Fuller Mossbarger Scott & May

FMSM ENGINEERS

Alhambra Creek

Conceptual Stream Restoration Report

Martinez, California

Prepared for:
Alhambra Valley Creek Coalition
Martinez, California

August 7, 2006

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August 7, 2006

O.1.1.LV2006020R02

Ms. Carla Koop
Contra Costa Resource Conservation District
5552 Clayton Road
Concord, California 94521

Re: Alhambra Creek
Conceptual Stream Restoration Report
Martinez, California

Dear Ms. Koop:

We are pleased to submit the Conceptual Stream Restoration Report for Alhambra Creek located in Martinez, California. This report addresses stream restoration options at the conceptual level for a section of Alhambra Creek bound by Alhambra Avenue and the intersection of Alhambra Valley Road and Wanda Way. Please feel free to contact us if you have any questions or comments at 502-212-5000.

Sincerely,

FULLER, MOSSBARGER, SCOTT AND MAY
ENGINEERS, INC.

Sarah L. Taylor, EIT
Project Engineer

Michael F. Adams, PE
Project Manager

/cab

Enclosures

cc:

Mike Vukman, Urban Creeks Council
Matthew Sorrenti
Jim & Yvonne Nierhake
Igor Skaredoff
Mitch Avalon
Bill Green
Peter & Marianne Allen
Matt Parkinen & Kim Haramaki
Ronald Dalton
Marie Denn, National Park Service
Jamie Menasco

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Alhambra Creek
Conceptual Stream Restoration Report
Martinez, California

1. Introduction

1.1. Overview of the Alhambra Creek Watershed Plan

The Alhambra Creek Watershed Plan (ACWP) was prepared by the Alhambra Creek Watershed Planning Group (ACWPG) in April of 2001 to describe the state of the watershed and to develop a strategy for promoting a healthy watershed. Alhambra Creek Watershed is located in north central Contra Costa County and partly within the City of Martinez. It is a functioning watershed with pockets of degredating stream habitat such as undercut and steep banks, poor vegetation, poor riparian cover, and degraded fish and wildlife habitat. Figure 1 contains a vicinity map.

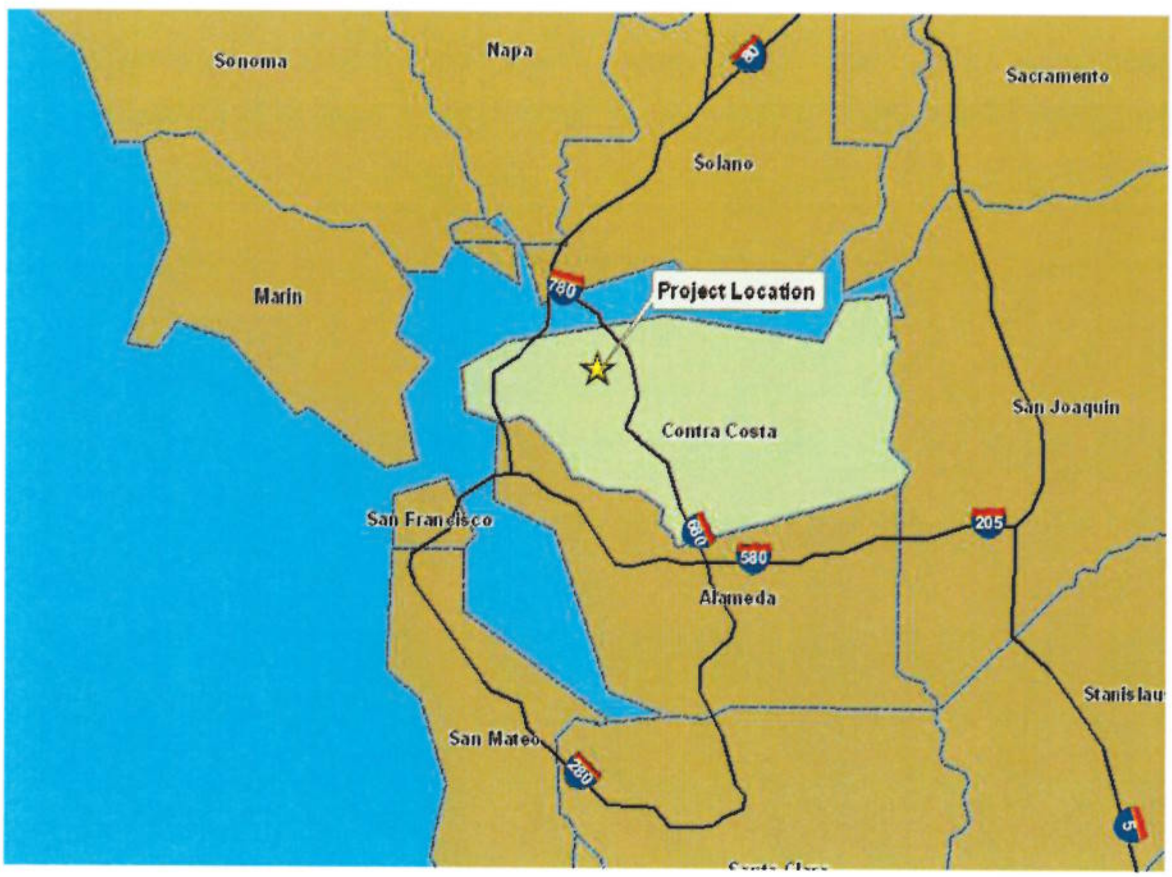

Figure 1. Project Location

The ACWP focuses on the history and usage of Alhambra Creek Watershed. Based on the reported conditions and other factors, nine goals were recommended with action items identified to implement and support each goal. In an effort to avoid restrictions and regulatory requirements on property rights, implementation of the plan is voluntary.

1.1.1. History of Watershed Planning Group

The ACWPG began in April of 1997 with approximately 30 members composed of residents, property owners, and those who recreate within the watershed. That year the Alhambra Creek Watershed experienced an unseasonable wet winter and El Niño floods. The community gathered to discuss a watershed management plan for the watershed and from that meeting the ACWPG was formed. The group focused on producing a "watershed plan with goals that focus on protecting and improving this magnificent natural resource, while ensuring public health, safety and quality of life."[1]

1.1.2. Primary Watershed Concerns

During the planning process the ACWPG developed a collection of issues and consortium of information regarding the watershed. Concerns of the group focused on the nine goals listed below.

- Reduce Flood Damage and Conserve Stormwater
- Prevent Excessive Erosion and Conserve Soil Resources
- Protect and Improve Water Quality
- Reduce Wildland Fire Damage
- Encourage Coordination of City and County General and Specific Plans with Each Other Using the Watershed as a Planning Unit
- Support Economically and Environmentally Sustainable Land Uses While Protecting Private Property Rights
- Promote a Sense of Watershed Community
- Maintain and Restore Fish and Wildlife Habitat and Native Plant Communities consistent with Environmentally and Economically Sustainable Land Use
- Maintain and Enhance the Quality of Life by Providing Increased Opportunities to Appreciate and enjoy Watershed Resources

1.1.3. Project Objectives

The objective of this project is to address the second goal, erosion and soil conservation, of the Watershed Plan through a conceptual level stream restoration design. For the purposes of this report, conceptual refers to a general layout of the proposed restoration alternatives. The conceptual design will incorporate natural channel design (NCD) and soil bioengineering

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[1] Alhambra Creek Watershed Planning Group. 2001. Alhambra Creek Watershed Management Plan A Users Manual, First Edition.

techniques to compute basic channel properties. The final design will consist of specific treatments throughout the project area, which will be determined after a series of meetings with stakeholders and individual property owners who live along the creek where treatments are necessary.

1.2. Site Description

1.2.1. Study Limits

The proposed restoration site is an approximately one mile reach which begins at the intersection of Wanda Way and Alhambra Valley Road and extends downstream to Alhambra Avenue. Figure 2 contains a map of the site.

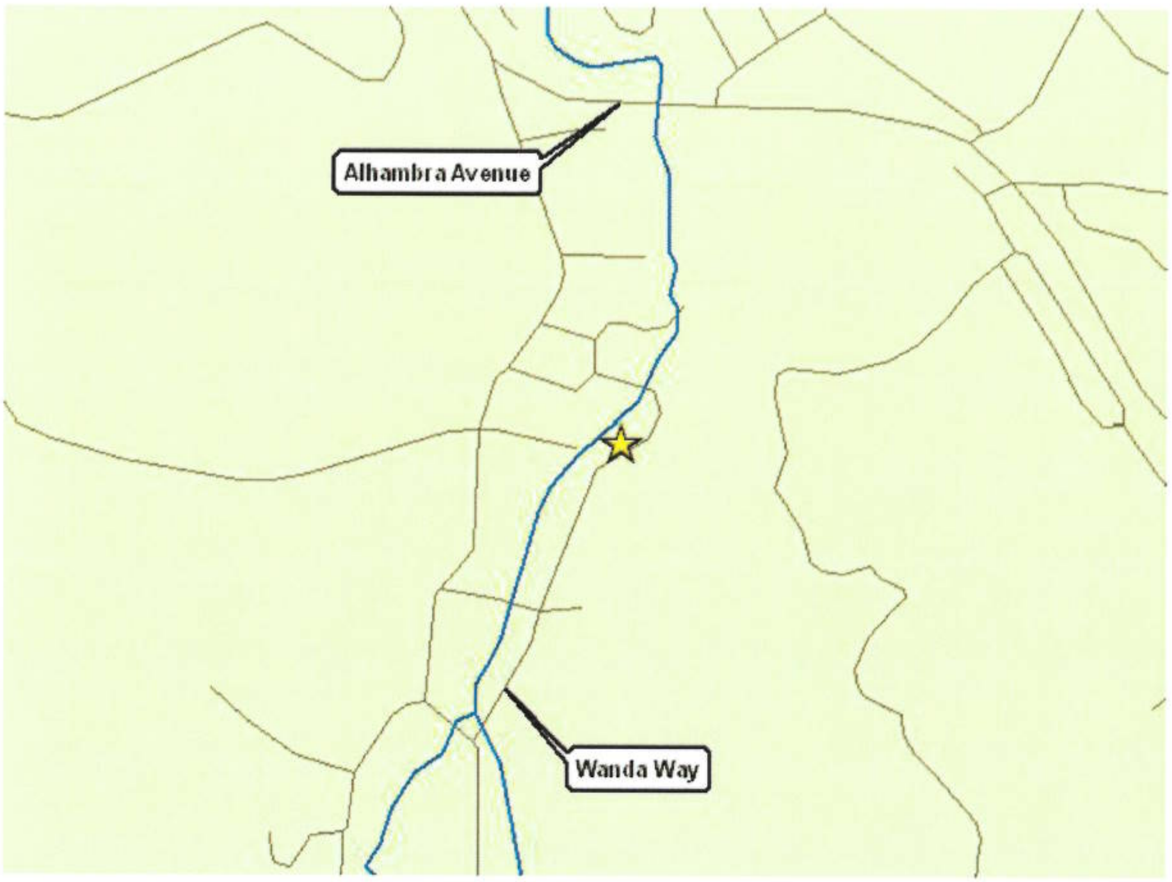


Figure 2. Site Map

1.2.2. Watershed Characteristics

The Alhambra Creek Watershed is approximately 16.5 square miles. At the project site the drainage area is approximately 11 square miles. Climate in the region is Mediterranean with average annual precipitation ranging from 18 to 22 inches and 90% of that rain occurring during winter months. The watershed contains a vast array of land. Upper watershed uses consist of recreation, farming, and pockets of residential living with wooded and grassy hills and valleys. In the lower watershed, commercial and residential areas are present. Rock formations such as the Briones formation, Martinez formation, and the Hambre formation are found within the watershed. Shales and sandstones have shaped the valleys and hills. The physiographic region in the project area is part of the Pacific Border Province of the Pacific Mountain System.

The City was formed in 1849 as over a hundred acres were staked and subdivided within the Alhambra Creek floodplain during the Gold Rush. The City of Martinez later became a shipping hub for agricultural products. In addition to farming, fishing was important industry. Large runs of salmon were recorded to travel through the Sacramento/San Joaquin River System and it is likely that Alhambra Creek supported salmon and steelhead during that time.

Fish barriers along the creek exist at several locations. Small check-dams are located along Alhambra Creek and its principal tributaries. While these dams help some stream habitat they may cause barriers to migrating fish population such as salmon.

Septic systems along the creek have raised concerns for several years. Many of these tanks were built closer to the stream than current ordinances allow and have drains which outlet in the creek. A December 26, 1997 letter in response to the Alhambra Valley Sewage System Survey confirms concerns, but does not find that they pose an imminent health hazard.

1.3. Characteristics of Alhambra Creek

During a field reconnaissance in April, 2006, Alhambra Creek was found to be highly entrenched and incised; meaning the ratio of floodplain width to bankfill width is low. Bankfill width refers to the width of the channel at its channel forming, sometimes referred to as dominant discharge. Low entrenchment ratios generally indicate the potential for unstable banks. In addition, the channel, while meandering, is confined.

Significant anthropogenic effects to the stream include bank armoring with material such as gunnite, boulders, rip-rap, piles/lagging, and gabions; and loss of floodplain due to urban growth and channel incision. Bank armoring has confined the creek in places along both banks. In several locations the armor has been undercut by the stream and the material has fallen into the channel.

2. Relevant Concepts in Stream Morphology

2.1. Function of Stream Habitat

Streams perform several functions including physical, chemical and biological processes. In general, however, third order streams such as Alhambra Creek are populated with organisms adapted to process materials from outside the system (allochthonous), as the shading typically present reduces the potential for algal growth. It is the combination of these and other processes that introduce many of the nutrients into the system in the form of leaf litter and the processes by which these materials are consumed by organisms in this particular niche.

2.2. The Rosgen Classification System

A description of the Rosgen Classification System is warranted prior to discussing the streams surveyed for this project. The Rosgen Classification system is a categorization tool developed to separate streams of similar characteristics based on their geomorphic shape/function and sediment supply. The classification system was first published by David L. Rosgen, PhD. in Catena 1994 and was further described in his book Applied River Morphology in 1998. A stream is categorized by a two-character description consisting of a letter A-G followed by a number. The letter represents a Level I geomorphic characterization of the stream channel and is derived from measurements taken at a riffle cross section; the number is a morphological description of channel materials. Two measured quantities are utilized for the determination of the geomorphic characterization of the stream channel: the aforementioned entrenchment ratio (ER) and the width to depth ratio. The entrenchment Ratio is the ratio of the floodprone width divided by the bankfull width. Floodprone width is defined as the width of the floodplain at an elevation of twice the maximum channel depth above the channel bottom. Figure 3 illustrates entrenchment by stream type.

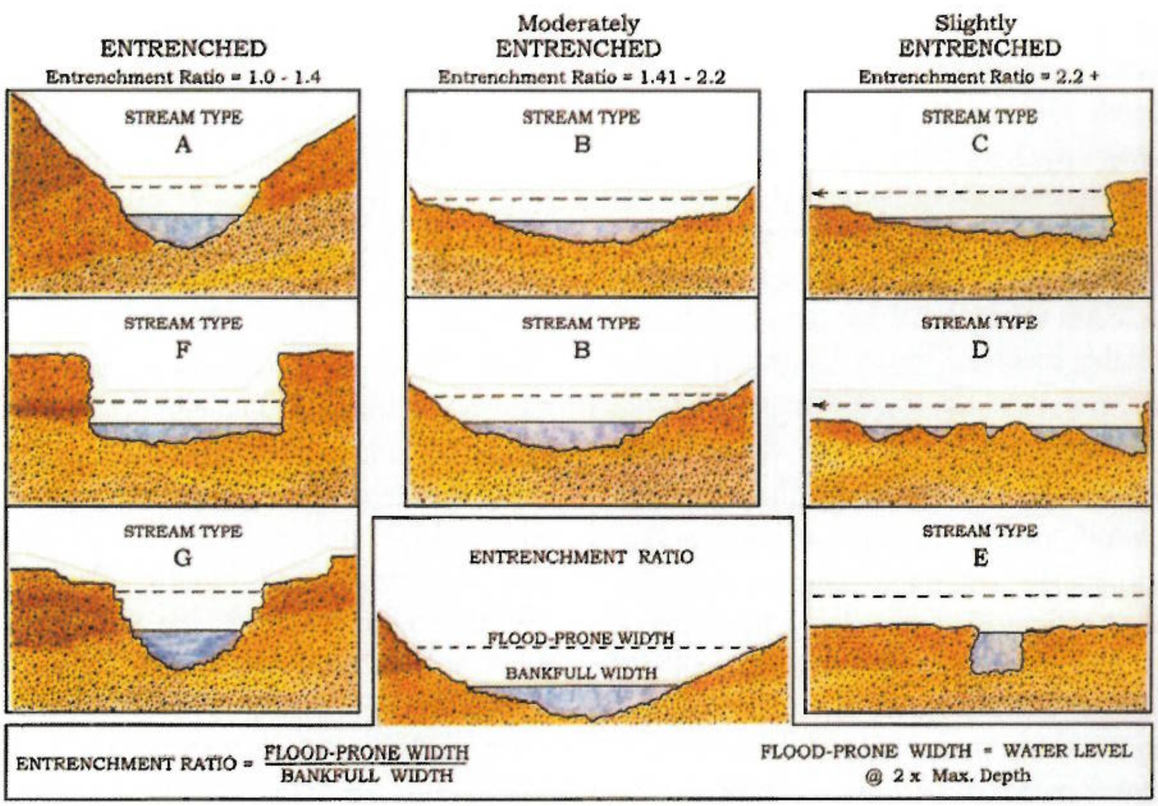


Figure 3. Entrenchment by Stream Type (Rosgen, 1996)

2.3. Stream Evolution Model

The stream evolution model is used to show the succession of stream changes associated with bank erosion, increased sediment supply, degradation/aggradation, and flow changes as the stream reaches equilibrium. This model can be used to predict future stream type.

There are several evolution scenarios as developed by Simon (1986) and Rosgen (1996). Channel evaluation can be a very destructive process as a channel forms a floodplain.

Two of these scenarios are applicable to the project site. The first is the C→Gc→F→C scenario shown in Figure 5. In this scenario, a stable C stream becomes unstable due to a change in climate and/or hydrology/land use. Prior to the 1800s when this area was first settled on a significant scale by non-indigenous people, Alhambra Creek was likely a C-type stream with a floodplain. Changes in land use likely caused the channel to incise into the valley bottom to its present Gc condition. The tendency for a channel in this state is to widen into an F channel before creating a floodplain and re-forming inside the F as a C-type channel. A C-type channel is thus known as the "potential" stream condition of Alhambra Creek.

The process of evolving from an F-channel to a C-channel is destructive as banks are eroded. Evidence of this has been documented throughout the project area and can be seen in Figure 4. Thus, it is reasonable to predict that Alhambra Creek will continue to attempt to develop a floodplain. The consequence of this will be continued bank erosion and loss of property along the stream corridor if nothing is done.

