MEMORANDUM

SUBJECT: Developing TMDLs for Waters Impaired by Polychlorinated Biphenyls (PCBs)

FROM:

TO:

The purpose of the attached document is to provide Regions, States, and other stakeholders with a compendium of updated information for using Clean Water Act (CWA) §303(d) to address waterbodies impaired by PCBs. This document identifies various approaches to developing PCB TMDLs and provides examples of them from around the country, complete with Web references.

PCBs rank sixth atop the national causes of water quality impairment in the country. Of the 71,000 waterbody-pollutant combinations listed nationally, over 6,000 (nine percent) are PCB-related. However, of the 44,000 TMDLs in place nationally, only about 400 (less than one percent) address PCBs as a pollutant. Our intent is that this document will aid in the completion of more PCB TMDLs, and ultimately the restoration of those waters impaired by PCBs.

The document opens with background on what PCBs are and some factors to consider in the early stages of TMDL development (e.g., scale, modeling approaches). Next, the document identifies the key elements of a TMDL (e.g., "Identification of Waterbodies, Pollutant Sources, Priority Ranking," "Water Quality Standards and TMDL Target," "Wasteload Allocation") and discusses how those elements can be addressed in PCB TMDLs. The document also summarizes and provides Web resources for related tools, including databases for PCB sources, references for analytical methods, and regional air monitoring initiatives.

We thank those who provided assistance in the development of this information and provided comments, including States. If you have further questions, please do not hesitate to contact me, or have your staff contact Sarah Furtak at 202-566-1167.

Attachment

cc: Alexandra Dunn, ASIWPCA

DISCLAIMER

This document provides technical guidance and recommendations to states, authorized tribes, and other authorized jurisdictions to develop Total Maximum Daily Loads (TMDLs) for legacy pollutants like polychlorinated biphenyls (PCBs) under the Clean Water Act (CWA). Under the CWA, states, authorized tribes and US Environmental Protection Agency (USEPA) establish TMDLs to implement water quality standards in impaired waterbodies. State and tribal decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance when appropriate and scientifically defensible. While this document contains USEPA's recommendations and guidance, it does not substitute for the CWA or USEPA regulations; nor is it a regulation itself. Thus it cannot impose legally binding requirements on USEPA, states, authorized tribes, or the regulated community, and it might not apply to a particular situation or circumstance. USEPA may change this guidance in the future.

I. Overview

A. What is the purpose of this document?

In this document, we aim to provide stakeholders with a compendium of updated information for using tools of Clean Water Act (CWA) §303(d) [i.e., total maximum daily loads (TMDLs) with wasteload allocations (WLAs) implemented in National Pollutant Discharge Elimination System (NPDES) permits] to address waterbodies impaired by polychlorinated biphenyls (PCBs) consistent with existing EPA regulations [40 CFR §130.7 (c)(1)].

This document will identify some different approaches that have been successfully used to develop PCB TMDLs and provide examples. In particular, the document will address how to develop PCB TMDLs that account for all sources (including "passive" sources such as landfills in which PCBs are contaminating the soil). One goal of this document is to illustrate how TMDLs can benefit from input from other EPA programs (e.g., NPDES and Water Quality Standards [WQS]).

B. Which pollutant are we addressing?

The focus of this document is on PCBs, one of the most significant legacy pollutants in terms of number of waterbodies impaired. PCBs rank sixth atop national causes of impairment as tracked in the Assessment, TMDL Tracking, and Implementation System (ATTAINS). PCBs represent about 9% of all causes of impairment nationally on CWA section 303(d) lists.[1]

C. What are PCBs[2]?

PCBs are a family of chlorinated organic compounds formed by two benzene rings linked by a single carbon-carbon bond. Various degrees of substitution of chlorine atoms for hydrogen are possible on the remaining ten benzene carbons. There are 209 possible arrangements of chlorine atoms on the biphenyl group. Each individual arrangement or compound is called a congener. Thirteen of the 209 congeners are known to show toxic responses similar to those caused by 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD), the most toxic dioxin compound.

Historically, PCBs were produced in very large quantities both within and outside the United States. Although their uses in capacitors and transformers are well known, PCBs were also used in a wide variety of applications including some involving direct contact with the environment (e.g., building materials, paints, sealants). In the United States, commercial PCBs production started in 1929 and continued until 1977. Importation of PCBs continued after U.S. production was banned until January 1, 1979.

[1] This estimate is based on current cause of impairment listings in the ATTAINS database (http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T).

[2] *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf.

PCB congeners vary markedly in their chemical and physical properties depending on the degree and position of chlorination. Important properties such as non-flammability, low electrical conductivity, high thermal stability, and high boiling point make PCBs highly stable and persistent in the environment. PCBs are also soluble in non-polar organic solvents and biological lipids, hence their tendency to bioaccumulate in living organisms.

II. Factors to Consider in Early Stages of PCB TMDL Development

With respect to development and establishment of PCB TMDLs, as with TMDLs addressing other pollutants, a variety of factors will determine the appropriate "investment" of time and resources. Motivating factors for prioritizing establishment of PCB TMDLs include the following:

- **Consent decrees** – Legal obligation may drive the establishment of these TMDLs.
- **Stakeholder interest** – National or local environmental or citizen's groups may have a specific interest in particular legacy pollutant listings or TMDL development decisions.
- **Risk to human health and the environment** – PCB "hot spots" in urban areas (e.g., a Superfund site) may be viewed as high priority for remediation or TMDL development to reduce risks to humans. When developing PCB TMDLs, consider developing targets protective for both human health and wildlife.

Other factors determining "investment" of time and resources with respect to PCB TMDLs, as with TMDLs addressing other pollutants, may include the scale at which PCB TMDLs are developed, pollutant sources, and the modeling approaches available:

- **Scale --** PCB sources tend to vary in combinations and concentrations from waterbody to waterbody, and hotspots may exist. States should be careful to think about PCB concentrations when selecting the scale at which a PCB TMDL is written. For example, the Delaware River Estuary is a large-scale multijurisdictional waterbody spanning the States of DE, PA, and NJ. A TMDL was established for each of five riverine zones in order to account for the variations in PCB concentrations throughout the estuary.[3] The Delaware River Estuary PCB TMDLs are being revised at the time of this document's development.
- **Sources --** A PCB TMDL can more quickly guide cleanup if a localized source or sources are determined to be affecting the waterbody (e.g., Superfund site, illegal discharge), and in turn, remediation tools and/or legal authorities are available to control the source(s). On the other hand, if the sources are more diffuse or not amenable to existing controls, environmental outcomes or benefits may manifest more slowly.

  Appendix Tables 1 and 2 identify common PCB sources (e.g., incinerators, wastewater treatment plants) and related databases.
- **Modeling approaches --** Various modeling approaches are available for developing PCB TMDLs. Simple, intermediate, and complex techniques for TMDL development are briefly contrasted below:
  - ***Simple approaches*** for PCB TMDLs include non-modeling approaches, such as assuming a proportional one-to-one relationship between PCB loadings and fish tissue, and using a bioconcentration factor to calculate a water column value. A simple approach may also involve back-calculating from the sediment targets and sediment data to determine the loading capacity. Examples of TMDLs that have used a simple approach include the Kawkawlin River in Michigan[4],

[3] *Total Maximum Daily Loads for Polychlorinated Biphenyls (PCBs) for Zones 2-5 of the Tidal Delaware River*, December 15, 2003, available at http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/DelawareRiver/TMDLreport.pdf.
[4] *Total Maximum Daily Load for Polychlorinated Biphenyls for the Kawkawlin River, Bay County, Michigan*, August 2002, available at http://www.epa.gov/waters/tmdldocs/3843_tmdl-kawkawlin.pdf.

Lower Okanogan River Basin in Washington[5], and TMDLs in California (San Diego Creek and Newport Bay[6], and Calleguas Creek[7]).

- ***Intermediate approaches*** may involve simple mass balance modeling, which estimate PCB concentrations in the water column, fish tissue and sediment using sampling data. An example of an intermediate modeling approach is the Shenandoah PCB TMDL[8].
- ***Complex approaches*** may involve linking a hydrodynamic sediment transport model with a PCB fate and transport model, and may also be linked with a watershed model. Examples of such complex models applicable to PCBs include a modified WASP-DYNHD hydrodynamic model (used in the Delaware River Estuary PCB TMDLs[9] and the Tidal Portions of the Potomac and Anacostia Rivers TMDLs [10]).

III. Identification of Waterbodies, Pollutant Sources, Priority Ranking

As described in existing guidance regarding elements of TMDLs, PCB TMDLs should include the following elements[11]:

- Identification of specific waterbody and pollutant (PCBs) addressed by the TMDL.
- Identification of the pollutant sources, including quantity and location(s) of NPDES-permitted sources within the waterbody (including regulated stormwater sources) and nonpoint sources (including non-regulated stormwater sources) (also see section VI of this document identifying point source loadings).
- Source assessment, including amount of PCBs from air deposition, and contribution from point and legacy sources (e.g., sediments; also see section VII on nonpoint source loadings). Although a comprehensive source assessment can be challenging, states are encouraged to consider the best available data in identifying PCB sources, and to describe how PCB sources were identified. Development of a PCB TMDL ensures that all sources are accounted for. *Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS* guidance describes the PCB analysis method EPA developed for use in CWA programs and for wastewater, surface water, soil, sediment, biosolids, and tissue matrices.[12]
- Linkage to 303(d) list/Integrated Report (i.e., identify waterbody and impairment as it appears on the 303(d) list, the listing cycle, and priority ranking of the waterbody).
- Identification of other factors within the waterbody or watershed that may affect PCB loadings (e.g., watershed area, land use/land cover, population, future growth, distribution of sources and loadings, including air deposition, etc.).

