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## CHANNEL SURVEYING REPORT

**Date:** November 28, 2007  
**To:** Laurel Marcus, California Land Stewardship Institute  
**From:** Paul Blank, Napa County RCD  
**Re:** Napa River Channel Survey Report, Oakville Cross Road to Oak Knoll Avenue, October 2006 to September 2007

### Introduction

On October 24, 2006, Napa County Resource Conservation District (RCD) entered into a contract with the California Land Stewardship Institute (CLSI) to perform a channel survey of the Napa River from Oakville Cross Road to Oak Knoll Avenue. The channel survey included measurement of cross sections at approximate 500-foot intervals, measurement of a longitudinal profile, and installation and surveying of semi-permanent surveying monuments at each new cross section. The surveying data were collected for use in the planning of a restoration project for the reach.

### Schedule

Field work was originally envisioned to take place prior to the onset of seasonal rains in December 2006; however, due to contracting delays, this timeframe became too short to complete the field work. Therefore, surveying of the longitudinal profile was rescheduled for late Spring 2007, after the rainy season and associated high stream flows.

### Pre-Existing Cross Sections

RCD measured 39 cross sections in the project reach during a 1996 surveying effort. At the time of surveying, monument locations and cross section line bearings were hand-plotted by RCD on large printouts of 1989 aerial photographs. Cross sections were measured relative to a semi-permanent (rebar and concrete) monument, set in-line with the cross section, by RCD with an engineering transit and stadia rod. Monument elevations were surveyed to NGVD29 by Michael W. Brooks and Associates Land Surveyors, of Yountville, California.

These 10-year-old cross sections would be used in the current project if it could be shown that no systematic change in the shape of the river channel had taken place since. To evaluate changes, RCD selected five of the 1996 cross sections from different parts of the reach to re-occupy as closely as possible, re-survey, and compare the results to the 10-year-old data.

### Property Access

During October 2006, RCD contacted all landowners in the project area by mail and requested permission to enter onto their property to survey the river channel. Several signed Right-of-Entry forms were soon received from landowners, and RCD began field activities on those properties. RCD followed up with the remaining landowners by telephone and received many more signed forms in subsequent weeks. Eventually, at least one-side access was gained to the entire reach, except for a 2,000-foot section in the southern portion of the project area. RCD's Right-of-Entry expired on December 31, 2006; therefore, CLSI negotiated and secured access for RCD's longitudinal profile survey in May/June 2007.

### Pre-Field Work

RCD created a GIS shapefile of 1996 monument locations by digitizing the points shown on the 1989 air photo printouts onto 2005 digital air photos. RCD then measured the bearings of the cross section lines with a protractor and noted the angle from true north. Horizontal coordinates were then generated for the 1996 monuments and loaded into a handheld GPS device.

RCD selected target locations for new cross sections between the 1996 cross sections to create approximate 500-foot intervals for the entire reach. Coordinates for the target locations were generated and transferred to the GPS device.

During October 2006, RCD went to the field and flagged approximate locations of 1996 cross sections (only one monument was found), and selected locations for new cross sections near the target points, but which would only require minimal (or at least reasonable amounts of) brush cutting.

### Transit Surveying

In late November 2006, RCD re-surveyed 1996 cross sections 4-13, 4-9, 2-5, 2-11, and 1-4 (new cross sections 13, 19, 40, 56, and 68, respectively). The 1996 and 2006 data were compared graphically by aligning the top-of-bank points, and shared with CLSI and Philip Williams Associates (PWA). No systematic differences were observed and the remaining 34 1996 cross sections were approved for reuse in the current project.

