Delta Mercury Control Program Phase 1 Methylmercury Control Studies Independent Scientific Review

A report to the Delta Science Program

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Delta Stewardship Council
Delta Science Program

Table of Contents

1. Executive Summary

As part of The Sacramento-San Joaquin Delta Mercury Control Program, this Independent Scientific Review considered seven Phase 1 Control Study Reports to evaluate compliance with approved work plans, and to assess the scientific validity of the results and conclusions of the work. In addition to reviews of each Control Study report, the Review Panel was also charged with providing an overall assessment of the Control Studies to inform an Advisory Panel that will ultimately guide the implementation of the Mercury Control Program.

The Control Studies reviewed all generally complied with their approved work plans, however the strength of the conclusions were compromised by relatively weak/sparse data sets and a lack of inclusion of relevant ancillary data. The Review Panel found that there was a range in scientific rigor and quality of the Control Studies, which in some cases impacted the ability to extend findings to the Delta. The Review Panel found that many Control Studies were more limited in their ability to extrapolate from pilot-scale studies/small sample sizes than the report authors reported; the Review Panel urges caution in drawing regional conclusions from some of the Control Study Reports. That being said, the Control Studies all report on methylmercury loads that are very small in the context of the overall methylmercury budget for the Delta. None of the methylmercury sources reported were out of alignment with the original Total Maximum Daily Load Waste Load Allocations (TMDL WLAs), and more often than not, are already (or are forecast to be) significantly below current WLAs. None of the facilities/areas can reduce their methylmercury loading to meaningfully offset any other sources of methylmercury in the Delta. The Review Panel’s Overall Assessment makes several key observations and recommendations:

1) Future climatic and hydrologic conditions in the Delta were handled in a rudimentary way (if at all) in the Control Studies, but the Review Panel recognizes that this is beyond the scope of individual reports. The Review Panel recommends that the Central Valley Water Board utilize a climate change vulnerability/adaptations assessment such as is in development by the Delta Stewardship Council as a framework for climate change adaptation that agencies and report authors of all Control and Characterization Studies can respond to in a consistent fashion.

2) The understanding of mercury biogeochemistry is sufficient to link mercury discharges and mercury in fish in the Delta; however, the Review Panel concludes that there is an overly simplistic view of this link implicit in the TMDL strategy. Not all methylmercury sources will have an equal or proportional impact on methylmercury in fish in the Delta, and some sinks of methylmercury in the short-term may be sources in the medium or long-term.

3) The Control Studies report on a collectively very small proportion of the total methylmercury load to the Delta, consistent with the original TMDL estimates and WLAs. Despite this, the Review Panel is of the opinion that continued monitoring and reporting is of value, as it will offer important insights into the impacts of climate, land-use and population change on mercury loading to the Delta.

2. Acknowledgments

The Independent Review Panel wishes to acknowledge the valuable contributions of Dr. Spencer Washburn, Postdoctoral Researcher at the Smithsonian Environmental Research Center, Edgewater, MD for his contributions to Control Study Reviews and overall Panel activities in support of Panel Member Dr. C. Gilmour. The Review Panel also wishes to acknowledge Dr. Yumiko Henneberry of the Delta Science Program for expertly coordinating the review process, participating in Review Panel teleconferences, serving as a critical liaison between the panel and the Delta Stewardship Council, and for providing feedback on draft versions of this report.

3. List of Abbreviations

ABC: Airport Business Center

BACI: Before-After-Control-Impact

BMP: Best Management Practices

LID: Low-Impact Development

MeHg: methylmercury

MS4: Municipal separate storm sewer systems

NPDES: National Pollutant Discharge Elimination System

ROWD: Report of Waste Discharge

SSQP: Sacramento Stormwater Quality Partnership

SUA: Stockton Urbanized Area

TAC: Technical Advisory Committee

THg: Total mercury

TMDL: Total Maximum Daily Load

WLA: Waste Load Allocation

WWTP: Wastewater Treatment Plant

4. Background, Intent and Scope

The Sacramento-San Joaquin Delta (Delta) is identified in the Clean Water Act's Section 303(d) list of impaired water bodies due to harmful levels of mercury in some fish eaten by people and wildlife. In response, the Central Valley Regional Water Quality Control Board (Regional Water Board) developed a Delta Mercury Control Program (Mercury Control Program) to control mercury and methylmercury in the Delta. The Mercury Control Program was adopted by the Regional Water Board as an amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) in April 2010. The Mercury Control Program received its final approval from the US EPA on 20 October 2011.

(From the Independent Scientific Review Panel Charge)

As part of the Water Quality Control Plan, entities responsible for reducing methylmercury in surface waters were required to develop control and characterization studies, with characterization studies for source types requiring additional information before appropriate control plans could be developed.

4.1. Review Panel Charge and Approach

This report of this independent scientific review panel (Review Panel) is the letter review of the reports of control studies from point sources approved by the Regional Water Board. This report provides assessments of compliance with approved work plans and evaluations of the scientific validity of studies' findings. A subsequent report on characterization studies will be conducted in 2020. These reports will ultimately inform an Advisory Panel that will provide recommendations on the Phase 2 implementation of the Mercury Control Program.

The Review Panel was asked to address whether or not the work plans were successfully completed, and to identify and synthesize key findings to inform the Advisory Panel. The Review Panel was **not** to develop recommendations for revisions to the final control study reports. The detailed comments on each control study report are presented in a format deemed most applicable by the Report reviewers, however most are structured around the set of questions laid out for the Review Panel in the Charge, as is the Overall Panel Assessment.

For this review, the Review Panel was provided with the following Control Study reports and supporting materials:

1. City of Stockton and County of San Joaquin (Urban Stormwater)

2. Sacramento Stormwater Quality Partnership (Urban Stormwater)

3. Contra Costa Clean Water Program (Urban Stormwater)

4. Port of Stockton

5. City of Sacramento (Urban Stormwater and Wastewater Combined)

6. Central Valley Clean Water Association (Municipal Wastewater)

7. California Department of Corrections Deuel Vocational Institution (Municipal Wastewater)

The Review Panel Chair assigned first and second reviewers to each Control Study Report. In the event that there was not convergence of opinion about a Study Report between the two reviewers, a third reviewer was to conduct an additional review. In no cases did a third reviewer need to be invoked as part of the review process. The reviews for the individual Control Study Reports are included verbatim in Section 6 of this Report.

The Review Panel held an initial organizational teleconference, and a mid-point teleconference to present and discuss each Control Study Report. During the mid-point call, overall assessments were presented. Final individual reports were completed by the lead reviewer for each Study Report and provided to the Lead Author for incorporation into this document. Information from individual report reviews and in depth discussion from the review mid-point teleconference were incorporated into the Overall Review Panel Assessment. The Panel reviewed a draft of this final report prior to submission to the Delta Stewardship Council.

5. Overall Review Panel Assessment of Phase 1 Control Studies

As part of its charge, the Review Panel was asked to consider a series of overarching questions to inform the Phase II Advisory Panel. The issues raised by these questions encompassed most (if not all) of the control studies, and as such are presented globally, rather than on a per study basis. The Control Study Report authors all made recommendations that were considered by the Review Panel and incorporated into this overall assessment.

1) What additional information would be needed, if any, to adapt the studies' results for changes in climatic and hydrologic conditions in the Delta?

The Review Panel recognizes this as a critical question given that climate (i.e. long term trends in temperature and precipitation) is a first order control on both the biogeochemical cycle of mercury *and* the hydrology of the Delta, both of which are linked in the context of load calculations. Temperature regulates microbial metabolism and impacts rates of *both* microbial Hg methylation and demethylation, although specific relationships are not quantified and may be highly variable depending on other regulating factors. Indeed given that demethylation can also be (photo) chemically regulated, the controls on future net methylmercury concentrations are highly uncertain. Changes in hydrology can directly affect Hg methylation (e.g. through changes in the timing and amplitude of wetting and drying cycles that has been shown to increase the release of inorganic Hg and the production of MeHg), and through changes in mass transport. All of these combine to influence TMDL estimates and measurements in an interactive and almost certainly non-linear way. The Review Panel is cognizant of the fact that a mechanistic assessment of climate change vulnerability for the Delta is in its early days and as such, climatic and hydrologic boundary conditions within which future TMDL predictions are to be made (e.g. estimates of changes in regional precipitation, magnitude of extreme events) are currently not defined.

The Control Study Reports that were considered by this Review Panel addressed future changes in climatic and hydrologic conditions to varying degrees, but many make no mention of climate change at all. The Review Panel is of the opinion that all of the Control Studies should have at least discussed future climate scenarios as an uncertainty, however given the lack of quantitative information around which to bound such discussions, the Panel believes that it may be an unreasonable burden to have agencies independently develop sophisticated assessments of the impacts of climate change on their specific operations, particularly if different boundary conditions are being considered. The Review Panel recommends that the Central Valley Water Board put forward a framework for climate change adaptation that agencies and report authors of all Control and Characterization Studies can respond to in a consistent fashion. The Central Valley Water Board could work with agencies already undertaking such exercises. For example, the Delta Stewardship Council is currently developing a Climate Change Vulnerability Assessment and Adaptation Strategy that could be of high utility. The integration of this kind of framework into the implementation of future TMDL efforts will not only provide a consistent framework for all agencies, but will also help estimate the level of scientific uncertainty around future load estimates, which is currently undefined.

In addition to climate change, land-use and population change will impact the hydrology and water quality of the areas of interest. Some Reports address fixed footprints (e.g. Port of Stockton; Duell Correctional Facility) in which case these changes are not relevant, but other Studies either encompass large mixed land use regions, and/or extrapolate findings from single control case studies to broader regions, including entire municipalities in an unsupported way. In most cases, Reports focused on the specific outcomes of the Control studies and did not address how the Control approaches might be applied across broader geographic regions. For example, given the varied nature of landcover in urban regions, on what basis can we presume that control measures implemented as a case study in one small subcatchment would scale proportionally over an entire region? Given that the Control Studies focusing on Low Impact Development approaches demonstrated that they are effective in helping to reach TMDL concentrations (if not loads), what evidence do we have that LID approaches are going to be adopted broadly across the Delta in a way that considers future climate, land-use, and population changes? No Control Studies adequately capture the uncertainty of either the estimates for the studies undertaken, or the uncertainty that would need to be considered for a spatial extrapolation.

As changes in hydrology will likely be the most pronounced impact of climate change in the Delta, the Review Panel is concerned that Permit Holders have generally not demonstrated the capacity to make good water flux measurements with which to couple mercury and methylmercury concentration data to calculate loads. In some Control Study reports (notably stormwater studies), there are no water fluxes reported at all despite investment of time and effort to develop composite sampling techniques (which presumably were done in order to be flow-weighted). Given that high quality water flux measurements are as critical as a precise and accurate measurement of mercury concentrations in water samples when calculating loads, Permit Holders should be required to undertake both with equal rigor in order to contribute scientifically-defensible load estimates to guide the TMDL process.

2) Do we have enough scientific understanding of methylmercury sources and processes in the Delta and its tributaries to implement controls to meet current fish tissue objectives? If not, what additional information are needed and what additional studies should be undertaken to obtain this information?

This question cannot be fully addressed until the Review Panel considers both the Control Studies (considered here) and the Characterization Studies (2020). The response here is only with consideration to the Control Studies.

With the exception of Reports from Contra Costa and the Port of Stockton, the control studies reviewed here did not consider the methylmercury sources in their geographic areas of consideration (e.g. the various potential sources where methylmercury is formed that is delivered to the INLETS of a WWTP or a stormwater detention basin). Given the relatively small contributions to the overall load one could argue that further investigation into methylmercury sources associated with the control studies are not warranted, however the Review Panel is of the opinion that additional information is needed in order to fully evaluate sources of methylmercury in the Delta and the processes that regulate them.

A) Several control studies have advocated for Low Impact Development (LID) storm runoff management strategies (detention basins, wetlands, biological barriers) to achieve or exceed WLAs. The case has largely been made based on the removal of total mercury through sedimentation. Panel Reviewers wish to highlight that the sedimentation of inorganic mercury may deliver bioavailable mercury to sites of methylation (e.g. submerged, or wet/dry/wet sediments), and study design weaknesses (either by design or in terms of duration, frequency, or timing of measurements) precluded the longer term quantification of both inorganic mercury and methylmercury load reductions. This uncertainty could be reduced with continued systematic monitoring of both dissolved and particulate mercury species (see next point).

