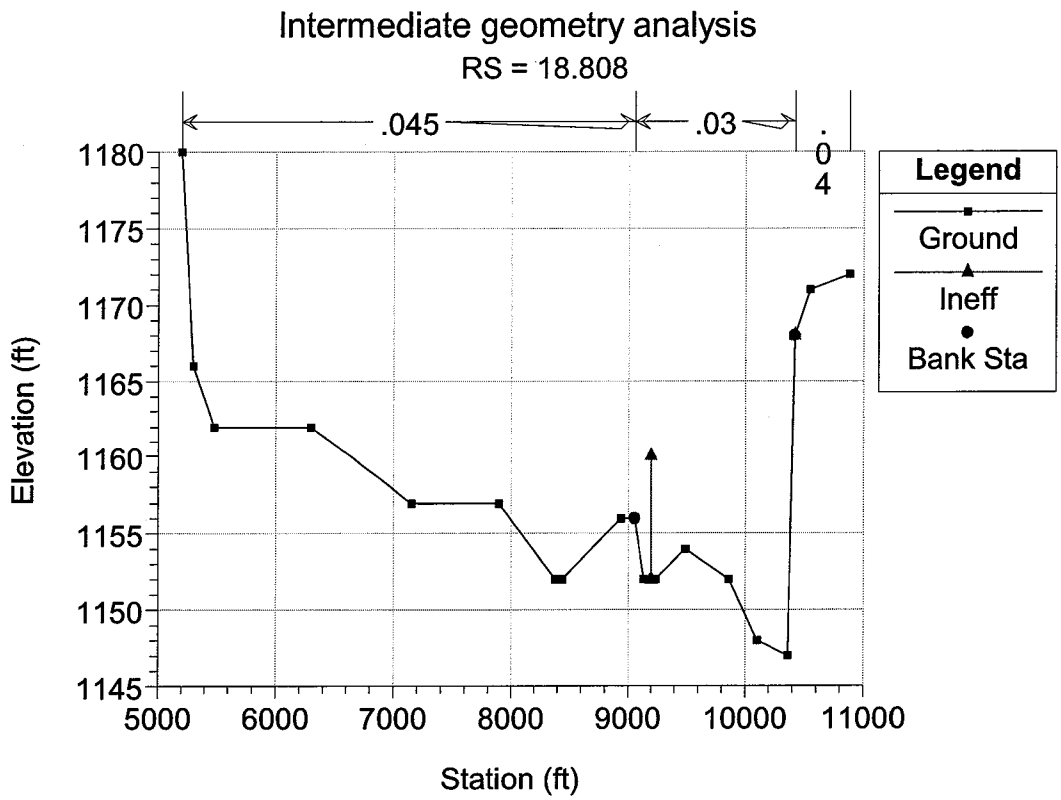

Intermediate geometry analysis
RS = 18.306
.045
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1165
1160
1155
1150
1145
1140
1135
5000
6000
7000
8000
9000
10000
11000
12000
Station (ft)

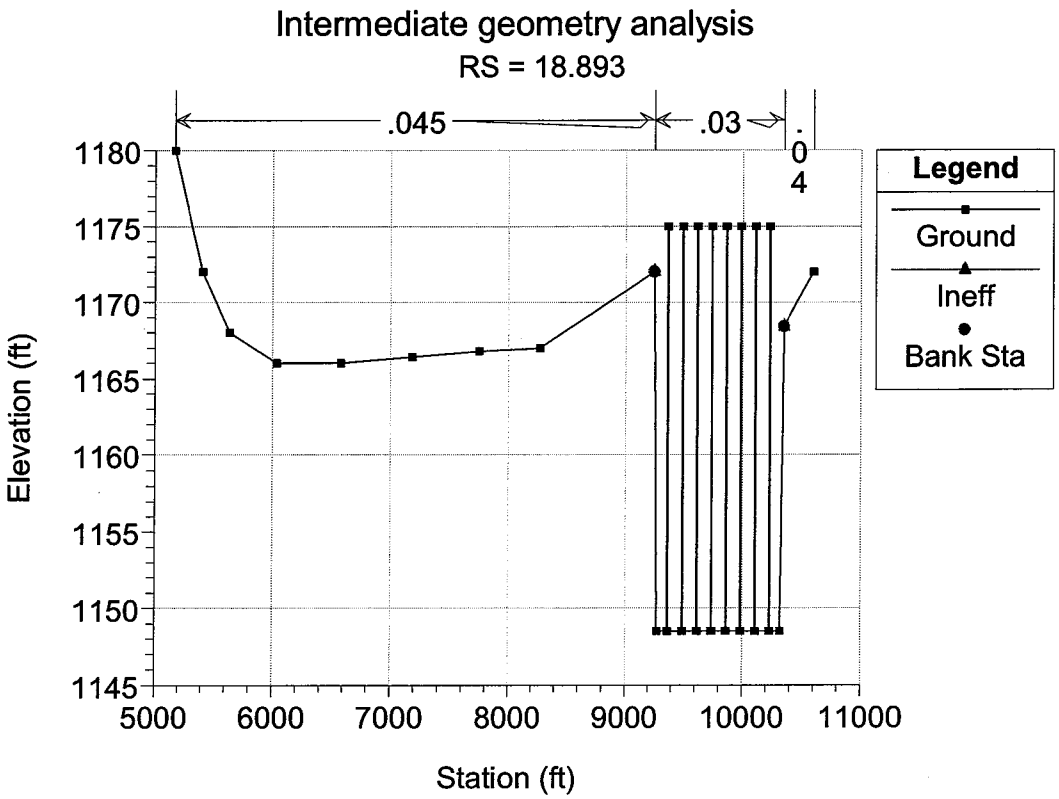

Intermediate geometry analysis
RS = 18.406
.045
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1165
1160
1155
1150
1145
1140
5000
6000
7000
8000
9000
10000
11000
12000
Station (ft)

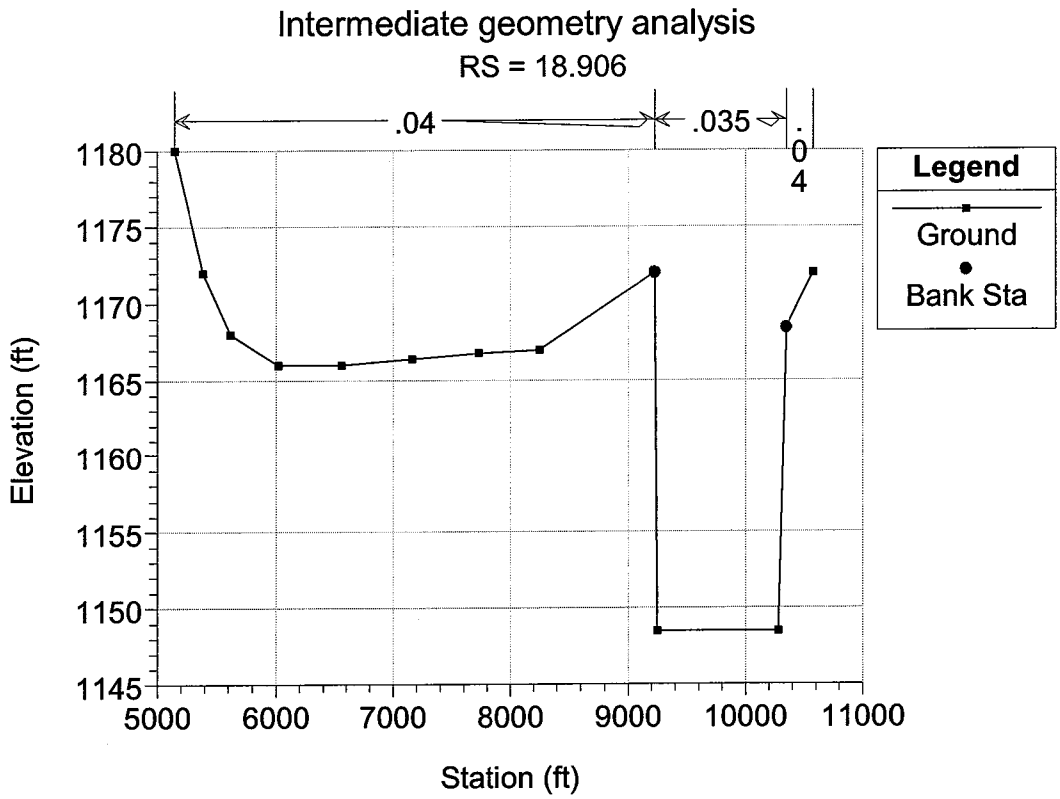

Intermediate geometry analysis
RS = 18.507
.045
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1165
1160
1155
1150
1145
1140
1135
5000
6000
7000
8000
9000
10000
11000
12000
Station (ft)

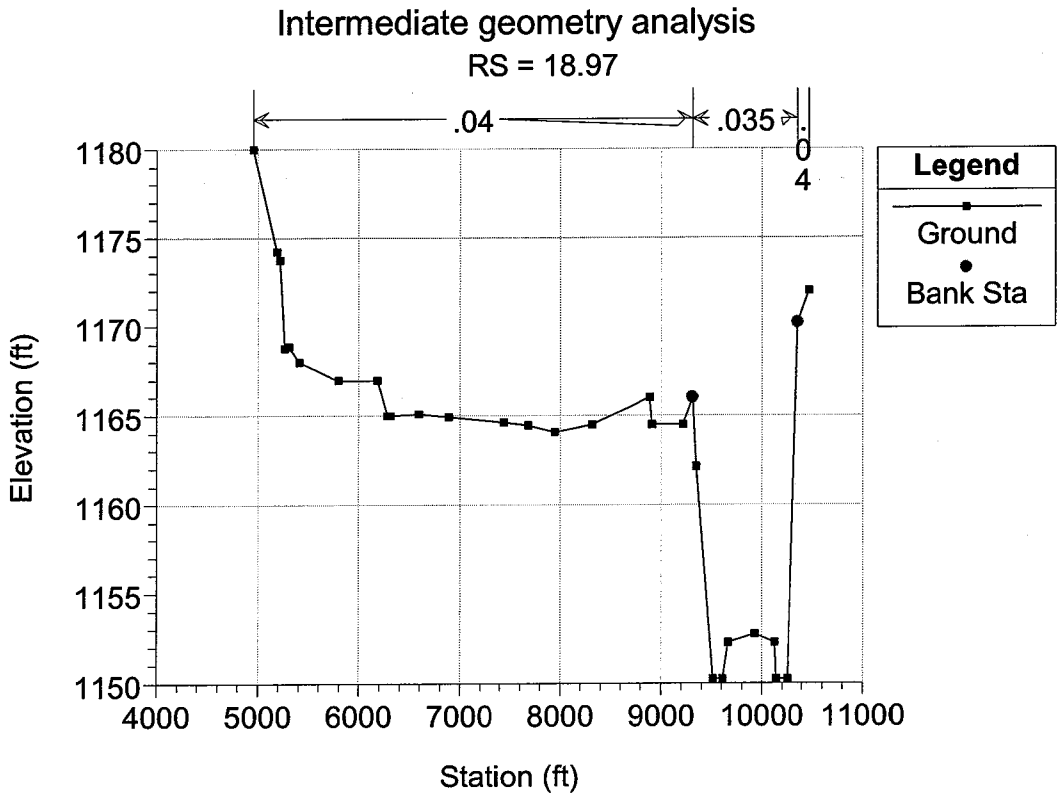

Intermediate geometry analysis
RS = 18.606
.045
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1175
1170
1165
1160
1155
1150
1145
1140
6000
7000
8000
9000
10000
11000
12000
Station (ft)

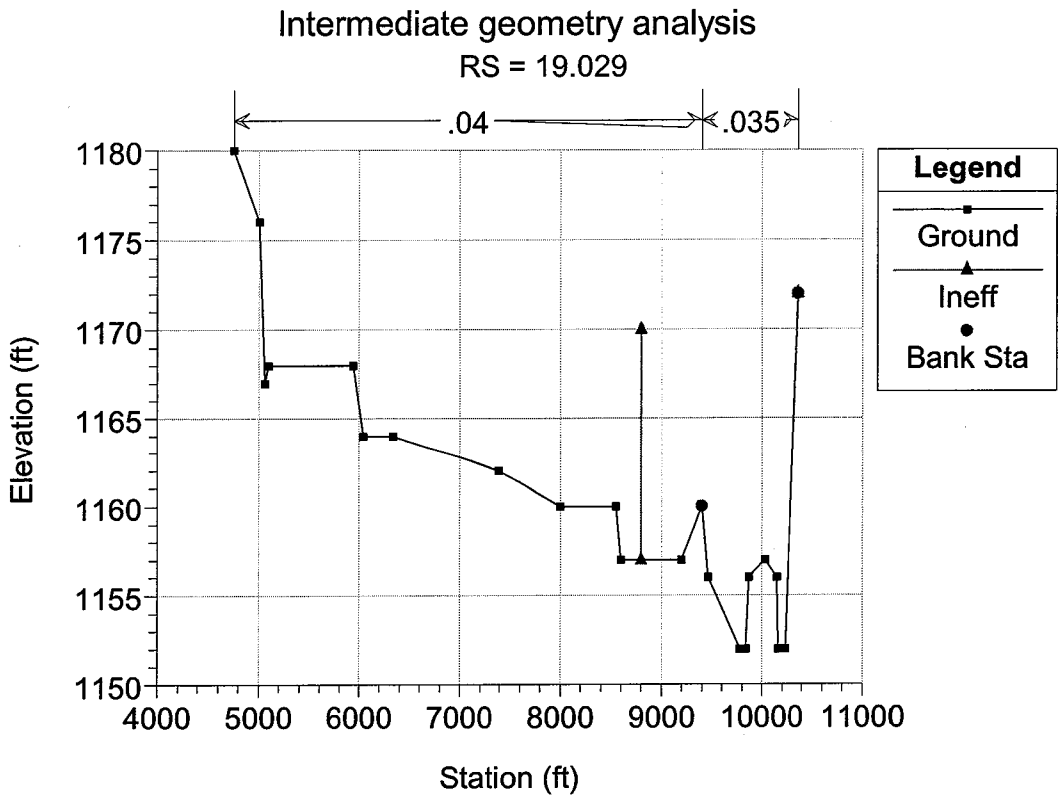

Intermediate geometry analysis
RS = 18.707
.045
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
1150
1145
5000
6000
7000
8000
9000
10000
11000
Station (ft)

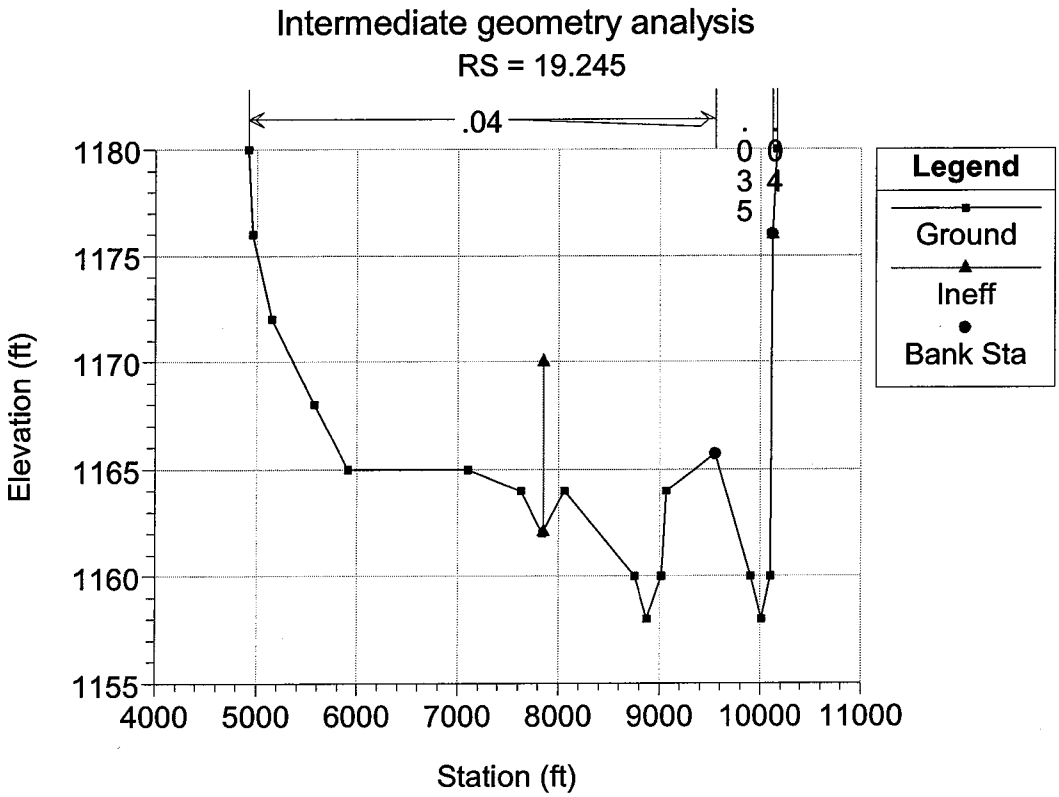

Intermediate geometry analysis
RS = 18.808
.045
.03
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
1150
1145
5000
6000
7000
8000
9000
10000
11000
Station (ft)

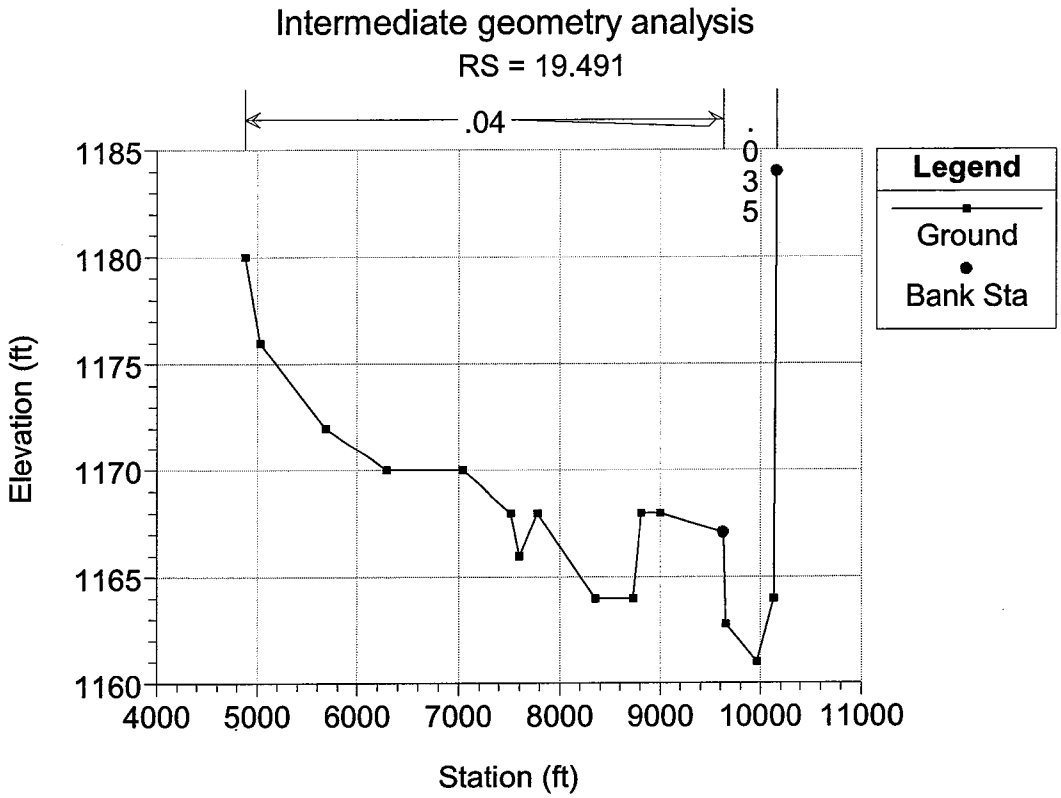

Intermediate geometry analysis
RS = 18.893
.045
.03
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
1150
1145
5000
6000
7000
8000
9000
10000
11000
Station (ft)

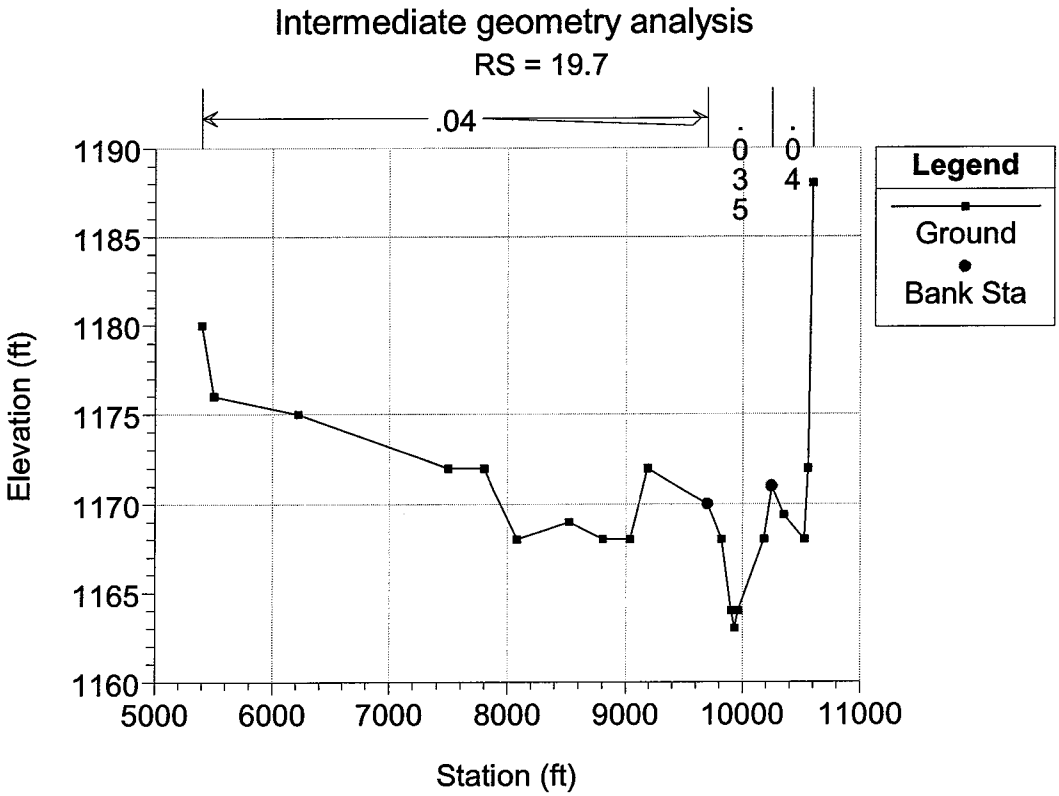

Intermediate geometry analysis
RS = 18.906
.04
.035
.04
Legend
Ground
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
1150
1145
5000
6000
7000
8000
9000
10000
11000
Station (ft)

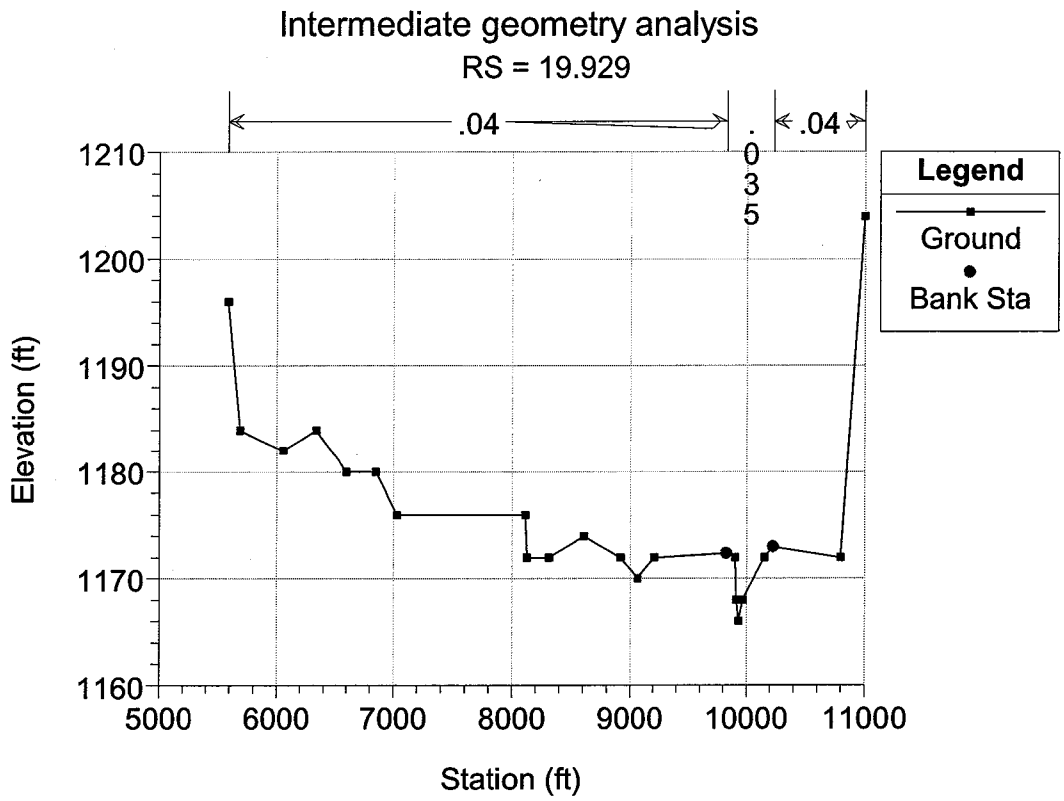

Intermediate geometry analysis
RS = 18.97
.04
.035
.04
Legend
Ground
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
1150
4000
5000
6000
7000
8000
9000
10000
11000
Station (ft)

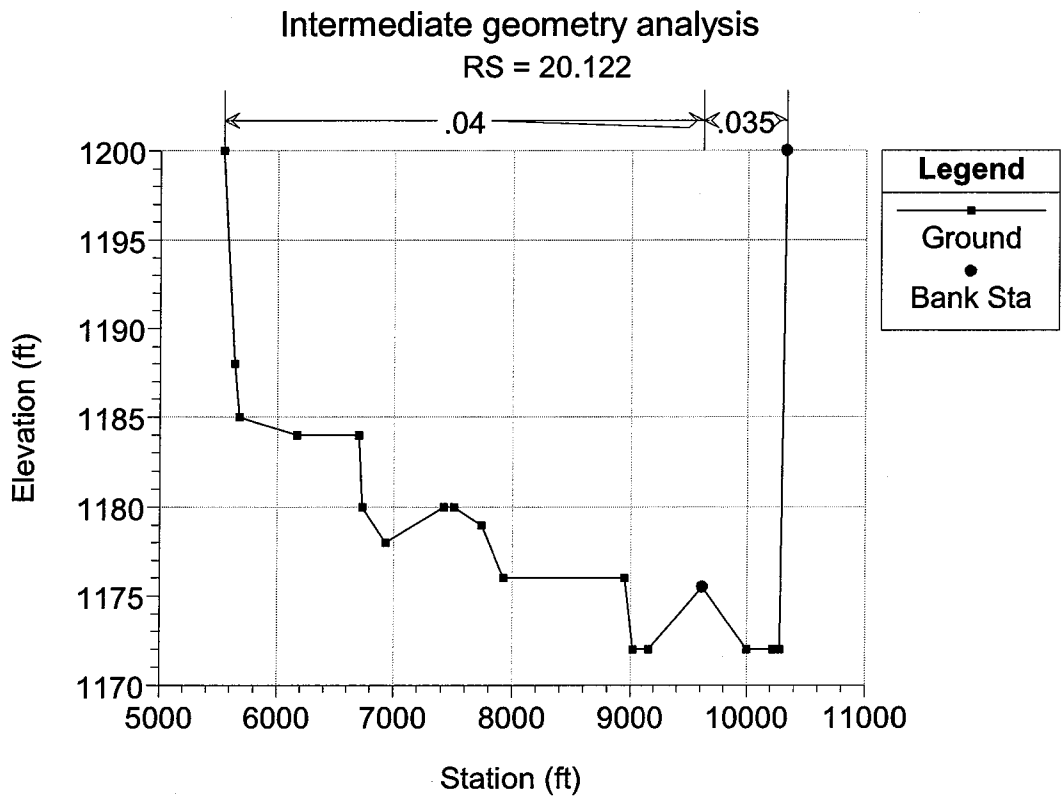

Intermediate geometry analysis
RS = 19.029
.04
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
1150
4000
5000
6000
7000
8000
9000
10000
11000
Station (ft)

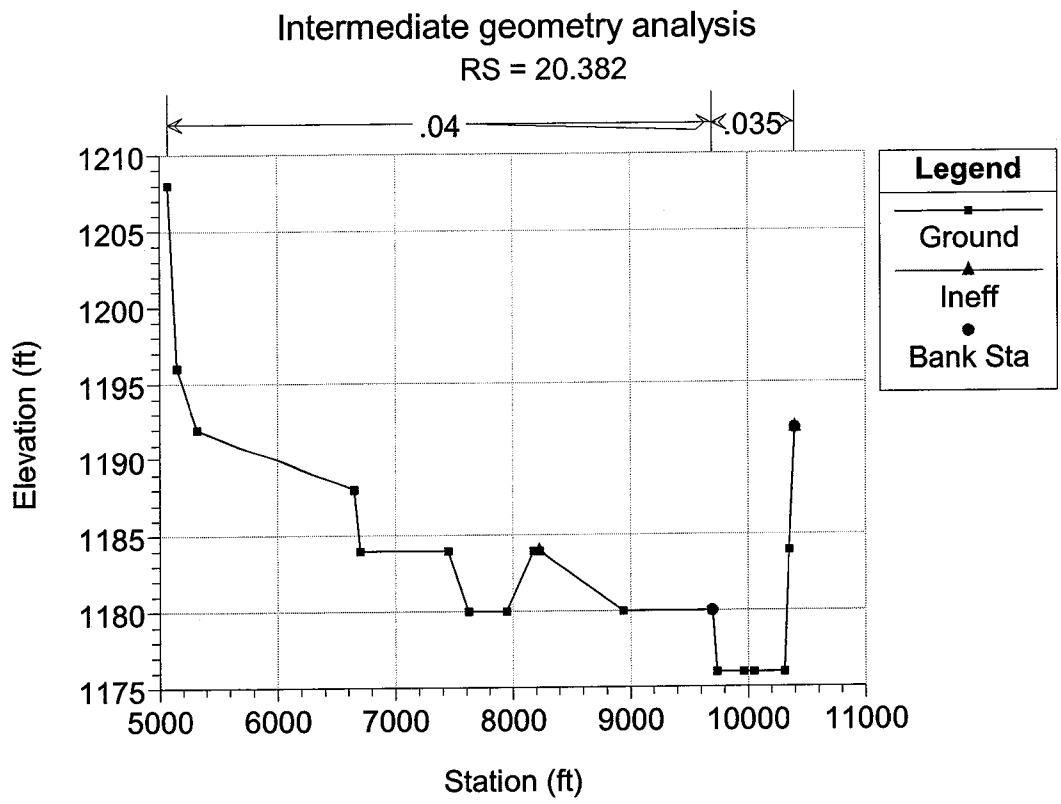

Intermediate geometry analysis
RS = 19.245
.04
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
4000
5000
6000
7000
8000
9000
10000
11000
Station (ft)

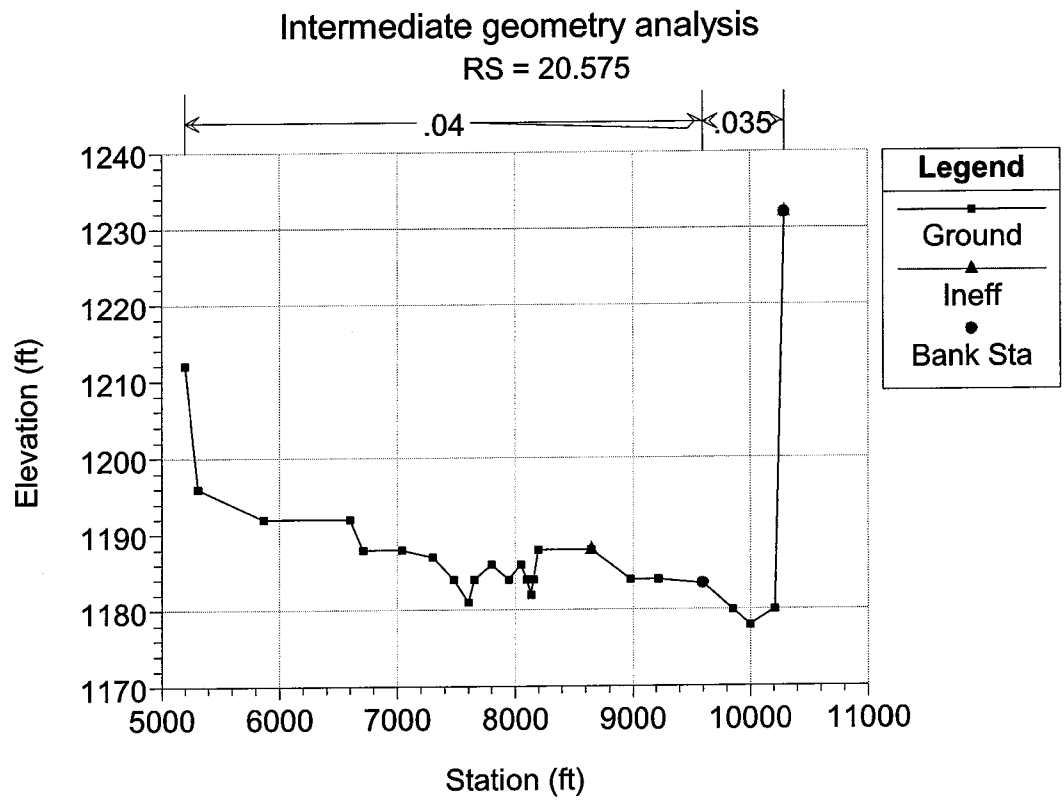

Intermediate geometry analysis
RS = 19.491
.04
.035
Legend
Ground
Bank Sta
Elevation (ft)
1185
1180
1175
1170
1165
1160
4000
5000
6000
7000
8000
9000
10000
11000
Station (ft)

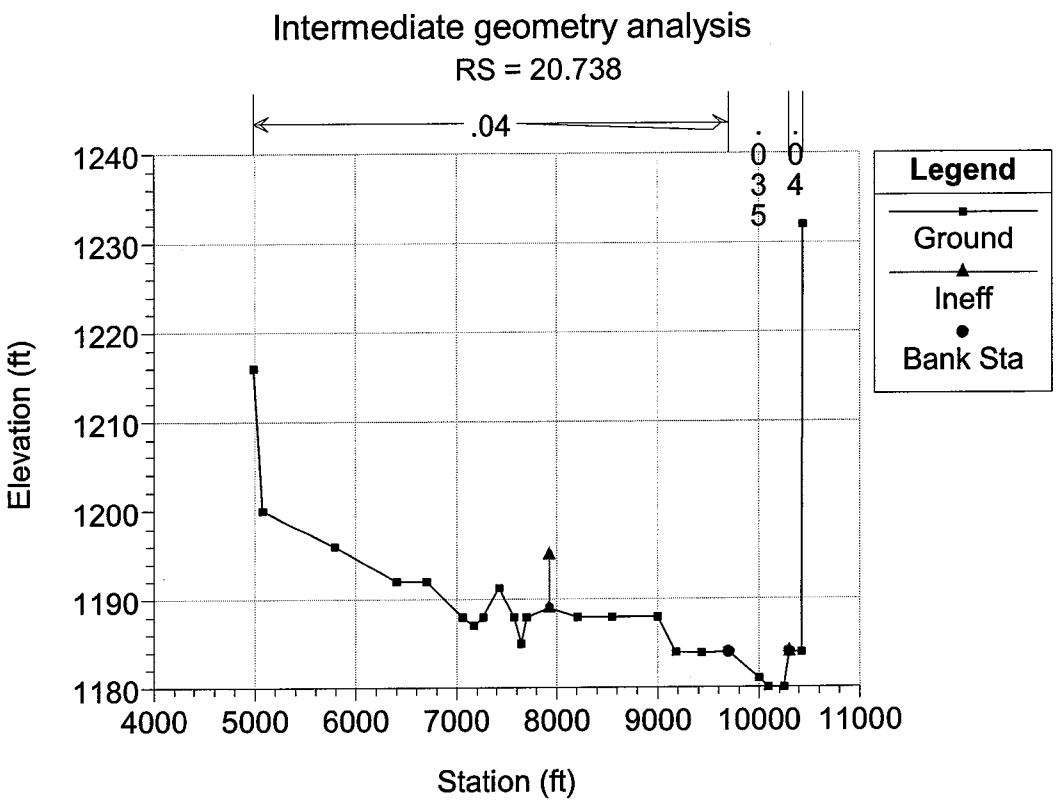

Intermediate geometry analysis
RS = 19.7
.04
.035
.04
Legend
Ground
Bank Sta
Elevation (ft)
1190
1185
1180
1175
1170
1165
1160
5000
6000
7000
8000
9000
10000
11000
Station (ft)

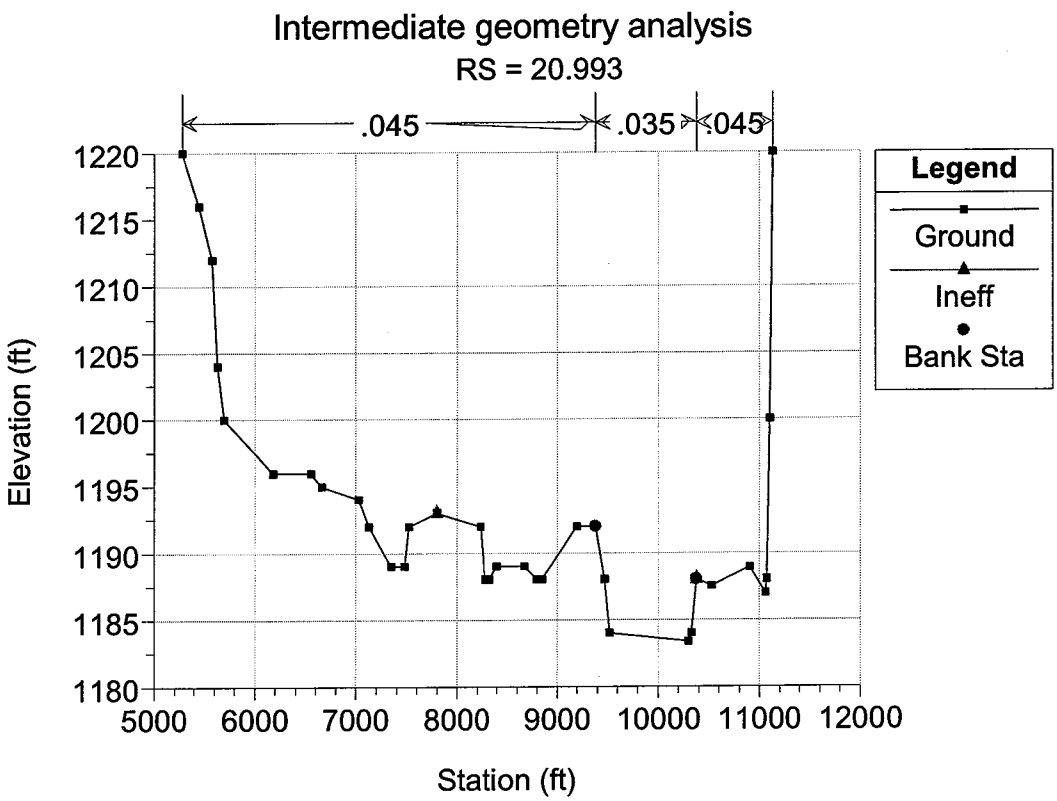

Intermediate geometry analysis
RS = 19.929
.04
.035
.04
Legend
Ground
Bank Sta
Elevation (ft)
1210
1200
1190
1180
1170
1160
5000
6000
7000
8000
9000
10000
11000
Station (ft)

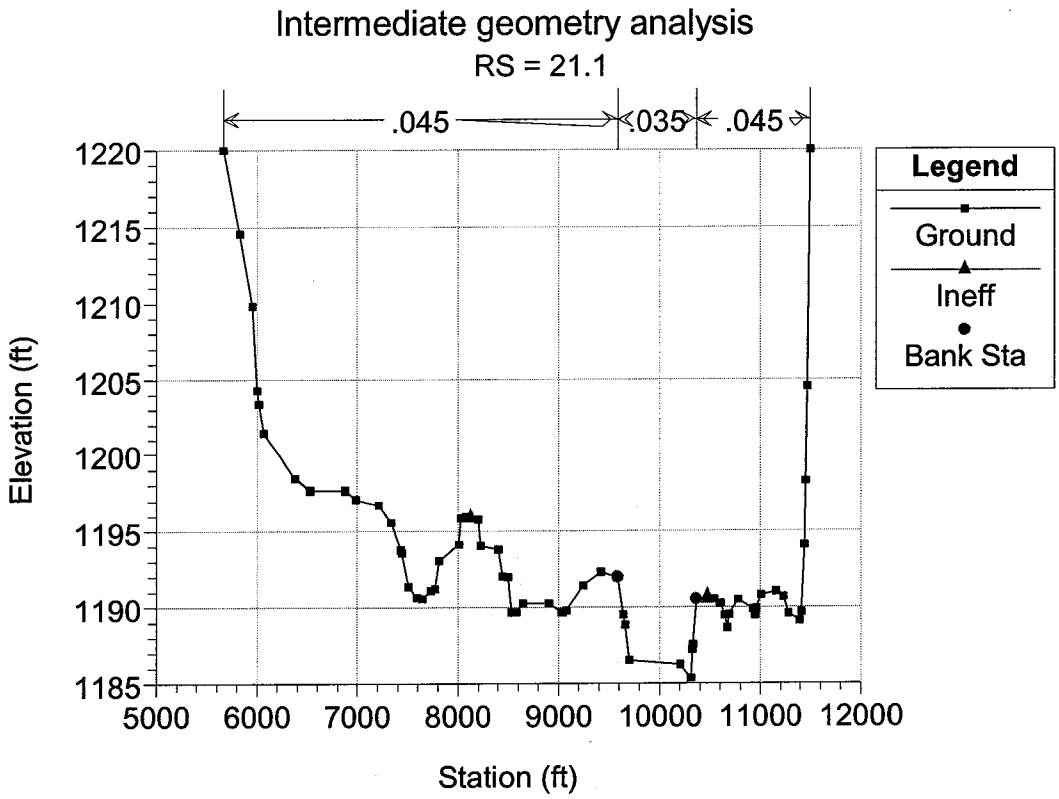

Intermediate geometry analysis
RS = 20.122
.04
.035
Legend
Ground
Bank Sta
Elevation (ft)
1200
1195
1190
1185
1180
1175
1170
5000
6000
7000
8000
9000
10000
11000
Station (ft)

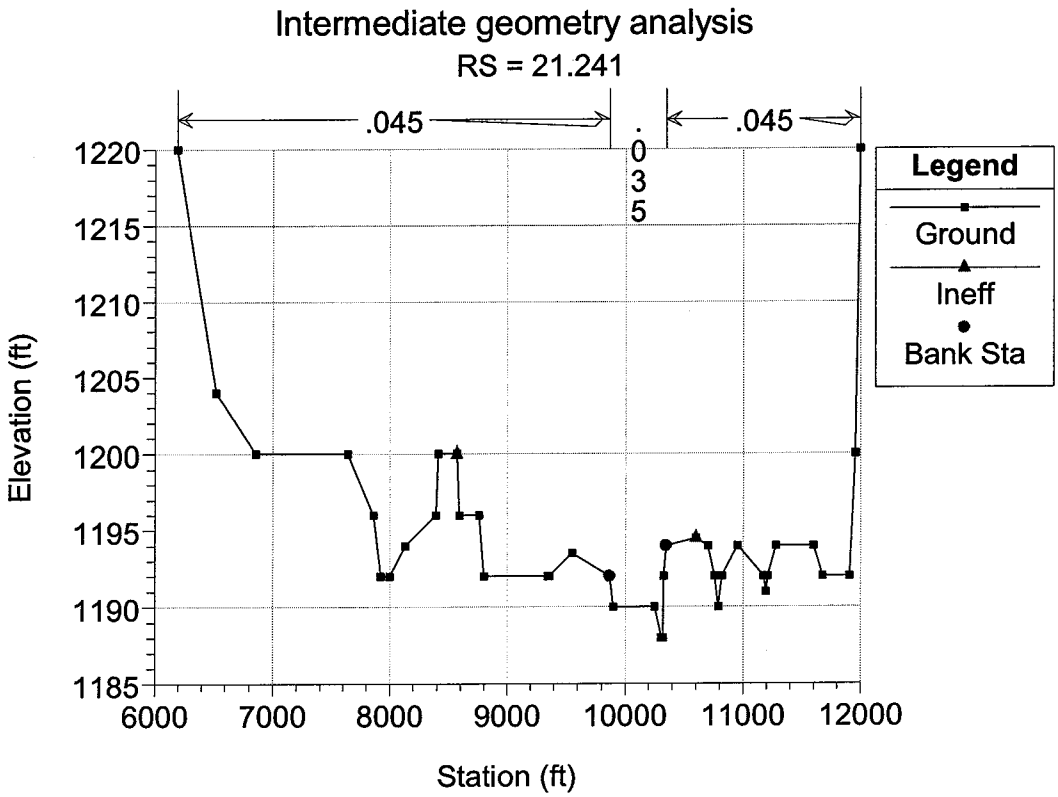

Intermediate geometry analysis
RS = 20.382
.04
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1210
1205
1200
1195
1190
1185
1180
1175
5000
6000
7000
8000
9000
10000
11000
Station (ft)

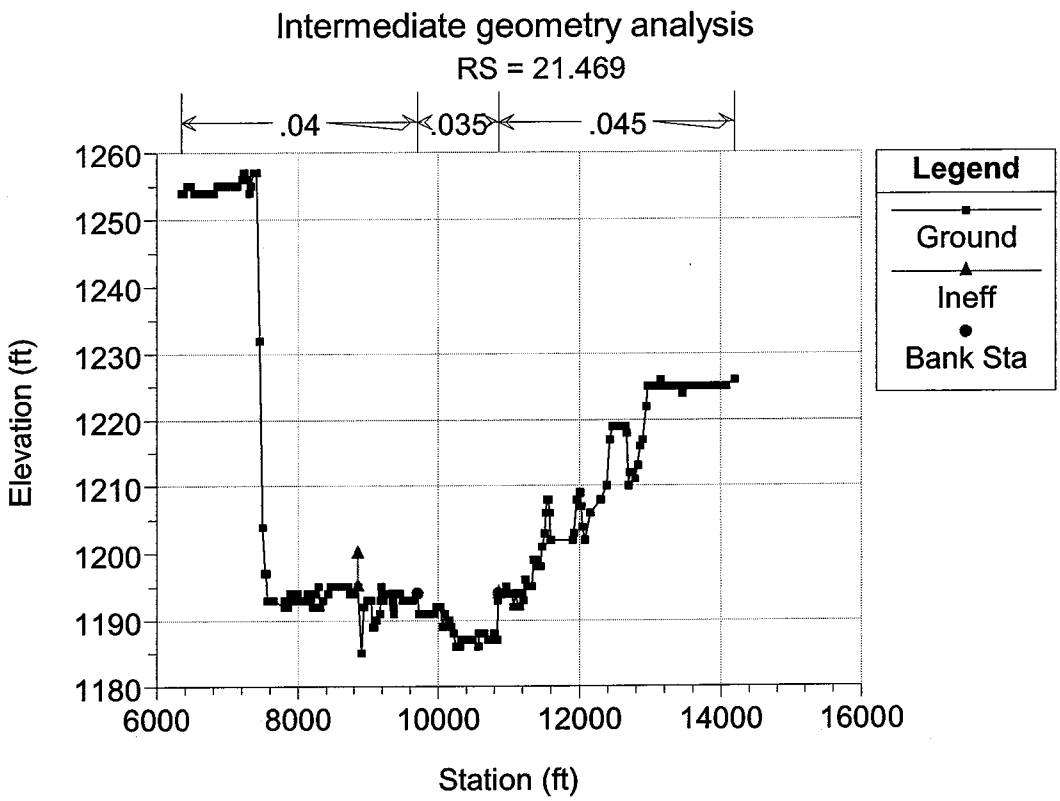

Intermediate geometry analysis
RS = 20.575
.04
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1230
1220
1210
1200
1190
1180
1170
5000
6000
7000
8000
9000
10000
11000
Station (ft)

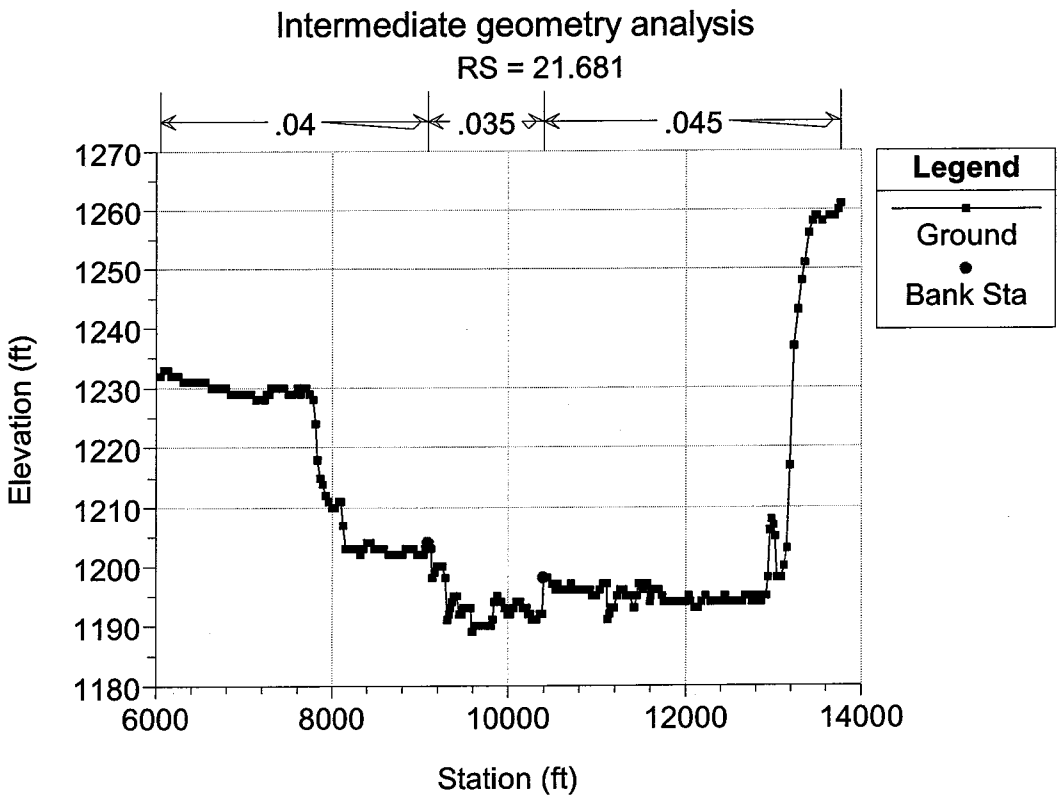

Intermediate geometry analysis
RS = 20.738
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1230
1220
1210
1200
1190
1180
4000
5000
6000
7000
8000
9000
10000
11000
Station (ft)

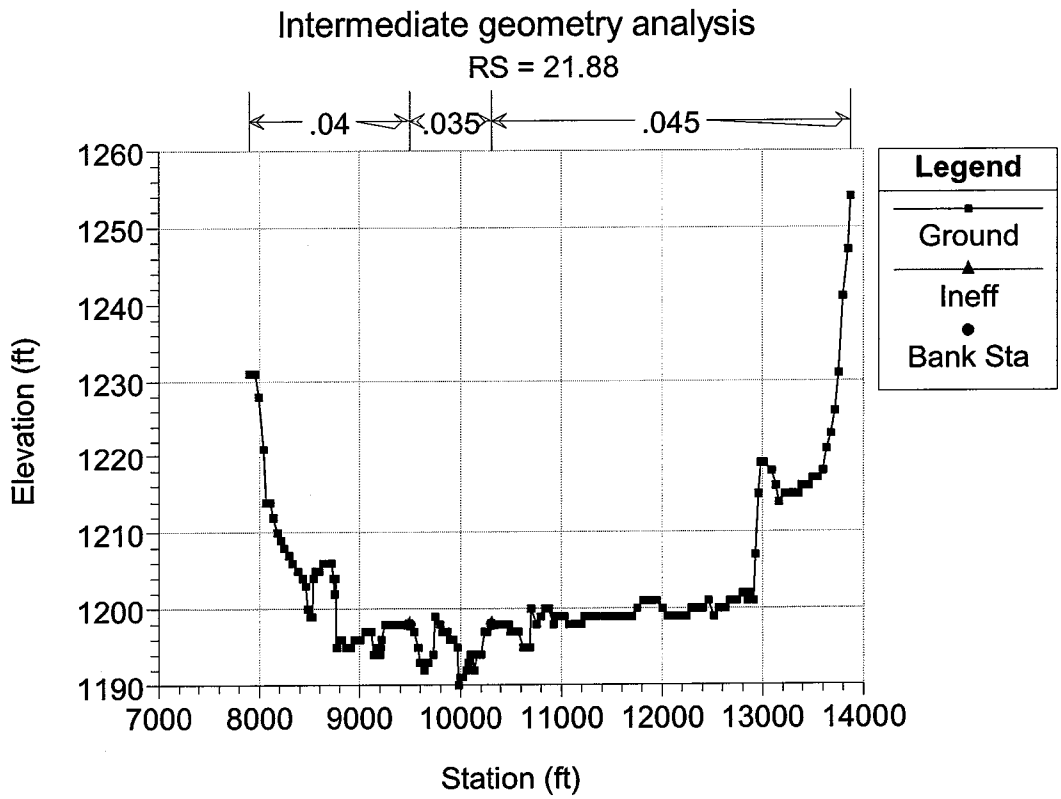

Intermediate geometry analysis
RS = 20.993
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1220
1215
1210
1205
1200
1195
1190
1185
1180
5000
6000
7000
8000
9000
10000
11000
12000
Station (ft)

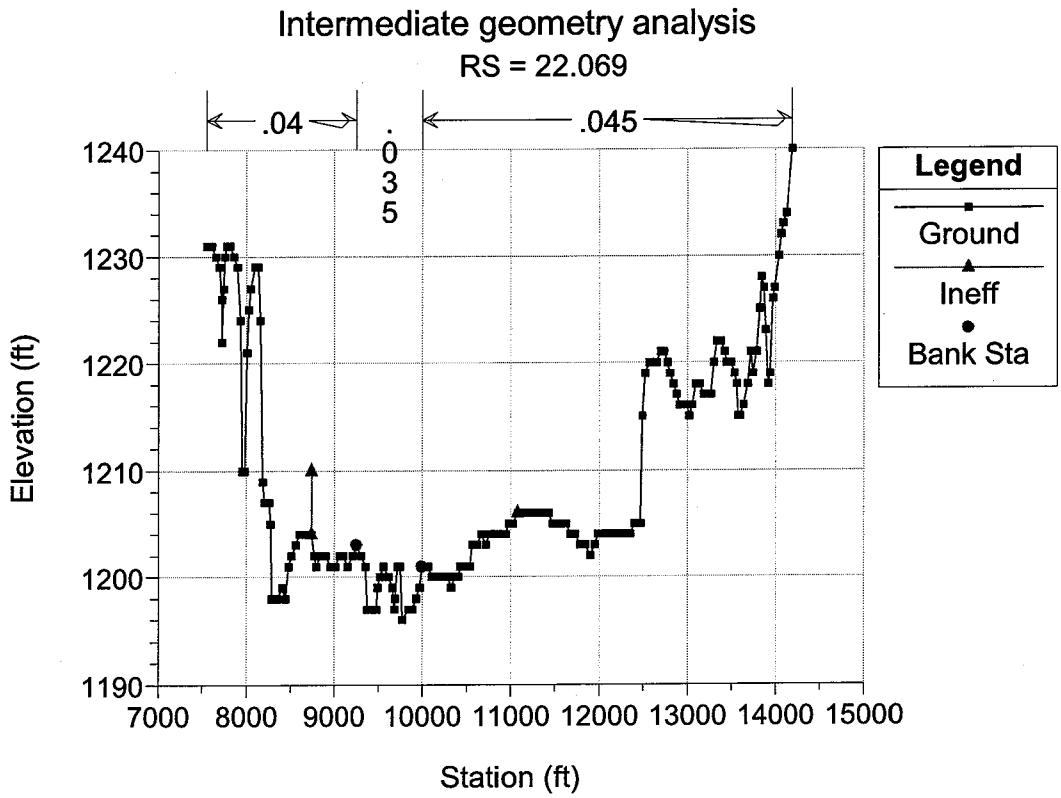

Intermediate geometry analysis
RS = 21.1
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1220
1215
1210
1205
1200
1195
1190
1185
5000
6000
7000
8000
9000
10000
11000
12000
Station (ft)

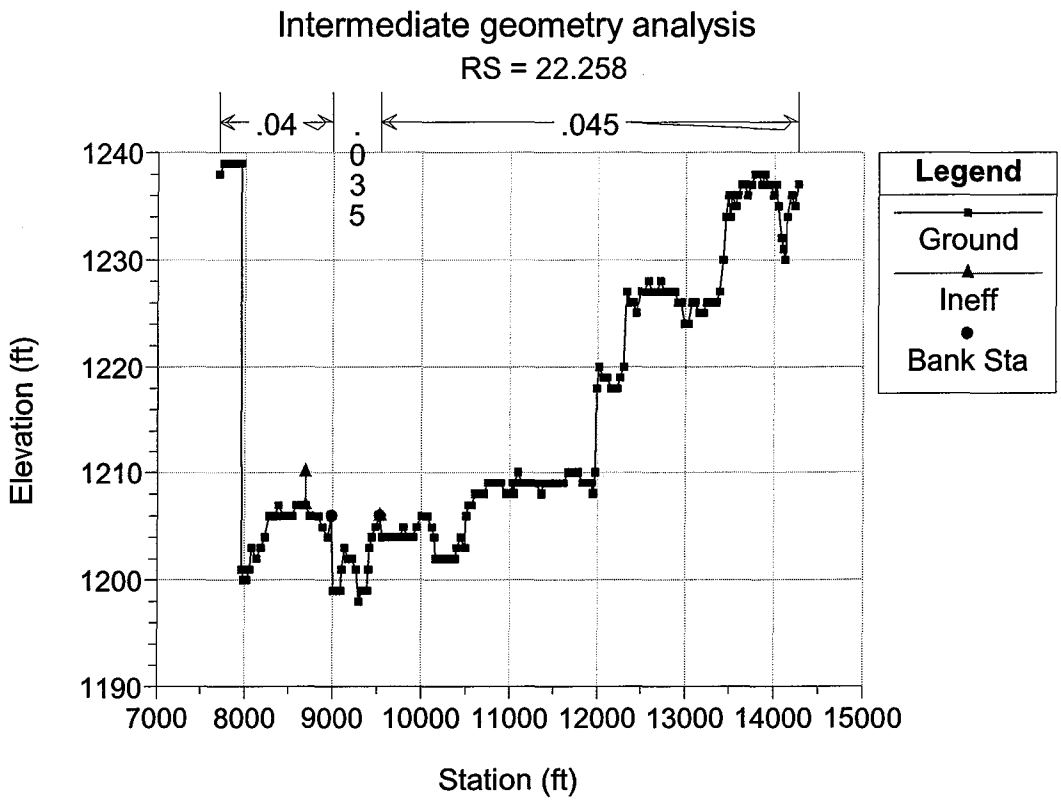

Intermediate geometry analysis
RS = 21.241
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1220
1215
1210
1205
1200
1195
1190
1185
6000
7000
8000
9000
10000
11000
12000
Station (ft)

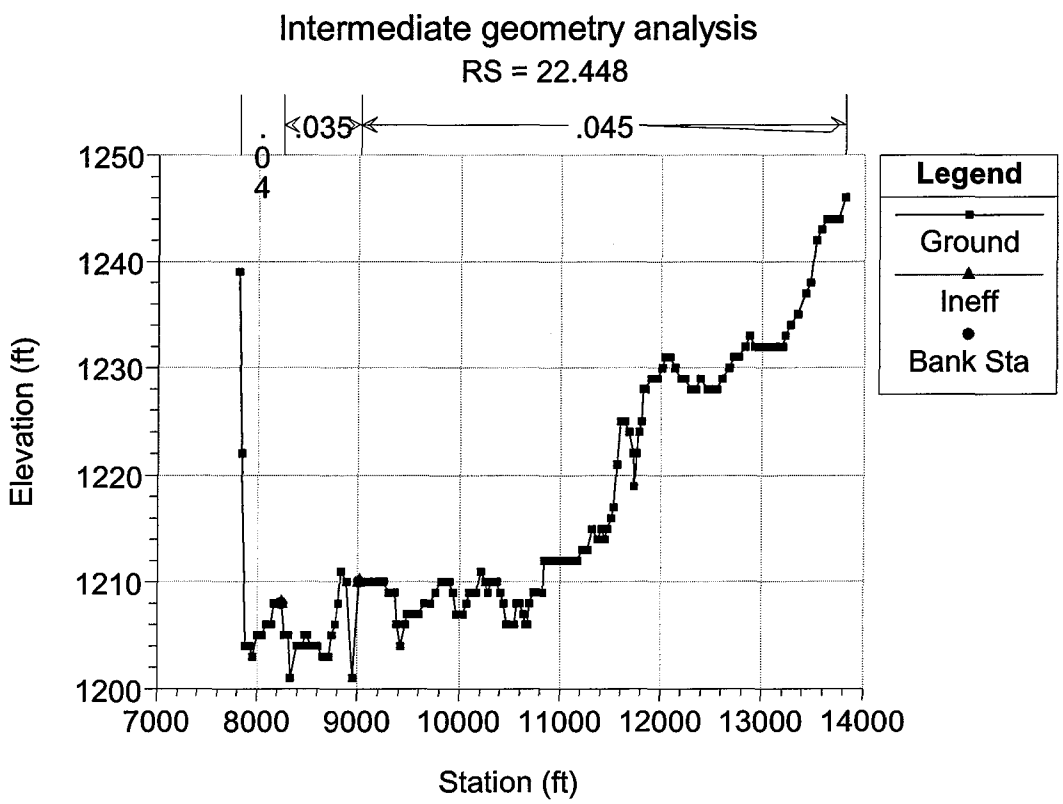

Intermediate geometry analysis
RS = 21.469
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1250
1240
1230
1220
1210
1200
1190
1180
6000
8000
10000
12000
14000
16000
Station (ft)

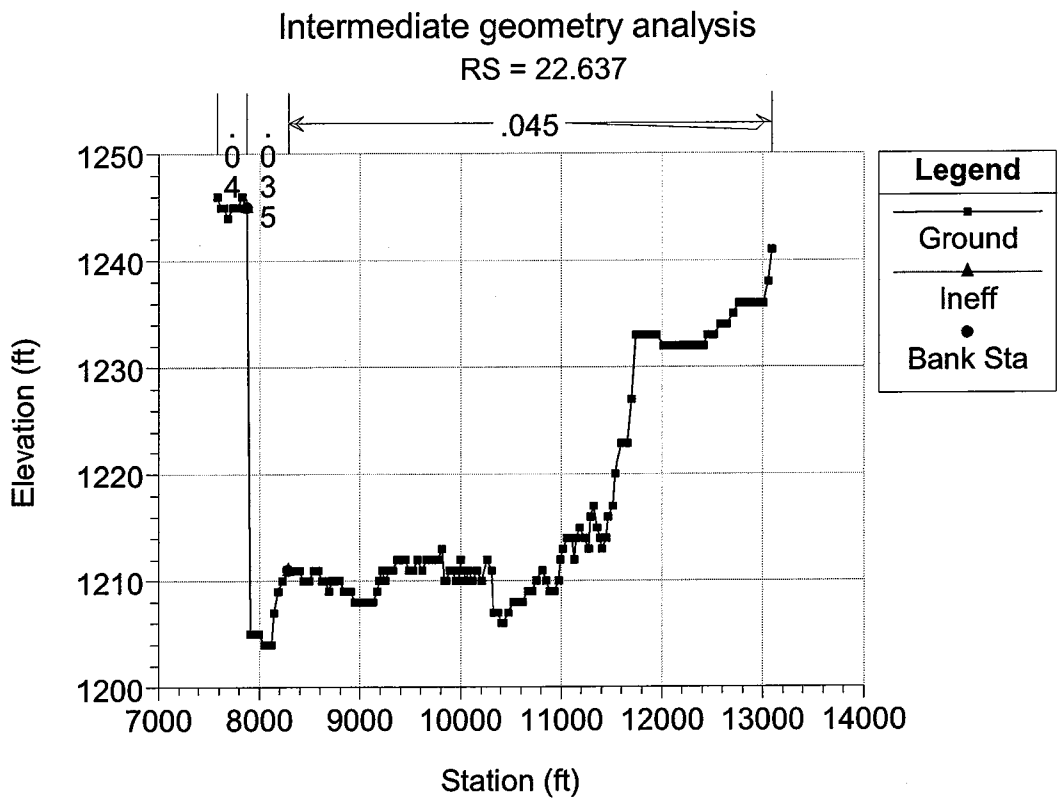

Intermediate geometry analysis
RS = 21.681
.04
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1270
1260
1250
1240
1230
1220
1210
1200
1190
1180
6000
8000
10000
12000
14000
Station (ft)

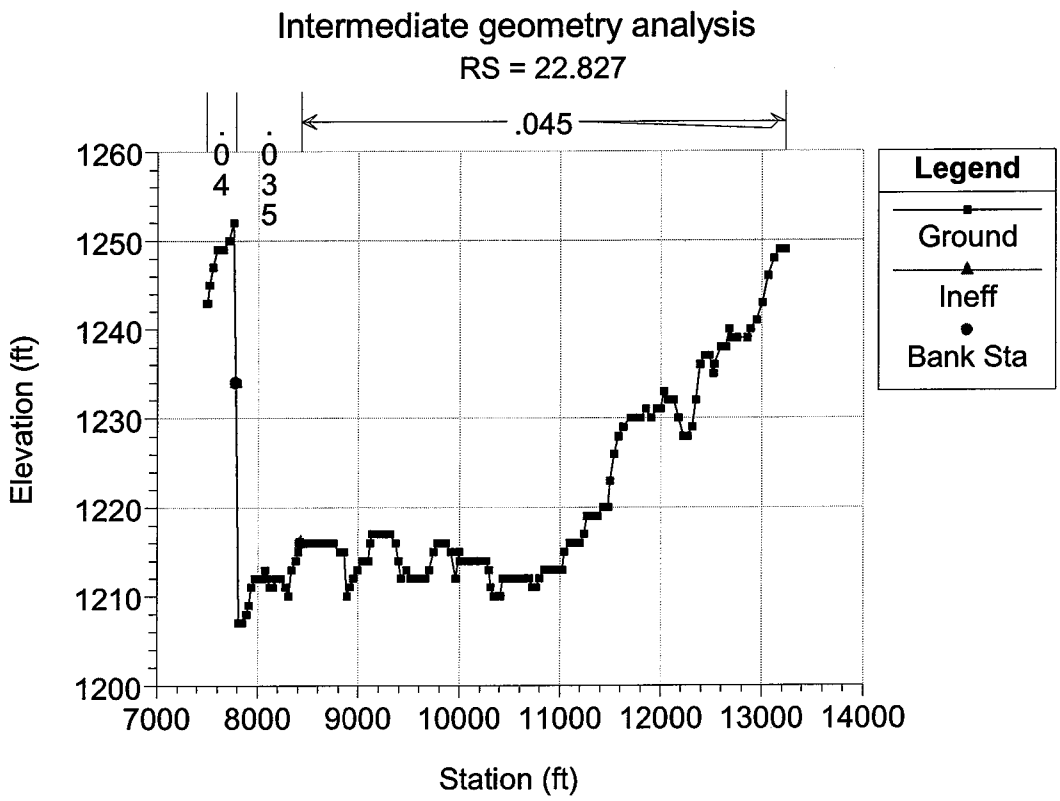

Intermediate geometry analysis
RS = 21.88
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1250
1240
1230
1220
1210
1200
1190
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)


Intermediate geometry analysis
RS = 22.069
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1230
1220
1210
1200
1190
7000
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)


Intermediate geometry analysis
RS = 22.258
.04
.035
.045
Elevation (ft)
1240
1230
1220
1210
1200
1190
7000
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)
Legend
Ground
Ineff
Bank Sta


Intermediate geometry analysis
RS = 22.448
.04
.035
.045
Elevation (ft)
1250
1240
1230
1220
1210
1200
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)
Legend
Ground
Ineff
Bank Sta


Intermediate geometry analysis
RS = 22.637
.045
.04
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1250
1240
1230
1220
1210
1200
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)


Intermediate geometry analysis
RS = 22.827
.045
.04
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1250
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1220
1210
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7000
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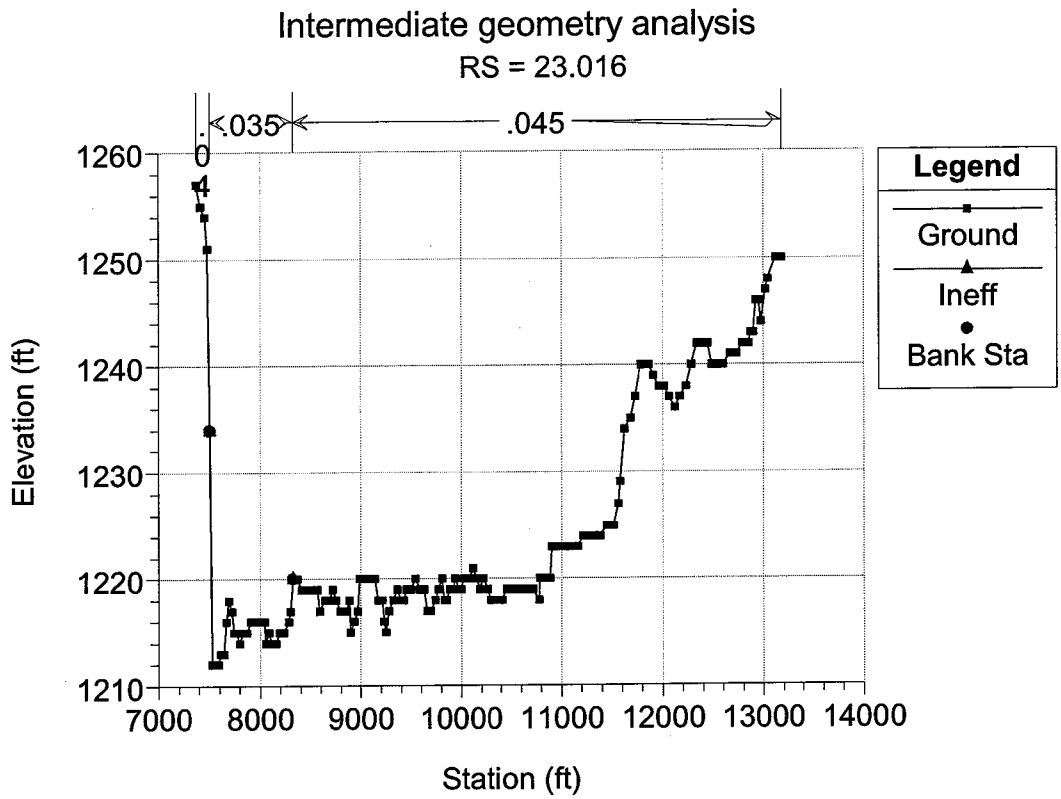
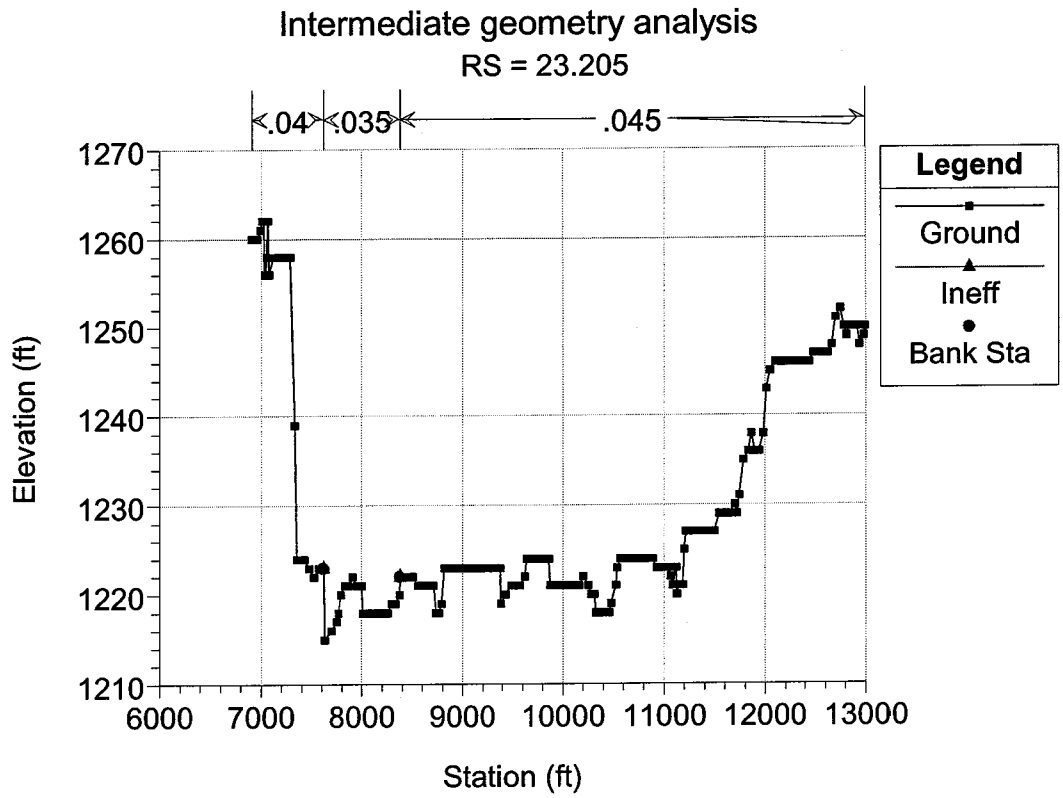
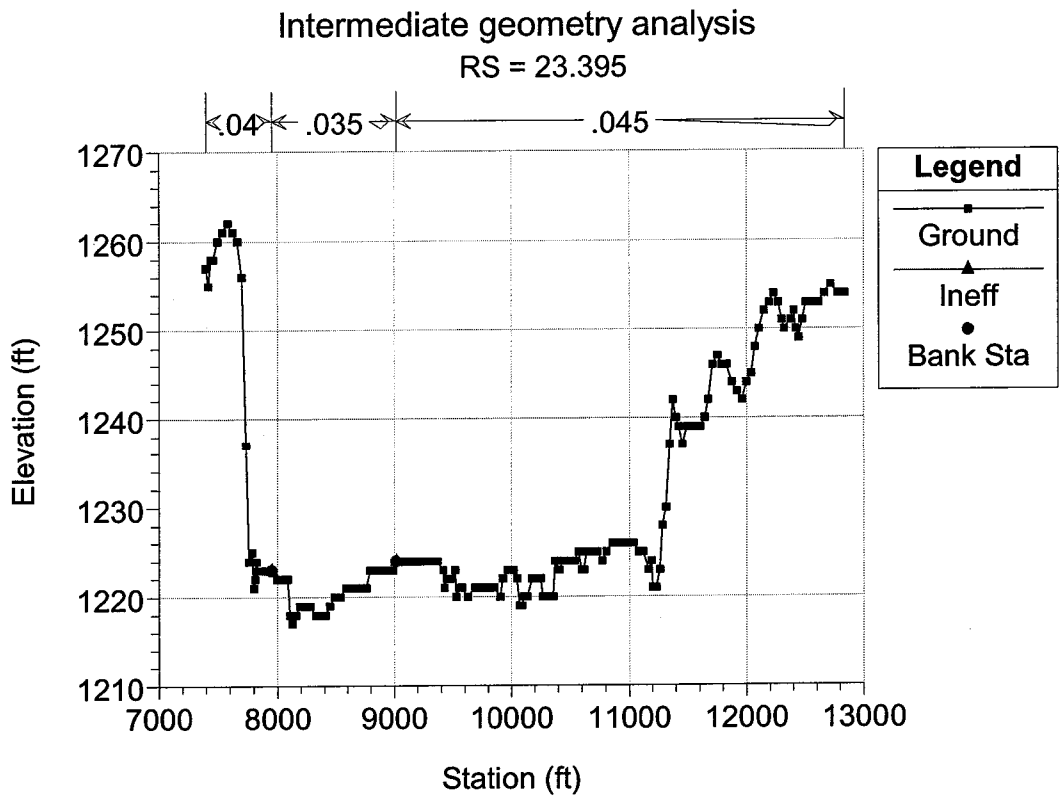
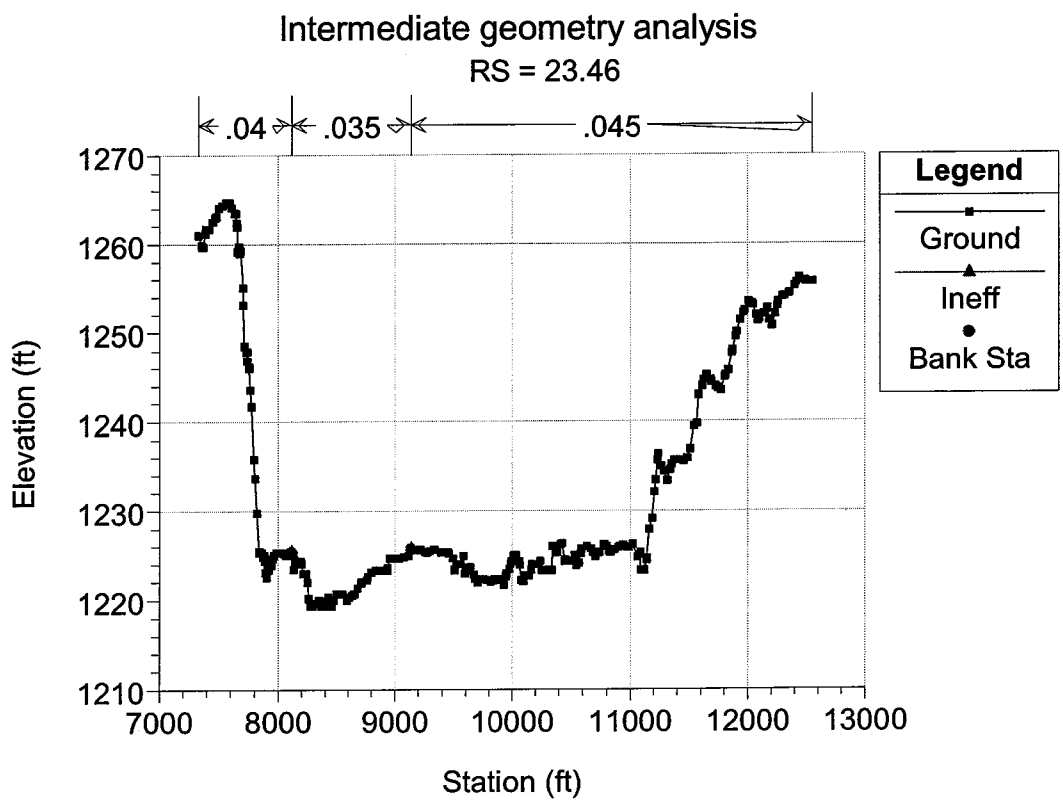
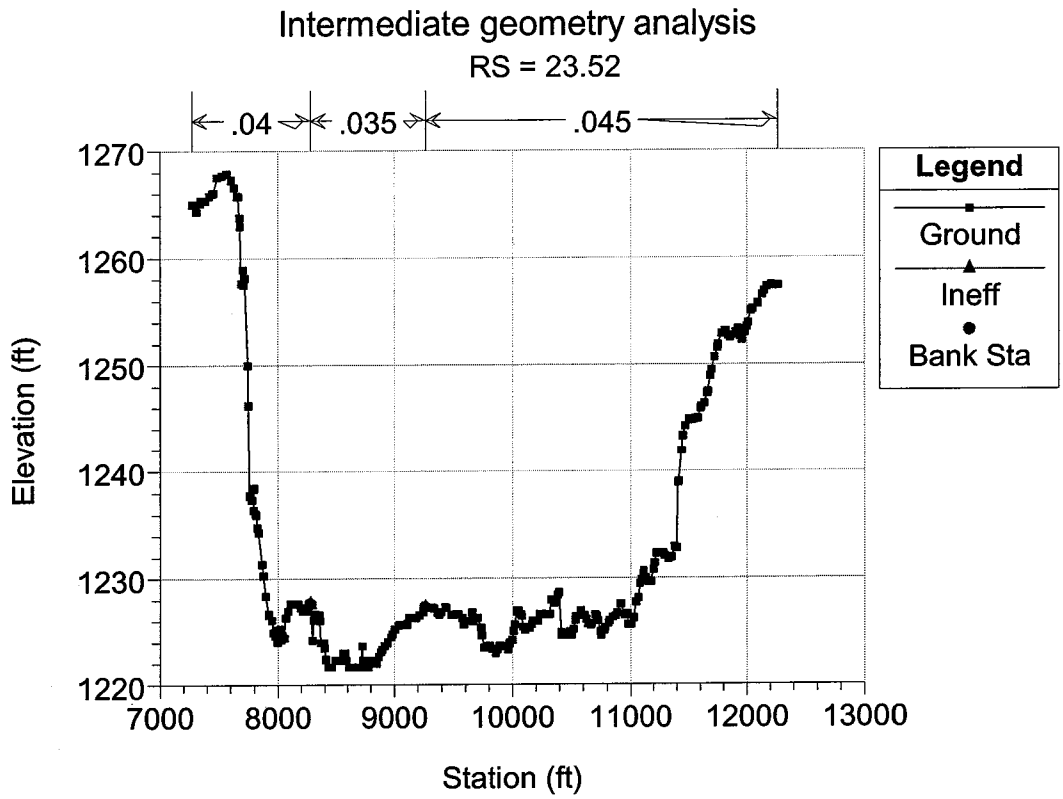
11000
12000
13000
14000
Station (ft)

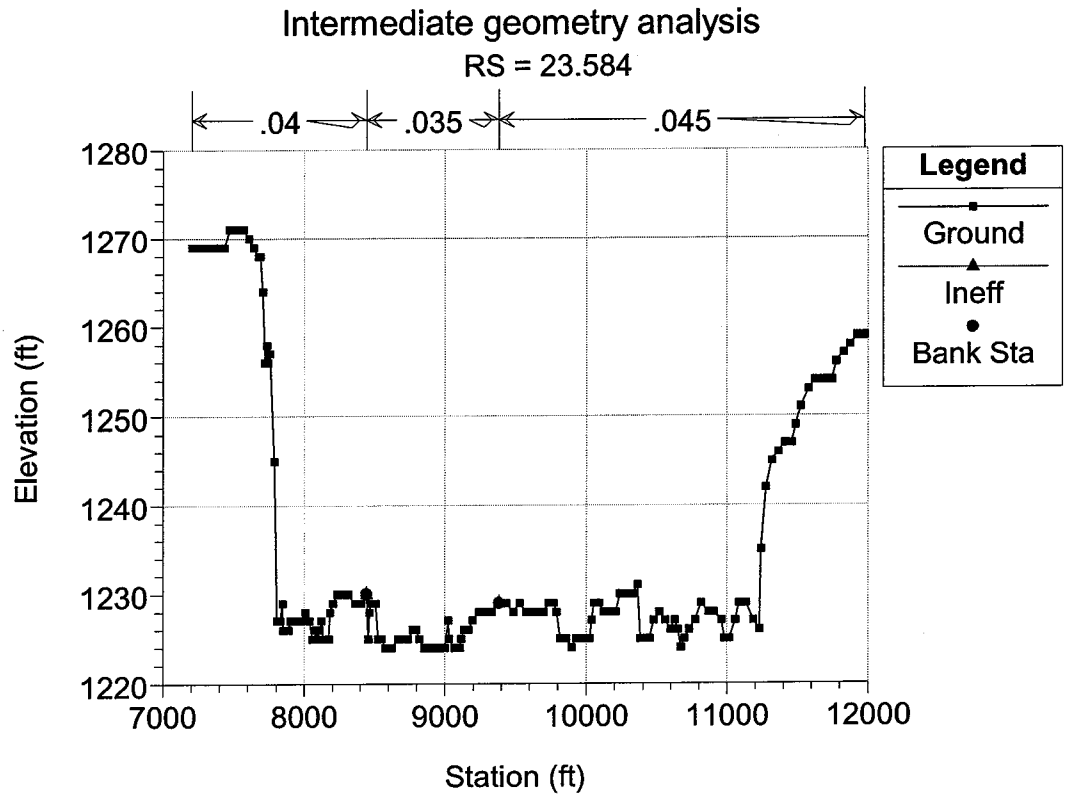

Intermediate geometry analysis
RS = 23.016
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1250
1240
1230
1220
1210
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)

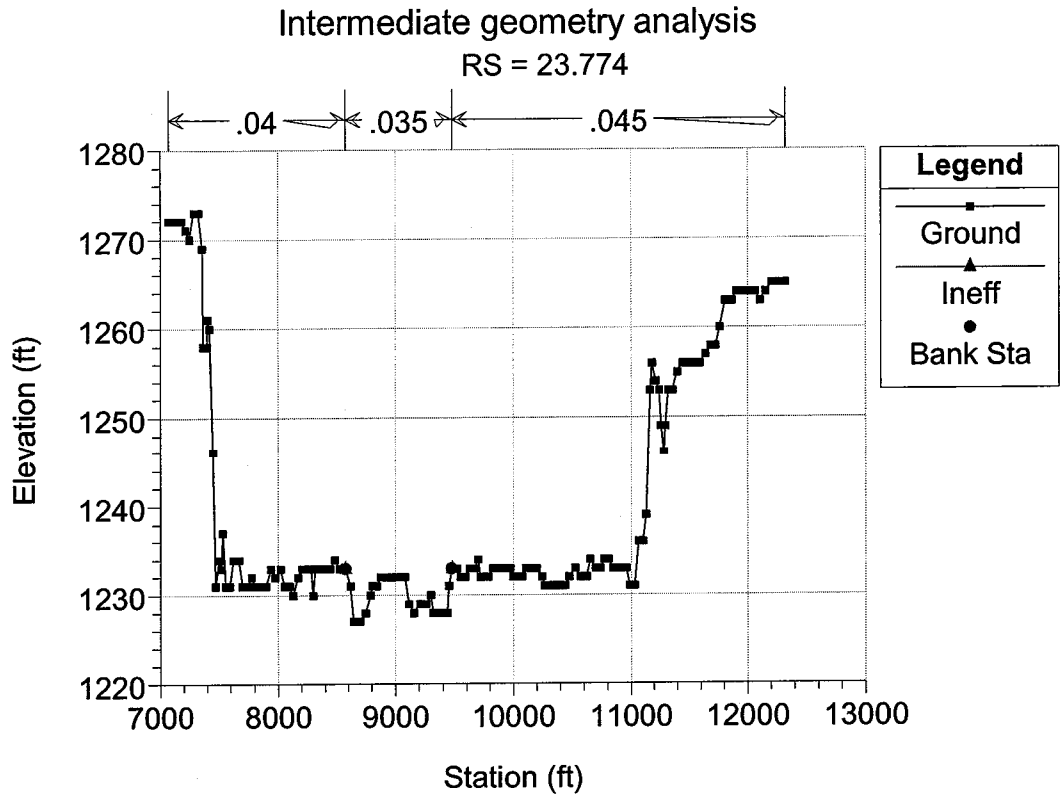

Intermediate geometry analysis
RS = 23.205
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1270
1260
1250
1240
1230
1220
1210
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

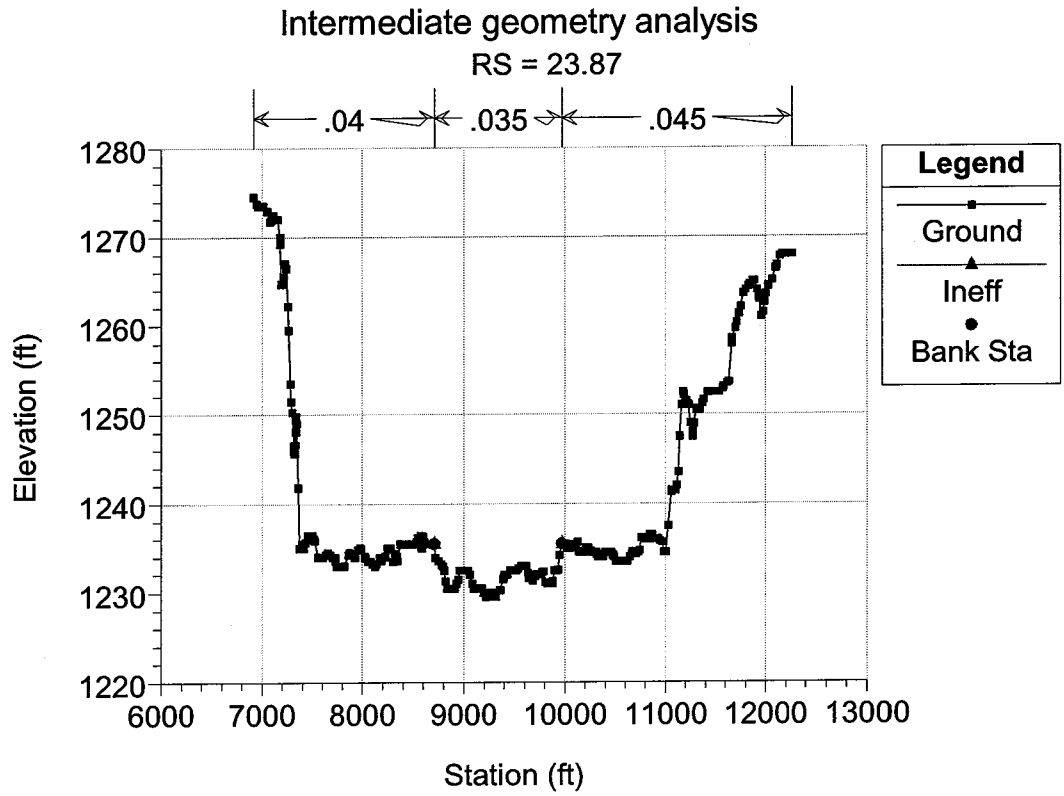

Intermediate geometry analysis
RS = 23.395
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1270
1260
1250
1240
1230
1220
1210
7000
8000
9000
10000
11000
12000
13000
Station (ft)

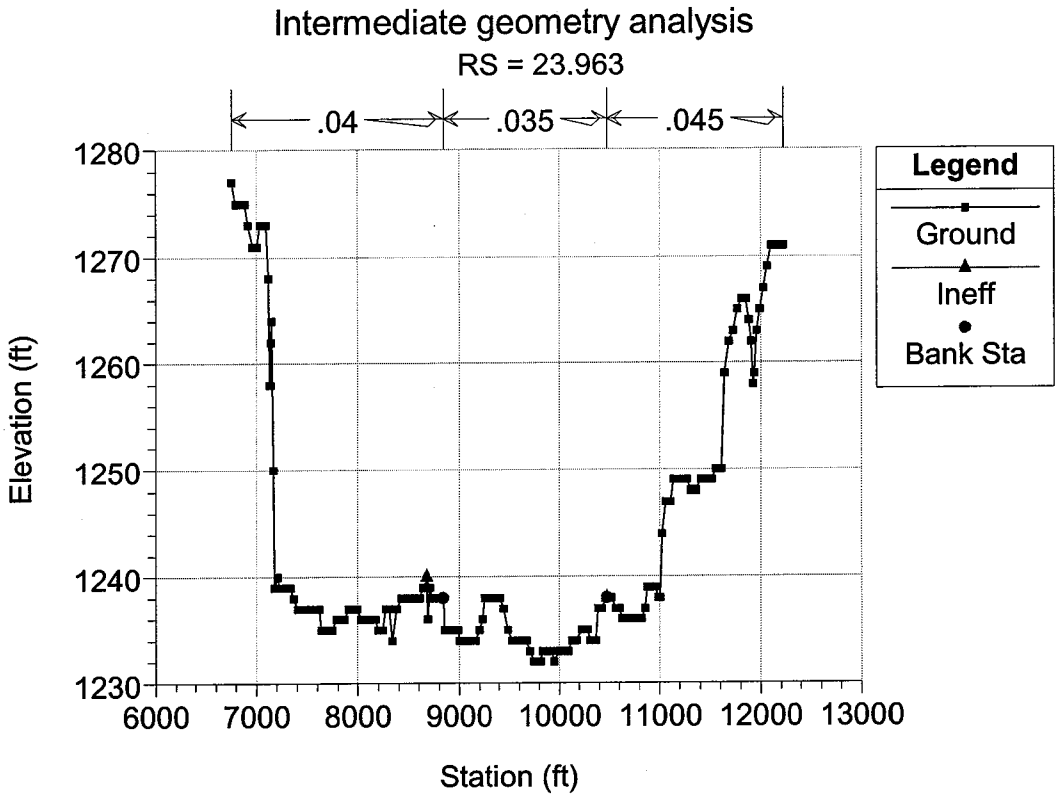

Intermediate geometry analysis
RS = 23.46
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1270
1260
1250
1240
1230
1220
1210
7000
8000
9000
10000
11000
12000
13000
Station (ft)

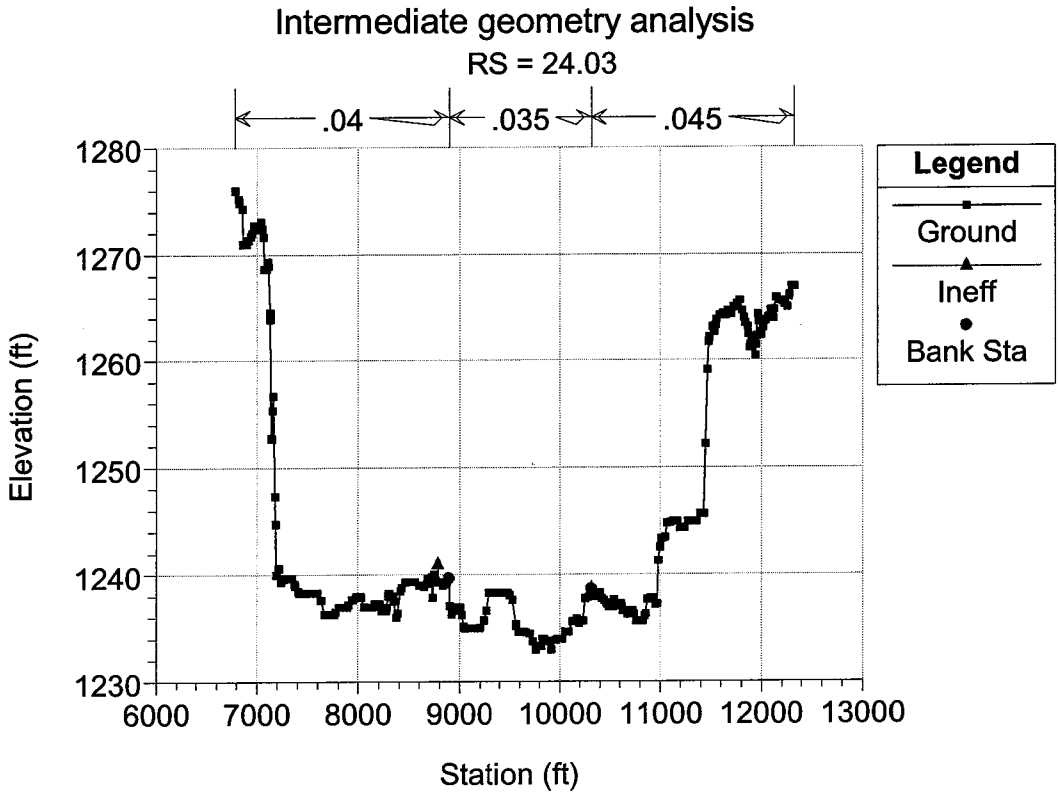

Intermediate geometry analysis
RS = 23.52
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1270
1260
1250
1240
1230
1220
7000
8000
9000
10000
11000
12000
13000
Station (ft)

