TOTAL MAXIMUM DAILY LOAD

TECHNICAL SUPPORT ANALYSIS FOR MERCURY IMPAIRMENT

OF

CLEAR CREEK AND HERNANDEZ RESERVOIR

Central Coast Regional Water Quality Control Board

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1. Watershed Description

1.1 Physical Setting

The Clear Creek watershed is located in San Benito County, California (Figure 1). The watershed is the southern upland drainage area of the Pajaro River and drains steep upland areas of the Diablo mountain range. Clear Creek runs into the San Benito River just upstream of Hernandez Reservoir, with only about a half-mile of river between the creek and the reservoir. Hernandez Reservoir is managed by the San Benito County Water District as a source, and as storage, of municipal water. The climate in the watershed is temperate, with wet winters and dry summers. There is typically little or no precipitation during the period May – November.

Clear Creek runs roughly northeast-southwest, and is bounded to the north and east by the Diablo mountains, and to the south and west by the San Benito River valley and the Gabilan mountains. Clear Creek drains an area that is predominantly federal land, managed by the US Bureau of Land Management (USBLM). Some of the land is privately held under leases (mostly for mineral rights), but most of the land is used for recreational purposes including off road vehicle usage. Past land use in the area has included a number of mining activities due to deposits of asbestos, chromium, mercury, and other metals in the mountains.

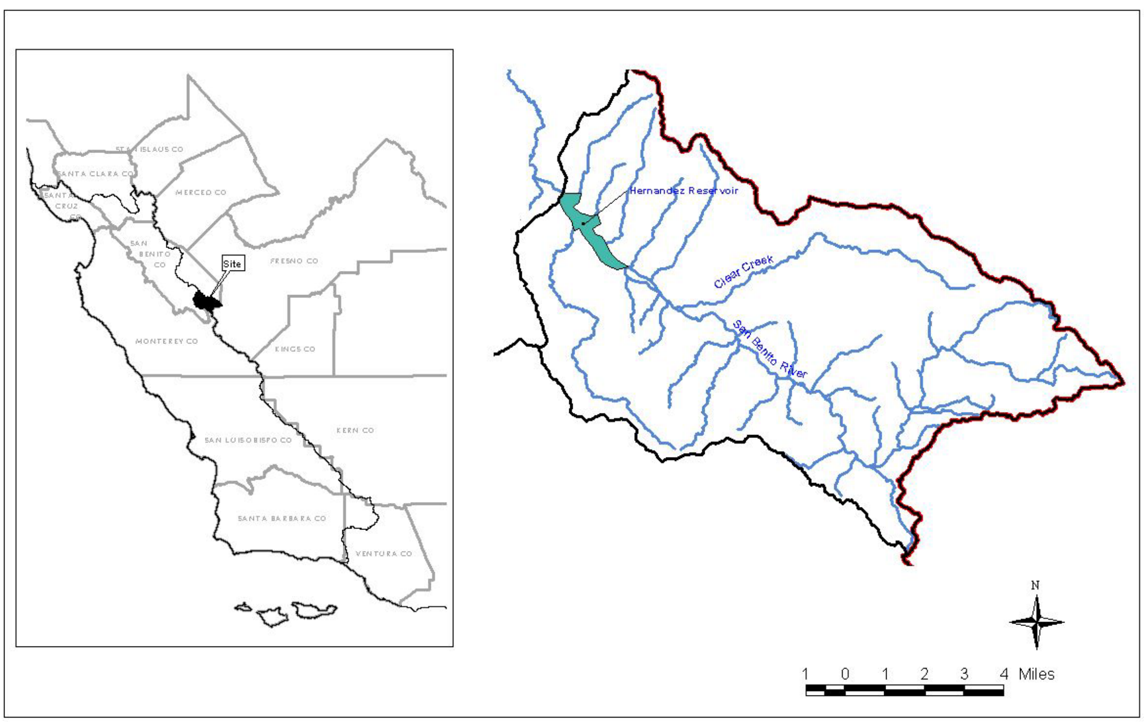

Figure 1. General Locations of Clear Creek and Hernandez Reservoir.

Habitat and fisheries

Clear Creek runs through a narrow canyon bordered by steep hillsides of asbestos-bearing lithologies. Little vegetation grows on these types of rocks, leaving the creek well-exposed to sunlight. From October 1993 to September 1994, USGS data indicate water temperatures ranged from 0 to 35.5 degrees Celsius in Clear Creek (USGS, 1995).

Hernandez Reservoir has had a sizeable fish population in the past, however draining of the lake in the mid 1990's resulted in the death of most fish and a reported mass burial of approximately 5 tons of fish (Regional Board, 1997).

Geology and mining

The watershed occurs within the Diablo mountains geologic province, which includes Franciscan Formation sedimentary rocks, and various igneous and metamorphic rocks, including serpentine.

The Watershed contains a number of inactive mines, dating from the 1800's through at least the 1970's (USBLM, 2001). Some mines experienced alternating phases of activity and inactivity. One mine, the Atlas Asbestos mine, has been placed on the National Priorities List (i.e., Superfund List) for remediation due to asbestos contamination and asbestos materials transported offsite into Coalinga (USEPA, 1997).

A key geologic feature of the Clear Creek area is a large dome-shaped deposit of serpentine. This geologic feature is commonly described as "barrens" at the land surface because the material is generally fairly crusty and does not support much vegetation. It also is noted on USBLM trail maps as an area of "Hazardous Asbestos" because bits of the serpentine rock become airborne asbestos particles as the rock decomposes or is broken down. The USBLM map for Clear Creek Management Area (USBLM, 2003) shows that virtually all of the Clear Creek watershed, the area above the Oak Flat Campground (which is also the location of the USGS Gaging Station on Clear Creek) are within this "Hazardous Asbestos" area.

The largest mineral deposits in the region occur as fillings in fractures around the edges of this serpentine dome (for example, the New Idria Mine, likely the best known and most extensive mine in the area). These deposits around the edges of the dome are generally outside of the Clear Creek drainage area. Smaller mineral deposits have been found filling fractures in the serpentine dome area, for example, the Alpine Mine (Eckel and Myers, 1946). Metals-rich sediment is common throughout the watershed, originating from the natural rocks and soils, mining operations, and human activities (e.g., roads, farming, recreational vehicles), which increase erosion.

2. Problem Definition

2.1 Designated Beneficial Uses

The *Water Quality Control Plan, Central Coast Basin – Region 3* (the Basin Plan) designates various beneficial uses for Hernandez Reservoir, the San Benito River, and Clear Creek (Regional Board, 1994), as depicted in Table 1, below:

Table 1: Beneficial Uses for Hernandez Reservoir, San Benito River, and Clear Creek.