B) The Review Panel is aware that the current TMDL sets target concentrations for methylmercury in *unfiltered samples.* The lack of requirement to measure (and sometimes failure to report in Control Studies) both particulate and dissolved methylmercury concentrations makes it difficult to connect ‘grab’ sample concentrations to overall fluxes when there is no information about particle load. It also makes it impossible to link these more recently collected data to existing data when no critical ancillary data (e.g. Total Suspended Solids) is reported, despite the fact that these measurements were in some cases made as part of the Control Study. The Review Panel is of the opinion that the reporting of methylmercury concentrations on particles on a dry weight basis, or at least calculating particle associated (methyl)mercury as the difference between total and dissolved (methyl)mercury, would greatly improve the ability to understand methylmercury sources and processes in the Delta since particle transport (and settling) is a significant removal mechanism. This data should be co-reported with the same measurements for total mercury such that the fraction of total mercury as methylmercury, and the inorganic mercury fraction can be calculated.

C) In the context of the Control Studies that were in whole or in part dealing with the human-built environment, additional information is required to link land-use (e.g. percent impervious cover) and the timing of development to methylmercury loads (concentrations). The Control Study from the Sacramento Storm Water Quality Partnership concluded that the actual characteristics of the land-use change (in an urban context) was less impactful on methylmercury loads than WHEN the land-use change occurred. This is in contrast with other Control Studies where neither the land-cover characteristics, nor the timing of land-use change, were considered. Given that the land-use of the Delta will not be static over the coming decades, the Review Penal is of the opinion that it is imperative that the land-cover characteristics and development history be considered when 'case-specific' Control Studies are being extrapolated to much broader geographic areas with diverse land-uses.

D) A system wide-synthesis or modeling exercise of both methylmercury *and* inorganic mercury sources and sinks that could be subsequently methylated should be undertaken. The Review Panel has concerns that the TMDL exercise draws a relatively simplistic link between the source of mercury (or methylmercury) and mercury concentrations in fish tissue in the Delta. Both methylmercury that is discharged directly, and inorganic mercury that may be methylated in receiving waters may ultimately be bioaccumulated. More information is required about the relative sources and contributions of methylmercury that is then bioaccumulated in biota, rather than presuming that all loads are created equal, and contribute proportionally to fish tissue mercury concentrations. The removal of methylmercury (in either the dissolved or particulate phase) is far from the only control mechanism required to satisfy methylmercury TMDL requirements. Methylation of inorganic mercury that is associated with either sedimentation and storage in the control measure (e.g. in a stormwater detention system), or downstream may also contribute to mercury in fish in the Delta.

E) The WLAs addressed in the control studies were derived from modeled loads as part of the TMDL exercise in 2010. It is unclear to the Review Panel what agency will take the lead in maintaining and updating the TMDL modeling framework, however it is clear that, based on the Control Studies, load estimates need to be updated and refined. As with the Review Panel's suggestion that climate change projections be promulgated to Permit Holders and study authors for consideration in planning and risk management, the Panel also believes that it is not the responsibility of individual studies to conduct these analyses; an updated TMDL framework will ensure consistency among reports and a common set of conditions within which to provide data.

3) Taken holistically, how do the study results encourage adjustments to the allocations?

The Control Study results suggest that the TMDL allocations to these sources may not be in alignment with the size of their contributions. The Review Panel agrees with the findings of the Control Studies taken together - LID approaches to stormwater management, and planned upgrades to wastewater treatment plants to tertiary-plus technologies will reduce mercury loading to surface waters in the Delta. The Review Panel is also comfortable with the conclusion that (despite the relatively weak studies that were undertaken) small-scale control issues (e.g. storm drains) are not a significant source of methylmercury relative to other sources documented as part of the TMDL inventory. Despite this, the Review Panel believes that monitoring of the Control Studies for methylmercury and inorganic mercury should continue and not be declared *de minimis* (i.e. should be not considered trivial with no required monitoring). Given the Control Study Reports' generally weak assessment of the implications of future climate and land-use change and lack of consideration of the potential for other relevant biogeochemical interactions, sufficient uncertainty remains around the trajectory of loading that continued monitoring over time is justified.

4) Do the cumulative study results address the ability to control inorganic mercury and methylmercury sources to attain overall load and waste load allocations? Would the expected load reductions have measurable effects on fish tissue concentrations?

Collectively, the Control Studies address the ability to control methylmercury sources to attain overall load allocations as specified by the Mercury Control Program. Given the small proportion of methylmercury loads to the Delta from the sources considered here, The Review Panel is quite definitive in its conclusion that the expected methylmercury load reductions will probably not have *measurable* effects. The Panel is not stating that load reductions will have *no* effect, but that the effects may be a) masked by the changes in fish tissue concentrations associated with load reductions from more significant sources in the future, or b) be sufficiently local in effect that the changes would not likely be captured by monitoring programs. Even proportionally large changes in methylmercury loads may be challenging to quantify since concentrations and total loads are, absolutely, very small.

5) If some sources can feasibly reduce mercury/methylmercury sources more than the minimum amount needed to achieve allocations, can this adequately offset loads from other sources?

The Review Panel is of the opinion that this question cannot be fully addressed until both the Control and Characterization Reviews are completed. In the context of *Control Studies only* we are confident saying that the higher efficacy of MeHg removal coupled to the considerably lower level of uncertainty associated with the well-studied WWTPs in the Delta suggests that these sources could offset loads from other sources that are considerably smaller, but that those other loads are also more variable/uncertain (due in part to the nature of the sources, and to the relatively weak Control Studies that did not provide definitive information concerning the range of potential concentrations/loads).

Given the very small proportion of the total methylmercury loads associated with the sources reported in these Control Studies, the Review Panel is also confident stating that under no circumstance could any of these sources offset loads from those associated with agricultural areas and tributaries that will be reported on in the Characterization Studies.

6. Individual Reviews of Control Studies

6.1. City of Stockton and County of San Joaquin (Urban Stormwater)

Overview

The City and County evaluated a detention basin located in the urbanized area, the Airport Business Center Basin (ABC Basin). Detention basins are a common Best Management Practice (BMP) in the Stockton Urbanized Area (SUA) for flood control and water quality control purposes. The objective of the Control Study is to evaluate the mercury and methylmercury removal effectiveness of the ABC Basin, along with the potential for methylmercury formation in the basin. Monitoring was conducted over three years, from October 1, 2013 to September 30, 2016.

1. Were the scientific objectives of the approved control study workplan fulfilled? Were the data quality control/quality assurance measures outlined in the report adequate?

From the workplan, the study objective was to "examine the mercury and methylmercury removal effectiveness of a detention basin in the SUA, along with the potential for methylmercury production in the basin." From this, a hypothesis was stated as: "The Airport Business Center Basin will reduce mercury and methylmercury loadings in the San Joaquin subarea. Sedimentation is the primary pollutant removal mechanism in detention basins, and as a result, detention basins will remove total mercury from the system, reducing the amount of mercury available for methylation."

The approved original control study workplan was adequately executed, but in the Reviewers' opinions, the original approved control study workplan was inadequate to meet its stated scientific objectives, primarily because of the examination of only inlet and outlet mercury and methylmercury concentrations without any consideration of flow data (in order to calculate loads).

The hypothesis reflects an incomplete consideration of well-understood aspects of the mercury cycle. The hypothesis assumes that removing THg by sedimentation from the water column takes it out of the methylating pathway. In reality, sedimentation transfers inorganic Hg to places where it in fact may be methylated. Therefore, simple sedimentation is not a singular mechanism for reducing MeHg loads. Moreover, the study did not include an analysis of key information such as suspended sediment concentration data, which would be required to test the hypothesis as written (not simply filtered vs unfiltered concentrations.

For QA/QC, standard QA/QC procedures are outlined in the study workplan. Sample data are included in several tables in appendices at the end of the workplan, but there is no compilation of QA/QC data nor an indication that this was closely examined.

In some respects, the analysis of the composite versus ‘grab’ samples constitutes a consideration of QA/QC. Hg concentrations in composite samples were compared grab samples but it is not clear if ‘grab’ samples are by hand or by autosampler. It is also unclear how the timing of grab samples is coordinated with composite samples, although it is presumed that they are in some way. The comparison in Table 8 shows relatively large differences in concentration among individual samples, but not really directional bias such that mean concentrations across all events work out. This however does not support the overall conclusion that individual grab samples are not significantly different from composite The grab sample concentrations will have been significantly affected by the timing of their collection. What this exercise did show however, was the level of uncertainty inherent in mixing composite and grab samples into the same loading analysis (~ +/- 75%).

2. Were the methods used in the study adequate to assess the scientific objectives?

The methods used were not fully adequate to assess the scientific objectives. Loadings were not examined – only concentrations. They used flow weighted composite samples (not clear how good the flow-weighting was) and then used analytical results as “event mean concentrations”. They then used the inflow and outflow concentrations to calculate a rather simplistic removal “efficiency”.

The workplan proposed to collect grab and composite samples (all THg/MeHg proposed as grabs) for 3 wet weather events and one dry weather period across each of 3 years. Sediment samples were to be collected during the dry weather periods as well. The number of samples (~10) was determined based on Sacramento Stormwater BMP effectiveness guidelines. Additional constituents to measure included run-of-the-mill sonde-type water quality variables, suspended sediment, total phosphorus, iron and sulfate.

In the workplan, it is unclear why one would add acid preservative to sediment samples and not simply freeze them (Table 6 on pdf page 75).

The data were all presented in a “lumped” manner, showing the distribution of concentrations at a particular site over the entire 3 year period. This assumes that the sampling is representative of the entire time period. Just three times per year and grab samples more often than composites, this is not clearly representative in my opinion.

In the study, samples across all three seasons are pooled (all inlets are pooled and compared against all outlet samples pooled together) and then Mood’s Median Test is applied in a single test for each chemical constituent. I think this is an erroneously over-simplified use of statistics to try to make a point. Moreover, in looking at the distribution of data and the very close median values for each (Table 9, page 31 of pdf), I find it hard to believe that these differences are statistically significant, even though the p-values given in table 10 are so low. For example, for dissolved MeHg, the inlet and outlet median values are 0.019 and 0.018 ng/l and determined to be significantly different at a p-value of 0.047. The p-value for the total MeHg difference (medians of 0.093 vs 0.088 ng/l) at p=0.01 seems plain incorrect to me.

Related to this, the pooling of the data is the main problem. This really should be a "paired" exercise. Pooling the data assumes there is no control needed over season, year or storm size. The authors should have considered the Wilcoxon test.

3. Are the conclusions regarding the effectiveness of the control measures supported by the monitoring results in the report?

No, the report unreasonably extrapolates from what is effectively a single pilot study with a relatively sparse dataset. That said, it is still apparent that loads are small.

4. Does the report adequately characterize the source's current and future predicted loads based on methylmercury controls? Did the study adequately address the uncertainty around the load reduction estimates?

No. A weakens of this study is that it does not examine loads at all.

- See Figure 10 on page 38 of pdf. Mostly just under TMDL, but wetter more recent year (2017) is way above.

- The future predictions are predicated on new and re-development at a relatively known rate. It is thought that compliance will take longer than until 2030.

a) If the study addressed existing controls, how well does the report evaluate existing control methods and, as needed, describe additional control methods (such as scaling up or combining controls) that could be implemented to achieve methylmercury load and waste load allocations? How adequate were evaluation methods, given available resources and workplan scope, in assessing the feasibility of reducing sources more than the minimum amount needed to achieve allocations?

It does a rudimentary job of assessing an existing control. It refers to a few other studies in California that similarly found small reductions with use of detention ponds. It does not significantly contribute to knowledge about scaling up or combining controls. The scaling is considered in a very linear way in relation to new and re-development into the future. There was no assessment of the feasibility of reducing sources more than the minimum amount.

b) If the study addressed additional controls necessary to achieve allocations, does the report adequately describe methylmercury and/or inorganic (total) mercury control practices identified by the study and evaluate the effectiveness, potential environmental effects, and overall technical feasibility of the control actions?

The study examined a single detention basin. There is no clear mechanistic understanding of the findings whatsoever. Although other constituents, such as suspended solids, were measured, these data were not presented and thus, an actual test of the study’s main hypothesis was not completed. Because of this, it is not possible from the study to scale findings elsewhere or to other low impact designs.

Potential environmental effects and overall technical feasibility were not explored. However, given the recommendation to continue with development as currently planned, technical feasibility does not seem to be an issue.

c) If the control study results indicate that achieving a given methylmercury allocation is infeasible, does the report adequately provide detailed technical information on why full compliance is not achievable and what methylmercury load reductions are achievable?

It is reasonably clear from the study that achieving the allocation during dry and/or near average rainfall years is probably feasible whereas it is not feasible during wet years.

