Association of
Metropolitan
Sewerage Agencies

December 17, 2002

James B. Bramson, D.D.S.
Executive Director
American Dental Association
Washington Office
Suite 1200
1111 14th Street, NW
Washington, DC 20005

Dear Dr. Bramson:

In your October 8, 2002 letter, you asked the Association of Metropolitan Sewerage Agencies (AMSA) to review and comment on a scientific assessment, *Evaluation of Mercury in Dental Facility Wastewater*, prepared by your organization that evaluates the amount of dental amalgam mercury discharged from dental offices in wastewater. This letter transmits AMSA's comments on the assessment.

In response to your October 8 request, a group of AMSA members from the Association's Mercury Workgroup was specifically formed to provide comments on the assessment. In addition to participating on a conference call with members of your staff and the consulting firm that prepared the assessment, these AMSA members have spent a significant amount of time over the past two months carefully reviewing the assessment and preparing the attached comments.

AMSA's review is based on the October 2002 draft, which we understand is referred to as *Revision 2*. Unfortunately, while the group of AMSA members was reviewing this revision, a third revision (dated November 20, 2002) was produced and distributed widely. Very little explanation was provided with the dissemination of *Revision 3* and many within the "mercury community" have received mixed messages as to the draft or final status of the assessment. Nevertheless, AMSA felt that it was important to complete a comprehensive review of Revision 2 and provide the ADA with comments.

As you will notice in the attached document, AMSA has a number of concerns with assumptions made in the assessment, particularly with regard to the bioavailability of mercury from dental amalgam. The report assumes that a certain percentage of

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mercury in dental amalgam is bioavailable. AMSA does not believe that there is enough information to support this assumption. The report should not imply that wastewater treatment plants are designed or intended to remove metals like mercury. While it is well known that treatment plants can achieve incidental removal of metals, which end up in the residual solids (e.g., biosolids), most commercial dischargers of toxic metals are required to meet stringent pretreatment standards designed to reduce the amount of metals entering treatment plants.

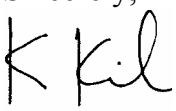
In addition, while AMSA agrees that dental clinics overall are a small contributor of mercury to the environment, in terms of discharges to wastewater treatment plants, dental clinics are a substantial contributor of mercury. As long as wastewater treatment plants are required to meet very stringent limits for mercury, wastewater agencies must continue to explore ways to decrease influent levels of mercury, and this will undoubtedly impact dental facilities

Many of AMSA's comments on the assessment warrant additional communication between AMSA and ADA. AMSA is willing to participate in another conference call to answer any questions that your staff or contractor may have about our concerns. As we understand it, the next step will be the development of a response to comments document to ensure that all peer review issues and concerns have been addressed in some fashion. AMSA looks forward to reviewing that document.

Finally, as mentioned above, AMSA notes that the October 7, 2002 issue of *ADA News* included two articles that gave readers of that publication, over 100,000 dentists nationwide, the impression that the assessment was complete and final. In fact, there is no mention in the articles as to the draft status of the assessment. AMSA is concerned that issues related to amalgam and mercury in wastewater may appear to be "resolved and insignificant" as a result of the *ADA News* articles. Furthermore, AMSA believes the premature release of the assessment has diminished the value of our peer review effort. Accordingly, prior to the dissemination or publication of the peer-reviewed, final version of the scientific assessment, AMSA strongly suggests that ADA permit AMSA to co-author a follow-up article for publication in *ADA News* to outline our concerns with the assessment.

As I am sure you are aware, the resolution of these issues surrounding dental contribution of mercury to wastewater treatment plants is of critical concern to both AMSA and ADA. AMSA looks forward to working with you and your staff in the future to tackle these tough issues. If you or your staff have any questions about the attached comments or would like to discuss these issues further, please contact Chris Hornback of my staff at 202/833-9106.

Sincerely,



Ken Kirk
Executive Director

cc:
Michael Tate, ADA
William Walsh, Pepper Hamilton, LLP

AMSA Review of American Dental Association (ADA) Scientific Assessment "Evaluation of Mercury in Dental Facility Wastewater" October 2002

General Comments

1. The report incorrectly implies that publicly owned treatment works (POTWs) are designed to handle dental mercury. The report must be revised to reflect that this not the case. When Congress created the National Pollutant Discharge Elimination System (NPDES) permitting system, it required POTWs to achieve technology based treatment requirements (secondary treatment), which were not intended to remove toxic pollutants from wastewater. Instead, the control of toxics from indirect dischargers was to be accomplished via local pretreatment requirements (*See* CWA Section 307(b)(1)) and Federal effluent guidelines (*See* CWA Section 307(a)(2)). Congress clearly recognized that removal of toxic pollutants by POTWs was the exception, not the rule, and that sewer uses must comply with local and Federal pretreatment requirements as necessary to maintain the integrity of the POTW wastewater treatment systems (*See* U.S.C. Section 1342(b)(8){TA \l "33 U.S.C. Section 1342(b)(8)" \s "33 U.S.C. Section 1324(b)(8)" \c 4}). Mercury from dental facilities, even if incidentally removed as part of a POTW's treatment system, still makes its way into the environment and is not "treated" contrary to the statements in the report. Mercury wastes are incompatible and must be removed at the source.

2. As POTW discharges are a small fraction of the national mercury problem, AMSA agrees that dental amalgam in wastewater is a small percentage of the national mercury problem. But the report must note that dentists remain a significant source of mercury for POTWs, and POTWs must comply with very stringent total mercury limits through permit requirements or ultimately through the implementation of total maximum daily loads (TMDLs). Many states also have adopted virtual elimination policies for mercury that require local agencies, including POTWs, to undertake all available means to reduce mercury releases to the environment. An AMSA study estimates that on average dentists contribute between 35 and 40% of the influent mercury received by POTWs[1]. Given the huge costs of removing mercury once it becomes part of a POTW's wastestream (estimates as much $21 million per pound have been made), it makes sense to implement all reasonable and cost effective source control options for reducing the discharge of mercury to POTWs, including programs for dentists.

3. The report makes definitive statements and assumptions about the bioavailability of mercury in dental amalgam with little or no supporting evidence. AMSA believes that there is too much uncertainty associated with the bioavailability of mercury in the environment from all sources to include such assumptions in the report's calculations.

[1] "Mercury Source Control and Pollution Prevention Program Evaluation." Prepared for the Association of Metropolitan Sewerage Agencies (AMSA), under Cooperative Agreement with the U.S. Environmental Protection Agency, by Larry Walker Associates. March 2002.

Accordingly, AMSA believes the report's calculations should be based solely on total mercury.

The report's text should, however, have a general discussion of the uncertainty associated with the bioavailability of mercury. This could include a statement that mercury in amalgam has relatively low bioavailability, but it should also include an acknowledgment that the bioavailability of this mercury can increase in the environment through, for example, dissolution and methylation and that the potential for this happening has been demonstrated by some studies. It could also refer to EPA estimates of the fraction of total mercury in the environment that is methylmercury, citing the criterion document but acknowledging that whether mercury from amalgam is ultimately more or less bioavailable than these estimates is unknown[2].

There should also be an acknowledgement that any considerations of bioavailability are irrelevant for POTWs that are implementing programs to achieve compliance with water quality based effluent limits for total mercury. POTWs beneficially reusing their biosolids will also be concerned with total mercury. Furthermore, for a POTW that incinerates or otherwise heat treats its solids, the process could affect the form of any mercury amalgam in the solids. Thus, bioavailability of mercury in dental amalgam discharged to a particular POTW may vary.

4. The purpose of the assessment was to evaluate contributions of mercury to the environment from the discharge of wastewater during placement and removal of dental amalgams. In preparing the summary, the author must be very careful not to generalize the results to include all emissions from dental amalgams, as the report does not consider air emissions during placement and removal of amalgams (0.7 tons/year for 1994-95, per the U.S. EPA, 1997[3]), nor does it consider mercury from amalgam that contaminates human waste from teeth grinding, or mercury air emissions from cremation of human remains with amalgam fillings.

5. ADA should acknowledge that their model of the national impact of dental discharges is based on little to no real data. ADA's contractor, ENVIRON International Corporation, uses assumptions and extrapolation, even when real data could be used. This approach could be used to reach many different conclusions. It is misleading to suggest that conclusions drawn from such limited data are the product of "rigorous scientific analysis." In particular, the authors' assumptions concerning the efficiency of amalgam separators and the "bioavailability" of amalgam released into the environment are arbitrary and unsupported by real data. Substituting different data on these points, but otherwise using the authors' model, leads to very different

[2] Water Quality Criterion for the Protection of Human Health: Methylmercury. EPA 823-R-01-001. U.S. Environmental Protection Agency. January 2001.
[3] *Mercury Study Report to Congress*. EPA-452/R-97-003. U.S. Environmental Protection Agency. Washington, D.C. 1997.

conclusions from those presented in the report. With those two changes, one could conclude that amalgam separators are in fact a highly cost effective mechanism for reducing mercury loadings to POTWs.

6. Paragraph 5 of Section 1 regarding "…a later version…" and "…that further versions of this assessment will be prepared as additional comments are provided…" should be inserted as the first paragraph in the *Executive Summary*.

