Watermark Engineering, Inc.

TECHNICAL MEMORANDUM

DATE: November 17, 1999

TO: Mr. Stephen J. Jones
Placer County Water Agency
P.O. Box 667
Foresthill, CA 95631

FROM: Patrick L. Stiehr, P.E. PLS

RE: Scour Evaluation at MF American River below Ralston Afterbay

INTRODUCTION

A gaging station at Middle Fork American River near Foresthill, CA (USGS No. 11-4333.00) provides stream flow data for this reach of the river. The USGS operated the gage from 1958 through 1986. Pearce Hydrology, Inc. then operated the gage for two years. Since 1989, Surface Water Data, Inc. (SWD) has operated the gage and provides the stream flow records that continue to be published by the USGS.

Periodic current meter measurements (CMM) have been made at the site to define the rating. A rating is the relation between gage height (river stage) and discharge and is an integral component of the data collection, analysis and generation of stream flow records. There are two types of CMM made at this site. During low-flow periods, (±100 cfs), wading measurements are made upstream of the gage and cableway. Wading has become more difficult over time and is not possible at higher flows. Cableway measurements are made most of the time.

The cableway measurements generally include approximately 22-30 soundings that provide an estimate of water depth along the measurement section. By converting water depths to elevations (gage datum), the measurements can provide a history of the channel section at the cableway. Comparison of the various CMM provide information concerning any changes that may occur in the channel.

Ralston Afterbay, constructed from 1964 through 1966 is located approximately 1.6 miles upstream of the gage site. Dams of this nature trap aggregate material that normally is carried downstream as part of the natural river processes. Downstream of dams, rivers generally continue to carry material farther downstream. Without a source of new material, a riverbed will generally degrade (scour) until the stream energy is equal to or less than the energy needed to move additional material. Armoring is when the size gradation of the streambed material is sufficiently large to prevent additional movement by the water forces. Typically of mountain rivers below dams, armoring occurs when the streambed consists of very large rock or bedrock that prevents further degradation

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PURPOSE

Typical of dams, the Ralston Afterbay has accumulated significant sediment deposits over the year. Casual observation of the river below the dam indicates significant scour has occurred. The purpose of this study is to provide a more formal review of available information to document the extent of the degradation.

Placer County Water Agency is interested in passing inflowing sediments and aggregate to slow down the rate at which the reservoir is filling with material, and to provide a source of natural aggregate to the river downstream of the dam. It is expected that the release of aggregate would raise the bottom of the river, provide a wider channel, and provide desirable fish habitat.

ANALYSIS

A total of 125 cableway CMM from April 1980 to May 1999 were reviewed. Rather than show plots of 125 measurements, selected measurements of similar stage were plotted to show changes over several time periods.

Figure 1 provides a comparison of the river section under the cableway between a CMM made April 1980 and a CMM made February 1982. The plot shows significant fill along the left side (looking downstream) and scour within the deeper right bank portion of the channel.

Information from SWD personnel that collected the field data and made the measurements indicated there was some gravel or gold mining within the left bank area during this time period. A reasonable observation of Figure 1 is that, during high flow, upstream materials filled the left bank portion of the channel, but higher velocities and scour occurred within the right bank portion of the channel.

Figure 2 compares cableway measurements made February 1982 and May 1983 at similar stages. The plot shows some scour on the left bank side but also shows very significant scour of almost 4 feet on the right bank side. Clearly, the main channel and most of the flow became concentrated on the right side because of the scour.

Figure 3 provides a comparison of the channel during measurements made in May 1983 and then before (January 1986) and after the high flow period that occurred in late February. Additional fill on the right bank side occurred in the two plus years from 1983 to January 1986 while the right side of the channel remained relatively stable

Note the significant scour that occurred on the left side of the deep channel, undoubtedly as a result of the high flow during late February. Please also note that the left bank portion of the old channel is above the water level and no longer contributes to the conveyance at this flow rate.

Information from SWD personnel that made the CMM during this time period indicate the channel flowline was near bedrock, so less vertical scour would be expected.

Figure 4 shows minimal channel changes from 1986 through April 1993. There was some scour along the left bank but the channel remained stable for about seven years. There were some high flows during this period but no significantly high flows.

There is a minor source of aggregate material from the unregulated North Fork of Middle Fork American River, which has a tributary area of approximately 92 square miles. That tributary discharges into the middle fork between the Afterbay and the gage site. As a comparison, the unregulated watershed area of the Middle Fork above Ralston is 214 square miles. There is also 214 square miles of regulated watershed also above Ralston Afterbay.

