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North Coast Regional Water Quality Control Board

MEMORANDOM

TO: File

FROM: Lance Le, WRCE, Planning Unit

DATE: March 11, 2016

SUBJECT: LITTLE RIVER ANALYSIS REVISITED

Little River annual water yields derived from USGS gage data were used for comparison to sediment yields in Upper Elk River. The purpose was to support staff's conclusion that sediment yields from Figure 15 of *Upper Elk River: Technical Analysis for Sediment* (Technical Report) are not entirely explained by precipitation and weather; in particular the time period 1988-1997. The Little River was used because USGS gage data at Elk River were unavailable outside of the time period 1958-1967. Figure 1 was incorporated into the Technical Report; public comments noted that the particular application of water yields to explain sediment production were inappropriate, noting that peak flows would be a better predictor of sediment production. In response to those comments, I generated Figure 2 which shows peak flow distributions binned by time periods instead of water yield.

Revisiting Little River, some analysis done previously had not been incorporated into the Technical Report; only the boxplot of annual yields was present. This memo sets out to include the remainder of the Little River analysis. Specifically, this memo sets out to (a) validate the appropriateness of comparing Little River and Elk River data through correlation and significance testing and (b) classify water year types and plot their distribution congruent with Figure 15 of the Technical Report.

1. Comparability of Little River and Elk River data

Three variables are used to assess whether Little River is an appropriate watershed in place of Elk River. These variables are (1) annual water yields normalized by contributing area, (2) annual peak flows normalized by contributing area (Table 1), and (3) daily flows. Pearson's product-moment correlations and t-test were used to assess the variables. Daily flows are not included in this memo, but may be obtained from USGS NWIS: Web Interface (http://waterdata.usgs.gov/). The results are reported in Table 2. Correlations for water yield and daily flows are statistically significant (α=0.05) at 0.92 and 0.88, respectively.

Correlation for peak flows (r=0.58) is not statistically significant (Table 2). An alternative to Pearson's *r* is Kendall's τ, which is a correlation based on the ranks of the data and results are similar: significant and positive correlation for water yield and daily flows, but non-significant positive correlation for peak flows (Table 3). Code used to conduct the correlations and significance testing is included in Attachment A.

Peak flow correlation is non-significant with a large confidence interval, suggesting the potential for similarity between Elk River peak flows and those of Little River, but with large uncertainty. Because of the limited number of data points and the fact that watershed conditions and management practices have changed over time, the correlation statistic may be non-stationary; that is to say, it may change over time. Since daily flows and annual yield are significantly correlated, Little River and Elk River are likely comparable.

Figure 1: Water yields at Little River binned by time periods congruent with Figure 15 of the Technical Report