Maryland and Virginia have recently published a source tracking study and point source guidance, respectively, that may be informative to other states. The “2005 Caged Clam Study to Characterize PCB Bioavailability in the Impaired Watersheds throughout the State of Maryland” aimed to characterize Maryland subwatersheds draining

[5] *Lower Okanogan River Basin DDT and PCBs Total Maximum Daily Load,* October 2004, available at http://www.ecy.wa.gov/pubs/0410043.pdf.

[6] *Total Maximum Daily Loads For Toxic Pollutants San Diego Creek and Newport Bay*, *California,* June 14, 2002, available at http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/docs/sd_crk_nb_toxics_tmdl/summary0602.pdf.

[7] *Calleguas Creek Watershed OC Pesticides and PCBs TMDL Technical Report*, June 20, 2005, available at http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/2005-010/05_0426/OC_6_TechnicalReport.pdf.

[8] “Shenandoah River PCB TMDL,” available at http://www.epa.gov/reg3wapd/tmdl/VA_TMDLs/Shenandoah/index.htm.

[9] *Total Maximum Daily Loads for Polychlorinated Biphenyls (PCBs) for Zones 2-5 of the Tidal Delaware River*, December 15, 2003, available at http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/DelawareRiver/TMDLreport.pdf. Note that these TMDLs are being revised at the time of this document's development.

[10] *Total Maximum Daily Loads of Polychlorinated Biphenyls (PCBs) for Tidal Portions of the Potomac and Anacostia Rivers in the District of Columbia, Maryland, and Virginia*, October 31, 2007, available at http://www.potomacriver.org/cms/index.php?option=com_content&view=article&id=136:tidal-pcb-tmdl&catid=41:pollution&Itemid=1.

[11] Unless otherwise noted, “existing guidance” in this document refers primarily to EPA's guidance for TMDL approvals, *Guidelines for Reviewing TMDLs under Existing Regulations* issued in 1992, available at http://www.epa.gov/owow/tmdl/guidance/final52002.pdf. Although some information is repeated from the 1992 guidance, this document does not replace that guidance.

[12] *Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS* guidance, April 2010, is available at http://water.epa.gov/scitech/methods/cwa/other.cfm. EPA proposed this method in a September 23, 2010 Federal Register notice and is currently reviewing comments on the proposed rule. A decision has not been made on the promulgation of this method. Additional background on PCB analysis includes: Muir, Derek and Ed Sverko, 2006. *Analytical methods for PCBs and organochlorine pesticides in environmental monitoring and surveillance: a critical appraisal.* Anal Bioanal Chem. 386: 769-789, available at http://www.inweh.unu.edu/Coastal/CCPP/2009_Merida/Reports/Muir&Sverko_AnalBioanalChem2006.pdf.

into the PCB-impaired tidal waters as (i) those with no apparent sources and (ii) those with relatively significant sources of PCB runoff.[13] Virginia Department of Environmental Quality personnel refer to a "Guidance for Monitoring of Point Sources for TMDL Development Using Low-Level PCB Method 1668" when selecting the types of facilities that should be targeted for PCB monitoring (within PCB fish impaired waterbodies) and for its standard operating procedures for sample collection, Method 1668 analysis of the samples, and submittal of PCB data to VADEQ by permitted dischargers.[14]

NPDES permitting: CWA section 308

Pursuant to CWA section 308, EPA may conduct inspection and monitoring of operations, including associated waste treatment and/or discharge facilities of current NPDES permit holders. Inspections ascertain the degree of compliance with requirements of the NPDES permit. During such an inspection, representatives may observe process operations, inspect monitoring and lab equipment methods, collect samples, and examine appropriate records.[15] The opportunity to scan or collect samples may help identify point sources of PCBs that otherwise would have escaped detection.

IV. Water Quality Standards and TMDL Target

TMDLs must identify the applicable WQS, including designated uses, numeric and narrative criteria, and antidegradation policy [40 CFR §130.7(c)(1)]:

- Depending on the impairment being addressed by the TMDL, existing criteria may include human health, aquatic life, and wildlife criteria.
- The state's existing numeric PCB criterion may be a water column concentration or fish tissue value.
- TMDLs must identify a numeric TMDL target or WQS criterion, a quantitative value used to attain and maintain applicable WQS, including designated uses. A TMDL must also include, as necessary depending on the nature of the sources, load allocations (LAs) and WLAs [40 CFR § 130.2(i)].

Where a fish tissue target is used for the TMDL, appropriate justification for using a fish tissue target should be included, considering existing numeric and narrative criteria as well as designated uses.[16] For example, where a state has a narrative criterion such as "no toxics in toxic amounts," and where a state considers there to be an impairment of a designated use due to presence of a fish consumption advisory, it may be appropriate to use a fish tissue target to interpret a narrative standard. Reliance on advisories may decrease as PCB detection levels become more precise/sensitive. The TMDL should include a demonstration of how meeting the fish tissue target will achieve WQS [40 CFR §130.7(c)].

In the San Francisco Bay PCB TMDL, the numeric target is a fish tissue concentration as fish tissue PCB concentrations are the direct cause of impairment of the designated uses. Additionally, in the State of Washington the cleanup standard is based on site-specific human health risk assessments, so it can vary widely based upon site-specific input parameters (e.g., local tissue concentrations, diet fraction, consumption rates).

Multi-state scale

For a TMDL established for a multi-jurisdictional waterbody, in addition to the above elements, TMDLs must identify WQS for each applicable state and must be established at a level to attain and maintain the WQS in each state. The TMDL should demonstrate that it is set at a level to achieve the WQS in each state; where the state standards are different, the TMDL should include a separate TMDL calculation to meet each standard.

---

[13] Available at http://www.mde.state.md.us/assets/document/2005_Corbicula_Study_final.pdf.

[14] *Guidance for Monitoring of Point Sources for TMDL Development Using Low-Level PCB Method 1668* , March 6, 2009, available at *http://www.deq.virginia.gov/waterguidance/pdf/092001.pdf.* Additional background on PCB analysis includes: Muir, Derek and Ed Sverko, 2006. *Analytical methods for PCBs and organochlorine pesticides in environmental monitoring and surveillance: a critical appraisal.* Anal Bioanal Chem. 386: 769-789, available at http://www.inweh.unu.edu/Coastal/CCPP/2009_Merida/Reports/Muir&Sverko_AnalBioanalChem2006.pdf.

[15] *NPDES Compliance Inspection Manual-- Appendix E: Sample Section 308 Letter*, available at http://epa.gov/compliance/resources/publications/monitoring/cwa/inspections/npdesinspect/npdesinspectappe.pdf.

[16] As described in the *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act* ("2006 IR Guidance"), when deciding whether to identify a segment as impaired, states need to determine whether there are impairments of designated uses and narrative criteria, as well as the numeric criteria. The guidance notes that, while numeric human health criteria for ambient water column concentrations of pollutants are a basis for determining impairment, the attainment of such criteria does not always mean that designated uses are being protected. For example, a segment can be meeting numeric ambient water quality criteria, but not attaining the designated uses because fish or shellfish tissue concentrations exceed levels that are protective of human health or levels used as the basis for fish consumption advisories. See the 2006 IR Guidance for additional information on listing waters with fish or shellfish consumption advisories at http://www.epa.gov/owow/tmdl/2006IRG.

Large, multi-state PCB TMDL examples include the Delaware River Estuary, Ohio River, and the Potomac River and Anacostia River TMDLs. The Delaware River Estuary TMDL – being revised at the time of this guidance - addresses impairments listed in DE, NJ, and PA. The Ohio River TMDL considered WV, OH, and PA WQS; the WV standard, being most protective of human health, was used to establish TMDL endpoints within the TMDL segment. The Potomac River and Anacostia River TMDLs address impairments listed in DC, MD, and VA and is written with allocations to achieve water column concentrations less than or equal to jurisdiction-specific water quality criteria and water column and sediment concentrations less than or equal to jurisdictional fish tissue thresholds.

Total PCBs

For San Francisco Bay in California, EPA established the PCBs water quality criterion for the protection of aquatic life based on the sum of Aroclors (i.e., the trade name given to different types of PCB mixtures) and for the protection of human health based on total PCBs (e.g., the sum of all congeners, or isomers or homologs or Aroclor analyses).[17]

In San Francisco Bay and Calleguas Creek PCB TMDLs[18], the pollutant 'total PCBs', has been defined as:

- Sum of Aroclors;
- Sum of the individual congeners routinely quantified by the Regional Monitoring Program (RMP) or a similar congener sum; or
- Sum of the National Oceanic and Atmospheric Administration (NOAA) 18 congeners converted to total Aroclors. A comparison of the sum of 18 NOAA congeners converted to Aroclor with quantified sums of Aroclors shows relatively good correlation in one study[19].

Sediment concentrations

Desorption of sediment-bound PCBs may contribute significantly to the concentrations detected in water. PCBs, particularly the highly chlorinated congeners, adsorb strongly to sediment and soil where they tend to persist with half-lives on the order of months to years. Specific examples of PCB contamination in sediment follow:

Calleguas Creek[20]

The applicable water quality criteria for protection of aquatic life in the Calleguas Creek Watershed are 0.014 µg/L [ppb] (freshwater) and 0.130 µg/L [ppb] (marine). Multiple numeric targets (including fish, sediment, and water) are considered in this TMDL as there is uncertainty that a single numeric target is sufficient to ensure protection of designated beneficial uses. In order to address impaired waters listings for PCBs in the water column, fish tissue, and sediment, multiple targets are used to protect organisms, wildlife, and human health from the potentially harmful effects of PCBs.

