Integrated Monitoring Report

Part B: PCB and Mercury Loads Avoided and Reduced via Stormwater Control Measures

Prepared for

Bay Area Stormwater Management Agencies Association

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B.1 BACKGROUND AND UNDERSTANDING

B.1.1 Introduction

Fish tissue monitoring in San Francisco Bay (Bay) has revealed bioaccumulation of polychlorinated biphenyls (PCBs), mercury, and other pollutants. The levels found are thought to pose a health risk to people consuming fish caught in the Bay. As a result of these findings, California has issued an interim advisory on the consumption of fish from the Bay. The advisory led to the Bay being designated as an impaired water body on the Clean Water Act "Section 303(d) list" due to PCBs, mercury, and other pollutants. In response, the California Regional Water Quality Control Board, San Francisco Bay Region (Regional Water Board) has developed Total Maximum Daily Load (TMDL) water quality restoration programs targeting PCBs and mercury in the Bay. The general goals of the TMDLs are to identify sources of PCBs and mercury to the Bay and implement actions to control the sources and restore water quality.

Municipal separate storm sewer systems (MS4s) are one of the PCB and mercury source/pathways identified in the TMDL plans. Local public agencies (i.e., Permittees) subject to requirements via National Pollutant Discharge Elimination System (NPDES) permits must implement control measures in an attempt to reduce PCBs and mercury from entering stormwater runoff and the Bay. These control measures, also referred to as best management practices (BMPs), are the tools that Permittees can use to assist in restoring water quality in the Bay.

NPDES permit requirements associated with Phase I municipal stormwater programs and Permittees in the Bay Area are included in the Municipal Regional Stormwater NPDES Permit (Order R2-2009-0074) (MRP), which was issued to 76 cities, counties and flood control districts in 2009. Consistent with the TMDL plans, provisions C.11 and C.12 of the MRP require the implementation of control measures to reduce PCBs and mercury in urban stormwater runoff. The results and findings of control measure implementation and effectiveness evaluations conducted to-date are presented in this Integrated Monitoring Report (IMR) Part B. The core objectives of IMR Part B are to:

- Demonstrate full compliance with the March 15, 2014 MRP reporting requirements associated with provisions C.11 (mercury) and C.12 (PCBs);
- Report on the effectiveness of PCB and mercury control measures implemented via the MRP, including estimates of loads reduced; and,
- Identify the chosen monitoring/measurement approach concerning PCB and mercury loads assessment and estimations of loads reduced.

Consistent with these objectives, IMR Part B is intended to answer the following core management questions:

- What are the approaches selected by Permittees to assess progress towards TMDL Waste Load Allocations?
- What mass of PCBs and mercury were reduced or avoided by control measures prior to the adoption of the TMDLs (e.g., baseline) and after TMDL adoption, including those implemented in compliance with the MRP?

B.1.2 PCBs and Mercury Total Maximum Daily Loads

Based on a determination of water quality impairment of the Bay associated with PCBs and mercury, the Regional Water Board developed TMDL plans for these pollutants. The purpose of the TMDL plans is to attain water quality standards that will protect sport fishing, human health, aquatic organisms, wildlife, and rare and endangered species in the Bay. To attain water quality standards, the TMDL plan sets regulatory targets and maximum total allowable pollutant loads from all sources combined (i.e., the TMDL). Load reductions needed to obtain the TMDL are assigned to sources through wasteload (point sources) and load (nonpoint sources) allocations. Urban stormwater runoff, which includes discharges from MS4s, was identified as an important contributor of pollutants to the Bay in both the PCBs and mercury TMDLs. Urban stormwater Permittees were therefore assigned wasteload allocations accordingly in the TMDLs.

B.1.2.1 TMDL Targets

On February 12, 2008, the U.S. Environmental Protection Agency (USEPA) approved a Basin Plan amendment incorporating a TMDL for mercury in the Bay (Mercury TMDL) and an implementation plan to achieve the TMDL. Prior to USEPA approval, the amendment was adopted by the Regional Water Board, the State Water Resources Control Board, and the state Office of Administrative Law. Mercury TMDL targets include:

- Bay-wide suspended sediment mercury concentration of 0.2 milligram (mg) mercury per kilogram (kg) dry sediment;
- Large fish target of 0.2 mg mercury per kg fish tissue that applies to striped bass; and
- Small fish target of 0.03 mg mercury per kg fish (average wet weight whole fish) for protection of wildlife (especially piscivorous birds).

The USEPA approved a TMDL for PCBs in the Bay on March 29, 2010. The Basin Plan amendment incorporating this TMDL and an implementation plan to achieve the TMDL was adopted or approved by the Regional Board, the State Water Resources Control Board, and the state Office of Administrative Law prior to the USEPA approval. The PCBs TMDL includes a fish tissue target of 10 nanogram (ng) of Total PCBs[1] per gram (g) of fish tissue (white croaker or shiner surfperch).

B.1.2.2 TMDL Wasteload Allocations

To reach the TMDL targets described above and obtain water quality standards in the Bay for mercury and PCBs, pollutant reductions are required from each source causing or contributing to Bay impairment. For mercury, a 43 percent reduction of total mercury discharged to the Bay from all sources combined is required. The largest mercury reductions are required from the Guadalupe River (legacy mining), Central Valley watershed, and urban stormwater runoff. For PCBs, a 24 kg/yr (approximately 70 percent) load reduction of total PCBs in discharges to the Bay is required from all sources combined to obtain water quality standards. The largest PCB load reductions are required from the Central Valley watershed and stormwater runoff.

The PCBs and mercury TMDL Staff Reports (SFBRWQCB 2006, 2008) provide estimates of pollutants loads from urban stormwater runoff.[2] Wasteload allocations for urban stormwater runoff are assigned by county to Bay Area stormwater programs. Stormwater programs identified in the TMDLs that represent Permittees subject to MRP requirements include:

- Santa Clara Valley Urban Runoff Pollution Prevention Program
- Alameda Countywide Clean Water Program
- Contra Costa Clean Water Program
- San Mateo Countywide Water Pollution Prevention Program
- Fairfield-Suisun Urban Runoff Management Program
- City of Vallejo & Vallejo Sanitation and Flood Control District

Mercury and PCB TMDL loads, wasteload allocations (WLA), and load reductions assigned to these stormwater programs are included in Table B.1.2.1. Pollutant load reductions are based on current understandings of pollutant contributions and represent the goal that stormwater programs should strive to attain through stormwater control measure implementation.

Wasteload allocations (WLAs) for urban stormwater runoff programs presented in Table B.1.2.1 implicitly include all current and future permitted discharges within the geographic boundaries of Permittees. Permitted discharges include those covered under municipal stormwater NPDES permits, and discharges attributable to the California Department of Transportation (Caltrans)

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[1] Based on the use the term "Total PCBs" in the PCBs TMDL, Total PCBs is defined as either: 1) sum of Aroclors; 2) sum of the individual congeners routinely quantified by the Regional Monitoring Program (RMP) for Water Quality in the San Francisco Estuary; or 3) sum of the National Oceanic and Atmospheric Administration (NOAA) 18 congeners converted to total Aroclors.

[2] As described in IMR Part C, loading estimates are currently under review and may be revised in the future.

roadways and non-roadway facilities and rights-of-way, atmospheric deposition onto the surface of the watershed, public facilities (e.g., schools), properties adjacent to stream banks, industrial facilities, and construction sites.

Table B.1.2.1. Mercury and PCB Loads, Wasteload Allocations and Load Reduction Goals for Bay Area Phase I Municipal Stormwater Programs

<table>
<tr><th rowspan="2">Entity</th><th colspan="3">Mercury (kg/yr)</th><th colspan="3">PCBs (kg/yr)</th></tr>
<tr><th>Load (2002)</th><th>Wasteload Allocation</th><th>Load Reduction[4]</th><th>Load (2002)</th><th>Wasteload Allocation</th><th>Load Reduction[4]</th></tr>
<tr><td>Santa Clara Valley Urban Runoff Pollution Prevention Program</td><td>44</td><td>23</td><td>21</td><td>5.5</td><td>0.5</td><td>5.0</td></tr>
<tr><td>Alameda County Clean Water Program</td><td>39</td><td>20</td><td>19</td><td>4.9</td><td>0.5</td><td>4.4</td></tr>
<tr><td>Contra Costa Clean Water Program</td><td>22</td><td>11</td><td>11</td><td>2.7</td><td>0.3</td><td>2.4</td></tr>
<tr><td>San Mateo County Water Pollution Prevention Program</td><td>16.4</td><td>8.4</td><td>8</td><td>2.1</td><td>0.2</td><td>1.9</td></tr>
<tr><td>City of Vallejo and VSFCD[1]</td><td>3.2</td><td>1.6</td><td>1.6</td><td rowspan="2">1.0[3]</td><td rowspan="2">0.1[3]</td><td rowspan="2">0.9[3]</td></tr>
<tr><td>Fairfield-Suisun Urban Runoff Management Program[2]</td><td>3.1</td><td>1.6</td><td>1.5</td></tr>
</table>

[1] Vallejo Sanitation and Flood Control District
[2] Includes the City of Fairfield and Suisun City
[3] The PCB TMDL assigns a combined allocation to "Solano County", which only includes discharges from the cities of Vallejo, Fairfield, and Suisun City
[4] Load reductions presented in the table were calculated for each stormwater program by subtracting the applicable WLA (originally based on relative populations) from the pollutant load (originally based on relative population).

B.1.2.3 TMDL Implementation Framework

Even if loads from all sources are reduced according to the wasteload allocations set by the TMDLs, recovery of the Bay is expected to take decades due to the large existing reservoirs of PCBs and mercury within Bay sediments. The urban stormwater runoff wasteload allocation for PCBs represents a 90 percent reduction from the estimated existing load. The TMDL implementation plans set roughly 20-year timelines for achieving the reductions but also incorporate an adaptive implementation planning approach. The adaptive approach consists of the development of a plan that includes early implementation actions based on existing knowledge that have a reasonable probability of success and an overview of options for future actions. For PCBs and mercury in the Bay, the immediate or early implementation actions are not expected to completely eliminate the Bay impairment. Therefore, future actions must be evaluated based on continued monitoring and response to the early implementation actions, as well as based on well-designed studies used for model refinement.

The MRP Fact Sheet notes that the initial focus of provisions C.11/12 is on measures designed to reduce PCBs, while also evaluating opportunities for mercury reduction. Implementation actions may fall into four categories depending on the available knowledge and confidence in a control measure's effectiveness (listed in decreasing order of confidence):

- Full-scale implementation throughout the region.
- Focused implementation in areas where benefits are most likely to occur.
- Pilot-testing in a few specific locations.
- Other: This may refer to experimental control measures, research and development, desktop analysis, laboratory studies, and/or literature review.

As described later in this introduction, control measures currently under implementation by Permittees vary in their phase of implementation.

B.1.3 PCB and Mercury Uses, Sources and Transport

B.1.3.1 Polychlorinated Biphenyls (PCBs)

PCBs are mixtures of up to 209 individual chlorinated compounds (known as congeners). PCBs were manufactured in the United States and used widely from the late 1920s through the 1970s. Due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other applications. Because of their persistent qualities and physical and chemical characteristics, PCBs are found in environmental media worldwide, including air, sediment from street sweeping and stormwater conveyance systems, sediment and water from flood control channels and receiving waters, and urban stormwater runoff.

Monsanto, an agricultural chemical company, commercially produced PCBs from 1929 to 1977 under the trade name Aroclor and is considered one of the major producers of this pollutant (McKee et al. 2006). According to Erickson (2001), PCBs use can be grouped into three main categories:

1. Controllable closed systems where leakage is avoided by design during the lifespan of the equipment;
2. Uncontrollable closed systems, which are technically closed but where leakage usually occurs (also referred to as nominally closed); and
3. Dissipative (open-ended) uses, which involves non-recoverable PCBs that come in direct contact with the environment (also referred to as open-ended applications).

Keeler et al. (1993) divided the dissipative category into two smaller groups of plasticizers and other uses (e.g., flame retardants, paints, inks, sealants, and carbonless copy paper). It is not known to what extent PCBs use in the Bay Area fell within the three categories described above.

The U.S. total production of PCBs by Monsanto has been reported to be approximately 640,000 metric tonnes (de Voogt and Brinkman 1989). Production peaked in 1970 at approximately 30,000 tonnes or about six percent of the total U.S. production (Figure B.1.1.). Approximately 57 percent of total production occurred between 1960 and 1974 and 73 percent of the U.S. production occurred between 1955 and 1977. Overall, it appears that total production is proportional to total consumption in the U.S. (Breivik et al. 2002).

Although total consumption of PCBs in the U.S. (and Bay Area) continues to be at zero due to the ban in 1977, PCBs still remain in use in certain closed system equipment and devices (e.g., transformers and capacitors) and may possibly continue to contribute to urban stormwater runoff discharges.

B.1.3.2 Mercury

Mercury is a naturally-occurring, persistent, bioaccumulative metal that can be present in the elemental, inorganic, or organic forms in the environment. It is both a legacy pollutant and a contemporary pollutant. Historically, mercury has been used in a variety of products. Primary among the over 3,000 historical industrial uses in the U.S. were battery manufacturing and chlorine-alkali production. Paints and industrial instruments have also been among the major uses. It is also used in laboratories for making thermometers, barometers, diffusion pumps, and many other instruments, including mercury switches and other electrical apparatuses. Mercury is used as an electrode in some types of electrolysis and in some types of batteries (mercury cells). Gaseous mercury is used in mercury-vapor lamps (e.g., fluorescent tubes) and advertising signs. Mercury is also the basis of dental amalgams and preparations, and can be a byproduct of burning fossil fuels and refining petroleum.

Peak production and use of mercury occurred twice in U.S. history (Figure B.1.2.). First, it was mined extensively during the Gold Rush in California, and a second time after World War II. In the Bay Area, production was almost entirely from the mercury-rich New Almaden Mining District in Santa Clara County.

The use of mercury in batteries and latex paint, two of the largest uses of mercury in the U.S. between 1950 and 1990, was banned in 1991. In addition, the mining of mercury as a primary mineral commodity was prohibited in the U.S. as of 1992 (McKee et al. 2006). As illustrated in Figure B.1.3., mercury consumption has also reduced substantially from 1970 to 2000 (Sznopek 2000) and the mass of mercury in the most current products and devices such as light bulbs and auto switches appear to also be decreasing (NEWMOA 2008). These decreases in mercury uses may assist the MRP Permittees in reducing loads of mercury to the Bay.

B.1.4 <u>Sources to Urban Stormwater Runoff</u>

The mass of a pollutant transported in stormwater in a particular particle size range is a product of the mass of the sediment load and the concentration of the pollutant in that particle size range (McKee et al. 2006). Finer particles typically have a greater surface area for constituents to adsorb to, and therefore concentrations tend to be higher on these particles (EOA 2007). These smaller particles are mobilized more than larger particles at low flows and therefore constitute the majority of the sediment mass being transported. However, under high flows, larger particles can have a far greater mass of the total sediment load than the smaller particles.

In collaboration with BASMAA member agencies, McKee et al. (2006) conducted a thorough literature review on sources and loads of mercury and PCBs entering urban stormwater and developed a mass balance (or conservation of mass) conceptual model based on this information. The intent of the model was to assist managers by providing a framework for identifying the most important mercury and PCBs uses and sources that likely impact Bay Area stormwater runoff. Although disparate information was used to develop the model, it provides the current best estimate of the mass of PCBs and mercury that is contributed to urban stormwater under a steady state scenario. The model also serves as context for management decisions, especially for mercury given its ongoing use (although reduced) in the urban environment and transport via atmospheric deposition. The following sections present the inventory of mercury and PCB sources to urban stormwater runoff based on the current understanding of PCB and mercury uses and linkages to stormwater.

PCB Uses and Sources

As illustrated in Figure B.1.4., McKee et al. (2006) estimate that erosion from the surface of the urban watershed is the largest source of PCBs to Bay Area urban stormwater. Watershed surface erosion includes diffuse sources of sediment in urban areas associated with construction sites, vacant lots, unpaved foot paths, and wear debris from road and building surfaces and represents the mass of PCBs associated with over 50 years of legacy accumulation on the surface of the Bay watershed. Building demolition and remodeling, PCBs that continue to be in use in equipment and devices, and transformers and large capacitors represent the next largest sources. Smaller sources include atmospheric deposition and identified industrial contaminated areas.

Mercury Uses and Sources

Similar to PCBs, McKee et al. (2006) estimate that erosion from the surface of the urban watershed is also the largest source of mercury to Bay Area urban stormwater (Figure B.1.5.). However, unlike PCBs, atmospheric deposition of mercury to the Bay watershed is estimated to provide a much larger proportion (27 percent) of the total load to urban stormwater. This suggests that mercury from atmospheric deposition may continue to play an important role in loadings of mercury to the Bay from stormwater.

Accidental breakage during transport or disposal of instruments such as barometers, hydrometers, manometers, pyrometers, sphygmomanometers, and thermometers or switches and thermostats that contain relatively large masses of mercury is also suggested to be a large source of mercury to stormwater. Based on these estimates, fluorescent lamps and identified industrial sites with relatively elevated mercury concentrations are far less of a source to stormwater.

One property that distinguishes mercury from PCBs is the fact that mercury bioaccumulation occurs primarily after transformation to methylmercury (methylation). Recent scientific studies have identified monitoring tools to quantify the fraction of mercury most susceptible to methylation – the “reactive mercury” fraction of the total mercury measurement (Marvin-DiPasquale et al. 2009). Studies have also shown that mercury from atmospheric deposition is primarily reactive mercury (Butler 2007). This could mean that stormwater may contain a relatively larger fraction of reactive mercury compared to purely terrestrial sources. If so, water quality benefits could be attained in receiving waters by measures that reduce the fraction of reactive mercury present in the total load. Although there is not sufficient monitoring data at present to make the case for loads reduced or avoided based on reducing the fraction of reactive mercury, that information may be developed over time and submitted to the Regional Water Board for consideration.

B.1.4.1 Transport of PCBs and Mercury to MS4s

A project funded by a State of California Proposition 13 grant and conducted by the San Francisco Estuary Institute (SFEI) defined conceptual models of sources and pathways of mercury and PCBs in Bay Area urban watersheds (Mangarella et al. 2010). These conceptual models were adapted for use in a desktop analysis conducted by EOA (2012), with a focus on the transport of sediment-bound pollutants from source areas to MS4s in historical industrial land uses where PCBs were used. The purpose of the conceptual model (Figure B.1.6.) is to illustrate the movement of sediment-bound pollutants from source areas through the MS4 to receiving waters, and to identify areas of accumulations/storage within the MS4 where enhanced O&M activities could be applied to increase sediment removal from the system. The following terms, as defined previously (Mangarella et al. 2010), were included in the conceptual model:

- **Source Areas** - the geographic areas in the landscape where pollutants are or were used, released, systematically discarded, or accumulated and where such prior/current usage causes higher pollutant concentrations in the air, water, or sediment than in surrounding areas.
- **Pathways** - a conduit or process that delivers pollutants from the source through the MS4 to the receiving water. Because mercury and PCBs attach strongly to soil and sediment particles, typically in the smaller fractions (e.g., fine sand, silt, and clay), sediment transport pathways dominate.
- **Storage** - any location within the MS4 where sediment is likely to accumulate. May be a dispersed location (e.g., along roadways) or a point location (e.g., within a storm drain inlet). Sediment accumulation and storage within the MS4 may vary, depending on factors such as storage capacity, flow rate and volume of runoff, and surface topography.

Sediment-bound pollutants from source areas potentially enter the MS4 via three major transport pathways:

- **Wind Dispersal**: Dry soils and sediment may be susceptible to wind dispersal, which can transport polluted soils/sediment away from source areas to the MS4.
- **Vehicle Tracking and Road Deposits**: Polluted soils/sediment may be tracked onto nearby roadways by vehicles that drive on and off unpaved lots and roads in industrial areas. Typically, the majority of the soil is deposited onto roadways within a short distance of the source (e.g., one or two city blocks). Other types of road deposits from vehicles include leaking gasoline, diesel, transmission fluids, and motor oils that may contain trace amounts of mercury, and trash and debris that fall off of vehicles during haulage that may contain PCBs or mercury. Roads servicing recycling areas and municipal or private landfills and disposal areas likely receive a larger share of PCBs and mercury in road deposits.
- **Surface Runoff from Source Areas**: Polluted soils/sediments on impervious surfaces and erosional areas (e.g., unpaved or damaged pavement) are subject to wash off via surface runoff, which transports pollutants to the MS4.

Once polluted soil/sediment has been transported to the MS4, accumulation and storage may occur in a number of locations, such as roadways (including curbs and gutters), storm drain inlets/catch basins, stormwater pipelines, and other structures (e.g., stormwater pump stations). These storage locations are potential implementation points for enhanced O&M activities that remove sediment.

B.1.5 Urban Stormwater Control Measures

B.1.5.1 Control Measure Categories

Urban stormwater runoff control measures for PCBs and mercury generally fall into three categories:

- **True Source Controls (Load Avoidance)** - focus on the original source or use of a potential pollutant. Load avoidance controls include regulations and laws adopted to minimize or eliminate the use of a pollutant for specific applications and pollution prevention activities such as inspections that identify high risk practices that could generate PCBs/mercury into the environment. By minimizing/eliminating the source/use/risk, the amount of a pollutant that would have entered the environment without the true source control measure in place is avoided at its source (i.e., true source control), thus avoiding the need to reduce/intercept the pollutant once in the environment. The one true source control measure for mercury is the reduction in the content/mass of mercury in devices/equipment as a result of legislation or voluntary reduction by manufacturers. No true source controls are currently available for PCBs due to the banning of the distribution and sale of these organic compounds in the 1970s.
- **Source Controls (Load Reduction)** - Source controls are load reduction control measures that reduce the risk of the pollutant from entering the environment after it has

already been used in devices/materials/equipment (e.g., recycling) or intercept the pollutant before it is discharged to a receiving water body. The control measure types that fall into this category include: the identification of PCBs in industrial inspections, source property identification and abatement, enhanced street sweeping and MS4 operation and maintenance, and reduction of PCBs during building demolition.

- **Treatment Controls (Load Reduction)** – Treatment controls are load reduction control measures that remove pollutants via physical, biological, or chemical processes. The control measure types that fall into this category include stormwater treatment measures and diversions of stormwater to Publically Owned Treatment Works (POTWs).

The following sections provide brief summaries of each of the potential control measure types that may assist municipalities in reducing PCBs and/or mercury in urban stormwater runoff. Control measure descriptions are grouped by the three categories described above.

B.1.5.2 True Source Controls

- Reduction/Elimination of Mercury in Devices - Mercury is present in a number of types of devices, equipment and products that may be handled and disposed of improperly. First order estimates by McKee et al. (2006) attribute approximately 11-31% of the total mercury in urban stormwater discharges to the Bay comes from improperly disposed of florescent lamps, thermostats, switches and relays and many other types of devices (e.g., barometers, hydrometers, manometers, pyrometers, sphygmomanometers, and thermometers). True source control measures applicable to mercury-containing devices and equipment include the adoption of laws and regulations to reduce/eliminate mercury in devices/products/equipment.

B.1.5.3 Source Controls

- Recycling of Mercury Containing Devices, Products and Equipment - In addition to true source control measures applicable to mercury-containing devices and equipment, the Permittees also promote, facilitate, and/or participate in collection and recycling of mercury-containing devices and equipment at the consumer level (e.g., thermometers, thermostats, switches, and bulbs). Recycling mainly occurs through County, City, and POTW Household Hazardous Waste Programs.
- Identification of Pollutants during Industrial Inspections - PCBs were used in a variety of electrical devices and industrial equipment (i.e., uncontrollable closed systems) that may leak and come into contact with stormwater. PCB-containing equipment may be found during stormwater inspections at industrial facilities. If identified during stormwater inspections, current or future impacts to stormwater may be reduced via inspectors working with facility owners/operators or referring unresolvable issues to the appropriate regulatory agencies.

- Investigations and Abatement of Sources in Drainages - Identifying and targeting high priority properties in historically industrial land-use areas where PCBs were used, released, or disposed of and/or where sediment concentrations are elevated above urban background may provide an effective way to minimize or prevent the release of PCBs and mercury to urban stormwater. Once identified, Permittees work with facility owners and operators to reduce discharges to stormwater and/or refer unresolved issues to appropriate regulatory agencies for further investigation/controls.
- Enhanced Municipal Operation and Maintenance Practices - Routine MS4 operation and maintenance (O&M) activities include street sweeping, drain inlet cleaning, and pump station maintenance. In addition, culverts and channels are also routinely maintained (i.e., desilted). Enhancements to routine operations and new actions such as storm drain line and street flushing may enhance the Permittees' ability to reduce PCBs and mercury in stormwater.
- Control PCBs during Building Demolition and Renovation - Prior to the 1979 production ban, PCBs were commonly used in various building materials, including sealants that were applied around windows and doors, between concrete and other materials, and around openings for ducts and other conduits. During demolition or renovation of buildings containing PCBs, there is the potential for PCBs to enter the MS4 and ultimately discharge to the Bay. Thus, building demolition or renovation has been identified as a potential source of PCBs to the Bay. Control measures that focus on reducing PCB-containing materials during demolition and renovation may therefore reduce the mass of PCBs entering stormwater from this source.

B.1.5.4 Treatment Controls

- On-Site Stormwater Treatment - Stormwater treatment measures fall into two general categories: (1) post-development treatment measures for new development and redevelopment projects, and (2) stormwater retrofit projects implemented outside of the context of new and redevelopment projects. Permittees currently require the incorporation of appropriate source control, site design, and stormwater treatment control measures in new development and redevelopment projects to address stormwater runoff pollutant discharges and to prevent increases in runoff flows. The preferred method of achieving these goals is through the implementation of low impact development (LID) techniques. Strategically retrofitting the MS4 system in areas known to have elevated PCB and/or mercury concentrations with onsite treatment facilities may also provide pollutant load reduction benefits.
- Diversion to Publicly Owned Treatment Works - Diversion of dry weather and/or first flush events from MS4s to POTWs has been identified as a potential control measure to reduce loads of PCBs and mercury in urban stormwater runoff. Diversions may be passive or active systems and may occur at pump stations or other strategic locations in

the stormwater conveyance system. Coordination with POTWs and sanitary sewer agencies would be required prior to a diversion taking place.

B.1.6 Municipal Regional Stormwater Permit

B.1.6.1 Provisions C.11 (Mercury) and C.12 (PCBs)

In provisions C.11 and C.12, the MRP requires Permittees to implement a series of control measures intended to reduce mercury and PCBs in urban stormwater runoff. Based on the phased implementation approach described in the previous section, Permittees are currently implementing PCB and mercury control measures at varying levels consistent with MRP. Table B.1.6.1 lists each control measure currently under implementation, the associated MRP provision, current level of implementation, and the number of projects required by the MRP. Figure B.1.7. illustrates the location of each pilot-scale control measure currently under implementation by Permittees in compliance with the MRP.

B.1.6.2 Clean Watersheds for a Clean Bay

The Clean Watersheds for a Clean Bay (CW4CB) project is a collaboration among all the MRP Permittees designed to evaluate the effectiveness of stormwater controls for PCBs and mercury. The CW4CB project is implementing a number of priority urban stormwater-related actions called for by the Bay PCBs and mercury TMDLs and the MRP. The project is facilitated through a partnership among Bay Area municipalities and countywide municipal stormwater management programs and is funded by a grant to Bay Area Stormwater Management Agencies (BASMAA) from the USEPA.[3] The total project budget is $7.04 million - $5M from USEPA and $2.04M matching funds from the Bay Area municipal stormwater agencies, municipal wastewater treatment agencies, and industrial dischargers. In addition, the project's efforts are leveraged by in-kind assistance from Permittees participating in the project.

[3] Funding is through USEPA's San Francisco Bay Area Water Quality Improvement Fund.

Table B.1.6.1. Urban Stormwater Runoff Control Measures for PCBs and Mercury and Current Levels of Implementation

MRP Provision	Control Measure	Current Level of Implementation				# of Projects Required by MRP	Collaborating Agency/Program
		Full Scale	Focused	Pilot	R&D or Desktop		
C.11.a	Collection and Recycling of Mercury-containing Devices	X				N/A	N/A
C.12.a	Identification of POCs During Industrial Inspections	X				N/A	BASMAA
C.11.b	Monitoring Methylmercury	N/A				At POC Loads Monitoring Stations	BASMAA & RMP
C.12.b	Evaluations of BMPs for Building Demolition and Renovation				X	1	BASMAA
C.11/12.c	Investigations and Abatement of Sources in Drainages			X		5	BASMAA (via CW4CB)
C.11/12.d	Enhanced Municipal Operation and Maintenance Practices			X		5	BASMAA (via CW4CB)
C.11/12.e	On-Site Stormwater Treatment via Retrofits			X		10	BASMAA (via CW4CB)
C.11/12.f	Diversions to Publicly Owned Treatment Works			X		5	Stormwater Programs
C.11/12.g	Stormwater Loads and Loads Reduced	N/A				N/A	BASMAA
C.11/12.h	Fate and Transport Studies	N/A				N/A	BASMAA & RMP
C.11/12.i	Regional Risk Reduction	X				N/A	BASMAA (via CW4CB)
C/11.j	Mercury Allocation Sharing	N/A				N/A	BASMAA

In coordination with other control measure evaluations (e.g., POTW diversions), findings from the CW4CB project will contribute to developing a comprehensive regional strategy for reducing PCBs and mercury in urban stormwater runoff. Strategies are described in IMR Part C and are based on the cost-effectiveness of the range of potential pollutant control measures described above.

B.1.7 Progress Assessment Methods

MRP provisions C.11.g and C.12.g require Permittees to develop and implement a monitoring program to quantify mercury and PCB loads reduced through the implementation of these (and other) control measures and to compare these loads against the WLAs described in TMDLs. Consistent with the TMDLs, load reductions and progress toward urban stormwater runoff WLAs may be demonstrated through one of three methods:

1. Quantify through estimates the average annual load reduced by implementing pollution prevention, source control, and treatment control efforts required by the provisions of the MRP or other relevant efforts;
2. Quantify the load as a rolling five-year average using data on flow and water column PCB/mercury concentrations; or
3. Quantitatively demonstrate that the concentration of mercury/PCBs on suspended sediment that best represents sediment discharged with urban runoff is below the target of 0.2 mg mercury/kg dry sediment.

During the term of the MRP, the Permittees have and continue to conduct studies to demonstrate loads reduced and progress towards WLAs using each of the methods described above. Water quality monitoring activities conducted through the Regional Monitoring Program for Water Quality in the San Francisco Bay (RMP) and the Bay Area Stormwater Management Agencies (BASMAA) Regional Monitoring Coalition (RMC) are currently attempting to quantify pollutant loads (Method #2) and concentrations (Method #3). However, due to the diffuse nature of mercury and PCBs in the San Francisco Bay watershed, observable trends in loads and concentrations in creeks and rivers draining to the Bay may take decades to observe. The results of initial quantification of loads reduced or avoided through pollution prevention, source controls, and treatment controls (Method #1) are provided in this report. Methods described in this report are consistent with the preliminary methods described by BASMAA (2010) and submitted to the Regional Water Board in compliance with MRP provision C.11/12.g. The loads reduced quantification methods described in this report:

- Provide MRP Permittees with methodologies to assess progress towards WLAs assigned to urban stormwater runoff in the PCBs and mercury TMDLs;
- May be used to evaluate the effectiveness of true source controls, source controls, and treatment controls currently implemented or planned for implementation in the Bay Area; and

- Include concepts of "baseline," "current," and "enhanced" levels of control measure implementation, which will allow Permittees to calculate load reductions attributable to new or enhanced control measures.

Terminology used in this report includes the following:

- **Baseline Load** – The mass of a pollutant discharged annually to the Bay via urban stormwater or discharged to urban stormwater via a specific pollutant source or source category (e.g., mercury devices) at the time that the TMDL was developed. The baseline urban stormwater load to the Bay is typically included in a TMDL report. Baseline load of a pollutant to urban stormwater from a specific source or source category is generally estimated via studies or calculations.
- **Current Load** – The mass of a pollutant discharged annually to the Bay via urban stormwater or discharged to urban stormwater via a specific pollutant source or source category during a year of interest that occurs after the date used to establish the baseline load. The current urban stormwater load to the Bay is typically estimated based on the difference between baseline load and load reductions/avoided, or empirical estimates of current loads. The current load of a pollutant to urban stormwater from a specific source or source category is generally based on an estimate via studies or calculations.
- **Baseline Load Reduction/Avoidance** – The mass of a pollutant reduced or avoided (could be based on an average) on an annual basis prior to the collection of data used to develop a TMDL Urban Stormwater Waste Load Allocation. For PCBs and mercury, the applicable date is July 1, 2002.
- **Current Load Reduction/Avoidance** – The mass of a pollutant reduced or avoided (could be based on an average) in a year of interest that occurs after the date used to establish baseline.
- **Enhanced Load Reduction/Avoidance** – the difference between baseline and current loads reduced/avoided.

B.1.8 Organization of IMR Part B

Each of the following sections included in this report pertains to a specific type of control measure. Each section includes the following information:

- Summary of MRP requirements associated with the control measure type;
- Status of control measure implementation, including baseline (pre-TMDL), current (Post-TMDL), and enhanced implementation;
- Descriptions of loads avoided/reduced calculation methodology;
- Estimates of baseline and current loads avoided/reduced; and

- A summary of uncertainties associated with control measure effectiveness and loads avoided/reduced calculations.

Information available on the effectiveness of each control measure at the time the IMR Part B was developed is contained in each section. As additional information becomes available, Permittees may choose to update (through revisions or by addenda) this report.

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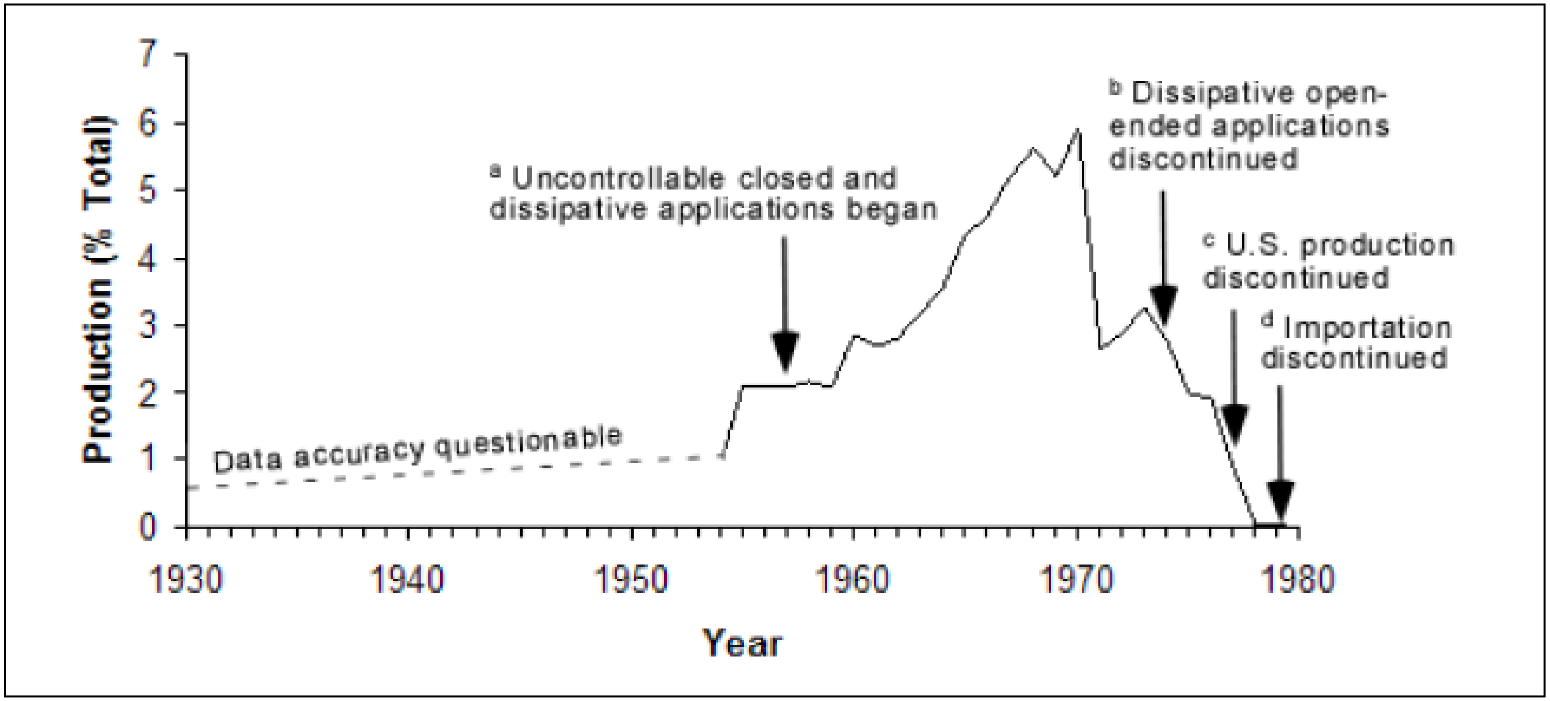
FIGURES B.1

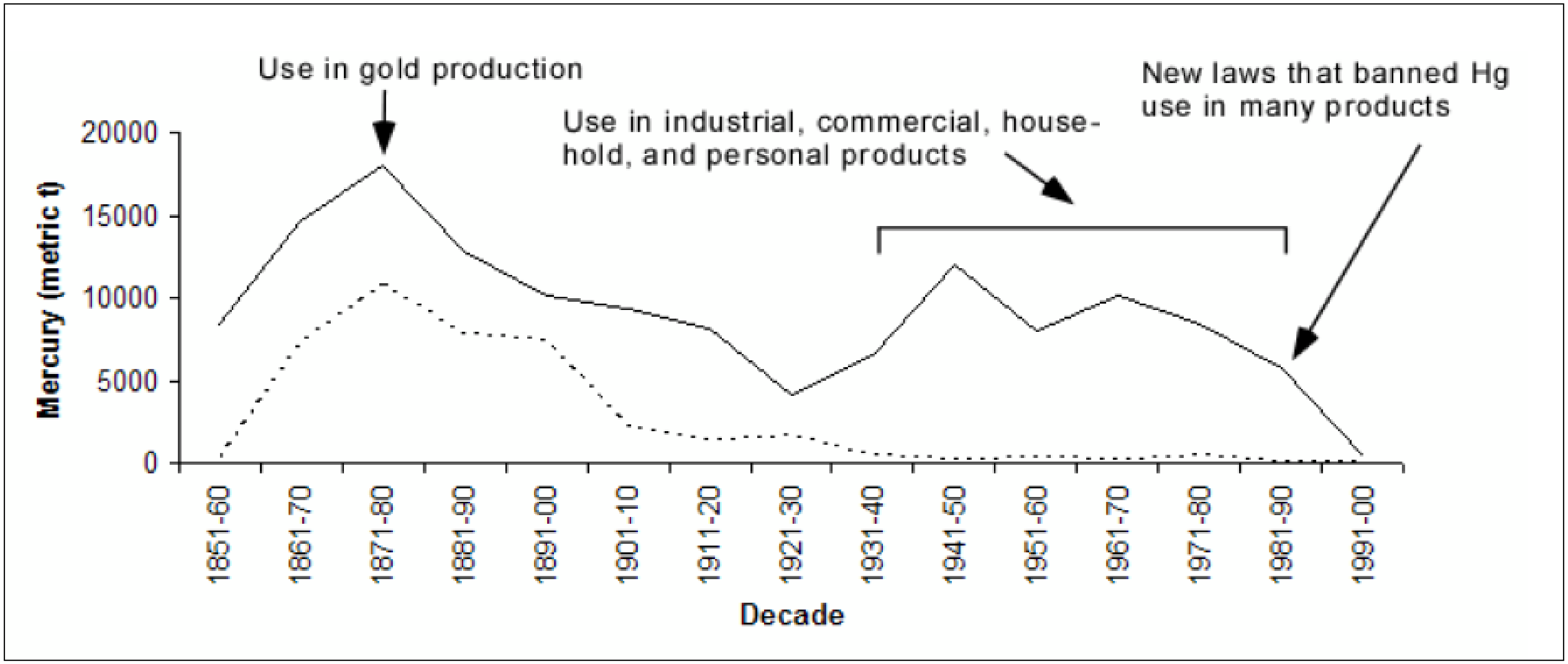


Annual Production of Polychlorinated Biphenyls (PCBs) in the U.S. from 1930 to 1970

Source:	Notes:
United States Environmental Protection Agency (1987)	

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	November 2013	B.1.1

internal info: path, date revised, author

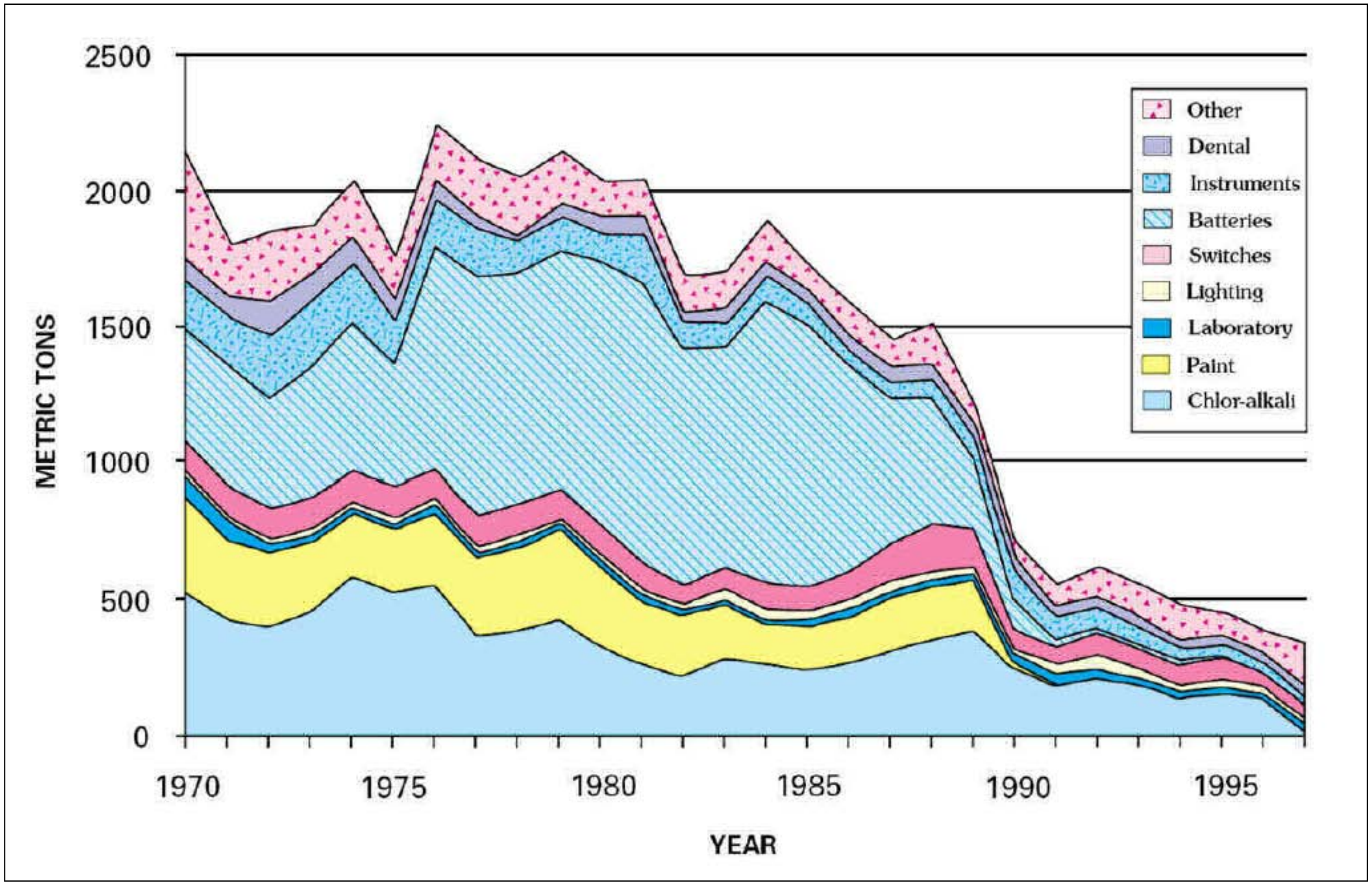


Source:	Notes:
McKee et al. (2006)	Mercury Production in the U.S (dark line) New Almaden Mining District (dotted line)

Mercury Production in the U.S and New Almaden Mining District between 1850 and 2000

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	November 2013	B.1.2

internal info: path, date revised, author

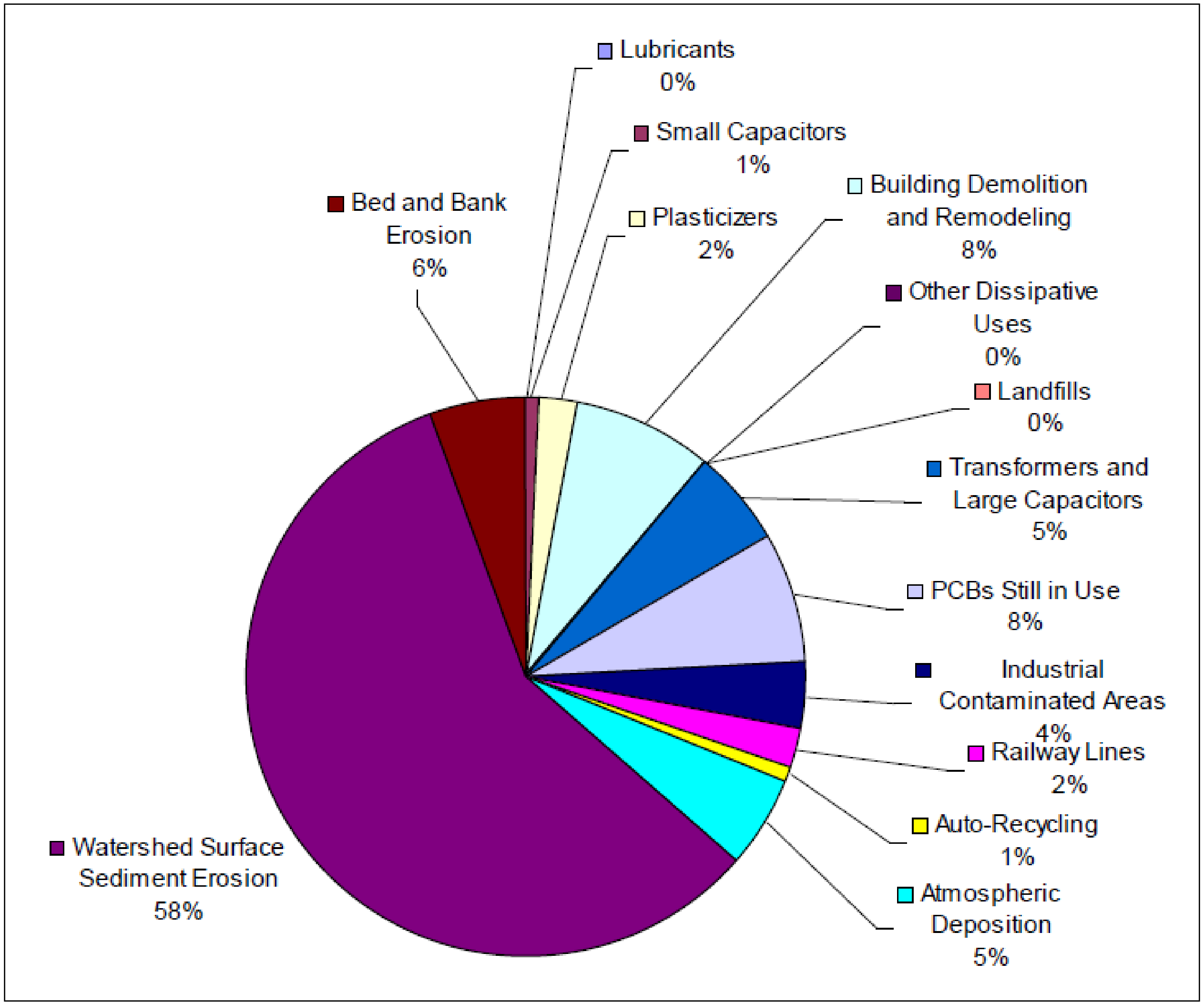


Mercury Use in the U.S. Between 1970 and 2000

Source:	Notes:
Sznopek (2000)	

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	November 2013	B.1.3

internal info: path, date revised, author

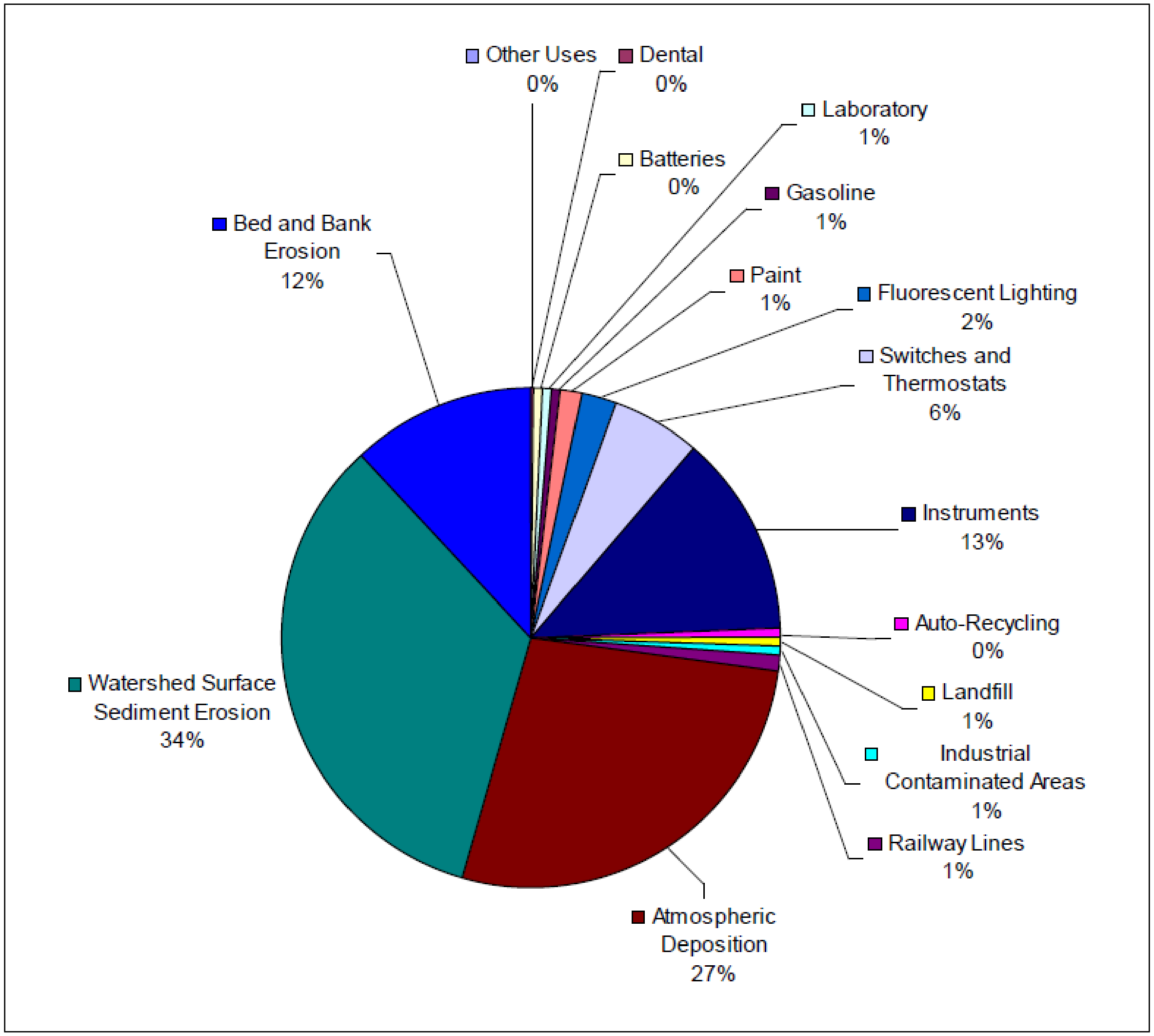


Estimated Relative Sources of PCBs to Bay Area Urban Stormwater Runoff

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	November 2013	Figure B.1.4

Source:	Notes:
McKee et al. (2006)	

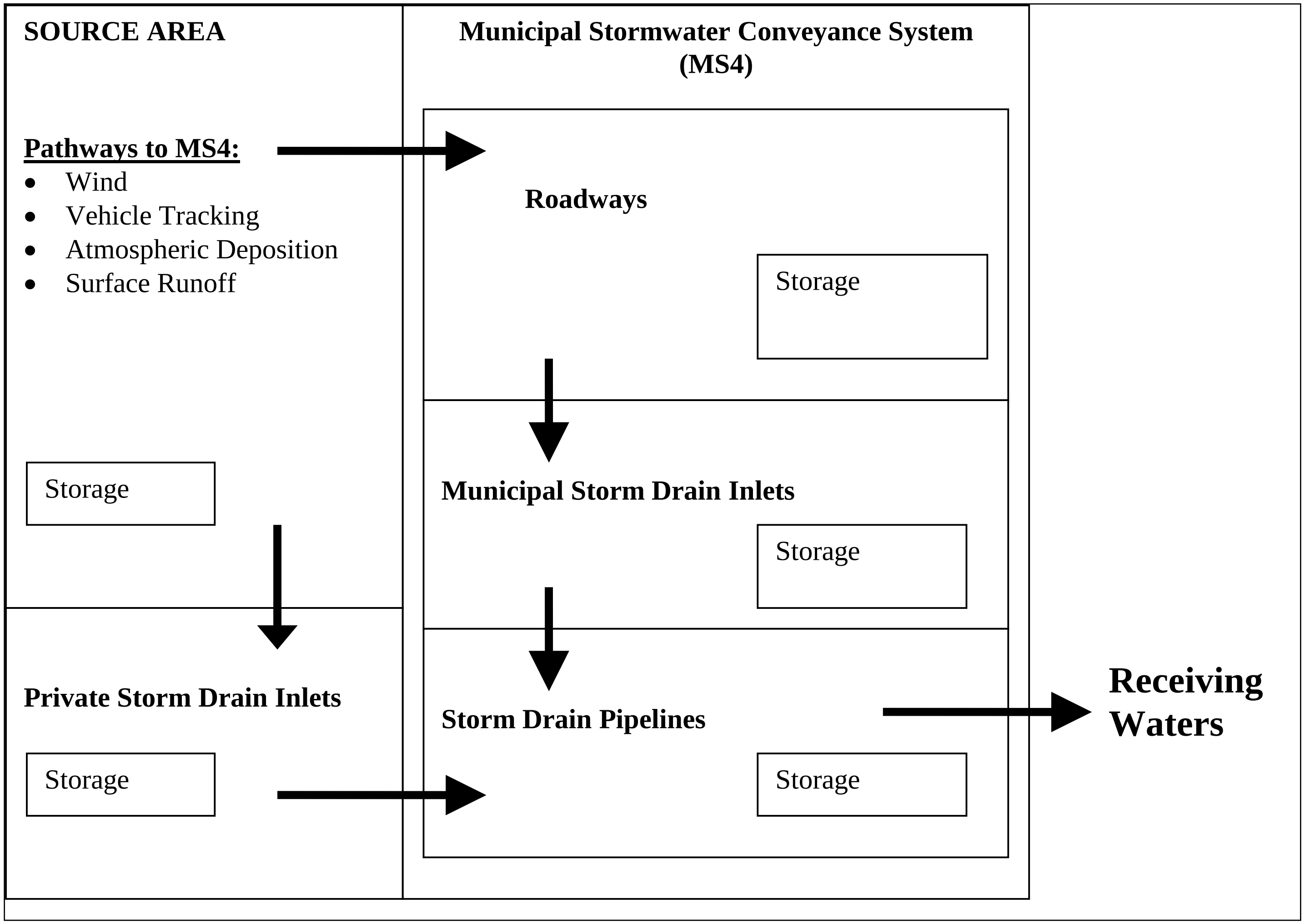
internal info: path, date revised, author



Estimated Relative Sources of Mercury to Bay Area Urban Stormwater Runoff

Source:	Notes:
McKee et al. (2006)	

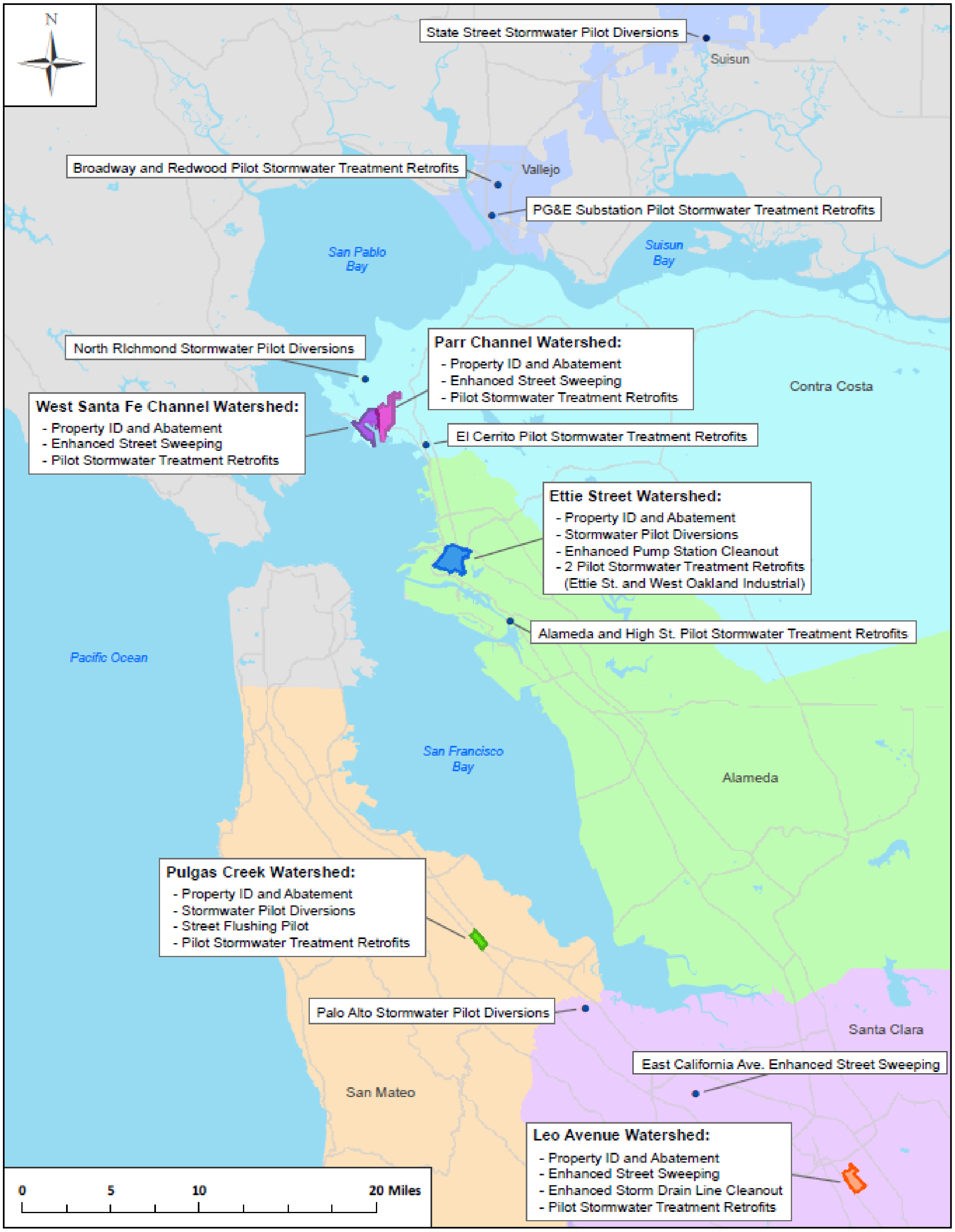
Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	November 2013	B.1.5



Conceptual Model of Pollutant Sources and Transport Pathways through an Urban Stormwater Conveyance System to Receiving Waters

Source:	Notes:	Entity	Date	Figure
EOA (2012)		Bay Area Stormwater Management Agencies Association	November 2013	B.1.6

internal info: path, date revised, author



Bay Area Pilot Stormwater Control Measures for PCBs and Mercury

Source:
EOA (2013)

Bay Area Stormwater Management Agencies Association

Entity	Date	
Bay Area Stormwater Management Agencies Association	November 2013	Figure B.1.7

B.2 MERCURY RECYCLING

B.2.1 Introduction

For over a century, mercury has been used in a wide variety of consumer devices, equipment and products. Because it is liquid at room temperature and it expands at a uniform rate with increasing temperature, mercury in its elemental form is used in measurement devices such as thermometers. Mercury is also used in a variety of electrical devices, such as switches and lamps (i.e., light bulbs) because it conducts electricity efficiently. These items can release mercury into the environment when broken or disposed of improperly. Once in the environment, mercury can potentially enter municipal separate storm sewer systems (MS4s) that discharge stormwater to San Francisco Bay.

First order estimates by McKee et al. (2006) attribute approximately 11-31% (18-53 kg/yr) of the total mercury in urban stormwater discharges to the Bay comes from improperly disposed mercury-containing devices and products. Control measures to reduce or avoid contributions of mercury to urban stormwater from these sources may assist municipalities in achieving water quality goals that were established through the adoption of the Total Maximum Daily Load (TMDL) for Mercury in San Francisco Bay (SFBRWQCB 2006).

Mercury production and use in the U.S. peaked in the1970s. Since that time, the total amount of mercury used in devices, products and other applications in the U.S. has been substantially reduced (Sznopek 2000). Additionally, since 2000 the mass of mercury in most new products and devices, such as lamps and auto switches has decreased on a per product/device basis (NEWMOA 2008). New regulations regarding the recycling of mercury-containing devices have also been enacted by the United States Environmental Protection Agency (USEPA) and the State of California since 2000, and local municipalities have increased their efforts to encourage individuals and businesses to recycle mercury-containing devices. These significant reductions in the amount of mercury used, and the enhanced recycling of mercury-containing devices/products suggests that the amount of mercury in Bay Area urban stormwater may have decreased since the monitoring data used to establish the load reduction goals in the TMDL was collected in 2002.

This purpose of this section of the Integrated Monitoring Report (IMR) – Part B is to:

- Describe control measures implemented to-date by Bay Area municipalities to effectively reduce the mass of mercury to the San Francisco Bay from MS4s from mercury-containing devices, products and equipment;
- Present a methodology for estimating the load avoidance or reduction that has been and will continue to be achieved as a result of enhanced management practices; and,
- Provide mercury load reduction estimates for Bay Area urban stormwater discharges that have occurred as a result of enhanced practices with a moderate level of confidence.

B.2.2 Summary of Major Types of Mercury-Containing Devices and Control Measures

B.2.2.1 MRP Requirements

Permittees are currently implementing controls measures to collect and recycle mercury-containing devices throughout the region. Provision C.11.a.i of the Municipal Regional Stormwater NPDES Permit (MRP) requires Permittees to promote, facilitate and/or participate in the collection and recycling of mercury-containing devices and equipment at the consumer level (e.g., thermometers, thermostats, switches, bulbs). Additionally, Provision C.11.a.ii requires Permittees to report on these efforts in their Annual Reports and provide an estimate of the mass of mercury collected via enhanced actions implemented post-TMDL (SFBRWQCB 2009).

Permittee and/or Countywide Program Annual Reports include descriptions of actions conducted by Permittees to promote and facilitate the collection and recycling of mercury–containing devices and equipment. Additionally, estimates of the mass of mercury collected via these actions are also provided. Summaries presented in this section of the IMR incorporate information gained from Annual Reports and other sources to provide a more robust estimate of mercury avoided via the collection and recycling of mercury-containing devices and equipment by Permittees and other entities. Part C of the IMR furthers the analysis by examining future implementation opportunities and benefits for these control measures.

B.2.2.2 Summary of Major Types of Mercury-Containing Devices and Control Measures

Mercury is present in a number of types of devices, equipment and products that may be handled and disposed of improperly. The types that represent the greatest mass of mercury potentially available to urban stormwater in the Bay Area are described below. Control measures applicable to mercury-containing devices and equipment that are discussed in this section of the IMR include the adoption of laws and regulations to reduce/eliminate mercury in devices/products/equipment (i.e., true source controls), and enhanced recycling of devices/products/equipment (i.e., source controls). Treatment controls are not discussed in this section.

Fluorescent Lamps

There are many types of lamps (i.e., light bulbs) manufactured and purchased in the U.S. The two main categories of lamps currently used in large quantities are incandescent and luminescent gaseous discharge lamps (e.g., fluorescent and low pressure sodium). High intensity discharge (HID) lamps (e.g., metal halide, ceramic metal halide, high pressure sodium, and mercury vapor) and neon lamps also comprise a portion of the lamp market, but to a much lesser degree than incandescent and luminescent gaseous discharge lamps.

Incandescent lamps do not contain mercury. Luminescent gaseous discharge lamps, specifically fluorescent lamps, contain mercury and are generally available in two types – tubular or compact. Tubular fluorescent lamps are mostly used in commercial or institutional buildings and usage is believed to have generally remained consistent over time. Compact fluorescent lamps (CFLs), however, are mostly used as energy-saving alternatives to incandescent lamps in homes and their use has increased substantially in recent years (DTSC 2008).

Both true source controls and source controls are currently being implemented to reduce/avoid the mass of mercury in urban stormwater associated with fluorescent lamps. True source controls began in the early 2000s when the lamp manufacturing industry began minimizing the mass of mercury present in fluorescent lamps, which inherently reduced the amount of mercury available to urban stormwater via this source/use.

A source control for lamps in the form of recycling is also used to reduce mercury releases to the environment. Technologies to reclaim mercury from spent lamps through recycling were developed in the U.S. starting in 1989. However, recycling did not drastically increase until the USEPA announced the addition of lamps to the Universal Waste Rule (UWR) in 1999 (ALMR 2003). Today, the State California's UWR prohibits the disposal of fluorescent lamps into landfills, regardless of the waste generator (household or business), and the California Department of Toxic Substances Control (DTSC) requires the safe management and recycling of fluorescent lamps.

Thermostats

Thermostats are commonly used in most homes and commercial facilities to regulate room temperature. Older mechanical thermostats often contain elemental mercury in glass bulbs called ampoules. Through the mishandling of thermostats during demolition and waste transport, ampoules can break and mercury can be emitted to urban land uses and impervious surfaces. Once emitted, mercury may become available for transport to the Bay via urban stormwater runoff.

Similar to fluorescent lamps, both true source controls and source controls are currently being implemented to reduce/avoid the mass of mercury in stormwater associated with thermostats. True source controls for thermostats began in 2006 through California Senate Bill (SB) 633, which banned the sale and distribution of mercury thermostats in California. Additionally, recycling is the primary source control used to reduce mercury releases to the environment from thermostats. Mercury thermostats are recycled by many entities, including household hazardous waste facilities operated by Permittees and the Thermostat Recycling Corporation (TRC), which was developed as a result of California's *Mercury Thermostat Collection Act of 2008* (AB 2347).

Switches and Relays

A mercury switch is a product that opens or closes an electrical circuit or gas valve, such as float switches, tilt switches, pressure switches, temperature switches, and flame sensors. A mercury relay is a product or device that opens or closes electrical contacts to effect the operation of other devices in the same or another electrical circuit, such as displacement relays, wetted reed relays, and contact relays. Mercury switches and relays have been used in many types of equipment and devices, including automobiles, where they for have been used in lighting controls (e.g., trunk lid lights), ride control, and anti-lock braking systems. Scrapped automobiles can leak mercury into the environment if these switches are not properly removed and managed.

Both true source controls and source controls are currently being implemented to reduce/avoid the mass of mercury in stormwater associated with switches and relays. True source controls began in 2005 as a result of the *California Mercury Reduction Act*, which banned the sale of vehicles manufactured on or after January 1, 2005, if they have light switches containing mercury. Source controls for auto-related switches and relays in the form of recycling are also used to reduce mercury releases to the environment from mercury switches and relays. Mercury switches and relays are recycled by many entities, including household hazardous waste facilities operated by Permittees and through the *National Vehicle Mercury Switch Recovery Program* (NVMSRP), which was initiated as a result of the *California Mercury Reduction Act*.

Other Instruments, Devices and Products

In addition to lamps, thermostats, switches and relays, many other types of devices, equipment and products contain mercury. For example, devices such as barometers, hydrometers, manometers, pyrometers, sphymonometers, and thermometers generally contain mercury. Mercury "button-type" batteries also can contain mercury. Additionally, novelty items used in practical jokes, figurines, toys, games, holiday decorations and footwear can also contain mercury.

Similar to other types of devices and products, both true source controls and source controls are currently implemented to reduce/avoid the mass of mercury in stormwater associated with instruments and novelty products. True source controls began to be implemented in 2003 as a result of the *California Mercury Reduction Act*, which banned the manufacture, sale, or distribution of mercury- added novelty items in California. Source controls for instruments and novelty products are also implemented in the form of recycling. Mercury products are recycled by household hazardous waste facilities operated by Permittees. Household hazardous waste facilities provide recycling opportunities for these devices/items, however tracking the amount of mercury recycled is challenging due to the heterogeneity in the types of novelties and the variability in the mass of mercury in each type.

B.2.3 <u>Status of Control Measure Implementation</u>

B.2.3.1 Baseline

Prior to 2002, the potential water quality impacts of improperly disposed of devices and products that contain mercury were known, but not widely publicized (USEPA 1997). Therefore, a very limited number of control measures designed to reduce the impacts of mercury devices/products on water quality were in place in the San Francisco Bay Area prior to the development of mercury load reduction goals for urban stormwater via the San Francisco Bay Area Mercury TMDL. Prior to 2002, mercury production and new uses in the U.S. continued to decrease, however many devices and products currently on the market in the U.S. at that time contained mercury. Additionally, programs that recycle mercury devices/products had not yet matured enough to cause a significant reduction in the amount of mercury entering the environment.

In summary, the most significant mercury control measures for devices, equipment and products that occurred prior to 2002 were:

- The adoption of emergency regulations in March 2000 by the California Department of Toxic Substance Control (DTSC) regarding the collection, transportation, recycling and disposal of "universal wastes." The emergency regulations designated several commonly used materials (including many mercury-containing devices and products) as "universal wastes" when they were disposed. The emergency regulations closely mirrored the federal Universal Waste Rule that became effective on January 6, 2000.
- The signing of the *California Mercury Reduction Act* of 2001 (Senate Bill 633) into law on October 9, 2001. The Act supported the objectives to reduce mercury releases to the environment by restricting certain consumer products that contain mercury. This bill prohibited the sale of mercury fever thermometers and novelty items, restricted school purchases of mercury items, and required special handling of mercury switches from discarded vehicles. Table B.2.3.1 lists each of the requirements of the Act.

As a result of these two significant actions taken by the State of California and the California Legislature, a number of associated mercury control measures have gone into place since that time. These "enhanced" (i.e., Post-TMDL) actions are described in the next section.

Table B.2.3.1. California Mercury Reduction Act Requirements and Effective Dates

Applicable Device Type	Requirement	Effective Date
Thermometers & Measuring Devices	Prohibits any K-12 school from purchasing devices and materials containing mercury for use in classrooms and labs, except measuring devices when no adequate alternative exists.	January 2002
Automobile Switches	Encourages removal and recovery of switches containing mercury, i.e., convenience lights under the hood or in the trunk, from vehicles before disposal or recycling of the vehicle.	January 2002
	Bans the sale of vehicles manufactured on or after January 1, 2005, if they have light switches containing mercury.	January 2005
Thermostats	Bans the sale of mercury thermostats.	January 2006

Applicable Device Type	Requirement	Effective Date
Thermometers	Bans the sale or distribution of fever thermometers containing mercury without a prescription from a doctor, dentist, veterinarian or podiatrist.	July 2002
Novelty Items	Prohibits the manufacture, sale, or distribution of mercury-added novelty items in California.	January 2003

B.2.3.2 Current

Building on the regulations and laws adopted prior to 2002, municipalities have enhanced their implementation of control measures designed to achieve reductions of mercury in urban stormwater discharges. The following section describes Post-TMDL actions that were conducted or caused to be conducted by Bay Area municipalities.

True Source Control Programs/Regulations (Mercury Load Avoidance)

The *California Mercury Reduction Act* adopted by the State of California in 2001 contains a number of true source controls that began to be implemented after 2002, including bans on the:

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

The implementation of the Act serves as "enhanced" control measures that result in a load of mercury avoided from entering urban stormwater. The requirements of the Act are currently enforced by the State.

In addition to the *California Mercury Reduction Act*, fluorescent lamps manufacturers continue to reduce the amount of mercury in lamps sold in the U.S. For example, effective October 1, 2010, lamp manufacturers associated with the National Electrical Manufacturers Association (NEMA) voluntarily capped the mercury content at 4 mg per CFL < 25 watts, and at 5 mg for 25 to 40 watt CFLs (NEMA 2010).

Additionally, manufactures have significantly reduced the amount of mercury in fluorescent linear tube lamps. U.S. EPA (1998) estimated that prior to 1997, a four foot linear fluorescent tube averaged between 15 and 41 mg per tube, depending on the year of manufacture and tube type (T8 or T12 types). Since that time, the average amount of mercury per tube has decreased to roughly 8 mg (NEMA 2005). The decrease is largely attributable to manufacture cost-savings and consumers preferentially choosing lamps that are smaller and more energy-efficient (e.g., T8 types). These actions serve as enhanced control measures that reduce the mass of mercury available to enter urban stormwater.

Mercury Device Recycling Programs (Mercury Load Reduction)

With regard to the Universal Waste Rule, permanent regulations were approved by the California Office of Administrative Law (OAL) and adopted on February 20, 2003, to effectively replace the emergency regulations established in 2000. The permanent regulations are found in Title 22 (Division 4.5) of the California Code of Regulations (CCR). In California wastes become universal wastes when DTSC defines them in as such in State regulations. Devices, equipment and products defined as universal wastes to-date by DTSC's of include mercury-containing thermostats, switches and lamps.

The Universal Waste Rule and DTSC's designations apply to both large and small quantity handlers of universal waste. A large quantity handler is one who has more than 5,000 kilograms (5.5 tons) of universal waste onsite (at any one place of business) at any one time. A small quantity generator has less than this amount of waste onsite at any one time.

There are generally three types of programs that promote and facilitate the collection and recycling of mercury–containing devices and products:

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

Enhanced control measures were implemented via each of these programs after 2002 and are summarized in the following sections.

HHW Drop-Off Facilities and Curbside or Door-to-Door Pickup

Bay Area household hazardous waste (HHW) facilities and associated activities target residents and exempted small universal waste generators (e.g., small businesses). Permittees effectively manage and/or promote permanent HHW drop-off facilities where residents and small business owners can recycle mercury-containing devices such as fluorescent lamps, thermostats and mercury thermometers. Permanent HHW drop-off facilities in the MRP area (five counties) are located in the cities of Oakland, Hayward, Berkeley, Freemont Livermore, Richmond, San Pablo, Martinez, Antioch, San Jose, Palo Alto, Fairfield, American Canyon (for Vallejo) and San Mateo. In addition, some Permittees work through agreements with their franchise waste haulers to have a door-to-door collection of mercury-containing universal wastes for residents. These Permittees include the cities of Belmont, Foster City, Hillsborough, Menlo Park, San Mateo, Cupertino, Albany, Emeryville, Piedmont, Union City, Clayton, Orinda, Daly City, Half Moon Bay, and Santa Clara. Many Permittees also facilitate and organize HHW drop-off events within their jurisdiction, typically in conjunction with other events such as Earth Day. Permittee involvement ranges from promotion of the event to residents, to providing a facility for the event. These events range from one event per-year to weekly drop-off events.

Permittees promote mercury-recycling events via their own public outreach and through participation in countywide and region-wide programs. Permittees advertise events in local newspapers or on television, issue press releases to local media, and include articles in local newsletters. Some Permittees also include promotional material for mercury-recycling events on utility bills and City calendars. Collection sites and special drop-off events are often advertised on flyers posted in public places such as libraries, community centers, retirement communities, City/Town Hall and on maintenance trucks.

As a result of enhanced control measures to promote, facilitate and manage HHW activities, MRP Permittees have collectively collected and recycled nearly 2 million pounds of fluorescent lamps and over 9,000 pounds of mercury thermostats, switches and thermometers from households and small businesses between Fiscal Years 2002-03 and 2011-12. Table B.2.3.2 lists the pounds of mercury devices and products collected via HHW facilities and associated activities in each MRP county during this timeframe. As illustrated in Figure 1, mercury device recycling has consistently increased during this timeframe.

Table B.2.3.2. Mercury-Containing Device Collection by Permittee Managed HHW Facilities, Drop-Off Events and Door-to-Door Pickup Between 2002 and 2011

Device Type	Alameda	Contra Costa	San Mateo	Santa Clara	Solano	Total
Fluorescent Lamps (kg)	168,927	185,046	142,716	384,006	3,746	**884,440**
Mercury Thermostats (kg)	55	119	0	441	0	**615**
Mercury Switches & Thermometers (kg)	621	880	619	1,430	5	**3,554**

Device/Product Take-Back and Recycling Programs

In addition recycling at HHW facilities and events that are sponsored by Permittees, a number of businesses that sell, manufacture or remove mercury-containing devices also serve as collection sites. For example, California's *Mercury Thermostat Collection Act of 2008* (AB 2347) requires that by 2009 thermostat manufacturers establish a collection and recycling program for out- of-service mercury-added thermostats. The Thermostat Recycling Corporation (TRC) serves as the collection and recycling program for manufacturers in California (TRC 2010). The TRC provides collection containers to HVAC wholesalers, thermostat retailers, and HVAC contractors for a one-time charge. Collection containers are also provided by the TRC to HHW facilities at no cost.

Aside from HHW-related activities, mercury thermostats were not collected and recycled in the Bay Area prior to 2008. Since the TRC program began in Fiscal Year 2008-09, the TRC has collected nearly 8,000 mercury thermostats from Bay Area businesses (see Figure 2), in addition to thermostats collected via HHW activities.

The *National Vehicle Mercury Switch Recovery Program* (NVMSRP) also provides a mechanism for recycling mercury-containing devices. The NVMSRP, in coordination with the DTSC and the California Scrap Automobile Dismantlers Association, provides incentives to dismantlers to remove mercury-containing switches from scrap vehicles before they are shredded and used to make new steel. The NVMSRP began in 2006 when U.S. EPA announced a national program to recover 80-90 percent of available mercury switches from scrap automobiles. The NVMSRP, primarily through the End of Life Vehicles Solution (ELVS) Corporation, provides educational materials, collection supplies, free shipping and monetary incentives to automobile dismantlers.

An estimated 144,000 mercury-containing automobile switches have been recycled to-date in the Bay Area as a result of the NVMSRP (NVMSRP 2013). As illustrated in Figure 3, the number of switches recycled peaked in 2005-06 and has slowly declined since that time. In California, this may be partially due to the *California Mercury Reduction Act*, which banned the sale of vehicles manufactured on or after January 1, 2005, if they have light switches containing mercury. The NVMSRP is scheduled to continue until 2017, based upon an estimate that all available mercury vehicle switches will have been collected by that year.

In addition to recycling efforts to target specific mercury-containing devices, a number of businesses that sell devices, also serve as collection sites. Some of the larger participating businesses include hardware stores such as Ace Hardware, Home Depot, Lowe's and Orchard Supply Hardware. Home Depot in particular launched a national campaign to collect and recycle compact fluorescent lamps from consumers. Additional stores such as IKEA, Best Buy, Goodwill and the Salvation Army also provide collection points for universal wastes. These businesses work directly with waste management businesses to transport and recycle devices/products and not directly associated with the HHW facilities. Permittees, however, promote businesses that collect universal waste through using similar methods as those related to HHW facilities and events.

Private Waste Management Services

Non-exempt small and large universal waste generators are also required to properly manage and recycle mercury-containing devices and products in accordance with federal and State laws. For certain types of devices, small and large business likely generate significantly higher levels of universal waste than residents. Specifically, the Association of Lighting and Mercury Recycling estimates that businesses use approximately 80% of the fluorescent lamps in the U.S. (ALMR 2003). Similar to households and exempt small waste generators, moderate and large businesses are also required to recycle mercury lamps. Spent lamps from businesses are generally collected through agreements with private waste management companies, which in turn ship lamps to recycling facilities. Although the number of fluorescent lamps has likely increased as a result of increased awareness of energy efficiency, data regarding the number of fluorescent lamps used by businesses annually and recycling rates are generally unknown.

B.2.4 Estimates of Loads Avoided/Reduced

B.2.4.1 Loads Avoided/Reduced Methodology

This section describes the methodology used to estimate urban stormwater load reductions that have occurred as a result of enhanced control measures for mercury- containing devices, equipment and products. The methodology is based on current and historical information regarding the baseline and current use of mercury devices, the mass of mercury in each type of device, the recycling rates of devices, and assumptions regarding the percentage of mercury that would enter Bay Area urban stormwater if the devices were not properly managed.

The methodology incorporates both mercury loads that were "avoided" via the implementation of true source controls, and loads "reduced" via enhanced source controls. The overall loads avoided/reduced formula for mercury-containing devices is as follows:

$$HgReductionL/S/T = BaseLoadL/S/T - CurLoadL/S/T \qquad \text{Eq. 1}$$

Where:

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

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

And;

$$BaseLoadL/S/T = BaseMassL/S/T \bullet BaseNumL/S/T \bullet T \qquad \text{Eq. 2}$$

$$CurLoadL/S/T = CurMassL/S/T \bullet CurNumL/S/T \bullet T \qquad \text{Eq. 3}$$

Where:

$BaseMass_{L/S/T}$ = *Average mass of total mercury in each lamp (L), switch (S), and thermostat (T) in 2002*

$CurMass_{L/S/T}$ = *Average mass of total mercury in each lamp (L), switch (S), and thermostat (T) in year of interest*

$BaseNum_{L/S/T}$ = *Number of lamps (L), switches (S), and thermostats (T) improperly discarded into the environment in 2002*

$CurNum_{L/S/T}$ = *Number of lamps (L), switches (S), and thermostats (T) discarded into the environment improperly in year of interest*

T = *% of total mercury in lamps (L), switches (S), and thermostats (T) that when improperly discarded are transported to the Bay via urban stormwater*

And;

BaseNumL/S/T	=	*BaseSpentL/S/T - BaseRecycleL/S/T*	*Eq. 4*
CurNumL/S/T	=	*CurSpentL/S/T - CurRecycleL/S/T*	*Eq. 5*

Where:

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

B.2.4.2 Loads Avoided/Reduced by Practices

The purpose of this section is to estimate the load reduction achieved through the implementation of enhanced management practices for the recycling of mercury-containing devices and equipment, and regulations and voluntary efforts to reduce the amount of mercury in such devices/equipment. As described in the previous section, estimates of loads reduced and avoided via these actions account for the mass of mercury removed prior to the enhancement of management actions implemented before the adoption of the Mercury TMDL for the San Francisco Bay. Mercury load reduction and avoidance estimates are based on the best available information and the assumptions described in the following sections.

Fluorescent Lamps

Information used to estimate mercury reductions to urban stormwater as a result of increased recycling of mercury-containing lamps and reduction in the mass of mercury in lamps was obtained from a variety of sources, but primarily the California Department of Resources Recycling and Recovery (CalRecycle). Assumptions used to estimate that mass of mercury reduced and avoided via management actions are included below.

- **Lamp Mercury Mass** *($BaseMass_L$ & $CurMass_L$)* – The mercury content can vary between bulb types, manufacturer and the date of production. Based on U.S. EPA (1999), the mercury content in linear tube fluorescent lamps sold before 1997 were between 3.75 and 10.25mg per linear foot of lamp, or 5.25mg on average per linear foot of lamp (T8 and T12 types). This mass per lamp foot estimate serves as the baseline mass estimate for the purposes of calculating load reduction estimates. Since 1999, manufactures have reported significant reductions in the mercury content in fluorescent linear tube lamps. The average mass of mercury per linear foot of fluorescent tube lamps reported currently averages 2 mg per foot (NEMA 2005). Additionally NEMA (2010) recently announced that participating manufacturers will cap the total mercury content in CFLs that are under

25 watts at 4mg per unit, and CFLs that use 25 to 40 watts of electricity will be capped at 5mg per unit. For the purpose of calculating load reductions, CFLs are assumed to contain an average of 4.5mg per unit.

HHW recycling data are collected in weight and therefore factors developed by CalRecycle (2013) were utilized to convert linear tube feet and CFL units to weight (mg). CalRecycle estimates that one-foot of linear lamp weighs 0.057 kg and each CFL unit weighs 0.113 kg, on average. Using the mercury mass per foot or CFL unit estimates presented in the previous paragraphs, and the conversion of linear tube foot and CFL unit to weight presented above, the baseline mass of mercury per kilogram of linear fluorescent lamps or CFLs is 93mg/kg. The mercury mass per linear foot or CFL in FY 2011-12 is assumed to be 35 mg/kg. The mercury content of lamps in years between baseline and FY 2011-12 were estimated based on interpolation of baseline and current masses. Mercury mass per kg of lamps are listed in Table B.2.5.

- **End-of-Life Lamps (**$BaseSpent_L$ & $CurSpent_L$**)** – Records of fluorescent lamps reaching their end-of-life in baseline and years of interest are not available. That said, the U.S. Department of Energy periodically conducts lighting market characterization studies that include surveys of the number and types of fluorescent lamps currently used in residential and commercial/industrial buildings around the U.S. (U.S. DOE 2011). Studies were conducted in 2001 and 2010, and results were used to estimate the lamps that reached their end-of-life in baseline (2001) and current (2010) years in the U.S. Numbers of lamps in the five MRP-associated counties were assumed to be proportional to population. For simplicity, estimates assume that the number of lamps reaching their end-of-life in a baseline year or in a year of interest is equal to the number of lamps purchased in that year. Standard conversion rates consistent with CalRecycle were used to convert numbers of lamps to pounds. Table B.2.4.1 provides a summary of estimated lamps reaching their end-of-life during baseline and current years. End-of-life estimates are provided for both residential and commercial/industrial facilities.

Table B.2.4.1. Estimates of Fluorescent Lamps Reaching Their End-of-Life in MRP-Counties during Baseline and Current Years

Land Use	CFLs (kg)	Linear Tube (kg)	Total (kg)
Residential			
Baseline (*circa* 2001)	154,430	2,440,798	2,595,229
Current (*circa* 2010)	2,758,777	2,483,895	5,242,672
Commercial & Industrial			
Baseline (*circa* 2001)	312,842	6,703,975	7,016,818
Current (*circa* 2010)	451,803	7,779,943	8,231,746

- **Lamps Recycled (***$BaseRecycle_L$ & $CurRecycle_L$*) - Records of lamps that were recycled at Bay Area HHW facilities between FYs 1993-94 and 2011-12 were obtained from CalRecycle (2013). All data provided by CalRecycle were presented in weight. Lamps recycled in FY 2001-02 serve as baseline. Lamps recycled on a per year basis post-FY 2001-02 are assumed to represent current lamp recycling. Reported mass of lamps collected via MRP-associated HHW facilities are provided in Table B.2.4.2. Commercial and industrial facility recycling rates are not well understood and therefore are not included in load reduction calculations presented in this section.

- **% Transported via Stormwater (T) -** While the mechanics of elemental mercury portioning and runoff are complex, the estimated percentage of mercury in fluorescent lamps that is transported to the Bay via urban stormwater by Mangarella et al. (2010) as part of the *Desktop Evaluation of Controls for Polychlorinated Biphenyls and Mercury Load Reduction*. The estimate considers elemental mercury volatilization rates (Barr Engineering 2001), Henry's Law of water/air solubility, and water/soil portioning. Additionally, the level of imperviousness in the urbanized Bay Area is also taken into account. Based on these considerations, Mangarella et al. (2010) estimates that roughly 4.8% of mercury in fluorescent lamps is transported to the Bay via urban runoff.

Table B.2.4.2. Fluorescent Lamps Collected by Permittee Managed HHW Facilities, Drop-Off Events and Door-to-Door Pickup Between FY 1993-94 and FY 2011-12

Fiscal Year	**Alameda** (kg)	**Contra Costa** (kg)	**San Mateo** (kg)	**Santa Clara** (kg)	**Solano** (kg)	**Total** (kg)
1993-94	23	NR	NR	NR	NR	23
1994-95	139	NR	NR	NR	NR	139
1995-96	88	7	NR	140	NR	235
1996-97	311	2,933	NR	348	NR	3,592
1997-98	295	445	NR	208	NR	948
1998-99	596	4,655	NR	322	NR	5,572
1999-00	249	2,037	NR	289	NR	2,576
2000-01	1,110	2,741	NR	733	NR	4,584
2001-02 (Baseline)	1,384	3,210	1,371	2,241	NR	8,205
2002-03	2,183	2,538	3,737	3,592	217	12,268
2003-04	2,835	3,817	NR	6,216	139	13,008
2004-05	13,193	8,614	13,406	26,946	385	62,544
2005-06	3,806	4,460	7,975	22,714	93	39,049
2006-07	12,717	20,887	15,532	45,875	273	95,284
2007-08	25,007	27,234	22,385	67,192	494	142,311
2008-09	25,826	26,748	24,157	50,373	858	127,963
2009-10	20,407	25,511	28,282	50,130	988	125,318
2010-11	34,539	34,184	7,641	48,331	208	124,903
2011-12	28,414	31,052	19,601	62,636	90	141,792
Totals	**173,122**	**201,073**	**144,087**	**388,286**	**3,746**	**910,315**

The estimated mass of mercury avoided and reduced from urban stormwater in the Bay Area post-2002 as a result of the implementation of true source controls and source controls for fluorescent lamps is illustrated in Table B.2.4.3. Estimates of the mercury load reduced or avoided by each county are provided at the end of this section.

It is important to note that only the mass of mercury recycled from lamps collected at HHW facilities was considered in the loads avoided/reduced analysis described above. Additional recycling of residential lamps occurs at hardware stores and other take-back locations. Additionally, each year, a substantial number of fluorescent lamps are used and reach their end-of-life at commercial and industrial facilities. Due to the lack of information on the recycling rates associated with these facilities, the mass of mercury avoided or reduced as a result these enhanced management of lamps was not reported. Therefore, the reported mass of mercury avoided/reduced in Table B.2.4.3 may be biased low.

Table B.2.4.3. Estimated Mass of Mercury Avoided or Reduced in Urban Stormwater in the MRP Area as a Result of Fluorescent Lamp Control Measure Implementation during FY 2002-03 to FY 2011-12

Fiscal Year	Base/Cur $Mass_L$	$Base/CurNum_L$		T	Base/Cur $Load_L$	Load $Reduction_L$
		Base/Cur $Spent_L$	Base/Cur $Recycle_L$			
	mg/kg	kg	kg	%	kg	kg
2001-02 (Baseline)	93	2,595,234	8,205	4.8%	11.5	**-**
2002-03	86	2,889,395	12,268	4.8%	11.9	**-0.4**
2003-04	80	3,183,556	13,008	4.8%	12.2	**-0.7**
2004-05	73	3,477,717	62,544	4.8%	12.0	**-0.5**
2005-06	67	3,771,878	39,048	4.8%	12.0	**-0.5**
2006-07	61	4,066,039	95,284	4.8%	11.6	**-0.1**
2007-08	54	4,360,199	142,311	4.8%	11.0	**0.5**
2008-09	48	4,654,360	127,963	4.8%	10.4	**1.1**
2009-10	42	4,948,521	125,318	4.8%	9.6	**1.9**
2010-11	35	5,242,682	124,903	4.8%	8.7	**2.8**
2011-12	35	5,536,843	141,792	4.8%	9.1	**2.4**

Mercury Thermostats

Information used to estimate mercury reductions to urban stormwater as a result of increased recycling of mercury-containing thermostats was obtained from CalRecycle (2013) and the TRC (2013). Assumptions used to estimate the mass of mercury reduced via management actions are described below.

- **Mercury Mass in Thermostats** *($BaseMass_T$ & $CurMass_T$)* – The mercury content can vary between thermostat types, manufacturer and the date of production. Based on information from the Thermostat Recycling Corporation (TRC), mercury thermostats contain between 1 and 2 ampoules of mercury, or 1.4 ampoules on average (TRC 2010).

Each ampoule contains an average of 2.8 grams of mercury, and therefore each mercury thermostat collected and recycled is assumed to contain 4 grams of mercury on average during both baseline and current years.

- **Number of End-of-Life Thermostats (**$BaseSpent_T$ & $CurSpent_T$) – The sale of mercury thermostats was prohibited in California in 2006. Therefore, the existing inventory of mercury thermostats should decrease overtime. Records of the total number of mercury thermostats reaching their end-of-life and available for recycling in the Bay Area during baseline and years of interest are not available. However, the State of California recently commissioned Skumatz Economic Research Associates, Inc. (SERA) to develop statistically robust estimates of the flow of mercury thermostats from residential & commercial buildings in the State (SERA 2009). Numbers of thermostats reaching their end-of-life from 2009-2024 were estimated based on surveying of the existing inventory of thermostats and considering their average life spans. Results of the SERA study were then used to develop current and baseline end-of-life estimates for the five MRP-associated counties based on the assumption that thermostat inventories are proportional to population. The number of thermostats reaching end-of-life during the baseline year (FY 2001-02) were developed using the linear regression developed by SERA (2009). Estimates of mercury thermostats reaching end-of-life FY 2001-02 (baseline) and subsequent years are presented in Table B.2.4.4.
- **Number of Thermostats Recycled (**$BaseRecycle_T$ & $CurRecycle_T$) - Numbers thermostats recycled at Bay Area HHW facilities between FYs 1993-94 and 2011-12 were obtained from CalRecycle (2013). Additional numbers of thermostats collected and recycled via Bay Area HVAC businesses and contractors, and reported to the TRC were also included in recycling estimates. Based on these data, no mercury thermostats were recycled in the Bay Area prior FY 2001-02. Therefore, the baseline number of thermostats recycled is assumed to be zero. Thermostats recycled on a per year basis after FY 2001-02 are assumed to represent current thermostat recycling. HHW recycling data are reported in weight and TRC data are reported in numbers of units recycled. To standardize units, each thermostat recycled is assumed to weigh roughly 12 ounces.
- **% Transported via Stormwater (T) -** While the mechanics of elemental mercury portioning and runoff are complex, the estimated percentage of mercury in thermostats that is transported to the Bay via urban stormwater by Mangarella et al. (2010) as part of the *Desktop Evaluation of Controls for Polychlorinated Biphenyls and Mercury Load Reduction*. The estimate considers elemental mercury volatilization rates (Barr Engineering 2001), Henry's Law of water/air solubility, and water/soil portioning. Additionally, the level of imperviousness in the urbanized Bay Area is also taken into account. Based on these considerations, Mangarella et al. (2010) estimate that roughly 4.8% of mercury in end-of-life thermostats is transported to the Bay via urban stormwater runoff.

Table B.2.4.4. Thermostats Collected at Permittee Managed HHW Facilities, Drop-Off Events and Door-to-Door Pickup, and the Thermostat Recycling Corporation (TRC) in FYs 1993-94 Through FY 2011-12

Fiscal Year	Alameda (kg)	Contra Costa (kg)	San Mateo (kg)	Santa Clara (kg)	Solano (kg)	Total (kg)
1993-94	0	0	0	0	0	0
1994-95	0	0	0	0	0	0
1995-96	0	0	0	0	0	0
1996-97	0	0	0	0	0	0
1997-98	0	0	0	0	0	0
1998-99	0	0	0	0	0	0
1999-00	0	0	0	0	0	0
2000-01	0	0	0	0	0	0
2001-02 (Baseline)	0	0	0	0	0	0
2002-03	0	0	0	0	0	0
2003-04	0	0	0	0	0	0
2004-05	0	94	0	0	0	94
2005-06	0	0	0	251	0	251
2006-07	0	0	0	0	0	0
2007-08	0	0	0	0	0	0
2008-09	258	50	115	178	21	622
2009-10	256	161	93	295	37	842
2010-11	181	104	52	474	35	845
2011-12	259	54	52	267	52	683
Totals	954	464	312	1,465	145	3,339

The estimated mass of mercury avoided and reduced from urban stormwater in the Bay Area post-2002 as a result of the implementation of true source controls and source controls for thermostats is illustrated in Table B.2.4.5. Estimates of the mercury load reduced or avoided by each county are provided at the end of this section.