	Hernandez Reservoir	San Benito River	Clear Creek
Municipal and Domestic Water Supply (MUN)	X	X	X
Agricultural Supply (AG)	X	X	
Ground Water Recharge	X	X	
Water Contact Recreation (REC-1)	X	X	X
Non Contact Water Recreation (REC-2)	X	X	X
Warm Freshwater Habitat (WARM)	X	X	X
Navigation (NAV)	X		
Freshwater Replenishment	X	X	
Commercial and Sport Fishing (COMM)	X	X	
Spawning, Reproduction , and/or Early Development (SPWN)	X	X	
Industrial Service Supply (ISS)		X	

Note: Clear Creek is not specifically listed in the Basin Plan, therefore, two general uses (encompassing four Beneficial Uses) designated for all water bodies in the Region apply to Clear Creek:

- Municipal and Domestic Water Supply (MUN),
- Protection of both recreation and aquatic life (REC-1 REC-2, WARM).

Numeric Objectives

Numeric mercury objectives for the beneficial uses listed in Table 1 range from 0.0002 mg/L total mercury (for Cold or Warm Freshwater Habitat) to 0.01 mg/L (for Agricultural use in livestock watering). The lowest Basin Plan objective for mercury (0.0002 mg/L) is superceded by the California Toxics Rule (Federal Register, 2000), which includes a health-based mercury objective of 0.050 μg/L (total mercury) for consumption of organisms and water (for the MUN use designation). This value is the numeric objective for all waters in the Region designated for municipal and domestic supply (MUN).

Narrative Objectives

Narrative water quality objectives are listed in the Basin Plan for suspended and settleable materials. Table 2 lists narrative water quality objectives for sediment in the Central Coast region. USEPA has recommended a criterion for methylmercury in fish tissue of 0.3 mg/kg (USEPA, 2001a). Methylmercury in fish tissue at levels above the EPA criterion is considered an indication that the suspended and settleable material narrative objectives are not being attained because of the nuisance for fish consumers and the adverse effect on the Commercial and Sport Fishing beneficial use (in Hernandez

Reservoir). In the absence of specific data on methylmercury levels, the total mercury levels in fish tissue are assumed to be equal to the methylmercury levels.

Table 2: Water Quality Objective: Narrative Objective Description.

Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain settleable material in concentrations that result in deposition of material that causes nuisance or adversely affects beneficial uses.

2.2 Data Analysis - Current Conditions in the Watershed

The available data located for use in this analysis of waters in Clear Creek and Hernandez Reservoir include:

- US Geological Survey published Water Resources Data, Water Year 1995.
- A draft US Geological Survey report of a study of mine tailings in the Clear Creek area (Rytuba et al, 2000).
- Central Coast Regional Water Quality Control Board files including Toxicity Sampling for the Hernandez Reservoir conducted in 1996 in conjunction with California Department of Fish and Game.
- Central Coast Ambient Monitoring Program (CCAMP) data from 1996 - 1999
- US Geological Survey data (electronic data files) including the Clear Creek sampling location for parts of 1997 through 2002.
- Central Coast Regional Water Quality Control Board sampling conducted in 2002 as part of this project

Data from these sources indicate total mercury levels in water in Clear Creek ranging from less than 0.1 µg/L up to 1.5 µg/L. As stated previously, the appropriate numeric objective for total mercury in water is 0.050 µg/L (as expressed in the California Toxics Rule), so Clear Creek is impaired by mercury. The available data indicate that the San Benito River is currently meeting water quality objectives for mercury. The data also indicate that Hernandez Reservoir is currently meeting water column objectives for mercury (1998 data), but the most recent fish tissue from the reservoir (which are older samples from 1995) contains mercury at levels averaging about 0.6 mg mercury/kg tissue.

Available data are summarized in Table 3.

Table 3. Available Mercury Data for Clear Creek and the Surrounding Area.

Sample ID	Date/ Location	Mercury, total in water (µg/L)	Sediment Mercury (mg/kg)	Note
USGS-Jan0995	1/9/95, Clear Crk Gage	**1.5**	0.47	1
USGS-Mar2295	3/22/95, Clear Crk Gage	**0.80**	0.28	1
USGS-Mar1296	3/12/96, Clear Crk Gage	**0.20**	**5.0**	
RB3-CC1	5/12/96, Clear Crk Gage	ND	0.27	2
USGS-97CC1	10/25/97, Clear Creek, Frontier Lab	0.0177		5
CCAMP- 305GOA	6/98, Clr Crk, Goat Mtn.	0.004	0.18	
CCAMP- 305HAH	6/98, Clr Crk, Halfway Hill		0.19	
CCAMP- 305CCC	9/1/98 crk @ Clr Crk Rd	0.003		
CCAMP- 305CCC	10/1/98 crk @ Clr Crk Rd	0.002		
CCAMP- 305CCC	11/1/98 crk @ Clr Crk Rd	0.004		
CCAMP- 305CCC	12/1/98 crk @ Clr Crk Rd	0.047		
CCAMP- 305CCC	1/1/99 crk @ Clr Crk Rd	0.004		
CCAMP- 305CCC	2/1/99 crk @ Clr Crk Rd	0.004		
CCAMP- 305CCC	3/1/99 crk @ Clr Crk Rd	**0.385**		
USGS-99CC01R	5/12/99, Clear Creek; Rytuba	<0.005 (ND)	**2.37**	5
USGS- 20000124	1/24/00, Clear Crk Gage	*<0.3 (ND)*	0.41	3
USGS-20000221	2/21/00, Clear Crk Gage	*<0.3 (ND)*	**0.72**	3
USGS – 20000328	3/28/00, Clear Crk Gage	**E0.17***	0.33	3, 4
USGS – 20000906	9/06/00, Clear Crk Gage	*<0.3 (ND)*	0.27	3
USGS- 20010111	1/11/01, Clear Crk Gage	**0.2**	0.32	3
USGS – 20010222	2/22/01, Clear Crk Gage	**0.54**	0.24	3
USGS – 20010327	3/27/01, Clear Crk Gage	<0.01 (ND)	0.22	
USGS – 20010905	9/05/01, Clear Crk Gage	<0.01 (ND)	0.11	
RB3- 305CL1	4/3/02, near "switchbacks"	<0.035	0.088	
RB3- 305CL2	4/3/02, @ staging area 6	E0.041*	<0.05	
RB3- 305CL3	4/3/02, u/s of Alpine Mine Rd	<0.035	0.16	
RB3- 305CL4	4/3/02, d/s of Alpine Mine Rd	E0.045*	<0.05	
RB3- 305CL5	4/3/02, @ staging area 2	**0.064**	0.088	
RB3- 305CL6	4/3/02, d/s of stage area 2	**0.089**	0.22	
RB3- 305CL7	4/3/02, @ Clear Crk. Gage	**0.18**	0.33	
RB3- 305CL1	5/15/02, near "switchbacks"	<0.035	0.072	
RB3- 305CL2	5/15/02, @ staging area 6	<0.035	0.059	
RB3- 305CL3	5/15/02, u/s of Alpine Mine Rd	<0.035	0.16	
RB3- 305CL4	5/15/02, d/s of Alpine Mine Rd	<0.035	<0.05	
RB3- 305CL5	5/15/02, @ staging area 2	<0.035	0.073	
RB3- 305CL6	5/15/02, d/s of stage area 2	<0.035	0.21	
RB3- 305CL7	5/15/02, @ Clear Crk. Gage	<0.035	0.11	
USGS-	2/4/02, Clear Crk Gage	**0.13** (diss.=0.04)	0.22	
USGS -	3/27/02, Clear Crk Gage	0.02	**1.3**	
USGS -	6/7/02, Clear Crk Gage	0.01	0.34	
USGS -	8/27/02, Clear Crk Gage	0.04	0.20	
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Hernandez Res. Or	**Table 3. (Continued)**			
San Benito River	Date/Location	Mercury, total in water (µg/L)	Sediment Mercury (mg/kg)	Note
RB3 – SBR-1	5/12/96, *Hernandez Reservoir*	ND	**1.3**	2
RB3 – SBR-2	5/12/96, San Benito R. just below Clear Creek	**0.34**	0.24	4
RB3 – SBR- 3	5/12/96, San Benito R. just above Clear Creek	ND	**1.2**	2
RB3 – SBR – 4	5/13/96, upper San Benito R., above RB3 – SBR-3	ND	0.25	2
RB3 – SBR – 5	5/13/96, San Benito R. near Picacho Creek	ND	ND	2
CCAMP- 305LAZ	6/98,*Hernandez Res*, Marina	0.001	0.21	
RB3- 305CL8	4/3/02, San Benito R @ u/s side of Clear Crk Rd crossing	<0.035	0.22	
RB3 – 305SB1	5/15/02, San Benito R @ d/s side of Clear Crk Rd crossing	E0.037*	0.19	
RB3- 305SB2	5/15/02, San Benito R. aprx 75 feet u/s of Clear Creek inflow	<0.035	0.11	
RB3- 305HR1	10/18/02 *Hernandez Res*., nr dam		0.10	
RB3- 305HR2	10/18/02, *HernandezRes*., s. shore		0.12	
RB3- 305HR3	10/18/02, *Hernandez Res*. @ mouth of Laguna Creek		0.053	
CCAMP- 305.50.60	Lake Hernandez/ San Benito R fish tissue sampling, 11/30/95			0.69 mg/kg
CCAMP- 305.50.60	Lake Hernandez/ San Benito R. fish tissue sampling, 11/30/95			0.52 mg/kg
	All other fish samples pre-1985			

