APPENDIX C

Peer Reviewer Evaluations
San Francisco Bay PCBs TMDL

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Peer Review of the Technical Basis for the Polychlorinated Biphenyls Total Maximum daily Load in San Francisco Bay

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Specific issues to be addressed in the peer review are outlined in Attachment 2 of Mr. Fred Hetzel's March 22, 2007 letter. These issues are addressed below based on the following materials:

Appendix A: Basin Plan Amendment-Draft (March 2007)

PCBs in San Francisco Bay, Total Maximum Daily Load (TMDL), Staff Report (March 2007)

In addition, the following reports were also considered in preparing this review:

Davis, J.A. 2003. The Long-term Fate of PCBs in San Francisco Bay: SFEI Contribution 47. San Francisco Estuary Institute, Oakland, CA.

Gobas, F.A.P.C. and J. Wilcockson. 2003. San Francisco Bay PCB Food Web Model, RMP Technical Report: SFEI Contribution 90. San Francisco Estuary Institute, Oakland, CA.

Gobas, F.A.P.C. and J. Arnot. 2005. San Francisco Bay PCB Food Web Model-Final Technical Report. Prepared for the Clean Estuary Partnership.

Davis, J.A., F. Hetzel, and J. Oram. 2006. PCBs in San Francisco Bay: Impairment Assessment/Conceptual Model report. Prepared for the Clean Estuary Partnership.

Fish Tissue Numerical Target

In this Basin Plan Amendment, we propose the use of a numeric polychlorinated biphenyls (PCBs) fish tissue numeric target. We propose that the human health protection provided by the proposed objective is consistent with, and as protective of human health as the water quality criterion in the California Toxics Rule.

a) *Is our derivation of the numeric fish target based on sound scientific knowledge, methods, and practices?*

The numeric fish target is based on standard risk assessment calculations using a 70-year lifetime, a mean body weight of 70 kg, a slope factor of 1 (mg/kg)/day, and a mean daily consumption rate of 320 g/day (based on the 95^{th} percentile upper bound estimate of fish intake reported for all Bay fish-consuming anglers), and a 10^{-5} risk level. The resulting numeric fish target for total PCBs of 10 ng/g is applied to white croaker (20-30 cm in length) and shiner surfperch (10-15 cm in length) collected in summer and fall seasons. Species

selection and fish collection times are justified based on: (1) previous fish sampling studies of San Francisco Bay and food chain model results which both indicate that white croaker and shiner surfperch are expected to have higher PCB body burdens than other fish species currently monitored in the Bay, and (2) on previous fish sampling studies of San Francisco Bay which indicate that PCB body burdens were highest in the summer and fall collection seasons.

Based on field-derived BioAccumulation Factors (BAFs) in Table 21 of the Staff Report, the numeric fish target of 10 ng/g is equivalent to a water quality criterion of approximately 20-50 pg/L. For comparison, the water quality criterion in the California Toxics Rule (CTR) is given as 170 pg/L. The numeric fish target is therefore considered to be more slightly more protective of human health.

Comments/Questions:

Since the use of the 95th percentile upper bound estimate of fish intake is important in establishing the margin of safety for the TMDL, further information should be given on fish intake. For example, a log probability plot of fish intake rates would be appropriate to show in the Staff Report so that the margin of safety for other segments of the population (e.g., the 50th percentile) can be readily quantified.

The slope factor used in establishing the TEQ screening level of 0.14 pg/g for dioxin-like PCBs should be cited (e.g., on page 24 of the Staff Report).

TMDL Problem Statement

In this section of the report, we describe the basis for concluding that PCBs impair San Francisco Bay beneficial uses. High concentrations of PCBs have been found in fish consumed by sport fishers. PCB concentrations in San Francisco Bay exceed the basin Plan narrative objective for bioaccumulation and impair beneficial uses, such as sport fishing, wildlife habitat, and preservation of rare and endangered species.

b) Is our description of the nature of the water quality problem caused by PCBs in San Francisco Bay based on sound scientific knowledge, methods, and practices?

Water quality problems caused by PCBs in San Francisco Bay are clearly stated in Section 2 of the Staff Report. Supporting information on measured PCB concentrations for water samples, fish and benthic organisms from the Bay are presented in Section 6, and are compared to CTR water quality criterion and screening levels for fish. This information is appropriately used to demonstrate the extent of impairments due to PCB contamination.

