Department of Water and Power the City of Los Angeles

April 15, 1999

Mr. Harry Schueller, Chief
Division of Water Rights
State Water Resources Control Board
901 P Street
Sacramento, California 95814

Dear Mr. Schueller:

Mono Basin Monitoring Report

Enclosed please find a copy of the monitoring report "Monitoring Summary for WY 1997 and WY 1998 for Rush Creek and Lee Vining Creek". The report was prepared by the scientists responsible for stream monitoring and summarizes the monitoring work the Los Angeles Department of Water and Power (Department) commissioned during the last two years on Rush and Lee Vining creeks. There was no requirement to do the monitoring, however, the Department believed that it was important for the scientists to become very familiar with the streams in how they function and more importantly to become versant with the monitoring protocol. The report, as a courtesy, has also been distributed to the parties for their review.

If you have any questions, please call me at (213) 367-1032.

Sincerely,

P. Kavounas

PETER KAVOUNAS
Mono Basin Restoration Manager

Attachment

c:

w/attachment	w/o attachment
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Monitoring Summary for WY1997 and WY1998
For
Rush Creek and Lee Vining Creek

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Pursuant to State Water Resource Control Board Decision 1631

April 12, 1999

Table of Contents

1. INTRODUCTION

This report presents monitoring data collected in water year 1997 (WY1997) and water year 1998 (WY1998) using Los Angeles Department of Water and Power's (LADWP) two volume monitoring plan. The White Book, *List of Monitoring Activities and Data Gathering Protocols* (December 12, 1997), lists the various monitoring objectives and activities for each stream, describes each activities' scope and duration, and establishes data-gathering protocols. The Blue Book, *Analysis and Evaluation of Monitoring Data*, describes specific methodologies for data collection, analysis, and evaluation for each protocol. Monitoring objectives for WY1997 and WY1998 included: (1) getting a head-start on establishing a contemporary baseline for channel morphology and fish populations before final approval of a monitoring plan by the State Water Resources Control Board (SWRCB), (2) testing/modifying sampling protocols, (3) refining monitoring endpoints, and (4) ultimately having a complete operational monitoring plan by the end of the water year in which the SWRCB approves a monitoring plan. Objectives for this report are to: (1) document geomorphic and fisheries monitoring results in WY1997 and WY1998, (2) comment on general stream channel responses to the high runoff in WY1997 and WY1998, and (3) collect baseline fisheries habitat and population data in WY1997 and WY1998, as well as to refine future fish monitoring techniques.

1.1. Rationale for Dependent and Independent Variables for Monitoring

There are two primary independent variables: flow and time. Flow can be further characterized by inter-annual and intra-annual magnitude, duration, frequency, and timing. Both independent variables have specific uses.

Time will be used to document project success or failure. For example, we expect channel narrowing, particle fining of the channelbed, greater confinement, greater hydraulic roughness, and increased sinuosity as both Rush and Lee Vining channels recover. In turn, these physical responses should encourage deeper pools and more overhanging bank and riparian cover, which in turn should improve the trout population. We may not be able to accurately predict what the median pool depth or total square feet of overhanging cover should be in the restored channel, but we expect increases in these dependent variables with time. Given that the monitoring project has just begun, little can be concluded about morphological responses from analyzing very short time trends, (e.g., we cannot conclude pool depths are increasing).

No one has forecasted channel recovery. Although this may be due to each scientists' definition for recovery, no one expects channel morphology in the mainstem of Lee Vining Creek to reach a new equilibrium morphology in the next 8 to 15 years (the predicted period needed to fill Mono Lake). Therefore, trend analyses cannot determine whether present-day and/or future flow prescriptions (as, and once, Mono Lake fills) will restore and maintain the stream channel. Time must be replaced by another independent variable (on the X-axis) to assess restoration capability.

Streamflow is the primary independent variable. The primary dependent variable should be a physical/riparian process. Recommending a flow regime adequate to restore and maintain the stream ecosystems will be the primary future management prescription. The magnitude, duration, frequency, and timing of unimpaired daily flows will be altered by water exports. The easiest flow characteristic to examine is magnitude. This can be represented on the X-axis simply as peak discharge (cfs). Several dependent variables have been identified among the alluvial attributes that should be functions of peak discharge and that will direct stream recovery and maintenance. These would be plotted on the Y-axis. The first is inundation depth over the floodplain and low terrace. But how does this provide insight into ecosystem recovery? As discussed in earlier documents the stream channel must increase confinement to even begin approaching pre-1941 morphological conditions. A stream can either downcut, thereby increasing confinement, and/or aggrade its floodplain and flood terraces via fine sediment deposition during flooding.

Both are happening. Floodplain and flood terrace aggradation occurs when hydraulic conditions become sufficiently rough to encourage fine sediment deposition. Of course, to initiate this process the flow must be sufficiently large to periodically inundate the floodplain and flood terraces.

There is an interesting, and potentially important, interplay of geomorphic feedback loops. As riparian vegetation matures, larger and more LWD will find its way into the mainstem channel. This will increase hydraulic roughness in the mainstem, elevating flow resistance and lowering water velocities. This will force a higher flow surface for the same discharge magnitude (to preserve flow continuity). Therefore, as the riparian community matures and the migrating channel accelerates input of larger LWD into the mainstem, the floodplain and flood terraces will experience greater inundation depths for identical flood magnitudes. Counterbalancing this feedback loop, however, will be the aggradation of floodplains and flood terraces, therefore requiring larger flows before inundation occurs. Equilibrium should be established rapidly, between very big floods, where the flood terraces achieve a relatively constant elevation. Without channel migration, floodplains would not persist, but rather be transformed into flood terraces.

Floodplain aggradation is complex. We hypothesized a threshold inundation depth for measurable floodplain aggradation. This was monitored in WY1997 and WY1998. However, the spatial pattern of aggradation in a single floodplain or flood terrace is not uniform. As sediment-laden flood flows encounter trees on the upper and lateral edges of the floodplain or low flood terrace, water velocities drop quickly causing abrupt sediment deposition. Only a small fraction of the sediment load entering a given floodplain reaches and deposits onto the interior and downstream portions of the floodplain. Overall this creates a sloping floodplain surface away from the main channel (e.g., cross section 13+36 in the Upper Rush Creek Monitoring Site). At successively higher flood flows, the extent of deposition would penetrate farther into the floodplain interior. Therefore the magnitude (and flood recurrence) of the flood flow will be traced back (this summer'99) to distinct characteristics in floodplain morphology.

Implications are many. The back channel's bed elevation becomes relatively lower than the riparian berm along the margin of the floodplain; the hydraulic gradient steepens across the floodway. This may encourage the mainstem to avulse (the stream "jumping" into a new channel) into this back channel during moderate floods. The probability of avulsion would be enhanced as the bend's radius of curvature tightened (as we have been observing in the lower Rush Creek site). The slope of the back channel also would be steepened, and therefore increase shear stress on the bed of the back channel. LWD would have a major influence over this avulsion scenario, either encouraging or discouraging avulsion depending on the specific structure and hydraulic setting of a log jam or single large log.

In summary, candidate dependent variables to be plotted with peak discharge or time on the X-axis are:

Time as the independent variable:
- change in thalweg variance
- frequency distribution of channel widths from the planmaps
- net scour/fill in thalweg profiles
- change in radius of curvature
- change in bed-averaged shear stress at Qbf
- relative and absolute changes in habitat types
- floodplain creation/flood terrace creation

Flow as the independent variable:
- channelbed mobility thresholds
- depositional thresholds
- channel migration thresholds
- channelbed scour thresholds

1.2. Monitored Channel Sites

According to the White Book (p. 7), monitored channel reaches should extend at least two meander wavelengths. One meander wavelength is approximately 9 to 11 bankfull channel widths (W_{bf}) long (Leopold 1994). On Rush Creek, pre-1941 W_{bf} averaged 37 ft (Larsen 1994). Therefore two meander wavelengths establish a minimum reach length of 740 ft (using 10 W_{bf}). On Lee Vining Creek, Trihey and Associates (Katzel 1992) estimated the pre-1941 W_{bf} averaged 12 to 14 ft. We consider 20 ft is a more conservative estimate for W_{bf}. The minimum monitoring reach length for Lee Vining Creek is 400 ft.

The following channel monitoring sites have been monitored:

- Lower Rush Creek site, beginning at the upstream end of the reconstructed meander bend and extending 1350 ft upstream (Figure 1). This site includes the upper portion of the 10 side channel;
- Upper Rush Creek site, beginning approximately 2000 ft upstream of the old Route 395 bridge and extending 1310 ft upstream (Figure 1);
- Upper Lee Vining Creek site, beginning 100 ft downstream of the B-1 connector and extending 1450 ft upstream (Figure 2). This site includes 760 ft of the A4 channel;
- Lower Lee Vining Creek site, beginning immediately downstream of a short meander loop (easily identified from aerial photographs) and extending 630 ft upstream (Figure 2). This site includes 600 ft of the B-1 channel.

Lower Rush Creek and Upper Lee Vining Creek sites were installed in summer/fall of WY1997 and monitored WY1998; Upper Rush Creek and Lower Lee Vining Creek sites were installed in summer/fall of WY1998, except for a few bed dynamics experiments installed prior to the WY1998 snowmelt runoff in late-spring 1998. These bed dynamics experiments were monitored in summer/fall of WY1998.

The channel reaches selected for monitoring deviate slightly from the 1,000 ft designations in the White Book (p. 7). Sites targeted developed and incipient alluvial features (e.g., point bars) formed during recent high flow events. On the Upper Lee Vining Creek study site, we wanted to include more of the historic A4 channel, as well as include the B1 confluence. This shifted the reach location downstream, as well as lengthened the total reach to 1450 ft. The Upper Rush Creek study site begins at the upstream tip of an island that will be used to divert flows into an historic left-bank channel. This monitoring site was then extended 1310 ft upstream.

Not all the reaches identified in the Blue/White Book were monitored in WY1998. Another reach between the Lower Rush Creek site and the Narrows was designated, as well as two proposed construction sites on Rush Creek above the Narrows. These will be included in the WY1999 monitoring.

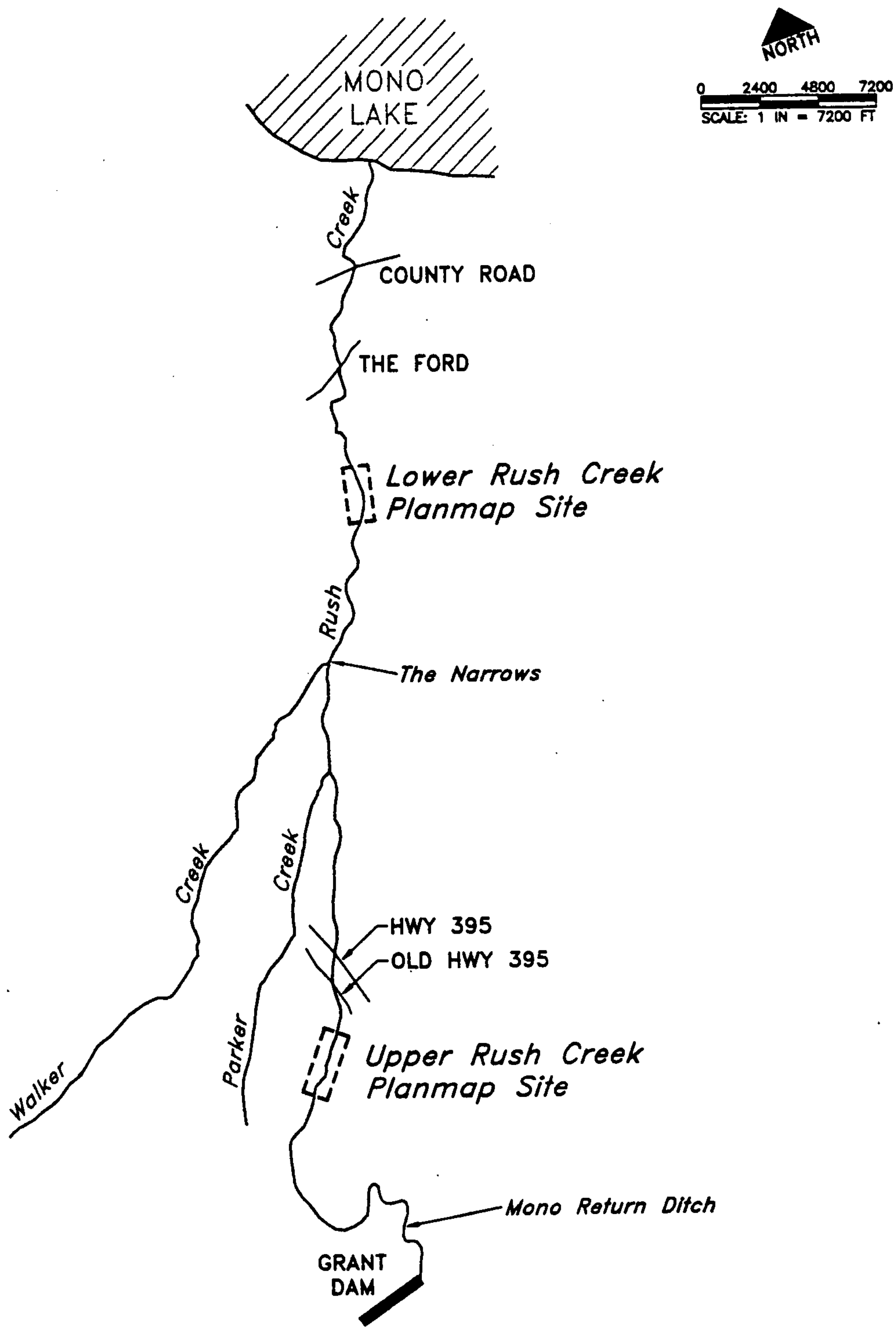


Figure 1. Site locations for the Rush Creek study sites in WY1997 and WY1998. [Map adapted from SWRCB White Book]

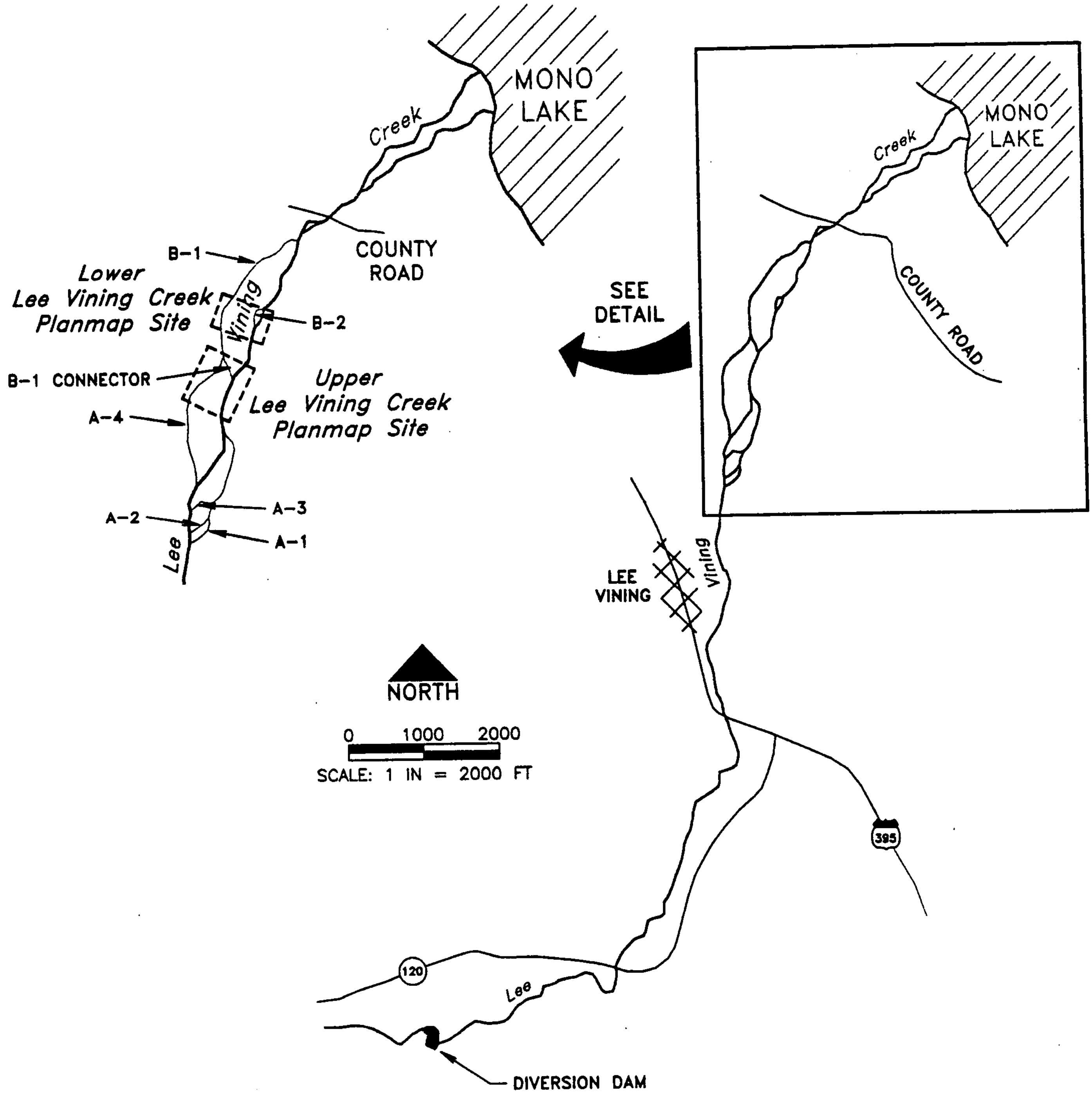


Figure 2. Site locations for the Lee Vining Creek study sites. [Map adapted from SWRCB White Book]

2. METHODS

2.1. Stream Discharge Measurements and Flow Records

LADWP Gaging Stations - Daily Average Annual Hydrographs
Continuous discharge measurements were recorded at Lee Vining Creek Spill at Intake (Sta. No. # 5009), Rush Creek Below Return Ditch (Sta. No. # RCBRD), Parker Creek under Conduit (Sta. No. # 5003), and Walker Creek under Conduit (Sta. No. # 5002) by LADWP. Annual hydrographs for WY1995 through WY1998 were presented because channel cross sections surveyed in WY1997 had distinct flood debris lines originating from the previous water year. Because the Rush Creek gage is immediately below Grant Lake, another set of annual hydrographs was developed for Rush Creek below the Narrows by summing daily average flows from Rush Creek (below return ditch confluence), Parker Creek, and Walker Creek.

Other Stream Discharge Measurements
Ambient discharges at Lee Vining Creek and Rush Creek in the mainstem and side channels were measured and estimated during channel mapping and fish habitat surveys. At the Upper Lee Vining Creek site, we measured discharge in the mainstem upstream of the B1 connector, the A4 channel upstream of the B1 connector, and the B1 connector (Figure 2). These measurements allow us to determine the proportion of streamflow in each side channel. At the Lower Rush Creek site we measured discharge in the main channel below the 10 channel split, and the 10 side channel (Figure 1). Stream discharge was measured using the methods in Buchanan and Somers (1969).

Instantaneous Peak Discharge Measurement
WY1997 and WY1998 instantaneous maximum peak discharges were provided by LADWP gaging stations, with peak discharges in individual side channels estimated using Manning's equation and field measurements. Measurements of slope, cross sectional area, and channel roughness were used to calculate discharge through each surveyed channel. High water flood marks were surveyed during longitudinal profile surveys to document the water surface elevation at the peak flow. To quantify roughness in the channel, Manning's n values of 0.040 and 0.045 were used. In addition, an hydraulic roughness relationship developed by Jarrett (1984) was used to estimate an n value based on channel slope and hydraulic radius. In WY1998, we made several trips during high flows to directly measure water surface slopes and back-calculate values for Mannings n under different hydraulic conditions.

2.2. Stream Channel Planmapping

Permanent benchmarks were established at Rush and Lee Vining Creek monitoring sites as fixed reference elevations (White Book, p. 7). These benchmarks were installed near previously established temporary benchmarks, then back-referenced to these older datums. The benchmarks were 2-inch aluminum caps set in concrete pads approximately 10 inches in diameter. Metal rebar was incorporated into the concrete so the benchmarks could be relocated with a magnetic locator if they became buried. All benchmarks were assigned an arbitrary elevation of 100 ft. Benchmarks were located and labeled on the final planmaps.

Monitored sites were planmapped to document channel configuration, channel width, habitat type, and all locations of cross sections and bed mobility experiments (White Book p. 7; Blue Book p. 5). To establish a baseline for future mapping, a channel tape was set approximately equidistant between the bankfull banks in straight segments. A compass bearing was taken on each tape segment. Segments were summed as the mapping proceeded so that all stationing increased upstream. All cross sections and experimental locations were referenced by station number on the channel tape. The intersection of the channel tape with each cross section was noted so that future channel tapes could be repositioned very close to the original position (i.e., not rely entirely on compass bearings for repositioning the channel tape). From this tape baseline, all features (described above) were plotted using compass traverses, measures perpendicular to the channel tape, and air photo references. Breaks in slope, terrace and floodplain surfaces, side channels, undercut banks, and prominent vegetation were mapped along both sides of the channel. Leading and downstream edges of cascades, riffles, runs, pools, and backwater eddies were mapped. Field maps were digitized, edited, and plotted in AutoCAD and Softdesk civil engineering software.

Even with accurate compass bearings, sequential planmaps for a given site required some adjustment to correct cumulative survey error, e.g., the WY1997 and WY1998 planmaps for lower Rush Creek. We plan to survey all established locations (primarily rebar pins on cross sections) using a total station in summer'99. This will establish a fixed two-dimensional grid of points from which to conduct future planmap surveys.

2.3. Longitudinal Thalweg and Water Depth/Width Profiles

Two surveys were conducted to document baseline conditions along the channel's thalweg (White Book p. 14; Blue Book p. 6). These profiles provide an important longitudinal perspective not readily apparent or measurable from aerial photography or planmapping. The profile data add a third dimension to the aerial photos and planmapping.

Longitudinal Thalweg Profiles

An auto level and engineers tape were used to survey channelbed thalweg elevations, noting the station number and perpendicular distance from the station number on the channel tape to the thalweg during planmapping. Thalwegs of large side channels were also surveyed. Thalweg elevations were measured at significant breaks in the channelbed such as riffle crests and the deepest location in all pools; a fixed distance between measurements was not adopted. While surveying the thalweg, suitable sites for cross sections were selected; rebar pins were placed along both banks to define both cross section endpoints. Tops of both rebar pins were then surveyed to tie the position and elevation of the longitudinal thalweg profile to the cross section.

Variability in the thalweg profile was measured by fitting a linear regression to the longitudinal thalweg profile. The distribution of regression residuals (i.e., deviations from the best-fit line) quantifies the variability of the thalweg profile. High values of kurtosis in the histogram indicate minimal topographic departure from a smooth slope defined by the regression line. Low values of kurtosis indicate a broad distribution of residuals and considerable topographic variability in the longitudinal profile. Analysis of the thalweg profile, as an indicator of stream habitat complexity and ultimately as one indicator of stream ecosystem health, is rapidly evolving. Though we expect the mode of analysis to improve in 1999, the basic methodology of surveying the thalweg in detail (many measured thalweg elevations) should remain the same.

Longitudinal Water Depth and Width Profiles

Brian Tillemans surveyed water depth at the thalweg and wetted channel width to quantify channel variability, the frequency of pools, and the width-to-depth ratio (White Book p. 14; Blue Book, p. 6). Surveys were conducted in Lee Vining Creek, Walker Creek, and Parker Creek. Rush Creek was not surveyed in WY1997. The surveys were timed so that discharge in Lee Vining Creek was 45 to 60 cfs. Reference points were documented and will be used as endpoints throughout the monitoring period.

The distance between measurements on Lee Vining Creek was 8 ft; the spacing on Walker Creek and Parker Creek was 5 ft. The distance between the cross sections was paced off along the middle of the channel as the survey proceeded. At each cross section, the depth of the water at the thalweg and the wetted width were measured with a survey rod. Distributions of the thalweg depths and the width-to-depth ratios were plotted as histograms and analyzed for normality and variance.

2.4. Channel Cross Sections

We established cross sections on straight reaches and at bend apexes (with point bars), placing rebar pins above the bankfull stage, and preferably to a middle terrace stage height on both banks (White Book p. 17; Blue Book p. 6). Cross sections were surveyed with an engineers level using guidelines in Harrelson et al. (1994), including stage height of readily-visible flood lines on or near the cross section. A tape stretched perpendicular to the high flow channel recorded the station number along the cross section, channel features, and the thalweg position. The cross section pins were labeled with stamped metal tags, noting cumulative distance from the downstream benchmark (as determined by station number along the centerline tape). Also included on the tags were the date the section was established and the name of the surveyor. Left and right banks (looking downstream) of the present water surface, active channel, bankfull channel, and the floodplain extent perpendicular to the centerline tape also were documented. One valley-wide cross section was surveyed for each reach (Upper Lee Vining Site has not been surveyed yet through the line of "C" piezometers). Measurements were not taken at fixed intervals, but rather at slope breaks and geomorphic or fluvial boundaries. Alluvial features such as point bars, pool tails, backwater channels, and riffles were also documented.

Modified Wolman pebble counts were conducted to quantify the D_{84}, D_{50}, and D_{31} of the coarse surface layer (Leopold 1970). In many locations, features were subdivided into different facies (portions of the channelbed with a homogenous particle composition) and pebble counts were used to distinguish and quantify surface particle size variability. These data guided selection of tracer rocks in the channelbed mobility experiments.

2.5. Channelbed Dynamics Experiments

Tracer rocks were placed at surveyed cross sections to document mobility of the surface layer (White Book p. 17; Blue Book p. 6). Using pebble count data, dry rocks from the floodplain and terraces were collected and painted with bright orange paint using an airless sprayer. Once dry, the painted rocks were placed in the streambed at regular spacings along a cross section, dividing the bed width into 10 to 20 compartments (Figure 3). Each of three size classes (D_{84}, D_{50}, D_{31}) was placed at each station along a cross section. If the cross section included a facies boundary where the particle size distribution changed, we placed painted rocks appropriately sized for each facies composition.

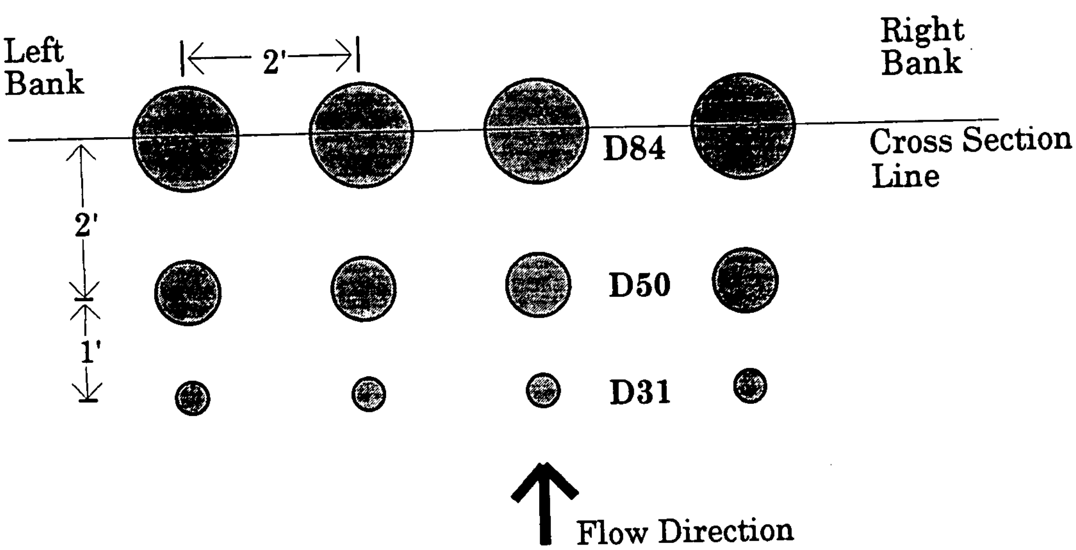


Figure 3. Typical tracer rock placement relative to flow direction and particle size.

Because tracer rocks only help quantify mobility of the channelbed surface, scour cores were installed to document scour depth and/or deposition in different alluvial features (White Book p.17). A six-inch diameter hole was excavated (using a modified McNeil sampler) in the channelbed along a monumented cross section to a depth of six inches or more (Figure 4). The floor of each hole was surveyed to a vertical datum. The hole was then re-filled with painted gravel. The hole was filled flush to the channelbed surface, then re-surveyed to the vertical datum. Following a high flow event or high flow season (e.g., snowmelt runoff period), the location of the scour core on the cross section was re-surveyed, then excavated down to the first indication of the painted gravels (Figure 4). This provided the depth of maximum scour and subsequent fill (if any).

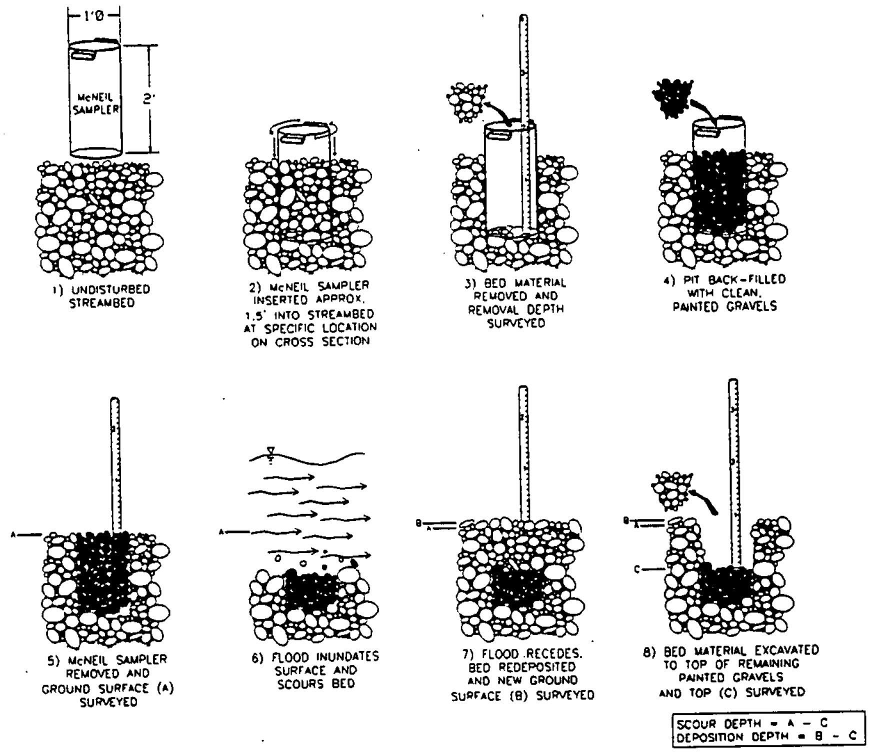


Figure 4. Method for installing scour cores and computing maximum scour and net deposition.

Water surface slopes for peak discharges in WY1997 and WY1998 were estimated (or directly measured as in WY1998 for many sites) to relate results of the marked rocks and scour cores to cross sectional averaged shear stress (lbs/ft^2) at appropriate locations.

Experiments were set-up in the following locations (refer to planmaps in Appendix A for locations within the monitoring sites):

Lower Rush Creek Monitoring Site

- tracer rock sets placed at cross sections 10+10 (pool tail), 7+70 (alternate bar), 7+70 (channelbed), 7+25 (alternate bar), 7+25 (channelbed), 4+08 (alternate bar)
- scour cores installed at cross sections 5+49 (n=5, alternate bar), 4+08 (n=2, alternate bar), 3+30 (n=3, pool tail), 0+86 (n=4, alternate bar)

Upper Rush Creek Monitoring Site

- tracer rock sets placed at cross sections 0+74 (pool tail), 5+45 (channelbed), and 12+95(alternate bar)
- scour cores installed at cross sections 0+74 (pool tail), 5+45 (channelbed), and 12+95(alternate bar)

Upper Lee Vining Creek Monitoring Site: Mainstem

- tracer rock sets placed at cross sections 13+92 (alternate bar), 9+31 (alternate bar), 6+61 (alternate bar), 3+45 (pool tail)
- scour cores installed at cross sections 13+92 (n=2, eddy deposit), 3+73 (n=2, eddy deposit)

Upper Lee Vining Creek Monitoring Site: A4 Side Channel

- tracer rock sets installed at cross sections 6+80 (riffle bed), 5+15 (alternate bar), 4+04 (alternate bar)

B1 Channel (approximately 200 ft downstream of A4 confluence with B1 channel)

- tracer rock set placed at bedload modeling cross section (6+08)

Lower Lee Vining Monitoring Site: Mainstem

- scour cores installed within a side channel, not on cross section
- tracer rock set placed at bedload modeling cross section (01+15)

2.6. Fisheries Field Methods

The fisheries and habitat information was collected under the direction of Doug Parkinson. Ross Taylor and Darren Mierau assisted Mr. Parkinson in the field; Brad Shepard analyzed the data. Project management and direction was the responsibility of Chris Hunter.

Techniques for estimating fish abundance in selected study reaches of Rush and Lee Vining Creeks included depletion-removal electrofishing and underwater observation (snorkel surveys) to count and measure trout and other fish species, and employed two general methods for classifying channel unit types and assessing microhabitat features (described below). Snorkel surveys were conducted during both daytime and nighttime hours within selected study reaches (100% night sampling in WY1998 only) to evaluate fish abundance and population size structure on a reach-wide basis, and was combined with electrofishing selected units within the snorkeled reaches for comparison to diver counts.

Surveys were conducted during the short window of time between the spring high flow runoff and the beginning of brown trout fall migratory movement and spawning activity, ideally targeting low streamflow conditions during August and early September. Both WY1997 and WY1998 were above average water years, with the high spring snowmelt runoff extending through August and into September. Consequently fish surveys were delayed until streamflows had receded to near fall/winter baseflow conditions.

WY1997 surveys were conducted from 8-September to 12-September, and included snorkel counts, depletion-removal electrofishing, and habitat inventories in the following reaches:

- The Lower Rush Creek study reach beginning just upstream of the 10-Side Channel return (including the re-constructed bend) and extending upstream 1,900 ft to the channel split (top of planmapped reach); and 420 ft of the 10-Side Channel near the return confluence with the main channel.

- The Upper Lee Vining Creek main channel (south channel) extending from the B-Connector upstream 500 ft; the A4 channel extending 900 ft upstream from the B-Connector confluence; and the B1 channel extending 500 ft downstream of the B-Connector. The B-Connector was not sampled.

Electrofishing in WY1997 was conducted at two pools on the Lower Rush Creek main channel, and at two riffles, two runs and one pool on Upper Lee Vining Creek, all in the A4 channel. Night snorkel surveys were conducted only in the electrofished units to compare methods.

WY1998 surveys were conducted from 22-Sep to 28-Sep, and included snorkel counts, depletion-removal electrofishing, and habitat inventories in the following reaches:

- Lower Rush Creek and 10-Side Channel reaches surveyed in WY1997, with noted changes through the main channel re-constructed bend.

- Upper Lee Vining Creek reaches surveyed in WY1997, with each surveyed reach lengthened to correspond to the entire planmapped reaches (1,400 ft of the main channel, 670 ft of the A4 channel) and an additional 430 ft of the B1 channel.

- Upper Rush Creek planmapped reach beginning at the channel split 100 ft below the reconstructed root-wad pool by Trihey and Associates, and extending upstream to the channel units adjacent to the constructed backwater pool (Duck Pond) and including two segments of split-channels.

- Lower Lee Vining Creek study reach, including 1,600 ft of the main channel above the County Road crossing, the B1 channel from its confluence with the main channel upstream 1,100 ft, and a 400 ft segment of side channel connected to the main channel.

Direct Observation Methods

Prior to fish population surveys, each study reach was surveyed to classify individual channel units by habitat types, including pool, run, riffle, high-gradient riffle, cascade, backwater (eddy), and side-channel habitat units. The convention of Overton (1997) was used for main channel and side channel unit numbering. Habitat units were temporarily marked with surveyor flagging for later field identification and collection of microhabitat information. Reaches selected for fish surveys corresponded to those identified in the White Book (1997). Occasionally extra units were snorkeled to ensure complete coverage of planmapped reaches ("buffer units"), or as practice units prior to initiating snorkel surveys.

Once the study reaches were selected and stratified into habitat types, snorkel surveys were initiated. All daytime snorkel surveys were conducted between 10 AM and 4 PM to minimize the influence of daylight on diver visibility. Nighttime snorkel surveys generally occurred between 8 PM and 1 AM. Before and after each survey, divers calibrated their fish size estimations underwater using fish silhouettes of varying sizes. Water visibility was also measured for each reach using a three-inch long "rapalla" rainbow trout lure, held underwater for divers to determine the maximum distance distinguishing fish markings could be observed.

Direct observation surveys were conducted by one to three divers and one data recorder. Divers began at the bottom of each reach and moved slowly upstream along the stream margins through each consecutive unit, stopping at unit boundaries, until they arrived at the top of the reach. Although diver observation lanes were not physically marked (such as with ropes), divers communicated separate observation areas prior to each dive unit. For example, a diver with complex bank or undercut bank habitat along one stream margin would move upstream in mid-channel and count fish only between himself and the bank. The second diver would be responsible for the remaining unit area behind the first diver. In situations where fish darted upstream or crossed imaginary dive "lanes", divers communicated verbally as to which diver counted the fish. When side channels were encountered, the main channel survey was completed first, then divers returned downstream and surveyed the side channel. Fish observed in each habitat unit were counted and their total lengths estimated in two inch increments (0-2", 2-4",...).

All WY1997 field data were recorded in bound survey notebooks; in WY1998 formatted data sheets were used to improve data recording efficiency. All fish species were included in surveys. A small section of the Lower Lee Vining Creek reach was not sampled in WY1998 because of shallow water depths. The locations of observed fish were not recorded in relation to specific microhabitat features such as undercut banks, woody debris, velocity shear zones or deep scour holes. Such information will be useful in future assessments of the efficacy of mimicking the natural hydrograph for habitat restoration.

During daytime snorkel surveys the data recorder remained downstream of divers to avoid disturbing fish. At night, the data recorder walked to the top of the unit and waited for the divers to approach, then flashed a light to signal they were approaching the dive unit boundary. Data recorders also assisted in keeping divers together and moving upstream at a uniform pace.

Nighttime snorkel surveys differed between WY1997 and WY1998. In WY1997 only habitat units that were electrofished were snorkeled at night for later comparison to daytime snorkel surveys and electrofishing results. The WY1998 nighttime surveys employed the same routine as daytime surveys, sampling 100% of the study reaches. In most cases the same divers that surveyed the reach during daytime also conducted the night surveys. Night dives used high-powered, hand-held underwater lights. The best technique was to sweep the channel with the light and count all fish observed, then turn out the light, move upstream 10 to 15 ft, turn on the light and sweep again, repeating this technique until the dive was complete.

In addition to fish count data, other information recorded for each surveyed reach included: general comments about the weather, diver initials and location in the channel (left bank, middle, right bank), underwater visibility, air and water temperatures, and dive duration for each habitat unit.

Electrofishing

After completion of snorkel surveys, several units within each reach were selected for electrofishing surveys. Units were selected subjectively, targeting at least one pool, run and riffle per reach, and biasing toward those units with complex habitat (LWD, undercut banks or bubble curtains) where fish could have been missed during snorkel surveys. Occasionally two habitat units were fished together to avoid difficulties with isolating individual units and disturbing fish.

Electrofishing surveys employed one or two backpack shockers depending on the unit size, with single-netted anodes and rat-tail cathodes. Occasionally a third backpack shocker was employed in place of a blocking net. During WY1997 surveys, blocking nets were employed at all electrofished units; this was standard practice in WY1998 unless the habitat unit boundary was a physical deterrence to fish movement, such as a steep cascade or shallow riffle-crest. Occasionally fish were observed moving out of habitat units during deployment of blocking nets. Blocking nets were difficult to maintain in units with fast velocities, deep thalwegs, and which lacked large substrates to anchor the nets.

Most habitat units used three-pass depletion-removal sampling, unless the first pass removed few or no fish. In WY1997 electrofishing surveys, one pass consisted of a single sweep upstream then downstream, followed by examination of the blocking nets. A large proportion of juvenile fish was collected from the blocking nets, and significant mortality occurred as a result of fish becoming impinged for long periods on the lower blocking net. In WY1998 the technique was modified to include only one downstream sweep for each pass to reduce mortality. Extra effort was given to instream woody debris elements, especially the artificially placed root-wads in the Upper Rush Creek reach. During each electrofishing pass, fish were collected and held in separate buckets and live-wells until all passes were completed. All fish were then identified, counted, measured in inches, and weighed in grams. No fish were marked. Fish condition, such as presence of burn marks or unusual coloration, was recorded as observed. All observed mortalities were recorded.

Additional information collected included: general comments about the weather, crew initials and task (shocker, netter, recorder), air and water temperatures, duration of each pass, electroshocker setting, and effort time of each shocker. In WY1998 the crew noted that some fish were ready to spawn, with gravid females, and males extruding milt.

Fish Habitat Assessments
After fish surveys were completed, each reach was systematically mapped to assess/quantify physical habitat variables within each unit. Two general techniques were employed to obtain comparable information. First, the entire reach was walked with hip-chain and measuring rod to measure unit dimensions (length, width, maximum and average depth) and to assess bank erosion, substrate types, overhead cover, and undercut banks. This approach was conducted on Rush and Lee Vining WY1997 study reaches and all four WY1998 study reaches. Second, the Lower and Upper Rush Creek reaches were walked in WY1998 with channel planmaps on a large clipboard to map microhabitat features and habitat unit boundaries onto planmaps. Microhabitat features included habitat unit dimensions (length, width, average and maximum depth), surface area, substrate type, extent of undercut banks and overhead cover, location of spawning habitat and particle size analysis by modified Wolman (1954) pebble counts, scour holes, back eddies, and velocity shear zones. Unit dimensions were obtained later from digitized planmaps and longitudinal profile data. Photographs were also taken of selected habitat units for future reference. Planmaps showing habitat unit boundaries and microhabitat features for each study reach accompany this report.

Depletion estimates were computed using the MICROFISH computer program (VanDeventer and Platts 1983). This program uses a maximum likelihood estimator. Population estimates, estimated probability of capture, standard errors (S.E.) of both the population estimate and estimated capture of probability, and 95% confidence interval (95% CI) for the population estimate were all reported. Symmetrical 95% confidence intervals are reported, however, these intervals were frequently not symmetrical because the lower 95% interval was lower than the total number of fish captured.

Table 1. Synoptic discharge estimates in monitored sites for the mainstem and side channels of Lower Rush Creek and Upper Lee Vining Creek in WY1997 and WY1998.

Date	Mainstem (study reach)		10 Channel		Total
	Q (cfs)	% of total Q	Q (cfs)	% of total Q	**Q (cfs)**
10-Oct-97	39	63%	23	37%	**62**
4-Jun-98	42	64%	23	36%	**65**
3-Jul-98	199	61%	127	39%	**326**
16-Jul-98	328				
13-Sep-98	117	86%	19	14%	**135**

Date	Mainstem above B Connector		A4 Channel		B1 Channel		Total
	Q (cfs)	% of total Q	Q (cfs)	% of total Q	Q (cfs)	% of total Q	**Q (cfs)**
05-Jun-98	76	68%	35	32%	51	46%	**111**
18-Jun-98	161	62%	98	38%	126	49%	**259**
11-Sep-98	56	68%	26	32%	38	47%	**82**

Table 2. WY1997 and WY1998 peak daily average discharges (cfs) for Rush Creek and Lee Vining Creek from LADWP gaging stations (instantaneous peak discharges (cfs) in parentheses).

LADWP Gaging Location	January-1997	WY1997 Spring Snowmelt (cfs)	WY1998 Spring Snowmelt (cfs)
Walker Creek under Conduit (5002)	42 (53)	34	47
Parker Creek under Conduit (5003)	52 (94)	48	72
Lee Vining Creek abv Intake (5008)	524 (740)	378 (404)	419 (451)
Lee Vining Creek at Intake (5009)	422 (578)	354 (378)	391 (391)
Rush Creek at Dam Site (5013)	167	211	495 (519)
Rush Creek blw Return Ditch (RCBRD)	167	172	539
Rush Creek blw Narrows [1]	158	226	635

[1] Discharge calculated by adding RCBRD+Walker+Parker

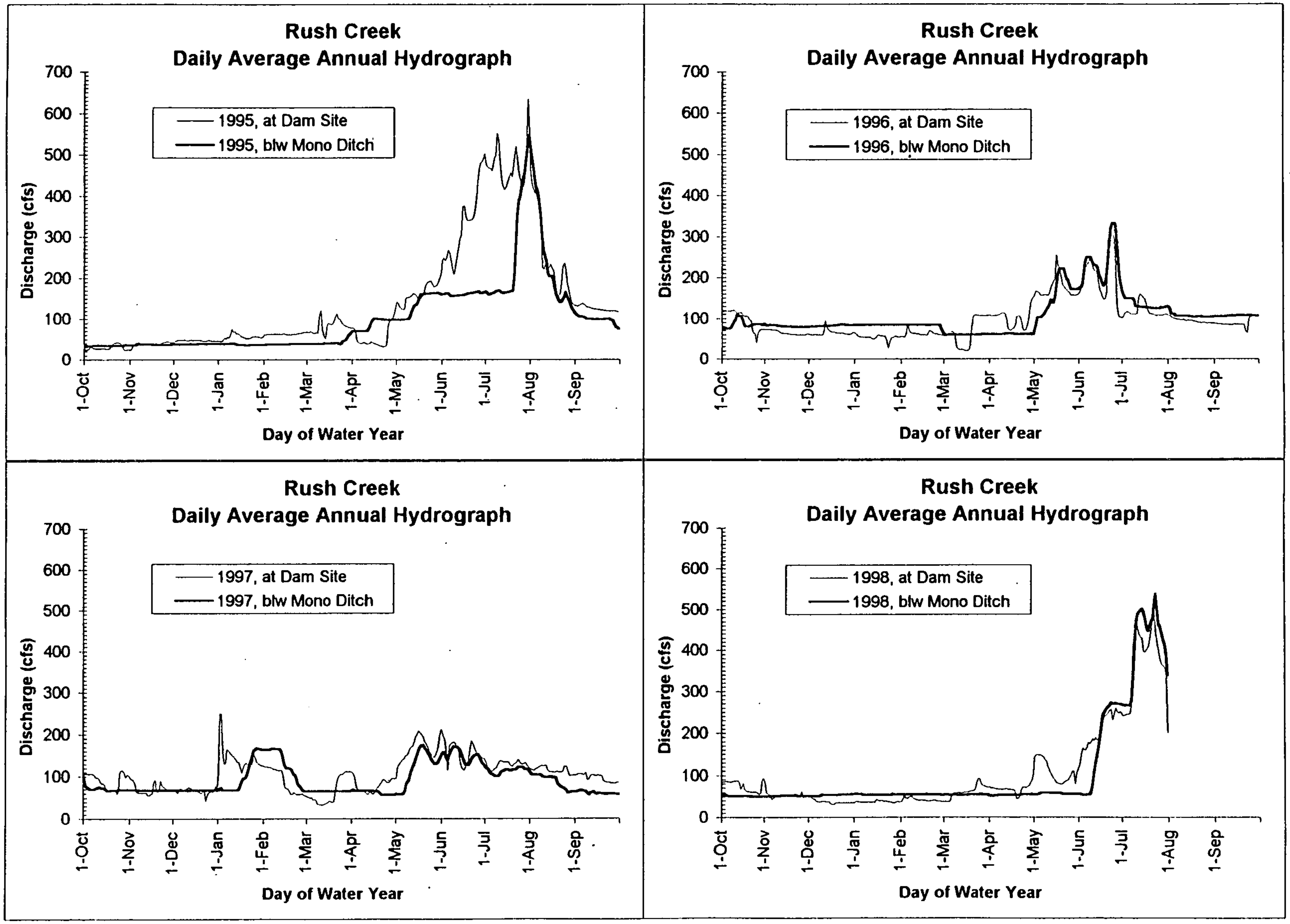


Figure 5. Daily average annual hudrographs for Rush Creek at Dam Site and below Mono Return Ditch, for WY 1995-98

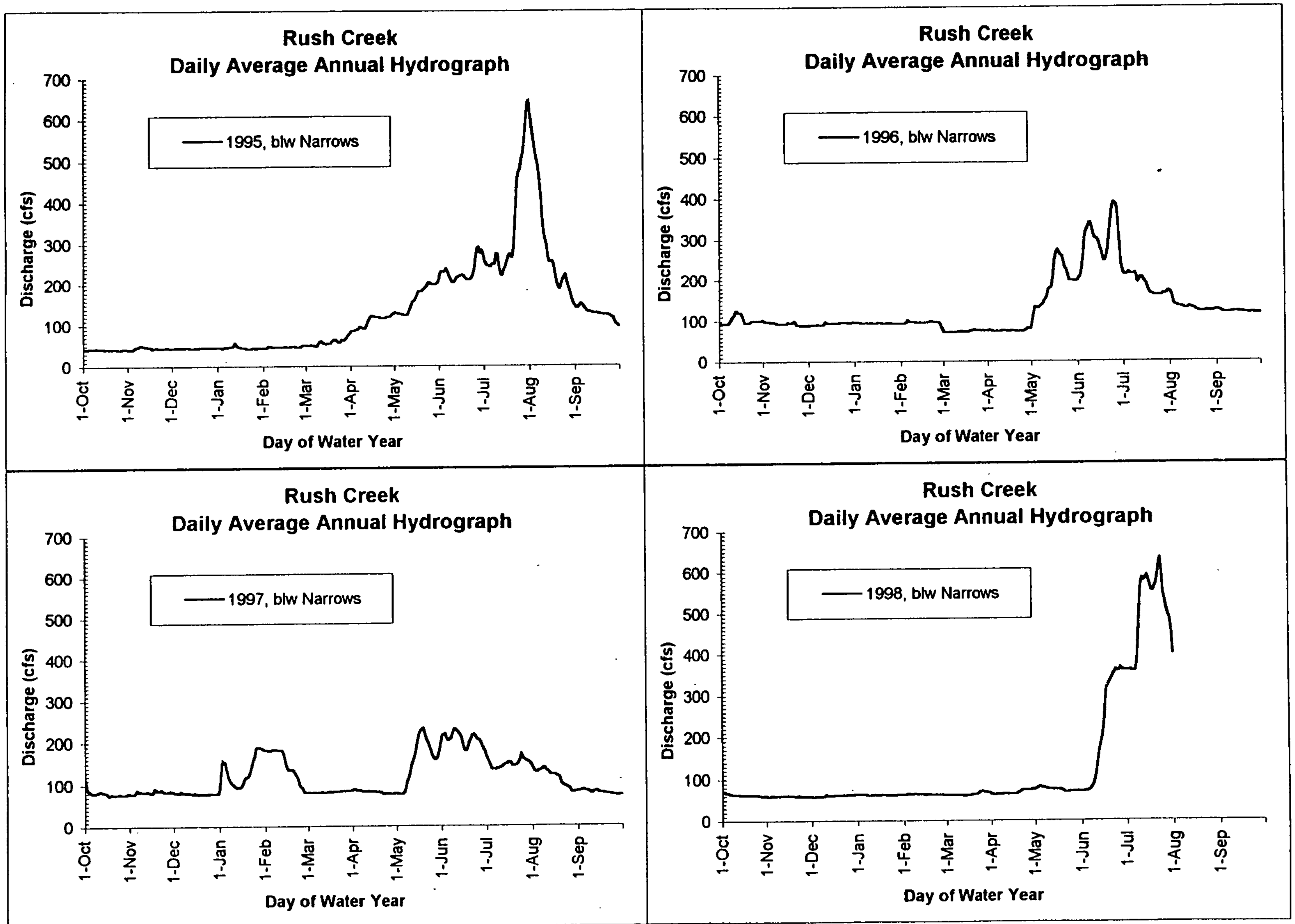


Figure 6. Daily average annual hydrographs for Rush Creek below the Narrows, calculated by summing the Return Ditch, Walker and Parker Creek flows, for WY 1995-98

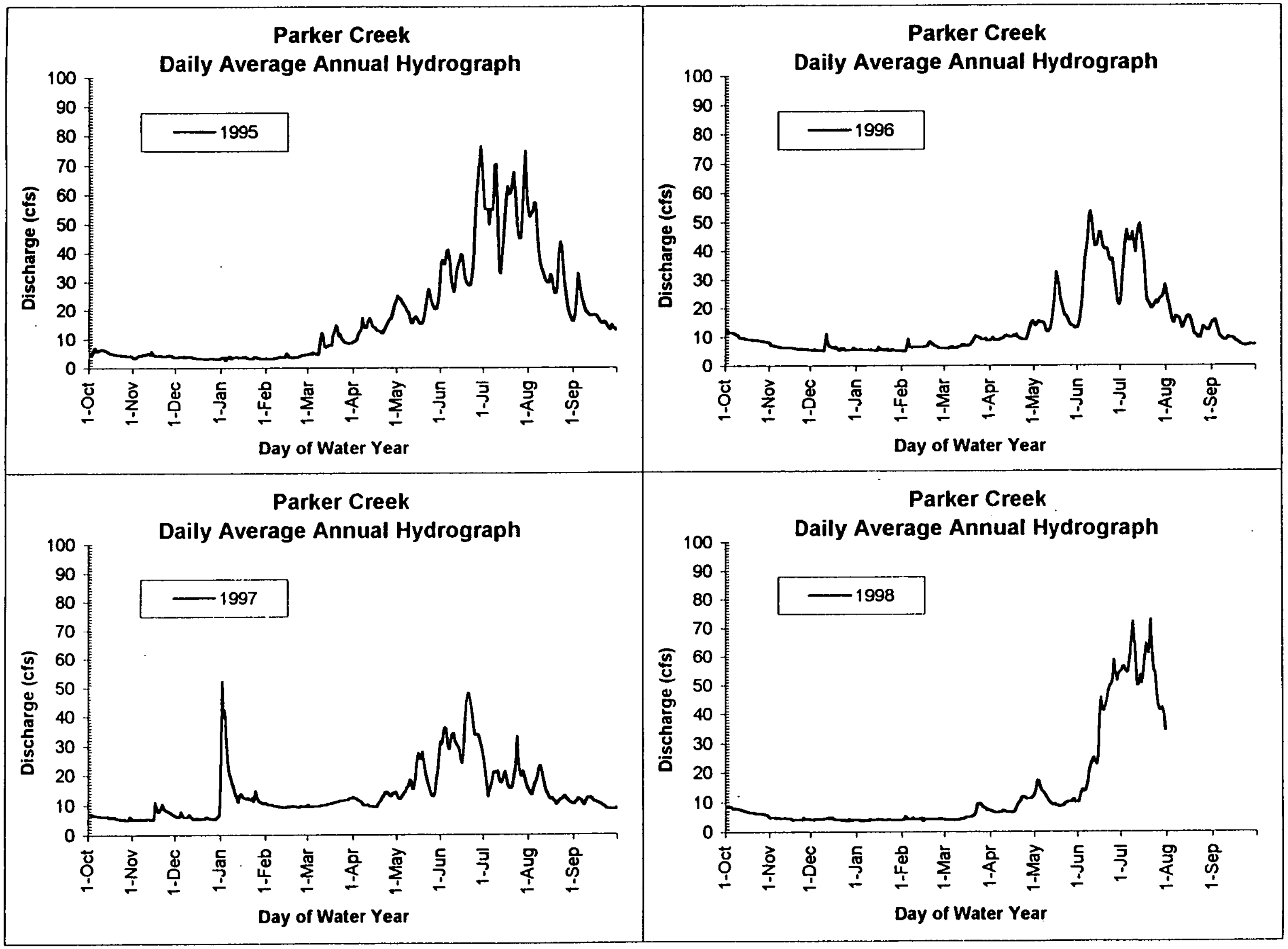


Figure 7. Daily average annual hudrographs for Parker Creek Under Conduit, tributary to Rush Creek, for WY 1995-98

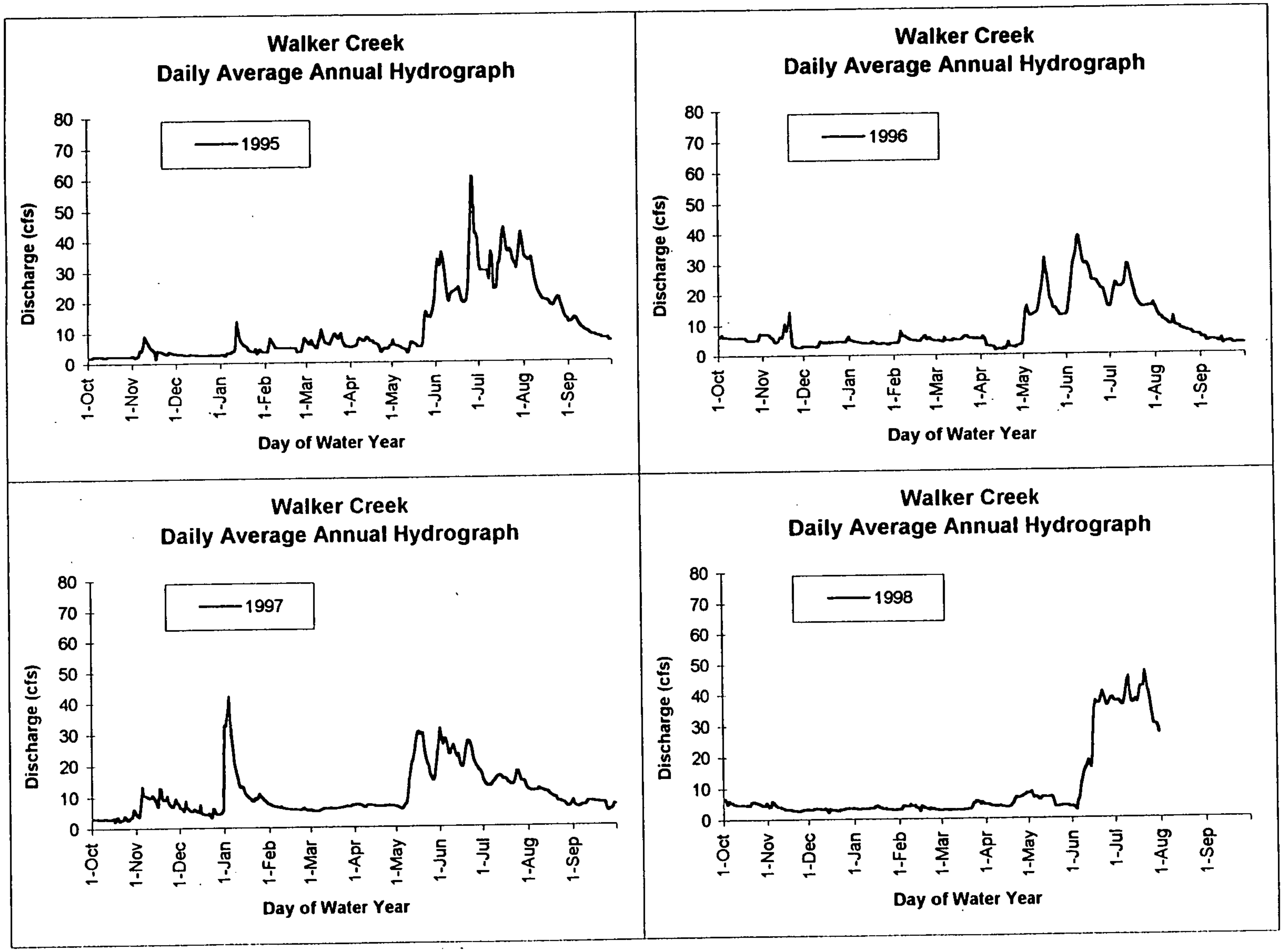


Figure 8. Daily average annual hydrographs for Walker Creek, tributary to Rush Creek, for WY 1995-98

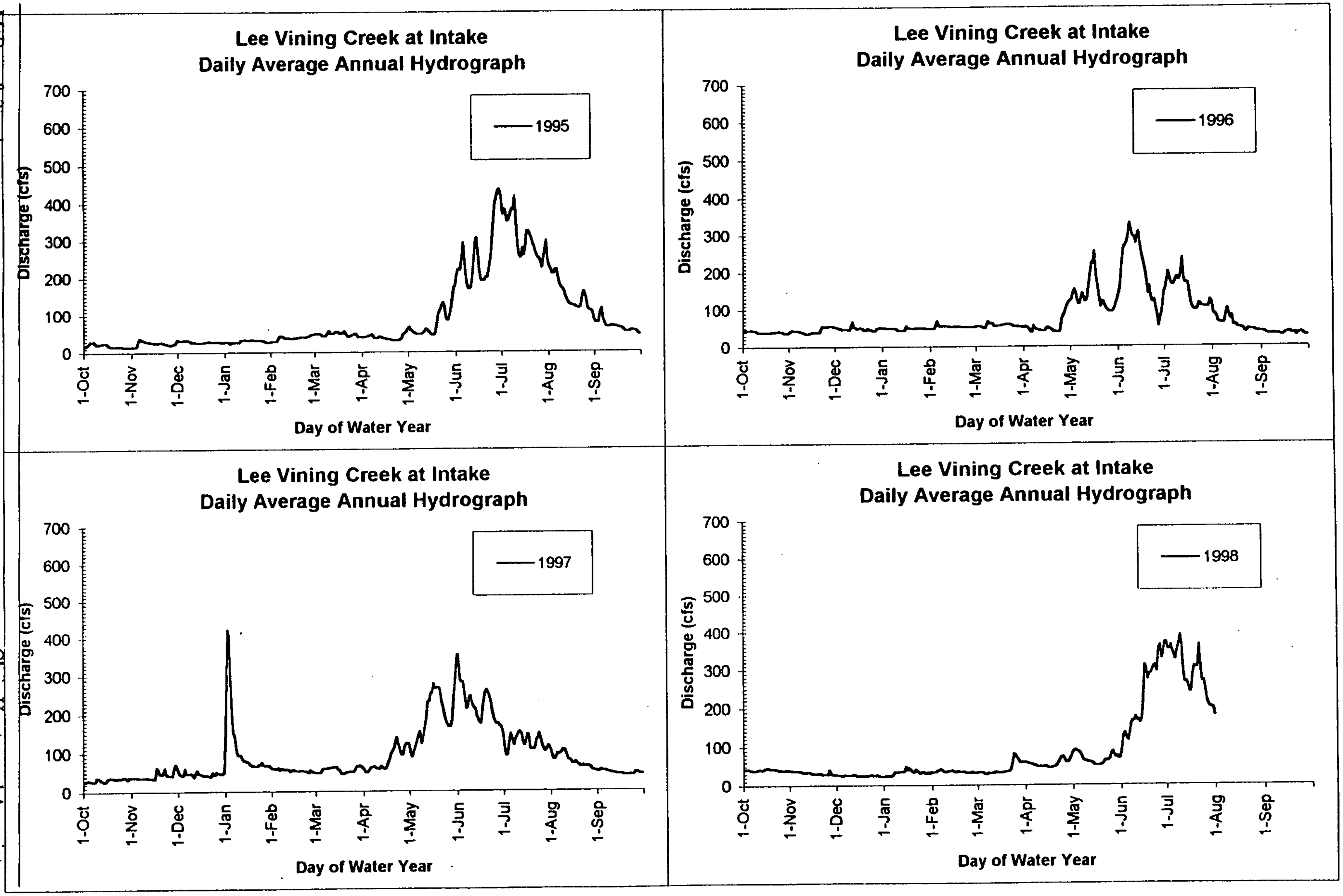


Figure 9. Daily average annual hydrographs for Lee Vining Creek at Intake, for WY 1995-98.