   There is no mention of the DRAFT nature of the report within the *Executive Summary*. Within the last paragraph of the *Executive Summary* there is mention of working with others on a National Action Plan. However, this last paragraph does not mention that the main report (regarding numbers and significance of loadings) is still under review. Also, the Cover Page of the document should indicate that the assessment is a "DRAFT."

Specific Comments

Executive Summary:
The ADA concludes that the dental community releases small amounts of mercury when compared to various facilities that may release mercury. While the ADA maintains that the total quantity of mercury released to all environmental media is minimal, analysis by the City of Wichita (Wichita, Kansas) has found that the dental community is the largest source contributor of mercury to the POTW. These findings are consistent with studies conducted by AMSA and other AMSA members. POTWs are not designed to carry, treat and remove mercury, and are required to meet stringent effluent discharge criteria as well as biosolids land application criteria.

The *Executive Summary* provides specific numbers of various specialties in the dental profession. Further clarification is needed on the amount of individual offices versus offices with numerous dentists on the same vacuum. The report does not take into account the fact that some specialties, although infrequently, do remove amalgam in certain situations during certain procedures.

Executive Summary, Paragraph 2:
"The mercury contained in dental amalgam, and its release during normal restorative procedures, is a source of mercury that has received particular scrutiny."

As this report only considers the release to wastewater of dental amalgam, this sentence should read, "The mercury released to wastewater from dental amalgam during normal restorative procedures is a source of mercury that has received particular scrutiny." Alternatively, the ADA could broaden its analysis to consider air emissions of mercury from dental facilities as well as wastewater discharges.

Executive Summary, Paragraph 2:
"the present paper quantifies, through a scientifically valid and comprehensive approach, the relative contribution of: (1) mercury from dental facilities that enters surface water as compared to the total amount of mercury entering surface water from other sources."

The report does not quantify mercury from dental facilities that enters surface water, as it does not include estimates of mercury from air emissions at dental facilities that may enter surface waters. Additionally, as written, the report does not compare the mercury from dental facilities to the total amount of mercury entering surface waters from other sources, but rather very narrowly compares the mercury in wastewater from dental facilities in the United States to the total amount of mercury emitted into the air from anthropogenic sources in the United States in the mid-1990s. Not all of the mercury emitted to the air in the United States is deposited in the United States. Rather, the *Mercury Study Report to Congress* clearly states that computer simulations indicate that only about one-third of the U.S. anthropogenic mercury emissions are deposited in the lower 48 states of the U.S. Additionally, the *Mercury Study Report to Congress* upon which the comparison is made does not quantify the amount of mercury air emissions which enters water bodies, but rather only discusses told amounts emitted in the U.S. and deposited in the U.S. Not all mercury from air emissions will reach water bodies, as some of the mercury will adhere to soils or be taken up by plants before it reaches a water body.

This phrase should therefore read, "the present paper compares … releases of mercury in dental facility wastewater to total air emissions of mercury in the United States in the mid-1990s." Even so, the statement would remain somewhat misleading, as only a third of the mercury emitted in the United States is actually deposited in the United States, and the amount of this mercury that enters surface waters is unknown.

Executive Summary, Paragraph 2:
"the present paper quantifies, through a scientifically valid and comprehensive approach, the relative contribution of: … (2) the amount of mercury in municipal sludge attributable to wastewater discharged from dental facilities"

The current version of the report does not determine the percentage of mercury in municipal sludge attributable to wastewater discharged from dental facilities. The report does indicate that the mercury concentration in POTW biosolids from dental facility wastewater is 0.49 mg/kg. As POTW biosolids have 1 to 3 mg/ dry kg of mercury, this represents 16% to 50% of the mercury in them. Additionally, the objectives of the study in the *Executive Summary* should match the objectives of the study as listed in Section 1. No mention is made of studying relative biosolids concentrations in the study objectives as presented in Section 1. This numbered item should be deleted from the paragraph or changes should be made to ensure the objectives throughout the report are consistent.

Executive Summary, Paragraph 2:
It is stated that "few studies have been conducted in a holistic manner." And that: "Therefore, the present paper quantifies, through a scientifically valid and comprehensive approach, the relative contribution of: (1 – 3) (see text)". The last paragraph of Section 1 discusses the "limits to this assessment." Section 1 states that "this assessment is not intended to be a precise model of mercury behavior in the environment…." Section 1 goes on to mention that others "are studying fate and transport mechanisms applicable to mercury." These comments are valid within the Introduction, and therefore should be included within the *Executive Summary*.

Executive Summary, Paragraph 2:
"the present paper quantifies, through a scientifically valid and comprehensive approach, the relative contribution of: … (3) the contribution of mercury from dental facilities to the levels of methylmercury in the environment."

Again, the scope of this report is limited to the examination of mercury in wastewater from dental facilities, not the entire environmental contribution of dental facilities (as it neglects air emissions from dental facilities). Additionally, no attempt is made in the report to determine the actual quantity of methylmercury currently present in the environment that has resulted from dental facility wastewater discharges. Rather, the current wastewater discharges from dental facilities are compared to total air emission rates in the United States. To break out methylmercury contributions, the author simply assumed that all air emissions of mercury are available for conversion to methylmercury, while only half the mercury discharged from POTWs due to dental amalgam is available for this conversion. There is no scientific basis for the assumption of only half of the dental mercury being bioavailable for methylmercury conversion. Rather, the author relies on several very short-term studies (53 days or less) that show small amounts of methylation of mercury in amalgams. The author does not present any evidence to show that all mercury entering wastewater from dental amalgams will not methylate, given long enough durations. Until such evidence can be produced, the attempt to translate total mercury from dental offices to methylmercury should not be made. As stated above, the reports calculations should be presented solely based on total mercury. Therefore, the phrase quoted above should be dropped from the report. Alternatively, all of Paragraph 2 of the *Executive Summary* should be altered to reflect the actual objectives of the report, as presented in Section 1, paragraph 4.

Executive Summary, Paragraph 4:
"Based on measured capture efficiencies of chair-side traps and vacuum filters, we calculated the industry-wide capture efficiency to be a weighted average of 77.8% using Best Management Practices (BMPs)."

The use of the figure "77.8%" implies a degree of precision in the calculations that is beyond the scope of the report. There is a large degree of uncertainty in the numbers for chair-trap

removal efficiency, vacuum filter removal efficiency, and the number of dentists using vacuum filters. It would be more appropriate to use the figure "78%" in place of "77.8%"

Additionally, the industry-wide capture efficiency was calculated assuming that 100% of dentists employed BMPs. It is unrealistic to expect that every single dentist maintains his/her chair-side trap and vacuum filter in perfect accordance with manufacturer's instructions. Rather, it would be more appropriate to assume some reasonable number of dentists do not employ full BMPs.

Executive Summary, Paragraph 6:
"We have estimated that up to half of the 0.53 tons of mercury could be converted to methylmercury in the environment." As discussed above, the authors give no basis for their assumption that half of the dental amalgam discharged from POTWs will never convert to methylmercury, regardless of the amount of time spent in the environment.

Executive Summary, Paragraph 7:
"The total annual loading of dental-related methylmercury was estimated to be 1.04 tons"

The total annual loading of dental-related methylmercury was never quantified in the report. "Dental-related" methylmercury would include mercury air emissions from dentists as well as mercury in human waste from amalgam fillings and air emissions from crematoria from the incineration of human remains. Additionally, it is beyond the scope of the report to discuss the amount of mercury from dental facilities that may eventually turn into methylmercury, as discussed above. The authors give no basis for their assumption that half of the dental amalgam discharged from POTWs will never convert to methylmercury, regardless of the amount of time spent in the environment.

Executive Summary, Paragraph 7:
"…representing less than 0.7% of the total bioavailable mercury released in the U.S. (based on the data contained in the EPA's 1997 Mercury Study Report to Congress)."

Once again, the scope of the report does not allow quantification, in a scientifically valid manner, of the amount of bioavilable mercury. The report should be limited to a discussion of total mercury, unless evidence can be produced that dental mercury does not methylate given long enough time periods.

As to the 0.7% figure, it is a comparison not with "total bioavilable mercury released in the U.S.", but rather to the total amount of mercury emitted into the air in the United States in the mid-1990s.

Executive Summary, Paragraph 8:
"When a significantly decreased BMP compliance was assumed, the conclusion of our assessment does not change."

While the overall conclusion of the report may not change, it is important to note that the calculated amount of mercury released to the environment changes substantially, almost doubling, when decreased BMP compliance is assumed.

Executive Summary, Paragraph 8:
"Wastewater from dental facilities is not a substantial contributor to methylmercury in the environment."

As this report does not present enough evidence to establish the degree to which mercury in dental facility wastewater methylates in the environment, this sentence should be worded, "Wastewater from dental facilities is not a substantial contributor to mercury in the environment."

Executive Summary, Paragraph 9:
"… the use of amalgam separators only reduces the national loading of bioavailable mercury from amalgam entering surface water by 0.57 to 0.97 tons."

Again, the report does not present enough evidence to establish the degree to which mercury in dental facility wastewater from amalgam is bioavailable. Additionally, the report does not address all mercury loadings from amalgam to surface waters but rather only those from dental facility wastewater, as it neglects other routes for amalgam to enter surface water such as amalgam in human waste from the grinding of fillings. Change calculations to address total mercury only. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Executive Summary, Paragraph 10:
"The USEPA has determined that regulation of mercury from other industries is not warranted at costs significantly less than the costs we calculate here."

