TECHNICAL MEMORANDUM

TO: Matt St John, North Coast Regional Water Quality Control Board

FROM: Mike Deas, Watercourse Engineering, Inc.

COPIES: Josh Viers, University of California, Davis
Michael Johnson, University of California, Davis

RE: Big Springs Creek and Spring Complex – Estimated Quantification

DATE: February 1, 2006

Summary

Review of available information suggests that Big Springs Creek water rights are on the order of 55 cubic feet per second (cfs), however, not all of these rights are met in all years. In addition, Big Springs Creek contributions to the Shasta River are estimated to be on the order of 60 cfs, but vary seasonally. It is estimated that Big Springs Creek historically (pre-diversion) delivered on the order of 100 to 125 cfs to the Shasta River.

Big Springs Creek and Spring Complex: Estimate of Shasta River Contributions

Glacial melting on Mount Shasta and mountain precipitation are principal sources of groundwater recharge in the Shasta Valley. A portion of this recharge reaches the Shasta River through spring discharge in the vicinity of Big Springs (DWR, 1991). The Big Springs Creek complex, for purposes of this discussion, includes Big Springs proper (assumed to originate at the eastern end of Big Springs Lake), Big Springs Lake, Big Springs Creek, Little Springs and the channel between Little Springs and Big Springs Creek (Figure 2). Examining historic Shasta River flow and temperature data from locations downstream and upstream of the Big Springs Creek confluence, it is postulated that the springs complex may also extend into the Shasta River proper. The extent and quantification of the springs complex is incomplete. Nonetheless, there is sufficient information to identify the potential range of contributions from the Big Springs Creek complex to the Shasta River.

Big Springs Lake and Little Springs Water Rights

Quantification of water rights at Big Springs Lake and Little Springs is well documented (

Table 1). Documented water rights to Big Springs Lake total approximately 47.5 cfs and rights to Little Springs total approximately 7.6 cfs. Although the combination of water rights for Big Springs Lake and Little Springs is on the order of 55 cfs, review of historic Watermaster Service records indicates that the water diversions from Big Springs Lake averages approximately 40 cubic feet per second (cfs) during the irrigation season.

Table 1. Big Springs Lake and Little Springs water rights (source: Water Master Service Records, DWR)

Entity		Big Springs Lake	Little Springs
Big Springs Irrigation District [A]		30	-
Newton [B]		7.5	-
Busk [C]		10	3.1
Louie		-	4.5
	Total	47.5	7.6

[A] Big Springs Irrigation District abandoned their surface water right and now meets district demand from groundwater wells, possibly due to frequent curtailment by the Watermaster.

[B] Previously Brahs et al

[C] Previously Louie

Big Springs Irrigation District (BSID) no longer pumps water from Big Springs Lake, but rather has drilled water supply wells upgradient, and pumps from groundwater. Review of Watermaster Service records indicates that BSID stopped withdrawing water directly from the lake around 1983.

In addition, there are numerous other smaller wells and springs utilized for irrigation in this area that could reasonably be presumed to be drawing on water that would otherwise contribute to the Big Springs complex. These include the Basey wells (or Pacy Wells), periodically used by the Montague Water Conservation District to supplement water from Dwinnell Reservoir and the subject of court action by the users of Big Springs Lake. An agreement was reached in 1986 between E.J. Louie, A.H. Newton, Jr., and the Montague Water Conservation District, wherein the parties "agreed that when the flows of Big Springs recede from 17.5 cfs to 10.0 cfs, Montague Water Conservation District would do the following:

- Turn off the Basey pumps until the flow of Big Sprigns was 17.5 cfs or pay A.H. Newton, Jr. the additional power costs to use his own pumps.
- If flows of Big Springs fall below 10.0 cfs, Montague Water Conservation District will shut off the Basey pumps until flows return to above 10.0 cfs." (Shasta Valley Watermaster Service Records, 1987)

Review of Watermaster Service Records suggests that the first season this agreement was implemented was in 1987.

Contributions to the Shasta River

Using water rights information, coupled with measured Shasta River flows above and below Big Springs Creek, an estimate of the contributions of the total potential springs complex to Shasta River flow can be made.