The compliance scenario is explained in relation to new and redevelopment rates only. It is not overly clear why full compliance is or is not achievable, but the report does state it may not be likely to meet full compliance by 2030.

d) Does the report adequately describe how the controls could be adapted over time as climatic and other conditions in the Delta change?

No, this is not discussed or described in the report.

5. Do you have comments on any other scientific issues related to this study or mercury/methylmercury source?

It is accurate that at the time of this study and report, little was known about how detention basins handle MeHg. This was a particular void (at least at the time – see Strickman and Mitchell papers over last couple of years though) in the peer-reviewed scientific literature.

Many reports, including this one, refer to the very small overall loading by municipal separate storm sewer systems (MS4) agencies. TMDLs are likely to be met via existing and/or proposed low impact design and other stormwater best management practices.

6.2. Sacramento Stormwater Quality Partnership (Urban Stormwater)

Overview

This review of the Sacramento Stormwater Quality Partnership (SSQP) TMDL Phase I Implementation Study was completed in June 2019, based on review of the document itself, the April 2013 workplan for the Study, and a review of the "2010 Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury". In addition, two prior contributing documents were consulted for details referred to in this Final Report – the SSQP 2015 MeHg TMDL Progress Report and the 2013 Report of Waste Discharge and Long-Term Effectiveness Assessment (ROWD).

The MeHg TMDL Phase I Implementation Study requires stormwater and wastewater dischargers in the Delta to determine if current waste load allocations (WLAs) are being met, to conduct pilot studies of management practices that could reduce MeHg loads, and to evaluate if new BMPs could reduce loads below WLAs by 2030. Entities regulated by the TMDL submitted workplans in 2013 that were approved by the Central Valley Water Board.

The Partnership represents a group of municipalities that together are permitted for urban stormwater runoff through a single MS4 permit. The regulated area is large, more than 180,000 acres, but only the roughly 5000 acres within Sacramento - San Joaquin River Delta are regulated under the MeHg TMDL.

After review and revision, the Partnership's 2013 workplan for BMP pilot studies focused on evaluation of Low Impact Development (LID) as the most promising control measure for current and future control of MeHg loading, primarily through volume reductions. This review panel was provided the revised work plan, but not the original draft, or the Technical Advisory Committee comments. The workplan (Study Objective) proposes to compare LID urban runoff quality and loading per acre to the non-LID runoff sites as paired samples, when possible. Specifically, the workplan calls for evaluation of runoff from and an existing LID redevelopment site (Sylvan Center) and a new retrofit project (The City Hall Green Parking lot study), both in the city of Citrus Heights.

Only the City Hall study was carried out. The report concluded that MeHg load was reduced by 85%, based on a study comparing one year before and one year after redevelopment. The data support the finding of significant reduction in MeHg load due to implementation of LID stormwater controls. However, issues in sampling and evaluation of only one year of data add significant error to this estimate. These error estimates were not evaluated and were not carried into modeling efforts for future loading after LID implementation. *As is, the report gives loading estimates without uncertainty; we suggest this be addressed and amended.* The TAC had similar comments on the 2015 Progress report on this study. In response, the Partnership acknowledged limitations to the Citrus Heights studies (mainly that they were conducted during a drought period) and the need to use those data "qualitatively" to estimate benefits of the current Stormwater Quality Design Manual for the SSQP. This statement should be carried forward into the main conclusion of the final report.

Based on modeling presented in this report, and on past modeling efforts, the Partnership concludes that it currently meets the 2030 MeHg TMDL wasteload allocation, based on a five-year rolling average. Although there are several potential issues with the modeling and monitoring approaches, the data presented generally support that conclusion. However, if the estimate for MeHg concentrations in runoff from post-1996 developments is low (see more detailed review in the appendix), the Partnership may not be currently in compliance.

Results of the City Hall study were used to project future MeHg loads, based on the assumption that areas where LID is fully implemented would see 85% load reductions. There are no data to support the idea that results of the City Hall study – which covered just a few acres – are scalable to larger basins; or how the load reductions might change under different hydrologic conditions. So, while it is reasonable to predict that implementation of stormwater runoff controls will probably reduce MeHg loads over time, the quantitative estimates provided need to be tempered with some estimate of uncertainty. A caveat is the potential for MeHg production in LID features like swales and ponds that could produce MeHg. Data on those features remains very limited.

In the recommendations in Section 10 of the Report, the Partnership requests several modifications to Phase 2 of the Delta Methylmercury TMDL. Although the MeHg loading from Sacramento area stormwater is a small portion of total loads to the Delta, the contribution to local rivers is more substantial, and should not be neglected in terms of monitoring and compliance. This was noted in a prior report "Urban area input loads increase the downstream concentration of methylmercury in the American River when compared with loads upstream of the urban area."

Nevertheless, since the contribution of the SSQP to the entire Delta MeHg load is tiny, the cost-effectiveness of new studies directed specifically at MeHg load reduction in urban stormwater is questionable. As long as LID controls are moving forward under other regulations, there is probably no reason to implement additional specific BMP controls for MeHg. <u>However, continued monitoring of both total Hg and MeHg in SSQP outfalls and receiving waters is critical to evaluating loads to the Delta over time, assuring compliance, and providing information on how LID implementation in the area over time affects MeHg load.</u> Modifications to the current monitoring program could improve the usefulness of the data.

Detailed review by study section

Control Measure Study: Citrus Heights Green Parking Lot LID project

This review section focuses on the pilot study conducted on how Low Impact Development (LID) affects MeHg loading. The workplan study design called for a comparison of MeHg concentrations and loads at two test sites with LID and non-LID runoff. The two monitoring studies were 1) a retrofit and expansion of a parking lot at the City of Citrus Heights Police Station and 2) the nearby Sylvan Center redevelopment LID site along with an adjacent non-LID development**.** This report did not present sampling details or the raw data from this study, but it was available online in a

2015 Progress Report. It was not possible to evaluate the main conclusion that the LID projects reduced MeHg load by 85% without digging into study details in the progress report.

After examining the study details in the progress report, we agree that the study supported the idea that LID features in the City Hall complex resulted in reduced MeHg in runoff, driven by reduced flows and by reduced concentrations in runoff. However, the finding of 85% reduction should be tempered, since there is a tremendous amount of uncertainty surrounding this value in this small and challenging study. In using the data in modeling and scale-up to the entire SSQP regulated area, some estimate of error/variability in LID-driven reduction in MeHg should be incorporated.

Changes from workplan

These are the study objectives from the original workplan, with short notes on changes and completion.

- Monitor urban runoff conditions at representative non-LID developments (prior to redevelopments) and two LID redevelopments.
    a. Only completed before and after LID redevelopment at one site (City Hall).
    b. No direct comparison of LID and non-LID site in the same time frame (planned for Sylvan Center)
- Accurately measure the volume of urban runoff exported (discharge to storm drain inlets) from the study sites
    a. Discharge measurements before LID installation at City Hall were not useable, discharge measurements in year 2 (after LID installation) were.
    b. No discharge measurements were made at the Sylvan Center site.
- Collect methylmercury and supporting water quality samples to accurately measure the concentration of urban runoff exported from the study sites, and
    a. MeHg measurements were made before LID installation at City Hall
    b. Effectively no MeHg measurements were made at the Sylvan Center site.
- Quantify differences in per acre loading from LID and non-LID sites.
    a. Significant reduction in MeHg loading after LID installation at City Hall were observed. No reduction data were obtained from the second site in the workplan.

b. The error in estimating MeHg reduction due to LID installation from the single completed study is high, and was not captured in the final report, or in modeling MeHg in stormwater for the entire regulated SSQP basin.

Details of the study

The workplan called for paired runoff sampling before and after LID installation at the City Hall site, as well as paired with and without-LID sampling at the Sylvan Center site. Much less sampling was conducted than planned, with effectively no useful sampling at the Sylvan Center or its adjacent non-LID control area.

Unfortunately, the Sylvan Center site was only sampled once in year 1 and once in year 2.

The high density of LID features meant that off-site stormwater flows almost never occurred. It was not clear why the adjacent non-LID watershed was not sampled to plan. The fact that no flow occurred in the Sylvan Center complex supports the idea that LID can reduce stormwater flows, but without paired data from before or from a control watershed, this cannot be quantified. However, there is a growing amount of worldwide data on LID that could be applied to modeling the impact of LID on flows in the SSQP watershed.

Only the City Hall study can be used to evaluate the effect of LID on MeHg concentrations in runoff. The design of the study included V-notch weirs on all 3 monitoring sites, but there were problems with flow and depth sensors (drift in pressure sensors, problems with an acoustic Doppler velocity sensor). Weirs worked best combined with bubble level sensors. The study found a drop in MeHg concentration in runoff between year 1 and 2 (pre and post LID installation). Based on the observed drop in concentration, the SSQP estimated an 85% reduction in MeHg stormwater load. They did not provide any estimate of the error around that value, either based on this study, or through comparison with other studies.

Data from the progress report were downloaded into a spreadsheet for analysis and evaluation as part of our evaluation. Overall, a decline in MeHg concentration between the years was evident, but there were a variety of issues that introduce significant error into the MeHg reduction estimate. For example, although roughly the same number of storm events was sampled each year, the number of total samples collected in year 1 was small overall (~10) and compared to year two (when several types of samplers were compared for certain storm events). Further, each of the three sampling sites was not sampled for each event (it was not clear if they did not flow or if they simply were not sampled). The sample timing (within the wet season) was different between years, with year 1 sampling starting later in the wet season. These sampling biases make the amount of MeHg reduction less certain.

Total Hg and MeHg concentrations commonly change across the hydrograph of a storm event (e.g. Eckley and Branfireun 2008). While sampling was targeted to the “estimated period of peak runoff,” hydrographs for each event were not presented, nor were the sampling times within the hydrograph given. There is a window of sampling times in Table 9 (progress report appendix), but not where these windows fit in the hydrograph, or when sampling was conducted within the window. Potential differences in sampling time along the storm hydrograph could introduces significant variability in the MeHg values collected.

For the City Hall data, plots of discharge vs. precipitation were constructed (which highlight problems in discharge measurements at site PL1), as well as plots of discharge vs TSS. There was a surprisingly weak relationship between THg and TSS, and no relationship with MeHg, both of which are expected based on other runoff and stream studies, including the urban runoff and urban tributaries data from this study (Fig 3 in the Final Report). Unfortunately, TSS was not collected at every sampling point; nor was turbidity measured routinely, or any correlation examined between TSS and turbidity. These issues highlight the difficulties in sampling in urban environments and potential problems in the data collected. While these issues do not invalidate the finding of Hg and MeHg reduction through LID, it does mean that the finding of "85% reduction in MeHg concentration" should be viewed with appropriate associated error when extrapolated to the entire watershed.

Quality Assurance and Quality Control

Importantly, the MeHg concentrations being measured in this study are very low, and often within an order of magnitude of method detection limits. This makes accurate assessment of MeHg concentrations in runoff challenging. The variability in MeHg concentration measured during each event is clearly high. Duplicate samples were taken occasionally across the study; additionally, multiple types of sampling approaches were sometimes compared (especially in year 2). In comparing all the samples taken at each site for each event, this yielded an average relative percent difference of roughly 40% for MeHg for each sampling event. This evaluation of the spread of the data is critical to constructing models for stormwater reduction and should be explicitly built into the reporting and models in this report.

Although blanks were not collected with each sampling, about half of the events had a field blank, and they were routinely near or below the analytical detection limit for MeHg.

We need to comment that we are puzzled by the lack of separation of filterable and particulate MeHg – and especially total Hg - in samples as part of the TMDL requirements. It is challenging to accurately sample solids in a flowing stream and through a hydrograph. Measuring whole water samples introduces much error due to variability in particle sampling. TSS and Hg/MeHg concentrations are often related (for any given watershed or sampling site), and TSS or turbidity is much easier to measure than Hg/MeHg. The data sets would be stronger and more informative if particulate Hg and MeHg were measured explicitly and built into a loading budget using relationships between TSS and Hg/MeHg and TSS and flow. Particulate vs filterable data would also provide so much more information on source and solution for both Hg and MeHg – e.g. does the focus need to be on reducing particulates? Or reducing filterable MeHg?

Statistical analysis.

