Written Comments for AMSA Hg P2 Draft Report

Comments received during the writing of this report are listed below. They are organized according to topic in the approximate order that these topics are discussed in the report. The authors have provided a written response for each comment indicating whether it was incorporated into the final report and detailing why certain comments were not incorporated.

Health and Environmental Impacts of Mercury

1. Add the following on health impacts of mercury exposure to the introduction. "A recent study completed by the National Academy of Science (2001), estimates that 60,000 children are born each year in the U.S. with learning disabilities due to the effects of mercury poisoning. It is further estimated in the report that up to 1.5 million pregnant women are exposed to high levels of mercury through the consumption of fish."

Response: It is acknowledged at the beginning of the report that mercury exposure has serious adverse health effects. The extent of these effects or the details of these effects is irrelevant to the rest of the report. The objective of this study is to determine if pollution prevention is an effective approach to achieving effluent limits. The objective of the study is not to assess the validity of the criteria. Therefore, this information was not added to the report.

2. There should be a separate section that more thoroughly discusses the effects of mercury on human health and wildlife (the Great Lakes wildlife criterion is one of the more stringent criteria in Table 1) that forms the basis for aggressive action on the part of municipalities.

Response: See the above response. There are several other issues that factor into the need for aggressive action by POTWs including whether or not their efforts will have the desired effect. These issues are presented in the report. Again, this study does not seek to dispute the seriousness of the adverse health effects of mercury. This information was not added to the report because it was not directly relevant to the objective of the report.

Water Quality Criteria

3. Attached is my calculation of water quality criteria from EPA's fish tissue residue criterion. The differences between this and EPA's calculations are probably attributable to differences in rounding. In any case, the differences are trivial.

Response: To account for the slight differences in the calculated water quality criteria based on the fish tissue residue criterion , the values in Tables 1 and 9 are expressed as ranges (i.e., Rivers and streams: 17-18; Lakes: 7.5-7.8)

4. Because the Great Lakes Initiative's 1.3 ng/L criterion is for the protection of wildlife, the second sentence in the first paragraph of the Introduction on page 1 should be changed to:

"The effects of mercury exposure on human health and wildlife drive these efforts."

Response: This change was made.

5. In Table 1 on page 2 and in Table 9, there should be a footnote or some other indication clarifying that 7.8 ng/L is not an actual water quality criterion. It is a projected criterion for total mercury in lakes and reservoirs that has been calculated from the national fish tissue residue criterion for methylmercury using, as default values, draft bioaccumulation factors, trophic level-specific fish consumption rates, and dissolved methyl-to-total mercury translators. The actual water quality criteria, when they eventually are determined, could be either much lower or much higher.

Response: This footnote was added.

6. The reason for increasingly stringent water quality criteria should be explained using phrasing like "Due to application of increasingly stringent water quality criteria by EPA as a result of the increasing contamination of the U.S. fish supply, NPDES permits are being issued to POTWs that more and more often include very low mercury effluent limits."

Response: We did not find information to indicate that contamination of the U.S. fish supply is increasing. However, concern for mercury in fish tissue has increased leading to more stringent water quality criteria for mercury. Therefore, the second paragraph of the report was added to clarify the reason for EPA and the States applying mercury water quality criteria. This paragraph states: "Increased monitoring of mercury in the water column and fish tissue and the application of more stringent standards has led to increasingly stringent mercury effluent limits in NPDES permits. The more stringent standards are the result of the use of a new calculation procedure intended to protect unborn children. The more stringent standards are based on use of a reference dose (daily intake) value derived from a study of child-bearing women and their offspring in the Faroe Islands. The reference dose value is intended to ensure zero risk to children of women who consume fish at the 90th percentile national consumption rate of 17.5 grams per day."

7. For the National Recommended Water Quality Criteria of 12 ng/L: Not sure where this criterion came from (1984 human health criterion?) but it should be replaced with EPA default values, see next comment. Also, for the EPA Fish Tissue Methyl Mercury based Criteria of 7.8 ng/L: This criterion (correct value is 7.5 ng/L) is applicable only to lakes if it is based on the default values in EPA's 2001 guidance. The rivers and streams criterion is 17.1 ng/L. Both of these

criteria should be shown in Table 1. Table 9 should also be revised to reflect these comments.

Response: **T**he criterion of 12 ng/L was the Freshwater Final Residue Value for methylmercury in the 1986 EPA "Gold Book" of National Recommended Water Quality Criteria. It was derived by dividing the FDA Action Level for mercury in fish (1.0 mg/kg) by a freshwater bioconcentration factor (81,700 L/kg). This criterion became the Freshwater Criterion Continuous Concentration for mercury in the 1992 EPA National Toxics Rule (40 CFR 131.36), and it remains the human health water quality criterion for mercury in many States (including for the Ohio River Basin in Ohio). However,12 ng/L was removed from these tables and replaced with the California Toxics rule criteria of 25 ng/L. Fish tissue based criteria for lakes and for rivers and streams were added to the tables and included in the analysis.

8. The report should explain that more stringent water quality criteria are due to the fact that the food supply has become increasingly contaminated from mercury and that this is especially problematic for people and wildlife that consume or subsist on fish. Further, as the sources, routes of exposure and toxicology of mercury have become better understood, water quality criteria for mercury have become more protective. As a result, POTWs are being asked to do more because they can significantly reduce the amount of mercury entering the environment (air, land and water) through aggressive P2 efforts. Thus, NPDES permit limits for mercury may be issued to more POTWs if their effluents have reasonable potential to violate water quality standards for mercury or if the waters they discharge to are already violating standards. However, this may have little affect on POTWs other than to require them to implement P2 because, based on limited data, many POTWs already have effluent mercury concentrations that are well below the EPA human health mercury criterion of 17.1 ppt for streams and rivers, and very close to compliance for those few POTWs outside the Great Lakes Basin that discharge to lakes where the EPA human health criterion is 7.5 ppt (mercury criteria based on EPA 2001 fish tissue methylmercury criteria and default values).

Response: See responses to comments 6 and 7. With respect to the comment regarding more POTWs getting permit limits, this was added to the report on page 1, 3rd paragraph. Whether or not POTWs can significantly reduce the amount of mercury entering the environment was the subject of this report. The report concluded that in many cases, measurable influent reductions can be achieved and that discharges to other media can also be reduced. However, there was not enough information regarding discharge to other media to allow us to quantify these efforts or determine if they were significant. The report also concluded that many POTWs could comply with a 17 ppt effluent limit and that P2 may be helpful in achieving a 7.5 ppt effluent limit.

Pollution Prevention Program Effectiveness

9. P2 effectiveness at hospitals is shown at 30%, yet many of our hospitals are moving towards becoming mercury free, and some have achieved that goal. This looks like 100% effectiveness to me.

Response: An effectiveness of 30% load reduction was used based on mercury levels measured in discharges from hospitals as reported by two agencies (Detroit and MWRA) before and after the implementation of BMPs by these hospitals. The report acknowledges that load reductions may be greater as hospitals move to mercury free operation. However, the load reduction may not be 100% due to the possibility of residual mercury collecting in the hospitals' plumbing. The load reduction used is the best information available because it is based on actual measurement of wastewater discharges.

10. This report is a "theoretical" paper on the impacts of mercury P2 on POTW effluents. There simply is not "experimental" verification of predicted results at this time because few, if any, POTWs have done all of this P2 work with sufficient history to demonstrate just how low mercury in the effluent will in fact go. That is not a criticism of this report, only a reflection of the current state of affairs. I continue to be concerned that theoretical failure of mercury P2 to achieve POTW final effluent compliance will be used by biased readers to justify not doing P2.

Response: The report acknowledges this limitation of the study-that it is indeed largely theoretical. However, it is based on measured results. The theoretical aspect is that measured results from a variety of sources are combined and applied to communities other than where results were measured and the very important fact that there is not direct measurement of effluent reduction as a result of implementation of the programs designed in this study. However, the report concludes that measurable influent reductions may be achieved by source control and pollution prevention. In addition, there are numerous other environmental benefits that may be realized as a result of these programs and the influent reductions achieved may be beneficial with respect to achieving effluent limits greater than 6 or 7 ng/L. However, very low effluent limits are unlikely to be met based on reductions from source control programs. There are enough positive impacts of pollution prevention identified in the report to be useful in encouraging its implementation by POTWs.