It is important to note that the water quality impacts associated with mercury thermostats will continue to be reduced due to the passing of the *Mercury Reduction Act* in 2001, which outlaws the sale or distribution of mercury thermostats, the *Mercury Thermostat Collection Act* in 2008, and new regulations recently adopted by DTSC (2013), which requires thermostat manufacturers to annually meet increasingly stringent recycling goals until 2017. By 2024, SERA (2009) estimates that 82% of the mercury thermostats in residential and commercial/industrial buildings will reach their end-of-life and based on the 2013 DTSC regulations, recycling rates should increase substantially.

Table B.2.4.5. Estimated Mass of Mercury Avoided or Reduced in Urban Stormwater in the MRP Area as a Result of Mercury Thermostat Control Measure Implementation during FY 2002-03 Through FY 2011-12

Fiscal Year	Base/Cur $Mass_L$	$Base/CurNum_L$		T	Base/Cur $Load_L$	Load $Reduction_L$
		Base/Cur $Spent_L$	Base/Cur $Recycle_L$			
	g/kg	kg	kg	%	kg	kg
2001-02 Baseline	2.3	107,753	0	4.8%	11.7	-
2002-03	2.3	105,496	0	4.8%	11.5	**0.2**
2003-04	2.3	103,240	0	4.8%	11.2	**0.5**
2004-05	2.3	100,984	459	4.8%	10.9	**0.8**
2005-06	2.3	98,727	1,218	4.8%	10.6	**1.1**
2006-07	2.3	96,471	0	4.8%	10.5	**1.2**
2007-08	2.3	94,215	2	4.8%	10.3	**1.5**
2008-09	2.3	91,958	3,027	4.8%	9.7	**2.0**
2009-10	2.3	90,440	4,092	4.8%	9.4	**2.3**
2010-11	2.3	86,266	4,110	4.8%	8.9	**2.8**
2011-12	2.3	84,242	3,320	4.8%	8.8	**2.9**

Other Devices, Equipment & Products

In addition to lamps and thermostats, switches, relays, barometers, hydrometers, manometers, pyrometers, sphymonometers, and thermometers generally contain mercury and may be recycled once reaching their end-of-life. Similar to lamps and thermostats, both true source controls and source controls are currently implemented to reduce/avoid the mass of mercury in Bay Area urban stormwater. Recycling data are collected by HHW facilities and the National Mercury Vehicle Switch Recycling Program (NMVSRP) and can be used to calculate the mass of mercury recycled, however, all data inputs needed to calculate loads avoided and reduced consistent with methodologies described in the section above are currently unavailable. Therefore loads avoided/reduced estimates for control measures associated with these devices could not be calculated at this time.

B.2.4.3 Summary of Key Uncertainties

There are a number of sources of uncertainty in accurately estimating PCB and mercury loads avoided/reduced to San Francisco Bay associated with baseline and enhanced mercury device true source controls (load avoidance) and source controls (load reduction).

- The mass of mercury in thermostats and lamps varies between types, manufacturer and the date of production. The variation has not been fully documented and therefore the average mercury mass in each device or per weight of a device was used in the absence of incorporating variations into calculations.

- To calculate the number of end-of-life thermostats and lamps in the Bay Area statewide or national literature values were obtained and interpolated to the MRP counties relative to population. It is unknown whether the usage of mercury-containing devices is consistent with population.
- To estimate the percentage of mercury that reaches the environment that is transported to the Bay via urban stormwater, considerations of water/air and soil/water portioning were included in this percentage. However, elemental mercury portioning and runoff are complex and challenging to average.

B.2.5 References

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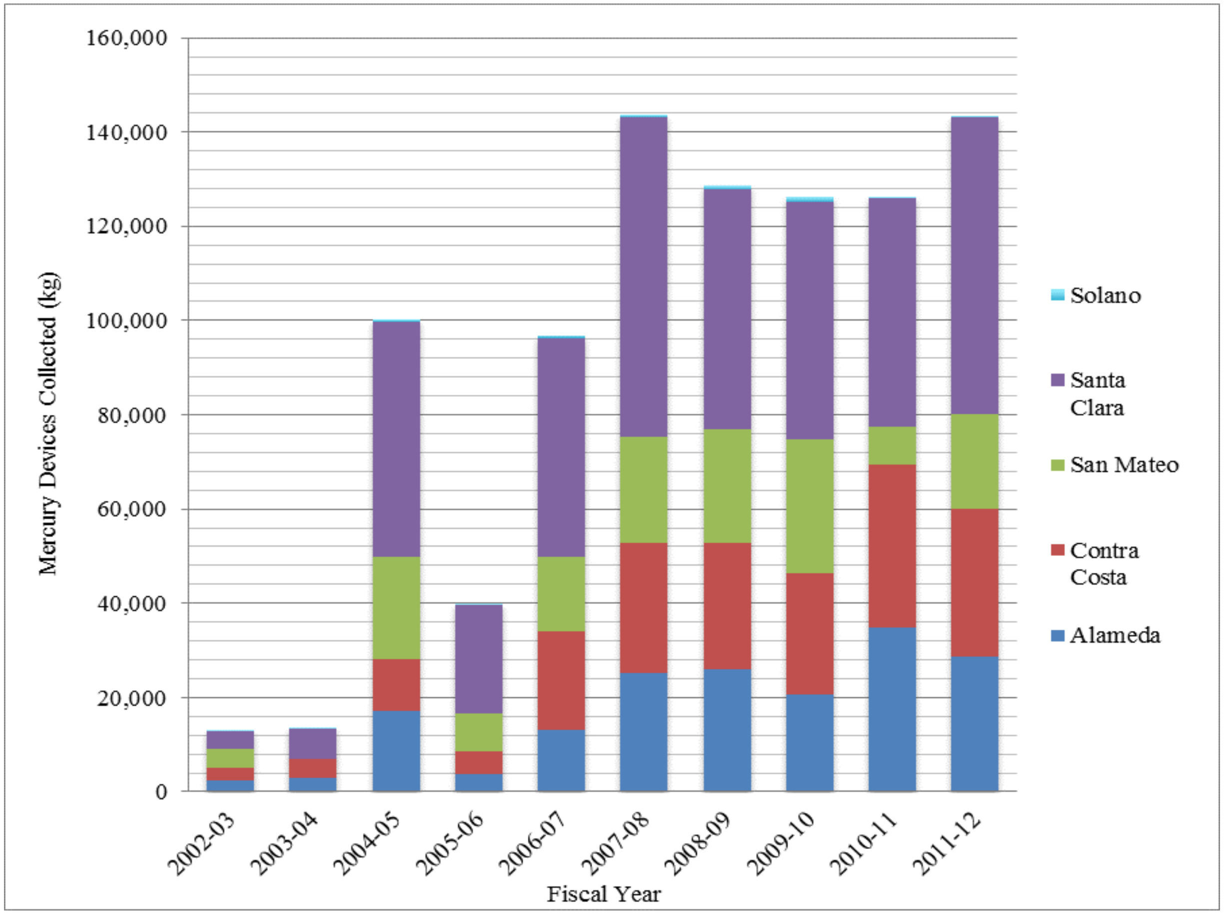
FIGURES B.2



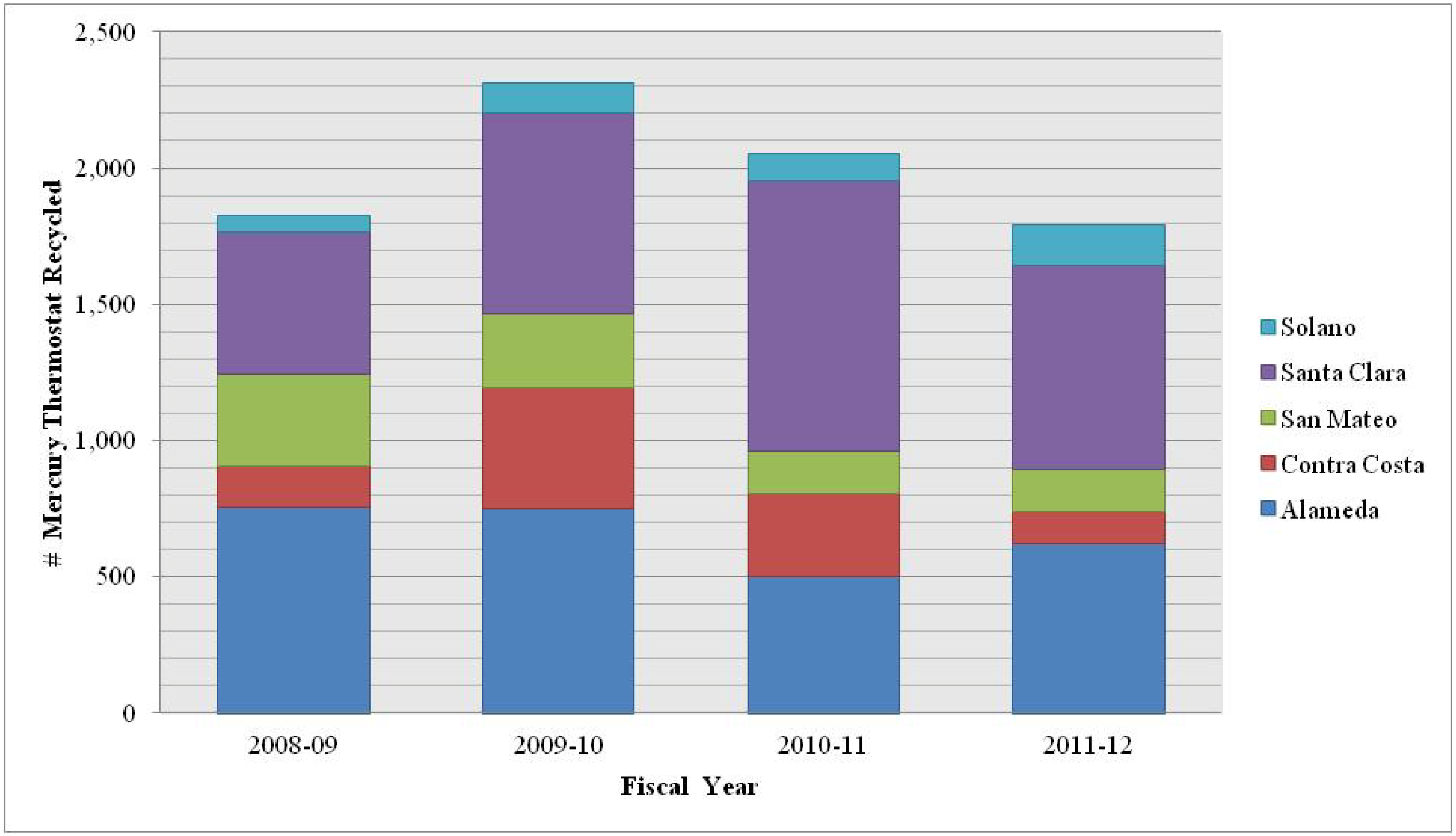
Kilograms of Mercury-Containing Devices Collected at Permittee-Managed HHW Facilities, Drop-Off Events and Door-to-Door Pickup from FY 2002-03 to 2011-12

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	September 2013	Figure B.2.1

Source:
CalRecycle 2012

Notes:
Includes all data reported to CalRecycle by Permittees

internal info: path, date revised, author

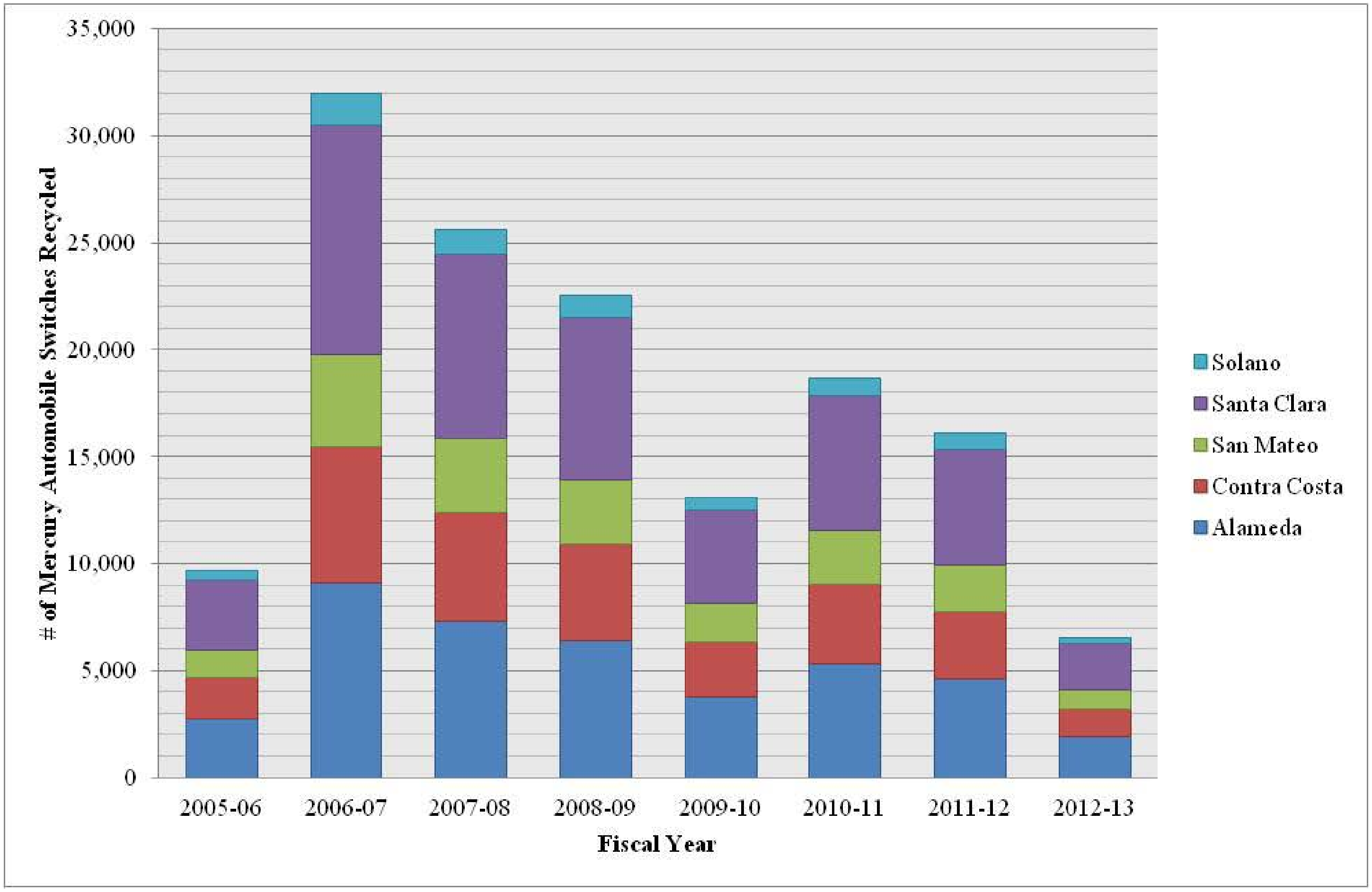


Number of Mercury-Containing Thermostats Collected and Recycled by the Thermostat Recycling Corporation (TRC) from Bay Area HVAC Contractors between FY 2008-09 to 2011-12

Source: Thermostat Recycling Corporation (2012)	Notes: May not include all thermostats collected by Household Hazardous Waste facilities

Bay Area Stormwater Management Agencies Association	September 2013	Figure B.2.2
Entity	Date	

internal info: path, date revised, author



Estimated Number of Mercury-Containing Automobile Switches in the Bay Area Collected and Recycled via National Vehicle Mercury Switch Recovery Program between FY 05-06 to 12-13

Bay Area Stormwater Management Agencies Association	September 2013	Figure B.2.3
Entity	Date	

Source: National Vehicle Merucy Switch Recovery Program (2013)	**Notes:**

internal info: path, date revised, author

B.3 IDENTIFICATION OF PCBS DURING INDUSTRIAL INSPECTIONS

B.3.1 Introduction

This section of the IMR summarizes Permittee activities to implement actions required under Municipal Regional Stormwater NPDES Permit (MRP) provision C.12.a – Incorporating PCB Identification into Existing Industrial Inspections. The reasoning behind this control measure is that since PCBs (polychlorinated biphenyls) were used in a variety of electrical devices and industrial equipment, some may be found during industrial inspections. Provision C.12.a requires the Permittees to ensure that industrial inspectors can identify PCBs or PCB-containing equipment during their inspections and that appropriate agencies are notified if they are found.

B.3.2 Summary of Incorporation of PCB Identification into Existing Industrial Inspections

B.3.2.1 MRP Requirements

Permittees are currently implementing controls measures to identify PCBs during industrial inspections at a full scale of implementation. MRP Permittees are collectively required to develop training materials and train municipal industrial building inspectors to identify, in the course of their existing inspections, Pollutants of Concern (POCs) or POC-containing equipment. Inspectors are then required to incorporate POC identification into their inspections, document incidents in inspection reports, and refer incidents to the appropriate regulatory agency as necessary. Permittees agreed to conduct activities in compliance with provision C.12.a through a combination of regional and Permittee-specific activities. Training materials were developed collectively by Permittees as a regional project and inspections and reporting were conducted by each Permittee. Each of these activities is described in the following sections.

B.3.3 Status of Control Measure Implementation

This section summarizes the level of implementation taken by Permittees to incorporate PCBs and PCB-containing equipment into industrial inspections. This information was gathered from Section C.12.a. of the 2011 and 2012 Annual Reports that Permittees submitted to the Regional Water Board. While most municipalities defer to their countywide program's reports in their Annual Reports regarding training and inspections for PCBs, a few have reported additional actions that they have taken to assist in identification of PCBs in industrial inspections. Information on the development of training materials, municipal staff trainings conducted to-date, and the results of inspections are included in the following sections.

B.3.3.1 Training Materials

The Bay Area Stormwater Management Agencies Association (BASMAA) developed training materials in 2010 to assist industrial stormwater inspectors in identifying three pollutants of concern (POCs) (i.e., copper, mercury, and PCBs) during stormwater inspections (BASMAA 2011). The training materials summarize the historical uses of these POCs and products that contain these POCs. The materials also discuss PCB identification strategies, possible pathways to the environment, ecological impacts, and applicable regulatory requirements and agencies. Included in the materials are a technical memorandum describing the materials, a guidance manual that provides information on sources, regulations, and proper management (storage, clean-up, and disposal) of POCs, a Microsoft PowerPoint™ presentation that may be used to train inspectors, and model inspection and reporting forms. Training materials were included in the BASMAA regional monitoring and pollutant of concern supplement to the FY 2009/10 Annual Report.

B.3.3.2 Staff Training

Using the training materials developed regionally, each countywide stormwater program has conducted multiple trainings on PCB identification for stormwater inspectors. Dates when trainings were conducted by the county-wide programs are provided in Table B.3.3.1. In addition, numerous Permittees have also supplemented the countywide program trainings within their municipalities.

B.3.3.3 Incorporation into Existing Inspections

As required by the MRP, Permittees reported the results of the initial training in their 2010 Annual Reports, and ongoing training and inspections for PCB identification in their 2011, 2012 and 2013 reports. Based on the review of Annual Reports, Permittees have incorporated PCB identification into their industrial stormwater inspection programs and utilized forms and checklists developed in the BASMAA regional project.

Table B.3.3.1. Training Dates for Identification of PCBs and PCB-Containing Equipment during Existing Industrial Inspections by Countywide Programs.

Countywide Program	Training Dates
Alameda Countywide Clean Water Program	June 2011 October 2012
Contra Costa Clean Water Program	July 2010 February 2011 October 2012 May 2013
San Mateo Countywide Water Pollution Prevention Program	June 2011 April 2012
Santa Clara Valley Urban Runoff Pollution Prevention Program	May 2011 June 2012 April 2013
Fairfield-Suisun Urban Runoff Management Program	August 2010 March 2012 February 2013

Some Permittees have integrated PCB identifications into all aspects of their existing industrial inspection programs. Others have focused on specific business types that have a relatively high risk for PCBs on-site. For example, inspectors from Contra Costa County have begun to focus attention on facilities that have the SIC code 4911 (Electric Utilities including Generation, Transmission and Distribution Facilities) and other SICs that identify PCB activities (e.g., rail yards and salvage yards).

B.3.3.4 Distribution of Outreach/Education Materials to Focused Businesses

A number of Permittees have begun distributing outreach/educational material regarding PCBs to individual businesses. Many of these materials were developed through the BASMAA regional project for training materials. Additionally, Contra Costa County has also developed its own guidance booklet from the BASMAA training materials which was mailed to industrial and commercial businesses in unincorporated parts of the County that may have PCBs onsite[4]. Contra Costa County inspectors have also been trained to educate owners and operators of these facilities on PCB BMPs.

B.3.4 Results of Inspections

Based on Permittee annual reporting in 2010, 2011, 2012 and 2013, no Permittees have reported the identification of PCBs or PCB-containing equipment during industrial inspections. A number of reports did indicate, however, that education/outreach materials regarding PCBs and associated equipment were distributed to facility owners/operators where PCBs or PCB-containing equipment may be present.

Permittee reports also suggest that although PCBs have not been identified to-date, PCB identification can be efficiently incorporated into existing industrial inspections via staff trainings and the use of materials developed via the BASMAA regional training project. Given the mass of PCBs believed to be currently in use at industrial facilities, identifying mislabeled PCB-containing materials or the inappropriate storage of PCB-containing equipment during a stormwater inspection at an industrial facility may prevent discharges of PCBs in the future.

B.3.5 Estimates of Loads Avoided/Reduced

B.3.5.1 Loads Avoided/Reduced Methodology

This section presents the conceptual approach that will be used to estimate PCBs stormwater loads avoided/reduced due to the implementation of PCB and PCB-containing equipment identification during industrial stormwater inspections.

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[4] From the Contra Costa Clean Water Program 2011 Annual Report: "The educational booklet includes topics related to Best Management Practices for PCBs; TSCA Regulations; Provision C.12 PCB Controls; Sources of PCBs; PCB-Containing Equipment; PCB Sources in Older Buildings; Industrial/Commercial Facilities of Concern w/PCBs; PCB-Containing Equipment Requirements: Equipment Labeling, Facility Labeling, Recordkeeping & Reporting; Regulatory Agencies for PCB Referrals; and Joint Provision C.11Mercury & C.12 PCB Municipal Requirements"

The total PCB load avoided due to stormwater inspections is difficult to quantify due the lack of available information about the mass of PCBs on the site of a particular facility and the associated discharge to a stormwater conveyance system. Because various types of PCB-containing equipment and products are included in a stormwater inspection, the load avoided due to inspection actions (e.g., labeling, storing, record keeping, disposal, and PCB spill clean-up) must be included in the method used to estimate loads avoided from stormwater conveyances. Typically, estimates of loads reduced and avoided control measures should account for the mass of PCBs removed prior to the enhancement of management actions implemented before the adoption of the PCB TMDL for the San Francisco Bay. However, considering that the incorporation of PCB identification into industrial inspections did not begin until after the TMDL was adopted, consideration of baseline (pre-TMDL) PCB load reduction and avoidance estimates is unnecessary in the methodology presented.

The methodology described below assumes that the PCBs from equipment and the mass of PCBs in equipment are known. The method also assumes that the percentage of PCBs avoided as a result of inspections that would enter Bay Area urban stormwater if the devices were not properly managed is also known. The methodology incorporates PCB loads that were "avoided" via the implementation of industrial inspections. The overall loads avoided/reduced formula for PCB-containing equipment identified during industrial inspections is as follows:

$$PCBReductionInd = CurMassIdentifiedInd \bullet T \qquad \text{Eq. 1}$$

where:

CurMassIdentifiedInd = *Total PCB mass identified in Industrial Facilities that may have been discharged in year of interest if the inspection would not have identified the PCB-associated equipment or materials.*

T = *% of total PCBs identified in industrial facilities that would have been transported to the Bay via urban stormwater if not identified during industrial inspection(s)*

B.3.5.2 Baseline and Currents Loads Avoided/Reduced

Based on the information gained from Permittee annual reports, PCBs and PCB-containing equipment have yet to be identified during existing industrial inspections post-TMDL adoption (July 1, 2002). Therefore, no PCB load reduction/avoidance should be accounted for as a result of incorporating PCB identification into industrial inspections at this time. Should PCBs be identified during industrial inspections in the future, the methodologies included in this previous section should be used to calculate enhanced load reductions. The best available information should be used as inputs to the methodology and the assumptions used to calculate loads avoided should be clearly documented.

B.3.5.3 Summary of Key Uncertainties

There are a number of sources of uncertainty in accurately estimating PCB and mercury loads reduced to San Francisco Bay associated with baseline and current identifcaiton of PCBs during industrial inspections:

- The mass of PCBs in equipment and materials can vary between equipment/material type and age. Without a laboratory analysis of the concentration of PCBs in the material, average concentration would need to be assumed.
- To estimate the percentage of PCBs in the equipment or material that would have reached the environment and have been transported to the Bay via urban stormwater assumptions would need to be incorporated into the estimate.

B.3.6 References

BASMAA 2011. Pollutant of Concern Commercial/Industrial Inspector Training Materials – PCBs, Copper and Mercury. Prepared for the Bay Area Stormwater Management Agencies Association. Prepared by EOA, Inc. January.

CA Regional Water Quality Control Board, San Francisco Bay Region, 2009. Municipal Regional Stormwater NPDES Permit, Order R2-2009-0074, NPDES Permit No. CAS612008. October 14, 2009.

B.4 SOURCE PROPERTY IDENTIFICATION AND ABATEMENT

B.4.1 Introduction

Source control measures that target high priority properties in historically industrial land-use areas where polychlorinated biphenyls (PCBs) were used, released, or disposed of and/or where sediment concentrations are elevated above urban background may provide an effective way to minimize or prevent the release of polluted sediment into the stormwater system and protect receiving water quality. The goal of the source property investigation and referral pilot studies is to assist municipalities in identifying properties with potential for elevated PCB and/or mercury concentrations, including public rights-of-way and stormwater conveyances with accumulated sediments with elevated PCBs and/or mercury concentrations in Bay Area watersheds, and refer those properties to the Regional Water Board and other appropriate agencies for abatement. These pilot studies are being implemented through the Clean Watersheds for a Clean Bay (CW4CB) project.

This report describes the five Bay Area watersheds selected for implementation of CW4CB pilot studies, the source property identification and referral pilot studies conducted in these watersheds, including the results of surface soil/sediment monitoring completed to date, and the methods that will be used to evaluate the effectiveness and estimated load reductions of future abatement efforts. Load reduction calculations due to abatement efforts will be completed at a later date, after the abatements have been completed.

B.4.2 Summary of PCB and Mercury Control Pilot Studies

B.4.2.1 MRP Requirements and Implementation Approach

Permittees are currently implementing controls measures to identify and abate PCB source properties at a pilot scale. Municipal Regional Stormwater NPDES Permit (MRP) provisions C.11.c. (mercury) and C.12.c (PCBs) were written identically to reflect similarities between the respective Total Maximum Daily Loads (TMDLs) for these pollutants, based on the legacy and sediment-associated nature of their occurrence. These provisions require that Permittees work collaboratively to review pertinent existing data and identify five Bay Area watersheds that contain relatively high levels of PCBs and mercury and conduct pilot projects to investigate and abate PCB and mercury sources. Specifically, the MRP requires that Permittees investigate and abate PCBs/Hg sources in or to their storm drain systems in conjunction with the Regional Water Board and other appropriate regulatory agencies with investigation and cleanup authorities. Additionally, the MRP requires that Permittees quantify and report the amount of PCB/Hg loads abated resulting from implementation of these measures. Projects are required in five drainage areas (MRP area-wide) that contain elevated levels of PCBs/Hg.

B.4.2.2 Selection of Pilot Investigation Watersheds (CW4CB Task 2)

An important first step in the CW4CB project was to select the five Bay Area region watersheds for source property identification and referral pilot studies. Per the MRP, sites for pilot studies were primarily chosen on the basis of the potential for reducing PCB loads, but consideration was given also to mercury removal in the final design and implementation of the studies. The CW4CB Project Management Team (PMT) developed a list of attributes and associated data sources to inform the selection of the five study watersheds, and then reviewed the available data (including analyzing appropriate data sets using Geographic Information System (GIS) software) in order to identify the five watersheds for pilot source property identification and referral investigations.

Table B.4.2.1 presents the list of attributes and associated data sources used to inform the selection of the five pilot watersheds. The majority of data were made available through a recent study conducted by the San Francisco Estuary Institute (SFEI) and funded by a State of California Proposition 13 grant that investigated options to better manage mercury and PCBs in urban stormwater (Yee and McKee 2010). The study developed and/or compiled a large amount of data related to the presence of PCBs and mercury in the Bay Area urban environment and indicators of potential sources of these pollutants.

The attributes used to conduct the analysis to identify the pilot watersheds (Table B.4.2.1) fell under three general categories: 1) presence of pollutants and indicators, 2) other desirable attributes, and 3) barriers.

Data related to the presence of pollutants and indicators included:

- Sediment chemistry. The SFEI Proposition 13 study compiled PCB and mercury chemical analysis results from about 600 sediment samples collected throughout the Bay Area from roadways and stormwater drainage infrastructure (e.g., storm drain inlets, pump house wet wells, piping beneath manholes, and open channels). About half of the sediment samples were collected by BASMAA agencies during studies conducted in the early to mid-2000s (Gunther et al. 2001; KLI and EOA 2002; EOA 2002; City of San Jose and EOA 2003; SMSTOPPP 2003; SMSTOPPP 2004; EOA 2004; Kleinfelder 2005; Kleinfelder 2006; and EOA 2007). The other half was collected during the more recent SFEI Proposition 13 study (Yee and McKee 2010).
- Pollutant indicators. SFEI Proposition 13 Study GIS layers containing data related to the following indicators of potential sources of PCBs and/or mercury:
    - Historic industrial land use.
    - Pacific Gas and Electric (PG&E) substations.
    - Auto dismantlers.
    - Railroad tracks.
    - Currently active PCB transformers.

Data regarding other desirable watershed attributes included the following:

- Watershed area. A model for CW4CB's property identification and referral process was a project conducted in the Ettie Street Pump Station watershed by the City of Oakland through a State of California Proposition 13 grant (Kleinfelder 2006). The project began a process to identify PCB source properties within the watershed. Based on a comparison of the CW4CB and Ettie Street project budgets, the PMT determined the approximate five square kilometer area of the Ettie Street Pump Station watershed was an appropriate upper bound for the areas of the CW4CB study watersheds.

- Pump station presence at the bottom of a study watershed. This attribute was desirable because a pump station can serve as an integrative monitoring station to sample sediments and water for chemical and other analyses as part of a study's effectiveness evaluation.
- Municipal street and storm drain system operation and maintenance activities. CW4CB Task 4 will evaluate methods to enhance the pollutant load reduction benefits of municipal operation and maintenance activities that remove sediment from streets and storm drain system infrastructure (e.g., street sweeping and storm drain inlet cleaning). Selecting study areas where these activities were routinely conducted was desirable since some Task 4 activities will likely be carried out within one or more of the five pilot watersheds (see the section describing Task 4 later in this report).

Table B.4.2.1. Summary of Watershed Attributes Used to Inform Pilot Watershed Selection

Category	Watershed Attribute	Data Sources
Presence of Pollutants and Indicators	Are there relatively high (≥ 1.0 ppm) levels of PCBs and secondarily mercury in sediments collected from roadway and stormwater drainage infrastructure in the watershed?	SFEI Proposition 13 Study compilation of sediment chemistry data.
	Are there other indicators of potential sources of PCBs in the watershed?	SFEI Proposition 13 Study GIS layers: • Historic industrial land use. • PG&E substations. • Auto dismantlers. • Historic railroads. • Currently active PCB transformers.
Other Desirable Attributes	Is the watershed's size within an acceptable range for the pilot study work (i.e., less than 5 square kilometers)?	• SFEI Proposition 13 Study Bay Area watershed GIS layer. • Creek and storm drain system data from several sources, including Cities of San Carlos and San Jose, Alameda and Contra Costa Counties, Oakland Museum of California, and William Lettis Associates.
	Is there a pump station at the bottom of the watershed?	SFEI Proposition 13 Study Bay Area pump station GIS layer.
	Are municipal street and storm drain system operation and maintenance activities conducted routinely in the watershed?	CW4CB project management team knowledge, municipal staff interviews.
Barriers	Are there institutional, regulatory, political, technical, and/or organizational barriers to conducting a source property identification and referral study in the watershed?	CW4CB project management team knowledge, municipal staff interviews.

Finally, the PMT evaluated whether there were any indications of major institutional, regulatory, political, technical, and/or organizational barriers to conducting a source property identification and referral study in a candidate study watershed.

Based on the results of the above data analysis, the PMT identified the following five study watersheds (Figure B.4.1 provides an overview of their locations):

1. Ettie Street Pump Station watershed, City of Oakland, Alameda County (Figure B.4.2.).
2. Lauritzen Channel watershed, City of Richmond in Contra Costa County (Figure B.4.3.).
3. Leo Avenue watershed, City of San Jose, Santa Clara County (Figure B.4.4.)
4. Parr Channel watershed, City of Richmond in Contra Costa County (Figure B.4.5.).

5. Pulgas Creek Pump Station watershed, City of San Carlos, San Mateo County (Figure B.4.6.).

Table B.4.2.2 summarizes pertinent attributes of the five identified watersheds, which range in area from about two to five square kilometers. Two of the watersheds have pump stations at the bottom of the drainage (Ettie Street Pump Station and Pulgas Creek Pump Station watersheds). Sediment samples with PCB concentrations higher than 1.0 parts-per-million (ppm) were collected from all five watersheds and comprise about 15 to 32 percent of the total samples from each watershed.[5] The maximum concentrations in sediment samples from the watersheds ranged from 2 - 93 ppm for PCBs and 1 - 6 ppm for mercury.

All five watersheds also contained current (year 2000) and historic industrial land use,[6] with the historic industrial use ranging from about 17 to 72 percent of the total watershed area. One or more of three other potential pollutant source indicators (PG&E substations, auto dismantlers, and railroad lines) were present in each of the five watersheds. In addition, municipal street and storm drain system operation and maintenance activities are routinely conducted in each of the five watersheds. Finally, indications were not found of any major institutional, regulatory, political, technical, and/or organizational barriers to conducting future source property identification and referral studies.

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[5] The number of sediment samples analyzed (Table B.4.2) is sometimes greater than the number of sample locations shown on Figures 2 - 6 because some locations were resampled one or more times.

[6] The SFEI Proposition 13 study developed the historic industrial land use data layer by intersecting areas classified "urban" in 1954 USGS maps and "industrial" in maps of land use in the year 2000 developed by the Association of Bay Area Governments.

Table B.4.2.2. Attributes of Pilot Study Watersheds.[1, 2]

Watershed Name	City *County*	Watershed Area (km^2)	Pump Station at Bottom of Watershed?	No. of Sediment Samples Total / ≥ 1.0 ppm PCBs	Max. Sediment PCB Concen-tration (ppm)	Max. Sediment Mercury Concen-tration (ppm)	Major Land Uses in Year 2000	Percent Historic Industrial Land Use[3]	No. of PG&E Sub-stations	No. of Auto Disman -tlers	Historic/ Current Rail[4] (m)
Ettie Street Pump Station	Oakland *Alameda*	4.9	Yes	96/28	93.4	1.6	Industrial Commercial Residential	34.9	0	2	4,226/ 7,140
Lauritzen Channel	Richmond *Contra Costa*	3.8	No	35/9	2.8	1.1	Industrial	23.3	0	0	3,836/ 9,770
Parr Channel	Richmond *Contra Costa*	4.3	No	19/6	2.3	1.4	Industrial	17.1	2	0	3,397/ 9,195
Pulgas Creek Pump Station	San Carlos *San Mateo*	1.4	Yes	48/8	11.5	0.9	Industrial Commercial	71.7	1	0	0/ 669
Leo Avenue	San Jose *Santa Clara*	2.2	No	26/4	26.7	6.2	Industrial Commercial	17.8	0	6	0/ 7,192

[1] Sources of data include the SFEI Proposition 13 study, SF Bay Area Regional Water Quality Control Board, Cities of San Jose and San Carlos, Contra Costa County, Oakland Museum of California, William Lettis and Associates, and past field studies (Gunther et al. 2001, KLI and EOA 2002, EOA 2002, City of San Jose and EOA 2003, SMSTOPPP 2003, SMSTOPPP 2004, EOA 2004, Kleinfelder 2005, Kleinfelder 2006, and EOA 2007), and municipal staff communications.

[2] All five watersheds share the following attributes: 1) routine municipal activities are conducted (e.g., street sweeping and storm drain inlet cleaning), 2) indications were not found of any major institutional, regulatory, political, technical, and/or organizational barriers to conducting future source property identification and referral studies, and 3) available records did not indicate the presence of active PCB transformers.

[3] The SFEI Proposition 13 study developed the historic industrial land use data layer by intersecting areas classified "urban" in 1954 USGS maps and "industrial" in maps of land use in the year 2000 developed by the Association of Bay Area Governments.

[4] The SFEI Proposition 13 study developed the historic rail layer by digitizing rail lines shown on georectified 1959 USGS topographic quads that were not present on a current rail layer included with the USGS Digital Line Graphic

B.4.2.3 Methods to Identify Specific PCB and Mercury Source Properties

The process to identify specific PCB and mercury source properties within the five project watersheds and refer these sites to regulatory agencies for cleanup and abatement consisted of the following five steps:

1. Records review. Review general information sources (e.g., spill site databases, historic land use and available sampling data) and records on specific properties/businesses to begin identifying potential source properties within the pilot watersheds.
2. Driving/walking survey. Perform a driving/walking survey of each pilot watershed to further identify potential source properties and begin looking for evidence that runoff from such locations is likely to convey pollutants to storm drains.
3. Facility inspections. Perform inspections of selected facilities within each pilot watershed.
4. Surface soil/sediment testing. Test surface soils/sediments from the public right-of-way and private properties in the pilot watersheds for PCBs, mercury and other particle-bound pollutants.
5. Property referrals. Where laboratory data confirm elevated pollutant concentrations, refer properties to regulatory agencies for cleanup and abatement.

One model for Task 3 of CW4CB was a recent project conducted by the City of Oakland through a Proposition 13 grant awarded by the California State Water Resources Control Board (Kleinfelder 2006). The project focused on identifying sources of PCB-containing sediments to the storm drain system in the Ettie Street Pump Station watershed in Oakland. The methods used for the source property investigations were generally based on the Ettie Street project experience. However, CW4CB adapted and refined the methods as appropriate for local conditions in each of the five pilot watersheds.

The methods that were used to implement the five steps of the property identification and referral process in each of the five project watersheds are described in detail below.

Step 1: Records Review

To begin identifying potential source properties within each of the five project watersheds, readily available general information sources (e.g., spill site databases, historic land use and available sampling data) and records on specific properties/businesses were reviewed. To the extent feasible within available project budget, appropriate records on all businesses in each pilot watershed were reviewed. Relevant and readily available databases (e.g., spill sites) and other general information sources were reviewed for evidence of pollutant use/release in the pilot watersheds, and at specific properties in each watershed. The type of information reviewed included the following:

- Records related to the use of hazardous materials and generation of hazardous waste (generally available from local fire departments, environmental agencies, or public health agencies) - a list of PCB product trade names is attached to assist this effort (Attachment 1);

- Business licenses or permits for a description of current and historical businesses that were present on a property;
- Digital aerial and site photographs (e.g., Google Earth); and
- Records from stormwater industrial/commercial facility inspections.
- Code enforcement records for evidence of non-permitted uses and activities;
- Building department records for site plans, electrical and plumbing plans, and demolition and construction plans;
- General Plans and Zoning Ordinances for information on permitted, conditionally-permitted and non-permitted uses within the watersheds, including local plans and redevelopment area plans, as appropriate;
- Business tax data for lists of businesses within the watershed;
- Illicit discharge and source identification records; and
- Recorded land title records for evidence of Activity Use Limitations (AULs).

Based on the information sources reviewed by City of Oakland staff during the Ettie Street project (Kleinfelder 2006) data sources reviewed included those shown in Table B.4.2.3.

Table B.4.2.3. General Information Sources on Pollutant Use/Release

Name of Database or List	Internet URL	Agency that Developed and Maintains	Description
Geo-tracker	http://geotracker.swrcb.ca.gov	California State Water Resources Control Board	• Leaking Underground Tank (LUST) sites • Regional Water Quality Control Board cleanup sites • Land disposal sites • Military sites • Permitted Underground Storage Tank (UST) facilities • Monitoring wells • Department of Toxic Substances Control (DTSC) cleanup sites • DTSC hazardous waste permit sites
SLIC – Spills, Leaks, Investigations and Cleanups	http://www.waterboards.ca.gov/sanfranciscobay/resources/database/lustis/slic.xls.	California State Water Resources Control Board	• Spills, Leaks, Investigations, and Cleanups Sites

Name of Database or List	Internet URL	Agency that Developed and Maintains	Description
DTSC Envirostor	http://www.envirostor.dtsc.ca.gov/public/	California Department of Toxic Substances Control	• National Priorities List (Federal Superfund Sites) • State Response Sites • Voluntary Cleanup Sites • School Cleanup Sites • Corrective Action Sites • Tiered MRP Sites • Leaking Underground Fuel Tank (LUFT) cleanups (same as LUST) • Spills, Leaks, Investigations and Cleanups Sites (SLIC)
Coast Guard Spills Database	http://www.nrc.uscg.mil/nrsinfo.html	United States Coast Guard	• Incidents of spills of oil and other toxic substances into the environment.
PG&E Bay Area PCB equipment spills	Not Applicable	Pacific Gas and Electric (PG&E)	• List of spills of PCB-containing dielectric fluids from PG&E distribution line equipment in the Bay Area (1994 -2000). CW4CB is currently attempting to obtain an update of this list.
Cleanup Sites in California	http://www.epa.gov/region9/cleanup/california.html	US Environmental Protection Agency	• Superfund Sites - EPA's program to identify, investigate and clean up uncontrolled or abandoned hazardous waste sites throughout the United States. • Brownfields – EPA's Brownfields Program works to clean up and redevelop potentially contaminated lands.
PCB Waste Handlers Database	http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/region9.pdf	US Environmental Protection Agency	• List of facilities that have notified the EPA of PCB activity, including storage, disposal and transformer registrations.
Toxic Release Inventory	http://www.epa.gov/tri/	US Environmental Protection Agency	• Data on toxic chemical releases and waste management activities reported annually by certain industries as well as federal facilities.
My Environ-ment	http://www.epa.gov/myenvironment/	US Environmental Protection Agency	• EPA-regulated facilities • Air Quality Index (AQI) • Water quality monitoring and conditions for local water bodies • Cleanup sites
Enviro-facts System	http://www.epa.gov/enviro/index.html	US Environmental Protection Agency	Allows retrieval of information from multiple databases including: • Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), Brownfields, and other cleanup sites • MRP Compliance System (PCS) • Resource Conservation Recovery Act - RCRAInfo • Toxic Release Inventory (TRI) • Toxic Substances Control Act (TSCA)

Step 2: Driving/Walking Survey

The next step was to conduct driving/walking surveys of the entire public right-of-way of each pilot watershed. The surveys provided additional information about subject properties and a check of the information obtained during the records review to identify potential source areas and estimate the potential for stormwater runoff to convey surface soils/sediments with PCBs and/or mercury from such areas to the municipal stormwater collection system.

Watershed maps and a survey data form adapted from the inspection check list developed during the Ettie Street project (Kleinfelder 2006) were used during the driving/walking surveys (Appendix B.4.A). The data form included potential indicators of PCB/mercury release risk that may not have been readily available during the records review, such as indications of sediment erosion from a property and migration to the street or storm drains, evidence of pollutant use/release in visible outdoor areas of properties, and impacts to the adjacent public right-of-way. The maps included the locations of the watershed boundary, streets, property lines, storm drain inlets, and other stormwater collection system infrastructure (e.g., flood control channels) within the drainage.

During the driving/walking surveys, the entire public right-of-way of each pilot watershed was visited on foot and/or by car as appropriate for local conditions. Digital photographs of notable features in each pilot watershed were taken. Field staff looked for potential indicators of pollutant use and/or release from properties and impacts to the adjacent public right-of-way, including, but not limited to the following:

- Unpaved or other areas where sediment erosion may occur, especially when there is evidence of migration of sediments from a property to the public right-of-way;
- Electrical equipment (e.g., transformers);
- Outdoor hazardous material/waste storage areas (e.g., tanks, drums), especially with poor housekeeping;
- Signs related to hazardous materials and wastes;
- Recycling/scrap yards (e.g., for automobiles);
- Building demolition, renovation or window replacement sites;
- Unusually stressed vegetation; and
- Unidentified puddles or stains.

These observations provided information used to evaluate the potential for migration of sediment-bound pollutants from suspect properties to stormwater conveyances.

Step 3: Facility Inspection

Based on the results of the records review and driving/walking survey, properties deemed to have higher potential to be a source of PCBs and/or mercury to storm drains were selected for facility inspections. Table B.4.2.4 presents typical attributes of sites with higher, medium and lower potential for PCB/mercury release to streets and stormwater conveyances. Other factors/constraints that were considered included available budget, existing inspection schedules (e.g., CUPA[7] hazardous material inspections), and inspector availability. Resources for inspectors included the recently developed Pollutants of Concern Stormwater Inspectors' Guidance Manual (BASMAA 2010b), a companion PowerPoint presentation, and Section 9 of the ASTM Phase I Environmental Site Assessment guidance (ASTM 2005). These training materials describe the types of facilities where PCBs and/or mercury may be used and typical applications, how to identify associated products and equipment, proper disposal/recycling and spill cleanup practices, and guidance on referring facilities to regulatory agencies when appropriate.

Table B.4.2.4. Typical Attributes of Sites with Higher, Medium and Lower Potential for PCB/Mercury Release to Streets and Stormwater Conveyances [1]

Typical attributes of sites with higher potential for PCB/mercury release: • Records of PCB/mercury release at the site. • Indications of PCB/mercury-associated materials/processes. • Locations where sediment may erode and be mobilized off-site by stormwater runoff, vehicles, and/or wind (e.g., unpaved areas). • Illegal dumping occurs. • Outdoor hazardous material/waste storage areas (e.g., tanks, drums) with poor housekeeping.
Typical attributes of sites with medium potential for PCB/mercury release: • Industrial land uses. • Electrical equipment (e.g., transformers with PCBs). • Outdoor hazardous material/waste storage areas (e.g., tanks, drums) with fair to good housekeeping. • Unidentified barrels or drums. • Demolition, large-scale window replacements, or other renovations have occurred (potentially releasing PCB caulks/sealants).
Typical attributes of sites with lower potential for PCB/mercury release: • Non-industrial land uses. • Minimal potential for sediment loading to stormwater collection system. • No history of PCB/mercury-related activities.

[1]Adapted from the Ettie Street project (Kleinfelder 2006).

The checklist developed for property inspections during the Ettie Street project (Kleinfelder 2006) and information from the above Inspectors' Guidance Manual was adapted for use in the

[7]Certified Unified Program Agency.

field during the facility inspections in the five pilot watersheds. The inspection form included priority uses and activities potentially associated with PCBs and/or mercury, examples of questions for inspectors to ask current owners, tenants or site supervisors, and a space for inspectors to sketch the site and observations made in the field (Appendix B.4.B).

Inspections of selected high priority facilities were conducted by Stormwater Program and/or municipal staff in each watershed. The combined results of the records review, driving/walking survey, and the facility inspections were used to rank each inspected property as having higher, medium or lower potential to release PCBs and/or mercury to streets and stormwater conveyances. Figure B.4.7 provides a description of the criteria and decision-making process used to rank properties. It should be noted that in some watersheds some of the Steps 1 - 3 activities were conducted to varying extents in the past and thus the extent of additional effort needed varied.

Specifically for the Ettie Street Pump Station watershed, extensive sampling had previously been conducted during sediment sampling conducted by the City of Oakland between June 2004 and June 2006. Additionally, the City of Oakland abated two areas within the Ettie Street Pump Station watershed through power-washing between May 15 and 24, 2006. The Department of Toxic Substances Control (DTSC) also remediated the Former Giampolini industrial site, as part of the outcome of the City's efforts.

In 2012 as part of CW4CB Task 3, the City of Oakland and Alameda Countywide Clean Water Program (ACCWP) staff developed a rationale for additional site inspections, drafted a list of potential sites to inspect, and conducted site inspections between May and June 2012. A list of potential inspection sites was developed using a four-step process. First, data from the SFEI study and additional data obtained from the Department of Toxic Substances Control (DTSC) EnviroSTOR website were compiled into a database and mapped using GIS. Second, areas that were either considered for abatement or were actually abated in 2006 were delineated (Kleinfelder, 2006). Third, all sites that discharged runoff to proposed tree well locations, as part of the CW4CB Task 5 West Oakland Industrial Area Project, were identified and omitted to avoid conflicting Project objectives. The goal of the tree well retrofits is to evaluate the effectiveness in reducing PCBs from storm water runoff; whereas the CW4CB Task 3 Ettie Street Project goal is to identify the sources of PCBs within the watershed. Fourth, all compiled data was then grouped by facility, which included the sediment PCB concentrations that were either taken on-site, in the surrounding public right-of-way, and in public catch basins adjacent to the facility. Finally, the sample with the highest PCB concentration was identified at each facility grouping. These representative samples were used to identify the top 15 facilities for inspection.

Step 4: Surface Soil / Sediment Testing

The results from Steps 1 – 3 were used to inform the development of surface soil/sediment sampling and chemical analysis monitoring programs within each project watershed. During the previous Ettie Street project sediment samples were first collected in the public right-of-way adjacent to selected suspect properties (Kleinfelder 2006). The chemical analysis results from these samples were used to prioritize properties for on-site sampling and areas in the right-of-way for abatement measures (e.g., removal of sediment via sweeping/shoveling or street flushing,). A similar two-phase sediment sampling approach was implemented here.

Prior to the start of the surface soil/sediment monitoring, the CW4CB PMT developed and submitted to EPA a draft Quality Assurance Project Plan (QAPP) and CW4CB Task 3 Sampling and Analysis Plan (SAP). EPA reviewed and approved these documents following recommended revisions. These documents provide detailed descriptions of the sample collection and chemical analysis methods, and quality assurance/quality control in the field and in the laboratory for all monitoring conducted under the source property identification and referral pilot studies (BASMAA 2012a,b).

The first phase of soil/sediment monitoring focused on sample collection from storm drain inlets, street curbs, driveways and other areas in the public right-of-way where sediment appeared to transport off priority properties and accumulate in the streets/storm drainage system. In order to finalize the list of right-of-way sample sites for Phase 1, locations of storm drain inlets in front of and nearby priority facilities as well as on those street segments that were also considered high priority were ground-truthed. All soil/sediment samples collected during Phase 1 monitoring were analyzed for PCBs, mercury, total organic carbon (TOC), and grain size. Approximately 10 percent of the samples (selected randomly) were also analyzed for dioxins, PBDEs, organochlorine pesticides, and PAHs.

Phase 2 is currently being planned (as of the writing of this report), and will focus on sample collection from private properties within the project watersheds based on the results of the Phase 1 monitoring and additional public right-of-way samples to further refine the location of POC sources in the watershed.

Step 5: Property Referrals

Where laboratory data confirm elevated pollutant concentrations, properties will be referred to regulatory agencies for cleanup and abatement. The CW4CB PMT is working with Regional Water Board staff to develop the referral process, including identification of the information required and the documentation that will be used to make referrals. As of the writing of this report, no referrals under CW4CB Task 3 have yet been made.

B.4.2.4 Results of the Source Property Identification and Referral Pilot Studies in Five CW4CB Project Watersheds

This section presents the results of the source property identification and referral pilot studies that have been conducted in the five CW4CB project watersheds. For each watershed, the relevant site history is presented followed by the results of each of the five steps of the process (described above) that have been completed as of the writing of this report.

Ettie Street Pump Station Watershed, Oakland CA

Site History

In 2000 and 2001 investigations by the Alameda Countywide Clean Water Program (ACCWP) suggested there were multiple sites in the Ettie Street Pump Station watershed that continued to discharge legacy PCBs to the storm drain system, but no specific current sources were identified. The City of Oakland sought funding from a State Water Resources Control Board Proposition 13 Grant to further investigate, identify, and remediate sources of PCBs in the watershed and evaluate control measures for addressing these sources of PCBs. The City was awarded $460,000 for the PCB Abatement Grant Project and initiated work in 2004. Project tasks included: surveying potential source areas for PCBs in the watershed, inspections of private properties, collection and chemical analysis soil/sediment samples from locations in the public right-of-way and on private properties, preparation of sampling reports, abatement of PCB-containing sediments in the public right-of-way, coordination with regulatory agencies for enforcement of PCB cleanup on private properties, and preparation and distribution of education and outreach materials (including a Fact Sheet). A case study and final report that details the methods and results for the PCB Abatement Grant Project was completed (Kleinfelder 2006). These efforts resulted in property referrals to regulatory agencies.

However, based on discussions with City of Oakland staff, additional work was needed to identify other contaminated properties for referral and abatement. The source property identification and referral pilot study in the Ettie Street Pump Station watershed builds upon the Kleinfelder study and the SFEI Proposition 13 study completed in 2010[8]. The methods used in the Ettie Street PCB Abatement Grant Project (Kleinfelder 2006) served as the model for the Clean Watersheds for a Clean Bay source property identification and referral pilot studies. Previous measurements of mercury and PCB concentrations in sediments collected from piping beneath manholes, drop inlets/catch basins, streets/gutters, and private properties in the watershed have ranged from 0.26 to 1.0 mg/kg for mercury and 0.039 to 93 mg/kg for PCBs (Gunther et al. 2001; KLI and EOA 2002; EOA 2002; Kleinfelder 2005; Kleinfelder 2006, Yee and McKee 2010).

Results of Source Property Identification and Referral Process

The source property identification and referral process in the Ettie Street Pump Station watershed has been conducted by the City of Oakland, with support provided by ACCWP.

Steps 1-3: Records Review, Driving Walking Survey, Property Inspections

Much of the property identification and referral process was conducted in the Ettie Street Pump Station watershed prior to Clean Watersheds for a Clean Bay, as described above. This pilot study built upon those results to identify additional properties for referral to regulatory agencies. ACCWP provided funding for Geosyntec Consultants to work with the City of Oakland staff to

[8]Spatial analysis results from the San Francisco Estuary Institute's 13 study (Yee and McKee 2010) showed, that in 15 locations of the Bay Area, elevated concentrations of PCBs or Hg were clustered together within 3 kilometers of one another, which may be due to similarities in land use or transport of shared pollutant sources. The watershed was identified as one of the 15 locations in the Bay Area with several elevated concentrations in the same general vicinity.

review the previous project's inspection reports and sampling data, and recommend 15 sites for additional inspections and sampling based on evidence of potential mercury and/or PCB sources and potential for sediment transport off the property.

In May and June 2012, the City of Oakland and Geosyntec staff inspected or re-inspected these 15 industrial sites to evaluate whether the properties were potential sources of PCBs. Based on data from these inspections, over 30 locations were recommended for sampling via the CW4CB. Some of the recommended locations were industrial properties that were considered "high priority" sites based on historic sources of PCB and/or current inspection information, but lacked sufficient sampling data to determine if the property was a potential source. Other locations were selected to evaluate the long-term effects of sediment abatement conducted in the street right-of way during 2006.

Step 4: Soil/Sediment Testing

Applied Marine Sciences (AMS) and ADH Environmental were selected through a competitive process as the CW4CB monitoring contractor team for the Ettie Street Pump Station watershed. AMS/ADH conducted right-of-way surface soil/sediment sampling at the sites selected by the City of Oakland/Geosyntec, according to the methods and procedures documented in the project QAPP and Task 3 SAP (BASMAA 2012 a, b). All Phase 1 samples in this watershed were collected between September 27, 2012 and October 2, 2012. A field methods report is provided in Appendix B.4.C.

The chemical analysis results for PCBs and mercury have undergone QA/QC review and are presented below. These data are considered preliminary, pending finalization of the QA/QC review for all Phase 1 data. A summary of the data quality review completed to-date for Phase 1 field and chemistry data in all five project watersheds is provided in Appendix B.4.D.

A total of 27 soil/sediment samples were collected during Phase 1 at the locations identified in Figures B.4.8 and B.4.9. Concentrations of total PCBs (sum of 40 congeners) ranged from 0.027 – 5.7 mg/kg (Figure B.4.8). Concentrations of mercury ranged from 0.07 – 1.6 mg/kg (Figure B.4.9).

As of the writing of this report, the Phase 1 sediment testing results are being used to select private property and/or additional public right-of-way sampling locations for Phase 2, which is anticipated to occur during May 2013. Chemical analysis results from the Phase 2 sampling effort are expected to be available within three months following completion of all field sample collection.

Step 5: Referrals

Based on the results of the public right-of-way and private property sediment testing, ACCWP and the City of Oakland will submit a list of facility referrals to the Regional Water Board for follow-up investigations at these facilities. The information requirements and documentation that will be used to make these referrals are currently being developed by the CW4CB PMT in cooperation with Regional Water Board staff. It is anticipated referrals will be made within six months of completion of the second phase of soil/sediment testing.

Lauritzen Channel and Parr Channel Watersheds, Richmond CA

Site Histories

This section describes activities undertaken going back to the year 2000 to investigate and abate PCB concentrations in sediments within the Lauritzen and Parr Channel pilot watersheds of the Santa Fe Channel drainage in the City of Richmond (Richmond), CA.

In 2000 and 2001, sediment samples were collected from drainage inlets throughout the Bay Area, in response to direction from the Regional Water Board (EOA, Inc., 2002). The sampling design targeted different land use types (residential, commercial, industrial) as a means of testing the working hypothesis that older industrial areas where PCBs have been used and / or released have higher concentrations in urban sediments. All of the analysis relied upon EPA Method 1668, and summed up the 41 congeners relied upon by the San Francisco Bay Regional Monitoring Program to quantify total PCB concentrations.

In Contra Costa County, the highest PCB concentrations in sediments collected from the MS4 system in 2000 and 2001 were found in Richmond, along Cutting Boulevard, and on Wright Avenue. Total PCB concentration found in 2001 along Cutting Blvd in a composite sample of four catch basins was 1,100 µg/kg; PCB concentrations in sediments from catch basin composites sampled at Wright Avenue at Harbour Way was 1,900 µg/kg. These two locations represented the highest concentrations in Contra Costa County for sediments collected from the MS4 system, and so warranted additional follow up.

Follow up sampling in 2002 resulted in catch basin samples along Cutting Boulevard near 1st and 2nd Streets which were generally above 700 µg/kg, and as high as 2,000 µg/kg; concentrations in catch basin sediments to the west along Cutting Boulevard dropped off. Individual catch basins sampled near the Wright and Harbor intersection in 2002 had PCB concentrations of 540, 150, and 180 µg/kg, respectively. At that time, the data suggested a local source in either the Cutting Boulevard or the Wright and Harbor area, with some trackout from the local source potentially involved.

At least four potential source areas were noted, based on the land use and activities:

- An electric substation located 1st Street and Cutting Boulevard (Older electric transformers are known to contain PCBs)
- A forklift and equipment repair shop on 2nd Street at Cutting Boulevard (old hydraulic fluids and lubricants are a potential PCB source)
- A scrap metal recycler located along 4th Street (The recycler shreds old equipment, including in the past used electric transformers, that could contain PCBs)
- Railroad tracks that crisscross City streets throughout the drainage

Detailed follow-up studies by CCCWP and Richmond during 2005 – 2007 presented a more comprehensive picture and helped pinpoint potential source areas (EOA Inc., May 2007; EOA Inc., October 2007). Surface street and gutter samples along Cutting Boulevard were generally lower than catch basin samples. Street sweeping samples evaluated to the north generally indicated low to moderate PCB concentrations, consistent with the "halo" effect of PCB concentrations in urban sediments that are moderately elevated in city streets and MS4 conveyances in areas near PCB sources (Yee and McKee 2010). In contrast, surface street samples collected from locations bracketing the metal recycler were consistently above 700 μg/kg.

The metal recycler, at the conclusion of the 2007 studies, was a high priority for follow-up and investigation, because of the elevated PCB concentrations on surface streets adjacent to the property. The evidence remained inconclusive, at that time, as to the potential for the fork lift repair shop or the transformer yard, to be causing the elevated PCB concentrations in the storm drain catch basins along Cutting Boulevard; other potential explanations could include tidal intrusion of sediments from the Richmond Harbor (the conveyance system in that area is partly tidal) and vehicle trackout from the metal recycler or some other as yet unidentified source.

The Total Maximum Daily Load for PCBs in San Francisco Bay was adopted in 2008. The MRP required control measures for PCBs, including the source identification and reporting project that is within the scope of this section. Concurrently, Richmond worked with the metal recycler to get them to initiate enhanced BMPs, including near continuous street sweeping on adjacent streets. While that enhanced BMP likely helps reduce trackout of potentially contaminated sediments, street sweepers cannot get complete removal because of the soft shoulder and lack of curb and gutter in the area. In addition, airborne transport of dust and shredder fluff (the fine, particulate grindings associated with metal shredding) may transport solids offsite beyond the activity area of high frequency street sweepers. Anecdotal evidence suggests that dust accumulation on cars is a nuisance for nearby residents.

Richmond also directed the metal recycler to cease discharging stormwater into the MS4 system, unless they could demonstrate attainment of EPA Benchmark levels for industrial stormwater and characterize the stormwater using methods with appropriately low detection limits. Since that direction, the metal recycler has stored stormwater onsite, and re-used onsite process water for dust control. Stored stormwater is currently discharged by the recycler into the sanitary sewer. Rainy weather has been anomalously light for the past few years, so the ability of the recycler to store water during larger events is as yet unproven.

Results of Source Property Identification and Referral Process

The source property identification and referral process in the Lauritzen Channel and Parr Channel watersheds in Richmond, CA, has been conducted by the City of Richmond, with support provided by CCCWP.

Steps 1-3: Records Review, Driving Walking Survey, Property Inspections

The source property identification and referral process in the Richmond watersheds built upon the source investigations conducted prior to the start of the pilot studies as described above. Records review, driving/walking surveys, and onsite inspections of properties in catchments draining into the watersheds were conducted by CCCWP during 2010 and 2011.

CCCWP assisted Richmond with a desktop reconnaissance of properties using a GIS parcels database provided by Richmond, combined with a review of Department of Toxics Substances Control (DTSC) cleanup databases and records of code enforcement. The desktop reconnaissance criteria included parcel size, current use, history of cleanup or prior code violations, and notably presence of potential sediment trackout as seen from Google Earth.

Of 165 parcels identified in those watersheds, 62 parcels were inspected from outside the property line, and 13 were inspected onsite. The focus of the inspections was to identify any sources of bare dirt on the property that could serve as a sediment source, and determine whether any known or suspected current or past activities could involve materials containing PCBs (i.e. transformers, wire insulation, hydraulic fluids, caulks and paints). Inspection results included field logs, photographs, site flow path sketches, and aerial photos from Google Earth. Inspection results were compiled in a simple Excel-based database.

Streetside inspections were performed May 18 through June 19, 2011. Onsite property inspections were performed June 9 through June 23, 2011. The master list of inspections was organized as a linked spreadsheet database so that each parcel was linked to the transcribed onsite inspection, photos taken, DTSC database entries, and Google Earth views of the property.

Based on information from the inspections, one property owner was notified by the City of Richmond that they are not allowed to discharge stormwater from the property into the MS4 system unless they provide detailed monitoring results for PCBs using appropriately low detection limit, and could demonstrate attainment of EPA benchmark values for other constituents. The property owner stored and re-used stormwater onsite during the 2011 – 2012 storm season.

Step 4: Soil/Sediment Testing

Applied Marine Sciences (AMS) and ADH Environmental were selected through a competitive process as the CW4CB monitoring contractor team for the Lauritzen Channel and Parr Channel watersheds. AMS/ADH conducted right-of-way surface soil/sediment sampling at the sites selected by the City of Richmond and CCCWP, according to the methods and procedures documented in the project QAPP and Task 3 SAP (BASMAA 2012 a, b). The locations to be monitored were based on lessons learned from 2001 – 2007, plus site reconnaissance conducted through this Task and Task 5 (stormwater treatment retrofits). Phase 1 samples in the Lauritzen Channel were collected on October 3, 2013. Phase 1 samples in the Parr Channel watershed were collected on October 4, 2013. A field methods report is provided in Appendix B.4.C.

The basis of the monitoring design was as follows (Figure B.4.10):

- Par- 01 and Parr-02: Railroad track crossings
- Parr-03: Follow up from earlier assessment
- Parr-04 and Parr-05: New assessment adjacent to an industrial facility where onsite inspection detected historic utility pad that may have had a transformer.
- Parr-06, Parr-07, Parr-08, and Lau-01: Metal recycler

- Lau-02: Railroad track crossing
- Lau-03 and Lau-04: Forklift repair
- Lau-05 and Lau-06: Transformer yard

The chemical analysis results for PCBs and mercury have undergone QA/QC review and are presented below. These data are considered preliminary, pending finalization of the QA/QC review for all Phase 1 data. A summary of the data quality review completed to date for Phase 1 field and chemistry data in all five project watersheds is provided in Appendix B.4.D.

A total of 14 soil/sediment samples were collected during Phase 1 at the locations identified in Figure B.4.10. Concentrations of total PCBs (sum of 40 congeners) ranged from 43 – 1,500 µg/kg (Figure B.4.10). Concentrations of mercury ranged from 20 – 1,900 µg/kg (Figure B.4.11).

Based on the results from Phase 1, CCCWP and the City of Richmond determined no additional soil/sediment monitoring was needed prior to making referrals to the Regional Water Board.

Step 5: Referrals

Based on a review of the inspections database and sediment sampling results in the Lauritzen and Parr Channel Watersheds, the following summaries informed the identification of properties for referral to the Regional Water Quality Control Board in compliance with MRP provision C.12.c:

1. The California Oils Corp at 1145 South Harbour Way had visible trackout and dirt that led up to drainage inlets. Onsite inspectors noted old concrete mounting pads that were stained and other signs of historic electrical transformers and substations. Sediment outside this property was targeted for follow-up collection and analysis. The PCB concentrations of sediment samples (71 – 119 µg/kg) were comparable to background concentrations for older urban industrial areas. No property referral to the Regional Water Board is recommended at the present time.
2. The PG&E Substation at 1st St. and Cutting Boulevard has a considerable number of live transformers known or suspected to contain PCBs. Sediment outside this property was targeted for follow-up collection and analysis. The PCB concentrations of sediment samples on the north and east sides of the property (47 – 106 µg/kg) were comparable to background concentrations for older urban industrial areas. No property referral to the Regional Water Board is recommended at the present time.
3. There are several areas throughout both pilot watersheds where railroad right of way, often abutted by empty dirt lots, shows visible trackout onto adjacent streets. Three of these railroad crossing areas were targeted for sediment sampling and analysis. The PCB concentrations of sediment samples from the locations sampled (47 – 119µg/kg) had PCB concentrations comparable to background concentrations for older urban industrial areas. No property referral to the Regional Water Board is recommended at the present time. The property is currently being redeveloped. Construction BMPs have reduced trackout

from the dirt lot. Post-construction BMPs are likely to reduce dirt generation onto city streets, although the configuration along the railroad line is unknown.

4. Rickert International, a forklift repair business, has old equipment stored onsite that inspectors noted was a risk for leaking hydraulic fluid. This location was targeted for sediment sampling from a storm drain inlet in front of the driveway entrance to the forklift repair yard. Sampling crews were able to collect soil directly adjacent to the property of the forklift storage yard, between the fence and the sidewalk in the public right of way. Sediment samples from the storm drain had PCB concentrations of 367 µg/kg; sediment samples collected adjacent to the fence had PCB concentrations of 326 µg/kg. These are consistent with prior PCB measurements in the area, and above what is considered urban background for the area. Although direct flow paths from the property to the storm system were not obvious to inspectors, the driveway entrance appears to be a visible trackout source onto city streets. This property is recommended for referral to the Regional Water Board.
5. SIMS Metal Management is located on the former United Heckathorn property, a Superfund site that is under remediation for DDT contamination. During the superfund investigation of the site, it was discovered that scrap metal previously recycled at this facility included used transformers. That practice is believed to have ceased, and the property owner has implemented Best Management Practices. Onsite inspectors noted activities on the large dirt lot of the facility had potential to generate trackout; there was also visible standing water as a result of dust control. The front entrance is a potential trackout source that is swept regularly as a BMP; however, sediment accumulates in crevices along the fence line on Fourth Street that appears to be beyond the reach of street sweepers. Sediment also accumulates in railroad track grooves adjacent to the rear entrance of the facility and on Hoffman Boulevard on the east side of the facility. Those sediments in adjacent streets have PCB concentrations ranging from 932 to 1,450 µg/kg, well above typical urban background. Those 2012 measurements are consistent with previous measurements in the area in 2006 and 2007. The property will be recommended for referral to the Regional Water Board. A pilot operations and maintenance enhancement will be evaluated along Hoffman Boulevard.

The information requirements and documentation that will be used to make referrals are currently being developed by the CW4CB PMT in cooperation with Regional Water Board staff. It is anticipated referrals will be made within six months.

Leo Avenue Watershed, San Jose, CA

Site History

Elevated PCB concentrations in sediments have been identified in the Leo Avenue area in past studies (KLI 2001 and 2002, City of San Jose and EOA Inc. 2002, City of San Jose and EOA Inc. 2003, and Yee et al. 2010). Previous case studies consisted of researching records of stormwater-related violations (e.g., washing sediment into storm drains) and Illegal Connection and Illicit Discharge (ICID) reports, researching current and historical land uses, and sampling bedded sediment within the stormwater conveyance system in the Leo Avenue area. Sampling results indicated that the highest PCB concentrations were found in sediments collected from the Leo Avenue stormwater conveyance system and sediments associated with the unpaved Union Pacific railroad track right-of-way area located at Leo Avenue's cul-de-sac. These studies indicated vehicular traffic between Leo Avenue and the right-of-way area, as well as stormwater runoff, likely facilitated the transport of sediments from the right-of-way area to storm drain inlets located on Leo Avenue. Other potential source areas included other properties located on Leo Avenue.

In 2004, City of San Jose staff observed that sediment appeared to accumulate in the Leo Avenue stormwater conveyance system and may have been trapped there for many years. In response, the City hired Clean Harbors, an environmental services company, to clean out the Leo Avenue storm drain inlets, publicly-owned laterals, and Leo Avenue main line from the western cul-de-sac to S. 7th Street in 2005. The San Jose Department of Transportation (DOT) took video of the main line and discovered a section of the western end of the line was substantially blocked with accumulated sediment. Subsequent to the line cleaning, DOT performed follow-up video of the Leo Ave main storm sewer line and did not find a break in the line but did find a dip in the storm drain line where much sediment had accumulated. With the exception of accumulated sediment remaining in the line at the low point (dip in the line), the follow-up video of the line taken by DOT showed that it was clean. Follow-up sampling was not conducted after the line cleaning.

The source property identification and referral pilot study in the Leo Avenue watershed builds upon the 2002-2003 Leo Avenue Case Study, the City's subsequent work in 2004/2005, and the SFEI Proposition 13 study completed in 2010. The boundaries of the Leo Avenue watershed expanded from the Leo Avenue vicinity to the entire Leo Avenue watershed[9]. Previous measurements of mercury and PCB concentrations in sediments collected from piping beneath manholes, drop inlets/catch basins, streets/gutters, and private properties in the Leo Avenue watershed have ranged from 0.089 to 6.2 mg/kg for mercury and ND to 27 mg/kg for PCBs (KLI and EOA 2002; EOA 2002; City of San Jose and EOA 2003, Yee and McKee 2010).

Results of Source Property Identification and Referral Process

The source property identification and referral pilot study in the Leo Avenue watershed has been conducted by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) and the City of San Jose.

Step 1: Records Review

The records review was initiated in December 2010. In total, 230 parcel numbers were obtained from the Santa Clara County Assessor's Office 'Assessment Roll Information Inquiry and Retrieval' website (http://www.scc-assessor.org/ari/home.do) for properties in the Leo Avenue watershed, most of which were matched with addresses using the virtual mapping website Google Maps and other online sources (e.g., 'yellow pages'). The list of properties was updated

[9] Spatial analysis results from the San Francisco Estuary Institute's 13 study (Yee and McKee. 2010) showed, that in 15 locations of the Bay Area, elevated concentrations of PCBs or Hg were clustered together within 3 kilometers of one another, which may be due to similarities in land use or transport of shared pollutant sources. The watershed was identified as one of the 15 locations in the Bay Area with several elevated concentrations in the same general vicinity.

from 230 to 233 properties using The City of San Jose's City Hall Records Imaging System (CHRIS) database which contains information from the Planning, Code Enforcement, Fire Prevention, Building and Public Works Departments.

The search of online databases identified a total of 62 of these properties with an enforcement history with a regulatory agency. Of the 62 properties, one business (with two properties next to each other), Lorentz Barrel and Drum Co., was found to be responsible for contaminating groundwater with PCBs in the past. Lorentz Barrel and Drum Co., formerly located at 1507 and 1515 S. 10th Street, is a Federal Superfund Site due to contaminated soil and groundwater from drum reconditioning. Pollutants identified include dioxin, metals, organochlorine pesticides, herbicides, PCBs, and volatile and semi-volatile organics. Through the subsequent reconnaissance survey, it was found this site is now paved and is being monitored by the appropriate agencies. It is unknown whether residue from this location may have been carried by wind to other properties in the watershed while it was operational.

A hard copy list of PG&E spills from the San Jose Division for 1997, 1998, and 1999 and the DeAnza Division for 1997 and 1999 did not reveal any PG&E spills in the watershed. Lists of spills since 2000 may be obtained in the future with the assistance of the Regional Water Board.

Using Google Earth, the list of 233 properties was reduced to 138 by removing land uses such as residential units and commercial buildings that are not considered to be a high priority.

Step 2: Driving/Walking Survey

The list of properties increased from a total of 138 to 159, due to additional identified properties during the driving/walking survey. The property data were filtered to remove properties that closed, relocated, or were paved or remediated. In addition, Google Earth was revisited to determine whether certain businesses should remain on the list as potential inspection sites. The results of the reconnaissance survey and these additional filtering steps led to reducing the list of 159 properties to 36. This list was then used to determine the locations and priority for the facility inspections.

Twenty-nine sites were categorized as high priority and seven as medium priority. In addition, four vacant facilities were identified as potential PCB sources due to insufficient information. It was determined that, although the facilities would not be inspected, they would be added to the list of potential right-of-way sampling sites.

Step 3: Facility Inspections

In September and October 2011, SCVURPPP and the City of San Jose staff conducted property inspections at the 36 sites. All properties were inspected within the planned budget and schedule. Of those 29 high priority sites, three sites could not be accessed. Despite repeated attempts to locate a person on the property, one of the three sites was removed from the list due to insufficient information. However, for the two remaining sites, observations were made from the street, while additional information was obtained about one site from a neighboring business owner, allowing for sufficient information to determine their sampling priority. Of the seven medium priority sites, one site was also observed from the street, which also allowed for enough information to determine its sampling priority.

Prior to the inspections, the City Stormwater Inspector provided an inspection history report, as available, for each facility. As a result of previously-established relationships with the property owners or site contacts, the Inspector provided access to the properties and facilitated the information gathering at each site. At each visit, the Inspector introduced the SCVURPPP staff member(s), explained the general purpose of the project, and carried out a general stormwater inspection. Meanwhile, the SCVURPPP staff member(s) asked the property owner or site contact questions about the property and surrounding area and filled out the facility inspection form (Appendix B.4.2.). In addition, for each inspection, relevant notes, such as locations of existing on-site private storm drain inlets or potential areas of concern, were drawn on a site map created using Google Maps. A site map, facility inspection form and a copy of the City stormwater inspection report were collected and completed as appropriate for each property.

No obvious sources of PCBs (i.e., no transformers, old hydraulic fluid, etc.) were identified during inspections. Fourteen properties were ranked as high or medium priority for right-of-way sediment sampling based on the degree of evidence that PCBs may be on the property and mobilized via stormwater/sediment transport.

Step 4. Soil/Sediment Testing

Kinetic Laboratories, Inc. (KLI) was selected through a competitive process as the CW4CB monitoring contractor for the Leo Avenue watershed. KLI conducted the Phase 1 right-of-way surface soil/sediment sampling at the sites selected by SCVURPPP and the City of San Jose, according to the methods and procedures documented in the project QAPP and Task 3 SAP (BASMAA 2012 a, b). All Phase 1 samples in this watershed were collected on October 1 and October 2, 2013. A field methods report is provided in Appendix B.4.E.

The chemical analysis results for PCBs and mercury have undergone QA/QC review and are presented below. These data are considered preliminary, pending finalization of the QA/QC review for all Phase 1 data. A summary of the data quality review completed to date for Phase 1 field and chemistry data in all five project watersheds is provided in Appendix B.4.D.

A total of 19 soil/sediment samples were collected during Phase 1 at the locations identified in Figures B.4.12 and B.4.13. Concentrations of total PCBs (sum of 40 congeners) ranged from 0.012 mg/kg to 7.1 mg/kg (Figure B.4.12). Concentrations of mercury ranged from 0.012 mg/kg to 8.1 mg/kg (Figure B.4.13).

As of the writing of this report, the Phase 1 sediment sampling results are being used to select private property and/or additional public right-of-way sampling locations for Phase 2, which is anticipated to occur during May 2013. Chemical analysis results from the Phase 2 sampling effort are expected to be available within three months following completion of all field sample collection.

Step 5: Referrals

Based on private property sampling results, SCVURPPP and the City of San Jose will submit a list of facility referrals to the Regional Water Board for follow-up investigations at these facilities. The information requirements and documentation that will be used to make these referrals are currently being developed by the CW4CB PMT in cooperation with Regional Water

Board staff. It is anticipated referrals will be made within six months of completion of the second phase of soil/sediment testing.

Pulgas Creek Pump Station Watershed, San Carlos, CA

Site History

In 2000 and 2001, a collaboration of BASMAA member agencies, termed the Joint Stormwater Agency Project (JSAP), measured concentrations of PCBs, mercury and other POCs in embedded sediments within stormwater conveyance systems throughout the Bay Area and identified the Pulgas Creek Pump Station area in the City of San Carlos as a potential source of elevated PCB concentrations (KLI, 2002). In 2002 and 2003, the San Mateo Countywide Stormwater Pollution Prevention Program (SMCWPPP) performed PCB source identification studies (i.e., case studies) in the Pulgas Creek Pump Station watershed (EOA, 2003). The JSAP sampling locations were re-sampled, and new locations were also sampled. Sampling results and records research showed the presence of potential PCB sources in the watershed such as a PG&E substation and a remediation property. However, based on the spatial distribution of PCBs in storm drain sediments, other sources remained unidentified. More recently, results from a 2010 study by the San Francisco Estuary Institute identified the watershed as one of 15 locations in the Bay Area with several elevated concentrations in the same general vicinity (Yee and McKee, 2010).

The source property identification and referral pilot study in the Pulgas Creek Pump Station watershed builds upon these previous efforts. Previous measurements of mercury and PCB concentrations in sediments collected from the pump station, piping beneath manholes, channels, drop inlets/catch basins, streets/gutters, and private properties have ranged from 0.042 to 0.92 mg/kg (mercury) and ND to 12 mg/kg (PCBs).

Results of Property Identification and Referral Process

The source property identification and referral process in the Pulgas Creek Pump Station watershed has been conducted by SMCWPPP.

Step 1: Records Review

The records review process began in November 2010 by accessing the San Mateo County (County) assessor website (http://www.smcare.org/apps/ParcelMaps/default.aspx) to obtain addresses and parcel information of the 480 properties located within the watershed. This information was entered into a spreadsheet to which all new information has since been added. Next, the addresses and parcel numbers of these properties were used to search several online databases that contain data about PCB waste, toxic chemical releases, regulated facilities and other useful information. Online databases that were accessed during the records review include, but are not limited to: State Water Resources Control Board's Geotracker (http://geotracker.swrcb.ca.gov/); CA Department of Toxic Substances Control (http://www.envirostor.dtsc.ca.gov/public/); U.S. Environmental Protection Agency's (EPA) Envirofacts (http://www.epa.gov/enviro/); and U.S. EPA's PCBs database (http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/data.htm).Fifty-two of properties were identified which had an enforcement history with a regulatory agency. Of the 52, three properties were identified that had been responsible for contaminating groundwater with PCBs or storing drums containing PCBs. Google Earth™ satellite and aerial imagery software were used to preliminarily identify current land use of properties located within the watershed, including screening out low priority properties such as residential units and commercial buildings. Google Earth™ was also used to collect preliminary information about apparent housekeeping and current property condition, including the existence of unpaved areas and the condition of paved areas such as parking lots and driveways. In total, the records review process identified 140 properties as potential source properties.

Step 2: Driving/Walking Survey

Program staff then conducted a driving and walking reconnaissance survey during March 2012 in the watershed's public right-of-way areas to collect additional information about subject properties and verify information collected during the records review. A global positioning system camera was used to capture locations and photographs of suspect properties that may be PCB or mercury sources, including those with the potential for sediment mobilization to the public right-of-way. Following the survey, the list of potential source properties was reduced to 40.

Step 3: Facility Inspections

Facility inspections were coordinated with the City and the San Mateo County Department of Environmental Health (SMCDEH), the agency that routinely conducts stormwater inspections in the city. Prior to property inspections, SMCDEH sent out letters to each property owner informing them of SMCWPPP's upcoming visit to inspect their sites. Inspections were conducted by SMCWPPP and SMCDEH staff in April 2012. Thirty-four properties were inspected. During the inspections, SMCWPPP staff asked the property owner or site manager questions about the property and surrounding area and completed facility inspection forms. Notes were kept about each property and the surrounding area, including locations of existing on-site private storm drain inlets or potential areas of concerns, which were mapped using Google Maps™. There were six properties from the list of 40 that were not inspected due to lack of access (no known owner, closed business, unsuccessful repeated attempts to contact owner). Those properties were surveyed to the extent possible from outside the property boundaries.

The results of the records review, field survey, and inspections were used to rank each inspected property as high, medium or low priority for right-of-way sampling based on the degree of evidence that PCBs may be on the property and potential for sediment mobilization via stormwater off the site. The inspections identified 8 properties with medium or high potential PCB sources on the property. Of these, five also had medium or high potential for sediment erosion. Another 8 properties had low potential PCB sources on the property, but medium or high potential for sediment erosion. In total, 16 properties were ranked medium or high priority for adjacent right-of-way sampling.

In order to inform selection of potential sediment sampling locations, Program staff ground-truthed locations of storm drain inlets and other features adjacent to medium and high priority properties in May 2012, and identified areas where sediment had accumulated. Accumulation of between 1 and 12 inches of sediment was observed in a number of storm drain inlets in the watershed at the end of the 2011/12 wet season. The results of the inspections were used to identify locations for sediment sampling in the public right-of-way and on private properties.

Step 4: Soil/Sediment Testing
Kinetic Laboratories, Inc. (KLI) was selected as the CW4CB monitoring contractor for the Pulgas Creek Pump Station watershed. KLI conducted right-of-way surface soil/sediment sampling at the sites selected by SMCWPPP, according to the methods and procedures documented in the project QAPP and Task 3 SAP (BASMAA 2012 a, b). All Phase 1 samples in this watershed were collected on September 24 and September 25, 2012. A field methods report is provided in Appendix B.4.E.

The chemical analysis results for PCBs and mercury have undergone QA/QC review and are presented below. These data are considered preliminary, pending finalization of the QA/QC review for all Phase 1 data. A summary of the data quality review completed to date for Phase 1 field and chemistry data in all five project watersheds is provided in Appendix B.4.D.

A total of 12 soil/sediment samples were collected during Phase 1 at the locations identified in Figures B.4.14 and B.4.15. Concentrations of total PCBs (sum of 40 congeners) ranged from 0.017 mg/kg to 2.5 mg/kg (Figure B.4.14). Concentrations of mercury ranged from 0.035 mg/kg to 1.1 mg/kg (Figure B.4.15).

As of the writing of this report, the Phase 1 monitoring results are being used to select private property and/or additional public right-of-way sampling locations for Phase 2, which is anticipated to occur between May and July 2013. Chemical analysis results from the Phase 2 sampling effort are expected to be available within three months following completion of all field sample collection.

Step 5: Referrals
Based on private property sampling results, SMCWPPP will submit a list of facility referrals to the Regional Water Board for follow-up investigations at these facilities. The information requirements and documentation that will be used to make these referrals are currently being developed by the CW4CB PMT in cooperation with Regional Water Board staff. It is anticipated referrals will be made within six months of completion of the second phase of soil/sediment testing.

B.4.3 Status of Control Measure Implementation

This section summarizes the baseline and enhanced level of implementation of the source property identification and referral pilot studies for each of the five CW4CB project watersheds.

B.4.3.1 Baseline

Prior to the TMDL (July 1, 2002) no source property identification and referral control measures for mercury and/or PCBs were implemented in any of the pilot watersheds. Thus the baseline level of implementation is no implementation for this control measure type.

B.4.3.2 Current

Ettie Street Pump Station Watershed, Oakland CA

Summary of Pre-CW4CB Level: 2002-2010

In 2000 and 2001, ACCWP investigations suggested there were multiple sites in the Ettie Street Pump Station watershed that continued to discharge legacy PCBs to the storm drain system, but no specific current sources were identified. In 2004, the City of Oakland was awarded funding from a State Water Resource Control Board Proposition 13 Grant to further investigate, identify, and remediate sources of PCBs in the watershed and evaluate control measures for addressing these sources of PCBs. Starting in 2004, the City surveyed potential source areas for PCBs in the watershed, conducted inspections of private properties, sampled and performed chemical analysis of soil/sediment samples from locations in the public right-of-way and on private properties, prepared sampling reports, coordinated with regulatory agencies for enforcement of PCB cleanup on private properties, and prepared and distributed of education and outreach materials. In 2006, these efforts led to abatement of two sites in the public right-of-way and remediation of one site on private property. In 2007, subsequent sampling was performed to evaluate the effectiveness of the abatement and remediation efforts.

Current Status of Implementation of the CW4CB Process: 2010 – Present

In 2011, as part of the CW4CB project, the Ettie Street Pump Station watershed was identified as one of five pilot study watersheds for pilot source property identification and referral investigations. In May and June 2012, the City of Oakland and Geosyntec staff inspected or re-inspected these 15 industrial sites to evaluate whether the properties were potential sources of PCBs. In September and October 2012, a total of 27 Phase 1 right-of-way surface soil/sediment sampling were collected by AMS/ADH. As of spring of 2013, the Phase 1 sediment sampling results are being used to select private property and/or additional public right-of-way sampling locations for Phase 2, which is anticipated to occur in the summer of 2013. Based on the results of the Phase 2 sampling, ACCWP and the City of Oakland will submit a list of facility referrals to the Regional Water Board for follow-up investigations at these facilities.

Lauritzen Channel and Parr Channel Watersheds, Richmond CA

Monitoring information collected by Contra Costa Clean Water Program (CCCWP) and Richmond in response to regulatory direction by the Regional Water Board from 2000 to the present helped prioritize property referrals to the Regional Water Board that are required under the MRP. For prioritization, this analysis divides PCB concentrations into three categories:

- Urban Background (< 200 µg/kg)
- Potentially high, to be further investigated (200 to 700 µg/kg)
- Actionable (>700 µg/kg)

Those three categories are simply tools of convenience to establish priorities for property referrals. Concentrations in sediments below 200 µg/kg will also need to be addressed; however, to the extent that such concentrations persist in the public right of way after source control actions have been completed, the appropriate abatement tools may be more along the lines of enhanced municipal operations and treatment retrofits. Sediments with PCB concentrations in the range of 50 – 200 µg/kg may be too widespread and diffuse to be abated via source control alone.

Summary of Pre CW4CB Level: 2002-2010

In 2000 and 2001, CCCWP and the City of Richmond investigations suggested there were multiple sites in the Santa Fe Drainage (which includes the Lauritzen and Parr Channels) that continued to discharge legacy PCBs to the storm drain system, but no specific current sources were identified. Follow up studies during 2005 – 2007 presented a more comprehensive picture and helped pinpoint potential source areas, including surface street samples collected from locations bracketing a metal recycler. Other potential source properties contributing to elevated PCB concentrations in storm drain catch basins in the drainage included a fork lift repair shop and PG&E transformer yard, although the evidence at that time remained inconclusive; other potential explanations were tidal intrusion of sediments from the Richmond Harbor (the conveyance system in that area is partly tidal) and vehicle trackout from the metal recycler or some other as yet unidentified source.

The TMDL for PCBs in San Francisco Bay was adopted in 2008. The MRP required control measures for PCBs, including the source identification and reporting project that is within the scope of this section. Concurrently, Richmond worked with the metal recycler to get them to initiate enhanced BMPs, including near continuous street sweeping on adjacent streets. While that enhanced BMP likely helps reduce trackout of potentially contaminated sediments, street sweepers cannot get complete removal because of the soft shoulder and lack of curb and gutter in the area. In addition, airborne transport of dust and shredder fluff (the fine, particulate grindings associated with metal shredding) may transport solids offsite beyond the activity area of high frequency street sweepers. Anecdotal evidence suggests that dust accumulation on cars is a nuisance for nearby residents.

Current Status of Implementation of the CW4CB Process: 2010 – Present

In 2011, as part of the CW4CB project, the Lauritzen Channel and Parr Channel watersheds were identified as two of five pilot study watersheds for pilot source property identification and referral investigations. In May and June 2011, the City of Richmond and CCCWP inspected industrial sites to evaluate whether the properties were potential sources of PCBs. CCCWP coordinated with other BASMAA member agencies through the CW4CB work groups to share lessons learned by CCCWP about the onsite property inspections.

Based on information from the inspections, Richmond directed the metal recycler to cease discharging stormwater into the MS4 system unless they provide detailed monitoring results for PCBs using appropriately low detection limit, and could demonstrate attainment of EPA benchmark values for industrial stormwater for other constituents. Since that direction in 2011, the metal recycler has stored stormwater onsite, and re-used onsite process water for dust control. Stored stormwater is currently discharged by the recycler into the sanitary sewer. Rainy weather has been anomalously light for the past few years, so the ability of the recycler to store water during larger events is as yet unproven.

In 2011 CCCWP also collected a sediment sample from a storm drain near a potential source area in the Lauritzen Channel watershed where a storm drain inlet plugged with sediment had been discovered. The sediment sampled from the storm drain was analyzed for PCBs using EPA Method 8020. PCB results were non-detect (<250 µg/kg total PCBs), indicating that the sediment did not have PCB concentrations greater than would be expected from an industrial urban setting.

In September and October 2012, a total of 14 Phase 1 right-of-way surface soil/sediment samples were collected by AMS/ADH. Monitoring through CW4CB Task 3 has brought into focus next steps based on confirmation of previous monitoring conducted 2000 – 2006. Referral of the Metal recycling property to the Regional Board is a logical next step pursuant to MRP Provision C.12.c. The desired information would be an assessment of PCB concentrations in soils and solids onsite, an assessment of pathways (trackout and aerial transport) that convey PCB-contaminated sediments onto Richmond Streets, and a proposed plan to prevent sediments with substantially elevated PCB concentrations from accumulating in the curb and gutter of adjacent streets. A similar referral is appropriate for the fork lift repair shop: trackout is visible from the driveway. A sediment sample collected just outside the fence line, in the public right of way, but obviously influenced by the shop yard, had 326 µg/kg PCBs, consistent with previous observations. It should be kept in mind that the concentrations observed near the Forklift shop may be the result of trackout from other potential source areas nearby; however, the elevated concentrations have been consistent at this location, over time, making it worthwhile to conduct sediment sampling onsite at the forklift repair shop.

CCCWP and the City of Richmond will submit these referrals to the Regional Water Board for follow-up investigations at these facilities. No other property referrals are immediately obvious at this time.

Approaches to abate sediments with PCB concentrations below 200 µg/kg identified in this study will be evaluated, including opportunities for enhanced municipal operations (MRP Provision C.12.d) in the pilot watersheds, working with property owners to reduce offsite sediment transport, improving curbs and gutters in the public right of way to enhance street sweeping efficiency, and design and construction of stormwater treatment retrofits. Although those activities are outside the scope of this source investigation and property referral task, they are mentioned briefly here because the source investigations informed those other activities, to help show how various required PCB control measures fit together. Those activities are described elsewhere in this report.

Leo Avenue Watershed, San Jose, CA

Summary of Pre CW4CB Level: 2002-2010

Elevated PCB concentrations in sediments have been identified in the Leo Avenue area in studies from 2001 through 2010 (KLI 2001 and 2002, City of San Jose and EOA Inc. 2002, City of San Jose and EOA Inc. 2003, and Yee et al. 2010). Case studies conducted in the watershed in 2002-

2003 consisted of records reviews, researching current and historical land uses, and sampling bedded sediment within the stormwater conveyance system in the Leo Avenue area. The highest PCB concentrations were found in sediments collected from the Leo Avenue stormwater conveyance system and sediments associated with the unpaved Union Pacific railroad track right-of-way area located at Leo Avenue's cul-de-sac. Additional potential source areas included other properties located on Leo Avenue but no conclusive evidence implicated any specific properties in the area. In 2005, the City of San Jose hired contractors to clean out accumulated sediment from the main storm drain line on Leo Avenue. Approximately four cubic yards of sediment containing of PCBs was removed from the line. However, the source(s) of PCBs and sediment in the line were not identified.

Current Status of Implementation of the CW4CB process: 2010 – present

In 2011, as part of the CW4CB project, the Leo Avenue watershed was identified as one of five pilot study watersheds for source property identification and referral investigations. In May and June 2012, SCVURPPP performed records reviews and watershed surveys and identified 36 potential source properties in the watershed for follow-up inspections. Inspections were conducted at those properties in September and October 2011 by SCVURPPP and the City of San Jose staff to evaluate whether the properties were potential sources of PCBs. Fourteen inspected properties were ranked as high priority for right-of-way sediment sampling based on the degree of evidence that PCBs may be on the property and mobilized via stormwater/sediment transport. In October 2012, a total of 19 Phase 1 right-of-way surface soil/sediment samples were collected by KLI Inc. The sampling results confirmed previously elevated sediment PCB concentrations in the Leo Avenue main storm drain line. As of spring of 2013, the Phase 1 sediment sampling results are being used to select private property and/or additional public right-of-way sampling locations for Phase 2, which is anticipated to occur in the late spring of 2013. Based on the results of the Phase 2 sampling, SCVURPPP and the City of San Jose will submit a list of facility referrals to the Regional Water Board for follow-up investigations at these facilities.

Pulgas Creek Pump Station Watershed, San Carlos, CA

Summary of Pre CW4CB Level: 2002-2010.

In 2000 and 2001 the JSAP investigations identified the Pulgas Creek Pump Station area in the City of San Carlos as a potential source of elevated PCB concentrations in embedded sediments within the stormwater conveyance system (KLI, 2002). In 2002 and 2003, follow-up PCB source identification studies were conducted in the watershed by SMCWPPP which involved both new sampling and re-sampling of previous JSAP locations. These case studies identified the presence of potential PCB sources in the watershed such as a PG&E substation and a remediation property. However, based on the spatial distribution of PCBs in storm drain sediments other sources remained unidentified. More recently, results from a 2010 study by the San Francisco Estuary Institute identified the watershed as one of 15 locations in the Bay Area with several elevated concentrations in the same general vicinity (Yee and McKee, 2010).

Current Status of Implementation of the CW4CB Process: 2010 – Present.

In 2011, as part of the CW4CB project, the Pulgas Creek Pump Station watershed was identified as one of five pilot study watersheds for source property identification and referral investigations. In 2011 and early 2012, SMCWPPP performed records reviews and watershed surveys and identified 40 potential source properties in the watershed for follow-up inspections. Inspections were conducted at those properties in April 2012 by SMCWPP staff to evaluate whether the properties were potential sources of PCBs. Sixteen inspected properties were ranked as high or medium priority for right-of-way sediment sampling based on the degree of evidence that PCBs may be on the property and mobilized via stormwater/sediment transport. In September 2012, a total of 12 Phase 1 right-of-way surface soil/sediment samples were collected by KLI Inc. The sampling results confirmed previously elevated sediment PCB concentrations in the watershed. As of spring of 2013, the Phase 1 sediment sampling results are being used to select private property and/or additional public right-of-way sampling locations for Phase 2, which is anticipated to occur in the late spring of 2013. Based on the results of the Phase 2 sampling, SMCWPPP will submit a list of facility referrals to the Regional Water Board for follow-up investigations at these facilities.