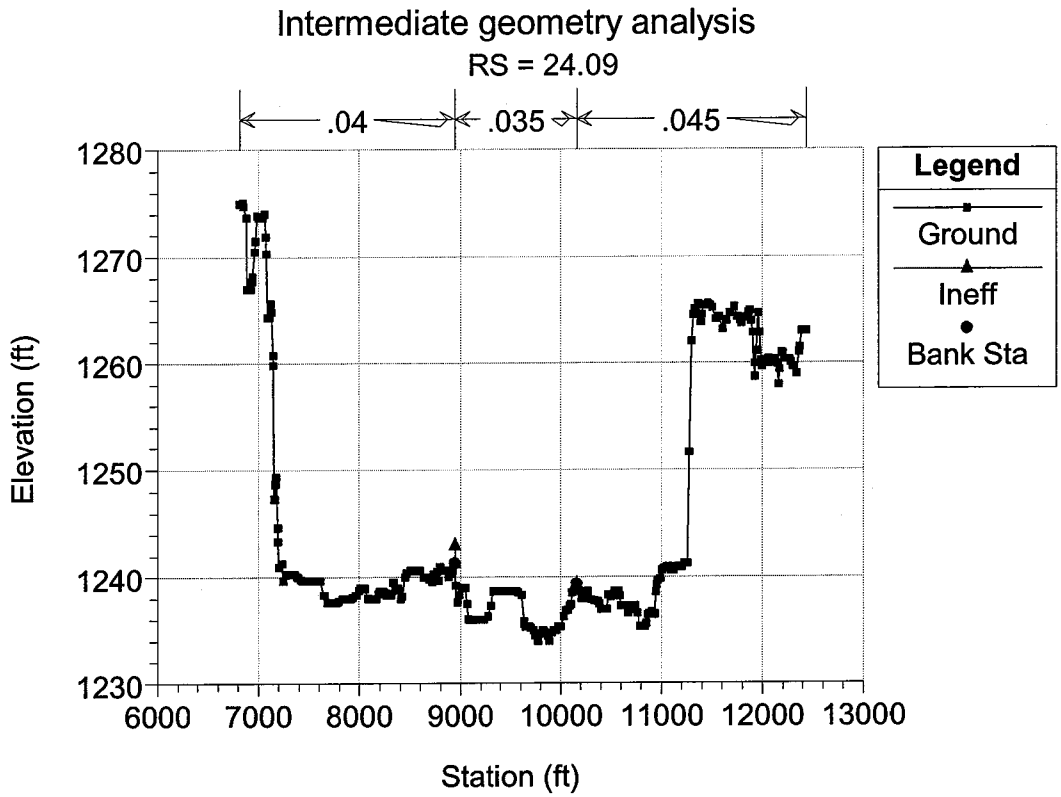

Intermediate geometry analysis
RS = 23.584
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1280
1270
1260
1250
1240
1230
1220
7000
8000
9000
10000
11000
12000
Station (ft)

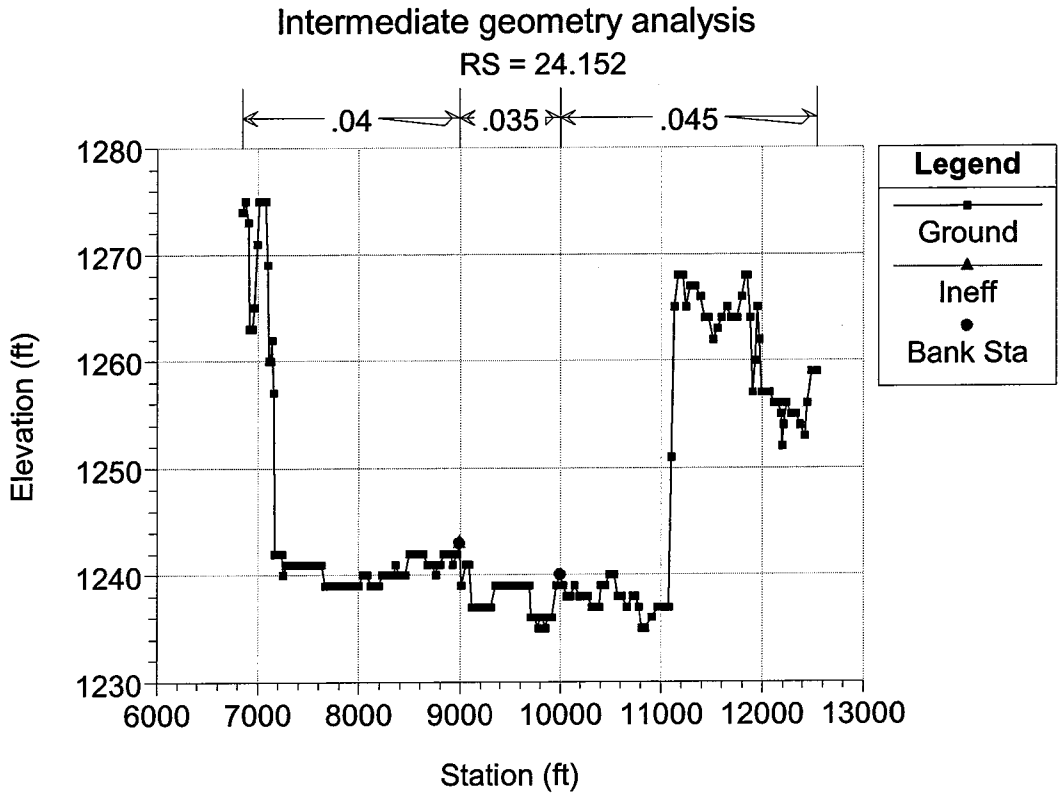

Intermediate geometry analysis
RS = 23.774
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1280
1270
1260
1250
1240
1230
1220
7000
8000
9000
10000
11000
12000
13000
Station (ft)

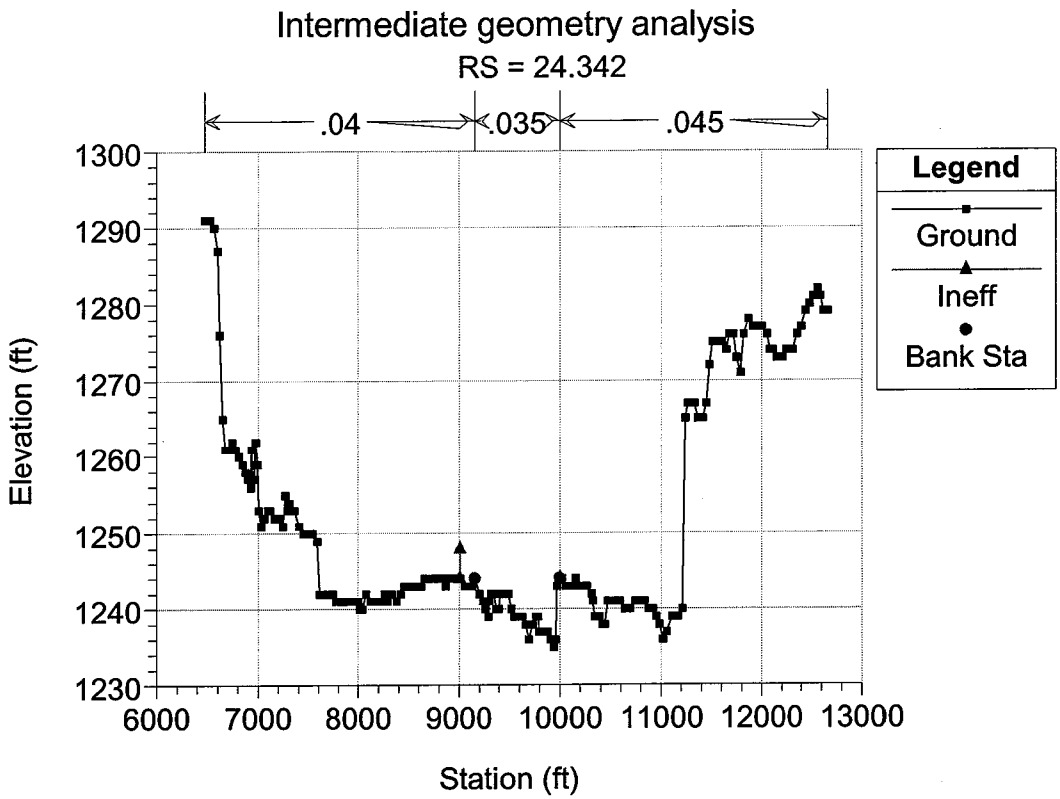

Intermediate geometry analysis
RS = 23.87
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1280
1270
1260
1250
1240
1230
1220
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

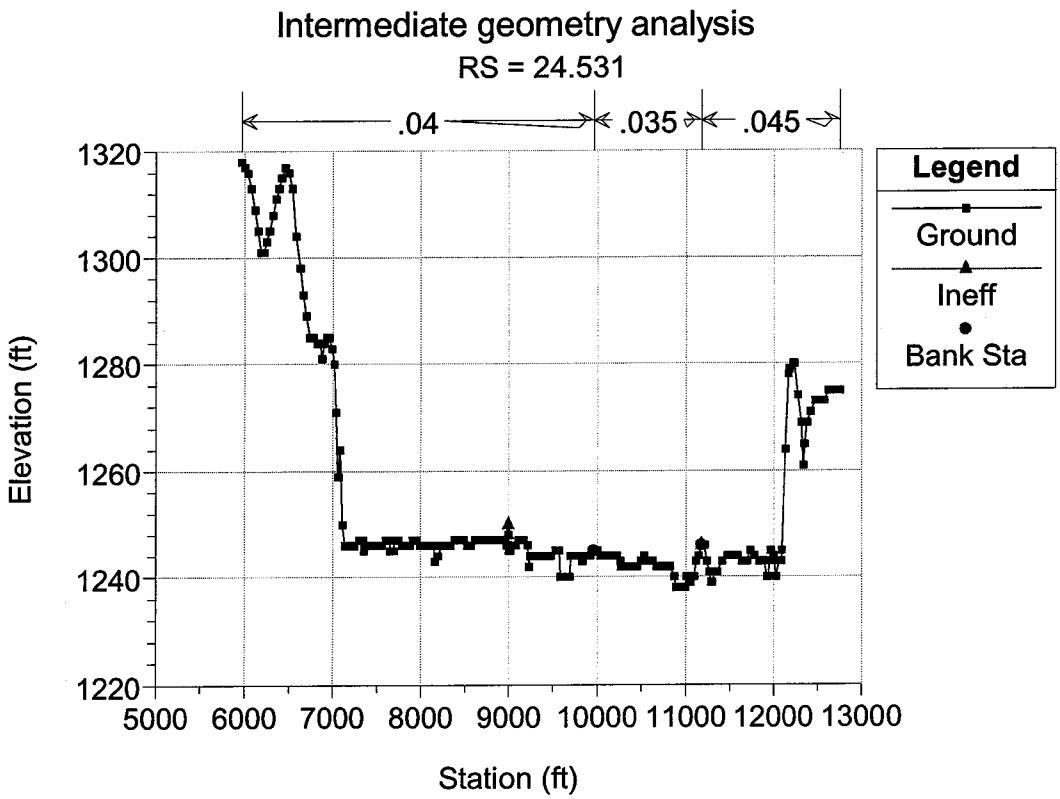

Intermediate geometry analysis
RS = 23.963
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1280
1270
1260
1250
1240
1230
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

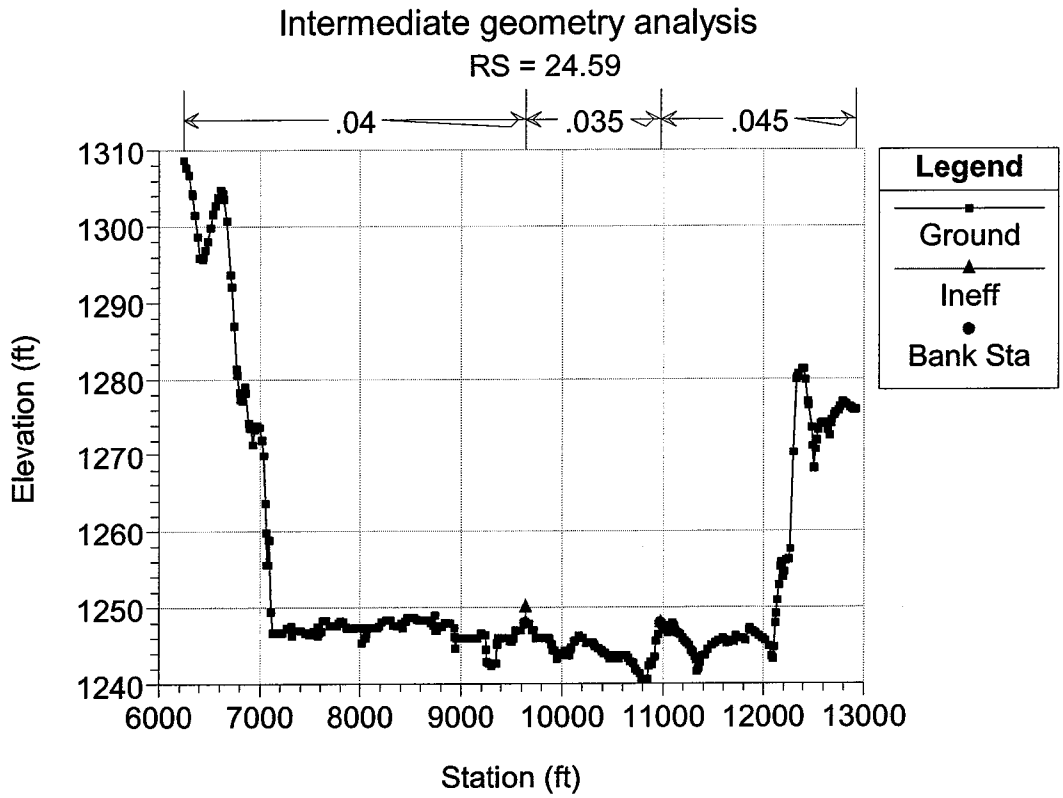

Intermediate geometry analysis
RS = 24.03
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1280
1270
1260
1250
1240
1230
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

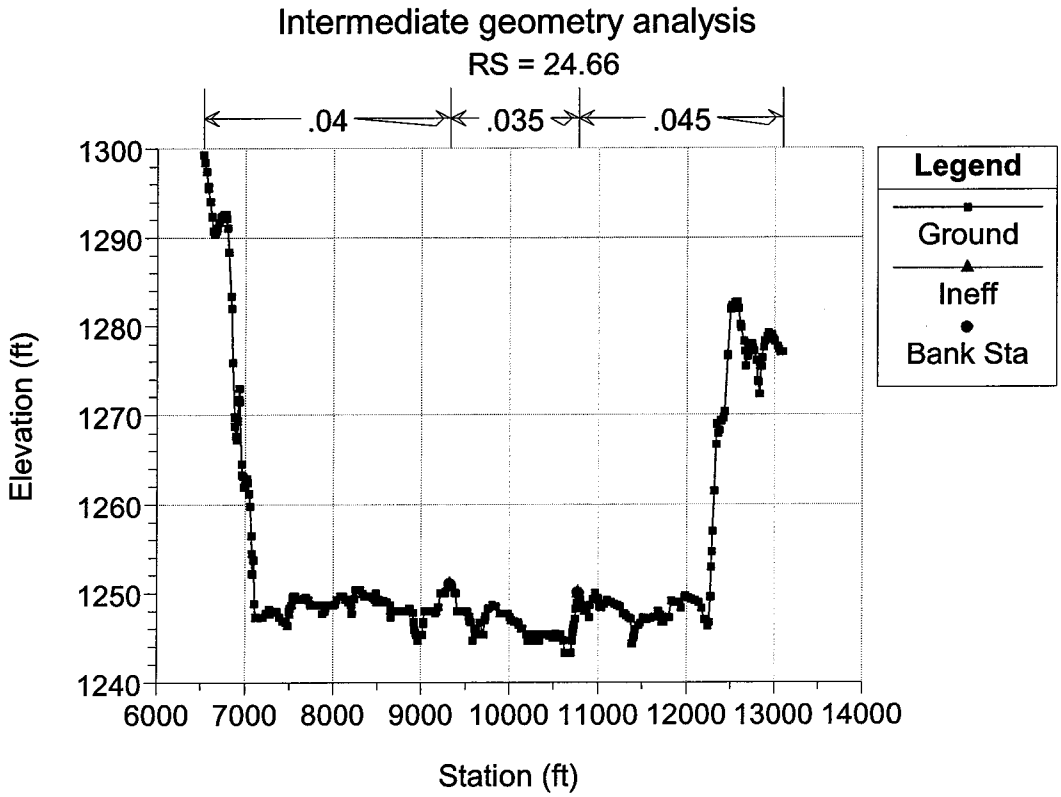

Intermediate geometry analysis
RS = 24.09
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1280
1270
1260
1250
1240
1230
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

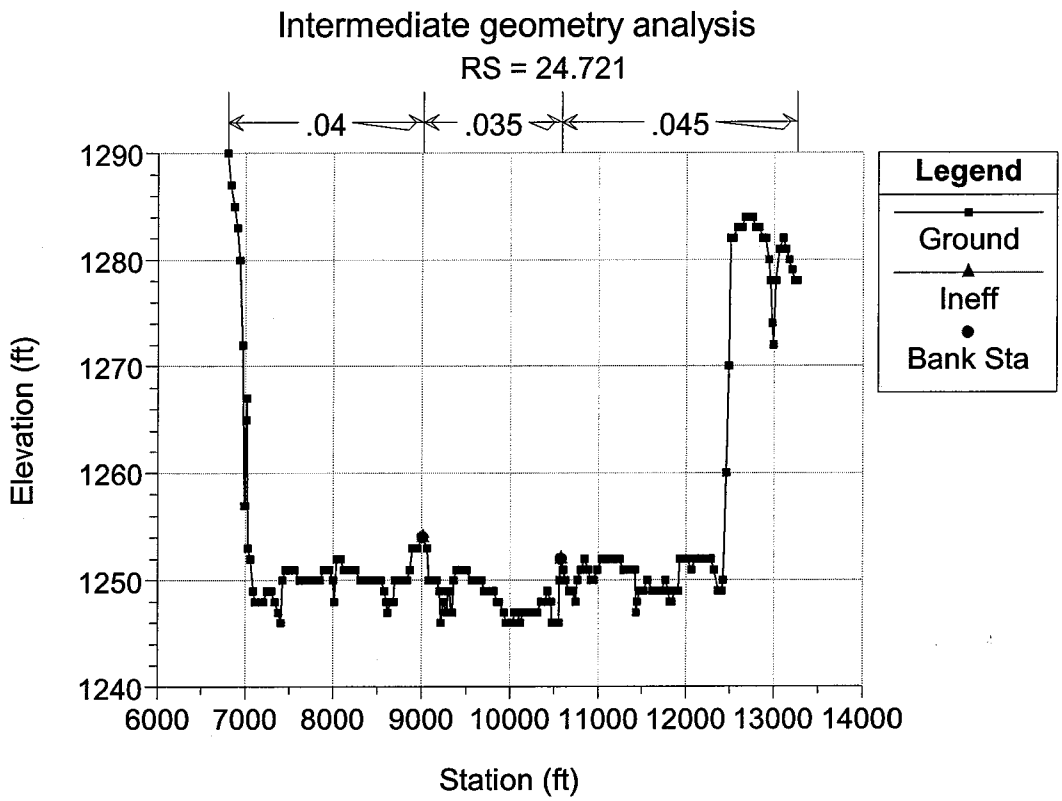

Intermediate geometry analysis
RS = 24.152
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1280
1270
1260
1250
1240
1230
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

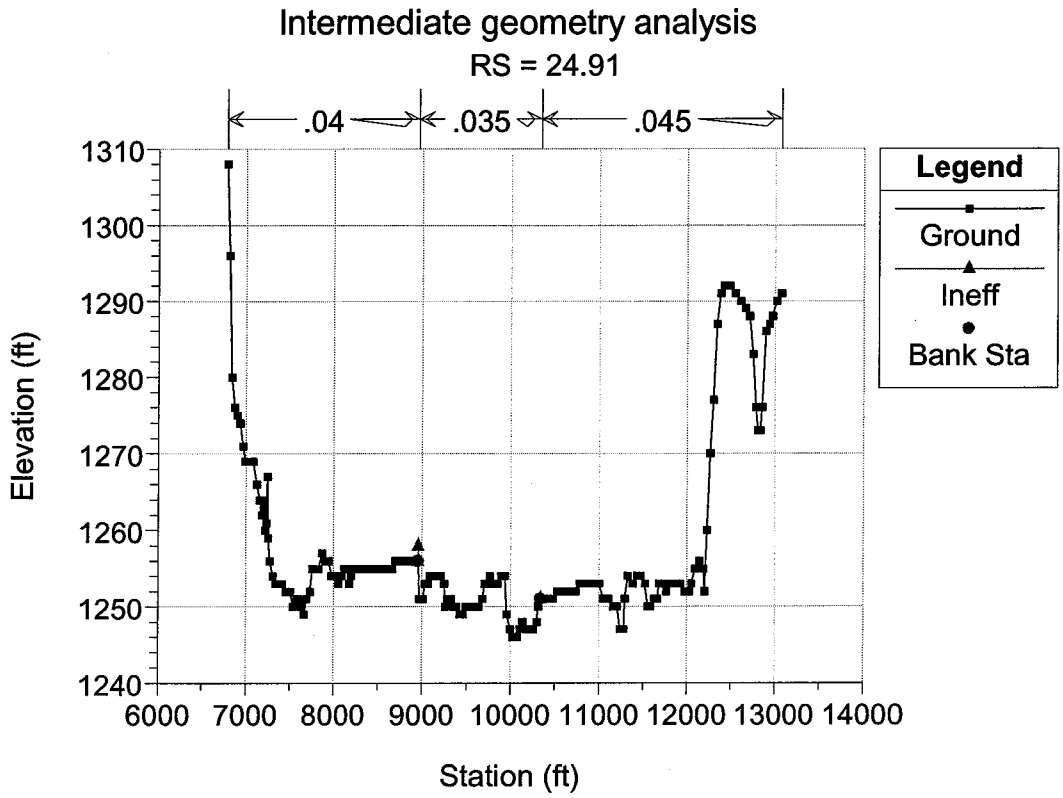

Intermediate geometry analysis
RS = 24.342
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1300
1290
1280
1270
1260
1250
1240
1230
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

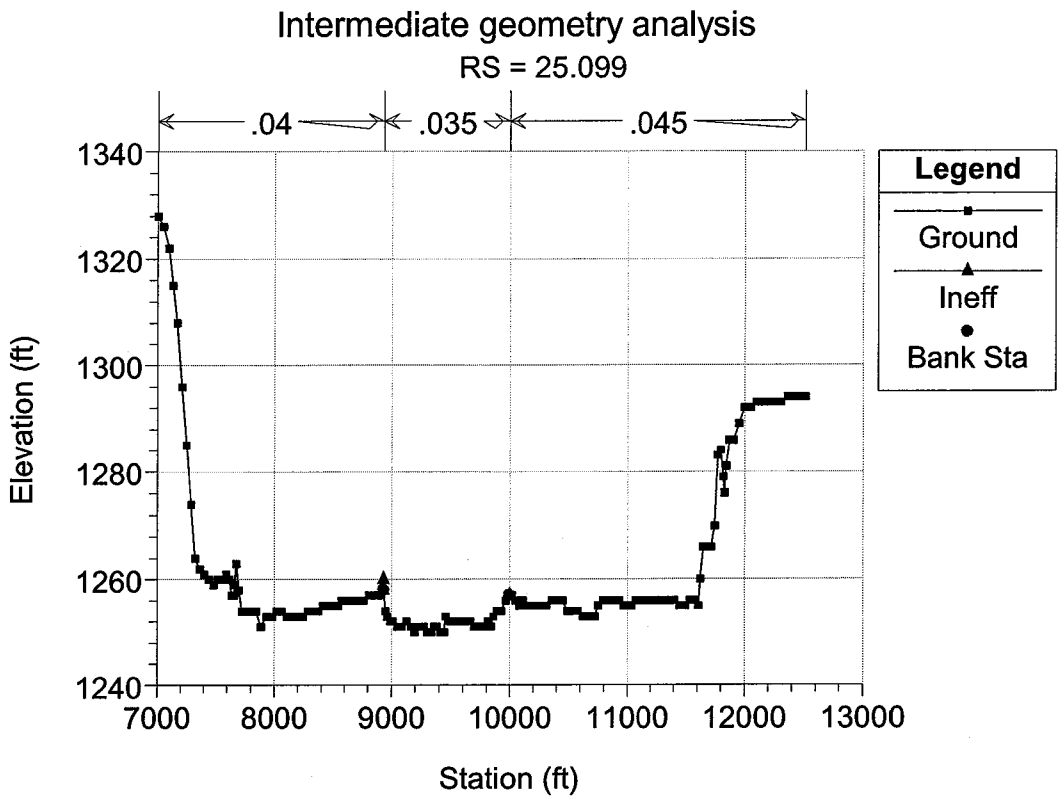

Intermediate geometry analysis
RS = 24.531
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1320
1300
1280
1260
1240
1220
5000
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

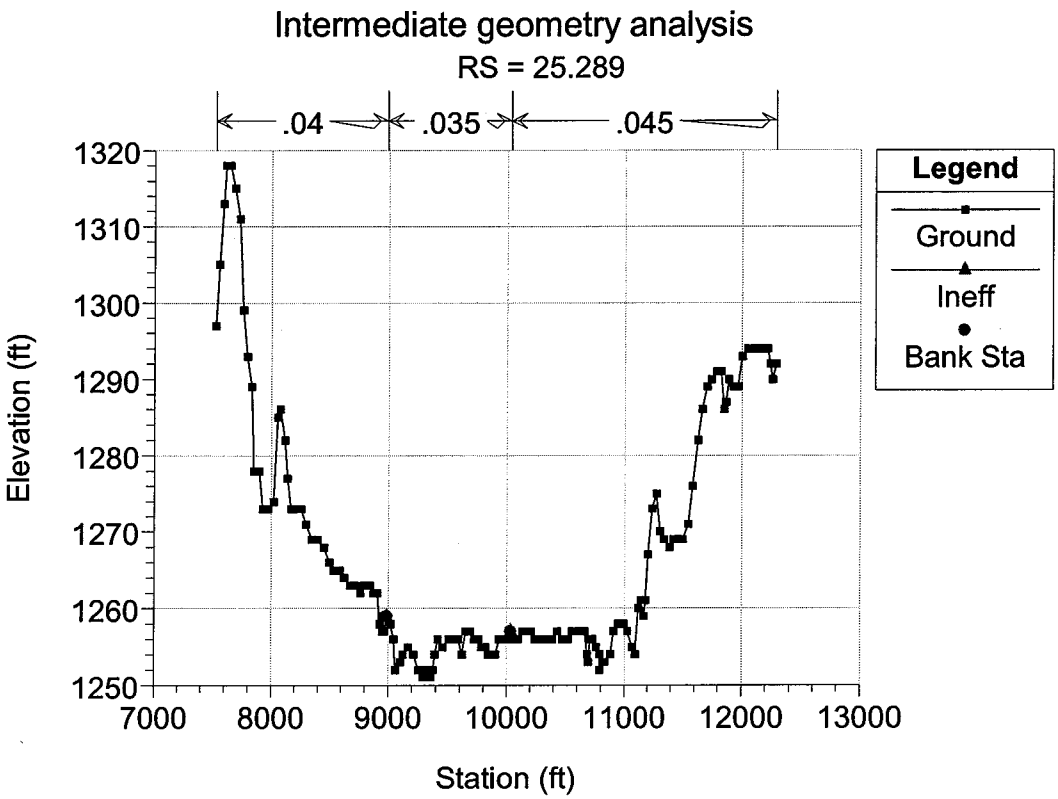

Intermediate geometry analysis
RS = 24.59
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1310
1300
1290
1280
1270
1260
1250
1240
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

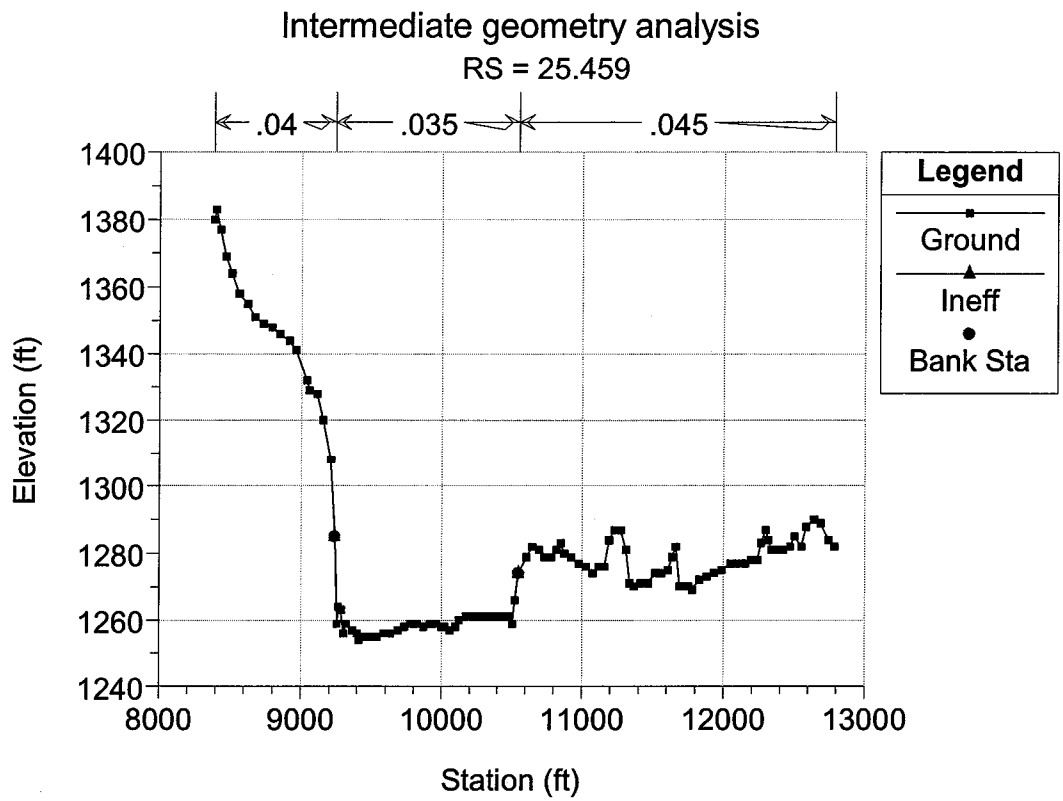

Intermediate geometry analysis
RS = 24.66
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1300
1290
1280
1270
1260
1250
1240
6000
7000
8000
9000
10000
11000
12000
13000
14000
Station (ft)

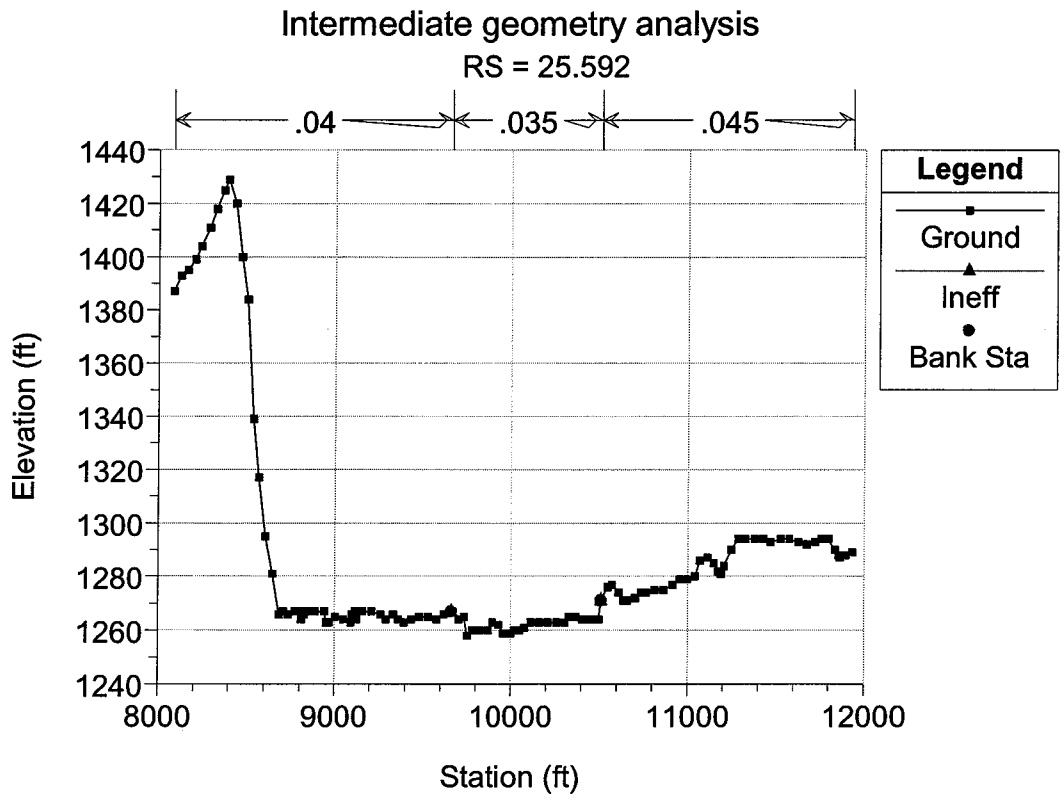

Intermediate geometry analysis
RS = 24.721
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1290
1280
1270
1260
1250
1240
6000 7000 8000 9000 10000 11000 12000 13000 14000
Station (ft)


Intermediate geometry analysis
RS = 24.91
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1310
1300
1290
1280
1270
1260
1250
1240
6000 7000 8000 9000 10000 11000 12000 13000 14000
Station (ft)


Intermediate geometry analysis
RS = 25.099
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1340
1320
1300
1280
1260
1240
7000
8000
9000
10000
11000
12000
13000
Station (ft)

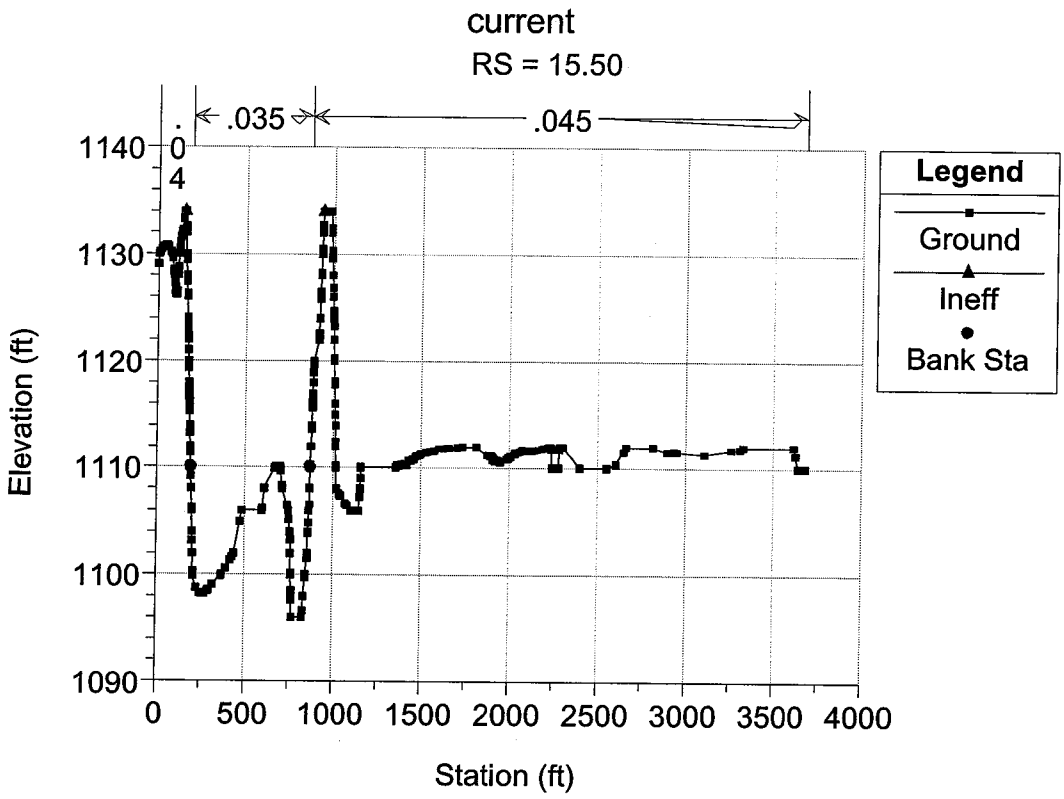

Intermediate geometry analysis
RS = 25.289
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1320
1310
1300
1290
1280
1270
1260
1250
7000
8000
9000
10000
11000
12000
13000
Station (ft)

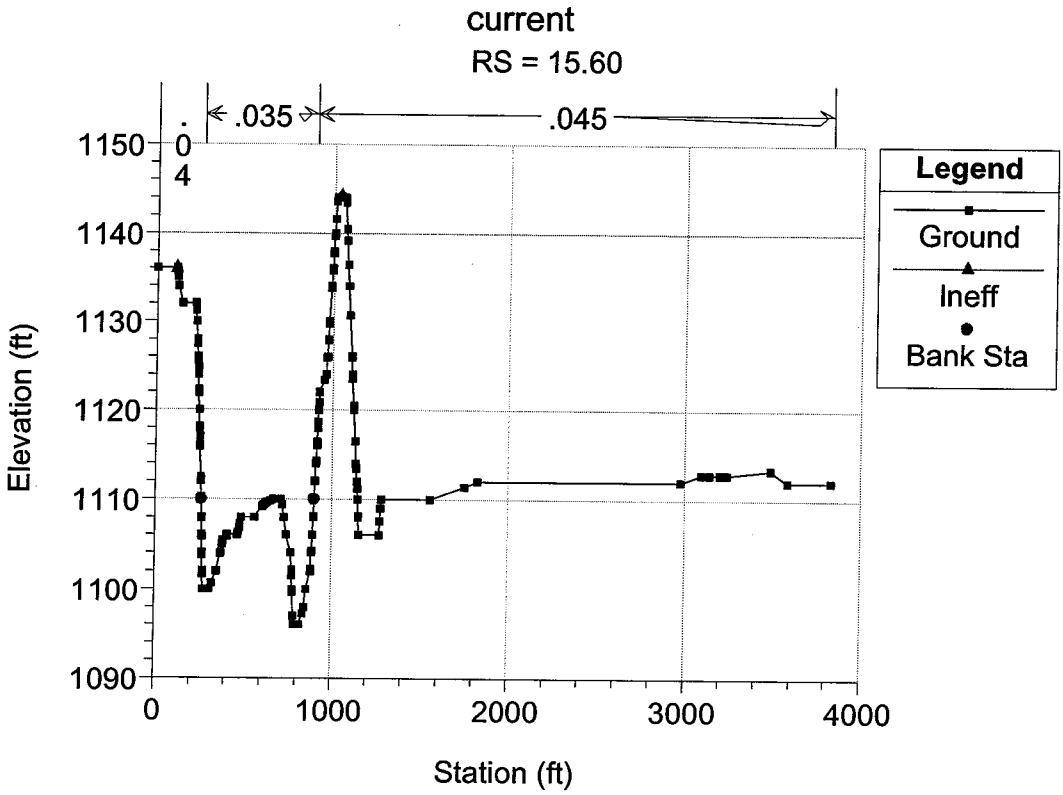

Intermediate geometry analysis
RS = 25.459
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1400
1380
1360
1340
1320
1300
1280
1260
1240
8000
9000
10000
11000
12000
13000
Station (ft)

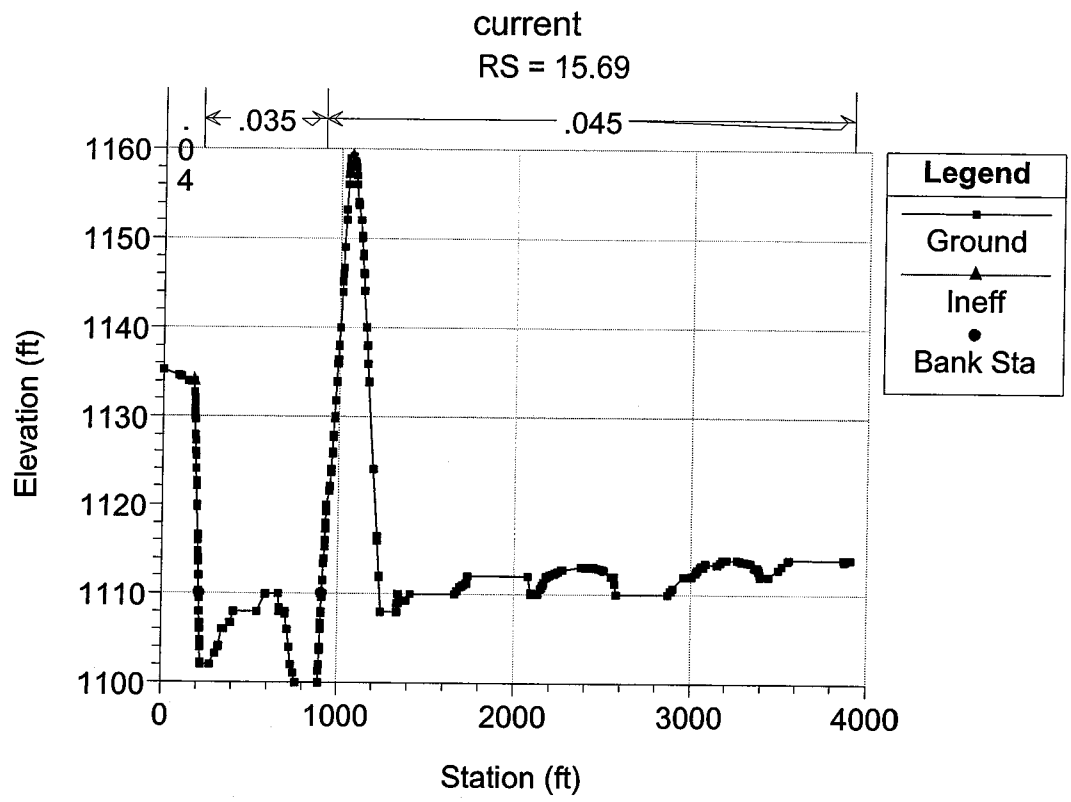

Intermediate geometry analysis
RS = 25.592
.04
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1440
1420
1400
1380
1360
1340
1320
1300
1280
1260
1240
8000
9000
10000
11000
12000
Station (ft)

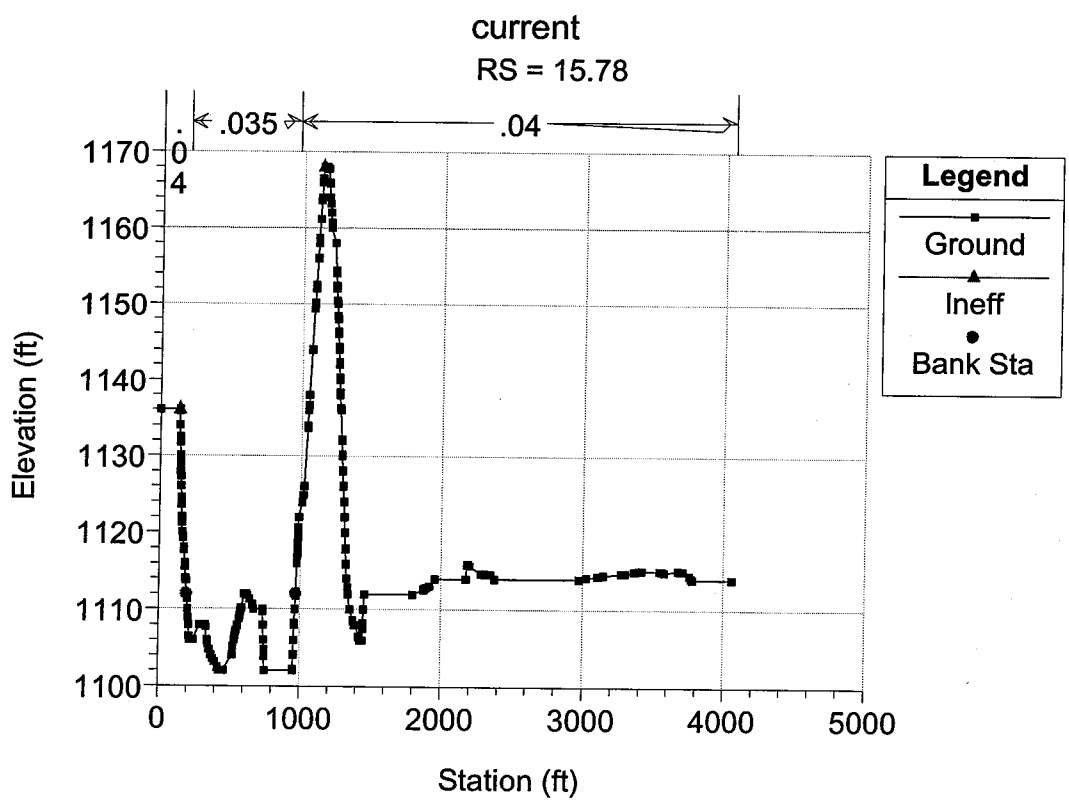
APPENDIX C

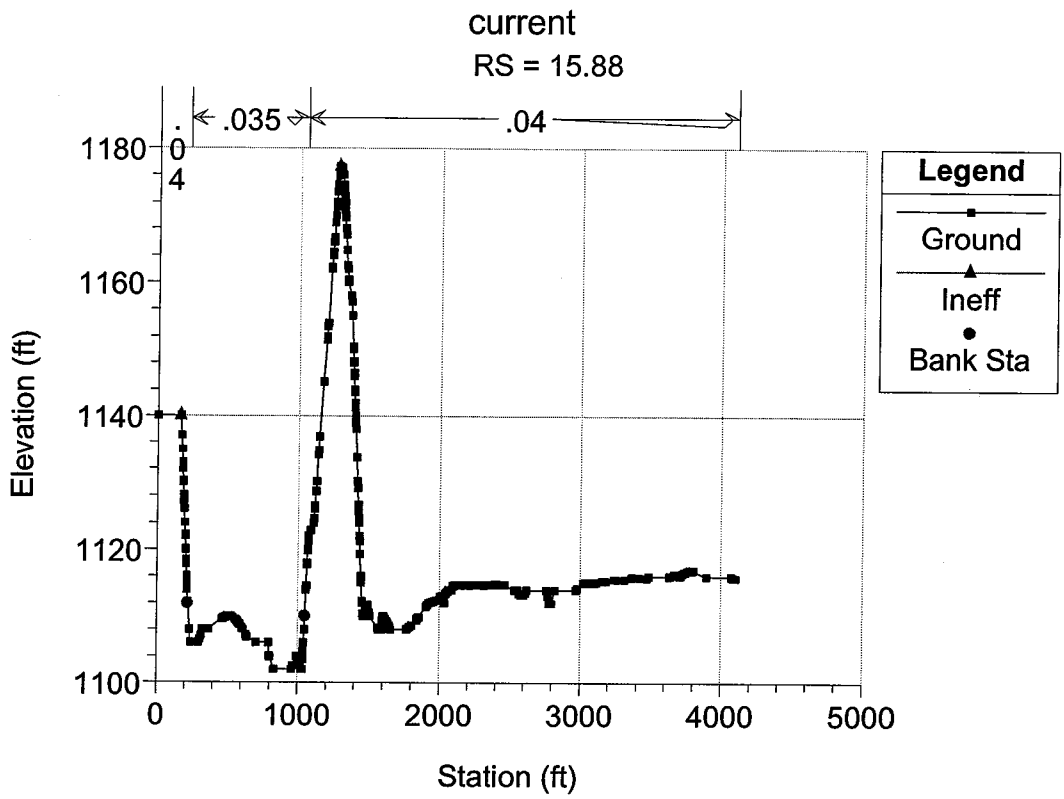
CROSS SECTION PLOTS FOR CURRENT MODEL

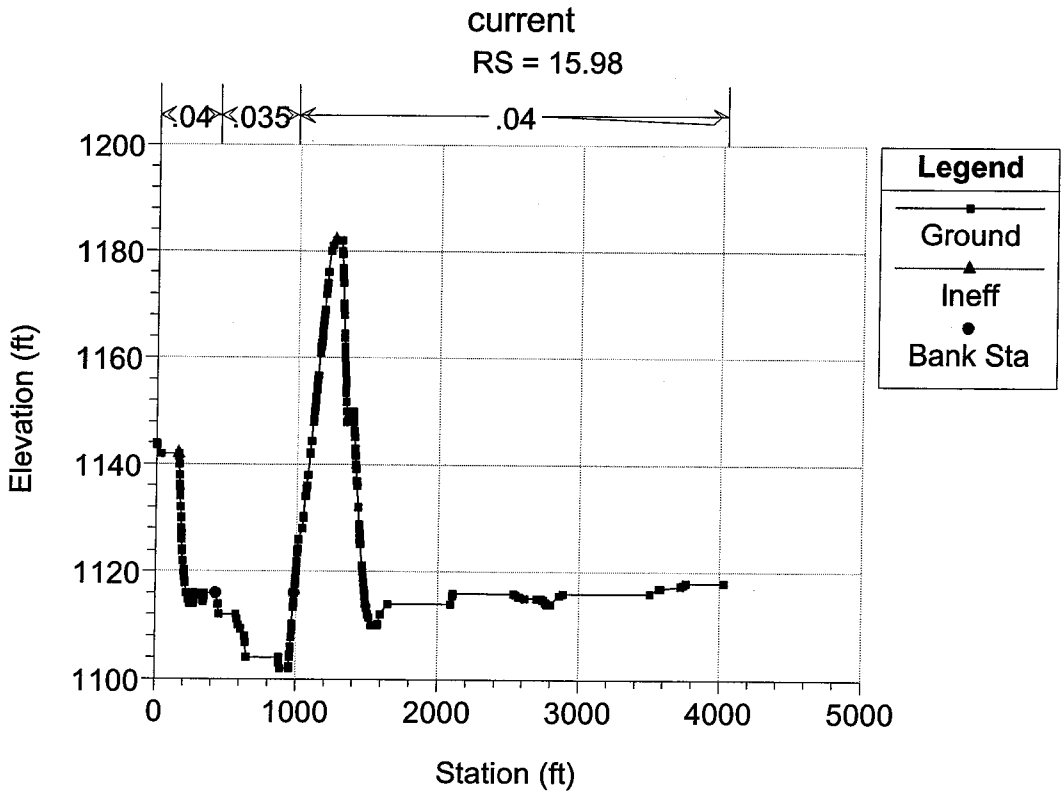

current
RS = 15.50
.035
.045
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1140
1130
1120
1110
1100
1090
0
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)

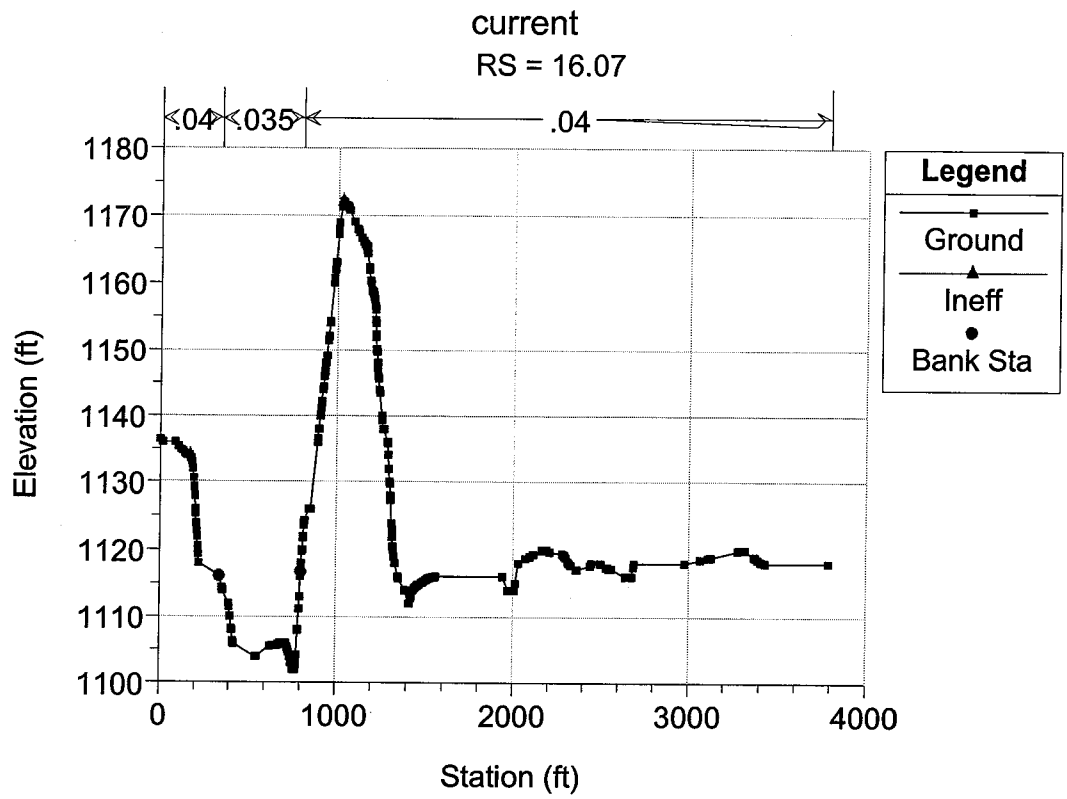

current
RS = 15.60
.035
.045
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
1090
0
1000
2000
3000
4000
Station (ft)

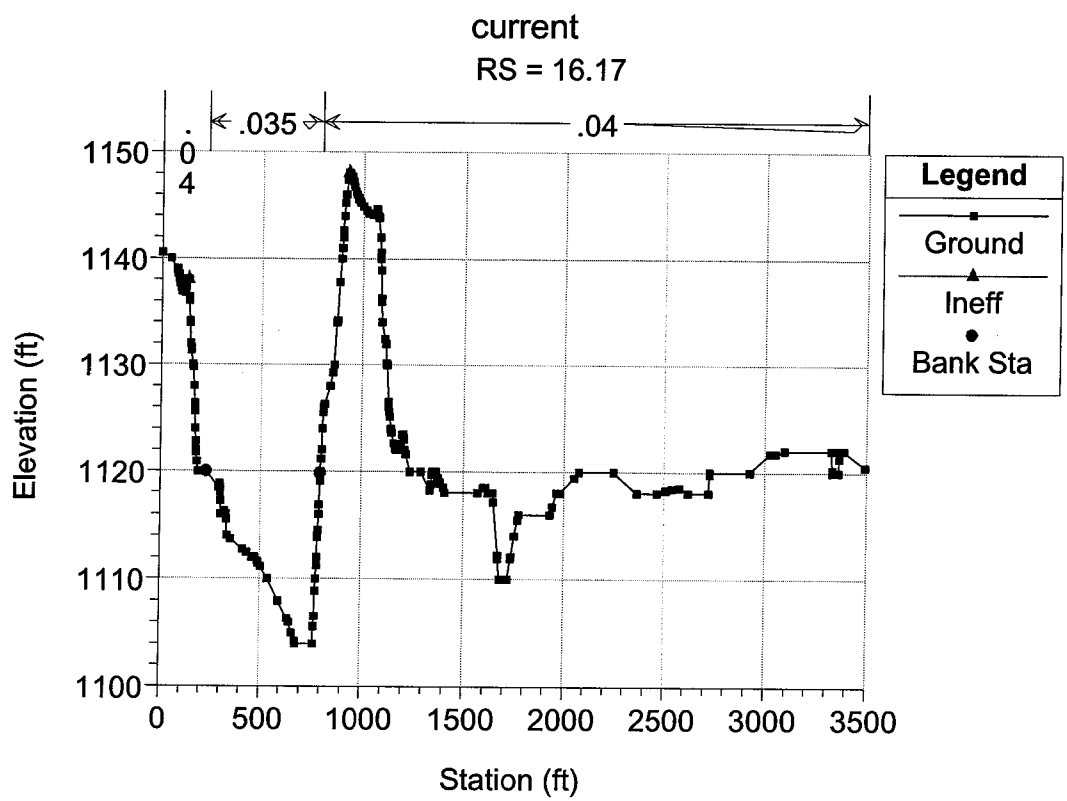

current
RS = 15.69
.035
.045
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1100
1110
1120
1130
1140
1150
1160
0
1000
2000
3000
4000

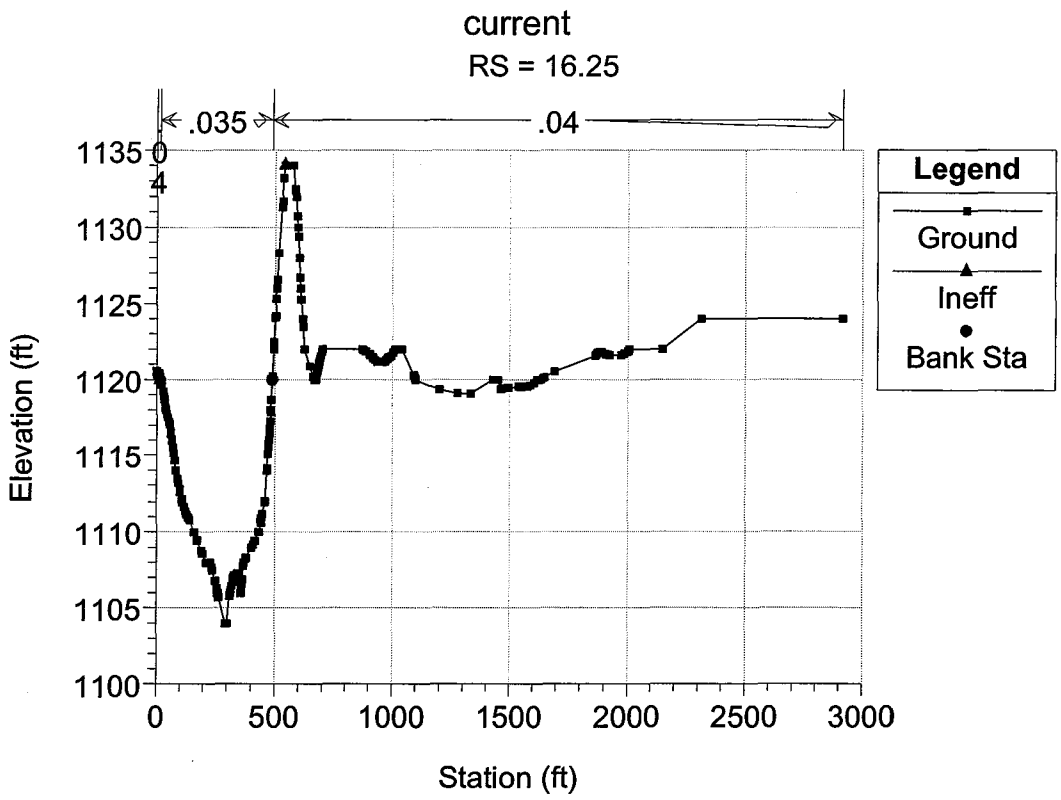

current
RS = 15.78
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1100
1110
1120
1130
1140
1150
1160
1170
0
1000
2000
3000
4000
5000

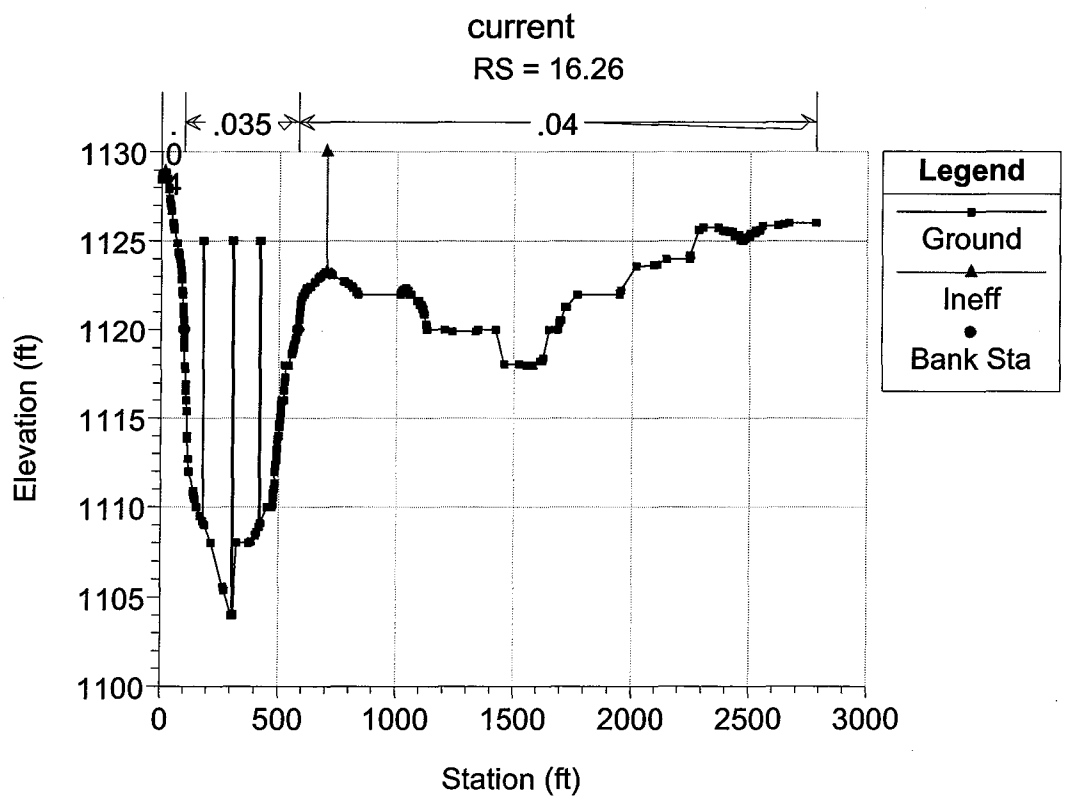

current
RS = 15.88
.035
.04
.04
1180
1160
1140
1120
1100
Elevation (ft)
0
1000
2000
3000
4000
5000
Station (ft)
Legend
Ground
Ineff
Bank Sta

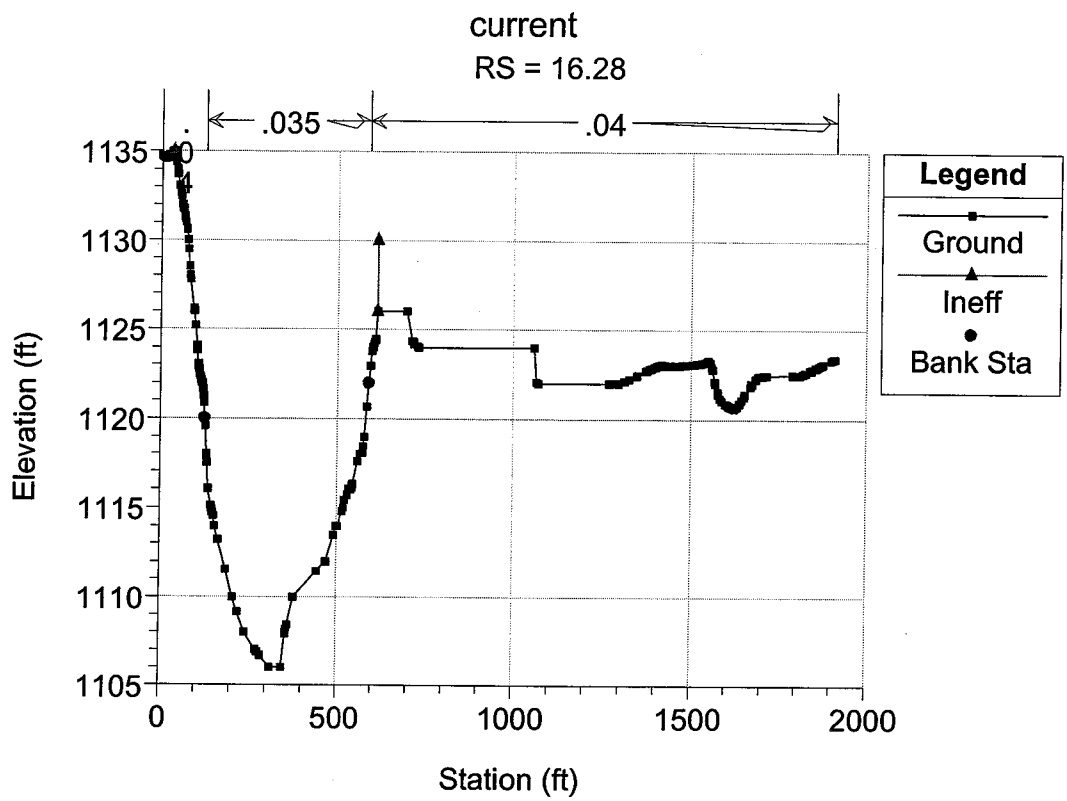

current
RS = 15.98
.04
.035
.04
1200
1180
1160
1140
1120
1100
Elevation (ft)
0
1000
2000
3000
4000
5000
Station (ft)
Legend
Ground
Ineff
Bank Sta

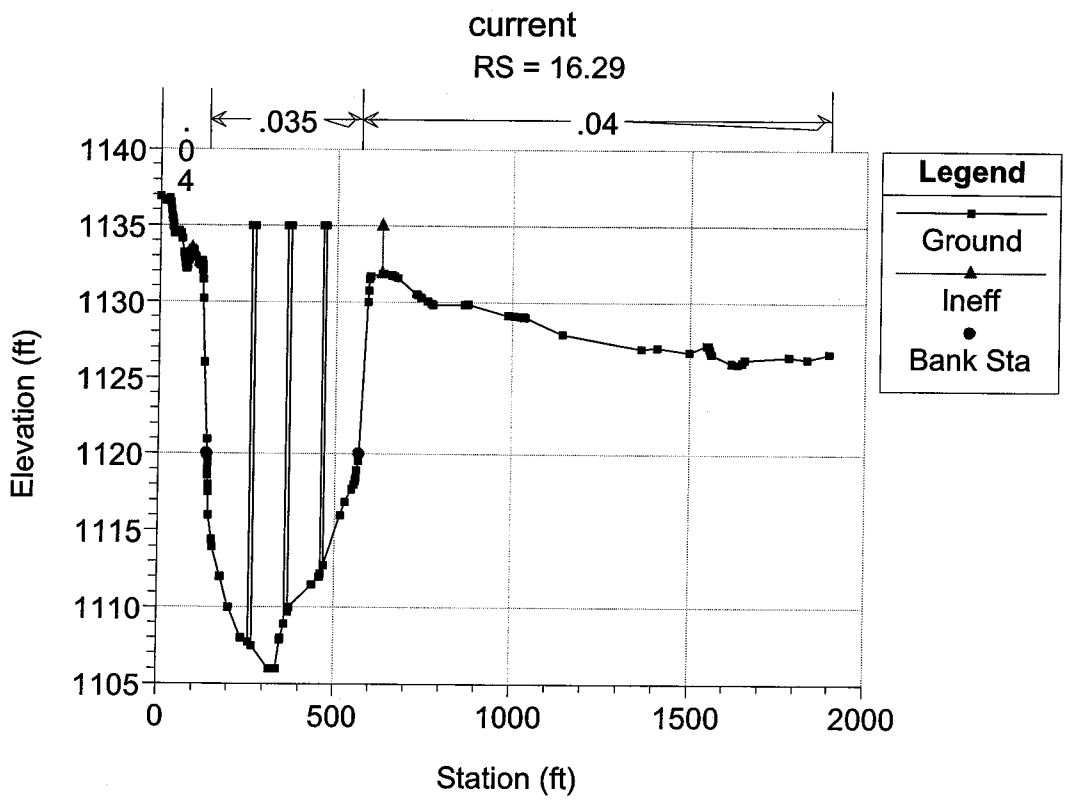

current
RS = 16.07
.04
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1170
1160
1150
1140
1130
1120
1110
1100
0
1000
2000
3000
4000
Station (ft)

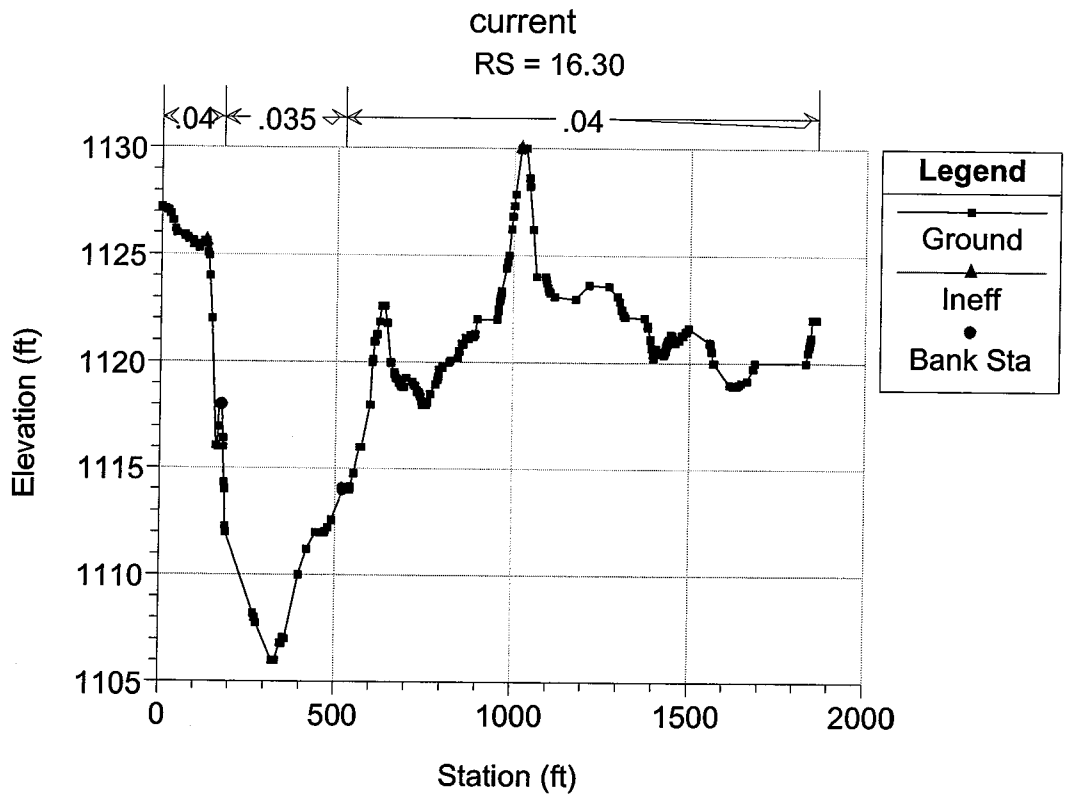

current
RS = 16.17
.035
.04
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

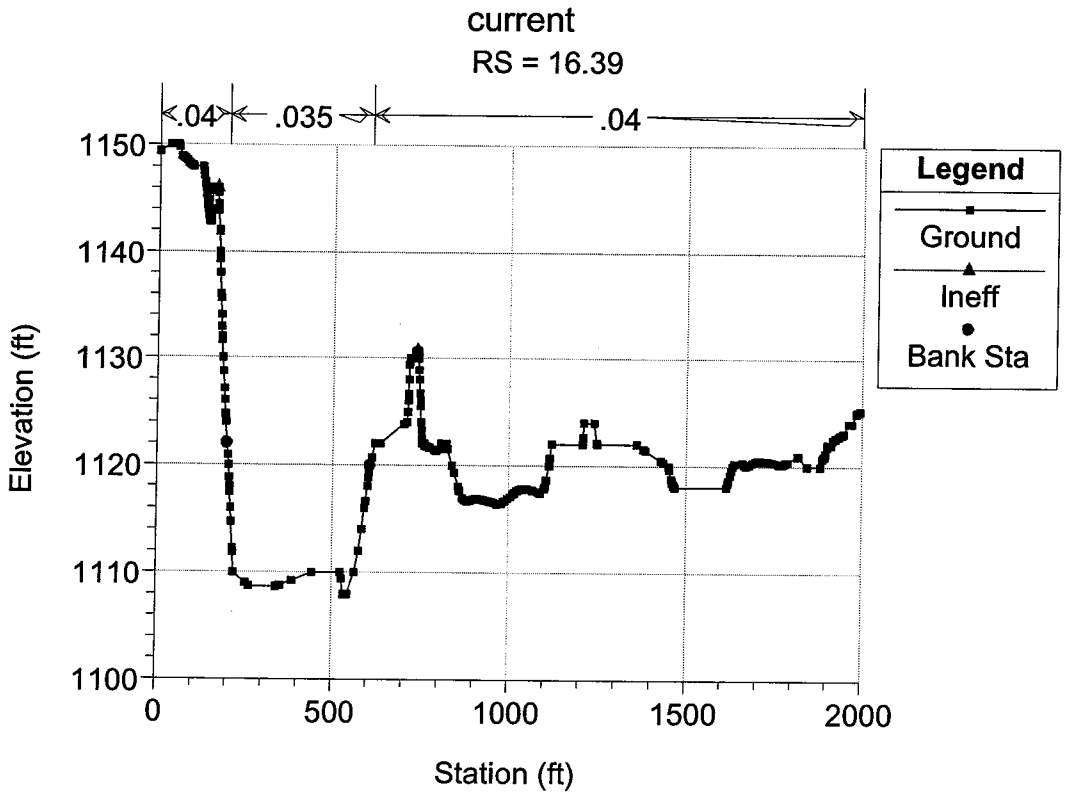

current
RS = 16.25
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1135
1130
1125
1120
1115
1110
1105
1100
0
500
1000
1500
2000
2500
3000

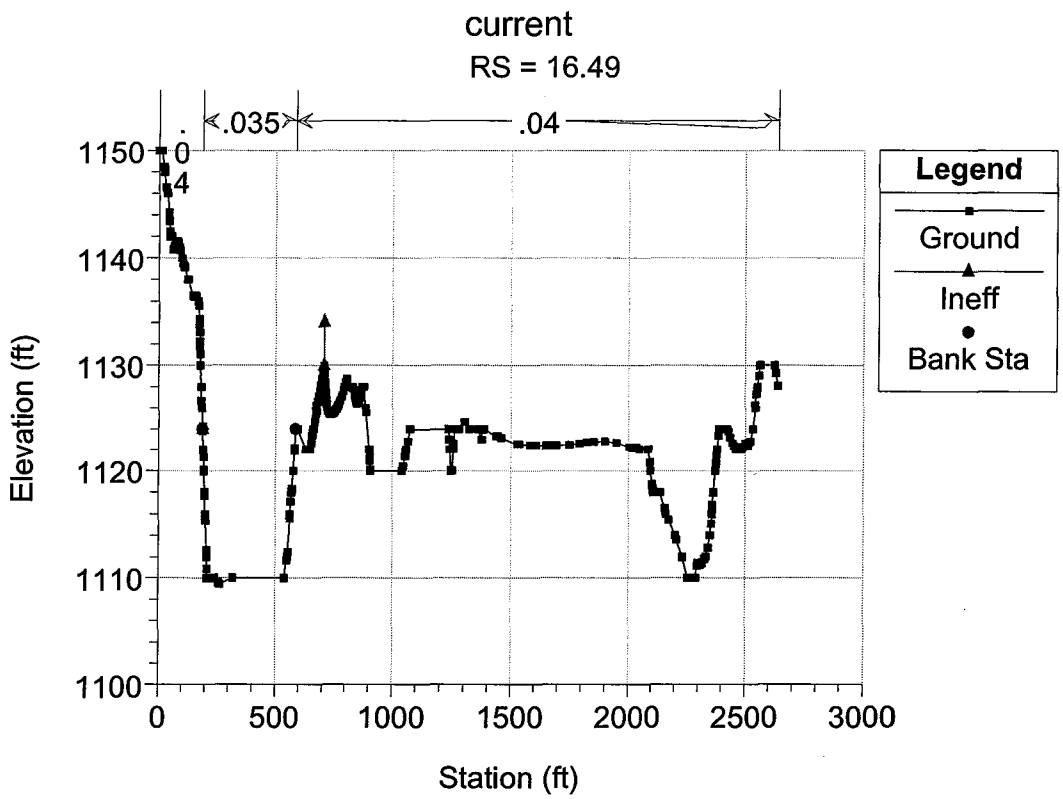

current
RS = 16.26
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1130
1125
1120
1115
1110
1105
1100
0
500
1000
1500
2000
2500
3000

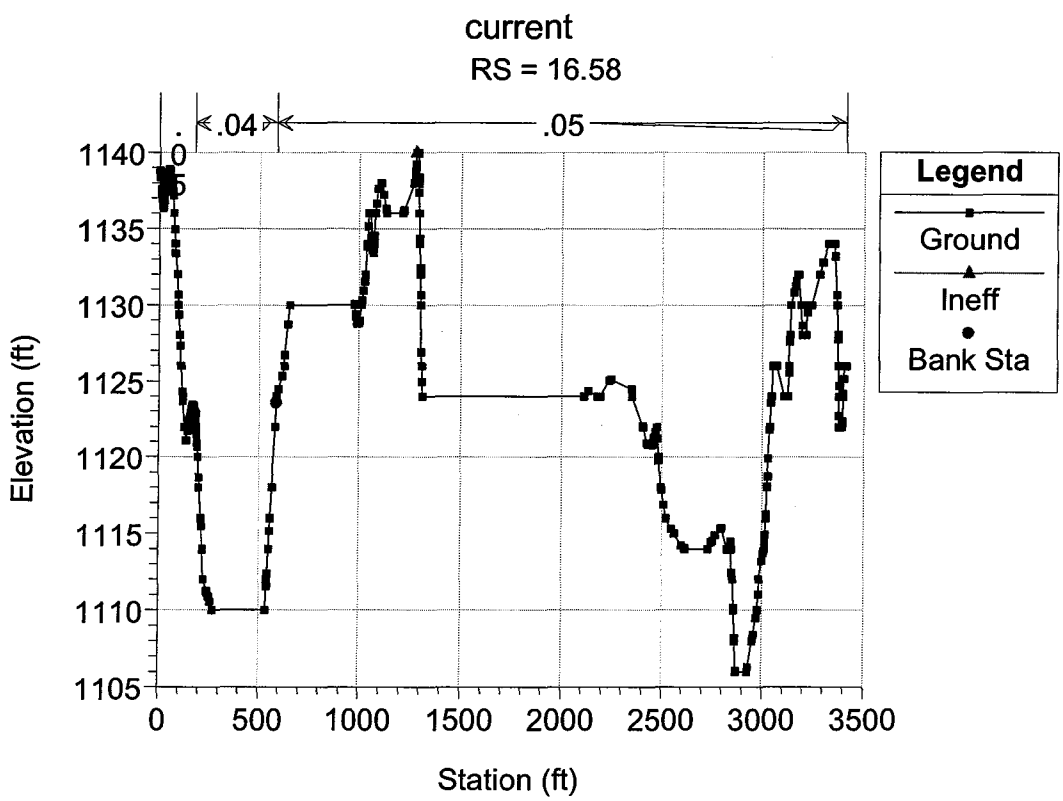

current
RS = 16.28
.035
.04
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1135
1130
1125
1120
1115
1110
1105
0
500
1000
1500
2000
Station (ft)

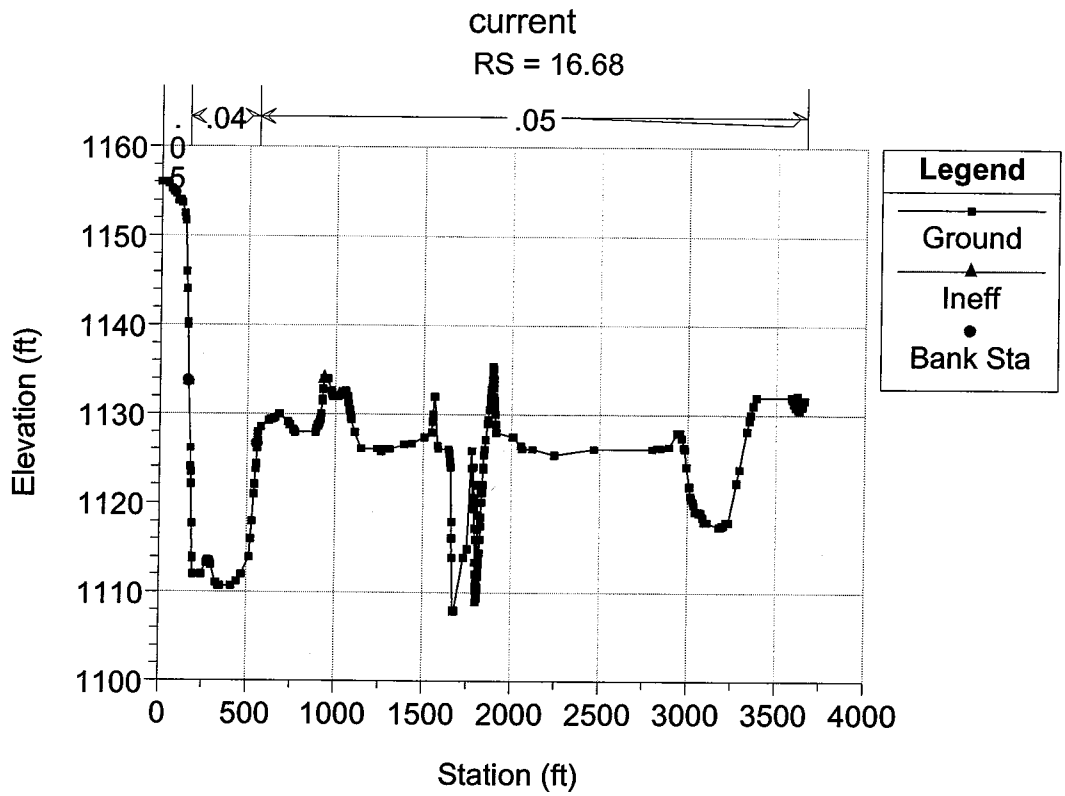

current
RS = 16.29
.035
.04
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1140
1135
1130
1125
1120
1115
1110
1105
0
500
1000
1500
2000
Station (ft)


current
RS = 16.30
.04
.035
.04
1130
1125
1120
1115
1110
1105
Elevation (ft)
0
500
1000
1500
2000
Station (ft)
Legend
Ground
Ineff
Bank Sta


current
RS = 16.39
.04
.035
.04
1150
1140
1130
1120
1110
1100
Elevation (ft)
0
500
1000
1500
2000
Station (ft)
Legend
Ground
Ineff
Bank Sta


current
RS = 16.49
.035
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
0
500
1000
1500
2000
2500
3000
Station (ft)


current
RS = 16.58
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1140
1135
1130
1125
1120
1115
1110
1105
0
500
1000
1500
2000
2500
3000
3500
Station (ft)


current
RS = 16.68
.04
.05
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
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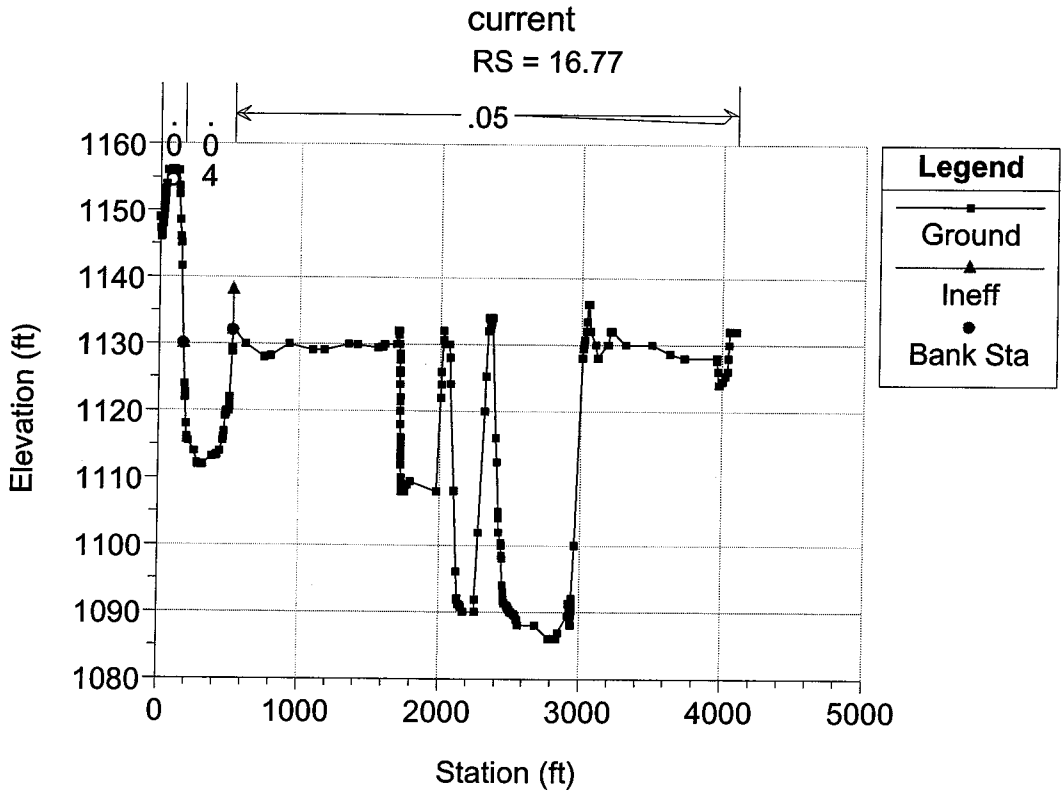
1150
1140
1130
1120
1110
1100
0
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)


current
RS = 16.77
.05
.04
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
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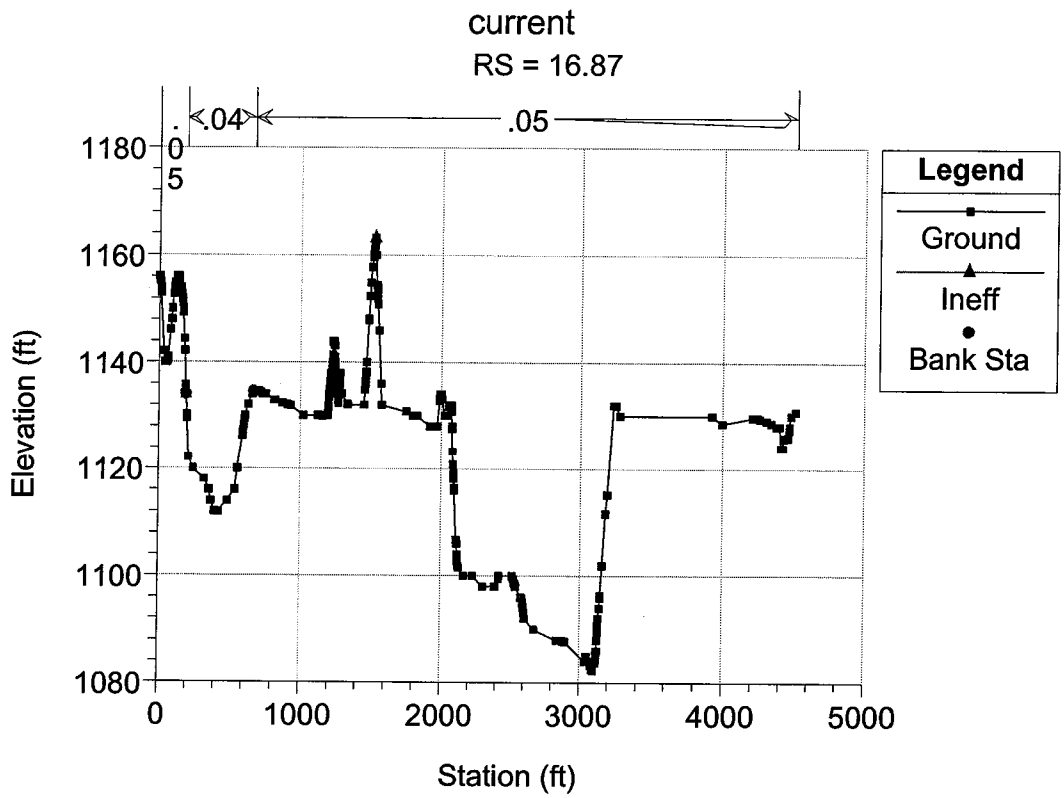
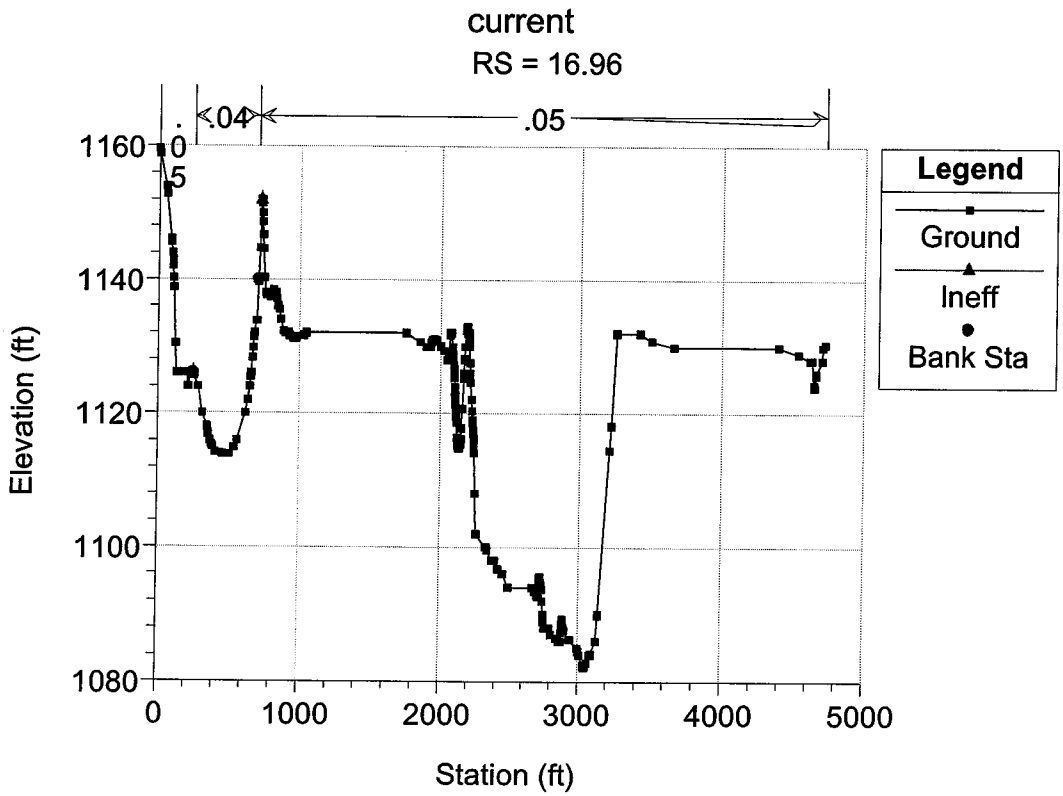
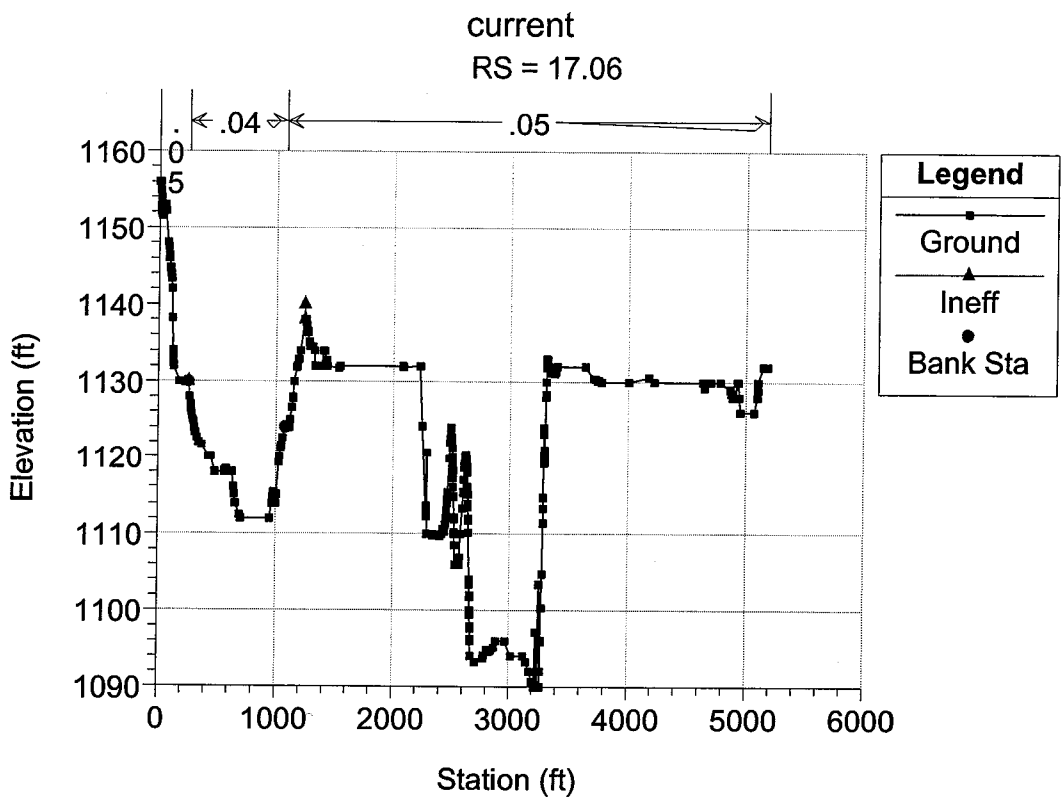
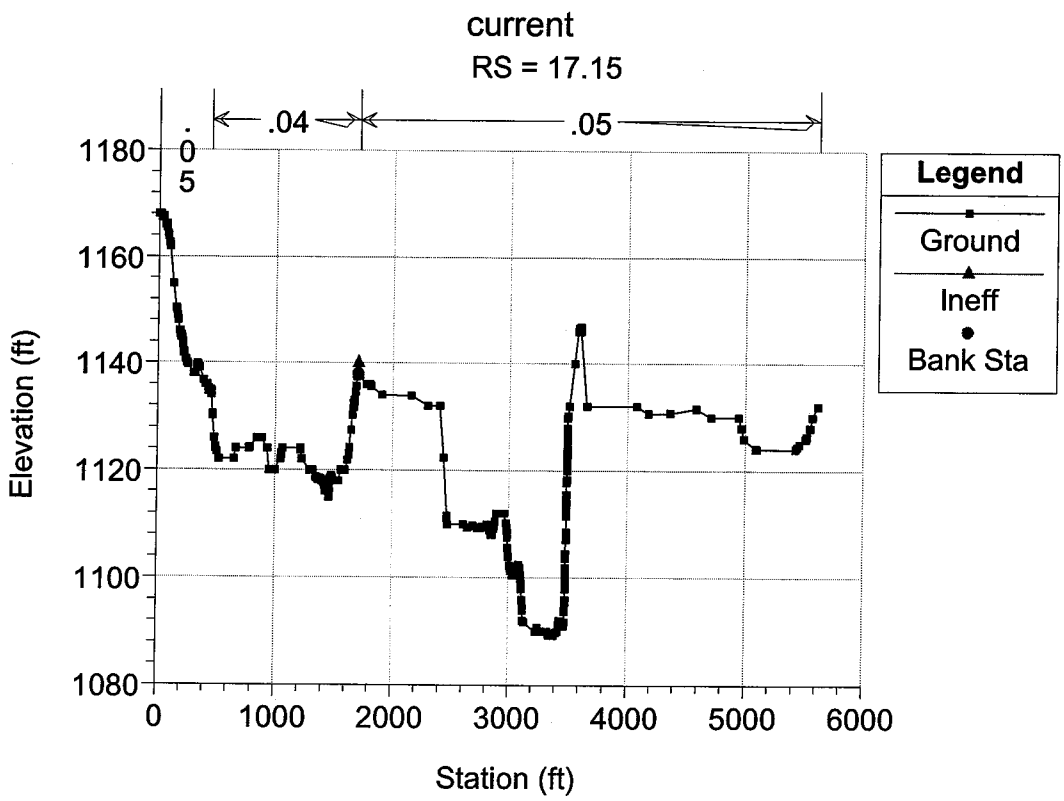
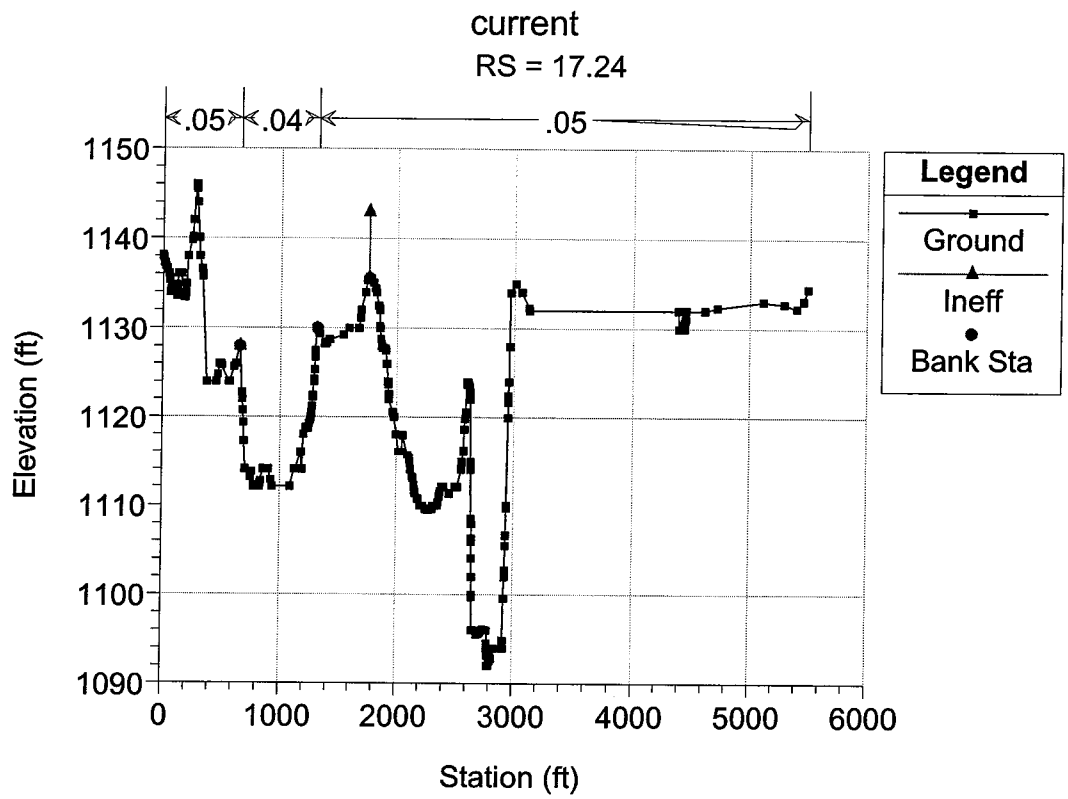
1140
1130
1120
1110
1100
1090
1080
0
1000
2000
3000
4000
5000
Station (ft)