11. Pollution prevention programs have proven ineffective in reducing mercury effluent levels and regulatory programs have proven to be more effective. Revise certain sections of the report to reflect this. Suggested revisions to the introduction are highlighted.

"Pollution prevention programs have been implemented on a limited basis around the country in an effort to address the sources of mercury pollution."

Response: This was not added because we are aware of significant pollution prevention efforts targeting mercury in most parts of the country where mercury effluent limits have been set including the North East, the Great Lakes region, the San Francisco Bay area and Puget Sound area.

Add to discussion of low mercury effluent limits in introduction. "Currently, POTW's whose NPDES require any mercury reduction is limited to approximately 6% of the municipal POTW's."

Response: This was added to the report on page 1.

"Non-regulatory approaches such as pollution prevention and source reduction programs have proven ineffective in achieving reductions for mercury in POTW effluents. King County, Washington obtained less than one percent participation from the local dental community with a voluntary program. POTWs that have implemented regulated or partially regulated mercury reduction programs have achieved mercury reductions in their effluent."

Response: This revision was not made. The point of the statement was that pollution prevention has proven effective for other constituents which is why it is worth considering for mercury. The report acknowledges that source control programs and other programs with regulatory elements are more effective in that higher participation rates are realized. However, there is limited information on the

connection between regulatory programs and mercury effluent reductions particularly in the range of effluent concentrations for the Case Study agencies.

12. In the section explaining how the reduction estimates were calculated it should be indicated that pollution prevention programs which typically rely on voluntary actions have proven generally unsuccessful and that, for commercial sources, voluntary programs are not proven to be effective. Alternatively, the data that supports the assertion that voluntary programs are effective should be cited.

Response: References were cited that describe effective voluntary programs. The Water Environment Research Foundation recently completed such a study that is cited in this report.

13. References should be cited for the sources used to get the load factors of 80% amalgam is captured by amalgam traps and that 50% of amalgam use in a dental practice comes from placing fillings. The Canadian study (O'Connor Associates) shows more mercury is being removed as old fillings versus replacements.

Response: References were cited (i.e., MWRA, 1997; WEF,1999)

14. When discussing the basis for the load factors developed based on Detroit and MWRA hospital programs, it should be noted that this program was not an entirely voluntary program. Hospital participated or were under threat of fine.

Response: Load factors are the percent reduction that can be achieved if the practice is implemented regardless of why it is implemented. The impact of a regulatory or voluntary approach is factored into the participation factor, which is arrived at separately. This change was not made.

15. The statement under the discussion of the Effectiveness of Hg P2 Programs regarding agencies with mature P2 programs like Palo Alto and WLSSD would lead one to conclude that their strategies are fully implemented and extremely successful. Has Palo Alto had success, for example, reducing dental discharges or hospital discharges?

Response: The point of the report's statement regarding mature P2 programs was that whatever reductions could be achieved by implementing pollution prevention strategies had been achieved because they were fully implemented. To conclude that voluntary strategies for dentists and hospitals were fully implemented by Palo Alto and WLSSD would be a correct conclusion. In addition, with respect to participation, their programs are extremely successful in that they have close to 100% cooperation/compliance. It is acknowledged that there is a limit to the reductions in loads that may be achieved by implementation of several of the strategies considered in the report as noted by the load factors used.

16. Also in the section on Effectiveness of Hg P2 Programs, it should be noted that educating dentists regarding proper disposal of amalgam wastes will reduce the

amount of these wastes that go to solid waste or to biohazardous waste only if the proper handling of amalgam wastes incurs no additional cost to the dentist.

Response: This was added to the report in the first paragraph under Benefits to Other Media.

17. Under Impact of Assumptions it should be stated that using higher values for dental discharges would have significant impact on the estimated load reductions.

Response: This was stated under Impact of Assumptions.

18. Need to discuss that current voluntary-based P2 and legislative efforts are not adequate and more needs to be done, and that municipalities can take the lead in facilitating change by influencing State legislation and local regulations, and by reducing mercury in the environment through aggressive P2 efforts.

Response: The section under Findings, "Benefits to Other Media", describes how municipalities' P2 programs can have benefits outside their service areas and with respect to reducing the environmental release of mercury.

19. The statement "In the case of residential sources, agencies do not have the authority to regulate residents so, except for product bans, voluntary approaches are the only strategies available" is misleading. Local city and county health and building codes can be modified to regulate residential sources of mercury; however, it is the responsibility of the "agencies" that are responsible for managing POTW's that must make city and county officials aware of what needs to be done so that the appropriate city and county agencies responsible for the health and building codes can make the appropriate modifications to their regulations. This issue was raised in my earlier comments using laundry graywater as an example and is shown below in *italic* for continuity.

The major point here is that there are building codes that can be modified to achieve "regulatory" compliance for households. If graywater is a significant problem (also, I would like to see the study that supports this assumption), then separate, small septic systems could be required for household laundry disposal. The mercury from wash water would settle in the septic tank, and relatively clean effluent could be dispersed in a small drain field or attached to a sewer connection. Obviously this should only be considered where simpler and less costly actions have been ineffective in reducing effluent concentrations, but there is no basic reason why it could not be required by any government entity that establishes building codes. Product substitutes or State/local prohibitions can also be effective where certain products are shown to be a substantial source of mercury to POTWs.

Response: This is addressed in the discussion of participation factors in the Reduction Estimate discussion in the Procedures section. There are several examples of POTWs working to make changes that are outside there direct control such as promoting

legislation or changing building codes. Under the right circumstances several agencies working together have been able to promote successful legislation banning or restricting the use of certain products. However, attempts to change building codes have been less successful. The results of these experiences are factored into the analysis through the participation factors. With respect to graywater systems, there are several issues related to installing graywater systems that simply modifying the building codes will not address including the need to properly maintain the system and the space (landscape) requirement necessary to install a workable system.

20. Table 4 should be expanded to include a regulatory option for those strictly voluntary programs such as commercial-hospitals, laboratories, etc., and residential-laundry graywater that could significantly improve participation and P2 effectiveness through local regulations. The regulatory approach for dentist should include amalgam separators with additional technology such as ion exchange or ion capture technologies, which would bring the Load Factor up in the range of 99 to 99.9 percent depending on the technology selected. Amalgam separators remove particulate but the load used for dentists (0.056 gm/dentist/day) only accounts for dissolved mercury so dentists discharging 0.056 grams per day are probably already using amalgam separators or the particulate amalgam load from dental offices is just being ignored in this analysis. As stated in my earlier comments, the load from dental offices should include mercury bound in amalgam particulate to remove this apparent bias and accurately demonstrate the effectiveness of different P2 strategies.

Response: An all voluntary approach and a semi-regulatory approach were used to show the difference in what could be achieved depending on the type of program. In addition, based on what we have observed in agencies around the country, these levels of effort are within the range of what POTWs can achieve with resources typically available to them so these seemed to be reasonable scenarios to use. Adding more regulatory scenarios would not add significantly to the useful information generated by the report. It is noted in the report that there is a limit to the reductions that can be achieved based on the portion of the influent load that is uncontrollable (i.e., human waste and some other residential sources). Comment #25 discusses the reason that dental loads were calculated using wastewater sampling results and why this is the most appropriate approach to assessing the effectiveness of pollution prevention with respect to achieving wastewater influent reductions.

21. The standard pollution prevention program should be renamed “basic or basic-voluntary” pollution prevention program since reductions are based primarily on voluntary P2 efforts for the most significant commercial and residential sources of mercury. This basic-voluntary program would be suitable for POTW’s that currently do not have mercury permit limits (about 4,000 POTWs nationwide) and want to reduce, for good public policy reasons, mercury releases to the environment. The “new” standard pollution prevention program should contain a balance of voluntary and regulatory efforts with regulatory efforts focused on major sources of mercury. The new standard program is for POTWs that

currently have mercury permit limits and want to do a better job of reducing mercury in their sludge and effluent. The deluxe pollution prevention effort should have more regulatory efforts than voluntary and be designed for POTWs that are out of compliance with their mercury permit limits. Having three levels of P2 programs (basic-voluntary, standard, deluxe) will better distinguish what degree of control is necessary to achieve different mercury reduction targets.