B.4.4 <u>Estimates of Loads Avoided/Reduced</u>

B.4.4.1 Loads Avoided/Reduced Methodology

This section presents the conceptual approach that will be used to estimate mercury and PCB stormwater loads avoided/reduced due to source property investigation and abatement efforts. The key assumptions and data requirements will also be discussed. The proposed methods are based on previous studies, and will be refined and updated as additional information becomes available. The loads avoided/reduced methodology involves the following three steps:

1. Estimate the baseline annual stormwater load from a given source property prior to abatement.
2. Apply abatement effectiveness scenario(s) to the baseline source property load to estimate the loads avoided/reduced due to abatement.
3. Refine above estimates as more data become available.

In order to estimate the loads avoided/reduced due to abatement efforts, the annual stormwater load of mercury and PCBs for a given source property prior to abatement will be estimated, and a range of assumed load reduction effectiveness for all abatement measures implemented on that property will be applied to the baseline load. The loads avoided/reduced estimates will be refined as additional data on stormwater concentrations and watershed loads, and load reduction effectiveness for specific abatement measures become available. Additional details on each of these steps are provided below.

Step 1: Estimate the baseline annual stormwater load from a given source property prior to abatement.

There are a number of potential methods that may be used to estimate the baseline stormwater load from a given source property. Existing models (e.g., the SFEI spreadsheet model) can be used to estimate stormwater loads at the watershed level; however, developing accurate estimates at the property scale is incredibly difficult given the need for site specific data and understandings of sediment movement at that spatial scale. Based on the limited data likely available at the property scale, a simpler method using an average annual sediment yield (sediment mass/acre) for industrial properties and average concentrations of PCBs or mercury on sediment collected on the property, or on sediment that likely originated from the property, is recommended. This method would provide first-order PCB or mercury baseline load estimates for abated properties.

Alternatively, the baseline annual load of mercury and PCBs coming off an individual property can be calculated directly using the simple method. Required property-specific inputs include stormwater concentrations, annual precipitation, runoff coefficient(s) and the area of the property. Stormwater concentration measurements are typically unavailable at the property-scale. However, a range of locally measured or modeled stormwater concentrations are available that could be applied to a given property. The following assumptions may be helpful in assigning stormwater concentrations to a given property: properties with higher POC sediment concentrations and higher potential for sediment release to stormwater have higher stormwater concentrations compared with properties that have lower sediment POC concentrations and lower potential for sediment release to stormwater.

Another possibility to estimate property-level stormwater concentrations is to apply the method used by Mangarella et al. (2010) in which stormwater concentrations were estimated from measured sediment data. In this method, the concentrations of mercury and PCBs on TSS in stormwater was assumed to be equivalent to the concentration of mercury and PCBs measured in depositional sediments in the area. Data on TSS concentrations by land use in the Bay Area are available, and the concentrations of mercury and PCBs in surface soil/sediment on a given property or in public right-of-ways adjacent to a given property were quantified in the pilot studies.

Step 2: Apply abatement effectiveness scenarios to the baseline source property load to estimate the load avoided/removed due to abatement

Once the baseline annual load for a given property has been established, a range of abatement effectiveness scenarios could be applied to estimate the loads avoided/reduced of the abatement measures for a given property. The assumed abatement effectiveness scenarios may include one or more of the following: (1) 100% effective (e.g., annual load equals zero following abatement); (2) sediment concentrations remaining on the property following abatement are reduced to urban background concentrations; (3) assumed effectiveness derived from the International BMP Database for any specific BMP measures applied as part of the property abatement(s); (4) measured sediment (or stormwater) concentrations from follow-up monitoring on an abated property. For each abatement effectiveness scenario, the annual load avoided/reduced would be calculated by subtracting the post-abatement property load from the baseline load. The same methods used to calculate the baseline load would be used to calculate the post-abatement property load, but with different inputs appropriate for the post-abatement conditions (e.g., reduced sediment concentrations/stormwater concentrations).

The total mass of mercury and PCBs removed from a property during abatement could also be calculated and compared with the annual baseline load to understand the implications of abatement efforts over time. For example, a given mass removed divided by the baseline annual load would yield the total number of years of loads avoided due to the abatement, assuming all of the mass would otherwise be released to stormwater at a steady rate over time. Furthermore, scenarios could be applied in which the sediment concentrations are reduced each year to estimate the annual stormwater loads over time as sediment concentrations gradually decrease down to an urban background concentration.

Step 3: Refine above estimates as more data become available

All of the above can be refined as additional/better data become available. For example, follow-up sediment sampling on the properties could help determine how effective the abatement was in reducing sediment concentrations (and thus subsequent stormwater loads from the property). Additional data on the distribution of pollutant concentrations on different particle size fractions could be used to refine the stormwater concentration estimates derived from sediment concentrations. Finer particles typically have a greater surface area for constituents to adsorb to, and therefore concentrations tend to be higher on these particles. Smaller particles are mobilized more readily than larger particles at low flows, and therefore constitute the majority of the sediment mass being transported. However, under high flows, larger particles can have a far greater mass of the total sediment load than the smaller particles. Information on the concentrations of mercury and PCBs on different particle size fractions in sediment would allow for better understanding of the fraction of the sediment mass that is likely to be mobilized during storm events, and thus how well the pollutant sediment concentrations represent the pollutant suspended sediment concentration in stormwater.

B.4.4.2 Summary of Key Uncertainties

There are a number of sources of uncertainty in accurately estimating PCB and mercury loads reduced to San Francisco Bay associated with baseline and current source property identification and abatement:

- Due to the limited stormwater loading data for the Pilot watersheds, baseline (pre-abatement) loading estimates could vary by an order-of-magnitude, depending on the method used to estimate loadings.
- Limited information is currently available on the ability of property-based control measures to effectively reduce PCBs in stormwater runoff. Additionally, abatement effectiveness scenarios are likely to be site-specific and may not be transferable between properties.

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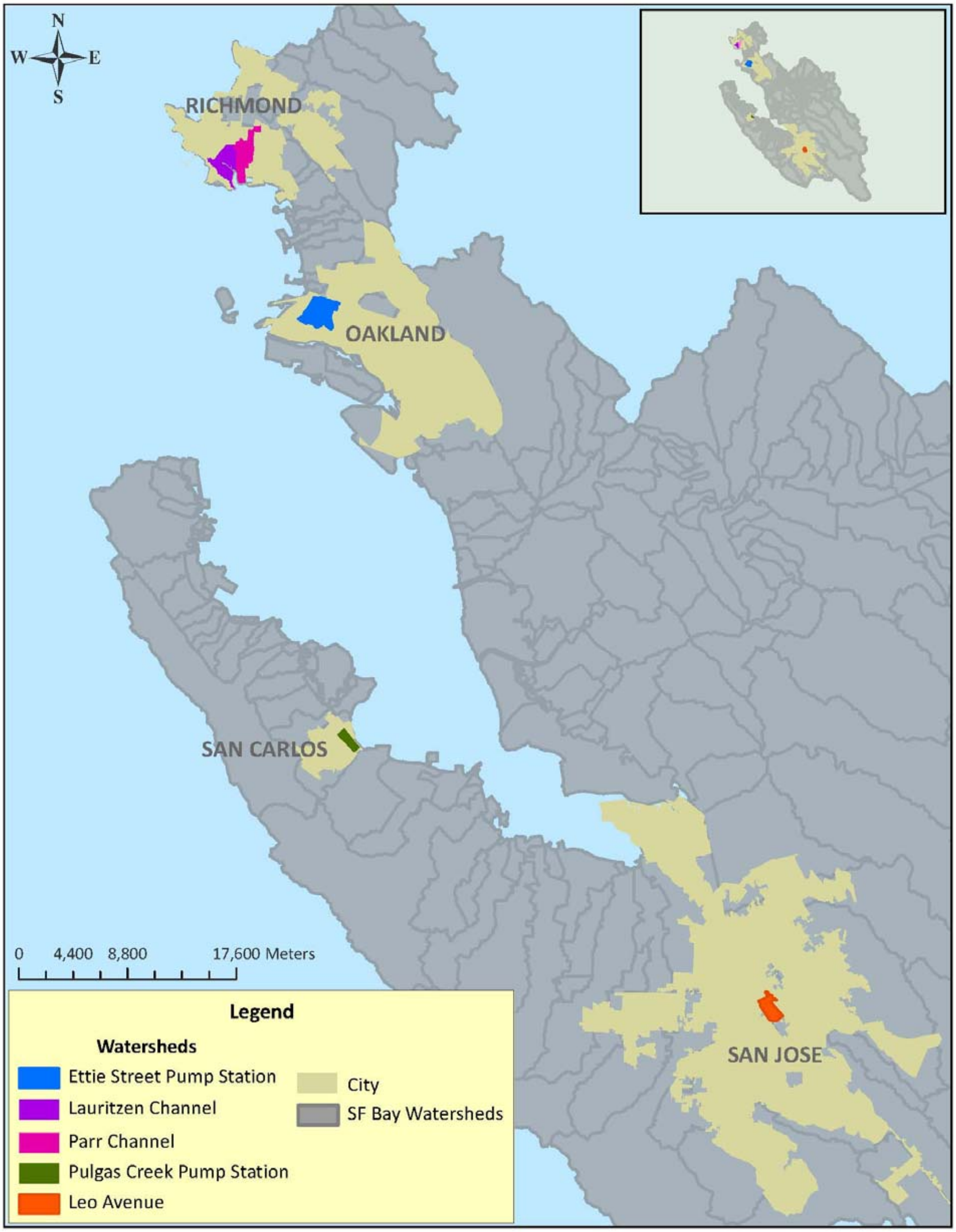
FIGURES B.4

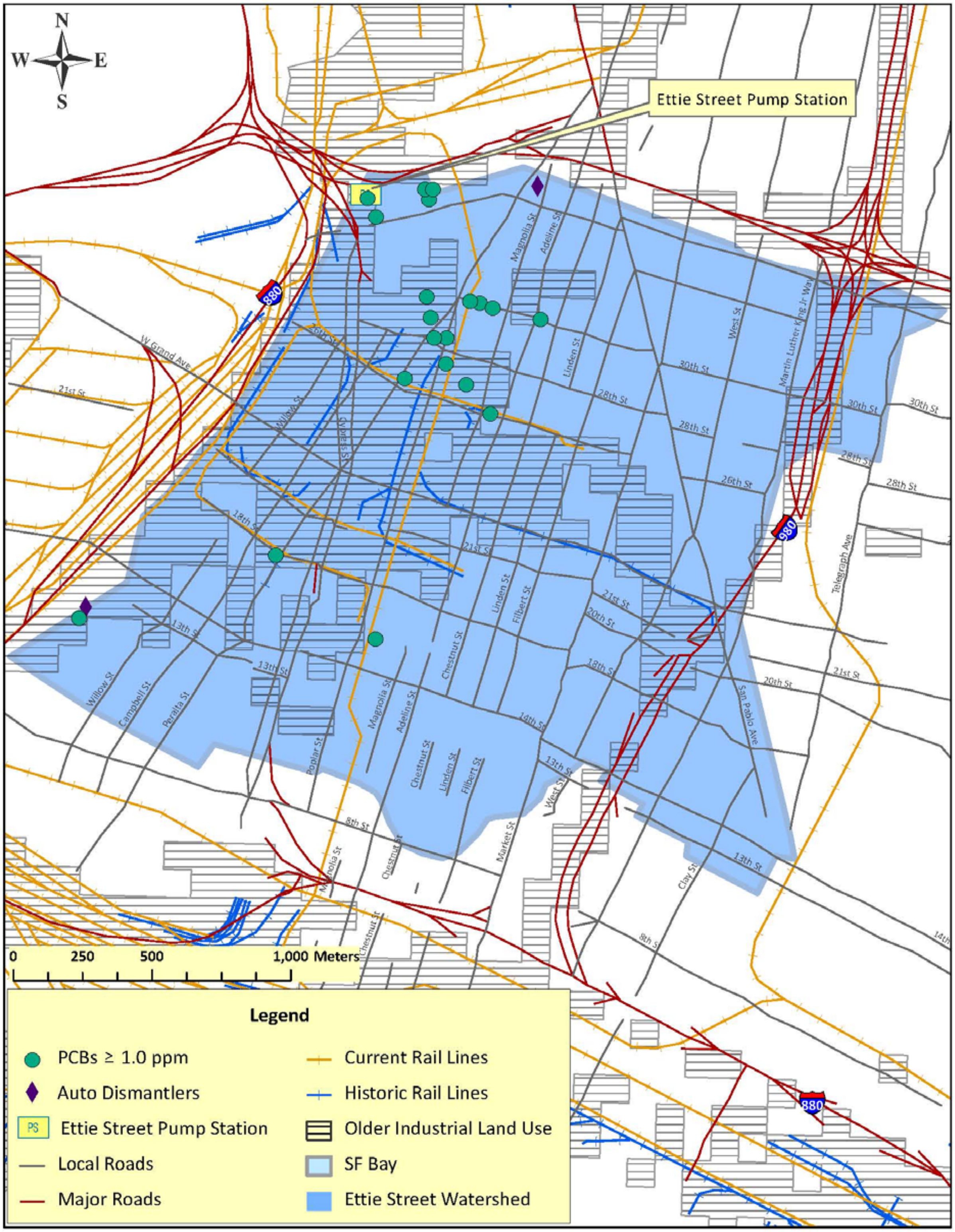


Source:

EOA, Inc. (2011)

CW4CB Pilot Investigation Watersheds

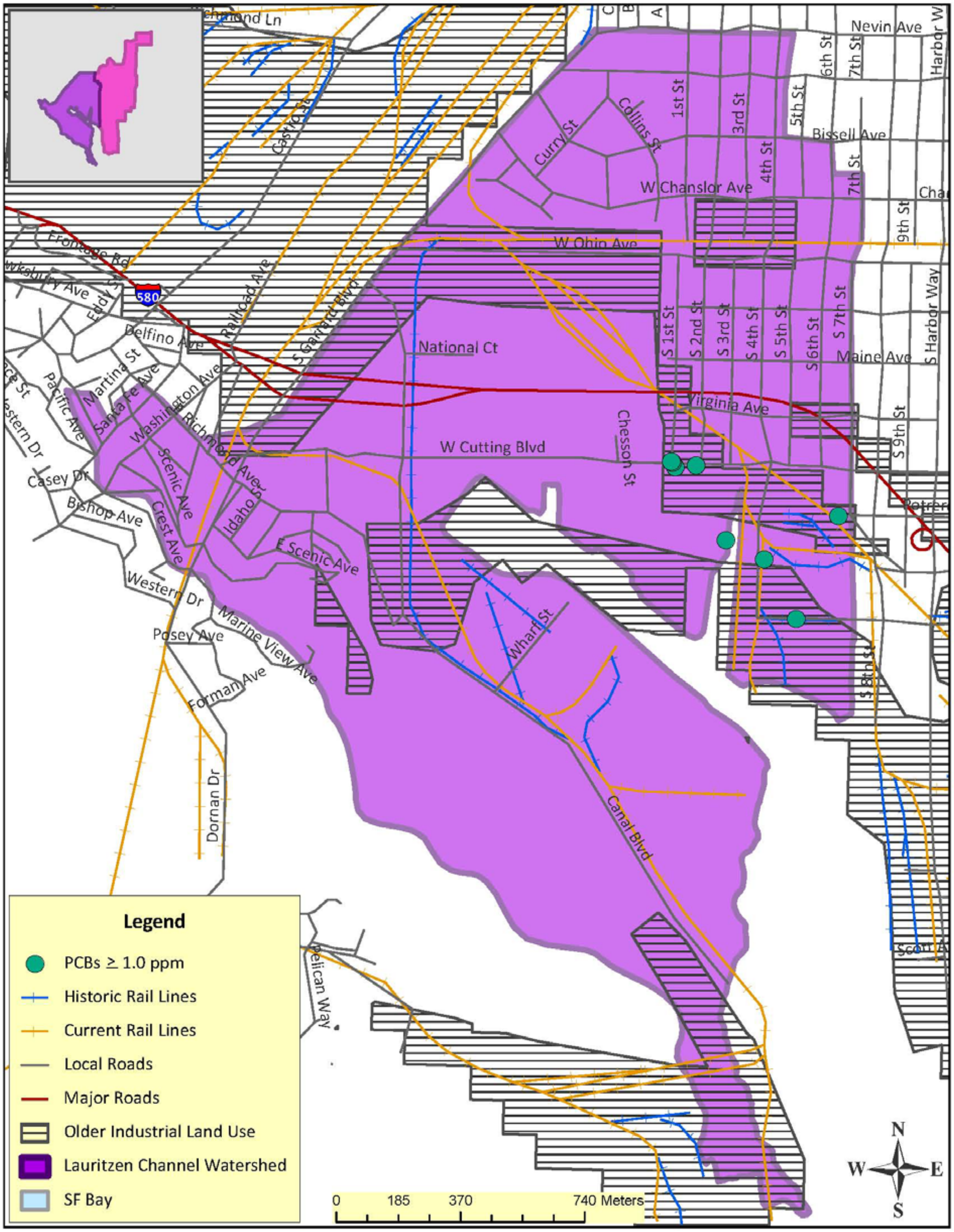
Bay Area Stormwater Management Agencies Association	May 2, 2011	Figure B.4.1
Entity	Date	



Ettie Street Pump Station Watershed in the City of Oakland, Alameda County

Source: EOA, Inc. (2011)	Bay Area Stormwater Management Agencies Association	May 2, 2011	Figure B.4.2
	Entity	Date	

internal info: path, date revised, author



Lauritzen Channel Watershed in the City of Richmond, Contra Costa County

Source:

EOA, Inc. (2011)

Bay Area Stormwater Management Agencies Association

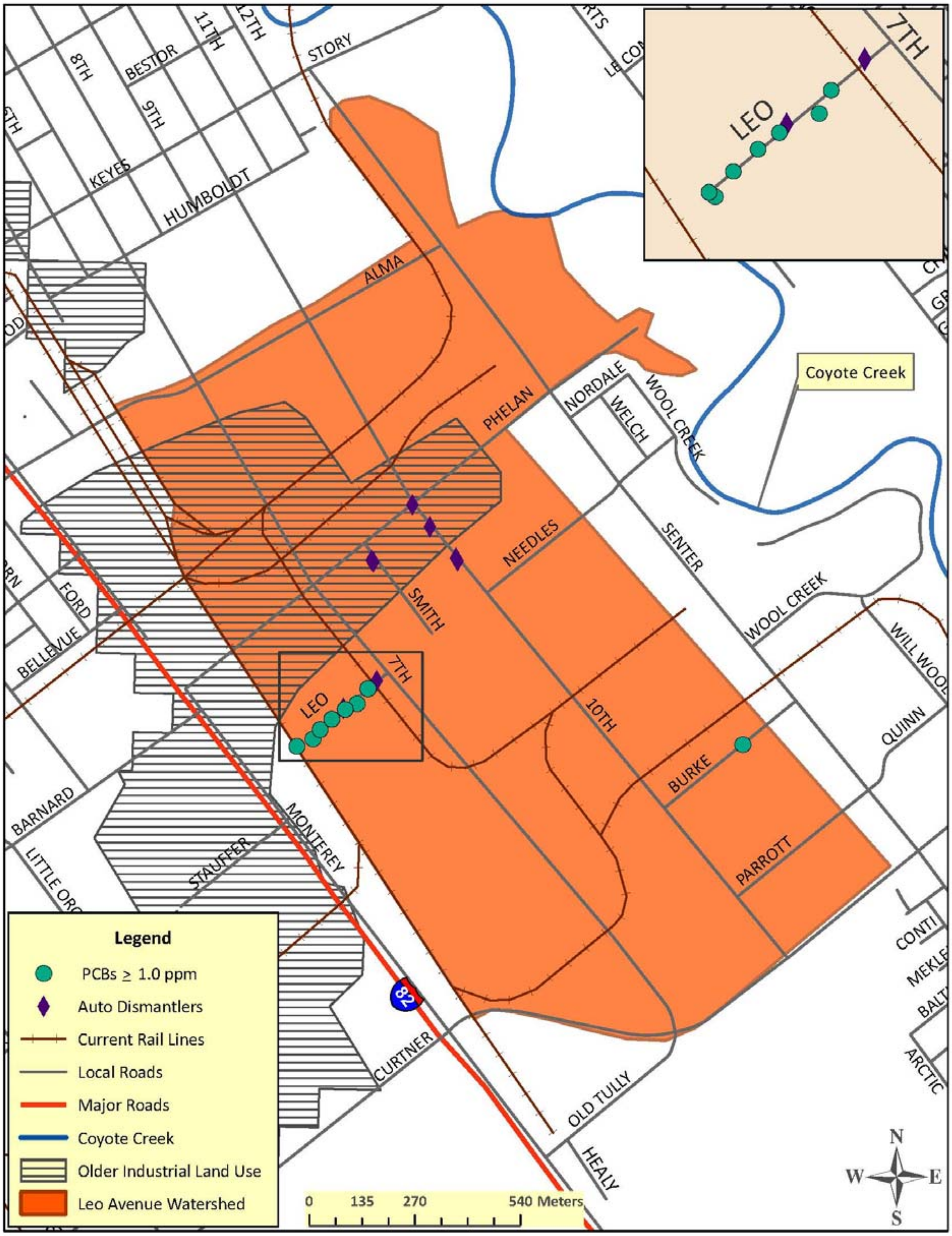
Entity

May 2, 2011

Date

Figure B.4.3

internal info: path, date revised, author



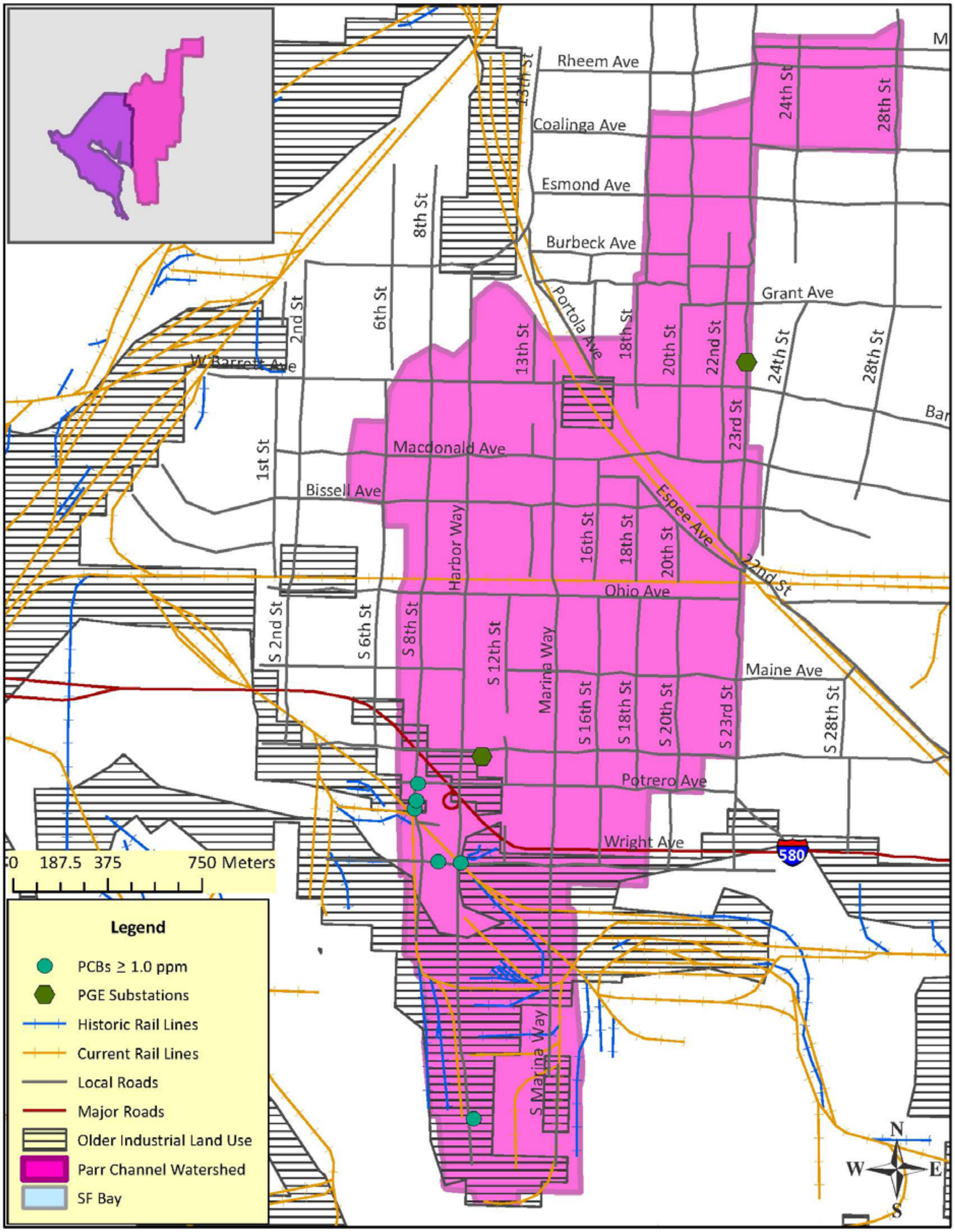
Leo Avenue Watershed in the City of San Jose, Santa Clara County

Source:

EOA, Inc. (2011)

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	May 2, 2011	B.4.4

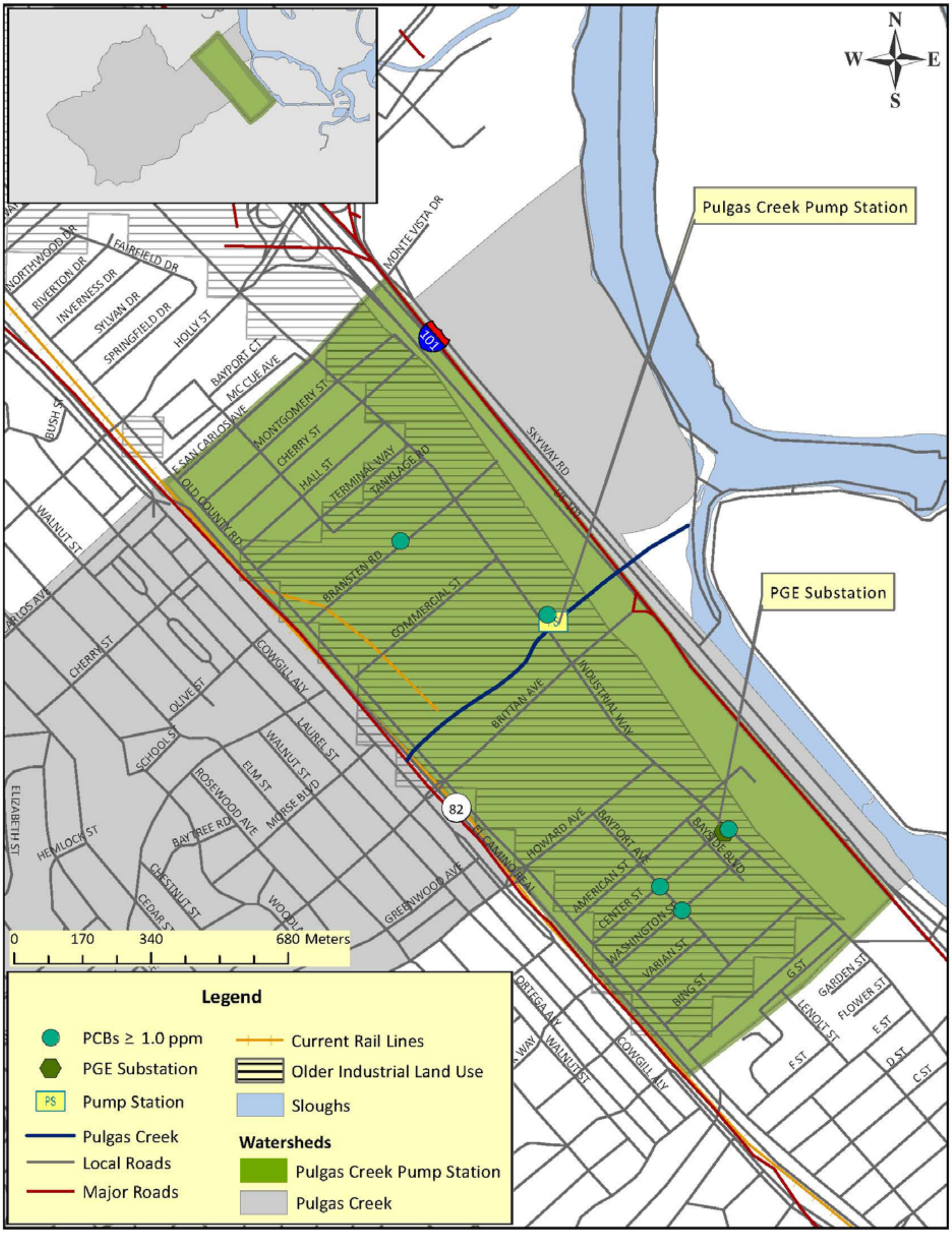
internal info: path, date revised, author



Parr Channel Watershed in the City of Richmond, Contra Costa County

Source: EOA, Inc. (2011)	Bay Area Stormwater Management Agencies Association	May 2, 2011	Figure B.4.5
	Entity	Date	

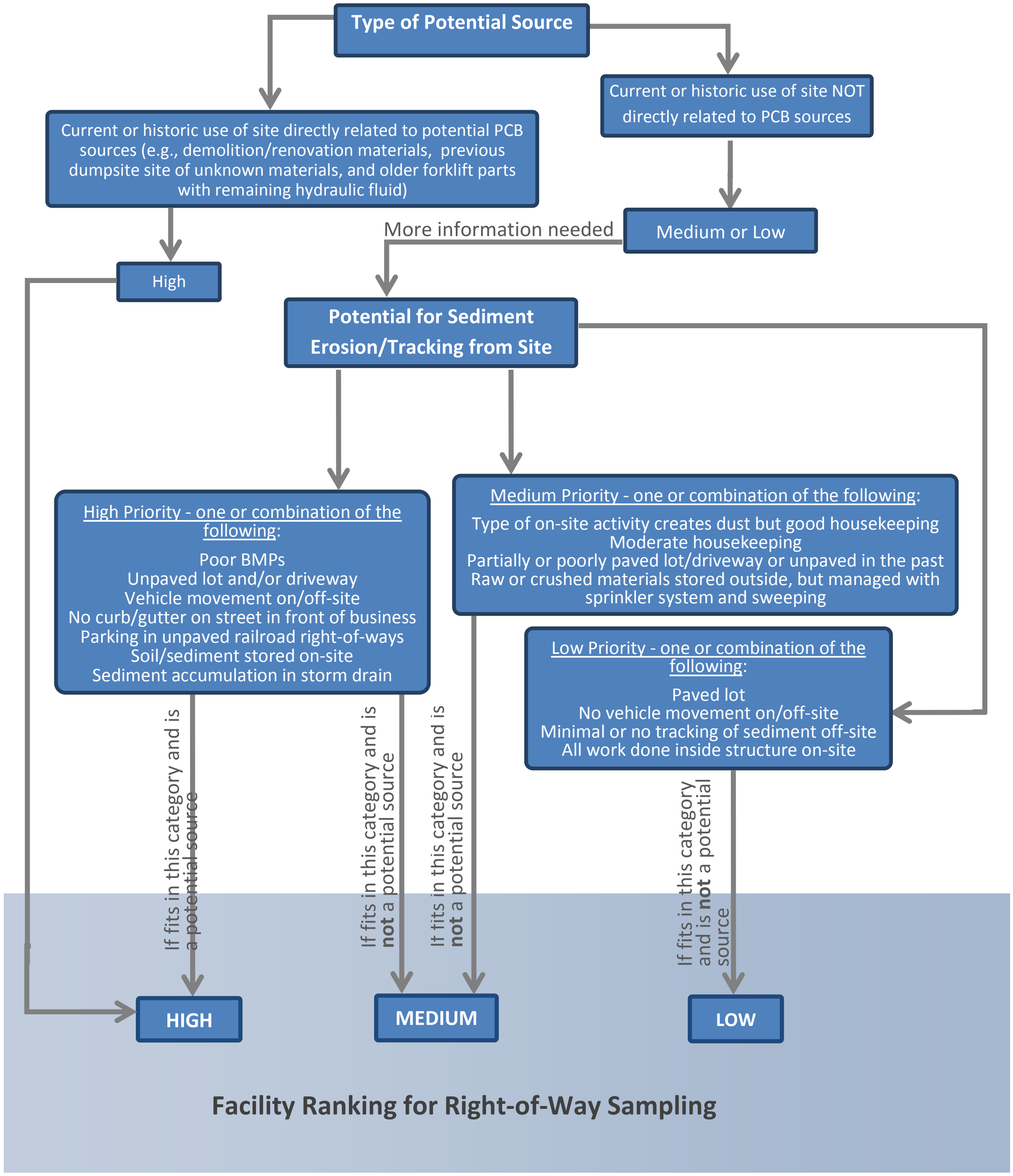
internal info: path, date revised, author



Pulgas Creek Pump Station Watershed in the City of San Carlos, San Mateo County

Source: EOA, Inc. (2011)	Bay Area Stormwater Management Agencies Association	May 2, 2011	Figure B.4.6
	Entity	Date	

internal info: path, date revised, author

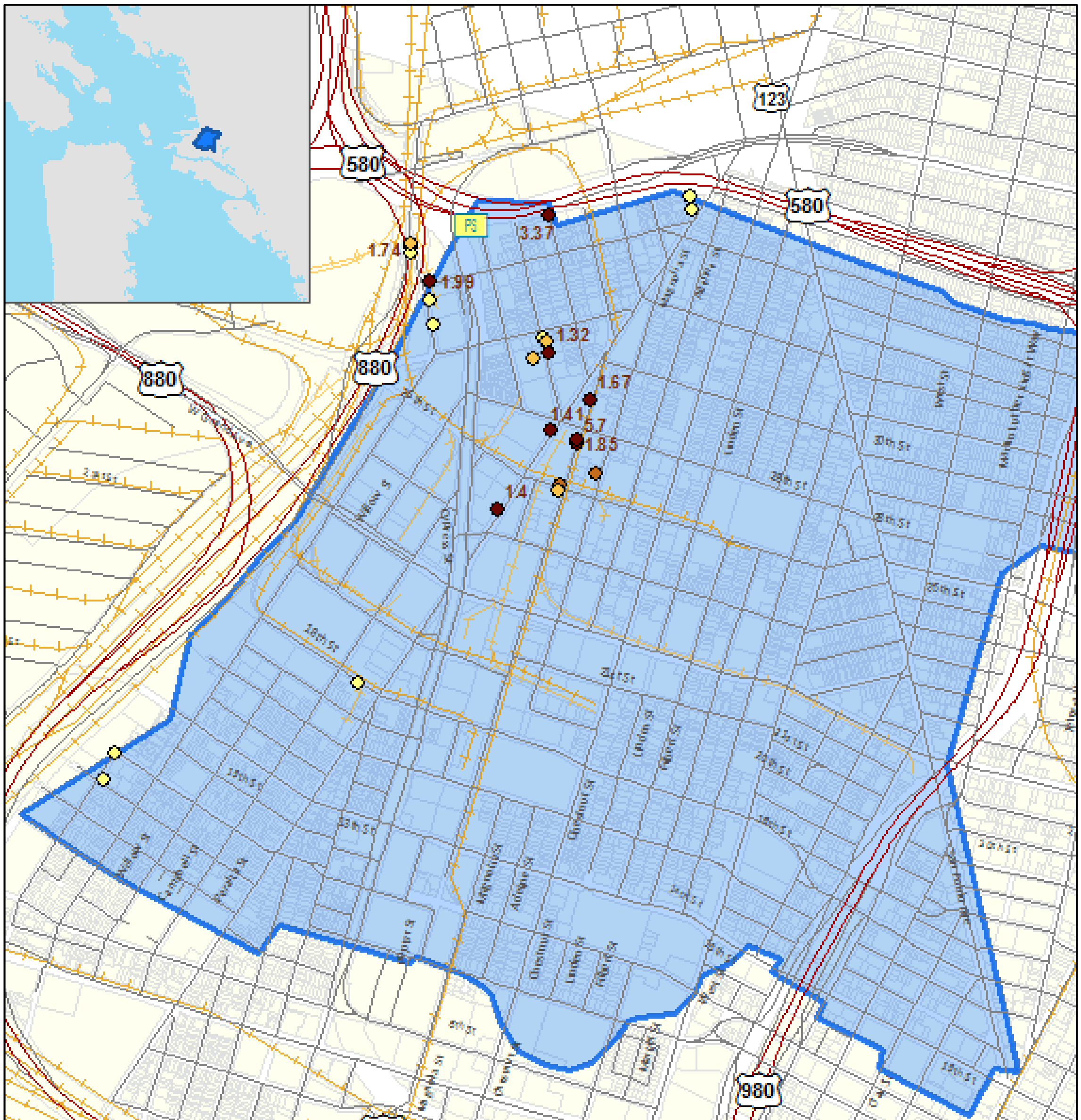


7

Decision Tree for Determining Facility Sampling Priority

Source:	Bay Area Stormwater Management Agencies Association	October 2013	Figure B.4.7
	Entity	Date	

internal info: path, date revised, author



Legend

PCB Conc. mg/kg

- 0 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- ≥ 1

- Local Roads
- Major Roads
- Current and Historic Rail Lines
- Ettie Street Pump Station
- Ettie Street Watershed

N

0 250 500 1,000 Meters

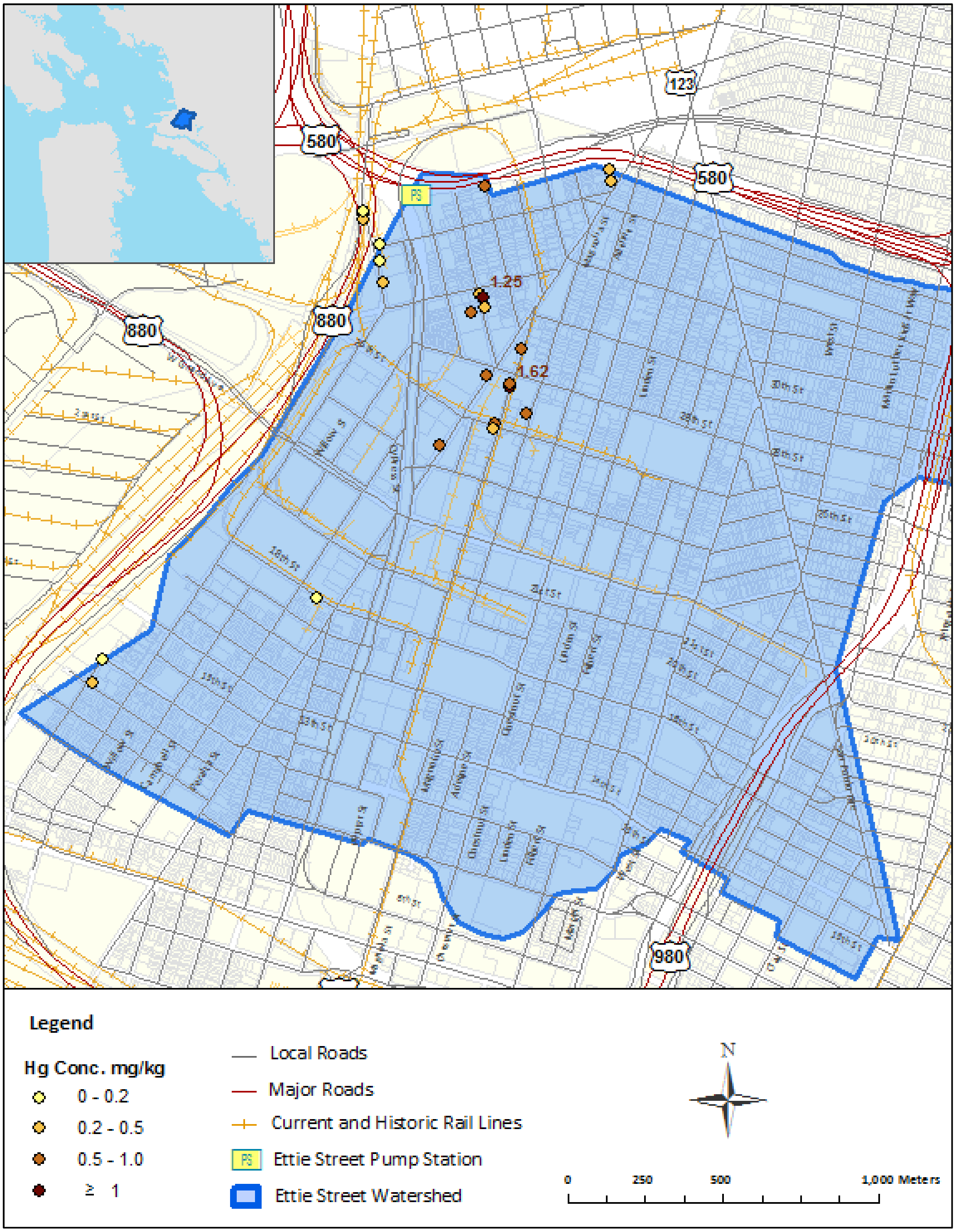
PCB Concentrations in Sediment Collected in the Public Right-of-Way in the Ettie Street Pump Station Watershed, Oakland, CA, September – October 2012

Entity	Date	
Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.8

Source:

EOA, Inc. (2013)

internal info: path, date revised, author



Mercury Concentrations in Sediment Collected in the Public Right-of-Way in the Ettie Street Pump Station Watershed, Oakland, CA, September – October 2012

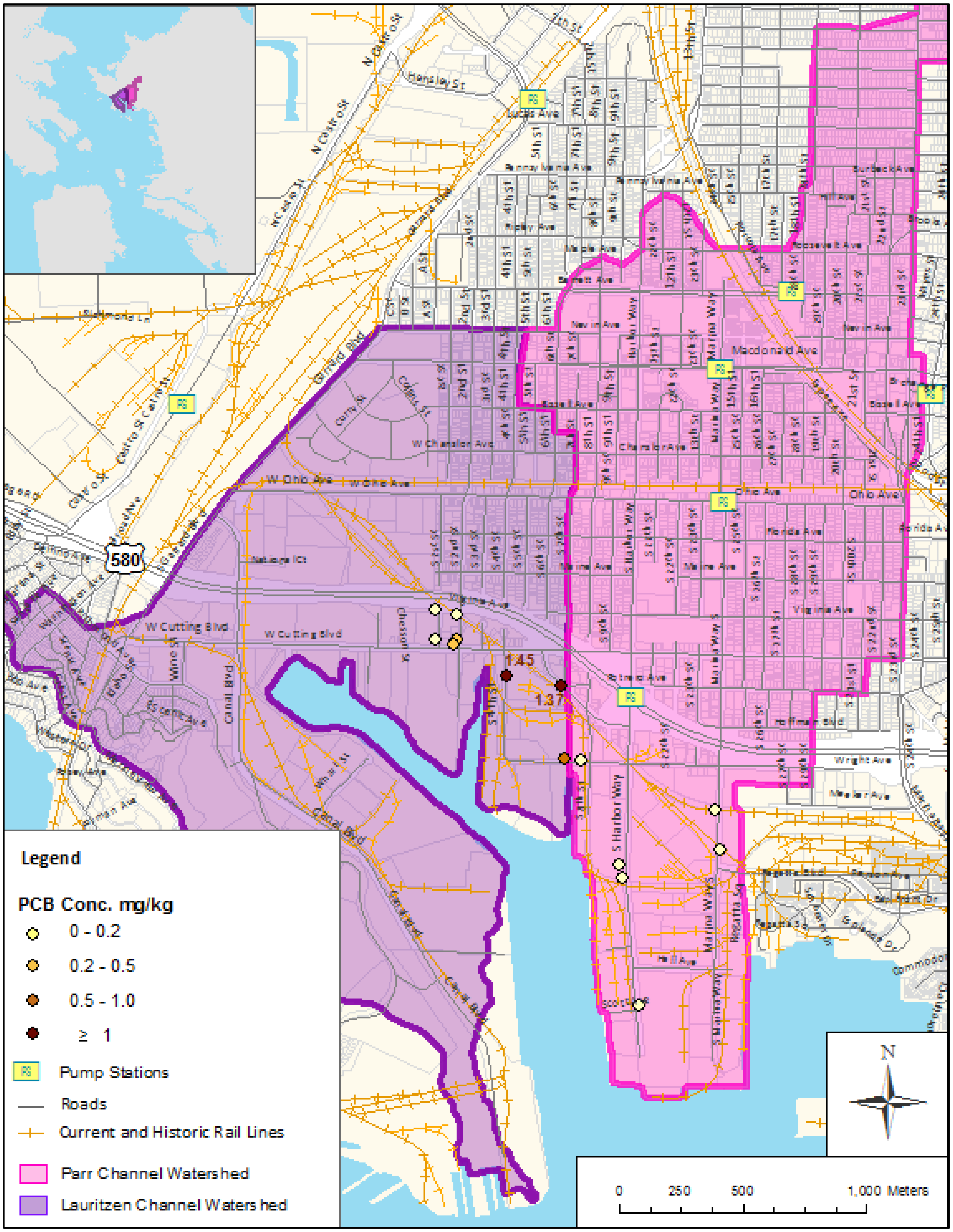
Source:

EOA, Inc. (2013)

Bay Area Stormwater Management Agencies Association

Entity	Date	
Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.9

internal info: path, date revised, author



Sampling Locations and PCB Concentrations for CW4CB Monitoring in the Lauritzen Channel and Parr Channel Watersheds

Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.10
Entity	Date	

Source:

EOA, Inc. (2013)

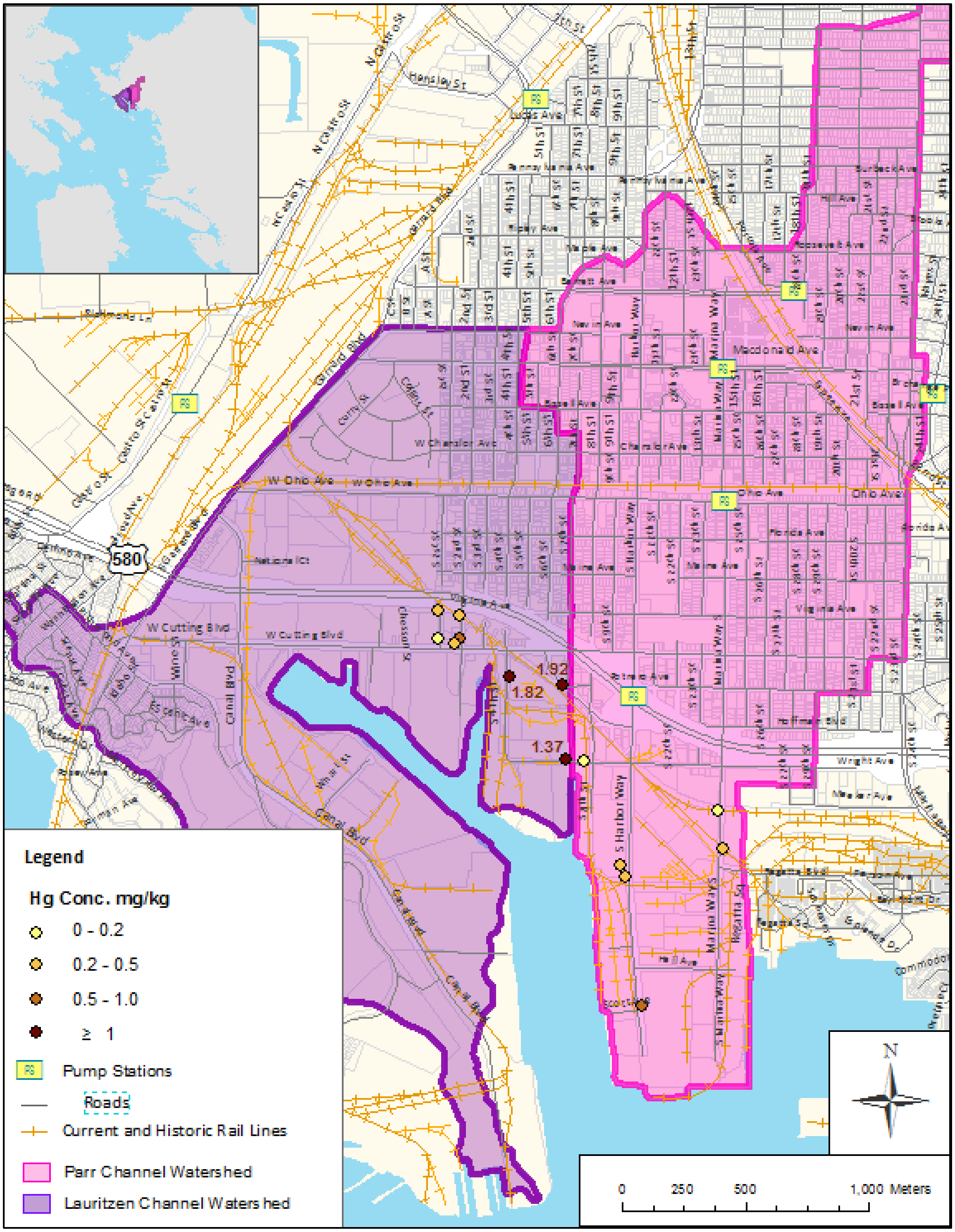
internal info: path, date revised, author

Source:	Notes: *Values in parentheses indicate PCB concentrations (µg/kg) measured in samples collected in October 2012 through CW4CB Task 3.*

Sampling Locations and PCB Concentrations for CW4CB Monitoring in the Lauritzen Channel and Parr Channel Watersheds

Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.11
Entity	Date	

internal info: path, date revised, author

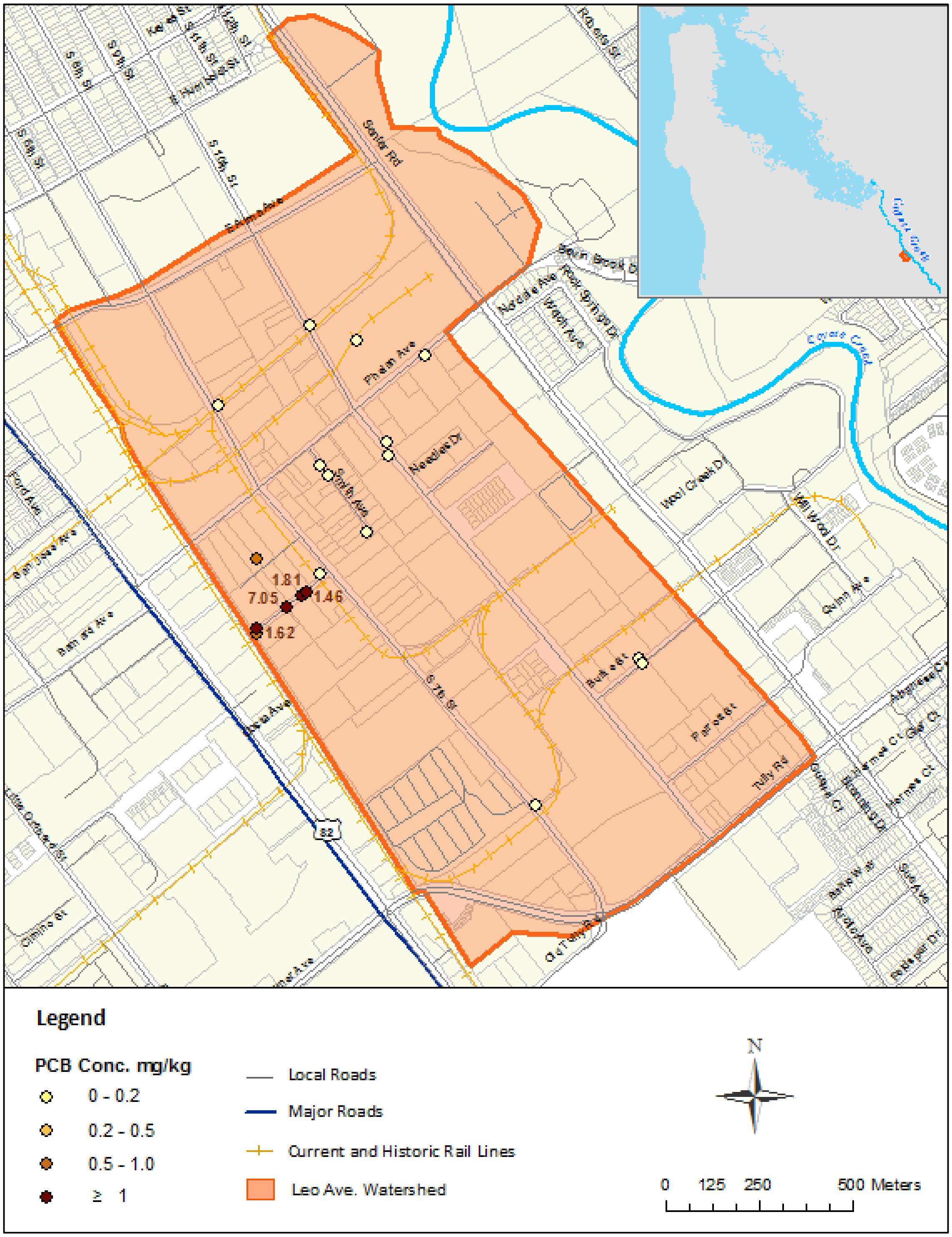


Sampling Locations and Mercury Concentrations for CW4CB Monitoring in the Lauritzen Channel and Parr Channel Watersheds

Entity	Date	Figure B.4.12
Bay Area Stormwater Management Agencies Association	October 1, 2012	

Source:

EOA, Inc. (2013)



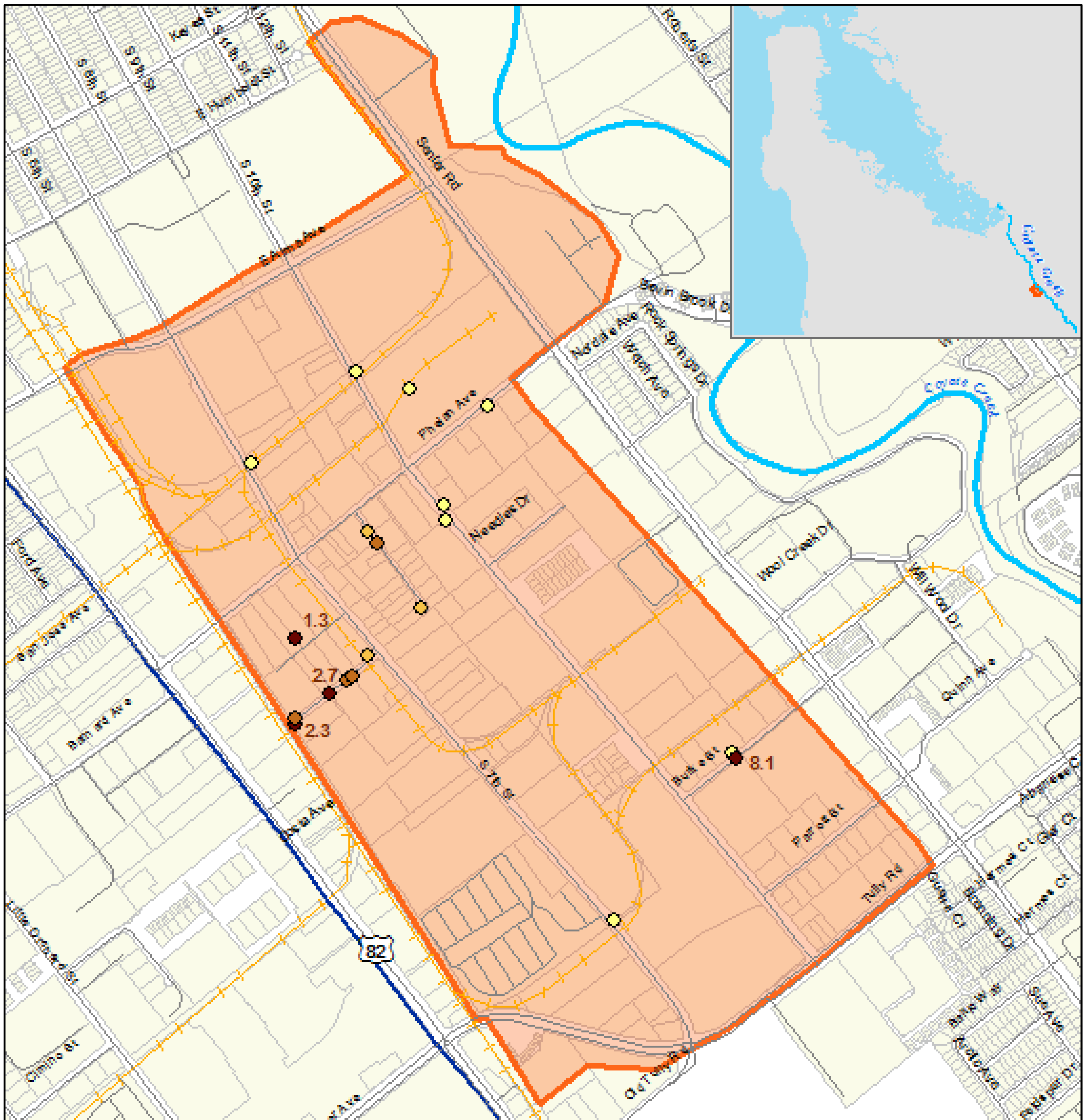
PCB Concentrations in Sediment Collected in the Public Right-of-Way in the Leo Avenue Watershed, San Jose, C, October 2012

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.13

Source:

EOA, Inc. (2013)

internal info: path, date revised, author



Legend

Hg Conc. mg/kg

- 0 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- ≥ 1

- Local Roads
- Major Roads
- Current and Historic Rail Lines
- Leo Ave. Watershed

N

0 125 250 500 Meters

Mercury Concentrations in Sediment Collected in the Public Right-of-Way in the Leo Avenue Watershed, San Jose, CA, October 2012

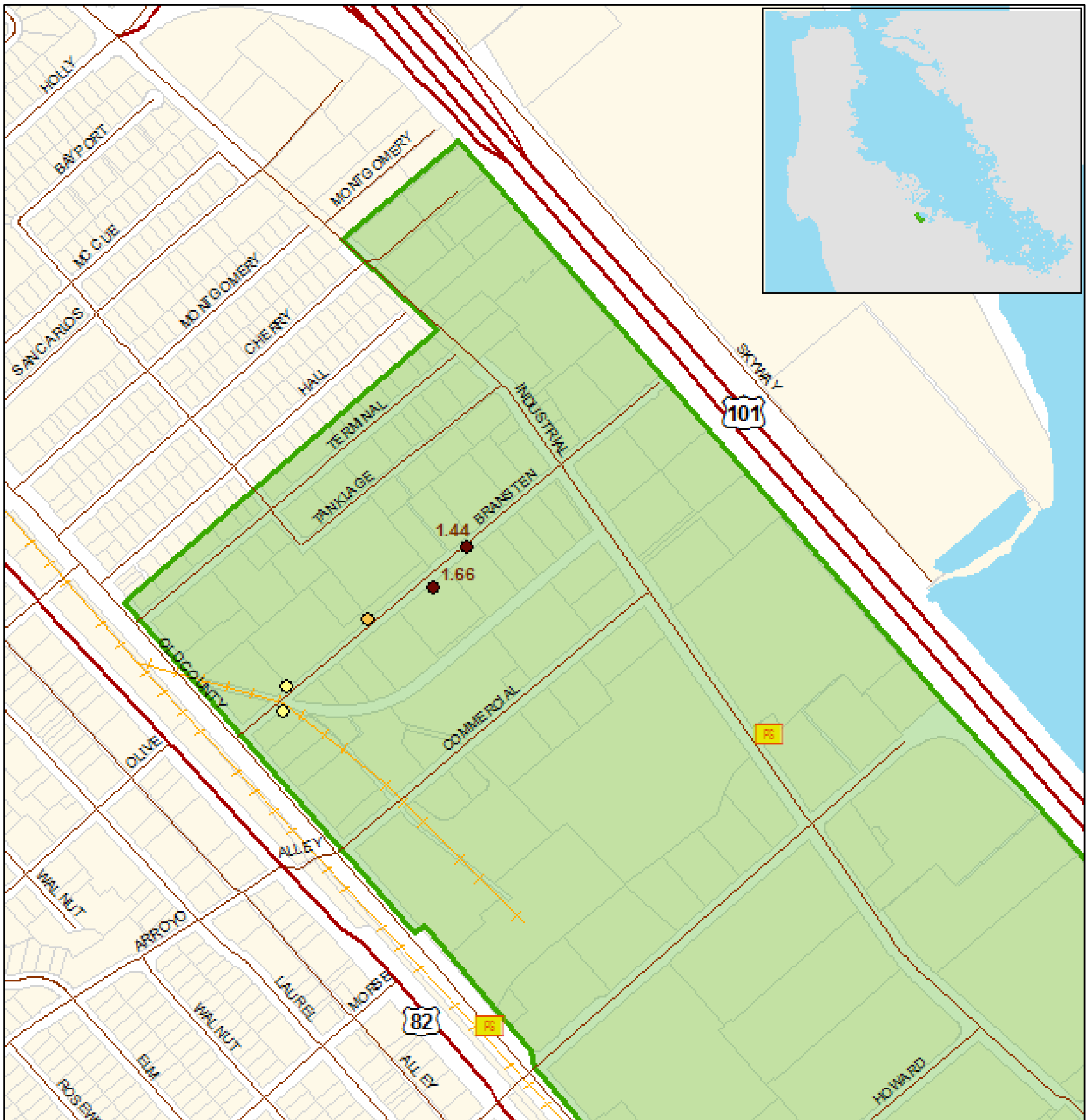
Source:

EOA, Inc. (2013)

Bay Area Stormwater Management Agencies Association

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.14

internal info: path, date revised, author



Legend

PCB Conc. mg/kg

- 0 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- ≥ 1

- Local Roads
- Major Roads
- Current and Historic Rail Lines
- Pump Stations
- Pulgas Watershed

N

0 60 120 240 Meters

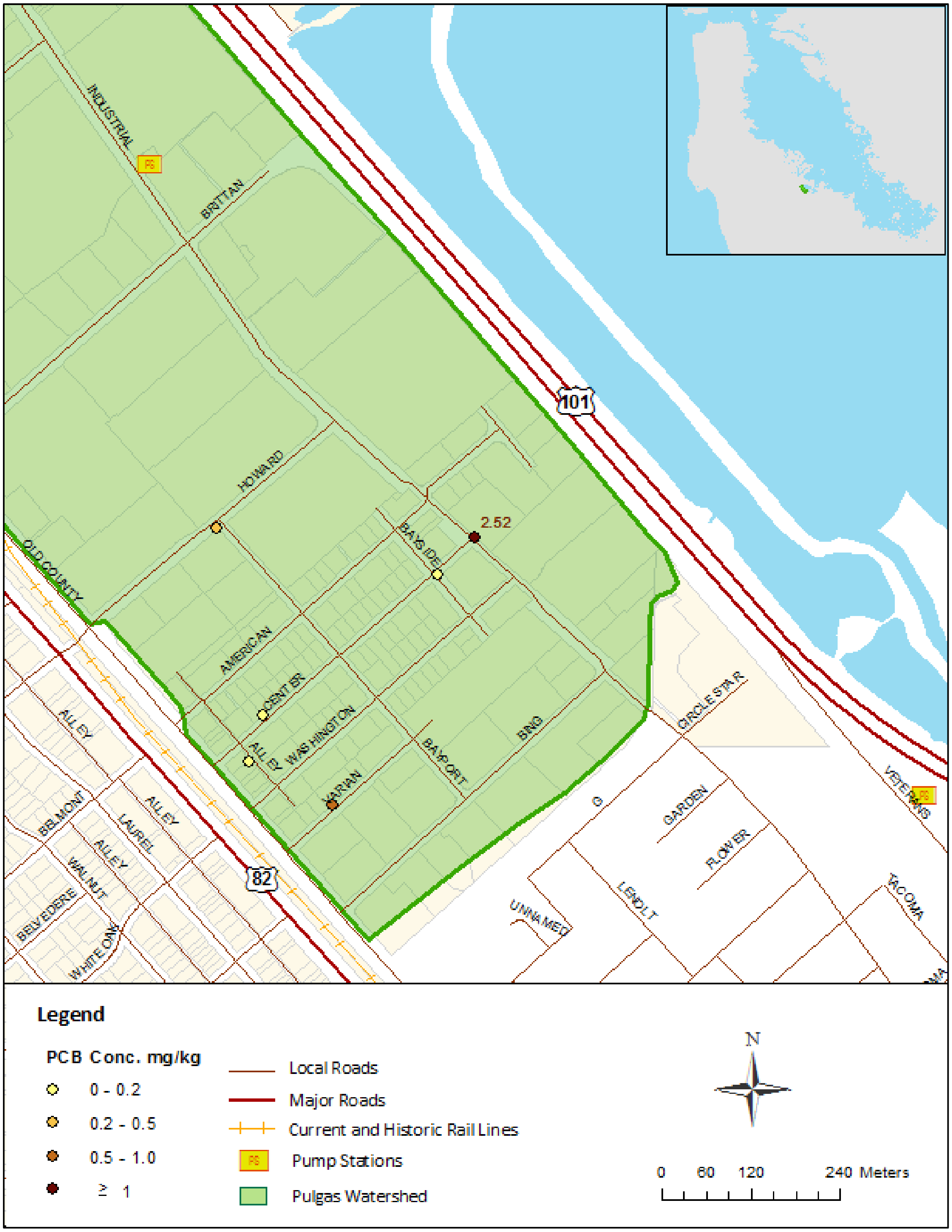
PCB Concentrations in Sediment Collected in the Public Right-of-Way in the Pulgas Creek Pump Station Watershed North (a), San Carlos, CA October 2012

Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.15
Entity	Date	

Source:

EOA, Inc. (2013)

internal info: path, date revised, author

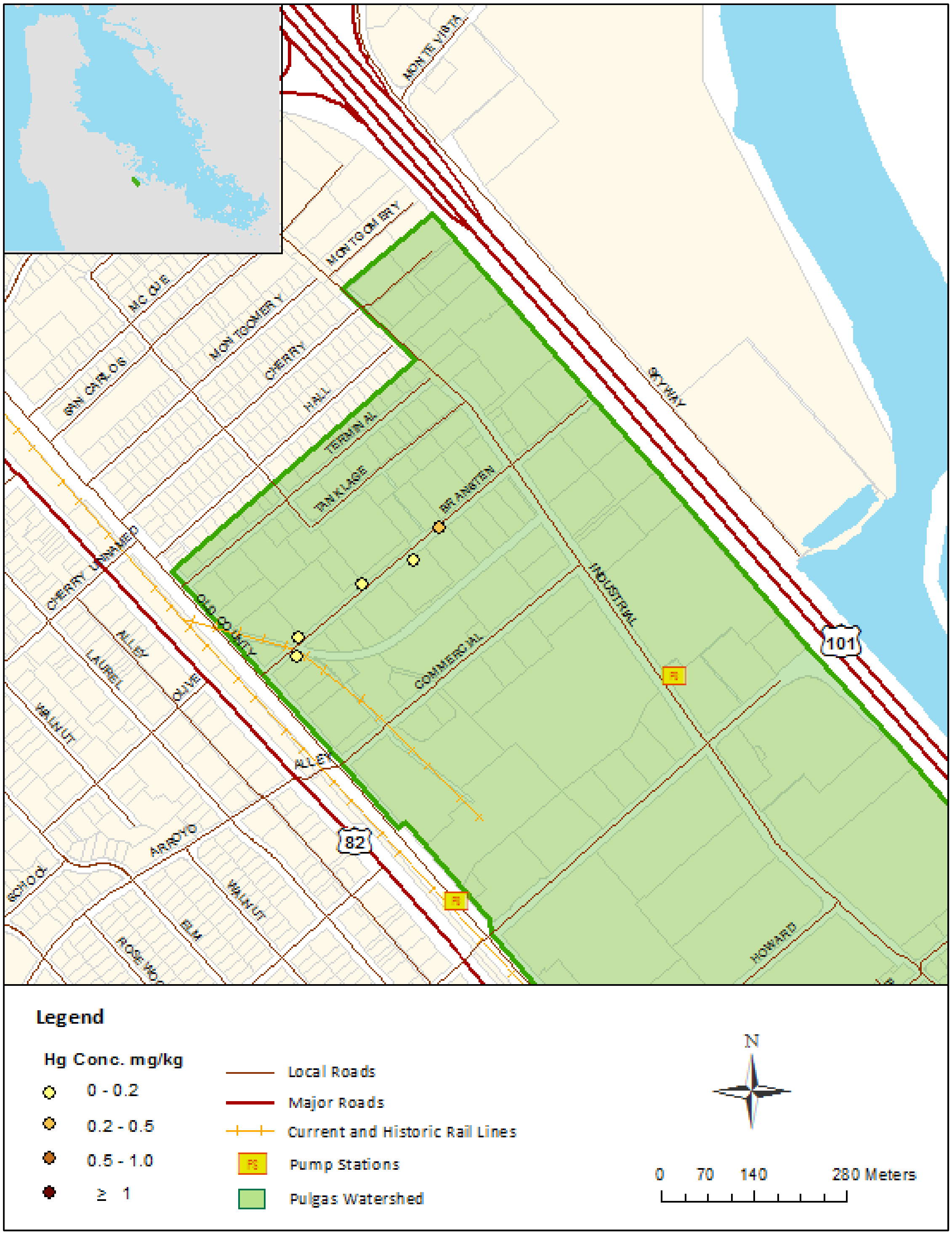


PCB Concentrations in Sediment Collected in the Public Right-of-Way in the Pulgas Creek Pump Station Watershed South, San Carlos, CA October 2012

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	October 1, 2012	B.4.16

Source:

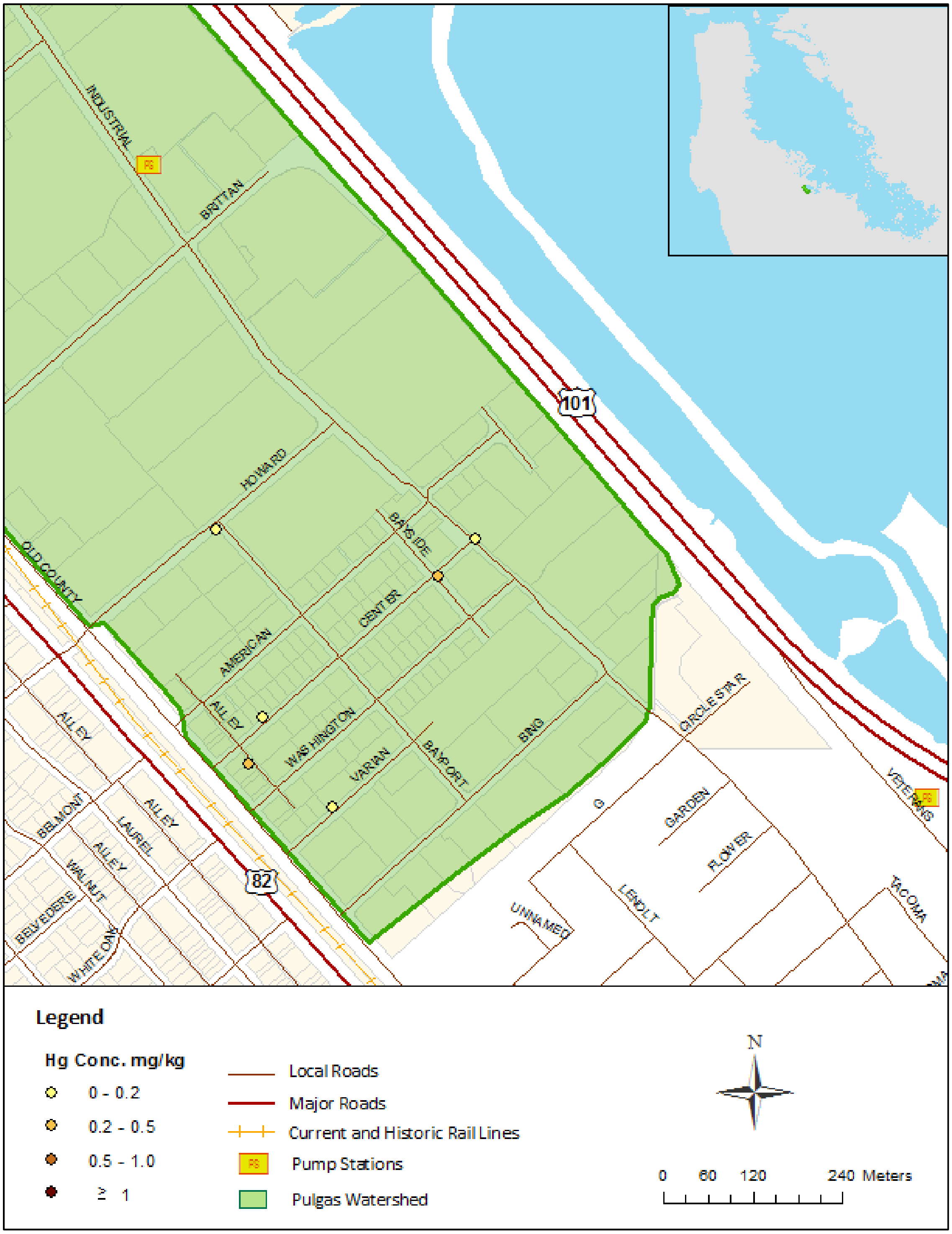
EOA, Inc. (2013)



Mercury Concentrations in Sediment Collected in the Public Right-of-Way in the Pulgas Creek Pump Station Watershed North San Carlos, CA, October 2012

Source: EOA, Inc. (2013)	Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.17
	Entity	Date	

internal info: path, date revised, author



Mercury Concentrations in Sediment Collected in the Public Right-of-Way in the Pulgas Creek Pump Station Watershed South San Carlos, CA, October 2012

Source: EOA, Inc. (2013)	Bay Area Stormwater Management Agencies Association	October 1, 2012	Figure B.4.18
	Entity	Date	

internal info: path, date revised, author

B.5 ENHANCED STREET SWEEPING

B.5.1 Introduction

The effectiveness of municipalstreet sweeping for reducing street sediment loading and improving stormwater runoff quality has been evaluated since the 1970s. Street sweeping was evaluated in the Nationwide Urban Runoff Program at a number of sites including a site in the Castro Valley Creek watershed (Pitt and Shawley 1981). The effectiveness of street sweeping for reducing sediment loads (and sediment-bound pollutants of concern) and improving stormwater runoff quality based on studies conducted in the San Francisco Bay Area and elsewhere is summarized in the *Sediment Management Practices Clean Watersheds for a Clean Bay Task 4 Literature Review* (EOA, Inc. and Geosyntec Consultants 2011). The discussion below is based on the findings of the report by EOA, Inc. and Geosyntec Consultants (2011).

The effectiveness of enhanced street sweeping practices is being evaluated because of the documented effect that municipal street sweeping has on removing sediment from streets. Street sweeping is a common practice for managing litter on municipal streets and because it is a routine municipal maintenance operation, street sweeping has the potential to be enhanced to target sediment and sediment-associated pollutants of concern.

Several variables and factors influence the effectiveness of municipal street sweeping, which include:

- **Climate** - The effectiveness of street sweeping depends on being able to reduce (in a cumulative way) street loadings prior to storm events. Thus seasonal variation in precipitation combined with rainfall intensity and spacing can affect the efficiency of street sweeping. In semi-arid climates where precipitation is limited to a wet season, the ability of street sweeping to reduce street surface loads prior to the first flush event and other early events in the season is considered critical.
- **Street Sediment Loading** - The sediment street loading is a measure of the mass of sediment on the street surface per unit length of roadway. Much of this mass tends to located adjacent to the curb and therefore sweepers that have access to the curb will be more efficient. Particle size also is important as some pollutants have a tendency to attach to the smaller size fractions, which also tend to be more easily mobilized during storm events.
- **Frequency of Sweeping** - Sweeping effectiveness is limited in time due to accumulation of pollutants on street surfaces on days following sweeping. As it is infeasible to sweep in response to weather forecasts, it is generally considered that sweeping would be more effective if it can be conducted as frequently or more frequently that the mean frequency of storm events in the area.

- **Sweeper Condition** - Sweepers must be maintained in good condition to be effective, including for example, brooms, filters, vacuums and nozzles. The effectiveness of the unit in cleaning close to the curb is critical.
- **Operator Skill** - Operator skill in negotiating the sweeper and being aware of the effectiveness of sweeping and modifying operation accordingly in response to local conditions is important.
- **Parking Restrictions** - The presence of parked vehicles prevents the sweeper for being able to access the curb, which is where the majority of sediments are deposited.
- **Road Condition** - Many studies indicate that road condition influences sweeping efficiency more than the sweeper type, at least for dirty streets. Generally sweeping is more effective on dirty streets than on clean streets. Streets are often dirty because of poor condition.
- **Sweeper Type** - The primary difference between mechanical broom sweepers and advanced sweepers is the effective particle size range for street sediment removal. Advanced street sweepers, including regenerative air and vacuum assisted models, are better at removing fine (<63 µm) particulates than mechanical broom sweepers. Finer street dirt particles typically have higher concentrations of mercury and PCBs, based on Bay Area sample data collected by EOA, Inc. (2007a) and Salop (2006), and finer particles, unless trapped in cracks in the road surface, are more easily mobilized by storm events. However, the greatest mass of certain sediment-bound pollutants such as PCBs may be associated with larger particles[10], which is the most effective particle size range for the sweeper to capture. Significant scatter in the field study data (primarily because of the varying conditions in which the studies were performed) make it difficult to assess if one sweeper type is more effective than another based on the amount of solids removed per curb mile. There have been no studies conducted recently in the Bay Area that reflect improvements in sweeper technology over approximately the last decade.
- **Sweeper Seasonal Timing** - In semi-arid climates, the timing of sweeping in relation to the first significant storm event of the season and subsequent events throughout the wet season is a critical efficiency factor, although difficult to study through field testing or modeling. Unfortunately, this factor cannot be controlled because it is impractical for municipal street sweeping programs to schedule sweeping based on weather forecasting. Some references suggest conducting on average one or two sweepings between storms. In

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[10] This management hypothesis that the greatest mass of PCBs on roadways and in the MS4 system is associated with coarser fractions (e.g., <63um) is based primarily on a preliminary particle settling experiment as reported by SFEI (2010). Other evidence supporting the concept that a substantial mass fraction of PCBs in urban sediments is associated with larger particles is the nature of contemporary PCB sources in urban settings, e.g., construction debris and auto shredder waste are potential sources that would generate coarser material, prior weathering in the environment. Finally, there is good evidence that coarse fractions are a greater proportion of the overall mass of sediment in urban drainages (Selbig and Bannerman, 2007).

semi-arid climates such as the Bay Area, some references recommended more intensive sweeping prior to the onset of the wet season (Pitt and Shawley 1981).

Sediment collected by street sweepers in the Bay Area contains detectable concentrations of polychlorinated biphenyls (PCBs) and mercury. In studies conducted in Alameda and Contra Costa Counties, street sweeper sediments were found to fall into three tiers of PCB concentrations (EOA 2007a; EOA 2007b; Salop 2006):

1. Cities Developed in Early 20th Century - Samples from Richmond, Martinez, and Berkeley had higher concentrations (> 0.10 mg/kg);
2. Cities Developed in Mid-Century - Samples from Walnut Creek, Pinole, Orinda, and Brentwood had relatively moderate concentrations (0.05 - 0.10 mg/kg); and
3. Cities Developed in Late 20th Century - Samples from Newark, Pleasanton, Concord, and Livermore had relatively low concentrations (<0.05 mg/kg).

The following results were noted for mercury concentrations:

1. Locations with higher mercury concentrations (>0.2 mg/kg) were from Berkeley, Richmond, Martinez and Pinole;
2. Locations with moderate concentrations (0.1-0.2 mg/kg) included Orinda, Walnut Creek, and Concord;
3. Locations with the lowest observed mercury concentrations (< 0.1 mg/kg) included Hayward, Newark, Pleasanton, Fairfield-Suisun, and Livermore.

Sample concentrations were likely affected by the age of urbanization of the municipality. Generally cities with elevated PCB concentrations also had elevated mercury concentrations, but that was not always the case.

As part of the Sediment Literature Review, Geosyntec Consultants estimated the load reductions that could potentially be achieved with a range of sweeping scenarios based on Bay Area sediment concentration data compiled by the San Francisco Estuary Institute (SFEI 2010). The concentration data were based on 15 sites in the database where street sediment data were in the upper 10th percentile. This analysis indicated that the 90th percentile concentration for PCBs was approximately 0.28 mg/kg and the corresponding total mercury concentration was 0.51 mg/kg. Two street sweeping scenarios were conducted for each of the 15 sites. A “lower bound” scenario assumed a 10 km road segment was swept monthly with a technology that reduced the street loading by 100 pounds/curb mile, and an “upper bound” scenario which assumed a 10 km road segment was swept by-monthly with a technology that reduced the street loading by 300 pounds/curb mile. The total annual mass of PCBs removed ranged from 0.035 kg to 0.21 kg, and the total annual mass of Hg removed ranged from 0.038 kg to 0.22 kg. This analysis shows that the annual mass of PCBs and mercury collected in areas with the highest concentrations is low relative to the Total Maximum Daily Load (TMDL) targets.

The effectiveness of municipal street sweeping for improving runoff water quality is not well understood and is therefore difficult to quantify. Most field studies have not been able to demonstrate a statistically reliable improvement in water quality, likely because the studies were not designed with sufficient statistical power to distinguish effects given the variability in stormwater quality loads (Kang et al. 2009), and because it is difficult to isolate the effect of roadway runoff from other sources (e.g., roofs and sidewalks) in designing monitoring studies.

The remainder of this section describes the enhanced street sweeping pilot study and presents a methodology for estimating the load reduction that could be achieved as a result of implementing enhanced street sweeping practices.

B.5.2 Summary of PCB and Mercury Control Pilot Studies

B.5.2.1 Implementation Approach to Meeting MRP Requirements

During FY 2010/11, existing literature was reviewed for information on previous studies related to sediment and pollutant removal during municipal operation and maintenance activities and other information relevant to the pilot evaluations (EOA, Inc. and Geosyntec Consultants 2011). The key data gaps and recommendations for the design of future studies in the literature review are summarized in the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Pollutants of Concern Report FY2010-2011 (BASMAA 2011).

Based on the results of the literature review and discussions with municipal staff, the Clean Watersheds for a Clean Bay (CW4CB) Task 4 sediment management workgroup developed study designs and a monitoring plan for conducting sediment management studies that will be implemented in 2013-2014. The pilot street sweeping study that is included in the monitoring plan is briefly described below.

Because the street sweeping pilot study was not be implemented in time for completion of the Integrated Monitoring Report (IMR), hopper data collected by Permittees for inclusion in their Annual Reports was used to evaluate the load reductions achieved by implementing enhanced street sweeping activities. The methodology for estimating the benefits of enhanced street sweeping will be replaced by the WinSLAMM model (described below), which will be used to evaluate the load reduction achieved through enhanced street sweeping. However hopper data could be used to calibrate the WinSLAMM model.

Pilot Study Implementation

The pilot study implementation approach entails conducting a hybrid monitoring and modeling study in four older industrial watersheds where elevated PCB concentrations were observed. The monitoring phase will be conducted to study the baseline sweeping condition, and the Windows version of the Source Loading and Management Model (WinSLAMM) will be used to model the effects of various enhancements including improved sweeper technology, more frequent street cleaning, restrictions on parking, and improved road conditions. The purpose of monitoring the baseline sweeping condition is to develop a baseline productivity function for each pilot test area, where the productivity function is the equation that describes how the post-sweeping street loading varies as a function of the pre-sweeping street loading. This and other information will then be used to calibrate WinSLAMM for local conditions in the Bay Area. The calibrated model then will be applied to evaluate the increase in loads avoided/reduced as a result of enhanced sweeping practices.

Field monitoring began in November 2013. The objective is to collect the data when street sediment loads are the highest, which is before and early into the wet season. The WinSLAMM modeling component would begin after the quality assurance quality control review of the data has been completed by SFEI. The WinSLAMM modeling component for the pilot study areas will likely be completed by fall 2014.

B.5.2.2 Pilot Study Description

Monitoring of the Current Conditions

Monitoring of the existing condition will occur in four industrial watersheds: (1) the Leo Avenue watershed in San Jose; (2) East California Avenue between North Fair Oaks and North Sunnyvale Avenue in Sunnyvale; (3) Hoffman Boulevard in Richmond; and (4) Cutting Boulevard in Richmond. Figure B.6.1 (in the Enhanced Operation and Maintenance section) shows the locations where the monitoring will be conducted. The sampling methodology is described in the *Clean Watershed for a Clean Bay (CW4CB) Study Designs for Five O&M Pilot Projects* (Geosyntec Consultants and CSU/OWP 2013).

The monitoring component entails sampling the baseline sweeping condition in the three test locations. Currently, street sweeping is not conducted along Hoffman Boulevard (Richmond). For the pilot study, Hoffman Boulevard sweeping would be conducted weekly using a regenerative air sweeper. The sweeper types and frequencies for the Cutting Boulevard (Richmond), San Jose and Sunnyvale locations are listed in Table B.5.4.4. A primary objective is to collect samples during periods when street loads are high (e.g., before and early in the wet season, for a normal wet year).

Sampling will involve vacuuming street sediment in narrow transects (approximately 4 inch swath corresponding to the width of the vacuum nozzle) extending from curb to curb. The vacuuming will be conducted before and after each sweeper pass, following methods described in Selbig and Bannerman (2007). Transects will be marked off approximately every 100 feet of roadway, and vacuuming will be conducted at approximately 10 strips selected randomly along the selected road segment, making sure that the post-sweeping transects are not the same as the pre-sweeping transects. Sediments will automatically be composited in the vacuum, dried if necessary, and screened to eliminate gross solids defined as > 2 mm prior to analysis. For each sampling round, there will be one composite sample for the pre-sweeping sampling, and one composite sample for the post-sweeping. The total number of samples to be analyzed for the 10 sampling rounds at each site will then be 20. Field work will also include observations and documentation (including photos) of street sweeping activities, traffic conditions, and pre- and post-storm event observations.

WinSLAMM Modeling

WinSLAMM is a continuous pollutant loading model which simulates pollutant loading from small developed urban catchments as well as the effectiveness of various source controls and treatment control measures in reducing overall pollutant concentration and loads. The types of street sweeping enhancements that can be modeled in WinSLAMM include:

- Street cleaning frequency;
- Type of sweeper (e.g., mechanical broom, vacuum assisted); and
- Street texture, parking density, and parking controls are collectively modeled by adjusting cleaner productivity, which defines the relation between pre- and post-sweeping street surface loading (pounds/curb-mile).

The field data will be used to develop the baseline productivity function for each pilot area for the model, and the model will then be used to model the effect of implementing enhanced street sweeping practices in each pilot study area.

B.5.3 Status of Control Measure Implementation

The status of baseline, current, and enhanced implementation was evaluated using readily available data reported by the municipalities on their street sweeping efforts in Annual Reports.[11] Data reported in Annual Reports included total volume of material removed by the sweeper and curb miles swept (determined by sweeper odometer readings); the type of sweeper utilized was not reported in Annual Reports. Baseline implementation refers to actions occurring prior to and including Fiscal Year 2001-02. Current implementation refers to actions occurring post Fiscal Year 2001-02. Enhanced implementation refers to actions occurring post Fiscal Year 2001-02 that are above and beyond baseline implementation.

Data reported for individual municipalities are summarized in Appendix B.5.A for the baseline and current periods. The various counties have different periods over which street sweeping level of effort data were recorded. For example, Fairfield and Suisun City have continuous data from Fiscal Year 93-94 through Fiscal Year 08-09. However there were no available compiled data for Vallejo. In contrast, data are available for Alameda County only for Fiscal Years 92-93 through Fiscal Years 96-97; therefore, no data are available for the enhanced period. Therefore, the reporting periods are noted in Appendix Table B.5.A.1 and Table B.5.A.2, to explain some of the variability in the curb miles swept and total volume of material removed. The data are

[11] Data for this evaluation were provided by EOA, Inc. (compiled in May 2011) and the Contra Costa Clean Water Program.

normalized by calculating a "rate", which is the volume of material removed per curb mile swept. In addition, the latest year of data collected by any municipality is Fiscal Year 09-10, as the MRP does not require the municipalities to report this information.

B.5.3.1 Baseline and Current

Figure B.5.1 illustrates the difference between the average volume (cy) of material removed per curb mile swept for each countywide program for the baseline and current periods, using the information in Appendix Table B.5.A.1 and Table B.5.A.2. Note there were no baseline data available for Santa Clara County municipalities and no current data for Alameda County municipalities. For the three countywide programs with both baseline and current data, the data showed an overall reduction in the volume of material removed per curb mile swept from the baseline to the current period. Summary statistics for each countywide program are provided in Table B.5.3.1.

Table B.5.3.1. Annual Material Collected per Curb Mile Summary Statistics

County	Baseline Material Collected per Curb Mile (cy/mi)					Current Material Collected per Curb Mile (cy/mi)				
	25th Percentile	Mean	Standard Deviation	50th Percentile	75th Percentile	25th Percentile	Mean	Standard Deviation	50th Percentile	75th Percentile
Solano	0.30	0.33	0.08	0.33	0.36	0.25	0.26	0.05	0.26	0.28
San Mateo	0.16	0.32	0.22	0.26	0.40	0.16	0.25	0.15	0.21	0.27
Santa Clara	No Data	No Data	No Data	No Data	No Data	0.27	0.37	0.15	0.32	0.48
Alameda	0.16	0.30	0.17	0.28	0.40	No Data	No Data	No Data	No Data	No Data
Contra Costa	0.22	0.97	2.11	0.31	0.53	0.19	0.67	1.07	0.34	0.50
All Municipalities	0.20	0.68	1.58	0.30	0.52	0.18	0.43	0.67	0.27	0.45

Because information about how the street sweeping programs changed from the baseline to the current periods (such as a reduced sweeping frequency due to budget cuts) is not included in the Annual Reports, it is not feasible to evaluate why the data appear to indicate a reduction in the volume of material removed per curb mile for the current period.

B.5.4 <u>Estimates of Loads Avoided/Reduced</u>

This section presents the methodology for estimating loads reduced by baseline and current municipal street sweeping efforts, and provides load reduction estimates for the baseline and current level of implementation for each municipality. In addition, annual load reductions are provided for the pilot study areas based on current practices.

B.5.4.1 Loads Avoided/Reduced Methodology

The baseline, current and enhanced load reduction methodology presented herein has been adapted based from the methodology presented in the Draft Technical Memorandum entitled

"*Methods for Quantifying Mercury and PCB Loads Reduced from Urban Stormwater Runoff, Assessing municipal stormwater program progress towards TMDL wasteload allocations through control measure implementation*" (EOA, Inc. 2011). The baseline and current load reduction achieved by street sweeping may be calculated as follows:

$$Baseline_{SS} = Vol_{Baseline\ SS} \bullet \%Sed_{SS} \bullet \rho_{SS} \bullet Conc_{SS}$$

and

$$Current_{SS} = Vol_{Current\ SS} \bullet \%Sed_{SS} \bullet \rho_{SS} \bullet Conc_{SS}$$

Where:

$Vol_{BaselineSS}$ =	Average volume of street sweeping material collected in baseline years (prior to an including Fiscal Year 2001-02)
$Vol_{CurrentSS}$ =	Average volume of street sweeping material collected in current years (post Fiscal Year 2001-02)
$\%Sed_{SS}$ =	Percent of material collected by the street sweeper that is "sediment"[12] (by volume)
ρ_{SS} =	Sediment density of the street sweeper material (weight per unit volume)
$Conc_{SS}$ =	Average (or measured) concentration of mercury or PCBs in street sweeping sediments collected. Note that the same concentration was used for baseline and current load reductions

Note that units and unit conversation factors must be supplied by the user.

Therefore, the enhanced load reduction may be calculated as follows:

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

Assumptions and Data Inputs

- <u>Volume of Material Collected ($Vol_{Baseline\ SS}$ and $Vol_{Current\ SS}$).</u> As stated above, the volume of material collected annually by street sweepers has been reported by the municipalities in their Annual Reports (see Appendix Table B.5.A.1 and Table B.5.A.2). Note that the years for which these data are available vary by municipality, and different years form the basis for the baseline and enhanced periods depending on the municipality.

[12] For purposes of this document, street sweeping sediment is defined as all street sweeping material that would pass through a 2mm sieve.

- Percent of Street Sweeping Material That is "Sediment" ($\%Sed_{SS}$). For the purposes of this analysis, it is assumed than material less than 2 mm is sediment. The estimate for the percent of material removed by street sweepers that is less than 2 mm comes from Salop (2006). Salop evaluated the characteristics of gross solids collected during street sweeping operations in Bay Area cities and estimated sediment/vegetative debris less than 2 mm in diameter accounted for approximately 55 percent (by mass) of total solids collected during street sweeping operations in Alameda County. Therefore $\%Sed_{SS}$ was assumed to be 55 percent for the baseline and enhanced load reduction analysis.

- Street Sweeping Sediment Density (ρ_{SS}) – The material collected by street sweepers is typically reported as a volume (cy). To calculate pollutant loads reduced, the volume of material must be converted into a mass using an assumed bulk density for the material. In support of the California Integrated Waste Management Act of 1989, FEECO International developed densities for a variety of waste materials. These densities continue to be utilized by the California Department of Resources Recycling and Recovery (CalRecycle 2013). In addition FEMA (2010) developed the "Debris Estimating Field Guide" which has densities for waste materials. The dry bulk density used for this analysis was estimated using the average density determined by these two sources; the selected density assumes the material is 30 percent vegetative debris by volume and the remaining volume is dry sand. Therefore, the assumed bulk density for dry material[13] less than 2 mm is 1,811 pounds per cubic yard.

- Concentration of Mercury/PCBs in Street Sweeping Sediment ($Conc_{SS}$) EOA developed representative concentrations for PCBs and mercury in street sweeping sediments using data collected from various studies in Contra Costa (EOA 2007a), Alameda (Salop and Akashah 2004) and Solano (EOA 2006) counties. Pollutant concentrations were compared to sweeper type, land use and age-of-urbanization to determine if significant relationships exist. Based on the results, concentrations of PCBs in street sweeping sediments appear to be dependent upon the very coarse age-of-urbanization categories assigned to cities in Contra Costa and Alameda Counties where street sweeping characterization occurred. Bay Area age-of-development categories include:
  - Early 20th Century – Represents the earliest and most extensive degree of urbanization/industrialization. May include municipalities where shipping and railways were used extensively for transporting industrial materials. Example cities include Richmond, Hayward, Oakland and Martinez.

[13] FEMA estimate was calculated from the conversion factor given for 70% dry sand, 30% vegetation and trash of 69 pounds per cubic foot or 1,870 pounds per cubic yard. CalRecycle estimate was calculated from the conversion factor given for "wet sand" of 110-130 pounds per cubic foot, and converting to a dry density by applying a porosity of 0.35 (porosity from Linsley and Franzini, Water Resources Engineering, 1964), which results in a dry bulk density of 1,752 pounds per cubic yard. The "best" (average) density estimate, 1,811 pounds per cubic yard, is equivalent to 821.5 kg per cubic yard.

- Mid-Century – Represents the intermediate range in both time and degree of urbanization/industrialization. Example cities include Pinole, Concord, Orinda and Walnut Creek.
- Late 20th Century – Represents the geographical area with the most recent urbanization. Includes areas where heavy industry never or minimally existed. Example cities include San Ramon, Livermore, Dublin, Brentwood and Clayton.

Table B.5.4.1 summarizes the low (25th percentile), average (mean) and high (75th percentile) concentrations of mercury and PCBs based on the age of urbanization of the municipality. For the load reduction analysis, each municipality was assigned an age, and the average PCB and mercury concentration for that age was used for the analysis.