3.2. Planmaps

Planmaps were developed for the Lower Rush Creek (Appendix A, Plate 1), and Upper Lee Vining Creek monitoring sites in September 1997, including separate planmaps for the mainstem and A4 channels in Lee Vining Creek (Appendix A, Plates 6 and 7). In WY1998 (September/October), both 1997 planmaps were re-assessed for significant changes. Lower Rush Creek was re-mapped in response to significant morphological changes to the mainstem (Appendix A, Plate 2). Also, the upper portion of the 10 side channel was mapped (the entire portion with a discrete channel) (Plate not included). Upper Lee Vining Creek was not re-mapped because only minor morphological changes had occurred (principally in the A4 side channel). These changes were noted on the WY1997 maps. In WY1998, two new channel reaches were planmapped: the Upper Rush Creek site (Appendix A, Plate 3) and Lower Lee Vining Creek site (Appendix A, Plates 4 and 5). All planmaps initially were plotted at either a 1 inch = 20 ft scale (1:240) or 1 inch = 10 ft scale (1:120). A larger scale was required for reasonably presenting each map in this data summary (the scale varied, as noted on each map).

3.3. Longitudinal Thalweg Profiles

Longitudinal thalweg profiles were surveyed in all new WY1997 and WY1998 planmap sites (Figures 10 to 17) to establish a contemporary baseline, and resurveyed in sites first planmapped in WY1997 that had changed significantly in WY1998.

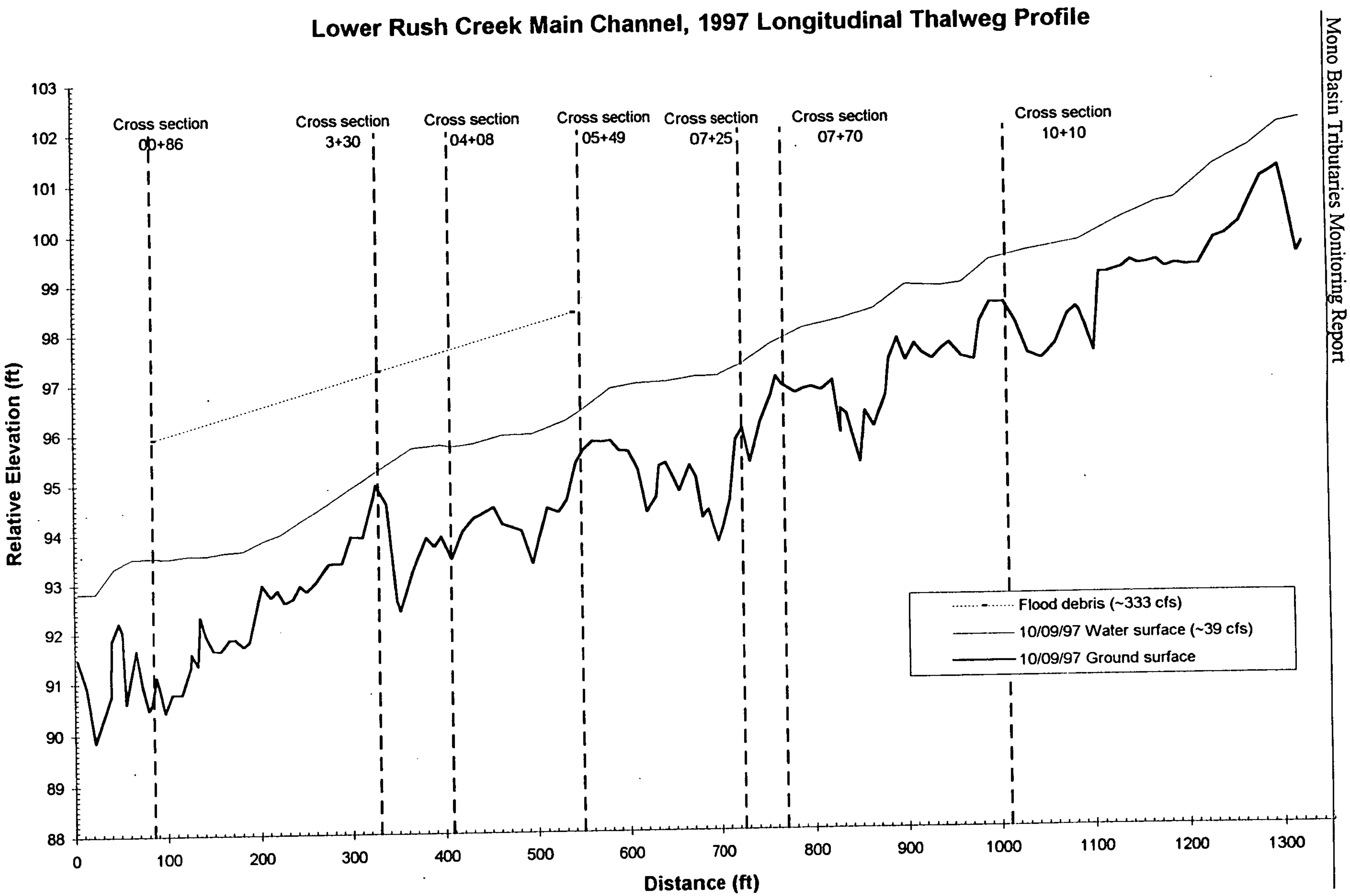


Figure 10. Longitudinal thalweg profile in the mainstem of Lower Rush Creek monitoring site for WY1997.

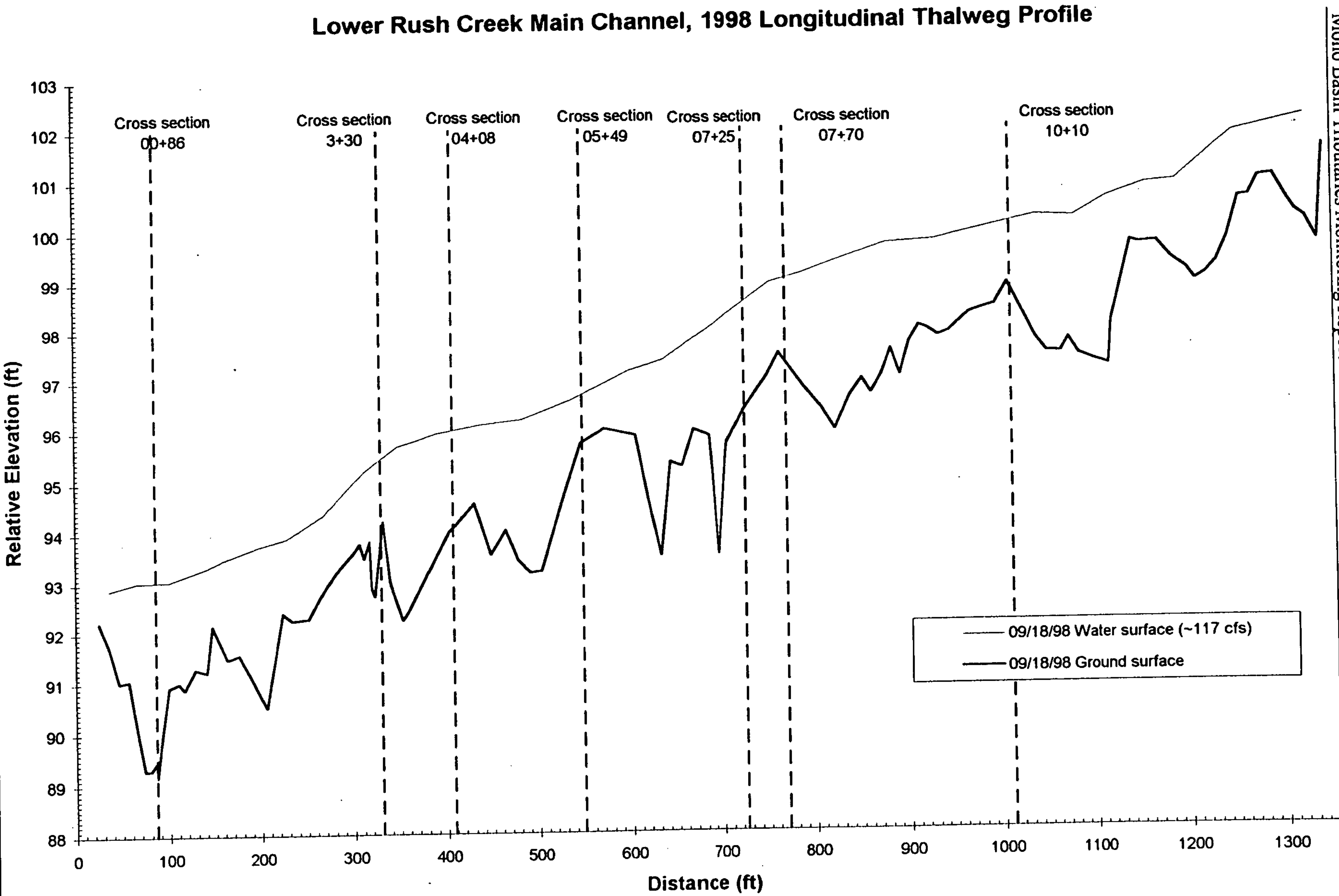


Figure 11. Longitudinal thalweg profile in the mainstem of Lower Rush Creek monitoring site for WY1998.

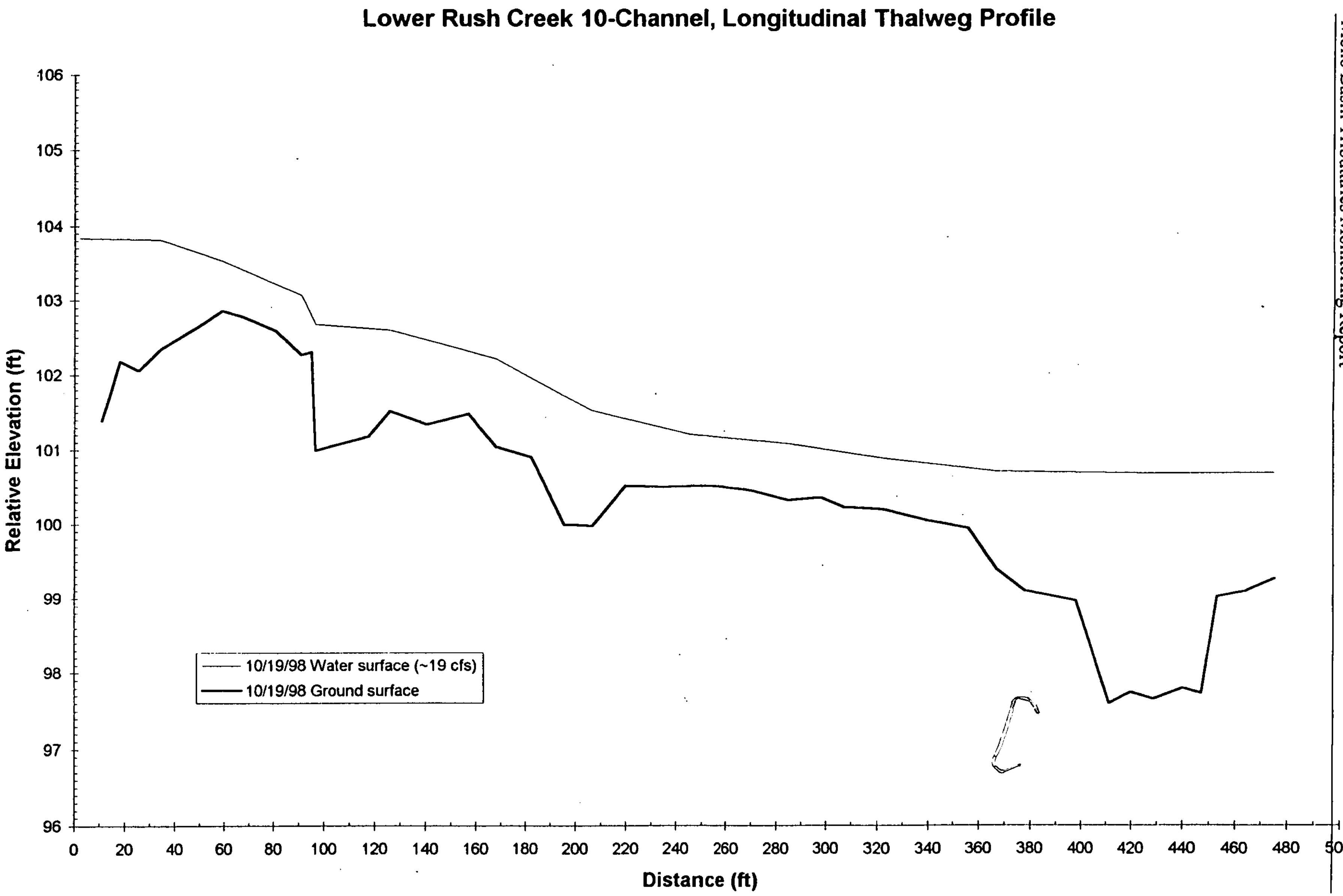


Figure 12. Longitudinal thalweg profile in the 10-Channel of Lower Rush Creek monitoring site for WY1998.

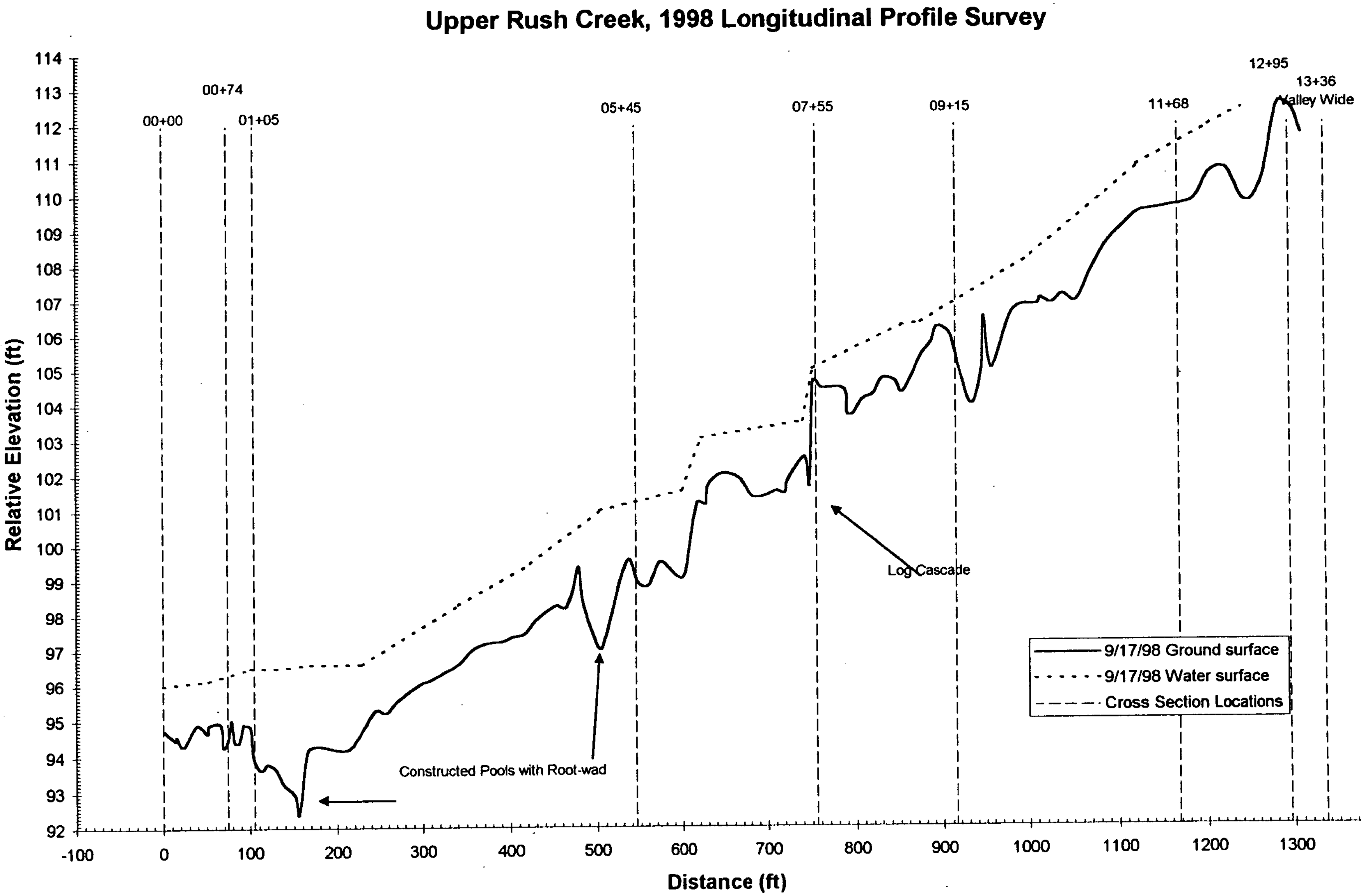


Figure 13. Longitudinal thalweg profile in the mainstem of Upper Rush Creek monitoring site for WY1998

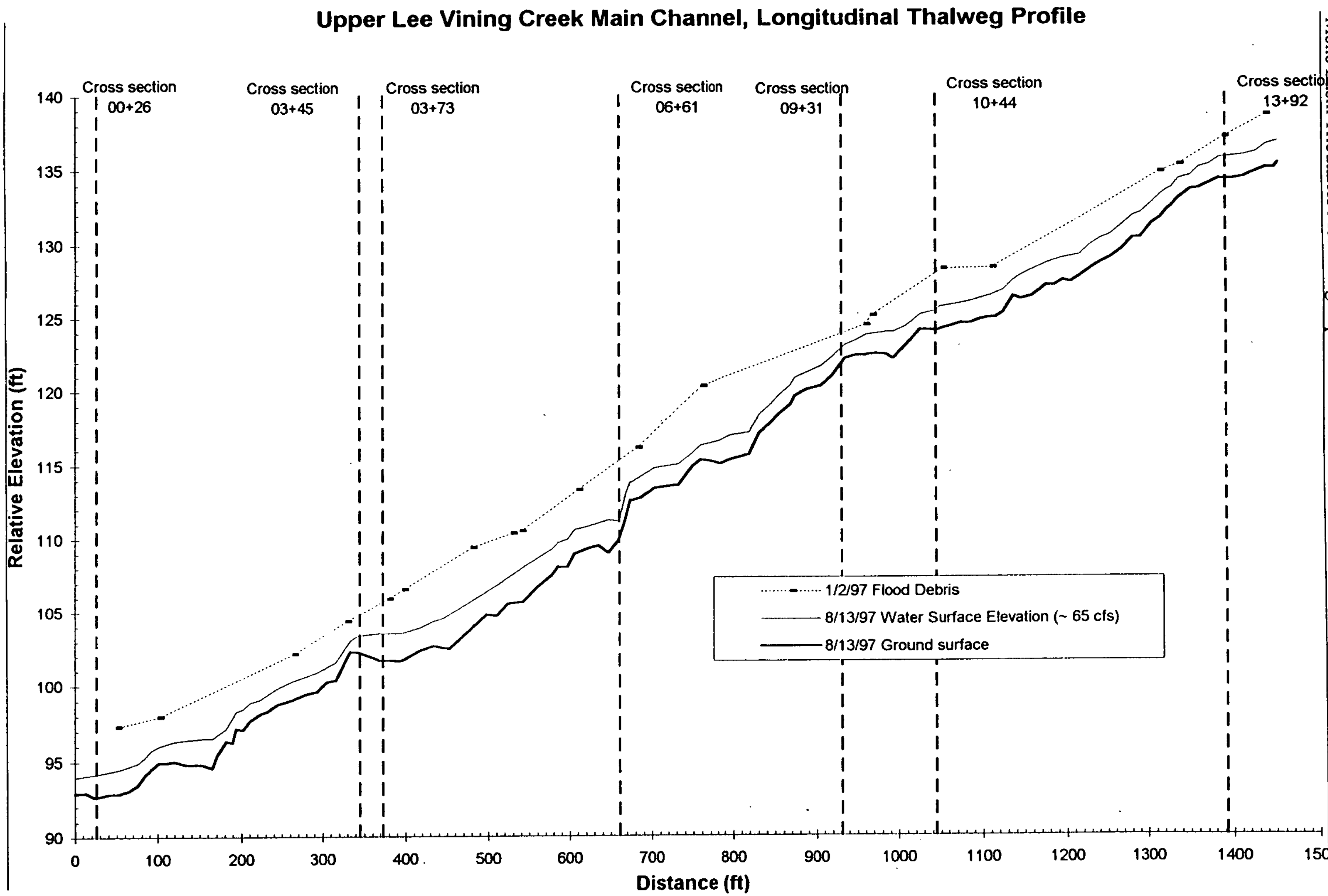


Figure 14. Longitudinal thalweg profile in the mainstem of Upper Lee Vining Creek monitoring site for WY1997.

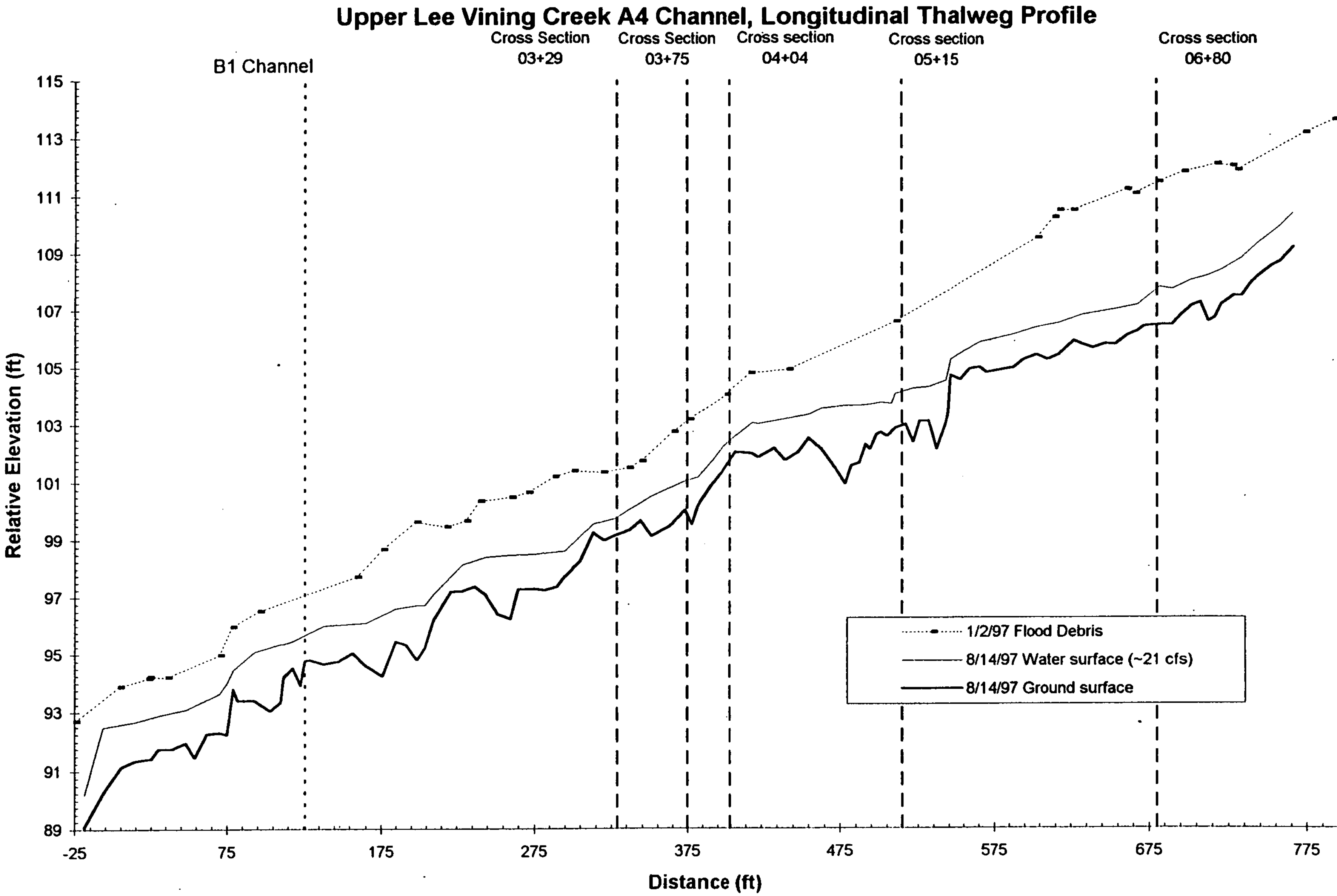


Figure 15. Longitudinal Thalweg profile in the A4 Channel of Upper Lee Vining Creek monitoring site for WY1997.

Lower Lee Vining Creek Main Channel, Longitudinal Thalweg Profile

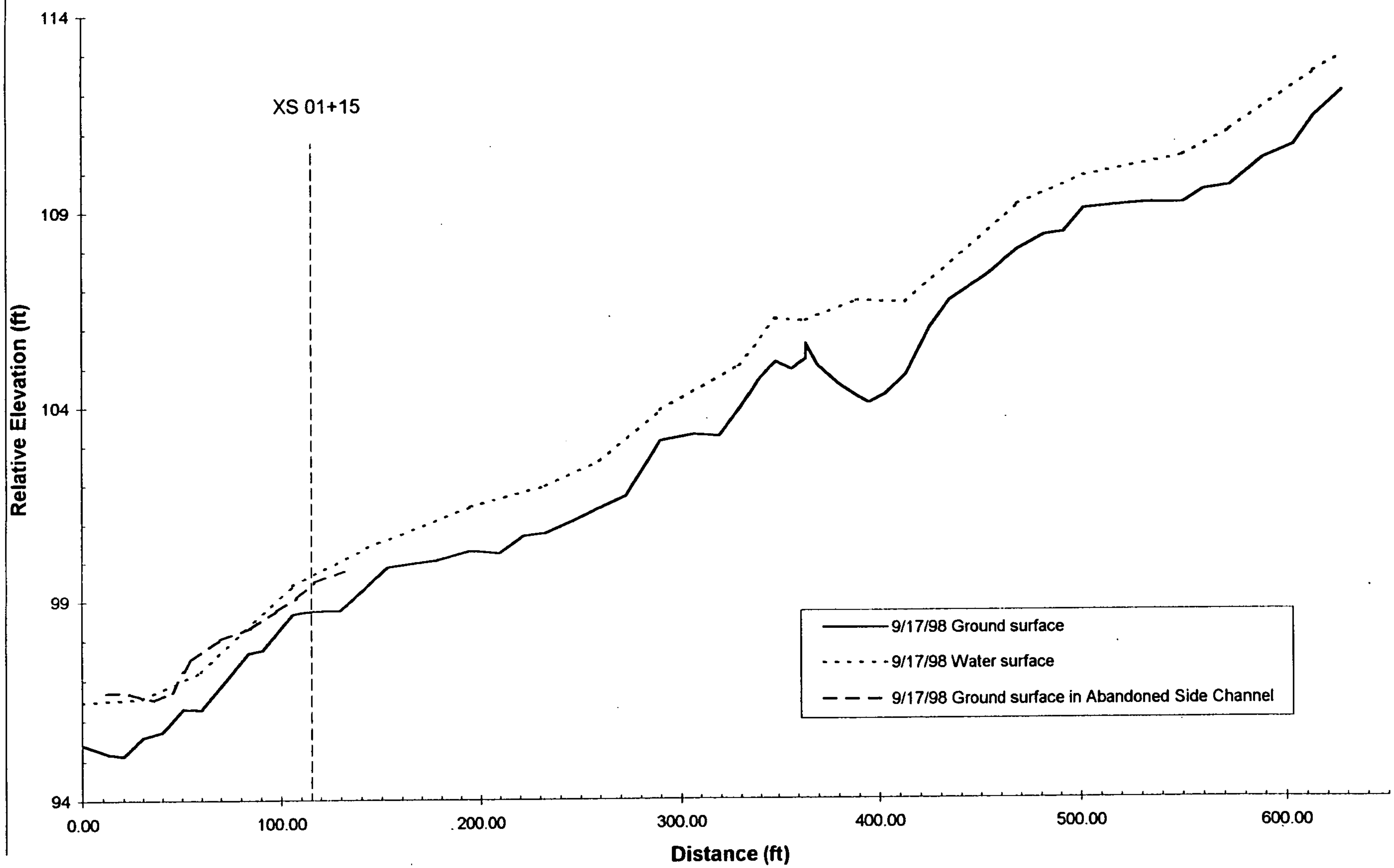


Figure 16. Longitudinal thalweg profile in the mainstem of Lower Lee Vining Creek monitoring site for WY1998.

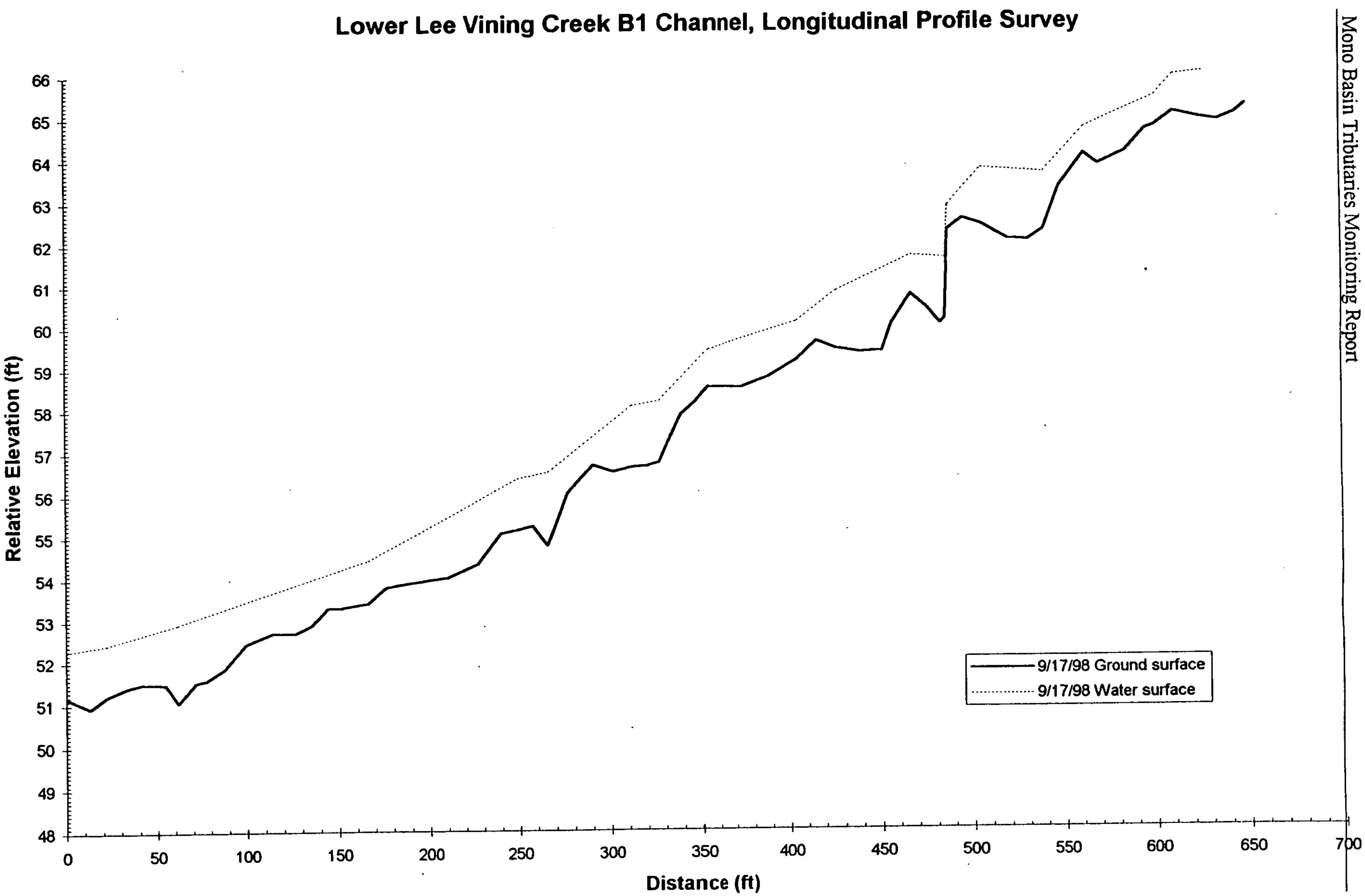


Figure 17. Longitudinal thalweg profile in the B1 Channel of Lower Lee Vining Creek monitoring site for WY1998.

3.4. WY1997 Longitudinal Water Depth/Width Profiles

The thalweg of Lee Vining Creek was surveyed on October 1, 1997. Discharge in the creek at the time of the survey was 42 cfs. The survey started at the black cottonwood upstream of the county road crossing and continued upstream for approximately 4,000 ft. Cross sections were approximately 8 ft apart. At all times measurements were taken in the channel estimated to contain the majority of flow, as multiple braiding is a common feature in this reach. The survey ended in reach 3A on the north end of a 1992 revegetation site where a backhoe trenched down 5 to 6 ft to hit the water table. Coyote willow was planted and set up with an artificial irrigation system at the site. The end-point was just upstream where the construction road crossed Lee Vining creek to allow heavy equipment access to sites in channels A1, A2, and A3. Histograms of the width, depth, and width to depth ratios are presented in Figure 18.

The thalweg survey of Walker Creek was conducted on September 30, 1997. The discharge in Walker Creek during the survey was 6 cfs. The survey reach started above highway 395 and above the county road. The first measurement was taken at fence post #3 on the south side of Walker creek above the county road. The survey continued upstream for approximately 500 ft. The distance between cross sections was approximately 5 ft, measured by pacing. The upstream end-point has no distinctive landmarks but ends where Walker creek heads towards the yellow trailer to the north, half way between a large willow downstream and a rose thicket upstream. There was a large piece of driftwood sticking through the fence on the north side to delineate the end. The top end was approximately 105 ft downstream from a white pipe near a rose thicket. Histograms of the width, depth, and width to depth ratios are presented in Figure 19.

The thalweg survey of Parker Creek was conducted on September 30, 1997. Discharge in Parker Creek during the survey was 8.5 cfs. A 500 ft reach was surveyed above highway 395 and above the county road on Parker creek. Cross sections were approximately 5 ft apart. The survey started at the beginning of one long meander bend downstream of the first large Jeffrey pine above the county road. This section of stream was very sinuous and stays near the large pine continually. Approximately 55 samples were taken downstream of the large pine and the remainder upstream. Histograms of the width, depth, and width to depth ratios are presented in Figure 20.

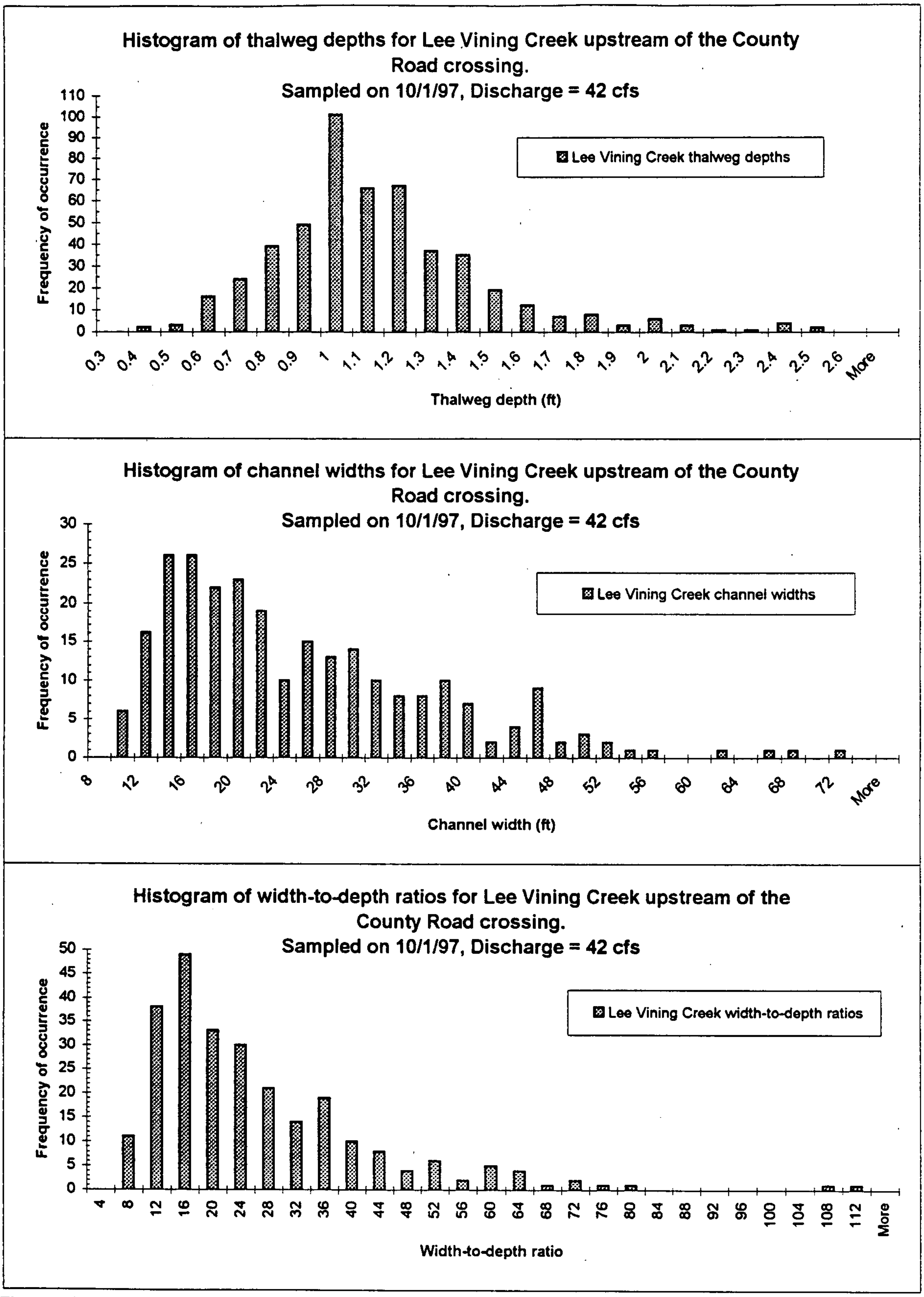


Figure 18. Histograms for width, thalweg depth, and width-to-depth ratio for Lee Vining Creek, from the County Road upstream to the top of the Upper Lee Vining Creek Monitoring Site, in WY 1997.

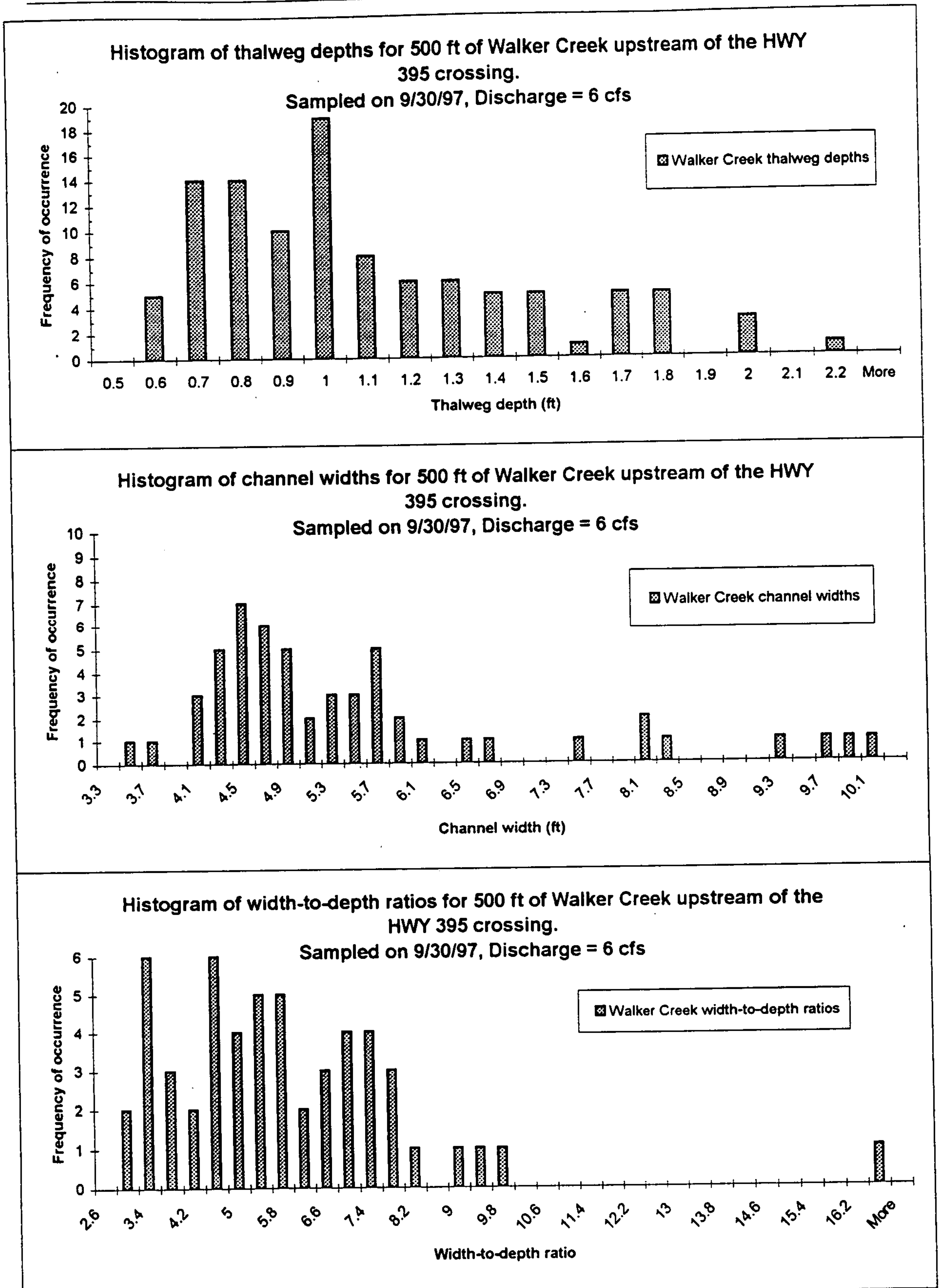


Figure 19. Histograms for width, thalweg depth, and width-to-depth ratio for Walker Creek above Rt. 395 in WY 1997.

Table 3. Rush Creek bed mobility experiment summary for WY1998

REACH	CHANNEL	CROSS SECTION	PARTICLE SIZE (mm)	PARTICLE SIZE CLASS	NUMBER OF TRACER ROCKS PLACED	PEAK DISCHARGE AT CROSS SECTION (cfs)	NUMBER OF TRACER ROCK MOBILIZED	PERCENT OF TRACER ROCKS MOBILIZED	GEOMORPHIC UNIT	NOTES
LOWER	MAIN	-10+10 (H)	125	D_{84}	12	403	12	100%	Riffle	No rocks were found up to 200 ft. downstream of cross section.
			63	D_{50}	12	403	12	100%	Riffle	No rocks were found up to 200 ft. downstream of cross section.
			44	D_{31}	12	403	12	100%	Riffle	No rocks were found up to 200 ft. downstream of cross section.
		-5+07 (D)	110	D_{84}	14	403	13	93%	Riffle	Rock in place at stations 77.0 and 78.0. All other rocks mobilized, one found 143 ft. downstream.
			52	D_{50}	14	403	13	93%	Riffle	Rock in place at station 77.0. All other rocks mobilized and not found downstream.
			36	D_{31}	14	403	13	93%	Riffle	Rock in place at station 77.0. All other rocks mobilized and not found downstream.
		-1+57 (E)	66	D_{84}	10	403		0%	Point Bar	Not entered yet
			38	D_{50}	10	403		0%	Point Bar	Not entered yet
			26	D_{31}	10	403		0%	Point Bar	Not entered yet
		4+08	56	D_{84}	7	403	7	100%	Point Bar	No rocks found up to 200 ft. downstream.
			35	D_{50}	7	403	7	100%	Point Bar	No rocks found up to 200 ft. downstream.
			28	D_{31}	7	403	7	100%	Point Bar	No rocks found up to 200 ft. downstream.
		7+25	99	D_{84}	7	403	0	0%	Lower Point Bar	No rocks moved. Many appear buried.
			53	D_{50}	7	403	1	14%	Lower Point Bar	One rock missing the rest are buried or assumed buried.
			40	D_{31}	7	403	2	29%	Lower Point Bar	Two rocks missing the rest are buried or assumed buried.
		7+25	43	D_{84}	8	403	0	0%	Upper Point Bar	No rocks moved. Some buried in 0.2 ft. of sand.
			26	D_{50}	8	403	0	0%	Upper Point Bar	No rocks moved. Some buried in 0.2 ft. of sand.
			19	D_{31}	8	403	0	0%	Upper Point Bar	No rocks moved. Some buried in 0.2 ft. of sand.
		7+70	99	D_{84}	8	403	8	100%	Channel Bed	All rocks moved, one found 70 ft. downstream
			53	D_{50}	8	403	8	100%	Channel Bed	All rocks moved, one found 98 ft. downstream.
			40	D_{31}	8	403	8	100%	Channel Bed	All rocks moved, none found.
		7+70	43	D_{84}	7	403	0	0%	Point Bar	No rocks moved.
			26	D_{50}	7	403	1	14%	Point Bar	One rock moved and was not found.
			19	D_{31}	7	403	2	29%	Point Bar	two rocks moved and were not found.
		10+10	78	D_{84}	10	403	9	90%	Pool Tail	Rock remained on station 18. No others found.
			46	D_{50}	10	403	9	90%	Pool Tail	Rock remained on station 18. No others found.
			28	D_{31}	10	403	9	90%	Pool Tail	Rock remained on station 18. No others found.
UPPER	Main	0+74 (A)	132	D_{84}	16	540	5	31%	Riffle	Rocks moved up to 14 ft. downstream. All rocks found.
			65	D_{50}	16	540	14	88%	Riffle	Rocks moved up to 65 ft. downstream. Some rocks not found.
			38	D_{31}	16	540	15	94%	Riffle	Rocks moved up to 71 ft. downstream. Some rocks not found.
		5+45 (B)	122	D_{84}	10	540	10	100%	Riffle	No rocks found, all mobilized
			75	D_{50}	10	540	10	100%	Riffle	No rocks found, all mobilized
			62	D_{31}	10	540	10	100%	Riffle	No rocks found, all mobilized
		12+95 (C)	140	D_{84}	12	540	9	75%	Pool Tail	Rocks moved along the left three-quarters of the cross section. No Mobilized rocks were found.
			77	D_{50}	12	540	10	83%	Pool Tail	Rocks moved along the left three-quarters of the cross section. No Mobilized rocks were found.
			53	D_{31}	12	540	12	100%	Pool Tail	Rocks moved along the left three-quarters of the cross section. No Mobilized rocks were found.

Table 4. Rush Creek bed scour experiment summary for WY1998.

