Interim Accounting Methodology for TMDL Loads Reduced

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

ACCWP	Alameda Countywide Clean Water Program
BASMAA	Bay Area Stormwater Management Agencies Association
CCCWP	Contra Costa Clean Water Program
GI	Green Infrastructure
GIS	Geographic Information System
IMR	Integrated Monitoring Report
mg/ac/yr	milligram per acre per year
mg/kg	milligram per kilogram
MPC	Monitoring and Pollutants of Concern Committee
MRP	Municipal Regional Permit
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PCBs	Polychlorinated Biphenyls
POC	Pollutants of Concern
POTW	Publically Owned Treatment Works
RAA	Reasonable Assurance Analysis
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFEI	San Francisco Estuary Institute
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
TMDL	Total Maximum Daily Load
WY	Water Year

1. INTRODUCTION

1.1 Background

The Municipal Regional Stormwater Permit (MRP; SFBRWQCB, 2015[1]) Provisions C.11.a and C.12.a require the Permittees to demonstrate cumulative Bay Area-wide and Program area-specific mercury and polychlorinated biphenyls (PCBs) load reductions over the current permit term. MRP Provisions C.11.b and C.12.b require the Permittees to develop and implement an assessment methodology and data collection program to quantify mercury and PCBs loads reduced through implementation of pollution prevention, source control, and treatment control measures. The Permittees will use this assessment methodology to demonstrate progress towards achieving the load reductions required in this permit term. This report has been prepared to address the requirements of MRP Provisions C.11.b.iii.(1) and C.12.b.iii.(1).

Methods included in this report build upon those included in the Integrated Monitoring Report (IMR) Part B (BASMAA, 2014) submitted by MRP Permittees to the Water Board on February 1, 2014; and methodologies described in MRP provision C.12 and the MRP Fact Sheet (SFBRWQCB, 2015).

1.2 Report Overview

A description of the control measures, load reduction accounting methodologies, reporting requirements, and assumptions are presented in Sections 2 through 7 of this report for the following mercury and PCBs control measure categories:

- Source Property Identification and Abatement;
- Green Infrastructure/Treatment Control Measures;
- Management of PCBs in Building Materials and Infrastructure;
- Enhanced Operations and Maintenance Control Measures;
- Pump Station Diversion; and
- Source Controls and Other Control Measures.

Section 8 presents a discussion of how the interim accounting methodologies may be updated and refined to account for new information gathered over this permit term. Section 9 presents a discussion on how the findings and framework from the interim accounting methodology may be

[1] Reissued November 19, 2015 with effective date January 1, 2016, to 77 Phase I municipal stormwater Permittees in five Bay Area counties which are among over 90 local agencies comprising the Bay Area Stormwater Management Agencies Association (BASMAA).

used to develop a longer-term accounting methodology consistent with the Reasonable Assurance Analysis (RAA) required by MRP Provisions C.11.c.ii.(2) and C.12.c.ii.(2).

1.3 Interim Accounting System Basis

The Interim Accounting System outlined in this report is based on relative mercury and PCBs yields from different land use categories. This methodology was outlined in the 2014 Integrated Monitoring Reports (IMRs) (ACCWP, 2014; CCCWP, 2014; SCVURPPP, 2014; SMCWPPP, 2014) and is described in the MRP Fact Sheet. The method involves using default factors for PCBs and mercury load reduction credits resulting from foreseeable control measures implemented during this permit term. This report documents the method described in the MRP Fact Sheet; updates and refines the accounting system to account for new information; justifies the assumptions, analytical methods, sampling schemes, and parameters used to quantify the load reduction for each type of control measure; and indicates what information will be collected and submitted to confirm the calculated load reduction for each unit of activity for each control measure.

As described in the MRP Fact Sheet, a land use-based yield is an estimate of the mass of a contaminant contributed by an area of a particular land use per unit time. Essentially, different types of land uses yield different amounts of pollutants because land use types differ in their degree of contamination resulting from differing intensities of historic or ongoing use of pollutants. The land use categories used to land use-based yields were identified from studies conducted to identify potential POC sources and source areas.

A number of preliminary GIS data layers were developed using existing and historical information on land use and facility types that were located in the Bay Area during the early to mid-20th century. GIS data layers developed included a revised "Old Industrial" land use layer that attempted to depict industrial areas that were present in the year 1968 and an "Old Urban" land use layer that depicts urbanized areas developed by 1974, other than Old Industrial areas. The year 1974 was used as this was the closest year to 1968 for which data were available. The other categories include "New Urban", which depicts areas urbanized after 1974; "Open Space", which represents undeveloped land; and "Other", which consists of airport and military areas. "Source Property" areas are located in historically industrial or other areas where PCBs were used, released, and/or disposed of and/or where sediment concentrations are significantly elevated above urban background levels.

PCBs were more heavily used in older industrial areas so older industrial land use areas yield a much higher mass of PCBs per unit area than newer urban land use areas. The estimated average PCBs and mercury yields are summarized for the six land use yield categories in Table 1 below. These yields are assigned based on land use, but may also be assigned by the Permittees based on monitoring data and/or inspection results. Table 2 presents land use area-weighted average particle concentrations of PCBs, based on average urban suspended sediment yields of roughly 40 metric tons per km^2 (McKee et al. 2013).

Table 1: Estimated Land Use-Based Yields for PCBs and Mercury

Land Use Category	Assumed Average PCBs Yield (mg/ac/yr)	Assumed Average Mercury Yield (mg/ac/yr)
Source Property	4,065	1,300
Old Industrial	86.5	1,300
Old Urban	30.3	215
New Urban	3.5	33
Other	3.5	26
Open Space	4.3	33

mg/ac/yr – milligrams per acre per year

Note: The derivation of these land use-based yields is described in Appendix A to this report. See Table A-3 for further detail.

Table 2. Estimated Average Land Use Sediment Concentrations for PCBs and Mercury

Land Use	PCBs (mg/kg)	Mercury (mg/kg)
Source Property	6.70	1.54
Old Industrial	0.33	0.40
Old Urban	0.25	0.44
New Urban	0.02	0.35
Agriculture/Open Space	0.03	0.28

mg/kg – milligrams per kilogram of sediment(< 2mm grain size)

*See Appendix B for additional information.

2. SOURCE PROPERTY IDENTIFICATION AND ABATEMENT

2.1 Control Measure Description

Source property identification and abatement involves investigations of properties located in historically industrial land use or other land use areas where PCBs or Mercury was used, released, and/or disposed of and/or where sediment concentrations are significantly elevated above urban background levels. The source property identification and abatement control measure begins with performing investigations in High Likelihood/Interest areas to identify PCB/Mercury sources to the municipal storm drain system. Once a source property is identified, the source of PCBs/Mercury on the property may be abated or caused to be abated directly by the Permittee or the Permittee may choose to refer the source property to the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) for investigation and abatement by the SFBRWQCB or another appropriate regulatory agency with investigation and cleanup authority. Source properties may include sites that were previously remediated but still have soils concentrations of PCBs/Mercury that are elevated above urban background levels or may be newly identified source properties.

The Permittees will validate the existence of significantly elevated PCB/Mercury concentrations through surface soil/sediment sampling in the right-of-way or through water sampling where visual inspections and/or other information suggest that a specific property is a potential source of significantly elevated PCB/Mercury concentrations. Where data confirm significantly elevated concentrations (e.g., a sediment concentration equal to or greater than 1.0 mg/kg or a concentration greater than 0.5 mg/kg and other lines of evidence) are present in soil/sediment from a potential source property or in stormwater samples, the Permittees will take actions to cause the property to be abated or will refer that property to the SFBRWQCB to facilitate the issuance of orders for further investigation and remediation of the subject property.

For each confirmed source property, the applicable Permittee will implement or cause to be implemented, where appropriate, one or a combination of interim enhanced operation and maintenance (O&M) measures in the street or storm drain infrastructure adjacent to the source property during the source property abatement process to remove historically deposited sediment and/or to prevent further contaminated sediment from entering the storm drain. These enhanced O&M measures will be described in the source property referral that is sent to the SFBRWQCB. If the Permittee finds that enhanced O&M measures are not justified based on the results of the soil/sediment investigation, the Permittee must discuss these findings with the SFBRWQCB prior to submitting the source property referral.

Categorical Source Properties

Categorical source properties include non-municipally-owned electrical utilities and railroads. These types of source properties present special challenges for identification and referral due to their quantity, dispersed nature, difficulty in sampling, and the general lack of Permittee control over the property owner.

Permittees may identify and refer specific electrical utility and railroad properties if considered a source property or area based on investigation. Where a Permittee demonstrates limited ability to perform enhanced O&M for this type of property, the Permittee may request that the SFBRWQCB use its authority to require the referred source property owner to implement control measures to prevent the release of PCBs (or Mercury) from the identified source property or area.

Permittees may choose to collect data on electrical utility properties and railroads in order to refer an entire category or subcategory of these properties to the SFBRWQCB at a future date. No special load reduction accounting methodology is proposed for categorical referrals in this report, but a categorical accounting methodology would be proposed at the time of categorical referral in the future.

2.2 Loads Reduced Accounting Methodology

The amount of PCBs and mercury loads (i.e., annual mass or milligrams per year (mg/yr)) reduced will be assessed using the following interim accounting method:

$$Load\ of\ POC\ Reduced = SP_A \bullet (SP_Y - OU_Y)$$

Where:

SP_A	=	Source property area (acres (ac))
SP_Y	=	Source property PCBs or mercury yield (mg/ac/yr)
OU_Y	=	Old Urban land use PCBs or mercury yield (mg/ac/yr)

Thus, for PCBs the load reduced in mg/yr will be calculated as the area of the source property in acres multiplied by 4,035 mg/ac/yr (i.e., 4,065 – 30.3 mg/ac/yr).

For mercury, the load reduced in mg/yr will be calculated as the area of the source property in acres multiplied by 1,085 mg/ac-yr (i.e., 1,300 – 215 mg/ac/yr).

As described in the MRP Fact Sheet, 50% of this load reduction will be credited to the Permittee for properties that are referred to the SFBRWQCB for abatement.[2] For these source properties, the Permittee will implement or cause to be implemented enhanced O&M measures in the vicinity of

[2] The MRP 2.0 Fact Sheet states that load reductions will be credited during this permit term for source property referrals during the first three years of the permit term. Properties that are identified as sources after this time period (e.g., as land uses and property owners change over time) may be referred and credited during future permit terms.

the referred source property. The remaining 50% load reduction for referred properties will be credited to the Permittee upon completion of the abatement process or at ten years, whichever occurs first. The SFBRWQCB will notify the Permittee when the abatement process is complete.

If the Permittee chooses to abate the property or cause the property to be abated directly without referral to the SFBRWQCB, either through encouraging voluntary actions by the property owner or using municipal enforcement powers, then 100% of the load reduction will be credited to the Permittee at the time that the abatement is complete.[3]

2.3 Reporting

For load reduction reporting associated with the source property identification and abatement control measure, the area of each property will be estimated using the County Assessor's parcel map or an equivalent method. For those source properties that are referred to the SFBRWQCB for abatement, a referral form will be provided that describes the enhanced O&M investigation and results, and identifies any enhanced O&M control measures that have been implemented or are planned to be implemented at the source property. For those source properties that are being abated or caused to be abated directly by the Permittee, the Permittee will provide a statement that the property has been abated, along with documentation on the type and extent of abatement.

