# State Water Resources Control Board

June 11, 2025

Lauren Leles
Senior Environmental Scientist, Supervisor
Mercury Program and Basin Planning Unit
Central Valley Regional Water Quality Control Board

**SUBJECT: Final Response to the Request for Peer Review of the Scientific Basis of the Proposed Revisions to the Total Maximum Daily Load Of Methylmercury to the Sacramento – San Joaquin Delta Estuary**

Dear Lauren,

This letter is in response to the attached 19 August 2024 request for external scientific peer review for the subject noted above. The review process is described below. All steps were conducted in confidence. Reviewers' identities were not disclosed.

To begin the process for selecting reviewers, I contacted the University of California, Berkeley (University) and requested recommendations for candidates considered qualified to perform the assignment. This service is supported through an Interagency Agreement co-signed by CalEPA and the University. The University was provided with the request letter and attachments. The University interviews each promising candidate.

Each candidate who was both qualified and available for the review period was asked to complete a Conflict of Interest (COI) Disclosure form and submit to the CalEPA Peer Review Program for review, with their Curriculum Vitae. The cover letter for the COI form describes the context for COI concerns that must be taken into consideration when completing the form: "As noted, staff will use this information to evaluate whether a reasonable member of the public would have a serious concern about [the candidate's] ability to provide a neutral and objective review of the work product."

For each candidate judged to be free of conflict, I approved that person as reviewer, affirmed by an approval letter to initiate the review. These letters provided access instructions to a secure FTP site where all material to be reviewed was placed. Each reviewer was asked to address each conclusion for which they had previously agreed, as outlined in my initiation letters. Thirty days were provided for the review, unless a reviewer requested additional time. Guidance was provided to ensure confidentiality through the review process.

Reviewers' names, affiliations, curriculum vitae, initiating letters and reviews are being

sent to you now with this letter. This information can be accessed easily through the bookmarks provided in this file.

The review commenced on October 22, 2024, Central Valley Water Board staff (Board staff) provided 60 days for the review, and all draft review reports were received by 20 January 2025. Upon receipt of the draft review reports, Board staff conducted a sufficiency review of each report and found the reviewers independently and collectively addressed all assumptions, conclusions, and findings under review. Clarification was sought from one reviewer as outlined in the *Memo to SWB Peer Review*. The review reports have since been brought into compliance with web accessibility standards. This letter includes those reports and concludes this peer review request.

Approved reviewers:

1. Laurel G. Larsen, Ph.D.
   Associate Professor, UC Berkeley
   Senior Fellow, Berkeley Institute for Data Science
   Civil and Environmental Engineering and Geography Departments
   University of California, Berkeley

2. Sarah E. Rothenberg, D.Env.
   Associate Professor, Environmental and Occupational Health Program
   College of Health, Oregon State University
   103 Milam Hall, Corvallis, Oregon, 97331, USA

3. Martin Tsz-Ki Tsui, Ph.D.
   Adjunct Associate Professor, Department of Biology
   University of North Carolina, Greensboro

4. Peter Weiss-Penzias, Ph.D.
   Associate Researcher, Microbiology and Environmental Toxicology Department
   Lecturer, Chemistry, Earth and Planetary Science, and Environmental Studies
   University of California, Santa Cruz

If you have any questions, please contact me directly.

Sincerely,

Carol Perkins, Environmental Scientist
CalEPA External Scientific Peer Review Program Lead
Office of Research, Planning, and Performance
State Water Resources Control Board

Carol.Perkins@waterboards.ca.gov

Attachments:

(1) 19 August 2024 Request by Lauren Leles for Scientific Peer Review

(2) Letters to Reviewers Initiating the Review
   i. Laurel G. Larsen, Ph.D.
   ii. Sarah E. Rothenberg, D.Env.
   iii. Martin Tsz-Ki Tsui, Ph.D.
   iv. Peter Weiss-Penzias, Ph.D.

(3) *Guidance to Reviewers*, posted at FTP site

(4) Curriculum Vitae
   i. Laurel G. Larsen, Ph.D.
   ii. Sarah E. Rothenberg, D.Env.
   iii. Martin Tsz-Ki Tsui, Ph.D.
   iv. Peter Weiss-Penzias, Ph.D.

(5) Memo to SWB Peer Review concerning clarification sought from a reviewer.

(6) Web Accessible Reviews
   i. Laurel G. Larsen, Ph.D.
   ii. Sarah E. Rothenberg, D.Env.
   iii. Martin Tsz-Ki Tsui, Ph.D.
   iv. Peter Weiss-Penzias, Ph.D.

cc: Meredith Howard
Environmental Program Manager, Planning Section
Central Valley Regional Water Quality Control Board

Adam Laputz
Assistant Executive Officer
Central Valley Regional Water Quality Control Board

Bayley Toft-Dupuy
Attorney, Office of Chief Counsel
California State Water Resources Control Board

TO: CAROL PERKINS
Manager, CalEPA Scientific Peer Review Program
Office of Research, Planning, and Performance
California State Water Resources Control Board

FROM: LAUREN LELES */ Original Signed as /*
Senior Environmental Scientist, Supervisor
Mercury Program and Basin Planning Unit
Central Valley Regional Water Quality Control Board

CC: MEREDITH HOWARD
Environmental Program Manager, Planning Section
Central Valley Regional Water Quality Control Board

ADAM LAPUTZ
Assistant Executive Officer
Central Valley Regional Water Quality Control Board

BAYLEY TOFT-DUPUY
Attorney, Office of Chief Counsel
California State Water Resources Control Board

DATE: August 19, 2024

SUBJECT: REQUEST FOR EXTERNAL SCIENTIFIC PEER REVIEW OF THE SCIENTIFIC BASIS OF PROPOSED REVISIONS TO THE TOTAL MAXIMUM DAILY LOAD OF METHYLMERCURY TO THE SACRAMENTO – SAN JOAQUIN DELTA ESTUARY

We request external scientific peer review regarding the scientific basis of proposed revisions to the total maximum daily load (TMDL) for methylmercury in the Sacramento – San Joaquin Delta Estuary (Delta) and associated implementation plan, collectively referred to as the Delta Mercury Control Program (DMCP). Board staff have written the *Delta Mercury Control Program Phase 1 Review of the Sacramento – San Joaquin Delta Estuary Total Maximum Daily Load for Methylmercury Staff Report for Scientific Peer Review* (DMCP Review Staff Report for SPR) which contains the detailed analysis of the Phase 1 Review.

Central Valley Water Board staff (Board staff) requests that you initiate the process to identify external scientific peer reviewers for proposed revisions to the TMDL for methylmercury in the Delta, per the requirements of California Health and Safety Code section 57004.

## Purpose of Review

In 2010, the Central Valley Water Board adopted the Delta Methylmercury TMDL and DMCP as a phased approach to manage methylmercury in the Delta. The TMDL was subsequently approved by USEPA on October 20, 2011. Scientific peer review of the *Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury Staff Report, April 2010* (2010 TMDL Staff Report) occurred in 2006.

Phase 1 of the DMCP required dischargers to collect methylmercury data and conduct control studies to investigate the reduction and control of methylmercury. Based on review of new data and the results of the control studies, Board staff were required to consider revising DMCP objectives, allocations, implementation strategies and schedules, and the final compliance date.

Board staff's review of Phase 1 of the DMCP (referred to as the "DMCP Review"), specifically the scientific portions of the proposed rule as required by the CA Health and Safety Code section 57004, is provided in the DMCP Review Staff Report for SPR. The scientific aspects include reevaluations of water quality objectives, methylmercury sources, and methylmercury allocations during Phase 2, which will be relied upon to drive compliance and implementation policy changes regarding control of methylmercury. The Central Valley Water Board will consider adopting these changes as amendments to the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan). Therefore, Board staff requests scientific peer review of the methods, calculations, and assumptions used to complete the scientific portions of the DMCP Review. Board staff is continuing to review and consider modifications to implementation provisions and schedules and the final compliance date.

## When All Supporting Documents and References will be Available at the FTP Site

All materials for the scientific peer review, including supporting documents for reference, will be available within 10 days of the date of this letter.

## Requested Review Period

We request that scientific peer review be completed within 60 days.

# Necessary Areas of Expertise for Reviewers

The DMCP Review Staff Report for SPR is highly technical with data analyses, in-depth scientific evaluations, modeling, and statistics. All reviewers must be proficient in scientific and statistical data analysis (e.g., calculation of pollutant loads, development of water quality objectives, and summary statistics). To review the scientific conclusions outlined in Attachment 2: Scientific Assumptions, Findings, and Conclusions to Review, reviewers should have expertise in (1) methylmercury, (2) Delta estuary management strategies, and/or (3) statistical analysis and data visualization, as described below.

### Methylmercury

Two reviewers with expertise in methylmercury pollution, fate, transport, and bioaccumulation. Reviewers need to have familiarity with (1) the relationship between mercury concentrations in fish and the ambient unfiltered methylmercury concentrations in water, (2) the mechanism of methylmercury bioaccumulation in fish, and (3) the fate and transport of total mercury, methylmercury, and the conversion between total mercury and methylmercury.

Corresponding conclusions in Attachment 2:

- Conclusion 1: Linkage Analysis and Black Bass Implementation Goal
- Conclusion 3: Source Analysis
- Conclusions 4.a.- 4.d.: Allocations

### Delta Estuary Management Strategies

One reviewer with expertise in Delta ecosystem management including water quality and resources (e.g., flow dynamics and constituents of concern). Additional knowledge on how these factors may affect mercury methylation and control is preferable.

Corresponding conclusions in Attachment 2:

- Conclusion 1: Linkage Analysis and Black Bass Implementation Goal
- Conclusion 3: Source Analysis
- Conclusions 4.a.- 4.d.: Allocations
- Conclusion 5: Climatic Variability

### Environmental Statistical Analysis and Data Visualization Using R

One reviewer with expertise in environmental statistical analysis techniques, and regression model evaluation.

Corresponding conclusions in Attachment 2:

- Conclusion 1: Linkage Analysis and Black Bass Implementation Goal
- Conclusion 2: Margin of Safety
- Conclusion 5: Climatic Variability

## Contact Information

Lauren Leles is the project manager: Lauren.Leles@waterboards.ca.gov, (916) 464-4668.

## Attachments

Attachment 1: Plain English Summary
Attachment 2: Scientific Assumptions, Findings, and Conclusions to Review
Attachment 3: Individuals who Participated in the Development of the Proposal
Attachment 4: References Cited

# Attachment 1: Plain English Summary

The Central Valley Water Board identified the Delta as impaired for mercury in 1990 because elevated fish mercury levels posed a risk for human and wildlife consumers. In 2006, the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay Water Board) identified Central Valley outflows through the Delta as one of the primary sources of total mercury to San Francisco Bay and assigned the Central Valley a load reduction of 110 kilograms per year.

In 2010, the Central Valley Water Board adopted the Delta Methylmercury TMDL and DMCP as a phased approach to manage methylmercury in the Delta. The DMCP is designed to protect human and wildlife health in the Delta and meet the Central Valley's mercury load allocation from the San Francisco Bay Water Board. The TMDL was subsequently approved by USEPA on October 20, 2011.

At the time of adoption, the Board recognized that additional information about methylmercury source control methods was needed to (1) determine how and if dischargers could attain load and waste load allocations and (2) evaluate potential benefits and adverse impacts to humans, wildlife, and the environment. Accordingly, the Board adopted the Delta Methylmercury TMDL and DMCP as a phased approach:

- Phase 1: Phase 1 of the DMCP required dischargers to collect methylmercury data and conduct control studies to investigate the reduction and control of methylmercury. These control studies were then reviewed by an independent scientific peer review panel.

- Phase 1 Review: Based on review of new data and the results of the control studies, Board staff is required to consider revising DMCP objectives, allocations, implementation provisions and schedules, and the final compliance date.

- Phase 2: Phase 2 requires dischargers to implement methylmercury control programs to meet allocations, continue total mercury reduction programs, and conduct compliance monitoring.

Board staff is currently conducting Phase 1 Review. The DMCP Review, specifically the scientific portions of the proposed rule as required by the CA Health and Safety Code section 57004, is provided in the DMCP Review Staff Report for SPR. As part of DMCP Review, Board staff is also continuing to review and consider modifications to implementation provisions and schedules and the final compliance date. These aspects of the DMCP Review, which will help inform proposed amendments to the Basin Plan, do not constitute scientific portions of the DMCP Review and thus are not included as part of this scientific peer review.

The TMDL geographic scope includes the area within the legal Delta boundary and the entire Yolo Bypass. The scope was divided into eight subareas (West Delta, Central Delta, Marsh Creek, San Joaquin River, Mokelumne/Cosumnes Rivers, Sacramento

River, Yolo Bypass – North, and Yolo Bypass – South) based on hydrologic

characteristics and mixing of source waters. Board staff propose including the Cache Creek Settling Basin within the geographic scope of the TMDL as part of the DMCP Review.

The 2010 TMDL Staff Report selected methylmercury (MeHg) in fish tissue as the numeric target for the Delta Methylmercury TMDL[1]. The numeric targets were developed based on fish consumption rates to protect human and wildlife health. For the DMCP Review, Board staff did not modify the numeric targets or water quality objectives listed in the 2010 TMDL Staff Report.

The 2010 TMDL Staff Report's linkage analysis determined that methylmercury concentrations in fish could be linked to methylmercury concentrations in ambient water. This empirical evidence assumes that ambient aqueous methylmercury concentrations are the primary factor in determining fish tissue methylmercury concentrations. For the DMCP Review, Board staff maintained this assumption and performed the linkage analysis using more recent and extensive data, and more robust methods. Both linkage analyses looked at multiple models and selected one. The selected model was used to develop an aqueous MeHg implementation goal that, when met, would result in a methylmercury concentration in fish that is safe for wildlife and humans to consume. After applying a margin of safety, the 2010 linkage model resulted in an aqueous MeHg implementation goal of 0.06 ng/L and the DMCP Review linkage model resulted in an aqueous MeHg implementation goal of 0.059 ng/L.

In the 2010 TMDL Staff Report, the ambient aqueous MeHg in all subareas except the Central Delta exceeded the aqueous MeHg implementation goal. In the DMCP Review, all subareas exceeded the aqueous MeHg implementation goal including the Central Delta. Therefore, the 2010 TMDL Staff Report and DMCP Review include a source analysis that identifies and quantifies sources of methylmercury.

As done in the 2010 TMDL Staff Report, the DMCP Review assigns methylmercury load allocations to methylmercury sources. Methylmercury allocations were assigned based on the reduction needed in each Delta TMDL subarea. To determine the reduction of methylmercury, the 2010 TMDL Staff Report compared the average methylmercury concentration in ambient water in each Delta TMDL subarea to the aqueous MeHg implementation goal of 0.06 ng/L. For the DMCP Review, Board staff compared the median methylmercury concentration in ambient water, calculated using more recent data, to the proposed aqueous methylmercury implementation goal of 0.059 ng/L.

