Bay Area Reasonable Assurance Analysis Guidance Document

Prepared for

Bay Area Stormwater Management Agencies Association

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LIST OF ACRONYMS AND ABBREVIATIONS

µg	microgram
µg/kg	micrograms per kilogram
ACCWP	Alameda Countywide Clean Water Program
APN	Assessor's Parcel Number
BASMAA	Bay Area Stormwater Management Agencies Association
Bay Area	San Francisco Bay Area
BMP	Best Management Practice
CCCWP	Contra Costa Clean Water Program
CCRWQCB	Central Coast Regional Water Quality Control Board
CIMIS	California Irrigation Management Information System
DMA	drainage management area
EMCs	event mean concentrations
g	gram
GIS	geographic information system
Guidance Document	Reasonable Assurance Analysis Guidance Document
HDS	hydrodynamic separator
IMRs	Integrated Monitoring Reports
kg	kilogram
kg/yr	kilograms per year
LARWQCB	Los Angeles Regional Water Quality Control Board
LID	Low Impact Development
mg	milligrams
mg/ac/yr	milligrams per acre per year
mg/kg	milligrams per kilogram
MRP	Municipal Regional Permit
MS4	municipal separate storm sewer system
NCEI	National Centers for Environmental Information
NED	National Elevation Dataset
ng	nanogram

NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
PCBs	polychlorinated biphenyls
PMT	Project Management Team
POTWs	publicly owned treatment works
ppm	parts per million
RAA	Reasonable Assurance Analysis
RMP	Regional Monitoring Program
ROW	right-of-way
RWSM	Regional Watershed Spreadsheet Model
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SFEI	San Francisco Estuary Institute
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SSURGO	Soil Survey Geographic Database
STLS	Small Tributaries Loading Strategy
STLS-T	Small Tributaries Loading Strategy-Trends Strategy
SWMM	Storm Water Management Model
SWRP	Stormwater Resource Plan
TAC	Technical Advisory Committee
TMDL	total maximum daily load
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
WBD	Watershed Boundary Dataset
WLA	wasteload allocation
WQBEL	water quality based effluent limit
WRCC	Western Regional Climate Center
WY	Water Year

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EXECUTIVE SUMMARY

This Reasonable Assurance Analysis (RAA) Guidance Document describes the background, requirements, and recommended approach for conducting RAAs for programs and permittees subject to the Municipal Regional Stormwater Permit (MRP) (Order No. R2-2015-0049). For the purposes of this Guidance Document, an RAA is a demonstration that the control measures proposed in the MRP Permittees' Green Infrastructure Plans and Polychlorinated Biphenyls (PCBs) and Mercury Control Measure Implementation Plans (see Section 2.1.3) as required by MRP Provisions C.3, C.11, and C.12, will meet the PCBs and mercury Total Maximum Daily Load (TMDL) wasteload allocations for urban stormwater runoff. Additionally, the RAA should provide a method for evaluating the type, size, number, location, and phasing of green infrastructure measures needed to most cost-effectively comply with the green infrastructure load reduction goal (i.e., 10 kilograms per year [kg/yr] mercury load reductions and 3 kg/yr PCBs load reductions by 2040) stated in MRP Provisions C.3.j and C.11/C.12.c. The MRP requires that both the green infrastructure RAA (C.11.c/C.12.c) and the wasteload allocation attainment RAA (C.11.d/C.12.d) be documented in the 2020 Annual Report.

This is not a regulatory document and the approaches included herein are recommendations. Permittees may choose alternative or modified approaches, but should consider when doing so that peer review and San Francisco Bay Regional Water Quality Control Board (Regional Water Board, SFBRWQCB) Executive Officer approval of RAAs is required.

It is recommended that the RAA process be interactive with other watershed planning efforts. Inputs to the RAA process may be derived from PCBs/mercury control measure implementation, green infrastructure, Stormwater Resource Plan (SWRP), and other applicable stormwater management planning efforts. The RAA output in turn will allow for planning outcomes to be iterated and will ultimately demonstrate that the plans will meet MRP requirements.

The RAA methodology may be used to calculate baseline loading and load reduction targets, and will be used to estimate PCBs and mercury load reductions achieved through implementation of current, planned, and future green infrastructure and source control measures. Additional quantification capabilities may also be beneficial to support decision making, but are not required at this time. Consistent with the TMDL accounting, the RAA area of analysis should include the areas within the MS4 drainage area boundaries of the Permittee's jurisdiction, and additional area needed for calibration or validation of the model.

The RAA will incorporate both estimation methods and computational methods. Estimation methods can be used to calculate load reductions achieved by source controls, and computational methods (or simplified methods based on factors established by computational methods) can be used to calculate load reductions achieved via green infrastructure.

It is the intent of this Guidance Document that models developed by different countywide stormwater programs and/or Permittees that follow the recommendations herein would produce results that are comparable with each other and can be aggregated regionally. Because there are modeling details that cannot be addressed as part of this Guidance Document, it is recommended that a RAA Work Group be convened by Bay Area Stormwater Management Agencies Association (BASMAA) to peer review and provide input on models as they are being developed, work with Regional Water Board staff to resolve technical and regulatory issues, and maintain consistency among models to the extent practicable.

The ultimate stakeholders in the outcome of the RAA methods will be members of the Permittees' boards and councils and other decision makers, who will need to approve the policies and projects that will achieve required load reductions.

1. INTRODUCTION

1.1 Document Goals and Objectives

The purpose of this Bay Area Stormwater Management Agencies Association (BASMAA) Reasonable Assurance Analysis Guidance Document (Guidance Document) is to establish a regional framework and provide guidance for conducting polychlorinated biphenyls (PCBs) and mercury reasonable assurance analyses (RAAs) in the San Francisco Bay Area (Bay Area).

1.1.1 RAA Definition

From a regulatory perspective, reasonable assurance is defined as the demonstration that the implementation of control measures will, in combination with operation of existing or proposed storm drain system infrastructure and management programs, result in sufficient pollutant reductions over time to meet total maximum daily load (TMDL) wasteload allocations, water quality-based effluent limits (WQBELs), or other water quality targets specified in a municipal separate storm sewer system (MS4) permit (United States Environmental Protection Agency [USEPA], 2017). From the perspective of a stakeholder in the watershed who is focused on the improvement of water quality or restoration of a beneficial use of a waterbody, reasonable assurance is the demonstration and a commitment that specific management practices are identified with sufficient detail (and with a schedule for implementation) to establish that necessary improvements in the receiving water quality will occur. From the perspective of an MS4 Permittee, reasonable assurance is a detailed analysis of TMDL wasteload allocations (WLAs), associated permit limitations, and the extent of stormwater management actions needed to achieve TMDL WLAs and address receiving water limitations. RAAs may also assist in evaluating the financial resources needed to meet pollutant reductions based on schedules identified in the permit, TMDL, or stormwater management plan, and in preparing associated capital improvement plans.

For the purposes of this Guidance Document, an RAA is a demonstration that the control measures proposed in Bay Area City and County Green Infrastructure Plans and PCBs and Mercury Control Measure Implementation Plans (see Section 2.1.3), as required by the Municipal Regional Stormwater Permit (MRP) (Order No. R2-2015-0049) Provisions C.3, C.11, and C.12, will meet the PCBs and mercury TMDL wasteload allocations for urban stormwater runoff over the defined period of time. Additionally, the RAA should provide a method for evaluating the type, size, number, location, and phasing of green infrastructure measures needed to comply with the green infrastructure load reduction goal (i.e., 10 kilograms per year [kg/yr] mercury load reductions and 3 kg/yr PCBs load reductions by 2040) stated in MRP Provisions C.11/C.12.c. As such, the green infrastructure planning and associated RAAs will require adaptive management. The RAA may also be used to justify extending the TMDL compliance schedules (San Francisco Bay Regional Water Quality Control Board [SFBRWQCB], 2015). [1]

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[1] See MRP Attachment A: Fact Sheet page Attachment A-122.

The MRP provides flexibility for Permittees to define what constitutes an acceptable RAA, however the RAAs developed in compliance with the MRP must be peer reviewed and must be approved by the San Francisco Bay Regional Water Quality Control Board (Regional Water Board). The MRP Fact Sheet provides the following details:

- Preparing the RAA will be a step-wise process.
- The RAA will require the use of one or more models.
- The Los Angeles Regional Water Quality Control Board (LARWQCB) guidelines for conducting an RAA are a starting point for the RAA required in MRP C.11/C.12.c in terms of the mechanics of the analysis, control measure identification, critical condition selection, choice of models, model calibration criteria, modeling inputs, and model outputs.
- The crucial feature of the existing Southern California RAAs is that they must demonstrate with sufficient analytical rigor that the suite of foreseeable control measures to reduce loads will result in compliance with final TMDL WLAs. The RAA performed for PCBs and mercury for the San Francisco Bay Area will likely be similar in many respects to the type of analysis described in the Los Angeles Region RAA guidance document (LARWQCB, 2014), but must also account for what has been learned about the distribution, fate, and transport characteristics, and effectiveness of source and treatment control strategies, of PCBs and mercury in the Bay Area.

Additionally, staff from the Regional Water Board and USEPA Region 9 made the following statements about RAAs at the *Integrating Reasonable Assurance Analysis and Stormwater/Green Infrastructure Plans* workshop held on September 23, 2015:

- RAAs should use robust analytical models and tools to:
    - Evaluate pollutant sources,
    - Locate stormwater control measures,
    - Determine the extent and magnitude of controls needed to meet permit requirements,
    - Guide infrastructure planning and funding decisions, and
    - Support control tracking, evaluation, and reporting;
- Available modeling tools vary in sophistication, capability, and cost; and
- RAAs provide a long term analytical foundation for robust stormwater programs.

This Guidance Document identifies viable RAA technical approach options that are capable of analyzing pathways to compliance with the MRP load reduction goals and TMDL wasteload allocations and can reliably quantify the anticipated effectiveness of the types of control measures that may be implemented by the Permittees.

1.1.2 Bay Area RAA Approach and Methods

The Bay Area RAA approach and methodologies presented in this Guidance Document are generally consistent with those presented in the Los Angeles RAA guidance (LARWQCB, 2014) and guidance provided by the USEPA (USEPA, 2017), and address the specific characteristics of water-quality impairments affecting the San Francisco Bay/Delta.

Bay Area RAA methods should have the capability to reflect the current understanding of the distribution of PCBs and mercury across the landscape and transport via stormwater runoff to the Bay, and should support the phased TMDL implementation approach outlined in the MRP Fact Sheet.[2] In addition to the focus on PCBs and mercury, however, Bay Area RAAs should also be able to complement other areas of stormwater program implementation and be useful for assessing potential future pollutants of concern.

Bay Area RAAs should be developed with a longer timeframe and larger geographic-scale mindset, with an understanding of the legacy nature of current pollutants of concern, with knowledge of the opportunistic character of potential control strategies, and with consideration of other planning and modeling needs. One major consideration for the selection of an approach for conducting the RAA is the ability for certain types of RAA models to be used to assess multiple benefits, other pollutants of concern, and other considerations beyond pollutant load reductions, such as supporting different types of future infrastructure planning.

Finally, Bay Area RAA modeling methods should only be as complex as can be justified given the uncertainty in the data and assumptions used to generate the TMDLs, while incorporating sufficient analytical rigor to meet MRP requirements and withstand the peer review validation process. RAA methods must also incorporate an appropriate level of accuracy and precision given the levels of uncertainty and variability in the data, assumptions, and TMDL load estimations and required reductions. See Section 4.5.1 for further discussion on model uncertainty, accuracy, and precision.