Between late October and mid-December 2006, RCD surveyed 69 new cross sections (including the 5 mentioned above) in the project reach. The banks of the Napa River are heavily forested making it hard to see the rod from the instrument. The use of an engineering transit allows the use of a 25-foot stadia rod, which is usually higher than the surrounding vegetation and can be read by the transit with minimal brush clearing. A total station must have direct line of sight to a 5- to 12-foot rod. Previous experience has taught us that total station surveying is difficult in the river, without extensive and costly brush clearing. For this reason, and because thirty-four 1996 transit-surveyed cross sections are being re-used in this project, RCD decided to use the transit for the cross section surveys.

RCD set rebar monuments in concrete at each new cross section location on the bank on which we had landowner access, set the instrument up over the monument, and measured height and distance along the line of section with a 25-foot stadia rod. Vertical angle shots were necessary

at the bottom of the channel on most cross sections. The bearing of the cross section line, instrument height over the monument, foresight, vertical angle, and rod readings at the upper and lower hash marks, as well as some features such as “bankfull” and “active scour channel” were recorded on field data sheets. Line of section bearing angles were collected by aligning the instrument zero with magnetic north at the monument, and measuring the angle to the line-of-section.

### Monument Surveying

During January 2007, under the guidance of the Natural Resources Conservation Service (NRCS), RCD surveyed the monuments at all new cross sections using Trimble GPS equipment provided by the NRCS. RCD attempted to collect measurements on all monuments, and gained initialization, and therefore good precision, on 31 of 69 monuments. Using the GPS equipment, RCD set control points in the vicinity of the remaining monuments. There were 2 monuments, 21 and 60 (field names 34 and 11, respectively) that are located so deep in thick forested areas that the GPS would not gain initialization even to set control points. Due to steep hill slopes and the meanders of the river, these locations could not be seen from any place open to the sky, so that it was not even possible to set a control point. The GPS equipment was able to measure the horizontal positions of these monuments to within 2 or 3 feet, even when initialization failed, and these values were used in the final dataset for monuments 21 and 60. Elevations for those 2 monuments would later be carried in from the nearest surveyed monument with a level and stadia rod. Since the project reach is 8.6 miles in length, and the equipment has an approximate 2-mile range, it was necessary to set up the base station four times at separate locations along the reach.

During March 2007, RCD returned to each un-surveyed monument with a total station, and surveyed in the location and elevation of the monument from the GPS control points. RCD also returned to monuments 21 and 60 with a rod and level and carried the elevation in from the nearest surveyed monument.

During September 2007, RCD, with an NRCS representative, again returned to the field to tie the survey into an NGS benchmark on the Oakville Cross Road bridge. This allowed reprocessing and better comparison of the data to the 1996 survey, and a recent upstream channel survey.

### Longitudinal Profile

During May and June 2007, RCD returned to the field to survey the longitudinal profile of the project reach. To create the longitudinal profile, RCD performed a tape and level survey along the thalweg of the Napa River, beginning at the downstream face of the Oakville Cross Road bridge and moving in the downstream direction to the upstream face of the Oak Knoll Avenue bridge.

The thalweg was measured using a 300-foot tape. Each stretch of the tape began at the point the last one ended. RCD took special care to mimic the shape of the thalweg with the tape by hooking it on branches or rocks. The elevation of each break-in-slope of the thalweg was measured using a stadia rod and an electronic theodolite, as the crew moved along each stretch of the tape. The tape reading (thalweg distance) was noted with each shot of the stadia rod. Each level survey began at a cross section monument (point of known elevation). RCD closed each

survey to another monument downstream. Generally, a survey was closed every 1,000 to 2,000 feet, although there were two surveys around 3,000 feet in length and one near 5,000 feet in length.

Several pools were encountered that were too deep to wade, and the field crew were able to skirt around the edges of most of these, or climb around on the bank. There were only 3 places where RCD could not further advance the tape, and had to end the survey unclosed. In these cases, the crew would climb out of the channel, move downstream to the nearest cross section monument, and begin a new survey. In two of these cases, RCD performed an unclosed survey in the upstream direction so that the gap in the long profile would be limited to the deepest portion of a single pool. In the third case, RCD could not move more than a couple hundred feet in either direction from each of a series of three cross sections, resulting in an overall gap in the longitudinal profile of approximately 2,600 feet. This section is not survey-able with the methods and equipment RCD used, and would likely require a depth sounding survey using a raft.