Figure 5 shows a comparison of measurements made in 1993, 1995 and 1999. The extreme flow period in early 1997 greatly accelerated the scour process at the cableway. As described earlier, the channel flow line and right bank side was at or near bedrock, so continued scour vertically or to the right was unlikely. The stream energy, at high flow, was sufficiently high to cause the additional scour along the left bank of the channel.

The last plot, Figure 6, provides a comparison of the first measurement within the analysis period and one of the more recent measurements made in 1999. In general terms, the scour depth extends an average of seven feet over a width of about 70 feet. This represents a loss of nearly 500 cubic feet of material per lineal foot of channel.

RESULTS

The comparison plots of the selected measurements clearly showed extensive channel scour during the study period. The scour was not uniform and varied significantly, generally as a result of high flows. Scour proceeded on the right bank portion of the channel, starting as a narrow deep section about 20 feet wide. Fourteen years later, the scour extended almost 70 feet wide to bedrock.

SUMMARY AND CONCLUSIONS

Stream flow current-meter measurements made from 1980 through 1999 were analyzed to determine the extent of scour that has occurred below Ralston Afterbay. The dam at the Afterbay has blocked the normal movement of aggregate material along the river. The stream energy, especially at high flow, is sufficient to move large quantities of aggregate material. The force of the water has scoured the available material. Without new material from upstream sources, the channel has degraded until bedrock and/or armoring has slowed the process. The comparison of measurement sections at the cableway clearly shows extensive scour and a deep narrow river section compared to a wider, shallower section in the past.

Figure 1. Comparison of 4/23/80 (1940cfs) and 2/26/82 (3210 cfs)