REACH	CHANNEL	CROSS SECTION	CORE #	PEAK DISCHARGE IN CHANNEL (cfs)	SCOUR DEPTH (ft)	REDEPOSITION DEPTH (ft)	GEOMORPHIC UNIT
UPPER	MAIN	0+74 (A)	1	540	-0.22	0.24	Pool tail
			2	540	-0.37	0.39	Pool tail
			3	540	-0.68	0.39	Pool tail
		5+45 (B)	1	540	-1.04	0.95	Eddy deposit
			2	540	-0.25	0.61	Lee deposit
		12+95 (C)	1	540	-0.33	0.19	Pool tail
			2	540	-0.12	0.10	Pool tail
LOWER	MAIN	7+70	1	403	0.04	0.03	Upper point bar/floodplain
		7+25	1	403	0.05	0.00	Upper point bar/floodplain
		5+49	1	403	-0.34	0.56	Riffle (transverse bar), within low water channel
			2	403	-0.37	0.47	Riffle (transverse bar), within low water channel
			3	403	-0.43	0.53	Riffle (transverse bar), within low water channel
			4	403	-0.04	0.04	Riffle (transverse bar), within low water channel
		4+08	1	403	-> 0.46	N/A	Point bar, within low water channel
			2	403	-> 0.67	N/A	Point bar, within low water channel
		3+30	1	403	-0.47	0.31	Pool tail, but really a transverse bar @ high Q's
			2	403	-> 0.55	N/A	Pool tail, but really a transverse bar @ high Q's
			3	403	-> 0.75	N/A	Pool tail, but really a transverse bar @ high Q's
		0+86	1	403	0.00	0.00	Upper point bar/floodplain
			2	403	-0.03	0.00	Middle of point bar
			3	403	-0.21	1.14	Point bar, within low water channel
			4	403	-0.30	0.77	Point bar, within low water channel
		-1+57 (E)	1	Channel abandoned by meander cut-off, considerable deposition			
			2	Channel abandoned by meander cut-off, considerable deposition			
		-5+07 (D)	1	Not collected yet			
			2	Not collected yet			

Table 5. Lee Vining Creek bed mobility experiment summary for WY1998

REACH	CHANNE	CROSS SECTION	PARTICLE SIZE (mm)	PARTICLE SIZE CLAS	NUMBER OF RACER ROCK PLACED	PEAK DISCHARGE AT CROSS SECTION (cfs)	NUMBER OF RACER ROCK MOBILIZED	PERCENT OF TRACER ROCK MOBILIZED	GEOMORPHIC UNIT	NOTES
UPPER	MAIN	3+45	210	D_{84}	15	357	7	47%	Pool Tail	Rocks moved downstream up to 15 ft. and movement was generally from the center toward the banks.
			104	D_{50}	15	357	9	60%	Pool Tail	Rocks moved downstream up to 51 ft..
			84	D_{31}	15	357	12	80%	Pool Tail	Rocks moved downstream up to 53 ft.. Most rocks were not found.
		6+61	175	D_{84}	12	357	0	0%	Point Bar	No rocks moved.
			95	D_{50}	12	357	0	0%	Point Bar	No rocks moved.
			66	D_{31}	12	357	2	17%	Point Bar	One rock moved 1 ft. and one was not found.
		9+31	144	D_{84}	11	357	5	45%	Riffle	Rocks moved up to 14 ft. downstream.
			77	D_{50}	11	357	9	82%	Riffle	Rocks moved up to 58 ft. downstream.
			54	D_{31}	11	357	10	91%	Riffle	Rocks not found.
		9+31	144	D_{84}	12	357	0	0%	Medial Bar	Very shallow, slow flow across the bar, no rocks moved.
			77	D_{50}	12	357	0	0%	Medial Bar	Very shallow, slow flow across the bar, no rocks moved.
			54	D_{31}	12	357	0	0%	Medial Bar	Very shallow, slow flow across the bar, no rocks moved.
		13+92	256	D_{84}	12	357	0	0%	Riffle	Stations 52.1 to 57.7 shifted slightly downstream (0.5 ft. to 1.0 ft.).
			95	D_{50}	12	357	3	25%	Riffle	One Rock located 30 ft. downstream shifted to left side of the channel.
			58	D_{31}	12	357	5	42%	Riffle	Rocks were not found.
	A4	4+04	165	D_{84}	10	168	5	50%	Medial Bar	Rocks on right half of channel moved up to 40 ft. downstream.
			112	D_{50}	10	168	4	40%	Medial Bar	Rocks on right half of channel moved up to 45 ft. downstream.
			90	D_{31}	10	168	4	40%	Medial Bar	Rocks on right half of channel moved, one found at 3 ft. no other rocks found.
		5+15	160	D_{84}	10	168	5	50%	Point Bar	Rocks along left half of channel moved or buried in up to 5 inches of sand and fine gravel. Rocks found up to 15.5 ft. downstream.
			60	D_{50}	10	168	5	50%	Point Bar	Rocks along left half of channel moved or buried in up to 5 inches of sand. No rocks found downstream.
			35	D_{31}	10	168	7	70%	Point Bar	Rocks along left half of channel moved or buried in up to 5 inches of sand. No rocks found downstream.
		6+80	250	D_{84}	6	168	1	17%	Riffle	Rock moved up to 6 ft. downstream.
			115	D_{50}	6	168	6	100%	Riffle	One rock moved into D_{84} position.
			86	D_{31}	6	168	6	100%	Riffle	Mobilized rocks were not found.
	B1	6+08	240	D_{84}	5	247	3	60%	Riffle	One rock found at 58 ft. and one found at 8 ft..
			125	D_{50}	5	247	5	100%	Riffle	One rock found at 47 ft. with a 1 ft. boulder on top and one found at 19 ft..
			81	D_{31}	5	247	5	100%	Riffle	Mobilized rocks were not found.
LOWER	MAIN	1+15	205	D_{84}	8	Estimate pending	4	50%	Riffle	Rocks from the center of the channel found along the right half and up to 37 ft. downstream.
			106	D_{50}	8	Estimate pending	5	63%	Riffle	Rocks from the center of the channel found along the right half and up to 140 ft. downstream.
			65	D_{31}	8	Estimate pending	6	75%	Riffle	Rocks moved from the center of the channel and not found.

Table 6. Lee Vining Creek bed scour experiment summary for WY19 98.

REACH	CHANNEL	CROSS SECTION	CORE #	PEAK DISCHARGE IN CHANNEL (cfs)	SCOUR DEPTH (ft)	REDEPOSITION DEPTH (ft)	GEOMORPHIC UNIT
UPPER	MAIN	13+92	1	357	0.06	0.11	Eddy deposit of coarse sand
			2	357	-0.20	0.19	Eddy deposit medium gravels
		10+44	1	357	No WY 1999 data		Eddy deposit, spawning gravels
			2	357	No WY 1999 data		Eddy deposit/exposed bar
		3+73	1	357	0.01	0.04	Eddy deposit of coarse sands
			2	357	-0.57	0.05	Eddy deposit medium gravels
LOWER	SECONDARY	1+15	1	Estimate pending	-0.01	0.00	Point bar deposit, pea gravels
			2	Estimate pending	-0.01	0.00	Point bar deposit, pea gravels

3.7. Fisheries Results

Preliminary results from WY1997 indicate that electrofishing, day snorkeling and night snorkeling each gives a different picture of the fish population. Figures 1 and 2 display these differences clearly. Both graphs represent the results of all three techniques from two pools in lower Rush Creek in WY1997. Day snorkeling was the best method for seeing small brown trout but virtually none larger than 7 inches were observed. Electrofishing was not as efficient for counting small brown trout as day snorkeling. It was however superior to day snorkeling for sampling larger fish. Night snorkeling results fell somewhere between. Night snorkeling was superior to day snorkeling for sampling brown trout larger than 7 inches but not as good as electrofishing for these larger trout. Night snorkeling was not as good as day snorkeling for brown trout smaller than 7 inches.

Depletion estimates of population were computed for Rush and Lee Vining trout by 2 inch size groups in WY1997 and WY1998. Estimates for Rush Creek had relatively low probabilities of capture (Table 1), translating into relatively wide 95% confidence intervals. In several cases, consecutive electrofishing efforts captured increasing numbers of fish, making a depletion estimate impossible (N/P on Table 1). Depletion estimates were also made for all trout by species 2 inches and longer (Table 1). This pooling of size classes assumes similar capture probabilities across all lengths of fish sampled. This assumption is usually not valid. Capture probabilities tend to increase with increasing size of fish up to some threshold large size, where capture probabilities normally decline rapidly due to the rarity of the largest fish and their ability to avoid capture. When captures by pass were pooled across all length groups, estimated probabilities of capture increased leading to an associated narrowing of the 95% confidence intervals. It was not possible to separate estimates for brown trout 8 inches and longer due to the small number of these larger fish being captured.

WY1998 snorkel counts were consistently lower than estimated fish populations. In several cases snorkel counts were lower than the total number of fish captured by electrofishing in three passes, and were sometimes less than the number of fish captured by the first electrofishing pass (Table 1 and Figures 3 and 4). Snorkel counts conducted during the day consistently observed more fish less than 5 inches than snorkel counts at night. Conversely, snorkel counts at night consistently observed more fish greater than 7 inches than day counts. In WY1998 it appears that one diver (diver 1 = D1) consistently observed more fish than the others. This lack of precision in replicate snorkel counts was somewhat troubling if snorkel counts are used in long-term monitoring and different snorkelers conduct the counts in different years.

Riley and Fausch (1992) found that two- and three-pass estimates underestimated actual fish populations estimated by four-pass estimates in seven sections of five small Colorado streams by conducting Monte Carlo simulations. They conclude underestimation was most often related to decreasing capture probabilities, but did not find a relationship between this under-estimation bias and habitat complexity. This bias may have occurred in the Rush Creek depletion estimates. Any under-estimation bias would increase the difference between actual fish numbers and snorkel counts.

Length frequency histograms for Rush Creek brown trout captured in WY1997 and WY1998 indicate that very few fish over 10 inches were captured (Figure 5). Length frequency data can be easily compared between years to determine size composition of the sampled population as long as sampling is conducted consistently.

Collecting fish population data by habitat unit using the depletion removal technique proved very labor intensive because it required setting up block nets for each habitat unit. Additionally because the habitat units are so small, and some are very challenging to sample, some statistical assumptions used to generate the population estimate by the sampling depletion method were violated. As a consequence these estimates are not particularly useful as a calibration of direct observation population estimates. Based on these results, we will conduct the population estimate next year over the entire length of the sample section utilizing mark-recapture techniques rather than the depletion technique used in WY1997 and WY1998. A mark-recapture method will be used to estimate the fish population within each study section. Fish will be captured, either by electrofishing or angling, marked and returned to the stream. After several days a recapture run will be made using snorkeling. One advantage to the snorkeling method is that habitats where fish are located will be recorded. As noted above, this information will be useful in assessing the ability of the flow regime to create habitats important to fish.

Fisheries termination criteria focus on catchable size fish. We are planning on using a controlled creel census to obtain a measure of the sizes and numbers of fish available to anglers. LADWP will be responsible for organizing and carrying-out the controlled creel census.

Wolman pebble counts indicate the availability of spawning habitat in the streams. Results of the Rush Creek WY1998 pebble counts indicate an abundance of suitable spawning gravels at the sites sampled (Figures 6 and 7). Substrates 8-16 millimeters in diameter were classified as medium gravel, those 17-32 mm as coarse gravel, and those 32-64 mm as very coarse gravel.

Future habitat typing conducted prior to fish population surveys will be simplified to include pool, riffle, cascade and complex (multiple subunits) habitat type identification. These units will be included on planmaps. This typing procedure will be more time efficient and less affected by changing flow conditions. Additionally, the data will still lend itself to analysis by different habitat strata or on a reach-wide basis. Inclusion of fish habitat features will be conducted on the regular planmapping schedule.

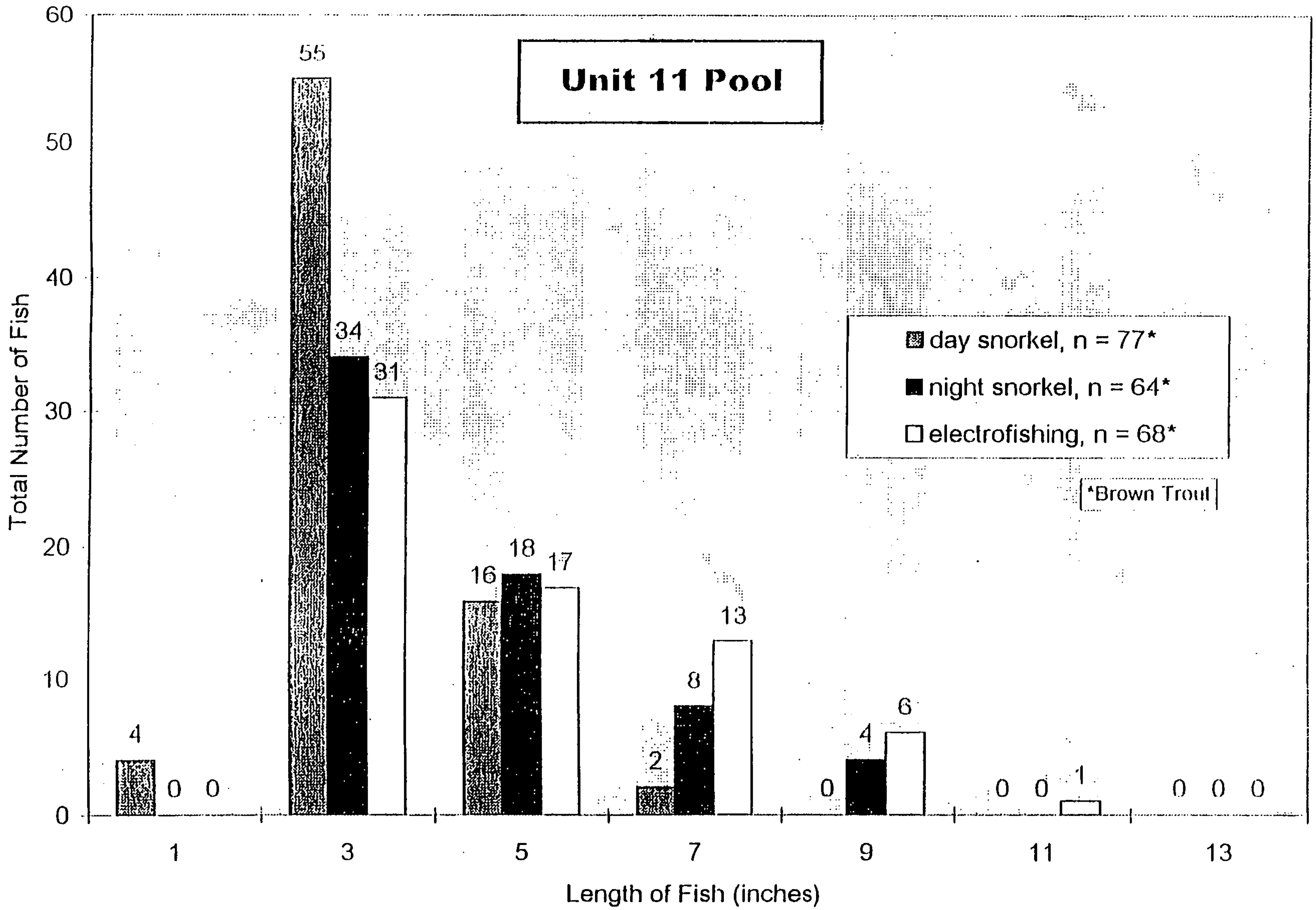


Figure 21. Frequency histogram comparing day snorkel, night snorkel, and electrofishing survey techniques, Rush Creek, Unit 11, September 1997.

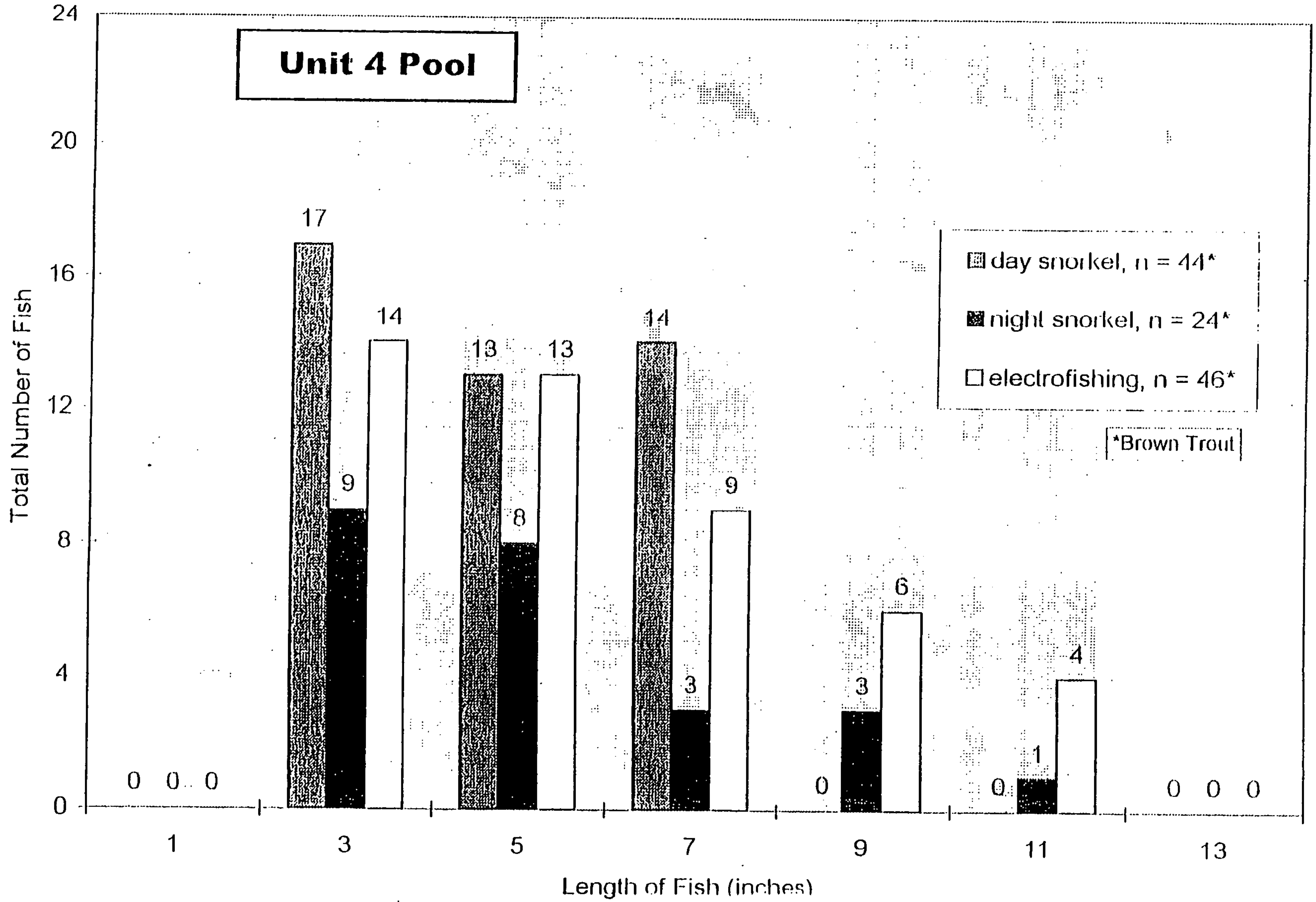


Figure 22. Frequency histogram comparing day snorkel, night snorkel, and electrofishing survey techniques, Rush Creek, Unit 4, September 1997.

Table 7. Electrofishing catches by pass and total, population estimate information including estimated population)N), standard error of estimated population (SE), low and high bound of 95% confidence interval for the estimate (95(low and 95% high), estimated capture efficiency (Capture) and its associated standard error (Capture SE) along with day and night snorkel counts by diver (D#) for brown trout and rainbow trout by size class (inch group) in Rush Creek during 1997 and 1998. "N/P" indicates estimate not possible and "na" indicates count not available.

Stream - Section - Unit - Year Species Length Group (in)	Electrofishing catches			Total	Population estimate information						Snorkel counts				
	Pass 1	Pass 2	Pass 3	captured	N	S.E.	95% low	95% high	Capture	Capture S.E.	Day - D1	Day - D2	Day - D3	Night - D1	Night - D2
Rush Creek - Lower - Run #10 - 1998															
Browns															
1-1.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
2-3.9	15	4	4	23	24	2	23	28	0.605	0.124	na	na	na	1	6
4-5.9	7	2	1	10	10	1	10	11	0.714	0.157	na	na	na	0	2
6-7.9	1	0	0	1	1	-	-	-	-	-	na	na	na	1	2
8-9.9	1	0	0	1	1	-	-	-	-	-	na	na	na	1	0
10-11.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
12-13.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
14-17.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
18+	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
2-9.9	24	6	5	35	36	2	35	40	0.648	0.094	na	na	na	3	10
Rainbow															
3-4.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
5-6.9	1	0	0	1	1	-	-	-	-	-	na	na	na	0	0
7-8.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
9-10.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
11-12.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
13-14.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
Rush Creek - Lower = Pool #23 - 1998															
Browns															
1-1.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
2-3.9	7	4	0	11	11	1	11	12	0.733	0.144	na	na	na	1	1
4-5.9	0	3	1	4	8	18	4	50	0.19	0.517	na	na	na	1	2
6-7.9	1	1	0	2	2	1	2	7	0.667	0.384	na	na	na	0	1
8-9.9	3	0	0	3	3	-	-	-	-	-	na	na	na	1	0
10-11.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
12-13.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
14-17.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
18+	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
2-9.9	11	8	1	Area	21	2	20	25	0.606	0.133	na	na	na	3	4
Rainbow															
3-4.9	0	0	0	Upper	0	-	-	-	-	-	na	na	na	0	0
5-6.9	1	0	0		1	-	-	-	-	-	na	na	na	0	0
7-8.9	0	0	0		0	-	-	-	-	-	na	na	na	0	0
9-10.9	0	0	0		0	-	-	-	-	-	na	na	na	0	0
11-12.9	0	0	0		0	-	-	-	-	-	na	na	na	0	0
13-14.9	0	0	0		0	-	-	-	-	-	na	na	na	0	0

Table 7. (Continued).

Stream - Section - Unit - Year Species Length Group (in)	Electrofishing catches			Total	Population estimate information						Snorkel counts				
	Pass 1	Pass 2	Pass 3	captured	N	S.E.	95% low	95% high	Capture	Capture S.E.	Day - D1	Day - D2	Day - D3	Night - D1	Night - D2
Rush Creek - Lower - Run #24 and Pool #25 - 1998															
Browns															
1-1.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
2-3.9	15	4	5	24	26	3	24	32	0.545	0.133	na	na	na	2	2
4-5.9	12	10	2	24	26	3	24	32	0.545	0.133	na	na	na	3	4
6-7.9	12	3	1	16	16	1	16	17	0.762	0.112	na	na	na	4	4
8-9.9	7	3	1	11	11	1	11	13	0.688	0.158	na	na	na	3	1
10-11.9	2	0	0	2	2	-	-	-	-	-	na	na	na	0	0
12-13.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
14-17.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
18+	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
2-11.9	48	20	9		82	4	77	90	0.592	0.069	na	na	na	12	11
Rainbow															
3-4.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
5-6.9	1	0	0	1	1	-	-	-	-	-	na	na	na	0	0
7-8.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
9-10.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
11-12.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
13-14.9	0	0	0	0	0	-	-	-	-	-	na	na	na	0	0
Rush Creek - Upper - Pool #8 - 1998															
Browns															
1-1.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-3.9	28	17	21	66	149	87	66	322	0.176	0.126	57	2	3	5	4
4-5.9	5	2	5	12	27	38	12	105	0.174	0.297	5	14	6	7	2
6-7.9	5	1	1	7	7	1	7	8	0.7	0.193	0	3	1	14	8
8-9.9	4	1	1	6	6	1	6	8	0.667	0.222	0	0	1	10	2
10-11.9	1	0	0	1	1	-	-	-	-	-	0	0	0	2	0
12-13.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
14-17.9	1	0	0	1	1	-	-	-	-	-	0	0	0	0	0
18+	0	1	0	1	1	-	-	-	-	-	0	0	0	0	0
2-18+	44	22	28		164	49	94	261	0.246	0.097	62	19	11	38	16
Rainbow															
1-1.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-3.9	0	4	1	5	N/P	-	-	-	-	-	0	0	0	0	0
4-5.9	0	1	0	1	1	-	-	-	-	-	1	0	0	0	0
6-7.9	1	0	0	1	1	-	-	-	-	-	1	0	0	0	0
8-9.9	0	0	0	0	0	-	-	-	-	-	3	0	0	0	0
10-11.9	0	1	0	1	1	-	-	-	-	-	0	0	0	0	0
12-13.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
14-17.9	1	0	0	1	1	-	-	-	-	-	0	0	0	1	0
18+	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-17.9	2	6	4		N/P	-	-	-	-	-	5	0	0	1	0

Table 7. (Continued).

Stream - Section - Unit - Year Species Length Group (in)	Electrofishing catches Pass 1	Pass 2	Pass 3	Total captured	Population estimate information N	S.E.	95% low	95% high	Capture	Capture S.E.	Snorkel counts Day - D1	Day - D2	Day - D3	Night - D1	Night - D2
Rush Creek - Upper - Run/Pool #12 - 1998															
Browns															
1-1.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-3.9	17	17	11	45	84	42	45	168	0.224	0.144	21	14	2	5	2
4-5.9	3	4	1	8	9	3	8	15	0.471	0.258	2	1	6	4	3
6-7.9	1	1	0	2	2	1	2	7	0.667	0.384	0	0	0	4	3
8-9.9	2	1	0	3	3	1	3	4	0.75	0.266	0	0	0	1	6
10-11.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
12-13.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
14-17.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
18+	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-9.9	23	23	12		92	28	58	148	0.28	0.119	23	15	8	14	14
Rainbow															
1-1.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-3.9	1	1	1	3							1	0	0	0	0
4-5.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
6-7.9	0	1	0	1	1	-	-	-	-	-	0	0	0	0	0
8-9.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
10-11.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
12-13.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
14-17.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
18+	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-7.9	1	2	1		4	1	4	9	0.5	0.367	1	0	0	0	0
Rush Creek - Upper - Run/Riffle/Run #22, 23, and 24 - 1998															
Browns															
1-1.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-3.9	39	18	16	73	91	12	73	114	0.412	0.09	9	5	12	4	5
4-5.9	3	1	5	9	N/P	-	-	-	-	-	12	5	5	2	3
6-7.9	4	0	4	8	13	13	8	40	0.258	0.335	8	0	2	3	2
8-9.9	1	1	0	2	3	1	3	8	0.5	0.424	1	0	0	3	0
10-11.9	1	0	0	1	1	-	-	-	-	-	0	0	0	2	0
12-13.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
14-17.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
18+	0	1	0	1	1	-	-	-	-	-	0	0	0	0	0
2-18+	48	21	25		134	24	94	182	0.33	0.088	30	10	19	14	10
Rainbow															
1-1.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
2-3.9	2	4	0	6	6	1	6	9	0.6	0.251	0	0	0	0	0
4-5.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
6-7.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
8-9.9	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
10+	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0

Table 7. (Continued).

Stream - Section - Unit - Year Species Length Group (in)	Electrofishing catches			Total	Population estimate information						Snorkel Counts				
											Daytime Passes				Night
	Pass 1	Pass 2	Pass 3	captured	N	S.E.	95% low	95% high	Capture	Capture S.E.	1	2	3	4	Pass
Rush Creek - Pool #4 - 1997															
Browns															
1.0-2.9	2	0	1	3	3	0.709	3	6	0.600	0.354	0	0	0	0	0
3.0-4.9	10	12	2	24	28	4.859	24	38	0.462	0.149	15	23	24	17	9
5.0-6.9	5	3	0	8	8	0.512	8	9	0.727	0.171	7	6	3	13	8
7.0-8.9	4	0	2	6	6	1.002	6	9	0.600	0.251	4	3	2	14	3
9.0-10.9	4	0	0	4	4						2	0	0	0	3
11.0-12.9	1	0	0	1	1						0	0	0	0	1
13.0 +	0	0	0	0	0						0	0	0	0	0
Total	26	15	5	46	50	3.788	46	58	0.554	0.094	28	32	29	44	24
1.0-4.9	12	12	3	27	31	4.762	27	41	0.474	0.138	15	23	24	17	9
5.0 +	14	3	2	19	19	0.770	19	21	0.731	0.110	13	9	5	27	15
Rush Creek - Pool #11 - 1997															
Browns															
1.0-2.9	3	3	0	6	6	0.666	6	8	0.667	0.222	0	0	0	4	0
3.0-4.9	12	17	18	47	N/P						58	74	68	55	34
5.0-6.9	3	4	3	10	20	25.403	10	73	0.200	0.318	9	7	4	16	18
7.0-8.9	5	3	1	9	9	0.947	9	11	0.643	0.189	2	3	3	2	8
9.0-10.9	5	1	0	6	6	0.142	6	6	0.857	0.142	0	0	2	0	4
11.0-12.9	0	0	0	0	0						0	0	0	0	0
13.0 +	0	0	0	0	0						0	0	0	0	0
Total	28	28	22	78	221	171.416	78	559	0.135	0.121	69	84	77	77	64
1.0-4.9	15	20	18	53	N/P						58	74	68	59	34
5.0 +	13	8	4	25	28	3.883	25	36	0.500	0.139	11	10	9	18	30

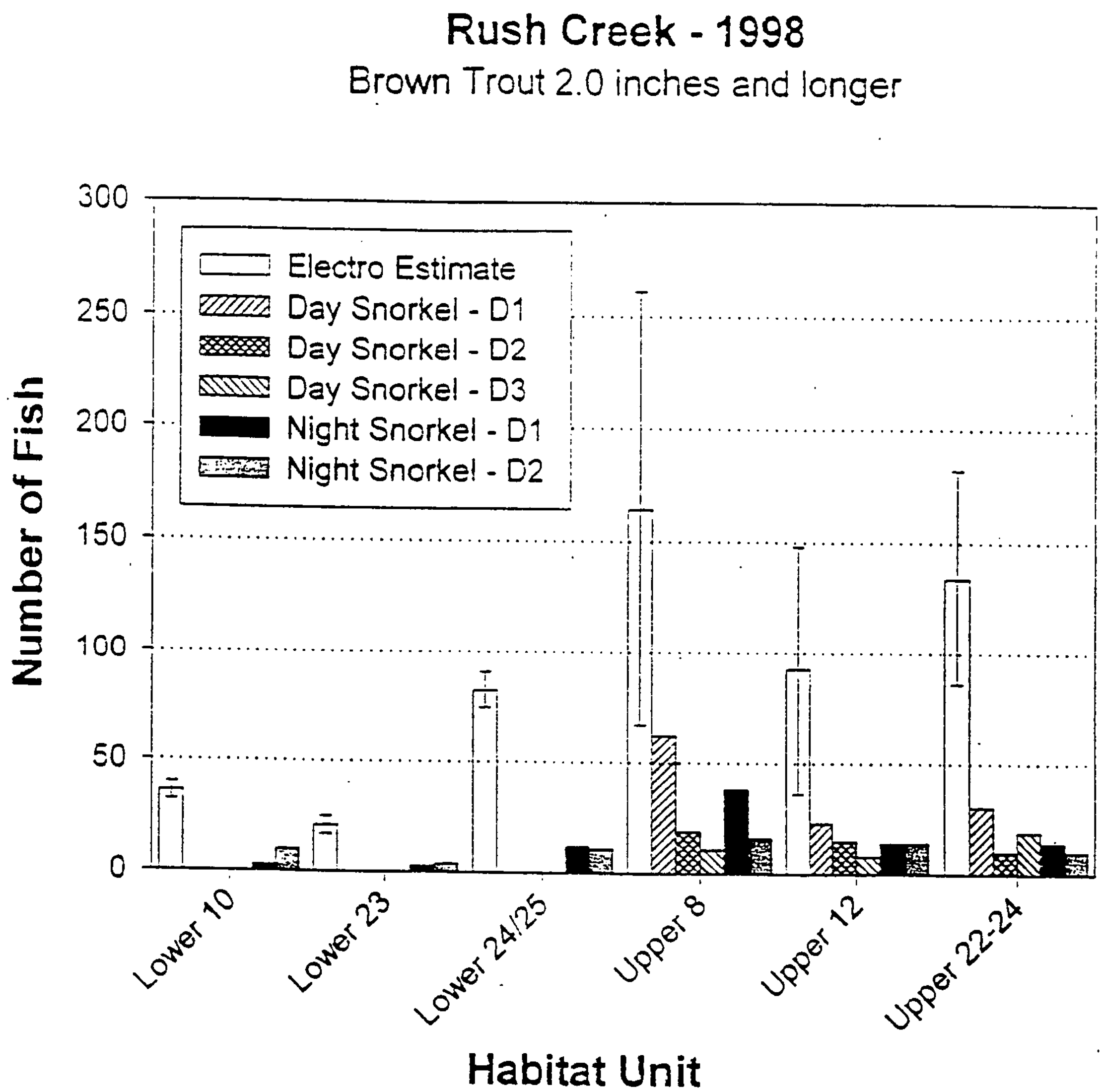


Figure 23. Electrofishing depletion estimate of brown trout 2 inched and longer (vertical lines show 95% confidence intervals) in various habitat units in Rush Creek in 1998 along with day and night snorkel counts by difference divers (D1-D3).

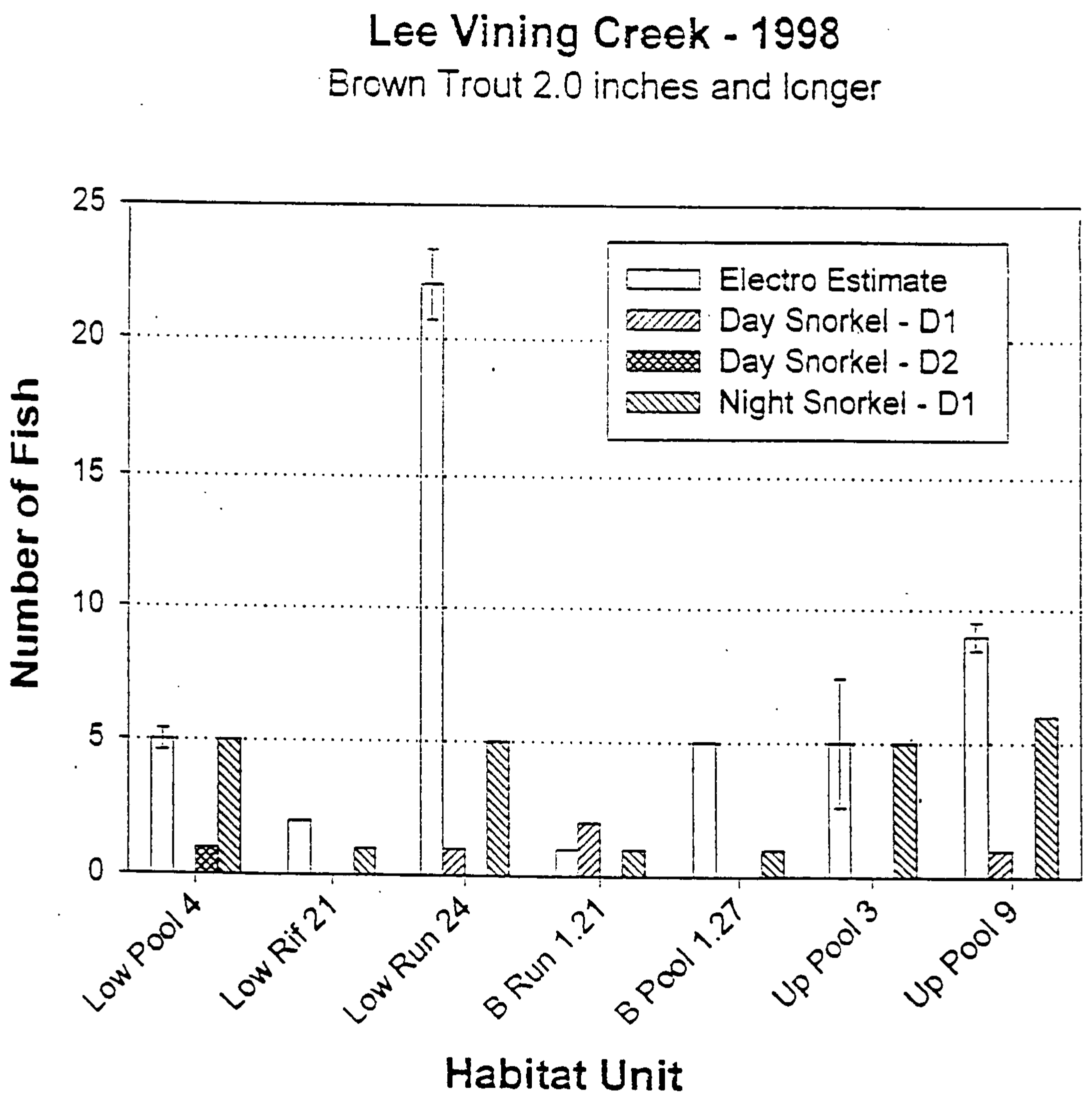
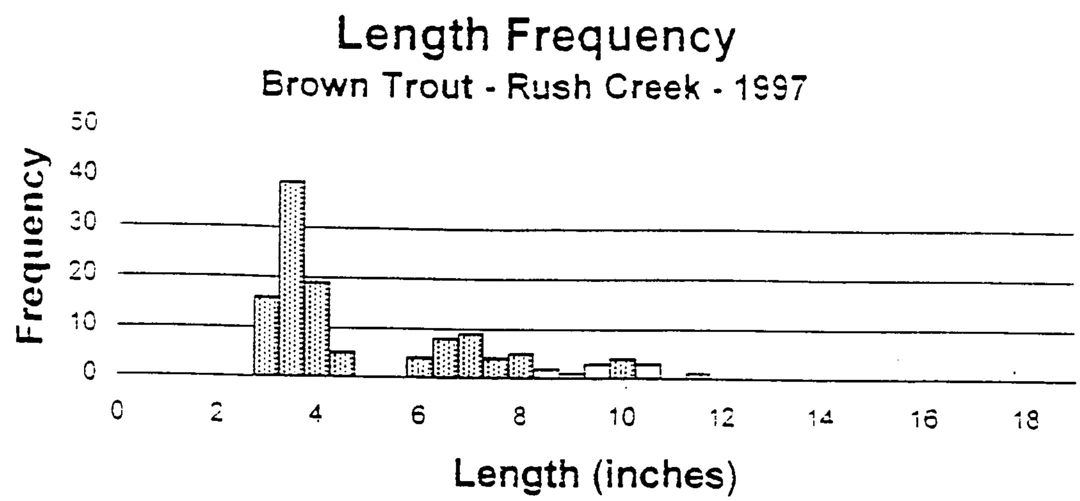


Figure 24. Electrofishing depletion estimates of brown trout 2 inches and longer (vertical lines show 95% confidence intervals) in various habitat units in Lee Vining Creek in 1998 along with day and night snorkel counts by different divers.



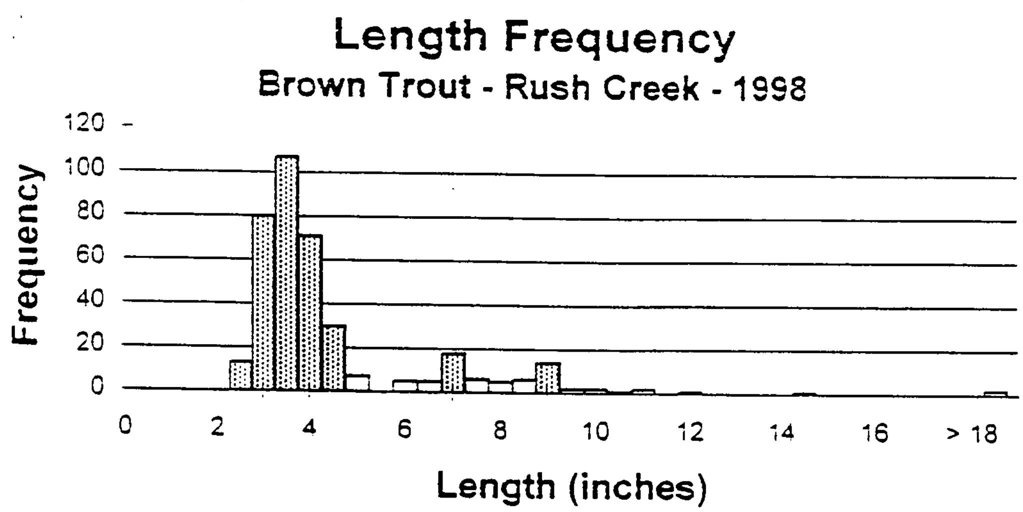
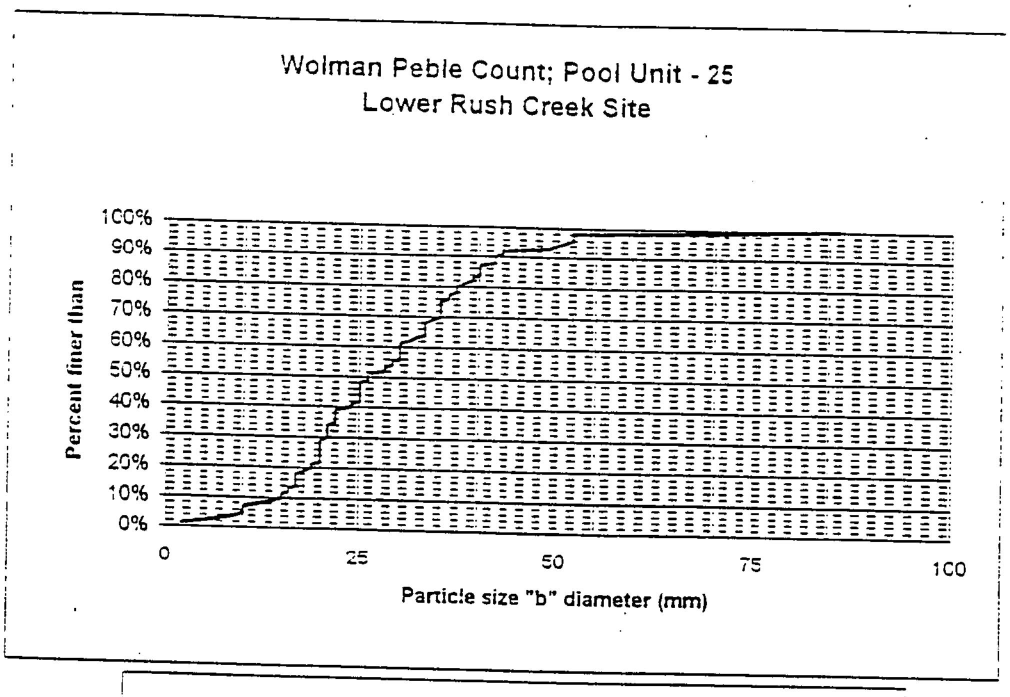


Figure 25. Length frequency histograms for brown trout in all electrofished habitat units of Rush Creek for 1997 (top) and 1998 (bottom).



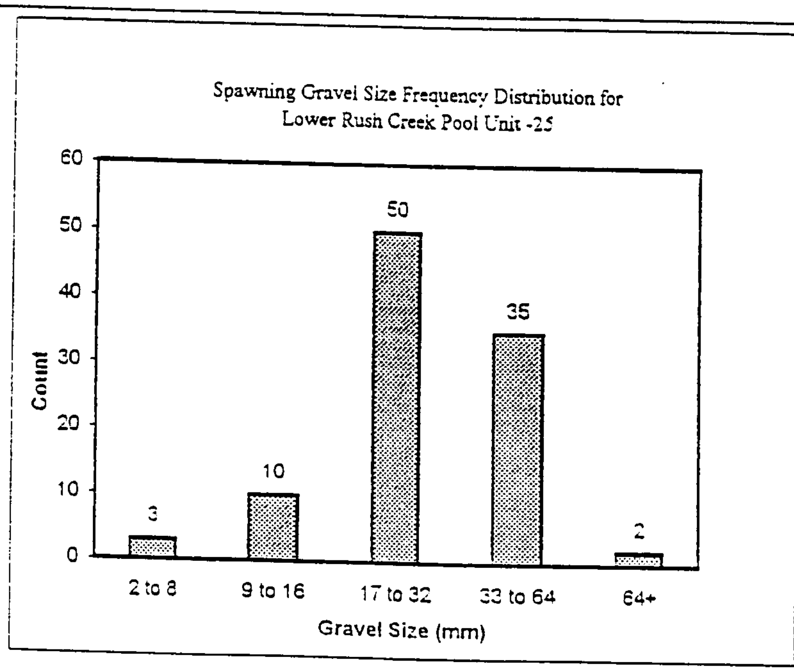
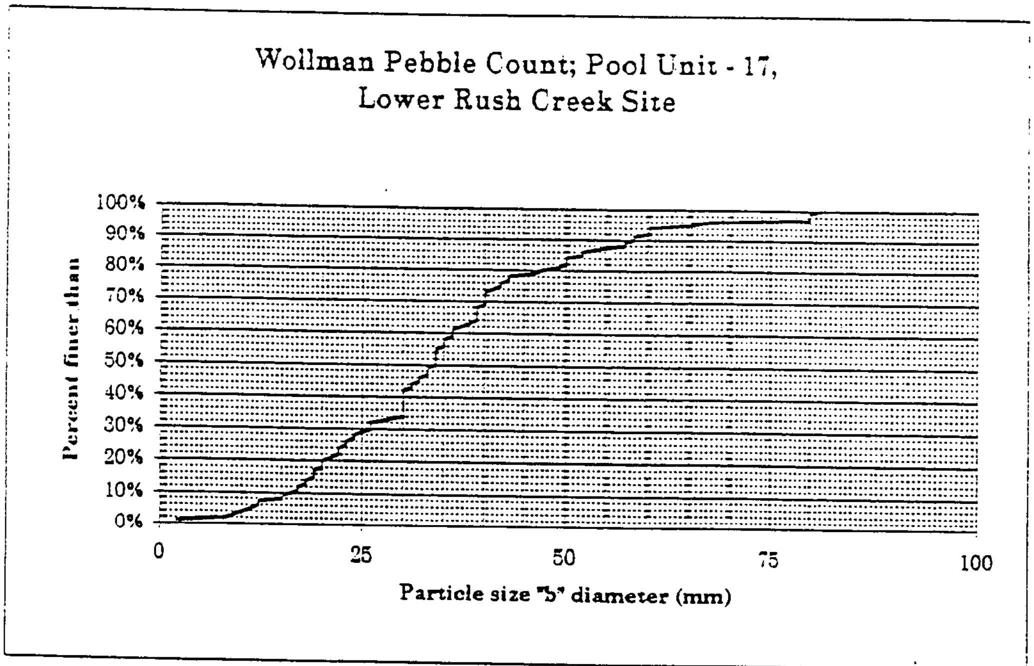


Figure 26. Spawning gravel size frequency distribution for Lower Rush Creek, Pool Unit 25.



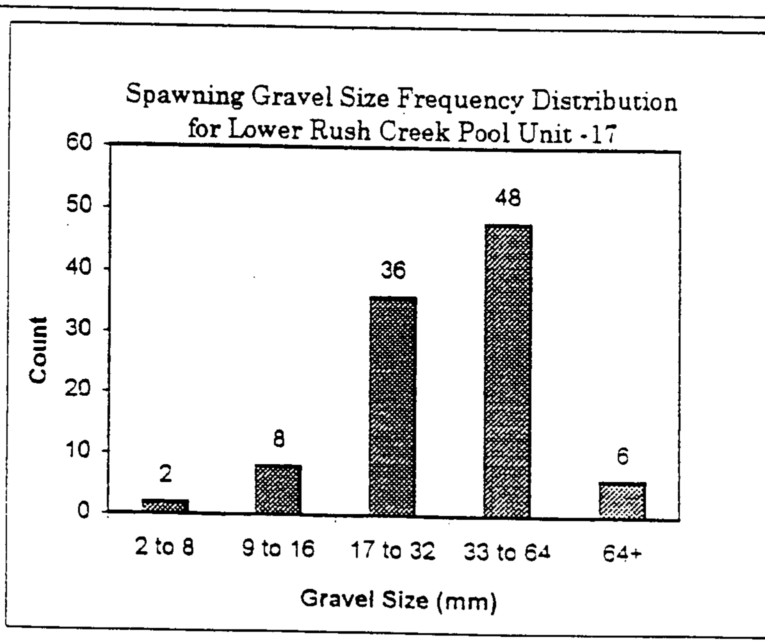


Figure 27. Spawning gravel size frequency distribution for Lower Rush Creek, Pool Unit 17.

4. SUMMARY OF FINDINGS

Time trend analyses, based on a one-year response, are premature to determine whether. Rush Creek and/or Lee Vining Creek are being restored. However, the January WY1997 flood in Lee Vining Creek and the snowmelt flood in WY1998 Rush Creek have revealed a few glimpses of future restoration trends.

A key objective for restoration is frequent mobilization of the channelbed surface and relatively infrequent significant scour/fill of alluvial features such as point bars (Blue Book p.3). The instantaneous peak discharge in WY1997 clearly caused significant mobilization of the channelbed in the mainstem of Lee Vining Creek whereas the peak flow in WY1998 did not. In Rush Creek, regulation prevented the large peak flows in January 1997, but did not prevent substantial peak flows in WY1998. Channelbed mobilization in WY1998 was widespread based on the marked rock and scour core experiments. As monitoring continues, the expected range of flows containing the channelbed mobility threshold will narrow.

Partitioning flows between mainstem and side channel has had important consequences for channelbed mobility thresholds. If the A4 side channel on Upper Lee Vining Creek had not captured most of the WY1998 flood peak, the channelbed mobility threshold would have been surpassed on the main channel. This will force an important management issue: by maintaining side channels, the frequency and intensity of mainstem channelbed mobility will decrease. Will this jeopardize mainstem recovery? Presently, selected side channels should be maintained until the dominant woody riparian vegetation in the floodplain and low flood terraces (i.e., cottonwoods) grow to a one foot diameter. In Ridenhour et al. (1995), tree ring counts on two cottonwoods indicated 30 years would be required to reach a one foot diameter. The influence of woody riparian vegetation on bank stability and the potentially huge role of LWD on channel hydraulics must be watched. The LWD stockpiled at the Cain Ranch (stumps) should be placed in lower Lee Vining Creek; not anchored but possibly cabled together (especially the smaller root boles).

5. REFERENCES

Dalrymple, T. and M.A. Benson. 1967. Measurement of peak discharge by the slope-area method. US Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter A2.

Griffith, J.S. 1981. Estimation of the age-frequency distribution of stream-dwelling trout by underwater observation. Progressive Fish Culturist 43:51-53.

Harrelson, C.C., Rawlins, C.L., and J. P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rept. RM-245. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experimental Station. 61 p.

Hillman, T.W., J.W. Mullan, and J.S. Griffith. 1992. Accuracy of underwater counts of juvenile chinook salmon, coho salmon, and steelhead. North American Journal of Fisheries Management 12:598-603.

Jarrett, R.D. 1984. Hydraulics of high-gradient streams. J. Hyd. Eng. 110:1519-1539.

Katzel, M (ed.). 1992. Comparison of historic and existing conditions on Lower Lee Vining Creek, Mono County, California. Prepared by Trihey and Associates for LADWP. (individual chapters paginated separately)

Keenleyside, M.H.A. 1962. Skin-diving observations of Atlantic salmon and brook trout in the Miramichi River, New Brunswick. Journal of the Fisheries Research Board of Canada 19:625-634.

Larsen, E.W. 1994. A study of pool morphology in pre-1941 channel segments of lower Rush Creek, Mono County, California. Prepared for LADWP by Trihey and Associates. 74 p.

Leopold, L.B. 1994. A View of the River. Harvard University Press. Cambridge, MA. 298 p.

Northcote, T.G. and D.W. Wilkie. 1963. Underwater census of stream fish populations. Transactions of the American Fisheries Society 92:146-151.

Overton, C.K., S.P. Wollrab, B.C. Roberts and M.A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures. General Technical Report INT-GTR-346. Intermountain Research Station, Ogden, UT.

Ridenhour, R.L., Hunter, C., and W.J. Trush. 1995. Mono Basin stream restoration: work plan. Prepared for LADWP. 228 p.

Riley, S.C. and K.D. Fausch. 1992. Underestimation of trout population size by maximum-likelihood removal estimates in small streams. North American Journal of Fisheries Management 12:768-776.

Robson, D.S. and H.A. Regier. 1964. Sample size in Petersen mark-recapture experiments. Transactions of the American Fisheries Society 93:215-226.

Rodgers, J.D., M.F. Solazzi, S.L. Johnson, and M.A. Buckman. 1992. Comparison of three techniques to estimate juvenile coho salmon populations in small streams. North American Journal of Fisheries Management 12:79-86.

Slaney, P.A. and A.D. Martin. 1987. Accuracy of underwater census of trout populations in a large stream in British Columbia. North American Journal of Fisheries Management 7:117-122.

Thruow, R.F. 1994. Underwater Methods for Study of Salmonids in the Intermountain West. General Technical Report INT-GTR-307, Intermountain Research Station, Odgen, UT.

Thurow, R.F. and D.J. Schill. 1996. Comparison of day snorkeling, night snorkeling, and electrofishing to estimate bull trout abundance and size structure in a second-order Idaho stream. North American Journal of Fisheries Management 16:314-323.

Zubik, R.J. and J.J. Fraley. 1988. Comparison of snorkel and mark-recapture estimates for trout populations in large streams. North American Journal of Fisheries Management 8:58-62.

