Summary of Slides
Putah Creek Mercury Water Quality Issues

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Introduction

Studies have been conducted since the mid-1990s on the occurrence of mercury in fish in Putah Creek. Drs. G. Fred Lee and Anne Jones-Lee presented information on the occurrence and sources of mercury in Putah Creek fish and water at the December 2, 2008 meeting of the Delta Tributaries Mercury Council. The PowerPoint slides used in that presentation are available at http://www.gfredlee.com/SJR-Delta/PutahHgMinesli.pdf, and are described below.

The headwaters of Putah Creek are in the Vaca Hills, upstream of Lake Berryessa (Figures 1 and 2). Putah Creek is a tributary of the Yolo Bypass, which, in turn, is a tributary of the Sacramento San Joaquin Delta (Delta) in the Central Valley of California. Some of the fish in the Delta, Yolo Bypass, Putah Creek, and many other Delta tributaries contain sufficient concentrations of mercury to pose a health hazard to those who eat the fish. The excessive level of mercury in edible fish is, in fact, one of the most significant public health-related water quality impairments of the Delta and many of its tributaries, and is also of concern as it may impact the reproduction of fish-eating birds. Information on the excessive mercury bioaccumulation of mercury in Central Valley fish is available at the Central Valley Regional Water Quality Board (CVRWQCB) at
http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/index.shtml

Mercury builds to excessive levels in fish through its bioaccumulation through the aquatic food web. Mercury in various forms is converted into methyl mercury at the sediment/water interface; that form is taken up by aquatic organisms and is further accumulated in organisms that consume them. In order to control the bioaccumulation of mercury in edible fish, the sources of mercury that bioaccumulate in fish and other aquatic life must be defined. As discussed further below, abandoned mercury mines in the headwater area of Putah Creek contribute mercury to Putah Creek and its upstream tributaries.

Previous Studies

The authors' interest in the bioaccumulation of mercury in Putah Creek fish began in the mid-1990s when Dr. Lee became US EPA Superfund Technical Assistant Grant (TAG) technical advisors to the Davis South Campus Superfund Oversight Committee (DSCSOC) on the adequacy of the investigation/remediation of the University of California Davis/Department of Energy (UCD/DOE) LEHR national Superfund site on the UCD campus in Davis, CA (Figure 3). (Information on the LEHR Superfund site and DSCSOC is available at http://www.gfredlee.com/DSCSOC/DSCSOC.htm; a photograph of Putah Creek near the LEHR site is shown in Figure 4.)

Figure 1 Map of Putah Creek Watershed
Adapted from UCD Putah-Cache Bioregion Project: UCD Davis
http://bioregion.ucdavis.edu/where/featrmap.html

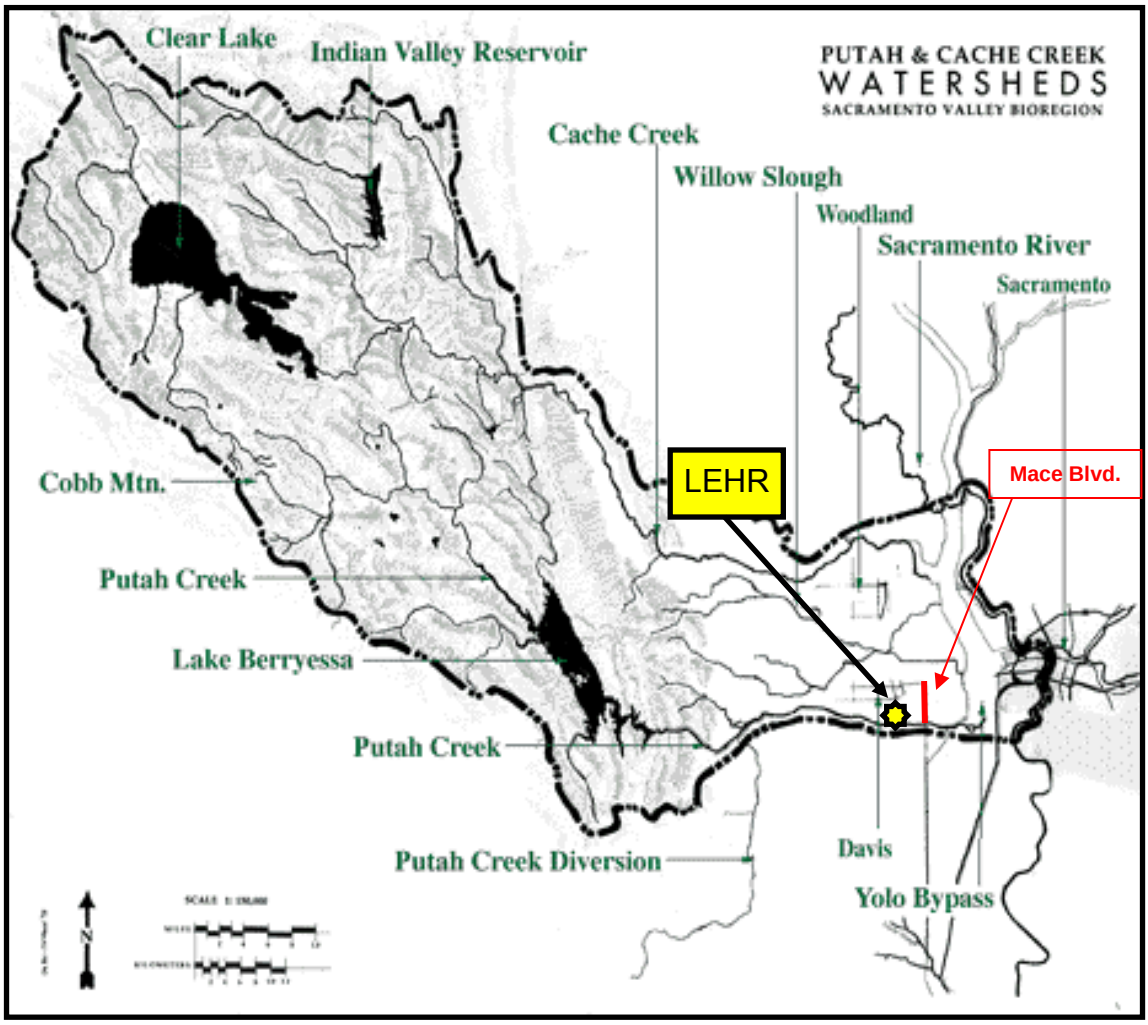


Figure 2. Portions of Upper Putah Creek Watershed Showing Primary Abandoned Mercury Mines (Slotton et al., 1999)