TMDL Development

In this section of the report, we describe the sources, loads and reservoirs of PCBs. This assessment relies on available information to describe and quantify relative contributions from many sources like wastewater and storm water discharges,

atmospheric deposition, Central Valley inputs, in-bay dredge material disposal, and contaminated sediments.

c) Are the source categories clearly defined?

Source categories are clearly defined and include: (1) direct atmospheric deposition; (2) Central Valley watershed discharge; (3) municipal and industrial wastewater discharges; (4) urban and non-urban storm water runoff; (5) internal cycling from the active sediment layer; and (6) sediment dredging.

d) Are the source categories, source estimates and estimation methodologies clearly stated for each source categories?

Estimates of PCB external loads were determined as follows:

Direct atmospheric loads: The annual rates for gaseous and particulate exchange rates were taken from SFEI (2001). Details of the estimation method are not given in the Staff Report.

Central Valley watershed: The annual PCB discharge rate was taken from SFB-RWQCB (2004) based on ten years of monitoring data for the Sacramento and San Joaquin Rivers. Details of the calculation are not provided in the Staff Report.

Municipal and Industrial Wastewater Dischargers: PCB loads were determined using average daily flows from POTWs and industries, and average PCB effluent concentrations for the following categories: (1) POTWs with secondary treatment; (2) POTWs with advanced treatment; (3) petroleum refineries; and (4) other industrial wastewater dischargers.

Urban and Non-urban Stormwater Runoff: PCB loads were estimated using model-generated runoff volumes and sediment loads from the 17 Bay Area watersheds along with median PCB concentrations on sediment for urban and for non-urban runoff.

Internal Cycling from the Active Sediment Layer: The inventory of PCBs in the active sediment layer was determined from the Bay surface area, an assumed active sediment layer of 15 cm, and a Bay-wide average PCB sediment concentration of 10 μg/kg.

Sediment Dredging: An annual estimate of PCB removal from the Bay by dredging is obtained from dredging records (given as 2.4 million cubic yards per year), and a Bay-wide average PCB concentration sediment concentration of 10 μg/kg. (The bulk density of the dredged material is not stated, but results appear reasonable.) A net removal of PCB by dredging is determined based on the amount of dredged material that is disposed at in-Bay disposal sites and the amount that is disposed at either upland sites or the deep ocean disposal site.

Comments/Questions:

For municipal and industrial wastewater dischargers, justification should be provided for using average concentrations in estimating PCB loading rates. A probability plot, or possibly a log probability plot of measured effluent concentrations would be very helpful.

For urban and non-urban stromwater runoff, justification should be provided for using median concentrations in estimating PCB loading rates. Again, a probability plot, or possibly a log probability plot of measured effluent concentrations would be very helpful.

Part of the discussion on sediment dredging needs clarification. In particular, the sentences on page 46 stating "… we estimate that, each year, about 10 kg/yr of PCBs are being disposed in the Bay at dredged sediment disposal sites. During the same period, placement of dredged sediment at either upland sites or the deep ocean disposal site removes about 13 kg of PCBs per year from the Bay resulting in a net loss of about 3 kg of PCBs each year" do not seem right. Based on the current wording, shouldn't the net loss be the 13, not 3, kg of PCBs? Also, shouldn't sediment dredging only be considered a loss from the active sediment layer if the underlying sediments are less contaminated? Has this issue been appropriately considered in subsequent TMDL mass balance calculations?

In this section of the report, we also propose a numeric target that will achieve attainment of water quality standards. A numeric target can be a numeric water quality objective or a numeric interpretation of a narrative objective. To this TMDL, we propose to use the fish tissue total PCB concentration as the numeric target.