2.4 Assumptions

The following assumptions apply to this control measure category:

- For source properties that include a combination of previously industrial area and area that is not likely to be a source of PCBs (e.g., unimpacted open space area), the source property yield will only be applied to the portion of the property that is likely to be a source area.
- The determination of the need and extent for enhanced O&M control measures for each identified source property (e.g., if significant quantities of soils/sediment are present in the street and/or storm drain adjacent to the identified source property and if those soils/sediment have significantly elevated PCBs concentrations) will be based on the best professional judgment of the Permittee given site-specific conditions. The referral submittal will include a quantitative justification for this determination. It is assumed that the majority of referred source properties will need enhanced O&M control measures. If the Permittee finds that enhanced O&M measures are not justified based on the results of the soil/sediment investigation, the Permittee must discuss these findings with the

[3] The Permittee shall provide documentation to the SFBRWQCB that abatement has effectively eliminated the transport of PCBs or mercury offsite and from entering the municipal separate storm sewer system (MS4) infrastructure for all transport mechanisms that apply to the site (e.g., stormwater runoff, wind, vehicle tracking). The documentation shall include information on the type and extent of abatement that has occurred (e.g., have the sources of PCBs to the MS4 been completely eliminated via capping, paving, walls, plugging/removal of internal storm drains, etc.) and any available water or sediment monitoring data that demonstrates the effective elimination of transport of PCBs offsite into the MS4.

SFBRWQCB prior to submitting the source property referral or the 50% load reduction credit will not be awarded.

- In addition to street sweeping, drain inlet cleaning, pump station cleaning, or storm drain cleanout conducted or caused to be conducted by the Permittee, enhanced O&M control measures may also include installation of rumble strips at entrances/exits of source properties to reduce offsite tracking of contaminated sediment; installation of silt fence, gravel bags, fiber rolls, walls, or other sediment control devices at the edge of the right-of-way to prevent contaminated sediment from reaching the MS4. The selected enhanced O&M control measure or combination of measures will be implemented during the source property abatement process and be sufficient to remove historically deposited sediment in the public right-of-way and prevent additional contaminated sediment from being discharged from the MS4.

3. GREEN INFRASTRUCTURE/ TREATMENT CONTROL MEASURES

3.1 Control Measure Description

This control measure includes both new development and redevelopment activities as well as retrofit of treatment controls (including green infrastructure) into existing developed areas. This control measure includes new development and redevelopment projects on private and public properties, as well as retrofit of existing infrastructure in public right-of-way areas and on public properties.

Permittees will account for previously implemented projects and/or will implement green infrastructure projects over this permit term to achieve the PCBs load reductions shown in MRP Table 12.2 and mercury load reductions shown in MRP Table 11.1.

3.2 Loads Reduced Accounting Methodology

As discussed in the MRP Fact Sheet, when contaminated areas are newly developed, redeveloped, or retrofitted, the pollutant yield of the area will be reduced through a variety of mechanisms (i.e., removal, capping, or paving of contaminated sediment and/or treatment of the post-development runoff). The amount of PCBs and mercury load reduction can be obtained by multiplying the area of the new development/redevelopment/retrofit project by the difference in land use-based yield (either Old Industrial minus New Urban or Old Urban minus New Urban, whichever pre-development land use is applicable).

Parcel-Based New Development, Redevelopment, or Retrofit Projects

The Permittees will quantify and report the amount of PCBs and mercury loads reduced from implementation of post-development treatment measures (as well as land use change and abatement) for new development, redevelopment, and parcel-based retrofit projects using the following interim accounting method:

$$Load\ of\ POC\ Reduced = P_A \bullet (P_Y - NU_Y)$$

Where:

P_A	=	New development/redevelopment/parcel-based retrofit project area (ac)
P_Y	=	Existing PCBs or mercury yield (mg/ac/yr)
NU_Y	=	New Urban PCBs or mercury yield (mg/ac/yr)

Green Street Projects, Regional Retrofit Projects, and Full Trash Capture Devices

The Permittees will quantify and report the amount of PCBs and mercury loads reduced from implementation of green street projects, regional retrofit projects[4], and full trash capture devices (i.e., hydrodynamic separators (HDS) units) using the following interim accounting method:

$$Annual\ Mass\ of\ PCB\ Reduced = P_A \bullet P_Y \bullet E_f$$

Where:

P_A	=	Tributary area treated by stormwater green infrastructure/retrofit treatment measure (acres)
P_Y	=	Area-weighted PCBs or mercury yield (mg/acre-year)
E_f	=	Efficiency factor for green infrastructure/retrofit treatment control measure (assumed to be 70%) or HDS units (assumed to be 20%)[5]

3.3 Reporting

The following information will be reported for new development/redevelopment/retrofit, green street, and HDS projects:

- Project name and location.
- Whether the project is a new development/redevelopment project subject to MRP Provision C.3.b.ii., a new development/redevelopment project subject to the provisions of the previous MRP, a retrofit project or other project that is not subject to the C.3 provisions of this permit term or the previous permit term, a green street project, or a full trash capture project.
- The year that project construction was completed.
- Total project area for new development/redevelopment/parcel-based retrofit projects and the project tributary drainage area for green streets, regional retrofit, and HDS projects.
- The land use area(s) for the project and the area-weighted land use-based yield for the project area.
- POC loads reduced for each project.

4 These projects provide treatment control for existing developed areas without redeveloping the tributary area.
5 See Appendix C for HDS unit efficiency factor data analysis.

4. MANAGE PCBS IN BUILDING MATERIALS AND INFRASTRUCTURE

4.1 <u>Control Measure Description</u>

PCBs in Building Materials

During the first three years of the permit term, the Permittees will develop and implement or cause to be developed and implemented an effective protocol for managing materials with PCBs concentrations of 50 ppm or greater in applicable structures at the time such structures undergo demolition, so that PCBs do not enter the municipal separate storm sewer system (MS4). PCBs from these structures can enter storm drains during and/or after demolition through vehicle track-out, airborne releases, soil erosion, stormwater runoff, or improper waste disposal. Applicable structures include, at a minimum, commercial, public, institutional and industrial structures constructed or remodeled between the years 1950 and 1980 with building materials with PCBs concentrations of 50 ppm or greater. Single-family residential and wood frame structures are exempt. A Permittee is exempt from this requirement if the only structures that existed pre-1980 within its jurisdiction were single-family residential and/or wood-frame structures.

PCBs in Infrastructure

PCBs-containing caulks and sealants may also be found in public infrastructure such as parking garages, bridges, dams, storm drain pipes, and pavement joints (e.g., curb and gutter).

4.2 <u>Loads Reduced Accounting Methodology</u>

PCBs in Building Materials

As stated in the MRP, for this permit term the Permittees will receive a total of 2,000 g/yr (2 kg/yr) PCBs load reduction value if protocols for managing PCBs-containing materials during demolition, as required in MRP Provision C.12.f., have been developed and implemented.

The Permittee-specific portion of the 2,000 g/yr PCBs load reduction value will be based on the proportion of the county population in each municipality in the 2000 Census. If all of the Permittees in a county wish to use an alternative method of distributing the load reductions for managing PCB-containing materials during demolition, these Permittees will report through their countywide stormwater programs on their alternative method (if different from the default population-based method) for assigning Permittee-specific load fractions in the 2019 Annual Report. This can be determined by the Permittees within each county and may be different from one county to the next, but all of the Permittees within a county must use the same method of distributing the county load reductions.

The PCBs load reduction for this control measure will be accounted for in the 2019 Annual Report, if the protocols are developed and implemented prior to July 1, 2019. If the protocols are developed and implemented prior to July 1, 2018, the PCBs load reduction for this control measure will be accounted for in the 2018 Annual Report.

PCBs in Infrastructure

For infrastructure projects, the following interim accounting method will be used to account for PCBs loads reduced by developing and implementing effective protocols for identifying and managing PCBs-containing materials during infrastructure improvement projects:

$$PCBs\ Loads\ Reduced = A + B$$

Where:

A	=	Estimated average annual mass of PCBs in the infrastructure that entered the MS4 from the infrastructure prior to the infrastructure improvement (mg/yr)
B	=	Estimated average annual mass of PCBs that would have entered the MS4 as a result of the improvement project without proper controls (this accounts for a change in the identification, management, and disposal practices for PCBs-containing caulks and sealants during infrastructure improvement projects) (mg/yr)

The PCB load reduction for this control measure will be accounted for on an individual project basis during this permit term. Monitoring conducted to address the requirements of MRP Provision C.12.e will be used to inform factors A and B above, in conjunction with project-specific monitoring to measure the mass of PCBs-containing caulk and/or sealants in the project's infrastructure.

4.3 Reporting

PCBs in Building Materials

The Permittees will summarize the steps they have taken to begin implementing this control measure, either collectively or individually, in the 2016, 2017, and 2018 Annual Reports.

Each Permittee seeking exemption from the C.12.f requirement to implement this control measure will submit documentation in the 2017 Annual Report, such as historic maps or other historic records, clearly demonstrating that the only structures that existed pre-1980 within its jurisdiction were single-family residential and/or wood-frame structures.

In the 2020 Annual Report, the Permittees will provide:

- Documentation demonstrating implementation with each of the minimum requirements in Provision C.12.f.ii(1)(a)-(c).

- An assessment methodology and data collection program to quantify PCBs loads reduced through implementation of the protocol for controlling PCBs during building demolition.

In the 2020 Annual Report and thereafter, the Permittees will provide documentation of each of the following items:

- The number of applicable structures that applied for a demolition permit during the reporting year; and
- A running list of the applicable structures that applied for a demolition permit (since the date the PCBs control protocol was implemented) that had material(s) with PCBs at 50 ppm or greater, with the address, demolition date, and brief description of PCBs control method(s) used.

PCBs in Infrastructure

The PCB load reduction for this control measure will be reported for each infrastructure project in the Annual Report following project completion. A report will be prepared that describes the infrastructure improvement project, the monitoring done to measure the PCBs present in the caulk and/or sealants, and how the factors A and B were determined.

Monitoring conducted to address the requirements of MRP Provision C.12.e will be reported in the 2018 Annual Report.

4.4 Assumptions

PCBs in Building Materials

- All Permittees will receive their share of the total of 2,000 g/yr PCBs load reduction value if protocols for managing PCBs-containing materials during demolition, as required in MRP Provision C.12.f., have been developed and implemented within their jurisdiction.
- Permittees that have SFBRWQCB Executive Officer approval as exempt from this requirement will also receive their share of the total 2,000 g/yr PCBs load reduction value.

PCBs in Infrastructure

- Sufficient data will be collected as part of the monitoring conducted to address the requirements of MRP Provision C.12.e. to inform the values for factors A and B. A project-specific analysis may also be conducted by the Permittee to develop these factors.

5. ENHANCED OPERATION AND MAINTENANCE CONTROL MEASURES

5.1 Control Measure Description

Routine MS4 operation and maintenance (O&M) activities include street sweeping, drain inlet cleaning, and pump station maintenance. In addition, culverts and channels are also routinely maintained (i.e., desilted). Enhancements to routine operations and new actions such as storm drain line and street flushing may enhance the Permittees' ability to reduce PCBs and mercury in stormwater. PCBs load reductions achieved through implementation of enhanced O&M control measures, aside from enhanced O&M control measures associated with source property referrals, may be counted as part of the overall load reductions expected during this permit term.

5.2 Loads Reduced Accounting Methodology

Inlet Cleaning and Street Sweeping

Load reductions for inlet cleaning and street sweeping will be calculated as follows:

$$\textit{Annual Load of PCB Reduced} = P_A \bullet P_Y \bullet EE_f$$

Where:

P_A	=	Catchment area for enhanced O&M measure (acres)
P_Y	=	Area-weighted PCBs yield (mg/acre-year) for the enhanced O&M catchment area based on land use yield (see Table 1)
EE_f	=	Enhancement Efficiency factor for enhanced O&M control measure (See Appendix D for enhanced inlet cleaning. The enhancement efficiency factor for street sweeping will be based on the results of CW4CB Task 4 WINSLAM modeling analysis).