Sediment quality guidelines endorsed by NOAA and contained in NOAA's Screening Quick Reference Tables are selected as numeric targets for PCB sediment concentrations. Use of threshold effect level (TEL) values and effect range low (EFL) values for marine sediment represents a conservative (i.e., more protective) choice. Since these sediment guidelines are not EPA-approved sediment quality criteria, they are used as numeric targets only for reaches with sediment listings. The TMDL is calculated as a reduction in sediment concentration, which is based upon fish tissue and water concentrations (and consideration of sediment guidelines for reaches with sediment listings. In order to translate required reductions in fish tissue and water column concentrations into sediment concentration reductions, it is

[17] *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf and "Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California. 40 CFR Part 131.38."

[18] *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf. *Calleguas Creek Watershed OC Pesticides and PCBs TMDL Technical Report*, June 20, 2005, available at http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/2005-010/05_0426/OC_6_TechnicalReport.pdf

[19] NOAA. 1993. Sampling and Analytical Methods of the National Status and Trends Program-National Benthic Surveillance and Mussel Watch Projects 1984-1992. NOAA Technical Memorandum NOS ORCA 71, Volume 1. July, 1993. pp.I-34-39.

[20] *Calleguas Creek Watershed OC Pesticides and PCBs TMDL Technical Report*, June 20, 2005, available at http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/2005-010/05_0426/OC_6_TechnicalReport.pdf.

assumed that bioaccumulation factors for fish tissue to sediment and partition coefficients for water to sediment are linear, and that a given percent reduction in fish tissue or water concentration results in an equal percent reduction in sediment concentration.

Ohio River[21]
Although the operating WQS of 0.044 ng/L [0.000044 µg/L or ppb] for the water column was used to establish TMDL endpoints, WV and OH conducted a sediment survey to address water column PCB loads resulting in part from resuspension of contaminated sediments and to identify “hot spots.” Specific sediment quality criteria for total PCBs have not been standardized for the Ohio River; however, *The Incidence and Severity of Sediment Contamination In Surface Waters of the United States* (EPA 823-R-97-006), also known as The National Sediment Inventory, includes multiple PCB screening levels for the protection of consumers. These values are based upon theoretic bioaccumulation potential and cancer risk levels from the primary route of human exposure to contaminated sediment: consumption of fish. Screening levels are guidelines for analysis of sediment quality data; they have no applicability as regulatory criteria.

San Francisco Bay[22]
The mass of PCBs in sediments is much greater than in the water column. However, it is important to note that a numeric PCB criterion exists in California for the water column but not for sediments.

PCB uptake by biota from sediment is well documented in the scientific literature. In a shallow bay with a large sediment PCB reservoir, such as San Francisco Bay, this is the most important pathway for PCB bioaccumulation in fish. Therefore, reducing PCB concentrations in Bay sediments is the most effective means of reducing fish tissue PCB concentrations. This TMDL uses a food web model to translate the fish tissue numeric target to a corresponding sediment concentration. It then uses a waterbody (mass budget) model to predict the long-term fate of PCBs in the Bay and determine the external load of PCBs that will attain the sediment concentration goal resulting in attainment of the fish tissue numeric target.

Starting with the numeric fish tissue target of 10 ng/g [0.01 µg/g or 10 ppb], the food web model yields a corresponding concentration of 1 µg/kg [1,000 µg/g, 1,000,000 ng/g, or 1,000,000 ppb] PCBs in sediment. This human consumption-based sediment PCB concentration goal is much lower than the sediment concentration California has deemed protective of wildlife of 160 µg/kg [160,000 µg/g, 160,000 ng/g, or 160,000,000 ppb] total PCBs, and is therefore considered to result in attainment of all beneficial uses currently impaired by PCBs.[23]

V. Loading Capacity – Linking Water Quality and Pollutant Sources

TMDLs must identify loading capacity and reductions needed to meet WQS [40 CFR §130.2(f)].

As described in existing guidance on TMDL elements, TMDLs should provide documentation of the approach used to establish a linkage between the numeric PCB target and PCB sources, factors within the waterbody or watershed that may affect PCB loadings, the strengths and weaknesses of the approach, and the results of any modeling. As described earlier, however, factors such as likelihood of controlling the PCB source, existence of consent decrees, and risk to human health and the environment will influence level of investment devoted to modeling and analysis (see section II).

Examples of PCB fate-and-transport assumptions that may influence the calculations in an approved TMDL include ocean influence treated as background and net burial of PCBs into sediments that result in removal of PCBs from the system. Below are additional considerations to bear in mind in conducting a linkage analysis:

---

[21] *Ohio River Total Maximum Daily Load (TMDL) for PCBs,* September 2002, available at http://www.epa.gov/reg3wapd/tmdl/wv_tmdl/Ohio/OhioReport.pdf.

[22] *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf.

[23] Water quality unit conversions available at US Geological Survey “Conversion Factors and Abbreviated Water-Quality Units,” http://pubs.usgs.gov/circ/circ1133/conversion-factors.html.

- A linkage analysis may include water quality modeling or other analytical approaches, although modeling is not required.
- Selecting an analytical approach depends on the type of questions to be answered and may include simple, non-modeling approaches, mass balance approaches, and more complex modeling approaches. Types of models that may be used to calculate PCB TMDLs include steady-state, hydrodynamic, and food web models. Results of air deposition modeling, as well as runoff models, may also be used as input to water quality models in a linked approach (see section II, "Factors to Consider…").
- Data on which the linkage analysis is based (e.g., waterbody characteristics, sources, fish tissue data) should be included in the TMDL.

Where a fish tissue target is used to establish a TMDL, states are encouraged to include the following items as part of the linkage analysis documentation. Unless otherwise noted, examples of each item below can be found in the San Francisco Bay PCB TMDL:

- A description of the fish tissue data (number of samples, concentration, locations, etc.)
- Identification of the specific fish species, or multiple species, and
- Identification of statistic used to calculate the baseline PCB concentration and the TMDL target (e.g., which percentile), and the rationale for the target level and fish species used.

VI. Linking Water Quality and Pollutant Sources – Point Source Loadings

As described in existing guidance on TMDL elements, the TMDL should, to the extent data allow, identify specific point sources covered by the TMDL, including NPDES-permitted stormwater sources, and the total point source loadings. Point sources may include wastewater treatment plants, combined sewer overflows (CSOs), municipal separate storm sewer systems (MS4), rail yards, landfills, or other locations where capacitors, transformers, or other PCB-laden products have been used.

The following are best practices to consider in determining the total point source loading of PCBs:

- States are encouraged to use data on point source loadings most representative of current conditions where relevant information is available.
- Where facility or category-specific PCB discharge data are available and of appropriate quality, states are encouraged to consider such data, and develop estimates of PCB loadings applicable to each category of sources (e.g., wastewater treatment, power plants, stormwater, and other potential PCB dischargers), rather than calculating a single average for all types of dischargers.
- Where source-specific data are not available, states are encouraged to develop representative estimates for loadings for each source category or land use.
- States should indicate how they have accounted for PCB contributions from NPDES-permitted stormwater sources in the estimate of total PCB loadings. Contributions from NPDES-permitted sources should be included in the point source estimate, and contributions from non-NPDES permitted stormwater sources may be included in the estimate of nonpoint source loadings[24]. States are encouraged to estimate contributions from specific NPDES-permitted sources such as MS4s.
- Maps showing location of key sources, land-use, and other waterbody characteristics are encouraged.

VII. Linking Water Quality and Pollutant Sources – Nonpoint Source Loadings

EPA regulations say that LAs "may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" [40 CFR §130.2(g)]. EPA encourages states to consider the most recent and best available data.

As described in existing guidance, the TMDL should include estimates of nonpoint source loadings (e.g., atmospheric deposition, contaminated sediment, runoff from contaminated sites, groundwater). Best practices to consider in developing such estimates include the following:

- As with point sources, maps showing the location of key sources or source areas are encouraged.

[24] "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs," November 22, 2002, available at http://www.epa.gov/npdes/pubs/final-wwtmdl.pdf.

- Loading estimates should account for air deposition and nonpoint sources other than those nonpoint sources containing loadings from air deposition (e.g., runoff from waste sites, legacy sources). States may wish to use runoff models to estimate PCB loadings to the waterbody from the watershed.
- While not necessary for developing the load allocation (LA), parsing out the contributions to the air deposition loading may be helpful in developing an implementation plan. Parsing out contributions to the air deposition loading is contingent upon decisions regarding the appropriate level of analysis; if contribution from air is small, environmental outcomes or benefits may not be commensurate with the amount of effort spent on this analysis. For example, in contrasting two water quality impairment scenarios -- a rural Kansas scenario vs. a downtown Chicago scenario -- industry codes in the latter may be able to help identify PCB release information.
- Studies have also shown that PCB flux from water to air is significant; according to the San Francisco Bay TMDL, PCBs escape to the atmosphere from the Bay at a greater rate than they are deposited from the atmosphere, resulting in a net loss of PCBs.[25] Similarly, a Lake Michigan Mass Balance Study publication concluded from the concentration and distribution of PCB congeners collected from vapor over water, over land, and dissolved in the water, that volatilization of PCBs from contaminated waters is a major source of PCBs to the local atmosphere.[26]
- Developing a detailed source identification plan may be especially important in a highly populated urban area for protection of human health.
- Where possible, the TMDL should include estimates of the contributions from air deposition to permitted stormwater sources and account for such loadings in the point source load estimate, rather than the nonpoint source load estimate. Contributions from nonpermitted stormwater sources may be included in the nonpoint source loading estimate.[27]