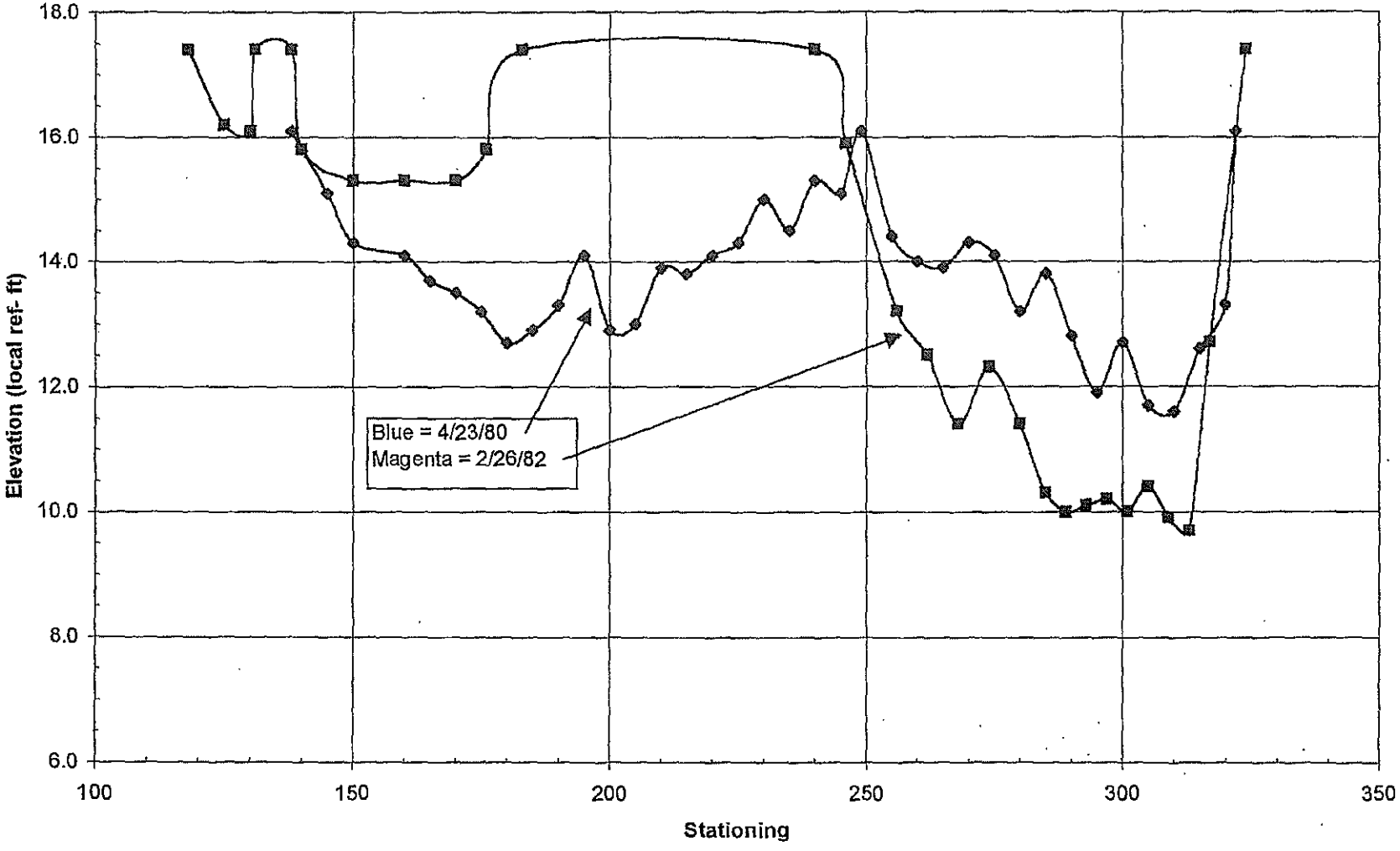


Figure 2. Comparison of 2/26/82 (3,210 cfs) and 5/3/83 (3,920 cfs)