Figure 4. High Bank Erosion

The second succession scenario, shown in Figure 5, is the C→Gc→F→B evolutionary sequence. This sequence progresses much like the scenario above except the floodplain is widened to a lesser degree. This is generally accompanied by an increase in the size of the channel bottom materials. B-type channels, by nature, have higher shear stress and greater roughness than C-type channels. The significance of this evolutionary sequence is discussed in the conceptual design section of this report.

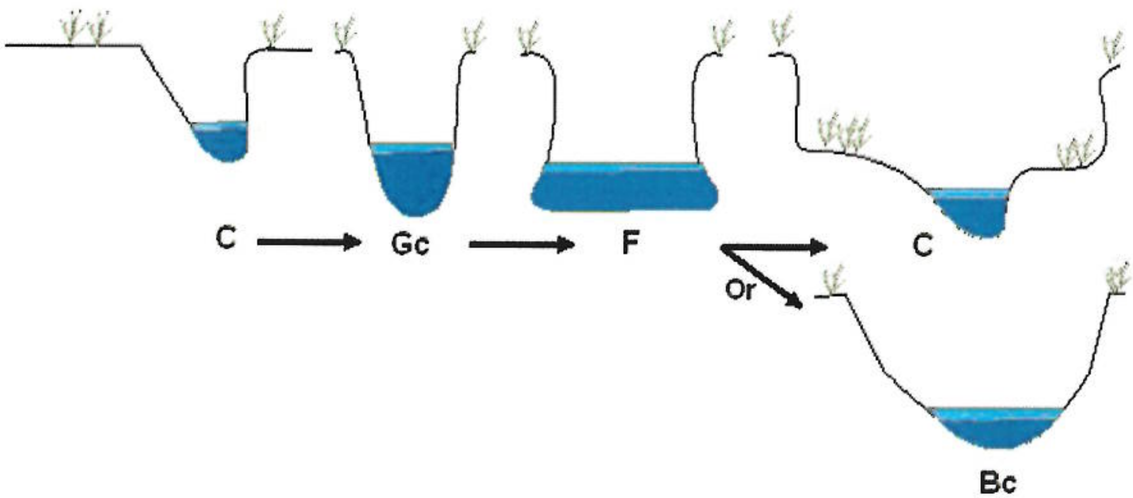


Figure 5. Stream Type Succession Scenarios

3. Fieldwork

3.1. Description of Fieldwork Performed

A field reconnaissance was performed in April, 2006 to document the condition of the stream and gather basic geomorphic data to be used in the conceptual design phase. Geomorphic cross sections were surveyed and a longitudinal profile was surveyed at Alhambra Avenue. A USGS gage in the watershed was also surveyed. In addition to observing Alhambra Creek, a reference reach was also located to be used in the NCD design phase. Members from FMSM Engineers and Urban Creeks Council were present.

3.2. Alhambra Creek Results

The walk indicated that the overall stream condition was poor. The channel is entrenched and incised throughout the reach with limited floodplain access. In addition, both banks of the creek have been constricted with the installation of concrete and other materials used to protect the banks from erosion. The material placed along the banks has been undercut in several places, fallen into the channel, and is redirecting flow causing new areas of unstable banks. Plots of surveyed cross sections are included in Appendix A Land Profile.

The fieldwork included a site visit to a USGS stream gage located on D Street in Martinez, California. The purpose of visiting the gage was to determine the return period for bankfull discharge. Bankfull indicators were located upstream and then projected through the gage longitudinally along the stream profile. A depth of 2.94 feet was estimated as the gage depth at bankfull. This translates to a bankfull discharge of 93cfs. Based on a linear interpolation of peak discharge data available for 1964 to 1982, the bankfull discharge equates to a return interval of approximately 1.2 years for bankfull discharge. This is a common interval for urban systems like Alhambra Creek. Appendix B contains a discharge-return interval plot for the gage.

3.3. Reference Reach

Donner Creek, a reference reach located in Contra Costa County near Mount Diablo, was surveyed as a reference reach. A reference reach is utilized as a blueprint for design for a stream in a similar valley and sediment setting. Geometric characteristics of the reference reach are converted into dimensionless ratios by dividing dimensions by the bankfull width and depth, as appropriate. Thus, a reference reach does not need to be the same size as the designed stream, it need only be transporting similar sediment and lay in the same valley type. Both conditions hold for to Alhambra Creek and Donner Creek. Reference Reach data and dimensionless ratios are included in Appendix C.

4. Conceptual Design

A conceptual design was developed to address the erosion issues identified during the field reconnaissance. This conceptual design is discussed below.

4.1. Constraints and Limitations

The intent of the conceptual design phase is to present multiple options to address the erosion along Alhambra Creek. The project team did not want to eliminate any reasonable alternatives at this point; however, some limitations and constraints had to be acknowledged. First, reconstructing Alhambra Creek in a new location with adequate floodplain access was not feasible. This would require the destruction of dozens of homes. The second limitation is that 100-year flood elevations could not be increased by the project. This constraint is not directly addressed in this design but the alternatives presented herein contain a provision whereby final dimensions and elevations would be determined such that flooding would not be exacerbated.

4.2. Objectives and Overview

The objectives of the conceptual design options are to reduce bank erosion. A consequence of a reduction in erosion is improved water quality and habitat. The channel evolutionary sequence described above is an integral component of the formation of the conceptual designs. As stated above, the potential for Alhambra Creek in its present point in the evolutionary sequence is likely a C-stream type. In urban stream restoration where the creation of a C-type channel is not feasible due to the limitations associated with construction of a floodplain, a B-type channel can be the target stream type of the restoration project. B channels are moderately entrenched, have a higher width-to-depth ratio than G channels, and are riffle dominated with occasional to infrequent pools. They are stable provided they are constructed with the appropriate bed materials. Also, constructing the B-channel would bypass the F-channel stage, which is a highly destructive phase of the succession sequence.

The alternatives described below have the objective of creating a B-type channel. Many of the alternatives include raising the channel bed approximately 3 feet. The purpose of this is to reduce the amount of bank excavation. It should be noted that the channel bed can only be increased in the upper part of the project limits and that any capacity lost for conveyance of floods would need to be replaced in the upper part of the channel cross sections. Hydraulic structure such as cross vanes and j-hooks would be incorporated into the design. Modeling of the flood flows would be required before finalizing the cross sectional shape of not just the raised-bed scenarios, but all 8 scenarios presented below.

4.3. Options

A total of nine different cross-sectional geometry configurations were considered for conceptual design. The following is an explanation of each option and benefits. Typical cross-sectional views are provided in Appendix D and plan views are shown in Appendix E. Figures for land loss are based on a typical cross section with a bank height of 17 to 18 feet above bankfull, or approximately 20 feet above the low flow water surface.

Option 1 consists of reshaping the bank at a slope of 2:1 beginning at bankfull. The new banks would be vegetated with native grasses, shrubs and trees. This option provides stable banks and floodplain access through increased cross-sectional geometry and would be the cheapest to construct; however may be limited by the available land on either bank. The loss of land on one side of the channel is approximately 34 feet.

Option 2 requires approximately 3 feet of fill in the existing thalwag to raise the stream bed upon which the bank will be reshaped at a slope of 2:1. The linear feet of land required to provide the additional floodplain access will be moderately less due to the raised channel geometry. The loss of land on one side of the channel is approximately 28 feet.

Option 3 requires three feet of fill upon which five foot vertical walls would be constructed on each bank. Slopes of 2:1 will be graded from the top of wall to existing ground. This option provides a benefit similar to Option 1 with less land required than Option 2 to provide floodplain access. The loss of land on one side of the channel is approximately 18 feet. This option could only be applicable with an entrenchment ratio close to 1.4 since it only provides minimal increase to the floodplain width.

Option 4 consists of installing vertical walls approximately 5 feet from the edge of bankfull with side slopes of 2:1 from the top of wall to existing ground. This option provides additional floodplain access and bank stability. The loss of land on one side of the channel is approximately 30 feet.

Option 5 requires installing vertical walls approximately 10 feet from the edge of bankfull rising upward to an elevation consistent with the existing ground. This option provides floodplain access with limited stream width required. The loss of land on one side of the channel is approximately 10 feet.

Option 6 consist of raising the channel three feet and installing vertical walls approximately 5 feet from the edge of bankfull with a height of 5 feet and side slopes of 2:1. This option is similar to Option 3, in its applicability. The loss of land on one side of the channel is approximately 23 feet.

<u>Option 7</u> requires the installation of vertical walls at bankfull. This option requires the least amount of cut and fill. The loss of land on one side of the channel is approximately 3 feet.

<u>Option 8</u> consists of installing vertical walls 10 feet outside the channel and upgrading the channel 3 feet. This option provides the most in-channel storage with minimal required stream width. The loss of land on one side of the channel is approximately 10 feet.

<u>Option 9</u> consists of soil bio-engineered slopes in place of pile and lagging in the above scenarios. The slopes would be reconstructed up to a 5V:1H slope and would be offset by a 10 foot bankfull bench. The loss of land on one side of the channel is approximately 14 feet. A rock cutoff layer would be required behind the layers of earth.

4.4. Geotechnical Considerations

A geotechnical exploration should accompany a project that includes retaining walls adjacent to a water course. The exploration provides important information utilized in the design of the walls and slopes including soil type, strength, strata configuration and presence of rock. Generally, this information is acquired using a truck-mounted drill rig.

4.5. Potential Permitting Issues

U.S. Army Corps of Engineers and other permits will be required prior to any construction in the creek. The permits are generally submitted at the 60% design phase.

4.6. Opinion of Probable Cost

Appendix F contains an opinion of probable cost. The costs are broken down by treatment.

4.7. Additional Work Required for Design

The design will require a detailed topographic survey of the project site to provide base mapping for the design. This mapping will be important for selecting the best alternative for the properties. Hydraulic and Hydrologic modeling will also be necessary for the final design and will likely impact the required offsets for daylighting the tops of banks so that flood elevations are not increased.

5. Recommendations

Potentially, all nine options may be utilized in this project. Given the preference of utilizing native materials and potential permitting obstacles associated with a pile and lagging wall, even if vegetation could be established, the preferred option is number 9. Bank restoration utilizing native materials produces a greater aesthetic quality as well as increasing habitat and water quality. The reinforcing action of the root mass reduces erosion while providing wildlife with a place to live. The reduction in erosion improves in-stream habitat quality. In addition, water quality increases through the filtering action of the near-stream plants. This option also provides a small floodplain on each side of the channel.

Given the wide range of bank slopes and preferences of property owners, it is recognized that all nine options will likely have their place in the final plan. It is highly recommended, however, that Options 3 and 6 only be considered where the entrenchment ratio already exceeds 1.4, at a minimum, and preferably greater than 1.6. Also, the use of a vertical pile and lagging wall (Option 7) does not create a natural cross section but it should be acknowledged that in some parts of the stream there may be few other options. It is probable, however, that where a vertical wall would be required a soil bioengineered retaining wall would probably be acceptable as long as the appropriate entrenchment ratio could be maintained.

An additional consideration for final design will be the transition between adjacent treatments. It may be necessary to perform modeling to understand how the hydraulics will be affected by the transitions.

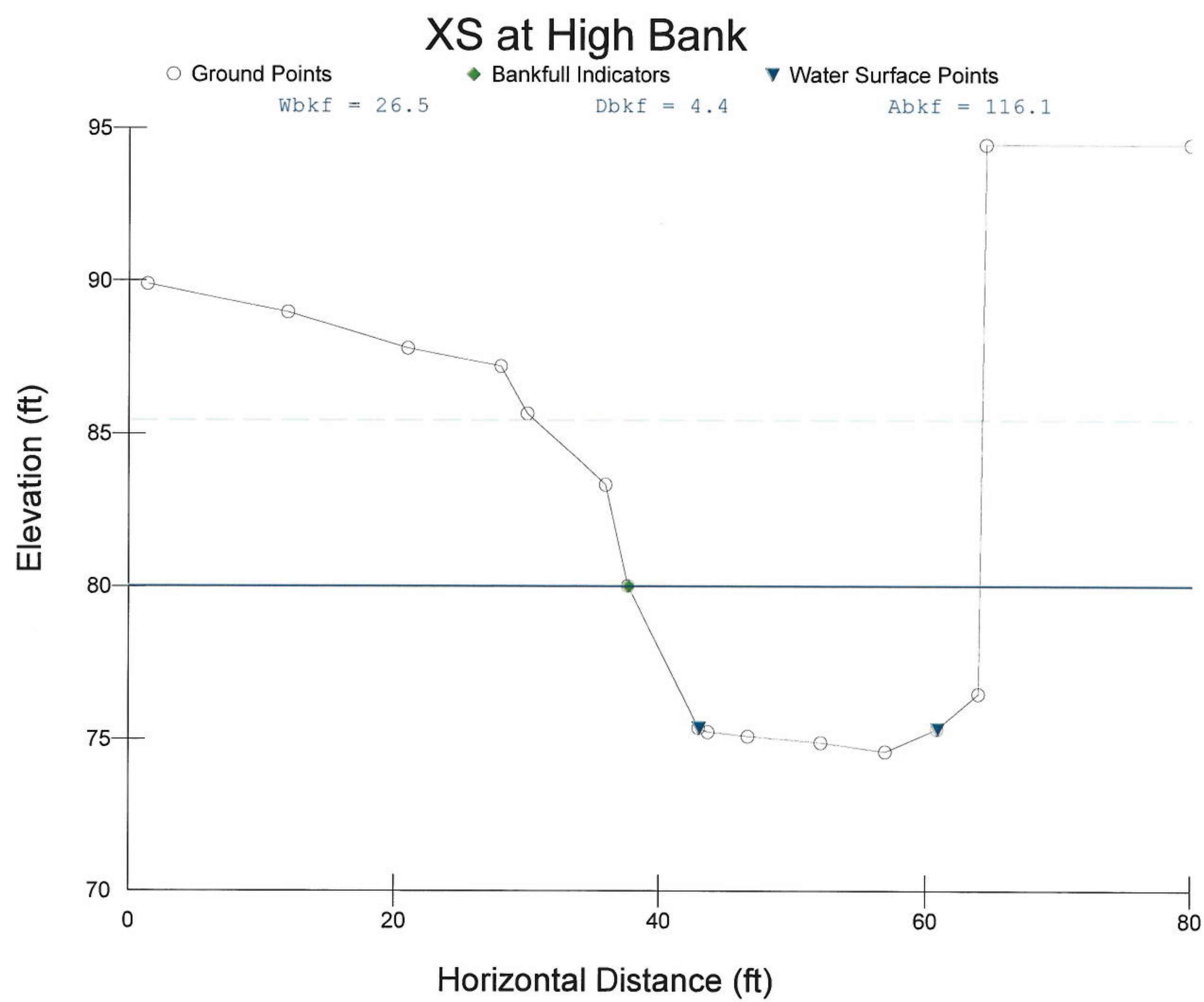
6. References

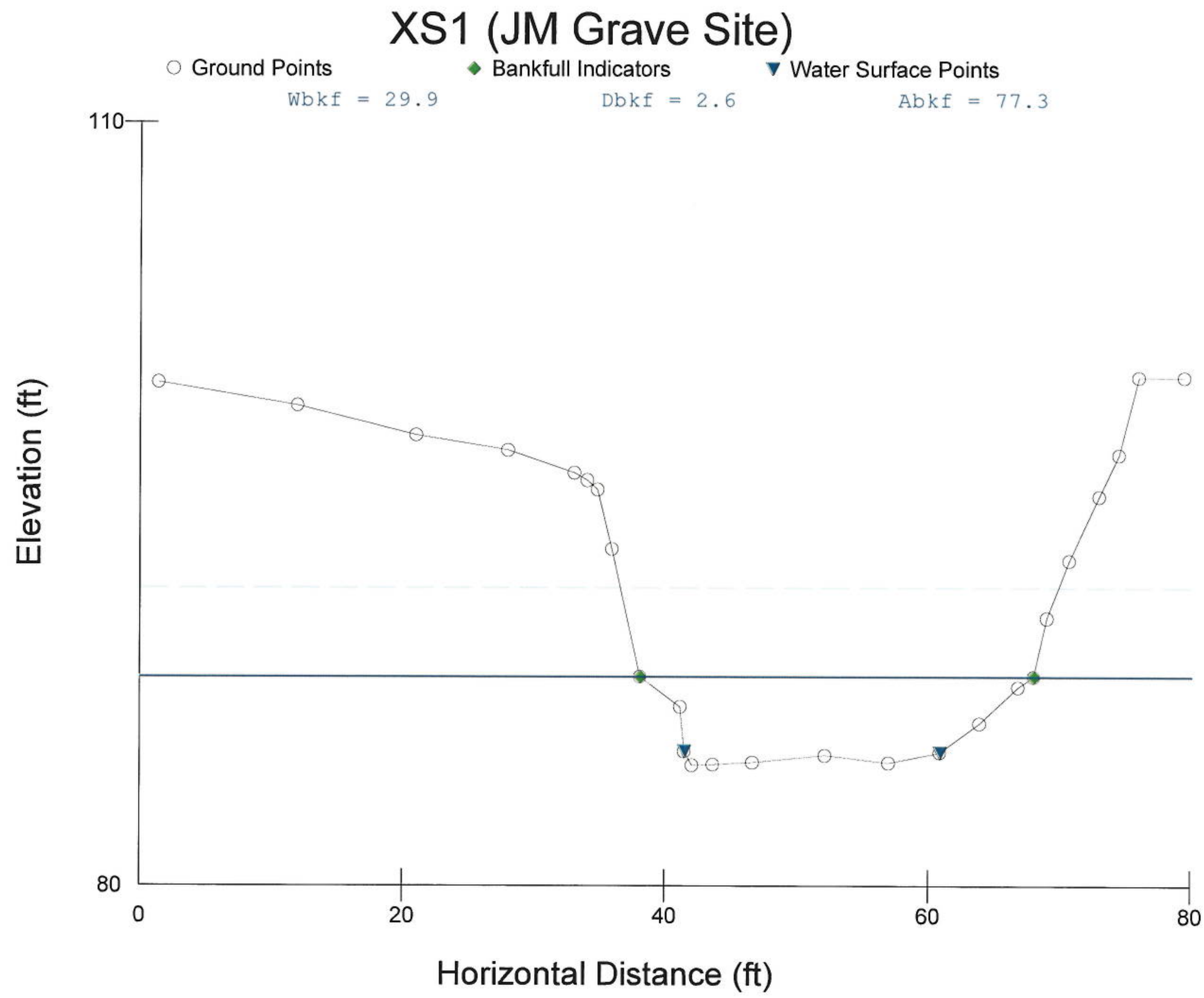
Alhambra Creek Watershed Planning Group. 2001. Alhambra Creek Watershed Management Plan A Users Manual, First Edition.

