# Bay Area Clean Water Agencies' Draft Dioxin Issue Paper: Expert Panel Response and Recommendations

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## I. Introduction and Background

Congeners of dioxins and furans have been found in the San Francisco Bay in several species of fish sometimes used for human consumption, causing the State of California to issue an interim fish consumption advisory. This fish consumption advisory has been used by the US Environmental Protection Agency and the State of California as a basis for placing the Bay on the State's list of impaired waterways required by the Clean Water Act. As a consequence, water quality-based discharge limits for dioxins are now being placed into NPDES permits for dischargers to the Bay where dioxins or furans have been detected in effluents.

At the request of the Bay Area Clean Water Agencies (BACWA), an association of municipal wastewater treatment utilities, the San Francisco Estuary Institute convened a panel of three qualified experts to review the factual case and to make recommendations. As a starting point, BACWA prepared a draft "Dioxin Issue Paper" on February 15, 2008, detailing the environmental problem, the regulatory context, and the specific difficulties presented by dioxin-related effluent limits in permits. The draft Dioxin Issue Paper also outlined an array of possible regulatory strategies which might help resolve the difficulties faced by dischargers, ranging from strategies related to impairment listing to strategies related to NPDES permit issuance. Panel members were asked to review the draft Dioxin Issue Paper, make recommendations for improvement, and respond to a number of questions posed by the San Francisco Estuary Institute.

The Panel met in Oakland, California, on February 22, 2008, at the San Francisco Estuary Institute. We were joined by representatives of the San Francisco Bay Regional Water Quality Control Board, the US Environmental Protection Agency, BACWA, and others with expertise in the field. Subsequently, we held numerous conference calls and agreed that we would address the questions posed by the Institute in both short- and long-term contexts. For the short term, we agreed upon recommendations that could help alleviate some of the dioxin-related regulatory difficulties faced by municipal wastewater treatment plants. For the long-term, however, we agreed that the problems faced by the dischargers are best addressed by solutions for the dioxin contamination problems in the Bay as a whole. We therefore also agreed to recommend a series of steps towards developing an integrated multi-media strategy for reducing dioxin levels in the San Francisco Bay.

## II. Major Findings

The panel reviewed numerous sources of information listed herein and in Appendix A, including BACWA's draft Dioxin Issue Paper. Drawing upon these sources, our discussions with the San Francisco Estuary Institute and others at our February 22, 2008, meeting in Oakland, and our

combined 97 years of professional experience in the environmental management field, we conclude the following:

- Solutions to the dioxin-related issues detailed by BACWA in its draft Dioxin Issue Paper are very closely tied to solutions for the Bay. Thus, solutions for BACWA members will be both short-term and long-term in nature. In the short-term, certain adjustments can be made to NPDES permits to increase practicality, ensure reasonable compliance attainability and minimize discharges of dioxin. In the long-term, though, BACWA members will continue to face increasing scrutiny and controversy until the dioxin-related problems of the Bay itself can be solved. This will likely take decades.

- Available data for levels of dioxins in fish in the San Francisco Bay over the last decade, although sparse, are sufficient enough to warrant concern and for the State and EPA to make judgments and begin taking protective action.

- Data for dioxins in fish tissue have been reported for the Bay on a wet-weight basis, which is appropriate for fish consumption advisory and water quality standards attainment determination purposes. If evaluated for temporal trends, the available wet-weight fish tissue data suggest that dioxin levels in the Bay may have been increasing through recent years. However, reliance on weight-weight fish tissue data for evaluating temporal and spatial trends in dioxin levels can be misleading. Dioxins are highly lipophilic and, therefore, their levels measured in fish tissue are highly dependent on lipid content, which can vary greatly even within size class and species. When lipid-normalized, data compiled by the San Francisco Estuary Institute and others over the last decade indicate that levels of dioxins measured in fish tissue have been neither increasing nor declining over time.

- The interim fish consumption advisory issued by California in the late 1990s appears appropriate as an interim step. However, further evaluation of fish-related environmental goals is also appropriate, using the best current data for risk level, cancer slope factor, population groups to be protected, and consumption rates of fish species actually consumed.

