Silas Creek
Stream Restoration Project
Year 1 Monitoring Report
Winston Salem, North Carolina

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program

Prepared By:

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February 2005

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Monitoring Report Prepared By Buck Engineering PC

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Silas Creek and Buena Vista Branch
Year 1 Monitoring Report
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Executive Summary

In 2003, the North Carolina Ecosystem Enhancement Program (EEP, formerly the Wetlands Restoration Program) restored 4,449 linear feet of stream along three reaches of Silas Creek and one reach of Buena Vista Branch in Winston-Salem, North Carolina.

The objectives of the Silas Creek stream restoration project are to enhance the Silas Creek watershed by:

- Restoring 4,449 LF of channel dimension, pattern, and profile to the extent possible considering the project constraints, watershed characteristics, and data from reference reaches in similar watersheds;
- Improving floodplain functionality by matching floodplain elevation with bankfull stage therefore increasing watershed attenuation and reducing peak flows;
- Establishing native floodplain vegetation which will allow treatment of diffuse storm flow and nutrient uptake while establishing part of a wildlife corridor in the watershed;
- Improving the natural aesthetics of the stream corridor; and,
- Improving the water quality in the Silas Creek watershed by reducing bank erosion, increasing nutrient storage and uptake, and increasing the dissolved oxygen of the system.

This is Year 1 of the 5-year monitoring plan for Silas Creek and Buena Vista Branch.

Table 1A. Background Information

Project Name	Silas Creek and Buena Vista Branch Stream Restoration
Designer's Name	Buck Engineering 1347 Harding Place, Suite 100 Charlotte, NC 28204 704.334.4454
Contractor's Name	North State Environmental, Inc. 2889 Lowery St. Suite B Winston-Salem, NC 27101 336-725-2010 (Earthwork and Planting)
Project County	Forsyth
Drainage Area	Silas Creek: 7.2 square miles (lower end); 5.4 square miles (upper end). Buena Vista Branch: 1.4 square miles
USGS Hydro Unit	03040102
NCDWQ Subbasin	03-07-06

Project Length	3,667 linear feet Enhancement I on Silas Creek 782 linear feet Restoration on Buena Vista Branch
Restoration Approach	Silas Creek: Instream structures installed to change channel dimension and profile over time and cut new floodplain at bankfull elevation. Priority 3 restoration of incised channel. Buena Vista Branch: Change dimension, pattern, and profile. Priority 2/3 restoration.
Date of Completion	Construction: Fall 2003 Plantings: January 2004
Monitoring Dates	As-Built Survey Fall 2003

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1 Introduction

1.1 Summary

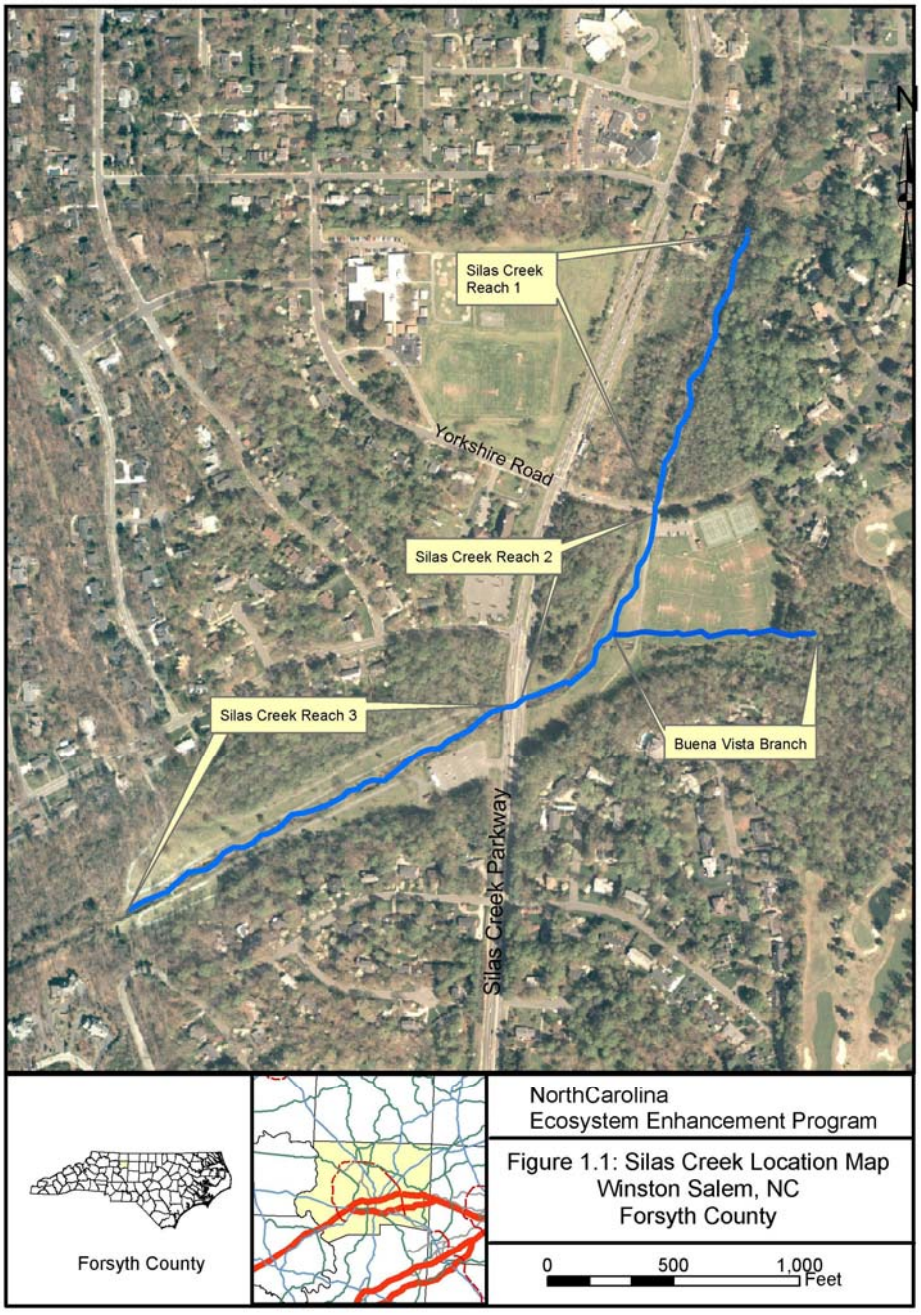
In 2003, the North Carolina Ecosystem Enhancement Program (EEP, formerly the Wetlands Restoration Program) restored 4,449 linear feet of stream along three reaches of Silas Creek and one reach of Buena Vista Branch in Winston-Salem, North Carolina. The reaches are located in Shaffner Park (Figure 1.1). These streams are tributaries to Muddy Creek (USGS Hydrologic Unit 03040102) and are in the Yadkin River basin. Buck Engineering (Buck) provided design, construction administration, As-Built survey, mitigation plan development, and Year 1 monitoring services for the project.

1.2 Year 1 Monitoring

Buck conducted Year 1 Monitoring for Silas Creek and Buena Vista Branch on October 28, 2004 in conformance with the methods outlined in the Silas Creek Stream Restoration Project Mitigation Plan (March 2004). As-Built conditions, including pattern, profile, dimension, bed material, and photos, were measured during the Fall of 2003 and are included with the mitigation plan. The purpose of this report is to compare Year 1 monitoring with As-Built conditions and recommend any necessary remedial actions.

1.3 Year 1 Results

In general, the streams are functioning as the design intended. Changes in dimension represent an increase in stability in most cases. The pattern has remained constant, and there has been little overall change to sinuosity. The profile indicates bedform features are remaining within a stable range and that, in most cases, pools are deepening. The establishment of native vegetation has been less successful. Live stakes are growing well, but bare root plantings have had low survival rates and terrace slope herbaceous vegetation has had limited success.


N
Silas Creek Reach 1
Yorkshire Road
Silas Creek Reach 2
Silas Creek Reach 3
Buena Vista Branch
Silas Creek Parkway
Forsyth County
NorthCarolina
Ecosystem Enhancement Program
Figure 1.1: Silas Creek Location Map
Winston Salem, NC
Forsyth County
0
500
1,000
Feet

2 Monitoring Results

Environmental components that allow an evaluation of channel stability and riparian survivability were monitored in this project. Specifically, channel stability and vegetation plantings were evaluated. Year 1 monitoring results are discussed in the following text. Statistical summaries are included in Tables 2.1 and 2.2, found at the end of this section.

2.1 Silas Creek

2.1.1 Dimension

The Silas Creek Stream Restoration Mitigation Plan (March 2004) indicated minor changes to dimension, an increase in vegetative density, deposition along the banks, a decrease in width/depth ratio, and a decrease in cross-sectional area are generally indicative of a stream gaining stability. Substantial shifts in cross-sectional area can represent unstable conditions such as down-cutting, erosion, and bank failure. In order to assess stability, each Year 1 surveyed cross section is directly compared to As-Built conditions as summarized in Table 2.1. For monitoring purposes, Year 1 monitoring bankfull elevation has been set to match As-Built bankfull elevation. In some instances, survey methods in Year 1 monitoring are adjusted from the As-Built survey methods to increase monitoring accuracy. Adjustments include increasing the frequency of survey shots and pulling a tape tightly across the section to ensure survey shots are taken in consistent locations. In some cases, this change in methodology may indicate a slight change in cross-sectional area when no change occurred.

X1 Riffle
X1 has narrowed from As-Built conditions by 2.7 feet due to what appears to be minor deposition on the left bench and channel. The right side of this cross section has also deepened by 0.5 feet, potentially indicating the development of a thalweg. No signs of instability were noted at this cross-section and these minor shifts are considered to be within a stable range. The change in depth at this cross section does not appear to be degradational but should be evaluated during future monitoring events.

X2 Pool
X2 has remained fairly stable since construction. Minor deposition has occurred along the left bank and variations in bankfull area is most likely attributed to more frequent survey shots taken in the Year 1 monitoring than during the As-Built survey.

X3 Riffle
Results for X3 indicate a stable width and some slight aggradation. Visual inspection of the constructed riffle cross-section did not indicate any instability and the slight shift in depth is considered well within the ranges of stable adjustment.

X4 Riffle
X4 is 0.3 feet deeper than the As-Built condition. Minor deposition has also occurred on the right and left benches. The change in depth at this cross-section does not appear to be degradational but should be evaluated during future monitoring events.

X5 Pool
X5 has deepened by 1.6 feet, indicating the upstream cross vane is functioning well. This trend is consistent with the design intentions and indicates a positive trend in habitat enhancement and energy dissipation.

X6 Riffle
X6 has deepened by 0.3 feet and the cross sectional area is 4.1 ft^2 less when compared to As-Built conditions. Part of this difference may be explained by differences in survey shot frequencies but it is plausible that this cross section may be adjusting. The change in depth at this cross section does not appear to be degradational but should be evaluated during future monitoring events.

X7 Pool
X7, like most of the pools, has deepened by 0.4 feet. Some slight narrowing is evident; sand deposition was apparent on the banks. Other minor changes in the cross-section are well within ranges of normal adjustment.

X8 Pool
X8 has deepened by 1.1 feet, which is consistent with the trend noted in the X5 and X7 pool locations.

X9 Riffle
X9 has narrowed by 2.0 feet and the bankfull area has decreased from 105.3 ft^2 to 95.8 ft^2. The maximum depth has increased by 0.5 feet. This cross-section is just upstream of a cross vane which is promoting channel narrowing. Although the channel has deepened considerably at this cross-section, incision is unlikely considering the cross vane located immediately downstream.

The four pool cross-sections, X2, X5, X7, X8 all are stable or deepening, indicating a positive trend. Riffle cross-sections all experienced some shifts in bankfull area, width, and/or depth. These adjustments were generally minor and may be due to settling or post-construction thalweg development. At this time, adjustments were within expected design parameters, but should be evaluated during future monitoring events.

2.1.2 Pattern and Profile

Pattern was not measured for the Priority 3 restoration efforts on Silas Creek. Visual observation of the three reaches did not indicate the channel has altered its present alignment.

Profile bedform diversity has improved since As-Built conditions with a decrease in pool to pool spacing and an increase in the pool depths (Table 2.1). This indicates the instream structures are performing as the design intended.

2.1.3 Bed Material Analysis

The Silas Creek Stream Restoration Mitigation Plan (March 2004) indicated the D_{50} and D_{85} should increase in coarseness in riffles and increase in fineness in pools.

Reaches 1 and 3 had an increase in the percentage of fine particle sizes reach wide and in individual riffles and pools. Reach 2 increased the percentage of fine particles in the riffle, decreased the D_{85} in the pool but increased in the D_{50} for the total reach wide (Table 2.1). All three reaches indicate the pools are increasing the number of fines, as expected, but the riffles are also increasing in the number of fines. These results may indicate the stream bed is still adjusting post construction or it may suggest deposition is moving through the stream system from the upstream urban watershed. Deposition within the channel was noted at some of the riffle cross section locations.

2.1.4 Vegetation Survival

Live stake survival within the Silas Creek vegetation monitoring plot indicated a 14% mortality rate (61 out of 71 live stakes were located). Visual inspection of Silas Creek generally suggested similar survival rates or higher. Bare root survival was extremely low within the monitoring plot. Only 7 out of 37 stems were found alive, representing an 81% mortality rate. Bare root survival appeared higher along most sections of the reach than in the monitoring plot but survival was still low. In most cases, the bare root planting was not found, indicating the plant had been washed away either alive or dead. Herbaceous cover within the vegetation monitoring plot was established on the floodplain benches but was nearly bare on the upper terrace slopes. The primary species established included Switchgrass (*Panicum virgatum*) and Soft Rush (*Juncus effusus*) which are expected to continue to spread and colonize in future monitoring years. We recommend at this time bare root species be evaluated reach wide and replacements be installed for unaccounted plantings. Live stakes should be added in a few locations experiencing scour, most notably at stations 26+50 and 35+00, and grass plugs should be added to the terrace slopes.