Rosgen, D.L. and H.L. Silvey. 1996.. Wildland Hydrology Books, Fort Collins, CO

Appendix A

Alhambra Creek Survey Data


XS at High Bank
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 26.5
Dbkf = 4.4
Abkf = 116.1
Elevation (ft)
95
90
85
80
75
70
0
20
40
60
80
Horizontal Distance (ft)

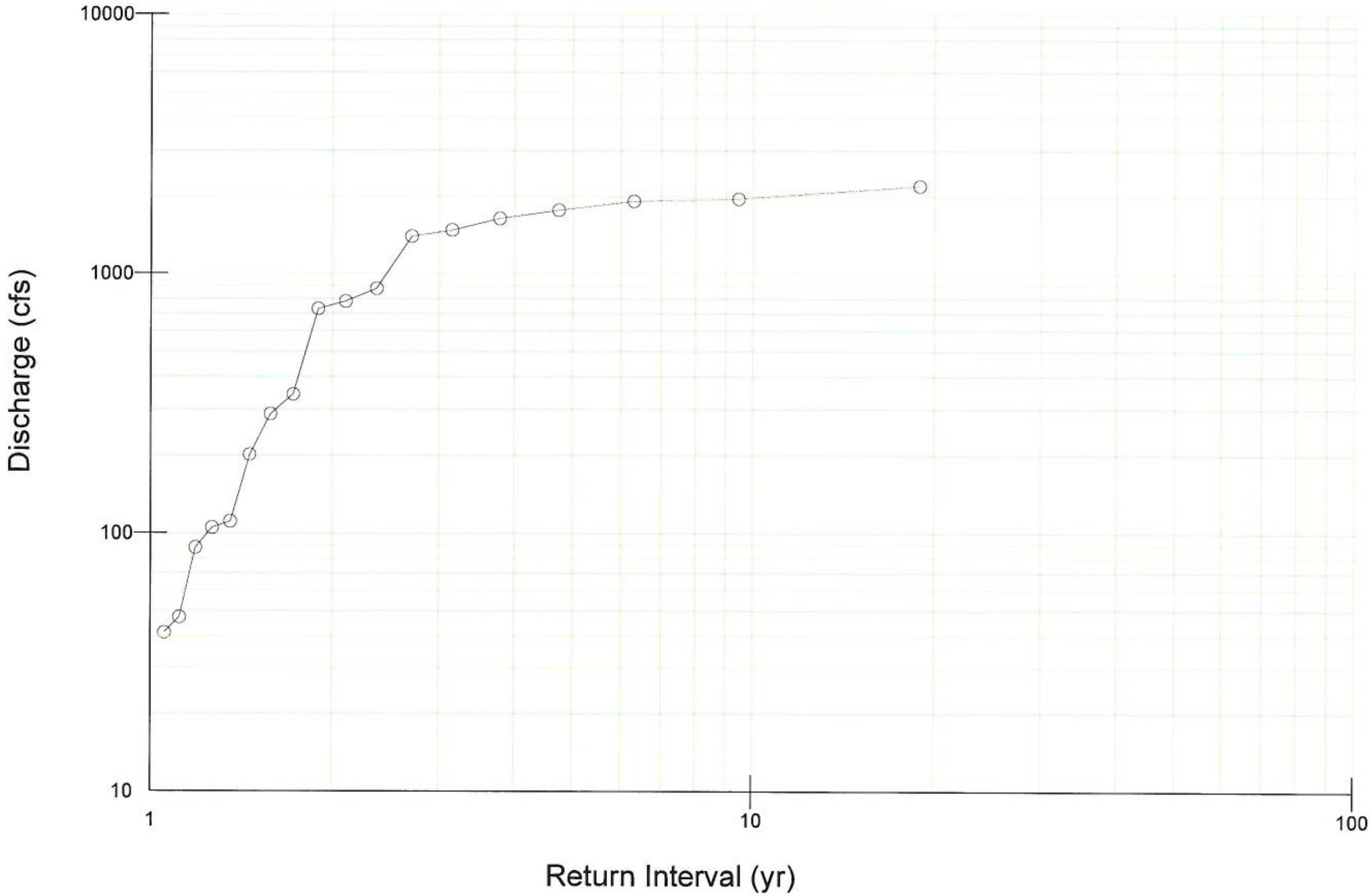


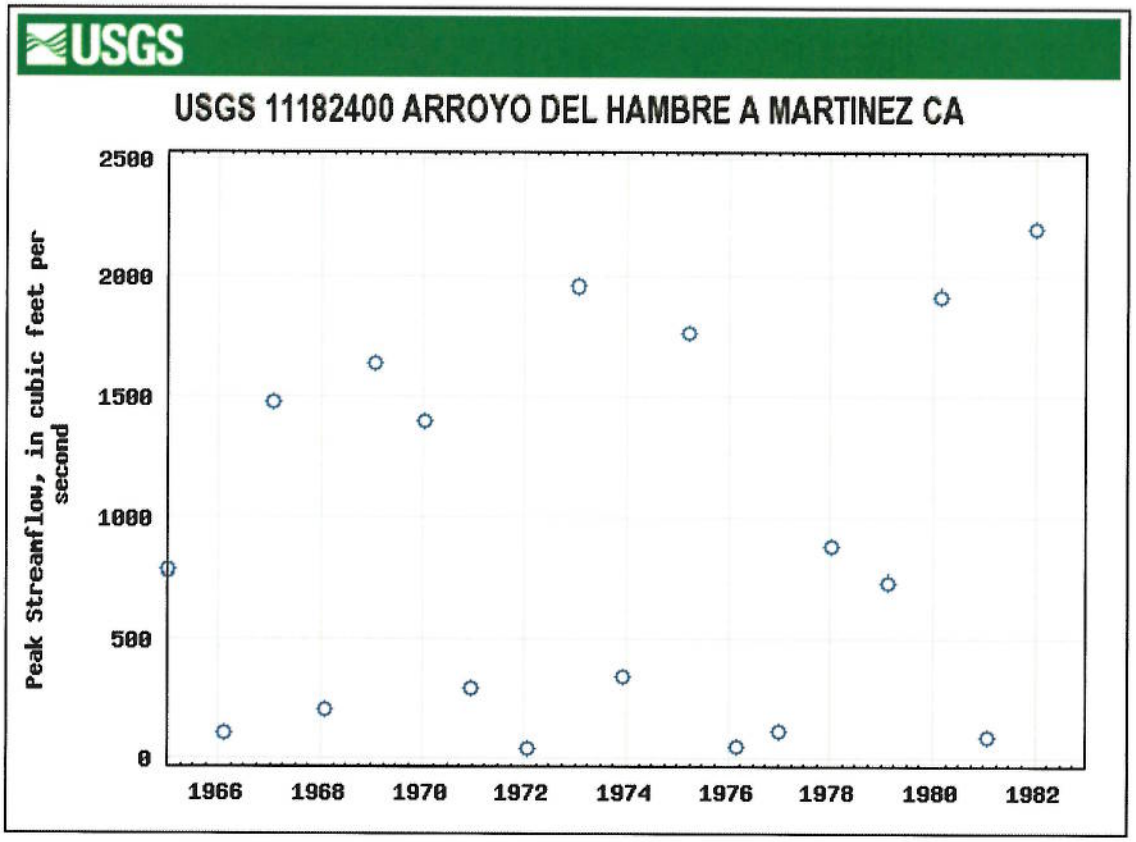
XS1 (JM Grave Site)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 29.9
Dbkf = 2.6
Abkf = 77.3
110
80
0
20
40
60
80
Elevation (ft)
Horizontal Distance (ft)

Appendix B

Gage Data

Alhambra at D Street




USGS
USGS 11182400 ARROYO DEL HAMBRE A MARTINEZ CA
Peak Streamflow, in cubic feet per second
2500
2000
1500
1000
500
0
1966
1968
1970
1972
1974
1976
1978
1980
1982

Appendix C

Reference Reach Data

Reference Reach Summary Data Form

... and Reference Reach Summary Data

Channel Dimension

Mean Riffle Depth (d_{bkf})	1.66	feet	Mean Riffle Width (W_{bkf})	12.93	feet	Mean Riffle Area (A_{bkf})	21.29	feet^2
Mean Pool Depth (d_{bkfp})	1.76	feet	Mean Pool Width (W_{bkfp})	15.79	feet	Mean Pool Area (A_{bkfp})	27.19	feet^2
Ratio Mean Pool Depth/Mean Riffle Depth	1.060	d_{bkfp}/ d_{bkf}	Ratio Pool Width/Riffle Width	1.221	W_{bkfp}/ W_{bkf}	Ratio Pool Area/ Riffle Area	1.277	A_{bkfp}/ A_{bkf}
Max Riffle Depth (d_{mrif})	1.72	feet	Max Pool Depth (d_{mpool})	2.31	feet	Max riffle depth/Mean riffle depth	1.036	
Max pool depth/Mean riffle depth	1.392					Point Bar Slope	0	
Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	8.52	ft/s				Estimation Method	Manning	
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	186.2	cfs				Drainage Area	0	mi^2

Channel Pattern

Geometry	Ave	Min	Max		Dimensionless Geometry Ratios	Ave	Min	Max
Meander Length (Lm)	90	70	100	feet	Meander Length Ratio (Lm/W_{bkf})	6.961	5.414	7.734
Radius of Curvature (Rc)	50	40	60	feet	Radius of Curvature/Riffle Width (Rc/W_{bkf})	3.867	3.094	4.640
Belt Width (W_{blt})	35	25	55	feet	Meander Width Ratio (W_{blt}/W_{bkf})	2.707	1.933	4.254
Individual Pool Length	16.1	8.89	25.11	feet	Pool Length/Riffle Width	1.245	0.688	1.942
Pool to Pool Spacing	35.23	11.77	44.47	feet	Pool to Pool Spacing/Riffle Width	2.725	0.910	3.439

Channel Profile

Valley Slope (VS)	0.0314	ft/ft	Average Water Surface Slope (S)	0.02871	ft/ft	Sinuosity (VS/S)	1.12
Stream Length (SL)	254	feet	Valley Length (VL)	227	feet	Sinuosity (SL/VL)	1.119

Low Bank Height (LBH)				Max Riffle Depth				Bank Height Ratio (LBH/Max Riffle Depth)		
	start	0	feet		start	1.72	feet		start	0
	end	0	feet		end	1.72	feet		end	0

Facet Slopes	Ave	Min	Max		Dimensionless Slope Ratios	Ave	Min	Max
Riffle Slope (S_{rif})	0.0952	0.0612	0.1341	ft/ft	Riffle Slope/Average Water Surface Slope (S_{rif}/S)	3.317	2.133	4.671
Run Slope (S_{run})	0.1175	0.0753	0.2205	ft/ft	Run Slope/Average Water Surface Slope (S_{run}/S)	4.092	2.623	7.681
Pool Slope (S_p)	0.0064	0.0045	0.0084	ft/ft	Pool Slope/Average Water Surface Slope (S_p/S)	0.224	0.156	0.292
Glide Slope (S_g)	0.0069	0.0042	0.0093	ft/ft	Glide Slope/Average Water Surface Slope (S_g/S)	0.241	0.147	0.323

Feature Midpoint [a]	Ave	Min	Max		Dimensionless Depth Ratios	Ave	Min	Max
Riffle Depth (d_{mrif})	1.720	1.270	2.020	feet	Riffle Max Depth/Riffle Mean Depth (d_{mrif}/d_{bkf})	1.036	0.765	1.217
Run Depth (d_{mrun})	1.790	1.430	2.080	feet	Run Max Depth/Riffle Mean Depth (d_{mrun}/d_{bkf})	1.078	0.861	1.253
Pool Depth (d_{mp})	2.310	1.800	2.560	feet	Pool Max Depth/Riffle Mean Depth (d_{mp}/d_{bkf})	1.392	1.084	1.542
Glide Depth (d_{mg})	1.620	1.350	1.860	feet	Glide Max Depth/Riffle Mean Depth (d_{mg}/d_{bkf})	0.976	0.813	1.120

Channel Materials

Catagories	Reach [b]	Riffle [c]	Bar	Indices	Reach [b]	Riffle [c]	Bar	
% Silt/Clay	0	0		D16	0	0		mm
% Sand	0	0		D35	0	0		mm
% Gravel	0	0		D50	26.05	32.72		mm
% Cobble	0	0		D84	54.19	77		mm
% Boulder	0	0		D95	0	0		mm
% Bedrock	0	0		D100	0	0		mm

a. The range of "feature" mid-point maximum bankfull depths, including the minimum, maximum and average values. (Pool depths are obtained from the deepest portion of the feature.)

b. A composite sample of materials from riffle and pool featutes taken within the designated reach.

c. Sample obtained within the "active" bed of a riffle feature at the location of the cross section.

Stream Classification Form

Stream Channel Classification (Level II) ...

Stream NAME: Donner Creek (Mt. Diablo State Park, Clayton, CA, Reach - Reach 1

Basin NAME: Donner Creek Drainage AREA: 0 acre 0 mi^2

Location: California

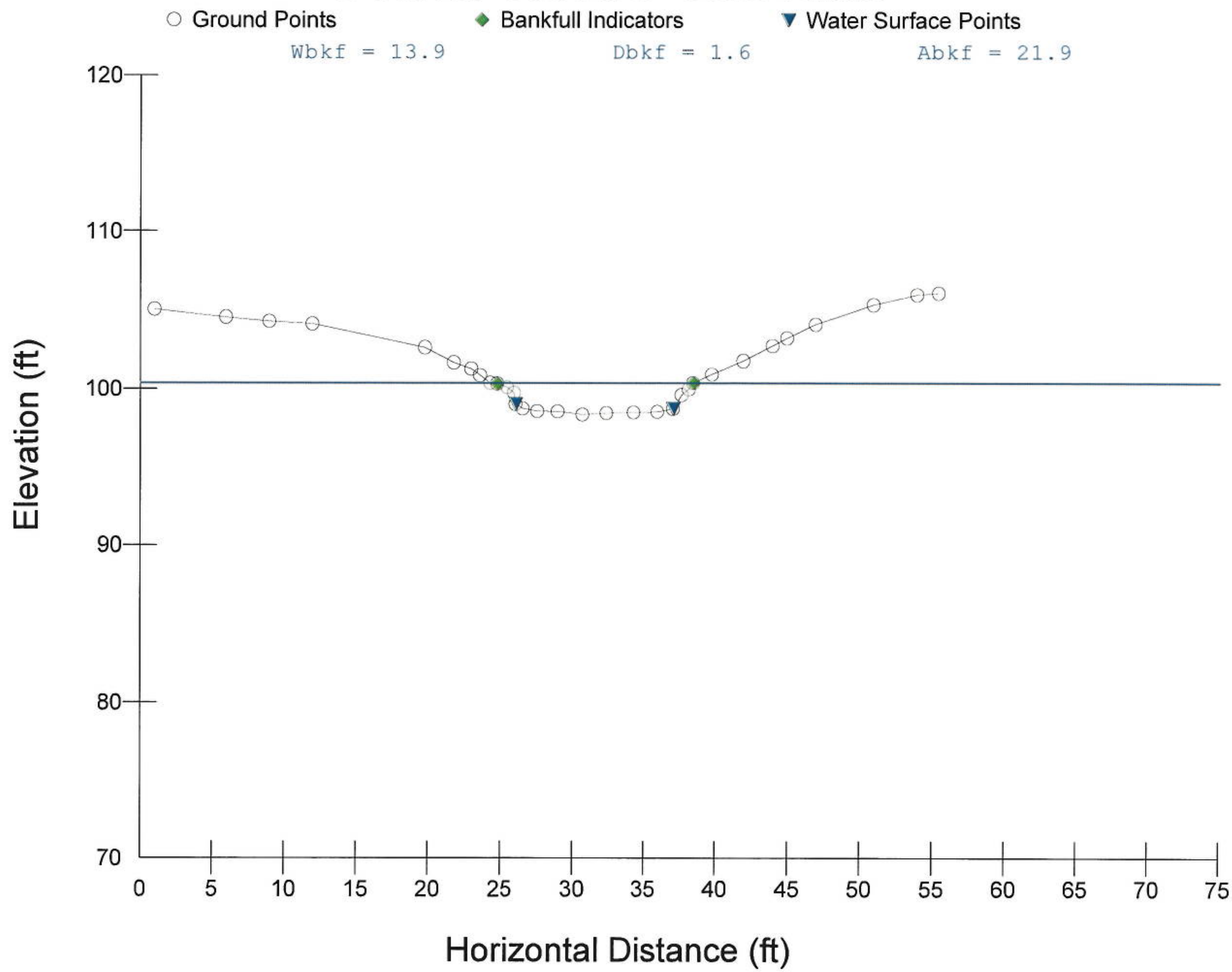
Twp: ____ Rge: ____ Sec: ____ Qtr: ____ Lat: 0 Long: 0

