Lower American River and Lake Natoma Mercury Control Program
Straw Proposal (3 September 2010)

This straw proposal is one of three documents intended to be discussion tools to help obtain input from stakeholders for the development of a regulatory program to reduce methylmercury levels in fish in the Lower American River and Lake Natoma (LAR). The three documents are:

- Guiding Principles. The purpose of the Guiding Principles is to guide the development of a LAR mercury control program. The Delta Methylmercury TMDL Stakeholder Group developed the Guiding Principles (attached to 3 September 2010 letter) using a consensus-seeking approach and agreed upon the Principles for the Delta mercury control program in May 2009. Stakeholders can provide suggestions for additions or changes to these principles to make them more relevant for upstream watersheds such as the American River.
- Straw Proposal. The purpose of this document is to start the discussion between Central Valley Water Board staff (staff) and stakeholders about numeric target and implementation options that will form the basis for the water quality objectives and implementation alternatives analysis, which include a California Environmental Quality Act evaluation of potential environmental impacts and cost considerations for implementing a mercury control program. These alternatives analyses lead to the selection of the preferred water quality objective and implementation alternatives, the calculation of the associated source load and wasteload allocations for all point and nonpoint sources, and the development of an implementation plan and timeline, all of which will be included in the draft Basin Plan Amendment (BPA).
- Preliminary Draft Basin Plan Amendment. The preliminary draft BPA will be presented in a table format that enables stakeholders to provide comments on specific text of the draft BPA language. The preliminary draft BPA will be developed after stakeholder input on the straw proposal. All feedback will be made publically available so that stakeholders can review each others' comments and suggest additional BPA text in an iterative process to address remaining concerns where possible. A similar process was used to develop the Delta mercury control program.

This straw proposal is provided in an outline form that summarizes several of the key elements of a TMDL and provides factors and options to consider for a Basin Plan amendment:

Highlighted throughout the straw proposal are particular questions that Board staff has for stakeholders. Stakeholders can provide responses to these questions as well as comments on any other element of the straw proposal.

The contents of this straw proposal are consistent with USEPA requirements for a TMDL and with Porter Cologne Water Quality Control Act requirements for a Basin Plan Amendment. However, this is a working draft document that should not be presumed to be complete, and it has not had Board legal or management review. Detailed descriptions of all the elements of this straw proposal and other elements needed to comply with Clean Water Act and Porter Cologne Act requirements will be provided in the draft Staff Report. Some elements in this straw proposal, such as the CEQA evaluation, cost considerations, and allocations, have not been addressed in this version because they are dependent on the results of the water quality objective and implementation alternatives analyses. As this document is reviewed by stakeholders, the straw proposal text will be expanded and modified as appropriate. Portions of the straw proposal text may be included in the draft BPA. A preferred water quality objective alternative and implementation alternative will need to be selected prior to the scientific peer review process. The draft Staff Report will include an explanation for the selection of the recommended alternatives and a complete list of citations.

In late fall 2010, the draft Staff Report and draft BPA is scheduled to be submitted for scientific peer review by the State Water Board's external scientific peer review process developed to comply with Health and Safety Code section 57004. After the scientific peer review process, the draft BPA text and draft Staff Report will undergo a formal public review process and then be presented to the Central Valley Water Board. Stakeholders can provide comments and suggestions on all elements of this straw proposal, as well as on the draft Staff Report and draft BPA submitted for scientific peer review, and the draft Staff Report and draft BPA that will be released for format public review.

I. Fish Mercury Concentrations, Fishing Patterns, and Possible Numeric Target Options

Numeric targets are the specific goals for the TMDL that will enable the protection of the beneficial uses of the lower American River. The beneficial use of the lower American River that is currently unmet is its use as a safe fishery for people and wildlife. A water quality target of mercury in fish tissue is appropriate because it provides the most direct assessment of fishery conditions and improvement. LAR fish have been collected and tested for mercury between 1970 and 2008. Existing data for fish species consumed by humans and wildlife provide a baseline against which future improvements can be measured.

Mercury levels vary by fish size and species. The amount of mercury that a person takes in depends on the amount and type of fish consumed. Similarly, key variables in determining a safe level of mercury in fish are the amount of fish eaten (consumption rate) and the type of fish. The target options are calculated by assuming particular rates and types of fish consumption. If people eat fish containing less mercury than in the fish used in target calculations, they can eat more fish than the assumed rate.