Available Flow Measurements

Shasta River flow measurements made during the late spring through summer period in 2002 at Louie Road (above Big Springs Creek) and at the Grenada Irrigation District (GID) diversion dam (below Big Springs Creek) indicated that the net accretion between these two locations ranged from approximately 55 cfs to over 80 cfs (Watercourse, 2004a, 2004b). This data was augmented with a combination of direct measurements within Big Springs Creek, Little Springs Creek, and Shasta River locations immediately above and below Big Springs Creek by the California Department of Public Works in

1922 and 1923 during the Shasta River Adjudication Proceedings (California, 1925) prior to the Shasta River adjudication. These latter data are the most detailed measurements of flows in the vicinity of Big Springs Creek. Although conditions may have changed over the last 80 years, the 2002 measurements largely corroborate the earlier measurements.

Big Springs Creek Inflows

As reported in the water supply and use report to support adjudication proceedings, it was not possible to obtain satisfactory discharge records in the creek proper due to extensive aquatic vegetation (California, 1925). Thus, measurements within Big Springs Creek were augmented through daily stream flow measurement carried out in the Shasta River upstream and downstream of Big Springs Creek to estimate the tributary input. The exact locations of these flow measurements are not known, but are presumed to be fairly close to the creek because the objective of the work was to capture creek inflows to the Shasta River. The results of these efforts for 1922 and 1923 are shown in Figure 1.