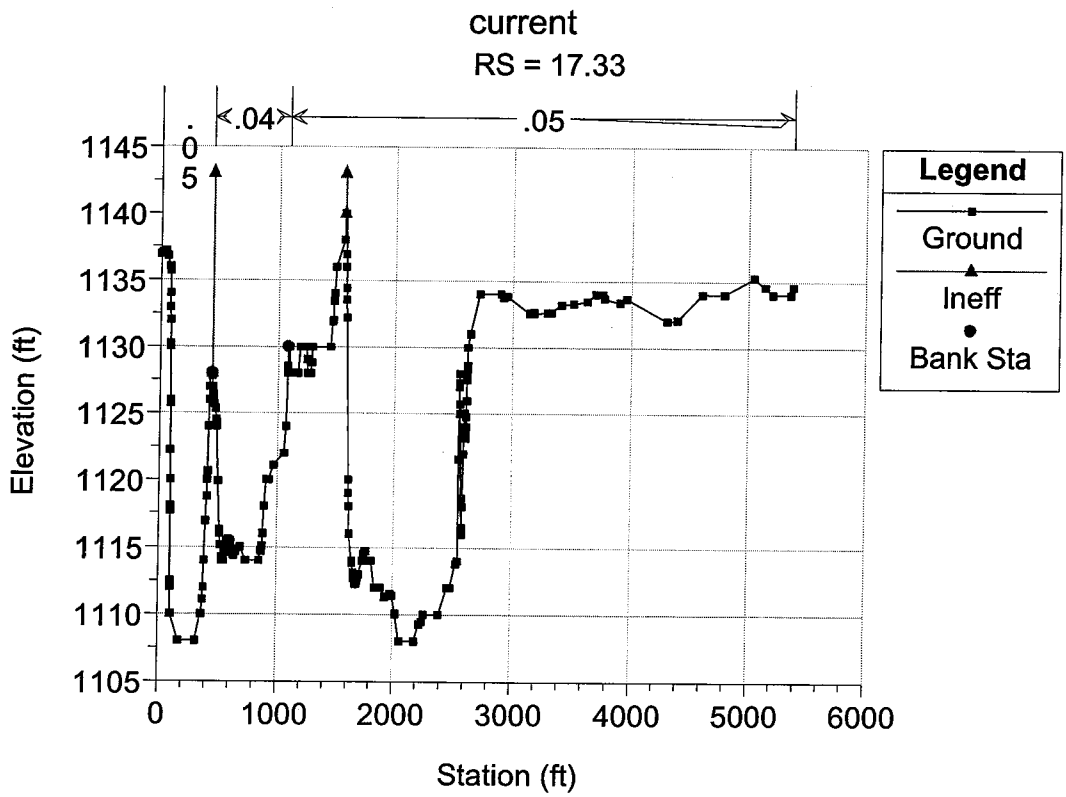

current
RS = 16.87
.04
.05
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1160
1140
1120
1100
1080
0
1000
2000
3000
4000
5000
Station (ft)

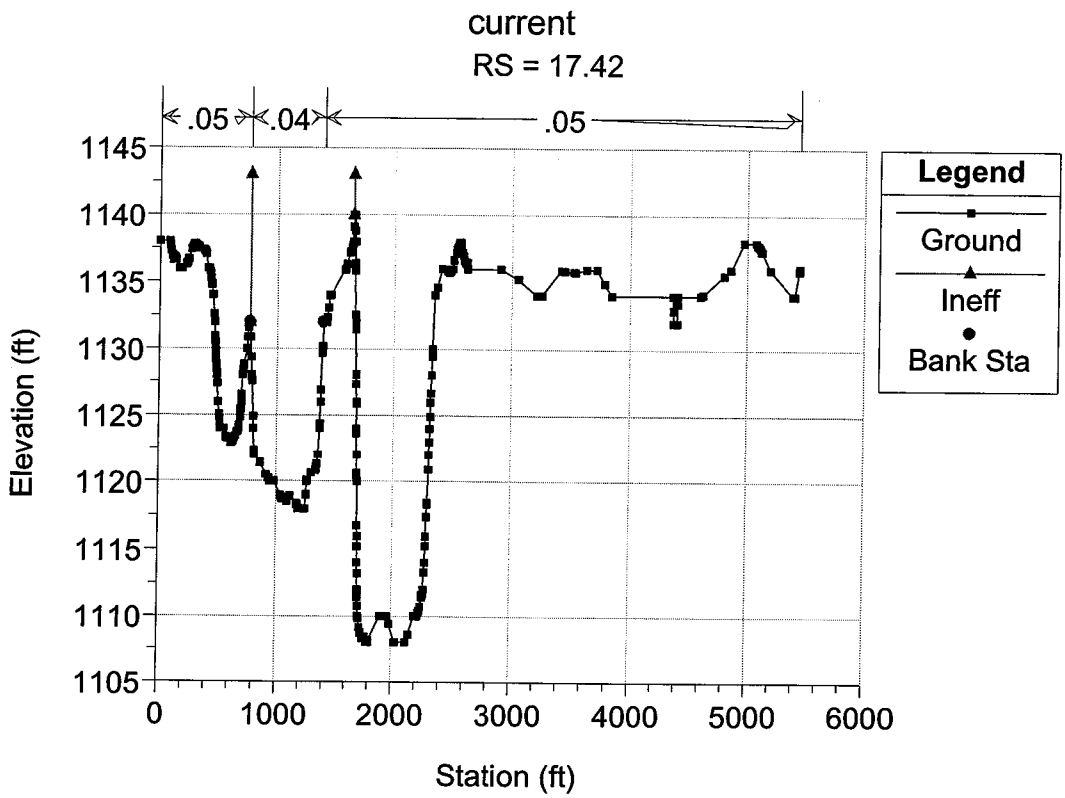

current
RS = 16.96
.04
.05
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1140
1120
1100
1080
0
1000
2000
3000
4000
5000
Station (ft)

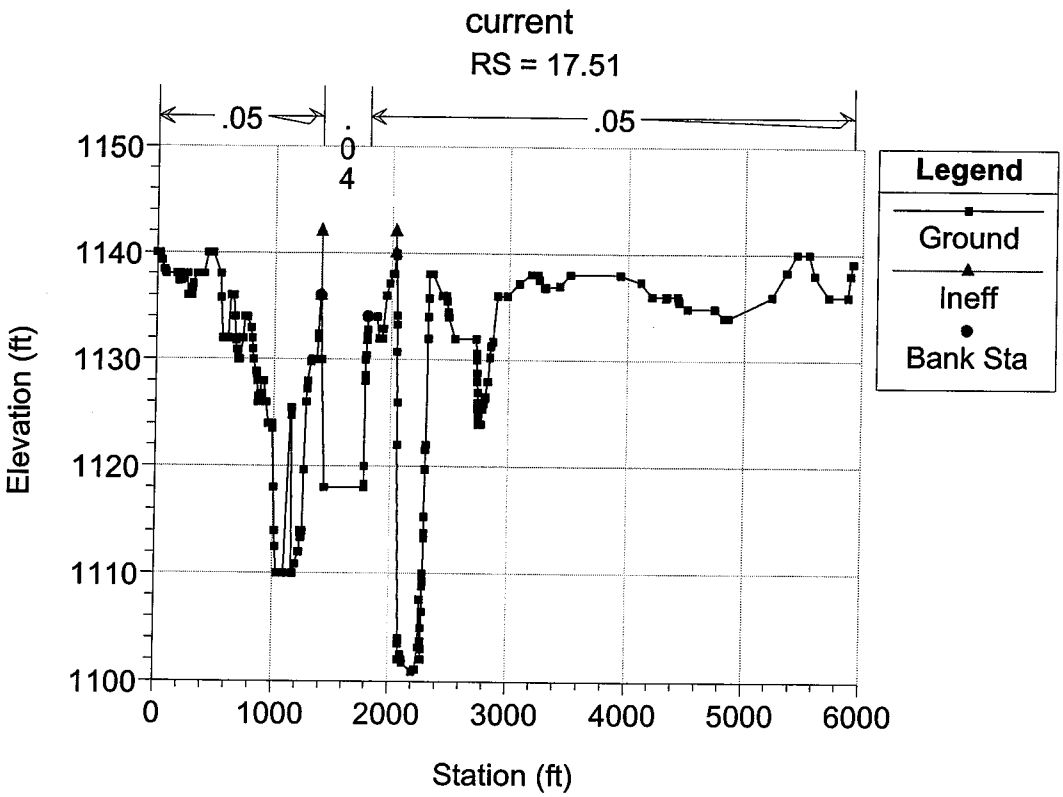

current
RS = 17.06
.04
.05
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1150
1140
1130
1120
1110
1100
1090
0
1000
2000
3000
4000
5000
6000
Station (ft)

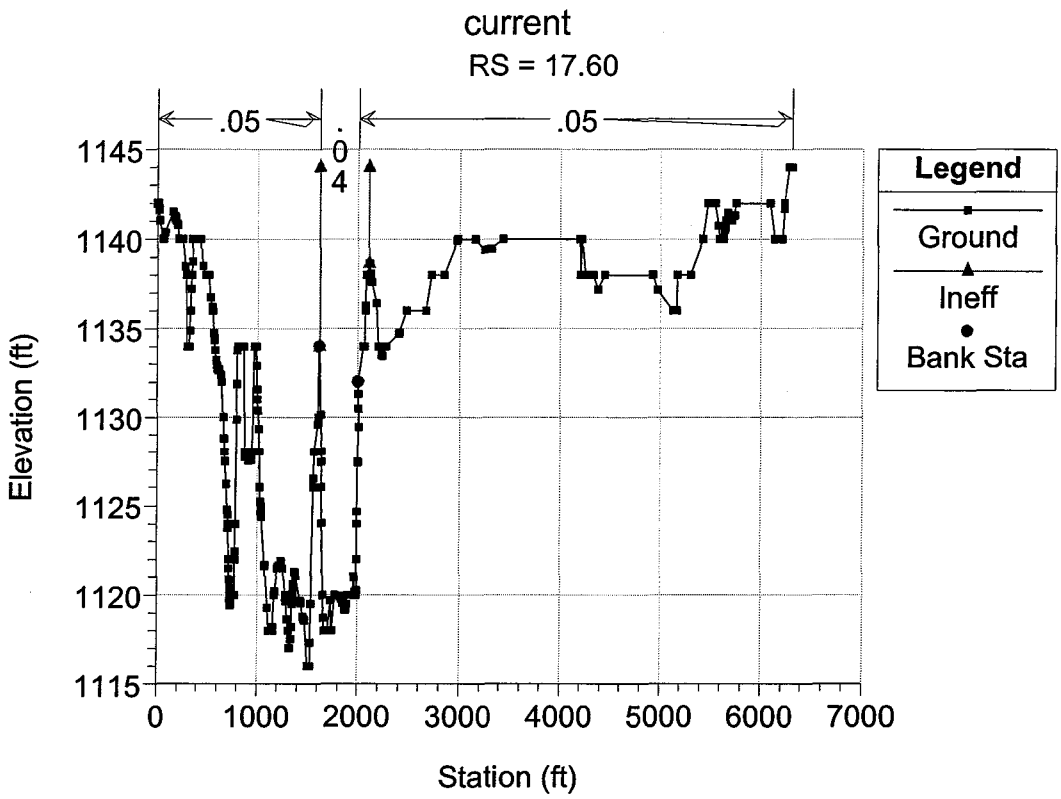

current
RS = 17.15
.04
.05
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1160
1140
1120
1100
1080
0
1000
2000
3000
4000
5000
6000
Station (ft)

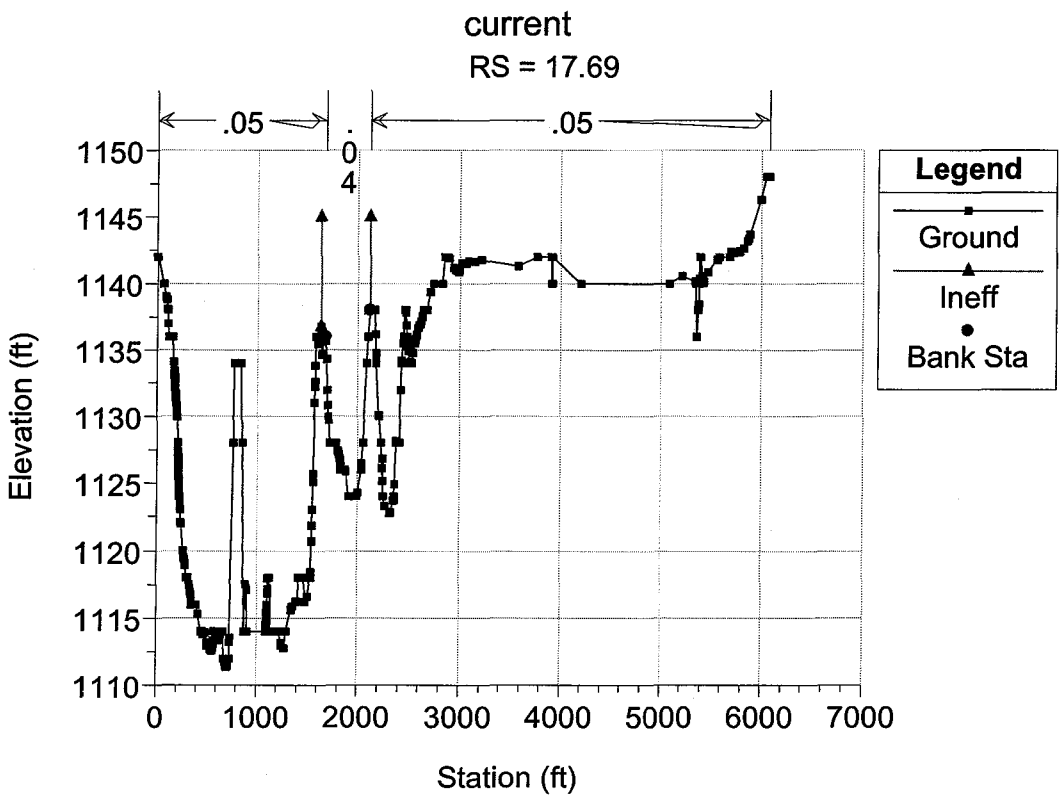

current
RS = 17.24
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
1090
0
1000
2000
3000
4000
5000
6000
Station (ft)

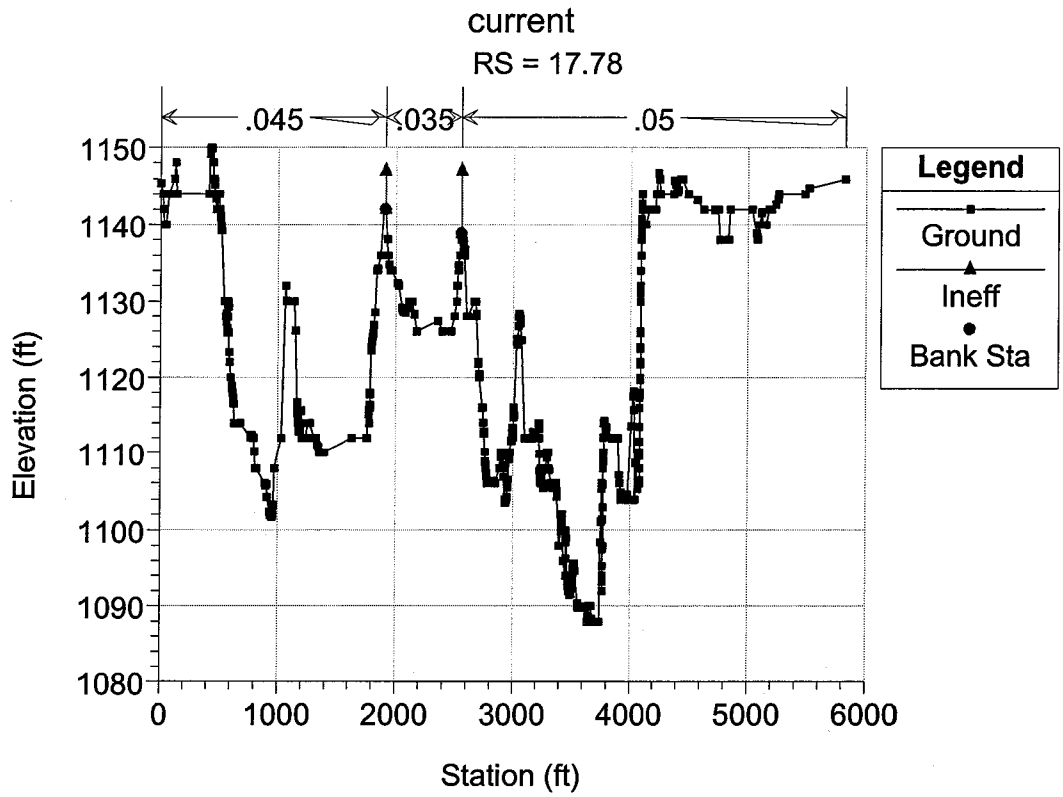

current
RS = 17.33
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1145
1140
1135
1130
1125
1120
1115
1110
1105
0
1000
2000
3000
4000
5000
6000
Station (ft)

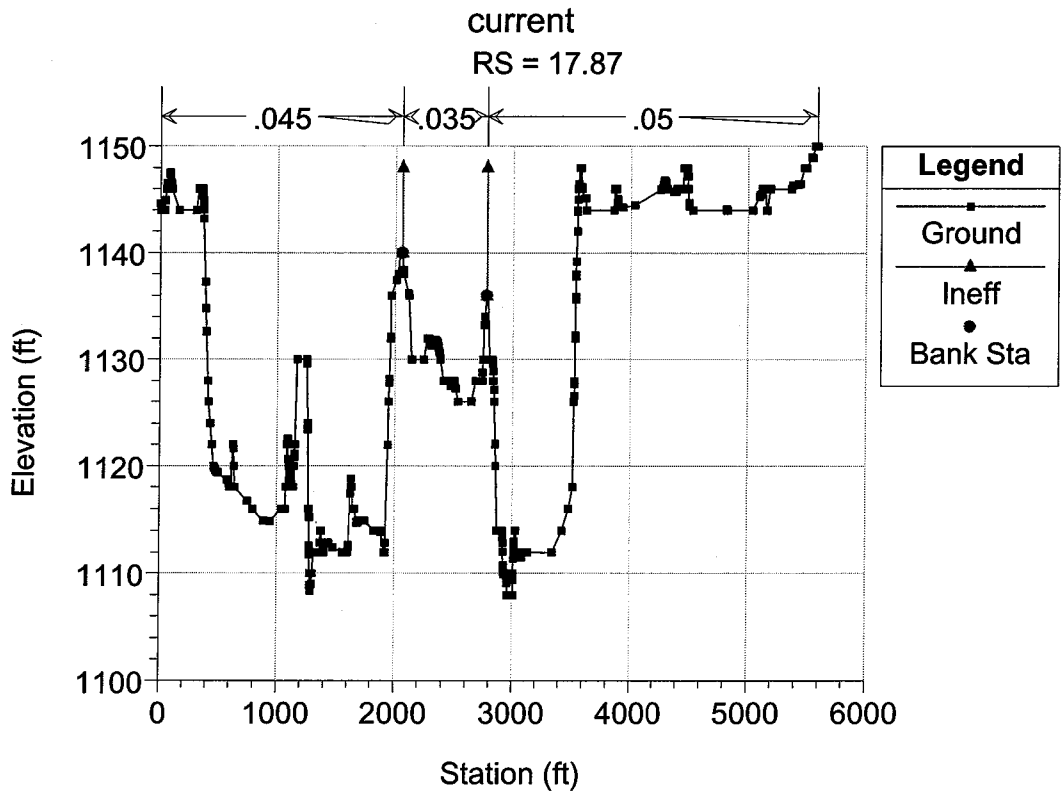

current
RS = 17.42
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1145
1140
1135
1130
1125
1120
1115
1110
1105
0
1000
2000
3000
4000
5000
6000
Station (ft)

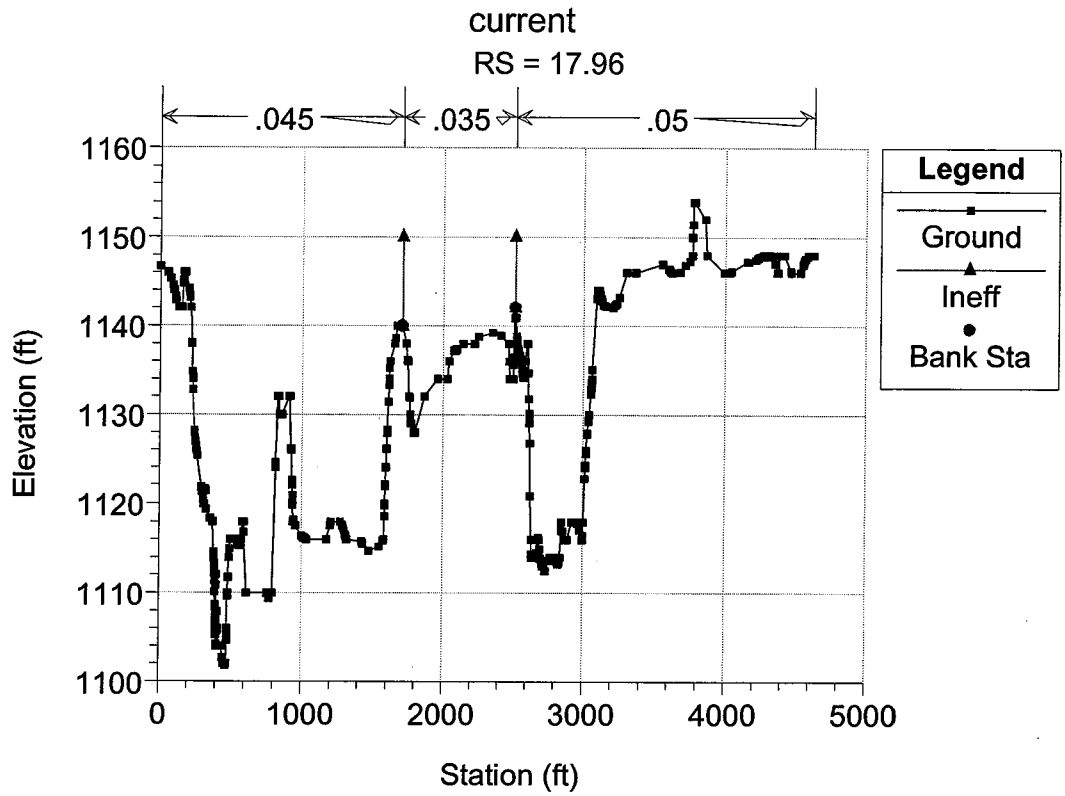

current
RS = 17.51
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
0
1000
2000
3000
4000
5000
6000
Station (ft)

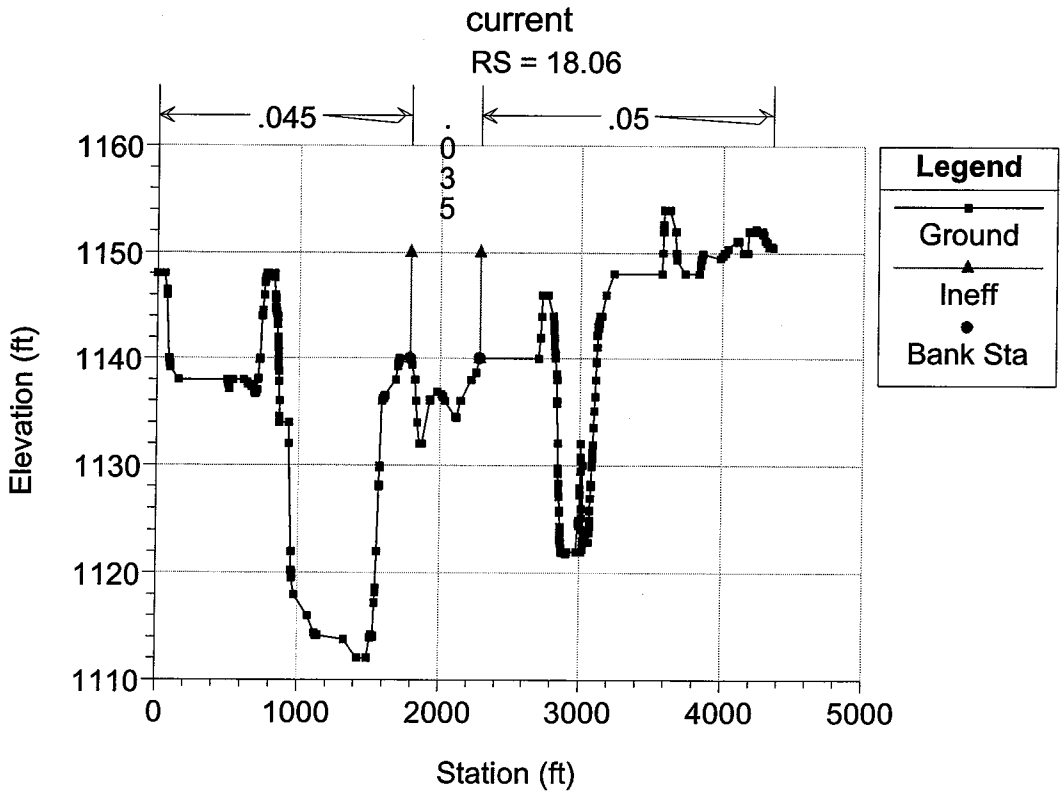

current
RS = 17.60
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1145
1140
1135
1130
1125
1120
1115
0
1000
2000
3000
4000
5000
6000
7000
Station (ft)

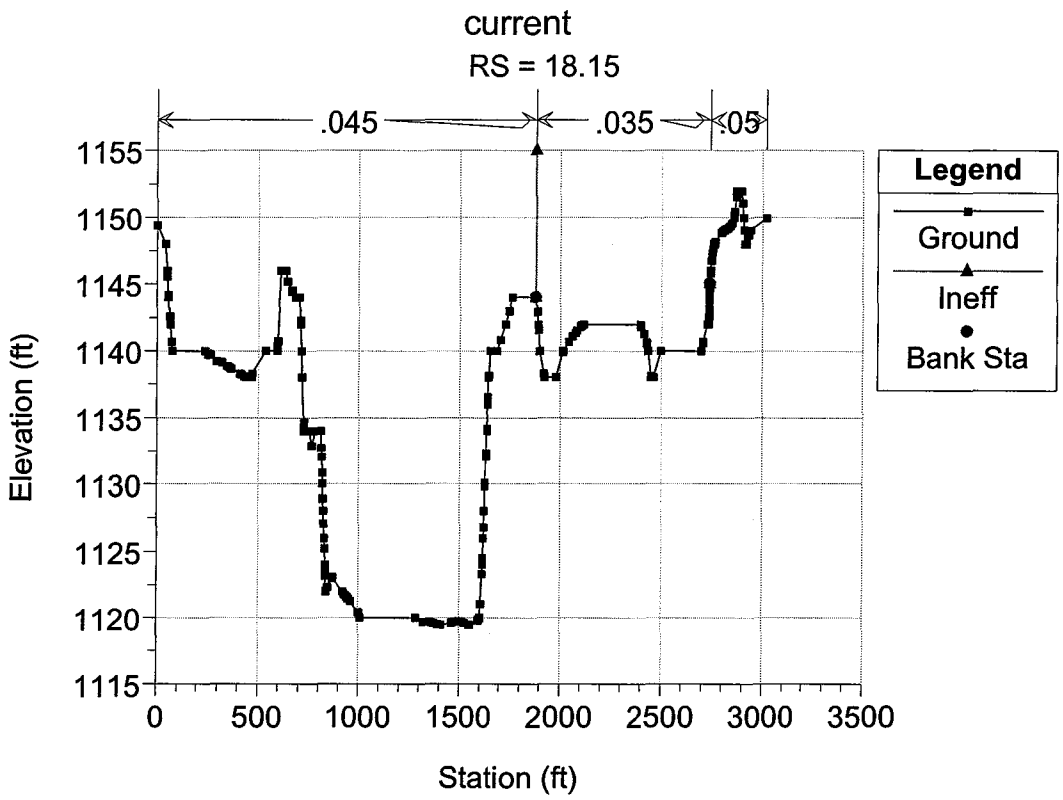

current
RS = 17.69
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1145
1140
1135
1130
1125
1120
1115
1110
0
1000
2000
3000
4000
5000
6000
7000
Station (ft)

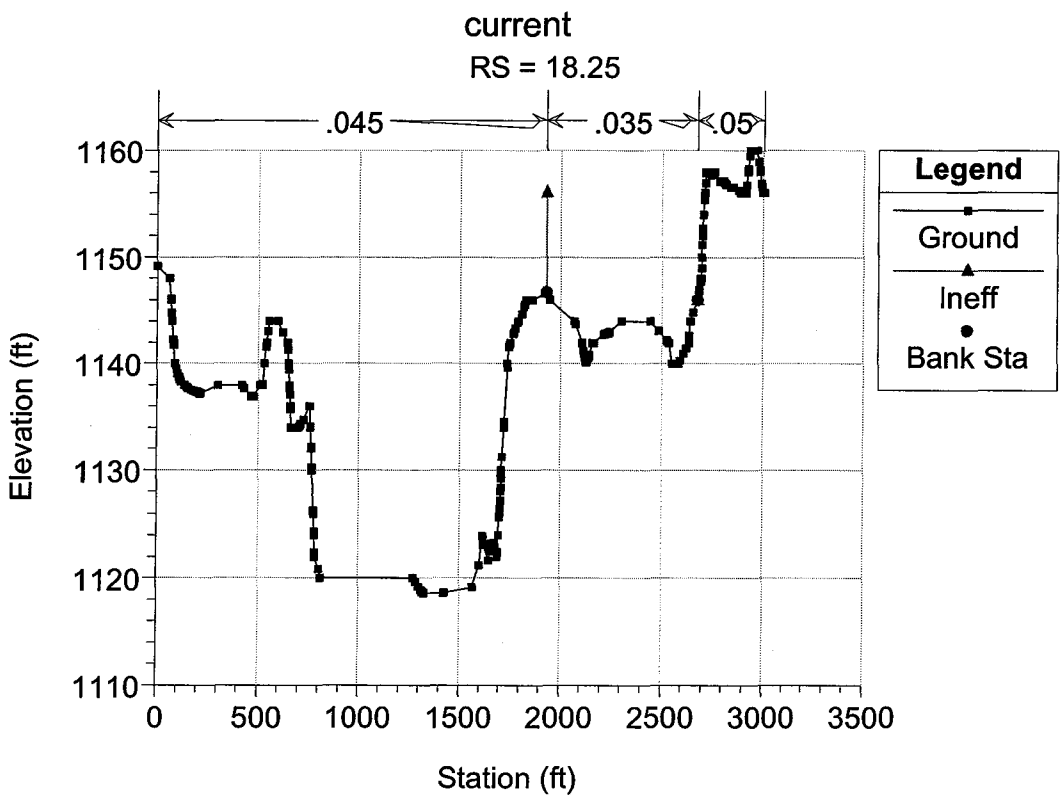

current
RS = 17.78
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
1090
1080
0
1000
2000
3000
4000
5000
6000
Station (ft)

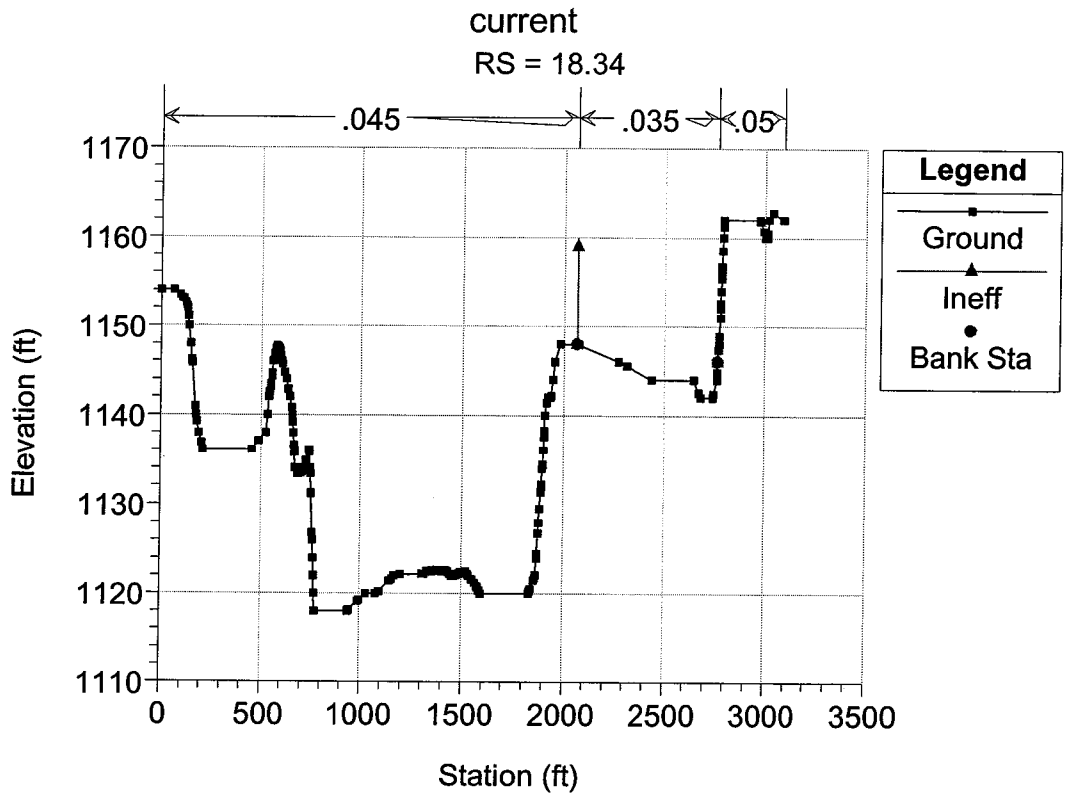

current
RS = 17.87
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
0
1000
2000
3000
4000
5000
6000
Station (ft)

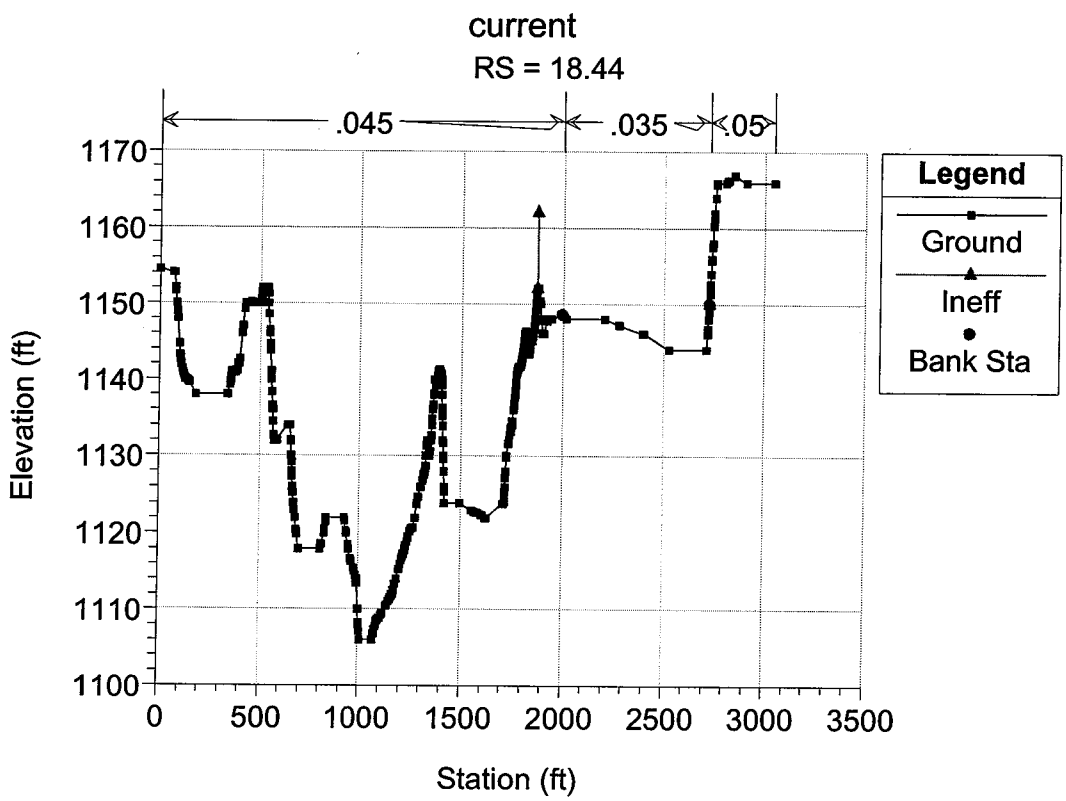

current
RS = 17.96
.045
.035
.05
1160
1150
1140
1130
1120
1110
1100
Elevation (ft)
0
1000
2000
3000
4000
5000
Station (ft)
Legend
Ground
Ineff
Bank Sta

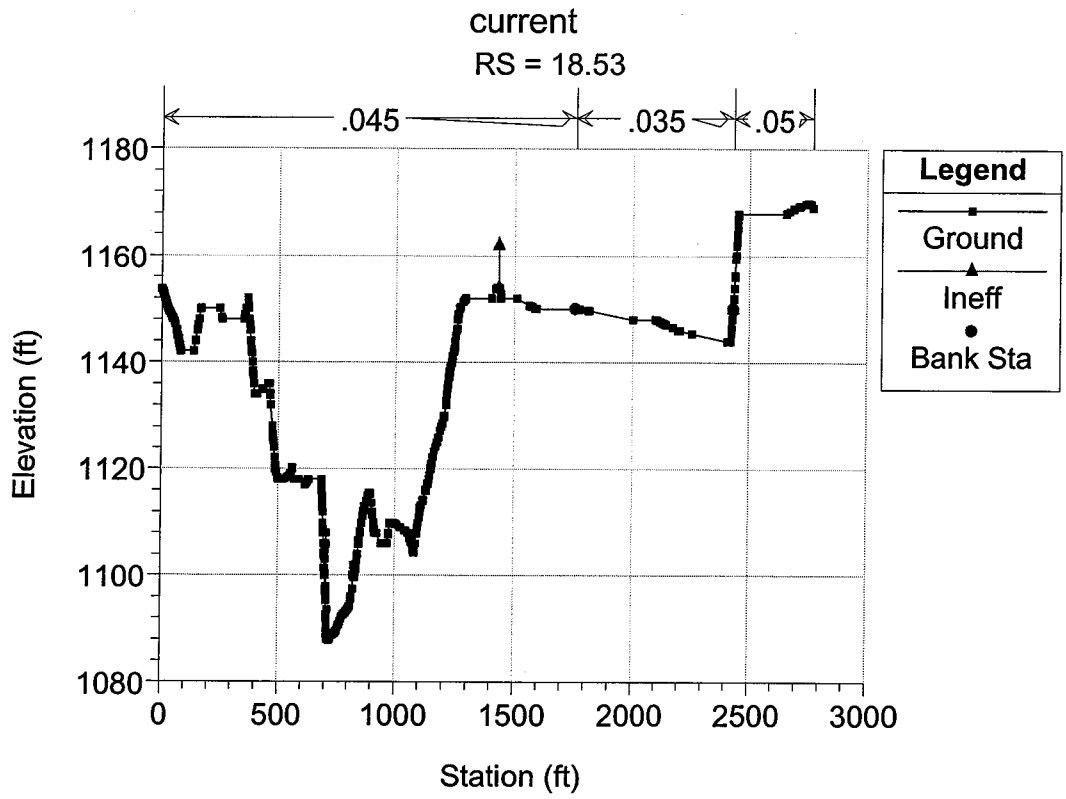

current
RS = 18.06
.045
.035
.05
1160
1150
1140
1130
1120
1110
Elevation (ft)
0
1000
2000
3000
4000
5000
Station (ft)
Legend
Ground
Ineff
Bank Sta

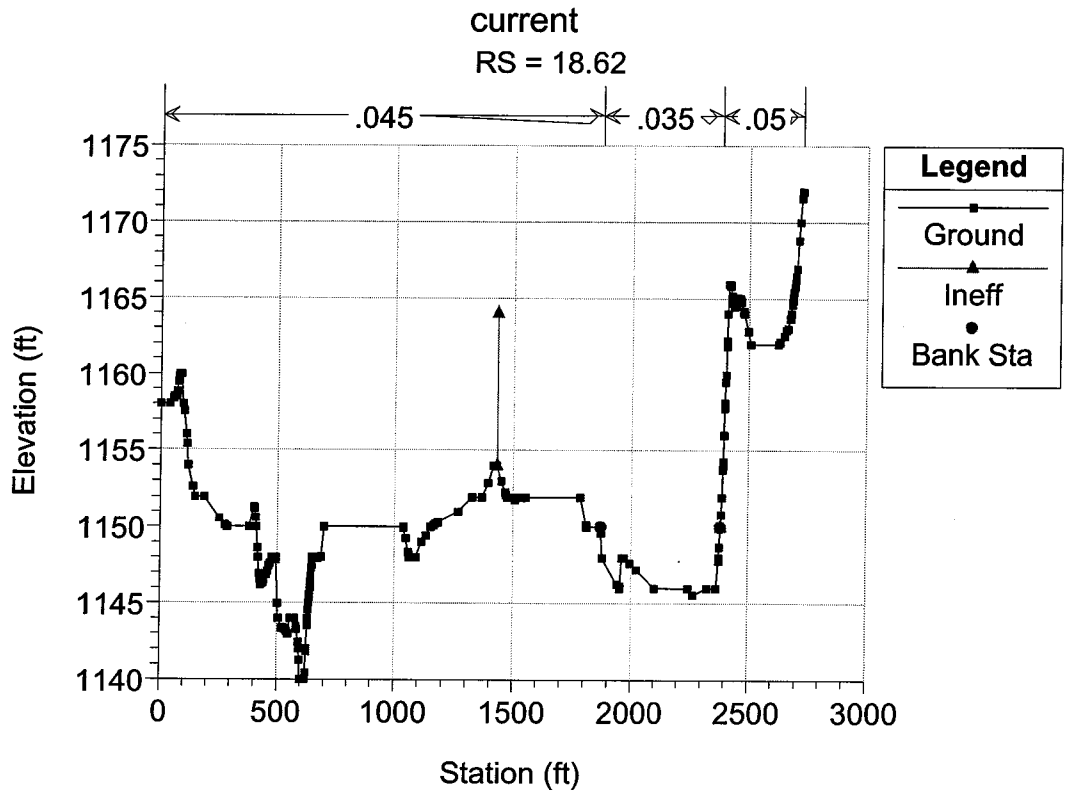

current
RS = 18.15
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1155
1150
1145
1140
1135
1130
1125
1120
1115
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

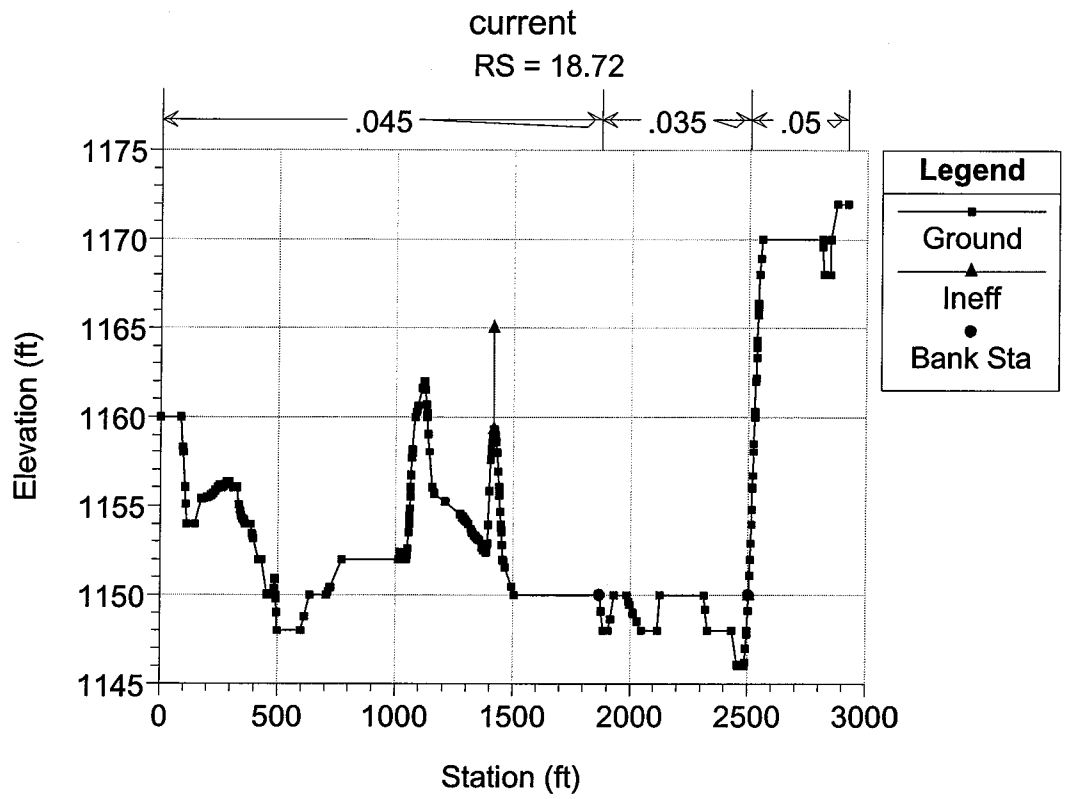

current
RS = 18.25
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1160
1150
1140
1130
1120
1110
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

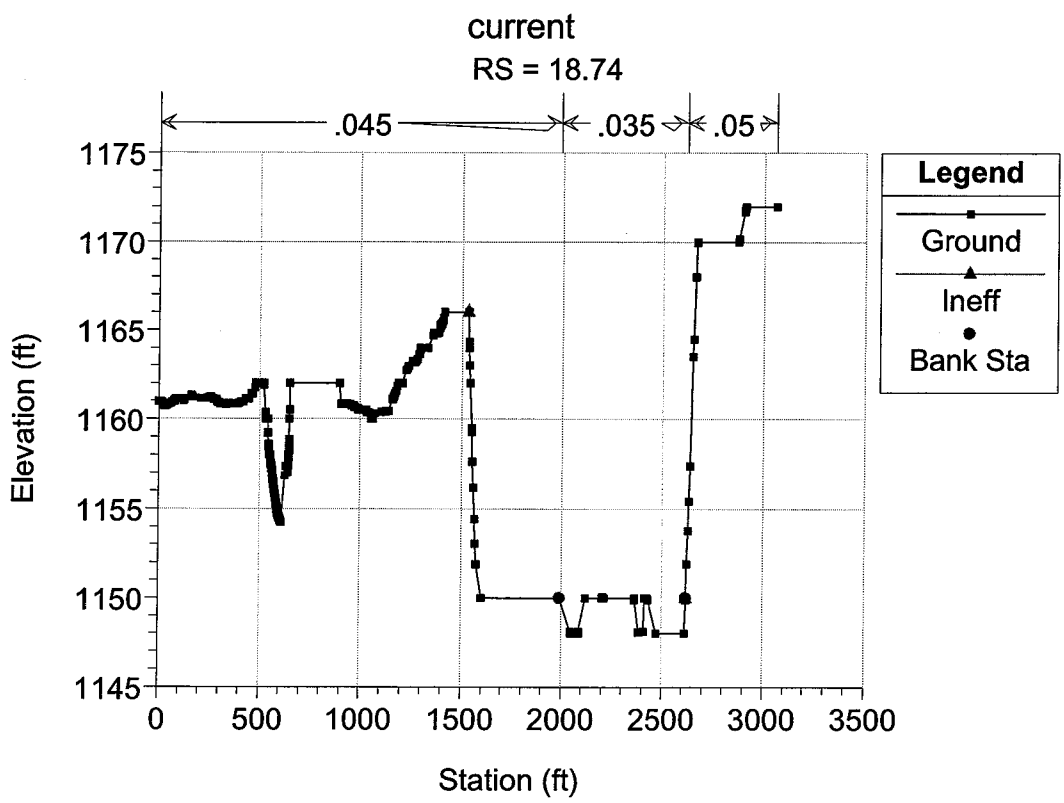

current
RS = 18.34
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1160
1150
1140
1130
1120
1110
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

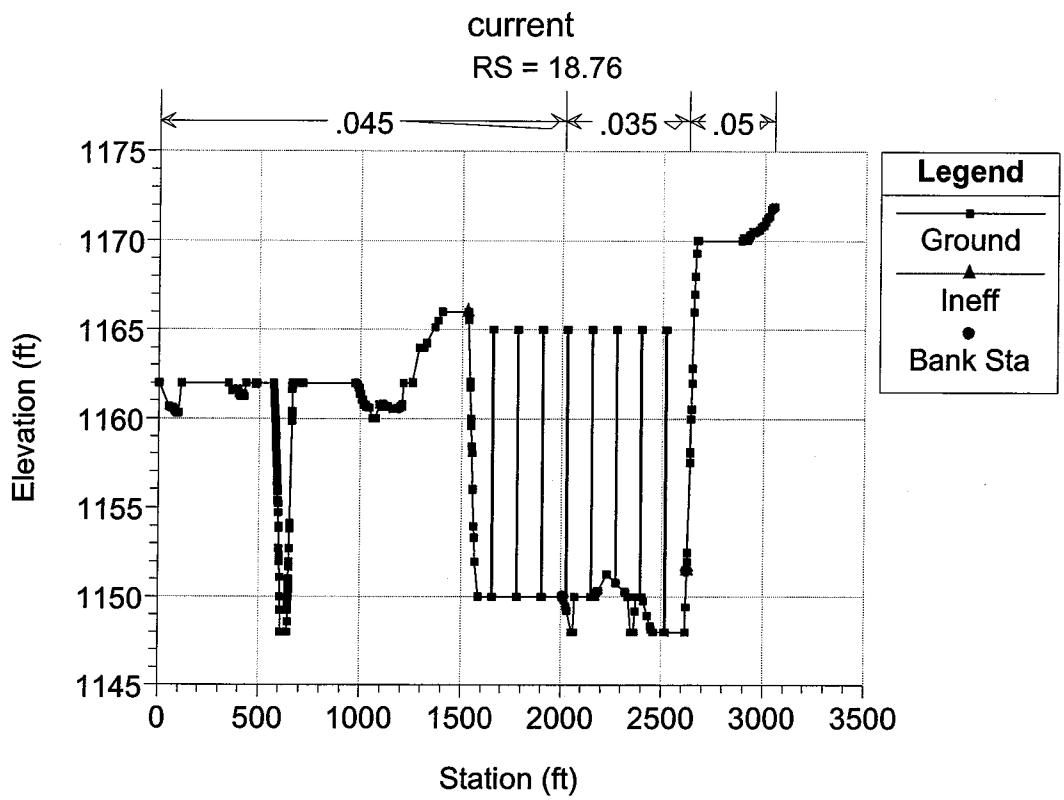

current
RS = 18.44
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1170
1160
1150
1140
1130
1120
1110
1100
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

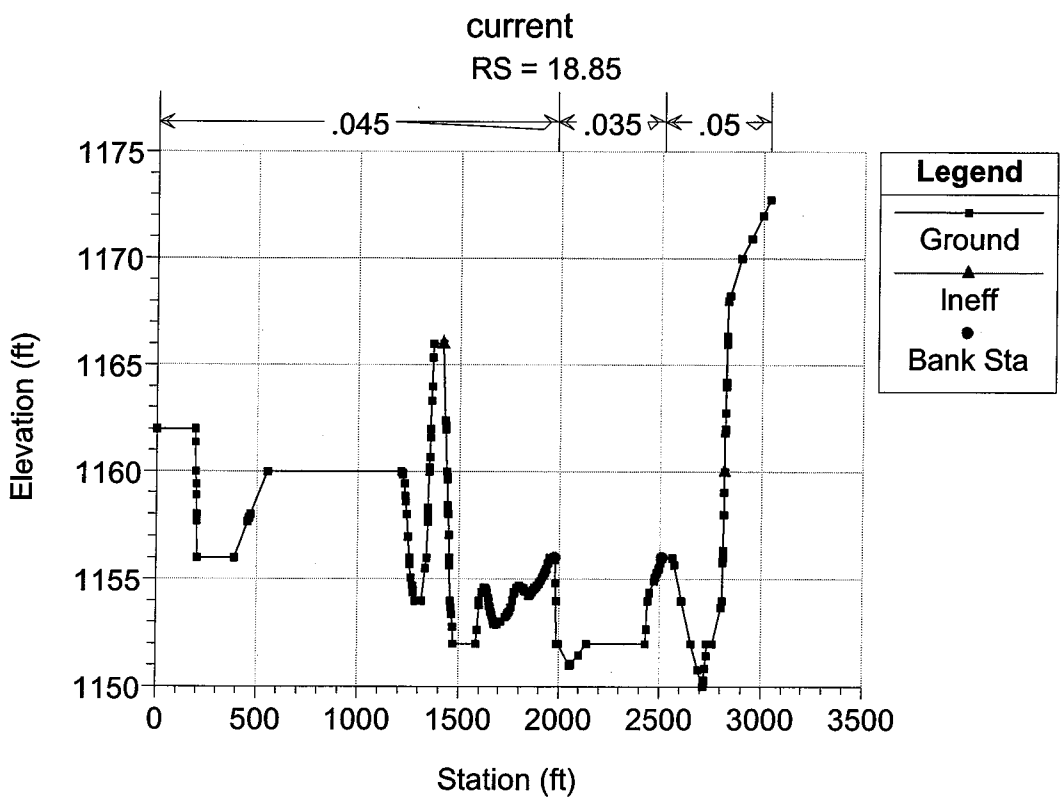

current
RS = 18.53
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1160
1140
1120
1100
1080
0
500
1000
1500
2000
2500
3000
Station (ft)

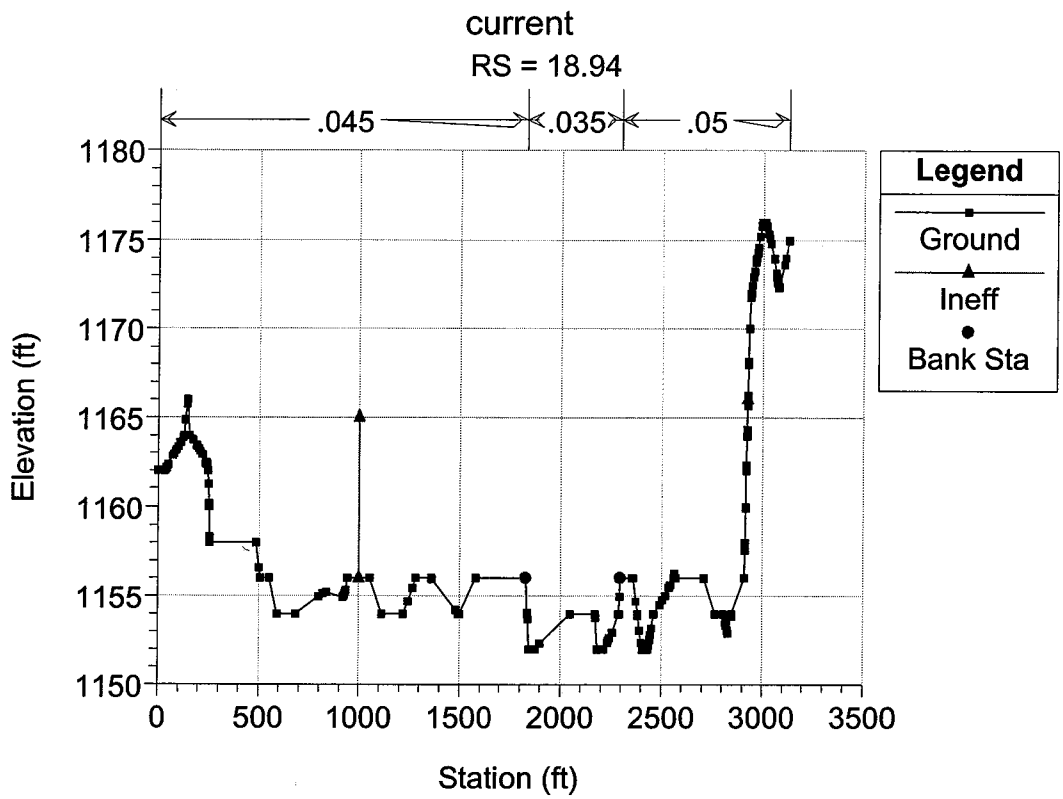

current
RS = 18.62
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1175
1170
1165
1160
1155
1150
1145
1140
0
500
1000
1500
2000
2500
3000
Station (ft)

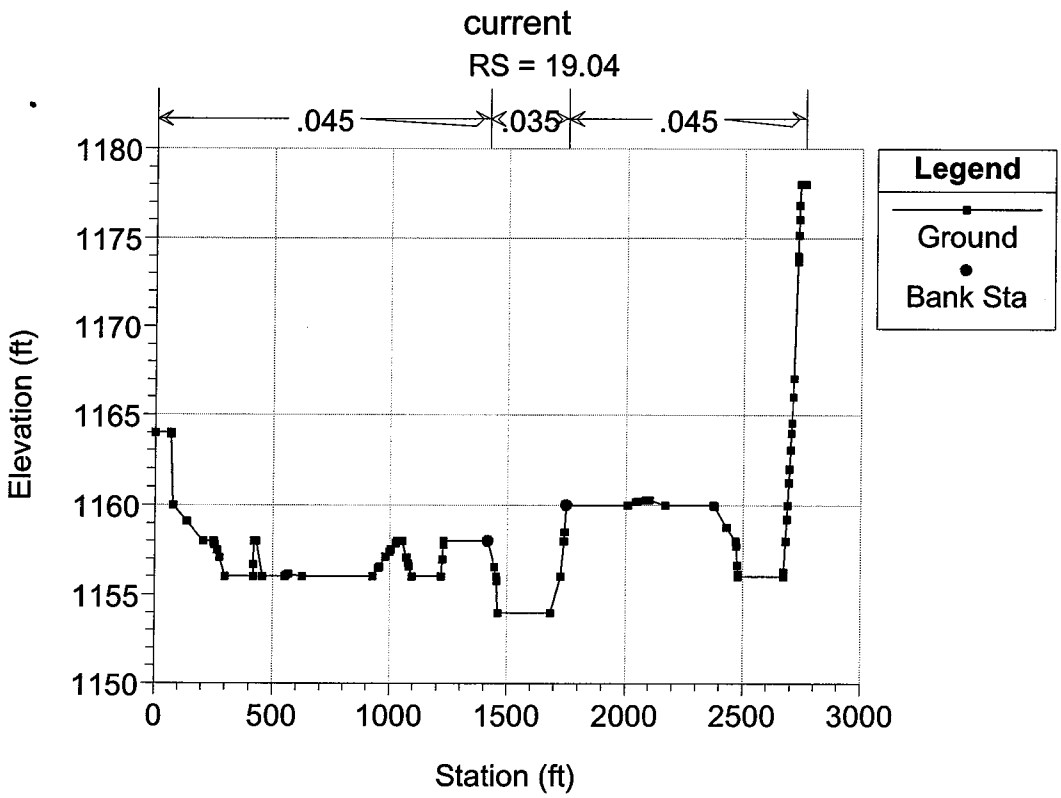

current
RS = 18.72
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1175
1170
1165
1160
1155
1150
1145
0
500
1000
1500
2000
2500
3000
Station (ft)

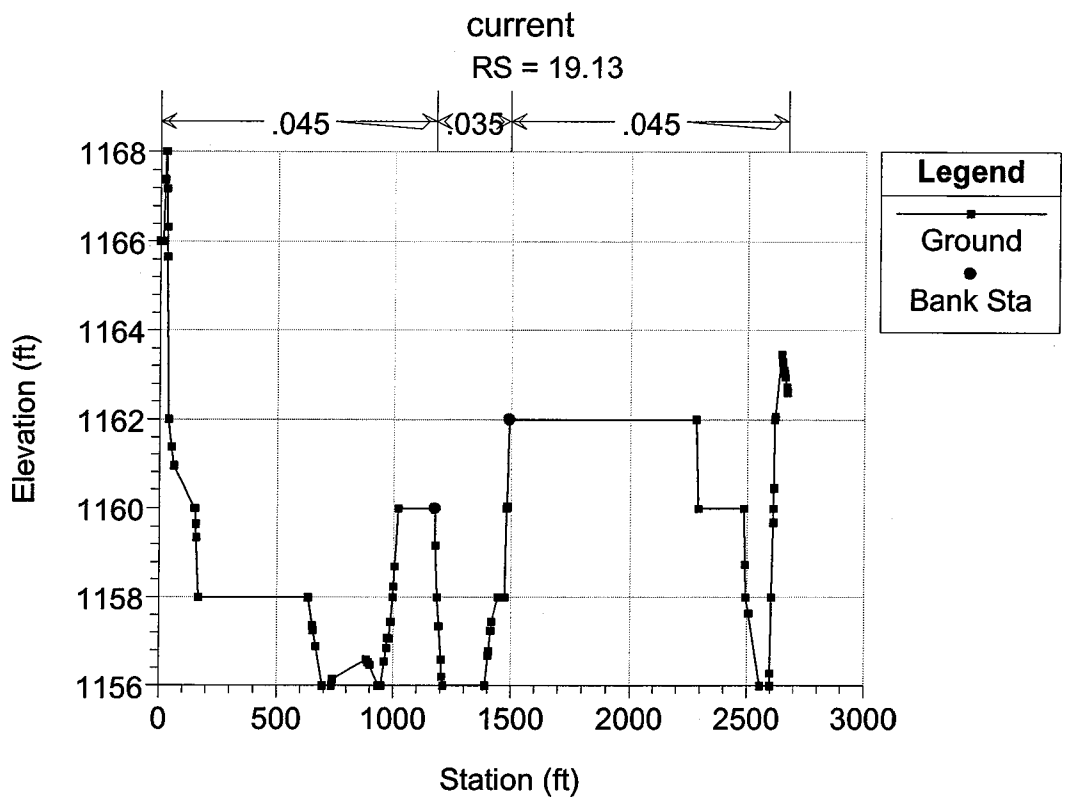

current
RS = 18.74
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1175
1170
1165
1160
1155
1150
1145
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

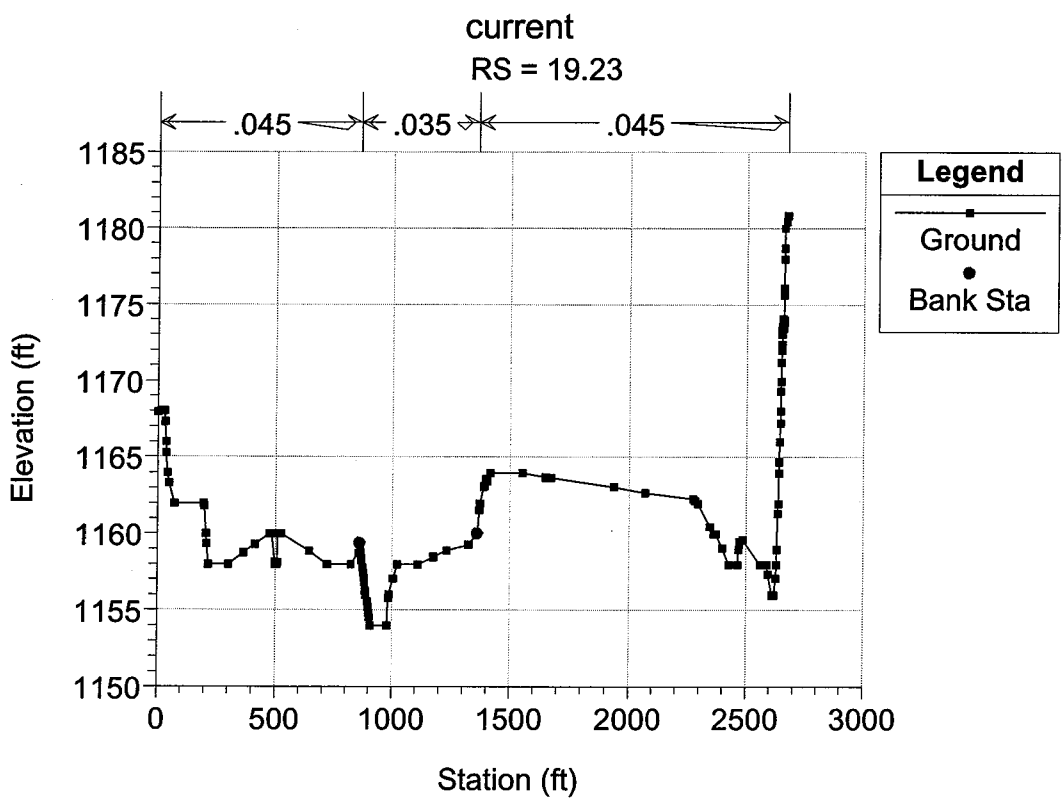

current
RS = 18.76
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1175
1170
1165
1160
1155
1150
1145
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

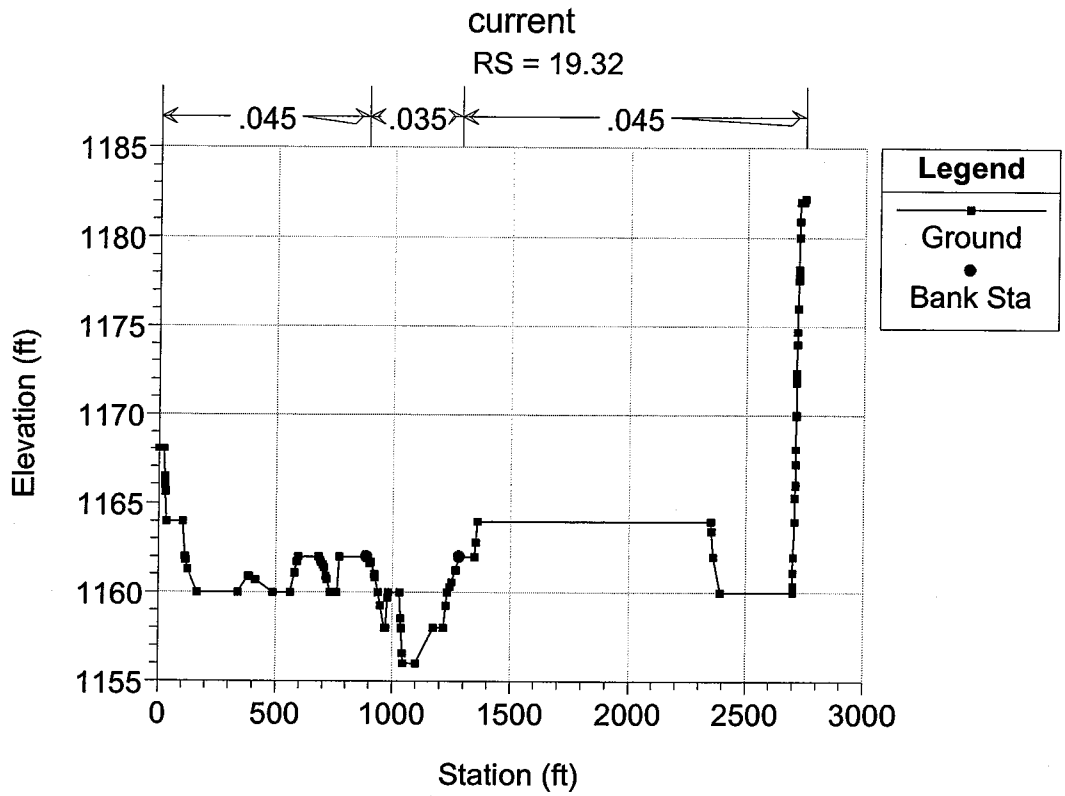

current
RS = 18.85
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1175
1170
1165
1160
1155
1150
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

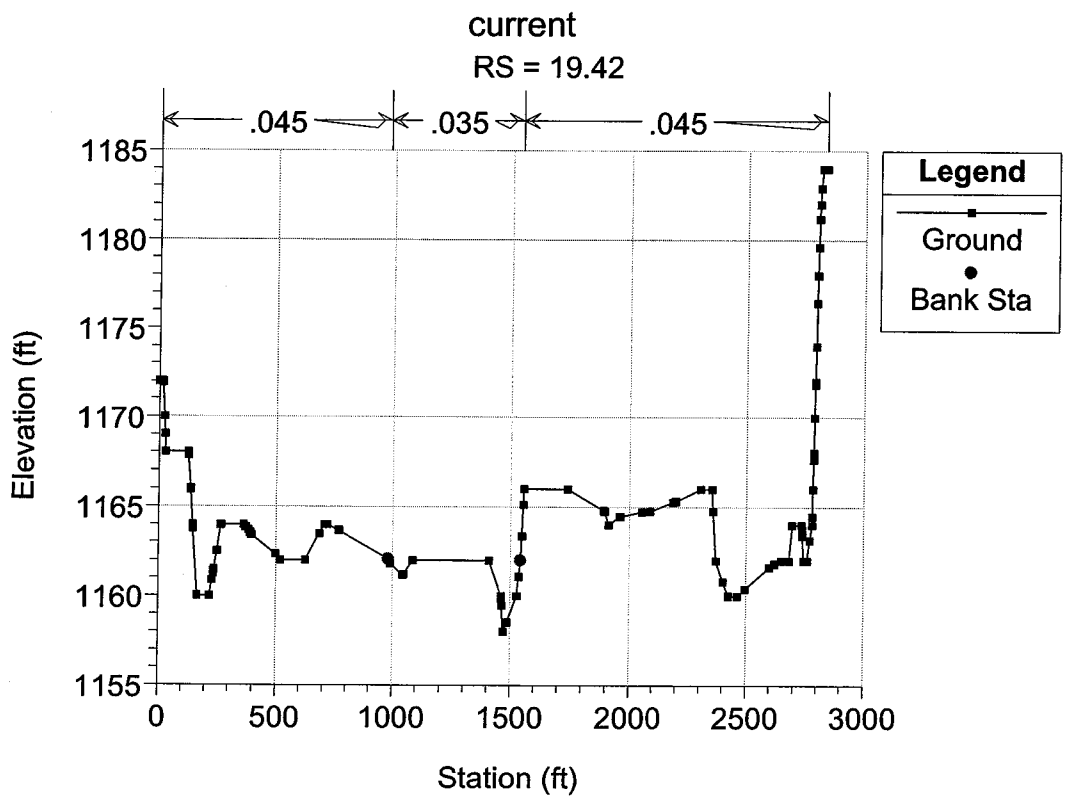

current
RS = 18.94
.045
.035
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
1150
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

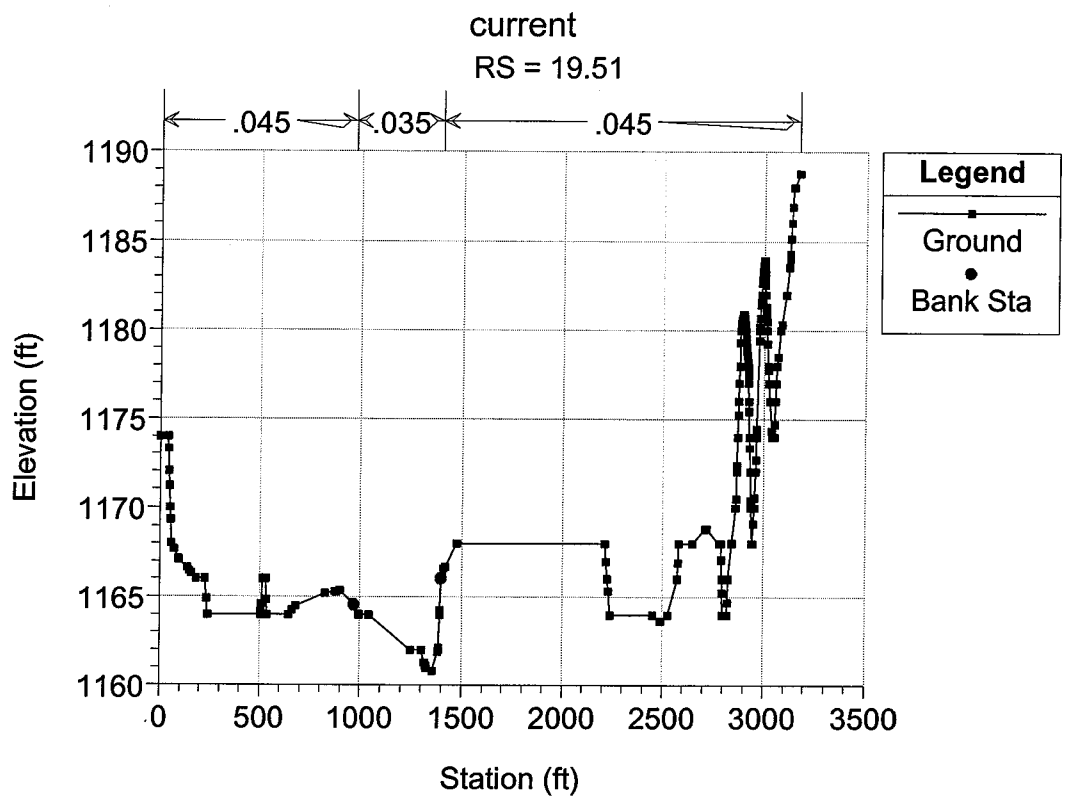

current
RS = 19.04
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1180
1175
1170
1165
1160
1155
1150
0
500
1000
1500
2000
2500
3000
Station (ft)

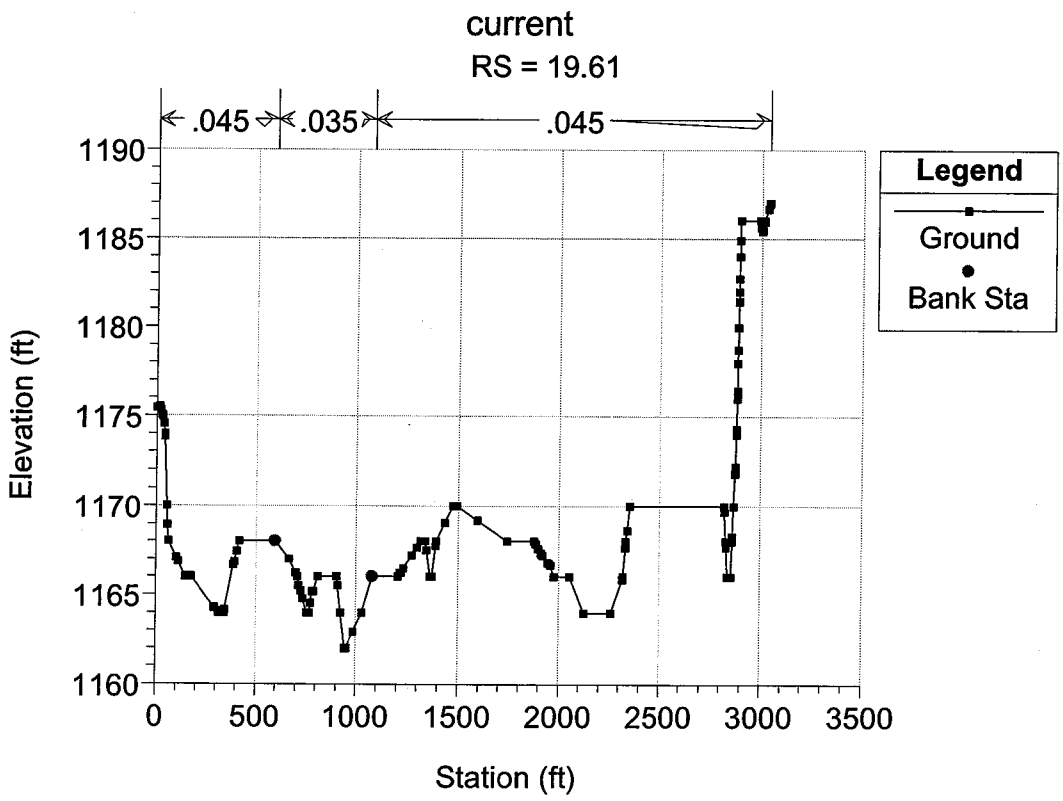

current
RS = 19.13
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1168
1166
1164
1162
1160
1158
1156
0
500
1000
1500
2000
2500
3000
Station (ft)

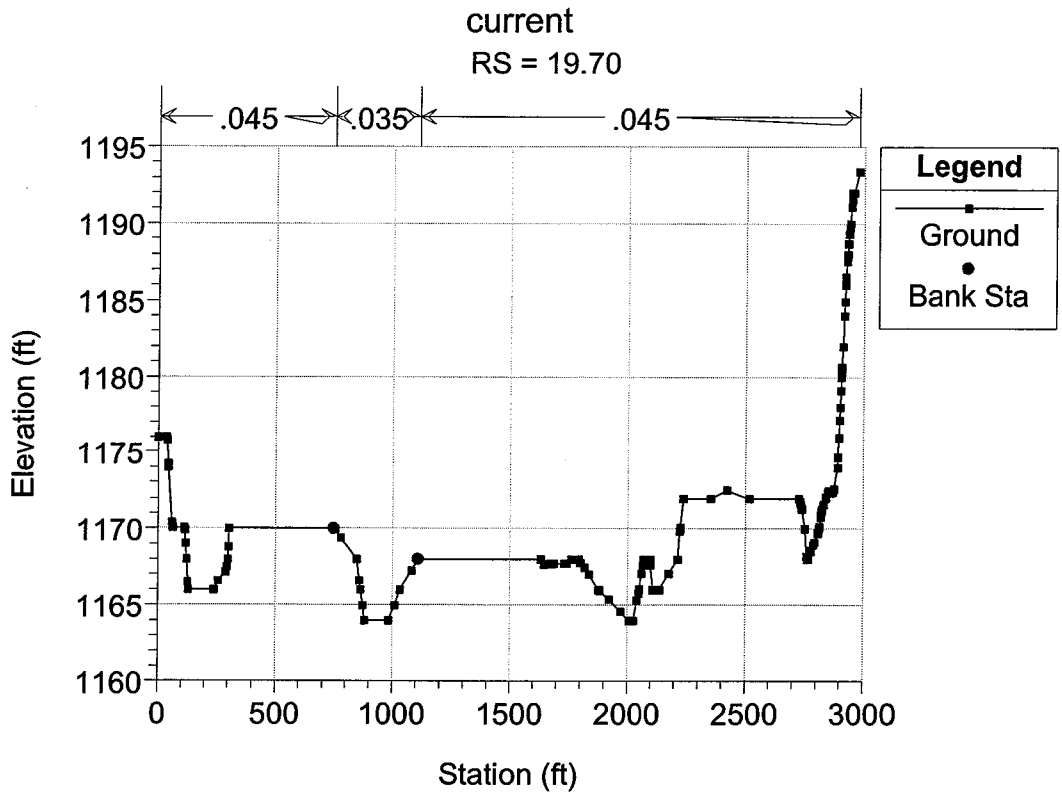

current
RS = 19.23
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1185
1180
1175
1170
1165
1160
1155
1150
0
500
1000
1500
2000
2500
3000
Station (ft)

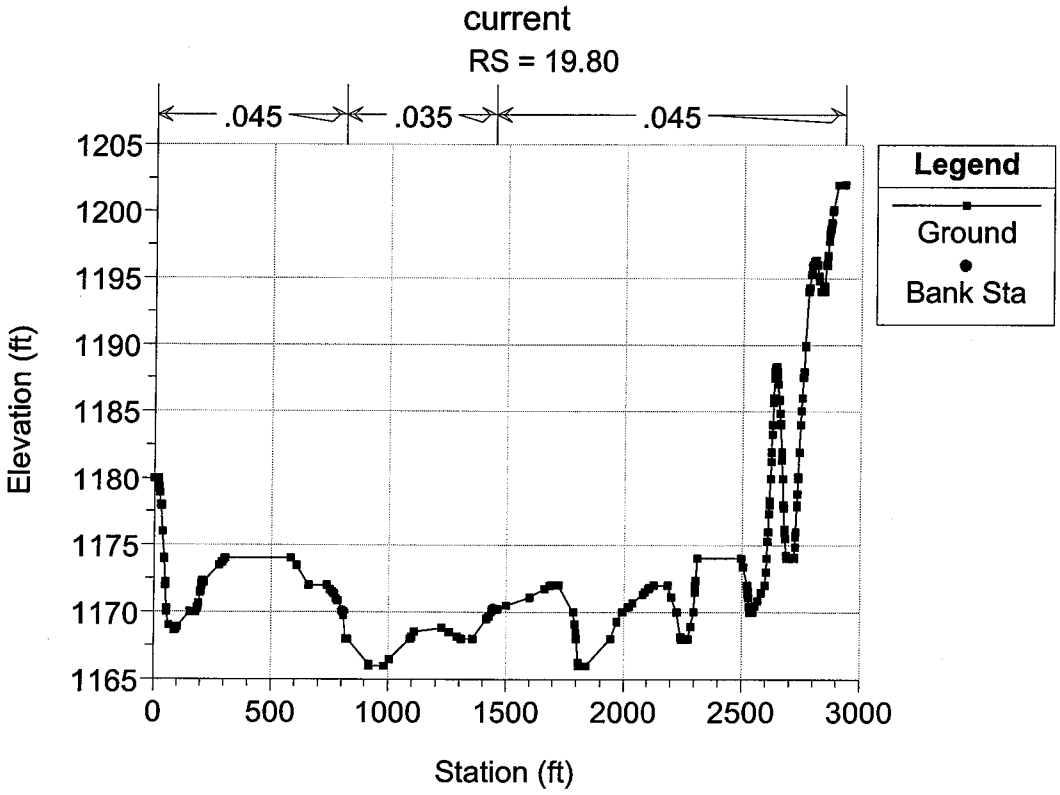

current
RS = 19.32
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1185
1180
1175
1170
1165
1160
1155
0
500
1000
1500
2000
2500
3000
Station (ft)

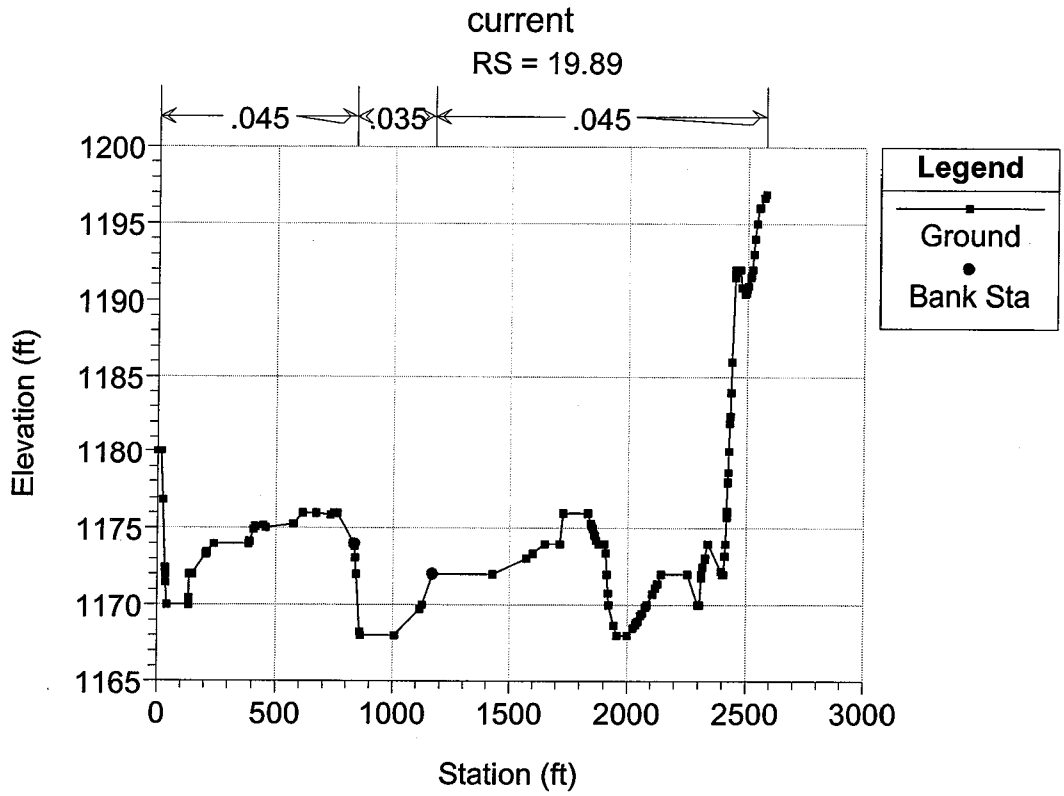

current
RS = 19.42
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1185
1180
1175
1170
1165
1160
1155
0
500
1000
1500
2000
2500
3000
Station (ft)

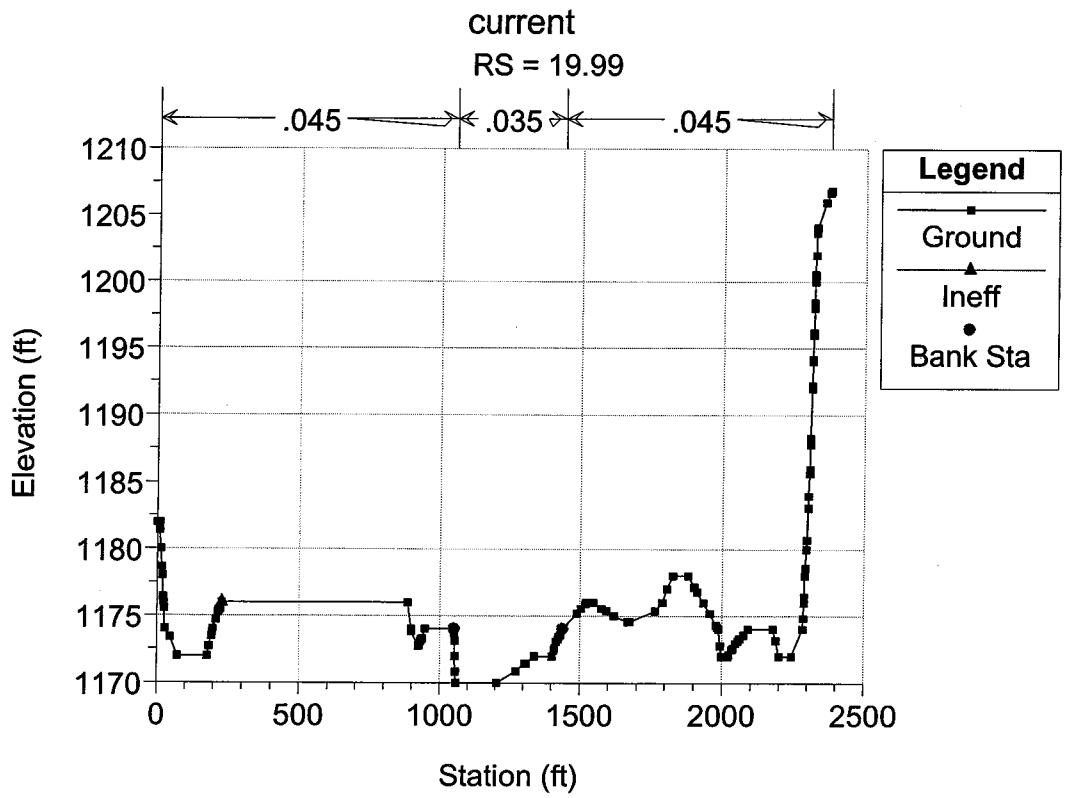

current
RS = 19.51
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1190
1185
1180
1175
1170
1165
1160
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

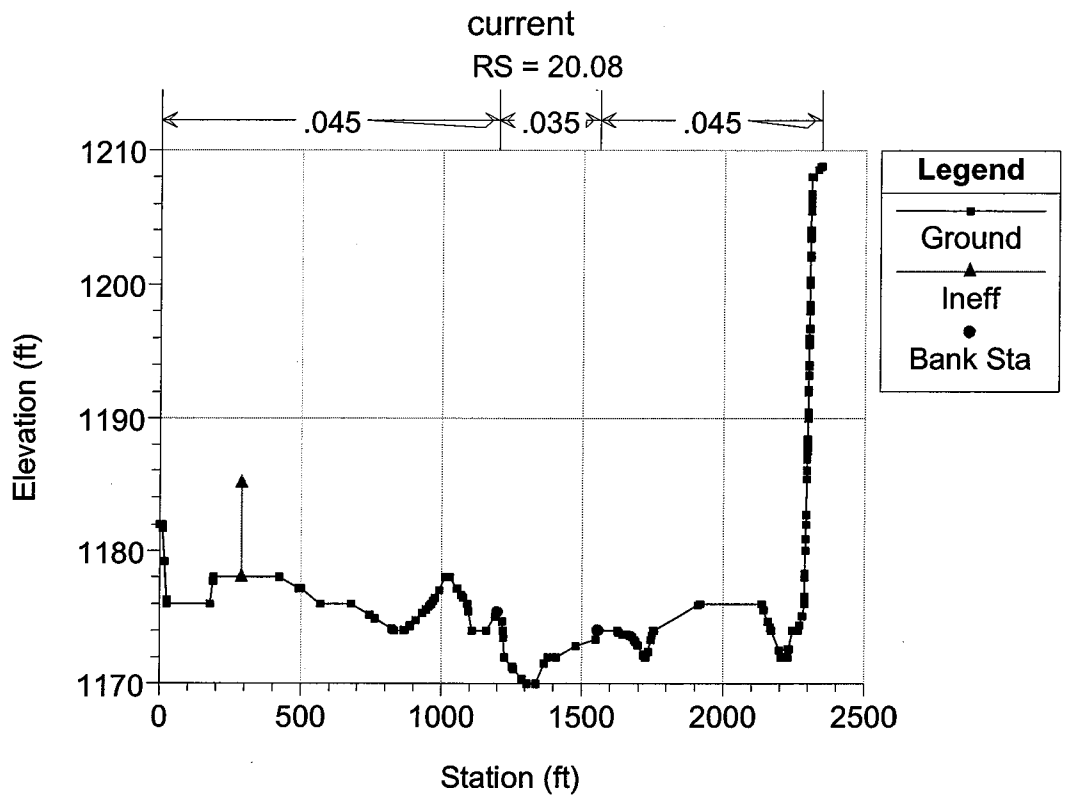

current
RS = 19.61
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1190
1185
1180
1175
1170
1165
1160
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

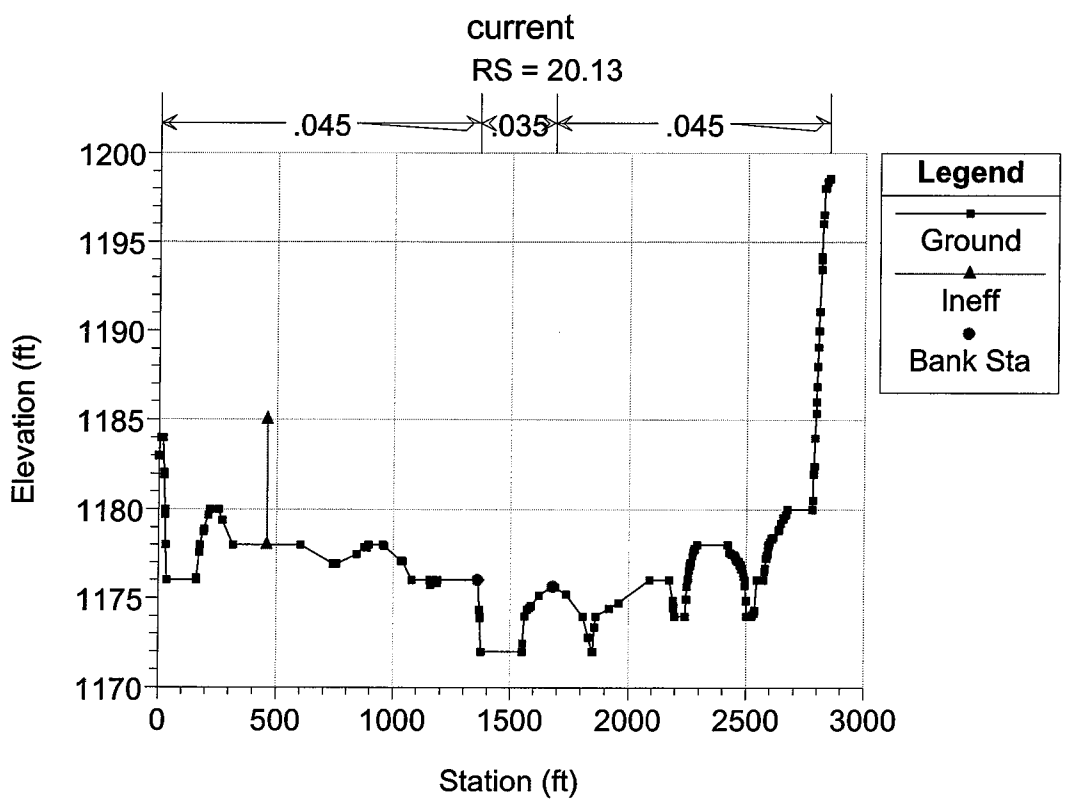

current
RS = 19.70
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1195
1190
1185
1180
1175
1170
1165
1160
0
500
1000
1500
2000
2500
3000
Station (ft)