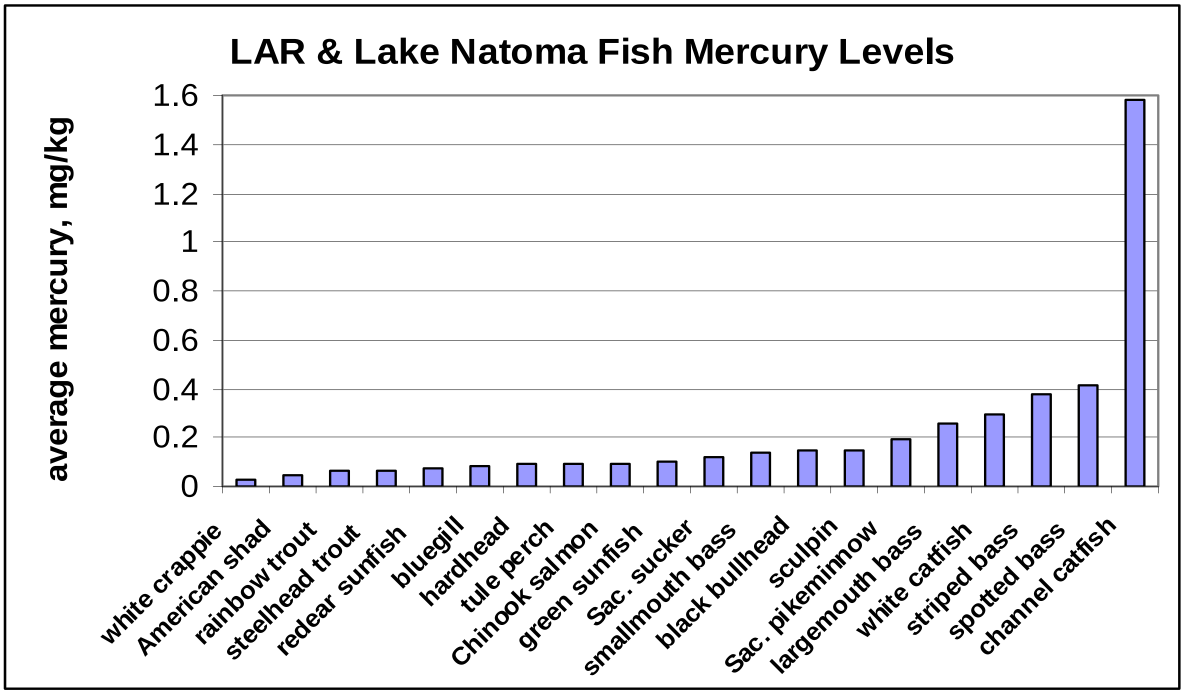

Figure 1. Average mercury concentrations in fish caught between Nimbus Dam and Discovery Park, 2000-2008.

Mercury accumulates in fish and concentrates up the food chain. Staff grouped fish species by general position in the food chain. Trophic level 3 (TL3) species eat mainly invertebrates and zooplankton and include crappie, shad, trout, salmon, and sunfish. Trophic level 4 (TL4) species eat mainly fish and include bass and catfish. Concentrations of mercury in TL3 and TL4 fish collected in Lake Natoma and near Discovery Park are statistically similar.

People eat a variety of LAR fish species. No comprehensive fish consumption survey has been conducted for this water body. According to California Department of Fish and Game's creel surveys (Figure 1), the most popular species, by far, taken home by anglers are salmon, shad, trout, and striped bass. Pikeminnow, largemouth bass, and catfish were rarely taken. However, the creel surveys were conducted during salmon fishing season. Staff received anecdotal information that some people depend heavily on LAR and Delta fish throughout the year.

Staff used the information of fish mercury concentrations and species to develop numeric target options (Table 1). Staff started with USEPA's recommended default consumption rate to protect sport fishers (17.5 g uncooked fish/day = one 8 oz meal/every two weeks of a mix of trophic level 2, 3, and 4 fish). Staff added options based on greater consumption rates. Staff also varied the type of fish consumed (ranging between mix of trophic level 2, 3 , and 4 fish to 100% trophic level 4 fish) and whether or not people also eat some commercial fish (e.g., tuna and scallops). Staff then calculated acceptable levels of mercury in fish, which are the possible numeric targets based on various consumption rates and types of fish.

Table 1. Target Options for Protection of Human Health

Scenario	Acceptable Daily Intake of mercury from LAR fish (ug/kg-day)	Total Consumption Rate of LAR Fish (g/day)	Proportion of LAR Fish in Diet			Possible Targets: Safe Concentrations of mercury in Fish by Trophic Level (TL) (mg/kg, wet wt)		
			TL2	TL3	TL4	TL2	TL3	TL4
A.1	0.073	17.5	21.7%	45.7%	32.6%	0.04	0.21	0.58
A.2			---	50%	50%		0.15	0.43
A.3			---	---	100%			0.29
B.1	0.073	32	21.7%	45.7%	32.6%	0.02	0.11	0.32
B.2			---	50%	50%		0.08	0.24
B.3			---	---	100%			0.16
C.1	0.1	17.5	21.7%	45.7%	32.6%	0.05	0.28	0.80
C.2			---	50%	50%		0.21	0.59
C.3			---	---	100%			0.40
D.1	0.1	32	21.7%	45.7%	32.6%	0.03	0.16	0.44
D.2			---	50%	50%		0.12	0.32
D.3			---	---	100%			0.22
E.1	0.073	64	21.7%	45.7%	32.6%	0.01	0.06	0.17
E.2			---	50%	50%		0.04	0.12
E.3			---	---	100%			0.08
F.1	0.1	64	21.7%	45.7%	32.6%	0.01	0.08	0.23
F.2			---	50%	50%		0.06	0.17
F.3			---	---	100%			0.11
G.1	0.1	142.4	21.7%	45.7%	32.6%	0.01	0.03	0.10
G.2			---	50%	50%		0.03	0.07
G.3			---	---	100%			0.05

For people eating fish from commercial markets and the lower American River, the safe intake level of methylmercury from lower American River fish is the USEPA reference dose minus the methylmercury from commercial fish (Scenarios A, B, and E). Scenarios C, D, F, and G assume no commercial fish are consumed. 17.5 g/day = one 8oz, uncooked, fish meal every two weeks; 32 g/day = 1 fish meal/week; 64 g/day = 2 meals/week; 142 g/day = 4.4 fish meals/week.

Groups most sensitive to harm from methylmercury are pregnant and nursing women, women who may become pregnant, and children. Currently, sensitive groups can safely eat an 8-oz meal of LAR fish at these rates: 1.7 times/month of striped bass; 1.8 times/week of salmon; and 3 times/week of steelhead, shad, and sunfish.

Target options shown in the table are a starting point for discussion. Scenarios A1, B1, C1, D1, E1, F1, and G1 assume people are eating a mixture of TL2, TL3, and TL4 species, based on a national food consumption survey. Consumers of LAR fish are more likely eating a mixture of TL3 and TL4 species, with TL3 species of salmon and shad strongly preferred when available. For each consumption rate, target scenarios that assume consumers eat 100% TL4 species are the most conservative.

Questions for Stakeholders: Are there other fish consumption scenarios that should be evaluated? Is there other fish consumption information that staff can incorporate?

Staff will present the members of the Central Valley Water Board with a range of target options and staff's recommended target. In evaluating target options, staff will consider: a) targets must also protect wildlife species that eat LAR fish, and b) targets are not expected to be lower than background levels of mercury in fish. Gray shading in the table indicates fish tissue concentrations that, if met, will also be protective of the most sensitive wildlife species that eat LAR fish. There are no data for concentrations of mercury in LAR fish prior to the use of mercury to recover gold in the watershed and the introduction of non-native bass and catfish. However, data for mercury in streams in the American west uncontaminated by mercury from mining suggests that a concentration as low as 0.05 ppm in TL4 fish may not be possible to achieve in the LAR.