[1] While the numeric targets are for methylmercury, mercury is typically analyzed as "total mercury" in fish because of the additional cost required for methylmercury analysis. Mercury exists almost entirely in the methylated form in small and TL4 fish. It is estimated that methylmercury accounts for 94.3% of the total mercury in fish. Therefore, the 2010 TMDL Staff Report assumed that all the mercury measured as total mercury in Delta fish was methylmercury.

# Attachment 2: Scientific Assumptions, Findings, and Conclusions to Review

The statutory requirement for external scientific review (CA Health and Safety Code, section 57004) states that it is the peer reviewer's responsibility to determine whether the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices.

The assumptions, findings, and conclusions that constitute the scientific portions of this TMDL project are identified and listed below. We request that the scientific peer reviewers determine if the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices per statute for external scientific peer review (CA Health and Safety Code, section 57004).

The DMCP Review Staff Report for SPR incorporates additional monitoring and modeling conducted as part of Phase 1 of the DMCP. The DMCP Review Staff Report for SPR is a highly technical document that contains in-depth scientific evaluations, complex statistical analyses, and conclusions that are based on data from independently produced technical studies and reports. The Central Valley Water Board requests that reviewers assess the appropriateness of using these evaluations, analyses, and conclusions in the DMCP Review Staff Report for SPR.

The following conclusions of the DMCP Review Staff Report for SPR comprise the bulk of the scientific analysis and require focused peer review. Each conclusion contains a list that summarizes the facts and background to support the conclusion.

1. **Linkage Analysis and Black Bass Implementation Goal**

Conclusion 1: The DMCP Review's proposed linkage model was determined by applying appropriate quantitative data analysis methods for pairing black bass mercury data with aqueous methylmercury data, finding the central tendency of data, and selecting regression models.

- Board staff selected three black bass species (largemouth bass, smallmouth bass, and spotted bass) instead of only one species (largemouth bass), as done in the 2010 TMDL Staff Report.
- Board staff evaluated three year ranges of aqueous methylmercury and black bass mercury data: 2000-2019, 2012-2019, and 2016-2019.
- For each year range, Board staff determined whether the central tendency of data should be calculated either by pooling all years of data or grouping by year.
- Board staff evaluated whether the mean, geomean, weighted average, or median would be a better measure of central tendency.
- Board staff considered six regression models (simple linear, exponential, logarithmic, power, nonlinear least squares, and generalized additive models) to standardize black bass mercury concentrations.

- In total, 405 potential linkage models were generated.
- The model that provided the lowest standard error of regression (SER) was selected as the final linkage model to represent the relationship between aqueous methylmercury and black bass mercury concentrations.

Sections of the DMCP Review Staff Report for SPR that pertain to the Linkage Analysis and Black Bass Implementation Goal include:

- Section 4.2 Black Bass Evaluation
- Section 5 Linkage analysis
- Appendix B
- Appendix C

2. **Margin of Safety**

Conclusion 2: The DMCP Review's proposed margin of safety sets an aqueous methylmercury implementation goal by accounting for the uncertainty in the linkage analysis data and modeling methods used to find the protective aqueous methylmercury concentration.

- Resampling was used to randomly select, with specified criteria, 10,000 representative subsets of aqueous methylmercury and black bass mercury sampling data.
- Each subset determined predicted protective aqueous methylmercury concentration.
- The 10,000 generated protective aqueous methylmercury concentrations were used to construct a probability distribution.
- The fifth percentile value from the probability distribution, 0.059 ng/L, was set as the aqueous methylmercury implementation goal, which equates to a margin of safety of about 3.3%.
- The fifth percentile value represents a 95% chance that the true protective aqueous methylmercury concentration is greater than the proposed aqueous methylmercury implementation goal of 0.059 ng/L.

Sections of the DMCP Review Staff Report for SPR that pertain to the Margin of Safety include:

- Section 5.3 Margin of Safety

3. **Source Analysis**

Conclusion 3: The DMCP Review's proposed water balance and methylmercury mass balance reasonably quantify and account for all water and methylmercury source and loss types in the Delta.

- To be consistent with the final linkage model, sources and losses of the water balance and methylmercury mass balance were calculated using medians to estimate the central tendency of aqueous methylmercury concentration and flow volume data.
- The source analysis incorporated data from water years 2000 through 2019, a period that encompasses a mix of wet and dry conditions.
- The water balance was calculated using the same methods used in the 2010 TMDL Staff Report.
- Some water balance sources and losses were calculated using flow estimate methods (e.g., flow models or precipitation runoff) rather than flow measurements (e.g., flow gauges).
- Board staff corrected miscalculations and incorporated additional calculations to better estimate the water balance and mass balance.
- Due to inclusion of multiple hydrologic models, Board staff recognize the potential that evaporation and precipitation may be overestimated in the water balance.

Sections of the DMCP Review Staff Report for SPR that pertain to the Source Analysis include:

- Section 6 Source Analysis

4. **Allocations**

The following conclusions should be considered:

Conclusion 4.a.: DMCP Review's proposed methylmercury load allocations and waste load allocations are achievable considering current technology, feasibility of controlling the sources, and recommended methylmercury allocation compliance calculations.

Conclusion 4.b.: Achieving load allocations and waste load allocations for Delta regulated entities (e.g., municipal separate storm sewers (MS4s), public wastewater treatment plants (WWTPs), irrigated agriculture) will result in measurable and statistically meaningful reductions in fish tissue mercury concentrations. This conclusion should be considered apart from whether other loads are achieved.

Conclusion 4.c.: Achieving load allocations and waste load allocations for Delta regulated entities (e.g., MS4s, WWTPs, irrigated agriculture) will result in a measurable reduction in Delta aqueous methylmercury concentrations. This conclusion should be considered apart from whether other loads are achieved.

Conclusion 4.d.: Measurable reductions of mercury in fish tissue will occur as all sources meet the proposed allocations, eventually attaining the proposed water quality objectives to protect human and wildlife health for consumption of trophic

level 3 and 4 fish.

- Methylmercury allocations were determined using the same analysis methodology in the 2010 TMDL Staff Report.

- Methylmercury allocations were calculated using the specific assimilative capacity for each Delta TMDL subarea based on available data from WYs 2000-2019. The assimilative capacity of each Delta TMDL subarea is set as the ambient aqueous methylmercury concentration to meet the proposed aqueous methylmercury implementation goal of 0.059 ng/L in unfiltered water and encompasses a margin of safety of 3.3%.

- Methylmercury allocations were calculated using gross methylmercury loading of sources to and within Delta TMDL subareas. For sources that are net sinks of methylmercury, Board staff assigned the source a 100% allocation.

- Methylmercury allocations are ultimately driven by the proposed water quality objectives, which were previously scientifically peer reviewed. The water quality objectives were reevaluated but not changed.

- Methylmercury allocations are based on estimating the median population growth to be 25% from 2020 through 2060.

- Methylmercury allocations incorporated an unassigned allocation for future flows from NPDES WWTPs, and MS4s in the Delta MeHg TMDL Boundary that were not evaluated in the DMCP Review.

- Compliance with tributary load allocations will be addressed in upstream mercury control programs.

The sections of the DMCP Review Staff Report for SPR that pertain to Allocations include:

- Section 8 Methylmercury Allocations, Total Mercury Limits, & Margin of Safety

- Appendix E Characterization and Control Study Summaries
    - Including the *Independent Scientific Review of the Delta Mercury Control Program Phase 1* reports coordinated through the Delta Science Program

5. **Climatic Variability**

Conclusion 5: The DMCP Review's proposed methylmercury source analysis, allocations, and compliance calculation methods reasonably account for climatic variability.

- Climate change is expected to create variable extremes of flow events and varying effects of mercury loading and methylmercury concentrations in the Delta.

- Climate change will likely affect precipitation rates, resulting in longer and drier drought periods and more intense storm systems that result in less runoff during drought periods and more runoff during flood years.
- Longer and drier drought periods and more intense storm systems expected with climate change should be similar to the recent dry periods observed in WYs 2001-2004, 2007-2010, and 2012-2016, followed by an extreme wet year, observed in 2005, 2011 and 2017.
- The methylmercury source analysis and allocation calculations incorporate data from WYs 2000-2019 to account for normal and critical conditions.
- Medians were used to determine the central tendency of methylmercury loads and exports and the amount of methylmercury reduction needed in each subarea.
- The median is a robust statistical measure of central tendency because up to 50% of the observations can be changed without affecting the median value, whereas the arithmetic mean is heavily influenced by skewed datasets and outliers.
- Proposed compliance for all methylmercury allocations is based on a rolling five-year median.
- The median is proposed to determine compliance with all methylmercury allocations because it is (1) the same statistic used to calculate allocations, (2) less influenced by the effects of extreme weather events, as compared to the arithmetic mean.

The sections of the DMCP Review Staff Report for SPR that pertain to Climatic Variability include:

- Section 6.1 Water Balance
- Section 6.4 Methylmercury Mass Balance
- Section 8.1 Methylmercury Allocations
- Section 8.4 Seasonal & Inter-annual Variability

# Attachment 3: Individuals who have Participated in the Development of the Proposal

**CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD**
Patrick Pulupa, Executive Officer
Adam Laputz, Assistant Executive Officer
Meredith Howard, Environmental Program Manager
Lauren Leles, Senior Environmental Scientist
Jennifer Fuller, Senior Environmental Scientist
Robin Merod, Water Resource Control Engineer (prior employee)
Jordan Robbins, Environmental Scientist (prior employee)
Leah Jones, Environmental Scientist (prior employee)

*2010 TMDL STAFF REPORT DEVELOPMENT:*
Pamela Creedon, Executive Officer (Retired)
Ken Landau, Assistant Executive Officer (Retired)
Jerry Bruns, Environmental Program Manager (Retired)
Patrick Morris, Senior Water Resource Control Engineer (Retired)
Janis Cooke, Environmental Scientist
Chris Foe, Environmental Scientist (Retired)
Michelle Wood, Environmental Scientist (prior employee)
Stephen Louie, Environmental Scientist (prior employee)

**STATE WATER RESOURCES CONTROL BOARD, OFFICE OF CHIEF COUNSEL**
Bayley Toft-Dupuy, Staff Counsel
Lori Okun, Staff Counsel (Retired)

**SCIENTIFIC PEER REVIEW OF 2010 TMDL STAFF REPORT**
Professor David Sedlak, University of California
Alexander J. Horne, Professor Emeritus, University of California

**COMMENTERS ON 2010 TMDL STAFF REPORT**
Alexis Straus, U.S. Environmental Protection Agency, Region 9
Andria Ventura, Clean Water Action
Angel Luevano, Todos Unidos
Art O'Brien, City of Roseville Wastewater Treatment
Aubrey White, UC Davis Graduate Student
Aviance Robinson, All Positives Possible
Bob Schneider, Tuleyome
Bud Hoekstra
Chris Scheuring, Farm Bureau
Christine Cordero, Center for Environmental Health
Chunky Harrigan, Whole Education
Corrina Gould, Chochenyo Ohlone for Indian People Organizing for Change
Dale K. Hoffman-Floerke, California Department of Water Resources
David Tompkins, City of Vacaville

Debbie Davis, Environmental Justice Coalition for Water
Debbie Webster, Central Valley Clean Water Association
Dipti Bhatnagar, Environmental Justice Coalition for Water
Duane Chamberlain, Yolo County Board of Supervisors
Erich Delmas, City of Tracy
Erick Soderlund, Department of Water Resources
Fraser Shilling, UC Davis, Department of Environmental Science
Gene Mullenmeister
Greg Meyer, City of Woodland
Greg Yarris, California Waterfowl Association
Hasheem Bason, Parents 4 A Healthy Community
Henry Clark, Dr., West County Toxics Coalition
Ian Wren, Baykeeper
Irenia Quitiquit, Scotts Valley Band of Pomo Indians
Jacqueline McCall, Central Valley Clean Water Association
Jay S. Punia, Central Valley Flood Protection Board
Jeff Willett, City of Stockton
John Herrick, South Delta Water Agency
Jovita Pajarillo, U.S. Environmental Protection Agency, Region 9
Kari Fisher, California Farm Bureau Federation
Kerry Schmitz, Sacramento County Department of Water Resources
L. Ryan Broddrick, Northern California Water Association
LaDonna Williams, People for Children's Health and Environmental Justice
Laura Leonelli, Southeast Asian Assistance Center
Leah Wills, Plumas County Flood Control and Water Conservation District
Leo Winternitz, The Nature Conservancy
Linda Fiack, Delta Protection Commission
Lonnie Mason, First Generation
Marty Hanneman, City of Sacramento
Mary K. Snyder, Sacramento Regional County Sanitation District
Meyo Marrufo, Robinson Rancheria of Pomo Indians
Michael Hoover, United States Fish and Wildlife Service
Michael L. Peterson, County of Sacramento
Michelle H. Denning, U.S. Department of Interior Bureau of Reclamation, Mid-Pacific Regional Office
Mike DeSpain, Mechoopda Tribe
Paul Buttner, California Rice Commission
Paul D. Thayer, California State Lands Commission
R. Mitch Avalon, Contra Costa County Public Works Department
Rudolph Rosen, Ducks Unlimited
Sarah Ryan, Big Valley Rancheria Band of Pomo Indians
Saroeum Yim, United Cambodian Families
Sejal Choksi, Baykeeper
Sherill Huun, City of Sacramento
Sherri Norris, California Indian Environmental Alliance
Susan Tatayon, The Nature Conservancy

Terrie Mitchell, Sacramento Regional County Sanitation District
Terry Erlewine, State Water Contractors
Tim O'Halloran, Yolo County Flood Control and Water Conservation District
Tony Pirondini, City of Vacaville
Whitney Dotson, North Richmond Shoreline Open Space Alliance

**OTHERS INVOLVED IN THE DMCP CONTROL AND CHARACTERIZATION STUDIES**

Albert Stricker, City of Rancho Cordova
Andrea Buckley, California Central Valley Flood Protection Board
Anna Kogler, West Yost Associates
Brandon Nakagawa, County of San Joaquin
Brian Branfireun, University of Western Ontario
Brian Laurenson, Larry Walker Associates
Carl Mitchell, University of Toronto Scarborough
Carol DiGiorgio, Department of Water Resources
Catherine McCalvin, Department of Water Resources
Charity Meakes, U. S. Army Corps of Engineers
Charles Hardy, West Yost Associates
Charlie Alpers, U.S. Geological Survey
Chris Wilkinson, Department of Water Resources
Christopher Knightes, U.S. Environmental Protection Agency
Christopher Martin, Department of Water Resources
Cindy Gilmour, Smithsonian Environmental Research Center
Collin Eagles-Smith, U.S. Geological Survey
Colonel James J. Handura, U. S. Army Corps of Engineers
Cory Koger, U. S. Army Corps of Engineers
Curtis Pollman, Aqua Lux Lucis, Inc.
Cynthia Herzog, California State Lands Commission
Dalia Fadl, City of Sacramento
Dan Sherry, Sacramento City Combined Wastewater Collection and Treatment System
Daniel Hack, Ross Island Sand and Gravel Co.
Dave Nugen, City of Folsom
Dean Messer, Department of Water Resources
Derek Murray, Tetra Tech, Inc.
Gary Wortham, Tetra Tech, Inc.
Harry McQuillen, U.S. Geological Survey
Hope Taylor, Sacramento Regional County Sanitation District
Itzia Rivera, , California Central Valley Flood Protection Board
Jacob A. Fleck, U.S. Geological Survey
Jaime Rodriguez, Deuel Vocational Institution
Jason Cashman, Port of Stockton
Jason Farnsworth, City of Stockton
Jeff Werner, City of Elk Grove
Jeffery Pelz, West Yost Associates
Jeremy Arrich, Department of Water Resources
Jobaid Kabir, United States Bureau of Reclamation