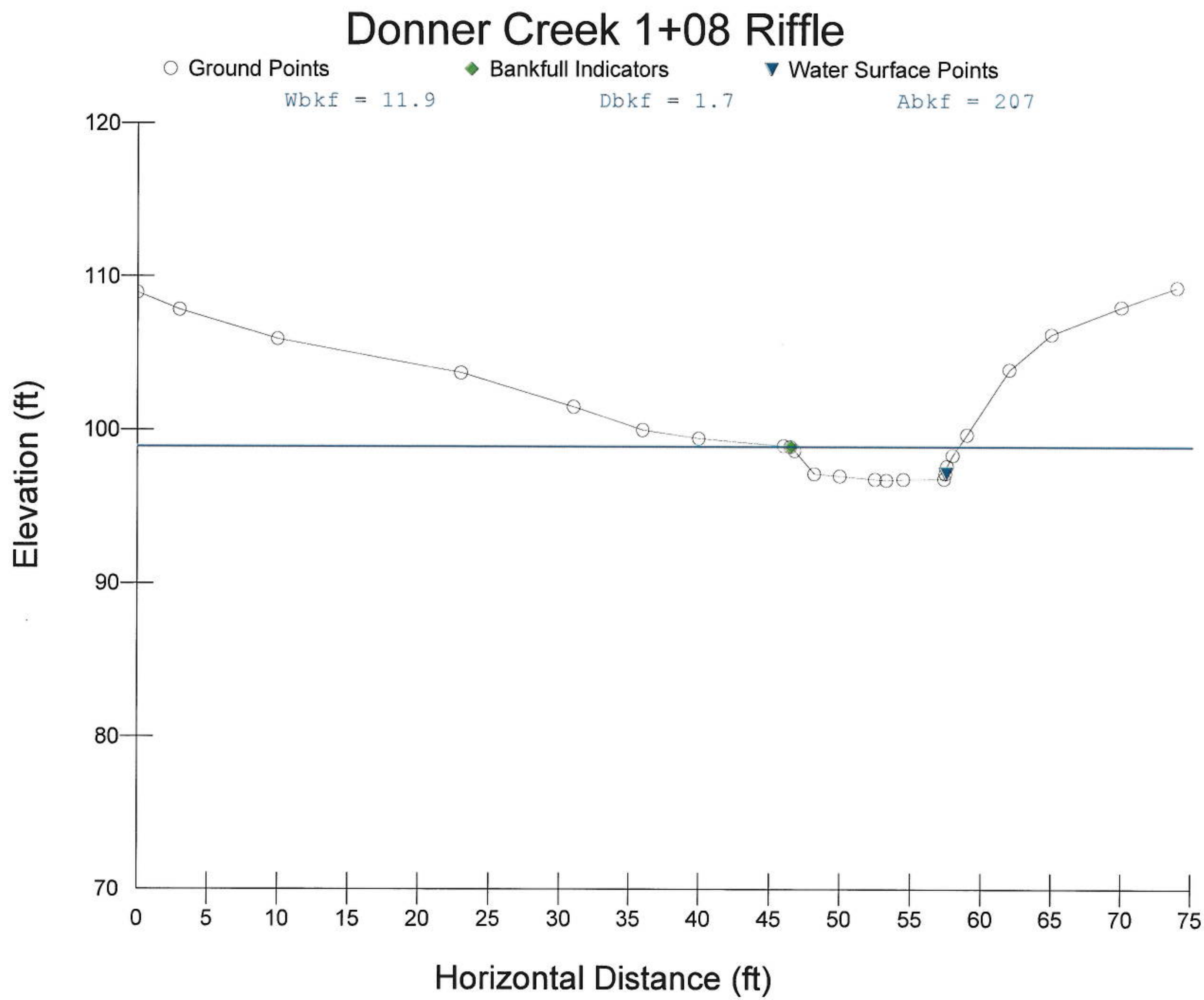
Observers: MA, NC, MV Date: 5/31/2006

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel, at bankfull stage elevation, in a riffle section.	12.93 Feet
Mean DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section. ($d_{bkf}=A_{bkf}/W_{bkf}$)	1.66 Feet
Bankfull Cross Section Area (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	21.29 $Feet^2$
WIDTH / DEPTH RATIO (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	7.79 Ft/Ft
Maximum DEPTH (d_{mrif}) Maximum depth of the bankfull channel cross-section, or elevation between the bankfull stage and thalweg in a riffle section.	1.72 Feet
Flood-Prone Area WIDTH (W_{fpa}) The stage/elevation at which flood-prone area WIDTH is determined in a riffle section at twice maximum DEPTH, or ($2 \times d_{mrif}$)	25.27 Feet
Entrenchment RATIO (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa}/W_{bkf}) in a riffle section.	1.95 Ft/Ft
Channel Materials (Particle Size Index) D50 The 50th percentile, or less than, from a pebble count frequency distribution of channel particles representing the median or dominant particle size.	26.05 mm
Water Surface SLOPE (S) Average water surface slope as measured between the same position of bed features in the profile over two meander wave lengths. This is similar to average bankfull slope.	0.02871 Ft/Ft
Channel SINUOSITY (K) Sinuosity: an index of channel pattern, determined from stream length / valley length, i.e. (SL/VL); or estimated from a ratio of valley slope divided by channel slope (VS/ S).	1.12

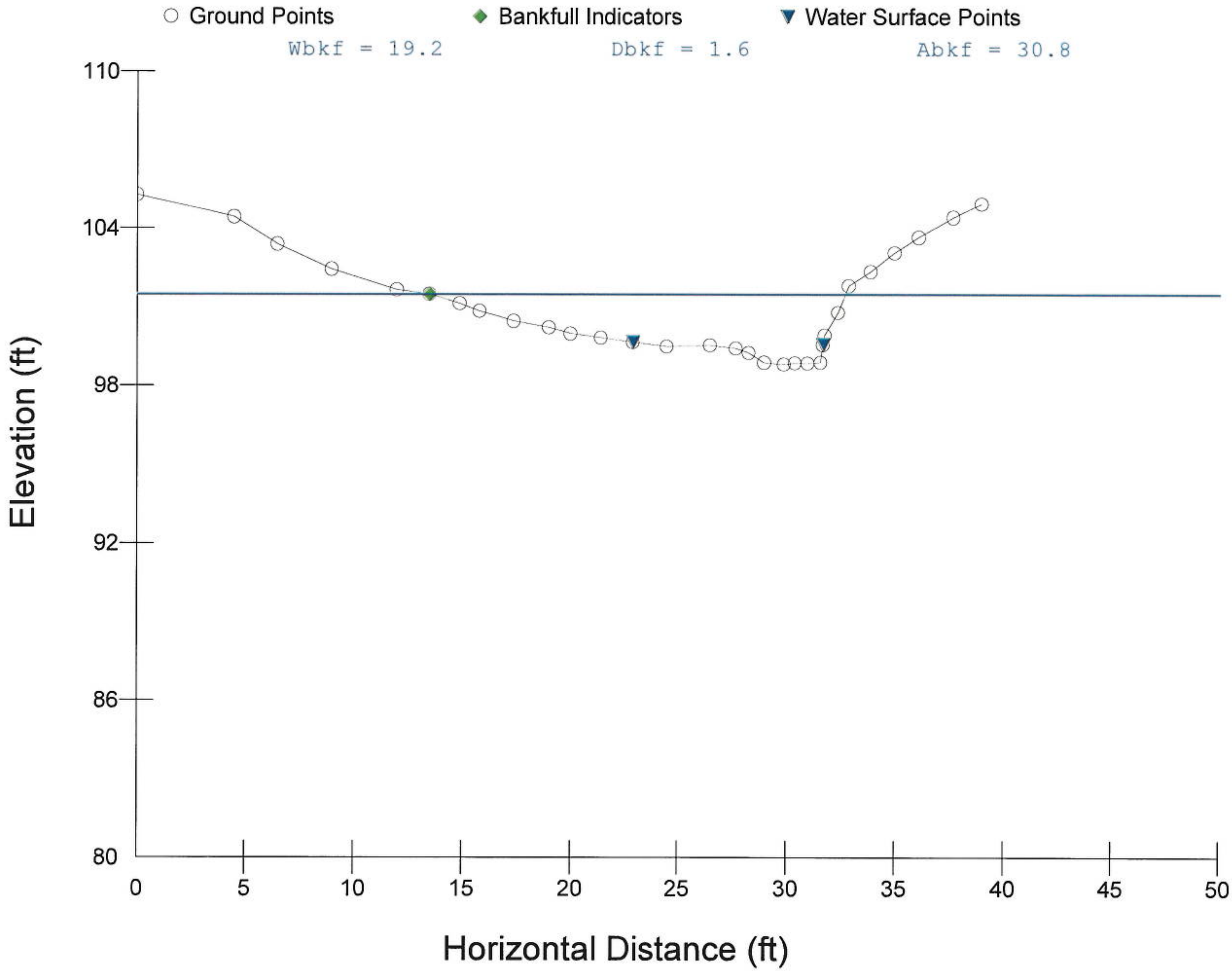
Stream Type → **B 4** ← *For Reference, see page 5-5, 5-6: Rosgen, 1996. Applied River Morphology.*

Donner Creek 0+66.5 Riffle

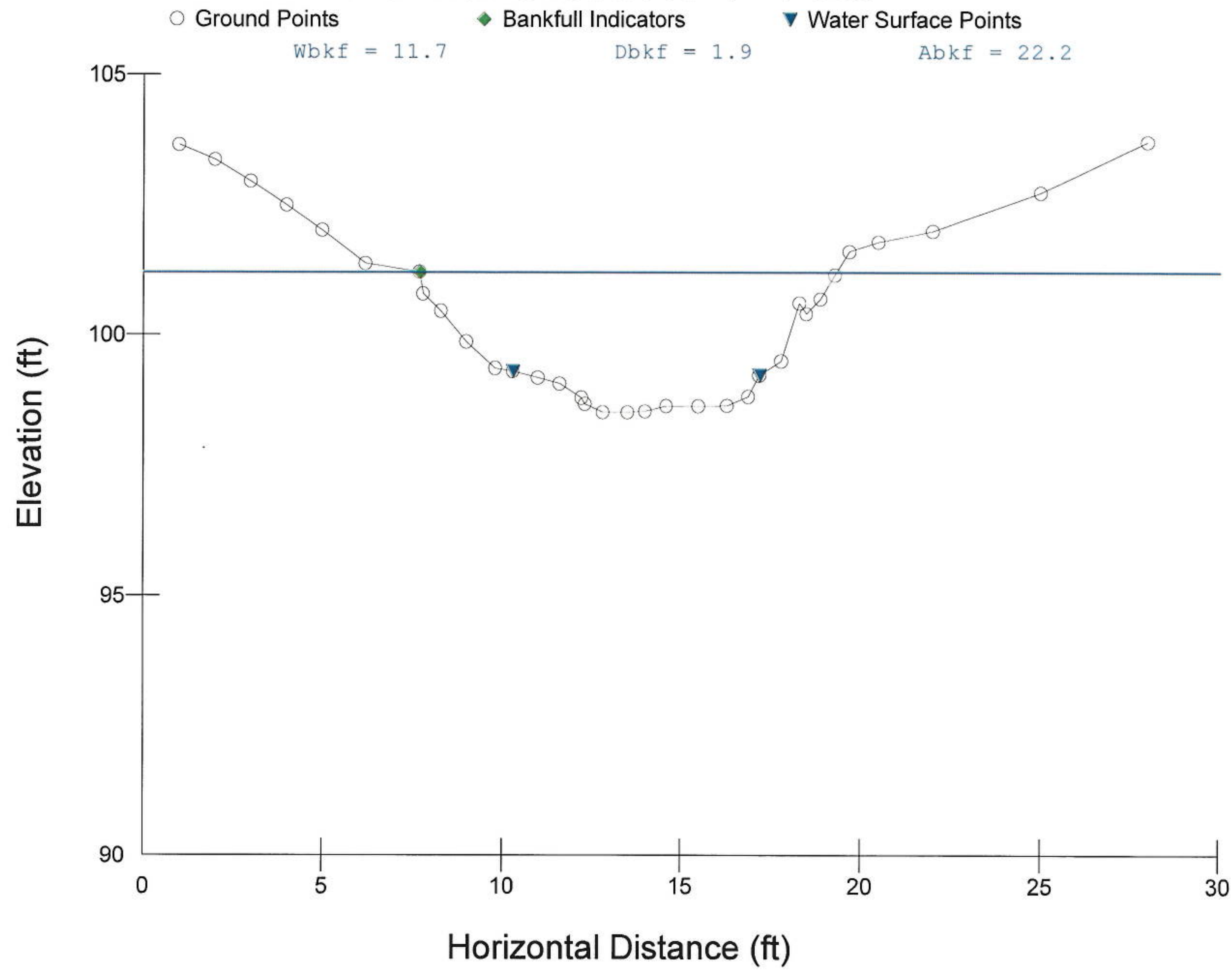



Donner Creek 1+08 Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 11.9
Dbkf = 1.7
Abkf = 207
120
110
100
90
80
70
Elevation (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Horizontal Distance (ft)

