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 Northern Russian 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 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 baseline information for the evaluation of channel conditions over the long term.

Stream Segment Delineation

The stream channel network for the Northern Russian 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 Northern Russian River WAU data, channels for four planning watersheds are assessed. 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 within the two main land holdings of the WAU (Ackerman Creek and Jack Smith Creek). No attention was focused on the source reaches (>20% gradient).

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, fine sediment abundance 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 the segment (continuous, discontinuous, inactive, none) and channel roughness characteristics. Large woody debris (LWD) functioning in the channel is inventoried (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.

Stream Monitoring Sites

Two stream channel monitoring segments were established to monitor stream channel morphology conditions and stream sediment characteristics related to a culvert removal and stream channel restoration project on Ackerman Creek. Along these segments longitudinal profiles, cross sections and streambed D50 measurements were surveyed. Permeability of spawning gravels was measured on one segment (methods and results presented in the Fish Habitat section). These monitoring segments will be re-surveyed and monitored over time to provide insight into changes in channel morphology, sediment transport and fish habitat conditions from our restoration work. It is not certain that these will become one of MRC's long term channel monitoring locations. The segments will be observed for at least the near future.

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 longitudinal profile is a survey of the thalweg, 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 station along the channel and the elevation is recorded. In the absence of visually apparent changes, thalweg measurements are taken every 15-20 feet along the channel. A profile graph of the channel's thalweg is created from the longitudinal survey (see Appendix E for longitudinal profiles for the Northern Russian WAU). A computer program (Longpro) 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 longitudinal 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 longitudinal profile, three to five 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 the Northern Russian WAU). 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.

Observations of the long term channel monitoring segments occurred in 2000 and 2001 for the upper Ackerman Creek segment and 2000, 2001 and 2002 for the lower segment. This provides a comparison of the longitudinal profile, cross sections and pebble counts for those segments.

RESULTS

Stream Channel Observations

Field channel surveys or observations were taken on 8 stream reaches in the Northern Russian River WAU during the summer of 2000. 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 of this report. LWD measured and evaluated in stream channels is reported in the Riparian Function section.

<u>Key to Table E-1</u>.

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. UU – Upper Ackerman UL – Lower Ackerman UJ – Jack Smith
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, based on the DTM in GIS.
Survey Length	Length of stream surveyed.
GIS slope category	Slope class as designated by DTM in GIS.
Field 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
Geomorphic Unit	Number of the geomorphic unit the channel segment is in.
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.
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	S=sparse, M=moderate, A=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 at a representative riffle.

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.
Pool Spacing	average space between pools by bankfull widths.
Mean Res. Pool Depth	average of all residual pool depths in segment.

Table E-1. Stream Channel Observations for the Northern Russian River Watershed Analysis Unit, 2000.

Segment Name	ID #	Channel Confine-ment	Survey Length (ft)	GIS Slope Category (%)	Field Observed Slope (%)	Maximum Bankfull Depth (ft)	Mean Bankfull Depth (ft)	Bankfull Width (ft)	Width/ Depth Ratio	Flood-prone Depth	Flood-prone Width	Entrench-ment Ratio
Ackerman Creek	UL1	Confined	696	0-3	2.3	3.2	3	30.6	10.2	6.4	45	1.5
Ackerman Creek	UL2	Unconfin ed	1372	0-3	1.1	4.6	2.1	56.0	26.7	9.2	95.0	1.7
Ackerman Creek	UU6	Confined	688	0-3	1.9	2	1.5	37.2	24.8	4.0	45	1.2
Alder Creek	UU10	Confined	537	0-3	4.0	2	1.4	23	16.4	4.0	45	2.0
Alder Creek	UU12	Mod. Confined	413	0-3	2.3	2	1.4	23	16.4	4.0	45	2.0
Alder Creek	UU13	Confined	328	3-7	2.8	2.2	1.45	18.5	12.8	4.4	70	3.8
Jack Smith Crk	UJ2	Mod. Confined	353	0-3	1.5	2.5	2	14	7.0	5.0	70	5.0
Jack Smith Crk	UJ3	Confined	368	0-3	1.5	2.2	1.5	9.6	6.4	4.4	22	2.3

Segment Name	ID #	Floodplain Continuity	Channel Roughness	Gravel Bar Abundance	Gravel Bar Types	Gravel Bar Percent	Fine Sediment Abundance	Fine Sediment Type	D50 (mm)
Ackerman Creek	UL1	None	R-B-C	Few	P	1	Sparse	P	84
Ackerman Creek	UL2	Common	F-BK	Common	P	3	Moderate	M	67
Ackerman Creek	UU6	None	C-B-R-LWD	Common	P,F	2	Moderate	M	78
Alder Creek	UU10	Discontinuous	C-R-LWD	Common	P	1	Sparse	P	75
Alder Creek	UU12	Discontinuous	C-LWD-BK	Common	P	2	Sparse	P	63
Alder Creek	UU13	Discontinuous	C-LWD	Common	P, F	2	Sparse	M	53
Jack Smith Crk	UJ2	Common	F,BK,LWD	Common	P	1	Sparse	P	43
Jack Smith Crk	UJ3	Discontinuous	LWD,F,C	Common	F-P	1	Moderate	M	40

Table E-1 Continued. Stream Channel Observations for the Northern Russian River Watershed Analysis Unit, 2000.

Segment Name	ID #	Geomorphic Unit	Montgomery/ Buffington Class	Rosgen Class	Free	LWD Forced	Boulder Forced	Bank Forced	Pool Spacing	Mean Res. Pool Depth (ft.)
Ackerman Creek	UL1	2	CAS	B2, A2	0	0	4	2	3.8	1.9
Ackerman Creek	UL2	1	P/R	C4	0	0	0	4	6.1	No data
Ackerman Creek	UU6	2	P/R	G4, F4	3	0	1	1	3.7	1.1
Alder Creek	UU10	1	P/R, PB	C4, F3	1	1	2	0	5.8	1.0
Alder Creek	UU12	1	P/R, PB	C4, F4	0	2	0	3	3.6	1.9
Alder Creek	UU13	2	P/R, FP/R	B4, G4	0	2	1	3	3.0	0.8
Jack Smith Crk	UJ2	2	P/R	E4, C4	0	0	0	3	8.4	1.4
Jack Smith Crk	UJ3	2	P/R, FP/R	F4, G4, C4	1	6	0	0	5.5	1.8

Stream Geomorphic Units

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

<u>Geomorphic Unit I</u>. Low Gradient, Unconfined to Moderately Confined Channels.

Includes Segments: *Field observed* – UL2, UU12
Extrapolated - UU1, UU11

***General Description*:**
The channels within this unit flow through short areas of unconfined to moderately confined canyons. Hillslopes or inner gorge topography typically controls the lateral edge of the floodplain. Some terraces are present and floodplains are present though discontinuously. The bankfull channel is typically between 15 and 60 feet in width. The channels in this unit are low gradient (0-2 percent, but usually <1 percent). These channels exhibit moderate sediment transport capacity. The meandering, low gradient pattern and profile facilitates sediment deposition. When terraces are present bank erosion is observed in this unit, particularly on the outside of meander mends and toes of large landslides.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology. The Rosgen classifications (Rosgen, 1994) for these channels are primarily C4, with some areas of F4 and DA4.

Fish Habitat Associations:
Spawning habitat and gravel are in moderate amounts in this unit, but spawning gravel quality is reasonably good where present. 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: High 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 wider braided channels.

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: 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.

Geomorphic Unit II. Confined Low Gradient Channel Segments.

Includes Segments: *Field observed* – UL1, UU13, UJ2, UJ3
Extrapolated – UJ1, UJ4, UU2, UU3, UU4, UU5, UU10,

General Description: The channels within this unit meander through confined canyons. The channels are typically confined by hillslopes with a narrow floodplain occasionally present, typically on the inside of meander bends. Alternating gravel bars on meander bends often define the bankfull width. The bankfull channel is typically between 10 and 30 feet in width. These channels are often entrenched within terrace or landslide deposits. Bank erosion is high. The channels in this unit are low gradient (<3 percent), but sediment transport capacity is high due to the highly confined channel keeping water energy directed within the channel. The channel bed is composed of primarily gravel-sized particles.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology, however some step pool and forced pool/riffle morphology does occur. The Rosgen classification (Rosgen, 1994) for these channels are predominantly F4.

Fish Habitat Associations:
This unit is characterized by large substrate that provides an element of roughness to the stream. Larger sized cobbles break up the flow of water creating velocity breaks and bubble curtains. Velocity breaks are located directly behind (downstream) cobble and boulders and provide a resting place for fish. The white water or bubble curtains that are created by larger, exposed substrate are considered a valuable source of shelter for fish. This unit has low amounts of large woody debris, due the confined nature of the channels wood recruitment would have a positive effect on the quality of in-stream habitat by providing increased scour and shelter to pool habitat.