Statistical modeling in the report could have been more thorough. A more in-depth evaluation of the data did not change the Partnership's general conclusions but can provide an estimate of the error associated with the calculated reduction in Hg and MeHg through the studied LID setting. The MeHg data for City Hall were not normally distributed but had apparently been evaluated in the report as if they were. In re-evaluating the MeHg data using log transformed data to normalize, there was still a significant difference between year 1 and 2 MeHg concentrations. However, there were only about 10 data points in the first year to evaluate (vs. 40 in year 2). Because sampling was not even among sites or sampling types, we included the potential effects of site and sampling type in a standard least squares model, but neither were significant. Using least square means on transformed values, the MeHg difference between years was about an 80% decline. However, the standard error on the estimate of MeHg concentration in year 2 was 25%. That represents a minimum estimate of the error in MeHg reduction. We also found significant differences in total Hg between years 1 and 2. Using least square means on transformed values, the difference was about a 50% decline, but the standard error on the estimate of total Hg concentration in year 2 was 35%.

The report states (p.17) that the City Hall LID study demonstrated a decrease in runoff coefficient from 0.71 (based on modeling) to 0.45 (measured). More data is necessary to support this for the LID study. We evaluated the discharge and precipitation data provided for PL2 (the only site with sufficient discharge data to do so) and found no significant difference in the discharge vs rain curve between years using ANCOVA.

Completeness of study objectives and ability to test hypotheses

The main hypothesis for the LID study was: "On a load per area basis, LID features reduce methylmercury discharged to the MS4 and receiving waters, in comparison with non-LID urban areas." The study design called for two tests of this idea (City Hall and Sylvan Center). Only the before/after City Hall test was accomplished, and no data were collected for the Sylvan center (either with or without LID sites). Ideally a before-after-control-impact (BACI) study would have been completed, by using City Hall for before and after, and the urban non-LID area adjacent to the Sylvan Center for the control. That design allows comparison with control under the same hydrologic conditions, which was not accomplished. The ability to test the main hypothesis was weakened by changes to the sampling design. In the end, the before/after study provided some assurance that LID features reduced MeHg in stormwater, but only for one location, and with a high amount of associated variability in the final estimate of reduction.

Potential environmental effects of control methods evaluated.

The TAC requested that the report include this, but we did not see any discussion of this.

Ability to test study hypothesis

H1: On a load per area basis, LID features reduce methylmercury discharged to the MS4 and receiving waters, in comparison with non-LID urban areas.

For the single study site tested, the data and analysis presented support a statistically defensible reduction in MeHg discharge due to LID installation. However, the magnitude of the decline has high associated error. The study did not provide the ability to estimate LID reductions under hydrologic conditions outside those of the study year, nor a way to scale the findings from the small study site to larger areas.

Recommendations

In their review of the 2015 progress report, the TAC asked for additional data collection to “confirm findings and address identified data gaps.” The final report from the SSQP states that this follow-up would be outside the requirements of the Phase I TMDL and is not being pursued. Since the original LID pilot study was not fully implemented, one could argue that completing it with additional data collection would not be outside the scope of the Phase I TMDL. We agree with the TAC and the SSQP that the amount of data being used to evaluate the impact of LID on MeHg flux is low and would benefit from evaluation at more sites and under additional hydrologic conditions. The 2007 NPDES order also requires that the “Permittees consider including monitoring in the design of future BMP studies to estimate the extent to which existing and new BMPs reduce total mercury transport and reduce and/or increase methylmercury discharges.”

Final recommendation: Continue monitoring of Hg and MeHg in future BMP/LID studies. In designing Hg/MeHg/TSS sampling programs, evaluate how fluxes change across storm hydrographs, take care to representatively sample TSS across storms and flow, and increase sampling frequency to better test hypotheses and evaluate variability.

Results from other studies of MeHg removal efficacy

In addition to the Citrus Heights LID studies approved in the workplan, this report also includes an overview of the results of a prior SSWP study of MeHg removal effectiveness in a wet detention basin (North Natomas) in Sacramento. More details of this study were available in the 2013 ROWD. Using North Natomas Basin 4 inlet and outlet samples, the study showed significant solids (~75%), and total Hg removal, but no MeHg removal. If particulate MeHg is an important part of stormwater MeHg loads, as shown elsewhere in the Final Report, this suggests there is a source of MeHg in the detention pond to balance the probable trapping of particulate MeHg. As study by Stickman and Mitchell (2017) demonstrated MeHg production in stormwater ponds, but found overall that ponds trapped Hg and produced relatively little MeHg. A better evaluation might be the examination of concentrations in the pond itself over time between storms. The outflow from this pond is the long-term urban stormwater monitoring site for post-1996 development. A note on p8 of the workplan suggests that prior studies may have observed MeHg production or export in wet detention basins, but this was not followed up in the TMDL Phase I work plan. Overall the data in hand suggest that wet detention ponds may not be a solution for MeHg reduction.

Additionally, as required by the workplan, the report reviews MeHg control studies done by other Delta jurisdictions, specifically a LID study in Contra Costa, and an evaluation of dry detention basin (the "ABS basin") in Stockton. In Contra Costa, bioinfiltration cells built with an underdrain were studied. One of the two cells showed very significant increases in MeHg concentrations. Without having reviewed that report, some possibilities come to mind, including MeHg production in saturated soils and washout as water moves through them. Evaluation of factors that enhance MeHg efflux from bioretention cells might bear more scrutiny so they could be avoided if possible during siting and construction. Although the ABC basin study reported a small decline in both Hg and MeHg from inlet to outlet during storm events, other reviewers questioned how data were analyzed in that study.

Ability to test study hypothesis

The above studies provide weak support at best for the idea that two specific LID features - wet and dry detention basins - reduce MeHg loads. The bioinfiltration cell study suggests that these features could increase MeHg loads under certain design and flow conditions.

SSQP Long-term monitoring for Hg and MeHg

The SSQP conducts routine monitoring for MeHg, THg, and other constituents at 3 urban runoff sites, and 4 urban tributaries as part of the "Discharge Characterization Program" (DCP). Low-level Hg monitoring began in 1996 and MeHg monitoring in 2002. The effectiveness of mid-1900's stormwater control measures on MeHg concentration, and overall compliance with the TMDL WLA were assessed using these monitoring data. The impact of the newer LID measures was assessed with the City Hall study (as LID is only required starting this year) and therefore cannot be evaluated with long-term monitoring data.

We could not ascertain the quality of the monitoring data since QA/QC information was not provided in this report (and was not readily available online).

The sampling design for Hg and MeHg was not provided. Data from 1996-2018 were presented in Fig 1 and several tables in Appendix C. It would be helpful to provide information on the sampling program for the outside reader (or a link to that information). The number of data points collected over the monitoring period (~30-40 MeHg for each site over ~20 years) seemed small (<2 per year on average). At what frequency are samples collected, and what drives that sampling pattern (rain? or dates in sampling plan)? Are they grabs or flow-weighted composites? Are the data presented in Figure 1 individual data points or averages? Critically, was sampling done to ensure even sampling of particles across time and space? Would they adequately represent the suspended solids load that might occur during high flows? Clearly, we are unable to evaluate the veracity of the data without these methodological details.

Figure 3 showed the relationship between MeHg and TSS, suggesting that a large fraction of MeHg in stormwater is particulate. Otherwise, I was not sure what these data were used for. The relationships were mostly driven by differences among sampling sites (watersheds), and at least for the top graph, the data were not normally distributed (so a linear regression is not appropriate). We noticed a switch from SCC to TSS in the monitoring data at some point in the past, and also noticed that TSS is not always collected along with Hg/MeHg samples (Table 1, Appendix C). Was a comparison of SCC to TSS methods made so that those data could be evaluated together over the long term (with a conversion coefficient if needed)? Concomitant TSS sampling provides important information on Hg and MeHg sources and control. The table captions for data tables in Appendix C should provide more information - period of collection, methods used, criteria for sample collection, etc.

The Final Report concluded that stormwater MeHg concentrations are lower in more recently developed parts of the regulated area, but otherwise the same across mixed land use categories. This finding is based on differences in average MeHg concentration between just one urban stormwater monitoring station (North Natomas) in a more recently developed area (post 1996 development), compared to two monitoring sites draining older areas of the city (Fig. 4). The report did not present any analysis of other factors that might have influenced differences in MeHg among these three sites/drainages. Supporting information for this conclusion is apparently in the 2013 ROWD but we could not find the appendices with the detail of the analysis online. Section 6.2 of the Final Report refers to a stepwise ANOVA that was performed to separate effects of other factors, like rainfall amount and duration, and antecedent conditions, but this analysis did not include land use as far as we were able to ascertain.

One potential concern is the location of each sampling site along the stormwater flow path. Stormwater runoff sampling is challenging (flashy, vandalized equipment, difficult to access, etc.), but the choice of sampling locations can dramatically impact results. For example, collections downstream of a detention pond could result in much lower TSS and contaminant concentrations. The North Natomas collection site is at the outflow of a wet detention basin, which has shown demonstrated reductions in TSS. The Strong Ranch site is apparently in a channel. Could the North Natomas collection on the outflow of a detention pond be the cause of lower particulate Hg and MeHg at that site, rather than the LID features of newer development in the drainage? ***Therefore, the data and analysis presented are not sufficient to support the conclusion that stormwater MeHg concentrations are lower in areas of post-1996 development.*** The conclusion that MeHg concentrations are lower in North Natomas than the other two urban runoff sites is supported by the data presented, but the conclusion that this is due to differences in development age is not. Perhaps the supporting data are in other documents, but this report should provide enough information for the reader to assess the finding.

Page 10: “No sources with significantly elevated methylmercury concentrations within the Partnership area have been identified during the last fifteen years of characterization monitoring.” This statement should be tempered. This statement is based on the existing stormwater monitoring program; which only covers a few sites, certainly not every potential source of MeHg in the SSQP watershed area. The 2013 ROWD noted that American River MeHg concentrations increased during transit through the urban area.

In the recommendations section (and in prior documents like the ROWD), the Partnership has asked to reduce or discontinue toxicity monitoring. In the ROWD, the Partnership asked to "Reduce the frequency of discrete monitoring events for urban discharge and urban tributaries. Monitoring efforts over the last 20 years have effectively characterized the water quality associated with the urban watershed… Because the occurrence of pollutants in our urban discharge is well understood, continuation of relatively frequent monitoring is no longer necessary." We agree with the sentiment that the number of sample sites and frequency of sampling for Hg/MeHg has not been sufficient to evaluate the impact of land use or specific BMPs. But stopping monitoring is not the answer. How would one ensure compliance or find new problems otherwise? How would one effectively demonstrate the effect of expensive new LID requirements without monitoring discharge?

The concentrations of total Hg in the SSQP stormwaters are often quite high, often above 100 ng/L. Reduction in Hg loads would be one of the best ways to reduce MeHg production. It is surprising that TMDL Phase I studies did not focus more on inorganic Hg reduction approaches. Given the high Hg concentrations, and the MeHg impairment in Delta waters, it is important to continue Hg and MeHg monitoring, perhaps with a re-evaluation of sample collection design that would better address specific questions about potential controls. Low frequency collection and high associated variability make analysis of the long-term data challenging. Without seeing the existing sampling design, it is difficult to make specific recommendations. We would also think that the NPDES MS4 permit would continue to require monitoring for toxics that create impairments. In DMCP TAC Progress Report Comments, they asked for an evaluation of multiple/alternative methods of monitoring for estimating loads, including ways to improve load calculations. We also think it would be worthwhile to revisit the monitoring strategy. The Central Valley Water Board requires an annual monitoring plan and report; next year's sampling plan might consider some of the above issues. See McKee et al. (2017) for additional ideas. Raw monitoring data should be made publicly available if they are not already.

Modeling current and future compliance with WLA

Did modeling efforts fulfill the workplan?

The workplan calls for these actions with regard to modeling MeHg loads*:*

- Update Watershed Treatment Model to consider methylmercury, new study information, and already implemented control strategies;
- Develop implementation scenarios of evaluated control strategies to determine the required control strategies to comply with the WLA;

- Develop achievable implementation schedules and cost estimates for the required control strategies based on expected rates of redevelopment within the TMDL urban area; and

- Prepare an evaluation of the overall feasibility of complying with the WLA.

Based on modeling presented in this report, and on past modeling efforts, the Partnership concludes that it currently meets the 2030 MeHg TMDL wasteload allocation, based on a five-year rolling average. Although there are several potential issues with the modeling and monitoring approaches, the data presented generally support that conclusion. However, if estimates for MeHg concentrations in runoff from post-1996 developments are low, the Partnership may not actually be in compliance. The report also makes the point that the Partnership is currently under the allocated annual load depending on what time period defines a "year" (Figs 5 and 6) – all of this is a function of when rainfall happens across year. Given the increasing variability of precipitation amount and timing, we think it is reasonable to regulate loads for the Partnership as the 5-year running average.