In this section of the report, we also present the results of a food web bioaccumulation model used to predict the sediment PCB concentration when fish tissue concentrations achieve the numeric target. A steady-state PCB fate model is then used to establish the TMDL needed to attain the predicted sediment concentration. These two models provide the linkage analysis between the numeric target and the TMDL.

e) *Are the linkages between sources and the numeric target clearly stated and based on sound scientific knowledge, methods, and practices?*

Linkage between external PCB sources and PCB concentrations in water and sediment are clearly described in the Staff Report. Details of the simple mass budget model are not provided in sufficient detail. (A general description for the simple mass budget model however is provided in SFEI, 2003. Details of the final model calculation with tidal exchange (Figure 28) are not adequately described in the Staff Report or in the cited reference (Davis et al, 2006).) The use of a Bay-wide box model to describe PCB contamination in the Bay does not appear to be consistent with observed spatial variations in PCB contamination (e.g., see map of PCB contamination in sediments (Figure 23). More detailed modeling for the long-term fate of PCBs in the Bay should therefore be given a high priority.

Linkage between PCB sediment concentrations and PCB accumulation in fish are appropriately described in the Staff Report and in the cited references. Steady-state, food web bioaccumulation model calculations for specific PCB congeners are fully described in Gobas and Wilcockson (2003), and Gobas and Arnot (2005) and are appropriately justified.

Comparison of model results and field observations are also documented, as well as the overall uncertainty associated for bioaccumulation model calculations.

Comments/Questions:

Although simple mass budget model results can be used in evaluating the "average" response for PCB contamination in the Bay, it may be reasonable to expect that sediment contamination in northern portion of the Bay may response faster due to larger incoming sediment loads from the Sacramento and San Joaquin Rivers, while the southern and more contaminated portions of the Bay may response much more slowly. Factors such as this should be acknowledged accordingly in discussions of model uncertainty.

A further explanation of PCB degradation, particularly in the active sediment layer, should be provided in the Staff Report. (This issue is not adequately addressed in Davis (2003) or Davis et al. (2006).)

For future model development, the effects of estuarine circulation, sediment transport, and organic carbon cycling should be considered in evaluating spatial and temporal responses of PCB contamination in the Bay.

Congener-specific, or at least homolog-specific, fate and bioaccumulation behavior should be considered in future model development and TMDL model evaluations.

In this section of the report, we allocate a portion of the TMDL to each source category, reserving a portion of the load as a margin of safety. A load allocation is proposed for each source category and for individual discharges in certain source categories.

f) Are the load and wasteload allocations and calculation methodologies clearly stated for each source category?

The methodologies for establishing a TMDL of 10 kg/yr are clearly stated. (The specifications of PCB tidal exchange and PCB degradation in the active sediment layer however need further clarification. See previous comments on the simple mass budget model.)

The methodologies for establishing wasteload allocations for each source category are also stated clearly.

g) Is the method of ensuring an implicit margin of safety clearly stated?

The conservative approach used in deriving the fish tissue numeric target (based on the 95th percentile upper bound estimate of fish intake reported for all Bay fish-consuming anglers) appears to be reasonable in providing an implicit margin of safety. As stated above, a log probability plot of fish intake rates, or some other information, should be provided so that the margin of safety for other segments of the population (e.g., the 50th percentile) can be readily quantified.

TMDL Implementation

The implementation plan contains proposed actions to reduce PCB loads to the bay and to reduce PCB bioaccumulation by biota. The plan also specifies a program of monitoring and special studies to address the various areas of uncertainty.

h) Are the implementation actions clearly stated?

The implementation actions are clearly stated and appear to be appropriate based on an adaptive management approach.

i) Is the proposed monitoring program adequate to evaluate progress toward achieving the fish tissue target?

The proposed monitoring program appears to provide an adequate approach for evaluating progress toward achieving the fish tissue target. In addition to monitoring of San Francisco Bay fish, sediments, and water, monitoring of external sources and in-bay PCB-contaminated sites provide important information in evaluating progress, and if necessary, in re-evaluating the TMDL.

j) Have we clearly stated the key management questions?

Issues related to long-term management plans, interim risk management actions, periodic review, and adaptive implementation are clearly described in the report.

Overarching questions

Reviewers are not limited to addressing only the specific issues presented above, and are asked to contemplate the following "big picture" questions.

k) In reading the staff report and proposed Basin Plan Amendments, are there any additional scientific issues that are part of the scientific basis of the proposed rule not described above? If so, are they based on sound scientific knowledge, methods, and practices?

None noted.

l) Taken as a whole, is the scientific portion of the proposed rules based on sound scientific knowledge, methods, and practices?