Conditions and Response Potential:
Coarse Sediment: Moderate Response Potential
These channels are not depositional areas for coarse sediment. Coarse gravel accumulations are common in point and medial gravel bars in this unit. The high confinement of these channels creates relatively high sediment transport capacity. However, if the supply of coarse sediment surpasses the transport capacity the impact can be filling of pools or increased scour of the bed.

Fine Sediment: Moderate Response Potential
The channels of this unit have high fine sediment transport capacity due to confinement of the channels. However, the watershed has a relatively high background sediment rate. This high rate of sediment input can result in pool filling or bed fining from high fine sediment accumulations.

Fine sediment accumulations were observed in this unit on the top of gravel bars, accumulated in the bed of plane bed reaches, along pool margins, and in some pools.

Large Woody Debris: 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.

Geomorphic Unit III. Moderate Gradient Confined Transport Segments.

Includes Segments: *Field observed* – UU6
Extrapolated – UU17, UJ8

General Description:
Stream channel segments in this unit are confined within canyons, though areas of moderate confinement occur locally. Typically entrenchment ratios (bankfull to floodprone width) are between 1 and 5 bankfull widths. This is sufficient to allow some isolated terrace formation and channel meandering, though not common. The channel segments in this unit are near the transition between deposition and transport channels. Due to the moderate gradient (3-7 percent) of the channels, they are responsive to aggradation and degradation from changes in the stream sediment supply. The stream bed 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 frequent 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 step pool and forced pool/riffle morphology, with areas of cascade morphology. The Rosgen classifications (Rosgen, 1994) for these channels vary from G1-4 with areas of B4 and 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. Sparse to moderate accumulations of fine sediment was 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.

Geomorphic Unit IV. High Gradient Transport Segments.

Includes Segments: UJ5, UJ6, UJ7, UJ8, UJ9, UJ10, UJ11, UJ12, UJ13, UJ14, UJ15, UJ16, UJ17, UM1, UM2, UL3, UL4, UL5, UU7, UU8, UU9, UU12, UU13, UU14, UU15, UU16, UU18, UU19, UU20, UU21, UU22, UU23, UU24, UU25, UU26, UU27, UU28, UU29, UU30

General Description:
Channel segments in this unit are high gradient transport reaches from 7-20% with high sediment transport capacity. The channel segments in this unit typically flow through tightly confined, V-shaped canyons. These are typically zones of scour during high flows or debris flows. Stream substrate is typically from cobble to large boulders. Typically, there is no surface water flow in this unit in the summer drought season.

Associated Channel Types:
This unit varies its 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:
Potential for steelhead trout utilization is low due to the high gradient; 8% to 20% and small channel sizes. 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 are not common in these high gradient, large substrate dominated channels even with increases in sediment supply.

Large Woody Debris: Moderate 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 and 2001 two long term channel monitoring segments on Ackerman Creek (UL2 and UU1) were surveyed for longitudinal profiles, cross sections, and particle size distribution. In 2002, UL2 was surveyed an additional time. The D50 of the bed was surveyed in two cross sections however the particle distribution was not available (the 2002 survey was conducted by a University of California research group). 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.

The longitudinal and cross section profiles for the upper monitoring segment of Ackerman Creek (UU1) show only small changes between 2000 and 2001. The residual depths and standard deviation of the residual depths are relatively close, though the 2001 observations do show slightly more variability (Table E-2). The particle distributions for the upper segment of Ackerman Creek (UU1) show a slightly finer bed of the stream channel (see appendix E for the graphs). It is not certain what this may indicate, over time this should be watched.

The longitudinal and cross section profiles for the lower monitoring segment of Ackerman Creek (UU1) show substantial changes between 2000 and 2002. This segment is directly in a stream segment that MRC is trying to restore to its natural function. The 2000 profiles show the stream profile prior to an under-sized culvert being removed; this culvert had created severe aggradation behind it through this survey reach. The 2001 profiles show the stream channel follow removal of the culvert but prior to receiving any winter streamflow. The 2002 profiles show the stream following two winters of streamflow. In 2002 the channel has shown substantial adjustment, primarily degrading in the upper section of the monitoring segment. This degradation we hypothesize is the stream channel attempting to achieve its historic grade prior to the culvert. It appears that the degradation is finished and that the channel is forming a new floodplain. Future surveys will need to confirm this. The residual depths and standard deviation of the residual depths for segment UL2 are different as well (Table E-2). Following the streamflow events (2002) the stream channel has become a long riffle that is transporting the sediment from the degradation of the upper portion of the stream segment. Over time some pool formation should occur and the residual depth observations should improve. The particle distributions for the lower segment of Ackerman Creek (UL2) show an increase in fine material in the bed of the channel (see graphs in appendix E). It is not certain what this may indicate particularly because of the stream channel degradation, over time this should be watched.

Table E-2. Comparison of residual depth data for thalweg profiles in long-term channel monitoring segments in Ackerman Creek.

Segment ID	Year	Maximum Residual Depth (ft)	Mean Residual Depth (ft)	Standard Deviation
UL2	2000	5.12	0.51	1.01
UL2	2001	4.11	0.61	0.88
UL2	2002	1.94	0.23	0.45
UU1	2000	2.52	0.33	0.53
UU1	2001	2.67	0.48	0.66

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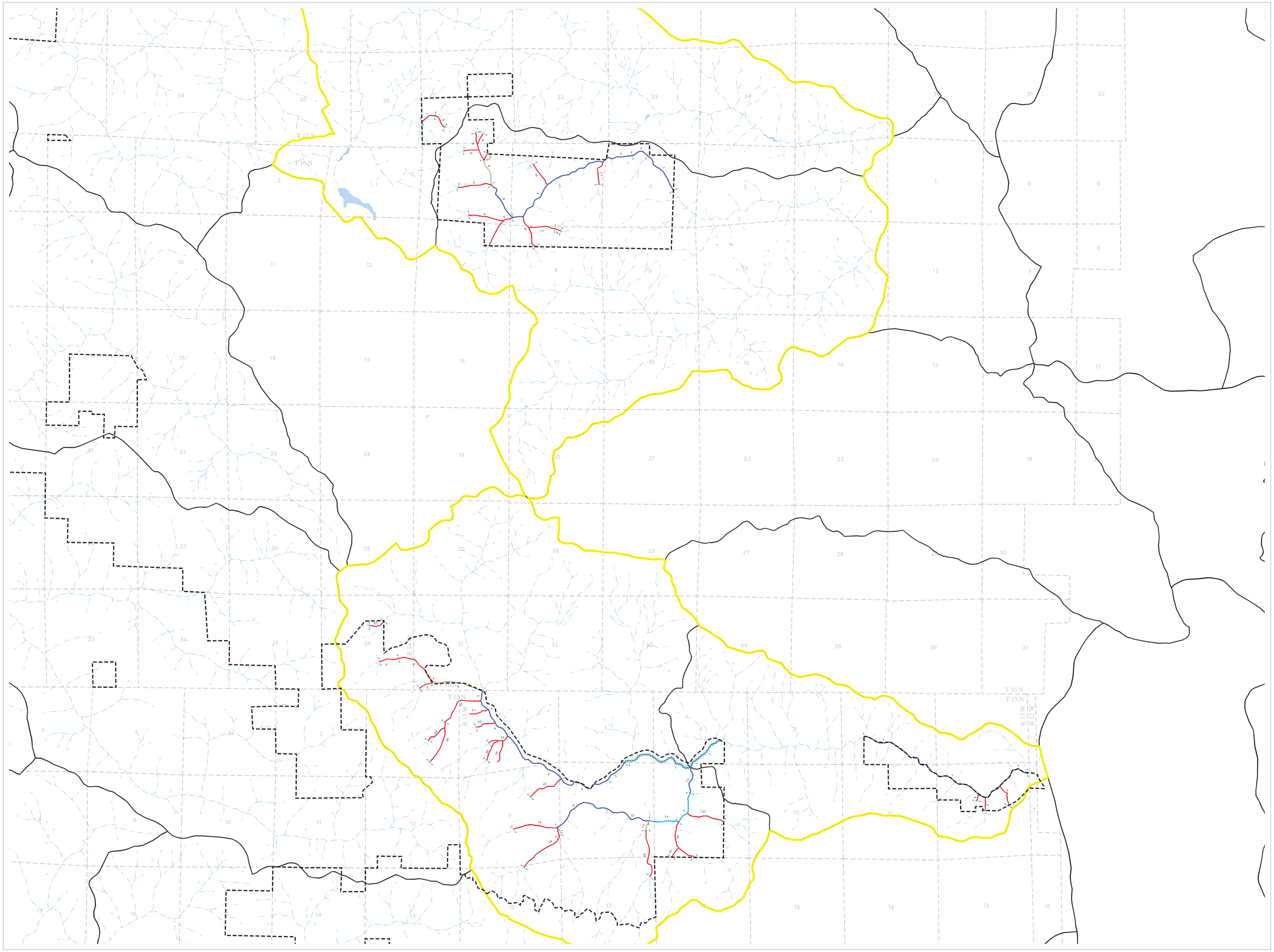
Appendix E



Northern Russian River Watershed Analysis Unit

Map E-1 Stream Channel Geomorphic Units and Segments

This map presents the stream channel network for the Northern Russian 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 Northern Russian 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 effects.