1.2 Control Measures

Existing and future control measures are input into the RAA methodology to evaluate load reduction benefits from their implementation. The methods for incorporating these measures into the RAA are presented in Guidance Document Sections 3 and 4. The control measures that can be accounted for in the RAA include the following:

- **Source Property Identification and Abatement –** Source property identification and abatement involves investigations of properties located in historically industrial land use or other land use areas where PCBs or mercury were used, released, or disposed of or where

[2] The MRP Fact Sheet includes pilot testing, focused implementation, and full-scale implementation, supplemented by other modes, including research and development, desktop analysis, laboratory studies, and/or literature review.

sediment concentrations of PCBs or mercury are significantly elevated above urban background levels. Once a source property is identified, the source of PCBs or 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 Regional Water Board or another appropriate agency for investigation and abatement. Source properties may include sites that were previously remediated but still have PCBs and/or mercury soils concentrations that are elevated above urban background levels or may be newly identified source properties.

- **Manage PCBs-Containing Materials and Wastes During Building Demolition Activities –** The MRP Permittees are developing a protocol for managing building materials and wastes with PCBs concentrations of 50 parts per million (ppm) or greater in applicable structures at the time demolition occurs so that PCBs do not enter the municipal storm drain system. Implementation of the protocol will begin by July 1, 2019.
- **Enhanced Operation and Maintenance Control Measures –** 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 flushing may enhance the Permittees' ability to reduce PCBs and mercury loads in stormwater.
- **Other Source Controls 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.
- **Green Infrastructure/Treatment Control –** This control measure includes new development and redevelopment projects on private and public properties regulated by Provision C.3, as well as treatment control retrofit of existing infrastructure in public right-of-way (ROW) areas and on public and private properties not subject to Provision C.3. This control measure also includes facilities that have been installed in the storm drain system for the purposes of full trash capture which also remove contaminated sediment.
- **Diversion to Publicly Owned Treatment Works –** This control measure consists of diverting dry weather and/or first flush events from MS4s to publicly owned treatment works (POTWs) as a method to reduce loads of PCBs and mercury in urban runoff.

1.3 Guidance Document Overview

The Consultant Team developed this Guidance Document in coordination with the BASMAA Project Management Team (PMT), which consisted of countywide program and Permittee representatives. The PMT worked with the Consultant Team to develop specific discussion topics for the Technical Advisory Committee (TAC). The TAC was comprised of Regional Water Board staff, USEPA Region 9 staff, and industry experts and served to provide "technical peer review" for the document from an objective regulatory and/or technical perspective. Additionally, the TAC helped to identify a range of issues that have been addressed in the Guidance Document.

This Guidance Document consists of the following sections:

- Section 1 provides an overview of reasonable assurance analysis for the Bay Area.
- Section 2 summarizes related regulatory requirements, including the mercury and PCBs TMDLs, MRP load reduction and planning requirements, and the Interim Accounting Methodology used to estimate load reductions during the current permit term.
- Section 3 describes the steps needed to conduct an RAA.
- Section 4 outlines the Bay Area RAA modeling requirements, including how to establish baseline pollutant loading and estimation methods for calculating source control pollutant load reductions.
- Section 5 discusses methods to track control measure implementation and associated load reductions.
- Section 6 suggests next steps for conducting Bay Area RAAs.
- Section 7 provides references for the document.

A number of other entities have developed RAA Guidance Documents that were used to inform content in this document or as a comparison. These include the USEPA's "Developing Reasonable Assurance: A Guide to Performing Model-Based Analysis to Support Municipal Stormwater Program Planning" (USEPA Guide) (USEPA, 2017) and the LARWQCB RAA Guidance Document (LARWQCB, 2014). The State Water Resources Control Board has initiated a project that will be developing an "Identification of Compliance Pathways and Pathway-Specific Quantitative Assurance Analysis," which will also provide guidance on conducting RAAs within California.

2. RELATED REQUIREMENTS AND IMPLEMENTATION APPROACHES

2.1 Regulatory Summary

The RAA requirements in the MRP are driven by TMDLs for mercury (Resolution No. R2-2004-0082 and R2-2005-0060) and PCBs (Resolution No. R2-2008-0012). Each TMDL has a specific WLA for discharges of the respective pollutant in urban stormwater. The development of each WLA is outlined in the respective TMDL Staff Reports (SFBRWQCB, 2006; SFBRWQCB, 2008).

2.1.1 Mercury TMDL

The mercury TMDL addresses two water quality objectives. The first, established to protect people who consume Bay fish, applies to fish large enough to be consumed by humans. The objective is 0.2 milligrams (mg) of mercury per kilogram (kg) of fish tissue (average wet weight concentration measured in the muscle tissue of fish large enough to be consumed by humans). The second objective, established to protect aquatic organisms and wildlife, applies to small fish (3-5 centimeters in length) commonly consumed by the California least tern, an endangered species. This objective is 0.03 mg mercury per kg fish (average wet weight concentration). To achieve the human health and wildlife fish tissue and bird egg monitoring targets and to attain water quality standards, the Bay-wide suspended sediment mercury concentration target is 0.2 mg mercury per kg dry sediment.

A roughly 50% decrease in sediment, fish tissue, and bird egg mercury concentrations is necessary for the Bay to meet water quality standards. Reductions in sediment mercury concentrations are assumed to result in a proportional reduction in the total amount of mercury in the system, which will result in the achievement of target fish tissue and bird egg concentrations (SFBRWQCB, 2004).

The urban stormwater runoff load to the San Francisco Bay is estimated to be equivalent to 116 kg/yr, as reported in the San Francisco Bay Regional Monitoring Program (RMP) for Water Quality's Sources, Pathways, and Loadings Report (McKee et al., 2015), which is less than the TMDL Staff Report reported load of 160 kg/yr[3] (corresponding to "baseline year" of 2003)[3]. The WLA for urban stormwater is 82 kg/yr (SFBRWQCB, 2006). Based on the TMDL reported load of 160 kg/yr, this results in an estimated total required load reduction of 78 kg/yr, required to be achieved by 2028. A summary of the WLA and load reductions required for each urban stormwater entity subject to the TMDL is provided in Table 2-1 (SFBRWQCB, 2006).

[3] This loading assumes an annual sediment load of 410,000,000 kg/yr of sediment with a concentration of 0.38 mg/kg (ppm) (SFBRWQCB, 2006). Although the estimates were based on monitoring data collected in previous years, the TMDL states the baseline year as 2003.

Table 2-1: Individual Wasteload Allocations for Urban Stormwater Discharges

Entity	Wasteload Allocation (kg/yr)[1]
Santa Clara Valley Urban Runoff Pollution Prevention Program	23
Alameda Countywide Clean Water Program	20
Contra Costa Clean Water Program	11
San Mateo County Stormwater Pollution Prevention Program	8.4
Vallejo Sanitation and Flood Control District	1.6
Fairfield-Suisun Urban Runoff Management Program	1.6
American Canyon	0.14
Sonoma County area	1.6
Napa County area	1.6
Marin County area	3.3
Solano County area	0.81
San Francisco County area	8.8
Total	82

[1] Listed in Table 4-w of Appendix A in the Mercury TMDL Staff Report (SFBRWQCB, 2006).

This document provides guidance on calculating the estimated baseline mercury and PCBs loadings from the watershed, which are used to estimate the load reductions needed via control measures (see Section 4.1). This guidance, however, does not recommend the recalculation of the urban stormwater WLAs or reallocation of the WLAs amongst the counties at this time.

Mercury TMDL compliance can be demonstrated through three different approaches[4]:

1. Show mercury concentrations are below 0.2 milligrams per kilogram (mg/kg) on a countywide level (i.e., monitoring-based compliance demonstration);
2. Meet the WLA (i.e., monitoring and/or modeling-based compliance demonstration);[5] and
3. Demonstrate the required load reductions can be achieved (i.e., modeling-based compliance demonstration).

This document describes how to demonstrate required load reductions through modeling; however, the focus of this document is demonstration of reasonable assurance to meet TMDL-related requirements.

2.1.2 PCBs TMDL

The PCBs TMDL was developed based on a fish tissue target of 10 nanograms (ng) of PCBs per gram (g) of fish tissue. This target is based on a cancer risk of one case per an exposed population of 100,000 for the 95th percentile San Francisco Bay Area sport and subsistence fisher consumer

[4] Detailed documentation requirements for demonstration of these approaches are summarized in the TMDL Staff Report (SFBRWQCB, 2006).

[5] Modeling-based compliance demonstration will require monitoring-based empirical inputs to conduct the analyses.

(32 g fish per day) (SFBRWQCB, 2008). A food web model was developed by San Francisco Estuary Institute (SFEI) to identify the sediment target concentration that would yield the fish tissue target; this sediment target was found to be 1 microgram (µg) of PCBs per kg of sediment. This is equivalent to reducing the total mass of PCBs in the active layer of the San Francisco Bay to 160 kg. The San Francisco Estuary Institute (Davis, 2003; 2007a) developed a mass budget model that identified the total external load of PCBs to the Bay that would attain a long-term (i.e., equilibrated) PCBs mass in the bay of 160 kg within approximately 30 years. The mass budget model estimated that reduction of the external load to 10 kg of PCBs per year would achieve this goal, assuming a starting Bay-wide PCBs concentration in surface sediment of 4.65 micrograms per kilogram (µg/kg)[6] (SFEI, 2007a). Twenty percent of the estimated allowable external load was allocated to urban stormwater runoff.

The WLA for PCBs for urban stormwater is 2 kg/yr by 2030. This load allocation was developed based on applying the required sediment concentration (1 µg/kg) to the estimated annual sediment load discharged from local tributaries. The PCBs Staff Report estimated the annual sediment load originating from stormwater to be 2,000,000 metric tons (i.e., 2,000,000,000 kg/yr) based on a range of then available estimates and differing methods (SFBRWQCB, 2008). This WLA was distributed among the county programs on a population basis (based on population in the year 2000). A summary of the allocations for each county is provided in Table 2-2.

Table 2-2: PCBs Allocations by County

County	Population (year 2000)	Wasteload Allocations (kg/yr)
Alameda	1,440,000	0.5
Contra Costa	790,000	0.3
Marin	240,000	0.1
Napa	120,000	0.05
San Francisco	630,000	0.2
San Mateo	600,000	0.2
Santa Clara	1,600,000	0.5
Solano	290,000	0.1
Sonoma	110,000	0.05
Total		2

The PCBs Staff Report estimates a total stormwater load of 20 kg/yr based on studies conducted by SFEI (SFEI, 2006; 2007b). SFEI calculated this baseline load (2006, 2007b) using three different methods to scale monitoring data (grab sample concentration data from Water Year (WY) 2005[7]; United States Geologic Survey [USGS] continuous discharge and suspended sediment data) from Coyote Creek and the Guadalupe River by area and land use. Subtracting the WLA for urban

[6] Bay-wide PCBs concentration in surface sediment estimated based on Regional Monitoring Program 2004 – 2006 data (SFEI, 2007a).

[7] Although the PCBs TMDL Staff Report states that PCBs loads estimates for the Guadalupe River were based on data collected between 2003 and 2005; SFEI, 2006 indicates that the baseline load estimate of 20 kg/yr was based on an extrapolation of monitoring data collected in WY 2005.

stormwater from this estimate resulted in a required load reduction of 18 kg/yr (i.e., a 90% reduction) by 2030. Note that the MRP area[8] portion of the 2 kg/yr allocation is 1.6 kg/yr[9].

This document provides guidance on estimating the baseline loading corresponding to the modeled watershed, which is used to estimate the load reduction of control measures (see Section 4.1), but does not recommend recalculation of the urban stormwater WLAs or reallocation of the WLAs amongst the counties.

PCBs TMDL compliance can be demonstrated through two different approaches:

1. Meet the WLA (i.e., monitoring and/or modeling-based compliance demonstration); and
2. Demonstrate the required load reductions can be achieved (i.e., modeling-based compliance demonstration).