Response: The two scenarios were renamed pollution prevention/all voluntary and source control/semi-regulatory. We chose not to add a third scenario because it did not appear to add useful information to the report. The sensitivity analysis addresses some of the extreme impacts that varying the assumption can have.

22. Pollution prevention typically refers to programs based on voluntary actions. In this report, pollution prevention is used to refer to both regulatory and voluntary programs. The distinction between voluntary and regulatory programs needs to be made more clearly. Perhaps the term Source Control should be used to refer to both types of programs and P2 should just refer to voluntary approaches.

Response: The two scenarios were renamed pollution prevention/all voluntary and source control/semi-regulatory.

23. It should be noted that voluntary programs over a longer time period can be as effective as regulatory programs over a short time period.

Response: This was added to the report.

24. I have two suggestions, both relating to the cost and impacts of creating regulatory requirements for dentists. First, you might want to refer to a Danish study by Professor Dorthe Arenholt Bindslev, in Environmental Aspects of Dental Restorative Materials, A Review of the Danish Situation, published in Mercury in the Environment; Proceedings of a Specialty Conference, Air and Waste Management Association (September, 1999), pp. 471-475. The reductions in mercury loadings that occurred after this regulation came into effect are all over the map, from 80% to zero.

Second, if you want to go into POTW costs, you might want to mention that a lot of work has been done on developing cost effective approaches to permitting large groups of similar small business dischargers, e.g., group permits for photo developers. I believe AMSA published a report on the photo developers group permits, for which we developed a resource estimate. For what its worth, we've estimated that we have about 3 times as many dentists as photo developers. We have thought about the resources that would be required to develop a group permit for dentists, and about how we could craft the permit to make it feasible with limited resources. We don't have a resource estimate that we're ready to publish, but the point to be made is that there is lots of potential for innovation.

I would not want you to imply that regulatory approaches necessarily have to look

like conventional industry permits, with concentration limits and frequent monitoring and reporting requirements. As an example, Seattle has just introduced a regulation that calls for dentists to select, install and maintain a separator from a list of approved products, but, as I understand it, exempts those who do install separators from monitoring and reporting on compliance with a concentration limit.

Response: The Danish Study is included in the report under Compliance Assessment in the Findings section. Resources needed for regulatory programs are discussed in the Procedures section under Cost of Compliance.

Dental Loading Estimates

25. With respect to the use of 0.056 gm/dentist/day as an estimate of dental loadings to the sewer, it should be noted that the use of this value would indicate that only 1.6 tons/year of mercury of the estimated 50 tons/year of mercury used by the dental industry actually make it to the a sewage treatment facility. It is assumed that the remainder is caught by dental traps or caught in dental plumbing lines. There may be analytical errors in the studies that are used due to the fact that the digestion procedure used will not fully dissolve mercury from amalgam.

Other studies show the following amounts estimated to be discharged from dental clinics.

Title	Author	Hg discharged
Mercury Removal from Dental-Unit Wastewater Stream	Mark Stone,Ernest Pederson	20-10,000 mg/l
Characteristics of amalgam in Dental wastewater	Naleway C. Osvey	484 mg/day
Distributional Properties of Dental wastewater Mercury And Silver Rates	Michael Cailas, James Drummand	498 mg/day
Environmental Aspects of Dental Restorative Materials	D. Arenholt-Bindslev	250 mg/day

The values from these studies should be included in the report.

Response: The objective of this study was to determine the potential for influent and effluent mercury reductions. Therefore, the mercury that would reach the treatment plant influent was of the greatest interest and utility to this study. The best information to date indicates that the larger amalgam particles that make up the difference between the wastewater measurements and the amounts measured in the studies listed above would settle in the collection system or be removed in the grit chamber before reaching the influent. Therefore, reductions of the discharge of these solid particles would have no impact on influent or effluent mercury levels. Even so, because of the potential reduction in other environmental releases associated with the discharge of larger particles, this information was included in the report and the report acknowledges that the

estimate of 56 mg/dentist/day does not account for the total amount of mercury/amalgam discharged per day by dentists.

26. None of the studies cited in Table 3 individually or in combination with one another have results that exhibit mass balance closure because they account for less than 5 percent of the total mercury from amalgam used in dental offices throughout the U.S. Based on the age and mass of mercury accounted for in these studies it is quite likely that they account for mostly dissolved mercury from dental offices and not the particulate form (i.e., mercury bound in amalgam particles) and, therefore, should not be used to evaluate the effectiveness of P2 for case study facilities. Ignoring particulate mercury from dental offices and only accounting for the dissolved fraction while including both particulate and dissolved mercury from residential sources such as human waste amalgam creates an intentional bias in the study results that makes it appear that less controllable residential sources have a greater influence on influent, sludge and effluent quality than is actually true.

Response: See response to comment #25. With respect to the possible overestimate of mercury from human waste, this is acknowledged as a limitation in the Findings section under Limitations of Analysis. The human waste numbers used are the best information available regarding this source as there are no direct wastewater measurements for this source (isolated from other residential sources). Therefore, under the Conclusions and Recommendations section it is recommended that research in this area be conducted.

27. No amount of explanation can justify the use of studies that are clearly in error. The WEF results, at 250 to 261 mg/dentist/day, when subjected to mass balance closure account for greater than 80 percent of the total mercury load that would be expected to pass through dental vacuum system filters and enter the sewerage from dental clinics. Therefore, the WEF study obviously accounts for both particulate and dissolved mercury and should be used as the commercial mercury load for dentists in place of the unweighted average of the data taken from the four studies cited in Table 3 above. I have commented before on the bias created in this analysis from using dissolved mercury data for dental/commercial sources and particulate and dissolved mercury for human waste amalgam/residential sources. For continuity, I have incorporated some of those earlier comments shown here in *italics.*

While I agree that the dissolved form of mercury is more problematic for effluent quality, discharge of particulate amalgam to sewers probably ends up as deposits in sewerage which subsequently could dissolve over time to become dissolved mercury in the influent. So it's important to know what the long-term total discharge from dentists is. Since you elect to use only dissolved data for dental practices, however, it's also important from a consistency perspective to ensure your other data are for dissolved mercury as well. A case in point, according to the majority of literature on the form of mercury in fecal material, mercury is in an inorganic form in feces--that is, it is not methyl-, ethyl-, or phenylmercury, the

chief dissolved forms. Therefore, most fecal mercury is probably already partitioned to the organic/bacterial substrate that composes fecal matter and sludge and will not appreciably affect effluent quality at the same rate as freely dissolved mercury from dental practices. This point may also apply to mercury bound to soils found in graywater unless the mercury has been completely solubilized as a result of using a strong laundry bleach.

It is thus difficult to establish a mass balance for mercury at any POTW unless all sources and all forms (dissolved/particulate/inorganic) are accounted for in all streams. As an alternative, a partial mass balance might be achieved based on dissolved mercury, but if this route is followed, only dissolved sources should be included in the commercial and residential generation rates. Or, as I mentioned during our August 6 conference call, the load from residential sources of predominately particulate mercury such as fecal and graywater mercury should be adjusted downward to account for a greater than average removal efficiency by the POTW of pollutants bound to particulate versus freely dissolved pollutants. Ignoring particulate mercury from dental offices and only considering the dissolved fraction while including both particulate and dissolved mercury from residential sources has the unintended effect of making it appear that residential sources have a greater influence on effluent quality than commercial sources when in fact they do not.

In addition, some explanation needs to be provided as to what percentage of the total mercury used in dental offices and discharged to sewer from dental offices is unaccounted for in your dissolved dental mercury number (used in dental offices but unaccounted for: 90% to 95%? discharged to sewer from dental offices but unaccounted for: 35% to 45%?). Other issues that should be addressed include: what load does the unaccounted for mercury translate into for each case study POTW (a factor of 2 to 6 times the dissolved mercury dental load?) and nationally (20 to 40 tons annually?); and what effect could this load have on influent, sludge and effluent quality if it goes undetected or unchecked (hidden environmental loads, noncompliance, the unnecessary installation of end-of-pipe treatment?)?