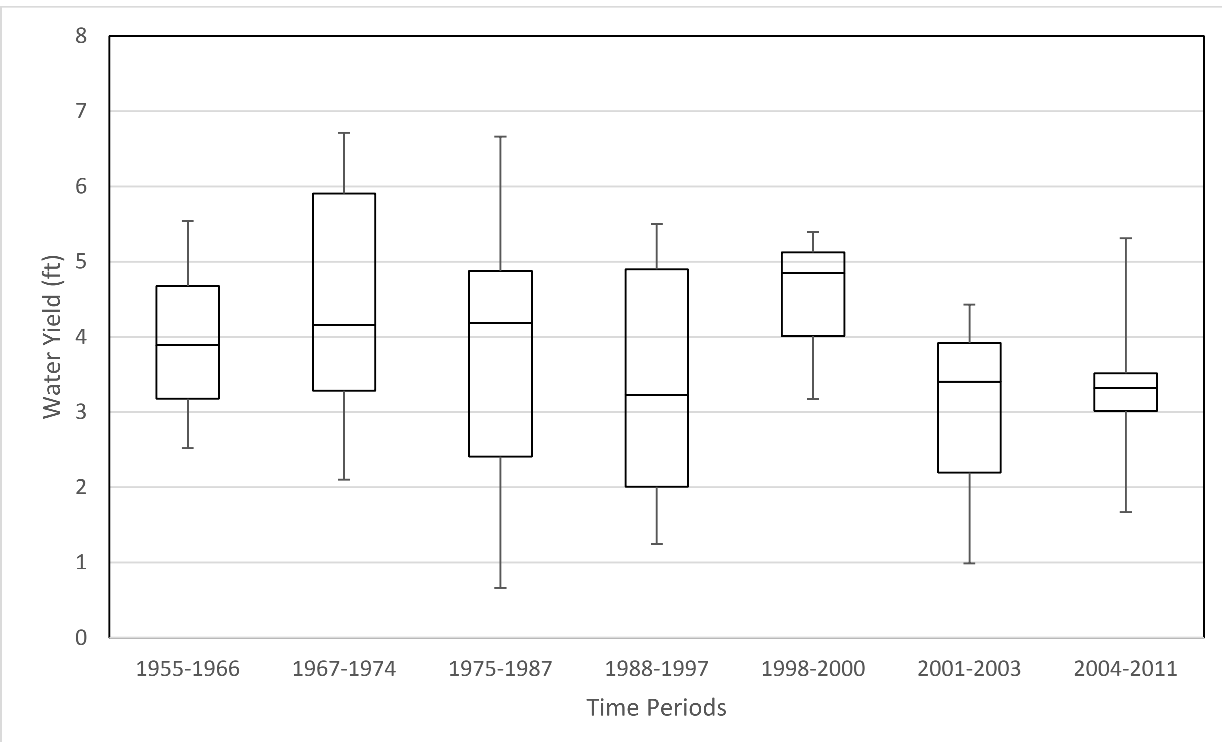

Table 1: Normalized annual water yields and peak flows for Elk River gage period

	Annual Water Yields (ft)		Annual Peak Flows (cfs/mi^2)	
Year	Little River	Elk River	Little River	Elk River
1958	5.19	3.45	148.1	63.1
1959	2.61	1.53	94.1	72.9
1960	3.09	1.42	155.1	47.3
1961	3.95	2.05	84.0	48.9
1962	2.52	1.47	118.0	48.0
1963	4.46	2.30	115.1	50.2
1964	3.89	2.26	195.8	66.7
1965	4.90	2.77	203.5	77.6
1966	3.26	1.92	205.7	74.0
1967	3.37	2.28	156.0	70.4

Figure 2: Peak flows at Little River binned by time periods congruent with Figure 15 of the Technical Report

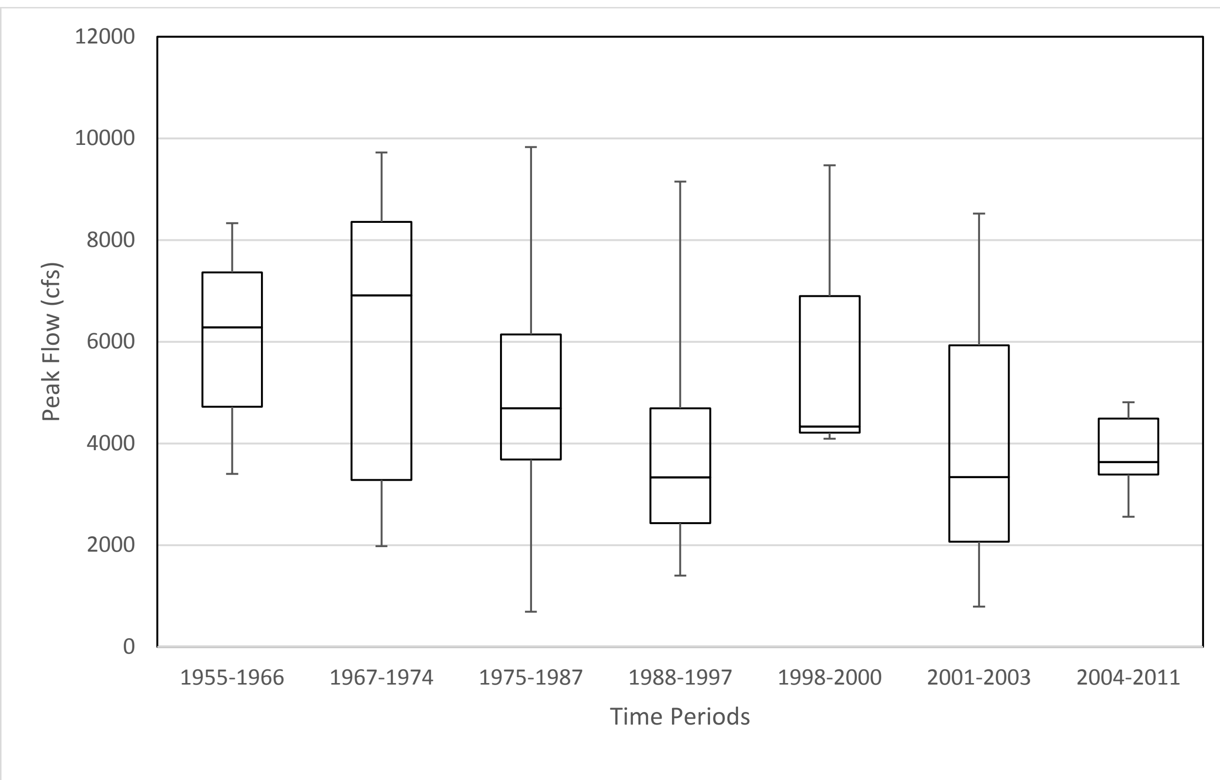

Table 2: Correlation and significance testing for water yields, peak flows, and daily flows