This document describes how to demonstrate required load reductions through modeling; however, the focus of this document is demonstration of reasonable assurance to meet TMDL-related requirements.

2.1.3 MRP Requirements

2.1.3.1 PCBs and Mercury Load Reduction Requirements

The MRP includes provisions to reduce loads of mercury and PCBs consistent with the TMDL implementation timeframe (Provisions C.11 and C.12, respectively) through implementation of green infrastructure projects (C.3.j, C.11.c/C.12.c) and source controls (C.11.d/C.12.d). These provisions are described below. A summary of the load reduction requirements contained in the MRP is included in Tables 2-3 through 2-5 below.

The MRP requirements for load reductions of mercury through green infrastructure by 2020 are provided in Table 2-3 below.

[8] Marin, Napa, San Francisco, and Sonoma are not within the MRP boundary.
[9] The load allocation for the permittees is included in provision C.12 of the MRP.

Table 2-3: MRP Required Mercury Load Reductions through Green Infrastructure

County Permittees	Mercury Load Reduction (kg/yr) by June 30, 2020, through Green Infrastructure
Alameda Permittees	0.015
Contra Costa Permittees	0.009
San Mateo Permittees	0.006
Santa Clara Permittees	0.016
Solano Permittees: Suisun City, Vallejo, Fairfield	0.002
Totals	0.048

In addition, the total mercury load reduction through green infrastructure and source control implementation is required to be sufficient to attain the mercury TMDL WLA (i.e., 82 kg/yr) by 2028.

The MRP includes required PCBs load reductions through implementation of source measures and green infrastructure projects that are consistent with the required PCBs TMDL implementation. The total load reductions required by 2018 and 2020 are provided in Table 2-4.

Table 2-4: MRP Required PCBs Load Reductions

County	PCBs load reduction (kg/yr) by June 30, 2018	PCBs Load Reduction (kg/yr) by June 30, 2020
Alameda Permittees	0.16	0.94
Contra Costa Permittees	0.09	0.56
San Mateo Permittees	0.06	0.37
Santa Clara Permittees	0.16	0.94
Solano Permittees: Suisun City, Vallejo, Fairfield	0.03	0.19
Totals	0.5	3

The load reduction required to be specifically achieved by green infrastructure per the MRP is included in Table 2-5.

Table 2-5: MRP Required PCBs Load Reductions through Green Infrastructure

County Permittees	PCBs Load Reduction (kg/yr) by June 30, 2020, through Green Infrastructure
Alameda Permittees	0.037
Contra Costa Permittees	0.023
San Mateo Permittees	0.015
Santa Clara Permittees	0.037
Solano Permittees: Suisun City, Vallejo, Fairfield	0.008
Totals	0.12

The MRP also requires an RAA to demonstrate that Permittees will achieve a mercury load reduction of 10 kg/yr and a PCBs load reduction of 3 kg/yr from implementation of green infrastructure projects by 2040, which equates to between 12% and 17% of the required pollutant load reduction, if the original TMDL baseline loading estimates are used.

The Permittees will calculate load reductions achieved before and during the current MRP term (2016 – 2020) using an Interim Accounting Methodology specified by the Regional Water Board in the MRP Fact Sheet. The Interim Accounting Methodology is the basis for much of the RAA accounting methodology described in this Guidance Document; the RAA allows for some additional methods to be used to calculate load reductions and allows for recalculation of baseline loads. The Interim Accounting Methodology is described in Section 2.1.4 and was approved by the Water Board Executive Officer on May 2, 2017.

2.1.3.2 Green Infrastructure Planning and Implementation

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 an RAA for inclusion in the 2020 Annual Report that predicts the mercury and PCBs load reductions that will be achieved by 2040 through implementation of the Permittees' Green Infrastructure Plans.

The RAA of the Green Infrastructure Plans 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 the green infrastructure strategies that are planned.
2. Estimate the amount and characteristics of land area that will be treated by green infrastructure by 2020, 2030, and 2040, and the sizing of that green infrastructure[10].
3. Estimate the amount of mercury and PCBs load reductions that will result from green infrastructure implementation by 2020, 2030, and 2040 for the selected "average" year.
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.

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[10] Green infrastructure sizing should be assumed to achieve 80 percent or more runoff capture per MRP Provision C.3.d, unless space constraints are known and a retrofit project must be undersized for implementation.

2.1.3.3 PCBs/Mercury Control Measure Implementation Plan

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 an 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 RAA, 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 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.

2.1.4 Interim Accounting Methodology

The Interim Accounting Methodology for TMDL Loads Reduced (BASMAA, 2017) establishes the methodology used to quantify mercury and PCBs loads reduced through implementation of source control and treatment control measures during the current MRP permit term (2016 – 2020).

The Interim Accounting System is based on relative mercury and PCBs yields from different land use categories. This methodology was outlined in the 2014 Integrated Monitoring Reports (IMRs) (Alameda Countywide Clean Water Program [ACCWP], 2014; Contra Costa Clean Water Program [CCCWP], 2014; Santa Clara Valley Urban Runoff Pollution Prevention Program [SCVURPPP], 2014; San Mateo Countywide Water Pollution Prevention Program [SMCWPPP], 2014) and is described in the MRP Fact Sheet. The method involves awarding Permittees load-reduction credits for implementation of PCBs and mercury load reduction programs and actions.

Under the Interim Accounting Methodology, most load-reduction credit for implementing controls is independent of the controls' location within the watershed, hydrology, or transport mechanism. For example, "Source Properties" are sites where PCBs were used, released, and/or disposed of and/or where sediment concentrations are significantly elevated above urban background levels. Methods are specified for calculating credits for the referral and cleanup of these sites, based on site characteristics.

Similarly, credits are given for adopting a program to implement controls on building demolition for certain types of buildings, for locating and cleaning up spills or potential spills, or locating and removing polluted sediments in storm drains, regardless of the location in the watershed where these activities take place.

Credits for green infrastructure, however, are based on land-use based yields. 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 (on average) differ in their degree of contamination resulting from differing intensities of historic or ongoing use of pollutants. The land use categories used to develop land use-based yields were identified from studies conducted to identify potential PCBs and mercury sources and source areas.

Several preliminary geographic information system (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.

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 2-6 below (cited in MRP, Attachment A: Fact Sheet). 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 2-7 presents average concentrations of PCBs and mercury in sediment collected within the street right-of-way, storm drain conveyance system, and private properties from 1999 through 2015 by BASMAA member agencies. Average concentrations are summarized by the predominant land use within the vicinity of where the sediment was collected. The datasets include a total of 1,204 PCB samples and 952 mercury samples.

Table 2-6: 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

Table 2-7. 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)

The Interim Accounting Methodology will be replaced by the RAAs for load reduction accounting in subsequent permit terms.

The estimation approach that forms the basis of the Interim Accounting Methodology will be incorporated into the RAAs with some updates. For further discussion, see Section 4.2.

2.2 Coordination of Planning Processes

As described in Section 2.1, the Permittees are in the process of developing Green Infrastructure Plans and PCBs/Mercury Control Measure Plans. Additionally, some of the countywide programs will be developing Stormwater Resource Plans (SWRPs) that will identify multiple benefit projects (e.g., water supply, water quality, flood control, community, and environmental benefits) that will be eligible for funding under the Water Quality, Supply, and Infrastructure Improvement Act (Proposition 1). Part of the SWRP process includes quantification of project stormwater capture volumes, as well as the pollutant load reductions achieved by water quality projects. The Permittees may also conduct other related watershed planning processes.

The RAA will be used to estimate the load reductions achieved by the projects that are identified in the Green Infrastructure, SWRP, PCBs/Mercury Control Measure Plans, and other watershed plans along with changes in land use over time. Revised land use and other GIS data layers, hydrologic modeling results, and monitoring data that are generated as part of these planning process will also be used to develop RAA models and/or for model calibration.

Additionally, the RAA process will inform these stormwater and watershed planning processes. The RAA will serve to calculate potential load reductions achieved by proposed projects, thereby providing a basis for adjustments to the plans to meet permit and TMDL requirements.

3. CONDUCTING REASONABLE ASSURANCE ANALYSES

3.1 RAA Development Process

The MRP requires an RAA process to be conducted to demonstrate load reductions for mercury and PCBs for both: (1) green infrastructure requirements (2020/2030/2040); and (2) attainment of the respective wasteload allocations by 2028 (for mercury) and 2030 (for PCBs) (see Section 2.1.3).

In addition to the LARWQCB RAA Guidelines, cited in the MRP, Attachment A, the USEPA Guide (USEPA, 2017) provides guidance on how the RAA process should be conducted; these steps can be followed to meet the RAA requirements included in the MRP. A flow chart from the Guidance Document is included as Figure 3-1. As shown in the flow chart and described in Section 2.2, the RAA process is interactive with other watershed planning efforts. Inputs to the RAA process are derived from PCBs/mercury control measure planning, green infrastructure planning, SWRP planning, and other applicable stormwater management planning efforts. The RAA output in turn allows for planning outcomes to be revised or demonstrate plans meet the TMDL and permit requirements.

Each of these steps are described in the following sections. Before conducting step 1 (identifying the area for analysis), the methodology for conducting the RAA should be selected. An overview of the RAA technical approach and considerations for selection of the methodology are provided in Section 3.2. The subsequent sections describe steps 1 through 5 as presented in the flow chart (Figure 3-1).

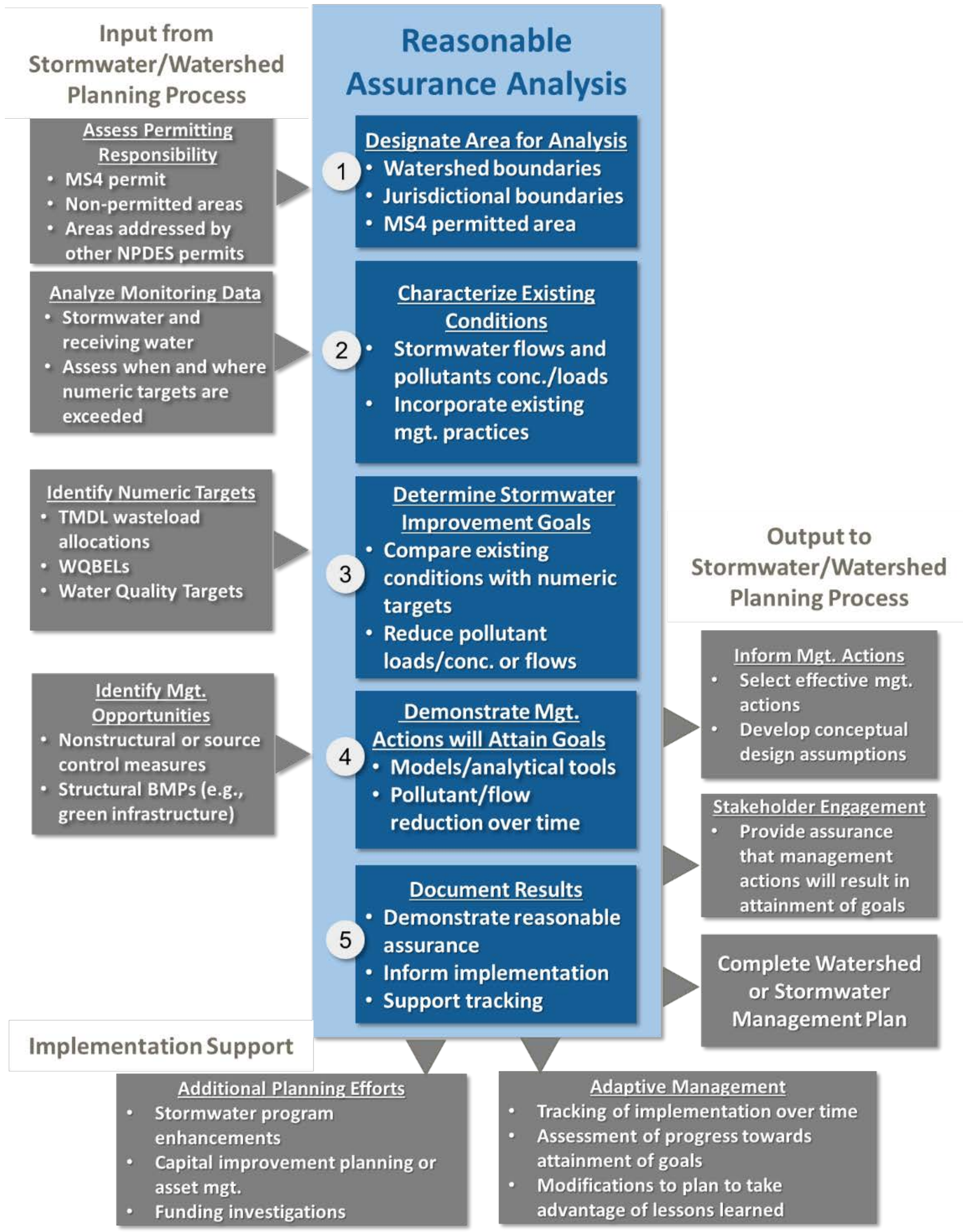

Figure 3-1: RAA Process Flow Chart (from USEPA, 2017)