John Callaway, Delta Stewardship Council
John Nosacka, Department of Water Resources
Josh T. Ackerman, U.S. Geological Survey
Julianna Manning, Department of Water Resources
Karen Ashby, Larry Walker Associates
Karin Graves, Contra Costa County
Kathryn Gies, West Yost Associates
Kelly Havens, GeoSyntec Consultants
Kevin J. Brown, Department of Water Resources
Khalil Abusaba, Wood Environment & Infrastructure Solutions, Inc.
Leslie Gallagher, Central Valley Flood Protection Board
Lindsay Correa, Delta Stewardship Council
Lisa Austin, GeoSyntec Consultants
Lisa Moretti, Sacramento City Combined Wastewater Collection and Treatment System
Lisa Welsh, GeoSyntec Consultants
Lisamarie Windham-Myers, U.S. Geological Survey
Lysa Voight, Sacramento Regional County Sanitation District
Mark List, Department of Water Resources
Mark Marvin-DiPasquale, U.S. Geological Survey
Mark Severeid, City of Woodland
Matt Weber, GHD Group
Michael Aguilera, Tetra Tech, Inc.
Michael Peterson, County of Sacramento
Paul Bedore, Robertson-Bryan, Inc.
Petra Lee, California Central Valley Water Quality Control Board
Philip Bachand, Tetra Tech, Inc.
Rob Thomas, Deuel Vocational Institution
Robert Burton, Deuel Vocational Institution
Robert Mason, University of Connecticut
Sherill Huun, Sacramento City Combined Wastewater Collection and Treatment System
Stephen McCord, McCord Environmental Inc.
Stuart Hodgkins, City of Citrus Heights
Sujoy Roy, Tetra Tech, Inc.
Teri Yessen, California Department of Corrections and Rehabilitation
Tom Grovhoug, Larry Walker Associates
Valentina Cabrera-Stagno, U.S. Environmental Protection Agency, Region 9
William Forrest, City of Galt
Yumiko Henneberry, Delta Stewardship Council

# Attachment 4: References Cited


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# State Water Resources Control Board

October 22, 2024

Laurel G. Larsen, Ph.D.
Associate Professor, UC Berkeley
Senior Fellow, Berkeley Institute for Data Science
Civil and Environmental Engineering and Geography Departments
University of California, Berkeley

Sent via email

SUBJECT: REVIEW COMMENCEMENT REGARDING THE SCIENTIFIC BASIS OF PROPOSED REVISIONS TO THE TOTAL MAXIMUM DAILY LOAD OF METHYLMERCURY TO THE SACRAMENTO – SAN JOAQUIN DELTA ESTUARY

Dear Professor Larsen,

Thank you for accepting the role as an external scientific peer reviewer of subject request. The purpose of this letter is to initiate the external peer review.

**Components of the review:**

1. Request for External Scientific Peer Review, with the following attachments:
    a. Attachment 1: Plain English Summary.
    b. Attachment 2: Scientific Assumptions, Findings, and Conclusions to Review.
    c. Attachment 3: Individuals who Participated in the Development of the Proposal.
    d. Attachment 4: References Cited.
2. Proposed rule or related documents (Draft technical staff report).
3. Electronic copies of references cited.
4. *Guidance for Reviewers*.

All components of the review are posted at a secure FTP site:

Site: [redacted]

- Username: [redacted]
- Password: [redacted]

The findings, assumptions, and conclusions that need review are listed in Attachment 2 of the review request. I ask that you review those findings, assumptions, and conclusions which you previously stated, in communications with me dated 10 October 2024, that you could address with confidence, based on your expertise and experience. These are the following conclusions:

*Conclusion* # 3: Concerning proposed water balance and methylmercury mass balance.

*Conclusion* # 4.a: Proposed load allocations and waste load allocations are achievable.

*Conclusion* # 4.c: Proposed load allocations and waste load allocations should result in aqueous concentration reductions.

*Conclusion* # 5: Proposed source analysis, allocations, and compliance calculation methods reasonably account for climatic variability.

If you decide to address other assumptions, findings, or conclusions, (other than those listed as *Additional Considerations*, Attachment 2) identify the expertise and experience you are relying on to do so. Please refer to *Guidance for Reviewers* for more information about your review and subsequent report, including formatting and web accessibility guidelines.

I will help provide support for any questions you have. To ensure a clear record of our communication, all communications should be in writing (email is preferred). My email address below should prepopulate an email.

Please email your review to me no later than **06 January 2025**. I will forward all reviews and the curricula vitae of all reviewers to the requesting organization. All information may be posted on their website.

The organization requesting the review may require clarification or additional information on a specific subject. If this occurs, I will ask you to supplement your review to address those comments.

Your participation in this review assignment is most appreciated.

Sincerely,

Carol Perkins
Manager, CalEPA External Scientific Peer Review Program
Office of Research, Planning, and Performance
State Water Resources Control Board
1001 “I” Street, 13th Floor Sacramento, California 95814
Carol.Perkins@waterboards.ca.gov

# State Water Resources Control Board

October 22, 2024

Sarah E. Rothenberg, D.Env.
Associate Professor, Environmental and Occupational Health Program
College of Health, Oregon State University
103 Milam Hall, Corvallis, Oregon, 97331, USA

Sent via email

SUBJECT: REVIEW COMMENCEMENT REGARDING THE SCIENTIFIC BASIS OF PROPOSED REVISIONS TO THE TOTAL MAXIMUM DAILY LOAD OF METHYLMERCURY TO THE SACRAMENTO – SAN JOAQUIN DELTA ESTUARY

Dear Professor Rothenberg,

Thank you for accepting the role as an external scientific peer reviewer of subject request. The purpose of this letter is to initiate the external peer review.

**Components of the review:**

1. Request for External Scientific Peer Review, with the following attachments:
   a. Attachment 1: Plain English Summary.
   b. Attachment 2: Scientific Assumptions, Findings, and Conclusions to Review.
   c. Attachment 3: Individuals who Participated in the Development of the Proposal.
   d. Attachment 4: References Cited.
2. Proposed rule or related documents (Draft technical staff report).
3. Electronic copies of references cited.
4. *Guidance for Reviewers*.

All components of the review are posted at a secure FTP site:

Site: [redacted]

- Username: [redacted]
- Password: [redacted]

The findings, assumptions, and conclusions that need review are listed in Attachment 2 of the review request. I ask that you review those findings, assumptions, and conclusions which you previously stated, in communications with me dated 14 October 2024, that you could address with confidence, based on your expertise and experience. These are the following conclusions:

*Conclusion* # 1: Concerning proposed linkage model applies appropriate quantitative data analysis methods.

*Conclusion* # 2: Concerning proposed margin of safety.

*Conclusion* # 4.a: Proposed load allocations and waste load allocations are achievable.

*Conclusion* # 4.b: Proposed load allocations and waste load allocations should result in concentration reductions in fish tissue.

*Conclusion* # 4.c: Proposed load allocations and waste load allocations should result in aqueous concentration reductions.

*Conclusion* # 4.d: Proposed water quality objectives are attainable.

*Conclusion* # 5: Proposed source analysis, allocations, and compliance calculation methods reasonably account for climatic variability.

If you decide to address other assumptions, findings, or conclusions, (other than those listed as *Additional Considerations*, Attachment 2) identify the expertise and experience you are relying on to do so. Please refer to *Guidance for Reviewers* for more information about your review and subsequent report, including formatting and web accessibility guidelines.

I will help provide support for any questions you have. To ensure a clear record of our communication, all communications should be in writing (email is preferred). My email address below should prepopulate an email.

Please email your review to me no later than **06 January 2025**. I will forward all reviews and the curricula vitae of all reviewers to the requesting organization. All information may be posted on their website.

The organization requesting the review may require clarification or additional information on a specific subject. If this occurs, I will ask you to supplement your review to address those comments.

Your participation in this review assignment is most appreciated.

Sincerely,

Carol Perkins
Manager, CalEPA External Scientific Peer Review Program
Office of Research, Planning, and Performance
State Water Resources Control Board
1001 “I” Street, 13th Floor Sacramento, California 95814
Carol.Perkins@waterboards.ca.gov

# State Water Resources Control Board

October 22, 2024

Martin Tsz-Ki Tsui, Ph.D.
Adjunct Associate Professor, Department of Biology
University of North Carolina, Greensboro

Sent via email

SUBJECT: REVIEW COMMENCEMENT REGARDING THE SCIENTIFIC BASIS OF PROPOSED REVISIONS TO THE TOTAL MAXIMUM DAILY LOAD OF METHYLMERCURY TO THE SACRAMENTO – SAN JOAQUIN DELTA ESTUARY

Dear Professor Tsui,

Thank you for accepting the role as an external scientific peer reviewer of subject request. The purpose of this letter is to initiate the external peer review.

**Components of the review:**

1. Request for External Scientific Peer Review, with the following attachments:
   a. Attachment 1: Plain English Summary.
   b. Attachment 2: Scientific Assumptions, Findings, and Conclusions to Review.
   c. Attachment 3: Individuals who Participated in the Development of the Proposal.
   d. Attachment 4: References Cited.
2. Proposed rule or related documents (Draft technical staff report).
3. Electronic copies of references cited.
4. *Guidance for Reviewers*.

All components of the review are posted at a secure FTP site:

Site: [redacted]

- Username: [redacted]
- Password: [redacted]

The findings, assumptions, and conclusions that need review are listed in Attachment 2 of the review request. I ask that you review those findings, assumptions, and conclusions which you previously stated, in communications with me dated 10 October 2024, that you could address with confidence, based on your expertise and experience. These are the following conclusions:

*Conclusion* # 1: Concerning proposed linkage model applies appropriate quantitative data analysis methods.

*Conclusion* # 2: Concerning proposed margin of safety.

*Conclusion* # 3: Concerning proposed water balance and methylmercury mass balance.

*Conclusion* # 4.a: Proposed load allocations and waste load allocations are achievable.

*Conclusion* # 4.b: Proposed load allocations and waste load allocations should result in concentration reductions in fish tissue.

*Conclusion* # 4.c: Proposed load allocations and waste load allocations should result in aqueous concentration reductions.

*Conclusion* # 4.d: Proposed water quality objectives are attainable.

*Conclusion* # 5: Proposed source analysis, allocations, and compliance calculation methods reasonably account for climatic variability.

If you decide to address other assumptions, findings, or conclusions, (other than those listed as *Additional Considerations*, Attachment 2) identify the expertise and experience you are relying on to do so. Please refer to *Guidance for Reviewers* for more information about your review and subsequent report, including formatting and web accessibility guidelines.

I will help provide support for any questions you have. To ensure a clear record of our communication, all communications should be in writing (email is preferred). My email address below should prepopulate an email.

Please email your review to me no later than **06 January 2025**. I will forward all reviews and the curricula vitae of all reviewers to the requesting organization. All information may be posted on their website.

The organization requesting the review may require clarification or additional information on a specific subject. If this occurs, I will ask you to supplement your review to address those comments.

Your participation in this review assignment is most appreciated.

Sincerely,

Carol Perkins
Manager, CalEPA External Scientific Peer Review Program
Office of Research, Planning, and Performance
State Water Resources Control Board
1001 “I” Street, 13th Floor Sacramento, California 95814
Carol.Perkins@waterboards.ca.gov

# State Water Resources Control Board

October 22, 2024

Dr. Peter Weiss-Penzias, Ph.D. Sent via email
Associate Researcher, Microbiology and Environmental Toxicology Department
Lecturer, Chemistry, Earth and Planetary Science, and Environmental Studies Depts.
University of California, Santa Cruz

SUBJECT: REVIEW COMMENCEMENT REGARDING THE SCIENTIFIC BASIS OF PROPOSED REVISIONS TO THE TOTAL MAXIMUM DAILY LOAD OF METHYLMERCURY TO THE SACRAMENTO – SAN JOAQUIN DELTA ESTUARY

Dear Dr. Weiss-Penzias,

Thank you for accepting the role as an external scientific peer reviewer of subject request. The purpose of this letter is to initiate the external peer review.

**Components of the review:**

1. Request for External Scientific Peer Review, with the following attachments:
   a. Attachment 1: Plain English Summary.
   b. Attachment 2: Scientific Assumptions, Findings, and Conclusions to Review.
   c. Attachment 3: Individuals who Participated in the Development of the Proposal.
   d. Attachment 4: References Cited.
2. Proposed rule or related documents (Draft technical staff report).
3. Electronic copies of references cited.
4. *Guidance for Reviewers*.

All components of the review are posted at a secure FTP site:

Site: [redacted]

- Username: [redacted]
- Password: [redacted]

The findings, assumptions, and conclusions that need review are listed in Attachment 2 of the review request. I ask that you review those findings, assumptions, and conclusions which you previously stated, in communications with me dated 09 October 2024, that you could address with confidence, based on your expertise and experience. These are the following conclusions:

*Conclusion* # 1: Concerning proposed linkage model applies appropriate quantitative data analysis methods.

*Conclusion* # 2: Concerning proposed margin of safety.

*Conclusion* # 3: Concerning proposed water balance and methylmercury mass balance.

*Conclusion* # 4.c: Proposed load allocations and waste load allocations should result in aqueous concentration reductions.

*Conclusion* # 4.d: Proposed water quality objectives are attainable.

*Conclusion* # 5: Proposed source analysis, allocations, and compliance calculation methods reasonably account for climatic variability.

If you decide to address other assumptions, findings, or conclusions, (other than those listed as *Additional Considerations*, Attachment 2) identify the expertise and experience you are relying on to do so. Please refer to *Guidance for Reviewers* for more information about your review and subsequent report, including formatting and web accessibility guidelines.

I will help provide support for any questions you have. To ensure a clear record of our communication, all communications should be in writing (email is preferred). My email address below should prepopulate an email.

Please email your review to me no later than **06 January 2025**. I will forward all reviews and the curricula vitae of all reviewers to the requesting organization. All information may be posted on their website.

The organization requesting the review may require clarification or additional information on a specific subject. If this occurs, I will ask you to supplement your review to address those comments.

Your participation in this review assignment is most appreciated.