Pump Station Cleanout, Storm Drain Line Cleanout, Street Flushing, and Culvert/Channel Desilting

Load reductions for enhanced pump station cleanout, storm drain line cleanout, street flushing, and culvert/channel desilting will be calculated as follows:

$$Enhanced_{LR} = Current_{LR} - Baseline_{LR}$$

Where:

$$Current_{LR} = Vol_{Current} \bullet \%Sed \bullet \rho \bullet Conc$$

$$Baseline_{LR} = Vol_{Baseline} \bullet \%Sed \bullet \rho \bullet Conc$$

$Vol_{Current}$	=	Average volume of material collected via the enhanced O&M control measure in current year(s) (post-Fiscal Year 2001-02) (m3/yr)
$Vol_{Baseline}$	=	Average volume of material collected via the O&M control measure in baseline years (prior to and including Fiscal Year 2001-02) (m3/yr) (assumed to be zero for storm drain cleanout and street flushing)
%Sed	=	Percent of material collected (by volume) by the enhanced O&M control measure that is sediment < 2mm in diameter (measured)
ρ	=	Sediment density of the material collected by the enhanced O&M control measure (weight per unit volume) (measured)
Conc	=	Average concentration of PCBs in sediments collected by the enhanced O&M control measure (mg/kg; see Section 1, Table 2, for land use-based suspended sediment concentrations to calculate area-weighted concentrations or alternatively use project-specific measurements).

5.3 Reporting

The following information will be reported for this control measure:

- Description of O&M measure enhancement, including the location of the enhanced measure and the frequency of implementation.
- Baseline and current volumes of material collected.
- Assumptions/data on the percent of the material that was < 2 mm
- Assumptions/data on sediment density
- The calculated loads reduced.

6. DIVERSION TO POTW

6.1 Control Measure Description

This control measure consists of diverting dry weather and/or first flush events from MS4s to publically owned treatment works (POTWs) as a method to reduce loads of PCBs and mercury in urban runoff.

6.2 Loads Reduced Accounting Methodology

The load reduction calculation method for this control measure is:

$$EnhancedReductionDiversion = CurReductionDiversion - BaseReductionDiversion$$

Where:

BaseReductionDiversion	=	Mass of PCBs or mercury reduced via POTW diversions of urban stormwater in 2010 (assume zero for all diversions prior to MRP 1.0 except the Palo Alto Diversion Structure)
CurReductionDiversion	=	Mass of PCBs or mercury reduced via POTW diversions of urban stormwater in Year of Interest

And:

Base or Cur ReductionDiversion = ConcDiversion • VolDiversion

Where:

ConcDiversion	=	Average concentration of PCBs or mercury in sediment and/or water diverted to POTW (measured)
VolDiversion	=	Volume of sediment and/or water diverted to POTW (measured)

6.3 Reporting

For diversions, a project-specific report will be prepared that describes the diversion and project-specific load reduction calculations.

7. SOURCE CONTROLS AND OTHER CONTROL MEASURES

This control measure category includes institutional source controls, such as mercury recycling, and other source control measures such as managing illegal dumping of construction debris and stockpiles of PCBs-containing materials. Descriptions of the control measures, accounting method, reporting, and uncertainties for each of these control measures are provided in the sub-sections following.

7.1 Mercury Load Avoidance and Reduction

Mercury load avoidance and reduction includes a number of source control measures listed in the California Mercury Reduction Act adopted by the State of California in 2001. These source controls include material bans, reductions of the amount of mercury allowable for use in products, and mercury device recycling. The following source controls bans are included:

- Sale of cars that have light switches containing mercury;
- Sale or distribution of fever thermometers containing mercury without a prescription;
- Sale of mercury thermostats; and,
- Manufacturing, sale, or distribution of mercury-added novelty items.

In addition, fluorescent lamps manufacturers continue to reduce the amount of mercury in lamps sold in the U.S. Manufactures have significantly reduced the amount of mercury in fluorescent linear tube lamps.

Mercury Device Recycling Programs resulting in Mercury load reduction generally include three types of programs that promote and facilitate the collection and recycling of mercury–containing devices and products:

1. Permittee-managed household hazardous waste (HHW) drop-off facilities and curbside or door-to-door pickup;
2. Private business take-back and recycling programs (e.g., Home Depot); and,
3. Private waste management services for small and large businesses.

Loads Avoided/Reduced Accounting Methodology

The load avoidance/reduction methodology for this control measure is:

$$HgReductionL/S/T = BaseLoadL/S/T - CurLoadL/S/T$$

Where:

BaseLoadL/S/T = Baseline load of mercury in urban stormwater in 2002 from lamps (L), switches (S), and thermostats (T)

CurLoadL/S/T	=	Current load of mercury in urban stormwater in year of interest from lamps (L), switches (S), and thermostats (T)

And:

BaseLoadL/S/T	=	BaseMassL/S/T • BaseNumL/S/T • T
CurLoadL/S/T	=	CurMassL/S/T • CurNumL/S/T • T

Where:

$BaseMass_{L/S/T}$	=	Average mass of total mercury in each lamp (L), switch (S), and thermostat (T) in 2002 (Assume: 93mg per kilogram of linear fluorescent lamp or Compact Fluorescent Lamp (CFL); 2.9g per switch; and 4g per thermostat).
$CurMass_{L/S/T}$	=	Average mass of total mercury in each lamp (L), switch (S), and thermostat (T) recycled in year of interest (Assume: 35mg per kilogram of linear fluorescent lamp or CFL; 2.9g per switch; and 4g per thermostat).
$BaseNum_{L/S/T}$	=	Number or weight of lamps (L), switches (S), and thermostats (T) improperly discarded into the environment in 2002.
$CurNum_{L/S/T}$	=	Number or weight of lamps (L), switches (S), and thermostats (T) discarded into the environment improperly in year of interest.
T	=	% of total mercury in lamps (L), switches (S), and thermostats (T) that when improperly discarded are transported to the Bay via urban stormwater (Assume 4.8%).

And:

BaseNumL/S/T	=	BaseSpentL/S/T - BaseRecycleL/S/T
CurNumL/S/T	=	CurSpentL/S/T - CurRecycleL/S/T

Where:

BaseSpentL/S/T	=	Number or weight of lamps (L), switches (S), and thermostats (T) that reached their end-of-life in 2002
BaseRcyL/S/T	=	Number or weight of lamps (L), switches (S), and thermostats (T) recycled in 2002
CurSpentL/S/T	=	Number or weight of lamps (L), switches (S), and thermostats (T) that reached their end-of-life in year of interest
CurRecycleL/S/T	=	Number or weight of lamps (L), switches (S), and thermostats (T) recycled in year of interest

Reporting

The following information will be reported for this control measure:

- Description of mercury recycling program and activities, including the baseline and current numbers or weights of lamps, switches and thermostats that were recycled or reached their end-of-life.
- The mass of mercury reduced or avoided as a results of these programs and activities and the parameters used to calculate the mass.

7.2 Illegal Dumping Clean-Up

This source control measure entails clean-up of construction and demolition debris from illegal dumping areas. This control measure will apply to construction and demolition illegal dumping only during this permit term, but may be expanded to other types of illegally dumped trash if supported by monitoring data.

The load reduction calculation method for this control measure is:

Load reduced = (volume of construction and demolition debris cleanup per year) • (average concentration of PCBs and mercury in construction and demolition debris)

Information needed to calculate the load reduction includes:

- Volume of construction and demolition debris (measured)
- Average concentration of PCBs and mercury measured in construction and demolition debris (measured)

Load reduced will be analyzed and determined on a case-by-case basis unless region-wide data is developed through monitoring at a later date.

7.3 Stockpile, Spills, and Disposal of PCBs

This control measure includes the proper clean-up and disposal of stockpiles, spills, and/or improperly disposed quantities of PCBs. The measure would involve, for instance, a concentrated source of PCBs (e.g., a barrel) that is found and cleaned-up or properly disposed.

The load reduction calculation method for this control measure is:

Load reduced = (mass of PCBs in pile) • (fraction of mass that was or could have entered the MS4 per year)

Load reduced would have to be analyzed and determined on a case-by-case basis. Factors that should be considered in determining the fraction of mass that was or could have entered the MS4 per year include proximity to a storm drain, lack of secondary containment/potential for a spill for stockpiles, extent of exposure to rainfall, history of previous spills, etc.

8. PROGRAM UPDATES AND REFINEMENTS

8.1 Interim Accounting Methodology

The interim accounting methodology outlined in this report may be updated and refined to account for significant new information as it becomes available. If needed, the proposed updates will be submitted as an addendum to this report for Executive Office approval in the 2017 Annual Report or subsequent Annual Reports during this permit term.

8.2 Transition to Long Term Accounting Methodology

Reasonable Assurance Analysis

Green Infrastructure

MRP Provision C.3.j requires the Permittees to develop a Green Infrastructure Plan for inclusion in the 2019 Annual Report. The Green Infrastructure Plan must be developed using a mechanism to prioritize and map areas for potential and planned green infrastructure projects, both public and private, on a drainage-area-specific basis, for implementation by 2020, 2030, and 2040. MRP Provisions C.11.c and C.12.c require the Permittees to prepare a Reasonable Assurance Analysis (RAA) for inclusion in the 2020 Annual Report that quantitatively demonstrates that mercury load reductions of at least 10 kg/yr and PCBs load reductions of at least 3 kg/yr will be achieved by 2040 through implementation of green infrastructure throughout the permit area.

This reasonable assurance analysis should do the following:

1. Quantify the relationship between the areal extent of green infrastructure implementation and mercury and PCBs load reductions. This quantification should take into consideration the scale of contamination of the treated area as well as the pollutant removal effectiveness of likely green infrastructure strategies.
2. Estimate the amount and characteristics of land area that will be treated through green infrastructure by 2020, 2030, and 2040.
3. Estimate the amount of mercury and PCBs load reductions that will result from green infrastructure implementation by 2020, 2030, and 2040.
4. Quantitatively demonstrate that mercury load reductions of at least 10 kg/yr and PCBs load reductions of at least 3 kg/yr will be realized by 2040 through implementation of green infrastructure projects.
5. Ensure that the calculation methods, models, model inputs, and modeling assumptions used have been validated through a peer review process.

TMDL Implementation Plan

Additionally, MRP Provisions C.11.d. and C.12.d. require the Permittees to prepare plans and schedules for mercury and PCBs control measure implementation and a RAA demonstrating that sufficient control measures will be implemented to attain the mercury TMDL wasteload allocations by 2028 and the PCBs TMDL wasteload allocations by 2030. The implementation plans, which will also be included in the 2020 Annual Report along with the green infrastructure RAA outlined above, must:

1. Identify all technically and economically feasible mercury or PCBs control measures (including green infrastructure projects, but also other control measures such as source property identification and abatement, managing PCBs in building materials during demolition, enhanced operations and maintenance, and other source controls) to be implemented;
2. Include a schedule according to which technically and economically feasible control measures will be fully implemented; and
3. Provide an evaluation and quantification of the mercury and PCBs load reduction of such measures as well as an evaluation of costs, control measure efficiency, and significant environmental impacts resulting from their implementation.

Long Term Accounting Methodology

MRP Provisions C.11.b.iii.(3)/C.12.b.iii.(3) require the Permittees to submit in the 2018 Annual Report any refinements, if necessary, to the Interim Accounting Methodology for use during the subsequent permit term. The need for updating to the Interim Accounting Methodology will be assessed at that time. At a minimum, the proposed Permanent Accounting Methodology will be consistent with green infrastructure RAA methodology for green infrastructure control measures. The Permanent Accounting Methodology for the other control measures will likely be based on the framework established in this Interim Accounting Methodology and will be informed by the implementation and monitoring conducted over the next two years.