This conclusion is not discussed in the text of the report. It should be deleted unless specific references are provided.

Executive Summary, Paragraph 11:
"However, the fact that dental facilities are not the primary or even a significant source of methylmercury…"

The reference to methylmercury should be dropped from this statement. Additionally, the conclusion as written is overly broad. Dental facilities may be the primary source of mercury influent to POTWs in some locations. In that case, they are certainly a significant source of mercury. Determination of significance depends on many factors. For a persistent, bioaccumulative, and toxic pollutant such as mercury, even small amounts can be of

significance. Better wording would be, "However, the fact that wastewater discharges from dental facilities are only a small source of mercury emissions in the United States…."

Executive Summary, Paragraph 11:
It is stated that: "This assessment was prepared to provide an objective tool…" The *Executive Summary* should make it clear to the reader that this is still a draft.

Executive Summary, Paragraph 12:
"…planning to engage in a dialogue with the USEPA, states, and sewerage management authorities to determine a fair and equitable role for the dental community in reducing mercury releases entering the environment."

Again, this statement is beyond the scope of this report. This report is not meant to address all mercury releases to the environment from the dental community, as numerous pathways for dental amalgam to enter the environment are ignored. This statement should be amended to read, "planning to engage in a dialogue with the USEPA, states, and sewerage management authorities to determine a fair and equitable role for the dental community in reducing mercury releases to wastewater from dental facilities."

The report neglects one of the primary concerns of the sewer management authorities, which is to ensure that wastewater discharged from their facilities meets all Federal, state, and local regulations, including mercury discharge limitations. As the report does not address the relative contribution of dental wastewater mercury versus other sources of mercury entering POTWs, it is not likely to be useful to sewer management authorities. A more useful document for these entities would be a report estimating the impact of dental wastewater and amalgam separators on mercury concentrations in POTW effluent and biosolids.

Section 1:
This section states that the mercury present in dental amalgams is not readily converted to the organic form in the environment. This is an assumption based on the few studies available and does not take into account the various conditions encountered in the POTW. Until further studies are performed that are of a longer duration and which take into account more specific variables, this statement cannot be made or defended. See General Comment 3.

Section 1, Paragraph 2:
"Although it is reported that the dental industry uses approximately 30 tons of mercury annually in dental amalgams, they are not a major source of mercury releases to the environment."

This sentence is a conclusion. It should be taken out of the introduction section.

Section 1, Paragraph 2:
"Nor is the mercury contained in amalgams present as methylmercury, or readily converted to this organic form in the environment."

Specific references should be provided for these statements, or they should be removed from the introduction. See General Comment 3.

Section 1, Paragraph 4:
"Specifically, we have identified the following two overall objectives: 1. Estimate the influence of dental amalgam discharges on the levels of methylmercury in the environment, and 2. Determine the costs versus the benefits of further reductions in dental amalgam discharges."

As discussed above, a discussion of methylmercury sources is beyond the scope of this report. Additionally, the report does not discuss the influence of dental amalgam discharges on the levels of mercury in the environment, but rather is limited to a comparison of the discharge of mercury in dental facility wastewater versus overall air emissions of mercury in the United States in the mid-1990s. Furthermore, the cost analysis in the report should be referred to as a cost-effectiveness analysis, not a cost benefit analysis, as it simply estimates a cost per pound of mercury removed by amalgam separators. To perform a cost-benefit analysis, the cost of the reductions would have to be compared to the benefits of performing the reductions in terms of improvements in environmental conditions or human health. It might also be helpful to compare the costs of removing mercury by amalgam separators to the costs of removing mercury from POTWs. For example, the cost per pound of removing mercury in dental facility wastewater via amalgam separators ($45,500 to $139,000 per pound, according to the report) could be compared to the cost per pound for POTWs to remove the same mercury (approximately $21 million per pound).

This sentence should be amended to read, "Specifically, we have identified the following two overall objectives: 1. Compare the release of mercury in dental facility wastewater to the total air emissions of mercury in the United States in the mid-1990s, and 2. Determine the cost-effectiveness of installation of amalgam separators on dental facility wastewater.

Section 1, Paragraph 4:
Wording related to "…support partisan positions." should be deleted. This type of language is not appropriate for a technical report.

Section 2, Paragraph 2:
"The following are the individual elements that will be addressed to achieve the first objective: … The amount of mercury in amalgam released from POTWs that could be converted to methylmercury."

As the report does not address, in a scientifically defensible manner, the amount of dental amalgam that can potentially be converted to methylmercury, the bullet item referring to methylmercury should be deleted. See General Comment Number 3.

Section 3:
There is some confusion regarding the number of dentists used throughout the report. AMSA believes that a more accurate count of dentists should include all general dentists (private, government/military, etc). AMSA believes the number used later in the report to estimate the high-end number of separators that may be required, 133,092, is a more accurate estimate of the total number of general practice dentists, and should be used throughout the report for the total number of dentists. AMSA believes the report should also indicate whether this number includes individuals at dental schools.

It should be noted that further on in the report (Section 8. *Mercury Released to POTWs*), the estimate of 6.34 tons appears to be valid.

Based on the study conducted by the Metropolitan Council Environmental Services (MCES) (St. Paul, Minnesota) and the Minnesota Dental Association (MDA), the following calculation can be made:

(133,092 general dentists)(234 mg Hg/day)(48 weeks/year)(4 days/week)(1 kg/1,000,000 mg) = 5980 kg/year = 13,155 pounds/year = 6.58 tons/year

The report estimates by headcounts, removal rates, etc. (a mass balance approach) that 6.34 tons/year would be released. The 6.58 and 6.34 values are very close.

Section 3, Paragraph 1:
"Therefore it is estimated that approximately 92,957 active general practice dentists place amalgam."

Amend this calculation to include all general practice dentists (i.e., 133,092). See Comment on Section 3 above regarding the total number of general practice dentists. The total number should not be limited to private general practice dentists. So 133,092*0.76=101,150 general practice dentists that place amalgams.

Section 6, Paragraph 1:
"Dividing the 66 million amalgam placements identified by the ADA in 1999 by the 92,957 general dentists conducting the procedures, we estimate that each general dentist conducts an average of about 713 amalgam placements per year."

As the number of amalgam placements per year is taken from 1999, and this number for placements is used as the basis for the dental wastewater mercury release calculations, the dental wastewater mercury releases should be compared to air emissions from 1999. As

1999 air emissions are not available, the mid-1990 air emission estimates should be amended to reflect air regulations that have significantly lowered the magnitude of mercury air emissions from several categories of businesses.

Additionally, correct these numbers to reflect all general practice dentists that place amalgams, not just private dentists.

Section 6, Paragraph 1:
"… we calculate an average annual placement rate of about 711 amalgam placements/active general dentist/year. Again, good internal correctional with the 713 amalgam placements/active general dentist/year identified by the ADA."

Correct these numbers to reflect all general practice dentists that place amalgams, not just private dentists.

Section 7, Paragraph 1:
"… we calculate an overall industry-wide capture efficiency of 77.8."

The use of the figure "77.8%" implies a degree of precision in the calculations that is beyond the scope of the report. There is a large degree of uncertainty in the numbers for chair-trap removal efficiency, vacuum filter removal efficiency, and the number of dentists using vacuum filters. It would be more appropriate to use the figure "78%" in place of "77.8%"

Additionally, the industry-wide capture efficiency was calculated assuming that 100% of dentists employed BMPs. It is unrealistic to expect that every single dentist maintains his/her chair-side trap and vacuum filter in perfect accordance with manufacturer's instructions. Rather, it would be more appropriate to assume some reasonable number of dentists do not employ full BMPs.

Section 7, Paragraph 1:
The phrase "Best Management Practices" is vague. "Management practices" implies active measures, but as used here, it appears to refer to the existence of chair-side traps and vacuum filters, which are passive devices that are standard and necessary elements of existing vacuum systems. There is little, if anything, in the way of "practices" a dentist could adopt to improve the efficiency of these devices. The only relevant "management practices" are the proper cleaning and disposal procedures for the solids captured in those devices.

The terms "conventional coarse traps and filters" would be clearer and more neutral. At a minimum, the report could define "BMPs" as "proper management of conventional coarse traps and filters." In addition, the report should note that the "percentage removals" cited by the report do not represent potential reductions in the existing loading of mercury to POTWs. Surveys conducted by the Massachusetts Water Resources Authority (Charlestown, Massachusetts) indicate that most dentists in the Authority's service area already use such

practices. If this is true, "BMPs" would largely represent conventional practices already in use in some communities, so the removals cited may reflect a portion of what is already being achieved nationwide. Thus, a program to promote proper management of solids from conventional devices might not have much impact on current, site-specific POTW loadings.

Section 8:
It should be mentioned in Section 8 of this report, which summarizes the release to POTWs, that if a clinic switches to a "turbine" or "dry" vacuum system that does not use a vacuum filter, there will be an increase in the release of amalgam and mercury to POTWs.

Given that dry systems are more economical to use over their life (save electricity and water), this is the dominant trend in the Minneapolis/St. Paul metropolitan area. This report should comment on whether or not this trend is occurring nationwide.

This information should be mentioned elsewhere in the report, especially in the *Executive Summary*.