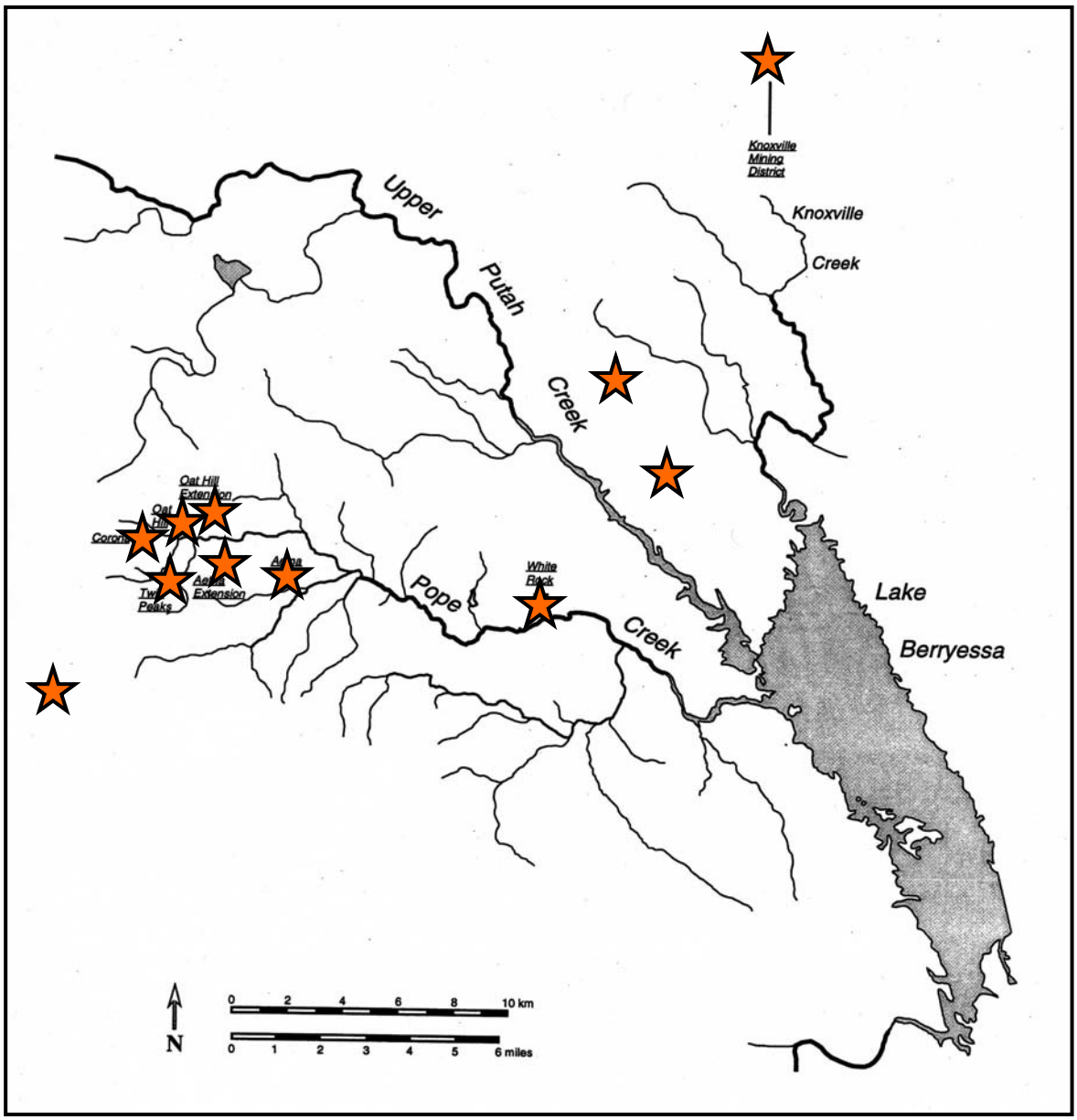


Figure 3. Aerial View of LEHR Superfund Site Environs
(LEHR site outlined in yellow)

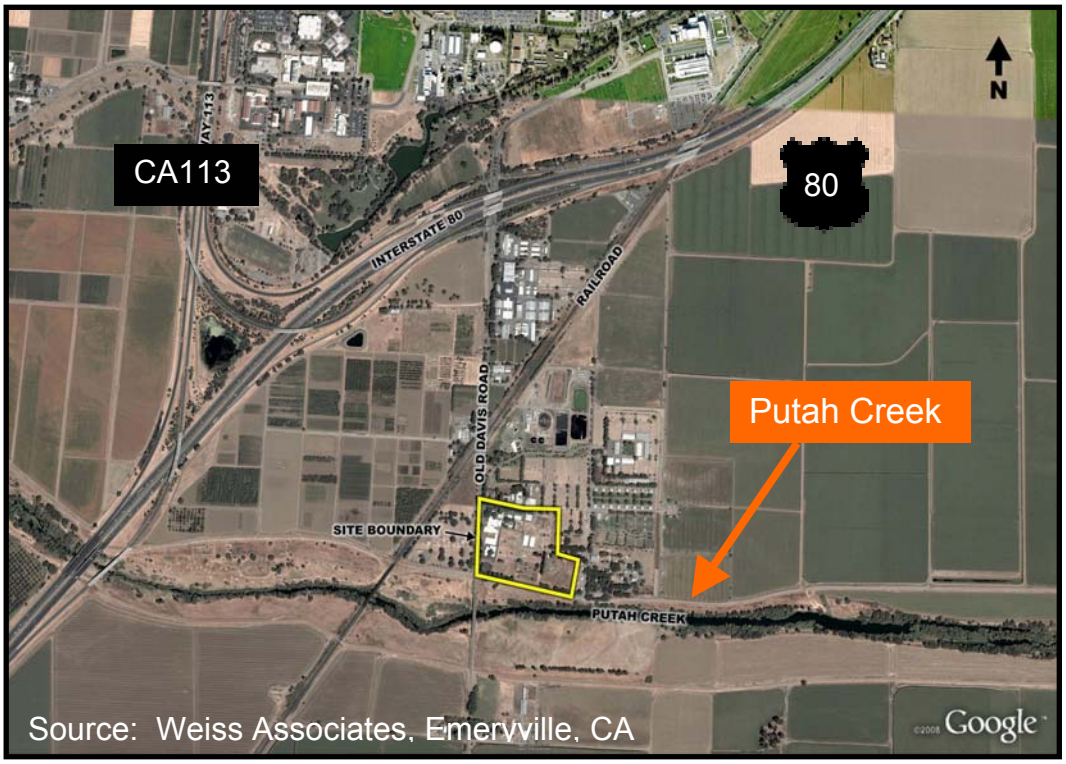


Figure 4. Putah Creek at the LEHR Site – November 30, 2008

In his early work as the TAG advisor to DSCSOC, Lee found that inadequate attention had been given to the bioaccumulation of waste chemicals in runoff from the LEHR site in Putah Creek fish, which are used by some as food (Lee and Jones-Lee, 1998).