Notes:
1 = Data from US Geological Survey Annual Water summary, 1995
2 = Quantitation Limit reported as 0.36 µg/l, higher than water quality objectives, data from Region 3 working files, laboratory analyses done by CA Dept. of Fish and Game
3 = data reported by US Geological survey in electronic data from USGS NWIS website
4 = data reported as estimated concentration below quantitation limit
5 = data reported in draft Rytuba et al, 2000, Table 3.
* = estimated value, data between practical quantitation limit (pql) and method detection limit (mdl)
bold type indicates water values in excess of CTR objective or sediment values above the PEL.

2.3 Basis of the 303(d) Listing

Clear Creek was placed on California's 1998 Clean Water Act section 303(d) List as impaired due to levels of mercury in the water column, which exceed water quality objectives for the municipal (MUN) beneficial use designation. Detailed review of available data indicates Clear Creek has exceeded water quality objectives for mercury in the past and may still be exceeding those objectives.

Hernandez Reservoir was also placed on the 1998 303(d) List as impaired by mercury. The presence of mercury in fish tissue at levels considered unsafe for consumption of the fish indicates the narrative objective regarding suspended solids was not being attained in Hernandez reservoir in samples collected as recently as 1995. This is considered an impairment of the commercial and sport fishing (COMM) beneficial use designation.

Because the beneficial uses are not being attained, these waterway segments require a Total Maximum Daily Load for the metal mercury.

3. Numeric Targets

3.1 Background Data

A limited number of samples in the database have been collected from areas upstream of anticipated mercury-rich mineral zones. Locations of samples collected by Regional Board staff in 2002, shown on Figure 2, are numbered 305CL"x" where "x" is a location number along the creek from the upstream site, CL1, to the USGS gage site, CL7. The three locations believed to be upstream of any significant impact from mercury mineralization are: CL1, CL2, and CL3. Maximum values of water and sediment samples from these locations suggest that background conditions in Clear Creek may be slightly less than 0.05 µg/L mercury in water and approximately 0.16 mg/kg mercury in sediment. The Regional Board database also includes two sediment samples from Clear Creek collected in 1998 with mercury levels of 0.18 and 0.19 mg/kg. The US Bureau of Land Management (2002a) has reported a local "background" concentration of mercury in "native bedrock (non-mercury ore)" as 0.2 parts per million (equal to 0.2 mg/kg), although the report does not detail how this number was determined. Considering the Regional Board 2002 samples, CCAMP samples from 1998, and the USBLM report, a reasonable estimated background mercury content of sediments in the Clear Creek watershed is about 0.2 mg/kg, which is slightly above the NOAA TEL (0.174 mg/kg) and well below the NOAA PEL (0.486 mg/kg). Background water column levels of mercury appear to be just below the 0.050 µg/L CTR objective.

To place sediment background values in perspective, the Screening Quick Reference Tables compiled by the National Oceanic and Atmospheric Administration (NOAA – SQuiRT) are helpful. These tables (Buchman, 1999) include sediment guidance values compiled from scientific literature regarding aquatic impacts of various chemicals in sediment. The tables include two values, Probable Effect Levels (PELs) and Threshold Effect Levels (TELs). In general, the PEL is the level <u>above</u> which aquatic life effects might be anticipated and the TEL is the level <u>below</u> which aquatic life effects are not anticipated. For mercury in freshwater sediments, the TEL is 174 ppb (0.174 mg/kg) and the PEL is 486 ppb (0.486 mg/kg). We assume that achieving an acceptable sediment level of mercury will also achieve acceptable fish tissue concentrations (below the 0.3 mg/kg health- based criterion).

