Appendix G

Metals Concentration Reduction Percentages

Required to Meet the Chollas Creek Metals Total Maximum Daily Loads

California Regional Water Quality Control Board, San Diego Region

Metals Concentration Reduction Percentages Required to Meet the Total Maximum Daily Load for Metals in Chollas Creek

The load allocation (LA) and waste load allocations (WLA) of the copper, lead, and zinc Total Maximum Daily Loads (TMDL) for Chollas Creek establish concentrations of copper, lead, and zinc that are protective of aquatic life beneficial uses in Chollas Creek.[1] Because the concentrations protective of aquatic life vary with hardness, the allocations in this TMDL are expressed as formulas that incorporate a hardness term, rather than as a constant concentration. To achieve Water Quality Objectives (WQOs) in the creek, concentrations of copper, lead and zinc must be significantly lower than presently measured. The potential ranges of the reductions should be thoroughly considered, as they will have practical implications on the feasibility and nature of implementation scenarios. Using concentration and hardness data from Chollas Creek, the likely range of metals concentration reduction percentages needed to meet the WQOs for copper, lead and zinc were calculated.

The Numeric Targets for copper, lead and zinc are presented in Table G.1 and are discussed in detail in the Technical Report. Concentrations of metals in Chollas Creek will be compared against the WQOs to assess compliance with this TMDL Project. The TMDLs (equal to the WLA and LA) for copper, lead, and zinc are listed in Table G.2. All discharges to Chollas Creek will be expected to meet this WLA and LA. Average and median concentrations of copper, lead and zinc currently exceed the proposed load and waste load allocations (Table G.3). The data used to calculate the mean and median concentrations can be found in Appendix A. To calculate the percent reductions required to meet the allocations, the following formula was applied:

$$\text{Percent Reduction} = \frac{(\text{Measured Concentration} - \text{WQO})}{\text{Measured Concentration}} \times 100$$

The loading capacity of Chollas Creek is equal to the Numeric Targets that are equal to either the Criteria Maximum Concentration (CMC) or Criteria Continuous Concentration (CCC) calculated from the hardness that is associated with the measured concentration of metal.

Example:

Mean Measured Copper Concentration = 16.6 µg/L
Mean Measured Hardness = 198.2 mg/L
At this hardness;
CCC = 16.1 µg/L
Percent Reduction = [(16.64 – 16.1) / 16.64] * 100 = 3.4%
CMC = 25.6 µg/L
Percent Reduction = [(16.64 – 25.6) / 16.64] * 100 = -54.2%

Therefore, if water quality conditions are equal to the mean copper concentration and mean hardness, the ambient copper concentration would need to be decreased by 3.4 percent to achieve the allowable chronic concentration and would not exceed the allowable maximum

[1] In this concentration based TMDL, the LAs and WLAs are equal to the same concentration, and can vary depending on hardness. The LAs and WLAs are not additive.

concentration. Negative percent reductions in Table G.2 indicate that the proposed WQOs are met and a reduction is not needed.

TABLE G.1. Numeric Targets for dissolved copper, lead and zinc for acute and chronic conditions

Metal	Numeric Target for Acute Conditions: Criteria Maximum Concentration	Numeric Target for Chronic Conditions: Criteria Continuous Concentration
Copper	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}
Lead	(1) * {1.46203 – [0.145712 * ln (hardness)]} * {e^ [1.273 * ln (hardness) - 1.460]}	{1.46203 – [0.145712 * ln (hardness)]} * {e^[1.273 * ln (hardness) - 4.705]}
Zinc	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]}	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]}

TABLE G.2. The Wasteload and Load Allcoations for dissolved copper, lead and zinc for acute and chronic conditions

Metal	Allocations for Acute Conditions – One-Hour Average (LA = WLA = 0.9 * Numeric Target)	Allocations for Chronic Conditions – Four-Day Average (LA = WLA = 0.9 * Numeric Target)
Copper	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}*0.9	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}*0.9
Lead	[1.46203 – 0.145712 * ln (hardness)] * {e^ [1.273 * ln (hardness) - 1.460]} * 0.9	[1.46203 – 0.145712 * ln (hardness)] * {e^[{1.273 * ln (hardness)} - 4.705]} * 0.9
Zinc	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]} * 0.9	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]} * 0.9

WLA = Waste Load Allocation LA = Load Allocation

Table G.3 is for illustrative purposes to frame the potential ranges of reductions in metal concentrations required to meet the proposed WQOs. Many of the scenarios presented do not result in a required reduction.

