SECTION E
STREAM CHANNEL CONDITION

INTRODUCTION

This report provides the results of an assessment of the stream channels of the Mendocino Redwood Company (MRC) ownership in the Big River watershed analysis unit (WAU). The assessment was done following a modified methodology from the Watershed Analysis Manual (Version 4.0, Washington Forest Practices Board). The stream channel analysis is based on field observations and stream channel slope class and channel confinement information developed from a digital terrain model in the company's Geographic Information System (GIS).

The goals of the assessment were to determine the existing channel conditions and identify the sensitivity of the channels to wood and sediment. Stream channels are defined by the transport of water and sediment. A primary structural control of a channel in a forested environment, besides large rock substrate, is from woody debris. Channel morphology and condition therefore reflect the input of sediment, wood and water relative to the ability of the channel to either transport or store these inputs (Sullivan et. al., 1986)

Stream channel conditions represent the strongest link between forest practices and fisheries resources. Changes in channel condition typically reflect changes to fish habitat. Because of this the fish habitat and stream channel assessments were done in the same stream reaches. The results for the fish habitat parameters are presented in Section F - Fish Habitat Assessment.

METHODS

The methods of the stream channel assessment are designed to identify channel segments that are likely to respond similarly to changes in sediment or wood and group them into distinct geomorphic units. These geomorphic units enable an interpretation of habitat-forming processes dependent on similar geomorphic and channel morphology conditions. The channels are also evaluated for current channel condition to provide for the evaluation of aquatic habitat conditions.

Stream Segment Delineation

The stream channel network for the Big River WAU was partitioned into stream segments based on three classes of channel confinement and several classes of channel gradient. These classifications were based on channel classifications prepared from digital terrain data in Mendocino Redwood Company's Geographic Information System (GIS). The slope classes used for delineation are 0-3%, 3-7%, 7-12%, and 12-20%. Channel confinement was classified by confined, moderately confined, and unconfined. Confined channels have a valley to channel width ratio of <2, moderately confined channels have a valley to channel width ratio of <4, and unconfined channels have a valley to channel width ratio of >4.

Channel segments were delineated based on either a change in slope class or change in channel confinement. The channel segments were numbered with a two letter code, corresponding to the planning watershed the channel segment is located, followed by a unique number (*1 through n* for each planning watershed). For the Big River WAU data, channels for 10 planning watersheds are delineated. The delineated stream segments are shown on Map E-1.

Field Measurements and Observations

Selection of field sites for stream channel observations was based on gathering a sample of response (0-3% gradient) and transport (3-20% gradient) channels from each planning watershed of the WAU. No attention was focused on the source reaches (>20% gradient), these reaches are analyzed only for sediment source hazard in the mass wasting module of this watershed analysis.

For each channel segment the bankfull width, bankfull maximum depth, bankfull average depth, floodprone depth, floodprone width, and channel bankfull width to depth ratio are measured at a cross section representative of the channel segment. A pebble count of 50 randomly selected pebbles is counted at the cross section to determine the D50 (median particle size) of the streambed. Streambed sediment characteristics are interpreted from observations of gravel bars, channel aggradation or degradation and particle size of the stream bed material. The segment is classified by morphology types based on Montgomery and Buffington (1993) and Rosgen (1994). The channel morphology is further interpreted by flood plain interaction for segment (continuous, discontinuous, inactive, none) and channel roughness characteristics. Large woody debris (LWD) functioning in the channel is evaluated (presented in Section D, Riparian Function). The number and type of pools (LWD forced, bank forced, boulder forced, free formed) are observed. The field observations are summarized and defined in Table E-1.

Geomorphic Units

Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes.

Interpretations related to sediment supply, transport capacity and LWD response were the basis for development of sensitivity of geomorphic units to coarse sediment, fine sediment and LWD inputs. These interpretations were based primarily on existing conditions observed in the stream channels of the WAU. The channel sensitivity to changes to coarse sediment, fine sediment and LWD are based on how the current state of the channel is likely to respond to inputs of these variables.

Long-Term Stream Monitoring Sites

To monitor stream channel morphology conditions and stream sediment characteristics related to fish habitat, 5 long-term stream channel monitoring segments were established in the Big River WAU. Along these segments thalweg profiles, cross sections and streambed D50 measurements were surveyed. Stream gravel bulk samples and permeability of spawning gravels are also measured (methods and results presented in the Fish Habitat section). These long-term segments will be re-surveyed and monitored over time to provide insight into long term trends in channel morphology, sediment transport and fish habitat conditions. Surveys of LWD within these long term monitoring segments will be included in future surveys. The long-term stream channel monitoring segment locations are shown on Map E-1.

The stream monitoring segments are typically 20-30 bankfull channel widths in length. Permanent benchmarks (PBMs) are placed at the upstream and downstream ends of the monitoring segment. The PBMs are monumented with nails in the base of large trees along with a re-bar pin in the ground adjacent to the nail.

The thalweg profile is a survey of the deepest point of the channel, excluding any detached or “dead end” scours and/or side channels. At every visually apparent change in thalweg location or depth, the distance along the channel is measured and the elevation is recorded. In the absence of visually apparent changes, thalweg measurements are taken every 20-25 feet along the channel. A profile graph of the channel’s thalweg is created from the survey (see Appendix E for Thalweg profiles from the Big River WAU). A computer program (Longpro 2.0 for Windows) developed by the USGS for Redwood National Park was used to analyze the profiles. This program converted the surveys into standardized data sets with uniform five-foot spacing between points and determined the residual water depth of each point. The residual water depth is the depth of water in pools of the channel segment defined by the riffle crest height at the outlet of the pool. No minimum pool depth is specified. The distribution, mean and standard deviation of the residual water depths for the thalweg profile segment are calculated. This provides the ability to statistically evaluate changes in the residual water depths from the thalweg profile over time.

Along the thalweg profile, 3-5 channel cross sections are surveyed (locations are permanently monumented). The cross sections are located along relatively straight reaches in the monitoring segment. Cross sections are surveyed from above the floodprone depth of the channel. A graph of the cross section is created from the survey (see Appendix E for cross sections graphs for Big River, 2000). At each cross section a pebble count is done, to determine the particle size distribution and median particle size (D50), by measuring 100 randomly selected pebbles along the cross section fall line.

RESULTS

Stream Channel Observations

Field channel surveys or observations were taken on 44 stream reaches in the Big River WAU during the summers of 2000 and 2001. Table E-1 provides a summary of the data collected. Further detail specific to in-channel fish habitat relationships is found in Section F - Fish Habitat Assessment. LWD inventoried and evaluated for stream channels is presented in Section D - Riparian Function of this watershed analysis.

Key to Table E-1.

Stream Channel Dimensions

Category	Description
ID #	The stream identification number (see Map E-1), two letter planning watershed code followed by unique number for the planning watershed. BI – Rice Creek BA – Martin Creek BR – Russell Brook BE – East Branch North Fork Big River BL – Lower North Fork Big River BT – Two Log Creek BG – Laguna Creek BP – Dark Gulch BS – South Daugherty BM – Mettick Creek
Geomorphic Unit	Number of the geomorphic unit the channel segment is in.
GIS Channel confinement	Confined-channel width to valley width ratio < 2, moderately confined-channel width to valley width ratio 2-4, unconfined-channel width to valley width ratio >4.
Surveyed Length	Length of segment surveyed.
GIS slope category	Slope class as designated by DTM in GIS.
Observed Slope	Mean slope of segment as observed in field.
Maximum Bankfull Depth	Maximum bankfull depth of representative cross section.
Mean Bankfull Depth	Average bankfull depth of representative cross section.
Bankfull width	Bankfull width of representative cross-section.
Width/Depth Ratio	Ratio of bankfull channel width to average bankfull depth.
Floodprone depth	Maximum depth during flooding, estimated by 2 times max. bankfull depth (Rosgen, 1996).
Floodprone width	Width of water at floodprone depth (Rosgen, 1996).
Entrenchment Ratio	Ratio of floodprone width to bankfull channel width.

Sediment/Bedform Characteristics

Category	Description
Montgomery/Buffington Class	The channel morphology type: PR = pool/riffle, FP/R = forced pool/riffle, SP = step pool, PB = plane bed, CAS = cascade (Montgomery and Buffington, 1993)
Rosgen Class	Rosgen channel morphology classification, (Rosgen, 1994).
Floodplain Continuity	Description of floodplain/channel interaction either: continuous, inactive, discontinuous or none.
Aggradation/Degradation in Past	Evidence of past problems.
Aggradation/Degradation Current	Current status.
Channel Roughness	B =boulders, C=cobbles, F=bedforms, V=live woody veg., W=large woody veg., R=bedrock, Bk=banks and roots.
Gravel Bar Abundance	Qualitative measure of amount of gravel bars in segment.
Gravel Bar Type	Gravel bar type either: A=alternating point bars, P=point, M=medial or F=forced.
Gravel Bar Proportion Class	Proportion of stream segment in gravel bars: 0-25%, 25-50%, 50-75%, 75-100%.
Fine Sediment Abundance	sparse, moderate, abundant
Fine Sediment Type	type of fine sediment accumulation: P=isolated pockets, M=moderate accumulations, B=high accumulations including in gravel bars.
D50	Median gravel size of the stream bed particle distribution.

Pool Characteristics

Category	Description
Free	number of free formed pools in segment.
LWD Forced	number of LWD forced pools in segment.
Boulder Forced	number of boulder forced pools in segment.
Bank Forced	number of bank forced pools in segment.
Total # Pools	total number of pools in segment.
Pool Spacing	average space between pools by bankfull widths.
Mean Res. Pool Depth	The average of all residual pool depths in segment.

Table E-1. Stream Segment Field Observations for Big River WAU, 2000-2001

Stream Channel Dimensions													
Segment Name	ID #	Geomorphic Unit	Channel Confinement	Survey Length (ft)	GIS Slope Category (%)	Field Observed Slope (%)	Maximum Bankfull Depth (ft)	Mean Bankfull Depth (ft)	Bankfull Width (ft)	Width/Depth Ratio	Floodprone Depth	Floodprone Width	Entrenchment Ratio
EAST BRANCH NF BIG RIVER	BE1	2	Confined	929	0-3	1.6	2.1	1.8	31.0	17	5.0	55	1.8
EAST BRANCH NF BIG RIVER	BE2	2	Confined	546	0-3	0.6	3.0	2.4	20.3	8	6.0	45	2.2
BULL TEAM GULCH	BE8	4	Mod. Confined	218	3-7	3.8	2.8	1.9	6.7	4	5.6	16	2.4
FRYKMAN GULCH	BE14	4	Confined	234	3-7	1.7	1.5	1	8.2	8	3.0	45	5.5
BIG RIVER	BI1	1	Confined	810	0-3	2.2	3.2	1.4	49.2	35	6.4	60	1.2
NORTH FORK BIG RIVER	BL1	1	Mod. Confined	889	0-3	1.6	3.9	3	47.0	16	7.8	54	1.1
NORTH FORK BIG RIVER	BL3	1	Confined	916	0-3	1.3	3.1	2.2	47.8	22	6.2	65	1.4
STEAM DONKEY GULCH	BL7	4	Confined	159	3-7	21.7	3.2	1.5	8.1	5	6.4	15	1.9
DUNLAP GULCH	BL12	4	Mod. Confined	329	3-7	9.5	2.5	1.7	10.9	6	5.0	16	1.5
SOUTH FORK BIG RIVER	BM1	1	Confined	934	0-3	0.9	4.0	2.9	62.7	22	8.0	73	1.2
SOUTH FORK BIG RIVER	BM3	1	Confined	972	0-3	1.2	5.0	2.9	52.0	18	10.0	65	1.3
SOUTH FORK BIG RIVER	BM5	1	Confined	932	0-3	1.3	3.9	2.7	46.0	17	7.8	58	1.3
RAMON CREEK	BM25	2	Confined	337	0-3	1.5	3.0	1.3	38.0	29	6.0	50	1.3
RAMON CREEK	BM26	2	Confined	511	0-3	2.1	3.6	2.3	22.1	10	7.2	30	1.4
RAMON CREEK	BM27	2	Confined	408	0-3	2.0	3.1	2.1	16.3	8	6.2	33	2.0
NORTH FORK RAMON CREEK	BM31	3	Confined	495	0-3	2.0	3.5	2.7	13.1	5	7.0	26	2.0
NORTH FORK RAMON CREEK	BM32	4	Confined	306	3-7	2.2	2.2	1.4	10.1	7	4.4	30	3.0
METTICK CREEK	BM54	4	Confined	371	3-7	3.0	2.6	1.6	14.4	9	5.2	18	1.3
METTICK CREEK	BM55	4	Confined	438	0-3	2.8	-		14.0	-	-	-	-
BOARDMAN GULCH	BM59	4	Confined	201	3-7	1.7	1.9	1.4	10.8	8	3.8	12	1.1
HALFWAY HOUSE GULCH	BM64	4	Confined	418	3-7	4.9	2.7	2.1	9.0	4	5.4	15	1.7
UNNAMED TRIB TO SF BIG RIVER	BM76	3	Mod. Confined	177	3-7	1.3	2.3	1.5	8.0	5	4.6	13	1.6
BIG RIVER	BR1	1	Confined	1105	0-3	1.3	4.0	3.3	48.0	15	8.0	58	1.2
BIG RIVER	BR2	1	Confined	1117	0-3	1.3	3.3	2.2	51.5	23	6.6	64	1.2
BIG RIVER	BR4	1	Confined	806	0-3	1.7	2.9	2.2	50	23	5.8	70	1.4
RUSSEL BROOK	BR5	3	Confined	565	0-3	3.5	3.0	1.8	27.5	15	6.0	33	1.2
RUSSEL BROOK	BR6	4	Confined	460	3-7	3.1	2.4	2.1	10.6	5	4.8	21	2.0
RUSSEL BROOK	BR7	4	Confined	312	3-7	4.8	1.9	1.6	10.5	7	3.8	14	1.3
WILDHORSE GULCH	BR9	4	Mod. Confined	400	3-7	12.0	-	-	-	-	-	-	-
PIGPEN GULCH	BR29	4	Confined	197	3-7	4.2	2.6	2.2	10.5	5	5.2	20	1.9
DAUGHERTY CREEK	BS1	3	Confined	874	0-3	1.7	4.5	2.65	36.3	14	9.0	43	1.2
DAUGHERTY CREEK	BS3	3	Confined	627	0-3	3.0	3.7	2.7	25.9	10	7.4	30	1.2
DAUGHERTY CREEK	BS5	4	Confined	310	3-7	3.7	2.6	1.7	14.5	9	5.2	30	2.1
SODA CREEK	BS15	3	Confined	389	0-3	3.0	2.9	1.9	20.5	11	5.8	29	1.4
GATES CREEK	BS23	3	Confined	542	0-3	2.1	2.5	1.7	32	19	5.0	39	1.2
JOHNSON CREEK	BS24	3	Confined	519	3-7	2.3	2.3	1.6	17.7	11	4.6	37	2.1
SNUFFINS CREEK	BS49	4	Confined	331	3-7	2.4	2.7	2.1	10.8	5	5.4	24	2.2
BIG RIVER	BT1	1	Confined	1766	0-3	0.7	5.3	4.7	76	16	10.6	95	1.3
BIG RIVER	BT2	1	Confined	1628	0-3	1.4	4.5	4	77.8	19	9.0	85	1.1
TWO LOG CREEK	BT4	2	Confined	480	0-3	1.8	4.4	3.3	22	7	8.8	50	2.3
TWO LOG CREEK	BT4(2)	2	Confined	494	0-3	2.0	3.0	2.3	20	9	6.0	38	1.9
BEAVER POND GULCH	BT5	4	Unconfined	224	3-7	5.1	2.8	2.2	11.7	5	5.6	22	1.9
TRAMWAY GULCH	BT12	2	Confined	218	3-7	1.8	2.7	1.7	8	5	5.4	30	3.8
DIETZ GULCH	BT26	4	Confined	328	3-7	1.1	1.4	1.2	8.3	7	2.8	80	9.6

Table E-1 (continued). Stream Segment Field Observations for Big River WAU, 2000-2001

Sediment/bedform Characteristics											Pools						
ID #	Montgomery/ Buffington Class	Rosgen Class	Floodplain Continuity	Channel Roughness	Gravel Bar Abundance	Gravel Bar Types	Gravel Bar Proportion Class	Fine Sediment Abundance	Fine Sediment Type	D50 (mm)	Free	LWD Forced	Boulder Forced	Bank Forced	Total # Pools	Pool Spacing	Mean Res. Pool Depth (ft.)
BE1	P/R	F4	D	C,F,V	Common	P	25-50%	Sparse	P	49	1	2	3	3	9	3.3	n/a
BE2	P/R	F4	D	C,BK	Common	P	25-50%	Sparse	P	46	0	1	0	3	4	6.7	1.4
BE8	FP/R	G4	N	LWD,C,BK	Few	F	0-25%	Moderate	B	29	0	4	0	2	6	5.4	0.8
BE14	FP/R,SP	B4	D	LWD,F	Common	F	0-25%	Abundant	B	24	0	1	0	6	7	4.1	n/a
BI1	P/R	F4	N	C,F	Common	P	25-50%	Sparse	P	104	1	0	0	4	5	3.3	1.8
BL1	P/R	F4	N	C,F	Common	P	25-50%	Sparse	P	63	0	1	0	2	3	6.3	2.7
BL3	P/R	F4	N	C,F	Common	P	25-50%	Sparse	P	50	1	0	0	2	3	6.4	4.3
BL7	CAS	A1	N	R, LWD	Few	F	0-25%	Sparse	P	N/A	2	0	0	2	4	4.9	1.4
BL12	FP/R,CAS	A3	N	LWD,C	Common	F	25-50%	Moderate	M	N/A	0	3	1	1	5	6.0	0.9
BM1	P/R,PB	F4	N	F,BK	Common	P,M	25-50%	Sparse	P	37	2	0	0	2	4	3.7	2.8
BM3	P/R,PB	F4	N	F,BK	Common	A	25-50%	Sparse	P	60	0	0	0	4	4	4.7	4.0
BM5	P/R	F4	D	C,R,V	Common	P,M	25-50%	Sparse	P	89	0	0	0	4	4	5.1	2.9
BM25	P/R	F4	D	C,LWD	Common	P	25-50%	Sparse	M	66	0	2	0	2	4	2.2	1.4
BM26	P/R	F4	I	C,LWD	Common	P	25-50%	Sparse	M	59	0	2	1	4	7	3.3	1.6
BM27	P/R	F4	D	B,C,R	Common	P	25-50%	Abundant	B	25	0	1	0	2	3	8.3	0.9
BM31	P/R	F4	N	LWD,C,BK	Common	P,F	0-25%	Moderate	M	32	1	0	0	7	8	4.7	2.1
BM32	P/R, FP/R	G4, B4	D	C,BK,LWD	Few	P,F	0-25%	Moderate	M	29	0	2	0	1	3	10.1	1.1
BM54	SP	G1	N	R	Few	F	0-25%	Sparse	P	31	1	0	0	5	6	4.3	1.3
BM55	-	-	-	-	-	-	-	-	-	35	1	0	0	3	4	7.8	0.9
BM59	CAS	A3,A1,G4	N	R,C	Few	F	0-25%	Moderate	M	35	0	0	0	0	0	0.0	0.9
BM64	CAS, FP/R	A1,A4,G4	N	R,LWD	Few	F	0-25%	Moderate	M	45	0	2	0	3	5	9.3	1.7
BM76	FP/R, P/R	F4, G4	N	C,BK	Few	F	0-25%	Abundant	B	34	0	1	0	2	3	7.4	0.5
BR1	P/R	F4	N	C,B,R	Common	P	25-50%	Sparse	M	63	0	0	0	4	4	5.8	3.1
BR2	P/R	F4	N	-	Common	P	25-50%	Moderate	M	84	0	1	0	5	6	3.6	3.0
BR4	P/R,PB	F4	D,N	B,C	Few	P	0-25%	Moderate	M	79	1	0	0	4	5	3.2	2.7
BR5	SP, FP/R	B4, G4	D	B,C	Few	F	0-25%	Sparse	P	121	1	0	6	1	8	2.6	1.2
BR6	P/R, PB	F4,G4	D	C,F,BK	Common	P,M	25-50%	Moderate	M	41	1	4	0	3	8	5.4	1.1
BR7	P/R,FP/R	G4,F4	N	LWD,B,BK	Few	F,P	0-25%	Abundant	B	55	0	2	3	3	8	3.7	1.1
BR9	-	-	-	-	-	-	-	-	-	NA	NA	NA	NA	NA	0	NA	-
BR29	FP/R	G4	N	C,LWD	Few	F	0-25%	Abundant	M	41	1	1	2	2	6	3.1	0.9
BS1	P/R	F4	N	C-R-F	Common	P	25-50%	Moderate	P	78	1	0	0	4	5	4.8	2.6
BS3	SP,FP/R	G3, B3	D	C-R-B	Few	F	0-25%	Moderate	M	45	1	0	1	2	4	6.1	2.3
BS5	SP	B4, G4	D	C-BK-LWD	Few	P	0-25%	Moderate	M	50	0	4	0	2	6	3.6	1.8
BS15	FP/R, P/R	G4	N	C-LWD-R	Common	F-P	25-50%	Moderate	M	48	1	3	0	3	7	2.7	1.2
BS23	SP, P/R	G3, B3	N	C-R-B-V	Few	P, F	0-25%	Moderate	M	65	0	0	0	5	5	3.4	1.3
BS24	FP/R	B4, G4	D	C-LWD	Few	M	0-25%	Moderate	M	64	2	6	0	3	11	2.7	1.1
BS49	P/R, FP/R	G4	D	C-V-LWD	Few	F	0-25%	Moderate	M	48	1	4	1	1	7	4.4	1.6
BT1	P/R, PB	F4	N	F,V	Common	P	0-25%	Moderate	M	30	2	2	0	1	5	4.6	1.8
BT2	P/R,PB	F4	N	F,BK	Common	P	25-50%	Sparse	P	37	0	0	0	7	7	3.0	2.9
BT4	P/R	Cb4,F4	D	C,LWD,BK	Common	P,F	25-50%	Sparse	P	35	0	3	0	2	5	4.4	1.6
BT4(2)	P/R	F4	D	C,LWD,BK	Common	P	25-50%	Sparse	P	36	2	3	0	2	7	3.5	1.4
BT5	SP	B4,G4	N	C,LWD	Few	F	0-25%	Sparse	P	30	1	2	0	2	5	3.8	0.7
BT12	P/R	E4/C4	C	C,LWD,BK	Few	F	0-25%	Sparse	P	30	0	3	0	2	5	5.5	0.7
BT26	P/R	E4,C4	C	V,LWD	-	-	-	Abundant	B	30	2	0	0	4	6	6.6	1

Stream Geomorphic Units

Stream geomorphic units were developed for the stream network on the MRC property in the Big River watersheds. These units are general representations of stream channels with similar sensitivities to coarse sediment, fine sediment and large woody debris inputs. Five stream geomorphic units were developed for interpretation of stream channel response to forest management interactions in the Big River WAU. The five stream geomorphic units are described below.

Geomorphic Unit I. Confined Low Gradient Channels of the Big River Watershed.

Segments: BT1, BT2, BT3, BR1, BR2, BR3, BR4, BL1, BL2, BL3, BI1, BM1, BM2, BM3, BM4, BM5

General Description:
The channels within this unit meander through confined canyons. The channels are commonly entrenched 50 to 100 feet deep within strath terraces or hillslopes. The channels of this unit are frequently controlled laterally by bedrock. Hillslopes typically control the lateral movement of the channels with inner gorge topography formed along sections of the channel. Though highly confined the river channels exhibit some occasional floodplain development, though discontinuously. The bankfull channel varies from approximately 50 to 80 feet in width. The channels in this unit are low gradient (0-2 percent), but sediment transport capacity is high due to the confined channel keeping water energy directed within the channel and relatively large drainage areas producing greater water flow.

Associated Channel Types:
This unit primarily exhibits pool/riffle and plane bed morphology. The Rosgen classification (Rosgen, 1996) for these channels are F4, due to the high entrenchment.

Fish Habitat Associations:
The confined channels of this units have a high sediment transport capacity during high flows, which flushes fine sediment, with the potential to create high quality spawning gravel. This same high-energy transport, in conjunction with bedrock and LWD, dominates pool development. Currently this unit has low amounts of large woody debris, however due to the confined canyons, wood recruitment would have a positive effect on the quality of in-stream habitat by making the shelter associated with pools more complex. The wide bankfull channel tends to create low shade, creating high summer water temperatures thus lowering summer rearing habitat quality for salmonids. Overwintering habitat is facilitated by bedrock that creates deep pools but can be limited in areas without this. LWD when present in this unit provides overwintering habitat for juvenile salmonids.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
These channels are depositional areas for coarse sediment due to their low gradient. The high confinement of these channels creates relatively high sediment transport capacity. If the supply of coarse sediment surpasses the transport capacity of the stream, pools can be filled, and the influence of large woody debris and bedrock controlled sections are lessened. The width to depth ratios of these channels is high. If significant amounts of coarse sediment are supplied to these channels then the channels are vulnerable to aggradation. Because the channels are

typically entrenched within bedrock the tendency toward widening or adjustments in meanders is minimal.

Fine Sediment: Moderate Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment do occur in this unit. Sparse to moderate accumulations of fine sediment was observed in this unit. These accumulations were observed in the gravel bars, along channel margins, and in some pools.

Large Woody Debris(LWD): Moderate Response Potential
Large woody debris is sparse in this unit. The LWD that is present is providing stream habitat development and cover. The confined high energy flow and large channels of this unit require very large LWD pieces or debris jams to keep the LWD in place. Very large LWD is recruited into channels infrequently due to the long growing times of streamside trees. However, LWD in this unit is still important because the channels in this unit gain greater pool depths and cover, for fish habitat diversity, with increased LWD.