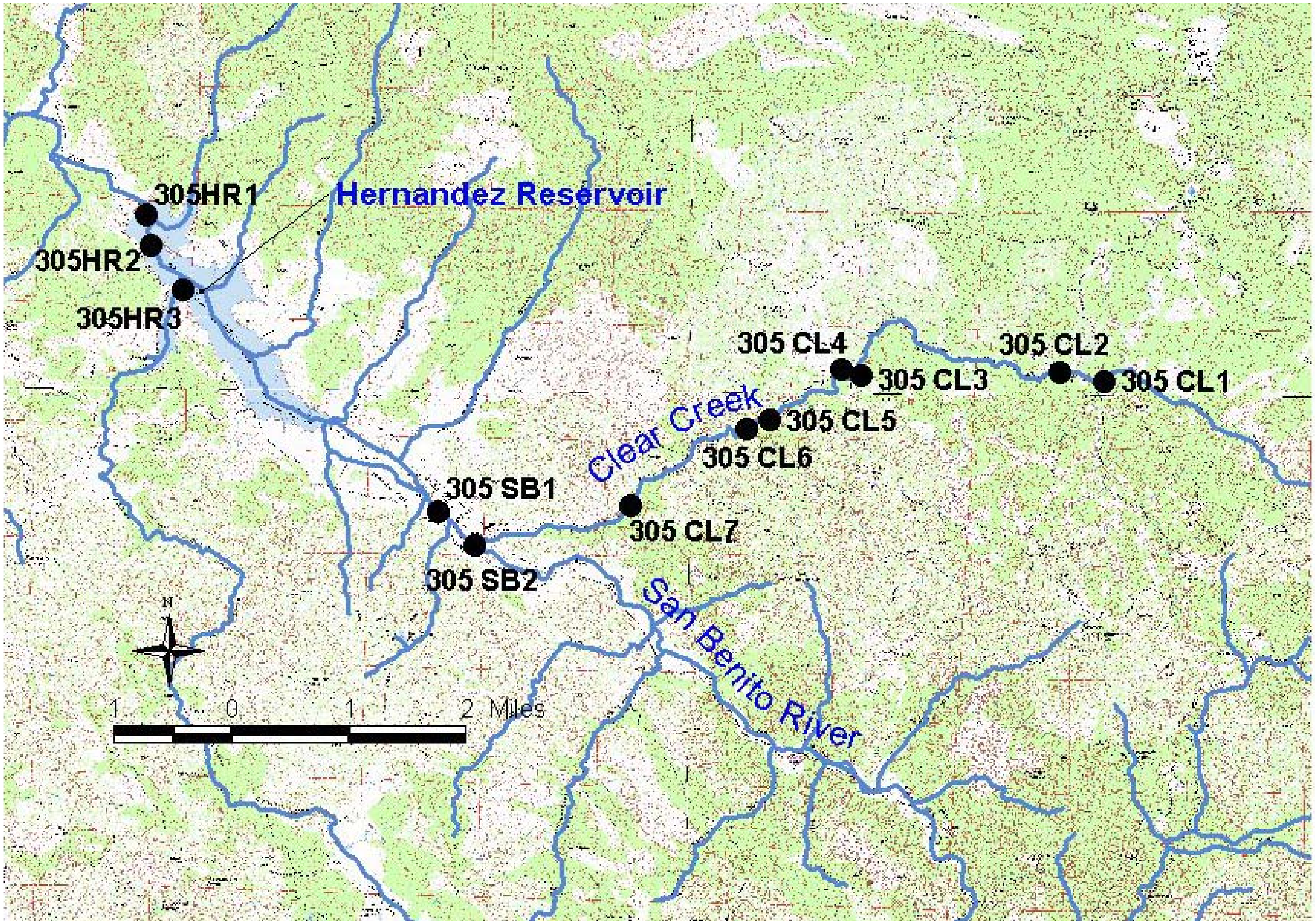


Figure 2. Map of Clear Creek area showing 2002 Sample Locations.

3.2 Remediation Goals

The remediation goal for Clear Creek is to establish conditions which meet the most stringent applicable water quality objectives, in this case those of the MUN beneficial use. The CTR contains a criterion for human health based on the consumption of water and organisms of 0.050 µg/L mercury.

The remediation goal for Hernandez Reservoir is to establish conditions which continue to meet the MUN beneficial use objectives and which will in the future meet the objectives of the COMM beneficial use. To be sure to address the most stringent water quality objectives for the reservoir, we propose two numeric targets. One target is the CTR criterion for human health based on the consumption of water and organisms of 0.050 µg/L mercury. The second target is an indicator of fish tissue being at or below the appropriate guidance value for safe consumption, currently 0.3 mg/kg methylmercury in tissue of trophic level 4 fish based on USEPA's revised criterion published in 2001 (USEPA, 2001a). The tissue target is an interpretation of the narrative objective pertinent to the COMM use designated for Hernandez Reservoir.

3.3 Numeric Targets Selected for this TMDL

The following numeric targets have been selected for this TMDL:

<u>Water in Clear Creek and Hernandez Reservoir</u>:
    0.050 µg/L total mercury (California Toxics Rule, MUN use)

<u>Fish Tissue in Hernandez Reservoir</u>:
    0.3 mg/kg methylmercury in trophic level 4 species

4. Source Analysis

4.1 Source Area Identification

Naturally occurring mercury was historically mined in the Clear Creek area. Two major activities have been conducted in the Clear Creek area which were evaluated for their possible contribution to mercury loads in the creek. These activities evaluated were: Off-Highway Vehicle use (OHV) and abandoned mine lands. Regional Board staff considered both of these activities in designing the water quality sampling program conducted in 2002.

For the 2002 sampling, seven locations were selected on Clear Creek and positioned to evaluate potential water quality impacts from the two major categories of activity. Sample locations were mostly located in pairs to evaluate water quality immediately upstream and downstream of a targeted area. For example, sites CL1 and CL2 were located upstream of any mining influences and bracketed an area of extensive OHV activity. Similarly, sample sites CL3 and CL4 were located just upstream and downstream of side drainages entering the creek in the vicinity of the Alpine mine and the Clear Creek mine. A third set of sample sites, CL5 and CL6, was located in the vicinity of OHV Staging Area Two.

As discussed earlier in section 4.1 "background data," a reasonable estimate for background levels of mercury in soils and sediment in the Clear Creek area is 0.2 mg/kg. Sediment data from the paired sample sites were essentially all at or below this value except for one sample collected at the furthest downstream location, the USGS gage. This indicates that sediment loading into the creek is roughly at background levels throughout most of the watershed, which suggests that the OHV activities are not causing any significant mercury loading. These data also suggest no appreciable loading is currently occurring in the vicinity of the Clear Creek and Alpine mine drainage.