Section 8, Paragraph 1:
The report's estimate of 6.34 tons of mercury going to POTWs appears to be reasonable, but it would be preferable if the estimate were checked against what might be calculated from actual observed discharges. One recommendation would be to use average daily discharge reported in the study by MCES[4]: 234 mg/dentist/day.

MCES's study is not the only source of empirical data. The study by Larry Walker Associates for AMSA[5] (the "AMSA study"), calculated an average loading value of 56 mg/dentist/day, using data from several different studies, suggesting a total loading value about 25% that of the MCES study. MWRA's sampling has found a broad range of variation in dental discharges, yielding loading estimates consistent with both the AMSA study, at the low end, and the MCES study at the high end. However, the MCES study was the most detailed and controlled, and should be regarded as credible evidence that the higher end estimate represents at least some of the discharges actually taking place. Furthermore, there is other data from Cailas and Drummond published by the Illinois Waste Management and Research Center that shows higher values than the MCES data.

The report does not compare its estimate of 6.34 tons discharged by dentists to wastewater with loadings from any other dischargers to POTWs, but nothing in the report contradicts the findings of the AMSA study concerning relative significance of dentists' contribution of mercury to POTWs. The AMSA study did not attempt to generate a national loadings estimate, but it did attempt to model the potential for reductions from different sources at

[4] Evaluation of Amalgam Removal Equipment and Dental Clinic Loadings to the Sanitary Sewer. Metropolitan Council of Environmental Services ("MCES"), St. Paul, MN (2001)
[5] "Mercury Source Control and Pollution Prevention Program Evaluation." Prepared for the Association of Metropolitan Sewerage Agencies (AMSA), under Cooperative Agreement with the U.S. Environmental Protection Agency, by Larry Walker Associates. March 2002.

representative POTWs, and dentists were consistently the source where the largest reductions are possible. The AMSA study concluded that the percent of influent mercury values coming from dentists varied from 25% to 100%, depending on the value used for dentists, and in the end found an average dental contribution of between 35 and 40%.

Section 9, Paragraph 3:
The idea that dental mercury in "beneficially re-used sludge" should be treated as if it were not released to the environment is unwarranted. If a sludge product is used as fertilizer, its contents technically enter the environment. AMSA cannot agree that compliance with applicable limits for mercury means that mercury amalgam discharged to a POTW can be disregarded. The pretreatment program requirements of state and Federal law require POTWs to maintain and enforce regulatory limits for toxic pollutants, including mercury, even when the POTW is in compliance with applicable limits. Furthermore, in some parts of the country, the presence of certain pollutants, even within the regulatory limits, may limit the management options available to a POTW.

Section 9, Paragraph 3:
The use of 40% for the amount going to grit is not valid. Apparently the 40% comes from a combination of theoretical and sampling data, but the report does not make it clear where the estimate comes from. Data from Balogh and Johnson 1998 show that 7% to 48% of the mercury entering a wastewater treatment plant may go out with the grit. This work was done in support of a MCES and MDA study coordinated by Claude Anderson (MCES) titled: *Community-Wide Dental Mercury Study*, 2001. The write-up for the Community-Wide study indicated that 7% was believed to be more representative for the eight MCES wastewater treatment plants. Also, not all POTWs have grit removal as part of their overall treatment processes, and thus this generalized removal factor cannot be applied to a nationwide estimate.

The report should use a range of 7% - 48% for its calculations or use an average of 7% and 48%, giving 28%, instead of 40%. AMSA strongly recommends that the report show what the range was if it cites Balogh and Johnson 1998.

The report states that "as much as 40% of the amalgam particles entering a POTW may be removed in the grit chamber." Stating "as much as" implies that they are using the upper end, or close to the upper end, of a range as the amount to base a calculation. This does not seem appropriate.

As with beneficially reused biosolids, the report should not discount the mercury removed in the grit chamber. Grit may be landfilled or, in some cases, added to the biosolids and sent for land application and is not sequestered in some way.

Section 9, Paragraph 3:
The September 2002 version of this report (Revision 1) compared the estimated 0.49 mg/dry kg to 5 mg/dry kg for wastewater treatment plant sludge. AMSA had (verbally) indicated to ADA and ENVIRON that 5mg/dry kg was too high. In this revised version, the reference to 5 mg/dry kg was not modified (lowered), but rather this reference was apparently eliminated altogether. Although AMSA does not have a precise figure, we estimate a range of 1 – 3 mg/dry kg.

Section 9, Paragraph 3 and 4:
Between these two paragraphs, a reference should be added regarding the *Community-Wide Dental Mercury Study*. This study found that there was a 29% - 44% decline in the mercury levels of sludge by installing amalgam separators at the clinics. (Since the separators did not remove all of the amalgam or mercury, the overall percent loading contribution from the clinics would have been higher than 29% - 44%.)

Section 10:
In this section the author states that grit chamber solids are managed as solid waste and disposed of in Subtitle D solid waste landfills. This is not the case for grit chamber solids from all POTWs (example provided by City of Wichita). In some cases, solids are incorporated with biosolids and land applied, which presents a new set of issues concerning the fate of amalgam in biosolids.

Section 10, Paragraph 2:
The report states that "there have been few, if any, rigorous studies on the environmental behavior of dental amalgam or amalgamated mercury." There have been remarkably few studies, but it would be false to state that there have been no studies. The report does not cite any of the studies that are actually available, and has not presented the actual findings of the studies that are cited.

The four studies cited in Table 1 on page 9, are short term studies of solubility under specific conditions. The studies by Senkpiel, et al, are studies of dissolved mercury in dental wastewater and anaerobic sludge. Heintze, et al, is a study of methylation of mercury from dental amalgam when exposed *in vitro* to oral streptococci. The authors reported that they did find methylmercury, and concluded that "The results indicate that organic mercury compounds may be found in the oral cavity." (This reviewer was not able to obtain a copy of "Beckert, 1988").

There are many other studies on the solubility of mercury in dental wastewater. Earlier in the report, the authors cite Drummond, 1995, and Naleway, et al, 1994, studies which reported dissolved and colloidal fractions of 5-10%. Other studies can be found at the

website of the International and American Associations for Dental Research. For example, Berdouses, et al,[6] found that

> *While the age of the amalgam and the amalgam type influence the extent of mercury release during the initial non-steady-state conditions, the steady-state value of mercury daily dose due to a single amalgam filling is 0.03 micrograms/day, which is well below the calculated threshold-limiting value (TLV) of 82.29 micrograms/day considered dangerous for occupational exposure in the United States.*

The research literature also includes numerous studies showing the affects of various factors, such as acidity, abrasion and heat, which increase the solubility of mercury in amalgam. For example, Certisimo, et al,[7] demonstrated that commercial tooth whitening products can increase the solubility of mercury from amalgam. Stone, et al,[8] demonstrated that oxidizing substances used for cleaning dental vacuum lines can dissolve a substantial portion of the mercury in amalgam. Dr. Stone and his colleagues at the Naval Dental Research Institute have also demonstrated that mercury in dental wastewater can become methylated in holding tanks downstream by bacteria present in the oral flora.[9]

There are at least three studies showing that fish placed in a tank with amalgam show significant uptake of mercury in their livers or muscle tissue.[10] These studies demonstrate that mercury in amalgam will be taken up by the aquatic food chain.

In the face of such results, there is no justification for the assumptions made in the report. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

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[6] *"Mercury release from dental amalgams: an in vitro study under controlled chewing and brushing in an artificial mouth,"* E. Berdouses, T. K. Vaidyanathan, A. Dastane, C. Weisel, M. Houpt and Z. Shey, Department of Prosthodontics and Biomaterials, UMDNJ-NJ Dental School, Newark 07103, USA, et al. Available at www.iadr.com.

[7] *"The Effect of Bleaching Agents on Mercury Release from Spherical Dental Amalgam,"* F.J. Certosimo, F.J. Robertello, M.V. Dishman, R.E. Bogacki, and M. Wexel, Virginia Commonwealth University, USA. Available at www.iadr.com.

[8] "*Line Cleanser/Disinfectant Effects on Soluble Mercury Content of Dental Wastewater,"* M. E. Stone, E. D. Pederson, R. A. Auxer, and S. L. Davis, The Naval Dental Research Institute, 310-A B Street, Building 1-H, Great Lakes, IL 60088-5259, USA. Available at www.dentalmercury.com.

[9] *"Methylmercury Content of Dental-Unit Wastewater,"* M.E.Stone, M.E. Cohen, S.Z. Schade, J.C. Kuehne, Naval Dental Research Institute, USA. Available at www.dentalmercury.com..

[10] "Mercury Concentrations in Fish from Dental Amalgam" ("Anrikning I fisk av kvicksilver fran tandamalgam") Rapport SNV PM 1072 States Naturvardsverk, Stockholm, Sweden, 1978 (English version available from the Swedish Natural Environmental Protection Agency Library); "Microcosm Environmental Analysis of Dental Waste Water," J.L. Drummond, BM Francis, MD Cailas, and TY Wu (University of Chicago and Urbana-Champagne, Il.)(Abstract #688, published in the Journal of Dental Research, 1988); "Uptake and accumulation of mercury from dental amalgam in the common gold fish, Carassius auratus," C.J. Kennedy. Department of Biological Sciences, Simon Fraser University. Environmental Pollution 121 (2003) 321–326.