Table B.5.4.1. Estimated PCB and Mercury Concentrations in Sediment Collected by Street Sweepers

Concentration of Pollutant of Concern (mg/kg)	Municipality's Age-of-Urbanization								
	Early 20th Century			Mid-Century			Late 20th Century		
	Low	Ave	High	Low	Ave	High	Low	Ave	High
Total PCBs	0.10	0.18	0.22	0.01	0.03	0.44	0.01	0.03	0.44
Total Mercury	0.17	0.25	0.32	0.05	0.11	0.14	0.03	0.05	0.07

B.5.4.2 Loads Avoided/Reduced by Implementing Municipal Street Sweeping

Using the methodology described above, Appendix Table B.5.A.3. summarizes the estimated PCB and mercury loads reduced by municipal street for the baseline and current periods. Because the period of data collection varies for the baseline and current periods for each municipality, the load reductions were normalized by reporting the data on an annual basis for the baseline and current periods. Table B.5.4.2. and Table B.5.4.3. provide the summary statistics for the data in Appendix Table B.5.A.3, for PCB and mercury load reductions, respectively.

Figure B.5.2 (PCBs) and Figure B.5.3 (mercury) show the average total annual loads reduced for each countywide program, for the baseline and current periods (each countywide program shows the sum of the annual load reductions for each municipality within the program for which data were available). For the three countywide programs for which both baseline and current data were available (Solano, San Mateo, Contra Costa), there does not appear to be a significant difference between the baseline and current period load reductions. PCB load reductions for each countywide program (Figure B.5.2) ranged from 621 grams to 5,280 grams for the baseline period, and ranged from 632 grams to 5,737 grams for the current period. Mercury load reductions for each countywide program (Figure B.5.3) ranged from 863 grams to 7,870 grams for the baseline period, and ranged from 878 grams to 8,461 grams for the current period.

Figure B.5.4 and Figure B.5.5 show the total load reduced per curb mile swept for the baseline and current periods, for PCBs and mercury, respectively. Using the current PCB load reduction per curb mile for Contra Costa County municipalities (8.1 mg/mile), there would need to be about 123 million miles swept throughout the county for remove 1 kg of PCBs. For Santa Clara County municipalities (29.2 mg/mile), there would need to be about 34 million miles swept throughout the county for remove 1 kg of PCBs.

B.5.4.3 Estimates of Current Loads Avoided/Reduced in Pilot Study Areas

Table B.5.4.4 summarizes the loads reduced in the pilot study areas based on current sweeping practices using the below methodology. The concentration data used for the load reduction estimates include pilot study area-specific concentrations (which are included in Table B.5.4.4.) and average concentrations from Table B.5.4.1 for early 20th century municipalities. The notes for Table B.5.4.4 further detail the data sources and methodology.

This methodology is currently being used in lieu of having the pilot study results (WinSLAMM), which will quantify the current load reductions. Improved estimates will be obtained through implementation of the pilot study. Note that there is currently no street sweeping program being implemented along Hoffman Avenue in Richmond.

Because the exact location in the Leo Avenue watershed where the pilot study would be performed is yet to be determined, the existing load reduction resulting from street sweeping was estimated for the entire Leo Avenue drainage. The annual mass of PCBs reduced ranges from 13 grams to 43 grams per year, depending on PCB concentration used for the estimate (concentrations representing street sediment data collected in the Leo Avenue watershed and an average concentration based on the age of urbanization were used). Annual mercury mass reduced ranges from 17 grams to 41 grams depending on the concentration used. The high range for load reduction estimates resulted from using Leo Avenue watershed-specific concentrations for mercury and PCBs in street sediment as shown in Table B.5.4.4.

For the Sunnyvale location along East California Avenue, the current load reduction estimate for annual PCB mass reduced ranges from 0.59 g to 1.1 g per year, depending on PCB concentration used for the estimate (concentrations representing street sediment data collected in Sunnyvale and an average concentration based on the age of urbanization were used). The current annual load reduction estimate for mercury ranges from 0.9 to 1.5 grams depending on the concentration used. Conversely to Leo Avenue, the low range for load reduction estimates resulted from using Sunnyvale-specific concentrations for mercury and PCBs in street sediment as shown in Table B.5.4.4.

Table B.5.4.2. Annual PCB Load Reduced Summary Statistics for Countywide Programs

County	Baseline Average Annual PCB Load Reduced (g)					Current Average Annual PCB Load Reduced (g)				
	25th Percentile	Mean	Standard Deviation	50th Percentile	75th Percentile	25th Percentile	Mean	Standard Deviation	50th Percentile	75th Percentile
Solano	228.8	310.6	231.5	310.6	392.5	227.0	316.2	252.1	316.2	405.3
San Mateo	9.2	104.0	133.7	21.3	190.8	8.5	97.0	106.7	47.7	193.8
Santa Clara	No Data	No Data	No Data	No Data	No Data	19.5	409.8	656.9	62.7	567.5
Alameda	23.5	377.2	676.3	50.8	496.6	No Data	No Data	No Data	No Data	No Data
Contra Costa	9.4	44.4	53.5	21.4	61.3	15.3	54.2	56.8	29.3	97.8
All Municipalities	10.2	159.4	370.4	32.6	145.2	13.4	169.0	364.0	34.1	171.4

Table B.5.4.3. Annual Mercury Load Reduced Summary Statistics for Countywide Programs

County	Baseline Average Annual Hg Load Reduced (g)					Current Average Annual Hg Load Reduced (g)				
	25th Percentile	Mean	Standard Deviation	50th Percentile	75th Percentile	25th Percentile	Mean	Standard Deviation	50th Percentile	75th Percentile
Solano	317.8	431.5	321.6	431.5	545.2	315.3	439.1	350.1	439.1	562.9
San Mateo	15.5	157.2	181.3	75.0	265.0	16.8	134.4	140.5	63.3	256.8
Santa Clara	No Data	No Data	No Data	No Data	No Data	71.3	604.4	893.0	230.0	788.2
Alameda	62.6	562.1	926.4	121.6	689.8	No Data	No Data	No Data	No Data	No Data
Contra Costa	23.2	79.3	84.9	48.0	101.3	26.0	98.4	99.5	56.2	129.1
All Municipalities	22.1	241.9	512.1	75.8	256.8	26.3	247.9	493.6	92.1	256.8

Table B.5.4.4. Current Annual Loads Avoided/Reduced in Pilot Study Areas

Pilot Study Area	San Jose, Leo Avenue Watershed	Sunnyvale E. California Ave between N. Sunnyvale Ave and N. Fair Oaks Avenue	Richmond, Hoffman Boulevard	Richmond, Cutting Boulevard
Sweeper Type	Mechanical rear broom sweeper	To be determined	Street sweeping is currently not performed in the area	Regenerative air
Curb Miles Swept per Event	15	0.94		
Sweeping Frequency [days]	14	14		7
Annual Curb Miles Swept	387	24.4		This site was added to the pilot study in October 2013. Current load estimates were therefore not performed.
Volume of Material Removed per Curb Mile [CY]	0.4	0.55		
Annual Volume of Material Removed [CY]	154.8	13.42		
Annual Mass of Material Removed [kg]	142,188	12,327		
Annual Mass of Sediment Removed [kg]	78,203	6,780		
Load Estimates Calculated Using Concentrations in Table B.5.4.1				
PCB Concentration [mg/kg]	0.18	0.18	0.18	
Mass PCBs Removed [g]	13	1.1	NA	
Hg Concentration [mg/kg]	0.25	0.25	0.25	
Mass Hg Removed [g]	17	1.5	NA	
Load Estimates Calculated Using Area-Specific Concentrations (See notes)				
PCB Concentration [mg/kg]	0.62	0.10	0.95	
Mass PCBs Removed [g]	43	0.59	NA	
Hg Concentration [mg/kg]	0.59	0.15	0.76	
Mass Hg Removed [g]	41	0.9	NA	

Notes:

Leo Avenue Watershed:

- The specific location within the Leo Avenue watershed where the pilot study will be conducted will be determined based on field reconnaissance.
- Sweeper type, sweeping frequency, annual curb miles swept and volume of material removed per curb mile from EOA, Inc., 2012.
- PCB and Hg area-specific concentrations represent street sediment samples collected in the Leo Avenue watershed. Data are from the SFEI database (SFEI 2010, KLI and EOA, 2002, City of San Jose and EOA, 2003), and CW4CB Task 3 data collected in the fall 2012 (n = 11 for PCBs and 18 for mercury).

Sunnyvale:

- PCB and Hg area-specific concentration data represent street sediment samples collected in Sunnyvale. Data are from SFEI database (SFEI 2010, KLI and EOA, 2002) (n = 6).

San Jose and Sunnyvale

- Density of the material assumed to be 1,811 pounds per cy (821.5 kg/cy)

Richmond

- PCB and Hg concentration 2 data represent street sediment samples collected in the Inner Richmond Harbor watershed. Data are from SFEI database (n = 6).

B.5.4.4 Estimate of Loads Reduced through Enhanced Street Sweeping in Pilot Study Areas

The increase in loads reduced in the pilot study locations due to implementing an enhanced street sweeping program will be modeled using WinSLAMM. In lieu of having the WinSLAMM results, the improvement in load reduction could be expressed through an enhancement factor (F_e) based on the literature, where:

> F_e = Load reduction from enhanced street sweeping/Load reduction from current street sweeping

Estimates for Fe resulting from enhanced sweeping practices based on a review of the literature (EOA Inc. 2012) are as follows:

- F_e for upgrading from a mechanical broom sweeper to a regenerative air sweeper ranges from 1.2-5.0.
- F_e for upgrading from a mechanical broom sweeper to a vacuum assisted sweeper ranges from 2.2-6.0.
- F_e for upgrading from a regenerative air sweeper to a vacuum assisted sweeper ranges from 1.2-1.5.
- In terms of the frequency of sweeping, for a mechanical broom sweeper, changing from monthly to weekly sweeping results in an F_e range of 1.3-1.4, and going from weekly to semi-weekly results in an F_e of 1.2.
- For a regenerative air or vacuum assisted sweeper, increasing the sweeping frequency from monthly to weekly results in an F_e of 1.4 and an F_e of 2 if going from weekly to semi-weekly sweeping.
- Changing from monthly sweeping with a mechanical broom sweeper to weekly sweeping with a regenerative air or vacuum assisted sweeper results in an F_e range of 3.3-3.45.

Data evaluated as part of the *Sediment Management Practices Clean Watersheds for a Clean Bay Task 4 Literature Review* showed a lot of variability in the productivity functions for different sweepers, primarily because the data reflect numerous studies where conditions are sufficiently different so it difficult to isolate the effects of improved technology (Figure B.5.6). The goal of the pilot studies will be to develop consistent productivity functions for each of the three pilot study areas.

B.5.4.5 Estimation of PCB Loads Reduced as a Result of New Street Sweeping Areas in Richmond and North Richmond

As part of MRP implementation, the City of Richmond and unincorporated Contra Costa County made specific changes to their street sweeping programs that have quantifiable benefits for additional PCB loads prevented from entering the MS4 system. These include implementing a curb and gutter improvement project in the North Richmond Stormwater Pump Station watershed, and initiation of high efficiency street sweeping adjacent to a potential source area in the Santa Fe Channel watershed. A summary of the documented changes in municipal street sweeping practices in these areas is included as Appendix Table B.5.A.2.

B.5.4.6 Summary of Key Uncertainties

There are a number of sources of uncertainty in accurately estimating PCB and mercury loads avoided/reduced to San Francisco Bay associated with baseline and enhanced street sweeping.

- It is not known what factors contributed to the change in the baseline and enhanced sweeping rate (volume of material removed per mile) reported by the permittees in the annual reports. It is not known if an increase in the rate is the result of actual enhanced sweeping practices such as upgrading to an advanced sweeper or increasing the sweeping frequency. Similarly, it is not known if a decreased rate is due to reduced implementation.
- The same PCB and mercury concentrations were applied to the baseline and current periods to calculate the loads reduced. Separating data collected during the baseline from the current period was not possible due to the variability of the data (and separating the data infers that any difference in concentration is statistically significant).
- The PCB and mercury concentrations assigned to the municipalities were a representative concentration based on the age of urbanization of the municipality. The uncertainty in using this method is reflected in the range of loads reduced calculated for the pilot study areas using both the "representative" concentration and data collected specifically within or near the pilot study area.
- A bulk density of 1,811 pounds per cy (821.5 kg/cy) was applied to all street sediment picked up by sweepers.
- It was assumed that 55% of the total volume collected by sweepers was in the fraction less than 2 mm, which was considered to be the amount of sediment removed.

B.5.5 <u>References</u>

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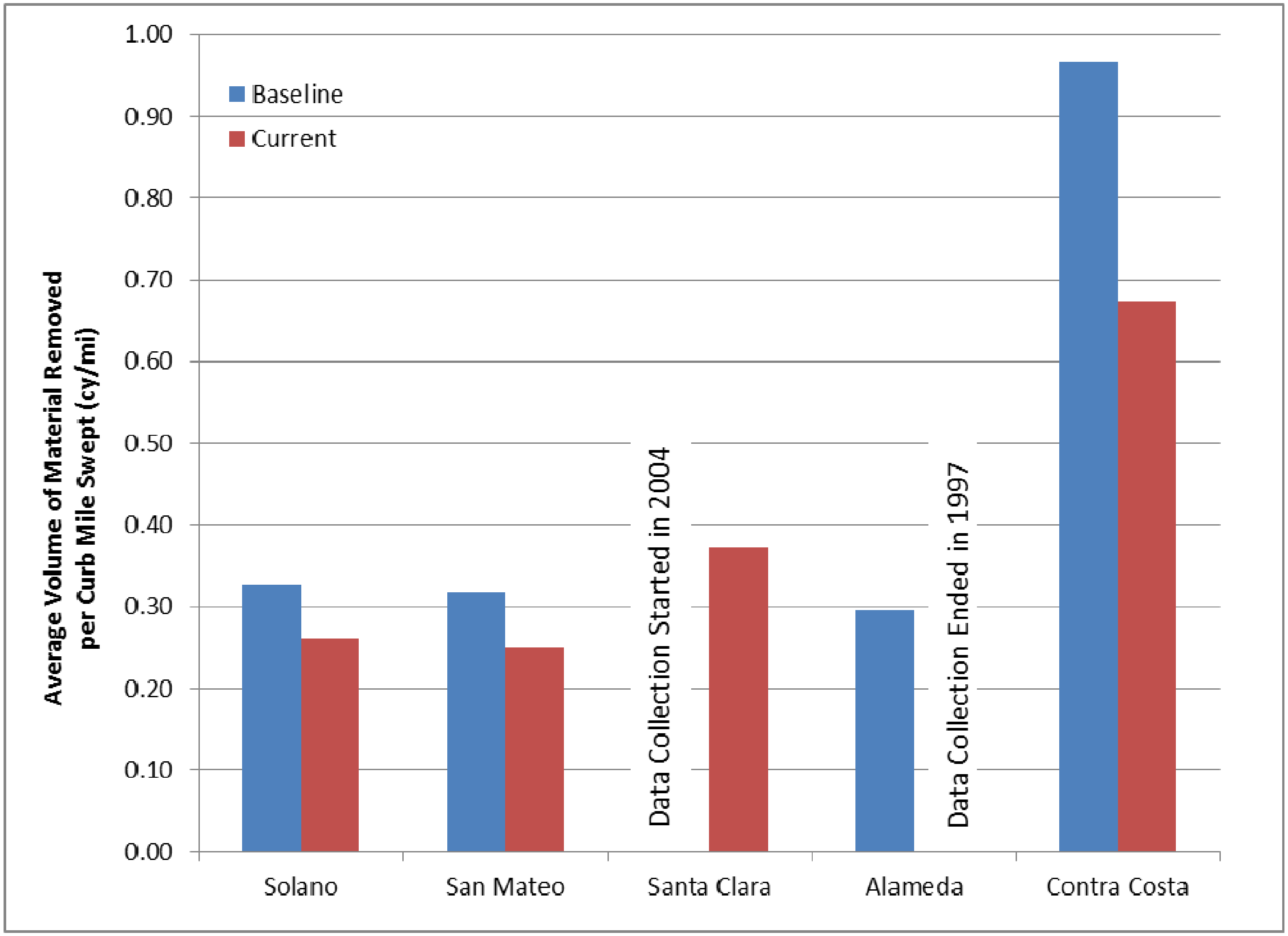
FIGURES B.5

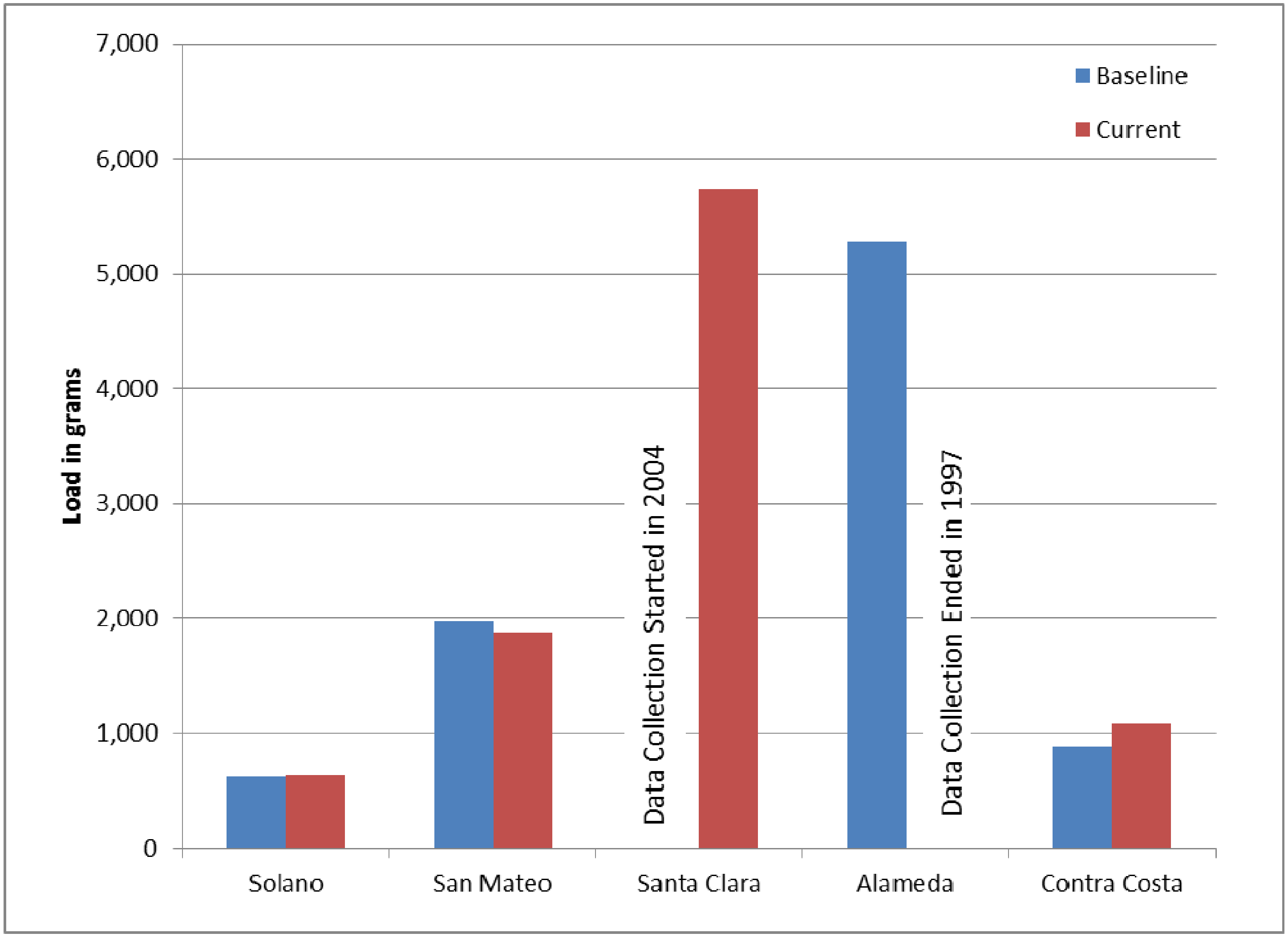


Average Volume of Material Removed per Curb Mile Swept

Source: Data per Appendix Table B.5.1-1 and Table B.5.1-2.	Notes:

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	December 2013	Figure B.5.1

internal info: path, date revised, author

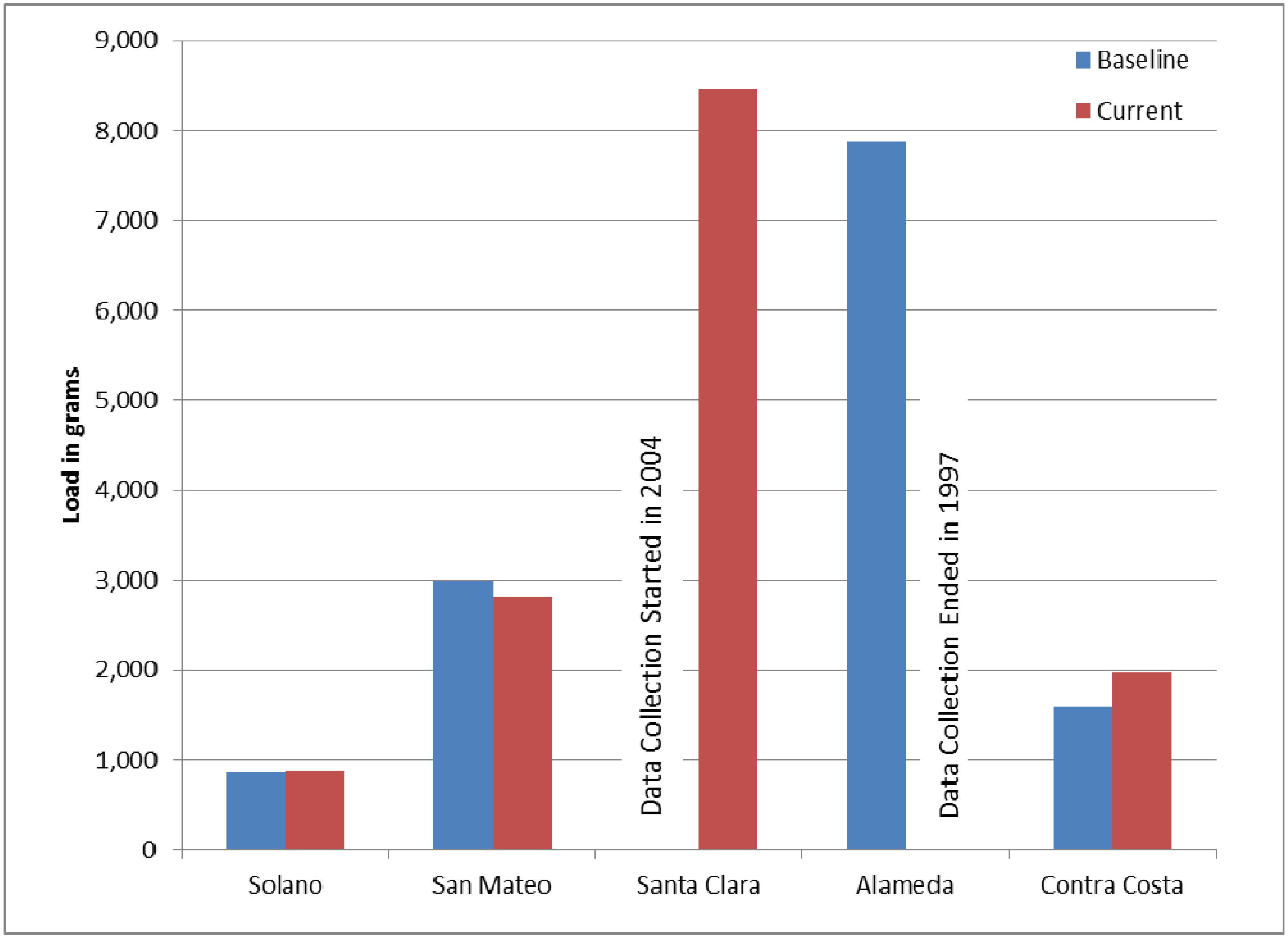


Average Total Annual PCB Load Reduced from Street Sweeping

Source: Data per Appendix Table B.5.1-3	Notes:

Bay Area Stormwater Management Agencies Association	December 2013	Figure B.5.2
Entity	Date	

internal info: path, date revised, author



Average Total Annual Mercury Load Reduced from Street Sweeping

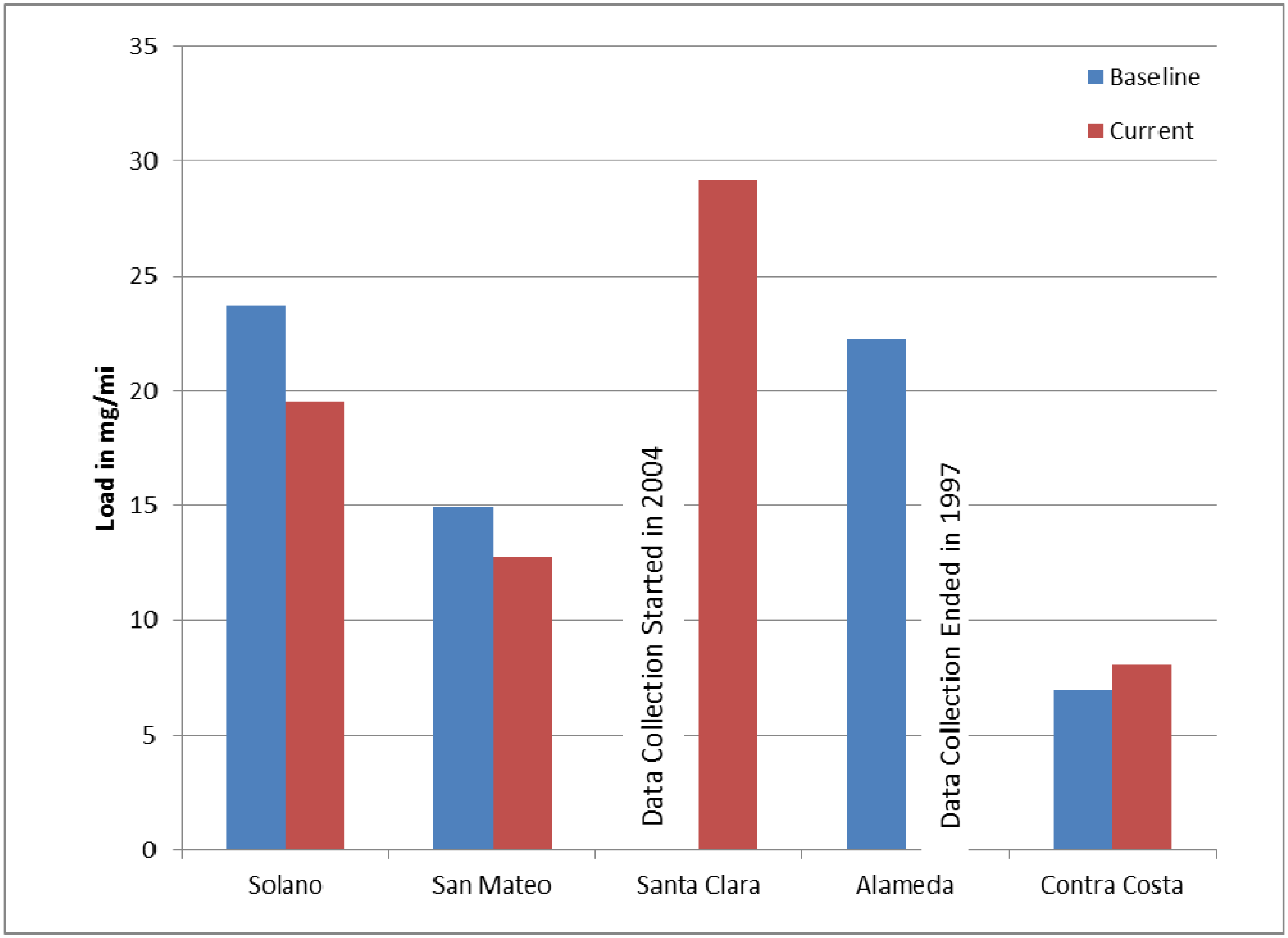
Figure B.5.3

Entity	Date
Bay Area Stormwater Management Agencies Association	December 2013

Source:
Data per Appendix Table B.5.1-3

Notes:

internal info: path, date revised, author

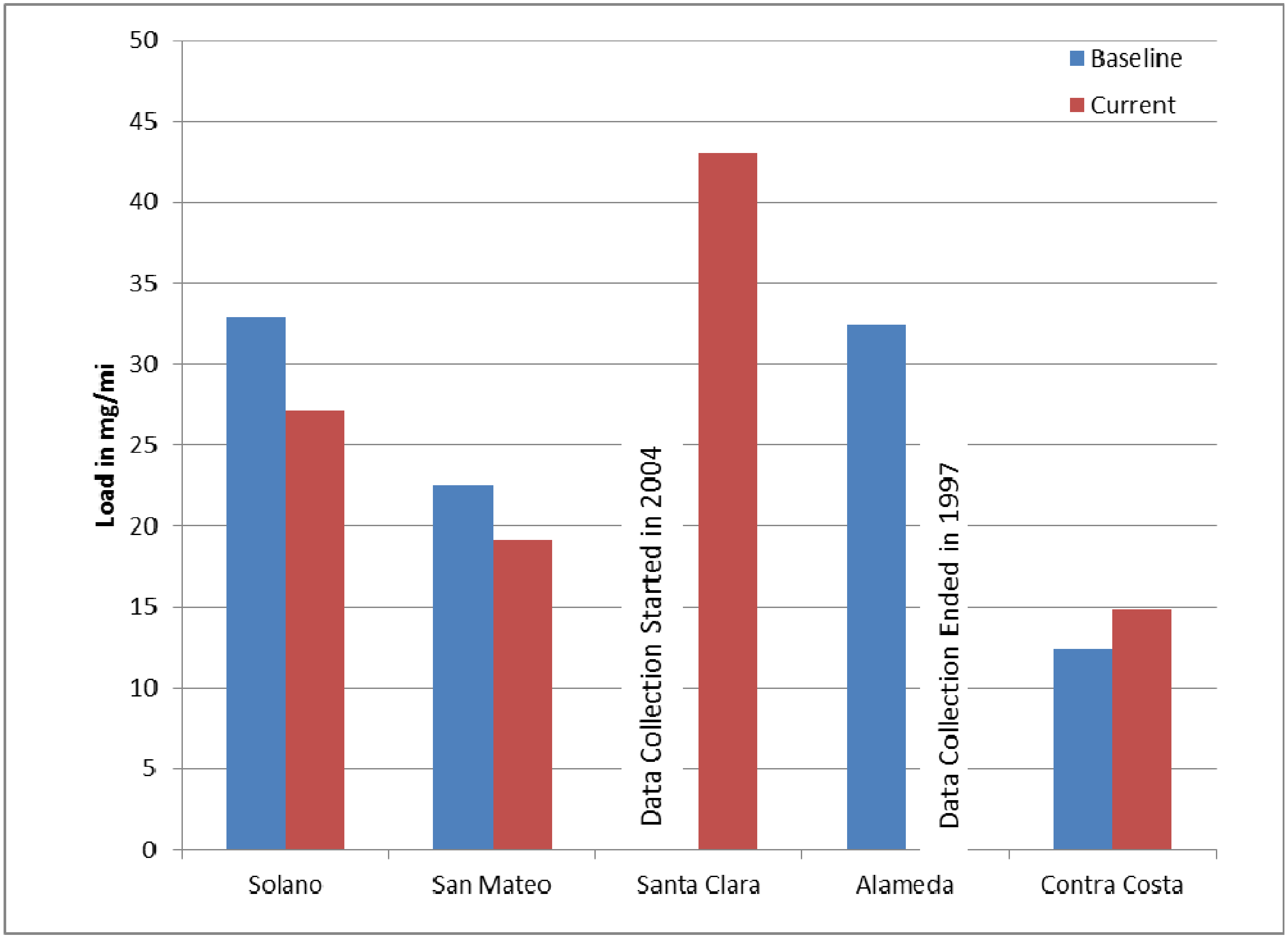


Total PCB Load Reduced per Curb Mile Swept

Entity	Date	
Bay Area Stormwater Management Agencies Association	December 2013	Figure B.5.4

Source:
Data per Appendix Table B.5.1-3

Notes:

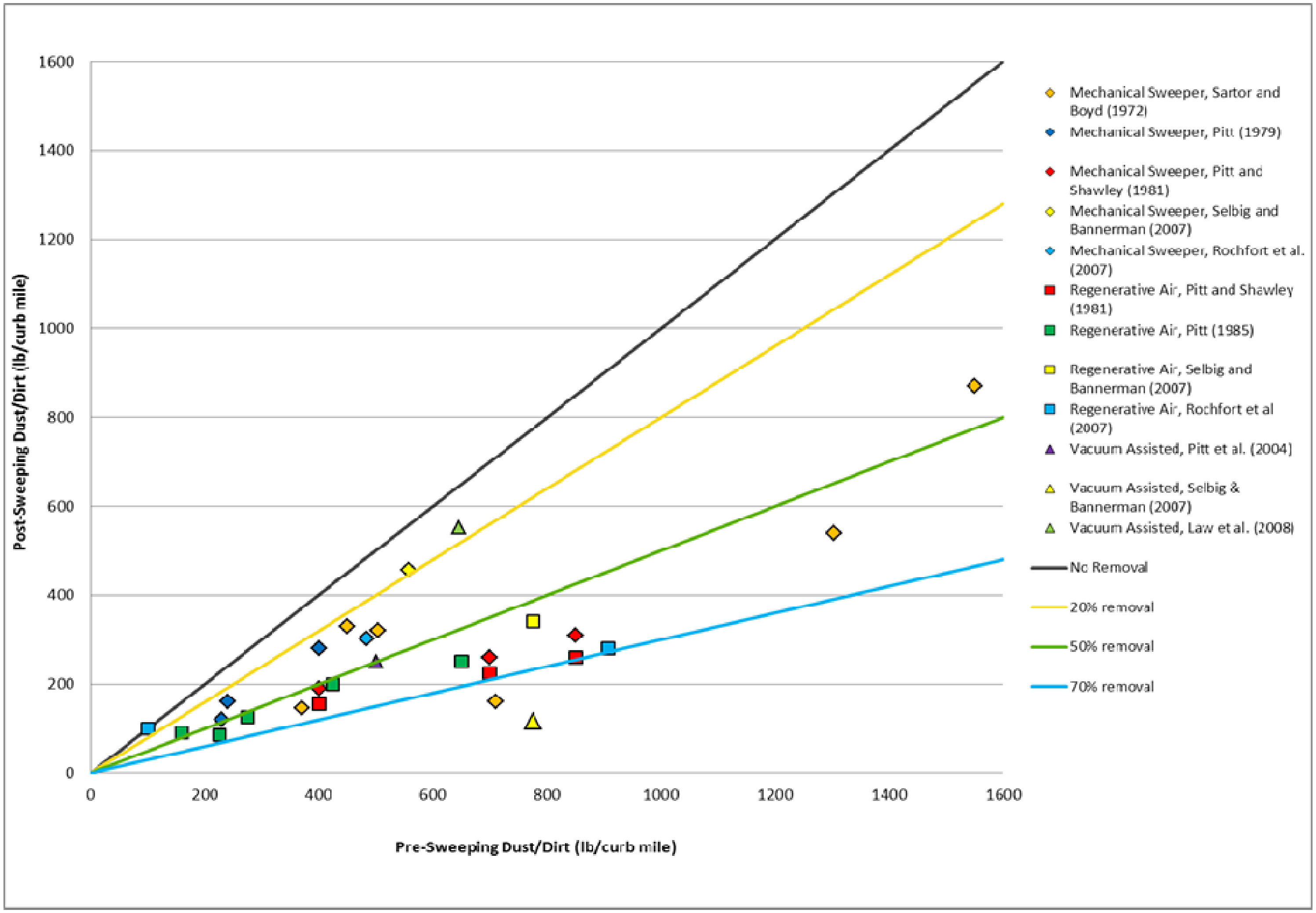


Total Mercury Load Reduced per Curb Mile Swept

Bay Area Stormwater Management Agencies Association	December 2013	Figure B.5.5
Entity	Date	

Source:
Data per Appendix Table B.5.1-3

Notes:



Effectiveness of Different Types of Street Sweepers

Bay Area Stormwater Management Agencies Association	December 2013	Figure B.5.6
Entity	Date	

Source:
EOA Inc. and Geosyntec Consultants (2011)

Notes:

internal info: path, date revised, author

B.6 ENHANCED OPERATION AND MAINTENANCE

B.6.1 Introduction

The term "stormwater conveyance system" refers to the constructed conveyance system designed to transport stormwater to receiving waters during runoff events. The conveyance system includes storm drain inlets, underground pipes, and pump stations. Routine stormwater conveyance system operation and maintenance (O&M) activities include drain inlet cleaning and pump station maintenance. In addition, culverts and channels are also routinely maintained (i.e., "desilting"). A literature review prepared for the Clean Watersheds for a Clean Bay (CW4CB) project entitled *Sediment Management Practices* (EOA, Inc. and Geosyntec Consultants 2011) summarizes municipal sediment management practices and discusses studies that evaluate the effectiveness of stormwater conveyance system maintenance as well as street flushing.

The *Sediment Management Practices* literature review includes a summary of storm drain inlet and catch basin cleaning studies. The majority of these studies focus on the effectiveness of catch basins (with sumps) versus drop inlets (without sumps). Of those, most do not define effectiveness or carry out comprehensive effectiveness evaluations. The studies indicated that pollutant removal effectiveness is affected by various factors including catch basin sump configuration, particle size of the material entering the inlet, maintenance frequency (increased frequency generally increases mass removal), rainfall patterns, and runoff velocity. Inlet cleaning is not being evaluated through an O&M pilot study; however, drain inlet cleaning information provided in the Annual Reports is summarized in Section 3 (as readily available compiled data) to describe the baseline (pre-TMDL[14]) and current (post-TMDL) level of drain inlet cleaning implementation; baseline and current loads reduced from drain inlet cleaning are estimated in Section 4. This analysis demonstrates that cleaning storm drain inlets has some effectiveness for reducing mass loading of polychlorinated biphenyls (PCBs) and mercury to the Bay.

Information from the *Sediment Management Practices* literature review about the effectiveness of pump station cleaning, storm drain line flushing, and street flushing, which are the O&M activities being evaluated through the O&M pilot studies, is briefly summarized below.

B.6.1.1 Pump Station Cleaning

The *Sediment Management Practices* literature review identified very few studies on pump station cleaning effectiveness. Salop (2006) analyzed PCB and mercury concentrations in material collected from two pump stations in September and October 2004, the Ettie Street Pump Station (ESPS) in Oakland, and a pump station associated with a railroad overpass in Pleasanton, adjacent to Valley Avenue near the intersection with Stanley Boulevard. The estimated volume of solids removed during the Pleasanton pump station clean out was 2.4 cubic yards (cy). The

[14] Total Maximum Daily Load

ESPS was not cleaned out during the study, but the estimated amount of solids accumulated in its four wet wells was 33 cy, which did not account for the material accumulated in the pump station forebays. Based on the amounts of solids and the corresponding pollutant concentrations measured, the study estimated that a relatively small mass of PCBs and mercury are removed during cleanouts of most pump station sumps- less than 0.01 kg of PCBs and less than 0.03 kg of mercury from each facility. The study also estimated the PCB mass that would be removed during a single cleanout of the ESPS based on the highest PCB concentration measured in the sumps (since 2000) is 0.3 kg. This demonstrates that estimates of pollutant mass contained within any one depositional facility can vary extensively based on pollutant concentrations measured at one point in time. The study concluded that it is unlikely that any depositional facility but the largest in the most industrialized areas would be expected to exhibit high enough concentrations of a pollutant of concern (POC) to make the accumulated waste at any one time contain a large mass of that POC.

A report for the City of Oakland's source identification project in the Ettie Street Pump Station watershed indicated that since the Alameda County Flood Control and Water Conservation District (ACFCWCD) took over the operation and management of the ESPS in March 1999, sediments in the pump station have been periodically removed (Kleinfelder 2006). The first sediment removal under the ACFCWCD's management was performed in 2001, when 29 cy of material was removed. In 2003, 14 cy of material were removed and in 2006, 61 cy of material were removed (the increased volume removed in 2006 was likely due to heavy rains during the 2005-2006 wet season). The approximate cost for the 2006 cleanout was $27,500, which included labor but not disposal costs as the ACFCWCD disposed of the material at the County yard in Hayward. (Note that the 2006 information differs from the ESPS cleanout information summarized in Section *Estimates of Loads Avoided/Reduced through Enhanced O&M Activities* for the current level of implementation, due to different data sources. Where there are discrepancies, information provided in Section *Estimates of Loads Avoided/Reduced through Enhanced O&M Activities* should be given more weight because it is more recent.)

B.6.1.2 Storm Drain Line Cleaning/Flushing

The *Sediment Management Practices* literature review also identified very few studies about the effectiveness of storm drain line cleaning/flushing. Storm drain cleanout effectiveness is influenced by the frequency of and method of cleanout (Center for Watershed Protection 2006) and the design of the conveyance system. A one-time survey of sediment accumulation in a stormwater conveyance system found that storm drain pipes with significant amounts of sediment accumulation were either sloped less than 1.5% or located close to a source of sediment (Pitt and Field 2004).

In 2005 the City of San Jose cleaned out storm drain inlets, publicly-owned laterals, and the Leo Avenue main line from the western cul-de-sac to South 7th Street (KLI and EOA 2002). Prior to the storm drain line cleaning, the City performed a camera inspection which revealed a dip in the storm drain line where sediment accumulated. It was estimated that the line flushing removed

3,500 kg of solids and approximately 4 grams to 70 grams of PCBs, based on the range of PCB concentrations previously measured in the Leo Avenue storm drain line sediments. The maintenance contractor and City costs for the one-time cleanout was estimated to be about $50,000.

B.6.1.3 Street Flushing

Street flushing was conducted in May 2006 in two areas (totaling 921 linear feet) in the ESPS watershed as a result of abatement activities required by regulatory agencies (Kleinfelder 2006). Excess dry sediment was removed from the streets using a Bobcat excavator or a brush and shovel. Then the streets were cleaned with a high pressure washer (3,000-6,000 pounds per square inch) and the material was collected for disposal. (Note that this activity is a combination of street sweeping and flushing, while the pilot studies will evaluate these components separately.) The abatement removed approximately 1.1 cy of material including 0.6 cy of dry sediment and 0.5 cy of wet sediment from Area 1 (approximately 1.2 tons of sediment assuming a density of 2,925 pounds/cy). For Area 2, 16 cy of dry sediment and 0.6 cy of wet sediment were removed (approximately 18.7 tons of sediment). Based on PCB concentrations of the dry sediment abated, the mass of PCBs removed was 2.8 grams from Area 1 and 5.7 grams from Area 2. The cost for the abatement was approximately $100,000, or $11 per mg of PCBs removed. This included sediment disposal at a hazardous waste facility due to elevated lead concentrations. A year later (in May 2007), Kleinfelder (2007) resampled the two areas to evaluate the effectiveness of the abatement activities. Post-abatement PCB concentrations in sediments were 27 to 94 percent lower than the pre-abatement results; however abatement at a private facility in drainage Area 2 may have contributed to the observed reduction in the post-abatement results.

A study conducted in Paris, France estimated that daily street flushing in a densely populated residential/commercial area contributed 15 percent in loads of suspended solids, organic matter and copper from the catchment to the combined sewer system (Gromaire et al. 2000).

B.6.2 <u>Summary of PCB and Mercury Control Pilot Studies</u>

Implementation Approach

CW4CB Task 4 is anticipated to result in Permittee compliance with Municipal Regional Stormwater NPDES Permit (MRP) Provisions C.11/12.d. This task is pilot-scale evaluation of methods to enhance the pollutant load reduction benefits of municipal operation and maintenance activities that remove sediment from streets and storm drain system infrastructure. Most of the pilot studies will be conducted within the five Bay Area region watersheds with elevated PCB levels selected in CW4CB Task 3.

During FY 2010/11, existing literature was reviewed for information on previous studies related to sediment and pollutant removal during municipal operation and maintenance activities and other information relevant to the pilot evaluations (EOA, Inc. and Geosyntec Consultants 2011)

(Section B.6.1 summarizes the major findings of the *Sediment Management Practices* literature review). The key data gaps and recommendations for the design of future studies in the literature review are summarized in the BASMAA Regional Pollutants of Concern Report FY2010-2011 (BASMAA 2011).

Based on the results of the literature review and discussions with municipal staff, the CW4CB Task 4 sediment management workgroup developed study designs for the O&M pilot studies that will be implemented in 2013, entitled *Clean Watershed for a Clean Bay (CW4CB) Study Designs for Five O&M Pilot Projects* (Study Designs) (Geosyntec Consultants and CSU/OWP 2013). Because the O&M pilot studies were not implemented in time for completion of the IMR, they are described briefly below based on information in the Study Designs. Figure B.6.1 shows the locations of the three O&M pilot studies (the fourth pilot study is an enhanced street sweeping study, which is described in Section B.5).

B.6.2.1 O&M Pilot Study Descriptions

The O&M pilot studies (Figure B.6.1) are designed such that the results are comparable to the extent feasible, by standardizing the analytical suite for the sediment sample analyses to include particle size distribution (PSD), mercury, PCBs, and total organic carbon. In addition, sediment samples may be analyzed for the mercury and PCB concentration in the particle size fraction less than and greater than 63 microns (representing the division between coarse and fine sediment), based on the initial PSD, mercury and PCB results for the whole sample.

Enhanced Pump Station Cleanout Pilot Study

The pilot study entails an enhanced cleanout of the ESPS, which is located in West Oakland at 3465 Ettie Street, adjacent to MacArthur Freeway to the north and Nimitz Freeway to the west. Its drainage catchment is comprised of approximately 954 acres in west Oakland and includes residential, commercial, and industrial land uses. The pump station has four wet wells and a forebay. Cleanout practices have varied over the years; however, the current cleanout protocol consists of an annual dewatering and cleanout (if warranted based on inspection) of the two southern wet wells in late spring or summer (after the rainy season). The cleanout is performed with a vactor truck. Per discussions with pump station personnel, a rough rule of thumb is that if upon inspection greater than 50% of the wet well floor has sediment accumulation greater than 1 foot, the wet well is cleaned out. The two northern wet wells are not cleaned out as part of the annual procedure because these wells cannot be accessed with the existing vactor truck. The forebay is also usually not cleaned as part of the annual maintenance activity.

The pilot study entails enhancing the current annual cleanout to include a clean out of the two northern wet wells, if warranted based on the sediment accumulation observations. This would be achieved via a manual cleanout with wheelbarrows and shovels, cleanout with a new vactor truck planned to be purchased in the summer of 2013, or by renting a more powerful vactor truck that creates more suction and is effective with the longer hose lengths needed to access the north wet wells.. The study will evaluate the increase in load reduction associated with cleaning all four wet wells and the forebay. Data representing the current O&M activity were collected during the May 2013 cleanout of the southern wet wells and forebay. These data included sediment accumulation measurements and analysis of sediment samples for specific gravity, particle size distribution, and mercury and PCBs and will be used in the evaluation of the pilot study data. The May 2013 data were collected consistent with the methods described in the Study Designs. These data are further discussed in Section *Estimates of Loads Reduced by O&M Activities.*

Key variables that will be measured for the pilot study are as follows:

- Volume and mass of sediment removed in each wet well.
- Particle size distribution of sediment removed.
- Concentration and mass of PCBs and mercury contained in the sediment removed.
- Spatial variation in depth of sediment in the wet wells.
- Costs for implementing the enhancement.

Street Flushing Pilot Study

The street flushing pilot study was implemented in the Pulgas Creek Pump Station watershed in the City of San Carlos. The watershed includes 1.1 km^2 (272 acres) of industrial and commercial land uses. Historically up to 72% of the area was comprised of industrial land use and there is a PG&E substation in the catchment (EOA, Inc. 2012). The pilot study focused on the area south of Brittan Avenue.

The primary objective of the pilot study was to determine the mass of mercury and PCBs removed by street flush and capture. A secondary study objective was to estimate the buildup rate of mercury and PCBs following a flush/capture effort. These data may be helpful in improving the effectiveness of various sediment maintenance efforts such as street sweeping and flushing.

The City of San Carlos maintenance staff implemented single flush and capture events on four dates: September 13, 16, 18 and 20th, 2013. Each event covered 500 to 1,000 feet of complete street width (curb to curb). Each event used two vactor trucks and four maintenance staff for a single day of flushing. The first vactor truck was the water source and used a wand attachment for flushing. The second vactor truck captured the debris and wash water using its vacuum, with no (or little) water allowed to enter the storm system. Wastewater was decanted and disposed of into the sanitary sewer system via an existing hose connection on the vactor truck. The remaining sediment slurry was emptied and dried at the municipal corporation yard and disposed of with other debris routinely collected by maintenance staff.

The current O&M activity in the pilot study area is weekly street sweeping, in addition to annual drain inlet cleaning. Although street flushing could be performed as an enhancement to street sweeping for future enhanced O&M implementation by the Permittees, street sweeping activities were stopped in two of the four pilot study sub-areas in June 2013. The pilot study was conducted in September 2013. The objective was to evaluate the effectiveness of street flushing with and without the confounding effects of street sweeping. Consistent with the street sweeping pilot study, street sediment samples were collected with a vacuum before and after each flushing event to evaluate street sediment loading.

Due to the availability of field crews, the sampling activities could not be planned to coincide with the wet season. It is recognized that a more practical evaluation of the effectiveness of street flushing requires knowledge of buildup/wash-off phenomena and what is available for wash-off during discrete storm events; this evaluation was beyond the scope of the study design.

The key variables involved in the study design (in addition to cost) are as follows:

- Volume and mass of sediment removed;
- Particle size distribution
- PCB and mercury concentrations in the sediment and decant water from the flushing activity;
- Water used; and
- Water pressure.

Storm Drain Line Cleanout Pilot Study

The pilot project is located in the Leo Avenue watershed in San Jose, CA. The pilot study will be focused on the main storm drain line along Leo Avenue between the western Leo Avenue cul-de-sac and South 7th Street. The pilot study is designed to estimate the load reduction benefit of cleaning out the Leo Avenue main storm drain line in an area with known legacy contamination. This study also aims to document how a video inspection of the stormwater drainage system can facilitate load reduction by identifying sources of polluted sediment in the main line (e.g., surface infiltration in areas with storm drain lines located below legacy contamination or from sediment coming into the main line from private lateral connections).

The goals of this pilot project are as follows:

- Remove accumulated sediment from the Leo Avenue main storm drain line between 7th Street and the Leo Avenue cul-de-sac in San Jose, including any public laterals connected to the line, to the extent possible. Quantify the volume and mass of sediment removed;
- Characterize concentrations of mercury and PCBs in sediments that are removed from the storm drain line;
- Perform a post-cleanout video inspection of the storm drain line to better delineate the stormwater drainage system and identify all private properties that are connected to the

public storm drain line (some connections/line locations are uncertain), and to determine whether cracks or joint separations exist that may allow infiltration of sediment into the storm drain from surrounding buried soils;

- Establish a baseline for comparison.

Current O&M activities conducted by the City of San Jose in the Leo Avenue watershed include street sweeping twice per month and annual drain inlet cleaning. In addition, a previous one-time cleanout of the Leo Avenue storm drain line was conducted in 2005 (as described in Section B.6.1).

B.6.3 Status of Control Measure Implementation

B.6.3.1 Drain Inlet Cleaning

The status of the baseline and current level of implementation was evaluated using readily available drain inlet cleaning data reported by the Permittees in their Annual Reports.[15] (Readily available data means data that were compiled in spreadsheets.) Baseline implementation refers to actions occurring prior to and including Fiscal Year 2001-2002. Current implementation refers to actions occurring post Fiscal Year 2001-2002. Enhanced implementation refers to actions occurring post Fiscal Year 2001-2002 that are above and beyond baseline implementation.

The Permittees reported in their Annual Reports on the total number of drain inlets, the number inspected and/or cleaned, and the volume of material removed from the inlets. Note that the reported number of drain inlets inspected/cleaned is often greater than the total number of inlets in the municipality. This is because some drain inlets were inspected and potentially cleaned more than once per year. The Permittees also record the number of inlets that require more frequent cleaning in their Annual Reports (based on information reported by Contra Costa County Permittees); but this information does not clearly link to the types of O&M enhancements implemented. Data were not available that documented the cleaning frequency for individual inlets. The format of the information available groups inlets that were inspected and cleaned together; therefore it was not possible to identify inlets that were inspected and cleaned versus inlets inspected but not cleaned because of low material accumulation and/or resources.

For each municipality, different years of data were available for the baseline and current implementation periods. For example, baseline data for the San Mateo County municipalities were available for Fiscal Years 2000-2001 and 2001-2002 only, while Alameda County municipalities have baseline data going back to Fiscal Year 1996-1997. San Mateo County municipalities have current data through Fiscal Year 2008-2009 while there are only current data for Alameda County municipalities through Fiscal Year 2004-2005. No drain inlet data were

[15] Data for this evaluation were compiled by EOA, Inc. (data were compiled in May 2011) and the Contra Costa County Clean Water Program. These data are compiled in Appendix Table B.6-1.

compiled for Vallejo and the Annual Reports are not available online. Santa Clara County municipalities do not collect information on drain inlet cleaning.

In addition, there were no drain inlet inspection and cleaning data collected for the MRP permit period because the MRP does not require the Permittees to track and report this type of information. Also, there is no information available to determine the number of drop inlets versus catch basins, but based on personal communications with a number of Permittee staff, it is believed that a majority of the storm drain inlets in the Bay Area are drop inlets and not catch basins that include a sump for sediment/debris storage.

Appendix Table B.6.A.1 summarizes the baseline and current implementation efforts in terms of average number of drain inlets inspected/cleaned per year, the average annual volume of material removed by inlet cleaning, and the average volume of material removed per inlet inspected/cleaned (rate) for each individual municipality.

It is challenging to compare the baseline and current level of implementation in terms of the change in the average volume of material removed per inlet inspected/cleaned (rate). This is because the number of inlets inspected but not cleaned was grouped with the number of inlets that were cleaned out; this effectively decreases the rate because it distributes the total volume of material removed over more inlets, an unknown number of which did not have any material removed. Further, it cannot be assumed that an increase in the rate for the current period for any individual municipality is due to an increased level of implementation, as this does not efficiently capture an increased inspection frequency.

The inlet cleaning data for Fairfield, Woodside, unincorporated Alameda County, Suisun City, and San Leandro showed (potentially unrealistically) high rates for the baseline and/or current implementation periods (unincorporated Alameda County had the highest rates; e.g., high means more than 1 cy of material removed per inlet inspected/cleaned). This variation could reflect that the municipality cleaned out more catch basins rather than drop inlets. Catch basins in some areas may have accumulated more vegetative waste or illegally dumped material. Potentially, material removed from culverts was included in the drain inlet estimates. Incorporate these high removal rates would skew the average amount of material removed when evaluating the level of implementation for each countywide program area.

Summary statistics for the volume of material removed (cy) per drain inlet inspected/cleaned for each countywide program are provided in Table B.6.3.1. and

Table B.6.3.2. for the baseline and current conditions, respectively, based on the Permittee reported values in Appendix Table B.6.A.1. Appendix Figure B.6.A.1 illustrates the information in Appendix Table B.6.A.1 graphically for each countywide program.

Table B.6.3.1. Summary Statistics on Reported Values for Volume of Material Removed per Drain Inlet Inspected/Cleaned for the Baseline Condition (per Appendix Table B.6.1-1)

Countywide Program	25th Percentile (cy/inlet)	Average (cy/inlet)	Standard Deviation (cy/inlet)	50th Percentile (cy/inlet)	75th Percentile (cy/inlet)
Solano	2.18	3.74	4.41	3.74	5.30
San Mateo	0.14	0.39	0.39	0.36	0.48
Alameda	0.04	0.72	1.81	0.12	0.48
Contra Costa	0.06	0.32	0.39	0.16	0.53
All Municipalities	0.07	0.57	1.28	0.20	0.54

Table B.6.3.2. Summary Statistics on Reported Values for Volume of Material Removed per Drain Inlet Inspected/Cleaned for the Current Condition (per Appendix Table B.6.1-1)

Countywide Program	25th Percentile (cy/inlet)	Average (cy/inlet)	Standard Deviation (cy/inlet)	50th Percentile (cy/inlet)	75th Percentile (cy/inlet)
Solano	1.21	1.70	1.38	1.70	2.19
San Mateo	0.15	0.35	0.28	0.24	0.46
Alameda	0.05	4.77	4.40	0.11	0.39
Contra Costa	0.03	0.18	0.22	0.07	0.30
All Municipalities	0.06	1.54	7.47	0.19	0.41

Because data from certain municipalities were causing the countywide estimates to be biased high, an alternate method was used to evaluate level of effort on a countywide program basis, which entailed assigning "representative" "low", "medium" and "high" removal rates based on a statistical analysis of the Permittee baseline and current data set. "High" removal rates were considered to be the 75th percentile rate and above; "medium" rates were between the 25th and 75th percentile; and "low" removal rates were values less than the 25th percentile for all countywide program data. The baseline and current 25th, 50th and 75th percentile values are provided in

Table B.6.3.3, for the entire data set. Each individual municipality was assigned a new removal rate based on the ranking method (see Appendix Table B.6.A.2) and then the countywide rate was calculated as the average rate of all the individual municipalities within that countywide program. The new rates assigned for each countywide program based on the statistical, for the baseline and current periods, are summarized in

Table B.6.3.4 and Table B.6.3.5, and also illustrated in Figure B.6.2. Per Figure B.6.2, the current average volume of material removed per inlet is lower than the baseline rate for all countywide programs. Baseline rates ranged from 0.24 cy/inlet to 0.54 cy/inlet. Current rates ranged from 0.13 cy/inlet/inlet to 0.31 cy/inlet.

Table B.6.3.3. Rank (Percentile) Values Calculated for Volume of Material Removed per Drain Inlet Inspected/Cleaned for the Baseline and Current Conditions

Countywide Program	Low (25th Percentile) (cy/inlet)	Medium (50th Percentile) (cy/inlet)	High (75th Percentile) (cy/inlet)
Baseline	0.07	0.20	0.54
Current	0.04	0.11	0.31

Table B.6.3.4. Summary Statistics for Volume of Material Removed per Inlet Cleaned/Inspected for Baseline Period Using the Ranking Method (
Table B.6.3.3.)

County	25th Percentile (cy/inlet)	Average (cy/inlet)	Standard Deviation (cy/inlet)	50th Percentile (cy/inlet)	75th Percentile (cy/inlet)
Solano	0.54	0.54	0.00	0.54	0.54
San Mateo	0.20	0.25	0.15	0.20	0.20
Alameda	0.07	0.24	0.20	0.20	0.37
Contra Costa	0.07	0.24	0.18	0.20	0.29
All Municipalities	0.10	0.25	0.18	0.20	0.45

Note: See Appendix Table B.6-2 for ranking values assigned to individual municipalities.

Table B.6.3.5. Summary Statistics for Material Collected per Inlet Cleaned/Inspected for Current Period Using the Ranking Method (
Table B.6.3.3.)

County	25th Percentile (cy/inlet)	Average (cy/inlet)	Standard Deviation (cy/inlet)	50th Percentile (cy/inlet)	75th Percentile (cy/inlet)
Solano	0.31	0.31	0.00	0.31	0.31
San Mateo	0.11	0.19	0.10	0.11	0.31
Alameda	0.09	0.14	0.10	0.11	0.16
Contra Costa	0.04	0.13	0.10	0.11	0.11
All Municipalities	0.11	0.16	0.11	0.11	0.31

Note: See Appendix Table B.6-2 for ranking values assigned to individual municipalities.

B.6.3.2 Pump Station Cleaning

Information about the number of pump stations cleaned out each year and the volume of material removed was not available in a compiled format. Information about pump stations in the MRP area was provided by EOA, Inc.[16] Pump station attribute data was also accessed from a data base provided by SFEI, containing data from 279 pump stations in the Bay Area. These data include the pump station location, maximum pumping capacity, tributary area, and dominant land uses.

[16] SFBRWQCB 2010. Compiled version of Municipal Regional Permit Associated Stormwater Pump Station Locations and Characteristics. Submitted by Permittees to the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) in compliance with Provision C.2.d.ii.(1) of the MRP (Board Order No. 2009-R2-0074). March.

Table B.6.3.6 summarizes the number of pump stations from the database in each countywide program area, including the total number of pump stations, the number of Caltrans operated pump stations and the number of non-Caltrans operated pump stations with dominant industrial land use in the tributary area. The number of pump stations with industrial land use was derived from the pump stations listed as having dominant industrial land use in the tributary area in the database and pump stations within 200 feet of old industrial land use based on the old industrial GIS layer.[17]

The database was used to characterize the distribution, pumping capacity, tributary area, and dominant land use of pump stations around the bay area. Since Ettie Street is a highly industrialized watershed, the database was filtered to only include pump stations with a tributary area that is dominated by industrial land use or is within 200 feet of land areas that have been classified as old industrial. Additionally, to limit the analysis to municipally operated pump stations, all pump stations that are operated by Caltrans were filtered out as well. A summary of the pump station attributes is provided in Table B.6.3.6 and

Table B.6.3.7 includes information for the non-Caltrans operated pump stations with tributary areas containing dominant industrial land use.

Table B.6.3.6. No. Pump Stations in MRP Area

	Alameda County	Contra Costa County	San Mateo County	Santa Clara County	Solano County	Total
Total Pump Stations	68	28	67	111	4	279
Caltrans Operated Pump Stations	20	5	8	28	0	62
Non-Caltrans Operated Pump Stations with Industrial Land Use	9	1	22	17	0	49

Table B.6.3.7. Average Maximum Pumping Capacity and Tributary Area for Non-Caltrans Pump Stations with Industrial Land Use.

Non-Caltrans Pump Stations with Industrial Land Use	Alameda County	Contra Costa County	San Mateo County	Santa Clara County
Average Maximum Pumping Capacity (Gal/Min)	148,728	45,000	18,719	23,761
Average Tributary Area (Acres)	737	666	65	129

[17] SFEI and EOA, 2013. Draft GIS datalayers depicting Old Industrial (constructed pre-1968).

This information was used to estimate PCB and mercury load reductions from pump station cleaning, based on more detailed information known about pump station cleanouts at the ESPS. Load reduction estimates are discussed in the next section.

B.6.4 Estimates of Loads Avoided/Reduced

This section presents the methodology for estimating loads reduced by baseline and current implementation efforts for drain inlet cleaning and pump station cleaning, and a methodology for evaluating the increase in load reduction from enhanced O&M implementation, which includes drain inlet cleaning and pump station cleaning. Two different load reduction methodologies are presented for pump stations. This section also includes load reduction estimates for the baseline and current level of implementation for each countywide program. In addition an estimate of the annual load reduced is provided for the pilot study areas based on current practices, as is an evaluation of how the additional load reductions achieved from implementing O&M enhancements could be quantified.

B.6.4.1 Loads Avoided/Reduced Methodology (Bay Area-Wide)

The baseline, current and enhanced load reduction methodology presented in this section has been adapted from the methodology presented in the Draft Technical Memorandum entitled "*Methods for Quantifying Mercury and PCB Loads Reduced from Urban Stormwater Runoff, Assessing Municipal Stormwater Program Progress Towards TMDL Wasteload Allocations Through Control Measure Implementation*" (EOA, Inc. 2011).

Drain Inlet Cleaning

The baseline and current load reduction achieved by drain inlet cleaning may be calculated as follows:

$$Baseline_{DI} = Vol_{Baseline\ DI} \bullet \%Sed_{DI} \bullet \rho_{DI} \bullet Conc_{DI}$$

And:

$$Current_{DI} = Vol_{Current\ DI} \bullet \%Sed_{DI} \bullet \rho_{DI} \bullet Conc_{DI}$$

Where:

$Vol_{BaselineDI}$ = Average volume of drain inlet material collected in baseline years (prior to and including Fiscal Year 2001-2002)

$Vol_{CurrentDI}$ = Average volume of drain inlet material collected in current years (post Fiscal Year 2001-2002)

$\%Sed_{DI}$ = Percent of material collected from drain inlets that is "sediment"[18] (by volume)

[18] For purposes of this document, drain inlet sediment is defined as the material that would pass through a 2 mm sieve.

ρ_{DI} = Density of the drain inlet sediment (weight per unit volume)

$Conc_{DI}$ = Average (or measured) concentration of mercury or PCBs in street sweeping sediments collected. Note that the same concentration was used for baseline and current load reductions

Note that units and unit conversation factors must be supplied by the user.

Therefore, the enhanced load reduction may be calculated as follows:

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

Assumptions and Data Inputs

- Volume of Material Collected ($Vol_{Baseline\ DI}$ and $Vol_{Current\ DI}$). The volume of material removed from drain inlets has been reported by the Permittees in their Annual Reports (see Appendix Table B.6-1 for baseline and current level of implementation). Note that the years for which these data are available vary by municipality, and different years form the basis for the baseline and current periods depending on the municipality. Therefore the average annual volume of material removed for the baseline and current implementation period was used for this load reduction analysis.
- Percent of Drain Inlet Material That is "Sediment" ($\%Sed_{DI}$). For the purposes of this analysis, it is assumed than material less than 2 mm is sediment. The estimate for the percent of drain inlet material that is less than 2 mm comes from Salop (2006). Salop evaluated the characteristics of gross solids collected during drain inlet cleaning operations in Bay Area cities and estimated sediment/vegetative debris less than 2 mm in diameter accounted for approximately 60 percent (by volume) of total solids collected during street sweeping operations in Alameda County. Therefore $\%Sed_{DI}$ was assumed to be 60 percent for the baseline and current load reduction analysis.
- Drain Inlet Sediment Density (ρ_{DI}) – The material removed from drain inlets is typically reported as a volume (cy). To calculate pollutant loads reduced, the volume of material must be converted into a mass using an assumed bulk density for the material. In support of the California Integrated Waste Management Act of 1989, FEECO International developed densities for a variety of waste materials. These densities continue to be utilized by the California Department of Resources Recycling and Recovery (CalRecycle 2013). In addition FEMA (2010) developed the "Debris Estimating Field Guide" which has densities for waste materials. The dry bulk density used for this analysis was estimated using the average density determined by these two sources; the selected density assumes the material is 30 percent vegetative debris by volume and the remaining volume

is dry sand. Therefore, the assumed bulk density for dry material[19] less than 2 mm is 1,811 pounds per cubic yard.

- Concentration of Mercury/PCBs in Drain Inlet Sediment ($Conc_{DI}$) Concentration data for sediment samples collected from drain inlets in the Bay Area and compiled into the SFEI database (SFEI 2010; KLI and EOA 2002; City of San Jose and EOA 2003) were used to represent the concentrations in sediment removed by drain inlet cleaning. Table B.6.4.1 summarizes the mean mercury and PCB concentrations from the SFEI database for each county, which were used to estimate the load reductions (the median concentrations are also included). If the total number of drain inlet sediment samples was eleven (11) or greater for a specific municipality (a reasonable cut off based on the data analysis), the municipality-specific mercury or PCB concentration was used to estimate the load reduction for that municipality. If the number of samples for a municipality was less than eleven, the mean concentration for the county was used to estimate the load reduction for that municipality. The same concentration was used to estimate the baseline and current load reductions. So it is assumed that there was no significant decrease in POC concentrations for the current period due to true source control or POC transformation/degradation.

Pump Station Cleaning

The baseline and current load reduction achieved by pump station cleaning may be calculated as described above in Section *Drain Inlet Cleaning*. The volume of material removed is reported in Annual Reports; the data are not included in this section because the information was not compiled and available in spreadsheet form.

[19] FEMA estimate was calculated from the conversion factor given for 70% dry sand, 30% vegetation and trash of 69 pounds per cubic foot or 1,870 pounds per cubic yard. CalRecycle estimate was calculated from the conversion factor given for “wet sand” of 110-130 pounds per cubic foot, and converting to a dry density by applying a porosity of 0.35 (porosity from Linsley and Franzini, Water Resources Engineering, 1964), which results in a dry bulk density of 1,752 pounds per cubic yard. The “best” (average) density estimate, 1,811 pounds per cubic yard, is equivalent to 821.5 kg per cubic yard.

Table B.6.4.1. Drain Inlet Sediment Concentration Data Used to Estimate Load Reductions

Municipality	PCBs			Mercury		
	No. Drain Inlet Sediment Samples	Mean PCB DI Sediment Concentration (mg/Kg)	Median PCB DI Sediment Concentration (mg/Kg)	No. Drain Inlet Sediment Samples	Mean Mercury DI Sediment Concentration (mg/Kg)	Median Mercury DI Sediment Concentration (mg/Kg)
Fairfield & Suisun	8	0.244	0.055	16	0.510	0.228
San Mateo County Municipalities	29	0.318	0.123	28	0.160	0.147
San Carlos	22	0.267	0.129	25	0.167	0.147
Alameda County Municipalities	47	0.294	0.122	75	0.384	0.204
Berkeley	8	0.147	0.122	11	0.343	0.241
Oakland	24	0.402	0.155	28	0.539	0.297
San Leandro	11	0.219	0.106	21	0.230	0.151
Contra Costa County Municipalities	46	0.515	0.168	48	0.413	0.308
Richmond	31	0.736	0.482	28	0.460	0.349

Notes:
Mean and median drain inlet sediment concentrations were calculated from the SFEI database (SFEI 2010, KLI and EOA 2002; City of San Jose and EOA 2003).

The percent of material that is sediment was assumed to be 60% for drain inlet materials. Even though pump stations include trash and debris, data are often reported as the volume of sediment removed, as opposed to the volume of total material (as is the case for the ESPS clean out data discussed in this section). Therefore, it is assumed that the reported volume of material removed from pump stations is primarily sediment, which is consistent with Salop (2006); therefore the percent of material removed that is sediment is assumed to be 100 percent.

Concentration data for sediment samples collected from pump stations in the Bay Area and compiled into the SFEI database (SFEI 2010; KLI and EOA 2002, City of San Jose and EOA 2003) were used to represent the concentrations in sediment removed by pump station cleaning. Table B.6.4.2 summarizes the mean mercury and PCB concentrations from the SFEI database for each county, which may be used to estimate the load reductions (the median concentrations are also included). There are no pump station sediment data for Contra Costa or Solano County municipalities.

Table B.6.4.2. Pump Station Sediment Concentration Data That May be Used to Estimate Load Reductions

County	PCBs			Mercury		
	No. Pump Station Sediment Samples	Mean PCB Pump Station Sediment Concentration (mg/Kg)	Median PCB Pump Station Sediment Concentration (mg/Kg)	No. Pump Station Sediment Samples	Mean Mercury Pump Station Sediment Concentration (mg/Kg)	Median Mercury Pump Station Sediment Concentration (mg/Kg)
San Mateo[1]	17	0.628	0.116	9	0.176	0.100
Santa Clara[1]	6	0.026	0.018	7	0.179	0.160
Alameda[1]	5	0.900	.315	2	0.579	0.575
Contra Costa[2]	NA	0.518	NA	NA	0.311	NA

[1] Data for San Mateo and Santa Clara are entirely from the SFEI Database. Alameda County statistics were calculated from five samples collected from the ESPS in 2000, 2001, 2004, 2006, and 2013.

[2] In the absence of pump station sediment data for Contra Costa County, the Contra Costa County concentrations are an estimate derived from the arithmetic mean of the other counties.

Storm Drain Line Cleaning

Storm drain line cleaning is not a regular O&M activity.

Street Flushing

Street flushing is not a regular O&M activity.

B.6.4.2 Alternate Method for Estimating Load Reductions from Pump Station Cleaning

Because information about the volume of material removed during pump station cleaning was not available as compiled information, load reduction achieved by pump station cleaning was estimated using ESPS information on mass load reductions of PCBs and mercury, and the volume of material removed, to estimate mass removal from the other pump stations with dominant industrial land use in the tributary area (Table B.6.3.6) based on the ratio of the maximum pumping capacity and tributary area (ratio between ESPS and selected pump station of interest). Two different methods were used as described below.

Method 1: Normalization Based on ESPS PCB and Mercury Mass Load Reductions

Method one estimates a range of potential PCB and mercury load reductions at each non-Caltrans operated pump station with industrial land use by normalizing the ESPS load reductions (Table B.6.4.3.) by the catchment area or the pumping capacity at the ESPS and the pump station of interest. The data were normalized using both the maximum pump station capacity and tributary because there was no correlation observed between pump station capacity and tributary area as follows:.

$$PCB\ or\ Hg\ removal = PCBor\ Hg\ Removal\ at\ Ettie\ Street \times \frac{Tributary\ Area}{Ettie\ Street\ Tributary\ Area}$$

Or

$$PCB\ or\ Hg\ removal = PCB\ or\ Hg\ Removal\ at\ Ettie\ Street \times \frac{Maximum\ Pump\ Station\ Capacity}{Ettie\ Street\ Pump\ Station\ Capacity}$$

A high and low estimate was calculated for each normalization method, based on the highest and lowest load reduction estimate at the ESPS (Table B.6.4.3.).

Method 2: Normalization Based on ESPS Volume of Material Collected

Method 2 estimates a high and low range of PCB and mercury load reductions at each non-Caltrans operated pump station with industrial land use by normalizing the volume of material removed at the ESPS (Table B.6.4.3., a high and low estimate of the volume of material removed was used) by the catchment area or the pumping capacity at ESPS and the pump station of interest (as described above). A mass removal was then estimated using the ESPS sediment density (measured from May 2013 samples) and county-specific sediment concentrations summarized in Table B.6.4.2. Using Method 2, ESPS sediment concentrations are not biasing the load reduction estimates for pump stations in other countywide program areas.

B.6.4.3 Methodology for Evaluating Loads Avoided/Reduced through Enhanced O&M in the Pilot Study Areas

The increase in loads reduced in the pilot study areas due to the enhanced O&M activities that will be implemented for the pilot studies can be expressed through an enhancement factor (F_e), where:

$$\textbf{Load Reduction}_{\textbf{Enhanced}} = \textbf{Load Reduction}_{\textbf{Current}} \bullet \textbf{F}_{\textbf{e}}$$

B.6.4.4 Estimates of Loads Avoided/Reduced through Enhanced O&M Activities

Bay-Area Wide Drain Inlet Cleaning

Using the methodology described above in Section *Drain Inlet Cleaning*, Appendix Table B.6-3 summarizes the estimated average annual PCB and mercury loads reduced by drain inlet cleaning for the baseline and current implementation periods, using the reported data. Appendix Table B.6-4 summarizes the average annual load reductions using the ranking method, and this is illustrated in Figure B.6.3 for PCBs and Figure B.6.4 for mercury. As shown in Figure B.6.3 for PCBs and Figure B.6.4, average annual load reductions are higher for the current period than for the baseline period for all countywide programs, for both PCBs and mercury. The average load reduction per inlet inspected/cleaned is provided in Figure B.6.5 and Figure B.6.6, for PCBs and mercury respectively.

Bay-Area Wide Pump Station Cleaning

Using the methodologies described above in Section *Alternate Method for Estimating Load Reductions from Pump Station Cleaning*, Figure B.6.7 through Figure B.6.10 show estimates of high and low PCB and mercury load reductions from non-Caltrans-operated pump stations with dominant industrial land use based on ESPS mass load reduction estimates; these figures show estimates based on normalizing the ESPS load reduction based on maximum pumping capacity and tributary area. Figure B.6.11 through Figure B.6.14 show estimates of high and low PCB and mercury load reductions from non-Caltrans-operated pump stations with dominant industrial land use based on ESPS material volume removal estimates and county-specific pump station sediment concentrations as summarized in Table B.6.4.2. Whether the tributary area or maximum pumping capacity normalization method yielder the higher estimate depending on the specific countywide program. Method 1(using ESPS load reduction calculations as the basis for all pump stations) yielded higher estimates than Method 2, which entailed estimating load reductions based on ESPS material volume removal and county-specific pump station sediment concentrations.

Bay-Area Wide Storm Drain Line Flushing

Load reduction estimates are not provided because storm drain line flushing is not a regular O&M activity.

Pilot Study Areas

This section provides projected estimates of loads reduced in the pilot study areas for the current implementation period, which have been compiled from various data sources. This section also provides summaries of enhancement factors, cited from other data sources, which could be achieved by implementing enhanced O&M practices in the pilot study areas.

Ettie Street Pump Station Cleanout

Table B.6.4.3 summarizes the volume of material removed annually by the pump station cleanouts and the estimated loads of mercury and PCBs reduced. This information is summarized from the Task 4 Study Designs (Geosyntec Consultants and CSU/OWP 2013) and Kleinfelder (2006). The load reduction methodology is consistent with the methodology described in Section *Loads Avoided/Reduced Methodology (Bay Area-Wide)*, except that all of the material removed from the pump station was documented as being sediment (therefore a percentage of the total volume of material that is sediment was not estimated), and the material was assumed to have a dry sediment density 1,376 kg per cy, which is the actual measured bulk density for the samples from ESPS wet wells 3 and 4, collected on May 14, 2013. The ESPS sediment concentrations were from data collected between 2001 and 2013. Load reduction estimates are provided using the low, high, and average concentrations in sediment removed during pump station cleanouts.

As a comparison, Table B.6.4.4 provides the influent load estimates for mercury and PCBs from the ESPS wastewater treatment plant diversion study (EBMUD 2010). The annual PCB influent loading calculated based on the diversion study data (Table B.6.4.4) is 172 grams compared to an annual load reduced by pump station cleaning based on the mean ESPS sediment concentration (Table B.6.4.3), which ranges from about 2.5 to 69 grams per year, depending on the year (and excluding years when no sediment was removed). The annual mercury influent loading calculated based on the diversion study data (Table B.6.4.4) is 186 grams compared to an annual load reduced by pump station cleaning based on the mean sediment concentration (Table B.6.4.3), which ranges from about 2.4 to 45 grams per year, depending on the year (and excluding years when no sediment was removed).

The enhancement factor F_e will be determined based on the increase in the mass of mercury and PCBs removed by cleaning out the two northern wet wells and the forebay, which is the enhancement over the current condition. It is reasonable to expect that F_e will be approximately 2.

Pulgas Creek Pump Station Watershed Street Flushing

Street Flushing is currently not performed in this watershed (other than the pilot study), and the current O&M activity is drain inlet cleaning (in addition to street sweeping). Current load reductions from drain inlet cleaning activities in the watershed were estimated in the Task 4 Desktop Analysis (EOA 2012), and are summarized in Table B.6.4.5. Depending on the concentration used, the annual PCB load reduction from drain inlet cleaning ranges from 0.09 to 0.73 grams per year, and the annual mercury load reduction ranges from 0.2 to 0.66 grams per year.

Table B.6.4.3. Estimated Current Annual Load Reduction from ESPS Cleanouts

Year	Number of Cleanings Per Year	Material Removed Per Year (cy)	Mass of PCBs Removed (grams)[1]			Mass of Mercury Removed (grams)[1]		
			Low (28 µg/kg)	High (3263 µg/kg)	Mean[2] (900 µg/Kg)	Low (270 µg/kg)	High (940 µg/kg)	Mean[2] (579 µg/kg)
2001	1	29	1.12	130.2	35.92	10.78	37.52	23.10
2003	1	14	0.54	62.9	17.34	5.20	18.11	11.15
2004	1	3	0.08	13.5	3.72	1.11	3.88	2.39
2005	1	14	0.36	62.9	17.34	5.20	18.11	11.15
2006	3	56	1.44	251.5	69.37	20.81	72.44	44.60
2008	2	26	0.67	116.8	32.21	9.66	33.63	20.71
2009	0	0	0	0.0	0.00	0.00	0.00	0.00

Year	Number of Cleanings Per Year	Material Removed Per Year (cy)	Mass of PCBs Removed (grams)[1]			Mass of Mercury Removed (grams)[1]		
			Low (28 µg/kg)	High (3263 µg/kg)	Mean[2] (900 µg/Kg)	Low (270 µg/kg)	High (940 µg/kg)	Mean[2] (579 µg/kg)
2011	0	0	0	0.0	0.00	0.00	0.00	0.00
2013[3]	1	13.3	--	--	2.49	--	--	3.23

[1] The mass removal calculations use a dry bulk density of 1,376 kg/cubic yard, which is the density measured for samples from Wet Wells 3 and 4, collected May 14, 2013.
[2] The mean concentration was calculated using the data included in the Study Designs Table 2-1 (Geosyntec Consultants and CSU-OWP. 2013), and the Ettie Street wet well data from samples collected on May 14, 2013.
[3] The 2013 mass removed was calculated using the mean concentration for the samples collected on May 14, 2013, and not the mean concentration listed above. The mean PCB concentration was 132 µg/Kg and the mean mercury concentration was 225 µg/kg.

Table B.6.4.4. ESPS Influent Loading Estimates from EBMUD Diversion Study

Weather Type	Days of weather condition	PCBs			Mercury		
		ESPS Influent Average Concentration (pg/L)	Total ESPS Influent Pollutant Loading (kg/day)	Annual Load [g]	ESPS Influent Average Concentration [µg/L]	Total ESPS Influent Pollutant Loading [kg/day]	Annual Load [g]
Dry Weather	300	4,647	0.00001	3	0.01	0.00003	9
Wet Weather	60	50,517	0.00270	162	0.04	0.0024	144
First Flush	5	36,816	0.00133	7	0.18	0.0065	33
Total	365			172			186

Source: EBMUD, 2010

Table B.6.4.5. Load Reduction Estimates from Current Annual O&M Activities in the Pulgas Creek Pump Station Watershed

O&M Activity	Current Activity	Current Annual PCB Load Reduction [g]			Current Annual Mercury Load Reduction [g]		
		10th Percentile	*50th Percentile*	*90th Percentile*	*10th Percentile*	*50th Percentile*	*90th Percentile*
Storm Drain Inlet Cleaning	Annual Sediment Removal	0.09	0.29	0.73	0.2	0.35	0.66

Source: EOA 2012.
The load was calculated using the 10th, 50th, and 90th percentile concentrations for sediment from drain inlets in the Pulgas Creek Pump Station Watershed.

The Task 4 Desktop Analysis provides estimates of the additional load reduction opportunities that could be achieved by street flushing (EOA 2012), which are summarized in Table B.6.4.6. An enhancement factor was not calculated in the Desktop Analysis because street flushing is not a current activity in the watershed. The enhancement factor may be calculated from the additional mass of PCBs and mercury removed over the mass removed by drain inlet cleaning and street sweeping activities.

Table B.6.4.6. Estimates of Load Reduction Enhancements Associated with Street Flushing in the Pulgas Creek Pump Station Watershed

Street Flushing Enhancement Scenario	Annual PCB Load Reduction Opportunity [g]		Annual Mercury Load Reduction Opportunity [g]	
	Median	Range	Median	Range
Annual flush of 1,000 linear feet of street/curb/sidewalk	0.33	0.054-0.96	0.094	0.071-0.47

Source: EOA 2012.
The range was calculated using the 10th and 90th percentile concentrations in street sediment from the watershed.
The estimate assumes 1.24 kg of wet sediment is removed per linear foot flushed (from Kleinfelder 2006).

Leo Avenue Watershed Storm Drain Line Flushing

A discrete storm drain line flushing event was conducted by the City of San Jose in 2005, but storm drain flushing is not performed regularly as an O&M activity. The current O&M activity is drain inlet cleaning (and street sweeping, which is discussed in Section B.5). Current load reductions from drain inlet cleaning activities in the watershed were estimated in the Task 4 Desktop Analysis (EOA 2012), and are summarized in Table B.6.4.7. Depending on the concentration used, the PCB annual load reduction from drain inlet cleaning ranges from 0.005 to 0.31 grams per year, and the mercury annual load reduction ranges from 0.15 to 0.82 grams per year.

Table B.6.4.7. Load Reduction Estimates from Current O&M Activities in the Leo Avenue Watershed

O&M Activity	Current Activity	Current PCB Load Reduction [g]			Current Mercury Load Reduction [g]		
		10th Percentile	*50th Percentile*	*90th Percentile*	*10th Percentile*	*50th Percentile*	*90th Percentile*
Storm Drain Inlet Cleaning	Annual Sediment Removal	0.005	0.05	0.31	0.15	0.24	0.82

Source: EOA 2012.
The load was calculated using the 10th, 50th, and 90th percentile concentrations for sediment from drain inlets in the Pulgas Creek Pump Station Watershed.

The Task 4 Desktop Analysis (EOA 2012) provides a range of enhancement factors and the additional mass of mercury and PCBs that could be removed by storm drain line flushing, based on the information collected during the 2005 flushing event at Leo Avenue (Table B.6.4.8). Table B.6.4.8 indicates that an enhancement factor of 1.25 to 1.75 can be achieved each time an additional flushing event is conducted. The additional load reduction opportunity ranges from 0.05 to 29 grams of PCBs and 0.33 to 2.6 grams of mercury, per flushing event. The actual enhanced mass removed will be calculated as the product of the volume of sediment removed, an assumed density, and the concentration of PCBs and mercury measured in composite samples collected during the pilot study.

Table B.6.4.8. Estimates of Enhancement Factors and Load Reduction Opportunities in the Leo Avenue Watershed

Enhancement Scenario	Range of Enhancement Factors	Annual PCB Load Reduction Opportunity [g]		Annual PCB Load Reduction Opportunity [g]	
		Median	Range	Median	Range
Additional flush of Leo Avenue line on a one-time basis	1.25-1.75	2.1	0.05-29	1.2	0.33-2.6

B.6.4.5 Summary of Key Uncertainties

There are a number of sources of uncertainty in accurately estimating PCB and mercury loads reduced to San Francisco Bay associated with baseline and current O&M practices (drain inlet cleaning).

- There are only limited data available for drain inlet cleaning (e.g., amount of sediment removed and pollutant concentrations in the sediment), but this potential BMP is not being evaluated through a pilot study.
- For the drain inlet cleaning data, the number of municipalities that showed an increase in the drain inlet cleaning rate (amount of material removed/number of inlets inspected/cleaned) was about the same as the number of municipalities that showed a decrease in the rate. It is not certain if the positive changes are the result of a true enhancement in O&M implementation. This is because information about what enhancements have been implemented is not readily available. In addition, there are uncertainties about data quality, such as estimates of the volume of material removed. In addition, a few municipalities reported very high rates which could potentially mean the municipality has more catch basins than drop inlets, material volumes from culvert cleaning were included in the drain inlet cleaning data, or an error was made in the reporting of the data. Therefore, the data were reevaluated using a ranking method based on a statistical analysis of the data. The high, medium, and low rates assigned to each

municipality were based on 25th percentile, 50th percentile and 75th percentile values derived from the statistical analysis.

- The same PCB and mercury concentrations were applied to the baseline and current implementation periods to calculate the loads avoided from drain inlet cleaning. Separating data collected during the baseline from the current period would imply that any differences between the data sets are statistically significant.
- For the load reduction estimates from drain inlet cleaning, the PCB and mercury concentrations assigned to the municipalities were from the SFEI database and a mean concentration obtained for a specific county was applied to all of the municipalities within that county (with the exception of municipalities that had more than 11 data points). It is assumed that the county-wide concentrations are representative concentrations to be used for the analysis.
- A dry bulk density of 1,376 kg/cubic yard (representing dry sand and 30 percent vegetative debris) was applied to all drain inlet sediment to calculate mass loads reduced, although the density of the material is likely to vary.
- It was assumed that 60% of the total volume of material removed from drain inlets was in the fraction less than 2 mm, which was considered to be the amount of sediment removed.
- As no pump station cleaning information was readily available, an analysis was developed to extrapolate annual load reductions for non-Caltrans-operated pump stations with dominant industrial land use. The analysis was based developing a potential correlation between the specific pump station of interest and the ESPS using the pump station spreadsheet data from the Regional Water Board. Information available on pump stations with industrial land use does not general include information about the pump station, such as the presence of a forebay or wet wells, does not allow for identification pump stations that trap sediment versus those that do not. Therefore the estimates are based on the sediment trapping dynamics at the ESPS and ESPS mass removal estimates, which may not necessarily apply to other pump stations with potential source areas within their tributary areas.