9. REFERENCES

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APPENDIX A

Yield Regression Analysis

A.1 METHODOLOGY

The methodology presented in this appendix was developed to assist the MRP Permittees in identifying which watershed characteristics correlate well with areas that have high, moderate, and low rates of pollutant of concern (POC) (i.e., mercury and polychlorinated biphenyls (PCBs)) loading to receiving waters via stormwater runoff. The methodology was developed using the collective local understanding of the types of land areas, facilities, and activities that generate POCs, with a focus on PCBs. The ultimate goal of the analysis was to provide first order estimates of POC loading rates from high, moderate, and low likelihood source areas and to assist Permittees in identifying areas for implementing POC load reduction measures that would have the greatest load reduction benefit.

A.1.1 Source Area Mapping

Documented uses and sources of PCBs and mercury in the urban environment and the results of PCBs source identification and abatement studies described in the 2014 Integrated Monitoring Report (IMR) Part B (BASMAA, 2014) have been used to identify PCBs source areas. Findings demonstrate that PCBs (and to a lesser extent mercury) sources are generally associated with watershed areas where equipment containing POCs were transported or used and facilities that recycle POCs or POC-containing devices and equipment. These sources include current and historic metal, automotive, and hazardous waste recycling and transfer stations; electrical properties and power plants; and rail lines. These sources are typically located in areas that were industrialized between the late 1920's and the late 1970's, the timeframe when PCBs and mercury production were the greatest in the U.S.

To assist Permittees in identifying potential POC sources and source areas, a number of preliminary GIS data layers were developed using existing and historical information on land use and facility types that were located in the Bay Area during the early to mid-20th century. GIS data layers included a revised "Old Industrial" land use layer that attempted to depict industrial areas that were present in the year 1968; an "Old Urban" land use layer that depicts urban areas developed by 1974, other than those depicted as Old Industrial; points depicting current facilities that have the potential to have or have had PCBs on-site; and historical and current rail lines where PCBs may have been transported.

A.1.1.1. Old Industrial Land Areas

Three sets of data layers were acquired and served as the primary sources of information used to create the Old Industrial data layer: 1) the 2005 version of the Association of Bay Area Governments (ABAG) land use data layers for the five Bay Area counties, which depicts current industrial land use areas; 2) 1968 aerial photographs for the Bay Area at 30,000 scale acquired from the United States Geological Survey's (USGS) Earth Explorer website; and 3) the most currently available County Assessor parcel data layers for Bay Area counties. Through the development of the Old Industrial layer, two data layers were created. The first depicts industrial land areas in 1968 that are not currently characterized as industrial by ABAG. This data layer was created by panning through 1968 aerial photography and identifying industrial land areas outside of the areas characterized as industrial land use in roughly 2005 by ABAG. The purpose of this layer was to identify potential industrial facilities that were present in 1968, but possibly redeveloped or incorrectly identified within the ABAG land use data. The second data layer that was created depicts areas characterized by ABAG in 2005 as industrial land uses that were clearly not industrial in the 1968 aerial photographs. Most of these areas were developed into industrial land uses after 1968 and are most commonly agricultural in the aerial photographs. All parcels that were identified as at least partially industrial in 1968 were visually checked in the data layer to provide greater confidence in its accuracy. Minor edits were then made based on this quality assurance check. If there was uncertainty as to whether a parcel in the 1968 photographs was industrial, then the parcel was classified based on the ABAG land use data. As a final check, the 1968 aerial photographs were also compared to current aerial photographs and each parcel that had been redeveloped was attributed with the current land use, even if that land use remained industrial.

A.1.1.2. Old and New Urban Land Areas

Old Urban and New Urban land use data layers that depict areas urbanized prior to and after 1974, respectively, were developed using an urban extents data layer from 1974, the closest year to 1968 that the data were available. All areas that were within the urban extent in 1974 were defined as Old Urban; those areas that fell outside of this definition were classified as New Urban.

A.1.1.3 Identification of Potential POC Associated Facilities

Point data were collected for a number of facility types that may be associated with either PCBs or mercury. These facility types include those associated with electrical generation, known mercury emitters, metal manufacturing, drum recycling, metal recycling, shipping, automotive recycling, general recycling, and those known to have or historically have had PCBs in use. This information was primarily gathered by the San Francisco Estuary Institute (SFEI) as part of the Urban Stormwater Best Management Practices (BMPs) Proposition 13 Grant project and contains data from a variety of sources, including the California Air Resources Board, EnviroStor, Superfund, Department of Toxic Substances Control, and the State Water Resource Control Board.

Certain facility types for which point data were developed were mapped in greater detail to develop polygons to allow area calculations to be performed. Of particular interest for PCBs were the several hundred electrical substations in the Bay Area. Areas for these facilities were delineated using current and 1968 aerial photographs to attribute whether each facility was built prior to or after 1968. Additionally, military, port, and railroad land use areas were developed using ABAG 2005 land use data and the latest assessor's parcel data. Military parcels were further edited to only include developed areas.

Land use and facility data layers created as part of this effort were then combined to create one contiguous data layer. This data layer was attributed with additional information such as city, county, and watershed.

A.2 YIELD ANALYSIS

The yield analysis consisted of the following three steps:

- Review watershed yield data,
- Characterize the watersheds in terms of yield, and
- Develop regression equations linking yields to watershed attributes.

The analysis results are discussed below.

A.2.1 Review of SFEI Watershed Yield Data

SFEI's *PCBs in San Francisco Bay: Assessment of the Current State of Knowledge and Priority Information Gaps* (Davis et al., 2014) summarizes what had been learned from monitoring PCBs in San Francisco Bay and in the watersheds that discharge to the Bay prior to 2014. Data are presented for various media including fish tissue, sediment, and water. Yield estimates are also provided for monitored watersheds (Figure A-1).

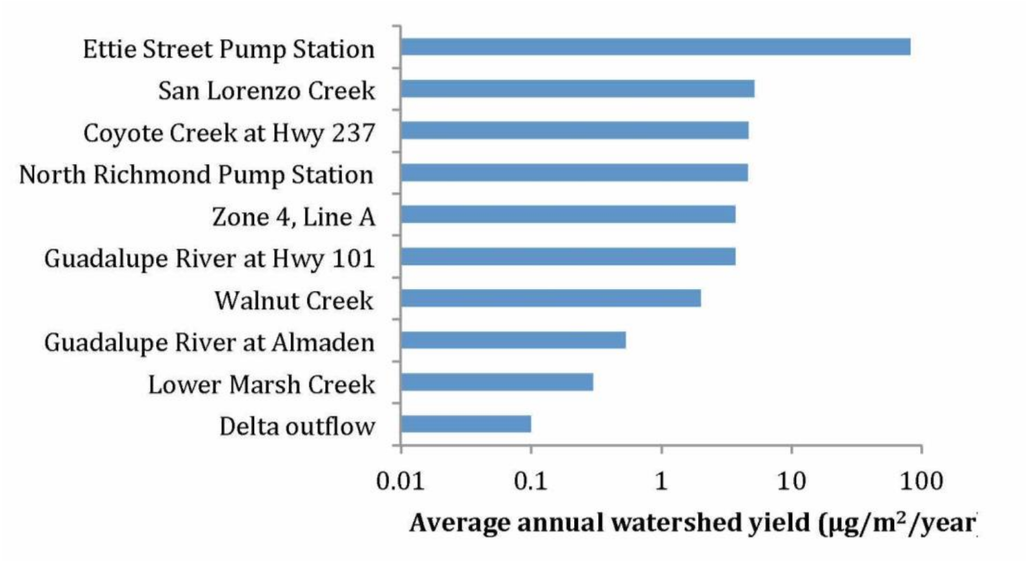

Figure A-1: Average Annual Watershed Yield

SFEI also reported yield estimates for Lower Marsh Creek, San Lorenzo Creek, Walnut Creek, Sunnyvale East Channel, and the Ettie Street Pump Station (ESPS) in the *POC Loads Monitoring Data, Water Year 2011 Report* (Table 13; McKee et al., 2012). The estimates of yield from these sources (ranked by yield) are provided in Table A-1 below. These yield estimates cover a range from approximately 0.1 to 82 µg/m^2/yr. The lowest yield is associated with the Delta outflow and the highest yield is associated with the ESPS watershed.

Table A-1: Mean Annual PCBs Yield Estimates

Watershed	PCBs Yield [μg/m²/yr]	PCBs Yield [μg/acre/yr]	Watershed Cluster No.[1]
Ettie Street Pump Station	82	331,843	1
Sunnyvale East Channel (H)	8.8	35,612	2
Sunnyvale East Channel (L)	4.8	19,425	2
Coyote Creek at Hwy 237	4.8	19,425	6
North Richmond Pump Station	4.7	19,020	NA
Zone 4, Line A	3.8	15,378	1
Guadalupe River at Hwy 101	3.8	15,378	6
San Lorenzo Creek	2.6	10,522	6
Walnut Creek	2.0	8,094	6
Guadalupe River at Almaden	0.54	2,185	6
Lower Marsh Creek	0.30	1,214	NA
Delta Outflow	0.10	405	NA

Sources: *PCBs in San Francisco Bay: Assessment of the Current State of Knowledge and Priority Information Gaps* (Davis et al., 2014) and *POC Loads Monitoring Report WY 2011* (McKee et al., 2012).
NA – not identified in list of watersheds in *Exploratory Categorization of Watersheds for Potential Stormwater Monitoring in San Francisco Bay* (Greenfield et al., 2010).
1 From *Exploratory Categorization of Watersheds for Potential Stormwater Monitoring in San Francisco Bay* (Greenfield et al., 2010). Clusters are a function of land cover, imperviousness, historic industrial land use, and other features.

Yield estimates for HgT provided in the *POC Loads Monitoring Report, WY 2011* (Table 13, McKee et al., 2012) are summarized in Table A-2 below.

Table A-2: Mean Annual Total Mercury Yield Estimates

Watershed	HgT Yield (μg/m2/year)	HgT Yield (μg/acre/yr)	Watershed Cluster No.
Ettie Street Pump Station	79	319,702	1
Walnut Creek	29	117,359	6
Sunnyvale East Channel (H)	23	93,078	2
Sunnyvale East Channel (L)	13	52,609	2
Lower Marsh Creek	9	36,422	NA
San Lorenzo Creek	8	32,375	6

Source: *POC Loads Monitoring Data WY 2011* (Table 13, McKee et al., 2012)
NA – not identified in list of watersheds in *Exploratory Categorization of Watersheds for Potential Stormwater Monitoring in San Francisco Bay* (Greenfield et al., 2010).

A.2.2 Watershed Characterization

The yield data summarized above indicates that yields vary between watersheds. Therefore, an analysis was conducted to look for trends between yield and watershed characteristics.

SFEI has conducted a watershed characterization study where they categorized 185 watersheds in the Bay Area into eight "clusters" depending on land cover, imperviousness, historical industrial land use, and other features (Greenfield et al., 2010). As indicated in Tables A-1 and A-2 above, the watersheds for which yield estimates are available fall into cluster numbers 1, 2 or 6, where the clusters (and the number of watersheds classified within each cluster) are defined as:

- Cluster No. 1: high commercial and residential land cover and imperviousness, high historic industry and railroads, no PG&E facilities, moderate area (41 watersheds)
- Cluster No. 2: High commercial and residential land cover and imperviousness, high historic industry and railroads, one to four PG&E facilities, large area (43 watersheds)
- Cluster No. 6: largest watersheds, with moderate population density, high open land cover, and low imperviousness (22 watersheds)

This analysis indicates that generally the highest yielding watersheds tend to be in clusters 1 and 2, which are the smaller, more developed and impervious watersheds.