6. APPENDIX A: STUDY SITE PLANMAPS

The following study site planmaps are included in Appendix A:

Plate 1.	Mainstem planmap of the Lower Rush Creek monitoring site for WY1997.
Plate 2.	Mainstem planmap of the Lower Rush Creek monitoring site in WY1998.
Plate 3.	Planmap for Upper Rush Creek monitoring site in WY1998.
Plate 4.	Mainstem planmap for Lower Lee Vining Creek monitoring site in WY1998.
Plate 5.	B1 planmap for Lower Lee Vining Creek monitoring site in WY1998.
Plate 6.	Mainstem planmap in the Upper Lee Vining Creek monitoring site for WY1997.
Plate 7.	A4 planmap in the Upper Lee Vining Creek monitoring site for WY1997.
Plate 8.	The 10 side channel planmap in the Lower Rush Creek monitoring site for WY1998

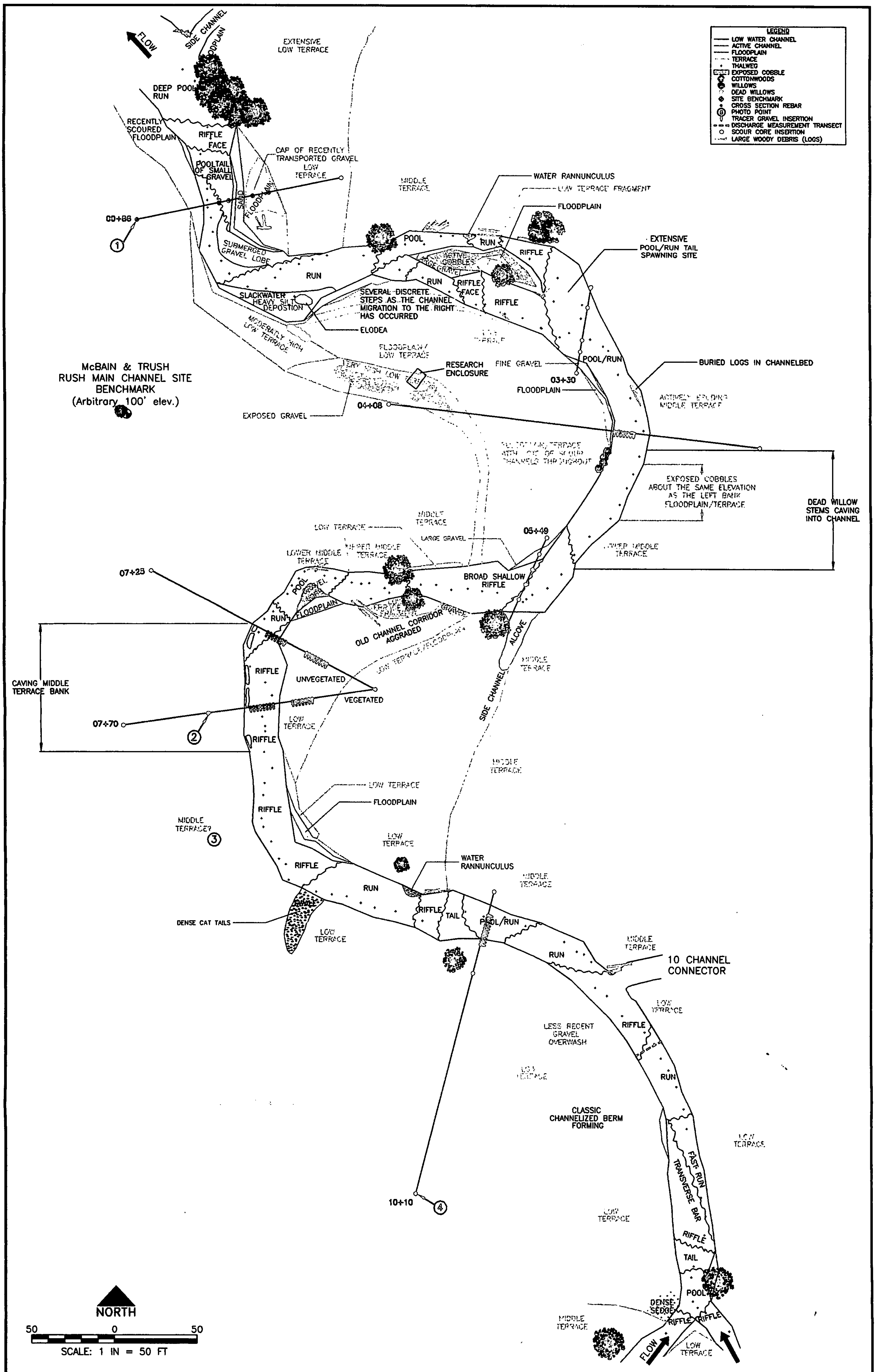


Plate 1. Mainstem planmap of the Lower Rush Creek monitoring site in WY1997

McBain & Trush 1998

12/1/98

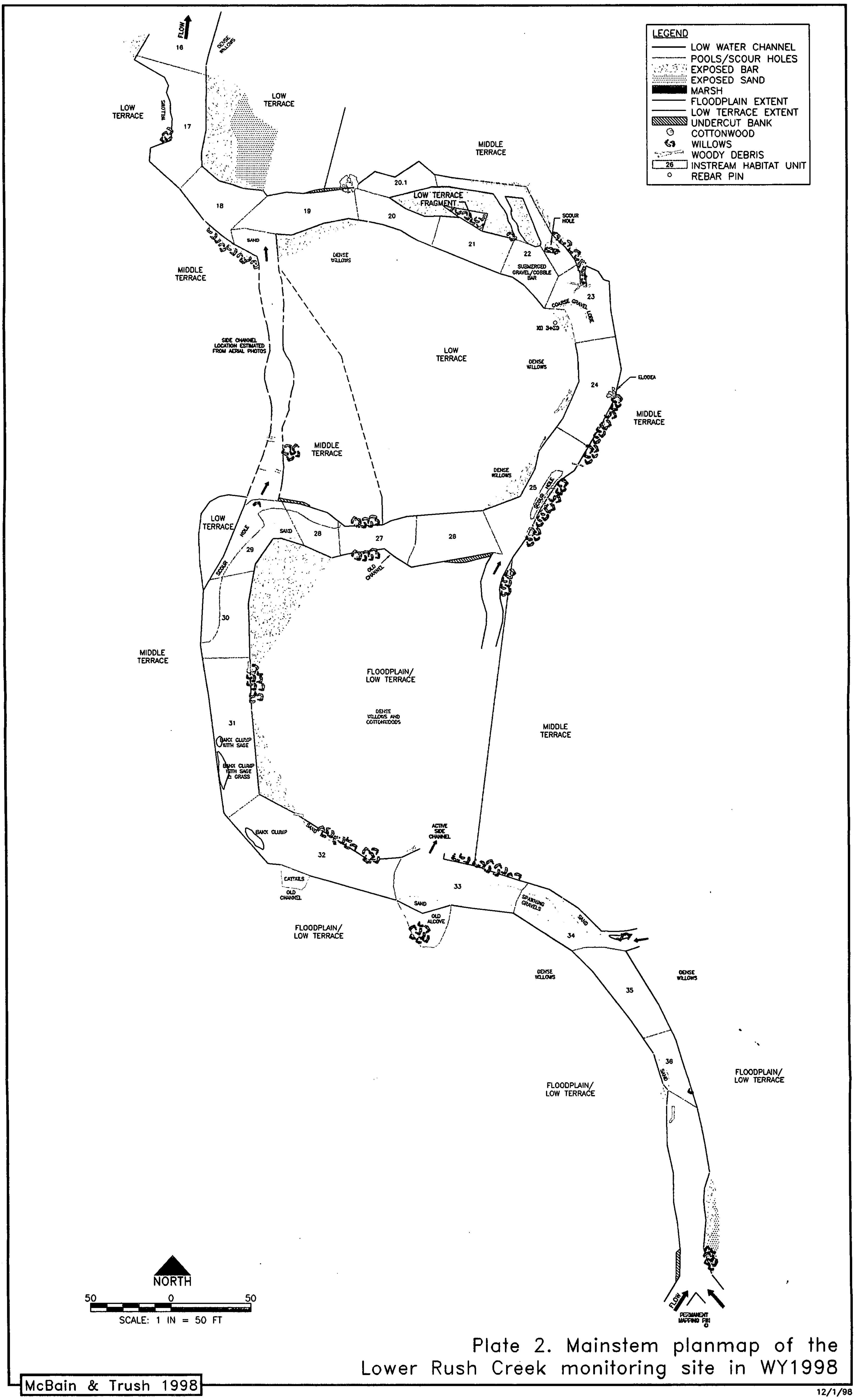


Plate 2. Mainstem planmap of the Lower Rush Creek monitoring site in WY1998

12/1/98

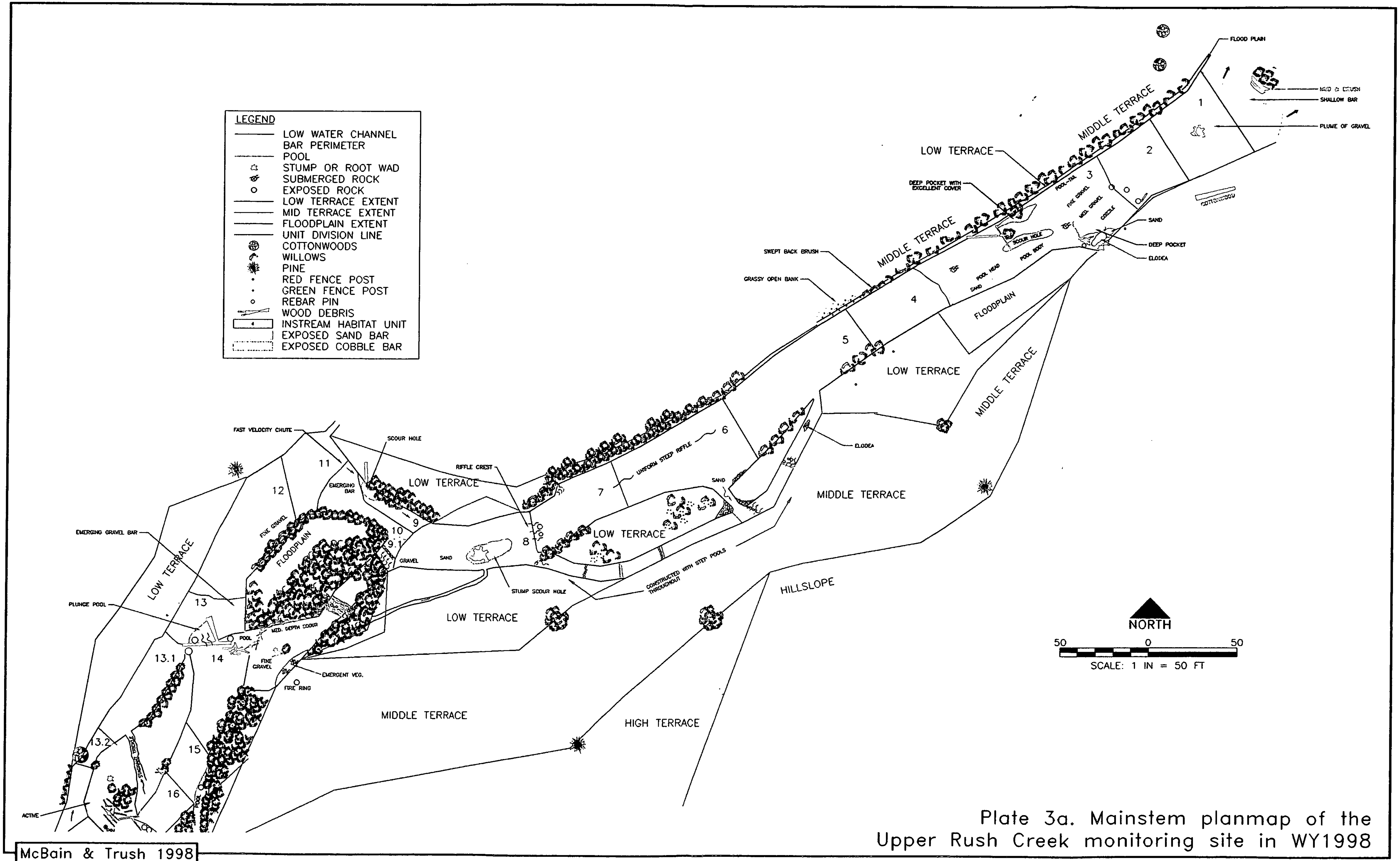


Plate 3a. Mainstem planmap of the Upper Rush Creek monitoring site in WY1998

McBain & Trush 1998

12/15/98

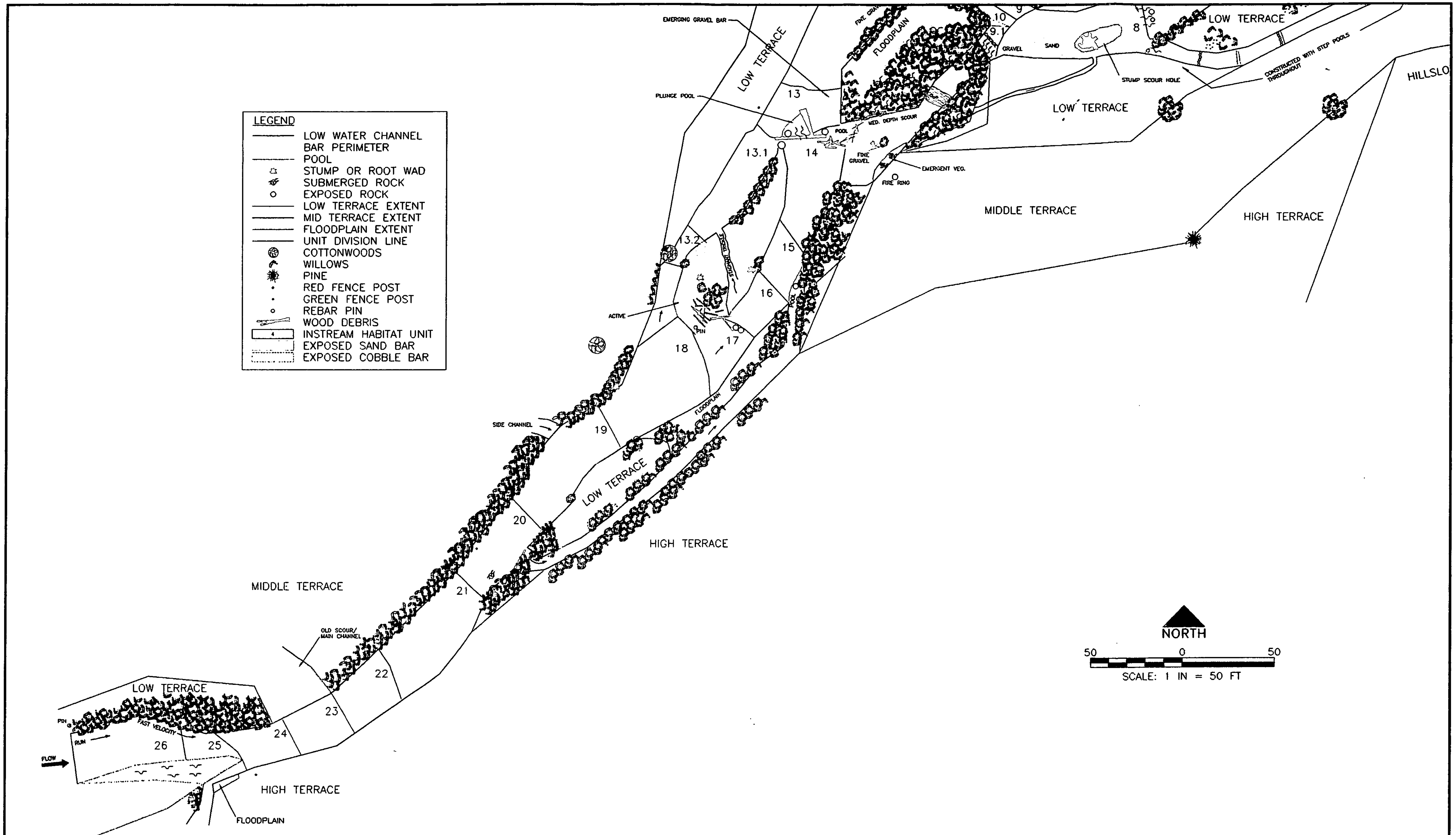


Plate 3b. Mainstem planmap of the Upper Rush Creek monitoring site in WY1998

McBain & Trush 1998

12/15/98

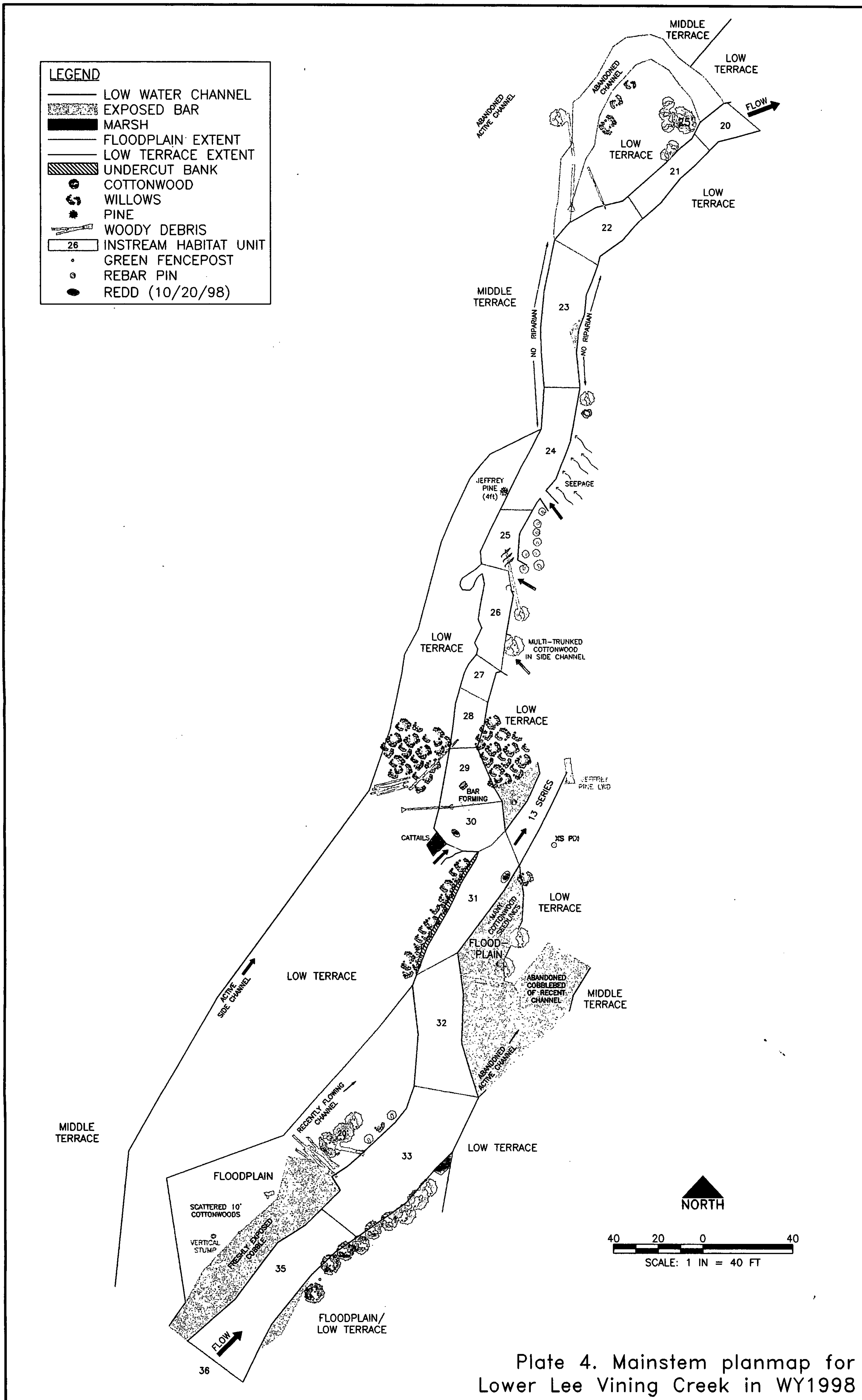


Plate 4. Mainstem planmap for Lower Lee Vining Creek in WY1998

McBain & Trush 1998

11/30/98

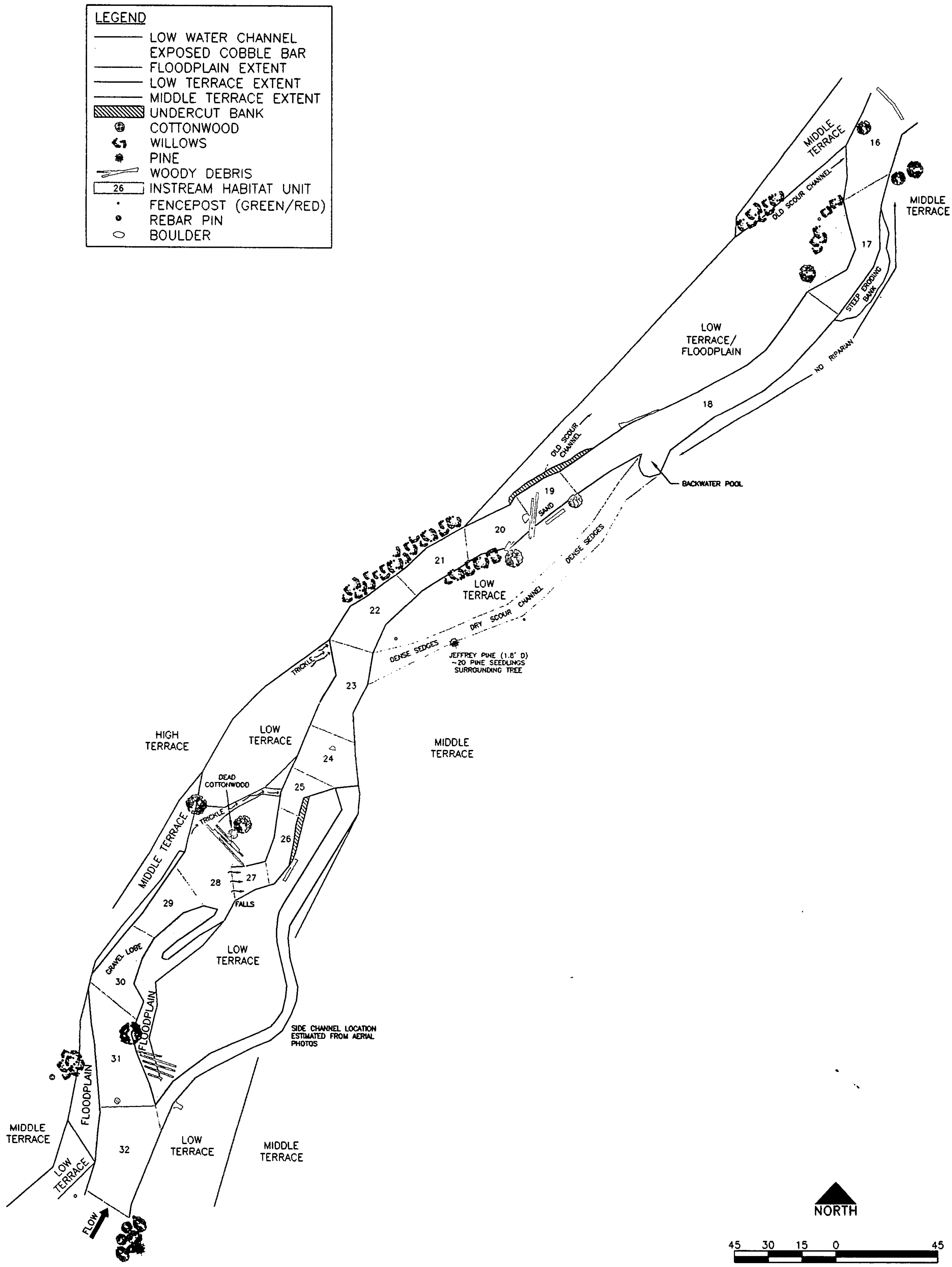


Plate 5. B1 Channel planmap for Lower Lee Vining Creek in WY1998

McBain & Trush 1998

11/30/98

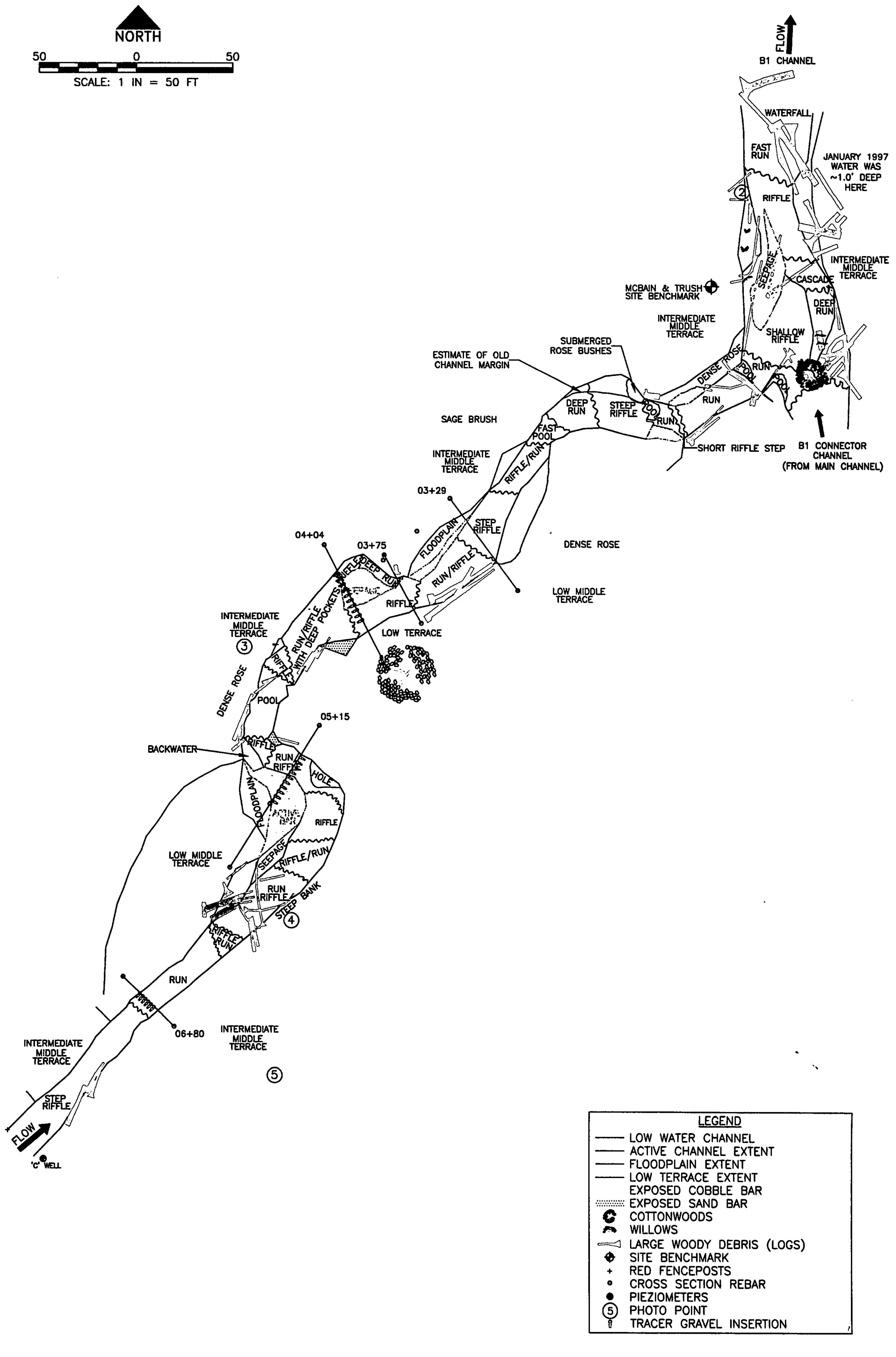


Plate 7. A4 planmap of the Upper Lee Vining Creek monitoring site in WY1997

McBain & Trush 1998

12/1/98

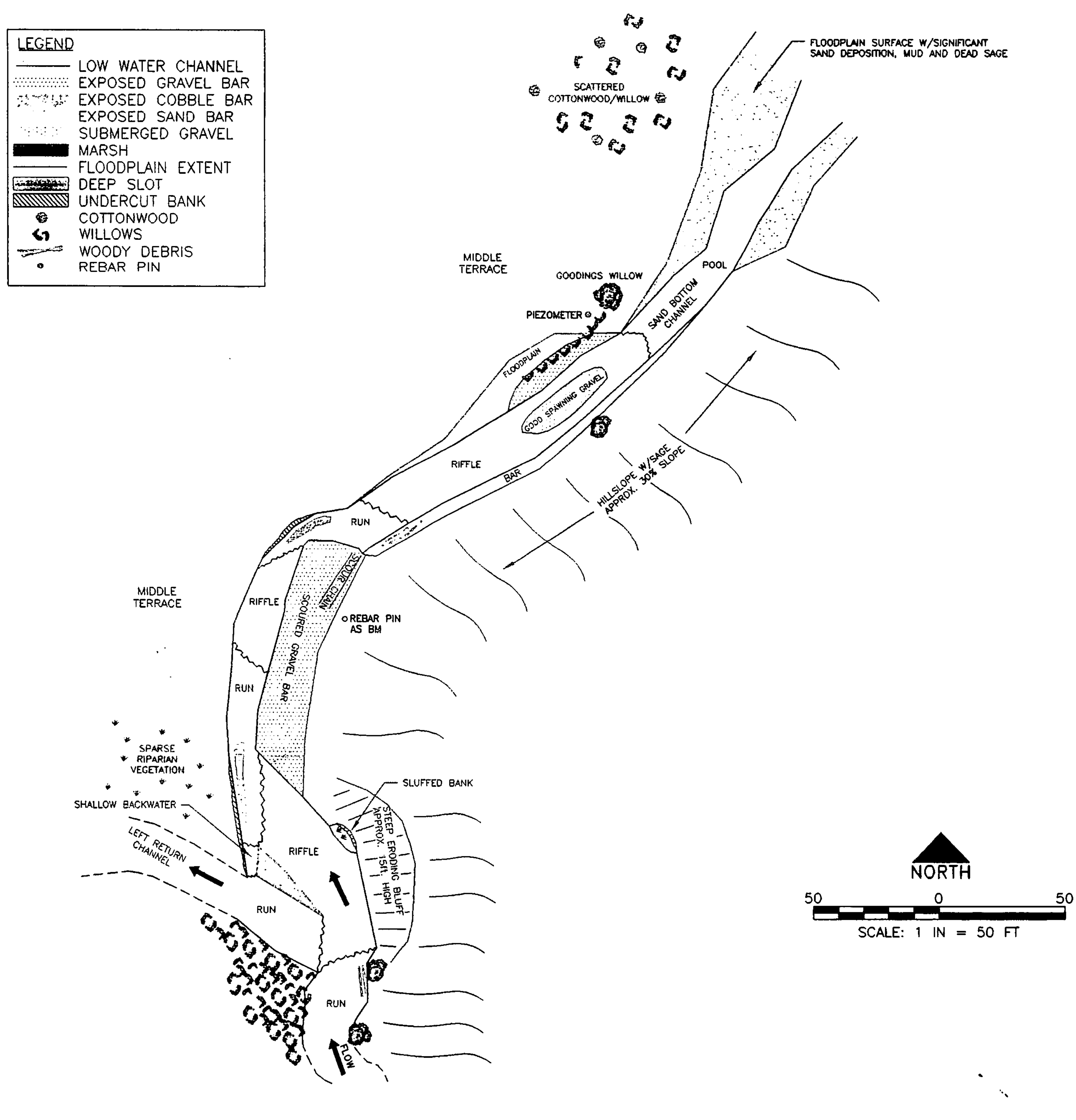


Plate 8. 10–Channel planmap of the Lower Rush Creek monitoring site in WY1998

McBain & Trush 1998

12/15/98

7. APPENDIX B: WY1997 AND WY1998 OPERATIONAL REPORTS FOR LOS ANGELES DEPARTMENT OF WATER AND POWER

The following reports are included in Appendix B:

Kavounas, P. 1997. Mono Basin Operations Guideline for Runoff Year 1997-98. 3 p. + 2 tables and 1 figure. April 23, 1997.

Kavounas, P. 1997. Update on Mono Basin Operations During Runoff Year 1997-98. 3 p. + 7 figures. August 6, 1997.

Kavounas, P. 1998. Mono Basin Operations Guideline for Runoff Year 1998-99. 3 p. + 2 tables and 1 figure. April 22, 1998.

Kavounas, P. 1998. Mono Basin Operations Guideline for Runoff Year 1998-1999. 1 p. May 27, 1998.

Kavounas, P. 1999. Update on Mono Basin Operations During 1998-99 Runoff Year. 3 p. + 12 figures.

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April 23, 1997

To Enclosed Distribution List:

Mono Basin Operations Guideline for Runoff Year 1997-98

The attached is an outline of the proposed guideline for the Los Angeles Department of Water and Power (LADWP) operations in the Mono Basin for the runoff year 1997-98. The guideline was developed on the following principles:

1. *Meet Decision 1631 minimum flows throughout the year.* Decision 1631 is in place and dictates the minimum flows that must be met in each stream. LADWP intends to meet the minimum flows or provide flow-through conditions throughout the year.

2. *Pass peak flows through LADWP facilities in Rush Creek.* Decision 1631 also requires LADWP to release specific channel maintenance flows in Rush Creek. To meet these requirements LADWP's facilities need to be rehabilitated as described in the restoration plans submitted to the State Water Resources Control Board (SWRCB) in February 1996. The facility modifications will not take place until the plans are approved by the SWRCB. Until that time, LADWP intends to make every effort to allow the impaired peak flows to pass downstream of Grant Lake unimpeded. Exports from the Mono Basin will be discontinued during the time of peak flows in Rush Creek to provide the highest peak possible.

3. *Spill Grant Lake as soon as possible.* Grant Lake will be brought to spilling conditions in early May, to allow for any early (false) peak flow events to also pass unimpeded.

4. *Pass peak flows through LADWP facilities in Parker, Walker, and Lee Vining creeks.* The Lee Vining, Walker and Parker creek requirements will be met by providing flow-through conditions. There are no planned diversions into the Lee Vining Conduit from any of the three creeks, and no irrigation diversions from either Walker or Parker creeks during peak flows. In the event that flows exceed the capacity of downstream culverts at Highway 395 and it becomes necessary to attenuate the flows, LADWP will divert portion of the flows as necessary.

5. *No diversions from Lee Vining Creek.* Since Grant Lake storage is at relatively high levels at the start of the year and the expected operations will maintain

that into the following year, LADWP is not planning on diverting any Lee Vining Creek water into the Lee Vining Conduit during the rest of 1997-98.

6. *Export 16,000 ac-ft from the basin.* As allowed by Decision 1631, LADWP will export its full entitlement. Water will be exported from the basin in a year-round pattern, except during Rush Creek channel maintenance flows.

7. *Maximize Grant Lake storage at the end of runoff year.* As described in No. 2 above, facility modifications (specifically the rehabilitation of the Mono Gate Return Ditch, which will require Grant Lake to be spilling) will need to be performed as soon as practical after the SWRCB issues its decision on the restoration plans. LADWP anticipates that it may be possible to perform the work on the Return Ditch in the next runoff year (1998-99). To prepare for such an eventuality, LADWP is planning to maximize the storage in Grant Lake at the end of the 1997-98 runoff year.

A copy of the Statistical Summary output of GLOM is attached in addition to the operations guideline. This summarizes the "educated guess" of distribution of monthly flows in Mono Basin streams and LADWP facilities for the 1997-98 runoff year. These do not represent minimum or maximum flows, or targets of any kind; they merely reflect a possible scenario of the flow distribution in the basin, under "normal" conditions. The actual flows will likely be different.

The values of expected magnitude and timing of the peak flows in Rush and Lee Vining creeks were generated by a predictive model, and are as follows:

	Peak flow magnitude (cfs)	Timing
Rush Creek (below the Narrows)	380	June 22, 1997
Lee Vining Creek	320	June 9, 1997

The prediction model uses regression analysis of historical data to predict future events. Since the values are primarily a function of temperature, it is more than likely that the values in the above table are not accurate. It is intended that they are used as an indicator of magnitude and timing of the peak flows. The predictions are based on the April 1, 1997 forecast, and assume median precipitation for the following six months. In light of the dry April, the values of magnitude may be lower.

Given the most current forecast, and the proposed operations guideline, the elevation of Mono Lake is expected to be approximately 6,382.8 ft amsl at the end of the runoff year. This is graphically shown in the attached "Historic and Projected Mono Lake

Elevation" graph. The estimate is derived from modeling, and includes a number of assumptions such as normal precipitation conditions for the rest of the year. Once again, the number is to be used as a general indicator, not an absolute fact.

The proposed operations for the 1997-98 runoff year do not follow the guidelines set in GLOMP, nor are they to be interpreted as an indicator of operations in future years. They are to deal with current hydrologic circumstances and facility limitations, while the SWRCB is in the process of evaluating the LADWP restoration plans. Further, the actual operations may differ from the plans to accommodate unforeseen circumstances.

The LADWP welcomes any comments by interested parties to the proposed operations guideline. A conference call to discuss comments is scheduled for Monday, May 5, 1997, at 3:00 p.m. Interested parties are encouraged to call Mr. Steve McBain at (213) 367-0963 and arrange their participation.

Sincerely,

P. Kavounas / SBM

Peter Kavounas

Attachments

RUNOFF YEAR 1997-98 MONO BASIN OPERATIONS GUIDELINE

Hydrologic Year Type: Wet-Normal
Forecasted Volume of Runoff[1]: 148,200 acre-feet

LOWER RUSH CREEK

Instream flows:

	Apr-Sept	Oct-Mar
Flow (cfs)	47	44

Minimum base flows are those described above, or the inflow to Grant Lake reservoir, whichever is less. If the inflow is less than the dry year instream flow requirements, then dry year base flow requirements apply.

Channel Maintenance Flows: Allow peak flow to pass through Grant Lake.

- Since facilities cannot provide the desired channel maintenance flows, Grant Lake will be made to spill as early as possible to pass through the impaired peak flows. Spilling is expected to commence in early May 1997.
- There will be no augmentation from Lee Vining Creek.
- The streamflow ramping rate will not be controlled by LADWP facilities, rather it will be the similar to the impaired flow fluctuation.
- Ramping of LADWP facilities for export will be the greater of 10% or 10 cfs.

LEE VINING CREEK

Instream Flows:

	Apr-Sep	Oct-Mar
Flow (cfs)	54	40

Minimum base flows are those specified above or the stream flow at the point of diversion, whichever is less.

Channel Maintenance Flows: Allow peak flow to pass point of diversion.

- Ramping rate: equal to that of impaired peak flows.

Lee Vining Conduit Diversions:

- With the exception of 25 cfs taken the first three days in April 1997, there are no planned diversions in the Lee Vining Conduit.

WALKER AND PARKER CREEKS

Instream Flows:

	Apr-Sept	Oct-Mar
Parker Creek (cfs)	9	6
Walker Creek (cfs)	6	4.5

Minimum base flows are those specified above or the stream flow at the point of diversion, whichever is less.

Channel Maintenance Flows: Allow peak flow to pass point of diversion.

Lee Vining Conduit Diversions: None

MONO BASIN EXPORTS

Export to the Upper Owens River (cfs):

Apr-June[2]	July-Aug[3]	Sept	Oct-Mar
20	30	25	22

[1] April 1, 1997 forecast.
[2] Diversions to continue until approximately two weeks prior to the anticipated peak flows.
[3] Diversions to resume approximately two weeks after the peak flows.

Grant Lake Operations Model - Statistical Summaries

1997 Runoff Year: Wet-Normal

Daily Flows

	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
	cubic feet/second									ac-ft	cubic feet/second				
Start										46,300					
Min	30	3	5	46	30	0	8	44	52	44,690	47	0	0	60	94
Ave	77	9	13	97	77	0	22	81	103	47,000	69	34	22	68	105
Max	320	27	35	310	320	25	62	319	381	47,580	87	272	30	102	137
End										44,670					

Monthly Average Flows

cubic feet/second	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage (1st of Month)	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
Apr	65	4	8	84	62	4	12	62	74	46,300	83	0	21	60	97
May	122	12	16	139	122	0	28	119	147	47,170	72	72	25	80	120
Jun	231	27	35	227	231	0	62	226	288	47,580	54	179	7	102	124
Jul	153	22	32	209	153	0	54	178	232	47,580	71	131	24	79	118
Aug	76	11	20	100	76	0	31	71	102	47,580	77	24	30	64	109
Sep	53	6	12	74	53	0	18	50	68	47,580	72	3	25	61	101
Oct	45	6	7	63	45	0	13	44	57	47,370	66	0	22	61	98
Nov	41	7	6	69	41	0	13	44	57	47,060	66	0	22	62	99
Dec	39	4	5	56	39	0	9	44	53	47,360	66	0	22	60	97
Jan	36	4	5	49	36	0	8	44	52	47,050	66	0	22	60	97
Feb	34	3	5	46	34	0	8	44	52	46,430	66	0	22	60	97
Mar	30	3	5	46	30	0	8	44	52	45,590	66	0	22	64	101

Monthly Total Flows

acre-feet	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage (Average)	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
Apr	3,888	238	476	5,012	3,666	222	714	3,689	4,403	46,552	4,959	0	1,269	3,590	5,752
May	7,488	738	984	8,547	7,488	0	1,722	7,327	9,049	47,548	4,443	4,421	1,537	4,939	7,398
Jun	13,756	1,607	2,083	13,513	13,756	0	3,689	13,473	17,162	47,580	3,233	10,676	436	6,070	7,398
Jul	9,420	1,353	1,968	12,879	9,420	0	3,320	10,965	14,286	47,580	4,378	8,075	1,488	4,858	7,268
Aug	4,669	676	1,230	6,179	4,669	0	1,906	4,386	6,292	47,580	4,735	1,496	1,845	3,935	6,702
Sep	3,154	357	714	4,423	3,154	0	1,071	2,950	4,021	47,544	4,280	154	1,484	3,630	6,006
Oct	2,767	369	430	3,874	2,767	0	799	2,705	3,505	47,220	4,058	0	1,353	3,751	6,026
Nov	2,440	417	357	4,106	2,440	0	774	2,618	3,392	47,205	3,927	0	1,309	3,689	5,891
Dec	2,398	246	307	3,443	2,398	0	553	2,705	3,259	47,210	4,058	0	1,353	3,689	5,964
Jan	2,214	217	288	3,013	2,214	0	505	2,705	3,211	46,750	4,058	0	1,353	3,689	5,964
Feb	1,888	167	260	2,555	1,888	0	427	2,444	2,871	46,025	3,666	0	1,222	3,332	5,387
Mar	1,845	184	296	2,828	1,845	0	480	2,705	3,186	45,125	4,057	0	1,352	3,935	6,209
Apr-Sep	42,374	4,969	7,454	50,552	42,152	222	12,423	42,790	55,213		26,027	24,822	8,059	27,021	40,525
Oct-Mar	13,551	1,600	1,940	19,819	13,551	0	3,539	15,884	19,423		23,825	0	7,941	22,086	35,442
Annual Total	55,926	6,568	9,393	70,372	55,703	222	15,962	58,674	74,636		49,852	24,822	16,000	49,107	75,967

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August 6, 1997

To Enclosed Distribution List:

Update on Mono Basin Operations during runoff year 1997-98

Although in the field of hydrology there is no such thing as a "normal" year, this year has been extremely unusual – a year of extremes. A warm, high elevation rain on snow event in early January triggered unseasonably high peak flows on all Mono Basin creeks. During this storm period, record setting peak flows were measured on all four Mono Basin Creeks gauged by LADWP. Instantaneous peaks of 740 cfs (estimated) were recorded on Lee Vining Creek, 318 cfs on Rush Creek, 94 cfs on Parker Creek, and 53 cfs on Walker Creek. All January peaks were well in excess of the "peak" flows that came later in the spring when stream hydrographs normally peak in the eastern Sierra Nevada. In contrast to the extremely wet December-January period, the subsequent February-May period was extremely dry, easily setting a new record as the driest in the eastern Sierra Nevada. During this extremely dry four month period, precipitation totals on the Sierra Nevada east slope measured only 14 percent of normal.

As a result of the juxtaposed extremes this winter, forecasting runoff proved to be a more challenging task than usual this year. Forecasting techniques, in general, are reasonably accurate in determining the volume of water that will runoff over the course of the year but are less accurate when trying to determine the distribution of runoff throughout the year and the magnitude, duration, and timing of peak flows. Using the best data available and applying accepted methodology proved inadequate to reasonably predict on April 1 the magnitude and timing of the peak flows this year. The extreme events that characterized this year's hydrology, exemplify the difficulties in accurately forecasting peak flow events and monthly runoff distributions weeks and months in advance. Some reasonable assumptions can be made as to when the high flows will most likely occur, but with limited certainty. Weather conditions, which vary from day to day and season to season, play a major role on the timing and magnitude of peak flows. This variability makes it difficult to accurately forecast peaks and necessitates flexibility in the operation of the facilities.

The following is a summary of LADWP's operations to date in the Mono Basin this runoff year.

- Lee Vining Creek: As proposed in the April 23, 1997 *Mono Basin Operations Guidelines for Runoff Year 1997-98,* no water has been diverted from Lee Vining Creek and LADWP has no plans to divert any additional water from the creek this runoff year. However, if LADWP goes forward with its plan to rehabilitate the Mono

Gate Return Ditch and it becomes necessary to augment the spill from Grant Lake, water may be diverted from Lee Vining Creek.

Three peaks occurred on Lee Vining Creek this season. The first peak occurred May 16 with a magnitude of 294 cfs (average daily) which was very close to that which was forecasted. The second peak occurred May 31 with a magnitude of 377 cfs. The third peak occurred June 19 with a magnitude of 287 cfs. (See attached hydrograph.)

- Walker Creek: The creek experienced a peak flow of 34 cfs (average daily) on June 1. (See attached hydrograph.) There have been no diversions from the creek and none are planned or anticipated.

- Parker Creek: The creek experienced a peak flow of 48 cfs (average daily) on June 20. (See attached hydrograph.) Irrigation diversions above the Lee Vining Conduit (conduit) began in early May and were discontinued June 3 in anticipation of passing the peak flow. Irrigation diversions above the conduit resumed on July 3.

  Unauthorized irrigation occurred below the conduit when a lessee diverted water which was overflowing the banks of the creek during a high flow event. As soon as personnel became aware of the activity, LADWP took action to cease the irrigation and restore the flow to the creek. The lessee was reprimanded and warned that continued unauthorized irrigation activities would result in termination of his lease.

- Rush Creek: Grant Lake's elevation on April 1, 1997 was 7,129.2 ft amsl, 0.80 feet below the lip of the spillway, providing the opportunity to spill and pass the peak this year. To promote the spill, releases through the return ditch have been maintained at a minimum level. A peak inflow into Grant Lake (Rush Creek at Damsite) of 310 cfs was forecasted to occur the week of June 22. On May 5 the reservoir began to spill. Water export to the Owens River was initiated on April 2 and ramped up to 25 cfs before being discontinued on June 6 in anticipation of passing the peak flow. Rush Creek at Damsite experienced a double peak this year, both relatively low in magnitude and both occurring early in the season. The first occurred on May 16 with a magnitude of 209 cfs (average daily). The second occurred June 1 measuring 211 cfs (average daily). It is estimated that lower Rush Creek experienced a high flow of approximately 172 cfs – combined flows of Grant Lake spill plus Mono Gate Return Ditch. Lower Rush Creek below the narrows experienced a high flow of approximately 226 cfs.

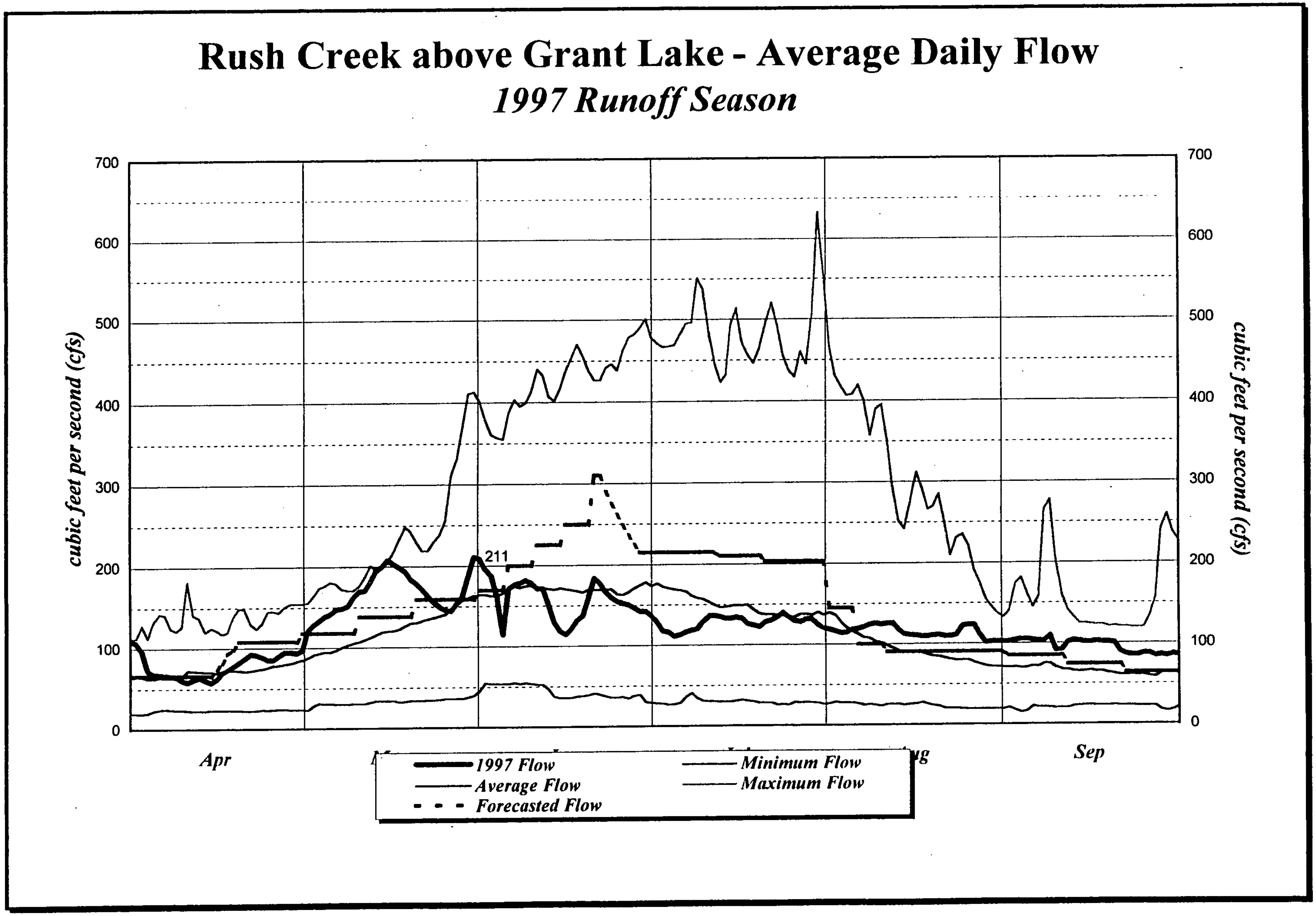
- Mono Basin Export: As discussed above, water exports from the Basin were initiated on April 2 and terminated on June 6 as proposed in the April 23 guideline. To date, export for the year totals 2,800 acre feet. (See attached mass diagram.) Exports have been curtailed since June 6 to facilitate rehabilitation of the return ditch. A decision to proceed this year with the rehabilitation work is anticipated later this week. In the event the work is not done this year, export from the Basin will resume immediately, averaging 28 cfs for the remainder of the runoff year (through March 1998).

If you have any questions regarding operations, please contact Jim Perrault. He can be reached at (213) 367-1119.

Sincerely,

Peter Kavounas / JRP

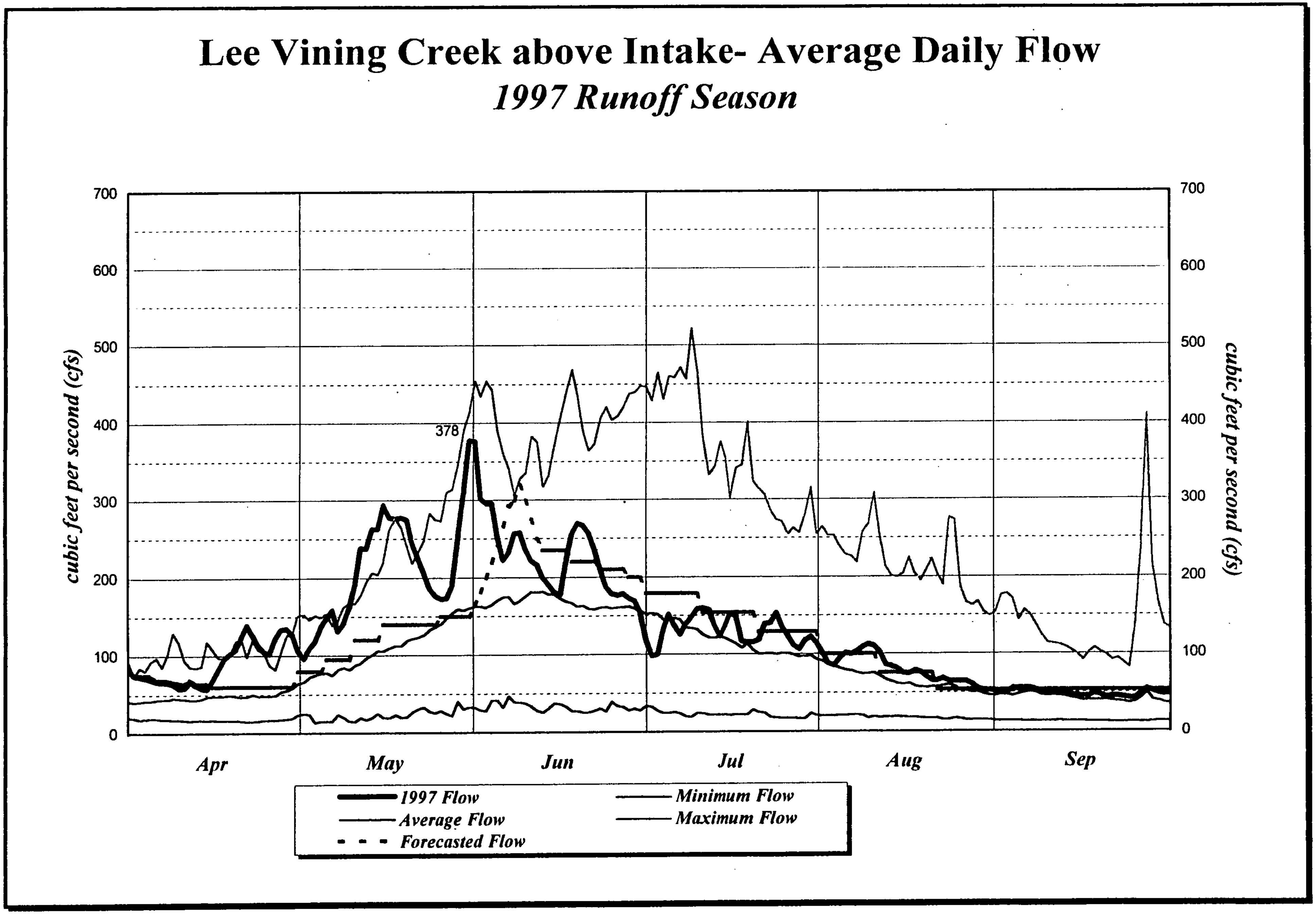
Peter Kavounas



Preliminary data, subject to revision.