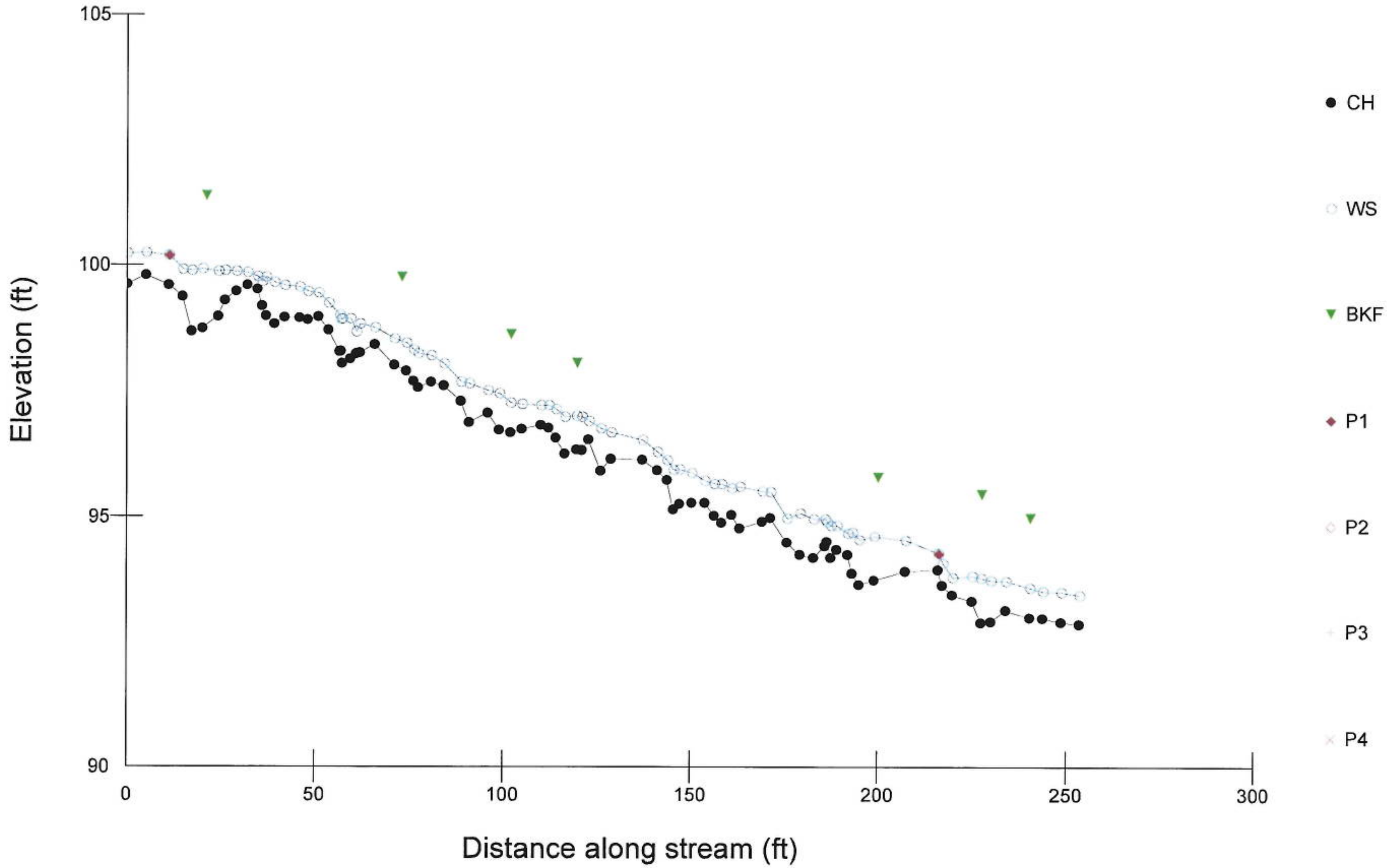
Donner Creek 0+40 Pool



Donner Creek XS 4 - Pool



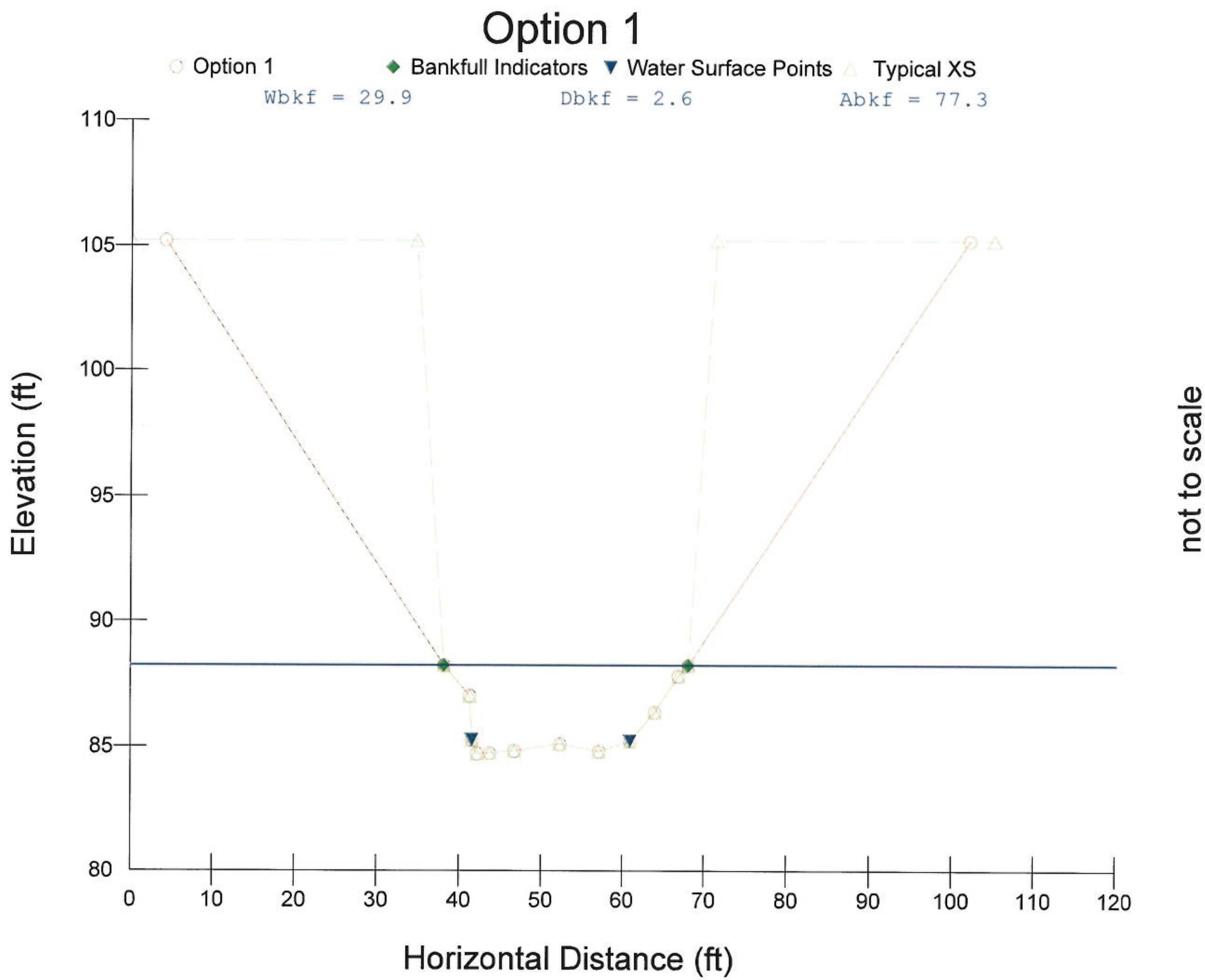
DC Profile



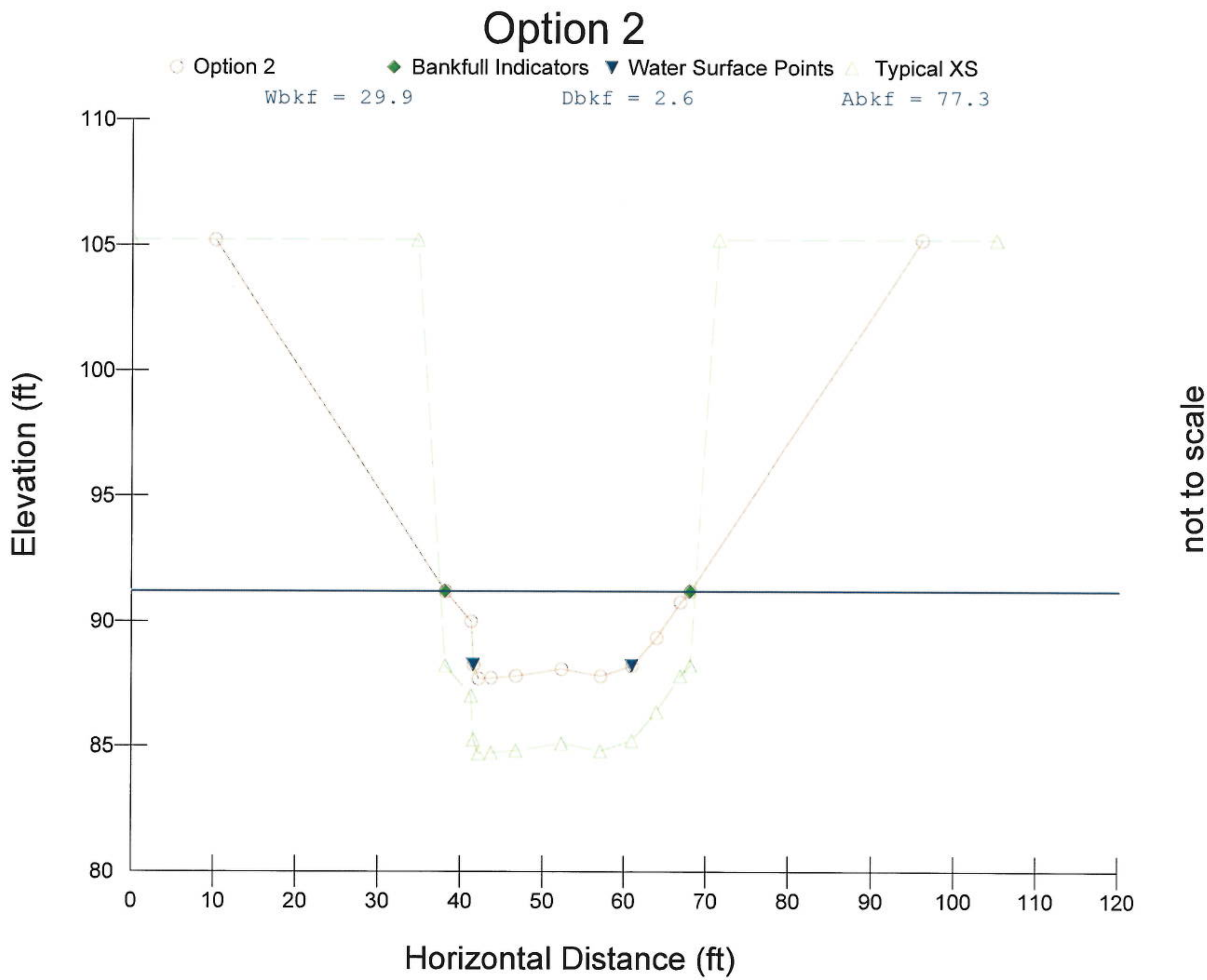
105
100
95
90
Elevation (ft)
0
50
100
150
200
250
300
Distance along stream (ft)
CH
WS
BKF
P1
P2
P3
P4

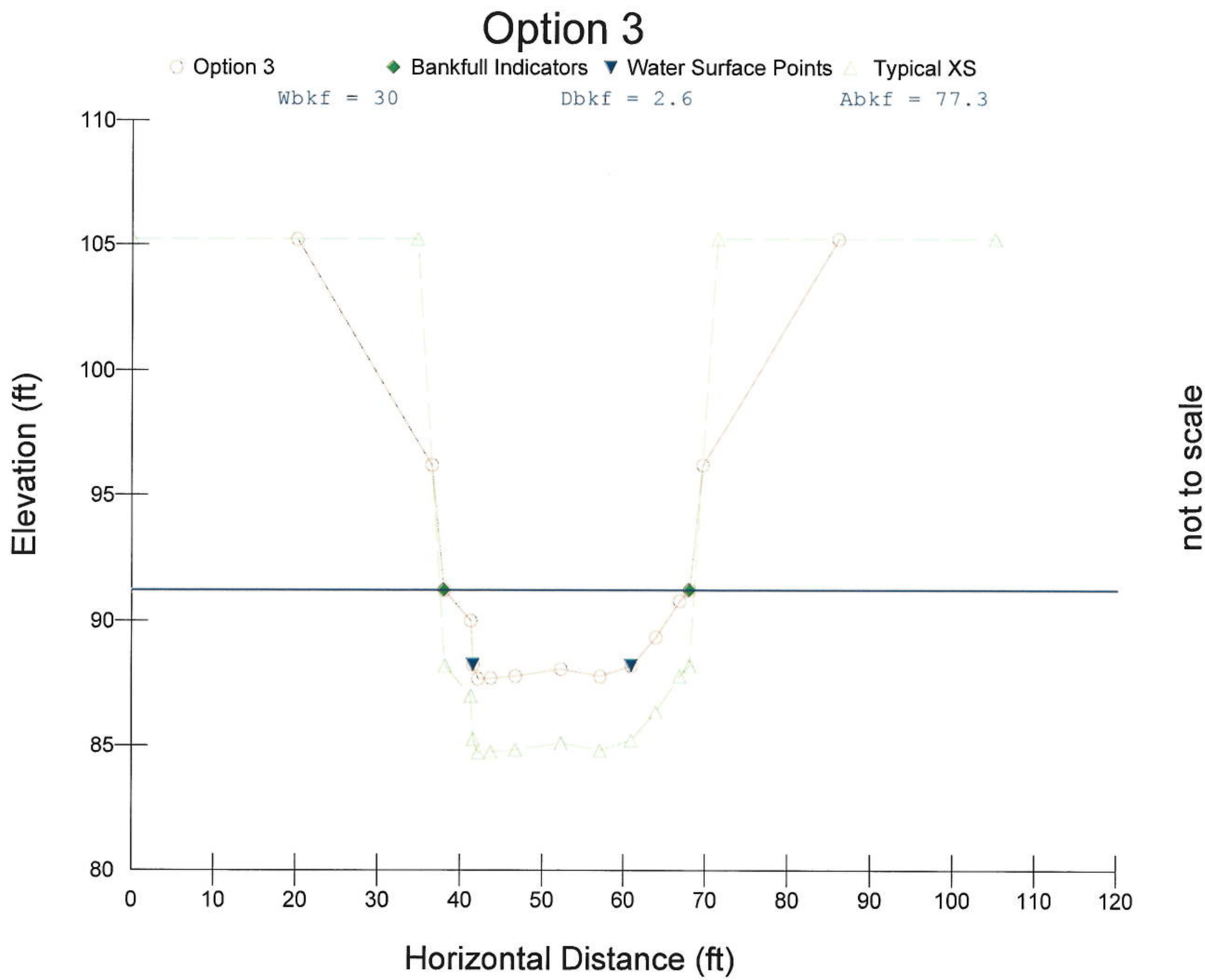
Appendix D

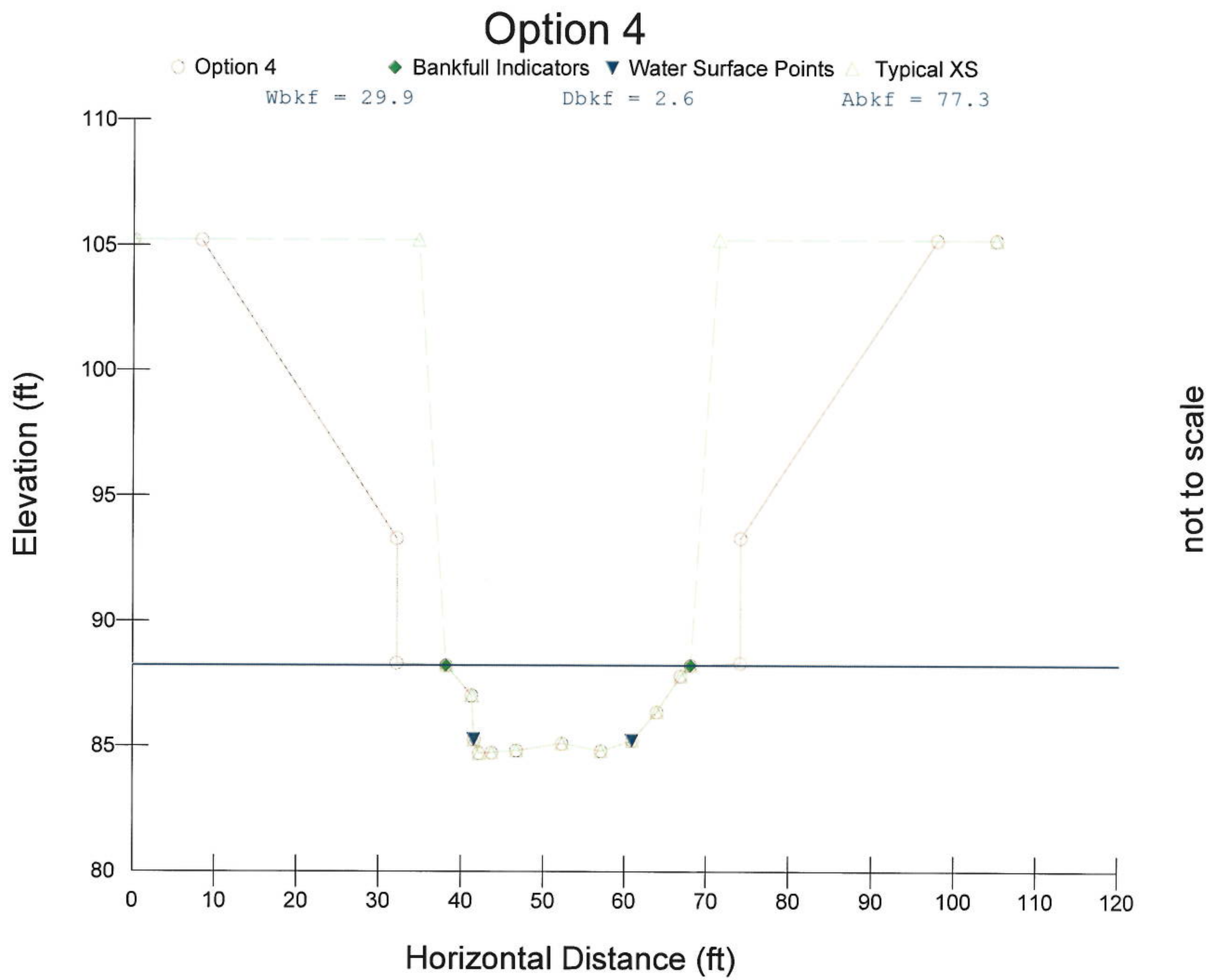
Typical Cross-Sections



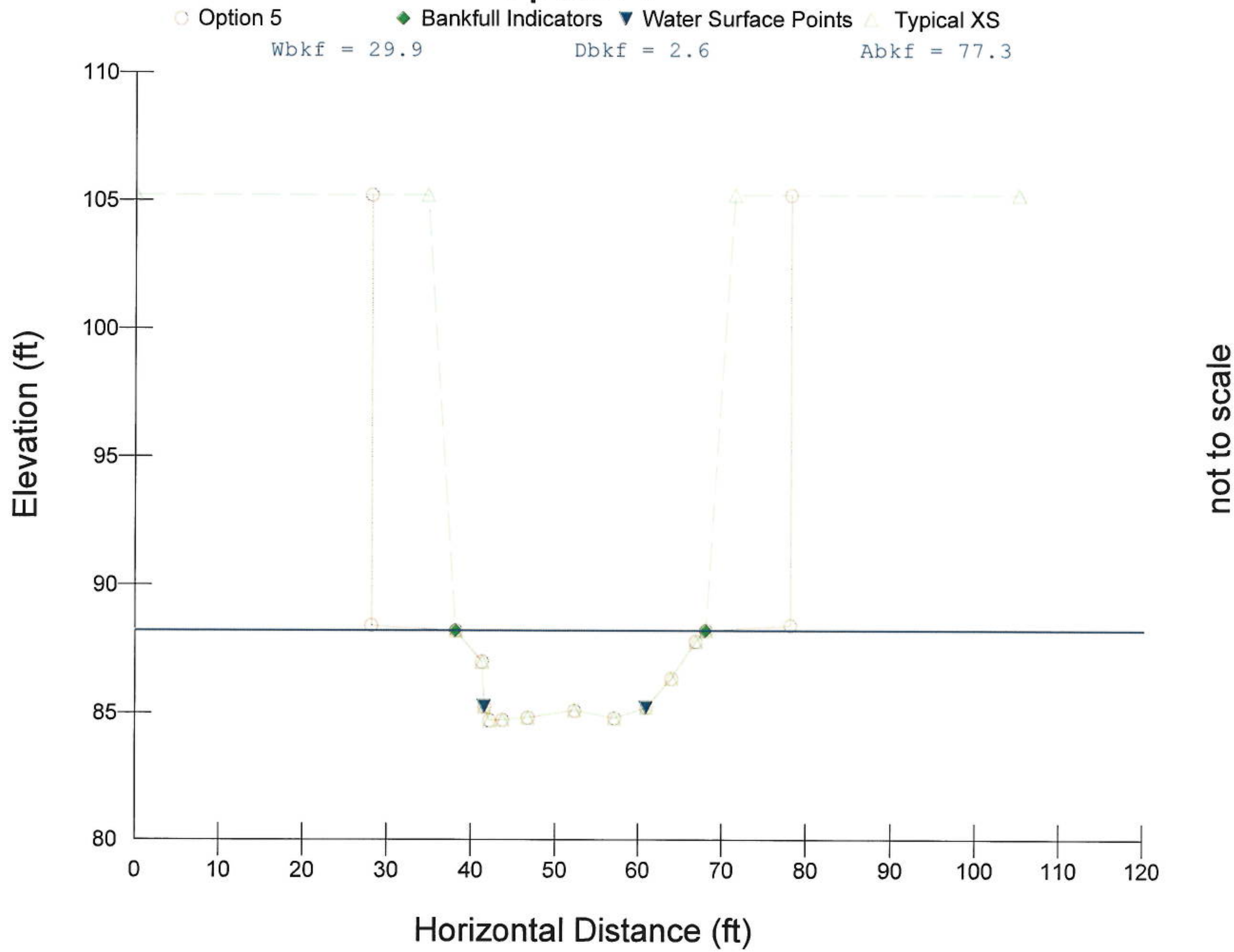
Option 1
Option 1
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 29.9
Dbkf = 2.6
Abkf = 77.3
Elevation (ft)
110
105
100
95
90
85
80
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)
not to scale


Option 2
Option 2
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 29.9
Dbkf = 2.6
Abkf = 77.3
Elevation (ft)
110
105
100
95
90
85
80
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)
not to scale

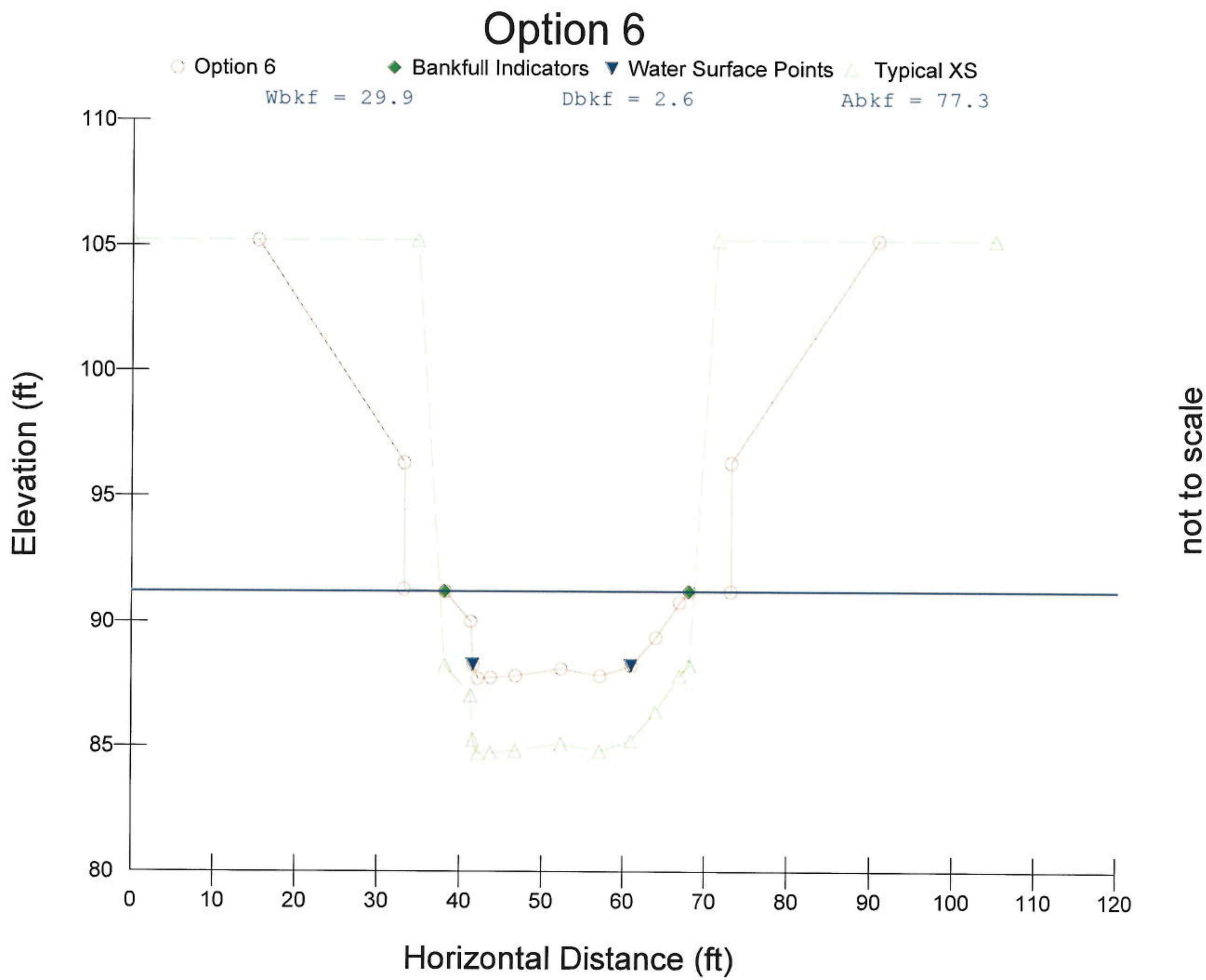

Option 3
Option 3
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 30
Dbkf = 2.6
Abkf = 77.3
Elevation (ft)
110
105
100
95
90
85
80
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)
not to scale