Response: See response to Comment #25. As noted previously, these studies are not in error as they are based on wastewater sampling conducted using sampling protocols appropriate for wastewater as discussed in the report and in comment #34.

27a. I believe the recommendation in the October 9th project meeting was to use the 250 mg/dentist/day from Drummond and Cailas in place of the 56 mg/dentist/day in the mass balance calculation because there is a large body of evidence that supports values significantly higher than 56. The 56 represents the absolute low end of the range of values reported in the literature, while 250 represents more of a midpoint with higher values reported in the 500 mg/dentist/day range. Explaining that there is considerable uncertainty regarding the fate and transport of solid amalgam *as well as other particulate mercury* in sewer lines and that 56 is used because you believe it represents what reaches the plant is misleading

because once the mercury is in the sewerage it will affect effluent quality and other environmental media through contamination of sewerage, grit chamber solids and sludge. It also understates the effectiveness of PMP/P2. Hiding the more accurate values for mercury from dental offices in a sensitivity analysis or response to comments appendix does not make the mass balance study more credible it makes it appear bias. Use 56 in the sensitivity analysis with 500, and use 250 in the mass balance calculation for the study is the recommended approach.

Response: There was no consensus from the group at the October 9 meeting that the number should be changed. Rather, the recommendation during the October 9th meeting was to include the information from the Cailas and Drummond study in the report in order to show that more amalgam is discharged from dental facilities than may show up in the wastewater and reach the treatment plant influent. As noted in the report, these particles settle out in the sewer lines and account for continual leaching of mercury back into the wastewater over time. The rate of transfer back into the wastewater and the time period over which this occurs is one of the uncertainties associated with this analysis. This uncertainty is acknowledged in the report in the Procedures section under Dental Loadings and in the Findings section under Limitation of Analysis. The fate and transport of amalgam in sewer lines is also discussed in comment #29.

28. The following information should be included in the discussion of the estimate of dental discharges of mercury:

Mercury Loadings in Dental Clinic Vacuum System Wastewater

All data is given as: milligrams of mercury per day	Passing Chairside Trap (per chair, soluble + solids)	Passing Chairside Trap (per chair, settled solids*)	Discharged (per dentist, without amalgam removal equipment)
Mean	612	773	250
Median	499	522	
N	58	66	10
Maximum		3298	842
Minimum		20	65
Std. Dev.	529	733	
Source	Cailas, et al. (1994)	Drummond, et al. (1995) * Supernatant passing chair also variable	Arenholt-Bindslev and Larsen (1996)
Drummond also measured the amount of mercury in solids retained in chairside traps. The median value was 819 mg/day, per chair. (N = 57, Std. Dev. = 1032)			

You could state:

Metropolitan Council Environmental Services (WEF, 1999) estimated that half of the mercury passing the chairside traps would be captured in a vacuum filter, commonly used with liquid-ring vacuum pumps. The other half, or 250-261 mg/day (reported as "per dentist"; WEF, 1999) would be discharged from the clinic vacuum system and mixed in with the clinic's other wastewater.

51 mg/dentist/day is the basis for the calculations in this report. In the sensitivity analysis, loading values greater than 51 mg/day will be used, up to 150 mg/dentist/day (with the understanding that the loadings may be higher than 51 mg/day based on data from Cailas, et al., Drummond et al., and Arenholt-Bindslev & Larsen).

The measurements leading to the average of 51 mg/day may be lower than data in Table 1 and lower than the 250-261 mg/day reported by the 1999 WEF monograph due to issues related to: (1) sampling dental vacuum system wastewater mixed with other wastewater generated at a dental clinic *(plus possibly other wastewater, if present, from other sources in the building)*, (2) subsampling prior to analysis, and (3) digestion methods of subsample.

Response: This information was added to the report.

29. In reference to the discussions about where all the dental amalgam solids go, it seems to me worth noting that in MWRA's system we have 5,640 miles of municipal sewer pipes, 11 pump stations, 5 headworks facilities, 6 treated CSO discharge facilities, and some 45 other CSOs. (MWRA is in the process of closing 32 of an original 81 CSOs). It is therefore not surprising that a calculated volume of mercury possibly discharged from dentists far exceeds the volume monitored at the sewage treatment plant. Amalgam solids probably are being deposited in the pipes, discharged from CSOs, and taken out with the grit removed at the pump stations, and the grit chambers at the STP. (Our 1997 loading calculations included an estimate of the amount of mercury discharged from CSOs, but not of the amount taken out with the solids from grit chambers, which are landfilled).

Response: While this information does lend credence to the hypothesis that much of the dental amalgam settles out in the collection system, it was not included in the report because there is no direct measurement associated with it. As noted in the report this is an issue requiring further study.

Human Waste Estimates

30. Both O'Conner and Barron rely heavily on data from a single Swedish study of 10 adults to estimate fecal mercury loads from amalgam fillings for Canadian and U.S. populations, respectively (Skare, 1995, Skare & Engqvist, 1994). However, the difference between the human waste-amalgam mercury loading from the two studies does not result solely from data averaging the number of fillings per person in Canada (O'Conner, 2001) versus the number of fillings per person in the United States (Barron, 2001), but in how the two studies adjust the linear regression equations for total mercury excretions by urine and feces taken from

the Swedish study for background output of mercury that is unrelated to amalgam (i.e., the "y" intercept when the number of amalgam fillings is zero representing an individual with no amalgam fillings). The linear regression equations developed by Skare (1995) are as follows:

Urinary Hg Excretion (U-Hg in ug/day/person) = 0.4 + 0.08*N
Fecal Hg Excretion (F-Hg in ug/day/person) = 15 + 1.45*N

where N is the number of amalgam filled surfaces.

O'Conner solves each equation for N equal to zero representing an amalgam-free individual to determine the background mercury output in urine and feces that is unrelated to amalgam. This produces a background mercury output that is unrelated to amalgam for urine of 0.4 ug/day/person and for feces of 15 ug/day/person. O'Conner subtracts the background mercury output that is unrelated to amalgam from the appropriate linear regression equation developed by Skare. This produces the following equations adjusted for background:

U-Hg (ug/day/person) = 0.08*N
F-Hg (ug/day/person) = 1.45*N

where N is the number of amalgam filled surfaces.

O'Conner then solves each equation using the average number of amalgam filled surfaces for individuals in Canada and totals the results.

Barron also adjusts the linear regression equations from the Swedish study for the background mercury output in urine and feces that is unrelated to amalgam but does so by subtracting the measured background mercury in urine and feces from the amalgam-free control individual used in the Swedish study. The measured background mercury output that is unrelated to amalgam in the amalgam-free control individual from the Skare is 0.4 ug/day/person for urine and 1.0 ug/day/person for feces. Barron subtracts the measured background mercury output that is unrelated to amalgam from the appropriate linear regression equation developed by Skare. This produces the following adjusted equations:

U-Hg (ug/day/person) = 0.08*N
F-Hg (ug/day/person) = 14 + 1.45*N

where N is the number of amalgam filled surfaces.

Barron then solves each equation using the average number of amalgam filled surfaces for individuals in the United States adjusted for the percentage of the population with amalgam fillings, and totals the results. Using an average number of amalgam filled surfaces of 16.58 (Dr. Jeffrey Hyman, DDS, National Institute of Health) for individuals in the United States adjusted by 65 percent (EIP

Associates, 1999) representing the percentage of the population with amalgam fillings, Barron estimates a total mercury load from humans with amalgam fillings as follows:

Total Hg Load From Humans with Amalgam Fillings (ug/day/person) = (U-Hg + F-Hg)*(0.65)

where,

Urinary Hg Excretion (U-Hg in ug/day/person) = 0.08*16.58 = 1.33 ug/day/person
Fecal Hg Excretion (F-Hg in ug/day/person) = 14 + 1.45*16.58 = 38.04 ug/day/person

or,

Total Hg Load from Humans with Amalgam Fillings = (39.37 ug/day/person)(0.65)

Total Hg Load from Humans with Amalgam Fillings = 25.59 ug/day/person or 9.34 mg/yr/person

Using O'Conner's equations adjusted for background yields the following results for individuals in the United States with amalgam fillings:

Total Hg Load From Humans with Amalgam Fillings (ug/day/person) = (U-Hg + F-Hg)*(0.65)

where,

Urinary Hg Excretion (U-Hg in ug/day/person) = 0.08*16.58 = 1.33 ug/day/person
Fecal Hg Excretion (F-Hg in ug/day/person) = 1.45*16.58 = 24.04 ug/day/person

or,

Total Hg Load From Humans with Amalgam Fillings = (25.37 ug/day/person)(0.65)

Total Hg Load from Humans with Amalgam Fillings = 16.49 ug/day/person or 6.02 mg/yr/person

The issue is which equations best estimate the mercury load from humans with amalgam fillings for individuals in the United States, O'Conner or Barron? A comparison of O'Connor's and Barron's adjustment for background output of mercury in urine reveals good agreement between the estimated background

urinary mercury excretion that is unrelated to amalgam from the linear regression equation (N=0, U-Hg=0.4) and what is actually measured from the amalgam-free control individual in the Swedish study (amalgam-free as measured, U-Hg=0.4). Therefore, these equations produce identical results and either O'Connor's or Barron's equation for urinary mercury excretion is acceptable.