- This interim fish consumption advisory is a reasonable and proper basis for the State and EPA to judge that approved State water quality standards for the Bay are not being met; in particular, the acceptable cancer risk upon which State water quality standards are based appears to be exceeded through average consumption of Bay fish at measured dioxin-TEQ levels (see http://www.swrcb.ca.gov/tmdl/docs/303d_policydocs/209.pdf). Thus, the Bay appears to be appropriately included on the State's list of impaired waterbodies and thus will likely need a Total Maximum Daily Load (TMDL).

- Use of Toxicity Equivalency Factors (TEFs) to gauge relative risk of numerous congeners of dioxins and furans is consistent with current scientific practice and is appropriate in the setting of permit discharge limits and evaluating aggregate risk of exposed populations. According to Section VIII.D of *Water Quality Guidance for the Great Lakes System: Supplementary Information Document* (EPA-820-B-95-001),

"[T]here is ample evidence indicating that there is a common mechanism of action for the expression of toxicity for the 17 dioxin congeners for which TEFs have been developed." For this reason, TEFs for dioxins and furans are encoded in federal regulations at Appendix F, Procedure 4 of 40 CFR Part 132 and have been in effect since 1995 for implementing water quality standards in the Great Lakes System.

- The general description in the draft Dioxin Issue Paper of NPDES permit requirements related to dioxin is consistent with the requirements of the Clean Water Act and with practices elsewhere in the U.S. In brief,
  - where discharges have the reasonable potential to contribute to water quality standards not being met, discharge permits must contain requirements adequate to meet those standards;
  - application of the applicable water quality criterion at the end of the pipe is consistent with EPA's recommendations for discharges to receiving waters where the criterion is exceeded and also for bioaccumulative pollutants prior to the development of a TMDL;
  - where the minimum quantitation level (ML) of a validated analytical method is greater than the water quality-based effluent limit or other regulatory requirement, a "compliance monitoring level" is appropriate; and
  - pollutant minimization programs and track-down programs are appropriate interim steps where no technology exists to reliably meet the applicable water quality criterion.

- The current EPA Method 1613 will likely remain the applicable analytical method for the foreseeable future for regulatory or compliance monitoring purposes. EPA staff are not aware of any new and more sensitive dioxin analytical methods for any of the dioxins or furans; new Part 136 analytical methods for dioxins or furans from EPA are not a priority.

- For all but a few congeners, the Method 1613 Minimum Levels (MLs) remain well above the levels of the dioxins and furans typically detected in water-column and effluent samples collected utilizing high-volume screening techniques not approved by EPA for regulatory applications. Average municipal effluent congener concentrations measured in 100-liter samples and reported by the San Francisco Estuary Institute (SFEI) ranged from 90 to 30,000 times lower than their respective Method 1613 MLs. Therefore, assignment of any typically-assumed value greater than zero (*e.g.*, one-half the ML) for a congener not measured at or above its respective Method 1613 ML is likely to substantially and artificially inflate the calculated total TEQ, especially because congener-specific values are summed in calculating total TEQs. For example, the total TEQ calculated from the SFEI 100-liter municipal effluent sample data assuming one-half the ML for each average congener concentration below its respective Method 1613 ML is 9,000 times higher than the total TEQ calculated directly from the reported values.

- Neither the State nor EPA has yet developed a long-term multi-media dioxin strategy for the recovery of the Bay from elevated levels of dioxins and furans in fish.

- A good, quantified understanding of all possible sources of dioxin to the Bay is a crucial first step towards developing a long-term strategy which achieves the greatest reductions in the most cost-effective way. Currently, the available data on possible sources of dioxin to the Bay are sparse and highly uncertain.
    - Current best estimate is that municipal wastewater treatment plants contribute less than 10% of the dioxins and furans delivered to the Bay.
    - Bioaccumulation equivalency factors have not been applied to data on dioxins and furans in water and wastewater.
    - Urban stormwater discharged to the Newark Bay has been found to be a significant source of dioxin contamination, yet dioxin loadings in stormwater do not appear to be well characterized in the San Francisco Bay basin. Similarly, dioxin and furan contributions from upstream watersheds are not well differentiated or quantified.
    - Although several sediment samples were collected by NOAA in 2000, sediments in the San Francisco Bay have not been systematically analyzed for dioxins and furans to understand the spatial and quantitative dimensions of the dioxin reservoir in Bay sediments, or to identify any hot spots.
    - Deposition of dioxin on land and on the Bay from air pollution sources, a very likely source of contamination, has not been quantified or modeled. Agricultural burning, incinerators, fireplaces and barbeque pits, power generation, and other possible sources of dioxin that can end up in water will need to be better understood.