3.2 RAA Method Overview and Approach Selection

The RAA methodology will be used to calculate baseline loading and load reduction requirements and to reasonably demonstrate load reductions achieved through implementation of current, planned, and future green infrastructure and source control measures. The area of analysis will be dependent upon the boundary of the Permittee areas covered under the MRP and decisions regarding to what extent and how land areas outside of the Permittees jurisdiction (e.g., non-urban land uses and non-traditional Phase II MS4s) are handled (see further Section 3.3). An overview of RAA computational and estimation methods and considerations is provided below.

The RAA will incorporate both estimation methods and computational methods. Estimation methods will be used to calculate load reductions achieved by source controls, and computational methods (or simplified methods based on factors established by computational methods) will be used to calculate load reductions achieved by green infrastructure.

The total load reduction—and the uncertainty associated with the total load reduction—will be the result of summing the two separate components, which will have been calculated by two different methods (estimation and computation).

3.2.1 Estimation Methods

Load reductions attributable to source controls will be calculated using a refinement of the estimation methods in the Interim Accounting Methodology. The assumed yields in the Interim Accounting Methodology (see Table 2-6) will be updated using the Regional Watershed Spreadsheet Model (RWSM) (Wu et al., 2017), which should be released to the public in 2017, along with the most recent monitoring data and land use layers. The RWSM may also be used to develop computational model inputs (e.g., land use-based stormwater event mean concentrations [EMCs] for PCBs and mercury). The refined estimation methodology to be used for the RAA will be submitted to the Regional Water Board Executive Officer for approval.

The RWSM is a regional project which has been ongoing since 2010. The RWSM was developed to serve as a GIS-based loading model that could be used to estimate pollutant loads to the San Francisco Bay. Though called a "spreadsheet" model, the model is primarily a GIS-based model with code-based calibration and other components. The RWSM has been calibrated for hydrology and PCBs and mercury loads using local monitoring data, and can be used to develop regional land use-based PCBs and mercury yields and annualized EMCs.[11] The RWSM is anticipated to be released in mid-2017 for use by countywide stormwater programs and/or Permittees (collectively or individually) to develop yields and EMCs for specific land use categories and watersheds, using high-quality pollutant loading or concentration data for calibration purposes.

3.2.2 Computational Methods

Computational methods[12] or tools created using computational methods should be used to calculate the load reductions associated with land use changes and green infrastructure projects. These methods may also be used to recalculate the baseline loading. Currently, these methods are not able to rigorously incorporate the effects of source controls, thus a refined version of the

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[11] The "EMC" outputs from the RWSM are not calculated directly from empirical data; instead, they represent regionally-calibrated annualized land-use specific concentrations disaggregated from annual loads calculated from flow and concentration monitoring data collected in the watersheds in the identified region.

[12] For the purposes of this Guidance Document, computational methods are methods based on dynamic modeling.

Interim Accounting Method, which is considered an "estimation method," should be used to calculate load reductions attributable to source controls. The types of computational methods that may be used by Bay Area Permittees are described in further detail in Section 4.

Selecting a computational RAA approach is dependent on multiple considerations. When selecting an RAA modeling approach, the primary consideration is balancing the cost of developing the model for the RAA application with the long-term use and benefits of the model. The approach can be developed to be relatively simple or more complex, depending on the model scale, the quality of inputs, the functionality needs, and the level of model verification and calibration required or desired. The data requirements for each approach vary greatly.

A cost benefit analysis should be conducted by entities when selecting a model. The costs of detailed data gathering alone can cause model costs to increase dramatically.[13] In addition to considering the cost of data gathering, entities should carefully evaluate whether data could be obtained within the relevant timeframe to support model development. Implementing a model when data are insufficient to support a defensible parameterization can lead to misplaced confidence and poorly informed decision-making. If sufficient data are available, however, and the model could be used to meet multiple stormwater management and infrastructure planning goals, the higher initial cost of developing a more complex model could be distributed over multiple objectives and many years. In all cases, the relative accuracy of the model is dependent on the availability of data and the rigor of model calibration and validation.

The USEPA Guide (USEPA, 2017) identifies three factors which should be considered when selecting an RAA modeling approach: (1) regulatory and planning needs; (2) analytical capabilities; and (3) practical considerations.

3.3 Identifying the Area for Analysis (Step 1)

The area of analysis should be consistent with the regulatory area covered by the TMDL and the MRP. The PCBs TMDL staff report (SFBRWQCB, 2008) states:

> "Wasteload allocations for urban stormwater runoff apply to all National Pollutant Discharge Elimination System (NPDES) permitted municipal stormwater discharges. These allocations apply to unincorporated areas and all municipalities in the county that drain to the Bay and are part of the San Francisco Bay Region. They implicitly include all current and future permitted discharges within the geographic boundaries of municipalities and unincorporated areas within each county."

The MRP defines areas contributing permitted discharges as Permittee areas (i.e., within the boundaries of the Permittee's jurisdiction) that discharge stormwater runoff from storm drains and watercourses within their jurisdictions into Central, Lower, and South San Francisco Bay, and

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[13] Suggested data used for the RAA model are listed in section 4.4.

Suisun and San Pablo Bays. Federal, State, and regional entities within Permittees' boundaries that are not subject to the MRP are not the responsibility of the Permittees (paraphrased from SFBRWQCB, 2015). Eastern Contra Costa County, currently regulated in the future under a separate Central Valley Regional Water Board MS4 permit, will be regulated under the MRP (SFBRWQCB, 2017) so should also be included in the area of analysis for the Contra Costa County RAA.

Consistent with the TMDL accounting, areas within the boundaries of the Permittee's jurisdiction that do not need to be incorporated into the area of analysis include non-urban land areas, including non-urban areas upstream from dams, which are not needed for calibration or validation of the RAA model.

Areas that are hydrologically connected to regulated areas that may not be subject to the TMDL and/or the MRP should be included in the area of analysis to adequately calibrate the model. Areas that are not subject to the TMDL and/or the MRP should be accounted for in RAA models, but do not require control measure assumptions or load reduction calculations (see Section 5).

In addition, the following factors (from USEPA, 2017) should be considered when defining the area for analysis:

- If multiple municipal jurisdictions are addressed by the RAA, the analysis should be capable of distinguishing among jurisdictions in terms of relative contributions of wet weather flow and pollutant loads.
- If areas not subject to municipal jurisdiction are included, their flows and loads should be distinguishable.
- The area of analysis should make sense in terms of hydrologic function and connectivity, and for some approaches flows and loads may require routing through the modeled area of analysis.

3.4 Selecting or Calculating the Baseline Pollutant Loading (Step 2)

All PCBs and mercury load reductions are calculated based on the difference in current or predicted future loading compared to the baseline condition. The baseline urban stormwater loading for mercury is the estimated average annual loading associated with the year 2003 per the Mercury TMDL (SFBRWQCB, 2006). As described in the PCBs TMDL, the baseline urban stormwater loading for PCBs is associated with the year data were collected, water year 2005 (SFBRWQCB, 2008; SFEI, 2006).

The baseline pollutant loading for use in the RAA can be selected or calculated using one of the following three methods:

1. Utilize the baseline loading presented in the TMDL Staff Reports (SFBRWQCB, 2006; SFBRWQCB, 2008).

2. Utilize the baseline loading produced by the RWSM output for the San Francisco Bay Area MRP region.

3. Recalculate the baseline loading using a calibrated model of the baseline period for the area of analysis.[14]

For the purposes of RAA analyses, the baseline period for both PCBs and mercury analyses is recommended to be water years 2000 – 2009 (for long-term continuous simulation), or water year 2002 (for representative year simulation). These baseline period options are generally representative of the period during which much of the data were collected for mercury and PCBs. A review of the rainfall records at the San Francisco Airport rainfall gage[15] shows that these years are also representative of the long-term rainfall record (water years 1949 – 2013) for both annual rainfall and distribution of storm depths. A summary of the rainfall for these selected baseline period options as measured at the San Francisco Airport gauge is provided in Table 3-1.

Table 3-1: Summary of Rainfall Statistics for Selected Baseline Period for Mercury and PCBs

Period	Average Annual/ Annual Rainfall (inches)	Median Storm (inches)	85th Percentile Storm (inches)	95th Percentile Storm (inches)	Maximum Storm (inches)	Average Event Duration (hours)	Average/ Total Number of Events
All Storms							
Full Record (WY 1949 – 2013)	19.8	0.1	0.7	1.4	6.9	9	56
WY 2000 – 2009	19.2	0.1	0.7	1.3	3.5	9	56
WY 2002	19.2	0.2	0.8	1.3	3.3	10	46
Storms ≥ 0.1 inch[1]							
Full Record (WY 1949 – 2013)	18.7	0.4	1.1	1.8	6.9	14	32
WY 2000 – 2009	18.3	0.4	1.0	1.8	3.5	14	32
WY 2002	18.6	0.4	0.9	1.6	3.3	15	29

[1] Assumes a 6-hour inter-event time.

An analysis of annual data for ten additional Western Regional Climate Center (WRCC) National Oceanic and Atmospheric Administration (NOAA) COOP gages[16] within the MRP region

[14] This could be conducted using the RWSM or another model, provided that there is sufficient data to conduct calibration (see Section 4).

[15] NOAA COOP identification number 047769, period of record WY 1949 – 2013. The San Francisco airport gage is located on the San Francisco Bay margin in the city of Millbrae. The long-term average annual rainfall is approximately 19.8 inches per year. This gage is considered to be representative of the average San Francisco Bay margin rainfall.

[16] Monthly values reported on the WRCC were converted to WY and incorporated into these calculations unless they were significantly, anomalously low (i.e., 1.0 inches per year or lower). Months and years with days of missing data were incorporated into WY totals used to calculate average annual rainfall and WY 2000 – WY 2009 rainfall.

demonstrated that annual rainfall depths associated with water year 2002 were greater than or within 5% of the average annual total for the period of WY 2000 – 2009 for 6 of 10 gauges, and 10% for 7 of 10 gauges. It does appear that this year could have been slightly drier than the WY 2000 – 2009 average for portions of the south bay and far east bay (Newark, Livermore, and San Jose), though for the case of the San Jose gauge (COOP 47821), this could partially be explained by missing gauge data. In all cases, other gauges within the respective county appear to have annual rainfall depths in 2002 which are representative of the period of WY 2000 – 2009, so it is anticipated that WY 2002 would still be representative of this period at a countywide scale.