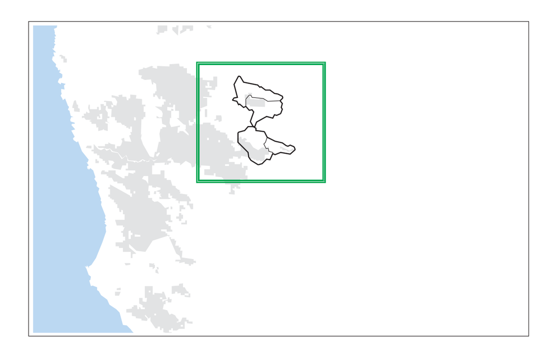
Geomorphic Classes

- Low Gradient Unconfined to Moderately Confined Channels
- Confined Low Gradient Channels
- Moderate Gradient Confined Transport Segments
- High Gradient Transport Segments
- Long Term Channel Monitoring Sites

- MRC Ownership
- Planning Watershed Boundary
- Northern Russian River Watershed Analysis Unit Boundary

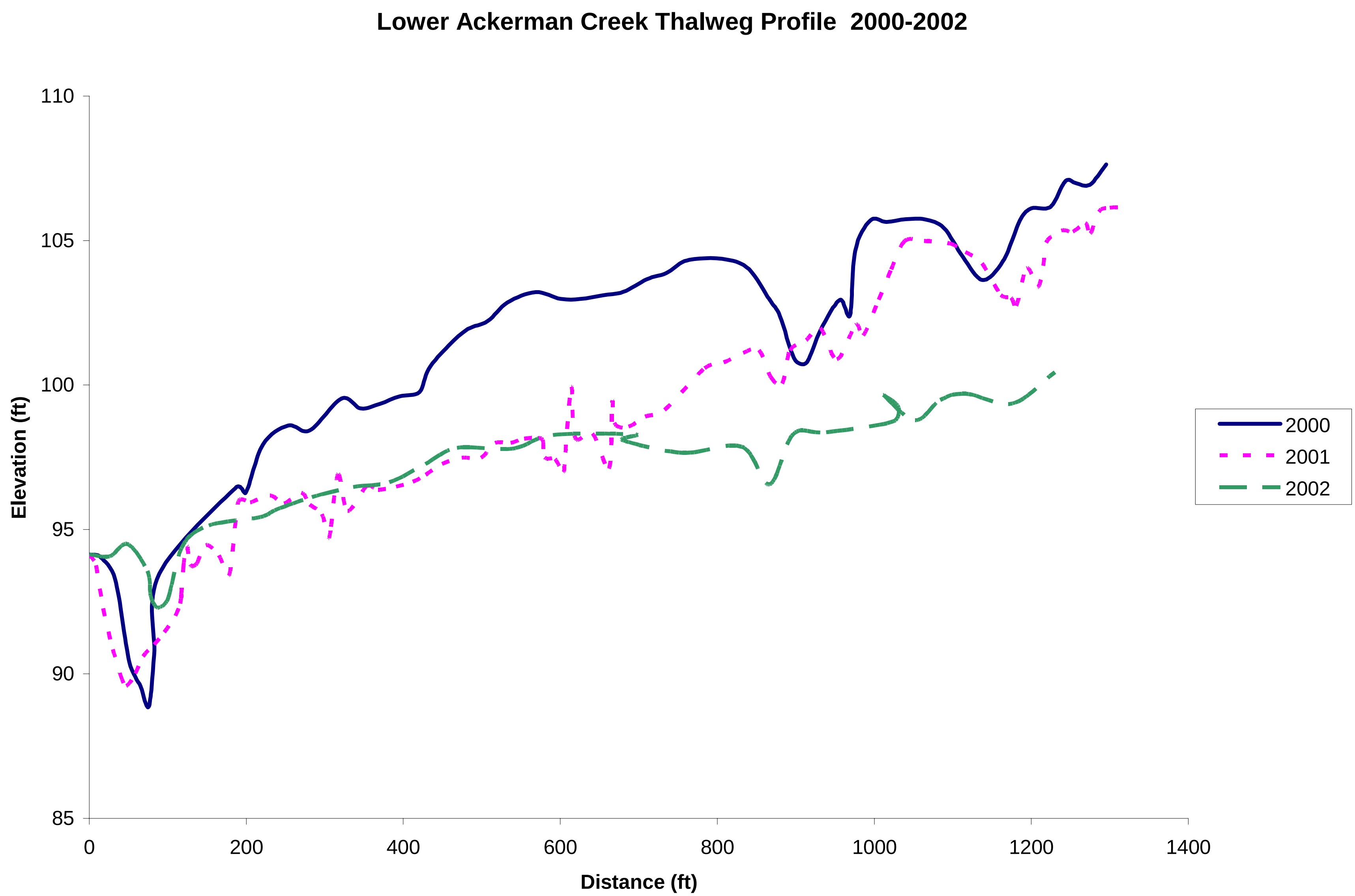
Flow Class

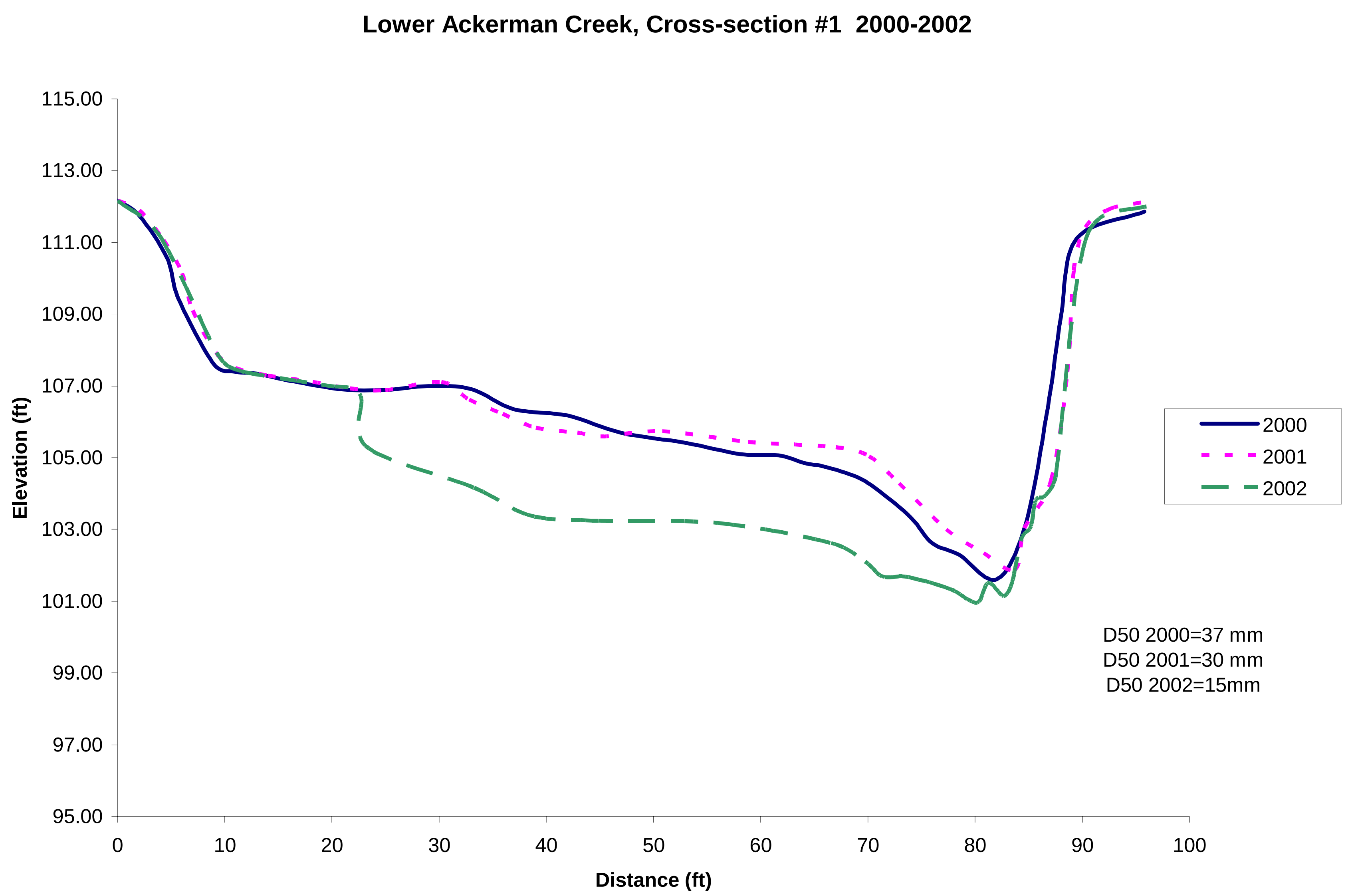
- Class I
- Class II
- Class III



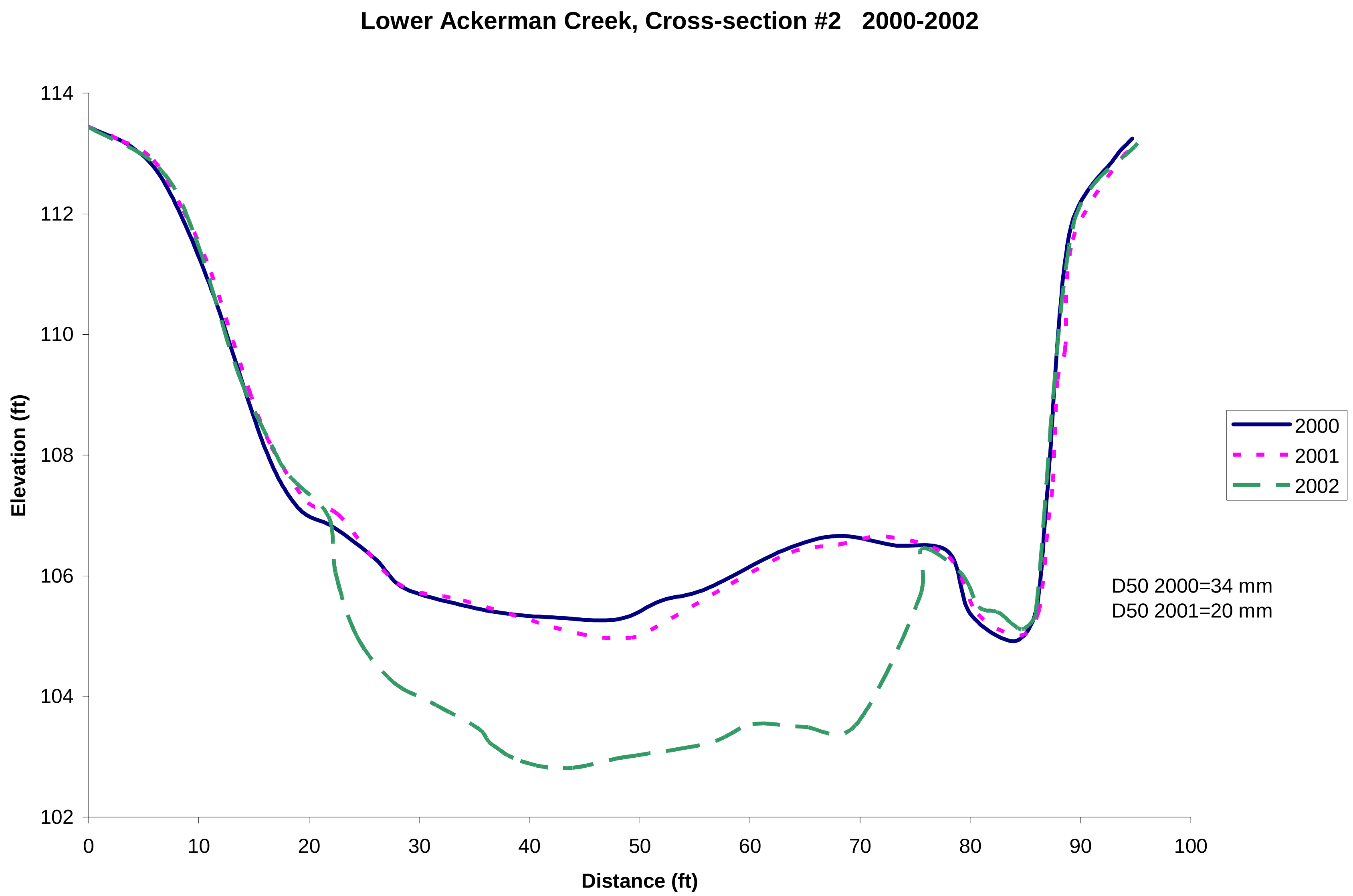
0 1/2 1 Mile

November 2004

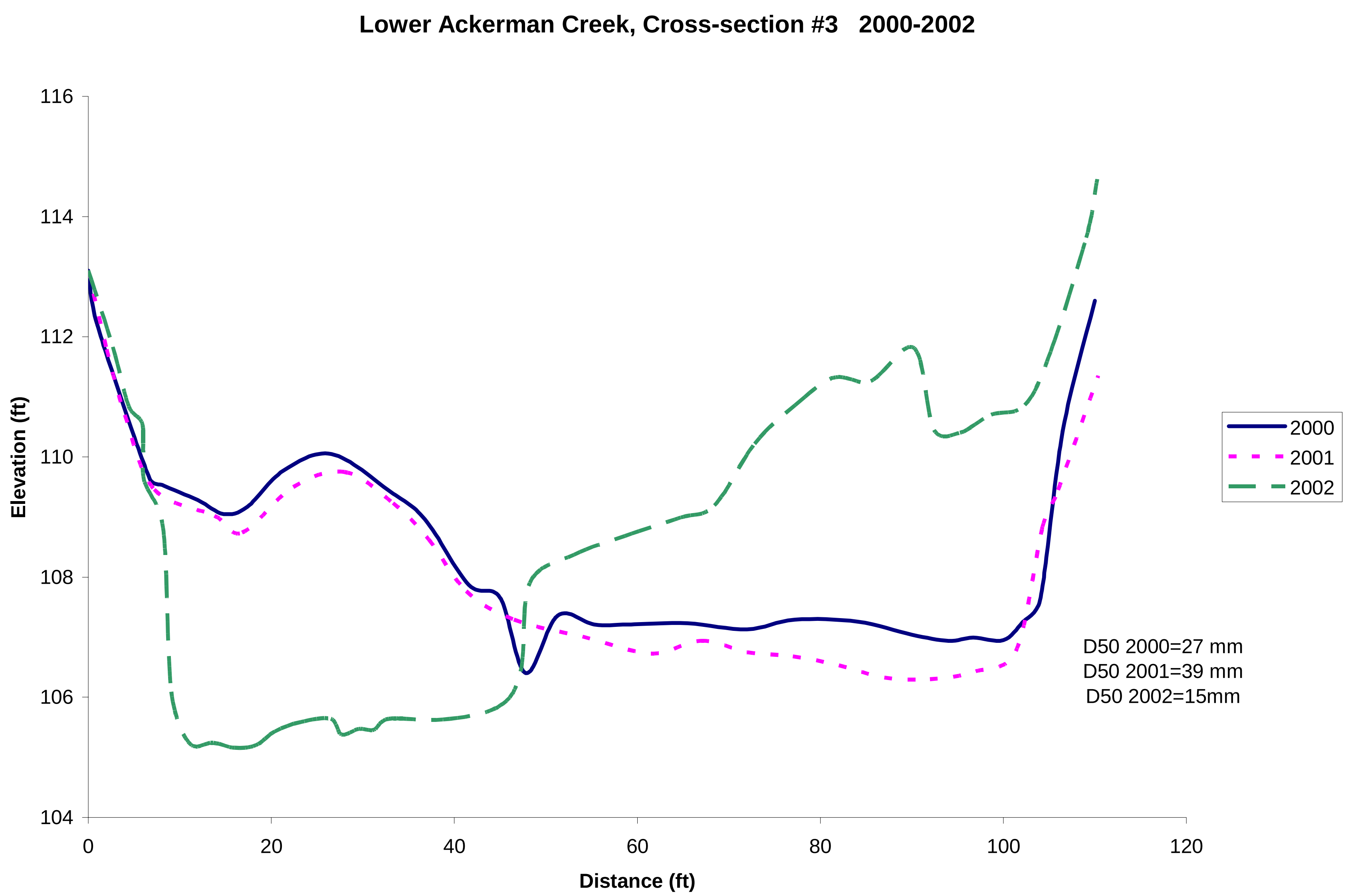

Lower Ackerman Creek Thalweg Profile 2000-2002
Elevation (ft)
110
105
100
95
90
85
0
200
400
600
800
1000
1200
1400
Distance (ft)
2000
2001
2002



Lower Ackerman Creek, Cross-section #1 2000-2002
115.00
113.00
111.00
109.00
107.00
105.00
103.00
101.00
99.00
97.00
95.00
Elevation (ft)
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)
2000
2001
2002
D50 2000=37 mm
D50 2001=30 mm
D50 2002=15mm



Lower Ackerman Creek, Cross-section #2 2000-2002
Elevation (ft)
114
112
110
108
106
104
102
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)
2000
2001
2002
D50 2000=34 mm
D50 2001=20 mm



Lower Ackerman Creek, Cross-section #3 2000-2002
116
114
112
110
108
106
104
0
20
40
60
80
100
120
Elevation (ft)
Distance (ft)
2000
2001
2002
D50 2000=27 mm
D50 2001=39 mm
D50 2002=15mm