Evaluation of the water column data from the 2002 Regional Board sampling yields a conclusion similar to the one drawn from the sediment data. Three samples collected in April 2002 exceeded the total mercury objective of 0.050 μg/L. Two locations, CL5 and CL6, in the vicinity of Staging Area Two and downstream of where most mine drainage enters the creek, were only slightly above the objective. The location where the sample result was about three times the objective was the most downstream location, CL7 at the USGS gage. It should be noted that even this location, CL7, had a value less than the 0.2 μg/L detection limit currently required of state-certified labs (the Regional Board sampling used a lower detection limit to develop a deeper understanding of potential loading sources). It is worth noting that a USGS sample collected just one week earlier at this same location and under very similar flow conditions was found to only have 0.02 μg/L of total mercury. This suggests that, although both sampling efforts (USGS and Regional Board) followed trace metal sampling protocols, the variability between samples because of sampling method and lab handling processes supports the policy of the State Implementation Plan for the CTR that requires labs to only use a detection limit of 0.2 μg/L (SWRCB, 2000) for mercury in water. In the May 2002 sampling event, none of the Clear Creek samples, including the three locations, CL5, CL6, and CL7, had any detectable water column mercury.

Based on both the water and sediment data collected by the Regional Board, it appears that high-use OHV areas are not a significant source of mercury loading. It also appears that abandoned mine lands may no longer be contributing appreciable loads of mercury to Clear Creek. One possible reason that abandoned mines may no longer be major sources of mercury to the creek is recent efforts of the US Bureau of Land Management (USBLM) to remediate those mine areas (USBLM 2002b, 2002c).

Recent Mine Remediation

Considering the local history of mining, the USBLM has taken steps to remediate major mine sources of mercury-rich sediment runoff in the Clear Creek watershed. Key mines the USBLM has addressed include the Alpine Mine and the Clear Creek Mine and a number of smaller mining and test pit areas (USBLM 2002b, USBLM 2002c, which are included in the Appendix). The USBLM effort was focused on controlling erosion and soil runoff from mine areas near or adjacent to a stream channel.

Some uncertainty exists about the relationship between sediment levels of mercury and water column or fish tissue levels of methylmercury, with some researchers reporting little correlation between sediment mercury levels and methylmercury levels in fish (Tetra-Tech, 1999, p. 33) and others reporting a correlation between sediment mercury and water column methylmercury levels (Krabbenhoft et al., 1999). We believe it is reasonable to anticipate that reduced mercury loading into the system will result in reduced levels of mercury in the water column and in fish tissue and, based on the conclusion of Krabbenhoft et al. (1999), we believe that a useful correlation exists at the relatively low levels of mercury being considered in the Clear Creek area.

Drainage from the mined areas mostly enters Clear Creek between Alpine Mine road and Staging Area One, which coincides with sampling locations CL4, CL5, and CL6 of the Regional Board's 2002 sampling effort. Sites CL6 and CL7 (the USGS gage, downstream of site CL6) had the highest mercury sediment results in the Regional Board 2002 data (with average values of 0.22 mg/kg at both locations, only slightly above the TEL, 0.174 mg/kg).

In the water column, sites CL5, CL6, and CL7 had the only exceedences of the CTR mercury objective in the 2002 sampling, with results of 0.06, 0.09, and 0.18 µg/L in the April sampling. The highest of these three values, 0.18 µg/L is below the older Basin Plan mercury objective of 0.2 µg/L and would be a "non-detected" amount if the analytical laboratory had been using the practical quantitation level of 0.2 µg/L required by the State Implementation Plan for the California Toxics Rule (SWRCB, 2000a). This sample is the sample that was collected just one week after a USGS sample at the same location was collected which had a reported value of only 0.02 µg/L. The week between the two samples had no significant storm events or changes in flow condition. The May samples collected by Regional Board staff at these three locations were all below even the more stringent 0.035 µg/L detection limit used for this project.

Taken together, the sediment and water column data suggest the BLM has properly identified the source of mercury runoff entering Clear Creek and has taken proper efforts to reduce or eliminate this load.

It is reasonable to expect a lag time between implementation of erosion control actions and improved sediment and water quality in the creek channel. No data were located that provided an accurate estimate of the lag time for Clear Creek, but, based on other creeks in the region and the small size of the Clear Creek drainage area, staff estimates approximately two to five years between implementation and water quality improvements. The available data suggest that water quality conditions may already be showing improvement about two years after the BLM implemented source removal and erosion control measures in 2000.

5. Linkage Analysis

The basic approach of reducing sediment mercury loads to estimated background conditions can also be assumed to restore tissue levels of mercury to background conditions (based on an assumption that background conditions pre-mining influence resulted in local fish tissue that supported the COMM designation, and assuming an adequate response time to mine remediation leading to re-establishing "background" sediment mercury levels). The linkage between the implementation actions of reducing sedimentary mercury loading from the mines and achieving the water column targets for mercury is demonstrated in the work of Krabbenhoft et al. (1999), which shows a correlation between sediment mercury and water column methylmercury levels at the relatively low ranges of values observed in the Clear Creek and Hernandez Reservoir data. In setting the criterion for methylmercury in fish tissue, the USEPA suggested three approaches to link methylmercury in tissue to methylmercury in the water column. We believe this combination linkage of mercury sediment loads to methylmercury in the water column and of methylmercury in the water column to methylmercury in fish tissue demonstrates that the proposed loads will achieve the numeric targets selected for Clear Creek and Hernandez Reservoir.

6. Load Allocations

The allocated loads are directly correlated with the average flows from Hernandez Reservoir and within Clear Creek because the Numeric Target selected for this TMDL is the CTR water column objective for total mercury. Therefore, the load allocation for mercury in Clear Creek can be calculated as the average flow at the USGS Gage on Clear Creek times the allowable water column concentration (incorporating factors for unit conversions).

A similar allocation for the reservoir itself can be made using outflow data from Hernandez Dam reported by the San Benito County Water District. The remaining portion of the load is allocated to general "background" non-point source runoff from the remaining portion of the Hernandez Reservoir watershed other than the Clear Creek sub-watershed. This method does not explicitly account for changes in storage within the reservoir, but by basing the total mercury load only upon the outflow from Hernandez Reservoir, the estimated allowable load is conservatively calculated.

Each of the load allocation calculations described above can also be tailored to the timeframes of available data (e.g., daily, monthly, or annual average flows). To account for seasonality and anticipating a reasonable monitoring schedule, a quarterly average flow has been selected as the basis for load allocations. The load allocations shown in Table 4 were derived by summing three consecutive months of monthly average flow data to obtain a quarterly (seasonal) average flow (in liters, L), then multiplying that flow times the 0.050 μg/L mercury objective concentration to obtain a quarterly load allocation.

Table 4. Mercury Load Allocations.

Time Period:	Hernandez Reservoir Flow (acre- ft)	Hernandez Load Allocation (grams)	Clear Creek Flow (acre-ft)	Clear Creek Load Allocation (grams)
1/1 – 3/31	5323	**336**	2078	**131**
4/1 – 6/30	4010	**253**	1155	**73**
7/1 – 9/30	5499	**347**	272	**17**
10/1 – 12/31	1245	**79**	238	**15**
Annual Total	16077	**1015**	3743	**236**

Note:
Calculations are: (Flow, in acre-ft)*(1,262,587 Liters/acre-ft)*(0.050 μg/L)*(1 g/1,000,000 μg)= Load (g.)
Flow data from: USGS Website (8 years of record) for Clear Creek, San Benito County Water District website (4 years of record) for Hernandez Reservoir outlet.