Table G.3. Average metal concentrations, hardness, associated allocations and percent reductions required

Metal	Total Hardness as $CaCO_3$ (mg/L)	CMC Freshwater CF	WQO (ug/L)	LA and WLA	CCC Freshwater CF	WQO (ug/L)	LA and WLA	Measured Concentration Dissolved (ug/L)	Percent Reduction Required to meet WQO	
		Acute Dissolved			Chronic Dissolved				CMC	CCC
Copper										
Minimum*	42.5	0.96	6.0	5.4	0.96	4.3	3.9	2.4	-150.1%	-79.6%
Median^	90.8	0.96	12.3	11.0	0.96	8.2	7.4	10.0	-22.7%	**17.5%**
Mean^	198.2	0.96	25.6	23.0	0.96	16.1	14.5	16.6	-53.9%	**3.4%**
Maximum*	120.0	0.96	16.0	14.4	0.96	10.5	9.4	81.6	**80.4%**	**87.2%**
Lead										
Minimum*	35.1	0.944	20.32	18.3	0.944	0.79	0.7	0.50	-3963.5%	-58.4%
Median^	88.9	0.808	56.80	51.1	0.808	2.21	2.0	3.00	-1793.4%	**26.2%**
Mean^	199.8	0.690	135.99	122.4	0.690	5.30	4.8	14.29	-851.6%	**62.9%**
Maximum*	71.0	0.841	44.39	40.0	0.841	1.73	1.6	118.00	**62.4%**	**98.5%**
Zinc										
Minimum*	484.0	0.978	446	401.2	0.986	449	404.5	3.0	-14759.5%	-14881.0%
Median^	90.8	0.978	108	97.2	0.986	109	98.0	66.5	-62.4%	-63.7%
Mean^	200.2	0.978	211	189.9	0.986	213	191.4	102.2	-106.5%	-108.1%
Maximum*	120.0	0.978	137	123.1	0.986	138	124.1	548.0	**75.0%**	**74.8%**

* Uses measured hardness that corresponds to max and min measured metal concentrations
^ Hardness listed is the statistical median or mean, respectively.
CCC = Criteria Continuous Concentration
CF = Conversion Factor
WLA = Waste Load Allocation
CMC = Criteria Maximum Concentration
LA = Load Allocation
WQO = Water Quality Objective

Figures G.1 through G.3 present the available metals data plotted against the associated hardness. The graphs also show CMC and CCC WQOs required at hardness concentrations from 25 to 400 mg/L.[2] These views of the data better illustrate that the majority of the metals concentration reductions need to occur at the lower hardness concentrations. Both the CMC (acute) and CCC (chronic) WQOs for all metals are exceeded within the lower range of measured hardness.

Thirty-six of eighty-one (39.5 percent) measured copper samples exceed the proposed acute WQO and forty-four (50.5 percent) exceed the proposed chronic WQO. The vast majority of the exceedances occur at or below a hardness of 150 mg/L. The maximum percent reduction required is approximately 90 percent for both the acute and chronic WQOs. The average reduction required is approximately 50 percent to meet the chronic WQO and 40 percent to meet the acute WQO. There is some good news in that almost half of the measured copper samples would not require a reduction under the proposed WQOs.

Eleven of seventy-nine (13.9 percent) measured lead samples exceed the proposed acute WQO and forty-three (54.4 percent) exceed the proposed chronic WQO. The vast majority of the exceedances occur at or below a hardness of 120 mg/L. The maximum percent reduction required is approximately 99 percent for the chronic WQO and 62 percent for the acute WQO. The average reduction required is approximately 66 percent to meet the chronic WQO and 25 percent to meet the acute WQO. Almost half of the measured lead samples

[2] This is the range of hardness that is appropriate for use in the California Toxics Rule (40 CFR 131.38).

would not require a reduction to meet the proposed chronic WQO and over 85 percent would already meet the proposed acute WQO.