In 1995, DSCSOC requested that the Agency for Toxic Substances and Disease Registry (ATSDR) determine, as part of its Public Health Assessment of the LEHR Superfund site, whether Putah Creek fish near LEHR contained concentrations of hazardous chemicals that could pose a public health threat to those who consume those fish. The initial 1996 ATSDR/US EPA fish sampling of Putah Creek fish found that largemouth bass taken from Putah Creek near the LEHR site contained 0.11 to 0.81 mg/kg Hg (wet weight) (ATSDR, 1997). That level was of sufficient concern that ATSDR recommended that the area of Putah Creek be posted as having unsafe fish; but no action was taken. The ATSDR/USEPA data for mercury in Putah Creek fish collected in the fall of 1997, summarized in Table 1, further established that some fish in Putah Creek near Davis, CA contained mercury at levels that pose a threat to human health (ATSDR, 1998). Lee (1998a,b; 1999) discussed those findings and issues for DSCSOC.

Slotten and Ayers (1999) subsequently found that some fish throughout Putah Creek below Lake Berryessa contained excessive levels of mercury. Slotten et al. (1999) also found elevated concentrations of mercury in small fish taken from tributaries of Lake Berryessa in the mercury mine area. A summary of the Slotten data on fish mercury concentrations in Putah Creek fish in the mid-late 1990s is presented in Table 2.

Table 1. Mercury Concentration in Largemouth Bass from Putah Creek – Oct/Nov 1997
(from ATSDR 1997)

Fish Size	Mean ± SD (mg Hg/kg)
Small (< 415 g)	0.17 ± 0.06
Medium (540 – 730 g)	0.32 ± 0.14

While those studies demonstrated that mercury in Putah Creek fish is apparently derived from the abandoned mercury mine area, it was also possible that the UCD/DOE LEHR Superfund site stormwater runoff and campus wastewater discharges to Putah Creek were also contributing to the excessive mercury in Putah Creek fish. As discussed below, stormwater runoff from the LEHR Superfund site has been found to contain sufficient mercury to contribute to the excessive bioaccumulation of mercury in Putah Creek fish near, and downstream of, LEHR.

The findings of excessive bioaccumulation of mercury in fish from Putah Creek caused DSCSOC to request that the Central Valley Regional Water Quality Board list Putah Creek as a Clean Water Act section 303(d) water quality limited waterbody. The listing of this waterbody in 2003 by the CVRWQCB/SWRCB/US EPA requires that all NPDES-permitted discharges of wastewaters and some stormwaters not exceed the water standard/objective for mercury.

Table 2 Mercury Concentrations in Putah Creek Fish 1998—1999
(Slotton & Ayers, 1999)

Fish Type & Location	Mean ± SD (mg Hg/kg) [no. fish]
Trout – near Lake Berryessa	0.85 ± 0.03 [11]
Bluegill – Upstream of UCD	0.21 ± 0.06 [7]
Bluegill – Downstream of UCD	0.2 ± 0.08 [5]
Largemouth Bass – Downstream of UCD	0.46 ± 0.23 [6]
Roach – Upstream of Lake Berryessa (only small fish)	Range: 0.08 – 0.17

Regulatory Standard for Mercury

The current water quality standard for mercury is the California Toxics Rule (CTR) criterion of 50 ng/L (nanograms/liter) total recoverable mercury. As discussed by the US EPA, at the time of promulgation of that CTR criterion, the 50 ng/L value was established for regulatory expedience; it was recognized that achieving that level in receiving water would not prevent the excessive bioaccumulation of mercury in fish. It is believed that excessive bioaccumulation will be minimized if concentrations of total recoverable mercury in water are maintained below about 5 ng/L.

As discussed in DSCSOC reports (http://www.gfredlee.com/dscsoc/doc.htm) concentrations of total recoverable mercury in stormwater runoff from the LEHR site have been found to repeatedly exceed 500 ng/L. This has caused the CVRWQCB to require that UCD develop stormwater runoff management programs in an attempt to keep the mercury concentration in LEHR site runoff below the current 50 ng/L CTR criterion. When the CTR value is adjusted to provide better protection against excessive bioaccumulation, the target Hg level in the runoff will need to be adjusted to about 5 ng/L Hg. At this time, UCD is attempting to manage the Hg-containing runoff from the LEHR site to Putah Creek by placing straw bails/rolls in front of stormwater inlets. It has been the experience of the authors that such measures will not be adequate to prevent violations of excessive mercury discharges in stormwater runoff from the LEHR site.

Fish Consumption Guidance

The California Office of Environmental Health Assessment (OEHHA, 2006) published concentrations of mercury in legal and/or edible-size fish and shellfish from Putah Creek and Lake Berryessa (Tables 3 and 4), and issued fish consumption guidelines for fish from Putah Creek upstream and downstream of Lake Berryessa, as well as within the lake

(http://oehha.ca.gov/fish/so_cal/putahcreek.html). The consumption guidelines for fish in Putah Creek and Lake Berryessa for the protection against excessive human consumption of Hg are shown in Figures 5 and 6.