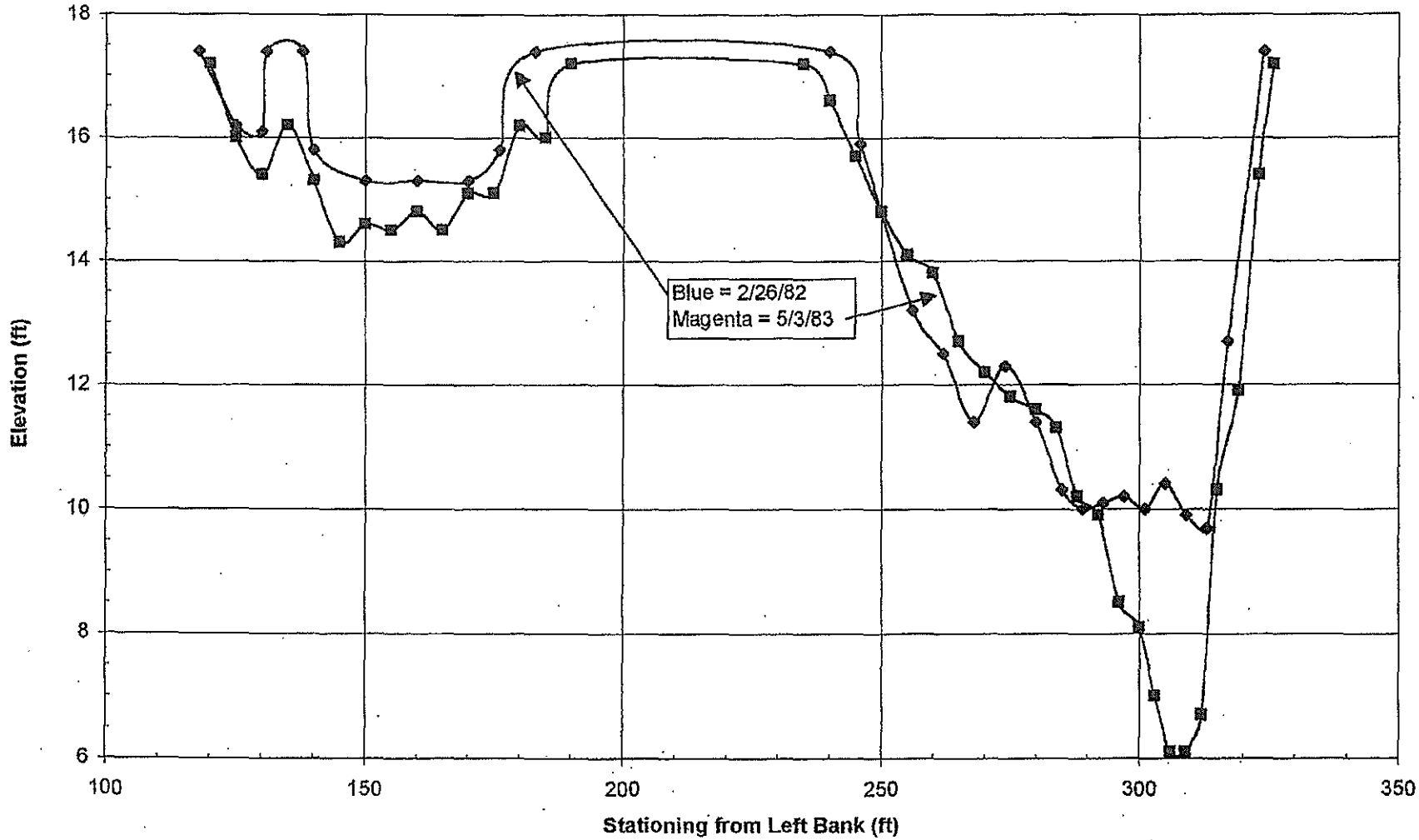


Figure 3. Comparison- 5/3/83, 1/8/86 and 3/31/86