As shown on Table 4, the total maximum annual load for mercury in Hernandez Reservoir is 1015 grams per year, allocated as follows:

Total Maximum Annual Load =
Clear Creek allocation + "rest of Hernandez watershed" Non-Point Load + MOS

Because the Margin of Safety (MOS) is implicitly derived from conservative assumptions in the development of the targets and the total load, the TMDL numerically becomes:

1015 grams/year = 236 grams/year (Clear Crk) + 779 grams/year (Non-Point Sources)

The load in Clear Creek is a combination of inactive mines and background from other lands in the Clear Creek watershed. The allocation will be met by USBLM activities that result in achieving 236 grams/year in Clear Creek as appropriate to that year's flow in the creek.

As a check on the non-point source load attributed to the remainder of the Hernandez Reservoir watershed (outside of the Clear Creek sub-watershed), an "order-of-magnitude" estimate was calculated assuming atmospheric deposition of mercury as the main source of mercury for the rest of the watershed (assuming essentially no mining impacts outside of the Clear Creek sub-basin). This calculation used annual deposition rates from a mercury deposition station in San Jose (the nearest station), assumed dry season deposition was equal to wet deposition, and assumed a pass-through rate of 20% (that is, 20% of the mercury deposited in the basin leaves in non-point source runoff, with the remainder being adsorbed to soils, adsorbed to plants or taken up in plant tissue, reemitted to the atmosphere, etc.). A rate of 20% is mid-range from one study in the literature for measurements reported for the forested, pasture, and cropland land uses found in the Hernandez Reservoir watershed (USEPA, 2001b). This “order-of-magnitude” calculation resulted in a non-point source mercury load to Hernandez Reservoir estimated to be about 239 grams/year. This estimate is in general agreement with the TMDL load calculation which assumes 779 grams per year of non-point source mercury load will still allow Hernandez Reservoir to meet the selected targets.

6.1 Margin of Safety

Clear Creek

The total maximum annual load for Clear Creek includes an implicit margin of safety. The margin of safety incorporates safety factors used in the derivation of the CTR water column objective and general factors using average recent flow conditions adjusted for critical seasonal times. The consideration of the lowest sediment guidance value (TEL) in evaluating site-specific data also contributes implicitly to the margin of safety.

Hernandez Reservoir

The total maximum annual load for Hernandez Reservoir includes an implicit margin of safety. The margin of safety incorporates safety factors used in the derivation of the CTR water column objective and general factors using average recent reservoir discharges regardless of storage volume change within the reservoir. Because Hernandez Reservoir is a public water supply facility and therefore is located within an area of restricted access (fenced and locked gates), this also adds an extra margin of safety for a fish tissue target because few, if any, people are likely to be able to regularly consume fish from Hernandez Reservoir at levels the health risk calculations used to derive the fish tissue value assume. That is, the tissue value was derived based on an estimated weekly fish consumption rate (of Hernandez Reservoir fish) that no one is likely to be able to reach (due to limited access to the reservoir and its fish).

7. Implementation

To discuss potential implementation of the load allocations for Clear Creek, it is important to re-visit the current conditions in the watershed and evaluate the results of recent erosion control and mercury load control efforts of the US Bureau of Land Management (USBLM, 2002b; USBLM, 2002c). Brief summaries of some of these actions are included in the Appendix. In general, the actions included:

- Removal and/or entombment of mining wastes,
- Capping of residual material with clean, native (non-mercury ore) soil,
- Re-vegetation of disturbed areas, and,
- Monitoring.

These are the same general activities the Regional Board would require as necessary actions under an implementation plan.

7.1 Current Conditions

It is appropriate to review the most recent available data for Clear Creek to see if any change in conditions can be observed, because the USBLM has recently completed efforts to control mercury-rich sediment runoff and prevent it from entering Clear Creek.

In reviewing the data on Table 3, one can consider both the water column data and the sediment data.

Water:
In reviewing the water column data, it is difficult to discern a clear pattern from the limited amount of data, however, it appears reasonable to conclude that water column conditions with respect to mercury are improving.

For example, in 1995, both water samples (100% of samples) collected by the USGS exceeded the 0.050 μg/L CTR value being used as a comparison. In fact, with an average value of 1.15 μg/L, these waters were significantly impaired with regard to mercury. In 2001, two of the four USGS samples (50% of samples) collected exceeded the CTR value, with an average value of approximately 0.19 μg/L (considering non-detected values at ½ of the method detection limit). The most recent data, the Regional Board 2002 results, had only three of fourteen samples (21% of samples) exceeding the CTR objective, with an arithmetic average value of 0.04 μg/L (note the average value is below the CTR objective). USGS data collected in 2002 (through August 2002) showed no exceedences of the CTR objective. The historic data are summarized in Table 5.

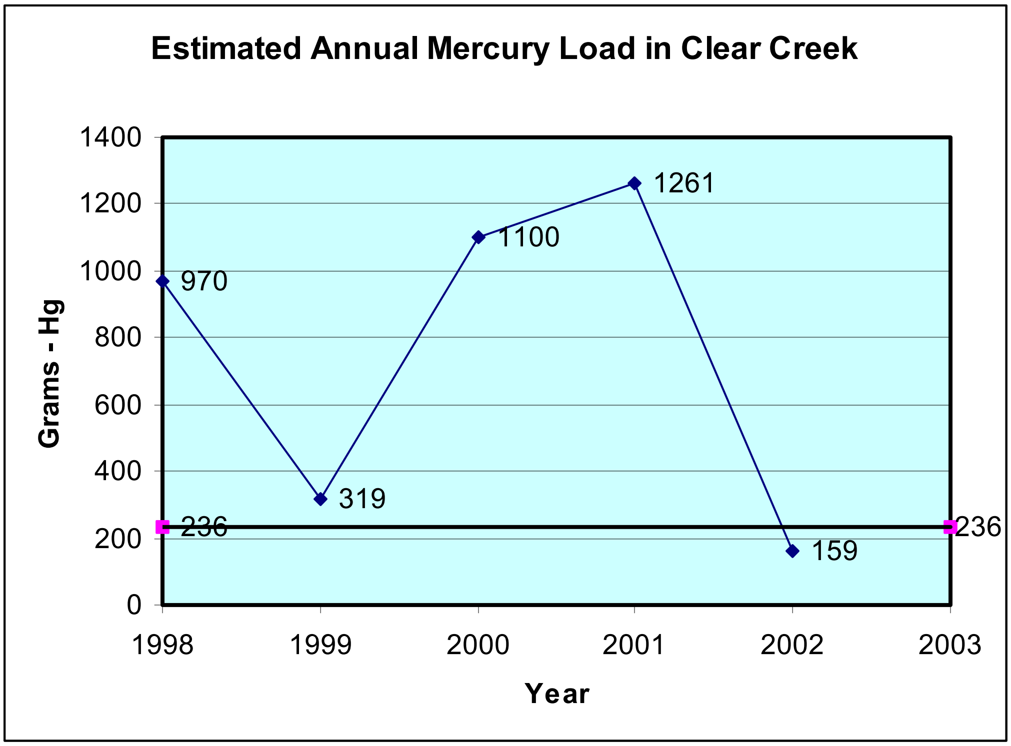
Table 5. Summary of historic Clear Creek water column data.