Sincerely,

Carol Perkins
Manager, CalEPA External Scientific Peer Review Program
Office of Research, Planning, and Performance
State Water Resources Control Board
1001 “I” Street, 13th Floor Sacramento, California 95814
Carol.Perkins@waterboards.ca.gov

# CalEPA Peer Review Program
# Guidance for Reviewers

*Updated June 2023*

**Communication with the CalEPA Peer Review Program.** To ensure a clear record of our communication, all our communications should be in writing (email is preferred).

**Confidentiality.** You are required to help maintain the confidentiality of this review process.

- Confidentiality began at the point you were contacted by the University of California, Berkeley (UC).
- You should not inform others about your role as reviewer.
- You will not know the names of other reviewers until all reviews are complete and the requesting organization decides to release reviews.
- You are not allowed to discuss the proposal with employees of the requesting organization or individuals who participated in development of the proposal. The individuals who participated in development are listed in Attachment 3 of the review request. Please let the CalEPA Program know if you have a question, and we will provide the support between you and the requesting organization.

**Independence.** If you learn what you are reviewing was developed by someone with whom you share a common supervisor or have or had a working relationship, you must let us know so that we can determine whether to seek another peer reviewer. For example, if the CalEPA organization asking for the review contracted with someone in your department or organization to help develop the material you were asked to review, you have a potential conflict of interest.

**Your review.** The statutory mandate for external scientific peer review (California Health and Safety Code Section 57004) states that the reviewer's responsibility is to determine whether "the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices." Your review should take into account both the scientific basis for the proposed rule and the intended application or implementation of that science in the context of the proposed rule.

Note: you are also invited to identify and address additional subjects that should be considered as part of the scientific basis of the proposed rule, and to consider, whether you conclude the proposed rule, taken as a whole, is based on sound scientific knowledge, methods, and practices.

**You may have been asked to review the implementation or application of science that has previously been peer reviewed.** In some cases, there is a clear, previously reviewed scientific basis for what you are reviewing but the scientific basis of a new

implementation of the science still must be reviewed. For example, the scientific foundation for a drinking water standard may have been reviewed when the drinking water standard was adopted, but you might determine that the same scientific foundation does not support the use of the same standard to protect aquatic life in a river.

**You may ask for clarification or for additional specific supporting documents.** We will provide what we can to you and all reviewers. Send clarification questions to the CalEPA Program.

**Text to include in your review.**

- Your name, professional affiliation, and the date.
- The name of the item you are reviewing.
- Begin your review with, “Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence:” and list them by number, as they are referred to in Attachment 2 of the review request.

**Formatting your review.** To ensure all people can perceive, understand, navigate, and interact with the materials posted on CalEPA websites, files posted on these websites must meet accessibility criteria. Your peer review may be posted on a CalEPA website so you must submit your review in an accessible format. The recommended way to make your file accessible is to use Microsoft Word to write your review and to use only basic text and headings during document creation. Then, run the built-in Word Accessibility Checker and resolve any accessibility issues.

Making your review accessible is your responsibility but staff at the UC may be able to assist you by suggesting changes for your approval.

General accessibility criteria include:

- Text. Text should be black, in Arial, size 12 points or larger.
- Non-text elements. If you use them, equations, graphs, figures, images, charts, or tables must follow accessibility criteria regarding meaningful captions and alternative text.
- Layout. Avoid complex document layouts, such as having text in more than one column, use of text boxes, use of color, and applying different font styles (i.e., bolding, underlining, etc.). It’s best to avoid letterhead, signatures, headers, and footers, aside from page numbers.
- Other requirements. There are also additional accessibility formatting requirements, including meaningful hyperlink text and appropriate use of styles for headings and lists.

The links below provide some information on accessible online content:

- Resources for Creating Accessible Content (created by the California Department of Rehabilitation).
- Video lessons for accessible Word documents (created by Microsoft).
- State, Federal, and Other Related Laws & Regulations on Digital Accessibility (created by the California Department of Rehabilitation).

**You may be asked to supplement your review.** The organization requesting the review may require clarification or additional information on a specific subject. If this occurs, the CalEPA Program will contact you to revise your review to address those comments.

**If you are asked to discuss your comments.** After you have submitted your review, you may be approached by third parties, the press, or by colleagues. You are under no obligation to discuss your comments with them and we recommend that you do not. Outside parties are provided an opportunity to address a proposed regulatory action during the public comment period. Discussions outside the provided avenues for comment could seriously impede the established process for vetting the proposal under consideration. Please direct third parties to the CalEPA Program.

# Central Valley Regional Water Quality Control Board

TO: CAROL PERKINS
Manager, CalEPA Scientific Peer Review Program
Office of Research, Planning, and Performance
California State Water Resources Control Board

FROM: MEREDITH HOWARD
Environmental Program Manager, Planning Section
Central Valley Regional Water Quality Control Board

CC: ADAM LAPUTZ
Assistant Executive Officer
Central Valley Regional Water Quality Control Board

DATE: February 11, 2025

SUBJECT: Request for clarifications from scientific peer Reviewer #2 on the *Delta Mercury Control Program Phase 1 Review of the Sacramento – San Joaquin Delta Estuary Total Maximum Daily Load for Methylmercury Staff Report for Scientific Peer Review* (DMCP Review Staff Report for SPR)

We request the question below be sent to Reviewer #2 to provide clarification on Conclusion 4d.

To Reviewer #2:

At the beginning of the review, Reviewer #2 states “I generally accept this report in its current form and I only have minor suggestions. In my review, I have considered all the points for each statement, and addressed the conclusions as written in the letter of request.”

Reviewer #2’s comments on Conclusion 4d, state a question but it is unclear if they agree, disagree, or partially agree with Conclusion 4d. Specifically, the comments state “Section 8: In the “key points” section at the end please address the issue of whether the water quality objectives are attainable. The phrase is used: “Board staff anticipates”

this could be justified for the reader. Why is it anticipated? Based on the calculations and the known Hg science?"

From the DMCP Review Staff Report for SPR, Section 8.5, Key Points states the following:

"Methylmercury allocations were made in terms of specific Delta TMDL subareas assimilative capacity using available data from WYs 2000-2019. The recommended aqueous methylmercury implementation goal is a median annual methylmercury concentration of 0.059 ng/L in unfiltered water (Section 5). This goal describes the assimilative capacity of Delta waters in terms of methylmercury concentration and encompasses a margin of safety of about 3.3%. *Board staff anticipates* that as the median concentration of methylmercury in each Delta TMDL subarea decreases to the aqueous methylmercury implementation goal, the targets for fish tissue will be attained."

The Delta linkage analysis focuses on the comparison of methylmercury concentrations in water and biota, specifically fish. This assumed that ambient aqueous methylmercury concentrations are the primary factor in determining fish tissue methylmercury concentrations, based on empirical evidence, statistically significant, positive correlations between aqueous methylmercury and aquatic biota, indicating that methylmercury levels in water are one of the primary factors determining methylmercury concentrations in fish. Board staff expect that the fish tissue targets will be attained once the median concentration of methylmercury decreases to meet the aqueous methylmercury implementation goal based on the existing science of mercury and methylmercury concentrations and bioaccumulation in fish tissue. The assumptions and methods are summarized in Sections ES 2 and ES 3.

We hope this provides clarity and addresses Reviewer #2's questions on Conclusion 4d. It is unclear from Reviewer #2 comments, if they agree, disagree, or somewhat agree or somewhat disagree with Conclusion 4d. We request Reviewer #2 expand on their comments for Conclusion 4d to provide more clarity on their perspective and add any suggestions for revisions.

# Review of "Delta Mercury Control Program Phase 1 Review of the Sacramento-San Joaquin Delta Estuary Total Maximum Daily Load for Methylmercury: Staff Report for Scientific Peer Review (March 2024)

Dr. Laurel Larsen
Associate Professor, Departments of Geography and Civil & Environmental Engineering, University of California-Berkeley
January 6, 2025

## Scope of Review

Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence:

- Conclusion 3: The DMCP Review's proposed water balance and methylmercury mass balance reasonably quantify and account for all water and methylmercury source and loss types in the Delta.
- Conclusion 4a: DMCP Review's proposed methylmercury load allocations and waste load allocations are achievable considering current technology, feasibility of controlling the sources, and recommended methylmercury allocation compliance calculations
- Conclusion 4c: Achieving load allocations and waste load allocations for Delta regulated entities (e.g., MS4s, WWTPs, irrigated agriculture) will result in a measurable reduction in Delta aqueous methylmercury concentrations. This conclusion should be considered apart from whether other loads are achieved.
- Conclusion 5: The DMCP Review's proposed methylmercury source analysis, allocations, and compliance calculation methods reasonably account for climatic variability.

I structure this review by first providing a set of overall comments and then detailed comments associated with each of the four conclusions above.

## General Comments

Board staff are to be commended for the comprehensive set of updates made to the 2010 TMDL staff report. For the most part, they have done an excellent job at summarizing and incorporating results from the Delta Mercury Control Program studies, the independent scientific peer review panel findings from those studies, and in greatly

expanding the range of data and water-year types included in their analysis. The comprehensive evaluation of over 400 candidate linkage models is likewise commendable. The processes affecting mercury transformation and transport in the Delta are incredibly complex, and the science highly uncertain, and in general, staff have taken a reasonable approach to developing quantitative estimates of linkages, loads, and needed TMDL allocations in the face of this uncertainty. My detailed critical comments often suggest alternative approaches that may be regarded as more scientifically robust, but given the high degree of uncertainty and variability in mercury fluxes and transformations, whether to undertake these analyses is a decision that should be weighed against staff time involved and likely sensitivity of the outcome to changes.

For future public release of this staff report, it would likely be helpful to include more general information about the approach to establishing load allocations up front, as a sort of road map. Specifically, there should be a statement that, as in the 2010 staff report, the net 110 kg/yr reduction in mercury load required by the San Francisco Bay TMDL is proportionally allocated to tributary inflows, and that the analyses covered in the staff report are primarily oriented toward achieving goal concentrations in fish tissue (which are linked to corresponding aqueous goal concentrations). Forefronting this information (currently, the information that the SF Bay TMDL load reduction is to be met by reductions to tributary inflows is in the final chapter of the report) provides important context to the decision to use median flow and concentration values and could reduce concerns about the implications of this decision for calculating annual loads. Secondly, doing so highlights important details about the timescale of the calculations: large fish like black bass accumulate mercury over their 10-15-year lifespan, so goal concentrations in fish tissue are much more sensitive to longer-term averages than to seasonal or interannual variability.

## Assessment of Conclusion 3: The DMCP Review's proposed water balance and methylmercury mass balance reasonably quantify and account for all water and methylmercury source and loss types in the Delta

In my professional opinion, conclusion 3 is *somewhat supported.* The staff report does an excellent job in identifying and attempting to quantify all significant sources and sinks of water and methylmercury in the Delta. It is commendable that in this report, tidal and nontidal sources are separated. Further, comparisons of some individual estimated fluxes to relevant fluxes computed elsewhere (e.g., the 2003 and 2008 CALFED

Reports) provide confidence in estimates. However, there are several salient areas of concern:

## *Method of medians for load calculations:*

While the use of median methylmercury concentrations is appropriate for the linkage model given the integrative nature of bioaccumulation, the use of median monthly flow and concentration values is less appropriate for developing a mass balance that elucidates relative concentrations of different sources and sinks, particularly for highly variable time series. Unlike mean values, medians may be completely insensitive to storm events or other "hot moments" that transport biologically relevant loads of methylmercury into or out of the Delta and should likely be considered in understanding relative contributions of dischargers. For this reason, widely used software packages for developing load contributions from discrete data, such as the USGS's LOADEST (Load Estimation; Runkel et al., 2004) or RLOADEST packages (the implementation of LOADEST in R; Lorenz et al., 2015) are grounded in the computation of representative averages, and there is widespread precedent in the use of average loads for mass balance calculations in systems such as the Great Lakes (e.g. Robertson et al., 2018). I suspect that the use of medians may be a big component of the noted mass balance closure errors.[1]

Second, the step in the data processing pipeline at which the relevant median is computed is important, and I believe it has been handled inappropriately. In general, to ensure that the median value is most representative of long-term conditions, the median should be taken as late in the data processing pipeline as possible. Since the goal for the mass balance calculations is to develop an annual mass balance, this means the most relevant median would be to take the median of the summed monthly totals (i.e., to take the median across years, rather than the median of the summed monthly median, as is done now). When flow and methylmercury concentrations are not statistically independent, it is also very important to take the median of the instantaneous product of concentration and flow (rather than the product of median flow and median concentration, which can be substantially different from the former and not representative of an "average" load.) Furthermore, wherever possible, measured daily data should be used to develop estimates aggregated to longer timescales. For example, to estimate flow from the Cache Creek Settling Basin (CCSB), staff calculated

[1] For certain components of the mass balance that are not expected to be highly variable within a month, the median may be an appropriate choice. Board staff are commended for conducting some comparisons of load calculations using the mean vs. median, such as the comparison of methylmercury loading from MS4 dischargers discussed on p. 148, for which the use of the median instead of the mean was not found to be the main cause of why the present estimate is less than that of the 2010 TMDL staff report.

monthly averages (medians) from the dataset, disaggregated those values to daily values, and then summed the disaggregated values to compute representative monthly volumes that were summed to develop annual volumes (section 6.3.7.2). This approach may hide variability in the annual volumes that would otherwise be computed from gap-filled daily measurements and may skew the estimation of a representative average or median.

In some places, choices for why the median annual load was computed in a certain way were not made clear. For example, on p. 85, it is explained that on several main tributaries, annual loads were determined as the sum of monthly loads, whereas on other tributaries, the estimated annual median flow was multiplied by the annual median methylmercury concentration. Presumably this difference is due to differences in data frequency/availability, but this should be stated.

### *Representation of interannual variability*

Presently, mass balance computations represent a long-term central tendency, masking the interannual variability that characterizes California's hydrologic dynamics. For purposes of the linkage model, this decision makes sense, as fish tissue integrates long-term variability in aqueous concentrations. However, for purposes of determining relative contributions of different sources and sinks to long-term aqueous concentrations in order to distribute allocations, this approach may be problematic in that it can underestimate contributions of sources that are nonlinearly activated during unusually wet or unusually dry periods.

I encourage Board staff to stratify mass balance results by water year type to better account for this climatic variability. Presenting this data graphically could help document uncertainty in the estimates of source and sink contributions by bracketing their variability. It would also highlight whether certain interventions would need to be targeted to abnormally wet or dry years and whether the calculus of relative source contributions changes substantially with climate. Finally, as climate change is expected to enhance extremes, stratifying the annual load data in this way would help refine the identification of how these loads are likely to change in the future.

### *Gap filling*

For sources such as certain tributaries or the Cache Creek Settling Basin that have gaps in the gage data, staff set the gaps to zero with the justification that these gaps tended to appear during the dry season and likely reflect periods of intermittent flow. While I agree that this often may be the case, my own experience with gage data

interpretation suggests that short-timescale gaps due to sensor malfunctioning or reasons other than zero-flow conditions are also common. There are many well documented approaches (e.g., USGS standard practices) for diagnosing the potential cause of gaps and filling them for annualized analyses, using methods that depend on the duration of the gap (e.g., regression-based, interpolation-based). I suspect that several of the gaps staff encountered may not actually be due to zero-flow conditions and that setting their values to zero may bias flow estimates to be low. At a minimum, additional information about the characteristics of gaps (e.g., percentage of the available data, range of durations) would be helpful information to include in the staff report, as well as information about how the data may have been pre-processed by the collector prior to Board staff's additional processing.