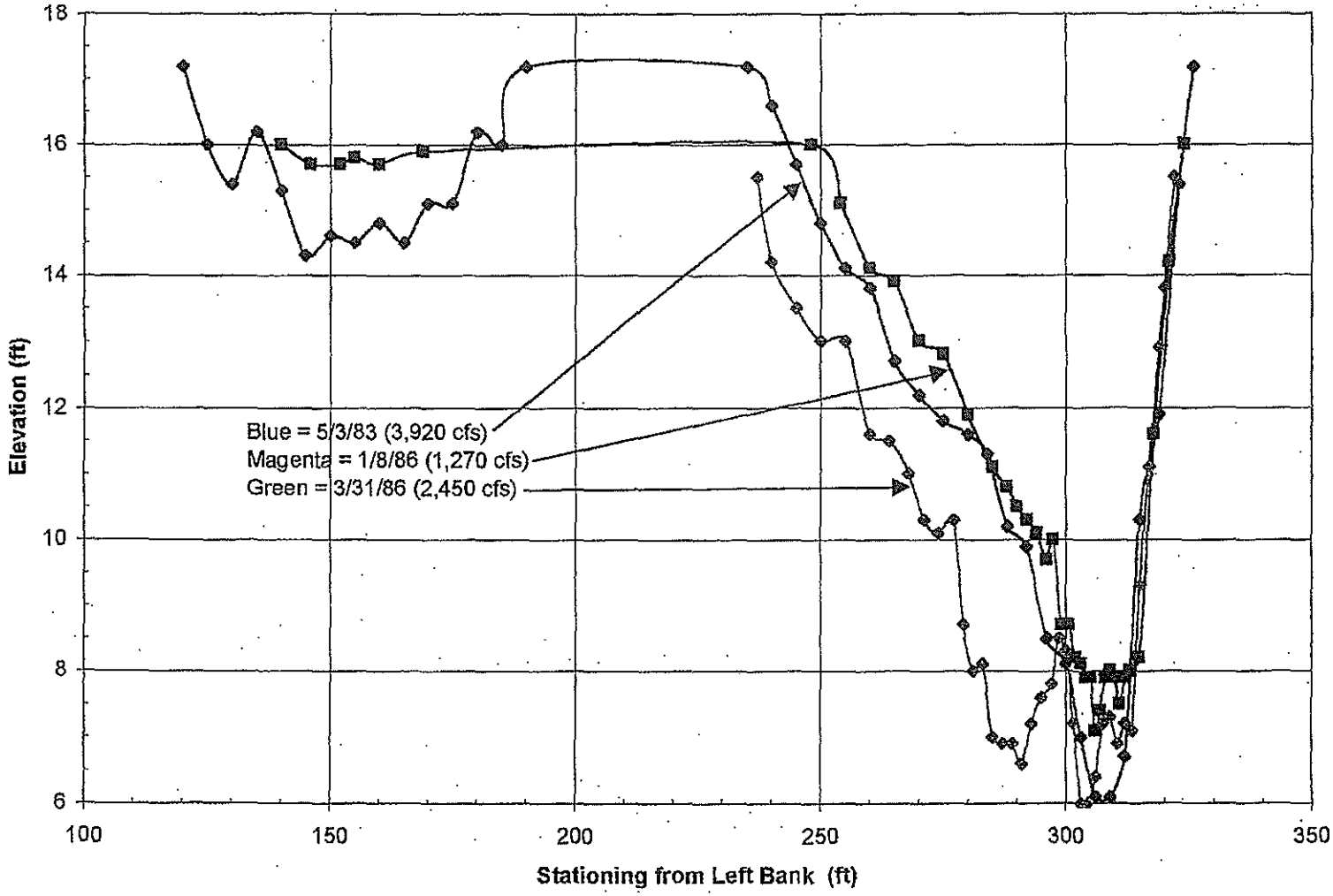


Figure 4. Comparison of 3/31/86, 4/3/89 and 4/2/93