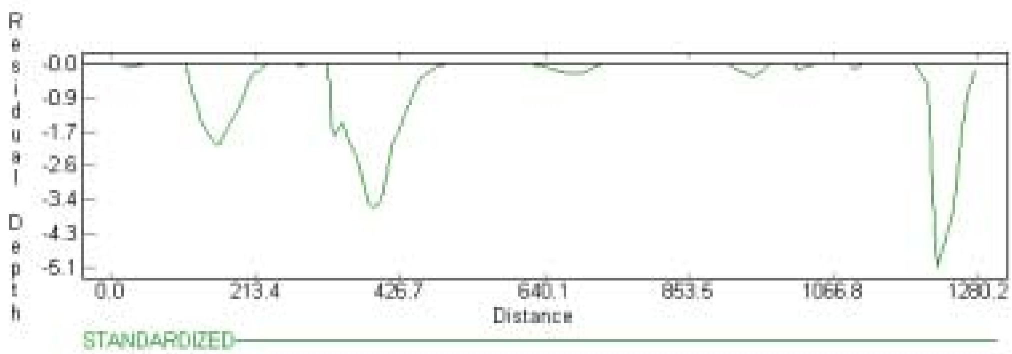
Lower Ackerman Creek Residual Depth Statistics 2000

Top Elevation: 10.24
Bottom Elevation: -8.52
Reach Length: 1280.20

Reach Step Distance: 5.00

Max Residual Depth: 5.12
Mean Residual Depth: 0.51
Standard Deviation: 1.01

Number of non-zero Residual Depths: 145
Percent of Reach as pool: 56.64
Percent of Reach as riffle: 43.36



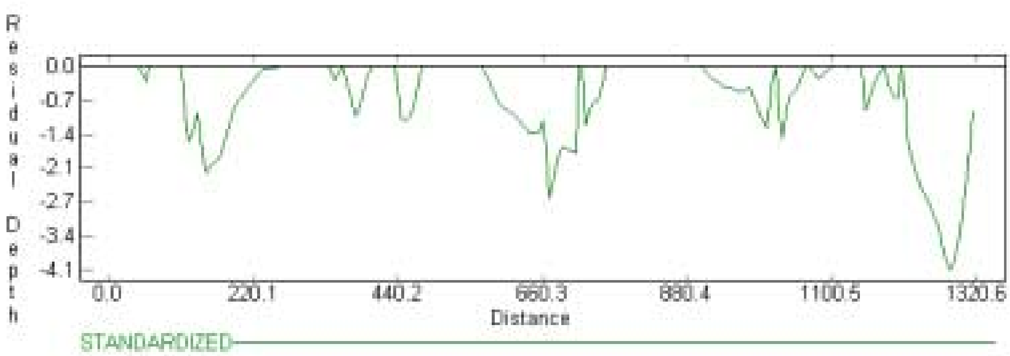
<u>Lower Ackerman Creek Residual Depth Statistics 2001</u>

Top Elevation: 106.16
Bottom Elevation: 89.58
Reach Length: 1320.60

Reach Step Distance: 5.00

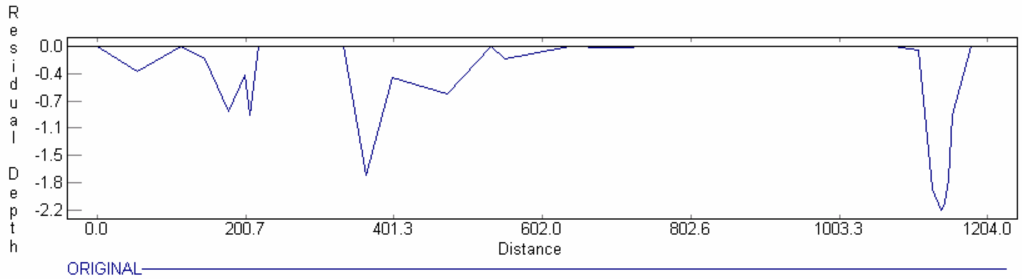
Max Residual Depth: 4.11
Mean Residual Depth: 0.61
Standard Deviation: 0.88

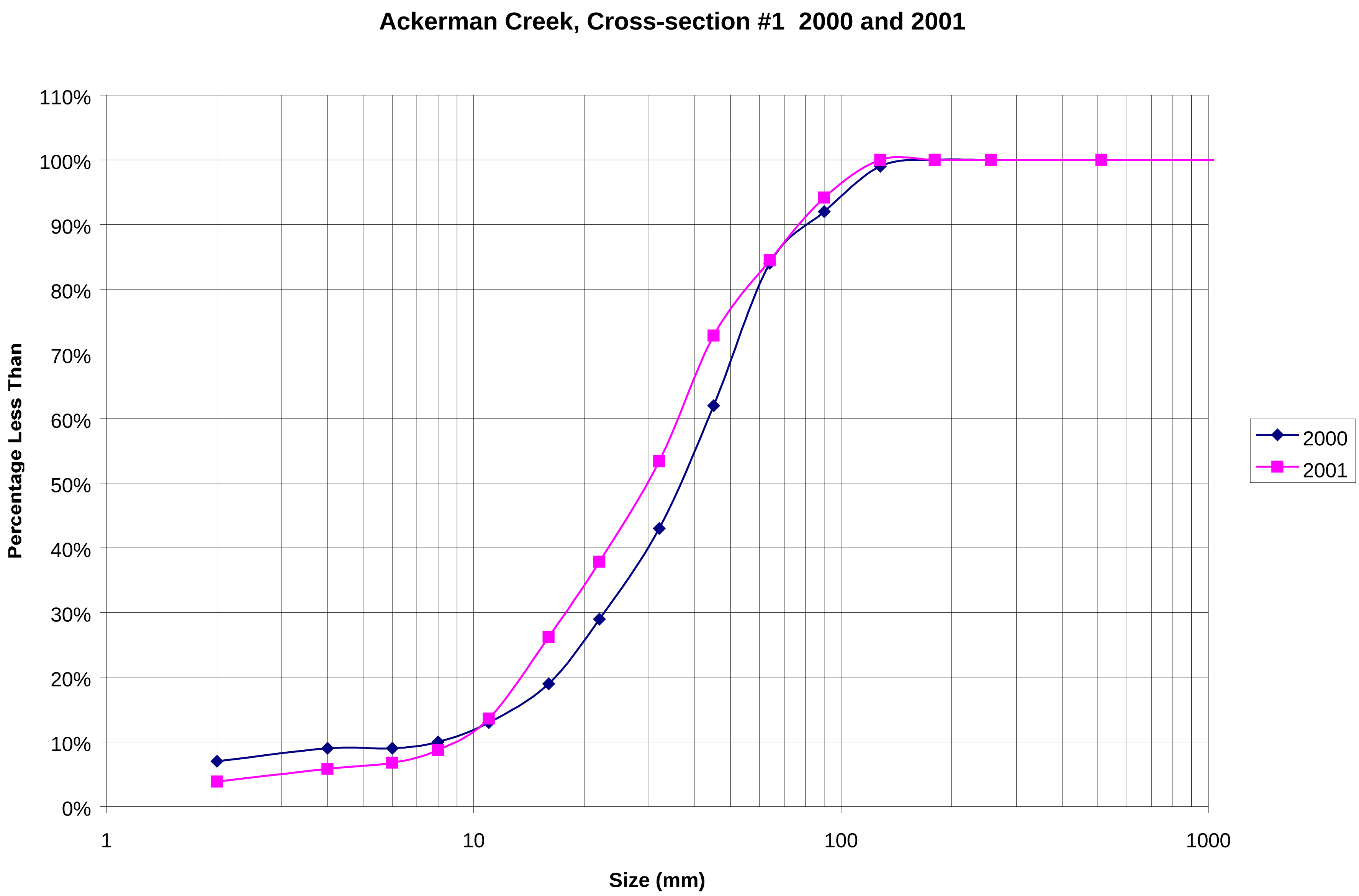
Number of non-zero Residual Depths: 169
Percent of Reach as pool: 64.02
Percent of Reach as riffle: 35.98