However, a comparison of O'Connor and Barron's adjustment for background fecal mercury excretion reveals very different results. In O'Connor's equation as the number of amalgam filled surfaces (N) approaches zero, the fecal mercury from amalgam approaches zero. Adding the actual measured background fecal mercury from the amalgam-free control individual in the Swedish study will then produce the correct result (N=0, measured background=1, F-Hg=1) with no error. In Barron's equation, however, as the number of amalgam filled surfaces (N) approaches zero, the fecal mercury from amalgam approaches 14 ug/day/person. So as the number of amalgam filled surfaces approaches zero, the error in Barrow's fecal mercury equation approaches 1400 percent (N=0, F-Hg=14). Adding the actual measured background fecal mercury from the amalgam-free control individual in the Swedish study increases this error to 1500 percent (N=0, measured background=1, F-Hg=15).

The reason Barron's equation produces such a large error for individuals like those in the United States that are lightly loaded (average 16.58) with amalgam filled surfaces is because the individuals studied by Skare were heavily loaded with amalgam filled surfaces in comparison. The range of amalgam filled surfaces in the Swedish study group ranged from 18 to 82 amalgam filled surfaces with an average of 40 amalgam filled surfaces. Barron states that the average in the Skare's study is 30 amalgam filled surfaces but this is incorrect. The average middle-aged Swedish citizen has 30 amalgam filled surfaces but the average number of amalgam filled surfaces in the Skare study group was 40. Therefore, the distribution of amalgam filled surfaces for individuals in the United States are significantly below the distribution of amalgam surfaces for Swedish individuals in the Skare study. In addition, the Skare study group is further skewed to produce higher urine and fecal mercury loads because of the condition of amalgam filled surfaces in one of the 10 study participants. As stated by Skare:

> "According to several studies, urinary excretions do not often exceed 1 ug Hg/d for amalgam-free individuals occupationally unexposed to Hg. Our control individual did apply to this prediction. Urinary excretions, due to amalgam, exceeding 15 ug Hg/d are also rare. Our worst case individual, having 82 restored amalgam surfaces, many of which in a bad condition, showed urinary excretion of 19 ug Hg/d."

The Skare study group has a measured urinary and fecal mercury excretion ranging from 28 to 209 ug/d for individuals with a range of 18 to 82 amalgam filled surfaces (average 40). Barron adjusts this urinary and fecal mercury excretion range by 1.4 ug/d (measured background output unrelated to mercury

from amalgam) and concludes that the results are appropriate for developing regression equations that can be applied to individuals in the United States with an average number of amalgam filled surfaces by age group ranging from 8 to 22 (average 16.58), a completely inappropriate conclusion. Because Barron applies the adjusted regression equations to individuals in the United States that have amalgam filled surfaces that are significantly below the Skare study group and approaching zero, Barron overestimates the total mercury load from amalgam fillings by as much as a factor of 14.

Because O'Connor's adjusted equations contain zero background mercury and account for only mercury excretions from amalgam fillings, they produce the more reliable estimates for individuals in the United States that are lightly loaded with amalgam fillings (i.e., a total mercury load for humans with amalgam fillings of 16.49 ug/day/person). I have commented before on the inappropriateness of data and the statistical limitations of using the Swedish study to estimate residential mercury from human waste amalgam for U.S. populations. I have incorporated some of my earlier comments shown here in *italics.*

Comment from 3/6/01: I have reviewed, however, the Swedish study (Skare, 1995) and believe that your estimate of 67 ug/d may be completely inappropriate as a high estimate for U.S. populations. A better high estimate may actually be your low estimate of 34.5 ug/d. Based on reviewing the literature, adults in the U.S. have on average between 10 (low estimate) to 20 (high estimate) amalgam filled surfaces (Winn, 1996, Albertini, 1997). The Swedish study group of adults (10 adults studied for fecal mercury, fecal mercury is more than 95% of the urinary/fecal excretion load) had an average of 40 amalgam filled surfaces (range 18 to 82). A better estimate for adults in the U.S. under the low scenario would be about 15 ug/d (replacing 34.5 ug/d in the equation) and under the high scenario 32 ug/d (replacing 67 ug/d in the equation). Because the mass balance as it is currently constructed is dominated by the load from human waste-amalgam (over 55% of the total residential load), if you or others in the work group would like I could try to further refine the default values for human-waste amalgam.

This, however, brings up a point touched on earlier, if human waste-amalgam is zeroed out of the low scenario the influent concentration to the POTW is still 100 ug/L, which is significantly greater than the lowest influent concentrations reported by AMSA (7/00) and some of the case study facilities (LAWPCA, PWD). I would suggest further evaluation or adjustment of residential drivers such as laundry graywater, household products and contact lens solution until you reach a low scenario influent concentration to the POTW from residential sources that when combine with human waste-amalgam does not exceed lower influent concentrations reported by others.

Comment from 3/27/01: I agree with your statement that "without adjustments, use of the Skare data, in particular, could overestimate this contribution" from dental amalgam mercury in human waste, but disagree with the statement that "the Skare study results indisputably indicate that the contribution to domestic wastewater from excreted dental amalgam mercury is substantial." The results from the Swedish study are indeterminate, especially for mercury from dental amalgam in human fecal waste (representing more than 96% of the mercury load from fecal-urinary human waste). The equations presented in the Skare paper are linear regressions that assume a constant amount of mercury is lost per amalgam-filled surface per day. However, the correlation coefficient for the fecal-mercury data indicates that about 45% of the variation in fecal mercury is explained by the number of amalgam-filled surfaces. This may result from the small sample size or from other factors such as age of fillings, and filling age has been mentioned as one of the key factors in determining the amount of fecal mercury: older fillings are more likely to contribute flakes of fillings to the digestive tract than newer fillings. This is important because Sweden does not fluoridate water supplies used for drinking, or the bottling and processing of food and beverages. Therefore, children in Sweden will have about 65 percent more caries than children in the United States. This means that not only will the general population in Sweden have significantly more amalgam-filled surfaces than the United States populace but that those amalgam fillings will be on average significantly older. I would also like to add that any study used to estimate dental amalgam in human waste especially human fecal waste needs to be closely scrutinized before it is used in the load calculation equations because it is the least likely value that model users will have community-specific data on but the mostly likely value that will be used to underestimate the effectiveness and broader environmental benefits from implementing pollution prevention programs. In addition, model users should be made aware that particulate amalgam mercury transported in human fecal material to POTWs will likely settle out early in the treatment process and will not significantly affect effluent quality or the effectiveness of pollution prevention programs in attaining effluent limitations at POTWs. However, mercury from dental and other commercial sources will have a more dramatic effect on both effluent and sludge quality, and that only through an aggressive pollution prevention program can they address these sources effectively.

Finally, concerning the appropriateness of the residential data selected under the low scenario, your memorandum states:

"These results are consistent with our observation of the extreme heterogeneity of mercury in domestic sewage. Considering the observed heterogeneity, an average in the lower range is likely to be attributable to an insufficient database, and mass balance adjustments should not have to be made to accommodate values from such a database."