Geomorphic Unit II. Confined to Moderately Confined Depositional Channels of Tributaries of the Big River Watershed.

Segments: BT4, BT12(partial), BE1, BE2, BM25, BM26, BM27

General Description:
The channels within this unit flow through confined canyons. Hillslopes or historic terraces typically control the lateral movement of the channels. Some recent terraces development is present and floodplains are present, though discontinuously. The bankfull channel is typically 10 and 40 feet in width. The channels in this unit are low gradient (1-3 percent). These channels exhibit moderate sediment transport capacity. The confined channel keeps water energy directed within the channel but the relatively smaller drainage areas does not produce as high a water energy from surface flow as Unit I.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology. The Rosgen classifications (Rosgen, 1996) for these channels are primarily F4, with occasional areas of Cb4 and E4.

Fish Habitat Associations:
Spawning habitat and gravel are in good amounts in this unit, but spawning gravel quality is only fair where present. These channels are confined within narrow canyons that produce good recruitment potential for LWD. The recruited LWD in turn facilitates pool development and offers shelter. Rearing habitat availability can be good where sufficient LWD creates good pool habitat and shelter, however summer rearing can be absent because some of the streams in this unit can go subsurface during the summer rearing period. Young fish would have to migrate to other areas to survive through the summer months. Overwintering habitat is provided by large cobble/boulder and bedrock substrates. LWD when present in this unit also provides overwintering habitat for juvenile salmonids.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
These channels are depositional areas for coarse sediment. The moderate sediment transport capacity makes these channels vulnerable to changes in supply of coarse sediment. Fluctuations of coarse sediment can occur that will surpass the transport capacity of the stream. When this occurs pools can be filled, the influence of large woody debris and bedrock controlled sections are lessened and the channels can aggrade. Aggradation of the channel can create greater bank erosion or produce limited lateral movement increasing localized bed scour thus causing the channels to entrench.

Fine Sediment: Moderate Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment do occur in this unit. Sparse accumulations of fine sediment were observed in this unit, however some isolated areas with abundant fine sediment were also observed. These accumulations were observed in the gravel bars, along channel margins, and in some pools.

Large Woody Debris(LWD): High Response Potential
The alluvial composition of the bed material in conjunction with a low gradient channel makes these channels highly responsive to LWD inputs. LWD is a dominant influence for pool

development, sediment storage behind LWD accumulations and stabilization of bank and bedforms within the channels in this unit. Currently LWD levels are below desired targets; additional LWD will greatly enhance the aquatic environment.

<u>Geomorphic Unit III.</u> Highly Confined Depositional Channels of Tributaries of the Big River Watershed.

Segments: BR5, BR6(partial), BP1, BM31, BM76, BS1, BS2, BS3, BS4, BS15, BS23, BS24

General Description:
The channels within this unit are highly entrenched and confined within narrow canyons. The channels are commonly entrenched 25 to 50 feet deep within strath terraces or hillslopes. The highly confined channels rarely have any floodplain or terrace development. The bankfull width of channels varies from approximately 10 to 30 feet. The channels in this unit are low gradient (1-3 percent), but sediment transport capacity is high due to the confined channel keeping water energy directed within the entrenched channels.

Associated Channel Types:
This unit primarily exhibits pool/riffle, forced pool/riffle morphology, with areas of step pool morphology. The Rosgen classifications (Rosgen, 1994) for these channels vary from F3-F4 and G3-G4 with areas of B3, B4 depending on the bank configuration, slope and channel substrate.

Fish Habitat Associations:
The confined channels of this units have a high sediment transport capacity during high flows, which flushes fine sediment, with the potential to create high quality spawning gravel. This same high-energy transport, in conjunction with bedrock and LWD, dominates pool development. Currently this unit has low amounts of large woody debris, however due to the confined channels, wood recruitment would have a positive effect on the quality of in-stream habitat by making the shelter associated with pools more complex. The narrow bankfull channel tends to create good potential for stream shade, potentially creating lower summer water temperatures providing summer rearing habitat for salmonids. Overwintering habitat is facilitated by cobble and boulder sized substrate. LWD when present in this unit provides overwintering habitat for juvenile salmonids.

Conditions and Response Potential
Coarse Sediment: Moderate Response Potential
These channels are depositional areas for coarse sediment. The high confinement of these channels creates relatively high sediment transport capacity. If the supply of coarse sediment surpasses the transport capacity of the stream, pools can be filled, and the influence of large woody debris and bedrock controlled sections are lessened. Because of the natural confinement of these channels the tendency toward widening or adjustments in meanders are minimized.

Fine Sediment: Moderate Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment do occur in this unit. Moderate levels of fine sediment were observed in this unit. These accumulations were observed in the gravel bars, along channel margins, and in some pools.

Large Woody Debris(LWD): High Response Potential
LWD provides a dominant influence for pool development, sediment storage behind LWD accumulations and stabilization of bank and bedforms within the channels in this unit. Currently LWD levels are below desired targets; additional LWD will greatly enhance the aquatic environment.

<u>Geomorphic Unit IV.</u> Moderate Gradient Confined Transport Channels of the Big River Watershed.

Segments: BT5, BT26, BT27, BL7, BL12, BE8, BE14, BR6(partial), BR7, BR9, BR29, BM6, BM30(partial), BM28, BM32, BM56, BM54, BM55, BM59, BM64, BM65, BM69, BM70, BM82, BM83, BM86, BS5, BS7, BS36, BS37, BS44, BS49, BS50, BP2, BP3, BP4

General Description:
Stream channel segments in this unit are confined within hillslopes. Typically valley widths are between 2 and 5 bankfull channel widths. This valley width is sufficient to allow some isolated terrace formation and channel meandering. The channel segments in this unit are near the transition between deposition and transport channels. Due to the moderate gradient (3-8 percent, though higher gradients do occur in this unit) of the channels, they are responsive to aggradation and degradation from changes in the stream sediment supply. The bed of the stream of these channels varies from gravel to boulder sized particles. The terraces in this unit appear to be created from large episodic sediment loads such as mass wasting. The gradient of the stream is high enough that stream segments in this unit easily down-cut through the terrace deposits when flow is concentrated.

Associated Channel Types:
This unit primarily exhibits forced pool/riffle and cascade morphology, with areas of step pool morphology. The Rosgen classifications (Rosgen, 1994) for these channels vary from B3-B4, G3-G4, and A1-A4 depending on the bank configuration, slope and channel substrate.

Fish Habitat Associations:
Spawning areas in this unit are infrequent, due to lack of accumulations of gravel sized particles. The steeper gradient segments of this unit typically form step-pool, cascade, and some pool-riffle habitat. The step-pools that are typically boulder formed, and offer substrate refugia, which provide both rearing and overwintering habitat.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
The channels in this unit have relatively high sediment transport capacity. In the lower gradient sections of these channels coarse sediment can create pool filling and aggradation, resulting in increased bank erosion and poor stream habitat. The step pool sections of these channels have relatively stable cobble and boulder component that can remain relatively static except in extreme flows. Increased coarse sediment supply can create pool filling, but is only moderately influential on the morphology because pool filling at these moderate gradients creates lower channel roughness which in turn promotes more step pool or cascade development, provided high inputs of coarse sediment subside.

Fine Sediment: Low Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment do occur but typically have short residence times in this unit. Moderate accumulations of fine sediment were observed in this unit. These accumulations were observed in the bed and along channel margins.

Large Woody Debris: Moderate Response Potential

The high confinement or entrenchment of these channels provides little opportunity for the channel to meander or develop a floodplain. Water energy is concentrated within the confines of canyon walls or stream banks making the role of LWD less sensitive as channels with less confinement or entrenchment. LWD is less likely to enter the channel because it becomes suspended over the channels narrower bankfull width. The role of LWD is typically as sediment storage or forced step pool development in these channels. Bed morphology in channels with slope gradients of 4-10% is typically step pool (Montgomery and Buffington, 1993). The large bed forming material of step pool morphology is generally stable making the role of LWD in these channels less sensitive than other channel types.

<u>Geomorphic Unit V.</u> High Gradient Transport Channels of the Big River Watershed.

Segments: BP5, BP6, BI2, BI3, BI4, BI5, BE3, BE4, BE5, BE6, BE7, BE9, BE10, BE11, BE12, BE13, BE15, BE16, BE17, BL4, BL5, BL6, BL8, BL9, BL10, BL11, BL13, BL14, BL15, BL16, BL17, BL18, BI2, BI3, BI4, BI5, BT6, BT7, BT8, BT9, BT10, BT11, BT12(partial), BT13, BT14, BT15, BT16, BT17, BT18, BT19, BT20, BT21, BT22, BT23, BT24, BT25, BT28, BT29, BT30, BT31, BM7, BM8, BM9, BM10, 11, BM12, BM13, BM14, BM15, BM16, BM17, BM18, BM19, BM20, BM21, BM22, BM23, BM24, BM29, BM30(partial), BM33, BM34, BM35, BM37, BM38, BM39, BM40, BM42, BM43, BM44, BM45, BM46, BM47, BM448, BM49, BM50, BM51, BM52, BM53, BM57, BM58, BM60, BM61, BM62, BM63, BM66, BM67, BM68, BM71, BM72, BM73, BM74, BM75, BM77, BM78, BM80, BM81, BM84, BM85, BM87, BR8, BR10, BR11, BR12, BR13, BR14, BR15, BR16, BR17, BR18, BR19, BR20, BR21, BR22, BR23, BR24, BR26, BR27, BR28, BR30, BR31, BR32, BR33, BR34, BR35, BR36, BR37, BR38, BR39, BR40, BR41, BR42, BR43, BR44, BR45, BR46, BR47BS6, BS8, BS9, BS10, BS11, BS12, BS13, BS14, BS16, BS17, BS18, BS19, BS20, BS21, BS22, BS25, BS26, BS27, BS28, BS29, BS30, BS31, BS32, BS33, BS34, BS35, BS38, BS39, BS40, BS41, BS42, BS43, BS45, BS46, BS47, BS48, BS51, BS52, BS53, BS54, BS55, BS56, BS57, BS58, BS59, BS60, BS61, BS62, BS63, BS64, BS65, BS66, BS67, BS68

General Description:
Channel segments in this unit are high gradient transport reaches from 8-20% with high sediment transport capacity. The channel segments in this unit typically flow through tightly confined, steep-sided, V-shaped canyons. However, many of the channels are located in more open or U-shaped colluvial and alluvial filled canyons. The channels tend to be highly entrenched in these areas making them as confined as channels directly adjacent to hillslopes. These are typically zones of scour during high flows or debris flows. Stream substrate is typically from cobble to large boulders. Typically, there is little to no water flow in this unit in the summer drought season.

Associated Channel Types:
This unit varies it morphology from step pool to cascades with some occasional waterfalls. The cascades and waterfalls occur in the steepest segments of this unit and only during winter storm events. The Rosgen (Rosgen, 1996) classification for these channels varies between A2, A3, and AA2, AA3 depending on channel gradient and substrate composition.

Fish Habitat Associations:
The high gradient channels of this unit prevent coho salmon from accessing these areas. Potential for steelhead trout utilization is low due to the high gradient; 8% to 20%. Rearing would be unlikely because stream flow typically goes subsurface in the summer months.

Conditions and Response Potential

Coarse Sediment: Low Response Potential
Typically the channel morphology in this unit is cascade, with some step pool morphology at the lower gradients observed in these channels. These channels have bed material that is coarse and relatively immobile. Down cutting or bank erosion are not common in these high gradient, large substrate dominated channels even with increases in sediment supply. Debris flows can cover the substrate creating the cascade morphology but this is generally short-lived due to the high sediment transport capacity of the channels.

Fine Sediment: Low Response Potential
The high gradient of the channels in this unit creates a high fine sediment transport capability. Pools or storage areas for fine sediment in these channels are limited making the impacts from fine sediment minimal. Down cutting or bank erosion can be common in these high gradient, large substrate dominated channels though typically this erosion is transported downstream.

Large Woody Debris: Low Response Potential
The role of LWD in these channels is to provide storage of sediment and also as a source for downstream LWD. LWD is needed in these channels however the need for LWD as a source for downstream LWD is episodic and therefore the least sensitive as other channel types. The storage of sediment by LWD in these channels is necessary, but can be accomplished by a range of size classes of LWD not necessarily very key LWD pieces.

Long Term Stream Monitoring

During the Summer of 2000 five long term channel monitoring segments were surveyed for thalweg profiles, cross sections, and particle size distribution in the Big River WAU. The monitoring segments were located on Big River, East Branch of the North Fork Big River, Ramon Creek, Daugherty Creek, and South Fork Big River. This was the first year that this data was collected, so there is no temporal or comparative analysis that can be done. This represents the base line condition for future monitoring. The plots of the surveys are included in the appendix of this module (Appendix E) for display. The results of the stream gravel bulk samples and permeability are presented in section F - Fish Habitat Assessment of this report. Future surveys in these monitoring segments will evaluate LWD.

LITERATURE CITED

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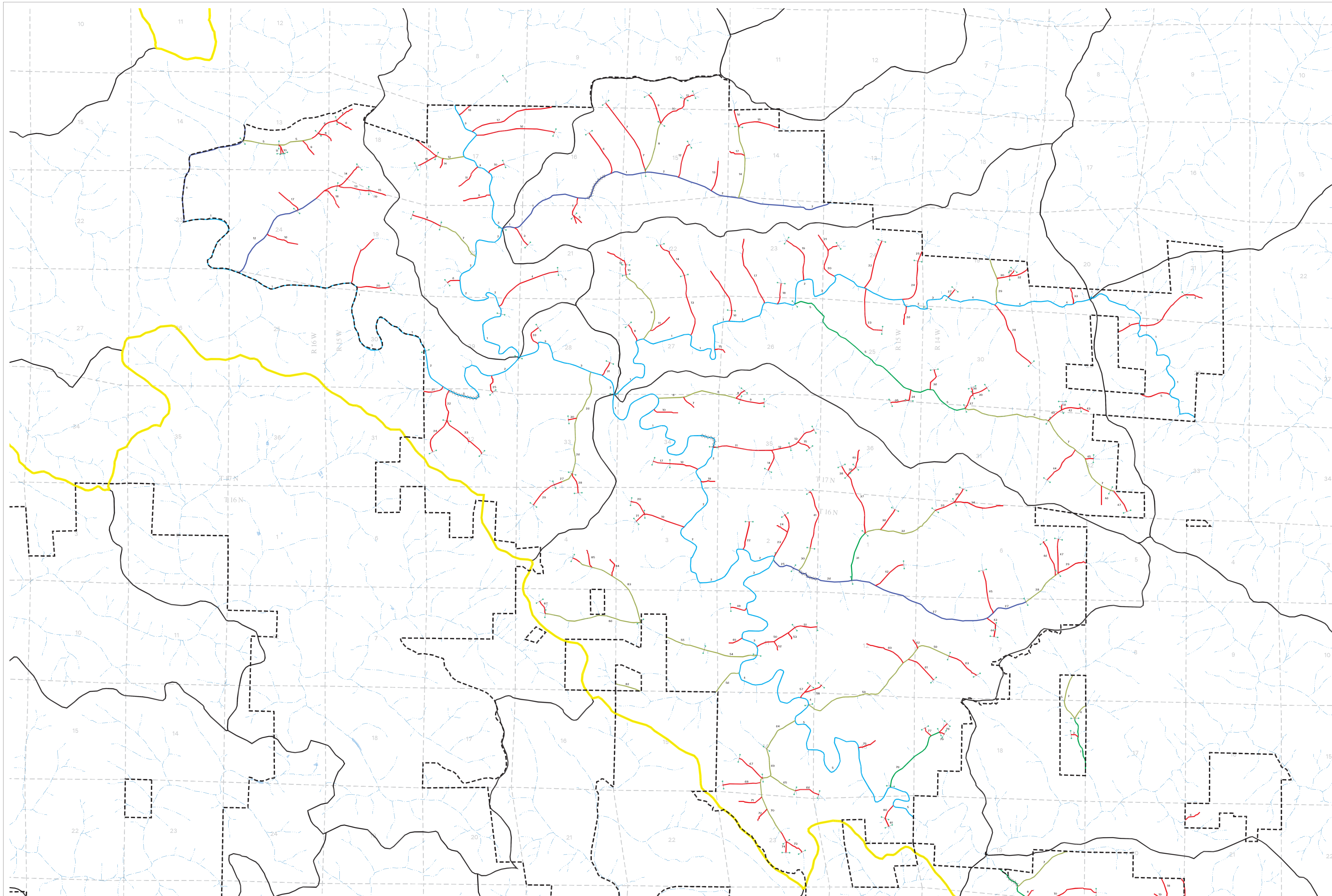
Sullivan, K., T. Lisle, C. Dollhof, G. Grant, and L. Reid. 1986. Stream channels: the link between forests and fishes. In: Salo E.O. and T. Cundy. Streamside Management: Forestry and Fishery Interactions. Proc. of Symposium held at the Univ. of Washington, Feb 12-14, 1986, Seattle, WA: 39-97.

Washington Forest Practice Board. 1997. Standard methodology for conducting watershed analysis. Version 4.0. WA-DNR Seattle, WA.



Big River Watershed Analysis Unit

Map E-1 Stream Channel Geomorphic Units and Segments

This map presents the stream channel network for the Big River WAU partitioned into stream segments based on channel confinement and channel gradient. Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the Big River WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes and responses to forest management affects.

Geomorphic Classes

- Unit I. Confined low gradient channels of the Big River watershed
- Unit II. Confined to moderately confined depositional channels of tributaries of the Big River watershed
- Unit III. Highly confined depositional channels of tributaries of the Big River watershed
- Unit IV. Moderate gradient confined transport channels of the Big River watershed
- Unit V. High gradient transport channels of the Big River watershed

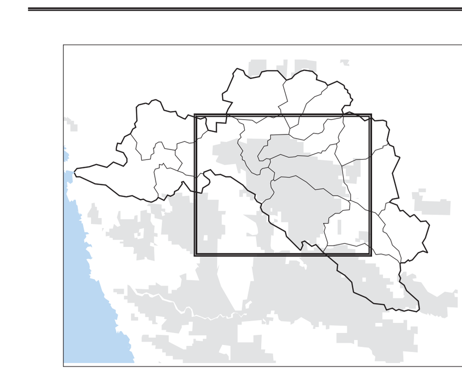
Long Term Channel Monitoring Sites

MRC Ownership
Planning Watershed Boundary
Big River Watershed Boundary

Flow Class

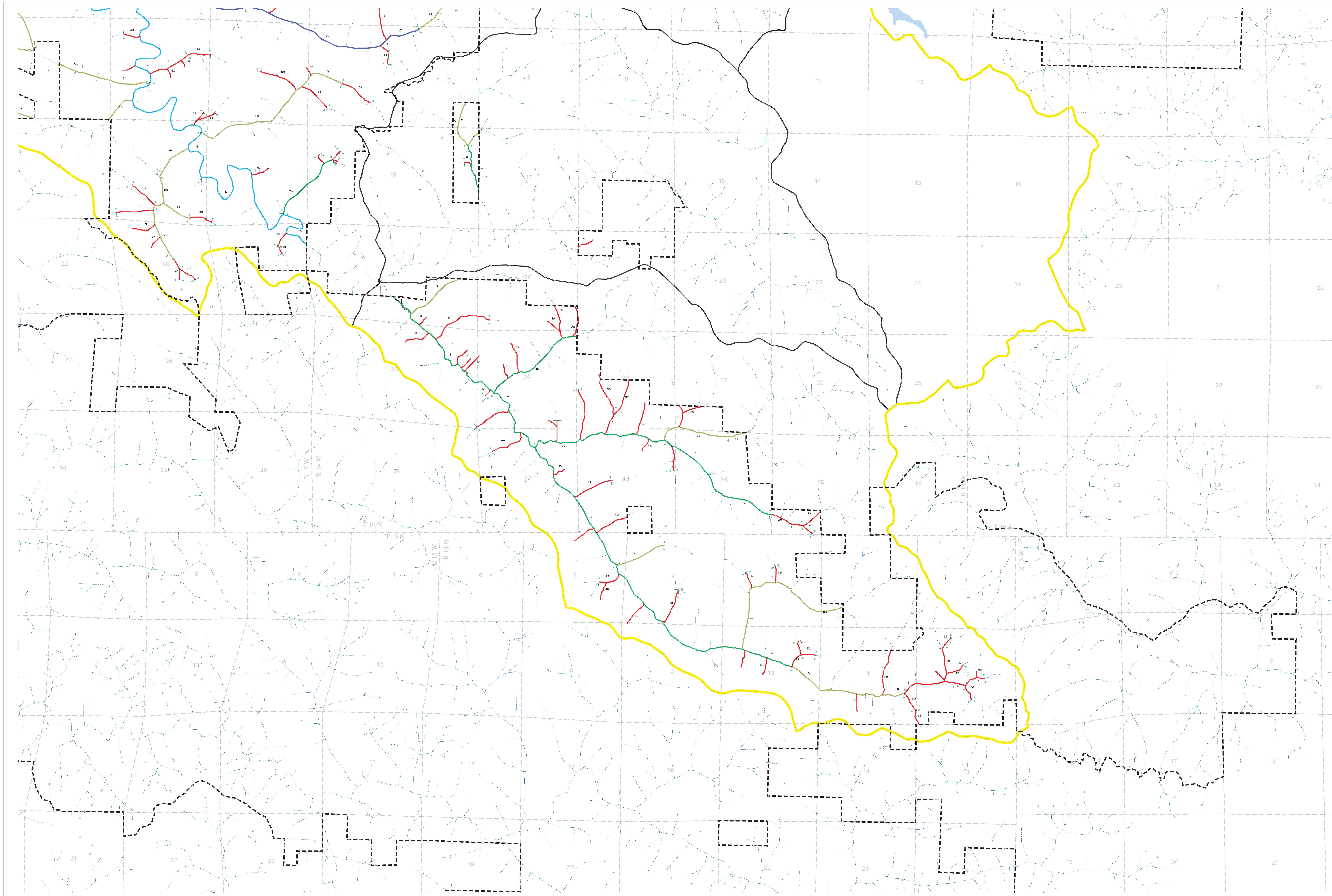
Class I
Class II
Class III

Sheet 1



0 1/2 1 Mile

September 2003



Big River Watershed Analysis Unit

Map E-1 Stream Channel Geomorphic Units and Segments

This map presents the stream channel network for the Big River WAU partitioned into stream segments based on channel confinement and channel gradient. Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the Big River WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes and responses to forest management affects.