Staff has not completed its evaluation of all of the target options. In a preliminary review, Scenario B.2 may be an appropriate fish tissue target because it would produce significant improvement in the fish eaten by people (45% reduction of existing levels) and would protect wildlife. This target appears technically achievable, relative to mercury concentrations seen in relatively uncontaminated areas. It also reflects local patterns of eating both TL3 and TL4 fish.

Some stakeholders have said that targets based on fish consumption of one meal per week of particular species are not protective of people that eat fish more frequently, especially catfish. Other stakeholders are concerned that such targets are too low because methods to control methylmercury are not known and may conflict with other land and water mandates, such as flood control.

Questions for Stakeholders: How would you evaluate target options? What targets would you recommend? If staff does not already have information supporting your recommendation, what information would you use?

II. Source Analysis

Sources of both methylmercury and total (inorganic) mercury need to be evaluated because:

- Methylmercury is the form of mercury that bioaccumulates in the Delta food web. Local and nationwide studies by scientific experts show that the concentration of methylmercury in water is the most important, single factor in determining how much methylmercury is in fish, and that the most direct way to reduce methylmercury in fish is to reduce the concentration of methylmercury in water.

- Methylmercury production has been found to be a function of the total mercury content of sediment. Reducing the concentrations of mercury in sediments would reduce the amount of methylmercury produced by open-water and wetland sediments and released to the water column.
- The mercury control program for the Lower American River and Lake Natoma must maintain compliance with the USEPA's CTR criterion for total recoverable mercury in freshwater sources.
- The Delta mercury control adopted by the Central Valley Water Board in April 2010 assigned a load allocation (44% reduction) for the Sacramento River inflow to the Delta. A portion of this load reduction could be assigned to outflows from the American River watershed to the Sacramento River.
- The mercury control program for San Francisco Bay has assigned a total mercury load reduction of 110 kg/yr to the Central Valley. The Delta mercury control program assigned a reduction of 110 kg/yr jointly to the sum total of 20-year average total mercury loads from the tributary watersheds that drain to the Delta to ensure compliance with the San Francisco Bay mercury control program's requirements. The April 2010 BPA indicated that initial reduction efforts should focus on watersheds that contribute the most mercury-contaminated sediment to the Delta and Yolo Bypass, such as the Cache Creek, American River, Putah Creek, Cosumnes River, and Feather River watersheds. These watersheds have suspended sediment mercury concentrations that are more than twice the mercury concentration of suspended sediment in the Sacramento River upstream of Colusa, a watershed with a much lower density of mine sites. A portion of 110 kg/yr load reduction could be assigned to outflows from the American River watershed.

The following five tables summarize the preliminary inorganic mercury (THg) and methylmercury (MeHg) loading analysis for the Lower American River and Lake Natoma. The purpose of the tables is to show the various sources and the relative contribution of each source. In general, the largest input of inorganic mercury to Lake Natoma and the river is Folsom Dam and unidentified sources. Unidentified sources could include elemental mercury in the lakebed that is re-suspended during high flow and flood events. Elevated loads of methylmercury are from Folsom Dam, upstream wetlands, urban runoff, and methylmercury flux from sediment in open-water areas.

Question for Stakeholders: There is a list of citations for the data used in the preliminary source analysis in included at the end of this straw proposal. Do you know of other data that could be useful for the source analysis? Do you know of any efforts underway of planned for future to collect additional water, sediment, or fish data in the American River watershed?

Table 2. Summary of Total Mercury Concentrations (ng/L) Collected from the Lower American River and Lake Natoma Watershed.

Station Name	n	Mean	Minimum	Median	Maximum
AR @ Discovery Park	240	2.60	0.46	1.71	18.51
Sump 111	41	23.31	2.16	22.7	72.3
AR @ Guy West Bridge	3	1.60	0.99	1.13	2.67
Strong Ranch Slough	40	90.64	3.07	28.75	1137.9
AR @ Goethe Park	8	2.12	0.57	1.46	6.23
AR @ Sunrise Blvd	2	1.96	1.25	1.955	2.66
AR @ Nimbus	199	2.09	0.083	1.33	15.4
Lake Natoma Bottom	1	1.64	1.64	1.64	1.64
Lake Natoma Top	5	0.99	0.476	0.876	1.63
Alder Creek	5	2.40	1.48	2.273	3.681
Willow Creek	14	20.88	1.83	7.63	110
Hinkle Creek	1	2.71	2.712	2.712	2.712
Folsom Lake Discharge	6	0.95	0.49	0.716	1.9
Folsom Lake Bottom	1	0.83	0.83	0.83	0.83
Folsom Lake Top	3	0.77	0.504	0.839	0.966

Table 3. Summary of Methylmercury Concentrations (ng/L) Collected from the Lower American River Watershed.

Station Name	n	Mean	Minimum	Median	Maximum
AR @ Discovery Park	122	0.071	0.01	0.0575	0.714
Sump 111	26	0.287	0.0351	0.184	1.05
AR @ Hwy 80	19	0.073	0.025	0.0581	0.229
AR @ Guy West Bridge	3	0.051	0.044	0.0492	0.0609
Strong Ranch Slough	27	0.451	0.067	0.237333	2.04
Arden Pond	6	0.241	0.076	0.2325	0.454
LAR Pond 2	2	0.104	0.042	0.1035	0.165
LAR Wetland 3	1	0.177	0.177	0.177	0.177
LAR Wetland 2	4	0.045	0.01	0.0435	0.081
LAR Wetland 1	5	0.049	0.035	0.053	0.065
AR @ Goethe Park	12	0.053	0.035	0.051	0.0928
LAR Pond 4	1	4.690	4.69	4.69	4.69
San Juan Pond	2	0.089	0.049	0.089	0.129
Minnesota Creek	4	0.101	0.035	0.111	0.146
AR @ Sunrise Blvd	2	0.054	0.0508	0.0539	0.057
AR @ Nimbus	103	0.045	0.0096	0.033	0.406

Table 4. Summary of Methylmercury Concentrations (ng/L) Collected from the Lake Natoma Watershed.