- A long-term solution for the San Francisco Bay will need to be multimedia and integrated.
    - The problems of the Bay cannot be remedied by isolated water quality-based limits on dioxins or furans on a relatively small number of individual dischargers.
    - Sources of dioxin in other environmental media will need to be reduced, almost certainly including air pollution sources and perhaps including contaminated sediments, if any are found.
    - Natural attenuation may play a role, once it is understood in the context of the Bay.
    - Phased, adaptive management approaches will likely be necessary to limit and reduce contributions from known sources and to test the effectiveness of applied remedies.

## III. **Recommendations: Toward a Strategy for the Bay**

### **A. Approach**

Current information indicates that the total loadings of dioxins and furans to the Bay from municipal wastewater treatment plants probably account for about 10% of the overall loadings. This figure, which is based on incomplete inventories, appears high to us, and points to a short-term need for a rigorous accounting of all possible air, water, and sediment sources of dioxins and furans to the Bay. Nationally, for example, *The Inventory of Sources and Environmental*

*Releases of Dioxin-Like Compounds in the United States: The Year 2000 Update* (External Review Draft, March 2005; EPA/600/P-03/002A) includes an inventory of contemporary releases from known sources in the United States. Only preliminary estimates were available for municipal wastewater discharges but, at 13 g TEQ/yr, they accounted for only 0.2% of the total estimated releases in the United States for 2000. Releases to air, at 8,187 g TEQ/yr, accounted for 98.6% of the 2000 total.

We do not believe that it is realistic, balanced, or fair to expect that municipal wastewater treatment plants discharging to the Bay should bear the major brunt of the loading reductions necessary to reduce dioxin exposures in fish in the Bay to safe levels, since discharges from this sector very likely are a minor fraction of the overall contribution load. Nonetheless, since dioxins and furans have been detected in effluents, municipal wastewater treatment plants will need to bear their fair share. In the long run, fair shares needed to meet environmental goals will emerge through the development of a multimedia dioxin strategy for the Bay and through a Total Maximum Daily Load for dioxin. In the short run, it is reasonable to expect that discharges of dioxins from municipal wastewater treatment plants are reduced to lowest practical levels, and that permit holders be asked to conduct investigations to track down and eliminate, where feasible, possible sources of dioxins entering sewer systems.

Experience elsewhere has shown that the best solutions for dischargers occur when a comprehensive solution can be devised for the watershed, including difficult cases involving legacy pollutants and multimedia sources of bioaccumulative toxic pollutants. Environmental loadings of dioxins and furans in the Great Lakes, for example, have declined to the point that American and Canadian workgroups for these pollutants have ceased work except to focus on the lone remaining source: backyard barrel burning.

EPA has repeatedly shown that it is open to discussions involving very long-term cleanup solutions where good environmental inventories have been developed and integrated multimedia strategies can be formulated; a good current example is the development of a PCB cleanup plan for the impaired waters of the Delaware Estuary. In this case and others, adaptive management approaches have been employed and, in some locations, are yielding results.

We agree that a comprehensive long-term solution for the dioxin problems in the Bay is possible and holds good promise as a means for allowing municipal wastewater treatment plants to minimize discharges of dioxin to the Bay, without being required to achieve unreasonable or unattainable outcomes.

### B. Short-Term Solutions

In the short-term, NPDES permit holders in the San Francisco Bay watershed face the potential for NPDES permit violations with consequent punitive and other enforcement actions which, under the current regulatory framework and assumptions, the permit holders may be unable to prevent.

We make three recommendations to address this predicament. These recommendations may be incorporated into the existing process of determining compliance with numeric effluent

limitations. The first involves developing and conducting a pollutant minimization program where reasonable potential to exceed numeric water quality standards is sufficient for imposition of water quality-based effluent limitations. The second involves the utilization of bioaccumulation equivalency factors. The third involves assumptions for levels of dioxins and furans below the analytical method's minimum level of quantification.

These recommendations are technically sound and have substantial regulatory precedent. We believe that, in combination, their adoption in the San Francisco Bay watershed should provide a short-term compliance solution suitable to all stakeholders.