Geomorphic Classes

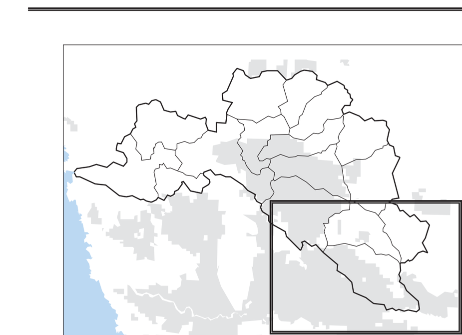
- **Unit I.** Confined low gradient channels of the Big River watershed
- **Unit II.** Confined to moderately confined depositional channels of tributaries of the Big River watershed
- **Unit III.** Highly confined depositional channels of tributaries of the Big River watershed
- **Unit IV.** Moderate gradient confined transport channels of the Big River watershed
- **Unit V.** High gradient transport channels of the Big River watershed

- Long Term Channel Monitoring Sites
- MRC Ownership
- Planning Watershed Boundary
- Big River Watershed Boundary

Flow Class

- Class I
- Class II
- Class III

Sheet 2

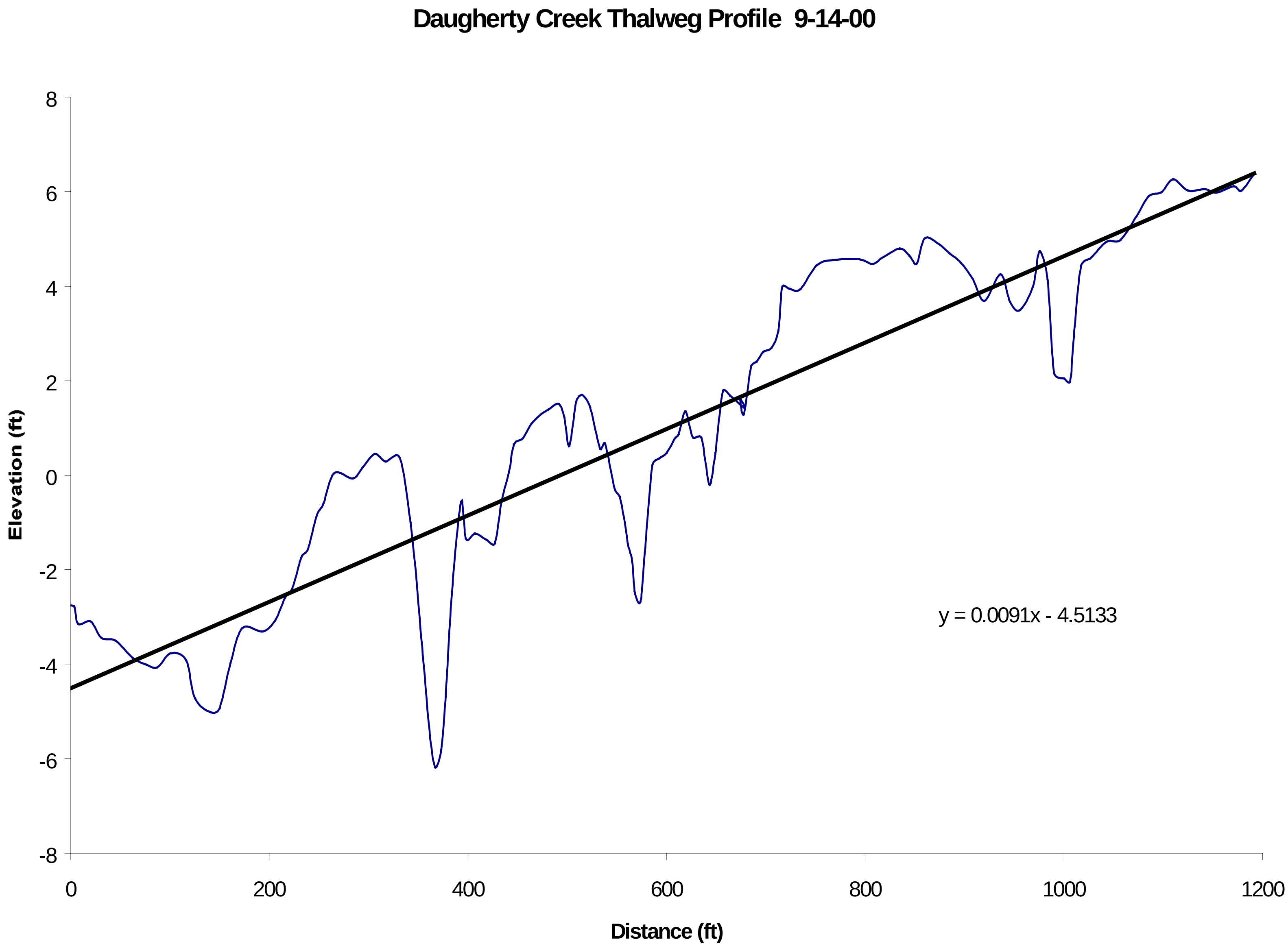


0 1/2 1 Mile

September 2003

Appendix E

Stream Channel Condition Module



Daugherty Creek Thalweg Profile 9-14-00
Elevation (ft)
8
6
4
2
0
-2
-4
-6
-8
0
200
400
600
800
1000
1200
Distance (ft)
y = 0.0091x - 4.5133

Daugherty Creek Thalweg Profile Analysis 2000

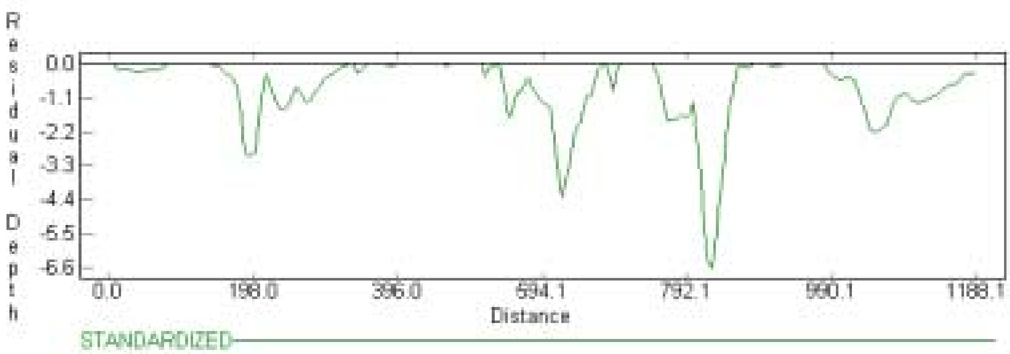
-

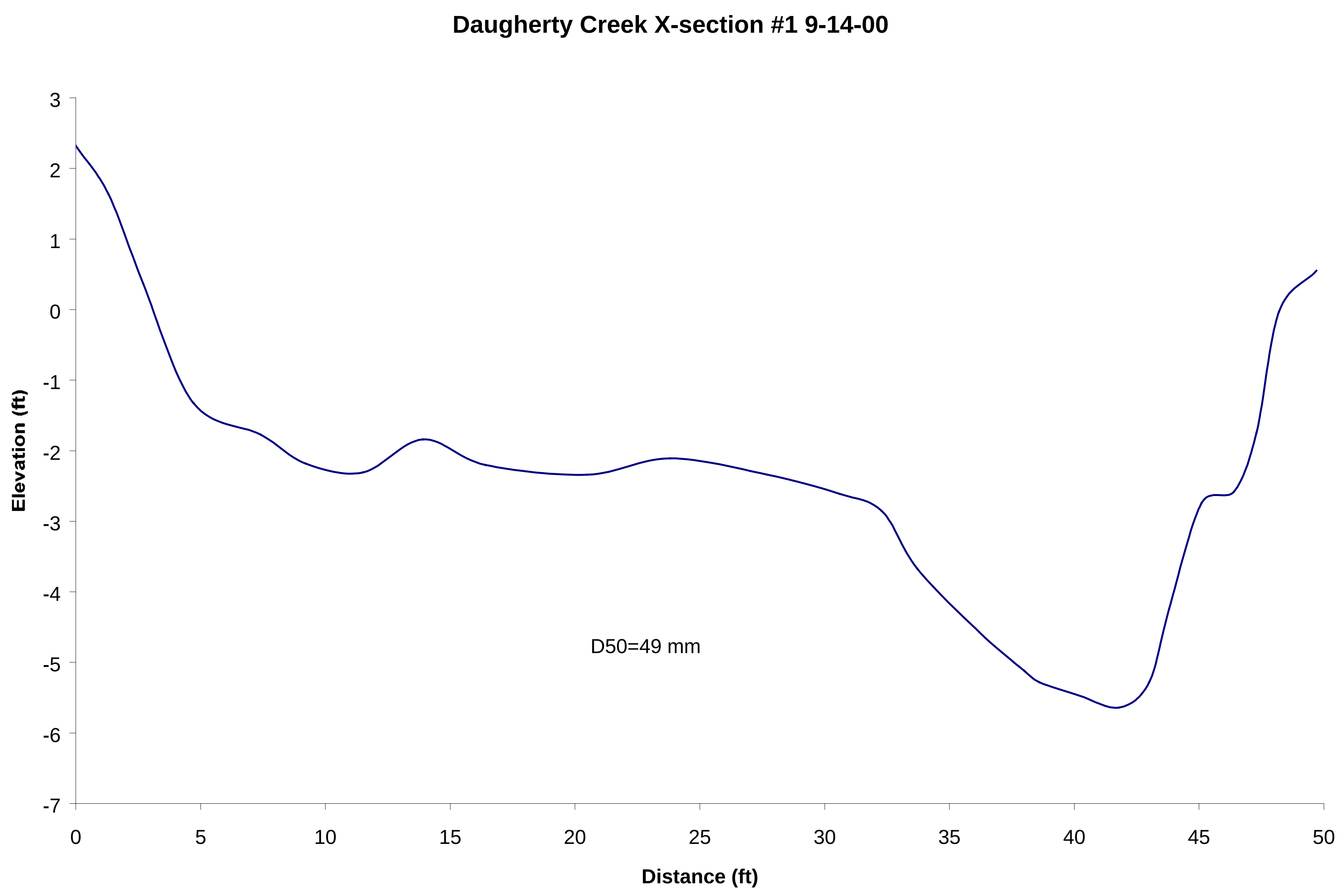
Standardized Statistics:
         Number of data points in raw data: 128
Number of data points in Standardized data: 238

Reach Step Distance: 5.00

 Max Residual Depth: 6.61
Mean Residual Depth: 0.79
 Standard Deviation: 1.13

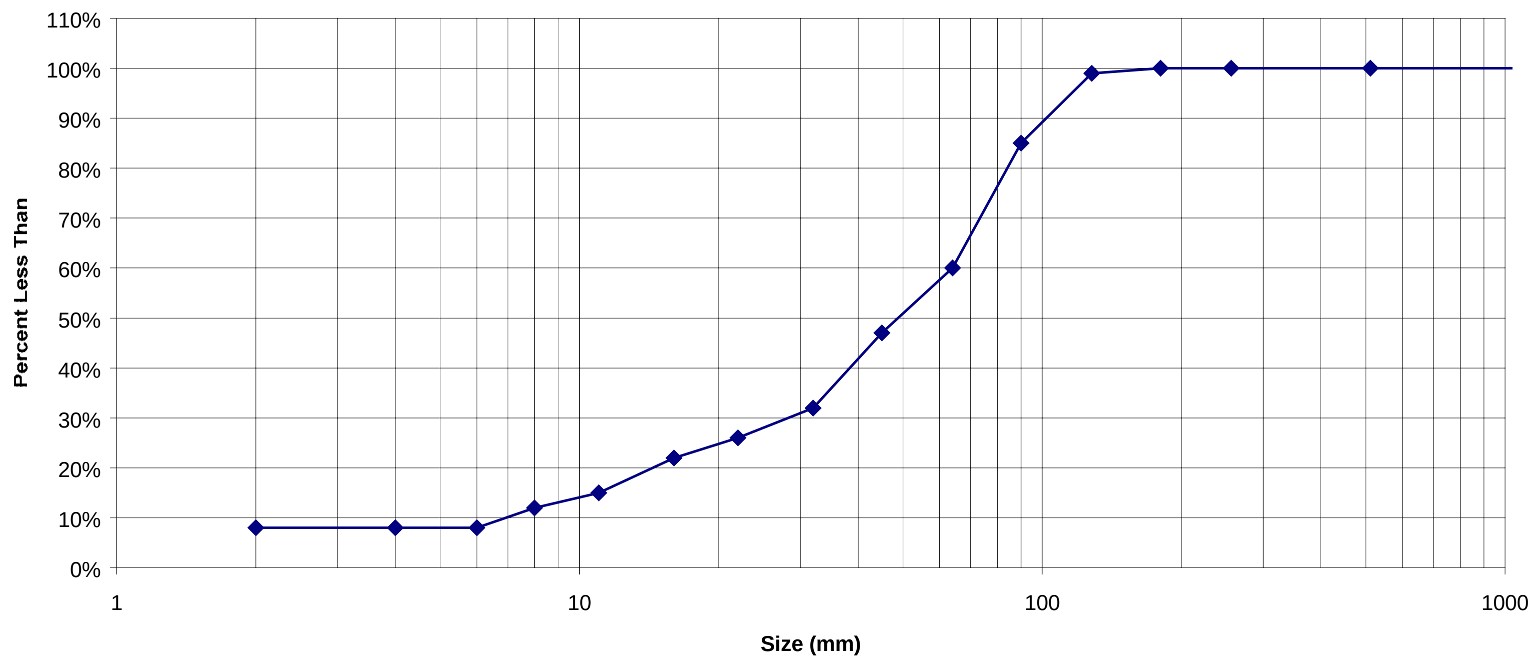
Number of non-zero Residual Depths: 179
  Percent of Reach as pool: 75.21
Percent of Reach as riffle: 24.79

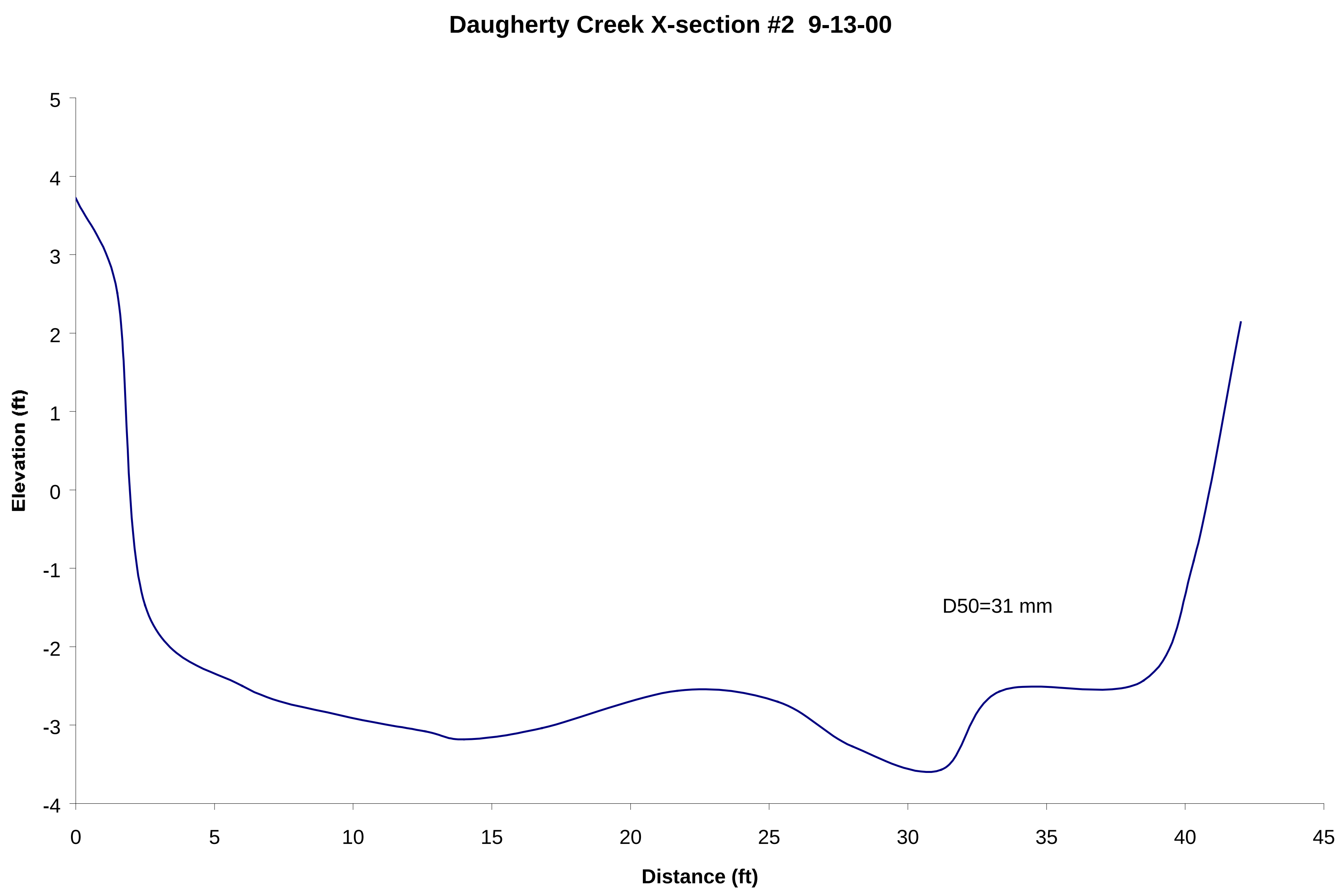


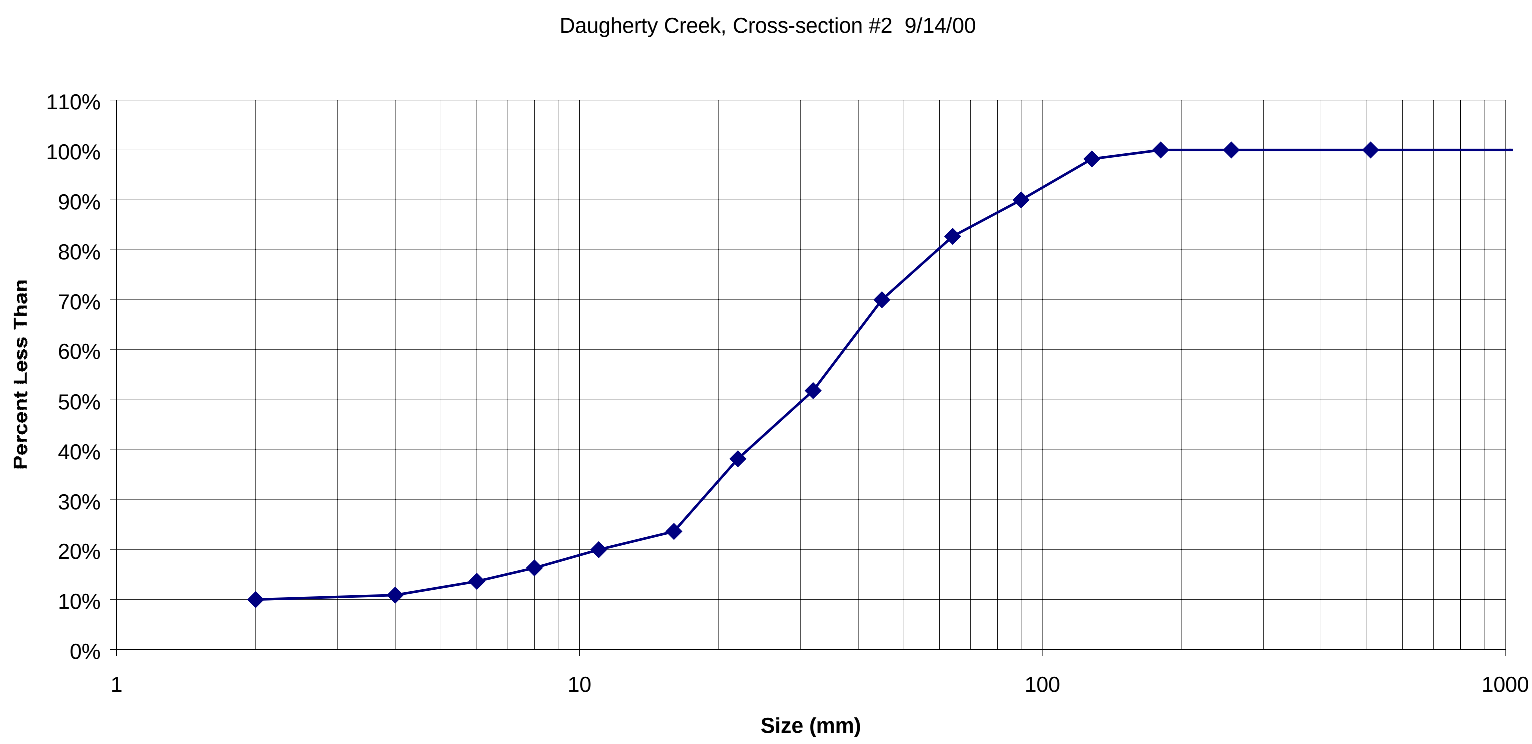


Daugherty Creek X-section #1 9-14-00
Elevation (ft)
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
0
5
10
15
20
25
30
35
40
45
50
Distance (ft)
D50=49 mm

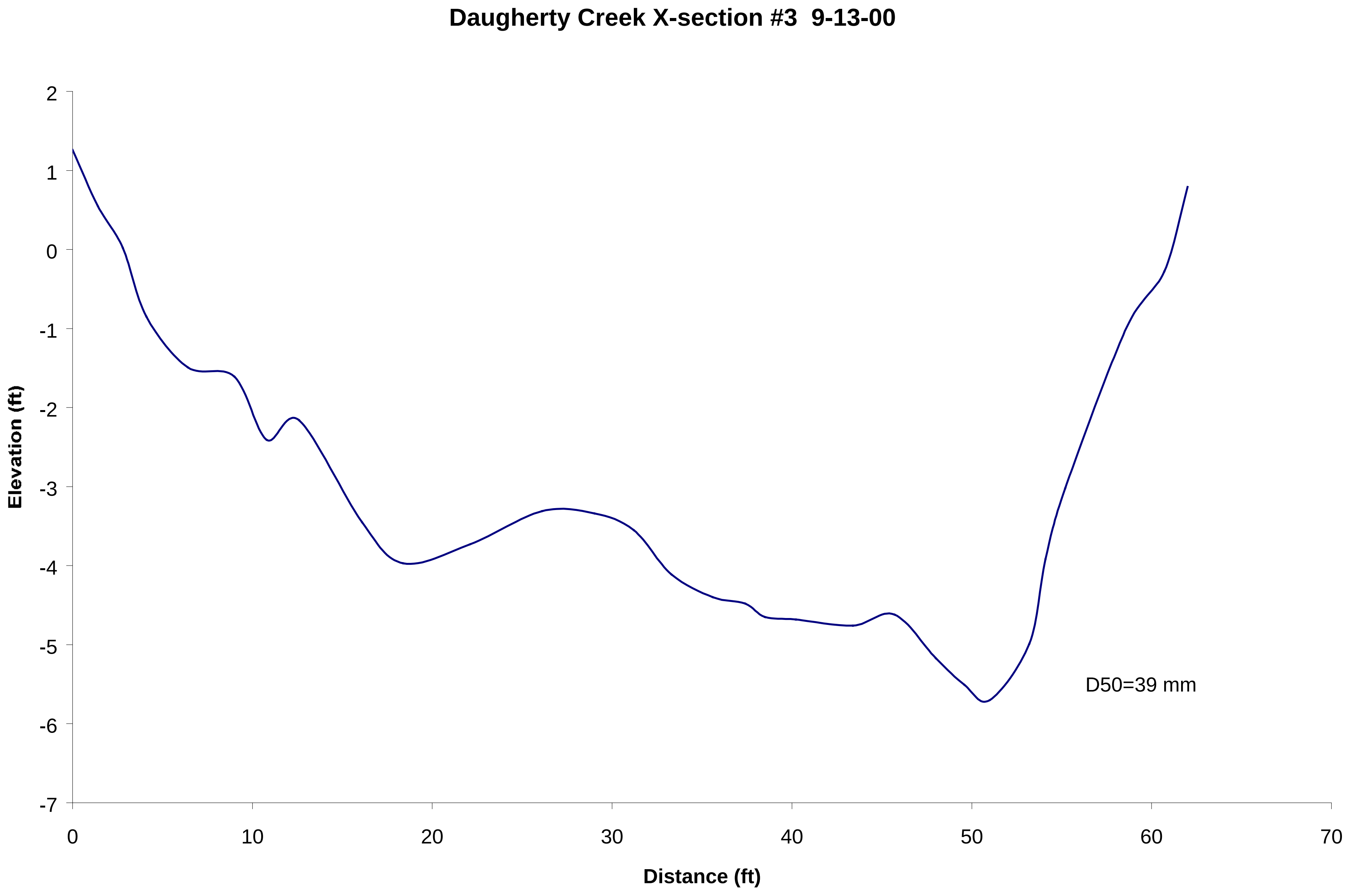
Daugherty Creek, Cross-section #1 9/14/00




Daugherty Creek X-section #2 9-13-00
Elevation (ft)
5
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30
35
40
45
Distance (ft)
D50=31 mm

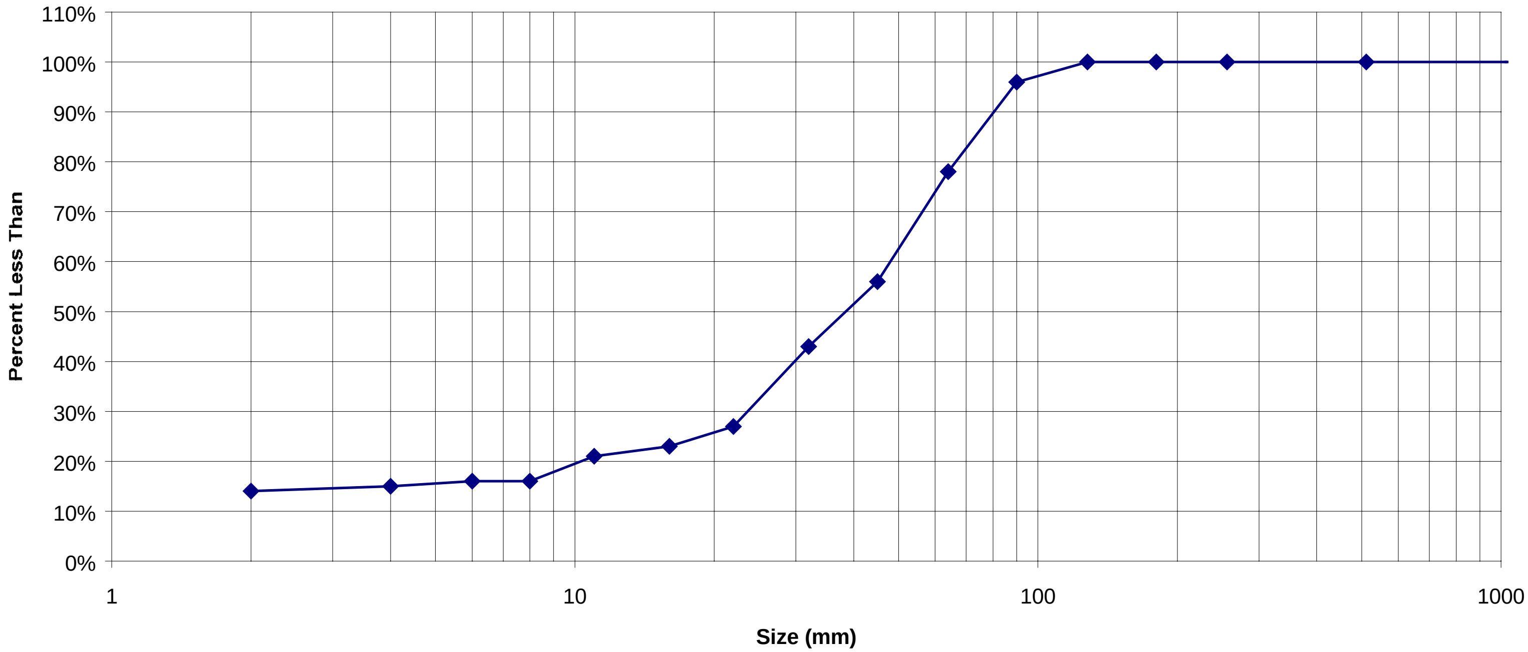


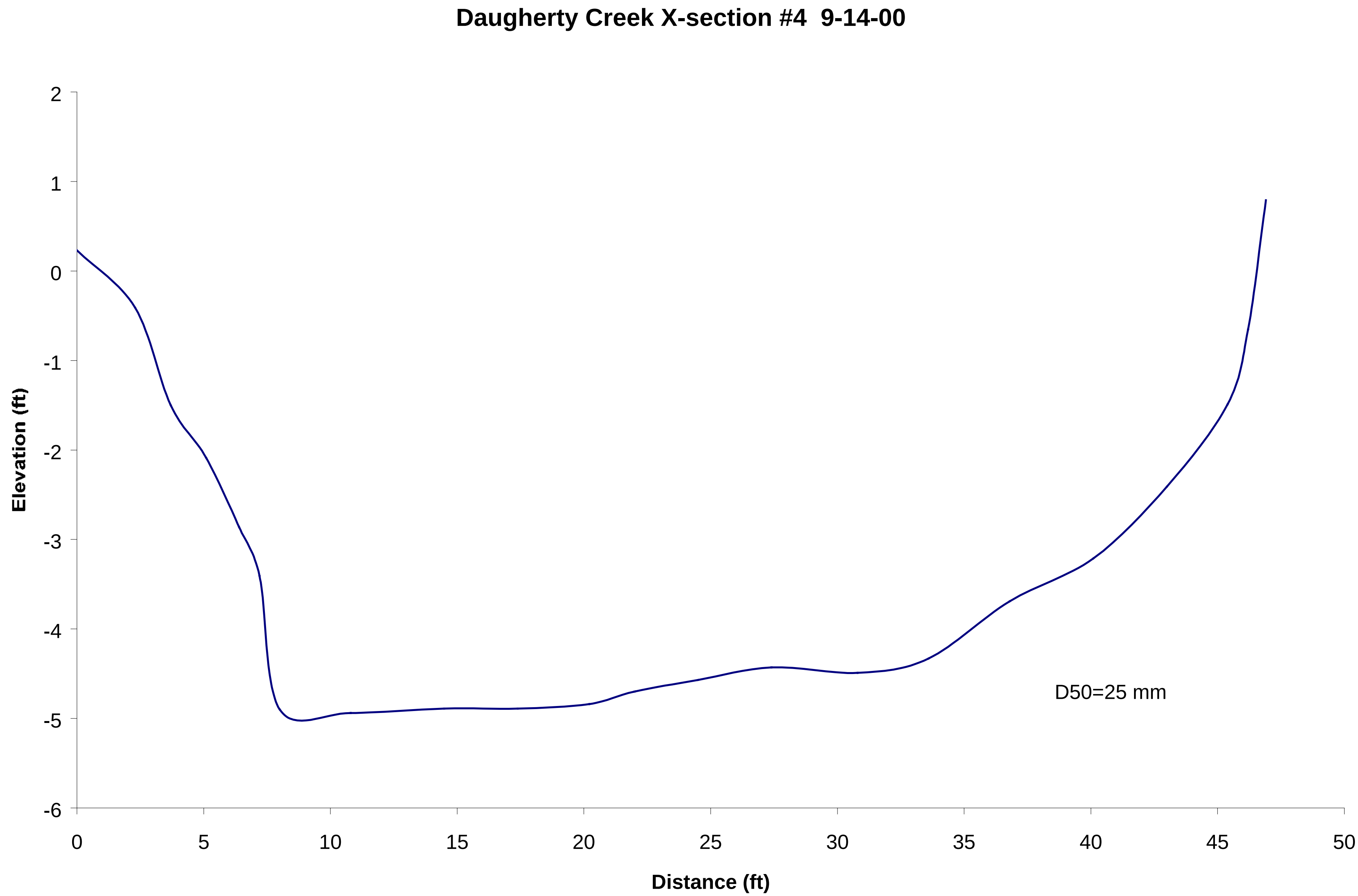
Daugherty Creek, Cross-section #2 9/14/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)