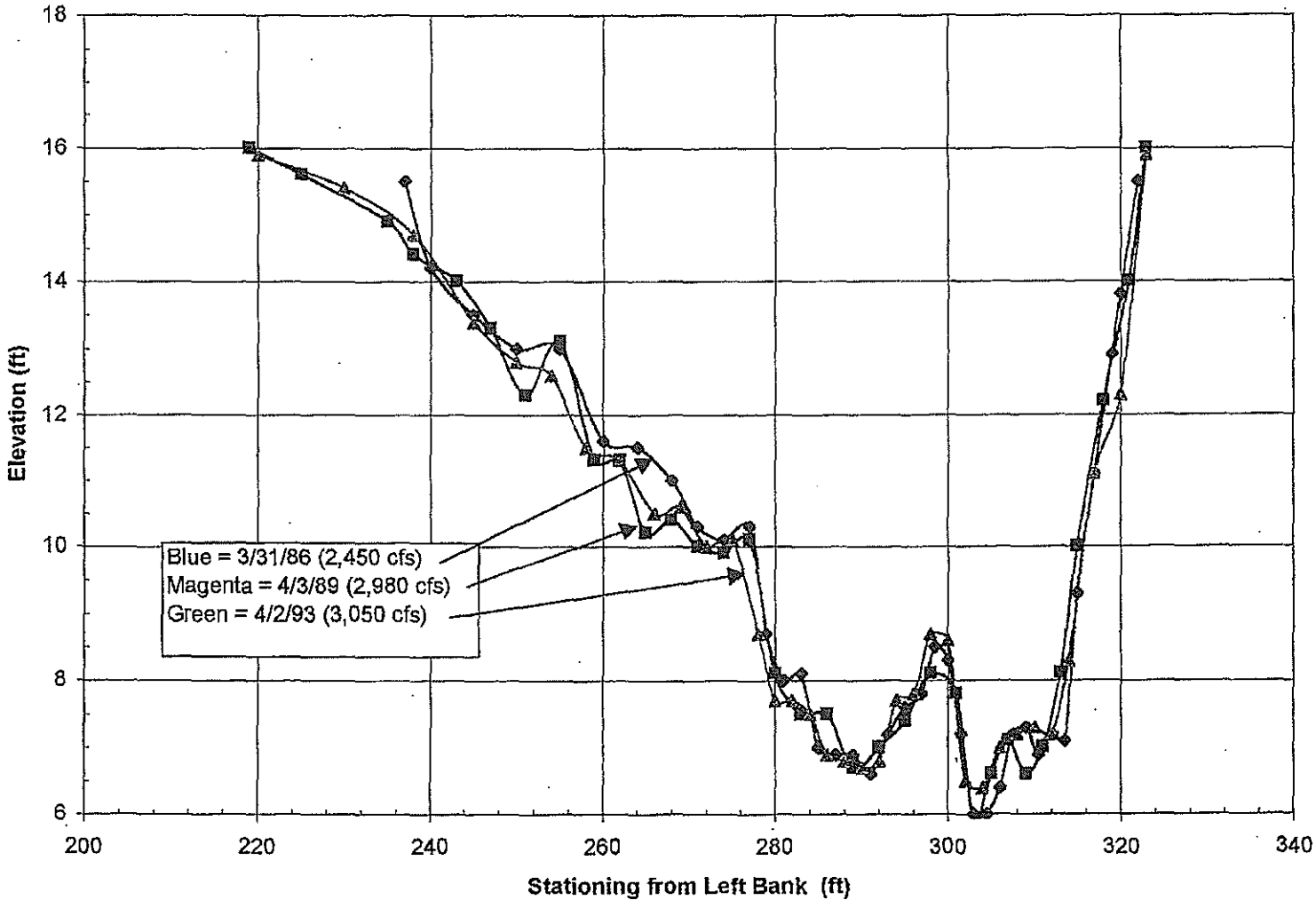


Figure 5. Comparison of 4/2/93, 6/6/95 and 3/5/97