Examples of PCB TMDLs that quantify nonpoint source loadings include State of Washington PCB TMDLs. In the Lower Okanogan River Basin DDT and PCB TMDL and the Palouse River Chlorinated Pesticide and PCB TMDL, sediment, runoff from waste sites, and legacy sources are considered to be nonpoint sources of focus.[28] [29]The Lower Okanogan River Basin DDT and PCB TMDL examines the relationship between contamination of fish tissue and bottom sediments.[30] Also, the Palouse River Chlorinated Pesticide and PCB TMDL evaluates total suspended solids levels from nonpoint source drainages and legacy hazardous waste sites.[31]

As mentioned earlier in this section VII, the nonpoint source loading portion of the TMDL may include, as appropriate, LAs for contaminated sites. The Delaware River Estuary PCB TMDLs, for example, acknowledge that reducing NPDES permitted point source discharges alone will not be sufficient to achieve estuary WQS. Runoff from contaminated sites is a significant source of PCBs: the combined load from these 49 sites in the Delaware watershed comprises about 57% of the loading from Zone 3, 38% of the loading from Zone 4, and about 46% of the loading from Zone 5.[32]

Regional air monitoring initiatives
There may be air deposition data that can be used in TMDL development as a result of various air monitoring efforts. Air monitoring efforts include the following:

---

[25] *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf.
[26] Hornbuckle, K.C. et al, 1993. *Over-Water and Over-Land Polychlorinated Biphenyls in Green Bay, Lake Michigan.* Environ. Sci. Technol. 27(1): 87-98, abstract available at http://www.epa.gov/glnpo/lmmb/results/pubs.html.
[27] "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs," November 22, 2002, available at http://www.epa.gov/npdes/pubs/final-wwtmdl.pdf.
[28] *Lower Okanogan River Basin DDT and PCBs Total Maximum Daily Load,* October 2004, available at http://www.ecy.wa.gov/pubs/0410043.pdf.
[29] *Palouse River Chlorinated Pesticide and PCB Total Maximum Daily Load Water Quality Improvement Report and Implementation Plan,* July 2007, available at http://www.ecy.wa.gov/pubs/0703018.pdf.
[30] *Lower Okanogan River Basin DDT and PCBs Total Maximum Daily Load,* October 2004, available at http://www.ecy.wa.gov/pubs/0410043.pdf.
[31] *Palouse River Chlorinated Pesticide and PCB Total Maximum Daily Load Water Quality Improvement Report and Implementation Plan,* July 2007, available at http://www.ecy.wa.gov/pubs/0703018.pdf.
[32] *Total Maximum Daily Loads for Polychlorinated Biphenyls (PCBs) for Zones 2-5 of the Tidal Delaware River*, December 15, 2003, available at http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/DelawareRiver/TMDLreport.pdf.

Great Lakes
Since 1990, EPA's Great Lakes National Program Office (GLNPO) has utilized the Integrated Atmospheric Deposition Network (IADN), a joint project with Canada, to determine atmospheric PCB loadings, look at trends in PCB concentrations, and use data to measure progress. IADN consists of 15 monitoring sites around the Great Lakes, five of which are US sites.

IADN also works with an EPA transformer database covering the Great Lakes States, New York, Pennsylvania and New Jersey. IADN data indicate no correlation between transformers and concentrations of PCBs (i.e., transformers are fairly closed systems); however, it is likely that data are missing (e.g., there may be discrepancies as industries have been phased out of the database). GLNPO still recommends phasing out transformers associated with PCBs as a means of restoring water quality within the Great Lakes system.

Western Airborne Contaminants Assessment Project (WACAP)
This project was initiated to determine risk to ecosystems and food webs in eight core national parks -- in the western US and Alaska -- from long-range transport of airborne contaminants. From 2002 to 2007, analysis of the concentration and biological effects of contaminants in air, snow, water, sediment, lichen, conifer needles, and fish was conducted in the national parks. Partners include the National Park Service, USEPA, US Geologic Survey, US Forest Service, Oregon State University, and University of Washington.[33]

New Jersey Atmospheric Deposition Network (NJADN)
NJ Department of Environmental Protection and Rutgers University partnered to measure concentrations of PCBs in air (gas phase), aerosol (particle phase), and precipitation at ten NJ sites representing an array of land-use regimes at regular intervals between 1997 and 2003. Based on the measured gas, particle, and precipitation phase concentrations, NJADN researchers estimated the atmospheric deposition flux, or flow, of total PCBs at the different sites.[34]

San Francisco Estuary Institutes' Regional Monitoring Program for Trace Substances (RMP) and Watersheds Science Program
The RMP is made up of a group of representatives from wastewater treatment plants, stormwater agencies, industrial dischargers, and the San Francisco Bay Water Board. The RMP works to support the development of TMDLs and other water quality attainment strategies for the San Francisco Bay.

The Watersheds Science Program provides Bay area environmental managers with quality science information in the context of the whole system (watersheds, the airshed, wetlands, and the Bay).[35]

Chesapeake Bay Atmospheric Deposition Network Nutrient-Toxics Deposition Monitoring Program (CBAD-NT)
The CBAD-NT was conducted at urban and non-urban sites along the shoreline of the Chesapeake Bay during 1995-1999. The primary objective of the CBAD-NT study was to provide the best possible estimates of total, annual atmospheric loadings of nitrogen-based nutrients and organic contaminants, including PCBs, directly to the surface waters of the Chesapeake Bay, and to conduct a study of a series of key processes for estimating reductions in deposition to the watershed and delivered loads to the tidal bay.[36]

[33] National Park Service and USEPA "Western Airborne Contaminants Assessment Project" available at http://www.nature.nps.gov/air/Studies/air_toxics/wacap.cfm and http://www.epa.gov/nheerl/wacap/, respectively.
[34] NJ Dept. of Environmental Protection "New Jersey Atmospheric Deposition Network" available at http://www.state.nj.us/dep/dsr/njadn/ and Atmospheric Deposition: PCBs, PAHs, organochlorine pesticides, and Heavy Metals available at http://www.nj.gov/dep/dsr/trends2005/pdfs/atmospheric-dep-pcbs.pdf.
[35] San Francisco Estuarine Institute, "Programs" website, available at http://www.sfei.org/programs.
[36] Maryland Power Plant Research Program, "Chesapeake Bay Atmospheric Deposition Network Nutrient-Toxics Deposition Monitoring Program" available at http://www.esm.versar.com/pprp/features/Atmosdep/regional_sites/cbadsnt/cbadnt_prog.html.

VIII. Wasteload Allocation (WLA)

TMDLs must include WLAs which identify the portion of the loading capacity allocated to individual existing and future point sources [40 CFR §130.2(h), 40 CFR §130.2(i)].

Consistent with the 2006 decision by the D.C. Circuit Court of Appeals in *Friends of the Earth v. EPA*, EPA has recommended that TMDL allocations be expressed as a daily load[37]. Because PCB levels in fish represent bioaccumulation over longer periods of time, it may be appropriate to express allocations in PCB TMDLs as both an annual and daily load. If appropriate, states may also express allocations using other averaging periods, such as seasonal, in addition to a daily load.

Stormwater

NPDES-permitted stormwater discharges must be included in a TMDL's WLA [40 CFR §130.2(h)[38]]. As described in section VI, states should identify and account for PCB loadings from NPDES-permitted stormwater sources where information on PCB contributions from those sources is available. Similarly, to the extent feasible based on available data and/or modeling projections, EPA recommends that States provide individual WLAs for NPDES-permitted stormwater sources such as MS4s.[39] Contributions from multiple NPDES-permitted stormwater discharges may be expressed as a single categorical WLA where data and information are insufficient to assign individual WLAs.

Here are three examples of TMDLs that address stormwater within their WLA:

San Francisco Bay[40]

The TMDL identifies the two major sources of PCB loadings to the Bay as Delta inflow from the Central Valley watershed and urban stormwater runoff. Sediments from the Central Valley watershed carry a large mass of PCBs but are lower in concentration than in-Bay sediments, potentially helping to reduce current impacts of PCBs on the Bay by burying more contaminated sediments. Implementation of the TMDL is thus focused on reducing sediment PCB concentrations by controlling PCB sources in urban stormwater runoff, as well as controlling the release of PCBs from contaminated in-Bay sediments.

A potential means to reduce urban stormwater runoff PCB loads might be to strategically intercept and route runoff to municipal wastewater treatment systems. The TMDL designates a separate WLA for discharges associated with urban stormwater runoff treatment via municipal wastewater treatment systems, since such actions will result in increased PCBs loads from municipal wastewater dischargers. The proposed individual WLAs for municipal wastewater dischargers reflect current performance levels. The TMDL also includes WLAs for stormwater runoff for each county. These WLAs apply to all NPDES permitted municipal stormwater discharges. These WLAs implicitly include all current and future permitted discharges within the geographic boundaries of municipalities and unincorporated areas within each county. Examples of discharges include, but are not limited to, California Department of Transportation (Caltrans) roadways and non-roadway facilities, atmospheric deposition, public facilities, properties proximate to stream banks, industrial facilities, and construction sites.

Delaware River Estuary[41]

In the 2003 Stage 1 PCB TMDL for the tidal Delaware River, point sources include all municipal and industrial discharges subject to regulation by the NPDES permit program, including CSOs and stormwater

---

[37] See Establishing TMDL "Daily" Loads in Light of the Decision by the US Court of Appeals for the DC Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, (April 25, 2006) and Implications for NPDES Permits at http://www.epa.gov/owow/tmdl/dailyloadsguidance.html. Note that, as described in the latter memo, the Court decision regarding daily loads does not imply that NPDES permit limits must be expressed in daily terms.

[38] See "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs," November 22, 2002, available at http://www.epa.gov/npdes/pubs/final-wwtmdl.pdf.

[39] See "Revisions to the November 22, 2002 Memorandum, 'Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs,' "November 12, 2010, available at http://www.epa.gov/npdes/pubs/establishingtmdlwla_revision.pdf.

[40] *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf.