Overall, development of the San Francisco Bay TMDL for PCBs appears to be based on sound scientific knowledge, methods, and practices. Portions of the analysis; e.g., the PCB fate model, should be considered as preliminary evaluations at this time, and should be developed in more detail under the adaptive implementation management strategy.

Some editorial corrections are also listed below:

Editorial Corrections: Appendix A Basin Plan Amendment

Page A8, first sentence, first paragraph: delete “will be required agencies”

Page A8, last sentence, first paragraph: delete “to and to conduct or cause … section.”

Page A9, last sentence, first paragraph: delete “to support actions”

Editorial Corrections: Staff Report

Page 10, last sentence: fix “PCb”

Page 15, five lines from bottom: delete “under”

Page 33, seven lines from bottom: “per cubic centimeter” should be “per square centimeter”

Page 39, last line, second paragraph: “g/kg” should be “μg/kg”

Page 50, third line, last paragraph: delete “in the”

Page 51, eighth line, first paragraph: fix “the entire and segment of the Bay”

Page 57, first line: “kgs” should be “kg/yr”

Page 59, last line: missing end of sentence

PEER REVIEW OF THE TECHICAL BASIS FOR THE POLYCHLORINATED BIPHENYLS TOTAL MAXIMUM DAILY LOAD IN SAN FRANCISCO BAY

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Fish Tissue Numeric Target:

1. Is our derivation of the numeric fish tissue numeric target based on sound scientific knowledge, methods, and practices?

The numeric fish tissue target is reasonable, with some qualifications, when one considers only PCBs. The screening level of 10 ng/g wet weight fish tissue falls within the risk-based consumption limit proposed by USEPA (2000) of 4 meals per month to avoid a risk of cancer beyond 1 in 100,000, or 12 meals per month to avoid excess in non-cancer health endpoints. However if one really wants to protect the public, the level for unlimited consumption given by USEPA (2000) is 1.5 ng/g (ppb) wet weight. There are certainly some sport fisherpersons, and especially some ethnic and immigrant groups who consume much more than 4 meals of fish per month. And it must be noted that the 1 in 100,000 limit is far from the 1 in 1,000,000 that is desirable. The EPA level given for unlimited consumption so as to avoid non-cancer adverse health effects is 5.9 ng/g (ppb), so even for non-cancer effects the screening level of 10 ng/g is somewhat high. Nevertheless setting this level is realistic, even if not ideal, and is consistent with other advisories throughout the country.

The bigger problem is that fish contain many other fat-soluble compounds that have carcinogenic and non-carcinogenic actions in addition to PCBs. Thus by setting the standards on the basis on consideration of only PCBs it is possible, indeed it is likely, that these standards are not protective of human health. In our study of farmed and wild salmon we found that there was a direct relationship between the levels of PCBs and those of hexachlorobenzene, lindane, heptaclor epoxide, dieldrin, endrin, trans-nanochlor, DDT, mirex, and dioxins (Huang et al., 2006). All of these substances are rated as probable human carcinogens, and all have non-cancer health effects as well. Furthermore we found that applying the EPA (2000) formula for recommended consumption rates based on consideration of all of these substances for which EPA gives cancer slope factors led to much more restrictive consumption advisories than when one considered only PCBs. Our studies also did not even consider emerging contaminants such as the polybrominated diphenyl ethers, which are also present in salmon at high concentrations (Hites et al., 2004) and are markedly rising in human breast milk in the US (Schecter et al., 2003). There are currently no confirmed cancer slope factor for the PBDEs, but they are similar in structure to PCBs and probably have similar actions. These considerations strongly suggest that the by consideration of only PCBs one is significantly underestimating the risk of consumption of fish from San Francisco Bay.

TMDL Problem Statement:

2. Is our description of the nature of the water quality problem caused by PCBs in San Francisco Bay based on sound scientific knowledge, methods, and practices?

Yes, the description of the water quality problem is sound and justified. The major problem is the large amounts of PCBs in the sediments. While PCBs are not very water soluble, they are in equilibrium with levels in the water. The report documents significant sediment contamination with PCBs, and even without additional input it will take generations before these levels decline. Removal of all of the contaminated sediments is not realistic with current technology.