We also recommend that BACWA members actively support the development of a long-term solution to the dioxin-related problems of the Bay, as outlined in Section III.C below.

### 1. Pollutant Minimization Programs

Where reasonable potential to exceed numeric water quality standards is sufficient for imposition of a water quality-based effluent limitation (WQBEL), the NPDES permit may include requirements for the permittee to develop and conduct a pollutant minimization program (PMP). A PMP requirement is particularly appropriate where sampling/analytical methods approved for regulatory application are insufficiently sensitive to directly measure compliance with the WQBEL. The goal of the PMP would be to identify and reduce all potential sources of the pollutant(s) to achieve and maintain effluent concentrations at or below the WQBEL. Cost-effectiveness should be considered by the permittee in developing the PMP and by the permitting authority in reviewing and approving the PMP plan.

**We recommend that, where the sampling/analytical methods approved for regulatory application are inadequate to directly measure compliance with a WQBEL for dioxins, NPDES permits include a requirement for developing and conducting an approved, cost-effective PMP.**

### 2. Bioaccumulation Equivalency Factors

Just as the various congeners of polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) exhibit differing levels of toxicity, so do they also exhibit differing levels of bioaccumulation potential. To account for the differing levels of toxicity when calculating toxic equivalents (TEQs), each congener is assigned its own specific 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalency factor (TEF). Similarly, to account for the differing levels of bioaccumulation potential when calculating TCDD equivalence concentrations (TECs) for wastewater effluents and other waters, each congener may also be assigned its own specific bioaccumulation equivalency factor (BEF).

This approach of applying both TEFs and BEFs in calculating TECs for PCDDs and PCDFs was adopted by EPA for the Great Lakes System in 1995 and is encoded in Federal regulations at Appendix F, Procedure 4 of 40 CFR Part 132. Table 2 of Appendix F, Procedure 4 lists

congener-specific BEFs to be utilized in the Great Lakes System. Derivation of these BEFs is described in Section III.F of the *Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors* (EPA-820-B-95-005), which states that, "Limited comparison to BEFs calculated from data obtained for other ecosystems confirms these bioaccumulation potential differences for PCDDs and PCDFs for fish in ecosystems outside the Great Lakes." (See Appendix A for sources of information.)

**We therefore recommend that both TEFs and BEFs are applied to PCDD and PCDF concentrations when calculating TECs for determining reasonable potential to exceed numeric water quality criteria, determining effluent compliance, and quantifying levels in the waters of, and loads to, the San Francisco Bay watershed.**

Information on the derivation of BEFs may be obtained by contacting EPA offices associated with the development and adoption of the Water Quality Guidance for the Great Lakes System. If suitable data are not available to derive site-specific and/or updated BEFs, utilization of the BEFs derived for the Great Lakes System remains preferable to the omission of BEFs. Because BEFs for the congeners most commonly detected in wastewater effluents can be as low as 0.01, TECs calculated in the absence of BEFs can mischaracterize the significance of PCDD and PCDF sources by as much as two orders of magnitude.

### 3. Assumptions for Values below the ML

In calculation of TECs, the assumptions for values below the analytical levels of quantification can also result in the mischaracterization of PCDD and PCDF levels by orders of magnitude. The assumptions for values below the level of quantification may be as high as the level of quantification or as low as zero. For determining effluent compliance, EPA has historically left such assumptions to the discretion of permitting authorities. See, for example, the federal regulations at Appendix F, Procedure 8, Paragraph B.4 of 40 CFR Part 132. The San Francisco Bay Regional Water Quality Control Board has specified that the NPDES permit compliance level for Dioxin-TEQ will be one half of the minimum levels (MLs) specified in EPA Method 1613, *Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS* (U.S. EPA, 1994).

For some pollutants, utilizing one half of the ML for values below the ML may be a reasonable default assumption in averaging values for certain data applications. However, this assumption is not reasonable for calculating TECs when determining effluent compliance for PCDDs and PCDFs. Effluent concentrations for many congeners measured utilizing high-volume screening techniques lacking approval for regulatory application remain, despite legitimate concerns about their accuracy, orders of magnitude lower than halves of the EPA Method 1613 MLs. Furthermore, the overestimation resulting from this assumption is compounded by the summation of congener-specific values when calculating TECs. Such assumptions are more typically and justifiably employed when averaging—not summing—values.