[41] *Total Maximum Daily Loads for Polychlorinated Biphenyls (PCBs) for Zones 2-5 of the Tidal Delaware River*, December 15, 2003, available at http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/DelawareRiver/TMDLreport.pdf.

discharges. This Stage 1 TMDL explicitly assigns a portion of each of the different estuary zone WLAs to storm water discharges. The TMDL acknowledges the relative difficulty of addressing stormwater compared to traditional point source discharges, as stormwater discharge is typically calculated by quantifying the area of urban and residential land uses in a basin.

In developing the Stage 1 TMDLs, the WLAs were calculated for traditional point source discharges based upon effluent concentrations and the actual effluent flows during a one-year model cycling period.

Calleguas Creek[42]
An aggregate concentration-based WLA was developed for MS4s. The aggregate allocation will apply to all NPDES-regulated municipal stormwater discharges in the watershed. Stormwater WLAs will be translated into the NPDES permits as ambient receiving water PCB concentration limits measured at instream discharge points for each subwatershed. They will be achieved through the implementation of BMPs as outlined in the implementation plan. Compliance will be determined through the measurement of in-stream water quality, sediment, and fish tissue measurements at the base of each subwatershed. To facilitate stormwater co-permittees measuring compliance in all six subwatersheds, additional monitoring stations will be needed in four of the subwatersheds mentioned within the TMDL.

Reserve capacity and WLA
A portion of a TMDL's loading capacity may be set aside as a "reserve" to allow for future increases in pollutant loading. Use of a reserve may be relevant to PCB TMDLs in particular, as there may be unexpected discharges of PCBs not identified in the initial TMDL. The concept of reserving loading capacity for "future" sources of pollutants is expressly included in the definitions of "wasteload" and "load" allocations [40 CFR § 130.2(g), 40 CFR § 130.2(h)]. Thus, a TMDL may assign a WLA or LA to a particular source that is larger than its current pollutant contribution to allow room for future loading increases by that source (in other words, using design capacity of a facility in setting its WLA). A TMDL may also set aside a gross, unallocated "reserve" (as part of the overall WLA, the overall LA, or the overall total loading capacity) to account for increased future pollutant contributions from a variety of existing or future sources. In all cases, the sum of the WLAs, LAs, the margin of safety (if an explicit load has been defined), and any reserve capacity must be equal to or less than the loading capacity (TMDL=ΣWLA + ΣLA + MOS + Reserve). EPA does not support trading of pollutants considered by EPA to be persistent bioaccumulative toxics (PBTs).[43]

In the case of PCB TMDLs for waterbodies where there are no permitted or un-permitted point source dischargers at the time the TMDL is established, inclusion of a reserve capacity in a TMDL's WLA could allow for permits for newly identified sources.

A reserve for future pollutant contributions from point sources may be included in the TMDL as a WLA. EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to the individual existing and future point source(s) [40 CFR §130.2(h), 40 CFR §130.2(i)]. Reserve capacity may be incorporated into the individual WLA of each individual point source. One method is to allocate a WLA at design flow of a facility when the facility is currently permitted under capacity. Individual WLA reserves may also be expressed as a percentage of the initial WLA as calculated in the Delaware River Estuary Volatile Organics and Toxicity TMDLs.[44]

It may be reasonable to express allocations from multiple point sources as a single categorical WLA when data and information are insufficient to assign each source or outfall individual WLAs.[45] In a PCB TMDL, it may thus be reasonable to set aside a gross WLA reserve to account for the following PCB point source loadings: (a) post-TMDL identified discharges from existing NPDES permittees that were not captured in a specific WLA (in

---

[42] *Calleguas Creek Watershed OC Pesticides and PCBs TMDL Technical Report*, June 20, 2005, available at http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/2005-010/05_0426/OC_6_TechnicalReport.pdf.
[43] USEPA "Final Water Quality Trading Policy," January 2003, available at http://www.epa.gov/owow/watershed/trading/finalpolicy2003.html.
[44] *Wasteload Allocations for Volatile Organics and Toxicity: Phase I TMDLs for Toxic Pollutants in the Delaware River Estuary,* December 1998, available at http://www.state.nj.us/drbc/regs/wlareport.pdf.
[45] "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs," November 22, 2002, available at http://www.epa.gov/npdes/pubs/final-wwtmdl.pdf.

other words, newly identified discharges from NPDES permittees that did not have PCB limits previously); and (b) newly identified dischargers (those not holding any NPDES permits previously).

IX. Load Allocation (LA)

TMDLs must include a LA, which identifies the portion of the loading capacity attributed to existing and future nonpoint sources and natural background. LAs may range from reasonably accurate estimates to gross allotments [40 CFR §130.2(g)].

As described in VIII above, contributions from NPDES-permitted stormwater sources that include contributions from air deposition must be included in the WLA. Contributions from air deposition in stormwater discharges not currently subject to NPDES regulation may be included in the LA.[46]

As with WLAs, the LAs should be expressed as a daily load; however, given bioaccumulative properties of PCBs, TMDL writers may wish to express allocations as both an annual and daily load.

X. Margin of Safety (MOS)

TMDLs must include an MOS to account for uncertainty in relationship between pollutant loads and quality of receiving water [CWA §303(d)(1)(C), 40 CFR §130.7(c)(1)]. As described in existing guidance, the MOS may be implicit (conservative assumptions in the calculations or overall approach) or explicit (e.g., build in additional percent load reduction). For an implicit MOS, the TMDL should describe the assumptions used to account for the MOS. The MOS in a TMDL is distinct from the conservative assumptions that may be incorporated into a WQS.

Implicit MOS

Examples of implicit MOS in PCB TMDLs include, but are not limited to, the following:

- Conservative approach to derive fish tissue target[47]
- Conservative assumptions of (1) mass assumed to be completely conserved as it passes through the study area and (2) existing OH River tributary loadings estimated using conservative approach[48]
- Combination of several conservative assumptions, including (1) selecting the greater percent reduction required of water or fish tissue concentrations as the basis for determining the percent reduction required in sediment, (2) ensuring protection of downstream subwatersheds from upstream inputs by reducing the allowable concentration for upstream subwatersheds where downstream allowable concentrations are lower, (3) decision to use the lower of the allowable concentration or the numeric target for sediment as the WLA and LA for all reaches with 303(d) listings for sediment.[49]

Explicit MOS

A range of explicit MOS values ranging from five percent to 20% of the total loading were observed per the sample of TMDLs below. States are encouraged to be conservative in developing MOS values unless they can justify otherwise.

The Palouse River Chlorinated Pesticide and PCB TMDL[50] recognizes the uncertainties associated with stormwater and WWTP loading of PCBs and dieldrin, and includes a safety margin of 20% of the loading capacities of the South Fork and mainstem Palouse River.

---

[46] See "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs," November 22, 2002, available at http://www.epa.gov/npdes/pubs/final-wwtmdl.pdf.

[47] *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf.

[48] *Ohio River Total Maximum Daily Load (TMDL) for PCBs,* September 2002, available at http://www.epa.gov/reg3wapd/tmdl/wv_tmdl/Ohio/OhioReport.pdf.

[49] *Calleguas Creek Watershed OC Pesticides and PCBs TMDL Technical Report*, June 20, 2005, available at http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/2005-010/05_0426/OC_6_TechnicalReport.pdf.

[50] *Palouse River Chlorinated Pesticide and PCB Total Maximum Daily Load Water Quality Improvement Report and Implementation Plan*, July 2007, available at http://www.ecy.wa.gov/pubs/0703018.pdf.

Within the Newport Bay and San Diego Creek TMDLs for toxic pollutants[51], a 10% explicit MOS was applied to account for uncertainties in the analysis. A 10% MOS was subtracted from the loading capacity or existing load, whichever was the smaller value. An explicit MOS was deemed appropriate because of significant uncertainty in the analysis of pollutant effects, loads, fate (i.e., chemical transformations and degradation following discharge), and transport in the watershed. The data supporting the TMDLs were somewhat limited. Additionally, for all pollutants the TMDLs also incorporate an implicit MOS because numerous conservative assumptions were made to ensure that the analytical methods applied are environmentally protective.

The Delaware River Basin Commission's (DRBC's) Toxic Advisory Committee recommended use of an explicit MOS of five percent within the Stage 1 PCB TMDLs. This recommendation, which was adopted in the TMDLs, was based upon the use of a one-year cycling period for the hydrodynamic and water quality model. Since the conditions under which the TMDL is determined, like tributary flows, are related to the long-term conditions and not to design conditions associated with human health WQS for carcinogens (such as the harmonic mean flow of tributaries), expression of the MOS as an explicit percentage of each zone TMDL was considered more appropriate than an implicit MOS.

XI. Critical Conditions and Seasonal Variation

TMDL calculations must take into account critical conditions for stream flow, loading and water quality parameters [40 CFR §130.7(c)(1)]. For PCBs, critical conditions might be based upon freshwater flow rates due to precipitation regardless of season. Thus, the applicable allocation for a given source does not depend on time of year, but on actual stream flow (or associated sediment disposition rate for organochlorine compounds) at time of discharge. Wet weather events, which may occur at any time of the year, produce extensive sediment redistribution and transport downstream. This would be considered the critical condition for loading; however, the effects of organochlorine compounds are manifested over long time periods in response to bioaccumulation in the food chain. Therefore, short term loading variations (within the time scale of wet and dry seasons each year) are not likely to cause significant variations in beneficial use effects. The Newport Bay and San Diego Creek TMDLs[52], for example, consider seasonal variations in loads and flows but are established in a manner that accounts for the longer time horizon in which ecological effects may occur.

As PCBs bioaccumulate over time, annual variations may be considered more important than seasonal variations, particularly if a fish tissue target is used. States are encouraged to indicate how, when, and where fish tissue data were collected.