B.6.5 References

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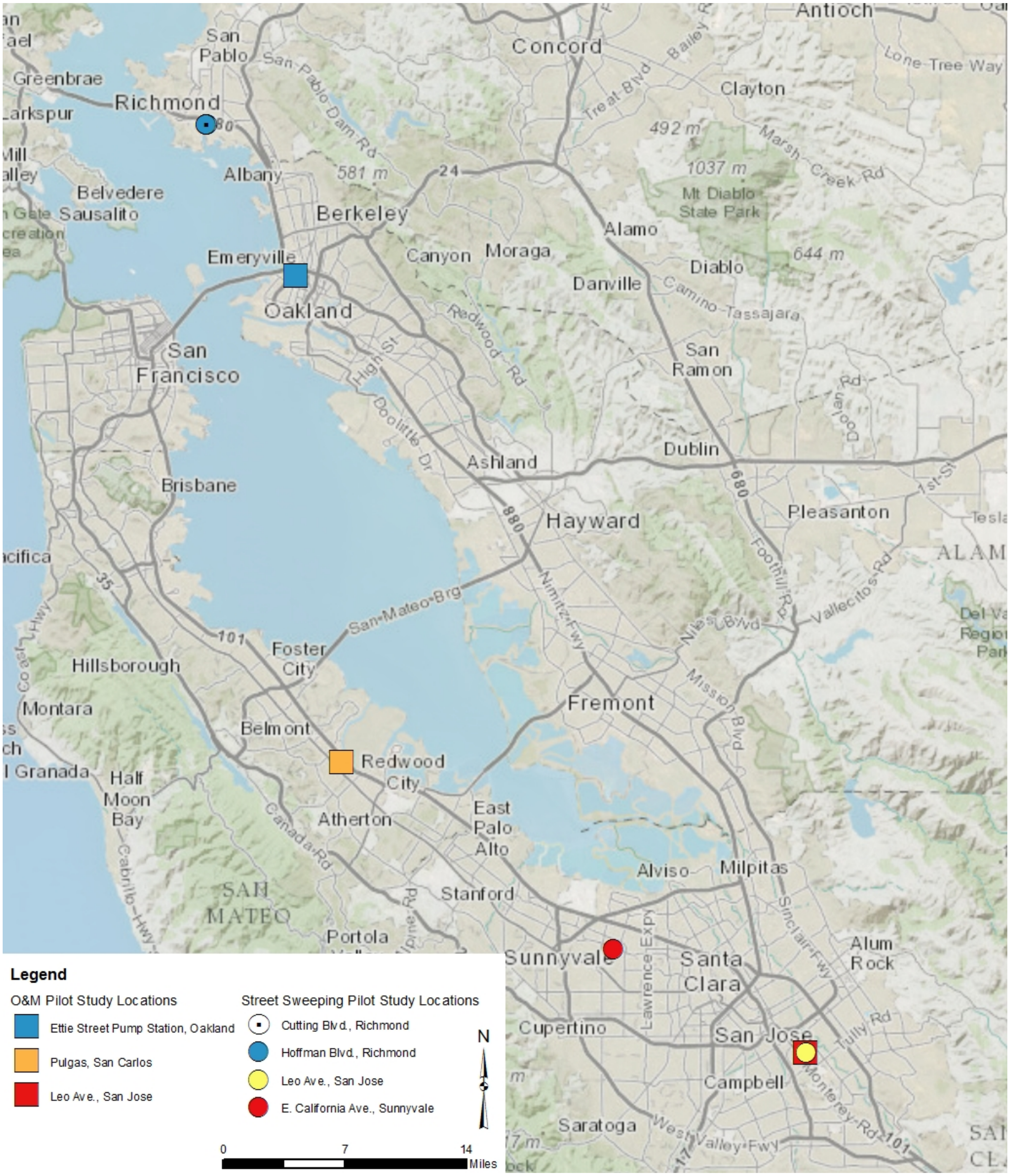
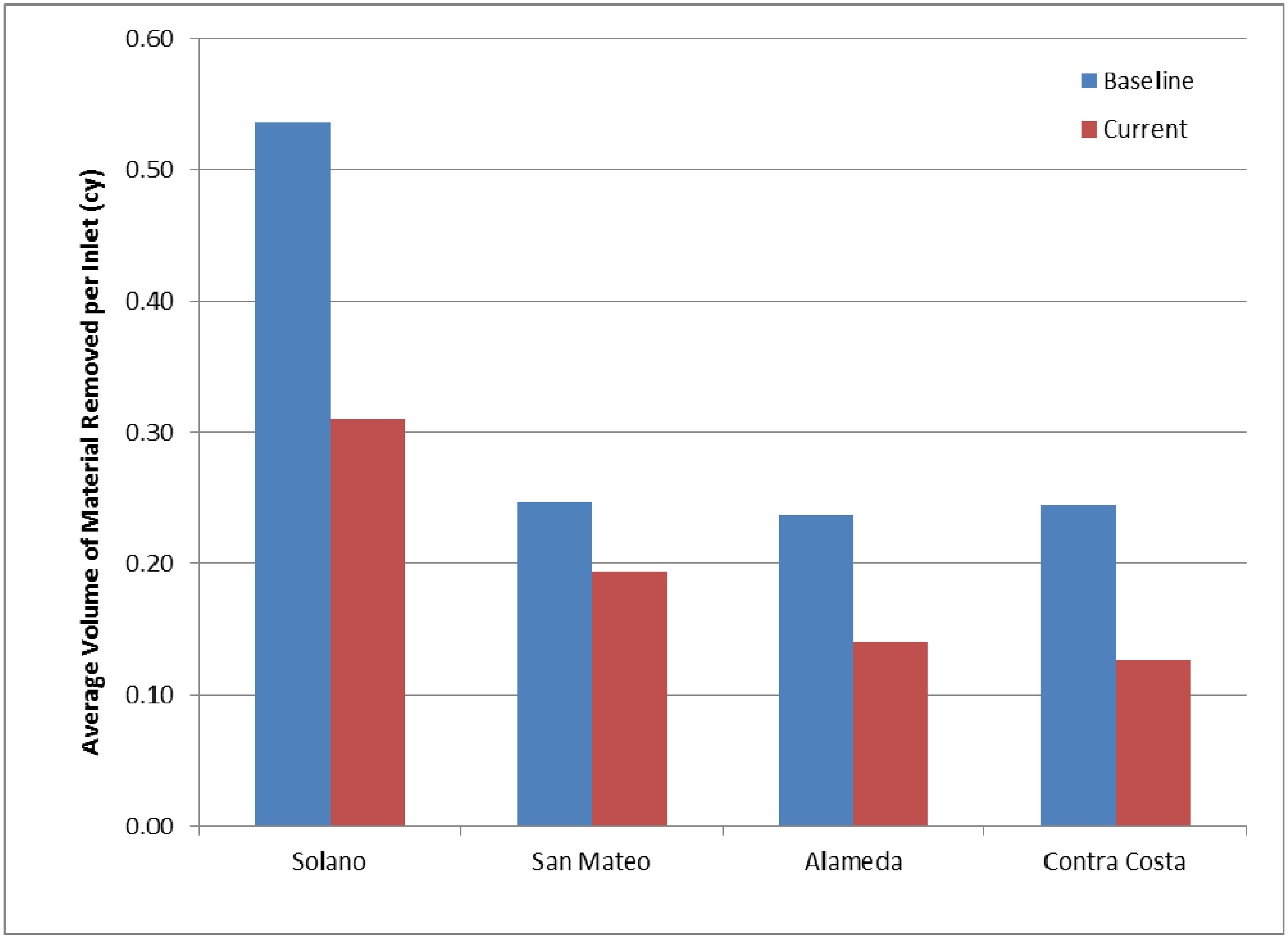
FIGURES B.6



Enhanced O&M Pilot Study Locations

Source:	Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.1
	Entity	Date	

internal info: path, date revised, author

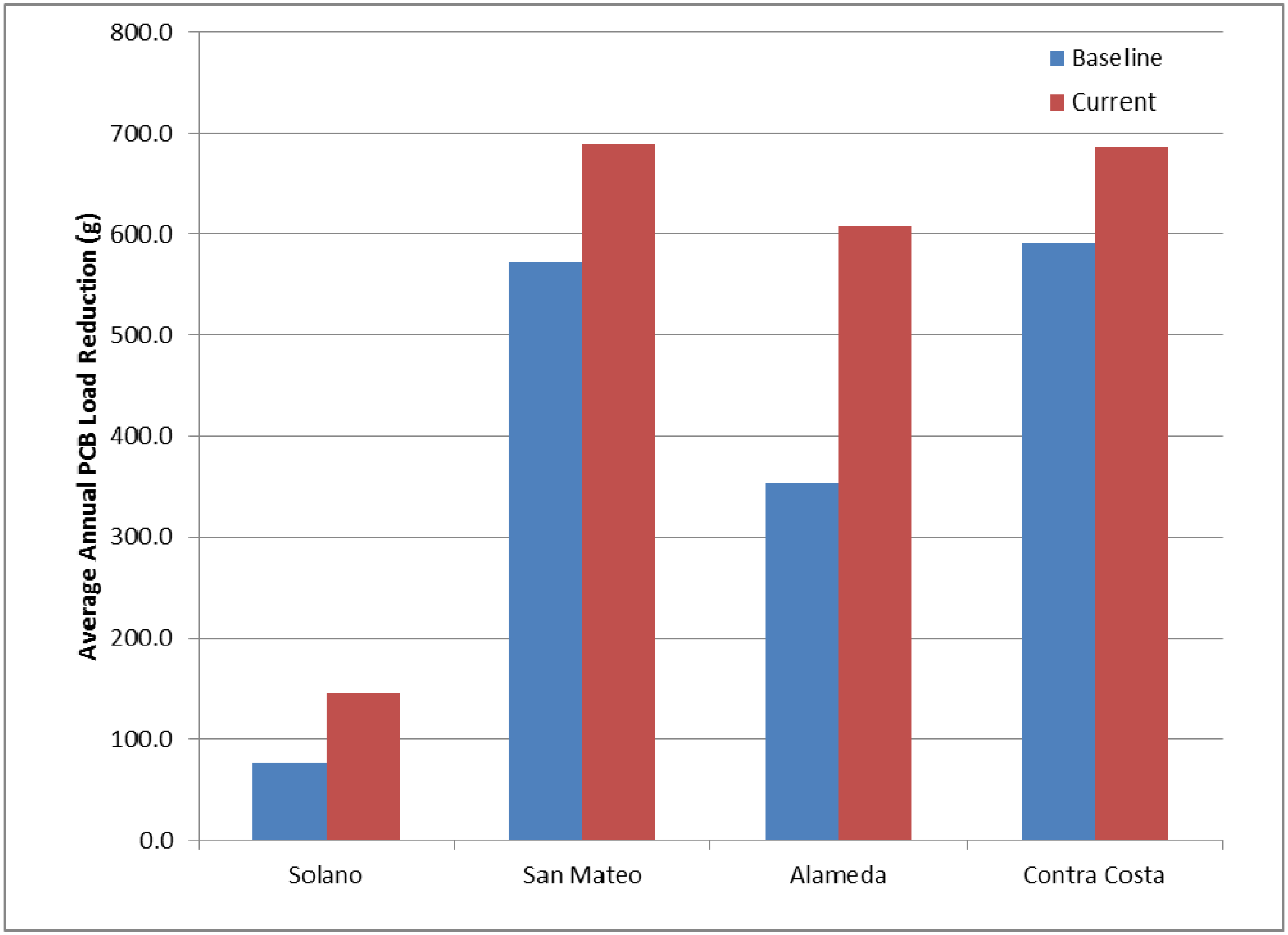


Estimated Average Volume of Material Removed per Drain Inlet Inspected/Cleaned (Using Ranking Method)

Source: Data per Appendix Table B.6-2	Notes: Drain inlet cleaning data were not available for Santa Clara County

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.2

internal info: path, date revised, author



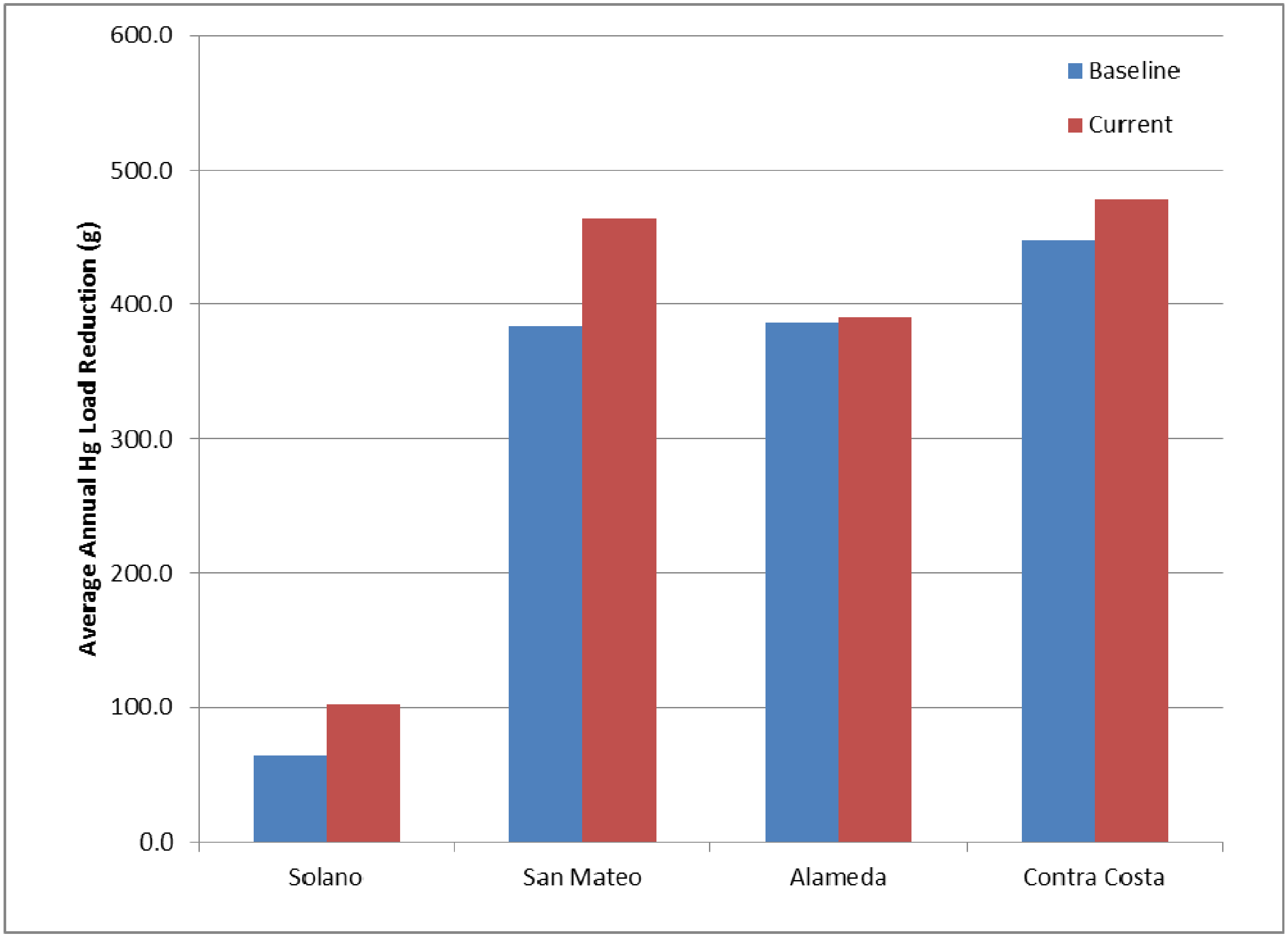
Average Annual Total PCB Load Reduction from Drain Inlets Cleaned/Inspected (Using Ranking Method)

Entity	Date	
Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.3

Source:
Data per Appendix Table B.6-4

Notes:
Drain inlet cleaning data were not available for Santa Clara County

internal info: path, date revised, author



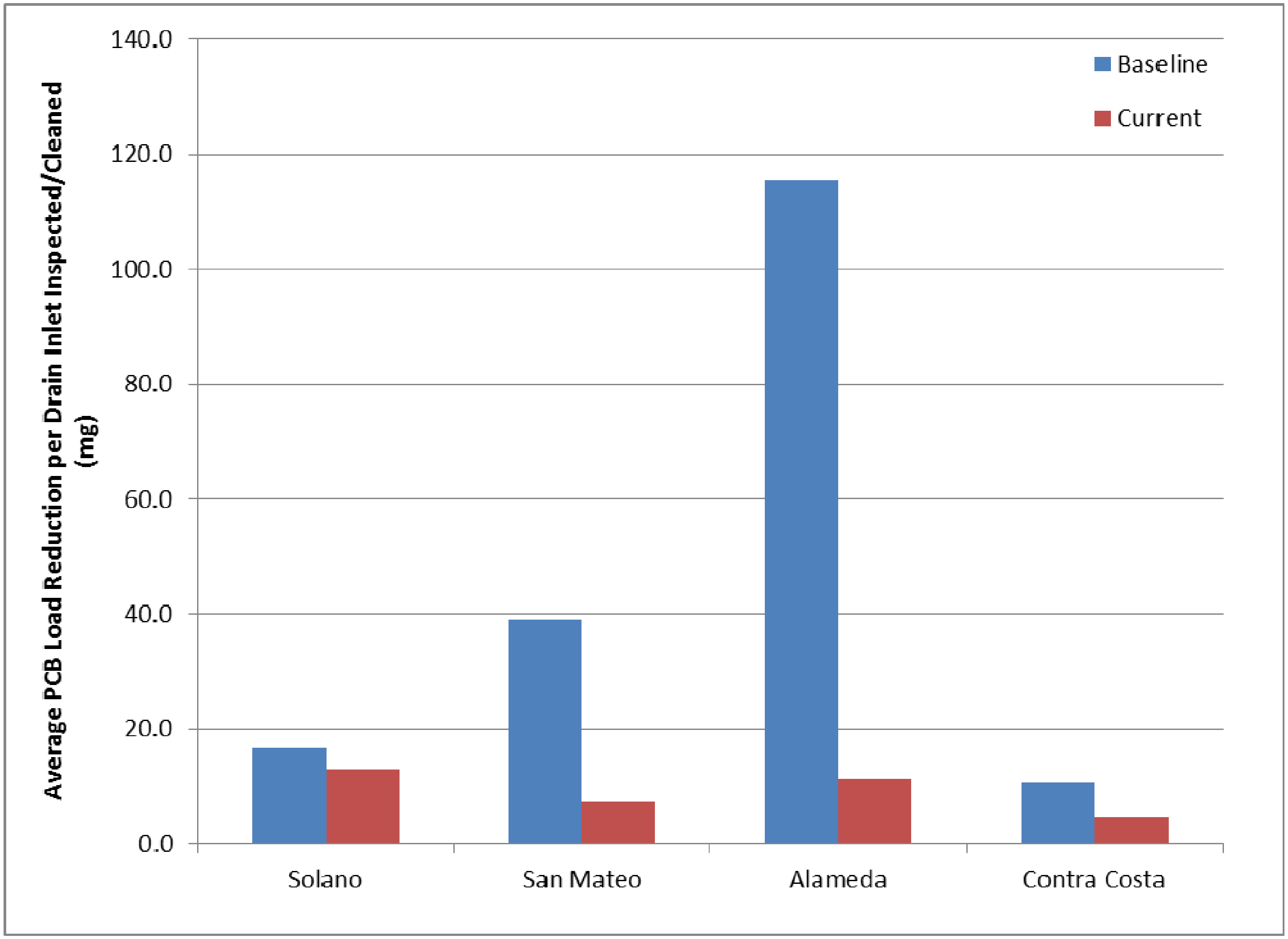
Average Annual Total Mercury Load Reduction from Drain Inlets Inspected/Cleaned (Using Ranking Method)

Source:
Data per Appendix Table B.6-4

Notes:
Drain inlet cleaning data were not available for Santa Clara County

Entity	Date	
Bay Area Stormwater Management Agencies Association	December 2013	**Figure B.6.4**

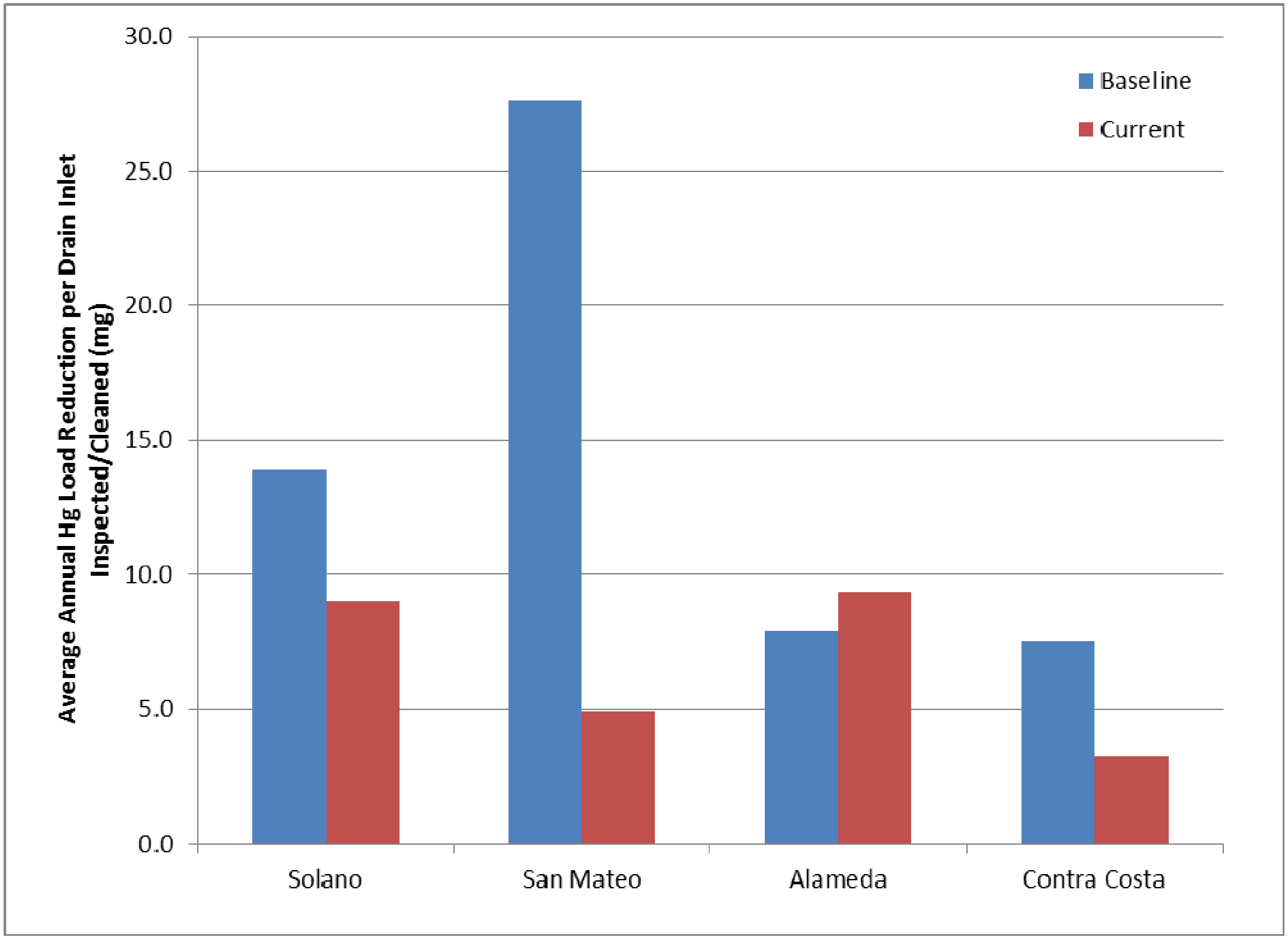
internal info: path, date revised, author



Average PCB Load Reduction per Drain Inlet Inspected/Cleaned (Using Ranking Method)

Source:	Notes:
Data per Appendix Table B.6-4	Drain inlet cleaning data were not available for Santa Clara County

Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.5
Entity	Date	

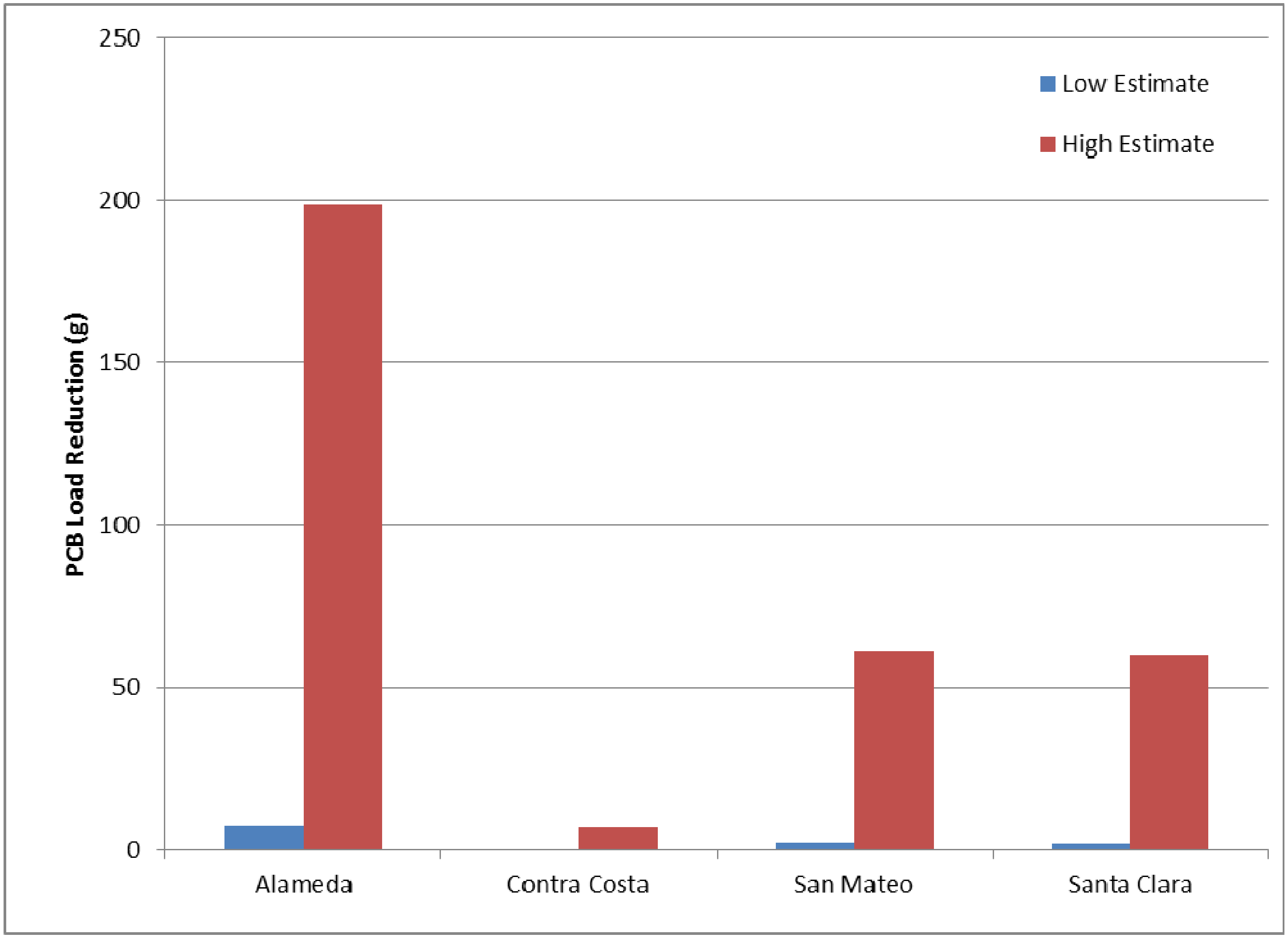


Average Mercury Load Reduction per Drain Inlet Inspected/Cleaned (Using Ranking Method)

Source:	Notes:
Data per Appendix Table B.6-4	Drain inlet cleaning data were not available for Santa Clara County

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	December 2013	B.6.6

internal info: path, date revised, author

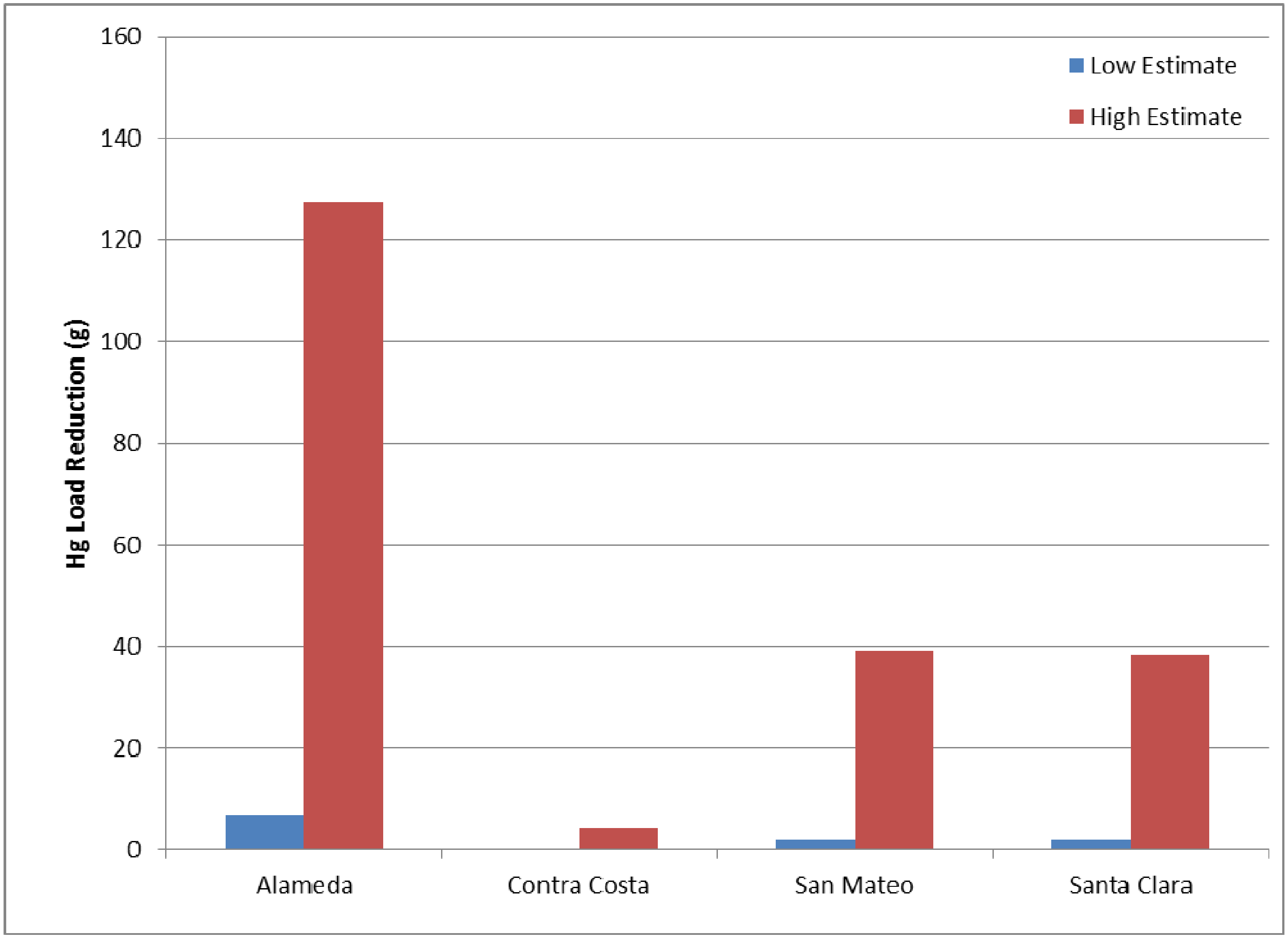


Estimated Average Annual PCB Load Reduction from Pump Station Cleaning Method 1, Normalized Using Max Pumping Capacity

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.7

Source:
Data per Appendix Table B.6.2-1

Notes:
Estimates only conducted for pump stations with industrial land use or within 200 feet old industrial land



Estimated Average Annual Hg Load Reduction from Pump Station Cleaning Method 1, Normalized Using Max Pumping Capacity

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.8

Source:
Data per Appendix Table B.6.2-1

Notes:
Estimates only conducted for pump stations with industrial land use or within 200 feet old industrial land

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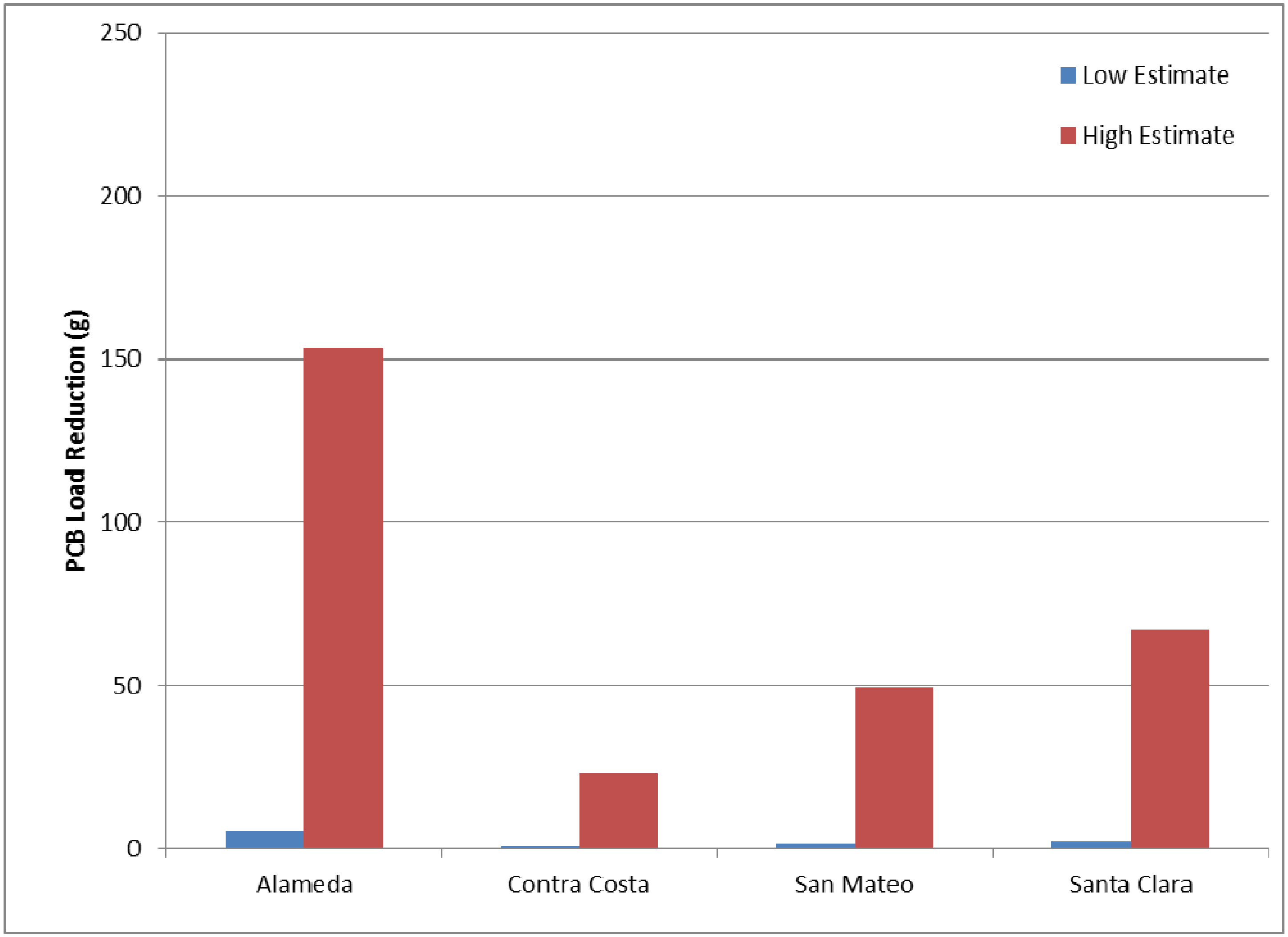

Estimated Average Annual PCB Load Reduction from Pump Station Cleaning Method 1, Normalized Using Tributary Area

Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.9
Entity	Date	

Source:
Data per Appendix Table B.6.2-1

Notes:
Estimates only conducted for pump stations with industrial land use or within 200 feet old industrial land

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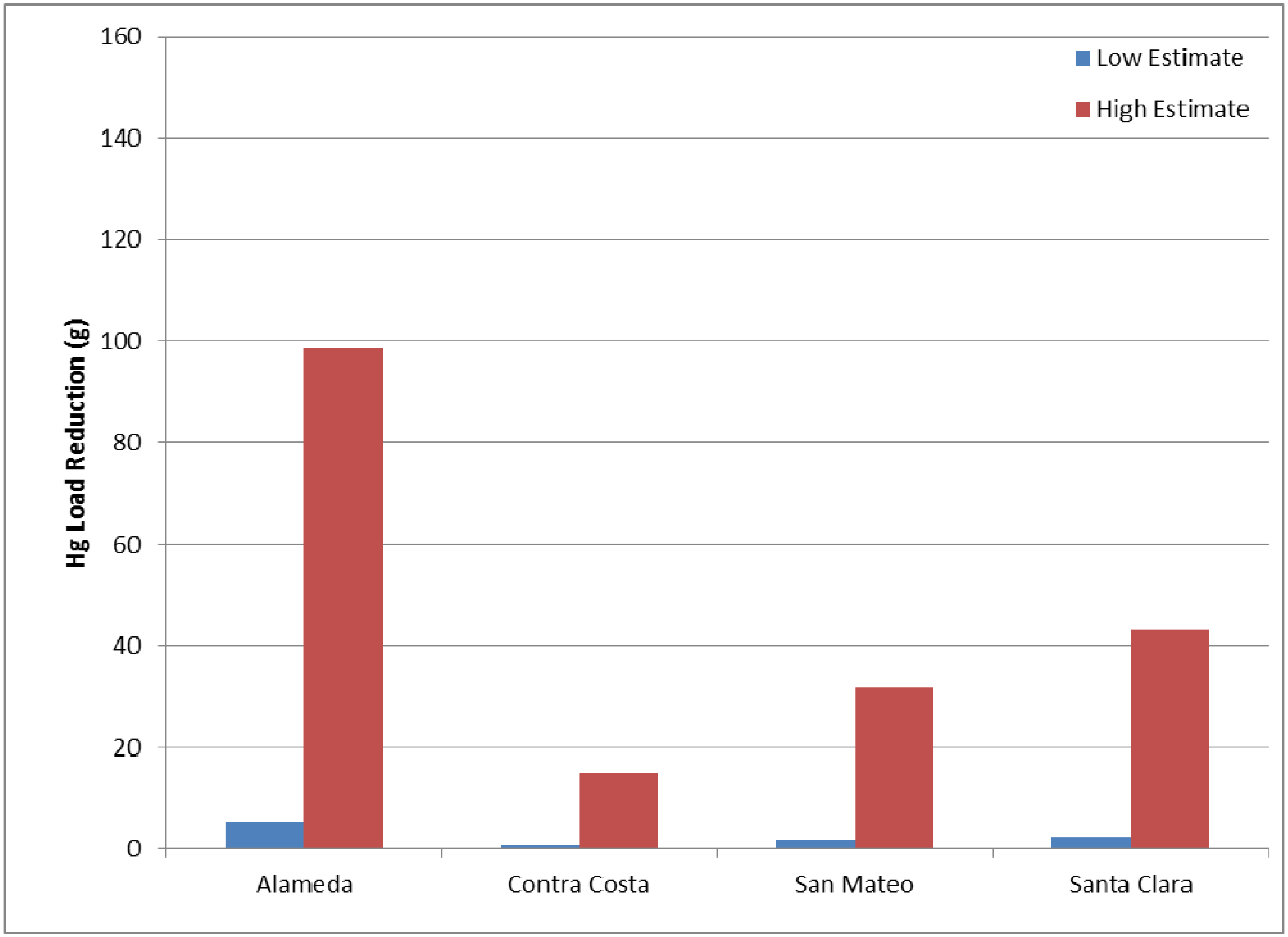


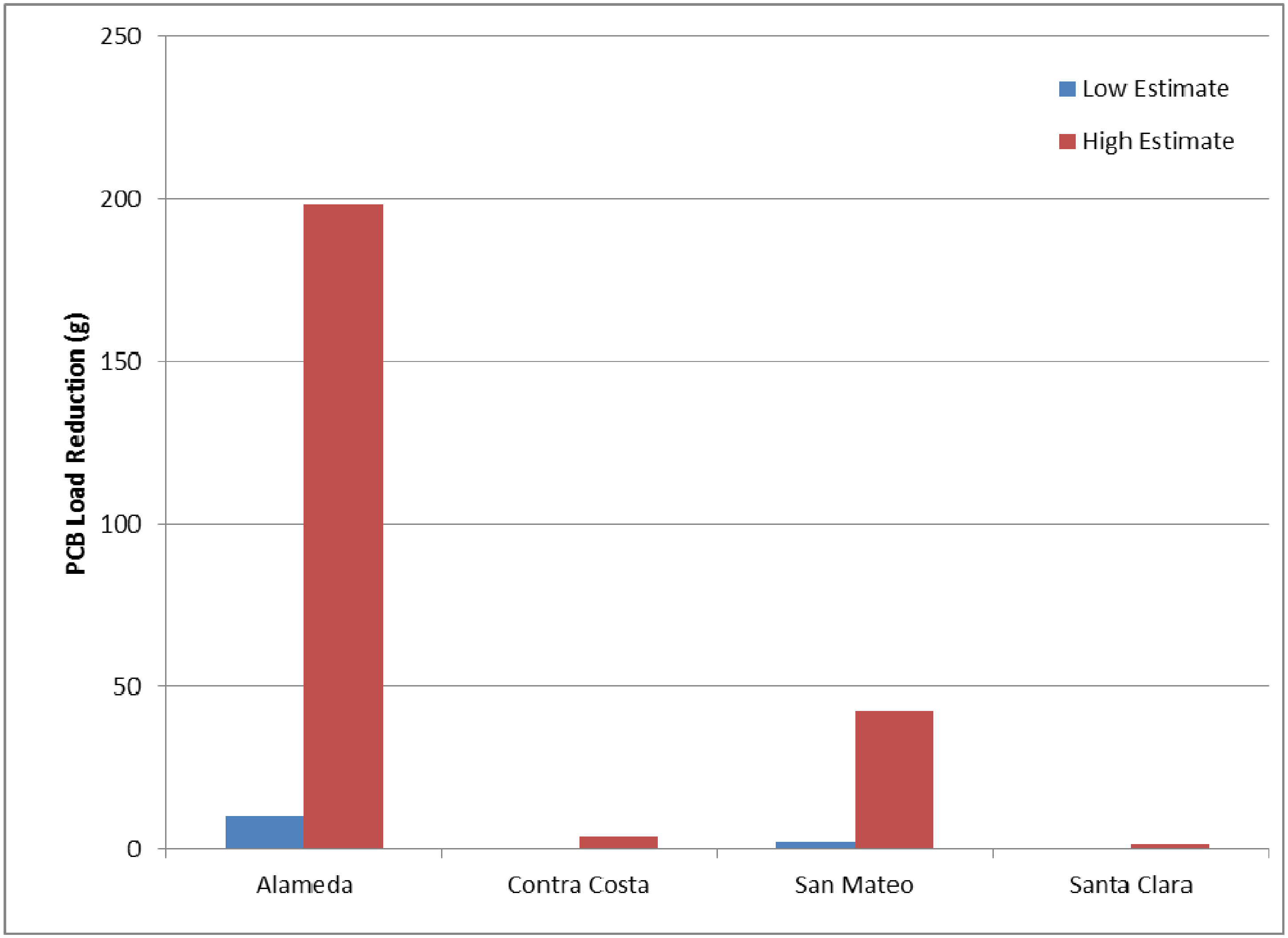
Source:
Data per Appendix Table B.6.2-1

Notes:
Estimates only conducted for pump stations with industrial land use or within 200 feet old industrial land

Estimated Average Annual Hg Load Reduction from Pump Station Cleaning Method 1, Normalized Using Tributary Area

Entity	Date	
Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.10

internal info: path, date revised, author

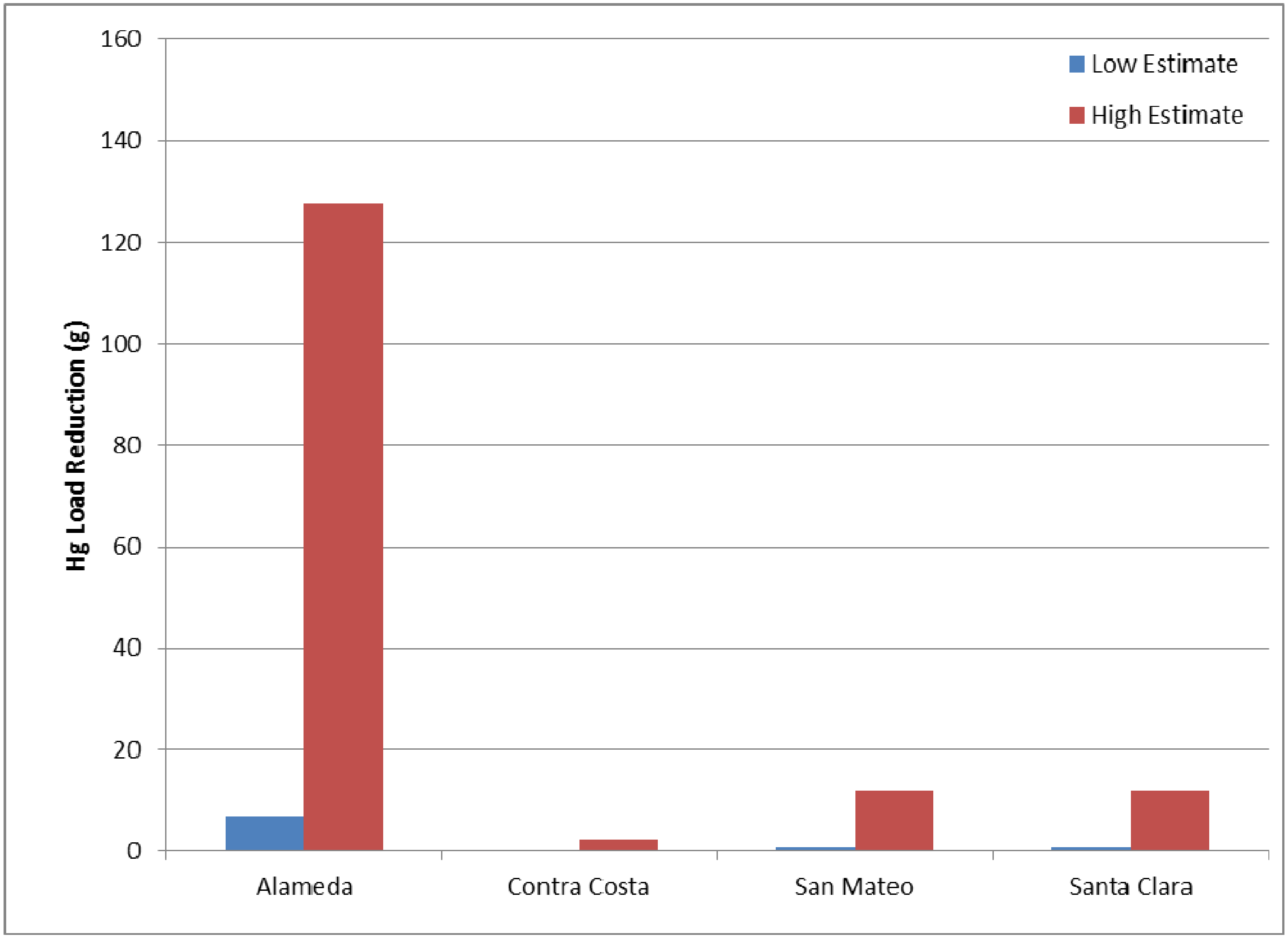


Estimated Average Annual PCB Load Reduction from Pump Station Cleaning Method 2, Normalized Using Max Pumping Capacity

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	December 2013	B.6.11

Source: Data per Appendix Table B.6.2-2

Notes: Estimates only conducted for pump stations with industrial land use or within 200 feet old industrial land



Estimated Average Annual Hg Load Reduction from Pump Station Cleaning Method 2, Normalized Using Max Pumping Capacity

Source: Data per Appendix Table B.6.2-2	Notes: Estimates only conducted for pump stations with industrial land use or within 200 feet old industrial land

Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.12
Entity	Date	

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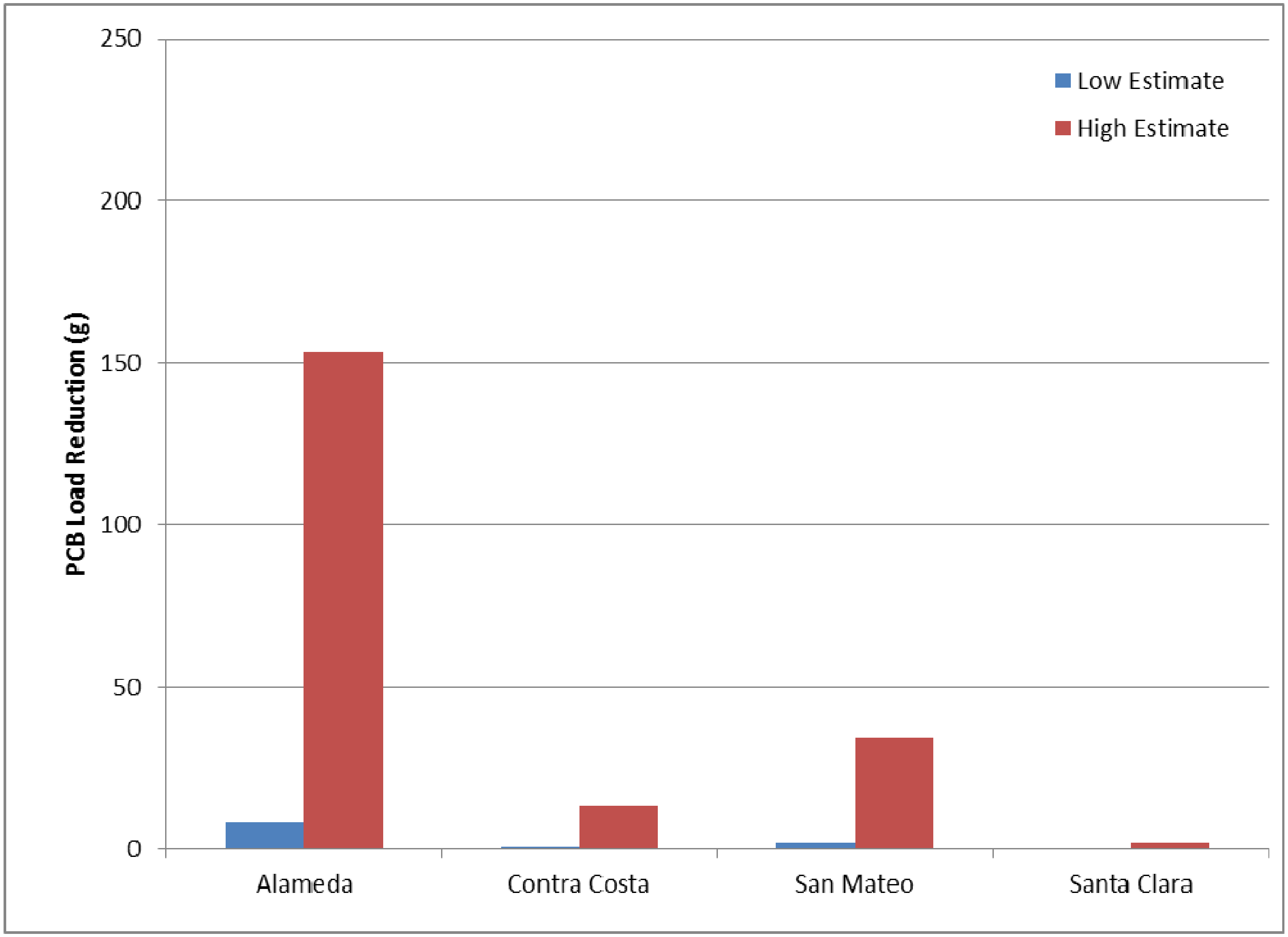


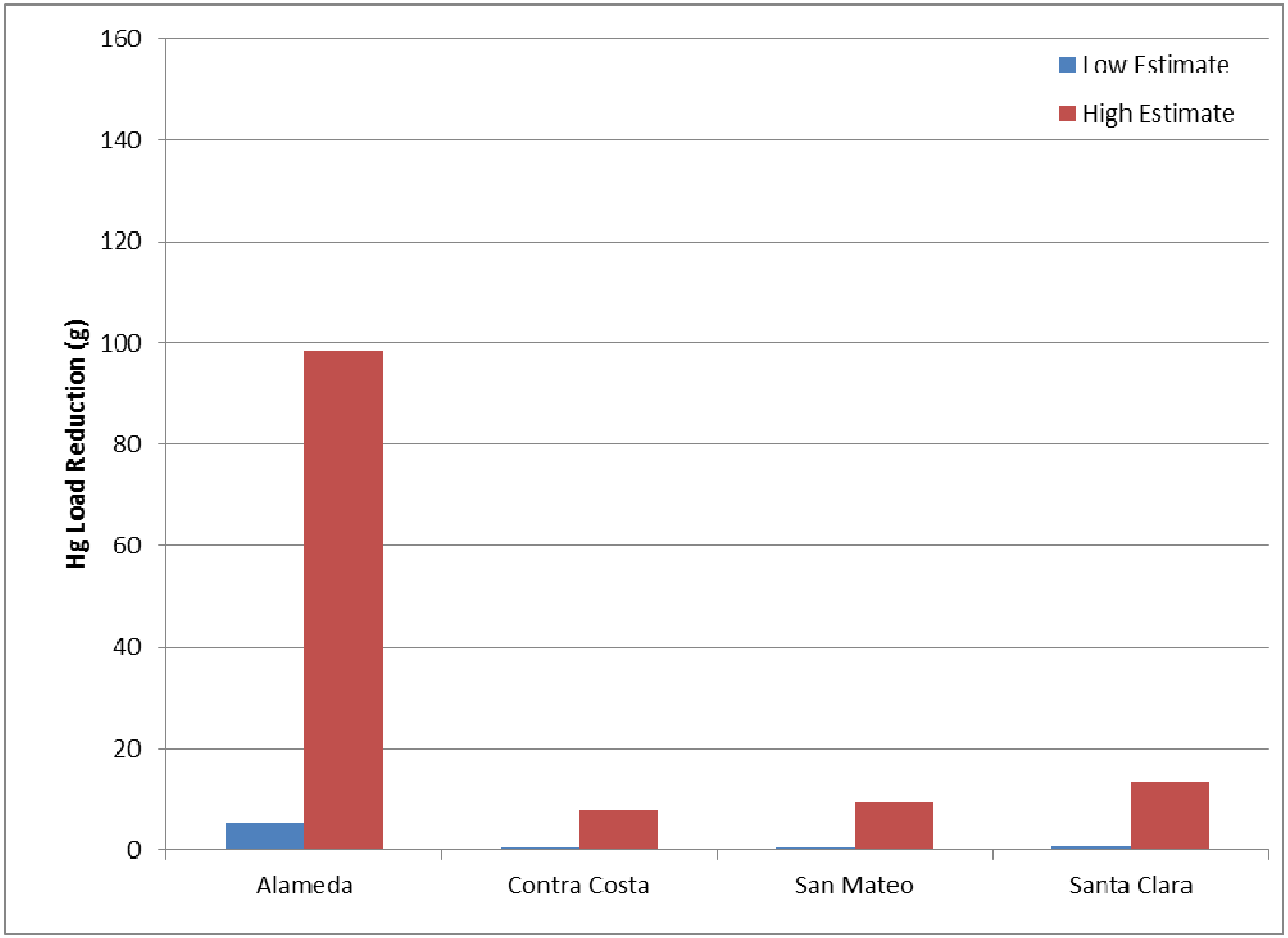
Estimated Average Annual PCB Load Reduction from Pump Station Cleaning Method 2, Normalized Using Tributary Area

Entity	Date	
Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.13

Source:
Data per Appendix Table B.6.2-2

Notes:
Estimates only conducted for pump stations with industrial land use or within 200 feet old industrial land

internal info: path, date revised, author



Estimated Average Annual Hg Load Reduction from Pump Station Cleaning Method 2, Normalized Using Tributary Area

Bay Area Stormwater Management Agencies Association	December 2013	Figure B.6.14
Entity	Date	

Source:
Data per Appendix Table B.6.2-2

Notes:
Estimates only conducted for pump stations with industrial land use or within 200 feet old industrial land

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B.7 STORMWATER TREATMENT MEASURES

B.7.1 Introduction

Stormwater treatment measures fall into two general categories: (1) post-development treatment measures for new development and redevelopment projects constructed in compliance with Municipal Regional Stormwater NPDES Permit (MRP) Provision C.3, and (2) the pilot scale retrofit projects required by MRP Provisions C.3.b.iii. and C.12.e.

The goal of this section of the Integrated Monitoring Report (IMR) is to estimate the load reductions of PCBs and mercury associated with the implementation of these two classes of treatment measures. This section includes a description of the polychlorinated biphenyls (PCB) and mercury control pilot studies, a summary of the status of implementation of the C.3 and pilot measures, and estimates of the loads avoided or reduced for these two classes of treatment control measures.

B.7.2 Summary of PCB and Mercury Control Pilot Studies

B.7.2.1 MRP Requirements

MRP Provision C.3. requires that the Permittees incorporate appropriate source control, site design, and stormwater treatment measures in new development and redevelopment projects to address both soluble and insoluble stormwater runoff pollutant discharges and prevent increases in runoff flows from new development and redevelopment projects. The preferred method of achieving these goals is through the implementation of low impact development (LID) techniques. Provision C.3.b. identifies Regulated Projects, which include special land use categories, new development projects that create 10,000 square feet or more of impervious surfaces, redevelopment projects that create and/or replace 10,000 square feet or more of impervious surface, and a variety of road projects that create 10,000 square feet or more of newly constructed contiguous impervious surface.

Provision C.3.b.iii. requires that the Permittees conduct ten pilot green streets retrofit projects that incorporate LID techniques for site design and treatment in accordance with Provision C.3.c. and provide stormwater treatment sized in accordance with Provision C.3.d. Each county (San Mateo, Contra Costa, Alameda, Santa Clara, and Solano) should have at least two project locations. Additionally, MRP Provision C.3.b.iii.(5) requires that the Permittees conduct appropriate monitoring of these projects to document the water quality benefits achieved. Appropriate monitoring may include modeling using design specifications and site-specific conditions.

Provisions C.11.e. and C.12.e require that the Permittees evaluate and quantify the removal of mercury through treatment measures (e.g., detention basins, bioretention units, sand filters, infiltration basins, treatment wetlands) via retrofits of such measures into existing storm drain systems. Each county (San Mateo, Contra Costa, Alameda, Santa Clara, and Solano) should have at least one selected location.

B.7.2.2 Implementation Approach

CW4CB Task 5 is anticipated to result in Permittee compliance with MRP Provisions C.11/12.e. The BASMAA Permittees have conducted a systematic process for identifying and prioritizing candidate watersheds, identifying sites within those watersheds that are suitable for retrofitting treatment measures, selecting a cross section of treatment measure types to be tested, and then conducting the implementation process of planning, designing, constructing and monitoring each of the pilot studies. As part of this process, candidate watersheds were screened and prioritized in terms of potential to be an important source of pollutants of concern (POCs). A key element in the process is coordination with the individual agencies to assist in the identification of candidate sites within their jurisdictions and to provide data to assist in the site characterization and the design process. To support the monitoring effort, study designs were developed that included development of management questions, which defined the overall monitoring scope. Sampling and Analysis Plans were then developed to support the pilot tests by defining field and laboratory protocols.

B.7.2.3 Pilot Study Descriptions

This section identifies ten Green Streets pilot projects that were selected in accordance with MRP Provision C.3.b.iii. The project descriptions include the project locations, proposed treatment measures, drainage catchment information, project design information, the status of the project and proposed completion date. The ten selected projects are in various stages of design and construction and will be completed within this MRP term. Figure B.7.1. shows the locations of the ten Green Streets pilot projects.

This section also describes ten retrofit pilot projects that were selected through the Clean Watersheds for a Clean Bay (CW4CB) Task 5 implementation to evaluate the effectiveness of retrofit projects to remove PCBs and other pollutants of concern. The project descriptions include the project locations, proposed treatment measures, drainage catchment information, available project design information, the status of the project and proposed completion date. The El Cerrito Green Streets and Bransten Road projects are also part of the Green Streets Pilot Projects, and are therefore not summarized a second time below. Figure B.7.2. shows the locations of the ten retrofit pilot projects.

In general, constructing the twenty pilot projects within an existing transportation corridor present major challenges. Public right-of-ways generally contain electrical utilities, gas lines, water lines, and other infrastructure. Treatment facilities need adequate space within the right-of-way to operate effectively but cannot conflict with existing utilities and transportation needs, and must be located at a lower elevation than the tributary impervious surface for which treatment is desired. These factors require a comprehensive evaluation of the existing site and its functionality with accurate mapping and information prior to construction. In addition to technical considerations, factors such as availability of funding, opportunity for integration into other planned projects, and community support are key for the success of the pilot projects.

B.7.2.4 Bioretention Facilities

San Pablo Avenue Green Spine—Richmond (Green Streets)

The City of Richmond's San Pablo Avenue Green Spine Project is located in Contra Costa County in the City of Richmond along the major arterial of San Pablo Avenue between McBryde Avenue and Andrade Avenue. The City of Richmond's San Pablo Avenue Green Spine Project is currently in the preliminary design phase and the city has committed that the design will qualify as a Bay-Friendly landscape. The project is located inside a Priority Development Area as designated by the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) FOCUS program. The total drainage area is approximately 2.25 acres. Additional catchment information is unknown at this time.

The proposed treatment measures currently consist of six bioretention areas consisting of one rain garden and five curb extensions. Five of the facilities will be located on the northern portion of San Pablo Avenue to the west of MacDonald Avenue, and one facility will be located on the southern portion of San Pablo Avenue to the east of MacDonald Avenue. Construction will be complete in 2013.

El Cerrito Green Streets Project (Green Streets and CW4CB Task 5)

The El Cerrito Green Streets Project is located in Contra Costa County in the City of El Cerrito. The project includes facilities at two locations along the major arterial of San Pablo Avenue: 1) the Eureka Rain Gardens at 10200 San Pablo Avenue, and 2) the Madison Rain Gardens at 11048 San Pablo Avenue. This project was originally part of the larger San Pablo Avenue Streetscape Project to add LID elements to pedestrian, bicycle, transit, and beautification improvements. The project is located inside the El Cerrito San Pablo Priority Development Area as designated by the ABAG/MTC FOCUS program. The project was completed in August 2010.

The total drainage area to the Project is 1.33 acres, which includes the area within the public right-of-way. The tributary area to the Madison Rain Garden is 0.39 acres and the tributary area to the Eureka Rain Gardens is 0.94 acres. There may be some additional runoff from adjacent properties, but this area was not included in the analysis. The tributary area is classified as 100% commercial, with approximately 99% imperviousness.

The Eureka Rain Garden consists of a series of 12 individual rain gardens and the Madison Rain Gardens consists of a series of seven individual rain gardens. The individual rain gardens are separated from each other to provide access between curbside parking and the sidewalk. The Madison Rain Garden was sized to effectively capture the 0.38 acres of the overall tributary area (0.39 acres) and is therefore, nearly 100% effective. The Eureka Rain Garden was sized to treat 0.64 acres of the overall tributary area (0.94 acres) and is therefore, only 68% effective.

Codornices Creek Restoration Project (Green Streets)

The Codornices Creek Restoration Project is located in Alameda County in the City of Albany and is a joint project between the City of Berkeley, City of Albany, and the University of California to restore lower Codornices Creek between the Union Pacific Railroad Tracks to the west and San Pablo Avenue to the east. As part of the overall restoration project, a series of rain gardens were installed to treat stormwater runoff prior to entering Codornices Creek. The project was completed in 2011. The total drainage area to the project is 1.93 acres of completely impervious area located on clay soils. The area will remain 100% impervious following the restoration, and is commercial and residential in land use with 60% of the area in the public right-of-way.

There are four rain gardens/bioretention areas that are 180 sq. ft., 260 sq. ft., 224 sq. ft., and 425 sq. ft. in size. There are two treatment areas located on either side of the 6^{th} Street, which are separated by a sidewalk providing access to the street. Facility sizing was based on the Alameda Countywide Clean Water Program's C3 Stormwater Technical Guidance, but two of the four basin areas were restricted in size by site conditions, such as driveway access requirements for semi-truck trailers, an existing shallow culvert crossing, and an improved pedestrian crossing.

Park and Hollis Stormwater Curb Extension (Green Streets)

The Park and Hollis Stormwater Curb Extension Project is located in the City of Emeryville in Alameda County at the northeast corner of Park Avenue and Hollis Street. The project is classified as a landscaped curb extension along a collector street that was required by the City of Emeryville as part of an expansion project by Pixar Animation Studios. The project was completed in 2010.

The total drainage area to the Project is 0.19 acres. The Project is located in a commercially developed area and the footprint is entirely in the public right-of-way. Prior to construction, the tributary area was 100% impervious and following the installation of the curb extension, the tributary area will be 93% impervious.

The curb extension is 650 square feet in area and consists of an on-street planted rain garden with an underdrain. The underlying soil is clay, so infiltration was determined to be infeasible. Biofiltration media was added above the impermeable clay layer and an underdrain was installed to convey water to the public storm drain. The Alameda Countywide Clean Water Program's C.3 Stormwater Technical Guidance was used to size the treatment measure, which requires treatment measures to be a minimum of 4% of the tributary area.

Stanley Boulevard Safety and Streetscape Improvement (Green Streets)

The Stanley Boulevard Safety and Streetscape Improvement Project is located in Unincorporated Alameda County along a three mile stretch of Stanley Boulevard between the city limits of Pleasanton and Livermore. The project is currently under construction and the Alameda County

Public Works Agency is converting a four-lane, high volume arterial street, which is currently a primarily industrial corridor, to a rural parkway setting. The overall project will use a variety of sustainable design concepts while improving the safety and aesthetics along Stanley Boulevard.

The total drainage area to the project is approximately 33 acres, 90% of which is in the public right-of-way. The pre-and post- development tributary area imperviousness values are 80% and 78%, respectively. Two treatment measures will be constructed along Stanley Boulevard: 1) an infiltration trench and 2) a bioswale. The infiltration trench is located on the northern side of Stanley Boulevard, approximately 13,895 feet long and 4 feet wide, and is designed to infiltrate all runoff. The bioswale is located on the south side of Stanley Boulevard and is approximately 13,895 linear feet long and 3 feet wide. The bioswale has a raised overflow structure that is 4 inches above grade. The Caltrans standards and Alameda Countywide Clean Water Program's C.3 Stormwater Technical Guidance were used to size the treatment measures.

Sustainable Streets and Parking Lot Demonstration (Green Streets)

The Sustainable Green Streets and Parking Lots Demonstration Project is located in San Mateo County in the City of Burlingame off of Donnelly Avenue and Burlingame Avenue. The project was incorporated into improvements to the Public Parking Lot C Project by the City of Burlingame to improve traffic circulation and add disabled accessible stalls, while maintaining the number of parking stalls. The project was completed in 2011.

The total drainage area to the project is 1.32 acres and consists of an existing parking lot and a building roof. The pre-development imperviousness was 95%. The runoff from this area will be routed into a rain garden, which will add 0.06 acres of landscaped area and result in a post-development imperviousness of 90%.

The proposed treatment measures consist of a 0.06 acre bioretention area (rain garden) and a 0.01 acre planter box (curb extension). The facilities were sized based on flow-based criteria to capture 0.2 inches per hour of rainfall intensity and to be at least 4% of the tributary impervious area in physical extent. The storm drain pipes are sized to handle the 0.2 in/hr rainfall intensity through the two facilities as well. The infiltration rate of the bioretention media is estimated at 10 inches per hour.

Bransten Road Green Streets (Green Streets and CW4CB Task 5)

The Bransten Road Green Streets Project is located in San Mateo County in the City of San Carlos along Bransten Road between Old Country Road and Industrial Road. The project is along a local street, and is in a location where elevated levels of PCBs have been identified through sediment monitoring. Project construction began in late 2013.

The area of impervious roadway surface area draining to the bioretention facilities is about 0.5 acres. This does not include drainage from other sources, such as private properties, adjacent sidewalks, rooftops, or parking lots. The surrounding area is primarily industrial in land use and the imperviousness in the area prior to construction is approximately 95%.

The treatment measures are seven bioretention areas of varying size that were constructed in newly created curb extensions. The San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) guidelines were used, where feasible, for designing the bioretention areas. The "Simplified Sizing Method" from the SMCWPPP was used to determine whether the bioretention areas satisfy C.3 guidelines. This method requires that the bioretention area is at least four percent of the impervious surface area draining to the individual facility. All of the proposed facilities satisfy this criterion, and some have added capacity to handle additional runoff from other sources besides the roadway areas.

Certain design aspects deviated from the SMCWPPP guidelines due to utility conflicts and site restrictions. The SMCWPPP guidelines state that there should be an underdrain system in place where HSG D soils are present for bioretention areas. However, four of the bioretention areas are designed without underdrains either due to their location along a stretch of Bransten Road with no existing storm drain system (and no feasible addition or extension of the storm drain) or due to the depth of the existing storm drain system being too shallow to connect to the drainage inlet. These four bioretention areas also deviate from the SMCWPPP guidelines of having a minimum soil layer depth of 18 inches due to utility conflicts, and are designed to have soil depths of 12 inches. These areas without underdrains are designed to infiltrate through the biotreatment soil media and into the underlying soils. The three remaining bioretention areas have underdrains with elevated orifices to allow for infiltration of the water that collects in the bottom of the rock layer.

Southgate Neighborhood Green Streets (Green Streets)

The Southgate Neighborhood Green Streets Project is located within the Southgate neighborhood in the City of Palo Alto, which is in the northern part of Santa Clara County. This is a residential neighborhood consisting of single-family homes. The residential streets within this neighborhood, which was subdivided in the 1920's, are very narrow. The existing storm drainage system serving this neighborhood is minimal in scope. Gutter flows from the majority of the streets are directed to a single storm drain inlet at the southeast corner of the neighborhood, at the intersection of Sequoia and Mariposa Avenues. While the surface flow pattern probably worked marginally well when the subdivision was initially laid out, the condition of the street and the curb and gutter has deteriorated over the years, with the damage exacerbated by the growth of shallow tree roots in the planter strips. With the present uneven grades along the curb and gutter, storm runoff is blocked at high points heaved by tree roots and ponds at depressions on its way to the single drain inlet. The key objective of the project is to eliminate severe street ponding through the use of innovative techniques that minimize storm runoff, improve storm water quality, and reduce potable water usage. The goal of the proposed project is to provide improved drainage performance through the use of innovative and environmentally friendly techniques that reduce storm runoff, eliminate ponding, and enhance neighborhood aesthetics in a way that also encourages bicycle and pedestrian travel.

The total area for the site is approximately 41.4 acres.

The proposed treatment measures include bioretention and biofiltration planters, porous pavement crosswalks, and a porous pavement "paseo" (pedestrian walkway connecting two streets). The bioretention planters will be incorporated into the street right-of-way and existing parkway strips (vegetated areas between the sidewalks and the streets). The project includes installation of 18 bioretention areas. Bioretention facility surface areas will range from 3 to 12 feet in width and from 8 to 50 feet in length, based on site constraints. The total surface area of the bioretention areas is 3,387 square feet.

Porous pavers will be incorporated into crosswalks at four intersections in the neighborhood. The pavers will connect each adjacent corner with a 10-foot-wide crosswalk, creating nearly 6,266 square feet of pervious walkway as a part of the project. The estimates of bioretention and pervious walkways are the maximum potential areas going out for bid, actual numbers may vary.

The project will begin construction in the late spring of 2014.

Packard Foundation Project (Green Streets)

The Packard Foundation Project is located in Santa Clara County in the City of Los Altos on Second Street between Lyell Street and Whitney Street. The project was constructed in 2012.

The total drainage area to the project is 0.5 acres of commercially developed land. The pre-project imperviousness is approximately 80%, which was reduced to approximately 67% following project completion.

The treatment measure is a curbside flow-through rain garden that is 3.5 feet wide and 25 feet long on the north side of Second Street and 6.5 feet wide and 25 feet long on the south side of Second Street. The rain garden was designed based on the Santa Clara County Urban Runoff Pollution Prevention Program (SCVURPPP) C.3 Stormwater Handbook and will operate with a target infiltration rate of 2 inches/hour.

Hacienda Avenue Green Streets (Green Streets)

The Hacienda Avenue Green Street Project is located in Santa Clara County within the City of Campbell on a segment of Hacienda Avenue that connects the San Tomas Area Neighborhood to Winchester Boulevard. The City is redeveloping Hacienda Avenue as a green street with proposed improvements including the installation of new sidewalk, bike lanes, street trees, bioswales and other stormwater treatment facilities; narrowing the existing development area; and encouraging infiltration in open areas or developed permeable surfaces.

The total drainage area to the project is 30.65 acres and has an imperviousness of 70% prior to the green streets improvements. The proposed imperviousness following project completion is 62%, due to the planned reduction in roadway width. The land use of the catchment is primarily residential.

The treatment measures to be implemented along Hacienda Avenue are still in the preliminary design phase, with a completed conceptual design. The proposed components include the installation of bioswales and other stormwater treatment facilities, and the use of permeable paving surfaces when the roadway is resurfaced. The allocation and schedule of additional funding is currently being negotiated, so the construction schedule has not yet been determined.

Nevin Avenue Improvement Project (CW4CB Task 5)

The Nevin Avenue Improvement Project is a planned streetscape project along Nevin Avenue between 19th Street and 27th Street in the City of Richmond. The project catchment contains mixed land uses, including civic, residential, and commercial areas. There are also light industrial and historical industrial land uses areas within close proximity to the project location. The drainage to the treatment measures will be largely street drainage with possible drainage from adjacent parcels.

A portion of the larger Nevin Avenue Improvement Project will be funded by the CW4CB grant. Those stormwater treatment features will be constructed first and will include two bioretention areas/rain gardens at 25th Street and Nevin Avenue on corner curb extensions and Silva Cells between 24th Street and 25th Street. Silva Cells are modular suspended pavement systems that use soil volumes to support tree growth and on-site stormwater management. There will be approximately 2,455 square feet of Silva Cells installed between 24th Street and 25th Street with subterranean drainage.

The project is planned for construction by March 2014.

PG&E Substation Project—1st and Cutting (CW4CB Task 5)

The PG&E Substation Project is located at South 1st Street and Cutting Boulevard in the City of Richmond, Contra Costa County, California. The PG&E substation is bounded by rail and Interstate 580 to the north, a recreational vehicle parking lot to the west, Cutting Boulevard to the south and South 1st Street to the east. The substation is surrounded by a concrete berm that retains most stormwater runoff on-site. Ground cover is largely gravel, along with a parking lot, which consists partially of concrete. There is no landscaping on-site. PCBs have been detected in storm drains directly adjacent to the site as well as in the greater site vicinity.

The treatment measures for the project include one bioretention facility with an underdrain and one bioretention without an underdrain along Cutting Boulevard. The bioretention facilities have been separated into four segments due to the placement of existing light poles that are to remain in place. The facilities were sized in accordance to the Contra Costa Clean Water Program

(CCCWP) C.3 guidance using a multiplying factor of 0.04 for bioretention areas with underlying HSG D soils. The total drainage management area (DMA) for Bioretention Areas #1 and #2 is 51,000 square feet and the total DMA for Bioretention Areas #3 and #4 is 21,500 square feet. Bioretention Areas #1 and #2 are undersized due to a necessary reduction in width to avoid utilities and segmentation to avoid the light poles.

The City of Richmond PG&E Substation Project is planned for completion by October 2013.

West Oakland Industrial Area (CW4CB Task 5)

The West Oakland Industrial Area Project is located in the vicinity of Peralta Street between 24th and 30th Streets in the City of Oakland within the Ettie Street Pump Station Watershed. The blocks adjacent to the six proposed treatment facility locations are highly industrial, and include a metal recycling facility, a concrete batch plant, various mixed light industrial and commercial properties, and some residential land use. The drainage areas for the proposed facilities range from approximately 0.05 acres and 0.33 acres, and largely consist of road land uses with an overall imperviousness of 87%.

The project consists of six Filterra tree well treatment units, with five tree well units, 4 ft by 4 ft, and one tree well unit, 8 ft by 4 ft. The tree wells are sited upstream from existing storm drain inlets, such that the runoff will be intercepted by the tree well curb openings before being routed through a mulch layer and underlying filter media then collected by a 4 inch diameter underdrain. The tree wells were sized based on the rational method using a rainfall intensity of 0.2 inches per hour and a runoff coefficient of 0.95 for their respective delineated tributary areas. The flow through the tree well was based upon the surface area of the facility and an infiltration rate of 100 inches per hour.

Construction is planned for completion by September 2013.

B.7.2.5 Vegetated Swale

Broadway and Redwood Project (CW4CB Task 5)

The Broadway and Redwood Project is located east of Broadway between Redwood and Valle Vista in downtown Vallejo. The project catchment is 0.93 acres and will include drainage from the northbound lanes, sidewalk, and the railroad right-of-way along Broadway Street between Redwood Street just south of Valle Vista Avenue and sheetflow from Valle Vista Avenue between Broadway Street and North Cam Alto. The portion draining from Broadway Street is completely impervious, whereas the area draining between the tracks and Broadway is mostly pervious. The overall land use can be characterized as transportation and lies on HSG D soils, which have very low infiltration rates when wet. The land is owned by Southern Pacific but the Vallejo Sanitation and Flood Control District has an easement on the property that permits construction of a treatment measure within the easement.

The treatment measure for this project consists of a vegetated swale in the existing ditch along Broadway Street. The swale will collect runoff from the sidewalk and northbound lanes of Broadway Street and from Valle Vista Avenue between Broadway Street and North Cam Alto. The swale will be located between the Southern Pacific railroad tracks and the northbound Broadway Street sidewalk. The swale will be designed in accordance with the Fairfield-Suisun Urban Runoff Management Program and will be 100 feet long with a top width of 5 feet and a bottom width of 1 foot. The upper 18 inches of the facility will be amended with biofiltration media to support infiltration. The bottom of the swale and the side slopes will be planted with native bioswale sod (i.e., biofiltration sod, delta native heartland sod, and native preservation mix) and hydroseed for treatment and aesthetic purposes. The plants will require irrigation for the first six to eight weeks during the plant establishment period.

The project is planned for completion by October 2013.

B.7.2.6 Media Filters

Ettie Street Pump Station (CW4CB Task 5)

The Ettie Street Pump Station Project is located in West Oakland at 3465 Ettie Street, adjacent to MacArthur Freeway to the north and Nimitz Freeway to the west. The Ettie Street Pump Station is an Alameda County Flood Control and Water Conservation District (ACFCWCD) facility that collects and pumps stormwater runoff to the San Francisco Bay. The Ettie Street Pump Station drainage catchment is comprised of approximately 954 acres in West Oakland and includes approximately 42% residential, 38% industrial, and 20% commercial land use areas.

The proposed stormwater treatment measure for the project is a media filter system with two parallel filter beds containing different media. The design media filter flow capacity for both filters is limited to approximately 30 gpm. The media filter system would be located at grade outside the pump station building and would include a pump and pretreatment storage tank. The pump would draw water up from one of the two forebays into the pretreatment storage tank, which is designed to settle out the fine and coarse particle sizes. Pumping would be triggered during storm events by elevated turbidity readings from a real-time turbidity sensor in the forebay. The flows would then be evenly split between each media bed using flow control valves. One filter bed would contain rhyolite sand and the second bed would contain a mix of media types, including rhyolite sand, zeolite, and granulated active carbon (GAC). The discharges from the media beds will be combined before returning to the forebay.

The project is planned for construction in the fall of 2013.

PG&E Substation Project—Vallejo (CW4CB Task 5)

The PG&E Substation Project in the City of Vallejo is located at 500 Sutter Street on the corner of Sutter Street and Pennsylvania Avenue. The PG&E substation is bounded by an alleyway (Ford AL) to the north, a truck container lot to the east, Pennsylvania Avenue to the south, and

Sutter Street to the west. Sutter Street is a crowned, two-lane road that has a sidewalk on both sides and is separated from the substation by approximately 12 feet of dense vegetation. The tributary area to the facility is approximately 0.13 acres and the groundcover is primarily compacted gravel.

The treatment measure concept for the PG&E Substation Project is to install a new drainage inlet to the substation driveway to collect sheetflow from the project site. The proposed inlet will be a Contech Catchbasin Stormfilter that provides treatment by capturing pollutants in a replaceable media filter cartridge. The filter media in the cartridge will be determined during the design phase.

The project will be complete by October 2013.

B.7.2.7 Hydrodynamic Separators

Alameda and High Street HDS Unit (CW4CB Task 5)

The City of Oakland Alameda and High Street Hydrodynamic Separator (HDS) Unit Project is located at the intersection of 42nd Avenue and High Street in Oakland. The Alameda and High Street CDS unit is located within a watershed with a high concentration of old industrial land uses, including historic rail lines. The tributary drainage area to the HDS is 35 acres.

The proposed HDS unit is the Contech CDS unit. The unit combines hydrodynamic forces and treatment screens to remove solids from stormwater. Specifications for the unit are not currently available.

The HDS unit was installed as part of Oakland's Trash Load Reduction Plan, with the design completed in December 2011 and construction completed in December 2012.

Leo Avenue HDS Unit Project (CW4CB Task 5)

The Leo Avenue Hydrodynamic Separator (HDS) Unit Project is located on 7th Avenue just southeast of Phelan Avenue in southeast San Jose. The Leo Avenue Watershed has a long history of industrial land uses, including auto repair and salvage yards, metal recyclers, and historic rail lines. This HDS unit was planned for installation as part of San Jose's Trash Load Reduction Plan, but will also serve to test the utility of the device for enhanced sediment removal.

A prefabricated HDS unit designed by Contech is the proposed treatment measure. The Leo Avenue Watershed HDS unit receives runoff from approximately 214 acres of commercial and industrial land uses.

The construction of the Leo Avenue HDS Unit project was completed in October 2012.

B.7.3 Status of Control Measure Implementation

B.7.3.1 Baseline

Stormwater treatment measures were not widely implemented in the baseline years (i.e., before July 1, 2002) since the first C.3 provisions that required implementation of treatment measures for new development and redevelopment projects were adopted in 2001 in the Bay Area county-specific MS4 Permits. Therefore, it is assumed that very few stormwater treatment measures were constructed prior to 2002.

B.7.3.2 Current

An inventory of constructed C.3 Regulated Projects.[20] was conducted by tabulating the stormwater treatment sites that are documented in the Fiscal Year (FY) 09/10, FY 10/11, and FY 11/12 Annual Reports for Alameda County, Contra Costa County, San Mateo County, Santa Clara County, and Solano County. C.3 project data for earlier years was not readily available; therefore this inventory represents a subset (i.e., possible low estimate) of the total number of C.3 treatment measures that have been installed. In total, 1,496 C.3 projects were identified as constructed from the available Annual Reports (Figure B.7.3). These treatment measures are considered as enhanced treatment measures as they were constructed after July 2002.

All of the Green Street and CW4CB pilot retrofit projects are enhanced measures, as they also were constructed or will be constructed after July 2002.

B.7.4 Estimates of Loads Avoided/Reduced

B.7.4.1 Loads Avoided/Reduced Methodology

The estimates of loads avoided/reduced were made using a spreadsheet model to predict mean annual estimates of loads reduced. The model converted rainfall to runoff based on percent imperviousness, and takes into account estimates of bypass (when inflow exceeds capacity of treatment measure) and incidental infiltration. Bypass was assumed to equal approximately 20 percent of inflow for the C.3 projects as the C.3 performance standard is intended to achieve approximately 80 percent capture of the average annual runoff volume. For retrofit projects, bypass was assumed to equal 30 percent, as retrofit treatment measures are often undersized due to space constraints and utility conflicts. Incidental infiltration for those BMPs where such infiltration is feasible was set at 20%, taking into account an analysis of data in the International BMP Database (Geosyntec and Wright Water Engineers 2012b). The water quality component in the model estimates influent and effluent PCBs and mercury as follows.

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[20]MRP Provision C.3.b. states that Permittees shall require all projects fitting the category descriptions listed in Provision C.3.b.ii (i.e. Regulated Projects) to implement LID source control, site design, and stormwater treatment on-site or at a joint stormwater treatment facilities. Regulated Projects include the following special use categories: 1. New development or redevelopment projects, 2. Other development projects, 3. Other redevelopment projects, and 4. Road projects.

The influent concentrations for PCBs and mercury were estimated using land use-based event mean particle concentrations (EMCs), back-calculated from mass emission station data utilizing the Regional Watershed Spreadsheet Model (RSWM) (SFEI 2012). The analysis methodology is referred to as "inverse optimization," a process by which land use runoff particle concentrations are varied to minimize the discrepancy between modeled and measured loads at the mass emission stations. The most appropriate land use categorizations for PCBs were determined to be old urban (pre-1954), new urban, old industrial, and agricultural/open space. For Hg, the inverse optimization methodology could not distinguish between old industrial and old urban runoff concentrations, so in this case, land use Hg concentrations were provided only for old urban, new urban, and agricultural/open space. For modeling purposes, the old urban particle concentration for Hg was used for old industrial. The influent particle concentrations for PCBs, and total mercury presented in Table B.7.4.1 were converted to water column concentrations by multiplying by the mean runoff concentrations of TSS by land use (BASMAA 1996). The concentrations in Table B.7.1 are the mean particle concentrations, because the mean concentration times the volume of runoff equals the load.

Table B.7.4.1. Influent Land Use Mean Particle Concentrations for PCBs and Mercury

Land Use	PCBs[1] (ppb)	Mercury[2] (ppm)
Old Urban	150	0.63
New Urban	0.87	0.16
Old Industrial	2800	0.63
Agri/Open Space	20	0.14

Source: SFEI Technical Memorandum; EMC Data Development for RWSM (SFEI 2012)

[1] For PCBs, the four land use categories used from the RWSM EMC analysis include: 1) old (pre-1954) industrial areas, 2) old urban areas, 3) newer urban areas, and 4) undeveloped land (agriculture/open space).

[2] For HgT, the three land use categories used from the RWSM EMC analysis include: 1) old urban areas, 2) newer urban areas, and 3) undeveloped land (agriculture/open space).

Effluent concentrations of PCBs and total mercury (HgT) were estimated assuming the same particle concentrations as indicated in Table B.7.1. But when converting to water column concentrations the method utilized the mean effluent total suspended sediment (TSS), as provided in the International BMP Database. Thus the method assumes that treatment controls reduce PCB and HgT concentrations in direct proportion to the TSS reduction and that particle concentrations are preserved through the treatment system. The International BMP Database contains effluent TSS data for bioretention facilities, bioswales, manufactured devices, media filters, detention basins, green roofs, and porous pavement (Geosyntec Consultants and Wright Water Engineers 2012).

Table B.7.4.2 summarizes the overall modeling methodology used for estimating influent and effluent PCB and mercury concentrations.

Table B.7.4.2. Modeling Methodology for Influent and Effluent PCB and Mercury Concentrations

Influent PCBs/Mercury	Effluent PCBs/Mercury
Influent PCB and Hg particle concentrations based on inverse optimization analysis of mass emission station data and calibration of RWSM. Particle concentrations converted to water column concentrations by multiplying by land use runoff TSS data as reported by Woodward Clyde (1996).	Effluent PCB and Hg particle concentrations based on inverse optimization analysis of mass emission station data and calibration of RWSM. Particle concentrations converted to water column concentrations by multiplying by BMP-specific mean effluent TSS reported in International BMP Database (Geosyntec Consultants and Wright Water Engineers, 2012).

B.7.4.2 Loads Avoided/Reduced by Practices

Green Streets Pilot Projects Results

Table B.7.4.3 contains the influent, effluent, and total loads reduced for PCBs and mercury for the ten Green Streets Pilot Projects. All of the green streets projects are volume-based treatment facilities. Since these facilities are retrofit projects, a number of the facilities will be smaller, based on current planning and design information, than the MRP requires for new development facilities. Therefore, it is anticipated that these facilities will bypass more than 20% of the inflow, and for the purposes of this analysis, it is assumed that the Green Streets Pilot Projects will bypass 30%, corresponding to a percent capture of 70%.

In addition to bypass, some BMP types could experience incidental infiltration, including bioretention facilities with underdrains (Geosyntec Consultants and Wright Water Engineers 2012c). For the purpose of this analysis, it was assumed that for selected BMPs (i.e., bioretention, bioswales, porous pavement and detention) the incidental infiltration would be 20%.

The land use breakdown for each site was based on draft GIS shapefiles developed by SFEI and EOA (2013), as part of the Regional Watershed Spreadsheet Model development. The shapefiles delineate potential PCB and mercury source areas based on historical land uses and potential PCB and mercury uses. The Green Streets Pilot Projects, which were not included in the C.3 Project locations point shapefile, were assumed to have an equal proportion of all three land uses if they were located within old industrial land use areas as defined by SFEI and EOA (2013) and were assumed to have an equal proportion of Old Urban and New Urban if they were located outside of industrial land use areas.

Table B.7.4.3. Influent and Loads Reduced of PCBs and Mercury for the Green Street Pilot Projects

Project	Average Annual Influent Load (mg)		Average Annual Load Reduction (mg)	
	PCBs (mg)	Hg (mg)	PCBs (mg)	Hg (mg)
Bransten Road Green Streets Project	103	39	66	24
Codornices Creek Restoration Project	488	184	310	114

Project	Average Annual Influent Load (mg)		Average Annual Load Reduction (mg)	
	PCBs (mg)	Hg (mg)	PCBs (mg)	Hg (mg)
El Cerrito Green Streets Project	338	128	215	79
Packard Foundation Project	3.1	16.2	1.8	9.6
Park and Hollis Stormwater Curb Extension	45	17	29	11
Stanley Blvd Safety and Streetscape Improvement Project	303	1588	171	896
Sustainable Streets and Parking Lots Demonstration Project	12	62	7	37
San Pablo Green Spine Project	14	74	8	44
Hacienda Avenue Green Streets	176	920	104	545
Southgate Neighborhood Green Streets Project	**253**	**1323**	**150**	**783**
Total	**1,785**	**4,617**	**1,082**	**2,654**

[1] Insufficient information at time of report. SCVURPPP will provide information.

CW4CB Task 5 Retrofit Pilot Projects Results

Table B.7.4.4 shows the mean annual influent and total loads reduced for PCBs and mercury for the ten CW4CB Task 5 Retrofit Pilot Projects. Imperviousness and/or tributary area was not available for the Ettie Street Pump Station, Alameda and High Street HDS Unit, Nevin Avenue Improvements, PG&E Substation—Vallejo, and the Broadway and Redwood projects, but were estimated from design specifications or aerial images.

Load reductions were estimated for those BMPs where the data in the International Stormwater BMP database indicated a statistically significant difference between the median influent and effluent concentrations. For those BMPs listed in Table B.7.4.4, statistical significance was shown for all but the HDS units (Geosyntec Consultants and Wright Water Engineers 2012c). Data on HDS units from a number of studies contained in the International BMP Database indicate that the median effluent concentration is not significantly different from the median influent concentration. Thus a load reduction estimate based on changes in influent and effluent quality was not made for HDS units. (Some coarse sediments are trapped in HDS units, so there is some load reduction that is achieved, and this will be evaluated as part of the pilot studies.)

Similar to the Green Streets Pilot Projects, it was assumed that the BMPs bypassed 30% of the inflow. The exception to this was the Ettie Street Pump Station where the pilot treatment media filters were estimated, based on runoff and media filter flow capacity, to capture and treat only 0.1% of the influent. For those BMPs that could experience incidental infiltration, the infiltration was set at 20%.

These projects were assumed to have an equal proportion of all three land uses if they were located within old industrial land use areas and were assumed to have an equal proportion of Old Urban and New Urban if they were located outside of industrial land use areas.

C.3 Regulated Projects Results

Of the constructed C.3 Regulated Projects tabulated, 1,022 projects could be geographically located using the information available in Permittee FY 09/10- FY 11/12 Annual Report Operations & Maintenance Tables. The land use breakdown for each site was based on shapefiles developed by overlaying C.3 treatment control locations with land use data layers developed by SFEI and EOA (2013) that delineate "old" and "new" urban and industrial land uses. For each treatment control, a table was generated that indicated the types of land uses in the areas tributary to each project categorized as new urban (constructed post-1974), old urban (constructed pre-1974), and old industrial (constructed pre-1968). Of the 1022 projects, 170 of these are located in old industrial land uses.

Table B.7.4.4. Influent, Effluent, and Loads Reduced (g) of PCBs and Mercury for the Retrofit Pilot Projects

Project	Average Annual Influent Load (mg)		Average Annual Load Reduction (mg)	
	PCBs (mg)	Hg (mg)	PCBs (mg)	Hg (mg)
Alameda and High St. HDS Unit [1]	8,083	3,059	0	0
Bransten Road Curb Extensions	105	40	67	25
Broadway and Redwood	236	89	142	51
El Cerrito Green Streets	16	81	9	48
Ettie St. Pump Station	220,322	83,366	188	68
Leo Avenue HDS System [1]	37,491	14,186	0	0
Nevin Avenue Improvements - Bioretention	23	122	14	72
Nevin Avenue Improvements- Silva Cells	47	244	24	127
PG&E Substation - 1st Ave	426	161	271	100
PG&E Substation - Vallejo	26	10	15	6
West Oakland Industrial Area	195	74	124	46
Total	**266,970**	**101,432**	**854**	**543**

[1] It was assumed that HDS units will not reduce TSS (and therefore PCBs and HgT) loads as the International BMP database does not demonstrate significant difference between influent and effluent TSS. Some load reduction is achieved through settling of coarse sediment, and this will be quantified through the pilot studies.

The POC Loads Monitoring Study completed by SFEI indicates that there is a positive correlation between elevated concentrations of PCBs and mercury and watersheds with older land uses in the San Francisco Bay Area (McKee et. al. 2012). Therefore, the estimated loads avoided/reduced due to C.3 stormwater treatment measures analysis focused on those projects located in old industrial areas as the concentration of PCBs in runoff is projected to be much higher in these areas (Table B.7.4.5).

The stormwater treatment projects identified in the Annual Report O&M tables that contained old industrial development were cross-referenced with older Annual Report Projects-Approved tables to extract the project area, post-project imperviousness, type and number of treatment measure implemented, and treatment measure sizing criteria used, if available. Of the 170 projects located in old industrial areas, 32 have complete available data. The remaining 138 projects were either in Annual Reports that could not be obtained or did not have data reported in the available Annual Reports.

Of the 32 projects, the type and number of treatment measures were: bioswales (15 facilities), manufactured devices (eight facilities), bioretention (seven facilities), media filters (six facilities), detention basins (two facilities), green roof (one facility), and porous pavement (one facility). Some of the projects reported having multiple treatment measures constructed on-site, so for the purposes of modeling, it was assumed that the catchment area contributing runoff to each treatment measure were equal.

For each BMP type, a separate loads analysis was conducted that generated a load per unit area as indicated in Table B.7.4.6. This then was applied to the total area treated by that type of BMP. In this way, the estimates for the 32 projects were extrapolated to include all 170 projects (Table B.7.7).

Table B.7.4.5. Estimates of Average PCB and Mercury Load Reductions per Treated Acre for 32 C.3 Regulated Projects in Old Industrial Land Use Areas

BMP Type	Number of Facilities[1]	Total Tributary Area (ac)	Sum of Average Annual PCB Load Reduction[2] (mg)	Sum of Average Annual HgT Load Reduction[2] (mg)	Average Annual PCB Reduction (mg/acre)	Average Annual HgT Reduction (mg/acre)
Bioretention	7	13	1691	622	129	47
Bioswale	15	147	19037	6883	130	47
Detention Basin	2	16	1038	363	65	23
Green Roof	1	0.3	64	24	191	71
HDS Unit [3]	8	30	0	0	0	0
Media Filter	6	25	2993	1080	118	43
Porous Pavement	1	2	212	76	97	35
Total	**40**	**234**	**25,035**	**9,048**	**730**	**266**

[1] Some of the thirty two regulated projects reported multiple treatment measures constructed on-site, which totaled to forty facilities.
[2] Determined from summing average annual load reductions from the thirty two individual regulated projects by BMP types listed.
[3] HDS units were not assumed to reduce TSS (and therefore PCBs and HgT) loads as the International BMP database does not demonstrate significant difference between influent and effluent TSS.

Table B.7.4.6. Estimated Load Reduction for 170 C.3 Regulated Projects in Old Industrial Land Use Areas

BMP Type	Total Extrapolated Tributary Area (acre)	Average Annual PCB Load Reduction[1] (g)	Average Annual HgT Load Reduction[1] (g)
Bioretention	74	9.6	3.5

BMP Type	Total Extrapolated Tributary Area (acre)	Average Annual PCB Load Reduction[1] (g)	Average Annual HgT Load Reduction[1] (g)
Bioswale	832	107.9	39.0
Detention Basin	91	5.9	2.1
Green Roof	2	0.4	0.1
HDS Units [2]	168	0.0	0.0
Media Filter	144	17.0	6.1
Porous Pavement	12	1.2	0.4
Total	**1324**	**141.9**	**51.3**

[1] Assumes load reduction per treated acreage values listed in Table B.7.6.
[2] HDS units were not assumed to reduce TSS (and therefore PCBs and HgT) loads as the International BMP database does not demonstrate significant difference between influent and effluent TSS.

B.7.4.3 Summary of Key Uncertainties

Due to the limitations in available project information and local water quality data, there are a number of sources of uncertainty in the loads reduced/avoided estimates.

Modeling Methodology

- The particle concentrations derived from the SFEI “inverse optimization” analysis is based on regional (watershed scale) data and may not reflect site-specific conditions pertinent to small scale pilot or C.3 projects.
- Assumptions regarding bypass and incidental infiltration are based on professional judgment and limited literature and may differ substantially from actual project conditions.
- The assumption that TSS is adequate to characterize solids may be a source of uncertainty as SSC is considered a preferable solids measure, especially where coarse solids are greater than 25% of the total dry solids. However, data from settling tests conducted by SFEI indicate that for PCBs the percent settled in less than 2 minutes (attributed to solids in coarse fraction >75 um) was generally less than 30%.
- The assumption to use equal proportions of land uses (New Urban, Old Urban, and Old Industrial) should be refined once more information on each pilot project catchment is available.
- The assumption that that the HDS units do not achieve any load reduction should be evaluated as monitoring data on the pilot studies becomes evaluated.
- Nationwide data contained in the International BMP Database was used to estimate the effluent TSS for each BMP type since the data for semi-arid areas is limited.

C.3 Projects

- For the C.3 regulated projects, the exact tributary area and characteristics were not available for all of the projects, so assumptions were made based upon available Annual Reports.
- For the C.3 regulated projects, PCB and mercury concentrations were assigned based on the location of the project within new urban, old urban, or old industrial land uses. The watersheds are often large in size and may include land uses different from that determined based on the location of the treatment measure.