A further analysis was conducted by Geosyntec Consultants to examine if the watersheds could be classified based on observed water quality, rather than watershed characteristics alone. For this purpose, data collected as part of the reconnaissance study conducted by McKee et al. (2012)[6] were examined. Figure A-2 below shows mean particle ratio[7] and mean total PCBs concentrations measured at various locations in the reconnaissance study (total of 17 watersheds). The bars represent the range of observations. The data clearly distinguish two categories of watersheds, a set of watersheds (black circles) in contrast to elevated watersheds (red squares) where concentrations are significantly higher. (A similar distinction was found by McKee et al. (2012) in their analysis of particle ratio data.)

The elevated watersheds consist of ESPS, Santa Fe Channel, Pulgas Creek North, and Pulgas Creek South, of which the latter three watersheds are in Cluster No. 2. Those watersheds near the origin of Figure A-2 have moderate discharge quality in contrast to the elevated watersheds, and are referred to herein as "baseline watersheds." The concept being that, unless data indicate that a watershed is elevated, the best estimate of loads would be derived from data describing the baseline watersheds.

A similar analysis for HgT indicated that most of the watersheds that were higher in PCBs concentrations were also higher in HgT concentrations, but the data exhibited more of a continuum (see Figure 4, McKee et al., 2012). So the decision was made to not distinguish watersheds for HgT as was done with PCBs, but rather to assume that all the watersheds were in the same population. This decision was also driven in part by the more limited data set that is available for HgT yield.

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[6]Source of Data: California Environmental Data Exchange Network (CEDEN), SFEI River Loading Study Program, http://www.ceden.us/AdvancedQueryTool

[7] The particle ratio is the ratio of the pollutant of concern concentration (e.g., PCB concentration) to the suspended sediment concentration, for a water sample.

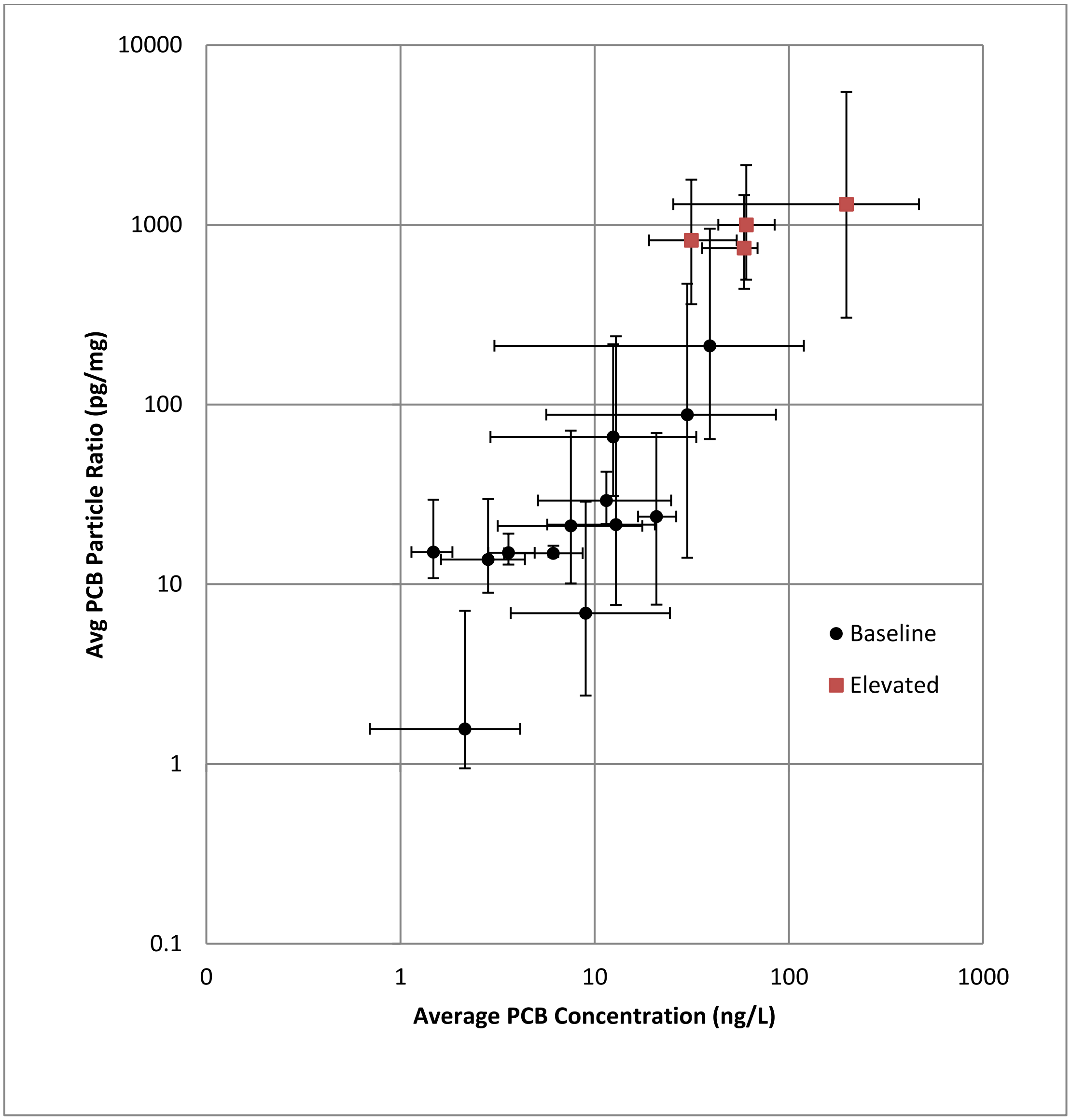

Figure A-2: Mean and Range of PCBs Concentrations in Various Watersheds

A.2.3 Regression Analysis

A regression analysis was conducted using data collected by McKee et al. (2012) for selected baseline watersheds where measured yields were available (from Davis et al., 2014). The selected watersheds were San Lorenzo Creek, North Richmond Pump Station, Zone 4 Line A, Guadalupe River at 101, Marsh Creek and Walnut Creek. Coyote Creek at 237 was not considered representative as most development in the watershed is relatively new; that is, the sum of old industrial and old urban land uses represents 22 percent of the watershed compared to 37 percent for the Walnut Creek watershed and 70 percent for the Guadalupe River at 101 watershed.

To simplify the regression, land use categorizations from the basemap described in section A.1.1 above were aggregated into five categories (Table A-3).

Table A-3: Land Use Categories for Regression Analysis

Specific Category	General Category
Electrical Property - Old	1 – Old Industrial
Industrial - Old	1 – Old Industrial
Industrial - Old - Now Open Space/Vacant	1 – Old Industrial
Industrial - Old - Now Redeveloped	1 – Old Industrial
Port	1 – Old Industrial
Railroad	1 – Old Industrial
Freeway	2 – Old Urban
Urban Old - Commercial	2 – Old Urban
Urban Old - HDR	2 – Old Urban
Urban Old - LDR	2 – Old Urban
Urban Old - Other	2 – Old Urban
Electrical Property - New	3 – New Urban
Industrial - New	3 – New Urban
Urban New - Commercial	3 – New Urban
Urban New - HDR	3 – New Urban
Urban New - LDR	3 – New Urban
Urban New - Other	3 – New Urban
Agriculture	4 – Open Space
Open Space	4 – Open Space
Airport	5 – Other
Military (Developed Areas Only)	5 – Other

The form of the linear regression equation is:

Yield (mg/acre/yr) = [(A x area (old industrial) + B x area (old urban) + C x area (new urban) + D x area (open) + E x area (other)]/Total Area

Where the coefficients (i.e., land use yields) are:

A = 50 mg/acre/year (old industrial)

B = 17.5 mg/acre/year (old urban)

C = 2 mg/acre/year (new urban)

D = 2.5 mg/acre/year (open space)

E = 2 mg/acre/year (other)

Coefficients were determined iteratively and are considered to represent the central tendency of the land use yields based on the watershed data available at the time (2013). The regression analysis results show the importance of land use type on yield, with old industrial having the highest yield. This is consistent with the analysis conducted by McKee et al. (2012), which showed a positive correlation between PCBs concentrations and historic industrialization. Old Urban also has a modest effect and the effects of other land uses are negligible. Figure A-3 below shows how the predicted yields using the regression equation compare to the reported yields from SFEI based on measurements. An R^2 of 0.87 indicates that approximately 87 percent of the variability in PCBs yields could be explained by land use.

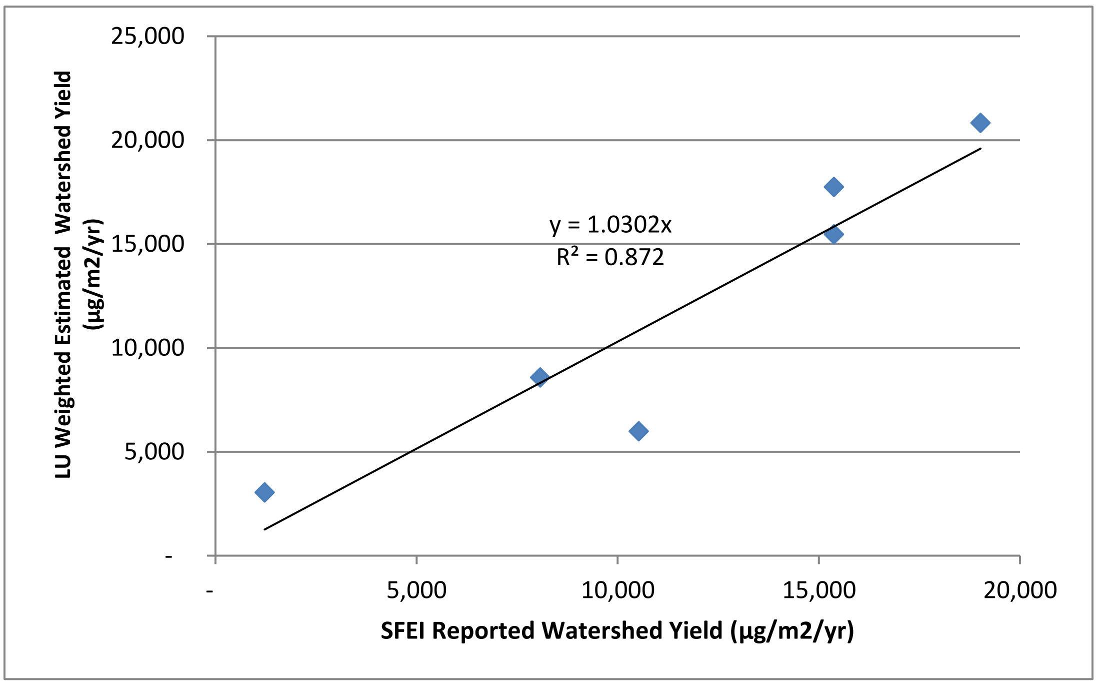

Figure A-3: PCBs Yields Using Linear Regression versus Estimated Yields Based on Monitoring Data

Similarly, a linear regression analysis was conducted for HgT which resulted in the following regression coefficients, considered to approximately represent the central tendency of the yields from land uses present in the watershed.

A = 1,000 mg/acre/year (old industrial)

B = 165 mg/acre/year (old urban)

C = 25 mg/acre/year (new urban)

D = 25 mg/acre/year (open space)

E = 20 mg/acre/year (other)

Figure A-4 below shows the correlation of the linear regression to the SFEI reported data. The R^2 of 0.76 indicates that land use explains about 76 percent of the variability in estimated yields. The importance of Old Industrial, and to a lesser extent Old Urban land use, similar to that with PCBs, is illustrated by the magnitude of the coefficients for these land uses.