Table 3-2: Summary of Annual Data for Ten WRCC NOAA COOP Gages

Gauge Name	COOP ID	County	Period of Record (WY)	Average Annual or Annual Rainfall (inches)			% Difference from WY 2002	
				Total Record	WY 2000 - 2009	WY 2002	Total Record	WY 2000 – 2009
Pacifica 4 SSE, CA[1]	46599	San Mateo County	1984-2011	30.1	30.8	27.9	-7%	-9%
San Jose, CA[1]	47821	Santa Clara	1894-2016	14.1	14.6	11.1	-21%	-24%
Palo Alto, CA[1]	46646		1954-2016	14.7	13.7	13.4	-8%	-2%
Newark, CA	46144	Alameda County	1943-2016	14.0	12.7	11.3	-19%	-12%
Livermore, CA	44997		1904-2016	14.0	13.3	11.2	-20%	-16%
Oakland Museum, CA[1]	46336		1971-2016	21.9	21.9	21.5	-2%	-2%
Richmond, CA[1]	47414	Contra Costa County	1951-2016	23.0	24.0	25.5	+11%	+7%
Mt Diablo Junction, CA	45915		1953-2016	23.8	22.8	22.5	-5%	-1%
Concord WWTP, CA	41967		1992-2016	17.7	16.6	16.3	-8%	-2%
Napa State Hospital, CA	46074	Fairfield/ Suisun	1894-2016	24.3	25.6	25.7	+6%	+1%

[1] Gauge summary indicated there was missing data in WY 2002.

All load reductions attributed to control measures are calculated as the difference in loading for the selected baseline period. The baseline is calculated incorporating the land use and control measures present in the area for analysis in this period. The critical condition, or temporal scale for which the pollutant load reduction is calculated, is considered to be annual, which is consistent with the temporal scale used to develop the TMDLs and the WLAs. The critical condition of the RAA model is predicated by the selected baseline period.

Additional details regarding the RAA modeling are provided in Section 4.1.

3.5 Identifying the Stormwater Improvement Goals (Step 3)

The pollutant load reduction goals are the loads that must be reduced to achieve the MRP load reduction requirements (see Table 2-3, 2-4, and 2-5, from provisions C.11.c/C.12.c of the MRP), and demonstrate quantitatively that planned control measures will result in load reductions sufficient to attain the TMDL WLAs (i.e., provisions C.11.d/C.12.d of the MRP). The load reduction masses included in the TMDLs (see Table 2-1 and Table 2-2) were based on the estimated baseline pollutant loading conducted during the development of the TMDLs. Since that time, available data and computational methods have expanded and improved. As such, the RAA computations could entail a recalculation of the load reduction goals based on the baseline loading computed using the RAA method in Step 2 and the WLAs stated in the TMDLs (see Table 2-1 and Table 2-2), as applicable. The stormwater improvement goal associated with the pollutant load reduction to meet the TMDL allocations for each pollutant of concern is calculated as:

$$LR_{goal} = \text{Baseline} - \text{WLA (kg/yr)}$$

Where:

LR_{goal} = The load reduction goal (kg/yr)

Baseline = The baseline pollutant loading as calculated through the RAA method (see Section 3.4) (kg/yr)

WLA = The WLA, summarized in Table 2-1 and Table 2-2

This load reduction goal is equivalent to the load reduction requirements stated in the TMDLs. The load reduction goal is also equivalent to the stormwater improvement goal associated with attainment of the TMDL WLAs (i.e., provisions C.11.d/C.12.d of the MRP).

The MRP load reduction required to be achieved through GI (i.e., C.11.c/C.12.c) is interpreted as a total mass required to be reduced as a proportion of the required load reduction. The required total load reduction for MRP permittees for mercury is 62 kg/yr[17] and for PCBs is 14.4 kg/yr (as stated in the introduction under provision C.12 of the MRP). In the case that a new baseline load has been computed using a calibrated model and a new load reduction goal has been calculated, the percent of the permittee load reduction can be used as the stormwater improvement goal for guiding planning and implementation of GI measures. Refer to Table 3-3 and Table 3-4 for the percent of the permittee load reduction associated with the MRP GI requirements.

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[17] Calculated as the sum of the Load Reduction (kg/yr) included in Table 4-w of the Mercury TMDL Staff Report (SFBRWQCB, 2006) for The Santa Clara Valley Urban Runoff Pollution Prevention Program, the Alameda Countywide Clean Water Program, the Contra Costa Clean Water Program, the San Mateo County Stormwater Pollution Prevention Program, the Vallejo Sanitation and Flood Control District, and the Fairfield-Suisun Urban Runoff Management Program.

Table 3-3: MRP Required Mercury Load Reductions Achieved through GI

MRP Requirement	Total Load Reduction Required (kg/yr)	Percent of Permittee Load Reduction (%)[1]
Quantitative Demonstration of Mercury Load Reduction by 2040, through Green Infrastructure (stipulated by MRP Provision C.11.c)	10.0 (through quantitative demonstration)	16.1%

[1] Based on a total load reduction of 62 kg/yr for MRP permittees (see footnote 14). McKee et al. (2015) recalculated the Bay Area wide baseline load and estimated this value to be 116 kg/yr, which would reduce the load reduction.

Table 3-4: MRP Required PCBs Load Reductions Achieved through GI

County Permittees	Total Load Reduction Required (kg/yr)	Percent of Permittee Load Reduction (%)[1]
Quantitative Demonstration of PCBs Load Reduction by 2040, through Green Infrastructure (stipulated by MRP Provision C.12.c)	3.0 (through quantitative demonstration)	20.8%

[1] Based on a total load reduction of 14.4 kg/yr for MRP permittees.

An example application of these percent of permittee load reduction values is provided:

> Program X has a population-based PCBs WLA of 0.4 kg/yr, and a population-based baseline load of 4 kg/yr. The program recalculates their baseline load as 3 kg/yr using their RAA methodology. Their new TMDL attainment load reduction goal is 2.6 kg/yr. Their new MRP required PCBs load reduction through GI by 2040 is 2.6 kg/yr * 20.8% = 0.54 kg/yr.

3.6 Estimating Load Reduction Achieved by Controls (Step 4)

The load reduction estimated through the RAA process accounts for numerous potential sources of load reduction, including redevelopment, green infrastructure and treatment control retrofit projects, and source controls. Combining these components, pollutant load reduction is calculated as:

$$LR_{Total} = LR_{SC} + LR_{GI/TM}$$

Where:

LR_{Total} = The total load reduction achieved

LR_{SC} = The total load reduction achieved from source controls, calculated using the approved estimation method

$LR_{GI/TM}$ = The total load reduction achieved from implementation of the requirements of C.3 provisions, green infrastructure, and treatment control retrofit projects, accounting for land use changes as a result of redevelopment

The total load reduction can be expressed in terms of mass reduced per year, or can be converted to a percent of required load reduction for comparison against the stormwater improvement goals, particularly when the model used to compute baseline results in a baseline load that differs from the baseline loads assumed for the TMDLs.

As RAAs must be conducted to provide reasonable assurance for different timeframes (i.e., 2020, 2028/2030, and 2040), the load reductions should be calculated for these timeframes based on the year when controls are implemented.

3.6.1.1 Load Reduction from Source Controls

Load reductions from source controls should be calculated using the approved estimation methods considering the year when controls are implemented (see Section 4.2).

3.6.1.2 Load Reductions from the Implementation of Green Infrastructure

Load reductions from Green Infrastructure include:

- Load reductions due to land use changes associated with redevelopment (for example, the conversion of old industrial lands to new residential, recreational (baseball and soccer fields are not uncommon) or commercial areas).
- Load reductions attributable to the implementation of Low Impact Development (LID) features and LID treatment controls, and non-LID treatment controls, on land development projects as required by Provision C.3 in the MRP and its predecessor permits.
- Load reductions attributable to the retrofit of existing streets and developed sites with LID features and treatment controls, and non-LID treatment controls.

Retrofit projects that are built within the public right-or-way (i.e., green street projects) consider the load reduction associated with the treatment control measure only, after any C.3 project load reduction benefits are applied within the project's drainage management area (DMA). The RAA must estimate these effects for each timeframe in the projection. Scenarios for specific areas that will be treated with C.3, green infrastructure, and treatment control retrofit (including full trash capture devices) in the applicable timeframe (i.e. 2020, 2028/2030, and 2040) should be developed prior to modeling each future condition.

3.6.1.3 Combining all Load Reduction Estimates

The load reduction estimates calculated using the various methods described above should be combined as part of RAA methods to estimate the total load reduction. Estimation methods are conducted using annualized units while computational methods used to calculate load reductions associated with implementation of green infrastructure and treatment control use a long-term, continuous simulation on a smaller time scale. To combine these two load reduction calculations, the results of the computational methods are summarized as the annual load reduction achieved. Because the TMDL WLAs and MRP-required load reductions are all described in units of kg/yr (or g/yr), this is an acceptable unit for combining load reductions from source controls and green infrastructure. As described, these should be converted to percent reduction of baseline load prior to combining if comparing against a baseline load calculated using a calibrated model.

In addition to the temporal differences that should be addressed to combine these calculations, the potential differences resulting from input data for these two methods should also be considered. To manage these differences, pollutant loading inputs to estimation methods and computational methods should be derived using similar data sources and approaches. One example of corresponding pollutant loading inputs that may be used for both computational methods and estimation methods are the pollutant event mean concentrations (EMCs, in mg/L) and land use-based yields (in mg/ac/yr) which will both be derived from the RWSM (Wu et al., 2017) or locally-based monitoring/modeling. Though the units are different, both inputs will be derived using the same base data and methodology, and thus will result in outputs from both estimation and computational methods that can reasonably be combined to calculate overall pollutant load reductions from municipal stormwater. It will also be important to use consistent EMCs and yields between the planning phase (RAA development) and the accounting phase to ensure compliance compatibility. Variability and uncertainty resulting from each component (estimation and computation) should be considered and the resulting uncertainty and variability in the combined result should be assessed. Standard accepted methods for computing potential error should be utilized to quantify error associated with uncertainty.

3.7 Documentation (Step 5)

The MRP requires that both the green infrastructure RAA (C.11.c/C.12.c) and the WLA attainment RAA (C.11.d/C.12.d) be documented in the 2020 Annual Report. The requirements for documentation of the green infrastructure RAA for mercury include:

1. The Permittees shall submit in their 2020 Annual Report a reasonable assurance analysis to demonstrate quantitatively that mercury reductions of at least 10 kg/yr[18] will be realized by 2040 through implementation of green infrastructure projects. This submittal shall include all data used and a full description of models and model inputs relied on to make the demonstration and documentation of peer review of the reasonable assurance analysis.
2. The Permittees shall submit as part of reporting for C.11.b.iii(2), beginning with their 2019 Annual Report, an estimate of the amount of mercury load reductions resulting from green infrastructure implementation during the term of the Permit. This submittal shall include all data used and a full description of models and model inputs relied on to generate this estimate.

The requirements for documentation of the green infrastructure RAA for PCBs include:

[18] Stipulated by MRP Provision C.11.c.

1. The Permittees shall submit in their 2020 Annual Report a reasonable assurance analysis to demonstrate quantitatively that PCBs reductions of at least 3 kg/yr[19] will be realized by 2040 through implementation of green infrastructure projects. This submittal shall include all data used and a full description of models and model inputs relied on to make the demonstration and documentation of peer review of the reasonable assurance analysis.
2. The Permittees shall submit as part of reporting for C.12.b.iii, beginning with their 2019 Annual Report, an estimate of the amount of PCBs load reductions resulting from green infrastructure implementation during the term of the Permit. This submittal shall include all data used and a full description of models and model inputs relied on to generate this estimate.