## *Evaporation*

The estimation of evaporation (technically evapotranspiration) is based on scaled-up discrete measurements from four Delta islands collected over various periods from 1948-1977 and from a more modern estimate of open-water evaporation. This generates a very coarse estimate at best and could potentially be one of the sources of error in the mass balance. Board staff included a question in the staff report about whether the mass balance might be double-counting evapotranspiration by including channel depletions computed by the DICU model, and I can confidently confirm that it is; all channel depletions in the DICU model are ultimately due to evapotranspiration, as groundwater seepage is from channels into the islands. Alternative and more relevant and reliable estimates of evapotranspiration for the time period of interest may be derived from DWR models such as Bay-Delta SCHISM, which provides this information in a spatially explicit manner that does not double-count Delta island channel depletions. A discussion between Board staff and DWR Bay-Delta modeling staff would be informative. Another more robust alternative would be to calibrate an evapotranspiration model to the available data and apply that model over the years of the study based on available climatological data.

## *Need for additional clarification:*

Little information is provided about the precipitation gage data that were used in the analyses. Appendix A references an Excel spreadsheet of precipitation that was not provided and indicates that "several" gages were used in the analysis. When several gages are available, there are multiple methods available to apply the data from the gages to spatial areas to ensure appropriate areal weighting, including through kriging or the use of Thiessen polygons. It would be helpful for the update to the staff report to specify the exact number of gages used and how the data were distributed over space.

Given the known spatial variability in precipitation, reliance on discrete gages and assumptions about how their data apply geographically can be another source of error in mass balance computations.

### *Methods of scaling up estimates:*

In general, the staff report is robust in highlighting limitations inherent in the estimates, based on available data. One of the biggest limitations in the development of the mass balance that is perhaps not emphasized enough is that of scaling up estimates from just a few experiments, such as the BREW study control ponds and Twitchell Island experimental ponds. Although the flux rates for nontidal wetlands adopted for the current staff report somewhat address a previous concern about constant flow-through conditions, they are still limited in applying rates measured in these studies to all nontidal wetlands. An alternative to consider would be to determine representative inflow and outflow rates from spatially explicit models, such as the Bay-Delta SCHISM model or RMA2D/3D models.

A related concern—involving scaling up in time—pertains to the method of computing methylmercury outflux to the San Francisco Bay. Methylmercury data were available only for a selection of water years in the 2000-2019 time frame. Staff used the available data to compute monthly medians, which were then multiplied by median monthly flows for the entire time period of interest. However, this approach for scaling up might not be robust if the water year classifications for the years with available methylmercury data are not representative of the time period of interest. For example, the years with available methylmercury data contain no critically dry years. A better approach would be to undertake a similar analysis subset by water year type, or to develop regressions between flow and methylmercury concentration for the monthly or annual fluxes and use this approach to fill gaps. The use of load computation packages such as the RLOADEST package mentioned earlier would be helpful in this type of analysis.

### *Representation of the Yolo Bypass*

I am especially concerned that the Yolo Bypass may not have been appropriately represented in the methylmercury source accounting, which may have contributed substantially to the mass-balance discrepancy that methylmercury losses exceeded source contributions. As mentioned in section 6.2.8.1, it is assumed that methylmercury fluxes from the inundated Yolo Bypass is assumed to be indirectly accounted for in source estimations such as agriculture, wetland, and atmospheric deposition. Nevertheless, these estimates do not account for the higher methylmercury loads in the soil of farmed regions of the Yolo Bypass cited in Windham-Myers (2010), and

contributions from wetlands are represented as sinks in the present analysis, as they fall under the nontidal wetlands category. The result is that the Yolo Bypass has a relatively small contribution to total methylmercury loads in the DMCP analysis, which contrasts with the recent findings of the DWR Mercury Open Water Final Report (2020), which suggested that the Yolo Bypass is an important internal source of methylmercury, contributing up to 1/3 the load of the tributaries to the Delta. These contributions were attributed primarily to flooded agricultural soils. I contend that a separate method of accounting for contributions of flooded soils in the Yolo Bypass is needed for the DMCP analysis, given the substantially different hydrologic management characteristics for this region compared to farmed islands elsewhere in the Delta.

### *Double counting in particle settling (sink) estimates*

On p. 173 of the staff report, Board staff note that the settling estimate based on the 2008 CALFED report may be an overestimate, as settling is also inherently included in load estimations for wetlands and agricultural lands. This staff concern seems relatively straightforward to address by subtracting out the settling that occurs over these areas, presuming that the areal coverage is known. However, this is likely a small source of error within the mass balance.

### *Summary of Major Recommendations:*

- In a future update, Board staff may wish to consider using peer-reviewed load computation packages (such as the USGS RLOADEST package) for data pre-processing (e.g., addressing issues of missing values or the need to scale up measurements) and computing loads from sources with discrete discharge and concentration time series over various desired timescales of aggregation.
- If it is infeasible to update the analysis with a package such as RLOADEST, it is recommended that staff undertake a more rigorous (e.g., regression-based, interpolation-based, etc.) gap-filling procedure to compute daily or monthly-scale loads (concentration x discharge) and then aggregate those loads to the annual scale before taking the median.
- In a future update, Board staff may wish to use a combination of the DICU model and either DSM2 or Bay-Delta SCHISM to estimate evapotranspiration, applying their current approach only to those areas of the Delta Mercury TMDL boundary that are outside the domain of the DICU.
- Board staff should consider a different method for estimating potential methylmercury contributions from flooded agricultural soils in the Yolo Bypass, given substantial differences in hydrologic regime between this region and farmed islands elsewhere in the Delta and large discrepancies between the

DMCP source estimates for the Yolo Bypass and the DWR Mercury Open Water Final Report (2020).

- Interannual variability in estimates should be better accounted for by stratifying load and mass balance computations by water year type (or, if more feasible, aggregated water year types, such as dry + critical).

## Assessment of Conclusion 4a: DMCP Review's proposed methylmercury load allocations and waste load allocations are achievable considering current technology, feasibility of controlling the sources, and recommended methylmercury allocation compliance calculations

In my professional opinion, Conclusion 4a is *potentially supported, with caveats*. In making this assessment, I focus on the new proposed allocations of the DMCP Review, excluding the allocations assigned to Delta tributaries to meet the SF Bay TMDL load reduction for the Delta, as there is little scientific evidence to suggest whether these reductions are feasible. For the source allocations within the Delta assigned to meet the aquatic methylmercury goal level, the DMCP Review suggests that these allocations are achievable in many subregions given implementation of current technology such as LID controls, as discussed in summary of the characterization and control studies (Appendix E). Additionally, the expansion of the data analysis to include additional years has shown that WWTFs, and MS4s have already achieved measurable reductions in methylmercury loads (Section 8). However, for some subregions or sources, control and characterization studies did not propose or address the feasibility of methylmercury control options (e.g., the control and characterization study on irrigated agriculture). Further, with respect to the Yolo Bypass, the Independent Scientific Peer Review Report on the Delta characterization and control studies concluded that it is unlikely that the TMDL target would be met.

As Appendix E highlights, while the early characterization and control studies are often promising as to whether proposed allocations are achievable, supporting data are strictly limited. For this reason, it will be important to adopt an adaptive management strategy to document progress toward achieving targets and make adjustments to rebalance allocations if certain types of allocations are infeasible.

Measuring progress toward achieving allocation targets, however, requires adequate monitoring. Recommended compliance calculations are based on a minimum of two data points per year for load: one during a wet period, and one during a dry period. This frequency is likely to be inadequate for estimating annual load contributions. I would

recommend that at least one sample per month is acquired, though for more variable fluxes (or fluxes that might occur in threshold fashion, such as fluxes from flooded agriculture or managed wetlands), this frequency also may not be adequate. I recommend that Board staff determine a more representative frequency of measurement for compliance calculations by resampling existing datasets representative of the entities to which allocations are assigned. For example, to test the adequacy of the currently recommended two sample points, staff could randomly sample from among the data representative of wet and dry parts of the year and compare the resulting two-point-estimated annual flux to the more robustly estimated value.

Compliance is also based on a five-year rolling window, which I support, given the high interannual variability of flows and the fact that allocations are currently based on a central tendency. The choice to adopt a five-year window for compliance determinations is also in line with requests and findings that resulted from the subregional DMCP control studies and is consistent with the basis for compliance with the San Francisco Bay TMDL load allocation for the Delta.

## *Summary of Major Recommendations*

- As the Board moves forward with implementing the TMDL allocations, an adaptive management strategy should be put into place to evaluate achievability of scaled-up allocations and to flexibly adapt the distribution of allocations if scaled-up implementation is infeasible. Monitoring associated with adaptive management will also refine understanding of load reductions achievable with particular technologies in particular places.
- Two data points per year for compliance is unlikely to be sufficiently informative of how annual loads are impacted by mercury control measures. It is recommended that Board staff engage in a data-guided selection process to identify the minimum sufficient number of control points that can robustly estimate annual loads.

## Assessment of Conclusion 4c: Achieving load allocations and waste load allocations for Delta regulated entities (e.g., MS4s, WWTPs, irrigated agriculture) will result in a measurable reduction in Delta aqueous methylmercury concentrations. This conclusion should be considered apart from whether other loads are achieved.

In my professional opinion, this conclusion is *supported*, given that the allocations were computed to achieve the aqueous mercury goal concentration, which is presently well below actual mercury concentrations. It is commendable that Board staff have evaluated multiple scenarios for quantification of present subregion-specific methylmercury concentrations and selected the one that is most protective of human and aquatic system health. Staff have also used robust calculations to estimate the load reduction needed in order to achieve the goal concentration. I have verified that the subregion-specific needed percent reduction values reported in table 8.1 for scenario B correspond with the total estimated reduction values reported in the region-specific tables.

Strong support for this conclusion is predicated on the assumption that annualized load calculations for sources are robust, and that the represented subregional calculations of concentrations are robust. Although more monitoring is always helpful, scenario B does seem to be the best choice for calculating concentrations (though Board staff should be aware that pilot studies to estimate methylmercury concentrations from remote sensing are underway but that they are not currently accurate enough for application). Please see my previous comments on the computation of source input loads (Assessment of Conclusion 3), which I believe could be made sufficiently more robust through the use of means or through improved calculation of medians.

## Assessment of Conclusion 5: The DMCP Review's proposed methylmercury source analysis, allocations, and compliance calculation methods reasonably account for climatic variability

In my professional opinion, this conclusion is *poorly supported* overall. However, support for the conclusion is contextually dependent. For the context of development of the linkage model and achievement of desired concentrations of methylmercury in fish tissue, the conclusion is fairly supported, given that the central tendencies used integrate data over a period of time that is likely representative with respect to the proportion of water year types. However, I will also note that the fish concentration data

used were sampled from the years immediately following the 2012-2015 drought and hence may be skewed to be more representative of long-term dry conditions.

While data from representative water year types were used to develop the annual medians used in the load calculations and mass balances, reporting of central tendencies only masks interannual variability in loads that may ultimately be important in understanding relative contributions of sources and subregions to Delta methylmercury concentrations. As argued in my assessment of Conclusion 3 (p. 4), it would be helpful to report a range of loads derived from analyses stratified by water-year types. This reporting may be as simple as reporting two numbers (representing wet and dry conditions) rather than the single number reported now. Based on this reporting, staff may decide that adjustments may be needed for the allocation strategy. At a minimum, regulated entities would have improved information for anticipating/planning their load reductions across wet and dry years. Reporting how loads vary in extreme wet and dry years will also help better anticipate the impacts of future climate change.

As discussed in the Assessment of Conclusion 3, estimates of aspects of the water balance (particularly evapotranspiration) that are based on scaled-up measurements inadequately account for the effects of climate variability. However, it is challenging to speculate on whether these simplifications are likely to be consequential for the present analysis. A sensitivity test in which different flux variables are perturbed within their likely range would be informative about which aspects of the TMDL analysis are likely to be worth investing time in to improve.

Last, as discussed in the assessment of conclusion 4a, the two annual samples currently required for compliance are unlikely to adequately represent potential intra-annual variability in load due to climate variability. However, the use of a rolling window of 5 years for calculation of the annual median is likely to capture interannual variability.

## *Summary of major recommendations:*

- Load and mass-balance computations should be stratified by water year type to bracket the effects of interannual hydrologic variability. At a minimum, two values, representative of wet and dry conditions, should be reported.
- More than two annual measurements should be required for compliance monitoring in order to adequately capture intra-annual variability.

## Additional References Cited

References cited beyond those in the staff report are detailed below:

Lorenz, D., Runkel, R. and De Cicco, L., 2015. River load estimation, rloadest package. *US Geol. Surv. Software*. https://github.com/USGS-R/rloadest

Robertson, D.M., Hubbard, L.E., Lorenz, D.L. and Sullivan, D.J., 2018. A surrogate regression approach for computing continuous loads for the tributary nutrient and sediment monitoring program on the Great Lakes. *Journal of Great Lakes Research*, *44*(1), pp.26-42.

Runkel, R.L., Crawford, C.G. and Cohn, T.A., 2004. *Load Estimator (LOADEST): A FORTRAN program for estimating constituent loads in streams and rivers* (USGS Techniques and Methods No. 4-A5). https://doi.org/10.3133/tm4A5.

From: Sarah Rothenberg, D.Env.
Oregon State University, College of Health
January 3, 2025

To: Carol Perkins
Manager, CalEPA Scientific Peer Review Program
Office of Research, Planning, and Performance
California State Water Resources Control Board

**Re: Scientific Peer Review of the Scientific Basis of Proposed Revisions to the Total Maximum Daily Load of Methylmercury to the Sacramento-San Joaquin Delta Estuary**

Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence, as follows:

- Conclusion 1: The DMCP Review's proposed linkage model was determined by applying appropriate quantitative data analysis methods for pairing black bass mercury data with aqueous methylmercury data, finding the central tendency of data, and selecting regression models.

- Conclusion 2: The DMCP Review's proposed margin of safety sets an aqueous methylmercury implementation goal by accounting for the uncertainty in the linkage analysis data and modeling methods used to find the protective aqueous methylmercury concentration.

- Conclusion 4.a.: DMCP Review's proposed methylmercury load allocations and waste load allocations are achievable considering current technology, feasibility of controlling the sources, and recommended methylmercury allocation compliance calculations.

- Conclusion 4.b.: Achieving load allocations and waste load allocations for Delta regulated entities (e.g., municipal separate storm sewers (MS4s), public wastewater treatment facilities (WWTFs), irrigated agriculture) will result in measurable and statistically meaningful reductions in fish tissue mercury concentrations. This conclusion should be considered apart from whether other loads are achieved.