Section 10, Paragraph 2:
"After reviewing all of the literature, a default bioavailability factor of 50% was chosen based on best scientific judgment. There have been few, if any, rigorous studies on the environmental behavior of dental amalgam or amalgamated mercury (McGroddy and Chapman 1997). All of these studies have weaknesses, as well as strengths. EPA and state regulatory agencies assume for simplicity that all of the total mercury that enters the environment may be converted to methylmercury."

Given the extremely small amount of data available on methylation of mercury in the environment, there is no sound scientific basis for a choice of 50% as the percentage of mercury in dental amalgam wastewater that is bioavailable. Clearly, the mercury in dental amalgam can methylate when stored in a holding tank (see M.E. Stone, et.al), so some fraction of the mercury in dental amalgam waste must be bioavailable. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 10, Paragraph 2:
More work and explanation is needed on the "default bioavailability factor". The report states that this 50% figure "was chosen based on best scientific judgment". (McGroddy and Chapman 1997 is cited in the context of limited data on amalgam). A 50% figure appearing in Attachment 1: Supporting Calculations, shows that this 50% was an "assumption" based on "Hg dissolution rates from Okabe 1987 and Marek 1990". These two citations don't appear to be listed with the other references.

If a wastewater treatment plant incinerates its sludge, and operates with a wet scrubber system, mercury from amalgam may be carried back to the headworks of the treatment plant. Therefore, mercury that came into the plant as amalgam may be discharged to a receiving water as mercury (not amalgam). See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 10, Paragraph 2:
It is stated that "EPA and state regulatory agencies assume for simplicity that all of the total mercury that enters the environment may be converted to methylmercury." The reason is not for "simplicity", but rather to be "protective, conservative, and recognizing the potential for long-term breakdown of materials". See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 10, Paragraph 4:
A "leachate collection system" is mentioned, without commenting on how leachate is managed. Leachate may be trucked or piped to wastewater treatment plants.

Section 10, Paragraphs 4 and 5:
Apparently, the report assumes that there will be no release of mercury from sludge, even though the third paragraph mentions the "general lack of data on the long-term environmental behavior of amalgamated mercury." This warrants additional discussion.

Section 10, Paragraph 5:
What is the following comment based on: "Mercury is known to be in utility ash…and is expected to be present in the ash from the incineration of sludge"? The report assumes that 100% is released, which is probably appropriate. The comment about "expected to be present in ash" should either be deleted or data for mercury in ash should be provided. MCES data showed zero (Balogh and Liang 1995).

Section 11, Paragraph 1:
"Figure 1 and the following summarizes…. Bioavailable mercury from dental facilities in POTW effluent entering surface waters – up to 0.27 tons…. Mercury from dental facilities in incinerated POTW biosolids that is converted to elemental mercury and may be converted into methylmercury – 0.77 tons…. Mercury from dental facilities that may be converted into methylmercury (from incineration of sludge and direct discharge in POTW effluent) – up to 1.04 tons."

As discussed above, there is insufficient information to make conclusions about bioavailability. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam. This passage should be modified to read, "Figure 1 and the following summarizes…. Mercury from dental facilities in incinerated POTW biosolids – 0.77 tons… Total mercury entering the environment from dental facility wastewater – 1.3 tons."

Section 11, Paragraph 3 and Table 2:
"Table 2 compares the estimated bioavailable mercury discharges associated with dental facilities with that from other domestic sources. Figure 2 graphically represents these data. These comparison data are from EPA's 1997 Mercury Study Report to Congress and represent data from the early to mid-1990s."

Table 2 and the accompanying discussion are misleading. A comparison is made between mercury discharged by dental facilities in the United States and mercury air emissions from various industrial sectors in the United States. However, as is clearly presented in the *Mercury Study Report to Congress* from which the data were taken, only about one-third of the air emissions of mercury in the United States are actually deposited in the United States. The purported objective of the report is to "Estimate the influence of dental amalgam discharges on the levels of methylmercury in the environment," (Section 1, Paragraph 4). To determine the influence of dental amalgam discharges on the environment, one needs to compare mercury loadings that are occurring in the same part of the environment. If the scope of the report was global mercury discharges from dental facilities it would make sense to ignore the effect of transport of mercury out of the area of interest. However, comparing

the discharge of mercury from U.S. dental facilities with overall U.S. air emissions of mercury, when two-thirds of that mercury is deposited out of the U.S., is misleading.

The amount of U.S. air emissions of mercury estimated to be deposited within the U.S. is 52 tons. An additional 35 tons of mercury is deposited in the U.S. from the global reservoir of mercury, for a total deposition of roughly 87 tons (per the *Mercury Study Report to Congress*). Any comparison of mercury reaching the environment from dental facility wastewater in the U.S. should be compared to the actual loading of mercury deposited in the U.S. from air emissions, which is 87 tons (based on mid-1990s data).

Additionally, Table 2 neglects to mention the air emissions from dental preparations, as presented in the *Mercury Study Report to Congress*. Per the *Mercury Study Report to Congress*, 0.7 tons per year of mercury enter the air from dental preparations. If the term, "Dental-Related" is to be used in Table 2, it should encompass all dental-related mercury emissions, including air emissions and mercury in human waste from amalgam fillings. A more appropriate term would be "Dental Facility Wastewater."

Finally, while the report has been modified to state that the data in Table 2 are from the early to mid-1990s, it is misleading to compare these data with 1999 dental facility wastewater discharges. Air emissions of mercury have declined significantly since the early to mid-1990s due to imposition of stringent air emission regulations on several sectors including municipal waste combustors and medical waste incinerators. In order for the report to be accurate, these reductions must either be taken into account or the dental facility wastewater discharges must be taken from the early to mid-1990s. While it is difficult to find actual data, the *Mercury Study Report to Congress* itself indicates that there will be at least a 90% reduction in mercury emissions from municipal waste combustors and medical waste incinerators.

Therefore, Section 11, paragraph 3 and Table 2 should be amended to read as follows: "Table 2 lists air emissions from domestic sources of mercury. These comparison data are from EPA's 1997 *Mercury Study Report to Congress*."

Table 2. Summary of Mercury Emissions Sources Located in the U.S.	
Source	Estimated Mercury Releases (tons Hg/yr)
Coal Utility Boilers	51.6
Commercial/Industry Boilers	28.4
Hazardous Waste Combustors	7.1
Chlor-alkali Manufacturing	7.1
Portland Cement Manufacturing	4.8
Municipal Waste Combustors	3.0[11]
Medical Waste Incinerators	1.6[12]

[11] Based on 29.6 tons Hg/yr emissions in the early to mid-1990s and a 90% reduction since then to new U.S. EPA emissions guidelines that have since been implemented.

Geothermal Power Production	1.4
Other	12.0
Total (from all sources)	117
Source: USEPA. 1997. Mercury Study Report to Congress. EPA-452/R-97-003	

"The *Mercury Study Report to Congress* further indicates that only approximately one-third of U.S. anthropogenic mercury emissions are deposited within the lower 48 United States. Additionally, another 35 tons of mercury is deposited in the U.S. from mercury in the global atmosphere. Therefore, the total amount of mercury deposited from air emissions in the U.S. is 74 tons per year (35 tons/yr + 117 tons/yr*0.3333) (1999 estimate; reductions in air emissions from mid-1990s to 1999 were taken into consideration). For comparison, the amount of mercury entering the environmental from dental facility wastewater discharges is 1.3 tons/yr."

Section 11, Paragraph 4:
"As indicated in Table 2, dental-related mercury that may be considered bioavailable represents less than 0.7% of the total bioavailable mercury released in the U.S."

As discussed above, it is misleading to compare dental facility wastewater discharges of mercury to air emissions of mercury in the U.S. This sentence should read, "As indicated above, the mass of mercury entering the environment from dental facility wastewater is 1.7% of the mass of mercury deposited in the U.S. due to air emissions. Mercury from dental facility wastewater may represent a higher loading of mercury to surface waters, as not all mercury deposited in the U.S. from air emissions will reach surface water bodies."

Section 12, Paragraph 1:
"The estimates of dental-related mercury discharges presented above assume that all of the general dentists…"

"Dental-related" mercury discharges would include amalgam in human waste from fillings. Additionally, the calculations were based only on private general dentists, not all general dentists. See comment on Section 3. The calculations should be based on the total number of general practice dentists (in this instance, those performing amalgam procedures), not only private general practice dentists.

Section 12, Paragraph 3:
"The decreased BMP and use and capture efficiencies considered in this scenario result in a 2.52-ton increase in the amount of mercury discharged to POTWs from dental facilities nationwide."

[12] Based on 16.0 tons Hg/yr emissions in the early to mid-1990s and a 90% reduction since then to new U.S. EPA emissions guidelines that have since been implemented.

The correct amount of mercury discharged to POTWs from dental facilities nationwide under Scenario 1 is 9.90 tons/year[13]. As the discharge under the baseline scenario is 6.34 tons/year, the increase is 3.56 tons/year.

Section 12, Paragraph 5:
The comment "increases only marginally to 1.85 tons" should be reworded. If the base value is 1.04 tons with proper management, an increase to 1.85 tons is not "only marginally".