Year	Data Source	# of samples	% above 0.050 μg/L	Arithmetic average
1995	USGS	2	100%	1.15 μg/L
1996	USGS + RWQCB/DFG	2	50%	0.15 μg/L
1998	RWQCB/CCAMP	5	0%	0.012 μg/L
1999	USGS + CCAMP	4	25%	0.099 μg/L
2000	USGS	4	25%	0.155 μg/L*
2001	USGS	4	50%	0.19 μg/L
2002	RWQCB	14	21%	0.04 μg/L

Note: * = USGS lab used PQL above 0.2 μg/L, average influenced by method of ND = ½ PQL.

The pattern of the data is a little clearer if some minor assumptions are made and the estimated current loads are plotted. This is shown in Figure 3, where estimated loads from the last 5 years are shown. These estimated loads were calculated using the average monthly flow data for the Clear Creek USGS gage, the water-column mercury level averaged from samples reported in Table 3, or, for those seasons where no water sample data were collected, assuming the water column mercury was at the 0.05 μg/L level. Although this assumption may impact the estimated loads shown in the graph, the fairly consistent timing of sample collection during the years 1998 – 2002 make it a reasonable aid to understanding the available data.

Figure 3. Estimated Clear Creek Loads in Recent Years.



From Figure 3, one can see that, although the 2002 estimated load (159 grams) is below the target for Clear Creek (236 grams), the 2002 load estimate is a marked improvement from previous years and suggests that the target load may be maintained in the future.

Sediment:

The sediment sample data exhibit a convincing pattern similar to the water column data and support the conclusion that conditions are improving in Clear Creek. Table 6 summarizes the available sediment data and compares those data against the *lowest* threshold sediment guidance value from the NOAA database, the threshold value below which no effects would be anticipated (TEL), 0.174 mg/kg. Considering an estimated "background" value of 0.2 mg/kg mercury in sediment, one can see that the 2001 data were close to this value and the average 2002 results were well below this value.

Table 6. Summary of Historic Sediment Data for Clear Creek

Year	Data Source	# of samples	% above TEL (0.174 mg/kg)	Average
1995	USGS	2	100%	0.375 mg/kg
1996	USGS + RWQCB/DFG	2	100%	2.637 mg/kg*
1998	RWQCB/CCAMP	2	100%	0.185 mg/kg
1999	USGS + CCAMP	1	100%	2.37 mg/kg*
2000	USGS	4	100%	0.432 mg/kg
2001	USGS	4	75%	0.222 mg/kg
2002	RWQCB	14	21%	0.117 mg/kg

Note: * = results skewed by small number of samples and one large value

7.2 Implementation Summary

No additional implementation efforts are proposed because it is clear that the recent remedial efforts of the US Bureau of Land Management (USBLM) are causing a decrease in sediment concentrations of mercury in Clear Creek and because water column data from Clear Creek appear supportive of the conclusion that conditions are improving. The USBLM has already implemented the actions that would normally comprise the implementation plan for a TMDL.

Achieving the load allocations in Clear Creek is reasonably expected to achieve the load allocations in Hernandez Reservoir and restore beneficial uses of the reservoir because the primary identified source of mercury load to Hernandez Reservoir was from within the Clear Creek watershed.

8. Tracking and Monitoring

Although recent actions of the US Bureau of Land Management appear to have implemented the mercury-loading controls necessary to achieve the TMDL, the waters of Clear Creek are not yet fully attaining standards. Therefore, it will be necessary to monitor the waters of Clear Creek until they attain standards. Regional Board staff is proposing to use the existing monitoring plan of the US Bureau of Land Management (USBLM), with minor modifications, to continue monitoring Clear Creek at the US Geological Survey (USGS) gage location. The modifications Regional Board staff will request are that the USBLM commit to five years of quarterly sampling and annual photo-monitoring. Because the TMDL is calculated using flow data and numeric objectives, staff finds that the TMDL will be achieved by demonstrating that the CTR water column mercury objective is being met in water samples collected from Clear Creek. Because the only other loading to Hernandez Reservoir is the “background” non-point source loading, we believe monitoring progress towards meeting water column objectives in Clear Creek is the only water column monitoring needed. Staff does intend to continue the regional ambient monitoring program rotation, which will include future fish tissue monitoring in Hernandez Reservoir.

Five Years of Quarterly Monitoring

For Clear Creek, staff will request the USBLM to collect a sample and have the sample analyzed for total mercury in the water column (by either the USGS or a state-certified laboratory with a detection limit of 0.2 μg/L) on a quarterly basis until a 3 year record of achieving the appropriate mercury objective (currently 0.050 μg/L) is established. The Regional Board initially expects a five year sampling program with sampling results reported to the Board at least annually. Regional Board staff will review the annual reports, and, in the event results indicate CTR objectives are not being met, staff will require additional actions on the part of the USBLM to investigate the cause(s) and achieve the CTR objective. If the investigation indicates a cause beyond USBLM's authority, Regional Board staff will re-visit this TMDL in light of the additional data from the investigation. Regional Board staff will review the data annually for the five year period, looking for at least 12 consecutive quarterly samples that attain the pertinent mercury objective (CTR includes an allowance for one exceedence every three years).

Photo-Monitoring

Additionally, staff proposes to request the USBLM to assemble a photo-monitoring record of conditions at the former Clear Creek mining sites included in the Appendix (Alpine Mine, Jade Mill, Clear Creek Mine). Photo-documentation of the current site conditions and annual photo-documentation of the site conditions demonstrating that erosion control measures remain in reasonable functioning condition will be sought for the five years of tracking and monitoring.

If the USBLM does not agree to adjust their monitoring program as requested, the Regional Board will require monitoring within one year of approval of this TMDL.

If after five years, no continuous record of meeting water quality objectives exists and/or annual photos show significant gullies or other erosional features which suggest sediment runoff from the former mine sites, Regional Board staff will propose additional requirements on USBLM to repair or maintain remediated conditions or consider different actions to improve water quality.