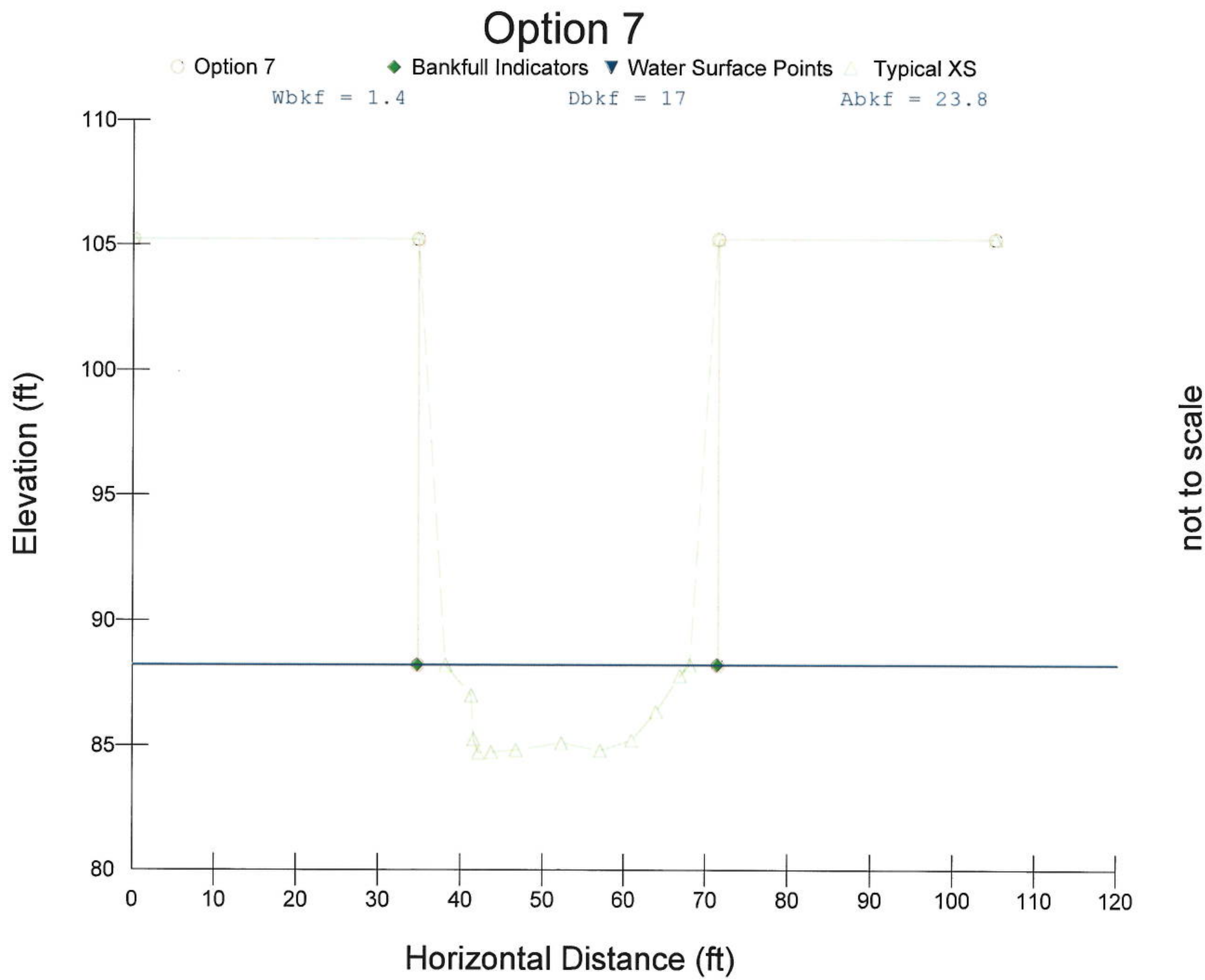

Option 4
Option 4
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 29.9
Dbkf = 2.6
Abkf = 77.3
110
105
100
95
90
85
80
Elevation (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)
not to scale

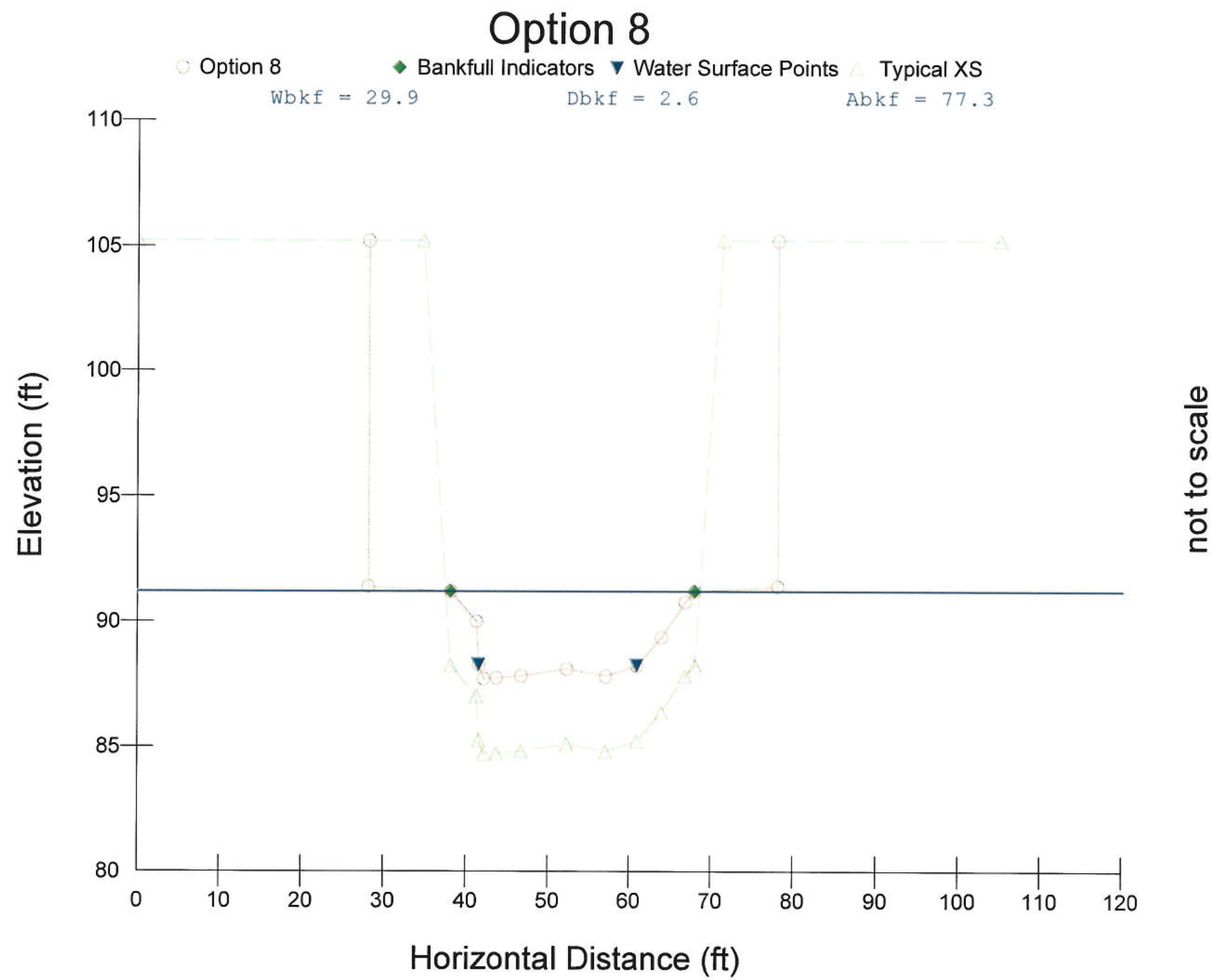
Option 5

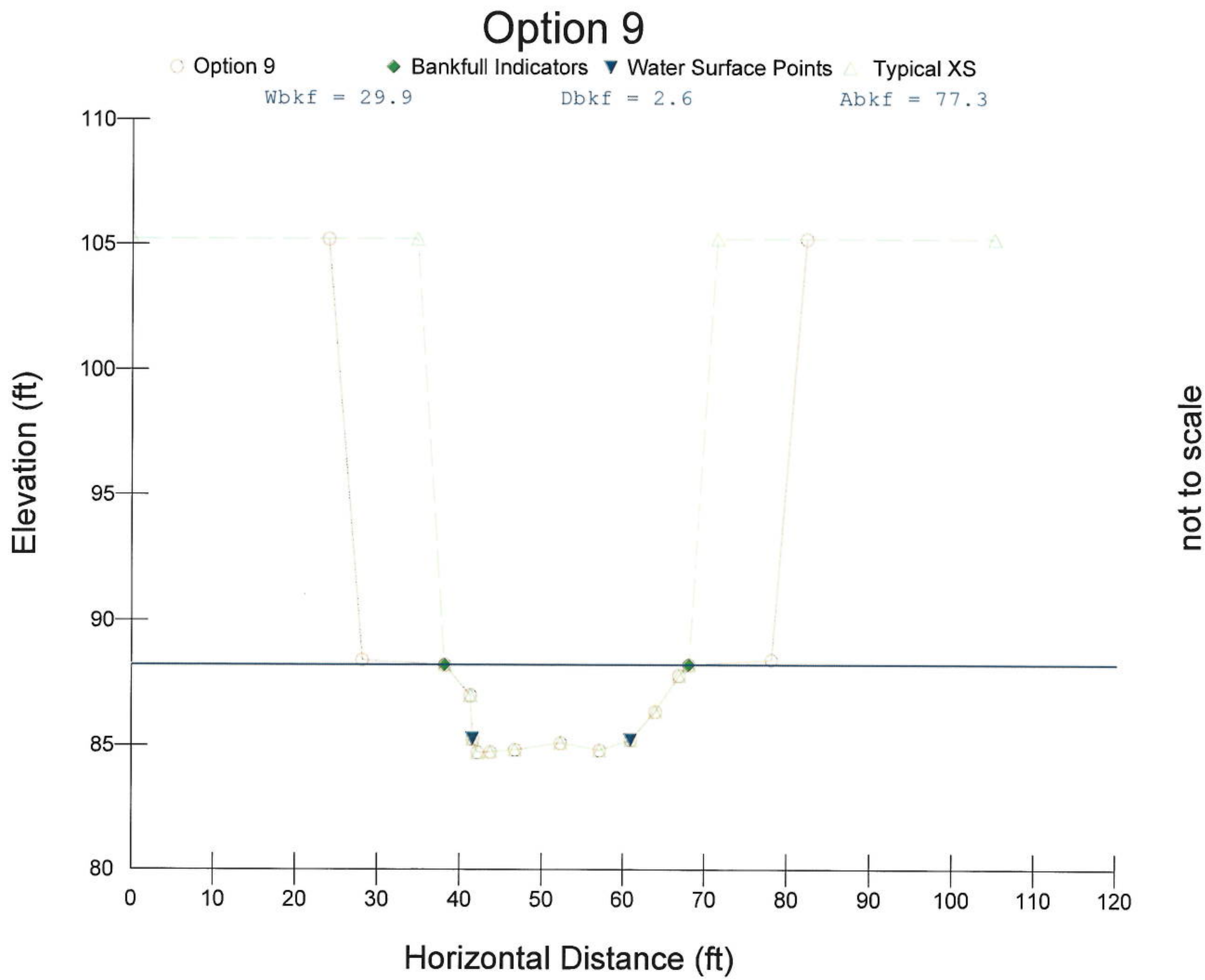


Option 5
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 29.9
Dbkf = 2.6
Abkf = 77.3
Elevation (ft)
110
105
100
95
90
85
80
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)
not to scale


Option 6
Option 6
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 29.9
Dbkf = 2.6
Abkf = 77.3
110
105
100
95
90
85
80
0
10
20
30
40
50
60
70
80
90
100
110
120
Elevation (ft)
Horizontal Distance (ft)
not to scale

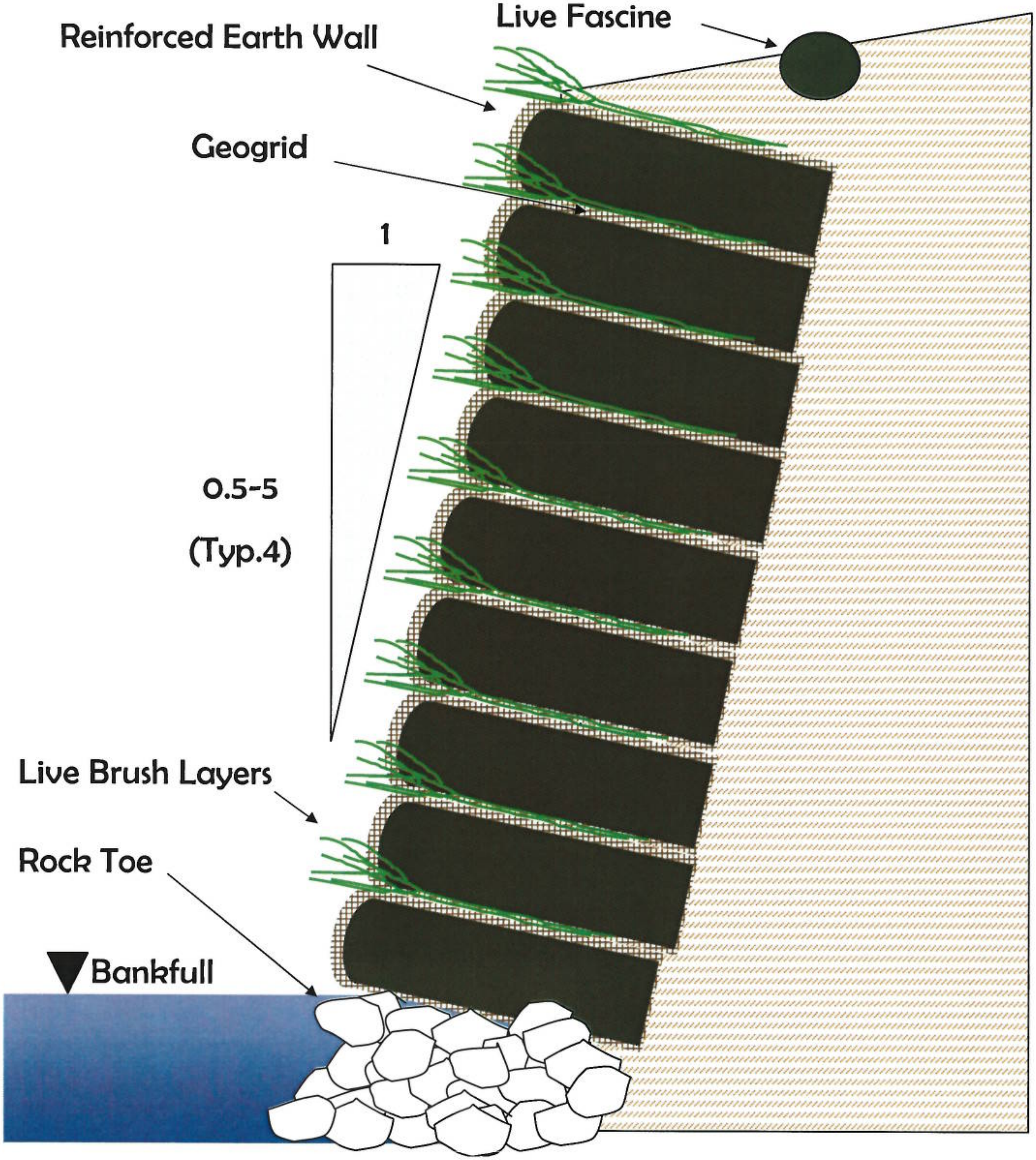

Option 7
Option 7
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 1.4
Dbkf = 17
Abkf = 23.8
110
105
100
95
90
85
80
Elevation (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)
not to scale


Option 8
Option 8
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 29.9
Dbkf = 2.6
Abkf = 77.3
Elevation (ft)
110
105
100
95
90
85
80
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)
not to scale

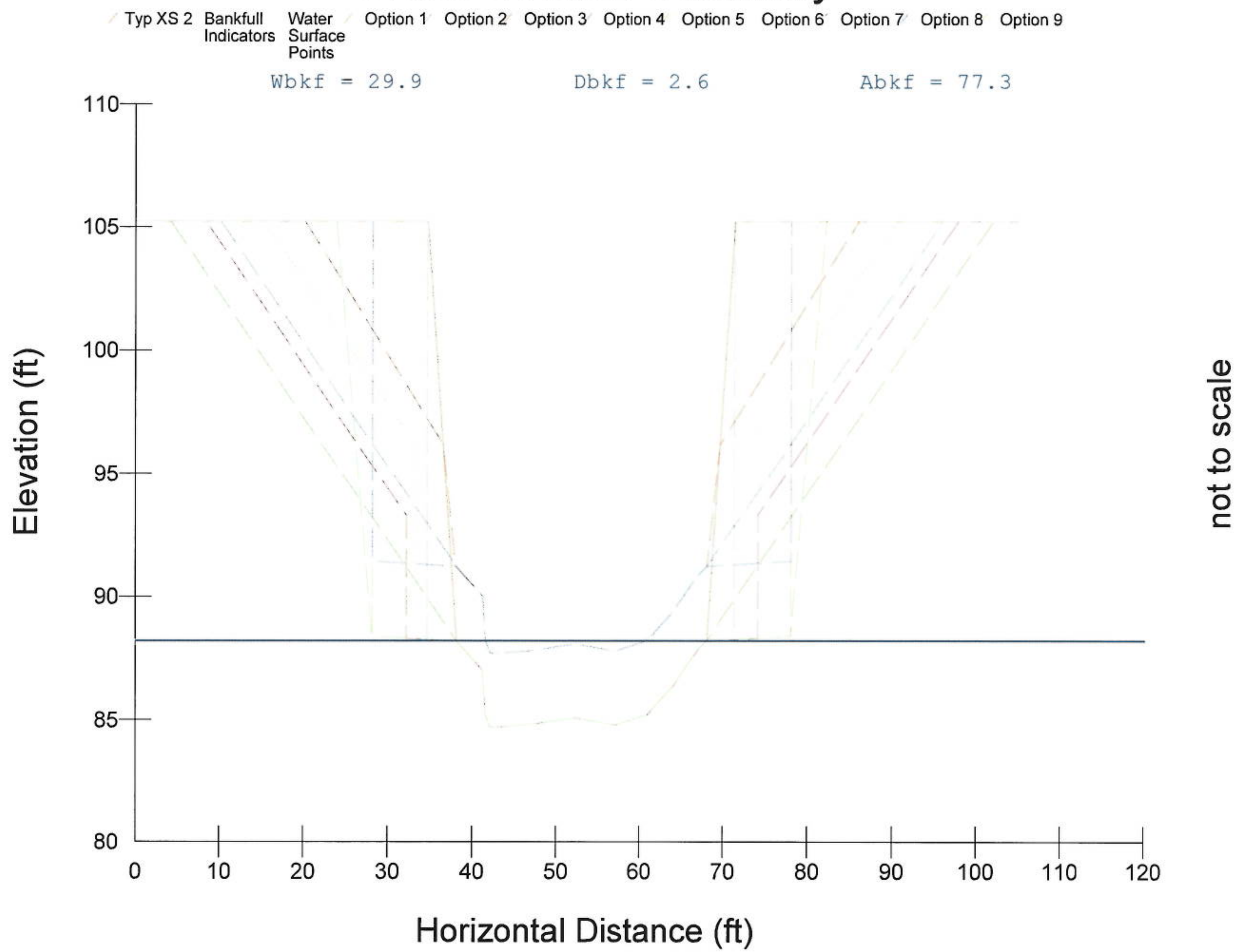


Option 9
Option 9
Bankfull Indicators
Water Surface Points
Typical XS
Wbkf = 29.9
Dbkf = 2.6
Abkf = 77.3
110
105
100
95
90
85
80
Elevation (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)
not to scale