However, model users should be warned that mass balance adjustments are made to increase the significance of residential sources but not commercial, regardless

of data quality. For example, mercury usage in dental amalgam in the United States is in the range of 45 to 75 tons per year. However, an evaluation of commercial dentists under the low scenario indicates that dental offices in the United States discharge only about 1 to 2 tons of mercury per year, while servicing a population (based on the low scenario residential source contribution from human waste amalgam) that are heavily loaded with amalgam filled surfaces. Further, in the absence of community-specific data for case study facilities the low scenario commercial dentists' contribution is used under the high scenario to adjust the mass balance downward for commercial sources but the human waste amalgam load is doubled. Model users taking the same approach under either scenario will significantly over predict the residential contribution and under predict the commercial and, therefore, fail to realize the stated purpose of this project "to evaluate pollutant minimization effectiveness in complying with the mercury effluent limitations that are anticipated at wastewater treatment plants."

Response:

We asked Tom Barron to review this set of comments and to provide us with more detail on his human waste calculation. As a result of this review, we revised our human waste estimate to 17.2 µg/person/day (down from 26 µg/person/day) for the study. This appears to be the best estimate available based on the best science available. Here is Barron's response (italicized):

As requested, I re-did my human Hg waste estimate based upon a new look at the Skare (1995) data, and upon points raised by both the O'Connor (2000) estimate and the set of EPA comments that you furnished.

Skare (1995) Data

I agree with you and the EPA reviewer that one can interpret Skare's 1995 data (in his Table 1) to get 40 amalgam surfaces and 66 µg/day/patient as the average Hg waste load for the test subjects that Skare studied. However, one can also interpret Skare (in his Figure 1) as recommending 30 surfaces and an assumed 60 µg/day/patient.

Impact of Alternative Interpretations of Skare

How much difference does this assumption of 30 vs. 40 surfaces make? As shown in the attached Excel spreadsheet (Table 7 of the report), Hg wastes from urine and feces combined are estimated as:

O'Connor: (2000)	*11.4 µg Hg waste / day / adult Canadian person based upon 7.6 amalgam surfaces per person and 1.5 µg of Hg waste per day per surface (Skare: 40 surfaces - avg.)*
Barron:	*17.2 µg Hg waste / day / adult US person*

(2001b) based upon 10.8 amalgam surfaces per person
and 1.6 µg of Hg waste per day per surface
(Skare: 40 surfaces - avg. & 18 surfaces - min.)

My earlier estimate that you used in your AMSA study was:

Barron: 25.6 µg Hg waste / day / adult US person
(2001a) based upon 10.8 amalgam surfaces per person
and 2.4 µg of Hg waste per day per surface
(Skare: 30 surfaces - avg.)

Recommendation

I suggest that we change our estimates to use 17 µg Hg waste/day/person.

This revision brings my Palo Alto Hg sources mass balance nearer to closure. In adition, these revised results are similar to those of O'Connor after accounting for the different population data we are using. Further comments appear below.

If the human Hg waste estimate needs to be defined more closely, I suggest that EPA sponsor

a) a monitoring program with a statistically significant number of test subjects; and
b) an update to the NIH estimate of fillings demographics.

Additional Comments:

A caution: I've shown numbers with up to four digits so that you can see the arithmetic, not to imply a high level of accuracy.

[1] I've gone through my various human waste Hg estimates and conclude:
the average number of amalgam surfaces is 16.6 per person
(based upon Hyman data for 1990 census).

daily average Hg waste (urine + feces) is in the range of 27 to 39 µg/day/patient. "Patient" means just those adults with amalgams.

Restated for all people, beyond just those who have amalgams:

the overall average number of amalgam surfaces is 10.8 per person.

overall daily average Hg waste (urine and feces) is in the rannge of 17 to 26 µg/day/person. "Person" as used here means all adults (20 years), including both those with and without amalgam fillings.*

The high and low end of these ranges arise from two different ways that I can interpret the data in Skare (1995). The earlier estimate that I did for Palo Alto (based upon the Hyman data for fillings per person) gives the high end of the above two ranges.

I arrive at the lower estimate by taking a different (and probably better) interpretation of Skare's data, and also by fixing what appears to be a math error in my earlier estimate (see the attached spreadsheet). I'm considering using this new, lower estimate in the next Palo Alto update.

[2] I did not use Skare's curve fit because his data include individual(s) with very high amalgam counts. Instead I based my estimates on judgement applied to Skare's average and low values (Skare - Table 1):

	Surfaces	*U Hg*	*F Hg*	** Hg*
Mid	*40*	*1.7*	*64*	*65.7 µg/day/patient*
Low	*18*	*1.4*	*27*	*28.4 µg/day/patient*

These values imply Hg waste loads of 1.64 and 1.58 µg/day PER AMALGAM SURFACE, respectively. In my just-updated estimate [Barron (2001b)] use 1.60 µg/day for this parameter. Doing so produces a human Hg waste result of 26.5 µg/day/adult patient, which is equivalent to an overall average of 17.2 µg/day/adult person.

[3] When I look at O'Connor (2000), I conclude from Table 4-2 that these investigators are working with data for the entire Canadian population (i.e., including both people with and without amalgams).

> *The overall average number of amalgam filling surfaces appears to be 7.6 per Canadian adult person*
>
> *The overall average average human Hg waste (uring + feces) that O'Connor estimates for Canadian adults appears to be 11.4 µg/day/person.*

I do not have the information needed to use O'Connor's data to back-calculate Hg waste averages per dental patient with amalgam fillings.

Other Mercury Sources

31. The sector contributions from schools (middle and high schools), vocational schools, colleges and universities looks much too low ... and therefore the

potential reduction from P2 is greatly underestimated. My approximate experience is that there is as much mercury in schools as hospitals, as many schools as medical facilities in a community, and more releases to sanitary sewers from schools via thermometer breaks than hospitals. Further, schools will have a very high % P2 participation because mercury spills have become a liability issue. Some States, e.g. Michigan, are outlawing mercury products in schools. Better accommodating school mercury in the report may significantly increase the overall effectiveness of the community P2 program.

Response: The potential impact of schools was assessed by assuming that mercury levels in their discharge was the same as for hospitals (i.e., 4.39 gm/school/day). The impact of changing this value was included in the Results section under the Sensitivity Analysis.

32. I do not remember seeing any mention of stormwater mercury influences via infiltration/inflow or combined sewers. I do not know whether this issue has any merit or not, but I have heard several large municipalities raise this issue in the past and silence on this subject will probably be viewed as an omission in the report.

Response: Infiltration and inflow was included in the evaluation if the agency provided local data for this. Overall, the contribution from this was estimated to be small. This is discussed in the Results section of the report.

33. Industrial sources to POTWs are treated as givens without any discussion as to the completeness of the sources sampled, the frequency of sampling, the methods used, or the representativeness of the (apparently) limited data. In fact, categories of industrial users are not discussed with regard to potential or measured contribution to the collection system. This seems somewhat illogical given the scrutiny given to other sources. It is logical to assume, given the attention given to these sources in the draft report, that the contribution from these sources is potentially a substantial underestimate. I commented on this issue before. For continuity, I have incorporated some of those earlier comments shown here in */italics.*

What analytical detection method was used in the Boston study and more importantly what method was used by the case study POTWs, and what was its detection limit, digestion procedure and were the samples filtered? If Method 245 was used on filtered samples with a detection limit of 200 ppt, then undetected and detected sources could potentially be significant. Super clean methods (with the appropriate digestion technique) are likely to indicate even higher contributions from industrial sources. We need a more reasoned discussion of industrial sources. Some industries are obviously worse than others. Which ones? How could so many products used in the home contain mercury (AMSA Study) but the industries that produce them discharge little or no mercury? Why are industrial users not given the same scrutiny as dentists or hospitals? The methods used to estimate industrial loads need to be spelled out and critically

evaluated as much as for other potential sources of mercury such as household products.

Response: Industrial contributions to influent loadings were small as shown in Figure 5 in the report. The specific industrial data used is included in the POTW spreadsheets, which are in Appendix A of the report. Because this data was all based on monitoring required under the Federal Pretreatment Program and because all these agencies have approved programs that are in compliance with the Federal standards, it was assumed that the reported data was adequate and met the quality standards needed for this report.

33a. Also should mention mercury found in biosolids from septage could be a significant source to POTWs that accept septage.