Table 3. Summary Mean Hg Concentrations for Legal &/or Edible-Size Fish & Shellfish from Putah Creek (OEHHA, 2006)

Species	Hg (ppm)*
Channel Catfish	**0.15**
White Catfish	**0.14**
Catfish	**0.14**
Largemouth Bass	**0.46**
Sacramento Blackfish	**0.09**
Sacramento Sucker	**0.16**
Bluegill	**0.14**
Green Sunfish	0.17
Redear Sunfish	0.15
Hybrid Sunfish	0.19
Sunfish	**0.14**
Carp	**0.18**
Rainbow Trout	0.08
Brown Trout	0.06
Trout	**0.07**
White Crappie	0.28
Black Crappie	0.33
Crappie	0.29
Hitch	0.09
Sacramento Pikeminnow	0.50
Crayfish	**0.21**
* **BOLD:** Samples with Sufficient Numbers	

Table 4. Summary Mean Hg Concentrations for Legal &/or Edible-Size Fish from Lake Berryessa (OEHHA, 2006)

Species	Hg (ppm)*
Channel Catfish	**0.52**
White Catfish	**0.77**
Catfish	**0.56**
Largemouth Bass	**0.75**
Smallmouth Bass	0.93
Black Bass	**0.76**
Rainbow Trout	**0.17**
Chinook (King) Salmon	**0.48**
Bluegill	0.39
Carp	0.54
*** BOLD: Samples with Sufficient Numbers**	

Figure 5. Safe Eating Guidelines Fish Consumption from Putah Creek (Source: OEHHA, 2006)

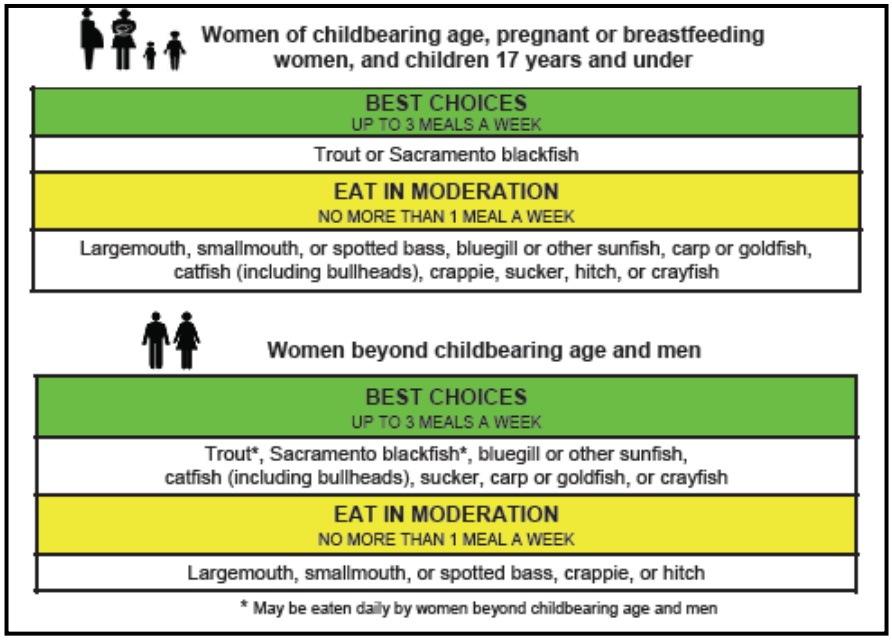
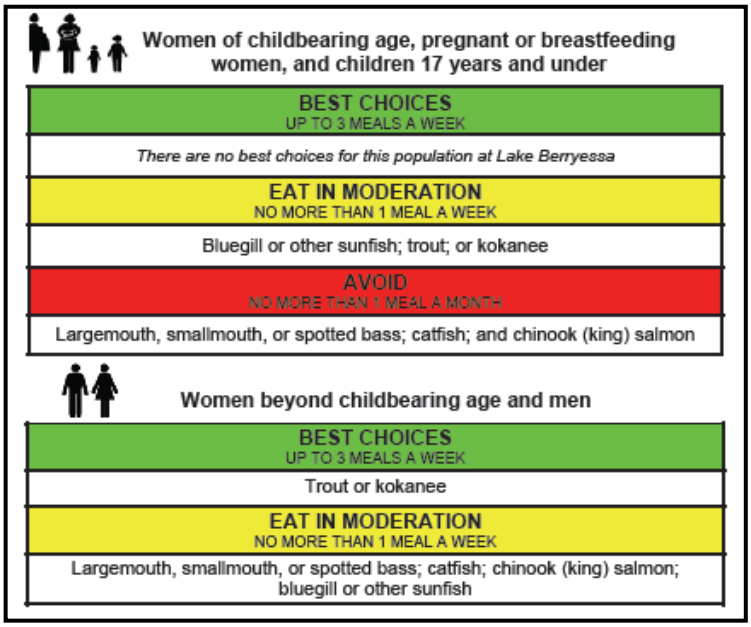


Figure 6. Safe Eating Guidelines Fish Consumption from Lake Berryessa
(Source: OEHHA, 2006)



CALFED Mercury Studies

In August 2008 the final reports from the multi-year, CALFED-supported mercury project were released (Stephenson et al., 2008). That project included monitoring of Putah Creek water for total recoverable mercury and methyl mercury at Mace Blvd. The location of Putah Creek at Mace Blvd. is shown in Figure 1; a photograph of the creek at that location is shown in Figure 7. Table 5 shows that the total recoverable mercury concentrations measured in Putah Creek in that study averaged 24 ng/L, with some high-flow values exceeding 100 ng/L. The methyl mercury concentration in Putah Creek was found to be about 0.15 ng/L.

Table 5. CALFED Mercury Project Concentrations of Hg in Water
(Based on data in Stephenson et al., 2008)

Location	Concentration or Mean ± SD (ng Hg/L)
Putah Creek at Mace Blvd (63 samples 2003 – 2006)	23.82 ± 16.64
Creek during Some High Creek Flows	100
MeHg in Putah Creek	0.15 ± 0.03
MeHg in Cache Creek	0.26 ± 0.09

Figure 7 Putah Creek at Mace Blvd. November 30, 2008

Foe (2008) indicated that the CVRWQCB staff will propose a fish tissue-based Basin Plan amendment for mercury as follows:

- "*our proposed basin plan amendment tissue objective for large trophic level 3 and 4 fish are 0.08 and 0.24 ppm wet weight. This will allow people to safely eat a meal a week.*
- *We are also proposing a small fish (up to 50 mm length) tissue objective of 0.03 ppm wet weight. This is to protect fish eating wildlife. The small fish number comes from recommendations by the US FWS to protect, among other animals, least terns. There is a least tern nest colony near Antioch.*
- *You can read the details in our TMDL report to the US EPA. The unfiltered methyl mercury concentration needed to meet these tissue numbers are site specific. The value for the Delta appears to be around 0.06 ng/l.*" Chris Foe

From this, it appears that the edible flesh of some fish in Putah Creek would be expected to contain excessive mercury since the mercury concentrations in Putah Creek are well above the proposed Basin Plan water quality objective for mercury. Information on the CVRWQCB proposed TMDL for the Delta may be found at http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/index.shtml.