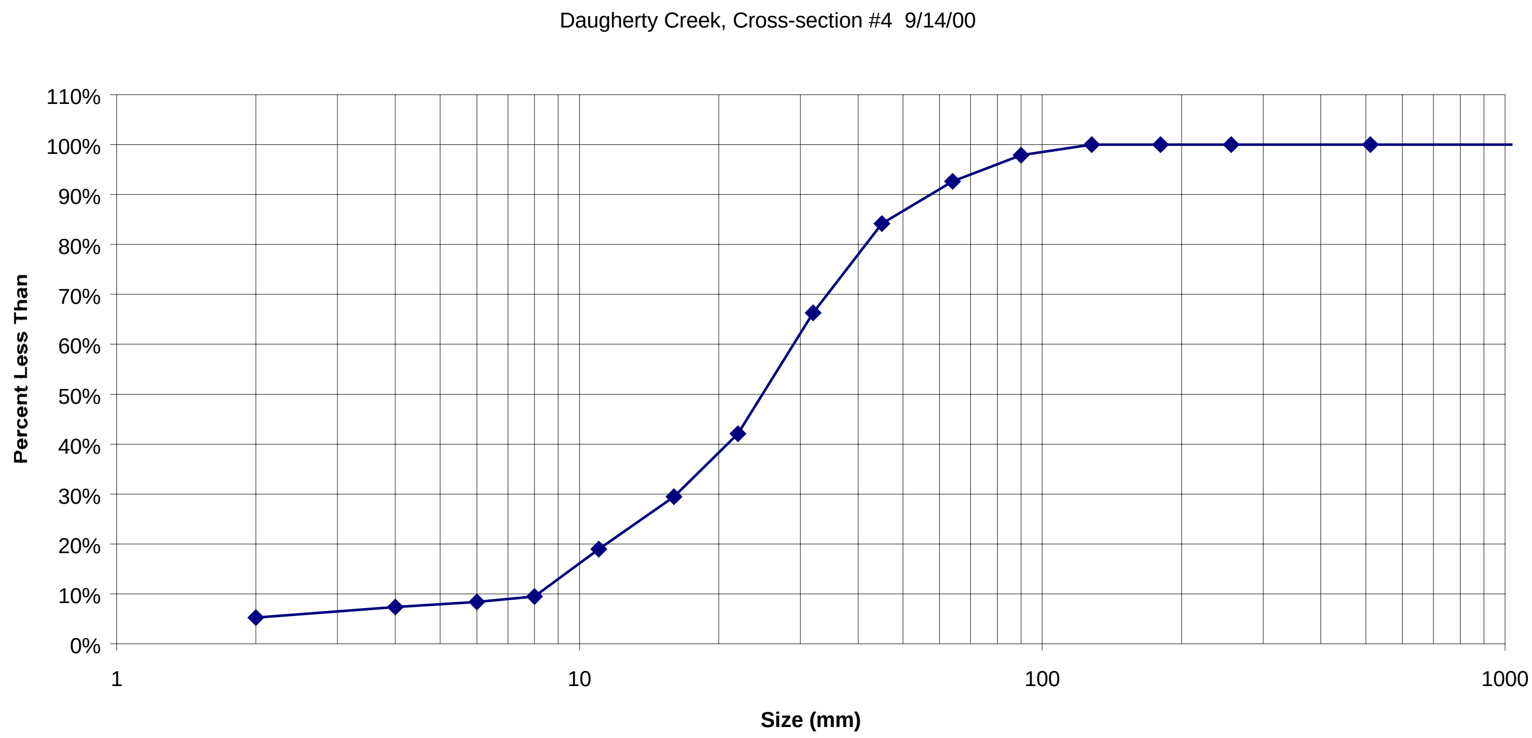


Daugherty Creek X-section #3 9-13-00
Elevation (ft)
2
1
0
-1
-2
-3
-4
-5
-6
-7
0
10
20
30
40
50
60
70
Distance (ft)
D50=39 mm

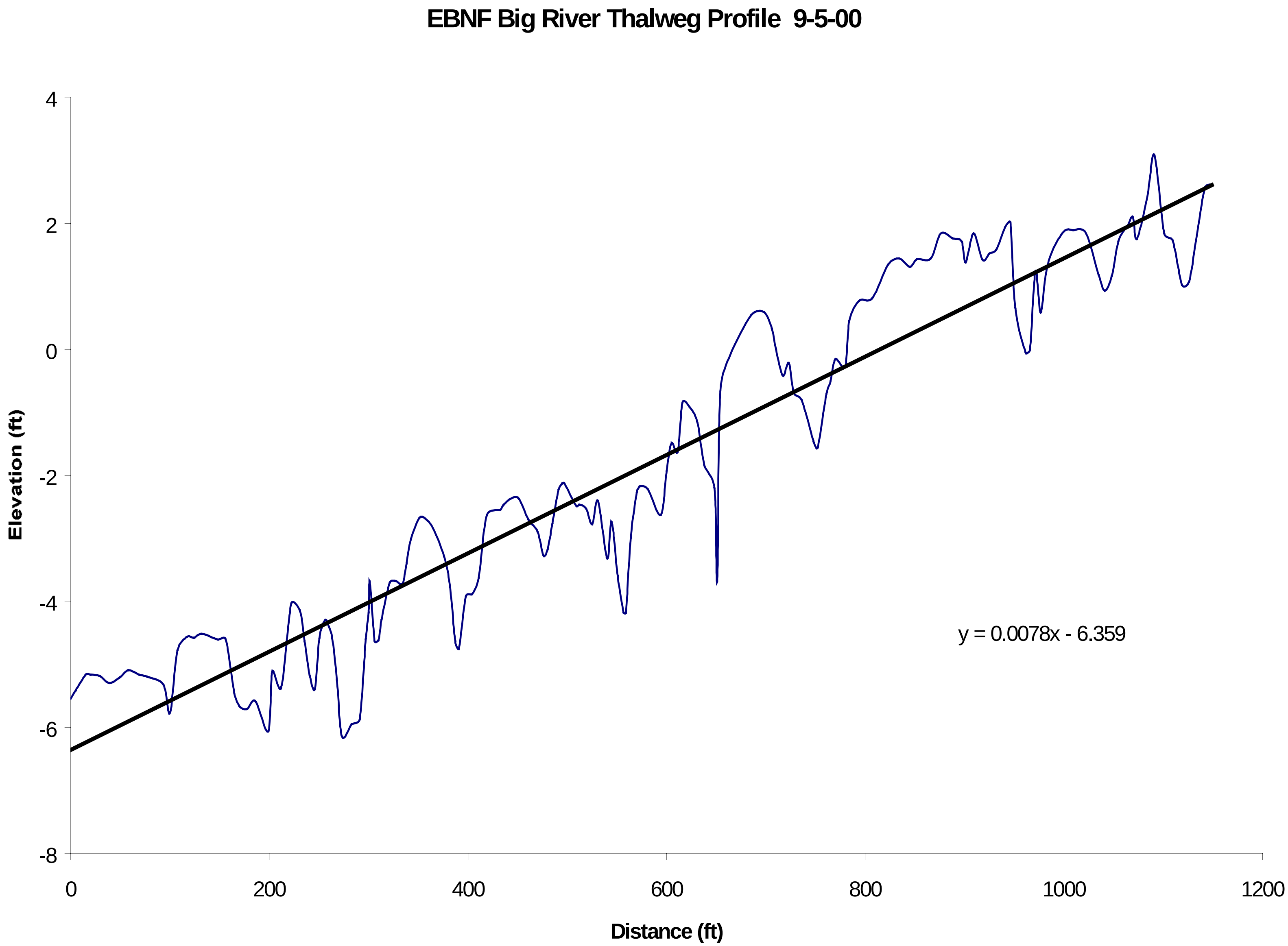
Daugherty Creek, Cross-section #3 9/14/00




Daugherty Creek X-section #4 9-14-00
2
1
0
-1
-2
-3
-4
-5
-6
Elevation (ft)
0
5
10
15
20
25
30
35
40
45
50
Distance (ft)
D50=25 mm



Daugherty Creek, Cross-section #4 9/14/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)



EBNF Big River Thalweg Profile 9-5-00
Elevation (ft)
4
2
0
-2
-4
-6
-8
0
200
400
600
800
1000
1200
Distance (ft)
y = 0.0078x - 6.359

East Branch North Fork Big River Thalweg Residual Depth Analysis 2000

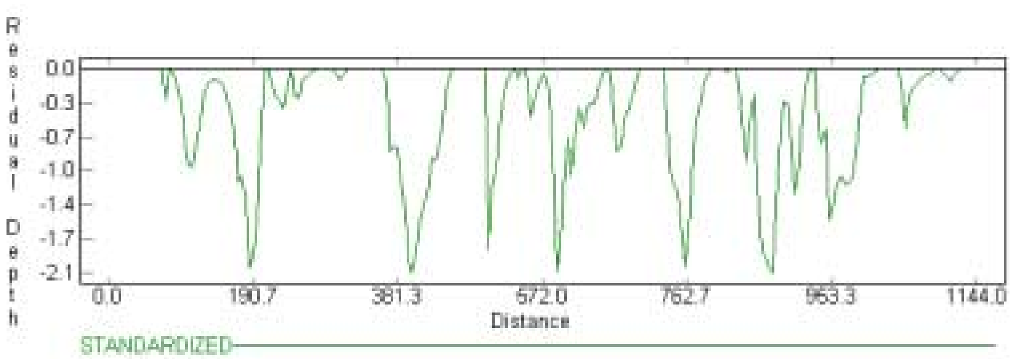
Top Elevation: 3.08
Bottom Elevation: -6.14
Reach Length: 1144.00

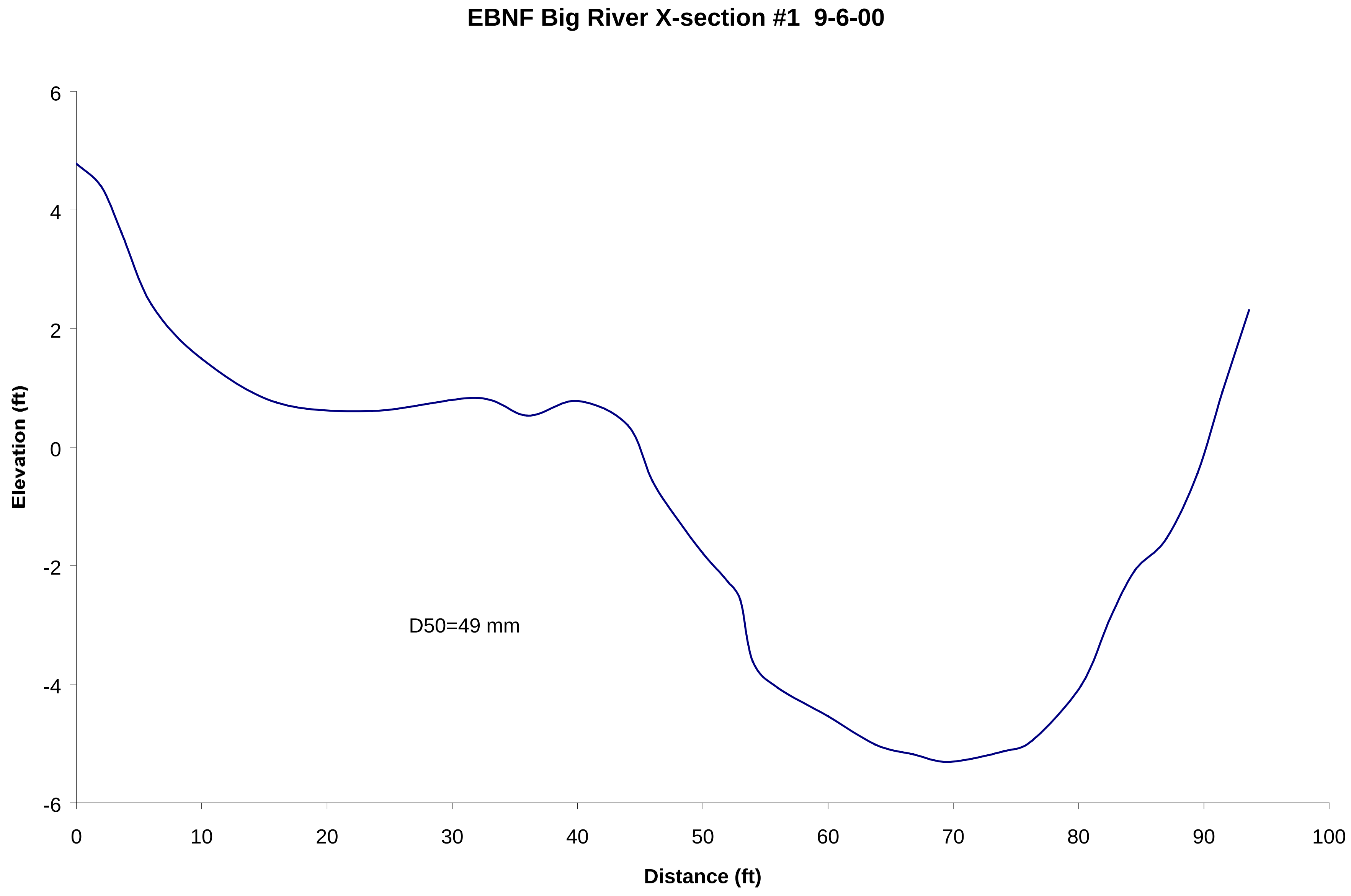
Standardized Statistics:
Number of data points in raw data: 155
Number of data points in Standardized data: 229

Reach Step Distance: 5.00

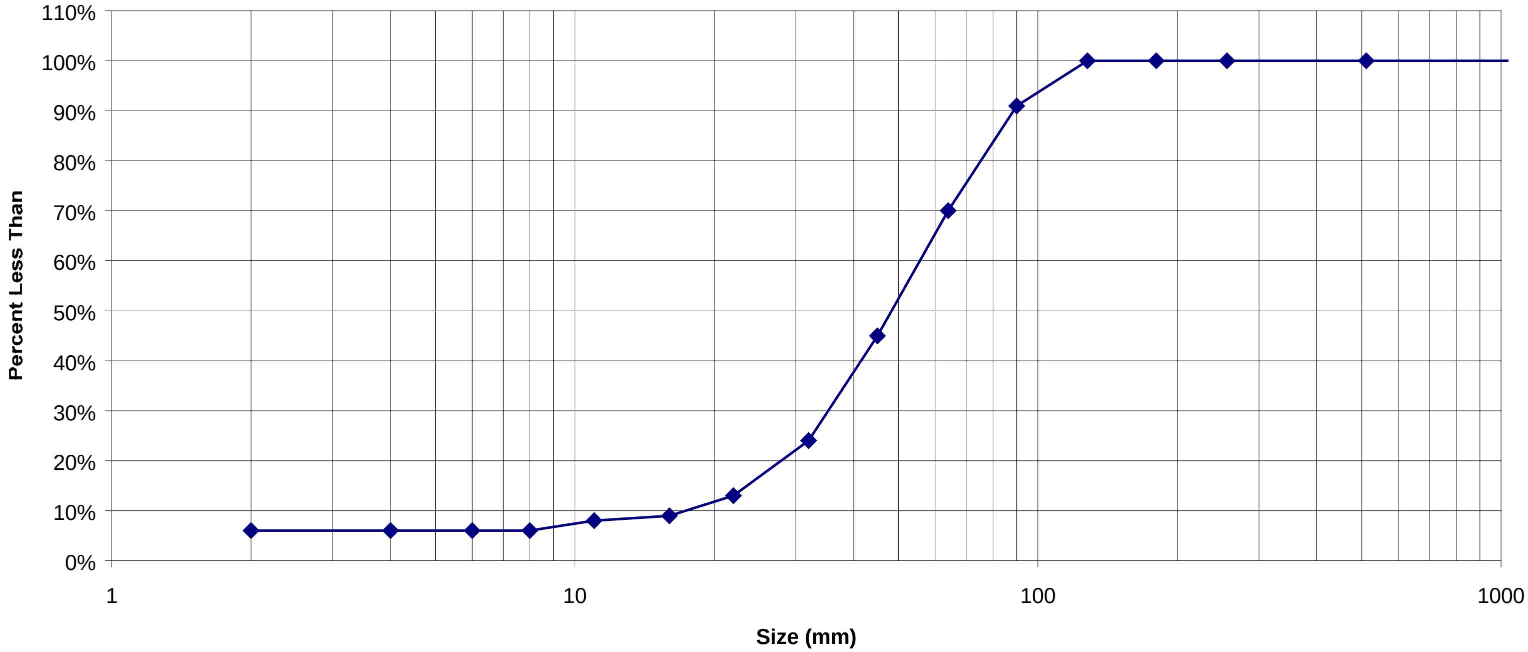
Max Residual Depth: 2.08
Mean Residual Depth: 0.45
Standard Deviation: 0.57

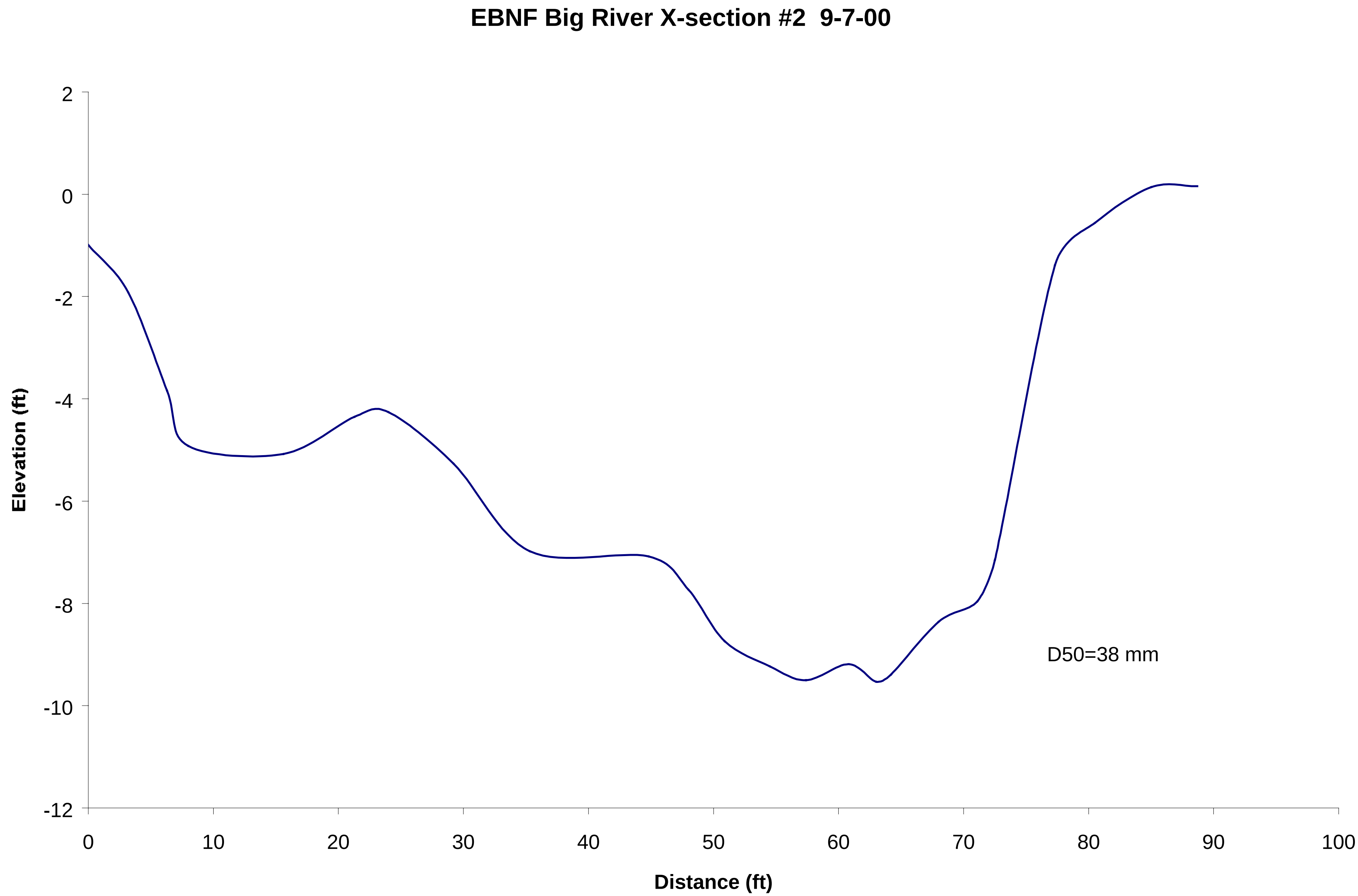
Number of non-zero Residual Depths: 167
Percent of Reach as pool: 72.93
Percent of Reach as riffle: 27.07



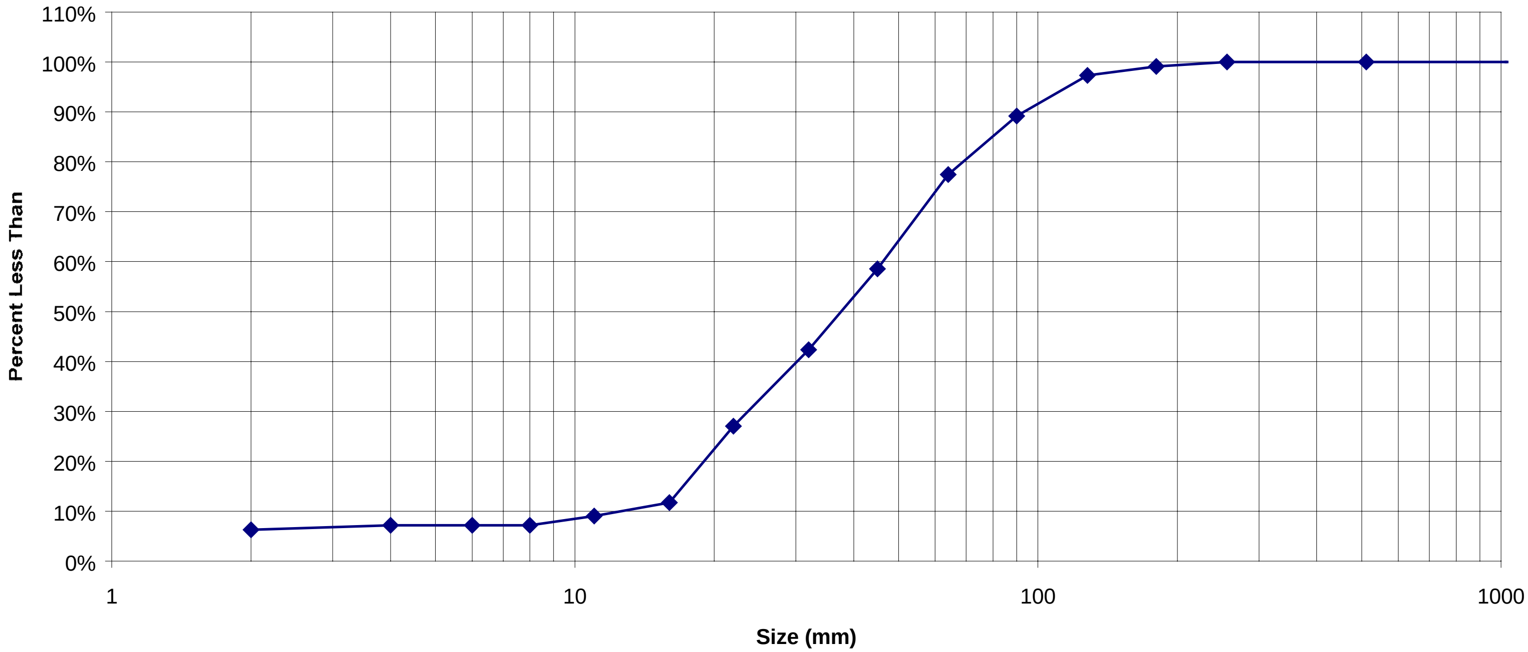

EBNF Big River X-section #1 9-6-00
6
4
2
0
-2
-4
-6
Elevation (ft)
D50=49 mm
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)