B.7.5 References

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FIGURES B.7

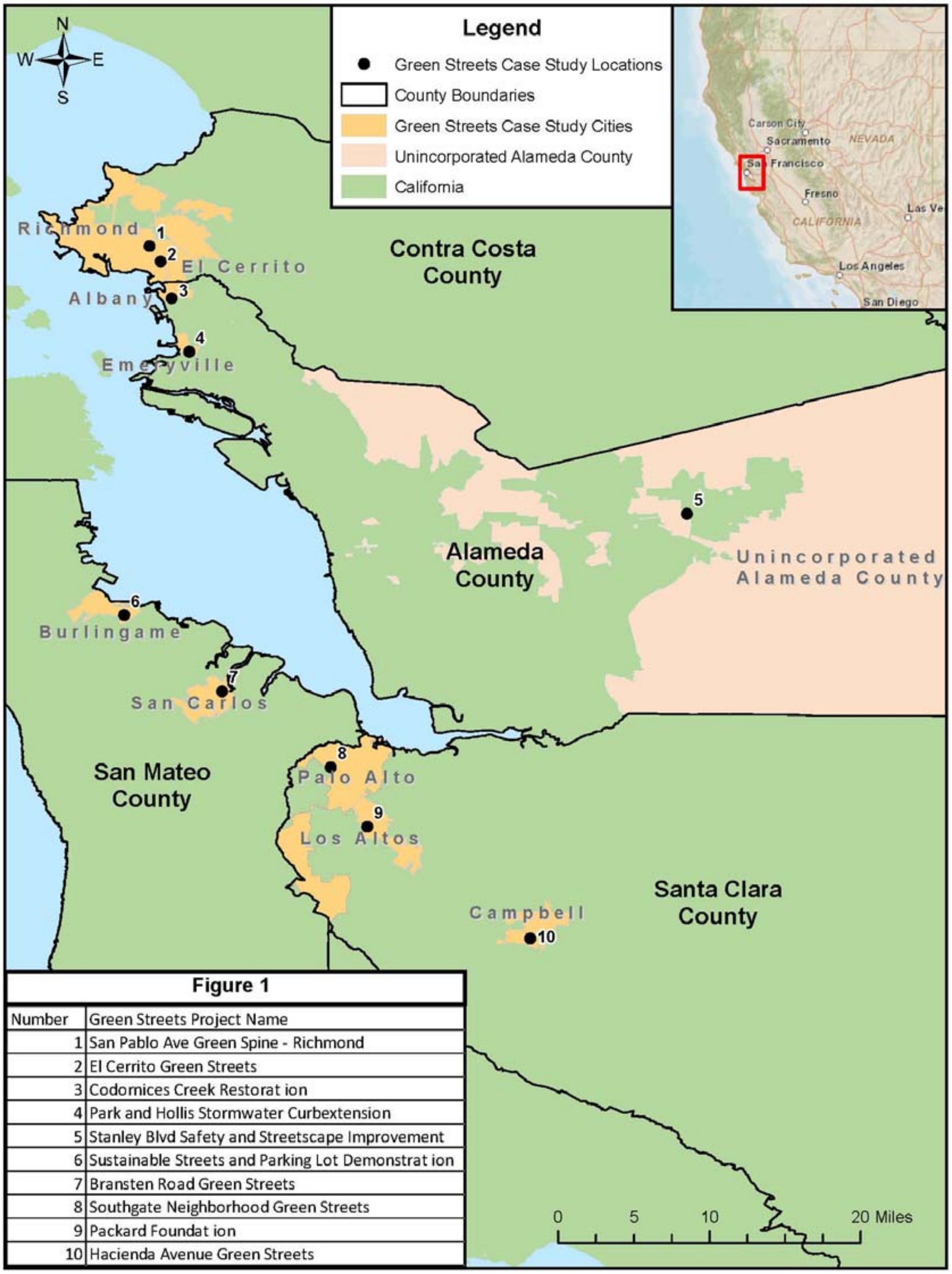

Figure 1

Number	Green Streets Project Name
1	San Pablo Ave Green Spine - Richmond
2	El Cerrito Green Streets
3	Codornices Creek Restorat ion
4	Park and Hollis Stormwater Curbextension
5	Stanley Blvd Safety and Streetscape Improvement
6	Sustainable Streets and Parking Lot Demonstrat ion
7	Bransten Road Green Streets
8	Southgate Neighborhood Green Streets
9	Packard Foundat ion
10	Hacienda Avenue Green Streets

Green Streets Project Locations,

San Francisco Bay Area CA

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Source:
Geosyntec Consultants

Bay Area Stormwater Management Agencies Association

May 2013

Figure B.7.1

Entity	Date

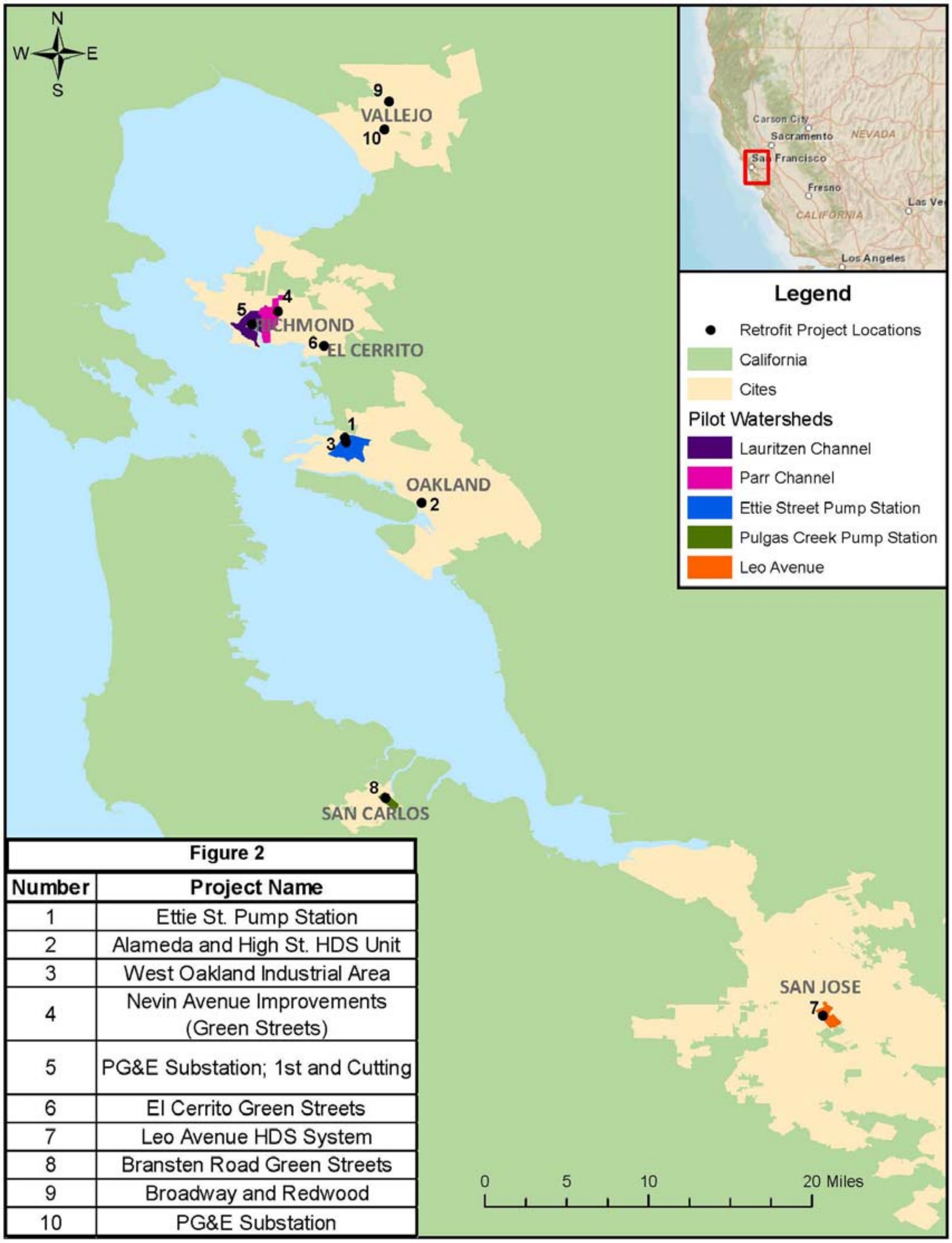


Figure 2

Number	Project Name
1	Ettie St. Pump Station
2	Alameda and High St. HDS Unit
3	West Oakland Industrial Area
4	Nevin Avenue Improvements (Green Streets)
5	PG&E Substation; 1st and Cutting
6	El Cerrito Green Streets
7	Leo Avenue HDS System
8	Bransten Road Green Streets
9	Broadway and Redwood
10	PG&E Substation

CW4CB Task 5 Pilot Retrofit Projects,

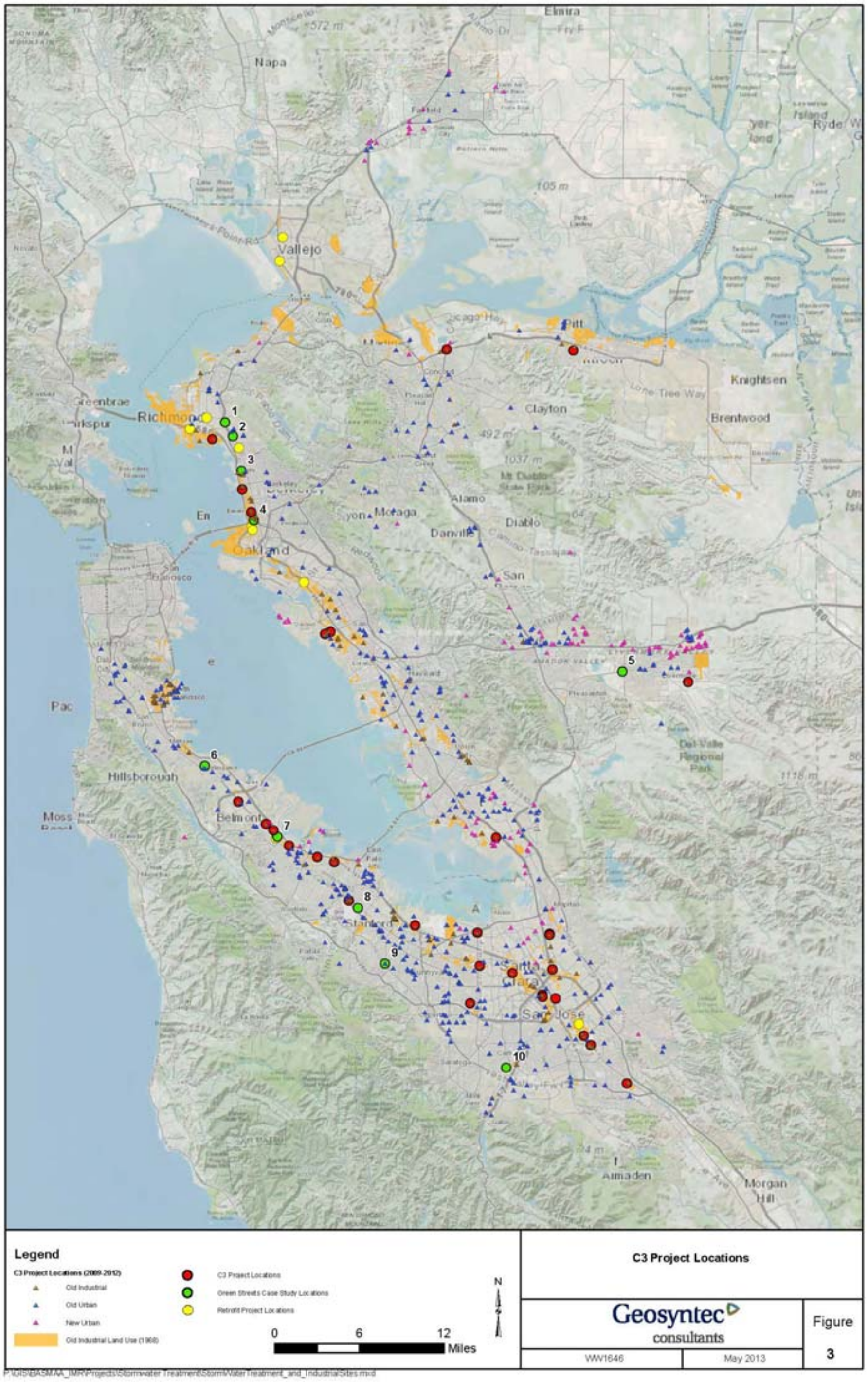
San Francisco Bay Area CA

internal info: path, date revised, author

Source:
Geosyntec Consultants

Bay Area Stormwater Management Agencies Association

Entity	Date	
Bay Area Stormwater Management Agencies Association	**May 2013**	**Figure B.7.2**



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Source:
Geosyntec Consultants

C.3 Project Locations, San Francisco Bay Area CA

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	May 2013	Figure B.7.3

B.8 PCBS IN CAULK

B.8.1 Introduction

Prior to the 1979 production ban by the United States Congress, polychlorinated biphenyls (PCBs) were commonly used in various building materials, including sealants that were applied around windows and doors, between concrete and other materials, and around openings for ducts and other conduits. During demolition or renovation of buildings containing PCBs, there is the potential for PCBs to enter the municipal separate storm sewer system (MS4) and ultimately discharge to San Francisco Bay. Thus, building demolition or renovation has been identified as a potential source of PCBs to San Francisco Bay.

Two pilot studies were conducted as part of the PCBs in Caulk Project managed by the San Francisco Estuary Partnership (SFEP) to help inform this issue[21] and address related requirements in the Municipal Regional Stormwater NPDES Permit (MRP). One of the pilot studies was conducted by the San Francisco Estuary Institute (SFEI) and focused on monitoring PCBs in different building types in the Bay Area and developing estimates of regional loads to the Bay. The second pilot study was conducted by Larry Walker Associates, Geosyntec Consultants, and TDC Environmental with the goal of working with the MS4 community to develop tools to assist MS4s in identifying demolition and renovation projects that could potentially release PCBs, and ensuring that the projects follow applicable regulations regarding PCB management.

This purpose of this section is to describe these pilot studies and to present a methodology for estimating the load avoidance or reduction that could be achieved with implementation of the enhanced management practices developed as part of the second pilot study.

B.8.2 Summary of PCB and Mercury Control Pilot Studies

B.8.2.1 MRP Requirements

MRP Provisions

MRP Provision C.12.b requires the Permittees to evaluate the potential presence of PCBs at construction sites, current material handling and disposal regulations/programs, and current level of implementation. Specific implementation requirements include:

[21] This project was originally funded by a Proposition 50 Coastal Nonpoint Source Pollution grant as part of SFEP's Taking Action for Clean Water project; ARRA stimulus funds later replaced state grant funding lost in the 2009 state bond freeze. BASMAA representatives and Regional Water Board staff collaborated in design of the PCBs in Caulk Project and participated in Project Team oversight.

- Develop a sampling and analysis plan to evaluate PCBs at construction sites that involve demolition activities (including research on when, where, and which materials potentially contain PCBs).
- Implement a sampling and analysis plan at a minimum of 10 sites distributed throughout the combined MRP area.
- Develop/select best management practices (BMPs) to reduce or prevent discharges of PCBs during demolition/remodeling. The BMPs should focus on methods to identify, handle, contain, transport and dispose of PCB-containing building materials.
- Develop model ordinances or policies, train and deploy inspectors, and pilot test BMPs at five sites.

PCBs in Caulk Project deliverables[22] were incorporated in the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Pollutants of Concern (POC) Reports describing regionally-implemented activities and submitted on behalf of all MRP Permittees to fulfill Annual Reporting requirements. The 2010 Regional POC Report included the sampling and analysis plan and a status report on sampling and analysis with the available sampling results. The 2011 Regional POC Report included the results of an evaluation of current regulations, level of implementation, and regulatory gaps; the final sampling and analysis report; and a list of appropriate BMPs, BMP training program, and model ordinances and policies to prevent PCB discharges from building demolition and improvement activities.

Part C of the Integrated Monitoring Report (IMR) provides an analysis of the pilot program effectiveness for future implementation opportunities.

Implementation Approach

BASMAA agencies collaborated with SFEP to implement MRP Provision C.12.b. The approaches taken included 1) characterizing via a field monitoring program the concentration of PCBs in different building types in the Bay Area and developing estimates of regional loads to the Bay, and 2) developing and evaluating BMPs which could potentially be applied at appropriate demolition and renovation projects to reduce or prevent the release of PCBs into the MS4. During the planning of these activities, BASMAA representatives made numerous attempts to obtain permission from municipal and private property owners to test building materials for PCBs. It was discovered that obtaining such permission was possible only when a blind sampling program was planned. This was not particularly surprising given that current regulations do not require PCB testing in association with demolition or renovation projects. Furthermore, if testing is conducted voluntarily and PCBs are found at a level exceeding 50 ppm in building materials such as caulks and sealants, the Environmental Protection Agency (EPA)

[22] Available at http://www.sfestuary.org/taking-action-for-clean-water-pcbs-in-caulk-project/

currently requires preparation of a cleanup plan and implementation of that plan, a process that is potentially time-consuming and expensive. When informed of these potential consequences, property owners would only agree to testing building materials for PCBs if a blind sampling program was implemented.

Thus the field monitoring characterization study employed a blind sampling program that kept the exact sampling locations confidential. This allowed for characterization of PCB concentrations found on exterior materials of buildings of various types and ages in the Bay Area without focus on specific locations.

The BMPs and an associated Model Implementation Process (MIP) developed to reduce or prevent discharges of PCBs during demolition/remodeling focused on methods to identify, handle, contain, transport and dispose of PCB-containing building materials. However, performing an implementation trial in the field to evaluate the effectiveness of the BMPs and MIP was problematic without the ability to analyze samples of building materials from specific locations for PCBs. Thus, in lieu of field implementation trials, a training workshop was held on July 26, 2011 to test and refine the MIP before finalization. The workshop targeted municipal staff with responsibility for demolition/renovation permitting.

As a final note, Regional Water Board staff and BASMAA representatives have had many discussions over the course of the permit term regarding implementing the PCB in building materials MRP provision. It was noted that when the MRP was developed it may have been envisioned that PCB BMPs would be applied concomitant to conventional demolition/renovation activities. However, it was later determined that a more plausible process would entail hazardous material inspection, sampling, lab testing, preparing an abatement plan, and abatement, all happening before demolition/renovation, similar to current procedures for asbestos and lead. The construction and demolition industry is becoming aware of the problem with PCBs in building materials but so far the focus has been on human exposure at the site rather than water quality concerns. BASMAA representatives believe the various facets of the "big picture" need to be addressed together (e.g., human exposure at the site, water quality, disposal) rather than trying to apply water quality BMPs outside of this context. BASMAA plans to continue to participate in the stakeholder process as EPA develops related regulations.

B.8.2.2 SFEI PCBs in Caulk Monitoring Study

SFEI prepared the "PCBs in Caulk Project: Estimated Stock in Currently Standing Buildings and Releases to Stormwater during Renovation and Demolition", or SFEI Monitoring Study, in October 2011[23].

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[23] Available at http://66.147.242.191/~sfestuar/userfiles/PCBsinCaulkFinalReport113011.pdf

The scope of the study, the selection process for the buildings that were monitored, the sampling and analysis methods used, and the collected data and results are summarized below.

Scope of Study

The specific scope and objectives of the SFEI Monitoring Study were to:

- Estimate the mass of PCBs that is associated with caulk in currently standing industrial and commercial buildings in the San Francisco Bay Area that were constructed between 1950 and 1980;
- Estimate the mass of PCBs that is released to urban runoff during the renovation and demolition of these buildings using current practices (i.e., before PCB in Caulk best management practices (BMP) implementation);
- Compare this estimated mass of PCBs released to urban stormwater runoff during renovation and demolition to other PCB sources in the Bay Area; and
- Summarize the information currently available pertaining to the potential effectiveness of BMPs during demolition and renovation of buildings with PCB-containing caulk.

The following sections characterize the types of buildings that were sampled and that contain caulk in the San Francisco Bay Area, the sampling and analysis methods for the testing of caulk concentrations in these buildings, the methodology used for estimating the overall PCB stock in caulk in the San Francisco Bay Area, and the methodology used for estimating the load of PCBs to stormwater during the renovation and demolition of buildings. A supplementary discussion and brief literature review of the potential effectiveness of selected BMPs to address PCB load will be discussed as in a section above.

PCB Concentrations in San Francisco Bay Area Buildings

During 2010 and 2011, samples were collected from the exteriors of 10 currently standing buildings in the San Francisco Bay Area that represented a range of construction types that were constructed during the 1950s, 1960s, 1970s, or 1980s (with the exception of one building that has an unknown construction date). Project partners identified buildings in the region that were candidates for inclusion in the Project based on the building's construction type, date of construction, and the known or suspected use of original caulk. The selected buildings were classified by their construction codes as being either precast/tilt-up concrete shear wall (PC1), pre-cast concrete frame (PC2), concrete shear-wall (C2), light wood-frame residential and commercial smaller than or equal to 5,000 square feet (W1), light wood-frame larger than 5,000 square feet (W2), and reinforced masonry (RM).

Sampling and Analysis Methods

Between 2010 and 2011, 29 caulk samples were collected from ten buildings selected using a blind sampling scheme, which omitted the sampling building locations in order to characterize concentrations found on the exteriors of the targeted buildings as a whole, and not focus on the specific locations. Each of the buildings had between one to seven samples collected from its exterior, with each sample taken from specific caulk types or functions. A maximum of one sample per caulk type or function combination was taken from each building to eliminate duplicates in characterization.

Of the 29 samples collected, 25 were randomly selected and analyzed for PCBs as part of the blind sampling process using a modified EPA method 8270 protocol (semi-volatile organic components by gas chromatography-mass spectroscopy [GC-MS]) by the East Bay Municipal Utility District (SFEI 2011). Method detection limits (MDLs) for the PCB congeners analyzed were based upon 40 CFR 136 Appendix B, and were scaled to reflect the mass and dilution for the samples actually extracted and analyzed. Only three of the 25 samples that were analyzed had PCB concentrations below these detection limits.

Data Analysis and Results

Twenty-two of the 25 caulk samples that were analyzed contained detectable concentrations of PCBs that ranged over six orders of magnitude, from 1 ppm to 220,330 ppm (Table B.8.2.1). Ten of these samples had concentrations that exceeded 50 ppm, which is the concentration at which caulk falls under regulation by the USEPA (USEPA 2012). The median PCB concentration of the entire range of samples was 32 ppm, and the median of only the samples containing concentrations greater than 50 ppm was 9,580 ppm. These sample characteristics are similar to patterns observed in PCBs in Caulk studies conducted in Boston, Toronto, and Switzerland (Herrick et al. 2004; Robson et al. 2010, Kohler et al. 2005).

Table B.8.2.1. PCB Concentrations in Caulk from San Francisco Bay Area Buildings (Klosterhaus et al. 2011)

Building Construction Year	Building Construction Type[1]	Caulk Location on Building	PCB concentration (ppm)
1950s	PC2	Between concrete	220,000
1950s	PC2	Between concrete	198,000
1950s	PC2	Between metal window frame and concrete	146,000
1960s	W2	Between glass and window frame	12,500
1950s	PC2	Between concrete	11,500
1950s	PC2	Around metal window frame	7,630
1950s	PC2	Between glass and metal window frame	3,600
1960s	C2	Between window glass and window frame	89
1980s	RM	Unknown	87
1970s	W2	Between wood and wood	60
1960s	C2	Between window glass and window frame	48

Building Construction Year	Building Construction Type[1]	Caulk Location on Building	PCB concentration (ppm)
1950s	W1	Between glass and metal window frame	15
Unknown	Unknown	Around window frame	15
1970s	W2	Between glass and window frame	11
1970s	W2	Between window frame and wood	10
1970s	W2	Around doorframe	8
1950s	W1	Around doorframe	6
1950s	W1	Around doorframe	5
1950s	W1	Between glass and window frame	3
1950s	W1	Between metal window frame and concrete	2
1960s	PC1	Between concrete	2
1950s	W1	Between wood window frame and wood	1
1950s	W1	Between wood and concrete	0
1950s	W1	Between wood and wood	0
1960s	RM	Between glass and window frame	0

[1] Construction codes: PC1=Precast/tilt-up concrete shear-wall; PC2=Pre-cast concrete frame; C2=Concrete shear-wall; W1=Light wood-frame residential and commercial smaller than or equal to 5,000 square feet; W2=Light wood-frame larger than 5,000 square feet; RM=Reinforced masonry

The distribution of concentrations observed (either less than 100 ppm or greater than 1,000 ppm) in the San Francisco Study area supports one proposed hypothesis: when PCBs were used as plasticizers in caulk, they were added in concentrations of at least 10,000 ppm to maintain the elasticity of the caulking material. Concentrations that are lower than 10,000 ppm are hypothesized to be due to the use of contaminated construction equipment during caulk application or due to secondary contamination via migration of PCBs from adjacent construction materials (Kohler et al. 2005).

The specific PCB congener profiles detected suggest that Aroclor 1254 was the predominant PCB commercial mixture used in typical construction types. This finding is consistent with profiling of contaminants in the Boston, Toronto, and Switzerland case studies. The specific placement/uses of the caulk samples that contained the highest levels of PCBs were located between concrete blocks and around window frames on concrete buildings. In general, buildings with wood frames contained low concentrations of PCBs in caulk (<60 ppm), with one exception. These results also agree with the findings in the previous studies in Boston, Toronto, and Switzerland (Herrick et al. 2004; Robson et al. 2010, Kohler et al. 2005).

The variation of PCB concentration with when the building was constructed is presented in Table B.8.2.2 below, which shows that buildings constructed in the 1950s and 1960s contained the highest PCB concentrations, often greater than 10,000 ppm. There was also PCB detection in a building constructed in the 1980s, which is past the year in which the sale and use of PCBs was banned.

Table B.8.2.2. Temporal Distribution of PCB Concentrations in Caulk Samples in San Francisco Study Area Buildings (Klosterhaus et al. 2011)

Construction Year	Number of Samples	# <MDL	# >MDL-50ppm	# 50-10,000 ppm	# >10,000 ppm	%>50 ppm
1950s	14	2	6	2	4	43
1960s	5	1	2	1	1	40
1970s	4	0	3	1	0	25
1980s	1	0	0	1	0	100
Unknown	1	0	1	0	0	0
Total #	25	3 (12%)	12 (48%)	5 (20%)	5 (20%)	

PCB Stock in Caulk in San Francisco Bay Area Buildings

The second component of the SFEI Monitoring Study was to improve the understanding of the current reservoir of PCBs in caulk in buildings in the San Francisco Bay Area. This characterization was subsequently used in the study to estimate the PCB mass that could potentially be released to stormwater runoff during renovation and demolition of buildings, and to compare caulk in buildings to other characterized sources of PCBs to stormwater in the Bay Area.

Analysis and Calculation Methods

In lieu of an available and accurate inventory of building types in the study area, a geographic information system (GIS)-based approach was used to estimate the number, area, and volume of currently standing buildings that were built during the 1950s -1980s. The GIS analysis was based on historical imagery (USGS Urban Extent 1954 and 1974), current land use data (ABAG 2005), and current aerial imagery (NHAP 1982 and NAIP 2010). The area of interest (AOI) included locations of relevant buildings and land uses. Within this AOI, a set of 100 randomly selected 0.25 square mile grid blocks were digitized to determine the footprints of all applicable currently existing buildings within each respective grid. This information was extrapolated within each MRP county stormwater program area (San Mateo County, Santa Clara County, Alameda County, Contra Costa County, City of Vallejo, and Fairfield-Suisun Cities) to estimate the total building footprint area. A similar approach was used to determine the number of stories within the buildings under consideration in the AOI.

A range of estimates (high, medium, and low) of loadings of PCBs in caulk were developed based on the building characterizations in the study (average footprint, number of stories, number of buildings) and the sampling results (detection frequency and concentration) of this study and those conducted previously in Boston, Toronto, and Switzerland. An approximation of the density of caulk (55 grams /m^3 building) in both the interior and exterior of buildings was used, as it was the most current and reliable estimate available at the time of the study. Table B.8.2.3 summarizes these factors and their respective sources.

Results

The GIS analysis estimated that there are approximately 6,300 currently standing buildings that were built between the 1950s and 1980s in the San Francisco Bay Area. The buildings are heavily concentrated in Santa Clara County (48%), with a remaining 26% in Alameda, 19% in Contra Costa, 6% in San Mateo, and less than 1% in both of the municipalities of Fairfield-Suisun and Vallejo. The density and land use distributions within each of the county and city areas varied, and could be valuable information to consider when making assumptions for management across larger urban areas.

The low, medium, and high estimates for PCB mass in caulk in buildings in the San Francisco Bay Area are 767 kg, 10,500 kg and 46,000 kg, respectively. These values correspond to averages of 0.6, 4.7, and 16 kg of PCBs per building.

Table B.8.2.3. Factors Used to Estimate the PCB Mass in Caulk in San Francisco Study Area Buildings (Klosterhaus et al. 2011)

Factor		Source
Height of one building story (ft)	10.3	Serdar et al. 2011; not standardized
Average # of stories in study area buildings	1.46	This study, Section 3.2.1
Mass caulk per volume building (g/m^3)	55	Robson et al. 2010; estimate from building contractor in Toronto
% of buildings with PCBs >50ppm in caulk (i.e., detection frequency)		Based on detection frequencies in this study, Boston (Herrick et al. 2004), Toronto (Robson et al. 2010), and Switzerland (Kohler et al. 2005).
Low	22	
Medium	36	
High	46	
PCB concentration in caulk (ppm)		25th, 50th, and 75th percentiles of the concentration distribution of this study, Boston (Herrick et al. 2004), and Toronto (Robson et al. 2010). Only samples with PCBs >50ppm collected from buildings built between 1950-1980 were considered
Low	950	
Medium	7,990	
High	27,300	

PCB Mass Loading to Stormwater during Building Renovation or Demolition

A range of estimates of the mass of PCBs that could potentially be released during the renovation or demolition of buildings with PCBs in caulk was determined based on the conceptual understanding of PCB losses to stormwater during these activities (prior to the implementation of BMPs intended to manage PCBs in caulk). The estimate did not account for releases from intact building caulk (i.e., volatilization loss, erosion of in-use caulk, or leaching during precipitation) or residues remaining post-demolition or renovation.

The estimates were based upon a range of average demolitions and renovations per year, the types and time of construction of buildings that were renovated or demolished, the percent of buildings that were assumed to contain PCBs in caulk at concentrations greater than 50 ppm[24], the average stock of PCBs in caulk per building, and the percentage of PCBs in caulk that could be released to stormwater per building. The number of demolitions and renovations in the study area was provided by the Bay Area Air Quality Management District (BAAQMD) "J" numbers, which are required permits for buildings that will be renovated or demolished and that contain greater than 100 square feet of asbestos material. The total number of "J" number permits issued between April 2010 and March 2011 was used as the basis for approximating the low, medium, and high estimates for renovation/demolition activities per year in the area of interest. In order to address the diversity of buildings that were renovated/demolished during that period, a range of high, medium, and low estimates for the percent of buildings potentially containing PCBs were applied (52, 46, and 23%, respectively).

One key assumption for evaluating the PCB loads during building renovation and demolition was quantifying the losses during activities associated with the renovation and demolition processes. A study in Sweden analyzing the PCB emissions during the replacement of PCB-containing caulk was used as a proxy for overall renovation and demolition activities (Jansson et al. 2000). The estimates for losses to the environment consider the PCB mass loss to air and soil, with a safety factor applied to account for releases during the physical transport, grinding, and deposition to soil from washing processes. The low, medium, and high estimates for total PCB mass in building caulk lost to the environment used were 0.0027, 0.0043, and 0.0099%, respectively.

Results

The estimates for the total mass of PCBs released from caulk to stormwater during building renovation and demolition activities ranged from 0.0008 kg/yr for the low estimate, 0.04 kg/yr for the medium estimate, and 0.6 kg/yr for the high estimate (Table B.8.2.4). For the medium estimate, approximately 50% of the total mass was attributed to demolition activities and 50% was attributed to renovation activities. These are likely underestimated values due to the omission of PCB losses from caulk scraps left on-site, in addition to other sources of uncertainty.

Table B.8.2.4. Estimated Annual PCB Mass Released From Caulk to Stormwater During Demolition and Renovation Activities in the San Francisco Bay Study Area (kg/yr) (Klosterhaus et al. 2011)

	PCB mass from demolitions (kg/yr)	PCB mass from renovations (kg/yr)	Total PCB mass (kg/yr)
Low estimate	0.0004	0.0004	0.0008
Medium estimate	0.02	0.02	0.04

[24] This concentration was used because of its significance in existing PCB regulations.

High estimate	0.22	0.39	0.6

When compared to previous studies in the Bay Area, the medium estimate was nearly 10 times lower than the estimate of 0.4 kg/yr calculated in 2010 by Mangarella et al. (low and high estimates were 0.4 and 4 kg/yr, respectively). This is due to an estimate for PCB loss per building in the Mangarella study being ten times higher (0.002 - 0.02 kg/building) than the SFEI Study (medium estimate, 0.0002 kg/building).

It should be emphasized that there are numerous sources of uncertainty in these estimates, and that new information and data should be continually incorporated to refine estimates that were produced for the SFEI Study.

BMP Effectiveness for Demolition and Renovation Practices

There is limited information available that specifically addresses the effectiveness of BMPs for preventing the release of PCBs to the environment during building demolition and renovation. The following sections provide the findings from a brief literature review conducted as part of the SFEI Pilot Study on the effectiveness of abatement and construction material management. Erosion and sediment control BMPs for addressing PCBs in caulk are also addressed.

Abatement BMP Effectiveness

Currently, Sweden and Switzerland have programs in place for the active management of PCB-containing building materials, including caulk. Two studies in Sweden estimated that more than 99% of the PCBs contained in caulk were captured following the implementation of activities that specifically targeted the prevention of PCB release to the environment (Sundahl et al. 1999; Jansson et al. 2000; Astehro et al. 2000). Most of the PCBs were captured via the removal of the caulk from the building through abatement-related activities. These activities included using high power vacuums during the grinding and cutting processes and power washing, which resulted in approximately 0.03% of the total PCB mass in the caulk running off into stormwater. Most of the PCBs that were released to the air resulted from the use of high temperature tools and/or heat generated during demolition or renovation activities.

At the time the SFEI pilot studies were being conducted, a series of reports funded by the USEPA through the National Risk Management Research Laboratory (NRMRL) were underway pertaining to PCBs in caulk. The fourth part, *Laboratory Study of Polychlorinated Biphenyl (PCB) Contamination and Mitigation in Buildings,* addresses the emissions of PCBs in selected primary sources, the migration of PCBs from primary sources to building materials and dust, and evaluates two potential abatement strategies for managing PCBs: encapsulation and chemical destruction.

In terms of effectiveness, encapsulation was demonstrated to be a viable interim option for isolating PCB contamination in buildings when the contaminated materials contain low levels of PCBs (maximum allowed concentration of 430 ppm) (Guo et al. 2012b). This value could be used as a threshold for the applicability of encapsulation as a mitigation strategy. The Activated Metal Treatment System (AMTS), a chemical destruction technique for PCBs, was also analyzed to screen for effectiveness of removing PCBs from a variety of building materials. AMTS has limited effectiveness as a treatment mechanism on its own due to limitations in effective penetration depth. However, it can be effective for treating contaminated materials after caulking material is removed due to the high thresholds of PCBs that it can treat (Liu et al. 2012).

An additional study was in progress during the time the SFEI pilot studies were being completed that focused on PCBs in school buildings in New York City (Thomas et al. 2012). The main objectives of the study were to characterize sources of PCBs, evaluate contaminant levels, and identify management practices for reducing human exposure. Although the focus was primarily on pathways and exposure in the indoor environment, the sampling results showed that remediation measures can be effective in reducing concentrations from buildings as a whole. Some remedial activities that were completed at the schools during the study included abatement activities, such as caulk patch and repair, fixture removal, HVAC evaluation and repair, encapsulation of exterior caulk, soil removal/replacement, and window removal/replacement. The study showed that even after primary sources of caulks containing PCBs were removed, some secondary reservoirs, such as paint, dust, and masonry, have detectable levels of PCBs remaining.

Construction Material Management Effectiveness

In general, many standard demolition and renovation management codes and regulations emphasize worker safety and hazard minimization. As a consequence, caution is often exercised when hazardous substances are suspected to be present. As noted in above, such precautions have mainly focused on asbestos and lead with limited awareness of PCB concerns. Specific studies on the effectiveness of these precautions to mitigate the deposition of PCBs into water sources have not been conducted. However, the Thomas et al. study on PCBs in schools in New York City successfully implemented some management practices that could be applicable to construction material management during the demolition or renovation of buildings with PCBs in caulk. These include proper ventilation, soil cover and access restriction, routine cleaning, and soil removal/replacement.

Soil and Erosion Control Effectiveness

A study conducted by the San Diego State University Soil Erosion Research Laboratory (SDSU/SERL) analyzed the performance of various mulching BMPs and soil binders for the purpose of soil and erosion control (Caltrans 2000). The BMPs that were included in the analysis include silt fences, compost berms, fiber rolls, hydraulic mulching, compost application, soil binders, hydraulic and bonded fiber matrices and rolled erosion control products. The majority of the BMPs have a relative erosion control effectiveness (when the BMP is compared to a bare soil of similar characteristics) of between 90% to 99%. The study shows that soil and erosion control

BMPs can be an effective management strategy in the detention of soil particles, which PCBs are known to bind to, thus being indirectly managed.

B.8.2.3 PCBs in Caulk Project: BMPs and Planning

The PCBs in Caulk Project aimed to develop tools for municipal agencies to improve the local role in managing potential releases of PCBs to storm drain systems during building demolition or remodeling. The following describes two major components in the project, the development of planning tools and training and the development of BMP guidance.

Model Implementation Process, Outreach, and training

The PCBs in Caulk Project started with a series of outreach workshops to obtain information from various stakeholders to better understand what current practices and policies were being followed in the management of PCB releases from building demolition and renovation projects. The stakeholders included a broad range of interests, including regulatory staff from the Regional Water Board and USEPA Region 9, municipal agency staff, and SFEI staff. Based on input received and additional information on regulatory requirements, an educational fact sheet was produced and distributed to municipal agencies. Project staff then developed a "Model Implementation Process" (MIP) document that provides a stepwise process by which municipal agencies can work with project proponents and the state regulatory agencies to ensure that building demolition and renovation projects comply with existing regulations. The MIP includes a number of templates designed to assist municipalities, including:

- Vendor lists for testing and abatement,
- Structure Type/Age Certification Form,
- PCBs in Caulk Assessment Checklist,
- Outline of PCB Runoff Prevention Plan,
- Building Staff Permit Issuance Checklist,
- PCB Sampling Report,
- Inspection Forms,
- Building Staff Permit Termination Checklist, and
- PCB Clean-up Completion Summary Report.

A training workshop was also conducted with municipal staff to test and refine the MIP before finalization.

BMP Practices

The SFEP Project also published the "Best Management Practices for Reducing PCBs in Runoff Associated with Demolition and Remodeling Projects"[25]. The purpose of the report is to summarize available information on BMPs that can be utilized to control the release of PCBs in caulk to stormwater runoff. Currently, the USEPA has recommended that contractors performing renovation and/or demolition activities implement a series of BMPs aimed at capturing PCB-containing dust that may be mobilized during the removal of caulk. The BMPs focus mainly on the PCB-to-air pathway in order to protect human health[26]. While the goal of the PCBs in Caulk Project is to reduce the exposure of PCBs to water, the BMPs aimed at protecting human health will also likely be effective in reducing the deposition of PCBs to the ground during dry weather periods, which will subsequently reduce the concentrations mobilized by rainfall and runoff. Additional BMPs that are routinely implemented on construction sites for sediment control, erosion control and waste management practices can also reduce the concentrations of PCBs that may be mobilized by wind and rainfall into waterways.

The range of potential BMPs that may be effective for reducing the exposure of PCBs in caulk to stormwater are presented below in three main categories: abatement (or practices implemented prior to demolition/renovation), construction materials management (or the isolation and disposal of materials), and erosion and sediment control practices.

Abatement Practices (Prior to Demolition)

BMPs that can be implemented prior to the start of renovation or demolition activities are considered abatement practices. The main abatement techniques involve the removal of PCB-containing materials, either through physical or chemical extraction from the building. The BMPs that were reviewed as part of the SFEP BMP and Planning Project that can be associated with abatement practices include the following: work area containment, worker training, tools and equipment, and personal protective equipment.

Work Area Containment

The goal of work area containment is to minimize the dispersion of contaminants outside of the specified work zone via wind and/or water mobilization. When used effectively, this BMP is designed to designate and confine the area that contains PCBs so that they may be removed efficiently. Some common practices include:

- Separate areas where work involving PCBs in caulk is planned from non-PCBs in caulk work areas;

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[25] Available at http://www.sfestuary.org/wp-content/uploads/2013/01/4_FinalBMPsNov142011.pdf

[26] Similar practices are required during abatement of asbestos-containing materials, some of which may also contain PCBs. However possible benefits in PCB removal of existing practices are outside the scope of the analyses in this Report.

- Phase work so that activities involving PCBs in caulk are completed, and contaminated materials and equipment are removed, prior to the start of subsequent work;
- Create a containment area where work involving PCBs in caulk is anticipated to isolate the dust and contaminant exposure;
- Take measures to protect nearby water sources, vegetation, buildings, or pathways where humans or the environment may be exposed; and
- Take decontamination precautions after interaction of equipment or personnel to PCBs in caulk.

Worker Training
Worker training emphasizes the proper handling and disposal of materials contaminated with PCBs, which can reduce the potential for PCBs to enter into stormwater. If the site is anticipated to contain soluble concentrations of PCBs above 5 mg/L or total concentrations above 50 mg/kg, it is considered to contain California Hazardous Wastes and the workers must be drained in Hazardous Waste Operations and Emergency Response (HAZWOPER). Specific site-training includes the discussion of the presence of PCBs in caulk and the consequences to human health and the environment from exposure, the identification of personnel responsible for site safety and health, how to identify hazards on site, proper use of Personal Protective Equipment (PPE), work practices that minimize risks from hazards, safe use of engineering controls and equipment, medical requirements, and review of a site-specific health and safety plan. If sites do not contain PCB levels above the thresholds to classify it as containing California Hazardous Wastes, workers are still entitled to receive information and training about PCH hazards and contamination.

Tools and Equipment
Tools and equipment used specifically for the removal of PCBs and those used during the demolition and renovation of buildings containing PCBs in caulk should be selected to minimize the potential for dust generation or mobilization of contaminants. An additional consideration is that tools and processes that generate high temperatures may produce gasses containing PCBs that will be released into the air. These gases may later deposit the PCBs on surfaces or in waters themselves that will contribute to the contamination of stormwater.

Personal Protective Equipment
The use of personal protective equipment (PPE) should be implemented to protect human health during abatement practices, and during actual renovation and demolition activities. When used correctly, PPE can minimize the transport and spread of PCBs from clothing and other materials that may have been unintentionally transported offsite and eventually into stormwater. A site-specific assessment is required prior to the determination of appropriate PPE for sites contaminated with PCBs.

Construction Material Management (Activities Associated with Demolition or Renovation and Engineering Management)

Construction material management BMPs are implemented during and following renovation and demolition projects to isolate and dispose of PCBs and contaminated tools or materials. BMPs that were reviewed as part of the SFEP Pilot Study and relate to construction material management include the following: building occupant notification, demolition BMPs, work area housekeeping and end-of-project activities, and transport and disposal. Many of the BMPs that can be implemented during the abatement phase are also applicable during the actual demolition and renovation process.

Building Occupant Notification

The notification of building occupants when renovation and demolition activities are planned is designed to protect human health, but it can also reduce the unintentional tracking of PCB-laden dust from the project site to water sources through the limitation of unauthorized access. Effective communication among all affected parties (i.e., building occupants, owners, workers, and community members) can help minimize the exposure of PCBs to humans and the environment.

Demolition BMPs

Demolition BMPs are intended to address demolition activities, such as razing of buildings, which occur after hazardous materials like PCBs have already been removed from the building. The BMPs generally involve wetting activities to minimize dust dispersion, and any runoff produced should be managed and contained properly.

Work Area Housekeeping and End-of-Project Activities

Housekeeping and maintenance of work areas is essential for managing PCBs in caulk during demolition and renovation. Daily housekeeping and cleaning activities should be completed to prevent cross-contamination across the project site and to minimize the tracking of PCBs off-site.

Following the completion of the actual building demolition or renovation, contractors should ensure that the trash and debris produced are removed and deposited in the appropriate manner and that the site is cleaned and decontaminated using practices that minimize the potential for dust or contaminant mobilization.

Transport and Disposal

Both the USEPA and the California Department of Toxics Substance Control manage the transport and disposal of materials containing PCBs produced during demolition and renovation projects. Transportation of PCBs must be in accordance with the California Health and Safety code and disposed of under the California Code of Regulations (CCR) Title 22. The disposal of the actual caulk containing PCBs, other contaminated solid wastes, and contaminated liquid wastes should be arranged with the appropriately permitted waste disposal facility and Federal decontamination and disposal regulations should be followed.

Erosion and Sediment Control Practices

Materials containing or exposed to PCBs that are temporarily stored on-site during renovation and demolition projects must be managed to limit exposure to wind and water. Traditional erosion and sediment control BMPs are often applicable when managing the protection of PCB-contaminated materials from erosion and transport. The California Stormwater Quality Association (CASQA) Stormwater Best Management Practice Handbook Portal: Construction (CASQA 2009) contains fact sheets for these BMPs with information pertaining to their purpose, suitable applications, limitations, implementation, costs, and maintenance.

While implementation of specific BMP types will be dependent on site conditions and constraints, the following categories are most applicable to building renovation and demolition where PCBs in caulk are present:

- Wind Erosion Control (WE-1)
- Stabilized Construction Entrance/Exit (TC-1)
- Storm Drain Inlet Protection (SE-10)
- Stockpile Management (WM-3)
- Hazardous Waste Management (WM-6)
- Contaminated Soil Management (WM-7)
- Concrete Waste Management (WM-8)
- Demolition Adjacent to Water (NS-15)
- Paving and Grinding Operations (NS-3)

These BMPs aim to adequately manage construction activities so that stormwater runoff from construction sites does not increase pollutants to levels that impact water quality. Specifically, sediment can be a pollutant and is the primary component of turbidity, total suspended solids (TSS) and suspended sediment concentration (SSC). Sediment can also transport other pollutants, like PCBs that bind to soil particles. Effective soil and erosion control BMPs, from non-structural controls like good-housekeeping, to structural controls like fiber rolls, silt fence, and sedimentation basins, can act to prevent the mobilization of soil and attached pollutants from migrating off-site.

It was the intent of the SFEP Project to test the effectiveness of the various BMPs described above in five case studies where actual demolition or renovation was being conducted by public agencies. After considerable outreach, it was determined that obtaining approval, planning, and implementation for such case studies within the available schedule was infeasible.

B.8.3 <u>Status of Control Measure Implementation</u>

B.8.3.1 Baseline

Table B.8.3.1 below shows the baseline practices governing demolition and renovation in the San Francisco Bay Area. Although monitoring is not required, if monitoring is conducted and concentrations are above 50 mg/kg, EPA regulations require the project or site manager to submit a self-implementing clean-up plan to EPA Region 9.

Table B.8.3.1. Baseline Management Practices for PCBs in Caulk

Practice	Baseline Implementation
Monitoring	Not required
Pre-Demolition Abatement	None
Demolition and Disposal	Standard demolition practices and disposal/ recycling as non-hazardous waste
Erosion and Sediment Control	Required as per the State Water Resources Control Board's Construction General Permit (SWRCB 2009)

B.8.3.2 Current

As no enhanced control practices have been implemented since TMDL adoption, the control measures in Table B.8.3.1 above also represent the current (enhanced) management practices, although there is considerable uncertainty regarding the level of implementation in the San Francisco Bay Area. A key question is the extent to which abatement is conducted for PCB management. As indicated above, the USEPA requires a management plan that includes abatement where monitoring data indicates PCB concentrations in sealants exceeding 50 ppm. But there is no regulatory requirement to monitor PCB concentrations in sealants. So, under the current regulations, abatement of PCBs in sealants may be quite limited. In a similar vein, in lieu of monitoring, the classification of waste is not evaluated and disposal or recycling as a non-hazardous waste could lead to reintroduction of PCBs into the environment.

B.8.4 <u>Estimates of Loads Avoided/Reduced</u>

B.8.4.1 Loads Avoided/Reduced Methodology

PCBs in Buildings and PCB Mobility

As described above, samples collected by SFEI indicate that concentrations of PCBs in caulk in Bay Area buildings fall into two tiers (Kosterhaus et al. 2011). Of the 25 samples analyzed, seven samples exceeded 1,000 ppm (maximum concentration of 220,000 ppm), with the remaining 18 samples less than 100 ppm. Also, 15 of the samples were less than 50 ppm, which is the current trigger for initiating EPA regulatory requirements for a management plan that includes abatement. The buildings with caulk containing the elevated PCB concentrations in excess of 1,000 ppm were all constructed in the 1950s, although there were other buildings with lower PCB concentrations that were also constructed in the 1950s.

Focusing only on those buildings with potential to have PCB-containing materials at concentrations greater than 50 ppm, Klosterhaus et al. conducted a GIS analysis of 1950 to 1980 land use data for areas subject to the MRP and estimated the mass of PCBs contained in caulk in buildings based on the median size of the buildings, the mass of sealant contained in buildings, and the sampling data collected in the San Francisco Bay Area, Boston and Toronto. The medium estimate of PCBs in each building was 4.7 kg of PCBs, with a low estimate of 0.6 kg, and a high estimate of 16 kg per building.

The data on the amount of PCBs from caulk that might be mobilized during demolition/renovation and available for further mobilization by rainfall and runoff is very limited. Kosterhaus et al. conducted a literature review and found only a few pertinent papers, including results from a study of one building in Stockholm, Sweden, where sealant was removed and the percent of mass of PCBs released to the air, soil, and water were reported. Based on their analysis of the data, Kosterhaus et al. estimated a medium value of 0.0043% of the original PCBs mass contained in building sealants entered the surface water runoff system. This study was not necessarily representative of typical demolition/renovation sites, since it required Kosterhaus et al. to make a number of assumptions. The authors indicated that this estimate could be biased low due to the omission of PCBs at concentrations under 50 ppm; and also the potential for PCB release from equipment and other building materials besides caulk and sealants.[27]

The SFEI Study results suggest that PCBs in sealants are not very mobile, and the principal pathway into the environment is via dust and larger sealant fragments released during the pre-demolition abatement process or during the demolition/renovation process itself.

Mass Balance Approach at the Building Scale

This section describes the methodology to be used to estimate the load reduction associated with the management of PCBs that could potentially be released during building demolition or renovation. The methodology is based on a mass balance for the PCBs contained in the sealants of an individual building subject to demolition or renovation.

The overall mass balance used at the building scale is as follows:

$$M_B = M_A + M_D + M_{ESC} + M_{MS4} \qquad \text{Eq. 1}$$

Where:

M_B = *Mass of PCBs in building,*

[27] While the SFEI Report did comment on other reservoirs of PCBs in existing buildings, discussion of management of non-caulk PCB sources was beyond the scope of the PCBs in Caulk Project and this report.

M_A = *Mass of PCBs removed by abatement prior to demolition,*

M_D = *Mass of PCBs removed by offsite disposal of demolition or renovation material,*

M_{ESC} = *Mass of PCBs removed by capture in erosion and sediment control practice, and*

M_{MS4} = *Mass of PCBs released to the MS4 storm drain system.*

The concept behind the mass balance approach is that the PCB containing materials in an individual building are managed through a sequence of BMPs or steps that can remove a certain portion of the original mass of PCBs. The mass remaining after each individual practice is subsequently available to be removed in the following practice. In this case, the mass of PCBs removed through abatement practices is considered first in the PCB removal hierarchy. Next, the mass remaining following abatement is subject to material management and disposal related controls. Any mass remaining after disposal that may still reside onsite is subject erosion and sedimentation control practices. Stockpile management and disposal and erosion and sediment control practices occur simultaneously, but this does not violate the mass balance.

If the mass removed is expressed as a product of the available mass times a “mass removal effectiveness”, or EFF value that varies between 0 and 1, the proportion of the original mass that is removed through the sequence of BMPs or steps can be obtained:

$$(M_B-M_{MS4})/M_B = EFF_A + EFF_D\ (1-EFF_A) + EFF_{ESC}(1-EFF_A - EFF_D + EFF_A*EFF_D) \qquad Eq.\ 2$$

Where:

EFF_A = *Mass removal effectiveness of abatement (expressed as fraction between 0 and 1 where 1 is 100% effective),*

EFF_D = *Mass removal effectiveness of offsite disposal, and*

$EFFES_C$ = *Mass removal effectiveness of erosion and sediment controls.*

For example, if abatement is assumed to be 50% effective, disposal is assumed to be 30% effective, and erosion and sediment control is assumed to be 70% effective, the overall percent of mass retained is approximately 90%:

Fraction of Mass Retained $=0.5+0.3(1-0.5) +0.7\ (1-0.5-0.3+0.5*0.3) = 0.895$

The remaining 10% of the PCB mass from the building is estimated to enter the MS4 system.

B.8.4.2 Loads Avoided/Reduced by Practices

The purpose of this section is to estimate the load reduction achieved by the implementation of enhanced management practices for the demolition and renovation of buildings containing PCBs in caulk. As no enhanced practices have been implemented at this time, the estimate presented in this section is for loads avoided by baseline management practices.

An estimate of the effectiveness for the baseline management practices was developed for a range (low, medium, high) of management strategy effectiveness levels and a range of mass of PCBs in San Francisco Bay Area buildings. Table B.8.4.1 estimates of the effectiveness for the baseline management practices for the range of management strategy effectiveness levels for the medium estimate of mass of PCBs per building (4.7 kg). The same methodology and assumed effectiveness values were applied for the low and high estimates of PCBs present per building as determined by SFEI (0.6 and 16, respectively) and are presented for comparison in Table B.8.4.2 below.

The estimates of effectiveness provided in Table B.8.4.1. are based on the literature review on effectiveness cited in an earlier section and on professional judgment. The rationale for the selection of effectiveness is summarized below:

- Pre-demolition abatement is assumed not to occur as part of the baseline management practices.
- Offsite disposal effectiveness encompasses practices designed to limit dust generation during demolition and materials stockpiling and removal offsite. Offsite disposal effectiveness also addresses the ultimate disposal of the materials and the extent to which such disposal prevents exposure to the environment. In general, the proper means of conducting these activities are well understood and are routinely implemented by good practitioners. However, the disposal and recycling options differ significantly depending on the classification of the waste. For the baseline management practices, the waste is assumed to be classified as ordinary construction material waste that could be recycled or disposed of in a non-hazardous waste landfill. In this case, there is potential for material to be introduced into the environment resulting in a range of lower effectiveness. Thus the effectiveness of offsite disposal management practices is estimated to range from 70 percent to 90 percent.
- Effective soil and erosion control practices are well known and required by the Construction General Permit. Estimates of effectiveness are supported by an extensive literature base, and although testing does not address PCBs specifically, controls that are effective in managing sediments are likely to be effective in controlling PCBs (which are primarily sediment bound).

Table B.8.4.1. Effectiveness of Baseline Control Measures (Mass per Building = 4.7 kg)

Control Measure Effectiveness	Abatement EFF	Offsite Disposal EFF	ESC EFF	Mass Captured (Fraction)	Mass Captured (kg)	Mass Released (kg)	Mass Released (%)
Low	0	0.7	0.6	0.88	4.14	0.564	12
Medium	0	0.8	0.7	0.94	4.42	0.282	6
High	0	0.9	0.8	0.98	4.61	0.094	2

Table B.8.4.2. Effectiveness of Baseline Control Measures for Low, Medium, and High Estimates of PCB Mass per Building

Control Measure Effectiveness	Mass per Building = 0.6 kg			Mass per Building = 4.7 kg			Mass per Building = 16 kg		
	Mass Captured (kg)	Mass Released (kg)	Mass Released (%)	Mass Captured (kg)	Mass Released (kg)	Mass Released (%)	Mass Captured (kg)	Mass Released (kg)	Mass Released (%)
Low	0.528	0.072	12	4.14	0.564	12	14.1	1.92	12
Medium	0.564	0.036	6	4.42	0.282	6	15.0	0.96	6
High	0.588	0.012	2	4.61	0.094	2	15.7	0.32	2

B.8.4.3 Summary of Key Uncertainties

There are a number of sources of uncertainty to accurately estimating PCB and Hg loads to San Francisco Bay associated with building demolition/renovation. The following describes those sources associated with input to the load estimation methodology, namely:

- Uncertainty in PCB Mass Contained in Buildings, and
- Uncertainty in Effectiveness of Control Measures.

Uncertainty in PCB Mass Contained in Buildings – A key input to the methodology is the amount of PCBs contained in the caulk in buildings subject to demolition or renovation. In one of the pilot studies, Klosterhaus et al. (2011) collected 25 samples from 10 buildings in the Bay Area. The data showed a range from non-detect to 220,000 ppm with generally higher concentration associated with pre-cast concrete structures built in the 1950s and 1960s. The amount of PCBs contained in buildings varied substantially depending on the age and type of buildings. The limited number of buildings sampled is a source of uncertainty in characterizing the Study Area building stock, and the limited number of samples per building also may not sufficiently characterize the variability in PCB concentrations in the caulk within each of the sampled buildings.

Uncertainty in Effectiveness of Control Efforts **–** The effectiveness of control efforts in mature stormwater program elements (e.g., new development controls) is generally well documented based on monitoring studies, and experience gained in the implementation of various types of measures under a variety of site conditions. In contrast, management of PCBs in caulk during demolition and renovation for environmental releases to the MS4 system is an emerging issue, and most control measures associated with demolition/renovation focus on worker safety rather than discharge to the MS4 and subsequent environmental effects. Three types of controls are identified in the methodology, pre-demolition abatement controls, demolition and disposal controls, and erosion and sediment transport controls at the site. The literature is very limited in terms of pilot studies that have addressed the effectiveness of abatement and demolition/disposal controls, although one somewhat dated study conducted in Switzerland and cited by Klosterhaus et al. (2011) indicates that abatement can be highly effective. The estimates provided in the methodology illustrate a range based for the most part on best professional judgment.

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B.9 DIVERSION TO POTWS

B.9.1 Introduction

This section of the Integrated Monitoring Report (IMR) addresses the use of diversions of dry weather and/or first flush events from municipal separate storm sewer systems (MS4s) to publically owned treatment works (POTWs) as a method to reduce loads of polychlorinated biphenyls (PCBs) and mercury in urban runoff.

B.9.2 Summary of Stormwater Diversion Pilot Projects

B.9.2.1 MRP Requirements and Implementation Approach

Permittees are currently implementing controls measures to divert stormwater to Publicly Owned Treatment Works (POTWs) at a pilot scale. Municipal Regional Stormwater NPDES Permit (MRP) Provisions C.11.f and C.12.f require the Permittees to pilot test diversions of first flush and dry weather urban runoff to POTWs. These provisions require the Permittees to collectively select five locations and five alternates by evaluating drainage characteristics and the feasibility of diverting flows to the sanitary sewer. In addition:

1. The Permittees should work with the local POTW on a watershed, program, or regional level to evaluate feasibility and to establish cost sharing agreements. The feasibility evaluation shall include, but not be limited to, costs, benefits, and impacts on the stormwater and wastewater agencies and the receiving waters relevant to the diversion and treatment of the dry weather and first flush flows.
2. From this feasibility evaluation, the Permittees shall select five pump stations and five alternates for pilot diversion studies. At least one urban runoff diversion pilot project shall be implemented in each of the five counties (San Mateo, Contra Costa, Alameda, Santa Clara, and Solano). The pilot and alternate locations should be located in industrially dominated catchments where elevated PCB concentrations are documented.
3. The Permittees shall implement flow diversion to the sanitary sewer at the five pilot locations. As part of the pilot studies, they shall monitor and measure PCB load reduction.

Permittees have conducted a systematic process for identifying, prioritizing, and implementing the five required pilot diversion projects. A stormwater diversion feasibility evaluation, coordinated through a Bay Area Stormwater Management Agencies Association (BASMAA) regional project, was conducted in 2009-2010. The evaluation included development of selection criteria for potential diversion projects and identified a range of candidate projects in each of the five counties regulated under the MRP. Based on input from the Regional Water Board, a revised Feasibility Evaluation Report (FER) was submitted in December 2010. This FER submittal fulfilled reporting requirements for Fiscal Year 2009-10 under provisions C.11.f and C.12.f of the MRP.

During FY2010/11, stormwater program representatives (on behalf of Permittees) implemented the screening process developed in the FER to propose five candidate and five alternate pilot diversion projects. Representatives met to refine the list based on expected learning benefits, opportunity areas, and constraints identified in the FER. Staff of the Regional Water Board attended meetings in October 2010, April 2011, and June 2011 to provide their comments on proposed pilot projects.

At that time, stormwater program representatives and Regional Water Board staff concurred that there was likely overlap between evaluations of the proposed diversion pilots and sediment management activities and they could collectively be carried out in fulfillment of Provisions C.11.d and C.12.d of the MRP. Opportunities were subsequently identified to evaluate the benefits of strategic storm drain cleanouts, street sweeping enhancements, street flushing, and other sediment management actions that could augment the planned pilot diversion projects.

Work plans for each of the five diversion projects were provided to the Regional Water Board in May 2012. These work plans identified project objectives, equipment and infrastructure requirements, water quality monitoring (including analytical methods), a general framework for identifying costs, benefits, and operation challenges associated with the diversions, and a time schedule for monitoring, evaluation, and reporting.

Status reports on the diversion projects were submitted with the BASMAA Regional Pollutants of Concern and Monitoring Supplements to the 2011, 2012, and 2013 Annual Reports to meet the MRP's annual reporting requirements. Both planning and implementation activities for the diversion projects were conducted during FY 2012/13 in accordance with May 2012 work plans.

Subsequent sections of this report summarize monitoring results available to-date and describe follow-up monitoring planned for FY 2013/14 as part of the IMR's overall evaluation of the pilot diversion projects and associated schedules for completion. Methodologies that will be used to assess the loads reduced via the pilot diversion projects are also described.

B.9.2.2 Pilot Stormwater Diversion Projects

The pilot diversion feasibility evaluation included costs, impacts on the stormwater and wastewater agencies, and benefits to the receiving waters. Selection criteria were based in part on a review of other programs that had scoped and/or implemented urban runoff diversion projects and on discussions with stormwater program representatives. The selection criteria were intended to inform the selection of sites (i.e., pump stations) for potential diversion and were framed around water quality needs, costs, and acceptability, as summarized in Table B.9.2.1 below.

Maps of PCB concentrations in sediments, pump station locations, and POTW service areas were included in the FER to assist with the needs criteria. Guidance was also provided for addressing the acceptability criteria. Tools for developing cost estimates and estimating potential load reductions of PCBs and Hg from stormwater discharges as a result of pilot diversion projects were also included in the FER.

Table B.9.2.1. Pump Station Diversion Selection Criteria and Information Needed

Criteria		Information Needed
Needs	Will the project likely yield a significant benefit to mercury and / or PCBs in receiving waters?	• PCB concentrations in sediments from the local drainage • Pump station inventories in GIS and tabular formats • Event-mean PCB concentrations in stormwater • TSS and flow measurements • Drainage area assessments
	Will the project provide unique or new information?	• Input from Technical Oversight Committee
	Does a pilot project fit into the broader regional context of pilot-testing a range of pollutant control strategies, including pollution prevention, site remediation, enhanced sediment management, and stormwater treatment retrofitting strategies?	• Input from Technical Oversight Committee
Costs	Are the capital and operation and maintenance costs associated with diversion prohibitive?	• Site investigations • Conceptual designs and drawings • Preliminary site-specific cost estimates • Treatment and connection costs/charges
Acceptability	Is there an accessible POTW willing and able to provide treatment service?	• POTW service area map • Communication with POTW managers
	Can the pilot diversion be sited within acceptable design criteria?	• Pre-design checklist assessment Table 1

The resulting five pilot diversion projects, one for each County regulated by the MRP, are listed in Table B.9.2.2 below and are indicated in Figure B.9.2.1.

Table B.9.2.2. Pilot Diversion Project Descriptions

County	City	Pilot Project
Alameda	Oakland	Dry and wet weather diversion at Ettie Street Pump Station to East Bay Municipal Utility District
Contra Costa	Richmond	Dry and wet weather diversion at North Richmond Pump Station to West County Sanitation District
Santa Clara	Palo Alto	Dry and wet weather collection from existing structure in Palo Alto that diverts urban runoff to the Palo Alto Regional Water Quality Control Plant
Solano	Fairfield	Dry season vactor truck wet well collection at State Street Pump Station and discharge to Fairfield-Suisun Sewer District
San Mateo	San Carlos	Dry and wet weather collection from Pulgas Creek Pump Station and discharge to South Bayside System Authority

A summary matrix identifying the evaluation approach for and characteristics of each of the five pilot diversion projects is included in Appendix B.9.A.

The following sections provide an overview and status of each pilot diversion project as of September 2013. Monitoring at four of the project sites (in Alameda, Santa Clara, San Mateo, and Solano Counties) commenced during the third quarter of 2012. Monitoring for the Contra Costa County project will commence in 1st quarter of 2015, to complement previous characterization monitoring. Agencies will continue to communicate with Regional Water Board staff as the projects progress and may adapt their work plans in response to those discussions and climatic conditions.

Ettie Street Pump Station, Alameda County

Project Overview and Objectives

ACCWP selected for the pilot study the Ettie Street Pump Station (ESPS), located in the City of Oakland. The selection was based on: 1) elevated PCB and mercury concentrations found in previous studies of sediment in the ESPS and its watershed, and 2) geographical proximity to the East Bay Municipal Utilities District (EBMUD) conveyance and wastewater treatment systems (see Figure B.9.2.).

Prior to the development of the Clean Watersheds for a Clean Bay (CW4CB) Pilot Study, the EBMUD investigated the feasibility of a stormwater diversion at ESPS for consideration as a possible PCB and mercury reduction offset program, collecting composite water samples between April 2008 and February 2010 from the pump station forebay during dry weather, first flush, and wet weather events. A pilot constant flow dry weather diversion of 75 gallons per minute (gpm) was implemented by EBMUD in collaboration with the City of Oakland during that same time period using a connection to an existing sanitary sewer line in the ESPS. The EBMUD study found that while the additional treatment volumes from the diversion would not significantly affect EBMUD discharge quality or operations, more “specific” data were needed to address the storm-to-storm variability. In addition, EBMUD would need to evaluate hydraulic capacity, costs, and regulatory implications to clarify the acceptability of a long-term diversion project.

Average PCB concentrations during first flush or other wet weather conditions monitored during the EBMUD project averaged one order of magnitude higher than in dry weather, and were more variable. Thus, the results of the study indicated that the opportunities for reducing PCB loads are much higher for diversions implemented during wet weather. Infiltration in the aging sanitary conveyance system, however, causes capacity problems at the EBMUD plant during peak runoff flows. ACCWP’s study therefore focused on diversion scenarios involving pretreatment storage of stormwater runoff followed by post-storm discharge to the sanitary sewer.

Following the EBMUD Study, the ESPS Diversion Pilot Project was planned to further evaluate the potential benefits of diversions. The Pilot Project was also designed to leverage the use of the

ESPS site for one of the retrofit treatment pilot projects included in the CW4CB grant project. The Pilot Project consists of two elements. The initial pilot phase installed a pilot test diversion to evaluate the feasibility of using a continuous turbidity sensor to direct selective pumping of stormwater from the ESPS wet well to a storage tank for detention and pretreatment. Water from the storage tank can be directed either to an existing sanitary sewer line or to a 2-bed media filter treatment system to be installed in fall 2013 as one of the CW4CB retrofit pilot projects described in Section B.7.

To support the overall goals of improving understanding of the cost-effective applications for mercury and PCB controls, the ESPS pilot project has the following objectives:

1. Evaluate potential for PCB and mercury load reductions under scenarios of different diversion pumping regimes;
2. Test use of turbidity thresholds as trigger criteria for diversion;
3. Establish a site-specific relationship between particle size, concentrations of PCBs and mercury, and turbidity to support annual load estimates;
4. Develop scenarios for larger-scale pretreatment and diversion and document additional feasibility considerations involved;
5. Evaluate costs and benefits of the pilot project and larger-scale implementation scenarios; and
6. Coordinate system and monitoring design with planning for the pilot retrofit media filters to maximize data leverage and cost-effectiveness for both pilot projects.

Status of Project

Installation of the turbidity probe and preliminary sampling during one storm event were conducted at the ESPS in spring 2012. Installation of a 500-gallon stainless steel storage tank for the small-scale pilot diversion was completed in summer 2012, followed by a stormwater sampling event in November 2012 that provided particle distribution data requested by CW4CB consultants to inform monitoring plan design for the CW4CB retrofit pilots. However, recurrent data quality problems were observed with the turbidity probe output showing a bias toward lower readings, which were attributed to fouling of the sensor glass and wiper. The probe mount was redesigned to permit regular wet season maintenance without confined space entry, and additional monitoring is planned for FY 2013-14 that will be coordinated with parallel monitoring of the retrofit media filters.

Based on comments by Regional Water Board staff on the May 2012 work plan, the monitoring design was revised to leverage the CW4CB monitoring efforts and increase the ACCWP resources directed to evaluation of costs and benefits associated with a larger scale diversion concept developed during FY12-13. The larger-scale diversion scenario incorporated the following elements:

- Larger pretreatment storage facilities constructed on adjacent land underneath the MacArthur Freeway (see Figure B.9.2.) if feasible through either acquisition of easement rights granted by the State of California to ACFCWCD or a Common Use Agreement between the State and ACFCWCD.
- Permanent diversion conveyance from ESPS to the pretreatment facility.
- Permanent diversion conveyance from pretreatment to sanitary sewer to be implemented by EBMUD and sized to carry typical dry weather flows from the ESPS (approximately 1000 gallons per minute). This conveyance, now in the initial planning stage, will be available in non-peak flow periods for transfer of pretreated stormwater from the ESPS. ACCWP will qualitatively review potential challenges in obtaining easements for a new larger-scale conveyance across existing freeways and railroads, in reference to the alternatives being considered by EBMUD for connection to existing conveyance lines owned by EBMUD or the City of Oakland.
- Wet weather diversion from ESPS to pretreatment that would be triggered by elevated turbidity during storm events. Multiple scenarios of diversion timing and volume will be developed in consideration of alternative turbidity thresholds and the characteristics and constraints of facility capacity and conveyance design.
- Estimated construction and operating costs for facilities and equipment for pumping, controls and monitoring, maintenance, sediment disposal and security for all facilities.
- Outlining terms of agreement with EBMUD for ongoing sharing of costs and TMDL load allocations for PCBs and mercury associated with the amounts transferred through stormwater diversion.

Additional Feasibility Study evaluations will be conducted during September 2013.

North Richmond Stormwater Pump Station, Contra Costa County

Project Overview and Objectives

The Contra Costa Clean Water Program (CCCWP) is facilitating implementation of a stormwater diversion pilot project to divert urban runoff from the North Richmond Stormwater Pump Station (North Richmond Station) to the West County Wastewater District (WCWD). The North Richmond Station is jointly owned by Contra Costa County (61 percent) and the City of Richmond (39 percent) through a Joint Powers Authority (JPA) based on a 1974 agreement. The WCWD is currently under a separate contract with the JPA to maintain and operate the North Richmond Station.

The North Richmond Station is designed to control stormwater flooding conditions for the unincorporated area of North Richmond. The station receives water from a network of stormwater collection sewers which drain into the wet well of the pump station. Stormwater is then pumped into the discharge channel of the pump station that drains by gravity into a 78-inch discharge pipeline.

As shown on Figure B.9.3, the area draining to the station consists of mainly industrial and residential land uses in the unincorporated area adjacent to the north boundary of the City of Richmond. The storm drainage system delivers stormwater to the North Richmond Station located on the southwest corner of Gertrude Avenue and Richmond Parkway. The station's 78-inch discharge pipeline runs westward from the pump station along an easement on the Chevron Chemical Company's property just south of Gertrude Avenue. At about 950 feet downstream of the pump station, the pipeline enters an 8-foot by 4-foot box culvert which crosses Gertrude Avenue and runs into a trapezoidal earth channel that drains to Wildcat Creek.

Objectives for the North Richmond Station pilot diversion project include:

7. Evaluate PCB and mercury loads avoided through pump station maintenance conducted in conjunction with diversion to a POTW;
8. Design a diversion pilot project that can be permitted for discharge to West County Wastewater District; and
9. Evaluate operating techniques that can treat first flush without adversely impacting POTW capacity.

The Project is being implemented by the County, a Permittee of the CCCWP. The County sought and obtained grant funding administered by the San Francisco Estuary Project through the USEPA San Francisco Bay Area Water Quality Improvement Fund. The Project is one of several in the “Estuary 2100 Phase 2: Building Partnerships for Resilient Watersheds” program. The grant provides $496,649 in USEPA funds, matched by $165,550 from the County to plan, design, construct, and monitor an engineered diversion into WCWD. Details of the diversion concept are discussed in a technical memorandum submitted to the WCWD in November 2012 (CCCWP 2012a).

Baseline water quality monitoring was performed per the scope of the grant between 2010 and 2012. WCWD staff had substantial input on the monitoring parameters for that baseline study. The baseline study was completed and reported in 2012 (Hunt et al. 2012). The water quality characterizations from the North Richmond Station, along with assessments of sediments in the associated drainage area, indicate that mercury and PCB concentrations in sediments are high enough to provide potentially significant benefits for stormwater management in that area. Mercury to suspended sediment ratios are the third highest of twenty-two Bay Areas watersheds characterized by SFEI (Yee and McKee 2012). PCBs to suspended sediment ratios are the fifth highest of Bay Area watersheds assessed in that same study.

Yee and McKee (2012) showed that for the period monitored, 160 million gallons of stormwater passed through the North Richmond Station, conveying an estimated load of approximately 11 grams of PCBs.

Status of Project

A probable construction cost estimate and preliminary schedule for the Project was developed by Brown and Caldwell in December 2012. The estimated construction cost, $764,000, exceeds the original grant assumption. Design costs for the diversion are approximately $100,000, in addition to the construction cost. The construction costs reflect not only the diversion, but also much needed infrastructure rehabilitation at the North Richmond Station. The diversion construction costs represent a moderate (i.e., approximately $50,000 - $100,000) in additional design and construction costs added to the costs of the infrastructure rehabilitation necessary to meet flood control needs.

The current recommended approach is a "hard-piped" diversion, with flows routed into the nearest sanitary sewer collections system. One main pump and one back-up low flow pump (250 gpm, 0.4 mgd) would be installed in the North Richmond Station wet well. The pumps would be connected to and controlled by a supervisory control and data acquisition system (SCADA). Water level sensors in the outlet of the conveyance pipe would allow the pumps to be shut down via the SCADA system if the conveyance was reaching its capacity. In addition, the SCADA system would be connected to continuous water quality probes that could detect petroleum or other spills and trigger pump shut-down.

Some of the more substantial costs of the diversion pilot are related to planning, monitoring, and risk management. The initial pre-diversion monitoring cost was approximately $180,000. Planning support by CCCWP consultants has cost $80,000 to date, and continues to accrue. Although pre-diversion monitoring has been completed (Hunt et al. 2012), concerns raised by WCWD may require additional monitoring. As of June 2013, the need for additional monitoring to support the Project is being discussed by the CCCWP Monitoring Committee.

CCCWP Management Committee Members have been regularly briefed on progress in scoping the diversion pilot. Between January and April 2013, CCCWP staff, along with County and Richmond staff, engaged directly with WCWD staff who were authorized by the WCWD Plans and Programs Committee to discuss pilot diversion concepts with project proponents. In those discussions, the following technical concerns were fleshed out by WCWD:

- Conveyance capacity
- Toxicity to activated sludge microorganisms
- Effluent quality
- Bio-solids quality
- Spills and illicit discharges

CCCWP is developing a technical memorandum addressing the above concerns expressed by WCWD. Concurrently, the County is moving forward with procurement of a design consultant to develop biddable plans, specifications, and cost estimates for the Project. The County continues to negotiate with WCWD over the terms and conditions of a permit to discharge dry weather urban runoff and first flush into the WCWD collection system. A significant challenge to obtaining that permit is regulatory relief from consequences should the diversion cause a sewage treatment system upset, a sanitary sewer overflow, or exceedance of an effluent limit.

The NPDES permit reissued to West County Agency May 8, 2013 by the Regional Water Board does not provide for explicit regulatory relief. However, it does include a Permit Reopener Provision (VI.C.1.f) that allows for reconsideration of this issue:

> *"If the Dischargers request adjustments in effluent limits due to the implementation of a stormwater diversion pursuant to the Municipal Regional Stormwater Permit (No. CA0038593), for redirecting dry weather and first flush discharges from the storm drain system to the sanitary sewer system as a stormwater pollutant control strategy."*

At present, it is anticipated that construction of the Project would commence in the dry season of 2014, to be ready for a diversion pilot in wet season 2014 – 2015. The proposed approach is for late dry season flows to continue to be diverted to the flood control channel, per normal operations. Weather reports would be monitored, and when there is a significant probability of a storm (e.g., greater than 75 percent chance of at least 0.5 inches of rain in a 24 hour period), the WCWD would be notified and the pump station valving changed to redirect flows to the WCWD. Diversions would continue until level sensors determined that pipeline capacity was less than 0.5 mgd.

The diversion would resume after capacity was restored. This pattern of weather tracking, notification, and diversion would continue for one month. Approximately six months after the first flush diversion was implemented and evaluated, a dry weather diversion would be implemented. The dry weather diversion would be conducted for a summer season (e.g., June through August).

Pulgas Creek Pump Station, San Mateo County

Project Overview and Objectives

The San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) pilot diversion project evaluated the diversion of dry weather runoff and first flush flows of stormwater from near the Pulgas Creek Pump Station to the sanitary sewer collection system served by the South Bayside System Authority's (SBSA) regional wastewater treatment plant. As described in the FY 2010-2011 annual report, SMCWPPP selected the City of San Carlos' Pulgas Creek Pump Station watershed for the pilot diversion project and other CW4CB studies because of the relatively high concentrations of PCBs found in pump station and storm drain sediments. The approximately 330-acre watershed draining to the Pulgas Creek Pump Station is comprised of current and historic industrial land uses.

As part of a stormwater runoff characterization study conducted for the Small Tributaries Loading Strategy (STLS) of the Regional Monitoring Program (RMP), analyses of PCBs and mercury were performed on stormwater samples from the two storm drain lines that flow to the Pulgas Creek Pump Station (McKee et al. 2012). The PCB results in Table B.9.2.3 show that the stormwater contained between about 19,000 and 84,500 picograms per liter (pg/L) of total PCBs. These concentrations are relatively elevated compared to the 886 pg/L Event Mean Concentration (EMC) of total PCBs calculated by SFEI from stormwater runoff sampling with similar methods from a parking lot and recreation area in Daly City (Lent et al. 2011).

The data also show that the concentrations of total PCBs from the north Pulgas Creek storm drain line were generally higher than those found in the south Pulgas Creek storm drain line.

Table B.9.2.3. Total PCBs (pg/L – total of 40 congeners) in Stormwater Runoff to Pulgas Creek Pump Station in San Mateo County

Sampling Date[1]	North Pulgas Creek Storm Drain Line	South Pulgas Creek Storm Drain Line
Feb. 17, 2011	46,896	53,894
	43,339	19,060
March 18, 2011	84,490	31,043
	66,554	21,883
Average	60,320	31,470

[1] Samples collected on the same dates were collected at different times.

One of the essential requirements of the pilot diversion project is to be able to dispose of the diverted dry weather urban runoff and stormwater to the City of San Carlos' sanitary sewer system. The Countywide Program staff worked with SBSA and City of San Carlos staff to obtain a wastewater discharge permit for the City of San Carlos.

In June 2012 SBSA staff distributed a draft permit and based on discussions among City of San Carlos, SBSA, and Countywide Program staff, modifications to the draft were proposed and accepted. The final permit was executed during the first half of July 2012. The permit authorizes the diversion of a limited volume of dry weather urban runoff and stormwater for a one-year period between July 1, 2012 and June 30, 2013. The permit describes discharge, monitoring, and reporting requirements. The discharge permit is subject to revision at any time for the purposes of protecting the sanitary sewerage facilities and workers and to accommodate new regulations and NPDES permit requirements that may be imposed on SBSA.

As outlined in the May 2012 project work plan, the pilot diversion project was to conduct wet and dry weather pilot scale diversions of urban runoff from the north Pulgas Creek storm drain line during FY 2012-2013. A flow meter and turbidity sensor were installed in the north Pulgas Creek storm drain line manhole, located immediately upstream from the pump station. Water was collected for diversion through a small submersible pump that sent water through a flexible conduit to a 500-gallon storage tank located in the yard adjacent to the pump station. Water from the storage tank was collected and transported by the City of San Carlos' Vactor truck for disposal through a sanitary sewer connection at the City of San Carlos' corporation yard that conveys wastewater for treatment and disposal by the South Bay System Authority (SBSA).

Targeted wet weather diversions were designed to include, to the extent feasible, the first rainfall event of the 2012-2013 wet season, plus up to three additional events. During each of the targeted storm events, discrete water quality samples were to be collected from the north Pulgas Creek storm drain line and tested for PCBs, mercury, and suspended sediment concentrations. In addition, as required by SBSA, testing was also to be conducted during disposal of diverted stormwater collected during two events. Samples would be collected from the Vactor truck discharge to the corporation yard's sanitary sewer connection. These samples would be tested for copper, mercury, and PCBs as the sum of 40 congeners. Sampling was also designed to be conducted in connection with one dry weather diversion event prior to the start of the 2012-2013 rainy season.

The pilot diversion project will also evaluate the projected costs and benefits of a larger scale and more permanent dry and/or wet weather diversion at the Pulgas Creek Pump station in order to have the technical information needed to evaluate the feasibility of diversions as part of future stormwater NPDES permit terms. The evaluation will also include how to coordinate possible plans for a long-term, more permanent sewer diversion with the City of San Carlos' planned upsizing of sewer pipelines along Industrial Road and Brittan Road in the vicinity of the Pulgas Creek Pump Station. One of the major problems with trying to divert stormwater to the sanitary sewer system in the Pulgas Creek Pump Station drainage area is that the sewer system is undersized in this area, and the City of San Carlos is already at its maximum capacity for discharging wastewater to SBSA.

Status of Project

Initial installation of the continuous monitoring equipment (data loggers, flow and turbidity meters, and batteries) in the Pulgas North storm drain line was accomplished in October 2012. A rainfall gauge was installed on the roof of the Pulgas Creek Pump Station. However, at a follow-up maintenance visit in November, technical problems were discovered with the flow/turbidity data logger that prevented logging of continuous turbidity measurements, although continuous flow measurements were being made. The data logger and turbidity sensors were removed and taken to the laboratory for troubleshooting. After several weeks of unsuccessful attempts to resolve the issues, replacement equipment was procured and installed at the site in December 2012.

Thus, prior to December 2012, no turbidity measurements were recorded, and only limited flow measurements (between the initial installation in October and removal of the data logger in November) were recorded. Following the December installation, regular maintenance events were conducted throughout the remainder of the rainy season (approximately every two weeks through the end of April) in order to download data and assure proper operation of all equipment. From December 2012 through May 2013, continuous flow, turbidity and rainfall data were measured at the site.

One dry weather diversion event was conducted in November 2012. Immediately prior to the diversion, water samples were collected from the North Pulgas storm drain line according to the methods and procedures described in the work plan. Using a portable, submersible pump, approximately 500 gallons of water were pumped out of the North Pulgas storm drain line through flexible conduit into a stainless steel tank. The City of San Carlos maintenance staff removed the water from the tank using their Vactor truck. The water was taken to the City's corporation yard and discharged into the sanitary sewer line, per the SBSA permit.

One storm diversion event was conducted in March 2013. Samples were collected from the Pulgas North storm drain line during the storm event according to the methods and procedures described in the work plan. Stormwater was diverted from the Pulgas North storm drain using the submersible pump/conduit system used for the dry weather diversion into the same stainless steel tank. Following the storm (during dry weather), the City of San Carlos maintenance staff removed the water from the tank using their Vactor truck and discharged the stormwater into the sanitary sewer line, per the SBSA permit. Samples of the water were collected as it was discharged into the sanitary sewer line and analyzed according to the SBSA permit requirements.

Due to the equipment issues[28] at the beginning of the 2012 wet season and the lack of storms during the remainder of the rainy season, only one storm was monitored and only one wet weather diversion was completed. The site was demobilized in May 2013. During the demobilization, water samples were collected from the Pulgas North storm drain line to provide additional data on concentrations of POCs during dry weather, but no water was diverted to the sanitary sewer.

Because only one dry diversion event and one wet weather diversion event has been completed to date, this project will continue through the 2013-2014 rainy season. Weather permitting, three wet weather diversion events will be conducted at this site between October 2013 and April 2014. SMCWPPP is coordinating with SBSA to obtain an extension of the SBSA discharge permit for San Carlos through June 30, 2014. The project schedule included in Appendix B.9.A illustrates the revised timeframe for completion of the project.

[28] Significant communication issues between the data loggers and samplers/probes deployed at the site caused monitoring to be postponed. Communication issues have been subsequently addressed.

Palo Alto Diversion Structure, Santa Clara County

Project Overview and Objectives

The pilot diversion project that is currently being implemented by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), in cooperation with the City of Palo Alto, is an evaluation of an existing dry and wet weather diversion structure located in the City of Palo Alto (Figure 6). The diversion structure was constructed in 1993 to divert a limited volume of urban runoff from the stormwater conveyance system to the Palo Alto Regional Water Quality Control Plant. The area draining to the diversion structure is roughly 50 acres and is bound by Hamilton Avenue, Bryant Street, Channing Avenue and Alma Street. The site was originally selected by the City of Palo Alto because of the land use in the drainage area (commercial, light industrial, multi-family residential), proximity of the 27" sewer trunk line to the storm drain line, and because the sewer trunk line had excess capacity. The structure was designed to divert urban runoff flows into the sanitary sewer at no more than 0.5 million gallons per day (MGD).

The overall goal of this pilot project is to comply with provisions C.11.f/C.12.f of the MRP by better understanding the applicability, costs and benefits associated with the existing Palo Alto urban runoff diversion structure. The Palo Alto pilot diversion project was designed to address the following three objectives:

1. Evaluate pollutant loads to the Bay that are reduced due to current operation of the existing diversion structure.
2. Estimate projected benefits, challenges and costs of constructing and operating a similar diversion structure in other watersheds (e.g., a larger drainage area and/or an area known to have elevated concentrations of PCBs or mercury).
3. Document the knowledge and experience gained from evaluation of the diversion structure to inform planning of urban runoff diversions in the next permit term.

A work plan that describes the methods used to evaluate the effectiveness of the Palo Alto diversion structure and to fulfill the objectives of the project was provided to the Regional Water Board in May 2012. The work plan was designed to guide monitoring and data collection activities over Fiscal Year 2012-13. Work plan tasks included: (1) project planning; (2) water quality monitoring; (3) evaluation of diversion costs and operational challenges; (4) cost and benefit analysis; and (5) reporting.

Monitoring activities outlined in the work plan include continuous monitoring of the volume and turbidity of urban runoff flowing into and through the diversion structure. Water quality sampling includes suspended sediment concentrations, particle size distribution, and mercury and PCB concentrations during two dry weather events and three wet weather events. These data will be used to calculate loads removed from urban runoff due to operation of the diversion structure.

The work plan also defined a framework to evaluate the construction, operation, and costs associated with the diversion structure. This framework guided information gathering activities associated with Work Plan Task 3 (evaluation of diversion costs and operational challenges). Activities conducted during FY 2011-2012 under this task included gathering and reviewing construction documents, and mapping and documentation of the site and the diversion structure. Additional information gathering, including investigation into construction and maintenance costs and operational challenges and constraints to the POTW receiving the diversion were continued during 2012-13.

Targeted storm diversion events included the first rain event of the 2012-2013 wet weather season that generated runoff at the site and additional storm diversion events selected to represent the range of expected flow conditions at the site.

Status of Project

Initial installation of the continuous monitoring equipment (data loggers, flow and turbidity meters, and batteries) at the Bryant/Channing diversion structure in Palo Alto, CA was completed in January 2013. Equipment was installed at two locations: (1) in the storm drain line immediately upstream of the diversion box; and (2) in the manhole immediately downstream of the diversion box, just prior to where the stormwater is discharged into the sanitary sewer line. Following the January installation, regular maintenance events were conducted throughout the remainder of the rainy season (approximately monthly through the end of April) in order to download data and assure proper operation of all equipment. Between January and May 2013, continuous flow was measured at both locations and turbidity was measured at the upstream location only. Rainfall data were collected from nearby existing rain gauges.

Two dry weather urban runoff diversion monitoring events were conducted in FY 2012-13. The first dry weather event was conducted in January 2013 and the second was conducted in May 2013. During both events, samples were collected from both monitoring locations (e.g., from the water as it entered the diversion structure and from the diverted water downstream of the diversion structure). Sand bags were used to temporarily block the diverted water from draining into the sanitary sewer to allow collection of the diverted water. Samples were collected and analyzed according to the methods and procedures described in the May 2012 work plan.

One wet weather monitoring event was conducted in March 2013. Samples were collected from both monitoring locations (upstream and downstream of the diversion box) according to the methods and procedures described in the work plan.

Due to equipment issues (described under the Pulgas Creek Pump Station Diversion project) and the lack of storms during the remainder of the rainy season, only one of the three planned storm monitoring events was completed. The site was demobilized in May 2013, but will be remobilized and continue during the 2013-2014 rainy season in order to collect two additional storm water diversion monitoring events between October 2013 and April 2014. The project schedule included in Appendix B.9.A illustrates the revised timeframe for completion of the project.

State Street Pump Station, Solano County

Project Overview and Objectives

The Solano County pilot diversion project is being implemented by the Fairfield Suisun Urban Runoff Program (FSURMP) and Fairfield-Suisun Sewer District (FSSD). The project involves changes to the operation of an existing pump station so as to divert stormwater from the station to the FSSD wastewater treatment plant. The State Street pump station is located in the City of Fairfield just upstream of Suisun City. It serves a watershed area of approximately six acres. The contributing area is commercial, of which a significant portion is automotive repair. (See Figures B.9.7. and B.9.8.).

The pump station changes to be evaluated for this project include:

- Shutting off the stormwater pump station during dry weather;
- Removing standing water in the pump station wet well throughout the dry season and before the first flush; and
- Monitoring concentrations of pollutants and pollutant indicators in the diverted water

The following three objectives have been developed for the project:

1. Evaluate pollutant loads to the Bay that are reduced due to stormwater diversion.
2. Estimate projected benefits, challenges and costs of operating a similar diversion in a similar drainage area and/or an area known to have elevated concentrations of PCBs or mercury.
3. Document the knowledge and experience gained from evaluation of the diversion project.

Status of Project

Normal discharges from the State Street Pump Station were terminated in mid-June 2012. The contents of the pump station's wet well (approximately 825 gallons) were subsequently removed by FSSD staff using a Vactor truck. Prior to removal, the discharge pumps were operated to mix the contents and to collect a representative sample. This June 18, 2012 sample was analyzed for PCBs, mercury, total organic carbon, total metals, and suspended sediment concentration. The contents were trucked and discharged to the FSSD treatment plant. As an "in-house" pilot project, there were no formal agreements needed for treatment plant's acceptance of the discharge.

There was minimal subsequent dry weather runoff accumulation in the pump station. FSURMP and FSSD removed approximately 1200 gallons on September 20, 2012, and analyzed a sample for the same suite of constituents as the June 18, 2012 sample. Following collection of this sample, the pump station was returned to normal wet season operation. Flows into the pump station were also monitored during summer 2013. The project schedule included in Appendix B.9.A. illustrates the revised timeframe for completion of the project.

B.9.2.3 Results of Pump Station Diversion Pilot Project Monitoring

As of the writing of this section, analytical results for the five diversion structure pilot projects are not yet available. Once monitoring data become available in FY 2013/14, BASMAA member agencies plan to analyze monitoring results and present data in subsequent reports. The timing of those reports and analyses will be contingent upon the completion of the projects. Current project schedules are included in Appendix B.9.A.

B.9.3 Status of Control Measure Implementation

This section summarizes the baseline and enhanced level of implementation of each of the five pilot stormwater diversion projects. Once monitoring data become available in FY 2013/14, BASMAA member agencies plan to analyze monitoring results and present load reduction benefits in subsequent reports.

B.9.3.1 Baseline

Prior to the TMDL (July 1, 2002) one of the five pilot stormwater diversion projects was operational. The Palo Alto Diversion Structure on Bryant Street was constructed in the mid 1990's and therefore load reductions associated with this structure should be considered baseline, unless the load reduction efficiencies of this structure post July1, 2002 can be enhanced and quantified. No mercury or PCB measurements were made prior to July 1, 2002 to establish baseline load reductions at this site, but could be assumed to be similar to current load reductions for the purposes of calculating the benefits of enhanced implementation in the future at this site.

B.9.3.2 Current

Four of the five pilot projects were active and collected and analyzed samples in FY 2012-13.

Ettie Street Pump Station, Alameda County

In 2013, as part of the C.11.f/C.12.f pilot diversion project, ACCWP began implementation of dry weather and stormwater diversions from the Ettie Street Pump Station (ESPS) in Alameda County to the East Bay Municipal Utilities District (EBMUD). ACCWP monitored turbidity during the FY 2012 – 2013 wet season and sampled stormwater from a November 2012 event, which was analyzed to provide requested particle distribution data. Work continues on evaluation of costs and benefits associated with a larger scale diversion concept similarly based on detention of wet weather diversions.

North Richmond Stormwater Pump Station, Contra Costa County

In 2013, as part of the C.11.f/C.12.f pilot diversion project, planning for the construction of a permanent stormwater diversion at the North Richmond Stormwater Pump Station in Contra Costa County continued. Baseline water quality characterization monitoring was completed during the 2010-2011 wet season. At present, it is anticipated that construction of the Project would commence in the dry season of 2014, to be ready for a diversion pilot in wet season 2014 – 2015.

Pulgas Creek Pump Station, San Mateo County

In FY 2012-13, as part of the C.11.f/C.12.f pilot diversion project, two monitoring events were implemented at the Pulgas Creek Pump Station in San Mateo County, including one diversion of 500 gallons of dry weather runoff and one diversion of 500 gallons of stormwater runoff from the Pulgas Creek Pump Station in San Mateo County to the SBSA. Chemical analysis results from monitoring during these diversion events (currently undergoing QA/QC review) will be used to calculate the total load of mercury and PCBs diverted. Weather permitting, three additional wet weather diversion events are planned for FY 2013-14.

In addition, Program staff continue to work with the City of San Carlos to evaluate the projected costs and benefits of a larger scale and more permanent dry and/or wet weather diversion at the Pulgas Creek Pump station in order to have the technical information needed to evaluate the feasibility of diversions.

Palo Alto Diversion Structure, Santa Clara County

In 2013, as part of the C.11.f/C.12.f pilot diversion project, three diversion monitoring events were conducted at the Bryant Street Diversion Structure in San Mateo County, including two dry weather events and one wet weather event. Monitoring data of flow, turbidity, and water chemistry collected during these events (currently undergoing QA/QC review) will be used to calculate the annual load of mercury and PCBs diverted to the sanitary sewer system at this site. Weather permitting, two additional wet weather diversion monitoring events are planned for FY 2013-14.

In addition, Program staff continues to work with the City of Palo Alto to evaluate the costs and benefits of constructing and maintaining the Bryant Street diversion structure.

State Street Pump Station, Solano County

In 2012, as part of the C.11.f/C.12.f pilot diversion project, the Fairfield Suisun Urban Runoff Program (FSURMP) and Fairfield-Suisun Sewer District (FSSD) began the Solano County pilot diversion project by implementing changes to the operation of the State Street Pump Station in order to divert stormwater from the station to the FSSD wastewater treatment plant.

During two events, dry weather accumulation in the pump station was removed and diverted to the FSSD wastewater treatment plant. Chemical analysis results of samples collected during these events will be used to calculate the load of mercury and PCBs diverted. Flows into the pump station were monitored during summer 2013.

B.9.4 Estimates of Loads Avoided/Reduced

B.9.4.1 Current Loads Avoided/Reduced Methodology

This section presents the conceptual approach that will be used to estimate mercury and PCB stormwater loads avoided/reduced due to pilot stormwater diversion projects.

The Ettie Street Pump Station and Pulgas Creek Pump Station projects each diverted dry season and wet season urban runoff (using differing methodologies) into 500-gallon storage/pretreatment tanks. The pollutant mass diverted is therefore determined by the avarage concentrations measured in the water and sediment in those 500-gallon tanks.

The State Street Pump Station project was shut down June – September 2012 and the volume contained in the wet well was pumped out twice (825 gallons and 1200 gallons) into a vactor truck. The mass diverted is therefore determined by the measured concentrations in the water and sediment diverted.

The Palo Alto Bryant Street Diversion Structure project uses continuous flow measurements recorded during the project to estimate the volume of runoff diverted, and the concentrations measured in the diverted flow (via estimated from turbidity-SSC relationships) to determine the mass diverted.

The basic load reduction calculation method used for each pilot study is shown below:

$$EnhancedReductionDiversion = CurReductionDiversion - BaseReductionDiversion \quad \text{Eq. 1}$$

where:

BaseReductionDiversion= *Mass of PCBs or Hg reduced via POTW diversions of urban stormwater in 2002*

CurReductionDiversion = *Mass of PCBs or Hg reduced via POTW diversions of urban stormwater in Year of Interest*

And:

$$Base\ or\ Cur\ ReductionDiversion = ConcDiversion \bullet VolDiversion \quad \text{Eq. 2}$$

Where:

ConcDiversion = *Average concentration of PCBs or mercury in sediment and/or water diverted to a POTW*

VolDiversion = *Volume of sediment and/or water diverted to a POTW*

The potential PCB load reduction benefits attainable from pilot diversion projects can be estimated based on either expected average PCB or mercury concentrations in stormwater, or expected average PCB or mercury concentrations in sediments captured by the pilot diversion. This section provides planning tools to assist with this estimation.

The first approach starts by asking "how much water is expected to be diverted to the POTW," and "what is the average PCB concentration in that diverted water?" Water volumes can be estimated from the design storm perspective and the conveyance and treatment capacity perspective. The design storm perspective would multiply the catchment area (acres) by the design storm event (inches of rain) and a runoff coefficient to derive the treatment volume, after unit conversion. However, in most cases, the limiting factor on treatment volume would be storage, conveyance, and treatment capacity. Therefore, it makes most sense, for estimating purposes, to base treatment volume estimates on constraints established by the conveyance system, available storage capacity (if any), and limits on the treated volume that are either set by the POTW or that necessarily result from treatment costs. A similar approach would apply to dry weather diversions. The flow question for a dry weather diversion would be "what is the average expected dry weather flow."

Average PCB and mercury concentrations in dry and wet weather flows can be estimated based on data that will be available via the pilot diversion studies and other recent projects (EBMUD 2010; Hunt et al. 2012; McKee et al. 2012).

B.9.4.2 Baseline and Current Loads Avoided/Reduced

The purpose of this section is to estimate the load reduction expected through pilot diversions of stormwater and dry weather runoff to POTWs. As described in the previous section, estimates of loads reduced and avoided via diversions should account for the mass of PCBs or mercury removed prior to the enhancement of management actions implemented before the adoption of the PCB or Mercury TMDLs for the San Francisco Bay. PCB and mercury load reduction and avoidance estimates should be based on the best available information and the assumptions described in the previous sections.

Prior to the PCB TMDL adoption (July 1, 2002), only one of the five pilot stormwater diversion projects was operational. The Palo Alto Diversion Structure on Bryant Street was constructed in the mid 1990's and therefore load reductions associated with this structure should be considered baseline. Baseline loads avoided/reduced at all other diversion sites are assumed to be zero, given that they were not in place until after July 1, 2002.

Data needed to calculate current loads avoided/reduced are currently being collected by Permittees via the pilot diversion projects. Volumes of water and sediment diverted to POTWs and the average/range of PCB and mercury concentrations in water and sediment diverted are therefore not available at the time. Once data are available, methodologies included in this previous section will be used to calculate enhanced load reductions attributable to pilot diversions to POTWs.

As an example, Table B.9.4.1 provides estimates of the loads diverted during the limited testing conducted during FY 2012 - 2013 using the volumes diverted during those sampling events and average PCB concentration values from the literature for dry and wet weather events, For the Alameda County Ettie Street Pump Station (ESPS) pilot project there was one 500 gallon stormwater diversion event. If assigned a PCB concentration of 34,515 pg/L based on historic ESPS effluent average wet weather monitoring data (EBMUD 2010), 0.0653 milligrams (mg) would be diverted from ESPS.

The Contra Costa County North Richmond Pump Station Pilot Project was not in operation during 2012 but there are historic dry and wet weather PCB monitoring data available (Hunt et al. 2012).

For the San Mateo County Pulgas Creek Pump Station pilot project, 500-gallons of water/sediment from one dry weather event and 500-gallons of water/sediment for one storm event were diverted. If the latter event was assigned a PCB concentration of 60,300 pg/L based on historic Pulgas Creek North wet weather monitoring data (McKee et al. 2012) 0.1141 mg would be diverted.

For the Santa Clara County Bryant Street Diversion Structure project there were two dry weather and one wet weather monitoring events conducted during which flows were continuously monitored (data being analyzed). There were no historic dry or wet weather PCB monitoring data identified for this site.