RAA model inputs, outputs, and iterative control measure planning process with Green Infrastructure Plans may also be documented within the permittee Green Infrastructure Plans.

The documentation requirements for the mercury WLA attainment RAA include:

Permittees shall prepare a mercury control measure implementation plan and corresponding reasonable assurance analysis that demonstrates quantitatively that the plan will result in mercury load reductions sufficient to attain the mercury TMDL wasteload allocations by 2028. The plan must:

- Identify all technically and economically feasible mercury control measures (including green infrastructure projects) to be implemented;
- Include a schedule according to which these technically and economically feasible control measures will be fully implemented; and
- Provide an evaluation and quantification of the mercury load reduction of such measures as well as an evaluation of costs, control measure efficiency and significant environmental impacts resulting from their implementation.

The documentation requirements for the PCBs WLA attainment RAA include:

1. Permittees shall prepare a PCBs control measures implementation plan and corresponding reasonable assurance analysis that demonstrates quantitatively that the plan will result in PCBs load reductions sufficient to attain the PCBs TMDL wasteload allocations by 2030. The plan must:
    a. Identify all technically and economically feasible PCBs control measures to be implemented (including green infrastructure projects);
    b. Include a schedule according to which these technically and economically feasible control measures will be fully implemented; and

[19] Stipulated by MRP Provision C.12.c.

c. Provide an evaluation and quantification of the PCBs load reduction of such measures as well as an evaluation of costs, control measure efficiency, and significant environmental impacts resulting from their implementation.

At a minimum, it is recommended that model input and method description documentation should include summaries of:

1. Input parameter values and their data sources or other assumptions (see Tables 4.2 and 4.3 for a list of inputs),
2. Calibration results (see Table 4-1 calibration targets),
3. Model assumptions, processes represented, and calculation procedures, or cite an available user's manual or guidance document,
4. Key outputs, including baseline loads, interim and final load reduction goals, and interim and final load reductions, as both countywide totals and by jurisdiction, and
5. Green infrastructure and source control measures modeled (e.g., type, location, sizing, basic conceptual design details, and drainage area information) and modeled load reduction breakdowns by control measure category, as well as other benefits, where quantified.

As part of the documentation of the model results, Permittees are encouraged to account for PCB and mercury loads from areas that are hydrologically embedded within the area of analysis, but will likely be addressed through regulatory mechanisms outside of the MRP.

4. MODELING REQUIREMENTS

This section identifies RAA technical approach options capable of: (1) demonstrating compliance with the future (post-MRP 2.0) load reductions for green infrastructure that are outlined in the MRP 2.0, and (2) reliably quantifying the anticipated effectiveness of other types of control measures implemented by the Permittees. As described in Section 3.4 and 3.6, the RAA process is used to calculate loading and load reductions in the baseline and future conditions. Based on outputs from modeling for the baseline condition and future source controls and green infrastructure controls, the reduction in loading of PCBs and mercury, at the most downstream point of the watershed, can be calculated.

It is the intent of this Guidance Document that models developed by different programs and/or Permittees that follow the recommendations included herein would output results that might be deemed comparable enough with each other such that it might be possible to aggregate the results regionally. Because there are details that cannot be addressed as part of this Guidance Document, it is recommended that an RAA Work Group be convened to provide review of the models developed, work together to resolve technical and regulatory issues, and work to maintain consistency as models are developed. The RAA Work Group is further described in Section 6.

This section will address the "estimation methods" (e.g., Interim Accounting-type methods) as well as computational methods that can be used to calculate loading and load reductions.

4.1 Modeling the Baseline Condition

As described in Section 3, there are three methods for identifying the baseline condition: (1) utilizing the TMDL Staff Report baseline loading (SFBRWQCB, 2006; SFBRWQCB, 2008); (2) utilizing the RWSM loading; and (3) recalculating the baseline using a calibrated computational model.

If utilizing the RWSM loading method, the outputs from the regionally calibrated RWSM can be used directly, or the RWSM can be run for a select number of watersheds to produce loads that are more program or permittee-specific. The remainder of this section focuses on the third method.

A computational method can be used as part of the RAA process to estimate baseline loading of mercury and PCBs. If a computational method is used to reestablish the baseline, the model should be calibrated for hydrology and pollutants using local data, to the extent data is available, to ensure the model reliably captures the watershed characteristics and condition.

4.1.1 Model Objectives

The selected model for the baseline condition should provide a reasonably accurate estimate of the baseline pollutant loading of the area of analysis; to the extent data are available. Model output should include total watershed PCBs and mercury loads for the baseline period (described in Section 3.4). The modeling approach should use an estimated distribution of PCBs and mercury across the watershed to translate land use configuration into estimated loading from the landscape and account for the fate of the combined total load as it is transported through the MS4 to receiving waters. Should the countywide programs or Permittees choose to report load reductions at the countywide or regional scale, models developed by different programs and/or Permittees should output results that are comparable to allow consistency when combining results.

4.1.2 Accepted Models

To meet the model objectives identified in Section 4.1.1, baseline loading model capabilities (for re-estimation purposes) should include:

1. Dynamic continuous long-term simulation of flows and pollutant loads.
2. Representation of surface rainfall and runoff processes, and include baseflow contributions where significant.
3. Representation of the variability in pollutant loadings based on land use (PCBs/ mercury), at a minimum.
4. A process-based approach or empirically-based approach to account for green infrastructure measures (to allow for computation of loading with implementation of green infrastructure).
5. Decision support to evaluate green infrastructure performance and cost.

A summary of available models that can be used for the Bay Area RAAs, along with associated functionality, are provided in Table 4-1. Most of these are public domain water quality models that are included in the Los Angeles Regional RAA Guidance (LARWQCB, 2014). All have built-in green infrastructure modeling capability.

Table 4-1: Available Models Acceptable for Use for Bay Area RAAs

Model or Tool	*Model Type*			Notes	Input Complexity	Simulation Type(s)	Built-in GI
	Hydrologic Model	Hydrologic /Hydraulic Model	Water Quality Model				
USEPA SWMM		X	X	SWMM can be used on its own or in combination with separate pollutant loading models.	Medium/ High	Event or Continuous	Yes
HSPF/LSPC		X	X	Can be linked to BASINS and SUSTAIN.	High	Event or Continuous	Yes
SUSTAIN (with HSPF)	X		X	Used to develop, evaluate, and select optimal GI combinations at various watershed scales based on cost and effectiveness.	Medium	Event or Continuous	Yes
GreenPlan-IT (with SWMM[1])	X		X	Used to prioritize GI activities in a watershed to optimize water quality return on investment.	Medium	Event or Continuous	Yes
SBPAT (with SWMM)	X		X	Used to prioritize GI activities in a watershed to optimize water quality return on investment.	Medium	Continuous	Yes

Notes:
[1] Represents current configuration of model. It could be developed further to utilize other dynamic simulation models such as HSPF or HEC..
[2] Receiving water models, if used, should be used in conjunction with a loading or integrated model for tributaries that discharge directly to the Bay.
[3] For peer review purposes, proprietary models are not included on this table. There are a number of proprietary models that could be used for RAA analyses if appropriate peer review is available, including but not limited to proprietary versions of USEPA's Storm Water Management Model (SWMM) (i.e., PCSWMM and XPSWMM), Infoworks, and TELR (developed for the Central Coast).

The listed models can be developed to be relatively simple or more complex, depending on the quality of inputs and the level of model verification and calibration. Details regarding model inputs are provided in Section 4.4.

4.1.3 Baseline Model Calibration

Calibration of the baseline model is important if it is to be used to reestablish baseline loading. Calibration should be conducted to check that modeled hydrologic output data are in agreement with monitored flows (if a sediment model is used, modeled sediment loading should be in agreement with monitored sediment loads).

Suggested ranges for percent differences between annual model results and observed data for the Bay Area RAAs have been adopted from the Los Angeles RWQCB RAA Guidance Document (from HSPF experience by A.S. Donigian, Jr., prepared for USEPA [2000], as cited in LARWQCB, 2014). Calibration will be conducted for hydrology, and sediment, mercury, and PCB loading.

Table 4-2: Model Calibration Ranges

Model parameters	Average % difference between simulated annual results and observed data		
	Very Good	Good	Fair (lower bound, upper bound)
Hydrology/Flow[1]	<10	10-15	15-25
Sediment[1]	<20	20-30	30-45
PCBs/mercury[2]	<30	30-50	50-80

[1] From Donigan, 2000 as cited in LARWQCB, 2014.

[2] If RWSM output is used to represent pollutant concentrations or loads, this calibration is assumed to be conducted as part of the RWSM process. Range recommended per recommendation from Jing Wu (Wu, 2017).

If sufficient concentration and loading data are available, these data should be used as part of model validation (described in the following section). Additional details on model calibration and validation are provided in Section 4.4.

4.1.4 Baseline Model Output

The baseline model, once calibrated to hydrology and/or sediment, should produce an estimate of the PCBs and mercury loading which occurred during the baseline period. This loading should be verified (to the extent possible) using available monitoring results from the baseline period.

4.2 Source Control Modeling

Load reductions for source controls should be calculated based on the methods provided in the approved refinement of the Interim Accounting Methodology. These methods apply to the following controls:

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

It is anticipated that the estimated average PCBs and mercury yields which will be utilized for the Interim Accounting Methodology methods used for Source Control estimates for RAAs will include revised yields outputted from the RWSM, regardless of the approach used to estimate baseline loading.

4.2.1 Source Control Load Reduction Crediting Adjustments

If a Permittee or stormwater program recalculates the baseline loading from their area or analysis using the output from a calibrated model and the output differs significantly from the population-based proportion of the baseline load reported in the TMDL Staff Report (SFBRWQCB, 2008) for PCBs or the revised mercury baseline load reported by McKee et al. (2015), the source control load reduction credits must be adjusted to be consistent with the new baseline. This is because the inputs to the load reduction calculations included in the current Interim Accounting Methodology are based on the reported baseline loads in the TMDL Staff Report for PCBs and the revised baseline load for mercury. The adjustment allows for load reduction credits associated with source control measures to be added to load reductions computed using the green infrastructure modeling approach. It is recommended that this is conducted by calculating the percent difference between the new computed baseline loads and the reported baseline loads in the TMDL Staff Report for PCBs or the revised baseline load for mercury. This percent difference can be represented as a scaling factor that should be applied to the land use specific PCBs and mercury yields used as an input to calculate the load reductions for source controls included in the Interim Accounting Methodology. Interim Accounting Methods that do not use land use-based yields do not require adjustment.

4.2.2 Source Control Load Reduction Calculations

When conducting the estimation calculations for the source control measures, the same land use data should be used to calculate the baseline loading as is used in the computational method.

For each planned or future source control identified in the area for analysis for the 2028/2030 scenario, the load reduction is calculated. The total source control load reduction is then calculated as the sum of load reductions associated with all source controls implemented in the area of analysis. Using a spreadsheet accounting approach, this load reduction is calculated as:

$$LR_{SC} = LR_{SC,1} + LR_{SC,2} + LR_{SC,3} + \ldots + LR_{SC,n} = \sum_{i=1}^{n} LR_{SC,i}$$

Where:

LR_{SC} = The total load reduction achieved from source controls (average annual)

$LR_{SC,i}$ = The load reduction achieved from the implementation of a single source control (average annual)

4.2.3 Comparison to Required Load Reductions

If the source control load reduction credits have been adjusted to account for a new computed baseline, the total load reduction achieved by source controls should be converted to the percent reduction of baseline. This will allow for comparison to the percent reduction of baseline associated with MRP load reduction requirements.