I find the calculation that the direct PCB loads to the Bay are estimated at 0.35 kg/yr, but the loss due to atmospheric transport to be 7.4 kg/yr, to be very surprising and almost not believable. I have reviewed the paper by Tsai et al. (2002) and the report by Tsai and Baker (2005), and certainly don't find anything wrong in their analysis. However the input to the Bay is very much lower than that to Lake Michigan, reported to be about 3,200 kg/yr, with 330 kg coming from Chicago (Hornbuckle and Green, 2000). In their review of persistent organic pollutants in the Great Lakes, Hornbuckle et al (2006) state that "the atmosphere is the largest source of PCBs to Lake Michigan…..Atmospheric deposition (gas, dry particle, and wet deposition) is larger than inputs from resuspension of contaminated sediments and larger than inputs from direct discharge and contaminated tributaries". Kelly et al. (1991) estimated total atmospheric input to Lake Erie to be 257 kg/yr. The EPA has estimated input to Lake Ontario to be 64 kg/yr. (USEPA, 2003). Strachan and Eisenreich (1988) estimated that the atmosphere contributes about 90% of the PCBs found in Lake Superior. Hsu et al. (2003) show that between 2 and 70 kg of PCBs enter the Chicago atmosphere each day, and a significant percentage of this is deposited into Lake Michigan. Wethington and Hornbuckle (2005) report 120 kg of PCBs go into Lake Michigan just from the city of Milwaukee. I don't doubt but there is more contamination with PCBs in the Midwest and East than on the West Coast, but it is hard to believe that the input to the Bay is so small. However, the conclusion that there is more loss than input from vapor-phase PCBs is consistent with the results from the Great Lakes, and so does not alter the conclusion that there is a net loss through this route. Certainly the methods for measurement of PCBs in air used by Tsai and Baker (2005) are standard, and reports look fine. But their result is highly questionable, in my judgment. With all of the cities and waste sites around the Bay it is simply not believable that only 0.35 kg/yr enter the Bay by atmospheric transport of gas phase PCBs.

TMDL Development:

3. Are the source categories clearly defined?

Yes.

4. Are the source categories, source estimates and estimation methodologies clearly stated or each source category?

They are clearly stated, but as discussed above, I have difficulty believing that the atmospheric deposition is as small as reported here. The other estimates appear reasonable to me.

5. Are the linkages between sources and the numeric target clearly stated and based on sound scientific knowledge, methods and practices?

Yes, the linkages between sources and numeric target are clearly stated, and use of fish PCB concentration as the numeric target is appropriate. While the numeric target may not be optimally protective for those consuming excessive amounts of fish, they are reasonable and justified on the basis of target levels used throughout the country.

6. Are the load and wasteload allocations and calculation methodologies clearly stated for each source category?

The load and wasteload allocations are clearly stated for each source category. The calculation methodologies are less clearly explained, and for most of the source categories the allocation is simply given without any great discussion of how it was derived. The allocations appear reasonable, but it would have been more satisfactory to have a detailed explanation of the methodology for their derivation.

7. Is the method of ensuring an implicit margin of safety clearly stated?

Yes, the methods for ensuring a margin of safety are clearly stated and are reasonable.

TMDL Implementation:

8. Are the implementation actions clearly stated?

The implementation actions are clearly stated and are logical and appropriate. There is also a realistic time frame for implementation of these goals, which cannot be accomplished immediately because of surface contamination.

9. Is the proposed monitoring program adequate to evaluate progress toward achieving the fish tissue target?

This monitoring program is appropriate. There will be more or less continuous monitoring, followed by a more complete evaluation every five years of progress in each of the categories of input to the Bay.

10. Have we clearly stated the key management questions?

Yes, this is well done. The three major implementation categories of a) control of external loadings, b) control of internal source and c) actions to manage risks to Bay fish consumers are clearly stated and discussed. The strategy of regular monitoring is

essential in order to determine whether goals are being met, and the proposed monitoring program is excellent. I do have some question as to whether the anticipated natural attenuation within the Central Valley watershed and from urban stormwater runoff is realistic, but having these as goals is appropriate. Our experience in the Great Lakes area indicates that cities are enormous reservoirs of PCBs, and that even old buildings contain significant amounts of PCBs in everything from paint, ceiling tile and caulking. The time frame for reduction from such sources is long. It is extraordinarily difficult to obtain the funds to clean up former and current industrial and especially military facilities. Dredging may only remove PCBs from one site and deposit them in another. Great care should be taken in dealing with dredged sediments.