Surveying was slow and arduous due to deep water, poor footing, thick brush, Himalayan Berry, insects, debris jams, etc. In addition, the channel bottom is generally 25 to 30 feet below the top of bank and the banks are very steep and often vertical. In many places it was not possible (as equipped) to climb out of the channel. When RCD was able to climb in and out to close a survey to a cross section monument, a vertical angle shot was usually necessary, which can add several hundredths of a foot of error to the survey.

As surveying progressed, RCD noted the approximate locations of the cross sections, at the point at which they crossed the thalweg.

#### Data Processing (Conventional Surveys)

Cross section data were recorded on field data sheets and manually entered into spreadsheets for vertical angle and elevation calculations. RCD converted the bearing of each line of section from magnetic north to bearings from true north by adding 18 degrees.

RCD converted the 1996 monument elevations from NGVD29 to NAVD88 using a program called VERTCON provided by the National Geodetic Survey (NGS). Corrections factors varied from south to north from 0.812-0.826 meters (2.66-2.71 feet).

Longitudinal profile data were recorded on field data sheets and manually entered into spreadsheets for calculation of thalweg distance, instrument height, and elevation, and correction of vertical angle shots.

It was necessary to estimate the length of the gaps in the longitudinal profile because we were unable to pull the tape the entire way. This was done by computing distances between cross sections along the channel centerline in GIS, and comparing these distances to those measured in the field. After omitting a few because the field measurements were known to be imprecise, RCD computed the average difference. The field measurements are on average 2.7% greater than those measured in GIS. The length of the gaps were measured in GIS and multiplied by 1.027 to complete the final long profile distance.

The distance and elevation data were then compiled into a single series and plotted against the thalweg shots from the 2006 cross sections. For the most part, the long profile fits the cross section thalwegs very well. They are generally off by less than a foot vertically. Most of this discrepancy is likely due to the difficulty of reproducing these shots. One exception was cross section 44, which plotted far below the long profile. After review of the cross section field notes, it appears the vertical angles were recorded inaccurately. This cross section was removed from the dataset.

#### Data Processing (GPS Survey)

The data file associated with the first setup of the base station was forwarded to the Online Positioning Users Service (OPUS), a service of the NGS. RCD later received an email from OPUS containing horizontal and vertical coordinates of the initial base station. This point was originally the basis of the survey. The positions of all monuments were measured relative to it, and all points in the cross sections and longitudinal profile were measured relative to those monuments.

RCD checked the horizontal (x,y) coordinates of the monuments over 2005 air photos in GIS. The horizontal positions looked very good. To check the vertical (z) coordinates, RCD compared them to values from the Napa County LiDAR DEM at the same point, and found the comparison to be reasonable; however, a discrepancy between the 1996 and 2006 monument elevations was soon found, with the 1996 elevations plotting significantly higher in the upper portion of the project reach. In June 2007, RCD received a copy of a recent professional survey performed in the Rutherford reach immediately upstream of the project area. These data also plotted higher, more in line with the 1996 data. The Rutherford survey was relative to an NGS benchmark on the Oakville Cross Road bridge; therefore, RCD, with the assistance of NRCS and CSDS, decided to return to the field to tie the GPS survey into the NGS benchmark and recalculate the monument elevations. The field work was performed during September 2007 and the data were reprocessed during October and November 2007.

The attached CD contains:

- An electronic copy of this report;
- A table listing the cross section monument coordinates;
- Cross section data and graphs;
- Longitudinal profile data and graph; and,
- GIS shapefiles of the monument locations, lines of section, and air-photo-derived channel centerline distances between cross sections.