Station Name	n	Mean	Minimum	Median	Maximum
AR @ Nimbus	103	0.045	0.0096	0.033	0.406
Lake Natoma Bottom	6	0.018	0.01	0.01	0.04
Lake Natoma Top	6	0.028	0.01	0.0265	0.042
Lake Natoma Runoff 2	1	0.104	0.104	0.104	0.104
Alder Creek	5	0.192	0.082	0.177	0.294
Lake Natoma Willow Creek Arm	4	0.056	0.01	0.042	0.128
Willow Creek	14	0.256	0.049	0.127	0.998
Hinkle Creek	5	0.104	0.058	0.086	0.167
Lake Natoma Wetland 1	5	0.033	0.01	0.026	0.061
Lake Natoma Wetland 2	1	0.033	0.033	0.033	0.033
Folsom Lake Discharge	6	0.023	0.01	0.02	0.04
Folsom Lake Bottom	5	0.029	0.01	0.03	0.055
Folsom Lake Top	5	0.038	0.024	0.032	0.0695

Table 5: Total Mercury Source Loads to Lake Natoma and the Lower American River.

Source/Sink	**THg Load (g/yr)**	**% of Sources to Lake Natoma**	**% of Sources to LAR**
Folsom Dam	3135	35%	
Urban Runoff/Urban Tribs[a]	218	2%	
Sediment Flux[b]	91	1%	
Atmospheric Deposition (Direct and Indirect)[c]	28	0.3%	
Hatchery & Canal[d]	-157	--	
Evasion[e]	-696	--	
Unknown Source to Lake Natoma	**5,403**	61%	
Nimbus Dam	**8,022**		63%
Urban Runoff[a]	2,003		16%
Sediment Flux[b]	252		2%
Atmospheric Deposition (Direct and Indirect)[c]	55		0.4%
Evasion[d]	-1915		--
NPDES Facilities[f]	171		1%
Unknown Source to LAR	**2202**		17%
American River @ Discovery Park	**10,790**		

[a]LWA, 2009. Sacramento Stormwater Quality Partnership, Additional Total Mercury and Methylmercury Analyses.

[b]Choe, 2004. Sediment Flux = 130 ng/m2/day

[c]Stephenson, 2008. Wet Deposition = 2.1 ng/m^2/day, Dry Deposition = 4.5 ng/m^2/day, multiplied by runoff coefficient.

[d]Loads calculated using reported export flow data (CA DFG = 59 cfs, Canal = 40 cfs) multiplied by average CA DFG influent total mercury concentrations.

[e]Stephenson, 2008. Evasion = 0.99 ug/m^2/day

[f]Bosworth, 2010. A Review of Methylmercury Discharges from NPDES Facilities in California's Central Valley for DGS Office of State Publishing. CA DFG loads calculated from SMR data. The two Aerojet permittees had no available data.

Table 6: Methylmercury Source Loads to Lake Natoma and the Lower American River.

Source/Sink	MeHg Load (g/yr)	% of Sources to Lake Natoma	% of Sources to LAR
Folsom Dam	76.8	54%	
Urban Runoff/Urban Tribs[a]	2.4	2%	
Open Water Sediment Flux[b]	3.3	2%	
Atmospheric Deposition (Wet Deposition only)[c]	0.6	0.4%	
Hatchery & Canal[d]	-4.0	--	
Instream Wetlands[e]	7.9	6%	
Upstream Wetlands[f]	13	9%	
Unknown Source to Lake Natoma	**37**	26%	
Nimbus Dam	**137**		62%
Urban Runoff[a]	21.6		10%
Open Water Sediment Flux[b]	9		4%
Atmospheric Deposition (Direct and Indirect)[c]	1		0.5%
Instream Wetlands[e]	23		10%
Upstream Wetlands[f]	12.8		6%
NPDES Facilities[g]	3.5		2%
Unknown Source to LAR	**13**		6%
American River @ Discovery Park	**221**		

[a]LWA, 2009. Sacramento Stormwater Quality Partnership, Additional Total Mercury and Methylmercury Analyses.

[b]Stephenson, 2008. Sediment Flux = 4.65 ng/m^2/day

[c]Stephenson, 2008. MeHg wet deposition = 3.4% THg wet deposition. No estimate of MeHg dry deposition.

[d]Loads calculated using reported export flow data (CA DFG = 59 cfs, Canal = 40 cfs) multiplied by average CA DFG influent methylmercury concentrations.

[e]Wood, 2010. Delta wetland production rates: warm season = 40.6 ng/m^2/yr and cool season = 3.0 ng/m^2/yr. Wetland acreage located within 50 meters of mainstem water bodies.

[f]Wood, 2010. Delta wetland production rates: warm season = 40.6 ng/m2/yr and cool season = 3.0 ng/m2/yr. Wetland acreage located outside of 50 meters from mainstem water bodies.

[g]Bosworth, 2010. A Review of Methylmercury Discharges from NPDES Facilities in California's Central Valley. CA DFG loads calculated using SMR water effluent volumes. Aerojet Sacramento Facility had no available data.

III. Potential Source Control Options – Preliminary Review

In general, there are two ways to reduce methylmercury in Delta waters:

- Reduce the amount of inorganic mercury available in sediment to be converted to methylmercury in open-water and wetland areas and other source areas within Lake Natoma and the Lower American River channel and their watersheds (e.g., urban and irrigated agriculture areas); and
- Control activities that enhance the production and/or loss of methylmercury in these areas.

Potential source control options could focus on reducing:

- Methylmercury loading from tributaries to Lake Natoma and the lower American River;
- In-river and in-lake production (and/or enhancing loss of methylmercury);
- Inorganic mercury loading from tributaries to the lake and river; and
- Mercury sediment concentrations in the lake and river.

Possible approaches to controlling methylmercury and inorganic (total) mercury inputs to the lower American River and Lake Natoma include developing and implementing management practices or control actions to reduce inputs of these constituents from: dredge tailings and other mine-related material in and upstream of the river and lake, municipal storm water, water storage and management (including reservoir and flood control activities), NPDES facilities, wetland restorations, and non-point sources in the watershed.