**We therefore recommend that, when calculating TECs in determining effluent compliance for PCDDs and PCDFs, values below the ML be assumed to be zero.**

The ML is defined as "the level at which the entire analytical system must give a recognizable signal and acceptable calibration point" (U.S. EPA, 1994). The quantification of congeners of PCDDs and PCDFs detected at levels below their respective MLs does not have sufficient analytical confidence to be the basis for NPDES permit violations subject to punitive or other enforcement actions. Assuming any value above zero for levels below the ML when determining effluent compliance would likely result in such actions being initiated where they are unwarranted.

### 4. New Analytical Methods for Dioxins and Furans

The draft Dioxin Issue Paper details the concerns of Bay Area municipal treatment plants that in the future they may be subjected to new and more stringent discharge limitations if new analytical methods are developed with lower and more sensitive quantitation levels than EPA's current Method 1613.

We believe, however, that the current EPA method 1613 will remain the applicable analytical method for the foreseeable future for regulatory or compliance monitoring purposes. EPA staff are not aware of any new and more sensitive dioxin analytical methods for any of the dioxins or furans; new Part 136 analytical methods for dioxins or furans from EPA are not a priority. Even if EPA staff were ordered to produce new methods quickly, they would be unable to do so since EPA has not identified any procedures with enough promise to even begin investigating.

Some investigators and EPA have used a high-volume pre-concentration step for samples prior to the application of current EPA method 1613 as a means for estimating trace quantities of dioxins and furans at levels below the ML of the method. This approach has been most successful when used for investigative purposes, for example, tracing the possible sources of dioxin contamination unintentionally generated by certain internal processes at chlorine-bleaching pulp and paper plants. This high-volume pre-concentration approach may have some value in the San Francisco Bay for investigating possible sources of dioxins and furans to the Bay, but is not validated for regulatory use.

### 5. Bridge to a Solution for the Bay

If current NPDES compliance limits are modified to reflect BEFs and values below the ML are treated as zeroes as we recommend above, then dioxin-related NPDES compliance obligations for BACWA members should remain stable for the foreseeable future. This provides an excellent opportunity for municipal wastewater treatment plants and others to look ahead to the support that they can give to finding a long-term solution to the dioxin-related problems of the San Francisco Bay.

**The Panel recommends that BACWA and its members actively support the development of a multi-media dioxin strategy for the Bay, as outlined below.**

### C. Long-Term Solutions

All NPDES permits must contain requirements necessary to meet water quality standards, as required by section 301(b)(1)(C) of the Clean Water Act and further elaborated in EPA's NPDES regulations. Prior to a TMDL, delegated States and EPA most frequently meet this statutory obligation by determining reasonable potential for individual dischargers of dioxin and deriving requirements for each facility. In some States, as in California, the water quality criterion for dioxin expressed in State water quality standards is simply applied at the end of the pipe. This one-at-a-time approach does not take into account the combined contributions of other point and nonpoint sources and air pollution deposition contributing the same pollutant to the same impaired waterbody. A much better approach is to develop a comprehensive multi-media strategy for meeting environmental objectives related to dioxin in the San Francisco Bay including, at the appropriate time, a TMDL for dioxin.

**We therefore recommend that work begin on a multi-media dioxin strategy for San Francisco Bay, including agreements on environmental objectives, necessary data gathering, a detailed restoration plan based on an adaptive management approach, and, at the appropriate time, a TMDL. We also recommend that State water quality standards be modified to provide for implementation of the restoration plan. To avoid delaying action while this multimedia dioxin strategy is being developed for the Bay, all feasible steps should be taken to stabilize or reduce loadings from all known air and water sources of dioxin.**

#### 1. Develop A Multi-Media Dioxin Strategy

Leadership for a Multi-Media Dioxin Strategy comes best from the San Francisco Bay Regional Board and the US Environmental Protection Agency, both of which are in a position to lead and coordinate the regulatory and public interest bodies necessary for success. Numerous models exist for such a strategy, most notably the Great Lakes Binational Toxics Strategy developed by the United States and Canada for the virtual elimination of toxic pollutants from air, water and sediment sources in the Great Lakes basin. See *http://www.epa.gov/glnpo/bns/index.html*