4.3 Green Infrastructure Control Modeling

Future loading of PCBs and mercury with implementation of green infrastructure controls and related redevelopment-associated land use changes is modeled to estimate load reductions resulting from these changes. A summary of the objectives, criteria, input, and options for accepted green infrastructure modeling methods are provided in the following sections.

4.3.1 Model Objectives

The selected model for green infrastructure should provide a reasonably accurate estimate of the pollutant loading of the DMAs with implementation of green infrastructure controls, to the extent DMA data are available. Model output should include total watershed PCBs and mercury loads for selected temporal scales that can be analyzed to develop a robust estimate of the average annual loading. The modeling approach should be capable of using the estimated distribution of PCBs and mercury across the watershed to translate land use configuration into estimated loading from the landscape and account for the fate of the combined total load as it is transported through the MS4 to receiving waters. The model should also have the ability to incorporate the effect of implementation of green infrastructure goals on reductions of pollutant loading to the MS4.

4.3.2 Accepted Models

Green infrastructure controls can be modeled using one of the accepted computational models described in Section 4.1.2, or using a spreadsheet or other calculation tool that utilizes factors derived from other computational methods. If the baseline is recalculated using a calibrated computational method, the methodology used to calculate green infrastructure load reductions should be consistent with the assumptions used to recalculate baseline and the recommended ranges for calibration must be applied appropriately (Section 4.1.3).

If a spreadsheet approach is used, the approach should utilize outputs of other computational methods, such as the RWSM (for baseline loading) and/or green infrastructure facility performance nomographs developed using continuous simulation hydrologic modeling with one of the accepted computational models. These outputs should be combined based on a geospatial representation of the watershed and locations of green infrastructure controls. Load reductions from green infrastructure would be calculated as part of a processing routine in a spreadsheet or coded database. The load reductions associated with green infrastructure should be applied such that these measures are appropriately credited given the computed baseline. Spreadsheet based methods, if used, would be substantiated through the RAA Work Group process.

4.3.3 Model Scenarios for Compliance Demonstration

Model scenarios used to calculate load reductions corresponding to the MRP required load reduction time frames and WLA attainment time frame should include:

1. 2020 condition (green infrastructure and redevelopment land use changes only).

2. 2028/2030 condition (source controls and green infrastructure and redevelopment land use changes).
3. 2040 condition (green infrastructure and redevelopment land use changes only).

Each of these conditions will be analyzed using the rainfall inputs corresponding to the baseline period to allow for comparison of pollutant loading. These conditions should incorporate the green infrastructure (i.e., projected private redevelopment and public retrofit areas using green infrastructure) anticipated to be in place in the watershed by the scenario date. The load reductions estimated for full trash capture devices (e.g., hydrodynamic separator [HDS] units) should be included in the 2028/2030 condition, but not the 2020 or 2040 conditions, as these devices are not considered to be green infrastructure.

4.3.4 Green Infrastructure Representations

To account for load reductions associated with green infrastructure, green infrastructure must be appropriately represented in the model used. Green infrastructure representations should be consistent with their anticipated facility type (i.e., facilities appropriate for use to meet C.3 requirements per countywide stormwater program technical guidance manuals) and sizing (i.e., assumed to be consistent with MRP C.3 requirements) and must be consistent with the typical function of these facilities. In this typical function, discharge concentrations tend to be unaffected by influent concentrations, so that percentage pollutant removal is largely a function of influent concentration. Further, these facilities are designed to treat smaller, lower intensity storms and will tend to bypass a portion of the flow from larger, higher intensity storms. As such, it is not recommended that "percent removal" of annual load constructs be used. Instead, green infrastructure performance should be simulated directly using a process based model, or simulated using a combination of continuous simulation-based volume performance and empirically-based concentration performance to estimate load reductions. The specific guidance provided in the Los Angeles Regional RAA Guidance (LARWQCB, 2014) can be used to define allowable methods.

4.3.5 Model Output

The model will result in estimates of the annual loading (with controls) for each of the conditions modeled. Ultimately, results should be displayed in terms of annual loading, consistent with the units of the WLA. Other output needed for documentation should be compiled when developing RAA model summaries (see Section 3.7).

Estimated average annual load reductions from baseline can be calculated by subtracting the average annual future condition loading from the average annual baseline condition loading. Prior to or after processing routines to incorporate loading are conducted, hydrologic and/or loading output may require post-processing to summarize output at the temporal scale needed.

4.4 Computational Model Inputs and Calibration/Validation Details

4.4.1 Model Input

Model input consists of input data and assumed parameters that are used to estimate the loading from the watershed. The available models can be used to model sediment or water to estimate loading and load reductions.

Depending on the model approach used, the inputs will include varying mixes of data and parameter inputs. These inputs are listed in Table 4-3. Details and suggested parameter sources are provided in Table 4-4.

Table 4-3: Model Input Data and Parameters

Model Input Component	Model Input Data	Model Input Parameters
General	N/A	• Timestep • Simulation timeframe
Watershed Characteristics	• Topography • Land Use/ Imperviousness • Drainage Areas • Soils Information (i.e., related to infiltration such as hydrologic soil group) • Proportion of drainage area treated by green infrastructure (for green infrastructure scenarios)	• Watershed hydrology parameters (i.e., related to applying Manning's, Green-Ampt, and other processes)
Pollutant Loading from the Watershed	• PCBs/Mercury/Total Suspended Solids (TSS) Water Event Mean Concentrations • PCBs/Mercury Sediment Concentrations	• Build-up/Wash-off water quality parameters • Build-up/Wash-off Sediment parameters • Drainage area to each BMP
Green Infrastructure/ Treatment	• Green infrastructure/treatment control effluent PCBs/mercury/TSS/SSC water concentrations • Green infrastructure effluent PCB/Hg concentrations on sediment	• BMP geometry (vol. and stage storage) • Percolation/underlying infiltration rate • Drawdown/orifice flow rate (stage discharge) • Pollutant treatment decay rates
Meteorology	• Precipitation • Evaporation • Temperature	• Storm inter-event times • Evaporation parameters (i.e., to derive from temperature)
Drainage Systems	• Storm drain (i.e., MS4) network • Stream network • Green infrastructure locations	N/A
Hydrology (for calibration)	• Flow data (in-stream)	N/A

Model Input Component	Model Input Data	Model Input Parameters
Outfall/ In-stream data for calibration/ validation)	• PCBs/Mercury/TSS/SSC water concentrations • Sediment data • PCBs/Mercury sediment concentrations • PCBs/Mercury loads	N/A

Table 4-4: Suggested Input Data Sources for Process Based Green Infrastructure Models and Empirically Based Green Infrastructure Models

Model Input Component	Model Input Data	Data Source	Data Period
Watershed Characteristics	Topography	USGS National Elevation Dataset (NED) or locally derived data	Most recent
	Land Use/ Imperviousness	Countywide land use data layer utilizing RWSM land use categorizations or equivalent	Baseline year[1] or Baseline year plus Redevelopment[2]
	Drainage Areas	USGS Watershed Boundary Dataset (WBD) or locally derived data	Most recent
	Soils Information	USDA/NRCS – Soil Survey Geographic Database (SSURGO)/ STATSGO2 or locally derived data	Most recent
Pollutant Loading	PCBs/Mercury /TSS Water Event Mean Concentrations	RWSM (as revised by BASMAA)	When available
	PCBs/Mercury Sediment Concentrations	RWSM (as revised by BASMAA)	When available
Green Infrastructure/ Treatment	Green infrastructure/ treatment control effluent PCBs/ mercury/ TSS water or sediment concentrations	International Best Management Practice (BMP) Database or other locally applicable data (e.g., CW4CB data and SFEI and Caltrans PCBs removal studies)	Most recent
Meteorology	Precipitation	NOAA National Centers for Environmental Information (NCEI) or locally derived data	Data for baseline period or year[3]
	Evaporation	NOAA NCEI, California Irrigation Management Information System (CIMIS) or locally derived data	Most recent
	Temperature	NOAA NCEI or locally derived data	Most recent
Drainage Systems	Stream network	National Hydrography Dataset (USGS)	Most recent
	Green infrastructure locations	Obtained from individual jurisdictions	Most recent
	Storm drain network (optional)	Obtained from individual jurisdictions	Most recent

Model Input Component	Model Input Data	Data Source	Data Period
Hydrology (for calibration)	Flow data (in-stream)	USGS and locally derived data	Hourly or 15-minute recommended, daily or monthly otherwise
Outfall/ In-stream data for calibration/ validation)	PCBs/Mercury/TSS/SSC water concentrations	Small Tributaries Loading Strategy (STLS) data collected by RMP/BASMAA or similar	Most recent
	Sediment data	STLS by RMP/BASMAA or similar	Most recent
	PCBs/Mercury sediment concentrations	STLS by RMP/BASMAA or similar	Most recent

[1] For land use inputs, geospatial land use data associated with the baseline year or period (i.e., approximately 2003 for mercury and 2005 for PCBs) should be utilized to calculate baseline loading from the watershed. Programs and Permittees have been encouraged to correct publicly available data (typically Association of Bay Area Governments data from 2005) to more accurately represent their baseline conditions and to incorporate industrial areas present prior to 1980.

[2] Land use changes associated with redevelopment should be added to the baseline land use so that they are reflected in future condition green infrastructure model runs.

[3] The baseline period is WY 2000 – 2009; the baseline year is WY 2002 (see section 3.4).

4.4.2 Model Calibration and Validation

Assessment and reporting of model performance is often achieved through the model calibration and validation process. Model calibration and validation is the method of adjusting rates and constants that represent physical, chemical, or biological processes, while confirming those adjustments to produce a robust predictor of the system modeled. The model calibration process is a step-wise procedure that starts with quality assurance of model input (e.g., weather data), and continues with calibration of model parameters that drive simulation of hydrology, transport, and water quality.

4.4.2.1 Model Calibration Requirements

Per the RAA Guide (USEPA, 2017), careful attention should be used in each step of the process to ensure that model uncertainty is not propagated to latter steps, as many model processes are dependent on other calibrated processes. For instance, hydrology calibration is one of the first steps in calibrating a model, and if not performed thoroughly, uncertainty in hydrology simulations could impact calibrations for sediment transport or water quality. A schematic describing a process for model calibration that aims to minimize the propagation of uncertainty is shown in Figure 4-1.