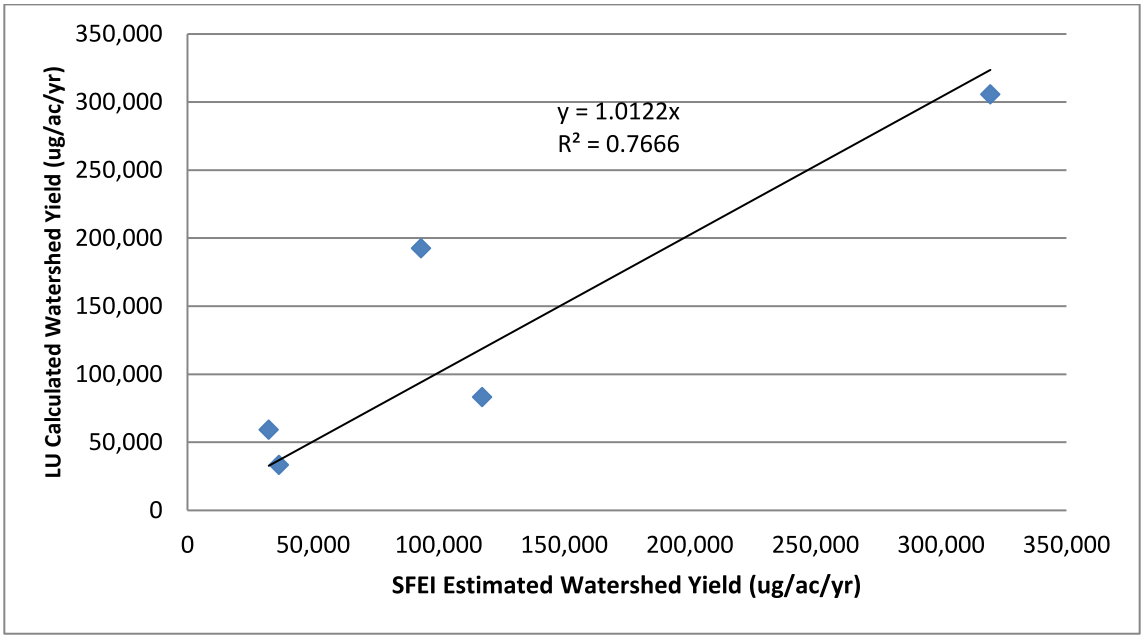

Figure A-4: Total Mercury Yields Using Linear Regression versus Estimated Yields Based on Monitoring Data

A.3 YIELD CORRECTION FACTOR

A.3.1 PCBs Yield

A.3.1.1 Land Use-Based Yields

The land use-based PCBs yields from the regression analysis reported above were multiplied by the area of each land use within each MRP Permittee's jurisdictional boundary to develop estimates of Permittee-based total calculated load. The resulting loads were reported in each countywide program's IMR Part C. These loads are summarized by county in Table A-4 below.

Table A-4: PCBs Loading Reported in the 2014 IMR

County	Load From Land Use Yields (g/yr)	Load From Elevated Watersheds (g/yr)[1]
Alameda	2,566	399
Contra Costa	1,995	354
San Mateo	1,086	86
Santa Clara	2,738	179
Solano[2]	285	N/A
Total	**8,670**	**1,018**

[1] Loading for the five pilot watersheds was calculated separately from the rest of the county land area using the yield from the Ettie Street Pump Station watershed (331,843 µg/ac/yr).
[2] Solano County loads were not reported in their IMR Part C. For this analysis, Solano County load was calculated using the same land use breakdown and yield regression analysis as other MRP Permittees.

The total loads calculated for the IMR have been normalized to the TMDL baseline load of 16 kg/yr for the MRP Permittees for the purposes of load reduction accounting. The total estimated PCBs loads shown above are 8.67 kg/yr from the baseline watersheds (calculated using the land use-based yields from the regression analysis), plus 1.01 kg/yr from the elevated watersheds[8]. A correction factor for the land use yield-based loads is appropriate as the land use-based yields were developed using monitoring data for the baseline watersheds (described in Section A.2.2 above). The elevated watershed loads, on the other hand, are not normalized as these loads are based on long-term measurements of PCBs and mercury loads in discharges from the Ettie Street Pump Station (see Section A.2.2 above). The area-normalized load corresponding to the Ettie Street Pump Station watershed was considered to be representative of the PCBs watershed-based yield for the other elevated watersheds. The estimated total loading for the baseline watersheds was corrected by applying a multiplier to the load calculated using land use-based yield according to the following equation:

$$8.67\frac{kg}{yr} * F + 1.01\frac{kg}{yr} = 16.0\frac{kg}{yr}$$

From this equation, the estimated land use yields should be multiplied by 1.73 to approximate a baseline load of 16.0 kg/yr. Thus, the adjusted land use-based PCBs yields for non-source areas/ property are:

- Old Industrial = 86.5 mg/ac/yr
- Old Urban = 30.3 mg/ac/yr

[8] Elevated watersheds include (BASMAA, 2014):

1. Ettie Street Pump Station watershed, City of Oakland, Alameda County.
2. Lauritzen Channel watershed, City of Richmond, Contra Costa County.
3. Leo Avenue watershed, City of San Jose, Santa Clara County.
4. Parr Channel watershed, City of Richmond, Contra Costa County.
5. Pulgas Creek Pump Station watershed, City of San Carlos, San Mateo County.

- New Urban/Other = 3.5 mg/ac/yr
- Open Space = 4.3 mg/ac/yr

A.3.1.2 Source Area/Property Yield

To support identification of potential PCBs sources by the Alameda Countywide Clean Water Program (ACCWP) and City of Oakland, Geosyntec Consultants conducted a desktop screening of the ESPS Watershed's Old Industrial land use areas and identified a set of properties with higher likelihood as PCBs sources (called High Likelihood parcels) for further evaluation. This screening effort resulted in the five-level breakdown of land areas shown in Table A-5 below.

Table A-5: ESPS Watershed Parcel Screening Results, Yields, and Loads

Land Use	Area (Acres)	Adjusted Yield (mg/ac/yr)	Adjusted Load (g/yr)
High Likelihood	89.5	4,065	363.8
Old Industrial	123.4	86.5	10.7
Old Urban	789.7	30.3	23.9
New Urban and Other	181.4	3.5	0.6
Open Space	18.7	4.3	0.1

The load from the High Likelihood area can be calculated by subtracting the adjusted load from the other land uses (35.3 g/yr, see Table A-5) from the overall ESPS load (399.1 g/yr, see Table A-4). Thus the High Likelihood area load is 363.8 g/yr. Back calculating for High Likelihood yield ((363.8 g/yr / 89.5 ac) x 1,000) results in an estimated 4,065 mg/ac/yr yield for the source area properties.

A.3.2 Mercury Yield

The land use-based PCBs yields from the regression analysis reported above were multiplied by the area of each land use within each MRP Permittee's jurisdictional boundary to develop estimates of Permittee-based total calculated load. The resulting loads were reported in each countywide program's IMR Part C. These loads are summarized by county in Table A-6 below.

Table A-6: Total Mercury Loading Reported in the 2014 IMR

County	Load From Land Use Yields (g/yr)
Alameda	31
Contra Costa	25
San Mateo	12
Santa Clara	30
Solano[1]	3.1
Total	**101**

[1] Solano County loads were not reported in their IMR Part C. For this analysis, Solano County load was calculated using the same land use breakdown and yield regression analysis as other MRP Permittees.

Mercury land-use based yields were similarly adjusted to better reflect the total wasteload allocation required for the TMDL. The total loads reported in the 2014 IMR were normalized to the TMDL baseline load of 128 kg/yr for the MRP Permittees for the purposes of load reduction accounting. The total estimated total mercury loads shown above are 101 kg/yr. The estimated total loading can be corrected by applying a multiplier to the total load calculated using the land use-based yields according to the following equation:

$$101\frac{kg}{yr} * F = 128\frac{kg}{yr}$$

This results in an adjustment factor of 1.3. Less precision was used in the estimation of the mercury factor as the mercury land use-based yields are slightly less certain than the PCBs loads (illustrated by the smaller correlation factor resulting from the regression). Thus, the adjusted land use-based total mercury yields are:

- Old Industrial = 1,300 mg/ac/yr
- Old Urban = 215 mg/ac/yr
- New Urban/Open Space = 33 mg/ac/yr
- Other = 26 mg/ac/yr

A.4 LIMITATIONS AND UNCERTAINTY

There are a variety of sources of uncertainty in the estimated POC yields, including:

- Elevated Watersheds. The data, especially for PCBs, indicate that there are some watersheds where concentrations are elevated relative to other monitored watersheds, and that these elevated watersheds have high PCBs yields and therefore contribute disproportionately to loads. There may be additional elevated watersheds that have not been identified due to limitations in monitoring conducted to date.
- Data Limitation. Limitations in the monitoring data used to estimate yields include the limited number of watersheds, the limited number of storm events sampled, and limited grab sample collection.
- Land Use Database Accuracy. Land use is the basis for the regression analysis. Not only is the type of land use important, but in the case of PCBs the age of the land use also is critical. The land use data therefore are attempting to characterize the historical evolution of land use based on available sources and aerial photo interpretation. The land use maps have not been fully "ground truthed" and therefore pose an important limitation in the analysis.

- Land Use as a Surrogate. Land use is used as a surrogate for actual PCBs and mercury sources, and although the types of potential sources have been identified, the actual locations and sizes of sources are difficult to determine at this level of analysis. So the same land use type in different locations may have very different sources and thus distinctly different PCBs and mercury concentrations in runoff.

In summary, it is difficult to assess the quantitative implications of these limitations on the magnitude of the projected loads, especially as analysis shifts from regional to smaller spatial scales. Experience with the difficulty in making loading estimates suggests that the projected loads be considered as first order approximation only, which are reflective of the central tendency of the data for the Bay Area as a whole.

SFEI's *Sources, Pathways and Loadings: Multi-Year Synthesis with a Focus on PCBs and Hg* (McKee et al., 2015) discusses the considerable challenges in developing improved estimates of land use-based yields of PCBs and mercury. As discussed above, the regression-based estimate of regional PCBs load that was reported in the 2014 IMR appears to be about 40 percent low. The report suggests that a regional estimate of approximately 20 kg/yr annual load of PCBs in urban runoff (for the entire Bay watershed) remains reasonable; however, other reports disagree. The regression-based estimate of regional total mercury load that was reported in the 2014 IMR appears to be about 20 percent low.

In addition, the standing conceptual model of relative distribution of PCB and total mercury in the landscape (SFEI, 2010) is that the PCBs unit load distribution in the landscape should be more variable than the total mercury distribution. This relative variation in land use yield is supported by product use history, degree of atmospheric recycling, and sources of the two pollutants; variation in concentrations found in Bay Area soils and sediments; and the yields generated from monitoring in the Bay Area which indicate a 800-fold variation for PCBs and a 70-fold variation for total mercury (if the Sacramento River is excluded) (see also SFEI, 2010; Davis et al., 2012; 2014). The relative variation in land use yield for the adjusted yields reported above, presented in Table A-7, is consistent with this conceptual model and therefore these yields are acceptable as first order approximations.