XII. Reasonable Assurance

All PCB TMDLs developed for waters receiving loadings from both point and nonpoint sources must demonstrate reasonable assurance that the point source and nonpoint source reductions will occur.[53]

In the Ohio River PCB TMDL, for example, initial actions are focused on addressing current point sources of PCBs. [54] Also, the Delaware River Estuary PCB TMDLs recognize that DRBC's regulations require that the WLAs be reviewed and, if required, revised every five years, or as directed by the Commission. This will ensure that additional discharges of the pollutant or increased nonpoint source loadings in the future will be considered.

Where a TMDL includes an aggregate allocation, states are strongly encouraged to include specific information on how individual NPDES permits, including stormwater permits, will be implemented. It is recommended that the TMDL specifically state that, at the time of permit issuance, an analysis will be conducted to determine that there will be no localized exceedances of the WQS. For example, three stormwater outfalls are located in hypothetical

---

51 *Total Maximum Daily Loads For Toxic Pollutants San Diego Creek and Newport Bay, California,* June 14, 2002, available at http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/docs/sd_crk_nb_toxics_tmdl/summary0602.pdf.

52 *Total Maximum Daily Loads For Toxic Pollutants San Diego Creek and Newport Bay, California,* June 14, 2002, available at http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/docs/sd_crk_nb_toxics_tmdl/summary0602.pdf.

53 See "Guidance for Water-Quality-based Decisions: The TMDL Process," April 1991, EPA440-4-91-001, available at http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/decisions_index.cfm and "New Policies for Establishing and Implementing Total Maximum Daily Loads (TMDLs) ," August 8, 1997, available at http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/ratepace.cfm

54 *Ohio River Total Maximum Daily Load (TMDL) for PCBs,* September 2002, available at http://www.epa.gov/reg3wapd/tmdl/wv_tmdl/Ohio/OhioReport.pdf.

Smith Creek watershed with an aggregate allocation of 30 pounds per day. One outfall is considerably closer to Smith Creek than the other two and wants a larger allocation of 12 pounds per day. The two remaining outfalls would then have an allocation of 9 pounds per day each. These allocations are allowable as long as they will not be contributing to localized exceedances of the WQS or designated uses at all three outfalls. Another option, using the same three stormwater outfalls, would be to assign a smaller allocation to the closer outfall to Smith Creek if necessary to implement WQS and designated uses due to the proximity of the outfall to the impaired waterbody.

XIII. Post-TMDL Monitoring

States are encouraged to implement a multi-media monitoring program to track progress in reducing emissions and loadings from PCB source categories and, in turn, to track progress toward the TMDL target.

Where discharge data on particular sources or source categories is not available when developing the TMDL, followup monitoring by those sources is encouraged. Further monitoring can assist in refining the loading estimates and allocations using an adaptive management approach. States are encouraged to implement as many elements of a multi-media program as possible to reduce PCB loadings, depending on resources.

A monitoring plan should identify which parameters will be monitored and the frequency of monitoring. States may also wish to identify a baseline against which to measure progress.

Delaware River Estuary

The 2003 Stage 1 TMDLs for PCBs within the tidal Delaware River Estuary anticipate that facilities that discharge to the river, including its tributary streams, will develop and implement a pollutant minimization plan (PMP) [55]. This PMP is expected to include a list of all known and suspected point and nonpoint sources of PCBs, a description of studies used to track down PCBs (i.e., evaluate the most appropriate sampling and analytical techniques for identifying PCB contamination to the municipal utility authority (MUA) collection system and identifying upland sources), a description of actions to minimize the discharge of PCBs, and a proposed time frame for PCB load reductions.

Innovative methods explored in this study included the use of PCB analytical Method 1668a to attain high sensitivity in sampling, including quantification of 124 separate PCB congeners as a means to identify unique source signatures, the use of passive in-situ continuous extraction samplers (PISCES) for sample integration over long time periods (14 days), the use of inexpensive immunoassay techniques for sampling PCBs in street soils, and the use of NJ Department of Environmental Protection's hazardous waste site's electronic data collection system in conjunction with a geographic information system (GIS) to screen and isolate potential upland sources for further investigation.[56] The pilot study was carried out in two phases. Phase 1 involved only in-sewer sampling of wastewater to identify sewersheds with PCB hotspots. Phase 2 followed up on this sampling with additional in-sewer sampling but also with more detailed street soil sampling for PCBs in front of suspect facilities.

Ohio River

The Ohio River PCB TMDL[57] states that initial actions were to be focused on addressing current point sources of PCBs. Limited sampling identified publicly owned treatment works (POTWs) as possible point sources. Additional monitoring was deemed necessary to better quantify the loadings from these facilities. Once loadings are established possible control strategies can be considered.
Limited high-volume water sampling conducted on the effluent at two municipal wastewater treatment plants within the TMDL study area revealed the presence of PCBs. Similar results were found at another POTW downstream of the study area. Considering the large number of POTWs within the entire Ohio River Basin, the potential loadings from these facilities may be significant. The TMDL recommended additional monitoring be

---

55 *Total Maximum Daily Loads for Polychlorinated Biphenyls (PCBs) for Zones 2-5 of the Tidal Delaware River*, December 15, 2003, available at http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/DelawareRiver/TMDLreport.pdf.
PCB TMDLs, Pollution Minimization Plans, and Source Trackdown in Camden City, August 2008, available at http://www.state.nj.us/dep/dsr/health/trackdown-rps.pdf.

56 Note *Method 1668C: Chlorinated Biphenyl Congeners in Water Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS* guidance, April 2010, available at http://water.epa.gov/scitech/methods/cwa/other.cfm, describes the updated analytical method version (1668C).

57 *Ohio River Total Maximum Daily Load (TMDL) for PCBs,* September 2002, available at http://www.epa.gov/reg3wapd/tmdl/wv_tmdl/Ohio/OhioReport.pdf.

conducted to more accurately quantify the PCB loads discharged from POTWs and to determine the amount of PCBs attributable to source water loadings.

XIV. Implementation

An implementation plan is not a federally-required element of a TMDL that is subject to EPA approval. However, a TMDL implementation plan is required in some states as a matter of state law. EPA encourages states to develop an implementation plan even where one is not required.

Superfund and Toxic Substances Control Act

In implementing a PCB TMDL, EPA recommends coordinating with the Superfund Program. For example, PCB levels might prompt active remediation per the Comprehensive Environmental Response Compensation and Liability Act (CERCLA, commonly known as Superfund). CERCLA provides broad authority to respond to releases of hazardous substances such as PCBs where they may pose a risk to human health and the environment; TMDLs often can be used as TBCs ("to be considered" criteria) in determining CERCLA cleanup levels at a site.

The principal federal law regarding PCBs is the Toxic Substances Control Act (TSCA) and its implementing regulations at 40 CFR 761)[58]. EPA regulations under TSCA allow discharge of water to a treatment works or navigable waters if the PCB concentration is less than 3 ug/L (parts per billion), or if the concentration complies with a PCB water discharge limit in the discharger's Clean Water Act permit [40 CFR 761(b)(1)(ii)].

Although PCBs were banned in 1979, EPA's regulations under TSCA allow the inadvertent manufacture of PCBs as the result of some manufacturing processes. Under the regulations, a manufacturer can have up to 50 ppm PCBs in products leaving the manufacturing site (except components of detergent bars can only have less than 5 ppm), so long as the annual average concentration in those products is less than 25 ppm, and so long as the manufacturer complies with other restrictions, including proper disposal of any PCB wastes produced [40 CFR 761.20(b), 761.3].

Examples of Superfund Program sites where the Program has helped in cleanup of waterways include the Lower Duwamish Waterway Site Washington and the Hudson River Site in New York (see "Sediment Sources: Dredging and Excavation" on page 17),

Air Sources

When developing PCB TMDLs, states are not required to identify contributions from individual air sources or air source categories; however, identifying such contributions can assist in developing a targeted implementation plan. PCBs may be released to the air from disposal sites containing transformers and capacitors, incineration of PCB-containing wastes, and redistribution of PCBs already present in soil and water.[59] For PCB air sources over which a state has control, particularly the most significant sources, TMDL implementation may be based on existing delegated and/or approved federal air program requirements. States are encouraged to address air sources not already covered by federal requirements. States should also evaluate cumulative emissions from air sources other than the most prominent (i.e., secondary, tertiary) and adopt controls as appropriate.

Water Point Sources

NPDES permitting: reasonable potential

Reasonable potential analysis may be useful in identifying point sources of PCBs. EPA's existing regulations require NPDES permits to include WQBELs to control all pollutants or pollutant parameters that the permitting authority determines are or may be discharged at a level which will cause, have a **reasonable potential** to cause or contribute to an excursion above any state WQS, including state

[58] http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfr761_08.html
[59] "Polychlorinated Biphenyls (PCBs) (Arochlors) ," January 2000, available at http://www.epa.gov/ttn/uatw/hlthef/polychlo.html.

numeric and narrative criteria for water quality [40 CFR §122.44(d)(1)(i)]. Reasonable potential can be determined with or without facility-specific effluent data.[60]

Three outcomes of the reasonable potential analysis are possible:

- Facility discharge has reasonable potential to cause or contribute to an excursion above a water quality criterion
- There is inadequate information to determine whether discharge will cause or contribute to an excursion above a water quality criterion
- Facility discharge does not cause an excursion above a water quality criterion

In the first outcome above, the permitting authority is required to establish a WQBEL in the permit [40 CFR §122.44(d)(1)(iii)].