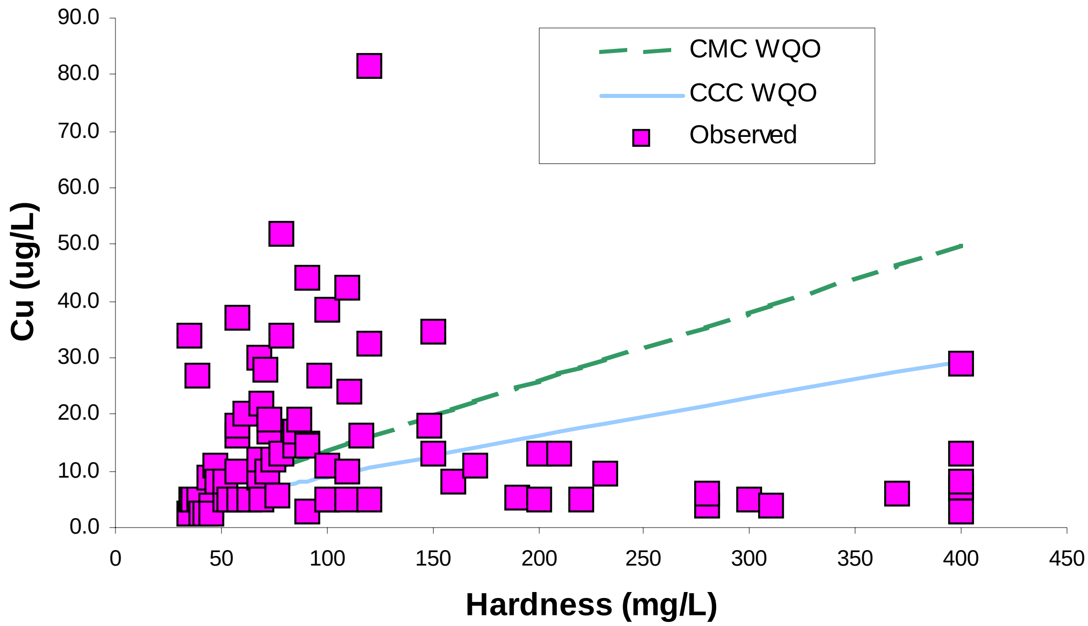

Figure G.1. Copper concentrations in Chollas Creek

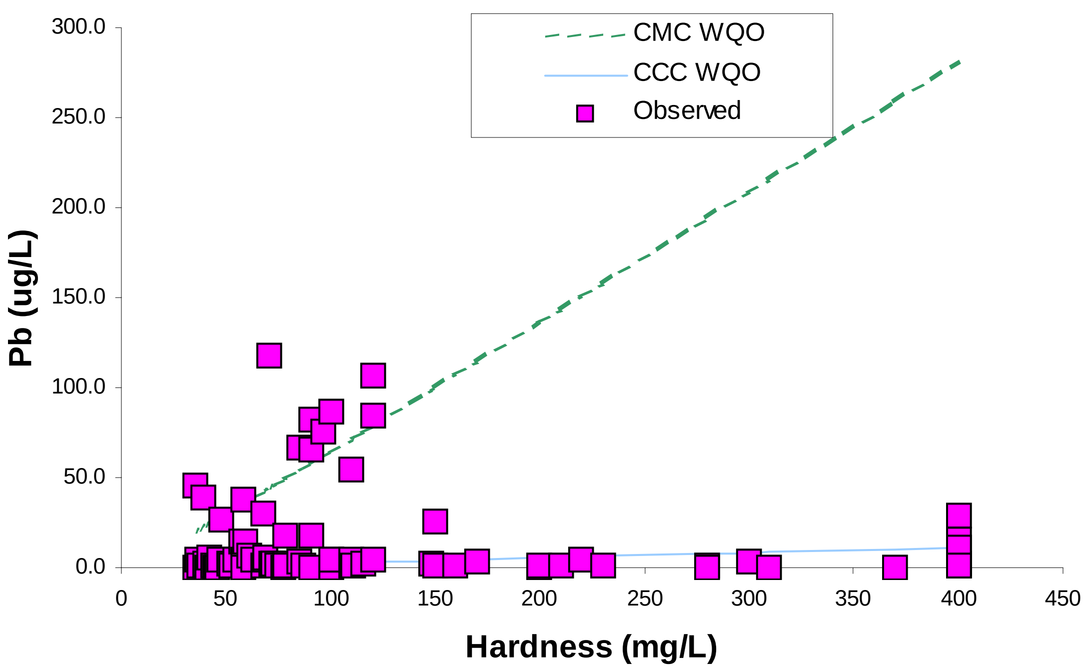

Figure G.2. Lead concentrations in Chollas Creek

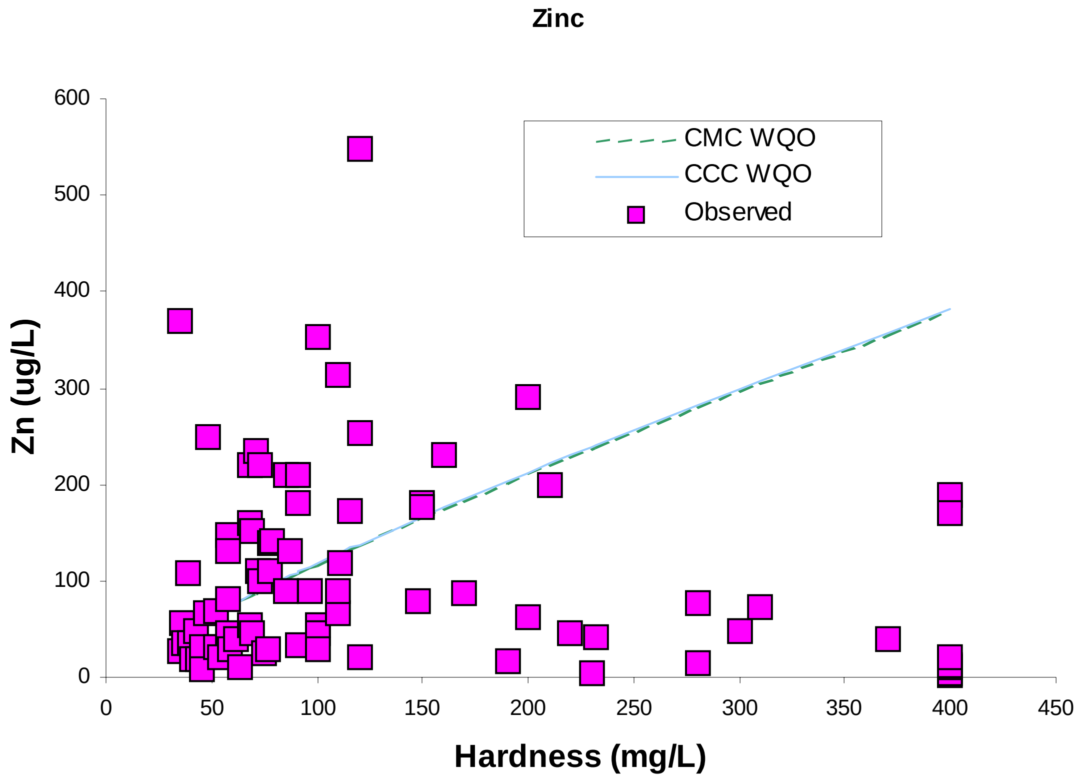

Figure G.3. Zinc concentrations in Chollas Creek

Thirty-three of eighty-two (40 percent) measured zinc samples exceed both the proposed acute and chronic WQOs. All of the exceedances occur at or below a hardness of 210 mg/L. The maximum percent reduction required is approximately 87 percent for both the acute and chronic WQOs, while the average reduction required is approximately 35 percent. For zinc, well over half of the measured samples would not require a reduction under the proposed WQOs.

All three metals require significant reductions from current concentrations to meet the WQOs. Most reductions are required at the lower range of the measured hardness and represent up to a 98 percent reduction. However, the average reduction required is closer to 50 percent and a significant number of previously measured metal concentrations would not require a reduction. This data should be investigated further when implementing best management practices and considering load reduction scenarios.