	Annual Water Yield	Annual Peak Flows	Daily Flows
Correlation coefficient *r*	0.92	0.58	0.88
Upper 95% Confidence Limit	0.98	0.89	0.89
Lower 95% Confidence Limit	0.69	-0.08	0.87
p-value	1.70×10^{-4}	0.0793	$<2.2\times10^{-16}$

Table 3: Kendall's rank correlation and significance testing

	Annual Water Yield	Annual Peak Flows	Daily Flows
Kendall's τ	0.78	0.38	0.87
p-value	9.46×10^{-4}	0.1557	$<2.2\times10^{-16}$

2. Qualitative classifications based on exceedance probability

Attachment B presents an analysis of annual water yields for Little River, constructing an exceedance probability plot. The analysis classifies the flows into five categories: Critically Dry, Dry, Average, Wet, and Extremely Wet. These categories are exceedance probabilities binned into five equal probability ranges; e.g. exceedance probabilities 0.0 to 0.19 are Extremely Wet, 0.2 to 0.39 are Wet, etc. The classified annual yields were further binned by time periods in correspondence with Figure 15 of the Technical Report (Figure 2). Figure 3 also shows the mean sediment loads from Figure 15.

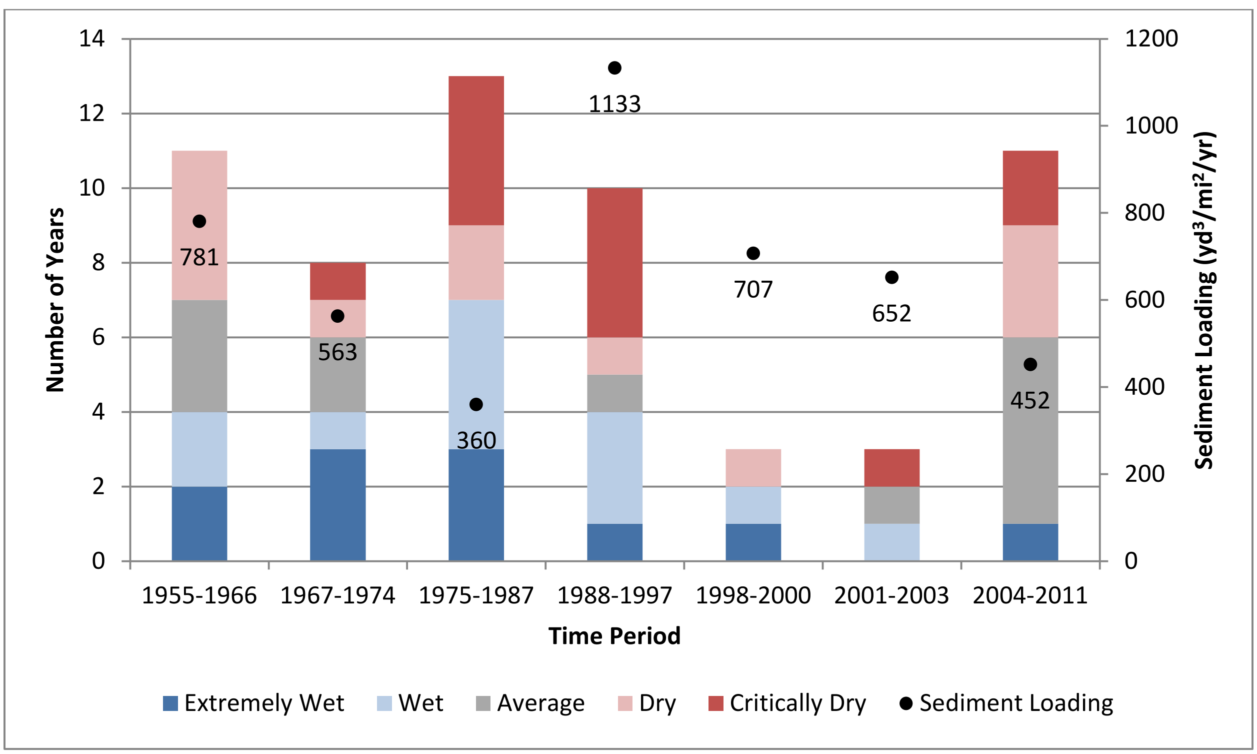

Figure 3: Stacked bar plot of classified water years binned into time periods congruent with Figure 15 of the Technical Report

Based on the evidence presented, staff's conclusion is supported given that 1988-1997 featured more Critically Dry water years than Extremely Wet water years. Any other visual inferences for the progressive decrease in sediment after 1997 is problematic due to two, short time periods and doubts as to whether annual water yields are good predictors for annual sediment yields.

Attachment A: R Code for correlation and significance testing
Attachment B: Analysis of Water Yield in the Little River Near Trinidad, CA (USGS Gaging Station #11481200)