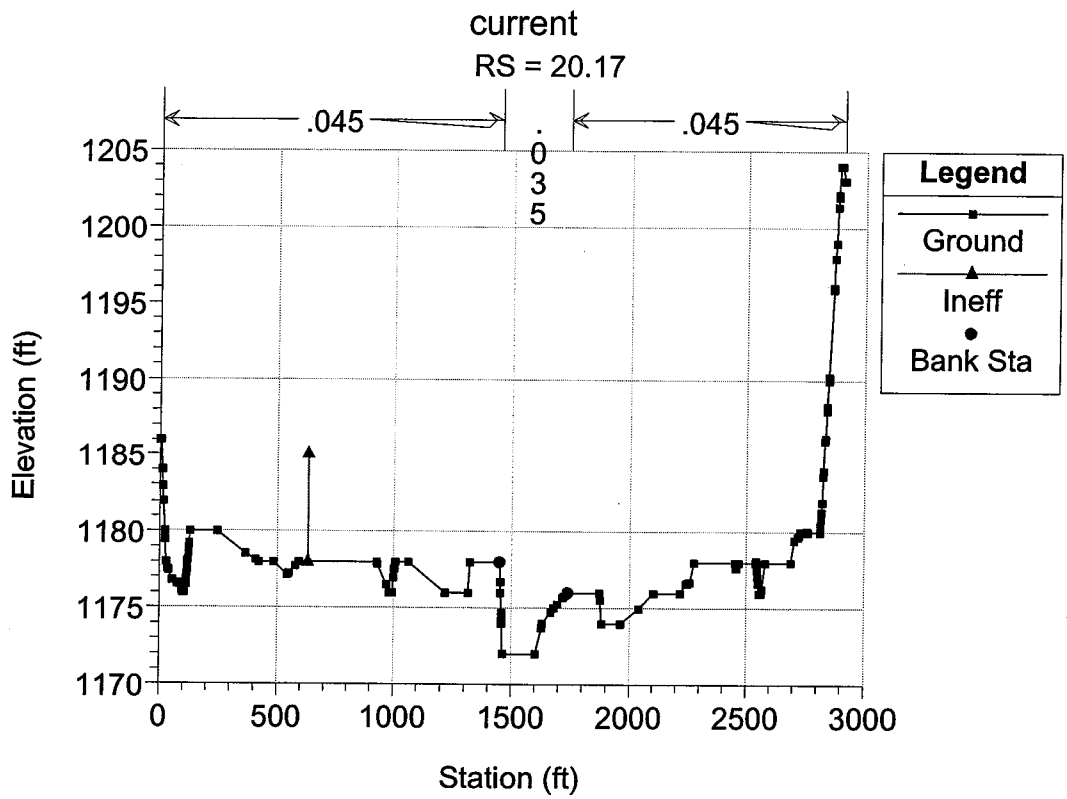

current
RS = 19.80
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1205
1200
1195
1190
1185
1180
1175
1170
1165
0
500
1000
1500
2000
2500
3000
Station (ft)

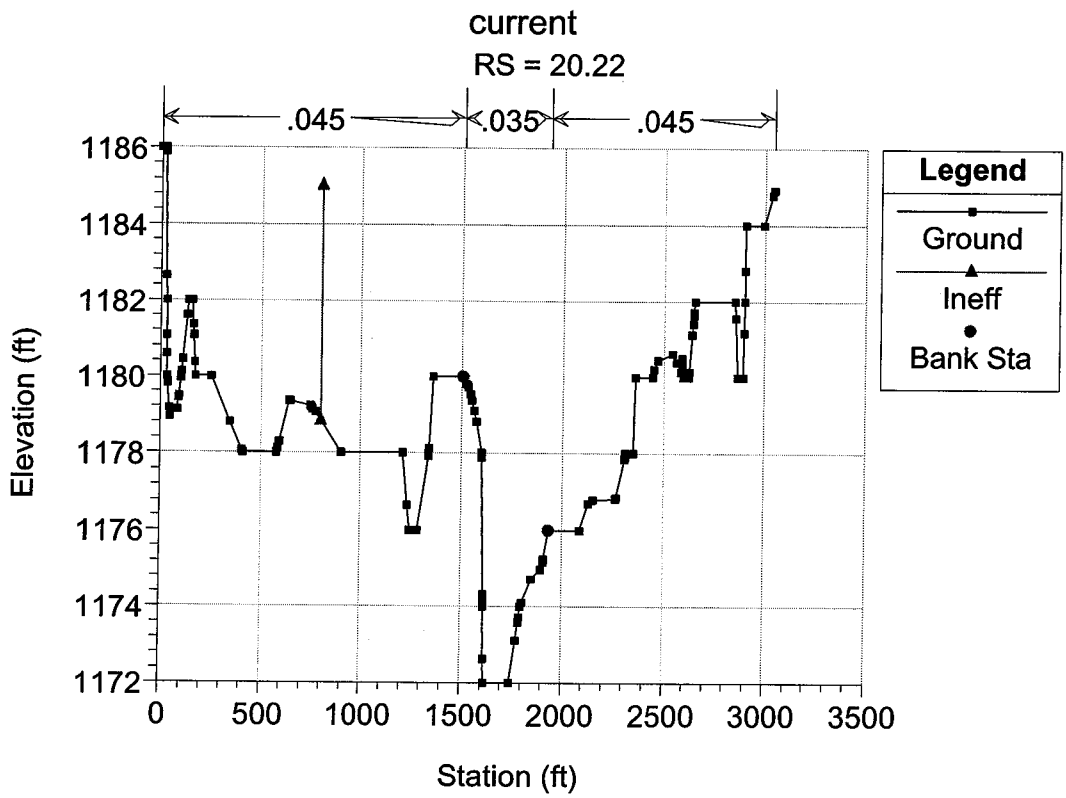

current
RS = 19.89
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1200
1195
1190
1185
1180
1175
1170
1165
0
500
1000
1500
2000
2500
3000
Station (ft)

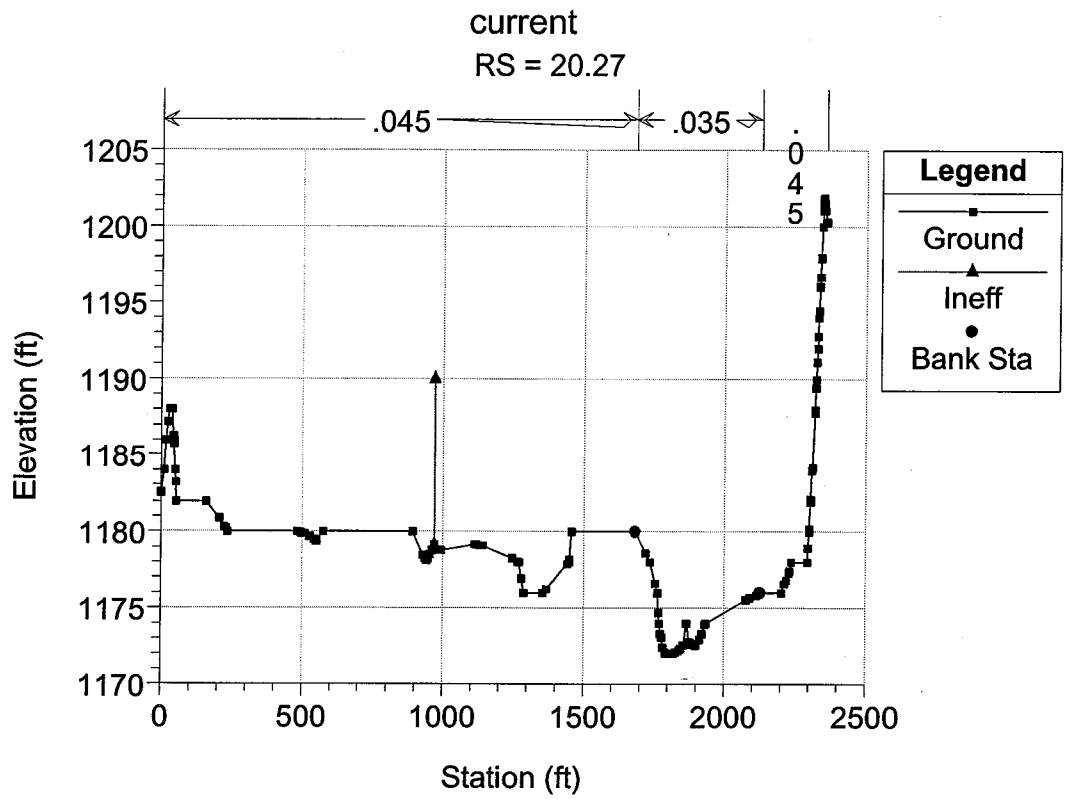

current
RS = 19.99
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1210
1205
1200
1195
1190
1185
1180
1175
1170
0
500
1000
1500
2000
2500
Station (ft)

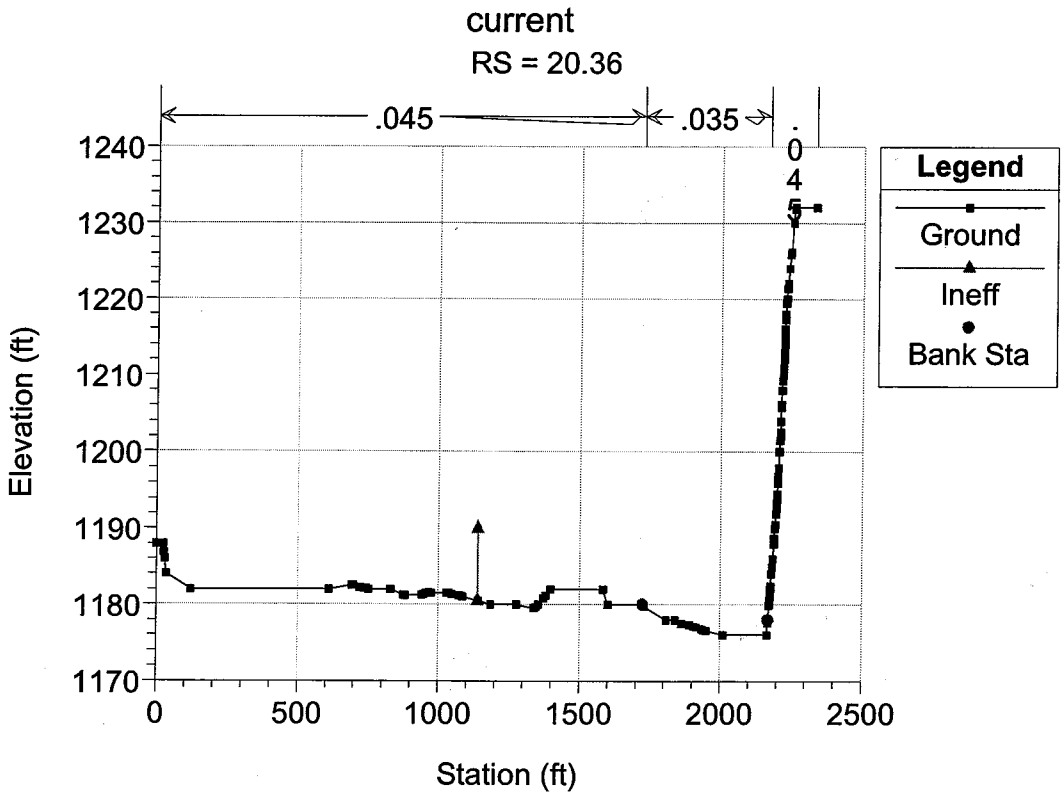

current
RS = 20.08
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1210
1200
1190
1180
1170
0
500
1000
1500
2000
2500
Station (ft)

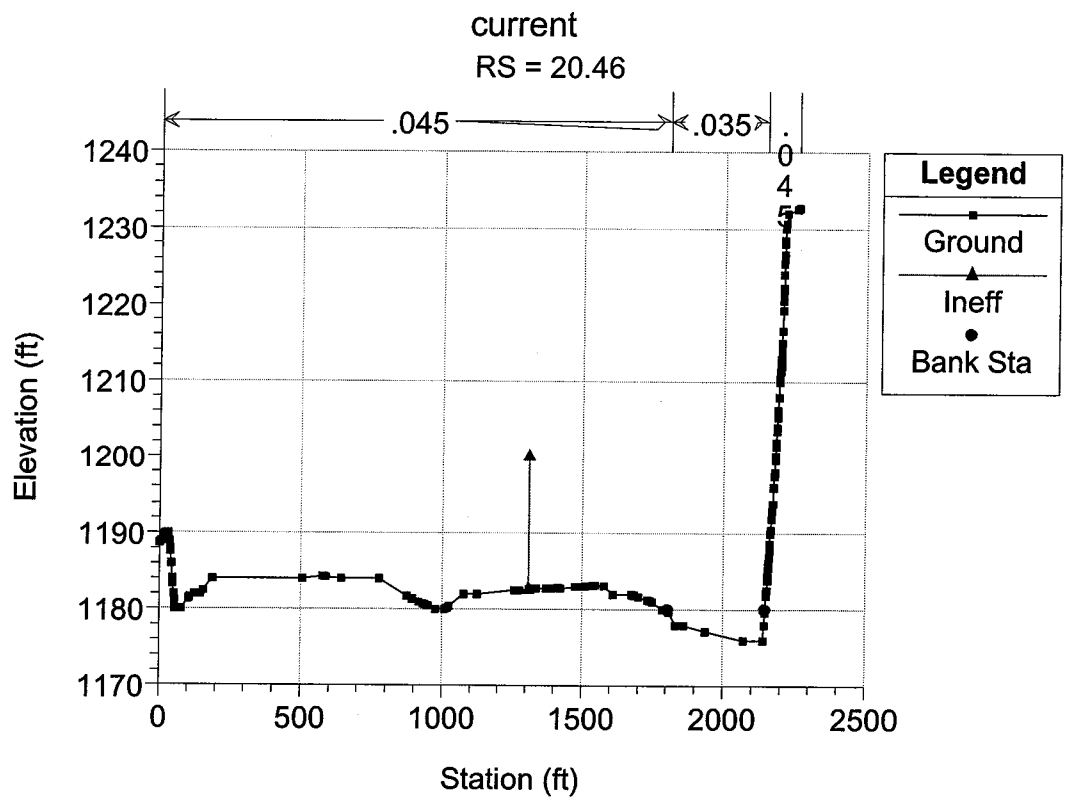

current
RS = 20.13
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1200
1195
1190
1185
1180
1175
1170
0
500
1000
1500
2000
2500
3000
Station (ft)

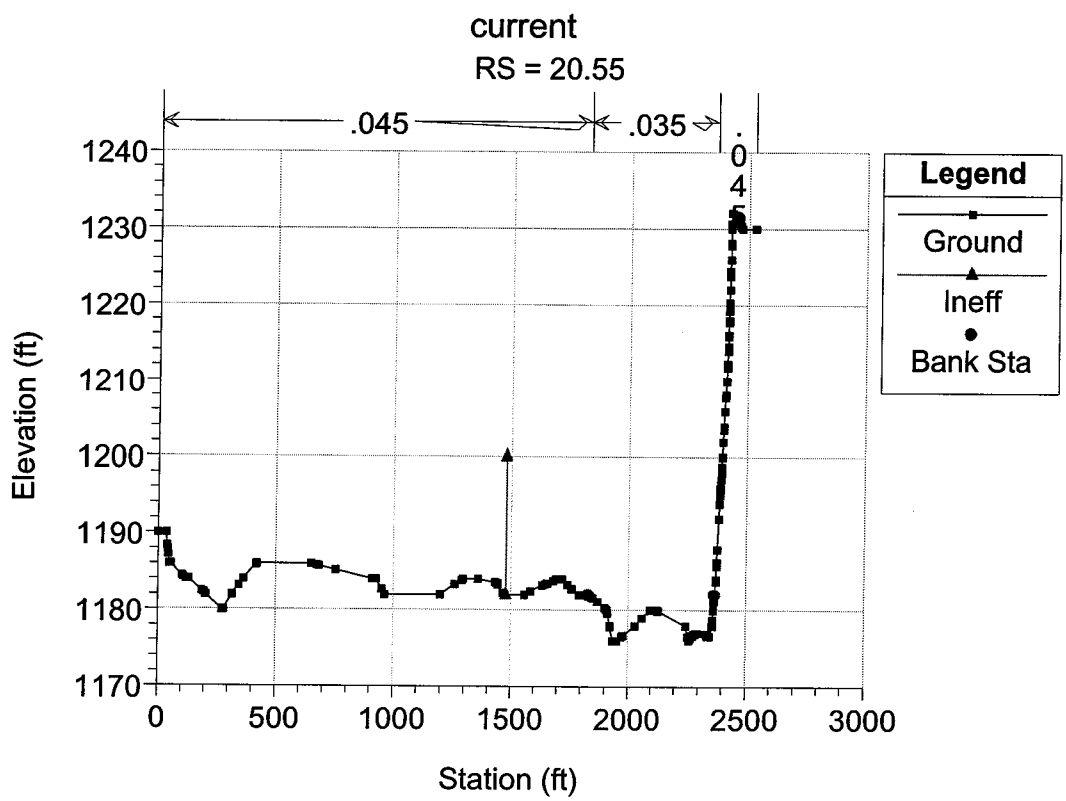

current
RS = 20.17
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1205
1200
1195
1190
1185
1180
1175
1170
0
500
1000
1500
2000
2500
3000

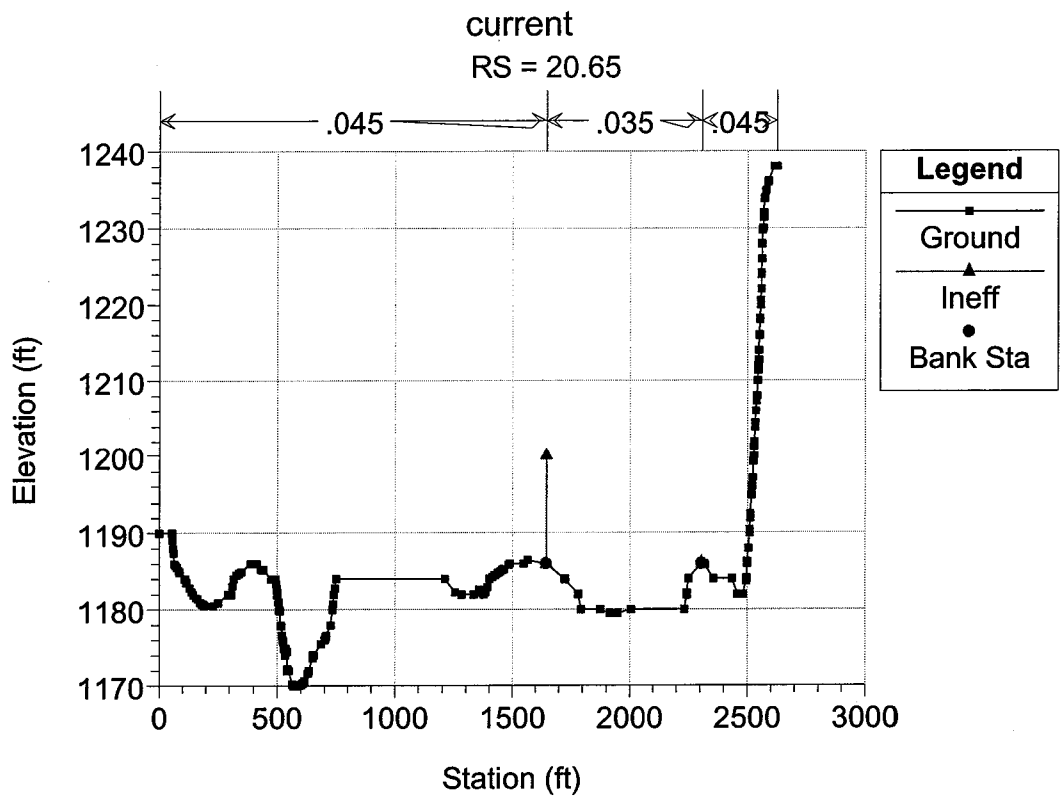

current
RS = 20.22
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1186
1184
1182
1180
1178
1176
1174
1172
0
500
1000
1500
2000
2500
3000
3500

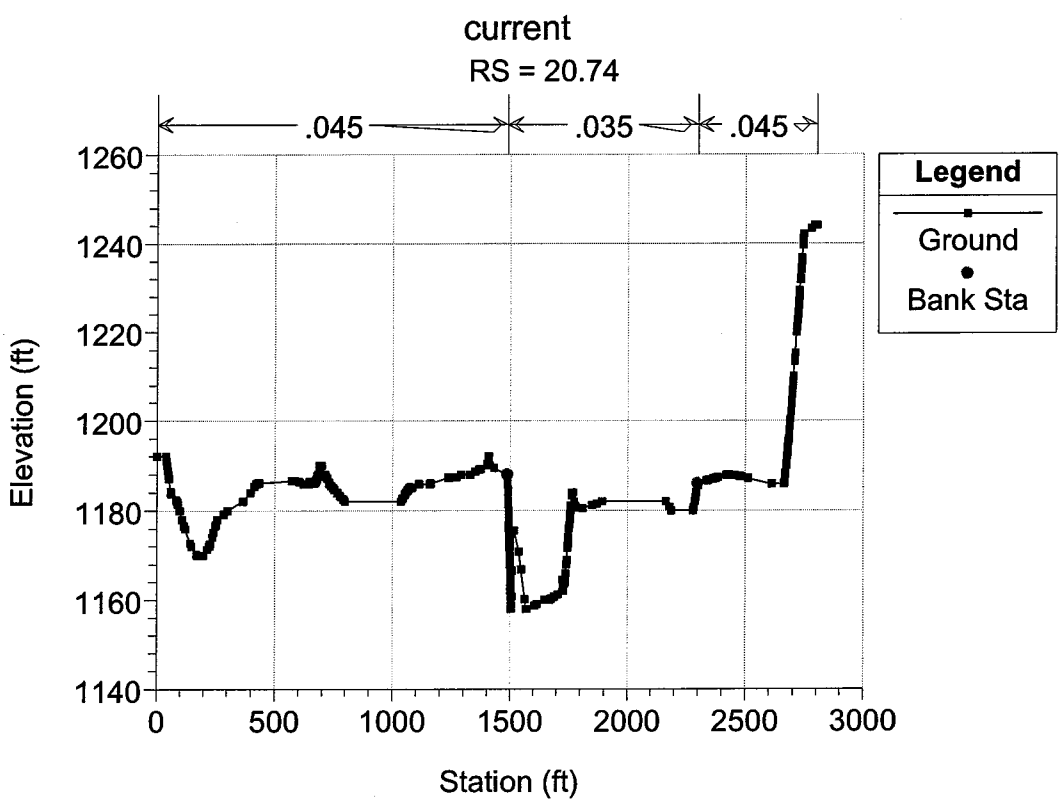

current
RS = 20.27
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1205
1200
1195
1190
1185
1180
1175
1170
0
500
1000
1500
2000
2500
Station (ft)

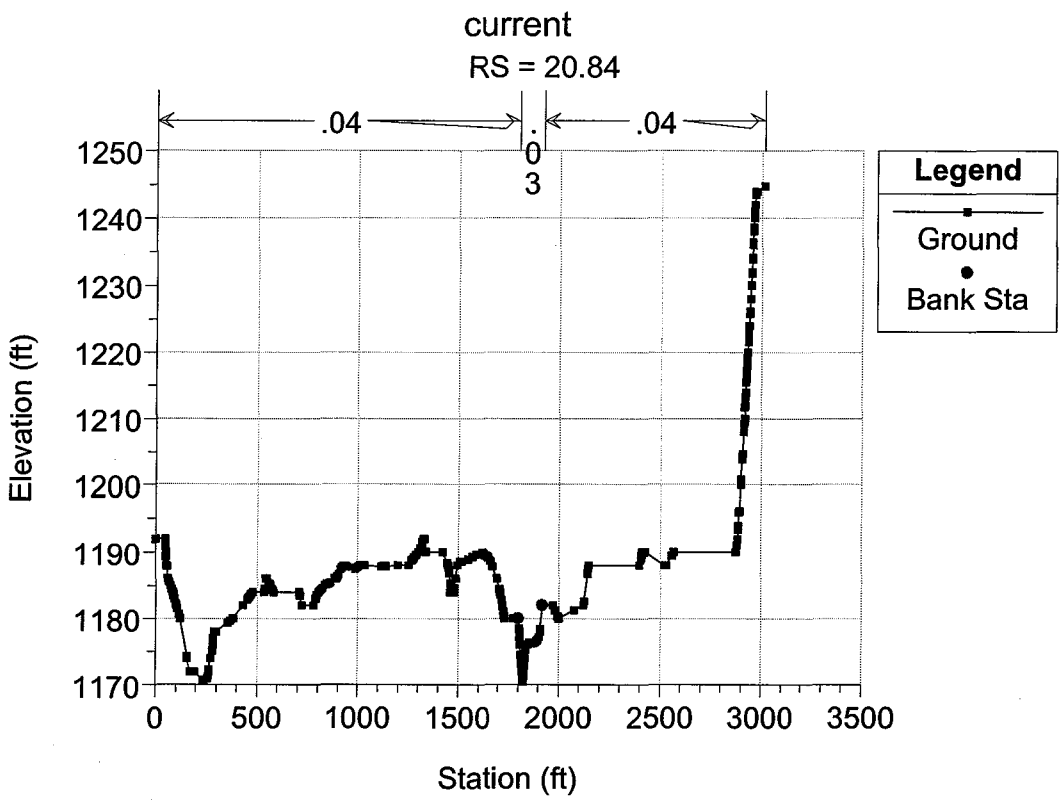

current
RS = 20.36
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1230
1220
1210
1200
1190
1180
1170
0
500
1000
1500
2000
2500
Station (ft)

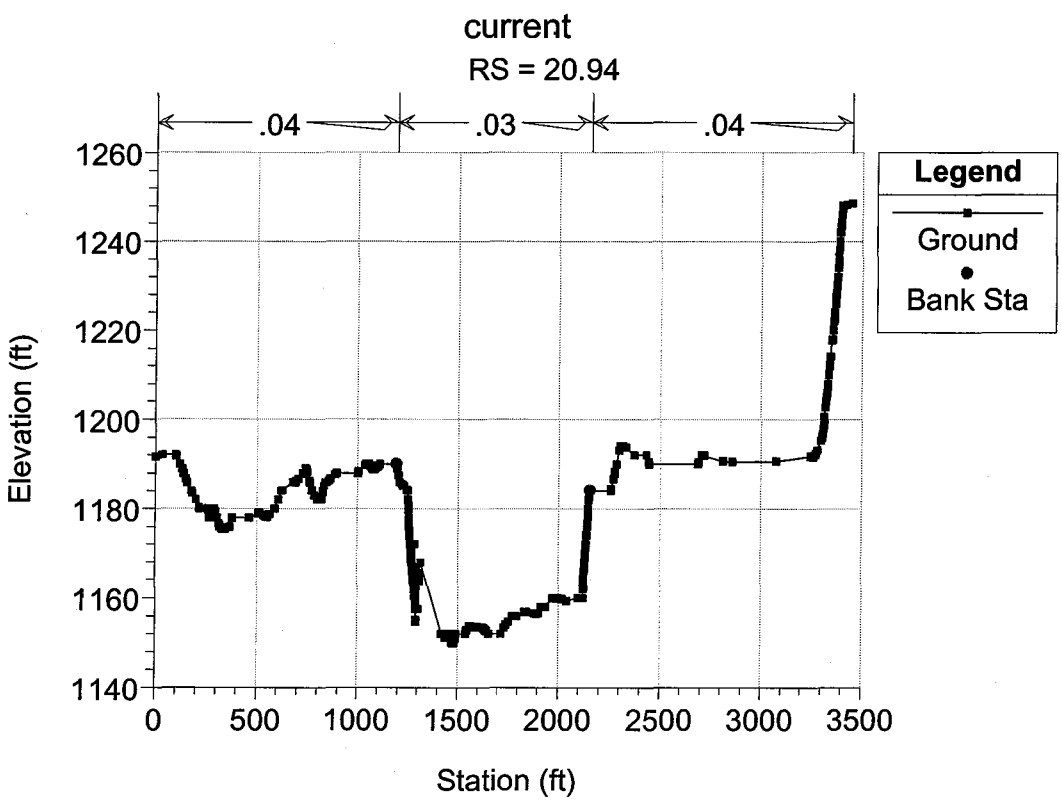

current
RS = 20.46
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1230
1220
1210
1200
1190
1180
1170
0
500
1000
1500
2000
2500
Station (ft)

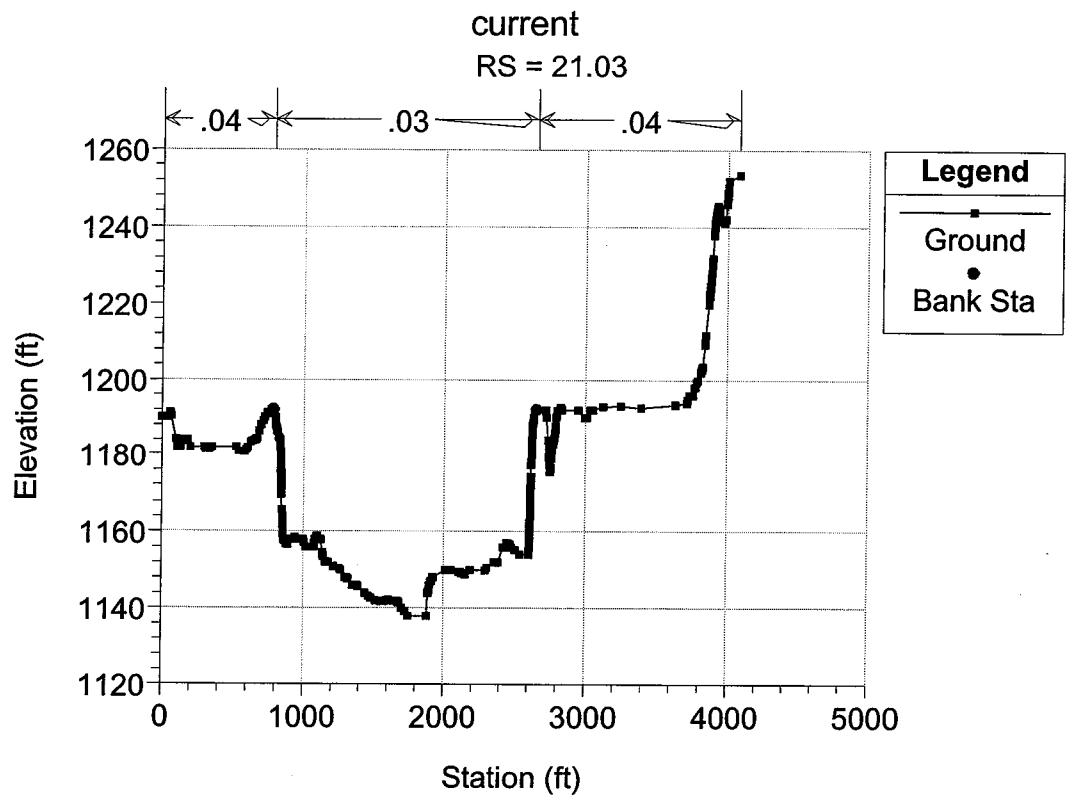

current
RS = 20.55
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1230
1220
1210
1200
1190
1180
1170
0
500
1000
1500
2000
2500
3000
Station (ft)

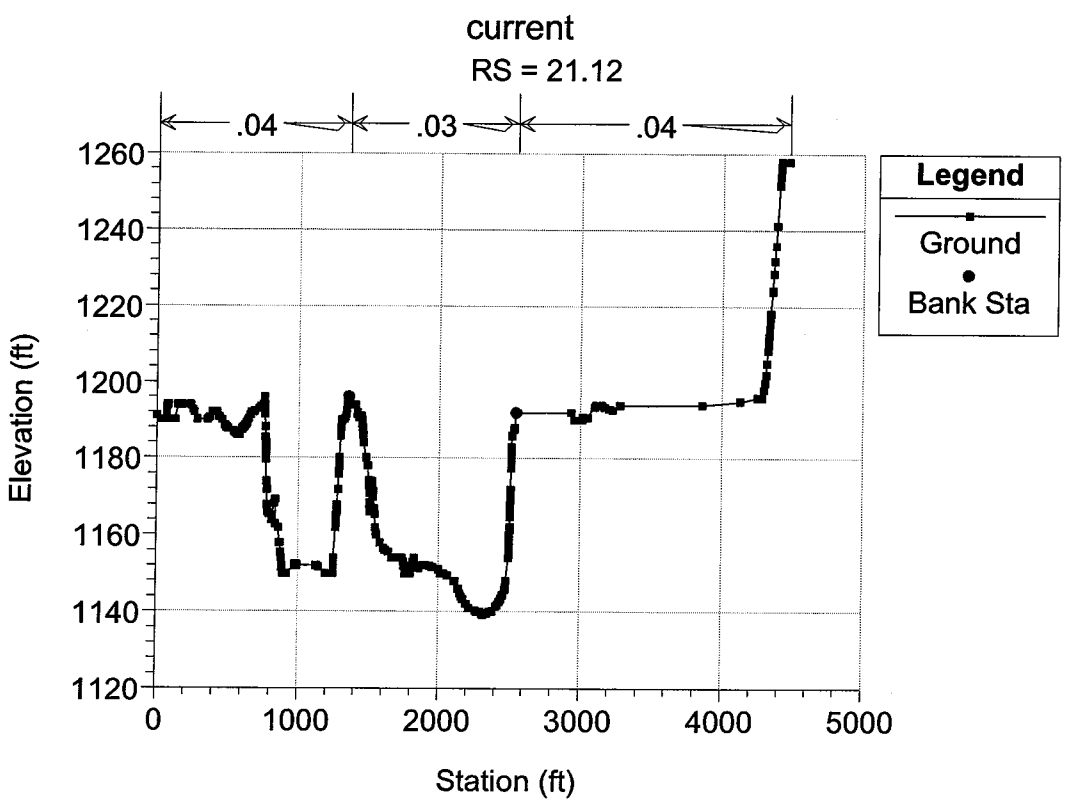

current
RS = 20.65
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1230
1220
1210
1200
1190
1180
1170
0
500
1000
1500
2000
2500
3000
Station (ft)

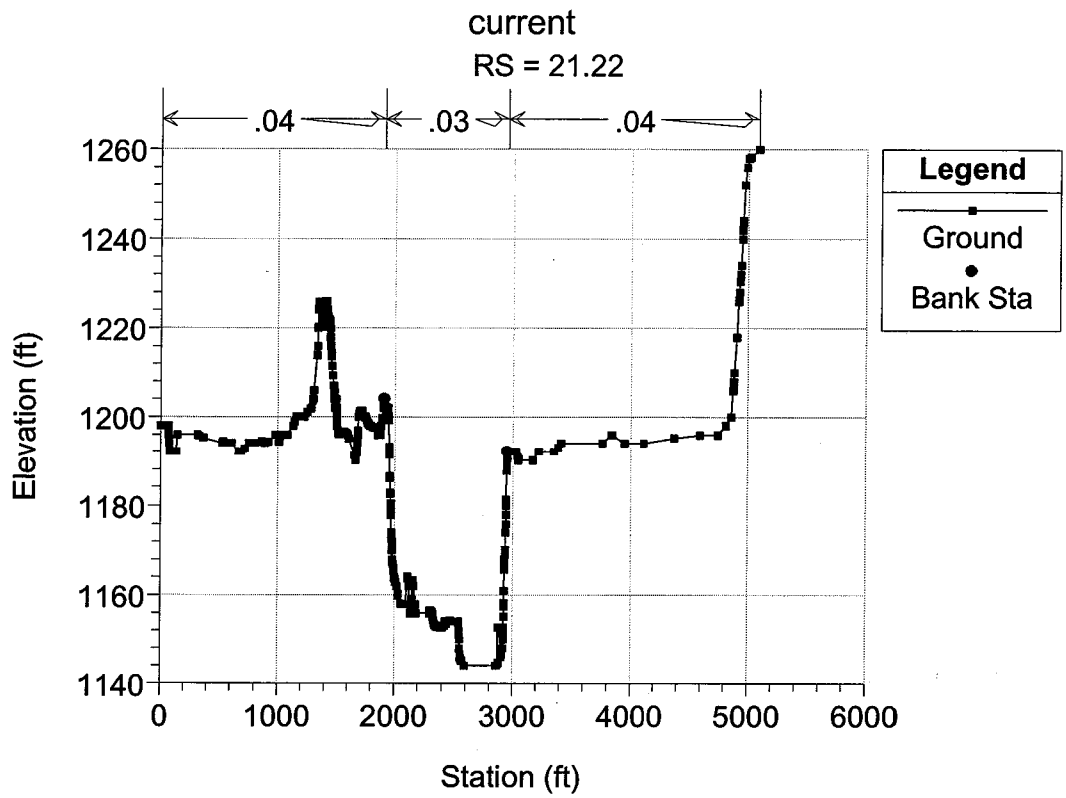

current
RS = 20.74
.045
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1260
1240
1220
1200
1180
1160
1140
0
500
1000
1500
2000
2500
3000
Station (ft)

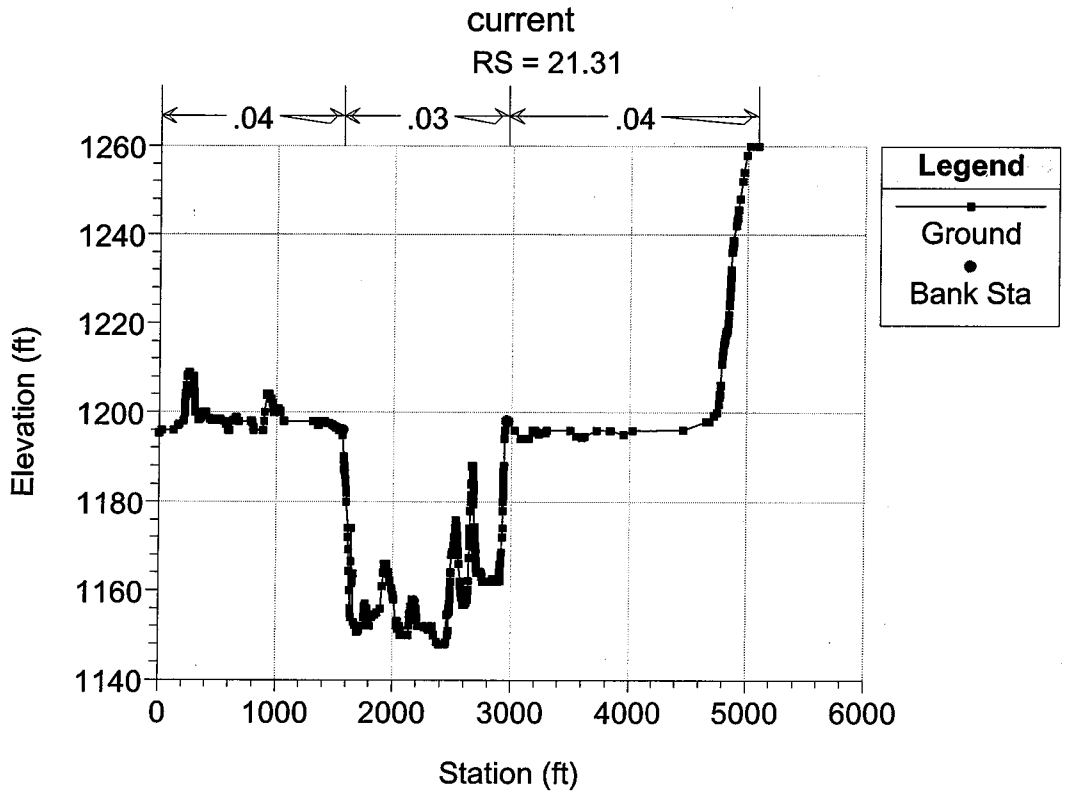

current
RS = 20.84
.04
.03
.04
Legend
Ground
Bank Sta
Elevation (ft)
1250
1240
1230
1220
1210
1200
1190
1180
1170
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

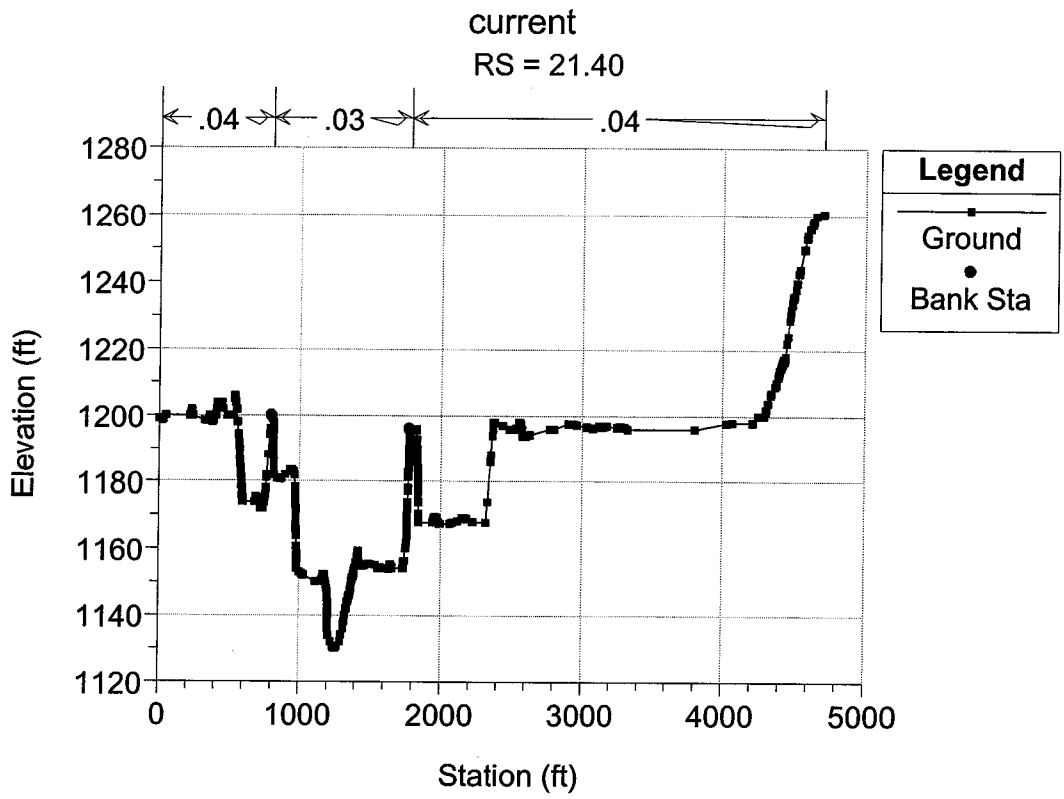

current
RS = 20.94
.04
.03
.04
Legend
Ground
Bank Sta
Elevation (ft)
1260
1240
1220
1200
1180
1160
1140
0
500
1000
1500
2000
2500
3000
3500
Station (ft)

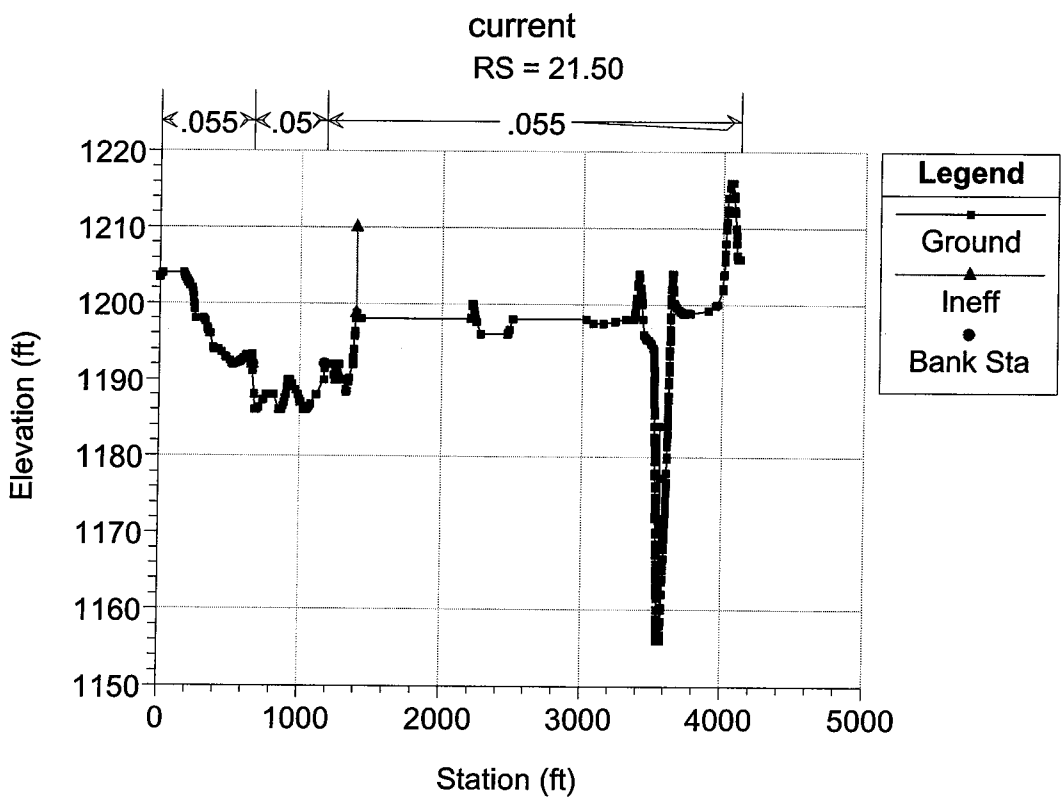

current
RS = 21.03
.04
.03
.04
Legend
Ground
Bank Sta
Elevation (ft)
1260
1240
1220
1200
1180
1160
1140
1120
0
1000
2000
3000
4000
5000
Station (ft)

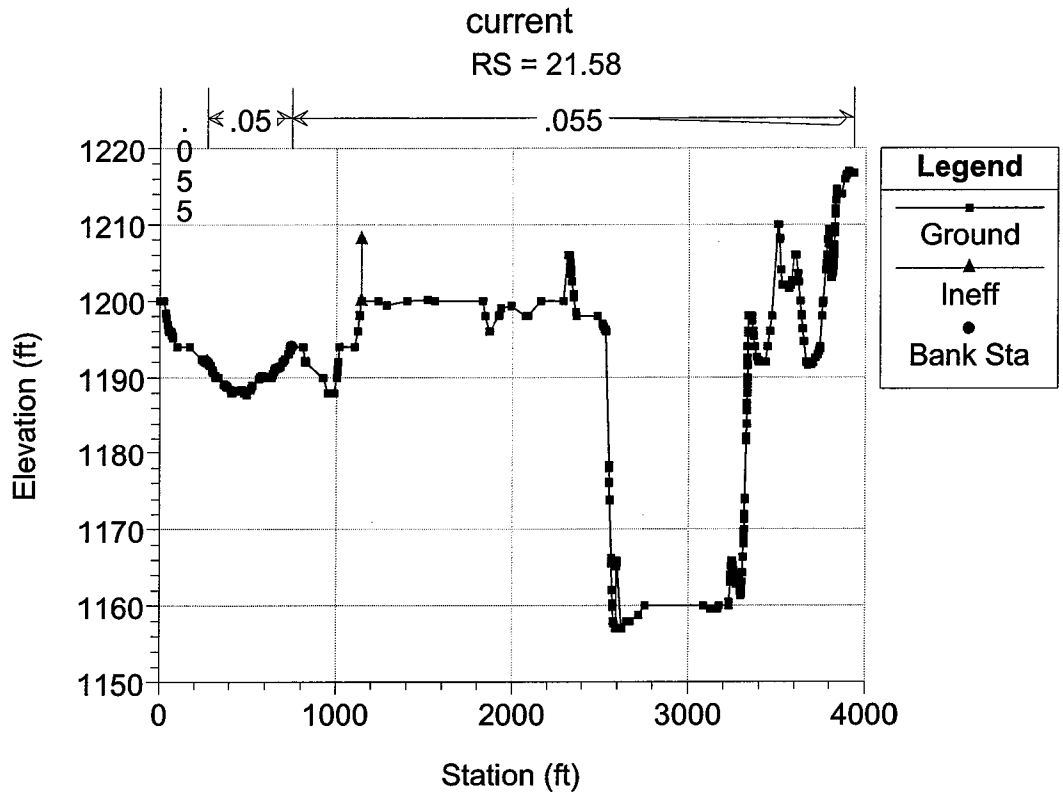

current
RS = 21.12
.04
.03
.04
Legend
Ground
Bank Sta
Elevation (ft)
1260
1240
1220
1200
1180
1160
1140
1120
0
1000
2000
3000
4000
5000
Station (ft)

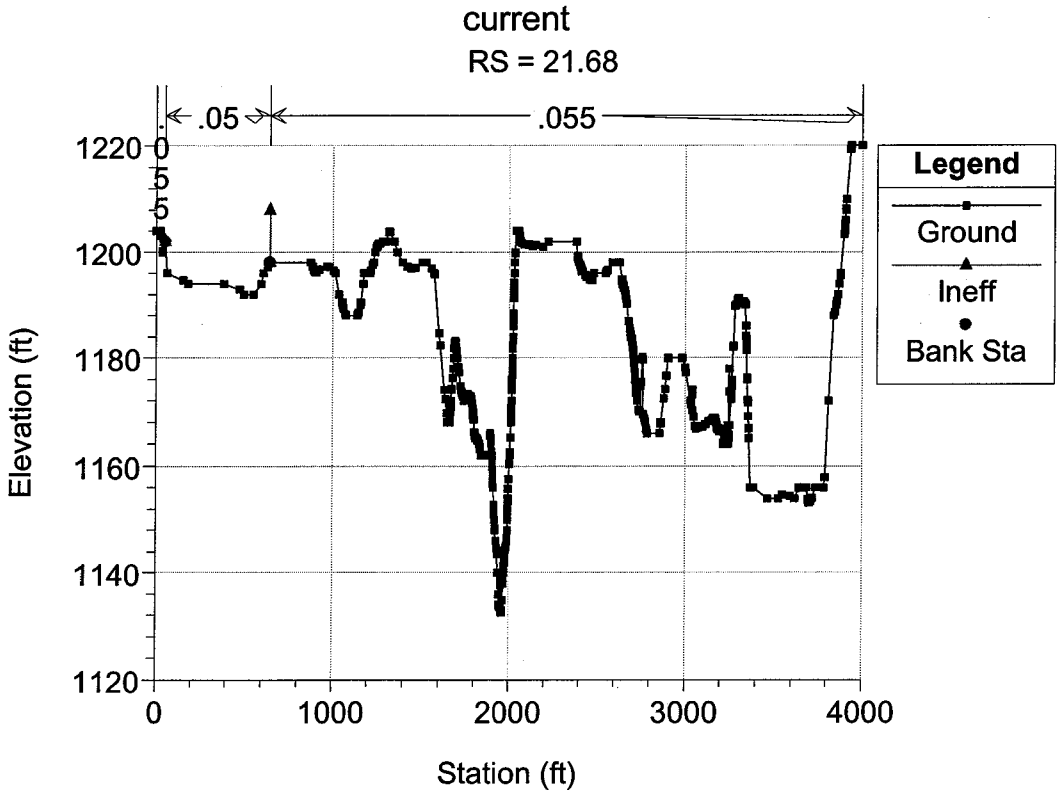

current
RS = 21.22
.04
.03
.04
Legend
Ground
Bank Sta
Elevation (ft)
1260
1240
1220
1200
1180
1160
1140
0
1000
2000
3000
4000
5000
6000
Station (ft)

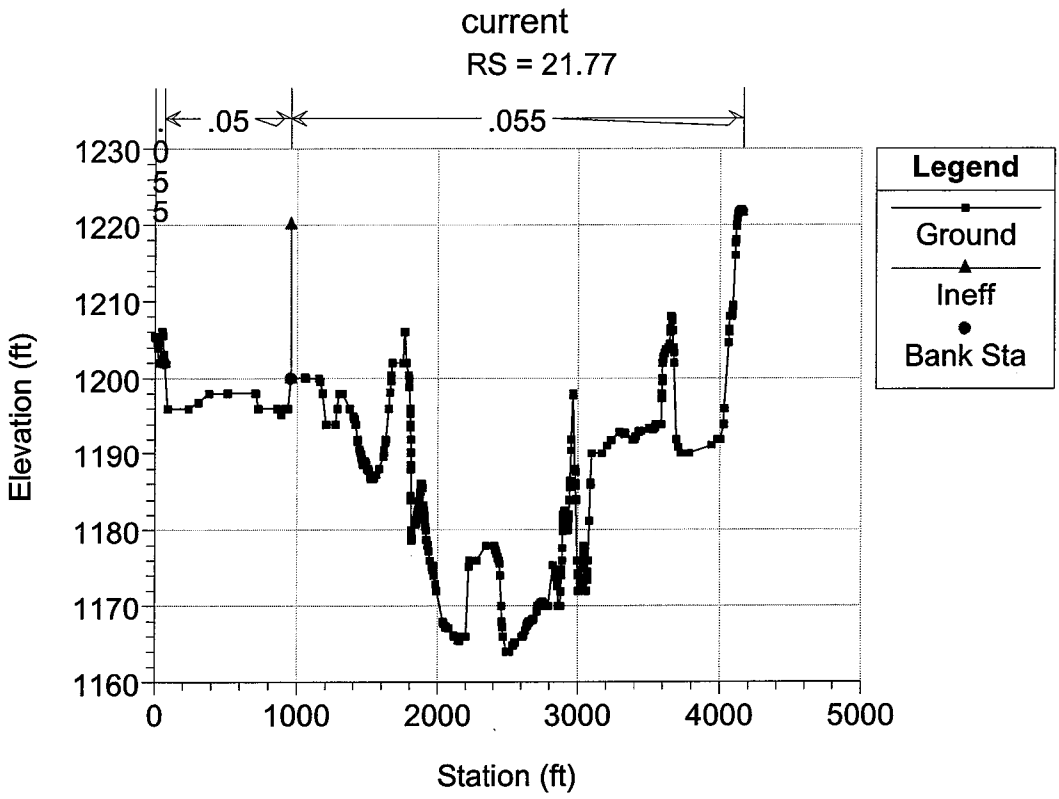

current
RS = 21.31
.04
.03
.04
Legend
Ground
Bank Sta
Elevation (ft)
1260
1240
1220
1200
1180
1160
1140
0
1000
2000
3000
4000
5000
6000
Station (ft)

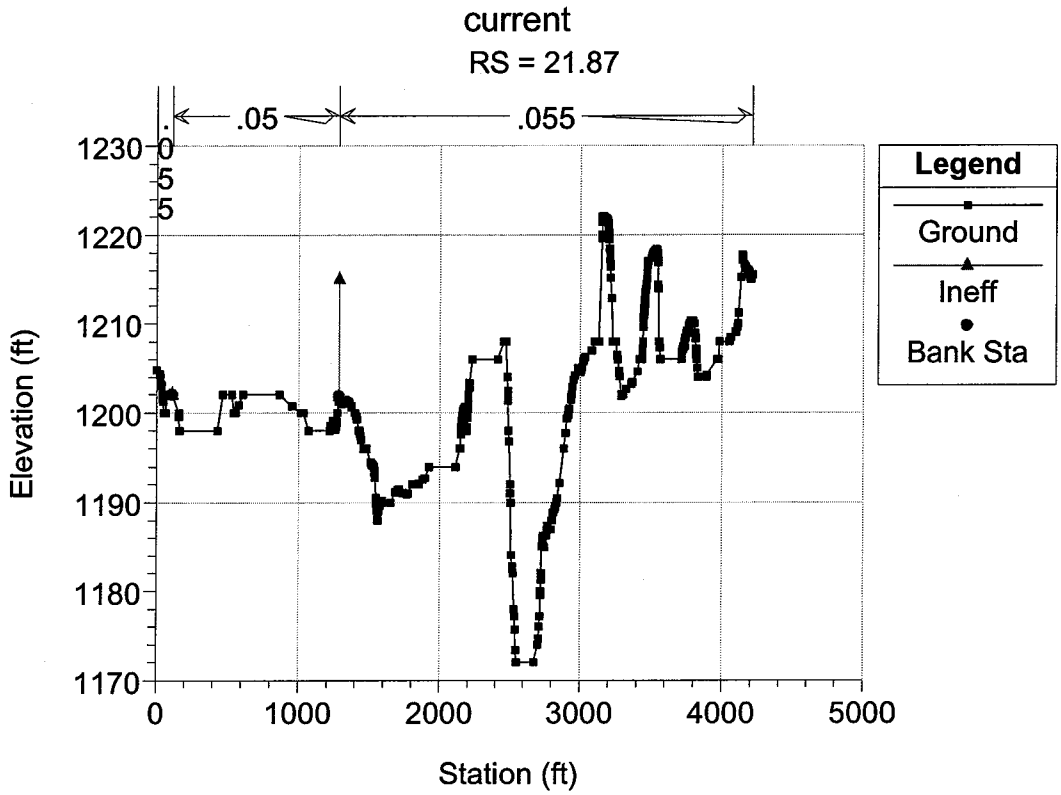

current
RS = 21.40
.04
.03
.04
Legend
Ground
Bank Sta
Elevation (ft)
1280
1260
1240
1220
1200
1180
1160
1140
1120
0
1000
2000
3000
4000
5000
Station (ft)

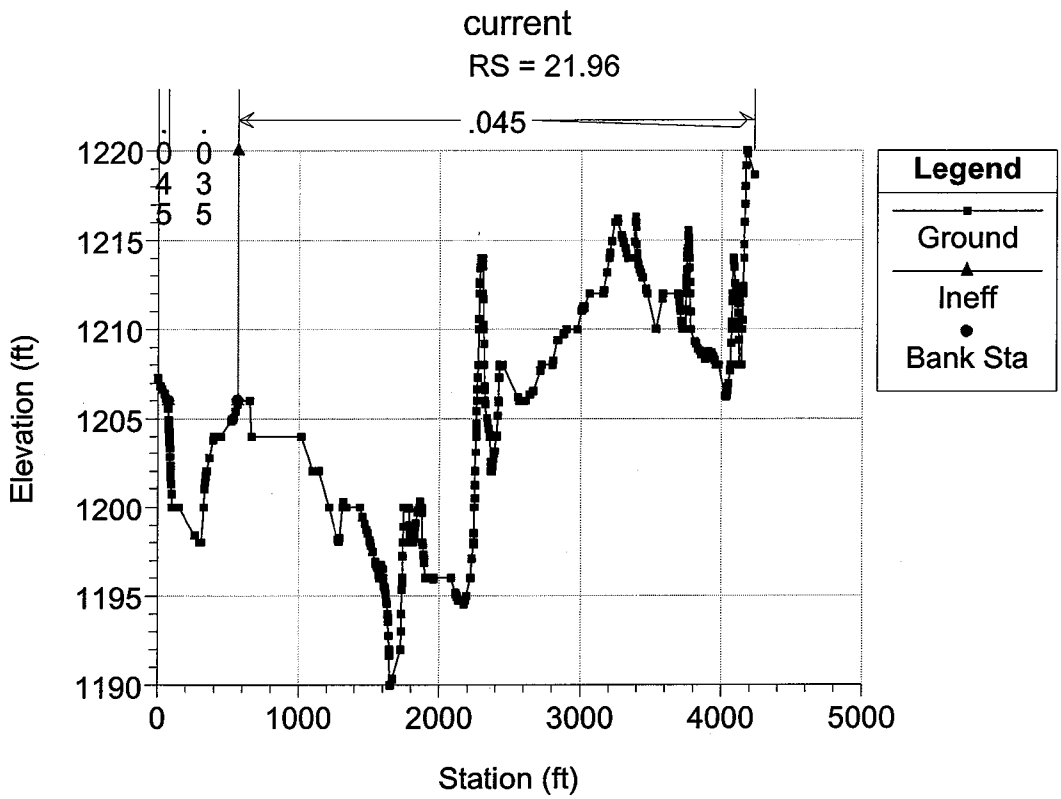

current
RS = 21.50
.055
.05
.055
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1220
1210
1200
1190
1180
1170
1160
1150
0
1000
2000
3000
4000
5000
Station (ft)

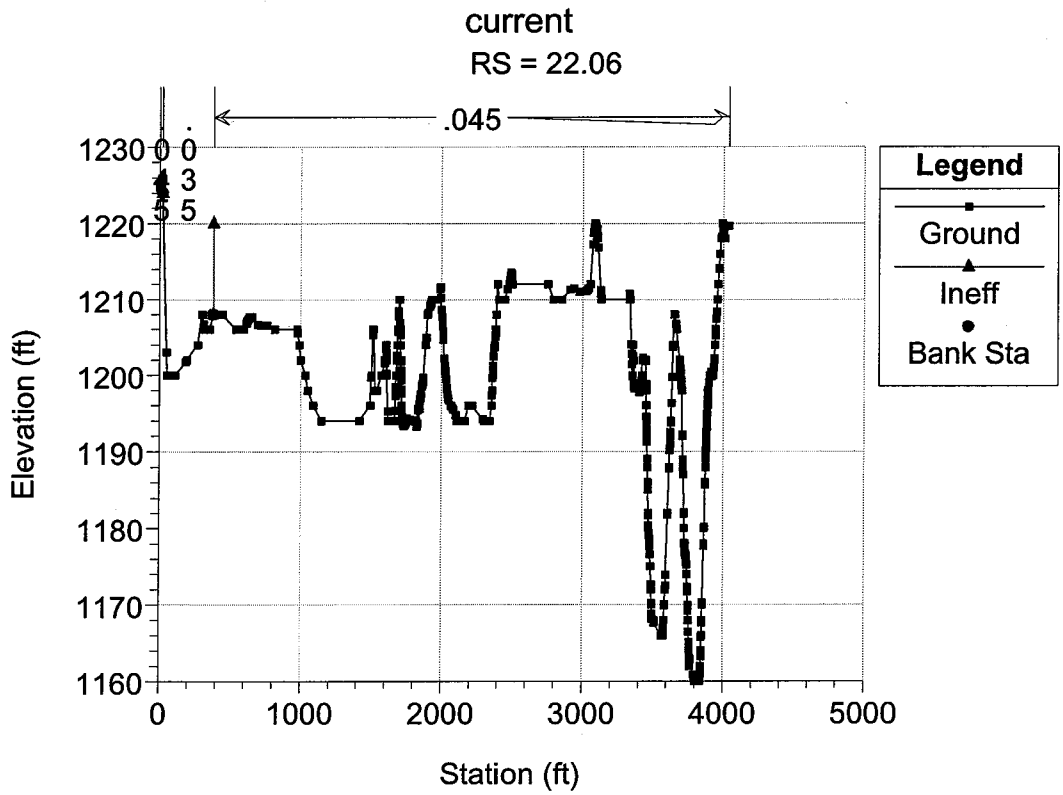

current
RS = 21.58
.05
.055
.055
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1220
1210
1200
1190
1180
1170
1160
1150
0
1000
2000
3000
4000
Station (ft)

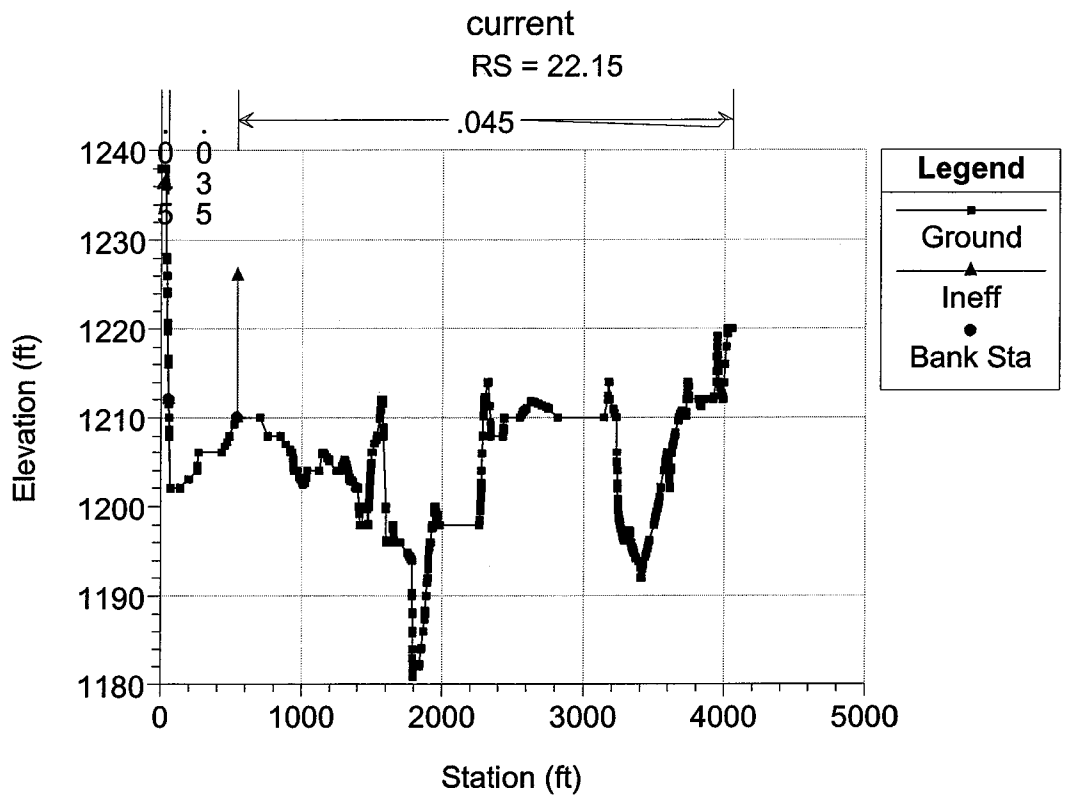

current
RS = 21.68
.05
.055
.055
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1220
1200
1180
1160
1140
1120
0
1000
2000
3000
4000
Station (ft)

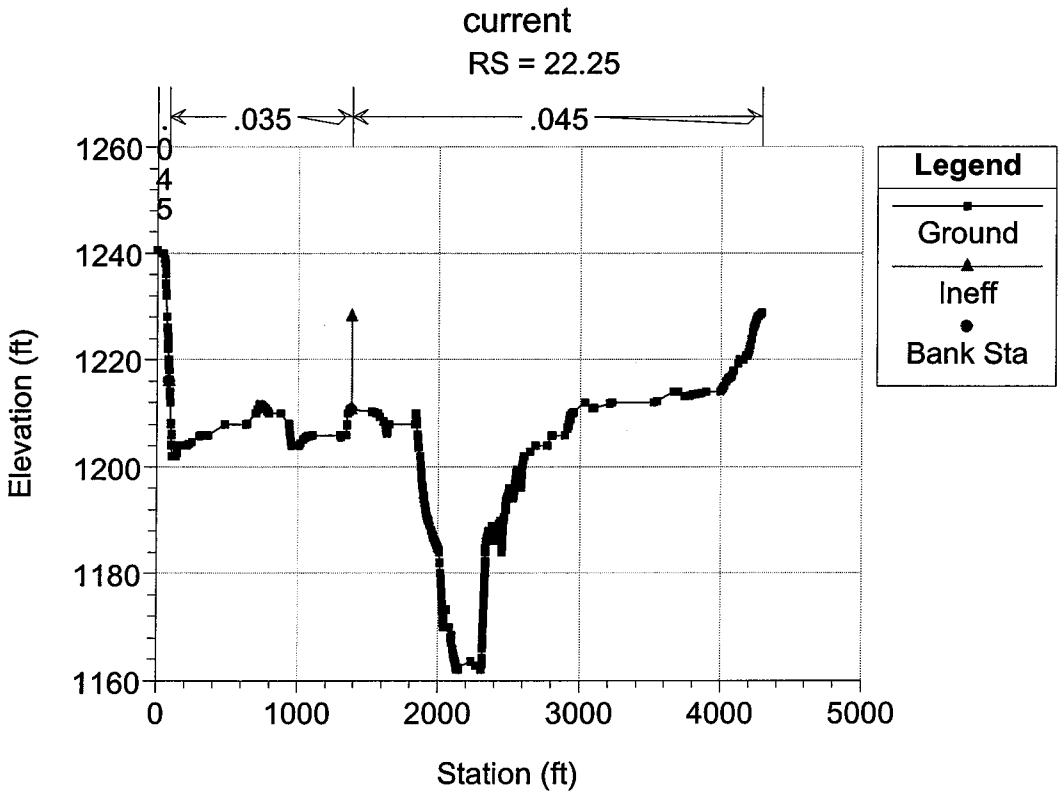

current
RS = 21.77
.05
.055
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1230
1220
1210
1200
1190
1180
1170
1160
0
1000
2000
3000
4000
5000

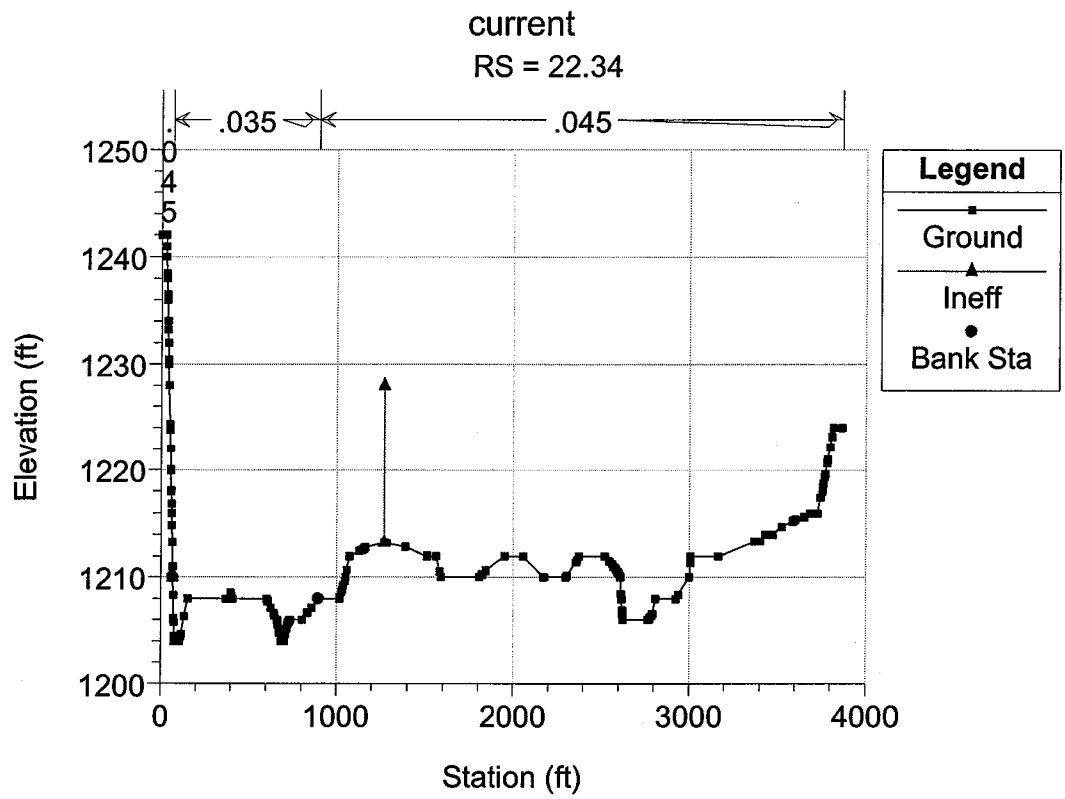

current
RS = 21.87
.05
.055
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1230
1220
1210
1200
1190
1180
1170
0
1000
2000
3000
4000
5000

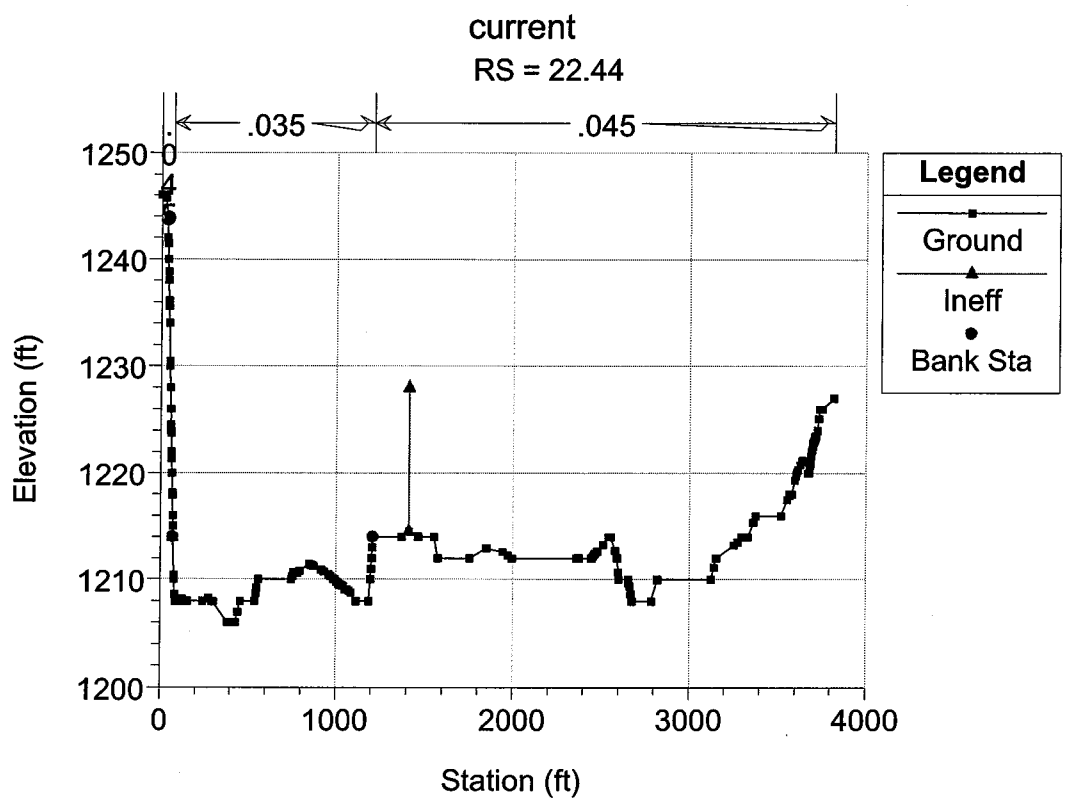

current
RS = 21.96
.045
.045
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1220
1215
1210
1205
1200
1195
1190
0
1000
2000
3000
4000
5000
Station (ft)

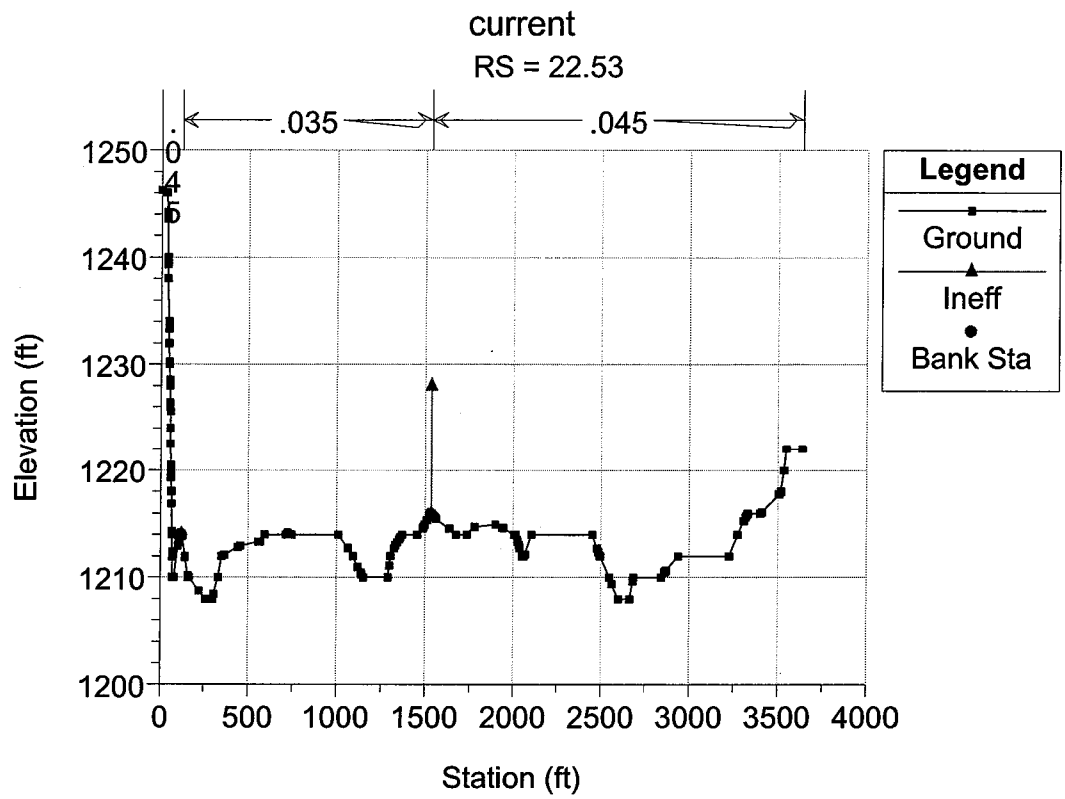

current
RS = 22.06
.045
.045
.035
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1230
1220
1210
1200
1190
1180
1170
1160
0
1000
2000
3000
4000
5000
Station (ft)

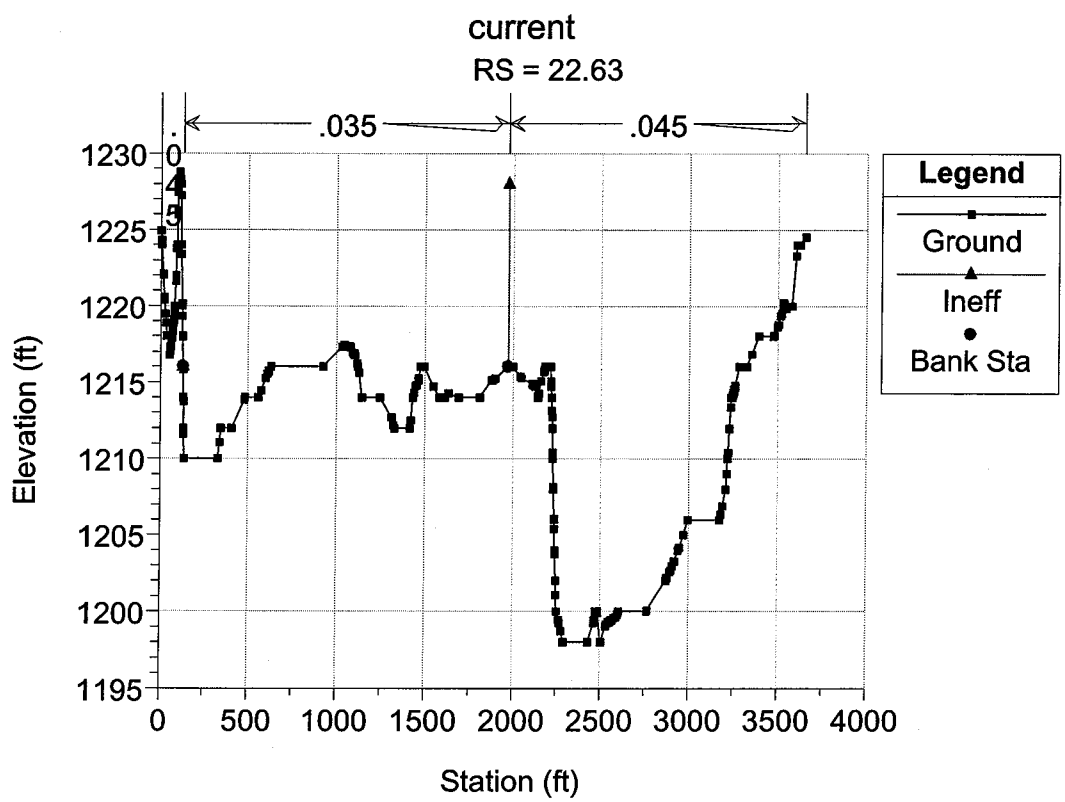

current
RS = 22.15
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1240
1230
1220
1210
1200
1190
1180
0
1000
2000
3000
4000
5000
Station (ft)

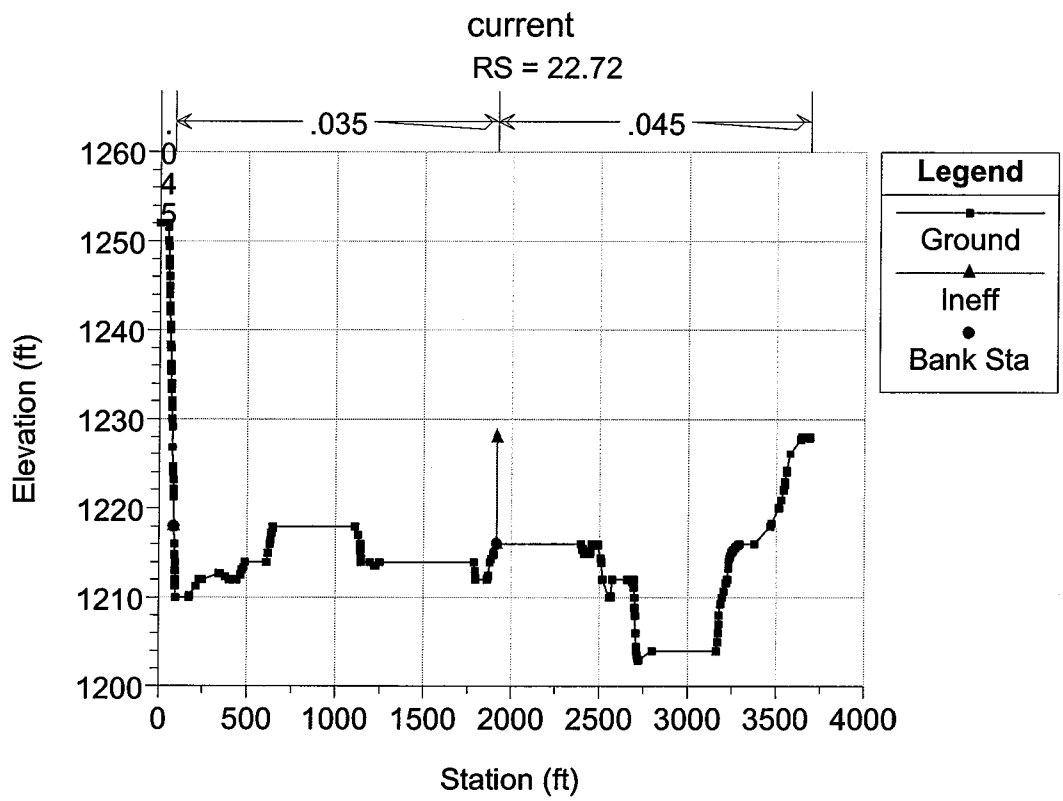

current
RS = 22.25
.035
.045
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1240
1220
1200
1180
1160
0
1000
2000
3000
4000
5000
Station (ft)

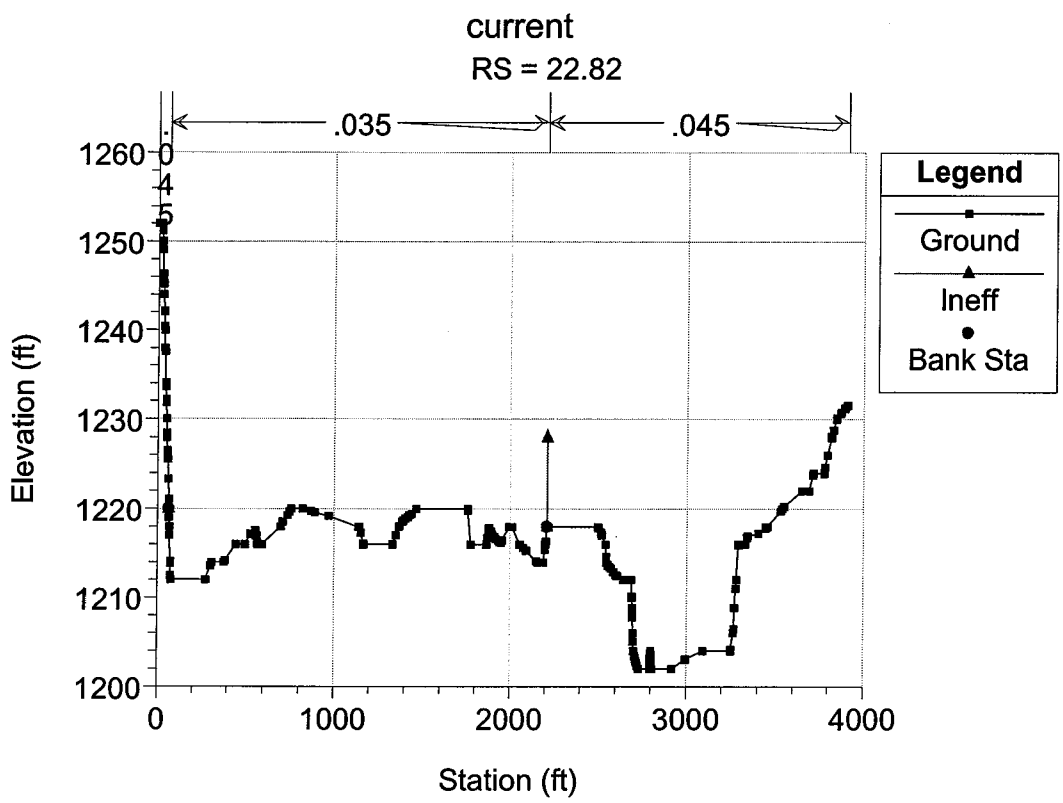

current
RS = 22.34
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1250
1240
1230
1220
1210
1200
0
1000
2000
3000
4000
Station (ft)

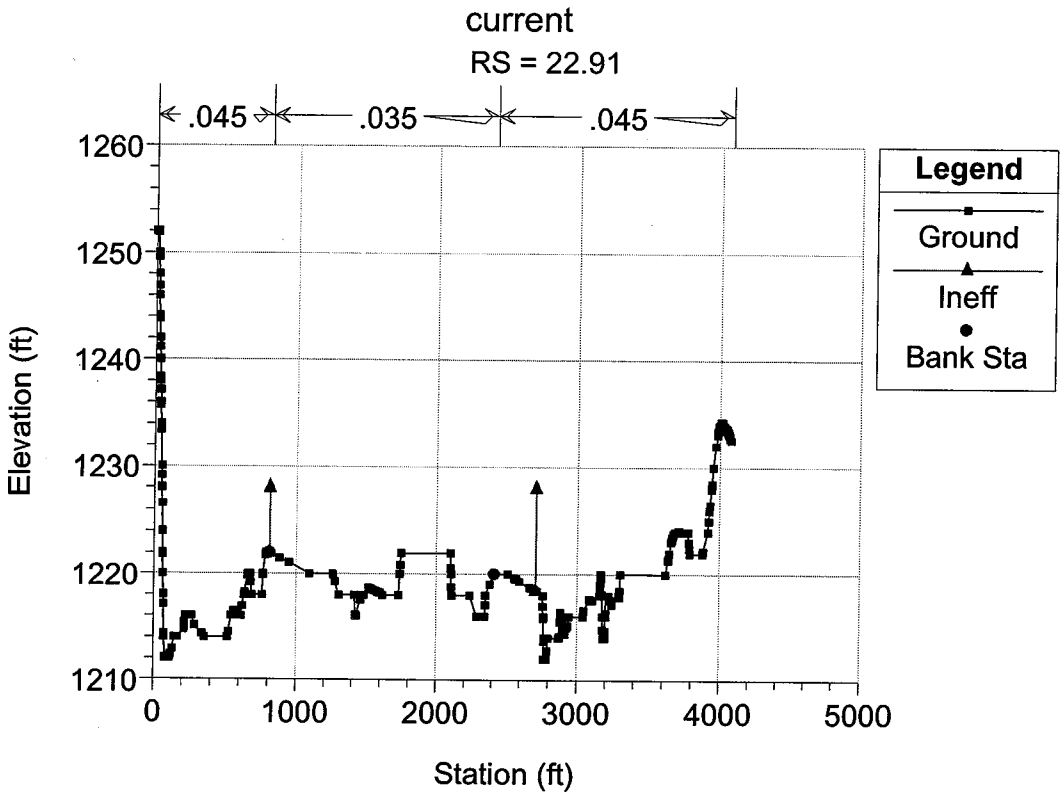

current
RS = 22.44
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1250
1240
1230
1220
1210
1200
0
1000
2000
3000
4000
Station (ft)

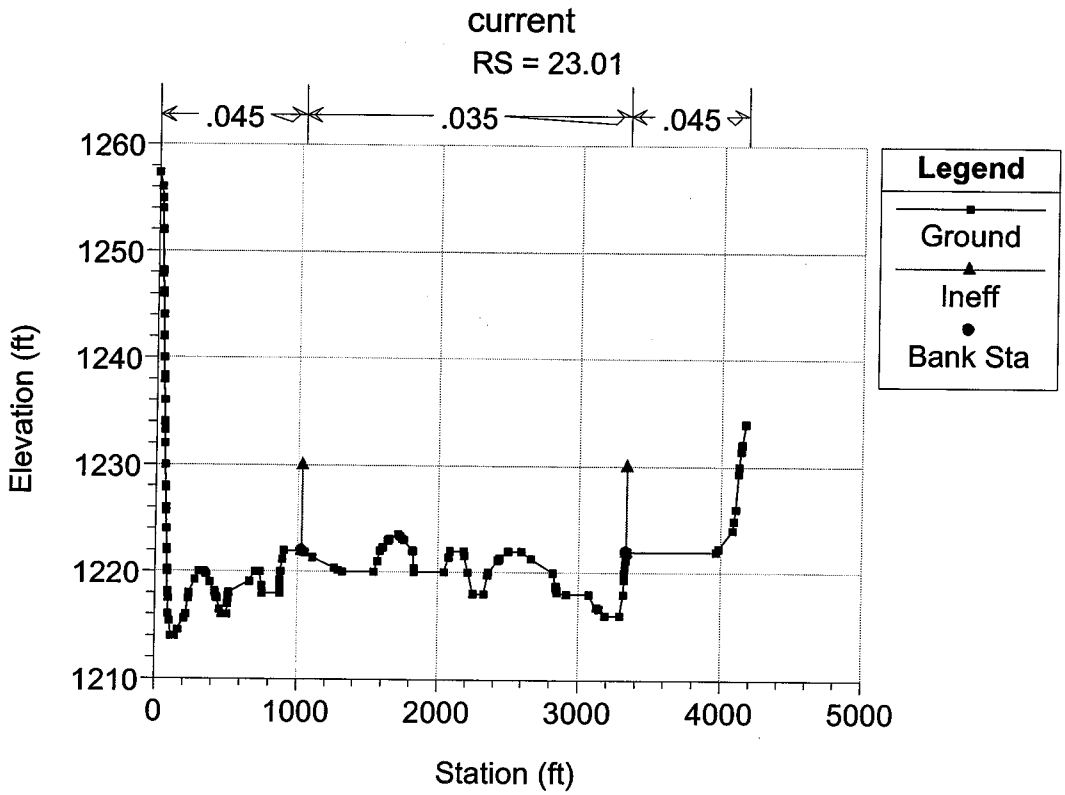

current
RS = 22.53
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1250
1240
1230
1220
1210
1200
0
500
1000
1500
2000
2500
3000
3500
4000

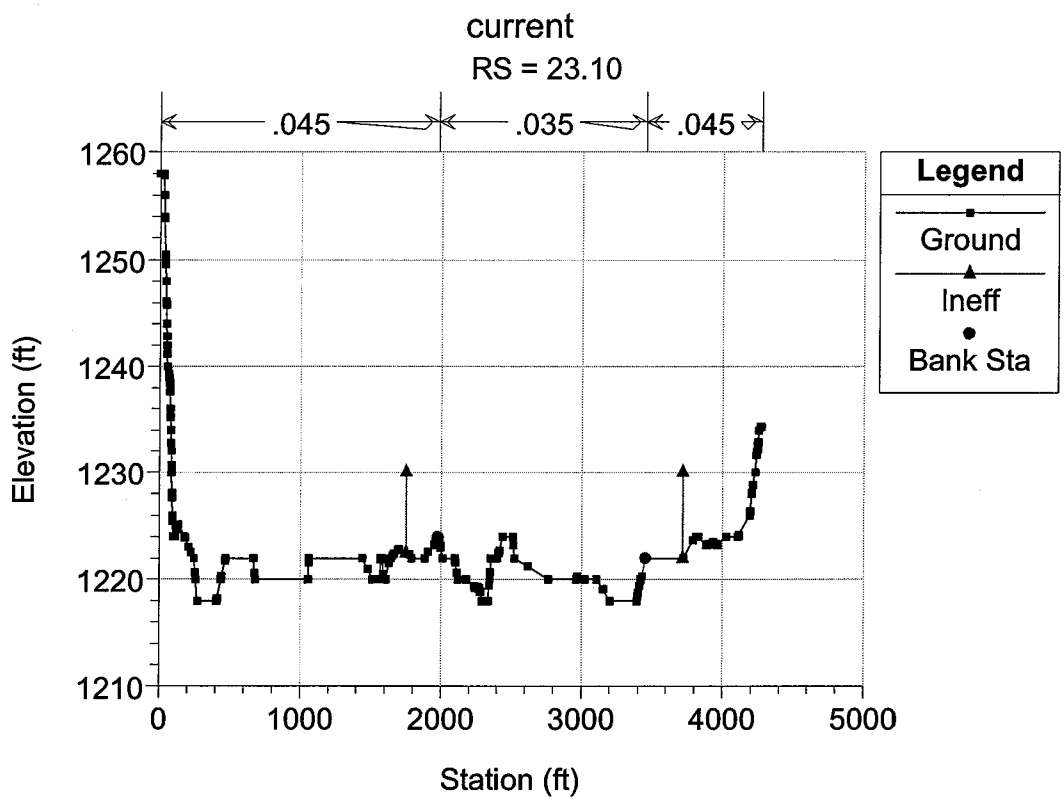

current
RS = 22.63
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1230
1225
1220
1215
1210
1205
1200
1195
0
500
1000
1500
2000
2500
3000
3500
4000

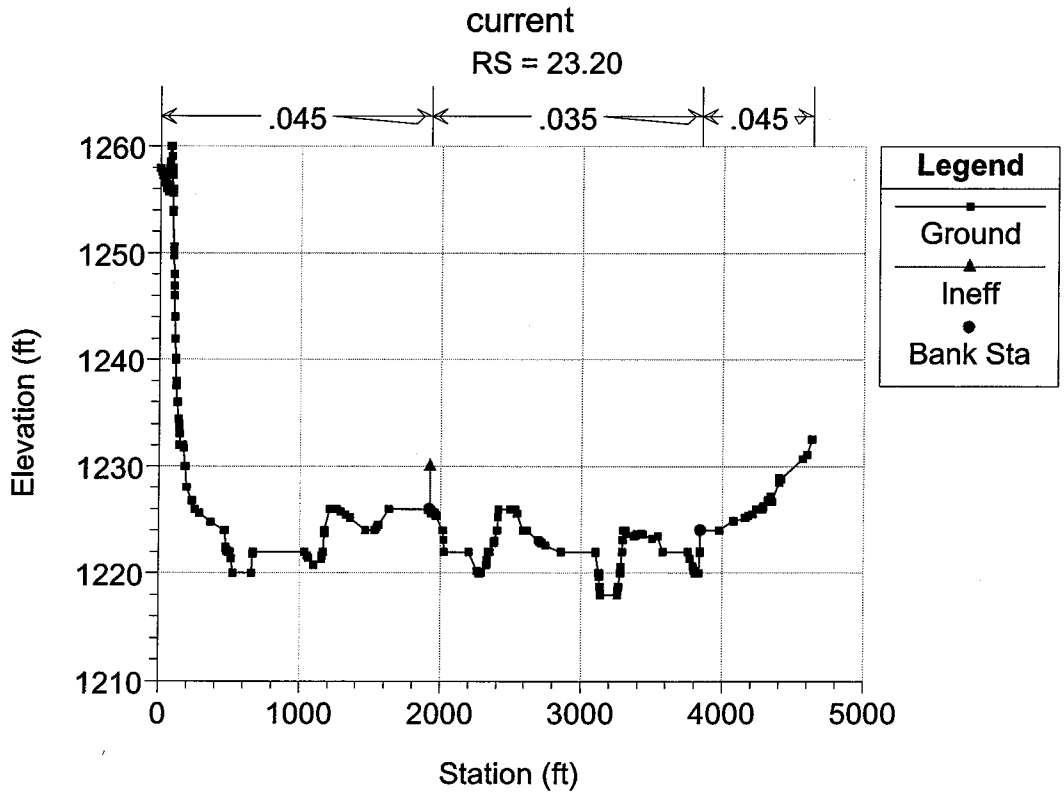

current
RS = 22.72
.035
.045
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1250
1240
1230
1220
1210
1200
0
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)