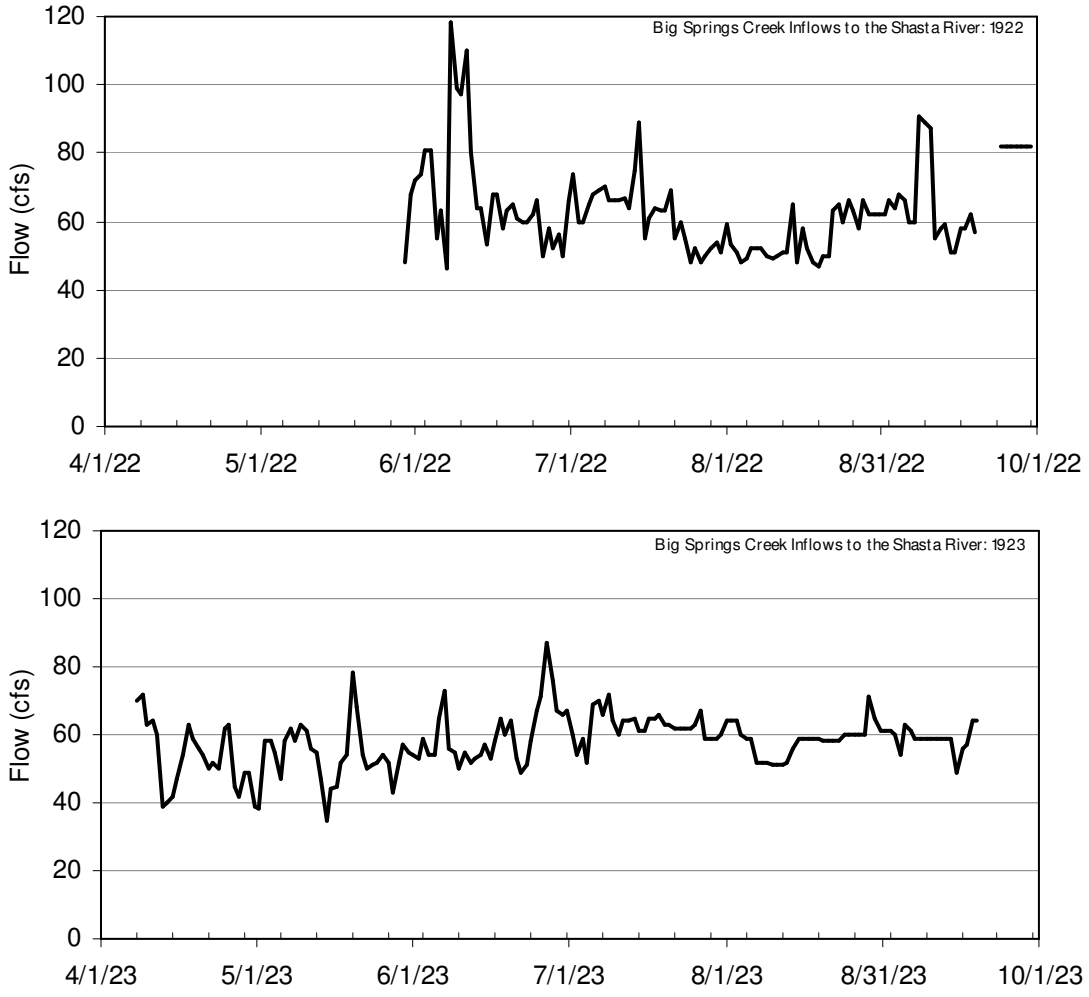

Figure 1. Daily Big Springs Creek inflow to the Shasta River: 1922 (top) and 1923 (bottom) (California, 1925)

There are several aspects of Figure 1 that are illustrative. One attribute that is unlike most streams in California during the summer period is the generally stable nature of Big Springs Creek. Summary statistics (Table 2) indicate that the mean flow was consistently on the order of 60 cfs, and that although the maximum and minimum values varied

considerably, the standard deviation was small. This is consistent with the 2002 flow observations.

Table 2. Summary statistics for daily flow in Big Springs Creek above the confluence with the Shasta River

Statistic	1922 (cfs)	1923 (cfs)
Mean	63.4	58.0
Maximum	118	87
Minimum	46	35
Standard Deviation	13.2	7.7

A second attribute, related to the first, is that the flow does not exhibit a typical seasonal reduction through the summer period, rather the spring signal is persistent through the summer and into early fall. In the 1923 record there appears to be an increase in flow as the summer season progresses: an observation that is noted in the Watermaster Service records.

Also apparent in the record is a notable amount of variation in Big Springs Creek inflow to the Shasta River. Daily records of diversions and irrigation practices were not available for this report. However, it is reasonable to assume that variations in cropping patterns, land use, and other practices could yield short term variability in creek flows.

A summary of individual daily measurements from the 1922-23 season (California, 1925) is presented in Table 3. These estimates may not determine if there are additional spring flow contributions to the Shasta River directly from the Big Springs complex. Nonetheless, the results suggest that Big Springs Creek historically (pre-diversion) delivered on the order of 100 to 125 cfs to the Shasta River.

Table 3. Summary of flows observed on individual days during the 1922 and 1923 irrigation seasons (California, 1925)

Date	Big Spring Creek Gage #1	Big Sp. Water Cons. Diversion Gage #3	Louie Bros Main Chanal Diversion Gage #40	Louie Bros Small Canal Diversion	Stallcup & Sons Diversions Gage #3	Total Diversion From Big Springs	Little Spring Creek Diversion	Total Flow of Big Spring Creek & Little Spring Creek
5-24-1922	112.2	0	1.4	0	0	1.4	0	113.6
6-05-1922	80.5	28.2	5.4	3	7.4	44	0	124.5
6-21-1922	79.9	28.1	7.4	2.8	7.4	45.7	0	125.5
10-12-1922	108.5	0	0	0	0	0	2.2	110.7
10-12-1922	104.4	0	0	0	0	0	2.2	106.6
10-17-1922	118.5	0	0	0	0	0	4	122.5
10-17-1922	96.5	0	0	0	0	0	4	100.5
10-21-1922	114	0	0	0	0	0	3.8	117.8
10-21-1922	99.9	0	0	0	0	0	3.8	103.7
11-04-1922	117.3	0	0	0	0	0	4.8	122.1
5-04-1923	58.2	31.8	7.6	2	7.2	48.6	7.8	114.4
5-07-1923	54.6	31.6	7.6	2	7.2	48.4	7.8	110.8
5-07-1923	61.1	31.6	7.6	2	7.2	48.4	7.8	117.1
6-04-1923	54.1	34.2	5.4	2	7.2	48.8	7.6	110.5
Average								114.3

*Note: values may not add up due to rounding and transcription errors due to old records

Factors that may affect this estimate include, but are not limited to:

- the relatively short data record
- additional pumping that may affect the inflow to Big Springs Lake (not only pumping early in the 20th century at the time of the flow measurements, but approximately 80 years of water resources development in the region, e.g., Basey wells)
- applied water irrigation efficiency
- annual variability in base flow within the Shasta River as well as springs inflow
- other water diversions and inflows (unassociated with the Big Springs Complex) between Louie Road and GID
- meteorological conditions
- variations in land use and applied water from Big Springs Lake and Little Springs

Current quantification of flows in and around the Big Springs complex would provide much needed detail in this unique reach of the Shasta River.