Reinforced Earth Soil Bioengineering Retaining Wall

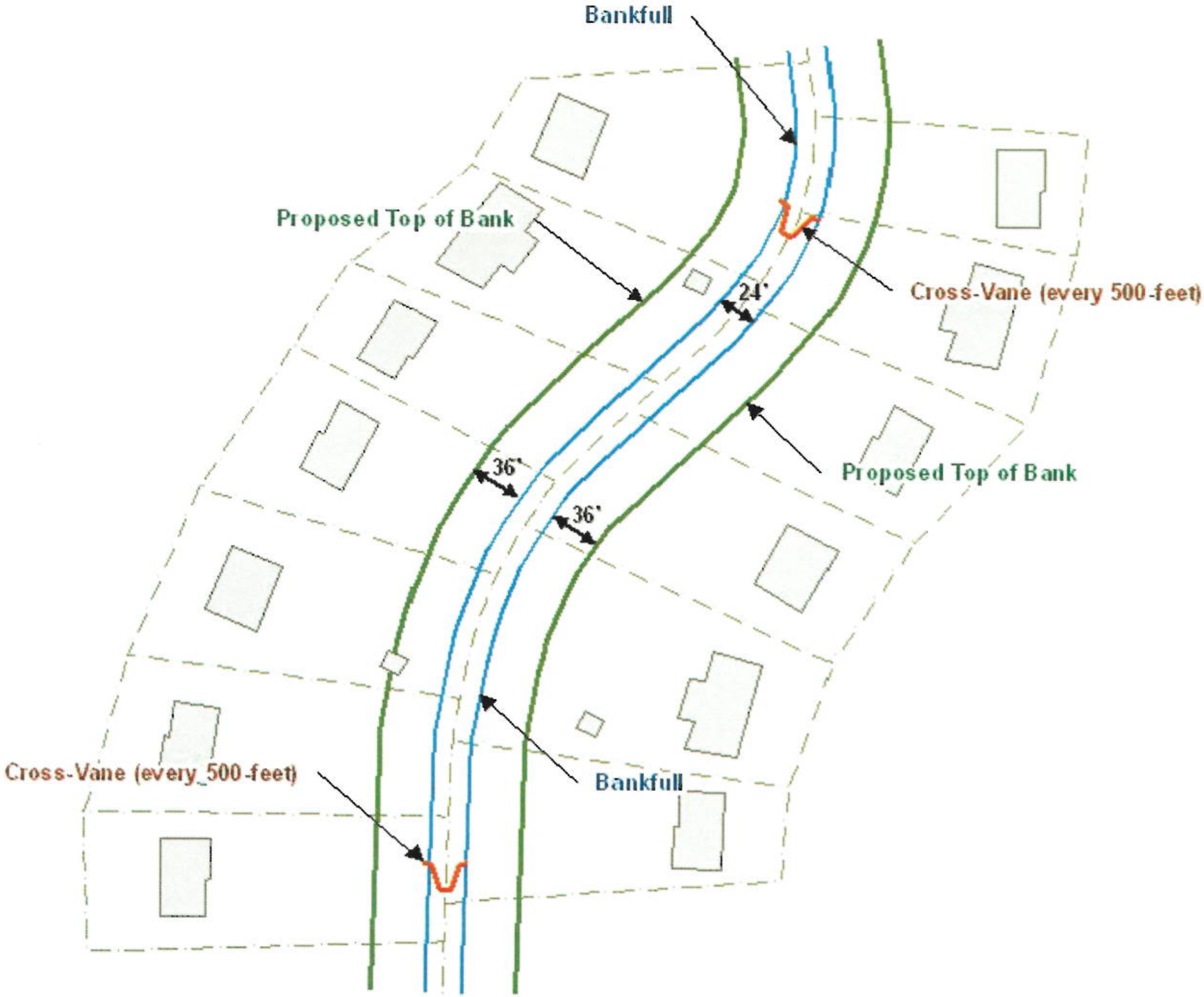


Cross Section Summary

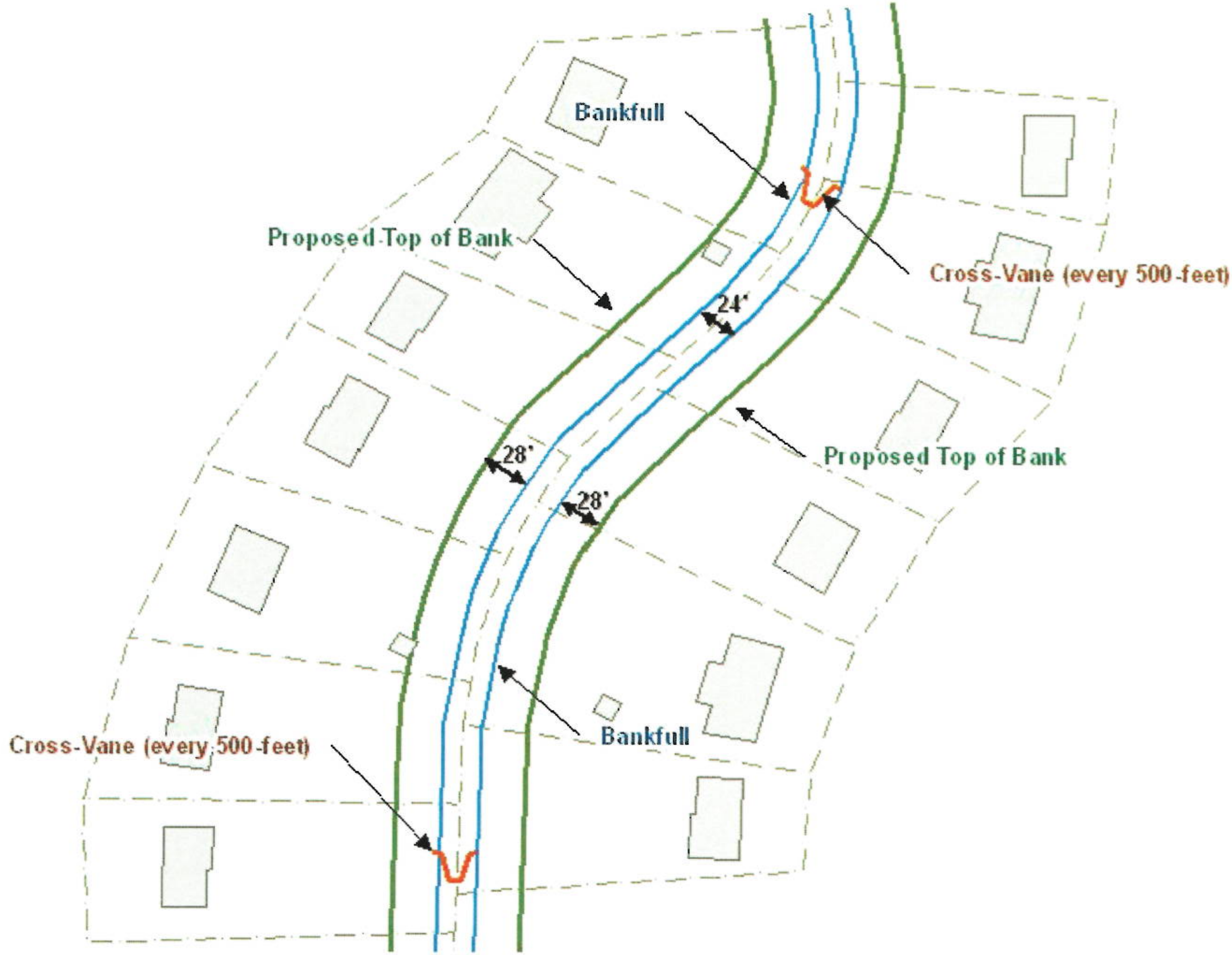


Appendix E

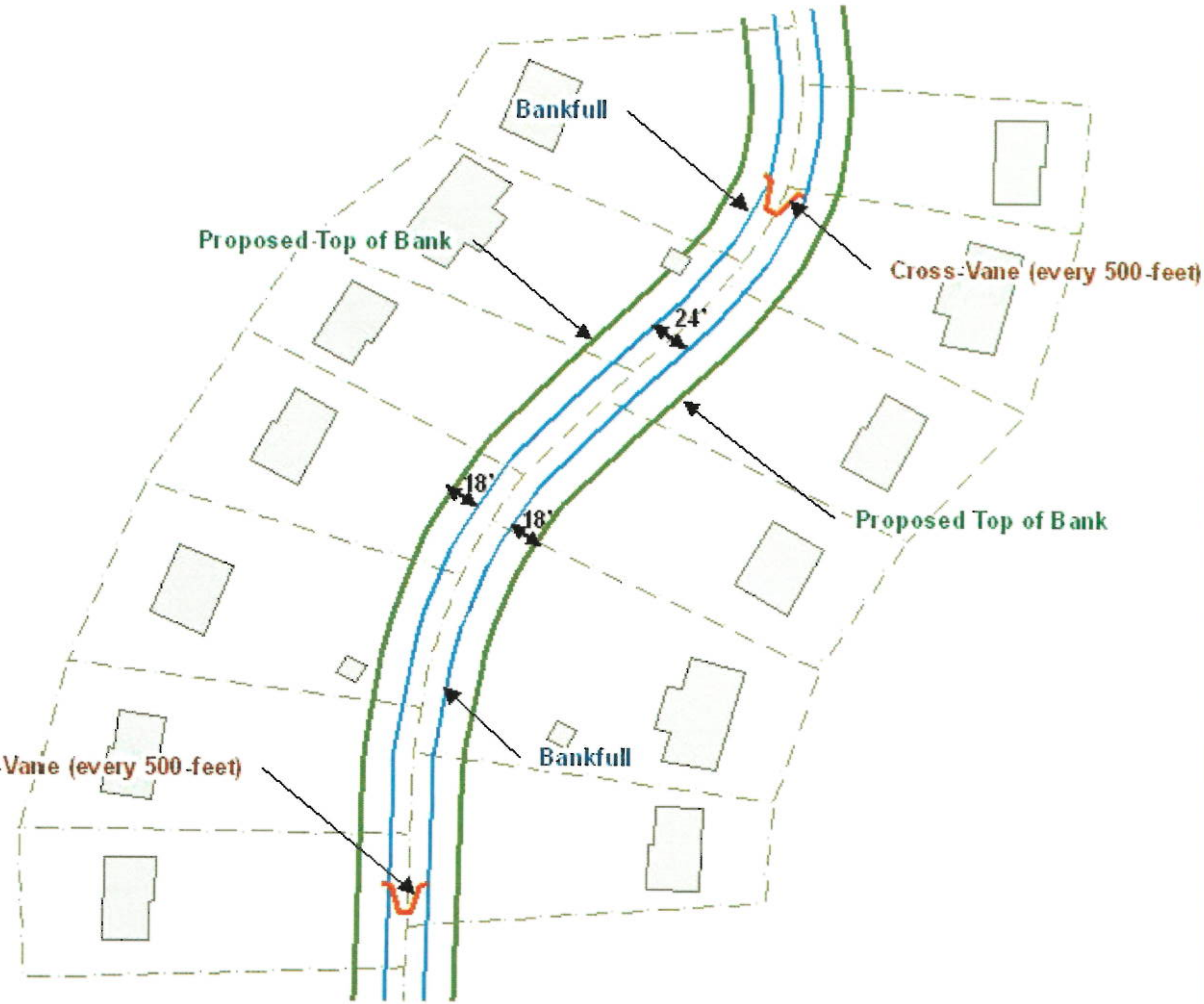
Typical Plan Views



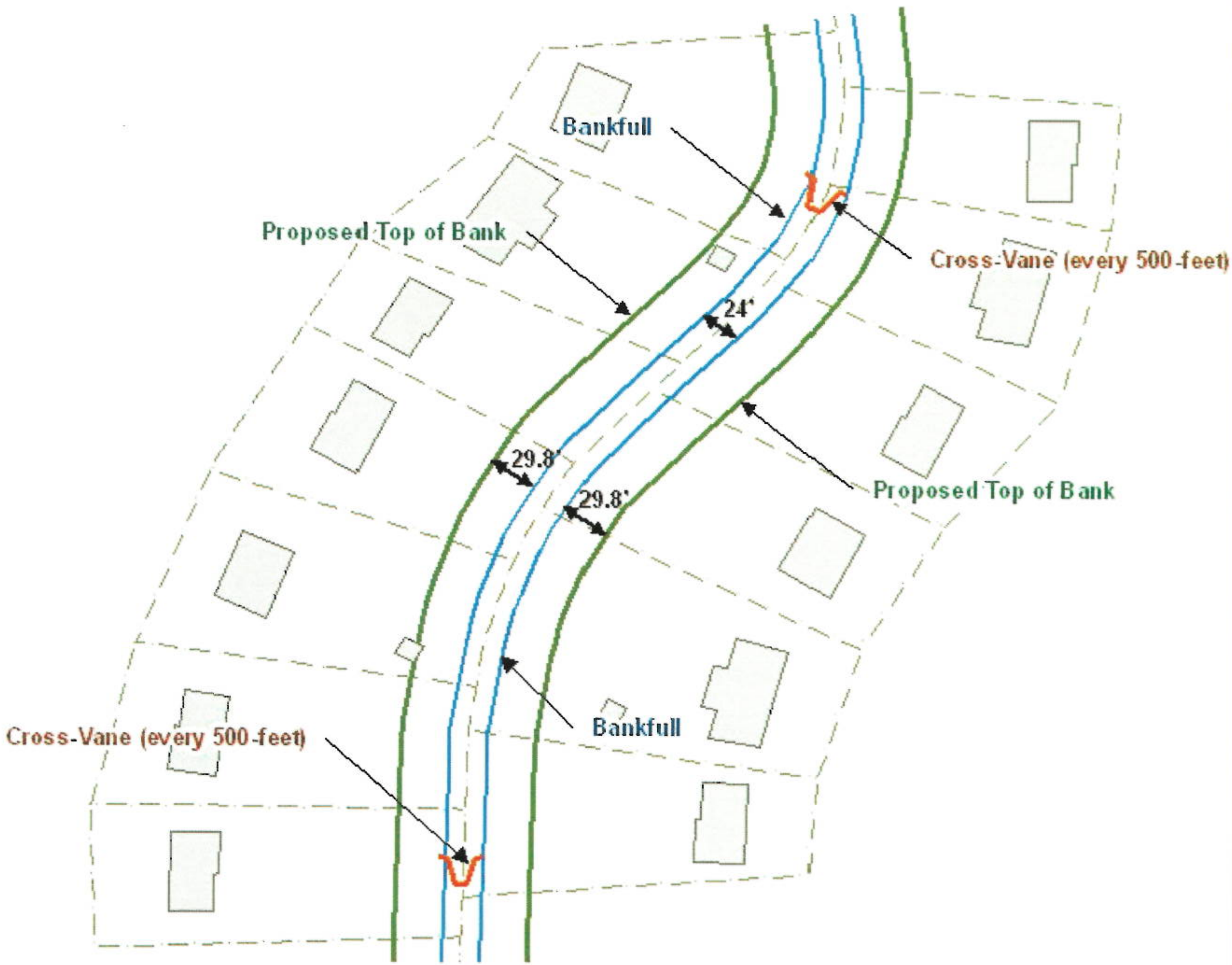
Option 1 (18-foot vertical banks) - Plan View



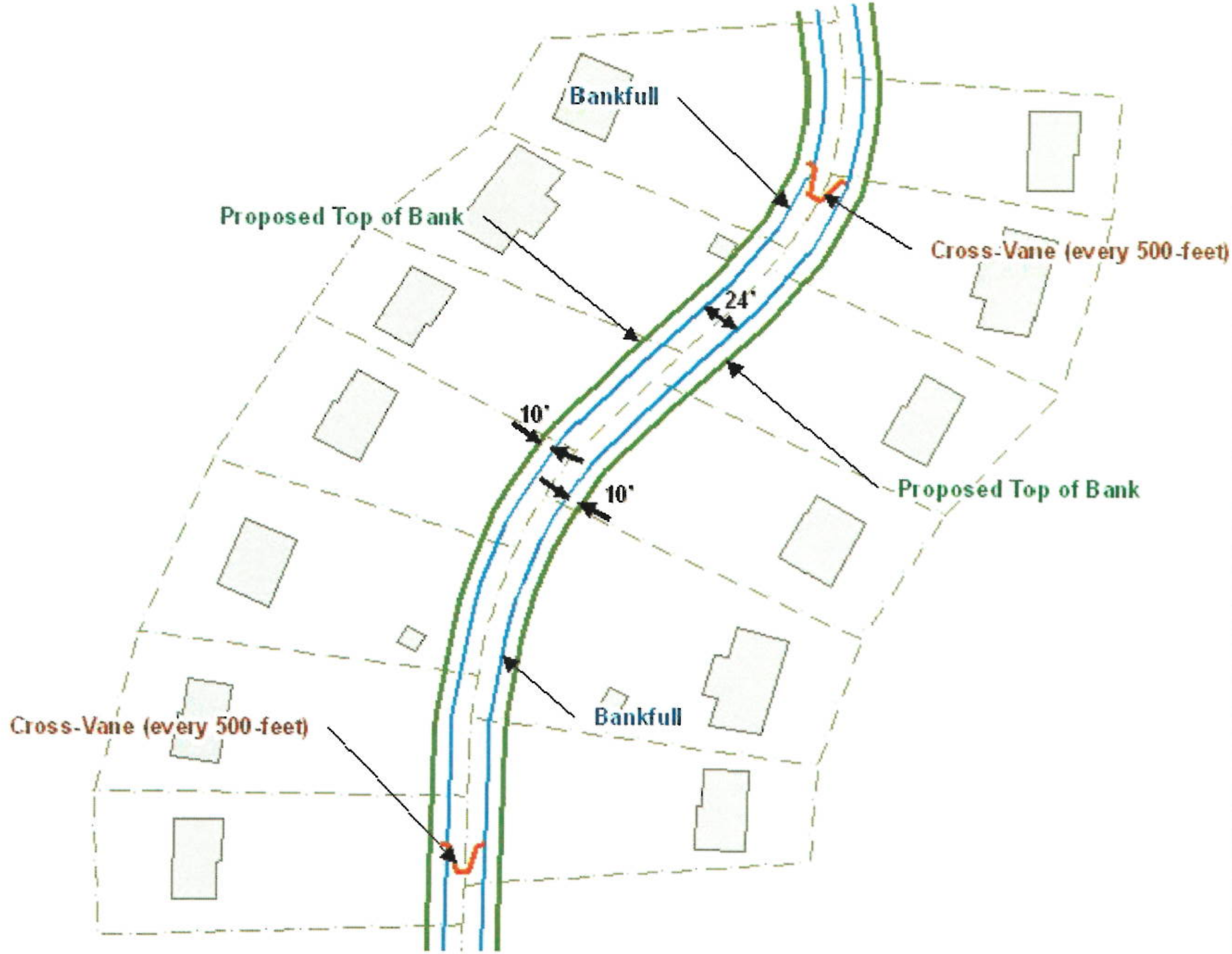
Option 2 (18-foot vertical banks) - Plan View