- Conclusion 4.c.: Achieving load allocations and waste load allocations for Delta regulated entities (e.g., MS4s, WWTFs, irrigated agriculture) will result in a measurable reduction in Delta aqueous methylmercury concentrations. This conclusion should be considered apart from whether other loads are achieved.

- Conclusion 4.d.: Measurable reductions of mercury in fish tissue will occur as all sources meet the proposed allocations, eventually attaining the proposed water quality objectives to protect human and wildlife health for consumption of trophic level 3 and 4 fish.

- Conclusion 5: The DMCP Review's proposed methylmercury source analysis, allocations, and compliance calculation methods reasonably account for climatic variability.

**Conclusion 1.**
**Summary:** The dataset considered for the linkage analysis originally included 1,203 black bass total mercury concentrations and 2,052 aqueous methylmercury concentrations, collected between 2000-2019 (Excel file Appendix A.1., Figure 1 this review). Data collected prior to 2000 were not included in the Excel file.

```
. tab data_for_bb_eval_subarea

          Subarea |      Freq.     Percent        Cum.
------------------+-----------------------------------
    Central Delta |        396       32.92       32.92
  Moke/Cos Rivers |        164       13.63       46.55
 Sacramento River |        267       22.19       68.74
San Joaquin River |        150       12.47       81.21
       West Delta |         98        8.15       89.36
         YB-North |          3        0.25       89.61
         YB-South |        125       10.39      100.00
------------------+-----------------------------------
            Total |      1,203      100.00

. tab linkage_analysis_aq_data_subarea

          Subarea |      Freq.     Percent        Cum.
------------------+-----------------------------------
    Central Delta |        351       17.11       17.11
      Marsh Creek |         30        1.46       18.57
  Moke/Cos Rivers |        104        5.07       23.64
 Sacramento River |        466       22.71       46.35
San Joaquin River |        146        7.12       53.46
       West Delta |        173        8.43       61.89
         YB-North |        187        9.11       71.00
         YB-South |        475       23.15       94.15
Yolo Bypass North |        120        5.85      100.00
------------------+-----------------------------------
            Total |      2,052      100.00
```

**Figure 1. Output from STATA (version 17.0) for data collected between 2000-2019, including the number of black bass total mercury concentrations (top) and the number of aqueous methylmercury concentrations (bottom) for each subarea (data from Excel file, Appendix A.1).**

For the linkage analysis, this dataset was collapsed to just 5 paired observations, representing the pooled median black bass total mercury concentration and the pooled median aqueous methylmercury concentration for 5 subareas (Central Delta, Moke/Cos Rivers, Sacramento River, San Joaquin River and West Delta). The time period was shortened from 2000-2019 to 2016-2019 because the standard error of the regression (SER) was minimized within this timeframe. The final linkage model (Figure 5.3) estimated the predicted aqueous methylmercury concentration when the black bass

total mercury concentration was 0.258 mg/Kg for standardized length of 350 mm [the Recommended Fish Tissue Implementation Goal (Table 4.5)], i.e., 0.061 ng/L.

**Comments:**
The linkage model from the DMCP Review (in Figure 5.3) is reproduced below with data from Table 5.1 (pg. 53), where *y* is the median aqueous methylmercury concentration, and *x* is the natural log of the median total mercury concentration for black bass. The regression equation in Figure 5.3 is: y = 0.109 + 0.0351 * ln(x), SER = 0.0195. The regression equation in this review is: y = 0.108 + 0.0349 * ln(x), SER = 0.0196. Slight differences may be due to roundoff error in Table 5.1.

```
. regress median_aqueous_mehg ln_median_bb
```

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| | | | | Number of obs | = 5 |
| | | | | F(1, 3) | = 3.97 |
| Model | .001525474 | 1 | .001525474 | Prob > F | = 0.1402 |
| Residual | .001151326 | 3 | .000383775 | R-squared | = 0.5699 |
| | | | | Adj R-squared | = 0.4265 |
| Total | .0026768 | 4 | .0006692 | Root MSE | = .01959 |

| median_aqu~g | Coefficient | Std. err. | t | P>\|t\| | [95% conf. | interval] |
|---|---|---|---|---|---|---|
| ln_median_bb | .0349491 | .0175296 | 1.99 | 0.140 | -.0208379 | .0907362 |
| _cons | .108479 | .0131978 | 8.22 | 0.004 | .0664777 | .1504803 |

**Figure 2. Output from STATA replicating the results in the DMCP Review (Figure 5.3). The variable "median_aqueous_mehg" is the median aqueous methylmercury concentrations (dependent) and "ln_median_bb" is the natural log of the median total mercury concentrations in black bass (independent) (n=5 observations).**

The main strength of this TMDL is the rich data set, which spans 20 years (2000-2019) and includes fish tissue and aqueous samples collected throughout the subareas. By collapsing this data set to just 5 paired observations, much of the information relating black bass total mercury concentrations and aqueous methylmercury concentrations was lost. More sophisticated statistical models, which account for both spatial and temporal autocorrelation, would better reflect the environmental risks due to methylmercury contamination and efficient biomagnification in fish tissue.

Moreover, certain subareas (e.g., Yolo Bypass- South) were entirely excluded from the linkage analysis because the hydrology differed (Section 5.2). It is important to retain these subareas in the linkage analysis in order to more accurately predict the impacts of reducing methylmercury loads to the Delta.

With just 5 paired samples, the study is no longer sufficiently powered to assess the associations between concentrations of aqueous methylmercury and black bass total mercury. Note that the 95% confidence intervals for black bass total mercury

concentrations are wide and include the null (95% confidence interval: -0.021, 0.091) (Figure 2 in this review). See comments below for Conclusions 4.b and 4.d.

Throughout the DMCP Review, the standard error of the regression (SER) (i.e., the root mean squared error, also called the residual standard error) was used as the sole measure of the goodness of fit of a model. For linear regression models (including the linkage model in Figure 5.3), assumptions for the residuals include: mean = 0 and homoskedastic (or constant) variance. If the model assumptions are not met (as is the case for the linkage analysis), the model is not valid, regardless of the SER.

Note that the linkage analysis in the DMCP Review (Figure 5.3) reversed the independent and dependent variables, compared to the 2010 Report. It would make more sense if the black bass total mercury concentration was the dependent variable.

**Conclusion 2.**
**Summary:** To obtain the margin of safety, the DMCP Review re-ran the linkage analysis, utilizing random subsets of the black bass total mercury data and random subsets of aqueous methylmercury data. For black bass total mercury concentrations, a random number of samples was selected (without replacement) ranging from 7 to the total number of samples, while 12 aqueous methylmercury concentrations were randomly selected with replacement for a randomly selected year. Data were regressed using various models; Figure 5.4 includes a histogram of the predicted aqueous methylmercury concentrations obtained after 10,000 iterations. The DMCP Review selected 0.059 ng/L (corresponding to the $5^{th}$ percentile) as the implementation goal. This value represented a 3.3% reduction (margin of safety) from 0.061 ng/L.

**Comments:**
The DMCP Review did not explain why the 10% explicit margin of safety (utilized in the 2010 Report) was not used here. The 10% margin of safety seems reasonable and is comparable to values selected for other Mercury TMDLs in California, including the Sulphur Creek TMDL for Mercury (Cooke and Stanish, 2007) and the Cache Creek, Bear Creek and Harley Gulch TMDL for Mercury (Cooke et al., 2004).

The margin of safety should account for uncertainty in the linkage analysis and modeling methods. Instead, the methods described in Section 5.3 add to the uncertainty, for example, 1) by pairing multiple years of black bass total mercury concentrations with a randomly selected year of aqueous methylmercury data, 2) by inconsistently resampling, i.e., with replacement (for aqueous methylmercury) and without replacement (for black bass total mercury data), and 3) by choosing a different regression model for each of the 10,000 iterations [e.g., linear, power, exponential, non-linear least squares (NLS), generalized additive models (GAM), or logarithmic models], depending on the SER, rather than use the same model as in Figure 5.3.

The range of values presented in Figure 5.4 (approximately 0.05-0.09 ng/L) is evidence against this approach for determining the margin of safety. More than 90% of the

aqueous methylmercury concentrations are actually greater than the original value (0.061 ng/L), i.e., less protective, and hence do not provide a margin of safety.

One way to account for the uncertainty in the model, is to utilize the 95% confidence interval for the beta coefficient. Because the confidence interval contains 0, the result is unachievable.

**Conclusion 4.a.**
**Summary**: This section considers whether waste load allocations (for point sources) and load allocations (for nonpoint sources) are achievable, given the current technology, feasibility of controlling the sources, and compliance calculations.

**Comments:**
My comments are focused on the methylmercury compliance calculations. In Section 8.1.4.1, the DMCP Review recommended using a five-year median annual load for all waste load allocations and load allocations for compliance. The median load is calculated from at least 2 aqueous samples collected annually during the dry/wet seasons, and the median flow volumes. This differed from the 2010 TMDL report, in which the average- not the median- was used for both variables. In addition, in the 2010 TMDL report, WWTFs used a one-year average, not a five-year rolling average to assess compliance. For the DMCP Review, although compliance is potentially achievable, using the median methylmercury load over a 5-year period will likely mask decreasing trends. It is recommended to use the mean or geometric mean.

In the same section (Section 8.1.4.1), an example was provided to assess compliance, including 10 aqueous methylmercury concentrations and 5 flow volumes from 5 consecutive years. One of the aqueous methylmercury concentrations was nondetectable. For samples below the detection level, half the minimum detection level should be used rather than 0 ng/L, as proposed in the DMCP Review. This difference will be important if using the mean or geometric mean.

Compliance will be most challenging for load allocations, including Tributary Inflows, Agricultural Returns and Open Water Sediment Flux, which comprise 57%, 18% and 9.0% of methylmercury gross loads, respectively (2,460 g/year, 771 g/year, and 391 g/year, respectively, from Tables 8.3-8.9), i.e., 84%. These methylmercury loads are much higher compared to NPDES WWTFs and MS4s (i.e., point sources), which contribute just 1% of methylmercury gross loads (44 g/year, Tables 8.3-8.9). There are few details regarding compliance for Tributary Inflows, Agricultural Returns and Open Water Sediment Flux (in Sections 8.1.4.7, 8.1.4.2, and 8.1.4.4, respectively). Hence, it is uncertain whether the load allocations are achievable. If compliance goals are not met, what measures are proposed to offset these significant sources of methylmercury loads?

In Table 8.21, the percent allocations or the methylmercury allocations may be incorrect. For example, for the Cache Creek Settling Basin, the percent allocation is 6.79%; however, the median annual methylmercury load did not differ from the

methylmercury allocation (69.931 g/year), i.e., no reduction, therefore the percent allocation should be 100%. The percent allocation for Cache Creek (above the settling basin) is 6.79%; however, this should be 1.535 g/year (not 4.981 g/year). Also, the methylmercury allocations for the tributaries Ridge Cut Slough, Willow Slough, Upper Lindsey, and Ulatis Creek are incorrect. For example, the methylmercury allocation for Ridge Cut Slough and Willow Slough are 8.447 g/year and 0.168 g/year, respectively; however, these should be 8.005 g/year and 0.667 g/year, respectively (for 6.79% allocation). Please check the calculations and update other tables if needed.

**Conclusion 4b.**
**Summary**: In the section, I was asked to consider whether the load allocations and waste load allocations for regulated entities will result in measurable and statistically meaningful reductions in fish tissue total mercury concentrations.

**Comments**:
My first concern is that the regulated entities (e.g., WWTFs, MS4s, and irrigated agriculture) comprise a small portion of the methylmercury load. As noted for Conclusion 4.a., the allocations for regulated entities comprised just 19% of gross methylmercury loading (Agricultural Returns = 18%, and the sum of WWTFs and MS4s = 1%) (Tables 8.3-8.9). Hence the corresponding reductions in black bass total mercury concentration are expected to be low.

My second- and more important- concern is that the association between aqueous methylmercury concentrations and black bass total mercury concentrations is not statistically significant (Figure 2 in this review). This is attributed mainly to the loss of data, from thousands of observations (see Figure 1 in this review) to just 5 paired observations. Also, certain subareas were omitted from the linkage analysis. With such a small data set, my confidence level is low that the waste load and load allocations for regulated entities will result in meaningful reductions in black bass total mercury concentrations.

Moreover, Marsh Creek, Yolo Bypass- North and Yolo-Bypass South subareas were omitted from the linkage model. The DMCP Review noted that Yolo Bypass areas differed from the other subareas, with high aqueous methylmercury levels and low fish tissue total mercury levels (Section 5.2, page 51). Given that these 3 areas were not included in the linkage analysis, it is uncertain the effect(s) of decreased methylmercury loading on fish tissue total mercury levels.

The timeframe for achieving the implementation goals was not provided.

**Conclusion 4.c**
**Summary**: In this section, I was asked to assess whether achieving load allocations and waste load allocations for regulated entities (WWTFs, MS4s, and irrigated agriculture) will result in a measurable reduction in Delta aqueous methylmercury concentrations.

**Comments**:
As methylmercury loads from regulated entities decline, Delta aqueous methylmercury concentrations will also likely decline.

My only reservation concerns the potential for *in situ* microbial methylation of legacy inorganic mercury, which may also be an important source of methylmercury to the Delta. *In situ* production of methylmercury may offset the declines in methylmercury loads from regulated entities. However, this potential source was not addressed in the DMCP Review- please clarify.

**Conclusion 4.d.**
**Summary:** In this section, I was asked to assess whether measurable reductions in fish tissue mercury levels will occur, including trophic level 3 and 4 fish, as all sources meet the proposed allocations.

**Comments**:
Similar to Conclusion 4.b., the linkage analysis indicated that the association between aqueous methylmercury concentrations and black bass total mercury concentrations was non-significant (Figure 2 in this review). Hence, my confidence level is low that measurable reductions in fish tissue mercury levels will occur as all sources meet the proposed allocations.

As noted above, the timeframe for achieving the implementation goals was not provided.

**Conclusion 5**.
**Summary**: Here, I was asked to assess whether the analyses in the DMCP Review reasonably account for climatic variability.

Climate change was addressed in 2 sections in the DMCP Review, including Section 6.1.13 (Future Conditions) and Section 6.4.1 (Climate Change). The DMCP Review indicated that “the effects of climate change will likely increase methylmercury loading in the Delta” (pg 221). However, the DMCP Review opted not to account for climate change in the margin of safety (pg 69), and noted there was too much uncertainty concerning the impacts of climate change to incorporate potential impacts into their models (pg 218). Instead the DMCP Review suggested several projects to study the effects of climate change on methylmercury mass balance, such as studies of extreme flooding, and studies of erosion and runoff from burned areas (pg 219-220). Moreover, the report cited the timeframe (WYs 2000-2019) for data collection, in which climate change impacts were observed, e.g., in 2015 (rise in sea level) and 2012-2016 drought) (pg 69). The report noted that “the inclusion of more recent years of methylmercury and flow data should account for some of the expected patterns in the next 100 years” (pg 224).