2.2 Buena Vista Branch

2.2.1 Dimension

In order to assess stability, each Year 1 surveyed cross-section is directly compared to As-Built conditions with the results summarized in Table 2.2. Visual inspection of Buena Vista Branch indicates the upstream section of Buena Vista (approximately station 10+00 to 13+00) is experiencing heavy deposition within the channel and banks. Downstream riffle features appear to have narrowed and pool features are well-formed and deep.

Buena Vista is likely experiencing adjustment where the stream transitions from an incised channel upstream of the project to the restored channel with a large, excavated floodplain bench. With large storm flows contained in the upstream channel, high velocities are slowed on the new floodplain, causing excessive sediment to deposit. Buena Vista should adjust to this transition and stabilize without remediation efforts but these impacts need to be evaluated during future monitoring events.

The pool cross-section (X2) is located within this upper section and is currently filling in (bankfull max depth has decreased from 3.6 feet to 2.6 feet) from the deposition. The riffle cross-section (X1) has narrowed (As-Built conditions measured 16.6 feet while 2004 results indicated 15.0 feet) and bankfull max depth has decreased slightly by 0.2 feet. Other than the excessive sedimentation, no signs of instability were noted throughout the reach and both cross sections are adjusting within normal parameters.

1.2.2 Pattern and Profile

Pattern measurements are similar for both As-Built and Year 1 monitoring results (Table 2.2). Minor differences are attributed to slight variations in measurement, survey shots, and minor stream adjustments.

The stream profile depicts a higher streambed elevation and shallower pools from stations 10+00 to 13+00 as a result of the deposition occurring. Pools have deepened from stations 13+00 to 16+50. A large pool has formed at the end of the reach where the stream enters a culvert and goes through a series of step pools before entering Silas Creek. Riffle slopes have decreased on average. In some locations, the riffles have shortened and steepened and should be evaluated for stability in future monitoring events. These profile adjustments should be monitored in the future but do not indicate major instability at this time.

2.2.3 Bed Material Analysis

Year 1 monitoring pebble counts indicate the sediment in riffles and pools are becoming finer. This condition may be a result of As-Built monitoring pebble counts including large, imported cobble in the riffle sections, but this condition is also a result of the large amounts of deposition occurring in the upstream section of stream.

2.2.4 Vegetation Survival

Live stake monitoring in the Buena Vista Branch vegetation monitoring plot indicated a 16% mortality rate (38 out of 45 live stakes were located). In general, live stakes appear to be doing well within this reach and are establishing appropriate cover. Similar to Silas Creek, bare root survival was extremely low within the monitoring plot. Only 4 out of 30 stems were found alive, representing an 87% mortality rate. The vegetation monitoring plot was in the upper section of Buena Vista Branch where heavy deposition occurred. This may be responsible for some mortality but survival appeared to be low throughout the reach. In most cases, the bare root plantings were not found, indicating the plants had

been washed away either alive or dead. Herbaceous cover within the vegetation monitoring plot was established on the floodplain benches and partially established on the upper terrace slopes. The primary species established included Switchgrass (*Panicum virgatum*) and Soft Rush (*Juncus effusus*) which are expected to continue to spread and colonize in future monitoring years. We recommend at this time that bare root species be evaluated reach wide and replacements installed for unaccounted plantings.

2.3 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrate monitoring will be conducted by the NC Division of Water Quality.

3 Maintenance Plans

3.1 Maintenance Concerns

Silas Creek and Buena Vista Branch both are stable or are adjusting towards stability in terms of pattern, profile, and dimension. Vegetation establishment continues to be a problem with extremely low bare root survivability within the two monitoring plots and low herbaceous cover on Silas Creek terrace slopes. A site visit noted the Winston-Salem Parks Department is currently dumping grass clippings near station 22+00 on the left bank, preventing vegetation establishment within this area. Buck recommends replacement vegetation for all missing or dead bare root plantings and that the Silas Creek terrace slopes be planted with grass plugs to supplement the limited cover. Live stakes should be added at stations 26+50 and 35+00 of Silas Creek.

3.2 Storm Water BMP

The berm on the storm water BMP adjacent to the parking lot has failed and water from the parking lot is concentrating in this area and threatening the slope (see Photo Log). The slope and berm should be reconstructed and matted with erosion control matting.

3.3 Future Maintenance Concerns

Future maintenance concerns include continuing to monitor the deepening riffles to evaluate whether incision is occurring, further evaluate the sediment deposition in the upper reach of Buena Vista Branch to insure that the stability of this reach is not threatened, and continue to evaluate the health of the vegetation especially the bare root replacements.

Table 2.1. Summary of Silas Creek Channel Conditions

DIMENSION	Silas Creek X1 Riffle		Silas Creek X2 Pool		Silas Creek X3 Riffle		Silas Creek X4 Riffle		Silas Creek X5 Pool		Silas Creek X6 Riffle		Silas Creek X7 Pool		Silas Creek X8 Pool		Silas Creek X9 Riffle	
	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004
Bankfull Cross-sectional Area (SF)	120.0	121.8	135.4	140.3	82.8	84.4	86.9	88.0	119.8	138.9	115.7	111.6	135.5	140.0	98.9	109.3	106.3	95.8
Bankfull Width (ft)	35.1	32.4	33.8	34.2	33.1	33.0	35.8	35.1	35.3	35.9	39.5	40.5	44.7	41.8	37.3	36.5	37.2	35.1
Bankfull Mean Depth (ft)	3.4	3.8	4.0	4.1	2.5	2.6	2.4	2.5	3.4	3.9	2.9	2.8	3.0	3.4	2.7	3.0	2.9	2.7
Bankfull Max Depth (ft)	4.5	5.0	7.1	7.1	4.3	4.2	3.3	3.6	5.4	7.0	4.8	5.2	5.9	6.3	4.8	5.9	3.7	4.2

PATTERN	Silas Creek As-built			Silas Creek 2004 (Year 1 Monitoring)		
	Minimum	Maximum	Median	Minimum	Maximum	Median
Meander Wave Length	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*
Radius of Curvature	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*
Beltwidth	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*

*Pattern measurements not taken on the Priority 3 restoration

PROFILE	Silas Creek As-built			Silas Creek 2004 (Year 1 Monitoring)		
	Minimum	Maximum	Median	Minimum	Maximum	Median
Riffle Length (ft)	N/A**	N/A**	N/A**	N/A**	N/A**	N/A**
Riffle Slope	N/A**	N/A**	N/A**	N/A**	N/A**	N/A**
Pool Length (ft)	N/A**	N/A**	N/A**	N/A**	N/A**	N/A**
Pool to Pool Spacing (ft)	54.0	210.4	457.0	30.0	143.6	388.0

**Riffle/Pool slopes were not measured on a Bc restoration.

SUBSTRATE	Silas Creek Reach 1						Silas Creek Reach 2						Silas Creek Reach 3					
	Riffle		Pool		Total		Riffle		Pool		Total		Riffle		Pool		Total	
	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004	As-built	2004
d50	14.66	11.00	2.40	0.40	4.43	0.94	28.87	22.60	0.39	1.00	4.85	8.00	13.65	5.60	0.38	0.50	0.75	0.74
d85	25.11	28.09	16.53	8.00	21.28	23.40	180.00	168.14	54.50	32.00	128.00	128.00	125.97	28.97	29.37	6.69	72.67	21.34

VEGETATION	Silas Creek Plot 1	
	Observed (2004	Planted
Live Stakes	61	71
Bare Root Plantings***	7	37
Herb Stratum (%cover)	50	100

*** For a detailed description see Vegetation Survival Plots under Tab 6

Table 2.2. Summary of Buena Vista Branch Channel Conditions

DIMENSION	Buena Vista Branch X1 Riffle		Buena Vista Branch X2 Pool	
	As-built	2004	As-built	2004
Bankfull Cross-sectional Area (SF)	24.9	18.6	85.2	68.3
Bankfull Width (ft)	16.64	14.97	62.72	63.63
Bankfull Mean Depth (ft)	1.5	1.24	1.36	1.07
Bankfull Max Depth (ft)	2.29	2.12	3.58	2.59

PATTERN	Buena Vista Branch As-built			Buena Vista Branch 2004 (Year 1 Monitoring)		
	Min	Average	Max	Min	Average	Max
Meander Wave Length	117.3	144.6	164.9	139.4	146.1	167.2
Radius of Curvature	18.8	29.4	35.6	19.0	31.5	41.0
Beltwidth	54.3	67.8	76.4	54.5	60.4	66.9
Sinousity	-	1.23	-	-	1.19	-

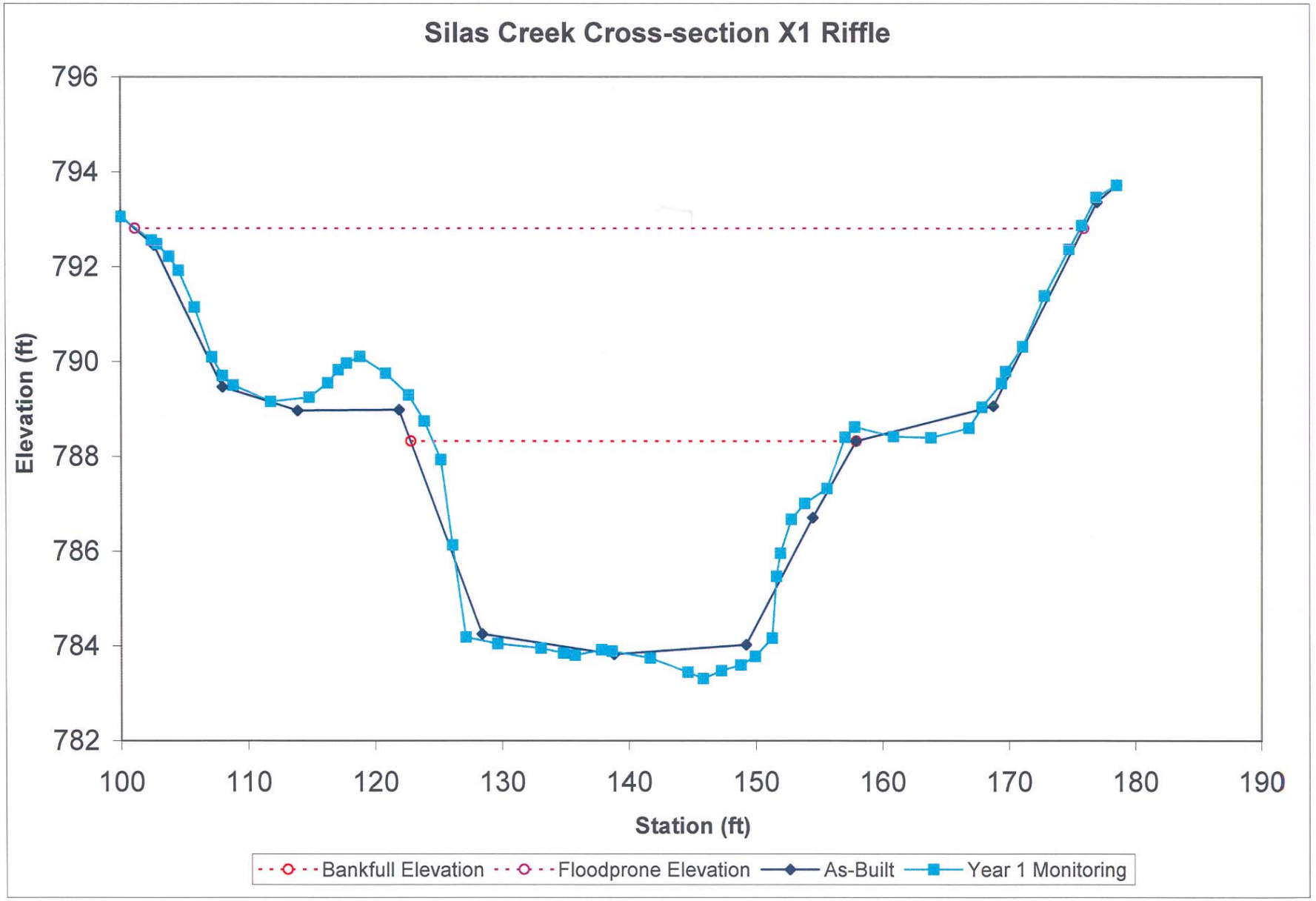
PROFILE*	Buena Vista Branch As-built			Buena Vista Branch 2004 (Year 1 Monitoring)		
	Min	Average	Max	Min	Average	Max
Riffle Length (ft)	17.3	24.0	27.7	11.5	21.8	28.9
Riffle Slope	0.04%	1.21%	2.46%	0.21%	0.69%	1.20%
Pool Length (ft)	43.1	62.2	84.7	32.8	59.0	59.8
Pool to Pool Spacing (ft)	65.1	87.0	103.0	59.4	83.3	102.5