Overarching questions:

11. In reading the staff report and proposed Basin Plan Amendments, are there any additional scientific issues that are part of the scientific basis of the proposed rule not described above? If so, are they based on sound scientific knowledge, methods, and practices?

I am rather pessimistic that the goals of this proposal will be achieved as easily as anticipated. I believe that this view would be shared by most of my colleagues who work on comparable issues around the Great Lakes. For example, Hornbuckle et al. (2006) in their recent review state "The atmosphere, especially near urban-industrial areas, is the major source to the open waters of the lakes. Other sources include contaminated tributaries and in-lake recycling of contaminated sediments. Until these remaining sources are controlled or contained, unsafe levels of PCBs will be found in the Great Lakes environment for decades to come." Part of our concern is that whereas PCB levels in Great Lakes fish declined dramatically for many years, they have now plateaued but at a level which exceeds any health-based standard. This is at least in part due to the failure to anticipate what an enormous source of PCBs urban areas are. But whether or not the goal of having fish from the Bay that are safe to eat is achieved in as rapid a time frame as proposed, the steps are all in the right direction. With load reductions and regular monitoring it will be possible at least to inform the public of the status of fish in the Bay.

12. Taken as a whole, is the scientific portion of the proposed rules based on sound scientific knowledge, methods, and practices?

Yes, the proposed rules are based on sound scientific knowledge, methods and practices. They use state-of-the-art approaches to anticipate loadings, and propose an excellent monitoring program to chart progress. While some of the problems may have been underestimated, this is an outstanding and innovative approach to regeneration of a fishery that does not pose health hazards to the public.

References:

Hites RA, Foran JA, Schwager SJ, Knuth BA, Hamilton MC and Carpenter DO (2004) Global assessment of polybrominated diphenyl ethers in farmed and wild salmon. Environ Sci Technol 38: 4945-4949.

Hornbuckle KC, Carlson DL, Swackhamer DL, Baker JE and Eisenreich SJ (2006) Polychlorinated biphenyls in the Great Lakes. In: The Handbook of Environmental Chemistry, Volume 5N, pages 13-70. RA Hites, Editor. Springer Berlin/Heidelberg.

Hornbuckle KC and Green ML (2000) The impact of Chicago on Lake Michigan: Results of the Lake Michigan mass balance study. Report to the International Joint Commission for the workshop on "Using models to develop air toxics reduction strategies: Lake Michigan as a test case." 10/23/00.

Hsu YK, Holsen TM and Hopke PK (2003) Locating and quantifying PCB sources in Chicago: Receptor modeling and field sampling. Environ Sci Technol 37: 681-690.

Huang X, Hites RA, Foran JA, Hamilton G, Knuth BA, Schwager SJ and Carpenter DO (2006) Consumption advisories for salmon based on risk of cancer and noncancer health effects. Environ Res 101: 263-274.

Kelly TJ, Czuczwa JM, Sticksel PR and Sverdrup GM (1991) Atmospheric and tributary inputs of toxic substances to Lake Erie. J Great Lakes Res 17: 504-516.

Schecter A, Pavuk M, Papke O, Ryan JJ, Birnbaum L and Rosen R (2003) Polybrominated diphenyl ethers (PBDEs) in US mother's milk. Environ Health Perspect 111: 1723-1729.

Strachan WMJ and Eisenreich SJ (1988) Mass balancing of toxic chemicals in the Great Lakes: The role of atmospheric depostion. Report to the International Joint Commission on Great Lakes Water Quality, International Joint Commisssion, Windsor, Ontario, Canada.

USEPA (US Environmental Protection Agency) (2000) Guidance for assessing chemical contaminant data for use in fish advisories. Vol 2. Risk assessment and fish consumption limits. Third Edition. Available at: www.epa-gov/ost/fishadvice/volume2/index.html

USEPA (US Environmental Protection Agency) (2003) Critical contaminants in the Great Lakes. http://www.great-lakes.net/humanhealth/fish/critical.html).

Wethington DM and Hornbuckle KC (2005) Milwaukee, WI, as a source of atmospheric PCBs to Lake Michigan. Environ Sci Technol 39: 57-63.