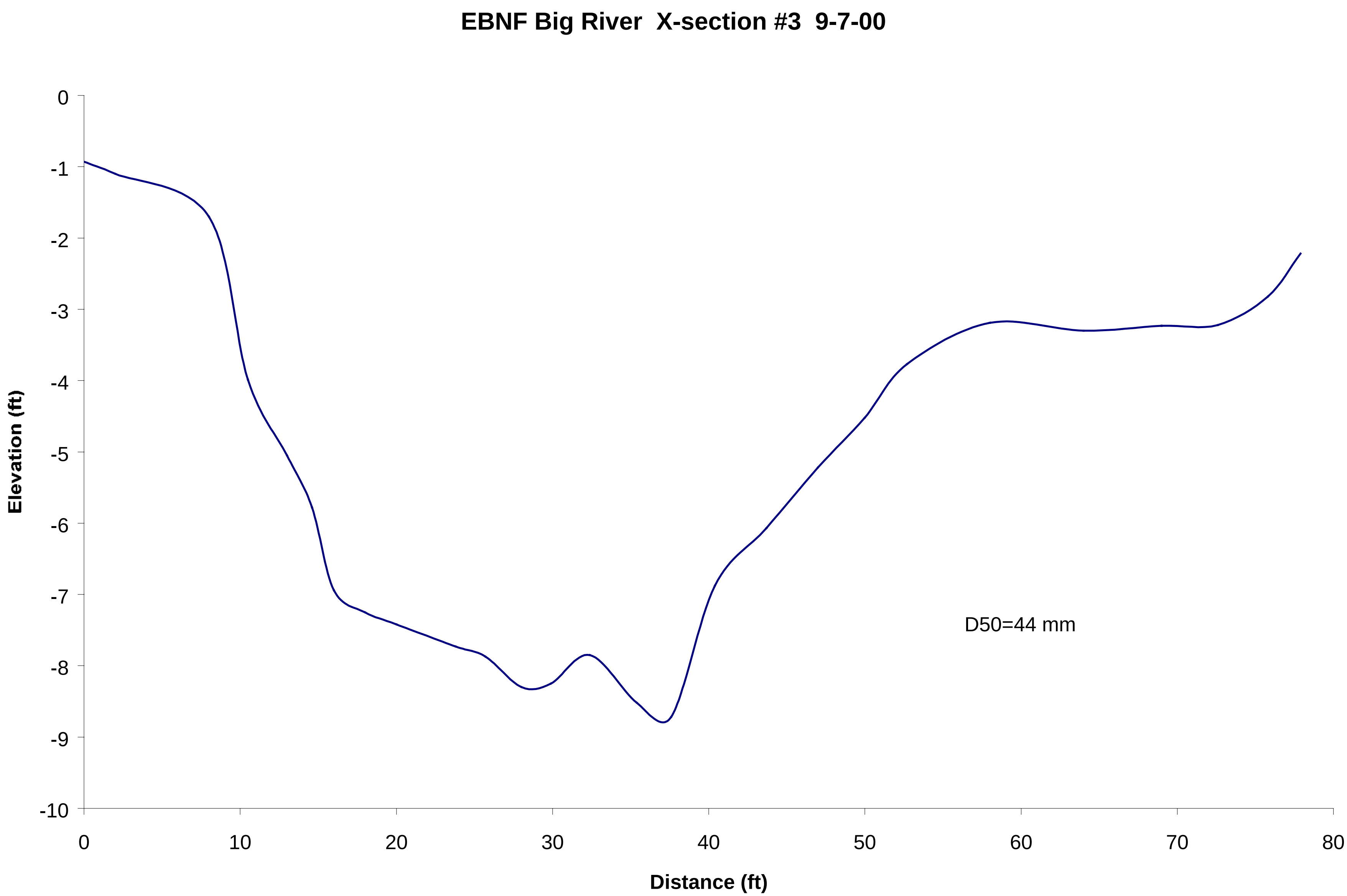
East Branch North Fork Big River, Cross-section #1 9/6/00




EBNF Big River X-section #2 9-7-00
Elevation (ft)
2
0
-2
-4
-6
-8
-10
-12
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)
D50=38 mm

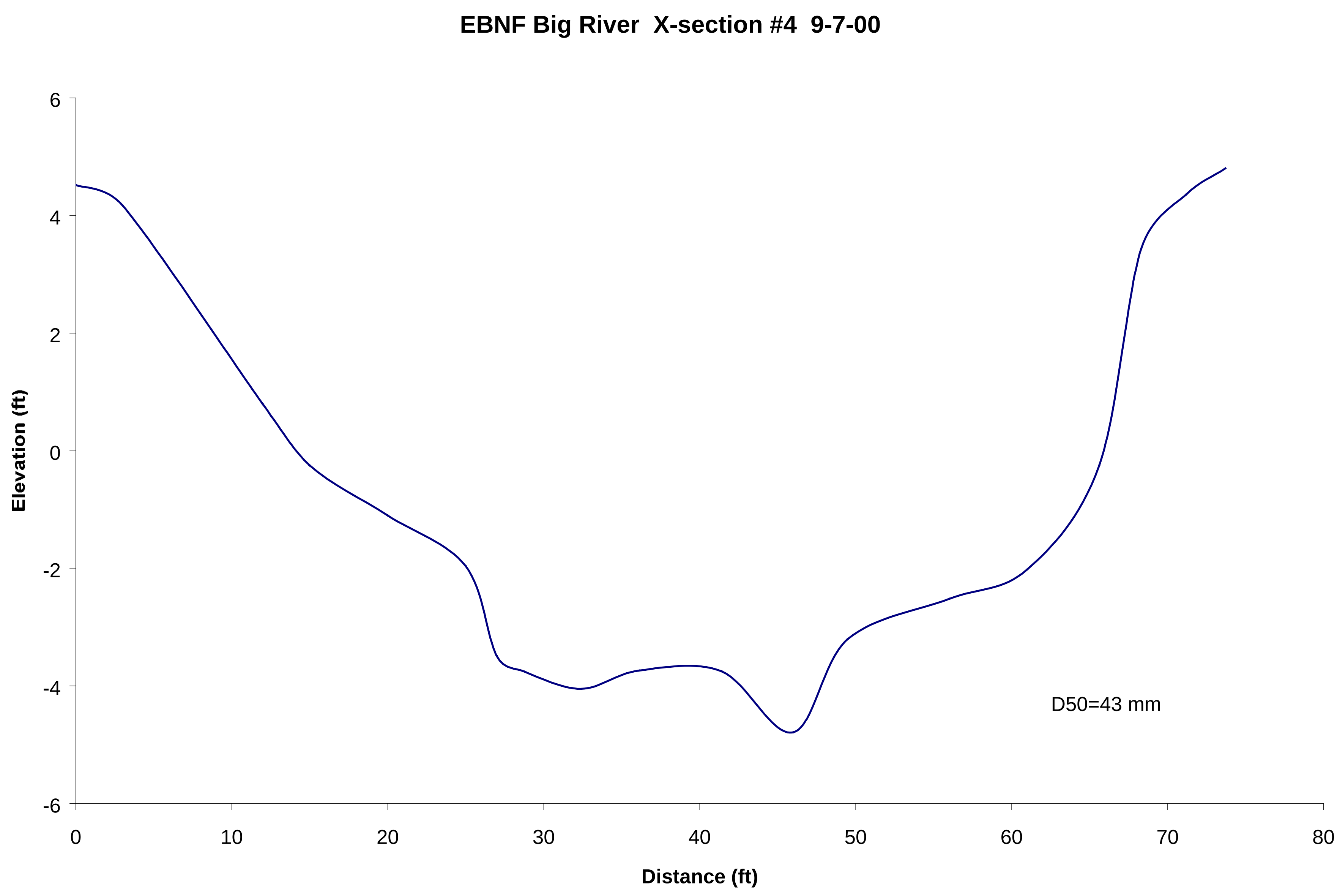
East Branch North Fork Big River, Cross-section #2 9/6/00

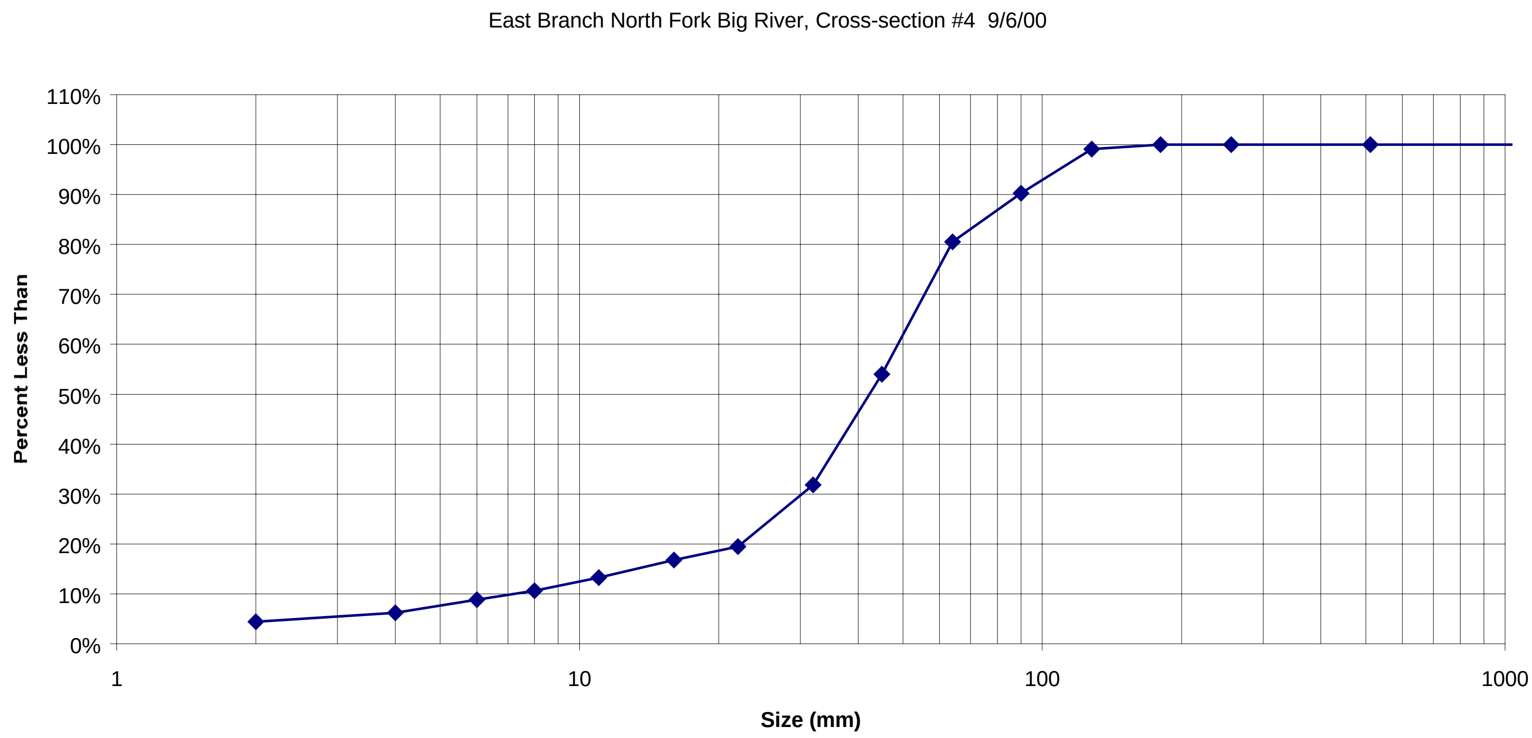


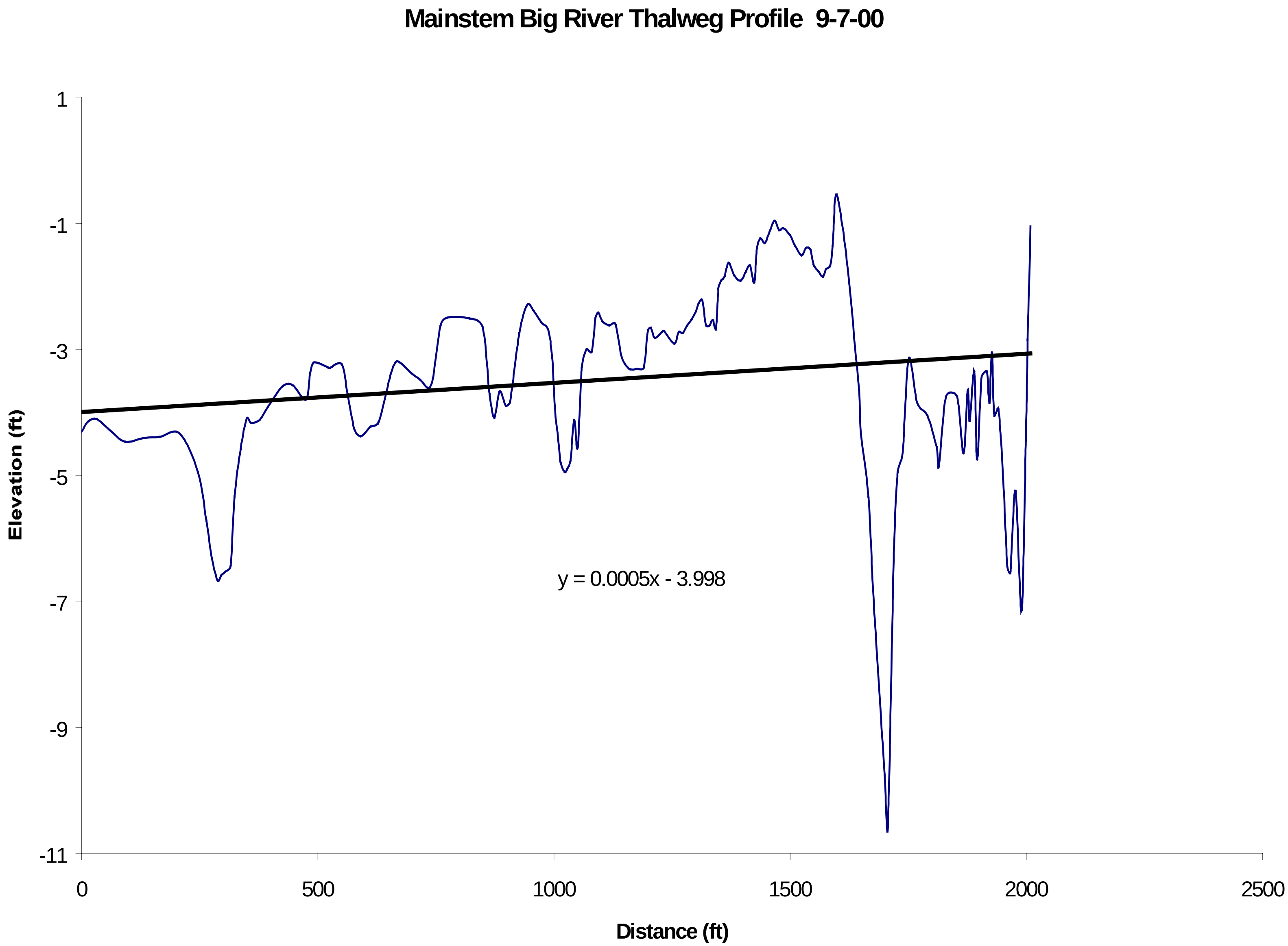


EBNF Big River X-section #3 9-7-00
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
Elevation (ft)
0
10
20
30
40
50
60
70
80
Distance (ft)
D50=44 mm


East Branch North Fork Big River, Cross-section #3 9/6/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)


EBNF Big River X-section #4 9-7-00
Elevation (ft)
6
4
2
0
-2
-4
-6
0
10
20
30
40
50
60
70
80
Distance (ft)
D50=43 mm

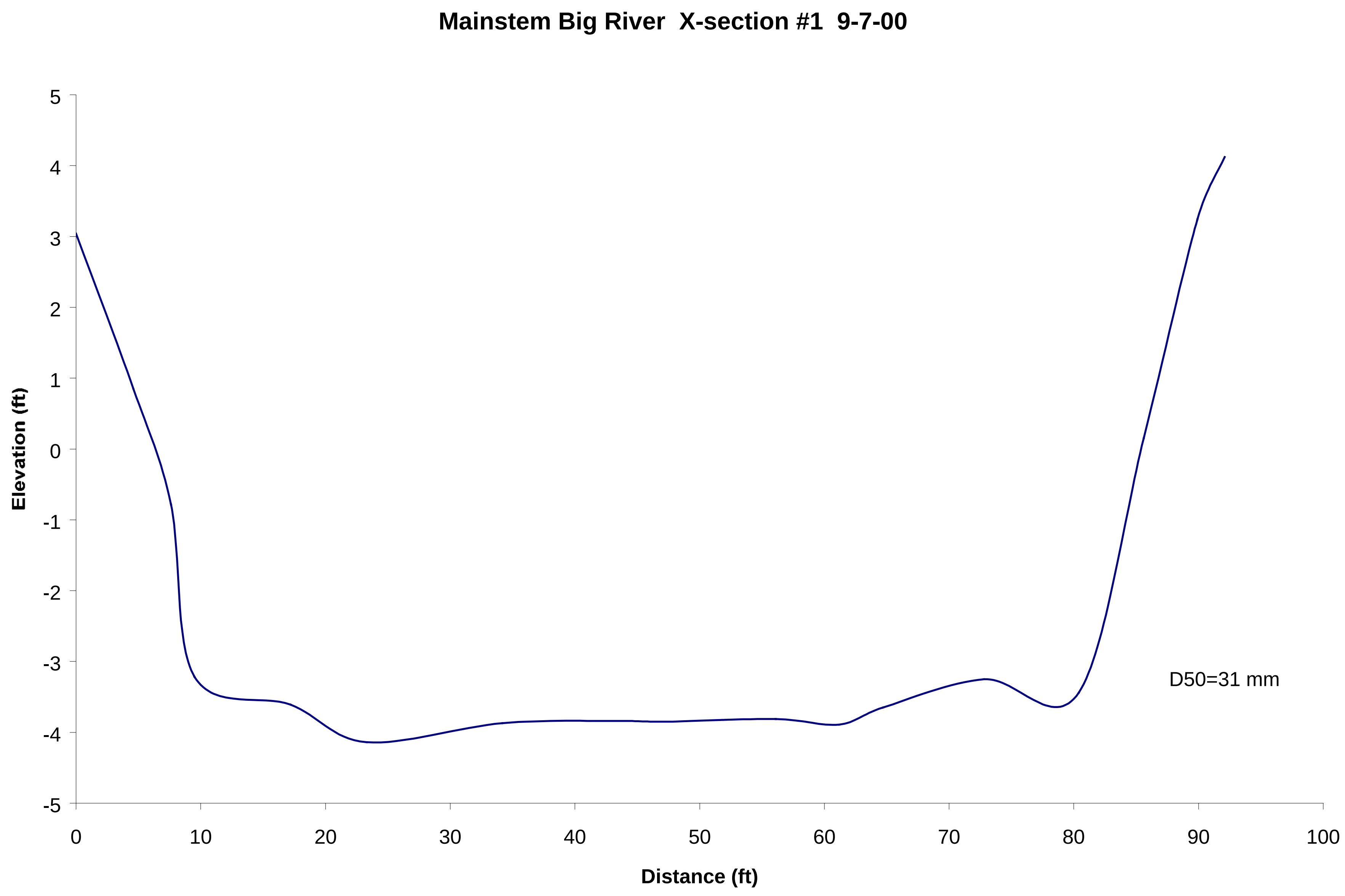

East Branch North Fork Big River, Cross-section #4 9/6/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)

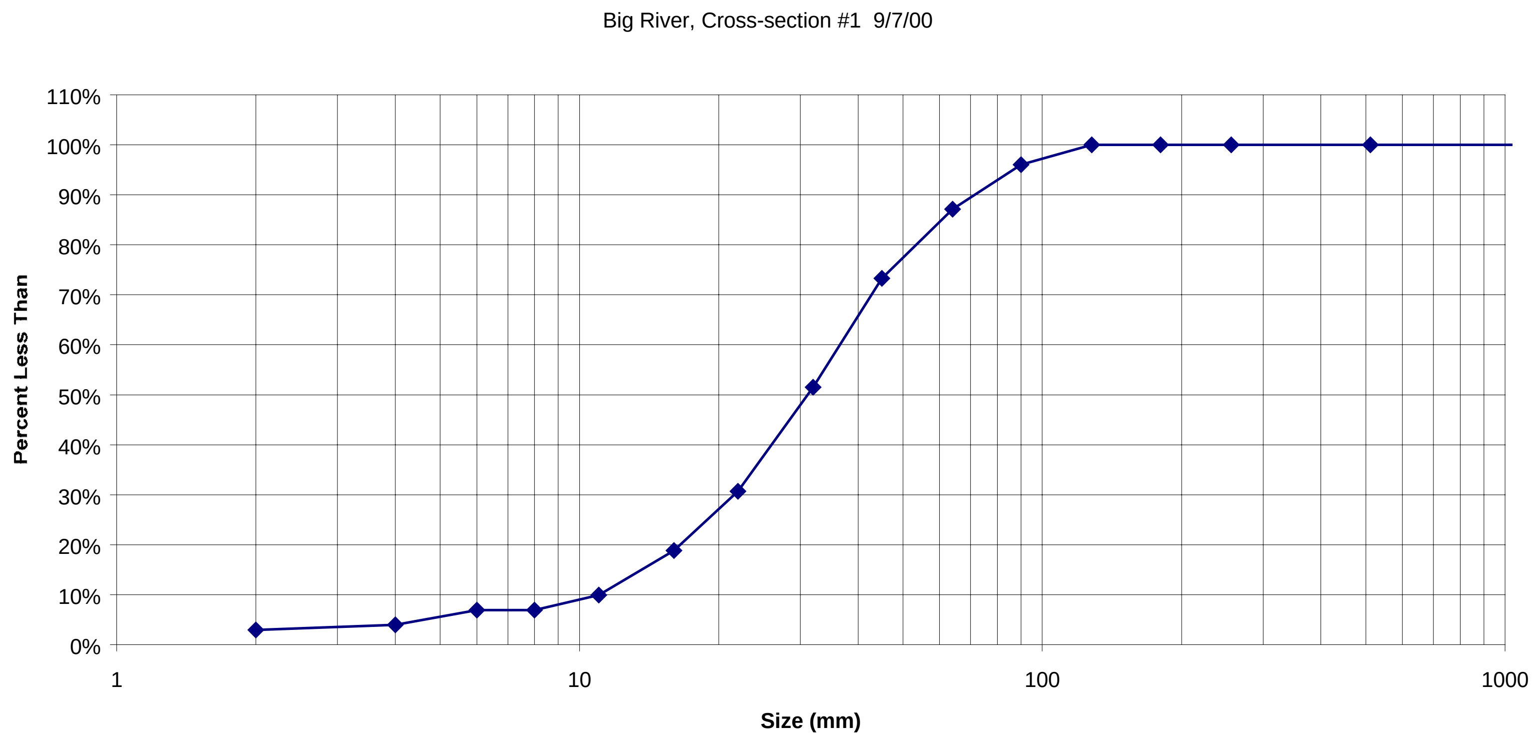


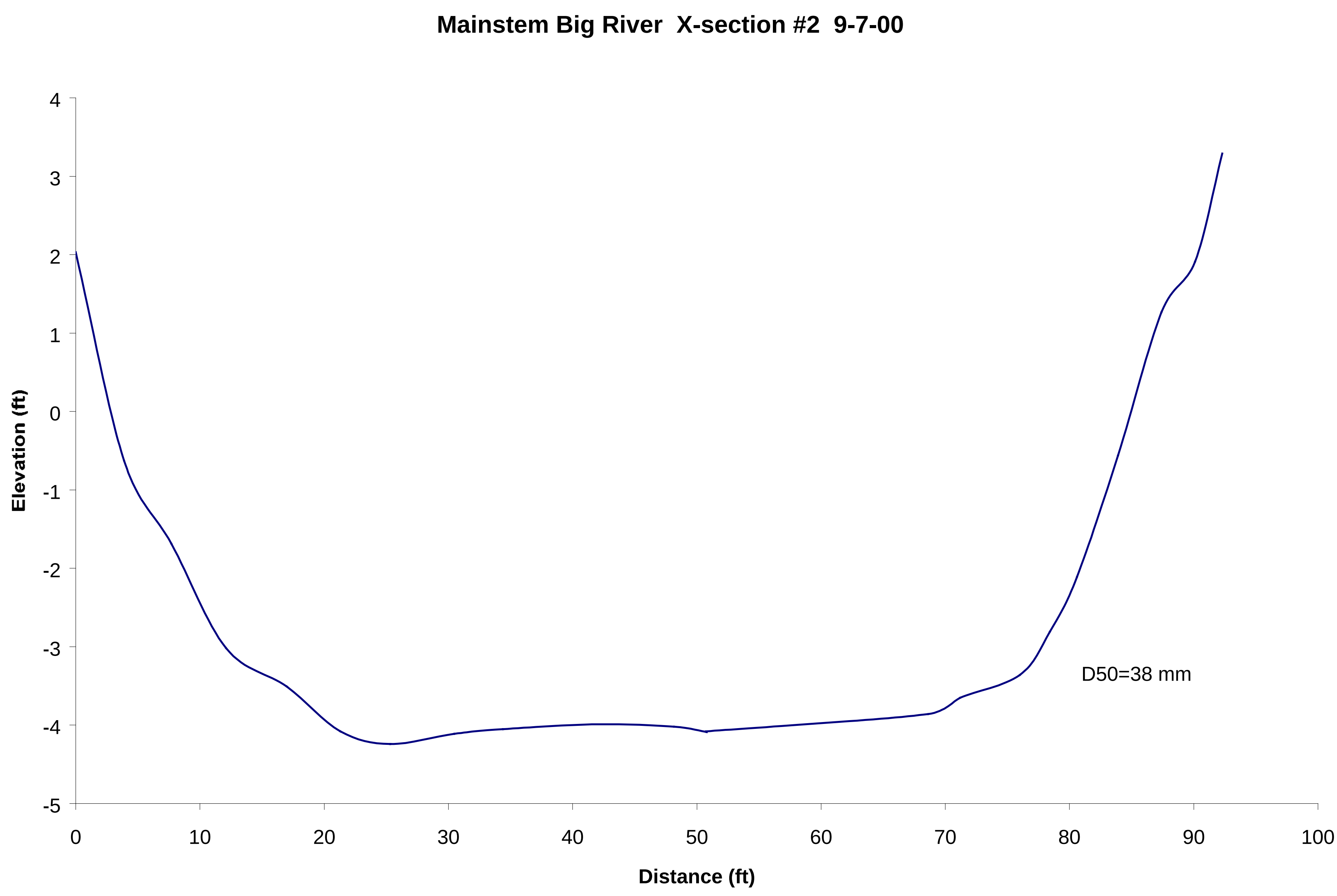
Mainstem Big River Thalweg Profile 9-7-00
Elevation (ft)
1
-1
-3
-5
-7
-9
-11
0
500
1000
1500
2000
2500
Distance (ft)
y = 0.0005x - 3.998