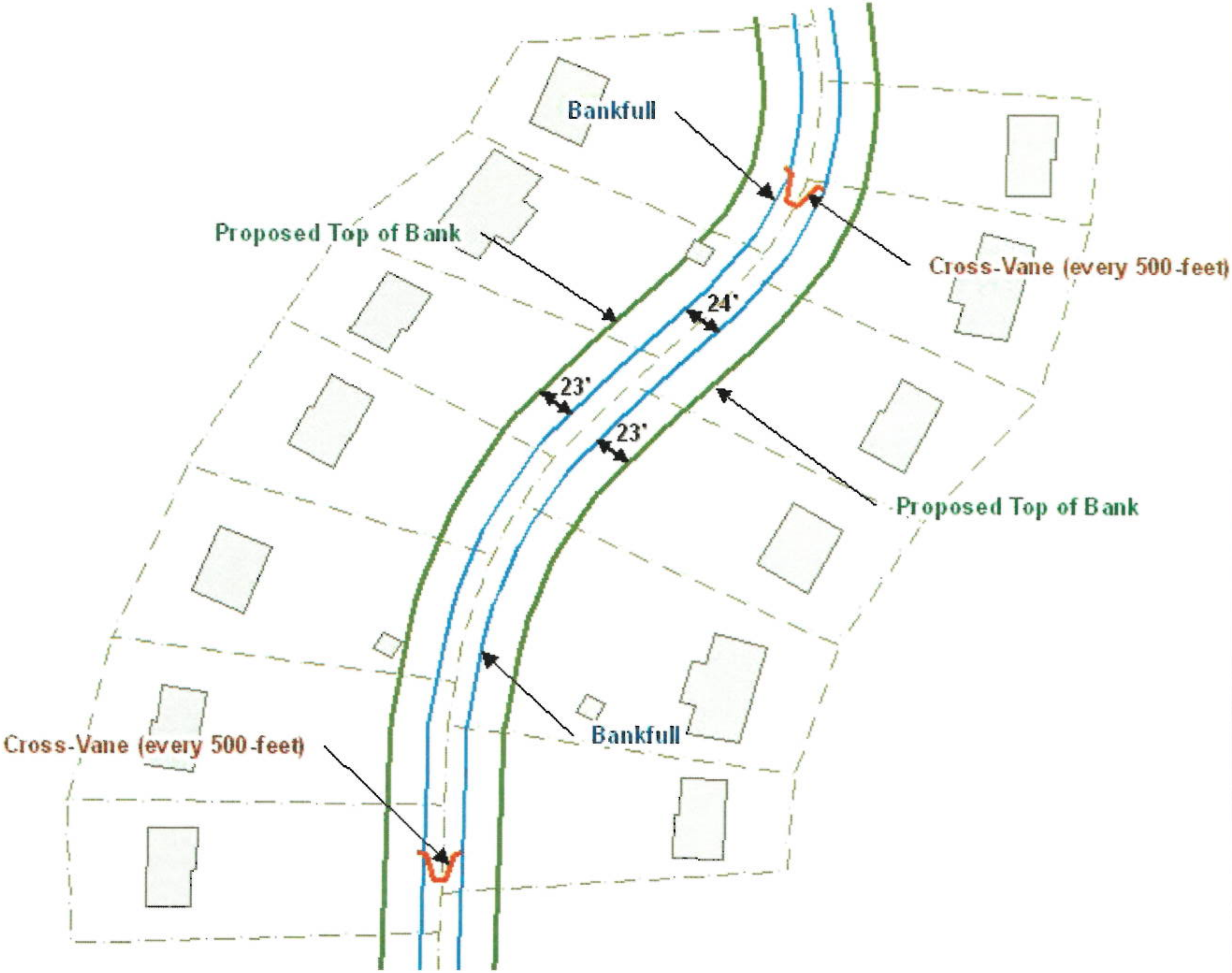
Option 3 (18-foot vertical banks) - Plan View



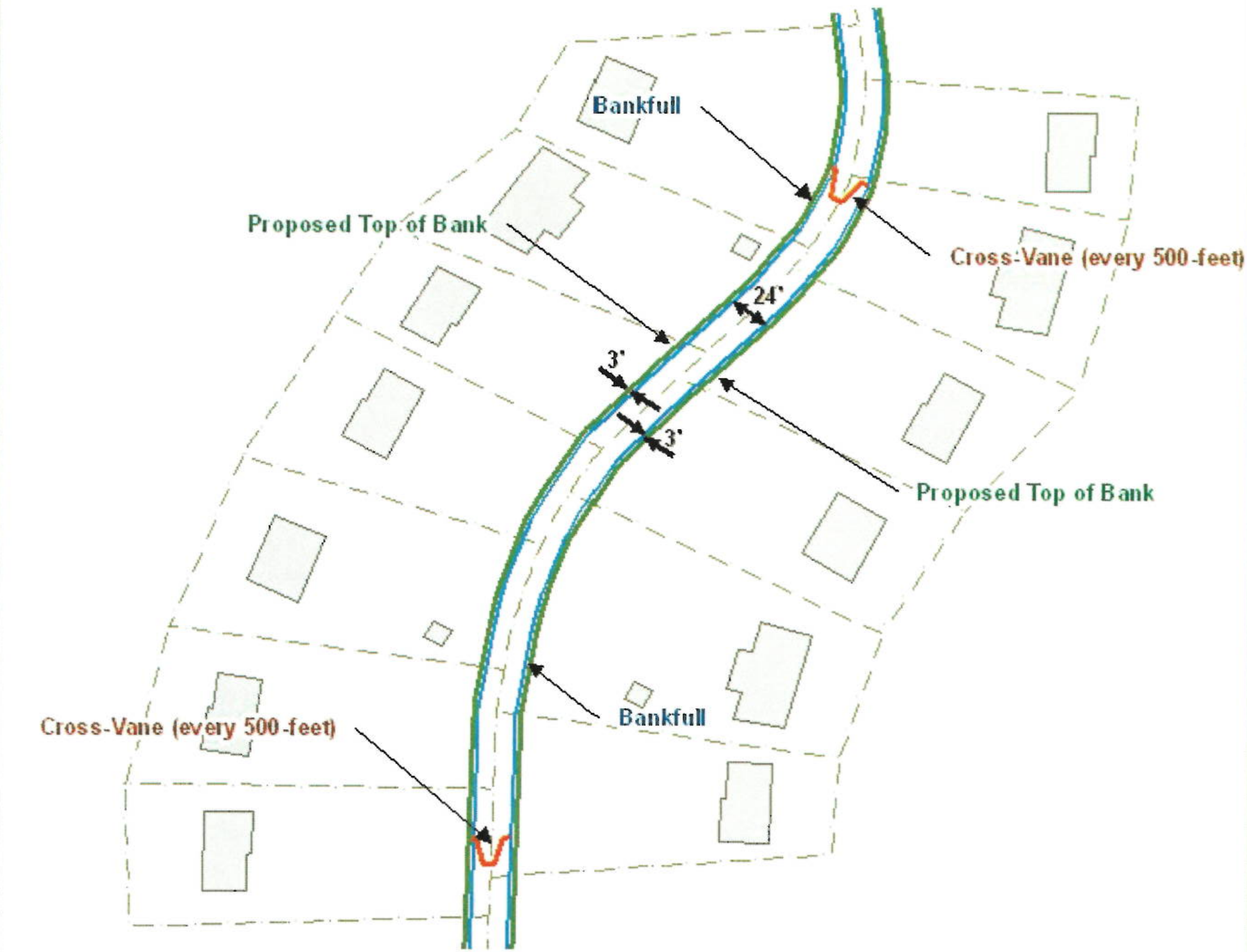
Option 4 (18-foot vertical banks) - Plan View



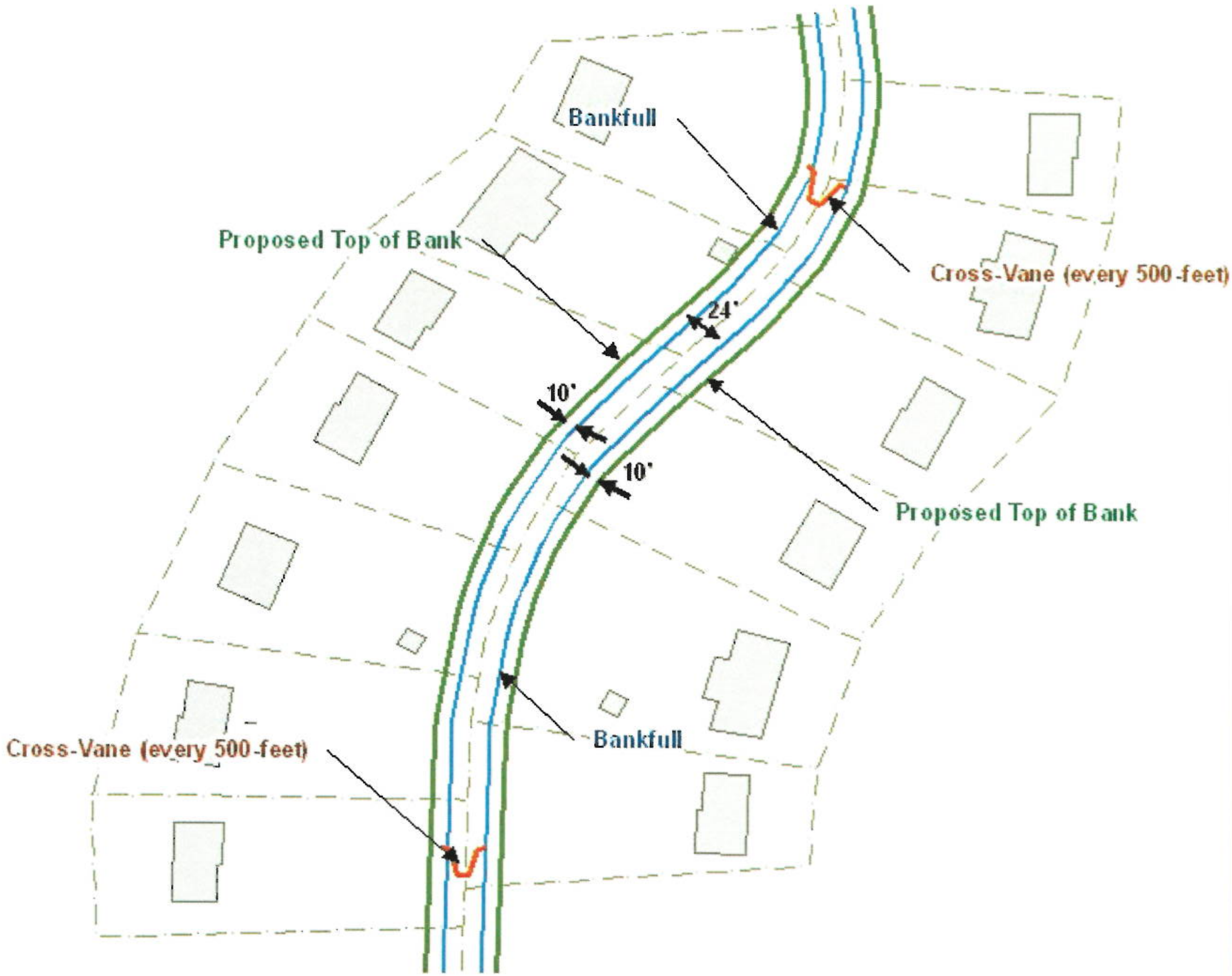
Option 5 (18-foot vertical banks) - Plan View



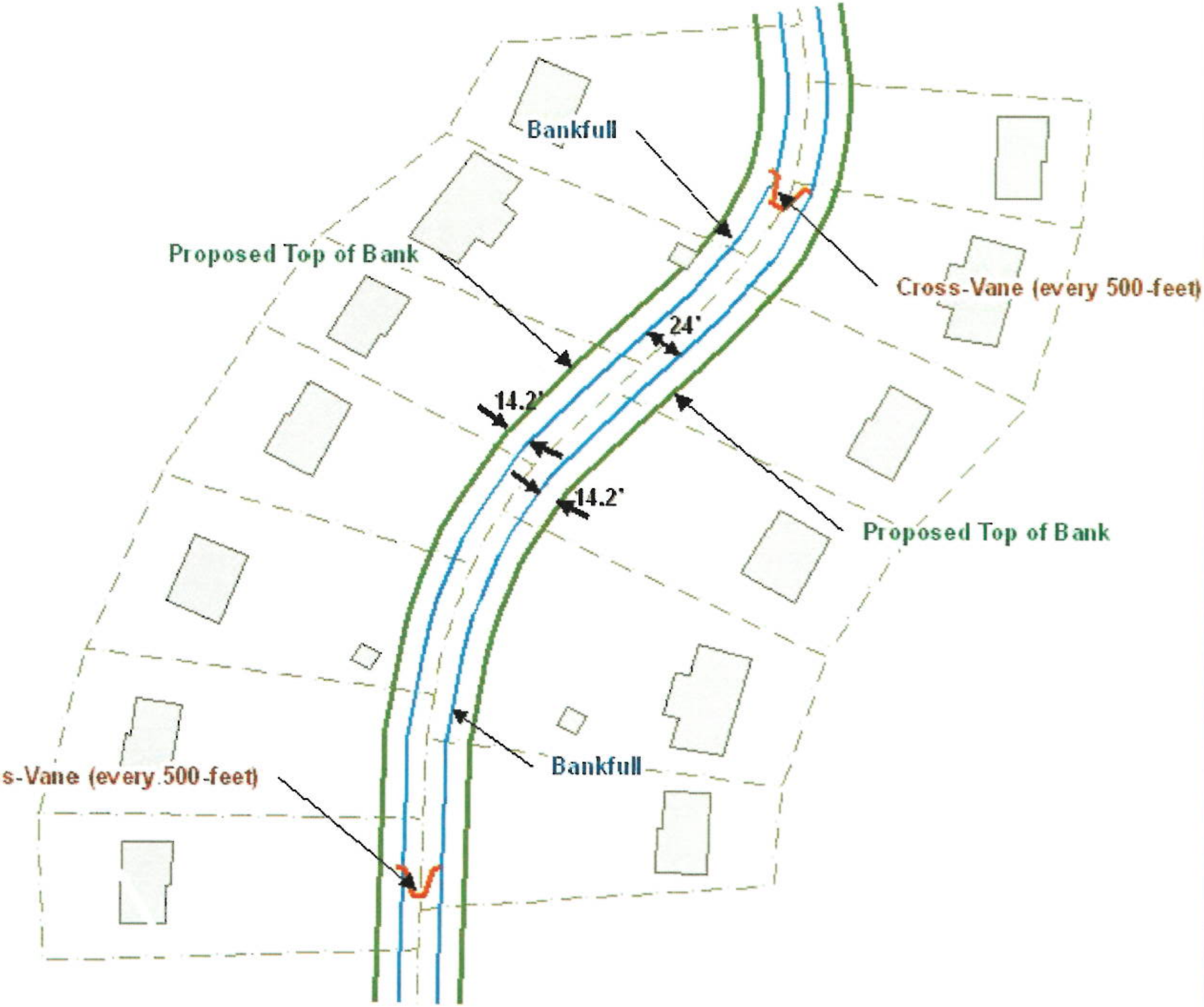
Option 6 (18-foot vertical banks) - Plan View



Option 7 (18-foot vertical banks) - Plan View



Option 8 (18-foot vertical banks) - Plan View



Option 9 (18-foot vertical banks) - Plan View

Appendix F

Opinion of Probable Cost

Probable Costs for One Side of Channel

	Length (FT)	Excavation XS Area (FT^2)	Excavation Volume (CY)	Fill XS Area (FT^2)	Stream Fill Volume (CY)	Retaining Wall Height (FT)	Retaining Wall Backfill (CY)	Soil Wall Height (FT)	Retaining Wall Area (SY)	Soil Engineered Wall Area (FT^2)	Excavation Cost/CY	Fill Cost/CY	Retaining Wall Cost/SY	Soil Wall/SY*	Cost	Contingency	Total Cost	Cost per foot
Option 1	200	230	1710		0				0		$ 12.00	$ 9.00	$ 600.00	$ 150.00	$ 20,520.00	20%	$ 24,700.00	$ 123.50
Option 2	200	50	380	80	600				0		$ 12.00	$ 9.00	$ 600.00	$ 150.00	$ 9,960.00	20%	$ 12,000.00	$ 60.00
Option 3	200	20	150	80	600	10	380		230		$ 12.00	$ 9.00	$ 600.00	$ 150.00	$ 148,620.00	20%	$ 178,400.00	$ 892.00
Option 4	200	220	1630		0	5	190		120		$ 12.00	$ 9.00	$ 650.00	$ 150.00	$ 99,270.00	20%	$ 119,200.00	$ 596.00
Option 5	200	150	1120		0	17	630		380		$ 12.00	$ 9.00	$ 600.00	$ 150.00	$ 247,110.00	20%	$ 296,600.00	$ 1,483.00
Option 6	200	80	600	80	600	5	190		120		$ 12.00	$ 9.00	$ 650.00	$ 150.00	$ 92,310.00	20%	$ 110,800.00	$ 554.00
Option 7	200	10	80		0	17	630		380		$ 12.00	$ 9.00	$ 600.00	$ 150.00	$ 234,630.00	20%	$ 281,600.00	$ 1,408.00
Option 8	200	70	520	80	600	14	520		320		$ 12.00	$ 9.00	$ 600.00	$ 150.00	$ 208,320.00	20%	$ 250,000.00	$ 1,250.00
Option 9	200	180	1340		0			17	0	380	$ 12.00	$ 9.00	$ 600.00	$ 150.00	$ 73,080.00	20%	$ 87,700.00	$ 438.50

* Overall Cost will be affected by design following global stability analysis

These costs assume 17 foot high banks. These should be used for guidance only. Actual costs will vary from those shown here depending on site conditions