Section 12, Paragraph 6:
"The results of Scenarios 1 and 2 indicate that the sensitivity of our analysis to any variations in the rate and manner in which BMPs are implemented in the dental industry is extremely limited…"

In the report, the results of Scenario 2 indicate a 78% increase in environmental releases of mercury due to lack of proper BMP usage. Corrected numbers reveal a doubling in environmental releases due to lack of proper BMP usage. "Extremely limited" is an inappropriate term to describe such a large impact. Rather, the sensitivity analysis indicates that the amount of mercury released to the environment from dental facility wastewater is strongly dependent upon the use of BMPs. Looking at the situation in reverse, if only 50% of dentists are currently fully compliant with BMPs (as depicted in Scenario 2), then encouraging dentists to fully implement BMPs could result in a substantial reduction of mercury releases to the environmental from dental facility wastewater.

Section 13:
In AMSA's telephone comments on the first draft, we emphasized that the draft misinterpreted the results reported by MCES, and recommended that the correct interpretation of that data shows an average capture of 89% amalgam passing vacuum filters, and about 94% of amalgam passing chair-side traps, for an average result of 92.5%. In the new draft, while acknowledging the existence of these empirical data, the author has chosen to rely on an entirely abstract calculation based on the theoretical possibility that a separator could pass the ISO 11143 test with a 95% capture efficiency, but only attain an "incremental" efficiency of 60-74% of the amalgam particles passing a vacuum filter. The problem with the use of this "scenario" is that there is no evidence that any currently available separator actually performs in this fashion.

The ADA has published the results of ISO testing of all of the amalgam separators that were available on the U.S. market at the time of their test.[14] The average results were greater than 99% removal, and no unit tested less than 97%. The difference between >99% and the report's theoretical 95%, is significant. The report assumes that its "straw-man" will allow

[13] Fax from Ann Heil of the Los Angeles County Sanitation Districts (LACSD) to Jay Vandeven, ENVIRON, November 12, 2002
[14] *"Laboratory Evaluation of Amalgam Separators,"* P.L. Fan, Hanu Batchu, et al, JADA, Vol. 133, 577-599 (May, 2002)

5% of amalgam to pass through, out of the 12% that pass through a vacuum filter, resulting in an "incremental efficiency" of approximately 60%. If, however, one uses the average result from the ADA test, and assumes that only 1% will pass through, the "incremental efficiency" turns out to be 92%. Moreover, the "incremental efficiency" would be even higher if the ADA's average result were not rounded down to 99%. In fact, there is no empirical evidence that the units tested by ADA would be *any* less effective on a smaller sized-particle mix than they are on the ISO formula.

The authors advance no justification for basing its analysis on a purely hypothetical possibility, while disregarding actual empirical results achieved in the testing of real devices. There are reasons to be concerned about the correlation between the ISO test and actual *in situ* performance, and these questions are the subject of on-going research. For purposes of creating a model based on currently available data, the results reported by MCES are far more defensible than the theoretical construction used in the report. The authors should discard the 60% to 74% theory, except perhaps for use in the sensitivity analysis. Its lead results should be based on 92% removal. (Note that the MCES study accounted for all mercury discharged through the system, including dissolved portions that are not measured in the ISO formula).

Using 95% as the high-end scenario would be inappropriate as the analysis is based on an arbitrary assumption. A better approach would be to use 99% as the high-end, based on an assumption that municipalities and regulatory agencies will use that as a Best Available Technology standard.

Section 13, Paragraph 4:
The report should note that clinics (at least in some service areas) are switching away from vacuum systems that use a vacuum filter, resulting in more waste discharged to the sewer. In such a situation, if a separator is installed, it will achieve a higher percent removal.

The report states that "Many studies have indicated that chair-side traps capture as much as 75% of amalgam particles and that vacuum filters capture as much as 50%." Please provide citations for this information.

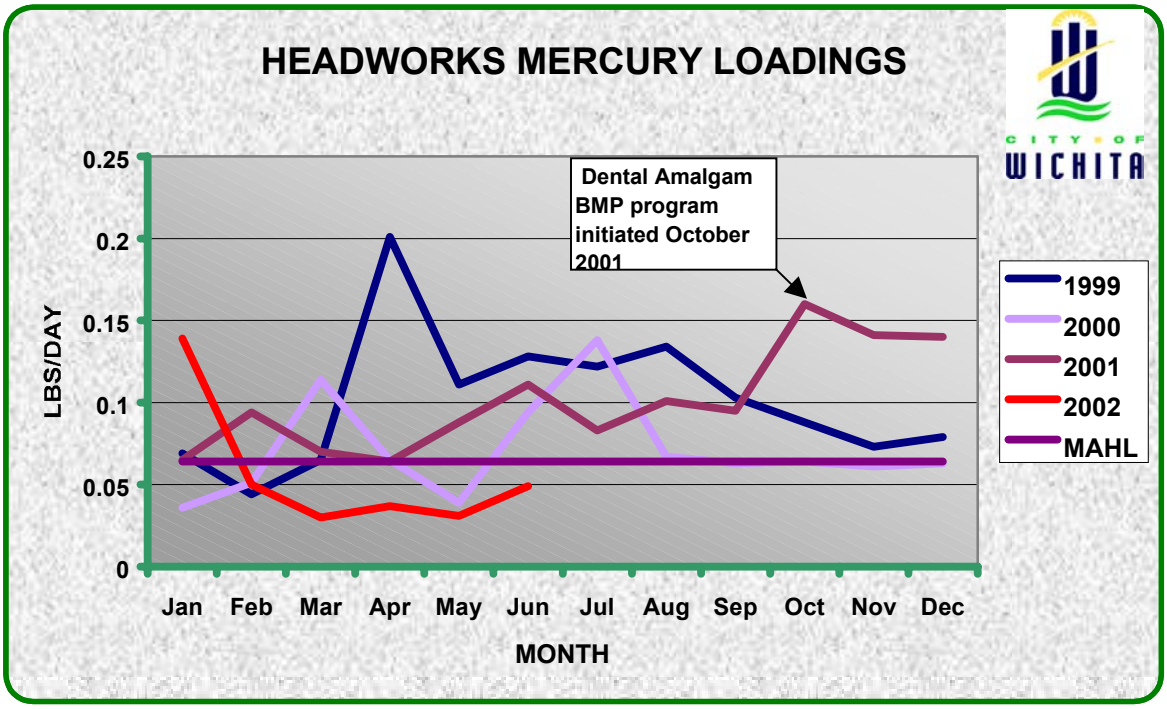
The authors may have been using WEF 1999 for the vacuum filter 50% figure, which may have been in error (too high of a percentage). Further discussion on this topic is needed.

If an ISO tested separator needs to pass 95%, it will be designed to remove more than 95%. The low end of the range (60%) is calculated out only by assuming chair-side traps and vacuum filters remove more and more – thereby acting as a two-stage "separator" anyway.

Section 14:
The report states that the capture efficiencies in conjunction with chair-side and filter traps were as low as 13%. It appears that the report's efficiency value is based on the total amount

of amalgam passing through the system and removed by the separator. However, to figure the efficiency of the separator, the amount entering the separator post chair-side and vacuum filter should be compared with the amount exiting the separator. This will produce a much more realistic picture of the efficiency of the product.

It should also be noted that the chair-side and vacuum filters may not be removing any additional amounts of amalgam since they have been in use for a long period of time. With recent attention given to BMPs, it is likely that the dental offices have increased maintenance activities on these apparatuses, resulting in slight decreases of mercury contaminated discharges, but not at levels sufficient enough to realize significant decreases of mercury loadings received at POTWs. The City of Wichita (Wichita, Kansas) implemented a dental mercury BMP program in September 2000, which involved increased maintenance activities for the removal of particles at the chair-side traps and cleaning the vacuum filter. The City did not see any measurable decreases at the POTW headworks until after January, 2002, three months after installation of amalgams separators was required.



Section 14, Paragraph 1:
Change reference to "Section 6" to "Section 7," as the capture efficiency of BMPs is discussed in Section 7.

Section 14, Paragraph 1:
At minimum, change "77.8%" to "78%," due to a lack of certainty in the numbers used to calculate the figure.

Section 14, Paragraph 2:
Change the term "dental-related" in the first and second sentences to "dental facility." The term "dental-related" in reference to wastewater discharges would include mercury loadings from human waste due to the presence of amalgam fillings in residents.

Section 14, Paragraph 2
The numbers in Figure 5 are incorrect. The purpose of Figure 5 is to examine the flow of mercury in dental wastewater nationwide with amalgam separators operating at 60% capture efficiency after implementation of dental BMPs (total system efficiency of 95%). However, the removal efficiency of vacuum filters was incorrectly accounted for in the calculations for Figure 5. AMSA has examined Figure 5 and amended the calculations below. However, we feel the underlying approach used may be inappropriate and warrants further discussion.

The value of 60% was established by assuming that the chair-side traps and vacuum filters remove 88% of mercury, more than the 81% mentioned in Section 13. When the efficiency of the chair-side traps and vacuum filters increases to 88%, more mercury is removed by the chair-side traps and vacuum filters, and less mercury is removed by the amalgam separators. This means that in Figure 5, the amount passing through the vacuum system after the chair-side traps and vacuum filters in not 6.34 tons, but rather a lesser amount.