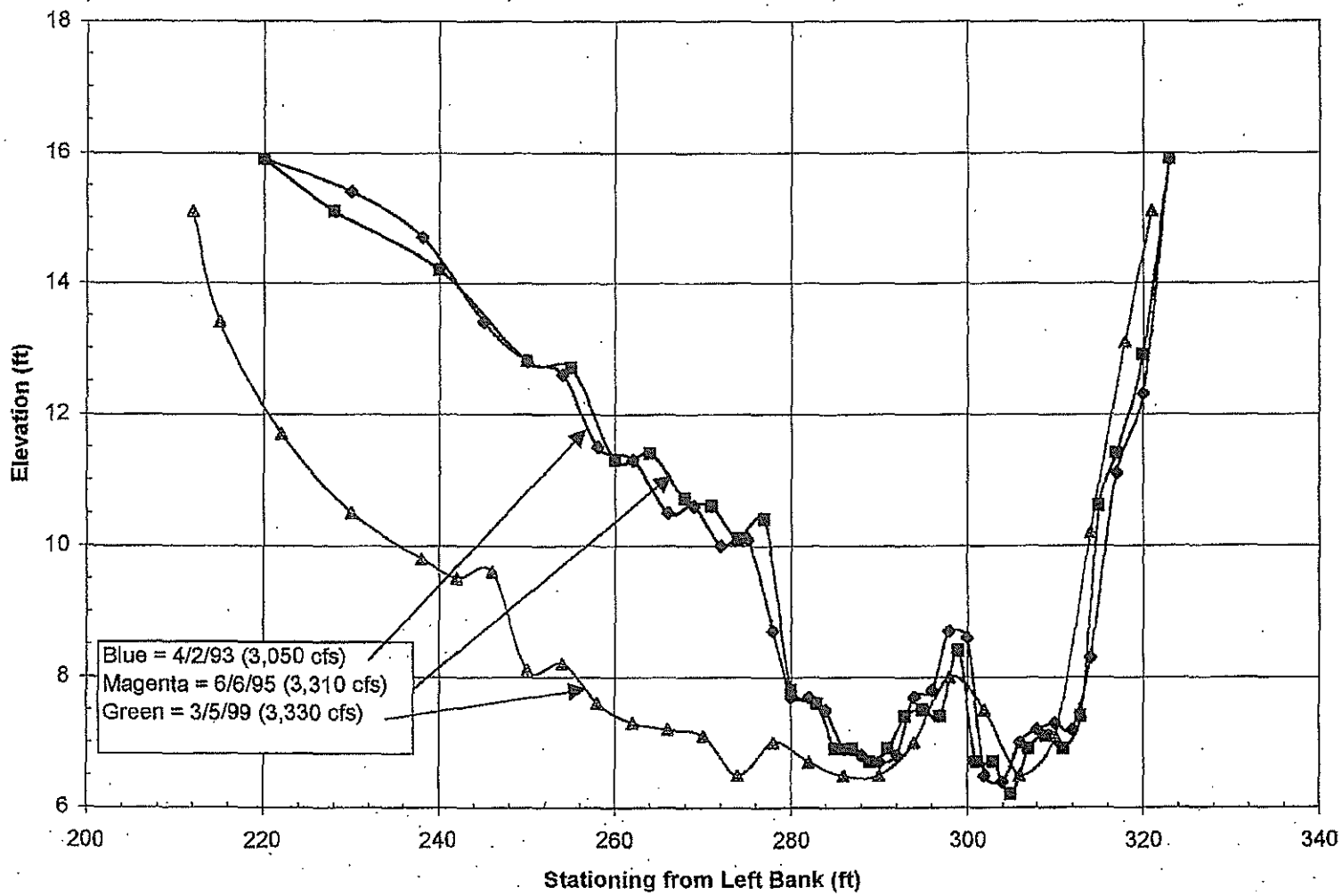
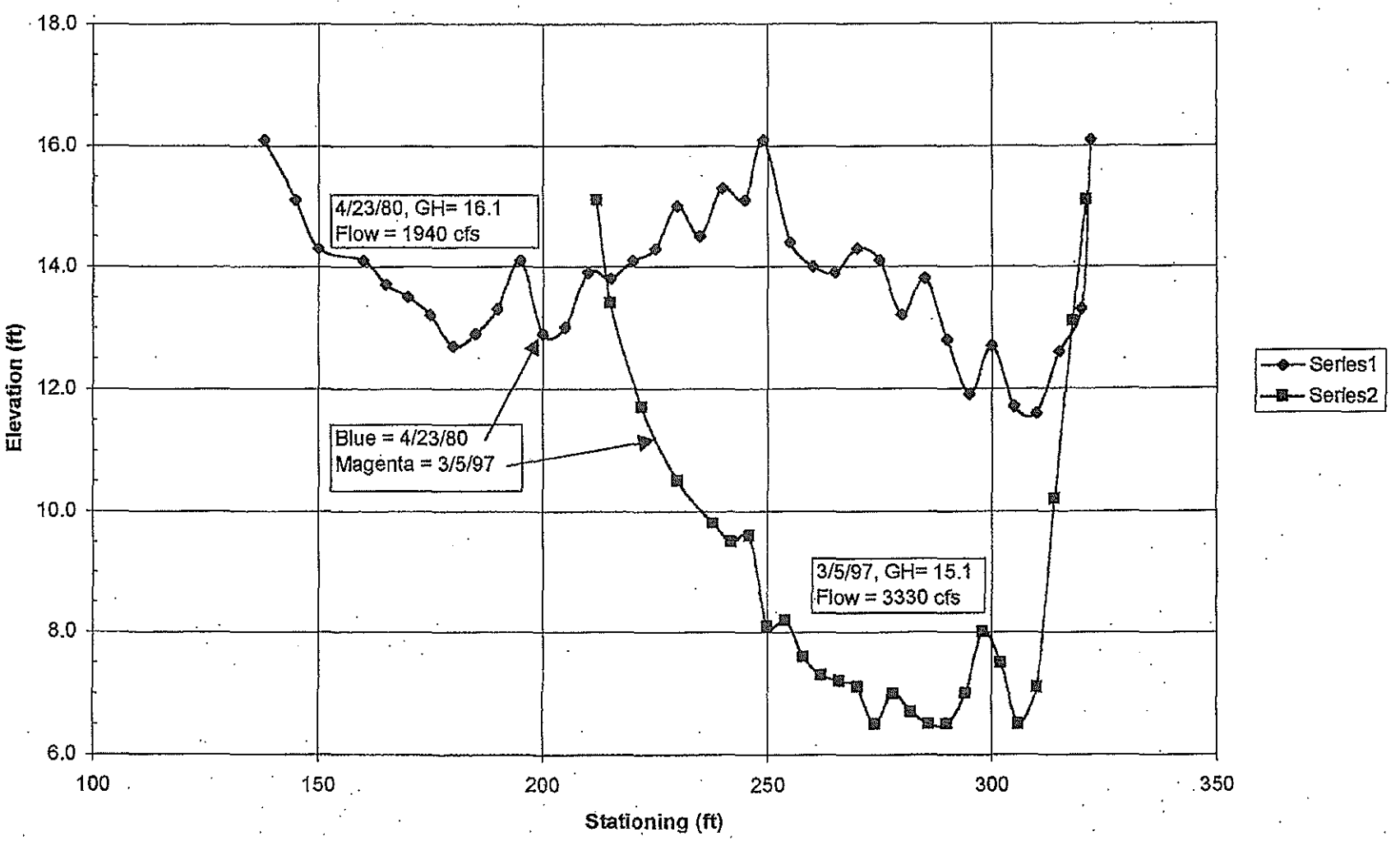