Table A-7: Normalized Land Use-Based Yields for PCBs and Mercury

Land Use Category	Assumed Average PCBs Yield (mg/ac/yr)	PCBs Yield Normalized to Open Space	Assumed Average Mercury Yield (mg/ac/yr)	Mercury Yield Normalized to Open Space
Source Property	4,065	945	1,300	50
Old Industrial	86.5	20	1,300	50
Old Urban	30.3	7	215	8.3
New Urban	3.5	0.8	33	1.3
Other	3.5	0.8	26	0.8
Open Space	4.3	1	33	1

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APPENDIX B

Street and Storm Drain Sediment

Data Analysis

B.1 Descriptive Statistics

Tables B-1 and B-2, and Figures B-1 and B-2 presents descriptive statistics for the PCBs and Mercury street and storm drain sediment dataset that has been compiled by BASMAA to-date. This dataset includes 1,204 PCBs samples and 952 mercury samples taken within the street right-of-way, storm drain conveyance system, and private properties from 1999 through 2015. Data are summarized by the predominant land use within the vicinity of where the sediment was collected.

Table B-1: PCBs concentrations in sediment (mg/kg) collected from streets, stormwater conveyance systems, and private properties located in Alameda, Contra Costa, Santa Clara, San Mateo, and Solano Counties between 1999 and 2015.

Statistic	PCB Source Properties	Old Industrial	Old Urban	New Urban	Open Space	All Samples
Maximum	192.91	93.41	16.81	0.07	0.20	192.91
90^{th} Percentile	11.52	0.47	0.36	0.03	0.07	0.83
75^{th} Percentile	5.35	0.14	0.13	0.02	0.04	0.17
Mean	6.70	0.33	0.25	0.02	0.03	0.72
Geometric Mean	2.17	0.05	0.04	0.01	0.01	0.05
Median	1.67	0.04	0.04	0.01	0.01	0.04
25^{th} Percentile	0.92	0.01	0.01	0.01	0.01	0.01
10th Percentile	0.60	0.01	0.01	ND	ND	0.01
Minimum	ND	ND	ND	ND	ND	ND
n	81	835	214	30	44	1204

Table B-2: Mercury concentrations in sediment (mg/kg) collected from streets, stormwater conveyance systems, and private properties located in Alameda, Contra Costa, Santa Clara, San Mateo, and Solano Counties between 1999 and 2015.

Statistic	PCB Source Properties	Old Industrial	Old Urban	New Urban	Open Space	All Samples
Maximum	20.60	18.90	12.54	3.31	4.26	20.60
90th Percentile	2.70	0.67	0.73	0.45	0.32	0.77
75th Percentile	1.37	0.30	0.39	0.28	0.18	0.32
Mean	1.54	0.40	0.44	0.35	0.28	0.44
Geometric Mean	0.55	0.18	0.21	0.19	0.12	0.19
Median	0.67	0.16	0.20	0.15	0.12	0.16
25th Percentile	0.15	0.09	0.10	0.10	0.07	0.09
10th Percentile	0.09	0.06	0.06	ND	ND	0.06
Minimum	0.02	0.01	0.01	0.05	0.02	0.01
n	41	740	161	29	40	952

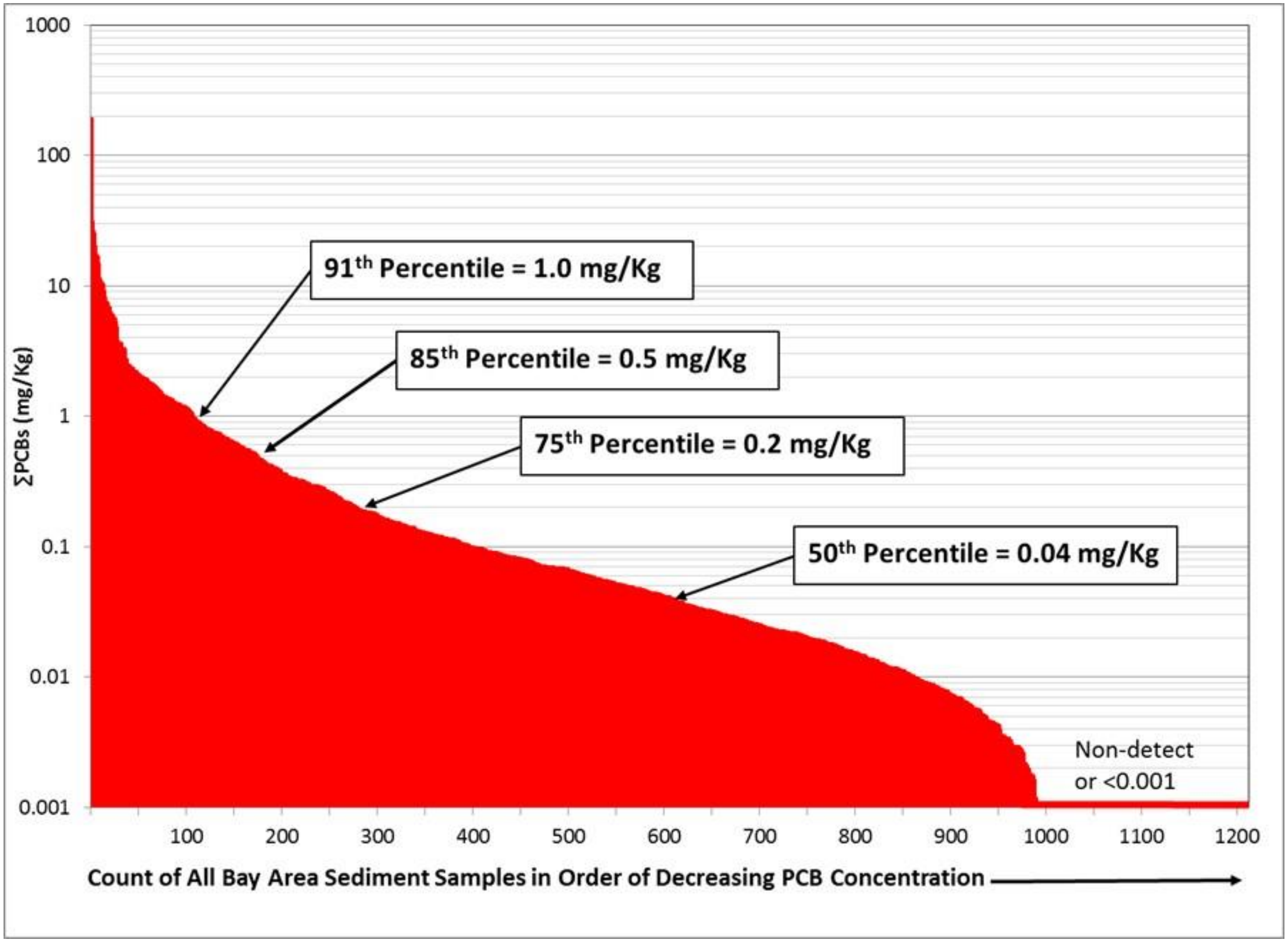

Figure B.1: Total PCB concentrations in sediment collected from streets, stormwater conveyance systems, and private properties located in Alameda, Contra Costa, Santa Clara, San Mateo, and Solano Counties between 1999 and 2015.

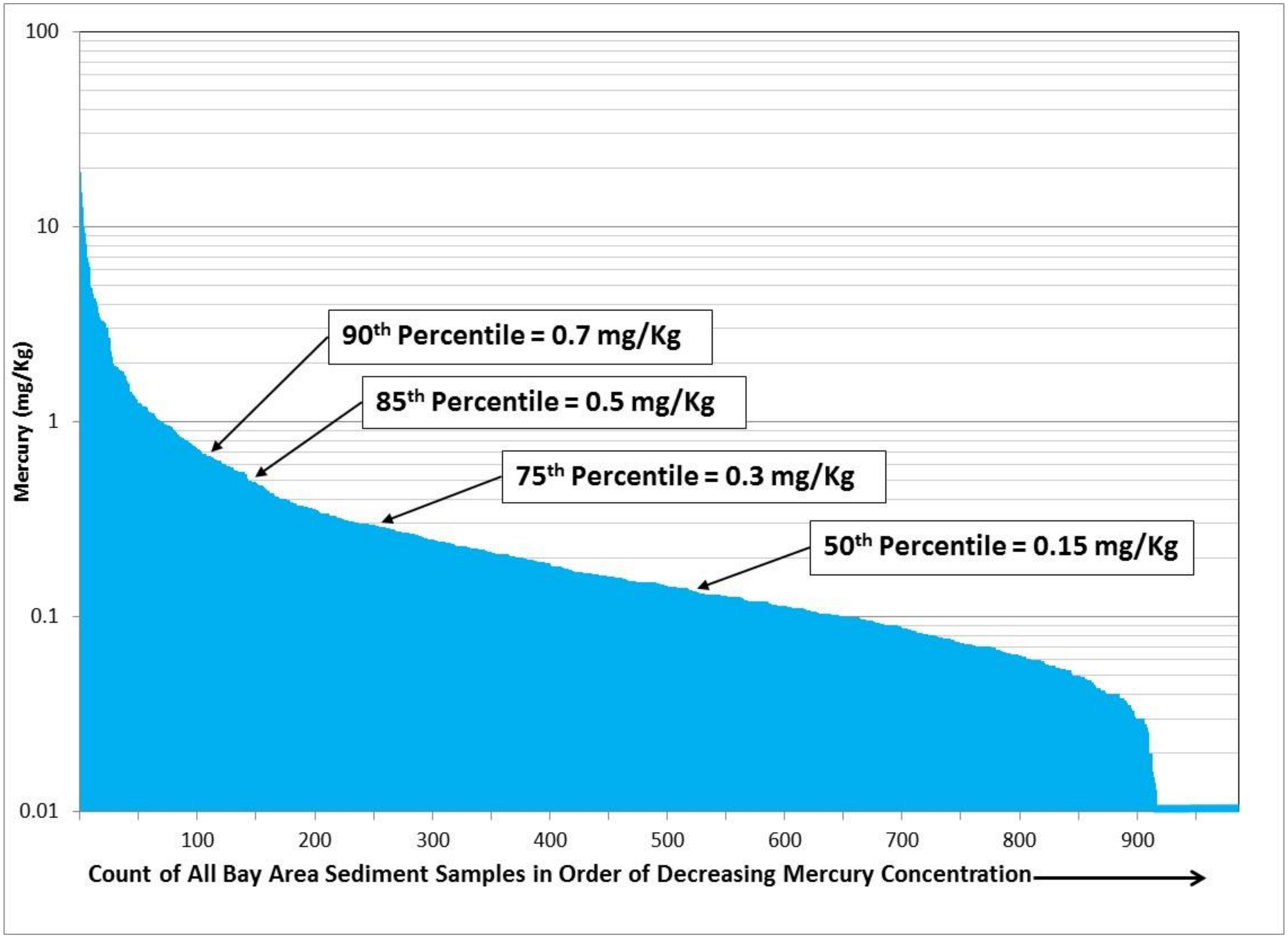

Figure B.2: Total mercury concentrations in sediment collected from streets, stormwater conveyance systems and private properties located in Alameda, Contra Costa, Santa Clara, San Mateo, and Solano Counties between 1999 and 2015.

APPENDIX C

HDS Unit Efficiency Factor Data Analysis

C.1 Purpose and Approach

The purpose of this appendix is to document findings of analysis conducted to determine average percent removal of total suspended solids (TSS) by hydrodynamic separator (HDS) units.

First, percent removal of TSS was calculated for the Clean Watersheds for a Clean Bay (CW4CB) Task 5 Leo Avenue pilot project. For this project, a prefabricated Contech HDS unit called the Continuous Deflective Separator (CDS) was retrofitted into the existing storm drain system in the Leo Avenue Watershed in San Jose.

Influent and effluent water quality was sampled at four events as summarized in Table C-1 below. The CDS unit removed an average of 30% of TSS coming into the unit.