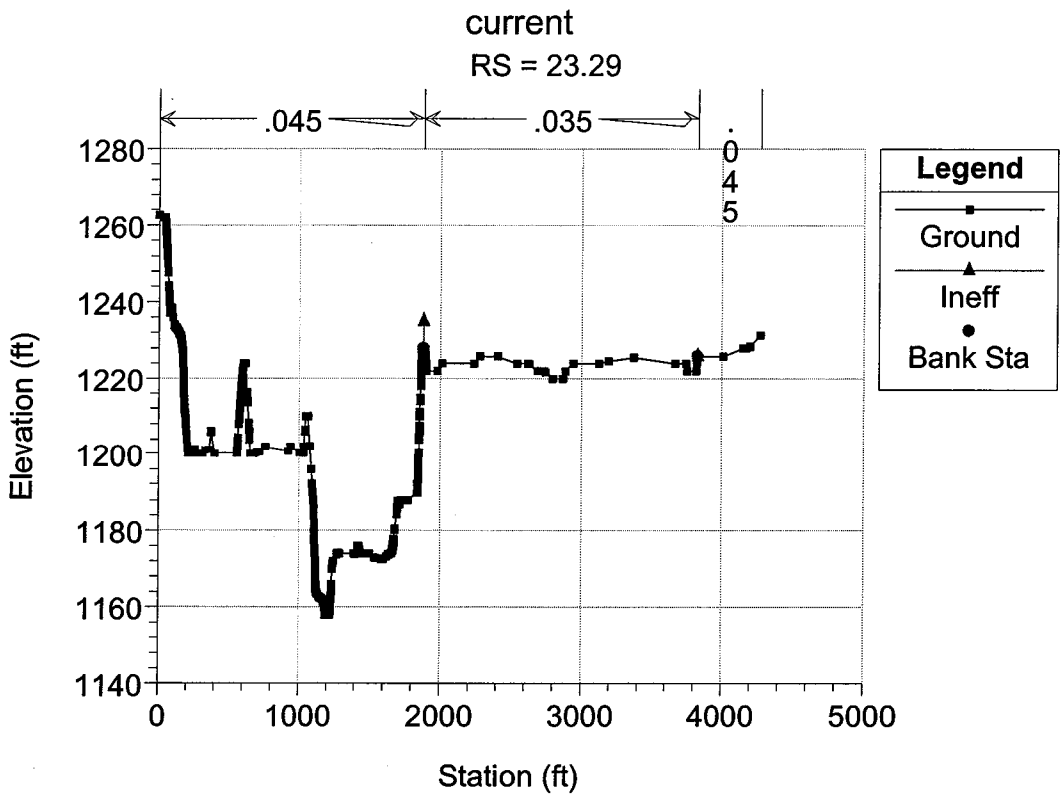

current
RS = 22.82
.035
.045
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1250
1240
1230
1220
1210
1200
0
1000
2000
3000
4000
Station (ft)


current
RS = 22.91
.045
.035
.045
1260
1250
1240
1230
1220
1210
Elevation (ft)
0
1000
2000
3000
4000
5000
Station (ft)
Legend
Ground
Ineff
Bank Sta


current
RS = 23.01
.045
.035
.045
1260
1250
1240
1230
1220
1210
Elevation (ft)
0
1000
2000
3000
4000
5000
Station (ft)
Legend
Ground
Ineff
Bank Sta


current
RS = 23.10
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1250
1240
1230
1220
1210
0
1000
2000
3000
4000
5000
Station (ft)


current
RS = 23.20
.045
.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
1260
1250
1240
1230
1220
1210
0
1000
2000
3000
4000
5000
Station (ft)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RS = 23.29
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.035
.045
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
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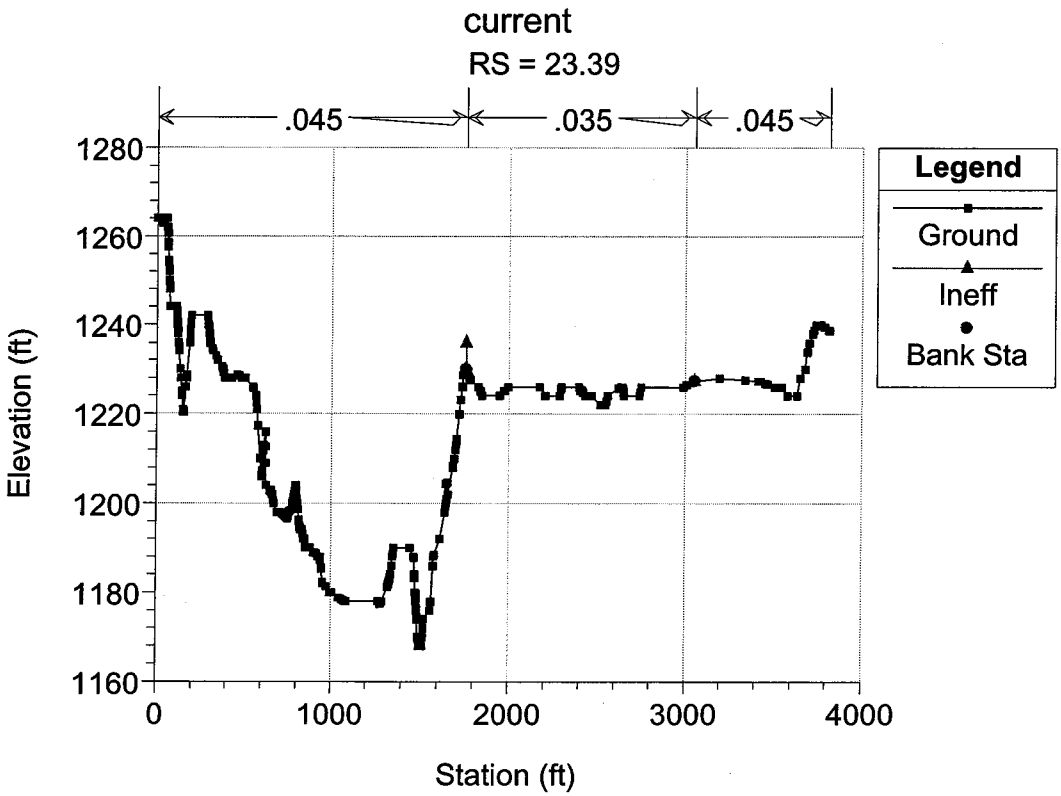
1260
1240
1220
1200
1180
1160
1140
0
1000
2000
3000
4000
5000
Station (ft)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1220
1200
1180
1160
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2000
3000
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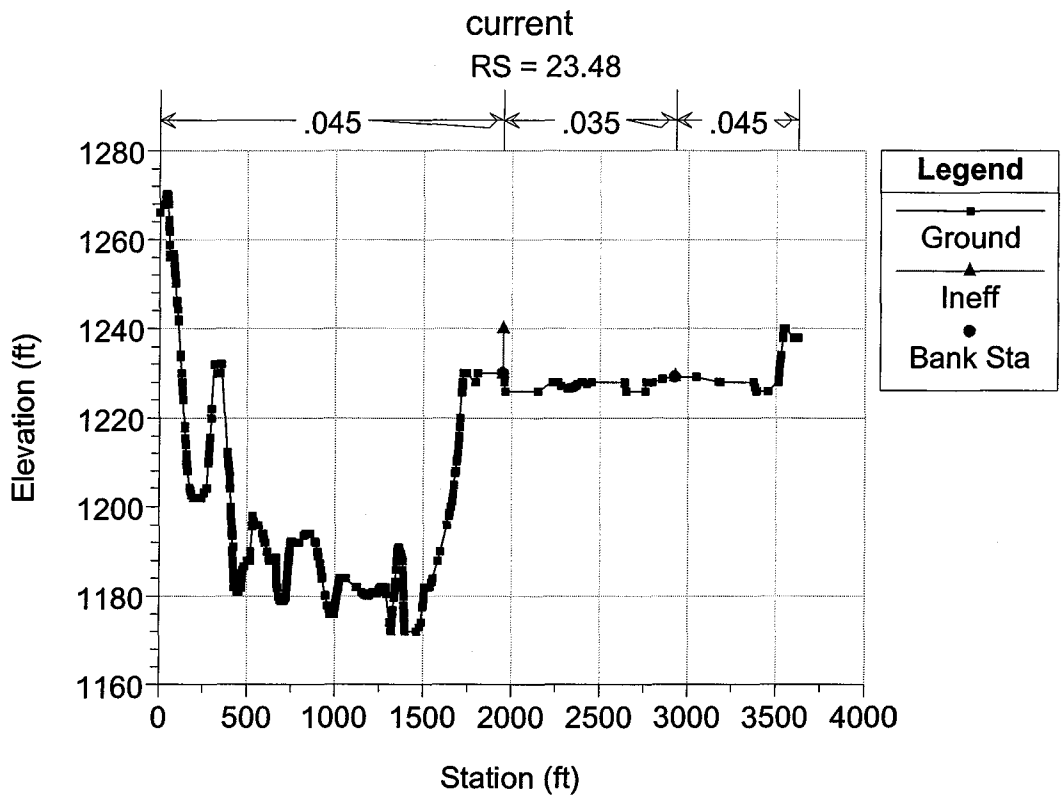
Station (ft)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Ground
Ineff
Bank Sta
Elevation (ft)
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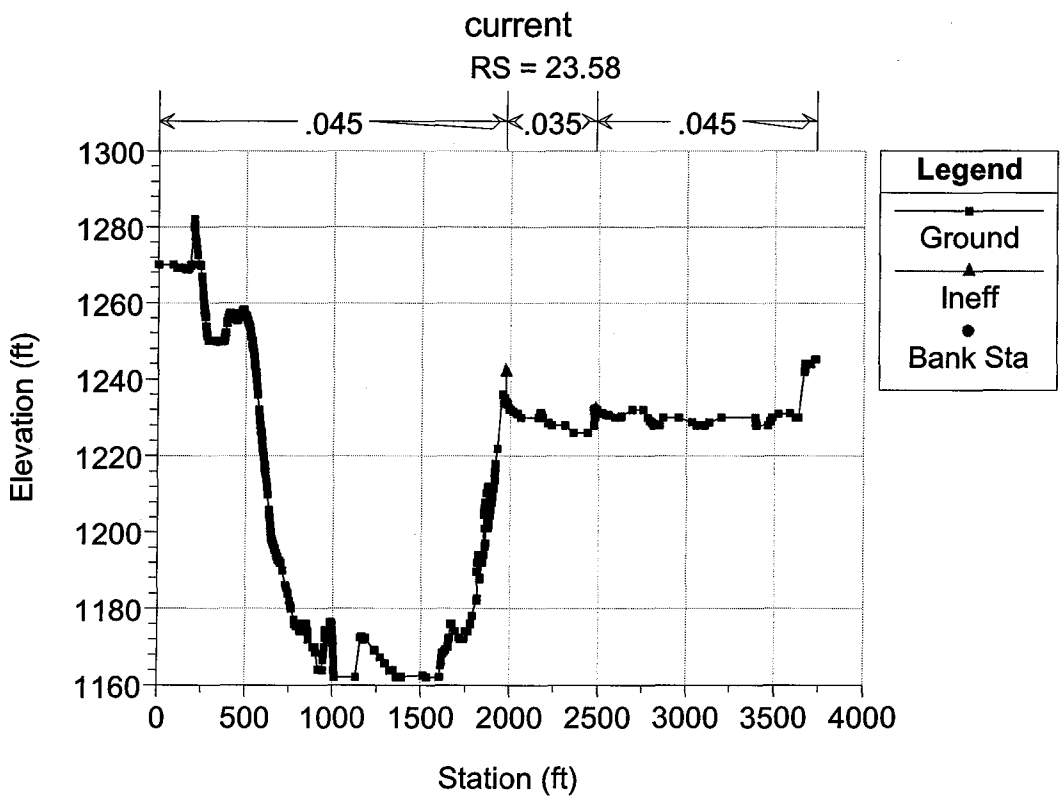
1180
1160
0
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)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Ground
Ineff
Bank Sta
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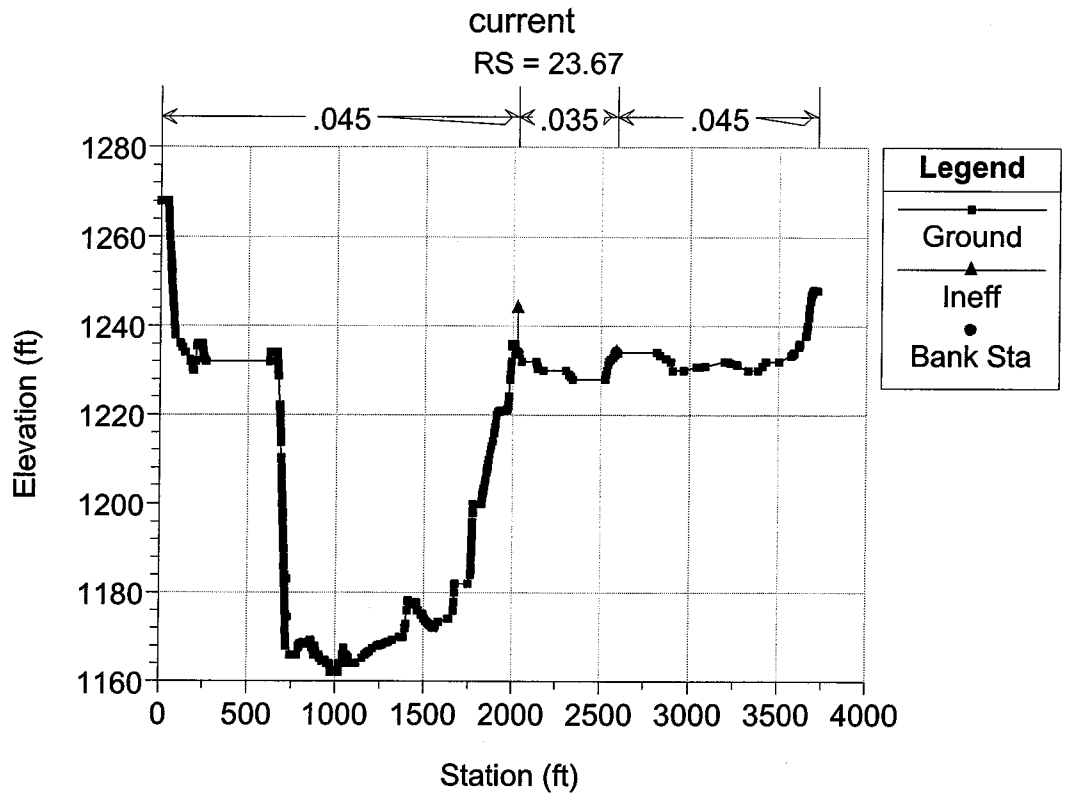
1220
1200
1180
1160
0
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)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Legend
Ground
Ineff
Bank Sta
Elevation (ft)
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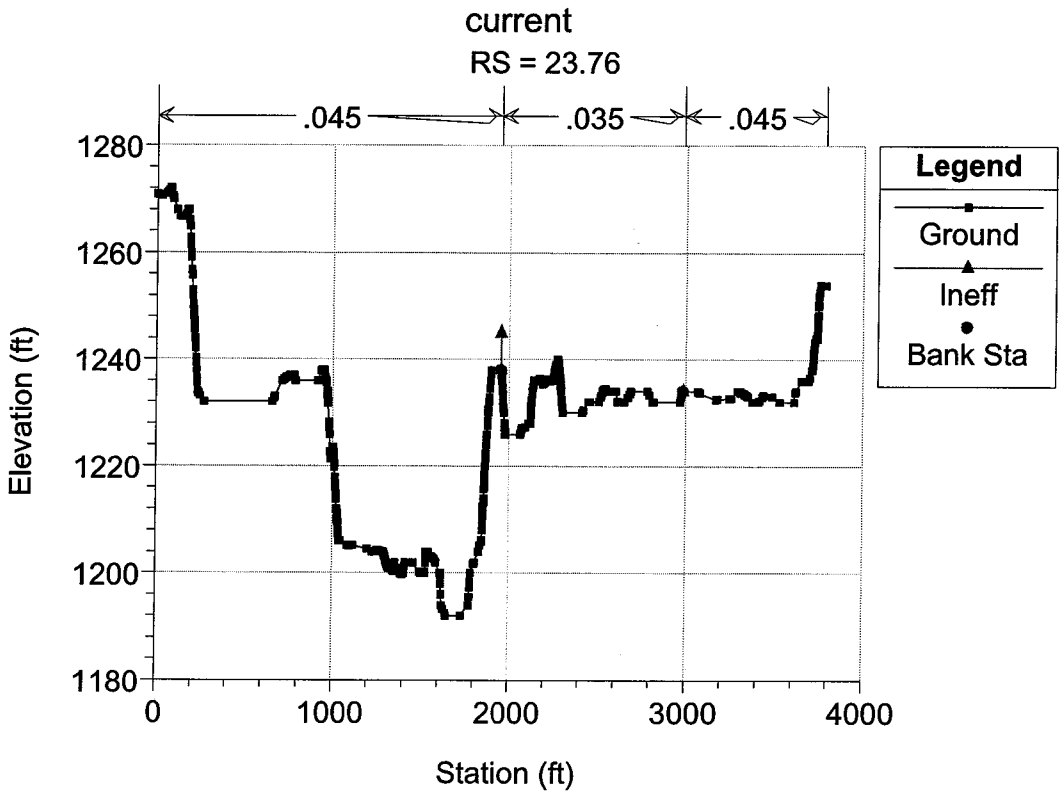
1220
1200
1180
1160
0
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)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Ground
Ineff
Bank Sta
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1180
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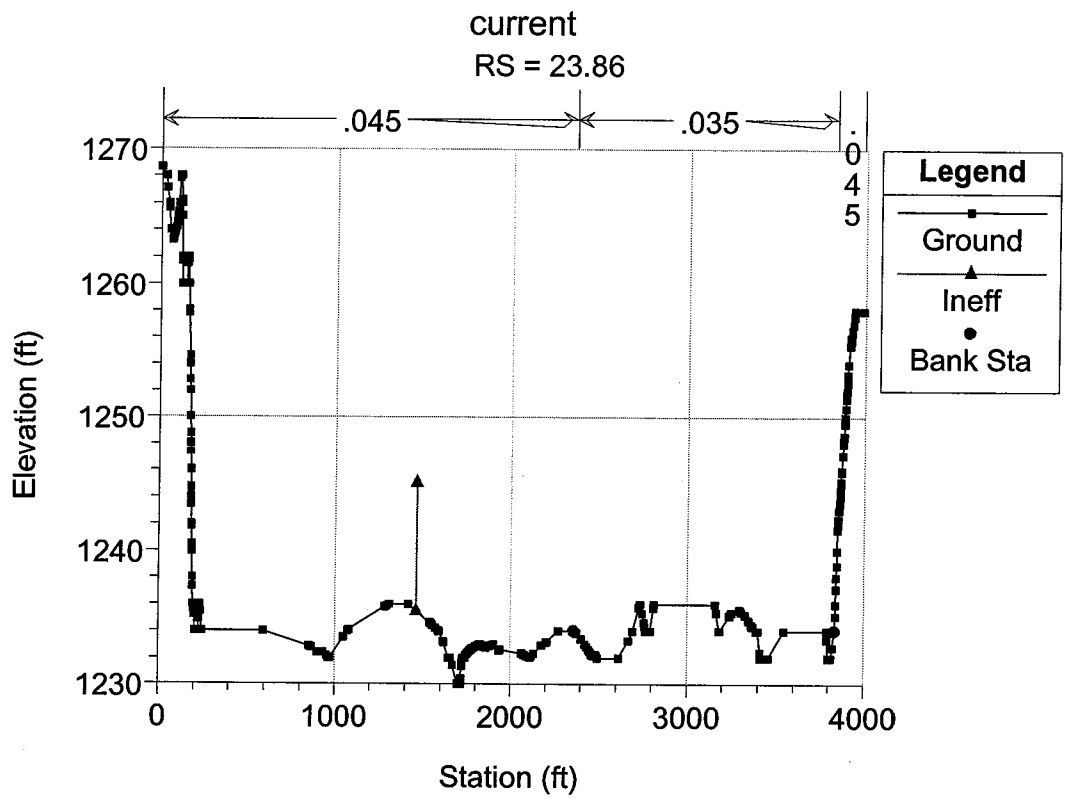
2000
3000
4000
Station (ft)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Ground
Ineff
Bank Sta
Elevation (ft)
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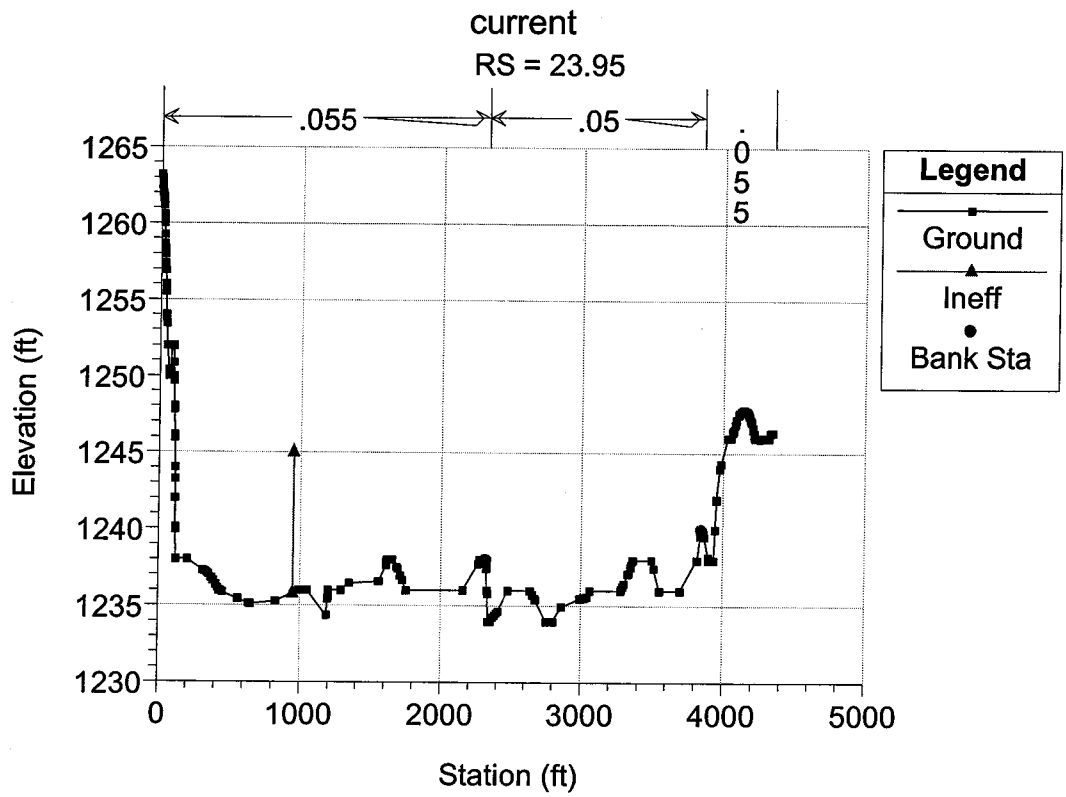
2000
3000
4000
Station (ft)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.055
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
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1250
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1235
1230
0
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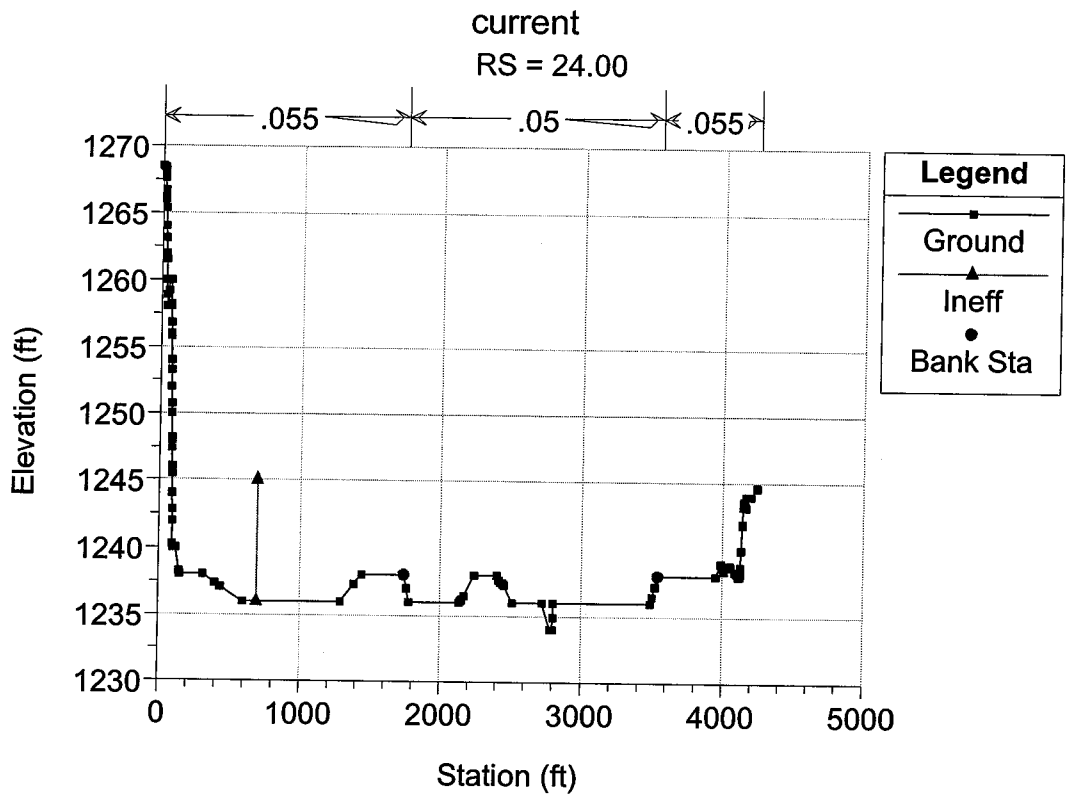
2000
3000
4000
5000
Station (ft)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.05
.055
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
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1250
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1240
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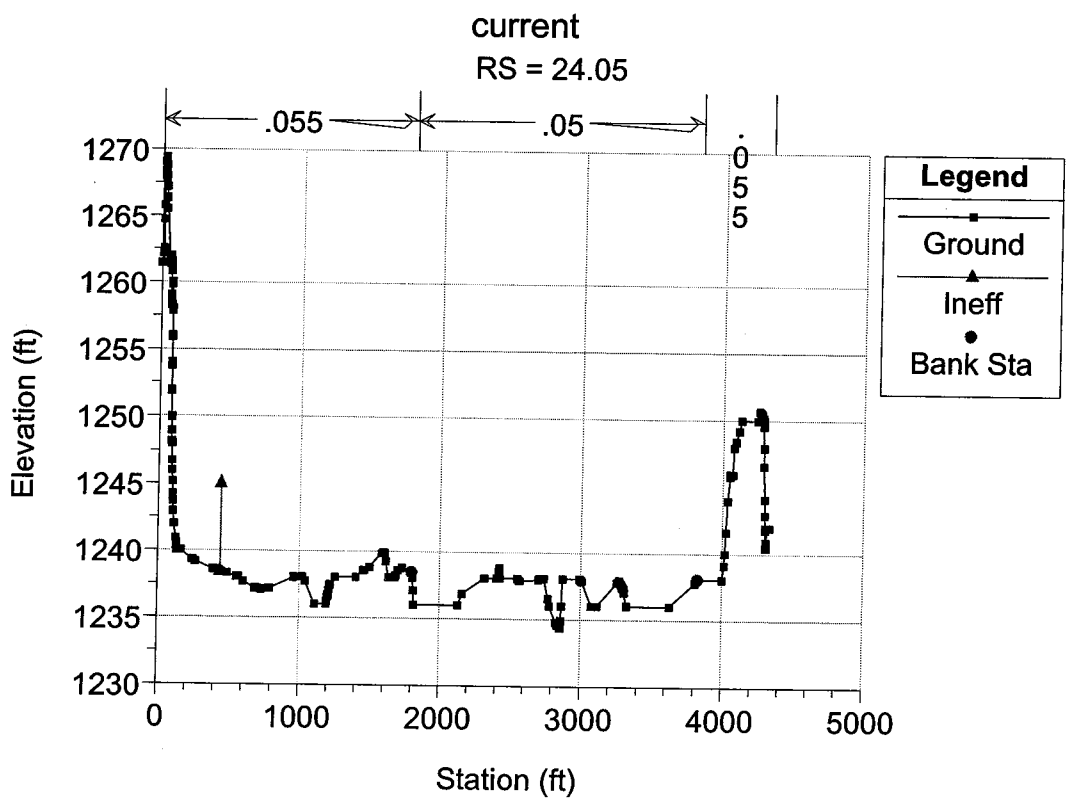
1230
0
1000
2000
3000
4000
5000
Station (ft)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.055
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
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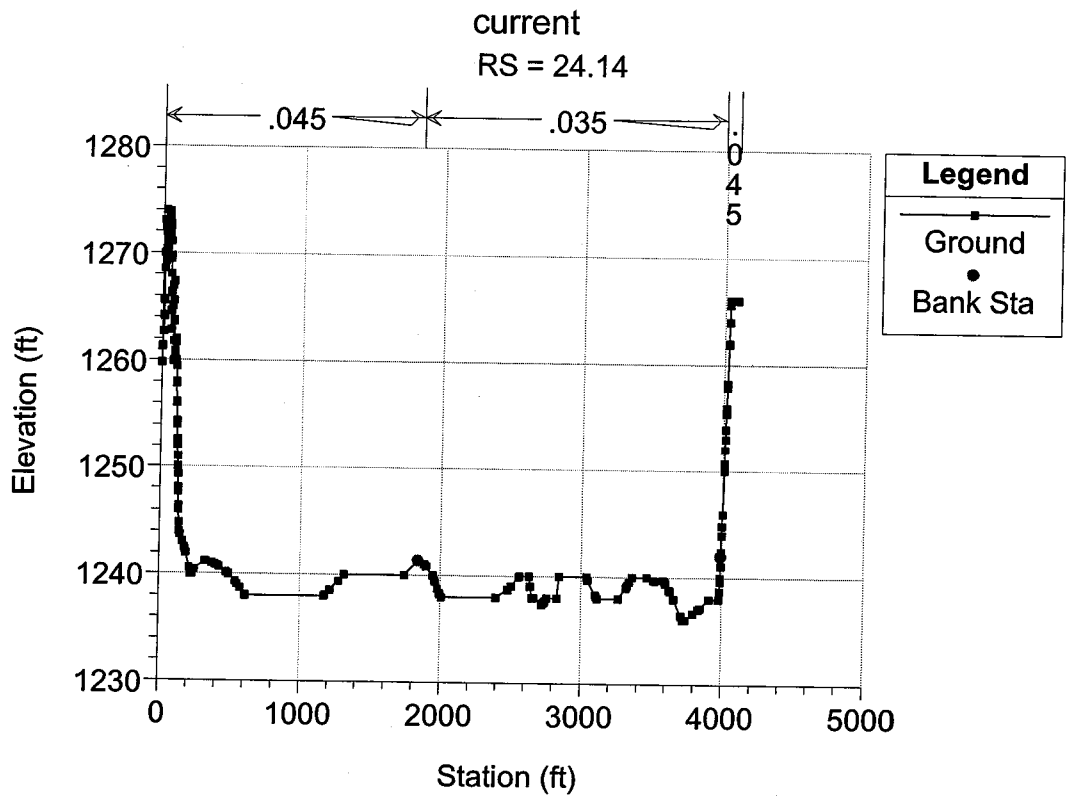
1255
1250
1245
1240
1235
1230
0
1000
2000
3000
4000
5000
Station (ft)


current
RS = 24.14
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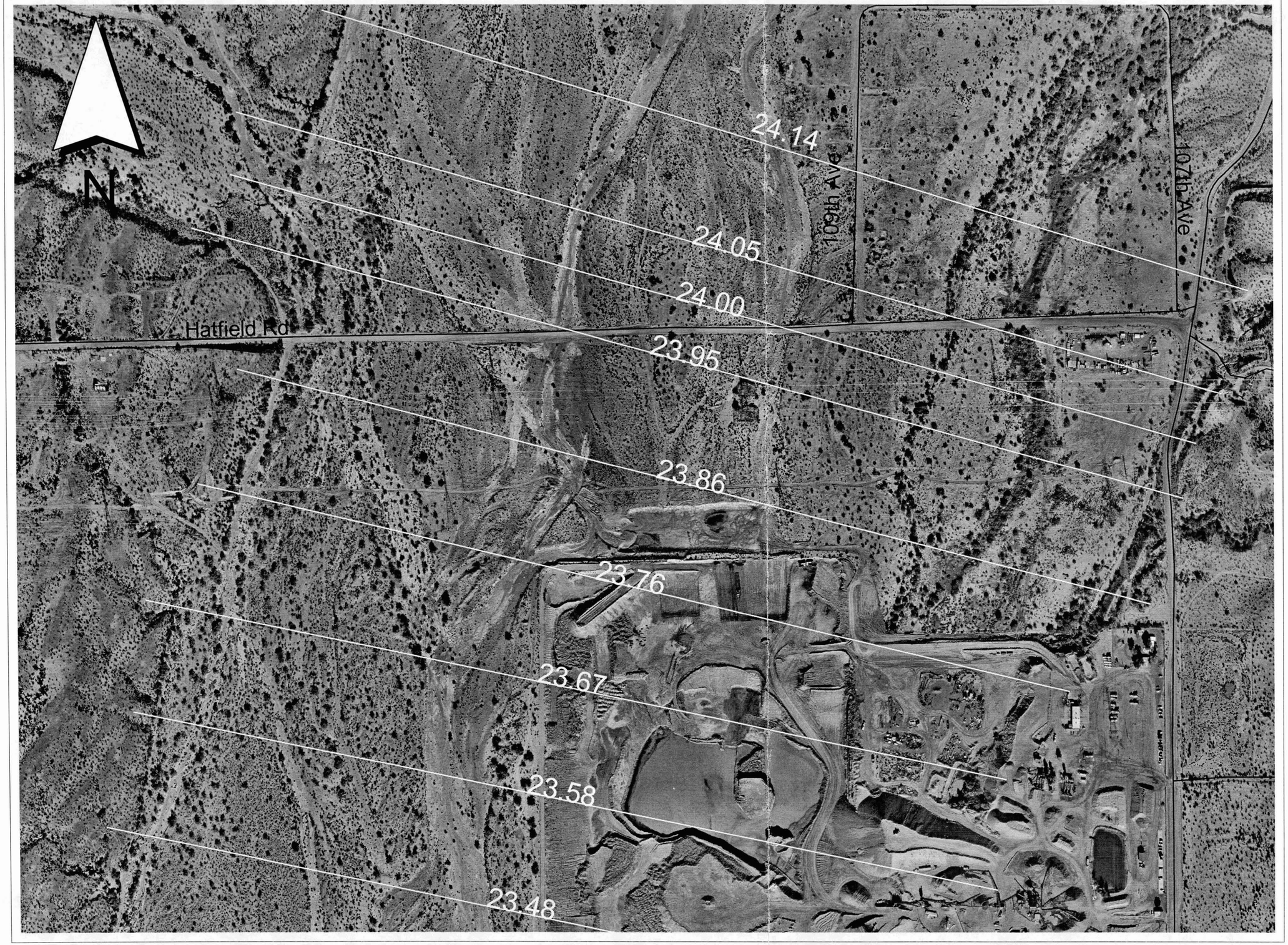
.035
.045
Legend
Ground
Bank Sta
Elevation (ft)
1280
1270
1260
1250
1240
1230
0
1000
2000
3000
4000
5000
Station (ft)

AVERY

APPENDIX D

PLAN VIEW OF STUDY REACH AND CROSS SECTION LAYOUT FOR CURRENT MODEL



Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 1 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

FA 86-044

Plan View of the Study Reach and Cross Section Layout for Current Model

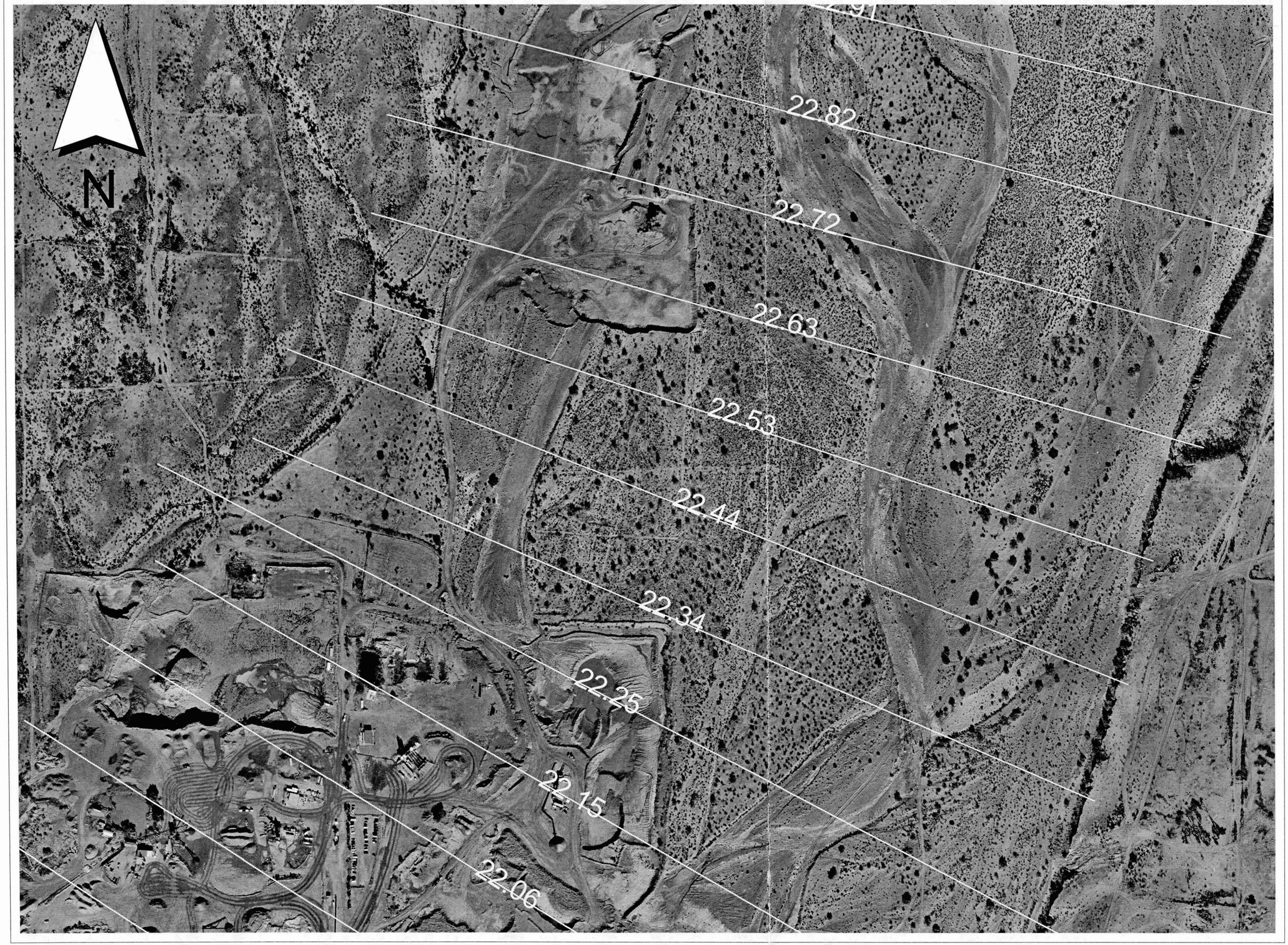
Plate 2 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.



Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 3 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

FA 02 - 009

Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 4 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

Rose Garden

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 5 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

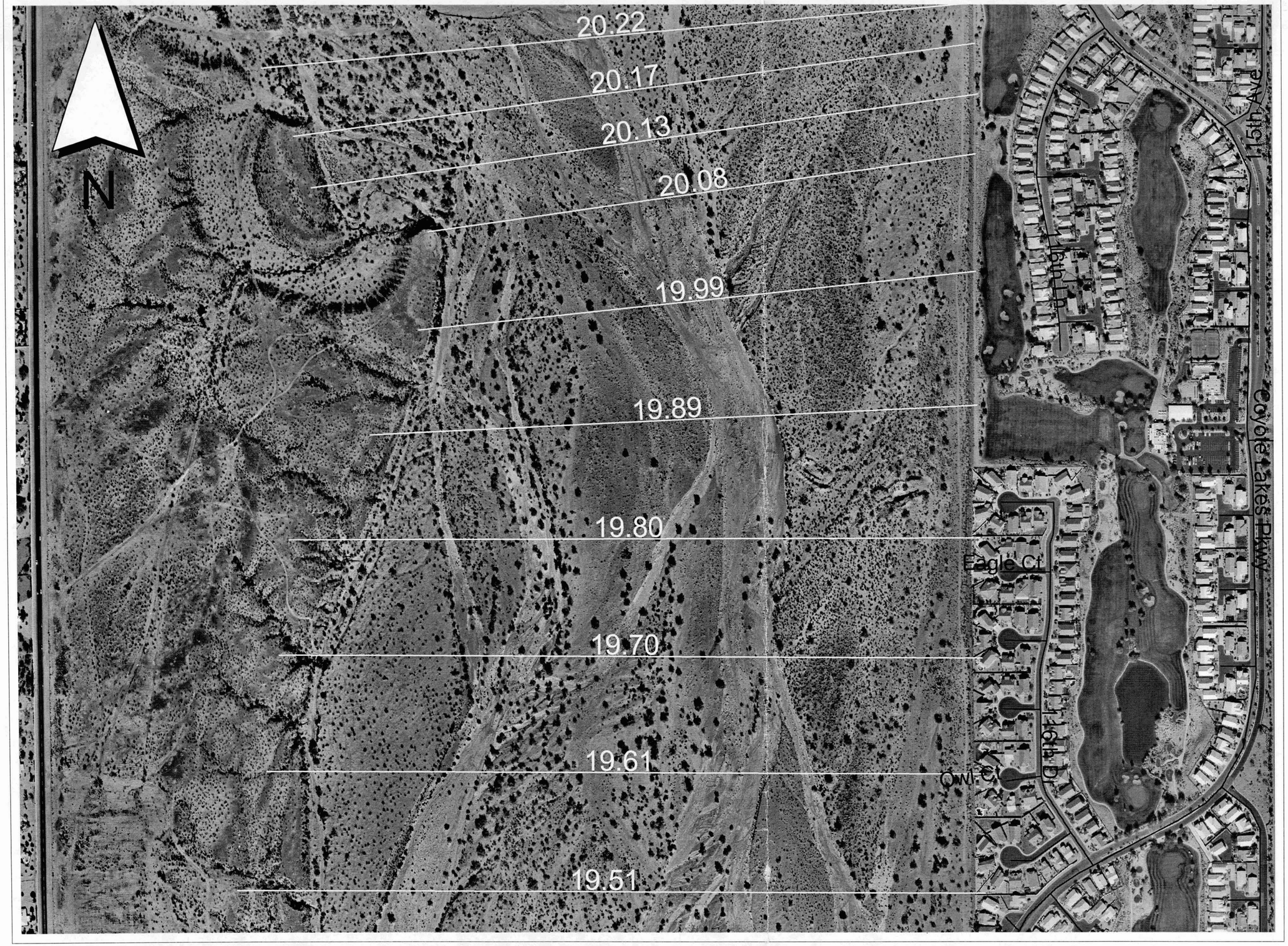
Plate 6 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.



Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 7 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 8 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

BELL RD

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 9 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 10 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 11 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 12 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 13 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

Grand Avenue

WEST CONSULTANTS, INC.

Agua Fria River Sediment Transport Study

Plan View of the Study Reach and Cross Section Layout for Current Model

Plate 14 of 14

200 0 200 400 Feet

1" = 400 ft

Flood Control District of Maricopa County

WEST CONSULTANTS, INC.

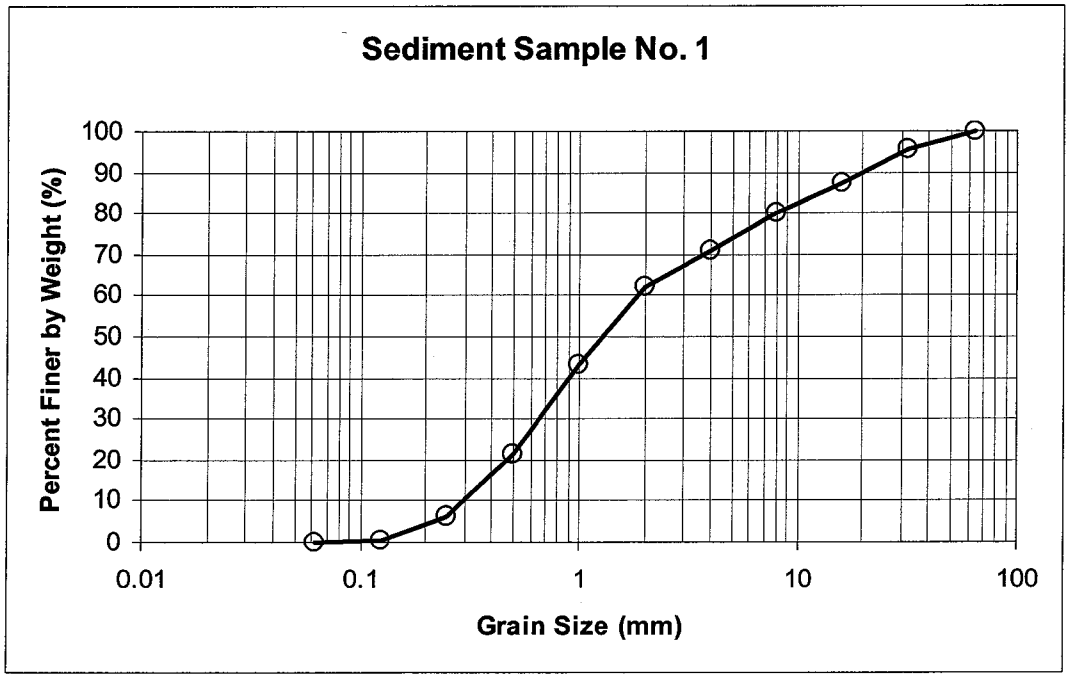
APPENDIX E

PARTICLE SIZE DISTRIBUTION OF RIVER BED SAMPLES

Sediment Sample No 1 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.176
0.125	0.623
0.25	6.431
0.5	21.526
1	42.988
2	62.26
4	70.784
8	80.139
16	87.342
32	95.768
64	100

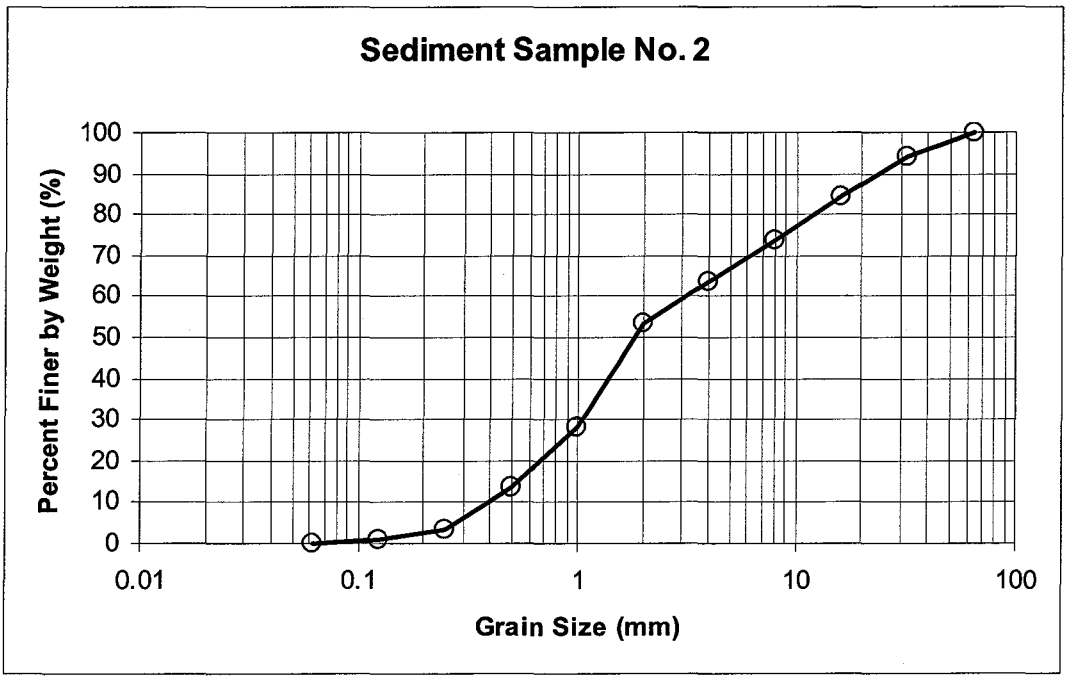
d_{15} (mm) = 0.39
d_{50} (mm) = 1.36
d_{85} (mm) = 13.40



Sediment Sample No 2 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.21
0.125	0.777
0.25	3.52
0.5	13.799
1	27.991
2	53.58
4	63.789
8	73.673
16	84.317
32	94.381
64	100

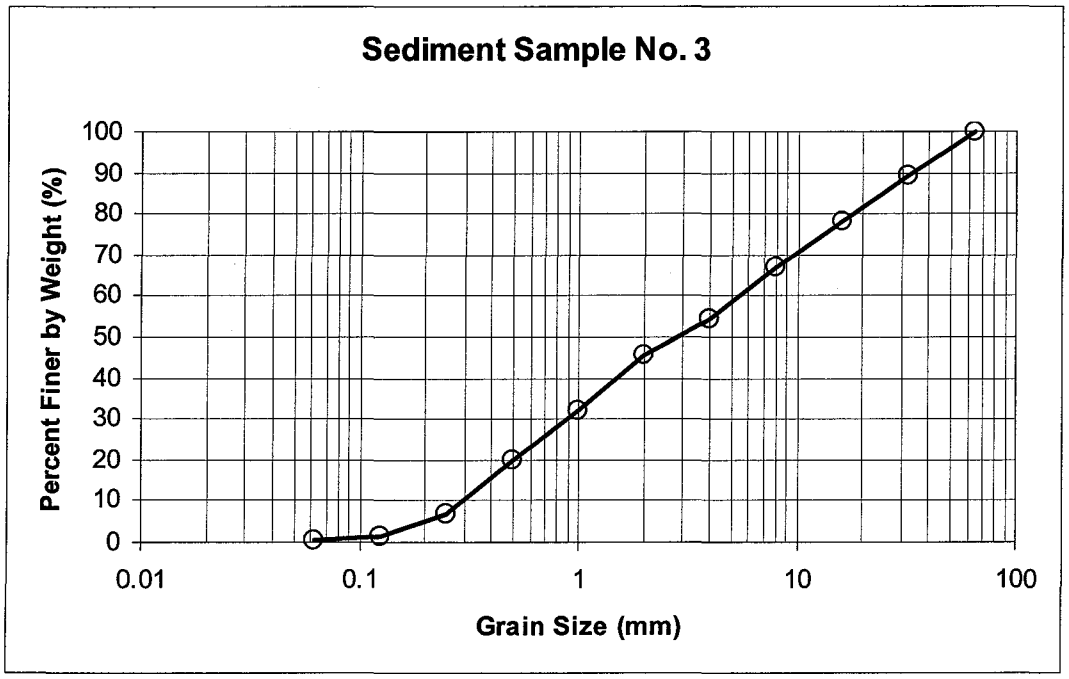
d_{15} (mm) = 0.54
d_{50} (mm) = 1.86
d_{85} (mm) = 17.09



Sediment Sample No 3 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.583
0.125	1.58
0.25	7.026
0.5	19.794
1	32.178
2	45.81
4	54.494
8	67.171
16	77.962
32	89.424
64	100

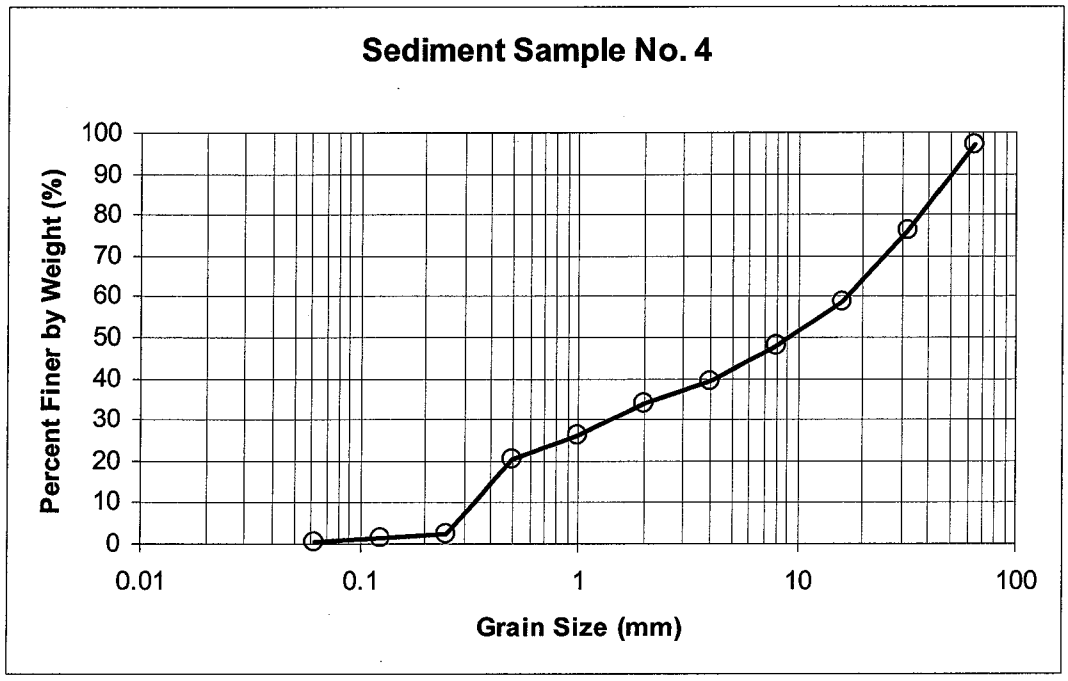
d_{15} (mm) = 0.41
d_{50} (mm) = 2.96
d_{85} (mm) = 25.82



Sediment Sample No 4 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.658
0.125	1.323
0.25	2.36
0.5	20.168
1	26.336
2	34.01
4	39.559
8	48.15
16	58.785
32	76.289
64	97.241

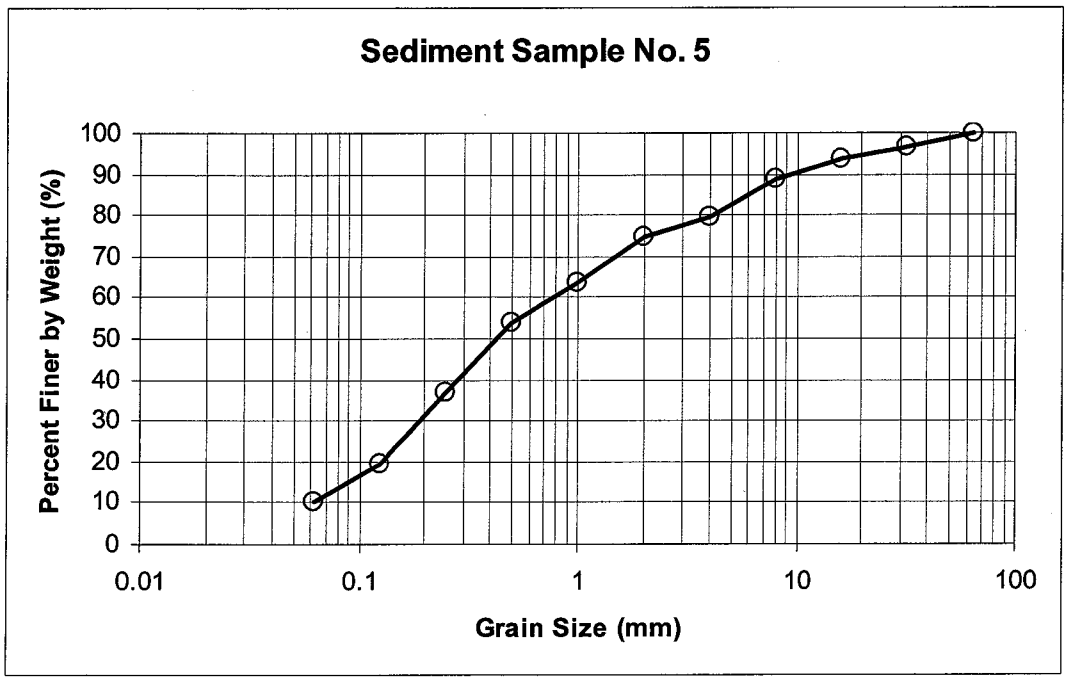
d_{15} (mm) = 0.43
d_{50} (mm) = 9.39
d_{85} (mm) = 45.30



Sediment Sample No 5 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	10.299
0.125	19.537
0.25	37.13
0.5	53.959
1	63.444
2	74.55
4	79.386
8	89.043
16	93.832
32	96.58
64	100

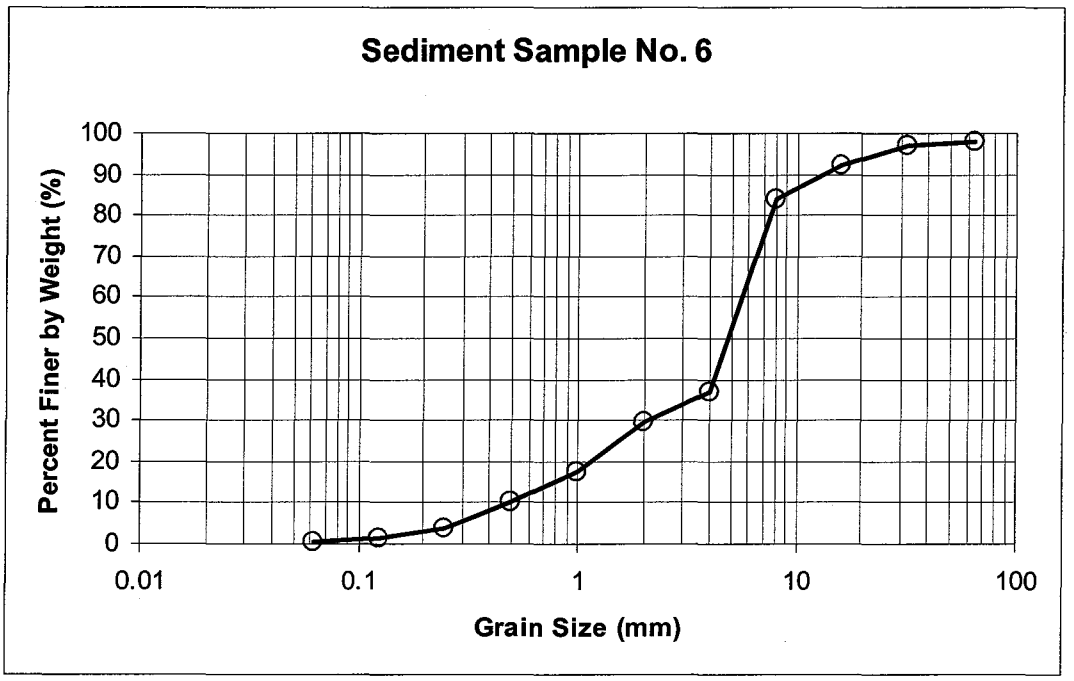
d_{15} (mm) = 0.09
d_{50} (mm) = 0.44
d_{85} (mm) = 6.33



Sediment Sample No 6 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.667
0.125	1.307
0.25	3.82
0.5	9.969
1	17.299
2	29.59
4	36.885
8	83.799
16	92.209
32	97.131
64	97.912

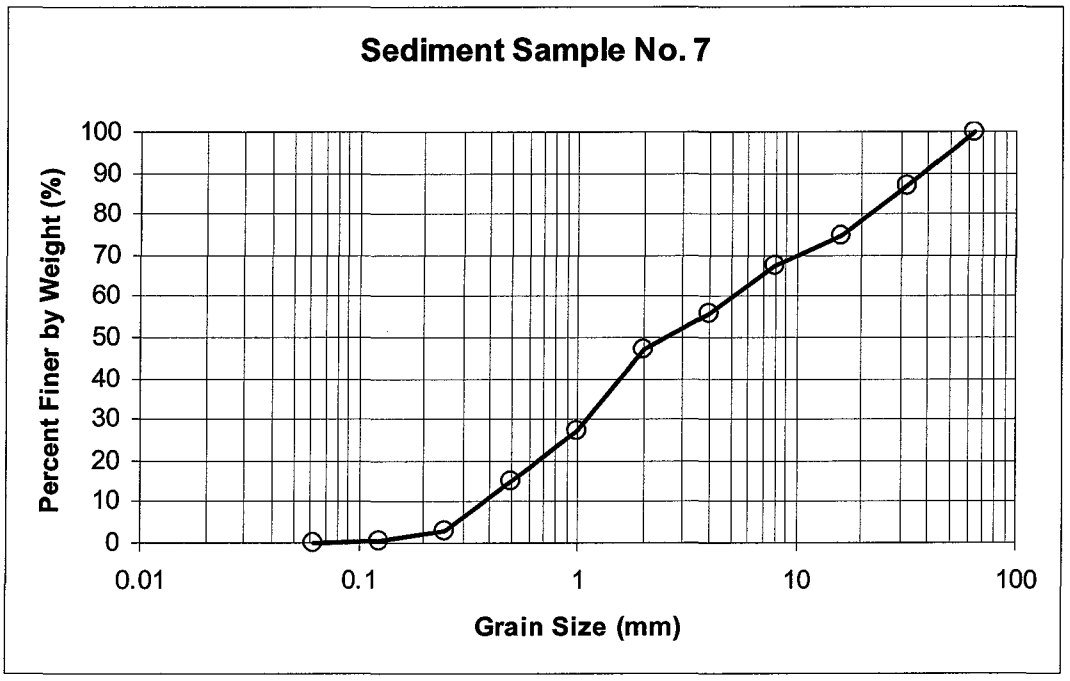
d_{15} (mm) = 0.84
d_{50} (mm) = 5.12
d_{85} (mm) = 9.14



Sediment Sample No 7 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.093
0.125	0.53
0.25	3.11
0.5	14.831
1	27.221
2	47.15
4	55.899
8	67.699
16	74.59
32	87.083
64	100

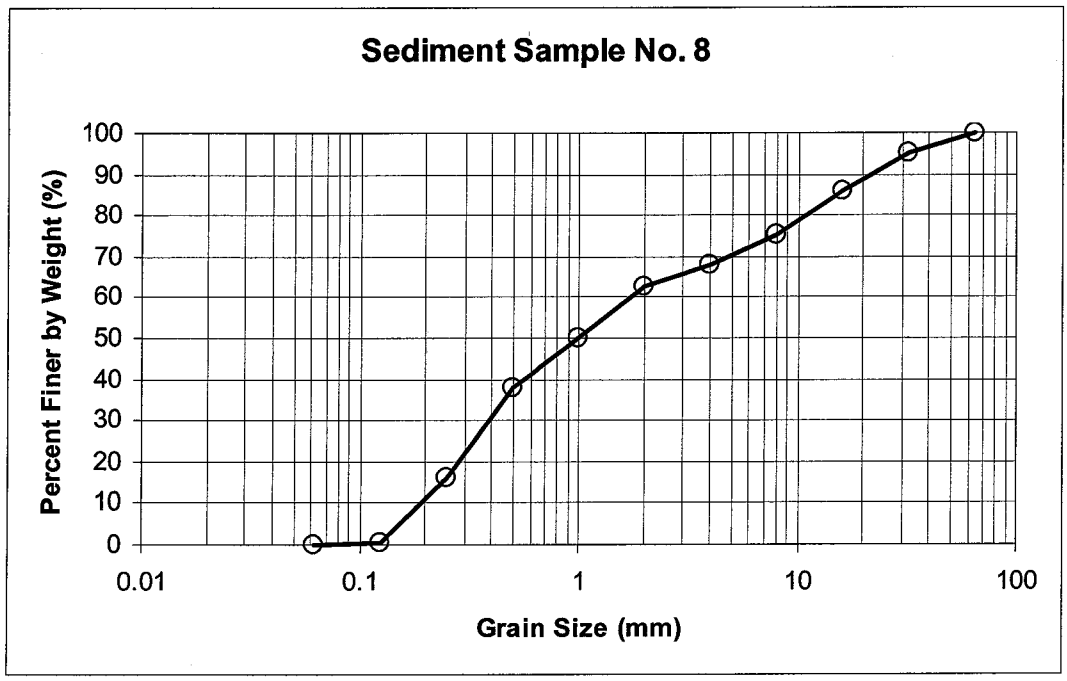
d_{15} (mm) = 0.51
d_{50} (mm) = 2.65
d_{85} (mm) = 29.33



Sediment Sample No 8 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.118
0.125	0.58
0.25	15.8
0.5	38.024
1	49.838
2	62.49
4	67.755
8	75.204
16	85.942
32	95.376
64	100

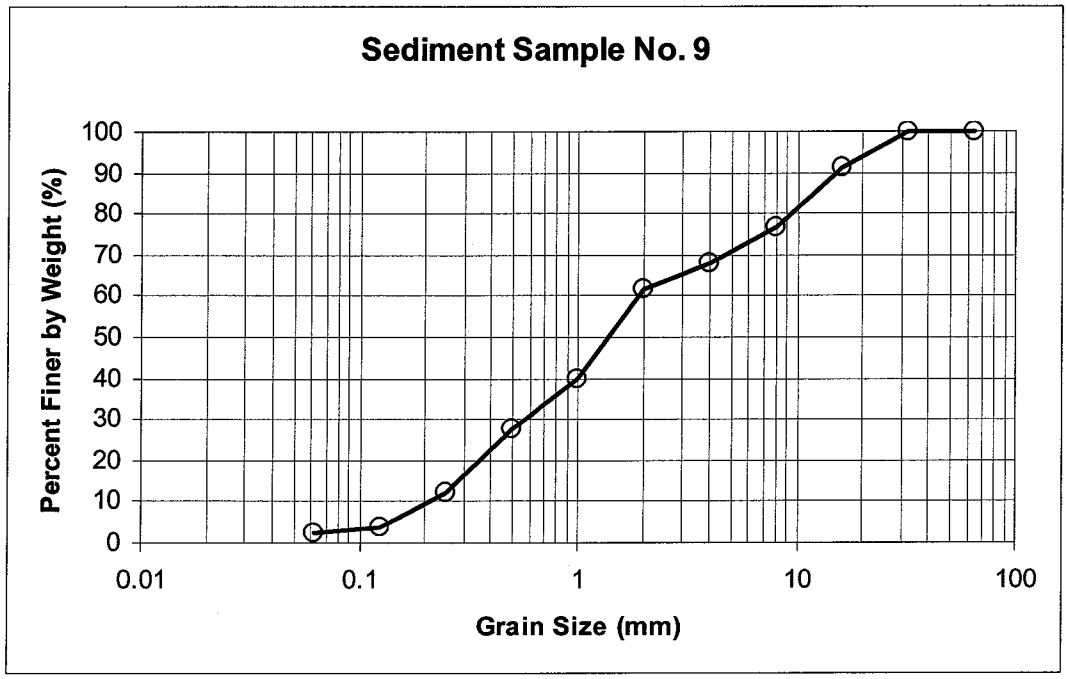
d_{15} (mm) = 0.24
d_{50} (mm) = 1.01
d_{85} (mm) = 15.30



Sediment Sample No 9 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	2.279
0.125	4.1
0.25	12.376
0.5	27.492
1	39.64
2	61.44
4	67.724
8	76.484
16	91.103
32	100
64	100

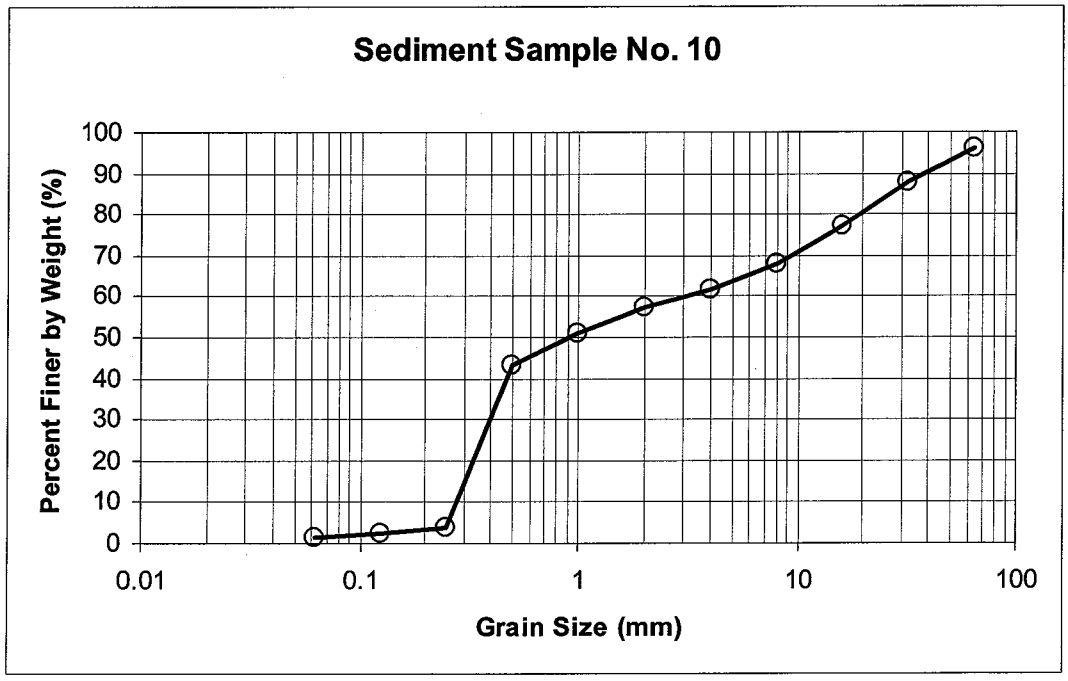
d_{15} (mm) = 0.29
d_{50} (mm) = 1.48
d_{85} (mm) = 12.66



Sediment Sample No 10 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	1.614
0.125	2.5
0.25	3.8
0.5	43.107
1	50.782
2	57.42
4	61.667
8	67.865
16	76.951
32	87.672
64	95.967

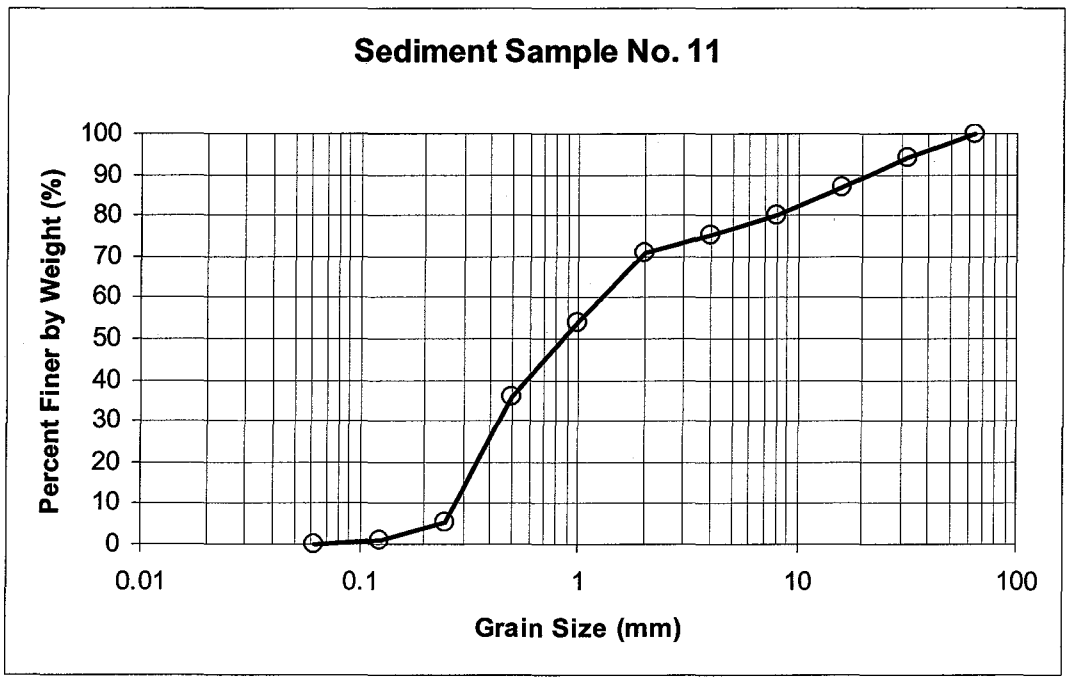
d_{15} (mm) = 0.32
d_{50} (mm) = 0.95
d_{85} (mm) = 28.01



Sediment Sample No 11 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.11
0.125	0.757
0.25	5.39
0.5	36.125
1	54.018
2	70.67
4	75.223
8	80
16	86.992
32	93.982
64	100

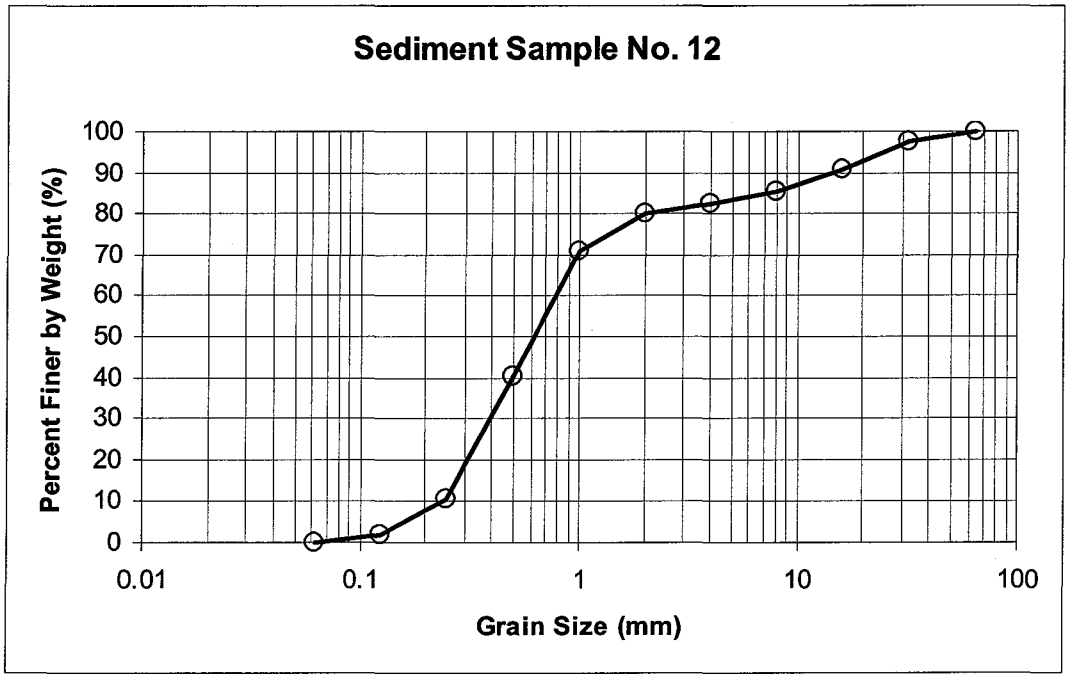
d_{15} (mm) = 0.33
d_{50} (mm) = 0.89
d_{85} (mm) = 13.72



Sediment Sample No 12 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.11
0.125	1.737
0.25	10.68
0.5	40.505
1	71.015
2	80.15
4	82.463
8	85.454
16	90.892
32	97.674
64	100

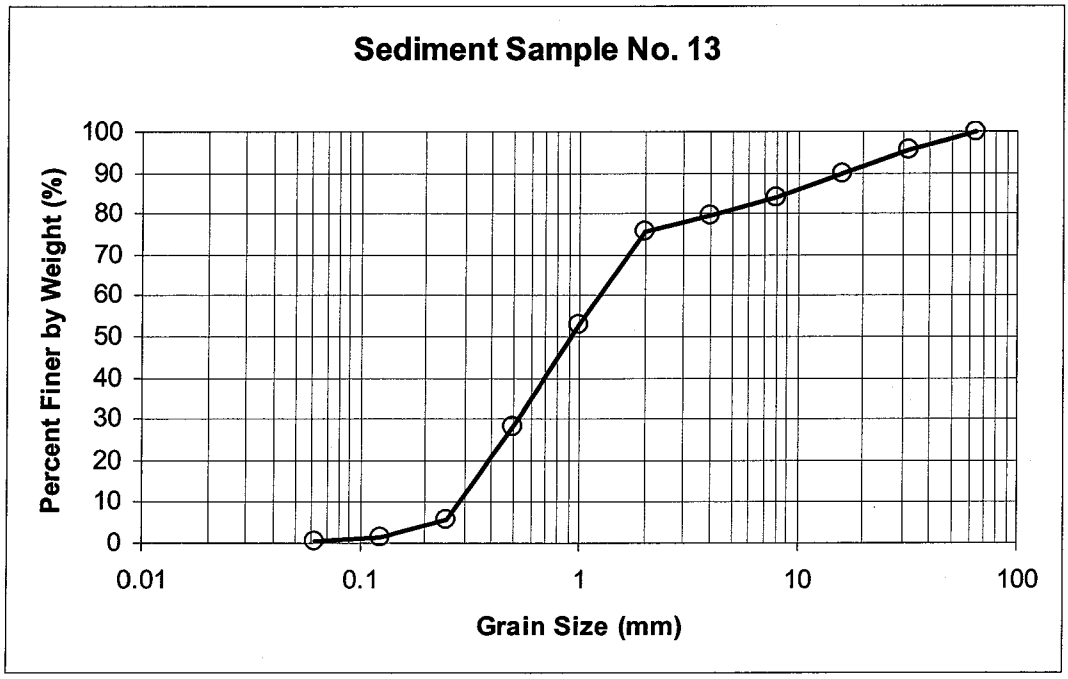
d_{15} (mm) = 0.29
d_{50} (mm) = 0.66
d_{85} (mm) = 7.39



Sediment Sample No 13 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.492
0.125	1.543
0.25	5.76
0.5	28.348
1	52.971
2	75.95
4	79.826
8	83.947
16	89.808
32	95.718
64	100

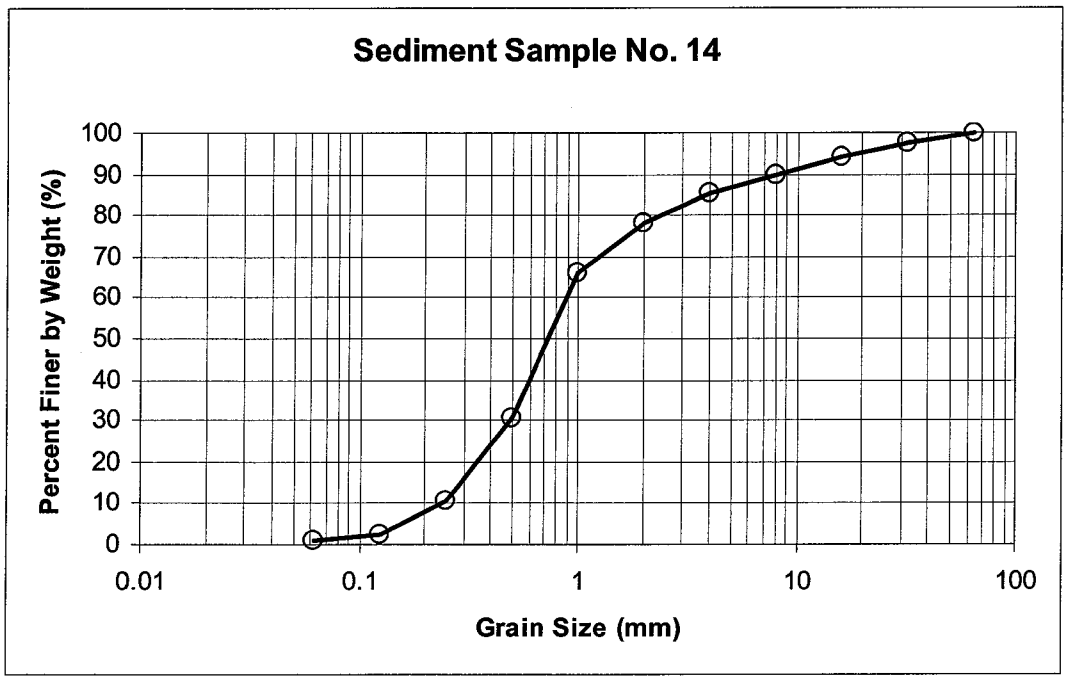
d_{15} (mm) = 0.35
d_{50} (mm) = 0.94
d_{85} (mm) = 9.44



Sediment Sample No 14 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.783
0.125	2.487
0.25	10.5
0.5	30.648
1	66.115
2	78.21
4	85.391
8	90.008
16	94.14
32	97.724
64	100

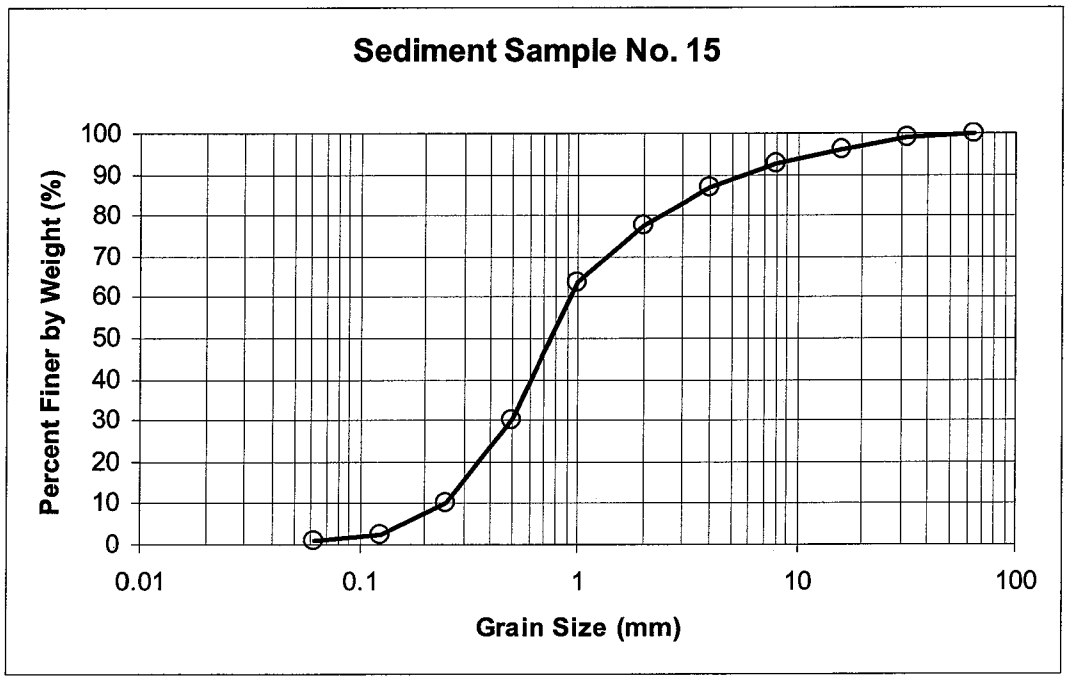
d_{15} (mm) = 0.31
d_{50} (mm) = 0.77
d_{85} (mm) = 3.89



Sediment Sample No 15 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.899
0.125	2.227
0.25	10.267
0.5	30.32
1	63.783
2	77.71
4	86.992
8	92.622
16	95.983
32	98.806
64	100

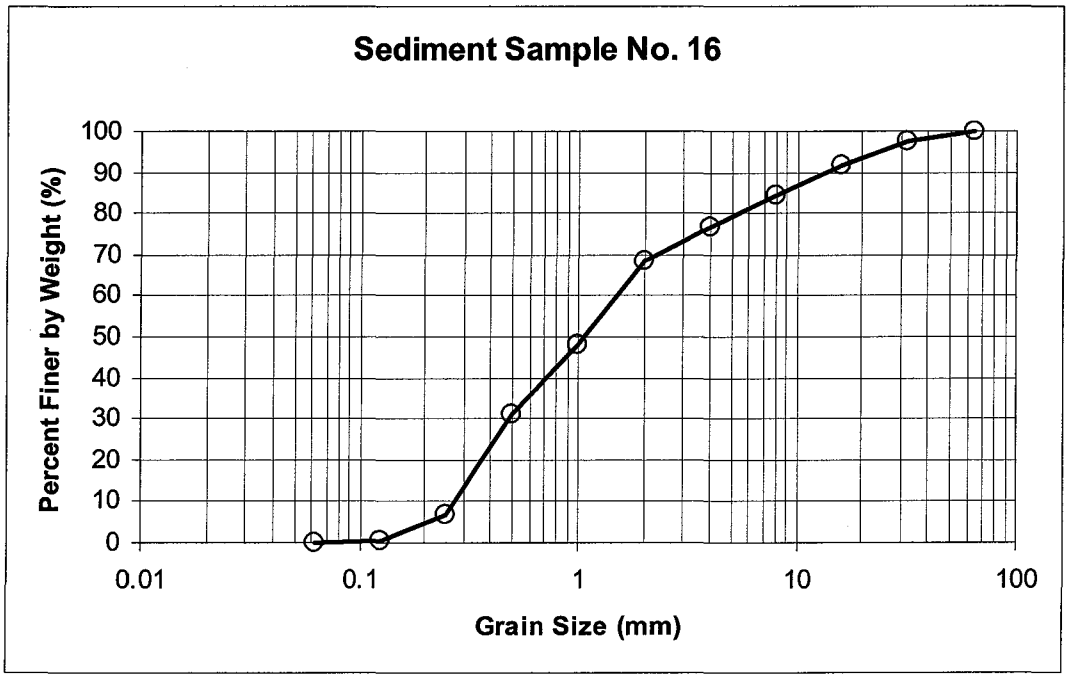
d_{15} (mm) = 0.31
d_{50} (mm) = 0.79
d_{85} (mm) = 3.57



Sediment Sample No 16 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.052
0.125	0.693
0.25	6.65
0.5	31.099
1	48.257
2	68.64
4	76.524
8	84.451
16	91.874
32	97.399
64	100

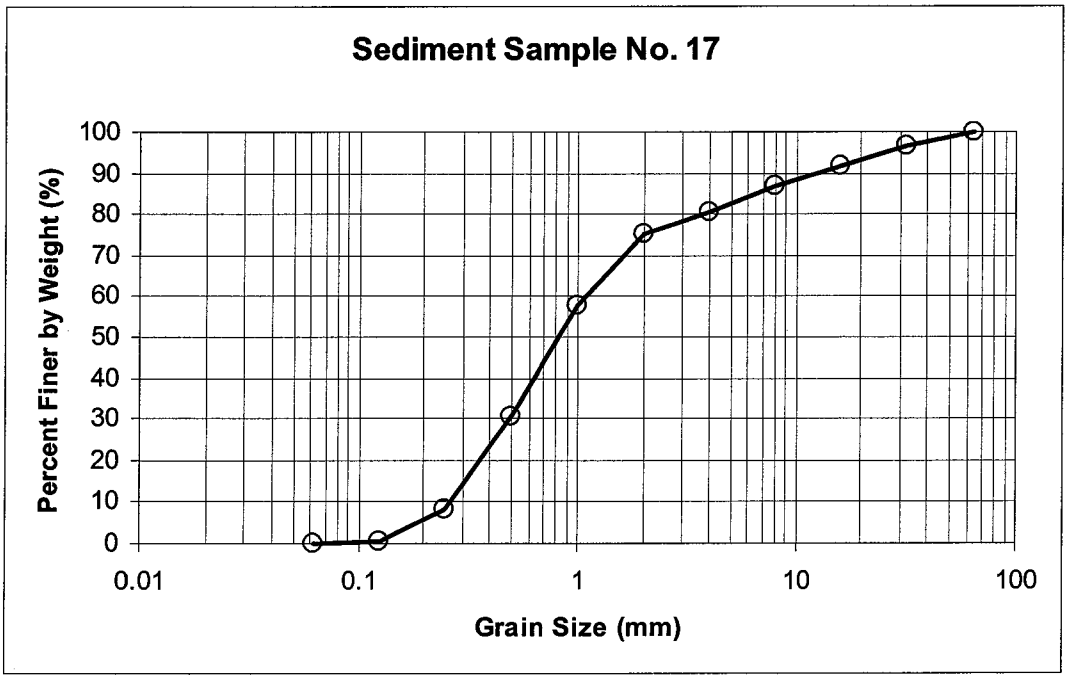
d_{15} (mm) = 0.34
d_{50} (mm) = 1.09
d_{85} (mm) = 8.59



Sediment Sample No 17 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.052
0.125	0.347
0.25	8.387
0.5	30.595
1	57.996
2	75.3
4	80.373
8	86.704
16	91.778
32	96.558
64	100

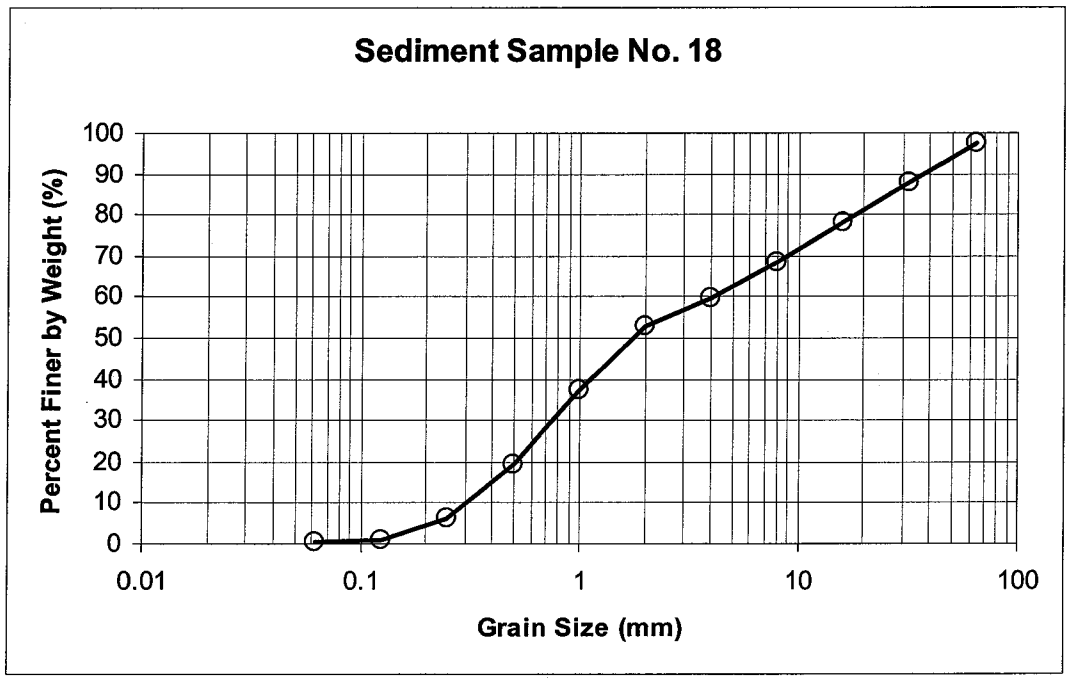
d_{15} (mm) = 0.32
d_{50} (mm) = 0.85
d_{85} (mm) = 6.92



Sediment Sample No 18 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.351
0.125	1.02
0.25	6.551
0.5	19.271
1	37.537
2	52.85
4	59.504
8	68.531
16	78.096
32	87.902
64	97.589

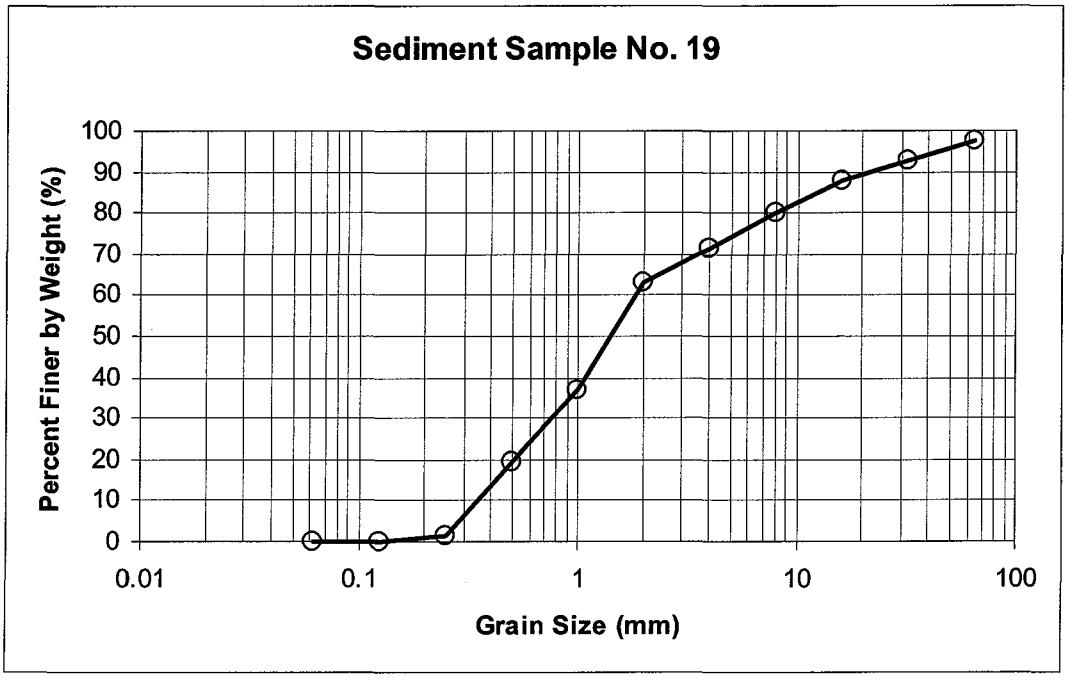
d_{15} (mm) = 0.42
d_{50} (mm) = 1.81
d_{85} (mm) = 27.26



Sediment Sample No 19 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.118
0.125	0.22
0.25	1.32
0.5	19.423
1	36.731
2	63.05
4	71.356
8	80.122
16	87.857
32	92.537
64	97.754

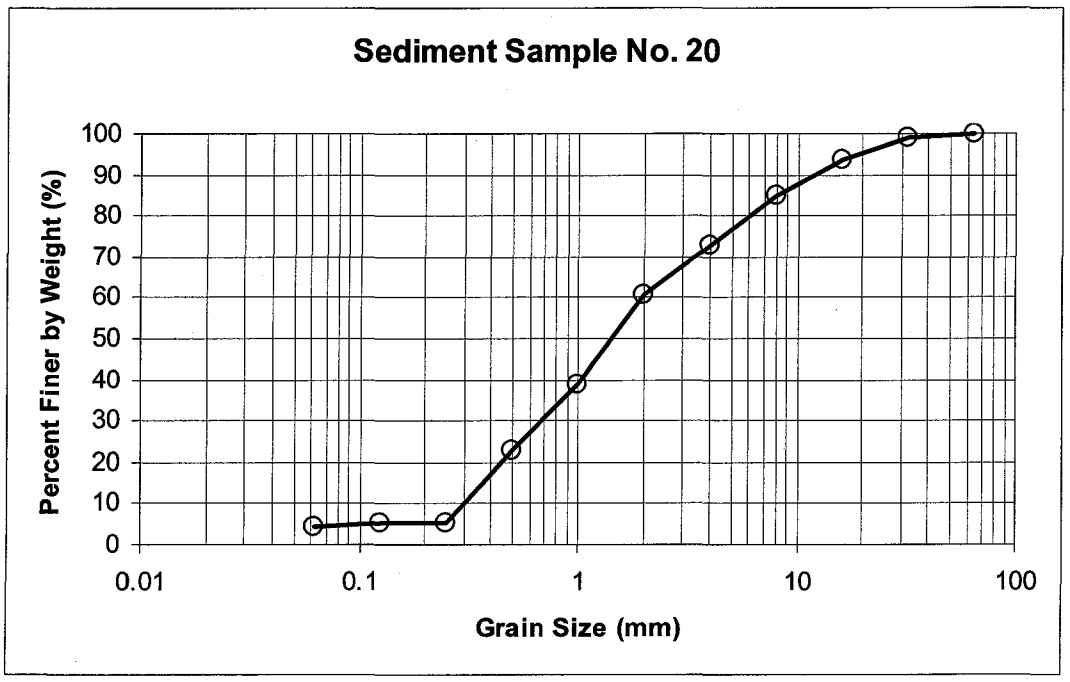
d_{15} (mm) = 0.44
d_{50} (mm) = 1.50
d_{85} (mm) = 13.05