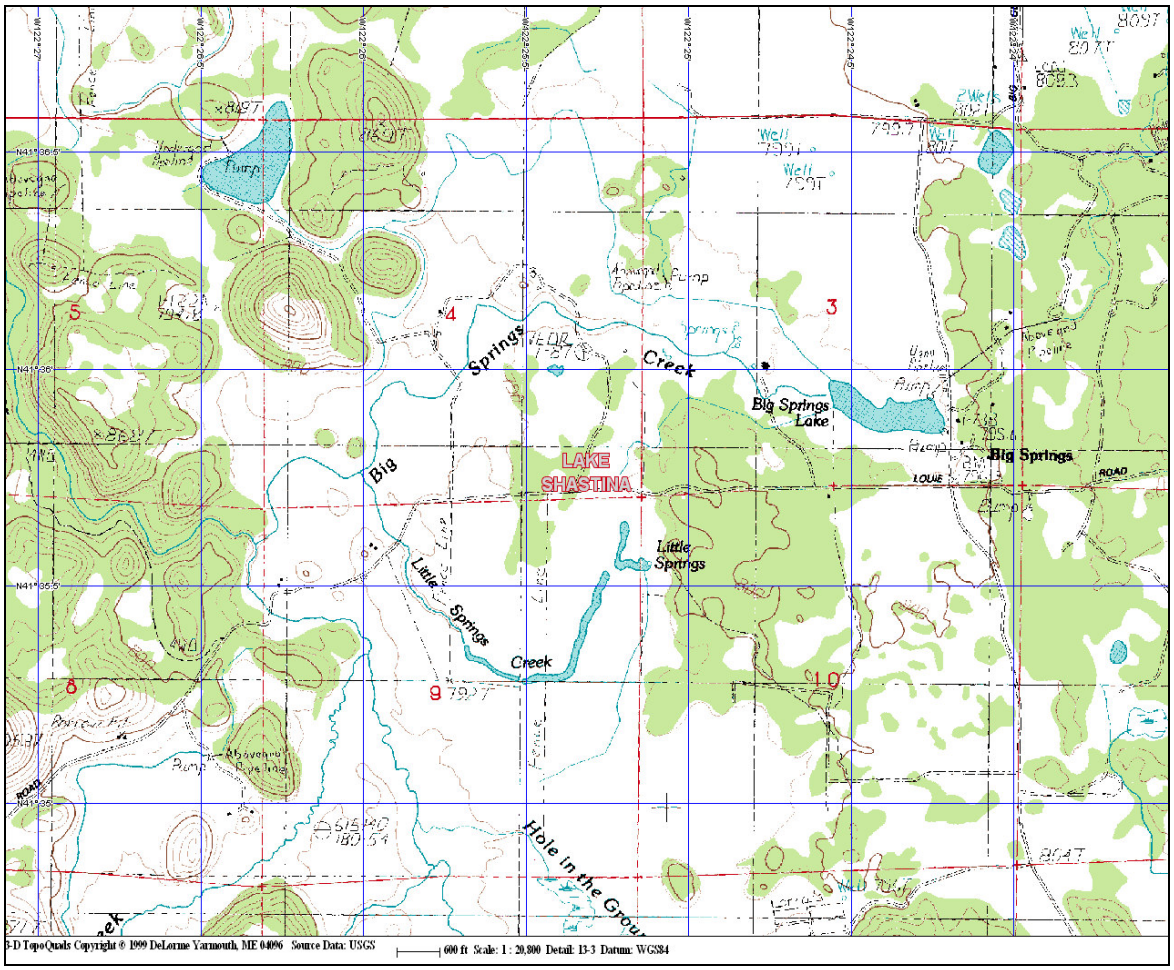

Figure 2. Big Springs Area

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