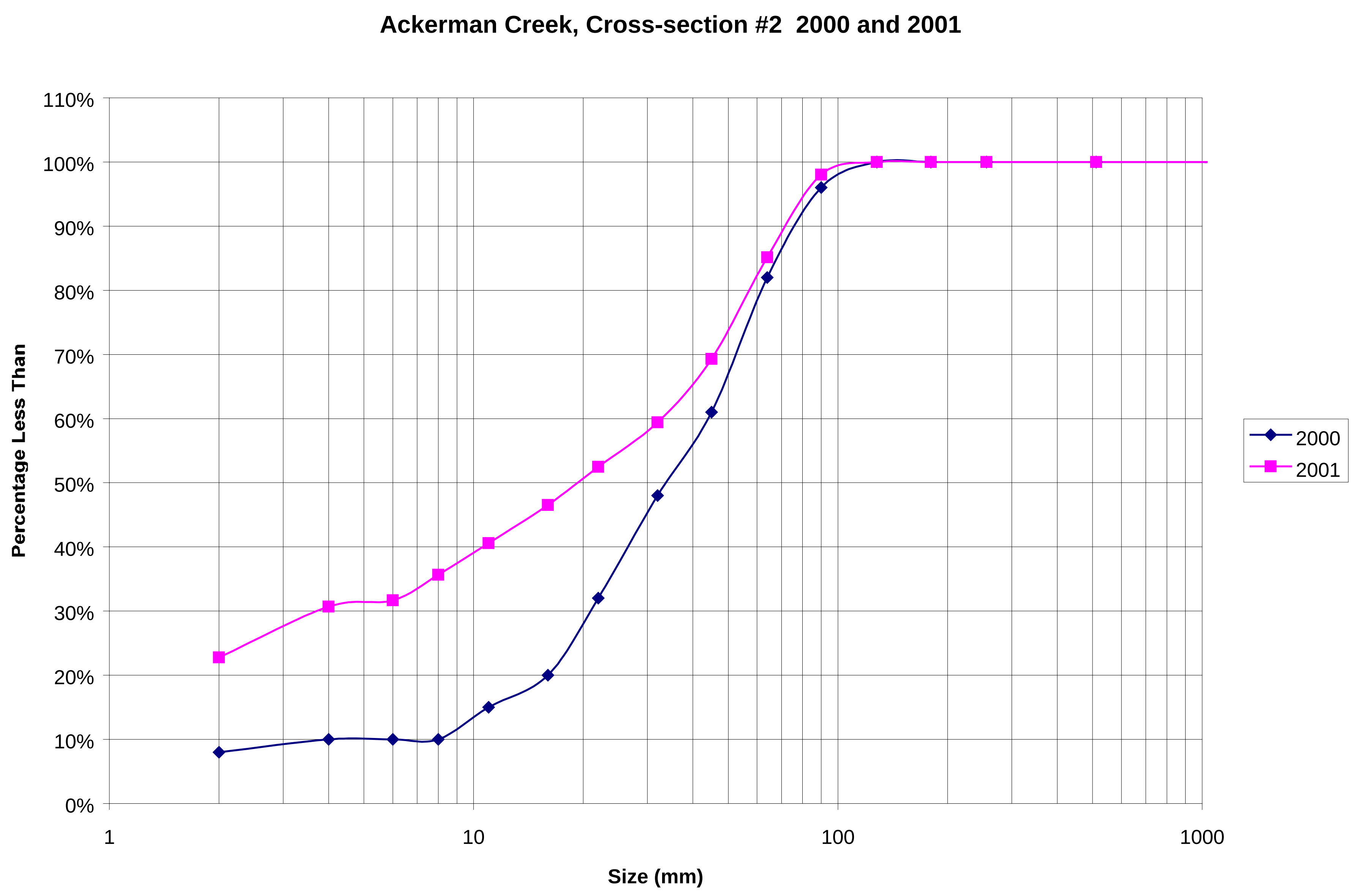
Lower Ackerman Creek Residual Depth Statistics 2002

```
Standardized Statistics:
         Number of data points in raw data: 33
Number of data points in Standardized data: 33

Reach Step Distance: 36.48

 Max Residual Depth:     1.94
Mean Residual Depth:     0.23
 Standard Deviation:     0.45

Number of non-zero Residual Depths: 16
  Percent of Reach as pool:  48.48
Percent of Reach as riffle:  51.52
```