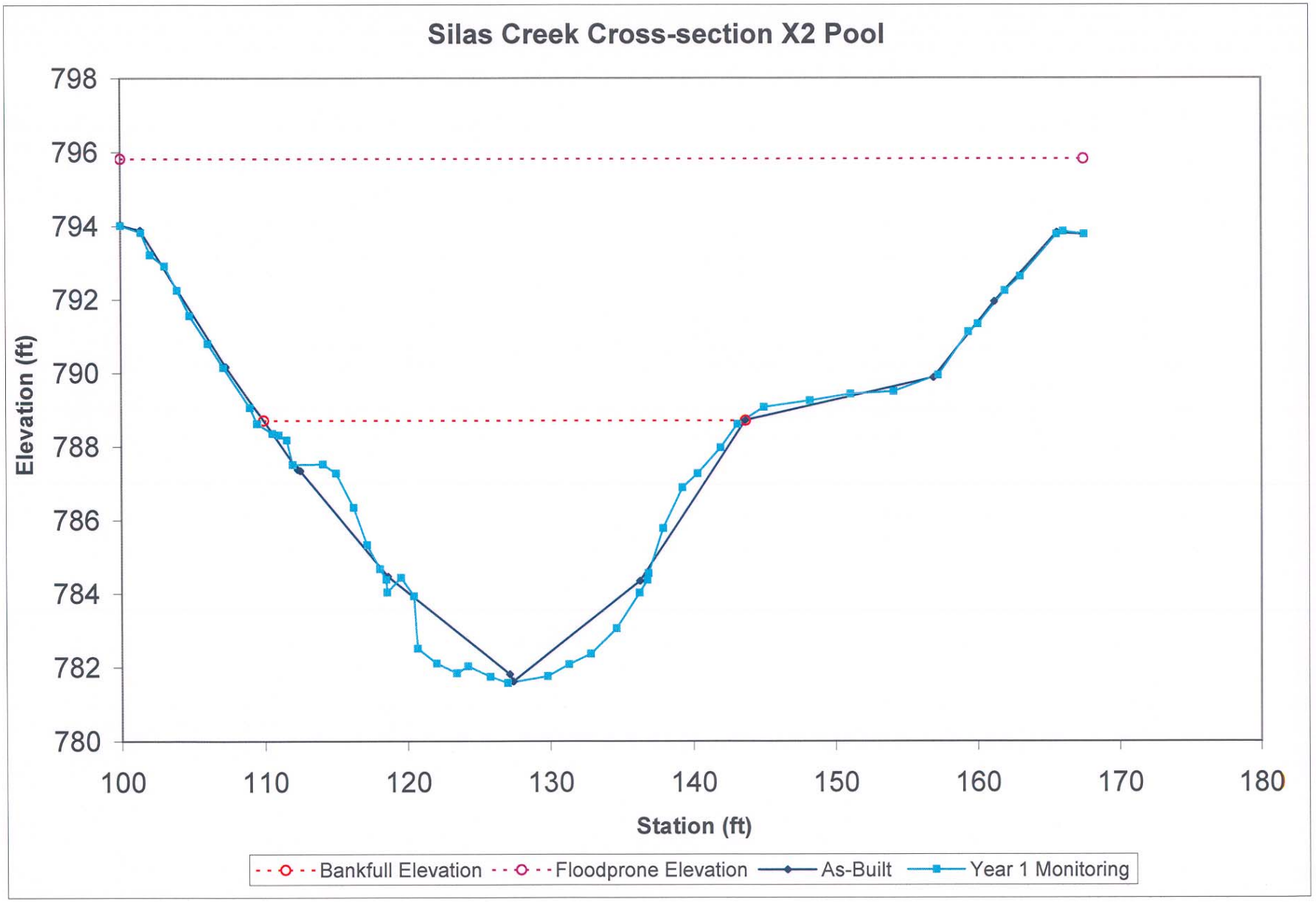
*Data for previous monitoring periods were not reported

SUBSTRATE	Buena Vista Branch Reach 1					
	Riffle		Pool		Total	
	As-built	2004	As-built	2004	As-built	2004
d50	18.44	0.67	0.31	0.38	10.48	0.52
d85	84.97	12.46	30.12	5.01	61.55	7.45

VEGETATION	Buena Vista Branch 2004	
	Observed	Planted
Live Stakes	38	45
Bare Root Plantings*	4	30
Herb Stratum (%cover)	60	100

* For a detailed description see Vegetation Survival Plots under Tab 6


Silas Creek Cross-section X1 Riffle
796
794
792
790
788
786
784
782
Elevation (ft)
100
110
120
130
140
150
160
170
180
190