LEHR Site and Area Surface Soil Mercury

Figure 8 and Tables 6 and 7 shows that surface soils at and near the LEHR site typically contain mercury concentrations of 1 to 2 mg/kg Hg with some values somewhat higher than these values.

The mercury concentrations in the deep soils near the LEHR site were typically a factor of 5 to 10 times less than those in the surface soils.

Figure 8 Map of the Mercury near LEHR Surface Soil Sampling Locations
[Dashed area is LEHR site] (Source: Weiss Assoc., 2008)

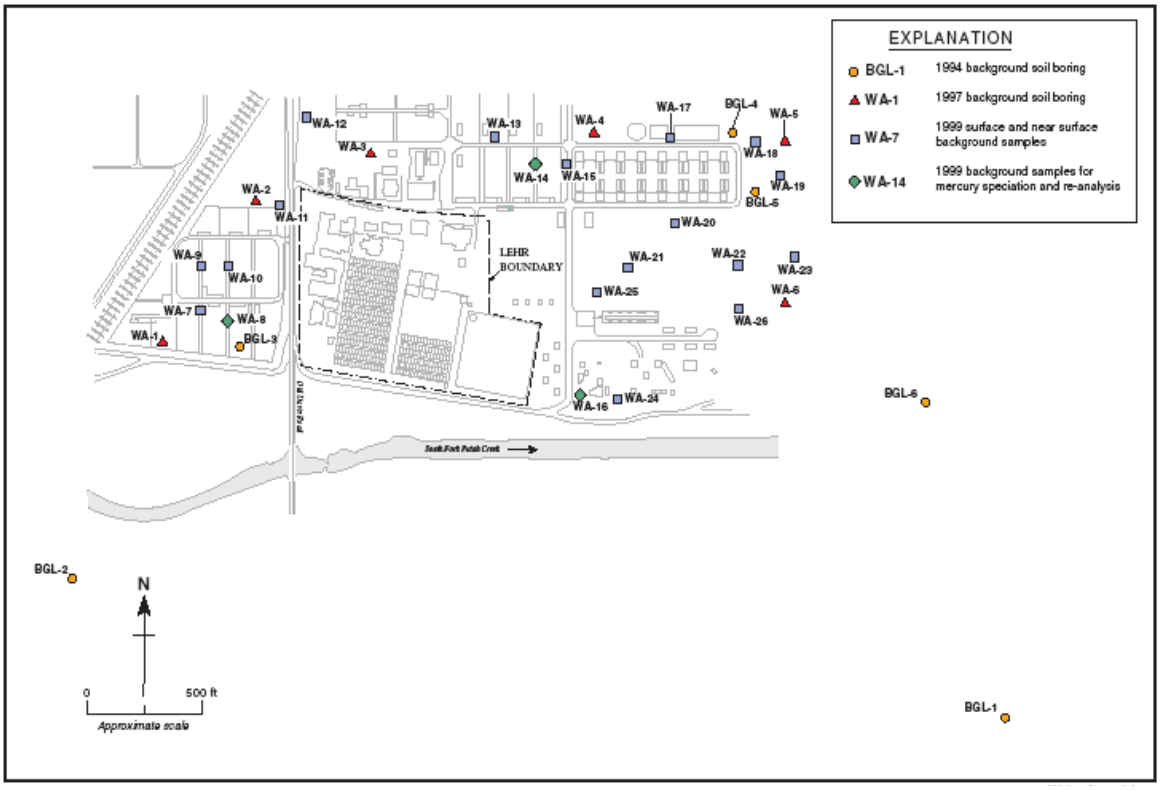


Table 6. Hg Concentrations in near-LEHR Area Soils
(Source: Weiss Assoc., 2008)

Sample Depth	Mean ± SD (mg/kg Hg)
Surface	1.3 ± 1.1
2 ft	1.9 ± 1.3
3 – 4 ft	0.25 ± 1.7
8 – 22 ft	0.16 ± 0.16
30 – 40 ft	0.19 ± 0.09

Table 7. Average Concentrations of Hg in Soil at Selected Locations at LEHR Site (Source: Weiss Assoc., 2008)

Area	Soil Depth: ≤ 2 ft			Soil Depth: >2 - 4 ft		
	No. Samples	Hg Concentration (mg/kg Hg)		No. Samples	Hg Concentration (mg/kg Hg)	
		Mean	SD		Mean	SD
Eastern Dog Pens	25	1.7	3.1	19	1.7	2.5
Western Dog Pens	163	1.1	0.92	28	1.1	1.1
Landfill No. 1	11	1.4	0.81	2	0.6	0.57
Landfill No. 2	11	0.5	0.29	5	0.93	0.69
Landfill No. 3	9*	1.1	0.8	1	0.75	n/a
Non OU Area	71	0.89	0.77	18	1.2	0.72
Old Davis Road Stormwater Runoff Ditch	5	0.8	0.59	0		

* One anomalous sample (49.5 mg/kg) excluded

The elevated mercury concentrations in the surface soil are likely related to the historic periodic flooding of the area by high flows of Putah Creek. Prior to the mid-1940s Putah Creek used to flood the lands near the channel. Those flood waters brought particulate-associated mercury with them from the upstream mining areas, which was deposited in the floodplain. This flooding was reduced in the mid-1940s when high levees were constructed as part of the Corps of Engineers' Putah Creek project. Since the completion of the Morrison Dam on Putah Creek forming Lake Berryessa in 1957, particulate mercury derived from the erosion of mine tailings at the mercury mines has been trapped in Lake Berryessa. Thus, at this time the source of the mercury that is bioaccumulating to excessive levels in Putah Creek fish is mercury originally derived from the mines upstream of Lake Berryessa prior to the construction of the dam and now accumulated in the Putah Creek stream sediments and banks, as well as mercury that has been added to the creek from runoff from the near-creek areas.