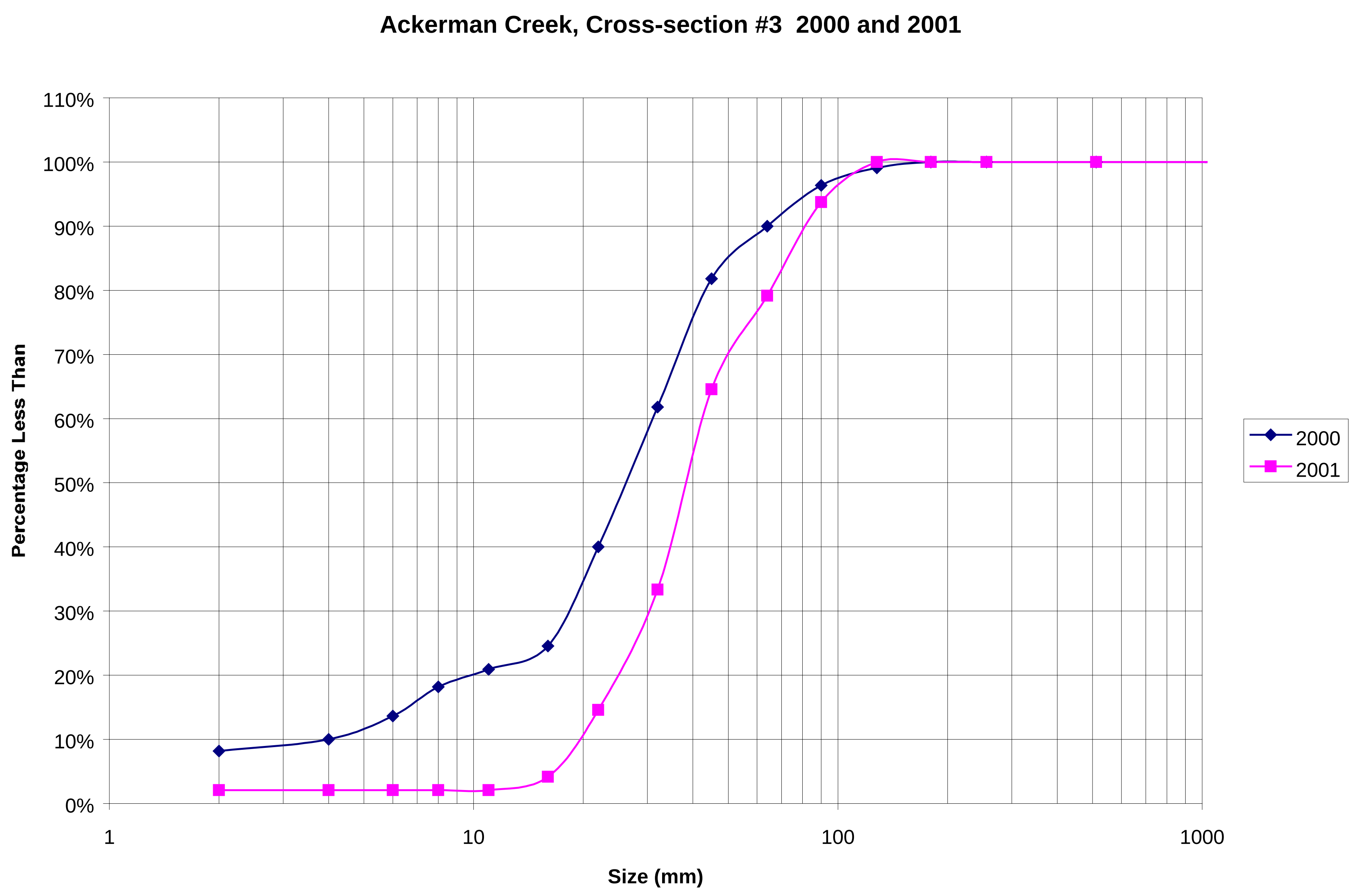


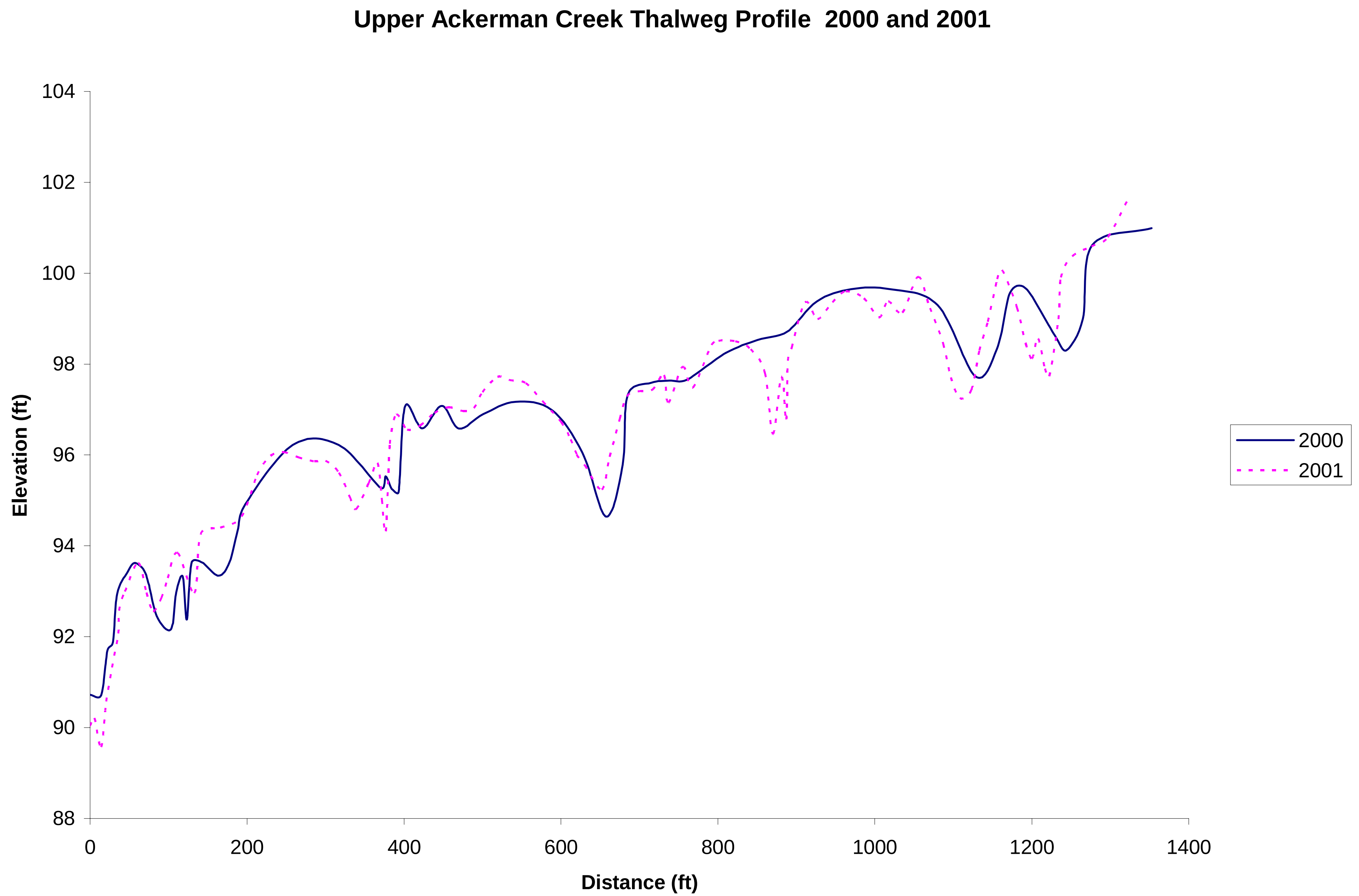


Ackerman Creek, Cross-section #1 2000 and 2001
Percentage Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)
2000
2001

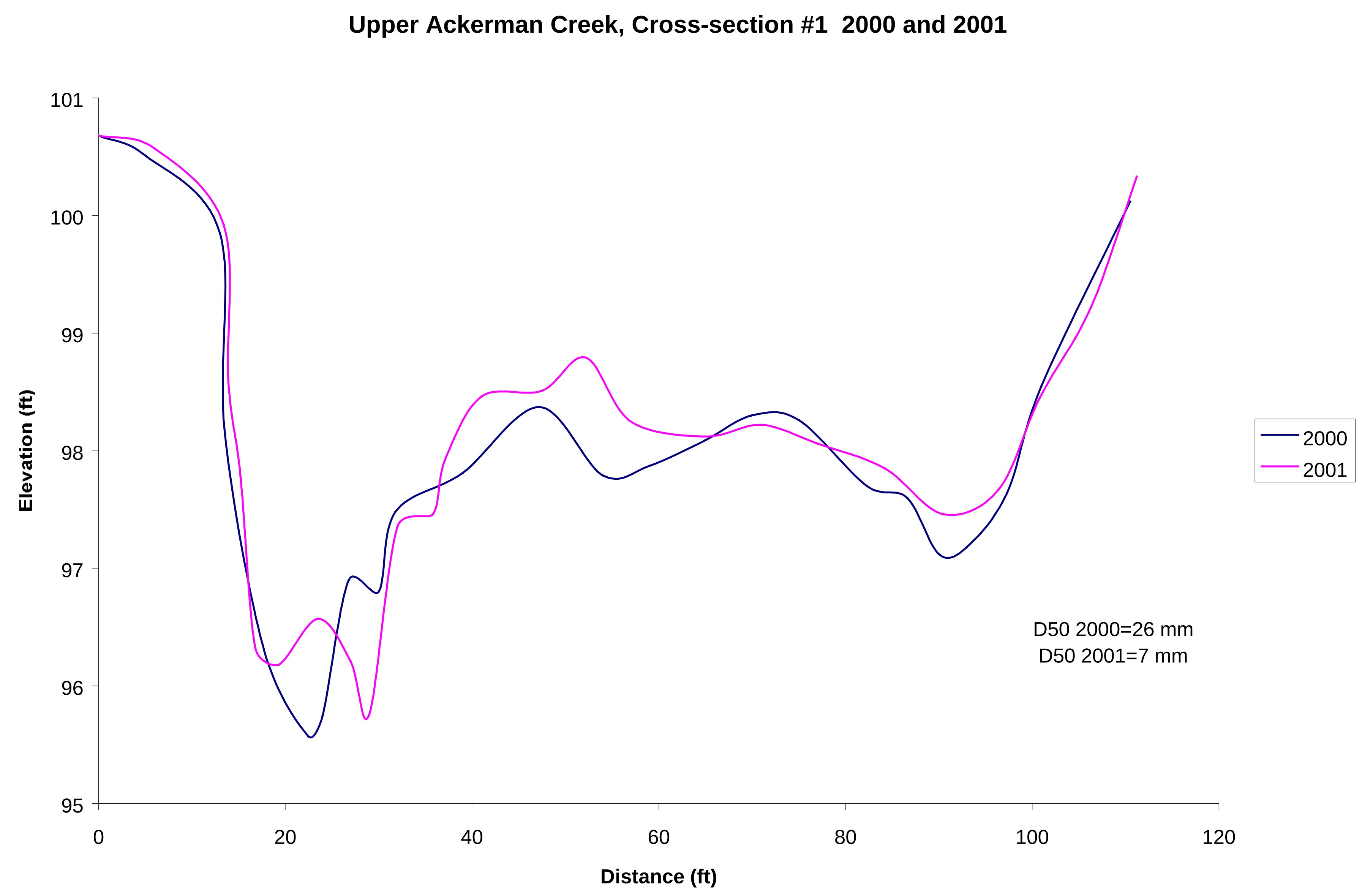


Ackerman Creek, Cross-section #2 2000 and 2001
Percentage Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)
2000
2001

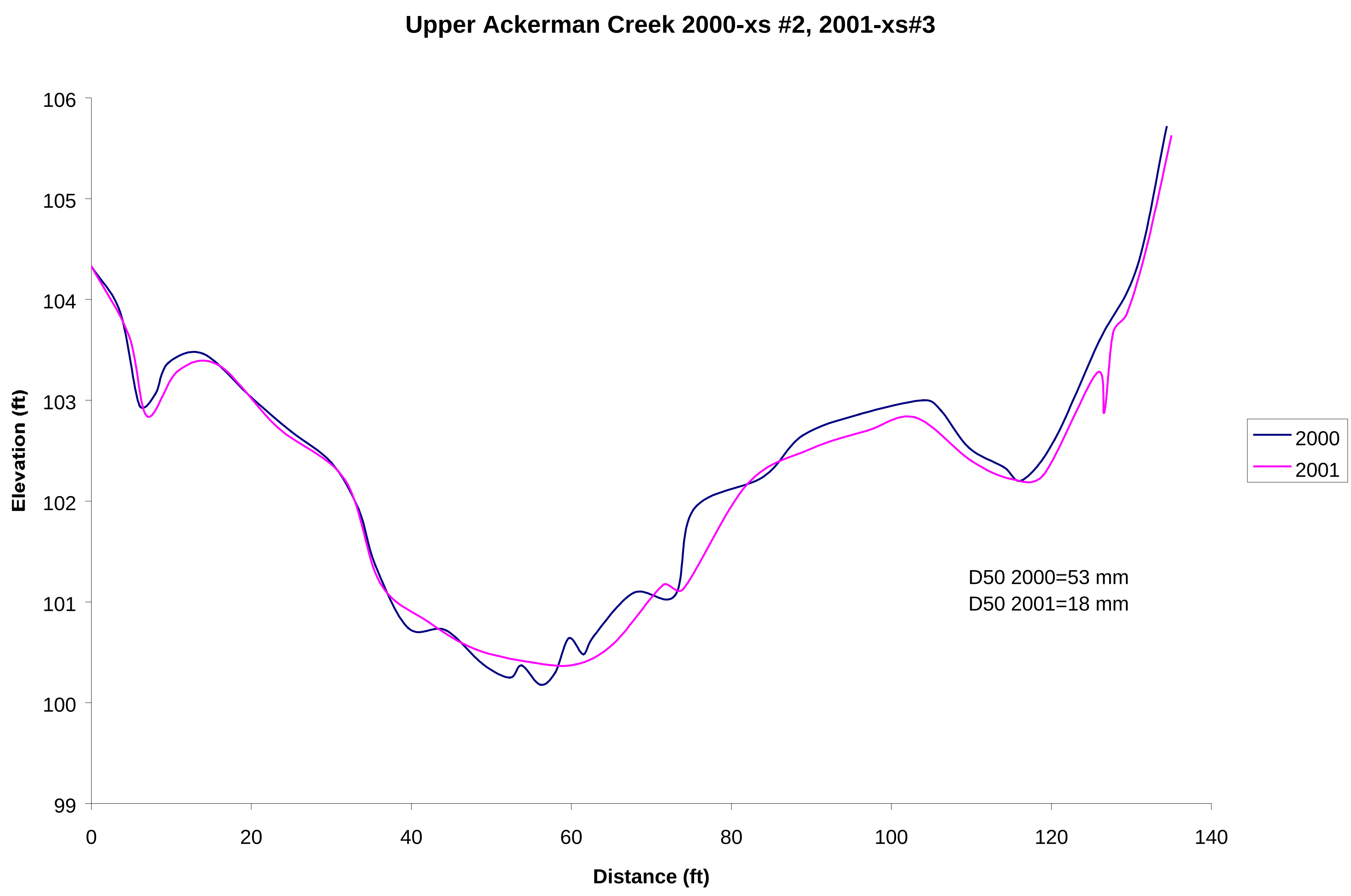

Ackerman Creek, Cross-section #3 2000 and 2001
Percentage Less Than
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
10
100
1000
Size (mm)
2000
2001