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring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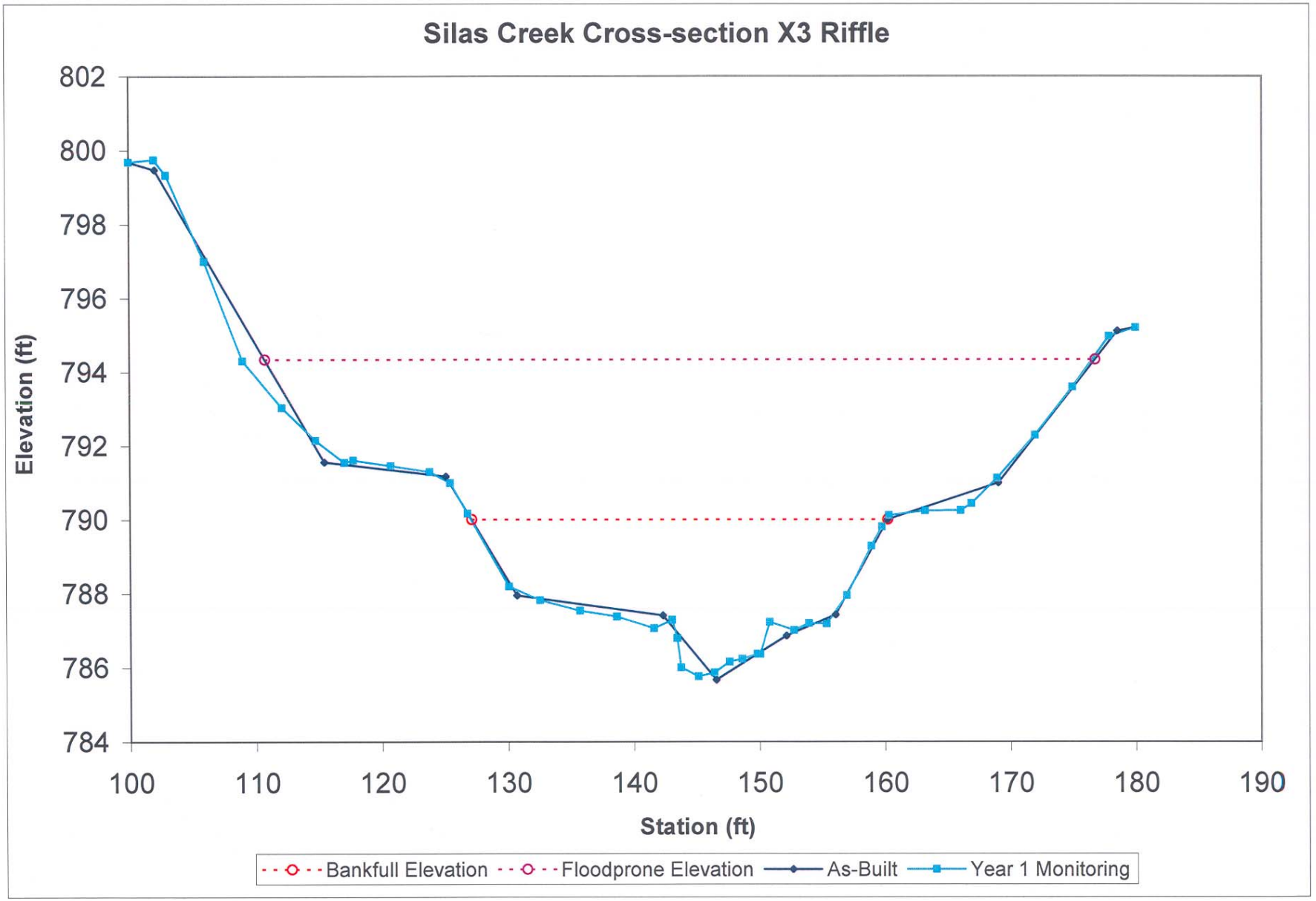
798
796
794
792
790
788
786
784
782
780
Elevation (ft)
100
110
120
130
140
150
160
170
180
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring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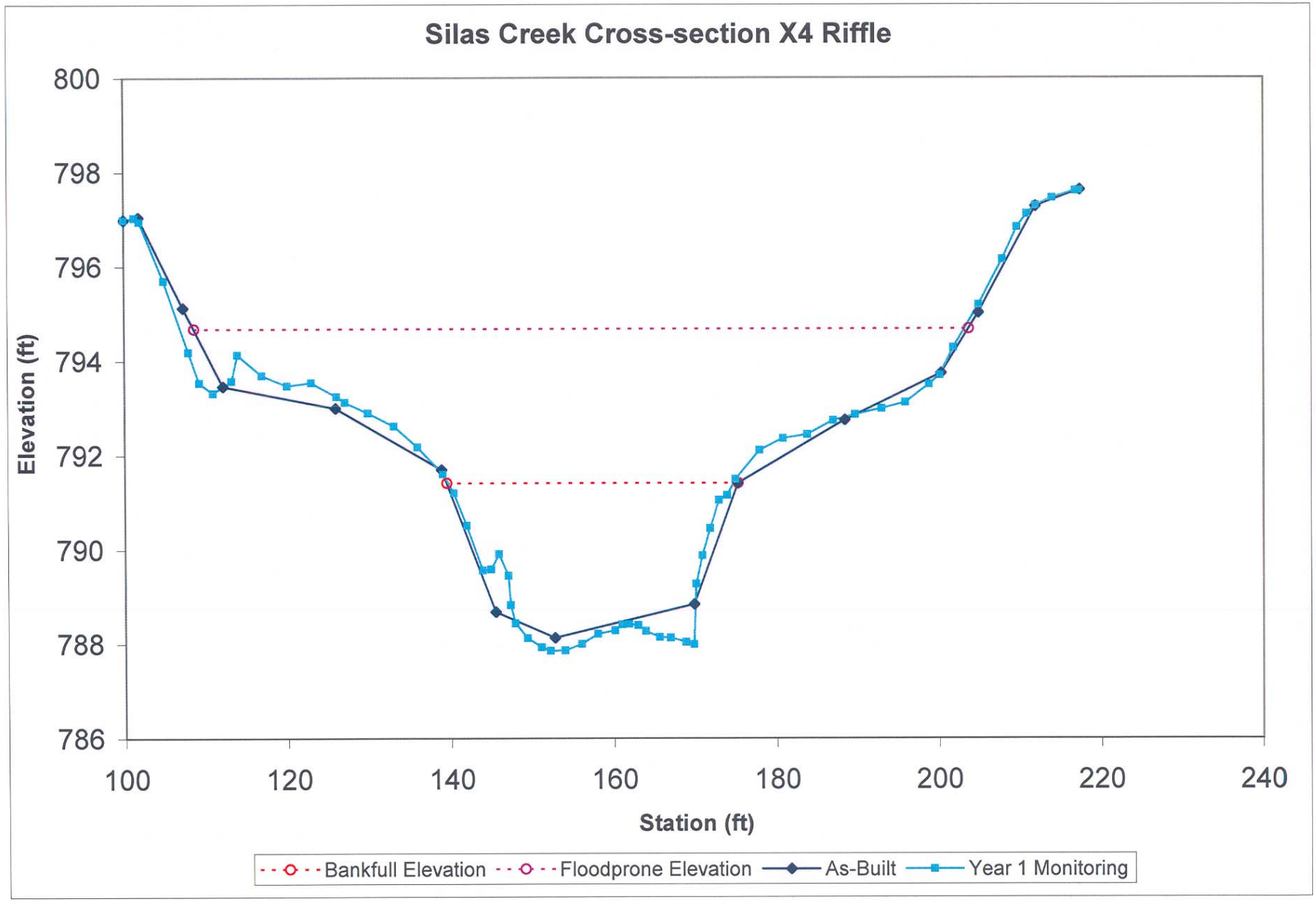
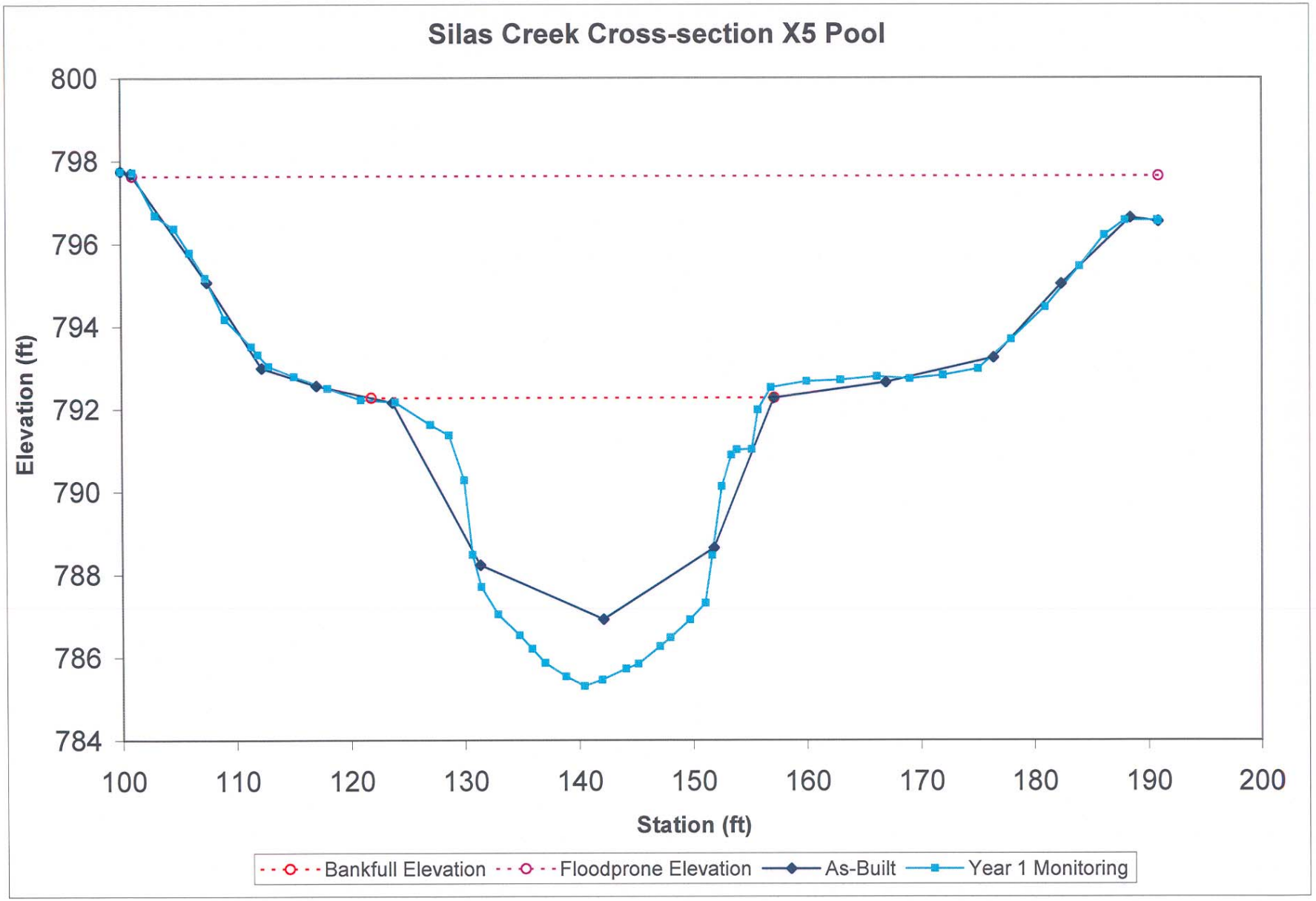
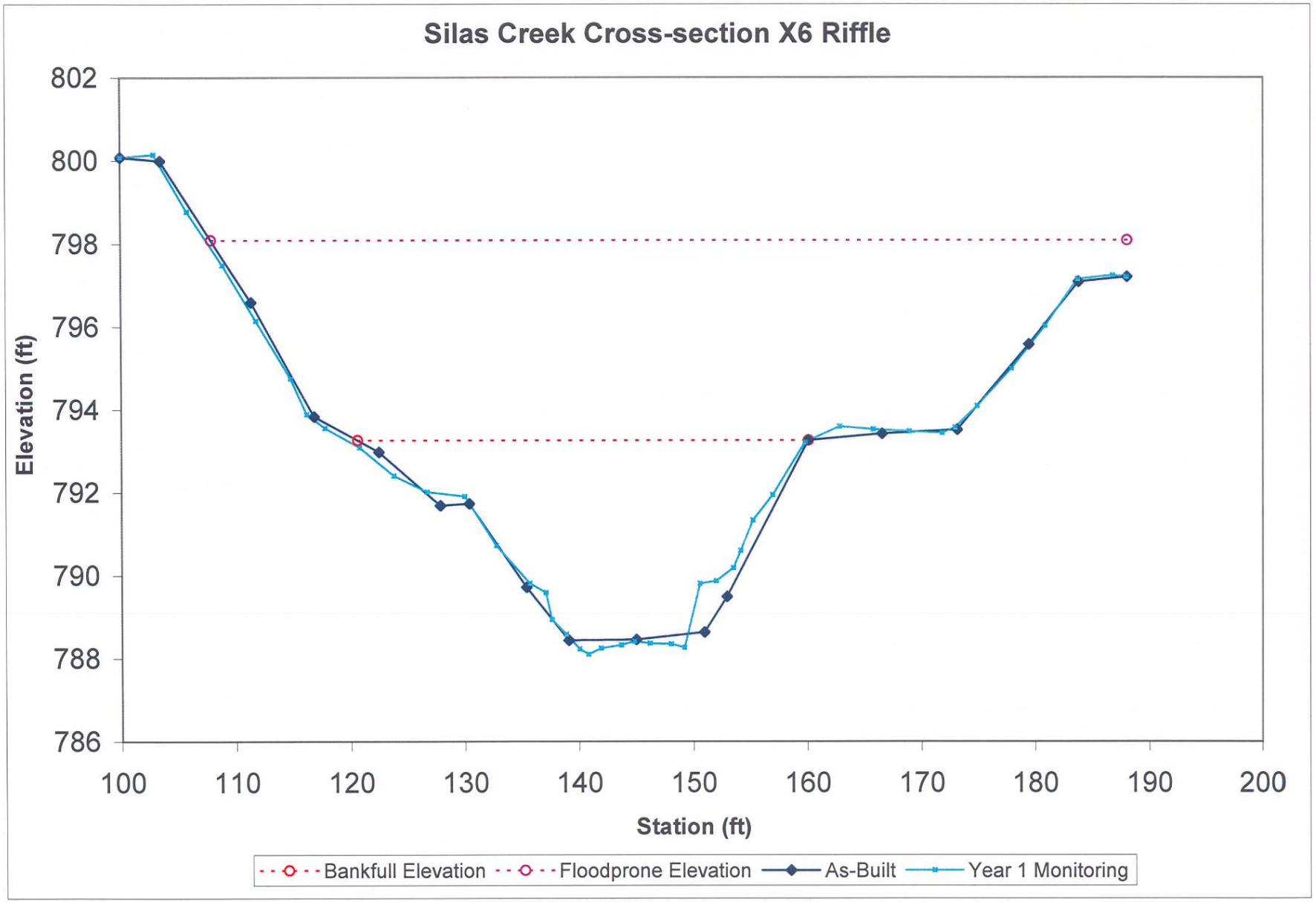
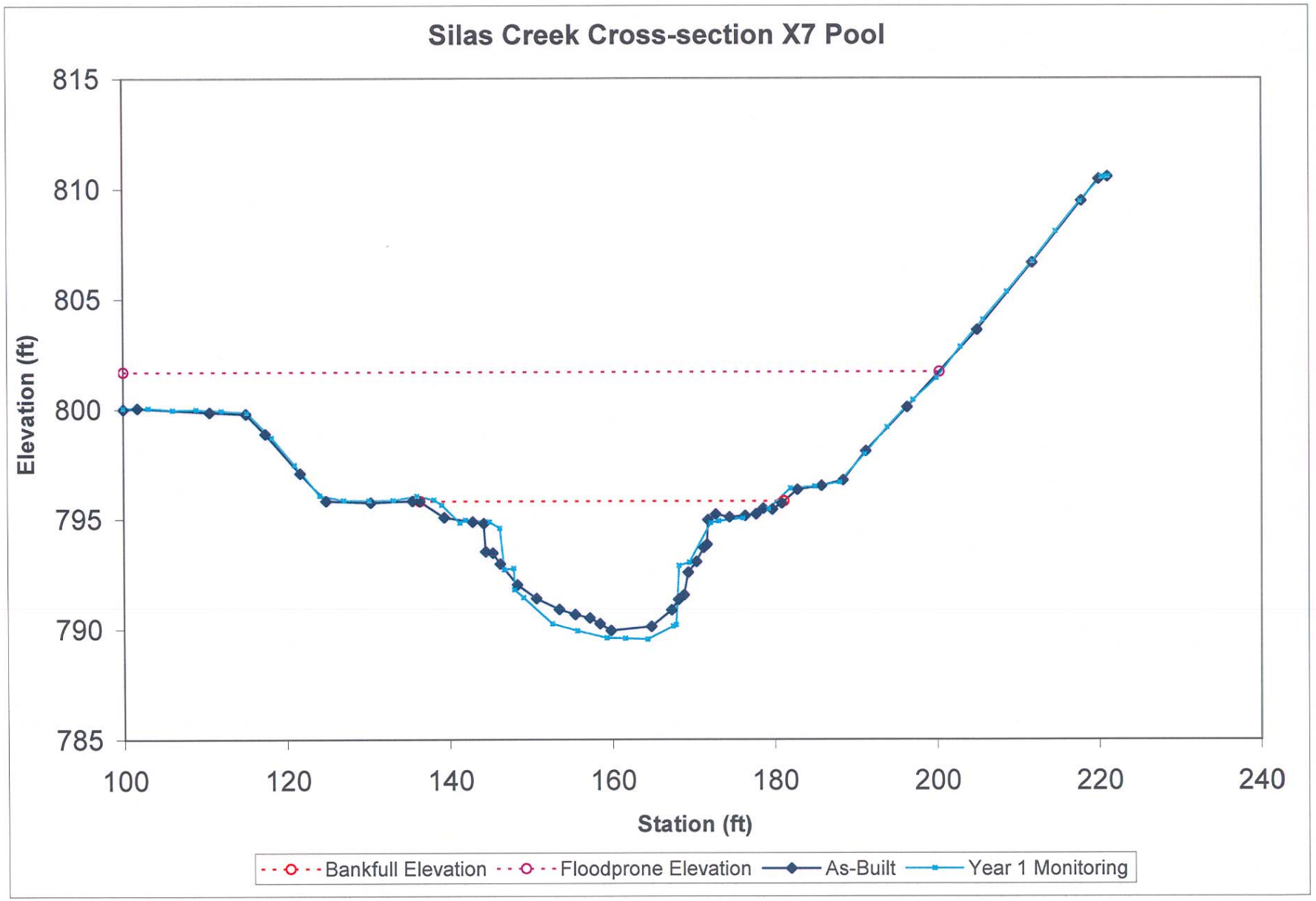
802
800
798
796
794
792
790
788
786
784
Elevation (ft)
100
110
120
130
140
150
160
170
180
190
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring


Silas Creek Cross-section X4 Riffle
800
798
796
794
792
790
788
786
Elevation (ft)
100
120
140
160
180
200
220
240
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring


Silas Creek Cross-section X5 Pool
800
798
796
794
792
790
788
786
784
Elevation (ft)
100
110
120
130
140
150
160
170
180
190
200
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring


Silas Creek Cross-section X6 Riffle
802
800
798
796
794
792
790
788
786
Elevation (ft)
100
110
120
130
140
150
160
170
180
190
200
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring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815
810
805
800
795
790
785
Elevation (ft)
100
120
140
160
180
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220
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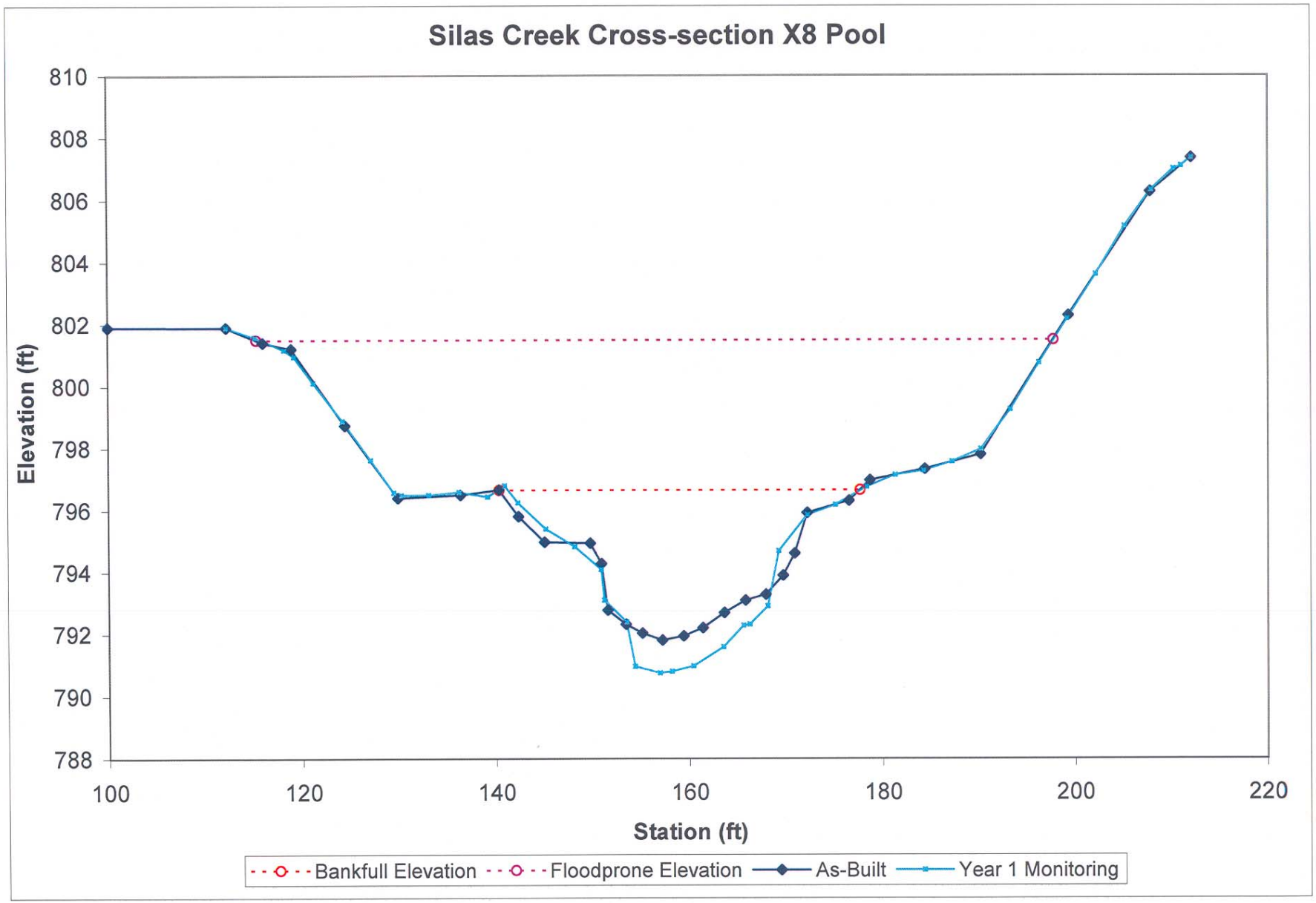
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring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Elevation (ft)
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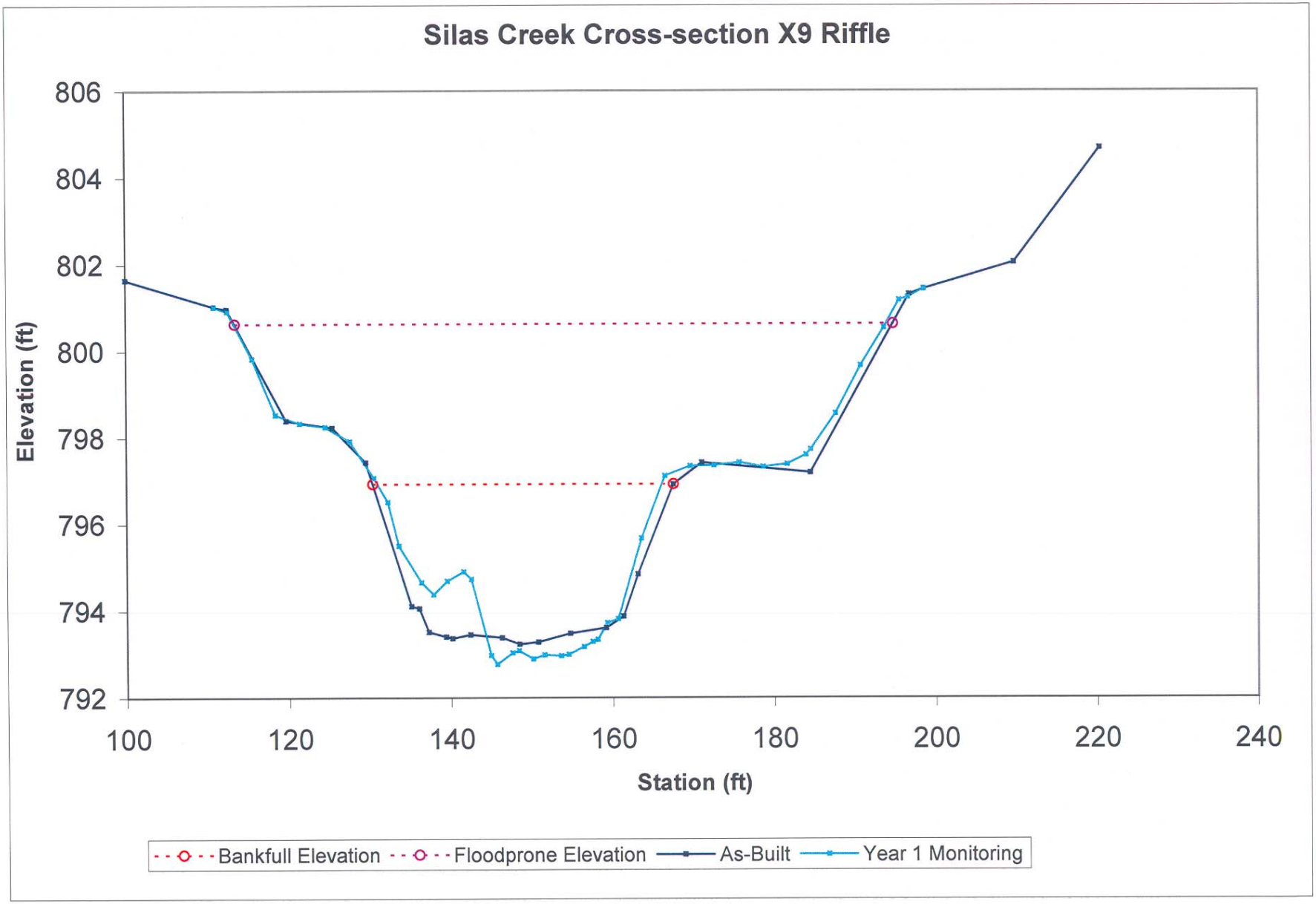
808
806
804
802
800
798
796
794
792
790
788
100
120
140
160
180
200
220
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring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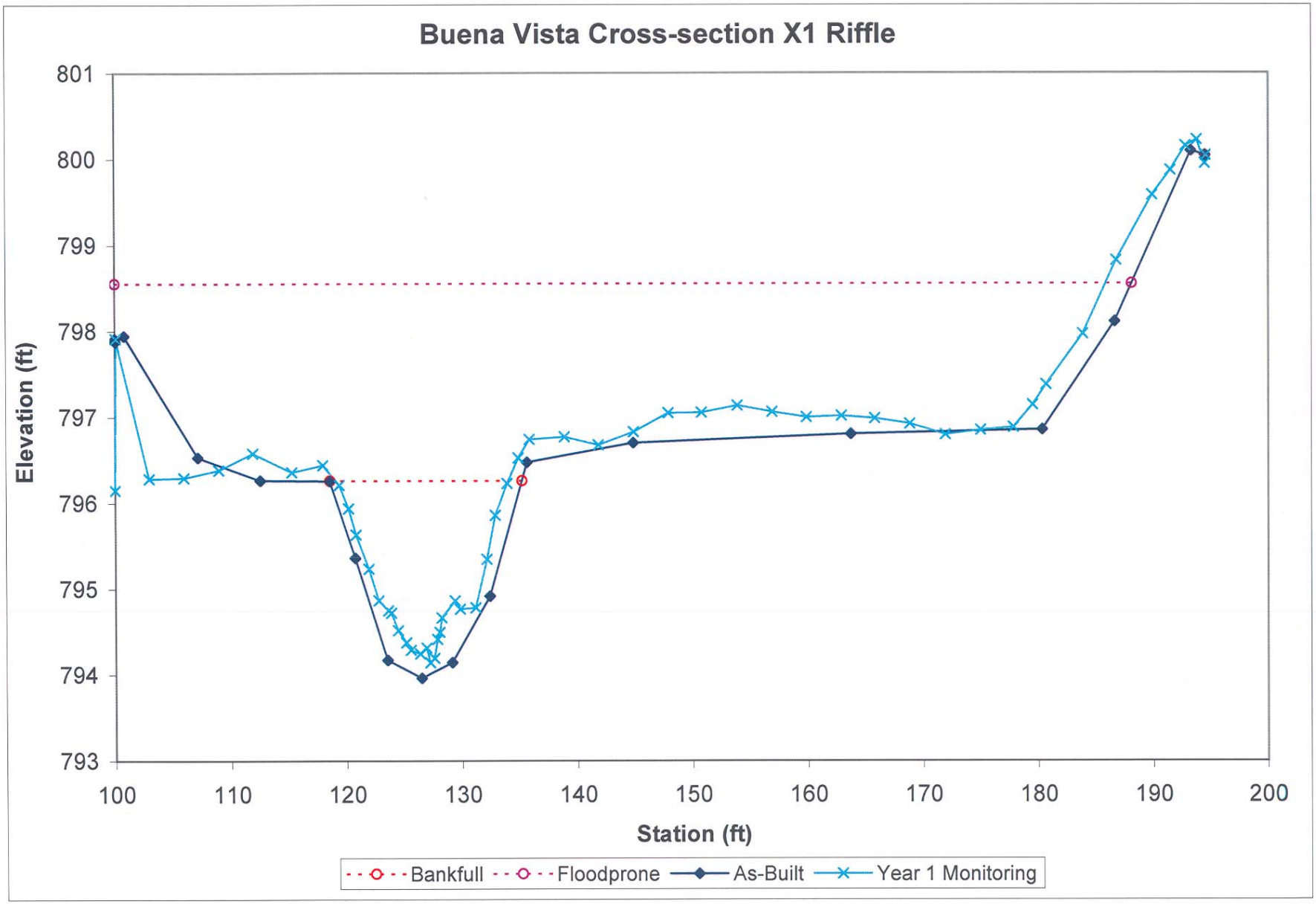
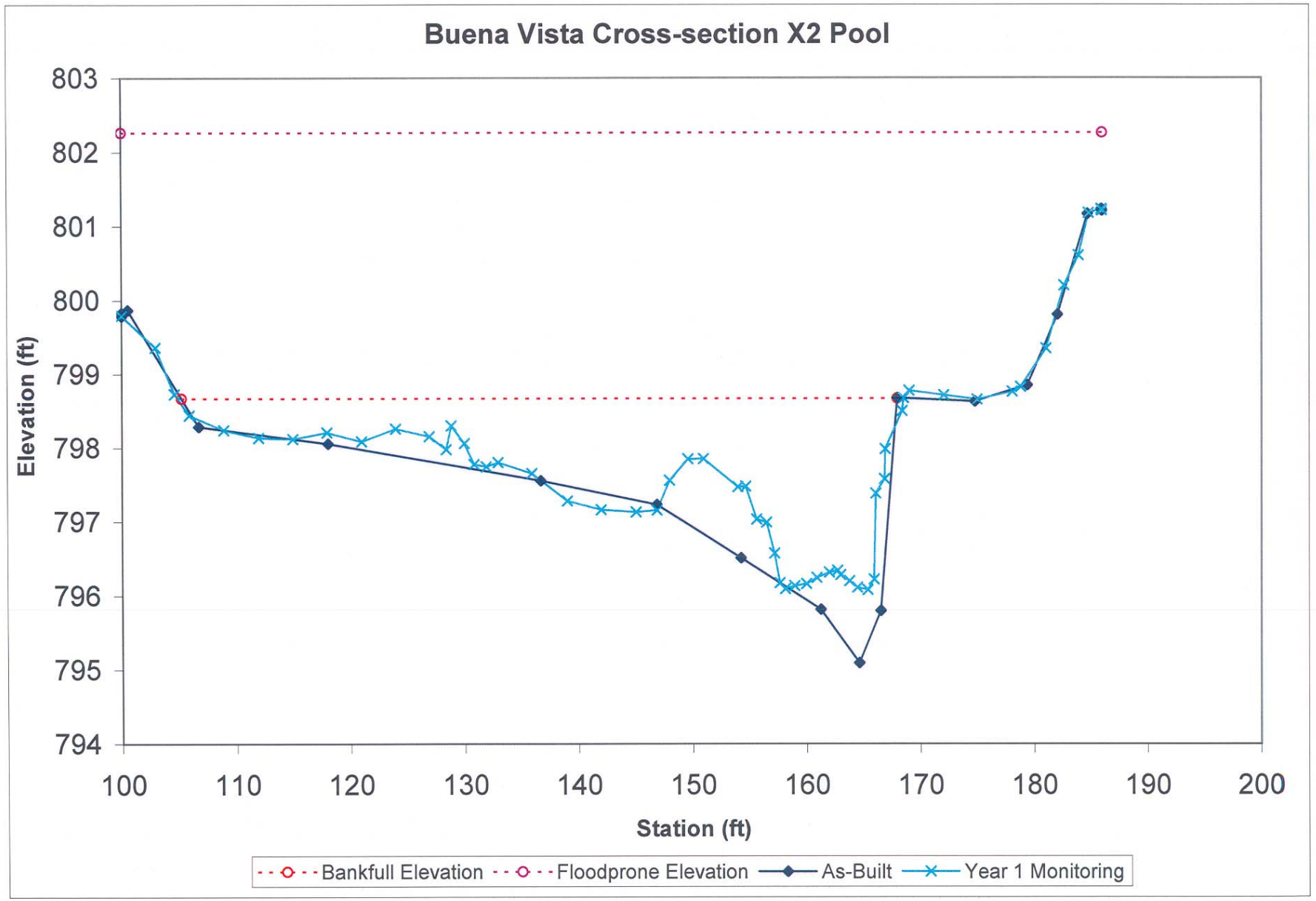
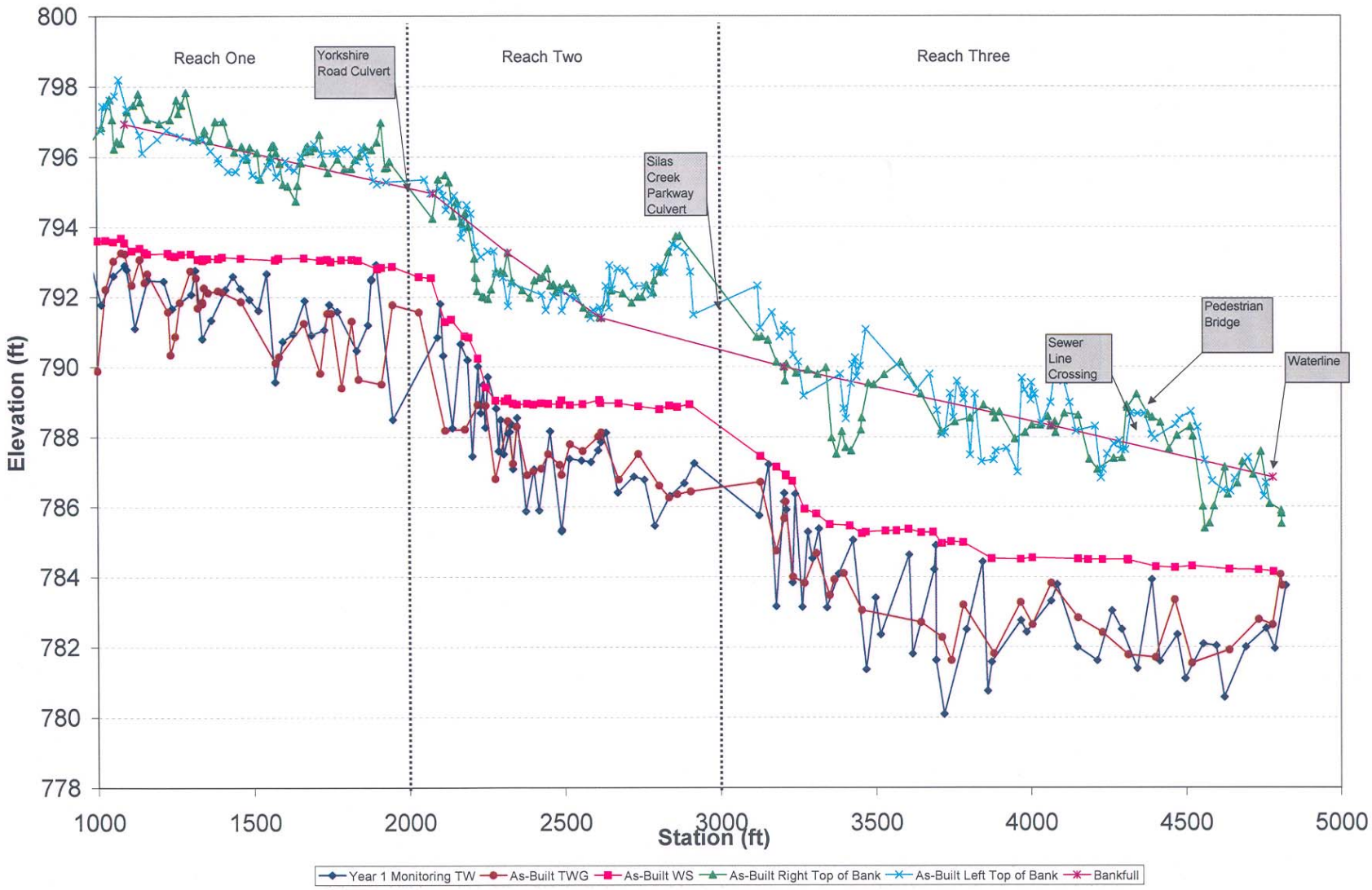
806
804
802
800
798
796
794
792
Elevation (ft)
100
120
140
160
180
200
220
240
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring

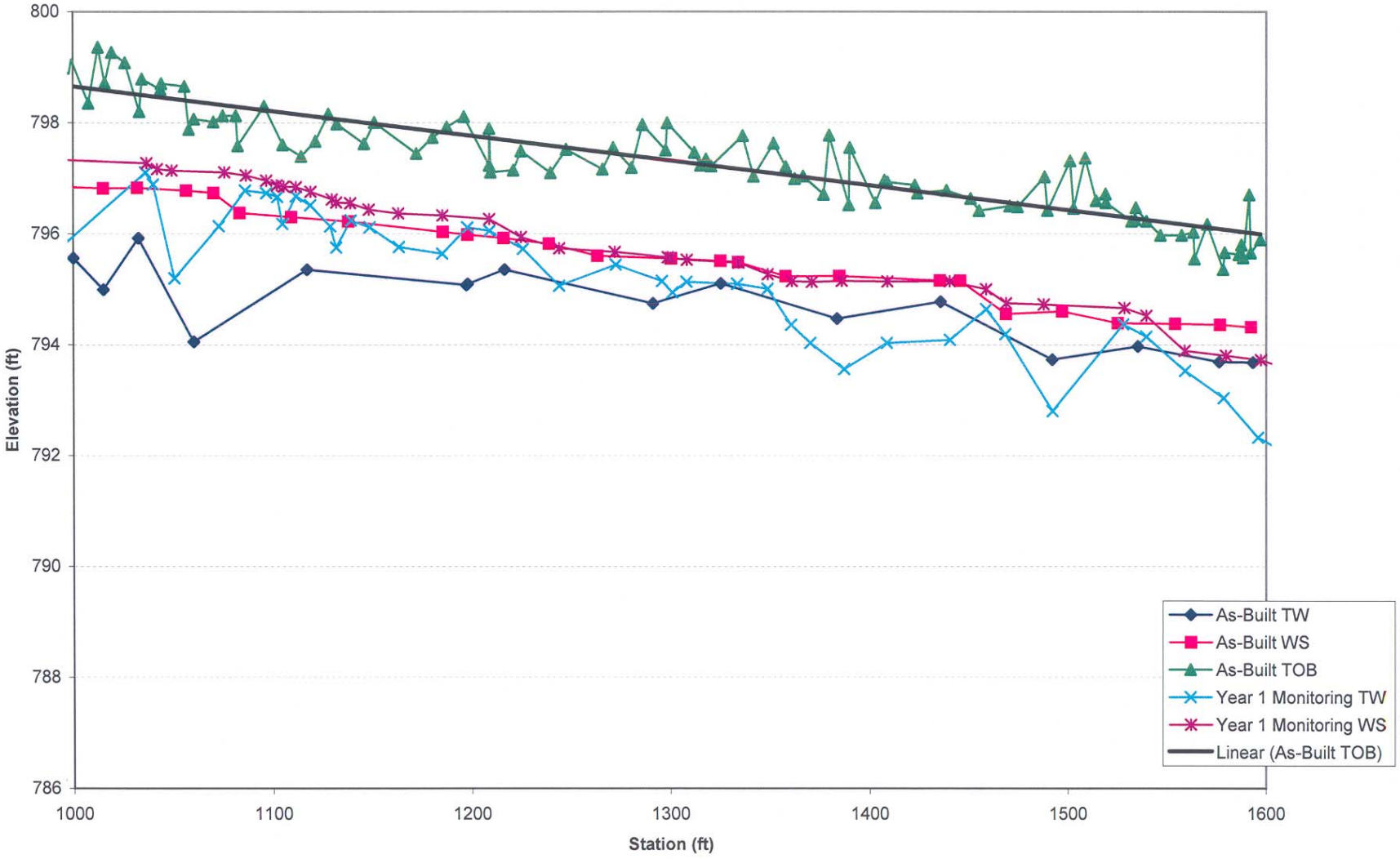

Buena Vista Cross-section X1 Riffle
801
800
799
798
797
796
795
794
793
Elevation (ft)
100
110
120
130
140
150
160
170
180
190
200
Station (ft)
Bankfull
Floodprone
As-Built
Year 1 Monitoring


Buena Vista Cross-section X2 Pool
803
802
801
800
799
798
797
796
795
794
Elevation (ft)
100
110
120
130
140
150
160
170
180
190
200
Station (ft)
Bankfull Elevation
Floodprone Elevation
As-Built
Year 1 Monitoring

Silas Creek Profile



Buena Vista Profile



PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	Silas Creek Year 1 Monitoring
REACH/LOCATION:	Reach 1
DATE COLLECTED:	25-Oct-04
FIELD COLLECTION BY:	JBP/IJE
DATA ENTERED BY:	KJM

SEDIMENT ANALYSIS DATA SHEET

			PARTICLE CLASS			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	2	6	8	8.00	8.00	4.00	4.00	12.00	12.00
SAND	Very Fine	.063 - .125					8.00		4.00		12.00
	Fine	.125 - .25	9	15	24	24.00	32.00	18.00	22.00	30.00	42.00
	Medium	.25 - .50	2	6	8	8.00	40.00	4.00	26.00	12.00	54.00
	Coarse	.50 - 1.0	2	9	11	11.00	51.00	4.00	30.00	18.00	72.00
	Very Coarse	1.0 - 2.0	2	3	5	5.00	56.00	4.00	34.00	6.00	78.00
GRAVEL	Very Fine	2.0 - 2.8	1	1	2	2.00	58.00	2.00	36.00	2.00	80.00
	Very Fine	2.8 - 4.0	1		1	1.00	59.00	2.00	38.00		80.00
	Fine	4.0 - 5.6	3	2	5	5.00	64.00	6.00	44.00	4.00	84.00
	Fine	5.6 - 8.0	1		1	1.00	65.00	2.00	46.00		84.00
	Medium	8.0 - 11.0	2	1	3	3.00	68.00	4.00	50.00	2.00	86.00
	Medium	11.0 - 16.0	4	2	6	6.00	74.00	8.00	58.00	4.00	90.00
	Coarse	16 - 22.6	8	1	9	9.00	83.00	16.00	74.00	2.00	92.00
	Coarse	22.6 - 32	8	2	10	10.00	93.00	16.00	90.00	4.00	96.00
	Very Coarse	32 - 45	3	2	5	5.00	98.00	6.00	96.00	4.00	100.00
	Very Coarse	45 - 64	1		1	1.00	99.00	2.00	98.00		100.00
COBBLE	Small	64 - 90	1		1	1.00	100.00	2.00	100.00		100.00
	Small	90 - 128					100.00		100.00		100.00
	Large	128 - 180					100.00		100.00		100.00
	Large	180 - 256					100.00		100.00		100.00
BOULDER	Small	256 - 362					100.00		100.00		100.00
	Small	362 - 512					100.00		100.00		100.00
	Medium	512 - 1024					100.00		100.00		100.00
	Large-Very Large	1024 - 2048					100.00		100.00		100.00
BEDROCK	Bedrock	> 2048					100.00		100.00		100.00
			50	50	100			100	100	100	100

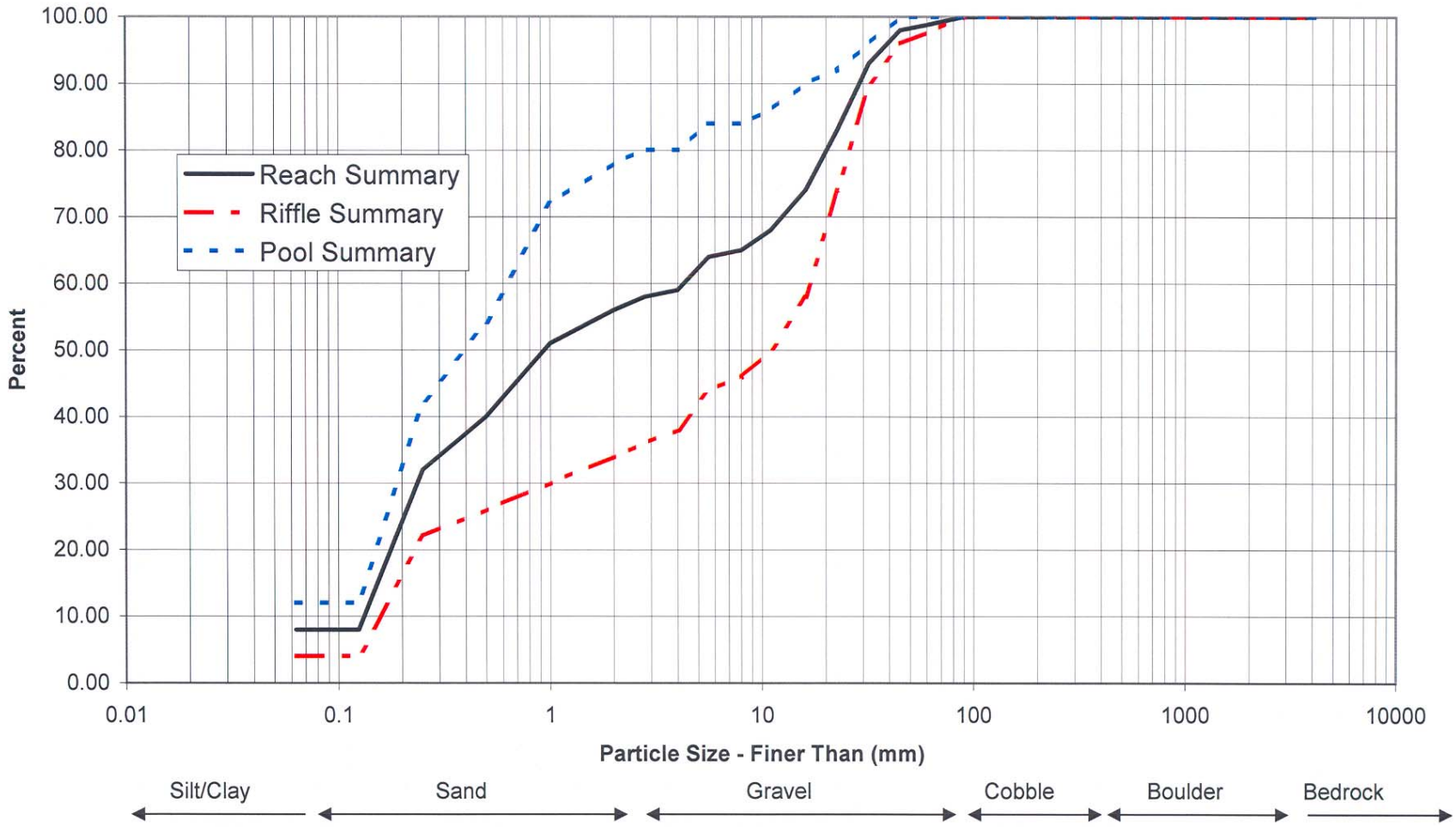
Cumulative	
Channel materials	
D_{16} =	0.16
D_{35} =	0.32
D_{50} =	0.94
D_{84} =	23.40
D_{95} =	36.68
D_{100} =	64 - 90

Riffle	
Channel materials	
D_{16} =	0.20
D_{35} =	2.37
D_{50} =	11.00
D_{84} =	28.09
D_{95} =	42.51
D_{100} =	64 - 90

Pool	
Channel materials	
D_{16} =	0.14
D_{35} =	0.21
D_{50} =	0.40
D_{84} =	8.00
D_{95} =	29.34
D_{100} =	32 - 45

Sediment Distribution by Feature

Silas Creek Year 1 Monitoring - Reach 1



PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	Year 1 Monitoring Silas Creek	
REACH/LOCATION:	Reach 2	
DATE COLLECTED:	25-Oct-04	
FIELD COLLECTION BY:	JBP/IJE	
DATA ENTERED BY:	KJM	

SEDIMENT ANALYSIS DATA SHEET

			PARTICLE CLASS			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	1	9	10	10.00	10.00	2.00	2.00	18.00	18.00
SAND	Very Fine	.063 - .125					10.00		2.00		18.00
	Fine	.125 - .25	9	3	12	12.00	22.00	18.00	20.00	6.00	24.00
	Medium	.25 - .50	3	11	14	14.00	36.00	6.00	26.00	22.00	46.00
	Coarse	.50 - 1.0	2	2	4	4.00	40.00	4.00	30.00	4.00	50.00
	Very Coarse	1.0 - 2.0		4	4	4.00	44.00		30.00	8.00	58.00
GRAVEL	Very Fine	2.0 - 2.8	1	1	2	2.00	46.00	2.00	32.00	2.00	60.00
	Very Fine	2.8 - 4.0					46.00		32.00		60.00
	Fine	4.0 - 5.6	1	3	4	4.00	50.00	2.00	34.00	6.00	66.00
	Fine	5.6 - 8.0					50.00		34.00		66.00
	Medium	8.0 - 11.0	2	3	5	5.00	55.00	4.00	38.00	6.00	72.00
	Medium	11.0 - 16.0	2	2	4	4.00	59.00	4.00	42.00	4.00	76.00
	Coarse	16 - 22.6	4	3	7	7.00	66.00	8.00	50.00	6.00	82.00
	Coarse	22.6 - 32	3	1	4	4.00	70.00	6.00	56.00	2.00	84.00
	Very Coarse	32 - 45	1	1	2	2.00	72.00	2.00	58.00	2.00	86.00
	Very Coarse	45 - 64	4	2	6	6.00	78.00	8.00	66.00	4.00	90.00
COBBLE	Small	64 - 90	2		2	2.00	80.00	4.00	70.00		90.00
	Small	90 - 128	3	1	4	4.00	84.00	6.00	76.00	2.00	92.00
	Large	128 - 180	5	1	6	6.00	90.00	10.00	86.00	2.00	94.00
	Large	180 - 256	3		3	3.00	93.00	6.00	92.00		94.00
BOULDER	Small	256 - 362	4	3	7	7.00	100.00	8.00	100.00	6.00	100.00
	Small	362 - 512					100.00		100.00		100.00
	Medium	512 - 1024					100.00		100.00		100.00
	Large-Very Large	1024 - 2048					100.00		100.00		100.00
BEDROCK	Bedrock	> 2048					100.00		100.00		100.00
			50	50	100			100	100	100	100