**Comments:**
The linkage analysis utilized a shorter timeframe (2016-2019), not 2000-2019, compared to the methylmercury source analysis. Because the allocations and compliance are based on the linkage analysis, it is not possible to affirm that these calculations adequately accounted for climatic variability. However, if the linkage analysis is revised utilizing all of the available data (2000-2019), then it is more likely that the calculations adequately account for climatic variability.

**References**

Cooke, J., Foe, C., Stanish, S., Morris, P. Cache Creek, Bear Creek, and Harley Gulch TMDL for Mercury, Staff Report. Regional Water Quality Control Board-Central Valley Region, 2004. Available: https://calisphere.org/item/ark:/86086/n2ng4qg5/.

Cooke, J., Stanish, S. Sulphur Creek TMDL for Mercury, Final Staff Report. Regional Water Quality Control Board-Central Valley Region, 2007. Available: https://calisphere.org/item/ark:/86086/n2c24w44/.

**Reviewer information**

Martin Tsz-Ki Tsui
School of Life Sciences, The Chinese University of Hong Kong
Submitted on 18 January 2025

**Item under review**

Staff Report for Scientific Peer Review – Delta Mercury Control Program Phase 1 Review of the Sacramento – San Joaquin Delta Estuary Total Maximum Daily Load for Methylmercury

**Overall comments:**

The data, documents and information are very extensive and carefully crafted, which are aimed at delivering a very important goal to reduce methylmercury (MeHg) levels in fish to protect wildlife and humans in the Central Valley and beyond. The original development of TMDL and the current revision appear to come along and definitely strengthen the scientific basis for the whole purpose. The amount and quality of data are good along with various reasonable assumptions, decisions, and adjustments made by the team. One of the most important conclusions is that it is the upstream tributaries, not local point sources, as the main contribution of MeHg to the Delta which is definitely a scientific accomplishment. However, such clear results also illustrate the difficulty in controlling mercury contamination through regulation of point sources.

**Comments to specific conclusion:**

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Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence on **Conclusion # 1: Concerning proposed linkage model applies appropriate quantitative data analysis methods.**

Under this conclusion, I agree with the exclusion of migratory fish species while the inclusion of three black bass species (largemouth bass, smallmouth bass, and spotted bass) would definitely help fill in data gaps in sites where largemouth bass were not caught or the number of samples was too small. However, it should be noted that these different black bass species (e.g. largemouth bass *vs.* smallmouth bass) can have somewhat different dietary preferences and potentially different methylmercury (MeHg) bioaccumulation patterns. You just cannot simply treat them the same.

For instance, a Lake Ontario study used stable isotope and molecular approaches, and showed that prey items for largemouth bass is much more diverse (3-4 times higher) than smallmouth bass (Nelson et al. 2017), while an earlier U.S.G.S. report found that the relationships between unfiltered MeHg and fish total Hg are much stronger for largemouth bass than smallmouth bass in a range of background aquatic habitats across the U.S. (Scudder et al. 2009). Thus, these results show an important aspect to be considered using different fish species across sites with caution. Another point should be noted that if one species is consistently absent in a subarea, it may imply that its prey items and other water conditions are very different from the others, and thus MeHg bioaccumulation and trophic transfer patterns may be potentially affected as well.

The selection of 2002-2019 data period would definitely maximize the range of fish mercury (Hg) data for black bass species and aqueous MeHg data. Regarding the size standardization, it is a commonly employed technique to examine fish tissue Hg levels across sites since it is well known that fish Hg levels generally increase with fish size because MeHg is very slowly eliminated from the fish body and fish with increasing size may consume higher trophic level prey items and this can accumulate more MeHg. The choice of total length of 350 mm seems appropriate because the fish length ranged from 150-600 mm from these monitoring efforts, which are often referred to as “standardized predator fish mercury concentrations”.

However, interpolation was used for most fish Hg data but for one site (i.e., Sacramento River in 2017) the fish length ranged only from 208-340 mm and extrapolation was used to estimate fish Hg levels in 350 mm, which seems fine but not ideal. In a published study, for example, the choice of the standardized length would be well justified by selecting a specific length near the mid-point among all fish samples examined, in which northern pike was standardized to 550 mm while walleye was standardized to 400 mm in this work at Minnesota (Monson, 2009). Figure below is derived from this work (for northern pike in one single year among sites) to illustrate this point:

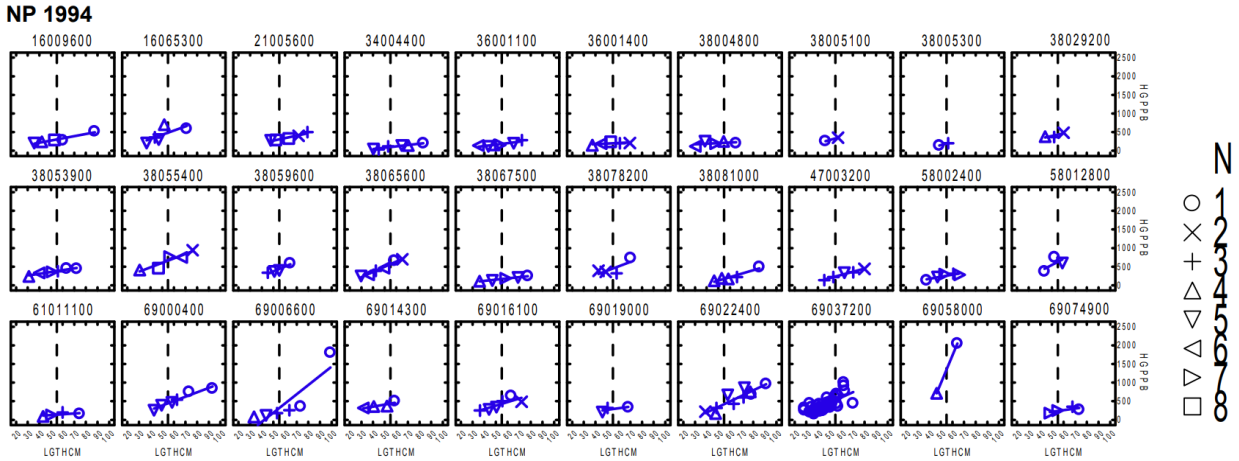


Figure caption: Fish Length (cm) versus Fillet Mercury Concentration (ng/g) by Species, Year, and Lake ID Number. The vertical dashed line is standard length (55 cm for northern pike, NP). Line connecting points are for reference only and were not used to calculate the standard-length mercury concentration. Adapted and modified from Monson (2009).

The regression models (with the lowest SER chosen) seem to provide a logical way to relate Hg in other TLG with TL4 fish (150-500mm) but as shown in Fig. 4.2 of the Staff Report the regression for all TL3 fish (C, D, E) showed non-linear relationships among the seven subareas. I suggest that nonlinearity would imply very different food web structures and/or prey items among these systems, and the “forced” fit of the relationships may just simply generalize the complicated relationships that we do not understand completely. Furthermore, the wide range of Hg contamination (as reflected

in MeHg content in fish) and potentially other pollution may also imply that these sites can have different ecosystem structures that are not known currently, which may compromise the simple comparison of the fish Hg data across sites. Nevertheless, I offer no suggestion to handle this particular situation. The final selection of 0.258 mg/kg in 350 mm black bass would compare well to the 0.3 mg/kg of EPA guideline, and as described it can provide adequate protection to humans and wildlife in the Delta. However, as shown in Table 4.4 the Hg content in the great majority of fish samples 350 mm well exceeded 0.258 mg/kg, as commented below, it will definitely be a big challenge for long-term fish Hg reduction in the Delta.

Regarding the linkage analysis between aqueous unfiltered MeHg and fish Hg concentrations, the selection of aqueous and black bass data from 2016 to 2019 seem to be sufficient and more relevant to the current situations (referring to 2024-2025). I support the provision of four seasonal years of aqueous MeHg data to match the lifespan of the sampled black bass fish. As noted above, the inclusion of smallmouth bass and spotted bass may add some uncertainty in interpreting the fish tissue Hg data, but this may be currently the only way to handle the situation. The use of median, rather than the mean, seems to make more sense since environmental data in these systems tend to be skewed quite a bit, using median can provide a more robust comparison.

The proposed linkage model (Fig. 5.2), however, is non-linear and seems to be different from the literature data. The issue may be less of a concern because board staff mainly focused on the lower end of the curve (x=0.258 and y=0.061), generating values at the low end of the non-linear regression curve between aqueous MeHg and 350 mm black bass Hg data. However, the use of unfiltered MeHg concentrations actually have some inherent problems and I want to elaborate this point below.

First of all, unfiltered MeHg would technically include both dissolved and particulate phases of MeHg in surface water. Surface water samples in the Delta and its upstream tributaries (e.g., Cache Creek) are well known to have variable particulate contributions as a function of hydrology, season, and extreme events (e.g., heavy rainfall, drought, wildfires). I used a set of data from a U.S.G.S. study at Cache Creek flowing into the Cache Creek Settling Basin (CCSB) measuring both unfiltered and filtered/dissolved MeHg (Domagalski et al., 2004), which I plotted their data among particulate MeHg (i.e., unfiltered MeHg minus dissolved MeHg) *vs.* dissolved MeHg:

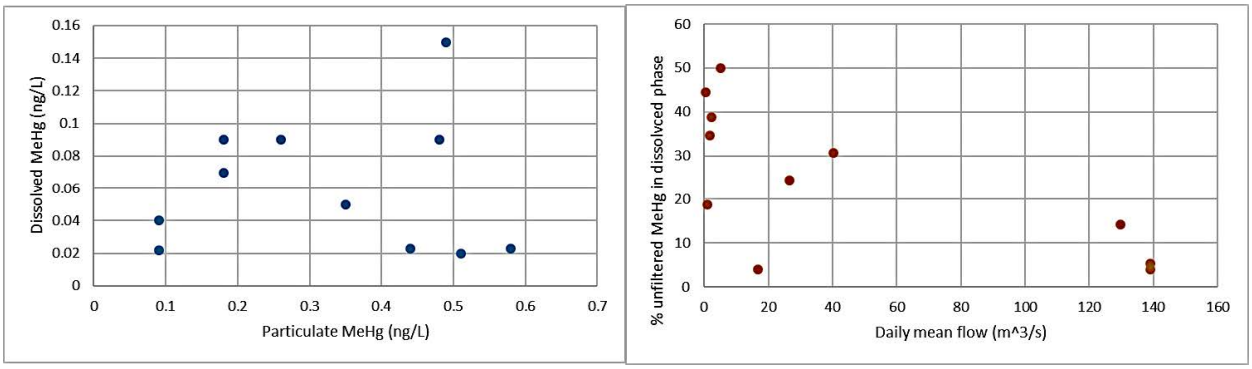


Figure caption: Left – A plot of particulate MeHg (i.e., unfiltered MeHg minus dissolved

MeHg) and dissolved MeHg in Cache Creek flowing into CCSB. Right – A plot of daily mean flow and percentage of unfiltered MeHg in dissolved phase in Cache Creek flowing into CCSB.

As shown in the above figure on the left, it is clear that increasing particulate MeHg in the water column (expressed as ng/L) may not necessarily translate into increasing dissolved MeHg pools. As shown in the figure on the right, it shows that the percentage of MeHg in each sample in the dissolved phase would be highly variable and in general decrease with increasing daily flow, implying that at high flow (e.g., wet season, winter) one may expect predominantly high TSS and high proportion of MeHg associated with the particulate phase.

Second, it is the most important after all and it is the potential difference of MeHg bioavailability among dissolved vs. particulate pools. Since fish take up MeHg predominantly from their diets such as smaller fish and/or invertebrates or detritus, and the lowest trophic levels such as phytoplankton and periphyton must take up MeHg in its dissolved phase only and it would be predominantly bound to dissolved organic matter in freshwater through thiol group (Seelen et al., 2024), and thus it is well regarded that dissolved MeHg should have a much higher relevance to fish Hg bioaccumulation, not the particulate phase. It is probable that some organisms such as filter-feeders can assimilate MeHg from the particulates while the MeHg on the particulates can desorb and dissolve in the water over time.

However, in the system under investigation, much of MeHg in surface water can be associated with particulates (except for periods of base flow), and thus by assessing only unfiltered MeHg we can mistakenly overestimate MeHg bioavailability. To illustrate this problem objectively, another U.S.G.S. study (published in peer-reviewed journal; Chasar et al. 2009) has demonstrated quantitatively that fish Hg correlated strongly and significantly with dissolved MeHg across sites, not particulate MeHg with predatory fish across streams. Thus, this evidence is in line with our understanding how MeHg moves up the food chain from the base of the food web largely through its dissolved pathway.

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Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence on **Conclusion # 2: Concerning proposed margin of safety**.

The derivation of 0.061 ng/L of unfiltered aqueous MeHg appears to be already at the low end of the aqueous MeHg data as shown in Fig. 5.4, being approximately 5-10th percentile. The deliberate selection of 5th percentile by the board staff would further reduce the desired aqueous MeHg to 0.059 ng/L which would definitely provide further protection. The reduction from 0.061 to 0.059 ng/L would result in 3.279% (or 3.3%) of margin of safety.

Nevertheless, on an analytical and technical basis for aqueous MeHg measurements, there is essentially “no difference” for 0.059 or 0.061 ng/L since aqueous MeHg

measurements are known to have much higher variability than its corresponding total Hg measurements, the variations are often up to 20% among replicate analyses, and thus a water sample reported to be exactly 0.059 ng/L can vary from as low as 0.047 ng/L to as high as 0.071 ng/L, on a theoretical basis. From another perspective, surface freshwater with an unfiltered MeHg level at 0.059 ng/L (even ±20%) is deemed to be among the background environments, and thus in many cases the fish (or black bass 350mm) should not exceed the threshold tissue concentration of 0.258 µg/g wet wt.

For the approaches employed by the board staff regarding resampling and the execution of modeling exercises for 5 years of data, I believe the approaches are appropriate. In the future, I would strongly recommend independent verification by collecting field samples (water and fish) and “plug” these new field samples into the constructed relationships to validate the models and approaches used here.

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Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence on **Conclusion # 3: Concerning proposed water balance and methylmercury mass balance**.
This section is definitely very challenging as it needs to account for all sources and losses of MeHg within the Delta. I do not think that any Hg scientist can cover all aspects of these processes!

The calculation of mass load (equation 6.1) would definitely increase the uncertainty as it includes both concentration and water volume, both terms subject to its own individual variations. Nevertheless, Table 6.4 provided a very comprehensive database (despite being subject to a large uncertainty), demonstrating the importance of tributaries in contributing MeHg to the Delta along with open water sediment flux, as opposed to the much minor contributions from point sources such as waster and urban runoff (combined for less than 1.5%). This is a very impressive exercise in showing their importance quantitatively, and setting up an objective basis for calculating the allocations that as long as the aqueous MeHg levels discharged from point sources do not exceed 0.059 ng/L they should not be a major concern. Fig. 6.4 further shows that the estimation for the importance of tributary inflows would be elevated to >70% while the importance of (nontidal) wetlands are much reduced from ~20% in 2010 TMDL Staff Report to less than 5% in DMCP Review, and I would think this may be not entirely correct, which would largely depend on the relative aerial coverage of wetlands within the Delta and other factors.