The basis for the Figure 5 numbers is given in Section 13, paragraph 4, which states that, "Many studies have indicated that chair-side traps capture as much as 75% of amalgam particles and that vacuum filters capture as much as 50%. Applying these percentages, the combined capture of the chair-side trap and vacuum filter approaches 88%… the actual incremental efficiency of the separator would be about 60%." This means that an incremental efficiency of 60% for the separator is only applicable when the combined chair-side trap and vacuum filter efficiency is taken to be at least 88% or so. In drawing up Figure 5, the author should use a combined chair-side trap and vacuum filter removal efficiency of 88%, not 78%. A simple assumption of 88% removal across the chair-side traps and vacuum filters results in 3.43 tons per year of mercury entering amalgam separators (28.6*(1 – 0.88) = 3.43), not 6.34 tons per year as indicated in Figure 5. Applying a 60% capture efficiency to the amalgam separators results in 1.37 tons per year of mercury exiting the separators (3.43*(1 – 0.6) = 1.37 tons/year), for a capture of 3.43 – 1.37 = 2.06 tons per year in the amalgam separators.

Note that the 3.43 tons per year figure of mercury entering the separators is only applicable if it is assumed that all dentists employ 50% efficient vacuum filters. If 20% of dentists do not have vacuum filters, as assumed in the baseline scenario depicted in Figure 1, this number would change. Assuming that 28.6 tons/year of mercury from dentists, 80% of this or 22.88 tons/year would be generated at dental facilities that have vacuum filters and the remainder, 5.72 tons/year, would be generated at dental facilities that do not have vacuum filters. All of the mercury would pass through 75% efficient chair-side traps, resulting in 5.72 tons/year of mercury leaving the traps at dental facilities with vacuum filters and 1.43 tons/year of

mercury leaving the traps at dental facilities without vacuum filters. The dental facilities with vacuum traps would remove an additional 50% of this mercury, for a discharge to amalgam separators from these facilities of 2.86 tons/year. At the facilities without vacuum filters, the full 1.43 tons/year leaving the chair-side traps would enter amalgam separators. Applying an amalgam separator removal efficiency of 60% to facilities with vacuum filters results in a discharge of 2.86*(1 - 0.6) = 1.14 tons/year of mercury discharged from the amalgam separators at these facilities. At the facilities without vacuum separators, it is not appropriate to apply an amalgam separator efficiency of 60%. The amalgam separator efficiency of 60% should only be used when the combination of chair-side trap removal and vacuum filter removal together is about 88%. This allows an amalgam separator efficiency of 60% to result in an overall (trap + filter + separator) removal efficiency of 95%. In the case of facilities with 75% efficient chair-side traps and no vacuum filters, 80% is the appropriate removal efficiency to use for the amalgam separator to obtain an overall removal efficiency of 95%. ((100% – 75%)*(100% – x) = 100% – 95%; x = 80%) Applying the 80% removal efficiency to the 1.43 tons/year of mercury entering amalgam separators at facilities without vacuum filters results in the discharge to POTWs of 0.29 tons/year from these facilities. The total discharge to POTWs from facilities with and without separators is then 1.14 + 0.29 = 1.43 tons/year. The amount of mercury removed in the separators is (2.86-1.14) + (1.43-0.29) = 2.86 tons/year. These calculations are graphically depicted in Attachment A.

Numbers in Section 14, paragraphs 2, 3, 4, and 5 should also be corrected, based on the above calculations.

Section 14, Paragraph 3:
Change the term "dental-related" in the last sentence to "dental facility," for reasons discussed above.

Section 14, Paragraph 3:
"As discussed above, we have conservatively assumed that approximately half of this dental-related mercury, or about 0.18 tons, will potentially be bioavailable over long durations in the environment."

Delete this sentence. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 14, Paragraph 3:
"… by about 0.17 tons (0.53 tons – 0.36 tons), corresponding to a reduction of potentially bioavailable mercury in the discharge of about 0.09 tons."

Change calculations and discussion to address total mercury only. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 14, Paragraph 4:
Change the term "dental-related" in the first sentence to "dental facility," for reasons discussed above.

Section 14, Paragraph 4:
Delete the phrases, "and converted to bioavailable mercury," and "potentially bioavailable," in the second and third sentences, respectively, for reasons discussed above.

Section 14, Paragraph 5:
Delete the terms "bioavailable" and "potentially bioavailable" in this paragraph for the reasons discussed above.

Section 14, Paragraph 6:
Change the term "dental-related" in the first, second, third, fourth, and fifth sentences to "dental facility," for reasons discussed above.

Section 14, Paragraph 6:
"Conservatively assuming that approximately half of this dental-related mercury will potentially be bioavailable over long durations in the environment, the use of amalgam separators results in a reduction of bioavailable mercury discharges in POTW effluent of 0.24 tons (assuming a 95% additional separator capture efficiency)."

Delete this sentence due to lack of evidence to support the hypothesis that only half of dental-related mercury is potentially bioavailable over long durations. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 14, Paragraph 7:
Change the term "dental-related" in the first, second, and third sentences to "dental facility," for reasons discussed above.

Section 14, Paragraph 7:
Change calculations and discussion to address total mercury only. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 14, Paragraph 8:
"Combining the reductions of bioavailable dental-related mercury from POTWs to receiving waters (0.24 tons) with… incineration of biosolids (0.73 tons)…by about 0.97 tons."

Remove references to bioavailable mercury and "dental-related" wastewater and correct calculation to address total mercury only. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 15, Title:
"Cost-Benefit and Cost-Effectiveness Analysis"

This title should be changed to "Cost-Effectiveness Analysis," as the section does not address any of the benefits of dental amalgam removal. To conduct a cost-benefit analysis, potential benefits resulting from the use of the amalgam separators would have to be discussed. As part of the cost effectiveness analysis, ADA should compare the cost per pound for a POTW to remove mercury from wastewater of $21 million to the cost per pound for dentists to remove amalgam via separators.

Section 15:
The cost estimates relied on by the authors are inconsistent with available information, including, for example, the estimates given in the ADA's report on its ISO testing of commercially available separators, which shows that among the units achieving >99% removal there are three available for $500 or less.[15]

The authors state that they took the average cost from the products for which they obtained cost information for. In modeling foreseeable costs in a greatly expanded market, it is debatable whether the average of current vendor quotes is a reasonable basis for assumed costs. Although several factors would affect prices in an expanding market, it would be reasonable to expect that vendors could take advantage of economies of scale, and that buyers would generally gravitate toward lower prices. Dominance of sales by products in the lower range of the current price scale represents, at a minimum, a highly likely scenario for future costs. Thus, the report's analysis is not credible without an estimate of the overall cost if the average purchase fell at $500, rather than the $1,000 to $2,000 figure used in the report.

Section 15:
The report uses a headcount of 133,092 dentists to determine the high-end number of separators needed. Elsewhere in the report, 122,312 dentists was used to determine loadings. As outlined above, AMSA believes the total number of general practice dentists for the loading determinations should be 133,092. The number of separators needed would not be based on this number, but rather on the number of clinics, as it is expected that clinics will only need one separator for all on-site dentists. AMSA believes 100,000 may be an accurate estimate for the number of separators needed nationwide.

Section 15:
AMSA suggests that ADA use the following figures for the reports cost estimates: Initial cost of the units is between $50 and $1895, with an average purchase price of $770. Installation costs average $179 (ranging from included with initial to $400). Operation and maintenance (O&M) costs average $366 ($50 - $780) as opposed to $700 - $1,000 (all costs

[15] *"Laboratory Evaluation of Amalgam Separators,"* P.L. Fan, Hanu Batchu, et al, JADA, Vol. 133, 577-599 (May, 2002).

are King County, Washington estimates based on information from 14 vendors and are consistent with other cost estimates reviewed).

Section 15, Paragraph 1:
"In this section, we estimate the industry-wide costs for an incremental reduction in methylmercury related to dental amalgam discharges."

The reference to methylmercury should be changed to reference total mercury, and the scope of the sentence should be made clear. The sentence should read, "In this section, we estimate the industry-wide costs for an incremental reduction in mercury related to dental facility amalgam discharges."

Section 15, Paragraph 1:
"The incremental bioavailable mercury reduction attained from using amalgam separators at these efficiencies ranges from 0.57 to 0.97 tons."

References to bioavailable mercury should be removed and the numbers should be corrected accordingly. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 15, Paragraph 2:
"… requiring separators at 110,910 to 133,092 individual locations."

Many dentists share office space with other dentists, and amalgam separators are available to treat the discharge from multiple dental chairs simultaneously. Therefore, it is unlikely that each dentist will require an individual separator. No explanation is given in the report for the 110,910 number. See comment above regarding number of dentists and number of required separators.

Section 15, Paragraph 2:
Regarding "costs not considered", it is unlikely that many POTWs would require sampling. POTWs would structure a program to operate as inexpensively as is possible for both the POTW itself and the dental community.

One set of costs not considered in this report are health costs associated with additional mercury releases to the environment. Fish consumption advisories can result in costs to administer the consumption advisory program. There may be lost revenues if there is less sport or commercial fishing.

One key point to consider regarding costs is that if a clinic operates with a vacuum filter, then installs an amalgam separator in place of the vacuum filter, the new cost will be partially offset if the vacuum filter is no longer needed, or if the vacuum filter is left in place downstream of the separator (as a back-up to protect the vacuum pump).