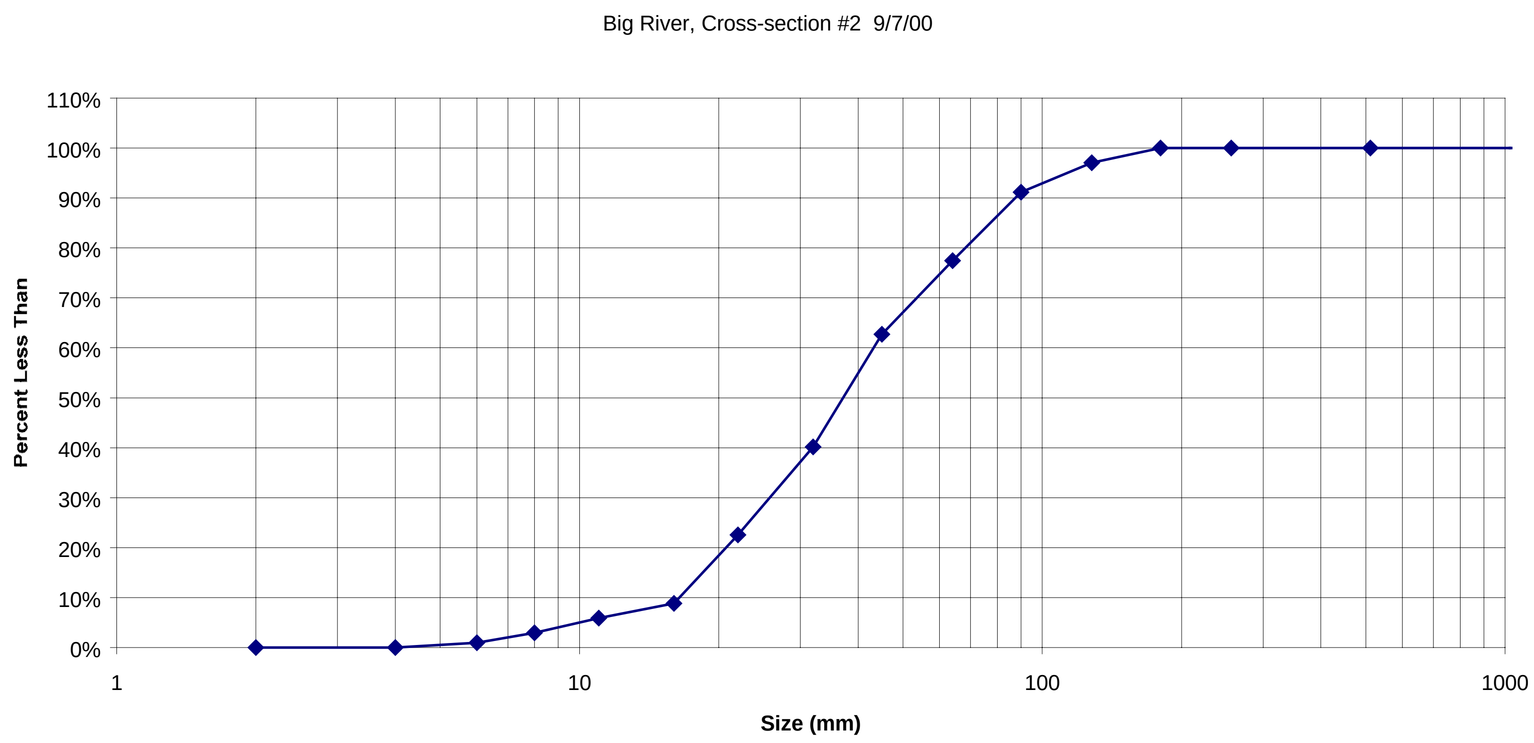
Mainstem Big River Thalweg Residual Depth Analysis 2000

```
Top Elevation:    -0.55
Bottom Elevation:   -10.55
    Reach Length:  1995.00

-----------------------------------------------------------------------------
-

Standardized Statistics:
         Number of data points in raw data: 159
Number of data points in Standardized data: 399

Reach Step Distance: 5.00

 Max Residual Depth:     2.64
Mean Residual Depth:     0.40
 Standard Deviation:     0.58

Number of non-zero Residual Depths: 277
  Percent of Reach as pool:  69.42
Percent of Reach as riffle:  30.58
```


Mainstem Big River X-section #1 9-7-00
Elevation (ft)
5
4
3
2
1
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)
D50=31 mm

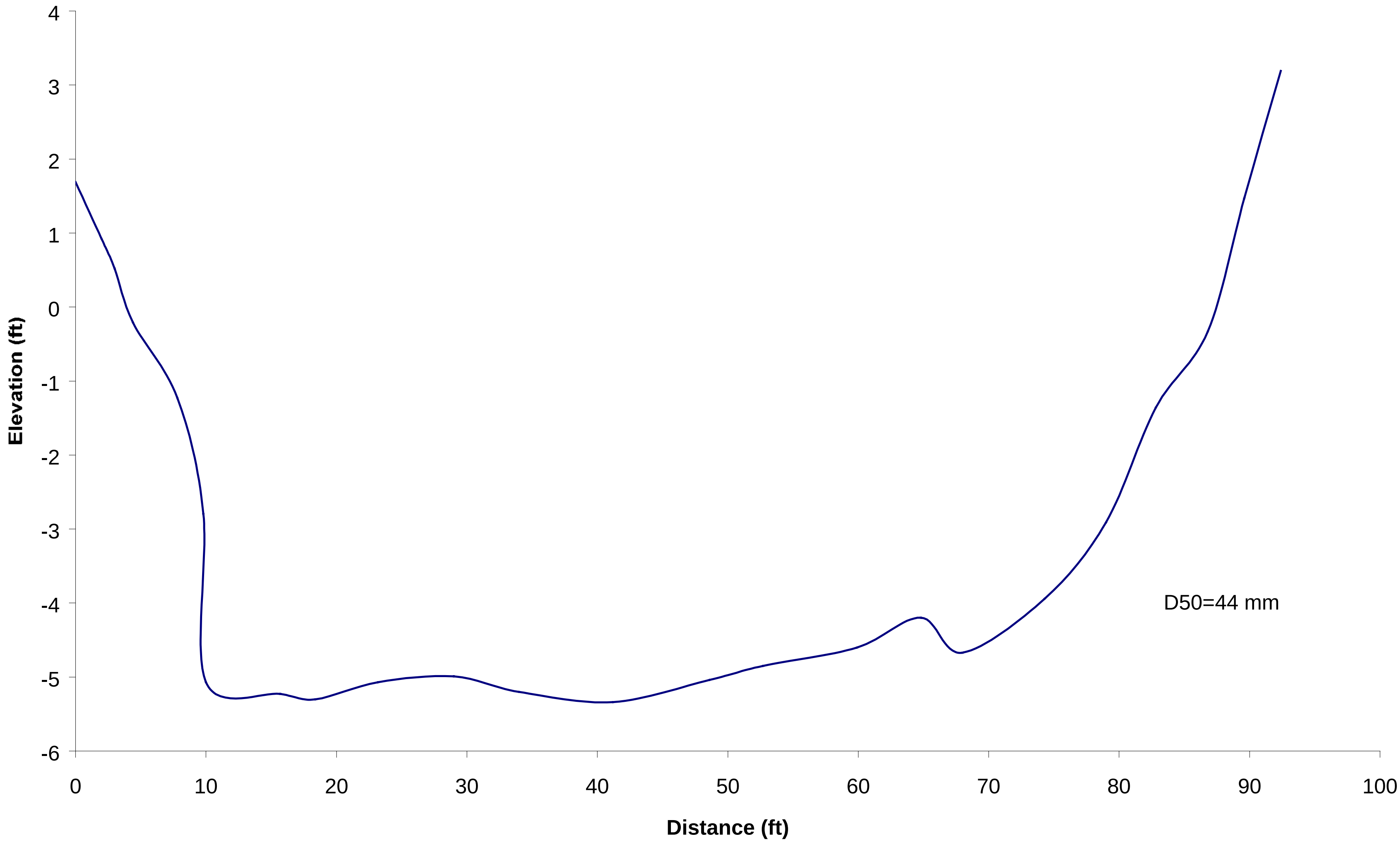

Big River, Cross-section #1 9/7/00
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Less Than
1
10
100
1000
Size (mm)

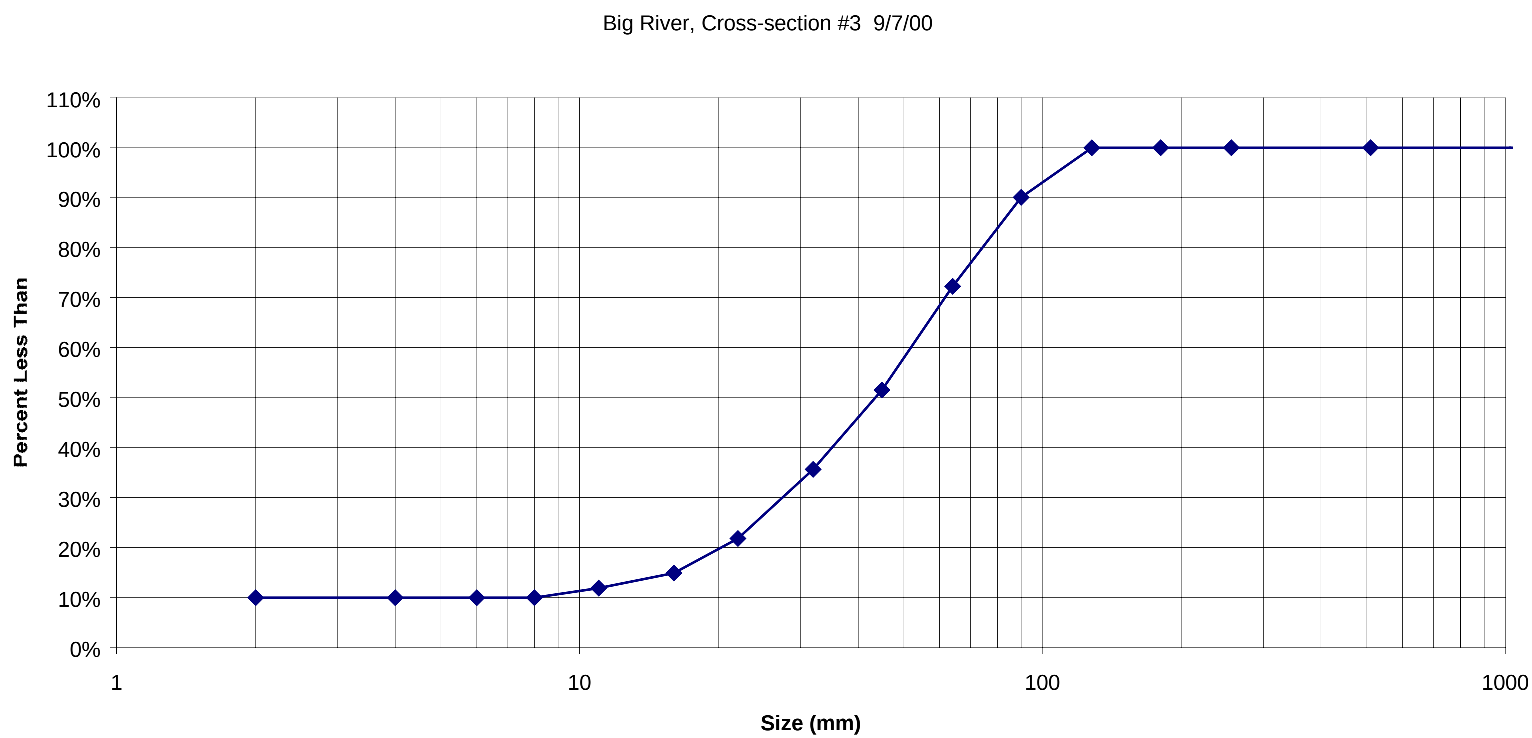

Mainstem Big River X-section #2 9-7-00
Elevation (ft)
4
3
2
1
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)
D50=38 mm

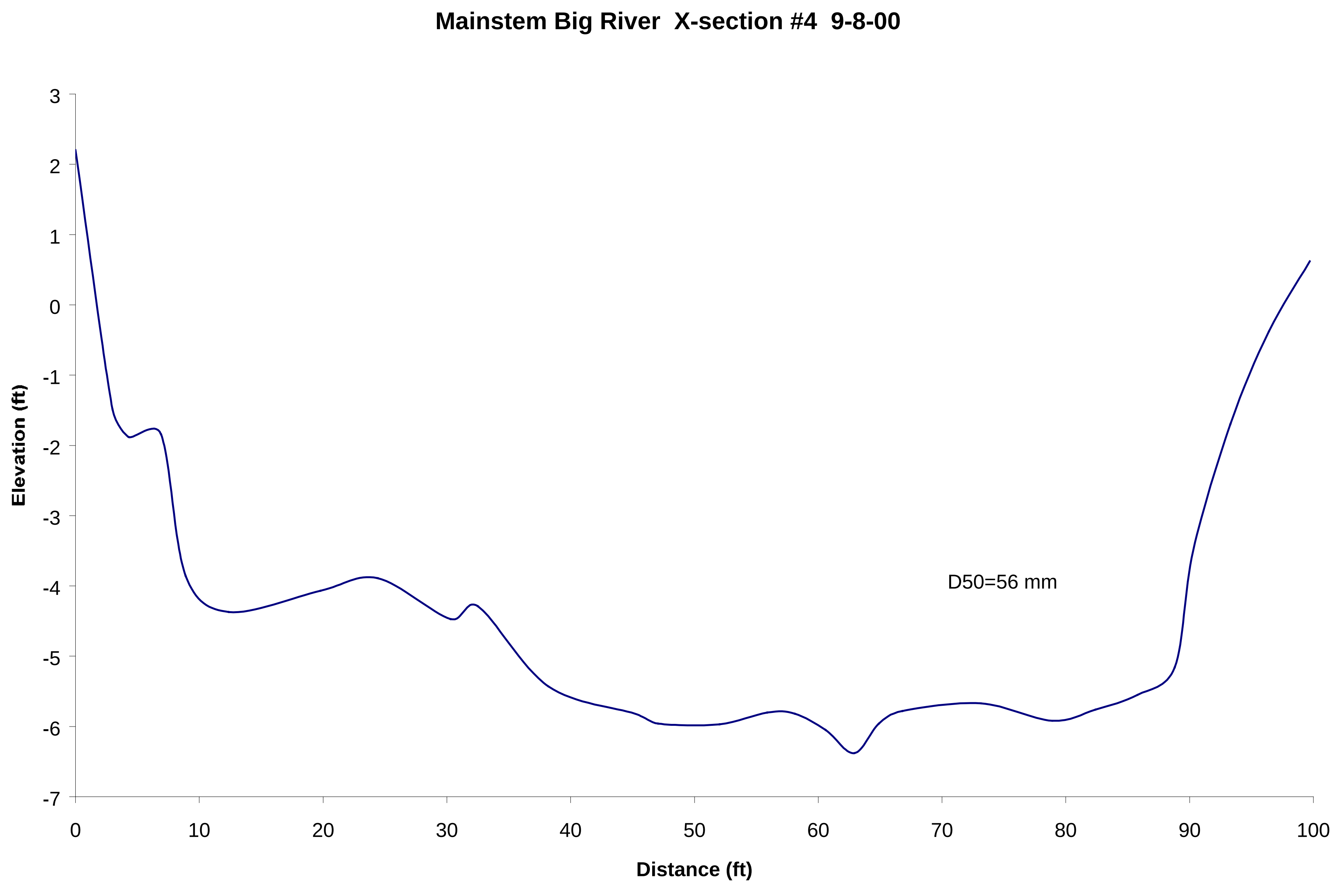


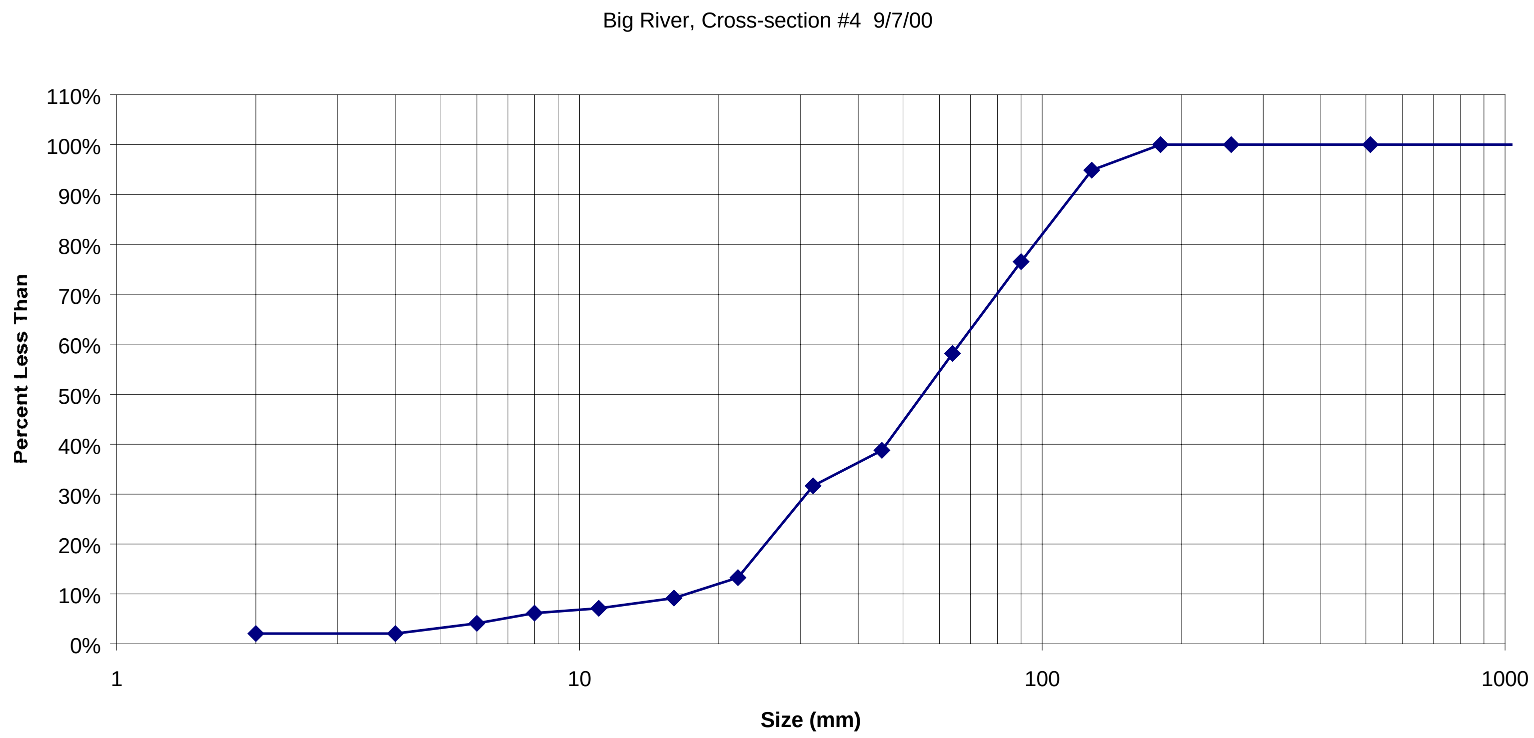
Big River, Cross-section #2 9/7/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)

Mainstem Big River X-section #3 9-8-00

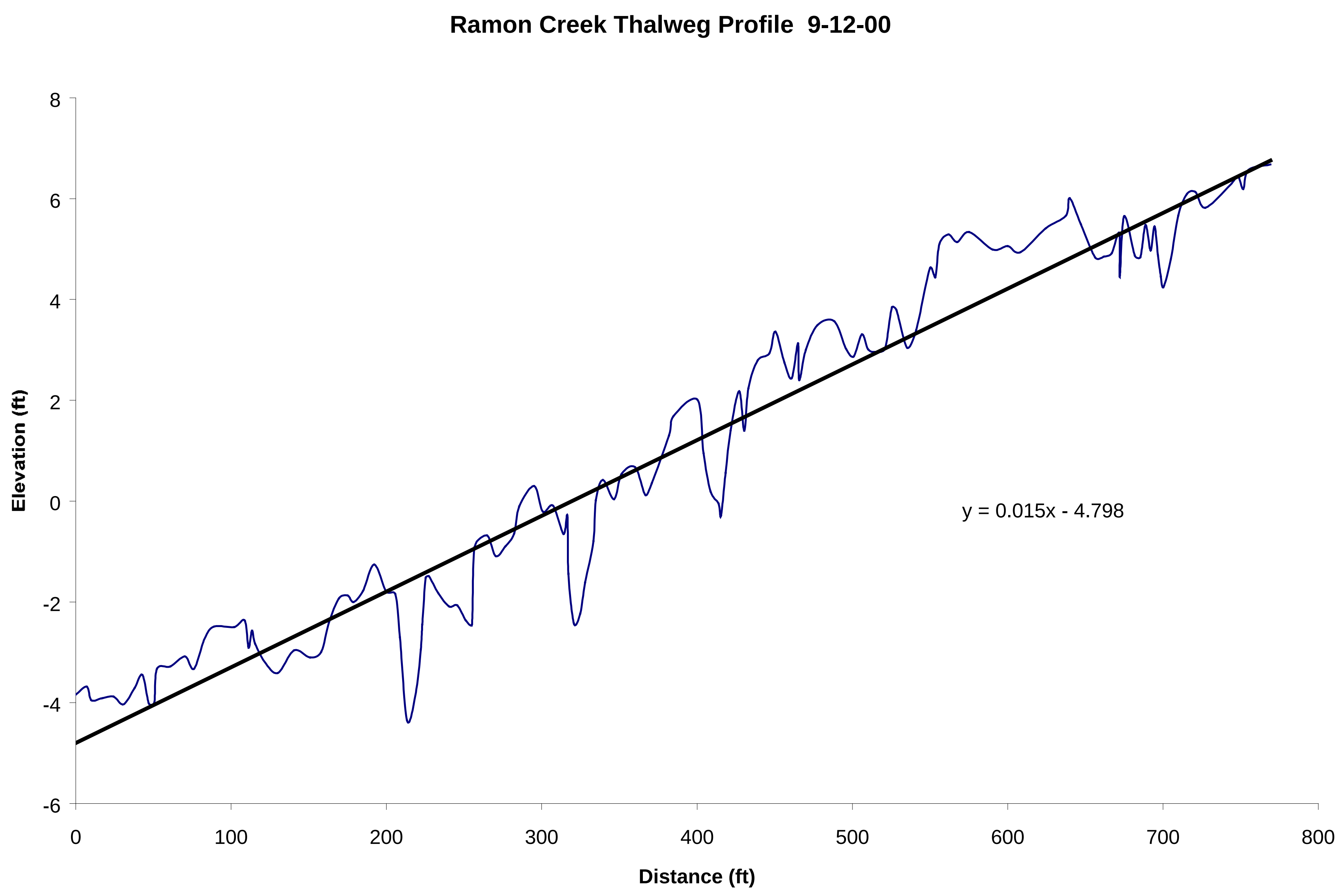



Big River, Cross-section #3 9/7/00
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Less Than
1
10
100
1000
Size (mm)


Mainstem Big River X-section #4 9-8-00
Elevation (ft)
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)
D50=56 mm



Big River, Cross-section #4 9/7/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)


Ramon Creek Thalweg Profile 9-12-00
Elevation (ft)
8
6
4
2
0
-2
-4
-6
0
100
200
300
400
500
600
700
800
Distance (ft)
y = 0.015x - 4.798