For the Fairfield/Suisun State Street Pump Station pilot project, the sump was pumped out twice during the dry weather (825 and 1,200 gallons) for a total of 2,025 gallons. Samples were analyzed to total PCBs (Vista Labs using USEPA Method 1668C) from the first pump out. Two congeners (110 and 138) were reported as detected–not-quantified (DNQ) for a combined concentration of 28.3 pg/L. If these DNQ values were used as actual detected values, 0.0002 mg would have been diverted.

Table B.9.4.1. Municipal Regional Permit – Pilot Stormwater Diversion Projects – Provisions C.11.f and C.12.f – PCB Monitoring and Loads Reduced

Municipal Regional Permit - Pilot Stormwater Diversion Projects - Provisions C.11f and C.12.f - PCB Monitoring and Loads Reduced

30-Aug-13	Project Characterization (May 2012 Workplan, Updated August 2013)																						
Project Name & Location	Catchment Size (acres)	Primary Land Uses	Diversion Type				Diversion Volume (gals)		Historic Concentration Based Load Reduced (Average Total PCB Congeners)		PCB Monitoring Results	2012 Events				2013 Events				2014 Events			
			Gravity	Pumped	Contin.	Batch	Dry Weather	Wet Weather	PCBs (pg/L)	Load Reduced (mg)		E1	E2	E3	E4	E1	E2	E3	E4	E1	E2	E3	E4
Alameda	1000	residential		X		X	500		2,927 (dry)	NS	Dry Season: Flow (gals)												
Ettie St. Pump Station		industrial mix						500	34,515 (wet)	**0.0653**	Concentration (pg/L)												
City of Oakland		commercial									Loading (grams)												
											Wet Season: Flow (gals)												
											Concentration (pg/L)												
											Loading (grams)												
Contra Costa	339	Mixed residential		X	TBD	TBD	TBD	TBD	700 (dry)	TBD	Dry Season: Flow (gals)												
North Richmond Pump Station		Light industrial							21,000 (wet)	TBD	Concentration (pg/L)												
City of Richmond		Former nurseries									Loading (grams)												
											Wet Season: Flow (gals)												
											Concentration (pg/L)												
											Loading (grams)												
Fairfield/Suisun	6	Commercial		X		X	2,025		28 (dry)	**0.0002**	Dry Season: Flow (gals)												
State Street Pump Station											Concentration (pg/L)												
											Loading (grams)												
											Wet Season: Flow (gals)												
											Concentration (pg/L)												
											Loading (grams)												
San Mateo	330	Industrial		X		X	500		NA (dry)		Dry Season: Flow (gals)												
Pulgas Creek Pump Station								500	60,300 (wet)	**0.1141**	Concentration (pg/L)												
City of San Carlos											Loading (grams)												
											Wet Season: Flow (gals)												
											Concentration (pg/L)												
											Loading (grams)												
Santa Clara	50	Light Industrial	X		X		Pending		NA		Dry Season: Flow (gals)												
Passive MS4 Diversion		Multi-family Res.						Pending	NA		Concentration (pg/L)												
City of Palo Alto											Loading (grams)												
											Wet Season: Flow (gals)												
											Concentration (pg/L)												
											Loading (grams)												

Table B.9.4.2 shows the results of PCB monitoring conducted by SFEI staff in 17 selected watersheds in the Bay Area during Water Year 2011. With the exception of the Santa Fe Channel site, mean concentrations were below about 60 ng/L with several sites in the low ng/L range. As shown in Table 9.4.2, these relatively low concentrations limit the mass that could potentially be diverted to fractions of a gram even if millions of gallons of stormwater were diverted to a POTW.

Further support for the representativeness of these PCB values is provided by McKee et al. (2012) in their summary of literature values, "*The range of PCB concentrations we observed during the study generally coincide with those reported in the literature for other urban areas (**ND-34 ng/L**, Curren et al., 2011; **2.0-28.9 ng/L**, Foster et al., 2000; **27-179 ng/L**, Marsalek and Ng, 1989; **26.9-1,120 ng/L**, Walker et al., 1999). Except for the Ettie St. Pump Station watershed, a known high leverage area for PCBs, yields reported for the other four watersheds were within similar ranges reported for other SF Bay local watersheds (3.0-5.0 µg/m2/y, Davis et al., 2000; 3.1 µg/m2/y, Gilbreath et al., 2012).*"(emphasis added)

Table B.9.4.2. Total PCB Concentration Minimum, Maximum, Mean (ng/L) and Sample Count in 17 Watersheds Monitored in Water Year 2011 (McKee et al. 2012)

Site	Minimum	Maximum	Mean	N
Belmont Creek	2.83	4.91	3.60	3
Borel Creek	3.41	8.67	6.13	3
Calabazas Creek	5.11	24.8	11.5	5
Ettie Street Pump Station	35.8	69.0	59.00	4
Glen Echo Creek	5.64	85.8	30.00	4
Lower Marsh Creek	0.70	4.14	2.15	6
Lower Penitencia Creek	1.14	1.85	1.48	4
Pulgas Creek South	19.1	53.9	31.5	4
Pulgas Creek North	43.3	84.5	60.3	4
Santa Fe Channel	25.4	468	198	5
San Leandro Creek	4.59	31.3	12.4	7
San Lorenzo Creek	5.70	20.4	12.9	5
Stevens Creek	3.17	17.6	7.53	6
San Tomas Creek	1.62	4.37	2.83	5
Sunnyvale Channel	9.41	67.5	39.2	5
Walnut Creek	3.69	24.4	9.00	6
Zone 5 Line M	16.7	26.3	20.8	4

Table B.9.4.3 below shows the theoretical mass (grams) of PCBs that would be removed for a given volume of stormwater or pump station sump diversion at a given PCB concentration. The above cited monitoring results indicate that average PCB concentrations even in areas with known high concentrations such as Ettie Street, have been found to be less than 100 ng/L. The table below shows that just under three million gallons of stormwater containing 100 ng/L of PCBs, would be need to be captured to divert about 1 gram of PCBs to a POTW willing and able to accept that amount of flow.

Table B.9.4.3. Mass (grams) of PCBs Diverted for Assumed Flow and Concentration

Gallons Diverted	Total PCB Concentration (ng/L)					
	1	5	10	50	100	200
20,000	0.0001	0.0004	0.0008	0.0038	0.0076	0.0151
50,000	0.0002	0.0009	0.0019	0.0095	0.0189	0.0379
100,000	0.0004	0.0019	0.0038	0.0189	0.0379	0.0757
200,000	0.0008	0.0038	0.0076	0.0379	0.0757	0.1514
400,000	0.0015	0.0076	0.0151	0.0757	0.1514	0.3028
500,000	0.0019	0.0095	0.0189	0.0946	0.1893	0.3785
1,000,000	0.0038	0.0189	0.0379	0.1893	0.3785	0.757
10,000,000	0.0379	0.1893	0.3785	1.8925	3.785	7.57

B.9.4.3 Summary of Key Uncertainties

There are a number of sources of uncertainty in accurately estimating PCB and mercury loads reduced to San Francisco Bay associated with baseline and current diversions of stormwater or dry weather flows to POTWs:

- The appropriate "average" concentrations of PCBs and mercury to use for specific types and locations of stormwater diversions is currently based on limited information on the variability in concentrations within and between diversion events.
- Uncertainties in the estimated volume of water and associated suspended sediments diverted to POTWs remain until data collection efforts via pilot projects are completed.
- The pollutant removal efficiencies of POTWs receiving diverted stormwater or dry weather flows have not been incorporated into the loads reduced/avoided formulas presented and therefore load reduction estimates calculated could be overestimated, although the overestimates are likely minimal.

B.9.5 References

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FIGURES B.9

Locations of Pilot Diversion Projects

Source: EOA, Inc.	Bay Area Stormwater Management Agencies Association	September 2013	Figure B.9.1
	Entity	Date	

internal info: path, date revised, author

Ettie Street Pump Station and Vicinity, Showing Nearby Transportation Facilities and EBMUD Treatment Plant, Oakland CA

Source: EOA, Inc.	Bay Area Stormwater Management Agencies Association	September 2013	Figure B.9.2
	Entity	Date	

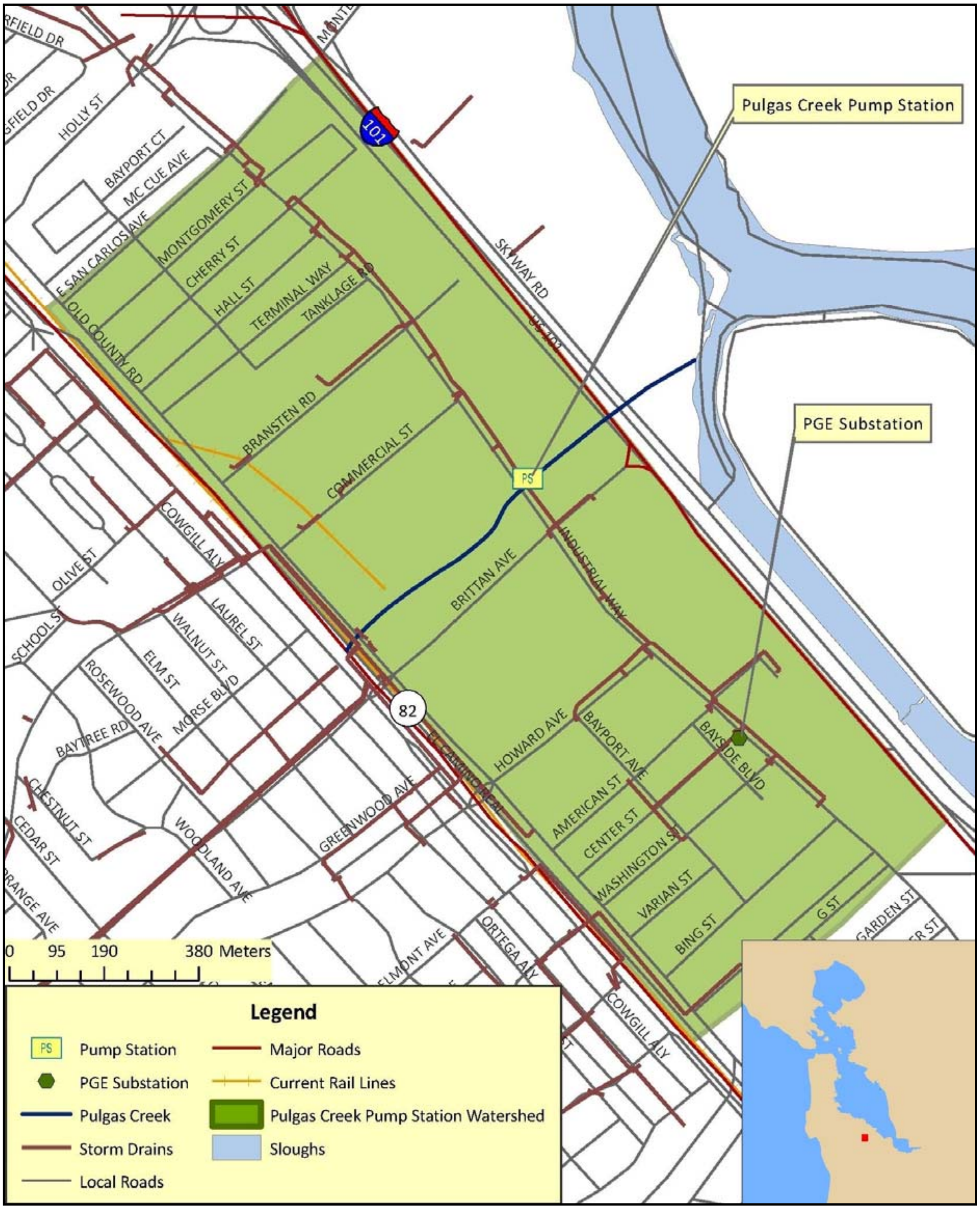
internal info: path, date revised, author

Site Map of North Richmond Stormwater Pump Station Diversion Project, Richmond CA

Source:	Notes:

Bay Area Stormwater Management Agencies Association	September 2013	Figure B9.3
Entity	Date	

internal info: path, date revised, author



Pulgas Creek Pump Station Drainage, City of San Carlos, San Mateo County, CA

Source:
EOA, Inc.

Bay Area Stormwater Management Agencies Association

September 2013

Figure B.9.4

Entity

Date

internal info: path, date revised, author

0 15 30 60 Feet

N

Legend

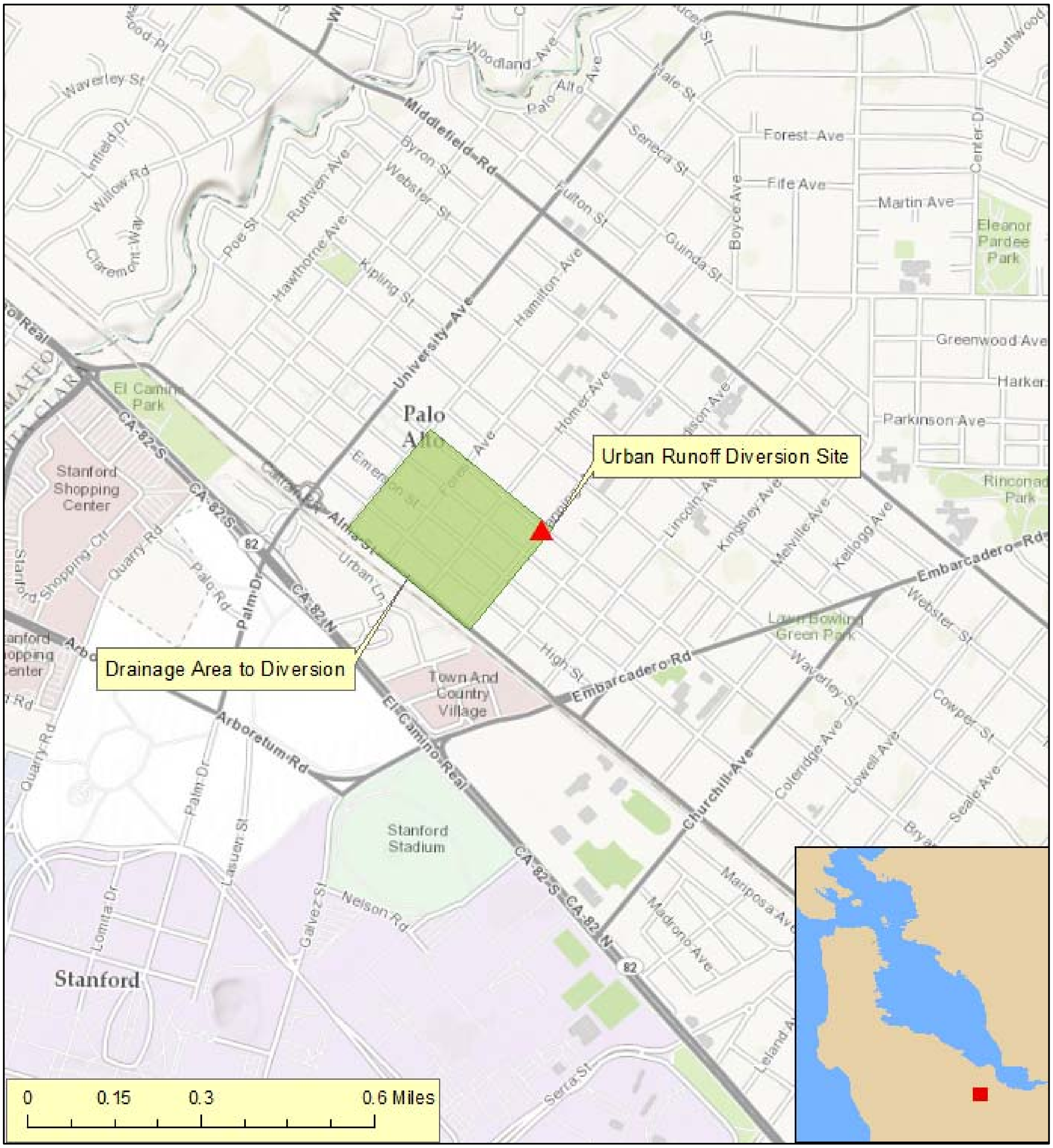
Storm Drain Line
A North Pulgas Storm Drain Manhole
B South Pulgas Storm Drain Manhole

Data
Map created: April 30th, 2012
Aerial photo source: Google Maps
Made by: EOA, Inc.
Note: Not drawn to scale, for illustration purposes only.

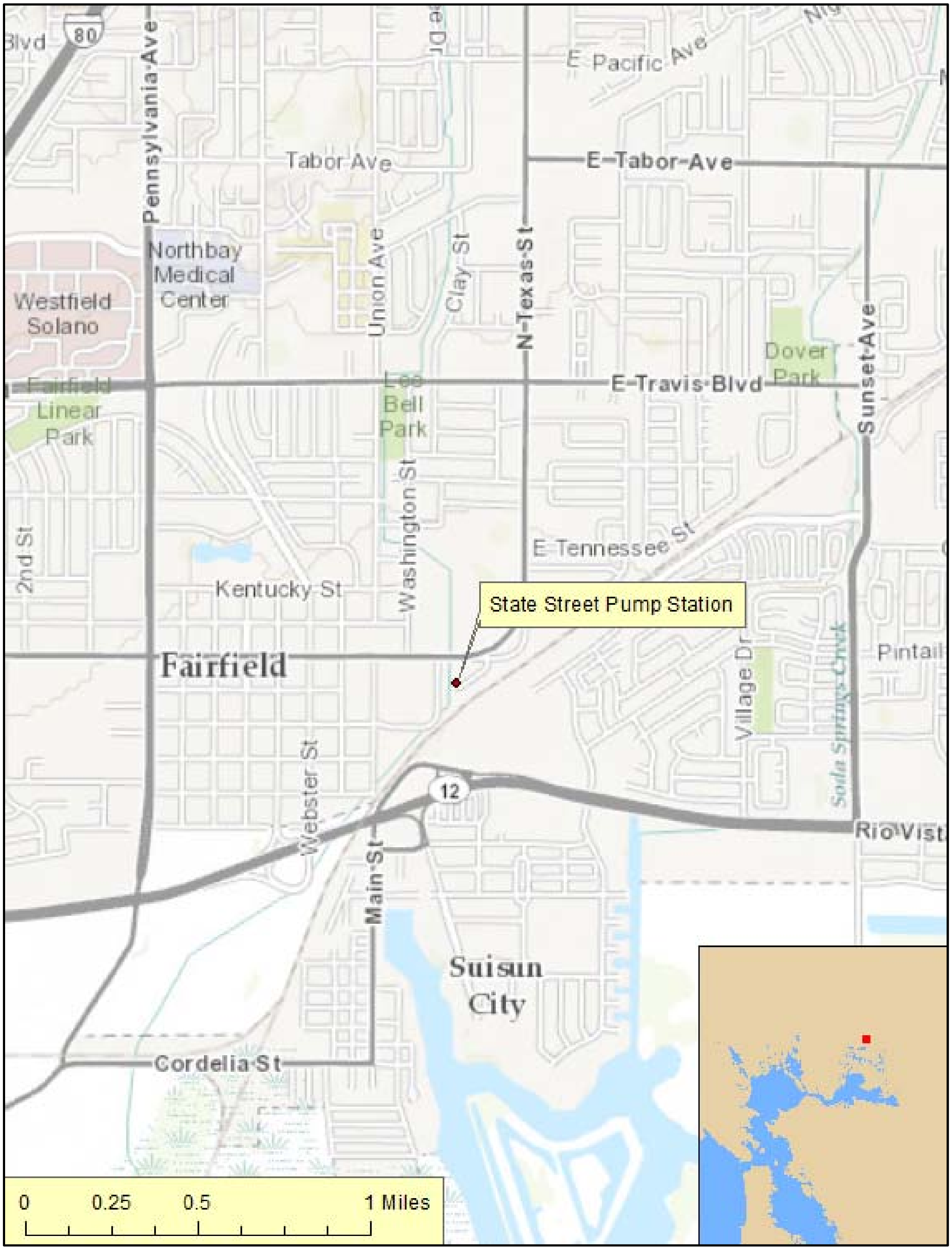
Pulgas Creek Pump Station Diversion Project, City of San Carlos, San Mateo County, CA		
Bay Area Stormwater Management Agencies Association	**September 2013**	**Figure B.9.5**
Entity	**Date**	

Source:
EOA, Inc.

internal info: path, date revised, author



Urban Runoff Diversion Site
Drainage Area to Diversion
Palo Alto
Stanford
Stanford Shopping Center
Stanford Stadium
Town And Country Village
El Camino Park
Eleanor Pardee Park
Rinconada Park
Lawn Bowling Green Park
University Ave
Middlefield Rd
Embarcadero Rd
El Camino Real
Alma St
Churchill Ave
Forest Ave
Fife Ave
Martin Ave
Greenwood Ave
Parkinson Ave
0 0.15 0.3 0.6 Miles



Solano County Diversion Project Location, Fairfield Suisun CA

Source:
EOA, Inc.

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	September 2013	B.9.7

internal info: path, date revised, author

State Street Pump Station Location and Contributing Area, Fairfield CA

Source:	Notes:

Entity	Date	Figure
Bay Area Stormwater Management Agencies Association	September 2013	B.9.8

internal info: path, date revised, author

APPENDICES

APPENDIX B.4.A

CW4CB Task 3 Reconnaissance Survey Form

CW4CB TASK 3 RECONNAISANCE SURVEY FORM

INSPECTED BY: ___________________________________ **DATE:** ________ /________ /________

SITE/AREA INFORMATION
LOCATION (include address/cross street, if applicable):
NAME OF BUSINESS(ES) (if available):
TYPE OF LAND USE: Commercial ☐ Industrial ☐ Municipal/Agency ☐ Transportation-related ☐ Type: ____________________ Misc. ☐ Explain: ________________________
DESCRIPTION OF SURVEYED AREA:

EVIDENCE OF POTENTIAL PCB SOURCE (check all that apply and describe in space given)	
Electrical applications/utilities (transformers, capacitors, appliances, televisions, fluorescent light ballast, motors, etc.)	
Evidence of outdoor hazardous material/waste storage areas (tanks, drums, scrap materials, e-waste). If so, are they labeled?	
Recycling/scrap yards (auto dismantlers)	
Outdoor burning or combustion	
Manufacturing industries with heat transfer systems (e.g., chemicals, high-tech, asphalt, metal products, etc.)	
Building demolition, renovation or window replacement sites/recyclers	
Miscellaneous (rail road lines/yards, coatings, printing inks, pesticides, stressed vegetation, etc.)	
Unidentified puddles or stains	

CW4CB TASK 3 RECONNAISANCE SURVEY FORM

POTENTIAL FOR SEDIMENT EROSION FROM SITE/AREA TO OCCUR (check all that apply and describe in space given)	
Property contains or appears to contain open areas (areas without structures or buildings)	
Street/driveway(s)/parking lot(s) not paved, partially paved or in poor condition	
Sidewalk(s) cracked, in poor condition, or lacking	
Vehicle activity (appears to occur) to/from site on unpaved areas	
Vacant or undeveloped lot(s)	
Site/area has been identified by the city or other party as an illegal dumping location	
ADDITIONAL INFORMATION. Does site/area confirm records review findings? Explain below. Add any additional notes that will inform potential facility inspections. Include names of any identified buildings. Sketch the site to show potential sediment sources and pathways to streets and storm drain inlets. Attach a separate piece of paper, if needed.	

APPENDIX B.4.B

Facilities Inspection Form

Facilities Inspection Form

Initial Priority Ranking: H M L
(based on inspection)

INSPECTED BY: ____ DATE: ________/________/________

MAP NUMBER/ID: ______________________________ PHOTO ID.#: _________________________________

SITE INFORMATION	
NAME OF CURRENT BUSINESS:	TYPE OF BUSINESS:
NAME OF OWNER:	COVERED UNDER GENERAL INDUSTRIAL PERMIT?
ADDRESS (include cross street, if possible):	
NAME AND TITLE OF OFF-SITE CONTACT:	CONTACT INFORMATION: ADDRESS PH EMAIL
NAME AND TITLE OF ON-SITE CONTACT (if different from above):	CONTACT INFORMATION: ADDRESS PH EMAIL
DESCRIPTION OF SITE (include areas of principal interest and apparent level of housekeeping). ALSO ATTACH A SKETCH OF THE SITE ON A SEPARATE PIECE OF PAPER (include potential sources and pathways to storm drain inlets and on-site and ROW sampling locations).	

TYPE OF POTENTIAL PCB SOURCE (consider current and past use; check all that apply and describe in space given below)	
Electrical applications/utilities (transformers, capacitors, appliances, televisions, fluorescent light ballasts, motors, etc.)	
Hydraulic fluids (lifts, die-casting machinery, etc.)	
Plasticizers (sealants, caulk, PVC, polyurethanes, polycarbonates, etc.)	
Evidence of outdoor hazardous material/waste storage areas (tanks, drums, scrap materials, e-waste) If so, can they be identified?	
Recycling/scrap yards (auto dismantlers)	
Outdoor burning or combustion	
Manufacturing industries with heat transfer systems (e.g., chemicals, high-tech, asphalt, metal products, etc.)	
Building demolition, renovation or window replacement site/recycler	
Gas compressors/stations/pipelines	
Miscellaneous (rail road lines/yards, coatings, printing inks, pesticides, stressed vegetation, etc.)	

Facilities Inspection Form

POTENTIAL FOR SEDIMENT EROSION FROM SITE/AREA TO OCCUR (check all that apply, describe in space given and include in attached sketch)	
Property contains open area(s)/driveway(s)/parking lot(s) not paved, partially paved or in poor condition (circle which applies)	
Vehicle activity to/from site on unpaved areas	
Does the property border streets without curbs, berms or other containment?	
Vacant or undeveloped lot	
If waste (construction/hazardous materials/etc.) is generated on-site, is it kept in a dumpster or other container? If so, describe	

STORMWATER INFRASTRUCTURE AND HYDROLOGY (if any of the below apply to this site, include in attached sketch)	
Are stormwater treatment practices present? If so, describe.	
Are private storm drains or inlets locationed at the facility? If so, describe.	
Has storm drain infrastructure identified in GIS been located on property? Any infrastructure not previously identified?	
Is there sediment accumulation at edges of property, curbs, catch basins, or elsewhere? If so, describe.	

QUESTIONS FOR OWNER/CONTACT (include dates when possible)
1. What type of business(es) did the previous tenant(s)/owner(s) have, and when did they exist?
2. Are PCBs in use now or have they been in the past on this facility? Have there been any spills or leaks? If so, when?
3. Have there been any building fires in the past? Major exterior renovation or window replacement? If so, when?
4. Does the facility have a power substation onsite? In the past? If so, when?
5. What type of business was on the neighboring properties (if applicable)?
6. How are the ground surfaces maintained (hosed, swept)? How is the material disposed of afterwards?
7. Are vehicles used on-site? If so, what type, and is there potential for dirt to be transferred off-site?

APPENDIX B.4.C

AMS/ADH Field Methods Report: Phase 1 Soil/Sediment Testing in the Ettie Street Pump Station, Lauritzen Channel and Parr Channel Watersheds

Field Sampling Report

2012 CW4CB Task 3

Phase I Sampling

November 15, 2012

Submitted to:

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APPLIED marine SCIENCES

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1. Introduction

This report details activities associated with implementation of Clean Watersheds for a Clean Bay (CW4CB) Task 3, Phase I sampling, conducted within the Ettie Street watershed in Oakland and Parr and Lauritzen Channel Watersheds in Richmond, CA. All sampling was conducted between September 27th and October 4th, 2012 by ADH Environmental personnel under the management of Applied Marine Sciences, Inc. (AMS).

2. Field Sampling Report

2.1. Objectives

The objectives of the sampling effort were to collect the following:

1. Sediment samples from up to 42 sites for analysis of PCB congeners, Hg, Total Organic Carbon (TOC), and particle size analysis by ALS Group (ALS).
2. Sediment samples from 10% of the target sites for analysis of field duplicate samples by ALS.
3. Sediment samples from 10% of the target sites for analysis of dioxins, PAHs, PBDEs, and OC pesticides by ALS.
4. Sediment samples from one site for delivery to Kinnetic Laboratories, Inc. (KLI) for analysis of OC pesticide and Hg split samples.

2.2. Personnel

The personnel and work assignments for Phase I sampling are shown in Table 1.

Table 1. Personnel for CW4CB Task 3 Phase I Sampling

Name	Affiliation	Duties
Paul Salop	AMS	Project manager, training for field team personnel
Traci Linder	AMS	Logistics
Lucile Paquette	ADH	Sample collection
Calvin Sandlin	ADH	Sample collection

2.3. Sampling Activities

Sampling activities for Task 3 Phase I sampling conducted within the Ettie watershed are summarized in Table 2. For the four inlet sites sampled within the Ettie Street watershed, City of Oakland personnel supported sampling efforts by providing traffic control and removing and replacing inlet grates. None of the samples collected within the Parr and Lauritzen Channel watersheds were collected from within the drop inlets, and therefore sampling personnel were able to operate independently throughout this sampling.

Table 2. Sampling Activities for CW4CB Task 3 Phase I Sampling

SiteCode	Site Description	Date	Lat	Long	Comments
ETT2	Cole Bros, 1797 12th St, along curb	10/2/12	37.81247	-122.30029	
ETT2a	Nautical Engineering, 1790 11th St	10/2/12	37.81176	-122.30064	

SiteCode	Site Description	Date	Lat	Long	Comments
ETT8a	ISSA Trucking; 1639 18th St	10/2/12	37.81438	-122.29249	
ETT29	Precision Casting; near 32nd and Hannah, on Hannah side	9/28/12	37.82326	-122.28675	
ETT29a	Precision Casting; near 32nd and Hannah, on 32nd side	9/28/12	37.82317	-122.28660	
ETT56	2838 Hannah St, near former driveway	9/28/12	37.82272	-122.28700	
ETT57	2838 Hannah St, adjacent to chain link fence	9/28/12	37.82116	-122.28620	Insufficient soil - no sample taken
ETT58	Vacant lot, directly across street from 2857 Hannah	9/28/12	37.82291	-122.28653	
ETT63	AMG - 3434 Helen St, southern portion of property	10/1/12	37.82639	-122.28638	Insufficient soil - no sample taken
ETT64-65	AMG - 3434 Helen St, northern portion of property	10/1/12	37.82583	-122.28639	Insufficient soil - no sample taken
ETT66	Drop inlet north end of Helen St	10/1/12	37.82640	-122.28662	Inlet
ETT84	CASS West - between 26th and 28th	9/28/12	37.81889	-122.28805	
ETT84b	CASS East Facility, along Union St, between 26th and 28th, at westernmost driveway	9/28/12	37.81985	-122.28493	
ETT84c	CASS north , along Peralta St	9/28/12	37.81987	-122.28490	Insufficient soil - no sample taken
ETT84d	CASS north, along Poplar, east of 28th, adjacent to blue wall	9/28/12	37.82172	-122.28519	
ETT84f	CASS East, along Poplar St	10/2/12	37.82061	-122.28555	Inlet
ETT85	CASS Central, along Poplar St, in front of mural	10/1/12	37.82069	-122.28558	
ETT85a	CASS Central - along Union, SW corner of Peralta & Hannah	10/2/12	37.82090	-122.28643	
ETT85b	NW corner Poplar & 26th, future tree well installation area	10/1/12	37.81938	-122.28612	
ETT121	Granite Expo - NE Corner of Wood St & 34th	9/27/12	37.82465	-122.29043	
ETT121a	CA Waste Solutions - 3300 Wood St, both sides of driveway	9/27/12	37.82418	-122.29042	
ETT121b	Illegal dumping site just south of ETT121a	9/27/12	37.82355	-122.29024	
ETT122	Granite Expo - 3430 Wood St, driveway along Wood St	9/27/12	37.82552	-122.29101	
ETT122a	North of Granite Expo - 3430 Wood St, on abandoned RR ROW	9/27/12	37.82536	-122.29100	
ETT122b	Dumping areas north of Granite Expo - 3430 Wood St	9/27/12	37.82563	-122.29101	
ETT123	Driveway entrance to Dan's Salvage, 3520 Harlan St	10/1/12	37.82696	-122.28209	
ETT123a	Inlet at Dan's Salvage, 3520 Harlan St	10/1/12	37.82663	-122.28201	Inlet
ETT124	Inlet, NW corner Poplar & 26th	10/1/12	37.81951	-122.28607	Inlet
LAU-01	Simms - West (600 South Fourth St)	10/3/12	37.92426	-122.36578	
LAU-02	S. 2nd, 1 block N of Cutting; 427 S 2nd	10/3/12	37.92646	-122.36809	
LAU-03	Rickert property; Cutting & 2nd, on 2nd St side (445 S. 2nd)	10/3/12	37.92559	-122.36807	
LAU-04	Rickert property; Cutting and 2nd, on Cutting side (135 Cutting)	10/3/12	37.92542	-122.36829	
LAU-05	PG&E lot (444 S 1st St; Cutting @ 1st)	10/3/12	37.92557	-122.36907	
LAU-06	PG&E (432 S. 1st St)	10/3/12	37.92664	-122.36912	
PAR-01	Marina North (939 Marina Way South); empty lot; 1st RR crossing south of Wright, across from Kaiser	10/4/12	37.91955	-122.35605	
PAR-02	Marina - South; same empty lot as PAR-01, about 100m south of PAR-01	10/4/12	37.91813	-122.35579	
PAR-03	Ford - North; near south end of Harbour. East side of street, in front of black chain link fence, near entrance to boiler house restaurant	10/4/12	37.91236	-122.35937	
PAR-04	Cal-Oils - North (1145 Harbour Way S); driveway just north of RR tracks	10/4/12	37.91703	-122.36024	
PAR-05	Cal-Oils - South; Large driveway before yellow RR sign on W side of Harbour	10/4/12	37.91750	-122.36045	

SiteCode	Site Description	Date	Lat	Long	Comments
PAR-06	Simms - south (803 Wright Ave), just W of 1st RR tracks on N side of Wright	10/4/12	37.92125	-122.36226	
PAR-07	Simms - south (799 Wright Ave, just W of Gate 6E)	10/4/12	37.92131	-122.36306	
PAR-08	Simms - north (600 Hoffman Blvd); Park at dead end road, 6th St, sampling site directly across Hoffman	10/4/12	37.92397	-122.36330	

Per the programmatic SAP, field duplicates were collected for analysis at a minimum of ten percent of sites sampled. Similarly, samples for analyses of OC pesticides, PAHs, PBDEs, and dioxins were also collected at ten percent of sites. In addition, a split sample from one location, ETT122a, was transferred from AMS to KLI for analysis of mercury and OC pesticides by laboratories employed by the KLI team, SCL and ATL. Samples collected by site are shown in Table 3.

Table 3. Summary of Requested Laboratory Analyses for CW4CB Task 3 Phase I Sampling

SiteCode	PCBs, Hg, TOC, Part. Size	FD, PCBs	FD, Hg, TOC, Part. Size	Dx, OCPs, PAHs, PBDEs	Split (Hg & OCPs)
ETT2	x				
ETT2a	x				
ETT8a	x			x	
ETT29	x				
ETT29a	x				
ETT56	x				
ETT58	x	x		x	
ETT66	x				
ETT84	x				
ETT84b	x				
ETT84d	x				
ETT84f	x				
ETT85	x				
ETT85a	x	x	x		
ETT85b	x				
ETT121	x				
ETT121a	x				
ETT121b	x				
ETT122	x				
ETT122a	x		x	x	x
ETT122b	x				
ETT123	x	x	x		
ETT123a	x				
ETT124	x				
LAU-01	x				
LAU-02	x	x	x		
LAU-03	x				
LAU-04	x				
LAU-05	x				
LAU-06	x				
PAR-01	x				
PAR-02	x				

SiteCode	PCBs, Hg, TOC, Part. Size	FD, PCBs	FD, Hg, TOC, Part. Size	Dx, OCPs, PAHs, PBDEs	Split (Hg & OCPs)
PAR-03	x				
PAR-04	x				
PAR-05	x			x	
PAR-06	x				
PAR-07	x				
PAR-08	x				
Total	38	4	4	4	1

2.4. Sample Handling

All sample containers were supplied by ALS. The containers used and sample handling implemented for Task 3 Phase I are summarized in Table 4.

Table 4. Sample Handling for CW4CB Task 3 Phase I Sampling.

Analysis	Container	Handling Requirements
Particle Size	Ziploc bag	Place on wet ice.
PCBs	8 oz glass	Place on wet ice.
Hg, TOC	8 oz glass	Place on wet ice.
Archive	8 oz glass	Place on wet ice.
PCBs, Dx	8 oz glass	Freeze on dry ice (only for 10% sites where additional analyses performed)
PBDE, OCP, PAH	8 oz glass	Place on wet ice.

2.5. Sample Labeling

The sample ID labeling system used is as follows:

WWW-S-NNN-##

Where:

WWW	=	Watershed
S	=	Media (S for soil)
NNN	=	Site number
##	=	Unique ID number

The photo ID labeling system used is as follows:

WWW-P-NNN-##

Where:

WWW	=	Watershed
P	=	Media (P for photo)
NN	=	Site number, identical to those used for sample ID
##	=	Unique ID number

2.6. Discussion

Representatives from the PMT met with AMS personnel in advance of sampling to review the viability of potential sampling sites and identify specific locations within each identified site for sample collection. On September 24th, Paul Salop of AMS conducted a site visit to proposed Ettie sampling sites with Becky Tuden from the City of Oakland and Adrienne Miller and Matt Freiberg of Geosyntec Consultants. Of those sites targeted for sampling during the reconnaissance, four sites were not sampled due to a lack of a sufficient volume of soil present during subsequent sampling operations, likely due to extensive street and sidewalk cleaning conducting between time of the survey and sampling by respective property owners.

On September 28th, Mr. Salop met with Joanne Le and Lynne Scarpa of the City of Richmond and Khalil Abu-Saba of Brown and Caldwell to perform site visits within the Lauritzen and Parr watersheds. A total of fourteen sites were identified for sampling, six within the Lauritzen watershed and eight within the Parr watershed. All sites were sampled as planned.

APPENDIX B.4.D

QA/QC Summary Report

Laboratory QA Summary

CW4CB Task 3 Phase I

October 20, 2013

Submitted to:

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1. Introduction

The Bay Area Stormwater Agencies Association (BASMAA) contracted with Applied Marine Sciences, Inc. (AMS) to support implementation of CW4CB Task 3. As part of its contract with BASMAA, AMS is providing project quality assurance for all Task 3 activities. Don Yee at SFEI is the Project QA Officer (QAO), and has completed preliminary data review of priority Task 3 analytes Hg and PCBs, which is discussed below.

Task 3 field monitoring was conducted in September and October of 2012. Hg samples were analyzed by two laboratories – (1) Soil Control Lab (SCL) for samples collected by KLI within San Mateo and Santa Clara Counties, and (2) ALS Global / Columbia Analytical Services (ALS) for samples collected by AMS within Alameda and Contra Costa Counties. In the case of PCBs, all samples collected for the Project were analyzed by ALS.

Attached are narrative summaries of reviews of QA/QC samples analyzed with reported field samples for the project. QA/QC samples were evaluated using the procedures and measurement quality objectives (MQOs) described in the project QAPP (BASMAA 2012). QA/QC results generally met project MQOs, with some minor deviations. Some mercury contamination was found in blanks from one lab (SCL), and some congeners in PCB blanks (ALS), likely affecting results for some of the lowest concentration samples reported by the labs, which were censored (not reported) in those samples as a result. PCBs in sediment samples showed moderate to large variation in replicate samples for some of the less abundant congeners; one congener (PCB 20/28) showed very large variation (>100% RPD) and was therefore censored. Details on the individual data submittals by various labs are provided below. All data should be considered preliminary until release of final data submittal by BASMAA.

2. PCBs

PCBs in sediment samples were analyzed by ALS. Samples were collected between September 24 and October 4, 2012, and were analyzed between October 24 and November 25, 2012. The 40 PCB congeners reported by the Regional Monitoring Program for Water Quality in the San Francisco Estuary[1] were reported for 81 field samples (including replicates). Blank and LCS (recovery) samples were also reported.

2.1. Sensitivity

PCB 008 was not detected (ND) in about 1/3 of the samples, but aside from that, most of the analytes were ND in only 2 to 6 of the 81 samples analyzed for PCBs.

2.2. Blanks

About half the analytes (20) were found in the blank at least 2x the MDL in one or more batches (QAPP page 7-5). For 13 of those, blanks were possibly > 10% of the field sample value in 2 or 3 samples - cases with ND results for diluted samples. It is unknown whether the blank signal would constitute a

[1] The RMP 40 list of PCBs has been the historic suite of PCB congeners analyzed by BASMAA agencies.

significant portion of the sample in these cases due to their dilution, so those results were censored with VRIP flag (Data rejected - Analyte detected in field or lab generated blank, flagged by QAO) as a worst-case assumption. Other samples were flagged with VIP (analyte detected in field or lab generated blank, flagged by QAO) as a warning but not censored since the blank contamination was <10% of those field sample concentrations.

2.3. Recovery

Recovery results were only reported for LCSs, with good recovery (within the 70-130% recovery (30% error) QAPP Table 26-2 target for PCBs. Only 3 out of the 29 reported analytes in the LCS were in the RMP 40 target analytes; although a range of PCB homologs were included in the LCS, some interferences are congener specific and would not necessarily be identified in the LCS.

2.4. Precision

Precision was calculated only for sample pairs where an analyte was detected in both samples. Precision results were averaged across batches for analytes, and those with average RPDs > the 25% MQO (QAPP Table 26-2) were flagged as having marginal precision but not censored, and those with RPDs grossly above the MQO (average RPD >50%) were censored (see table below). Only one analyte, PCB 20/28, fell into this latter category.

PARAMETER	avgRPD
PCB 020/28	**100.76%**
PCB 086/87/97/109/119/125	32.80%
PCB 105	44.86%
PCB 110/115	31.82%
PCB 118	26.64%
PCB 132	33.76%
PCB 141	45.14%
PCB 147/149	26.00%
PCB 156/157	27.53%
PCB 158	33.14%

3. Hg - ALS

Mercury in sediment samples collected by AMS/ADH was analyzed by ALS. Samples were collected between September 25 and October 4, 2012, and were analyzed between October 23 and 25, 2012. Total mercury in the <2mm sediment fraction was reported for 47 field samples (including replicates and an intercomparison sample). Blank and LCS (recovery) samples were also reported.

3.1. Sensitivity

Sensitivity was sufficient so no non-detects were reported for total mercury.

3.2. Blanks

No mercury blank contamination was found.

3.3. Recovery

Recovery results were only reported for LCSs, with good recovery (within the QAPP Table 26-4 target 75-125% recovery (25% error) for mercury (actual average 4.6%). The LCS used was ERA D076-540, a metal spiked soil from ERA (external supplier).

3.4. Precision

Precision on lab replicates was good, averaging 6.6% RPD, less than the 25% MQO (QAPP Table 26-4), so no results were flagged for marginal or poor precision. Field replicates were more variable, with individual pairs up to 37% RPD, suggesting field sample heterogeneity, although the average of all replicate pairs was still <25% RPD.

3.5. Intercomparison sample

Results included one sample analyzed for intercomparison to a second lab. The PUL8 result of 0.073 mg/kg dw here, was 51% lower (67% RPD) than the average of SCL results for the same site of 0.22, 0.11 and 0.11 mg/kg dw (for a split sample, a split blind field duplicate, and its lab duplicate, respectively). The intra-lab variation between the split sample and its blind dupe suggest some variation due to sample heterogeneity

4. Hg - SCL

Mercury in sediment samples collected by KLI was analyzed by SCL. Samples were collected between September 24 and October 2, 2012, and were analyzed on October 12, 2012. Total mercury in a <2mm sediment fraction was reported for 36 field samples (including replicates). Blanks, MS/Ds, LCM, and CRM (recovery) samples were also reported.

4.1. Sensitivity

Sensitivity was sufficient so no non-detects were reported for total mercury.

4.2. Blanks

Mercury blank contamination was found slightly over 2x the MDL (QAPP page 7-5), but at concentrations averaging only 0.0057 mg/kg. Four of the lowest concentration samples (all from Pulgas) were < 10x that and flagged VRIP (censored), but the remainder were flagged without censoring (VIP flag).

4.3. Recovery

Recovery samples had good recovery (within the 75-125% recovery (25% error) target (QAPP Table 26-4) for mercury. Recovery errors on the LCM & CRM averaged 6.7%, and on the MS/Ds 4.4%, well within the target, so no recovery qualifiers were needed.

4.4. Precision

Precision on lab replicates was good, averaging 2.2% RPD, less than the 25% MQO (QAPP Table 26-4), so no results were flagged for marginal or poor precision. Field replicates were more variable, with 45% RPD suggesting field sample heterogeneity, but results were not flagged for potentially variable field replicates.

4.5. Intercomparison sample

Results included one sample analyzed for intercomparison to a second lab. The ETT122a result of 0.27 mg/kg dw here, 41% lower (51% RPD) than the average of ALS results for the same site of 0.4 and 0.51 mg/kg dw. Intra-lab variation on sample replicates was 24%, suggesting some sample heterogeneity, which may account for a portion of the total variation.

5. PAHs - ALS

PAHs in sediment samples collected by AMS were analyzed by ALS. Samples were collected between September 27 and October 4, 2012, and were analyzed on October 20-23, 2012. PAHs in a <2mm sediment fraction were reported for 4 field samples. A blank, MS/Ds, and two LCS samples were also reported.

5.1. Sensitivity

Sensitivity was sufficient to have no NDs for most PAHs, but Biphenyl, 2,6-Dimethylnaphthalene, Dibenzothiophene, and Fluorene had 1 ND each, and Acenaphthene had 2.

5.2. Blanks

PAHs were not found in the blank at concentrations over the detection limit.

5.3. Recovery

Matrix spike recovery was never outside the target MQO of 50-150%, but average recovery errors above 35% were seen for Dibenz(a,h)anthracene, 2,6-Dimethylnaphthalene, Indeno(1,2,3-c,d)pyrene, and 2-, Methylnaphthalene.

5.4. Precision

Precision on lab replicates was good for most analytes, with RPDs less than the 25% MQO (QAPP Table 26-2), except for Anthracene, Biphenyl, 2,6-Dimethylnaphthalene, and Fluorene, with RPDs ranging 26-37%.

6. PAHs - ATL

PAHs in sediment samples collected by KLI were analyzed by ATL. Samples were collected between September 24 and October 2, 2012, and were analyzed on October 30 and November 8, 2012. PAHs in a

<2mm sediment fraction were reported for 4 field samples. A blank, MS/Ds, and an LCS sample were also reported.

6.1. Sensitivity

Sensitivity was sufficient to have no NDs for most PAHs, but Acenaphthylene, Anthracene., Fluorene, 2-Methylnaphthalene, and Naphthalene each had one ND result.

6.2. Blanks

Fluorene was found in the blank at a concentration over the detection limit, and greater than or equal to one third the concentration in field samples, so all Fluorene results were censored.

6.3. Recovery

Matrix spike recoveries were never outside the target MQO of 50-150%, and all had <25% error for analytes spiked in a quantitative range (at least 3x MDL).

6.4. Precision

Precision on matrix spike replicates was good for the 3 analytes spiked, with RPDs less than 10%, well within the 25% MQO (QAPP Table 26-2).

7. Pesticides - ALS

Pesticides in sediment samples collected by AMS/ADH were analyzed by ALS. Samples were collected between September 27 and October 4, 2012, and were analyzed on November 6, 2012. 31 pesticides, mostly legacy organochlorine compounds, in a <2mm sediment fraction were reported for 4 field samples. A blank, MS/Ds, and two LCS samples were also reported.

7.1. Sensitivity

Sensitivity was sufficient to have detections of only about half the pesticides, and all but 6 analytes had one or more NDs, despite MDLs mostly <1 ug/kg, meeting the project QAPP targets (most 1 ug/kg or more)

7.2. Blanks

Pesticides were not found in the blank at concentrations over the detection limit.

7.3. Recovery

Matrix spike recovery was outside the target MQO of 50-150% only for Endrin Aldehyde (47%), with Endosulfan I, Endrin, and Hexachlorobenzene approaching those limits with deviations above 35%.

7.4. Precision

Precision on was good for most analytes, with RPDs less than the 25% MQO (QAPP Table 26-2), except for Oxychlordane, Isodrin, Hexachlorobenzene, and Endrin Ketone, with RPDs ranging 28-63%.

8. Pesticides - ATL

Pesticides in sediment samples collected by KLI were analyzed by ATL. Samples were collected between September 24 and October 2, 2012, and were analyzed on October 10 to 15, 2012. 22 pesticides (mainly legacy organochlorines) in a <2mm sediment fraction were reported for 4 field samples and 1 intercomparison sample. A blank, MS/Ds, and an LCS sample were also reported. The analytes reported omitted a number requested in the project QAPP, namely all of the o,p' DDT derivatives, as well as hexachlorobenzene, mirex, cis & trans nonachlor, and oxychlordane.

8.1. Sensitivity

Samples were 100% NDs except for the chlordanes and DDTs. Most of the MDLs were <1ug/kg dw, so met the project requirements

8.2. Blanks

None of the target analytes were detected in blanks.

8.3. Recovery

Recovery was evaluated from matrix spikes and spike dupes, spiked for 6 of the analytes. Recoveries on all the spiked analytes were <70%, always biased low, but within the project target of 50-150%.

8.4. Precision

Precision was measured via matrix spike duplicates, with RPDs within the MQO target of <25% (QAPP Table 26-2) except for p,p' DDT (RPD 32%) which was flagged VIL (not meeting precision target) but not censored

8.5. Intercomparison samples

Results included one sample analyzed by ALS. RPDs between lab results for analytes reported by both ranged from 17 to 90%, with the 90% RPD occurring on an analyte <3xMDL for one of the labs. There were a half dozen or so analytes reported by ALS without results from ATL in the intercomparison sample.

9. PBDEs - ALS

PBDEs in sediment samples collected by AMS/ADH and KLI were analyzed by ALS. Samples were collected between September 24 and October 4, 2012, and were analyzed on November 26 and 27, 2012. 17 PBDE congeners, in a <2mm sediment fraction were reported for 8 field samples. A blank and two LCS samples were also reported.

9.1. Sensitivity

Detection limits ranged 14 to 174 ug/kg dw (highest for PBDEs 206 and 209), about 100x above the project target MRLs of 0.1 to 1 ug/kg. PBDEs were NDs in all samples except for 47, 99, and 209. These are typically among the most abundant PBDEs.

9.2. Blanks

No PBDEs were found in the blank at concentrations over the detection limit.

9.3. Recovery

LCSs were used to evaluate accuracy. Average recoveries had <25% error for all congeners, within the MQO target, so no records needed to be qualified.

9.4. Precision

Replicates of the LCS were used to evaluate precision. The average RPD was <7% for all congeners in the LCS, below the target MQO of 25%. No additional qualifiers were added.

10. Dioxins - ALS

Dioxins in sediment samples collected by AMS/ADH and KLI were analyzed by ALS. Samples were collected between September 24 and October 4, 2012, and were analyzed between October 18 and November 2, 2012. 17 dioxin and furan congeners with 2,3,7,8-TCDD activity, in a <2mm sediment fraction were reported for 8 field samples. Two blanks and 3 LCS samples were also reported.

10.1. Sensitivity

Detection limits ranged 0.07 to 22.5 ng/kg dw (highest for OCDD), slightly above the project target MRLs of 1 to 10 ng/kg for some of the analytes. 1,2,3,7,8,9-HxCDF was ND in all samples, and 2,3,7,8-TCDD, and 1,2,3,7,8-PeCDF were ND in one sample each.

10.2. Blanks

Two lab blanks were reported with 41% (7 out of 17) of the individual analytes having some blank contamination. Most blank contaminations was <10% of field sample concentrations, but one 1,2,3,4,7,8,9- HpCDF result was censored for a higher contribution of the blank.

10.3. Recovery

LCSs were used to evaluate accuracy. Average recoveries had <25% error for all analytes, within the MQO target, so no records needed to be qualified.

10.4. Precision

Replicates of the LCS were used to evaluate precision. The average RPD was below the target MQO of 25% for all congeners in the LCS so no additional qualifiers were added.

11. TOC - ALS

Total organic carbon (TOC) in sediment samples collected by AMS/ADH were analyzed by ALS. Samples were collected between September 27 and October 4, 2012, and were analyzed on October 22 to 23, 2012. TOC in a <2mm sediment fraction were reported for 42 field samples, with 3 lab replicates and one field replicate. Lab blanks, MS/Ds, and LCS samples were also reported.

11.1. Sensitivity

The detection limits were above the project QAPP target of 0.01%, but all TOC results were above the detection limits (TOC MDL 0.05%) with no NDs reported.

11.2. Blanks

TOC was not found in the blanks at concentrations over the detection limit.

11.3. Recovery

MSs were spiked to around 20% TOC, near the high end of field sample concentrations. Recovery errors for the MSs averaged 4%, well within the target MQO of 80-120%. LCSs spiked to only 5x the MDL (0.28% TOC, below any samples) had OK recovery as well, averaging 19% error, so no additional qualifiers were needed.

11.4. Precision

Lab replicates were used to evaluate precision for TOC. The average RPD, around 3.5%, was well within the target MQO of 25% for TOC. A field sample replicate was analyzed, but not used to assess precision, and had a similarly small RSD of 2.5% (analyzed 3x total, paired with a sample with a lab replicate).

12. TOC - ATL

Total organic carbon (TOC) in sediment samples collected by KLI were analyzed by ATL. Samples were collected between September 24 and October 2, 2012, and were analyzed on October 11, 2012. TOC in a <2mm sediment fraction was reported for 31 field samples, along with lab replicates, field blind replicates, lab blanks, and CRMs.

12.1. Sensitivity

All TOC results were above the detection limits (TOC MDL 0.01, meeting the project QAPP target) with no NDs reported.

12.2. Blanks

Some TOC was measured in blanks, but at concentrations (0.02% dw) less than 10% of the lowest field sample (0.28% dw TOC) so no results were censored.

12.3. Recovery

Two certified reference materials (CRMs) were run for TOC and were used to evaluate accuracy. Recovery for the CRMs was 97 to 98%, within the target MQO of 80-120%.

12.4. Precision

The average RPD for lab replicates was within the target MQO of 25% for TOC (individual RPDs of 12.6 and 1.2%). Field sample replicates were not used to flag precision, also met the target with an average RPD of 17.8%.

13. Total Solids - ALS

Total solids in sediment samples collected by AMS/ADH and KLI were analyzed by ALS. Samples were collected between September 24 and October 4, 2012, and were analyzed between October 8 and November 1, 2012. Total solids in a <2mm sediment fraction were reported for 179 samples, including 15 lab replicates and 9 field replicates. No other sample types were reported.

13.1. Sensitivity

Total solids were reported to within 0.1%, with no NDs reported.

13.2. Precision

Lab replicates were used to evaluate precision for total solids, with RPDs <1%, well within the <25% RPD for other sediment conventional analytes.

14. Total Solids - ATL

Total solids were reported in sediment samples analyzed by ATL for intercomparison for chemical analytes. Samples were collected between September 24 and October 2, 2012, and were analyzed on October 8 to 12, 2012. Total solids in a <2mm sediment fraction was reported for 5 field samples, plus 1 lab replicate.

14.1. Sensitivity

Total solids were reported to the nearest 1%, with no NDs reported.

14.2. Precision

The RPD for lab replicates was <1%, within the target MQO of 25% for other sediment conventional analytes.

14.3. Intercomparison samples

The difference in average total solids between the two labs was good, always <3% RPD.

15. Grainsize - ALS

Grainsize in sediment samples collected by AMS/ADH were analyzed by ALS. Samples were collected between September 27 and October 4, 2012, and were analyzed between October 23 and 26, 2012. Grainsize in 9 fractions (from <75 to <0.005 mm) using the ASTM scale were reported in sediment samples for 45 samples, including 3 lab replicates and 4 field replicates. Some of the ASTM sizes are slightly offset from the ranges requested in the project QAPP. No other sample types were reported.

15.1. Sensitivity

Grainsize fractions were reported to within the nearest 0.1% or better, with no NDs reported.

15.2. Precision

Lab replicates were used to evaluate precision for grainsize. The average RPD was below the target MQO of 25% for all size ranges except Medium Gravel (55% RPD), flagged but not censored (CW4CB has no listed censoring threshold). Field sample replicates showed similar variability, with some RPDs higher and others lower than for lab replicates,

16. Grainsize - SCL

Grainsize in sediment samples collected by KLI were analyzed by SCL. Samples were collected between September 24 and October 2, 2012, and were analyzed October 19, 2012. Grainsize in 17 fractions (from <64 to <0.00098 mm) using the Wentworth/Plumb scale were reported in sediment samples for 31 field samples, plus 2 lab replicates and 3 field replicates. No other sample types were reported.

16.1. Sensitivity

Grain sizes were reported to the nearest 0.01% or better, with frequent (sometimes 100%) NDs reported for some of the coarser (pebble) fractions.

16.2. Precision

Lab replicates were used to evaluate precision, except the three pebble fractions which were mostly NDs. Average RPD was above the target MQO (25%) for the majority of analyte/fraction combinations (eight of 14 fractions with detects), and were flagged with a qualifier "VIL" for precision outside the MQO target. Field sample replicates were analyzed, but not used to assess precision, and had similarly large RPDs ranging from 0.02 to 145% (the latter for a pebble fraction, likely to be heterogeneous), with 47% of analyte/fraction combinations having average RPDs>25%. The frequent exceedance of the 25% RPD MQO may in part be due to the numerous fractions; with each fraction representing a smaller portion of the total size range, equivalent shifts in absolute percentages of total mass become amplified when expressed as RPD (a percentage relative to the average of a given fraction).

17. References

BASMAA, 2012. *Quality Assurance Project Plan: Clean Watersheds for a Clean Bay – Implementing the San Francisco Bay's PCBs and Mercury TMDLs with a Focus on Urban Runoff, EPA San Francisco Bay Water Quality Improvement Fund Grant # CFDA 66.202.* Prepared by Applied Marine Sciences, Inc. July 26, 2011.

APPENDIX B.4.E

Kinetic Laboratories, Inc., Field Methods Report: Phase 1 Soil/Sediment Testing in the Leo Avenue and Pulgas Creek Pump Station Watersheds

BASMAA CW4CB – Field Methods Report for Pulgas Creek Pump Station and Leo Avenue Watersheds Phase 1 Sediment Sampling

Prepared by Kinnetic Laboratories Inc.

10 January 2013

1.0 Field Sampling Procedures

Sediment sampling equipment was prepared in the laboratory prior to sampling. Sampling equipment included:

- Stainless steel sampling scoops and spoons
- Stainless steel and Tefzel-coated compositing buckets
- Natural fiber whisk brooms
- Wash bottles and storage containers for deionized water
- Wash bottles for hydrochloric acid and methanol

Prior to sampling, with the exception of new natural fiber whisk brooms, equipment was thoroughly cleaned. Equipment was soaked (fully immersed) for three days in 2% Micro® solution and deionized water. Equipment was then rinsed three times in deionized water and then allowed to dry in a clean place. Equipment was then rinsed with a 1.0% solution of hydrochloric acid, followed by a triple rinse with deionized water to eliminate the acid. A rinse with reagent grade methanol was then followed by another triple rinse with deionized water. Equipment was then allowed to dry in a clean place. Equipment was wrapped in aluminum foil or stored in clean Ziploc bags until used in the field.

Field crews identified areas of sediment accumulation within areas targeted for sampling and analysis. Standardized field data sheets were used to record, at a minimum; date, names of crew members, narrative description of the sampling site (general location), other relevant catchment information such as construction activities, weather conditions, sample matrix, whether soil/sediment is submerged or exposed, method used to collect sample, and sample IDs collected for analysis or archive. A minimum of one set of latitude/longitude per sample site was also recorded at the time of sampling.

In addition to complete field data sheets, a bound logbook was used to record relevant information for each day of sampling. These at a minimum included:

- Team members and their responsibilities
- Time of arrival/entry on the site and time of departure
- Other personnel on site
- Summary of any meetings or discussions with property owner or agency personnel
- Deviations from sampling plans, site safety plans, and QAPP procedures
- Changes in personnel and responsibilities with reasons for the changes.

Photographic documentation was reported on an associated photo log. Photographs were taken documenting sampling sites with each photograph listed in the photo log with time, date, location, description of the subject photographed, and the name of the person taking the photograph.

Samples were collected directly into compositing buckets which have been covered with aluminum foil when not in use. No sieving of sediments was performed in the field, however, larger debris and cobble were removed from the samples. At the conclusion of sample collection at each site, all sediment was composited in the buckets and then subsampled for distribution to the appropriate laboratories. Disposable powder free nitrile gloves were worn while collecting and compositing samples to mitigate potential contamination. Gloves were changed between each location to reduce the potential for cross-contamination.

Samples were labeled for proper identification in the field and for tracking in the laboratory. The sample labels contained the following information: station location, date of collection, analytical parameter(s), and method of preservation. Every sample, including samples collected from a single location but going to separate laboratories, were assigned a unique sample number. Each sample collected was labeled according to the following naming convention, WWW-NN-MMDDYY where:

WWW	=	Project watershed code (first three letters, i.e., Ett, Lau, Par, Pul, or Leo)
NN	=	Sequential Number (i.e., 01, 02, 03…10, 11…etc.)
MMDDYY	=	Date as month (i.e., 01, 02…12), day (01 through 31), and last two digits of year (i.e., 20**12**)

All sampling equipment used at a particular sampling location was field cleaned prior to use at a different sampling location. The field-cleaning protocol involved 1) removal of sediments using a scrub brush and deionized water; 2) scrubbing of sampling gear and compositing equipment with a 2% Micro® solution and deionized water; 3) rinse with deionized water; 4) rinse with a 1.0% solution of hydrochloric acid; 5) rinse with methanol; and 6) rinse with deionized water.

At the conclusion of sample processing; all samples were be wrapped in protective bubble wrap and stored on ice, or in the case of dioxins dry ice, in the field. At the conclusion of a day's sampling, all samples were either stored overnight on dry ice or removed to a freezer for temporary storage prior to distribution to the analytical laboratories.

2.0 Sample Chain-of-Custody Forms and Custody Seals

All sample shipments for analyses were be accompanied by a Kinnetic Laboratories chain-of-custody record (COC). COCs were completed and sent with samples for each laboratory and each shipment. If multiple coolers were sent to a single laboratory on a single day, multiple forms were completed and set with the samples for each cooler. The COC identified the contents of each shipment and maintained the custodial integrity of the samples. A self-adhesive custody seal was be placed across the lid of each sample at a point of closure. The shipping containers in which samples are stored were sealed with a self-adhesive custody seal any time they were not in someone's possession or view before shipping. All custody seals were signed and dated.

3.0 Pulgas Creek Pump Station Watershed

Sediment sampling for the Pulgas Creek Pump Station watershed was performed over two days (24 – 25 September 2012). The field sampling crew consisted of Jonathan Toal and Amy Howk of Kinnetic Laboratories Inc., Krista McDonald of 2ND Nature LLC, and Nick Zigler of EOA, Inc. Jon Konnan of EOA, Inc. and Jan O'Hara of the Regional Water Quality Control Board (RWQCB) provided additional direction for sampling of sites on the 25th of September. The field crew initially arrived at Bransten Road, San Carlos at 09:00 on 24 September and at Center Street, San Carlos at 09:00 on 25 September.

<u>24 September 2012</u>

3.1 PUL-1-092412 – 37.50618°N; 122.25345°W

The sample was collected by sweeping up a mixture of fines with sand and some gravel with a natural fiber whisk broom and a stainless steel scoop from the gutter in front of the gate of GC Lubricants Company (977 Bransten Road). Larger pieces of gravel and organics (leaves & sticks) where removed during processing. Sample collection was completed at 09:50.

3.2 PUL-2-092412 – 37.50510°N; 122.25538°W

The sample was collected by sweeping up what appeared to be a fine cement dust. This material was collected from the northeast corner of a broken up access driveway next to a green plastic/cyclone fence of the Cemex Concrete Supply plant (1026 Bransten Road). A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 10:22.

3.3 PUL-10-092412 – 37.50583°N; 122.25432°W

The sample was collected by sweeping up fine sediment from the eastern end of a broken up access driveway at AIM Sheet Metal (1008 Bransten Road). A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 10:45.

3.4 PUL-15-092412 – 37.50662°N; 122.25301°W

The sample was collected by sweeping up fine sediment from the gutter east of the main AHERN Equipment Rental (941 Bransten Road) access driveway up to the second (low use) access driveway. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 11:15.

3.5 PUL-5-092412 – 37.50662°N; 122.25301°W

The sample was collected by scooping sediment from dirt in a low point in the main driveway on Bransten Road, west toward Old County Road of the Garden Supply Company (803 Old County Road). The nearest drop inlet was investigated but there was no sediment in the bottom. A stainless steel scoop was used to collect the sample. Sample collection was completed at 11:55.

3.6 PUL-7-092412 – 37.50662°N; 122.25301°W

The sample was collected from a catch basin on Howard Avenue at the southwest corner of Howard Avenue and Bayport Avenue. Drainage from OK Lumber (1323 Old County Road) was suspected of partially flowing between the two buildings directly south of the catch basin, into the street gutter on Bayport Avenue and then to the catch basin on Howard Avenue. There was a very high organic component to the material from decomposing eucalyptus leaves. A thick layer of leaves was removed to access the bottom of the catch basin. In addition, sediment was also gathered from the gutter just east of the catch basin and following the suspected drainage pattern. A stainless steel scoop was used to collect the sample. Sample collection was completed at 15:30.

<u>25 September 2012</u>

3.7 PUL-13-092512 – 37.49748°N; 122.24727°W

The sample was collected by compositing sediment from four stained areas in the dirt/gravel alley between Center Street and Washington Street. A petroleum odor was noticed after the soil was disturbed. A stainless steel scoop was used to collect the sample. Sample collection was completed at 09:20.

3.8 PUL-14-092512 – 37.49804°N; 122.24707°W

The sample was collected from a dirt/gravel area in front of the gate at 1062A Center Street and included some small stained areas and fines accumulated in the street gutter. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 09:45.

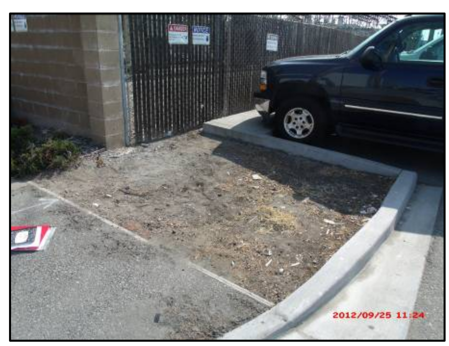
3.9 PUL-12-092512 – 37.49697°N; 122.24599°W

The sample was collected in front of the driveway gate at Provence Stone (1040 Varian Street) including a small stained area. A stainless steel scoop was used to collect the sample. Sample collection was completed at 10:10.

3.10 PUL-9-092512 – 37.49940°N; 122.24394°W

The sample was collected from just outside the southwest corner of the PG&E substation just southwest of the corner of Industrial Road and Washington Street. Jon Konnan (EOA, Inc.) and Jan O'Hara (RWQCB) were present to provide insight on the property. A small amount of fine sediment was collected where there was obvious directional flow from the PG&E substation property toward the street gutter. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 11:15.

3.11 PUL-8-092512 – 37.49979°N; 122.24445°W



The sample was collected from a dirt area just outside of the northwest corner of the PG&E substation just southwest of the corner of Industrial Road and Center Street. Jon Konnan (EOA, Inc.) and Jan O'Hara (RWQCB) were present to provide insight on the property. It was suspected that stormwater that is contained in the property is pumped out across the ground to the local storm drainage system. A valve was found behind the fence which could possibly be where storm water is pumped out. Any discharge from this valve would flow across the sampling area. A stainless steel scoop was used to collect the sample. Sample collection was completed at 11:35.

3.12 PUL-4-092512 – 37.50024°N; 122.24389°W

The sample was collected from a manhole at 1411 Industrial Road directly across the street from the PG&E substation. This sampling location was previously sampled in 2002 (Sample Identification SMC047) as part of a case study investigating PCB sources for the Pulgas Creek Pump Station. Elevated levels of PCBs were detected from that case study sample. A stainless steel scoop on a pole was used to collect the current sample. Sample collection was completed at 12:20.

Additional Investigated Pulgas Creek Pump Station Watershed Sites Not Sampled

Three other sites were investigated on 24 September but no samples were collected at these sites as no suitable samples were found. These three sites were **1)** Morey Maintenance (781 Old County Road – 37.50539°N; 122.25682°W) at 13:10; **2)** Ramirez Excavation and Demolition (841 Old County Road – 37.50398°N; 122.25519°W) at 13:20; and **3)** L-3 Communications Electron Devices Division (960 Industrial Road – 37.50517°N; 122.24980°W) at 14:15.

4.0 Leo Avenue Watershed

Sediment sampling for the Leo Avenue watershed was performed over two days (1 – 2 October 2012). The field sampling crew consisted of Jonathan Toal and Amy Howk of Kinnetic Laboratories Inc., Krista McDonald of 2ND Nature LLC, and Nick Zigler of EOA, Inc. Lisa Sabin of EOA, Inc., and Eric Dunleavey and Carol Boland of the City of San Jose provided additional direction for sampling of sites on the 1st of October. Carol Boland of the City of San Jose provided additional direction for sampling of sites on the 2nd of October. Don Yee of the San Francisco Estuary Institute observed the sampling for QA review on the 2nd of October. The field crew initially arrived at Leo Avenue, San Jose at 08:40 on 1 October and at the City of San Jose Central Service Yard (1661 Senter Street) at 08:45 on 2 October.

1 October 2012

4.1 LEO-1-100112 – 37.31023°N; 121.86527°W

The sample was collected by compositing sediment from two catch basins at the western end of the cul-de-sac. A blind duplicate sample was generated at this site designated to analytical laboratories as sample identification LEO-28-100112. A stainless steel scoop was used to collect the sample. Sample collection was completed at 09:25.

4.2 LEO-2-100112 – 37.31036°N; 121.86524°W

The sample was collected from the vault of the last manhole at the western end of the cul-de-sac. The sediment collected was taken from the line entering the vault from an unknown source due west of the end of the street and not from the lines from the two catch basins sampled for LEO-1. A stainless steel scoop was used to collect the sample. Sample collection was completed at 09:50.

4.3 LEO-3-100112 – 37.31204°N; 121.86528°W

The sample was collected from sediment in the gutter at the western end of the cul-de-sac between Century Tow and the northern catch basin, and from sediment in the gutter and on the sidewalk between the northern and southern catch basins. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 10:20.

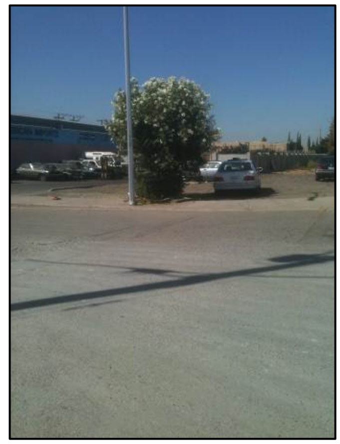
4.4 LEO-4-100112 – 37.31117°N; 121.86394°W

The sample was collected from the vault of the manhole in front of the Premiere Recycling gate. This manhole vault is where the original Leo Avenue sample was collected in 2000. A stainless steel scoop was used to collect the sample. Sample collection was completed at 11:10.

4.5 LEO-5-100112 – 37.31126°N; 121.86375°W

The sample was collected from the vault of the next manhole downstream (east) of LEO-4. A stainless steel scoop was used to collect the sample. Sample collection was completed at 11:35.

4.6 LEO-6-100112 – 37.31169°N; 121.86336°W



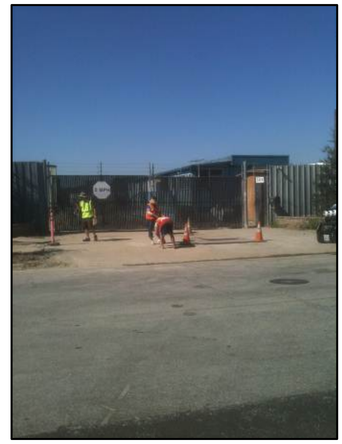
The sample was collected from driveway cracks and in the gutter between the driveway at the northwest corner of Leo Avenue and 7th Street to the west end of the driveway just east of American Imports. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 13:10.

4.7 LEO-7-100112 – 37.31088°N; 121.86436°W

The sample was collected from the vault of the manhole across the street from T&L Autoservices. The owner/manager of nearby Premiere Recycling came out and talked with Nick Zigler, Eric Dunleavy, and Jonathan Toal while sampling was being performed. A stainless steel scoop was used to collect the sample. Sample collection was completed at 13:45.

4.8 LEO-8-100112 – 37.31088°N; 121.86436°W

The sample was collected from sediment from both the east and west driveways/sidewalks of SafeTrans Transportation (505 Burke Street). All sediment sampled was collected prior to where it would reach the street gutter. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 14:30.



4.9 LEO-9-100112 – 37.30963°N; 121.85363°W

The sample was collected from the vault of the manhole between the two driveways of 505 Burke Street. A stainless steel scoop was used to collect the sample. Sample collection was completed at 15:00.

4.10 LEO-10-100112 – 37.30619°N; 121.85678°W

The sample was collected near an old railroad right of way where sediment would discharge to a small catch basin near 2070-G South 7th Street. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 15:40.

2 October 2012

4.11 LEO-11-100212 – 37.31731°N; 121.86239°W

The sample was collected by compositing sediment from two catch basins at the City of San Jose Central Service Yard (1661 Senter Street). Sediment was collected from inside one catch basin (approximately 40% of the sample) and from sediment accumulated around a sand bagged catch basin (approximately 60% of the sample). A blind duplicate sample was generated at this site designated to analytical laboratories as sample identification LEO-27-100212. A stainless steel scoop was used to collect the sample. Sample collection was completed at 09:23.

4.12 LEO-12-100212 – 37.31701°N; 121.86031°W

The sample was collected by sweeping the driveway just east of 506 Phelan on the south side of the road. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 10:25.

4.13 LEO-13-100212 – 37.31490°N; 121.86144°W

The sample was collected by sweeping the driveway in front of Greer Autowreckers at 1750 S. 7th Street. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 11:00.

4.14 LEO-14-100212 – 37.31456°N; 121.86135°W

The sample was collected from the vault of the manhole in front of Pacific Auto Parts at 1777 S. 10th Street. A stainless steel scoop was used to collect the sample. Sample collection was completed at 11:30.

4.15 LEO-15-100212 – 37.31766°N; 121.86376°W

The sample was collected by sweeping where sediment had drifted west off an old railroad right of way onto the public sidewalk. This location is just south of the gun club at 1580 S. 10th Street. A natural fiber whisk broom and a stainless steel scoop were used to collect the sample. Sample collection was completed at 12:05.

4.16 LEO-16-100212 – 37.31572°N; 121.86652°W

The sample was collected along the edge of the road where sediment is suspected to have migrated from a nearby old railroad right of way. The owner (Randy) of the property just north of the sampling site stated that he is leasing with an option to buy the old railroad right of way. He stated that he thought a lot of the sediment was blown from across the street (western to eastern side of the road) from the Valley Recycling facility. He seemed very proactive in cleaning up the area and wanted to clean up storm water flow off of the properties. He told us to come talk to him if we needed any help. A stainless steel scoop was used to collect the sample. Sample collection was completed at 13:45.

4.17 LEO-17-100212 – 37.31272°N; 121.86199°W

The sample was collected from the vault of the manhole in front of Straight Line Steering at 1802 Smith Avenue. A stainless steel scoop was used to collect the sample. Sample collection was completed at 14:15.

4.18 LEO-18-100212 – 37.31407°N; 121.86319°W

The sample was collected from the vault of the manhole in front of European Specialty Auto Dismantler at 1731 Smith Avenue. A stainless steel scoop was used to collect the sample. Sample collection was completed at 14:40.

4.19 LEO-19-100212 – 37.31429°N; 121.86341°W

The sample was collected from the vault of the manhole just north of 3M United Auto Parts. A stainless steel scoop was used to collect the sample. Sample collection was completed at 15:10.

APPENDIX B.5.A

Street Sweeping Baseline Level of Implementation and Estimated Load Reductions by Individual Municipality

Table B.5.A.1. Summary of Baseline Level of Implementation for Municipal Street Sweeping

Municipalities	Volume of Material Removed (CY)	Curb Miles Swept	Rate Volume of Material Removed per Curb Mile Swept
Fairfield (FY 93-94 through 01-02)	52,498	193,701	0
Suisun City (FY 93-94 through 01-02)	16,260	42,284	0
San Mateo County Municipalities			
Atherton	--	--	--
Belmont (FY 00-01 through 01-02)	524	11,239	0
Brisbane (FY 01-02)	194	1,537	0
Burlingame (FY 00-01 through 01-02)	7,873	30,597	0
Colma (FY 00-01 through 01-02)	264	701	0
Daly City (FY 00-01 through 01-02)	4,263	39,396	0
East Palo Alto (FY 00-01 through 01-02)	1,123	8,249	0
Foster City (FY 00-01 through 01-02)	1,890	8,180	0
Half Moon Bay (FY 00-01 through 01-02)	650	1,530	0
Hillsborough	--	--	--
Menlo Park (FY 00-01 through 01-02)	5,371	10,189	1
Millbrae (FY 00-01 through 01-02)	2,410	12,406	0
Pacifica (FY 00-01 through 01-02)	3,019	15,771	0
Portola valley (FY 00-01 through 01-02)	316	367	1
Redwood City (FY 00-01 through 01-02)	11,329	31,432	0
San Bruno (FY 00-01 through 01-02)	2,873	5,468	1
San Carlos (FY 00-01 through 01-02)	1,436	11,630	0
San Mateo (FY 00-01 through 01-02)	6,511	33,195	0
San Mateo County (Unicorporated) (FY 00-01 through 01-02)	8,195	22,223	0
South San Francisco (FY 00-01 through 01-02)	5,121	19,714	0
Woodside (FY 00-01 through 01-02)	158	215	1
Santa Clara County Municipalities			
Cupertino	Data Collection Started in 2004		
Los Altos	Data Collection Started in 2004		
Los Altos Hills	Data Collection Started in 2004		
Milpitas	Data Collection Started in 2004		
Mountain View	Data Collection Started in 2004		
Palo Alto	Data Collection Started in 2004		
San Jose	Data Collection Started in 2004		
Santa Clara	Data Collection Started in 2004		
Sunnyvale	Data Collection Started in 2004		
Campbell	Data Collection Started in 2004		

Municipalities	Volume of Material Removed (CY)	Curb Miles Swept	Rate Volume of Material Removed per Curb Mile Swept
Los Gatos	Data Collection Started in 2004		
Monte Sereno	Data Collection Started in 2004		
Saratoga	Data Collection Started in 2004		
Santa Clara County(Unincorporated)	Data Collection Started in 2004		
Alameda County Municipalities			
Alameda County (Unincorporated) (FY 92-93 through 94-95)	7,107	39,239	0
Alameda (FY 92-93 through 96-97)	31,076	76,234	0
Albany (FY 92-93)	74	478	0
Berkeley (FY 92-93 through 96-97)	37,211	130,793	0
Dublin (FY 92-93 through 94-95)	1,021	11,859	0
Emeryville (FY 92-93 through 95-96)	417	2,658	0
Fremont (FY 92-93, 94-95 through 96-97)	31,762	59,707	1
Hayward (FY 92-93 through 96-97)	50,405	179,196	0
Livermore (1992-1994,1995-1997)	10,311	26,246	0
Newark (FY 92-93 through 96-97)	12,618	21,503	1
Oakland (FY 92-93 through 96-97)	155,459	490,518	0
Piedmont	--	--	--
Pleasanton (FY 92-93 through 95-96)	3,276	38,904	0
San Leandro (FY 92-93 through 96-97)	28,913	56,315	1
Union City (FY 92-93 through-93-94, 96-97)	4,578	27,421	0
Contra Costa Municipality			
Antioch (FY 94-95 through 01-02)	14,961	67,134	0
Brentwood (FY 98-99 through 01-02)	16,808	182,160	0
Clayton (FY 94-95 through 01-02)	828	5,202	0
Concord (FY 94-95 through 01-02)	38,424	119,415	0
County (FY 94-95 through 01-02)	11,156	7,825	1
Danville (FY 94-95 through 01-02)	11,773	31,912	0
El Cerrito (FY 94-95 through 01-02)	2,757	5,932	0
Hercules (FY 94-95 through 01-02)	1,783	2,704	1
Lafayette (FY 94-95 through 01-02)	4,300	8,120	1
Martinez (FY 94-95 through 01-02)	11,640	21,794	1
Moraga (FY 94-95 through 01-02)	631	208	3
Oakley (FY 01-02)	1,072	113	9
Orinda (FY 94-95 through 01-02)	708	3,242	0
Pinole (FY 94-95 through 01-02)	3,753	13,432	0
Pittsburg (FY 94-95 through 98-99, 00-01, 01-02)	13,649	64,905	0
Pleasant Hill (FY 94-95 through 01-02)	7,261	34,362	0

Municipalities	Volume of Material Removed (CY)	Curb Miles Swept	Rate Volume of Material Removed per Curb Mile Swept
Richmond (FY 94-95 through 01-02)	19,736	96,880	0
San Pablo (FY 94-95 through 01-02)	5,760	19,588	0
San Ramon (FY 94-95 through 01-02)	19,244	63,864	0
Walnut Creek (FY 94-95 through 01-02)	19,412	61,395	0

Table B.5.A.2. Summary of Current Level of Implementation for Municipal Street Sweeping

Municipalities	Volume of Material Removed (CY)	Curb Miles Swept	Rate (Volume of Material Removed per Curb Mile Swept)
Fairfield (FY 02-03 through 08-09)	42,558	186,616	0.23
Suisun City (FY 02-03 through 08-09)	11,870	40,043	0.30
San Mateo County Municipalities			
Atherton (FY 03-04 through 08-09)	813	3,532	0.23
Belmont (FY 02-03 through 08-09)	7,157	42,438	0.17
Brisbane (FY 02-03 through 08-09)	1,011	6,070	0.17
Burlingame (FY 02-03 through 08-09)	26,406	104,874	0.25
Colma (FY 02-03 through 08-09)	1,037	1,726	0.60
Daly City (FY 02-03 through 08-09)	15,917	145,759	0.11
East Palo Alto (FY 03-04 through 08-09)	10,017	52,914	0.19
Foster City (FY 02-03 through 08-09)	2,342	25,310	0.09
Half Moon Bay (FY 02-03 through 08-09)	2,363	9,989	0.24
Hillsborough	--	--	--
Menlo Park (FY 02-03 through 08-09)	22,528	33,761	0.67
Millbrae (FY 02-03 through 08-09)	6,708	38,549	0.17
Pacifica (FY 02-03 through 08-09)	8,917	62,650	0.14
Portola Valley(FY 02-03 through 08-09)	2,611	7,808	0.33
Redwood City (FY 02-03 through 08-09)	17,441	57,125	0.31
San Bruno (FY 02-03 through 08-09)	11,597	30,131	0.38
San Carlos (FY 02-03 through 08-09)	5,469	41,089	0.13
San Mateo (FY 02-03 through 08-09)	20,218	125,483	0.16
San Mateo County (Unicorporated) (FY 02-03 through 08-09)	24,649	98,910	0.25
South San Francisco (FY 02-03 through 08-09)	20,767	128,521	0.16
Woodside (FY 03-04 through 06-07)	264	1,056	0.25
Santa Clara County Municipalities			

Municipalities	**Volume of Material Removed (CY)**	**Curb Miles Swept**	**Rate (Volume of Material Removed per Curb Mile Swept)**
Cupertino (FY 04-05 through 09-10)	15,113	51,387	0.29
Los Altos (FY 04-05 through 09-10)	7,777	35,069	0.22
Los Altos Hills (FY 06-07 through 09-10)	747	4,535	0.16
Milpitas (FY 04-05 through 09-10)	35,550	73,608	0.48
Mountain View (FY 04-05 through 09-10)	32,979	61,690	0.53
Palo Alto (FY 04-05 through 09-10)	88,282	130,895	0.67
San Jose (FY 04-05 through 09-10)	172,009	373,043	0.46
Santa Clara (FY 04-05 through 09-10)	44,830	171,379	0.26
Sunnyvale (FY 04-05 through 09-10)	48,801	88,608	0.55
Campbell (FY 04-05 through 09-10)	11,120	37,405	0.30
Los Gatos (FY 04-05 through 09-10)	20,370	60,777	0.34
Monte Sereno (FY 04-05 through 09-10)	603	1,407	0.43
Saratoga (FY 04-05 through 09-10)	4,614	19,864	0.23
Santa Clara County (Unincorporated) (FY 04-05 through 09-10)	19,994	70,005	0.29
Alameda County Municipalities			
Alameda County (Unincorporated)	Data Collection Ended in 1997		
Alameda	Data Collection Ended in 1997		
Albany	Data Collection Ended in 1997		
Berkeley	Data Collection Ended in 1997		
Dublin	Data Collection Ended in 1997		
Emeryville	Data Collection Ended in 1997		
Fremont	Data Collection Ended in 1997		
Hayward	Data Collection Ended in 1997		
Livermore	Data Collection Ended in 1997		
Newark	Data Collection Ended in 1997		
Oakland	Data Collection Ended in 1997		
Piedmont	Data Collection Ended in 1997		
Pleasanton	Data Collection Ended in 1997		
San Leandro	Data Collection Ended in 1997		
Union City	Data Collection Ended in 1997		
Contra Costa County Municipalities			
Antioch (FY 02-03 through 08-09)	18,151	75,754	0.24
Brentwood (FY 02-03 through 09-10)	18,176	123,233	0.15
Clayton (FY 02-03 through 09-10)	2,320	12,712	0.18
Concord (FY 02-03 through 08-09)	55,824	146,599	0.38
Contra Costa County (Unincorporated) (FY 02-03 through 08-09)	13,826	3,078	4.49
Danville (FY 02-03 through 09-10)	16,524	37,371	0.44

Municipalities	Volume of Material Removed (CY)	Curb Miles Swept	Rate (Volume of Material Removed per Curb Mile Swept)
El Cerrito (FY 02-03 through 08-09)	6,965	12,516	0.56
Hercules (FY 02-03 through 08-09)	2,213	8,176	0.27
Lafayette (FY 02-03 through 08-09)	6,980	14,672	0.48
Martinez (FY 02-03 through 08-09)	11,090	3,905	2.84
Moraga (FY 02-03 through 08-09)	1,748	6,321	0.28
Oakley (FY 02-03 through 08-09)	3,574	4,982	0.72
Orinda (FY 02-03 through 08-09)	2,694	5,846	0.46
Pinole (FY 02-03 through 08-09)	3,049	4,848	0.63
Pittsburg (FY 02-03 through 09-10)	15,480	86,666	0.18
Pleasant Hill (FY 02-03 through 08-09)	11,625	29,670	0.39
Richmond (FY 02-03 through 08-09)	12,019	105,277	0.11
San Pablo (FY 02-03 through 08-09)	6,120	20,142	0.30
San Ramon (FY 02-03 through 08-09)	16,635	88,036	0.19
Walnut Creek (FY 02-03 through 09-10)	14,143	90,535	0.16

Table B.5.A.3. Estimated PCB and Mercury Loads Reduced for Baseline and Current Municipal Street Sweeping

Municipalities	Total Baseline PCB Load Reduced (g)	Total Current PCB Load Reduced (g)	Total Baseline Mercury Load Reduced (g)	Total Current Mercury Load Reduced (g)	Annual Baseline PCB Load Reduced (g)	Annual Current PCB Load Reduced (g)	Annual Baseline Mercury Load Reduced (g)	Annual Current Mercury Load Reduced (g)
Fairfield	4,269	3,461	5,930	4,807	474	494	659	687
Suisun City	1,322	965	1,837	1,341	147	138	204	192
Atherton	NA	66	NA	92	NA	11	NA	15
Belmont	43	582	59	808	21	83	30	115
Brisbane	3	14	10	50	3	2	10	8
Burlingame	640	2,147	889	2,983	320	307	445	426
Colma	21	84	30	117	11	12	15	17
Daly City	347	1,294	481	1,798	173	185	241	257
East Palo Alto	15	136	25	226	8	23	13	38
Foster City	26	32	43	53	13	5	21	8
Half Moon Bay	9	32	32	117	4	5	16	17
Hillsborough	NA	23	NA	32	NA	23	NA	32
Menlo Park	437	1,832	607	2,545	218	262	303	364
Millbrae	33	91	120	333	16	13	60	48

Municipalities	Total Baseline PCB Load Reduced (g)	Total Current PCB Load Reduced (g)	Total Baseline Mercury Load Reduced (g)	Total Current Mercury Load Reduced (g)	Annual Baseline PCB Load Reduced (g)	Annual Current PCB Load Reduced (g)	Annual Baseline Mercury Load Reduced (g)	Annual Current Mercury Load Reduced (g)
Pacifica	41	121	150	443	20	17	75	63
Portola Valley	4	35	16	130	2	5	8	19
Redwood City	921	1,418	1,280	1,970	461	203	640	281
San Bruno	234	943	325	1,310	117	135	162	187
San Carlos	117	445	162	618	58	64	81	88
San Mateo	530	1,644	735	2,284	265	235	368	326
San Mateo County (unincorporated)	111	334	407	1,225	56	48	204	175
South San Francisco	416	1,689	578	2,346	208	241	289	335
Woodside	2	4	8	13	2	1	8	3
Cupertino	NA	205	NA	751	NA	34	NA	125
Los Altos	NA	105	NA	386	NA	18	NA	64
Los Altos Hills	NA	10	NA	37	NA	3	NA	9
Milpitas	NA	482	NA	1,767	NA	80	NA	294
Mountain View	NA	2,682	NA	3,725	NA	447	NA	621
Palo Alto	NA	7,179	NA	9,971	NA	1,197	NA	1,662
San Jose	NA	13,988	NA	19,428	NA	2,331	NA	3,238
Santa Clara	NA	3,646	NA	5,064	NA	608	NA	844
Sunnyvale	NA	3,969	NA	5,512	NA	661	NA	919
Campbell	NA	151	NA	553	NA	25	NA	92
Los Gatos	NA	1,657	NA	2,301	NA	276	NA	383
Monte Sereno	NA	8	NA	30	NA	1	NA	5
Saratoga	NA	63	NA	229	NA	10	NA	38
Santa Clara County (Unincorporated)	NA	271	NA	994	NA	45	NA	166
Alameda County (Unincorporated)	96	NA	353	NA	32	NA	118	NA
Alameda	2,527	NA	3,510	NA	505	NA	702	NA
Albany	6	NA	8	NA	6	NA	8	NA
Berkeley	3,026	NA	4,203	NA	605	NA	841	NA
Dublin	14	NA	23	NA	5	NA	8	NA
Emeryville	34	NA	47	NA	8	NA	12	NA
Fremont	430	NA	1,578	NA	143	NA	526	NA
Hayward	4,099	NA	5,693	NA	820	NA	1,139	NA
Livermore	140	NA	233	NA	35	NA	58	NA
Newark	171	NA	627	NA	34	NA	125	NA
Oakland	12,642	NA	17,559	NA	2,528	NA	3,512	NA
Piedmont	NA	NA	NA	NA	NA	NA	NA	NA

Municipalities	Total Baseline PCB Load Reduced (g)	Total Current PCB Load Reduced (g)	Total Baseline Mercury Load Reduced (g)	Total Current Mercury Load Reduced (g)	Annual Baseline PCB Load Reduced (g)	Annual Current PCB Load Reduced (g)	Annual Baseline Mercury Load Reduced (g)	Annual Current Mercury Load Reduced (g)
Pleasanton	266	NA	370	NA	67	NA	93	NA
San Leandro	2,351	NA	3,266	NA	470	NA	653	NA
Union City	62	NA	228	NA	21	NA	76	NA
Antioch	635	771	635	771	79	128	79	128
Brentwood	228	246	380	411	57	35	95	59
Clayton	11	31	19	52	2	5	3	9
Concord	521	757	1,910	2,774	74	108	273	396
Contra Costa County (Unincorporated)	151	187	554	687	19	31	69	115
Danville	160	224	266	373	20	32	33	53
El Cerrito	224	566	311	787	32	94	44	131
Hercules	145	180	201	250	18	26	25	36
Lafayette	58	95	97	158	8	16	14	26
Martinez	947	902	1,315	1,253	118	129	164	179
Moraga	9	24	14	39	1	3	2	6
Oakley	46	152	46	152	23	25	23	25
Orinda	10	37	35	134	1	5	4	19
Pinole	51	41	187	152	6	6	23	22
Pittsburg	1,110	1,259	1,542	1,748	139	180	193	250
Pleasant Hill	98	158	361	578	14	23	52	83
Richmond	1,605	977	2,229	1,358	201	163	279	226
San Pablo	78	83	286	304	10	14	36	51
San Ramon	261	225	435	376	33	32	54	54
Walnut Creek	263	192	965	703	33	27	121	100

APPENDIX B.5.B

A Summary of Documented Changes in Municipal Street Sweeping Practices in the North Richmond Pump Station Watershed and Santa Fe Channel Drainages

Appendix B.5.B

Estimation of PCB Loads Avoided / Reduced as a Result of New Street Sweeping Areas in Richmond and North Richmond

As part of MRP implementation, the City of Richmond and unincorporated Contra Costa County made specific changes to their street sweeping programs that have quantifiable benefits for additional PCB loads prevented from entering the MS4 system. There are two examples that can help extrapolate the benefits of enhanced municipal O&M for PCB load reductions: a curb and gutter improvement project in the North Richmond Stormwater Pump Station (NRSPS) watershed, and initiation of high efficiency street sweeping adjacent to a potential source area in the Santa Fe Channel watershed.

The two projects serve as useful bookends for the range of watershed PCB load management scenarios that may be encountered in the rest of Contra Costa County. The NRSPS watershed is an example of a moderately contaminated older industrialized watershed. PCB concentrations in suspended sediments monitored in stormwater at the NRSPS are approximately 220 µg/kg. The watershed as a whole discharged approximately 10 grams of PCBs during the wet season periods monitored in September 2010 – January 2012 (Hunt et al., 2012). For the 2.0 km^2 drainage area, the monitored loads correspond to a production rate of 4.6 $\mu g/m^2/yr$. For context, 4.6 $\mu g/m^2/yr$ is in the upper range of PCB yields for more typical urban Bay Area watersheds, but is below the maximum value of 82 $\mu g/m^2/yr$ noted in the highly contaminated Ettie Street Pump station watershed.

In contrast to the NRSPS, the Santa Fe Channel appears to discharge sediments having approximately 1,000 – 1,400 µg/kg PCBs, about three-fold to five-fold higher than PCB concentrations in sediments discharged from the NRSPS. The sediment production rate of the Santa Fe Channel watershed is unknown at present; however, if the PCB yield in the Santa Fe channel is comparable to that of the Ettie Street watershed (i.e., about 80 $\mu g/m^2/yr$), then the annual PCB load from the Santa Fe Channel watershed would be approximately 260 g per year, as compared to approximately 10 g per year from the 2.0 km^2 NRSPS watershed.

A key question to be addressed for future MRP implementation is whether the majority of required PCB load reduction can be achieved in just a few, highly contaminated watersheds such as Ettie Street or the NRSPS, or whether the majority of load reductions required would have to be spread out over many more moderately contaminated watersheds, such as NRSPS. At present, it does not appear that there are many more “low hanging fruit” examples like the Santa Fe Channel or Ettie Street watersheds; however, that will need to be verified through future reconnaissance monitoring. In the meantime, lessons learned about how enhanced street sweeping translates to load reductions in the NRSPS and Santa Fe Channel helps set expectations for the degree to which enhanced street sweeping can result in aggregate PCB load reductions when applied to other areas of Contra Costa County.

In the summer of 2012, a project was completed to improve the sidewalk, curb and gutter along a section of Market Avenue between 7th street and the Union Pacific Railroad line in the NRSPS watershed (Figure 1). Approximately 300 feet of sidewalk, curb and gutter was installed on the north side of Market Avenue in the Project area where there was formerly soft shoulder. The condition of the north side of Market Avenue before project completion is visible from Google Earth Street View (Figure 2).