Courtesy Los Angeles Department of Water and Power

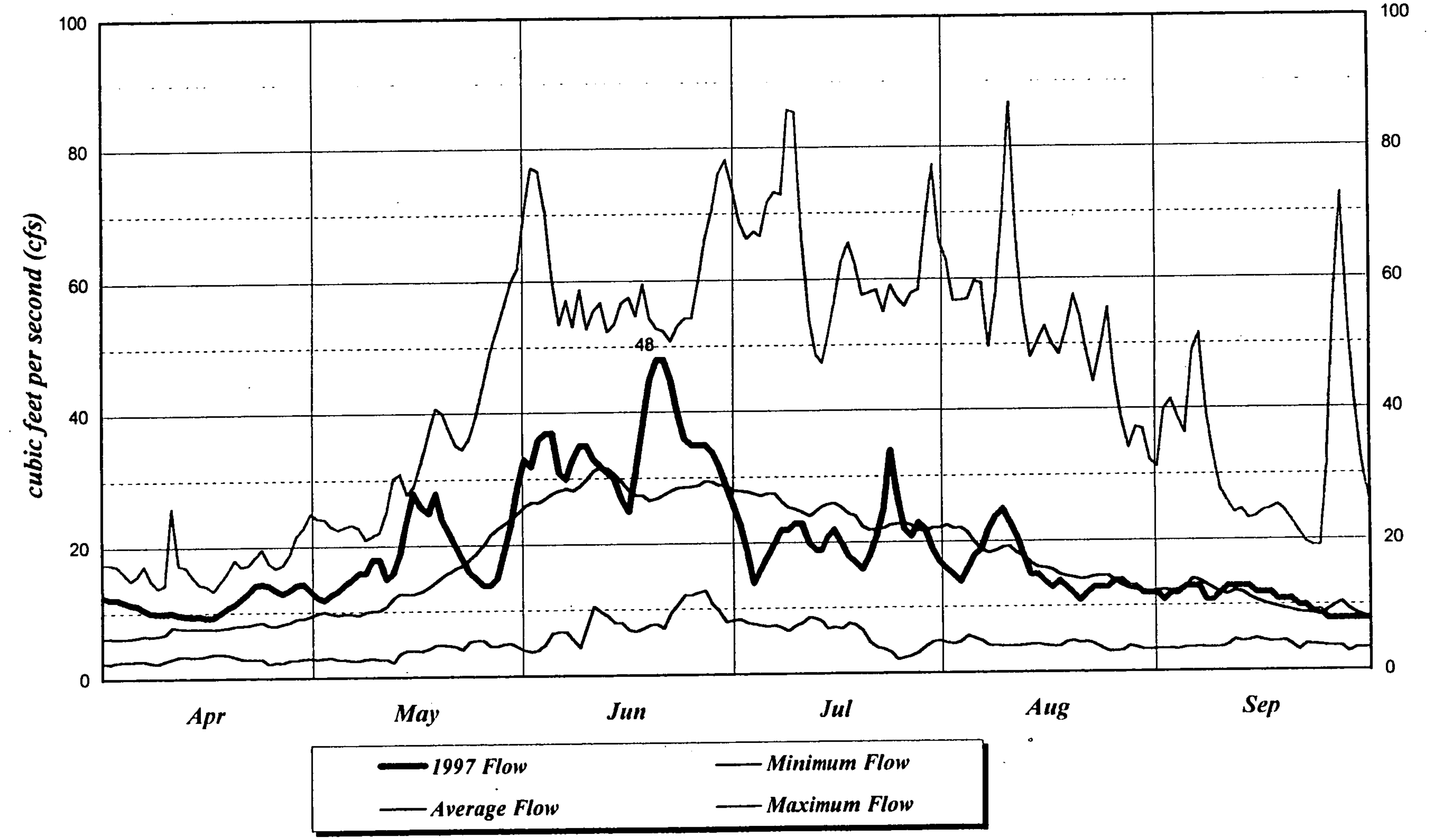
Data as of 4/8/99



Preliminary data, subject to revision. Courtesy Los Angeles Department of Water and Power Data as of 4/8/99

Parker Creek above Conduit- Average Daily Flow

1997 Runoff Season



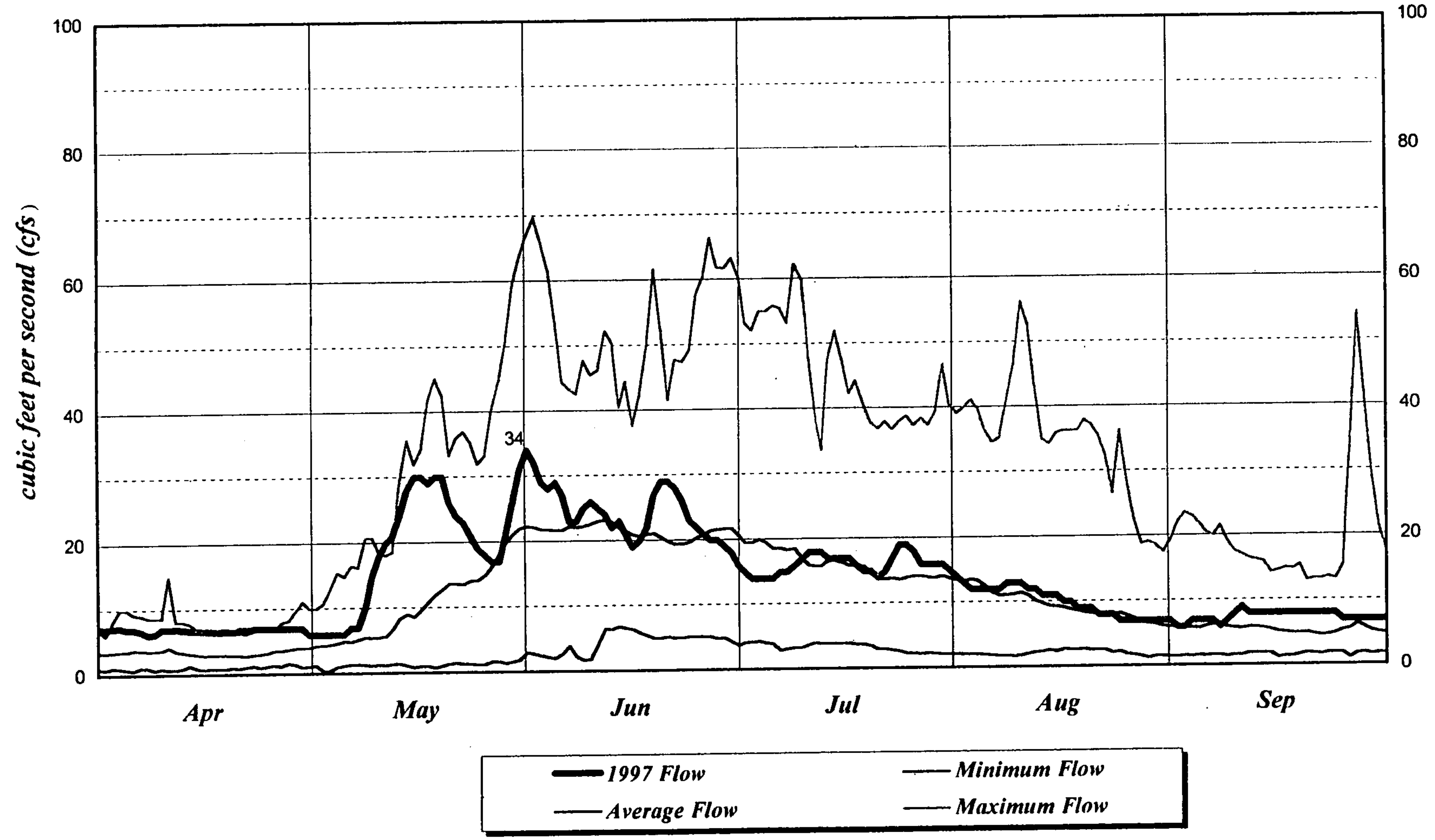
Preliminary data, subject to revision.

Courtesy Los Angeles Department of Water and Power

Data as of 4/8/99

Walker Creek above Conduit- Average Daily Flow

1997 Runoff Season

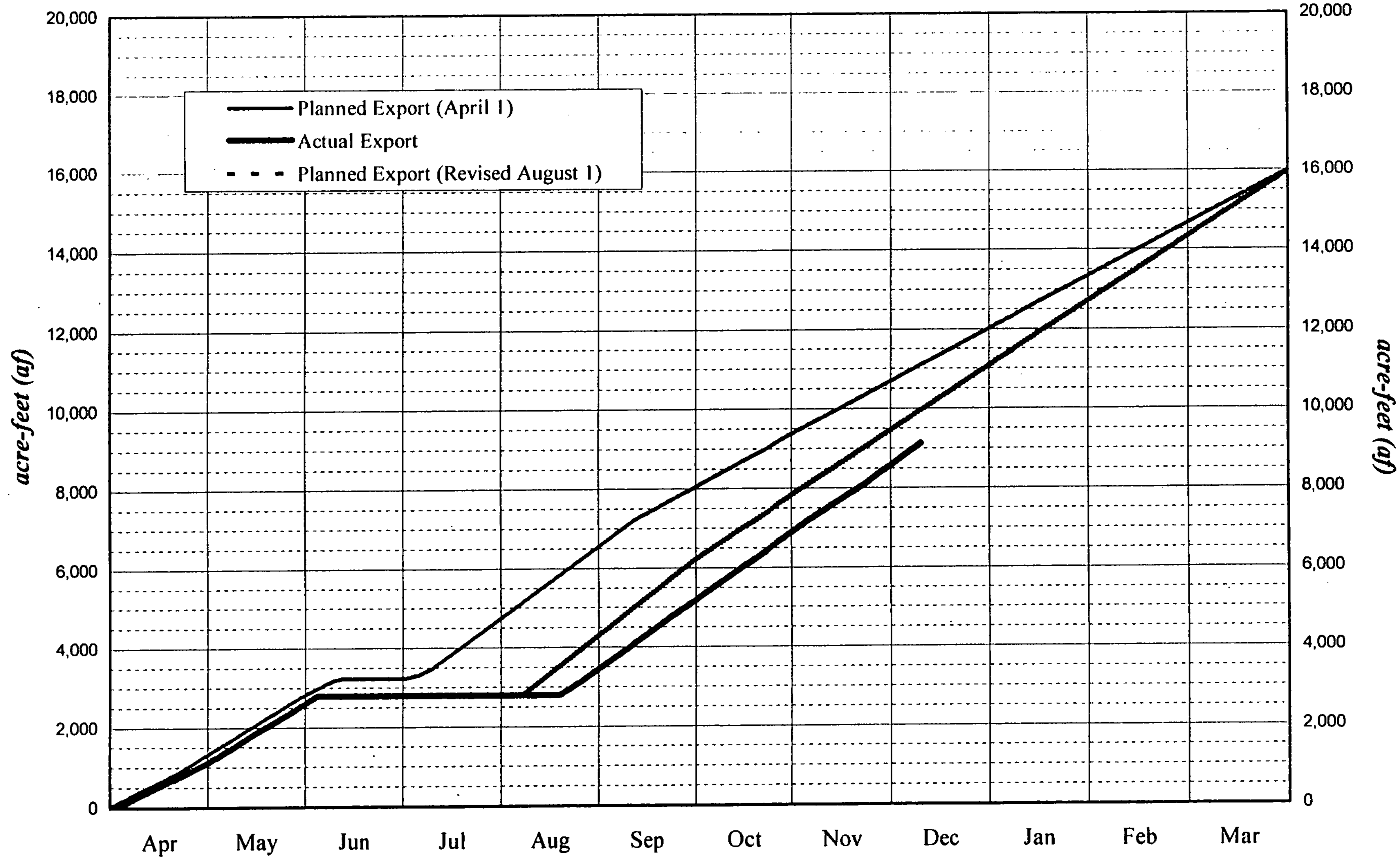


Preliminary data, subject to revision.

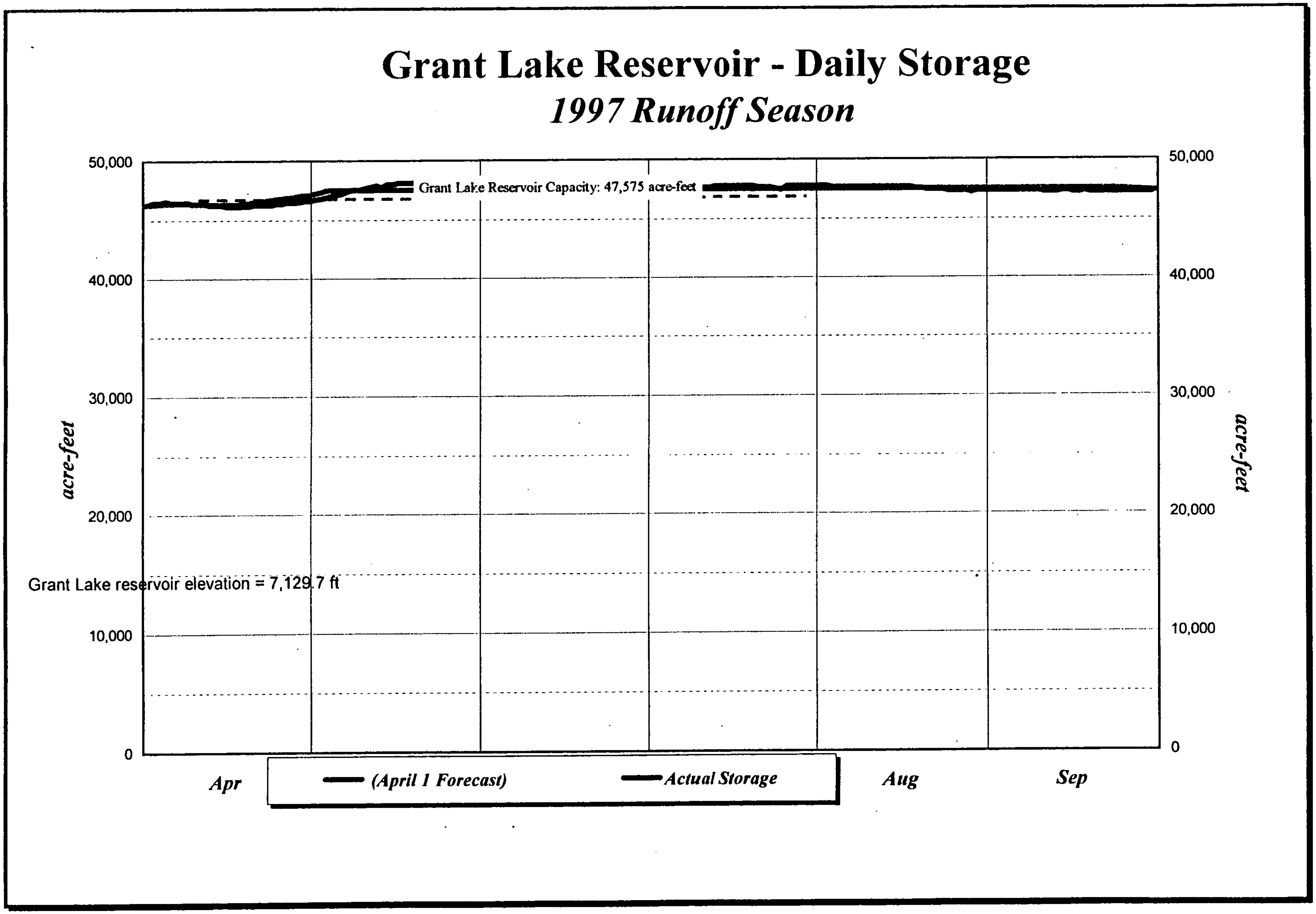
Courtesy Los Angeles Department of Water and Power

Data as of 4/8/99

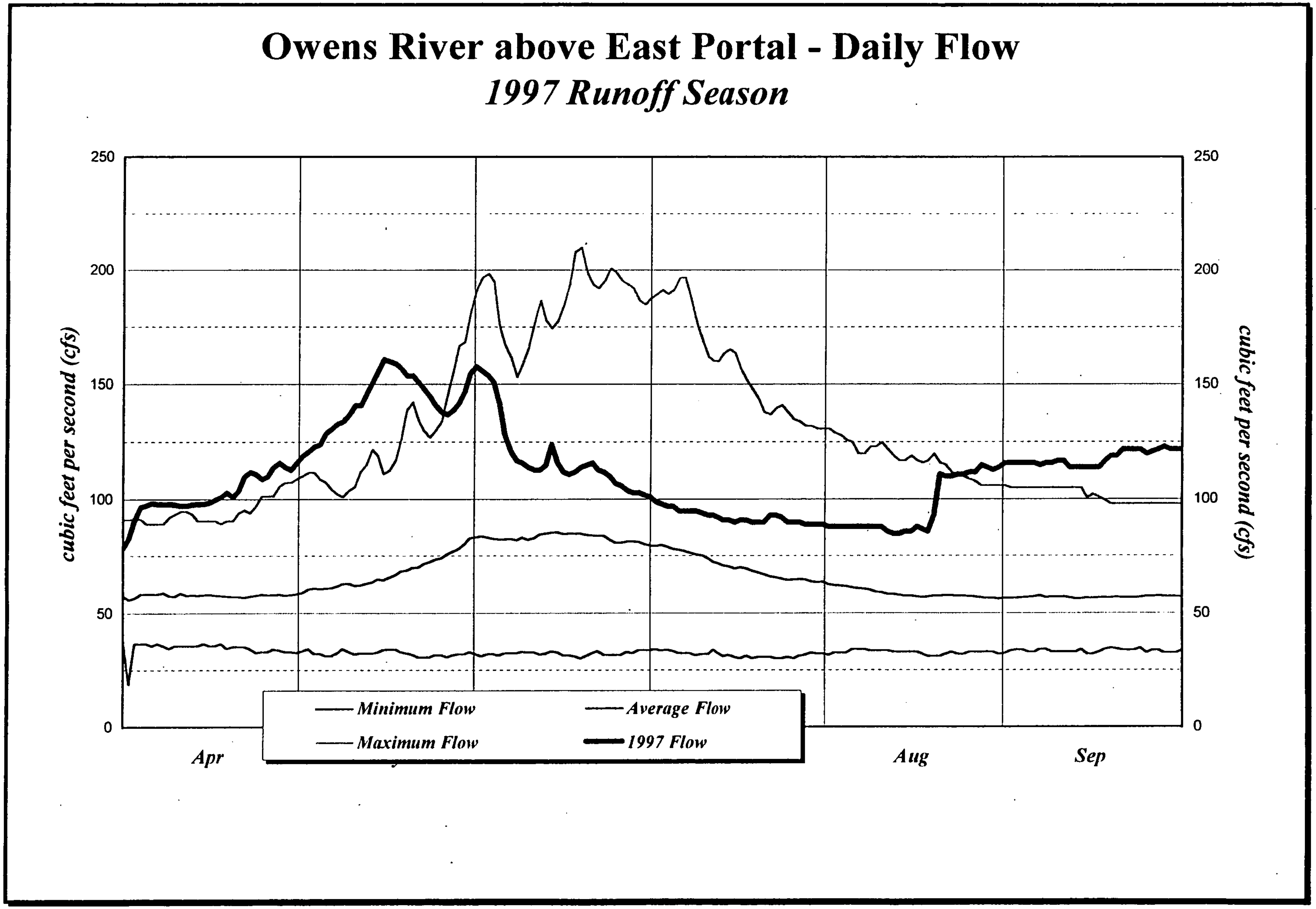
Mono Basin Cumulative Daily Export
1997 Runoff Year



Preliminary data, subject to revision. Courtesy Los Angeles Department of Water and Power Data as of 4/8/99



Courtesy Los Angeles Department of Water and Power



Courtesy Los Angeles Department of Water and Power

PETER KAVOUNAS, *Mono Basin Restoration Manager*
Los Angeles Department of Water and Power
111 N. Hope St., Room 1469
Los Angeles CA 90012
(213) 367-1032; FAX (213) 367-1128

April 22, 1998

To Enclosed Distribution List:

Mono Basin Operations Guideline for Runoff Year 1998-99

Mono Basin runoff[1] for the year is forecasted to be 163,800 acre-feet or 134 % of normal[2]. As defined by Decision 1631 year-type designations, this year is a "normal" year. On April 1, 1998, Mono Lake's water surface elevation measured 6383.0 ft. amsl and storage in Grant Lake Reservoir was 39,940 acre-feet (85% of capacity).

The attached is an outline of the proposed guideline for Los Angeles Department of Water and Power (LADWP) operations in the Mono Basin for the runoff year 1998-99. The guideline was developed on the following principles:

1. *Meet Decision 1631 minimum flows throughout the year.* Decision 1631 is in place and dictates the minimum flows that must be met in each stream. LADWP intends to meet the minimum flows or provide flow-through conditions throughout the year.

2. *Pass peak flows through LADWP facilities in Rush Creek.* Decision 1631 also requires LADWP to release specific channel maintenance flows in Rush Creek. To meet these requirements LADWP's facilities need to be rehabilitated as described in the restoration plans submitted to the State Water Resources Control Board (SWRCB) in February 1996. Without these facilities in place, LADWP intends to make every effort to allow the impaired peak flows to pass downstream of Grant Lake unimpeded. Exports from the Mono Basin will commence after peak flows in Rush Creek have passed to provide the highest peak possible.

3. *Spill Grant Lake as soon as possible.* Until Grant Lake begins to spill, outflow will be limited to the required minimum instream flows to allow storage levels to rise as quickly as possible. Spill conditions are forecasted to commence in late May. A full reservoir will allow any early (false) peak flow events to also pass unimpeded.

4. *Pass peak flows through LADWP facilities in Parker, Walker, and Lee Vining creeks.* The Lee Vining, Walker and Parker creek flow requirements will be met by providing flow-through conditions. There are no planned diversions

[1] Based on the April 1, 1998 runoff forecast.
[2] Using the 1941-1990 average of 122,124 acre-feet.

into the Lee Vining Conduit from any of the three creeks, and no irrigation diversions from either Walker or Parker creeks during peak flows. In the event that flows exceed the capacity of downstream culverts at Highway 395 and it becomes necessary to attenuate the flows, LADWP will divert portion of the flows as necessary.

5. *No diversions from Lee Vining Creek.* Since Grant Lake storage is at relatively high levels at the start of the year and the expected operations will maintain that into the following year, LADWP is not planning on diverting any Lee Vining Creek water into the Lee Vining Conduit during runoff year 1998-99.

6. *Export 16,000 ac-ft from the basin.* As allowed by Decision 1631, LADWP will export its full entitlement. Water will be exported from the basin at a constant rate after Rush Creek channel maintenance flows have been allowed to pass.

7. *Maximize Grant Lake storage at the end of runoff year.* As described in No. 2 above, facility modifications (specifically the rehabilitation of the Mono Gate Return Ditch, which will require Grant Lake to be spilling) will need to be performed as soon as practical. LADWP anticipates that it may be possible to perform the work on the Return Ditch in the next runoff year (1999-2000). To prepare for such an eventuality, LADWP is planning to maximize the storage in Grant Lake at the end of the 1998-99 runoff year.

A copy of the Statistical Summary output of GLOM is attached in addition to the operations guideline. This summarizes the "educated guess" of distribution of monthly flows in Mono Basin streams and LADWP facilities for the 1998-99 runoff year. These do not represent minimum or maximum flows, or targets of any kind; they merely reflect a possible scenario of the flow distribution in the basin, assuming climatic conditions, subsequent to the forecast date, are average. The actual flows will likely be different.

The values of expected magnitude and timing of the peak flows in Rush, Parker, Walker, and Lee Vining creeks were generated by a predictive model, and are as follows:

	Peak flow magnitude (cfs)	Timing
Rush Creek (@ Damsite)	340	June 25
Parker Creek (above LV Conduit)	60	June 18
Walker Creek (above LV Conduit)	50	June 13
Lee Vining Creek	360	June 11

The prediction model uses regression analysis of historical data to predict future events. Since the values are primarily a function of future ambient temperatures that are difficult to accurately predict with any degree of certainty, it is more than likely that the values in the above table are not accurate. It is intended that they are used as an indicator of magnitude and timing of the peak flows. The predictions are based on the April 1, 1998 forecast, and assume median precipitation for the following six months.

Given the most current forecast, and the proposed operations guideline, the elevation of Mono Lake is expected to be approximately 6384.6 ft amsl at the end of the runoff year. This is graphically shown in the attached "Historic and Projected Mono Lake Elevation" graph. The estimate is derived from modeling, and includes a number of assumptions such as normal precipitation conditions for the rest of the year. Once again, the number is to be used as a general indicator, not an absolute fact.

The proposed operations for the 1998-99 runoff year do not follow the guidelines set in GLOMP, nor are they to be interpreted as an indicator of operations in future years. They are to deal with current hydrologic circumstances and facility limitations, while the SWRCB is in the process of evaluating the LADWP restoration plans. Further, the actual operations may differ from the plans to accommodate unforeseen circumstances.

The LADWP welcomes any comments by interested parties to the proposed operations guideline. A conference call to receive comments is scheduled for Monday, May 4, at 1:00 p.m. Interested parties are encouraged to call Mr. Steve McBain at (213) 367-0963 and arrange their participation.

Sincerely,

ORIGINAL SIGNED BY

Peter Kavounas

Attachments

RUNOFF YEAR 1998-99 MONO BASIN OPERATIONS GUIDELINE

Hydrologic Year Type: Normal
Forecasted Volume of Runoff[1]: 163,800 acre-feet

LOWER RUSH CREEK

Instream flows:

	Apr-Sept	Oct-Mar
Flow (cfs)	47	44

Minimum base flows are those described above, or the inflow to Grant Lake reservoir, whichever is less. If the inflow is less than the dry year instream flow requirements, then dry year base flow requirements apply.

Channel Maintenance Flows: Allow peak flow to pass through Grant Lake.

- Since facilities cannot provide the desired channel maintenance flows, Grant Lake will be made to spill as early as possible to pass through the impaired peak flows. Spilling is expected to commence in late May 1998.
- There will be no augmentation from Lee Vining Creek.
- The streamflow ramping rate will not be controlled by LADWP facilities, rather it will be similar to the impaired flow fluctuation.
- Ramping of LADWP facilities for export will be the greater of 10% or 10 cfs.

LEE VINING CREEK

Instream Flows:

	Apr-Sept	Oct-Mar
Flow (cfs)	54	40

Minimum base flows are those specified above or the stream flow at the point of diversion, whichever is less.

Channel Maintenance Flows: Allow peak flow to pass point of diversion.

- Ramping rate: equal to that of impaired peak flows.

Lee Vining Conduit Diversions:

- There are no planned diversions into the Lee Vining Conduit.

WALKER AND PARKER CREEKS

Instream Flows:

	Apr-Sept	Oct-Mar
Parker Creek (cfs)	9	6
Walker Creek (cfs)	6	4.5

Minimum base flows are those specified above or the stream flow at the point of diversion, whichever is less.

Channel Maintenance Flows: Allow peak flow to pass point of diversion.

Lee Vining Conduit Diversions: None

MONO BASIN EXPORTS

Export to the Upper Owens River (cfs):

Apr-Aug[2]	Sept-Mar
0	38

[1] April 1, 1998 forecast.
[2] No planned diversions prior to September 1, 1998.

Grant Lake Operations Model - Statistical Summaries

1998 Runoff Year: Normal

Daily Flows

	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
	cubic feet/second									ac-ft	cubic feet/second				
Start										39,940					
Min	28	4	5	43	28	0	9	49	58	39,770	52	0	0	67	82
Ave	88	11	15	107	88	0	26	91	117	45,612	73	41	22	79	116
Max	360	48	57	337	360	0	88	348	418	47,580	90	296	38	126	141
End										39,700					

Monthly Average Flows

cubic feet/second	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage (1st of Month)	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
Apr	66	4	8	91	66	0	13	52	65	39,940	52	0	0	67	82
May	150	14	21	116	150	0	35	55	90	42,940	52	3	0	91	106
Jun	276	30	40	252	276	0	70	259	329	47,580	52	207	0	126	141
Jul	177	26	44	257	177	0	70	248	318	47,580	52	196	0	99	114
Aug	95	14	27	92	95	0	41	95	136	47,580	52	43	0	76	91
Sep	61	7	12	98	61	0	19	60	79	47,580	90	8	38	72	125
Oct	67	7	7	111	67	0	14	75	89	47,580	87	26	38	70	123
Nov	35	8	6	82	35	0	14	53	67	47,580	87	4	38	70	123
Dec	32	5	5	50	32	0	10	49	59	47,580	87	0	38	69	122
Jan	31	5	5	43	31	0	10	49	59	45,720	87	0	38	68	121
Feb	31	4	5	47	31	0	9	49	58	43,550	87	0	38	68	121
Mar	28	4	5	44	28	0	9	49	58	41,870	87	0	38	70	123

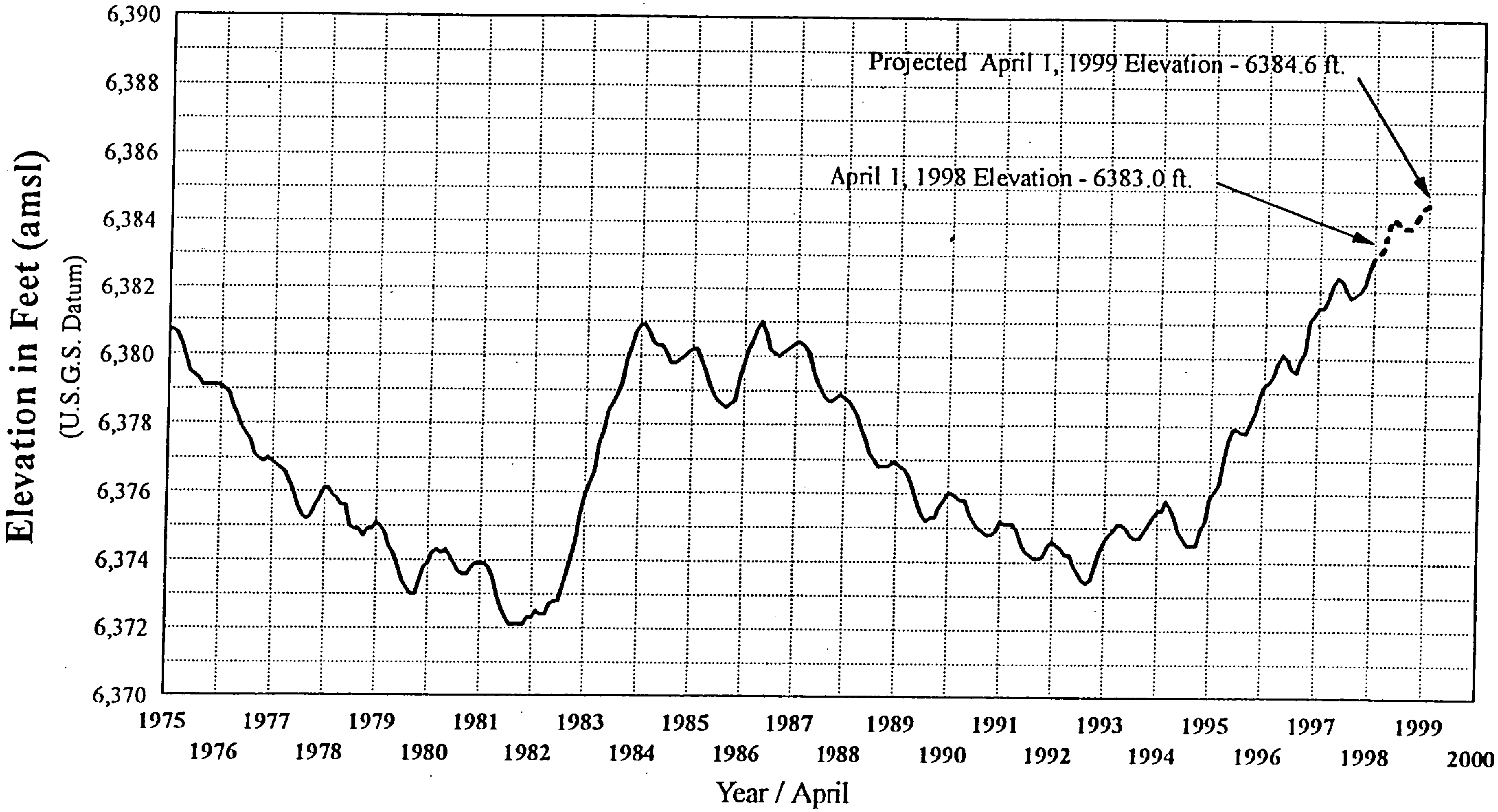
Monthly Total Flows

acre-feet	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage (Average)	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
Apr	3,927	262	500	5,415	3,927	0	762	3,094	3,856	41,390	3,094	0	0	3,987	4,879
May	9,223	861	1,291	7,133	9,223	0	2,152	3,362	5,514	45,335	3,197	164	0	5,595	6,518
Jun	16,408	1,791	2,364	15,007	16,408	0	4,155	15,413	19,568	47,580	3,094	12,318	0	7,498	8,390
Jul	10,883	1,599	2,705	15,803	10,883	0	4,304	15,274	19,578	47,580	3,197	12,076	0	6,087	7,010
Aug	5,841	861	1,660	5,657	5,841	0	2,521	5,838	8,359	47,580	3,197	2,640	0	4,673	5,595
Sep	3,630	417	714	5,831	3,630	0	1,131	3,573	4,703	47,580	5,358	479	2,264	4,284	7,441
Oct	4,120	430	430	6,825	4,120	0	861	4,585	5,445	47,580	5,353	1,572	2,340	4,304	7,566
Nov	2,083	476	357	4,879	2,083	0	833	3,143	3,976	47,580	5,180	227	2,264	4,165	7,322
Dec	1,968	307	307	3,074	1,968	0	615	3,019	3,634	46,680	5,353	6	2,340	4,243	7,505
Jan	1,906	307	288	2,644	1,906	0	596	3,013	3,609	44,670	5,353	0	2,340	4,181	7,443
Feb	1,722	222	260	2,610	1,722	0	483	2,721	3,204	42,740	4,835	0	2,113	3,777	6,723
Mar	1,722	246	296	2,706	1,722	0	542	3,013	3,555	40,785	5,353	0	2,340	4,304	7,566
Apr-Sep	49,913	5,790	9,235	54,846	49,913	0	15,025	46,553	61,578		21,139	27,678	2,264	32,125	39,834
Oct-Mar	13,520	1,989	1,940	22,739	13,520	0	3,929	19,494	23,423		31,425	1,805	13,736	24,974	44,125
Annual Total	63,432	7,779	11,175	77,585	63,432	0	18,954	66,047	85,001		52,564	29,483	16,000	57,099	83,959

16,000 af Export

Historic and Projected Mono Lake Elevation

April 1975 - April 1999



Projected 1998-1999 Mono Lake Elevation

Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
6383.0	6383.1	6383.3	6383.8	6384.2	6384.1	6383.9	6383.9	6383.9	6384.1	6384.3	6384.5	6384.6

PETER KAVOUNAS, *Mono Basin Restoration Manager*
Los Angeles Department of Water and Power
111 N. Hope St., Room 1469
Los Angeles CA, 90012
(213) 367-1032; FAX (213) 367-1128

May 27, 1998

Mr. Edward Anton, Chief
Division of Water Rights
State Water Resources Control Board
901 P Street
Sacramento, CA 95814

Dear Mr. Anton:

Mono Basin Operations Guideline for Runoff Year 1998-1999

On April 22, 1998 we distributed the Los Angeles Department of Water and Power's (LADWP) Mono Basin Operations Guideline for runoff year 1998-1999. The proposed operations plan as outlined in the guideline was based on the April 1 runoff forecast.

Decision 1631 requires that the May 1 forecast be used for the final determination of runoff classification for the year. As shown in the table below, no change in runoff year type classification and a minor change in forecasted runoff volume occurred between the forecast dates.

Forecast Date	1998-1999 Runoff [1]	% of Normal [2]	Year Type
April 1	163,800 af	134 %	Normal
May 1	163,000 af	133 %	Normal
Difference	-800 af	-1 %	

A small magnitude change such as this, does not alter peak flow forecasts or operational assumptions. As a result, the LADWP will follow the operations guidelines during 1998-1999 as set in the April 22 correspondence.

If you have any questions or comments regarding this matter, please call me. I can be reached at (213) 367-1032.

Sincerely,

P. Kavounas

PETER KAVOUNAS

c: Attached distribution list

[1] April 1, 1998 through March 30, 1999.
[2] Based on the 1941-1990 average, 122,124 af.

PETER KAVOUNAS, *Mono Basin Restoration Manager*
Los Angeles Department of Water and Power
111 N. Hope St., Room 1469
Los Angeles CA, 90012
(213) 367-1032; FAX (213) 367-1128

February 3, 1999

To Enclosed Distribution List:

Update on Mono Basin Operations During 1998-99 Runoff Year

The timing of the Mono Basin runoff was nearly four weeks later than predicted and three of the four creeks experienced flow magnitudes which were significantly greater than those forecasted. Walker Creek came close but did not exceed the forecasted flow magnitude. The table below compares April 22nd forecasted magnitudes and timing to the flows that were actually measured:

	Predicted		Measured	
	Magnitude	Timing	Magnitude	Timing
Rush Creek @ Damsite	340 cfs	June 25	519 cfs	July 21
Parker Creek	60 cfs	June 18	79 cfs	July 09
Walker Creek	50 cfs	June 13	47 cfs	July 21
Lee Vining Creek	360 cfs	June 11	451 cfs	July 09

All four of the creeks experienced two peaks. The flows on Walker, Parker, and Lee Vining creeks began to significantly increase during mid June giving the indication that the peak flows were close or actually occurring. The increase in the flow magnitude began to taper off in early July and the flow magnitude experienced on all three creeks had come close to or exceeded that which was predicted. After a review of Lee Vining Creek data, it appeared that the peak occurred on June 26th and a decision was made to begin the augmentation in early July after at least 10 days had passed. On July 9th the Department began the Rush Creek augmentation by ramping Lee Vining Conduit to approximately 50 cfs, maintaining the flow for six days then ramping down to complete the augmentation on July 18th. The augmentation, while the operation went very smoothly, demonstrated the difficulty to accurately predict when peak runoff will most likely occur. Lee Vining Creek experienced its peak flow during the start of the augmentation operation. It also demonstrated the need to have the Mono Gate Return Ditch rehabilitated to its designed capacity to allow the Department operating flexibility for restoration and for timing peak flows events on Rush Creek.

The following is a summary of LADWP's operations to date in the Mono Basin for the 1998-99 runoff year:

- Walker Creek: The creek experienced two peaks. The first peak occurred July 10th with a magnitude of 45 cfs (average daily) and the second peak occurred July 21st with a magnitude of 47 cfs. The second peak exceeds the historic maximum flow for the (average daily.) The second occurred July 22nd with a magnitude of 495 cfs (see attached hydrograph.)

Rush Creek below the confluence of the Mono Gate Return Ditch and Grant Lake spill also experienced two peaks. The first event occurred on July 14th with a magnitude of 501 cfs (average daily.) The spill provided 395 cfs, the Return Ditch 56 cfs, and approximately 50 cfs was from Rush Creek augmentation that was initiated July 9th. The second event occurred July 23rd with a magnitude of 538 cfs (average daily.) The spill provided 483 cfs and the Return Ditch 55 cfs. During the second peak, there was no water being diverted from Lee Vining Creek (see attached hydrograph.)

Rush Creek below the narrows experienced three peaks. The first occurred on July 14th with a magnitude of 592 cfs (average daily), the second occurred July 21st with a magnitude of 597 cfs and the third occurred on July 23rd with a magnitude of 635 cfs (see attached hydrograph.)

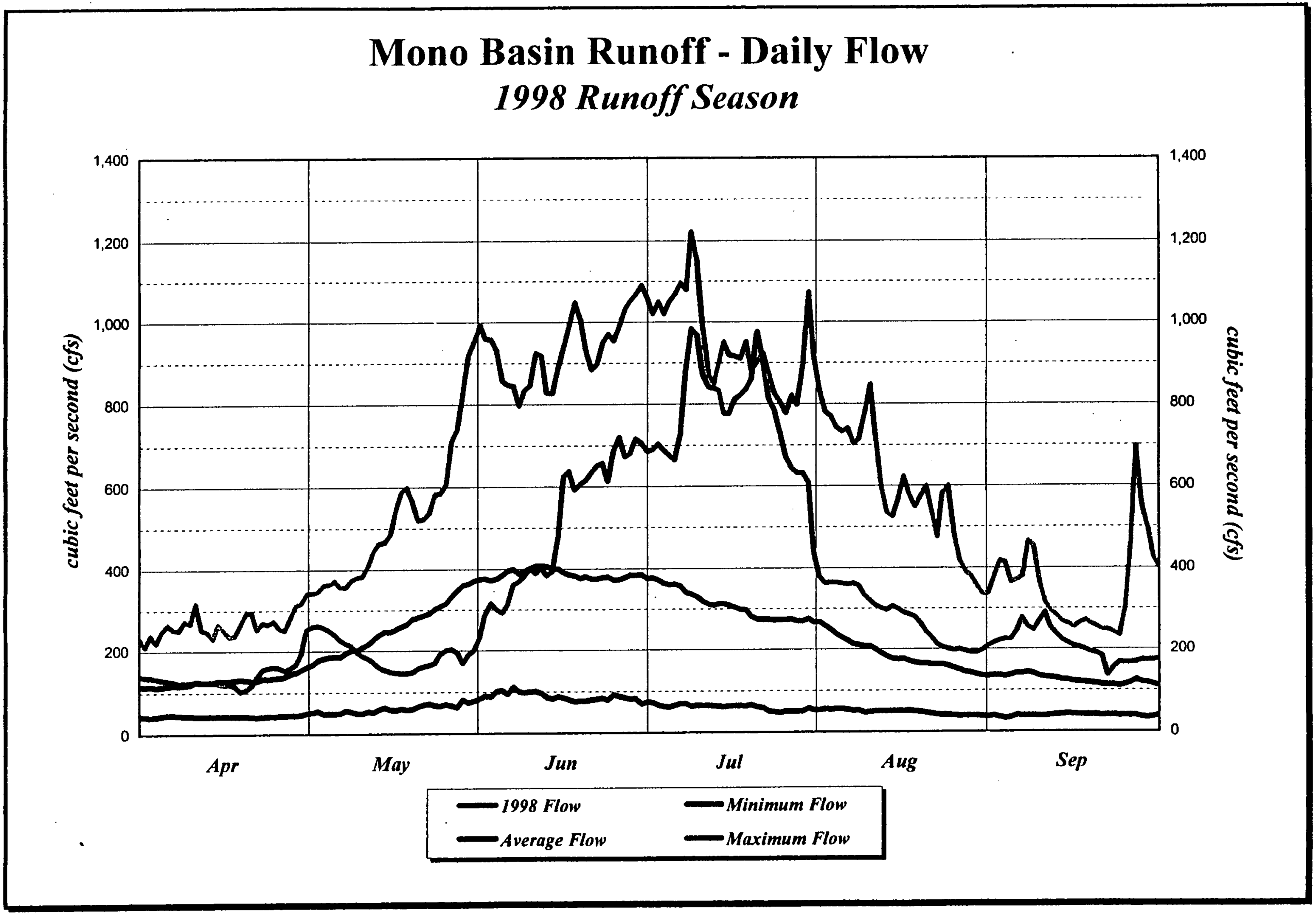
- Grant Lake Reservoir: Releases from the reservoir to Rush Creek were maintained slightly above the minimum and exports were suspended on April 3rd to facilitate a spill. Grant Lake began to spill on June 9th and continued spilling for nearly four months achieving a maximum spill of 483 cfs on July 23rd. The spill ended October 28th (see attached hydrograph.)

- Mono Basin Exports: Exports were suspended in early April to assure a spill and curtailed until the peak had passed on Rush Creek. Exports were resumed on September 9th at an average flow rate of 42 cfs (see attached hydrograph.) The exports will continue through the remainder of the runoff year, and are expected to conclude in late March, 1999.

If you have any questions or need additional information regarding operations, please contact me.

Sincerely,

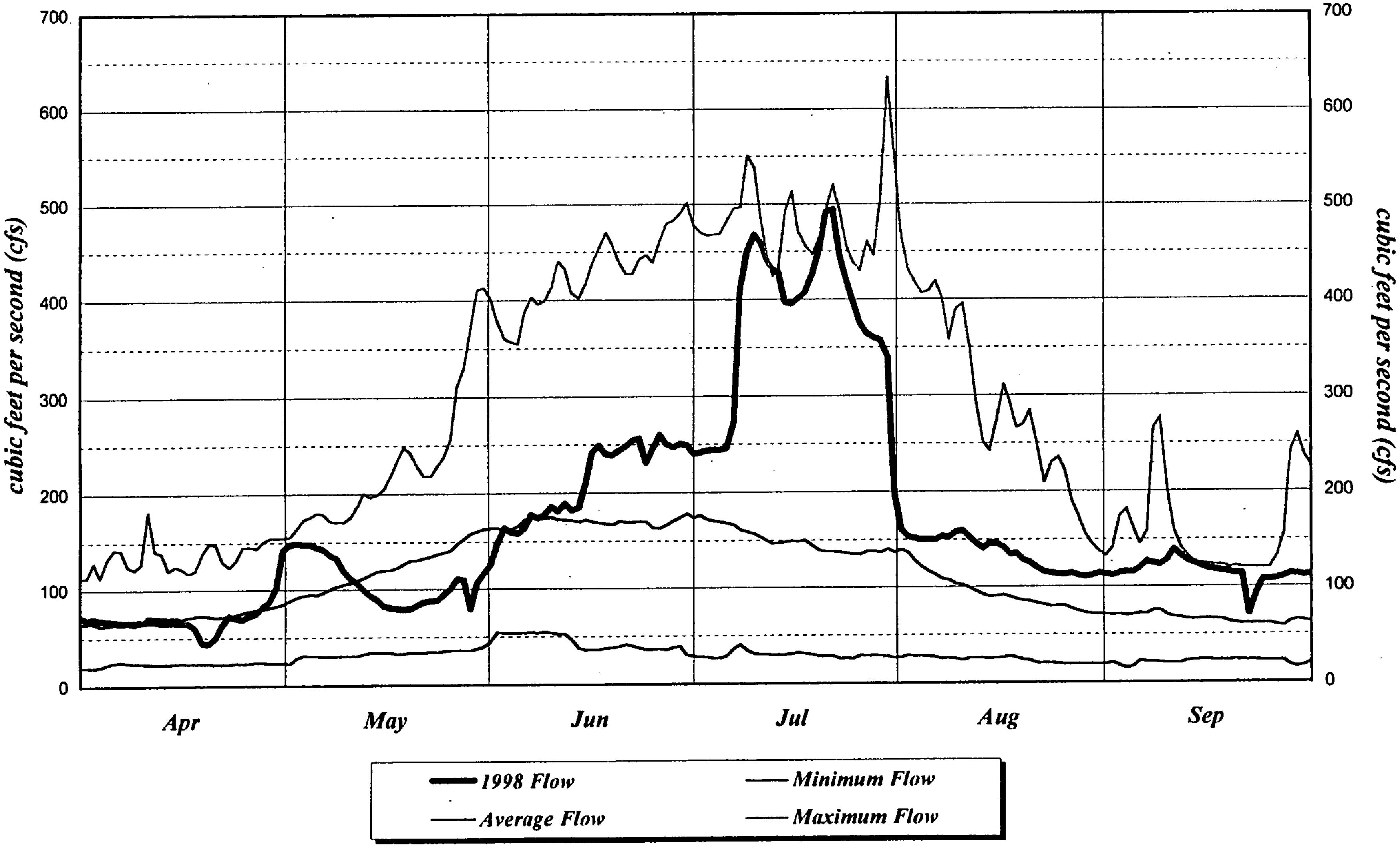
Peter Kavounas
Mono Basin Restoration Manager



Courtesy Los Angeles Department of Water and Power

Rush Creek above Grant Lake - Average Daily Flow

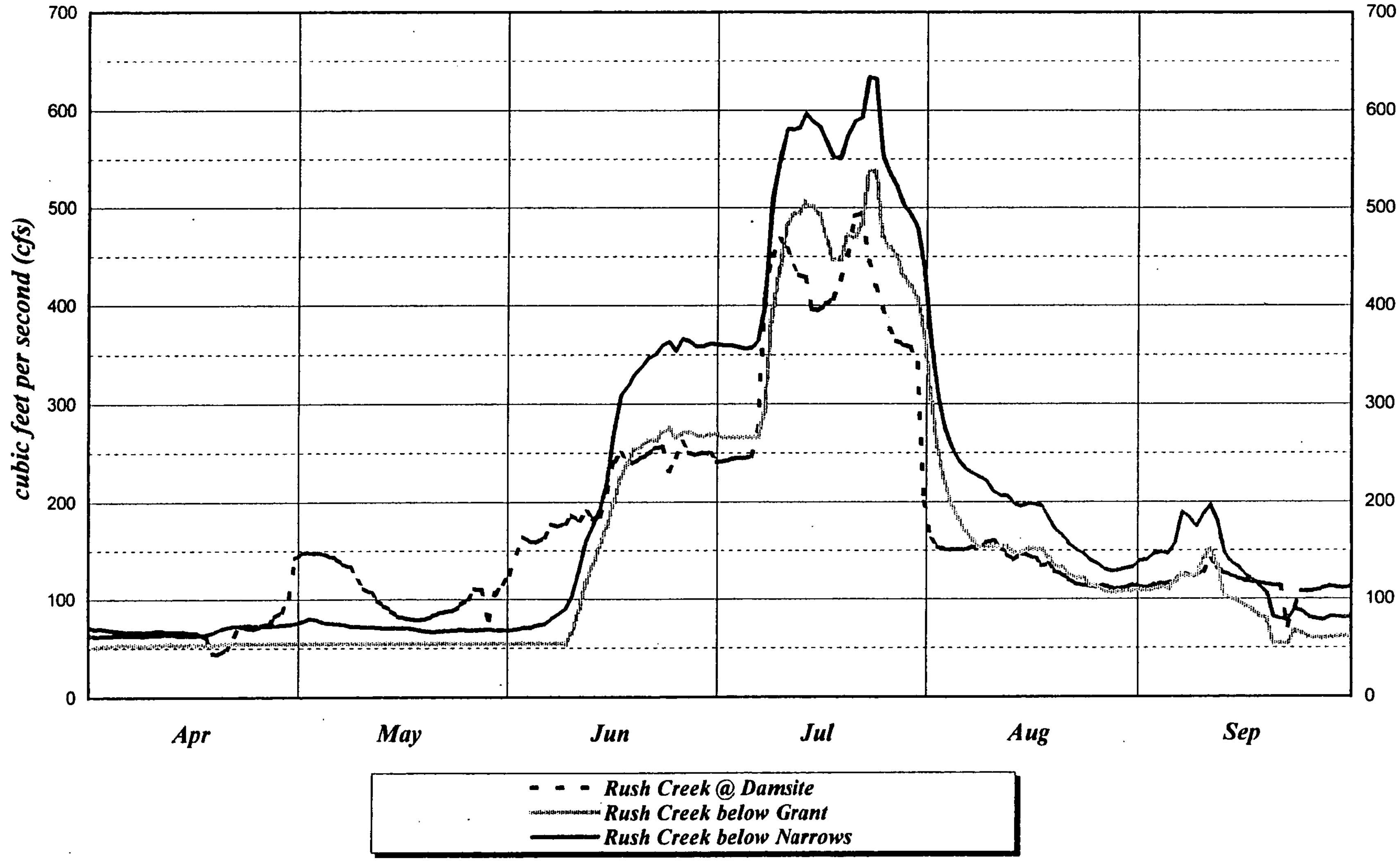
1998 Runoff Season



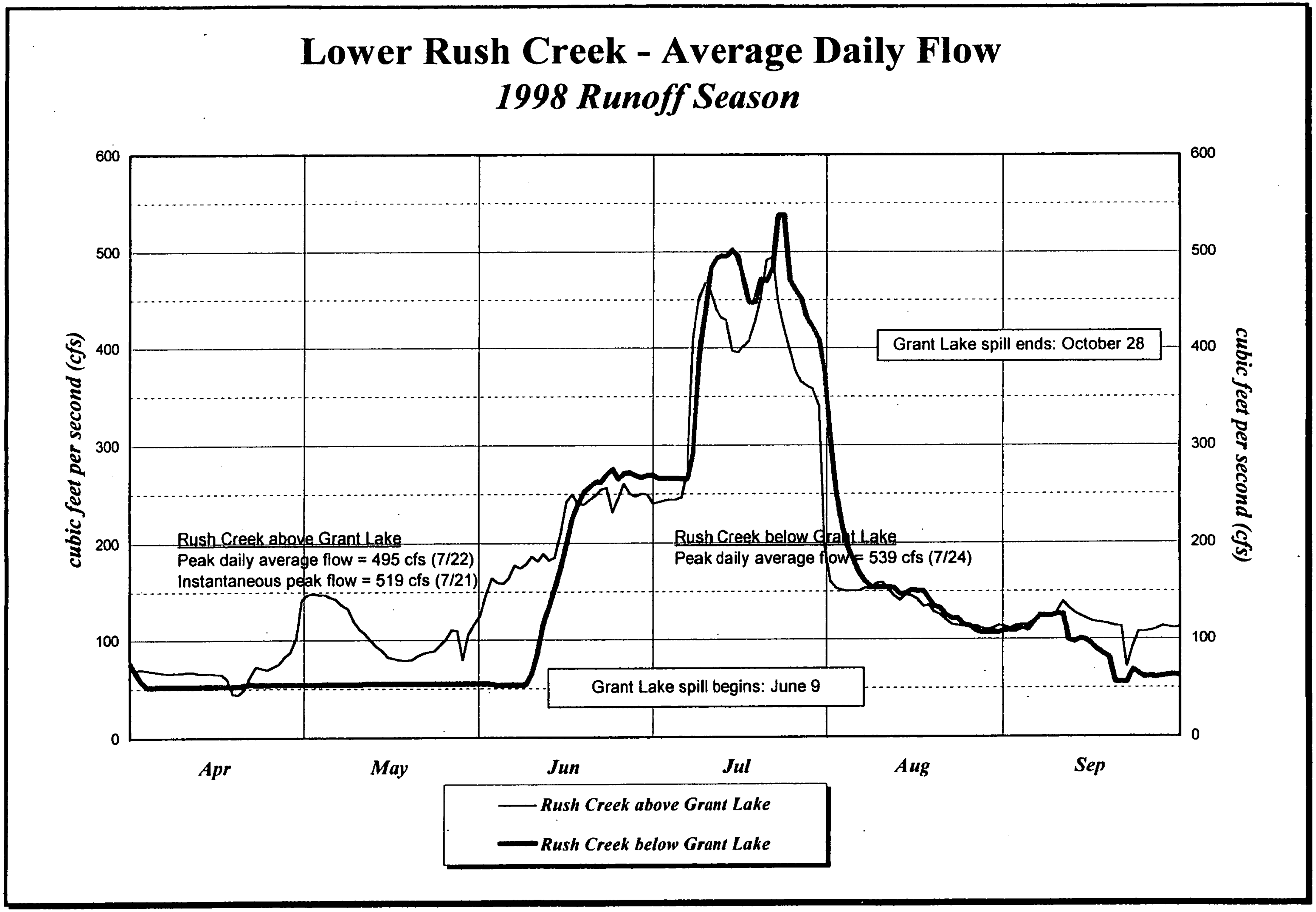
Preliminary data, subject to revision. Courtesy Los Angeles Department of Water and Power Data as of 1/13/99

Rush Creek above & below Grant Lake - Average Daily Flow

1998 Runoff Season

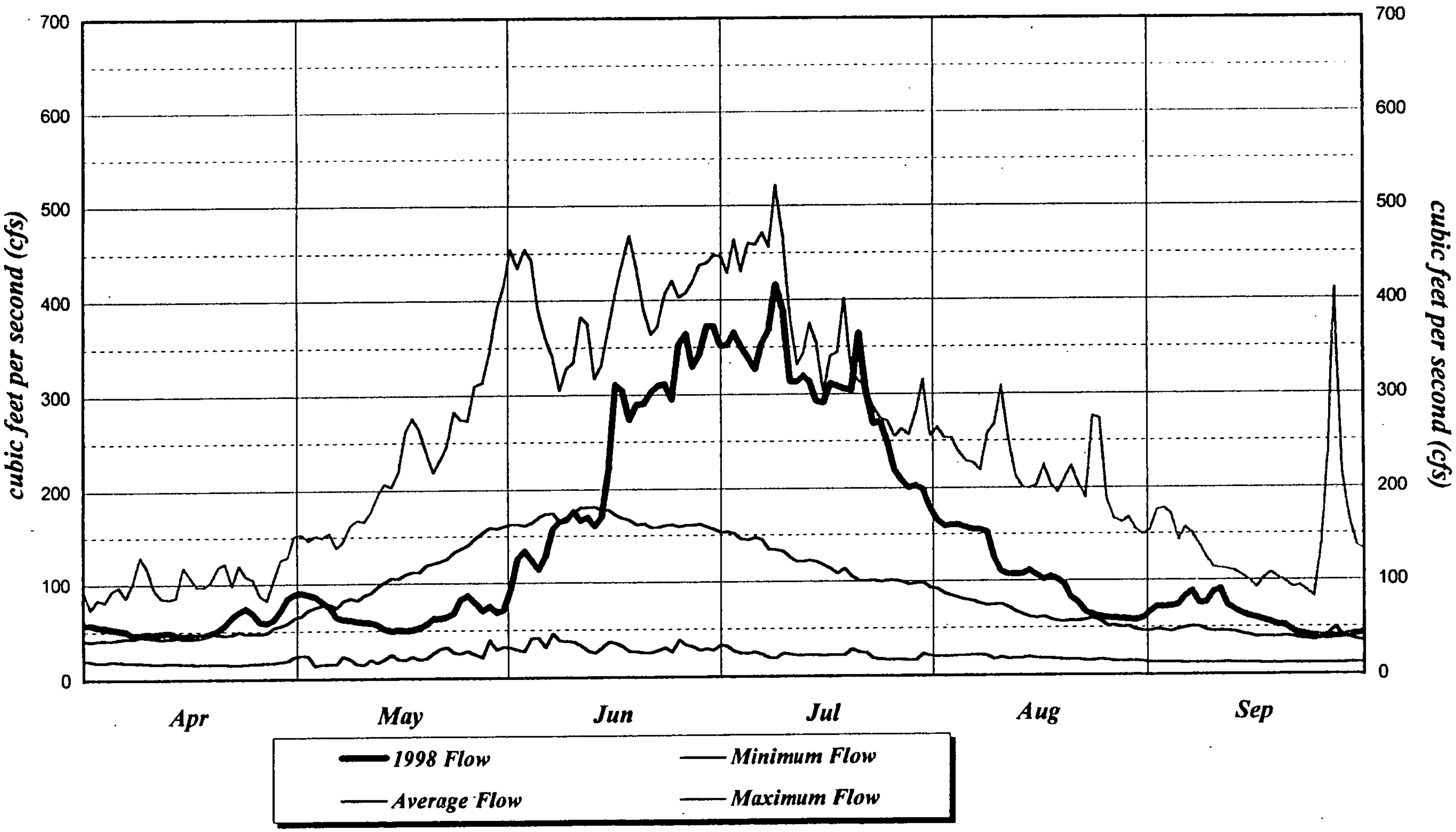


Preliminary data, subject to revision. Courtesy Los Angeles Department of Water and Power Data as of 1/13/99


Lower Rush Creek - Average Daily Flow
1998 Runoff Season
600
500
400
300
200
100
0
cubic feet per second (cfs)
Rush Creek above Grant Lake
Peak daily average flow = 495 cfs (7/22)
Instantaneous peak flow = 519 cfs (7/21)
Rush Creek below Grant Lake
Peak daily average flow = 539 cfs (7/24)
Grant Lake spill ends: October 28
Grant Lake spill begins: June 9
Apr
May
Jun
Jul
Aug
Sep
Rush Creek above Grant Lake
Rush Creek below Grant Lake

Lee Vining Creek above Intake- Average Daily Flow

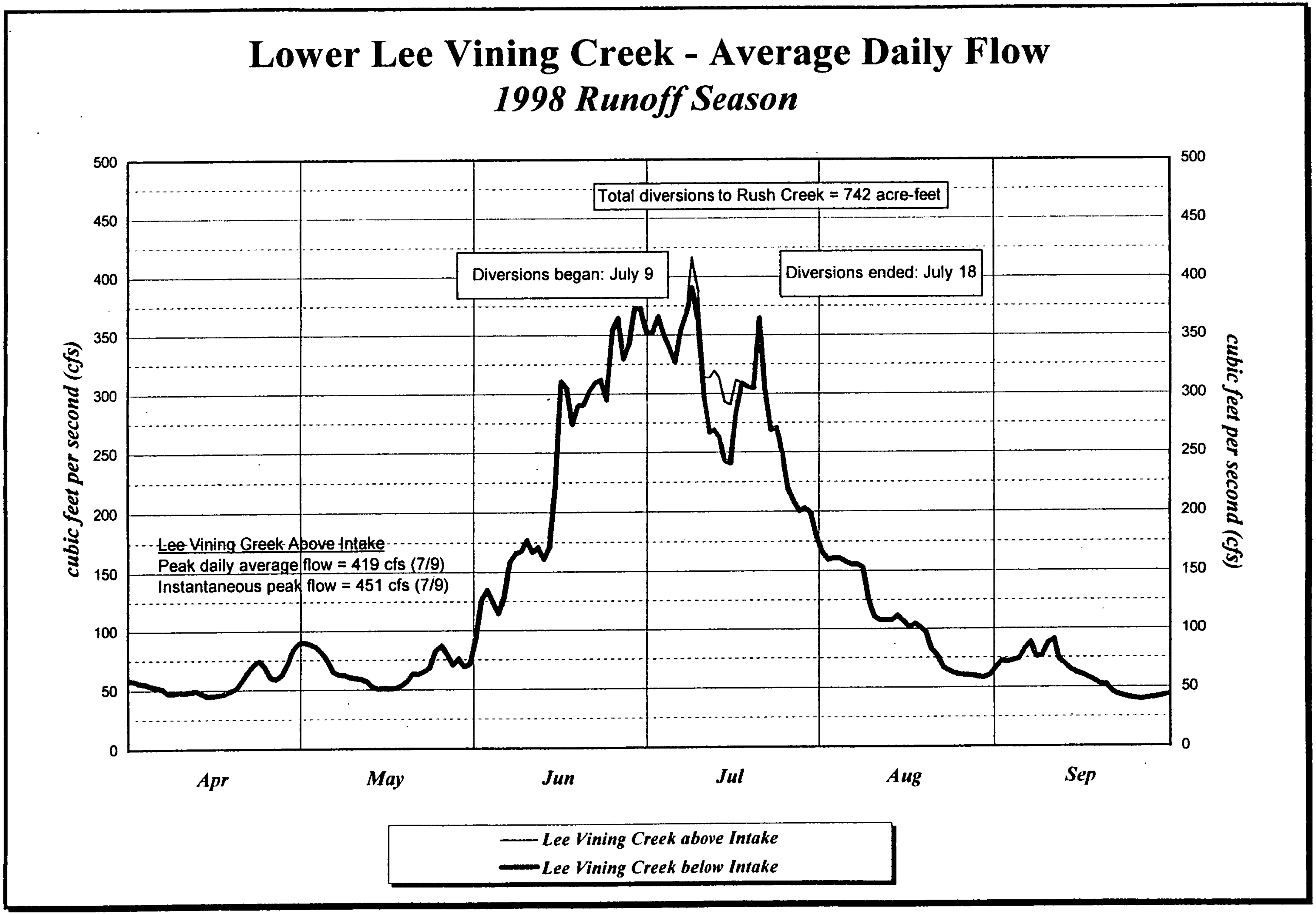
1998 Runoff Season



Preliminary data, subject to revision.