There are many sediment factors and landscape events important in net methylmercury production and loss, including:

- Amount and kind of inorganic mercury present in the sediment;
- Sulfate and pH concentration of the overlying water;
- Percent organic content of the sediment;
- Creation of new water impoundments;
- Amount of permanent or seasonally flooded wetland in a watershed;
- Deposition of particle-bound methylmercury in the water column; and
- Photodegradation of methylmercury in the water column.

Each of these and other factors will be reviewed in the draft Staff Report. It is important that a control program focuses on “controllable processes”, and not solely on some determination of background levels of inorganic mercury or methylmercury in ambient water. Focusing on controllable processes is expected to increase the number of control options at our disposal and enable more rapid improvements. In addition, there are many factors that have changed during the past century, for example (but not limited to): the routing, timing, and water characteristics (e.g., temperature and EC) of “natural” flows has fundamentally changed with the implementation of major water projects and creation of numerous reservoirs; invasive species (e.g., largemouth bass, striped bass, and Asian clam) have fundamentally altered the food web; extensive tracts of “natural” habitats have been lost to urbanization and agriculture; and other local and global sources of anthropogenic mercury have increased substantially. The American River of today defies comparison to the American River of the early 1800’s, so much so that it would be extremely difficult to estimate methylmercury conditions of the past, and it likely will not be reasonable to have a control program based on historic natural background conditions that are no longer applicable.

Staff developed a list of potential source control options organized by source type Table 7. This list of potential control options will not be listed as requirements in the BPA. The Central Valley Water Board does not specify the actual means of compliance by which responsible entities (e.g., dischargers, government, nonprofit, and private agencies, or other persons responsible for complying with total mercury and/or methylmercury control requirements) choose to comply with the proposed Basin Plan amendments. This list has several intended purposes:

- Use as a brainstorming tool for discussions with stakeholders to help identify additional potential control options;
- Basis for evaluating potential environmental impacts that could be associated with implementing a mercury control program for the LAR;
- Basis for estimating a range of potential costs of implementing a mercury control program for the LAR; and
- Consideration of implementation plan alternatives and allocation distribution.

Question for Stakeholders: Can you think of other potential control options besides those listed in Table 7?

Staff expects that the suite of potential control activities may vary for different areas of the lower American River, Lake Natoma, and their watersheds, depending on the nature of the methylmercury and inorganic mercury sources, potential negative environmental effects that could result from possible control actions, available mitigation measures for negative environmental effects, and expected effectiveness and cost of different control actions. In addition, as discussed in the next section, staff expects that studies will be needed to identify additional control options and to evaluate their effectiveness, cost, potential environmental effects, and potential mitigation measures for identified negative environmental effects.

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Table 7: Generalized List of Possible Source Control Options Derived from the April 2010 Delta Methylmercury Basin Plan Amendment Staff Report

<table>
<tr><th colspan="2">ALL SOURCES</th></tr>
<tr><td colspan="2">- Work individually or collaboratively with local entities, watershed groups, and agencies to conduct methylmercury and total mercury control studies that identify technically-feasible and cost-effective control options and management practices with no or minimal negative effects on other beneficial uses of American River and Lake Natoma waters or current land uses</td></tr>
<tr><th>POINT SOURCES</th><th>NONPOINT SOURCES</th></tr>
<tr><td>NPDES Facilities
- Develop and implement total mercury minimization programs, which could include, but are not restricted to, the following elements:
o Describe the discharger’s existing mercury control efforts and baseline annual average effluent total mercury concentration and loads
o Describe all possible mercury sources contributing, or potentially contributing, to the mercury loading in the facility influent and effluent, including chemicals used by the facility that may contain mercury because of how they were produced, pH-altering chemicals, gages, and switches
o Analyze potential pollution prevention and control actions that could reduce effluent total mercury concentrations and/or loads, including modifying procedures or materials to reduce mercury in the discharge
o Describe tasks, cost, and time required to implement actions to control effluent total mercury concentration and load;
o Implement a monitoring program to determine the results of the pollution prevention and control actions
o Analyze the benefits and any potential adverse environmental impacts, including cross-media impacts or substitute chemicals, that may result from the implementation of the mercury source controls.
- Implement additional treatment to further reduce particle-bound methyl and total mercury (e.g., retention in aeration tanks, retention ponds, filtration)
- Incorporate ultraviolet radiation disinfection in coordination with filtration, which could conceivably promote photo-demethylation of the remaining methylmercury in the effluent
- Identify other uses for the discharge</td><td>Dredge Tailings and Other Mine-Related Material
- Stabilize channel and reservoir banks and floodplain surfaces to prevent erosion of mercury-enriched sediments into the lower American River and Lake Natoma
- Construct settling basins downstream of erosive areas with contaminated sediment that cannot be otherwise stabilized or remediated

Open Water Habitats
- Identify hotspots of methylation in open-water areas and make those areas a high priority for evaluation of control projects
- Evaluate and implement methods as feasible to reduce methylation and/or increase methylmercury loss processes for new and existing water storage, diversion, and flood control projects, for example:
o Periodically dredge shallow/warm areas to create deeper/cooler areas to reduce methylmercury production and increase deposition of sediment-bound mercury
o Remove or otherwise remediate mercury-contaminated sediment within the reservoirs and river channel
o Modify project discharge patterns (volume, frequency, season)
o Implement engineered controls to minimize anoxic zone (e.g., aeration and circulation)
o Modify discharge from top or bottom of reservoirs
o Modify channel or floodplain geometry to route water away from mercury-contaminated areas
o Evaluate alternate locations for new projects (i.e., is the proposed project in a mercury contaminated area?)
o Work with watershed groups and agencies to identify and reduce sources of mercury-enriched sediment that is deposited in open water habitats to reduce methylmercury production
- Identify reservoir areas that are accumulating mercury-contaminated sediment and develop and implement a sediment management plan(s) to prevent the release of mercury-contaminated sediment during reservoir maintenance activities (e.g., by off-site disposal of dredged sediment) and operations</td></tr>
</table>