Table C-1: Percent Removal of TSS at Leo Ave CDS Unit

Event	Date	Sample Location	TSS (mg/L)	% Removal
1	28-Feb-14	Inflow	110	17%
		Outflow	91	
2	29-Mar-14	Inflow	230	17%
		Outflow	190	
3	31-Oct-14	Inflow	62	88%
		Outflow	7.5	
4	02-Dec-14	Inflow	82	-3%
		Outflow	84.5	
Average				**30%**

Next, the International Stormwater BMP Database (http://bmpdatabase.org/) was evaluated for potentially useful studies. Twenty studies of manufactured devices were identified as useful for analysis. These studies had a total of 334 paired inflow/outflow data points for TSS. Percent removal was calculated for each paired data point and then averaged for the BMP. The results for these studies along with descriptions of land use type and watershed size and imperviousness are presented in Table C-2 below. Average percent removal ranged from -85% (i.e., an increase in TSS concentration in outflow compared to inflow) to 73% and averaged 19% across all studies (including the Leo Ave. unit).

The dataset was also analyzed by removing BMPs that were treating just roads or highways, parking lots, or college campuses. In this scenario, ten studies remained that had mixed, other, or unknown land use type. Including the Leo Ave unit, the average percent removal of TSS from the BMPs evaluated in this group of studies was slightly higher at 22%.

Table C-2: Percent Removal of TSS for Studies in BMP Database

Site and BMP	Device Model	Land Use Type	Watershed % impervious	Watershed Area (ac)	Average TSS % Removal[1]
OP Soccer Complex: PMSU56_40_40	Contech CDS, Model PMSU56_40_10	Parking lots adjacent to soccer fields.	90	3.98	-85%
NW Birch Place CDS unit: Continuous Deflective Separation unit	CDS Unit	Low Density Residential: 47.4% Office Commercial: 42.2% Multi-Family Residential: 10.3%	--	45.0	-14%
Broadway Outfall: CDS Unit	CDS			132	-6%
University of New Hampshire F3: Continuous Deflective Separation	CDS	College Campus: 100%	100	0.32	-5%
Lake O Sediment Demo: CDS Unit	PSW56_53		--	--	-3%
I-210 / Orcas Ave: Orcas	CDS	Roads/Highway: 100%	100	1.11	-3%
USGS_WI_HSD_DD: Hydrodynamic Settling Device	Downstream Defender®, manufactured by Hydro International.		84	1.90	-1%
I-210 / Filmore Street: Filmore CDS	CDS	Roads/Highway: 100%	100	2.50	2%
University of New Hampshire F2: Environment 21 V2B1	Environment 21 V2B1	College Campus: 100%	100	0.32	5%
University of New Hampshire F1: Vortechnics	Vortechnics	College Campus: 100%	100	0.32	13%
USGS_WI_HSD: HSD	Hydrodynamic Settling Device, Contech	The HSD treats a 0.25-acre deck section of the westbound I–794 freeway	100	0.25	26%
Harrisburg Public Works Yard: PAYardTerreKleene	Terre Kleen	--	90	3.21	28%
SC_StructBMP3: BMP3	Vortechnics	BMP3 is located along the westbound lane of S.C. Highway 802	--	--	29%
Indian River Lagoon CDS Unit: CDS Unit	CDS	Open Space: 38% Light Industrial: 32% Office Commercial: 19%	11	61.5	30%

Appendix C: HDS Unit Efficiency Factor Data Analysis

Site and BMP	**Device Model**	**Land Use Type**	**Watershed % impervious**	**Watershed Area (ac)**	**Average TSS % Removal[1]**
Leo Avenue: HDS Unit[2]	Contech CDS	--	--	--	30%
SC_StructBMP1&2: BMP2	CDS Technologies	BMP2 is located along the southbound lane of U.S. Highway 21	100	1.11	39%
University of New Hampshire E1: Aqua Swirl	Aqua Swirl	College Campus: 100%	100	0.99	40%
Timothy Edwards Middle School: Vortechs No 5000	Vortechs	--	80	1.95	45%
VC: VC	Vortcapture	Residential area with lots of organic matter/leaf litter loading	--	--	53%
Marine Village Watershed: VortechsTM Stormwater Treatment System	Vortechs	Office Commercial: 50% Medium Density Residential: 45% Unknown: 5%	95	9.34	72%
NJ Manasquan Bank: NJManasquanCDS	High Efficiency Continuous Deflective Separator (CDS), Model 20_25	--	79	0.89	73%

Notes: -- indicates information was not provided.

1. Based on analysis of paired inflow/outflow results.
2. Leo Ave CW4CB study. Not a BMPDB Study.

The manufacturer's removal efficiency claims and the tested removal efficiencies of six of the BMPs evaluated in the studies were summarized as reported in the Massachusetts Stormwater Technology Evaluation Project (MASTEP) clearinghouse database (Table C-3).

Table C-3: Percent Removal of TSS for Six Manufactured Devices from MASTEP

Product (BMP)	Manufacturer	Manufacturer's Removal Efficiency claim	Tested Removal Efficiency
Aqua-Swirl	Aqua Shield	85%	84-87%
CDS	Contech	70%	65-95%
Vortechs	Contech	35-85%	35-64%
Downstream Defender	Hydro International	90%	70%
V2B1	Environment 21	80%	65%
Terre Kleen	Terre Hill	78%	17-50%
Average[1]			**56%**

Notes: 1. Average based on low end of reported efficiency range.

Based on the above findings, 20% is a conservative estimate of the average percent removal of TSS by HDS units. For the purposes of interim load reduction accounting, the method assumes that HDS units reduce PCBs and mercury concentrations in direct proportion to the TSS reduction.

APPENDIX D

Enhanced Inlet Cleaning Efficiency Factor Data Analysis

D.1 Purpose and Approach

The purpose of this appendix is to document findings of analysis conducted to determine the enhanced efficiency factors (EE_f) for sediment removal associated with increasing the frequency of storm drain inlet cleaning.

Based on a review of available literature, there are limited data available on the reductions of pollutants (including sediment) associated with different storm drain inlet maintenance frequencies. No studies were found that assessed the reduction either PCBs or mercury due to enhanced inlet cleaning frequencies. Two studies in particular, Woodward Clyde (1994) and Caltrans (2003), however evaluated the increase in the removal of material (i.e., sediment, vegetation and trash) from inlets under different cleaning frequencies. Results from both studies indicated that the volume of material removed from inlets increased with cleaning frequency.

The CalTrans (2003) *Drain Inlet Cleaning Efficacy Study* was designed to measure the potential increases in material volume/mass and water quality benefits due to increased inlet cleaning frequencies on freeways. The study was conducted from 1996 through 2000 The volume and mass of material removed under annual, biannual, and 3 times per year cleaning frequencies at 55 to 90 inlets, depending on the year, were measured.

The Woodward Clyde (1994) *Storm Inlet Pilot Study* was conducted in Alameda County in 1993. This study was also designed to measure the potential increases in material volume/mass due to increased inlet cleaning frequencies. A total of 15 inlets draining residential, industrial or commercial land uses were monitored. The volume and mass of material removed under annual, biannual, quarterly and monthly cleaning frequencies were measured.

The increased removal of material measured during both studies is presented in Figure D-1. Caltrans removals appear to be much greater than removal efficiencies measured during the Woodward Clyde study and therefore may not be realistic for the purposes of developing conservative efficiency factors for the Interim Accounting Methodology. Results from the Woodward Clyde study, however, appear to be generally consistent with the results of similar studies (BASMAA 2014; SCVURPPP 2016) that were focused on litter/trash, but also removed and measured other materials (e.g., sediment and vegetation) from inlets.

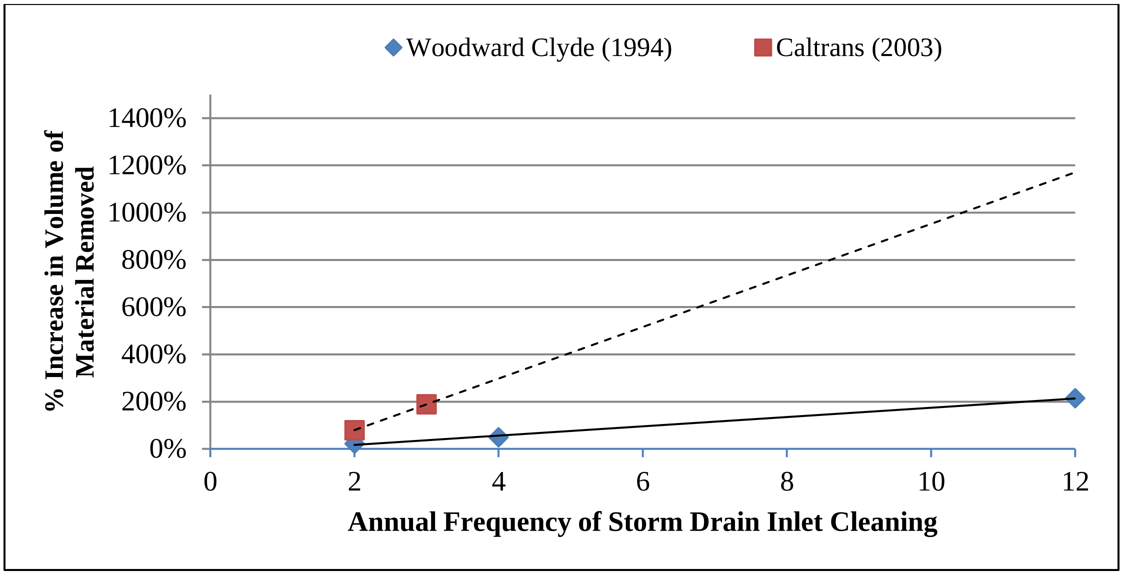

Figure D.1: Reported results of increases in material (e.g., sediment, vegetation and litter) removed as a result of increased storm drain inlet cleaning.

Based on the above findings, Table D.1 presents a conservative estimate of the enhanced efficiency factors for enhanced storm drain inlet cleaning. For the purposes of interim load reduction accounting, the method assumes the following:

- Based on an analysis of 36 Alameda County and San Mateo Permittee storm drain inlet cleaning datasets from 1996 through 2009, on average, municipalities clean their inlets once per year (annually);
- Based on the same dataset, an average of 100 kg of material (sediment, vegetation and litter) is removed from each inlet annually (see descriptive statistics below);

Statistic	Mass (kg) of Material Removed Annually per inlet
Maximum	4049
90th Percentile	476
75th Percentile	284
Mean	268
Geometric Mean	100
Median	91
25th Percentile	41
10th Percentile	21
Minimum	5
# of Municipalities in Dataset	36

- Each inlet (on average) receives drainage from a catchment of 1 acre (BASMAA 2014), equating to a unit material removal rate of 100kg per acre per year;
- The fraction of material associated with PCBs and mercury yields (i.e., sediment <63um) is approximately 15% on average (McKee et al. 2006);
- The annual suspended sediment load to each inlet is roughly 162 kg per year on average (see Table 2); and
- Based on the assumptions above, roughly 15 kg of sediment associated with PCBs and mercury is removed from each inlet cleaned on an annual frequency, equating to about a 9% reduction of PCBs and mercury via annual cleaning (i.e., 15 kg / 162 kg).

Table D.1: Enhanced efficiency factors (EE_f) for increased storm drain inlet cleaning frequencies.

		Enhanced Cleaning Frequency		
		Biannually	Quarterly	Monthly
Original Cleaning Frequency	Annually (Baseline = 0.09)	0.02	0.05	0.20
	Biannually		0.03	0.18
	Quarterly			0.15

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