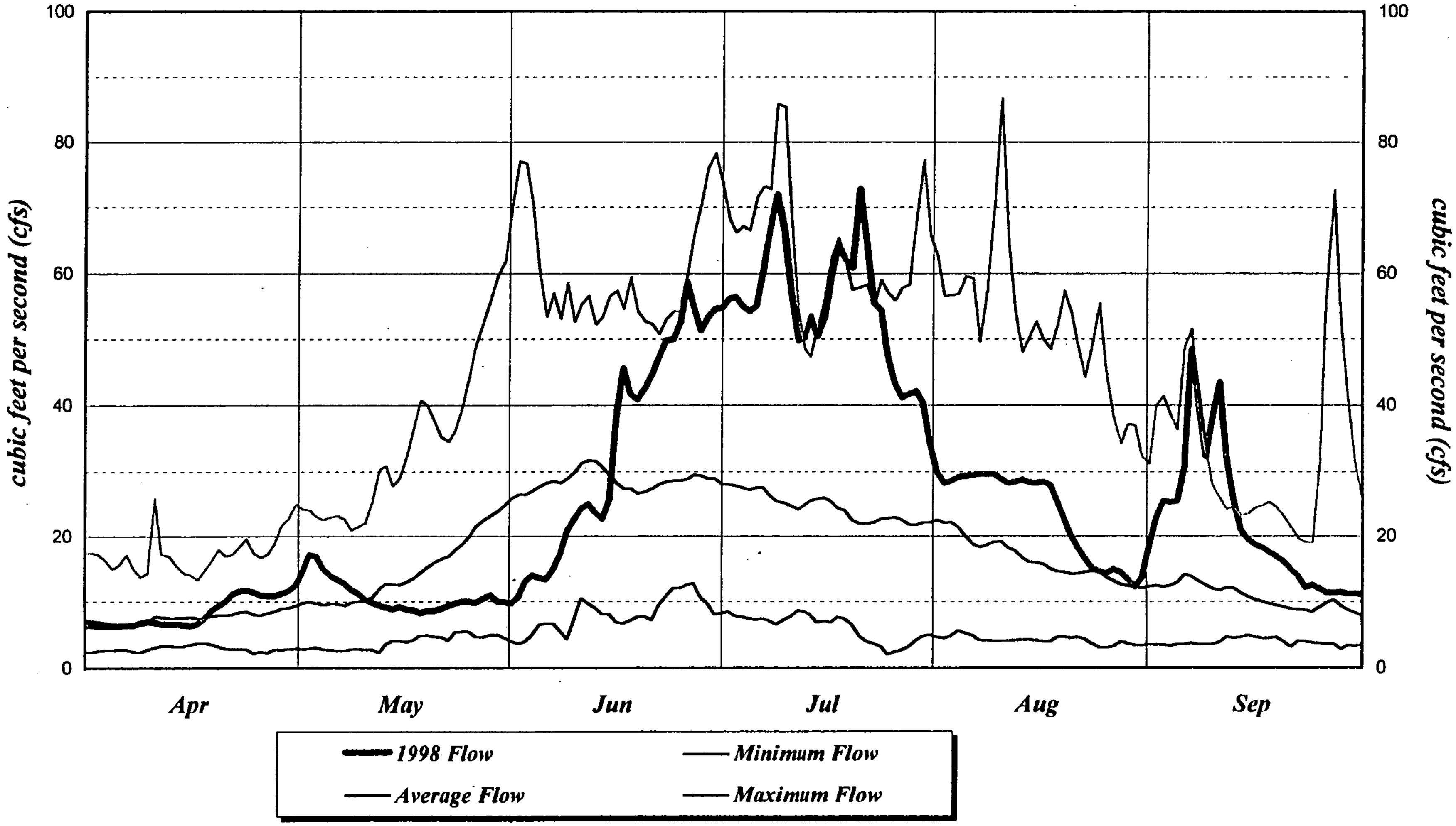
Courtesy Los Angeles Department of Water and Power

Data as of 1/5/99

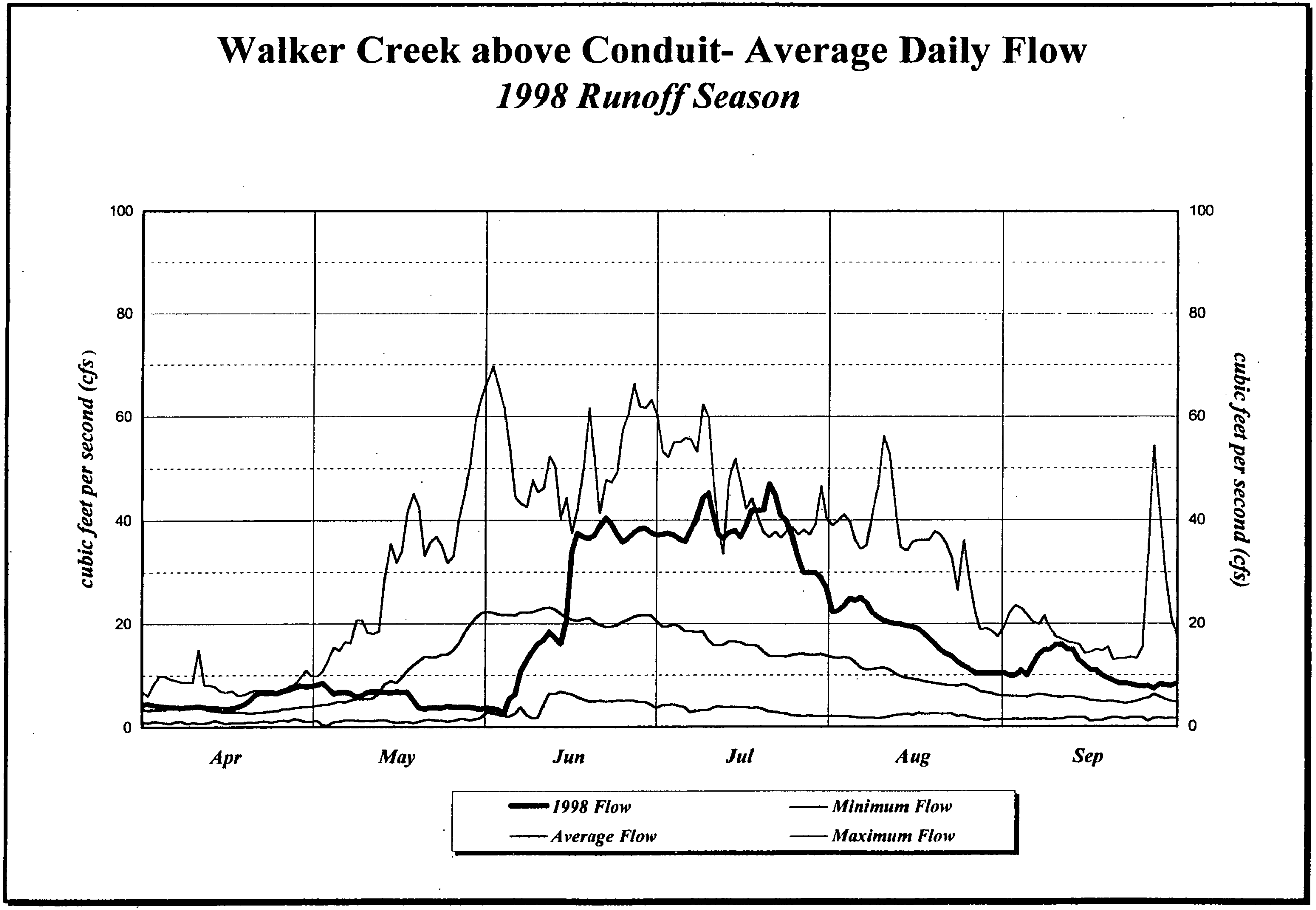

Lower Lee Vining Creek - Average Daily Flow
1998 Runoff Season
Total diversions to Rush Creek = 742 acre-feet
Diversions began: July 9
Diversions ended: July 18
Lee Vining Greek Above Intake
Peak daily average flow = 419 cfs (7/9)
Instantaneous peak flow = 451 cfs (7/9)
cubic feet per second (cfs)
cubic feet per second (cfs)
0
50
100
150
200
250
300
350
400
450
500
Apr
May
Jun
Jul
Aug
Sep
Lee Vining Creek above Intake
Lee Vining Creek below Intake

Parker Creek above Conduit- Average Daily Flow

1998 Runoff Season



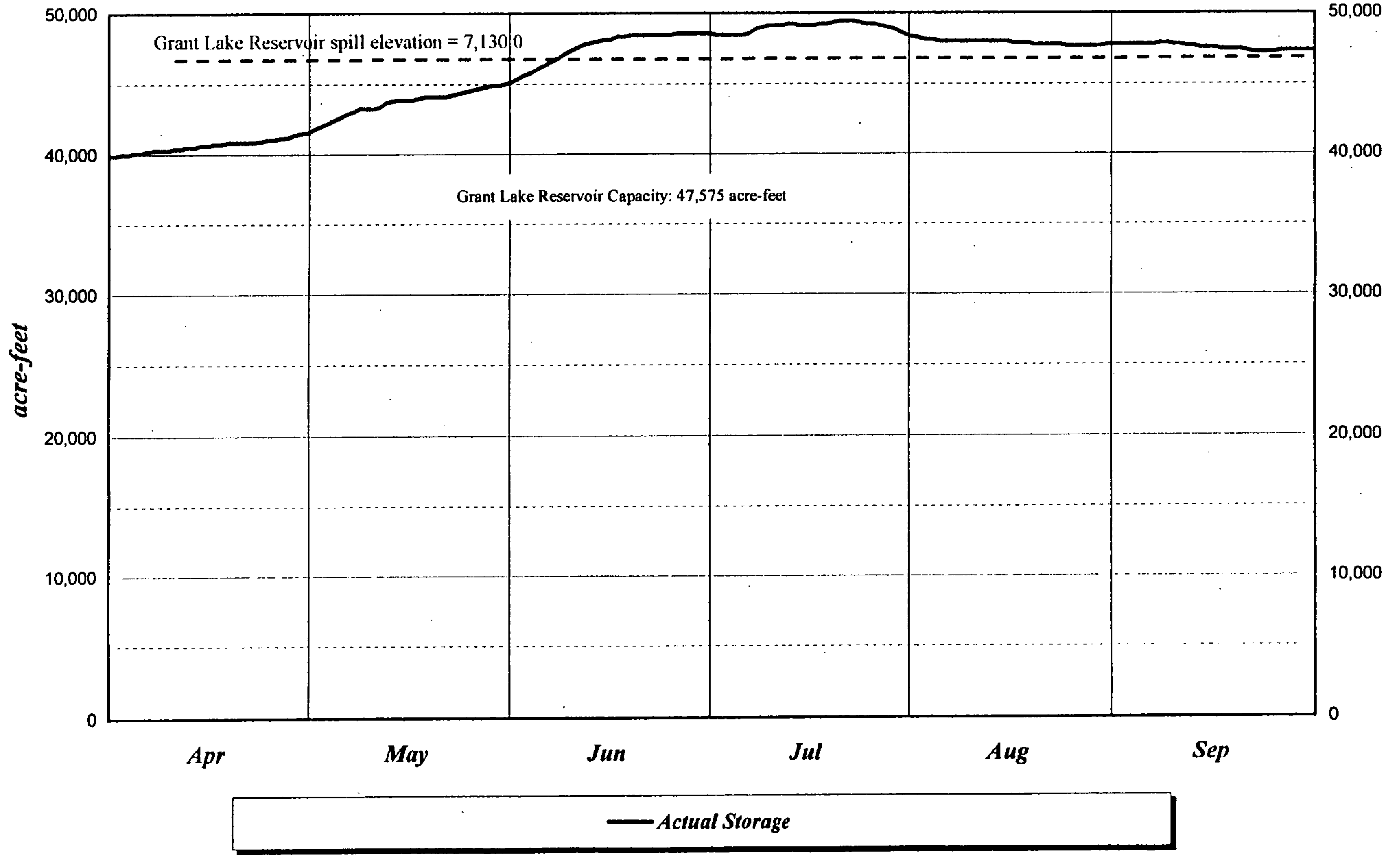
Preliminary data, subject to revision. Courtesy Los Angeles Department of Water and Power Data as of 1/5/99



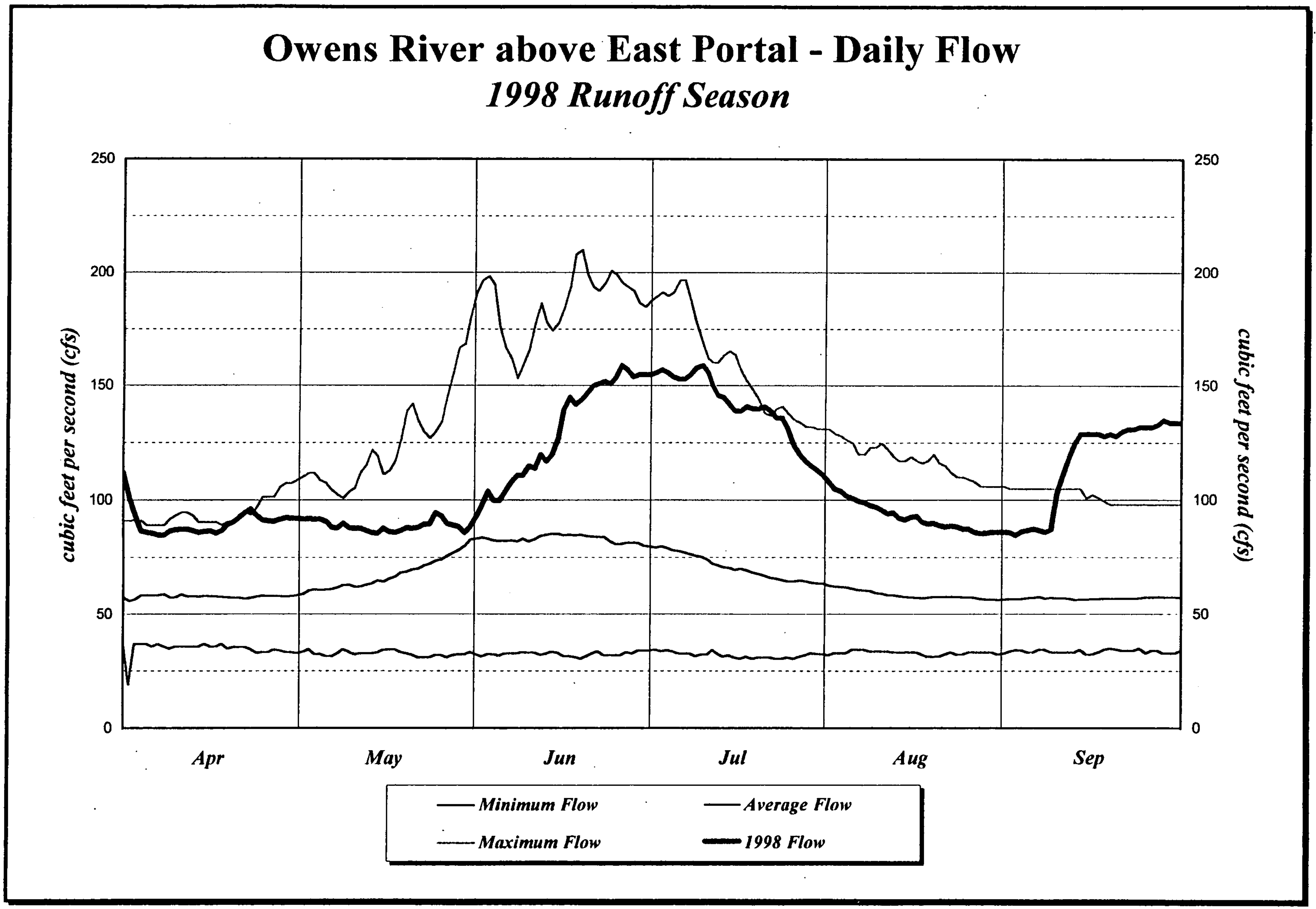
Preliminary data, subject to revision. Courtesy Los Angeles Department of Water and Power Data as of 1/5/99

Grant Lake Reservoir - Daily Storage

1998 Runoff Season



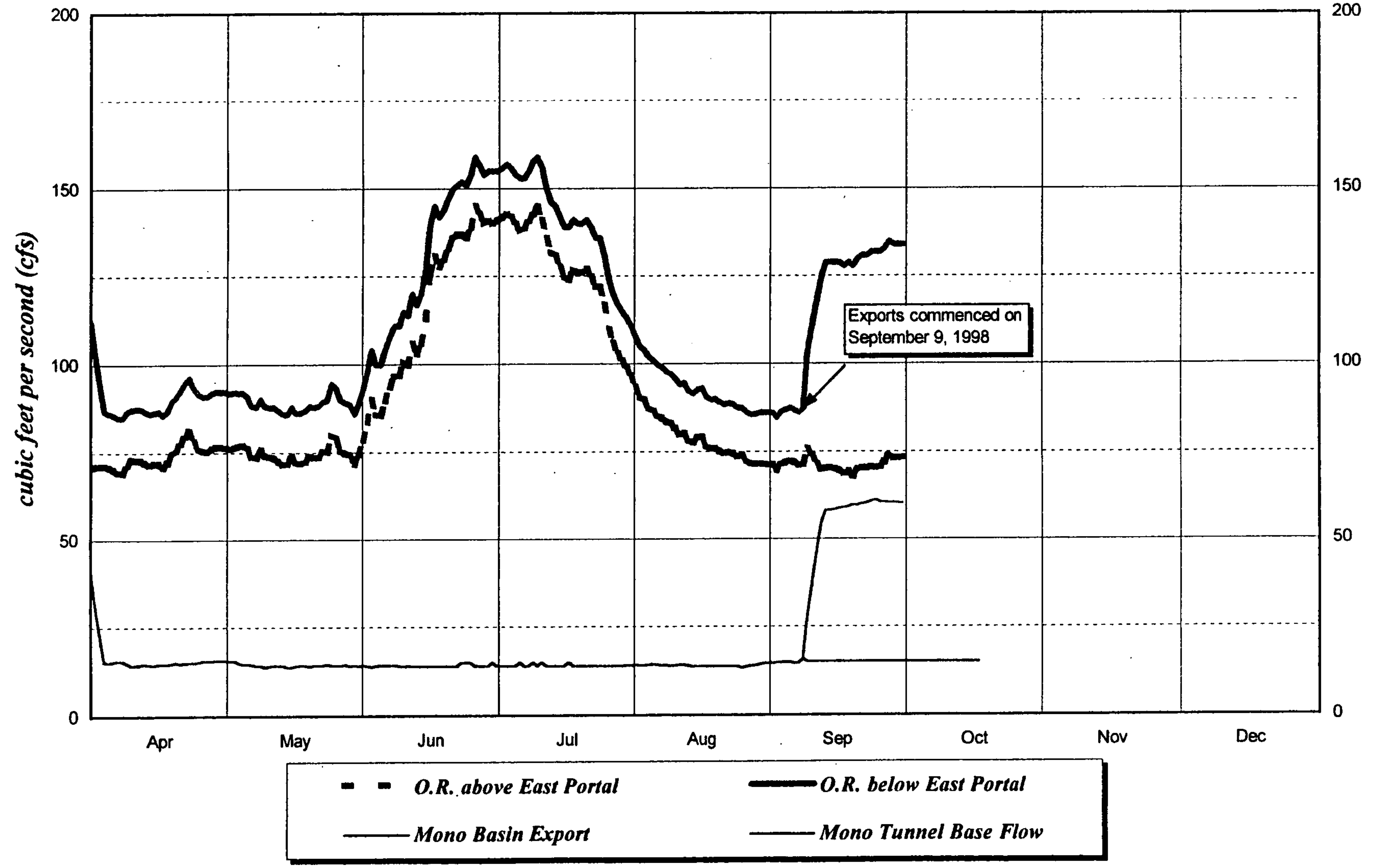
Courtesy Los Angeles Department of Water and Power

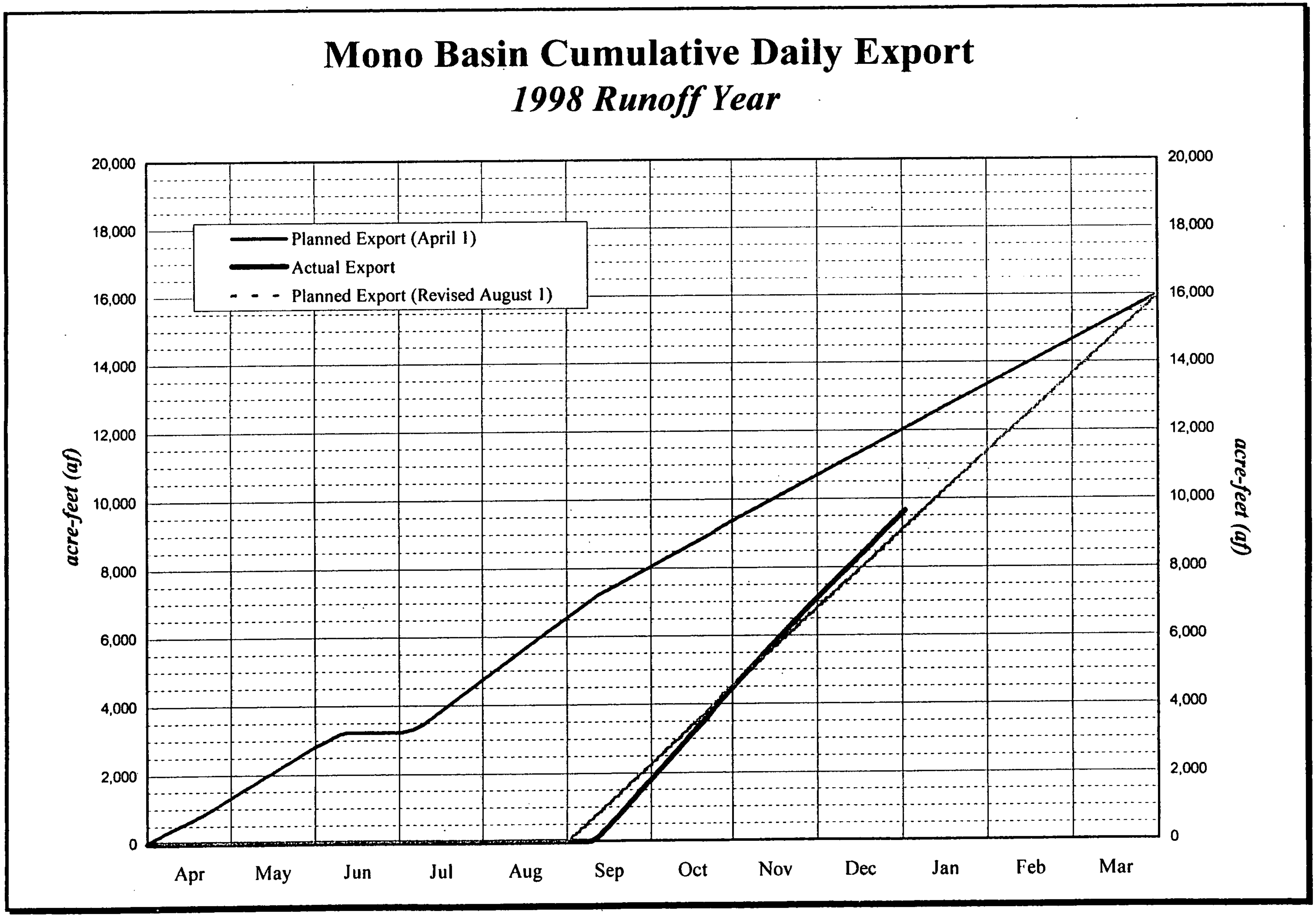


Courtesy Los Angeles Department of Water and Power

Upper Owens River - Daily Flow

As of September 30, 1998

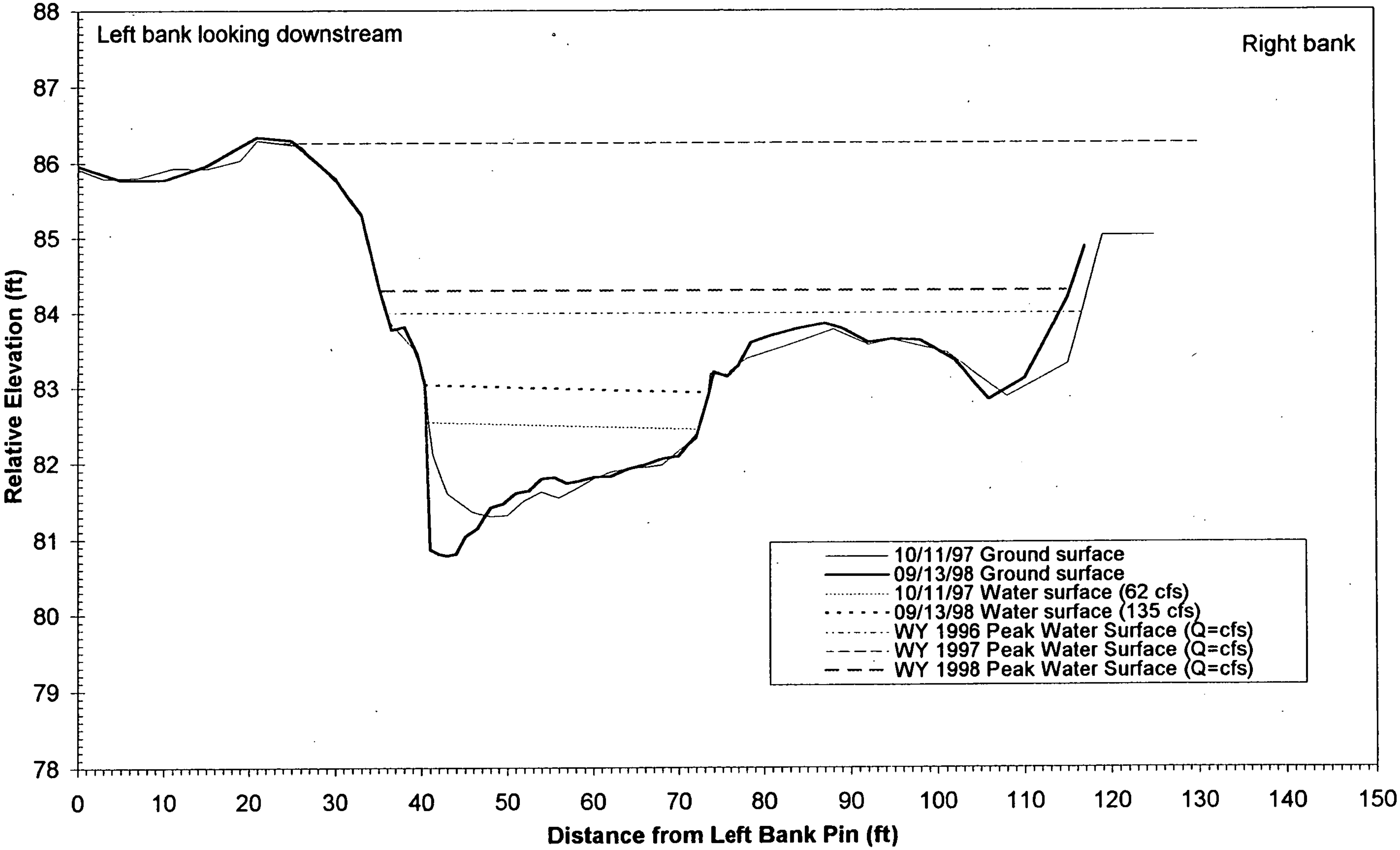


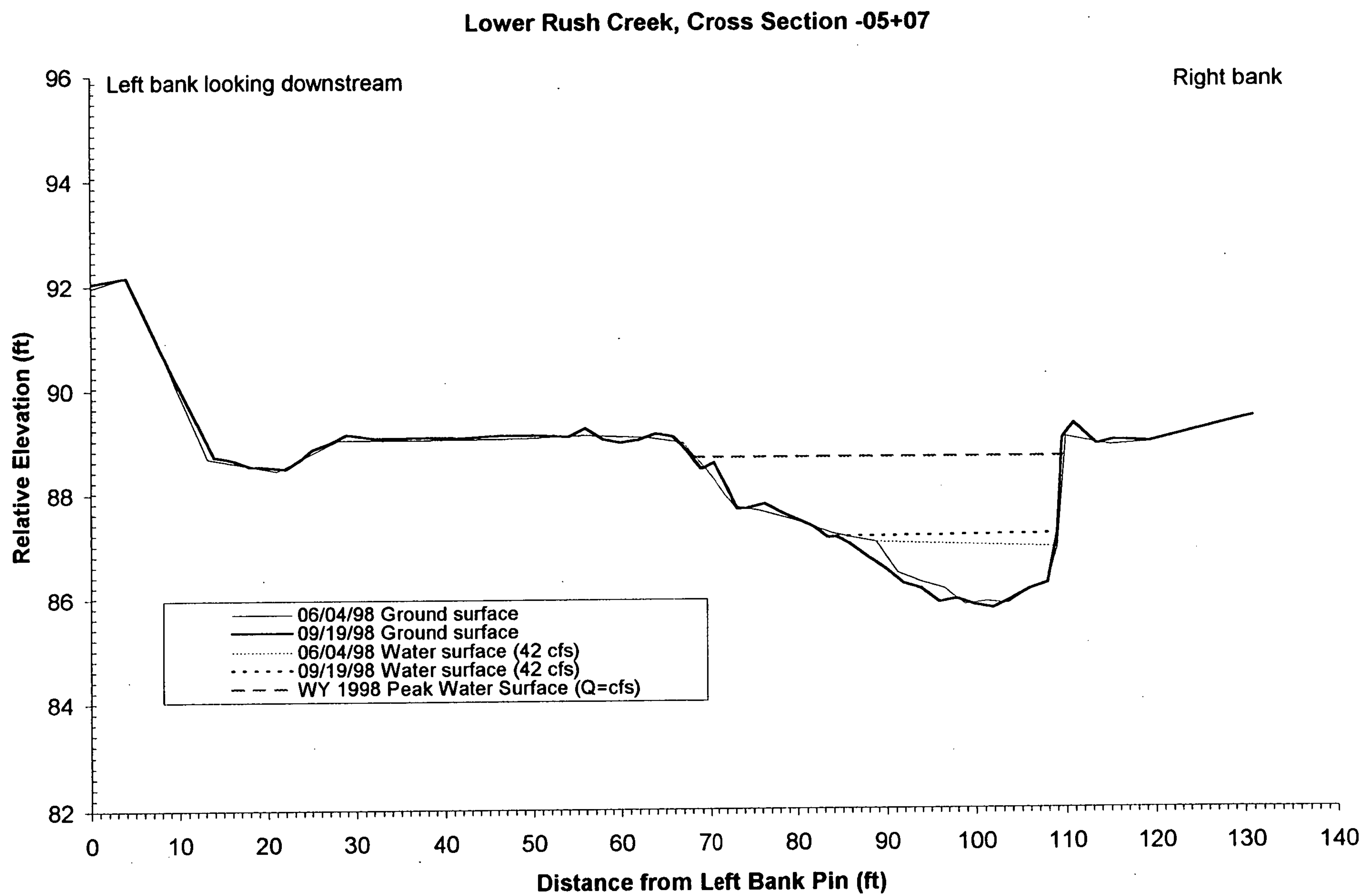


Preliminary data, subject to revision. Courtesy Los Angeles Department of Water and Power Data as of 1/5/99

8. APPENDIX C: CROSS SECTION SURVEYS

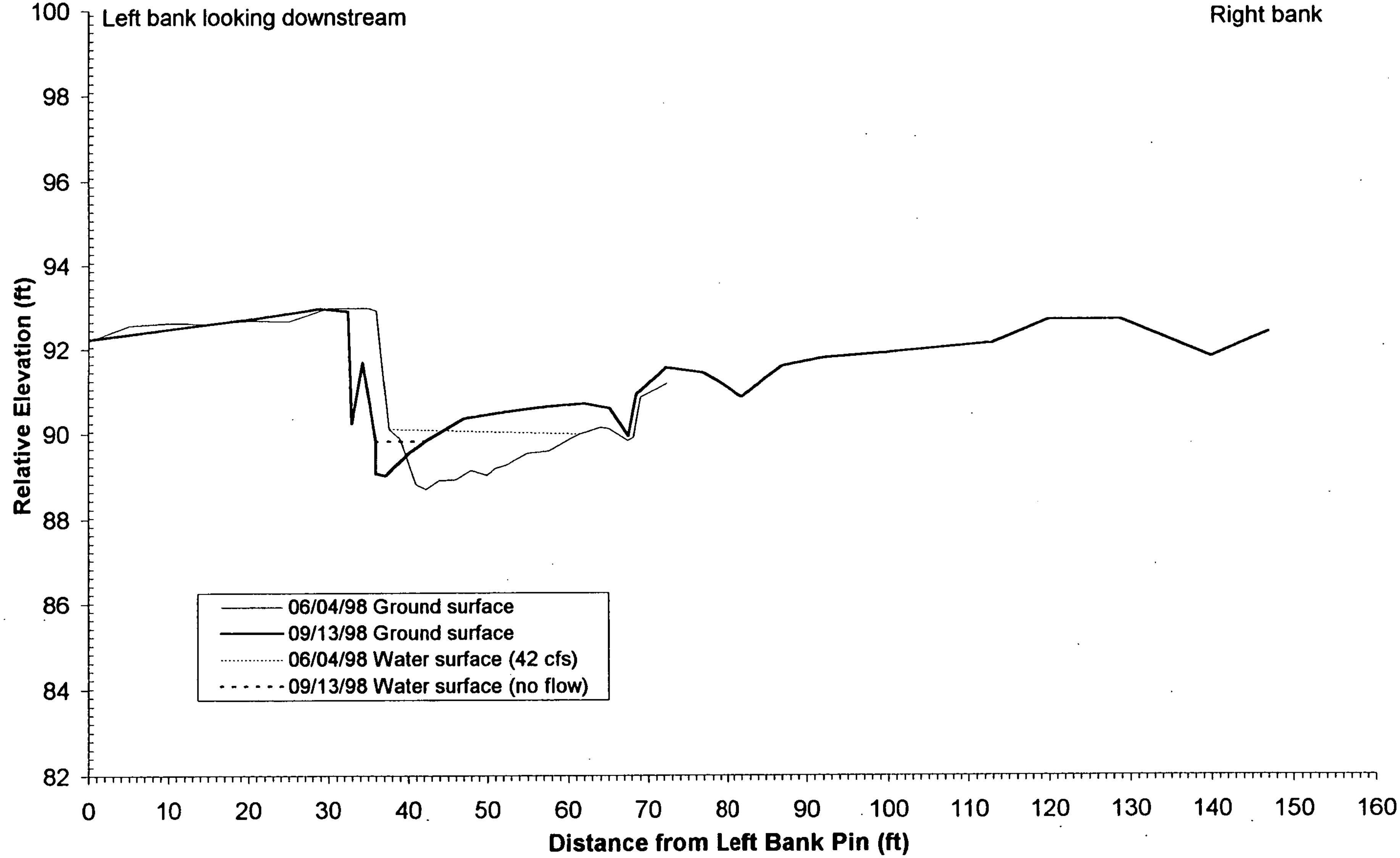
Lower Rush Creek, Cross Section -09+82
Bedload Mobility Modeling Cross Section

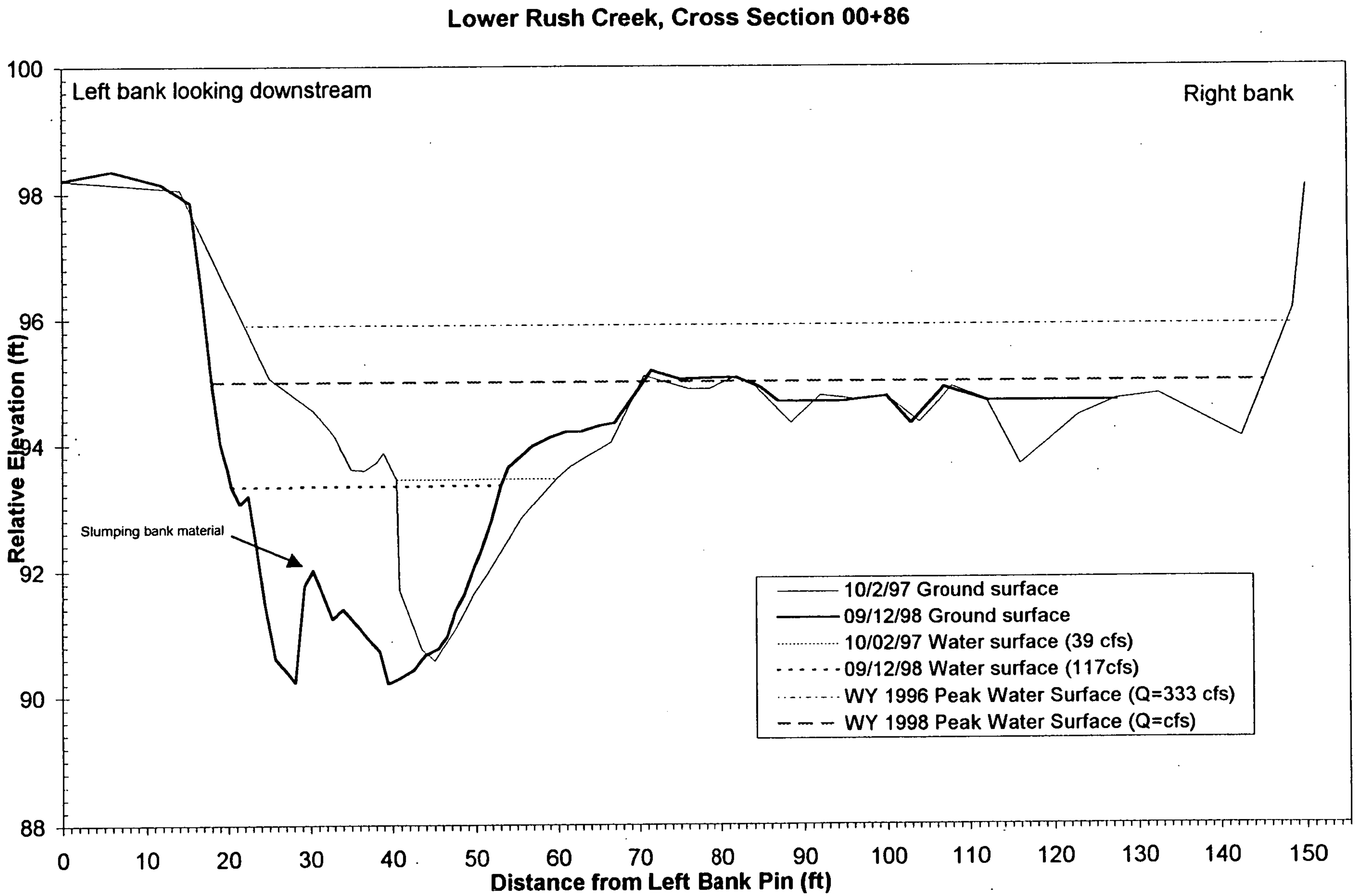




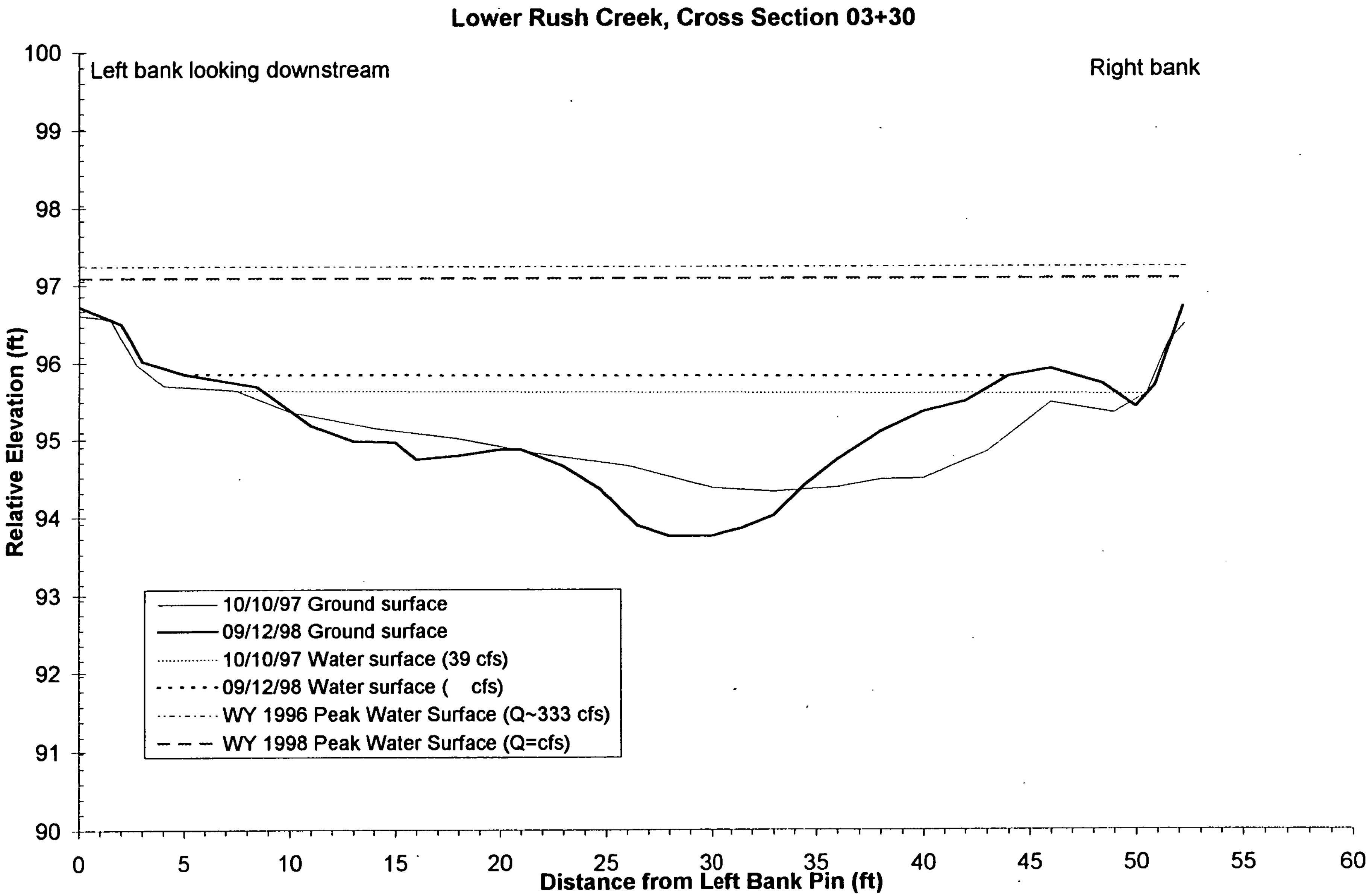
Lower Rush Creek, Cross Section -05+07
Left bank looking downstream
Right bank
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
96
94
92
90
88
86
84
82
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
06/04/98 Ground surface
09/19/98 Ground surface
06/04/98 Water surface (42 cfs)
09/19/98 Water surface (42 cfs)
WY 1998 Peak Water Surface (Q=cfs)

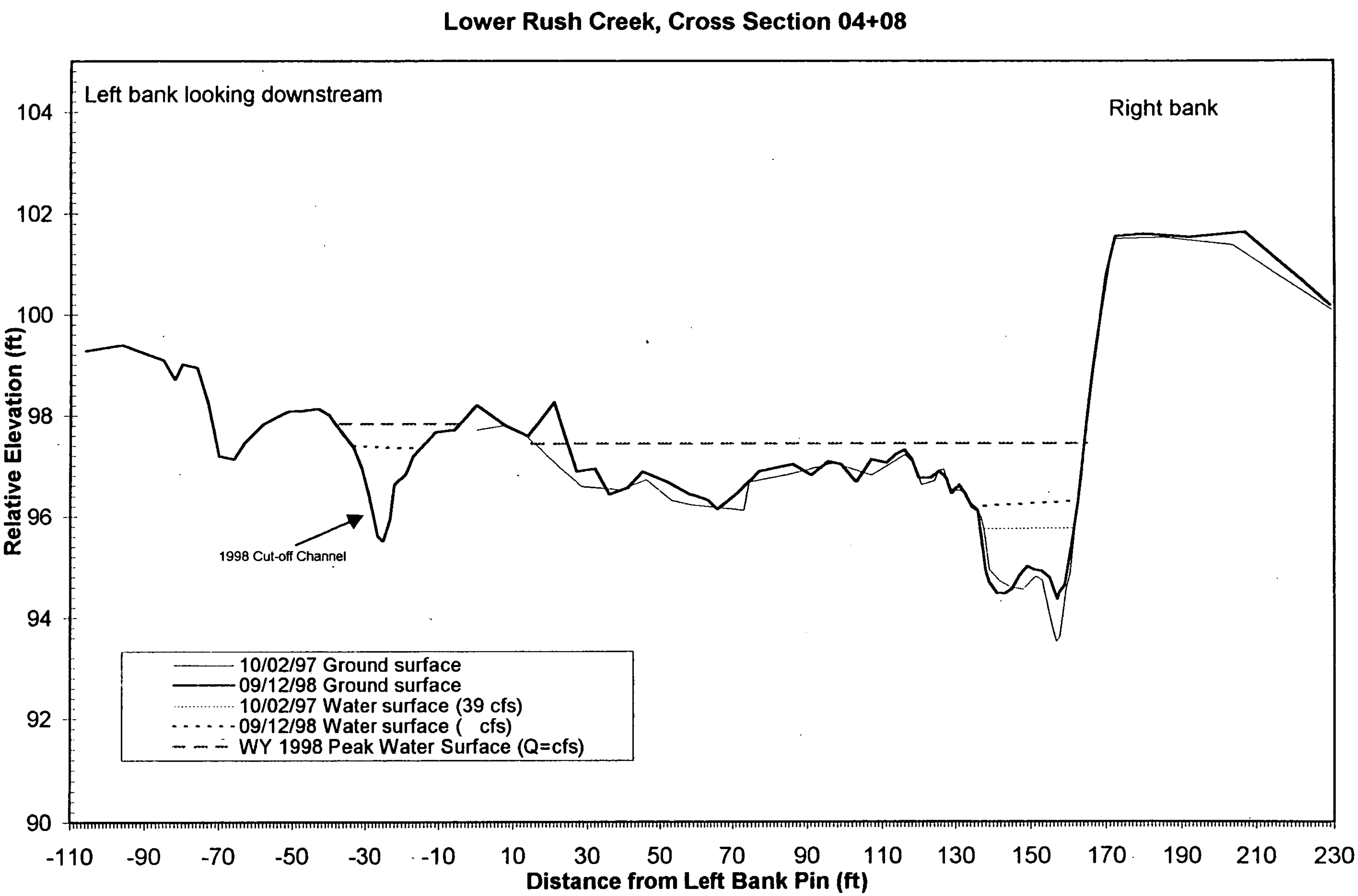
Lower Rush Creek, Cross Section -01+56



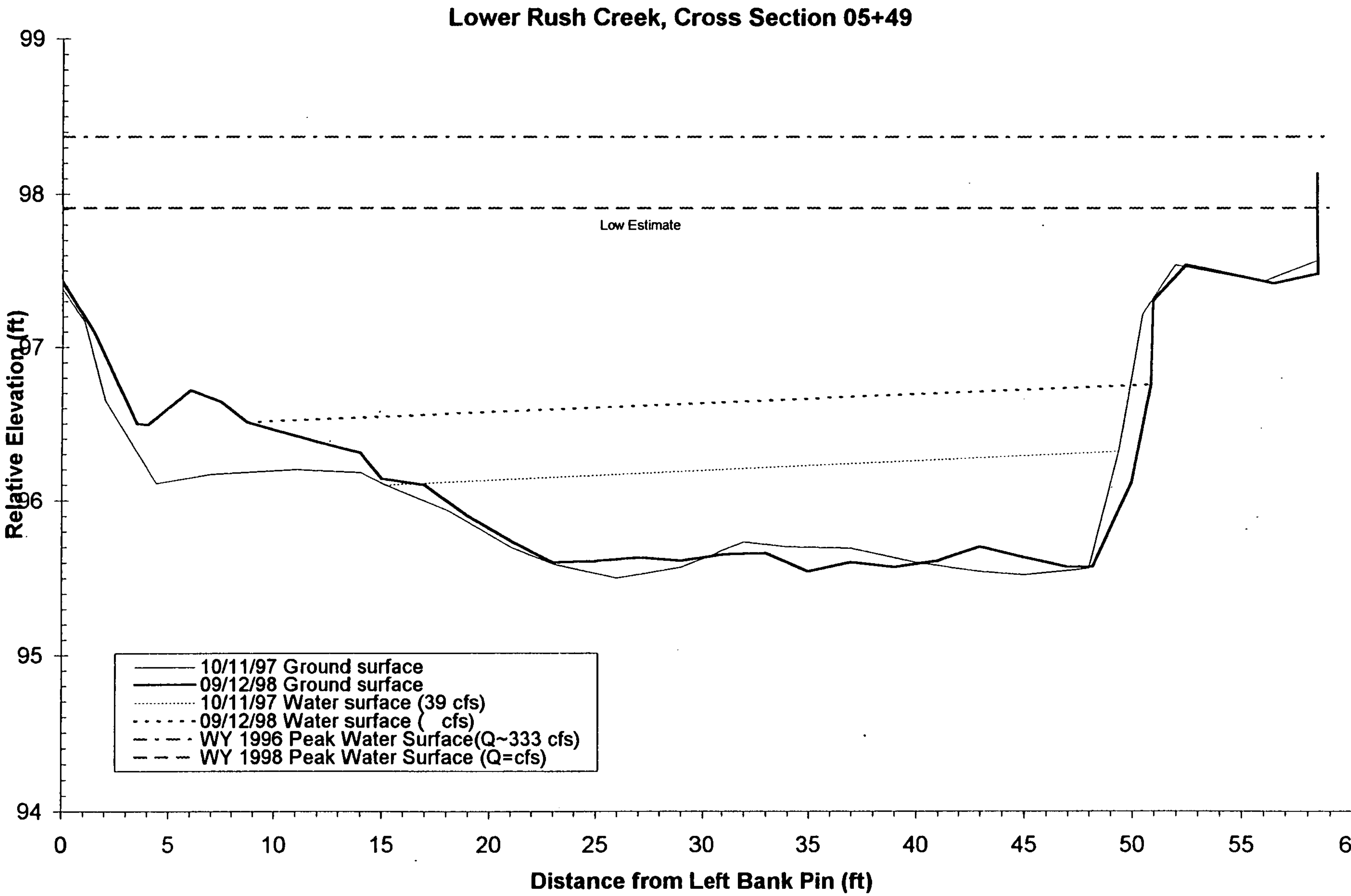


Lower Rush Creek, Cross Section 00+86
Left bank looking downstream
Right bank
Slumping bank material
10/2/97 Ground surface
09/12/98 Ground surface
10/02/97 Water surface (39 cfs)
09/12/98 Water surface (117cfs)
WY 1996 Peak Water Surface (Q=333 cfs)
WY 1998 Peak Water Surface (Q=cfs)
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
100
98
96
94
92
90
88
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150