Figure 6. Comparison of 4/23/80 and 3/5/97



Watermark Engineering, Inc.

TECHNICAL MEMORANDUM # 2

DATE: October 12, 2004

TO: Mr. Stephen J. Jones

FROM: Patrick L. Stiehr

RE: Update of Scour Evaluation at MF American River below Ralston Afterbay.

This technical memorandum (TM) provides an update to a previous scour evaluation presented as a TM dated November 17, 1999. The Introduction and analysis procedure from the earlier analysis is essentially the same for this TM and is therefore not repeated.

The purpose of the update is to determine if there were significant channel changes that may have occurred on August 5, 2004. On that day, there was a gate malfunction at Ralston Afterbay Dam, causing a sharp rise in flow for several hours. Details of the event are not part of this TM. A secondary reason for the update is to track channel changes over the last five years.

Figure 1 provides a plot of two measurements made this spring and a recent measurement made August 11, after the gate malfunction. Current meter measurements (CMM) made before and after the August 5th event indicate only minor changes to the channel section under the cableway.

Figure 2 is similar to Figure 6 of the original TM except the August 11 CMM has been added. The plot shows the channel section in 1980, 1999 and the most recent measurement made August 11, 2004. The general observation is the current channel section has filled slightly but remains similar to the 1999 channel shape.

Please call if there are questions of if additional information or plots are needed.

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Figure 1. Comparison of 3/4/2004, 6/9/2004, & 8/5/2004

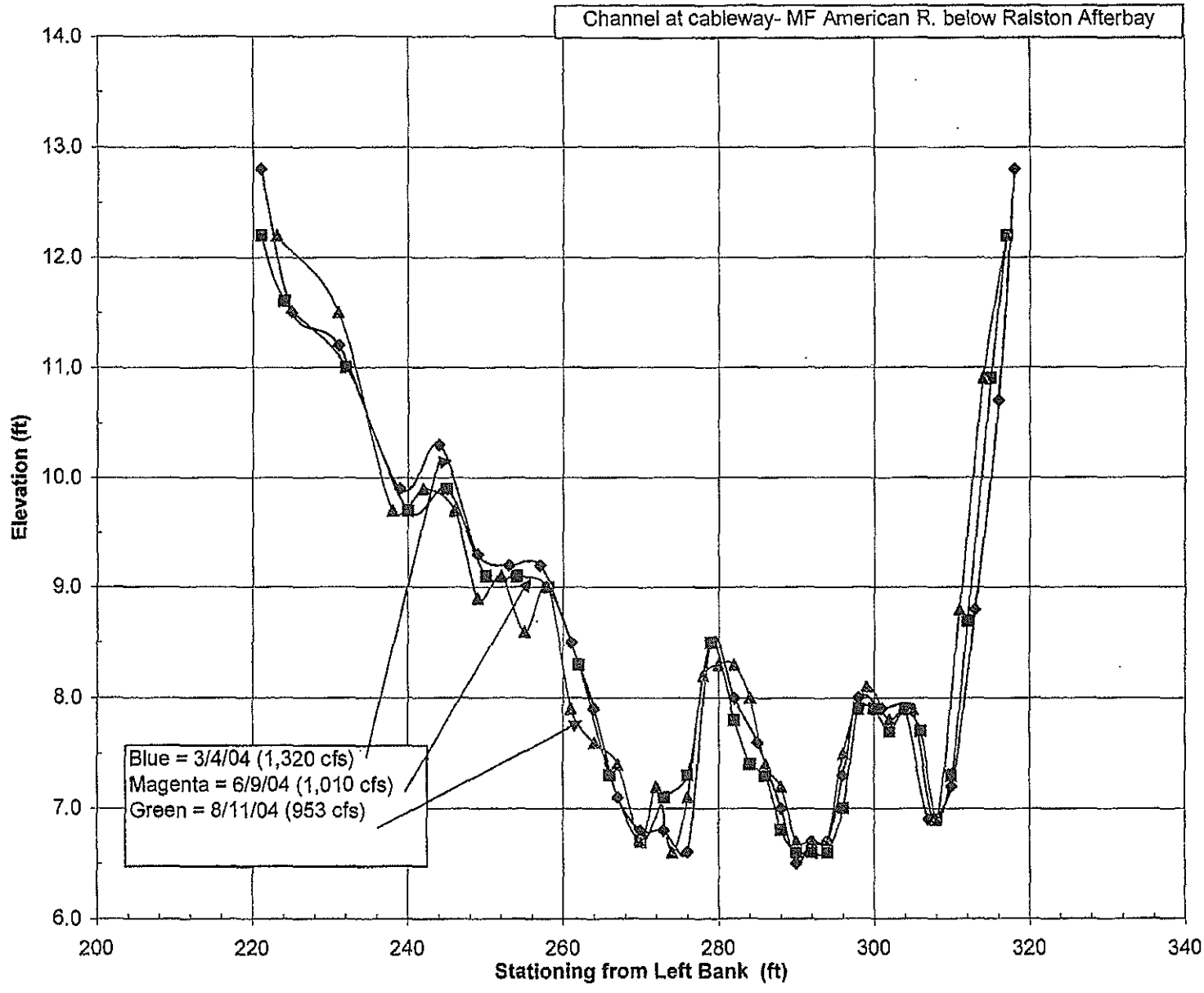

Figure 2. Comparison of 4/23/80, 3/5/99, and 8/11/04