Several modeling efforts to characterize Hg and MeHg loads from the Partnership TMDL area have been made to date. The NPDES MS4 General Permit (2016) requires this, as well as development of water quality milestones toward compliance if needed. MeHg load modeling was done as part of the 2013 ROWD, for the entire SSQP NPDES permitted area. This report updates that modeling to predict future loads, using the results of the LID study.

Modeling MeHg concentrations in runoff.

The 2010 TMDL baseline MeHg load was calculated based on the assumption that the average MeHg in runoff for the Partnership's area is 0.24 ng/L, across all land uses, yielding a baseline MeHg load of 1.8 g/y. The TMDL has a target concentration of 0.13 ng MeHg/L in runoff. A 44% reduction to 1.0 g/y is required by 2030.

Runoff concentrations for the model were calculated from monitoring data, using regression analyses to calculate the impact of several factors. The factors identified as important for MeHg were land use development age, antecedent conditions, and event storm parameters. The Natomas basin data was used to represent areas developed since 1996. Please see previous concerns above, specifically whether siting the sampling location downstream from a detention pond could have caused the observed reduction in MeHg concentrations relative to sampling sites draining pre-1996 areas.

How much impact on load estimate would an underestimated runoff concentration in post -1996 developments areas have? Post -1996 development represents only ~15% of the jurisdictional runoff area. The median MeHg concentrations at the urban runoff monitoring site with the highest concentration was 0.49 ng/L compared to 0.14 from Natomas. In the worst case scenario, if 0.49 ng/L was applied to new development areas, the MeHg load from those areas would be 3.5X higher; resulting in a 50% increase in load estimate for the entire regulated area.

The City Hall parking lot study was used to predict concentrations in areas of future development/redevelopment to LID standards. Please see concerns above about the error associated with that estimate, and the ability to scale the MeHg reduction up from a very small test area.

The amount of available MeHg monitoring data seems sparse for the creation of regression models for factors that impact concentration. As noted on p 26 “Urban runoff constituent concentrations and loads are known to vary over time and location as a result of a large number of factors. This high variability poses challenges to characterization programs with lower-resolution monitoring programs.” Only three urban monitoring sites were used in the regression analysis, with often only a couple of data points per year available. Was the regression analysis done separately for each monitoring station/sub-basin? If not, how much error is introduced by pooling the data sets across sites? Fortunately, the sampling time frame covers almost two decades.

The fitted concentration regression model in Fig 8. highlights the shortcomings of this approach using a small data set, with a poor fit and high error for storm events that generate high MeHg concentrations.

Load calculation errors.

Confidence intervals for model predictions were provided in section 6.3.3., based on the error in the regression models for MeHg concentration, which are based on antecedent conditions and storm event parameters. Using this approach, the median annual error for MeHg loading estimates was 36%. However, this approach did not consider the errors associated with MeHg concentration values based on current and future land use, which could be significant. Overall, the error calculations are difficult to assess because:

- None of the verification exercises showed good model performance though some caveats were given.
- t does not appear that any sensitivity analysis was performed on model parameters.
- A rather small number of concentration values are used in the modeled versus measured scenarios.

Discharge flow modeling.

Streamflow is modeled using a modified rational method approach. The rational method itself works relatively well to predict peak flows, particularly in urban systems because of the strong control on runoff from impervious surfaces in cities. It is most often used to size culverts and pipes. The “modified” rational method is used in this study even though the authors themselves state that it is not well suited to individual storms – still, the modeling does appear to be handled on an individual storm basis. The report refers to the hydrological flows coming from a “mechanistic model”, but it is not clear that anything more than the modified rational method is actually used for this, which is *not* a mechanistic hydrological model. In fact, this is the simplest of possible hydrological models. That said, this appears to be a commonly used approach in the region though the information provided suggests that the model performance for flows is quite poor.

From appendix E, it would appear that the hydrological modeling was not very good. Though some caveats were given, model verification generally was quite poor and in the case of the somewhat smaller drainage areas, directionally biased. Though fits to cumulative flows were used as a means of potentially showing good model-data agreement, this is a biased assessment when loads are modeled from individual storms and in relation to metrics such as storm-to-storm antecedent conditions.

Growth of urban areas.

The Partnership predicts that growth of urban areas will not increase MeHg flux, referencing a 2007 analysis (page 20). Details of that analysis were not provided. The rationale is that MeHg loads from agriculture in the Delta are higher than from urban runoff, and that urban development will not increase runoff relative to agriculture as LID is implemented. However, the agriculture data were not specific to the area around Sacramento. We think that it is unlikely that applying the results of the City Hall study to larger drainage areas is appropriate, as MeHg yields may not scale with watershed size.

Implementation of LID.

It seems unreasonable to assume that LID implementation will have a significant effect on MeHg load by 2030. However, what implementation does occur should tend to decrease MeHg loads unless implementation includes construction of features that generate anaerobic soils.

6.3. Contra Costa Clean Water Program

Overview

This review is of the Contra Costa Clean Water Program's Oct. 2018 Methylmercury Control Study Final Report, and supporting Dec. 2013 Revised Methylmercury Control Study Workplan. The final report presents the results of the two major monitoring efforts outlined in the Workplan within Contra Costa County, a watershed characterization of Marsh Creek and West and East Antioch Creek, as well as a pilot study to evaluate the effectiveness of bioretention cells to reduce MeHg concentrations in urban stormwater runoff.

The watershed characterization of Marsh Creek was partially successful in meeting the Workplan objectives. Specifically, this study provided sufficient evidence that the hypothesis that the variability of MeHg concentrations within the Marsh Creek sub-area is explained partially by the variability of TSS and partially by enhanced methylation in areas of standing or slow-moving water. However, as noted by the authors, the monitoring efforts described within the report did not address a number of significant data gaps which will be crucial to address whether wasteload allocations for MeHg are being met.

The BMP effectiveness evaluation provided less clear results. The scope of the pilot monitoring study was sufficient to meet the objectives of determining whether bioretention cells, as a specific LID control measure, could reduce suspended sediment concentrations, thereby reducing MeHg concentrations. However, the implementation of the pilot study was hampered by unexpected conditions (e.g. tidal inundation), making it difficult to conclusively say whether or not such control measures would be effective for reaching TMDL allocations within the Delta.

The report concludes that reaching the TMDL wasteload allocation for the Marsh Creek sub-area is unfeasible by 2030, given that LID measures would need to reduce suspended sediment concentrations by greater than 75%, and such a large amount of development would be infeasible from both a cost and timescale for implementation perspective. This conclusion is supported by the data and reasoning presented in the report. However, the report does not clearly address other potential control measures (e.g. modification of detention basins to improve drainage thereby reducing potential zones of methylation), nor present a clear framework for calculating specific loadings associated with high flow events.

1. Were the scientific objectives of the approved control study workplan fulfilled? Were the data quality control/quality assurance measures outlined in the report adequate?

The stated objectives of the work plan were to characterize concentrations of methylmercury in urban runoff discharges within eastern Contra Costa County and to evaluate attainment of the implementation goal of 0.06 nanograms per liter (ng/L) methylmercury established by the Total Maximum Daily Load (TMDL) for Methylmercury in the Sacramento and San Joaquin River Delta". These objectives are met in the West and Central Delta sub areas of Contra Costa County as described in this report, which are demonstrated to be currently in attainment. However, the report is inconclusive about Marsh Creek sub-area, although it clearly shows that the sub-area is not currently within attainment of the MeHg load allocation during wet weather periods. The report outlines data gaps that need to be addressed in order to fulfill the scientific objectives for this sub-area. The overall study goal was met in that the findings supported the stated alternate hypothesis that the variability of [MeHg] in discharges (from Contra Costa County MS4) is explained by the variability of TSS and there was enhanced methylation in standing or slow-moving water.

The data QA/QC measures outlined in the report state that EPA methods were used for mercury and ASTM for TSS. Samples followed the measurement quality objectives of the study work plan. QA/QC details are provided specifically and clearly in the study report, and minor QC issues are noted.

2. Were the methods used in the study adequate to assess the scientific objectives?

The methods used were partially adequate to assess the scientific objectives, and the authors are transparent in presenting a number of data gaps which will need to be addressed moving forward (Section 4.2) and express that additional monitoring efforts are necessary.

Additional monitoring during wet periods of the other sampling locations (M1, M3-M5) would also be beneficial for addressing the data gaps identified by the authors. For example, the authors mention on pg. 54 that there is a significant portion of the year for which there are no data at sites downstream of the Brentwood WWTP, as only dry season samples were collected at sampling location M1. MeHg concentrations were demonstrated to be below the 0.06 ng/L TMDL goal during this period, and the authors suggest that this is the result of a significant portion of the flow being made up of Brentwood WWTP effluent – does the same pattern hold during wet periods or storm events?

The study authors claim at multiple points throughout the report (e.g. pg. 37) that suspended sediment concentration explains 30% of the variability of MeHg concentrations based on a regression of all data from both Marsh Creek and West and East Antioch Creeks across all seasons (both wet and dry period data are combined) [Figure 11]. Such combination could be confounding observation of differences between the watersheds, as well as between seasons and hydrologic regimes. A regression of SSC against MeHg conc. might lead to a more useful estimate of the overall influence of suspended sediment on MeHg loads if this analysis is repeated, but separated by watershed and hydrologic conditions (wet vs. dry). Additionally, the report made no effort to distinguish between the differing flow regimes during storm events within Marsh Creek (local peaks vs second peaks due to number of retention basins within the watershed) as identified in the Work Plan. Planning future monitoring efforts to delineate between these flow regimes will be important for accurately determining MeHg loads associated with high flow events, as well as evaluating the efficacy of control measures aimed at reducing the production of MeHg within detention ponds.

The Workplan gave the goal of sampling 12 to 16 storms – data for only 6 is presented in the Final report. Why wasn't the stated monitoring goal met? Many of the data gaps mentioned specifically in the report are the result of insufficient sampling of storm events – the authors claim "the data gaps are well outside the scope of the original methylmercury control plan…" (pg. 57), but this seems to be misleading given that they didn't meet the stated number of stormwater sampling events.

3. Are the conclusions regarding the effectiveness of the control measures supported by the monitoring results in the report?

The report clearly walks through the MeHg concentration calculations used to come to the conclusion that achieving the necessary load reduction through suspended sediment reduction via bioretention cells to be unfeasible, but do not present any discussion or estimation of the amount of water that would need to be directed into such treatment cells to achieve the load allocation. Rather, the authors report that a 75% reduction in suspended sediment concentration will achieve the required reduction in MeHg concentrations. This estimate assumes that all stormwater flows have similarly elevated MeHg concentrations and MeHg/SSC ratios, which is not supported by the stormwater data presented in the report. Future monitoring efforts to better estimate MeHg concentration during storm events, and during periods of extended wet weather, are needed to make such estimates with greater confidence.

With regards to the BMP effectiveness evaluation, there is only data presented for a small number (n=2) of bioretention sites to explore the effectiveness of this control measure, and for one site the potential influence of periodic tidal inundation significantly confounds interpretation of the results. This reviewer would prefer to see data from additional pilot bioretention studies to more thoroughly describe the potential effectiveness of this control measure for these watersheds. Additionally, the studied bioretention facilities were not within the watersheds subject to the TMDL reporting guidelines, and biorentention cells installed within the Marsh Creek watershed may have a differing degree of effectiveness for reducing MeHg concentrations relating to specific watershed characteristics.

The report does not consider any of the additional control measures suggested in the Workplan, such as removing or capping sediment in the Marsh Creek Reservoir or modification of detention basins to reduce ponded water. As the bioretention pilot study suggested that MeHg concentrations were not significantly reduced in effluent, focusing future monitoring efforts to evaluate the effectiveness of such control measures for MeHg load reduction within March Creek would be beneficial.

4. Does the report adequately characterize the source's current and future predicted loads based on methylmercury controls? Did the study adequately address the uncertainty around the load reduction estimates?

In general, the report makes much more use of MeHg concentration goals rather than MeHg load goals when discussing metrics of control measure effectiveness, and attainment of wasteload allocations, correctly pointing out that there is not sufficient data to constrain the MeHg loads across the range of potential flow regimes. No discussion of uncertainty is included when discussing MeHg concentration goals, or in the calculation of current MeHg loads. This could be improved in future reporting.