Consistent with the ultimate goal of ensuring that fish are safe to eat in the San Francisco Bay, an early necessary step is to evaluate and affirm or revise the precise dioxin fish tissue levels required to protect human health. This should be done using the best current data for risk level, cancer slope factor, population groups to be protected, and consumption rates of fish species actually consumed. These fish tissue levels should then be translated into dioxin water and/or sediment target concentrations using site-specific data for water column bioaccumulation factors (BAFs) and/or biota-sediment accumulation factors (BSAFs). Although reliance on wet-weight fish tissue data is appropriate for water quality standards attainment determination purposes, fish tissue dioxin levels should be lipid-normalized for all analyses of temporal and spatial trends.

Another necessary step in reducing overall dioxin loadings to the San Francisco Bay, which should be undertaken in parallel with reevaluating and affirming targets, is to identify and quantify watershed loading sources and water quality responses in the Bay. This step involves filling existing data gaps and developing needed new data, including a reasonably accurate

watershed inventory of sources of dioxin to the Bay from water sources, air sources, and sediments. The principal data requirements are the following:

- Tributary inflows to the Bay.
- Watershed loadings of solids and organic carbon.
- Watershed loadings of dioxins and furans from all contributing point and nonpoint sources.
- Atmospheric wet/dry deposition and atmospheric gas phase dioxin concentrations.
- Dioxin concentrations in water, sediment and fish tissue in the Bay.
- Net solids burial rates and time-history of dioxin deposition using dated sediment cores.

For these investigative and screening purposes, it might be appropriate to use high-volume collection and analysis methods for dioxins and furans, with the understanding that these screening techniques are neither reliable enough nor validated for regulatory purposes. Toxicity equivalency factors and bioaccumulation equivalency factors should both be utilized in interpreting data for congeners in all water samples.

In parallel with filling existing data gaps and developing needed new data, the Multi-Media Dioxin Strategy should also include the development of a water quality model to link watershed and atmospheric loadings to ambient dioxin concentrations in the Bay. A key element is that the model should be used as a design tool for any new required monitoring and as an organizing framework for managing the overall database. The most expeditious approach would be to build upon the existing PCB TMDL model for the Bay.

The model should first be calibrated using the best available data and used to conduct sensitivity analyses of Bay water quality responses to changes in internal model parameters and different combinations of dioxin loadings for the principal external sources. Results from these simulations will provide better understanding of load-response relationships in the Bay and the ranges of model uncertainties corresponding to uncertainties in the model inputs.

The calibrated model should then be used to estimate the total external dioxin load from the watershed and from atmospheric deposition that could enter the system and still meet the water quality standards. This estimate could be made for the Bay as a whole or for individual spatial zones within the Bay. The model could then be used to evaluate which combinations of reductions in dioxin loadings from individual source categories (including air pollution sources) might be most effective in making progress towards environmental goals for the Bay.

Another step we recommend is to modify State water quality standards to recognize that current conditions cannot be remedied by any means in the short-term and to allow for implementation of a phased restoration plan for achieving designated uses over time. Modifying standards in this manner early in the process will facilitate collaboration among all stakeholders and optimize the time- and cost-effectiveness of the overall process. This modification should have two purposes: (1) retaining the long-term designated use of the Bay with criteria protective of human health; and (2) attainment of water quality standards through implementation of feasible controls in a staged fashion according to a Restoration Plan.

### 2. Phased Restoration Plan

One outcome of the Multi-Media Dioxin Strategy should be a specific Restoration Plan that identifies specific goals to be achieved over time, identifies specific priority action items that can be undertaken voluntarily by stakeholders, and identifies needed regulatory requirements that can be implemented for air and water pollution sources to achieve specific goals within reasonable timeframes.

The Restoration Plan would involve phased attainment of water quality standards by specifying restoration periods with restoration objectives. For example, a baseline objective would lock in achieved reductions through permit limitations, ensuring that known conditions do not worsen. Progressive improvement objectives would also be identified, expressed in narrative form, that would be achieved by implementation of feasible controls over a certain period of time, perhaps 10 years. This approach, including changes to applicable water quality standards to allow for implementation of standards in accordance with a Restoration Plan, is currently being pioneered for reduction of PCB contamination in the Delaware Estuary.