Per the second outcome above, a permitting authority may have inadequate information to determine whether a discharge causes, has the reasonable potential to cause, or contributes to an excursion of a water quality criterion. In this case, the permitting authority is not required to establish a WQBEL. EPA does, however, recommend that the permitting authority establish appropriate monitoring requirements and a reopener clause in the permit. A reopener clause authorizes reopening the permit and establishing additional permit conditions based on monitoring results or other new factors that indicate that the effluent may cause, have the reasonable potential to cause, or contribute to an excursion about WQS. Such a reopener clause could help identify permitted facilities (for contaminants other than PCBs) that may be discharging PCBs as scanning methods become more sensitive and the five year permitting cycle nears its end.

Pollutant minimization plans (PMPs)

In the case of waters impaired by PCBs, states may consider implementing cost-effective PMPs for wastewater treatment plants and industrial discharges [see “Pollutant Minimization Plans (PMPs),” below]. For implementation of the WLA by permitted sources, also see discussion under previous sections VIII [“Wasteload Allocation (WLA)”] and XII (“Reasonable Assurance”).[61]

NPDES permitting: compliance schedules

EPA regulations at 40 CFR §122.47 establish the minimum requirements for schedules of compliance in NPDES permits. Among other things, compliance schedules must be limited to “as soon as possible” for the discharger to meet its water quality-based effluent limit pursuant to the Administrator’s decision in *In the Matter of Star-Kist Caribe*, 3 EAD 172 (1990). A compliance schedule can only be allowed for effluent limitations that are derived from WQS that are new or revised since July 1, 1977, and state WQS must authorize the use of compliance schedules. Compliance schedules cannot be granted solely on the basis that a TMDL will be developed nor can they be granted solely on the basis that time is needed to conduct a use attainability analysis. Compliance schedules in permits must be supported by the administrative record and must have a justification within the permit fact sheet. Once a permit is in place, a compliance schedule can only be modified under limited circumstances which include an act of God, strike, or flood [40 CFR § 122.62(a)(4)].

---

[60] *Regions 9 and 10 Guidance for Implementing Whole Effluent Toxicity Testing Programs,* May 31, 1996, available at http://www.epa.gov/region09/water/npdes/pdf/r9and10wetguidance.pdf and *NPDES Permit Writers’ Manual*, December 2006, available at http://cfpub.epa.gov/npdes/writermanual.cfm?program_id=45.

[61] For the Great Lakes, in *Water Quality Guidance for the Great Lakes System* (GLI) regulations at 40 CFR Part 132, EPA has provided two different mechanisms for potentially accounting for pollutants of concern in intake water in the absence of a TMDL. The GLI regulations allow for either: the determination that a discharge will not have the reasonable potential to cause or contribute to an exceedance of a WQS and thus will not need a WQBEL or a direct adjustment to the applicable WQBEL. Both mechanisms may be utilized where the discharge contains pollutants found in the intake, that is from the same body of water as the discharge. According to the GLI, where a facility is simply “passing through” a pollutant (e.g., PCBs) taken from the waterbody, the discharge of intake pollutants may not have reasonable potential to cause or contribute to violations of WQS so long as the facility does not chemically or physically alter the pollutant of concern, the facility does not increase the concentration of the pollutant of concern, and the facility does not contribute any additional mass. In addition, where all such requirements for a finding of "no reasonable potential" are met, but the facility does contribute the pollutant of concern to the wastestream, the permitting authority may establish limits based on a "no net addition" principle. Thus, a facility could potentially contribute additional mass of PCBs to its wastestream, but permit limits will be set to ensure that the discharge contains no more mass of that pollutant than had been in the intake water. Note that the "no net addition" provision in the regulations terminated on March 23, 2007. See also *Water Quality Guidance for the Great Lakes System: Supplementary Information Document*, March 1995, available at http://www.epa.gov/owow/tmdl/glguidance.pdf.

In the third outcome above, the permitting authority need not establish a WQBEL; however, EPA recommends that monitoring be repeated once every five years (prior to the next permit reissuance process). Such periodic monitoring could help identify facilities that may be discharging PCBs as scanning methods become more sensitive.

Sediment Sources

Remediation approaches for PCBs include capping, dredging, and natural attenuation. Descriptions of these measures and examples within PCB TMDLs follow:

Capping

In-situ capping refers to the placement of a subaqueous covering or cap of clean material over contaminated sediment that remains in place. Caps are generally constructed of clean sediment, sand, or gravel, but can also include geotextiles, liners, or the addition of material, such as organic carbon, to attenuate the flux of contaminants into the overlying water.[62] The San Francisco Bay TMDL discusses cost estimates and potential implications of capping in-bay sediments for area noise and cultural resources.[63]

Dredging and excavation

Dredging and excavation are the two most common means of removing contaminated sediment from a waterbody, either while it is submerged (dredging) or after water has been diverted or drained (excavation). Both methods typically necessitate transporting the sediment to a location for treatment and/or disposal. They also frequently include treatment of water from dewatered sediment prior to discharge to an appropriate receiving waterbody.[64] The San Francisco Bay PCB TMDL discusses the cost of dredging and disposal of in-bay sediments.[65] The challenges of dredging, including high cost and risks of habitat destruction and resuspension of contaminants are recognized in the Ohio River TMDL.[66]

A collection of technical reports on PCB treatment technologies, including sediment capping, in-situ thermal desorption-destruction of PCBs, and phytoremediation of persistent organic compounds is available through EPA's Technology and Innovation Program[67]. USEPA, United Nations Environment Programme, and US Army Engineer Research and Development Center are among the developers of these resources.

Examples of Superfund Program sites utilizing sediment source remediation include the cleanup of Lower Duwamish Waterway in Washington and the Hudson River in New York.

The Lower Duwamish Waterway Cleanup Site covers a 5.5 mile waterway that runs into Elliot Bay in Seattle. Because of the health risks to people and animals exposed to sediments contaminated with PCBs and other pollutants (e.g., dioxins/furans, arsenic, and other metals) EPA and Washington Department of Ecology listed the 441-acre Lower Duwamish Waterway under the federal Superfund law and the Washington Toxic Substances Control Act in 2001-2002. Currently, EPA is overseeing a Feasibility Study and a proposed plan to cleanup which should be available for public comment in early 2010. Meanwhile, PCBs have driven several of the "Early Action" cleanup areas' sediment investigation and removal plans.[68]

The Hudson River PCBs Site encompasses a nearly 200-mile stretch of the Hudson River in eastern New York State from Hudson Falls, New York to the Battery in New York City. EPA named this a Superfund site,

---

62 More details on in-situ capping can be found in EPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, December 2005, available at http://www.epa.gov/superfund/health/conmedia/sediment/pdfs/guidance.pdf.

63 *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf.

64 More details on in-situ capping can be found in EPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, December 2005, available at http://www.epa.gov/superfund/health/conmedia/sediment/pdfs/guidance.pdf.

65 *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf.

66 *Ohio River Total Maximum Daily Load (TMDL) for PCBs,* September 2002, available at http://www.epa.gov/reg3wapd/tmdl/wv_tmdl/Ohio/OhioReport.pdf.

67 "Contaminant Focus: Polychlorinated Biphenyls (PCBs) – Treatment Technologies," available at http://www.clu-in.org/contaminantfocus/default.focus/sec/Polychlorinated_Biphenyls_(PCBs)/cat/Treatment_Technologies/.

68 USEPA, "Lower Duwamish Waterway Superfund Site" website, available at http://yosemite.epa.gov/r10/cleanup.nsf/sites/lduwamish.

contaminated by PCBs, in 1984. From approximately 1947 to 1977, the General Electric Company (GE) discharged as much as 1.3 million pounds of PCBs from its capacitor manufacturing plants into the Hudson River. Since 1976, high levels of PCBs in fish have led New York State to close various recreational and commercial fisheries and to issue fish consumption advisories,

Phase 1 dredging for Hudson River cleanup took place between May and October 2009 in a six-mile stretch of the Upper Hudson River near Fort Edward in New York. Phase 1 was designed to address approximately 10 percent of the material to be dredged over the six-year project timeframe. At the end of Phase 1, an estimated 293,000 cubic yards of PCB-contaminated sediment had been removed from the river. EPA continues to work with GE on technical plans for the second (and final) phase of cleanup, with dredging scheduled for Spring 2011.[69]

Multi-media Sources

PCBs contained in products discarded as solid waste may have cross-media impacts. Examples of approaches to address these sources include natural attenuation and PMPs (below), as well as working with industry, local governments, and the general public through outreach and communication regarding proper disposal of PCB-containing products.

Natural attenuation

Natural attenuation refers to the removal of a contaminant through natural processes. These processes include burial by cleaner sediments, dispersion, volatilization, and biodegradation (i.e., air, water, and multi-media sources). While this is a relatively low-cost method of PCB "treatment," these natural removal processes act very slowly on conservative pollutants such as PCBs (one estimate from GLNPO[70] calculates the half-life of PCBs at about 10 years and another estimate in the Central Valley puts half-life at 56 years[71]).[72] Natural attenuation, in itself, is equivalent to no further action taken. Monitored natural attenuation (MNA), in contrast, involves actively tracking natural removal processes.

Monitored natural attenuation (MNA) has been selected as a component of the remedy for contaminated sediment at over one dozen Superfund sites. Historically, at many sites MNA is combined with dredging or in-situ capping of other areas of a site. Although natural recovery following effective source control has been observed, long-term monitoring data on fish tissue are not yet available at most sites to document continued risk reduction.

When considering MNA versus a more aggressive remedy, Superfund uses a risk-based (i.e., not based on standards like WQS) options selection process. Superfund evaluates cancer risk. Generally, a 10^{-4} to 10^{-6} risk range (i.e., 1/10,000 - 1/1,000,000 risk range) is acceptable. This risk-based criteria may be inconsistent with some other stakeholder expectations, and conflicting objectives can make the discussion of considering MNA versus a more aggressive remedy difficult.