Table 7: Generalized List of Possible Source Control Options, *continued*

POINT SOURCES	NONPOINT SOURCES
Urban Runoff - Implement BMPs to control erosion and sediment discharges to the maximum extent practicable to reduce particle-bound inorganic mercury and methylmercury (as already required by individual and general NPDES permits) o Erosion control BMP examples: avoidance of increased erosion and transport of contaminated soil into receiving waters via runoff by not conducting construction activities during wet weather; preservation of existing vegetation; development of slope drains; stabilization of stream banks; use of hydraulic mulch, hydroseeding, straw mulch anchored with a tackifier, polyacrylamide, rolled erosion control products (e.g., blankets and mats), earth dikes, drainage swales, and velocity dissipation devices o Sediment control BMP examples: installation of silt fences, sediment basins, sediment traps, fiber rolls, gravel bag berms, sandbag barriers, storm drain inlet protection, and check dams - Implement mercury-specific pollution prevention measures and BMPs to the maximum extent practicable to control total mercury discharges, e.g.: o Thermometer exchange and fluorescent lamp recycling programs o Public education and outreach on disposal of household mercury-containing products and replacement with non-mercury alternatives o Education of auto dismantlers on how to remove, store, and dispose of mercury switches in autos o Enhancement of household hazardous waste collection programs to better address mercury-containing waste products (potentially including thermometers and other gauges, batteries, fluorescent and other lamps, switches, relays, sensors and thermostats) o Survey of use, handling, and disposal of mercury-containing products used by the Sacramento County permittee agencies and development of a policy and time schedule for eliminating the use of mercury containing products by the permittees o Implementation of additional programs to reduce vehicle exhaust (e.g., improvements to mass transit, ride share, and bicycle-to-work programs) because emissions from vehicles powered by hydrocarbon-based fuels contain mercury as well as hydrocarbons that are involved in the formation of ground-level ozone and subsequently reactive gaseous mercury, which is more likely to be converted to methylmercury than other fractions of mercury. o Expansion of existing urban tree planting programs, particularly of species that have low emissions of volatile organic compounds, to help reduce ground-level ozone, particulate matter, and other pollutants and subsequently reactive gaseous mercury - Modify storm water collection and retention systems to reduce methylmercury production, e.g., installation of aerators or circulation devices in basins may promote degradation of methylmercury in the water column, and identification and removal of sediment from basins would reduce the supply of inorganic mercury available for methylation	**Wetland Habitats** - Managed and Unmanaged Wetlands: o Work with watershed groups and agencies to identify and reduce sources of mercury-enriched sediment that is deposited in the wetlands to reduce methylmercury production - Managed Wetlands: o Modify managed wetlands' design, e.g., water depth, flooding frequency and/or duration (e.g., recent studies suggest episodically flooded wetlands produce more methylmercury than permanently flooded wetlands), vegetation types, and vegetation density (dense cover or more open water) o Modify managed wetlands' discharge patterns, e.g., hold irrigation water on-site longer at wetlands to allow methylmercury concentrations to decrease before discharging the water or otherwise transfer and re-use the water elsewhere to decrease the amount of discharge **Other Nonpoint Sources** (agricultural & other upland areas) - Modify irrigation return water discharge patterns, e.g., implement tailwater recovery systems to prevent discharge of irrigation water to receiving waters or hold irrigation water on-site longer to allow methylmercury concentrations to decrease (e.g., through photodegradation) before discharging the water - Utilize drip irrigation systems or other water-efficient systems to minimize or limit irrigation runoff and discharge to the receiving water - Identify upland areas with runoff of mercury-enriched sediment and install retention basins or other management practices as feasible to reduce sediment transport and control erosion from activities such as grazing and road maintenance **Atmospheric Deposition** - Identify facilities within and upwind of the American River watershed that emit mercury (e.g., concrete, sand, gravel, paving, brick and tile products; crematories; rendering companies; and other electrical and commercial services) - Work with the California Air Resources Board to develop a statewide atmospheric total mercury reduction program and implement actions to reduce mercury emissions - The two major approaches under development for controlling mercury emissions from coal-fired power plants are multi-pollutant controls (using current controls for SO_2, NO_x, and particulate matter) and mercury-specific controls (activated carbon injection (ACI)); local air emissions and controls of mercury warrant additional research.

IV. Phased Implementation Options for a Control Program

Board staff recommends that a phased, adaptive management approach be incorporated in any mercury control program developed for the lower American River and Lake Natoma. Adaptive management is a systematic process that uses scientific information to help formulate management policies and practices and allows for continually improving those policies and practices by learning from the outcomes of implementation and monitoring programs. The first phase of the control program could focus on studies and control options that are already identified as feasible and cost-effective. The second phase of the control program could focus on implementing additional control options as needed to achieve the water quality objectives.

The following general topics could be the focus of studies, pilot projects, and other implementation actions as part of a phased, adaptive management approach:

- Identification of sources of mercury-enriched sediment within the channel, lake bed, and watersheds of the lower American River and Lake Natoma.
- Identification of possible inorganic mercury and methylmercury source controls and evaluate their effectiveness, cost, and potential environmental effects, and potential mitigation measures for identified negative environmental effects.
- Evaluation of modifying the frequency and duration of anoxic conditions by evaluating reservoir aeration, circulation or other reservoir management practice that reduces the incidence and frequency of anoxic conditions (e.g., as was done at Camanche Reservoir and Almaden Lake).
- Evaluation of the removal, burial, stabilization, and/or other remediation of contaminated sediment in dredge tailings and other mine waste within the lake and river channel.
- Evaluation of fish management options that would reduce exposure of humans consuming fish from the reservoirs (i.e., could there be more emphasis on trout or salmon consumption (because salmon and trout have lower methylmercury concentrations) and less emphasis on bass and other sport fish?), in coordination with public health agencies and affected communities.
- Evaluation of additional efforts to restore fish species that are low in mercury (e.g., salmon and steelhead).
- Participation in the development of a mercury offset program as is being done for the Delta.

In general, a schedule for a phased approach could include:

- Final compliance date for allocations: Twenty years from the effective date of the amendment
- Develop workplans and detailed study plans: 1 year
- Initiate exposure reduction activities workplan: 3 years

- Final study results and management plans: 7 years

The following pages provide lists of potential activities that could take place during the first phase of the control program.