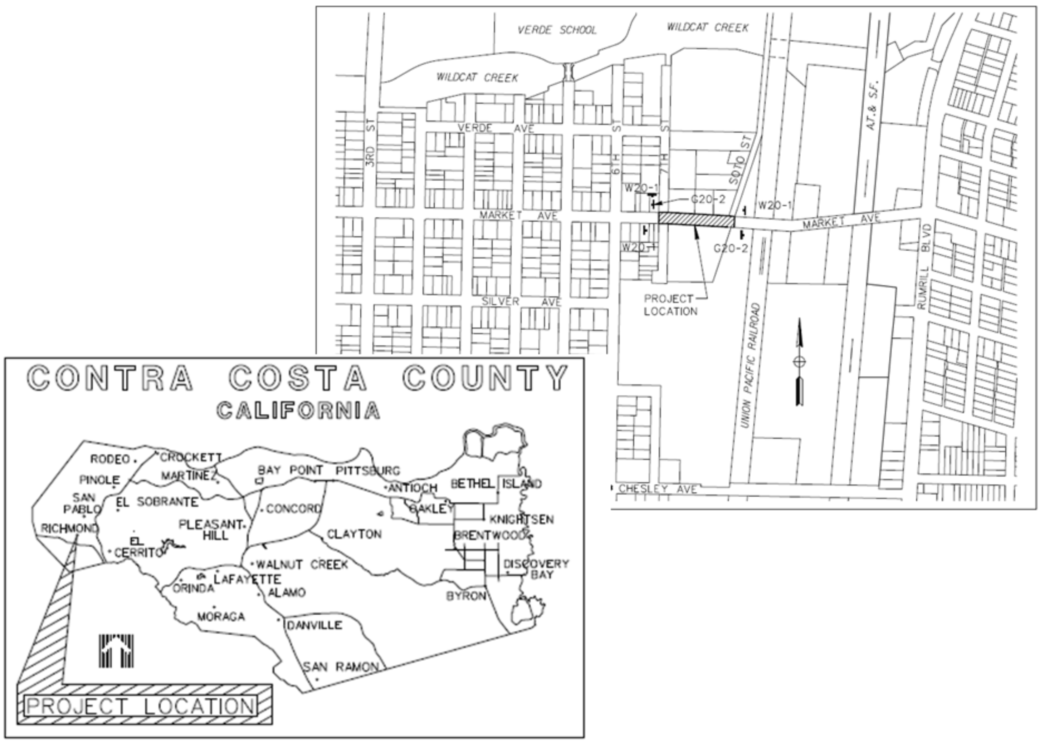


Figure 1. Location of Sidewalk, Curb, and Gutter Improvement Project in the NRSPS Watershed.

Figure 2. Condition Prior to Improvement of Sidewalk Curb and Gutter Along the North Side of Market Avenue (left side of photo).

Figure 3. Condition After Improvement of Sidewalk Curb and Gutter Along the North Side of Market Avenue (left side of photo).

The condition of Market Avenue following completion of the improvement was photographed in the summer of 2012 (Figure 3). The photograph shown in Figure 3 was taken prior to commencement of street sweeping activities in the project area, which was not previously done because of the soft shoulder. The accumulated sediment in the gutter helps provide an estimate of the sediment and PCB loads avoided as a result of new street sweeping activity in the improved area.

The improved section is approximately 300 linear feet. The accumulated sediment shown in in the photograph in Figure 3 is approximately six inches wide and one inch deep – corresponding to approximately 12.5 cubic feet of sediment, or 938 kg sediment assuming a density of 2.65 g/ml. If the PCB concentration in gutter sediments ranges from 100 to 300 µg/kg, then the PCB mass found in the accumulated sediment shown in Figure 3 would be approximately 0.1 to 0.3 grams. The sediment build-up and track out dynamics of this area are unknown, so the replenishment rate of this 0.1 to 0.3 grams is unknown. For simplicity, it can be assumed that this 12.5 cubic feet of sediment represents the minimum total annual accumulation and wash-off, and that the total could be as much as two or three times greater. In effect, the act of improving sidewalk, curb and gutter along a single city block in North Richmond represents a PCB load reduction of 0.1 gram to as much as 1 gram of PCBs per year as a result of new street sweeping in the improved area.

The proximity of the improved area to bare dirt along rail lines and adjacent dirt lots near Market Avenue suggests that those areas may be the source of sediments. The assumption that sediments from railroad right of ways could be between 100 and 300 µg/kg is reasonable, based on previous assessments in other watersheds (i.e., EOA Inc., 2007). The actual concentration of PCBs in street sediments near the Market Avenue sidewalk improvement will be verified in conjunction with other pilot project monitoring activities conducted in the 2013 – 2014 storm season.

Figure 4. Railroad Right of Way Bisecting Market Avenue and Adjacent Dirt Lots are Suspected Sediment Sources to City Streets

In the Santa Fe Channel, during MRP-required investigations of potential PCB source areas located on private property, sediments were sampled along Hoffman Blvd. adjacent to one such suspect property (Figure 5). The sediment samples collected had approximately 1,400 µg/kg PCBs, consistent with the observed PCB/ suspended sediment ratios observed during the initial watershed reconnaissance of the Santa Fe Channel. On further investigation, it was discovered that the section of Hoffman Boulevard shown in Figure 5 was not on the City of Richmond’s logs for regular street sweeping; the section is now being swept weekly as an arterial. The added section of roadway is approximately 1500 feet; the sediment shown in Figure 5 is approximately three inches wide and an inch deep. Therefore, commencement of street sweeping along Hoffman Boulevard would remove approximately 31 cubic feet of sediment, or 2,300 kg, which would otherwise have discharged to the MS4 system. At an estimated PCB concentration of 1,400 µg/kg, this corresponds to a PCB load avoided of approximately 3 grams as a result of adding approximately 1500 linear feet of new street sweeping. As with the NRSPS example, the replenishment rate of the sediments along Hoffman Blvd. is unknown, so the actual annual loads avoided may be substantially more than 3 grams per year.

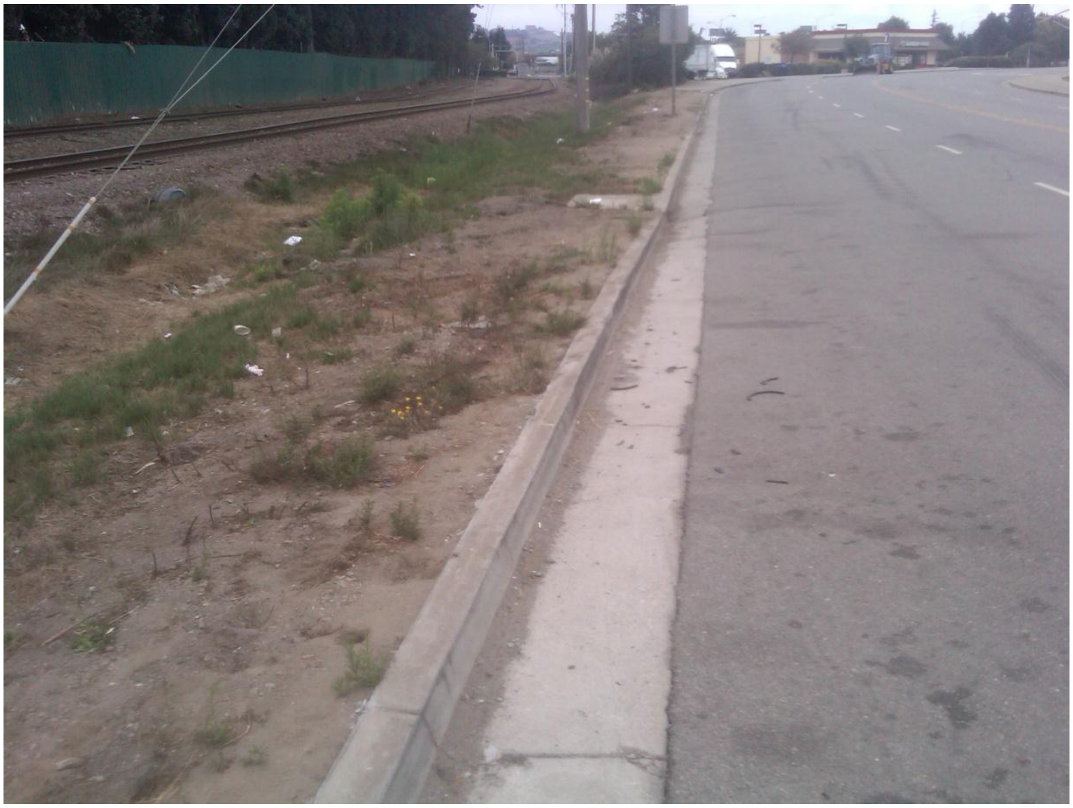


Figure 5. Accumulated Sediments in the Gutter Along Hoffman Blvd., adjacent to a Suspected PCB Source Area

The above estimates of loads avoided by documented changes in municipal street sweeping practices in the NRSPS and Santa Fe Channel drainages can be put into context by comparison with the previously described WinSLAM modeling results. As noted in Table 4-3 above, street sweeping 15 curb miles in the Leo Avenue watershed is modeled to result in an annual load reduction of 48 grams, or 3.2 grams per curb mile annually. Street sweeping in the Sunnyvale East / California Avenue area of 0.94 curb miles results in an annual load reduction of 0.7 grams per curb mile swept. For comparison, the Market Avenue improvement yields from 1.7 to 4.9 grams PCBs annually avoided / reduced per new curb mile swept. New street sweeping activity along a 0.3 mile section of Hoffman Blvd annually avoids at least 3.2 grams of PCBs, or approximately 12 grams PCB per curb mile swept annually.

These practical lessons learned, in combination with modeling results using WinSLAM, help begin to define "rule of thumb" measures of how addition of new street sweeping areas could result in PCB loads reduced. In moderately contaminated areas, such as the NRSPS, curb and gutter improvements would lead to 2 to 5 grams of PCBs reduced annually per curb mile improved, where improvements allow street sweeping in previously un-swept areas. New street sweeping in the less frequently encountered areas that are highly contaminated, such as the Santa Fe Channel drainage near the metal recycler, could yield as much as 10 to 12 grams PCBs annual reduced per curb mile swept. These estimates can help define expectations for the outcome of watershed improvement and management activities in other areas where there may be opportunities to expand street sweeping through sidewalk, curb and gutter improvements.

APPENDIX B.6.A

Data Summaries for Reported Values and Ranking Method for Drain Inlet Cleaning

Table B.6.A.1. Summary of Reported Values for Baseline and Current, and Enhanced Level of Implementation for Drain Inlet Cleaning.

	Baseline				Current			
Municipality	Total Number of Inlets	Total Number of Inlets Cleaned	Total Volume Removed (CY)	Average Volume Removed/ Inlet (CY/Inlet)	Total Number of Inlets	Total Number of Inlets Cleaned	Total Volume Removed (CY)	Average Volume Removed/Inlet (CY/Inlet)
Solano County Municipalities								
Fairfield (FY 93-94 through 08-09)	4500	2223	15245.5	6.9	4500	12990	9393.5	0.7
Suisun (FY 93-94 through 08-09)	1500	2558.5	1598.5	0.6	1500	3613	9656.5	2.7
San Mateo County Municipalities								
Atherton (FY 00-01 through 08-09)	198	1628	311.3	0.2	198	2523	597.9	0.2
Belmont (FY 00-01 through 08-09)	1410	1045	372.8	0.4	1410	3918	1815.8	0.5
Brisbane (FY 00-01 through 08-09)	410	551	76.6	0.1	410	8444	1245.2	0.1
Burlingame (FY 00-01 through 08-09)	1100	2293	1222.5	0.5	1100	5738	4884.0	0.9
Colma (FY 00-01 through 08-09)	185	58	8.8	0.2	185	1201	126.8	0.1
Daly City (FY 00-01 through 08-09)	1850	426	298.5	0.7	1850	2267	2172.5	1.0
East Palo Alto (FY 00-01 through 03-04)	437	253	29.1	0.1	437	1466	133.8	0.1
Foster City (FY 00-01 through 08-09)	1275	229	85.5	0.4	1275	2770	399.8	0.1
Half Moon Bay (FY 00-01 through 08-09)	70	408	251.3	0.6	70	1262	249.3	0.2
Hillsborough (FY 00-01 through 08-09)	646	4339	1621.0	0.4	646	12760	2421.0	0.2

	Baseline				Current			
Municipality	Total Number of Inlets	Total Number of Inlets Cleaned	Total Volume Removed (CY)	Average Volume Removed/ Inlet (CY/Inlet)	Total Number of Inlets	Total Number of Inlets Cleaned	Total Volume Removed (CY)	Average Volume Removed/Inlet (CY/Inlet)
Menlo Park (FY 00-01 through 08-09)	704	487	123.5	0.3	704	1518	1102.4	0.7
Millbrae (FY 00-01 through 08-09)	623	2511	1036.0	0.4	623	11113	2445.8	0.2
Pacifica (FY 00-01 through 08-09)	986	1708	1058.0	0.6	986	11652	4598.0	0.4
Portola Valley (FY 00-01 through 08-09)	264	93	40.0	0.4	264	777	251.4	0.3
Redwood City (FY 00-01 through 08-09)	2685	4455	2143.7	0.5	2685	14676	7181.5	0.5
San Bruno (FY 00-01 through 08-09)	950	2069	243.5	0.1	950	5959	1436.9	0.2
San Carlos (FY 00-01 through 08-09)	701	807	252.3	0.3	701	8679	2733.3	0.3
San Mateo, City (FY 00-01 through 08-09)	5000	9740	424.0	0.0	5000	26812	1333.3	0.0
San Mateo, County (FY 00-01 through 08-09)	1500	5311	352.2	0.1	1500	15951	4695.2	0.3
So. San Francisco (FY 00-01 through 08-09)	1136	6199.5	373.0	0.1	1136	14242	1320.5	0.1
Woodside (FY 00-01 through 08-09)	350	171	314.5	1.8	350	2698	2354.1	0.9
Alameda County Municipalities								
Alameda County (unincorporated (FY 99-00 through 04-05)	3050	4430	31705.5	7.2	3050	1943	33449.6	17.2
Alameda (FY 96-97, 00-01 through 04-05)	2000	1085	434.0	0.4	2000	2705	350.8	0.1
Albany (FY 99-00 through 04-05)	5900	3868	113.3	0.0	5900	3915	224.5	0.1

	Baseline				Current			
Municipality	**Total Number of Inlets**	**Total Number of Inlets Cleaned**	**Total Volume Removed (CY)**	**Average Volume Removed/ Inlet (CY/Inlet)**	**Total Number of Inlets**	**Total Number of Inlets Cleaned**	**Total Volume Removed (CY)**	**Average Volume Removed/Inlet (CY/Inlet)**
Berkeley (FY 96-97, 99-00 through 04-05)	984	13528	1906.2	0.1	984	24030	860.7	0.0
Dublin (FY 96-97, 99-00 through 04-05)	225	2362	138.0	0.1	225	1335	385.6	0.3
Emeryville (FY 96-97, 99-00 through 04-05)	6000	2762	138.0	0.0	6000	3560	193.8	0.1
Fremont (FY 99-00 through 04-05)	3500	9738	1173.7	0.1	3500	10017	736.0	0.1
Hayward (FY 96-97, 99-00 through 04-05)	1823	10983	1075.6	0.1	1823	10976	1629.0	0.1
Livermore (FY 96-97, 99-00 through 04-05)	1249	6459	129.7	0.0	1249	3465	124.8	0.0
Newark (FY 96-97, 99-00 through 04-05)	9471	20410	398.2	0.0	9471	23672	275.8	0.0
Oakland (FY 96-97, 99-00 through 04-05)	150	24927	27472.0	1.1	150	24934	17777.0	0.7
Piedmont (FY 99-00 through 04-05)	4825	691	392.0	0.6	4825	1297	107.8	0.1
Pleasanton (FY 99-00 through 04-05)	2182	1592	1255.0	0.8	2182	1597	297.1	0.2
San Leandro (FY 96-97, 99-00 through 04-05)	3000	8560	204.5	0.0	3000	3181	6255.8	2.0
Union City (FY 96-97, 99-00)	1858	1141	188.0	0.2	1858	452	0.0	0.0
Zone 7 (FY 02-03 through 04-05)	No Data	No data	No data	No data	No data	329	18213.5	55.4
Contra Costa County Municipalities								
Antioch (FY 98-99 through 08-09)	6700	2487	475.6	0.2	6700	6950	963.5	0.1
Brentwood (FY 98-99 through 08-09)	4747	4845	1167.0	0.2	4747	25929	19036.0	0.7

	Baseline				Current			
Municipality	**Total Number of Inlets**	**Total Number of Inlets Cleaned**	**Total Volume Removed (CY)**	**Average Volume Removed/ Inlet (CY/Inlet)**	**Total Number of Inlets**	**Total Number of Inlets Cleaned**	**Total Volume Removed (CY)**	**Average Volume Removed/Inlet (CY/Inlet)**
Clayton (FY 94-95 through 97-98, 01-02 through 08-09)	650	4715	315.0	0.1	650	4550	295.0	0.1
Concord (FY 94-95 through 07-08)	5600	32785	2125.0	0.1	5600	47250	569.0	0.0
Contra Costa County (unincorporated) (FY 97-98 through 08-09)	8130	9464	10527.2	1.1	8130	63200	5123.0	0.1
Danville (FY 98-99 through 08-09)	4694	2566	1339.0	0.5	4694	6913	1285.0	0.2
El Cerrito (FY 98-99 through 08-09)	900	705	378.0	0.5	900	1479	467.0	0.3
Hercules (FY 94-95 through 08-09)	1800	1187	105.6	0.1	1800	2015	127.0	0.1
Lafayette (FY 98-99 through 08-09)	1496	4348	3100.3	0.7	1496	10507	3100.0	0.3
Martinez (FY 98-99 through 08-09)	1320	3945	840.0	0.2	1320	8786	525.0	0.1
Moraga (FY 98-99 through 07-08)	858	3412	17.0	0.0	858	6468	252.0	0.0
Oakley (FY 00-01 through 08-09)	2515	1308	384.7	0.3	2515	10644	140.8	0.0
Orinda (FY 98-99 through 08-09)	1040	550	338.0	0.6	1040	1940	575.1	0.3
Pinole (FY 94-95 through 08-09)	1789	4030	522.1	0.1	1789	10893	1408.5	0.1
Pittsburg (FY 96-97 through 08-09)	2009	7056	10075.0	1.4	2009	7202	3090.5	0.4
Pleasant Hill (FY 98-99 through 08-09)	1294	6024	21.8	0.0	1294	7337	64.3	0.0
Richmond (FY 95-96 through 08-09)	3950	17241	508.0	0.0	3950	18040	12356.3	0.7
San Pablo (FY 98-99 through 08-09)	326	1300	126.2	0.1	326	4599	170.4	0.0

	Baseline				Current			
Municipality	**Total Number of Inlets**	**Total Number of Inlets Cleaned**	**Total Volume Removed (CY)**	**Average Volume Removed/ Inlet (CY/Inlet)**	**Total Number of Inlets**	**Total Number of Inlets Cleaned**	**Total Volume Removed (CY)**	**Average Volume Removed/Inlet (CY/Inlet)**
San Ramon (FY 98-99 through 08-09)	2762	8491	124.8	0.0	2762	19138	428.6	0.0
Walnut Creek (FY 98-99 through 08-09)	3477	11254	690.0	0.1	3477	25860	87.0	0.0

Note: The information in this table is based on already compiled information reported by the Permittees in their Annual Reports.

Table B.6.A.2.Estimated Material Removed per Inlet Calculations for Baseline, Current, and Enhanced Conditions Using the Ranking Method

	Baseline		Current		Enhanced
Municipality	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Δ Volume Removed/Inlet (Cubic Yards/Inlet)
Solano County Municipalities					
Fairfield (FY 93-94 through 08-09)	High	0.54	High	0.31	-0.22
Suisun (FY 93-94 through 08-09)	High	0.54	High	0.31	-0.22
San Mateo County Municipalities					
Atherton (FY 00-01 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Belmont (FY 00-01 through 08-09)	Medium	0.20	High	0.31	0.11
Brisbane (FY 00-01 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Burlingame (FY 00-01 through 08-09)	Medium	0.20	High	0.31	0.11
Colma (FY 00-01 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Daly City (FY 00-01 through 08-09)	High	0.54	High	0.31	-0.22
East Palo Alto (FY 00-01 through 03-04)	Medium	0.20	Medium	0.11	-0.10
Foster City (FY 00-01 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Half Moon Bay (FY 00-01 through 08-09)	High	0.54	Medium	0.11	-0.43
Hillsborough (FY 00-01 through 08-09)	Medium	0.20	Medium	0.11	-0.10

	Baseline		Current		Enhanced
Municipality	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Δ Volume Removed/Inlet (Cubic Yards/Inlet)
Menlo Park (FY 00-01 through 08-09)	Medium	0.20	High	0.31	0.11
Millbrae (FY 00-01 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Pacifica (FY 00-01 through 08-09)	High	0.54	High	0.31	-0.22
Portola Valley (FY 00-01 through 08-09)	Medium	0.20	High	0.31	0.11
Redwood City (FY 00-01 through 08-09)	Medium	0.20	High	0.31	0.11
San Bruno (FY 00-01 through 08-09)	Medium	0.20	Medium	0.11	-0.10
San Carlos (FY 00-01 through 08-09)	Medium	0.20	High	0.31	0.11
San Mateo, City (FY 00-01 through 08-09)	Low	0.07	Medium	0.11	0.04
San Mateo, County (FY 00-01 through 08-09)	Low	0.07	Medium	0.11	0.04
So. San Francisco (FY 00-01 through 08-09)	Low	0.07	Medium	0.11	0.04
Woodside (FY 00-01 through 08-09)	High	0.54	High	0.31	-0.22
Alameda County Municipalities					
Alameda County (unincorporated (FY 99-00 through 04-05)	High	0.54	High	0.31	-0.22
Alameda (FY 96-97, 00-01 through 04-05)	Medium	0.20	Medium	0.11	-0.10
Albany (FY 99-00 through 04-05)	Low	0.07	Medium	0.11	0.04

	Baseline		Current		Enhanced
Municipality	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Δ Volume Removed/Inlet (Cubic Yards/Inlet)
Berkeley (FY 96-97, 99-00 through 04-05)	Medium	0.20	Low	0.04	-0.16
Dublin (FY 96-97, 99-00 through 04-05)	Low	0.07	Medium	0.11	0.04
Emeryville (FY 96-97, 99-00 through 04-05)	Low	0.07	Medium	0.11	0.04
Fremont (FY 99-00 through 04-05)	Medium	0.20	Medium	0.11	-0.10
Hayward (FY 96-97, 99-00 through 04-05)	Medium	0.20	Medium	0.11	-0.10
Livermore (FY 96-97, 99-00 through 04-05)	Low	0.07	Low	0.04	-0.03
Newark (FY 96-97, 99-00 through 04-05)	Low	0.07	Low	0.04	-0.03
Oakland (FY 96-97, 99-00 through 04-05)	High	0.54	High	0.31	-0.22
Piedmont (FY 99-00 through 04-05)	High	0.54	Medium	0.11	-0.43
Pleasanton (FY 99-00 through 04-05)	High	0.54	Medium	0.11	-0.43
San Leandro (FY 96-97, 99-00 through 04-05)	Low	0.07	High	0.31	0.24
Union City (FY 96-97, 99-00)	Medium	0.20	Low	0.04	-0.16
Zone 7 (FY 02-03 through 04-05)	0	0.00	High	0.31	0.31
Contra Costa County Municipalities					
Antioch (FY 98-99 through 08-09)	Medium	0.20	Medium	0.11	-0.10

	Baseline		Current		Enhanced
Municipality	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Δ Volume Removed/Inlet (Cubic Yards/Inlet)
Brentwood (FY 98-99 through 08-09)	Medium	0.20	High	0.31	0.11
Clayton (FY 94-95 through 97-98, 01-02 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Concord (FY 94-95 through 07-08)	Low	0.07	Low	0.04	-0.03
Contra Costa County (unincorporated) (FY 97-98 through 08-09)	High	0.54	Medium	0.11	-0.43
Danville (FY 98-99 through 08-09)	Medium	0.20	Medium	0.11	-0.10
El Cerrito (FY 98-99 through 08-09)	High	0.54	High	0.31	-0.22
Hercules (FY 94-95 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Lafayette (FY 98-99 through 08-09)	High	0.54	Medium	0.11	-0.43
Martinez (FY 98-99 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Moraga (FY 98-99 through 07-08)	Low	0.07	Medium	0.11	0.04
Oakley (FY 00-01 through 08-09)	Medium	0.20	Low	0.04	-0.16
Orinda (FY 98-99 through 08-09)	High	0.54	Medium	0.11	-0.43
Pinole (FY 94-95 through 08-09)	Medium	0.20	Medium	0.11	-0.10
Pittsburg (FY 96-97 through 08-09)	High	0.54	High	0.31	-0.22
Pleasant Hill (FY 98-99 through 08-09)	Low	0.07	Low	0.04	-0.03

	Baseline		Current		Enhanced
Municipality	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Volume Reduction Ranking	Volume of Material Removed per Inlet Inspected/ Cleaned Estimate (cy)	Δ Volume Removed/Inlet (Cubic Yards/Inlet)
Richmond (FY 95-96 through 08-09)	Low	0.07	High	0.31	0.24
San Pablo (FY 98-99 through 08-09)	Medium	0.20	Low	0.04	-0.16
San Ramon (FY 98-99 through 08-09)	Low	0.07	Low	0.04	-0.03
Walnut Creek (FY 98-99 through 08-09)	Low	0.07	Low	0.04	-0.03

Note: For the basis for the categories "low", "medium" and "high" values, see Section B.6.3. "High" removal rates were considered to be the 75th percentile rate and above; "medium" rates were between the 25th and 75th percentile; and "low" removal rates were values less than the 25th percentile.

Table B.6.A.3. Estimated Baseline, Current and Enhanced Load Reductions from Drain Inlet Cleaning Using Reported Values

Municipality	Average Annual Baseline PCB Load Reduced [g]	Average Annual Current PCB Load Reduced [g]	Average Annual Enhanced PCB Load Reduced [g]	[Average Annual Baseline Mercury Load Reduced [g]	Average Annual Current Mercury Load Reduced [g]	Average Annual Enhanced Mercury Load Reduced [g]
Solano County Municipalities						
Fairfield (FY 93-94 through 08-09)	204.1	161.7	-42.4	426.2	337.6	-88.6
Suisun (FY 93-94 through 08-09)	21.4	166.2	144.8	44.7	347.1	302.4
San Mateo County Municipalities						
Atherton (FY 00-01 through 08-09)	24.4	13.4	-11.0	12.3	6.7	-5.6
Belmont (FY 00-01 through 08-09)	29.2	40.6	11.4	14.7	20.5	5.8
Brisbane (FY 00-01 through 08-09)	6.0	27.9	21.9	3.0	14.1	11.0
Burlingame (FY 00-01 through 08-09)	95.7	109.3	13.5	48.3	55.1	6.8
Colma (FY 00-01 through 08-09)	0.7	2.8	2.2	0.3	1.4	1.1
Daly City (FY 00-01 through 08-09)	23.4	48.6	25.2	11.8	24.5	12.7
East Palo Alto (FY 00-01 through 03-04)	2.3	3.0	0.7	1.1	1.5	0.4
Foster City (FY 00-01 through 08-09)	6.7	8.9	2.2	3.4	4.5	1.1

Municipality	Average Annual Baseline PCB Load Reduced [g]	Average Annual Current PCB Load Reduced [g]	Average Annual Enhanced PCB Load Reduced [g]	[Average Annual Baseline Mercury Load Reduced [g]	Average Annual Current Mercury Load Reduced [g]	Average Annual Enhanced Mercury Load Reduced [g]
Half Moon Bay (FY 00-01 through 08-09)	19.7	5.6	-14.1	9.9	2.8	-7.1
Hillsborough (FY 00-01 through 08-09)	126.9	54.2	-72.8	64.0	27.3	-36.7
Menlo Park (FY 00-01 through 08-09)	9.7	24.7	15.0	4.9	12.4	7.6
Millbrae (FY 00-01 through 08-09)	81.1	54.7	-26.4	40.9	27.6	-13.3
Pacifica (FY 00-01 through 08-09)	82.8	102.9	20.0	41.8	51.9	10.1
Portola Valley (FY 00-01 through 08-09)	3.1	5.6	2.5	1.6	2.8	1.3
Redwood City (FY 00-01 through 08-09)	167.9	160.7	-7.2	84.7	81.1	-3.6
San Bruno (FY 00-01 through 08-09)	19.1	32.1	13.1	9.6	16.2	6.6
San Carlos (FY 00-01 through 08-09)	16.6	51.4	34.8	10.4	32.1	21.7
San Mateo, City (FY 00-01 through 08-09)	33.2	29.8	-3.4	16.7	15.0	-1.7
San Mateo, County (FY 00-01 through 08-09)	27.6	105.0	77.5	13.9	53.0	39.1
So. San Francisco (FY 00-01 through 08-09)	29.2	29.5	0.3	14.7	14.9	0.2
Woodside (FY 00-01 through 08-09)	24.6	52.7	28.0	12.4	26.6	14.1
Alameda County Municipalities						

Municipality	Average Annual Baseline PCB Load Reduced [g]	Average Annual Current PCB Load Reduced [g]	Average Annual Enhanced PCB Load Reduced [g]	[Average Annual Baseline Mercury Load Reduced [g]	Average Annual Current Mercury Load Reduced [g]	Average Annual Enhanced Mercury Load Reduced [g]
Alameda County (unincorporated (FY 99-00 through 04-05)	1531.5	1615.8	84.2	1999.5	2109.5	110.0
Alameda (FY 96-97, 00-01 through 04-05)	15.7	16.9	1.2	20.5	22.1	1.6
Albany (FY 99-00 through 04-05)	4.1	10.8	6.7	5.4	14.2	8.8
Berkeley (FY 96-97, 99-00 through 04-05)	69.1	41.6	-27.5	80.6	48.5	-32.1
Dublin (FY 96-97, 99-00 through 04-05)	5.0	18.6	13.6	6.5	24.3	17.8
Emeryville (FY 96-97, 99-00 through 04-05)	5.0	9.4	4.4	6.5	12.2	5.7
Fremont (FY 99-00 through 04-05)	42.5	35.6	-7.0	55.5	46.4	-9.1
Hayward (FY 96-97, 99-00 through 04-05)	39.0	78.7	39.7	50.9	102.7	51.9
Livermore (FY 96-97, 99-00 through 04-05)	4.7	6.0	1.3	6.1	7.9	1.7
Newark (FY 96-97, 99-00 through 04-05)	14.4	13.3	-1.1	18.8	17.4	-1.4
Oakland (FY 96-97, 99-00 through 04-05)	1361.3	1174.5	-186.8	1822.8	1572.7	-250.1
Piedmont (FY 99-00 through 04-05)	14.2	5.2	-9.0	18.5	6.8	-11.7
Pleasanton (FY 99-00 through 04-05)	45.5	14.4	-31.1	59.4	18.7	-40.6

Municipality	Average Annual Baseline PCB Load Reduced [g]	Average Annual Current PCB Load Reduced [g]	Average Annual Enhanced PCB Load Reduced [g]	[Average Annual Baseline Mercury Load Reduced [g]	Average Annual Current Mercury Load Reduced [g]	Average Annual Enhanced Mercury Load Reduced [g]
San Leandro (FY 96-97, 99-00 through 04-05)	5.5	225.2	219.7	5.8	236.1	230.4
Union City (FY 96-97, 99-00)	6.8	0.0	-6.8	8.9	0.0	-8.9
Zone 7 (FY 02-03 through 04-05)	No data	879.8	--	No data	1.0	--
Contra Costa County Municipalities						
Antioch (FY 98-99 through 08-09)	30.2	35.0	4.8	24.2	28.0	3.8
Brentwood (FY 98-99 through 08-09)	74.1	690.7	616.6	59.4	553.9	494.5
Clayton (FY 94-95 through 97-98, 01-02 through 08-09)	13.3	10.7	-2.6	10.7	8.6	-2.1
Concord (FY 94-95 through 07-08)	67.5	24.1	-43.4	54.1	19.3	-34.8
Contra Costa County (unincorporated) (FY 97-98 through 08-09)	534.7	185.9	-348.9	428.8	149.1	-279.8
Danville (FY 98-99 through 08-09)	42.5	46.6	4.1	34.1	37.4	3.3
El Cerrito (FY 98-99 through 08-09)	24.0	16.9	-7.1	19.2	13.6	-5.7
Hercules (FY 94-95 through 08-09)	3.4	4.6	1.3	2.7	3.7	1.0
Lafayette (FY 98-99 through 08-09)	196.9	112.5	-84.4	157.9	90.2	-67.7

Municipality	Average Annual Baseline PCB Load Reduced [g]	Average Annual Current PCB Load Reduced [g]	Average Annual Enhanced PCB Load Reduced [g]	[Average Annual Baseline Mercury Load Reduced [g]	Average Annual Current Mercury Load Reduced [g]	Average Annual Enhanced Mercury Load Reduced [g]
Martinez (FY 98-99 through 08-09)	53.3	19.0	-34.3	42.8	15.3	-27.5
Moraga (FY 98-99 through 07-08)	1.1	10.7	9.6	0.9	8.6	7.7
Oakley (FY 00-01 through 08-09)	48.8	5.1	-43.7	39.2	4.1	-35.1
Orinda (FY 98-99 through 08-09)	28.6	20.9	-7.8	22.9	16.7	-6.2
Pinole (FY 94-95 through 08-09)	16.6	51.1	34.5	13.3	41.0	27.7
Pittsburg (FY 96-97 through 08-09)	852.9	261.6	-591.3	684.0	209.8	-474.2
Pleasant Hill (FY 98-99 through 08-09)	1.4	2.3	1.0	1.1	1.9	0.8
Richmond (FY 95-96 through 08-09)	26.3	746.6	720.3	16.5	466.9	450.4
San Pablo (FY 98-99 through 08-09)	10.7	6.2	-4.5	8.6	5.0	-3.6
San Ramon (FY 98-99 through 08-09)	7.9	15.6	7.6	6.4	12.5	6.1
Walnut Creek (FY 98-99 through 08-09)	43.8	4.4	-39.4	35.1	3.5	-31.6

Table B.6.A.4. Estimated Baseline, Current and Enhanced Load Reductions from Drain Inlet Cleaning Using the Ranking Method

Municipality	PCBs					Mercury				
	Baseline PCB Load Reduction Ranking	**Average Annual Baseline PCB Load Reduction Estimate (g)**	**Current PCB Load Reduction Ranking**	**Average Annual Current PCB Load Reduction Estimate (g)**	**Average Annual Enhanced PCB Load Reduction Estimate (g)**	**Baseline Hg Load Reduction Ranking**	**Average Annual Baseline Hg Load Reduction Estimate (g)**	**Current Hg Load Reduction Ranking**	**Average Annual Current Hg Load Reduction Estimate (g)**	**Average Annual Enhanced Hg Load Reduction Estimate (g)**
Solano County Municipalities										
Fairfield (FY 93-94 through 08-09)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
Suisun (FY 93-94 through 08-09)	Medium	24.5	High	72.7	48.2	Medium	16.6	High	51.0	34.4
San Mateo County Municipalities										
Atherton (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Low	8.6	-8.0
Belmont (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Brisbane (FY 00-01 through 08-09)	Low	8.4	Medium	28.7	20.3	Low	7.0	Medium	19.0	12.0
Burlingame (FY 00-01 through 08-09)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
Colma (FY 00-01 through 08-09)	Low	8.4	Low	10.7	2.3	Low	7.0	Low	8.6	1.5

Municipality	PCBs					Mercury				
	Baseline PCB Load Reduction Ranking	**Average Annual Baseline PCB Load Reduction Estimate (g)**	**Current PCB Load Reduction Ranking**	**Average Annual Current PCB Load Reduction Estimate (g)**	**Average Annual Enhanced PCB Load Reduction Estimate (g)**	**Baseline Hg Load Reduction Ranking**	**Average Annual Baseline Hg Load Reduction Estimate (g)**	**Current Hg Load Reduction Ranking**	**Average Annual Current Hg Load Reduction Estimate (g)**	**Average Annual Enhanced Hg Load Reduction Estimate (g)**
Daly City (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
East Palo Alto (FY 00-01 through 03-04)	Low	8.4	Low	10.7	2.3	Low	7.0	Low	8.6	1.5
Foster City (FY 00-01 through 08-09)	Low	8.4	Low	10.7	2.3	Low	7.0	Low	8.6	1.5
Half Moon Bay (FY 00-01 through 08-09)	Medium	24.5	Low	10.7	-13.8	Medium	16.6	Low	8.6	-8.0
Hillsborough (FY 00-01 through 08-09)	High	52.2	Medium	28.7	-23.5	High	47.4	Medium	19.0	-28.4
Menlo Park (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Low	7.0	Medium	19.0	12.0
Millbrae (FY 00-01 through 08-09)	High	52.2	Medium	28.7	-23.5	Medium	16.6	Medium	19.0	2.4
Pacifica (FY 00-01 through 08-09)	High	52.2	High	72.7	20.5	Medium	16.6	High	51.0	34.4

Municipality	PCBs					Mercury				
	Baseline PCB Load Reduction Ranking	Average Annual Baseline PCB Load Reduction Estimate (g)	Current PCB Load Reduction Ranking	Average Annual Current PCB Load Reduction Estimate (g)	Average Annual Enhanced PCB Load Reduction Estimate (g)	Baseline Hg Load Reduction Ranking	Average Annual Baseline Hg Load Reduction Estimate (g)	Current Hg Load Reduction Ranking	Average Annual Current Hg Load Reduction Estimate (g)	Average Annual Enhanced Hg Load Reduction Estimate (g)
Portola Valley (FY 00-01 through 08-09)	Low	8.4	Low	10.7	2.3	Low	7.0	Low	8.6	1.5
Redwood City (FY 00-01 through 08-09)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
San Bruno (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
San Carlos (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
San Mateo, City (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
San Mateo, County (FY 00-01 through 08-09)	Medium	24.5	High	72.7	48.2	Medium	16.6	High	51.0	34.4
So. San Francisco (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Woodside (FY 00-01 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Alameda County Municipalities										

Municipality	PCBs					Mercury				
	Baseline PCB Load Reduction Ranking	**Average Annual Baseline PCB Load Reduction Estimate (g)**	**Current PCB Load Reduction Ranking**	**Average Annual Current PCB Load Reduction Estimate (g)**	**Average Annual Enhanced PCB Load Reduction Estimate (g)**	**Baseline Hg Load Reduction Ranking**	**Average Annual Baseline Hg Load Reduction Estimate (g)**	**Current Hg Load Reduction Ranking**	**Average Annual Current Hg Load Reduction Estimate (g)**	**Average Annual Enhanced Hg Load Reduction Estimate (g)**
Alameda County (unincorporated (FY 99-00 through 04-05)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
Alameda (FY 96-97, 00-01 through 04-05)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Albany (FY 99-00 through 04-05)	Low	8.4	Medium	28.7	20.3	Low	7.0	Medium	19.0	12.0
Berkeley (FY 96-97, 99-00 through 04-05)	High	52.2	Medium	28.7	-23.5	High	47.4	Medium	19.0	-28.4
Dublin (FY 96-97, 99-00 through 04-05)	Low	8.4	Medium	28.7	20.3	Low	7.0	Medium	19.0	12.0
Emeryville (FY 96-97, 99-00 through 04-05)	Low	8.4	Low	10.7	2.3	Low	7.0	Medium	19.0	12.0
Fremont (FY 99-00 through 04-05)	Medium	24.5	Medium	28.7	4.2	High	47.4	Medium	19.0	-28.4
Hayward (FY 96-97, 99-00 through 04-05)	Medium	24.5	High	72.7	48.2	High	47.4	High	51.0	3.7

Municipality	PCBs					Mercury				
	Baseline PCB Load Reduction Ranking	**Average Annual Baseline PCB Load Reduction Estimate (g)**	**Current PCB Load Reduction Ranking**	**Average Annual Current PCB Load Reduction Estimate (g)**	**Average Annual Enhanced PCB Load Reduction Estimate (g)**	**Baseline Hg Load Reduction Ranking**	**Average Annual Baseline Hg Load Reduction Estimate (g)**	**Current Hg Load Reduction Ranking**	**Average Annual Current Hg Load Reduction Estimate (g)**	**Average Annual Enhanced Hg Load Reduction Estimate (g)**
Livermore (FY 96-97, 99-00 through 04-05)	Low	8.4	Low	10.7	2.3	Low	7.0	Low	8.6	1.5
Newark (FY 96-97, 99-00 through 04-05)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Oakland (FY 96-97, 99-00 through 04-05)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
Piedmont (FY 99-00 through 04-05)	Medium	24.5	Low	10.7	-13.8	Medium	16.6	Low	8.6	-8.0
Pleasanton (FY 99-00 through 04-05)	Medium	24.5	Medium	28.7	4.2	High	47.4	Medium	19.0	-28.4
San Leandro (FY 96-97, 99-00 through 04-05)	Low	8.4	High	72.7	64.3	Low	7.0	High	51.0	44.0
Union City (FY 96-97, 99-00)	Low	8.4	Low	10.7	2.3	Medium	16.6	Low	8.6	-8.0
Zone 7 (FY 02-03 through 04-05)	No Data	0.0	High	72.7	72.7	No Data	0.0	Low	8.6	8.6
Contra Costa County Municipalities										

Municipality	PCBs					Mercury				
	Baseline PCB Load Reduction Ranking	Average Annual Baseline PCB Load Reduction Estimate (g)	Current PCB Load Reduction Ranking	Average Annual Current PCB Load Reduction Estimate (g)	Average Annual Enhanced PCB Load Reduction Estimate (g)	Baseline Hg Load Reduction Ranking	Average Annual Baseline Hg Load Reduction Estimate (g)	Current Hg Load Reduction Ranking	Average Annual Current Hg Load Reduction Estimate (g)	Average Annual Enhanced Hg Load Reduction Estimate (g)
Antioch (FY 98-99 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Brentwood (FY 98-99 through 08-09)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
Clayton (FY 94-95 through 97-98, 01-02 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Concord (FY 94-95 through 07-08)	High	52.2	Medium	28.7	-23.5	High	47.4	Medium	19.0	-28.4
Contra Costa County (unincorporated) (FY 97-98 through 08-09)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
Danville (FY 98-99 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
El Cerrito (FY 98-99 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Hercules (FY 94-95 through 08-09)	Low	8.4	Low	10.7	2.3	Low	7.0	Low	8.6	1.5

Municipality	PCBs					Mercury				
	Baseline PCB Load Reduction Ranking	**Average Annual Baseline PCB Load Reduction Estimate (g)**	**Current PCB Load Reduction Ranking**	**Average Annual Current PCB Load Reduction Estimate (g)**	**Average Annual Enhanced PCB Load Reduction Estimate (g)**	**Baseline Hg Load Reduction Ranking**	**Average Annual Baseline Hg Load Reduction Estimate (g)**	**Current Hg Load Reduction Ranking**	**Average Annual Current Hg Load Reduction Estimate (g)**	**Average Annual Enhanced Hg Load Reduction Estimate (g)**
Lafayette (FY 98-99 through 08-09)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
Martinez (FY 98-99 through 08-09)	High	52.2	Medium	28.7	-23.5	Medium	16.6	Medium	19.0	2.4
Moraga (FY 98-99 through 07-08)	Low	8.4	Low	10.7	2.3	Low	7.0	Low	8.6	1.5
Oakley (FY 00-01 through 08-09)	Medium	24.5	Low	10.7	-13.8	Medium	16.6	Low	8.6	-8.0
Orinda (FY 98-99 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Pinole (FY 94-95 through 08-09)	Medium	24.5	Medium	28.7	4.2	Medium	16.6	Medium	19.0	2.4
Pittsburg (FY 96-97 through 08-09)	High	52.2	High	72.7	20.5	High	47.4	High	51.0	3.7
Pleasant Hill (FY 98-99 through 08-09)	Low	8.4	Low	10.7	2.3	Low	7.0	Low	8.6	1.5
Richmond (FY 95-96 through 08-09)	Medium	24.5	High	72.7	48.2	Medium	16.6	High	51.0	34.4

Municipality	PCBs					Mercury				
	Baseline PCB Load Reduction Ranking	**Average Annual Baseline PCB Load Reduction Estimate (g)**	**Current PCB Load Reduction Ranking**	**Average Annual Current PCB Load Reduction Estimate (g)**	**Average Annual Enhanced PCB Load Reduction Estimate (g)**	**Baseline Hg Load Reduction Ranking**	**Average Annual Baseline Hg Load Reduction Estimate (g)**	**Current Hg Load Reduction Ranking**	**Average Annual Current Hg Load Reduction Estimate (g)**	**Average Annual Enhanced Hg Load Reduction Estimate (g)**
San Pablo (FY 98-99 through 08-09)	Medium	24.5	Low	10.7	-13.8	Medium	16.6	Low	8.6	-8.0
San Ramon (FY 98-99 through 08-09)	Low	8.4	Medium	28.7	20.3	Low	7.0	Medium	19.0	12.0
Walnut Creek (FY 98-99 through 08-09)	Medium	24.5	Low	10.7	-13.8	Medium	16.6	Low	8.6	-8.0

APPENDIX B.6.B

Data Summaries Pump Station Load Reduction Estimates

Table B.6.B. Estimates of Annual PCB and Mercury Load Reductions from Pump Station Cleaning using Maximum Pumping Capacity and Tributary Area to Normalize Calculated Load Reductions from the Ettie Street Pump Station

Municipality	Pump Station Location	Maximum Pumping Capacity (gal/min)	Tributary Area (acres)	PCB Low Max Capacity[(1)] [g]	PCB High Max Capacity [g]	Hg Low Max Capacity [g]	Hg High Max Capacity [g]	PCB Low Tributary Area [g]	PCB High Tributary Area [g]	Hg Low Tributary Area [g]	Hg High Tributary Area [g]
Alameda	Arbor Street at Clement Ave (extension)	30,000.0	0.0	0.16	4.45	0.15	2.86	--	--	--	--
Menlo Park	1221 Chrysler Dr., Menlo Park, CA 94025	619.4	33.5	0.00	0.09	0.00	0.06	0.04	1.16	0.04	0.75
Fremont	South Grimmer/ Osgood	1,500.0	0.0	0.01	0.22	0.01	0.14	--	--	--	--
Hayward	Addison Way	54,000.0	773.0	0.29	8.00	0.28	5.15	0.96	26.81	0.92	17.24
Hayward	Behind Pepsi Plant	190,700.0	322.0	1.01	28.27	0.97	18.17	0.40	11.17	0.38	7.18
Hayward	Eden Landing Rd	82,200.0	306.0	0.44	12.18	0.42	7.83	0.38	10.61	0.37	6.82
Hayward	Crocker/ Santana	365,200.0	847.0	1.94	54.13	1.86	34.81	1.05	29.38	1.01	18.89
Hayward	End of Cabot Rd.	105,300.0	0.0	0.56	15.61	0.54	10.04	--	--	--	--
Oakland	3455 Ettie St.	468,000.0	2000.0	2.49	69.37	2.39	44.60	2.49	69.37	2.39	44.60
Redwood City	Bair Island & E. Bayshore	63,200.0	8.0	0.34	9.37	0.32	6.02	0.01	0.28	0.01	0.18
Redwood City	1180 Broadway	12,800.0	203.0	0.07	1.90	0.07	1.22	0.25	7.04	0.24	4.53
Redwood City	15 Waterside Cr.	32,400.0	43.0	0.17	4.80	0.17	3.09	0.05	1.49	0.05	0.96
Redwood City	1101 Douglas	18,000.0	541.0	0.10	2.67	0.09	1.72	0.67	18.76	0.65	12.06
Redwood City	End of Maple (Eastside)	13,000.0	26.0	0.07	1.93	0.07	1.24	0.03	0.90	0.03	0.58
Redwood City	305 Main St.	42,600.0	88.0	0.23	6.31	0.22	4.06	0.11	3.05	0.11	1.96
Redwood City	195 Seaport Blvd - Across	7,600.0	43.0	0.04	1.13	0.04	0.72	0.05	1.49	0.05	0.96

Municipality	Pump Station Location	Maximum Pumping Capacity (gal/min)	Tributary Area (acres)	PCB Low Max Capacity(1) [g]	PCB High Max Capacity [g]	Hg Low Max Capacity [g]	Hg High Max Capacity [g]	PCB Low Tributary Area [g]	PCB High Tributary Area [g]	Hg Low Tributary Area [g]	Hg High Tributary Area [g]
Redwood City	207 Penobscot Dr.	83,000.0	63.0	0.44	12.30	0.42	7.91	0.08	2.19	0.08	1.40
Redwood City	800 Seaport Blvd.	12,500.0	122.0	0.07	1.85	0.06	1.19	0.15	4.23	0.15	2.72
Redwood City	123 Seaport Blvd., 195-199 Seaport Blvd., 295 Seaport Blvd.	1,000.0	10.4	0.01	0.15	0.01	0.10	0.01	0.36	0.01	0.23
Redwood City		5,200.0	4.0	0.03	0.77	0.03	0.50	0.00	0.14	0.00	0.09
Redwood City	N/End Veterans - 101	35,000.0	164.0	0.19	5.19	0.18	3.34	0.20	5.69	0.20	3.66
Richmond	Richmond Parkway at Gertrude Avenue	45,000.0	666.0	0.24	6.67	0.23	4.29	0.83	23.10	0.80	14.85
San Carlos	Old County & Brittan	2,000.0	1.8	0.01	0.30	0.01	0.19	0.00	0.06	0.00	0.04
San Carlos	1041 Industrial	63,000.0	20.3	0.33	9.34	0.32	6.00	0.03	0.70	0.02	0.45
San Jose	Park Avenue @ Los Gatos Creek	1,740.0	0.0	0.01	0.26	0.01	0.17	--	--	--	--
San Leandro	2048 Farallon Dr.	41,650.0	171.0	0.22	6.17	0.21	3.97	0.21	5.93	0.20	3.81
Santa Clara	2800 Mead (between Chromite & Kifer) Underpass	2,750.0	1.0	0.01	0.41	0.01	0.26	0.00	0.03	0.00	0.02
Santa Clara	1500 Warburton Ave. - Dewatering	0.0	1.0	--	--	--	--	0.00	0.03	0.00	0.02

Municipality	Pump Station Location	Maximum Pumping Capacity (gal/min)	Tributary Area (acres)	PCB Low Max Capacity[1] [g]	PCB High Max Capacity [g]	Hg Low Max Capacity [g]	Hg High Max Capacity [g]	PCB Low Tributary Area [g]	PCB High Tributary Area [g]	Hg Low Tributary Area [g]	Hg High Tributary Area [g]
Santa Clara	1701 De La Cruz Blvd. (South of Reed St.) - Underpass	0.0	5.0	--	--	--	--	0.01	0.17	0.01	0.11
Santa Clara	5611 Lafayette (South of 237)	50,000.0	284.0	0.27	7.41	0.26	4.77	0.35	9.85	0.34	6.33
Santa Clara	3905 Freedome Circle at Mission College Blvd.	35,200.0	200.0	0.19	5.22	0.18	3.35	0.25	6.94	0.24	4.46
Santa Clara	3301 Bassett St (North of Laurelwood Rd.)	2,300.0	1.0	0.01	0.34	0.01	0.22	0.00	0.03	0.00	0.02
Santa Clara	1890 Lafayette St. (south of Reed St.)	200.0	1.0	0.00	0.03	0.00	0.02	0.00	0.03	0.00	0.02
Santa Clara	3298 Lakeside Dr.	30,000.0	170.0	0.16	4.45	0.15	2.86	0.21	5.90	0.20	3.79
Santa Clara	3401 Victor St.	59,150.0	335.0	0.31	8.77	0.30	5.64	0.42	11.62	0.40	7.47
Santa Clara	1990 Walsh Ave. - dewatering	0.0	1.0	--	--	--	--	0.00	0.03	0.00	0.02
Santa Clara	3575 Victor St.	78,150.0	5.0	0.42	11.58	0.40	7.45	0.01	0.17	0.01	0.11
Santa Clara	2501 Stars & Stripes	11,100.0	60.0	0.06	1.65	0.06	1.06	0.07	2.08	0.07	1.34
Santa Clara	5099 Lick Mill Blvd. at Shulman - dewatering	600.0	0.0	0.00	0.09	0.00	0.06	0.00	0.00	0.00	0.00
Santa Clara	2900 Old Mt. View Alviso Rd.	64,500.0	366.0	0.34	9.56	0.33	6.15	0.45	12.69	0.44	8.16

Municipality	Pump Station Location	Maximum Pumping Capacity (gal/min)	Tributary Area (acres)	PCB Low Max Capacity[1] [g]	PCB High Max Capacity [g]	Hg Low Max Capacity [g]	Hg High Max Capacity [g]	PCB Low Tributary Area [g]	PCB High Tributary Area [g]	Hg Low Tributary Area [g]	Hg High Tributary Area [g]
South San Francisco	291 Shaw Road	4,000.0	8.3	0.02	0.59	0.02	0.38	0.01	0.29	0.01	0.19
South San Francisco	Rail Road Right-of-way west of 1335 block of Lowrie Ave.	3,000.0	14.8	0.02	0.44	0.02	0.29	0.02	0.51	0.02	0.33
South San Francisco	Near 270 South Maple Ave.	2,800.0	5.5	0.01	0.42	0.01	0.27	0.01	0.19	0.01	0.12
South San Francisco	Near 270 South Maple Ave.	2,800.0	5.5	0.01	0.42	0.01	0.27	0.01	0.19	0.01	0.12
South San Francisco	Near 270 South Maple Ave.	2,800.0	5.5	0.01	0.42	0.01	0.27	0.01	0.19	0.01	0.12
South San Francisco	South Canal St.	3,000.0	10.2	0.02	0.44	0.02	0.29	0.01	0.35	0.01	0.23
South San Francisco	South Linden	1,500.0	1.3	0.01	0.22	0.01	0.14	0.00	0.05	0.00	0.03
Sunnyvale	Between WPCP at Borregas and Smart Station at Carl Rd.	59,250.0	500.0	0.31	8.78	0.30	5.65	0.62	17.34	0.60	11.15
Sunnyvale	Central Expwy and Fair Oaks	9,000.0	0.0	0.05	1.33	0.05	0.86	--	--	--	--

NOTES:

(1) “High” and “Low” estimates for PCB and mercury load reductions were obtained using the highest and lowest annual load reductions calculated for the ESPS.

(2) --: The pump station maximum pumping capacity or tributary area is not known.

Table B.6.B.2. Estimates of PCB and Mercury Load Reductions from Pumping Station Cleaning Using Maximum Pumping Capacity and Tributary Area to Normalize Sediment Removed from the Ettie Street Pump Station

Municipality	Pump Station Location	Maximum Pumping Capacity (gal/min)	Tributary Area (acres)	PCB Low Max Capacity(1) [g]	PCB High Max Capacity [g]	Hg Low Max Capacity [g]	Hg High Max Capacity [g]	PCB Low Tributary Area [g]	PCB High Tributary Area [g]	Hg Low Tributary Area [g]	Hg High Tributary Area [g]
Alameda	Arbor Street at Clement Ave (extension)	30,000.0	0.0	0.24	4.45	0.15	2.86	--	--	--	--
Menlo Park	1221 Chrysler Dr., Menlo Park, CA 94025	619.4	33.5	0.00	0.06	0.00	0.02	0.04	0.81	0.01	0.23
Fremont	South Grimmer/ Osgood	1,500.0	0.0	0.01	0.22	0.01	0.14	--	--	--	--
Hayward	Addison Way	54,000.0	773.0	0.43	8.00	0.28	5.15	1.44	26.80	0.92	17.24
Hayward	Behind Pepsi Plant	190,700.0	322.0	1.51	28.26	0.97	18.18	0.60	11.17	0.38	7.18
Hayward	Eden Landing Rd	82,200.0	306.0	0.65	12.18	0.42	7.84	0.57	10.61	0.37	6.83
Hayward	Crocker/ Santana	365,200.0	847.0	2.90	54.12	1.87	34.82	1.57	29.37	1.01	18.89
Hayward	End of Cabot Rd.	105,300.0	0.0	0.84	15.60	0.54	10.04	--	--	--	--
Oakland	3455 Ettie St.	468,000.0	2000.0	3.72	69.35	2.39	44.62	3.72	69.35	2.39	44.62
Redwood City	Bair Island & E. Bayshore	63,200.0	8.0	0.35	6.53	0.10	1.83	0.01	0.19	0.00	0.05
Redwood City	1180 Broadway	12,800.0	203.0	0.07	1.32	0.02	0.37	0.26	4.91	0.07	1.38
Redwood City	15 Waterside Cr.	32,400.0	43.0	0.18	3.35	0.05	0.94	0.06	1.04	0.02	0.29
Redwood City	1101 Douglas	18,000.0	541.0	0.10	1.86	0.03	0.52	0.70	13.09	0.20	3.67
Redwood City	End of Maple (Eastside)	13,000.0	26.0	0.07	1.34	0.02	0.38	0.03	0.63	0.01	0.18
Redwood City	305 Main St.	42,600.0	88.0	0.24	4.40	0.07	1.23	0.11	2.13	0.03	0.60

Municipality	Pump Station Location	Maximum Pumping Capacity (gal/min)	Tributary Area (acres)	PCB Low Max Capacity[(1)] [g]	PCB High Max Capacity [g]	Hg Low Max Capacity [g]	Hg High Max Capacity [g]	PCB Low Tributary Area [g]	PCB High Tributary Area [g]	Hg Low Tributary Area [g]	Hg High Tributary Area [g]
Redwood City	195 Seaport Blvd - Across	7,600.0	43.0	0.04	0.79	0.01	0.22	0.06	1.04	0.02	0.29
Redwood City	207 Penobscot Dr.	83,000.0	63.0	0.46	8.58	0.13	2.41	0.08	1.52	0.02	0.43
Redwood City	800 Seaport Blvd.	12,500.0	122.0	0.07	1.29	0.02	0.36	0.16	2.95	0.04	0.83
Redwood City	123 Seaport Blvd., 195-199 Seaport Blvd., 295 Seaport Blvd.	1,000.0	10.4	0.01	0.10	0.00	0.03	0.01	0.25	0.00	0.07
Redwood City		5,200.0	4.0	0.03	0.54	0.01	0.15	0.01	0.10	0.00	0.03
Redwood City	N/End Veterans - 101	35,000.0	164.0	0.19	3.62	0.05	1.01	0.21	3.97	0.06	1.11
Richmond	Richmond Parkway at Gertrude Avenue	45,000.0	666.0	0.21	3.84	0.12	2.31	0.71	13.29	0.43	7.99
San Carlos	Old County & Brittan	2,000.0	1.8	0.01	0.21	0.00	0.06	0.00	0.04	0.00	0.01
San Carlos	1041 Industrial	63,000.0	20.3	0.35	6.51	0.10	1.83	0.03	0.49	0.01	0.14
San Jose	Park Avenue @ Los Gatos Creek	1,740.0	0.0	0.00	0.01	0.00	0.05	--	--	--	--
San Leandro	2048 Farallon Dr.	41,650.0	171.0	0.33	6.17	0.21	3.97	0.32	5.93	0.20	3.81
Santa Clara	2800 Mead (between Chromite & Kifer) Underpass	2,750.0	1.0	0.00	0.01	0.00	0.08	0.00	0.00	0.00	0.01
Santa Clara	1500 Warburton Ave. - Dewatering	0.0	1.0	--	--	--	--	0.00	0.00	0.00	0.01

Municipality	Pump Station Location	Maximum Pumping Capacity (gal/min)	Tributary Area (acres)	PCB Low Max Capacity(1) [g]	PCB High Max Capacity [g]	Hg Low Max Capacity [g]	Hg High Max Capacity [g]	PCB Low Tributary Area [g]	PCB High Tributary Area [g]	Hg Low Tributary Area [g]	Hg High Tributary Area [g]
Santa Clara	1701 De La Cruz Blvd. (South of Reed St.) - Underpass	0.0	5.0	--	--	--	--	0.00	0.01	0.00	0.03
Santa Clara	5611 Lafayette (South of 237)	50,000.0	284.0	0.01	0.21	0.08	1.47	0.02	0.28	0.10	1.96
Santa Clara	3905 Freedome Circle at Mission College Blvd.	35,200.0	200.0	0.01	0.15	0.06	1.04	0.01	0.20	0.07	1.38
Santa Clara	3301 Bassett St (North of Laurelwood Rd.)	2,300.0	1.0	0.00	0.01	0.00	0.07	0.00	0.00	0.00	0.01
Santa Clara	1890 Lafayette St. (south of Reed St.)	200.0	1.0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Santa Clara	3298 Lakeside Dr.	30,000.0	170.0	0.01	0.13	0.05	0.88	0.01	0.17	0.06	1.17
Santa Clara	3401 Victor St.	59,150.0	335.0	0.01	0.25	0.09	1.74	0.02	0.34	0.12	2.31
Santa Clara	1990 Walsh Ave. - dewatering	0.0	1.0	--	--	--	--	0.00	0.00	0.00	0.01
Santa Clara	3575 Victor St.	78,150.0	5.0	0.02	0.33	0.12	2.30	0.00	0.01	0.00	0.03
Santa Clara	2501 Stars & Stripes	11,100.0	60.0	0.00	0.05	0.02	0.33	0.00	0.06	0.02	0.41
Santa Clara	5099 Lick Mill Blvd. at Shulman - dewatering	600.0	0.0	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Santa Clara	2900 Old Mt. View Alviso Rd.	64,500.0	366.0	0.01	0.28	0.10	1.90	0.02	0.37	0.14	2.52

Municipality	Pump Station Location	Maximum Pumping Capacity (gal/min)	Tributary Area (acres)	PCB Low Max Capacity[1] [g]	PCB High Max Capacity [g]	Hg Low Max Capacity [g]	Hg High Max Capacity [g]	PCB Low Tributary Area [g]	PCB High Tributary Area [g]	Hg Low Tributary Area [g]	Hg High Tributary Area [g]
South San Francisco	291 Shaw Road	4,000.0	8.3	0.02	0.41	0.01	0.12	0.01	0.20	0.00	0.06
South San Francisco	Rail Road Right-of-way west of 1335 block of Lowrie Ave.	3,000.0	14.8	0.02	0.31	0.00	0.09	0.02	0.36	0.01	0.10
South San Francisco	Near 270 South Maple Ave.	2,800.0	5.5	0.02	0.29	0.00	0.08	0.01	0.13	0.00	0.04
South San Francisco	Near 270 South Maple Ave.	2,800.0	5.5	0.02	0.29	0.00	0.08	0.01	0.13	0.00	0.04
South San Francisco	Near 270 South Maple Ave.	2,800.0	5.5	0.02	0.29	0.00	0.08	0.01	0.13	0.00	0.04
South San Francisco	South Canal St.	3,000.0	10.2	0.02	0.31	0.00	0.09	0.01	0.25	0.00	0.07
South San Francisco	South Linden	1,500.0	1.3	0.01	0.16	0.00	0.04	0.00	0.03	0.00	0.01
Sunnyvale	Between WPCP at Borregas and Smart Station at Carl Rd.	59,250.0	500.0	0.01	0.25	0.09	1.75	0.03	0.50	0.18	3.45
Sunnyvale	Central Expwy and Fair Oaks	9,000.0	0.0	0.00	0.04	0.01	0.27	--	--	--	--

NOTES:

(1) "High" and "Low" estimates for PCB and mercury load reductions were obtained using the highest and lowest volume of materials removed during cleanouts at the ESPS and sediment concentration data included in Table B.6.9.

(2) --: The pump station maximum pumping capacity or tributary area is not known.

APPENDIX B.7.A

Green Streets Pilot Project Status Table

Appendix B.7.A.1. Project Information for 10 Selected Green Street Pilot Projects

Program	County	No.	Project Name	Owner/ Municipality	Project Location	Project Type (check all that apply)					Project Description	Project Attributes (check all that apply)									Project Status	Project Contact	Estimated Date of Comple-tion	Monitor-ing	Modeling	Project Status
						Arterial	Collector	Local	Parking Lot	Other (*specify*)		Bay-Friendly Landscaping	Stormwater Storage/Use	Stormwater Infiltration	Stormwater Treatment	Enhance Pedestrian and /or bicycle environment	Park-like elements	Connect residential, recreation, schools,	Parking Management	ABAG/MTC- designated Priority Development						
ACCWP	Alameda	1	Park and Hollis Stormwater Curb Extension	Emeryville	Northeast Corner of Park Ave and Hollis Street		X				Planted stormwater curbextension constructed in 2010 as part of new corner plaza area.	X	X			X	X			X	Constructed	Peter Schultze-Allen (Emeryville)	2010	None planned	Yes	Project completed. Pixar Animation Studios responsible, cost information not broken down or available.
ACCWP	Alameda	2	Codornices Creek Restoration Project	Berkeley, Albany, University of California	San Pablo Avenue at 6th Street			X			4 Rain Gardens/Bioretention areas with underdrains with discharge to Codornices Creek	X		X	X	X	X	X			Constructed	Jim Scanlin (ACPWA)	2011	Yes 5-Year Plan	Yes	Maintenance of all the improvements made on Codornices Creek is divided among the three agencies (Albany, Berkeley, and UC Berkeley) through a Memorandum of Understanding (MOU). The bioretention facilities were included in this MOU by an amendment before acceptance of construction.The Creek Project requires 5 years of monitoring.
ACCWP	Alameda	3	Stanley Boulevard Safety and Streetscape Improvement Project	Unincor-porated Alameda County	Stanley Boulevard Safety and Streetscape Improvement Project	X					Improving 3 miles of roadway, incorporating LID to convert industrial corridor to more rural parkway setting.	98		X	X	X	X	X			Contruction Phase	Justin Laurence (ACCWP)	September 2012	None planned	Yes	Construction is currently in progress. The BMPs have not yet begun construction.
CCCWP	Contra Costa	4	El Cerrito Green Streets	El Cerrito	10200 block of San Pablo Avenue (east side) and 11048 San Pablo Avenue	X					2 Rain Gardens (bioretention with underdrains)	X			X	X	X			X	Constructed	Stephen Pree (El Cerrito)	August 2010	Yes Conducted	Yes	The project was completed in August 2010 and completed water quality monitoring through WY 2012.
CCCWP	Contra Costa	5	San Pablo Avenue Greenspine Project	Richmond	12900 block of San Pablo Ave (west side) between McBryde Ave & Andrade Ave	X					5 Bioretention facilities, including infiltration			X		X	X	X			Preliminary Design Phase	Josh Brandt (SFEP)	Fall 2013	Planned	No	The project is currently in the 30% design phase. Design anticipated to be completed by late summer 2013 and construction to begin in late summer/fall 2013.
SMCWPPP	San Mateo	6	Sustainable Streets and Parking Lots Demonstration Project	Burlingame	1227 Donnelly Avenue, between Primose Road and Bellevue Avenue, Assessor Parcel Number 029-152-300			X	X		Rain Garden (bioretention without underdrain) and curb extention	X		X	X						Constructed	Jane Gomery (Burlingame)	January 2011	No	Yes	The project was completed in January 2011.
SMCWPPP	San Mateo	7	Bransten Road Green Street	San Carlos	Bransten Road between Old County Road and Industrial Road			X			Bioretention areas in newly constructed curb extensions				X	X	X		X		100% Design Phase	Ray Chan (San Carlos)	December2014	CW4CB Task 5 Planned	Yes	The project is currently at the 100% design phase phase; construction is anticipated to be completed by the MRP Provision C.3.b.iii due date of December 1, 2014.
SCVURPPP	Santa Clara	8	Packard Foundation Project	Los Altos	343 Second Street, between Whitney and Lyell			X			Flow-through rain gardens in park strip along street and at an intersection; conversion of impervious to pervious area			X	X	X					Constructed	Jill Bicknell (SCVURPPP)	July 2012	None planned	Yes	Construction completed July 2012.
SCVURPPP	Santa Clara	9	Hacienda Avenue Green Street	Campbell	Hacienda Avenue, between South San Tomas Aquino Rd & Winchester Blvd	X					Improving 1 mile of roadway. Adding bike lanes, sidewalk infill, narrowing roadway width to install bioretention swales and bulbouts	X		X		X	X	X	X		Final Design Phase	Fred Ho (Campbell)	Late 2014/early 2015	Yes (water balance only)	Yes	Conceptual designs approved by City Council. Construction to begin in summer 2014.
SCVURPPP	Santa Clara	10	Southgate Neighborhood Green Street	Palo Alto	Various streets centered around Miramonte and Castilleja Avenues			X			Adding bioretention and biofiltration planters and pervious pavement throughout a residential neighborhood	X		X	X	X	X	X			Final Design Phase	Jill Bicknell (SCVURPPP)	Early 2014	None planned	Yes	Design received approval from city architectural review design staff. Construction to begin in fall 2013.

Appendix B.7.A.2. Project Information for All Reported Bay Area Green Street Projects

Pro-gram	County	No.	Project Name	Owner/ Municipality	Project Location	Project Type (check all that apply)					Project Description	Project Attributes (check all that apply)									Project Status	Project Contact	Estimated Date of Comple-tion	WQ Monitor-ing	Modelling	Project Schedule, Funding, and Other Information
						Arterial	Collector	Local	Parking Lot	Other *(specify)*		Bay-Friendly Landscaping	Stormwater Storage/Use	Stormwater Infiltration	Stormwater Treatment	Enhance Pedestrian and /or bicycle environment	Park-like elements	Connect residential, recreation, schools,	Parking Management	ABAG/MTC- designated Priority Development						
ACCWP	Alameda	A1	**Park and Hollis Stormwater Curb Extension**	**Emeryville**	Northeast Corner of Park Ave and Hollis Street		X				Planted stormwater curbextension constructed in 2010 as part of new corner plaza area.	X	X			X	X			X	Constructed	Peter Schultze-Allen (Emeryville)	2010	None planned	Yes	Project completed. Pixar Animation Studios responsible, cost information not broken down or available.
		A2	**Codornices Creek Restoration Project**	**Berkeley, Albany, University of California**	San Pablo Avenue at 6th Street			X			4 Rain Gardens/Bioretention areas with underdrains with discharge to Codornices Creek	X		X	X	X	X	X			Constructed	Jim Scanlin (ACPWA)	2011	Yes 5-Year Plan	Yes	Maintenance is divided among 3 agencies (Albany, Berkeley, and UC Berkeley) through a Memorandum of Understanding (MOU) for entire project. The Creek Project requires 5 years of monitoring.
		A3	**Stanley Boulevard Safety and Streetscape Improvement Project**	**Unincor-porated Alameda County**	Stanley Boulevard Safety and Streetscape Improvement Project	X					Improving 3 miles of roadway, incorporating LID to convert industrial corridor to more rural parkway setting.	98		X	X	X	X	X			Contruction Phase	Justin Laurence (ACCWP)	September 2012	None planned	Yes	Construction is currently in progress. The BMPs have not yet begun construction. State Prop 1B & Local funds (64.3%), CEMEX and Vulcan Materials Companies (34.5%), Bay Area Air Quality Management District – Transportation for Clean Air Grant Funds (0.008%), StopWaste.org Bay Friendly Grant Funds (0.002%)
		A4	**San Pablo Avenue Greenspine Project**	**Albany**	San Pablo Ave & Monroe St, Albany 94706	X					3 Stormwater Curb Extensions and Sidewalk Planters	X			X		X				60% Design Phase	Josh Brandt (SFEP)	Fall 2014	Planned	No	Project is funded from USEPA SF Bay Water Quality Improvement Fund and the State's IRWM program. Construction funded by Caltrans. SFEP administers grants.
		A5	**San Pablo Avenue Greenspine Project**	**Berkeley**	San Pablo Ave & Cordornices Creek, Berkeley 94708	X					5 Stormwater Curb Extensions	X			X		X				60% Design Phase	Josh Brandt (SFEP)	Fall 2014	Planned	No	Project is funded from USEPA SF Bay Water Quality Improvement Fund and the State's IRWM program. Construction funded by Caltrans. SFEP administers grants.
		A6	**San Pablo Avenue Greenspine Project**	**Emeryville**	San Pablo Ave & W MacArthur Blvd, Emeryville 94608	X					3 Rain Gardens	X			X	X	X				60% Design Phase	Josh Brandt (SFEP)	Fall 2014	Planned	No	Project is funded from USEPA SF Bay Water Quality Improvement Fund and the State's IRWM program. Construction funded by Caltrans. SFEP administers grants.
		A7	**San Pablo Avenue Greenspine Project**	**Oakland**	San Pablo Ave & 17th Street, Oakland, 94612	X					Stormwater Planters and Street Trees	X		X	X		X		X		60% Design Phase	Josh Brandt (SFEP)	Fall 2014	Planned	No	Project is funded from USEPA SF Bay Water Quality Improvement Fund and the State's IRWM program. Construction funded by Caltrans. SFEP administers grants.
CCCWP	Contra Costa	CC1	**El Cerrito Green Streets**	**El Cerrito**	10200 block of San Pablo Avenue (east side) and 11048 San Pablo Avenue	X					2 Rain Gardens (bioretention with underdrains)	X			X	X	X			X	Constructed	Stephen Pree (El Cerrito)	August 2010	Yes Conducted	Yes	Funded through a federal ARRA Grant and by the El Cerrito Redevelopment Agency and administered through the State Water Resources Control Board via SFEP.
		CC2	**San Pablo Avenue Greenspine Project**	**El Cerrito**	San Pablo Ave & Stockton Ave; San Pablo Ave & Moeser Ave, El Cerrito 94530; El Cerrito 94530	X					Stormwater Curb Extensions, Rain Gardens, and Sidewalk Planters	X		X	X		X				60% Design Phase	Josh Brandt (SFEP)	Fall 2014	Planned	No	Project is funded from USEPA SF Bay Water Quality Improvement Fund and the State's IRWM program. Construction funded by Caltrans. SFEP administers grants.
		CC3	**San Pablo Avenue Greenspine Project**	**Richmond**	12900 block of San Pablo Ave (west side) between McBryde Ave & Andrade Ave	X					5 Bioretention Facilities, including Infiltration	X		X		X	X	X			60% Design Phase	Josh Brandt (SFEP)	Fall 2014	Planned	No	Project is funded from USEPA SF Bay Water Quality Improvement Fund and the State's IRWM program. Construction funded by Caltrans. SFEP administers grants.
		CC4	**San Pablo Avenue Greenspine Project**	**San Pablo**	13613 San Pablo Ave, San Pablo 94806	X					Stormwater Planters	X					X				60% Design Phase	Josh Brandt (SFEP)	Fall 2014	Planned	No	Project is funded from USEPA SF Bay Water Quality Improvement Fund and the State's IRWM program. Construction funded by Caltrans. SFEP administers grants.
		CC5	**Nevine Avenue Improvements Green Streets**	**Richmond**	Nevin Avenue from 19th St to 27th St			X			Rain gardens (bioretention w/underdrain) curb extensions, permeable pavement			X	X	X	X				100% Design Phase	Lynn Scarpa (Richmond)	March 2014	Planned as part of CW4CB Task 5	No	The project is currently at the 100% design phase phase; construction is anticipated to be completed by the MRP Provision C.3.b.iii due date of December 1, 2014.

Appendix B.7.A.2. Project Information for All Reported Bay Area Green Streets Projects

Program	County	No.	Project Name	Owner/ Municipality	Project Location	Project Type (check all that apply): Arterial	Collector	Local	Parking Lot	Other (*specify*)	Project Description	Project Attributes (check all that apply): Bay-Friendly Landscaping	Stormwater Storage/Use	Stormwater Infiltration	Stormwater Treatment	Enhance Pedestrian and /or bicycle environment	Park-like elements	Connect residential, recreation, schools, streets,	Parking Management	ABAG/MTC- designated Priority Development Area	Project Status	Project Contact	Estimated Date of Completion	WQ Monitoring	Modelling	Project Status
		CC6	**PG&E Substation at 1st & Cutting**	**Richmond**	South 1st Street & Cutting Blvd, Richmond 94804		X				4 Bioretention areas (2 w/underdrains; 2 w/o underdrains)			X	X						100% Design Phase	Lynn Scarpa (Richmond)	October 2013	Planned as part of CW4CB Task 5	No	The project is currently at the 100% design phase phase; construction is anticipated to be completed by the MRP Provision C.3.b.iii due date of December 1, 2014.
SMCW PPP	**San Mateo**	**SM1**	**Sustainable Streets and Parking Lots Demonstration Project**	**Burlingame**	1227 Donnelly Avenue, between Primose Road and Bellevue Avenue, Assessor Parcel Number 029-152-300			X	X		Rain Garden (bioretention without underdrain) and curb extention	X		X	X						Constructed	Jane Gomery (Burlingame)	January 2011	No		Funding for the projects come from a countywide vehicle registration fee under Assembly Bill (AB) 1546, which went into effect on July 1, 2005, and was subsequently extended to 2012 through Senate Bill (SB) 348.
SMCW PPP	**San Mateo**	**SM2**	**Bransten Road Green Street**	**San Carlos**	Bransten Road between Old County Road and Industrial Road			X			Bioretention areas in newly constructed curb extensions				X	X	X		X		100% Design Phase	Ray Chan (San Carlos)	December2014	Planned as part of CW4CB Task 5	Yes	The project is currently at the 100% design phase phase; construction is anticipated to be completed by the MRP Provision C.3.b.iii due date of December 1, 2014.
SCVUR PPP	**Santa Clara**	**SC1**	**Packard Foundation Project**	**Los Altos**	343 Second Street, between Whitney and Lyell			X			Flow-through rain gardens in park strip along street and at an intersection; conversion of impervious to pervious area			X	X	X					Constructed	Jill Bicknell (SCVURPPP)	July 2012	None planned	Yes	Construction completed July 2012. Funding was provided entirely by the David & Lucile Packard Foundation as part of construction of its headquarters office building.
SCVUR PPP	**Santa Clara**	**SC2**	**Hacienda Avenue Green Street**	**Campbell**	Hacienda Avenue, between South San Tomas Aquino Rd & Winchester Blvd	X					Improving 1 mile of roadway. Adding bike lanes, sidewalk infill, narrowing roadway width to install bioretention swales and bulbouts	X		X		X	X	X	X		Final Design Phase	Fred Ho (Campbell)	Late 2014/early 2015	Yes (Water balance only)	Yes	Conceptual designs approved by City Council. Construction to begin in summer 2014. Funding assistance provided by $2 million grant from State's IRWM program (43%) and $0.5 million in Federal funding via Caltrans (11%). City is providing the remainder of the funding (46%).
SCVUR PPP	**Santa Clara**	**SC3**	**Southgate Neighborhood Green Street**	**Palo Alto**	Various streets centered around Castilleja &Miramonte Aveunes			X			Adding bioretention and biofiltration planters and pervious pavement throughout a residential neighborhood	X		X	X	X	X	X			Final Design Phase	Jill Bicknell (SCVURPPP)	Early 2014	None planned	Yes	Design received approval from city architectural review design staff. Construction to begin in fall 2013. The project is being funded entirely by the City of Palo Alto.
SCVUR PPP	**Santa Clara**	**SC4**	**Martha Gardens Green Alleys Pilot Project**	**San Jose**	Alley between Second and Third Street; Virginia and Martha Strret					x	"Green" concrete sloped to permeable pavers draining to below-grade infiltration galleries.			x	x	x					Project Design Phase	Jill Bicknell (SCVURPPP)	Late 2013	Pre and post-project sediment analysis	No	Project was selected for Prop 84 Stormwater Implementation Grant funding.
SCVUR PPP	**Santa Clara**	**SC5**	**Park Avenue: Green Avenue Pilot Project**	**San Jose**	Park Avenue between Meridian Ave. and Sunol St.		x				Bioretention areas constructed at existing curb and at new curb extensions, and permeable paver median.			x	x	x					Preliminary Design Phase	Jill Bicknell (SCVURPPP)	Late 2014	Pre and post project pollutant analysis, flow reduction.	No	Project was selected for Prop 84 Stormwater Implementation Grant funding.

APPENDIX B.7.B

CW4CB Task 5 Pilot Project Status Table

Appendix B.7.B. CW4CB Task 5 Pilot Project Status Table

	Program	No	Project Name	Project Sponsor	Project Contact	Designer	Schedule											Notes
							10% Designer under BASMAA Contract	100% Designer under BASMAA Contract	Project Sponsor under BASMAA Contract	100% Design Finished	Board or City Council Approves Project	Construction Project Out to Bid	Board or City Council Approves Construction Contractor Selection	CEQA and Building Permits	Construction Begins	Construction Ends	Monitoring Year	
Selected Projects	ACWP	1	Ettie St. Pump Station	ACFCWCD	Arleen Feng	WRECO	N/A	7/13?	10/12	9/13	N/A	10/13?	11/13?	N/A	12/13	12/13	Soonest Jan 1, 2014	100% design completed.
Selected Projects	ACWP	2	Alameda and High St HDS Unit	Oakland	Becky Tuden	Oakland	N/A	N/A		12/11	N/A	3/12	5/12	5/12	10/12	12/12	13/14	Construction complete.
Selected Projects	ACWP	3	West Oakland Industrial Area	Oakland	Becky Tuden	WRECO	N/A	3/16/12	5/1/12	10/12	N/A	1/13	4/16/13	Completed Notice of Exemption	9/13	End of 10/13	Soonest Nov 1, 2013	100% design completed. Construction begins 9/25/13.
Selected Projects	CCCWP	4	Nevin Avenue Improvements (Green Streets)	Richmond	Lynn Scarpa	Richmond /BKF	N/A	N/A	5/15/12	4/13	N/A	11/13	12/13	Done	3/14 - 5/14	7/14	**14/15**	100% design completed. Delay due to Caltrans not submitting comments. Monitoring in 2014/15 instead.
Selected Projects	CCCWP	5	PG&E Substation; 1st and Cutting	Richmond	Lynn Scarpa	WRECO	12/23/11	4/9/12	5/15/12	4/13	N/A	11/13	12/13	N/A	3/14 - 5/14	7/14	**14/15**	100% design completed. Delay due to rejection of first round of bid packages. Monitoring in 2014/15 instead.
Selected Projects	CCCWP	6	El Cerrito Green Streets	El Cerrito	Kahlil Abusaba	Construc-ted	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13/14	Construction complete.
Selected Projects	SCVURPPP	7	Leo Avenue HDS System	San Jose	James Downing	San Jose	N/A	N/A	Prior to 5/24/12	1/31/12	N/A	3/22/12	4/6/12	N/A	7/12	10/12	13/14	Construction complete.
Selected Projects	SMCWPPP	8	Bransten Road Curb Extensions	San Carlos	Jon Konnan	WRECO	1/19/12	4/17/12		3/13	4/13	5/13	6/13	Complete Notice of Exemption	9/13	End of 10/13	Soonest Nov 1, 2013	100% design completed. Construction began 9/9/13.
Selected Projects	SC	9	Broadway and Redwood	Vallejo	Sam Kumar	WRECO		2/13/12	6/13	9/13	N/A	10/13	11/13	N/A	12/13	2/14	Soonest April 1, 2014	100% design completed.
Selected Projects	SC	10	PG&E Substation	Vallejo	Sam Kumar	WRECO		2/13/12	6/13	9/13	N/A	10/13	11/13	N/A	12/13	2/14	Soonest April 1, 2014	100% design completed.

Notes:
White – Completed activity
Red – To be completed (Short-term)
Green – To be completed (Long-Term)
Blue – Delayed monitoring year
Bold – Deadline has passed; Need status update

APPENDIX B.7.C

Modeling Methodology

INTEGRATED MONITORING REPORT: SECTION B.7 STORMWATER TREATMENT
APPENDIX B.7.C - MODELING METHODOLOGY

1 Model Overview

A simple spreadsheet model was developed to estimate present and future PCB load reductions for existing and proposed Projects. Existing or proposed Project area, imperviousness, and BMP information were used as site-specific inputs to the model, along with geospatial "Old Industrial" land use information, Bay Area land-use based monitoring data and BMP performance data from the WERF International BMP Database. A summary of the model inputs and potential sources of error is included in the sections below.

2 Model Inputs

2.1 Runoff Calculation

Annual runoff was calculated using the rational method. Two rain gauges were used to calculate annual rainfall depth: Oakland WSO (Station ID # 6335, 1948 – 1986) and San Jose (Station ID # 7821, 1948 – 2001). The Oakland gauge was used for Projects located in Contra Costa and Alameda counties; the San Jose gauge was used for Projects located in Santa Clara and San Mateo counties.

Area and imperviousness is based on project data received by Geosyntec. The runoff coefficient was calculated as 0.9 times the Project imperviousness. This represents a coefficient for roofs from the Santa Clara County C.3 Stormwater Handbook; and also matches LA County and WEF method runoff coefficient values for 100% impervious surfaces.

2.2 Project Land Use

Project land use was assumed to be a mix of Old Urban, New Urban, and Old Industrial land uses to allow for correlation to particle-based PCB concentrations developed by SFEI as part of the Regional Watershed Spreadsheet Model (RWSM) effort (SFEI, 2012). The land use breakdown for each site was based on shapefiles received from EOA on 24 May 2013. The land use information was binary in that it indicated only if a specific land use was in a catchment. Because of this, C.3 Projects, which were included in the "C3 Project locations" (2009-2012) point shapefile (storm_water_treatment_sites_Bay_Area.shp), were assumed to have an equal proportion of each land use listed for each project in the tributary area. Green Streets and CW4CB Task 5 Pilot Projects, which were not included in the C.3 Project locations point shapefile, were assumed to have an equal proportion of all three land uses if they were located within "Old Industrial" land use areas (Bay_Area_Industrial_1968_with_ports.shp); and were assumed to have an equal proportion of Old Urban and New Urban if they were located outside of industrial land use areas. Table 1 shows the assumed proportion of land uses for the C.3 Projects, the Green Streets Pilot Projects, and the CW4CB Task 5 Pilot Projects.

Table 1. Assumed Land Use Breakdown by Project

Project	Assumed Proportion of Land Use Type in Tributary Area		
	Old Industrial	**Old Urban**	**New Urban**
C.3. Projects Modeled			
4040 Campbell	0.33	0.33	0.33
Airgas CP12-0025	0.33	0.33	0.33
ALCO Iron & Metal Co.	0.33	0.33	0.33
Ashby Lumber	0.33	0.33	0.33
Bio-Rad	0.33	0.33	0.33
BRE	0.33	0.33	0.33
Coleman Retail Center (Phase 1 and Phase 2)	0.33	0.33	0.33
Dasco Construction & Drywall	0.33	0.33	0.33
Davis Street Transfer Station / WMI	0.33	0.33	0.33
Dona Spring Animal Shelter	0.33	0.33	0.33
Emerystation Greenway	0.33	0.33	0.33
Extra Space Storage	0.33	0.33	0.33
Fire Prevention Bureau	0.33	0.33	0.33
Fire Station 23	0.33	0.33	0.33
Grocery Outlet	0.33	0.33	0.33
In N Out Burger	0.33	0.33	0.33
Intuitive Surgical Building 103	0.33	0.33	0.33
Lewis & Tibbits	0.33	0.33	0.33
Lowe's	0.33	0.33	0.33
Michael J’s Body Shop	0.33	0.33	0.33
Mil Aspen Associates	0.33	0.33	0.33
Montecito Vista Urban Village -Siena	0.33	0.33	0.33
Mozart Car Museum	0.33	0.33	0.33
Pacific Commons	0.33	0.33	0.33
Palo Alto Medical Foundation	0.33	0.33	0.33
Panasonic	0.33	0.33	0.33
Paragon, PJ3204	0.33	0.33	0.33
Robinson Oil	0.33	0.33	0.33
Stanford Medical	0.33	0.33	0.33
Wente Vineyards	0.33	0.33	0.33
Green Streets Projects Modeled			
Bransten Road Green Street Project	0.33	0.33	0.33
Codornices Creek Restoration Project	0.33	0.33	0.33
El Cerrito Green Streets Project	0.33	0.33	0.33
Green Spine Project		0.50	0.50
Hacienda Avenue Green Streets		0.50	0.50

Project	Assumed Proportion of Land Use Type in Tributary Area		
	Old Industrial	Old Urban	New Urban
Packard Foundation Project		0.50	0.50
Park and Hollis Stormwater Curb Extension	0.33	0.33	0.33
Southgate Neighborhood Green Streets Project		0.50	0.50
Stanley Blvd Safety and Streetscape Improvement Project		0.50	0.50
Sustainable Streets and Parking Lots Demonstration Project		0.50	0.50
IMR Projects Modeled			
Alameda and High St. HDS Unit	0.33	0.33	0.33
Bransten Road Curb Extensions	0.33	0.33	0.33
Broadway and Redwood	0.33	0.33	0.33
El Cerrito Green Streets		0.50	0.50
Ettie St. Pump Station	0.33	0.33	0.33
Leo Avenue HDS System	0.33	0.33	0.33
Nevin Avenue Improvements (Green Streets)		0.50	0.50
PG&E Substation	0.33	0.33	0.33
West Oakland Industrial Area	0.33	0.33	0.33

2.3 Land Use Based Influent Concentrations

Land use based TSS loads were calculated as the product of the land use based area-weighted TSS concentration and the runoff volume (described above). BASMAA monitoring data from the San Francisco Bay Area Stormwater Runoff Monitoring Data Analysis 1988-1995 (BASMAA, 1996) was used to develop land use based TSS concentrations for the three designated land use types (Table2).

Table 2. Land Use Based TSS Concentration Data

Modified TSS Influent Data	
Land Use	**TSS (mg/L)**
Old Urban[1]	92
New Urban[1]	92
Old Industrial	157

[1] Assumed to be the average of BASMAA Residential and Commercial as urban redevelopment projects are typically a mix of these two land uses.

Influent PCB and total mercury (HgT) concentrations and loads were calculated using particle-based concentrations calculated from the RWSM analysis (SFEI, 2012). These particle-based concentrations were multiplied by the TSS concentrations included in Table 2 above to obtain the land-use based PCB and HgT concentrations shown in Table 3.

Table 3. PCB and HgT Particle and Water Concentration Data

Land Use	Particle Concentrations		Resulting Water Concentrations	
	PCBs (µg/kg)	HgT (mg/kg)[1]	PCBs (µg/L)	HgT (µg/L)
Old Urban	150	0.63	0.0138	0.05796
New Urban	0.87	0.16	0.00008004	0.01472
Old Industrial	2800	0.63	0.4396	0.09891

[1] SFEI could not distinguish old industrial from old urban for HgT, so old industrial was assumed to equal old urban in model.

These water concentrations were multiplied by the average annual runoff from the project to obtain influent PCB and HgT loads.

2.4 BMP Performance

The reduction in PCB and HgT load was determined based on the BMPs present in the existing or proposed Projects. For the Green Streets and CW4CB Task 5 Pilot projects, the number and types of BMPs were determined based on Project information that was available at the time of modeling as provided by individual project leads. For the constructed C.3 Regulated Projects, the number and types of BMPs were determined using the information available in Permittees' FY 09/10- FY 11/12 Annual Report Operations & Maintenance Tables. In the case of multiple BMPs per catchment, the individual tributary area for each BMP is assumed to be the total area divided by the number of BMPs.

2.4.1 Capture and Volume Reduction

BMPs were assumed to capture a specified proportion of the influent volume. Eighty percent of average annual runoff for C.3 Projects and 70% of average annual runoff for Green Streets and CW4CB Task 5 Pilot Projects was assumed to be captured in the BMPs. Additionally, for bioretention facilities, bioswales, detention basins, and porous pavement BMPs, 20% of the captured volume was assumed to be infiltrated in the BMP, with the associated pollutant loads removed via infiltration.

2.4.2 Treated Effluent Concentrations

The treated, un-infiltrated volume was assumed to have the effluent concentrations listed in Table 4. Effluent PCB data was calculated to be the combination of effluent TSS concentration and land use based, particle-based PCB concentration. This assumes that the particle-based concentration is the same in the influent and the effluent.

Table 4: BMP Effluent Concentrations and Capture Efficiency

BMP Type	Effluent Concentration (mg/L)	% Capture (C.3 Projects)	% Capture (IRM and Green Streets Projects)	% Infiltration of Captured Volume
Bioretention	17.70	80	70	20
Bioswale	27.00	80	70	20
HDS Units	--[1]	80	70	0
Media Filter	22.4	80	70	0
Detention Basin	42.3	80	70	20

Green Roof	10.5	80	70	0
Porous Pavement	29.4	80	70	20

[1] HDS units were not assumed to reduce TSS (and therefore PCBs and HgT) loads as the International BMP database does not demonstrate significant difference between influent and effluent TSS.

2.4.3 Discharged Load

The discharged load was calculated as the sum of the BMP effluent load, determined as described above, and the bypass load, calculated as the influent concentration times the proportion of the average annual runoff volume which is not treated by the BMP. The difference between the discharged load and the inflow load is assumed to represent the total load reduction.

APPENDIX B.9.A

Pilot Stormwater Diversion Project Summary Table and Schedules

Appendix B.9.A. Pilot Stormwater Diversion Project Summmary Table and Schedules

Project Name & Location	Project Objectives	Catchment Size (acres)	Primary Land Uses	Diversion Type				Expected Diversion Flow (gpm)		Monitoring		Tasks	2012				2013				2014			
				Gravity	Pumped	Contin.	Batch	Wet weather	Dry weather	Pollutants	Other		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Alameda	1. Evaluate load reductions	1000	residential		X		X	25 max	25 max	Mercury, PCBs	SSC, DOC (potential),	1. Pre-project wet and/or dry season monitoring and analysis		■	■									
Ettie St. Pump Station	2. Pilot turbidity trigger for diversion		industrial mix								particle size, turbidity (forebay),	2. Detailed planning and work plan development	■	■										
City of Oakland	3. Establish particle size-POC concentration relationships		commercial								station pumping volume,	3. Equipment installation/construction and implementation	■	■	■			■						
	4. Project cost/benefits and challenges of larger-scale project scenarios										pretreatment volume,	3.a Large scale scenario development				■	■	■	■					
	5. Coordinate with pilot retrofit to leverage data collection										diversion volume, rainfall	4. Post installation/construction monitoring and analysis			■	■	■	■		■	■			
												5. Data analysis and interpretation and project reporting			■	■		■	■	■	■			
Contra Costa North Richmond Pump Station	1. Evaluate PCB and mercury loads avoided through pump station maintenance conducted in conjunction with diversion to a POTW.	339			X	TBD	TBD	TBD	TBD	PCBs, mercury, metals	Mass sediment removed	1. Pre-project wet and/or dry season monitoring and analysis	■											
												2. Detailed planning and work plan development		■	■	■	■	■						
City of Richmond												3. Equipment installation/construction and implementation							■	■				
	2. Design a diversion pilot project that can be permitted for discharge to West County Wastewater District		Mixed residential, light industrial; formerly used for nurseries									4. Post installation/construction monitoring and analysis									■			
	3. Evaluate operating techniques that can treat first flush without adversely impacting POTW capacity											5. Data analysis and interpretation and project reporting										■		

Project Name & Location	Project Objectives	Catchment Size (acres)	Primary Land Uses	Diversion Type				Expected Diversion Flow (gpm)		Monitoring		Tasks	2012				2013				2014			
				Gravity	Pumped	Contin.	Batch	Wet weather	Dry weather	Pollutants	Other		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Fairfield/Suisun	1. Evaluate pollutant loads to the Bay that are reduced due to stormwater diversion.	6	Commercial				**X**	NA	10000 gallons	Mercury, PCBs	SSC	1. Pre-project wet and/or dry season monitoring and analysis	■											
State Street Pump Station	2. Estimate projected benefits, challenges and costs of operating a similar diversion in a similar drainage area and/or an area known to have elevated concentrations of PCBs or mercury.											2. Detailed planning and work plan development	■	■										
	3. Document the knowledge and experience gained from evaluation of the diversion project.											3. Equipment installation/construction and implementation			■									
												4. Post installation/construction monitoring and analysis			■	■	■	■	■					
												5. Data analysis and interpretation and project reporting						■	■	■				
San Mateo	1. Characterize PCB and Hg concentrations in dry & wet weather flows into the pump station and establish relationships as feasible among turbidity, SSC, and pollutant concentrations.	330	Industrial		**X**		**X**	25 max	25 max	Mercury, PCBs	SSC, TOC, particle size, turbidity	1. Pre-project wet and/or dry season monitoring and analysis	NA											
Pulgas Creek Pump Station	2. Pilot-test the practicability of using a turbidity threshold trigger to selectively divert flows with elevated turbidity and associated particle-bound pollutants and thereby optimize pollutant loads diverted.										diversion and stormwater runoff volumes, rainfall	2. Detailed planning and work plan development	■	■										