For each restoration period, specific actions would be identified to reduce dioxin releases to the Bay from contributing sources. Discharge permits would include a numeric limit reflecting effluent levels already achieved to meet the baseline objective, a requirement to continue implementation of pollutant minimization plans or any other steps needed to meet the progressive improvement objective, and monitoring to provide data to establish levels achieved and assess improvements during the restoration period. Permit writers would use the restoration targets specified in the applicable water quality standards as the basis for numeric limits during each restoration phase. Basically, the Restoration Plan implemented through water quality standards, not the water quality criterion, would drive NPDES permits until such time as the criterion can actually be achieved.

### 3. Develop a TMDL for Dioxin in the San Francisco Bay

The San Francisco Bay Regional Water Quality Control Board is currently scheduled to begin work on a formal dioxin TMDL for the Bay in 2019. We do not make a recommendation regarding this schedule but rather recommend that the State and EPA reevaluate it in light of the overall Multi-Media Dioxin Strategy for the Bay. A TMDL has many advantages, but since so much work remains to reevaluate targets, gather data, and identify possible reductions achievable from air pollution, stormwater, agricultural, and other possible sources, a TMDL should not be begun until enough information has been gathered that it has a reasonable likelihood of success.

Over time, as the Multi-Media Dioxin Strategy for the Bay is developed and as the adaptive management approaches in the phased Restoration Plan are implemented, the knowledge base would become much more complete and the success of air and water pollution reductions would be measured. At the appropriate time in the process, a dioxin TMDL could provide a helpful regulatory framework for placing Bay Area municipal wastewater treatment plants within a watershed context and for establishing the technical basis for a regulatory approach commensurate with their relatively small contributions to total watershed loads.

A TMDL as defined by EPA in its regulations includes quantified wasteload allocations (WLAs) for point source contributions and quantified load allocations for nonpoint sources which, together with a margin of safety, will in the aggregate achieve water quality standards. If it is determined in this process that municipal wastewater facilities do not contribute substantially to the total loadings of the Bay and that little or no further reductions are needed from this sector to attain the standards, then the WLAs in a TMDL would reflect only the reductions actually needed from this sector. These WLAs can then be placed into NDPES permits and satisfy the requirements of section 301(b)(1)(C) of the Clean Water Act. The resulting NPDES permit limits can be less stringent than the applicable water quality criterion. They can reflect discharge levels achievable with feasible control technologies, as long as there are reasonable assurances that the TMDL as a whole will achieve water quality standards.

### 4. Continued Monitoring and Reassessment

Under any scenario, achievement of the water quality standards for dioxin in San Francisco Bay will require a minimum of several decades. During this period, there will be a continuing need for monitoring in air, water, sediments and fish, and for determination of point and nonpoint source loadings. Information from this monitoring program will be necessary to document baseline conditions and assess progress during restoration periods, and to assess long-term status and trends in the coupled air, land and water compartments of the San Francisco Bay Estuary. This future phase should also include periodic reassessments of the state-of-the-science for dioxin sources, transport, fate, transformation, bioaccumulation potential and toxicity.

## APPENDIX A

## Sources of Information on BEFs and their Use

- Procedure 4.B of Appendix F to 40 CFR Part 132:

http://a257.g.akamaitech.net/7/257/2422/03jul20071500/edocket.access.gpo.gov/cfr_2007/julqtr/pdf/40cfr132.6.pdf

Included are the bioaccumulation equivalency factors (BEFs) and equation for calculating a 2,3,7,8-TCDD toxicity equivalence concentration in effluent to be used when implementing human health criteria in the Great Lakes System.

- Section III.F of *Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors* (EPA-820-B-95-005):

http://www.epa.gov/region5/water/wqs5/pdf/baf_tsd.pdf

Included is a description of BEFs and their derivation for use in the Great Lakes System.

- Section VIII.D.7 of *Water Quality Guidance for the Great Lakes System: Supplementary Information Document (SID)* (EPA-820-B-95-001):

http://www.epa.gov/region5/water/wqs5/pdf/supp_inf_doc.pdf

Included is the U.S. EPA rationale for adoption and use of BEFs in the Great Lakes System.