The report should also note that BMPs are not cost free. For example, there are costs associated with replacement filters for vacuum systems. At least some separators would allow the dentist to forego the cost of filter replacement, and would probably extend the life of the vacuum system. The *incremental* cost of the separator would therefore be less, perhaps significantly less, than its total purchase and O&M cost.

If a clinic is properly managing waste vacuum filters, the cost savings could be significant if such filters are no longer purchased or shipped out for recycling or processing.

Section 15, Paragraph 3
As discussed above, we recommend that cost calculations be based upon 100,000 separators. As also discussed above, we recommend that the capital cost of each unit should be the average purchase cost plus the average installation, or $949 ($770 + $179), and O&M costs should be taken as $366 per year. Therefore, the industry-wide capital cost is estimated to be $94.9 million (100,000*$949). The annual industry-wide O&M cost is estimated to be $36.6 million (100,000*$366). If it is assumed that each separator has a ten-year useful life and that the capital cost is spread evenly over the ten years, the combined annual industry-wide cost is estimated to be $46.1 million ($94.9 million/10 + $36.6 million).

Section 15, Paragraph 4
To determine the cost per pound of mercury removed in amalgam separators, the report only looks at reductions in bioavailable mercury. As discussed extensively throughout these comments, references to bioavailable mercury should be removed. See General Comment 3 for our recommended approach to address bioavailability of mercury from dental amalgam. Additionally, the report does not consider reductions of mercury to grit or land applied biosolids as actual reductions in mercury released to the environment. We recommend that all mercury removed by amalgam separators, whether it ends up in incinerated biosolids, land-applied biosolids, surface waters, or grit to be considered in determining the cost effectiveness of amalgam separators. Therefore, the amounts of mercury removed by amalgam separators should be taken as 2.86 tons/year for separators having an incremental removal efficiency of 60%, and 6.02 tons/year for separators having an incremental removal efficiency of 95%. Accordingly we estimate the cost to remove mercury in dental wastewater using amalgam separators ranges from $3830 to $8060 per pound (($46.1 million/6.02 tons per year)(1 ton/2000 pounds) = $3830/pound; ($46.1 million/2.86 tons per year)(1 ton/2000 pounds) = $8060/pound), or about $8 to $18 per gram.

Section 15, Paragraph 5
"The use of amalgam separators will not be cost effective in reducing environmental levels of methylmercury."

The calculations in these comments indicate that the use of amalgam separators is highly cost effective in preventing releases of mercury to the environment, particularly when compared

to the costs to remove mercury at POTWs of approximately $21 million per pound or $46,000 per gram.

Section 15, Paragraph 5
"The difference in the quantity of bioavailable mercury released to the environment from the use of BMPs and an amalgam separator – at most 0.97 tons – is relatively small compared to the total amount of bioavailable releases."

Delete references to bioavailable mercury in this paragraph, per General Comment 3. Additionally, the amount of mercury removed via amalgam separators alone – up to 6.02 tons per year – constitutes a large portion of the mercury loadings to POTWs in the United States. Therefore, installation of amalgam separators at dental facilities nationwide is likely to have a significant impact on levels of mercury in wastewater reaching POTWs. As POTWs do not destroy mercury, but rather transfer it to effluent, grit, and biosolids, a significant reduction in the amount of mercury entering POTWs will result in a significant reduction in the amount of mercury released from POTWs. We agree that the total amount of mercury released from POTWs is small compared to other releases of mercury in the United States, but POTWs must still meet regulatory requirements for their releases, particularly to surface water bodies.

Section 16:
For the reasons discussed above, the cost figures are too high. AMSA does not know what the long-term maintenance and disposal costs for separators will be, but we believe that market forces will drive prices downward.

These costs break down even further when taken to the individual patient level. The authors state that dentists nationally performed 66 million amalgam placements in 1999. It would appear that a national effort to install amalgam separators would be likely to cost the average dental patient less than $1.

Section 16:
ADA estimated the cost for the entire dental community to remove mercury at the source of the discharge to be $45,000 - $139,000 per pound. The costs would be escalated well beyond that figure if POTWs have to treat to remove mercury in order to meet water quality standards or biosolids disposal criteria. This is directly due to the increased flows POTWs must treat as compared to the discharge volumes leaving a dental facility. The report should reflect this information.

Section 16, Paragraph 1:
"… levels of methylmercury in the environment."

Change to, "… levels of mercury in the environment."

Section 16, Paragraph 1:
"… the amount of dental-related mercury in the wastewater."

Change to, "the amount of mercury from dental facilities in the wastewater," since mercury in wastewater from human waste containing amalgam is not discussed.

Section 16, Paragraph 1:
"The large majority of the mercury removed by these processes has a low bioavailability and is managed in a manner (e.g., recycling, landfilling) that would not significantly contribute to methylmercury levels in surface waters.

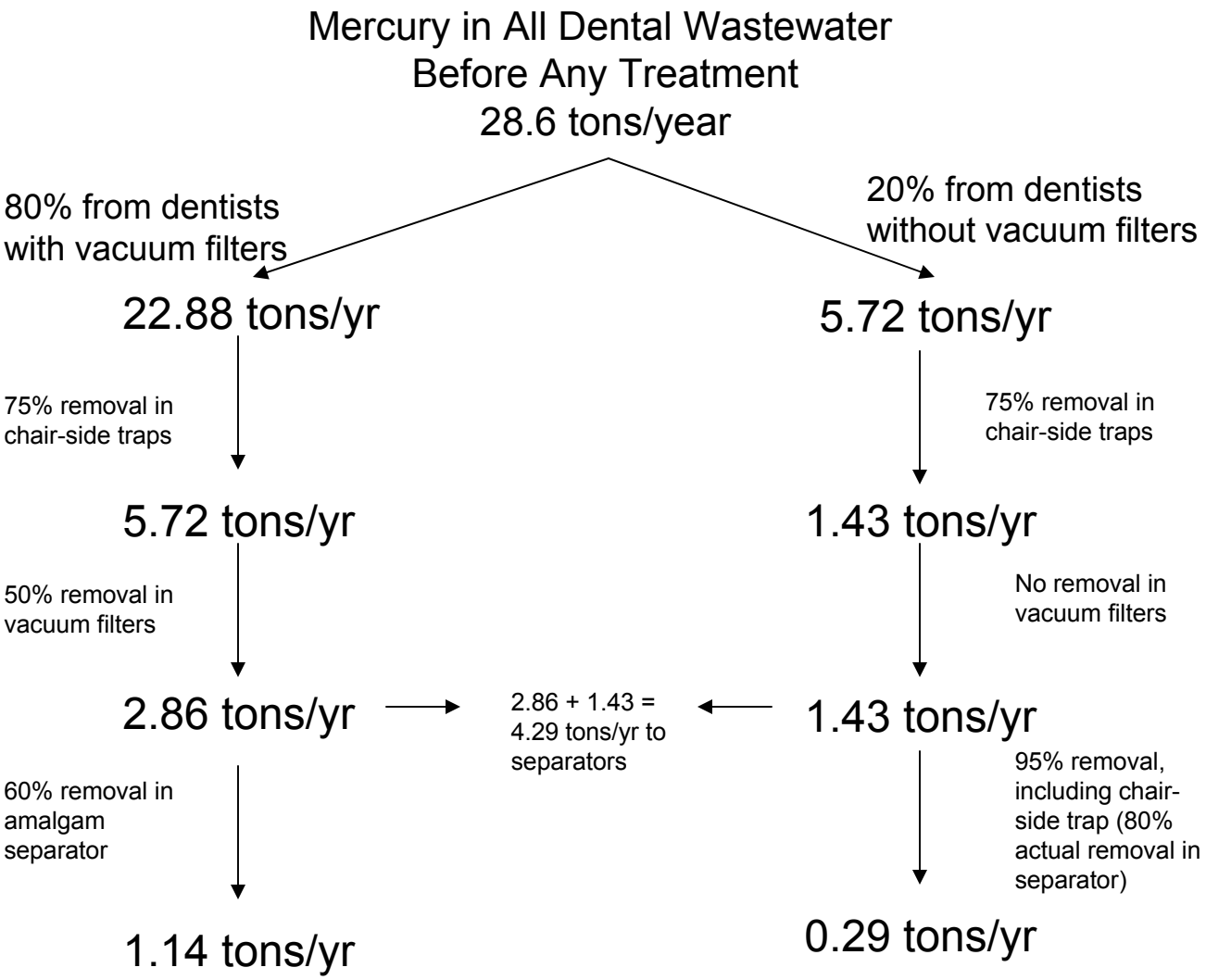
References to bioavailable mercury should be removed. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 16, Paragraph 1:
"As a result, only about 1 ton of the mercury used in dental amalgam nationwide is ultimately converted to a bioavailable form that could potentially be methylated in the environment."

References to bioavailable mercury should be removed. Additionally, make it clear that dental amalgam in human waste was not considered. See General Comment 3 for approach to address bioavailability of mercury from dental amalgam.

Section 16, Paragraph 1:
Correct the last two sentences to reflect total mercury instead of bioavailable mercury and use revised cost figures as discussed above.

Attachment A – Figure 5 Calculations



Total to POTWs =
1.14 tons/yr + 0.29 tons/yr = 1.43 tons/yr

Total removed in amalgam separators =
(2.86 – 1.14) + (1.43 – 0.29) = 2.86 tons/yr