Ramon Creek Thalweg Residual Depth Analysis 2000

```
Top Elevation:     6.68
Bottom Elevation:    -4.35
    Reach Length:   762.00

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-

Standardized Statistics:
         Number of data points in raw data: 137
Number of data points in Standardized data: 152

Reach Step Distance: 5.00

 Max Residual Depth:     3.02
Mean Residual Depth:     0.42
 Standard Deviation:     0.56

Number of non-zero Residual Depths: 105
  Percent of Reach as pool:  69.08
Percent of Reach as riffle:  30.92
```
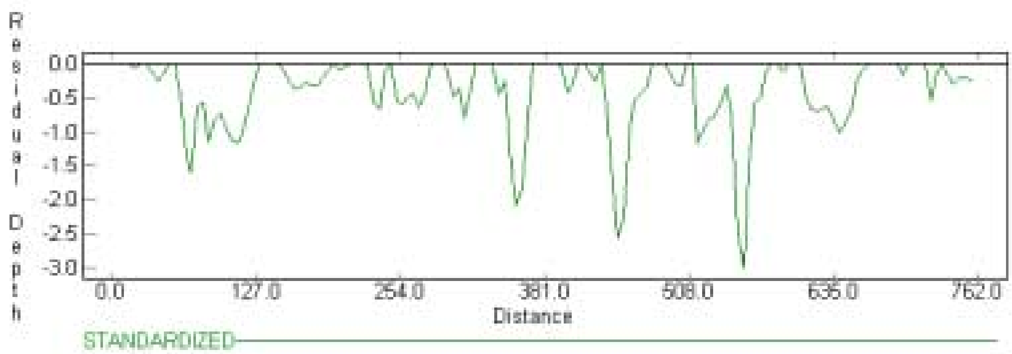
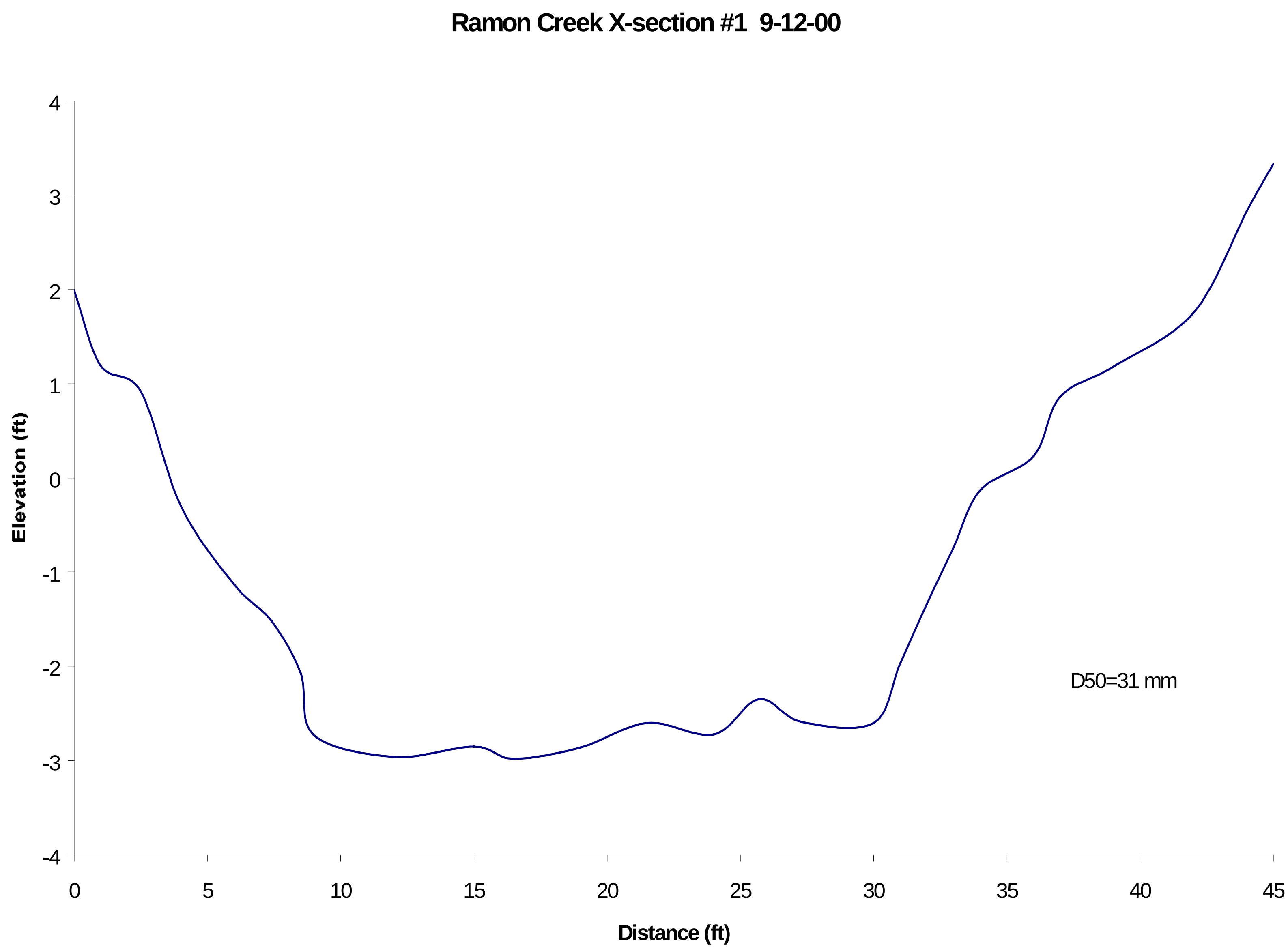
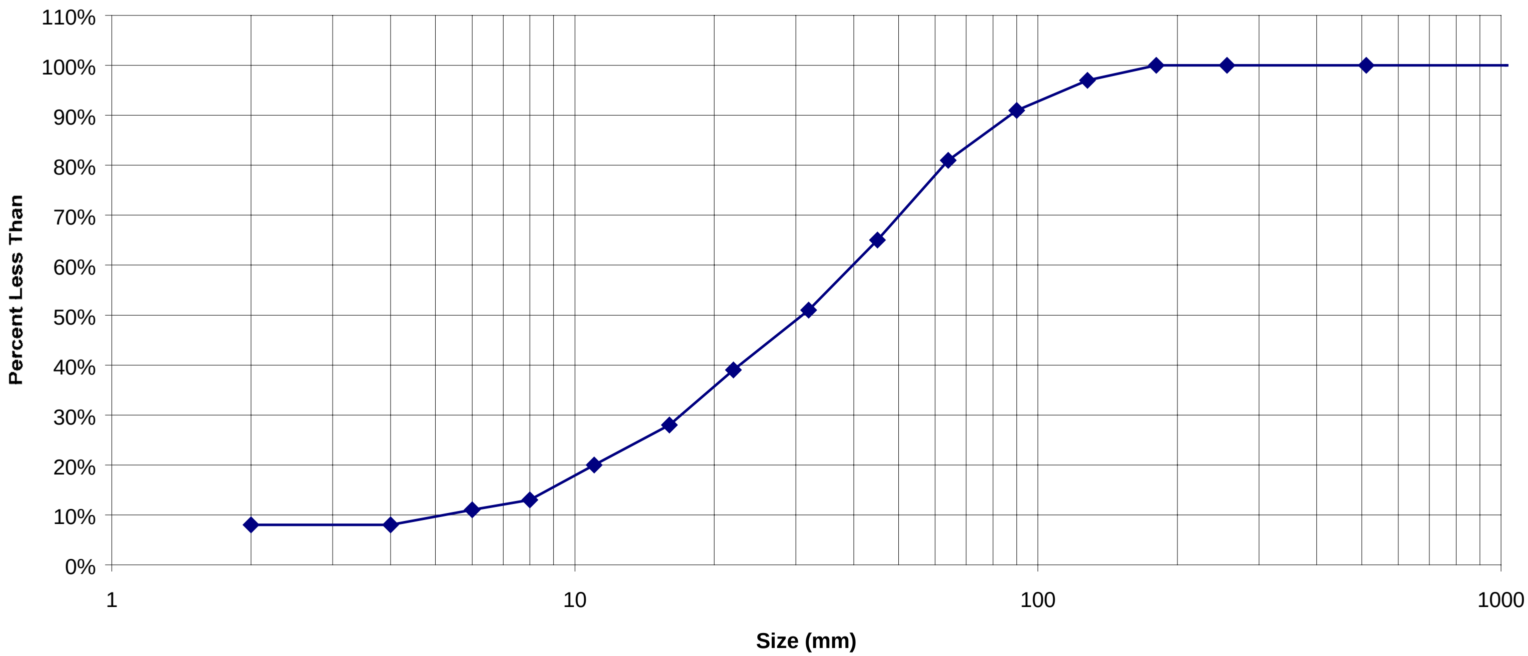
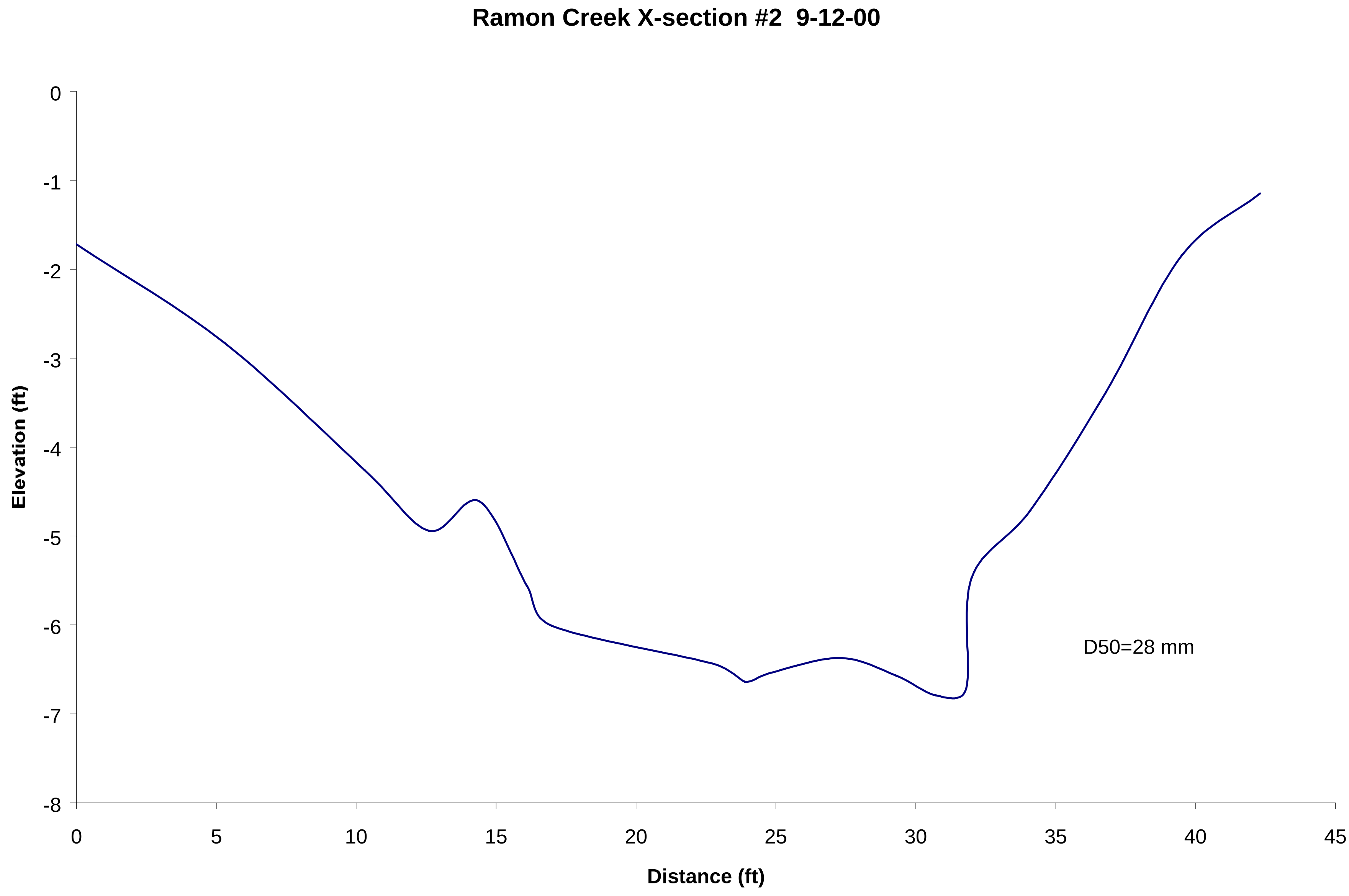





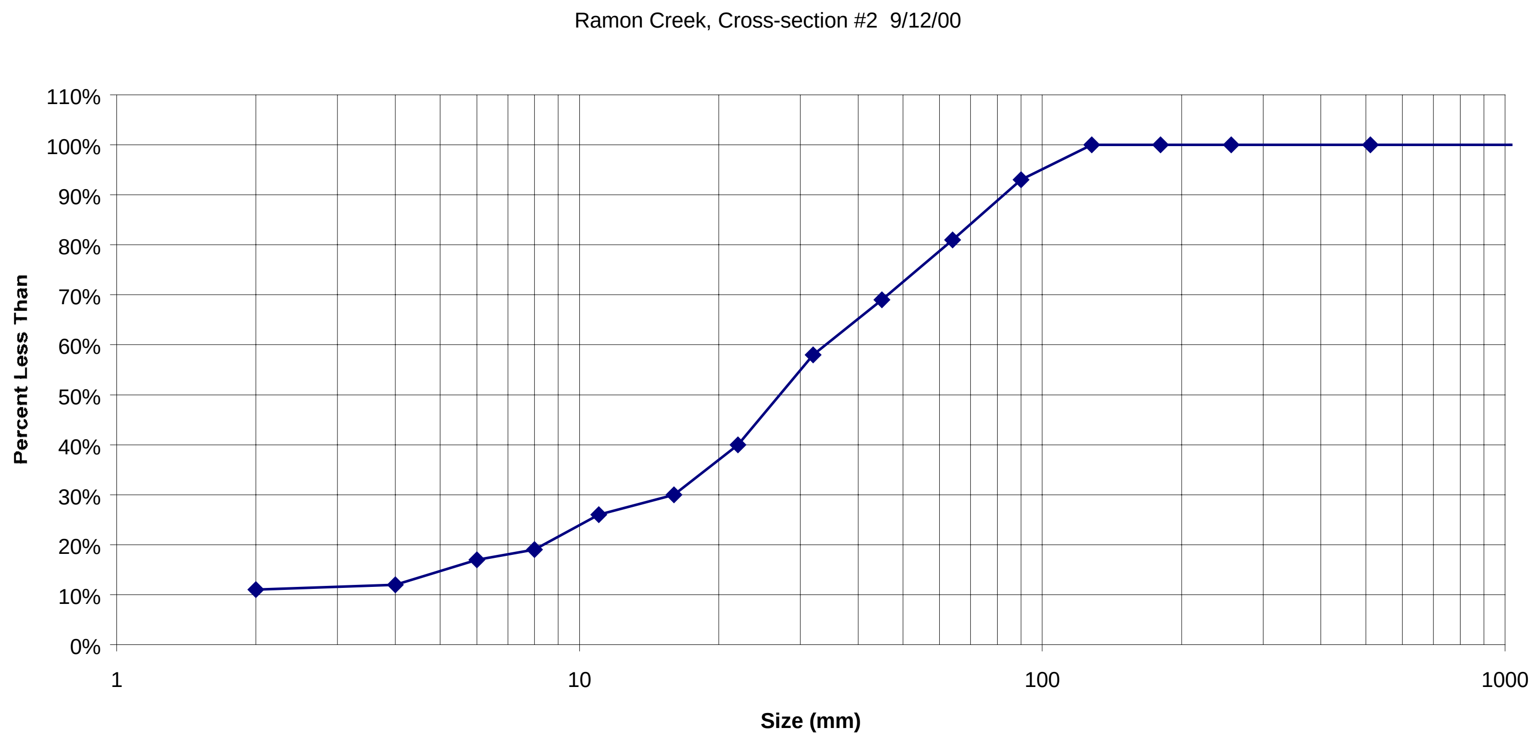
Ramon Creek X-section #1 9-12-00
Elevation (ft)
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30
35
40
45
Distance (ft)
D50=31 mm

Ramon Creek, Cross-section #1 9/12/00

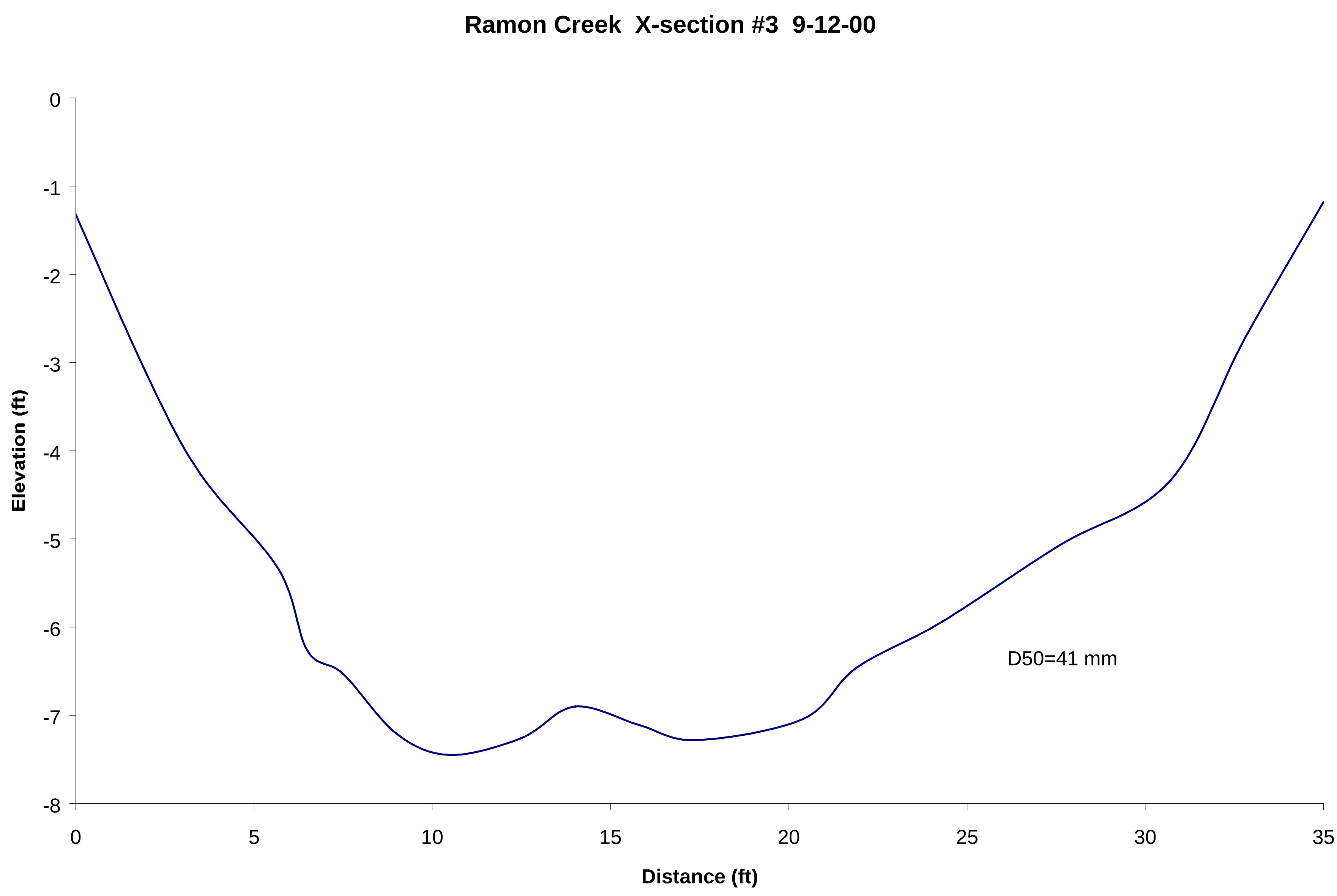




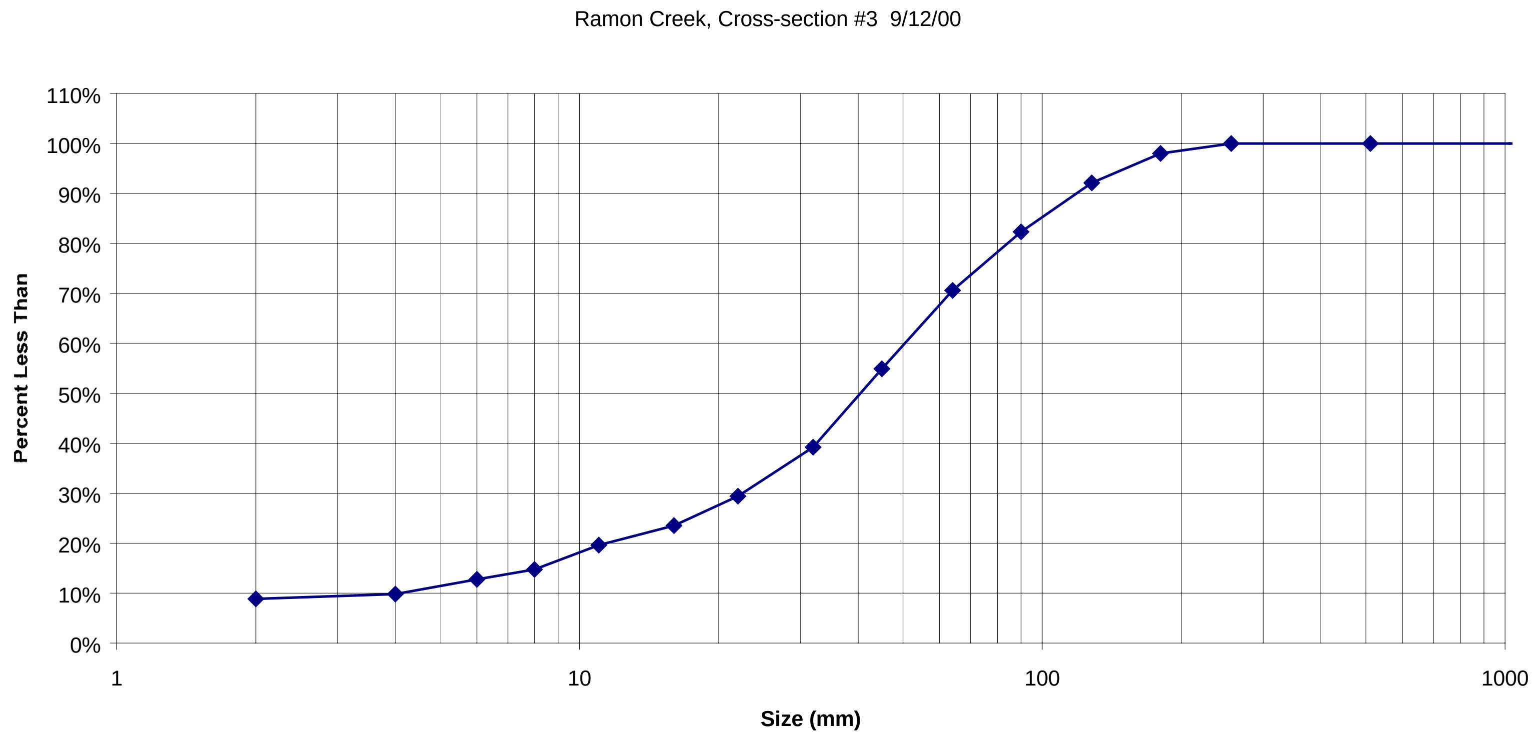
Ramon Creek X-section #2 9-12-00
Elevation (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
0
5
10
15
20
25
30
35
40
45
Distance (ft)
D50=28 mm

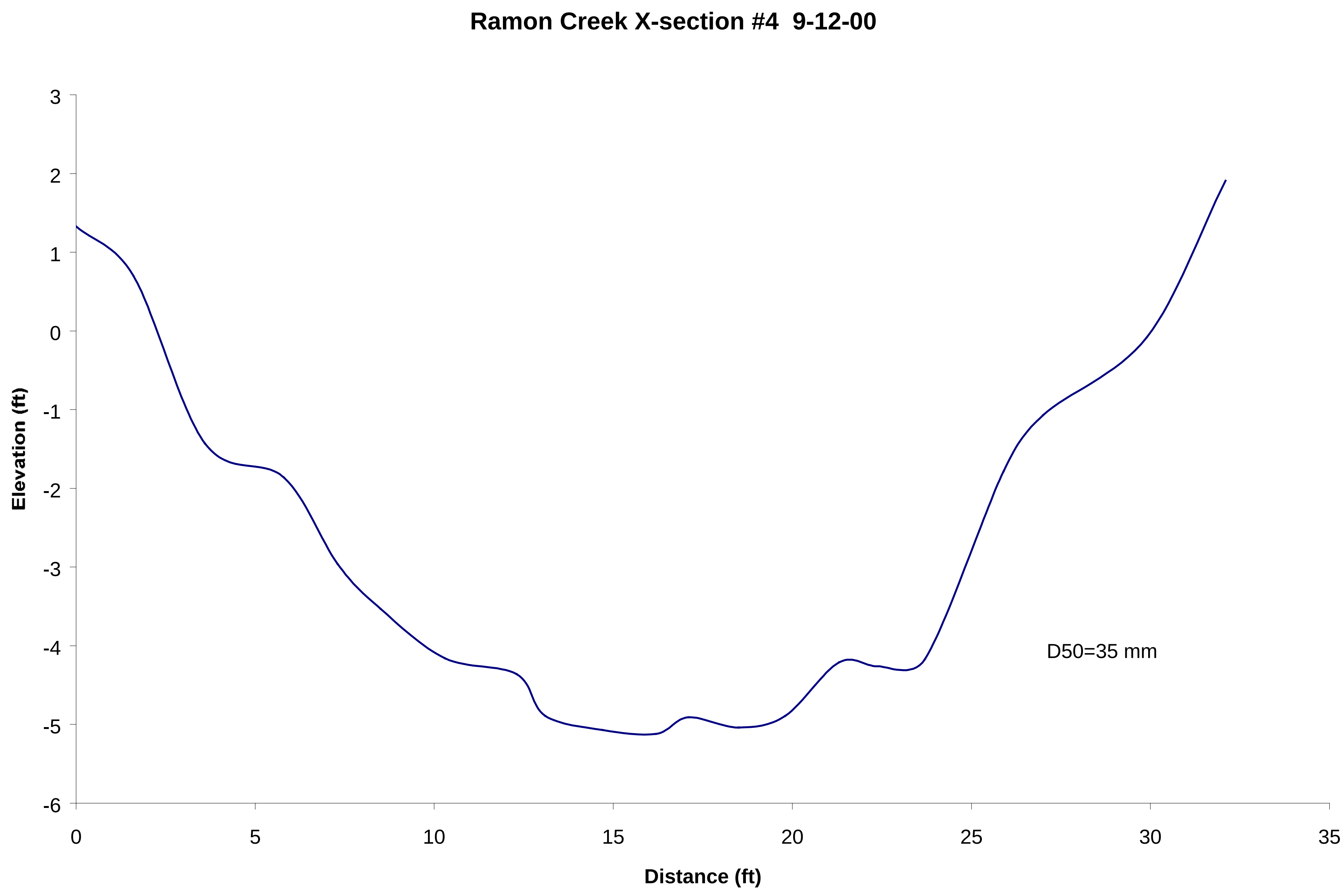


Ramon Creek, Cross-section #2 9/12/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)