## APPENDIX B

### Biographical Sketches of Panel Members

**Victor J. Bierman, Jr., Ph.D.,** is a Senior Scientist at LimnoTech with 34 years of experience in the development and application of water quality models for transport and fate of toxic chemicals, and eutrophication, leading to his publication of over 100 technical papers and reports. He is a former U.S. Environmental Protection Agency National Expert in Environmental Exposure Assessment, and a former Associate Professor in the Department of Civil Engineering at the University of Notre Dame. Dr. Bierman is a leading expert in toxic chemical transport, fate, partitioning, and bioaccumulation. He is also a leading expert in the assessment and solution of problems related to nutrients, dissolved oxygen, nuisance algal blooms, nitrogen fixation, exotic species, and ecosystem processes. Dr. Bierman has conducted quantitative studies in lakes, rivers, estuaries, coastal marine systems, the Great Lakes, and at U.S. EPA Superfund sites.

Key accomplishments by Dr. Bierman include synthesis of results from five different eutrophication models, including his own model of Saginaw Bay, to develop target phosphorus loadings to the Great Lakes as part of the 1978 Water Quality Agreement between the U.S. and Canada; modeling of hypoxia in the Gulf of Mexico to assess the influence of nutrient loadings from the Mississippi Basin; transport and fate modeling of PCBs as part of the Hudson River Reassessment RI/FS; development of a coupled phytoplankton-exotic species-PCB model of Saginaw Bay, Lake Huron; development of models for PCB TMDLs in the Delaware and Potomac River Estuaries; modeling of eutrophication and sediment diagenesis in Lake Okeechobee; modeling of phosphorus transport and fate in the Florida Everglades; and development of a model to support a dioxin TMDL in the Columbia River Basin.

**Geoffrey H. Grubbs** directed the Office of Science and Technology at the US Environmental Protection Agency from 1999 until he retired in 2005. He was responsible for a wide range of national programs to limit water pollution discharges, including best available technology regulations for industrial categories such as animal feeding operations, power plants, and offshore oil and gas platforms. He and his capable staff set EPA's analytical methods for measuring water pollution, set water quality criteria and standards to protect human health and ecosystems, and established science-based goals for contaminants in the nation's drinking water supply. He also managed EPA's national programs for fish consumption advisories and water quality at beaches.

Geoff's career at EPA began in 1972, shortly after the Agency was created. He managed a very wide range of organizations, including those responsible for water quality monitoring, watershed protection, nonpoint sources, water discharge permitting, air pollution from stationary sources, and enforcement policy. Geoff worked for several years in the mid-1980's for the United Nations Environment Programme in Nairobi, Kenya, and for USAID in Jakarta, Indonesia. He received his Bachelor of Science in Engineering Degree from Princeton University in 1972.

Geoff has received numerous awards, including the National Environment Award presented by the National Association of Clean Water Agencies. In 2005, President Bush conferred upon Geoff the rank of Distinguished Executive, the highest possible honor for career federal executives. He currently divides his time volunteering for hospice and performing consulting work for private-sector clients.

**Keith J. Linn** has been employed by the Northeast Ohio Regional Sewer District since 1980 as an Investigator for the Industrial Waste Section, as the Supervisor of Environmental Assessment, and as an Environmental Specialist.

Mr. Linn is Chair of the National Association of Clean Water Agencies (NACWA) Water Quality Committee. He is also currently a member of the Water Environment Research Foundation (WERF) Research Council.

Mr. Linn was the NACWA Mercury Work Group Chair from 2005 to 2007. He represented the Northeast Ohio Regional Sewer District at meetings of the Great Lakes Water Quality Initiative's Technical Work Group and Public Participation Group from 1990 to 1993. He has participated in the Cuyahoga River Remedial Action Plan as Co-Chair of the Fish Consumption Technical Committee. He has also served on the Lake Erie Protection Fund Review Committee, on the Human Health Technical Advisory Committee of the Case Western Reserve University Center for the Environment's Regional Environmental Priorities Project, and on the Ohio Environmental Protection Agency's Great Lakes Water Quality Initiative External Advisory Group.

In 1990, Mr. Linn received the Technician of the Year award from the Water Management Association of Ohio. In 1994, he received the Environment Award from the Association of Metropolitan Sewerage Agencies. In 2006, he received the F.H. Waring Award from the Ohio Water Environment Association (OWEA) and the Pretreatment Award from the Northeast Section of the OWEA. In 2008, he received the NACWA President's Award.