Factors to take into account when considering monitored natural attenuation versus other remedies include cost, half-life of PCBs (above), and site conditions. Site conditions conducive to monitored natural recovery include the following:

- Anticipated land uses/new structures are not incompatible with natural recovery,
- sediment bed reasonably stable and likely to remain so,
- contaminants already readily biodegrade or transform to lower toxicity forms, and
- contaminants have low ability to bioaccumulate.[73]

Several PCB TMDLs consider natural attenuation within their implementation sections. For example, the Ohio River TMDL looks toward addressing PCB contamination present in sediments; options include

[69] USEPA, "Hudson River PCBs" website, available at http://www.epa.gov/hudson/.

[70] Presentation by Todd Nettesheim to Legacy Pollutant Strategy Workgroup, "PCBs: As seen through the Integrated Atmospheric Deposition Network and other efforts," December 18, 2008.

[71] *Total Maximum Daily Load for PCBs in San Francisco Bay Final Staff Report for Proposed Basin Plan Amendment*, February 13, 2008, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf.

[72] *Ohio River Total Maximum Daily Load (TMDL) for PCBs,* September 2002, available at http://www.epa.gov/reg3wapd/tmdl/wv_tmdl/Ohio/OhioReport.pdf.

[73] Presentation by Dean Maraldo to Legacy Pollutant Strategy Workgroup, "PCBs, Natural Attenuation, and TMDLs," March 19, 2009.

natural attenuation. The TMDL acknowledges further study is necessary before a recommended plan of action can be developed for sediment contamination.[74]

Pollutant minimization plans (PMPs)
The Delaware River Estuary TMDL process recognized some level of uncertainty associated with several elements of the TMDL development process. For this reason, EPA and the states recommended the use of nonnumeric WQBELs following completion of the Stage 1 TMDLs. This approach allowed time for additional collection of more precise monitoring data on point source discharges and refined quantification of loads to the Estuary. The Delaware River Estuary TMDLs suggest that dischargers be required to develop and implement "waste minimization and reduction programs," also known as PMPs, along with conducting additional monitoring.[75]

According to *Pollution Minimization Plans, and Source Trackdown in Camden City*[76], In New Jersey, Pennsylvania and Delaware, as part of the implementation of the Delaware River Estuary PCB TMDLs, PMPs require dischargers to actively seek out, and reduce, PCBs on their facilities which might get into the MUA collection system.

A PMP includes an identification of all known and suspected point and nonpoint sources of PCBs, a description of studies used to track down PCBs, a description of actions to minimize the discharge of PCBs, a proposed time frame for PCB load reductions, a method to demonstrate progress, and required PCB monitoring. These PMP elements were subsequently codified in a DRBC resolution and guidance manual[77]. DRBC has aggregated resources for completing and implementing PMPs -- including a handbook on PCBs in electrical equipment, a report on technological feasibility for proposed water quality criteria for NJ, and a NJ pilot trackdown for the sewer system -- on its website[78].

The primary objective of a recent Camden PCB trackdown study was to identify PCB sources entering storm drains and CSOs in order to abate PCB transport to the Delaware River, thereby decreasing bioaccumulation in foodfish and decreasing risk to human consumers. To that end, the State of New Jersey narrowed down the universe of potential PCB sources in Camden County MUA's collection system from a county-wide range of potential sources and municipalities to just a few specific neighborhoods, industry types and streets in Camden City (77% of PCB load). Methods used included soil collection, enzyme-linked immunosorbent assays (ELISA), and high resolution gas chromatography/high resolution mass spectrometry. [79]

According to guidance from DRBC[80], recommended actions to minimize known and probable on-site PCB sources include the following:

- Removal;
- Engineering controls (such as caps and containment dikes);
- Fluid changeout;
- Substitutions / modifications of raw or finished materials used in the treatment process;
- Modifications to material handling including transport; and
- Remedial activities for spills and leaks (current or legacy).

Minimization activities for probable collection system sources include the following:

[74] *Ohio River Total Maximum Daily Load (TMDL) for PCBs,* September 2002, available at http://www.epa.gov/reg3wapd/tmdl/wv_tmdl/Ohio/OhioReport.pdf.
[75] *Schuylkill River PCB TMDLs Appendix E: Developing an Adaptive Management NPDES Permitting Strategy: Incorporating Schuylkill River PCB TMDL Requirements*, April 2007, http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/SchuylkillRiverPCB/SchuylkillPCBAppendices.pdf.
[76] *Pollution Minimization Plans, and Source Trackdown in Camden City,* August 2008, available at http://www.state.nj.us/dep/dsr/health/trackdown-finalreport.pdf
[77] *Pollution Minimization Plans, and Source Trackdown in Camden City,* August 2008, available at http://www.state.nj.us/dep/dsr/health/trackdown-finalreport.pdf.
[78] Available at http://www.state.nj.us/drbc/PMP_Resources/index.htm.
[79] *PCB TMDLs, Pollution Minimization Plans, and Source Trackdown in Camden City,* August 2008, available at http://www.state.nj.us/dep/dsr/health/trackdown-rps.pdf.
[80] *Recommended Outline for Pollution Minimization Plans for Polychlorinated Biphenyls in the Delaware Estuary*, January 26, 2006, available at http://www.state.nj.us/drbc/PMP-POTW-012606.pdf

- Indirect Discharge Permit review and amendment;
- Recommendations for improved and upgraded industrial pre-treatment;
- Remedial activities for spills and leaks (current or legacy);
- Recommendations for remediation by other agencies under other regulatory programs; and
- Hydraulic controls to minimize PCB mass loads through CSOs.

Where appropriate, states may wish to use "adaptive implementation," which is "an iterative implementation process that makes progress toward achieving water quality goals while using any new data and information to reduce uncertainty and adjust implementation activities."[81] In implementing a TMDL, states may wish to modify implementation activities as new information on assumptions in the TMDL, such as previously uncharacterized dischargers as described in section V, becomes available. PCB TMDLs have also used a "staged" implementation approach, in which implementation is staged over a period of time, with reduction goals to be met in several phases.[82]

[81] See "Clarification Regarding "Phased" Total Maximum Daily Loads," August 2, 2006, at http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.html and *Adaptive Implementation of Water Quality Improvement Plans: Opportunities and Challenges,* September 2007, at http://nicholasinstitute.duke.edu/water/quality/adaptive-implementation-of-water-quality-improvement-plans-opportunities-and-challenges.

[82] See *Total Maximum Daily Loads for Polychlorinated Biphenyls (PCBs) for Zones 2-5 of the Tidal Delaware River*, December 15, 2003, available at http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/DelawareRiver/TMDLreport.pdf.

Appendix: PCB Sources

Table 1. Databases for PCB Sources

Database	**Description**	**Location**	**Comments**
Toxic Release Inventory (TRI)	Contains information on releases of nearly 650 chemicals and chemical categories from industries, including manufacturing, metal and coal mining, electric utilities, commercial hazardous waste treatment, among others.	www.epa.gov/tri	Other sources for information on toxic chemical site releases: www.epa.gov/triexplorer --www.epa.gov/enviro --www.scorecard.org --www.rtk.net
Permit Compliance System (PCS)	Provides information on companies which have been issued permits to discharge waste water into rivers. You can review information on when a permit was issued and expires, how much the company is permitted to discharge, and the actual monitoring data showing what the company has discharged.	http://www.epa.gov/enviro/html/pcs/	
National Priority List (NPL)	Lists national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation.	http://www.epa.gov/superfund/sites/query/basic.htm (Basic Query)	--Locate NPL sites, check their cleanup progress, and get information on new and proposed NPL sites. --Query parameters include contaminant of concern (e.g., PCBs)
Envirofacts Warehouse Database	Provides access to several EPA databases (e.g., PCS, TRI) to provide information about environmental activities that may affect air, water, and land anywhere in the United States.	http://www.epa.gov/envirofw/	Learn more about environmental activities in your area or generate maps of environmental information here.
EPA Transformer Registration and PCB Activity Databases	Provides information on companies or people who have PCB transformers, are conducting business involving the disposal of PCBs, or are conducting research and development involving PCBs.	http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/data.htm	

Table 2. General PCB Sources		
General Source	**Description**	**Related Databases (reference Table 1, above)**
Items intentionally containing PCBs	Transformers, capacitors, hydraulic and heat transfer fluids	EPA Transformer Registration and PCB Activity Databases
Industry	Steel manufacturing, power plants, electric lamps, plastic materials and resins, motors, carbon and graphite products, wiring devices, communication equipment, rubber, aluminum foundries	TRI, NPL, EPA Transformer Registration and PCB Activity Databases
Combustion of PCB-laden materials	Incinerators of municipal, medical, and hazardous wastes; sewage sludge, scrap tires, industrial and utility boilers	TRI
Environmental sinks	Contaminated sediments	NPL
Inadvertent generation of PCBs	--Combination of carbon, chlorine, and high temperatures can result in PCB generation --Up to 200 chemical processes may create PCB byproducts --Products inadvertently containing PCBs include paint, inks, ag chemicals, plastics, detergent bars	
Storage and disposal facilities	Storage facilities, wastewater treatment plants, incinerators, landfills, decontamination facilities, hazardous waste sites (old products include dust control agents, adhesives, construction materials, gaskets, sound deafening felt)	TRI, NPL, EPA Transformer Registration and PCB Activity Databases
Sources: "Ohio River PCBs TMDL: What We Know About Sources" Technical Committee Meeting Presentation (October 11-12, 2005), contents of email to Sarah Furtak from Dean Maraldo, October 16, 2008. *Ohio River Total Maximum Daily Load (TMDL) for PCBs,* September 2002, available at http://www.epa.gov/reg3wapd/tmdl/wv_tmdl/Ohio/OhioReport.pdf.		