The influence of storm events is not adequately characterized at this time given the currently available monitoring data. The study authors admit that this was a phenomena affecting the MeHg load (pg. 56-57) that was not expected or planned for in the control plan and additional monitoring is needed. Gathering sufficient data on storm events and associated MeHg pulses will be critical to understanding the true MeHg loads from the Marsh Creek watershed and designing effective control measures.

a) If the study addressed existing controls, how well does the report evaluate existing control methods and, as needed, describe additional control methods (such as scaling up or combining controls) that could be implemented to achieve methylmercury load and waste load allocations? How adequate were evaluation methods, given available resources and workplan scope, in assessing the feasibility of reducing sources more than the minimum amount needed to achieve allocations?

Not applicable as existing control measures within the Marsh Creek sub-area, such as current implementation of green infrastructure controls, is not directly discussed.

b) If the study addressed additional controls necessary to achieve allocations, does the report adequately describe methylmercury and/or inorganic (total) mercury control practices identified by the study and evaluate the effectiveness, potential environmental effects, and overall technical feasibility of the control actions?

The study sufficiently describes the results of the study of two pilot bioretention plots, but these are largely insufficient to provide a clear picture of how effective this control measure will be for these watersheds (particularly Marsh Creek) in the longer term. See more detailed discussion above.

c) If the control study results indicate that achieving a given methylmercury allocation is infeasible, does the report adequately provide detailed technical information on why full compliance is not achievable and what methylmercury load reductions are achievable?

The report makes the important distinction that the infeasibility of MeHg load reduction for the Marsh Creek sub-area is motivated differently for surface water vs stormwater flows. For surface waters they argue that elevated background methylmercury in suspended sediments makes the 0.06 ng/L MeHg conc. goal infeasible. For stormwater, the report authors argue infeasibility is related to the cost and time necessary to implement sufficient control measures (namely retention and infiltration to reduce suspended sediment concentrations). However, the report is focused on attainment of the concentration limit and not a load allocation. As the report states “Suspended sediment concentration is an important parameter, controlling about 30 percent of the variability in methylmercury concentrations in urban stormwater. Because of the controlling effect of suspended sediments, it is infeasible to expect all urban stormwater to achieve 0.06 ng/L methylmercury as a long-term average." There is limited discussion of whether the load attainment could be reached through flow reduction, suggesting that there is currently insufficient data needed to develop a hydrologic model capable of addressing this uncertainty.

Although the West and Central Delta sub-areas are demonstrated to currently be in attainment of wasteload allocations, it would be interesting to consider if relatively low cost control measures in these watersheds could offset the loads above attainment in the Marsh Creek sub-area.

d) Does the report adequately describe how the controls could be adapted over time as climatic and other conditions in the Delta change?

The report does not account for changing climatic and hydrologic conditions in the Delta. Given the pooled system observed during dry periods and ephemeral nature of flows described in Upper and Lower Marsh Creek, changing hydrologic conditions could have significant effect on MeHg loads in this system and need to be included in future planning efforts.

5. Do you have comments on any other scientific issues related to this study or mercury/methylmercury source?

The report makes clear that the portions of Marsh Creek that are upstream of the Marsh Creek Reservoir, including the Mount Diablo Mercury Mine, are outside the legal boundary of the Delta and not subject to the Delta Methylmercury TMDL. Future monitoring efforts and studies of control measure effectiveness would likely benefit from treating the Marsh Creek watershed holistically, as the current watershed bifurcation inhibits a clear understanding of the effects of hydrologic regime on MeHg concentration.

6.4 Port of Stockton

Overview

The Port of Stockton MS4 is an identified urban runoff point-source discharger into the Sacramento-San Joaquin Delta Estuary. This work had two objectives. First, it wanted to determine if methylmercury was accumulating in the sediments in storm drains. Second, it wanted to determine the impact of drain maintenance on accumulation of methylmercury in storm drains. Through their study, there was no discernable trend in sediment [MeHg] in the control study catch basins, and it was inconclusive if methylmercury is generated or accumulated in catch basin sediment. Rather, variability seems related to year-to-year variability and hydrologic condition. There was also no observed effect due to catch basin maintenance. The report also discusses its previous waste load allocation, and uses GIS to argue that the boundaries of the subareas were incorrect. With the the new boundaries, they are able to meet their waste load allocations and comply with the TMDL. If the re-evaluation is accepted, then the port can meet the TMDL criteria. If not, it cannot. This study was relatively straightforward.

1. Were the scientific objectives of the approved control study workplan fulfilled? Were the data quality control/quality assurance measures outlined in the report adequate?

The Control Study report details effectively the objectives of the study and the results and conclusions of the work. Overall, the loads are relatively low and are a small fraction of the total regional inputs. The Port of Stockton has a different set of circumstances in that it discharges into two different hydrologic sub-areas – the San Joaquin and the Delta sub-areas. This has unique implications on the allocations and whether they are met are strongly driven by the assessment of the degree to which the port discharges into each sub-area. The scientific objectives of the control study were to investigate whether MeHg accumulates in storm drains and what the impact was due to drain maintenance on the accumulation of MeHg in the storm drain sediments. The study followed the approved workplan.

They sampled storm drain pairs at 3 times each year and once during the maintenance. The original study plan was for 2 years, and they had chosen two locations that seemed adequate, but found that these locations had little sediment accumulation. Two new locations were chosen, and they sampled these for 2 years. The 3 sample times and 2 locations were part of the original workplan, so they fulfilled what they had originally submitted. Their results showed that the control methodology did not have a significant impact on sediment [MeHg].

EPA methods were used as well as field methods for pH, DO, ED, redox, and T. QA/QC procedures were followed including duplicates, blanks, control samples, matrix spikes, and method matrix spike duplicates. Laboratory QC data were reviewed to ensure quality data.

As part of this study, they used GIS to argue that the boundaries of the two subareas were incorrect and adjusted them. By doing so, each area was then met the goals of the waste load allocation. If this restructuring is accepted, then the port can meet the TMDL criteria.

2. Were the methods used in the study adequate to assess the scientific objectives?

This study was straightforward. They sampled over two years, at 3 times, at two locations, and measured both HgT and MeHg as well as other environmental parameters. They wanted to determine the effect of storm drains. The measurements resulted in a lot of scatter in the results, so that there was no trend and not a significant difference over time. However, the methods were approved in the study plan proposal, and the study followed their proposed methods. The main issue with this study is the allocation to the sub-basins rather than with the load determinations themselves. The impacts of the various control strategies within the system, outlined in the objectives above, were small and would not have an overall impact on the load estimation.

3. Are the conclusions regarding the effectiveness of the control measures supported by the monitoring results in the report?

The conclusions of this study were that the storm drains showed no trends for sediment or water [MeHg]. In this, their conclusions are supported by the monitoring results. The conclusions are based on very limited sampling, and the recommendation is that further sampling should be done to confirm these initial findings. The fact that there were issues in finding suitable sites, illustrates that this may not be a substantial problem for the port area. There was no trend as there was scatter throughout the course of the study with no significant trend. The study also states that they cannot conclude whether MeHg is being generated or not in the catch basin sediment. The basins do act as settling basins, and they remove Hg laden sediment, which amounts to about 0.11 g/yr of MeHg from the Port's MS4. It is unclear how much this would affect the actual [MeHg] in the system.

Perhaps there are other locations that could be examined, or other control measures that could be evaluated. However, given the reported removal of material from the systems on a yearly basis, and the [MeHg] of the sediment, this amounts to a small amount of MeHg (~5 mg). Additional removal from street cleaning removes an equivalent amount of MeHg as well. This is a small amount of the total MeHg load allocation to both sub-areas and suggests that the residual sediment in the drains is not the main source of MeHg. Most of the MeHg is transported during water flow events. However, as noted in the report, while the removal of sediment may not have a substantial effect on the loading, it is not an expensive thing to do, and should be continued to contribute to lower MeHg inputs. Overall, however, if the TMDL allocation is met, as it would be given the re-evaluation of the discharges to the two sub-areas, then there may be little gained from further study given that the loads are small and a small fraction of the loading overall to each sub-area.

4. Does the report adequately characterize the source's current and future predicted loads based on methylmercury controls? Did the study adequately address the uncertainty around the load reduction estimates?

The study did not find an effect of sediment accumulation in the storm drains. Separate from that part of the study, the authors revised the waste load allocations by incorporating revised drainage areas. This is due, the authors argue, to the fact that there were inaccuracies in the acreages of urban areas and land-use classifications were incorrect. These adjustments changed the waste load allocation, and the current conditions of [MeHg] multiplied by discharge meets the waste load allocation. The redistribution of the sub-areas decreased the area discharging into the Central Delta and increased the area of the San Joaquin sub-area. Overall, this does not change the estimated WLA into the Central Delta substantially (~20% decrease), but does significantly increase the load to the San Joaquin (~20 times). With these revised allocations, the TMDL can be met based on the evaluation in the report (Tables 10 & 11) – 5 yr average for Central Delta is 0.086 compared to the WLA of 0.32 g/yr; 5 yr average is 0.0069 compared to the WLA of 0.061 g/yr. Under the previous scenario of division of the sub-areas, the WLA for the San Joaquin sub-area would not have been met. Overall, this conclusion is the major outcome of the study, and the allocations will be met if this re-allocation is adopted, and additional measures would not be required. These are well described in the report which gives sufficient detail on all aspects of the study. Uncertainty was not addressed explicitly. The study identified one outlier, which was beyond the 95% confidence interval, so they calculated the current loads with and without the outlier. Even with the outlier, the waste load allocation is met. This work had nothing to do with the control study itself, since the control study was inconclusive.

a) If the study addressed existing controls, how well does the report evaluate existing control methods and, as needed, describe additional control methods (such as scaling up or combining controls) that could be implemented to achieve methylmercury load and waste load allocations? How adequate were evaluation methods, given available resources and workplan scope, in assessing the feasibility of reducing sources more than the minimum amount needed to achieve allocations?

The study did not find that the controls had any significant effect. however, after the revised drainage areas, they were in compliance with their WLA. Given that the control method was inconclusive, and their WLA was met, the study didn't address the feasibility of reducing sources more than the minimum.

b) If the study addressed additional controls necessary to achieve allocations, does the report adequately describe methylmercury and/or inorganic (total) mercury control practices identified by the study and evaluate the effectiveness, potential environmental effects, and overall technical feasibility of the control actions?

The study didn't address additional controls. The current condition meets the waste load allocation.

c) If the control study results indicate that achieving a given methylmercury allocation is infeasible, does the report adequately provide detailed technical information on why full compliance is not achievable and what methylmercury load reductions are achievable?

The study showed that they were meeting the waste load allocations, by adjusting the areas. As long as these changes are accepted, then they will meet the allocation. Otherwise, they will not.

d) Does the report adequately describe how the controls could be adapted over time as climatic and other conditions in the Delta change?

The report does not address climate change or other changing conditions. However, these changes are unlikely to have an effect on the discharges, though this is not discussed.

5. Do you have comments on any other scientific issues related to this study or mercury/methylmercury source?

This study was straightforward and found the drainage basins did not have an effect, or at least was inconclusive. They do discuss, however, that the settling of sediments allows removal of 0.11 g/yr, which is beneficial and should be continued. However, it is unclear if this removal of MeHg would affect the [MeHg] in the system.

6.5 Sacramento Combined Sewer System Report

Background

This review covers the Final Report of the City of Sacramento Combined Sewer System (CSS) Methylmercury Phase I Control Study. The report was prepared by Larry Walker Associates. The study was based on a Work Plan submitted in April, 2013 and was revised apparently in June 2013 based on comments from the Delta MeHg TMDL TAC and the Regional Water Quality Control Board, although the revised plan was not available for review. The Sacramento CSS collects storm water and wastewater together from a portion of the city. Outflow from the system is fed into the Sacramento Regional WWTP except at very high flows (>60 MGD), when the capacity of the CSS reservoirs is exceeded. In high flow circumstances, the system discharges directly to the Sacramento River. Generally, the discharge is retained long enough to undergo primary treatment in the system's storage locations – the Pioneer Reservoir and the Combined Wastewater Treatment Plant (CWTP).

While the current report provides sufficient information on the approach, objectives and hypotheses, there were some concerns raised about the sampling approach and experimental methods, as detailed below. The overall study objectives were to: 1) evaluate plant and conveyance processes to understand their impact on potential methylation, and therefore MeHg load, with specific focus on the impact of storage and solids handling process, and also to identify if there were any methylation "hot spots" in the collection system; and 2) evaluate the impact of stormwater runoff reduction using low Impact Development (LID) control measures, and overall wet weather flow mitigation through specific capital improvement projects.

1. Were the scientific objectives of the approved control study workplan fulfilled? Were the data quality control/quality assurance measures outlined in the report adequate?