Lake Natoma and Folsom Lake

The entities responsible for operating the reservoirs could conceivably conduct studies with the following goals:

- Characterize current concentrations of inorganic mercury in reservoir sediment, concentrations of inorganic mercury entering the reservoir in tributaries and the concentration of methylmercury in reservoir water and tributaries entering the reservoir.
- Evaluate water management practices and other actions (e.g., dredging to deepen key areas of methylation or increase sedimentation and burial of mercury-enriched sediment) that could be implemented to reduce the amount of methylmercury that is contributed from the reservoir sediment and the amount of methylmercury that is discharged downstream.
- Develop a management plan to reduce the in-reservoir production of methylmercury and/or increase the in-reservoir loss of methylmercury.
- Coordinate with existing and/or new watershed groups to develop load reduction programs for watersheds tributary to the reservoir.
- Work with entities responsible for managing fish populations in the reservoirs (e.g., California Department of Fish and Game), public agencies and affected communities to determine whether changes in fish management practices could be implemented to reduce the risk of exposure to humans consuming fish from the reservoirs.

Fish Management Entities

Entities responsible for managing fish populations in the reservoirs and rivers through fishing licenses and access to fishing locations (e.g., USBR, CDFG, State Parks, and Sacramento County) could provide additional information on the rates of consumption of fish typically taken home by people. In addition, responsible entities could submit a report to the Central Valley Water Board describing fish management alternatives that could be implemented to reduce exposure to humans that consume fish from the reservoirs (emphasis on different species, different harvest regulations, etc.).

Nimbus Fish Hatchery and American River Fish Hatchery

Entities responsible for managing discharges from the NPDES-permitted the hatcheries (e.g., USBR and DFG) could develop and evaluate water management or other treatment practices (e.g., aeration or other treatment in holding ponds), that could be implemented to reduce the amount of methylmercury that is discharged from the hatcheries to the American River.

Urban Runoff from Municipalities

Sacramento County and the Cities of Folsom and Rancho Cordova (permittees of the Sacramento Area NPDES MS4[1] permit) could follow the requirements established for the Delta Mercury Control Program and for their MS4 permit:

- Implement best management practices (BMPs) to control erosion and sediment discharges consistent with their existing permits and orders with the goal of reducing mercury discharges.
- Implement pollution prevention measures and BMPs to minimize total mercury discharges. This requirement will be implemented through mercury reduction strategies required by their existing permits and orders. Annually, the dischargers will report on the results of monitoring and a description of implemented pollution prevention measures and their effectiveness.
- Continue to conduct mercury control studies to monitor and evaluate the effectiveness of existing BMPs per existing requirements in permits and orders, and to develop and evaluate additional BMPs as needed to reduce their mercury and methylmercury discharges into the Lake Natoma and the lower American River.
- For the mercury studies, entities may participate in the collaborative process developed for the Delta Mercury Control Program.

In addition, the municipalities could implement best management practices to ensure new development projects do not increase inorganic mercury or methylmercury loads to local waterways and develop additional construction guidelines as needed.

<u>American River Parkway</u>

The entity responsible for maintaining the American River Parkway and its access locations (e.g., Sacramento County Parks and Recreation and/or nonprofit groups) could coordinate with the MS4 permittees to do the following:

- Characterize current concentrations of inorganic mercury in river sediment and concentrations of inorganic mercury entering the river via tributaries and storm drains.
- Characterize current concentrations and loads of methylmercury in river water, from instream and upland wetlands, and from tributaries and storm drains.
- Determine if inorganic mercury or methylmercury ‘hot spots’ exist within the high water level of the river channel.
- Evaluate land and water management practices and other actions that could be implemented to reduce the amount of inorganic mercury and methylmercury that is within American River Parkway water bodies and is discharged downstream.
- Develop a management plan to reduce levels of methylmercury production (and/or increase methylmercury loss), and/or erosion of mercury-enriched sediment.
- Coordinate with existing and new watershed groups to develop load reduction programs for tributary watersheds.

[1] MS4: Municipal Separate Storm Sewer System

- Work with entities responsible for managing fish populations to determine whether changes in fish management practices could be implemented to reduce the risk of exposure to humans consuming fish from American River Parkway water bodies.

Army Corp of Engineers
The Army Corp of Engineers could evaluate management methods and develop and implement management plan(s) and construction guidelines as needed to ensure that Folsom Dam operations, levee modification projects, etc. do not increase inorganic mercury and/or methylmercury loads to local waterways.

Exposure Reduction
Similar to what was done with the Delta mercury control program, LAR stakeholders could form a stakeholder group or coordinate with the Delta stakeholders to work with the Central Valley Water Board, California Department of Health Services, and OEHHA to investigate ways to address public health impacts of mercury in fish, including activities that reduce actual and potential exposure of and mitigate health impacts to those people and communities most likely to be affected by mercury in fish caught in the lower American River and Lake Natoma, such as subsistence fishers and their families. The stakeholder group should include local fishing communities; tribes; local, state, and federal agencies that are named in the BPA; and local health agencies.

Central Valley Water Board
The Central Valley Water Board, as part of the control program, could commit to the following:

- Adhere to a phased, adaptive approach to implementing the control program.
- Include a periodic review of fish tissue objectives, allocations, implementation requirements and time schedules based on new information received.
- Schedule a control program review concurrent with Delta Mercury Control Program review (about 2019).

Question for Stakeholders: Can you think of other potential studies or implementation activities that would support an adaptive management approach for reducing LAR fish mercury concentrations and exposure?