Control of Mercury in Putah Creek Fish

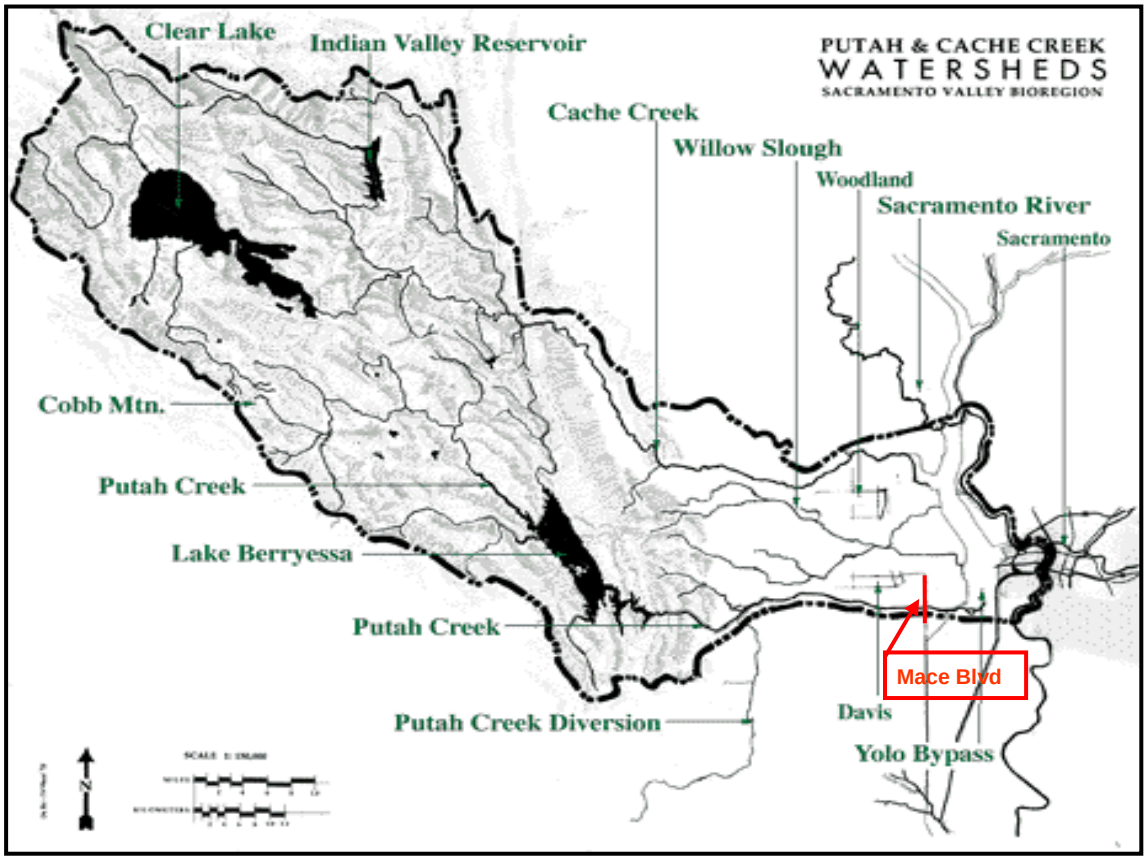
The CVRWQCB has scheduled a TMDL for control of mercury in Putah Creek for 2015. As part of implementing this TMDL it will be necessary for studies to be conducted to determine if there are locations along Putah Creek that are major sources of the total recoverable and methyl mercury currently in the Creek. Similarly, studies need to be conducted to define the contributions of mercury to Putah Creek from the surface soils along Putah Creek, including at and near the LEHR site, and within the city of Davis. Such studies could define hot spots that need attention for mercury control as part of implementing the TMDL. Additional information on the implementation of this TMDL is provided below.

Fate of Mercury in Putah Creek

An issue of concern is the fate of the mercury that is transported all the way down Putah Creek to the areas near the Yolo Bypass. Table 5 showed that the average concentration of mercury in Putah Creek waters at Mace Blvd., several miles upstream of the point at which Putah Creek

enters the Yolo Bypass (see Figure 9), was about 24 ng/L between 2003 and 2006. Between Mace Blvd. and the Yolo Bypass, agricultural interests divert Putah Creek water to irrigate crops. According to Feliz (2008) during Putah Creek high flows, creek waters flood agricultural lands west of the Bypass. Both the irrigation diversion and the flooding cause mercury to be deposited on agricultural lands. Some of that mercury is transported from the irrigated lands in the tail water discharges to the Yolo Bypass.

Figure 9. Map of the Putah Creek and Cache Creek Watersheds Showing Location of Mace Blvd
[Adapted from UCD Putah-Cache Bioregion Project: UCD Davis http://bioregion.ucdavis.edu/where/featrmap.html]



The flow into parts of the Yolo Bypass is controlled by the Los Rios Check Dam (Figure 10). DFG et al. (2008) discussed the influence of that check dam on Putah Creek flow into the Yolo Bypass. Seasonally, that dam is operated to increase the elevation of Putah Creek to assist in the diversion of water from the Creek for irrigation. During the fall/winter, the boards controlling the spillway elevation at the dam are removed to facilitate the migration of Chinook salmon and steelhead trout from the Bypass to upstream Putah Creek for spawning. When the boards have been removed, the flow to Putah Creek is via a channel to the Toe Drain. When the boards are in place, some of the Putah Creek water and its associated mercury in diverted into Yolo Bypass near its west side.

C. Foe of the CVRWQCB (personal communication, 2008) suggested the development of settling basin to settle particulate mercury in Putah Creek water before it enters the Yolo Bypass. A major issue is the development of a fund for this and an approach is the removal and disposal of the mercury-containing sediments from the settling basin.

Figure 10. Los Rios Check Dam at the End of Putah Creek in the Yolo Bypass

Mercury TMDL Implementation

The implementation of the TMDL for controlling mercury in Putah Creek will need to include consideration of the potential significance of the mercury in stormwater runoff from the areas along Putah Creek that used to flood during the periods of high Putah Creek flows. Further, it will need to address the fact that urban areas such as Davis are not required to monitor stormwater runoff and are therefore not required to control discharges of mercury to Putah Creek in stormwater runoff. At the LEHR site, runoff of stormwater from the east (LEHR) side of Old Davis Road is regulated; it is not to contain mercury in excess of the CTR criterion. However UCD's Phase II NPDES stormwater permit does not require that the stormwater runoff from the west side of Old Davis Road (which has the same elevated levels of mercury in surface soils as the LEHR side) be monitored for any pollutant, including mercury, even though samples of that stormwater have been found to contain more than 500 ng/L total recoverable mercury.