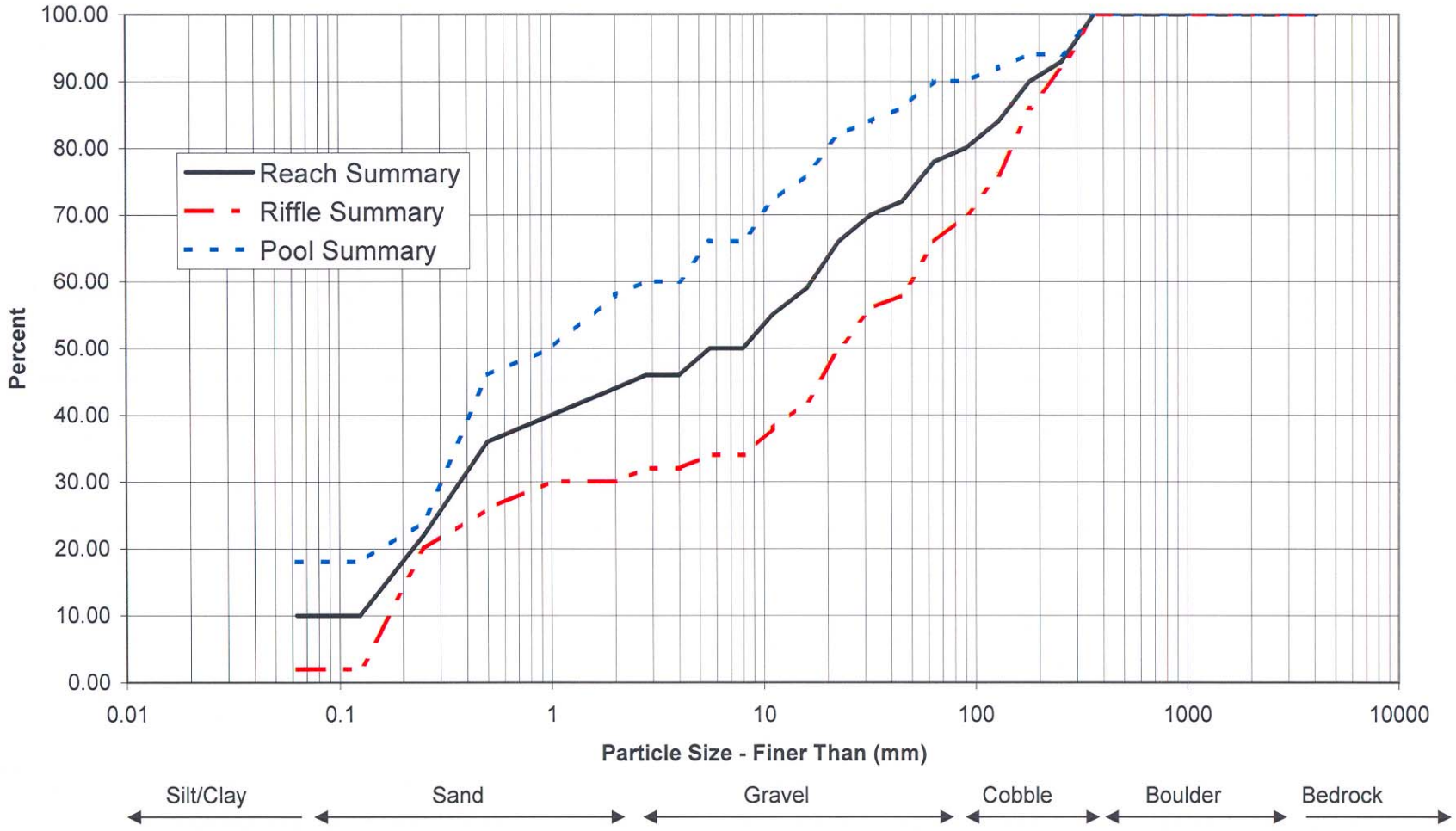
Cumulative	
Channel materials	
D_{16} =	0.18
D_{35} =	0.48
D_{50} =	8.00
D_{84} =	128.00
D_{95} =	282.64
D_{100} =	256 - 362

Riffle	
Channel materials	
D_{16} =	0.21
D_{35} =	8.66
D_{50} =	22.60
D_{84} =	168.14
D_{95} =	291.52
D_{100} =	256 - 362

Pool	
Channel materials	
D_{16} =	#N/A
D_{35} =	0.35
D_{50} =	1.00
D_{84} =	32.00
D_{95} =	271.22
D_{100} =	256 - 362

Sediment Distribution by Feature

Year 1 Monitoring Silas Creek - Reach 2



PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	Year 1 Monitoring Silas Creek	
REACH/LOCATION:	Reach 3	
DATE COLLECTED:	25-Oct-04	
FIELD COLLECTION BY:	JBP/IJE	
DATA ENTERED BY:	KJM	

SEDIMENT ANALYSIS DATA SHEET

			PARTICLE CLASS			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	4	7	11	11.00	11.00	8.00	8.00	14.00	14.00
SAND	Very Fine	.063 - .125					11.00		8.00		14.00
	Fine	.125 - .25	4	6	10	10.00	21.00	8.00	16.00	12.00	26.00
	Medium	.25 - .50	9	12	21	21.00	42.00	18.00	34.00	24.00	50.00
	Coarse	.50 - 1.0	4	10	14	14.00	56.00	8.00	42.00	20.00	70.00
	Very Coarse	1.0 - 2.0	2	5	7	7.00	63.00	4.00	46.00	10.00	80.00
GRAVEL	Very Fine	2.0 - 2.8	1	1	2	2.00	65.00	2.00	48.00	2.00	82.00
	Very Fine	2.8 - 4.0					65.00		48.00		82.00
	Fine	4.0 - 5.6	1		1	1.00	66.00	2.00	50.00		82.00
	Fine	5.6 - 8.0	2	2	4	4.00	70.00	4.00	54.00	4.00	86.00
	Medium	8.0 - 11.0	3	1	4	4.00	74.00	6.00	60.00	2.00	88.00
	Medium	11.0 - 16.0	3	2	5	5.00	79.00	6.00	66.00	4.00	92.00
	Coarse	16 - 22.6	4	2	6	6.00	85.00	8.00	74.00	4.00	96.00
	Coarse	22.6 - 32	7	1	8	8.00	93.00	14.00	88.00	2.00	98.00
	Very Coarse	32 - 45					93.00		88.00		98.00
	Very Coarse	45 - 64	4		4	4.00	97.00	8.00	96.00		98.00
COBBLE	Small	64 - 90	1	1	2	2.00	99.00	2.00	98.00	2.00	100.00
	Small	90 - 128					99.00		98.00		100.00
	Large	128 - 180	1		1	1.00	100.00	2.00	100.00		100.00
	Large	180 - 256					100.00		100.00		100.00
BOULDER	Small	256 - 362					100.00		100.00		100.00
	Small	362 - 512					100.00		100.00		100.00
	Medium	512 - 1024					100.00		100.00		100.00
	Large-Very Large	1024 - 2048					100.00		100.00		100.00
BEDROCK	Bedrock	> 2048					100.00		100.00		100.00
			50	50	100			100	100	100	100

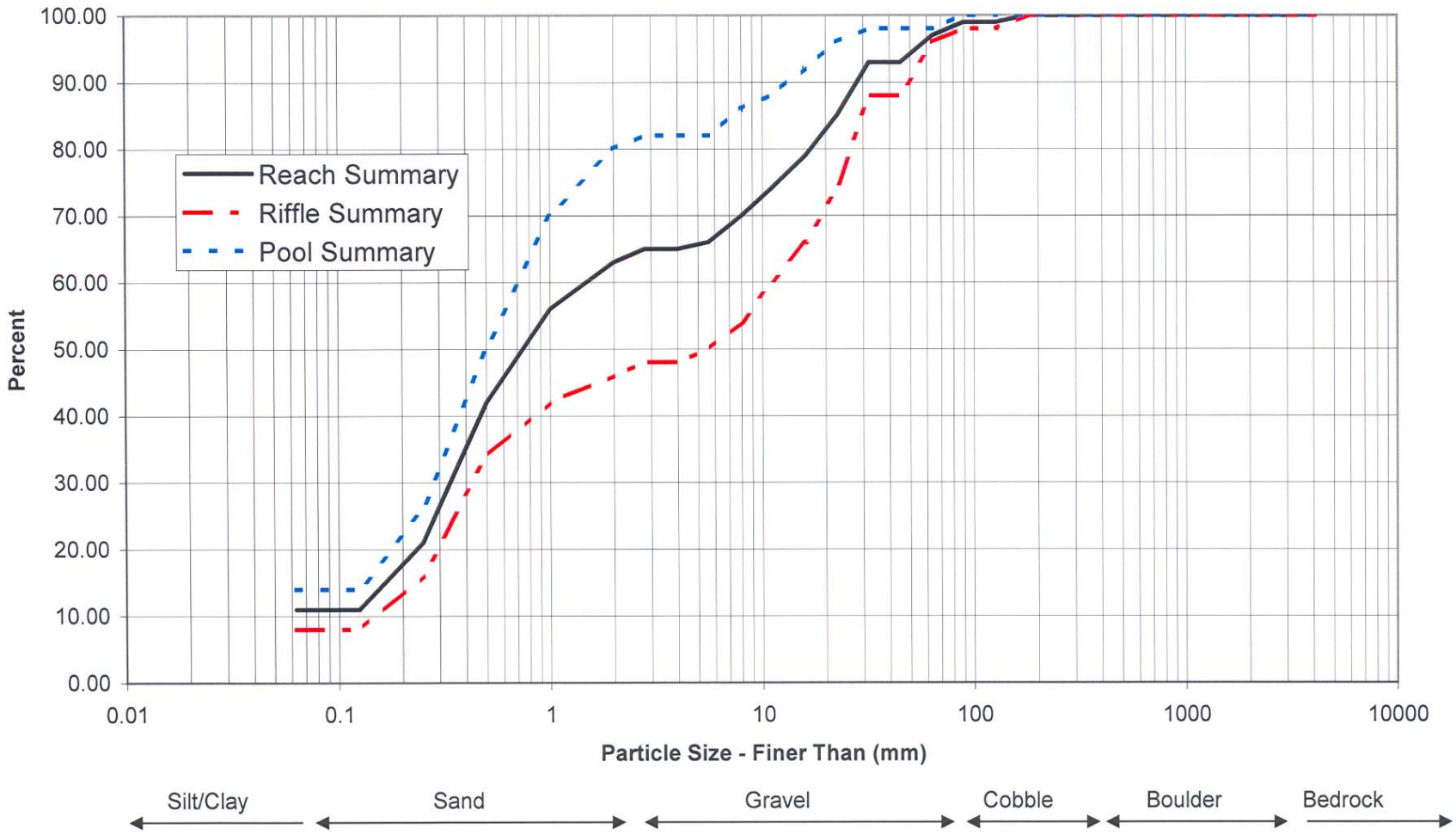
Cumulative	
Channel materials	
D_{16} =	0.18
D_{35} =	0.40
D_{50} =	0.74
D_{84} =	21.34
D_{95} =	53.67
D_{100} =	128 - 180

Riffle	
Channel materials	
D_{16} =	0.25
D_{35} =	0.55
D_{50} =	5.60
D_{84} =	28.97
D_{95} =	61.24
D_{100} =	128 - 180

Pool	
Channel materials	
D_{16} =	0.14
D_{35} =	0.32
D_{50} =	0.50
D_{84} =	6.69
D_{95} =	20.73
D_{100} =	64 - 90

Sediment Distribution by Feature

Year 1 Monitoring Silas Creek - Reach 3



PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	Year 1 Monitoring
REACH/LOCATION:	Buena Vista Branch
DATE COLLECTED:	25-Oct-04
FIELD COLLECTION BY:	JBP/IJE
DATA ENTERED BY:	KJM

SEDIMENT ANALYSIS DATA SHEET

			PARTICLE CLASS			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	4	6	10	10.00	10.00	8.00	8.00	12.00	12.00
SAND	Very Fine	.063 - .125		4	4	4.00	14.00		8.00	8.00	20.00
	Fine	.125 - .25	6	9	15	15.00	29.00	12.00	20.00	18.00	38.00
	Medium	.25 - .50	10	10	20	20.00	49.00	20.00	40.00	20.00	58.00
	Coarse	.50 - 1.0	12	10	22	22.00	71.00	24.00	64.00	20.00	78.00
	Very Coarse	1.0 - 2.0	3	1	4	4.00	75.00	6.00	70.00	2.00	80.00
GRAVEL	Very Fine	2.0 - 2.8					75.00		70.00		80.00
	Very Fine	2.8 - 4.0					75.00		70.00		80.00
	Fine	4.0 - 5.6	2	3	5	5.00	80.00	4.00	74.00	6.00	86.00
	Fine	5.6 - 8.0	3	2	5	5.00	85.00	6.00	80.00	4.00	90.00
	Medium	8.0 - 11.0	1	1	2	2.00	87.00	2.00	82.00	2.00	92.00
	Medium	11.0 - 16.0	3	1	4	4.00	91.00	6.00	88.00	2.00	94.00
	Coarse	16 - 22.6					91.00		88.00		94.00
	Coarse	22.6 - 32					91.00		88.00		94.00
	Very Coarse	32 - 45	3		3	3.00	94.00	6.00	94.00		94.00
	Very Coarse	45 - 64	1		1	1.00	95.00	2.00	96.00		94.00
COBBLE	Small	64 - 90	1	1	2	2.00	97.00	2.00	98.00	2.00	96.00
	Small	90 - 128	1	1	2	2.00	99.00	2.00	100.00	2.00	98.00
	Large	128 - 180					99.00		100.00		98.00
	Large	180 - 256		1	1	1.00	100.00		100.00	2.00	100.00
BOULDER	Small	256 - 362					100.00		100.00		100.00
	Small	362 - 512					100.00		100.00		100.00
	Medium	512 - 1024					100.00		100.00		100.00
	Large-Very Large	1024 - 2048					100.00		100.00		100.00
BEDROCK	Bedrock	> 2048					100.00		100.00		100.00
			50	50	100			100	100	100	100