Response: The report noted that if agencies provided us septage data it was included in their load calculation. This was not a significant source for the Case Study agencies.

Form of Mercury (particulate vs. dissolved)

34. I would like to clarify the analytical procedures that NEORSD has used for mercury in dental office wastewater and treatment plant sludge. In both cases, the samples are digested with nitric acid in a microwave (EPA Methods 3015 and 3051 from SW-846). After this digestion, the dental office wastewater samples are completely clear of any remaining visible solids. (Some solids remain in the treatment plant sludge samples after digestion, but our lab personnel assure me that these solids are not digestible and are unlikely to consist of mercury amalgam particles.) Volatilization is minimized by complete cooling before removal of the samples. The samples are then analyzed using EPA Method 245.1, including its permanganate digestion procedure. So, each sample has undergone "double digestion."

    We acknowledge, given the typically extreme heterogeneity of dental office wastewater, that there is a great deal of uncertainty regarding the representativeness of the samples. However, for the above reason, we do not believe that any significant uncertainty in the NEORSD mercury data is attributable to inadequate digestion procedures.

Response: The NEORSD dental data was included in the report because, as noted in this comment, it was representative of mercury levels in wastewater and the sampling and analytical protocols used were appropriate for wastewater samples.

35. The list of factors near the top of page 2 should include the forms of the mercury (e.g., dissolved versus particulate). The success of source control in achieving effluent reductions depends heavily upon this factor. Source control efforts which achieve major reductions in mercury discharged into the sewer system and arriving at the plant influent could conceivably have no measurable effect on the

effluent levels if virtually all of that form of mercury had been removed by the treatment plant anyway. Such efforts would produce sludge mercury reductions but would not significantly improve the ability to achieve effluent limitations.

Response: This change was made to the report.

36. The major uncertainties about the forms of mercury and how they affect effluent levels must be acknowledged under "Limitations of Analysis". Addressing these uncertainties must be included under "Recommendations".

Response: This discussion was added to the report in these sections.

37. In the section on Load Calculation that discusses the determination of influent loads it should be noted that "Actual plant influent levels were used for the loading values at the plant. Due to the difficulty of sampling at treatment plants, any mercury that would be caught in the grit chamber would not be analyzed and therefore omitted from the values used at the plant." Plant loadings calculated in this way will understate mercury losses to the grit chamber. It is assumed, for the purpose of this study, that there is no loss of mercury to the grit chamber. There are currently no data to support this assumption due to the difficulty of sampling.

Response: As noted in the response to comment #25, the purpose of this study was to determine potential for influent and effluent reductions so the levels in the influent were of most direct interest and utility. It was acknowledged, however, that particulate matter may get removed in the grit chamber and may deposit in the sewer lines. The uncertainties associated with the amount of particulate mercury discharged to treatment plants was also acknowledged and discussed in the report.

38. Under the Sensitivity Analysis, it is stated in the report that "the use of the 0.15 gm/dentist/day resulted in negative influent and effluent concentrations." This may be due to the digestion method used in sampling or the potential understatement of mercury at the plant that was lost to the grit chamber and not measured or a combination of both.

Response: See responses to comment #25 and comment #37.

39. Add to Limitations of Analysis that there is the potential that an amount of mercury would be caught in POTW grit chambers. This amount is assumed to be zero for the purposes of this report due to the difficulty in sampling sludge in grit chambers.

Response: The uncertainties associated with particulate mercury in wastewater discharges is discussed in Limitations of Analysis in the Findings section.

40. Because digestion procedures used in 245 and 1631 will only solubilize a small part of the mercury found in dental amalgam, it is impossible to achieve true mass balance closure for any of the case study facilities that use these analytical

methods. In addition, case study facilities may be collecting influent samples after their grit chamber, which will further reduce the mass loading of mercury from amalgam particulate and other forms of particulate mercury. Not showing the particulate load of mercury in POTW influents will make it appear that there is little opportunity for P2 by reducing its estimated effectiveness. Therefore, mass balance closure should not be a criterion used to select case study facilities for evaluation. As discussed in greater detail under the sections below on Dental Loading and Human Waste Amalgam Loading, this error is further compounded because case study facilities deemed to have mass balance closure are evaluated for P2 effectiveness using a residential mercury mass loading based on a Swedish study that specifically measured mercury from amalgam in human fecal matter (most significant residential source - human waste amalgam). Thus, case study facilities are shown to get a significant portion of their total mercury load from estimates of human waste amalgam when mercury from amalgam is not accurately measured in the influent, sludge and effluent for any of the case study facilities and particulate mercury contained in amalgam is not accounted for in the estimated loads from dental offices (commercial – Dentist).

Response: The digestion methods used in 245 and 1631 are appropriate for wastewater samples with low solids. This is how these analytical methods were used for the samples discussed in this report. Issues associated with digestion methods are discussed in the report in the Findings section under Limitations of Analysis and in the Source Identification and Data Sources section under Dental Loading.

41. The report indicates that reduced influent and effluent values were used to calculate the reduction that plants would see in their biosolids concentrations. This underestimates the true reductions in sludge because it does not account for mercury bound in amalgam particulate. This could add an additional 20 tons or more of mercury nationally.

Response: This potential underestimate was noted in the Results section under Estimate Changes in Biosolids Mercury Levels.

42. There is no clear basis for excluding any of the POTWs from this analysis since neither 245 or 1631 will measure mercury bound in amalgam particulate, which is the major source of mercury load to POTWs from commercial-dentist and residential-human waste amalgam.

Response: As discussed above in response to comment #40, 245 and 1631 use digestion methods appropriate for wastewater. POTWs were excluded from the analysis based on the quality (detection limits) and quantity of influent and effluent data. This is discussed under Select Case Studies in the Results section.

Influent and Effluent Reductions

43. The Finding on page 32 that "The sources with the greatest potential for achieving measurable reductions are dental offices and hospitals" may not be true

if the “reductions" referred to are effluent reductions. Throughout the document, clarification of whether "reductions" refers to influent or effluent reductions is needed.

Response: The report was revised to clarify this and refer to influent reductions.

44. I disagree with the conclusion at the top of page 34 that "it is clear that discharges from dentists represent the largest contributor to mercury effluent levels..." This may be so for influent levels, but it is not necessarily so for effluent levels.

Response: See response to comment #43.

Compliance Assessment

45. Attainability of the 1.3 ppt criterion end-of-pipe remains an important issue at the NEORSD. Our current wasteload allocation for mercury equals the criterion, and it will be our water quality-based effluent limit in 2003. It is also the basis for our current NPDES permit requirement to establish and implement local industrial pretreatment limits for mercury.

We fully support efforts to reduce mercury releases from dental offices and other sources, and we agree that they are a "good idea" regardless of compliance implications. Nevertheless, we had hoped that this AMSA/EPA project would shed some light upon on whether controlling mercury discharges from our more than 700 dentists, etc. could have any realistic chance of reducing our effluent mercury by the more than 75 percent necessary to consistently comply with the effluent limit.

Now that it has become increasingly evident that the remaining uncertainty will preclude any definitive answer to this question, we hope the report will clearly identify opportunities for reducing the uncertainty. Variances are temporary, and, even under a variance, the adequacy of source control efforts will become an issue if significant progress toward meeting the effluent limit is not achieved.

Response: This is addressed in the Recommendation and Conclusions section.

46. NPDES permit effluent violations for mercury appear to be increasing at Ohio POTWs as the use of EPA Method 1631 is being required for compliance monitoring. Go to the Quarterly Non-Compliance Reports (QNCRs) posted by EPA Region 5 at

http://www.epa.gov/r5water/weca/reports/oh4qtr00.txt
http://www.epa.gov/r5water/weca/reports/oh1qtr01.txt
http://www.epa.gov/r5water/weca/reports/oh2qtr01.txt
http://www.epa.gov/r5water/weca/reports/oh3qtr01.txt

Among these POTWs is the City of Delphos (1.5 MGD average) which had been included in EPA's 1994 "Analytical Survey of Nine POTWs from the Great Lakes

Basin." According to the EPA study, Delphos was one of four POTWs with an effluent mercury concentration lower than the detection level of 0.24 ng/L. However, according to the QNCRs, Delphos has now had permit effluent violations for mercury every month from August 2000 to May 2001 (the latest month posted).