Lower Rush Creek, Cross Section 03+30
Left bank looking downstream
Right bank
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
100
99
98
97
96
95
94
93
92
91
90
0
5
10
15
20
25
30
35
40
45
50
55
60
10/10/97 Ground surface
09/12/98 Ground surface
10/10/97 Water surface (39 cfs)
09/12/98 Water surface (cfs)
WY 1996 Peak Water Surface (Q~333 cfs)
WY 1998 Peak Water Surface (Q=cfs)

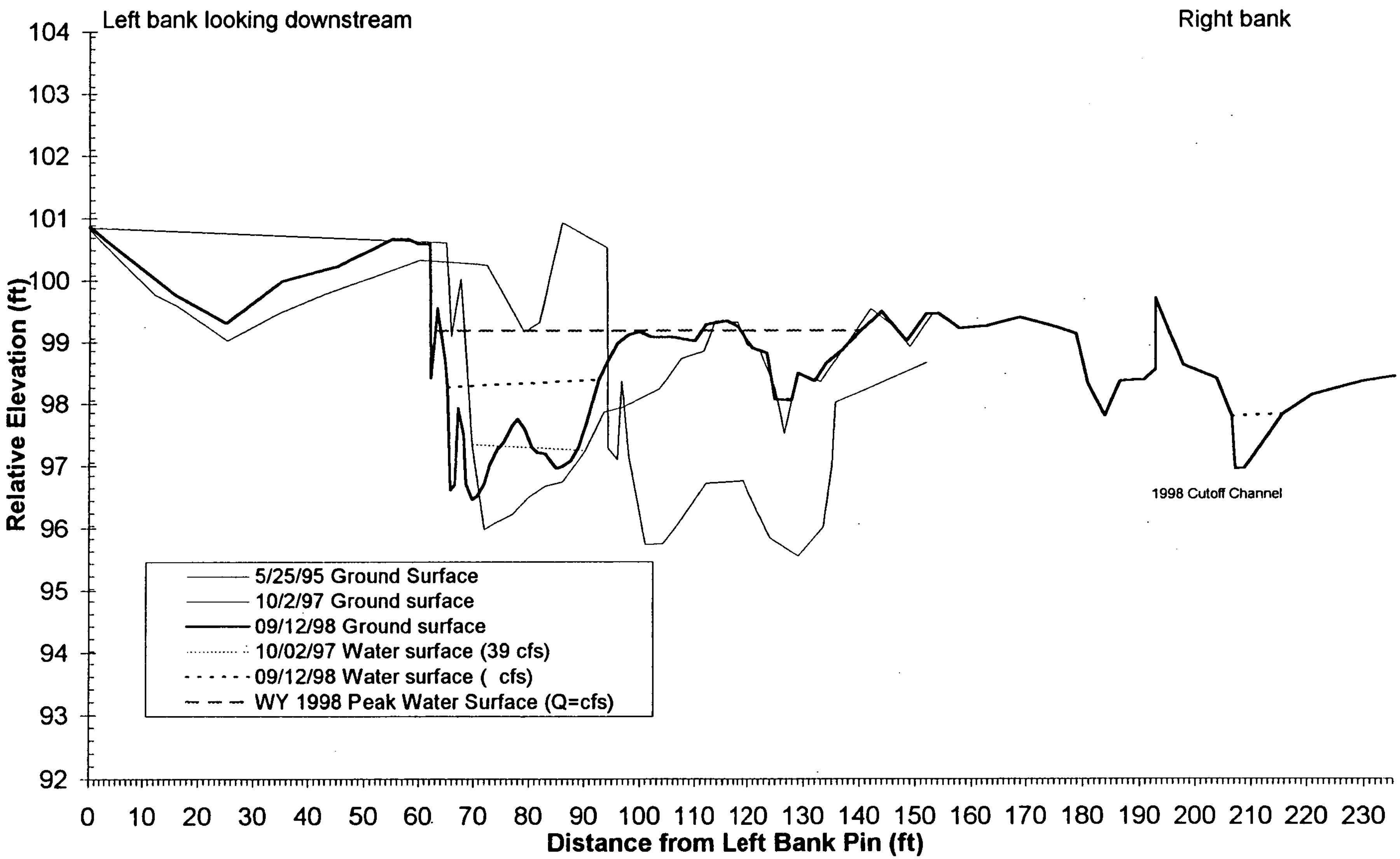


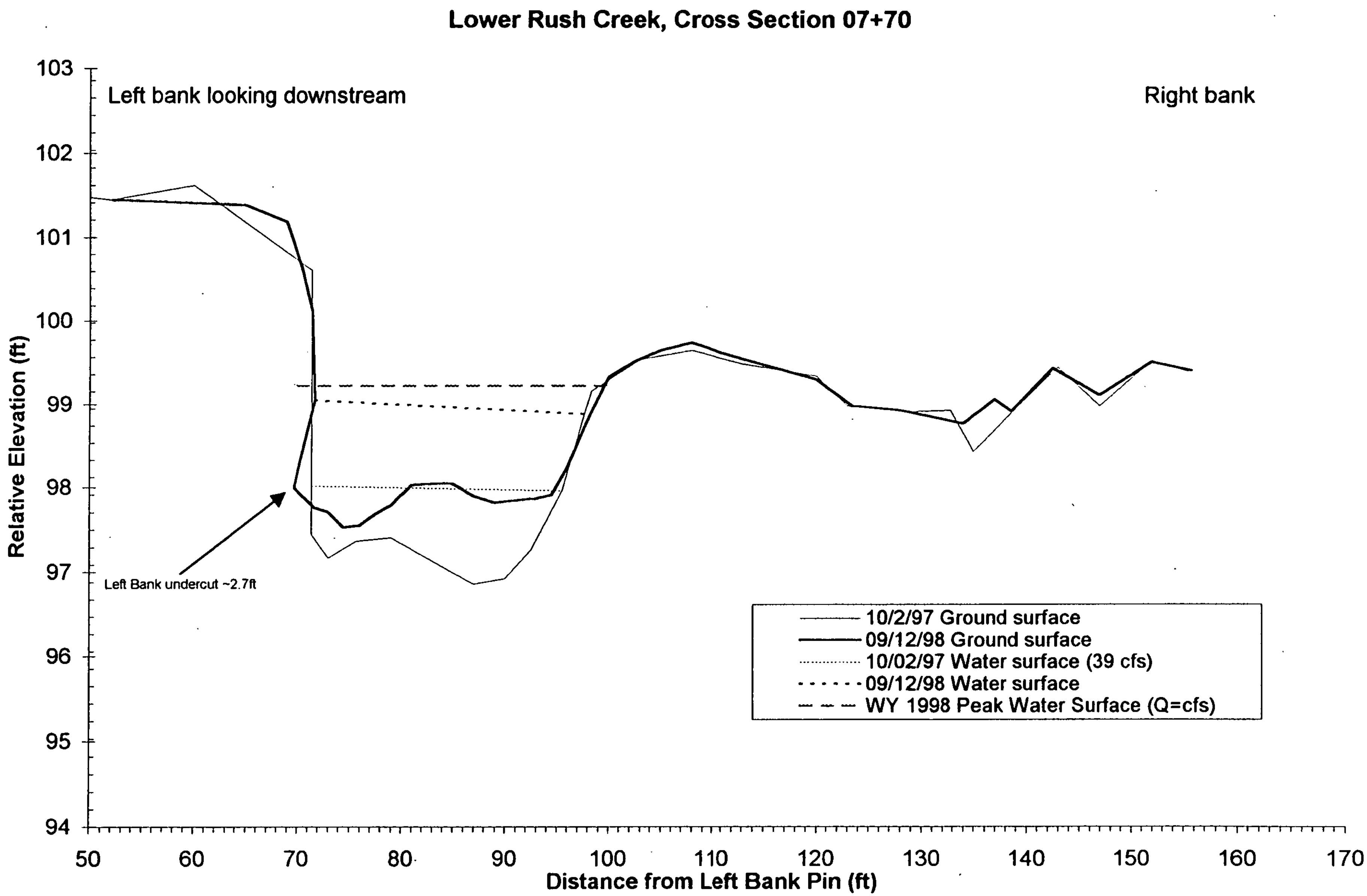
Lower Rush Creek, Cross Section 04+08
Left bank looking downstream
Right bank
Relative Elevation (ft)
104
102
100
98
96
94
92
90
1998 Cut-off Channel
10/02/97 Ground surface
09/12/98 Ground surface
10/02/97 Water surface (39 cfs)
09/12/98 Water surface (cfs)
WY 1998 Peak Water Surface (Q=cfs)
-110
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
190
210
230
Distance from Left Bank Pin (ft)



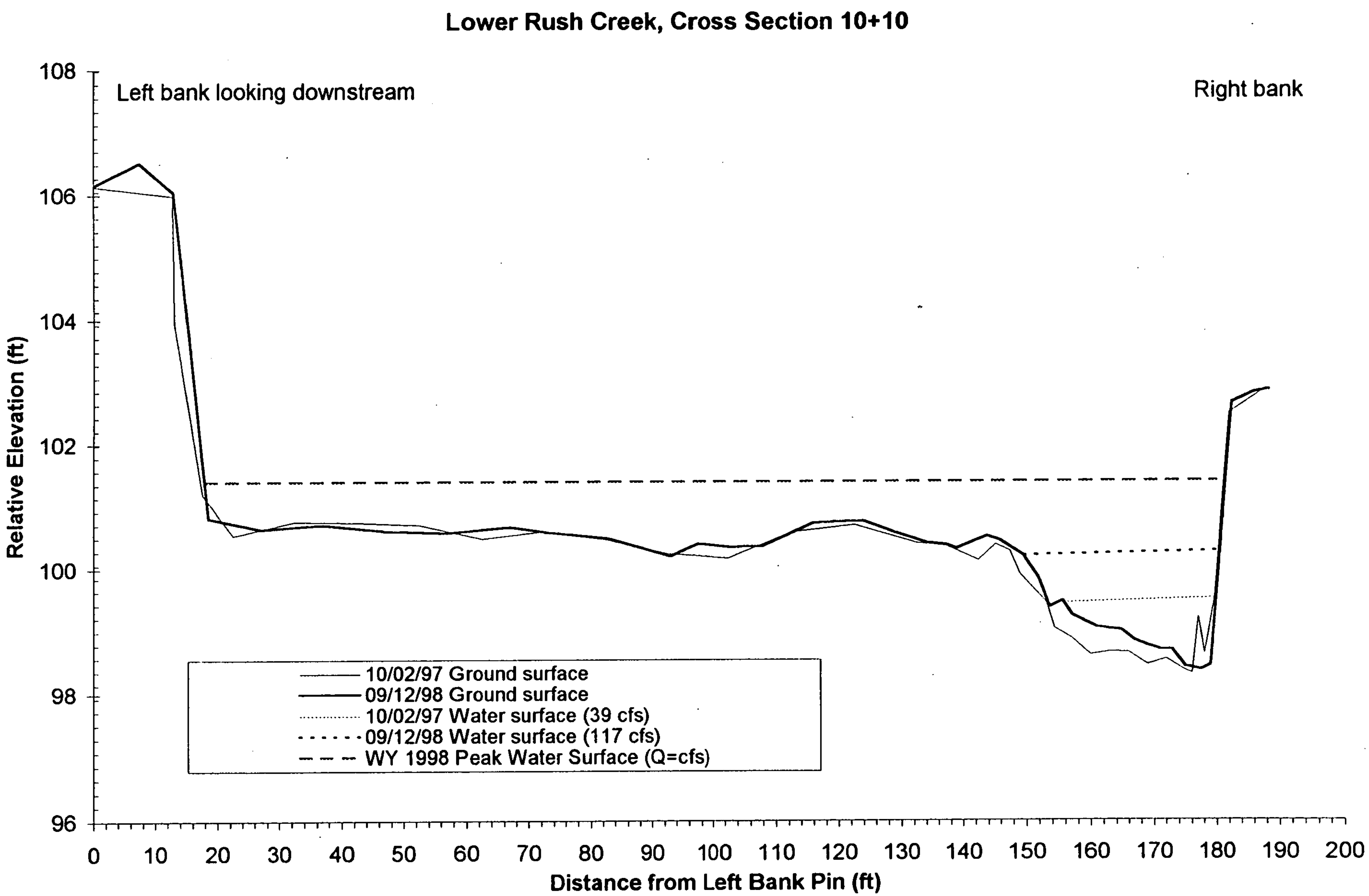
Lower Rush Creek, Cross Section 05+49
Relative Elevation (ft)
99
98
97
96
95
94
Low Estimate
0
5
10
15
20
25
30
35
40
45
50
55
60
Distance from Left Bank Pin (ft)
10/11/97 Ground surface
09/12/98 Ground surface
10/11/97 Water surface (39 cfs)
09/12/98 Water surface (cfs)
WY 1996 Peak Water Surface(Q~333 cfs)
WY 1998 Peak Water Surface (Q=cfs)

Lower Rush Creek, Cross Section 07+25

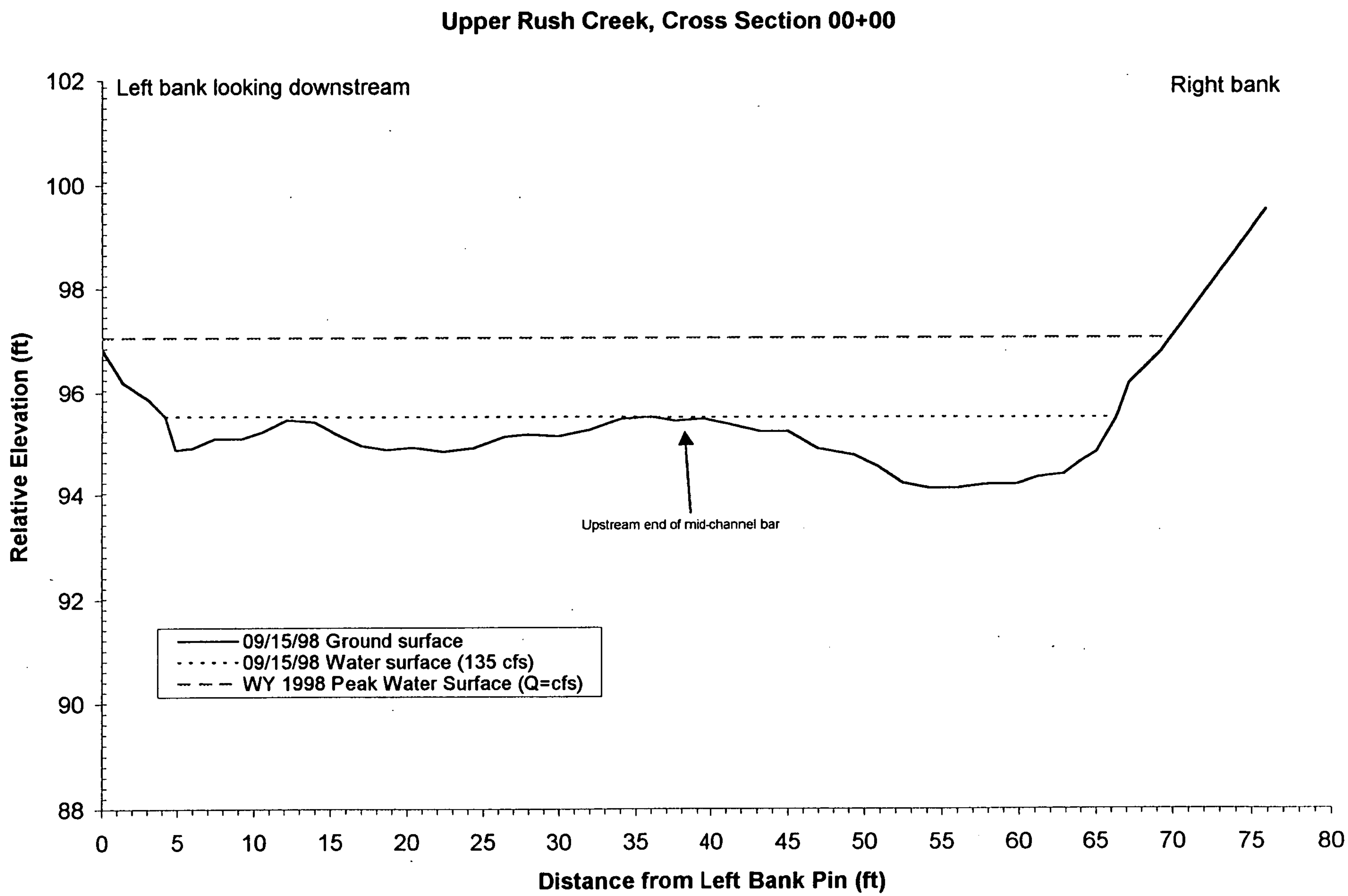


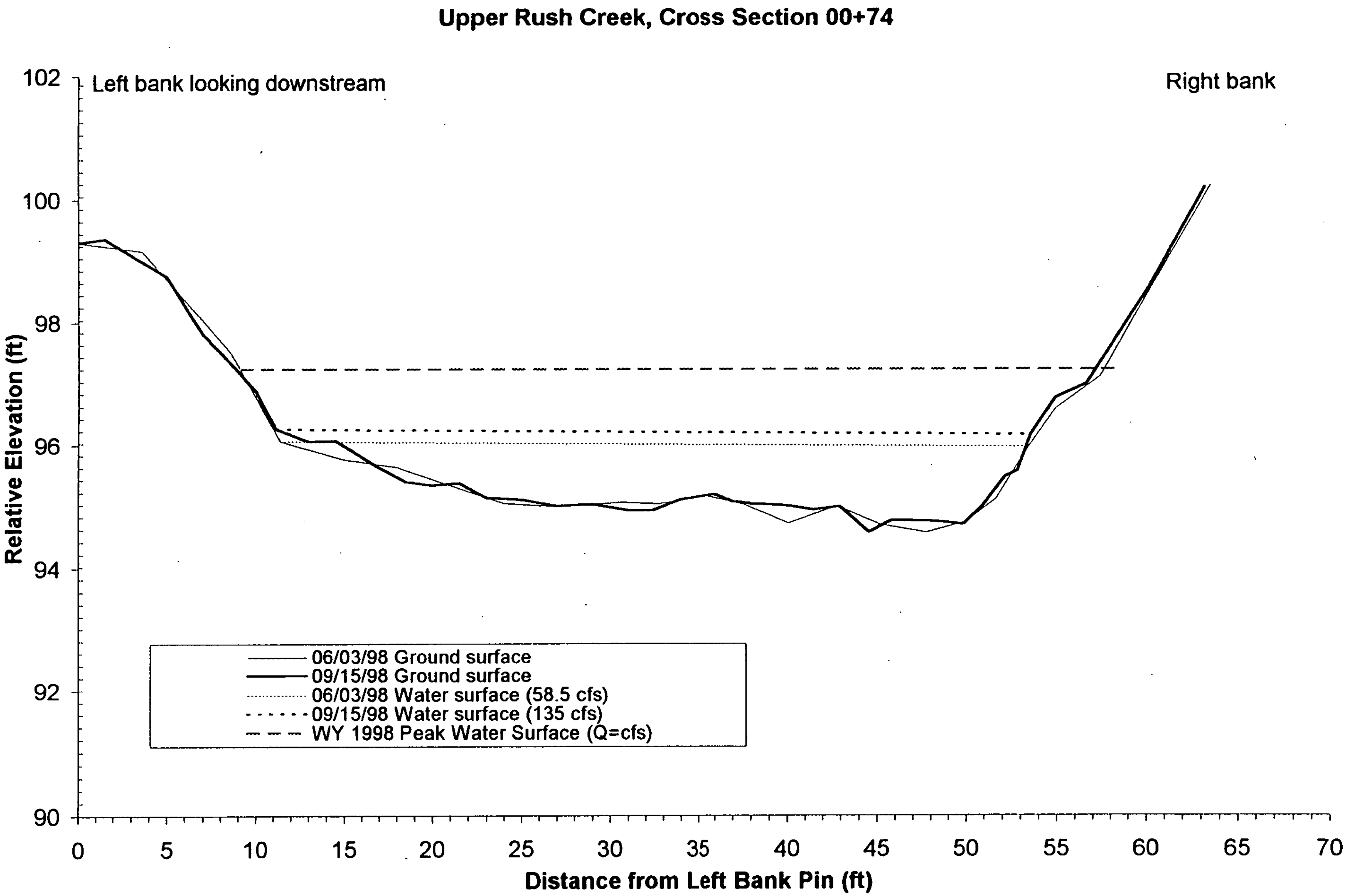


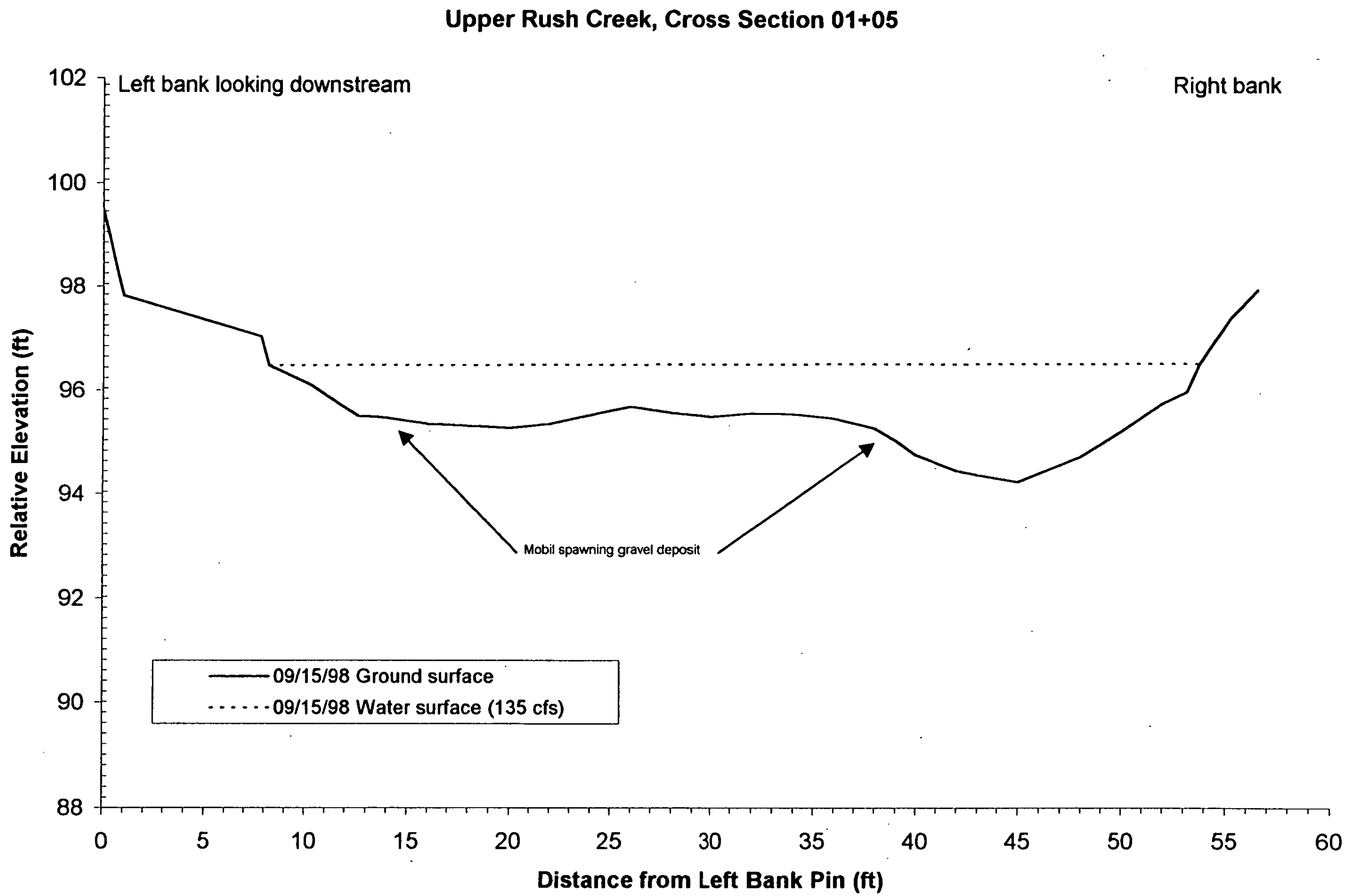
Lower Rush Creek, Cross Section 07+70
Left bank looking downstream
Right bank
Left Bank undercut ~2.7ft
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
103
102
101
100
99
98
97
96
95
94
50
60
70
80
90
100
110
120
130
140
150
160
170
10/2/97 Ground surface
09/12/98 Ground surface
10/02/97 Water surface (39 cfs)
09/12/98 Water surface
WY 1998 Peak Water Surface (Q=cfs)



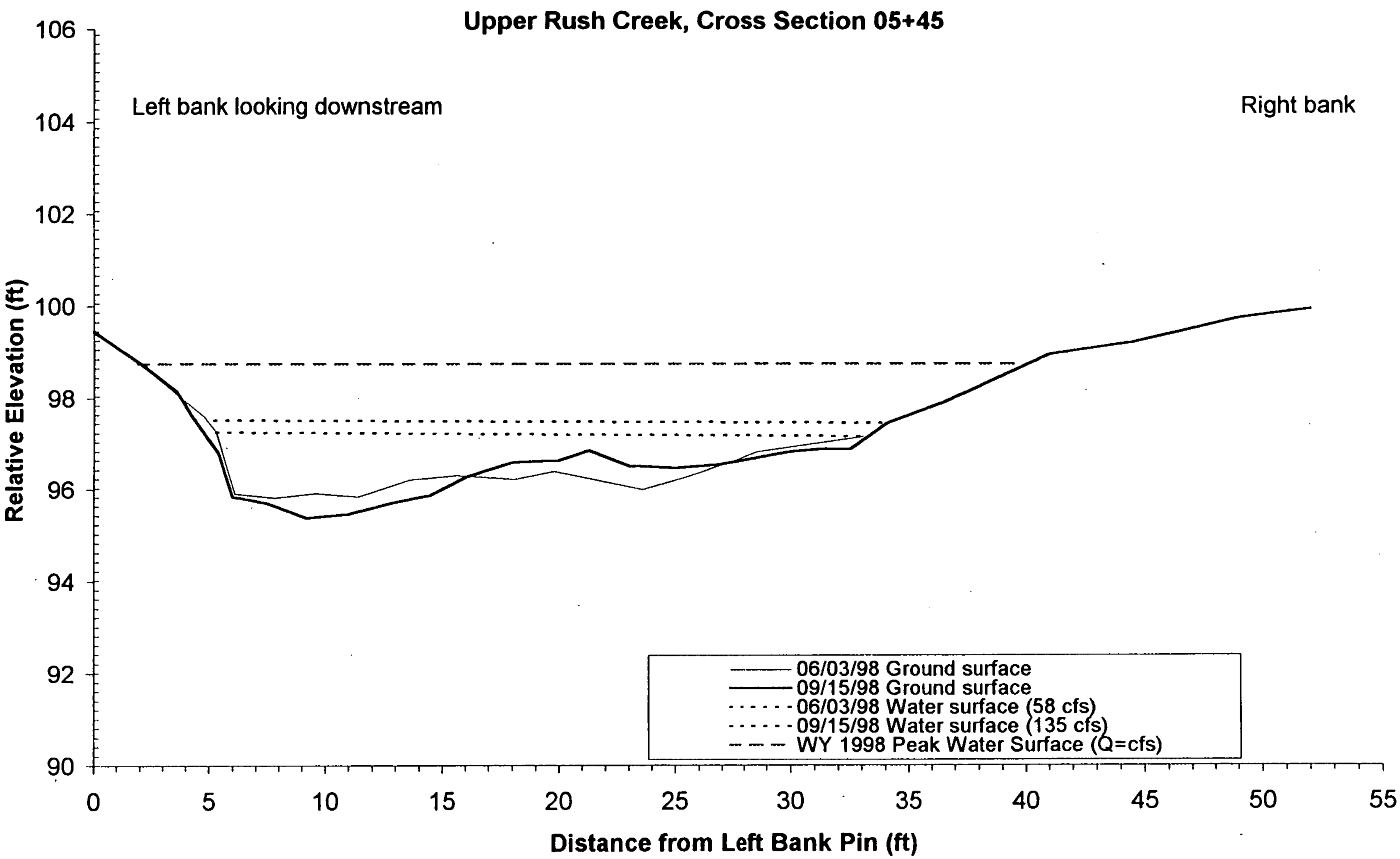
Lower Rush Creek, Cross Section 10+10
Left bank looking downstream
Right bank
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
108
106
104
102
100
98
96
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
10/02/97 Ground surface
09/12/98 Ground surface
10/02/97 Water surface (39 cfs)
09/12/98 Water surface (117 cfs)
WY 1998 Peak Water Surface (Q=cfs)

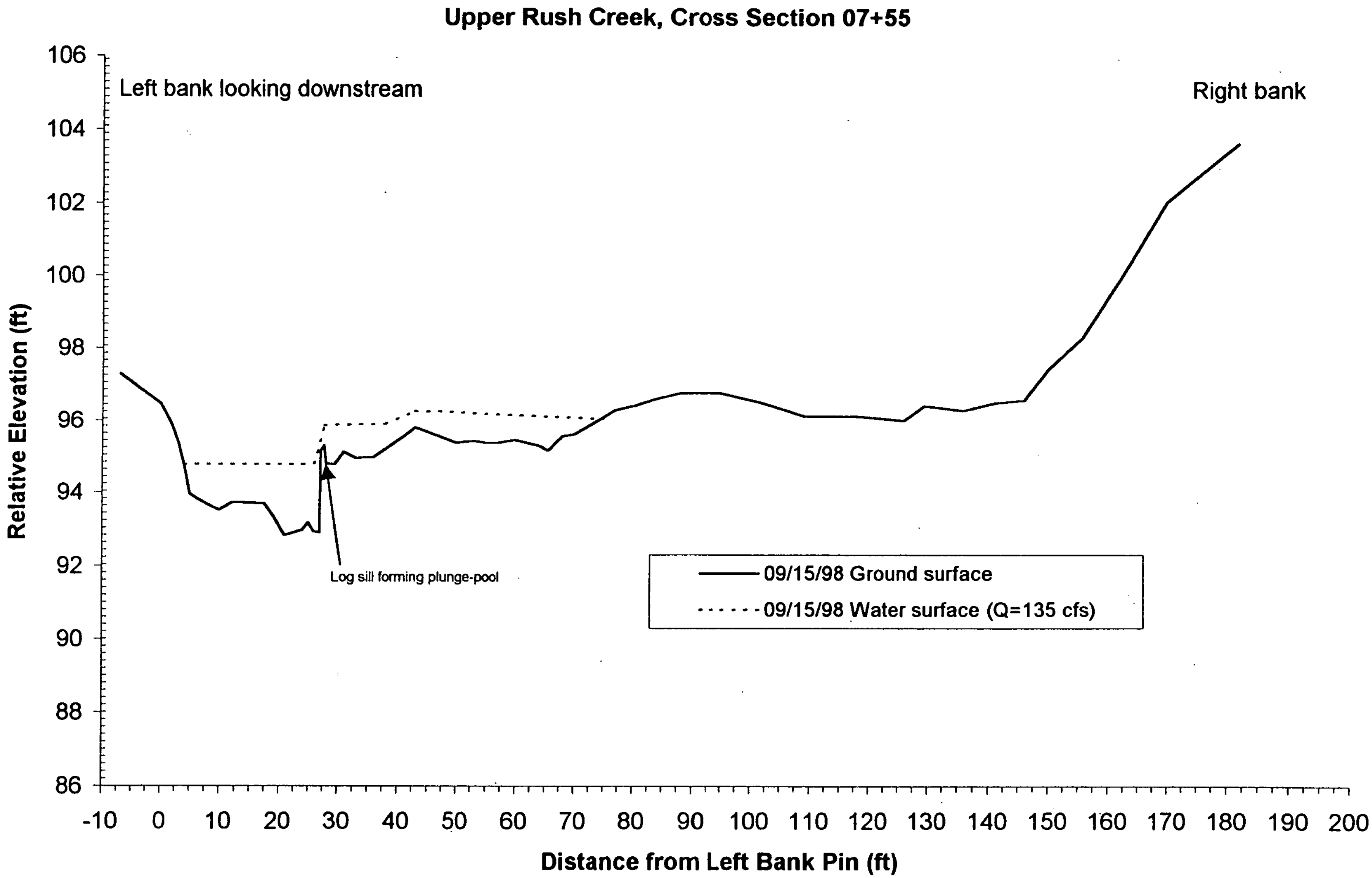

Upper Rush Creek, Cross Section 00+00
Left bank looking downstream
Right bank
Relative Elevation (ft)
102
100
98
96
94
92
90
88
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Distance from Left Bank Pin (ft)
Upstream end of mid-channel bar
09/15/98 Ground surface
09/15/98 Water surface (135 cfs)
WY 1998 Peak Water Surface (Q=cfs)


Upper Rush Creek, Cross Section 00+74
Left bank looking downstream
Right bank
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
102
100
98
96
94
92
90
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
06/03/98 Ground surface
09/15/98 Ground surface
06/03/98 Water surface (58.5 cfs)
09/15/98 Water surface (135 cfs)
WY 1998 Peak Water Surface (Q=cfs)

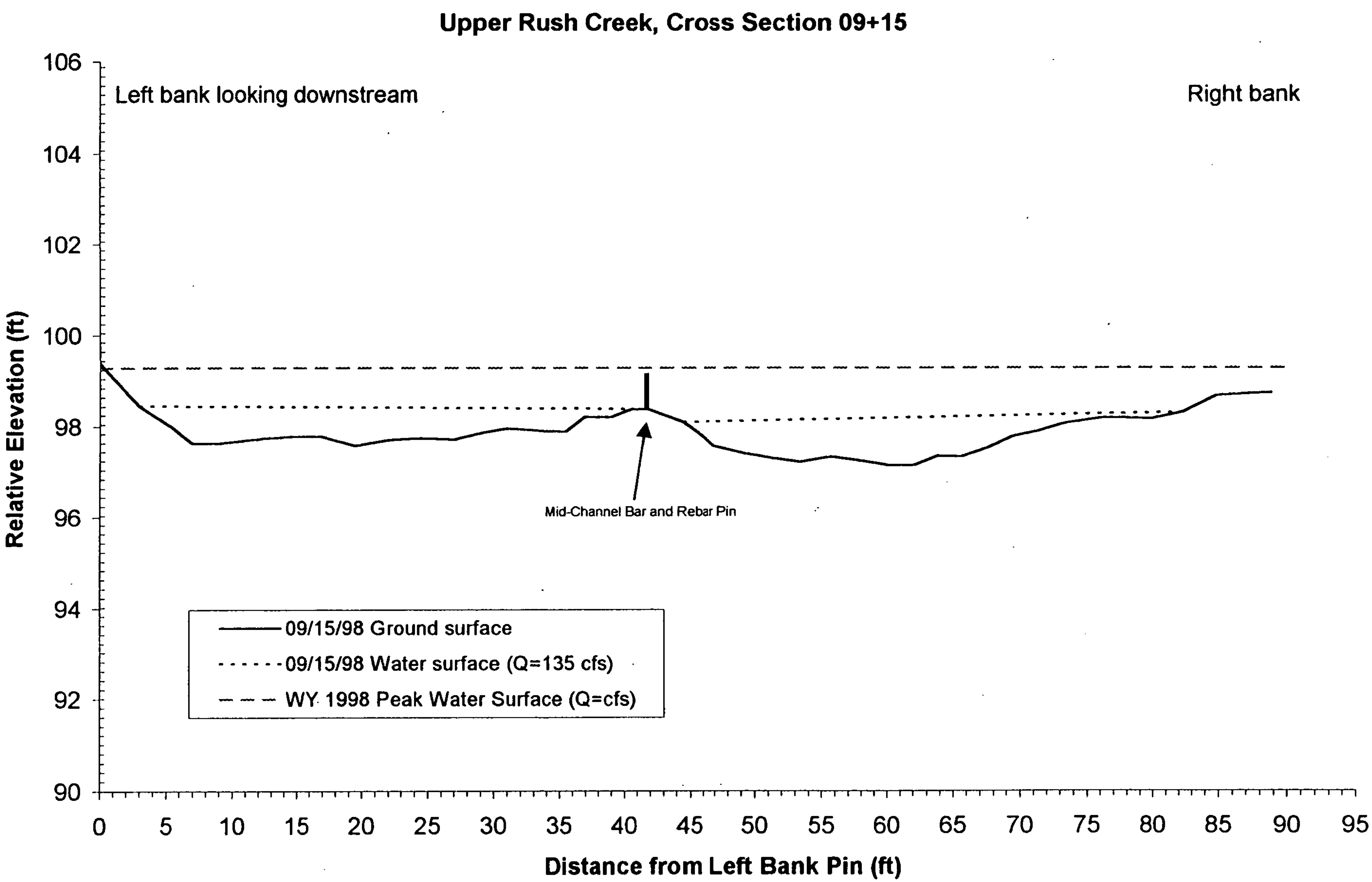


Upper Rush Creek, Cross Section 01+05
Left bank looking downstream
Right bank
Relative Elevation (ft)
102
100
98
96
94
92
90
88
Mobil spawning gravel deposit
09/15/98 Ground surface
09/15/98 Water surface (135 cfs)
0
5
10
15
20
25
30
35
40
45
50
55
60
Distance from Left Bank Pin (ft)

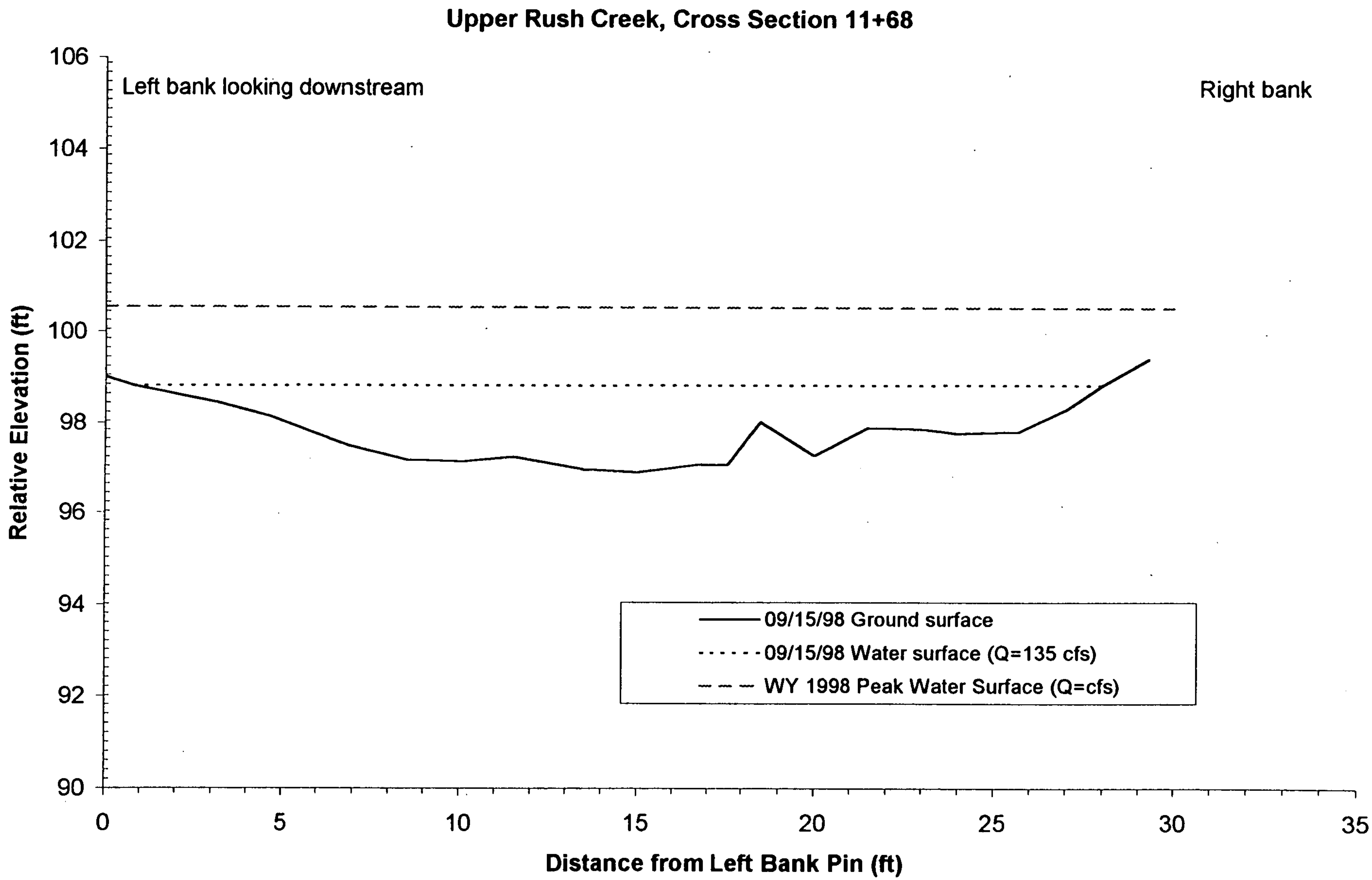

Upper Rush Creek, Cross Section 05+45
Left bank looking downstream
Right bank
Relative Elevation (ft)
106
104
102
100
98
96
94
92
90
0
5
10
15
20
25
30
35
40
45
50
55
Distance from Left Bank Pin (ft)
06/03/98 Ground surface
09/15/98 Ground surface
06/03/98 Water surface (58 cfs)
09/15/98 Water surface (135 cfs)
WY 1998 Peak Water Surface (Q=cfs)



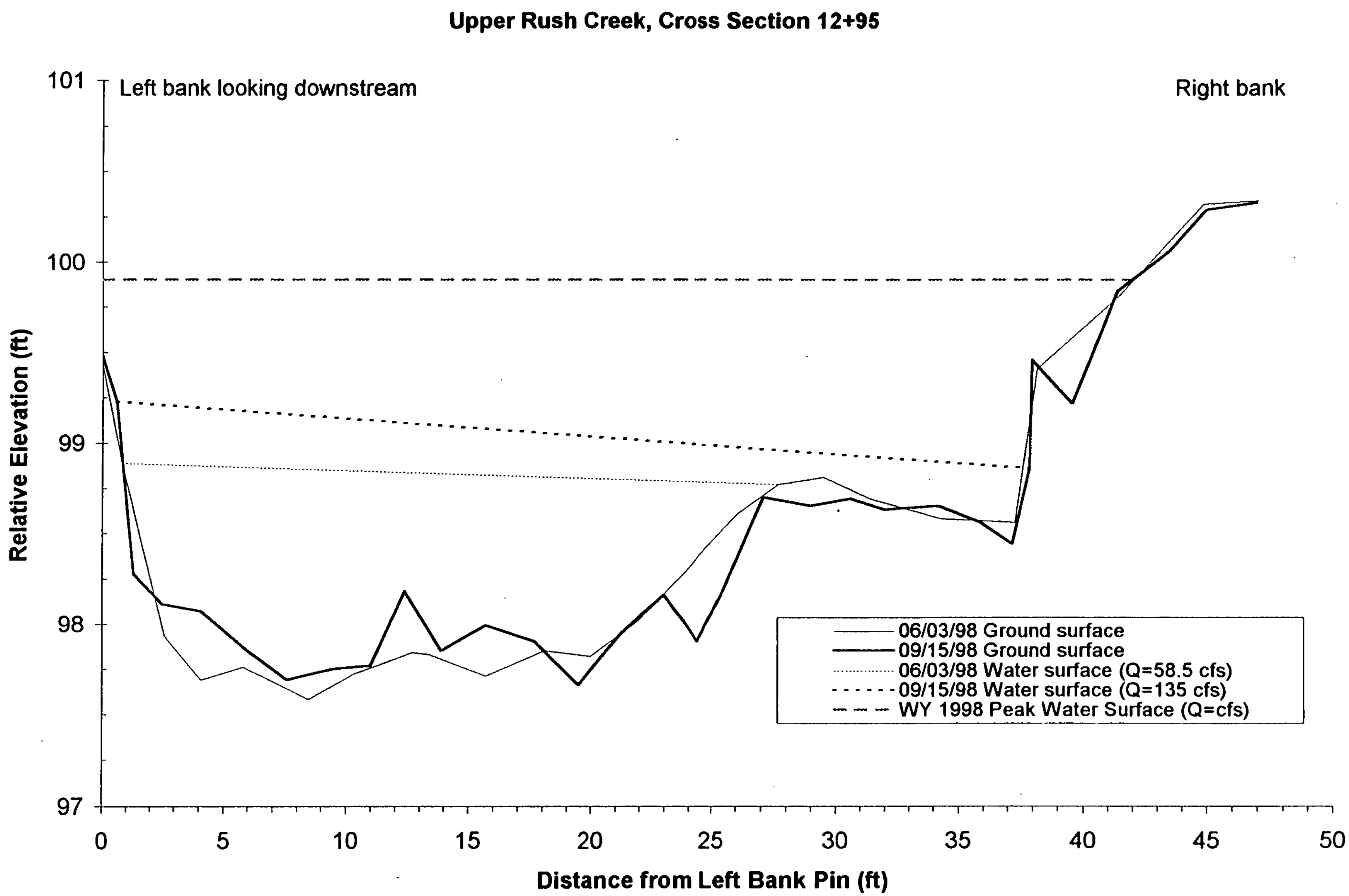
Upper Rush Creek, Cross Section 07+55
Left bank looking downstream
Right bank
Relative Elevation (ft)
106
104
102
100
98
96
94
92
90
88
86
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance from Left Bank Pin (ft)
Log sill forming plunge-pool
09/15/98 Ground surface
09/15/98 Water surface (Q=135 cfs)



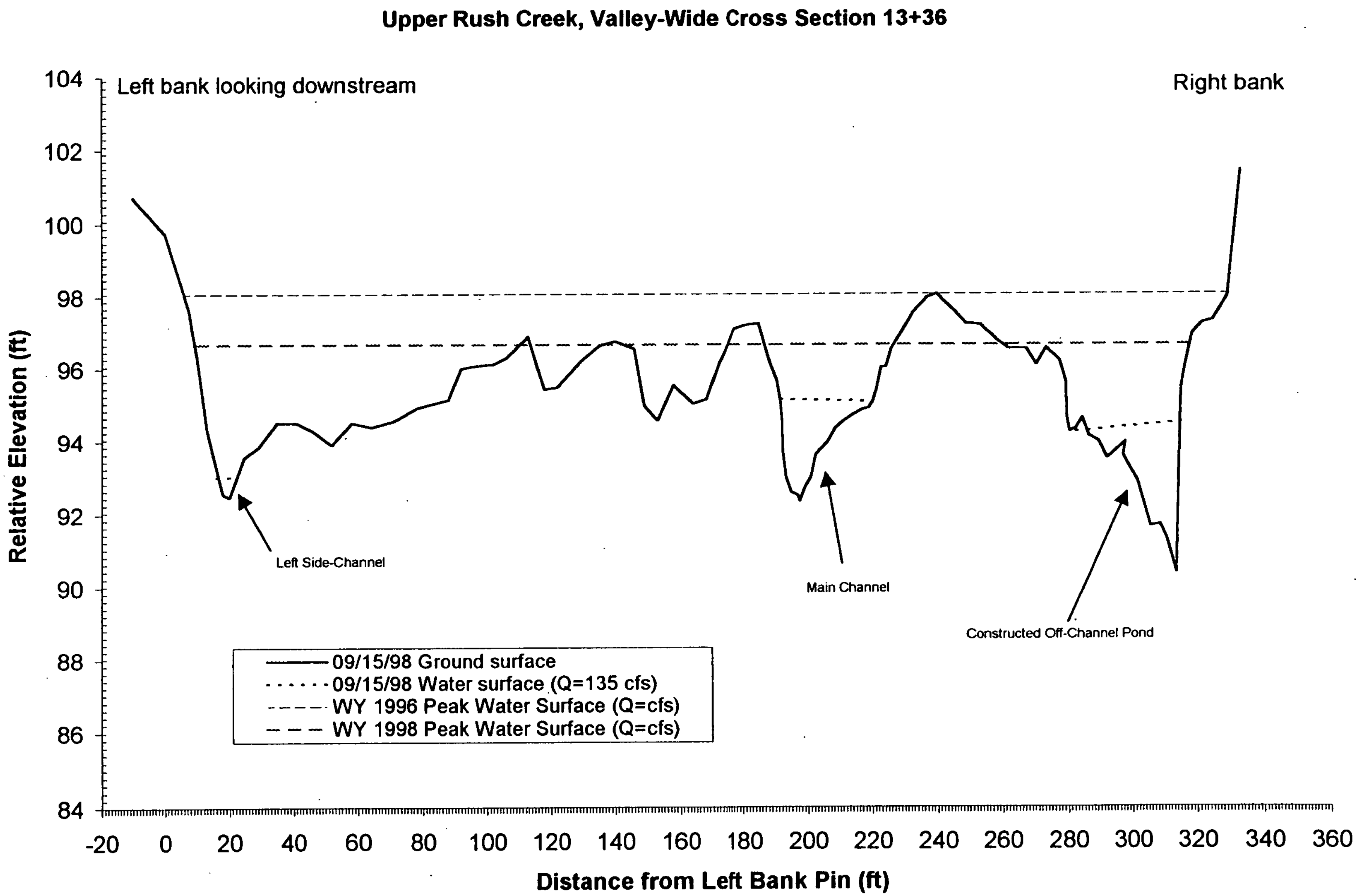
Upper Rush Creek, Cross Section 09+15
Left bank looking downstream
Right bank
Mid-Channel Bar and Rebar Pin
09/15/98 Ground surface
09/15/98 Water surface (Q=135 cfs)
WY 1998 Peak Water Surface (Q=cfs)
Relative Elevation (ft)
106
104
102
100
98
96
94
92
90
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Distance from Left Bank Pin (ft)

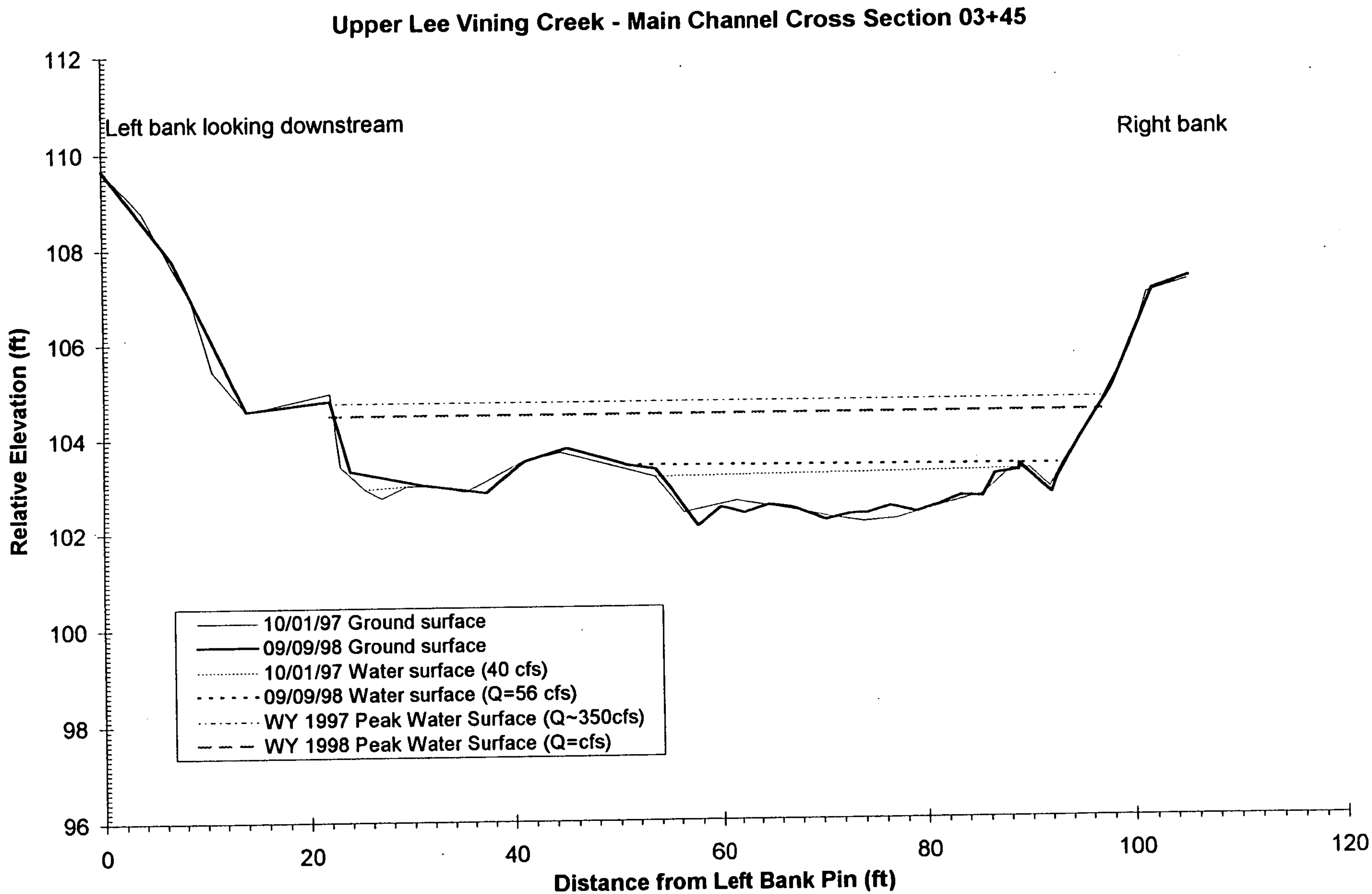


Upper Rush Creek, Cross Section 11+68
Left bank looking downstream
Right bank
Relative Elevation (ft)
106
104
102
100
98
96
94
92
90
0
5
10
15
20
25
30
35
Distance from Left Bank Pin (ft)
09/15/98 Ground surface
09/15/98 Water surface (Q=135 cfs)
WY 1998 Peak Water Surface (Q=cfs)