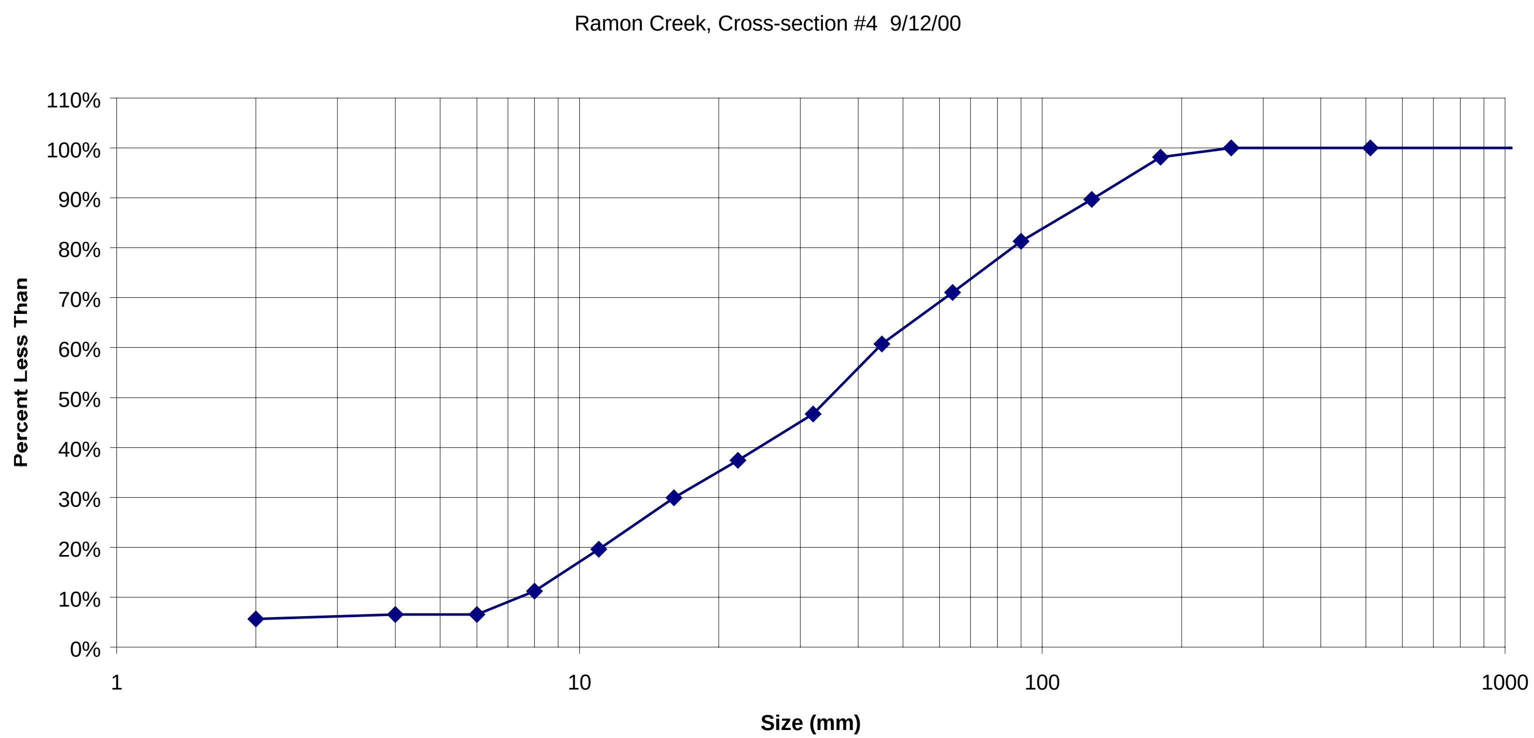


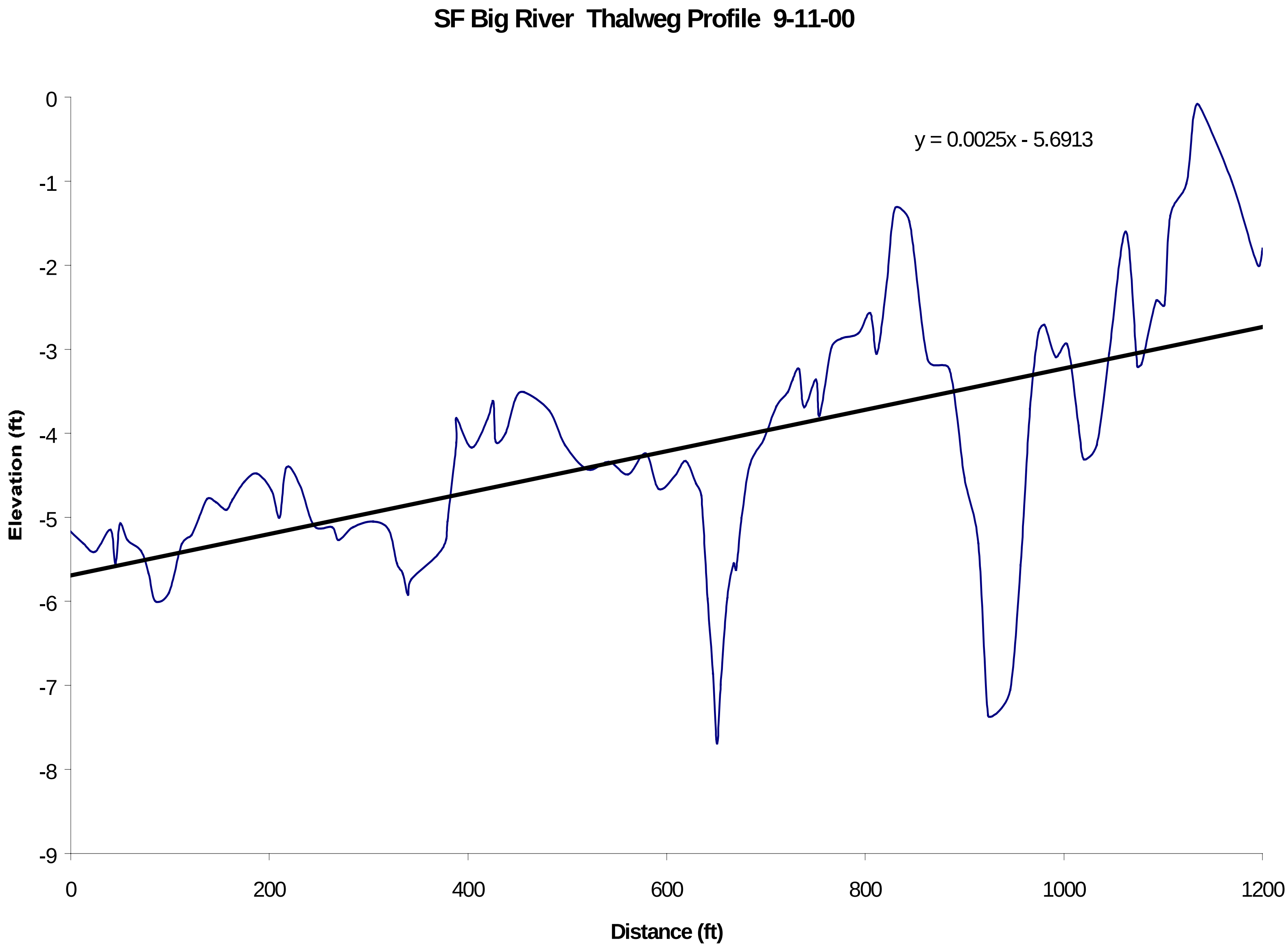
Ramon Creek X-section #3 9-12-00
Elevation (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
0
5
10
15
20
25
30
35
Distance (ft)
D50=41 mm


Ramon Creek, Cross-section #3 9/12/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)



Ramon Creek X-section #4 9-12-00
Elevation (ft)
3
2
1
0
-1
-2
-3
-4
-5
-6
0
5
10
15
20
25
30
35
Distance (ft)
D50=35 mm

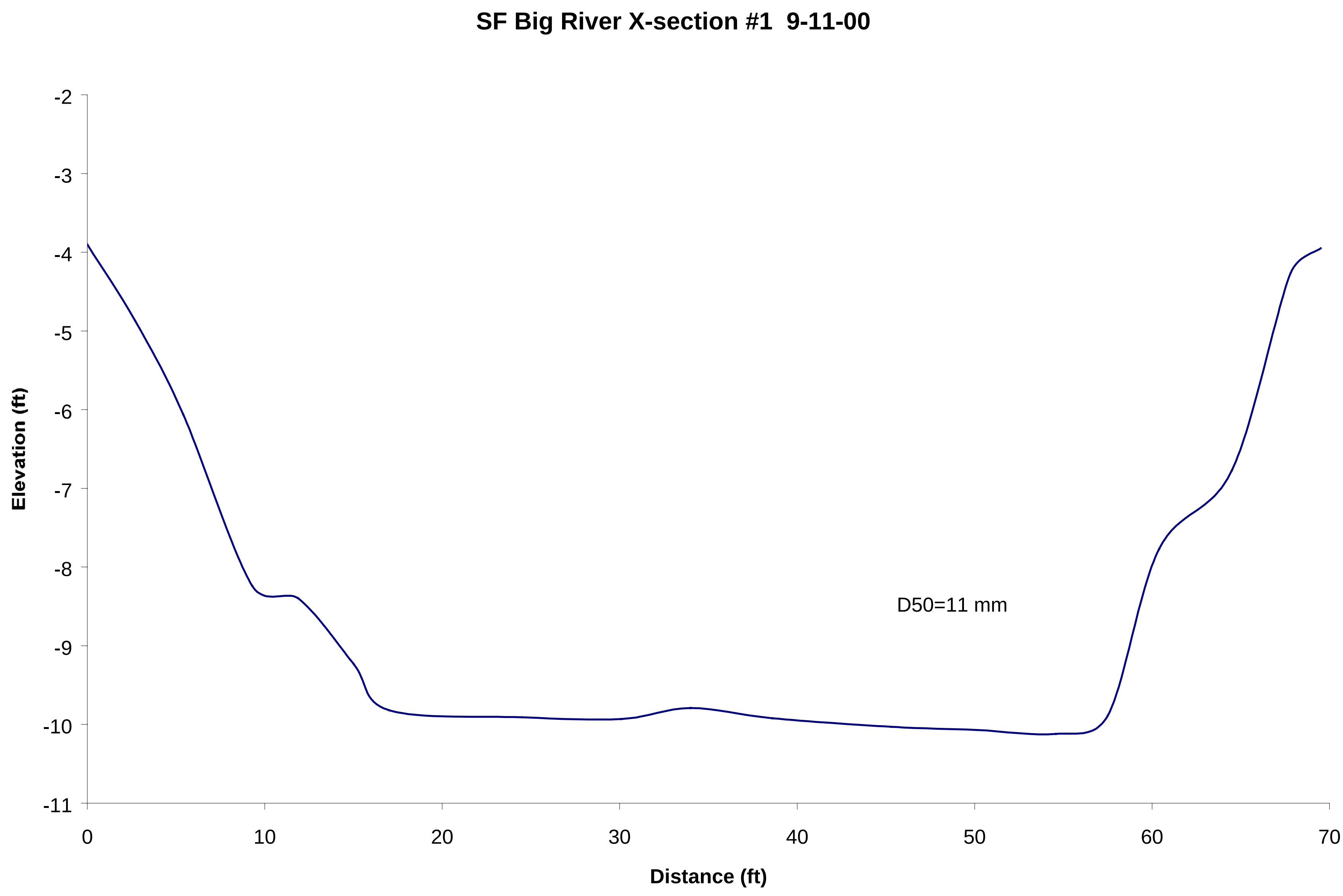

Ramon Creek, Cross-section #4 9/12/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)



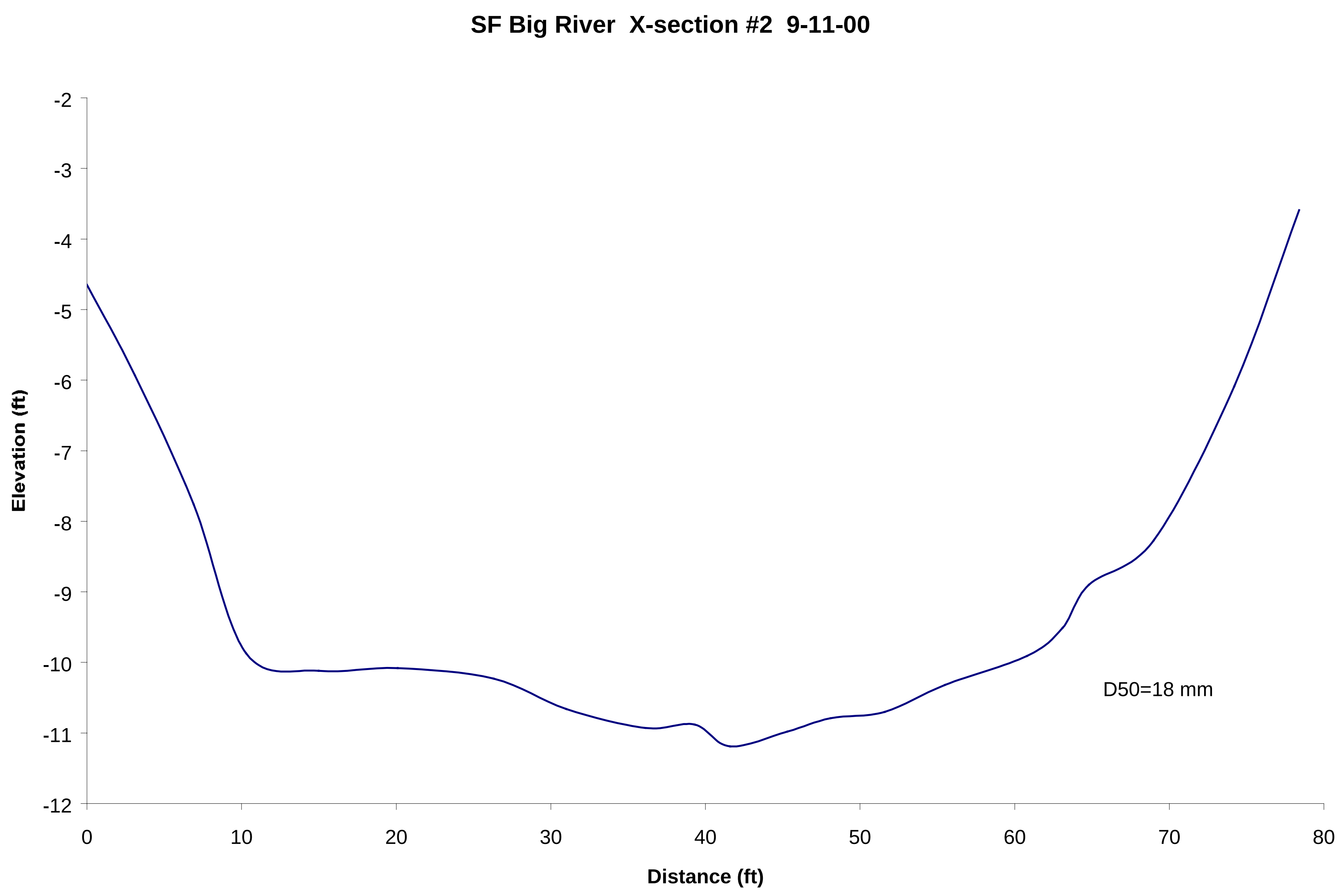
SF Big River Thalweg Profile 9-11-00
y = 0.0025x - 5.6913
Elevation (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
0
200
400
600
800
1000
1200
Distance (ft)

SF Big River Thalweg Residual Depth Analysis

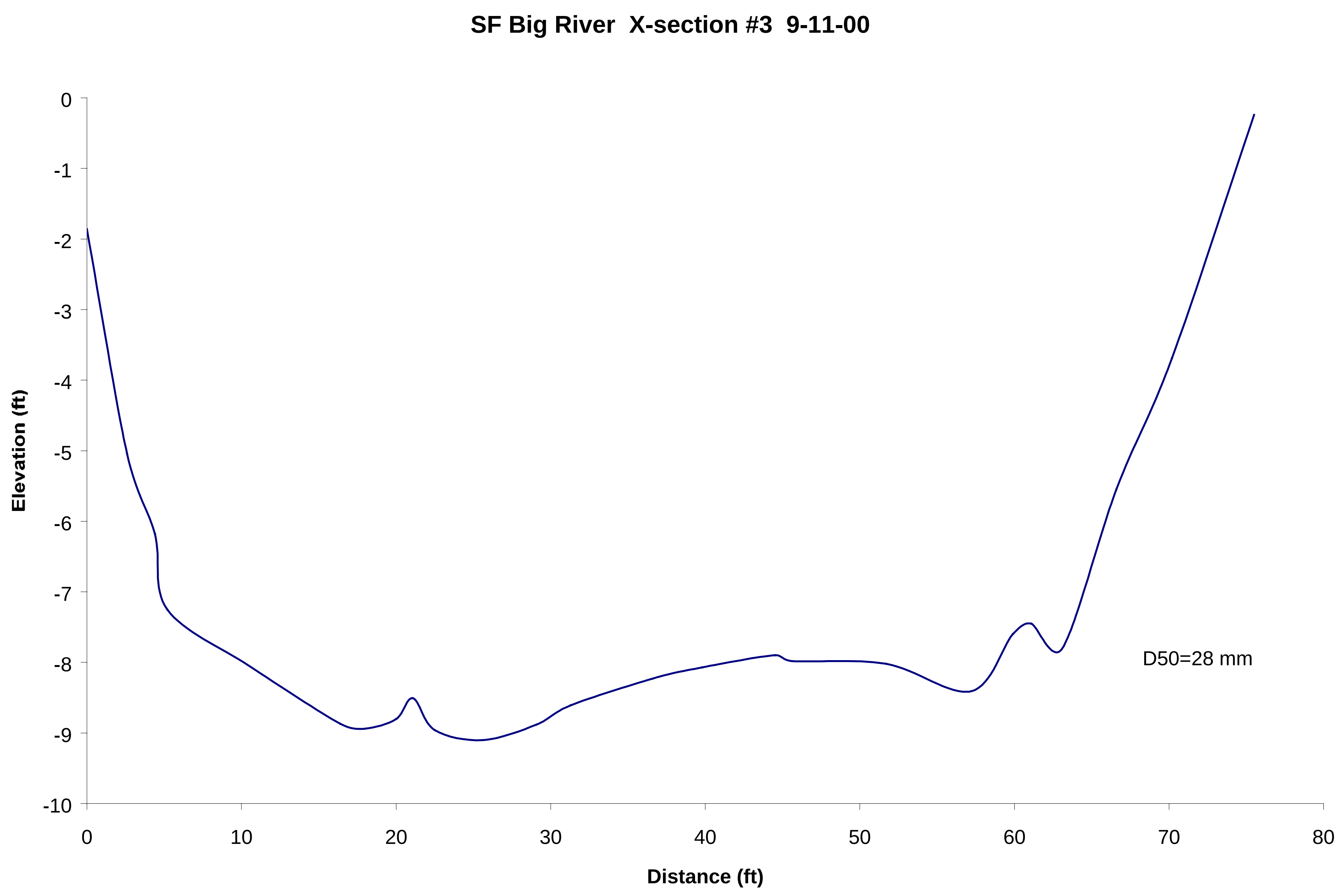
```
Top Elevation:    -0.10
Bottom Elevation:    -7.69
    Reach Length:  1187.30

------------------------------------------------------------------------------
-

Standardized Statistics:
         Number of data points in raw data: 110
Number of data points in Standardized data: 237

Reach Step Distance: 5.00

 Max Residual Depth:     6.03
Mean Residual Depth:     0.95
 Standard Deviation:     1.23

Number of non-zero Residual Depths: 192
  Percent of Reach as pool:  81.01
Percent of Reach as riffle:  18.99
```


SF Big River X-section #1 9-11-00
Elevation (ft)
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
0
10
20
30
40
50
60
70
Distance (ft)
D50=11 mm


South Fork Big River, Cross-section #1 9/11/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)

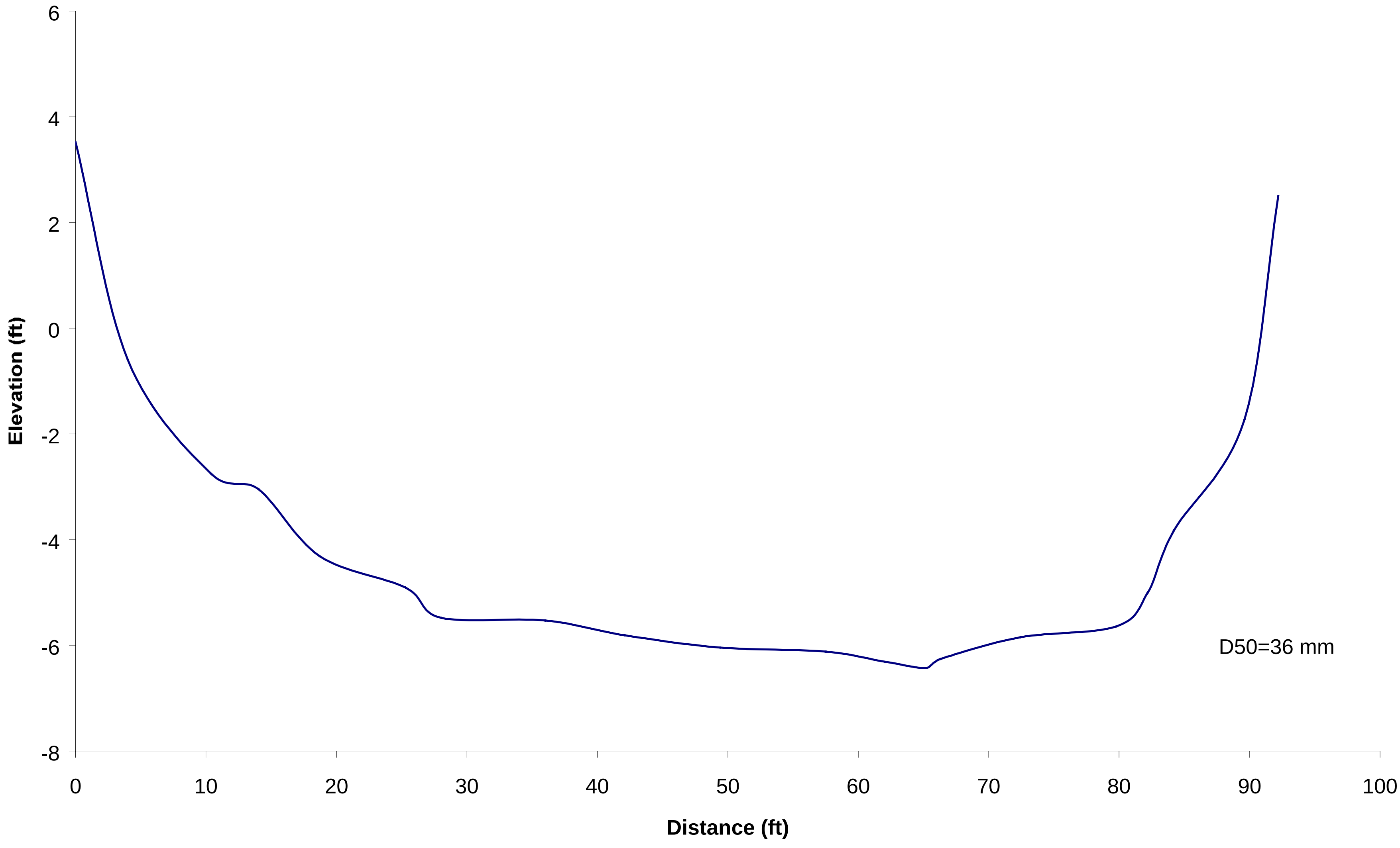

SF Big River X-section #2 9-11-00
Elevation (ft)
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
0
10
20
30
40
50
60
70
80
Distance (ft)
D50=18 mm

South Fork Big River, Cross-section #2 9/11/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)


SF Big River X-section #3 9-11-00
Elevation (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
0
10
20
30
40
50
60
70
80
Distance (ft)
D50=28 mm


South Fork Big River, Cross-section #3 9/11/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)

SF Big River X-section #4 9-11-00




South Fork Big River, Cross-section #4 9/11/00
Percent Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)