Sediment Sample No 20 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	4.556
0.125	5.5
0.25	5.56
0.5	22.816
1	38.689
2	60.59
4	72.954
8	85.051
16	93.615
32	98.834
64	100

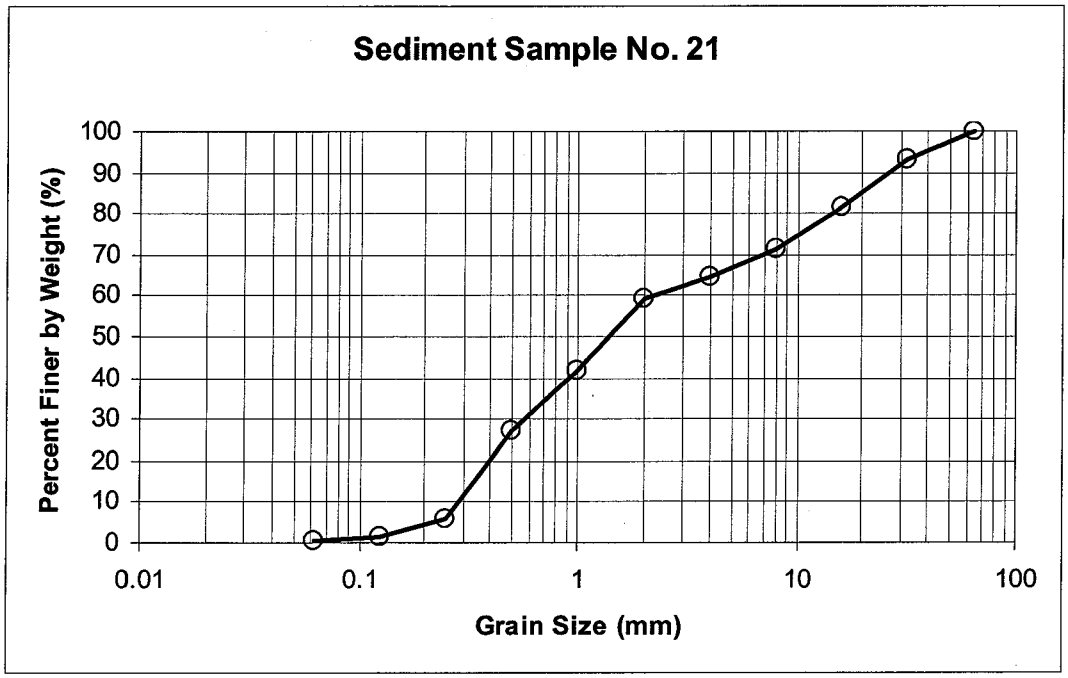
d_{15} (mm) = 0.39
d_{50} (mm) = 1.52
d_{85} (mm) = 7.98



Sediment Sample No 21 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.351
0.125	1.273
0.25	5.74
0.5	27.064
1	41.806
2	59.04
4	64.684
8	71.438
16	81.516
32	93.15
64	100

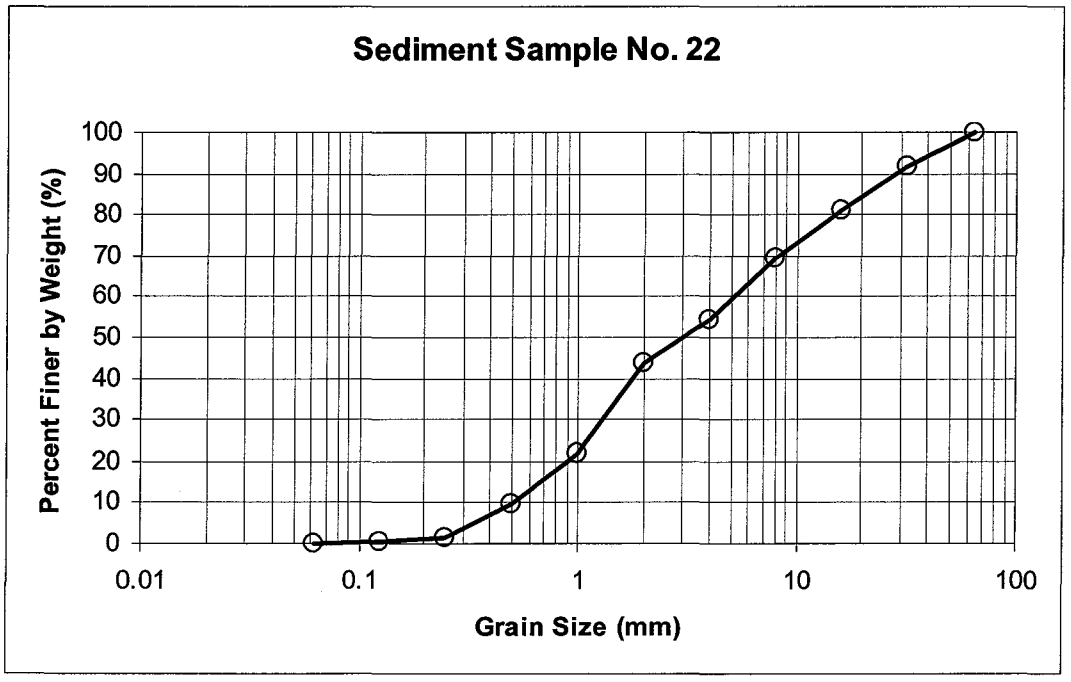
d_{15} (mm) = 0.36
d_{50} (mm) = 1.48
d_{85} (mm) = 20.79



Sediment Sample No 22 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.151
0.125	0.3
0.25	1.28
0.5	9.714
1	21.805
2	43.89
4	54.414
8	69.494
16	81.009
32	91.969
64	100

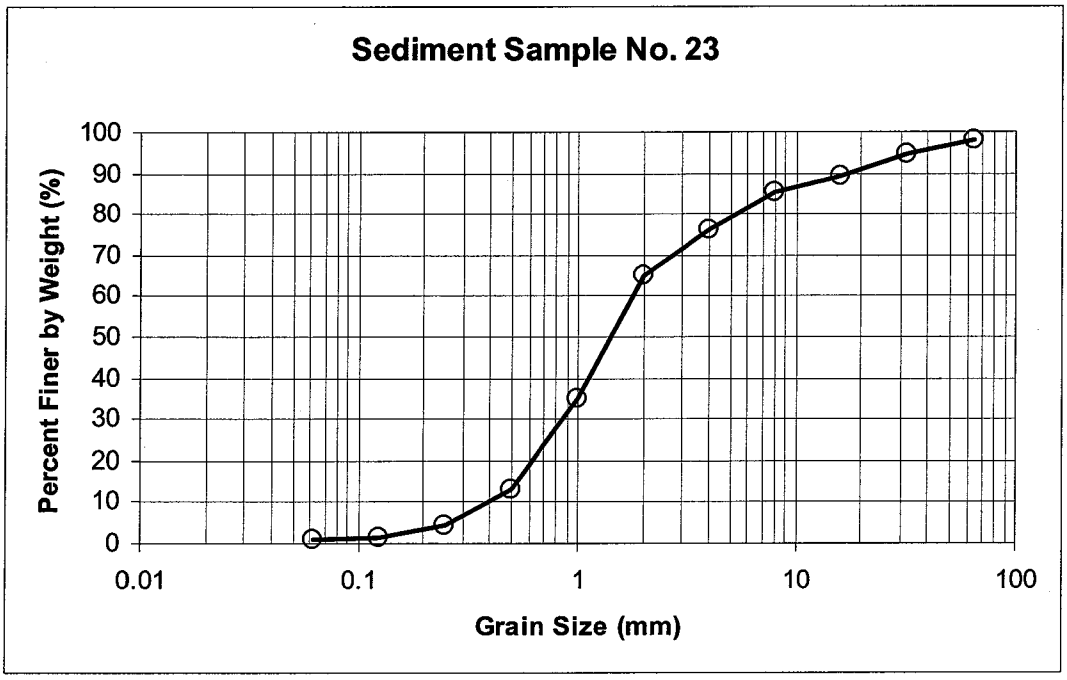
d_{15} (mm) = 0.72
d_{50} (mm) = 3.16
d_{85} (mm) = 21.83



Sediment Sample No 23 (ASU, 1994)

Sediment Size (mm)	Percent Finer by Weight (%)
0.062	0.949
0.125	1.487
0.25	4.58
0.5	13.08
1	34.859
2	65.25
4	76.021
8	85.212
16	89.19
32	94.762
64	98.148

d_{15} (mm) = 0.54
d_{50} (mm) = 1.50
d_{85} (mm) = 7.91



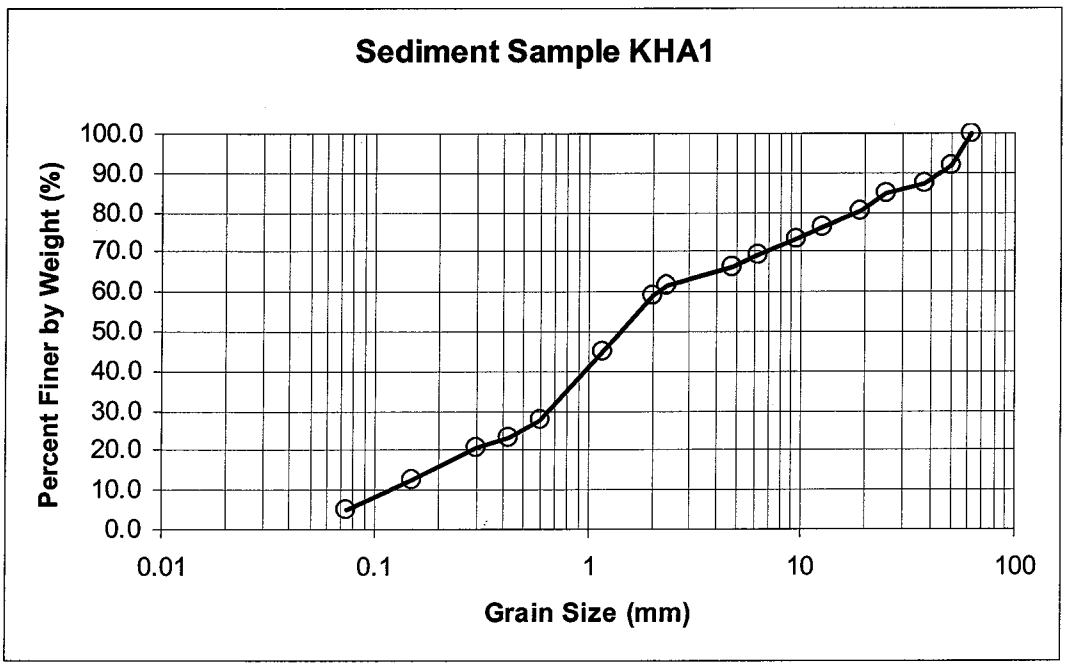
Sediment Sample KHA1 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	5.2
0.15	12.7
0.3	20.6
0.425	23.4
0.6	27.7
1.18	44.8
2	58.9
2.36	61.7
4.75	66.2
6.3	69.2
9.5	73.4
12.5	76.4
19	80.2
25	84.8
37.5	87.6
50	92.1
62.5	100.0
75	100.0

d_{15} (mm) = 0.19

d_{50} (mm) = 1.48

d_{85} (mm) = 26.07



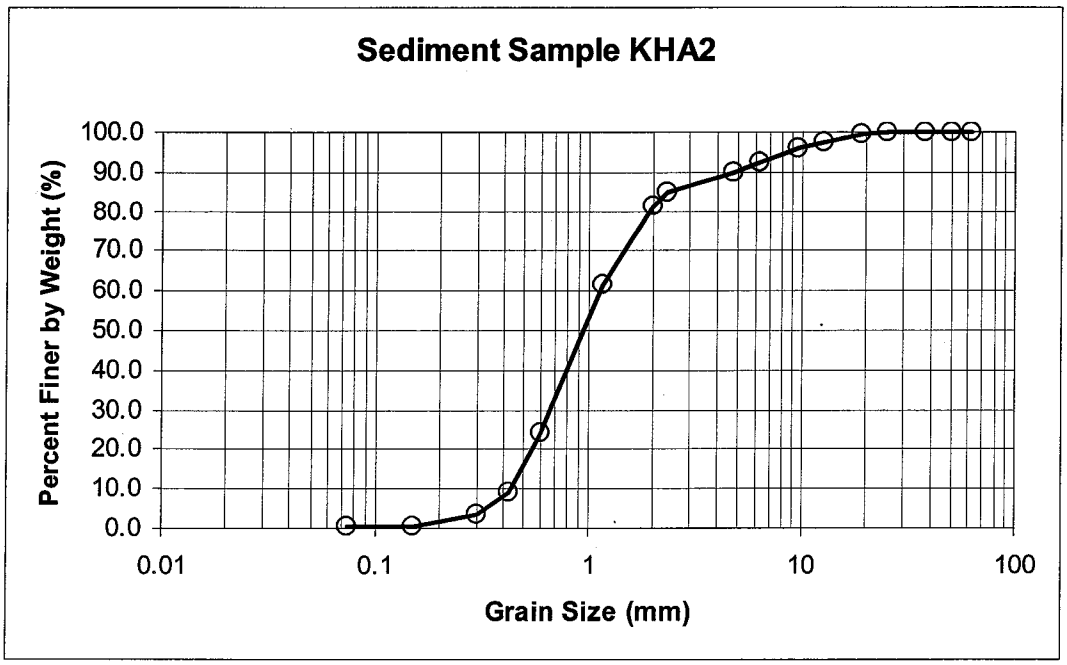
Sediment Sample KHA2 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	0.5
0.15	0.7
0.3	3.5
0.425	9.0
0.6	24.0
1.18	61.6
2	81.5
2.36	85.0
4.75	90.0
6.3	92.5
9.5	95.8
12.5	97.5
19	99.4
25	100.0
37.5	100.0
50	100.0
62.5	100.0
75	100.0

d_{15} (mm) = 0.49

d_{50} (mm) = 1.00

d_{85} (mm) = 2.38



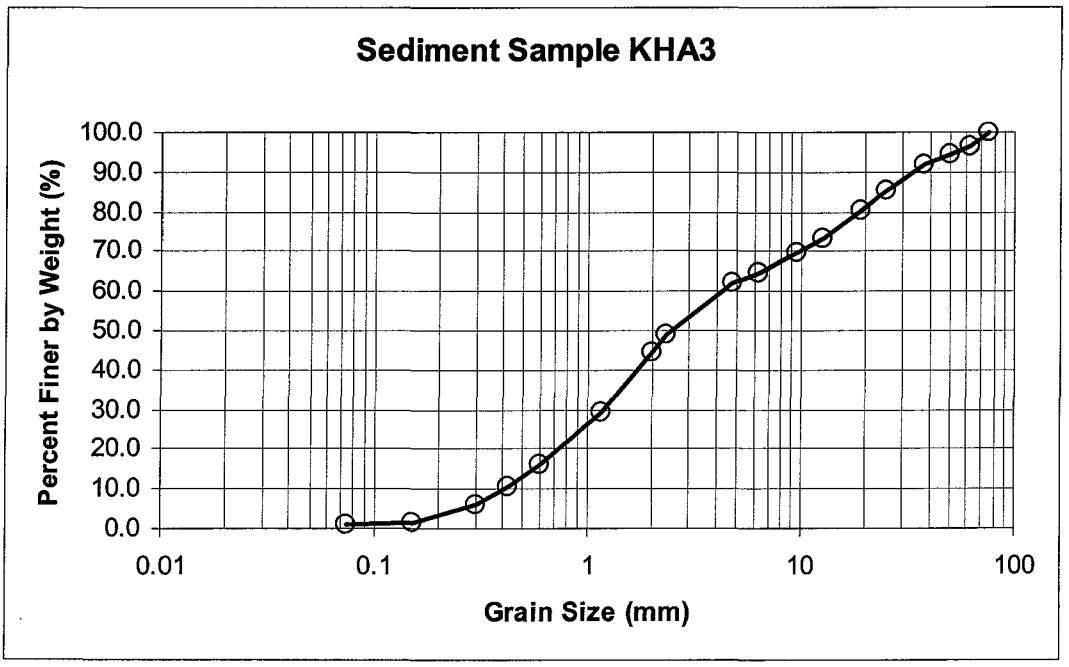
Sediment Sample KHA3 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	0.8
0.15	1.5
0.3	6.2
0.425	10.8
0.6	16.0
1.18	29.3
2	44.5
2.36	48.8
4.75	62.0
6.3	64.8
9.5	69.6
12.5	73.5
19	80.2
25	85.4
37.5	91.7
50	94.5
62.5	96.6
75	100.0

d_{15} (mm) = 0.57

d_{50} (mm) = 2.57

d_{85} (mm) = 24.51



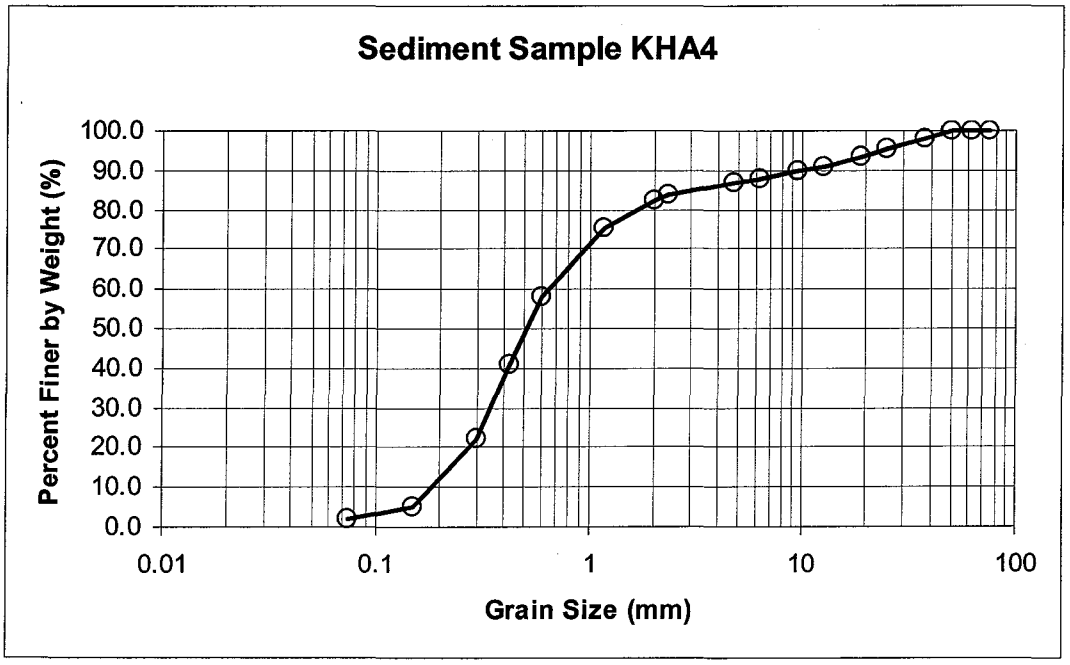
Sediment Sample KHA4 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	1.8
0.15	4.9
0.3	22.2
0.425	41.0
0.6	58.1
1.18	75.4
2	82.2
2.36	83.7
4.75	86.7
6.3	87.9
9.5	89.7
12.5	91.0
19	93.2
25	95.2
37.5	98.1
50	100.0
62.5	100.0
75	100.0

d_{15} (mm) = 0.24

d_{50} (mm) = 0.52

d_{85} (mm) = 3.43



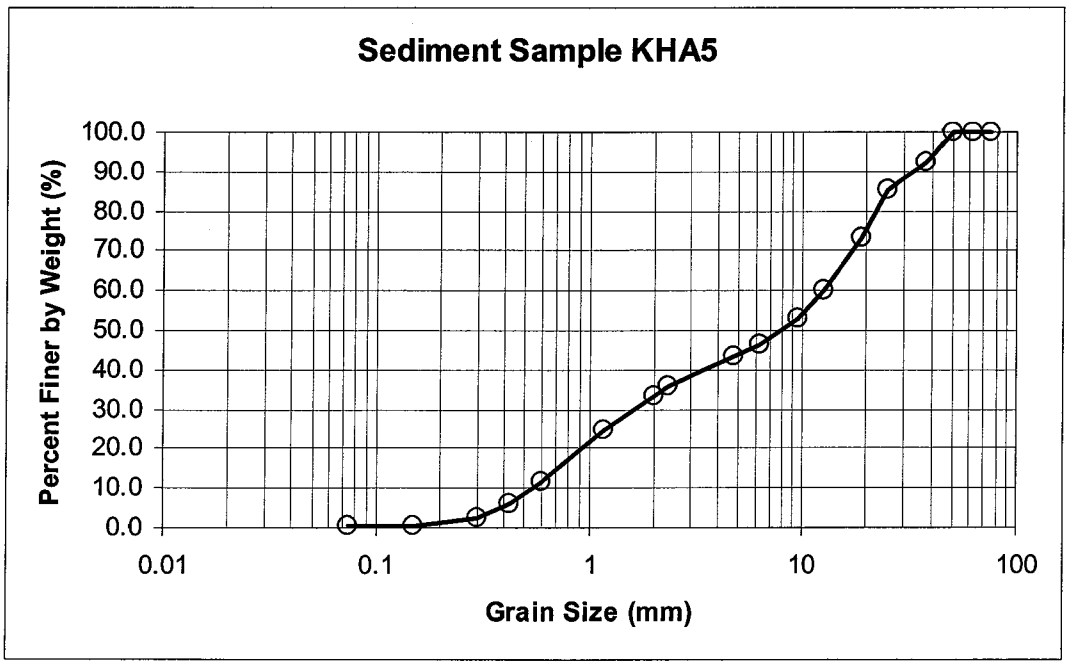
Sediment Sample KHA5 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	0.4
0.15	0.7
0.3	2.7
0.425	5.9
0.6	11.8
1.18	24.8
2	33.6
2.36	35.7
4.75	43.6
6.3	46.7
9.5	53.0
12.5	59.9
19	73.3
25	85.2
37.5	92.5
50	100.0
62.5	100.0
75	100.0

d_{15} (mm) = 0.74

d_{50} (mm) = 8.00

d_{85} (mm) = 24.89



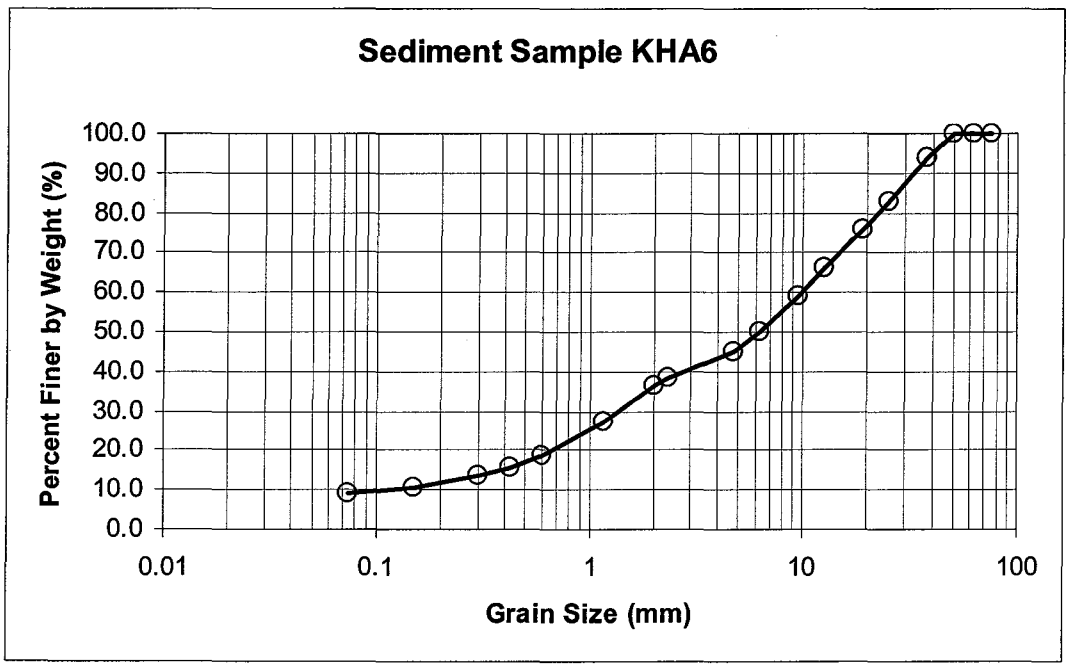
Sediment Sample KHA6 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	9.1
0.15	10.7
0.3	13.4
0.425	15.5
0.6	18.6
1.18	27.3
2	36.2
2.36	38.6
4.75	45.0
6.3	50.2
9.5	59.3
12.5	66.2
19	75.7
25	82.7
37.5	93.9
50	100.0
62.5	100.0
75	100.0

d_{15} (mm) = 0.40

d_{50} (mm) = 6.24

d_{85} (mm) = 27.56



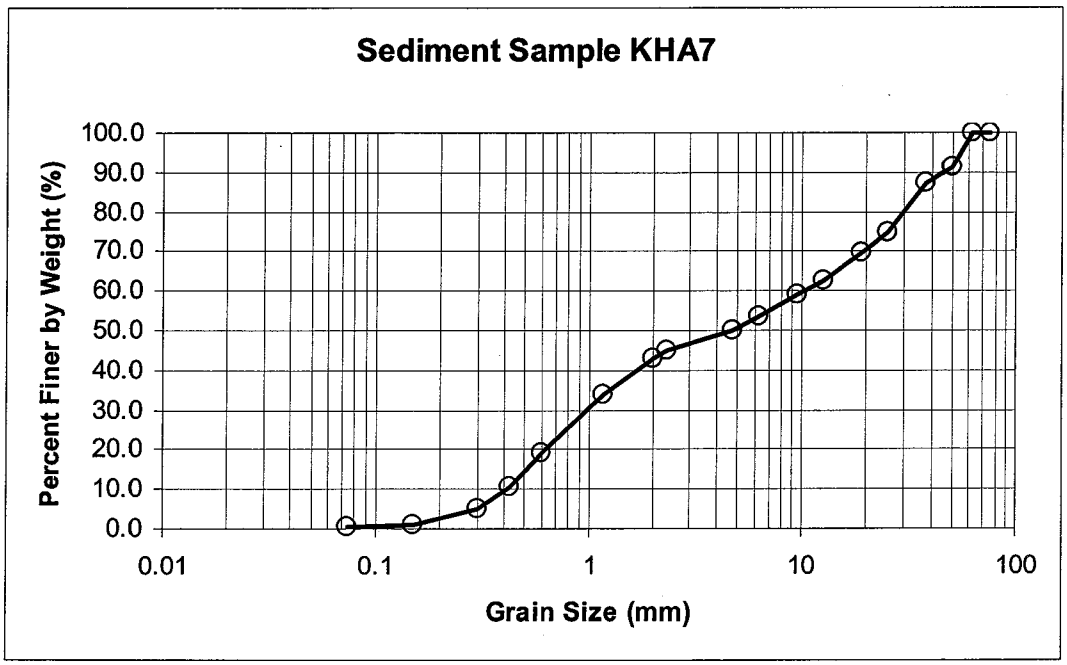
Sediment Sample KHA7 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	0.3
0.15	1.0
0.3	5.1
0.425	10.8
0.6	19.2
1.18	33.9
2	42.8
2.36	44.9
4.75	50.1
6.3	53.7
9.5	58.8
12.5	62.5
19	69.5
25	74.9
37.5	87.1
50	91.3
62.5	100.0
75	100.0

d_{15} (mm) = 0.51

d_{50} (mm) = 4.69

d_{85} (mm) = 35.33



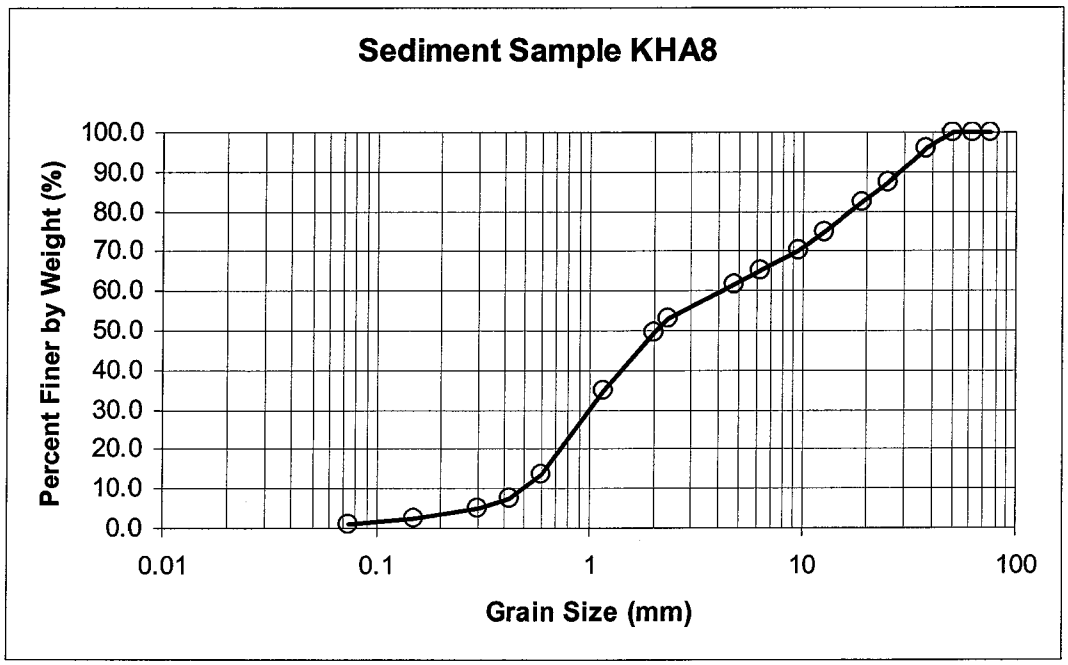
Sediment Sample KHA8 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	1.2
0.15	2.3
0.3	4.9
0.425	7.4
0.6	13.8
1.18	34.9
2	49.7
2.36	52.9
4.75	61.4
6.3	64.9
9.5	70.3
12.5	74.8
19	82.4
25	87.5
37.5	95.8
50	100.0
62.5	100.0
75	100.0

d_{15} (mm) = 0.63

d_{50} (mm) = 2.03

d_{85} (mm) = 22.07



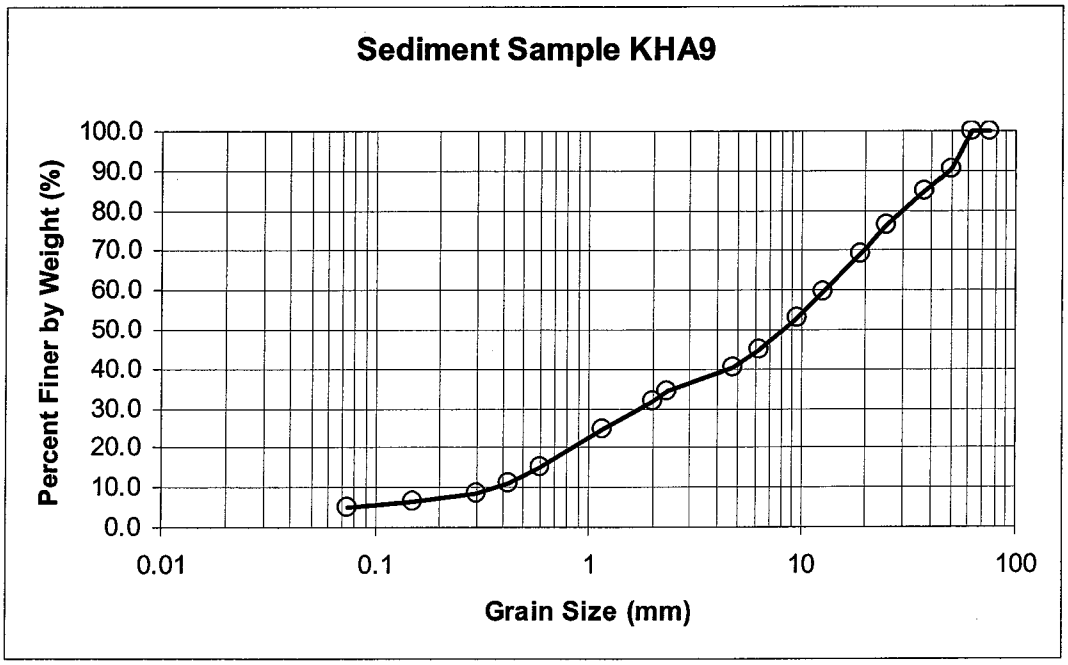
Sediment Sample KHA9 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	5.2
0.15	6.4
0.3	8.8
0.425	11.1
0.6	15.1
1.18	24.6
2	32.1
2.36	34.1
4.75	40.3
6.3	44.9
9.5	52.9
12.5	59.5
19	69.3
25	76.2
37.5	84.7
50	90.2
62.5	100.0
75	100.0

d_{15} (mm) = 0.60

d_{50} (mm) = 8.34

d_{85} (mm) = 38.14



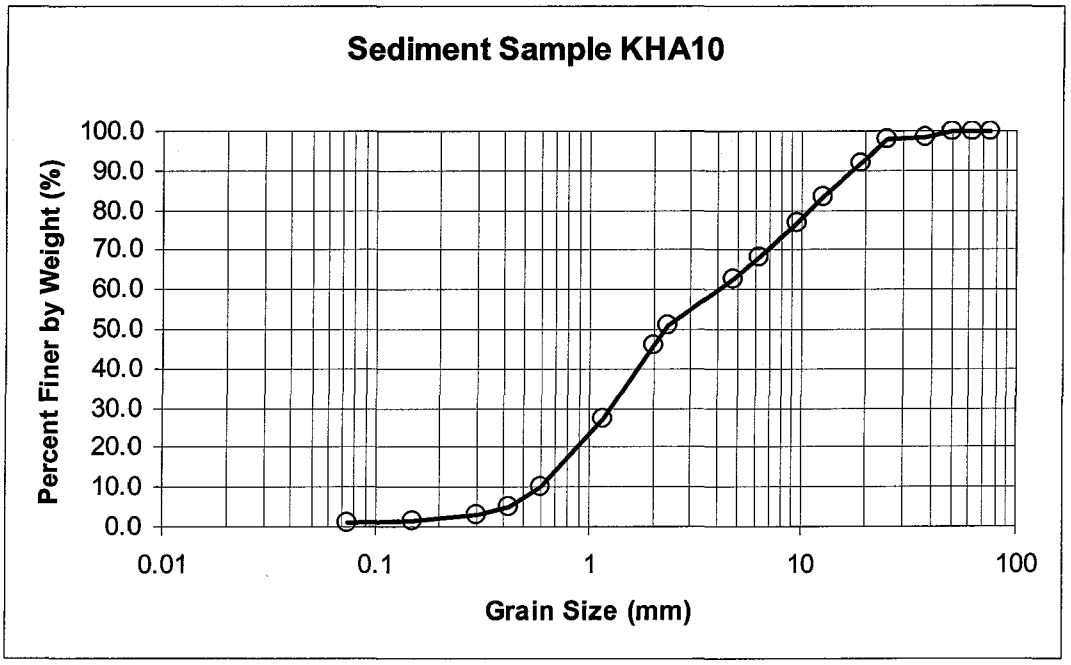
Sediment Sample KHA10 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	1.0
0.15	1.4
0.3	2.8
0.425	5.0
0.6	10.0
1.18	27.3
2	45.9
2.36	50.9
4.75	62.7
6.3	68.0
9.5	77.0
12.5	83.4
19	91.9
25	98.1
37.5	98.4
50	100.0
62.5	100.0
75	100.0

d_{15} (mm) = 0.77

d_{50} (mm) = 2.30

d_{85} (mm) = 13.69



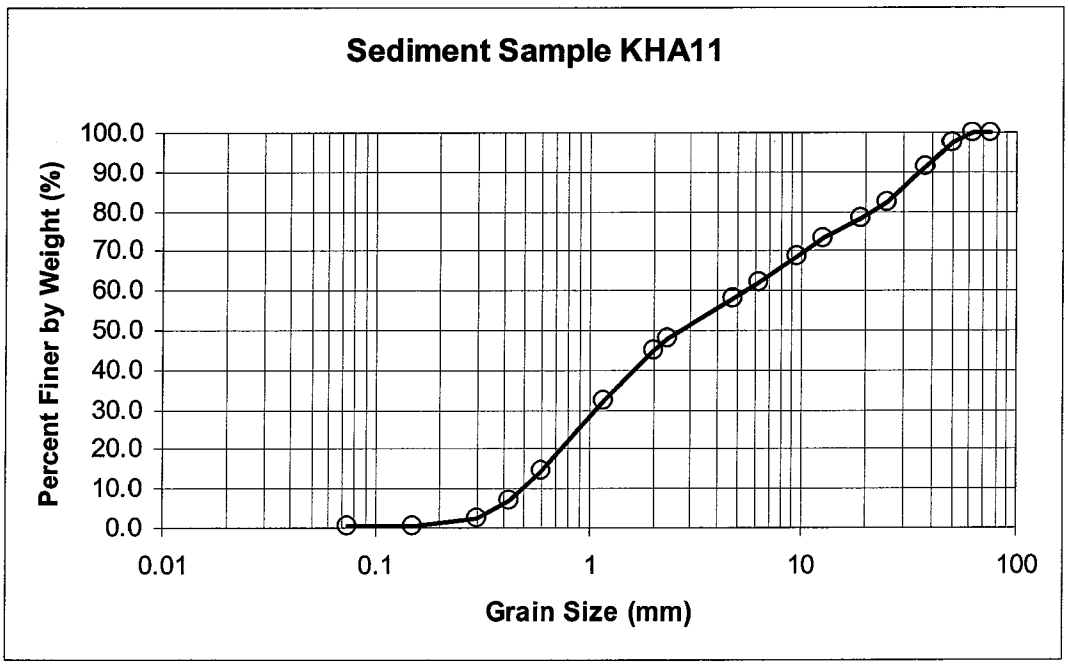
Sediment Sample KHA11 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	0.4
0.15	0.5
0.3	2.8
0.425	7.1
0.6	14.6
1.18	32.2
2	44.8
2.36	47.9
4.75	58.0
6.3	62.2
9.5	68.4
12.5	73.1
19	78.5
25	82.5
37.5	91.2
50	97.6
62.5	100.0
75	100.0

d_{15} (mm) = 0.61

d_{50} (mm) = 2.86

d_{85} (mm) = 28.56



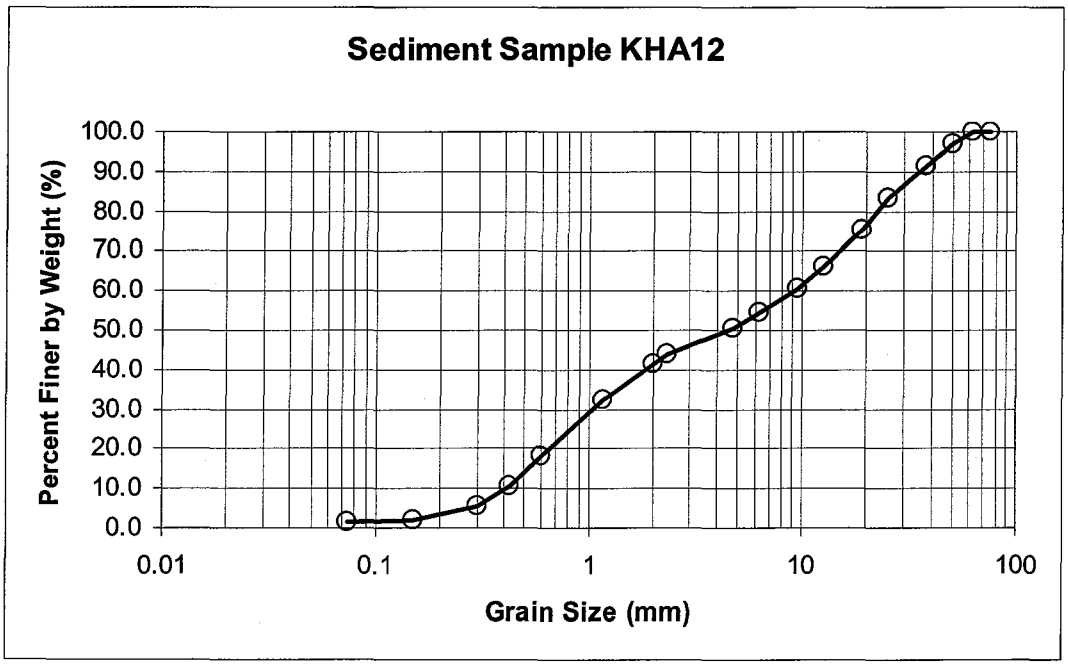
Sediment Sample KHA12 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	1.6
0.15	2.2
0.3	5.7
0.425	10.6
0.6	18.0
1.18	32.4
2	41.6
2.36	43.8
4.75	50.5
6.3	54.3
9.5	60.8
12.5	66.2
19	75.2
25	83.1
37.5	91.3
50	96.8
62.5	100.0
75	100.0

d_{15} (mm) = 0.53

d_{50} (mm) = 4.57

d_{85} (mm) = 27.90



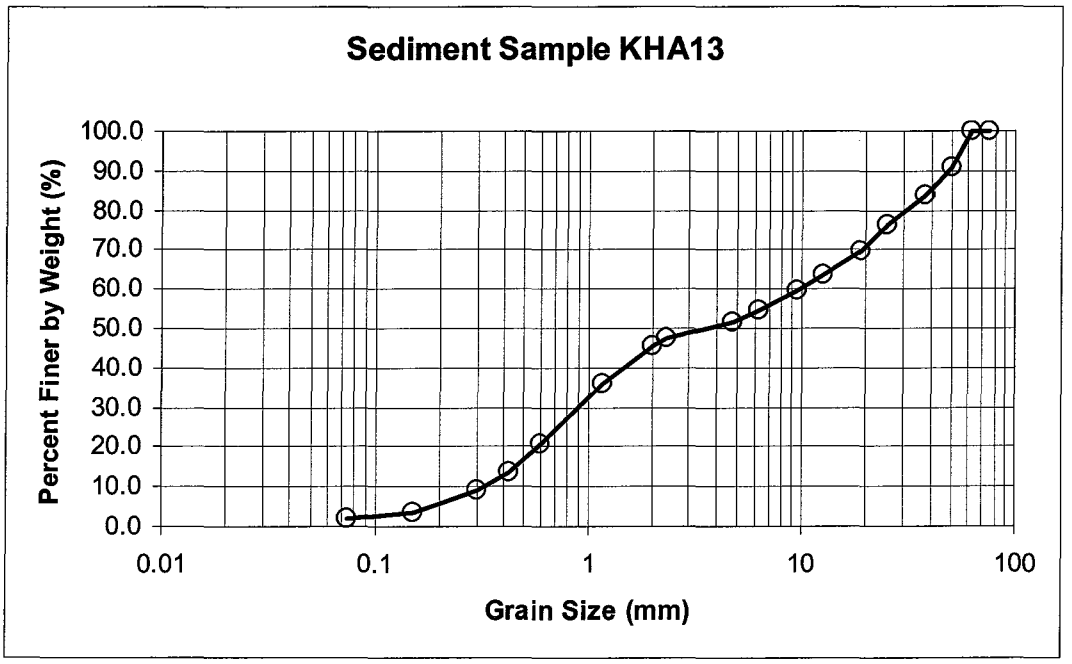
Sediment Sample KHA13 (KHA, 2000)

Sediment Size (mm)	Percent Finer by Weight (%)
0.075	2.2
0.15	3.8
0.3	9.1
0.425	13.5
0.6	20.7
1.18	36.0
2	45.3
2.36	47.3
4.75	51.7
6.3	54.4
9.5	59.6
12.5	63.8
19	69.8
25	76.4
37.5	83.8
50	90.7
62.5	100.0
75	100.0

d_{15} (mm) = 0.46

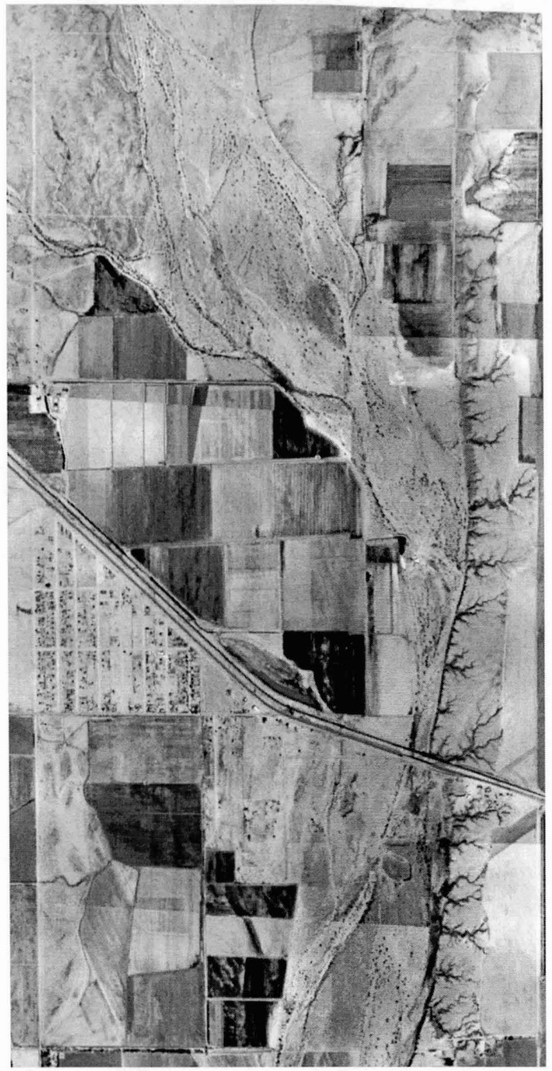
d_{50} (mm) = 3.84

d_{85} (mm) = 39.74



APPENDIX F

HISTORICAL SERIES OF AERIAL PHOTOGRAPHS

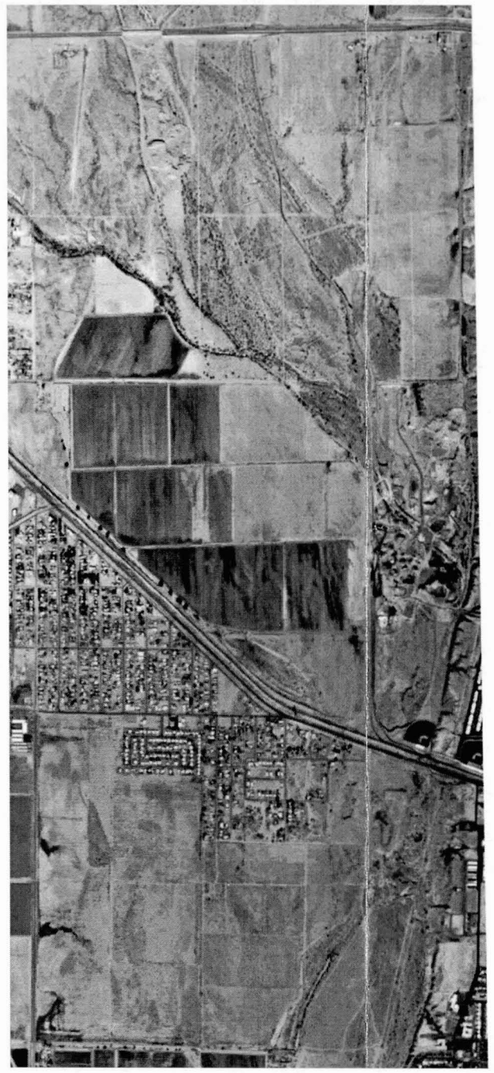


Reach 1: 1949

Reach 1: 1954

Reach 1: 1964

Reach 1: 1967



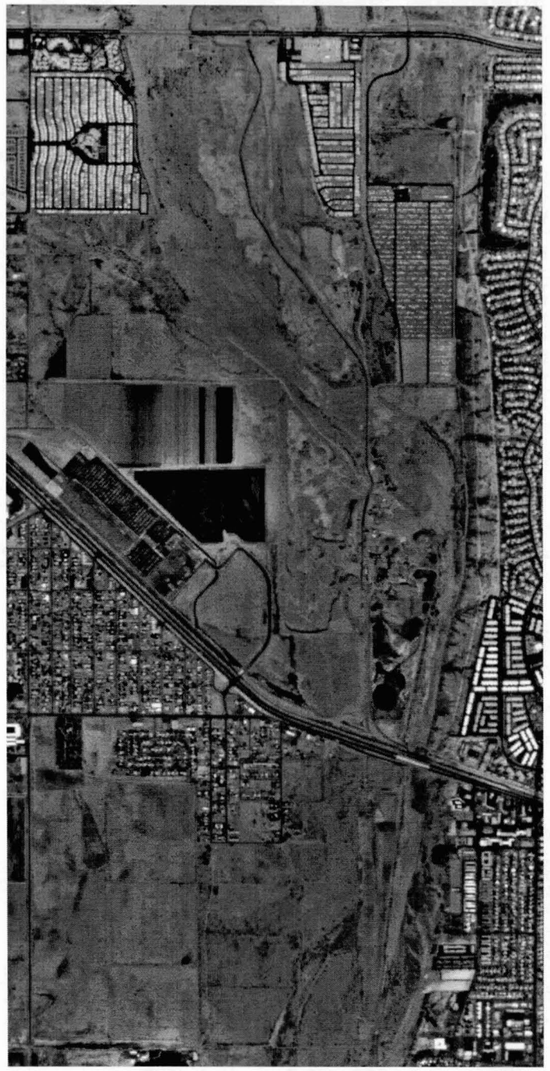
Reach 1: 1977

Reach 1: 1979

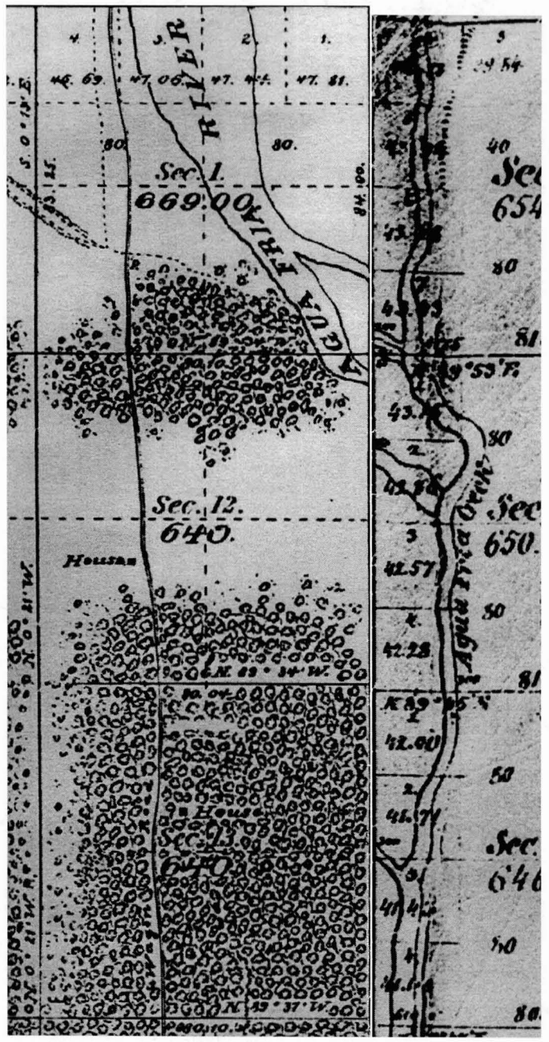
Reach 1: 1980

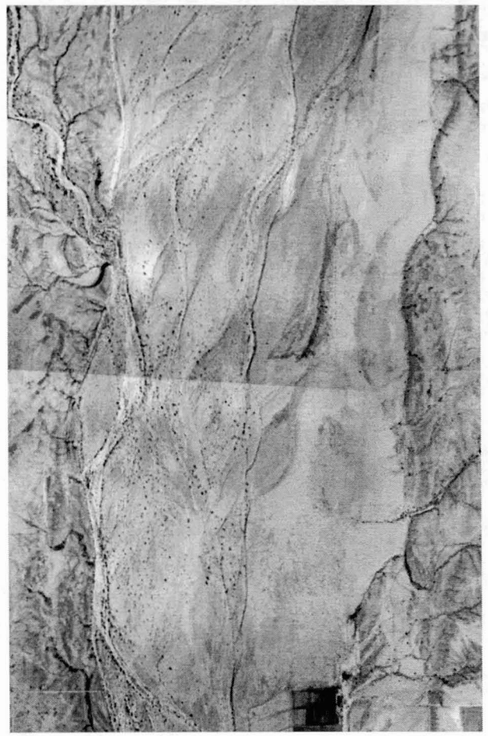
Reach 1: 1985

Reach 1: 1992



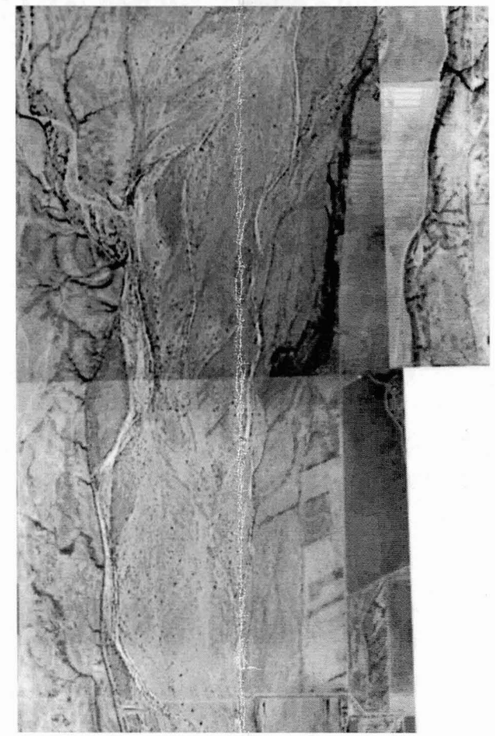
Reach 1: 1997



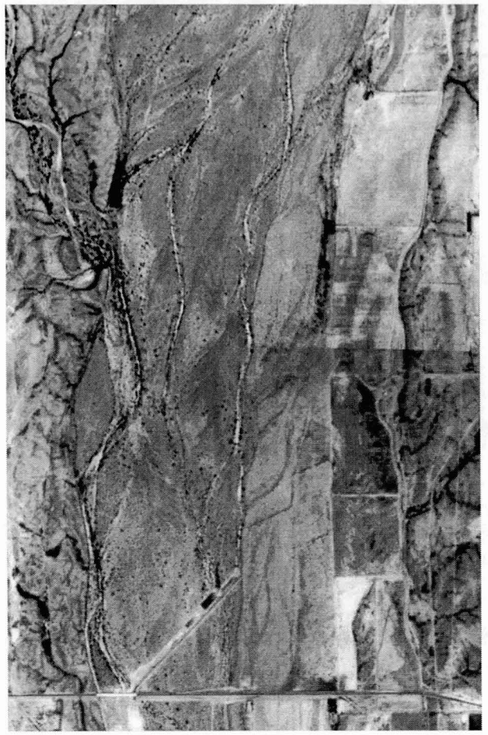


Reach 2: 1949

Reach 2: 1954

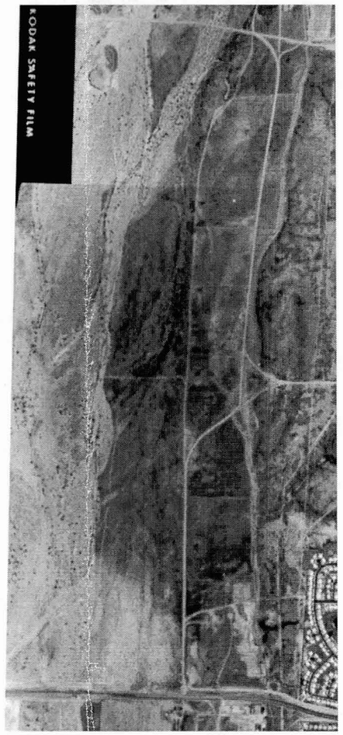


Reach 2: 1964

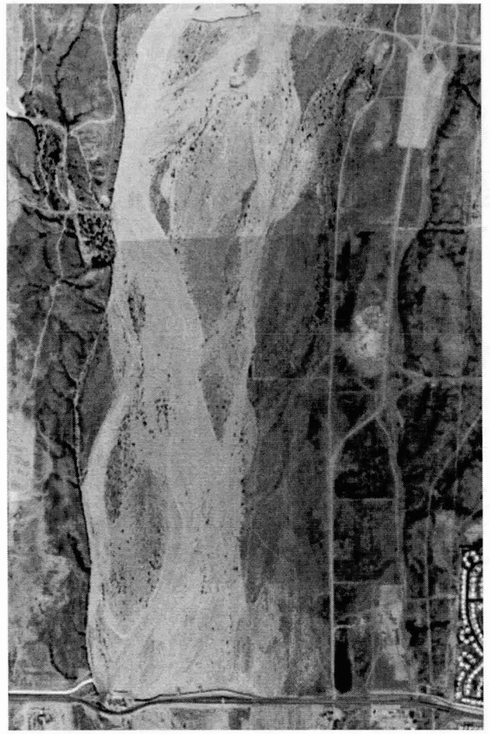


Reach 2: 1967

Reach 2: 1977



Reach 2: 1979



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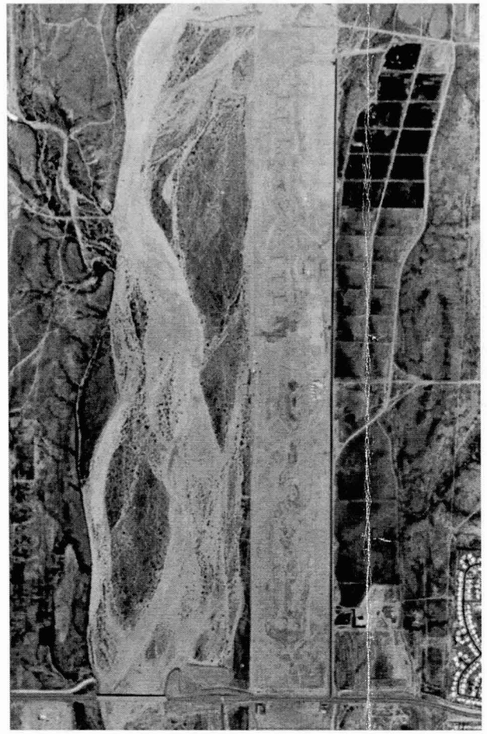


Reach 2: 1985

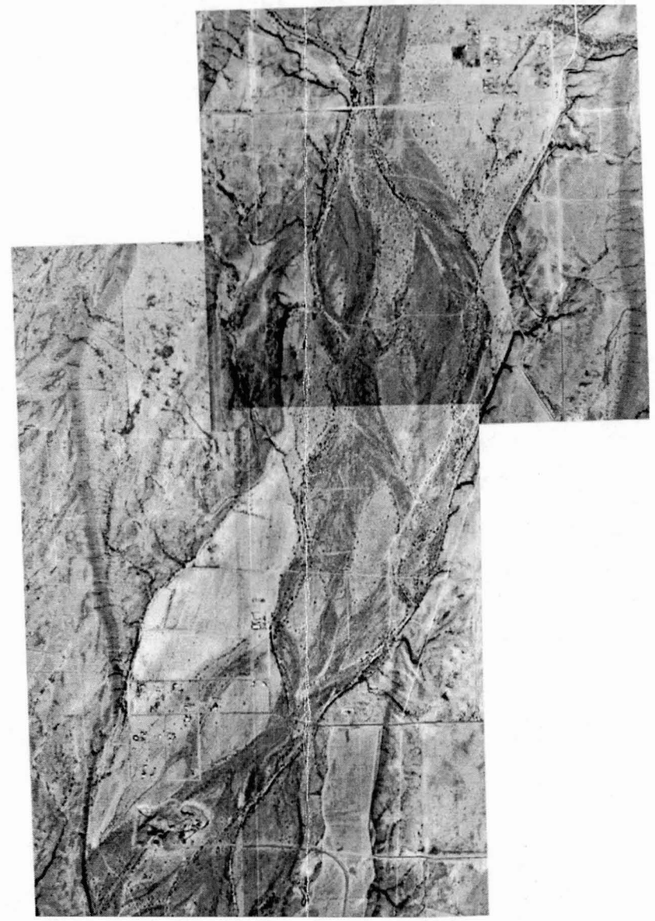
Reach 2: 1992

Reach 3: 1949

Reach 3: 1954

Reach 3: 1964

Reach 3: 1967



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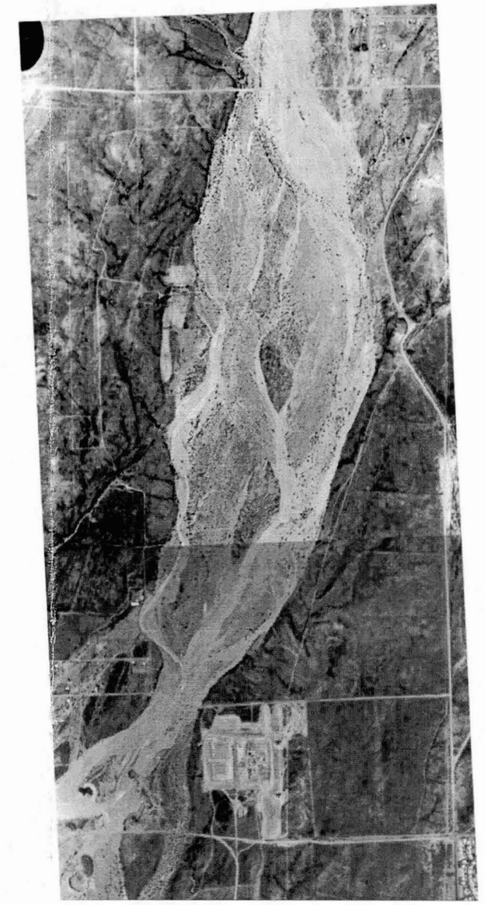

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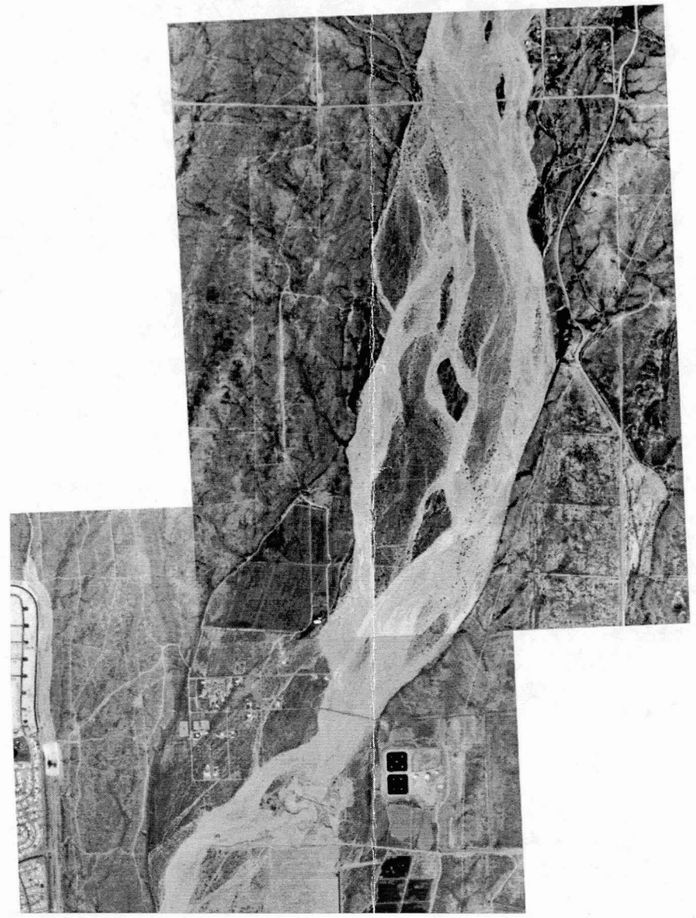
Reach 3: 1980



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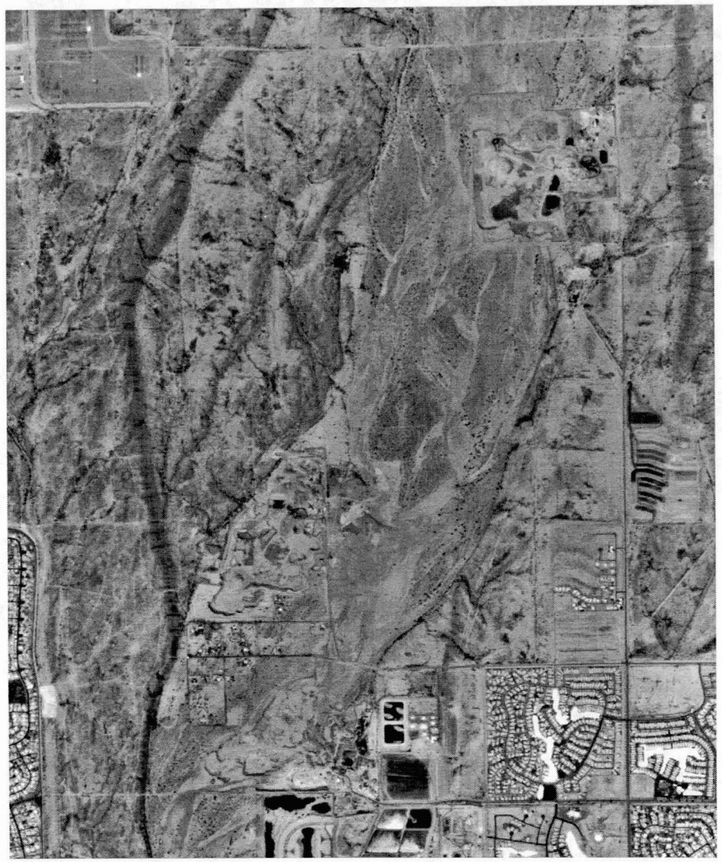

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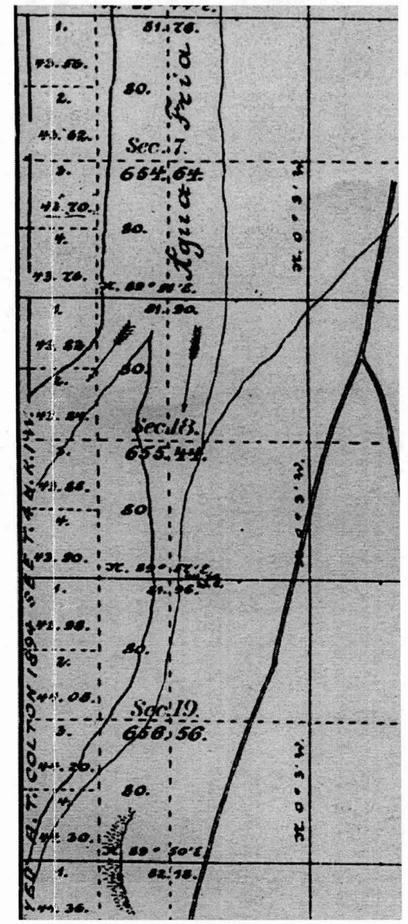
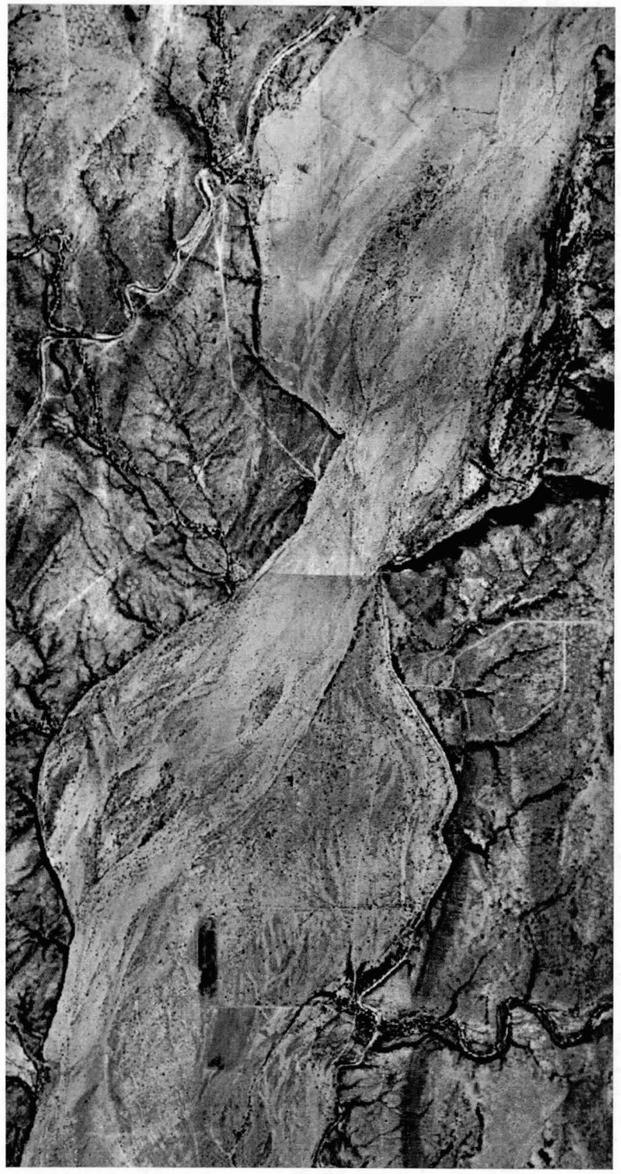
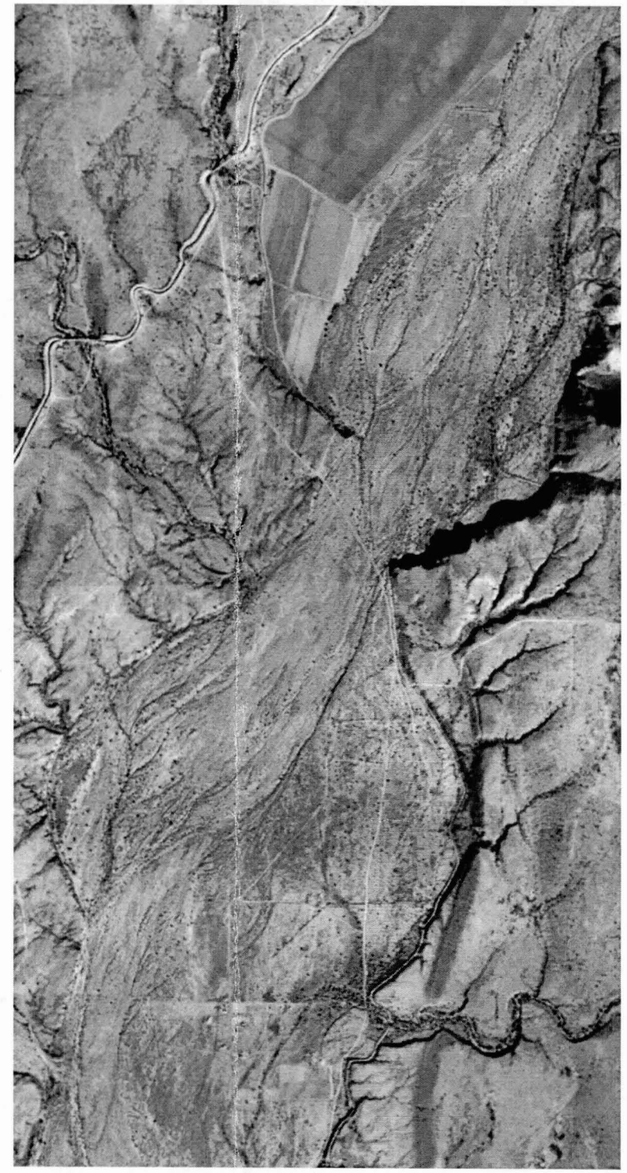




Reach 4: 1949

Reach 4: 1954



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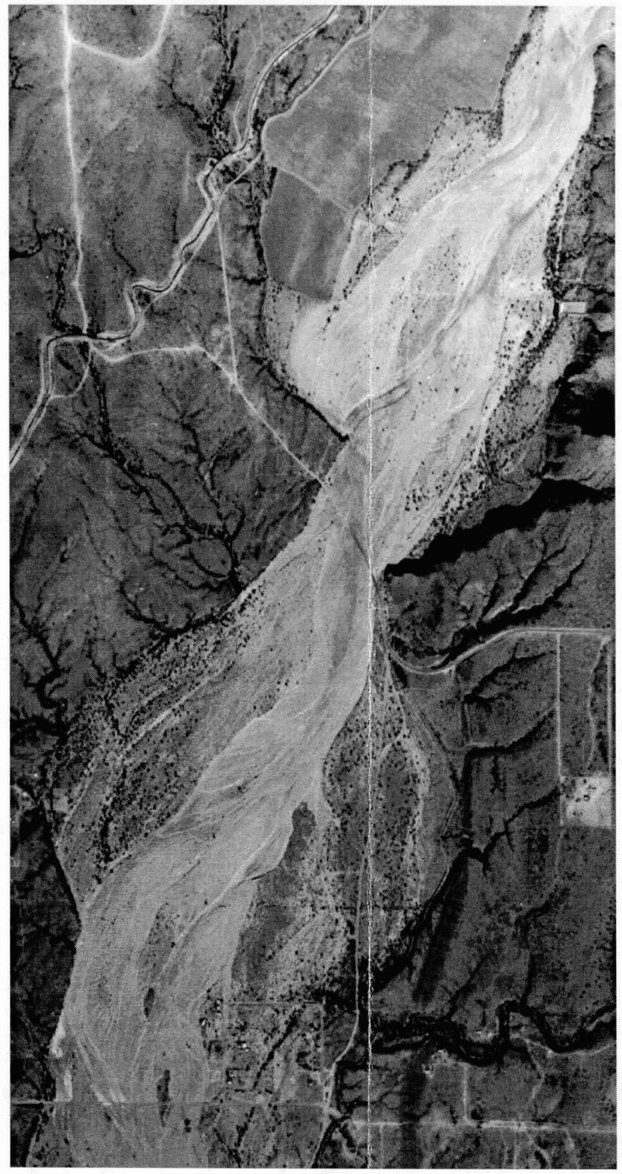

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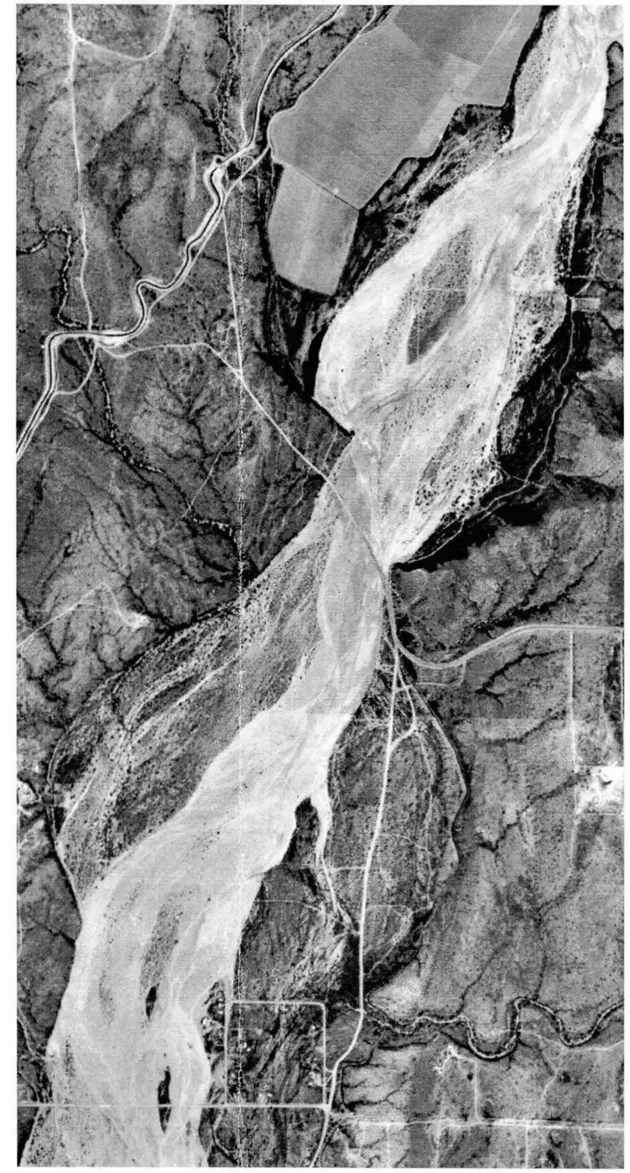

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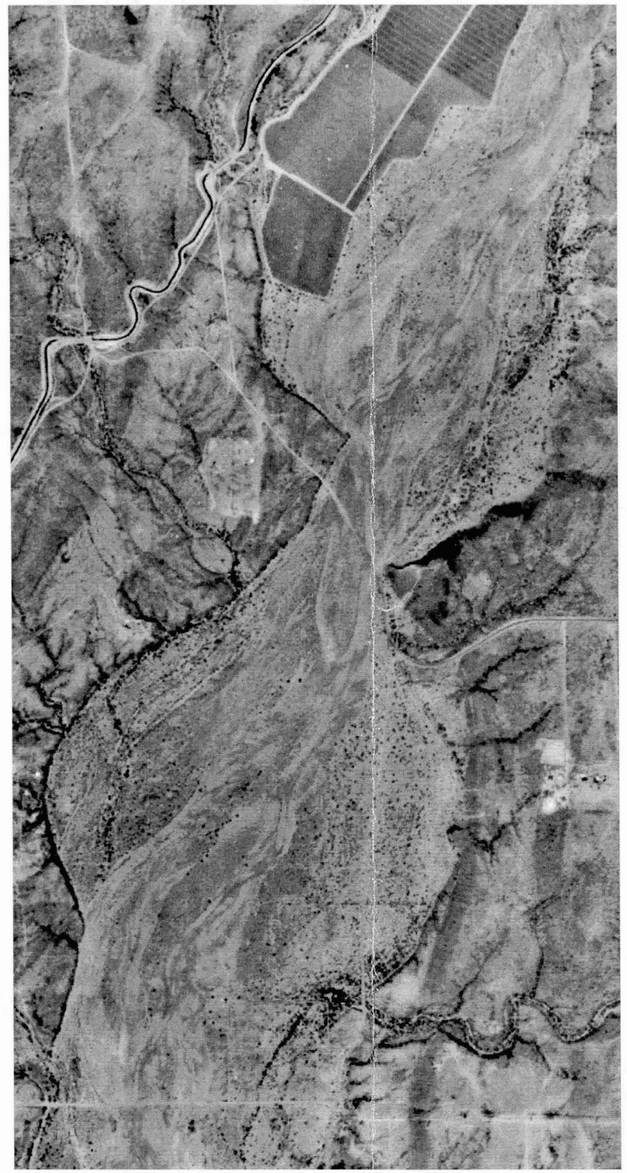

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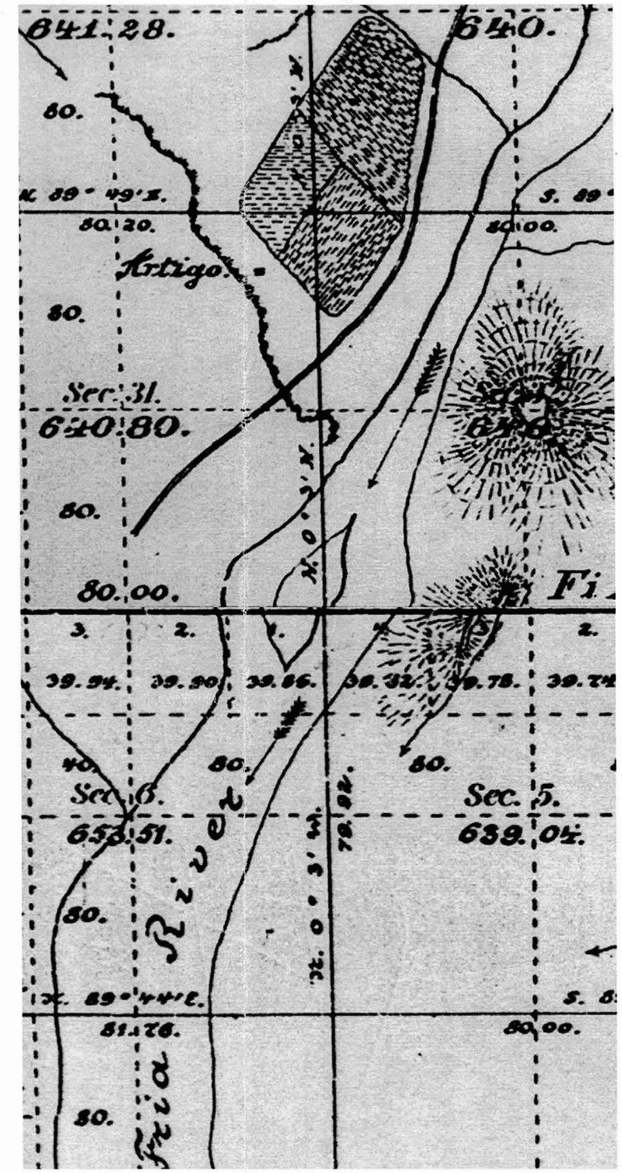


APPENDIX G

PREDICTED PROFILES FOR INITIAL MODEL

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Yang								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1094.28	1092.12	1094.1	1093.81	1093.84	1094.37	1094.33	1094.35	1094.42	1094.36	1094.4
15.64	1095.78	1093.84	1096.04	1096.21	1096.29	1095.84	1095.88	1095.87	1095.82	1095.83	1095.82
15.9	1099.61	1095.69	1098.86	1098.15	1098.91	1098.41	1098.19	1098.69	1098.93	1098.31	1098.71
16.1	1103.56	1097.34	1103.16	1103.11	1103.01	1102.43	1101.99	1102.21	1102.43	1102.32	1102.45
16.2	1103.79	1097.77	1103.32	1103.3	1103.16	1102.91	1102.62	1102.72	1102.35	1102.42	1102.22
16.4	1105.18	1101.57	1104.84	1104.86	1104.79	1104.82	1104.79	1104.83	1104.63	1104.53	1104.7
16.56	1107.55	1103.00	1107.57	1107.6	1107.58	1104.75	1105.84	1105.81	1103.26	1103.3	1104.4
16.71	1108.25	1104.09	1108.53	1108.53	1109.41	1101.22	1101.44	1103.65	1100.84	1101.04	1103.87
16.8	1109.6	1104.96	1110.6	1110.71	1110.59	1106.06	1106.39	1106.71	1103.88	1103.41	1105.39
16.9	1110.88	1107.10	1109.51	1109.59	1111.14	1100.87	1100.98	1101.36	1103.19	1104.24	1104.7
17	1114.42	1110.29	1110.84	1112.04	1107.85	1113.66	1113.76	1113.64	1111.71	1105.77	1110.31
17.07	1115.89	1112.37	1114.18	1114.37	1114.79	1108.47	1108.93	1109.08	1108.85	1112.35	1108.23
17.08	1116.47	1112.56	1109.32	1109.26	1109.98	1114.12	1115.09	1115.01	1115.49	1108.7	1114.74
17.1	1116.49	1112.81	1116.96	1117.09	1116.68	1109.74	1115.47	1113.96	1108.1	1116.36	1112.26
17.15	1116.4	1112.31	1110.97	1110.59	1111.1	1115.92	1115.59	1115.72	1115.61	1109.01	1113.96
17.2	1116.59	1112.96	1117.27	1117.37	1117.05	1115.25	1116.32	1116.34	1113.78	1117.18	1111.2
17.3	1117.36	1113.51	1116.1	1115.98	1116.75	1115.98	1115.77	1116.04	1116.55	1113.92	1114.9
17.4	1118.84	1114.36	1117.01	1116.9	1116.84	1116.32	1116.29	1117.13	1113.77	1115.1	1113.63
17.6	1119.07	1114.82	1118.01	1117.89	1118.06	1112.88	1114.86	1114.68	1117.72	1117.43	1117.13
17.9	1121.64	1121.47	1122.52	1122.83	1122.92	1114.59	1115.73	1116.59	1107.78	1109.76	1107.15
18.02	1124.43	1123.18	1125.52	1125.46	1125.03	1117.66	1119.3	1119.99	1117.75	1118.14	1117.41
18.14	1128.58	1125.13	1127.81	1127.94	1128.07	1122.29	1123.59	1124.19	1115.53	1120.81	1115.58
18.2	1129.72	1127.01	1130.69	1130.55	1130.3	1123.75	1125.74	1125.85	1123.26	1123.43	1124.83
18.36	1132.13	1128.70	1133.58	1133.49	1133.86	1128.87	1129.93	1130.03	1126.1	1126.67	1126.67
18.48	1134.89	1130.80	1134.04	1134.47	1133.96	1128.45	1130.06	1130.08	1127.85	1127.89	1128.64
18.61	1137.28	1131.97	1135.23	1134.39	1135.66	1130.65	1131.19	1131.21	1126.84	1127.4	1127.05
18.82	1141.27	1135.09	1137.43	1140.04	1138.59	1134.3	1135.64	1135.24	1133.44	1134.17	1134
19	1145.04	1138.79	1144.51	1143.52	1143.21	1142.71	1141.99	1141.8	1140.7	1140.68	1139.88

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Yang								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19.23	1149.44	1143.33	1147.08	1148.37	1147.92	1143.98	1143.69	1143.64	1142.38	1142.85	1142.14
19.48	1151.77	1147.81	1150.57	1150.51	1150.47	1146.53	1147.38	1147.7	1145.1	1145.44	1146.15
19.59	1152.3	1148.47	1148.61	1149.97	1150.09	1148.45	1147.96	1147.66	1146.81	1147.71	1146.01
19.7	1155.4	1152.22	1153.3	1153.74	1153.61	1150.84	1151.52	1152.01	1150.74	1150.14	1151.09
19.86	1155.91	1156.73	1156.15	1156.26	1156.34	1155.6	1155.01	1153.14	1152.54	1155.79	1151.6
20.08	1158.41	1160.82	1158.42	1158.45	1158.44	1158.03	1154.69	1158.02	1153.79	1157.38	1157.05
20.3	1162.47	1163.61	1162.68	1162.66	1162.66	1162.7	1162.53	1162.56	1162.29	1161.79	1161
20.48	1166.62	1167.13	1166.29	1166.17	1166.18	1164.58	1165.13	1165.85	1164.51	1163.82	1165.15
20.65	1170.07	1170.36	1169.68	1169.53	1169.49	1169.34	1169.65	1169.44	1169.19	1168.65	1168.96
20.86	1175.2	1173.03	1174.66	1174.92	1175.02	1171.67	1171.74	1171.83	1169.78	1169.82	1169.95
21.09	1180.46	1176.01	1178.1	1179.37	1179.4	1175.94	1176	1175.99	1173.96	1173.98	1173.99
21.26	1182.48	1178.91	1179.54	1181.14	1181.2	1178.56	1179.45	1178.97	1178.32	1179.05	1179.72
21.57	1185.27	1182.58	1183.58	1185.41	1185.67	1182.51	1181.26	1181.29	1180.9	1180.56	1179.46
21.87	1190.14	1187.35	1190.27	1190.51	1190.7	1190.21	1189.38	1189.8	1189.64	1188.95	1189.95
22.07	1193.24	1189.39	1192.57	1193.23	1193.57	1192.26	1193.06	1193.05	1191.76	1193.01	1192.78
22.32	1195.16	1190.31	1195.19	1195.33	1195.73	1195.17	1195.3	1195.73	1195.14	1195.3	1195.67
22.72	1200.53	1195.49	1198.57	1199.79	1200.27	1199.65	1199.86	1200.34	1198.61	1200.01	1200.44
22.97	1205.04	1200.73	1205.05	1205.13	1205.42	1205.13	1205.14	1205.47	1205.06	1205.12	1205.53
23.15	1208.25	1202.93	1206.83	1207.19	1207.54	1206.29	1207.2	1207.41	1206.96	1207.32	1207.43
23.33	1211.38	1204.30	1208.16	1208.78	1209.21	1208.26	1208.79	1209.14	1208.15	1208.83	1209.18
23.62	1215.41	1212.13	1214.64	1215.47	1216	1214.4	1215.47	1215.92	1214.53	1215.48	1215.96
24.04	1220.57	1218.66	1220.14	1220.91	1222.25	1220.17	1220.91	1222.24	1220.15	1220.91	1222.26
24.32	1225.16	1224.69	1223.14	1225.04	1227.02	1223.14	1225.04	1227.06	1223.18	1225.01	1227.06
		RMSE	3.220	3.385	3.245	3.008	2.470	2.283	4.771	3.886	4.560

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and Schoklitsch								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1094.28	1092.12	1093.92	1093.89	1093.48	1093.12	1093.18	1092.89	1093.24	1093.21	1093.05
15.64	1095.78	1093.84	1096.24	1096.27	1096.26	1096.03	1096.03	1096.03	1095.98	1095.96	1095.96
15.9	1099.61	1095.69	1099.55	1099.52	1099.48	1099.11	1099.12	1099.06	1099.09	1099.11	1099.08
16.1	1103.56	1097.34	1102.39	1102.52	1102.57	1101.99	1101.97	1102.12	1101.69	1101.92	1102.01
16.2	1103.79	1097.77	1102.46	1103.01	1102.86	1102.27	1102.11	1102.16	1102	1102.02	1102.13
16.4	1105.18	1101.57	1105.19	1105.19	1105.14	1104.55	1104.59	1104.57	1104.37	1104.36	1104.52
16.56	1107.55	1103.00	1107.61	1107.66	1107.62	1105.29	1105.3	1104.93	1104.72	1104.72	1104.53
16.71	1108.25	1104.09	1109.53	1109.26	1109.64	1104.79	1103.84	1103.49	1102.38	1100.09	1102.51
16.8	1109.6	1104.96	1110.61	1110.76	1110.68	1106.68	1106.98	1106.35	1104.74	1103.98	1104.76
16.9	1110.88	1107.10	1109.01	1108.19	1109	1104.45	1103.12	1102.76	1103.49	1103.37	1103.49
17	1114.42	1110.29	1112.53	1112.5	1111.49	1108.57	1107.2	1106.1	1107.91	1106.89	1107.76
17.07	1115.89	1112.37	1107.57	1107.83	1111.91	1107.24	1104.58	1105.05	1107.23	1106.35	1107.12
17.08	1116.47	1112.56	1112.21	1112.1	1111.78	1111.06	1109.35	1108.34	1110.31	1110.07	1110.05
17.1	1116.49	1112.81	1109.89	1111.19	1112.8	1109.26	1113.79	1115.86	1109.51	1112.5	1111.55
17.15	1116.4	1112.31	1113.56	1112.99	1112.58	1109.5	1107.58	1108.98	1109.75	1109.52	1109.14
17.2	1116.59	1112.96	1111.07	1111.68	1112.59	1109.79	1111.99	1113.41	1108.88	1111.54	1110.02
17.3	1117.36	1113.51	1114.74	1114.74	1114.18	1109.31	1110.16	1114.97	1110.29	1110.69	1109.94
17.4	1118.84	1114.36	1113.31	1114.26	1114.66	1111.36	1112.21	1112.95	1109.85	1111.25	1109.96
17.6	1119.07	1114.82	1114.86	1115.5	1116.13	1108.17	1108.34	1115.92	1111.31	1109.29	1110.71
17.9	1121.64	1121.47	1121.91	1122.26	1122.61	1109.62	1110.44	1110.42	1107.09	1110.45	1108.13
18.02	1124.43	1123.18	1123.4	1123.77	1124.44	1115.01	1114.89	1117.42	1113.19	1112.9	1113.31
18.14	1128.58	1125.13	1127.75	1128.24	1128.31	1122.27	1122.34	1122.71	1120.41	1121.05	1121.12
18.2	1129.72	1127.01	1131.52	1129.58	1129.96	1123.91	1123.71	1124.57	1120.93	1120.92	1122.17
18.36	1132.13	1128.70	1132.78	1133.37	1133.17	1127.05	1127.55	1128.13	1124.67	1124.31	1125.93
18.48	1134.89	1130.80	1134.39	1133.76	1134.31	1127.9	1127.92	1128	1126.14	1125.92	1126.01
18.61	1137.28	1131.97	1133.76	1133.78	1134.63	1130.4	1130.43	1130.46	1126.9	1126.24	1127.82
18.82	1141.27	1135.09	1138.51	1137.98	1138.2	1134.08	1134.66	1134.24	1132.75	1132.51	1132.94

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and Schoklitsch								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1145.04	1138.79	1141.91	1142.41	1141.78	1139.65	1140.25	1139.91	1137.85	1137.94	1138.25
19.23	1149.44	1143.33	1146.54	1147.23	1147.78	1144.06	1143.97	1143.87	1142.06	1142.15	1141.95
19.48	1151.77	1147.81	1149.25	1150.1	1149.58	1146.85	1146.8	1146.87	1145.17	1145.53	1145.27
19.59	1152.3	1148.47	1150.68	1151.68	1151.47	1148.1	1149.21	1149.98	1146.84	1147.2	1146.69
19.7	1155.4	1152.22	1151.49	1152.53	1152.61	1150.95	1149.55	1150.27	1149.94	1150.1	1149.86
19.86	1155.91	1156.73	1155.89	1156.36	1155.24	1152.93	1154.67	1154.91	1151.69	1152.55	1151.61
20.08	1158.41	1160.82	1157.95	1158.65	1158.23	1155.56	1155.69	1155.47	1154.19	1152.92	1154.73
20.3	1162.47	1163.61	1162.88	1163.45	1163.67	1162.81	1162.63	1161.73	1160.24	1160.62	1159.05
20.48	1166.62	1167.13	1166.39	1166.75	1165.4	1165.27	1165.2	1163.84	1163.06	1162.97	1162.86
20.65	1170.07	1170.36	1169.42	1169.62	1169.55	1168.78	1169.03	1168.67	1167.92	1168.21	1167.31
20.86	1175.2	1173.03	1174.69	1174.82	1174.53	1171.7	1171.7	1171.64	1169.66	1169.71	1169.81
21.09	1180.46	1176.01	1178.37	1177.67	1178.03	1176	1175.95	1176.09	1174.03	1173.89	1174.01
21.26	1182.48	1178.91	1178.67	1179.74	1178.88	1178.83	1179.27	1177.17	1178.5	1178.45	1179.3
21.57	1185.27	1182.58	1184.8	1181.6	1183.49	1181.82	1180.18	1181.87	1179.94	1179.87	1179.62
21.87	1190.14	1187.35	1189.64	1189.55	1189.05	1187.36	1188.91	1188.86	1186.89	1187.49	1188.74
22.07	1193.24	1189.39	1191.66	1190.36	1190.93	1191.45	1190.22	1191.2	1191	1190.02	1189.92
22.32	1195.16	1190.31	1195.2	1195.59	1194.74	1194.17	1195.45	1194.89	1193.11	1195.43	1195.39
22.72	1200.53	1195.49	1197.47	1196.85	1199.11	1198.53	1195.3	1199.36	1198.21	1195.84	1196.93
22.97	1205.04	1200.73	1205.08	1205.1	1204.35	1205.22	1205.1	1204.07	1203.62	1204.57	1203.95
23.15	1208.25	1202.93	1204.65	1205.91	1206.98	1205.66	1205.37	1207.28	1205.38	1205.81	1206.02
23.33	1211.38	1204.30	1208.38	1208.98	1208.53	1209.09	1209.21	1208.24	1207.85	1208.71	1208.36
23.62	1215.41	1212.13	1214.04	1214.79	1215.45	1213.46	1214.71	1215.43	1213.03	1214.82	1215.37
24.04	1220.57	1218.66	1220.02	1220.6	1221.45	1219.79	1220.62	1221.3	1220.06	1220.57	1221.52
24.32	1225.16	1224.69	1222.63	1224.22	1226.44	1222.5	1224.24	1226.57	1222.7	1224.28	1226.45
		RMSE	2.630	2.558	2.397	4.312	4.349	3.743	5.271	4.862	4.910