Overall, the report sufficiently examined their objectives with the studies they performed although there were some concerns about the methods used, and the interpretation of the data, as detailed below. However, the overall aim of the study was to quantify the impacts of the various proposed control measures on the methylmercury (MeHg) levels and to evaluate their specific objectives and hypotheses and in this sense, the proposed work was adequately completed. The proposed studies were aimed at examining the potential for reducing MeHg inputs from the Combined Sewer System (CSS) of Sacramento as the available data suggested that while it was possible under more typical conditions to meet the TMDL allocation, this was not possible in years of high precipitation/flow. Reducing MeHg load in high flow years could be obtained either by reducing the concentration/MeHg production within the system, or reducing the water flow. Both approaches were examined. More studies may be warranted as it is clear that the conclusions could be bolstered and further supported with more data on the yearly loads, and more detailed sampling, although there do appear to be consistent trends between flow and loading of MeHg. Therefore, while the data to date is still somewhat limited, it is clear that the load is strongly related to flow and this may be the primary variable for control of high loading. The load evaluation was based on more recent historic data (2011- 2018) and it was shown that loading had been reduced by recent efforts compared to the earlier data, so prior controls have had an effect. However, there was no effort made to predict how these may change in the future with climate change and other large-scale changes that are likely well projected for the region from other studies, and could dramatically change rainfall and water flow, the primary control variable. This clearly is an important part of the assessment that has not been addressed, and should be completed, Clearly, if there is large change projected in the future then this needs to be properly assessed in how this would impact MeHg load.

Overall, the report details the conclusions about the studies of the factors within the Pioneer and CWTP plants that may impact MeHg load and most factors examined had little impact on the overall MeHg load. This is likely a function of the short residence time of the water in the plant examined, and this could have been discussed in more detail in the report. There was concern about the sampling strategy as all collections were composites - the study took “composite”, “grab” and “microsamples.” The methods for each type of collection weren’t clear in the text (P3-8) or in the table caption (Appendix A), and more details would have improved understanding of the results. For example: Were the reported microsample or composite values, volume weighted? How many samples made up a composite, and when were they sampled? Were composite samples composited over time or space? What methods were used to take each type of sample - manual or pump sampling? Were all samples taken across the same section of the flow path (this could affect particle concentration) or is it assumed that the flow path solids are well mixed across the cross section? It was reported that the microsampling resulted in less error (reported as relative standard deviations (RSDs)) but how this was evaluated was not presented in any detail. There was a definite need for more detail in the report to help evaluate the results. Appendix A needs a table caption. The data labelled “pollutograph samples” in Fig. 7 are not defined. The data in Fig. 7 is plotted with the assumed 120 min delay between inflow and outflow – surely this timing is dependent on the amount of flow through the system and is not constant? This should be commented on in the report. Also, what is the basis for the regression equation and the formulation of this equation should be based on an understanding of what is happening over time – dilution of solids already in the plant with time? – and not just the best fit to the data. If flow rates are measured at the time of sampling, then it may be better to plot concentration versus flow and examine the correlation. Overall, the results suggest that the effluent MeHg may be higher than the influent, but it is difficult to examine this in detail given the way the results are presented. Also, are the data in Figs 6 & 7 the same? – this does not appear so from the figures.

The data plotted in Fig. 8 are not adequate to support the conclusion in the report that the time since washout doesn’t have an impact – the y-axis scale is large enough that all the values appear similar but this may just be a function of how the data is plotted – it is difficult to ascertain this with the current figure.

The bench tests were also not adequately described and the results obtained are likely not to be truly representative of what would be occurring within the facility. No information was presented on the size of the study containers, but the sediments were

1” deep – assume this is comparable to the facility. The sediments were incubated with influent water for 50 hrs, but is seemed only the water was sampled – dissolved or total MeHg? - over time and not sediments. This was a static test – was the water stirred? – and is therefore unlike the conditions in the treatment plants during a flow event. Were water samples filtered? If not, was the sediment disturbed during sampling – e.g. do the water samples contain much suspended material, and is it consistent across all sampling? Again, the details on the experimental approach are lacking and make it difficult to overall assess the results of the study. Given these concerns with the methods, it is hard to agree with the conclusion that sediment holding time doesn’t impact MeHg in the effluent. One question was why solids retention time was evaluated as solids from CWTP already go to regional Sac WWTP for further processing. As there doesn’t seem to be any reasonable way to control retention time in Pioneer, then is a moot point. Given these concerns, it is unlikely that these results can be extrapolated to other locations.

The studies on the LID concluded that the various approaches investigated would lead to little reduction in MeHg load and were not cost effective. While the examined LIDs will reduce MeHg loads, this would not be enough to ensure compliance with the WLA in years with high-flow events. The report concludes that the cost for enough retrofitting to the LIDs to meet the WLA in high flow years would be >$1 Billion. As noted above, reducing flow is the most effective way of reducing MeHg load. The city has a Long Term Control Plan (LTCP) in place, but only 20% of the overall Combined Sewer System Improvement Plan (CSSIP) will be implemented by 2028 (at a cost of $67 Million), and this would result in <1% increase in flows by 2028 (relative to 2013). It was not clear in the report exactly was is included in the LTCP. Full implementation of the CSSIP (cost of $403 Million) would reduce MeHg load by 17% relative to 2013 baseline – this is again not enough to meet the WLA in high flow years. Overall, it appears that it is not feasible to meet the WLA if this is based on yearly loads, but it would be feasible if the load was averaged over more than one year.

2. Were the methods used in the study adequate to assess the scientific objectives?

Some of the concerns about methods are detailed above. For the Pioneer study, the results are not sufficient to support the main conclusion that holding time does not impact the concentration, based on the comments above. Also, as there was variability in the timing between the collections of influent and effluent samples, and given the rapid changes in concentration with time in Figs. 6 & 7, the comparison of samples and the relative differences are clearly a function of the elapsed time between influent and effluent sampling. This needs to be considered and discussed in the report.

In terms of the discharge, the report properly describes the loads and highlights the primary variable involved in driving the load, and the primary variables controlling achievement of the TMDL or not. The allocated TMDL load for the SCSS is 0.53 g MeHg/yr and the 2010 - 2018 average load was 0.32 g/year. Two of the last nine years exceeded the WLA. However, the 5-year rolling average MeHg annual load has consistently been below the WLA. It should be noted that prior improvements have already reduced flows - a 44% reduction for the 2004-2018 annual flow rate (281 MG) versus the baseline flow rate from 1993 - 2003 of 476 MG. The report discusses the importance of water flow and how this correlates with load, and provides a flow value over which load exceedance would likely occur. It is worth noting that the so-called "high flow years" are years with high flow events and the load is strongly driven by the number of these events, rather than the total flow. So, while the total flow and number of events are likely related, it is control of water discharge during high flow events that is the main factor for MeHg load. The report makes a valid point about the impact of the timescale of the load evaluation. If the evaluation is done independently for each year, then exceedances will occur in high flow years, but if some averaging was instituted – the report suggests a 5 year running average - to offset these higher values, then it is much less likely that there would be exceedances. This is a valid point and something worthy of further discussion – is the TMDL necessarily focused on yearly loads given that these can vary widely because of climate and seasonal differences?

3. Are the conclusions regarding the effectiveness of the control measures supported by the monitoring results in the report?

The impact of processes within the plant are discussed above and need to be better described in the report, and while it seems somewhat incongruous that these different processes did not have any major impact on the MeHg load given the various factors that impact net Hg methylation, but it likely represents a residence time issue: that the water flow is high enough that the residence time is too low for processes of methylation/demethylation to have a substantial impact. Overall, the results are very curious in that the impacts of the different treatments are so minimal. Perhaps some more discussion of the expectation versus the actual outcomes should be included in the report given that most of the examined control measures had little impact on the MeHg levels, according to the report's conclusions.

4. Does the report adequately characterize the source's current and future predicted loads based on methylmercury controls? Did the study adequately address the uncertainty around the load reduction estimates?

a) If the study addressed existing controls, how well does the report evaluate existing control methods and, as needed, describe additional control methods (such as scaling up or combining controls) that could be implemented to achieve methylmercury load and waste load allocations? How adequate were evaluation methods, given available resources and workplan scope, in assessing the feasibility of reducing sources more than the minimum amount needed to achieve allocations?

There were additional potential controls presented and discussed and these did not make any significant changes to the loads and were considered to be ineffective given a cost benefit analysis. The conclusions appeared to be appropriate in this regard. As noted above, if there was some consideration on averaging loads over longer time, then these investigated measures would not be necessary.

b) If the study addressed additional controls necessary to achieve allocations, does the report adequately describe methylmercury and/or inorganic (total) mercury control practices identified by the study and evaluate the effectiveness, potential environmental effects, and overall technical feasibility of the control actions?

Overall, based on information discussed in the report there has been substantial effort made already to reduce loads and further costly efforts are not likely to provide sufficient additional benefit. The Pioneer facility is perhaps an exception here and there is no discussion really of what the long-term goal for this facility is. Clearly, how overall flow changes in the future is the main concern and efforts to reduce flow are the most important area of focus.

c) If the control study results indicate that achieving a given methylmercury allocation is infeasible, does the report adequately provide detailed technical information on why full compliance is not achievable and what methylmercury load reductions are achievable?

As already noted above, the report provides an adequate justification of why the load is not met in some years, but not all the time, and provides a reasonable alternative way to examine the load relative to the criteria.

d) Does the report adequately describe how the controls could be adapted over time as climatic and other conditions in the Delta change?

The report needs to make a better effort to discuss the potential impacts of climate change as this clearly will have a substantial impact on the actual load because of the strong relationship to flow. Other potential changes in the future are not discussed.

5. Do you have comments on any other scientific issues related to this study or mercury/methylmercury source?

Firstly, as noted above, it appears unusual given the factors that are known to control methylation/demethylation that none of the scenarios that were examined made any significant difference to the MeHg concentration, or that the effect was small enough that it was not clearly evident given the variability in concentration over short timescales. This could also be an issue related to the experimental design which may not have been an adequate representation of the natural conditions. Some thoughts on why there was no effect on MeHg could be presented in the report: 1) is this just a flow rate issue for the plants that the water residence time in the plant is small; 2) are the rates of methylation/demethylation fast enough that the system reaches steady state quickly so these examined changes do not result in a net change across the plant; or 3) is this reflective of the partitioning dynamics and the removal of MeHg with solids leaves a residual water column concentration that is driven mostly by the residual suspended solid load, which is relatively consistent over the control studies.

It is noted that improvements to Pioneer in ~2000 resulted in a reduction in the discharge volume of untreated water. However, as discussed above the overall volume in wet years is still high and it is not clear if this will be the case when upgrades are completed. Also, are other approaches possible to reduce untreated flows from SWCP?

What is the ongoing fate of Pioneer Reservoir as it could not be sampled because of safety issues and if it is replaced this may have a substantial impact on flows? Are there other long-term plans that would be useful to discuss in terms of the larger Sacramento area?

6.6 Central Valley Clean Water Association

Background

The purpose of the MeHg Control Study was to evaluate existing methods used to control MeHg discharges from the MeHg SPG wastewater treatment facilities (SPG Facilities) and to identify the effectiveness of applying additional MeHg control methods to meet Total Maximum Daily Load (TMDL) waste load allocations(WLAs) that have been prescribed for the Sacramento-San Joaquin Delta and Yolo Bypass. The SPG Facilities include 14 of the 20 facilities that discharge to the MeHg TMDL Project Area under NPDES permits and are assigned WLAs under the Delta MeHg Control Program, plus six additional NPDES Facilities that discharge outside the boundary of the MeHg TMDL Project Area. The 14 SPG Facilities that have WLAs assigned represent 99.5 percent of the total NPDES Facility WLA assigned under the Delta MeHg Control Program. All of the WWTP's have at least secondary treatment, all but three (Yuba City, Rio Vista, Discovery Bay) have plans to upgrade to tertiary plus nitrification/denitrification by 2030.

1. Were the scientific objectives of the approved control study workplan fulfilled? Were the data quality control/quality assurance measures outlined in the report adequate?

The three stated overall objectives of the work plan were clearly articulated and addressed.

OBJECTIVE 1: Determining whether treatment process improvements that have recently been completed or are planned to be completed by 2030 result in statistically significant reductions in MeHg loads such that WLAs are met.

The control study determined that the planned or already completed treatment process improvements will result in statistically significant reductions in MeHg loads (compared 2030 estimated loads [3.65 g/yr] to 2004-2005 measured loads [131 g/yr for TMDL affected SPG facilities]).

OBJECTIVE 2: Considering the potential for load reduction benefits associated with blanket application of additional treatment control methods at individual NPDES Facilities beyond those that are already implemented and/or planned.