To accomplish these plans, Regional Board staff propose to send a formal request for a revised monitoring plan to the USBLM within 60 days of Regional Board approval of this TMDL and Implementation Plan. Regional Board staff will request USBLM to submit a monitoring plan to include the water quality sampling and photo-monitoring described above. The Regional Board staff will review this plan and the Executive Officer will either approve the plan or take further actions under existing authorities to see that monitoring occurs in an appropriate fashion for compliance with the numeric targets set forth in this technical analysis, or, that appropriate additional measures are taken to achieve the selected numeric targets.

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APPENDIX

Abandoned Mine Website Pages downloaded from the USBLM's Website

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Alpine Mine and Mill Site

Click on thumbnail photos below for larger versions

Alpine Millsite before and after cleanup and restoration

SITE DESCRIPTION

NAME: Alpine Mine and Mill Site

AMLIS #: CA021900002

LOCATION: Hollister FO, N

CONGRESSIONAL DISTRICT: (17)

Español

ENVIRONMENTAL RISK ISSUES: Water quality, Hg contamination

SITE NARRATIVE

This mine was active from 1910 up to the 1950´s and consisted of several shallow open cuts and 100 feet of subsurface workings. Historic photographs of the mine in operation, indicated several structures were present which may have housed the miners. However, very little evidence of these structures remained just prior to the site clean up. The retort structures were removed. One small rockcrusher, generator, ore hopper and grizzly were the only mining artifacts left

The calcines were dumped into the steep ravine and, over time, a substantial portion of the wastes were washed downstream. The remediation plan called for the excavation and entombment of 3,000 cubic yards of calcines and other mining debris.

RESTORATION AND COSTS

In 2001 the calcines were removed from the riparian and adjacent zones to an unused mining haul road located on the western side of the mill site. The retort wastes were capped with two-three feet of native (non-mercury ore) soil, seeded with the native plants and then covered with the weed-free rice straw. The excavated calcine pit was recontoured with native soil, reseeded with the same native plants and five rows of rice bales were staked along slope contours to reduce stormwater runoff. A sampling program is planned for 2002 to determine the mercury content of soils and tailings at the site. Total costs for the project was $17,400

Abandoned Mine Lands California main page

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Large Version – “Before” Photo (next page).

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Jade Mill Site

Click on thumbnail photos below for larger versions

Jade Millsite before and after cleanup and reclamation

Español

.SITE DESCRIPTION

NAME: Jade Mill Site

AMLIS #: CA021900005

LOCATION: Hollister FO, N41 50 26, W120 21 42

CONGRESSIONAL DISTRICT: (17**)**

ENVIRONMENTAL RISK ISSUES: Water quality, Hg contamination

SITE NARRATIVE

The Jade Mill Site probably began operations sometime around 1900 and, based on the volume of retort tailings, produced an estimated 50 flasks of mercury. The site contained two brick and one metal retorts, a two-bedroom cabin, a water well, and several outbuildings. Total retort tailings was estimated at about 500 cubic yards. In the 1970's the site was used for gemstone production.

RESTORATION AND COSTS

Site restoration began in the Spring of 2001 and was completed in the Summer of the same year. All structures were removed, all retort brick and calcine wastes were buried on site and capped. The site was fenced and seeded. Total costs for the project is approximately $3,500. This site is being considered for a public staging/camping site.

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Xanadu Mill Site

Click on thumbnail photos below for larger versions

Xanadu mill site after restoration

Español

Xanadu mill site after restoration

SITE DESCRIPTION

NAME: Xanadu Mill Site

AMLIS #: CA013200004

LOCATION: Hollister FO, N41 , W120 21 42

CONGRESSIONAL DISTRICT: (17**)**

ENVIRONMENTAL RISK ISSUES: Water quality, Hg contamination

SITE NARRATIVE

The Xanadu Mil Site was a small commercial operation, within the riparian zone, and produced very little calcines. However, the site was very heavily used by the visiting public for camping and target shooting, and the retort area was contaminated with mercury.

The retorting operation is best described as follows: The bottom opening is where a fire is used either using wood, natural gas, propane or some other fuel to heat the three large diameter, horizontal iron pipes (ovens). Crushed cinnabar ore is placed in the ovens and heated driving off the mercury as vapor. The vapor is then cooled by condenser coils causing the mercury to condense into a liquid often referred to as "Quick Silver". The two vertical pipes vented the remaining roasting gasses into the atmosphere after the mercury was condensed. As a result, depending on the design and operation of the retort, some mercury was vented to the atmosphere and settled on the adjoining lands.

RECOMMENDATIONS AND ESTIMATED COSTS

The remediation plan called for the removal and on_site encapsulation of the milling retort oven debris, contaminated soils and building remnants.

Abandoned Mine Lands California main page

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Next Page:
Aurora Mine (actually in Central Valley Region, Regional Water Quality Control Board 5) included for information only.

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Aurora Mine and Mill Site

Click on thumbnail photos below for larger versions

Español

Calcine tailings before reclamation and cleanup

Aurora Repository before and after reclamation

SITE DESCRIPTION

NAME: Aurora Mine and Mill Site

AMLIS #: CA021900001

LOCATION: Hollister FO, N

CONGRESSIONAL DISTRICT: (17**)**

ENVIRONMENTAL RISK ISSUES: Water quality, Hg contamination

SITE NARRATIVE

This mine was active from 1853 up to the 1950´s the entire mine consisted of surface benches, 5 adits, 4 shafts with a total of 1600´ of underground workings. Historic photographs of the mine showed that several structures were erected to house the workers and during the clean_up excavation historic whiskey, beer containers were found along with other historic debris, such as bathtubs and kitchen implements. The site also contained an improved water source for the mine along with two large metal water tanks. The furnace which was used to retort the ore was previously taken off location so little or no above ground structures were left.
The retorted calcines and furnace soot ranged in mercury concentration from 20_1,120 parts per million. The clean_up objective was developed based on the native bedrock (non_mercury ore) which has a background concentration of only 0.2 parts per million.

RECOMMENDATIONS AND ESTIMATED COSTS

In the summer of 2000, restoration activities began with the removal of 8,000 cubic yards of mercury retort waste rock (calcines) and placement into a repository located adjacent to the site. All unearthed mining debris was also placed into the repository. The disturbed areas were recontoured and capped with two to three feet of non-mercury native soil. Native plant seeds from the adjacent vegetated areas were collected and then spread out under several inches of weed-free rice straw. To control erosion and stormwater runoff, rice straw hay bales were staked in the ground along the slope contours to help slow down the water and allow for the germination of the native plants. Total cost for restoration was $324,000.

During the winter of 2000/2001, two severe storms dumped over 4" of rain in the watershed above the restored site. The ephemeral drainage, which was recontoured through the site, overflowed and cut into the cap material causing extreme erosion. Creek reconstruction/stabilization will be initiated in the

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