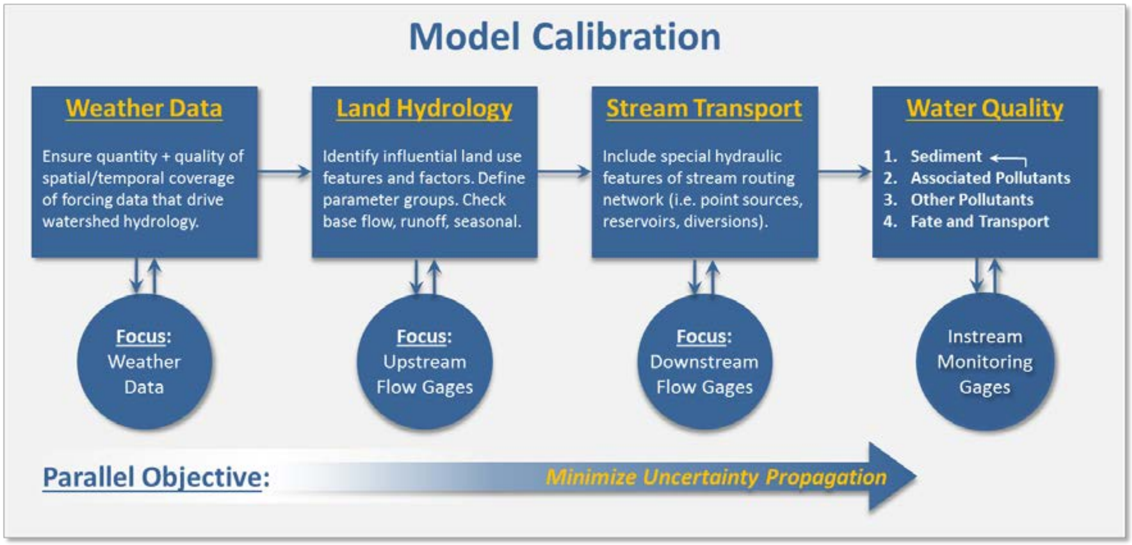

Figure 4-1: Model Calibration Example Process (USEPA, 2017)

4.4.2.2 Model Validation

Model validation should occur per the instructions provided in the RAA Guide (USEPA, 2017):

> Once a model is calibrated, model predictions are then compared to an independent dataset for validation. This independent dataset may be monitoring data collected at another location or during a different period than that used for calibration. If the model is not validated, then the model calibration is revisited with an emphasis on the adjustment of parameters that are hypothesized to result in the lack of validation. Throughout each step of this iterative calibration and validation process, appropriate statistical and sensitivity analyses should be performed to support assessment of model uncertainty. Through comparison with the model performance criteria, the RAA should document the model uncertainty to demonstrate that the model reasonably predicts existing conditions of the system. Additional sensitivity analysis can be used to further investigate the degree of uncertainty of key modeling assumptions that highly impact modeling results. Such an analysis can inform future monitoring efforts and the collection of data that can be used to improve the model over time through an iterative process.

The first step of model validation may include a check of the input data and parameters to confirm that they are consistent with the suggested sources provided herein (Tables 4-3 and 4-4). Model calibration outcomes should be compared against allowable ranges (Table 4-2). As a final check, independent data can be used to validate that the model outcomes are reasonably consistent with monitoring data.

4.5 Uncertainty and Degradation

Uncertainty in the RAA analysis is driven by a number of factors, including data uncertainty, the effect of pollutant degradation, and the effect of source controls on reducing pollutant loads to green infrastructure and treatment control retrofit projects over time. The overall level of uncertainty in the load reduction analyses for the 2028/2030 condition will be dominated by the level of uncertainty inherent in the estimation methods used to calculate source control load reductions.

4.5.1 Model Uncertainty

According to USEPA's Guidance on the Development, Evaluation, and Application of Environmental Models (USEPA Model Guidance, 2009), model uncertainty describes the lack of knowledge about models, parameters, constants, data, and beliefs. The USEPA Model Guidance identifies two types of uncertainty related to models: model framework uncertainty, related to the scientific soundness of the model, and data uncertainty, arising from measurement errors, analytical imprecision, and limited data sample sizes. As the computational methods included in this Guidance Document are all widely used, peer reviewed, and have been accepted by the regulatory agencies, the primary source of uncertainty for these computational methods is expected to be data uncertainty.

The USEPA Model Guidance (USEPA, 2009) describes the three components that affect data uncertainty:

- Accuracy – the closeness of a measured or computed value to its "true" value.
- Variability – data differences arising from true heterogeneity or diversity in model parameters and their underlying input datasets.
- Precision – the quality of being reproducible in outcome or performance.

Due to natural variability, data limitations affect both accuracy and precision, resulting in higher data uncertainty. Because of this, data limitations will also inform the complexity of the model.

In addition, as indicated in the USEPA Guide (USEPA, 2017), calibration and validation can be used to manage model uncertainty, though data limitations will still cause uncertainty in model output. Because of this, the USEPA Guide suggests that it is important to update RAA modeling tools over time as additional data become available. Uncertainty analysis can be conducted as part of the development of an RAA modeling effort to identify data needed to reduce important sources of model uncertainty over time (USEPA, 2017).

Sources of uncertainty that cannot be addressed as part of the RAA model development include hydrologic changes associated with climate change, along with degradation and source reduction.

4.5.2 Degradation and Source Reduction

Degradation is the process of natural reduction in pollutant concentration, which is anticipated to occur over time as a result of numerous factors present in the watershed. A component of degradation which lends itself to uncertainty is the reduction of PCBs as a source. PCBs are a legacy pollutant in the environment, as they have not been in production for almost 40 years and the allowable uses have been mostly phased out and should be further reduced over time. Therefore, the load of PCBs that is currently available for transport and conveyance in the MS4 can only be degraded and removed, not added to. It is anticipated that PCBs as a source will diminish over time as a result of source control activities that may not be captured by the load reduction estimation methods, as well as natural dispersion and biological degradation processes. Little information is known about these processes in upland areas, thus insufficient information is available to develop a methodology for accounting for degradation and source reduction in the watershed. Because of this, degradation overtime can account for a considerable amount of uncertainty in the future condition, particularly in the anticipated concentrations in urban runoff. The Permittees may consider degradation and source reduction in the future as more information becomes available.

5 CONTROL MEASURE IMPLEMENTATION AND LOAD REDUCTION TRACKING

A ***Mercury and PCBs Load Reduction Accounting Tool*** was developed as a regional project by the BASMAA in 2016/2017. This tool is designed to assist the Permittees and programs in documenting progress towards and achievement of load reductions of mercury and PCBs required by MRP provisions C.11 and C.12. The Accounting Tool incorporates the load reduction calculation methodologies that are presented in the *Interim Accounting Methodology for TMDL Loads Reduced* (BASMAA, 2017) and methodologies described in MRP provisions C.11 and C.12, as well as the MRP Fact Sheet (SFBRWQCB, 2015). Permittee and stormwater program staff can use the *Mercury and PCBs Load Reduction Accounting Tool* to document and track control measure implementation, calculate the associated mercury or PCBs load reduction credits, and present summaries of the total load reductions achieved or projected during this permit term.

The types of data that should be collected for the purposes of tracking control measure implementation and load reduction accounting are listed in Table 5-1 through Table 5-3.

Table 5-1: Project Implementation Tracking Data

DATA	DESCRIPTION
Jurisdiction	Jurisdiction project is located in.
Project Name	Project Name or other general descriptor.
Project Location	Project location (e.g., street address or intersection, GIS coordinates, or other location information).
Project Area	Project total treated/controlled area (acres).
Property APN	Project location's Assessor's Parcel Number(s) (APN) (if applicable).
Project Type	New development or redevelopment projects subject to the C.3.b.ii provisions of the current permit term (MRP 2.0) and new development or redevelopment projects subject to the C.3 provisions of the previous permit term (MRP 1.0) should state "parcel-based". Public retrofit of treatment controls and green infrastructure into existing developed areas including infrastructure in public ROW areas and on public properties should state "green street/retrofit". State "full trash capture" for stand-alone HDS units only (i.e., not part of a parcel-based project).

DATA	DESCRIPTION
Treatment Type	Treatment Measure: 1. Bioretention with underdrain (unlined) 2. Vegetated swale 3. Filter strip 4. Wetlands 5. Infiltration system (includes unlined bioretention w/out underdrain, dry well, infiltration trench, infiltration gallery, infiltration basin, pervious pavement w/out underdrain, or other infiltration systems) 6. Rainwater storage and use 7. Extended detention basin 8. Tree well biofilter 9. Vault-based media filter 10. Planter box/lined bioretention 11. Other non-LID treatment measure 12. Self-retaining areas and areas that drain to self-retaining areas 13. Self-treating areas
Project area treated	Enter the tributary drainage area of the facility.
Public/Private	If the project is on private property, state “private”. If the project is on public property, state “public”.
Hydromodification Control	State whether the facility includes hydromodification control measures (Yes or No).
Construction Completion Date	The date that project construction was complete (mm/yyyy).
Hydraulic sizing criteria % capture	Criteria used to size the treatment control measures in terms of percent capture of the average annual runoff volume.

Table 5-2: Source Property Id Referral/Abatement Data

DATA	DESCRIPTION
Property APN	Project location’s APN number(s) (if applicable).
Property Location	Project location (e.g., street address or intersection, GIS coordinates, or other location information)
Property Area	Source Property Area (acres)
Referral Status	Was the property referred to the SFBRWQCB?
Referral Date	Referral Date (month-year)
Enhanced O&M Status	Were O&M Enhancements implemented in vicinity of source property?
Enhanced O&M Description	Description, scope and start date of O&M Enhancements (as applicable)
Abatement Status	Was the property abatement completed?
Abatement Date	Abatement Date of Completion (Month-Year)
Abatement Description	Describe abatement measures and/or provide abated property concentrations (soil/sediment/stormwater)

Table 5-3: Other Source Control Measure Data

DATA	DESCRIPTION
Jurisdiction	Jurisdiction source control measure is located in.
Source Control Measure	Source control measure. 1. PCBs/Infrastructure 2. Street Sweeping 3. Inlet Cleaning 4. Pump Station Cleanout 5. Storm Drain Cleanout 6. Street Flushing 7. Desilting 8. Diversion to POTW 9. Other Source Control
Implementation Date	Date source control measure enhancement began.
Source Control Measure Description	Describe source control measure enhancement.
Location	Where the source control measure was implemented.

Additionally, some programs are developing GIS tools for mapping and tracking control measure implementation and load reduction accounting, as well as C.3 compliance. These GIS databases will be used in future permit terms to revise the RAAs to account for control measure implementation once per permit term.

6. ADAPTIVE MANAGEMENT

6.1 RAA Work Group

This Guidance Document is intended to provide initial boundaries for how RAAs should be conducted; however, there are details and topics that cannot be fully characterized within this Document. To address such concerns, as well as to provide consistency between modeling approaches, it is recommended that an RAA Work Group be convened as the RAAs are developed during the current permit term. The purpose of the RAA Work Group will be to work together to resolve technical and regulatory issues, provide further consistency between modeling approaches, and provide peer review. Data and analysis gaps identified and prioritized by Permittees, associated with control measure effectiveness and other topics, can be addressed through the RAA Work Group to allow for adaptation of modeling assumptions as needed. The RAA Work Group should include technical experts, including professionals with experience in developing RAAs and/or modeling stormwater, and appropriate Regional Water Board staff. If it would be potentially useful to the success of regional efforts to reduce pollutant loadings, the RAA Work Group might also include practitioners with experience in designing and implementing control measures, or managing municipal stormwater programs.

6.2 Approach to Longer Term Adaptive Management

The RAA conducted for the current MRP term is, in most cases, anticipated to be developed with longer-term use in mind. The model files that are developed to complete the RAA should be able to be adapted for stormwater management planning uses as additional data and information become available.

Inputs to the RAA which may require updating include model input data, which could change as more monitoring data and measurements become available. These include data which may currently be complete but may be revised based on changes over time, such as meteorological information, and this can also include data which may be updated to be more complete or accurate and/or capture more variability. Data in the latter category include but are not limited to: pollutant concentrations, soils, land use, and drainage information. Additional changes may consist of changes to parameters or assumptions made in the model. These may include changes to hydrologic parameters, based on updated information, or changes to build-up/wash-off parameters, if a process-based model is used to estimate loading from the watershed. Additionally, if more information is known about degradation processes that occur over time, the inclusion of this mechanism in the model could be revisited. This adaptive management type approach is critical to maintaining a model that is consistent with the best knowledge available at any given time. Although the incorporation of additional data into the RAAs may reduce variability over time, uncertainties in the analysis will always exist and may not be substantially reduced by updating models with additional data in the future.

In addition, the Small Tributaries Loading Workgroup of the RMP has developed a strategy for monitoring trends in stormwater concentrations and loads of PCBs and mercury, connecting management effort on land with water quality improvements in the Bay (the Small Tributaries Loading Strategy-Trends Strategy (STLS-T). The results of the STLS-T will provide additional feedback that may prove useful in long-term adaptive management of the RAAs.

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