The control study determined that no statistically difference for estimated ("planned") loads in 2030 between blanket application of Secondary vs Secondary+N, but there were statistically significant differences between Secondary vs Secondary+NDN or Tertiary+NDN. However, these differences are very small (<2g/yr).

O*BJECTIVE 3: Assess whether the variability observed in influent MeHg concentrations is statistically correlated to the variability observed in effluent MeHg concentrations at different treatment levels in order to evaluate the potential for load reduction benefits associated with additional source control methods.*

The control study determined that influent and effluent MeHg variances are not statistically correlated, suggesting that all of the treatment levels provide some degree of MeHg removal. Interestingly, the report found that at higher treatment levels, the variability in effluent MeHg concentrations is less controlled by the influent concentrations, suggesting that source control measures to reduce influent concentrations would have a limited impact on reducing effluent concentrations.

Overall, this report fulfilled the listed scientific objectives from the study workplan, in a detailed, data-driven way. Quality assurance was appropriate and adequate, and data analyses was undertaken in a sophisticated way (see next point).

2. Were the methods used in the study adequate to assess the scientific objectives?

Yes, the methods used were adequate and satisfactory. The report is scientific in its approach and rigorous in analyses and interpretation of data.

The report authors should be commended for their sophisticated handling of their data analysis, and in particular non-detects, which are common when dealing with ultra-trace contaminants. It is rare to see either a scientific or a consulting report apply Helsel's robust method for the handling of non-detects, and given that non-detects need to be incorporated into load calculations in some way shape or form (given that they are not 'zero'), it is recommended that a method such as this be applied to all Control and Characterization Studies. An alternative would be to assume that all non-detect values are equal to the method detection limit (or more appropriately the method reporting limit if working in strict compliance with USEPA Methods for ultratrace mercury or methylmercury analyses), but this would result in a conservative overestimate of concentrations and loads that may not be defendable under the TMDL framework. Certainly, Helsel's method is more satisfactory than assuming that non-detects are equal to half of the detection limit calculation (something done in other Control Reports).

Only a couple of relatively minor questions arise from the methods of the study:

1) In the description of sampling techniques, it is stated that water sampels were "generally" conducted using ultra-clean sampling techniques – what does that mean? 90% of the time? Always except once or twice? This is not a serious issue, but is a curious choice of language.

2) Is the "Water Conservation Factor Adjustment" for future loads set at 5% reasonable? It is not clear where this value comes from, and indeed speaks to issues related to uncertainty in future climate, population and land-use issues that are not fully addressed.

3. Are the conclusions regarding the effectiveness of the control measures supported by the monitoring results in the report?

Yes, the results of the report support the conclusion that most of the treatment facilities are already in attainment of WLAs, and that planned future upgrades (whether to tertiary or secondary treatment) will meet or exceed TMDL criteria. Unlike many of the control studies that used only single/pilot sites to draw conclusions, the number of facilities monitored was sufficient to support these conclusions.

4. Does the report adequately characterize the source's current and future predicted loads based on methylmercury controls? Did the study adequately address the uncertainty around the load reduction estimates?

Did discharge calculations for WWTP with intermittent flows take into account drought conditions when forecasting forward, as the number of discharge days was calculated from a period that included drought years (Sep. 2011 – Sep. 2014)?

a) If the study addressed existing controls, how well does the report evaluate existing control methods and, as needed, describe additional control methods (such as scaling up or combining controls) that could be implemented to achieve methylmercury load and waste load allocations? How adequate were evaluation methods, given available resources and workplan scope, in assessing the feasibility of reducing sources more than the minimum amount needed to achieve allocations?

The report clearly identifies how planned improvements will result in a greater than 95 percent reduction in MeHg loads discharged to the MeHg TMDL Project Area among the Delta MeHg Control Program Dischargers, relative to 2004-2005 levels. The report clearly demonstrates that although treatment levels beyond secondary result in a statistically significant reduction in methylmercury load, it is a very small reduction on an already significantly reduced load. We agree that the proportionally small decrease in load is difficult to justify given the cost associated with the implementation of more advanced treatment techniques.

b) If the study addressed additional controls necessary to achieve allocations, does the report adequately describe methylmercury and/or inorganic (total) mercury control practices identified by the study and evaluate the effectiveness, potential environmental effects, and overall technical feasibility of the control actions?

The dischargers associated with this Control Study do not require additional control measures to achieve allocations as they are already within allocations and forecast significant future reductions by simply phasing in planned improvements. As such, 'additional controls' are planned technical improvements that are adequately described.

c) If the control study results indicate that achieving a given methylmercury allocation is infeasible, does the report adequately provide detailed technical information on why full compliance is not achievable and what methylmercury load reductions are achievable?

Not applicable. The methylmercury WLA is feasible and loads will be significantly less than the allocation in the future.

d) Does the report adequately describe how the controls could be adapted over time as climatic and other conditions in the Delta change?

The report addresses climatic change to a limited degree by considering facility performance over different hydrological conditions. The report authors compared influent and effluent MeHg values across SPG facilities treatment levels of interest across three years with differing hydrologic conditions (Normal 2010; Dry 2016; Wet 2017). Only tertiary+NDN had a statistically significant difference between effluent MeHg when comparing the wet to the dry water year (slightly higher in the wet year, but still below the WLA).

From an adaptive management perspective, it would be useful to consider these results further broken down by season, or by POTW to see if there are differing sensitivities among facilities to changing influent characteristics in wet vs. dry years. The analysis and reporting of ongoing monitoring efforts could be easily adjusted to answer some of these questions. Evaluating data in this way would permit deeper consideration of aspects of land-use or population change in the Delta as well given the presumably differing catchments of the facilities. This is a more of a scientific question than one associated with WLAs and the TMDL – this is not necessarily a statement of requirement of future reports by permit holders.

5. Do you have comments on any other scientific issues related to this study or mercury/methylmercury source?

This was a very well executed and superbly presented report and is a model for other studies. The conclusions of the report are uncontestable - The SPG Facilities' WLAs are currently being satisfied, and by 2030 the MeHg loads are estimated to be 0.074 percent of the total MeHg TMDL Project Area WLA. Current planned developments and facility upgrades will facilitate these reductions, and no specific action is required to further reduce already small loads to the Delta from these sources. Certainly, we are also in agreement that there is an unjustifiably low 'return on investment' when considering facility treatment system upgrading for measurable changes in methylmercury loads that would be an unquantifiably small in the overall mercury mass balance of the Delta.

Recommendations made in Section 9 for the overall project seem to be very reasonable and supported by the information in this report. We respect the argument for POTW being a *de minimus* source that could be permitted/allocated as a large single entity source, but support continued monitoring in order to better constrain the performance of the different facilities under a suite of environmental changes that are expected in the Delta.

6.7 California Department of Corrections Deuel Vocational Institution (Municipal Wastewater)

Overview

The CA Department of Corrections and Rehabilitations had a study plan to bring the Deuel Vocational Institute (DVI) into compliance with the Delta Mercury Control Program. The first objective of this study was to determine if inorganic or methylmercury concentrations change due to advanced wastewater treatment. The study collected [HgT] and [MeHg] in the influent and effluent monthly from Feb to July in 2013. The work found that [HgT] and [MeHg] both decreased from influent to effluent. The removal rate for [HgT] ranged from 94.2% to 99.6%, and the removal rate for [MeHg] ranged from 87.5% to 97.8%. Originally, there was a second objective, which was to test if [HgT] and [MeHg] can be reduced by source control. The second objective study was not done because the waste load allocation had been met.

Specific scientific questions for review of the 2019 control study reports:

1. Were the scientific objectives of the approved control study workplan fulfilled? Were the data quality control/quality assurance measures outlined in the report adequate?

The first objective of the control study workplan was fulfilled. They set out to address how [HgT] and [MeHg] changed due to the WWTP. The study plan was designed to sample influent and effluent monthly, and then to test if inorganic and methylmercury can be reduced through source control. The study sampled monthly, for 6 months from February to July, for MeHg and HgT in influent and effluent. They found that throughout the time period, both were reduced by at least 87.5% for MeHg and 94.2% for HgT. Given they were meeting their allocation, the second objective was not carried out and for good reason.

Sample collection methods and analytical methods are presented, as well as QA/QC. Sample analysis was conducted by accredited laboratories that used standard chain-of-custody procedures. Standard methods (EPA 1630 and 1631E) were used. Quality control measures included field and laboratory blanks, field duplicates and matrix spikes. All MeHg field blanks were measured below detection limits. There were a few field blanks for THg with values in the <2 ng/l, but nothing with outrageous contamination issues given the observed, relatively high influent concentrations. There is some relatively large variation around duplicate measurements of influent water, which is explainable by variations between separate measurements and the less homogenous chemical conditions of influent water. A good practice to encourage here for duplicate sampling is to do “splits” under such a condition, since the main purpose of duplicates is to understand analytical precision/replication. “Splits” (one larger sample split into duplicates in the lab) would suffer much less from sampling bias. Matrix spike and matrix spike duplicate results seem mostly reasonable with only a few samples outside of the rather broad 65-135% recovery bounds.

2. Were the methods used in the study adequate to assess the scientific objectives?

The methods for this study were straightforward. They followed the approved study plan. They measured influent and effluent concentrations of both HgT and MeHg, monthly for 6 months. Based on their method they were able to conclude that there were reductions of approximately 90% for both HgT and MeHg. While meeting the objectives, the study only sampled for 6 months, February to July, 2013. Some additional data, like sediment concentrations in water samples would have been helpful to more clearly test hypotheses about sediment flushing and some rather high THg concentrations in influent samples.

3. Are the conclusions regarding the effectiveness of the control measures supported by the monitoring results in the report?

The conclusions are supported by the monitoring results. The DVI waste load allocation is met through the treatment plant, so no additional study of control measures was deemed necessary, and, therefore, was not a part of the study. This study simply looked at the concentrations before and after the WWTP. Therefore the WWTP was the only control measure and no other control measures were investigated. (Study Objective 2 was dropped). Removal of MeHg ranged from 87.5% to 97.83%, with effluent concentrations of 0.02 to 0.06 ng/L (0.02 is the detection limit).

4. Does the report adequately characterize the source's current and future predicted loads based on methylmercury controls? Did the study adequately address the uncertainty around the load reduction estimates?

The report briefly discusses the source's current loads. Adding a source control would not reduce methylmercury load, as effluent has low methylmercury concentrations ([MeHg]). The report did not discuss uncertainty around the estimates directly, as [MeHg] in effluent was near detection limits and the current effluent load was below the waste load allocation.

a) If the study addressed existing controls, how well does the report evaluate existing control methods and, as needed, describe additional control methods (such as scaling up or combining controls) that could be implemented to achieve methylmercury load and waste load allocations? How adequate were evaluation methods, given available resources and workplan scope, in assessing the feasibility of reducing sources more than the minimum amount needed to achieve allocations?

For this study, the current situation is meeting the waste load allocation, so the study only measured the current condition of influent and effluent concentrations. Because the load allocation was met, the study states that they did not further pursue any of these concerns. Their control method varied over the course of the study, with one sample reaching 0.06 ng/L. They don't discuss how to control for variability in the effluent, though the effluent ranged from 0.02 to 0.06 ng/L, which is either meeting the criterion or better, which feasibly results in reducing sources beyond the minimum amount.

b) If the study addressed additional controls necessary to achieve allocations, does the report adequately describe methylmercury and/or inorganic (total) mercury control practices identified by the study and evaluate the effectiveness, potential environmental effects, and overall technical feasibility of the control actions?

No additional controls were addressed.

c) If the control study results indicate that achieving a given methylmercury allocation is infeasible, does the report adequately provide detailed technical information on why full compliance is not achievable and what methylmercury load reductions are achievable?

The MeHg load allocation is being met.

d) Does the report adequately describe how the controls could be adapted over time as climatic and other conditions in the Delta change?

The report does not discuss climate change or other conditions. The WWTP will continue to monitor for HgT and MeHg as part of its NPDES. If conditions change, and the measurements exceed the waste load allocation, then they may investigate additional options, including implementing Study Objective 2.

5. Do you have comments on any other scientific issues related to this study or mercury/methylmercury source?

This study was straight forward. Since the WWTP was reaching its waste load allocation, the study stopped with completion of Objective 1. For what the study set out to do, it accomplished it rather simply. The one thing that this study did show is that the plant was able to reduce both total and MeHg by approximately 90%, which allowed them to meet the criterion or do even better. Although these met the study plan, the study only ran from Feb to July, so it would be useful to know how it does the rest of the year to make sure it doesn’t increase on a certain month.