Response: This information was referred to in the Introduction in the paragraph under Table 1.

47. For assessing attainability of the GLI criterion, I would like to suggest that a useful research project could be a worldwide search to find a POTW that has had effluent mercury levels consistently lower than 1.3 ng/L. I am not yet aware of one. If one is found, it could then be studied to determine what factors produce mercury effluent levels that low.

Response: We are also not aware of any such agency and this suggestion was not included in the report recommendations.

48. It appears that we're using comparisons of POTW's with existing NPDES permits requiring low levels of mercury and using it as a basis to compare the effectiveness of a program to POTW's with no mercury discharge requirements.

Response: The objective of this study was to determine if pollution prevention and source control would be effective with respect to POTWs ability to comply with proposed or existing mercury effluent limits. Therefore, it makes sense to focus on agencies with these requirements.

49. Need to discuss that less than 6 percent (253 out of 4307 POTWs) of the major POTWs in the United States have permit limits for mercury and less than 10 percent (423 out of 4307 POTWs) have monitoring requirements. The percentage for minor POTWs, effluent flow less than one million gallons per day, is probably less than 1 percent. In addition, very few of the POTWs with mercury limits are implementing pollution prevention (P2) programs and that many of these programs are minimal programs that focus mainly on voluntary efforts.

Response: The proportion of major POTWs with mercury effluent limits is noted in the Introduction in the paragraph under Table 1. The pollution prevention programs that are being implemented by these agencies are not minimal based on review of the programs in the Bay Area, the Great Lakes region, Puget Sound area, and the North East. As noted in the text, there are several examples of voluntary programs that are not minimal and have been successful in obtaining high levels of cooperation and BMP implementation.

50. The report indicates that to assess compliance effluent limits were compared to effluent concentrations based on applying estimated reductions to maximum observed and average effluent concentrations reported by the POTWs. This statement is misleading because the criteria in Table 5 were applied end-of-pipe

without a mixing zone. While this may be the case for POTWs located in the Great Lakes Basin once mixing zones are phased out in 2010 or for POTWs located on waters not attaining standards for mercury, the vast majority of the POTWs located throughout the country will probably not even get mercury permit limits, except for reasons of good public policy, because the mercury concentrations in their effluents are already below current national criteria without a mixing zone.

Response: Compliance was evaluated end-of-pipe because that is where effluent limits are being applied for many POTWs who have limits because their receiving water is impaired for mercury. It is also acknowledged that many POTWs can meet certain standards including the California Toxics Rule criterion of 25 ng/L. This is discussed in the Procedures section under Comparison to Effluent Limits.

50.a Need to indicate that plants will be operated with a factor of safety (50%). Don't want to *just* meet criteria. Add a sentence about this and that the study is based on averages so plants would operate within a margin of safety to assure compliance.

Response: This was added to the text in the Results section under Assess Potential Compliance.

Other Report Modifications

51. There are no Northeast (New England) POTW case studies in the report where much mercury P2 work is occurring.

Response: One of the agencies, Westbrook, is in Maine. The report was revised to make this more clear.

52. My overall reaction was that the section on the sensitivity analysis took up too much room in the report and could be summarized more briefly.

Response: The Sensitivity Analysis was made shorter with some of the more detailed tables placed in Appendix D and Appendix E. Even so, it takes up a lot of room because of the concern expressed regarding some of the assumptions made and how these assumptions impact the results of the analysis.

53. I think the subject of Benefits to Other Media needs substantially more emphasis as it is a major benefit to community P2 work ... so much so that we are trying to figure out how we can credit other media mercury benefits to POTWs as an offset against final effluent discharge compliance.

A similar topic that we are discussing in Wisconsin could be called "Benefits Outside POTW Jurisdictional Boundaries". POTW educational outreach here is clearly crossing POTW service area boundaries and we want to credit POTW mercury P2 efforts with those reductions in some fashion. I will ask the group if they have any ideas on this subject.

Response: A section on Benefits to Other Media was added to the Findings Section under Effectiveness of Mercury Pollution Prevention and Source Control Programs.

54. One way to show the benefits to other media would be to show the gross total mercury load from all products/sources that could be targeted by a pollutant minimization program (P2, source controls, etc.) compared to the total effluent load from POTWs. The difference between the two numbers would represent mercury released to the environment through other media that goes unaccounted for when evaluating only effluent quality.

Response: This is a good idea but we did not have the resources available to obtain this information.

55. On page 16, "North East Ohio Regional Sanitation District" should be changed to "Northeast Ohio Regional Sewer District".

Response: This revision was made.

56. Please add the highlighted phrase to the second paragraph of the introduction. Mercury enters waterways through several pathways including air deposition from the combustion of coal, oil, medical wastes and sewage sludge, urban runoff, wastewater discharges, and contaminated sediments. Therefore, efforts to reduce mercury in the environment must target a variety of activities.

Response: The reference to combustion and incineration was added to this sentence.

57. The cost to maintain an amalgam separator unit is $35 -$200/ month.

Response: This revision was made.

58. The same unit of measure should be used in Table 25 for describing the dental discharge estimate and the human waste amalgam estimate.

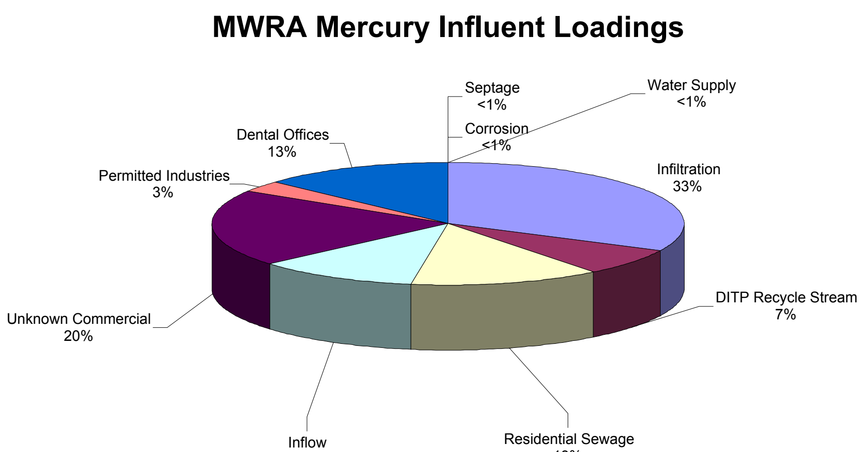
Response: These are completely different numbers calculated using different sets of assumptions based on the best available information. It did not seem necessary to make them seem more similar. This revision was not made.

59. Under the Findings it should be noted that this report does not address the amount of mercury discharged to air via the incineration of sewage sludge from POTW's.

Response: This revision was not made because it is not relevant to the stated objective of the report.

60. Under the section on Compliance Assessment, it is stated that regulatory approaches to controlling commercial sources <u>are</u> labor intensive. This should be changed to <u>can be</u> labor intensive.

Response: Based on the review of effective pollution prevention and source control programs conducted for the WERF study (WERF 2000, WERF 2001), effective programs are labor intensive. This is discussed in more detail in the Procedures section under Cost of Compliance.



61. Figure 1 (the flow chart of the process used) does not print out clearly.

Response: We have attempted to correct this.

62. During the October 9th project meeting, it was suggested that some of the mercury source loading estimates that have been calculated by POTWs be included in the report for reference. MWRA's mercury source loading estimates is shown below.

The important points about this chart are: 1) the "residential" source is based on actual sampling at locations receiving only residential sources. In a Local Limits survey we did in 1993, we found some spikes in our residential locations, which turned out to be located near dental offices. In those days, all the other residential locations were non-detect. We are pretty confident that the current round represents real residential discharges. 2) "DITP" refers to "Deer Island Sewage Treatment Plant." This is the wastewater we generate by de-watering our sludge in the process of turning it into fertilizer pellets. We discharge it back to the sewer, well upstream of the plant, so it comes back to us. 3) The dental contribution estimate is based on our 1997 study, which you already have. Note

also the large "unknown" portion, which probably includes some dental solids.

Response: Estimates of source loadings by different agencies were added to the Sensitivty Analysis.