Upper Ackerman Creek Thalweg Profile 2000 and 2001
Elevation (ft)
104
102
100
98
96
94
92
90
88
0
200
400
600
800
1000
1200
1400
Distance (ft)
2000
2001



Upper Ackerman Creek, Cross-section #1 2000 and 2001
101
100
99
98
97
96
95
0
20
40
60
80
100
120
Elevation (ft)
Distance (ft)
2000
2001
D50 2000=26 mm
D50 2001=7 mm


Upper Ackerman Creek 2000-xs #2, 2001-xs#3
Elevation (ft)
106
105
104
103
102
101
100
99
0
20
40
60
80
100
120
140
Distance (ft)
2000
2001
D50 2000=53 mm
D50 2001=18 mm

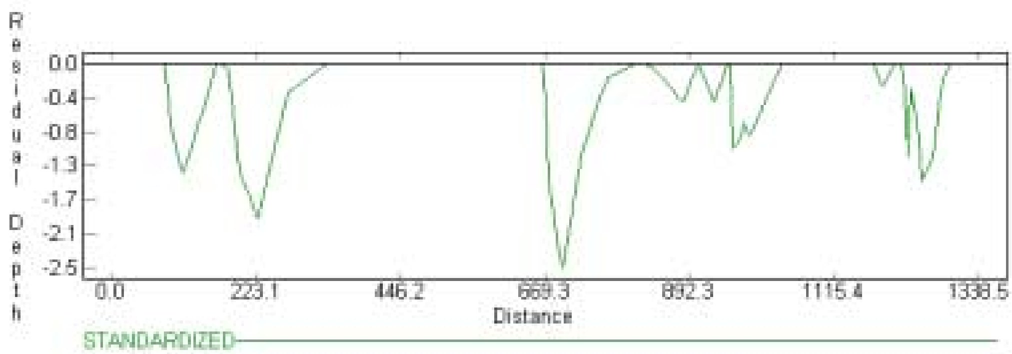
<u>**Upper Ackerman Creek Residual Depth Statistics 2000**</u>

Top Elevation: 0.96
Bottom Elevation: -9.32
Reach Length: 1338.50

Reach Step Distance: 5.00

Max Residual Depth: 2.52
Mean Residual Depth: 0.33
Standard Deviation: 0.53

Number of non-zero Residual Depths: 143
Percent of Reach as pool: 53.36
Percent of Reach as riffle: 46.64



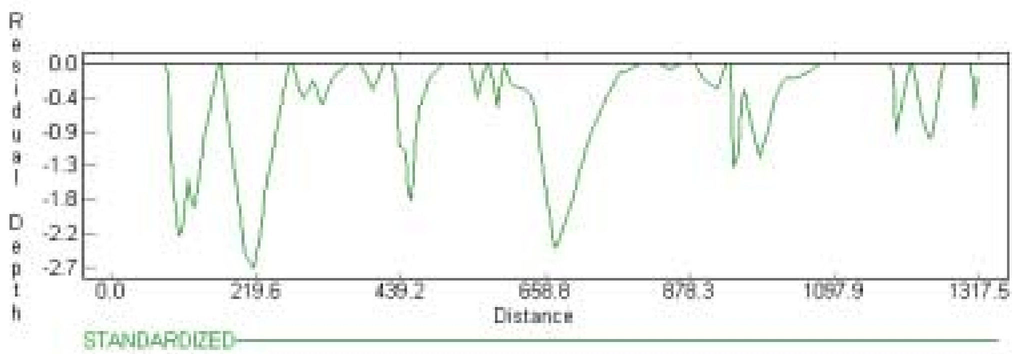
Ackerman Creek Residual Depth Statistics 2001

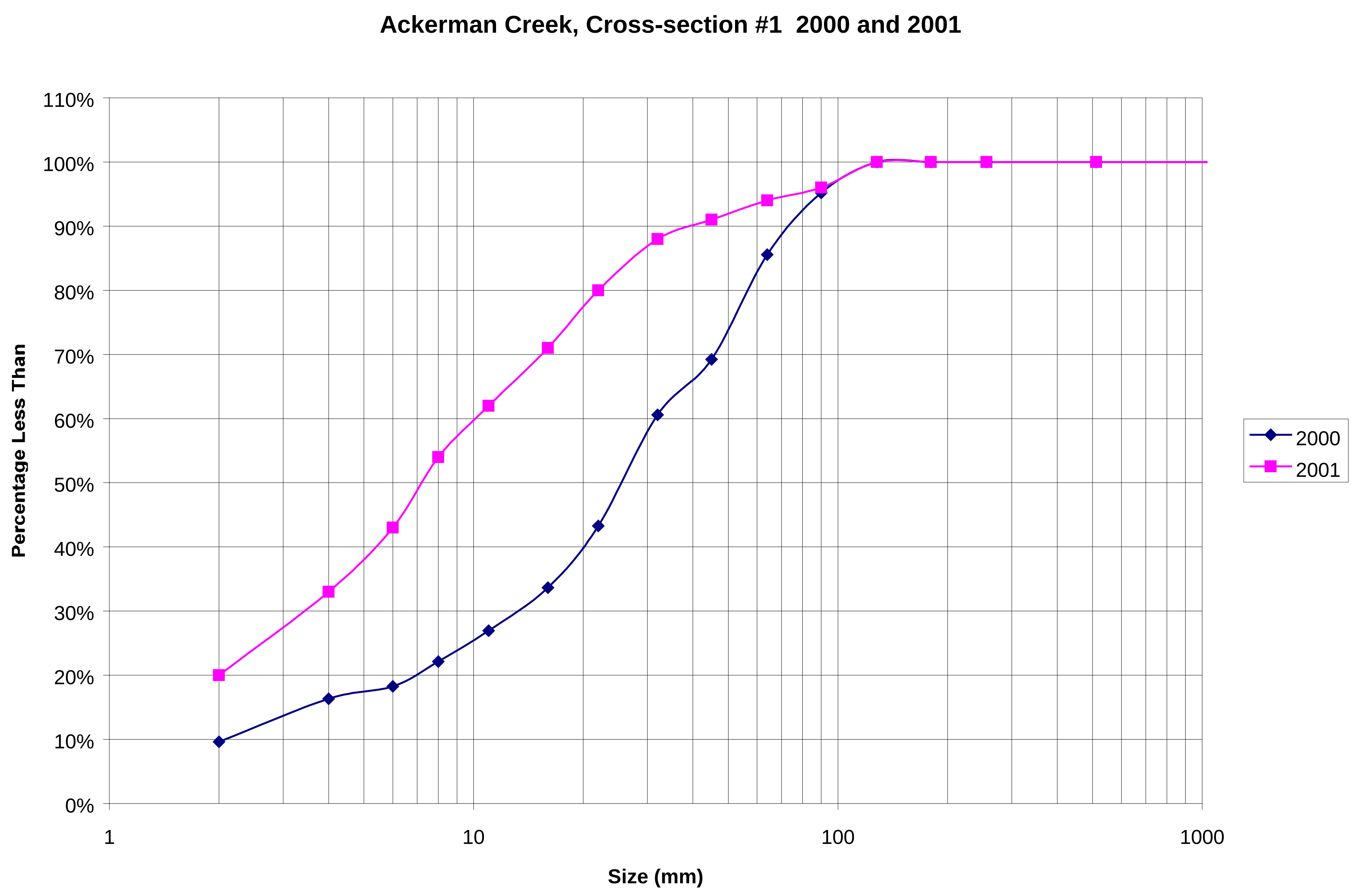
Top Elevation: 102.33
Bottom Elevation: 90.26
Reach Length: 1317.50

Standardized Statistics:
Number of data points in raw data: 97
Number of data points in Standardized data: 264

Reach Step Distance: 5.00

Max Residual Depth: 2.67
Mean Residual Depth: 0.48
Standard Deviation: 0.66




Ackerman Creek, Cross-section #1 2000 and 2001
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage Less Than
1
10
100
1000
Size (mm)
2000
2001

Ackerman Creek, Cross-section #2 2000 and 2001