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Meyer-Peter and Muller								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1094.28	1092.12	1092.63	1092.63	1092.61	1092.57	1092.57	1092.58	1092.51	1092.51	1092.51
15.64	1095.78	1093.84	1096.97	1097.04	1097.06	1096.93	1096.92	1096.91	1096.65	1096.66	1096.66
15.9	1099.61	1095.69	1099.4	1099.43	1099.2	1098.92	1098.94	1098.95	1098.77	1098.77	1098.77
16.1	1103.56	1097.34	1102.4	1102.45	1102.57	1102.15	1102.12	1102.11	1102.21	1102.21	1102.21
16.2	1103.79	1097.77	1102.77	1102.6	1102.81	1102.54	1102.54	1102.53	1102.66	1102.66	1102.67
16.4	1105.18	1101.57	1105.84	1105.75	1105.74	1104.57	1104.56	1104.56	1104.56	1104.57	1104.57
16.56	1107.55	1103.00	1107.08	1107.34	1107.34	1105.33	1105.27	1105.3	1104.12	1104.15	1104.06
16.71	1108.25	1104.09	1111.35	1110.91	1111.14	1106.38	1106.23	1106.19	1101.97	1101.7	1102.25
16.8	1109.6	1104.96	1109.26	1109.44	1109.49	1106	1105.82	1106.37	1105.56	1105.93	1105.52
16.9	1110.88	1107.10	1110.41	1110.33	1110.26	1105.13	1104.87	1104.95	1103.33	1103.29	1103.26
17	1114.42	1110.29	1109.16	1110.37	1110.38	1106.9	1106.69	1106.56	1106	1105.97	1106.04
17.07	1115.89	1112.37	1110.26	1111.16	1111.08	1105.7	1105.72	1105.91	1105.62	1105.51	1105.7
17.08	1116.47	1112.56	1111.49	1112.02	1110.52	1108.61	1109.03	1108.48	1109.34	1109.38	1109.33
17.1	1116.49	1112.81	1110.71	1110.27	1111.39	1108.96	1108.88	1107.87	1108.47	1109.56	1108.58
17.15	1116.4	1112.31	1112.47	1112.57	1111.98	1109.06	1108.45	1108.71	1108.95	1108.96	1108.72
17.2	1116.59	1112.96	1109.38	1109.26	1110.99	1108.57	1108.61	1108.17	1107.52	1107.4	1107.46
17.3	1117.36	1113.51	1113.97	1114.15	1114.3	1109.06	1109.16	1109.17	1108.46	1108.58	1108.43
17.4	1118.84	1114.36	1112.61	1112.73	1111.82	1110.77	1110.75	1110.73	1108.92	1108.92	1108.92
17.6	1119.07	1114.82	1118.43	1117.39	1116.99	1107.8	1107.92	1107.95	1108.73	1108.83	1108.64
17.9	1121.64	1121.47	1121.81	1122.25	1122.19	1110.97	1110.95	1111.04	1105.8	1105.8	1105.88
18.02	1124.43	1123.18	1123.74	1124.46	1124.7	1115.82	1115.83	1115.63	1113.48	1113.53	1113.17
18.14	1128.58	1125.13	1128.96	1128.5	1129.17	1121.44	1121.48	1122.06	1118.69	1118.75	1119.04
18.2	1129.72	1127.01	1130.92	1130.55	1131.38	1123.84	1123.88	1123.47	1122.03	1122.02	1122.09
18.36	1132.13	1128.70	1134.04	1133.2	1134.45	1127.82	1127.83	1127.82	1125.57	1125.56	1125.62
18.48	1134.89	1130.80	1134.39	1134.77	1135.03	1128.12	1128.08	1128.03	1126.87	1126.89	1126.87
18.61	1137.28	1131.97	1135.62	1135.44	1136.13	1130.16	1130.09	1130.15	1125.98	1125.93	1126.03
18.82	1141.27	1135.09	1139.37	1139.4	1139.39	1133.27	1133.28	1133.27	1132.75	1132.75	1132.79

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Meyer-Peter and Muller								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1145.04	1138.79	1143.77	1143.6	1143.76	1139.39	1139.28	1139.35	1137.5	1137.54	1137.5
19.23	1149.44	1143.33	1147.04	1147.09	1147.29	1143.47	1143.48	1143.49	1141.55	1141.57	1141.58
19.48	1151.77	1147.81	1151.25	1151.37	1151.08	1146.33	1146.38	1146.33	1144.5	1144.52	1144.6
19.59	1152.3	1148.47	1148.04	1148.19	1148.09	1147.86	1147.5	1147.82	1146.06	1146.17	1146.05
19.7	1155.4	1152.22	1153.91	1154.01	1153.89	1149.92	1150.02	1149.96	1149.3	1149.28	1149.37
19.86	1155.91	1156.73	1154.94	1154.82	1154.84	1153.33	1153.46	1153.39	1151.93	1152.08	1152.03
20.08	1158.41	1160.82	1159.71	1159.81	1159.82	1156.15	1156.17	1156.15	1155.59	1155.37	1155.48
20.3	1162.47	1163.61	1160.56	1160.42	1160.34	1162.88	1162.98	1162.98	1162.09	1162.09	1162.1
20.48	1166.62	1167.13	1168.37	1168.45	1168.33	1165.48	1165.48	1165.42	1165.3	1165.27	1165.23
20.65	1170.07	1170.36	1170.05	1170.11	1170.04	1169.36	1169.35	1169.34	1169.24	1169.23	1169.23
20.86	1175.2	1173.03	1175.34	1175.43	1175.36	1171.68	1171.68	1171.67	1169.77	1169.77	1169.76
21.09	1180.46	1176.01	1178.5	1178.43	1178.53	1176	1176	1175.99	1173.93	1173.93	1173.93
21.26	1182.48	1178.91	1180.16	1180.13	1180.2	1177.99	1178.02	1178.03	1177.48	1177.5	1177.43
21.57	1185.27	1182.58	1183.04	1182.99	1182.95	1181.15	1181.06	1180.91	1179.69	1179.63	1179.6
21.87	1190.14	1187.35	1191.15	1191.18	1191.22	1190.44	1190.55	1190.56	1189.66	1189.72	1189.86
22.07	1193.24	1189.39	1191.42	1191.21	1191.15	1191.46	1191.36	1191.22	1191.22	1191.07	1191.05
22.32	1195.16	1190.31	1196.21	1196.22	1196.24	1195.94	1196	1196.07	1196.19	1196.25	1196.18
22.72	1200.53	1195.49	1196.69	1196.59	1196.46	1196.82	1196.65	1196.57	1196.77	1196.73	1196.56
22.97	1205.04	1200.73	1206.7	1206.65	1206.66	1206.66	1206.62	1206.7	1206.68	1206.59	1206.67
23.15	1208.25	1202.93	1206.12	1205.98	1206.1	1206.08	1205.9	1205.99	1206.12	1206.02	1206.15
23.33	1211.38	1204.30	1209.01	1208.7	1208.55	1208.99	1208.69	1208.61	1209	1208.65	1208.58
23.62	1215.41	1212.13	1214.93	1215.82	1216.37	1214.95	1215.81	1216.38	1214.94	1215.86	1216.39
24.04	1220.57	1218.66	1220.27	1220.41	1220.56	1220.27	1220.41	1220.55	1220.27	1220.41	1220.52
24.32	1225.16	1224.69	1222.5	1223.2	1224.06	1222.5	1223.21	1224.1	1222.5	1223.21	1224.06
		RMSE	3.108	2.953	3.161	4.428	4.424	4.492	5.924	5.881	5.918

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and MPM								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1094.28	1092.12	1093.72	1093.37	1092.83	1092.74	1092.97	1092.84	1092.62	1092.96	1092.56
15.64	1095.78	1093.84	1096.53	1096.32	1096.45	1096.23	1096.25	1096.29	1096.2	1096.17	1096.15
15.9	1099.61	1095.69	1099.36	1099.31	1099.2	1098.67	1098.61	1098.7	1098.34	1098.37	1098.38
16.1	1103.56	1097.34	1101.91	1102.24	1102.17	1101.8	1101.85	1101.93	1101.69	1101.86	1101.84
16.2	1103.79	1097.77	1102.72	1102.74	1102.26	1102.05	1101.95	1101.98	1101.59	1101.77	1101.87
16.4	1105.18	1101.57	1104.59	1105.22	1104.93	1104.28	1104.36	1104.41	1104.1	1104.13	1104.01
16.56	1107.55	1103.00	1107.15	1106.8	1107.1	1105.73	1105.36	1105.29	1103.51	1103.84	1104.43
16.71	1108.25	1104.09	1110.04	1110.02	1109.53	1104.03	1105.51	1105.61	1103.3	1103.65	1100.91
16.8	1109.6	1104.96	1108.7	1108.3	1108.74	1106.99	1105.83	1105.83	1102.28	1102.96	1105.16
16.9	1110.88	1107.10	1109.59	1108.82	1107.28	1102.06	1103.07	1102.75	1103.5	1103.57	1103.54
17	1114.42	1110.29	1109.7	1108.15	1109.82	1108.1	1108.3	1107.72	1106.06	1106.49	1107.07
17.07	1115.89	1112.37	1110.99	1110.25	1109.5	1106.85	1104.81	1107.12	1106.35	1106.44	1106.2
17.08	1116.47	1112.56	1105.65	1109.3	1109.42	1110.12	1109.22	1108.96	1109.46	1110.23	1109.98
17.1	1116.49	1112.81	1112.47	1111.21	1111.64	1109.23	1108.6	1108.85	1108.82	1108.67	1109.61
17.15	1116.4	1112.31	1109.05	1110.52	1110.11	1110.66	1110.28	1110.39	1110.81	1109.93	1111.22
17.2	1116.59	1112.96	1112.88	1111.73	1112.34	1110.12	1109.08	1109.75	1108.12	1108.24	1108.53
17.3	1117.36	1113.51	1109.76	1112.84	1108.64	1109.62	1109.12	1109.31	1109.5	1108.55	1108.86
17.4	1118.84	1114.36	1113.68	1113.38	1113.51	1114.05	1111.12	1112.02	1110.11	1109.79	1109.77
17.6	1119.07	1114.82	1115.36	1117.29	1117.33	1105.51	1109.48	1109.16	1112.77	1109.57	1109.76
17.9	1121.64	1121.47	1123.45	1123.46	1123.23	1112.16	1111.44	1110.87	1105.48	1107.16	1106.14
18.02	1124.43	1123.18	1125.32	1126.16	1125.56	1114.39	1114.39	1117.34	1114.31	1113.87	1112.8
18.14	1128.58	1125.13	1131.01	1130.69	1130.69	1124.14	1123.68	1122.43	1119.48	1120.19	1119.3
18.2	1129.72	1127.01	1130.69	1133.06	1131.68	1122.18	1122.33	1124.7	1121.81	1121.25	1120.83
18.36	1132.13	1128.70	1134.63	1135.49	1135.7	1128.39	1127.62	1127.98	1125.55	1125.87	1125.73
18.48	1134.89	1130.80	1134.26	1134.75	1133.9	1128.05	1127.98	1128.09	1126.83	1126.77	1126.16
18.61	1137.28	1131.97	1135.54	1136.42	1136.85	1130.46	1130.39	1130.5	1126.77	1126.02	1126.48
18.82	1141.27	1135.09	1137.68	1137.58	1137.78	1133.03	1132.79	1133.2	1133.24	1134.16	1134.4

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and MPM								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1145.04	1138.79	1142.51	1143.02	1143.43	1138.36	1138.35	1138.53	1136.59	1136.59	1137.21
19.23	1149.44	1143.33	1144.19	1143.57	1144.79	1144	1143.98	1144.08	1142	1142.28	1142.1
19.48	1151.77	1147.81	1150.97	1151.07	1150.36	1147.57	1147.82	1147.42	1146.18	1144.79	1144.88
19.59	1152.3	1148.47	1147.85	1147.85	1145.67	1147.95	1147.64	1147.79	1147.17	1147.13	1145.98
19.7	1155.4	1152.22	1154.32	1154.24	1153.03	1153.99	1155.68	1151.79	1151.38	1150.8	1150.6
19.86	1155.91	1156.73	1153.49	1153.39	1154.56	1152.27	1152.52	1151.97	1151.89	1152	1151.17
20.08	1158.41	1160.82	1158.36	1158.71	1152.84	1156.69	1156.27	1156.41	1154.16	1153.37	1156.05
20.3	1162.47	1163.61	1160.22	1160.45	1163.13	1159.64	1159.31	1158.66	1158.11	1158.3	1157.83
20.48	1166.62	1167.13	1166.43	1166.62	1164.75	1165.39	1164.73	1164.8	1162.41	1162.64	1163.26
20.65	1170.07	1170.36	1168.44	1168.37	1169.05	1166.88	1167.2	1166.52	1165.96	1166.16	1165.69
20.86	1175.2	1173.03	1174.88	1174.82	1174.61	1171.81	1171.64	1171.52	1169.56	1169.59	1169.5
21.09	1180.46	1176.01	1177.72	1177.14	1178.5	1173.59	1175.52	1174.31	1173.19	1173.13	1173.01
21.26	1182.48	1178.91	1179.09	1180.28	1178.92	1179.66	1179.79	1178.05	1177.4	1177.61	1179.06
21.57	1185.27	1182.58	1182.17	1179.87	1182.43	1178.57	1180.29	1182.22	1181.47	1179.6	1178.68
21.87	1190.14	1187.35	1189.17	1189.62	1189.23	1188.9	1188.13	1188.48	1188.72	1189.32	1187.51
22.07	1193.24	1189.39	1190.59	1190.85	1191.6	1188.5	1190.08	1190.48	1188.43	1190	1189.43
22.32	1195.16	1190.31	1192.8	1191.53	1192.29	1192.41	1190.67	1190.84	1192.26	1190.27	1191.07
22.72	1200.53	1195.49	1200.99	1201.89	1201.33	1196.88	1201.49	1202.49	1198.67	1202.12	1199.98
22.97	1205.04	1200.73	1202.01	1202.98	1203.93	1203.69	1203.43	1200.92	1202.23	1201.38	1203.68
23.15	1208.25	1202.93	1206.12	1208.09	1209.08	1204.95	1207.85	1208.05	1205.73	1207.63	1208.74
23.33	1211.38	1204.30	1206.05	1205.9	1206.33	1206.98	1206.45	1206.29	1206.48	1205.81	1206.81
23.62	1215.41	1212.13	1213.11	1214.95	1214.58	1212.91	1214.38	1214.69	1213.28	1214.38	1214.51
24.04	1220.57	1218.66	1218.45	1219.28	1220.99	1219.35	1219.25	1221.09	1218.85	1219.28	1221
24.32	1225.16	1224.69	1221.62	1223.07	1225.42	1222.04	1223.08	1225.55	1221.78	1223.1	1225.52
		RMSE	3.341	3.368	3.497	4.273	4.379	3.868	5.414	5.409	5.651

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Laursen-Copeland								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1094.28	1092.12	1093.43	1093.31	1092.9	1092.94	1093.65	1093.33	1093.61	1094.19	1094.35
15.64	1095.78	1093.84	1097.53	1096.95	1096.89	1096.18	1096.39	1096.52	1096.25	1096.26	1096.23
15.9	1099.61	1095.69	1097.98	1098.23	1097.94	1098.62	1098.42	1098.13	1097.83	1097.96	1098.1
16.1	1103.56	1097.34	1101.92	1101.42	1101.37	1100.9	1101.05	1101.41	1100.89	1100.97	1100.87
16.2	1103.79	1097.77	1100.23	1100.45	1100.22	1101.29	1101.25	1101.04	1100.82	1101.1	1100.59
16.4	1105.18	1101.57	1105.61	1104.37	1106.16	1102.58	1102.8	1102.88	1103.34	1103.12	1103.22
16.56	1107.55	1103.00	1104.68	1105.99	1104.55	1105.94	1106.07	1106.14	1103.43	1104.19	1103.18
16.71	1108.25	1104.09	1109.38	1107.28	1110.19	1101.74	1101.85	1102	1104.68	1106.14	1104.54
16.8	1109.6	1104.96	1104.33	1105.47	1100.94	1107.25	1107.28	1107.36	1094.8	1099.5	1096.77
16.9	1110.88	1107.10	1105.48	1106.33	1109.08	1101.08	1098.94	1103.44	1103.83	1105.69	1103.89
17	1114.42	1110.29	1109.06	1109.32	1108.4	1109.92	1110.42	1109.93	1107.21	1107.76	1107.36
17.07	1115.89	1112.37	1109.48	1107.9	1109.61	1111.07	1111.84	1109.31	1108.44	1109.27	1110.23
17.08	1116.47	1112.56	1107.73	1105.41	1108.1	1108.94	1115.92	1106.09	1112.75	1111.49	1115.59
17.1	1116.49	1112.81	1122.19	1122.62	1122.66	1116.49	1117.12	1117.26	1109.99	1110.04	1110.21
17.15	1116.4	1112.31	1108.73	1108.2	1108.24	1108.41	1107.83	1108.36	1110.47	1111.89	1110.1
17.2	1116.59	1112.96	1121.55	1123.18	1123.86	1116.66	1117.39	1116.9	1110.02	1110.44	1110.08
17.3	1117.36	1113.51	1118.13	1117.44	1120.1	1109.14	1109.86	1109.27	1108.22	1109.54	1108.52
17.4	1118.84	1114.36	1122.44	1122.92	1123.72	1117.66	1118.38	1117.89	1113.87	1117.31	1115.51
17.6	1119.07	1114.82	1119.34	1118.85	1118.2	1104.04	1103.97	1113.06	1111.89	1113.64	1109.37
17.9	1121.64	1121.47	1125.43	1127.5	1126.31	1117.83	1120.15	1116.37	1111.96	1115.49	1115.28
18.02	1124.43	1123.18	1125.57	1123.81	1124.97	1117.88	1118.26	1121.64	1120.37	1123.44	1120.99
18.14	1128.58	1125.13	1131.03	1132.3	1132.19	1128.34	1131.17	1124.87	1116.03	1119.76	1126.3
18.2	1129.72	1127.01	1132.6	1128.84	1131.48	1126.38	1126.52	1127.28	1126.26	1128.98	1126.99
18.36	1132.13	1128.70	1133.41	1136.33	1135.13	1130.08	1133.62	1128.86	1126.92	1126.34	1132.24
18.48	1134.89	1130.80	1136.25	1132.55	1134.3	1130.91	1131.9	1131.27	1129.35	1130.96	1129.17
18.61	1137.28	1131.97	1133.45	1136.13	1136.48	1131.53	1134.11	1130.9	1128.76	1129.35	1133.17
18.82	1141.27	1135.09	1139.51	1136.35	1135.05	1135.75	1137.32	1136.75	1134.92	1135.63	1135.42

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Laursen-Copeland								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1145.04	1138.79	1141.27	1142.62	1143.52	1141.99	1142.12	1142.53	1145.24	1138.04	1142.72
19.23	1149.44	1143.33	1146.38	1145.42	1144.92	1144.87	1144.89	1146.3	1146.1	1142.42	1142.97
19.48	1151.77	1147.81	1147.66	1149.86	1148.69	1148	1146.93	1149.22	1147.72	1144.7	1146.53
19.59	1152.3	1148.47	1148.85	1146.2	1146.18	1148.68	1148.43	1149.75	1150.11	1145.77	1147.07
19.7	1155.4	1152.22	1151.93	1152.54	1151.67	1153.35	1151.83	1153.86	1149.73	1149.24	1150.19
19.86	1155.91	1156.73	1154.41	1151.47	1152.25	1151.96	1153.43	1151.71	1154.84	1151.04	1151.97
20.08	1158.41	1160.82	1153.76	1154.64	1155.35	1155.05	1154.15	1158.36	1152.89	1152.01	1153.56
20.3	1162.47	1163.61	1159.99	1155.87	1158.49	1156.83	1158.41	1158.91	1157.98	1156.68	1156.82
20.48	1166.62	1167.13	1161.9	1164.84	1165.25	1163.47	1163.21	1164.55	1161.77	1159.79	1161.25
20.65	1170.07	1170.36	1164.41	1164.32	1166.45	1165.8	1165.56	1166.28	1165.58	1165.91	1165.09
20.86	1175.2	1173.03	1169.82	1170.75	1171.28	1171.91	1171.12	1171.57	1169.59	1163.9	1169.51
21.09	1180.46	1176.01	1175.84	1175.51	1175.22	1169.74	1172.39	1173.02	1168.7	1174.02	1170.19
21.26	1182.48	1178.91	1177.23	1175.97	1178.35	1180.42	1177.74	1176.21	1179.14	1179.99	1178.24
21.57	1185.27	1182.58	1181.78	1182.79	1182.96	1176.82	1177.54	1181.07	1177.41	1181.44	1179.03
21.87	1190.14	1187.35	1186.09	1186.91	1187.91	1185.95	1186.44	1183.37	1187.41	1188.58	1185.5
22.07	1193.24	1189.39	1191	1190.33	1194.14	1189.58	1186.25	1192.9	1187.31	1186.83	1187.79
22.32	1195.16	1190.31	1187.24	1188.8	1188.43	1191.19	1191.1	1188.82	1188.76	1194.34	1184.81
22.72	1200.53	1195.49	1198.13	1197.12	1200.5	1196.92	1193.31	1199.07	1196.05	1193.43	1198.68
22.97	1205.04	1200.73	1199.27	1197.78	1199.84	1197.65	1201.38	1197.9	1196.92	1202.55	1197.69
23.15	1208.25	1202.93	1202.75	1205.63	1206.44	1202.51	1202.11	1205.01	1202.46	1202.99	1204.5
23.33	1211.38	1204.30	1204.28	1202.3	1206.07	1203.83	1205.12	1202.86	1204.17	1206.02	1202.74
23.62	1215.41	1212.13	1210.23	1215.94	1212.54	1210.03	1210.84	1215.61	1210.24	1211.99	1222.24
24.04	1220.57	1218.66	1216.17	1218.57	1219.02	1216.12	1217.02	1220.01	1215.92	1217.59	1221.74
24.32	1225.16	1224.69	1219.47	1223.74	1222.42	1219.45	1221.31	1224.81	1219.32	1221.6	1227.1
		RMSE	4.950	5.448	5.493	3.677	4.055	3.120	4.010	2.743	2.915

Cross Section	Thalweg		Predicted Thalweg Using Yang								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1092	1088.56	1090.79	1090.4	1090.32	1091.58	1091.52	1091.56	1091.65	1091.57	1091.61
15.64	1094	1090.03	1094.19	1094.4	1094.5	1094.01	1094.05	1094.04	1094	1094	1094
15.9	1098	1093.63	1096.74	1095.7	1096.77	1095.94	1095.57	1096.4	1096.79	1095.8	1096.43
16.1	1100	1094.09	1099.45	1099.36	1099.29	1097.67	1096.93	1097.24	1097.67	1097.5	1097.73
16.2	1101	1095.91	1100.92	1100.8	1100.56	1097.99	1097.42	1097.74	1097.6	1096.89	1097.26
16.4	1102	1099.17	1102.13	1102.12	1102.22	1100.97	1100.79	1100.92	1100.73	1100.52	1100.83
16.56	1104	1100.00	1104.48	1104.43	1104.38	1102.84	1105.05	1104.63	1099.29	1099.34	1101.59
16.71	1105	1101.03	1105.64	1105.63	1106.97	1102.33	1102.39	1104.98	1102.28	1102.42	1105.74
16.8	1107.5	1101.90	1107.48	1107.47	1107.5	1107.88	1108.23	1108.53	1105.7	1105.08	1107.36
16.9	1110	1104.34	1108.61	1108.61	1110.62	1101.54	1101.62	1102.45	1105.01	1106.44	1106.83
17	1112.5	1108.00	1106.66	1108.45	1102.25	1111.19	1111.35	1111.16	1108.19	1098.93	1106.04
17.07	1114.5	1110.40	1112.05	1112.18	1112.86	1105.33	1105.7	1105.97	1104.72	1108.58	1104.77
17.08	1115	1110.16	1105.7	1105.63	1106.3	1111.63	1112.37	1112.45	1108.68	1102.23	1105.72
17.1	1115.5	1111.77	1114.98	1115.03	1114.74	1103.72	1111.2	1109.3	1101.72	1113.06	1107.05
17.15	1116	1110.99	1105.68	1105.66	1107.51	1114.99	1114.38	1114.55	1114.43	1103.7	1110.78
17.2	1116.2	1112.06	1116.61	1116.67	1115.95	1113.9	1115.57	1115.58	1111.75	1116.7	1108.03
17.3	1116.7	1111.80	1114.65	1114.42	1115.3	1114.64	1114.24	1114.62	1115.32	1111.54	1113.21
17.4	1118.3	1113.10	1115.21	1114.93	1114.82	1114.57	1114.36	1115.44	1111.2	1112.78	1110.73
17.6	1117.4	1111.96	1115.41	1115.21	1115.49	1112.65	1114.76	1114.6	1118.55	1118.37	1117.23
17.9	1120	1117.18	1120.72	1121.61	1120.61	1121.7	1123.13	1124.25	1114.08	1116.75	1112.99
18.02	1122.5	1119.81	1122.56	1122.37	1122.18	1121.19	1122.84	1123.58	1121.35	1121.77	1120.83
18.14	1125	1122.46	1123.85	1123.94	1124.27	1122.33	1123.64	1124.29	1115.03	1120.88	1115.02
18.2	1127	1125.06	1125.91	1125.48	1125.41	1124.02	1126.09	1126.23	1123.24	1123.41	1125.09
18.36	1130	1126.03	1131.19	1130.74	1131.08	1129.75	1130.86	1130.97	1127.1	1127.73	1127.65
18.48	1132.5	1127.04	1131.47	1131.89	1131.56	1128	1129.87	1129.87	1128.35	1128.4	1129.18
18.61	1135	1129.20	1130.58	1128.4	1130.53	1130.04	1130.49	1130.76	1128.18	1128.42	1128.41
18.82	1140	1131.29	1135.53	1138.47	1136.83	1131.46	1132.88	1132.93	1129.77	1129.82	1130.41

Cross Section	Thalweg		Predicted Thalweg Using Yang								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1143	1135.44	1142.11	1140.68	1140	1139.38	1138.4	1137.97	1136.57	1136.37	1135.36
19.23	1147	1139.32	1143.66	1145.04	1144.6	1144.46	1144.1	1144.09	1142.82	1143.39	1142.57
19.48	1150	1146.29	1149.21	1148.99	1149.04	1147.21	1148.06	1148.42	1145.77	1146.12	1146.87
19.59	1152.3	1148.50	1148.1	1149.65	1149.79	1147.92	1147.36	1147.01	1146.04	1147.07	1145.13
19.7	1153	1150.77	1149.28	1149.73	1149.39	1145.8	1146.84	1147.59	1144.64	1145.25	1146.09
19.86	1155	1155.29	1154.97	1155.06	1155.08	1154.29	1153.39	1150.77	1149.94	1154.48	1148.67
20.08	1157	1159.44	1156.89	1156.92	1156.95	1156.43	1152.1	1156.42	1150.98	1155.62	1155.27
20.3	1160	1161.85	1159.87	1159.85	1159.91	1160.05	1159.61	1159.71	1159.18	1158.54	1157.04
20.48	1165	1163.98	1164.47	1164.34	1164.22	1162.29	1162.9	1163.77	1162.07	1161.2	1162.61
20.65	1168	1166.13	1167.37	1167.27	1167.21	1166.85	1167.04	1166.75	1166.54	1165.49	1165.79
20.86	1175	1172.44	1174.07	1174.53	1174.65	1171.91	1172	1172.09	1170.05	1170.08	1170.22
21.09	1180	1175.94	1176.82	1178.5	1178.58	1175.97	1176.04	1176.03	1173.99	1174.02	1174
21.26	1180	1177.67	1176.47	1178.81	1178.65	1167.85	1170.68	1174.92	1167.14	1169.5	1171.77
21.57	1183	1181.62	1180.05	1182.92	1183.28	1178.32	1176.38	1176.34	1175.7	1175.19	1173.32
21.87	1185	1186.09	1184.49	1184.37	1184.63	1183.63	1181.24	1181.23	1182.61	1181.07	1181.93
22.07	1190	1187.14	1188.86	1189.52	1189.8	1188.33	1189.16	1188.68	1187.78	1189.14	1188.41
22.32	1194	1187.73	1194.01	1194.17	1194.58	1194	1194.13	1194.58	1193.97	1194.14	1194.52
22.72	1199	1192.93	1196.48	1197.79	1198.39	1197.83	1197.89	1198.52	1196.56	1198.1	1198.67
22.97	1205	1198.30	1205	1205.07	1205.38	1205.09	1205.08	1205.44	1205.01	1205.07	1205.51
23.15	1208	1200.21	1206.13	1206.53	1206.88	1205.5	1206.55	1206.85	1206.28	1206.74	1206.84
23.33	1211	1202.13	1207.01	1207.63	1208.17	1207	1207.64	1208.08	1207.02	1207.7	1208.11
23.62	1214	1208.83	1212.92	1213.96	1214.44	1212.61	1213.97	1214.34	1212.75	1213.97	1214.38
24.04	1220	1215.86	1219.42	1220.37	1221.85	1219.45	1220.37	1221.84	1219.43	1220.37	1221.86
24.32	1224	1224.00	1220.77	1223.71	1226.48	1220.86	1223.73	1226.55	1220.85	1223.69	1226.54
		RMSE	3.654	3.872	3.476	3.199	3.041	3.306	3.894	3.318	3.392

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and Schoklitsch								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1092	1088.56	1090.42	1090.38	1089.95	1089.47	1089.56	1089.16	1089.65	1089.6	1089.41
15.64	1094	1090.03	1094.26	1094.26	1094.27	1094.14	1094.14	1094.12	1094.13	1094.11	1094.11
15.9	1098	1093.63	1097.82	1097.78	1097.74	1096.88	1096.89	1096.81	1096.86	1096.88	1096.79
16.1	1100	1094.09	1098.15	1098.41	1098.45	1096.8	1096.74	1097.02	1096.58	1097.01	1097.01
16.2	1101	1095.91	1099.68	1100.37	1100	1097.79	1097.52	1097.65	1097.04	1097.3	1097.54
16.4	1102	1099.17	1102.03	1102.02	1102.03	1100.62	1100.53	1100.38	1100.32	1100.3	1100.69
16.56	1104	1100.00	1103.95	1104.1	1104	1104.13	1104.1	1103.53	1103.45	1103.24	1103.32
16.71	1105	1101.03	1107.01	1106.85	1106.95	1106.16	1104.96	1104.59	1103.6	1100.75	1103.61
16.8	1107.5	1101.90	1108.2	1108.43	1108.1	1108.27	1108.65	1107.96	1106.24	1105.5	1106.26
16.9	1110	1104.34	1107.91	1106.63	1107.69	1106.15	1104.52	1104.22	1105.01	1105.03	1105.01
17	1112.5	1108.00	1109.21	1109.14	1107.87	1103.36	1101.21	1099.18	1102.25	1100.58	1102.13
17.07	1114.5	1110.40	1105.73	1105.44	1108.76	1104.27	1101.7	1101.81	1104.65	1101.09	1104.55
17.08	1115	1110.16	1108.18	1108.67	1110.11	1104.04	1103.02	1102.24	1102.91	1102.41	1102.25
17.1	1115.5	1111.77	1105.32	1107.2	1107.82	1104.35	1109.36	1112.2	1102.66	1106.87	1105.31
17.15	1116	1110.99	1111.39	1111.26	1110.89	1105.85	1103.6	1103.39	1106.13	1103.16	1103.63
17.2	1116.2	1112.06	1108.05	1108.71	1109.87	1106.31	1108.74	1110.47	1105.08	1107.95	1106.18
17.3	1116.7	1111.80	1111.99	1111.82	1111.15	1104.9	1106.24	1112.32	1106.59	1106.57	1106.18
17.4	1118.3	1113.10	1109.43	1110.67	1111.24	1107.37	1108.18	1109.69	1105.65	1107.27	1105.69
17.6	1117.4	1111.96	1111.04	1111.92	1112.52	1105.76	1105.99	1115.8	1110.84	1108.34	1110.18
17.9	1120	1117.18	1119.17	1120.34	1120.49	1115.02	1116.06	1116.08	1113.24	1117.89	1114.7
18.02	1122.5	1119.81	1120.13	1120.61	1120.61	1118.34	1118.26	1120.88	1116.66	1116.32	1116.76
18.14	1125	1122.46	1124.25	1125.71	1125.52	1122.24	1122.37	1122.69	1120.39	1121.11	1121.14
18.2	1127	1125.06	1120.84	1118.99	1120.02	1124.13	1124.06	1124.81	1121.28	1121.13	1122.45
18.36	1130	1126.03	1128.58	1128.32	1129.29	1127.75	1128.26	1128.92	1125.46	1125.06	1126.89
18.48	1132.5	1127.04	1131.73	1131.02	1131.68	1127.5	1127.51	1127.51	1126.48	1126.32	1126.08
18.61	1135	1129.20	1126.44	1127.05	1128.54	1129.8	1129.99	1130.01	1126.99	1127.53	1128
18.82	1140	1131.29	1136.19	1135.7	1136.49	1131.31	1131.85	1131.68	1128	1127.82	1128.29

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and Schoklitsch								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1143	1135.44	1138.46	1139.09	1138.18	1135.02	1135.87	1135.11	1132.22	1131.57	1132.65
19.23	1147	1139.32	1142.68	1143.75	1144.4	1144	1144.09	1144.07	1142.3	1142.01	1142.1
19.48	1150	1146.29	1147.56	1148.41	1147.96	1147.51	1147.45	1147.47	1145.81	1146.19	1145.99
19.59	1152.3	1148.50	1150.46	1151.6	1151.35	1147.51	1148.78	1149.65	1146.08	1146.49	1145.91
19.7	1153	1150.77	1145.49	1147.41	1147.94	1143.05	1140.36	1143.25	1142.41	1140.99	1143.46
19.86	1155	1155.29	1154.46	1155.01	1153.36	1150.53	1152.91	1153.23	1148.7	1149.95	1148.64
20.08	1157	1159.44	1156.74	1157.59	1156.99	1153.66	1153.83	1153.62	1151.77	1150.03	1152.4
20.3	1160	1161.85	1159.88	1160.05	1160.55	1159.59	1159.22	1157.55	1155.41	1155.89	1152.7
20.48	1165	1163.98	1164.42	1164.84	1163.23	1162.87	1163.04	1161.51	1159.61	1160.2	1159.66
20.65	1168	1166.13	1166.71	1167.14	1166.75	1166.14	1166.54	1165.57	1164.26	1165.03	1163.61
20.86	1175	1172.44	1174.19	1174.26	1173.99	1171.95	1171.95	1171.87	1169.9	1169.96	1170.08
21.09	1180	1175.94	1177.14	1176.27	1176.76	1176.04	1175.98	1176.14	1174.08	1173.9	1174.04
21.26	1180	1177.67	1175.22	1177.54	1175.74	1168.43	1169.84	1170.81	1167.38	1167.22	1169.93
21.57	1183	1181.62	1181.54	1176.68	1179.68	1176.74	1174.41	1177.04	1173.6	1173.68	1173.37
21.87	1185	1186.09	1184.28	1183.72	1183.83	1180.68	1179.52	1182.4	1180.32	1181.36	1182.32
22.07	1190	1187.14	1187.71	1186.06	1186.79	1186.85	1185.42	1186.54	1186.71	1185.44	1185.41
22.32	1194	1187.73	1194.03	1194.44	1193.52	1192.93	1194.27	1193.71	1191.77	1194.22	1194.2
22.72	1199	1192.93	1194.63	1193.75	1196.96	1196.08	1192.13	1197.18	1195.61	1192.76	1194.24
22.97	1205	1198.30	1205	1205.01	1204.18	1205.12	1205	1203.89	1203.44	1204.44	1203.75
23.15	1208	1200.21	1203.51	1204.67	1206.16	1204.62	1204.28	1206.31	1204.13	1204.52	1205.01
23.33	1211	1202.13	1207.2	1207.89	1207.45	1208.03	1208.17	1207.16	1206.5	1207.57	1207.26
23.62	1214	1208.83	1212.17	1213.19	1213.98	1211.41	1213.07	1213.94	1210.85	1213.22	1213.87
24.04	1220	1215.86	1219.24	1219.9	1220.99	1218.94	1219.89	1220.79	1219.3	1219.85	1221.07
24.32	1224	1224.00	1220.27	1222.43	1225.73	1220.08	1222.46	1225.91	1220.37	1222.52	1225.75
		RMSE	3.232	3.279	2.978	4.150	4.026	3.612	4.532	4.450	4.333

Cross Section	Thalweg		Predicted Thalweg Using Meyer-Peter and Muller								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1092	1088.56	1088.9	1088.9	1088.88	1088.81	1088.82	1088.82	1088.76	1088.76	1088.76
15.64	1094	1090.03	1095.24	1095.33	1095.39	1095.27	1095.26	1095.23	1094.93	1094.93	1094.94
15.9	1098	1093.63	1097.48	1097.52	1097.18	1096.64	1096.67	1096.69	1096.43	1096.43	1096.43
16.1	1100	1094.09	1097.81	1097.92	1098.08	1097.16	1097.11	1097.09	1097.12	1097.12	1097.12
16.2	1101	1095.91	1098.82	1098.61	1098.89	1098.02	1097.97	1097.94	1098.09	1098.09	1098.1
16.4	1102	1099.17	1103.48	1103.16	1103.18	1100.61	1100.59	1100.55	1100.48	1100.49	1100.49
16.56	1104	1100.00	1102.7	1103.32	1103.22	1103.54	1103.4	1103.4	1100.85	1100.91	1100.69
16.71	1105	1101.03	1108.96	1108.45	1108.64	1108.2	1108.04	1107.99	1103.51	1103.16	1103.85
16.8	1107.5	1101.90	1106.85	1107.15	1107.09	1107.5	1107.33	1108	1107.4	1107.85	1107.34
16.9	1110	1104.34	1109.42	1109.4	1109.33	1106.87	1106.67	1106.73	1105.24	1105.19	1105.2
17	1112.5	1108.00	1104.32	1106.32	1106.11	1100.45	1100.12	1099.92	1097.87	1097.84	1097.97
17.07	1114.5	1110.40	1108.27	1109.07	1109.12	1101.75	1101.77	1102.12	1101.53	1101.68	1101.52
17.08	1115	1110.16	1109.89	1109.54	1106.99	1102.49	1102.66	1103.57	1102.29	1102.35	1102.4
17.1	1115.5	1111.77	1106.11	1105.9	1108.07	1102.87	1102.82	1101.82	1101.9	1103.31	1102.02
17.15	1116	1110.99	1110.9	1110.98	1110.32	1104.13	1103.64	1103.82	1103.7	1103.58	1103.68
17.2	1116.2	1112.06	1105.76	1105.57	1107.84	1103.86	1104.04	1103.8	1103.02	1102.93	1103.02
17.3	1116.7	1111.80	1111.65	1111.97	1112.33	1104.77	1104.91	1104.9	1104.48	1104.68	1104.47
17.4	1118.3	1113.10	1108.66	1108.83	1107.56	1106.89	1106.79	1106.78	1104.59	1104.62	1104.58
17.6	1117.4	1111.96	1116.42	1114.98	1114.49	1105.63	1105.78	1105.83	1108.76	1108.92	1108.67
17.9	1120	1117.18	1119.37	1120.95	1120.9	1116.99	1116.97	1117.09	1111.76	1111.75	1111.85
18.02	1122.5	1119.81	1122.71	1122.97	1123.53	1119.3	1119.32	1119.1	1117.12	1117.16	1116.79
18.14	1125	1122.46	1126.4	1125.77	1126.73	1121.57	1121.62	1122.25	1118.85	1118.92	1119.24
18.2	1127	1125.06	1125.97	1124.06	1126.48	1124.25	1124.28	1123.85	1122.6	1122.58	1122.66
18.36	1130	1126.03	1131.29	1130.13	1131.7	1128.59	1128.61	1128.59	1126.58	1126.57	1126.64
18.48	1132.5	1127.04	1132.35	1132.77	1133.2	1127.78	1127.73	1127.67	1127.52	1127.54	1127.53
18.61	1135	1129.20	1130.66	1129.85	1131.33	1129.99	1130.02	1130	1127.65	1127.57	1127.69
18.82	1140	1131.29	1137.51	1137.54	1137.57	1130.72	1130.74	1130.73	1128.61	1128.68	1128.65

Cross Section	Thalweg		Predicted Thalweg Using Meyer-Peter and Muller								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1143	1135.44	1141.08	1140.84	1141.07	1133.22	1133.24	1133.1	1130.9	1130.89	1130.89
19.23	1147	1139.32	1143.42	1143.5	1143.77	1144	1144	1144	1142.09	1142.12	1142.11
19.48	1150	1146.29	1149.86	1149.96	1149.7	1147	1147.05	1147	1145.19	1145.22	1145.29
19.59	1152.3	1148.50	1147.45	1147.62	1147.51	1147.24	1146.83	1147.19	1145.19	1145.31	1145.17
19.7	1153	1150.77	1147.31	1147.53	1147.64	1144.91	1145.57	1144.6	1142.79	1142.58	1141.12
19.86	1155	1155.29	1153.3	1153.13	1153.15	1151.1	1151.26	1151.18	1149.13	1149.38	1149.32
20.08	1157	1159.44	1158.82	1158.94	1158.95	1154.22	1154.24	1154.21	1153.44	1153.17	1153.33
20.3	1160	1161.85	1156.48	1156.23	1156.07	1160.09	1160.41	1160.43	1159.35	1159.3	1159.31
20.48	1165	1163.98	1167.56	1167.7	1167.51	1163.65	1163.66	1163.58	1163.04	1162.98	1162.91
20.65	1168	1166.13	1168.36	1168.46	1168.38	1166.75	1166.73	1166.71	1166.38	1166.4	1166.39
20.86	1175	1172.44	1175.04	1175.13	1175.05	1171.92	1171.92	1171.92	1170.04	1170.03	1170.03
21.09	1180	1175.94	1177.36	1177.26	1177.4	1176.05	1176.04	1176.03	1173.95	1173.95	1173.96
21.26	1180	1177.67	1176.21	1176.21	1176.29	1166.57	1166.63	1166.66	1167.02	1166.88	1166.8
21.57	1183	1181.62	1179.23	1179.16	1179.1	1175.76	1175.61	1175.43	1173.51	1173.38	1173.27
21.87	1185	1186.09	1187.76	1187.78	1187.92	1186.81	1186.88	1186.98	1185.78	1185.84	1185.99
22.07	1190	1187.14	1187.37	1187.21	1187.13	1187.46	1187.33	1187.14	1187.12	1186.93	1186.92
22.32	1194	1187.73	1195.19	1195.19	1195.2	1194.89	1194.95	1195.02	1195.16	1195.24	1195.15
22.72	1199	1192.93	1193.64	1193.53	1193.37	1193.77	1193.61	1193.52	1193.76	1193.73	1193.5
22.97	1205	1198.30	1206.76	1206.69	1206.71	1206.71	1206.66	1206.75	1206.73	1206.64	1206.72
23.15	1208	1200.21	1205.31	1205.16	1205.3	1205.26	1205.06	1205.18	1205.31	1205.2	1205.36
23.33	1211	1202.13	1207.82	1207.46	1207.29	1207.81	1207.45	1207.36	1207.81	1207.4	1207.33
23.62	1214	1208.83	1213.31	1214.45	1215.14	1213.33	1214.45	1215.16	1213.33	1214.51	1215.17
24.04	1220	1215.86	1219.57	1219.73	1219.86	1219.57	1219.72	1219.86	1219.56	1219.72	1219.82
24.32	1224	1224.00	1220.1	1221.18	1222.46	1220.09	1221.18	1222.51	1220.09	1221.19	1222.45
		RMSE	3.902	3.822	3.918	4.970	4.973	4.977	5.548	5.404	5.526

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and MPM								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1092	1088.56	1090.13	1089.59	1088.89	1088.92	1089.33	1089.08	1088.87	1089.36	1088.8
15.64	1094	1090.03	1094.64	1094.37	1094.49	1094.27	1094.3	1094.3	1094.26	1094.25	1094.22
15.9	1098	1093.63	1097.48	1097.45	1097.22	1096.24	1096.14	1096.26	1095.77	1095.8	1095.81
16.1	1100	1094.09	1096.97	1097.61	1097.42	1095.95	1096.17	1096.34	1095.78	1096.03	1096.03
16.2	1101	1095.91	1099.63	1099.75	1099.12	1097.52	1097.41	1097.07	1096.47	1096.6	1096.68
16.4	1102	1099.17	1100.83	1101.88	1100.79	1099.78	1100.12	1100.13	1099.55	1099.46	1099.14
16.56	1104	1100.00	1102.78	1102.29	1102.48	1104.73	1104.04	1104.1	1100	1100.78	1101.9
16.71	1105	1101.03	1107.46	1107.52	1106.91	1105.1	1106.87	1106.9	1104.85	1105.23	1101.93
16.8	1107.5	1101.90	1105.95	1105.29	1105.89	1108.84	1107.35	1107.36	1103.51	1104.34	1106.91
16.9	1110	1104.34	1108.73	1107.71	1105.73	1103.18	1104.43	1104.02	1105.16	1105.26	1105.17
17	1112.5	1108.00	1104.45	1102.26	1104.69	1102.62	1102.93	1102.04	1099.39	1100.06	1100.9
17.07	1114.5	1110.40	1108.99	1108.45	1107.68	1104.36	1101.99	1104.58	1103.39	1104.19	1103.77
17.08	1115	1110.16	1103.39	1106.04	1108.43	1104.55	1104	1103.43	1102.24	1101.85	1102.75
17.1	1115.5	1111.77	1108.73	1108.31	1108.2	1104.25	1103.72	1104.09	1101.96	1102.7	1102.52
17.15	1116	1110.99	1106.03	1106.51	1107.45	1105.37	1105.34	1104.5	1104.37	1104.49	1104.88
17.2	1116.2	1112.06	1110.27	1108.69	1109.62	1106.53	1105.23	1106.34	1103.67	1104.56	1104.5
17.3	1116.7	1111.80	1106	1110.13	1104.75	1105.2	1104.99	1104.81	1104.56	1104.71	1105.04
17.4	1118.3	1113.10	1110.3	1110	1110.13	1111.09	1107.13	1108.32	1105.79	1105.38	1105.43
17.6	1117.4	1111.96	1112.34	1114.82	1114.81	1102.4	1107.7	1107.04	1113.01	1108.94	1109.33
17.9	1120	1117.18	1122.43	1122.49	1122.18	1118.47	1117.5	1116.74	1111.11	1113.43	1112.07
18.02	1122.5	1119.81	1122.53	1124.1	1122.95	1117.59	1117.63	1120.76	1117.89	1117.45	1116.3
18.14	1125	1122.46	1124.69	1125.22	1125.47	1124.2	1123.77	1122.43	1119.53	1120.2	1119.27
18.2	1127	1125.06	1123.06	1126.92	1124.58	1122.31	1122.53	1124.8	1122.08	1121.54	1121.14
18.36	1130	1126.03	1130.23	1132.55	1131.89	1129.22	1128.34	1128.74	1126.49	1126.8	1126.69
18.48	1132.5	1127.04	1131.48	1132.07	1131.21	1127.51	1127.51	1127.64	1127.24	1127.31	1126.6
18.61	1135	1129.20	1129.66	1132.68	1131.47	1130.01	1130	1130.01	1126.51	1126.6	1126.31
18.82	1140	1131.29	1135.62	1135.4	1135.64	1128.98	1130.17	1129.31	1127.25	1128.67	1129.14

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and MPM								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1143	1135.44	1139.24	1139.9	1140.55	1132.94	1132.97	1132.51	1129.98	1130.33	1130.55
19.23	1147	1139.32	1138.88	1138.18	1139.63	1144	1144	1144	1142.01	1142.32	1142.13
19.48	1150	1146.29	1150.11	1149.8	1149.36	1148.21	1148.46	1147.98	1146.66	1145.2	1145.46
19.59	1152.3	1148.50	1147.23	1147.23	1144.75	1147.34	1146.99	1147.16	1146.45	1146.41	1145.1
19.7	1153	1150.77	1149.81	1148.87	1147.9	1140.38	1144.02	1141.11	1138.4	1137.11	1140.59
19.86	1155	1155.29	1151.35	1151.16	1152.77	1149.23	1149.87	1149.19	1148.83	1148.92	1147.77
20.08	1157	1159.44	1147.41	1144.29	1149.83	1155.13	1154.95	1155.06	1151.98	1150.93	1154.51
20.3	1160	1161.85	1155.66	1155.28	1159.39	1154.66	1153.98	1152.58	1151.56	1152.44	1151.51
20.48	1165	1163.98	1164.67	1164.78	1162.78	1161.87	1162.41	1161.52	1159.2	1159.21	1159.76
20.65	1168	1166.13	1165.81	1165.76	1165.87	1163.63	1164.01	1162.58	1161.76	1161.87	1161.46
20.86	1175	1172.44	1174.39	1174.28	1174.08	1172.06	1171.87	1171.72	1169.78	1169.81	1169.69
21.09	1180	1175.94	1176.28	1175.51	1177.31	1172.87	1175.42	1173.81	1172.97	1172.89	1172.71
21.26	1180	1177.67	1173.55	1174.3	1174.43	1170.87	1171.48	1165.17	1163.9	1164.56	1169.15
21.57	1183	1181.62	1177.44	1173.8	1177.83	1171.62	1173.23	1177.5	1176.46	1173.42	1171.93
21.87	1185	1186.09	1184.09	1183.79	1184.48	1182.55	1182.75	1175.02	1173.41	1177.01	1180.53
22.07	1190	1187.14	1186.78	1187	1188.04	1183.72	1185.73	1184.9	1182.72	1184.57	1184.7
22.32	1194	1187.73	1191.37	1189.95	1190.81	1190.87	1188.93	1189.22	1190.63	1188.63	1189.51
22.72	1199	1192.93	1198.82	1200.63	1199.89	1193.69	1199.95	1200.94	1195.77	1200.44	1197.83
22.97	1205	1198.30	1201.69	1202.73	1203.72	1203.49	1203.21	1200.52	1201.92	1201.01	1203.49
23.15	1208	1200.21	1204.86	1206.88	1208.19	1203.71	1206.8	1206.8	1204.52	1206.35	1207.83
23.33	1211	1202.13	1204.36	1204.17	1204.5	1205.35	1204.75	1204.51	1204.92	1204.13	1205.08
23.62	1214	1208.83	1210.3	1213.16	1212.98	1210.15	1212.53	1213.03	1210.79	1212.47	1212.86
24.04	1220	1215.86	1217.2	1218.29	1220.28	1218.34	1218.25	1220.44	1217.71	1218.28	1220.3
24.32	1224	1224.00	1218.83	1220.93	1224.3	1219.44	1220.89	1224.51	1219.07	1220.95	1224.41
		RMSE	3.589	3.703	3.727	4.430	4.515	4.229	5.257	4.998	5.061

Cross Section	Thalweg		Predicted Thalweg Using Laursen-Copeland								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
15.44	1092	1088.56	1089.72	1089.62	1088.7	1088.97	1089.75	1089.29	1089.99	1090.41	1090.84
15.64	1094	1090.03	1095.6	1094.77	1094.86	1094.08	1094.26	1094.37	1094.2	1094.26	1094.19
15.9	1098	1093.63	1095.44	1095.79	1095.22	1096.1	1095.66	1095.2	1094.86	1094.9	1095.22
16.1	1100	1094.09	1096.84	1097.55	1097.06	1094.23	1094.44	1095.05	1094.82	1094.91	1095.23
16.2	1101	1095.91	1094.41	1094.48	1094.18	1095.65	1095.7	1094.97	1094.3	1094.48	1093.74
16.4	1102	1099.17	1099.69	1099.23	1103.42	1095.88	1096.03	1095.76	1098.03	1097.13	1097.6
16.56	1104	1100.00	1098.4	1101.31	1098.76	1104.7	1104.69	1104.66	1099.08	1101.06	1099.01
16.71	1105	1101.03	1107.15	1102.33	1108.36	1102	1102	1102	1106.23	1107.92	1106.09
16.8	1107.5	1101.90	1099.87	1101.47	1095	1108.86	1109.02	1109	1094.5	1099.93	1096.75
16.9	1110	1104.34	1103.97	1104.49	1108.55	1101.37	1098.85	1104.36	1105.57	1107.65	1105.46
17	1112.5	1108.00	1104.07	1104.21	1101.95	1105.33	1105.86	1105.3	1100.94	1101.49	1100.89
17.07	1114.5	1110.40	1109.15	1106.43	1109.51	1109.94	1110.72	1107.9	1105.11	1106.4	1104.71
17.08	1115	1110.16	1102.73	1102.13	1102.71	1101.4	1097.93	1101.58	1101.43	1101.94	1100.82
17.1	1115.5	1111.77	1118.36	1120.18	1121.21	1113.33	1113.8	1113.51	1104.28	1105.29	1104.55
17.15	1116	1110.99	1105.33	1104.05	1104.1	1103.71	1103.68	1103.41	1105.18	1106.1	1105.3
17.2	1116.2	1112.06	1119.47	1121.95	1122.75	1114.65	1115.45	1115.09	1106.1	1106.81	1105.92
17.3	1116.7	1111.80	1115.48	1114.23	1117.44	1103.76	1105.08	1103.74	1103.96	1105.39	1103.9
17.4	1118.3	1113.10	1120.57	1121.39	1122.12	1114.39	1114.89	1114.58	1110.29	1113.97	1111.98
17.6	1117.4	1111.96	1115.58	1115.17	1113.97	1099.65	1099.26	1110.74	1111.13	1112.75	1107.43
17.9	1120	1117.18	1125.96	1128.35	1127.27	1125.58	1128.79	1123.49	1119.81	1124.17	1124.02
18.02	1122.5	1119.81	1123.7	1122.41	1124.68	1121.09	1121.41	1125.17	1124.07	1127.11	1124.66
18.14	1125	1122.46	1128.87	1128.67	1129.34	1128.34	1131.41	1124.45	1115.27	1119.46	1126.6
18.2	1127	1125.06	1130.51	1123.65	1127.41	1126.55	1126.28	1127.34	1126.64	1129.37	1127.56
18.36	1130	1126.03	1129.7	1131.46	1131.16	1130.79	1134.81	1129.49	1127.89	1127.04	1133.85
18.48	1132.5	1127.04	1132.54	1128.5	1130.29	1130.47	1131.61	1131.22	1129.52	1131.29	1129.2
18.61	1135	1129.20	1127.29	1133.41	1132.6	1130.41	1133.72	1129.25	1128.22	1128.4	1134.54
18.82	1140	1131.29	1137.04	1133.86	1132.07	1131.07	1133.41	1132.21	1129.06	1128.71	1129.42

Cross Section	Thalweg		Predicted Thalweg Using Laursen-Copeland								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
19	1143	1135.44	1137.39	1136.6	1132.84	1124.33	1125.45	1122.37	1134.73	1128.68	1131.68
19.23	1147	1139.32	1140.25	1139.22	1136.9	1144.38	1144.15	1146.19	1146.02	1142.01	1142.39
19.48	1150	1146.29	1142.63	1144.4	1142.68	1148.51	1147.34	1149.82	1148.25	1145.06	1147.05
19.59	1152.3	1148.50	1148.36	1145.35	1145.33	1148.17	1147.89	1149.39	1149.81	1144.86	1146.34
19.7	1153	1150.77	1131.29	1139.89	1142.2	1145.1	1145.13	1146.63	1139.89	1139.63	1137.92
19.86	1155	1155.29	1151.34	1147.58	1148.63	1147.1	1150.33	1147.56	1149.45	1147.44	1146.44
20.08	1157	1159.44	1150.96	1151.68	1153.2	1152.97	1151.8	1157.15	1150.16	1149.15	1151.17
20.3	1160	1161.85	1156.43	1149.28	1150.34	1150.86	1154.05	1154.43	1153.37	1151.14	1151.08
20.48	1165	1163.98	1157.1	1161.22	1162.79	1162.29	1158.29	1160.61	1156	1151.97	1155.51
20.65	1168	1166.13	1162.53	1161.42	1163.85	1158.16	1160.04	1160.32	1158.68	1158.59	1157.05
20.86	1175	1172.44	1167.86	1168.93	1169.7	1172.17	1171.19	1171.78	1169.8	1162.39	1169.71
21.09	1180	1175.94	1173.79	1173.22	1172.88	1167.77	1171.27	1172.11	1167.04	1174	1169.01
21.26	1180	1177.67	1165.6	1172.34	1168.99	1173.45	1173.93	1170.67	1169.4	1172.11	1166.54
21.57	1183	1181.62	1173.98	1173.95	1174.7	1167.68	1168.69	1174.31	1168.84	1175.8	1170.62
21.87	1185	1186.09	1167.55	1174.96	1170.63	1178.55	1179.68	1177.15	1168.58	1170.53	1166.05
22.07	1190	1187.14	1185.48	1183.77	1185.73	1184.92	1180.73	1187.88	1180.26	1178.84	1181.68
22.32	1194	1187.73	1185.34	1186.95	1186.43	1189.66	1189.49	1186.94	1186.99	1193.07	1182.75
22.72	1199	1192.93	1195.4	1193.91	1198.64	1194.18	1189.65	1196.69	1192.88	1190.05	1196.05
22.97	1205	1198.30	1198.74	1197.12	1199.17	1197.01	1200.99	1197.21	1196.22	1202.26	1197.03
23.15	1208	1200.21	1200.75	1204.32	1205.07	1200.63	1200.34	1203.41	1200.86	1201.47	1203.09
23.33	1211	1202.13	1201.8	1199.53	1204.65	1201.51	1202.87	1199.8	1201.32	1204.15	1199.86
23.62	1214	1208.83	1205.98	1214.01	1207.68	1205.39	1206.42	1214.06	1205.58	1207.89	1221.79
24.04	1220	1215.86	1214.23	1217.1	1217.34	1214.15	1215.2	1218.6	1213.87	1215.82	1220.88
24.32	1224	1224.00	1215.5	1221.79	1219.16	1215.48	1218.21	1222.95	1215.28	1218.51	1226.23
		RMSE	5.152	5.589	5.863	5.727	6.689	5.280	4.720	4.708	5.227

APPENDIX H

PREDICTED PROFILES FOR INTERMEDIATE MODEL

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Yang								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1084.28		1084.29	1084.3	1084.29	1084.21	1084.22	1084.22	1084.21	1084.21	1084.22
14.501	1087		1086.86	1086.86	1086.86	1086.82	1086.82	1086.83	1086.82	1086.82	1086.83
14.69	1089.77		1089.54	1089.54	1089.54	1089.6	1089.6	1089.6	1089.6	1089.6	1089.6
14.879	1091.17		1091.26	1091.26	1091.26	1091.12	1091.11	1091.12	1091.11	1091.11	1091.12
15.069	1093.31		1093.35	1093.35	1093.35	1093.31	1093.3	1093.3	1093.31	1093.31	1093.3
15.258	1094.87		1094.84	1094.84	1094.83	1094.81	1094.81	1094.81	1094.81	1094.81	1094.81
15.454	1097.09		1097.07	1097.07	1097.07	1097.01	1097.01	1097.02	1097.01	1097.01	1097.01
15.647	1098.02	1096.00	1098.02	1098.02	1098.02	1098.01	1098.01	1098.01	1098.01	1098.01	1098
15.823	1102.93	1101.45	1102.92	1102.92	1102.91	1102.91	1102.92	1102.92	1102.92	1102.92	1102.92
16.013	1103.07	1104.25	1103.25	1103.23	1103.24	1103.08	1103.07	1103.06	1103.07	1103.07	1103.06
16.153	1105.06	1104.68	1105.07	1105.06	1105.07	1105.06	1105.06	1105.04	1105.06	1105.06	1105.05
16.35	1112.37	1108.09	1111.49	1111.48	1111.48	1111.49	1111.49	1111.49	1111.49	1111.49	1111.49
16.355	1112.53	1108.24	1108.43	1108.44	1108.91	1108.92	1108.75	1108.53	1108.84	1108.77	1108.51
16.376	1112.82	1108.58	1112.95	1113.01	1112.97	1113.02	1113.05	1113.08	1113.04	1113.05	1113.09
16.431	1112.19	1109.39	1111.64	1111.65	1111.63	1111.07	1111.04	1111.06	1111.05	1111.06	1111.08
16.481	1113.05	1109.44	1113.4	1113.43	1113.41	1113.07	1113.07	1113.08	1113.07	1113.07	1113.11
16.58	1113.36	1110.07	1113.52	1113.54	1113.53	1113.18	1113.18	1113.16	1113.17	1113.16	1113.04
16.681	1114.8	1110.41	1115.05	1115.08	1115.06	1114.53	1114.6	1114.54	1114.59	1114.58	1114.58
16.78	1113.04	1112.03	1115.18	1115.22	1115.21	1113.05	1113.05	1113.05	1113.04	1113.04	1113.04
16.879	1113.4	1113.64	1116.18	1116.23	1116.2	1113.5	1113.5	1113.5	1113.49	1113.49	1113.49
16.979	1116.1	1114.87	1117.16	1117.19	1117.17	1116.1	1116.1	1116.1	1116.11	1116.11	1116.11
17.078	1118.58	1115.65	1118.84	1118.87	1118.85	1108.58	1108.58	1108.58	1106.58	1106.58	1106.58
17.174	1121.42	1115.42	1121.45	1121.46	1121.45	1111.99	1111.99	1111.99	1109.99	1109.99	1109.99
17.273	1122.8	1117.79	1122.89	1122.89	1122.89	1113.59	1113.59	1113.59	1111.61	1111.61	1111.61
17.398	1124.51	1115.23	1124.63	1124.63	1124.64	1115.19	1115.23	1115.36	1113.49	1113.5	1113.48
17.509	1127.18	1118.87	1127.37	1127.37	1127.36	1120.66	1120.66	1120.66	1118.69	1118.81	1118.81
17.607	1128.63	1118.36	1128.57	1128.58	1128.58	1120.77	1120.77	1120.77	1118.77	1118.77	1118.77
17.71	1131.12	1119.38	1131.18	1131.16	1131.17	1123.46	1123.47	1123.47	1121.38	1121.48	1121.47

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Yang								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1132.27	1125.30	1132.49	1132.48	1132.48	1126.11	1126.12	1126.12	1123.72	1124.09	1124.12
17.909	1132.72	1127.42	1132.85	1132.86	1132.85	1124.31	1124.31	1124.31	1122.31	1122.31	1122.31
18.009	1135.1	1128.63	1135.08	1135.11	1135.14	1127.56	1127.56	1127.56	1125.56	1125.56	1125.56
18.109	1137.17	1132.31	1137.25	1137.23	1137.25	1129.54	1129.54	1129.54	1127.52	1127.51	1127.38
18.207	1138.72	1136.76	1138.6	1138.59	1138.63	1138.25	1138.29	1138.24	1138.24	1138.34	1138.25
18.306	1141.11	1140.69	1140.99	1141	1140.99	1140.55	1140.48	1140.44	1140.41	1140.68	1140.51
18.406	1142.94	1143.32	1142.68	1142.64	1142.69	1141.77	1141.82	1141.82	1141.5	1141.94	1142.26
18.507	1143.41	1144.97	1143.37	1143.33	1143.37	1142.8	1143.01	1143.05	1142.83	1143.13	1143.18
18.606	1144.84	1146.39	1144.48	1144.47	1144.5	1144.13	1144.12	1144.13	1143.95	1144.15	1144.37
18.707	1147.28	1146.62	1147.03	1147.02	1147.03	1146.92	1146.95	1146.95	1146.8	1146.97	1147
18.808	1148.3	1147.78	1148.28	1148.29	1148.28	1148.27	1148.27	1148.27	1148.24	1148.26	1148.28
18.893	1148.47	1149.34	1149.35	1149.34	1149.39	1149.23	1149.29	1149.27	1149.24	1149.31	1149.26
18.906	1148.49	1149.71	1149.71	1149.7	1149.71	1149.64	1149.66	1149.65	1149.61	1149.65	1149.65
18.97	1151.78	1151.46	1151.7	1151.71	1151.72	1151.7	1151.71	1151.7	1151.69	1151.69	1151.71
19.029	1153.27	1152.48	1152.82	1152.84	1152.79	1152.86	1152.86	1152.89	1152.86	1152.86	1152.86
19.245	1159.57	1155.90	1158.83	1158.84	1158.79	1158.82	1158.83	1158.85	1158.83	1158.81	1158.82
19.491	1162.16	1158.98	1162.04	1162.04	1162.03	1162.03	1162.03	1162.04	1162.03	1162.03	1162.04
19.7	1165.58	1163.52	1165.27	1165.27	1165.27	1165.25	1165.25	1165.25	1165.25	1165.24	1165.25
19.929	1170.31	1167.20	1169.44	1169.39	1169.39	1169.34	1169.3	1169.31	1169.29	1169.39	1169.29
20.122	1172.66	1170.29	1172.53	1172.53	1172.53	1172.41	1172.41	1172.4	1172.4	1172.38	1172.4
20.382	1176.06	1173.44	1175.77	1175.79	1175.78	1175.57	1175.58	1175.58	1175.56	1175.54	1175.56
20.575	1179.47	1176.88	1179.15	1179.16	1179.16	1178.48	1178.48	1178.48	1178.48	1178.49	1178.47
20.738	1181.49	1178.67	1181.48	1181.47	1181.47	1180.01	1180	1180.01	1180.09	1180.1	1180.09
20.993	1183.78	1182.03	1183.99	1184	1184	1183.58	1183.58	1183.58	1183.57	1183.57	1183.57
21.1	1186.36	1177.66	1185.6	1185.59	1185.58	1174.84	1174.84	1174.84	1154.84	1154.84	1154.84
21.241	1189.9	1152.28	1188.46	1188.48	1188.46	1177.9	1177.9	1177.9	1157.91	1157.91	1157.91
21.469	1188.71	1157.29	1190.02	1190.03	1190.02	1175.92	1175.92	1175.92	1152.49	1152.2	1152.46
21.681	1191.5	1187.21	1192	1192.01	1191.99	1191.57	1191.57	1191.57	1191.53	1191.53	1191.53
21.88	1193.48	1194.88	1193.52	1193.52	1193.51	1193.45	1193.45	1193.45	1192.98	1192.93	1192.95

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Yang								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1197.59	1199.07	1197.54	1197.55	1197.55	1197.53	1197.53	1197.53	1197.53	1197.53	1197.52
22.258	1200.39	1203.31	1200.24	1200.18	1200.25	1200.23	1200.23	1200.23	1200.16	1200.23	1200.22
22.448	1203.84	1206.83	1203.94	1203.91	1203.93	1203.94	1203.91	1203.91	1203.93	1203.92	1203.91
22.637	1205.07	1209.58	1205.16	1205.18	1205.14	1205.03	1205.15	1205.1	1205.09	1205.19	1205.15
22.827	1210.64	1213.19	1209.98	1210.01	1210.04	1210.07	1210.03	1210.05	1210.06	1209.99	1210.04
23.016	1214.71	1217.99	1214.36	1214.42	1214.41	1214.42	1214.41	1214.42	1214.39	1214.4	1214.39
23.205	1217.79	1220.02	1217.79	1217.79	1217.8	1217.8	1217.8	1217.8	1217.8	1217.79	1217.79
23.395	1219.83	1223.96	1220.3	1220.32	1220.33	1220.28	1220.32	1220.31	1220.28	1220.35	1220.3
23.46	1220.42	1225.28	1220.89	1220.9	1220.89	1220.89	1220.9	1220.89	1220.89	1220.91	1220.89
23.52	1222.43	1226.79	1222.39	1222.4	1222.41	1222.37	1222.4	1222.39	1222.38	1222.41	1222.39
23.584	1224.69	1227.65	1224.31	1224.32	1224.31	1224.33	1224.32	1224.33	1224.34	1224.32	1224.33
23.774	1228.43	1230.14	1228	1228	1228.03	1228.01	1228	1228.01	1228.01	1228	1228
23.87	1231.31	1232.68	1230.96	1230.98	1230.95	1230.96	1230.97	1230.98	1231.01	1230.97	1230.97
23.963	1233.8	1235.23	1233.42	1233.45	1233.49	1233.45	1233.45	1233.44	1233.45	1233.46	1233.43
24.03	1234.58	1236.14	1234.41	1234.41	1234.4	1234.41	1234.41	1234.42	1234.41	1234.41	1234.41
24.09	1235.56	1237.15	1235.21	1235.25	1235.25	1235.23	1235.27	1235.26	1235.24	1235.27	1235.22
24.152	1236.55	1237.88	1236.24	1236.25	1236.21	1236.24	1236.25	1236.27	1236.24	1236.26	1236.24
24.342	1238.34		1238.24	1238.53	1238.45	1238.37	1238.59	1238.56	1238.52	1238.6	1238.39
24.531	1240.98		1241.06	1241.1	1241.03	1240.99	1241.11	1241.09	1241.07	1241.12	1240.99
24.59	1243.03		1242.63	1242.47	1242.61	1242.58	1242.54	1242.59	1242.53	1242.52	1242.68
24.66	1245.34		1244.75	1244.77	1244.75	1244.74	1244.78	1244.76	1244.78	1244.78	1244.69
24.721	1247.01		1246.47	1246.4	1246.4	1246.41	1246.38	1246.41	1246.4	1246.38	1246.46
24.91	1248.89		1248.12	1248.04	1248.1	1248.06	1247.98	1248.06	1247.93	1247.99	1248.24
25.099	1260		1258.56	1258.55	1258.69	1258.65	1258.48	1258.6	1258.55	1258.49	1258.65
25.289	1254.79		1255.17	1255.84	1256.47	1255.16	1255.88	1256.47	1255.17	1255.84	1256.46
25.459	1257.42		1258.64	1258.92	1259.19	1258.65	1258.85	1259.18	1258.64	1258.9	1259.19
25.592	1259.98		1259.49	1259.95	1260.75	1259.53	1260.05	1260.7	1259.49	1259.94	1260.73
		RMSE	7.147	7.150	7.146	4.651	4.649	4.648	4.071	4.066	4.061

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and Schoklitsch								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1084.28		1084.49	1084.49	1084.48	1084.36	1084.37	1084.37	1084.35	1084.35	1084.37
14.501	1087		1086.73	1086.73	1086.73	1086.75	1086.75	1086.75	1086.75	1086.75	1086.75
14.69	1089.77		1089.46	1089.46	1089.46	1089.42	1089.43	1089.43	1089.42	1089.42	1089.42
14.879	1091.17		1091.24	1091.24	1091.24	1091.21	1091.21	1091.2	1091.2	1091.2	1091.21
15.069	1093.31		1093.73	1093.71	1093.72	1093.41	1093.43	1093.4	1093.4	1093.41	1093.41
15.258	1094.87		1094.83	1094.83	1094.83	1094.84	1094.84	1094.84	1094.84	1094.84	1094.84
15.454	1097.09		1097.25	1097.24	1097.25	1097.07	1097.08	1097.07	1097.08	1097.08	1097.08
15.647	1098.02	1096.00	1098.13	1098.12	1098.12	1098.02	1098.02	1098.02	1098.02	1098.02	1098.02
15.823	1102.93	1101.45	1102.99	1102.96	1102.96	1102.9	1102.9	1102.89	1102.9	1102.9	1102.9
16.013	1103.07	1104.25	1103.77	1103.79	1103.81	1103.52	1103.54	1103.5	1103.52	1103.53	1103.54
16.153	1105.06	1104.68	1105.56	1105.5	1105.51	1105.37	1105.41	1105.38	1105.4	1105.4	1105.38
16.35	1112.37	1108.09	1111.8	1110.83	1110.77	1110.72	1110.84	1111.04	1110.94	1110.8	1110.76
16.355	1112.53	1108.24	1109.04	1109.02	1108.94	1105.58	1103.07	1105.96	1102.88	1102.8	1105.82
16.376	1112.82	1108.58	1110.24	1110.29	1110.29	1109.98	1109.69	1109.87	1109.6	1109.75	1109.69
16.431	1112.19	1109.39	1110.91	1110.93	1111	1110.61	1110.72	1110.58	1110.66	1110.65	1110.58
16.481	1113.05	1109.44	1111.76	1111.87	1111.83	1111.55	1111.57	1111.54	1111.58	1111.65	1111.49
16.58	1113.36	1110.07	1112.36	1112.57	1112.6	1111.91	1112.03	1111.82	1111.95	1111.88	1111.58
16.681	1114.8	1110.41	1114.03	1114.05	1114.04	1113.92	1113.56	1113.8	1113.94	1113.95	1113.98
16.78	1113.04	1112.03	1114.34	1114.88	1115.01	1113.12	1113.05	1113.01	1113.17	1113.15	1113.13
16.879	1113.4	1113.64	1116.46	1115.95	1115.92	1113.8	1113.69	1113.81	1113.55	1113.56	1113.56
16.979	1116.1	1114.87	1116.62	1117.5	1117.45	1115.97	1115.95	1115.97	1116.14	1116.14	1116.15
17.078	1118.58	1115.65	1118.96	1118.92	1118.91	1108.51	1108.55	1108.55	1106.22	1106.07	1105.97
17.174	1121.42	1115.42	1121.4	1121.63	1121.6	1111.99	1111.99	1111.99	1110	1110	1110
17.273	1122.8	1117.79	1122.92	1122.97	1122.95	1113.57	1113.57	1113.55	1111.58	1111.58	1111.59
17.398	1124.51	1115.23	1124.51	1124.56	1124.57	1114.67	1114.6	1114.59	1113.5	1113.5	1113.5
17.509	1127.18	1118.87	1127.26	1127.26	1127.26	1120.65	1120.67	1120.62	1118.81	1118.81	1118.8
17.607	1128.63	1118.36	1128.43	1128.43	1128.43	1120.77	1120.77	1120.77	1118.77	1118.77	1118.77
17.71	1131.12	1119.38	1131.16	1131.18	1131.17	1123.43	1123.45	1123.4	1121.42	1121.42	1121.41

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and Schoklitsch								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1132.27	1125.30	1132.28	1132.29	1132.28	1125.99	1126	1125.98	1123.98	1123.97	1123.98
17.909	1132.72	1127.42	1133.15	1133.15	1133.14	1124.31	1124.31	1124.31	1122.31	1122.31	1122.31
18.009	1135.1	1128.63	1135.01	1135.05	1135.06	1127.57	1127.57	1127.56	1125.56	1125.56	1125.56
18.109	1137.17	1132.31	1137.8	1137.8	1137.8	1129.54	1129.54	1129.55	1127.54	1127.54	1127.54
18.207	1138.72	1136.76	1138.79	1138.87	1138.85	1138.29	1138.26	1138.19	1138.09	1138.09	1138.11
18.306	1141.11	1140.69	1141.19	1141.18	1141.2	1139.93	1140.15	1139.93	1140.3	1140.31	1140.29
18.406	1142.94	1143.32	1142.44	1142.47	1142.44	1140.8	1140.97	1141.06	1140.72	1140.61	1140.69
18.507	1143.41	1144.97	1143.71	1143.66	1143.7	1142.99	1142.94	1142.82	1142.94	1143	1142.97
18.606	1144.84	1146.39	1144.52	1144.51	1144.52	1143.58	1143.52	1143.72	1143.45	1143.45	1143.41
18.707	1147.28	1146.62	1147.07	1147.08	1147.07	1146.13	1145.88	1146.27	1145.76	1145.73	1145.61
18.808	1148.3	1147.78	1148.3	1148.28	1148.37	1147.72	1147.97	1147.94	1147.73	1147.74	1147.61
18.893	1148.47	1149.34	1149.4	1149.47	1149.31	1148.54	1148.61	1148.6	1146.73	1146.16	1146.2
18.906	1148.49	1149.71	1150.22	1150.24	1150.24	1149.04	1149.17	1149.17	1148.7	1148.7	1148.41
18.97	1151.78	1151.46	1151.65	1151.84	1151.6	1151.35	1151.37	1151.45	1151.36	1151.37	1151.43
19.029	1153.27	1152.48	1152.96	1152.91	1152.96	1152.84	1152.91	1152.9	1152.87	1152.88	1152.9
19.245	1159.57	1155.90	1158.5	1158.46	1158.53	1158.38	1158.31	1158.41	1158.41	1158.46	1158.44
19.491	1162.16	1158.98	1161.4	1161.41	1161.49	1160.98	1161.13	1161.27	1161.07	1160.98	1161.14
19.7	1165.58	1163.52	1165.18	1165.34	1165.09	1165.33	1165.02	1164.86	1165.2	1165.15	1165.31
19.929	1170.31	1167.20	1169.63	1169.73	1169.65	1169.25	1169.43	1169.07	1169.52	1169.56	1169.28
20.122	1172.66	1170.29	1171.78	1171.81	1171.96	1171.1	1171.38	1171.63	1171.56	1171.57	1171.55
20.382	1176.06	1173.44	1175.66	1175.42	1175.46	1174.79	1174.69	1174.62	1174.79	1174.81	1174.77
20.575	1179.47	1176.88	1179.06	1178.96	1178.98	1178.55	1178.51	1178.46	1178.6	1178.61	1178.6
20.738	1181.49	1178.67	1181.09	1180.88	1180.91	1180.23	1180.21	1180.08	1181.17	1181.16	1181.14
20.993	1183.78	1182.03	1184.6	1185.54	1184.98	1183.85	1183.85	1183.85	1183.07	1183.06	1183.05
21.1	1186.36	1177.66	1185.74	1185.14	1185.71	1174.84	1174.84	1174.84	1154.84	1154.84	1154.84
21.241	1189.9	1152.28	1188.29	1188.4	1188.39	1177.9	1177.9	1177.9	1157.9	1157.9	1157.9
21.469	1188.71	1157.29	1189.47	1189.15	1189.28	1175.92	1175.92	1175.92	1155.92	1155.92	1155.92
21.681	1191.5	1187.21	1191.98	1191.95	1192	1190.22	1190.2	1190.39	1190.03	1190.02	1189.98
21.88	1193.48	1194.88	1193.53	1193.52	1193.51	1192.6	1192.72	1192.76	1192.76	1192.71	1192.78

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and Schoklitsch								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1197.59	1199.07	1197.29	1197.27	1197.28	1195.82	1195.78	1195.84	1195.24	1195.7	1195.62
22.258	1200.39	1203.31	1200.09	1200.11	1200.11	1198.12	1198.09	1197.56	1198.1	1197.7	1198.01
22.448	1203.84	1206.83	1203.87	1203.86	1203.89	1202.21	1202.37	1202.15	1202.46	1202.44	1202.65
22.637	1205.07	1209.58	1205.37	1205.45	1205.4	1203.01	1203.2	1203.36	1204.91	1204.88	1204.93
22.827	1210.64	1213.19	1210.15	1210.08	1210.13	1209.59	1209.59	1209.78	1210.08	1210.08	1210.09
23.016	1214.71	1217.99	1214.46	1214.39	1214.47	1214.18	1214.36	1214.32	1214.36	1214.44	1214.36
23.205	1217.79	1220.02	1217.73	1217.65	1217.72	1217.68	1217.68	1217.67	1217.65	1217.71	1217.68
23.395	1219.83	1223.96	1220.52	1220.69	1220.54	1220.49	1220.5	1220.5	1220.48	1220.51	1220.51
23.46	1220.42	1225.28	1221.09	1221.1	1221.12	1221.11	1221.11	1221.1	1221.11	1221.1	1221.12
23.52	1222.43	1226.79	1222.47	1222.67	1222.49	1222.46	1222.48	1222.46	1222.45	1222.46	1222.47
23.584	1224.69	1227.65	1224.45	1224.39	1224.43	1224.45	1224.44	1224.43	1224.44	1224.43	1224.44
23.774	1228.43	1230.14	1228.1	1228.11	1228.06	1228.1	1228.08	1228.07	1228.11	1228.1	1228.05
23.87	1231.31	1232.68	1231.14	1231.14	1231.17	1231.14	1231.19	1231.11	1231.17	1231.16	1231.16
23.963	1233.8	1235.23	1233.34	1233.32	1233.34	1233.33	1233.34	1233.35	1233.33	1233.33	1233.33
24.03	1234.58	1236.14	1234.36	1234.36	1234.38	1234.35	1234.38	1234.35	1234.38	1234.38	1234.36
24.09	1235.56	1237.15	1235.04	1235.01	1235.01	1235.04	1234.99	1235.05	1235.03	1235.03	1235.02
24.152	1236.55	1237.88	1235.77	1235.87	1235.84	1235.77	1235.91	1235.78	1235.85	1235.87	1235.79
24.342	1238.34		1238.85	1238.73	1238.83	1238.85	1238.7	1238.94	1238.82	1238.52	1238.94
24.531	1240.98		1241.6	1241.68	1241.6	1241.6	1241.67	1241.62	1241.59	1241.53	1241.66
24.59	1243.03		1243.02	1242.92	1242.97	1243.05	1242.9	1243.16	1242.95	1242.85	1243.15
24.66	1245.34		1244.74	1244.77	1244.79	1244.75	1244.76	1244.76	1244.76	1244.77	1244.78
24.721	1247.01		1246.93	1246.93	1246.91	1246.93	1246.93	1246.94	1246.92	1246.89	1246.94
24.91	1248.89		1247.97	1248.04	1247.99	1247.97	1248.02	1247.86	1247.99	1248.27	1248.03
25.099	1260		1256.54	1256.71	1257.08	1256.55	1256.72	1257.13	1256.51	1256.87	1256.84
25.289	1254.79		1255.56	1256.36	1257.02	1255.56	1256.36	1257.01	1255.57	1256.28	1256.99
25.459	1257.42		1258.05	1258.32	1258.75	1258.05	1258.32	1258.77	1258.04	1258.37	1258.77
25.592	1259.98		1259.2	1259.54	1260.1	1259.2	1259.56	1260.1	1259.2	1259.54	1260.08
		RMSE	7.036	7.020	7.035	4.676	4.694	4.668	4.080	4.094	4.042

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Meyer-Peter and Muller								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1084.28		1084.23	1084.23	1084.23	1084.23	1084.23	1084.23	1084.23	1084.23	1084.23
14.501	1087		1086.81	1086.81	1086.81	1086.81	1086.81	1086.81	1086.81	1086.81	1086.81
14.69	1089.77		1089.41	1089.41	1089.41	1089.41	1089.41	1089.41	1089.41	1089.41	1089.41
14.879	1091.17		1091.12	1091.12	1091.12	1091.12	1091.12	1091.12	1091.12	1091.12	1091.12
15.069	1093.31		1093.71	1093.71	1093.71	1093.71	1093.71	1093.71	1093.71	1093.71	1093.71
15.258	1094.87		1094.71	1094.71	1094.71	1094.71	1094.71	1094.71	1094.71	1094.71	1094.71
15.454	1097.09		1097.2	1097.2	1097.2	1097.2	1097.2	1097.2	1097.2	1097.2	1097.2
15.647	1098.02	1096.00	1098.02	1098.02	1098.02	1098.02	1098.02	1098.02	1098.02	1098.02	1098.02
15.823	1102.93	1101.45	1102.85	1102.85	1102.85	1102.84	1102.84	1102.84	1102.84	1102.84	1102.84
16.013	1103.07	1104.25	1103.5	1103.5	1103.5	1103.49	1103.5	1103.49	1103.48	1103.48	1103.48
16.153	1105.06	1104.68	1105.51	1105.51	1105.51	1105.47	1105.47	1105.47	1105.49	1105.49	1105.49
16.35	1112.37	1108.09	1110.29	1110.27	1110.28	1110.37	1110.37	1110.37	1110.23	1110.23	1110.23
16.355	1112.53	1108.24	1110	1110.03	1110.04	1109.87	1109.95	1109.88	1109.93	1109.93	1109.94
16.376	1112.82	1108.58	1110.88	1110.87	1110.87	1111.03	1110.97	1111.03	1110.83	1110.83	1110.83
16.431	1112.19	1109.39	1111.15	1111.15	1111.15	1111.1	1111.11	1111.11	1111.08	1111.07	1111.08
16.481	1113.05	1109.44	1112.2	1112.2	1112.2	1112.18	1112.17	1112.18	1112.16	1112.16	1112.16
16.58	1113.36	1110.07	1112.63	1112.63	1112.63	1112.34	1112.36	1112.34	1112.4	1112.4	1112.4
16.681	1114.8	1110.41	1114.3	1114.3	1114.3	1113.96	1113.97	1113.96	1113.95	1113.95	1113.95
16.78	1113.04	1112.03	1114.02	1114.02	1114.02	1113.18	1113.18	1113.18	1113.12	1113.12	1113.12
16.879	1113.4	1113.64	1115.14	1115.14	1115.14	1113.73	1113.73	1113.73	1113.68	1113.68	1113.68
16.979	1116.1	1114.87	1117.2	1117.2	1117.21	1116.29	1116.29	1116.29	1116.29	1116.29	1116.29
17.078	1118.58	1115.65	1118.26	1118.26	1118.26	1108.44	1108.45	1108.45	1106.58	1106.58	1106.58
17.174	1121.42	1115.42	1121.47	1121.47	1121.48	1111.99	1111.99	1111.99	1109.99	1109.99	1109.99
17.273	1122.8	1117.79	1122.61	1122.61	1122.61	1113.6	1113.6	1113.6	1111.61	1111.61	1111.61
17.398	1124.51	1115.23	1124.81	1124.82	1124.82	1115.59	1115.59	1115.59	1113.63	1113.63	1113.63
17.509	1127.18	1118.87	1127.05	1127.05	1127.04	1120.34	1120.34	1120.35	1118.81	1118.81	1118.81
17.607	1128.63	1118.36	1128.83	1128.84	1128.82	1120.77	1120.77	1120.77	1118.77	1118.77	1118.77
17.71	1131.12	1119.38	1130.91	1130.87	1130.91	1123.5	1123.5	1123.5	1121.03	1121.04	1121.04

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Meyer-Peter and Muller								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1132.27	1125.30	1132.73	1132.73	1132.73	1125.12	1125.12	1125.11	1123.72	1123.72	1123.72
17.909	1132.72	1127.42	1132.47	1132.47	1132.46	1124.3	1124.3	1124.3	1122.31	1122.31	1122.31
18.009	1135.1	1128.63	1135.77	1135.77	1135.77	1127.56	1127.56	1127.56	1125.56	1125.56	1125.56
18.109	1137.17	1132.31	1136.79	1136.79	1136.79	1129.54	1129.54	1129.54	1127.54	1127.54	1127.54
18.207	1138.72	1136.76	1138.88	1138.88	1138.88	1138.19	1138.19	1138.19	1138.04	1138.04	1138.04
18.306	1141.11	1140.69	1140.82	1140.82	1140.82	1140.45	1140.45	1140.46	1140.58	1140.57	1140.58
18.406	1142.94	1143.32	1142.3	1142.3	1142.3	1141.06	1141.08	1141.06	1140.56	1140.56	1140.55
18.507	1143.41	1144.97	1143.93	1143.95	1143.93	1143.17	1143.17	1143.17	1142.99	1142.99	1142.99
18.606	1144.84	1146.39	1144.55	1144.52	1144.55	1143.76	1143.79	1143.77	1143.48	1143.47	1143.48
18.707	1147.28	1146.62	1147.8	1147.8	1147.8	1146.7	1146.71	1146.69	1146.41	1146.41	1146.41
18.808	1148.3	1147.78	1147.76	1147.78	1147.81	1147.64	1147.66	1147.65	1147.68	1147.68	1147.68
18.893	1148.47	1149.34	1151.09	1151.05	1150.98	1150.45	1150.47	1150.44	1150	1150	1150
18.906	1148.49	1149.71	1150.27	1150.31	1150.41	1149.95	1149.95	1149.93	1149.73	1149.74	1149.73
18.97	1151.78	1151.46	1153.4	1153.41	1153.33	1153.32	1153.32	1153.33	1153.21	1153.19	1153.21
19.029	1153.27	1152.48	1153.17	1153.15	1153.11	1153.15	1153.14	1153.14	1153.01	1153.01	1153.01
19.245	1159.57	1155.90	1158.78	1158.77	1158.79	1158.75	1158.77	1158.77	1158.81	1158.81	1158.81
19.491	1162.16	1158.98	1160.76	1160.77	1160.8	1160.78	1160.77	1160.78	1160.82	1160.81	1160.82
19.7	1165.58	1163.52	1165.95	1165.95	1165.95	1165.83	1165.92	1165.92	1165.93	1165.93	1165.93
19.929	1170.31	1167.20	1169.87	1169.88	1169.86	1170.07	1169.94	1169.94	1169.96	1169.96	1169.96
20.122	1172.66	1170.29	1171.86	1171.86	1171.86	1171.96	1171.99	1171.99	1172	1172	1172
20.382	1176.06	1173.44	1176.55	1176.52	1176.53	1176.12	1176.14	1176.14	1176.11	1176.11	1176.11
20.575	1179.47	1176.88	1179.12	1179.15	1179.15	1178.98	1179.01	1179.02	1179.01	1179.01	1179.01
20.738	1181.49	1178.67	1180.91	1180.91	1180.91	1180.59	1180.54	1180.54	1180.53	1180.52	1180.52
20.993	1183.78	1182.03	1185.19	1185.19	1185.19	1183.9	1183.9	1183.9	1183.9	1183.9	1183.9
21.1	1186.36	1177.66	1185.62	1185.63	1185.62	1174.83	1174.83	1174.83	1154.84	1154.84	1154.84
21.241	1189.9	1152.28	1188.53	1188.54	1188.53	1177.9	1177.9	1177.9	1157.9	1157.9	1157.9
21.469	1188.71	1157.29	1188.56	1188.56	1188.56	1175.92	1175.92	1175.92	1155.92	1155.92	1155.92
21.681	1191.5	1187.21	1192.04	1192.04	1192.03	1190.59	1190.59	1190.77	1190.27	1190.28	1190.28
21.88	1193.48	1194.88	1192.99	1192.99	1193	1192.81	1192.81	1192.94	1192.69	1192.69	1192.68

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Meyer-Peter and Muller								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1197.59	1199.07	1197.97	1197.97	1197.99	1195.56	1195.67	1195.69	1196.38	1196.36	1196.36
22.258	1200.39	1203.31	1200.45	1200.45	1200.41	1199.3	1199.34	1199.62	1199.52	1199.51	1199.51
22.448	1203.84	1206.83	1203.65	1203.65	1203.66	1203.33	1203.34	1203.49	1203.41	1203.43	1203.42
22.637	1205.07	1209.58	1205.64	1205.66	1205.61	1205.83	1205.87	1205.69	1205.77	1205.79	1205.81
22.827	1210.64	1213.19	1210.31	1210.26	1210.32	1210.32	1210.28	1210.24	1210.29	1210.3	1210.27
23.016	1214.71	1217.99	1214.42	1214.4	1214.41	1214.43	1214.44	1214.4	1214.42	1214.42	1214.42
23.205	1217.79	1220.02	1217.56	1217.54	1217.52	1217.52	1217.54	1217.53	1217.53	1217.55	1217.51
23.395	1219.83	1223.96	1220.47	1220.55	1220.54	1220.48	1220.41	1220.56	1220.51	1220.49	1220.45
23.46	1220.42	1225.28	1221.2	1221.24	1221.16	1221.26	1221.34	1221.29	1221.29	1221.23	1221.38
23.52	1222.43	1226.79	1222.39	1222.44	1222.41	1222.5	1222.49	1222.51	1222.48	1222.47	1222.53
23.584	1224.69	1227.65	1225.77	1225.55	1225.75	1225.03	1225.1	1225.05	1225.05	1225.16	1224.97
23.774	1228.43	1230.14	1227.31	1227.25	1227.26	1228.11	1228.15	1228.04	1228.06	1227.97	1228.31
23.87	1231.31	1232.68	1231.32	1231.53	1231.41	1230.76	1230.73	1230.79	1230.79	1230.83	1230.64
23.963	1233.8	1235.23	1233.51	1233.46	1233.45	1233.36	1233.34	1233.36	1233.35	1233.32	1233.42
24.03	1234.58	1236.14	1234.11	1234.17	1234.15	1234.35	1234.36	1234.38	1234.38	1234.38	1234.3
24.09	1235.56	1237.15	1234.95	1234.96	1234.94	1235.21	1235.18	1235.19	1235.2	1235.19	1235.18
24.152	1236.55	1237.88	1235.69	1235.7	1235.69	1235.77	1235.76	1235.77	1235.76	1235.77	1235.74
24.342	1238.34		1238.66	1238.68	1238.69	1238.67	1238.7	1238.68	1238.68	1238.7	1238.7
24.531	1240.98		1241.52	1241.5	1241.51	1241.5	1241.43	1241.49	1241.5	1241.46	1241.46
24.59	1243.03		1243.37	1243.4	1243.44	1243.4	1243.52	1243.45	1243.42	1243.45	1243.5
24.66	1245.34		1245.02	1245.01	1245.01	1245.02	1245.04	1245.03	1245.02	1245.03	1245.04
24.721	1247.01		1246.87	1246.88	1246.88	1246.88	1246.89	1246.89	1246.88	1246.89	1246.89
24.91	1248.89		1248.23	1248.21	1248.19	1248.22	1248.21	1248.21	1248.21	1248.21	1248.19
25.099	1260		1259.12	1259.15	1259.19	1259.12	1259.15	1259.19	1259.12	1259.15	1259.19
25.289	1254.79		1254.85	1254.99	1255.3	1254.85	1254.99	1255.3	1254.85	1254.99	1255.3
25.459	1257.42		1258.55	1259.07	1259.05	1258.55	1259.07	1259.07	1258.55	1259.07	1259.07
25.592	1259.98		1259.77	1261.16	1263.37	1259.77	1261.16	1263.28	1259.77	1261.16	1263.27
		RMSE	7.000	7.000	7.000	4.623	4.620	4.618	3.976	3.976	3.975