A similar situation exists for the regulation of mercury in tail water discharges and stormwater runoff from irrigated agriculture. The CVRWQCB does not require monitoring for mercury in streams impacted by runoff/discharges from irrigated lands. Since many of the waters that are used by irrigated agriculture are polluted with mercury, the irrigated agriculture tail water

discharges and stormwater runoff are sources of mercury. At this time there is no information on how much of the mercury that becomes associated with irrigated lands subsequently contributes to the excessive bioaccumulation of mercury in waters downstream of runoff/discharge from that land. The changes in the behavior of soil-associated mercury and transformations of mercury that occur on the agricultural lands need to be investigated to determine if additional mercury bioaccumulation problems occur because of the discharge of mercury from irrigated lands.

Under the Phase II Stormwater NPDES permits and in accord with the US EPA requirements for implementing Phase II permits, the CVRWQCB is not, at this time, requiring that permittees monitor stormwater runoff for violations of water quality standards/objectives, such as for mercury discharges to Putah Creek. However with the implementation of the Putah Creek mercury TMDL in 2015, the CVRWQCB will have the regulatory authority to require Phase II permittees to prevent violations of water quality objectives that are considered in the TMDL. This requirement could also apply to discharges from agricultural lands, such as those from areas of lower Putah Creek where Creek mercury containing water is used for irrigation of crops and where lands are flooded during periods of high Creek flow.

Additional photographs of Putah Creek are available on the PowerPoint slides of this presentation available at http://www.gfredlee.com/SJR-Delta/PutahHgMinesli.pdf.

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Experience in Work on Mercury Water Quality Issues

Dr. Lee is nearing his fifth decade in the water quality evaluation and management field, a career that has incorporated university teaching and research, as well as advising and performing investigations for public agencies and private concerns. He has been involved in evaluating the environmental impacts of mercury in terrestrial and aquatic systems since the early 1960s. At that time he held the position of Professor of Water Chemistry and Director of the University of Wisconsin graduate degree program in Water Chemistry. In the 1960s he served as a advisor to the state of Wisconsin on evaluating and managing the mercury pollution of several Wisconsin rivers due to paper mills use of mercury electrode generation of chlorine at chloralkali electrolysis facilities. Those facilities released considerable amounts of mercury to rivers to which they discharged that resulted in the excessive bioaccumulation of mercury in fish. His

work on mercury pollution in the 1960s included investigating the use of mercury-based fungicides by paper mills that was leading to mercury pollution of areas near the paper mills where those fungicides were used.

In the 1970s, under a US Army Corps of Engineers Dredged Material Research Program contract, Dr. Lee conducted an approximately $1-million study of the potential release of mercury and about 30 other potential pollutants associated with dredged sediments during open water disposal of contaminated dredged sediments taken from about 100 waterways located throughout the US. It was found that the mercury in those sediments was not released to the water column during dredged sediment disposal operations. The results of those studies were published in 1978 in several Corps of Engineers DMRP comprehensive reports. A summary of the findings of those studies was published as.

> Lee, G. F. and Jones-Lee, A., "Water Quality Aspects of Dredging and Dredged Sediment Disposal," In: Handbook of Dredging Engineering, Second Edition, McGraw Hill, New York, NY, pp. 14-1 to 14-42 (2000).
> http://www.gfredlee.com/Sediment/dredging.html

and in

> Jones-Lee, A. and Lee, G. F., "Water Quality Aspects of Dredged Sediment Management," In: Water Encyclopedia: Water Quality and Resource Development, Wiley, Hoboken, NJ, pp 122-127 (2005).
> http://www.gfredlee.com/Sediment/WileyDredging.pdf

as well in a series of professional papers, some of which are located on, www.gfredlee.com in the "contaminated sediment" section (http://www.gfredlee.com/psedqual2.htm).

In the mid-1980s Dr. Lee was a consultant to the American Dental Association helping the ADA evaluate the potential water quality impacts of the mercury in dental amalgam discharged by dental offices to municipal sewerage systems. He was involved in studies that demonstrated that dental office disposal of mercury in amalgams to the sanitary sewerage system typically represented a few percent of the total mercury in the domestic wastewater wastewaters. Little of that mercury was present in the POTW treatment plant effluent since it was removed in the treatment process, and did not represent a threat to the environment in the treatment plant sludge.

In the early 2000s Dr. Lee developed an EIR for the Yolo County Department of Public Works covering the water quality impacts of Cache Creek improvement projects that have the potential to impact water quality in the Creek and downstream. Of particular concern were projects that involved the removal of invasive vegetation that is blocking Cache Creek flow, the dredging of sand bars, and creek bank stabilization projects, all of which had the potential to mobilize sediment-associated mercury. The results of Dr. Lee's part of the EIR review are summarized in,

> Lee, G. F., "Water Quality," Chapter 4.6 of Yolo County's Supplemental Environmental Impact Report for the Cache Creek Resources Management Plan and Cache Creek Improvement Program County of Yolo Planning and Public Works Department, Woodland, CA (2002).
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> Lee, G. F. and Jones-Lee, A., "Review of Yolo County Lower Cache Creek Water Quality," Report of G. Fred Lee & Associates, El Macero, CA (2002). Available as WQ 003 from gfredlee@aol.com.

Throughout Dr. Lee's professional career he has been involved in the development of water quality criteria/standards and their appropriate use in water quality management. The US EPA's California Toxics Rule (CTR), developed in 2000, contained new criteria for mercury in water. As discussed by Lee (2003), the US EPA's approach to developing

> Lee, G. F., "Regulating Mercury in the Water Column and Sediments," Report to Dredge Tailings Workgroup, by G. Fred Lee & Associates, El Macero, CA (2003).
> http://www.gfredlee.com/SurfaceWQ/TotalMercuryandDissolvedMercuryStandardsrev.pdf

the CTR criterion for mercury is not protective of the public, because it does not adequately consider the excessive bioaccumulation of mercury in edible fish. The adopted CTR criterion for total recoverable mercury of 50 ng/L is about ten times higher than would be necessary to prevent excessive mercury bioaccumulation in some fish in some waters. Since the aquatic chemistry of mercury in aquatic systems is complex and not well understood, Dr. Lee recommended that excessive bioaccumulation of mercury in fish be regulated based on fish tissue concentrations and the use of US EPA proposed fish tissue consumption guidelines, rather than on total recoverable mercury in the water column.