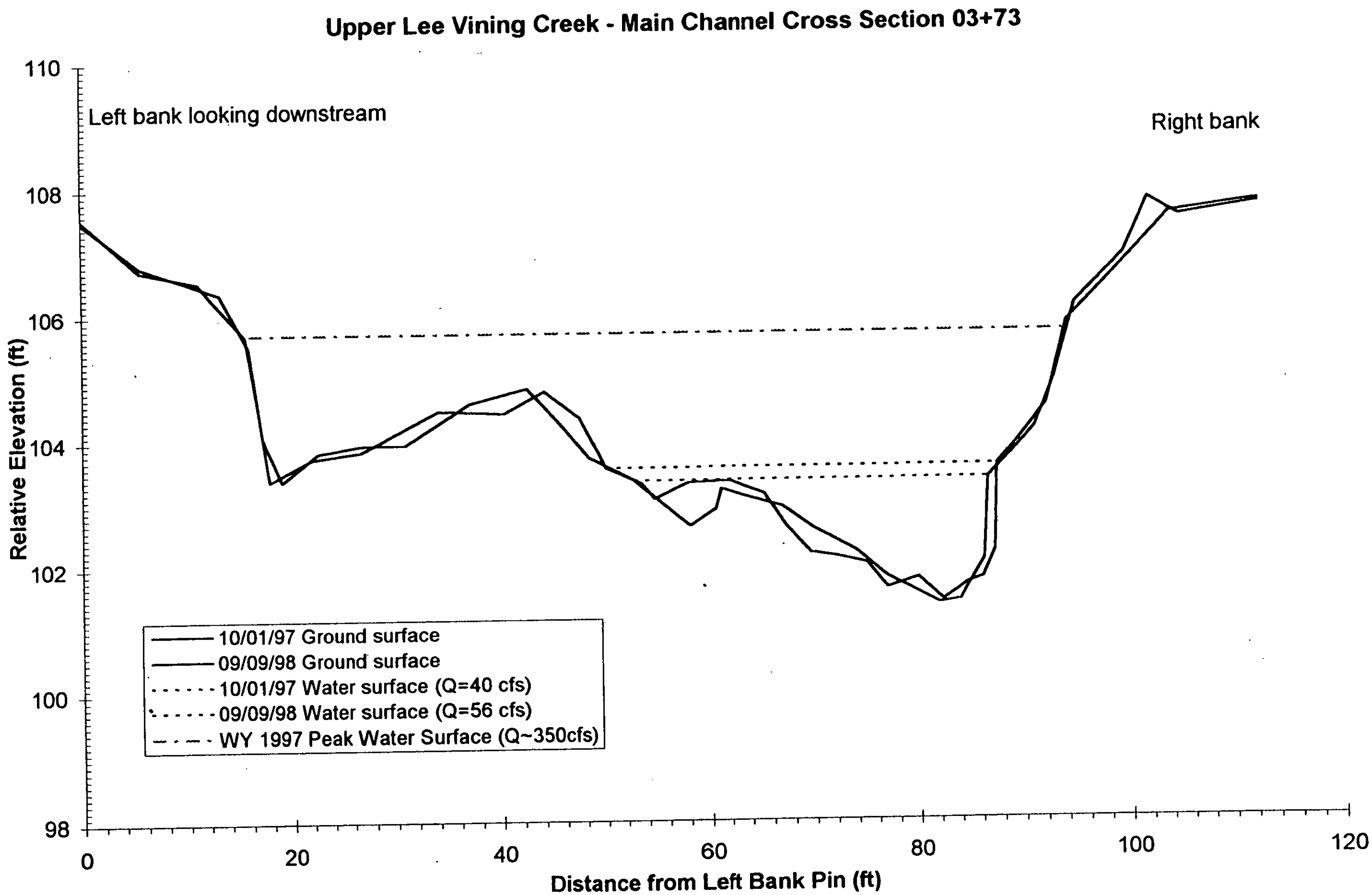


Upper Rush Creek, Cross Section 12+95
Left bank looking downstream
Right bank
101
100
99
98
97
Relative Elevation (ft)
0
5
10
15
20
25
30
35
40
45
50
Distance from Left Bank Pin (ft)
06/03/98 Ground surface
09/15/98 Ground surface
06/03/98 Water surface (Q=58.5 cfs)
09/15/98 Water surface (Q=135 cfs)
WY 1998 Peak Water Surface (Q=cfs)

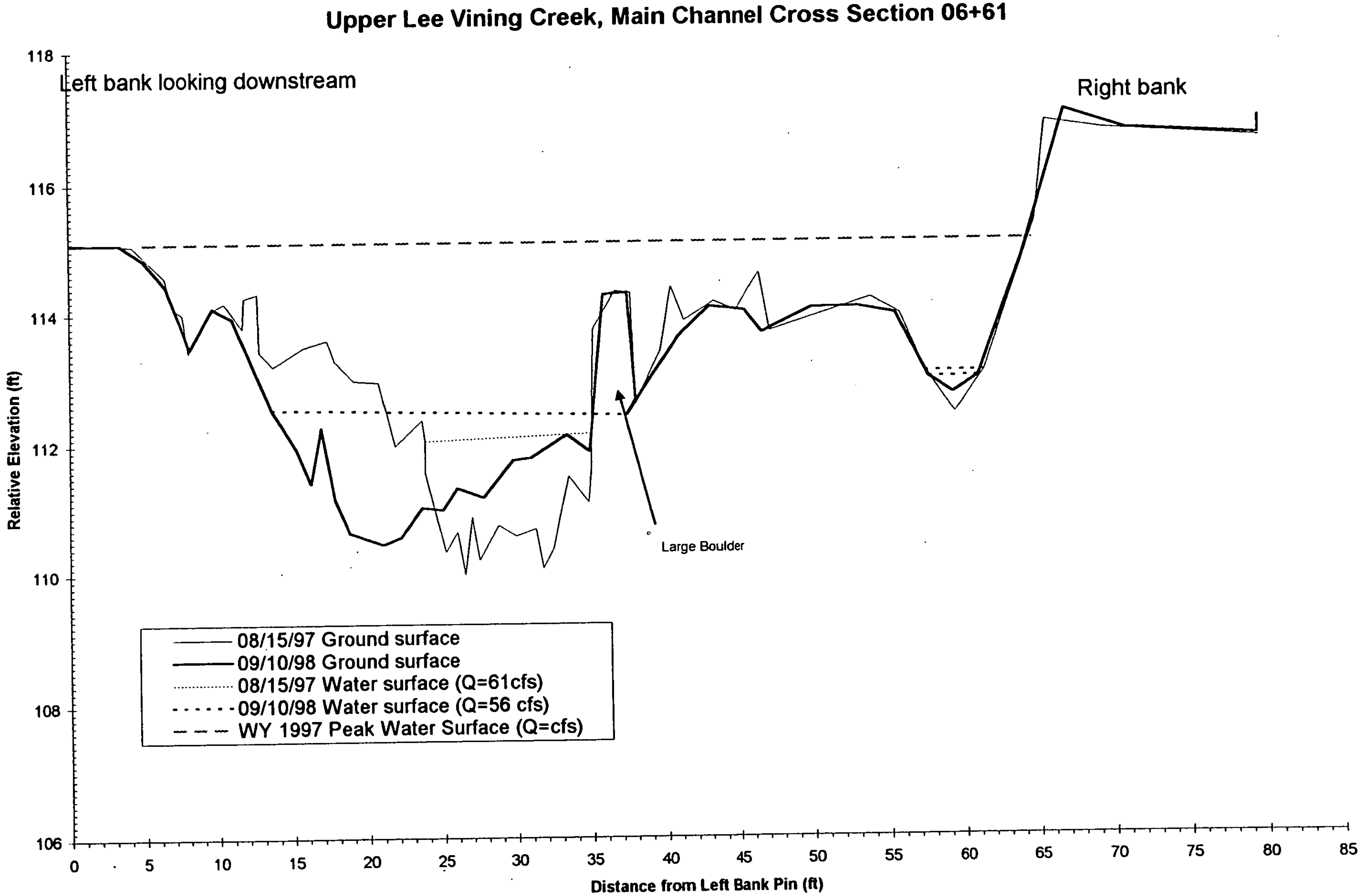

Upper Rush Creek, Valley-Wide Cross Section 13+36
Left bank looking downstream
Right bank
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
Left Side-Channel
Main Channel
Constructed Off-Channel Pond
09/15/98 Ground surface
09/15/98 Water surface (Q=135 cfs)
WY 1996 Peak Water Surface (Q=cfs)
WY 1998 Peak Water Surface (Q=cfs)
104
102
100
98
96
94
92
90
88
86
84
-20
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360



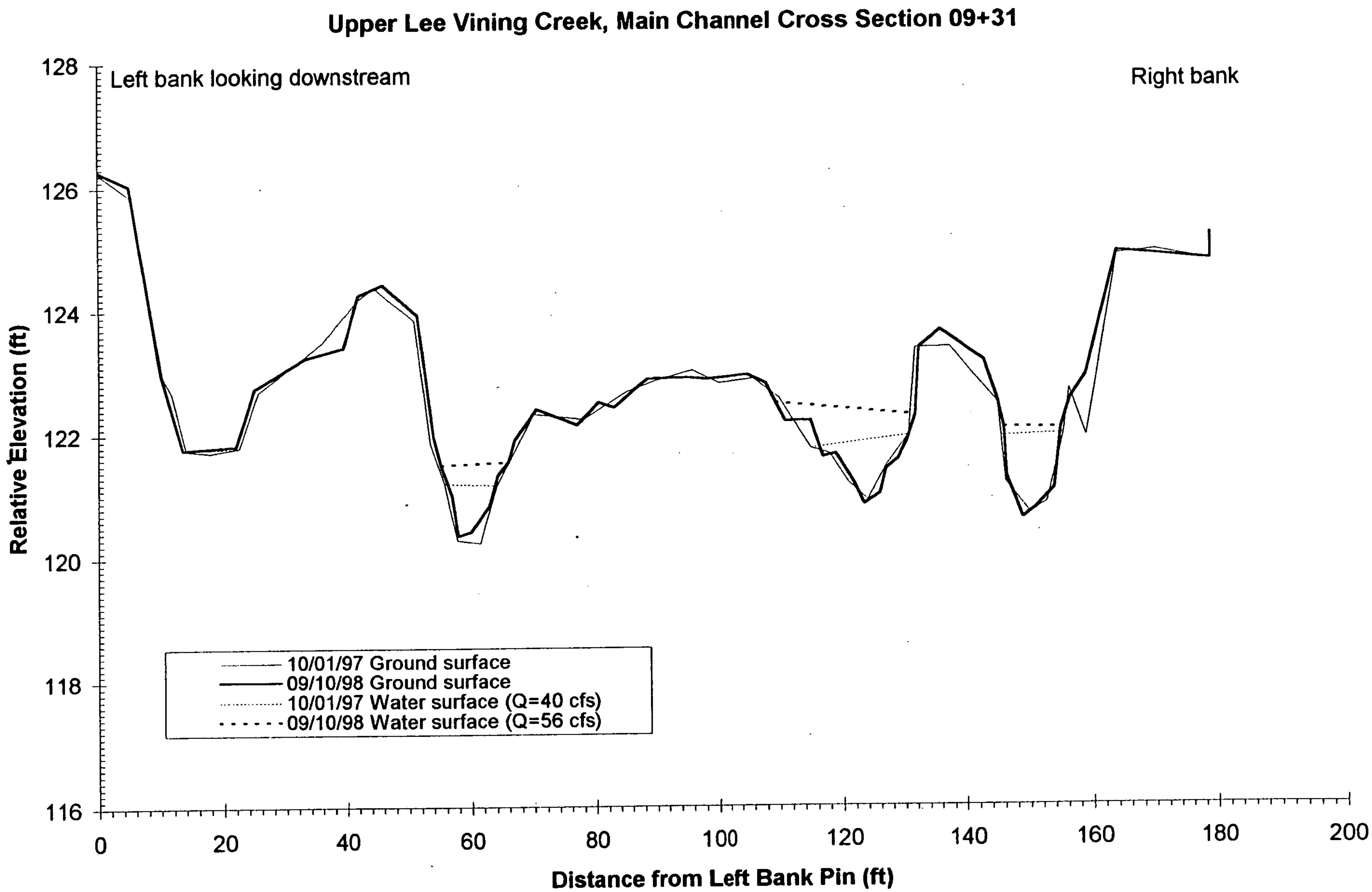
Upper Lee Vining Creek - Main Channel Cross Section 03+45
Left bank looking downstream
Right bank
Relative Elevation (ft)
112
110
108
106
104
102
100
98
96
0
20
40
60
80
100
120
Distance from Left Bank Pin (ft)
10/01/97 Ground surface
09/09/98 Ground surface
10/01/97 Water surface (40 cfs)
09/09/98 Water surface (Q=56 cfs)
WY 1997 Peak Water Surface (Q~350cfs)
WY 1998 Peak Water Surface (Q=cfs)



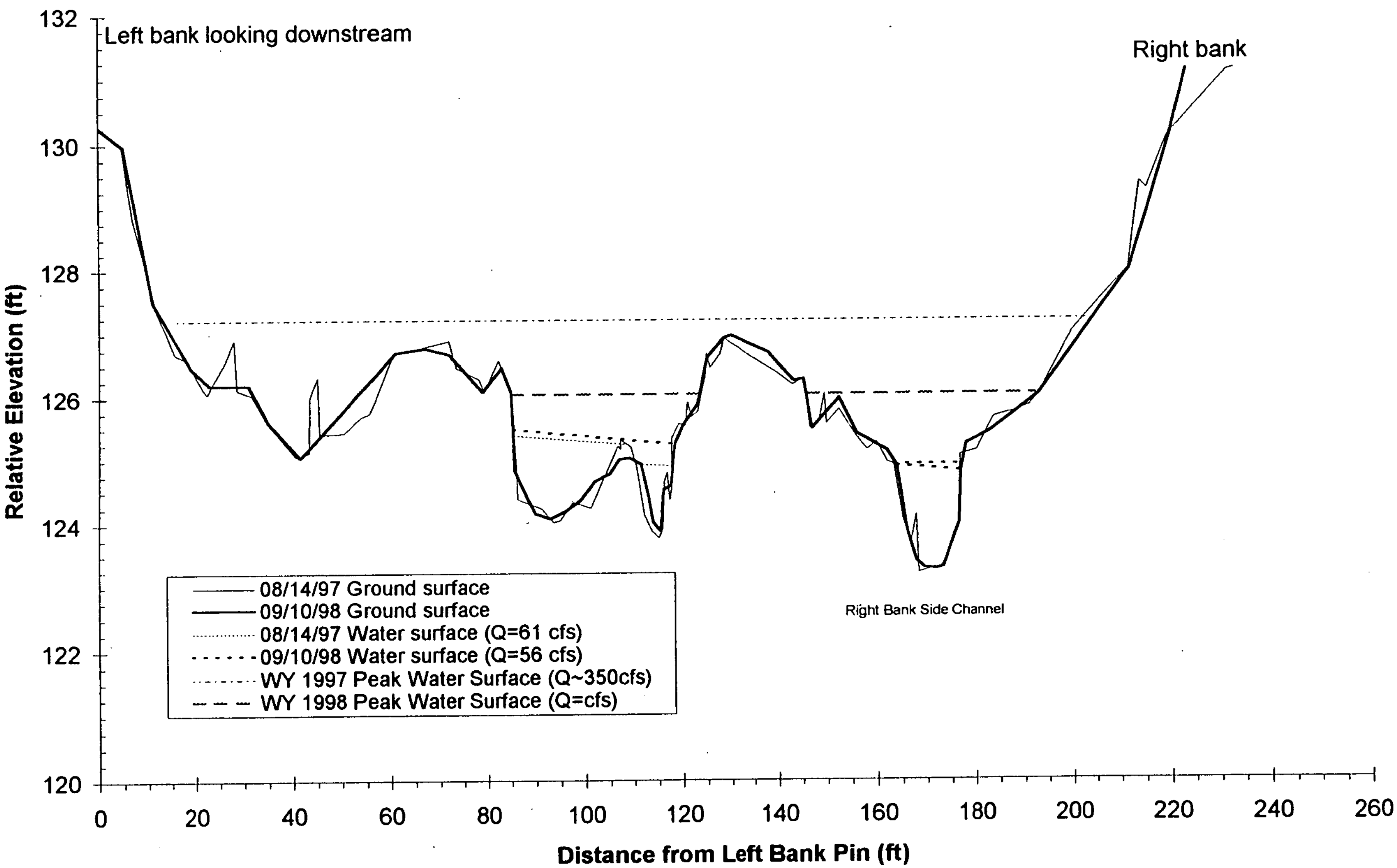
Upper Lee Vining Creek - Main Channel Cross Section 03+73
Left bank looking downstream
Right bank
Relative Elevation (ft)
110
108
106
104
102
100
98
0
20
40
60
80
100
120
Distance from Left Bank Pin (ft)
10/01/97 Ground surface
09/09/98 Ground surface
10/01/97 Water surface (Q=40 cfs)
09/09/98 Water surface (Q=56 cfs)
WY 1997 Peak Water Surface (Q~350cfs)



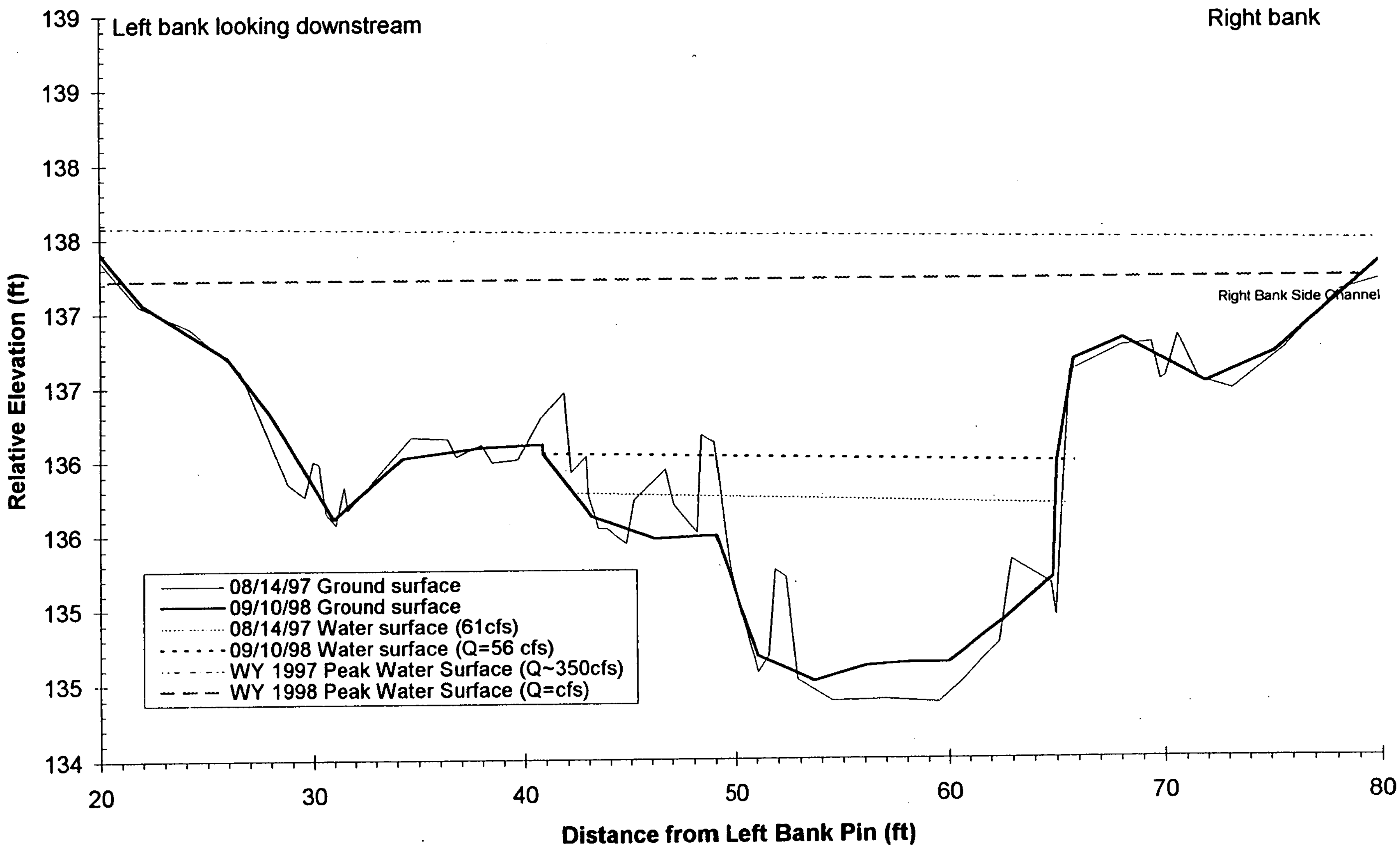
Upper Lee Vining Creek, Main Channel Cross Section 06+61
Left bank looking downstream
Right bank
Large Boulder
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
118
116
114
112
110
108
106
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
08/15/97 Ground surface
09/10/98 Ground surface
08/15/97 Water surface (Q=61cfs)
09/10/98 Water surface (Q=56 cfs)
WY 1997 Peak Water Surface (Q=cfs)

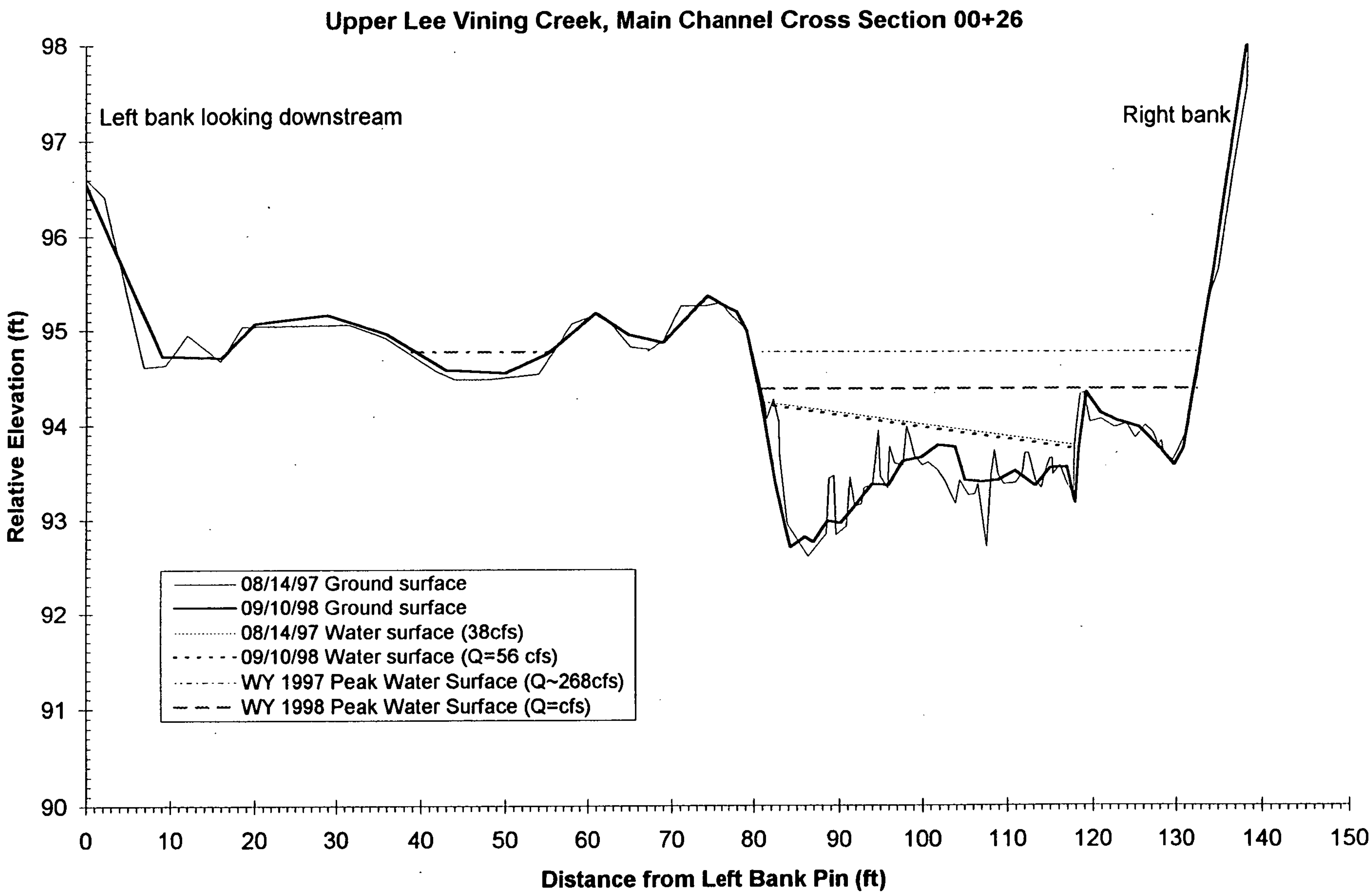

Upper Lee Vining Creek, Main Channel Cross Section 09+31
Left bank looking downstream
Right bank
Relative Elevation (ft)
128
126
124
122
120
118
116
0
20
40
60
80
100
120
140
160
180
200
Distance from Left Bank Pin (ft)
10/01/97 Ground surface
09/10/98 Ground surface
10/01/97 Water surface (Q=40 cfs)
09/10/98 Water surface (Q=56 cfs)

Upper Lee Vining Creek, Main Channel Cross Section 10+44



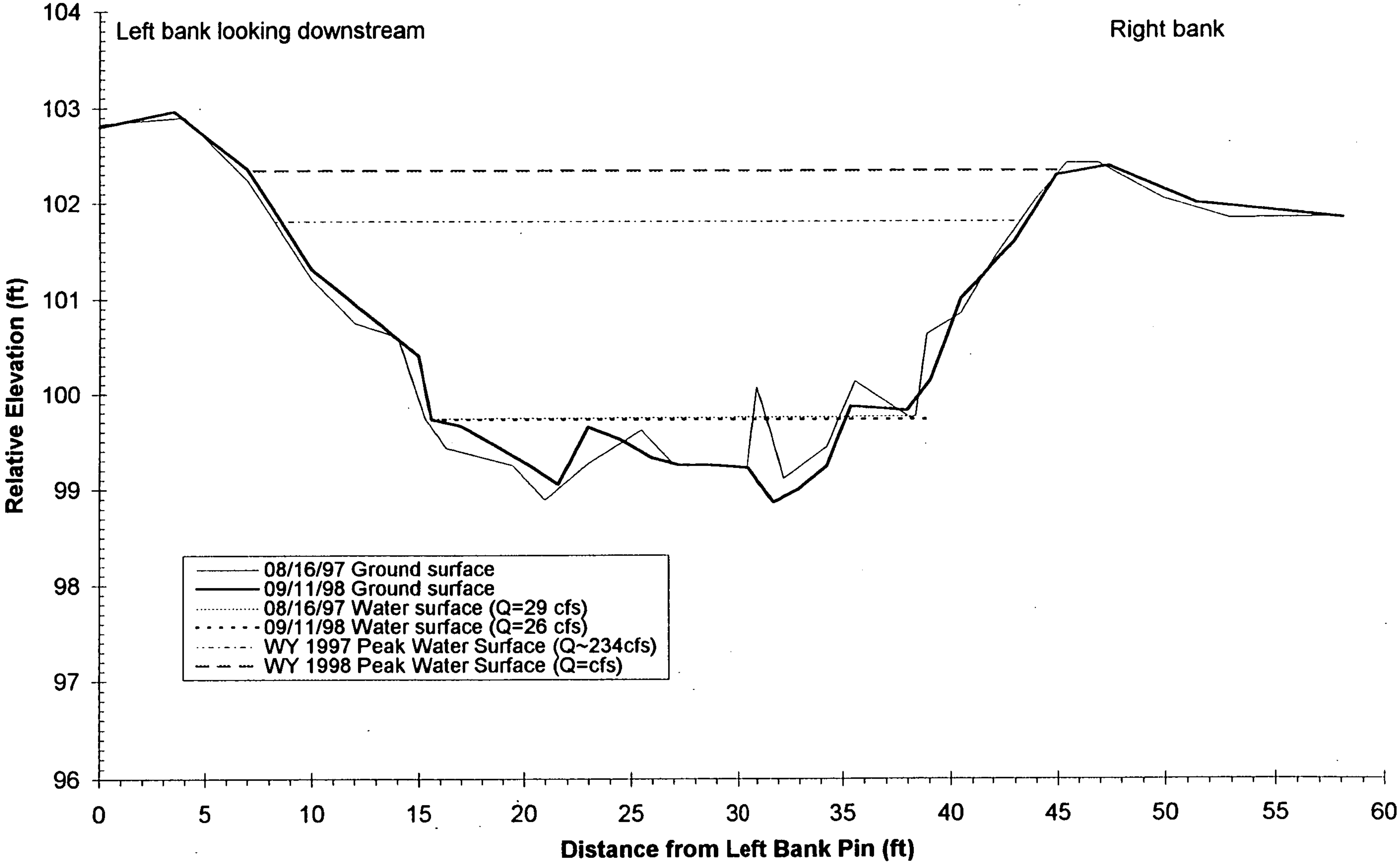
Upper Lee Vining Creek, Main Channel Cross Section 13+92

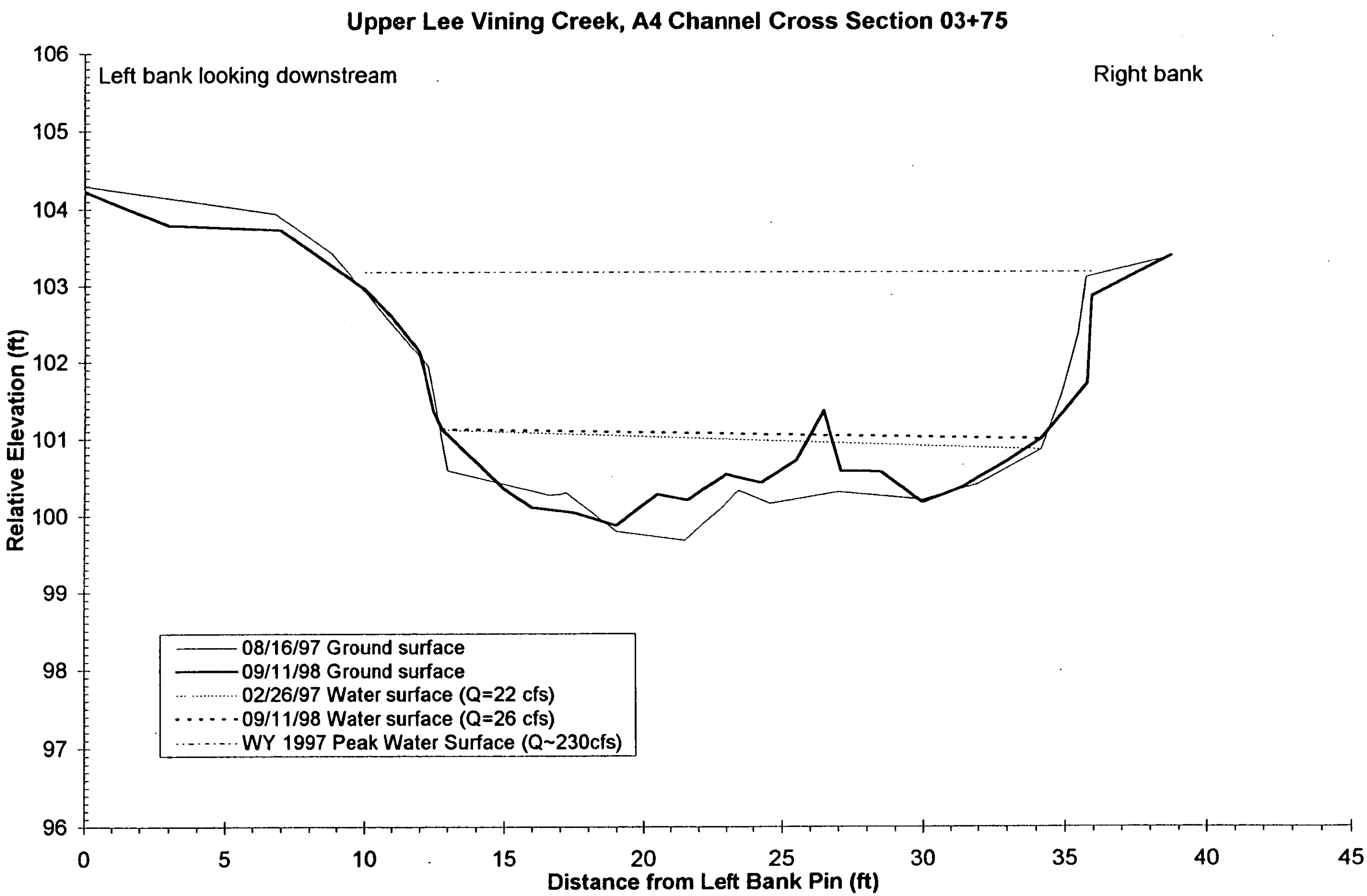




Upper Lee Vining Creek, Main Channel Cross Section 00+26
Left bank looking downstream
Right bank
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
98
97
96
95
94
93
92
91
90
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
08/14/97 Ground surface
09/10/98 Ground surface
08/14/97 Water surface (38cfs)
09/10/98 Water surface (Q=56 cfs)
WY 1997 Peak Water Surface (Q~268cfs)
WY 1998 Peak Water Surface (Q=cfs)

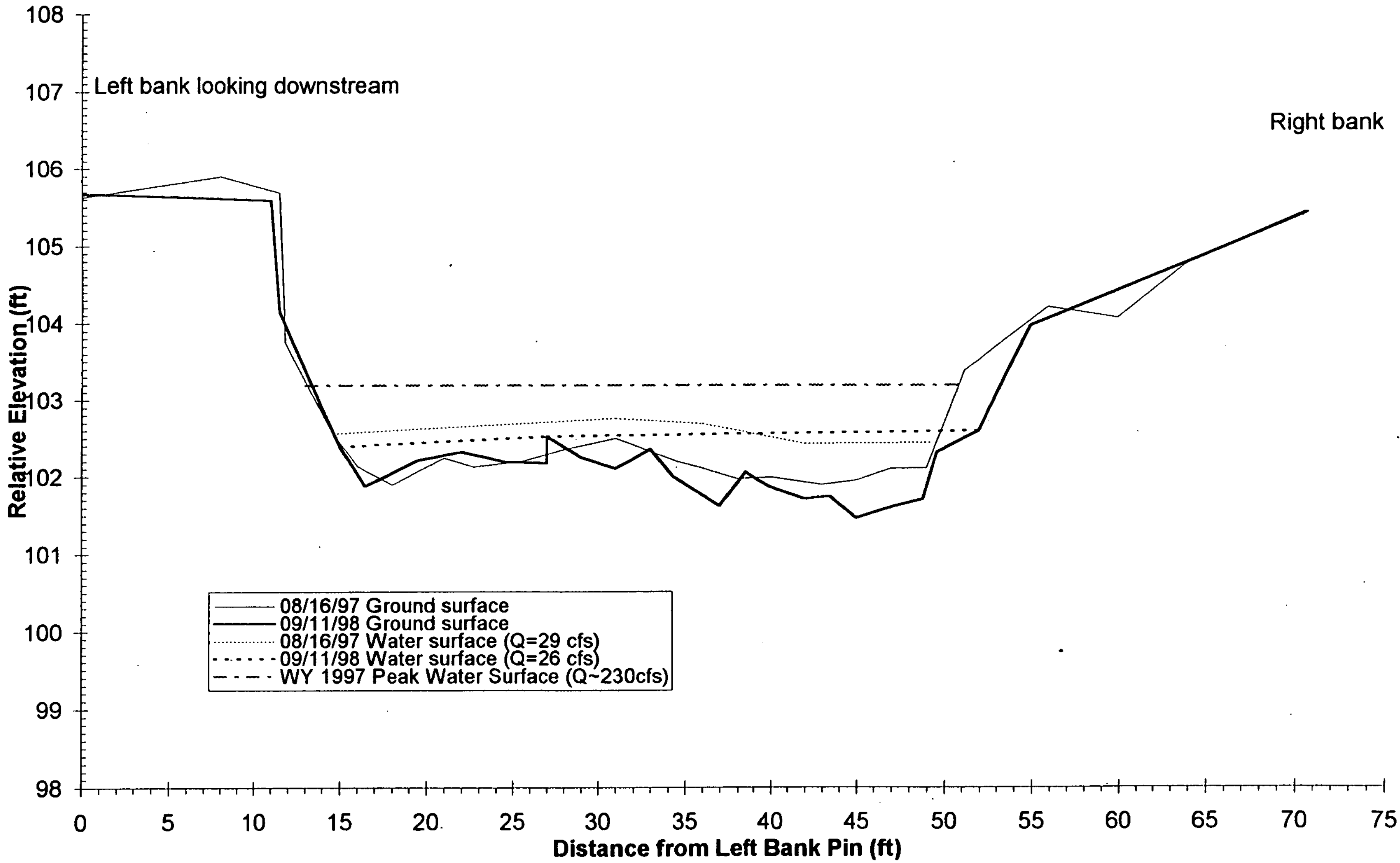
Upper Lee Vining Creek, A4 Channel Cross Section 03+29

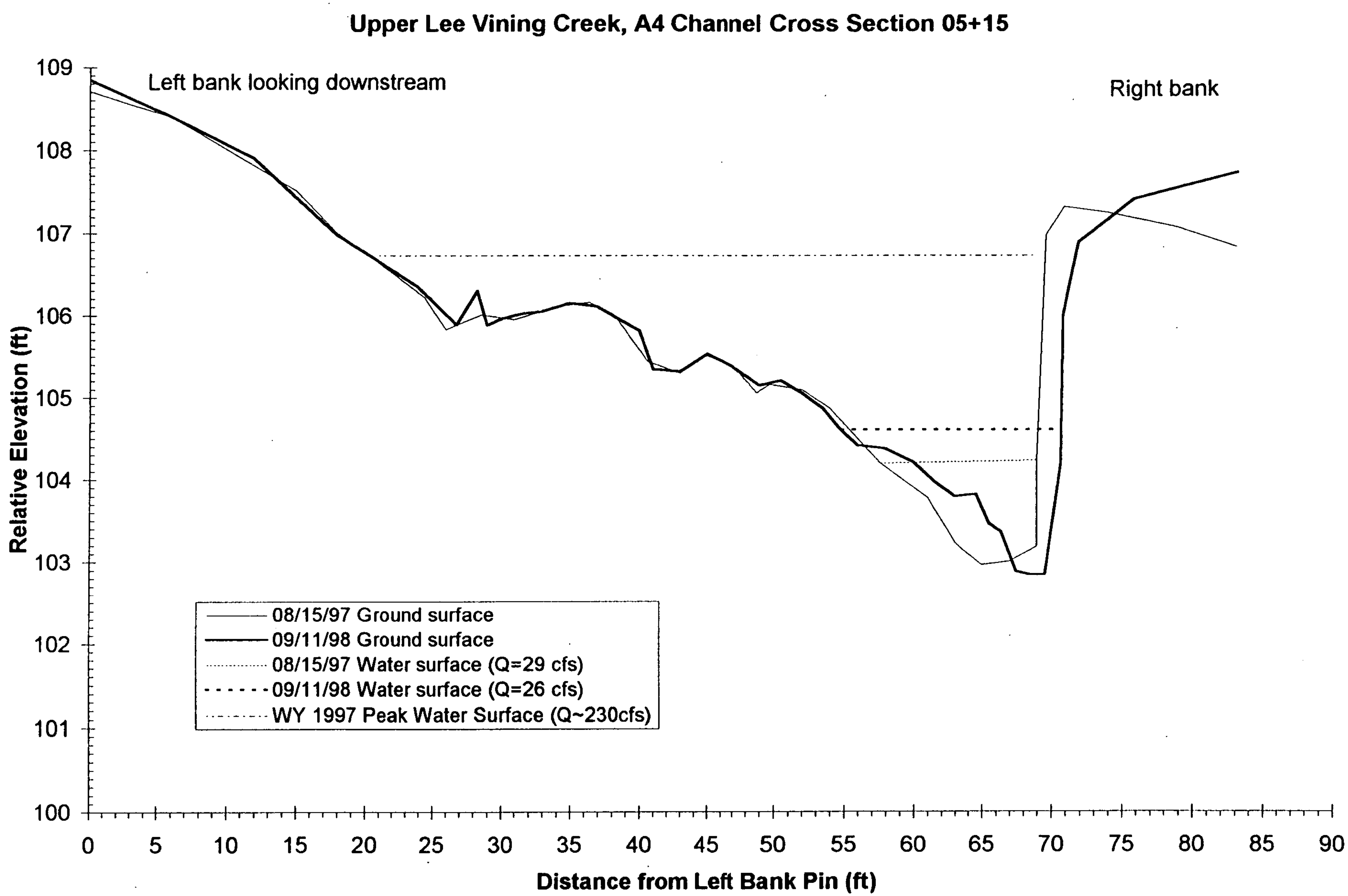


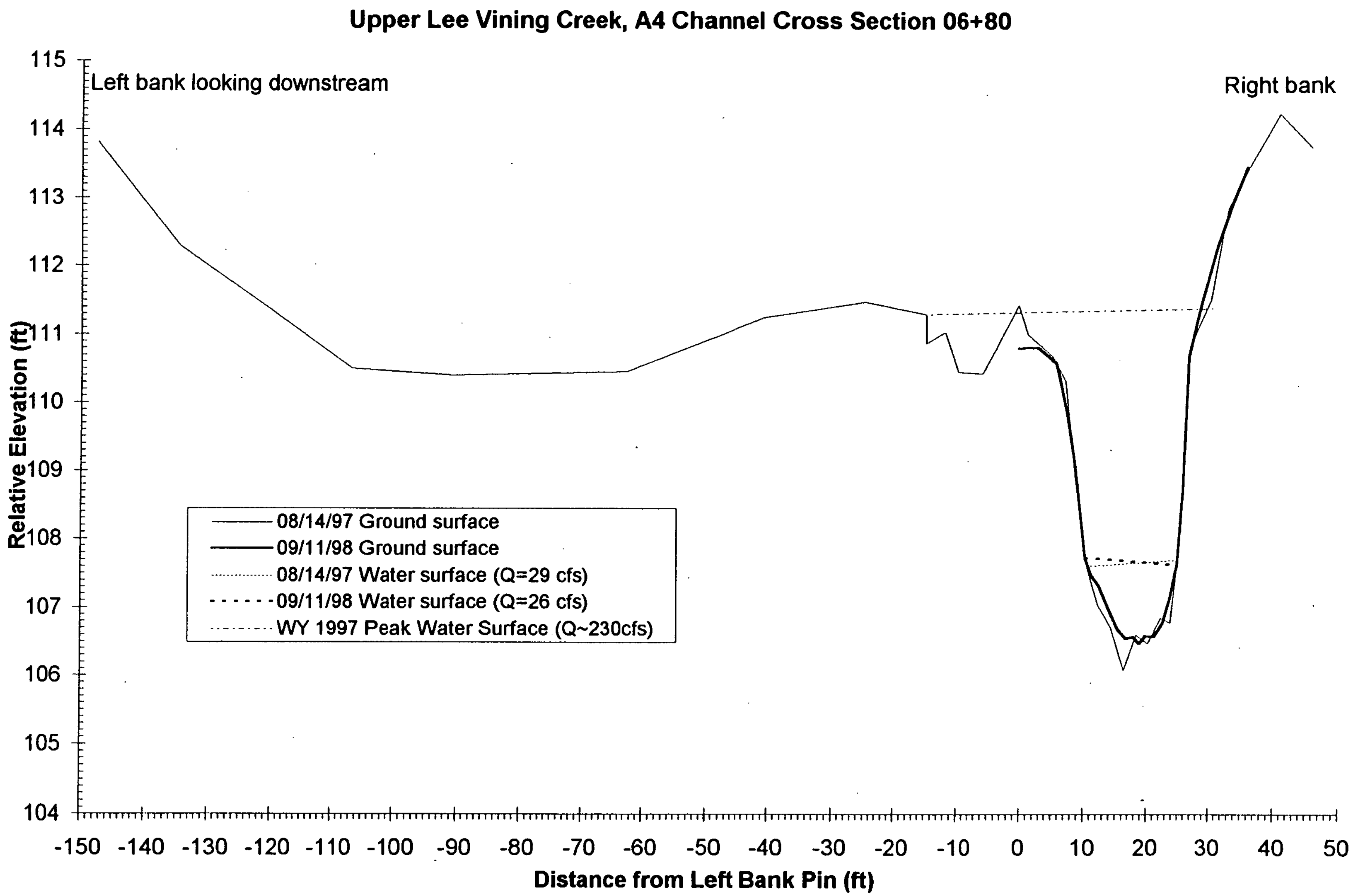


Upper Lee Vining Creek, A4 Channel Cross Section 03+75
Left bank looking downstream
Right bank
Relative Elevation (ft)
106
105
104
103
102
101
100
99
98
97
96
0
5
10
15
20
25
30
35
40
45
Distance from Left Bank Pin (ft)
08/16/97 Ground surface
09/11/98 Ground surface
02/26/97 Water surface (Q=22 cfs)
09/11/98 Water surface (Q=26 cfs)
WY 1997 Peak Water Surface (Q~230cfs)

Upper Lee Vining Creek, A4 Channel Cross Section 04+04

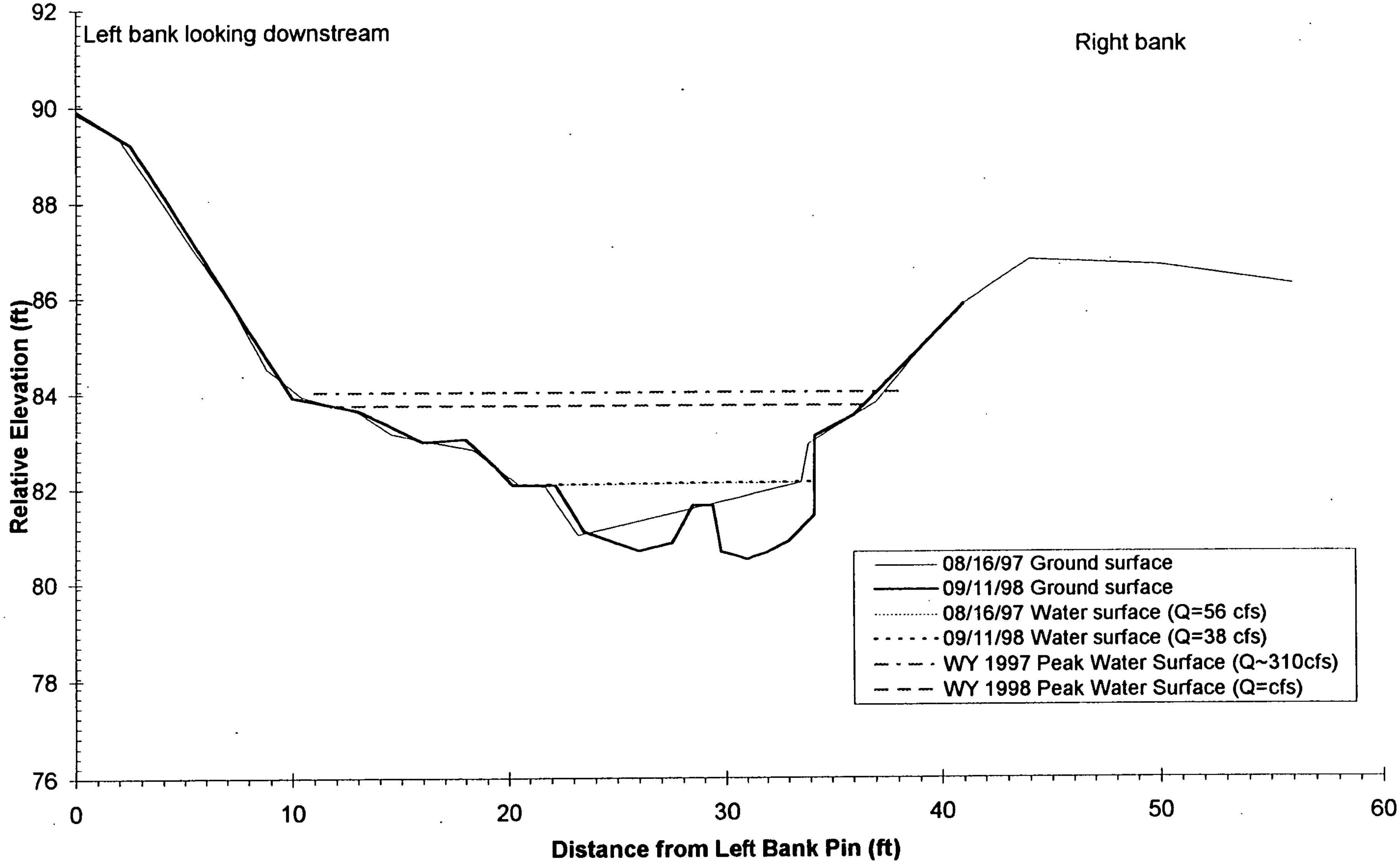


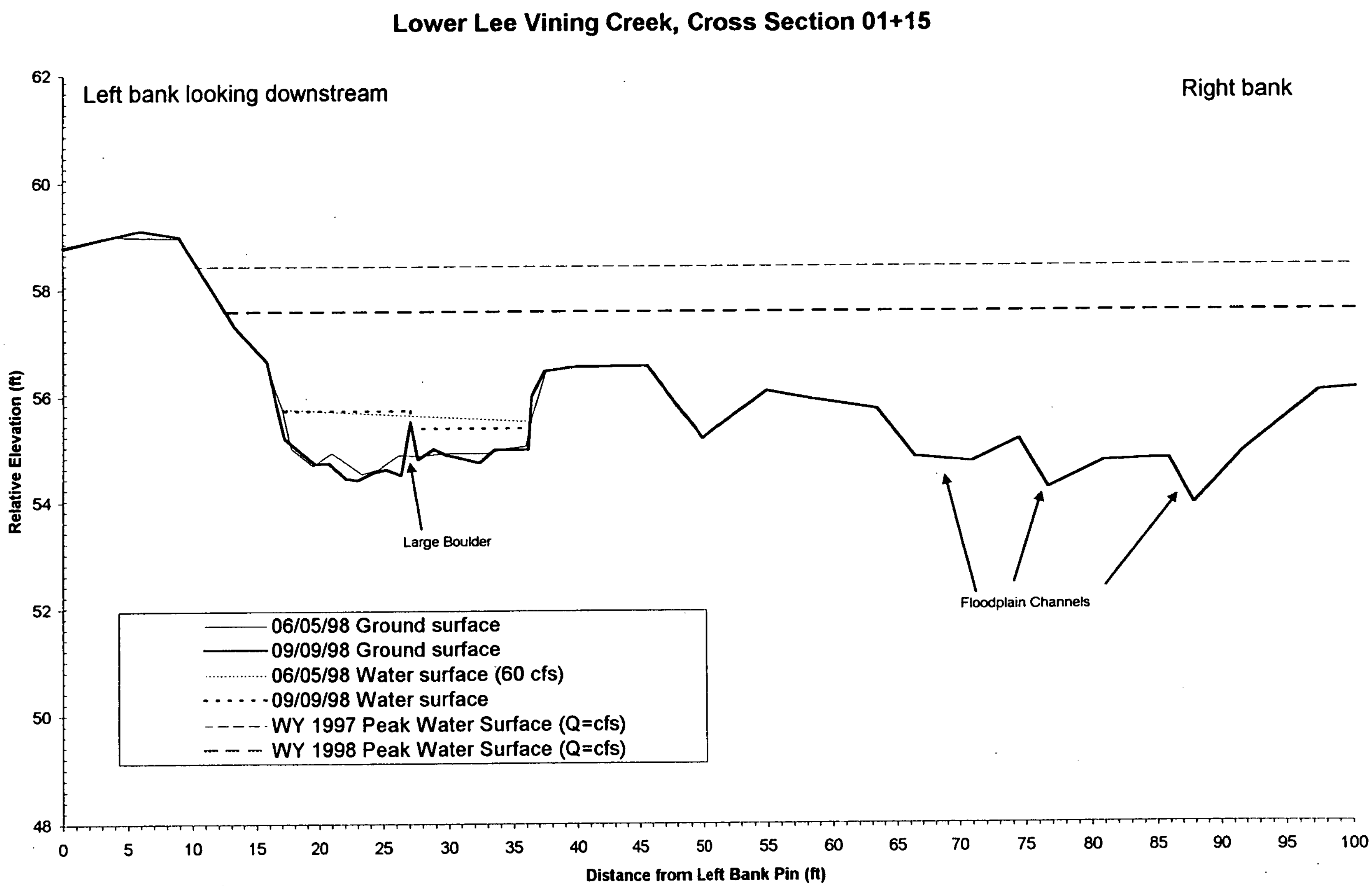

Upper Lee Vining Creek, A4 Channel Cross Section 05+15
Left bank looking downstream
Right bank
Relative Elevation (ft)
Distance from Left Bank Pin (ft)
109
108
107
106
105
104
103
102
101
100
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
08/15/97 Ground surface
09/11/98 Ground surface
08/15/97 Water surface (Q=29 cfs)
09/11/98 Water surface (Q=26 cfs)
WY 1997 Peak Water Surface (Q~230cfs)



Upper Lee Vining Creek, A4 Channel Cross Section 06+80
Left bank looking downstream
Right bank
Relative Elevation (ft)
115
114
113
112
111
110
109
108
107
106
105
104
08/14/97 Ground surface
09/11/98 Ground surface
08/14/97 Water surface (Q=29 cfs)
09/11/98 Water surface (Q=26 cfs)
WY 1997 Peak Water Surface (Q~230cfs)
-150 -140 -130 -120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50
Distance from Left Bank Pin (ft)

Upper Lee Vining Creek, B1 Channel Cross Section 06+08, Bed Surface Mobility Modelling Cross Section




Lower Lee Vining Creek, Cross Section 01+15
Left bank looking downstream
Right bank
Relative Elevation (ft)
62
60
58
56
54
52
50
48
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Distance from Left Bank Pin (ft)
Large Boulder
Floodplain Channels
06/05/98 Ground surface
09/09/98 Ground surface
06/05/98 Water surface (60 cfs)
09/09/98 Water surface
WY 1997 Peak Water Surface (Q=cfs)
WY 1998 Peak Water Surface (Q=cfs)