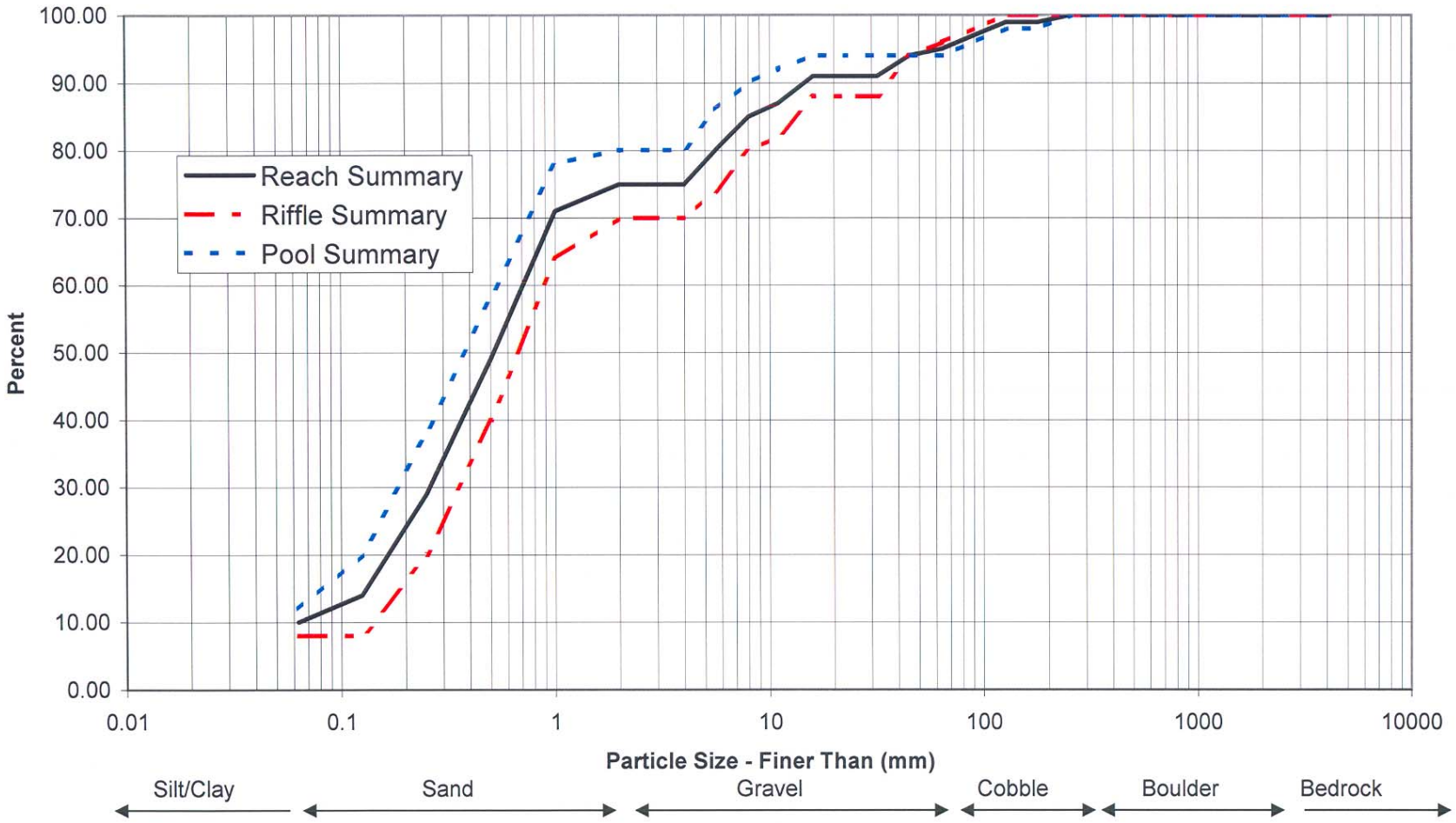
Cumulative	
Channel materials	
D_{16} =	0.14
D_{35} =	0.31
D_{50} =	0.52
D_{84} =	7.45
D_{95} =	64.00
D_{100} =	180 - 256

Riffle	
Channel materials	
D_{16} =	0.20
D_{35} =	0.42
D_{50} =	0.67
D_{84} =	12.46
D_{95} =	53.67
D_{100} =	90 - 128

Pool	
Channel materials	
D_{16} =	0.09
D_{35} =	0.22
D_{50} =	0.38
D_{84} =	5.01
D_{95} =	75.89
D_{100} =	180 - 256

Sediment Distribution by Feature

Year 1 Monitoring - Buena Vista Branch



Silas Creek
Photo Log

Silas Creek

Reach 1 – Photos 67-90 (Long 23-28, X1-X3)

Reach 2 – Photos 40-66, 91-96 (Long 14-22, X4-X6)

Reach 3 – Photos 1-39, 97-102 (Long 1-13, X7-X9)

Vegetation Plot 1- Photo 113

Buena Vista Branch

BVB – Photos 103-112 (BVB Long 1-6, BVB X1-X2)

Vegetation Plot BV- Photo 114

Notes:
1. Photo point locations are shown on the plan views in the actual location the picture was taken.
2. All points are marked with a wooden stake and orange flagging tape. For channel points, the stake is set up on the most accessible bank at that same station.
3. Photo locations include longitudinal photos, cross sections, and vegetation plots.

	
Photo 1-Long 1 (Downstream)	Photo 2-Long 1 (Across)
	
Photo 3-Long 1 (Upstream)	Photo 4-Long 2 (Downstream)
	
Photo 5-Long 2 (Across)	Photo 6-Long 2 (Upstream)

	
Photo 7-Long 3 (Downstream)	Photo 8-Long 3 (Across)
	
Photo 9-Long 3 (Upstream)	Photo 10-Long 4 (Downstream)
	
Photo 11-Long 4 (Across)	Photo 12-Long 4 (Upstream)

	
Photo 13-Long 5 (Downstream)	Photo 14-Long 5 (Across)
	
Photo 15-Long 5 (Upstream)	Photo 16-Long 6 (Downstream)
	
Photo 17-Long 6 (Across)	Photo 18-Long 6 (Upstream)

	
Photo 19-Long 7 (Across)	Photo 20-Long 7 (Upstream)
	
Photo 21-Long 7 (Across)	Photo 22-Long 8 (Upstream)
	
Photo 23-Long 8 (Across)	Photo 24-Long 8 (Upstream)

	
Photo 25-Long 9 (Downstream)	Photo 26-Long 9 (Across)
	
Photo 27-Long 9 (Upstream)	Photo 28-Long 10 (Downstream)
	
Photo 29-Long 10 (Across)	Photo 30-Long 10 (Upstream)

Photo 31-Long 11 (Downstream)

Photo 32-Long 11 (Across)

Photo 33-Long 11 (Upstream)

Photo 34-Long 12 (Downstream)

Photo 35-Long 12 (Across)

Photo 36-Long 12 (Upstream)

	
Photo 37-Long 13 (Downstream)	Photo 38-Long 13 (Across)
	
Photo 39-Long 13 (Upstream)	Photo 40-Long 14 (Downstream)
	
Photo 41-Long 14 (Across)	Photo 42-Long 14 (Upstream)

	
Photo 43-Long 15 (Downstream)	Photo 44-Long 15 (Across)
	
Photo 45-Long 15 (Upstream)	Photo 46-Long 16 (Downstream)
	
Photo 47-Long 16 (Across)	Photo 48-Long 16 (Upstream)

	
Photo 49-Long 17 (Downstream)	Photo 50-Long 17 (Across)
	
Photo 51-Long 17 (Upstream)	Photo 52-Long 18 (Downstream)
	
Photo 53-Long 18 (Across)	Photo 54-Long 18 (Upstream)

	
Photo 55-Long 19 (Downstream)	Photo 56-Long 19 (Across)
	
Photo 57-Long 19 (Upstream)	Photo 58-Long 20 (Downstream)
	
Photo 59-Long 20 (Across)	Photo 60-Long 20 (Upstream)

Photo 61-Long 21 (Downstream)

Photo 62-Long 21 (Across)

Photo 63-Long 21 (Upstream)

Photo 64-Long 22 (Downstream)

Photo 65-Long 22 (Across)

Photo 66-Long 22 (Upstream)

Photo 67-Long 23 (Downstream)

Photo 68-Long 23 (Across)

Photo 69-Long 23 (Upstream)

Photo 70-Long 24 (Downstream)

Photo 71-Long 24 (Across)

Photo 72-Long 24 (Upstream)

	
Photo 73-Long 25 (Downstream)	Photo 74-Long 25 (Across)
	
Photo 75-Long 25 (Upstream)	Photo 76-Long 26 (Downstream)
	
Photo 77-Long 26 (Across)	Photo 78-Long 26 (Upstream)

Photo 79-Long 27 (Downstream)

Photo 80-Long 27 (Across)

Photo 81-Long 27 (Upstream)

Photo 82-Long 28 (Downstream)

Photo 83-Long 28 (Across)

Photo 84-Long 28 (Upstream)

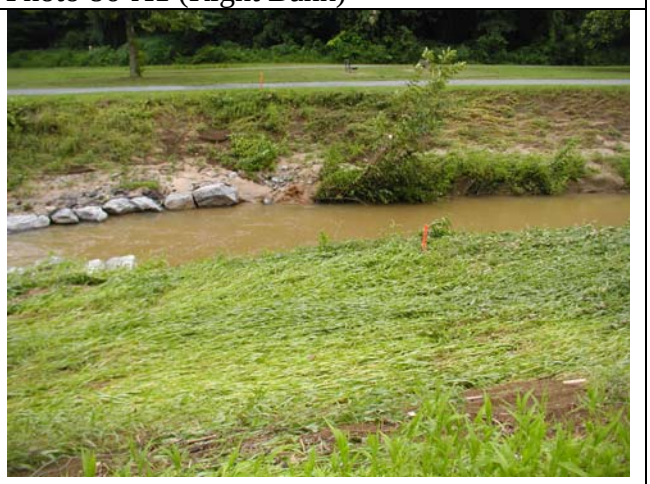
	
Photo 85-X1 (Left Bank)	Photo 86-X1 (Right Bank)
	
Photo 87-X2 (Left Bank)	Photo 88-X2 (Right Bank)
	
Photo 89-X3 (Left Bank)	Photo 90-X3 (Right Bank)

	
Photo 91-X4 (Left Bank)	Photo 92-X4 (Right Bank)
	
Photo 93-X5 (Left Bank)	Photo 94-X5 (Right Bank)
	
Photo 95-X6 (Left Bank)	Photo 96-X6 (Right Bank)

	
Photo 97-X7 (Left Bank)	Photo 98-X7 (Right Bank)
	
Photo 99-X8 (Left Bank)	Photo 100-X8 (Right Bank)
	
Photo 101-X9 (Left Bank)	Photo 102-X9 (Right Bank)

Photo 103-BVB Long 1

Photo 104- BVB Long 2

Photo 105- BVB Long 3

Photo 106- BVB Long 4

Photo 107- BVB Long 5

Photo 108- BVB Long 6

Photo 109- BVB X1 (Left Bank)

Photo 110- BVB X1 (Right Bank)

Photo 111- BVB X2 (Left Bank)

Photo 112- BVB X2 (Right Bank)

Photo 113- Vegetation Plot 1 (Silas Creek) looking downstream

Photo 114- Vegetation Plot BV (Buena Vista Branch) looking downstream

Silas Creek
Vegetation Survival Plots

Live Stakes

Plot	Photo Point (#)	Planted (stakes)	Year 1 (stakes)	Year 2 (stakes)	Year 3 (stakes)	Year (stakes)	Year 5 (stakes)
1		**71**	**61**				
BV		**45**	**38***				

*Plot includes a brush mattress installation making individual stems difficult to count.

Bare Root Plantings

Plot	Photo Point (#)	Planted (Total Stems)	Year 1 (stems)	Year 2 (stems)	Year 3 (stems)	Year 4 (stems)	Year 5 (stems)
1		**37**	**30**				
BV		**30**	**26**				

Bare Root Plantings By Species

Plot 1	**Planted (stems)**	**Year 1 (stems)**	**Year 2 (stems)**	**Year 3 (stems)**	**Year 4 (stems)**	**Year 5 (stems)**
Sycamore	3	3				
Ironwood	7	1				
Spicebush	3	0				
Willow Oak	4	0				
River Birch	5	3				
PawPaw	2	0				
Shagbark Hickory	6	0				
Southern Sugar Maple	3	0				
Red Chokeberry	4	0				
Plot BV						
Sycamore	5	4				
Ironwood	4	0				
Spicebush	2	0				
Willow Oak	2	0				
River Birch	3	0				
PawPaw	2	0				
Shagbark Hickory	3	0				
Southern Sugar Maple	4	0				
Red Chokeberry	5	0				

Notes:

1. All plots are shown on the plan views. All plot corners are marked with wooden stakes with orange flagging tape.
3. Photo point locations are shown on the plan views and marked with wooden stakes with orange flagging tape.
4. Use successive columns for survivability from year to year.