Regarding atmospheric deposition, wet deposition of MeHg has been demonstrated as MeHg can be (barely) detectable in rainfall and snowfall samples. For total Hg, dry deposition is now regarded as the dominant pathway over the wet deposition. For MeHg, I think dry deposition of MeHg can exist and serve as another source of MeHg such as those through foliar uptake and/or in-vivo methylation of inorganic Hg within the foliage which have been recently postulated and demonstrated (Tabatchnick et al. 2012; Stinson et al. 2024). In other whole ecosystem studies, for example, St. Louis et al. (2001) showed a significantly higher atmospheric deposition of MeHg in forested areas

than open areas in proximity since litterfall contributed about half of total deposition, illustrating the real existence of dry deposition pathways for MeHg but we cannot confirm the possibility of methylation within foliage and/or litter. I do not know the exact numbers in the Delta but this source may need to be considered in the future.

For the loss pathways of MeHg, it is interesting to note the stark differences between tidal and nontidal wetlands. While I agree that particle settling can be a major loss pathway of MeHg from the surface water, the MeHg buried in the sediments may not be actually lost and may stay within "the Delta" for a while. I agree with the importance of particle settling because much of the aqueous MeHg can be associated with particulates in these aquatic ecosystems.

However, for photodegradation I am not quite sure if it can account for 25% of MeHg loss annually, because if much of MeHg is bound to particulates, I wonder if they can really be photodegraded by sunlight (e.g., the high turbidity in waters may actually attenuate much of sunlight already). I am not aware if there are literature explicitly showing the photodegradation of MeHg associated with mineral particles but there is at least one study showing the potential sunlight-mediated degradation of intracellular tissue MeHg in marine phytoplankton species (Kritee et al. 2017). The study by Gill (2008c) suggested essentially no difference for photodegradation of MeHg among unfiltered and filtered samples. However, by assessing its Fig. 5, one can find that the rate of MeHg loss would be similar among these two sample types but my speculation is that the photodegradation still occurs predominantly through dissolved phase in the unfiltered sample, because the two slopes looked almost identical. In fact, the slope is even higher for filtered samples (-0.00348) compared to that of unfiltered samples (-0.00288), which I am not sure if the presence of particulates may reduce sunlight penetration and/or reduce MeHg photodegradation in the dissolved phase.

If we only assume that MeHg photodegradation occurs mainly in the dissolved phase, then photodegradation of MeHg may actually occur much less extensively in the surface waters within the Delta due to high turbidity especially during high flow conditions. Another piece of evidence can come from the novel use of stable Hg isotope tools, in which the magnitude of mass-independent fractionation can help indicate the degree of surface water MeHg photodegradation (principally via dissolved pool). From the limited research in the region (e.g., San Francisco Bay by Gehrke et al. 2011 and upstream tributaries by Donovan et al. 2016), we can see that photodegradation is somewhat limited compared to other much clearer freshwater systems (e.g. Great Lakes).

The overall MeHg "budget" shown in Fig. 6.29 appears to be reasonable though there can be under-/over-estimation in various items, but I concur with the board staff's view that the dominance of tributary inflows (6.7 g/day) to the Delta and should be the main target to regulate for any substantial and meaningful MeHg reduction.

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Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence on **Conclusion # 4.a: Proposed**

**load allocations and waste load allocations are achievable**.
All the values for load allocations (LAs) and waste load allocations (WLAs) are reasonable and based on the numeric target of aqueous MeHg concentrations (0.059 ng/L; or 0.258 mg/kg in black bass 350 mm). Regarding whether they can be achievable, it would be hard to tell but we can look at each one, based on the summary in Table 8.22.

For LA, there is basically 100% allocation for atmospheric deposition, open water sediment flux, tidal wetlands, and Cache Creek settling basin (CCSB), and this is largely correct that these are mostly non-point sources and even natural sources of MeHg. As addressed in Appendix E.3., it is possible to reduce the inputs of Hg and MeHg from CCSB to the Delta by increasing the sediment trapping capacity. In a recent study examining Cache Creek and a small tributary of Putah Creek (Cold Creek), it was shown that the total Hg concentrations in the suspended sediment from Cache Creek (201–334 ng/g) would be roughly 4 times of those suspended sediments in Cold Creek (56–88 ng/g) (Ku et al. 2024), implying that trapping these suspended sediments from Hg point sources originated from upstream Cache Creek (e.g., Sulphur Creek), by CCSB, would be very crucial in preventing these high Hg materials flowing into the Delta, get methylated, and/or get further transported to downstream such as San Francisco Bay.

For other LAs, agricultural returns would need quite a “deep cut” in order to meet the allocated amounts (e.g., from 234.578 g/yr to 57.211 g/yr for Central Delta), and it would be quite difficult to achieve that unless there is a drastic change in agricultural practices in these sites (e.g., complete eradication of agricultural wetland habitats). Another one is tributary inflows and it is again very difficult to achieve that (e.g., from 449.444 g/yr to 30.523 g.yr for YB-N and S), and according to different suggestions, trapping of suspended sediments seem to be a viable option because much of the Hg and MeHg in water are associated with particulate in these systems especially during high flow conditions, which may be achieved by CCSB. However, for other tributaries, I am not sure how the Hg and MeHg can be removed when the stream is draining into the Delta, and as mentioned, there should be tributary mercury control programs in place especially those with high allocations such as Sacramento River.

Among WLAs, the largest contributions would be derived from dredging and they have been given 100% allocations for the current load. I think there can be ways to mitigate or reduce MeHg release or production upon sediment dredging. For other WLAs, their contributions are very minor, and the current allocations are appropriate considering also future population growth.

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Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence on **Conclusion # 4.b: Proposed load allocations and waste load allocations should result in concentration reductions in fish tissue**.

I think I should have answered the question in Conclusion 4.c. first because in order to achieve the LAs and WLAs we should first significantly reduce aqueous MeHg concentrations (but still not sure if we can arrive at the proposed goal of 0.059 ng/L) before any meaningful reduction of fish Hg levels. The LAs and WLAs, if achieved, should significantly reduce aqueous total Hg and potentially MeHg, and thus based on that I agree that it will result in measurable and significant reductions in fish Hg levels.

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Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence on **Conclusion # 4.c: Proposed load allocations and waste load allocations should result in aqueous concentration reductions**.

Compared to the question from Conclusion 4.b. above, this seems to be a more straightforward one to deal with. With all the LAs and WLAs achieved, there are definitely reductions of aqueous MeHg in the Delta. Based on Table 8.11, there must be a very significant reduction to achieve the proposed goal of 0.059 ng/L. Because most of our controls would be on total (inorganic) Hg, not MeHg directly, and thus the final outcomes are still highly variable. For example, you can have low total Hg in a system but relatively high MeHg if the conditions are highly favorable for Hg methylation and not favorable for degradation of MeHg (e.g., dense canopy blocking sunlight into the streams). Nevertheless, my prediction is that achieving these allocations will result in a measurable decline of aqueous MeHg.

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Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence on **Conclusion # 4.d: Proposed water quality objectives are attainable**.

I believe this is the most important question after all if these efforts and Hg control can translate into meaningful results, i.e., reduction of fish Hg to a safe and acceptable level !!! As explained in my comments above, I believe that the consideration of unfiltered MeHg is not the most accurate way to reflect the bioavailable pools of MeHg in the water for the food webs (and thus fish uptake). However, if this is true here, then say there is more than 50% of MeHg in the surface water associated with suspended particulates, then the bioavailability and its potential risk should be even lower than just glanced from the number, and thus achieving the allocations should likely result in a significant reduction of fish Hg content.

While I am not doubting the reduction of fish Hg levels upon decreasing aqueous MeHg (filtered and particulates), I am actually more concerned whether we would see similar degree of reduction of fish Hg content among the subareas because the fish and aqueous MeHg relationships are NOT linear among sites, but in the real world within each ecosystem I think fish Hg would respond in its own way with aqueous MeHg if the food web structures in site are relatively stable over time. To complicate the situation, by achieving the allocated amounts, you are reducing total (inorganic) Hg and other

conditions (e.g., sulfate, organic matter) may not be changed correspondingly, and thus whether you can reduce MeHg and thus fish Hg at the same degree or not, it is really hard to predict (but is a great scientific question to work on). Thus, I question whether there would be the same amount of beneficial outcomes (i.e., fish Hg reduction) per unit decrease of aqueous MeHg across sites within the Delta.

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Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence on **Conclusion # 5: Proposed source analysis, allocations, and compliance calculation methods reasonably account for climatic variability**.

Climatic variability would be more difficult to predict than those of fish Hg-aq MeHg-allocation relationships because I think our knowledge on climatic variability and how Hg cycling is impacted by climatic changes are still limited at the moment. For example, wildfires (common in California) can drive extremely high particulate Hg (Ku et al. 2024) and may enhance downstream MeHg bioaccumulation in some invertebrates (Baldwin et al., 2024) as food webs have been shown to be restructured following wildfire events (Kelly et al. 2006) which as we know can significantly influence MeHg trophic transfer pathways and fish Hg levels. As Hg cycling and MeHg formation are heavily impacted by hydrology, the consideration of the dry and wet seasons is very important. The current calculation methods already accounted for wet and dry years as depicted in Fig. 6.2 and Fig. 6.3 that there have been extreme wet and dry years in these water years. Therefore, I think the current calculation methods can reasonably account for climatic variability but may not capture all potential/extreme consequences leading to unknown Hg cycling processes in the future under a changing climate.

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-- End of review comments --

Review of DMCP

Peter Weiss-Penzias, Researcher and Lecturer, UC Santa Cruz

~~12/16/2024~~
2/26/2025

Note that is an amended original report in response to clarity sought by Central Valley Regional Board (RB5) regarding findings for Conclusion #4d.

I am reviewing Delta Mercury Control Program (DMCP) Staff Report and the findings reported therein.

Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence.

In general, the DMCP Review's linkage analysis, methylmercury source analysis, and methylmercury allocations described in the TMDL that I reviewed is a substantial and well-written document. The conclusions are based on years of scientific research. The assumptions used are generally highly defensible. I generally accept this report in its current form and I only have minor suggestions. In my review, I have considered all the points for each statement, and addressed the conclusions as written in the letter of request.

*Conclusion # 1: Concerning proposed linkage model applies appropriate quantitative data analysis methods.*

Section 4.1: Perhaps additional language fully defining and explaining what the significance is of using the 350 mm standardized Hg concentration should be added.

I agree that keeping the Sacramento subarea in the linkage analysis is important and a good justification for using all available black bass species (p 37, 47)

When multiple years are included in the black bass standard and evaluation, there are some years in some locations with non-representative data. I agree with the justification for whether the extrapolated concentration of the 350 mm standardized black bass mercury concentration should be included in the analysis (p 38, 47).

I agree with the method to group aqueous Hg concentration data (pooling for the lifetime of the fish).

I agree with grouping all years and expressing the central tendency of the data as a median.

The comparison of regression models adds confidence to the report's findings.

Using the Standard Error of Regression as a criteria statistic for selecting the best model is an important contribution to the field of environmental science.

Even though there are only 5 data points in Figures 5.2 and 5.3, each of these data points represents the central tendency of other data sets and I think the linkage equations generated have scientific merit.

I agree with the exclusion of the fish Hg concentrations from Marsh Cr, YB, and Cache Creek – not enough data and non-representative flows (Table 5.1).

*Conclusion # 2: Concerning proposed margin of safety.*

Page 56 – I understand the benefit of randomly resampling the data to find the probability distribution and select criteria concentration. Perhaps the justification for all the details chosen by the Board should be explained a bit better. Random sampling “with” or “without” replacement is a bit murky. In the first paragraph where it states that Board staff created a custom function, a citation should be used. What is the general approach? I am not an expert in this area, so the explanation reads a little like “take our word for this”. I see the footnotes below but they are hard to decipher. Would an equation help to explain the procedure you used?

Otherwise, I think the general finding of 0.059 ng/L as the aqueous MeHg implementation goal is reasonable, and an important finding.

I also think the statement “margin of safety” on page 57 should be more clearly defined or described. In particular, what calculation was used to reach this value of 3.3%?

*Conclusion # 3: Concerning proposed water balance and methylmercury mass balance (Source Analysis).*

The water balance (Table 6.3) is presented clearly.

Page 77, please include a reference for the “whole ecosystem monitoring” technique of determining MeHg sources by landcover type.

I agree with the methods of calculating the MeHg loadings for the tributary inflows (sec 6.2.1).

The MeHg load calculations look good to me.

The revised (lower) open water flux rate of 4.5 ng/m2/day is acceptable (p 103). It would be clearer if the process of MeHg fluxing from the sediments was spelled out in more detail. Sometimes the sediments are a sink for MeHg? I assume that is what the -58 to 120 ng/m2/d refers to on p 103.

It is a bit unclear how the atmospheric deposition load in the DMCP review was 141 g/y, which is ½ the load found in the 2010 report (p 160) but according to figure 6.4,

the size of the atmospheric deposition bar is smaller for the DMCP review compared to the 2010 TMDL staff report.

In general Section 6, the source analysis is very thorough. The text, tables, and figures are clear.

Section 6.3 on methylmercury losses is clearly written.

Figure 6.15 has some cross-hatching on the bar within the 2010 report category that is not identified in the legend.

Figure 6-29 is especially nice and encapsulates a lot of work and good science.

*Conclusion # 4.c: Proposed load allocations and waste load allocations should result in aqueous concentration reductions.*

Section 8: the use of medians instead of averages and using a longer dataset compared with the 2010 staff report are important improvements in the DMCP report.

Table 8.1 It is unclear why Delta TMDL Subareas are listed twice. Is the only difference the Dataset Ranges? Also a reminder of why some calculated % reductions used pooled medians vs. regression medians would be helpful.

I agree that the proposed load and waste load allocations should result in aqueous MeHg concentration reductions.

*Conclusion # 4.d: Proposed water quality objectives are attainable.*

I have reviewed Conclusion 4d and Section 8 of the report and I do agree with the conclusion "that as the median concentration of methylmercury in each Delta TMDL subarea decreases to the aqueous methylmercury implementation goal, the targets for fish tissue will be attained."

A minor suggestion is to include a phrase that indicates that this conclusion is based on your load and assimilation calculations and the state of knowledge about mercury biogeochemistry.

~~Section 8: In the “key points” section at the end please address the issue of whether the water quality objectives are attainable. The phrase is used: “Board staff anticipates” this could be justified for the reader. Why is it anticipated? Based on the calculations and the known Hg science?~~

*Conclusion # 5: Proposed source analysis, allocations, and compliance calculation methods reasonably account for climatic variability.*

I agree with this, since the calculations were made over multiple water years to account for some degree of climatic variability. I don’t think this review is an exhaustive examination of the effects of climate change on the Delta mercury cycle, however.

The use of medians is justified for grouping aqueous methylmercury data.