In 1995, Dr. Lee was appointed as the US EPA-supported Technical Assistance Grant advisor to the public through the Davis South Campus Oversight Committee (DSCSOC) in the matter of the adequacy of investigation and remediation of the University of California Davis and US Department of Energy (DOE) LEHR national Superfund site located on the UC Davis campus. As part of that activity he was able to cause the US EPA and the Agency for Toxic Disease Registry (ATSDR) to conduct studies to define whether fish taken from Putah Creek, near the LEHR site, contain excessive concentration of hazardous chemicals including mercury that would be a threat to the health of those who eat Putah Creek fish. Those studies were the first of their type conducted on Putah Creek. They showed that some fish taken from Putah Creek near the LEHR Superfund site contained excessive mercury and that the LEHR site and/or the UCD campus wastewater treatment plant discharges could be source(s) of that mercury.

Dr. Lee developed a series of reports on this situation that may be downloaded from the DSCSOC website, http://www.gfredlee.com/DSCSOC/DSCSOC.htm. Those reports served as a part of the technical basis for the Central Valley Regional Water Quality Control Board's (CVRWQCB) listing of Putah Creek as a 303(d) listed impaired waterbody due to excessive mercury bioaccumulation in some creek fish.

Dr. Lee's review of the stormwater runoff water quality data that UCD and DOE had been collecting on runoff from the LEHR showed that at times the stormwater contained total mercury in concentrations more than 10 times the CTR criterion. It is clear that LEHR site stormwater runoff has contributed to the excessive bioaccumulation of mercury in some Putah Creek fish. It was Dr. Lee's reports on this issue through DSCSOC that caused the CVRWQCB to issue an order to UCD and DOE to implement management practices to prevent discharges of mercury from the LEHR site stormwater runoff above the CTR criterion. That requirement is being implemented at this time.

Dr. Lee was a member of the CALFED dredged tailings review group that reviewed the potential for using dredged tailings from former gold recovery operations as a source of gravel to improve fish spawning habitat. Those dredged tailings contain mercury, which, when dumped into a stream for habitat improvement, could lead to excessive bioaccumulation of mercury in stream

fish. Dr. Lee found that the approach being used by California Department of Fish and Game (DFG) to evaluate whether or not the mercury in the dredged tailings were a threat to cause excessive bioaccumulation when reused in this manner, was technically invalid. He developed a report presenting his recommended approach for evaluating this situation as:

> Lee, G. F., "Comments on the CA Bay Delta Authority Dredge tailings issue paper: Draft 1/14/05 Mercury in Dredge Tailings: Considerations for Restoration, prepared by D. Podger," Report of G. Fred Lee & Associates, El Macero, CA, January (2005). http://www.gfredlee.com/Sediment/DredgSedHgcom.pdf

For the past decade or so, Dr. Lee has been following the CVRWQCB staff's presentations on the ongoing studies of the bioaccumulation of mercury in edible fish in the Delta and its tributaries. He has participated in many of the Delta Mercury Tributaries Council meetings, and served as a member of the CALFED-supported Fish Mercury Project steering committee. Of particular relevance to the Putah Creek/LEHR mercury issues report is Dr. Lee's involvement in Delta water quality issues over the past 20 years. From late-1989 through 2004 he was involved in the CALFED-supported studies of the San Joaquin River (SJR) Deep Water Ship Channel (DWSC) low-dissolved-oxygen problem near the Port of Stockton. He served as coordinating principal investigator for that more than $2-million project devoted to investigating and defining the nature of, causes for, and potential approaches for developing solutions to, the low dissolved oxygen in the DWSC near the Port of Stockton. Through that work he became familiar with how waters that enter the Delta from the Sacramento and San Joaquin Rivers move through the Delta and transport nutrients, algae, and other potential pollutants including mercury and methyl mercury. He and Dr. Anne Jones-Lee developed a series of reports on that work, including the comprehensive synthesis report:

> Lee, G. F. and Jones-Lee, A., "Synthesis and Discussion of Findings on the Causes and Factors Influencing Low DO in the San Joaquin River Deep Water Ship Channel Near Stockton, CA: Including 2002 Data," Report Submitted to SJR DO TMDL Steering Committee and CALFED Bay-Delta Program, G. Fred Lee & Associates, El Macero, CA, March (2003). http://www.gfredlee.com/SJR-Delta/SynthesisRpt3-21-03.pdf
>
> Lee, G. F. and Jones-Lee, A., "Supplement to Synthesis Report on the Low-DO Problem in the SJR DWSC," Report of G. Fred Lee & Associates, El Macero, CA, June (2004). http://www.gfredlee.com/SJR-Delta/SynthRptSupp.pdf

Their papers and reports on Delta water quality issues are available on their website, www.gfredlee.com at http://www.gfredlee.com/psjriv2.htm.

Following the completion of the SJR DWSC low-DO synthesis report, he and Dr. Jones- Lee conducted several special-purpose studies with the support of the DeltaKeeper (William Jennings). Those studies focused on the flow of the San Joaquin and Sacramento Rivers through the Delta as they enter the Delta and move through the Delta channels to the USBR and DWR water export projects at Tracy and Banks, as well as to San Francisco Bay. Their reports on those studies provide important information on how the water and associated pollutants, including total mercury and methyl mercury, in the SJR are transported through the Delta.

> Lee, G. F.; Jones-Lee, A. and Burr, K., "Results of the August 5, 2003, Tour of the South Delta Channels," Report of G. Fred Lee & Associates, El Macero, CA (2004). http://www.gfredlee.com/SJR-Delta/South-Delta-Tour.pdf

Lee, G. F.; Jones-Lee, A. and Burr, K., "Summary of Results from the July 17, 2003, and September 17, 2003, Tours of the Central Delta Channels," Report of G. Fred Lee & Associates, El Macero, CA (2004).
http://www.gfredlee.com/SJR-Delta/Central-Delta-Tours.pdf

Subsequently, Monsen et al. published a report on their investigation into the flow of water through the Delta.

Monsen, N., Cloern, J., and Burau, J., "Effects of Flow Diversions on Water and Habitat Quality: Examples from California's Highly Manipulated Sacramento– San Joaquin Delta," San Francisco Estuary & Watershed Science, Vol. 5, Issue 3, Article 2, July (2007) http://repositories.cdlib.org/jmie/sfews/vol5/iss3/art2

Their findings regarding the water flow through the Delta channels were similar to those reported in the Lee et al. (2004) reports. As discussed in these comments, those findings should be considered in OEHHA's development of "Safe Eating Guidelines" for fish consumption in the "Southern Delta."

It is with this background that the following comments are made on the Putah Creek and the LEHR Superfund site mercury water quality issues.