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and MPM								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1084.28		1084.38	1084.4	1084.41	1084.32	1084.32	1084.29	1084.33	1084.31	1084.32
14.501	1087		1086.77	1086.77	1086.77	1086.76	1086.77	1086.76	1086.77	1086.76	1086.76
14.69	1089.77		1089.06	1089.05	1089.05	1089.08	1089.07	1089.09	1089.08	1089.08	1089.07
14.879	1091.17		1091.25	1091.25	1091.24	1091.2	1091.2	1091.19	1091.2	1091.19	1091.2
15.069	1093.31		1093.92	1093.89	1093.91	1093.75	1093.75	1093.74	1093.72	1093.75	1093.72
15.258	1094.87		1094.81	1094.79	1094.79	1094.83	1094.83	1094.83	1094.83	1094.83	1094.83
15.454	1097.09		1097.29	1097.31	1097.3	1097.11	1097.1	1097.11	1097.09	1097.11	1097.09
15.647	1098.02	1096.00	1098.08	1098.08	1098.08	1098.02	1098.02	1098.02	1098.02	1098.02	1098.02
15.823	1102.93	1101.45	1102.83	1102.85	1102.84	1102.8	1102.8	1102.8	1102.79	1102.78	1102.79
16.013	1103.07	1104.25	1103.86	1103.89	1103.83	1103.59	1103.59	1103.59	1103.59	1103.58	1103.59
16.153	1105.06	1104.68	1105.7	1105.76	1105.74	1105.54	1105.49	1105.48	1105.49	1105.52	1105.51
16.35	1112.37	1108.09	1109.63	1109.8	1109.65	1109.32	1109.71	1109.59	1109.65	1109.53	1109.49
16.355	1112.53	1108.24	1110.1	1110.13	1110.19	1109.82	1109.97	1109.85	1109.92	1109.97	1109.87
16.376	1112.82	1108.58	1109.94	1109.87	1109.83	1109.37	1109.54	1109.58	1109.2	1109.29	1109.4
16.431	1112.19	1109.39	1111.01	1111.02	1111.15	1110.8	1110.92	1110.69	1110.88	1110.88	1110.84
16.481	1113.05	1109.44	1111.77	1111.66	1111.66	1111.31	1111.28	1111.26	1111.42	1111.22	1111.44
16.58	1113.36	1110.07	1112.78	1112.65	1112.7	1112.09	1112.14	1112.15	1111.77	1112.05	1111.74
16.681	1114.8	1110.41	1113.71	1113.59	1113.6	1113.7	1113	1113.77	1113.68	1113.31	1113.67
16.78	1113.04	1112.03	1114.95	1114.78	1114.74	1113	1113.24	1113.04	1113.04	1113.06	1113.04
16.879	1113.4	1113.64	1115.79	1115.73	1115.72	1113.87	1113.79	1113.84	1113.81	1113.68	1113.78
16.979	1116.1	1114.87	1117.47	1117.51	1117.35	1115.7	1115.89	1115.79	1116.02	1116.03	1116.1
17.078	1118.58	1115.65	1119.2	1118.98	1119.16	1108.4	1108.39	1108.4	1106.58	1106.58	1106.58
17.174	1121.42	1115.42	1121.52	1121.53	1121.57	1111.99	1111.99	1111.99	1109.99	1109.99	1109.99
17.273	1122.8	1117.79	1123	1122.97	1123.01	1113.57	1113.54	1113.48	1111.61	1111.61	1111.61
17.398	1124.51	1115.23	1124.59	1124.61	1124.61	1115.64	1115.63	1115.62	1113.53	1113.6	1113.53
17.509	1127.18	1118.87	1127.34	1127.41	1127.37	1120.12	1120.14	1120.47	1118.49	1118.31	1118.46
17.607	1128.63	1118.36	1128.49	1128.45	1128.52	1120.77	1120.77	1120.77	1118.77	1118.77	1118.77
17.71	1131.12	1119.38	1131.36	1131.25	1131.19	1123.43	1123.45	1123.45	1121.47	1121.48	1121.47

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and MPM								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1132.27	1125.30	1131.98	1132.19	1132.17	1125.31	1125.23	1125.2	1123.19	1123.13	1123.15
17.909	1132.72	1127.42	1133.51	1133.1	1133.18	1124.31	1124.31	1124.31	1122.31	1122.3	1122.3
18.009	1135.1	1128.63	1135.23	1135.25	1135.15	1127.56	1127.56	1127.56	1125.56	1125.56	1125.56
18.109	1137.17	1132.31	1138.01	1137.94	1138.38	1129.54	1129.54	1129.54	1127.55	1127.54	1127.54
18.207	1138.72	1136.76	1138.79	1138.53	1138.59	1138.14	1138.13	1138.18	1138.05	1138.03	1137.94
18.306	1141.11	1140.69	1141.26	1141.74	1141.5	1140.4	1140.4	1140.37	1140.27	1140.47	1140.47
18.406	1142.94	1143.32	1141.98	1142.05	1142.03	1140.94	1141.08	1141.14	1140.83	1140.78	1140.45
18.507	1143.41	1144.97	1143.91	1143.88	1144.11	1142.8	1143.11	1142.79	1142.91	1142.8	1142.72
18.606	1144.84	1146.39	1144.15	1144.05	1143.76	1143.23	1143.41	1143.37	1143.51	1143.22	1142.86
18.707	1147.28	1146.62	1147.1	1147.3	1147.6	1145.81	1145.91	1146.16	1145.48	1145.63	1145.79
18.808	1148.3	1147.78	1148.09	1148.4	1147.39	1147.03	1147.02	1147.43	1147.5	1147.47	1146.8
18.893	1148.47	1149.34	1150.29	1150.53	1150.71	1148.24	1148.59	1148.59	1145.56	1145.8	1148.72
18.906	1148.49	1149.71	1150.58	1150.84	1149.97	1149.14	1149.18	1149.28	1148.78	1148.78	1148.63
18.97	1151.78	1151.46	1152.56	1152.75	1152.88	1151.44	1151.48	1151.42	1151.34	1151.38	1152.38
19.029	1153.27	1152.48	1153.44	1153.4	1153.54	1152.91	1152.87	1152.88	1152.86	1152.86	1153.14
19.245	1159.57	1155.90	1158.37	1158.44	1158.36	1158.58	1158.65	1158.41	1158.63	1158.67	1158.35
19.491	1162.16	1158.98	1160.93	1160.71	1160.95	1161.21	1161.02	1160.95	1160.9	1161.19	1160.81
19.7	1165.58	1163.52	1165.01	1164.97	1164.97	1165.3	1165.35	1164.96	1164.97	1165	1164.9
19.929	1170.31	1167.20	1169.66	1169.45	1169.6	1169.71	1169.14	1169.57	1169.18	1169.63	1169.58
20.122	1172.66	1170.29	1171.18	1171.17	1171.14	1171.87	1172.32	1171.67	1171.92	1171.62	1171.47
20.382	1176.06	1173.44	1176.01	1176.07	1175.97	1174.93	1174.73	1174.84	1174.88	1174.87	1174.92
20.575	1179.47	1176.88	1178.98	1178.97	1178.98	1177.9	1177.98	1178.26	1178.08	1178.21	1178.15
20.738	1181.49	1178.67	1181.09	1181.1	1181.1	1179.05	1177.96	1178.92	1178.9	1179.28	1179.12
20.993	1183.78	1182.03	1184.44	1184.41	1184.4	1183.99	1183.96	1183.99	1183.82	1183.84	1183.85
21.1	1186.36	1177.66	1185.82	1185.77	1185.77	1174.83	1174.83	1174.83	1154.84	1154.84	1154.84
21.241	1189.9	1152.28	1187.53	1187.61	1187.56	1177.9	1177.9	1177.9	1157.9	1157.9	1157.9
21.469	1188.71	1157.29	1189.26	1189.34	1189.67	1175.92	1175.92	1175.92	1155.92	1155.92	1155.92
21.681	1191.5	1187.21	1191.67	1191.64	1191.38	1190.24	1190.19	1190.22	1190.22	1190.24	1190.18
21.88	1193.48	1194.88	1194.45	1194.52	1194.6	1192.35	1192.49	1192.34	1192.84	1192.8	1192.85

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Toffaleti and MPM								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1197.59	1199.07	1197.29	1197.32	1197.18	1195.4	1195.35	1195.28	1196.18	1196.16	1196.13
22.258	1200.39	1203.31	1200.56	1200.56	1200.64	1197.73	1197.67	1197.76	1198.48	1198.78	1198.49
22.448	1203.84	1206.83	1203.52	1203.54	1203.49	1201.98	1202.02	1201.63	1202.56	1202.25	1202.42
22.637	1205.07	1209.58	1205.67	1205.88	1205.76	1205.05	1205.02	1205	1205.15	1205.06	1205.15
22.827	1210.64	1213.19	1210.37	1210.24	1210.32	1210.21	1210.23	1210.26	1210.32	1210.25	1210.26
23.016	1214.71	1217.99	1214.44	1214.42	1214.47	1214.44	1214.46	1214.43	1214.43	1214.46	1214.44
23.205	1217.79	1220.02	1217.44	1217.38	1217.41	1217.4	1217.41	1217.49	1217.44	1217.36	1217.47
23.395	1219.83	1223.96	1220.61	1220.79	1220.66	1220.61	1220.66	1220.62	1220.62	1220.86	1220.71
23.46	1220.42	1225.28	1221.1	1221.14	1221.08	1221.03	1221.05	1221.11	1221.07	1221.1	1221.14
23.52	1222.43	1226.79	1222.8	1222.95	1222.78	1222.84	1222.85	1222.78	1222.87	1223.06	1222.82
23.584	1224.69	1227.65	1224.59	1224.57	1224.56	1224.53	1224.62	1224.58	1224.57	1224.62	1224.65
23.774	1228.43	1230.14	1228.12	1228.26	1228.3	1228.07	1228.15	1228.22	1228.19	1228.12	1228.21
23.87	1231.31	1232.68	1230.92	1230.84	1230.95	1230.94	1230.92	1230.96	1230.86	1230.9	1230.97
23.963	1233.8	1235.23	1233.38	1233.42	1233.33	1233.39	1233.36	1233.33	1233.39	1233.21	1233.36
24.03	1234.58	1236.14	1234.2	1234.01	1234.1	1234.15	1234.12	1234.08	1234.12	1234.07	1234.06
24.09	1235.56	1237.15	1235.21	1235.26	1235.13	1235.17	1235.14	1235.13	1235.17	1235.09	1235.23
24.152	1236.55	1237.88	1235.29	1235.25	1235.21	1235.33	1235.21	1235.27	1235.29	1235.21	1235.27
24.342	1238.34		1238.9	1238.72	1238.87	1238.91	1238.89	1238.89	1238.89	1238.88	1238.68
24.531	1240.98		1241.23	1241.19	1241.21	1241.24	1241.24	1241.2	1241.21	1241.23	1241.16
24.59	1243.03		1243.13	1243.14	1243.13	1243.19	1243.16	1243.11	1243.16	1243.13	1243.14
24.66	1245.34		1244.63	1244.63	1244.61	1244.56	1244.63	1244.65	1244.54	1244.61	1244.64
24.721	1247.01		1246.54	1246.56	1246.54	1246.5	1246.53	1246.58	1246.55	1246.54	1246.55
24.91	1248.89		1247.79	1247.77	1247.78	1247.66	1247.78	1247.78	1247.63	1247.79	1247.76
25.099	1260		1258.21	1258.32	1258.41	1258.42	1258.34	1258.45	1258.45	1258.35	1258.36
25.289	1254.79		1255.14	1255.77	1256.58	1255.1	1255.74	1256.67	1255.1	1255.76	1256.78
25.459	1257.42		1258.68	1258.9	1258.97	1258.74	1258.93	1258.9	1258.74	1258.9	1258.75
25.592	1259.98		1259.59	1260.75	1262.33	1259.67	1260.72	1262.17	1259.68	1260.76	1262.34
		RMSE	6.970	6.969	6.996	4.634	4.624	4.634	3.981	3.985	3.969

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Laursen-Copeland								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1084.28		1084.69	1084.66	1084.71	1084.55	1084.54	1084.57	1084.55	1084.53	1084.57
14.501	1087		1086.64	1086.64	1086.6	1086.78	1086.77	1086.77	1086.78	1086.78	1086.77
14.69	1089.77		1089.23	1089.22	1089.21	1089.02	1089.05	1089.04	1089.03	1088.98	1089.08
14.879	1091.17		1090.7	1090.7	1090.6	1090.82	1090.8	1090.82	1090.8	1090.83	1090.79
15.069	1093.31		1094.06	1094.08	1094.03	1093.83	1093.8	1093.82	1093.82	1093.81	1093.85
15.258	1094.87		1094.72	1094.73	1094.67	1094.63	1094.74	1094.64	1094.63	1094.77	1094.64
15.454	1097.09		1097.15	1097.14	1097.14	1097.13	1097.1	1097.13	1097.12	1097.1	1097.13
15.647	1098.02	1096.00	1098.22	1098.16	1098.15	1098.03	1098.11	1098.04	1098.04	1098.12	1098.1
15.823	1102.93	1101.45	1102.65	1102.69	1102.89	1102.61	1102.63	1102.6	1102.61	1102.63	1102.61
16.013	1103.07	1104.25	1104.94	1104.79	1104.36	1104.1	1103.92	1104.08	1104.05	1103.96	1104.18
16.153	1105.06	1104.68	1105.66	1106.53	1106.45	1104.87	1105.65	1104.88	1104.88	1105.66	1105.09
16.35	1112.37	1108.09	1108.56	1106.58	1106.98	1110.13	1109.49	1110.26	1110.46	1109.55	1109.1
16.355	1112.53	1108.24	1108.39	1110.25	1109.82	1105.88	1109.05	1103.03	1102.09	1109.12	1103.98
16.376	1112.82	1108.58	1109.28	1106.62	1107.81	1111.02	1109.75	1110.76	1111.26	1109.78	1110.21
16.431	1112.19	1109.39	1110.74	1110.41	1110.38	1109.59	1109.86	1109.39	1109.47	1109.92	1109.19
16.481	1113.05	1109.44	1110.39	1109.2	1110.47	1111.9	1111.29	1111.67	1112.1	1111.2	1111.12
16.58	1113.36	1110.07	1113.67	1113.67	1113.12	1111.51	1111.36	1111.42	1111.48	1111.34	1111.45
16.681	1114.8	1110.41	1112.09	1111.9	1112.57	1112.71	1111.85	1112.73	1112.79	1111.66	1112.1
16.78	1113.04	1112.03	1116.2	1115.97	1115.2	1113.46	1112.79	1113.45	1113.53	1112.85	1113.41
16.879	1113.4	1113.64	1114.8	1114.15	1115.12	1113.5	1112.95	1113.53	1113.25	1112.46	1112.99
16.979	1116.1	1114.87	1118.5	1119.24	1117.54	1115.63	1115.29	1115.64	1115.7	1115.42	1115.66
17.078	1118.58	1115.65	1118.58	1117.28	1118.75	1108.57	1108.58	1108.57	1106.54	1106.5	1106.53
17.174	1121.42	1115.42	1122.59	1122.13	1121.93	1111.99	1111.99	1111.99	1109.99	1110	1109.99
17.273	1122.8	1117.79	1122.66	1123.36	1122.95	1113.61	1113.61	1113.61	1111.61	1111.61	1111.61
17.398	1124.51	1115.23	1125.48	1125.01	1125.09	1115.64	1115.64	1115.64	1113.63	1113.56	1113.58
17.509	1127.18	1118.87	1126.8	1127.44	1127.25	1118.78	1118.82	1118.88	1117.75	1117.78	1117.96
17.607	1128.63	1118.36	1128.67	1128.56	1128.79	1120.75	1120.73	1120.72	1117.96	1118.63	1118.32
17.71	1131.12	1119.38	1131.1	1131.51	1131.38	1123.29	1123.45	1123.39	1121.5	1121.5	1121.5

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Laursen-Copeland								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1132.27	1125.30	1131.95	1131.88	1132.18	1124.2	1124.38	1124.33	1122.62	1122.77	1122.51
17.909	1132.72	1127.42	1133.39	1133.43	1133.45	1124.31	1124.16	1124.31	1122.31	1122.31	1122.31
18.009	1135.1	1128.63	1134.04	1134.33	1134.4	1127.1	1127.39	1127.56	1125.27	1125.41	1124.91
18.109	1137.17	1132.31	1137.79	1137.95	1137.82	1129.54	1129.54	1129.54	1127.54	1127.54	1127.54
18.207	1138.72	1136.76	1138.3	1138.38	1138.21	1138.62	1138.57	1138.66	1138.5	1138.54	1138.47
18.306	1141.11	1140.69	1141.56	1141.59	1141.1	1140.26	1140.3	1140.25	1140.14	1140.13	1140.14
18.406	1142.94	1143.32	1140.75	1140.91	1141.05	1140.03	1139.88	1140.48	1139.97	1140.07	1140.08
18.507	1143.41	1144.97	1144.15	1143.82	1143.7	1143.16	1143.15	1143.08	1142.77	1142.81	1142.72
18.606	1144.84	1146.39	1143.1	1142.63	1142.72	1142.3	1142.41	1142.6	1142.28	1142.33	1142.17
18.707	1147.28	1146.62	1146.87	1147.03	1147.13	1146.04	1146.26	1146.17	1146.07	1145.98	1146.11
18.808	1148.3	1147.78	1146.29	1146.45	1146.53	1145.59	1145.58	1144.99	1145.31	1145.59	1145.37
18.893	1148.47	1149.34	1147.92	1147.52	1148.15	1145.89	1146.99	1146.11	1145.99	1145.92	1146.01
18.906	1148.49	1149.71	1144.45	1145.43	1145.88	1145.05	1145.2	1145.87	1144.59	1144.76	1144.8
18.97	1151.78	1151.46	1151.58	1151.58	1151.6	1150.19	1150.12	1149.7	1150.03	1149.67	1149.99
19.029	1153.27	1152.48	1149.98	1150.07	1150.05	1149.8	1149.84	1149.99	1149.83	1149.87	1149.77
19.245	1159.57	1155.90	1161.78	1161.8	1161.74	1161.62	1161.29	1160.73	1161.66	1161.03	1161.42
19.491	1162.16	1158.98	1161.49	1161.36	1161.61	1160.68	1161.29	1160.6	1160.78	1161.31	1160.86
19.7	1165.58	1163.52	1164.9	1164.88	1164.89	1165.25	1164.94	1164.93	1165.21	1164.88	1165.08
19.929	1170.31	1167.20	1165	1164.98	1165	1165.09	1164.97	1164.86	1165.09	1165.02	1164.74
20.122	1172.66	1170.29	1175.19	1175.24	1175.26	1174.66	1174.66	1174.7	1174.63	1174.63	1174.54
20.382	1176.06	1173.44	1174.93	1174.86	1174.85	1174.19	1174.21	1174.18	1174.06	1174.01	1174.32
20.575	1179.47	1176.88	1178.4	1178.37	1178.38	1177.92	1177.98	1178.04	1177.87	1177.92	1178.13
20.738	1181.49	1178.67	1177.13	1177.04	1177.05	1175.24	1175.42	1175.44	1174.87	1175.12	1175.02
20.993	1183.78	1182.03	1185.95	1185.9	1186.02	1184.43	1184.45	1184.45	1184.85	1184.86	1184.85
21.1	1186.36	1177.66	1185.11	1185.17	1185.04	1174.82	1174.82	1174.81	1154.84	1154.84	1154.84
21.241	1189.9	1152.28	1187.25	1187.12	1187.42	1177.9	1177.9	1177.9	1157.9	1157.9	1157.9
21.469	1188.71	1157.29	1188.24	1188.49	1188.29	1175.92	1175.92	1175.92	1155.92	1155.92	1155.92
21.681	1191.5	1187.21	1193.08	1193.04	1193.05	1193.28	1193.28	1193.29	1193.5	1193.5	1193.5
21.88	1193.48	1194.88	1191.2	1191.24	1191.26	1190.82	1190.89	1190.9	1190.15	1190.29	1190.29

Cross Section	Average Bed Elevation		Predicted Average Bed Elevation Using Laursen-Copeland								
			No Mining			3-10 feet Mining			5-30 feet Mining		
	1983	2000	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1197.59	1199.07	1199.79	1199.78	1199.83	1199.96	1199.82	1200.01	1199.85	1199.98	1200.02
22.258	1200.39	1203.31	1197.86	1198.06	1198.14	1197.85	1197.72	1198.01	1197.61	1197.66	1197.74
22.448	1203.84	1206.83	1207.11	1206.95	1206.87	1206.98	1207.23	1206.82	1207.31	1207.16	1207.23
22.637	1205.07	1209.58	1205.27	1205.48	1206.03	1204.9	1205.03	1204.93	1204.84	1205.43	1205.51
22.827	1210.64	1213.19	1211.61	1211.56	1211.45	1211.31	1211.76	1211.32	1211.66	1211.32	1211.42
23.016	1214.71	1217.99	1213.52	1213.66	1213.33	1212.38	1213.32	1212.77	1212.75	1212.61	1213.52
23.205	1217.79	1220.02	1218.69	1218.18	1218.94	1221.01	1218.79	1219.12	1219.67	1220.2	1218.09
23.395	1219.83	1223.96	1221.11	1221.17	1220.73	1219.93	1221.15	1220.79	1221.27	1220.1	1220.85
23.46	1220.42	1225.28	1222.09	1221.52	1221.57	1222.57	1221.76	1221.64	1221.41	1221.92	1221.43
23.52	1222.43	1226.79	1223.09	1223.15	1222.36	1218.33	1222.81	1222.21	1222.93	1222.09	1222.54
23.584	1224.69	1227.65	1223.8	1223.26	1222.49	1224.52	1223.54	1222.5	1223.83	1222.85	1222.13
23.774	1228.43	1230.14	1227.72	1228	1228.46	1227.92	1227.87	1228.77	1227.52	1228.3	1228.72
23.87	1231.31	1232.68	1230.59	1230.41	1229.79	1230.68	1230.32	1229.65	1230.73	1230.64	1230.2
23.963	1233.8	1235.23	1232.54	1232.84	1233.28	1232.47	1232.76	1233.88	1232.43	1232.96	1233.3
24.03	1234.58	1236.14	1233.01	1233.22	1232.46	1233.75	1233.15	1232.69	1233.45	1233.33	1233.14
24.09	1235.56	1237.15	1234.44	1234.87	1235.12	1234.48	1234.8	1235.1	1234.4	1234.85	1234.8
24.152	1236.55	1237.88	1233.54	1233.81	1233.98	1233.88	1233.83	1233.94	1233.78	1233.91	1233.69
24.342	1238.34		1239.63	1239.48	1239.62	1239.6	1239.45	1239.72	1239.46	1239.6	1239.73
24.531	1240.98		1240.7	1240.77	1240.79	1240.66	1240.69	1240.68	1240.67	1240.7	1240.63
24.59	1243.03		1243.34	1243.38	1243.46	1243.38	1243.43	1243.45	1243.34	1243.38	1243.45
24.66	1245.34		1243.47	1243.46	1243.51	1243.41	1243.37	1243.28	1243.48	1243.41	1243.29
24.721	1247.01		1245.93	1246.05	1245.95	1245.8	1246	1246.03	1245.83	1245.96	1246.09
24.91	1248.89		1246.64	1246.7	1246.68	1246.65	1246.68	1246.69	1246.63	1246.65	1246.71
25.099	1260		1257.58	1257.58	1258.13	1257.67	1257.83	1258.16	1257.69	1257.78	1258.17
25.289	1254.79		1255.68	1256.3	1257.02	1255.67	1256.34	1256.97	1255.67	1256.31	1256.83
25.459	1257.42		1259.08	1260.85	1262.66	1259.08	1260.71	1262.69	1259.08	1260.84	1262.22
25.592	1259.98		1260.89	1264	1265.53	1260.95	1264.09	1265.76	1260.96	1264.03	1266.19
		RMSE	7.023	7.042	7.039	4.926	4.791	4.861	4.370	4.270	4.313

Cross Section	Thalweg		Predicted Thalweg Using Yang								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1081		1079.04	1079.04	1079.04	1079.15	1079.15	1079.14	1079.15	1079.14	1079.14
14.501	1084		1082.78	1082.76	1082.76	1082.53	1082.54	1082.62	1082.54	1082.52	1082.55
14.69	1088		1087.42	1087.41	1087.41	1087.57	1087.57	1087.57	1087.56	1087.55	1087.57
14.879	1089		1089.5	1089.49	1089.48	1089.01	1089	1089.01	1088.99	1089	1089.01
15.069	1088		1088.29	1088.28	1088.27	1088.01	1088	1088.01	1088.01	1088	1088.01
15.258	1094		1093.75	1093.75	1093.73	1093.59	1093.59	1093.58	1093.59	1093.59	1093.58
15.454	1093		1093.03	1093.03	1093.02	1092.62	1092.61	1092.64	1092.61	1092.61	1092.62
15.647	1097	1096.00	1097.05	1097.05	1097.05	1096.89	1096.88	1096.88	1096.88	1096.89	1096.86
15.823	1100	1100.02	1099.86	1099.84	1099.83	1099.81	1099.81	1099.82	1099.82	1099.81	1099.82
16.013	1100	1102.00	1100.48	1100.46	1100.45	1100.17	1100.17	1100.18	1100.17	1100.17	1100.18
16.153	1102	1102.00	1102	1101.99	1102	1101.98	1101.98	1101.88	1101.98	1101.98	1101.93
16.35	1110.4	1104.00	1109.19	1109.2	1109.19	1109.19	1109.2	1109.2	1109.19	1109.19	1109.2
16.355	1110	1104.47	1104.03	1103.29	1103.72	1104.1	1103.82	1103.44	1103.97	1103.85	1103.41
16.376	1111.84	1105.52	1112	1112.09	1112.04	1112.11	1112.15	1112.19	1112.13	1112.15	1112.21
16.431	1110.8	1106.82	1110.04	1110.05	1110.03	1109.25	1109.21	1109.24	1109.22	1109.23	1109.27
16.481	1111.8	1107.92	1112.41	1112.48	1112.44	1111.8	1111.8	1111.82	1111.8	1111.8	1111.88
16.58	1111.6	1109.43	1111.91	1111.95	1111.93	1111.35	1111.36	1111.32	1111.34	1111.32	1111.16
16.681	1113.6	1110.02	1113.86	1113.91	1113.88	1113.18	1113.28	1113.19	1113.27	1113.26	1113.25
16.78	1111.6	1110.79	1114.18	1114.22	1114.22	1111.61	1111.61	1111.61	1111.6	1111.6	1111.6
16.879	1110.6	1112.00	1115.51	1115.56	1115.51	1110.68	1110.68	1110.68	1110.66	1110.67	1110.67
16.979	1113.2	1112.26	1115.57	1115.59	1115.6	1113.09	1113.09	1113.09	1113.11	1113.11	1113.11
17.078	1116.6	1113.70	1117.52	1117.57	1117.55	1113.6	1113.6	1113.6	1111.6	1111.6	1111.6
17.174	1117.1	1112.36	1117.35	1117.39	1117.35	1114.1	1114.1	1114.1	1112.1	1112.1	1112.1
17.273	1119.3	1114.31	1117.52	1117.54	1117.62	1116.28	1116.28	1116.28	1114.3	1114.3	1114.3
17.398	1121.6	1113.13	1121.23	1121.22	1121.25	1118.14	1118.18	1118.31	1116.45	1116.46	1116.44
17.509	1125.3	1117.10	1125.14	1125.13	1125.14	1122.1	1122.1	1122.1	1120.13	1120.25	1120.25
17.607	1126	1118.00	1126.14	1126.15	1126.14	1123	1123	1123	1121	1121	1121
17.71	1127.2	1118.00	1127.37	1127.4	1127.38	1124.16	1124.16	1124.17	1122.08	1122.18	1122.17

Cross Section	Thalweg		Predicted Thalweg Using Yang								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1129.9	1124.06	1129.91	1129.92	1129.91	1126.83	1126.84	1126.84	1124.41	1124.81	1124.83
17.909	1129.9	1126.00	1130.98	1130.99	1130.97	1126.9	1126.9	1126.9	1124.9	1124.9	1124.9
18.009	1131.3	1126.38	1132.2	1132.26	1132.18	1128.3	1128.3	1128.3	1126.3	1126.3	1126.3
18.109	1133.3	1129.11	1133.44	1133.52	1133.46	1130.3	1130.3	1130.3	1128.28	1128.26	1128.14
18.207	1135.4	1133.83	1134.79	1134.68	1134.66	1130.2	1130.74	1130.17	1129.94	1131.35	1130.06
18.306	1136.8	1138.68	1135.11	1135.31	1134.98	1129.56	1129.69	1129.54	1128.05	1130.08	1126.23
18.406	1142	1140.76	1140.93	1140.73	1140.98	1137.67	1137.82	1137.89	1136.4	1138.22	1139.6
18.507	1138.8	1142.83	1140.18	1140.02	1140.36	1137.12	1136.73	1137.01	1137.23	1137.79	1138.9
18.606	1143.4	1144.00	1143.01	1142.97	1143.05	1141.82	1141.19	1141.27	1140.94	1141.4	1142.67
18.707	1145.5	1144.80	1145.12	1145.11	1145.13	1144.82	1144.85	1144.84	1144.5	1144.93	1145.05
18.808	1147	1145.80	1146.59	1146.59	1146.57	1146.56	1146.55	1146.55	1146.47	1146.54	1146.61
18.893	1148.5	1148.00	1149.44	1149.43	1149.48	1149.31	1149.38	1149.35	1149.33	1149.4	1149.34
18.906	1148.5	1148.44	1149.77	1149.76	1149.77	1149.7	1149.72	1149.71	1149.66	1149.71	1149.7
18.97	1150.25	1150.50	1150.58	1150.56	1150.61	1150.43	1150.44	1150.42	1150.38	1150.4	1150.43
19.029	1152	1151.48	1150.85	1150.89	1150.78	1150.95	1150.95	1151.02	1150.94	1150.94	1150.95
19.245	1158	1155.42	1155.67	1155.65	1155.59	1155.89	1155.93	1155.87	1155.85	1155.84	1155.9
19.491	1161	1156.50	1160.89	1160.9	1160.89	1160.88	1160.89	1160.89	1160.88	1160.88	1160.89
19.7	1163	1161.30	1162.47	1162.49	1162.49	1162.41	1162.43	1162.42	1162.44	1162.38	1162.44
19.929	1166	1165.60	1163.63	1163.47	1163.46	1163.32	1163.2	1163.26	1163.16	1163.55	1163.17
20.122	1172	1169.55	1171.81	1171.82	1171.82	1171.64	1171.64	1171.63	1171.62	1171.6	1171.62
20.382	1176	1172.00	1175.67	1175.69	1175.68	1175.43	1175.44	1175.45	1175.42	1175.4	1175.43
20.575	1178	1176.00	1177.44	1177.46	1177.44	1176.31	1176.32	1176.31	1176.29	1176.31	1176.29
20.738	1180	1176.67	1179.96	1179.96	1179.96	1177.81	1177.8	1177.8	1177.95	1177.96	1177.95
20.993	1183.4	1180.65	1183.68	1183.69	1183.69	1183.14	1183.14	1183.14	1183.13	1183.13	1183.13
21.1	1185.35	1172.40	1184.51	1184.5	1184.49	1175.35	1175.35	1175.35	1155.35	1155.35	1155.35
21.241	1188	1141.20	1186.04	1186.07	1186.04	1178	1178	1178	1158.01	1158.01	1158.01
21.469	1186	1149.34	1187.73	1187.73	1187.72	1176	1176	1176	1152.53	1152.24	1152.5
21.681	1189	1186.00	1190.69	1190.73	1190.69	1188.84	1188.84	1188.86	1188.46	1188.49	1188.47
21.88	1190	1193.19	1190.22	1190.23	1190.22	1189.96	1189.96	1189.96	1188.79	1188.71	1188.73

Cross Section	Thalweg		Predicted Thalweg Using Yang								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1196	1198.00	1195.75	1195.76	1195.77	1195.74	1195.73	1195.74	1195.77	1195.77	1195.78
22.258	1198	1201.23	1197.83	1197.77	1197.87	1197.82	1197.82	1197.82	1197.75	1197.81	1197.82
22.448	1201	1203.53	1200.38	1200.27	1200.32	1200.35	1200.34	1200.33	1200.27	1200.31	1200.31
22.637	1204	1207.79	1204.25	1204.24	1204.2	1204.05	1204.22	1204.14	1204.12	1204.25	1204.21
22.827	1207	1210.07	1204.81	1205.04	1205.16	1205.35	1205.12	1205.23	1205.29	1204.91	1205.11
23.016	1212	1216.00	1210.21	1210.43	1210.42	1210.58	1210.46	1210.5	1210.35	1210.59	1210.26
23.205	1215	1218.00	1214.85	1214.9	1214.92	1214.94	1214.91	1214.92	1214.92	1214.91	1214.9
23.395	1217	1220.85	1217.43	1217.46	1217.45	1217.4	1217.44	1217.42	1217.37	1217.51	1217.41
23.46	1219.33	1222.54	1219.6	1219.62	1219.64	1219.65	1219.64	1219.62	1219.64	1219.65	1219.62
23.52	1221.67	1225.45	1221.56	1221.58	1221.61	1221.52	1221.58	1221.57	1221.55	1221.59	1221.56
23.584	1224	1226.00	1223.38	1223.41	1223.39	1223.44	1223.41	1223.41	1223.44	1223.41	1223.42
23.774	1227	1226.55	1226.15	1226.17	1226.26	1226.23	1226.15	1226.18	1226.19	1226.15	1226.18
23.87	1229.5	1230.88	1228.62	1228.65	1228.53	1228.61	1228.63	1228.65	1228.74	1228.62	1228.64
23.963	1232	1233.73	1230.09	1230.17	1230.54	1230.17	1230.23	1230.18	1230.17	1230.23	1230.1
24.03	1233	1234.05	1231.43	1231.36	1231.25	1231.27	1231.32	1231.42	1231.27	1231.34	1231.39
24.09	1234	1234.83	1232.79	1232.88	1232.75	1232.84	1232.94	1232.92	1232.86	1232.94	1232.79
24.152	1235	1236.00	1234.15	1234.2	1234.08	1234.19	1234.23	1234.26	1234.19	1234.24	1234.19
24.342	1235		1235.49	1235.99	1236.05	1235.84	1236.13	1236.02	1235.99	1236.15	1235.61
24.531	1238		1238.1	1238.12	1238.27	1238.22	1238.17	1238.22	1238.14	1238.17	1238.18
24.59	1240.67		1239.57	1239.78	1239.64	1239.61	1239.87	1239.82	1239.83	1239.86	1239.66
24.66	1243.33		1238.62	1238.17	1238.38	1238.4	1237.94	1238.2	1238.01	1237.98	1237.74
24.721	1246		1242.92	1242.42	1242.29	1242.37	1242.3	1242.51	1242.35	1242.32	1242.77
24.91	1246		1243.32	1242.87	1242.8	1242.64	1242.63	1242.97	1242.46	1242.67	1243.77
25.099	1250		1258.52	1258.51	1258.66	1258.62	1258.44	1258.57	1258.52	1258.46	1258.62
25.289	1251		1251.38	1252.06	1252.7	1251.37	1252.1	1252.7	1251.38	1252.06	1252.69
25.459	1254		1256.5	1257.3	1258.25	1256.54	1257.28	1258.15	1256.5	1257.23	1258.19
25.592	1258		1257.46	1257.56	1256.89	1257.54	1257.59	1256.91	1257.46	1257.51	1256.78
		RMSE	8.235	8.240	8.230	6.362	6.368	6.371	4.227	4.098	4.239

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and Schoklitsch								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1081		1079.16	1079.15	1079.14	1079.15	1079.12	1079.14	1079.17	1079.14	1079.13
14.501	1084		1081.43	1081.41	1081.42	1081.26	1081.27	1081.26	1081.26	1081.25	1081.25
14.69	1088		1086.86	1086.92	1086.92	1086.77	1086.78	1086.75	1086.8	1086.77	1086.77
14.879	1089		1089.58	1089.59	1089.56	1089.39	1089.41	1089.41	1089.37	1089.38	1089.41
15.069	1088		1090.47	1090.46	1090.47	1088.54	1088.61	1088.54	1088.56	1088.59	1088.59
15.258	1094		1093.77	1093.77	1093.76	1093.8	1093.79	1093.8	1093.81	1093.79	1093.8
15.454	1093		1094.47	1094.31	1094.35	1093.09	1093.12	1093.08	1093.11	1093.12	1093.1
15.647	1097	1096.00	1098.11	1098.06	1098.03	1097.06	1097.07	1097.05	1097.08	1097.07	1097.06
15.823	1100	1100.02	1100.7	1100.48	1100.45	1099.74	1099.75	1099.71	1099.74	1099.74	1099.73
16.013	1100	1102.00	1100.67	1100.74	1100.71	1100.44	1100.49	1100.43	1100.48	1100.48	1100.42
16.153	1102	1102.00	1103.52	1103.42	1103.33	1103	1103.15	1103.14	1103.12	1103.11	1102.94
16.35	1110.4	1104.00	1105.54	1105.65	1105.65	1104.27	1104.97	1102.87	1104.95	1104.76	1103.65
16.355	1110	1104.47	1105.04	1104.9	1105.31	1102.03	1099.15	1102.38	1098.93	1098.84	1101.89
16.376	1111.84	1105.52	1105.66	1106.42	1106.45	1102.26	1105.22	1102.19	1103.85	1103.98	1103.71
16.431	1110.8	1106.82	1106.87	1107.41	1107.53	1105.58	1106.49	1105.38	1106.22	1106.28	1104.92
16.481	1111.8	1107.92	1107.63	1107.78	1107.29	1107.27	1106.61	1106.3	1106.84	1107.07	1107.42
16.58	1111.6	1109.43	1109.27	1109.36	1109.76	1108.82	1108.28	1107.64	1107.54	1107.75	1108.01
16.681	1113.6	1110.02	1112.47	1112.46	1112.47	1112.57	1112.15	1112.43	1112.53	1112.53	1112.59
16.78	1111.6	1110.79	1113.17	1113.91	1114.02	1111.59	1111.3	1111.45	1111.77	1111.73	1111.71
16.879	1110.6	1112.00	1116.07	1115.32	1115.25	1111.43	1111.14	1111.53	1110.62	1110.66	1110.64
16.979	1113.2	1112.26	1114.52	1117.04	1117	1111.59	1111.68	1111.85	1112.77	1112.77	1112.85
17.078	1116.6	1113.70	1117.71	1117.51	1117.68	1113.53	1113.57	1113.57	1111.22	1111.06	1110.96
17.174	1117.1	1112.36	1117.22	1118.63	1118.38	1114.1	1114.1	1114.1	1112.1	1112.1	1112.1
17.273	1119.3	1114.31	1116.41	1117.98	1118.15	1116.25	1116.26	1116.23	1114.27	1114.27	1114.28
17.398	1121.6	1113.13	1120.79	1120.89	1121	1117.6	1117.53	1117.52	1116.46	1116.46	1116.46
17.509	1125.3	1117.10	1124.97	1124.91	1125	1122.09	1122.11	1122.06	1120.25	1120.25	1120.24
17.607	1126	1118.00	1126.52	1126.55	1126.53	1123	1123	1123	1121	1121	1121
17.71	1127.2	1118.00	1127.37	1127.39	1127.39	1124.13	1124.15	1124.09	1122.12	1122.12	1122.1

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and Schoklitsch								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1129.9	1124.06	1129.84	1129.86	1129.85	1126.7	1126.7	1126.69	1124.68	1124.68	1124.68
17.909	1129.9	1126.00	1131.91	1131.91	1131.9	1126.9	1126.9	1126.9	1124.9	1124.9	1124.9
18.009	1131.3	1126.38	1133.23	1133.34	1133.31	1128.3	1128.3	1128.3	1126.3	1126.3	1126.3
18.109	1133.3	1129.11	1135.57	1135.4	1135.45	1130.3	1130.3	1130.31	1128.3	1128.3	1128.3
18.207	1135.4	1133.83	1136.53	1136.68	1136.56	1130.62	1130.25	1129.35	1128.27	1128.32	1128.52
18.306	1136.8	1138.68	1138.86	1138.2	1138.65	1126.23	1126.98	1129.04	1126.34	1126.15	1125.4
18.406	1142	1140.76	1140.28	1140.4	1140.26	1134.21	1135	1135.24	1133.98	1133.18	1133.27
18.507	1138.8	1142.83	1141.71	1141.23	1141.58	1134.42	1134.63	1135.55	1133.34	1134.06	1133.95
18.606	1143.4	1144.00	1143.07	1143.03	1143.06	1138.13	1137.83	1138.3	1137.17	1136.44	1136.4
18.707	1145.5	1144.80	1145.37	1145.42	1145.49	1142.51	1141.16	1142.94	1141.53	1141.15	1140.93
18.808	1147	1145.80	1146.51	1146.4	1146.57	1142.81	1145.48	1144.36	1143.51	1143.94	1144.14
18.893	1148.5	1148.00	1149.49	1149.56	1149.4	1148.57	1148.65	1148.64	1146.65	1146.03	1146.07
18.906	1148.5	1148.44	1150.3	1150.32	1150.32	1149.08	1149.21	1149.21	1148.72	1148.72	1148.42
18.97	1150.25	1150.50	1150.69	1151.18	1150.68	1150.31	1150.29	1150.21	1150.2	1150.16	1150.06
19.029	1152	1151.48	1151.2	1151.09	1151.21	1150.91	1151.09	1151.06	1150.98	1151	1151.04
19.245	1158	1155.42	1151.86	1151.7	1152.18	1151.27	1150.82	1151.59	1151.21	1151.64	1151.79
19.491	1161	1156.50	1159.72	1159.64	1159.88	1158.97	1159.25	1159.57	1159.12	1159.02	1159.36
19.7	1163	1161.30	1163.18	1163.01	1162.3	1162.96	1162.1	1162.4	1162.55	1162.43	1162.83
19.929	1166	1165.60	1163.77	1163.59	1162.8	1162.94	1163.02	1162.54	1163.43	1163.51	1163.59
20.122	1172	1169.55	1170.74	1170.78	1170.99	1169.76	1170.16	1170.53	1170.42	1170.44	1170.4
20.382	1176	1172.00	1175.54	1175.26	1175.31	1174.54	1174.42	1174.34	1174.55	1174.56	1174.52
20.575	1178	1176.00	1177.46	1177.35	1177.36	1175.89	1175.74	1175.55	1175.93	1175.88	1175.87
20.738	1180	1176.67	1179.38	1179.02	1179.11	1178.01	1177.9	1177.84	1179.68	1179.66	1179.64
20.993	1183.4	1180.65	1184.27	1185.69	1184.82	1183.44	1183.44	1183.43	1182.03	1182	1181.98
21.1	1185.35	1172.40	1184.65	1183.7	1184.48	1175.35	1175.35	1175.35	1155.35	1155.35	1155.35
21.241	1188	1141.20	1185.01	1184.91	1186.67	1178	1178	1178	1158	1158	1158
21.469	1186	1149.34	1187.27	1186.47	1186.73	1176	1176	1176	1156	1156	1156
21.681	1189	1186.00	1185.89	1185.39	1186.09	1137.17	1134.63	1143.92	1180.25	1180.17	1179.99
21.88	1190	1193.19	1190.06	1190.23	1190.13	1180.22	1180.93	1181.26	1182.92	1182.44	1183.33

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and Schoklitsch								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1196	1198.00	1192.75	1192.14	1192.2	1182.68	1181.53	1181.54	1183.38	1183.03	1183.04
22.258	1198	1201.23	1197.5	1197.63	1197.59	1184.08	1186.22	1186.15	1190.15	1190.55	1188.98
22.448	1201	1203.53	1199.72	1199.63	1199.79	1191.29	1191.27	1191.88	1195.03	1195.01	1195.42
22.637	1204	1207.79	1204.63	1204.82	1204.7	1199.69	1200.14	1200.6	1203.9	1203.87	1203.91
22.827	1207	1210.07	1205.81	1205.53	1205.75	1203.51	1203.92	1204.03	1205.56	1205.48	1205.6
23.016	1212	1216.00	1211.27	1211.04	1211.28	1209.71	1210.62	1210.46	1210.62	1211.19	1210.57
23.205	1215	1218.00	1214.93	1214.75	1214.93	1214.79	1214.72	1214.69	1214.69	1214.89	1214.74
23.395	1217	1220.85	1217.4	1217.76	1217.33	1217.11	1217.14	1217.07	1217.09	1217.23	1217.07
23.46	1219.33	1222.54	1219.86	1219.84	1219.88	1219.8	1219.78	1219.74	1219.77	1219.8	1219.81
23.52	1221.67	1225.45	1221.71	1221.98	1221.77	1221.68	1221.73	1221.67	1221.67	1221.71	1221.71
23.584	1224	1226.00	1223.54	1223.4	1223.53	1223.57	1223.52	1223.55	1223.55	1223.5	1223.54
23.774	1227	1226.55	1226.32	1226.19	1226.08	1226.32	1226.17	1226.23	1226.32	1226.23	1226.11
23.87	1229.5	1230.88	1228.98	1229.06	1229.14	1228.99	1229.17	1228.88	1229.09	1229.13	1229.1
23.963	1232	1233.73	1230.08	1230.03	1229.92	1230.07	1229.95	1230.16	1230.05	1229.94	1229.91
24.03	1233	1234.05	1231.25	1231.4	1231.32	1231.24	1231.47	1231.31	1231.42	1231.35	1231.26
24.09	1234	1234.83	1232.48	1232.55	1232.52	1232.49	1232.5	1232.59	1232.56	1232.54	1232.54
24.152	1235	1236.00	1233.61	1233.58	1233.36	1233.63	1233.59	1233.67	1233.46	1233.44	1233.64
24.342	1235		1237.33	1236.78	1237.12	1237.35	1236.68	1237.54	1237.18	1236.44	1237.47
24.531	1238		1240.21	1240.29	1240.19	1240.22	1240.23	1240.33	1240.18	1239.78	1240.37
24.59	1240.67		1242.6	1242.29	1242.36	1242.61	1242.24	1242.72	1242.44	1242.05	1242.7
24.66	1243.33		1242.27	1242.51	1242.47	1242.3	1242.55	1242.66	1242.44	1241.85	1242.48
24.721	1246		1246.05	1246.03	1246.04	1246.06	1246.04	1246.22	1246.15	1245.76	1246.19
24.91	1246		1243.64	1243.87	1243.51	1243.66	1243.76	1243.06	1243.63	1244.63	1243.73
25.099	1250		1256.46	1256.63	1257.01	1256.47	1256.64	1257.06	1256.43	1256.79	1256.76
25.289	1251		1251.8	1252.78	1253.62	1251.8	1252.77	1253.61	1251.81	1252.64	1253.63
25.459	1254		1255.51	1255.21	1255.9	1255.52	1255.25	1255.9	1255.48	1255.43	1255.93
25.592	1258		1256.18	1257.1	1257.05	1256.18	1256.85	1257.17	1256.19	1256.79	1256.93
		RMSE	8.029	7.999	8.173	9.524	9.656	8.874	5.268	5.294	5.318

Cross Section	Thalweg		Predicted Thalweg Using Meyer-Peter and Muller								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1081		1079.39	1079.39	1079.41	1079.4	1079.4	1079.4	1079.4	1079.41	1079.4
14.501	1084		1081.83	1081.83	1081.75	1081.75	1081.74	1081.76	1081.76	1081.74	1081.76
14.69	1088		1086.68	1086.68	1086.65	1086.66	1086.67	1086.66	1086.68	1086.66	1086.66
14.879	1089		1088.85	1088.85	1088.84	1088.84	1088.85	1088.84	1088.84	1088.84	1088.84
15.069	1088		1090.84	1090.85	1090.84	1090.84	1090.84	1090.84	1090.82	1090.82	1090.82
15.258	1094		1092.85	1092.85	1092.85	1092.85	1092.85	1092.85	1092.85	1092.86	1092.85
15.454	1093		1094.44	1094.44	1094.44	1094.39	1094.39	1094.39	1094.4	1094.4	1094.4
15.647	1097	1096.00	1097.04	1097.04	1097.05	1097.03	1097.03	1097.03	1097.03	1097.03	1097.03
15.823	1100	1100.02	1098.95	1098.96	1098.96	1098.92	1098.92	1098.92	1098.93	1098.93	1098.93
16.013	1100	1102.00	1101.14	1101.14	1101.14	1101.06	1101.07	1101.06	1101.06	1101.06	1101.06
16.153	1102	1102.00	1104.05	1104.06	1104.07	1103.87	1103.87	1103.87	1104	1104	1104
16.35	1110.4	1104.00	1106.34	1106.31	1106.34	1106.54	1106.48	1106.54	1106.29	1106.31	1106.29
16.355	1110	1104.47	1106.24	1106.19	1106.22	1105.59	1105.92	1105.6	1106.16	1106.21	1106.17
16.376	1111.84	1105.52	1107.19	1107.2	1107.11	1107.9	1107.75	1107.91	1106.97	1106.97	1106.94
16.431	1110.8	1106.82	1108.29	1108.27	1108.3	1108.14	1108.19	1108.14	1108.13	1108.12	1108.13
16.481	1111.8	1107.92	1109.49	1109.48	1109.51	1109.47	1109.45	1109.47	1109.52	1109.5	1109.51
16.58	1111.6	1109.43	1110.49	1110.49	1110.49	1109.97	1110.02	1109.97	1110.05	1110.06	1110.06
16.681	1113.6	1110.02	1112.83	1112.83	1112.83	1112.18	1112.22	1112.18	1112.22	1112.23	1112.23
16.78	1111.6	1110.79	1112.85	1112.85	1112.85	1111.76	1111.77	1111.76	1111.7	1111.7	1111.7
16.879	1110.6	1112.00	1113.27	1113.27	1113.27	1111.03	1111.03	1111.03	1110.92	1110.92	1110.92
16.979	1113.2	1112.26	1116.15	1116.17	1116.19	1113.07	1113.07	1113.06	1113.05	1113.06	1113.05
17.078	1116.6	1113.70	1115.93	1115.95	1115.94	1113.46	1113.46	1113.46	1111.6	1111.6	1111.6
17.174	1117.1	1112.36	1117.89	1117.92	1117.97	1114.1	1114.1	1114.1	1112.1	1112.1	1112.1
17.273	1119.3	1114.31	1117.13	1117.15	1117.19	1116.29	1116.29	1116.28	1114.3	1114.3	1114.3
17.398	1121.6	1113.13	1122.1	1122.15	1122.09	1118.55	1118.55	1118.55	1116.59	1116.59	1116.59
17.509	1125.3	1117.10	1124.62	1124.62	1124.57	1121.78	1121.77	1121.78	1120.25	1120.25	1120.25
17.607	1126	1118.00	1127.46	1127.47	1127.41	1123	1123	1123	1121	1121	1121
17.71	1127.2	1118.00	1126.63	1126.51	1126.62	1124.2	1124.2	1124.2	1121.72	1121.73	1121.73

Cross Section	Thalweg		Predicted Thalweg Using Meyer-Peter and Muller								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1129.9	1124.06	1131.31	1131.32	1131.32	1125.75	1125.75	1125.74	1124.41	1124.41	1124.41
17.909	1129.9	1126.00	1128.36	1128.36	1128.31	1126.89	1126.89	1126.89	1124.9	1124.9	1124.9
18.009	1131.3	1126.38	1135.31	1135.32	1135.31	1128.3	1128.3	1128.3	1126.3	1126.3	1126.3
18.109	1133.3	1129.11	1131.64	1131.63	1131.63	1130.3	1130.3	1130.3	1128.3	1128.3	1128.3
18.207	1135.4	1133.83	1137.04	1137.05	1137.04	1127.87	1127.87	1127.91	1126.11	1126.12	1126.12
18.306	1136.8	1138.68	1134.5	1134.54	1134.44	1129.25	1129.18	1129.22	1125.96	1125.92	1125.95
18.406	1142	1140.76	1139.66	1139.69	1139.66	1135.28	1135.37	1135.3	1133.55	1133.55	1133.53
18.507	1138.8	1142.83	1141.78	1142.1	1141.78	1134.7	1134.78	1134.68	1131.77	1131.83	1131.77
18.606	1143.4	1144.00	1142.65	1142.57	1142.66	1138.99	1139.09	1138.99	1138.03	1137.96	1138.02
18.707	1145.5	1144.80	1147.46	1147.45	1147.45	1144.25	1144.3	1144.25	1143.56	1143.57	1143.58
18.808	1147	1145.80	1144.53	1144.68	1144.76	1143.04	1143.09	1143.04	1142.78	1142.77	1142.77
18.893	1148.5	1148.00	1151.3	1151.25	1151.18	1150.61	1150.63	1150.61	1150.13	1150.13	1150.13
18.906	1148.5	1148.44	1150.36	1150.39	1150.5	1150.02	1150.02	1150	1149.79	1149.8	1149.79
18.97	1150.25	1150.50	1153.36	1153.39	1153.3	1153.26	1153.28	1153.29	1153.15	1153.14	1153.16
19.029	1152	1151.48	1151.74	1151.7	1151.59	1151.69	1151.66	1151.66	1151.33	1151.33	1151.33
19.245	1158	1155.42	1153.38	1153.37	1153.48	1153.23	1153.34	1153.36	1153.63	1153.62	1153.62
19.491	1161	1156.50	1158.68	1158.69	1158.74	1158.73	1158.69	1158.71	1158.76	1158.76	1158.76
19.7	1163	1161.30	1164.81	1164.8	1164.81	1164.47	1164.73	1164.73	1164.78	1164.79	1164.79
19.929	1166	1165.60	1165.07	1165.1	1165.08	1165.85	1165.33	1165.33	1165.33	1165.32	1165.34
20.122	1172	1169.55	1170.85	1170.86	1170.86	1170.99	1171.04	1171.04	1171.05	1171.05	1171.05
20.382	1176	1172.00	1176.56	1176.53	1176.54	1176.07	1176.09	1176.09	1176.05	1176.06	1176.05
20.575	1178	1176.00	1177.47	1177.5	1177.5	1177.23	1177.26	1177.26	1177.24	1177.24	1177.24
20.738	1180	1176.67	1178.77	1178.77	1178.77	1178.32	1178.26	1178.28	1178.29	1178.27	1178.28
20.993	1183.4	1180.65	1185.09	1185.1	1185.11	1183.47	1183.47	1183.47	1183.47	1183.47	1183.47
21.1	1185.35	1172.40	1184.49	1184.5	1184.49	1175.35	1175.35	1175.35	1155.35	1155.35	1155.35
21.241	1188	1141.20	1182.83	1182.92	1182.86	1178	1178	1178	1158	1158	1158
21.469	1186	1149.34	1185.59	1185.6	1185.6	1176	1176	1176	1156	1156	1156
21.681	1189	1186.00	1190.72	1190.71	1190.72	1155.24	1155.09	1171.17	1180.45	1180.44	1180.44
21.88	1190	1193.19	1188.73	1188.73	1188.73	1182.03	1182.19	1184.96	1185.44	1185.38	1185.36

Cross Section	Thalweg		Predicted Thalweg Using Meyer-Peter and Muller								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1196	1198.00	1197.48	1197.49	1197.53	1181.18	1181.12	1188.35	1184.99	1185.07	1185.07
22.258	1198	1201.23	1198.43	1198.43	1198.36	1195.24	1195.33	1196.09	1195.92	1195.82	1195.83
22.448	1201	1203.53	1198.36	1198.37	1198.37	1197.1	1197.18	1197.53	1197.32	1197.4	1197.37
22.637	1204	1207.79	1205.18	1205.18	1205.12	1205.5	1205.59	1205.31	1205.43	1205.47	1205.51
22.827	1207	1210.07	1205.42	1205.22	1205.48	1205.73	1205.54	1205.27	1205.54	1205.58	1205.4
23.016	1212	1216.00	1210.54	1210.39	1210.46	1210.55	1210.56	1210.45	1210.54	1210.57	1210.54
23.205	1215	1218.00	1213.93	1213.59	1213.62	1213.77	1213.75	1213.56	1213.66	1213.85	1213.39
23.395	1217	1220.85	1215.58	1217.47	1217.04	1215.89	1215.58	1217.71	1216.6	1216.09	1217.06
23.46	1219.33	1222.54	1219.17	1219.45	1219.07	1219.41	1219.65	1219.64	1219.61	1219.17	1219.99
23.52	1221.67	1225.45	1221.44	1221.53	1221.52	1221.68	1221.69	1221.68	1221.7	1221.57	1221.74
23.584	1224	1226.00	1226.05	1225.68	1226.02	1224.84	1224.95	1224.91	1224.87	1225.11	1224.64
23.774	1227	1226.55	1222.53	1222.63	1222.55	1225.81	1225.95	1225.73	1225.61	1225.27	1226.45
23.87	1229.5	1230.88	1229.64	1230.14	1229.67	1227.02	1226.96	1226.75	1226.82	1226.69	1226.93
23.963	1232	1233.73	1231.33	1231.12	1231.24	1231.17	1230.99	1231.07	1231.1	1231	1231.41
24.03	1233	1234.05	1230.85	1231.04	1230.88	1231.08	1231.22	1231.28	1231.22	1231.22	1231.02
24.09	1234	1234.83	1233.41	1233.32	1233.34	1233.23	1232.81	1232.95	1232.99	1232.98	1232.87
24.152	1235	1236.00	1231.83	1231.9	1231.82	1232.4	1232.27	1232.32	1232.33	1232.3	1232.23
24.342	1235		1236.37	1236.42	1236.44	1236.39	1236.7	1236.43	1236.41	1236.62	1236.62
24.531	1238		1240	1239.9	1239.92	1239.91	1239.47	1239.83	1239.85	1239.62	1239.64
24.59	1240.67		1241.87	1242.27	1242.24	1242.21	1242.84	1242.5	1242.38	1242.53	1242.74
24.66	1243.33		1241.52	1241.48	1241.49	1241.53	1241.58	1241.54	1241.52	1241.55	1241.51
24.721	1246		1245.14	1245.19	1245.18	1245.19	1245.23	1245.21	1245.19	1245.22	1245.24
24.91	1246		1243.56	1243.48	1243.38	1243.53	1243.48	1243.45	1243.49	1243.48	1243.39
25.099	1250		1259.1	1259.13	1259.17	1259.1	1259.13	1259.17	1259.1	1259.13	1259.17
25.289	1251		1251.06	1251.2	1251.51	1251.06	1251.19	1251.51	1251.06	1251.2	1251.5
25.459	1254		1256.01	1257.79	1257.71	1256.01	1257.79	1257.72	1256.01	1257.79	1257.73
25.592	1258		1258.13	1258.63	1259.44	1258.12	1258.66	1259.65	1258.12	1258.63	1259.63
		RMSE	7.850	7.843	7.843	7.876	7.886	6.873	5.033	5.045	5.029

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and MPM								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1081		1079.17	1079.15	1079.06	1079.27	1079.29	1079.27	1079.24	1079.28	1079.17
14.501	1084		1080.91	1080.8	1080.82	1080.78	1080.83	1080.82	1080.82	1080.8	1080.8
14.69	1088		1085.23	1085.17	1085.2	1085.25	1085.25	1085.3	1085.25	1085.25	1085.18
14.879	1089		1088.96	1088.96	1088.95	1089.03	1089.05	1089.02	1089.06	1089.03	1089.12
15.069	1088		1091.7	1091.88	1091.98	1090.5	1090.44	1090.5	1090.43	1090.53	1090.35
15.258	1094		1093.62	1093.56	1093.55	1093.75	1093.75	1093.74	1093.76	1093.76	1093.74
15.454	1093		1095.11	1094.52	1094.44	1093.69	1093.61	1093.63	1093.42	1093.63	1093.41
15.647	1097	1096.00	1097.62	1097.63	1097.62	1097.05	1097.03	1097.07	1097.07	1097.05	1097.06
15.823	1100	1100.02	1099.32	1099.46	1099.35	1098.76	1098.8	1098.84	1098.74	1098.65	1098.78
16.013	1100	1102.00	1099.72	1099.72	1100.11	1100.29	1100.34	1100.34	1100.25	1100.3	1100.31
16.153	1102	1102.00	1104.5	1105.09	1105.11	1104.39	1104.26	1104.23	1104.21	1104.31	1104.23
16.35	1110.4	1104.00	1105.18	1104.61	1104.74	1103.93	1104.24	1104.24	1104.14	1104.04	1104.33
16.355	1110	1104.47	1105.79	1105.28	1105.36	1104.44	1104.7	1104.69	1104.47	1104.55	1104.68
16.376	1111.84	1105.52	1105.9	1105.35	1105.25	1104.13	1104.54	1104.57	1103.7	1103.9	1104.23
16.431	1110.8	1106.82	1107.7	1107.92	1108.37	1107.12	1107.47	1106.91	1107.39	1107.36	1107.26
16.481	1111.8	1107.92	1108.61	1107.98	1108.4	1107.09	1107.23	1107.23	1107.43	1107.14	1107.69
16.58	1111.6	1109.43	1110.72	1110.1	1110.37	1108.12	1109.13	1108.94	1108.27	1108.93	1108.78
16.681	1113.6	1110.02	1112.23	1112.04	1112.05	1112.35	1111.04	1112.33	1112.22	1111.97	1112.07
16.78	1111.6	1110.79	1113.42	1112.85	1113.13	1111.41	1112.11	1111.47	1111.51	1110.93	1111.37
16.879	1110.6	1112.00	1114.83	1114.82	1114.85	1111.62	1110.47	1111.42	1111.26	1110.79	1111.05
16.979	1113.2	1112.26	1116.5	1116.57	1116.49	1110.92	1111.51	1111.13	1111.68	1111.73	1112.2
17.078	1116.6	1113.70	1119.08	1118.61	1118.69	1113.41	1113.4	1113.42	1111.6	1111.6	1111.6
17.174	1117.1	1112.36	1118.21	1118.02	1118.39	1114.1	1114.1	1114.1	1112.1	1112.1	1112.1
17.273	1119.3	1114.31	1118.35	1116.72	1118.52	1116.26	1116.23	1116.17	1114.3	1114.3	1114.3
17.398	1121.6	1113.13	1120.48	1120.34	1120.47	1118.6	1118.59	1118.58	1116.49	1116.56	1116.49
17.509	1125.3	1117.10	1124.57	1124.87	1124.58	1121.56	1121.57	1121.91	1119.92	1119.74	1119.89
17.607	1126	1118.00	1125.37	1125.82	1125.44	1123	1123	1123	1121	1121	1121
17.71	1127.2	1118.00	1129.2	1128.72	1128.9	1124.13	1124.15	1124.15	1122.17	1122.18	1122.17

Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and MPM								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1129.9	1124.06	1128.52	1129.22	1128.58	1125.96	1125.87	1125.84	1123.83	1123.76	1123.79
17.909	1129.9	1126.00	1133.6	1132.18	1133.13	1126.9	1126.9	1126.9	1124.9	1124.89	1124.89
18.009	1131.3	1126.38	1132.28	1132.08	1131.59	1128.3	1128.3	1128.3	1126.3	1126.3	1126.3
18.109	1133.3	1129.11	1135.35	1136.83	1137	1130.3	1130.3	1130.3	1128.31	1128.3	1128.3
18.207	1135.4	1133.83	1136.83	1135.72	1134.82	1128.16	1128.09	1128.56	1127.13	1126.89	1125.87
18.306	1136.8	1138.68	1138.74	1138.44	1139.81	1129.38	1129.5	1129.18	1127.5	1126.33	1126.64
18.406	1142	1140.76	1138.77	1138.88	1138.92	1134.26	1134.65	1134.96	1133.56	1133.43	1132.18
18.507	1138.8	1142.83	1141.52	1139.01	1141.87	1134.42	1135.2	1134.55	1135.69	1134.5	1132.76
18.606	1143.4	1144.00	1141.12	1141.42	1139.92	1136.14	1137.1	1136.67	1137.62	1136.53	1134.56
18.707	1145.5	1144.80	1145.31	1146.25	1145.98	1141.57	1141.95	1142.94	1141.26	1141.18	1140.93
18.808	1147	1145.80	1145.91	1146.74	1143.91	1141.79	1141.06	1143.5	1143.41	1142.91	1139.65
18.893	1148.5	1148.00	1150.44	1150.69	1150.89	1148.25	1148.63	1148.62	1145.39	1145.64	1148.76
18.906	1148.5	1148.44	1150.68	1150.95	1150.04	1149.18	1149.22	1149.32	1148.8	1148.8	1148.64
18.97	1150.25	1150.50	1152.45	1152.69	1152.81	1149.91	1150.04	1150.14	1150.23	1149.79	1152.09
19.029	1152	1151.48	1152.55	1152.33	1152.82	1151.07	1150.97	1150.99	1150.94	1150.96	1151.67
19.245	1158	1155.42	1151.14	1151.56	1152.31	1153.61	1153.9	1151.75	1152.85	1153.96	1151.14
19.491	1161	1156.50	1158.99	1158.84	1159.13	1159.53	1159.32	1159.02	1158.8	1159.48	1158.77
19.7	1163	1161.30	1162.34	1162.23	1162.24	1163.63	1163.95	1162.49	1162.48	1162.64	1162.24
19.929	1166	1165.60	1165.01	1164.67	1164.73	1165.27	1164.24	1164.94	1163.59	1165.02	1164.91
20.122	1172	1169.55	1169.87	1169.86	1169.82	1170.86	1171.51	1170.57	1170.94	1170.51	1170.3
20.382	1176	1172.00	1175.94	1176.01	1175.89	1174.7	1174.48	1174.6	1174.64	1174.63	1174.69
20.575	1178	1176.00	1177.56	1177.59	1177.58	1175.52	1174.58	1175.95	1175.35	1175.87	1175.68
20.738	1180	1176.67	1179.19	1179.18	1179.19	1175.64	1173.81	1175.74	1175.79	1176.46	1176.17
20.993	1183.4	1180.65	1183.23	1183.23	1183.25	1183.45	1183.42	1183.46	1182.99	1183.05	1183.13
21.1	1185.35	1172.40	1184.71	1184.68	1184.68	1175.34	1175.34	1175.34	1155.35	1155.35	1155.35
21.241	1188	1141.20	1178.3	1178.43	1178.19	1178	1178	1178	1158	1158	1158
21.469	1186	1149.34	1187.27	1187.49	1188.21	1176	1176	1176	1156	1156	1156
21.681	1189	1186.00	1189.8	1189.69	1188.77	1148.37	1145.7	1146.2	1176.44	1176.5	1176.16
21.88	1190	1193.19	1193.45	1193.59	1193.38	1181.69	1181.69	1181.67	1186.35	1185.94	1187.11

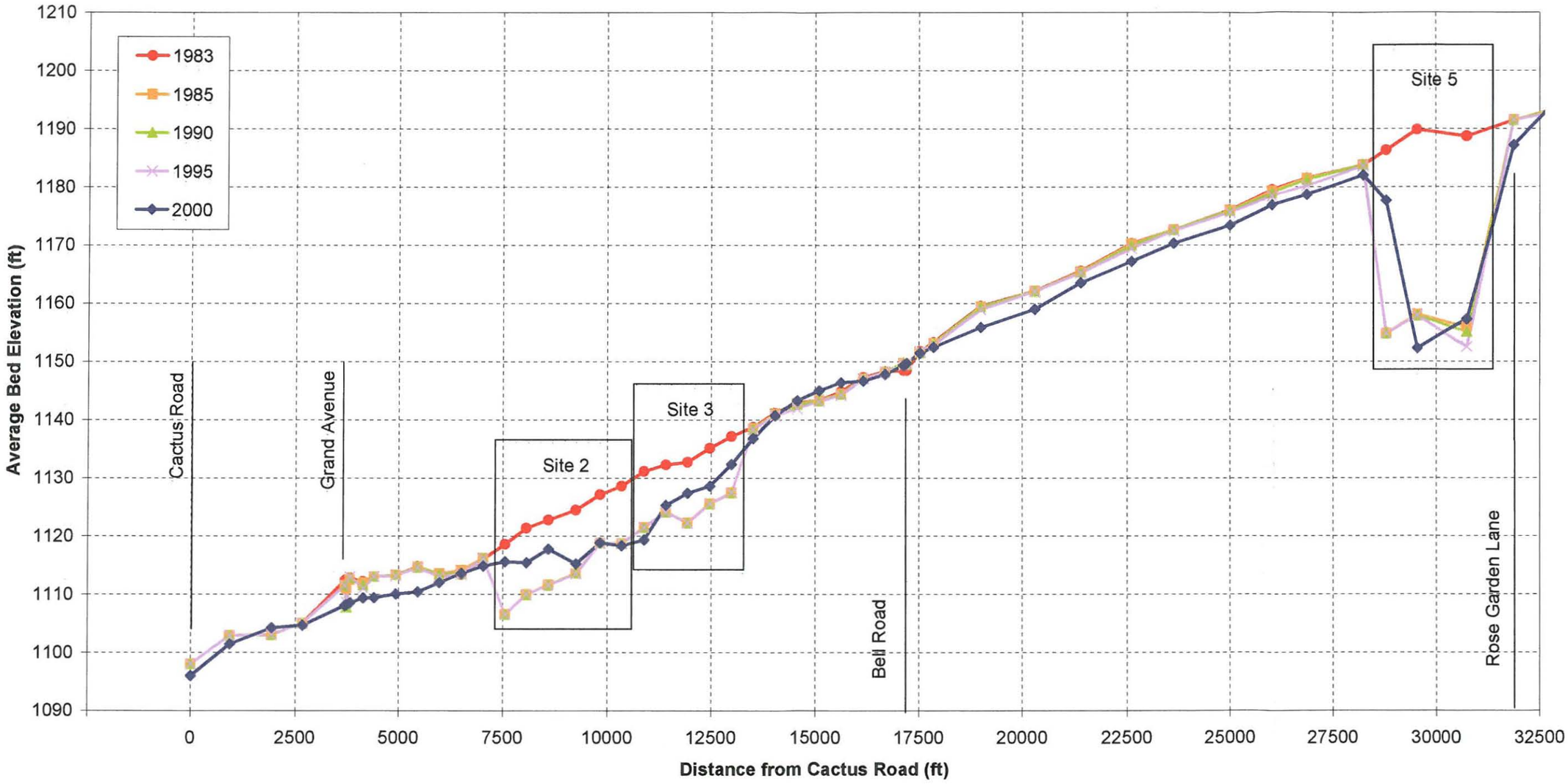
Cross Section	Thalweg		Predicted Thalweg Using Toffaleti and MPM								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1196	1198.00	1193.21	1193.32	1192.9	1175.13	1174.69	1175.82	1182.89	1181.78	1182.5
22.258	1198	1201.23	1198.72	1198.61	1198.87	1191.02	1190.84	1190.91	1192.44	1193.43	1192.5
22.448	1201	1203.53	1198.91	1199	1199.05	1193.71	1193.81	1192.62	1195.92	1194.91	1195.49
22.637	1204	1207.79	1205.21	1205.53	1205.37	1204.05	1203.94	1203.88	1204.01	1204.07	1204.12
22.827	1207	1210.07	1206.71	1206.17	1206.78	1206.16	1206.38	1206.58	1206.65	1206.46	1206.57
23.016	1212	1216.00	1210.17	1210.16	1210.38	1210.18	1210.3	1210.2	1210.15	1210.26	1210.32
23.205	1215	1218.00	1213.28	1212.89	1212.99	1213.02	1212.94	1213.32	1213.12	1212.56	1213.34
23.395	1217	1220.85	1218.01	1218.73	1218.12	1218.21	1218.35	1217.9	1218.2	1219.13	1218.05
23.46	1219.33	1222.54	1219.95	1219.84	1219.54	1219.7	1219.56	1219.88	1219.79	1219.51	1219.62
23.52	1221.67	1225.45	1222.36	1222.82	1222.51	1222.51	1222.66	1222.19	1222.62	1223.22	1222.42
23.584	1224	1226.00	1224.14	1223.98	1223.97	1224.08	1224.16	1224.07	1224.04	1224.17	1224.22
23.774	1227	1226.55	1225.89	1225.84	1226.83	1225.15	1225.71	1226.05	1225.8	1225.06	1225.94
23.87	1229.5	1230.88	1226.97	1226.36	1227.45	1227.17	1226.98	1227.1	1226.45	1226.79	1227.11
23.963	1232	1233.73	1230.59	1231.28	1229.74	1230.42	1229.98	1229.92	1230.92	1229.62	1230.16
24.03	1233	1234.05	1229.83	1229.72	1229.63	1230.25	1229.68	1230.23	1230.05	1229.7	1229.7
24.09	1234	1234.83	1232.56	1233.47	1231.75	1230.97	1232.3	1231.45	1232.35	1231.96	1232.91
24.152	1235	1236.00	1231.49	1231.57	1231.22	1231.39	1231.27	1231.39	1231.51	1231.21	1231.4
24.342	1235		1236.82	1235.24	1236.8	1236.95	1236.8	1236.84	1236.88	1236.85	1235.08
24.531	1238		1238.65	1238.41	1238.59	1238.68	1238.66	1238.65	1238.58	1238.64	1238.34
24.59	1240.67		1240.88	1240.86	1240.87	1241.42	1240.96	1240.94	1241.03	1240.93	1240.84
24.66	1243.33		1239.02	1239.05	1238.72	1238.11	1239.08	1238.76	1238.39	1238.85	1238.8
24.721	1246		1243.97	1244.09	1243.98	1243.83	1244.01	1244.1	1244.17	1244.02	1243.92
24.91	1246		1241.71	1241.61	1241.67	1241.23	1241.64	1241.66	1241.1	1241.7	1241.56
25.099	1250		1258.17	1258.28	1258.37	1258.39	1258.3	1258.41	1258.41	1258.31	1258.32
25.289	1251		1251.35	1251.99	1252.83	1251.31	1251.96	1252.92	1251.31	1251.98	1253.05
25.459	1254		1256.7	1257.02	1257.49	1256.8	1257.07	1257.26	1256.81	1256.94	1256.81
25.592	1258		1256.74	1257.34	1257.18	1257.03	1257.01	1256.9	1257.03	1256.94	1255.32
		RMSE	7.608	7.622	7.676	8.680	8.854	8.785	5.105	5.270	5.394

Cross Section	Thalweg		Predicted Thalweg Using Laursen-Copeland								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
14.311	1081		1079.53	1079.2	1079.51	1079.39	1079.39	1079.4	1079.23	1079.27	1079.38
14.501	1084		1080.68	1081.1	1081.11	1081.28	1081.28	1081.27	1081.54	1081.63	1081.49
14.69	1088		1083.31	1082.85	1082.36	1083.98	1083.92	1084.09	1084.27	1083.74	1084.56
14.879	1089		1086.76	1086.46	1086.2	1087.15	1087.08	1087.18	1086.95	1087	1086.92
15.069	1088		1089.42	1089.31	1089.3	1090.28	1090.05	1090.29	1090.1	1090.05	1090.09
15.258	1094		1093.02	1093.09	1092.65	1092.51	1093.12	1092.52	1092.44	1093.35	1092.53
15.454	1093		1092.79	1092.7	1092.88	1093.55	1093.11	1093.47	1093.4	1093.1	1093.33
15.647	1097	1096.00	1099.32	1098.63	1098.52	1097.27	1098.09	1097.48	1097.36	1098.18	1097.93
15.823	1100	1100.02	1098.76	1099.43	1101.03	1097.91	1098.4	1097.94	1097.87	1098.55	1098.02
16.013	1100	1102.00	1099.63	1099.72	1098.83	1100.22	1099.38	1100.55	1100.03	1098.96	1100.6
16.153	1102	1102.00	1103.84	1106.81	1107.03	1099.88	1104.21	1100.02	1099.96	1104.24	1100.66
16.35	1110.4	1104.00	1103.14	1103.18	1103.69	1108.15	1103.63	1106.44	1108.36	1103.36	1106.45
16.355	1110	1104.47	1103.96	1106.33	1106.53	1102.38	1104.17	1099.12	1098.03	1104.03	1100.2
16.376	1111.84	1105.52	1104.21	1102.88	1103.83	1108.01	1103.36	1106.2	1108.26	1103.03	1106.27
16.431	1110.8	1106.82	1108.54	1108.15	1108.52	1107.17	1106.53	1106.71	1107.02	1106.25	1106.6
16.481	1111.8	1107.92	1105.87	1105.12	1106.77	1109.22	1106.01	1108.5	1109.53	1106.05	1107.57
16.58	1111.6	1109.43	1111.76	1112.29	1111.45	1108.85	1107.83	1108.69	1108.83	1107.67	1108.7
16.681	1113.6	1110.02	1110.15	1109.92	1110.67	1109.99	1108.55	1110.07	1110.1	1108.18	1108.99
16.78	1111.6	1110.79	1115.64	1115.29	1114.6	1112.04	1110.51	1112.02	1112.11	1110.74	1111.89
16.879	1110.6	1112.00	1113.28	1112.35	1113.92	1110.76	1109.97	1110.78	1110.24	1109.17	1109.88
16.979	1113.2	1112.26	1118.48	1120.09	1116.61	1111.93	1111.19	1111.92	1111.82	1111.12	1111.66
17.078	1116.6	1113.70	1117.49	1114.92	1117.69	1113.59	1113.6	1113.59	1111.56	1111.52	1111.55
17.174	1117.1	1112.36	1116.52	1121.08	1117.92	1114.1	1114.1	1114.1	1112.1	1112.1	1112.1
17.273	1119.3	1114.31	1117.97	1120.48	1119.1	1116.3	1116.3	1116.3	1114.3	1114.3	1114.3
17.398	1121.6	1113.13	1120.23	1122.19	1120.97	1118.6	1118.6	1118.6	1116.59	1116.53	1116.54
17.509	1125.3	1117.10	1122.36	1125.15	1124.2	1120.19	1120.24	1120.29	1119.17	1119.2	1119.38
17.607	1126	1118.00	1124.77	1125.95	1125.78	1122.98	1122.96	1122.95	1120.18	1120.86	1120.55
17.71	1127.2	1118.00	1126.6	1127.7	1127.1	1123.98	1124.15	1124.09	1122.2	1122.2	1122.2

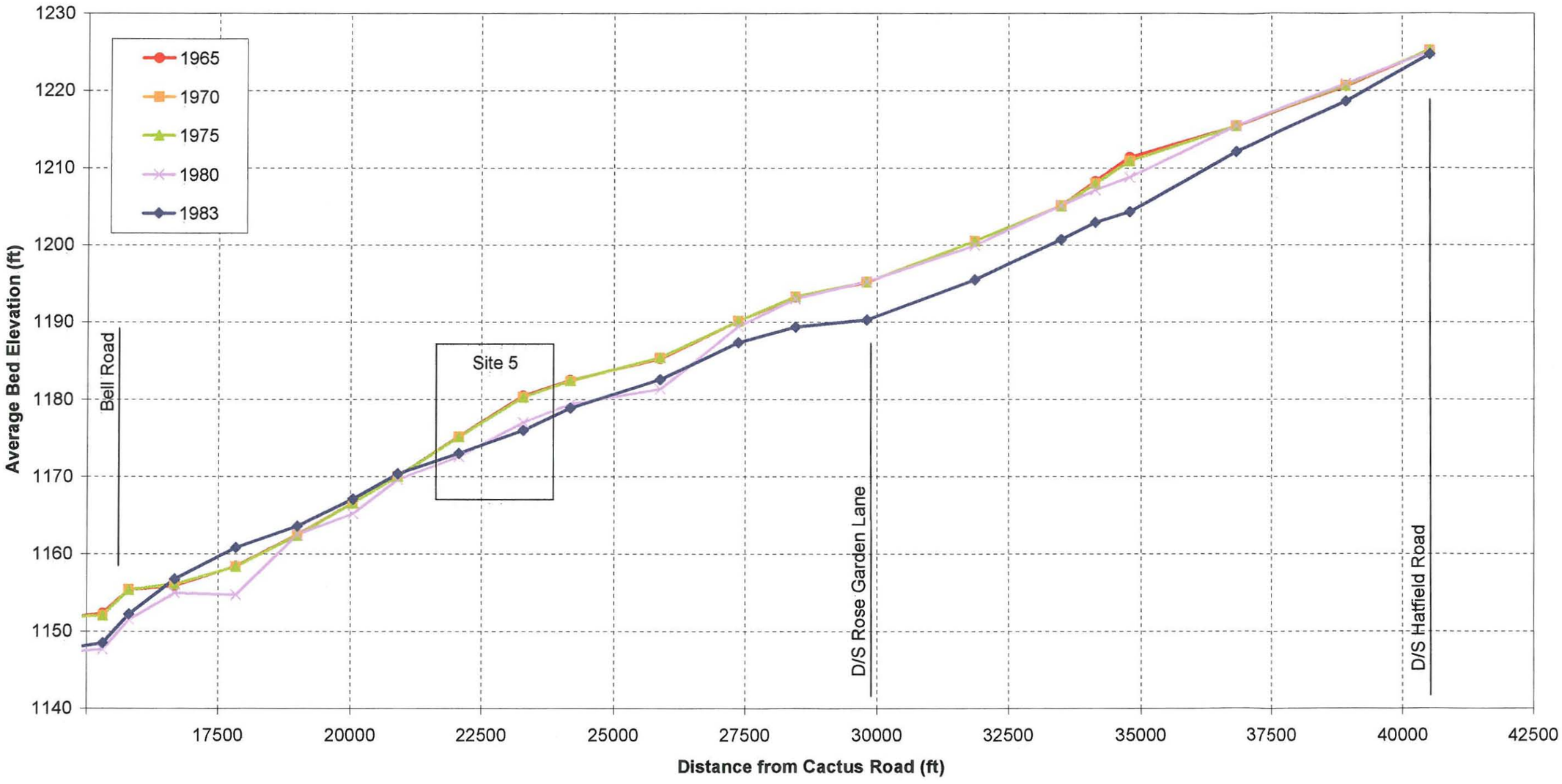
Cross Section	Thalweg		Predicted Thalweg Using Laursen-Copeland								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
17.81	1129.9	1124.06	1127.37	1127.09	1127.83	1124.76	1124.95	1124.9	1123.21	1123.38	1123.1
17.909	1129.9	1126.00	1131.21	1132.03	1131.48	1126.9	1126.75	1126.9	1124.9	1124.9	1124.9
18.009	1131.3	1126.38	1127.78	1128.57	1127.88	1127.83	1128.13	1128.3	1126	1126.14	1125.63
18.109	1133.3	1129.11	1136.01	1135.37	1135.32	1130.3	1130.3	1130.3	1128.3	1128.3	1128.3
18.207	1135.4	1133.83	1132.86	1132.15	1130.25	1127.91	1127.4	1128.5	1126.5	1127	1126.33
18.306	1136.8	1138.68	1137.61	1138.72	1138.97	1130.98	1130.86	1130.15	1127.05	1126.86	1127.26
18.406	1142	1140.76	1136.05	1135.6	1135.91	1131.21	1130.94	1133.15	1131.11	1131.65	1131.3
18.507	1138.8	1142.83	1141.09	1141.74	1142.48	1134.46	1133.85	1133.17	1130.63	1131.12	1130.72
18.606	1143.4	1144.00	1135.95	1136.97	1138.17	1131.09	1130.23	1131.79	1130.1	1130.28	1130.1
18.707	1145.5	1144.80	1144.75	1144.83	1145.48	1139.03	1139.48	1138.42	1138.13	1138.53	1138.21
18.808	1147	1145.80	1138.76	1139.6	1140.62	1133.99	1128.61	1135.14	1131.29	1128.22	1130.85
18.893	1148.5	1148.00	1147.91	1147.48	1148.15	1145.74	1146.92	1145.98	1145.85	1145.78	1145.87
18.906	1148.5	1148.44	1144.29	1145.31	1145.78	1144.91	1145.07	1145.77	1144.43	1144.61	1144.66
18.97	1150.25	1150.50	1150.09	1150.08	1150.14	1146.93	1148.07	1146.61	1147.93	1146.99	1147.86
19.029	1152	1151.48	1143.58	1143.8	1143.76	1143.11	1143.21	1143.59	1143.18	1143.29	1143.05
19.245	1158	1155.42	1162.37	1162.38	1162.32	1162.46	1161.91	1161.11	1162.51	1161.54	1162.13
19.491	1161	1156.50	1160.32	1160.17	1160.46	1159.43	1160.11	1159.31	1159.53	1160.13	1159.62
19.7	1163	1161.30	1163.21	1163.15	1163.17	1164.31	1163.08	1163.17	1163.97	1162.89	1163.57
19.929	1166	1165.60	1153.87	1153.83	1153.94	1154.16	1153.46	1153.56	1154.17	1153.53	1153.28
20.122	1172	1169.55	1175.43	1175.5	1175.51	1174.8	1174.79	1174.85	1174.77	1174.75	1174.62
20.382	1176	1172.00	1174.7	1174.62	1174.61	1173.85	1173.88	1173.84	1173.71	1173.64	1174.01
20.575	1178	1176.00	1176.06	1176.22	1176.16	1175.55	1175.42	1175.37	1175.45	1175.25	1174.95
20.738	1180	1176.67	1172.99	1172.87	1172.91	1171.07	1170.46	1170.61	1170.56	1170.19	1170.05
20.993	1183.4	1180.65	1186.03	1185.96	1186.11	1184.11	1184.15	1184.15	1184.63	1184.65	1184.64
21.1	1185.35	1172.40	1183.96	1184.03	1183.88	1175.33	1175.33	1175.33	1155.35	1155.35	1155.35
21.241	1188	1141.20	1186.52	1186.39	1186.76	1178	1178	1178	1158	1158	1158
21.469	1186	1149.34	1184.7	1185.22	1184.8	1176	1176	1176	1156	1156	1156
21.681	1189	1186.00	1192.86	1192.27	1192.14	1193.64	1193.64	1193.69	1193.97	1193.97	1193.95
21.88	1190	1193.19	1185.42	1185.34	1185.29	1185.05	1185.16	1185.2	1183.95	1184.03	1183.99

Cross Section	Thalweg		Predicted Thalweg Using Laursen-Copeland								
			No Mining			3-5 feet Mining			5-10 feet Mining		
	1965	1983	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow	50% Sed Inflow	100% Sed Inflow	150% Sed Inflow
22.069	1196	1198.00	1200.46	1200.48	1200.53	1200.7	1200.56	1200.77	1200.61	1200.76	1200.8
22.258	1198	1201.23	1194.55	1194.79	1194.9	1194.43	1194.33	1194.75	1194.06	1194.29	1194.42
22.448	1201	1203.53	1207.08	1207.04	1206.8	1207.05	1207.56	1206.79	1204	1207.24	1207.57
22.637	1204	1207.79	1205.09	1205.23	1205.94	1204.44	1204.67	1204.44	1204.63	1205.27	1205.27
22.827	1207	1210.07	1210.63	1210.32	1210.09	1209.83	1210.89	1209.99	1210.77	1209.96	1210.2
23.016	1212	1216.00	1208.94	1209.38	1208.15	1205.43	1208.14	1206.45	1206.54	1206.02	1209
23.205	1215	1218.00	1212.24	1210.9	1213.19	1221.13	1211.89	1215.87	1215.49	1218.98	1210.28
23.395	1217	1220.85	1218.27	1217.98	1216.88	1213.67	1217.97	1217	1218.76	1213.71	1217.51
23.46	1219.33	1222.54	1219.96	1218.1	1218.66	1223.47	1218.62	1218.93	1219.87	1219.91	1217.7
23.52	1221.67	1225.45	1222.31	1223.4	1221.84	1214.33	1222.22	1220.7	1221.85	1221.34	1222.04
23.584	1224	1226.00	1222.94	1222.55	1221.61	1224.15	1222.41	1220.93	1222.95	1221.89	1220.98
23.774	1227	1226.55	1226.24	1227.23	1227.45	1226.63	1225.99	1228.57	1226	1227.14	1228.24
23.87	1229.5	1230.88	1224.98	1224.96	1225.68	1227.69	1227.25	1223.34	1226.57	1227.83	1224.59
23.963	1232	1233.73	1229.44	1229.48	1231.85	1229.5	1230.06	1233.31	1228.75	1230.33	1231.38
24.03	1233	1234.05	1227.57	1228.14	1227.15	1228.88	1227.73	1227.29	1227.59	1229.09	1228.4
24.09	1234	1234.83	1230.81	1231.89	1233.5	1230.9	1232.17	1233.66	1230.33	1231.96	1232.47
24.152	1235	1236.00	1228.78	1229.32	1229.81	1228.92	1229.16	1229.68	1228.14	1229.65	1229.39
24.342	1235		1239.08	1238.75	1239.12	1238.94	1238.77	1239.33	1238.71	1238.98	1239.36
24.531	1238		1234.47	1234.84	1235.52	1234.28	1234.49	1235.02	1234.31	1234.42	1234.81
24.59	1240.67		1240.2	1240.36	1240.81	1240.16	1240.25	1240.85	1240.21	1240.23	1240.97
24.66	1243.33		1236.37	1236.43	1236.52	1236.5	1236.36	1236.36	1236.61	1236.42	1236.44
24.721	1246		1242.22	1242.43	1242.67	1242.23	1242.31	1242.77	1242.27	1242.3	1243.09
24.91	1246		1238.68	1238.87	1238.71	1238.8	1238.72	1238.81	1238.66	1238.6	1238.9
25.099	1250		1257.52	1257.53	1258.09	1257.62	1257.78	1258.12	1257.64	1257.73	1258.12
25.289	1251		1251.9	1252.55	1253.3	1251.89	1252.59	1253.24	1251.89	1252.56	1253.09
25.459	1254		1257.7	1260.9	1262.89	1257.75	1259.05	1262.92	1257.78	1260.89	1262.41
25.592	1258		1260.6	1258.84	1262	1260.68	1259.02	1261.92	1260.59	1258.74	1265.76
		RMSE	8.496	8.677	8.510	7.554	7.594	7.400	6.139	6.173	6.141

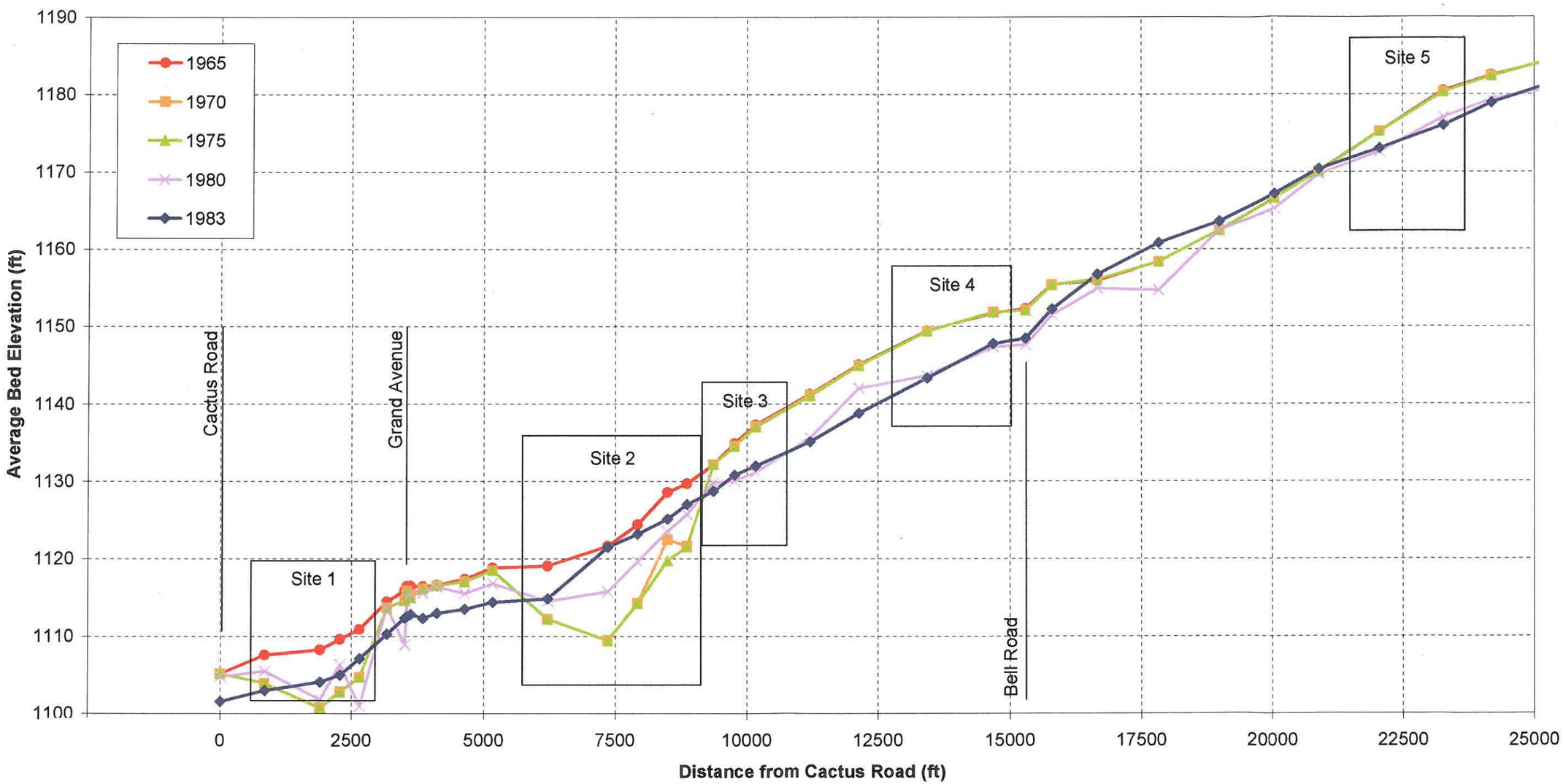
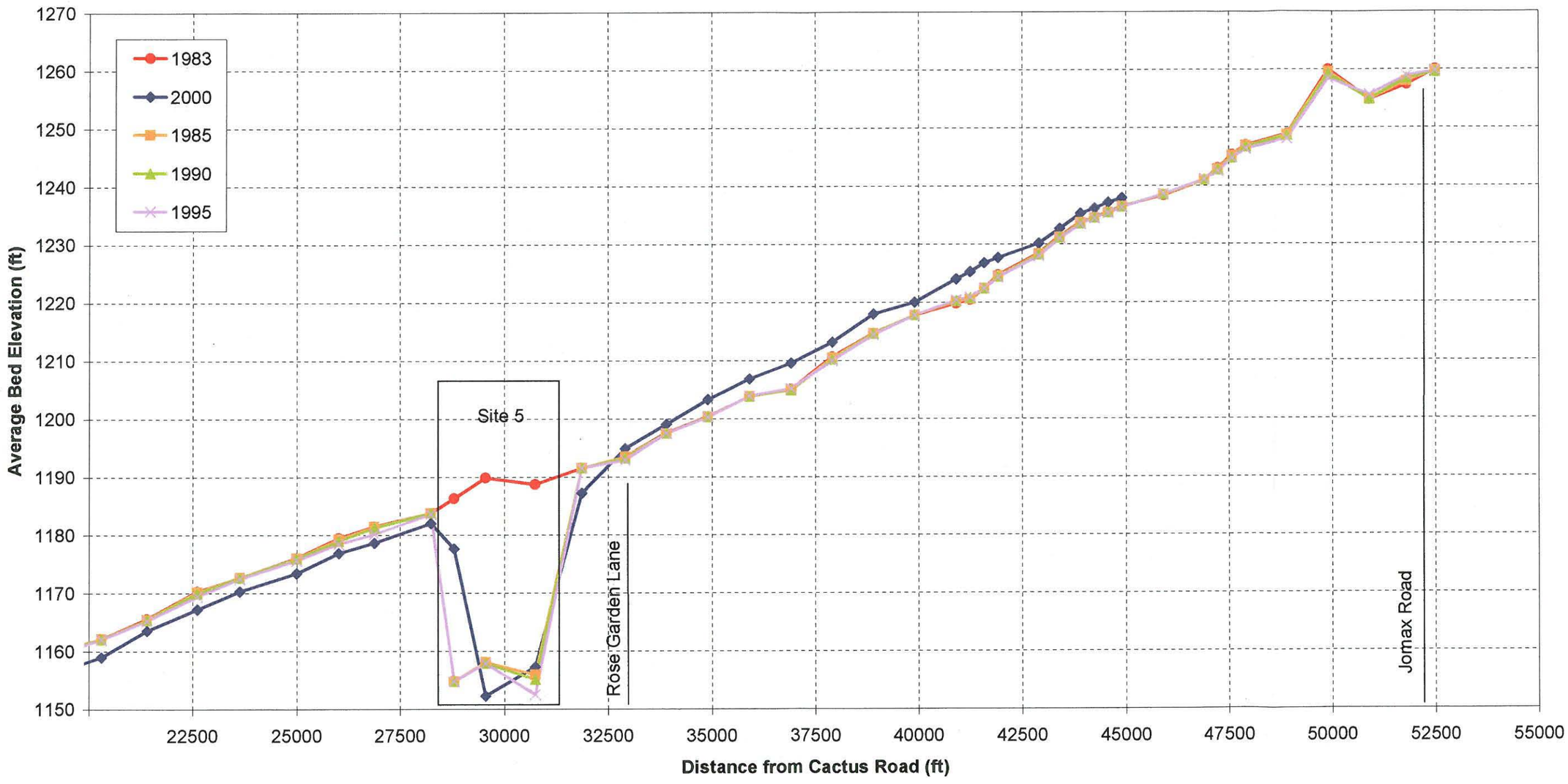
Agua Fria River Sediment Transport Study - Intermediate Model
Yang Equation - 100% Equilibrium Load Inflow - High Mining Scenario



Agua Fria River Sediment Transport Study - Initial Model
Yang Equation - 100% Equilibrium Load Inflow - Low Mining Scenario



Agua Fria River Sediment Transport Study - Initial Model
Yang Equation - 100% Equilibrium Load Inflow - Low Mining Scenario



Agua Fria River Sediment Transport Study - Intermediate Model
Yang Equation - 100% Equilibrium Load Inflow - High Mining Scenario