V. California Environmental Quality Act Evaluation

A California Environmental Quality Act (CEQA) evaluation of potential environmental impacts from implementing a control program for the LAR will be conducted once a range of water quality objective alternatives and implementation options have been identified. The CEQA evaluation will be included in the draft Staff Report. For an example of a recent CEQA evaluation for a mercury TMDL control program, please refer to Chapter 7 in the

April 2010 Final Staff Report for the Delta methylmercury TMDL, available at the following Board website:
http://swrcb2.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/apr2010_bpa_staffrpt_final.pdf

Question for Stakeholders: Can you provide additional examples of potential environmental impacts that could result from implementation of the control options listed in Table 7 and possible mitigation measures to avoid or reduce impacts? *[besides those listed in the above- referenced Delta methylmercury TMDL/BPA report]*

VI. Cost Considerations

Cost estimates for potential LAR control program activities will be developed once a range of water quality objective alternatives and implementation options have been identified. The cost estimates will be included in the draft Staff Report. For an example of a recent compilation of cost estimates, please refer to Chapter 4 (Section 4.4.2), Chapter 7 (Section 7.4 Economic Factors) and Appendix C (Cost Consideration Calculations) in the April 2010 Final Staff Report for the Delta methylmercury TMDL, available at the following Board website:
http://swrcb2.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/apr2010_bpa_staffrpt_final.pdf

Question for Stakeholders: Can you provide information about the potential costs of implementing the potential source control options listed earlier in Table 7 and possible ways to reduce those costs? *[in addition to those cost estimate methods and cost reduction methods listed in the above- referenced Delta methylmercury TMDL/BPA report]*

VII. Load and Waste Load Allocations and Margin of Safety

A water body's loading capacity (assimilative capacity) represents the maximum rate of loading of a pollutant that the water body can assimilate without violating water quality standards. A TMDL typically represents the sum of all individual allocations of the water body's point and nonpoint sources and must be less than or equal to the assimilative capacity. Allocations are divided among "waste load allocations" for point sources and "load allocations" for nonpoint sources including natural background. The TMDL is the sum of these components:

TMDL = Waste Load Allocations + Load Allocations

A TMDL need not be stated as a daily load (Code of Federal Regulations, Title 40, §130.2[i]).
Other measures, such as annual average loads or average concentration are allowed if appropriate. There needs to be a linkage analysis that demonstrates that the assigned load or concentration-based allocations will maintain the assimilative capacity of a water

body and achieve the water quality objectives. An allocation is the maximum load (or concentration) allowed to be discharged from a source.

All identified point and nonpoint sources must be addressed by an allocation. However, each source does not necessarily need to have a reduction assigned to it. For example, an allocation could be set equal to a current source's discharge (100%), or a given source could even be allowed by its allocation to increase (e.g., 120%). However, if some sources have no reduction requirement or are allowed to increase, other sources will need to achieve a relatively greater reduction so that the sum of all the allocations does not exceed the assimilative capacity of the water body.

Allocations can be assigned to both methylmercury and total mercury sources, or allocations can be assigned just to methylmercury sources with other types of limits assigned to sources of total mercury loads or particular sources of mercury-enriched sediment. A variety of allocation strategies are possible based on information about available inorganic and methylmercury sources. Ultimately, any allocations and limits for the LAR control program need to reflect the preferred water quality and implementation alternatives selected for the control program and must be designed to address the beneficial use impairment in all areas of the river and lake as well as minimum reduction requirements established by downstream TMDL control programs (e.g., the Delta and San Francisco Bay control programs). As a result, specific allocation numbers are not included in this straw proposal. Allocations will be included in the preliminary draft BPA to be released for stakeholder review before the draft Staff Report is submitted for scientific peer review.

Board staff recommends that at a minimum, methylmercury allocations be assigned to the following sources identified to date:

Lake Natoma nonpoint sources:

- Folsom Lake outflow
- Methylmercury flux from sediments in open-water and wetland habitats in Lake Natoma
- Tributary creeks
- Atmospheric deposition
- Irrigated agriculture

Lower American River nonpoint sources:

- Lake Natoma outflow
- Methylmercury flux from sediments in in-channel open-water and wetland habitats
- Tributary creeks
- Atmospheric deposition
- Irrigated agriculture

Point sources:

- Sacramento County MS4
- CA DGS Office of State Publishing

- CA DFG Fish Hatcheries
- Aerojet General Corporation Groundwater Extraction and Treatment Systems
- Aerojet General Corporation Sacramento Facility

Additional allocations, goals, or limits could be established for sources of mercury-enriched sediment (e.g., dredge tailings and other mine-related material in or adjacent to Lake Natoma and the lower American River) and other inorganic mercury sources.

The compliance date for meeting the allocations needs to be set at the time a Basin Plan amendment is adopted for a TMDL, but the compliance date may be modified when the TMDL is reviewed by the Central Valley Water Board in the future.

The preliminary source analysis indicates that about half of the methylmercury loading and about a third of the total mercury loading to Lake Natoma comes from the American River watershed upstream of Folsom Dam. Reductions in upstream sources will almost certainly be needed to achieve any fish tissue objectives adopted for Lake Natoma and the lower American River. Additional source-specific allocations and control requirements for specific methylmercury and total mercury point and nonpoint sources within the tributary watershed would be included in future Basin Plan amendments for control programs for the upstream tributary watersheds. Staff is currently evaluating options for developing the upstream TMDLs.

Finally, a margin of safety needs to be included to address uncertainty. This is a required component for TMDLs. A margin of safety can be either explicit or implicit. Development of a margin of safety is in progress for the LAR TMDL. The Delta methylmercury TMDL had the following:

- The water column methylmercury goal of 0.06 ng/l incorporates an explicit margin of safety of approximately 10%. The linkage analysis predicted a safe level of 0.066 ng/l for average aqueous methylmercury, from which 0.006 was subtracted to provide a margin of safety.
- In addition, there is an implicit margin of safety of 25% or more for some wildlife species that consume Delta fish. (See Chapter 8 [Section 8.3] in the April 2010 Delta TMDL Report for a detailed discussion.)

Questions for Stakeholders: Can you suggest possible allocation strategies given the distribution of inorganic and methylmercury source loads and concentrations described earlier in Tables 2 and 3? Can you suggest other methods to incorporate a margin of safety?

VIII. Surveillance and Monitoring Program

Options for a Surveillance and Monitoring Program can be more easily developed once a range of water quality objective alternatives and implementation goals have been identified. For an example of a recent compilation of surveillance and monitoring program options, please refer to Chapter 4 (Section 4.3.4) and Chapter 5 in the April 2010 Final Staff Report for the Delta methylmercury TMDL, available at the following Board website: http://swrcb2.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/apr2010_bpa_staffrpt_final.pdf

IX. Source Analysis and Fish Data References

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